Carroll County
225 North Center St. • Westminster, MD 21157

Carroll County Alternatives Evaluation

September 28, 2009

6531-001

MALCOLM PIRNIE

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Acronyms Used in the Report

BLI	Buildable Land Inventory
DGA	Designated Growth Area
DNR	Department of Natural Resources
GIS	Geographical Information System
HUC	hydrologic unit code
LUD	Land Use Designation
MDE	Maryland Department of the Environment
MDP	Maryland Department of Planning
SSA	sewer service area
WRE	Water Resources Element
WSA	water service area
WWTP	wastewater treatment plant

Units Used in the Report

gpd	gallons per day
mgd	million gallons per day

1. Introduction

Carroll County and its municipalities are in the process of evaluating their water resources through the 2006 state mandated Water Resource Element (WRE). The WRE will be an important part of a jurisdiction's comprehensive plan and is meant to assess the adequacy of present and future water supply, wastewater infrastructure, stormwater runoff and impacts to water resources. A water balance of water resources in Carroll County was performed by Malcolm Pirnie, Inc., based on existing and future buildout conditions (results presented in the Carroll County Water Demands and Availability report completed in July 2009)[1]. The results of the water balance were utilized as part of the alternatives evaluation, which is presented in this report. The County recognizes that the alternatives/options developed as part of the alternatives evaluation go beyond the actual requirements of what needs to be included in the WRE. The County and its municipalities will use these to include general strategies in the WRE plan document, but the next steps will provide guidance for implementing these alternatives.

1.1. Purpose

The purpose of the alternatives evaluation is to identify the future demands by locality and at the County-level, along with the potential water supply and wastewater reuse alternatives that may be available to satisfy the needs of the localities and County. This report describes the local and County-wide needs, the potential water supply and wastewater reuse alternatives that were evaluated, the criteria used for this evaluation, and the results of the alternatives evaluation.

1.2. Limitations

The information presented in this report for the numerous alternatives was derived from Malcolm Pirnie's work along with previous reports and studies and conversations with local water system contacts. Where applicable, assumptions have been made with regards to pipeline routes and locations of other associated facilities. The information presented for the water supply and wastewater reuse alternatives is at the conceptual level, so additional steps must be followed if any of the alternatives are to be implemented in the future.

2. Statement of Needs

2.1. Methodology

The water resources of Carroll County were evaluated using a water balance approach to estimate existing and future water demands and availability, as documented in the Carroll County Water Demands and Availability Report (July 30, 2009). As part of this evaluation, the future water supply needs by locality and County-wide were calculated using the current water supply appropriations for each service area and the projected priority plus future service area average day demands.

2.2. Existing Water Supply Sources

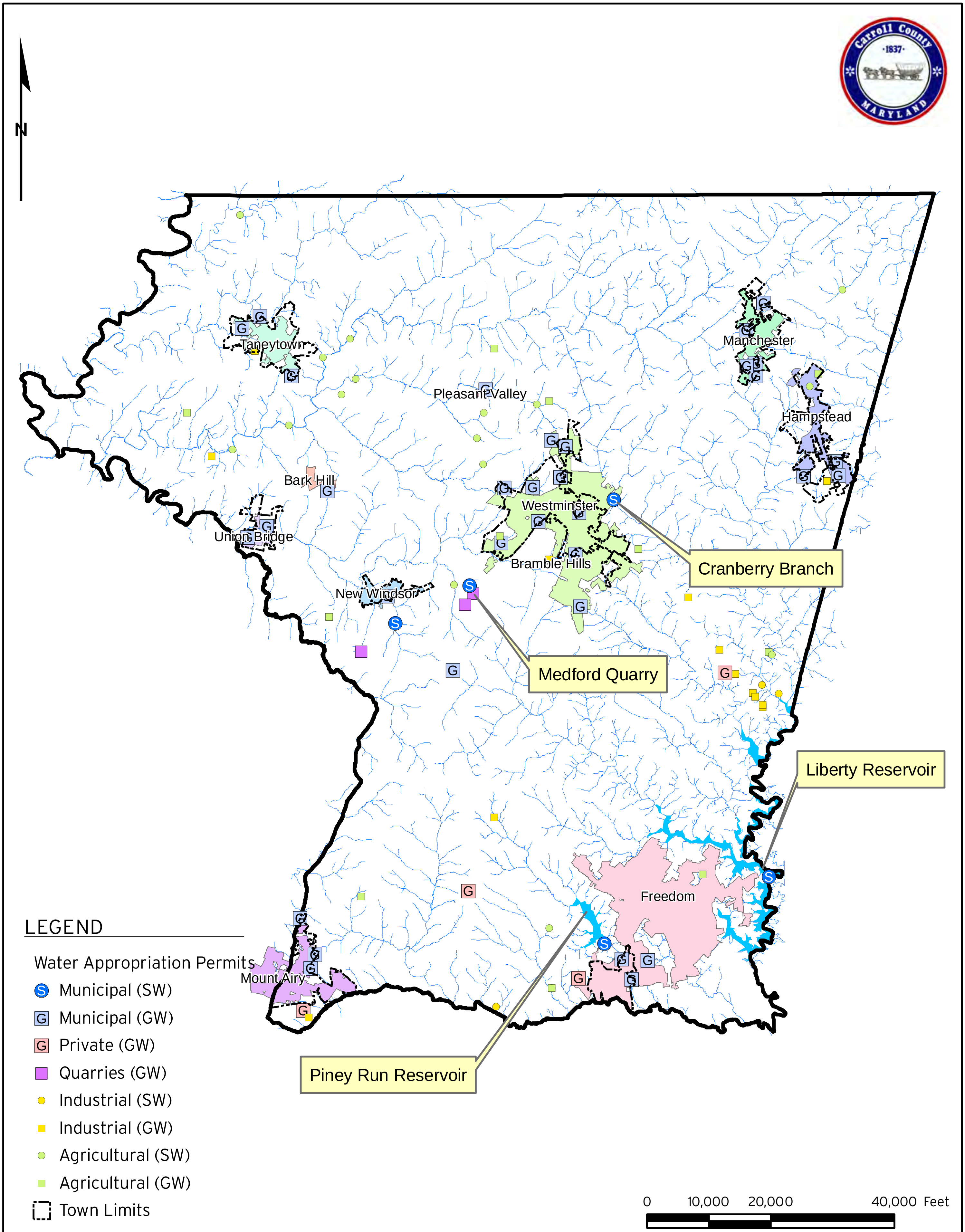
Carroll County municipal water supply sources include groundwater wells, surface water sources and quarries. The locations of existing municipal water supply appropriation permits are shown on Figure 2-1.

2.3. Local Water Needs by Water Service Area

An assessment of future water demands was included in the July 2009 Carroll County Water Demands and Availability[1]. Projected demands for buildout to the Future Service Area (FSA) boundaries for each of the service areas in the County were projected as part of the analyses associated with the report and were included in Appendix B of the report[1]. Probable additional future demands were calculated based on the difference between these projected demands for buildout to the FSA boundaries and the total current average day water appropriation for each water service area (Table 2-1). The total projected additional water requirement for the County and municipal water service areas is approximately 4.0 MGD.

2.4. Relationship Between Water Balance and Wastewater Limitations

An assessment of future wastewater limitations was included in the May 2009 Carroll County Wastewater Limitations report. Projected discharges for buildout to the Designated Growth Area (DGA) boundaries for each of the service areas in the County were projected as part of the analyses associated with the report. The total projected additional wastewater treatment capacity beyond planned design capacities is 3.9 mgd on a net County-wide basis, or 4.7 mgd if Westminster's projected 0.8 mgd surplus capacity is ignored (Table 2-2).



MALCOLM PIRNIE

CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Existing Water Appropriations Location Map

Aug 2009

Figure 2-1

Table 2-1:
Summary of Water Demand by Growth Area

	DEMANDS					
	❶ Groundwater Only	❷	❸ EXISTING CONDITIONS	❹	❺ BUILDOUT	❻
Growth Area	Current Total Permitted Average Day Withdrawals [gpd]	Estimated 2007 Average Day Withdrawals [gpd]	Current Total Permitted Average Day Withdrawals [gpd]	Estimated 2007 Average Day Withdrawals [gpd]	Projected Priority + Future Service Area Average Day Demands [gpd]	Probable Maximum Additional Water Requirement [gpd]
Freedom	*438,000*	*129,210*	*4,638,000°*	*2,316,268*	*3,182,178*	*-1,456,000*
Hampstead	*580,000*	*459,649*	*580,000*	*459,649*	*1,107,988*	*528,000*
Manchester	*571,700*	*300,826*	*571,700*	*300,826*	*425,139*	*-147,000•*
Mount Airy ••	*895,000*	*757,000*	*895,000*	*757,000*	*1,258,770*	*364,000*
New Windsor	*196,000*	*104,181*	*196,100*	*104,181*	*394,356*	*198,000*
Taneytown	*583,000*	*508,819*	*583,000*	*508,819*	*1,746,686*	*1,164,000*
Union Bridge	*208,300*	*152,164*	*208,300*	*152,164*	*802,515*	*594,000*
Westminster	*1,976,000*	*1,350,418*	*4,115,000*	*3,218,703*	*4,394,904*	*1,176,000†*
Total WSAs	**5,213,000**	**3,762,267**	**11,787,100**	**7,817,610**	**13,312,535**	**4,024,000**

Notes:

❶ current groundwater appropriations for each WSA based on 2008 MDE data
❷ estimated 2007 groundwater usage from MDE data
❸ current total water appropriations for each WSA based on 2008 MDE data
❹ estimated 2007 total water usage from MDE data
❺ Projected priority + future service area demands average day demands based on Water Balance Assessment Tool Analysis of Current Plan
❻ Projected maximum groundwater requirement (if future demands were met by first using up existing appropriations and all subsequent appropriations were met using new appropriations) (❻=❺-❸) (rounded to the nearest 1,000 gpd)
• If Manchester's existing well capacities continue to produce less water than what is currently appropriated, Manchester could experience an infrastructure deficit of approximately 124,000 gpd under Buildout conditions (❺-❷=124,000 gpd)
•• Mount Airy permitted (❶) and estimated 2007 withdrawal (❷) values are based on personal communications [Dinne, 7/2/09]
† Assumed existing withdrawals in Westminster are equal to actual yield because existing wells are known to have significantly lower yields than the permitted amount (❻=❺-❹)
° Permitted withdrawals for Freedom include 4.2 mgd for Liberty reservoir, and 0.438 mgd for groundwater wells, but do not include the existing permit for Piney Run due to the absence of treatment facilities or the Springfield Hospital wells

Table 2-2:
Summary of Wastewater Capacity Needs by Growth Area

Wastewater Service Area	WASTEWATER*							
	Reported 2008 Average Day Discharge	Existing + S1 Average Day Discharge	Priority + Future Average Day Discharge	DGA Buildout Average Day Discharge	Existing Design Capacity	Planned Design Capacity	Priority + Future Area Surplus	DGA Buildout Area Surplus
Freedom	2,080,000	2,654,123	3,731,253	5,394,643	3,500,000	3,500,000	-231,253	-1,894,643
Hampstead	580,000	666,856	925,867	1,552,837	900,000	900,000	-25,867	-652,837
Manchester	430,000	373,039	467,289	837,809	500,000	500,000	32,711	-337,809
Mount Airy	667,000	1,007,730	1,397,900	1,398,900	1,200,000	1,200,000	-197,900	-198,900
New Windsor	60,000	69,666	301,666	305,466	94,000	115,000	-186,666	-190,466
Taneytown	830,000	922,253	1,743,703	1,744,453	1,100,000	1,100,000	-643,703	-644,453
Union Bridge	140,000	279,867	889,507	927,997	200,000	200,000	-689,507	-727,997
Westminster	4,440,000	4,827,295	5,032,065	5,705,905	5,000,000	6,500,000	1,467,935	794,095
Total Service Areas	**9,227,000**	**10,800,829**	**14,489,250**	**17,868,010**	**12,494,000**	**14,015,000**	**-474,250**	**-3,853,010**

Notes
- all numbers in gallons per day
* estimates based on results of May 2009 Carroll County Wastewater Limitations report

3. Water Supply Alternatives and Evaluation

A brief discussion of the criteria that were used in the evaluation of water supply options, along with a brief discussion of each water supply alternative is presented below. Results of the evaluation are presented in Section 5.

3.1. Source of Information

Information pertaining to the alternatives was derived from a number of sources, including previously published studies and reports, conversations with water service area contacts for each locality (see Appendix A), and new analysis conducted by Malcolm Pirnie.

Cost information for the Gillis Falls, Union Mills and Piney Run Reservoir alternatives was prepared by Schnabel Engineering working in conjunction with Malcolm Pirnie to define and evaluate reservoir options (included in Appendix B).

3.2. Alternatives Evaluation Criteria

The alternatives were evaluated against several criteria, which are grouped into the following categories:

- Water Supply Benefits
- Environmental Impacts
- Implementability
- Relative Cost Estimate

3.2.1. Water Supply Benefits

The Water Supply Benefits of each alternative were evaluated based on the following categories:

- Safe Yield – the more favorable alternatives under this category are those that either meet or exceed the water supply needs of the localities likely to be served by an alternative. The less favorable alternatives are those that do not meet the long-term needs of the localities.

- Improved Reliability – the more favorable alternatives under this category are considered more resilient to drought and future regulatory trends, while the less favorable alternatives are those sources such as groundwater supplies that may be more susceptible to procedural changes in how appropriations are made by the State. In general, a more diverse mix of water supply sources should improve overall water supply reliability for the County. Likewise, water sources that are under more direct control of the County and towns (as opposed to purchase agreements with communities outside the County) would generally be considered more reliable for the long-term.

3.2.2. Environmental Impacts

The Environmental Impacts of each alternative were evaluated based on the following categories listed below. In general, the more favorable alternatives with respect to environmental impacts are those that have a relatively small project footprint, which minimizes the impact to local residents, habitat and wildlife.

- Surface Water Impacts – the more favorable alternatives under this category are those that do not have negative environmental impacts on streams or other surface waters, while those that rank less favorable are the alternatives that have the potential to cause negative habitat impacts.

- Groundwater Impacts – the more favorable alternatives under this category are those that have no impact on the quality or quantity of groundwater in the region. The less favorable alternatives under this category are those that have the potential to negatively affect the groundwater quality or quantity in the region.

- Wetland and Stream Impacts – the more favorable alternatives under this category are those that have no negative effects on wetlands or streams as a result of project implementation. The less favorable alternatives are those that have the potential to negatively affect wetlands or streams, such as reservoirs, which require stream and wetland inundation in order to construct.

- Impacts to Current Land Use – the more favorable alternatives under this category are those that have minimal impacts to the current land or source use. The less favorable alternatives under this category are those that have the potential to create significant impacts to the current land use.

- Infrastructure Impacts – the more favorable alternatives under this category are those that have minimal impacts to roads and other infrastructure. The less favorable alternatives under this category are those that have significant impacts to roads and other infrastructure, such as projects that require the relocation of a road.

- Cultural and Historic Impacts – the more favorable alternatives under this category are those that have no impacts to cultural or historic sites. The less favorable alternatives under this category are those that have the potential to cause negative impacts to cultural and historic sites. It should be noted that most of the alternatives evaluated are still in the conceptual phase, therefore, no new studies have been performed to evaluate cultural or historic impacts.

3.2.3. Implementability

The implementability of each alternative was evaluated from the standpoint of potential opposition from environmental advocacy organizations or other special interest groups, potential permitting complexities that could result in lengthy timeframes for regulatory approval, or other legal or institutional challenges that an alternative may face, such as local political opposition.

3.2.4. Relative Cost Estimate

Based on available cost information from prior studies for the County and towns, as well as new cost estimates prepared by Malcolm Pirnie and Schnabel Engineering, alternatives were evaluated based on the Unit Capital Cost of the project ($/gallon). The more favorable alternatives under this category are those with lower capital cost per gallon as compared to other alternatives. The less favorable alternatives under this category are those with the highest capital costs per gallon as compared to the other alternatives.

It was possible to be more specific in terms of identifying potential footprint locations for surface water options than for groundwater alternatives where specific well locations have not been fully defined and more assumptions had to be made.

3.3. Description of Alternatives

Water supply alternatives have been developed and evaluated in this effort. These alternatives are broken down by alternative type (Reservoir, Stream/River Intake, Quarry, Interconnection, Groundwater and Demand Management). The alternatives are delineated in the following sections, with summarized highlights of each.

For each of the potential water supply alternatives, the following information has been included in the evaluation:

1. Fact Sheet – containing a project description, key implementation steps, and a project vicinity map.

2. Location Map – containing a more detailed map showing the location of the alternative and associated facilities.

3. Evaluation Matrix – containing the criteria scores as assigned by Malcolm Pirnie across all of the water supply alternatives. The individual scoring matrices for each alternative are presented in Appendix D. A summary matrix of criteria scores is presented in Section 5.

For Demand Management, a table listing various existing practices by the County and towns is presented.

Figures 3-1 and 3-2 show the County-wide locations of surface water supply options and groundwater supply options, respectively. Table 3-1 summarizes the communities that would be served by each alternative.

3.3.1. Reservoir Alternatives

In developing concepts for the Gillis Falls, Piney Run and Union Mills reservoir alternatives, monthly timestep water balance analyses specific to the drainage areas at each reservoir site were completed by Malcolm Pirnie. Streamflow data used in these analyses were obtained for USGS gages 01586000 (North Branch Patapsco River at Cedarhurst, MD) and 01639500 (Big Pipe Creek at Bruceville, MD). This work was conducted to estimate potential safe yield benefits during drought of record conditions. These water balance analyses take into account updated reservoir dimensions, natural inflow via runoff, net evaporation estimates specific to each month of the simulated record, minimum release assumptions, and minimum storage reserve assumptions (i.e., dead storage). Table 3-2 includes pertinent characteristics of the Gillis Falls, Piney Run and Union Mills reservoir alternatives and indicates whether the information was developed by Malcolm Pirnie or is based on prior studies conducted for the County.

In addition to the safe yield analyses, Malcolm Pirnie worked closely with its subcontractor Schnabel Engineering to produce a Preliminary Evaluation of Reservoir Alternatives which is included in Appendix B. This report describes the basis for the design concepts and estimated costs developed for the reservoir alternatives.

Alternative R-1a: Gillis Falls Reservoir (Proposed)

- Reservoir to serve as regional source of supply for Mount Airy and Sykesville/Freedom Service Areas.
- Safe Yield: 3.85 mgd with Normal Pool Elevation of 610 ft.

Alternative R-1b: Gillis Falls Reservoir (Expanded)

- Reservoir to serve as regional source of supply for Mount Airy and Sykesville/Freedom Service Areas.
- Safe Yield: 5.0 mgd with Normal Pool Elevation of 630 ft

Alternative R-2: Piney Run Reservoir – Use as a Water Resource

- Existing reservoir to be utilized as a water supply source for Mount Airy and the Sykesville/Freedom Water Service Areas.
- Safe Yield: 3.65 mgd with a Normal Pool Elevation of 524 feet

Alternative R-3: Expansion of Piney Run Reservoir

- Increase capacity of the existing reservoir to be utilized as a water supply source for Mount Airy and the Sykesville/Freedom Water Service Areas. Capacity increased by raising the spillway riser and emergency spillway.
- Raise the normal pool elevation by 4 feet, which increases the Safe Yield to 4.11 mgd (0.46 mgd increase from existing safe yield of Piney Run Reservoir).

Alternative R-4a: Union Mills Reservoir (Proposed)

- Regional reservoir planned to supplement Westminster, Hampstead, Taneytown and Manchester Water Service Areas.
- Safe Yield: 3.76 mgd with Normal Pool Elevation of 610 feet.

Alternative R-4b: Union Mills Reservoir (Expanded)

- Regional reservoir planned to supplement Westminster, Hampstead, Taneytown and Manchester Water Service Areas.
- Safe Yield: 7.93 mgd with Normal Pool Elevation of 630 feet.

Alternative R-5: Increase Capacity of Cranberry Reservoir

- Existing 115 MG raw water reservoir serves as terminal reservoir in Westminster system, which supplies raw water to the Cranberry WTP.

- Potential Expansion Options:
  - Expand horizontally through purchase of additional land (60 MG increase)
  - Expand vertically through raising dam one foot (~8 MG increase)

Alternative R-6: Prettyboy Reservoir

- Baltimore's plans to develop 120 mgd treatment plant for its Susquehanna River intake could significantly increase the reliability of Baltimore's system, so purchase of excess capacity from Prettyboy Reservoir may be practicable.
- Conceptual plans for a 3.0 mgd intake and a 7.5-mile long, 16-inch raw water pipeline from Prettyboy Reservoir to a new 3.0 mgd WTP in Hampstead. Also requires a high service pump station located at the intake site.

3.3.2. Stream/River Intake Alternatives

Information on Alternative S-1 was obtained from Hazen and Sawyer's Water Supply Alternatives Study for the Town of Mount Airy (April 2006 report and April 2007 addendum)[2].

The current MDE approach to permitting new surface water withdrawals is to require significant minimum flowby amounts. Consequently, in order for a stream intake project to be dependable even under drought conditions (i.e., when natural flows decline below desired minimum flows), additional storage is needed for such periods. Therefore, in developing concepts for stream intake options S-2, S-3 and S-4, daily timestep water balance analyses specific to the drainage areas at each intake site were completed by Malcolm Pirnie. Streamflow data used in these analyses were obtained for USGS gage 01639500 (Big Pipe Creek at Bruceville, MD). This work was conducted to estimate potential raw water pumped storage volume required to secure the desired safe yield during drought of record conditions.

These water balance analyses were simplified in that natural inflow via runoff, net evaporation, seepage losses and minimum releases were not considered. Instead, the storage change term (daily change in storage volume) was assumed to dominate the water balance for a small impoundment. Using these water balance analyses, the desired safe yield was set and then the optimum stream pump station capacity and required storage was estimated, assuming that a minimum 20% storage reserve would be retained in worst simulated drought periods. Based on recent input from MDE, the Maryland Most Common Flow Method (May-October and November-April averaging periods) was used to define minimum instream flow levels below which no stream withdrawals would be allowed to meet demand or refill raw water storage. Table 3-3 includes pertinent characteristics of stream intake sites for alternatives S-2, S-3 and S-4.

Alternative S-1: New Surface Water Intake in Gillis Falls Area

- Develop new surface water intake on Carroll County-owned property near the proposed Gillis Falls Reservoir.
- Safe Yield: 0.85 mgd with a 100-120 MG off-stream storage impoundment

Alternative S-2: New Intake on Big Pipe Creek in Union Mills Area

- Develop new surface water intake on Big Pipe Creek in the vicinity of the proposed Union Mills Reservoir dam area to supply water to Westminster.
- Safe Yield: 0.70 mgd yield achieved with a 4.0 mgd intake and a 280 MG storage impoundment.

Alternative S-3: New Intake on Little Pipe Creek for Westminster

- Develop new surface water intake on Little Pipe Creek as an additional short-term supply option for Westminster.
- Safe Yield: 0.5 mgd yield achieved with a 1.3 mgd intake and a 260 MG storage impoundment. Also potential to use Hyde's Quarry as a backup supply to be used when stream flows in Little Pipe Creek are below minimum in-stream flows.

Alternative S-4: New Intake on Big Pipe Creek for Taneytown

- Develop new surface water intake on Big Pipe Creek as an additional short-term supply option for Taneytown.
- Safe Yield: 0.4 mgd yield achieved with a 2.0 mgd intake and a 125 MG storage impoundment.

3.3.3. Quarry Alternatives

Alternative Q-1: Hyde's Quarry – New Raw Water Reservoir

- Construct a raw water line to Westminster's Service Area for additional supply. Hyde's Quarry could also be used solely as a backup supply for the proposed Little Pipe Creek Intake (see Alternative S-3).
- Approximate yield of 0.5 mgd needed to serve as backup supply for Little Pipe Creek Intake.

Alternative Q-2: Lehigh Quarry – Union Bridge

- Use of Lehigh Quarry in Union Bridge as a raw water reservoir to supply approximately 0.6 mgd to Union Bridge.
- Due to contamination concerns, this option is more feasible when quarry operations cease.

Alternative Q-3: Lehigh Quarry – New Windsor

- Use of Lehigh Quarry near New Windsor as a raw water reservoir to supply approximately 0.25 mgd to New Windsor.
- Preferred method of transferring water to the WTP is via a release to the nearby stream, and subsequent withdrawal at the treatment plant.

Alternative Q-4: Medford Quarry – Use as a Permanent Water Supply

- Convert Westminster's current "Emergency Only" appropriations permit for the Medford Quarry to a permanent normal use appropriations permit.
- Previous dewatering records indicate that the average available groundwater is approximately 139,000 gpd, which may be the yield that can be expected to be appropriated if the permit is converted to normal use.

3.3.4. Interconnection Alternatives

Alternative I-1: Mount Airy Interconnection with Frederick County

- Interconnection with the Frederick County water system and purchase agreement to supply 0.85 mgd (with a maximum agreement of 1.2 mgd).

Alternative I-2: Interconnection with York Water Company

- Interconnection with the York Water Company to provide approximately 0.90 mgd of finished water to Manchester and Hampstead. Requires a purchase agreement between all parties.

Alternative I-3: Freedom to Supply Mount Airy Using Existing Sources

- Sykesville/Freedom to supply Mount Airy using projected 1.09 mgd surplus from existing water supply sources.
- Conceptual plans for a 9.7-mile long transmission main between the Sykesville/Freedom Service Area and the Mount Airy Service Area.

3.3.5. Groundwater Alternatives

Groundwater alternatives were developed for six service areas (Hampstead, Mount Airy, New Windsor, Taneytown, Union Bridge, and Westminster) that have projected demands above their existing appropriations (Figure 3-2). A groundwater alternative was also developed for the Manchester service area to satisfy potential demands resulting from actual groundwater capacity being less than the currently appropriated supply. Finally, a separate groundwater alternative was developed for the Union Mills Reservoir area, utilizing County-owned land to supply the Westminster service area with additional water. Fact sheets for each of these alternatives (excluding the Manchester groundwater alternative) are presented at the end of Section 3. The analyses supporting these alternatives were based on the current criteria for obtaining an MDE groundwater appropriation permit:

1) demonstrated demand,
2) available groundwater recharge,
3) well yield, and
4) no adverse impact to nearby wells.

Typically, the most restrictive of the above criteria, on a case-by-case basis, controls the permitting of groundwater appropriations in Maryland.

Probable future additional demand requirements for the County's service areas total approximately 4.0 MGD and are discussed in Section 2.2 above.

Available groundwater recharge for each water service area was determined according to MDE methods[3]. MDE's method of determining groundwater recharge available for appropriation is based on lands that are owned or controlled by the permittee on a watershed-by-watershed basis, with basins greater than two square miles being protected, using the following steps:

1. The 1-in-10 year drought recharge rate is applied to the areas owned or controlled the permittee,
2. Losses due to impermeable surfaces are deducted from the effective recharge rate,
3. The calculated 7Q10 stream flow is subtracted from the effective recharge rate to provide additional protection for baseflow,
4. Withdrawals are assumed to be equally distributed throughout the watershed,

5. Half of the appropriated water usage is assumed to involve consumptive uses (such as municipal supplies and golf courses), while the other half is assumed to involve non-consumptive uses (such as subdivisions on individual wells and septic systems).

Exemptions to the above methodology have been made for previously existing well, quarries and mines, and where public health is an issue. Water budgets for each water service area are presented in Appendix C and summarized in Table 3-4. The amount of additional land that each water service area would likely need to own or control in order to have sufficient recharge area for the projected additional demands was estimated using the average recharge rate for each water service area. Four of the six water service areas are likely to require ownership/control of a total of approximately 5,180 acres of additional recharge areas in order to obtain appropriations meeting the projected demand shortfall. It may be possible that some of the County-owned lands could be credited to the water service areas as recharge areas provided they are in the same watershed as proposed appropriation(s).

Likely well yields in the vicinity of each water service area were estimated based on an analysis of typical hydrogeologic parameter values determined in previously reported field investigations[4]. Field test derived values of the specific capacity of municipal wells in each water service area were multiplied by the saturated depth to the top of the water bearing zone of the well to determine the maximum acceptable pumping rate in an average well in each service area. The maximum pumping rate was reduced by a factor of safety of 10% to provide a more conservative yield estimate for each well. This method of estimating likely yield was applied over the median, minimum, and maximum values of wells in each water service area to determine both a likely well yield and the anticipated range of values for productive wells in the vicinity of each water service area. Well yields determined using this method were compared to the average appropriation permitted by MDE per municipal groundwater well by service area. The average per well MDE groundwater appropriation was typically lower and therefore more restrictive than the median of the field tested values. In order to be conservative, the average MDE appropriation values were used as the basis for evaluating individual groundwater alternatives. The results of the analysis are presented in Appendix C and summarized in Table 3-4.

Impacts to nearby wells are difficult to predict in the fractured rock area of Maryland without direct field investigations. For the purpose of this evaluation, it was assumed that any wells for which the County or municipalities would seek to obtain a groundwater appropriation permit would be situated such that they are not hydraulically connected to a significant extent or that they are located at a sufficient distance to minimize impacts to nearby wells. Therefore, only the first three MDE groundwater appropriation criteria were directly evaluated.

Key groundwater implementation steps as well as concise descriptions of the groundwater alternatives are presented below. Based on prior experience, these implementation steps would take a significant amount of time to complete.

1. Obtain control over sufficient acreage in the appropriate watershed(s) to meet the MDE required recharge rate.

2. Begin MDE water appropriation permitting process

3. Acquire ownership or easement of well site(s)obtain control over sufficient acreage in the appropriate watershed(s) to meet the MDE required recharge rate.

4. Drill and develop well site(s)

5. Conduct pumping test(s) and source water quality analyses

6. Finalize MDE water appropriation permit process

7. Install permanent wellhead(s) and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

Alternative G-1: Hampstead Groundwater Wells

- Drill and develop 20 groundwater wells (based on the average MDE appropriation of existing Hampstead wells) to meet projected additional demand requirements of approximately 528,000 gpd.

Alternative G-2: Mount Airy Groundwater Wells

- Drill and develop 5 groundwater wells (based on the average MDE appropriation of existing Mount Airy wells) to meet projected additional demand requirements of approximately 364,000 gpd.

Alternative G-3: New Windsor Groundwater Wells

- Drill and develop 3 groundwater wells (based on the average MDE appropriation of existing New Windsor wells) to meet projected additional demand requirements of approximately 198,000 gpd.

Alternative G-4: Taneytown Groundwater Wells

- Drill and develop 16 groundwater wells (based on the average MDE appropriation of existing Taneytown wells) to meet projected additional demand requirements of approximately 1,164,000 gpd.

- Additional sites will likely need to be identified to complete this alternative

Alternative G-5: Union Bridge Groundwater Wells

- Drill and develop 6 groundwater wells (based on the average MDE appropriation of existing Union Bridge wells) to meet projected additional demand requirements of approximately 594,000 gpd.

Alternative G-6: Westminster Groundwater Wells

- Drill and develop 9 groundwater wells (based on the average MDE appropriation of existing Westminster wells) to meet projected additional demand requirements of approximately 1,176,000 gpd.

Alternative G-7: Union Mills Area Wells

- Drill and develop 10 groundwater wells (based on the average MDE appropriation for existing Manchester and Westminster wells) on existing County-owned property in the proposed Union Mills Reservoir area to meet a portion of the projected additional demand requirements for Westminster.

- Construction of new 5-mile long raw water transmission main to pump groundwater to Cranberry Reservoir for treatment at the Cranberry WTP. Pipeline to be sized for Union Mills Reservoir (Alternative R-4a).

Alternative G-8: Manchester Wells

- Drill and develop 6 groundwater wells to meet potential appropriated water demand deficit of approximately 124,000 gpd (Build-out Demand less 2007 Average Day Withdrawals).

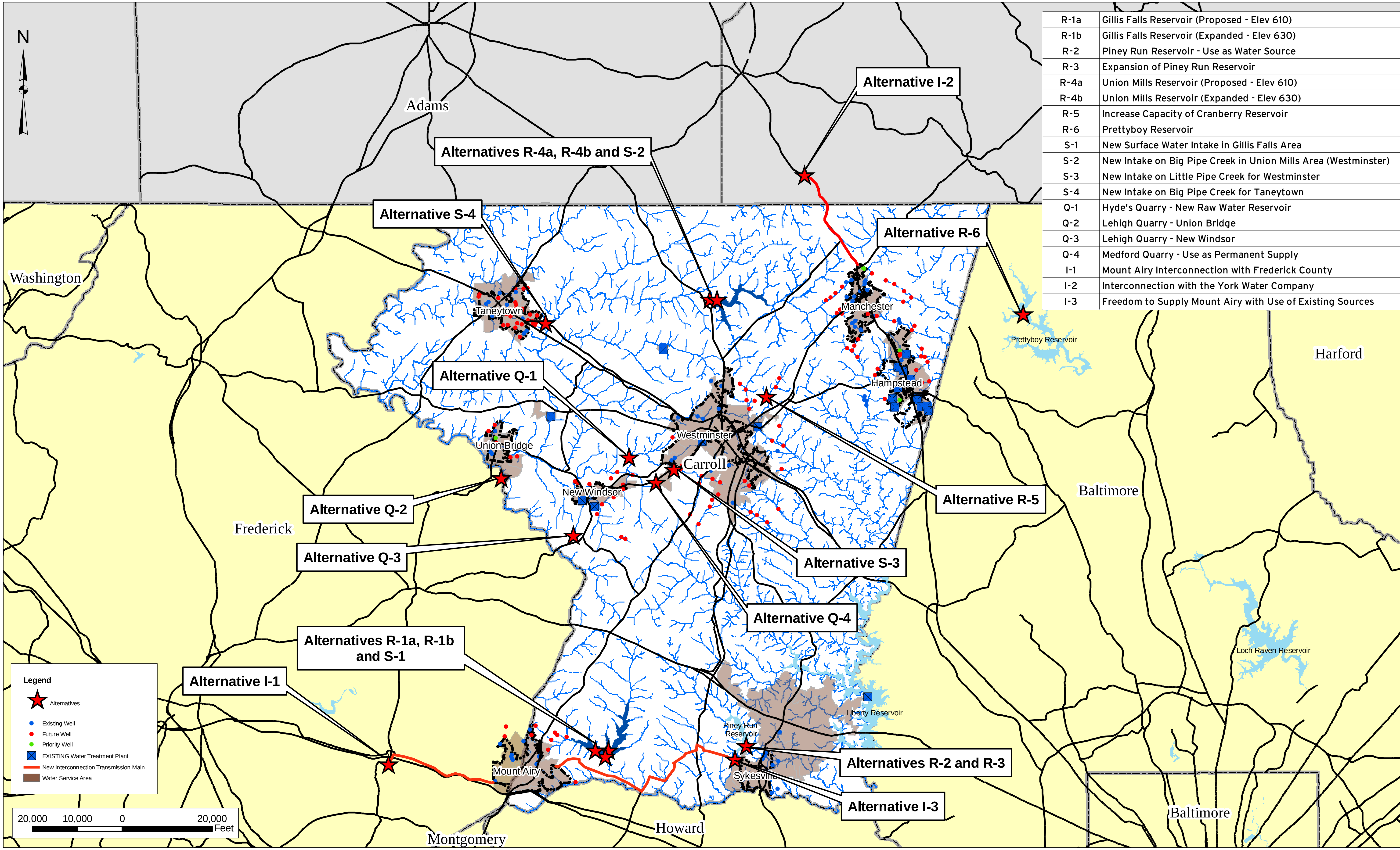
- Number of groundwater wells required to satisfy this potential 124,000 gpd deficit was calculated as follows:
    - No. Wells = 124,000 gpd / Average Demand per Well
        - Average Demand per Well = 2007 Average Usage/No. of Wells
          21,488 gpd/well = 300,826 gpd/14 wells

3.3.6. Demand Management

Water utilities can implement a number of Demand Management practices. Some measures result in more permanent reductions of water use during normal operating conditions, while other measures achieve temporary demand reductions during emergencies related to drought or other circumstances. Categories and examples of Demand Management practices are as follows:

- Public Education Measures – including informative brochures, posters, newsletters and websites that educate customers on ways that they can conserve water.
- Water Loss Management – including leak detection and repair programs, meter replacement programs, and water use audits that reduce the amount of water loss in a system.
- Drought Management Measures – typically include voluntary and mandatory water use restrictions that are implemented during a drought. Restrictions may include those related to lawn watering, car washing, etc.
- Low-Flow Devices – utilities may distribute low flow plumbing devices to their customers for free or a reduced cost.
- Water Use Rate Schedule – billing rate structures that charge a higher rate for greater water consumption. A progressive water rate schedule may encourage conservation by customers.
- Billing Cycle – typically a more frequent billing cycle (i.e. monthly) makes it easier for utilities to track water use and determine if leaks are a problem as well as provide more timely feedback to water customers on their usage patterns.
- Other Demand Management Measures – may include rain barrel programs, efforts to adjust irrigation system settings for more efficient water use, xeriscaping, cistern use, promotion of low impact development technologies, etc.

As part of moving forward with development of new water supply alternatives, it is important, as a first step, to document the Demand Management practices that are already being followed by the localities within Carroll County. Based on such an inventory, it may become more apparent where additional demand management efforts should be considered. Table 3-5 summarizes the existing Demand Management practices that are in place for each locality, based on the Draft Carroll County Comprehensive Water Conservation Recommendations, conversations with water service area representatives at the May 21, 2009 progress meeting, and telephone conversations with water system contacts.



MALCOLM PIRNIE

Carroll County Water Resources Element
Carroll County, Maryland

Master Surface Water Supply Alternatives Location Map

MALCOLM PIRNIE, INC.

Figure 3-1

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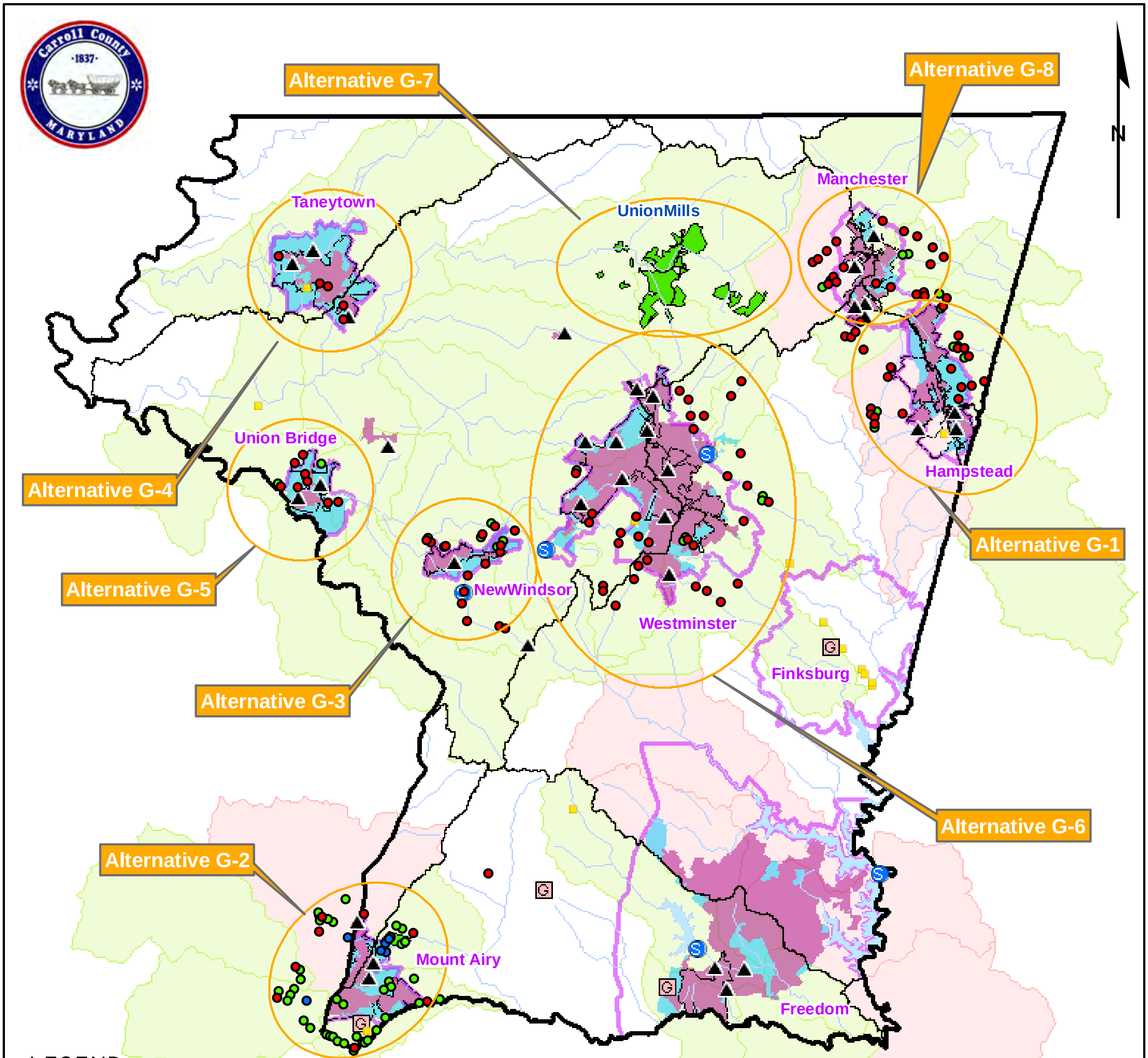


LEGEND

Potential Municipal Well Site
- Well (drilled, not permitted)
- Primary (site to be explored)
- Secondary (site to be explored)
- Existing Municipal Permit
- Surface Water Intake
- Private (GW)
- Industrial (GW)

Water Service Areas
- Priority+Future
- Existing
- Growth Area Boundary
- County Owned Land
- Town Limits

MDE Recharge Budget Analysis
- No Groundwater Availability
- Groundwater Availability

Note: "No Groundwater Availability" means that for a particular water service area, the town does not currently own and control enough land in that watershed for any new groundwater to be available. It does not mean that new own and control areas couldn't be sited in that watershed.

Data Sources:
Future Well Sites: *County Well Data shapefile (Potential_wellsites_5-26-09.shp)*
Existing Wells Sites: *Based on current MDE Appropriation Permits*
MDE Recharge Budget Analysis: *based on an Analysis by Hugh Murphy (County Hydrogeologist) using MDE recommended methods*

0 10,000 20,000 40,000 Feet

MALCOLM PIRNIE	CARROLL COUNTY, MD ALTERNATIVES EVALUATION	Groundwater Alternatives Location Map	Aug 2009 Figure 3-2

Table 3-1
Summary of Communities Served by Alternatives

		Freedom	Hampstead	Manchester	Mount Airy	New Windsor	Taneytown	Union Bridge	Westminster
R-1a	Gillis Falls Reservoir (Proposed - Elev 610)				Alternative exceeds the Build-out Deficit of 0.364 mgd				
R-1b	Gillis Falls Reservoir (Expanded - Elev 630)				Alternative exceeds the Build-out Deficit of 0.364 mgd				
R-2	Piney Run Reservoir - Use as Water Source				Alternative exceeds the Build-out Deficit of 0.364 mgd				
R-3	Expansion of Piney Run Reservoir				Alternative exceeds the Build-out Deficit of 0.364 mgd				
R-4a	Union Mills Reservoir (Proposed - Elev 610)		Alternative exceeds the Build-out Deficit of 0.528 mgd	Assuming that groundwater capacities are less than currently appropriated, this alternative could satisfy the resulting potential Build-out Deficit			Current alternative could meet the Build-out Deficit of 1.164 mgd through flow augmentation of Big Pipe Creek		Alternative exceeds the Build-out Deficit of 1.176 mgd
R-4b	Union Mills Reservoir (Expanded - Elev 630)		Alternative exceeds the Build-out Deficit of 0.528 mgd	Assuming that groundwater capacities are less than currently appropriated, this alternative could satisfy the resulting potential Build-out Deficit			Current alternative could meet the Build-out Deficit of 1.164 mgd through flow augmentation of Big Pipe Creek		Alternative exceeds the Build-out Deficit of 1.176 mgd
R-5	Increase Capacity of Cranberry Reservoir								Does not satisfy long-term Build-out Deficits
R-6	Prettyboy Reservoir		Alternative exceeds the Build-out Deficit of 0.528 mgd	Assuming that groundwater capacities are less than currently appropriated, this alternative could satisfy the resulting potential Build-out Deficit					Alternative meets the Build-out Deficit of 1.176 mgd
S-1	New Surface Water Intake in Gillis Falls Area				Alternative exceeds the Build-out Deficit of 0.364 mgd				
S-2	New Intake on Big Pipe Creek in Union Mills Area (Westminster)								Alternative only satisfies 0.7 mgd of the 1.176 mgd Build-out Deficit
S-3	New Intake on Little Pipe Creek for Westminster								Alternative only satisfies 0.5 mgd of the 1.176 mgd Build-out Deficit
S-4	New Intake on Big Pipe Creek for Taneytown						Only satisfies 0.4 mgd of the 1.16 mgd Build-out Deficit		
Q-1	Hyde's Quarry - New Raw Water Reservoir								Alternative only satisfies 0.5 mgd of the 1.176 mgd Build-out Deficit
Q-2	Lehigh Quarry - Union Bridge							Alternative meets the Build-out Deficit of 0.594 mgd	
Q-3	Lehigh Quarry - New Windsor					Alternative meets the Build-out Deficit of 0.198 mgd			
Q-4	Medford Quarry - Use as Permanent Supply								Alternative only satisfies 0.14 mgd of the 1.176 mgd Build-out Deficit
I-1	Mount Airy Interconnection with Frederick County				Alternative exceeds the Build-out Deficit of 0.364 mgd				
I-2	Interconnection with the York Water Company		Alternative exceeds the Build-out Deficit of 0.528 mgd	Assuming that groundwater capacities are less than currently appropriated, this alternative could satisfy the resulting potential Build-out Deficit					
I-3	Freedom to Supply Mount Airy Using Existing Sources				Alternative exceeds the Build-out Deficit of 0.364 mgd				
G-1	Hampstead Wells		Alternative was sized to meet the Build-out Deficit of 0.528 mgd						
G-2	Mount Airy Wells				Alternative was sized to meet the Build-out Deficit of 0.364 mgd				
G-3	New Windsor Wells					Alternative was sized to meet the Build-out Deficit of 0.198 mgd			
G-4	Taneytown Wells						Alternative was sized to meet the Build-out Deficit of 0.198 mgd		
G-5	Union Bridge Wells							Alternative was sized to meet the Build-out Deficit of 0.594 mgd	
G-6	Westminster Wells								Alternative was sized to meet the Build-out Deficit of 1.176 mgd
G-7	Union Mills Area Wells								Alternative only satisfies 0.56 mgd of the 1.176 mgd Build-out Deficit
G-8	Manchester Wells			This alternative satisfies the potential Build-out Deficit of 0.124 mgd through the addition of 6 new wells to fully access the amount of water that is currently appropriated for the town.					

Table 3-2:
Carroll County Reservoir Data

	Piney Run (Existing)	Piney Run (Expanded)	Gillis Falls (Planned)	Gillis Falls (Expanded)	Union Mills (Planned)	Union Mills (Expanded)
Volume (billion gallons)	1.97 (a)	2.40 (a)	4.15	8.02	2.44	5.49
Surface Area (acres)	298 (a)	336 (a)	452	744	298	633
Normal Pool Elevation (feet)	524 (b)	528	610 (e)	630	610 (i)	630
Drainage Area (square miles)	10.43 (b)	10.43 (b)	17.4 (e)	17.4 (e)	24.86 (j)	24.86 (j)
Safe Yield Estimate (mgd)	3.65 (c)	4.11 (c)	3.85 (f)	5.00 (f)	3.76 (k)	7.93 (k)
Average Minimum Release (mgd)	1.0 (d)	1.0 (d)	5.45 (g)	5.45 (g)	5.48 (l)	5.48 (l)
Inundated Wetlands (acres)	N/A	12.6	177 (h)	225 (m)	114	165
Inundated Streams (miles)	N/A	1.05	10.1	14.2	8.4	15.1

(a) Piney Run Recreation / Water Supply Compatibility Study (September 1989), Table 4.

(b) Work Plan for the Piney Run Watershed (1968 and 1972).

(c) Assuming 873 MG of dead storage. The Work Plan for the Piney Run Watershed (USDA-SCS 1968 and 1972) lists sediment and recreation storage as 2,679 ac-ft (873 MG).

(d) MDE Water Appropriation and Use Permit.

(e) Gillis Falls Reservoir Environmental Report (January 1990), pages 2-10 & 2-11.

(f) Assuming 1,122 MG of dead storage which is estimated storage below elevation 580 feet. Gillis Falls Reservoir Environmental Report (January 1990) lists minimum pool elevation as 580 feet.

(g) Lesser of either natural runoff or Gillis Falls Reservoir Environmental Report (January 1990), page 4-14, minimum releases between 5.3 cfs (Jul-Oct) and 13.2 cfs (Mar-May) on a monthly basis.

(h) Gillis Falls Reservoir Environmental Report (January 1990), pages 3-27 & 3-28. Project would impact 188 acres of wetlands, open water and riverine habitat. Reservoir itself would inundate 177 acres of wetlands.

(i) Carroll County Water Resources Study (May 1988), page 5-54.

(j) For comparison, Watershed Plan and EIS for the Big Pipe Creek Watershed (June 1976), page I-39, lists drainage area as 25.0 square miles.

(k) Assuming 761 MG of dead storage. The Watershed Plan and EIS for the Big Pipe Creek Watershed (June 1976) lists sediment and recreation storage as 2,335 ac-ft (761 MG).

(l) Lesser of either natural runoff or calculated Maryland Most Common Flows which range between 4.9 mgd (May - Oct) and 6.5 mgd (Nov - Apr).

(m) GIS-based estimate of an additional 48 acres of wetland impact, which was added to the 177 acres of wetland impact that was documented through field study in (h).

Note: Yellow shaded cells were quantified in 2009 by Malcolm Pirnie as part of WRE assistance.

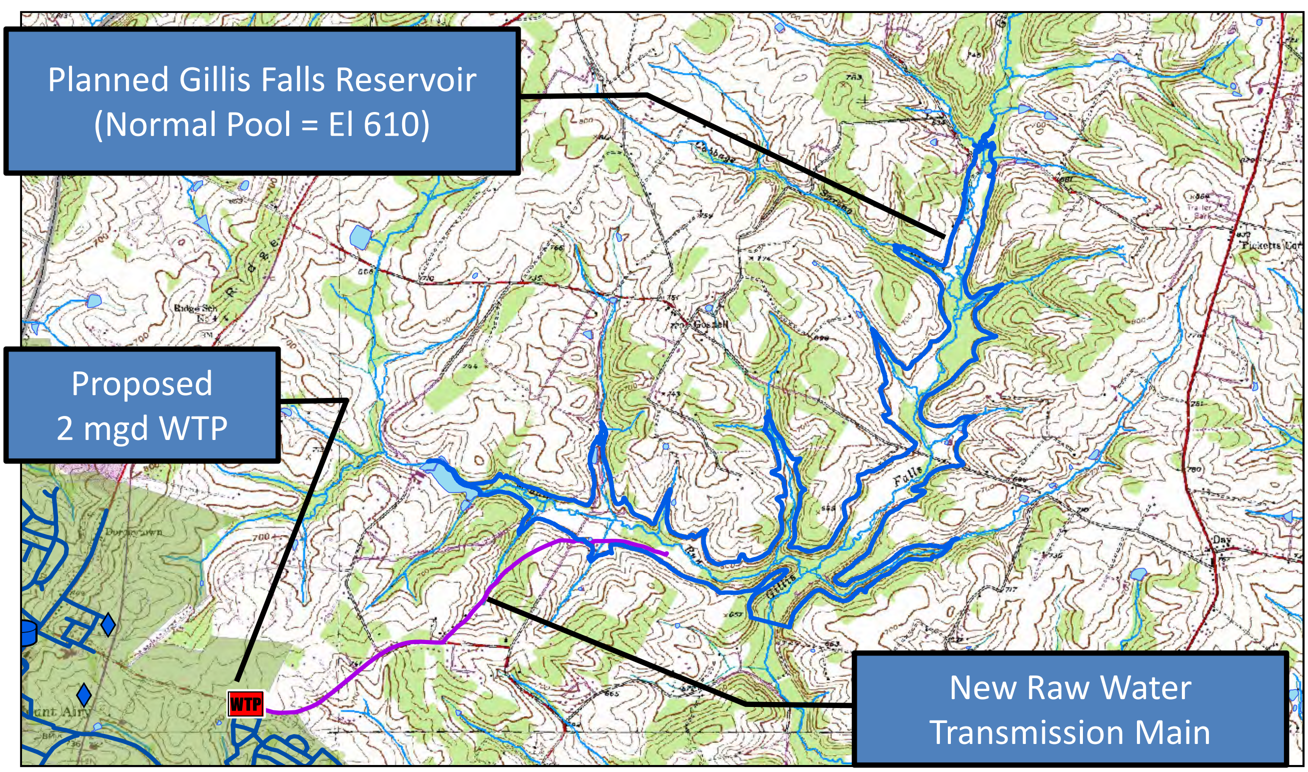
Alternative R-1a: Gillis Falls Reservoir (Proposed – El 610)

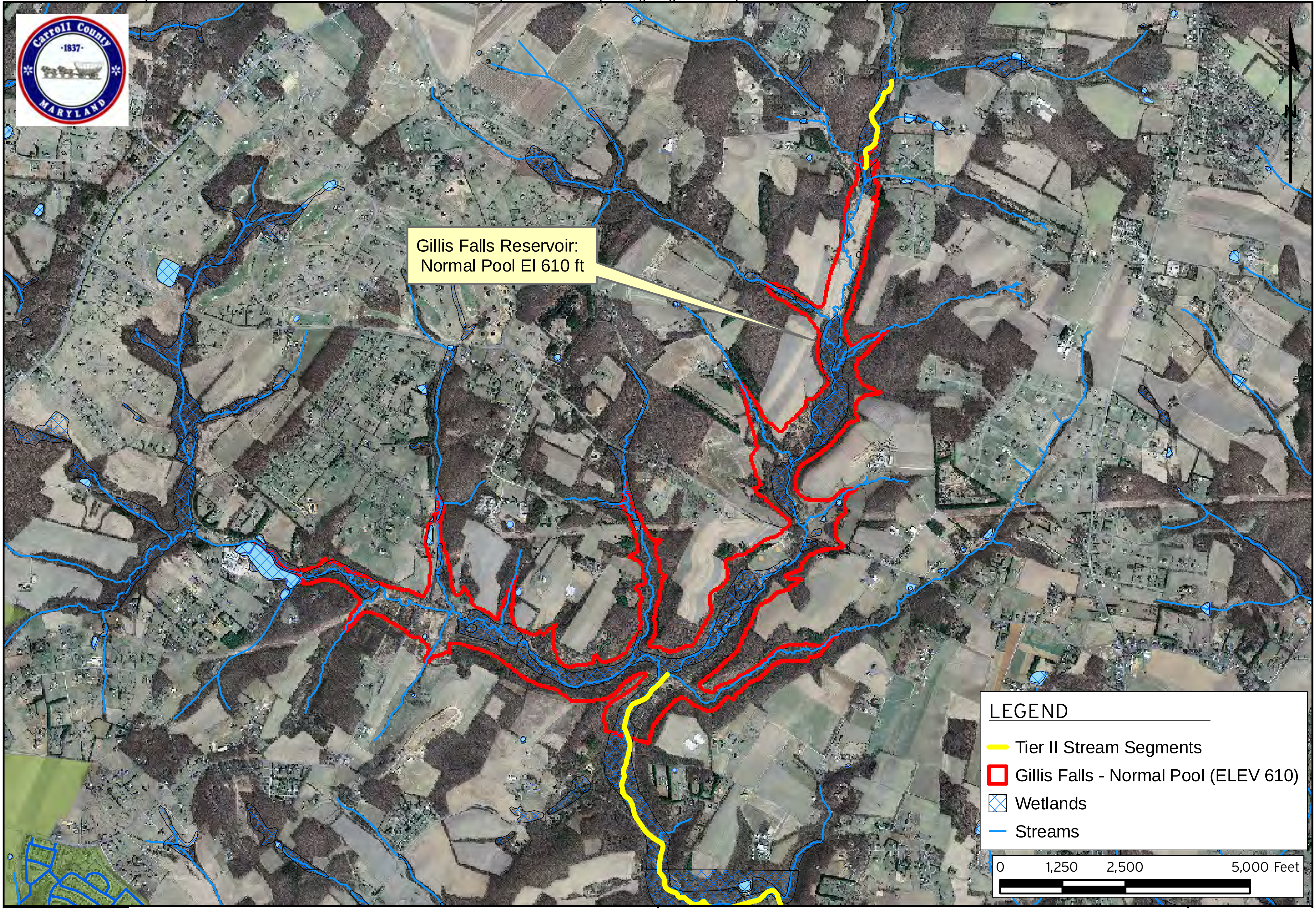
Description of Alternative:

- Reservoir planned as regional water supply for Mount Airy and Freedom/Sykesville Water Service Areas
- Safe Yield = 3.85 mgd; Total Volume = 4.15 BG; dead storage assumed below elevation 580 ft
- Drainage Area = 17.4 square miles
- Surface Area = 452 ac. at Normal Pool El. 610 ft
- Average minimum release of 5.45 mgd
- Raw water to be treated at new 2 mgd WTP in Mt. Airy.
- Requires 2.0 miles of new Raw Water Transmission Main
- One pump station at reservoir

Key Implementation Steps:

- County complete purchase of approximately 587 acres of land, including +/- 5 residences
- Key Permits Required:
  - USACE Section 404 permit
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
  - Non-tidal Wetland and Waterways Permit
  - Dam Safety Permit
- Renegotiate more realistic reservoir release rates
- Complete surveys for aquatic habitat and cultural resources within the affected project footprint.
- Develop Mitigation Plan:
  - Approx. 10.1 miles of stream impacts
  - Approx. 177 acres of wetland impacts
- Class III natural trout stream would require downgrading to Class IV recreational trout stream
- Address Tier II stream designations extending upstream on north arm from Gillis Road crossing and extending downstream from just upstream of the dam site.





MALCOLM PIRNIE

CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative R-1a:
Gillis Falls Reservoir (Proposed)

Aug 2009

Figure R-1a

Alternative R-1b: Gillis Falls Reservoir (Expanded – El 630)

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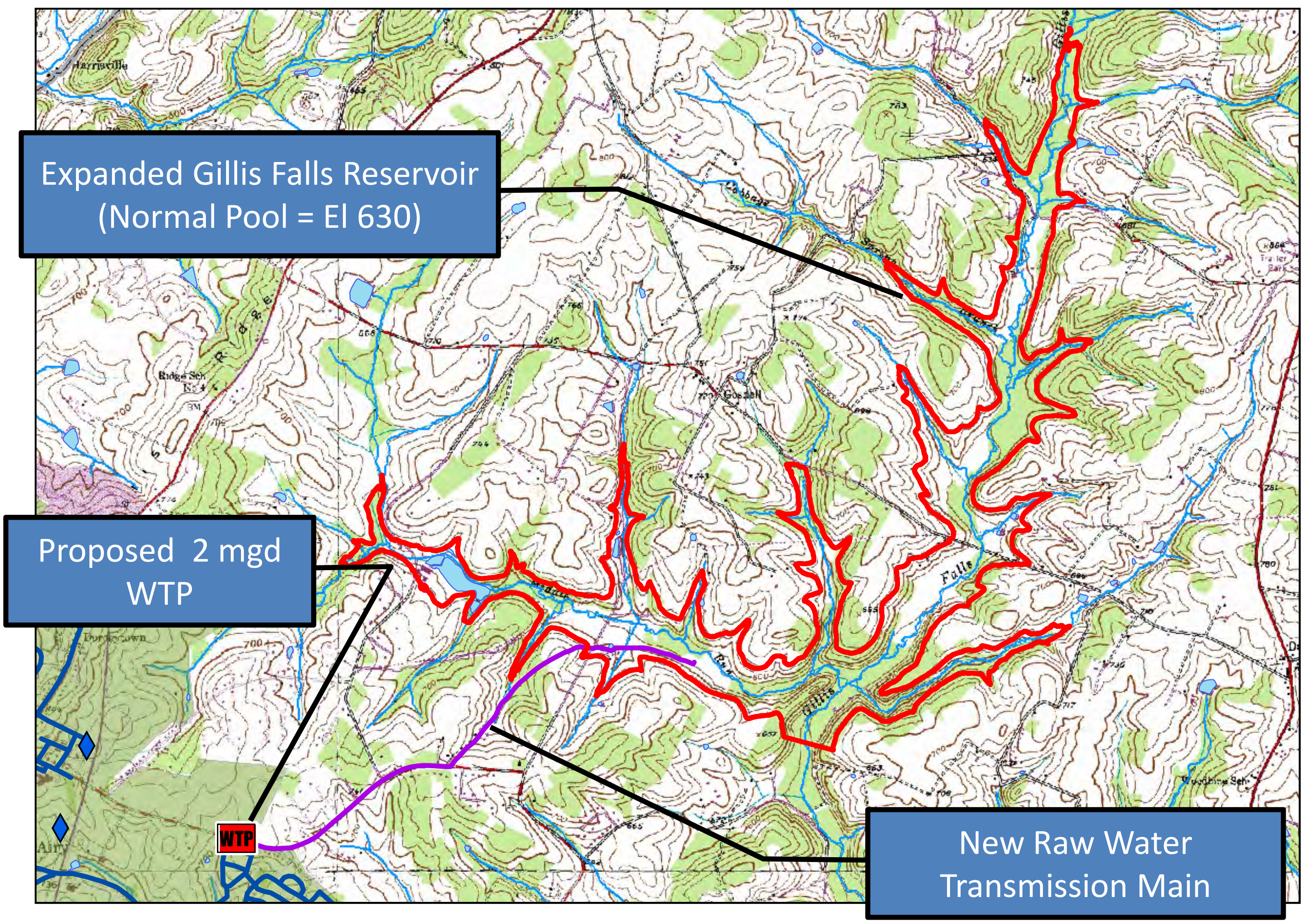
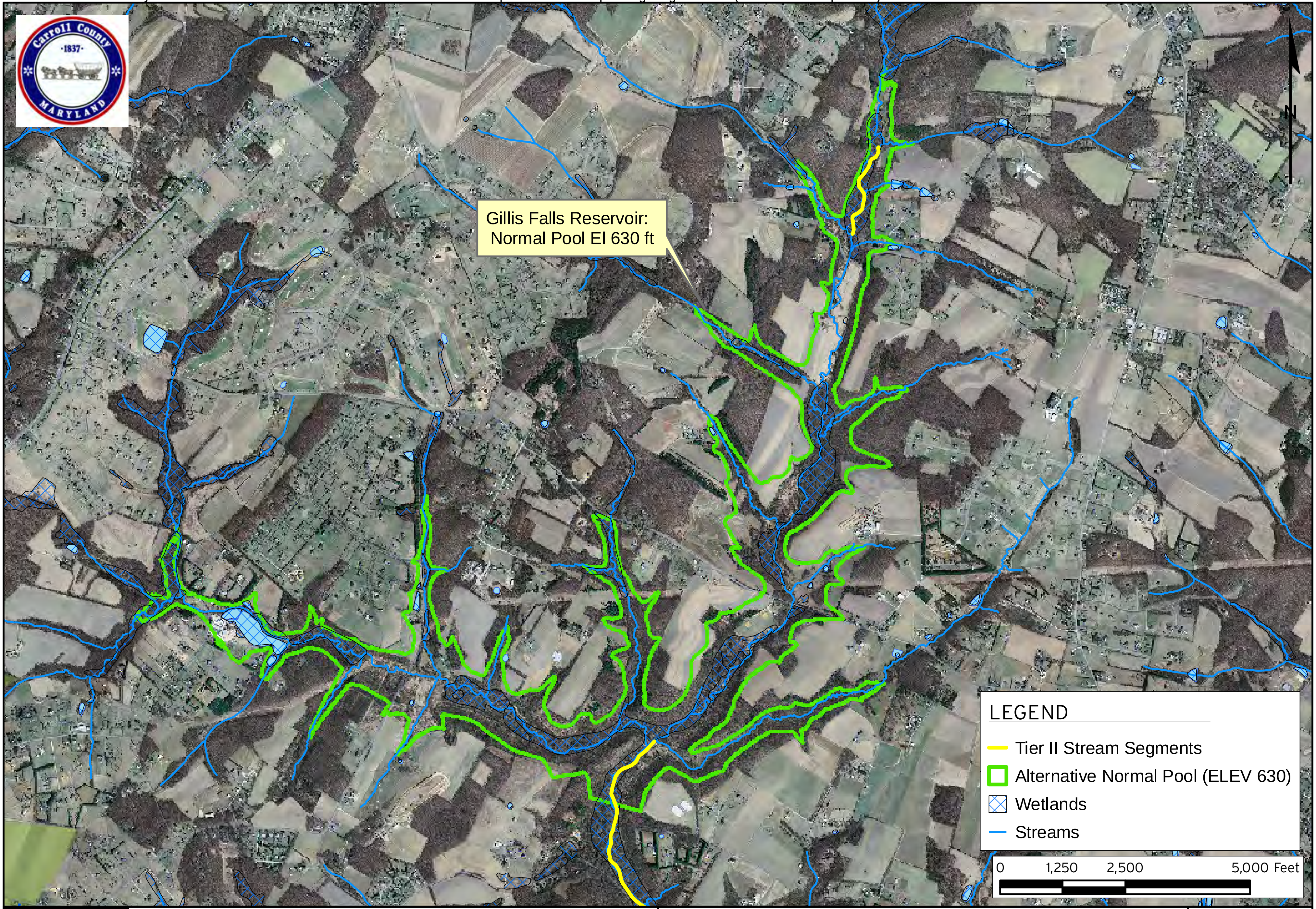
Description of Alternative:

- Reservoir planned as regional water supply for Mount Airy and Freedom/Sykesville Water Service Areas
- Safe Yield = 5.0 mgd; Total Volume = 8.02 BG; dead storage assumed below elevation 580 ft
- Drainage Area = 17.4 square miles
- Surface Area = 744 ac. at Normal Pool El. 630 ft
- Average minimum release of 5.45 mgd
- Raw water to be treated at new 2 mgd WTP in Mt. Airy.
- Requires 2.0 miles of new Raw Water Transmission Main
- One pump station at reservoir

Key Implementation Steps:

- County complete purchase of approximately 1,541 acres of land, including +/- 16 residences
- Key Permits Required:
  - USACE Section 404 permit
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
  - Non-tidal Wetland and Waterways Permit
  - Dam Safety Permit
- Renegotiate more realistic reservoir release rates
- Complete surveys for aquatic habitat and cultural resources within the affected project footprint.
- Develop Mitigation Plan:
  - Approx. 14.2 miles of stream impacts
  - Approx. 225 acres of wetland impacts
- Class III natural trout stream would require downgrading to Class IV recreational trout stream
- Address Tier II stream designations extending upstream on north arm from Gillis Road crossing and extending downstream from just upstream of the dam site.





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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative R-1b:
Gillis Falls Reservoir (Expanded)

Aug 2009

Figure R-1b

Alternative R-2: Piney Run Reservoir – Use as Water Resource

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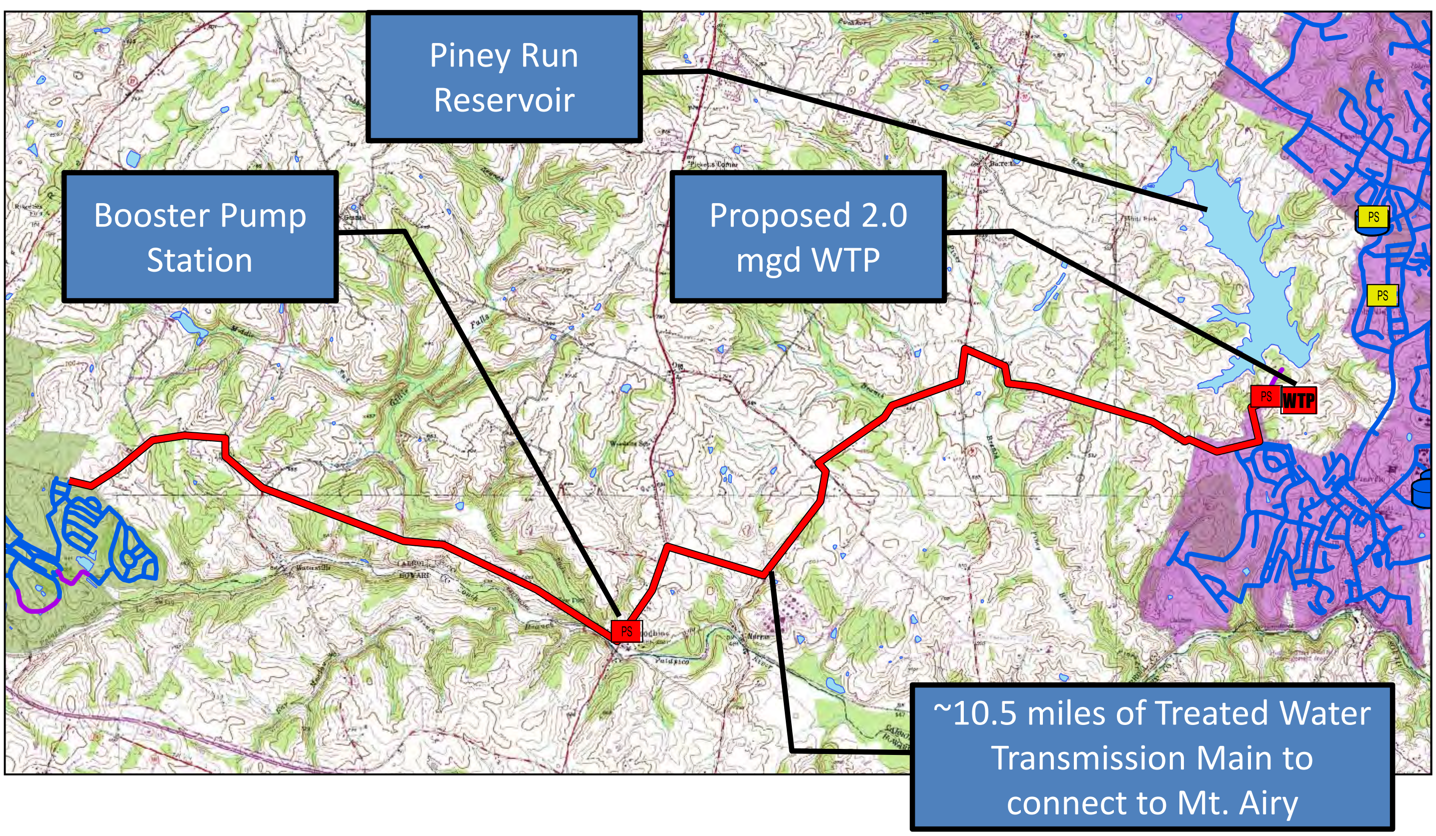
Description of Alternative:

- Convert existing reservoir (completed in 1975) to water supply source for Mt. Airy and possibly Sykesville/Freedom Water Service Area
- Safe Yield = 3.65 mgd; Total Volume = 1.97 BG
- Drainage Area = 10.43 square miles
- Surface Area = 298 ac. at Normal Pool El. 524 ft
- Average minimum release = 1.0 mgd
- Construct new 2.0 mgd WTP on Hollenberry Road and 1.0 MG storage facility
- Approximately 1,000 feet of 16" raw water transmission main
- Approximately 10.5 miles of 16-inch treated water transmission main to connect to Mt. Airy service area.
- Two pump stations (one at WTP, one booster pump station near Woodbine).
- 2.0 MG Storage Tank (located near Woodbine)

Key Implementation Steps:

- Potential community opposition for project.
- Key Permit Required:
  - Water and Sewerage Construction Permit
- Land Easement/Acquisition for WTP and pipeline
- Pipeline, storage, and pump station engineering



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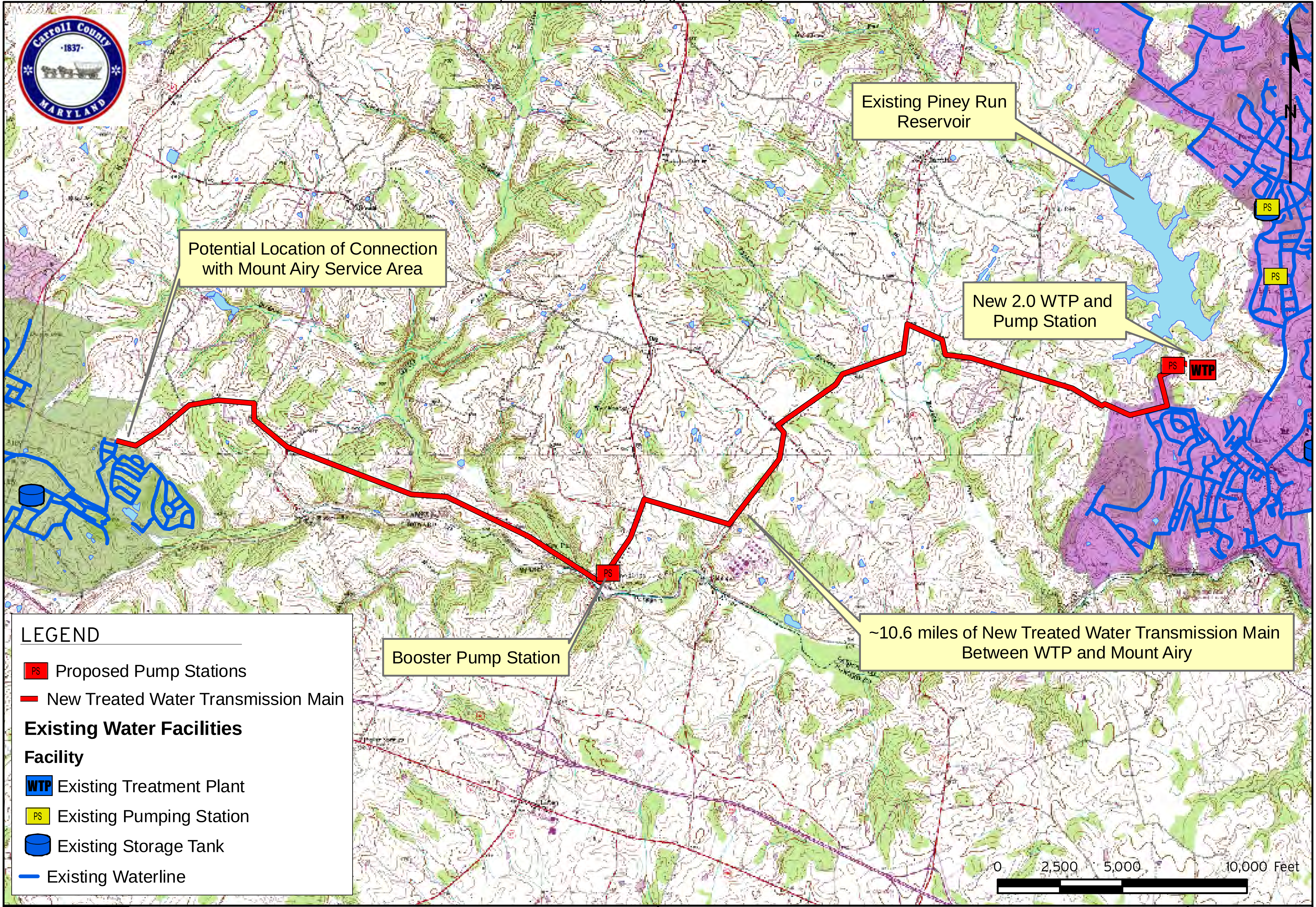

MALCOLM PIRNIE	CARROLL COUNTY, MD ALTERNATIVES EVALUATION	Alternative R-2: Piney Run Reservoir - Use as Water Source	Aug 2009 Figure R-2

Alternative R-3: Expansion of Piney Run Reservoir

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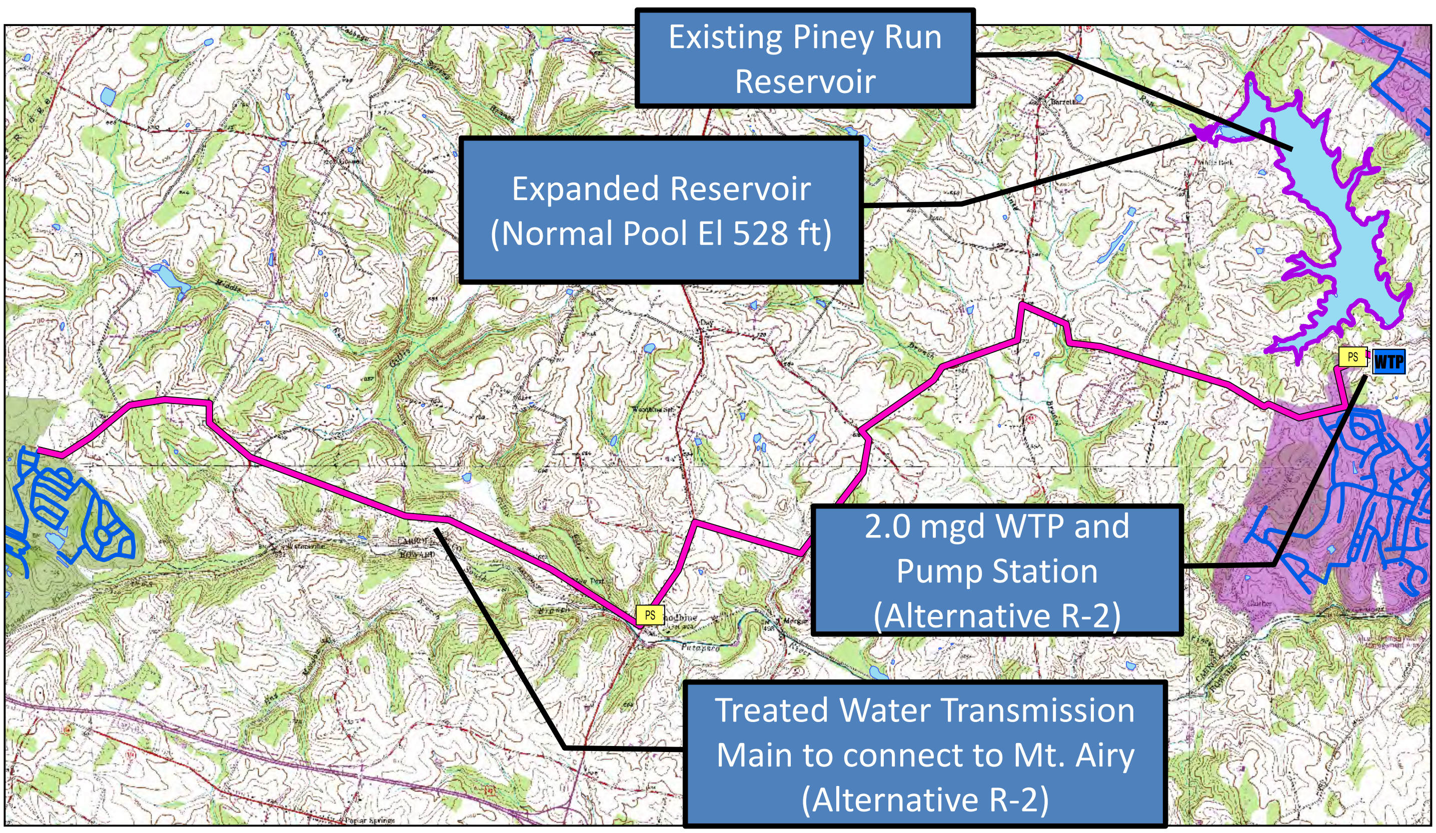
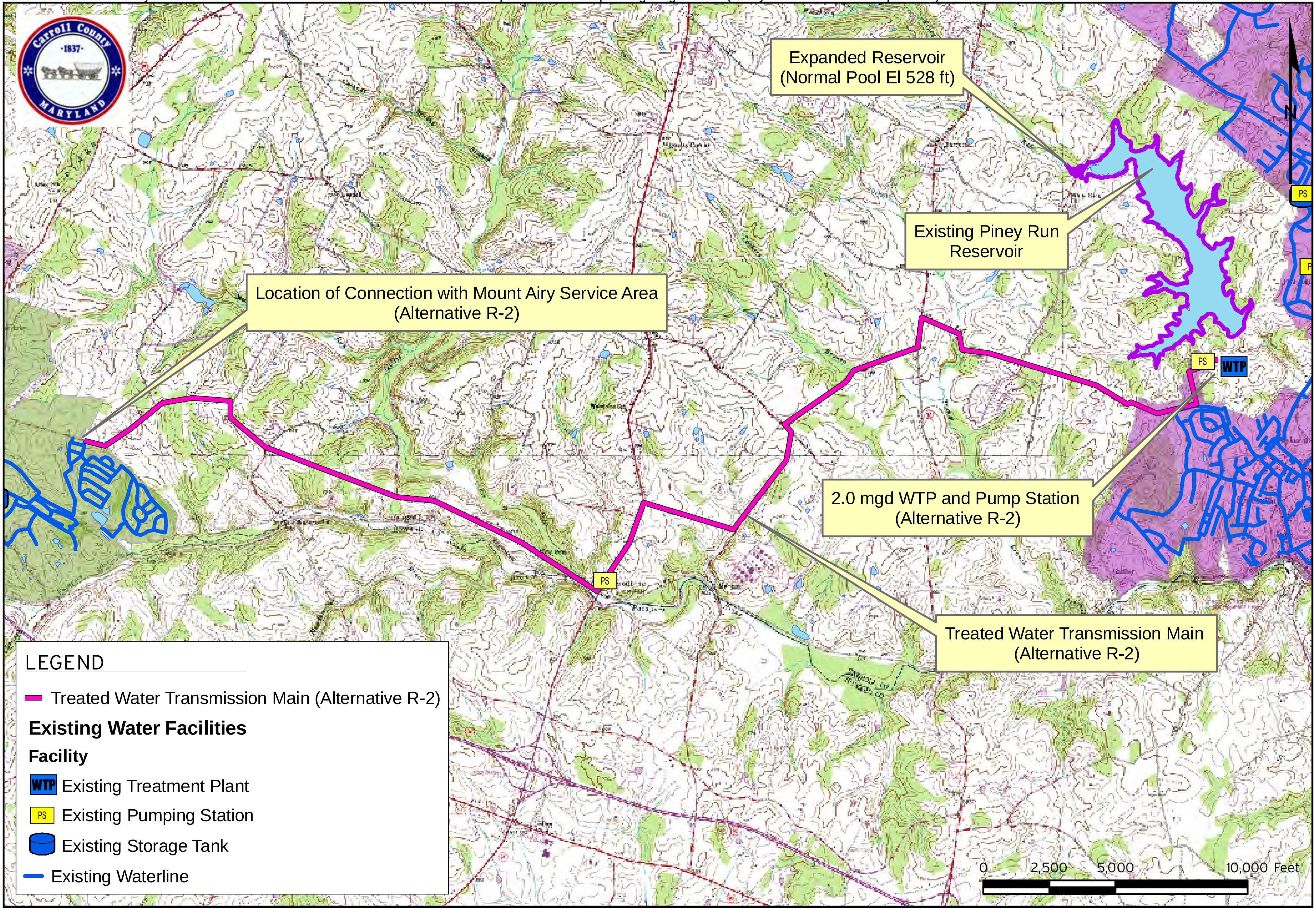
Description of Alternative:

- Increase capacity of existing Piney Run Reservoir by raising the spillway riser and emergency spillway.
- Raise normal pool elevation by 4 feet
  - Safe Yield: 4.11 mgd (incremental increase of 0.46 mgd from existing Piney Run Reservoir, Alternative R-2)
  - Surface Area: 336 acres
  - Normal Pool: 528 ft
  - Volume: 2.40 BG
  - Average Min. Release = 1.0 mgd
- All components of Alternative R-2 would already be in place prior to expansion of Piney Run Reservoir.

Key Implementation Steps:

- Receive approval from MDE Dam Safety to raise normal pool elevation and change dam classification from current "high hazard" designation.
- Key Permits Required:
  - Water Appropriation and Use Permit
  - Non-tidal Wetlands and Waterways Permit
  - Dam Safety Permit
- Land Easement/Acquisition for reservoir expansion.
- Complete surveys for aquatic habitat and cultural resources within the affected project footprint.
- Develop Mitigation Plan:
  - Wetland Impacts: 12.6 acres
  - Stream Impacts: 1.05 miles
- Confirm that any impacts to Waters Edge Farm and County park/marina can be addressed.





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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative R-3:
Expansion of Piney Run Reservoir

Aug 2009

Figure R-3

Alternative R-4a: Union Mills Reservoir (Proposed – El 610)

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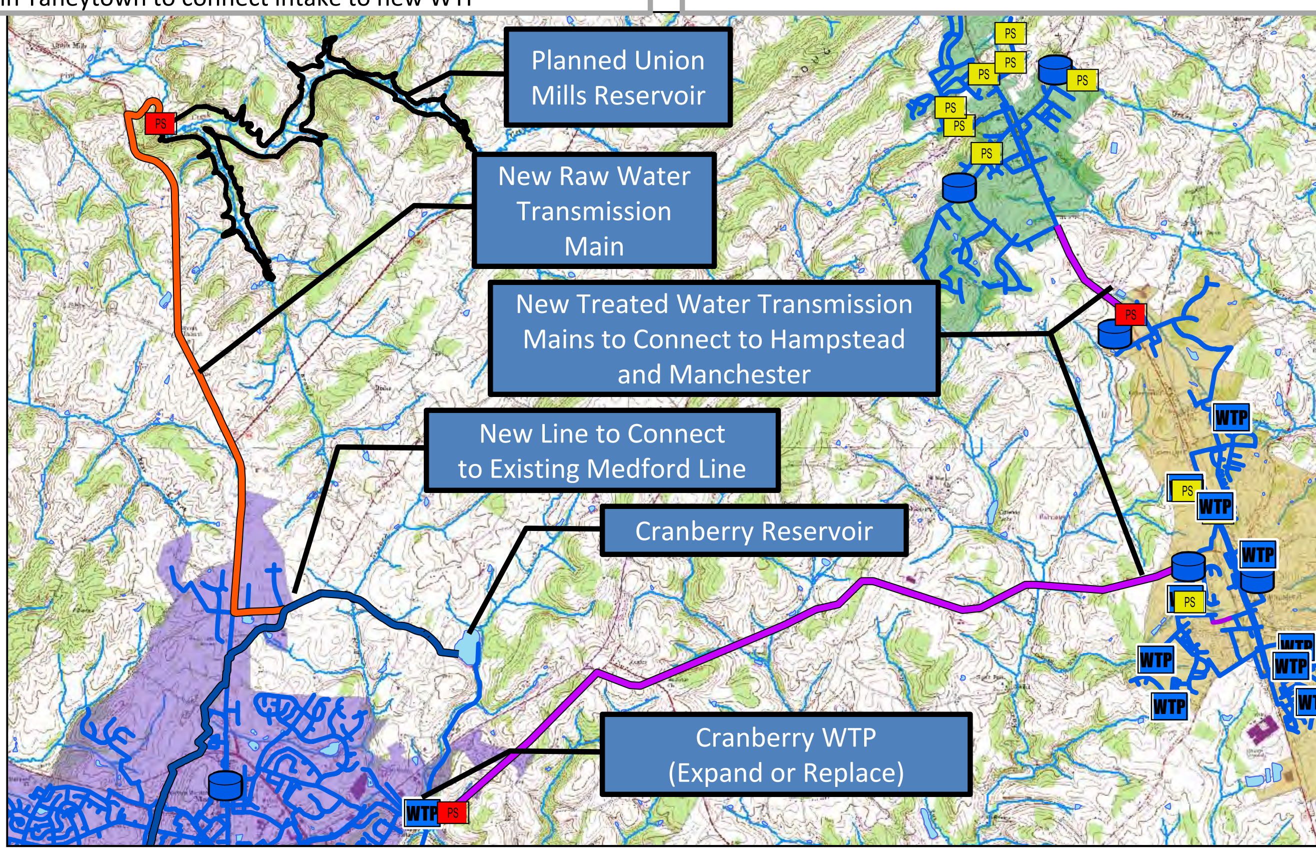
Description of Alternative:

- Regional reservoir planned to supplement Westminster, Hampstead, Manchester and Taneytown Water Service Areas and provide flood control
- Safe Yield = 3.76 mgd; Total Volume = 2.44 BG
- Drainage Area = 24.86 square miles
- Surface Area = 298 ac. at Normal Pool El. 610 ft
- Average minimum release = 5.48 mgd
- Phased implementation – potential for phased implementation, starting with a groundwater option (G-7) and/or a surface water intake on Big Pipe Creek (S-2). If either project is completed, the raw water pipeline will already be in place for the Union Mills Reservoir.
- Construction of a new 3.2 mgd WTP in vicinity of existing Cranberry WTP or expand Cranberry WTP capacity by 3.2 mgd.
- Installation of approximately 5 miles of 20-inch raw water transmission mains to connect Union Mills Reservoir to Cranberry Reservoir.
- Installation of approximately 7.8 miles of treated water transmission main to connect to Hampstead and Manchester Water Service Areas.
- New intake and three new pump stations
- Taneytown to be served through flow augmentation of Big Pipe Creek and downstream withdrawal. Construction of a new 1.8 mgd WTP in Taneytown. Installation of approximately 1.0 mile of raw water transmission mains in Taneytown to connect intake to new WTP

Key Implementation Steps:

- County complete purchase of approximately 781 acres of land, including +/- 3 residences
- Key Permits Required:
  - USACE Section 404 permit
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
  - Non-tidal Wetland and Waterways Permit
  - Dam Safety Permit
- Complete surveys for aquatic habitat and cultural resources within the affected project footprint.
- Develop Mitigation Plan:
  - Approx. 8.4 miles of stream impacts
  - Approx. 114 acres of wetland impacts
- Negotiate less restrictive minimum reservoir releases with MDE to increase project safe yield.
- Confirm that any impacts to Whittaker Chambers Farm (National Historic Landmark) can be addressed.
- Confirm that any potential water quality impacts on reservoir from adjacent John Owings Landfill can be addressed.



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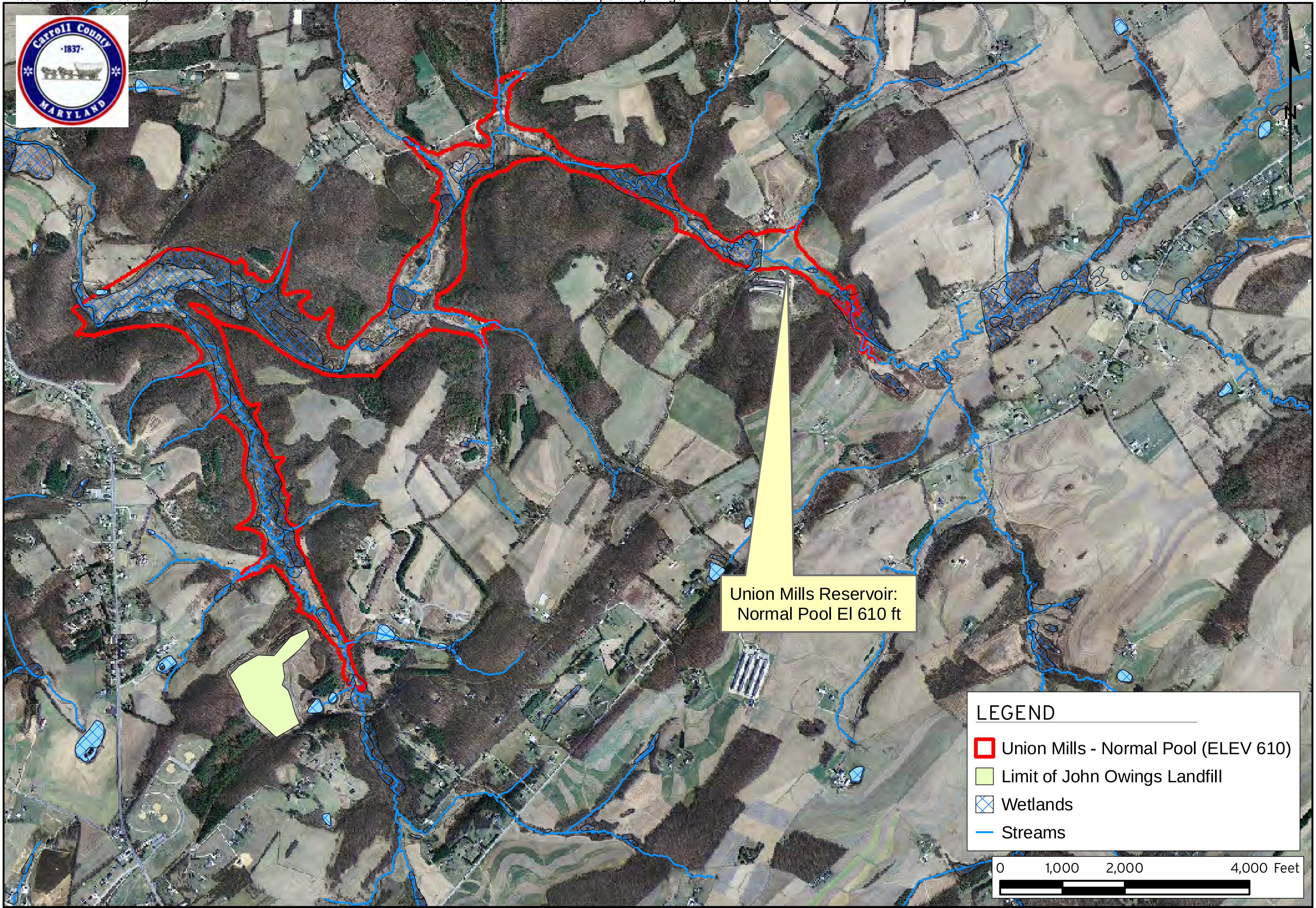

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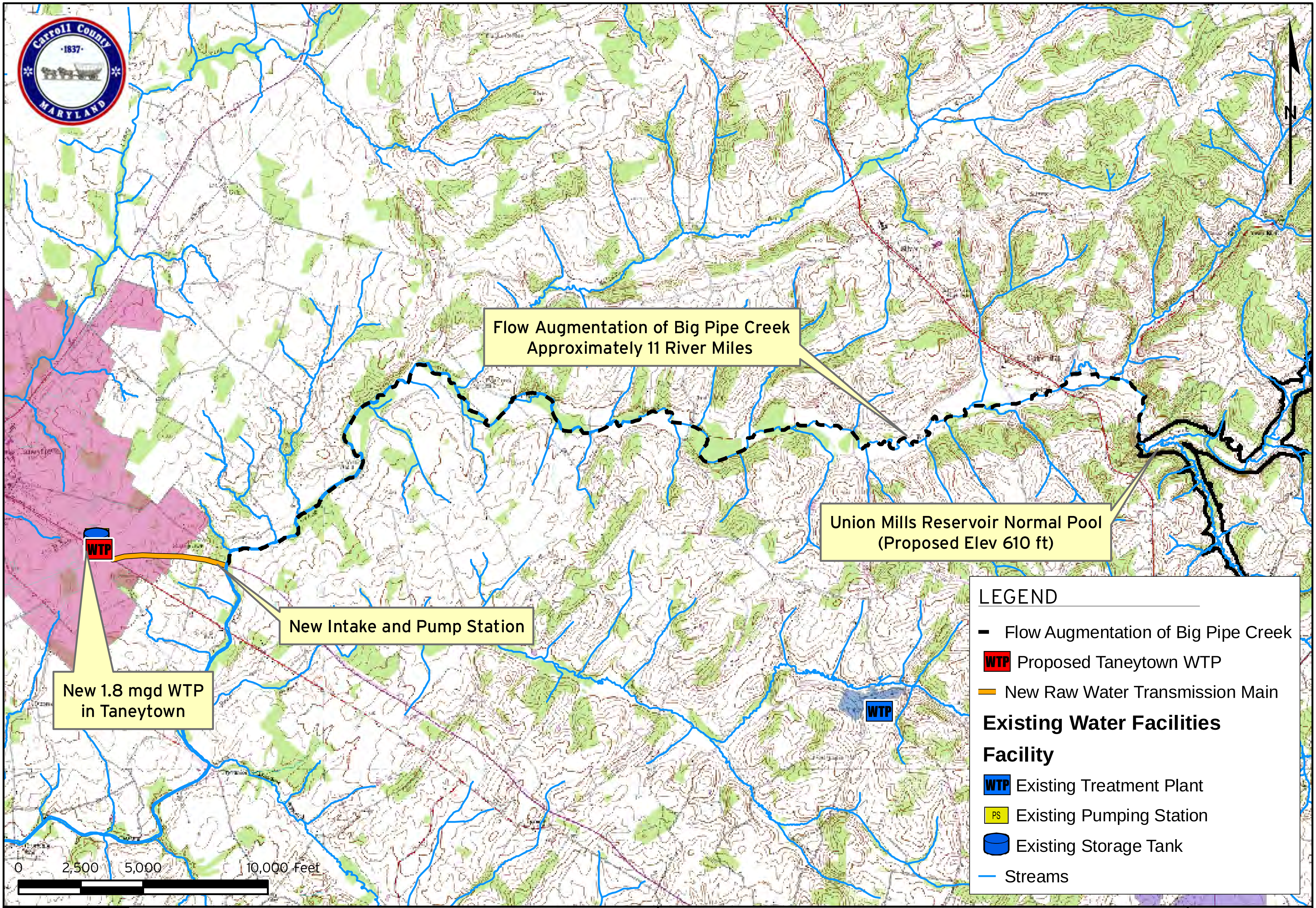
CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative R-4a:
Union Mills Reservoir (Proposed)

Aug 2009

Figure R-4a(1)



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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Union Mills Reservoir Flow Augmentation of Big Pipe Creek to Supply Taneytown

Aug 2009

Figure R-4a (2)

Alternative R-4b: Union Mills Reservoir (Expanded – El 630)

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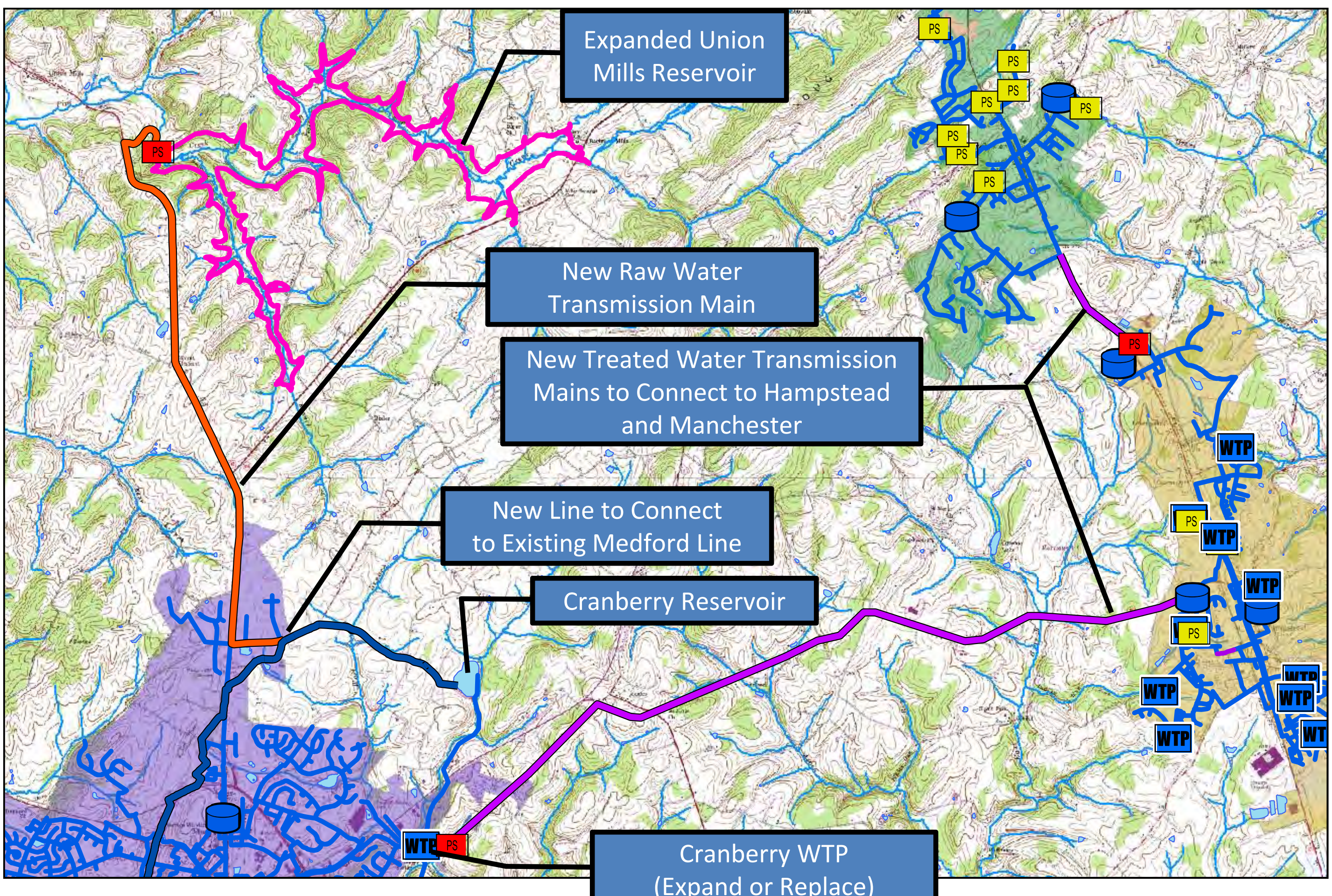
Description of Alternative:

- Regional reservoir planned to supplement Westminster, Hampstead, Manchester and Taneytown Water Service Areas and provide flood control
- Safe Yield = 7.93 mgd; Total Volume = 5.49 BG
- Drainage Area = 24.86 square miles
- Surface Area = 633 ac. at Normal Pool El. 630 ft
- Average minimum release = 5.48 mgd
- Construction of a new 3.2 mgd WTP in vicinity of existing Cranberry WTP or expand Cranberry WTP capacity by 3.2 mgd.
- Installation of approximately 5 miles of 36-inch raw water transmission mains to connect Union Mills Reservoir to Cranberry Reservoir.
- Installation of approximately 7.8 miles of treated water transmission main to connect to Hampstead and Manchester Water Service Areas.
- New intake and three new pump stations
- Taneytown to be served through flow augmentation of Big Pipe Creek and downstream withdrawal. Construction of a new 1.8 mgd WTP in Taneytown. Installation of approximately 1.0 mile of raw water transmission mains in Taneytown to connect intake to new WTP .

Key Implementation Steps:

- County complete purchase of approximately 1,144 acres of land, including +/- 4 residences
- Key Permits Required:
  - USACE Section 404 permit
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
  - Non-tidal Wetland and Waterways Permit
  - Dam Safety Permit
- Complete surveys for aquatic habitat and cultural resources within the affected project footprint.
- Develop Mitigation Plan:
  - Approx. 15.1 miles of stream impacts
  - Approx. 165 acres of wetland impacts
- Negotiate less restrictive minimum reservoir releases with MDE to increase project safe yield.
- Confirm that any impacts to Whittaker Chambers Farm (National Historic Landmark) can be addressed.
- Confirm that any potential water quality impacts on reservoir from adjacent John Owings Landfill can be addressed.



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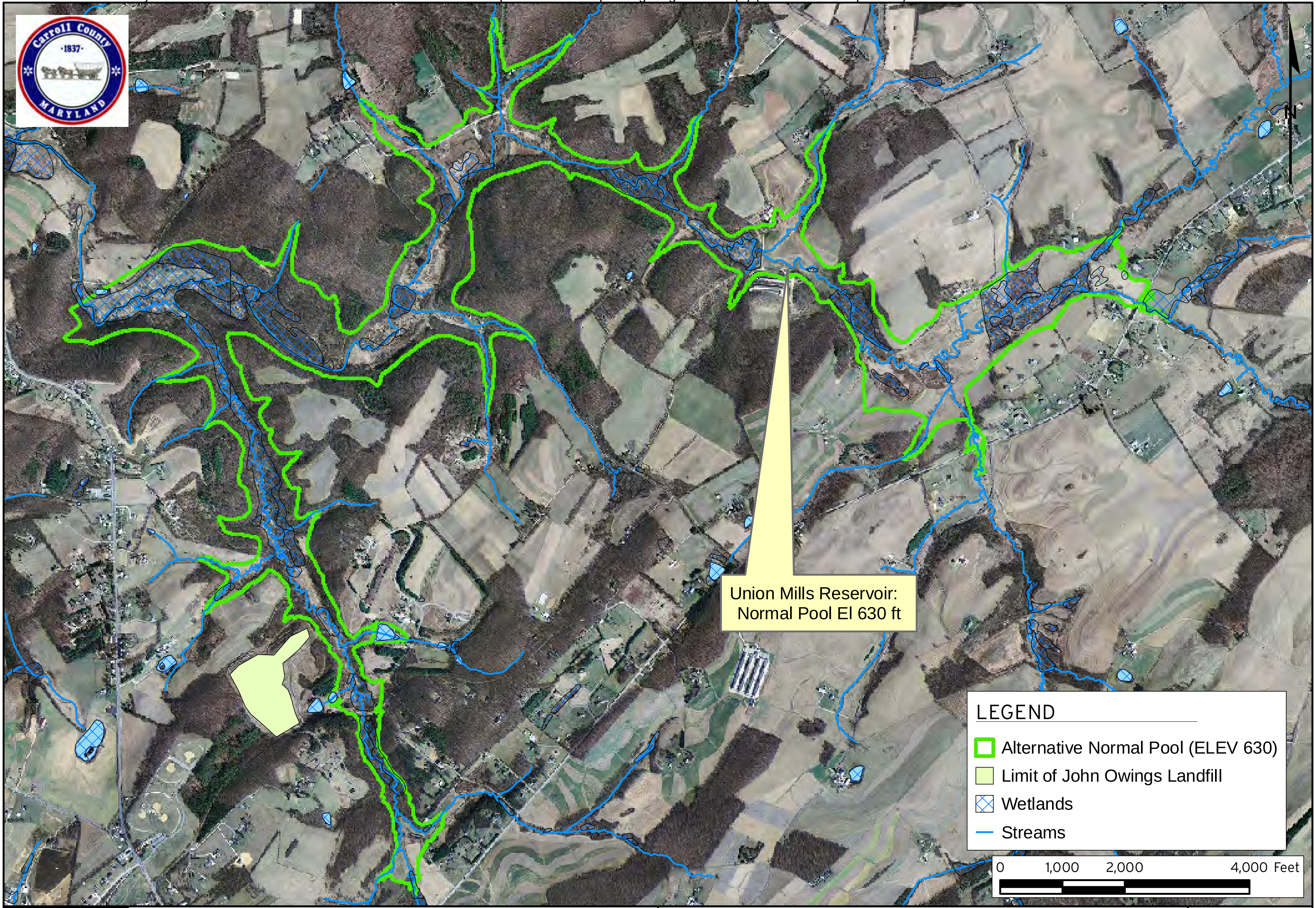

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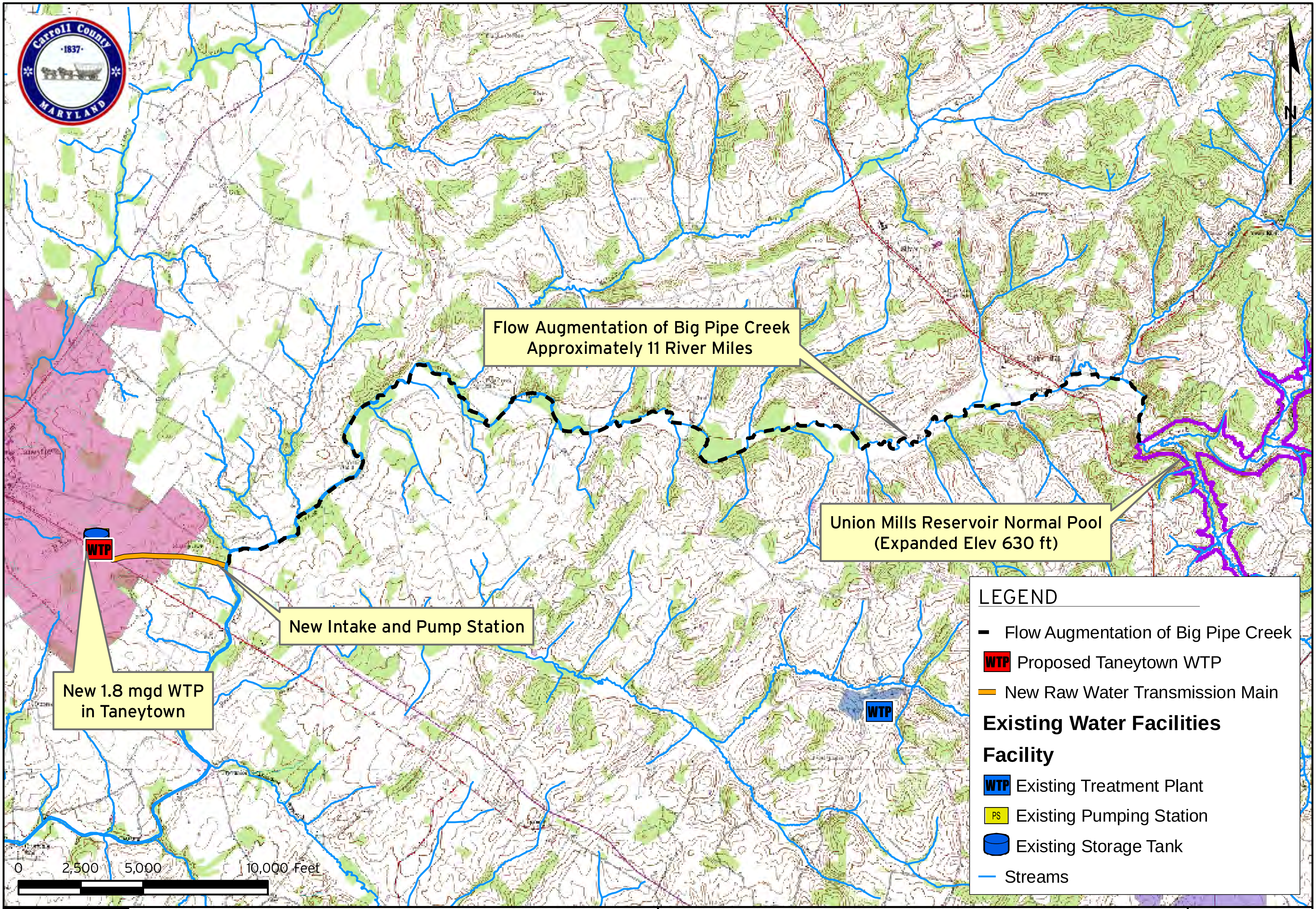
CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative R-4b:
Union Mills Reservoir (Expanded)

Aug 2009

Figure R-4b(1)



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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Union Mills Reservoir Flow Augmentation of Big Pipe Creek to Supply Taneytown

Aug 2009

Figure R-4b (2)

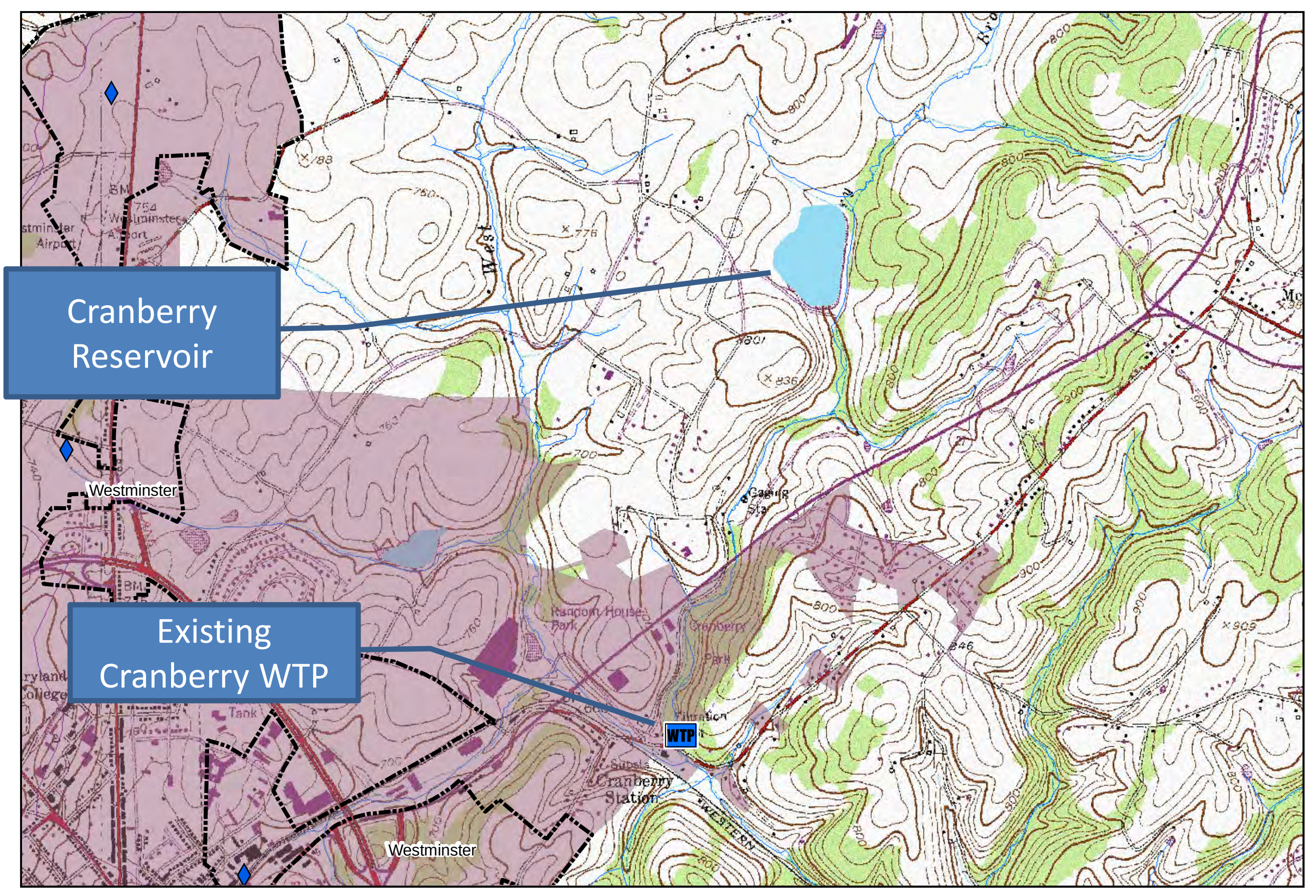
Alternative R-5: Increase Capacity of Cranberry Reservoir

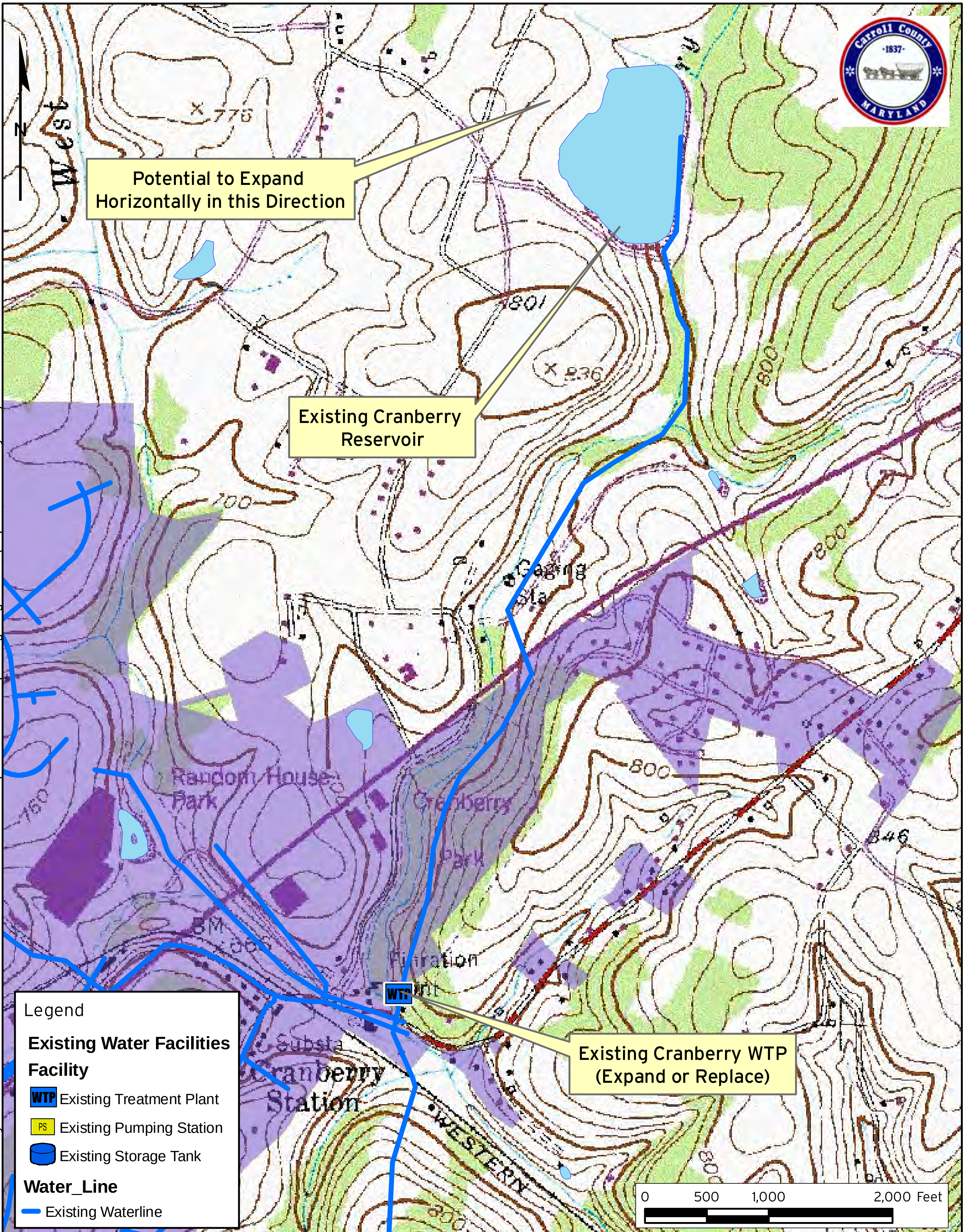
Description of Alternative:

- 115 MG raw water reservoir located along Cranberry Branch, north of Lucabaugh Mill Rd.
- All water in the reservoir is pumped from the raw water intake on Cranberry Branch. The raw water in the reservoir is used either when conditions prevent direct withdrawal from the stream or to supplement low stream flow.
- Two potential expansion options:
    - Expand horizontally through purchase of additional property (60 MG increase)
    - Expand vertically through raising dam one foot (~8 MG increase).
- According to Westminster staff, vertical expansion is the most likely alternative, resulting in an estimated 0.1 mgd safe yield increase (based on the current safe yield of 1.17 mgd and existing capacity of 115 MG).

Key Implementation Steps:

- City of Westminster to purchase additional land and/or receive permission from MD Dam Safety to raise dam by one foot.
- Key Permit Required:
    - Dam Safety Permit
- Overcome political and community opposition with the horizontal expansion option. Previous attempts to purchase land required for horizontal expansion of the reservoir have been unsuccessful.





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MALCOLM PIRNIE

CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative R-5:
Increase Capacity of Cranberry Reservoir

Aug 2009

Figure R-5

Alternative R-6: Prettyboy Reservoir

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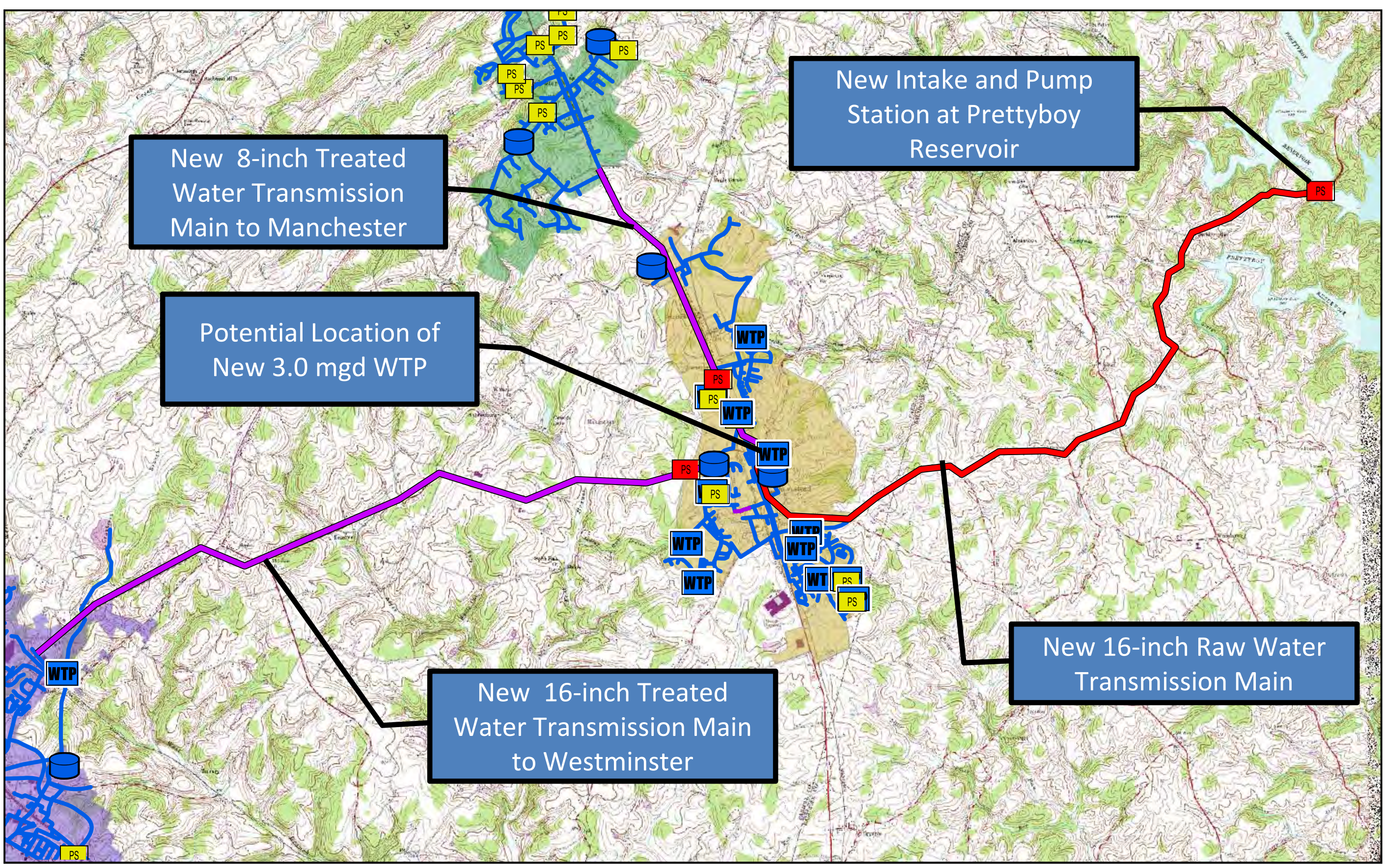
Description of Alternative:

- Potential for Baltimore's Prettyboy Reservoir to supply parts of northeastern Carroll County
- Baltimore's plans to develop a 120 mgd treatment plant for its Susquehanna River supply could significantly increase the reliability of Baltimore's water system (assuming more regular use of Susquehanna supply) such that purchase of excess capacity from Prettyboy Reservoir may become more practicable
- Baltimore water system stores 74.3 BG in 3 reservoirs draining 463 sq. mi. and includes 137 mgd capacity (250 mgd allowable) Susquehanna River Withdrawal.
- Conceptual alternative includes piping 3.0 mgd of raw water from Prettyboy via a 7.5-mile transmission main to a WTP in Hampstead.
- Requires new 3.0 mgd WTP in Hampstead.
- Regional approach to this option includes an interconnection with the Manchester (3.0-mile transmission main) and Westminster (6.7-mile transmission main) Service Areas to help supply future demands.
- Requires one high service pump station located at the intake on Prettyboy Reservoir, and two pump stations for the Manchester and Westminster interconnections.

Key Implementation Steps:

- Pursue an agreement with the City of Baltimore to purchase raw water from Prettyboy Reservoir.
- Evaluate treatment capacity of Manchester and/or Hampstead WTPs to treat additional water.
- Land Easement/Acquisition for pump station, intake, pipeline , and new WTP.
- Design and permitting for new intake and transmission mains.
- Key Permits Required:
  - USACE Section 404 Permit (assumes that a foundation will be constructed in the reservoir for the new intake structure).
  - Water and Sewerage Construction Permit
  - Water Appropriation and Use Permit
  - Non-tidal Wetlands and Waterways Permit
- Overcome potential local opposition in Baltimore County.



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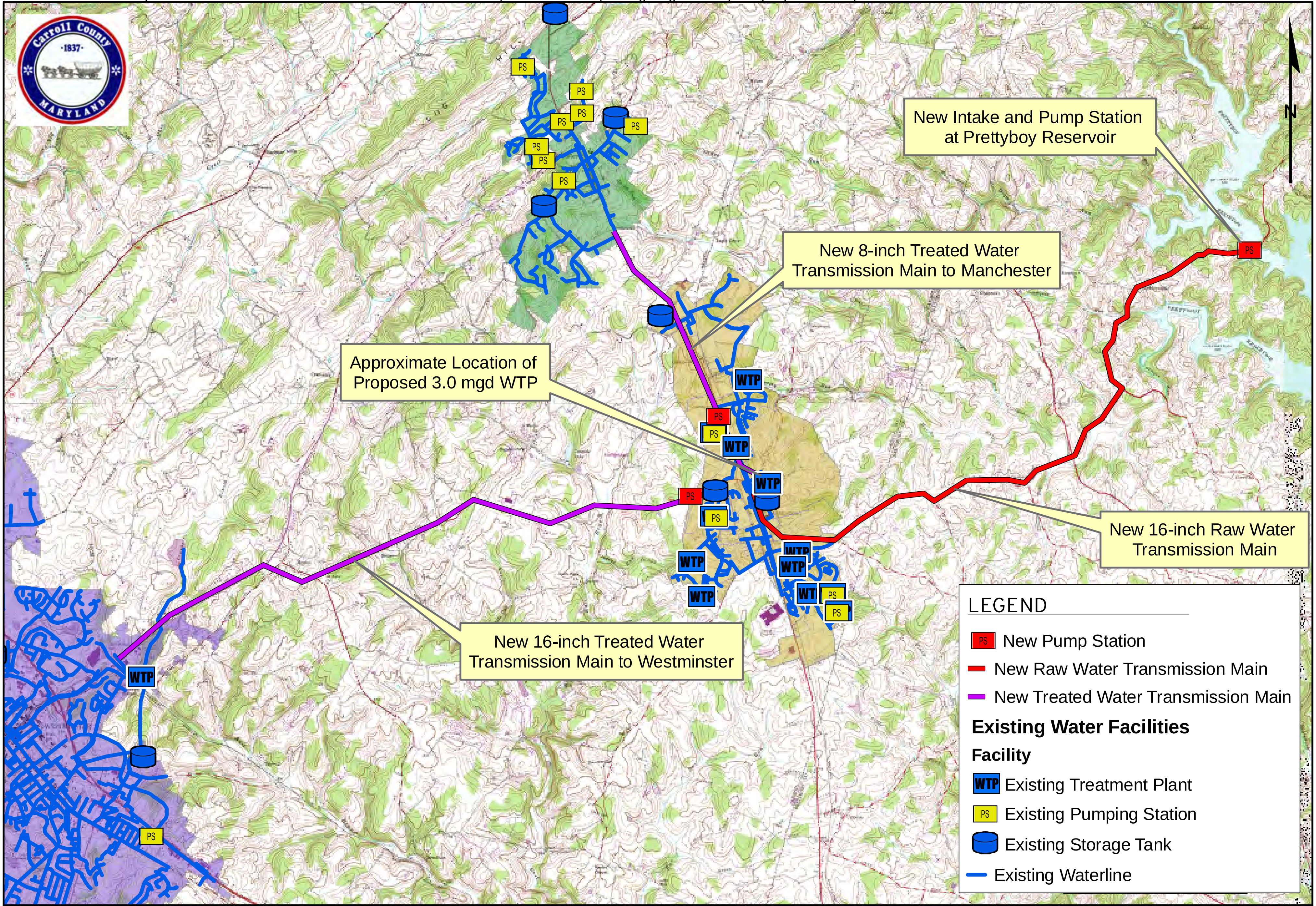

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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative R-6:
Prettyboy Reservoir

Aug 2009

Figure R-6

Table 3-3

Characteristics of Stream Intake Sites for Alternatives S-2, S-3 and S-4

Alternative	Intake Description	Drainage Area at Intake (sq. mi.)	Watershed Name	MDE 8 Digit HUC	Demands Required from Intake (mgd) [1]	Appropriate Stream Gage	UNADJUSTED Environmental Flows - Req'd Flow By (mgd) [2]		ADJUSTED TO INTAKE SITE Environmental Flows - Req'd Flow By (mgd)	
							May - Oct	Nov - Apr	May - Oct	Nov - Apr
S-2	Intake on Big Pipe Creek in Union Mills Area	24.86	Double Pipe Creek	2140304	1.4 to 2.0	1639500 - Big Pipe Creek at Bruceville, MD	32.4	43.0	4.9	6.5
S-3	Intake on Little Pipe Creek near Westminster	5.30	Double Pipe Creek	2140304	0.5	1639500 - Big Pipe Creek at Bruceville, MD	32.4	43.0	1.0	1.4
S-4	Intake on Big Pipe Creek near Taneytown	55.95	Double Pipe Creek	2140304	0.8 to 1.5	1639500 - Big Pipe Creek at Bruceville, MD	32.4	43.0	11.0	14.6

[1] Range of demands based on proposed demands for alternatives and projected needs (worst case) for nearby service area(s). Little Pipe Creek = 350 gpm.

[2] Environmental flows are based on three gages (1639000, 1571500, 1639500) and use of Maryland Most Common Flow Method.

Alternative S-1: New Surface Water Intake in Gillis Falls Area

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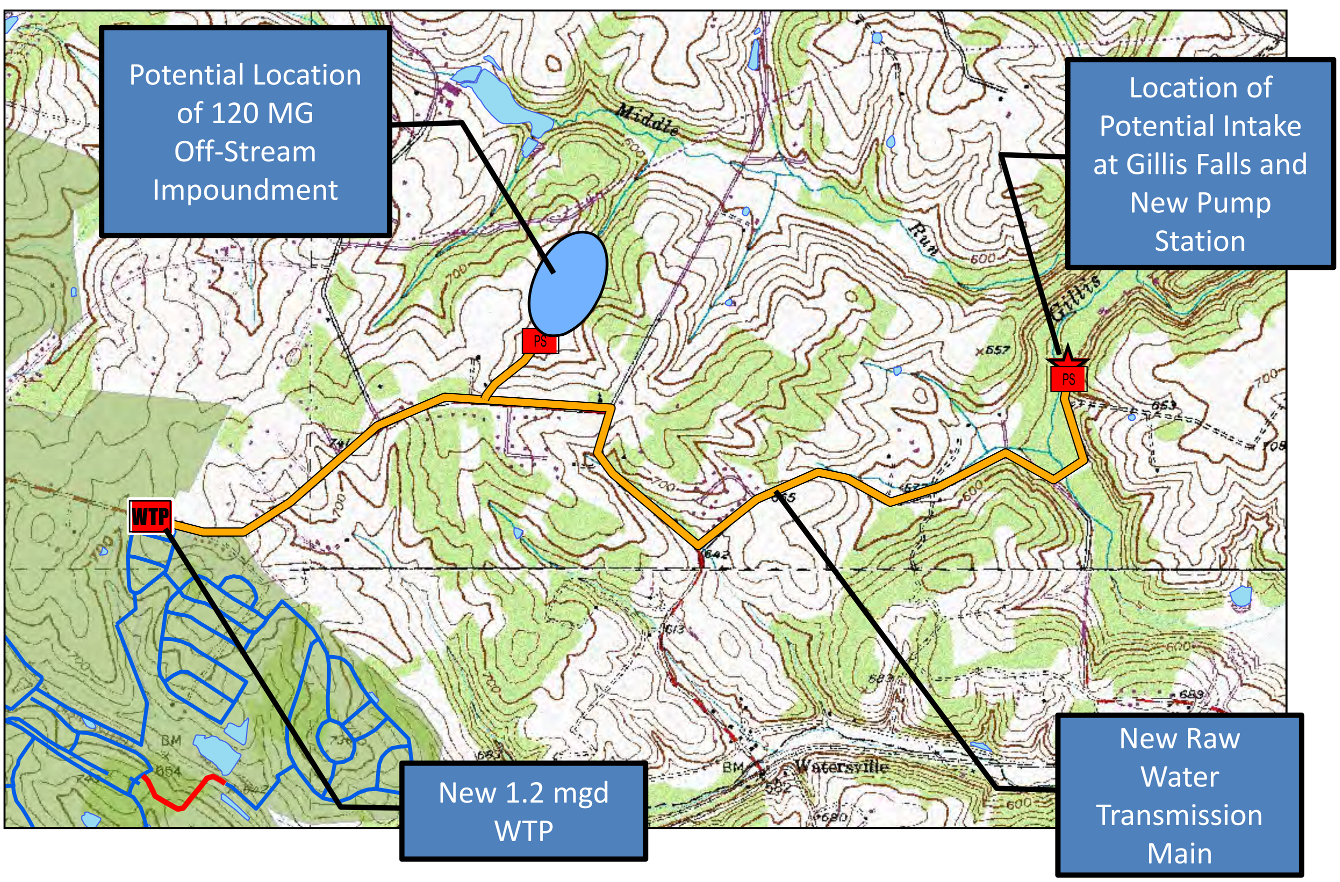
Description of Alternative:

- Mt. Airy to develop new surface water intake on Carroll County-owned property near proposed Gillis Falls Reservoir
- Intake at Gillis Falls:
  - Safe Yield = 0.85 mgd (with 100-120 MG Off-Stream Reservoir).
  - 4 mgd Raw Water Intake
- Construction of new 1.2 mgd WTP, 3 miles (16,000 l.f.) of raw water mains, 0.2 miles (1,000 l.f.) of finished water mains, and two new pump stations.
- This alternative could serve as an interim measure prior to construction of the Gillis Falls Reservoir (see Alternatives R-1a and R-1b).

Key Implementation Steps:

- Key Permits Required:
  - USACE Section 404 Permit
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
  - Dam Safety Permit
- Environmental impact studies including surveys for aquatic habitat and cultural resources within the footprint of the raw water storage impoundment.
- Confirm that 100-120 MG of off-stream storage is adequate to secure the desired 0.85 mgd stream intake safe yield
- Address Tier II stream impact review.



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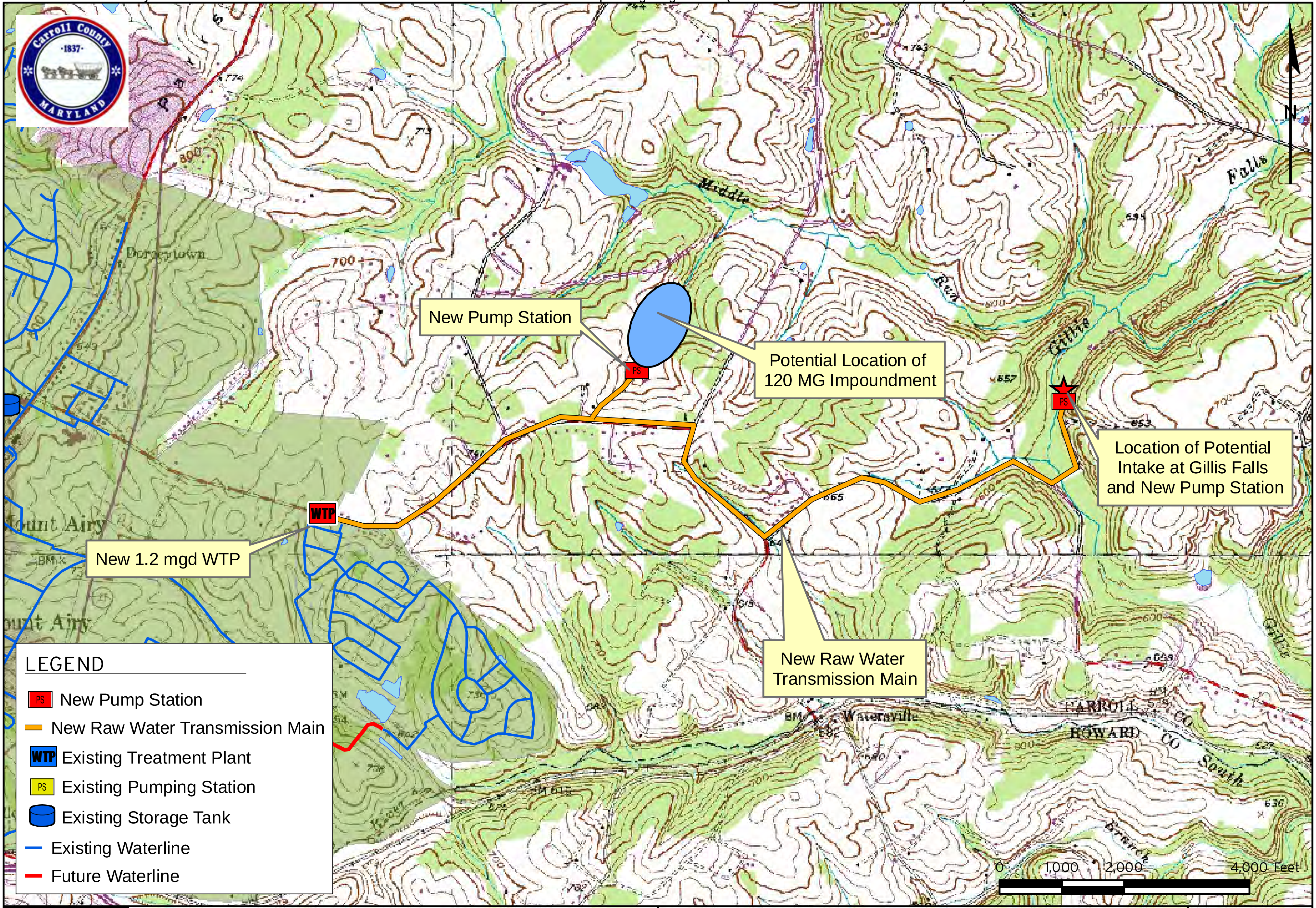

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ALTERNATIVES EVALUATION

Alternative S-1:
New Surface Water Intake in Gillis Falls Area

Aug 2009

Figure S-1

Alternative S-2: New Intake on Big Pipe Creek in Union Mills Area (Westminster)

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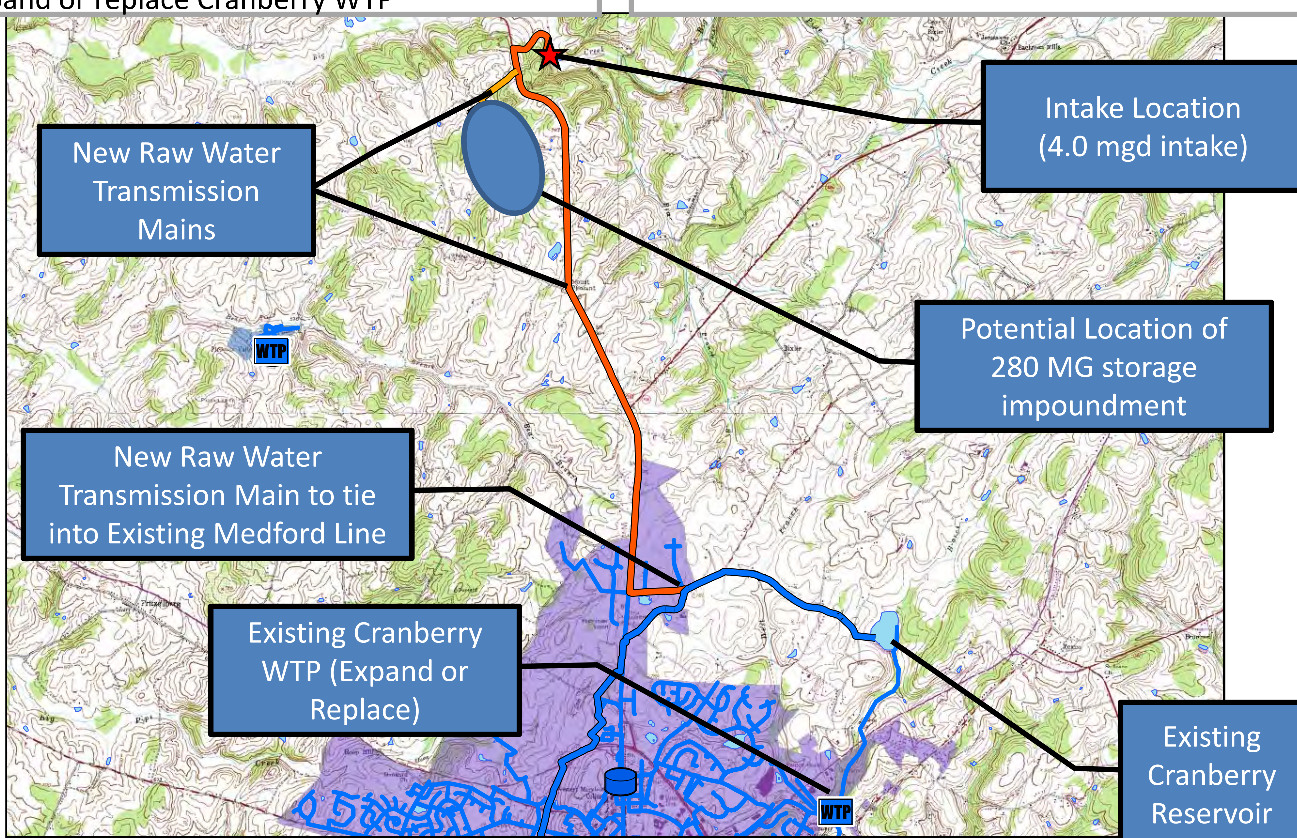
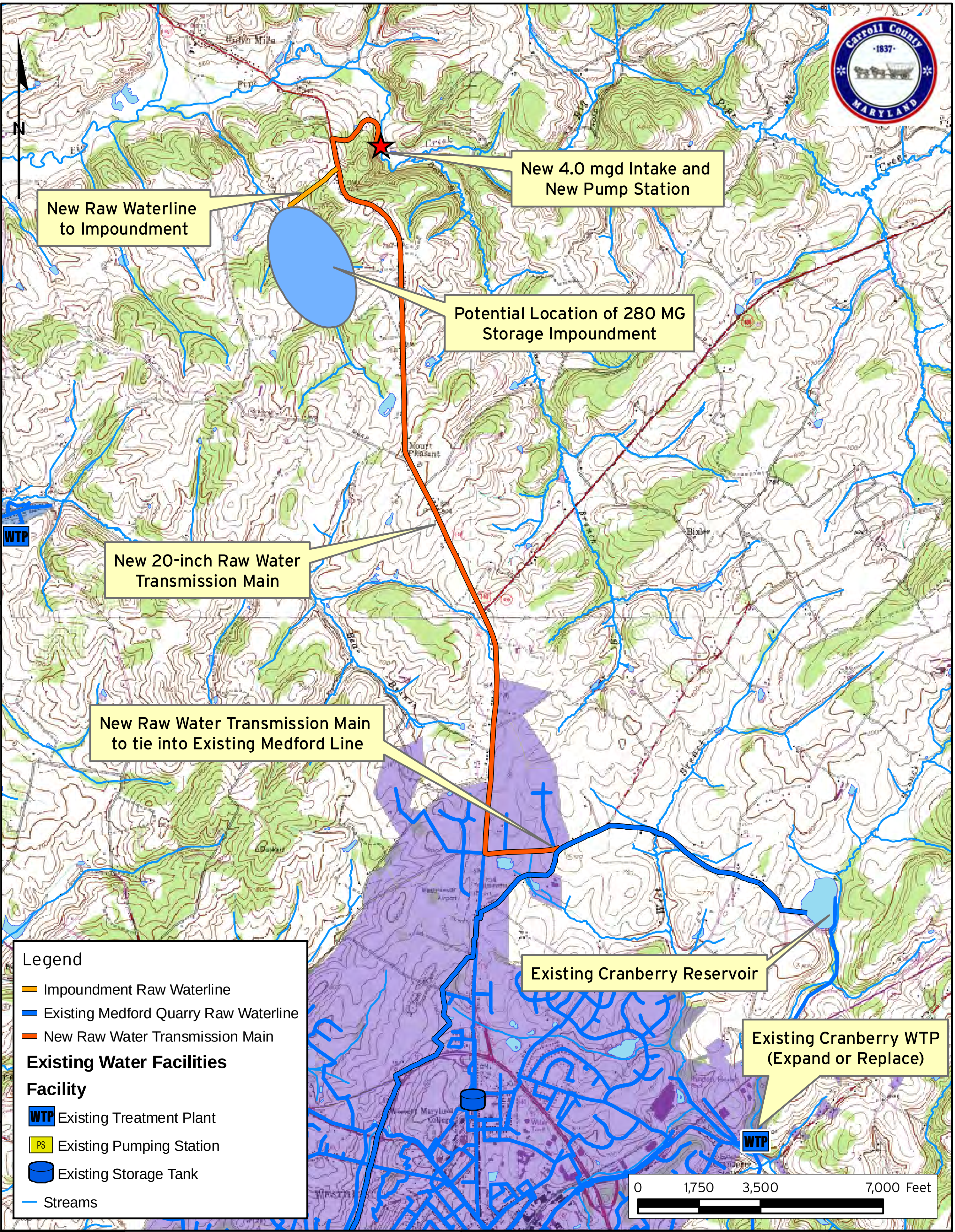
Description of Alternative:

- City of Westminster – construct intake on Big Pipe Creek in the Union Mills Area
- 0.7 mgd safe yield with 4.0 mgd intake. Original desired safe yield of 2.0 mgd does not appear feasible due to lack of available open land for 1.0 BG storage impoundment outside of proposed footprint of Union Mills Reservoir
- New pump station at intake location
- 280 MG off-stream storage impoundment (Normal Pool El 650 ft) would leave an estimated minimum 20% storage reserve in worst simulated drought periods
- Approximately 5 miles of raw water transmission mains to Cranberry Reservoir and storage impoundment. Transmission main to be sized for Union Mills flows (4.0 mgd max day capacity), requiring 20-inch pipeline.
- Phased project – development of this intake on Big Pipe Creek may be constructed prior to the ultimate development of the Union Mills Reservoir.
- Expand or replace Cranberry WTP

Key Implementation Steps:

- Raw water transmission main to tie into existing Medford line.
- Confirm location of off-stream storage impoundment and confirm that approximately 280 MG could be stored at such location
- Develop Mitigation Plan (associated with impoundment):
  - Approx. 1.1 miles of stream impacts
  - Approx. 3.5 acres of wetland impacts
- Environmental impact studies including surveys to confirm aquatic habitat and cultural resources within the footprint of the raw water storage impoundment
- Land and Easement Acquisition
- Key Permits Required:
  - USACE Section 404 Permit
  - Water Appropriation and Use Permit (submitted in May 2006)
  - Water and Sewerage Construction Permit
  - Dam Safety Permit
  - Non-tidal Wetlands and Waterways Permit





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ALTERNATIVES EVALUATION

Alternative S-2:
New Intake on Big Pipe Creek in Union Mills Area (Westminster)

Sept 2009

Figure S-2

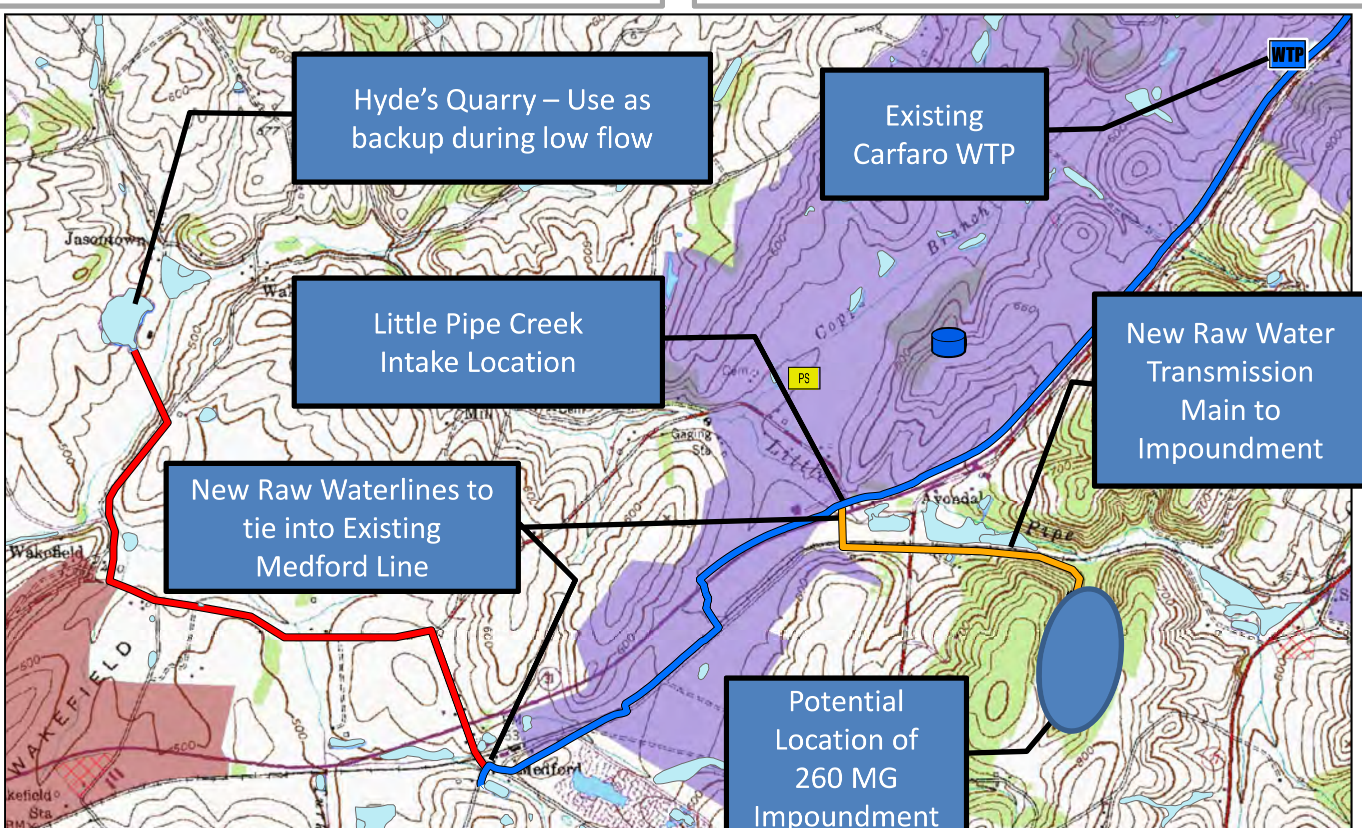
Alternative S-3: New Intake on Little Pipe Creek for Westminster

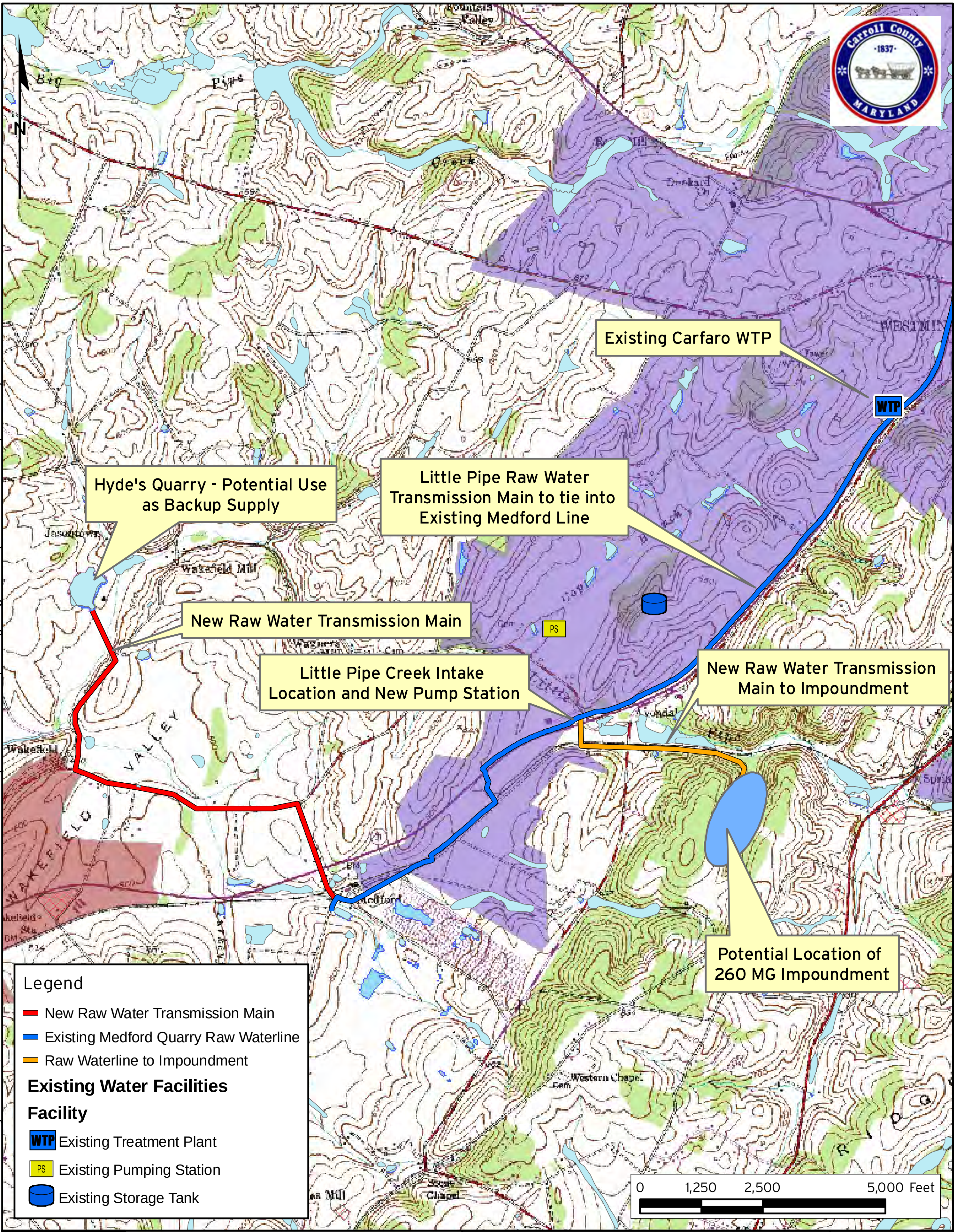
Description of Alternative:

- City of Westminster evaluating use of Little Pipe Creek as additional supply to meet a portion of its future needs.
- 0.5 mgd demand to be satisfied with a 1.3 mgd intake on Little Pipe Creek near the intersection of Route 31 and Old New Windsor Pike.
- 260 MG off-stream storage impoundment (Normal Pool El 680 ft) would leave an estimated minimum 20% storage reserve in worst simulated drought periods
- Potential to use Hyde's Quarry as backup to use during low flow periods.
- Requires new intake, two pump stations (one at intake and one at impoundment/Hyde's Quarry) and approximately 0.8 miles of new raw water transmission main (approx. 2.0 miles of raw water mains required if Hyde's Quarry is utilized as backup source).
- Existing Carfaro WTP has sufficient capacity to treat Little Pipe Creek water

Key Implementation Steps:

- Environmental impact studies including surveys for aquatic habitat and cultural resources within the footprint of the raw water storage impoundment. No stream or wetlands impacts at the proposed impoundment site, based on GIS analysis of available mapped aquatic habitat.
- Confirm that MDE would appropriate the full 0.5 mgd for this source, because the nearby Gazelle Well has been appropriated for 0.32 mgd, which may reduce the appropriation for this intake.
- Confirm location for off-stream storage impoundment and confirm that approximately 260 MG could be stored at such location Land and Easement Acquisition
- Key Permits Required:
  - USACE Section 404 Permit
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
  - Dam Safety Permit





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ALTERNATIVES EVALUATION

Alternative S-3: New Intake on Little Pipe Creek

Aug 2009

Figure S-3

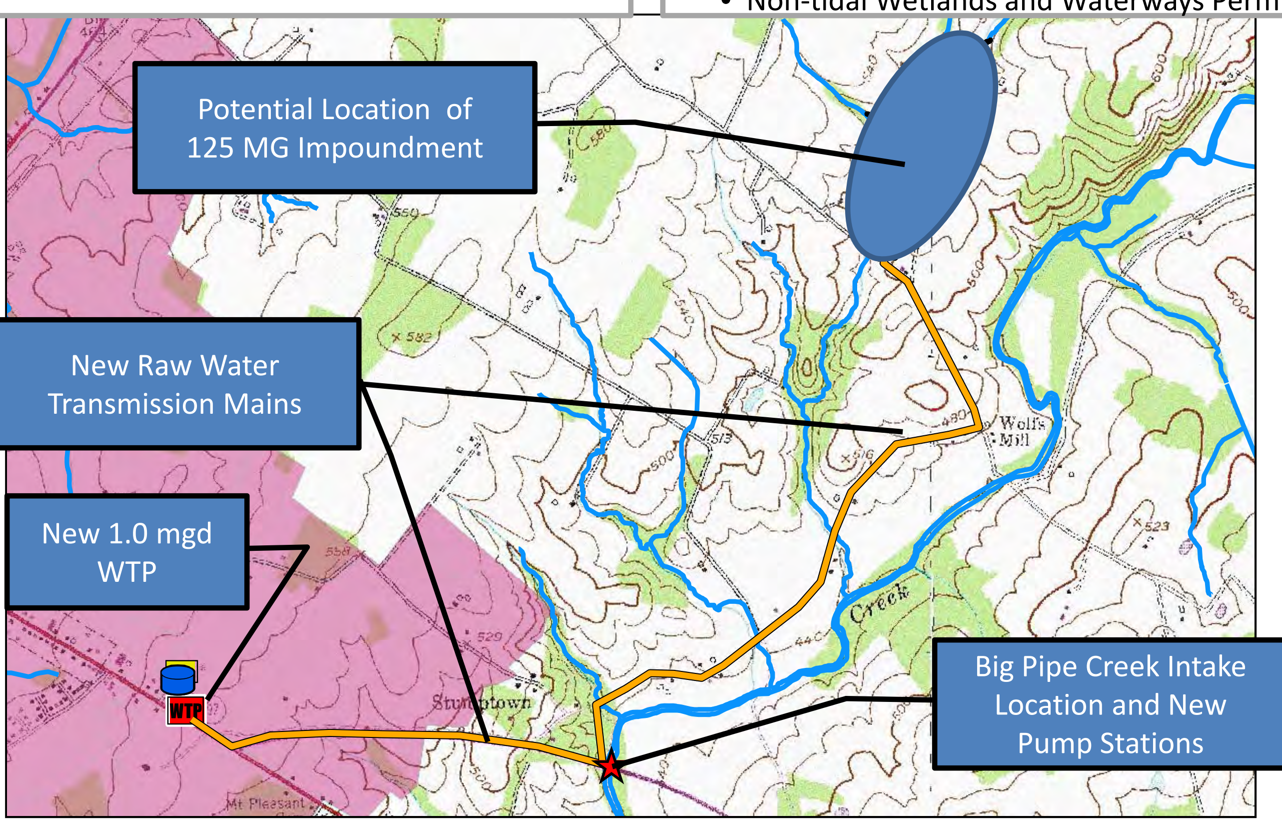
Alternative S-4: New Intake on Big Pipe Creek for Taneytown

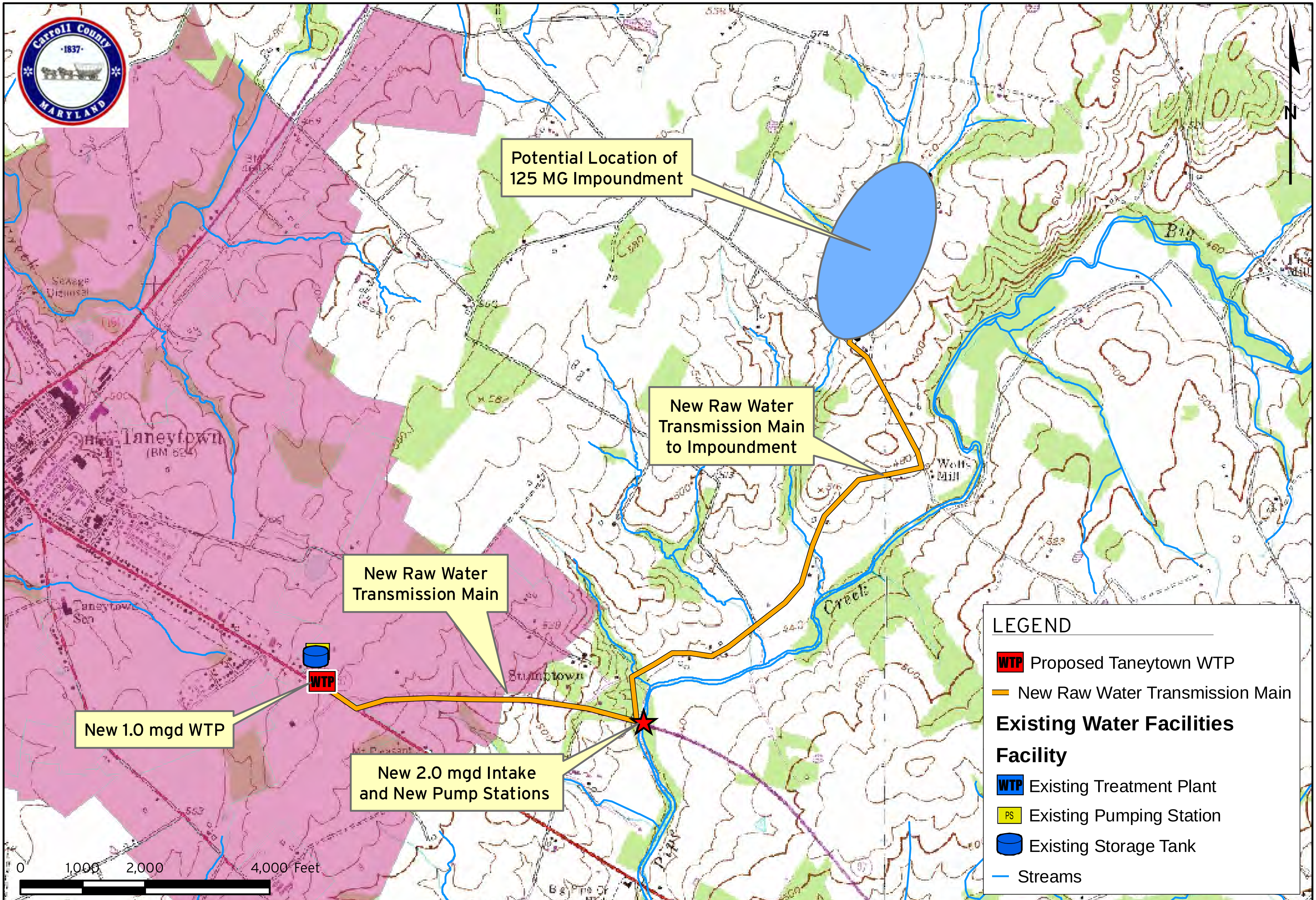
Description of Alternative:

- Taneytown – development of new surface water supply on Big Pipe Creek.
- 0.4 mgd safe yield with 2.0 mgd intake. Original desired safe yield of 1.5 mgd does not appear to be feasible due to lack of available open land for 720 MG storage impoundment
- 125 MG off-stream storage impoundment (Normal Pool El 500 ft) would leave an estimated minimum 20% storage reserve in worst simulated drought periods
- Requires construction of intake structure and two raw water pumping stations at Big Pipe Creek in the area of MD 140; approximately 2.8 miles of new raw water transmission line (1 mile to new WTP and 1.8 miles to impoundment) and new 1.0 mgd WTP

Key Implementation Steps:

- Design and construction of new WTP
- Confirm location of off-stream storage impoundment and confirm that approximately 125 MG could be stored at such location
- Develop Mitigation Plan:
  - Approx. 0.8 miles of stream impacts
  - Approx. 9.1 acres of wetland impacts
- Environmental impact studies including surveys to confirm aquatic habitat and cultural resources within the footprint of the raw water storage impoundment
- Land and Easement Acquisition
- Examine Geologic Constraints
- Pipeline from intake and impoundment would need to be constructed through Carroll County Agricultural Land Preservation Easements.
- Key Permits Required:
  - USACE Section 404 Permit
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
  - Dam Safety Permit
  - Non-tidal Wetlands and Waterways Permit





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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative S-4: New Intake on Big Pipe Creek for Taneytown

Aug 2009

Figure S-4

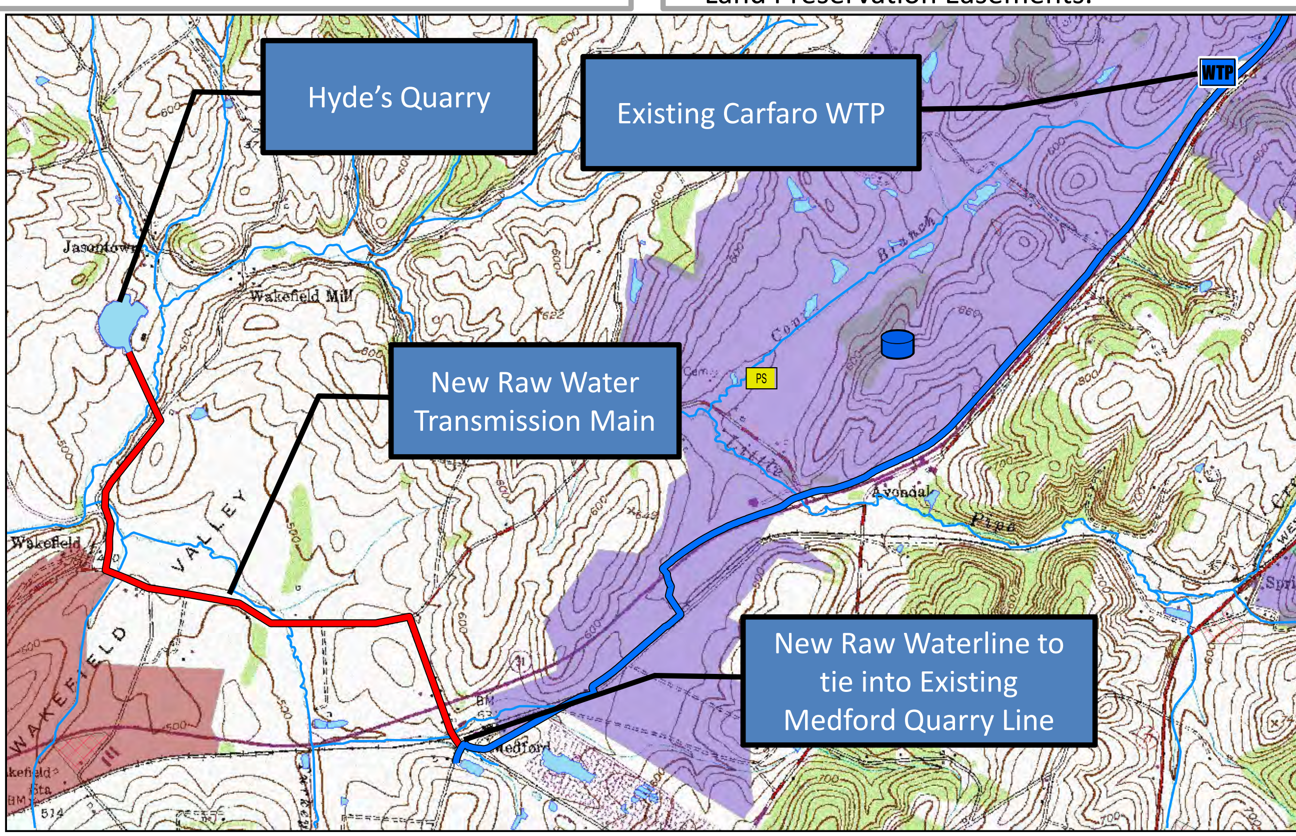
Alternative Q-1: Hyde's Quarry – New Raw Water Reservoir

Description of Alternative:

- Extend raw water line from Hyde's Quarry to City of Westminster's system for additional supply. Treat at existing Carfaro WTP.
- Quarry could serve as backup to Little Pipe Creek intake during periods of drought or as new water source
- Surface area of 9 acres, 50-75 feet deep
- Approximately 1.0 mgd AAD (based on dewatering allocation). Approximate yield of 0.5 mgd needed to serve as backup supply for Little Pipe Creek Intake.
- Approximately 2 miles of raw water transmission mains to tie into existing Medford Quarry Line

Key Implementation Steps:

- Land and Easement Acquisition
- Additional testing, including tests to ensure that flow from Little Pipe Creek does not infiltrate into quarry. WWTP effluent is discharged to Little Pipe Creek approximately 2 miles upstream of the quarry.
- Key Permits Required:
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
- Steps completed to date:
  - Withdrawal application submitted in December 2006. Initially quarry to be used as backup for Little Pipe Creek. Once Hyde's Quarry withdrawal is permitted and connected to the City's system, use quarry as additional water supply source.
- Confirm that storage volume of Hyde's Quarry is adequate to secure the desired 0.5 mgd stream intake.
- Pipeline from Hyde's Quarry would need to be constructed through Carroll County Agricultural Land Preservation Easements.



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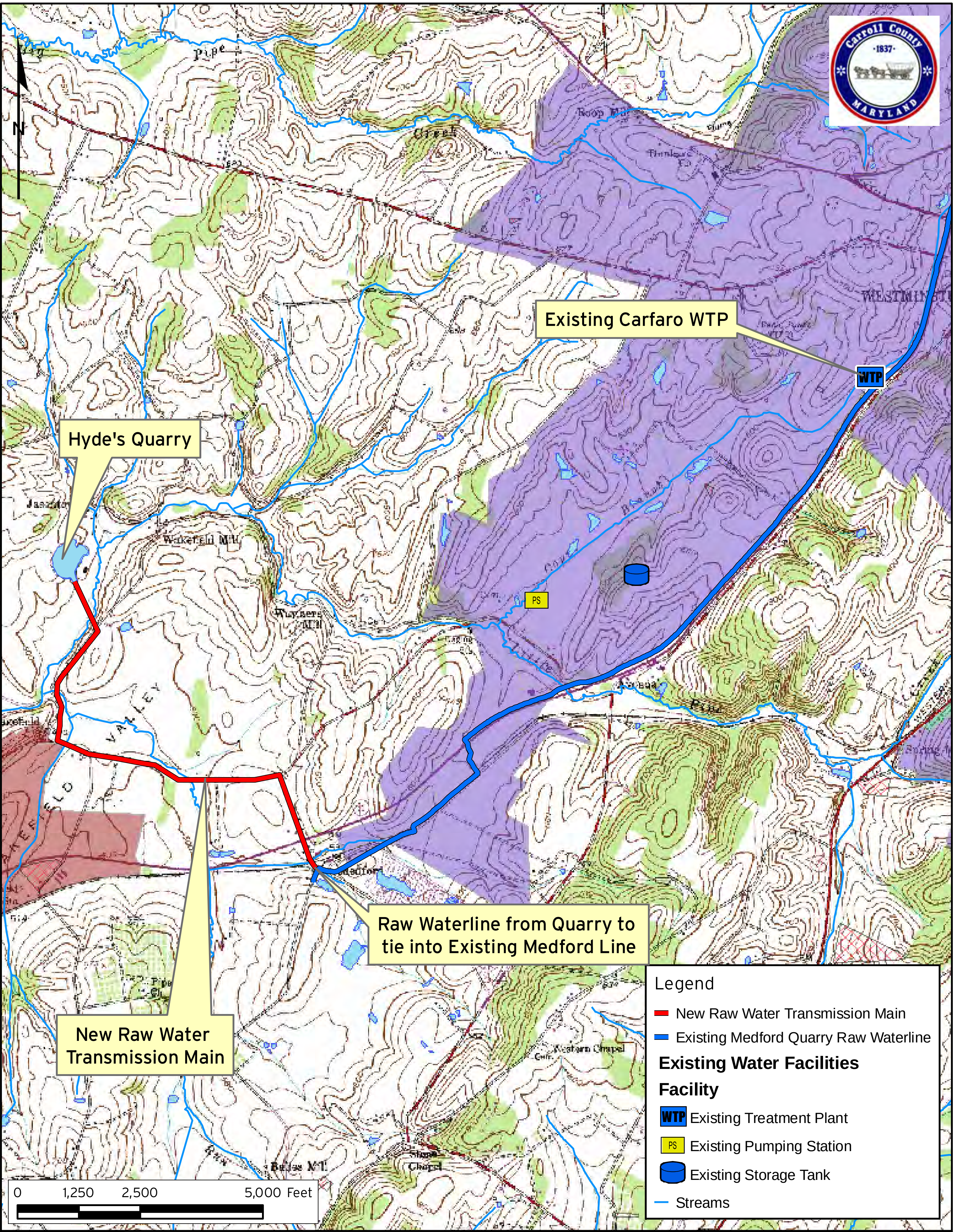


MALCOLM PIRNIE	CARROLL COUNTY, MD ALTERNATIVES EVALUATION	Alternative Q-1: Hyde's Quarry	Aug 2009 Figure Q-1

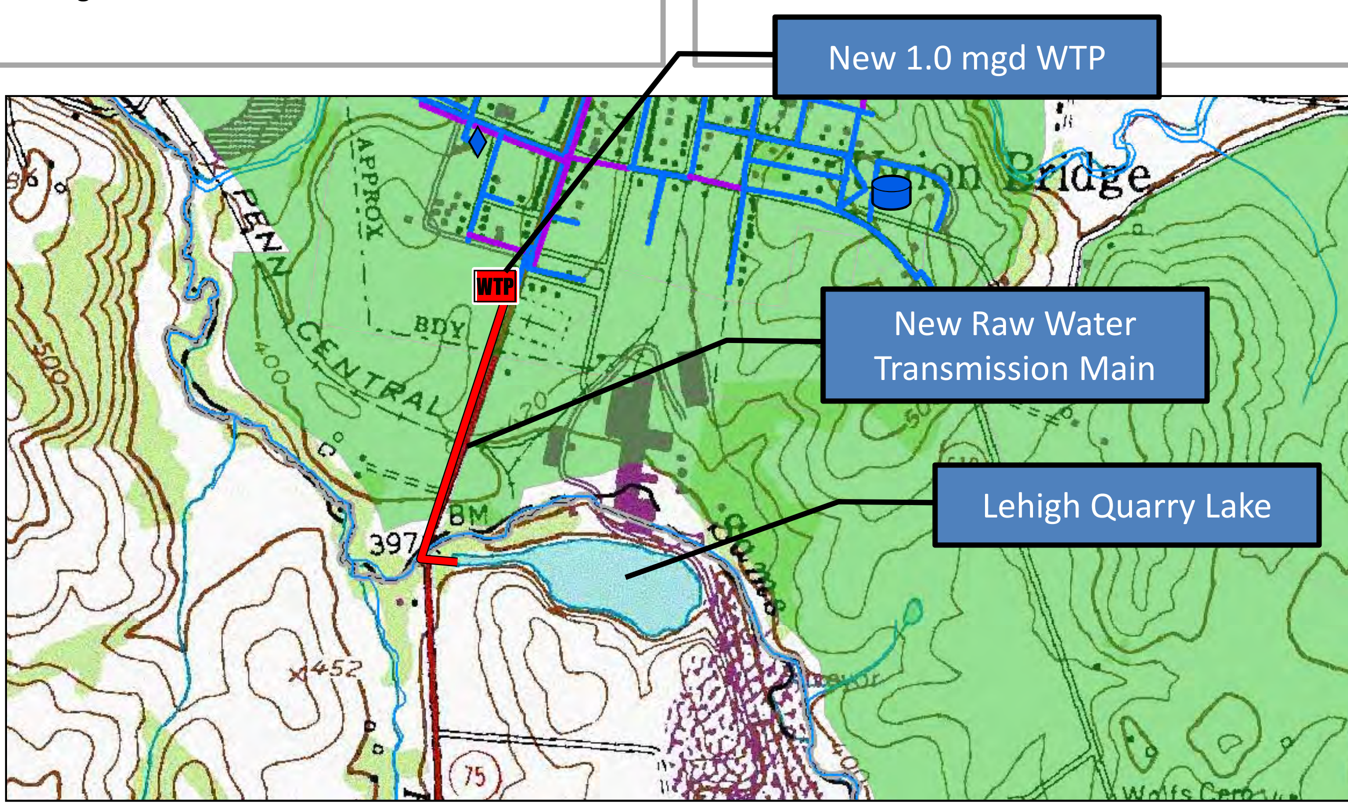
Alternative Q-2: Lehigh Quarry – Union Bridge

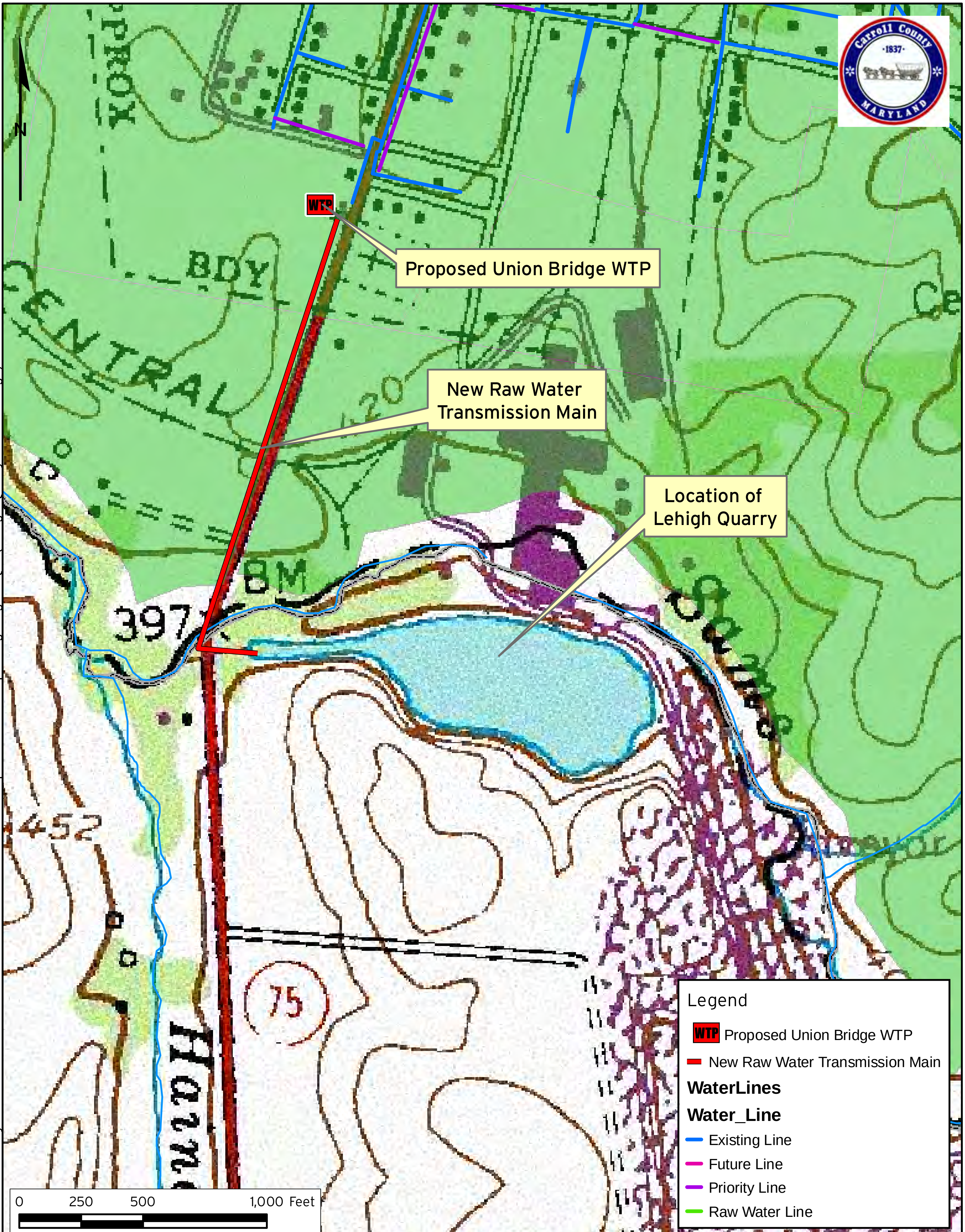
Description of Alternative:

- Lehigh Quarry as raw water reservoir for Union Bridge. Inactive quarry that has filled with water and discharges to Sams Creek. Another pit is currently being mined, but it appears that the need could be satisfied using the existing inactive pit.
- Requires improvements at the existing floating lake pump station to allow for significant drawdown of the lake without interrupting or significantly impacting the existing pump station. In addition, an in-line booster pump needs to be installed in order to maintain pressure in the line if the water level is drawn down too low.
- New 0.5-mile raw water transmission lines to Union Bridge and new 1.0 mgd WTP
- Lehigh Cement Company has appropriation permit (effective June 1, 2005) to withdraw 1 mgd AAD (2 mgd average during month of maximum use) for quarry dewatering.
- Target supply at 0.6 mgd to meet future Union Bridge Service Area needs.

Key Implementation Steps:

- Either wait to utilize this source after quarry operations have ceased (since quarry currently uses this source as cooling water) or implement measures to ensure contamination potential is minimized.
- Key Permits Required:
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit
- Develop agreement with quarry owner





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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative Q-2: Lehigh Quarry - Union Bridge

Aug 2009

Figure Q-2

Alternative Q-3: Lehigh Quarry – New Windsor

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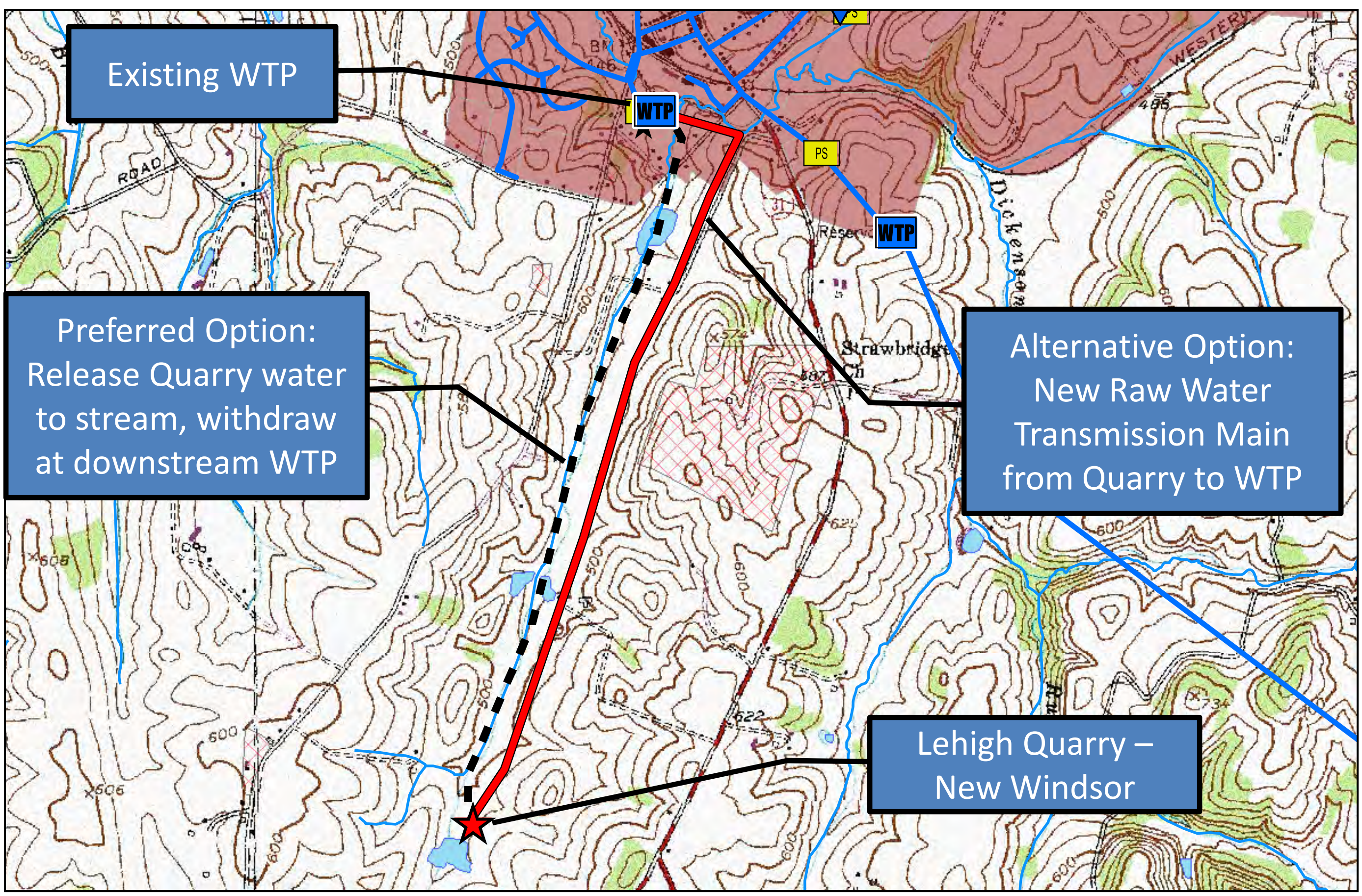
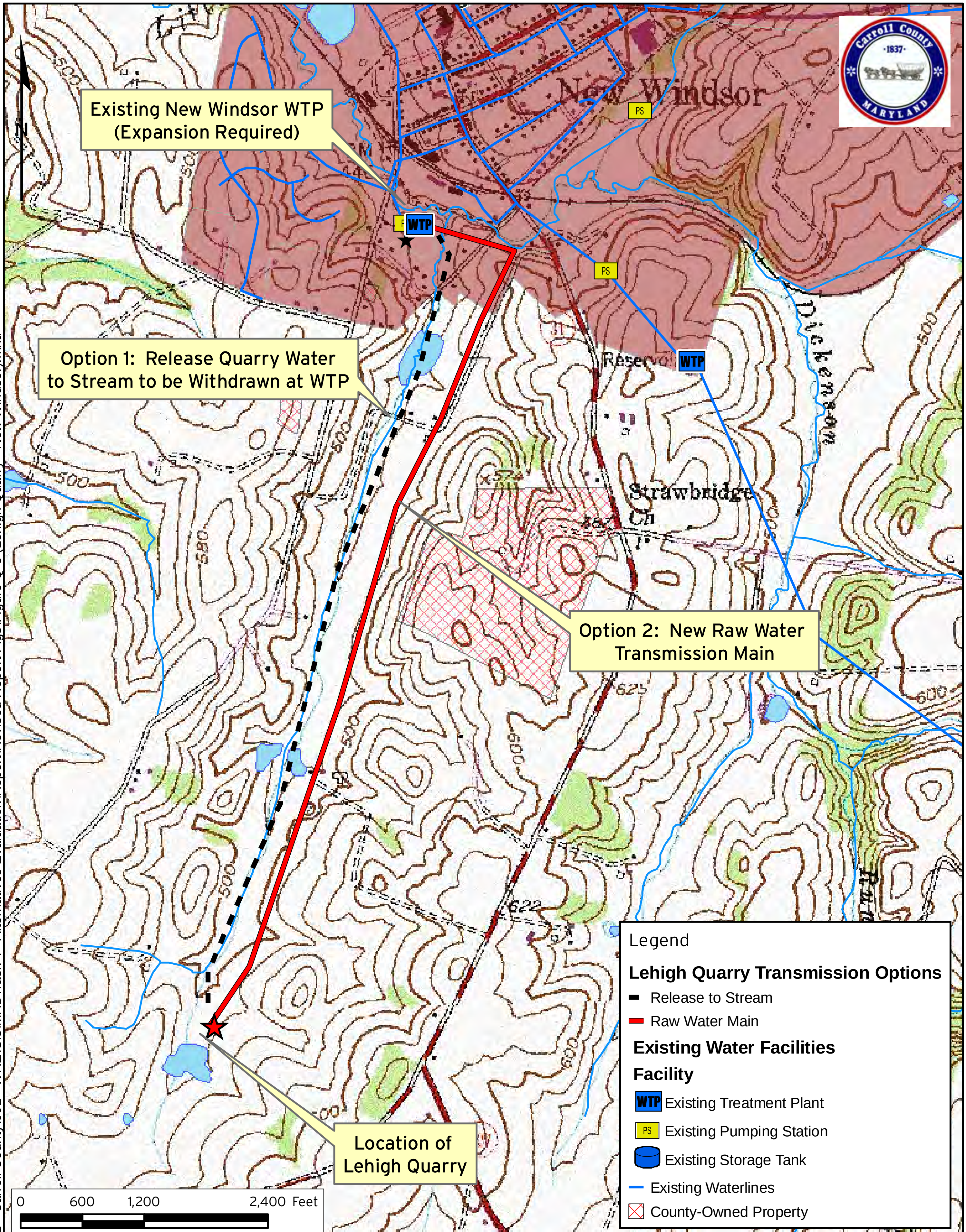
Description of Alternative:

- Lehigh Quarry as raw water reservoir
- Quarry is still being developed, and will likely take 10 years before a “hole” is formed that can be dewatered. Estimated 20-40 years before quarry is inactive, leaving a potential raw water source.
- May require a new 1.7-mile raw water transmission main to New Windsor water service area.
- Target supply at 0.25 mgd to meet future New Windsor Service Area needs.
- Dewatering permit allocation of 1 mgd AAD, 2 mgd average during month of maximum use.

Key Implementation Steps:

- Obtain appropriations permit for use of discharge from dewatering operations or use of inactive quarry as raw water source.
- Approval from MDE to release quarry water to stream for withdrawal downstream at WTP. Pending water quality testing of discharge water.
- Key Permits Required:
  - Water Appropriation and Use Permit
  - Water and Sewerage Construction Permit





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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative Q-3: Lehigh Quarry - New Windsor

Aug 2009

Figure Q-3

Alternative Q-4: Medford Quarry – Use as Permanent Water Supply

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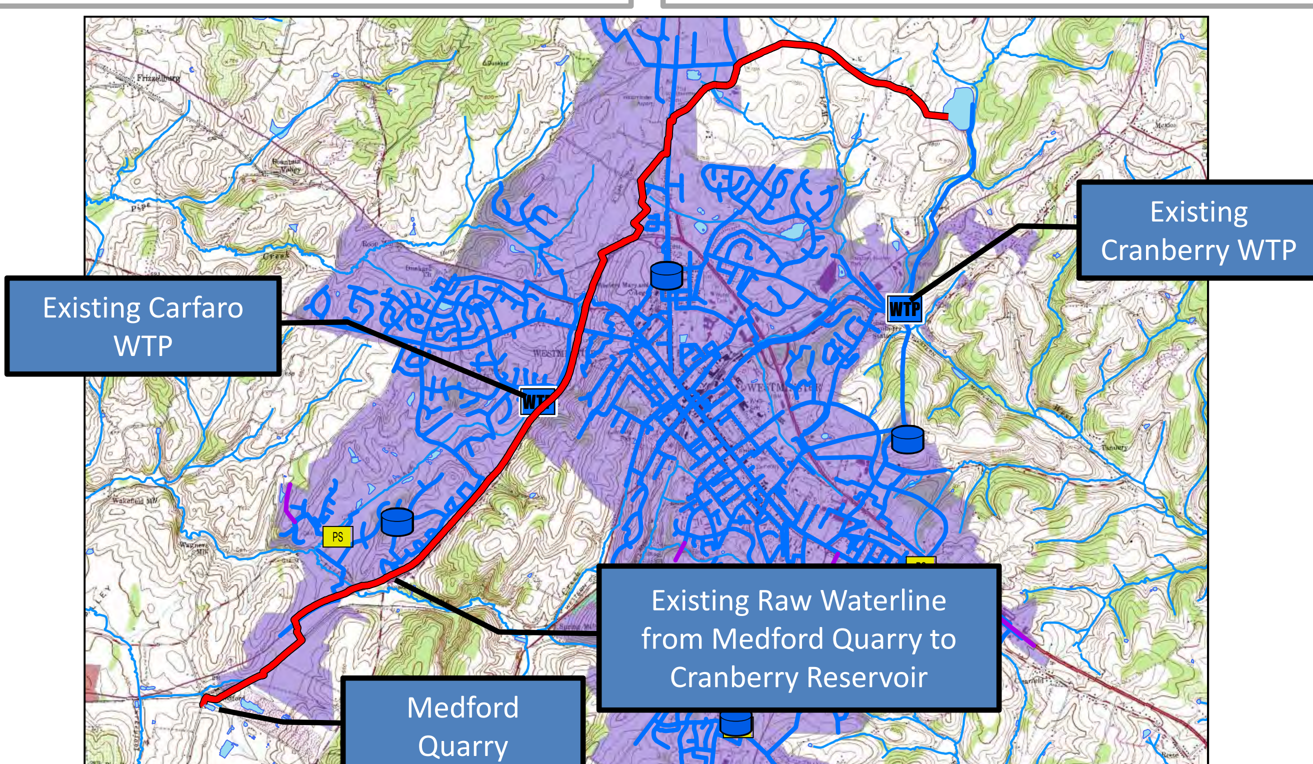
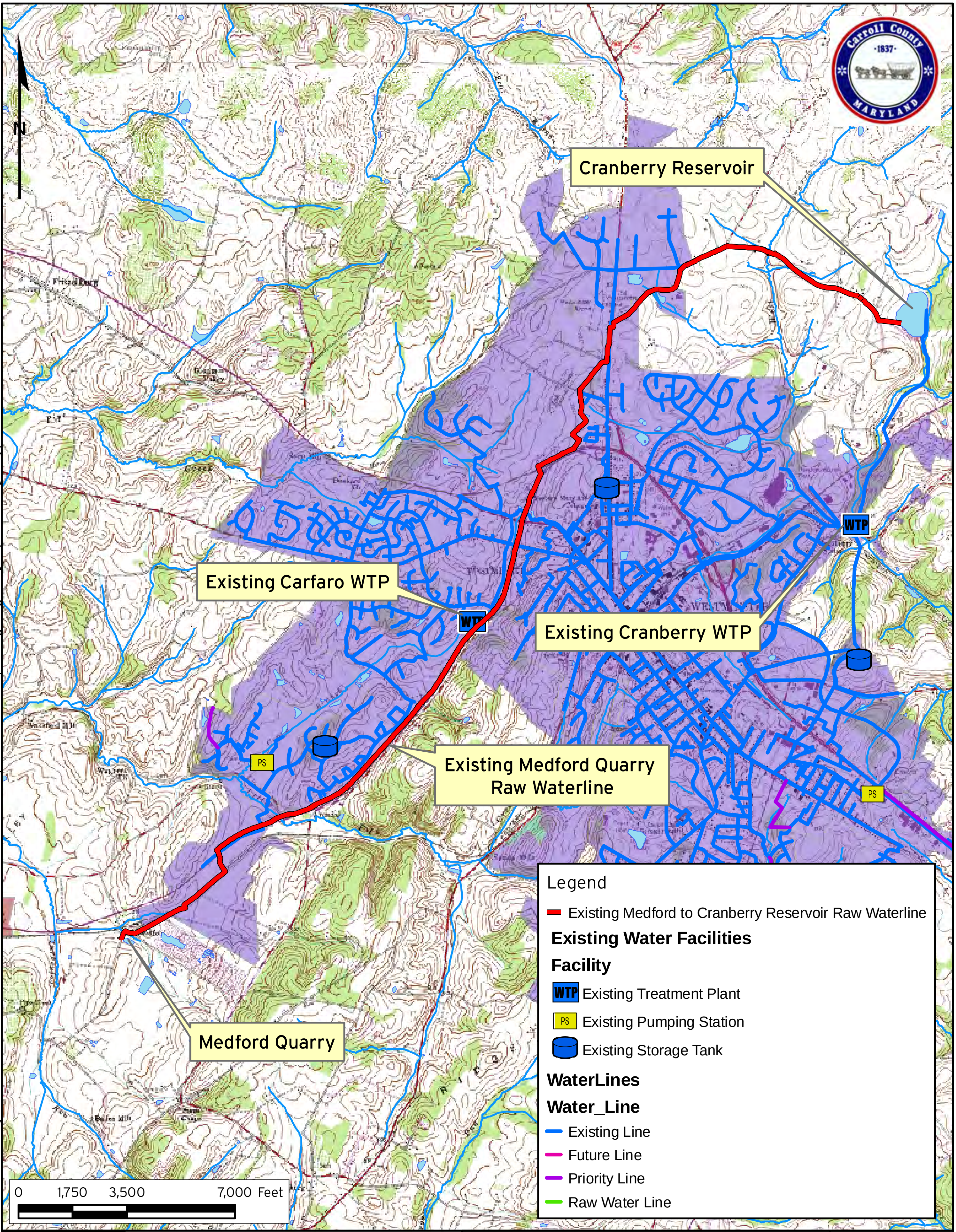
Description of Alternative:

- Medford Quarry currently appropriated for "emergency use" only (90-day backup supply). This option includes having the appropriation definition changed by MDE to allow Westminster to use the Medford Quarry as a permanent water supply, not just an emergency supply source.
- Current Emergency (90-day) Appropriation:
  - 162,000 gpd annual average
  - 655,000 gpd maximum daily withdrawal
- Note – according to the Impact Analysis Summary included as part of the appropriation permit, the amount of groundwater available on the quarry property is 139,000 gpd avg.. The amount of water that was pumped from the quarry during the summer of the 2002 drought (90-day period) was approximately 922,500 gpd.
- Pipeline and associated facilities are already in place for the use of water from the Medford Quarry.
- Medford Quarry water can be treated at Carfaro or Cranberry WTPs (no capacity expansion required).

Key Implementation Steps:

- Obtain approval from MDE to change the conditions of Westminster's current appropriation permit (CL2002G042(03)).
- Analyze water supply potential via the appropriation process





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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative Q-4: Medford Quarry - Use as Permanent Source

Aug 2009

Figure Q-4

Alternative I-1: Mount Airy Interconnection with Frederick County

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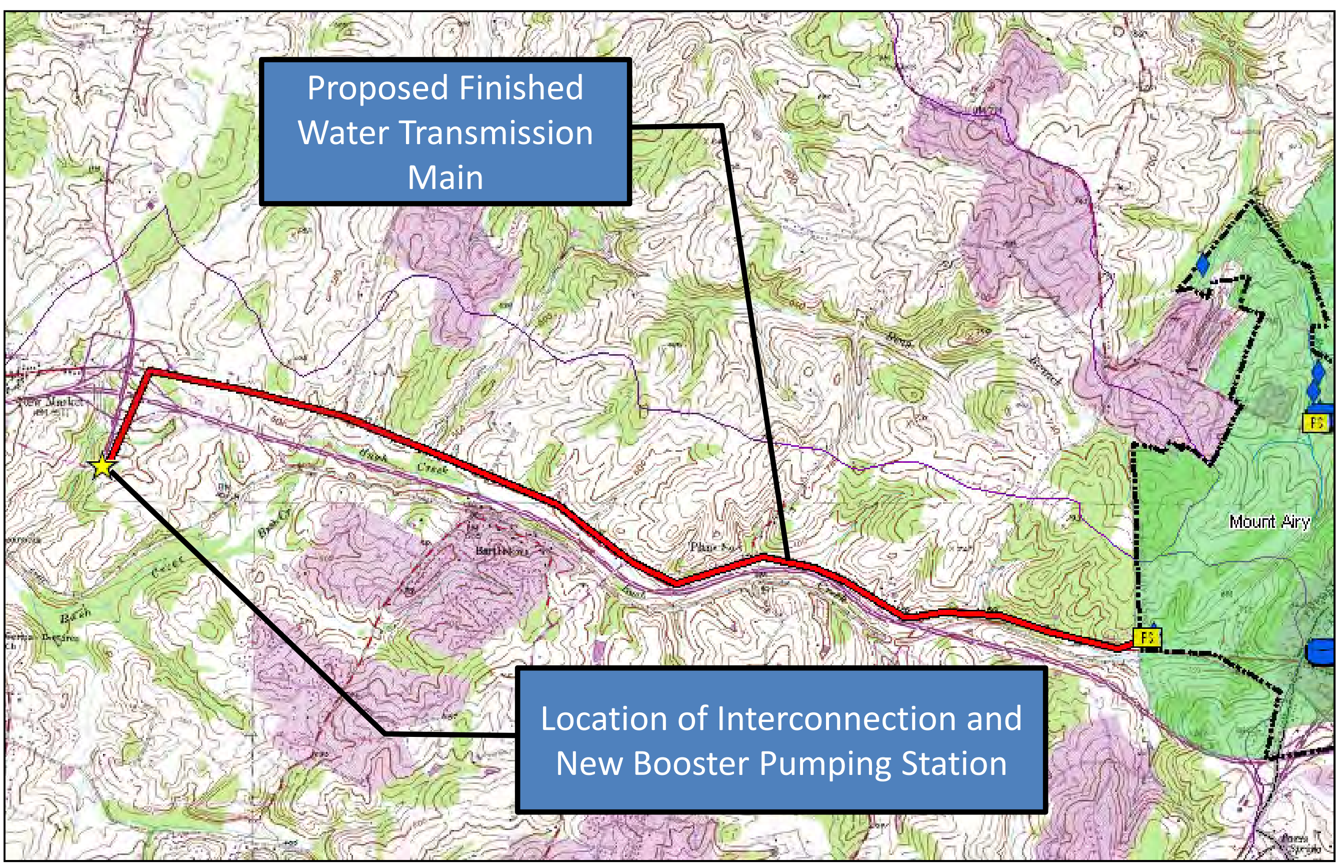
Description of Alternative:

- Interconnection with the Frederick County finished water system
- Based on the Town of Mount Airy Water Supply Alternatives Study (Hazen and Sawyer, April 2006):
  - Requires booster pumping station at Monrovia and 7.6 miles (40,000 feet) of 16-inch finished water main to the Town of Mount Airy
  - Long-term annual demand deficit of 0.85mgd. Purchase agreement to supply 0.6 mgd (max agreement of 1.2 mgd).

Key Implementation Steps:

- Requires Town of Mount Airy to reach agreement with Frederick County to purchase an initial 0.6 mgd of finished water with an option to purchase another 0.6 mgd in the future (1.2 mgd total).
- Design and permit treated water transmission main to connect to Mount Airy.
- Land and Easement Acquisition



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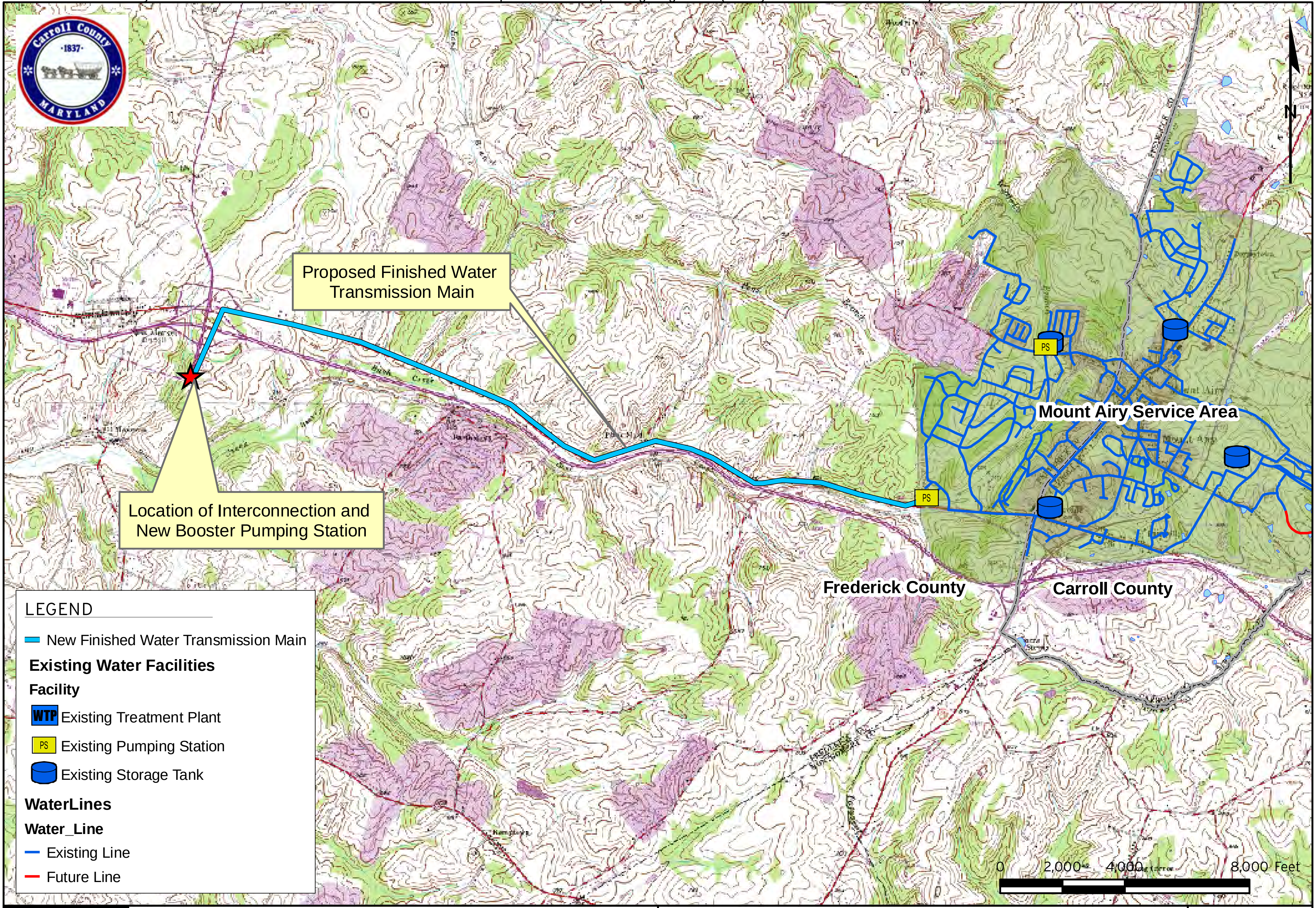


MALCOLM PIRNIE	CARROLL COUNTY, MD ALTERNATIVES EVALUATION	Alternative I-1: Mount Airy Interconnection with Frederick County	Aug 2009 Figure I-1

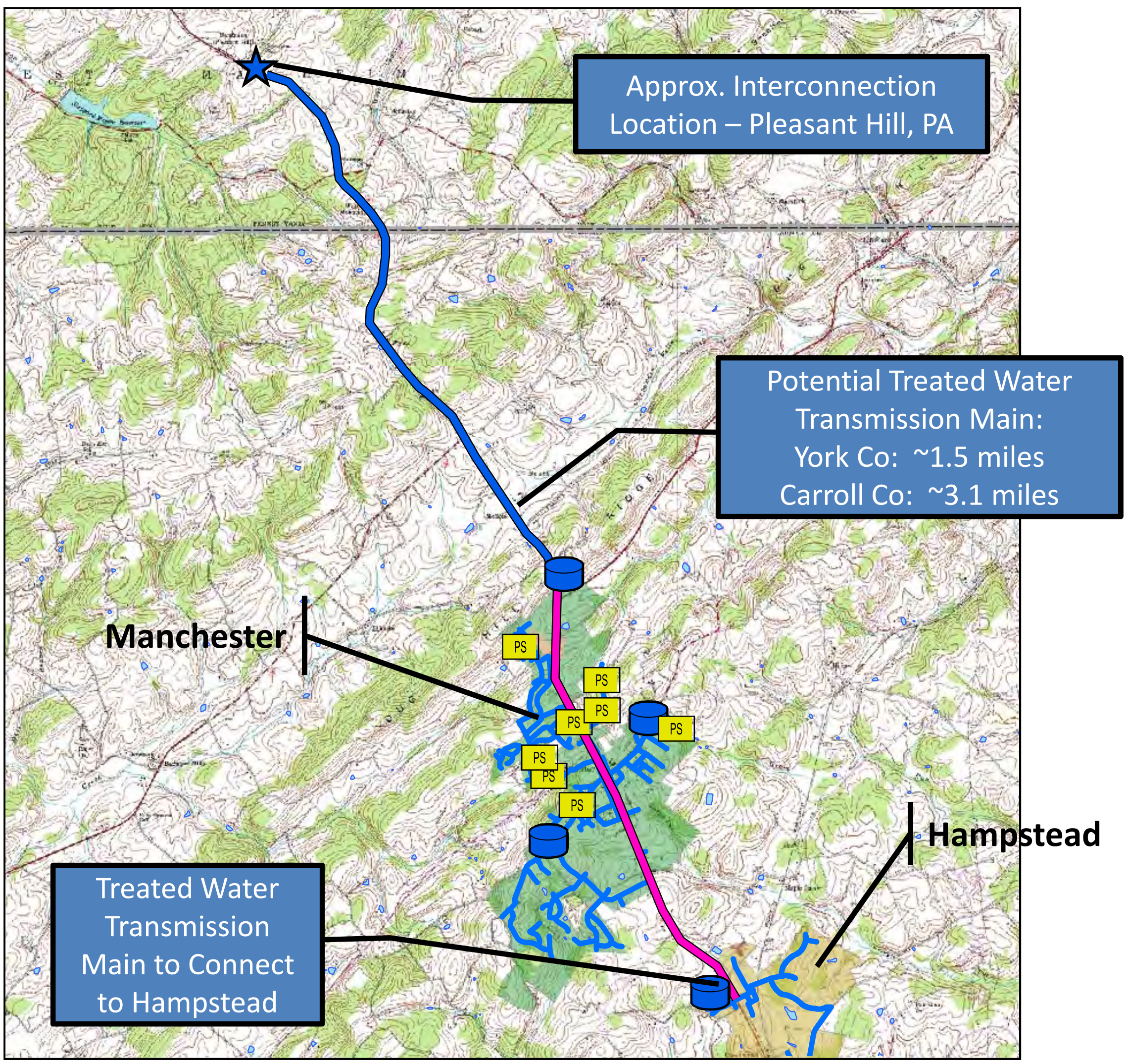
Alternative I-2: Interconnection with York Water Company (York, PA)

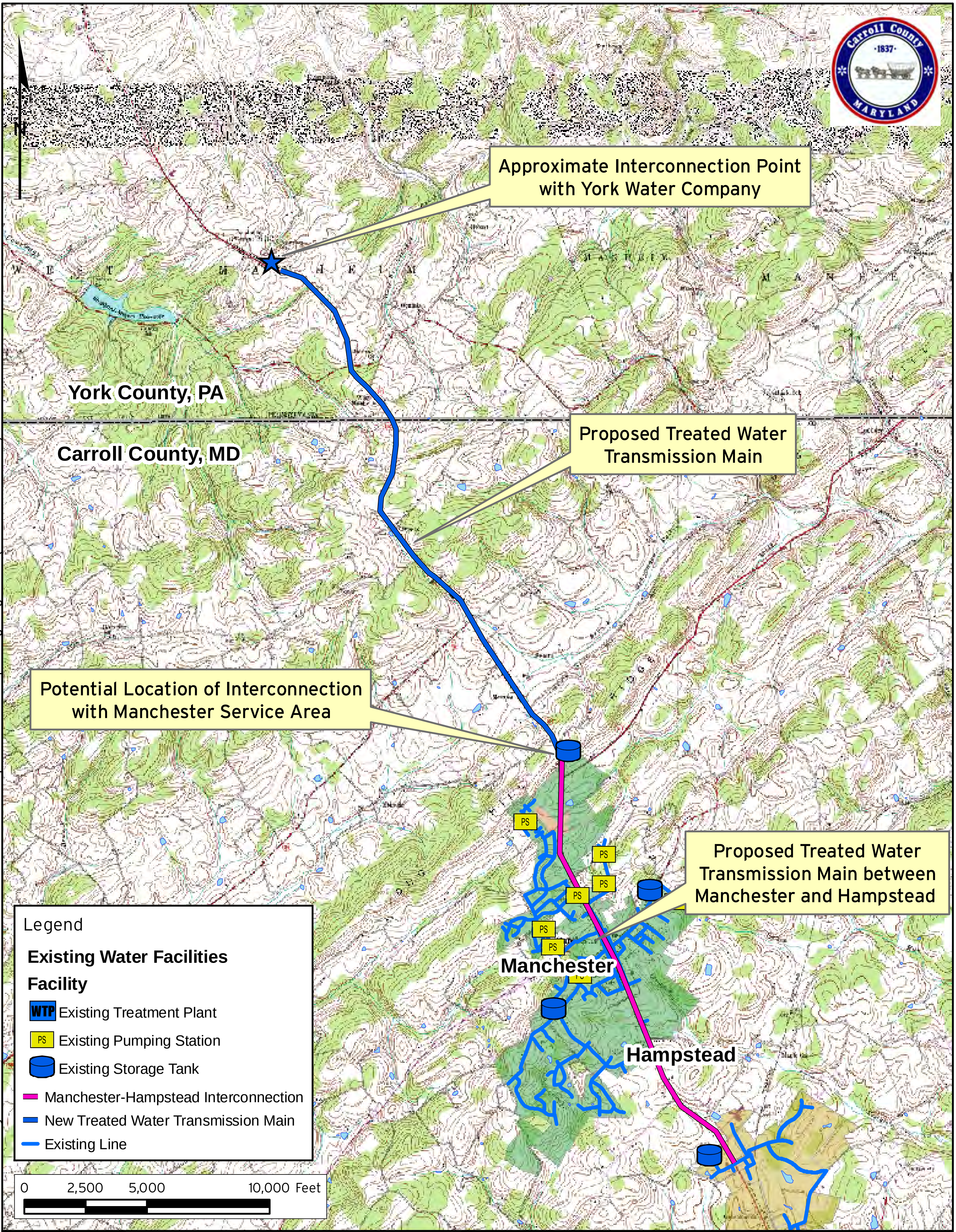
Description of Alternative:

- Interconnection with the York Water Company (YWC), which supplies water to York, PA
- Manchester and/or Hampstead to purchase treated water from YWC
- Approximately 4.6 miles of new 12-inch treated water transmission main to tie in with existing Manchester water service area. An additional 3.5 miles of 12-inch treated water transmission main to connect to Hampstead water service area.
- Minimum purchase of 150,000 gpd
- Approximately 0.90 mgd purchase required to satisfy Build-out Deficit of Hampstead and Manchester (assuming that Manchester groundwater capacities are less than currently appropriated).

Key Implementation Steps:

- Agreement between YWC and Hampstead/Manchester to purchase water.
- Design and permit treated water transmission main to connect to towns.
- Land and Easement Acquisition
- Based on previous discussions between Manchester and YWC, the following issues would need to be addressed:
  - Maintenance agreements for transmission main.
  - Cost sharing of transmission main project (YWC to pay for York Co portion and pump station, Manchester to pay for Carroll Co portion).
  - Purchase amounts – minimum purchase of 150,000 gpd required.
- Confirm that YWC will have adequate capacity in drought years. This may require coordination with the Susquehanna River Basin Commission.





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MALCOLM PIRNIE	CARROLL COUNTY, MD ALTERNATIVES EVALUATION	Alternative I-2: Interconnection with York Water Company	Sept 2009 Figure I-2

Alternative I-3: Freedom to Supply Mount Airy Using Existing Sources

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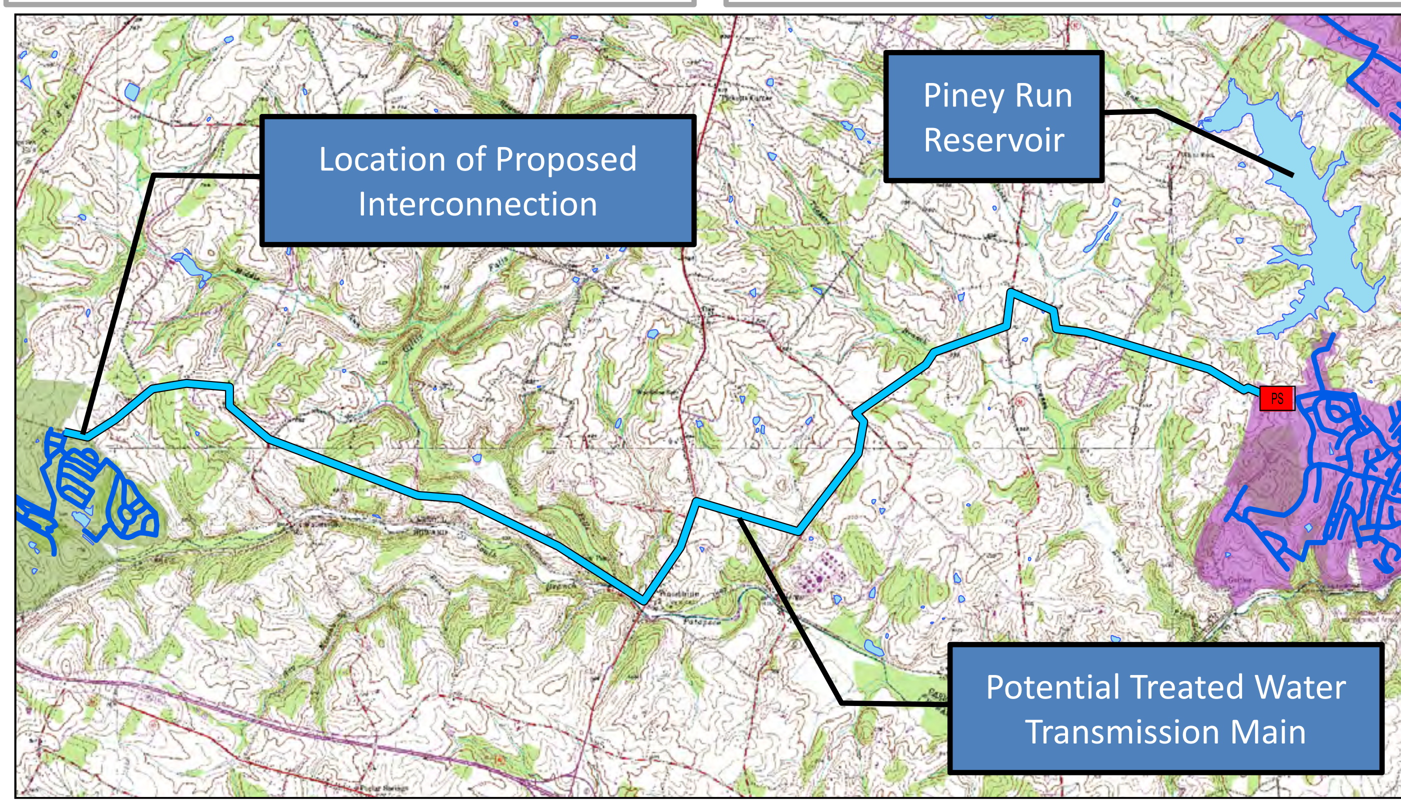
Description of Alternative:

- Interconnection between Sykesville/Freedom water service area and Mount Airy to supply Mount Airy with 0.75 mgd using existing supply sources.
- Approximately 9.7 miles of new treated water transmission main to tie in with existing Mount Airy water service area.
- Requires one new pump station

Key Implementation Steps:

- Agreement between Mount Airy and Sykesville/Freedom to purchase water.
- Design and permit treated water transmission main to connect service areas.
- Land and Easement Acquisition



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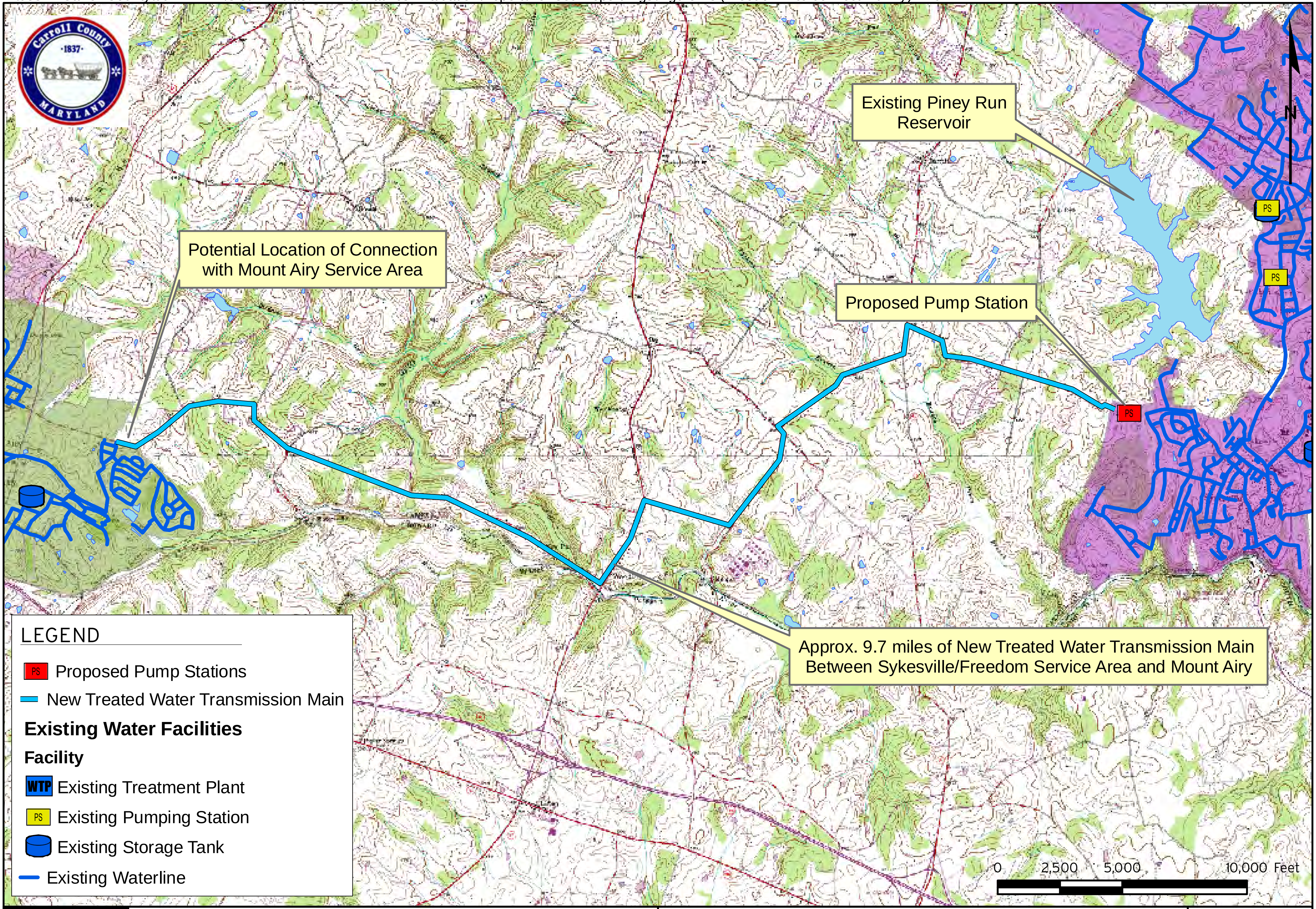

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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

Alternative I-3:
Freedom to Supply Mount Airy Using Existing Sources

Aug 2009

Figure I-3

Table 3-4

Summary of Groundwater Alternative Appropriation Criteria

		DEMAND	SERVICE AREA MDE AVAILABLE RECHARGE					ESTIMATED WELL REQUIREMENTS	
		(1)	(1)	(2)	(3)	(4)	(5)	(1)	(2)
			Priority + Future Service Area						
Alt	Growth Area	Probable Maximum Additional Water Requirement [gpd]	Area [ac]	Total Available Recharge [gpd]	Remaining Available Recharge [gpd]	Projected Water Surplus [gpd]	Total Required MDE GW Recharge Area [ac]	Number of Additional Wells based on Average MDE Appropriation per Groundwater Well [-]	Total Exploration Sites [-]
G-1	***Hampstead***	***528,000***	***2,656***	***934,979***	***214,364***	*-313,636*	***891***	***20***	***28***
G-2	*Mount Airy*	*364,000*	*3,543*	*1,197,463*	*532,598*	*168,598*	*0*	*5*	*54*
G-3	***New Windsor***	***198,000***	***953***	***290,665***	***94,665***	*-103,335*	***339***	***3***	***22***
G-4	***Taneytown***	***1,164,000***	***3,274***	***949,460***	***366,460***	*-797,540*	***2,750***	***16***	***5***
G-5	***Union Bridge***	***594,000***	***1,430***	***436,150***	***227,850***	*-366,150*	***1,200***	***6***	***11***
G-6	*Westminster*	*1,176,000†*	*8,543*	*3,007,136*	*1,531,136*	*355,136*	*0*	*9*	*38*
G-7	*Union Mills*	*N/A*	*1,600*	*563,310*	*563,310*	*563,310*	*0*	*10*	*--*
G-8	*Manchester*	*124,000††*	*0*	*0*	*0*	*0*	*0*	*6*	*--*
	WSA Totals	**4,148,000**	**20,399**	**6,815,853**	**2,967,073**	**-1,056,927**	**5,180**	**75**	**158**

Notes:

- (1) Projected maximum groundwater requirement (see Table 2-1)
- (1) Area of Priority+Future Service Area (GIS layer supplied by County)
- (2) Total Available Recharge in Priority+Future Service Areas based on recommended MDE method (Recharge = 1yrQ10 - 7Q10 by hydrogeomorphic region)
- (3) Adjusted Available Recharge in Piority+Future Service Areas (Total Available adjusted by subtracting existing allocations)
- (4) Projected Surplus of Available Recharge (Max((3),0)-(1))
- (5) The amount of additional land that a given WSA would need to own/control to obtain an appropriation permit to meet total projected demands by groundwater (-MIN((1)/,0)*(2)/(1))
- (1) Estimated number of wells needed to meet maximum probable GW demands (1)
- (2) Total number potential wells sites identified by the County and its water service areas for exploration

† Assumed existing withdrawals in Westminster are equal to actual yield because existing wells are known to have significantly lower yields than the permitted amount

†† Manchester needs additional wells to access water that is already appropriated, but cannot be used due to reduced well capacities.

Alternative G-1: Hampstead Wells

MALCOLM PIRNIE

Description of Alternative:

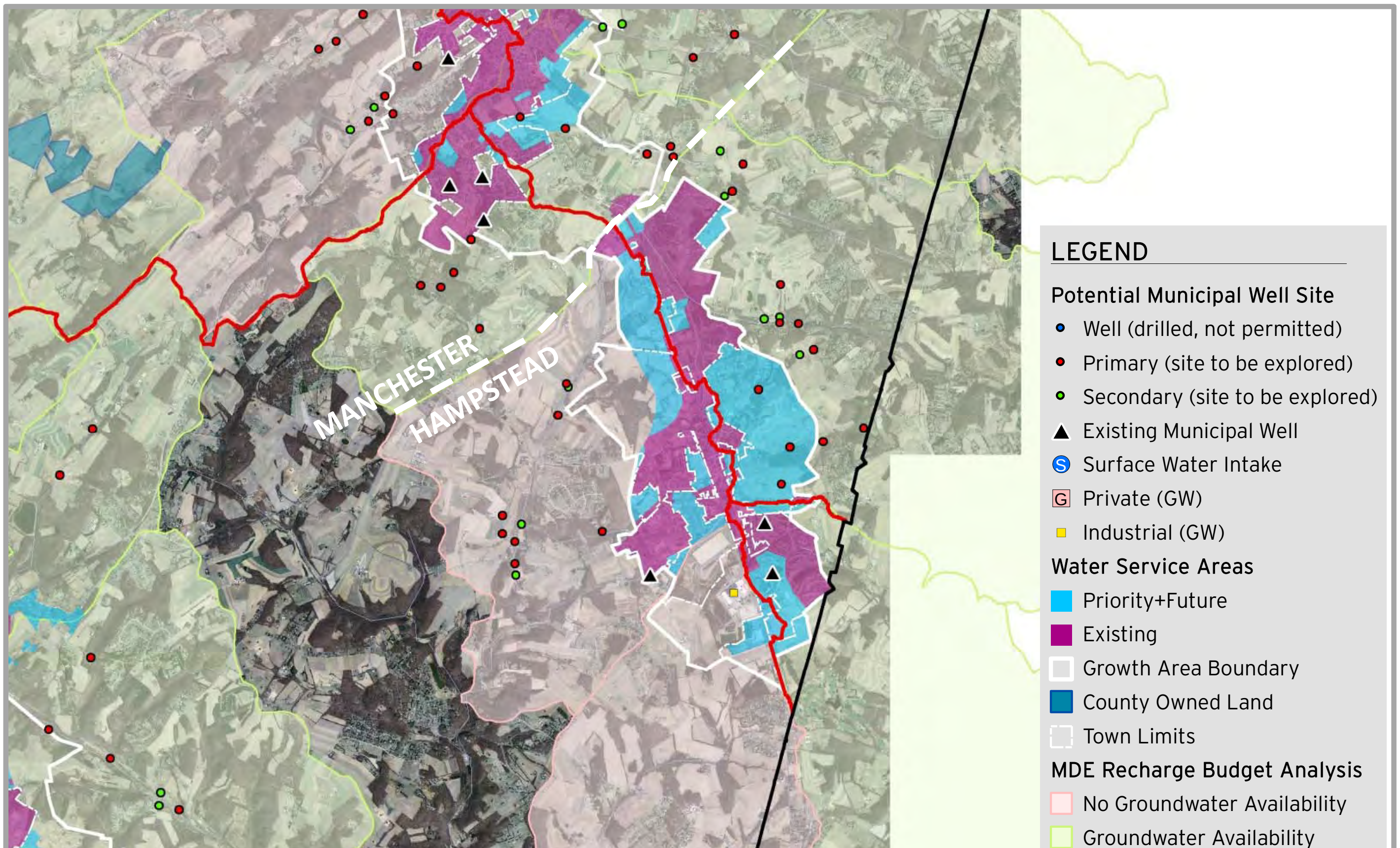
- Develop a sufficient number of additional groundwater wells in and around the Hampstead Water Service Area to meet projected demands

Hampstead Wells (G-1)		
Yield to offset future needs (mgd)	**0.528**	
# Wells (range)	**4**	**15**
# Wells (likely)	**7**	
# Wells (avg. MDE appropriation)	**20**	
# Well Exploration Sites†	**--**	
# Primary Well Sites Identified†	**20**	
# Secondary Well Sites Identified†	**8**	

Key Implementation Steps:

- Obtain own/control status of well site(s) and sufficient net recharge area by watershed, according to MDE methodology
- Begin MDE water appropriation permit process
- Drill and develop well site(s)
- Conduct pumping test(s) and source water quality analyses
- Finalize MDE water appropriation permit process
- Install permanent wellhead and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

† Sites explored in watersheds with groundwater availability given own/control of future service area acreages



Alternative G-2: Mount Airy Wells

MALCOLM PIRNIE

Description of Alternative:

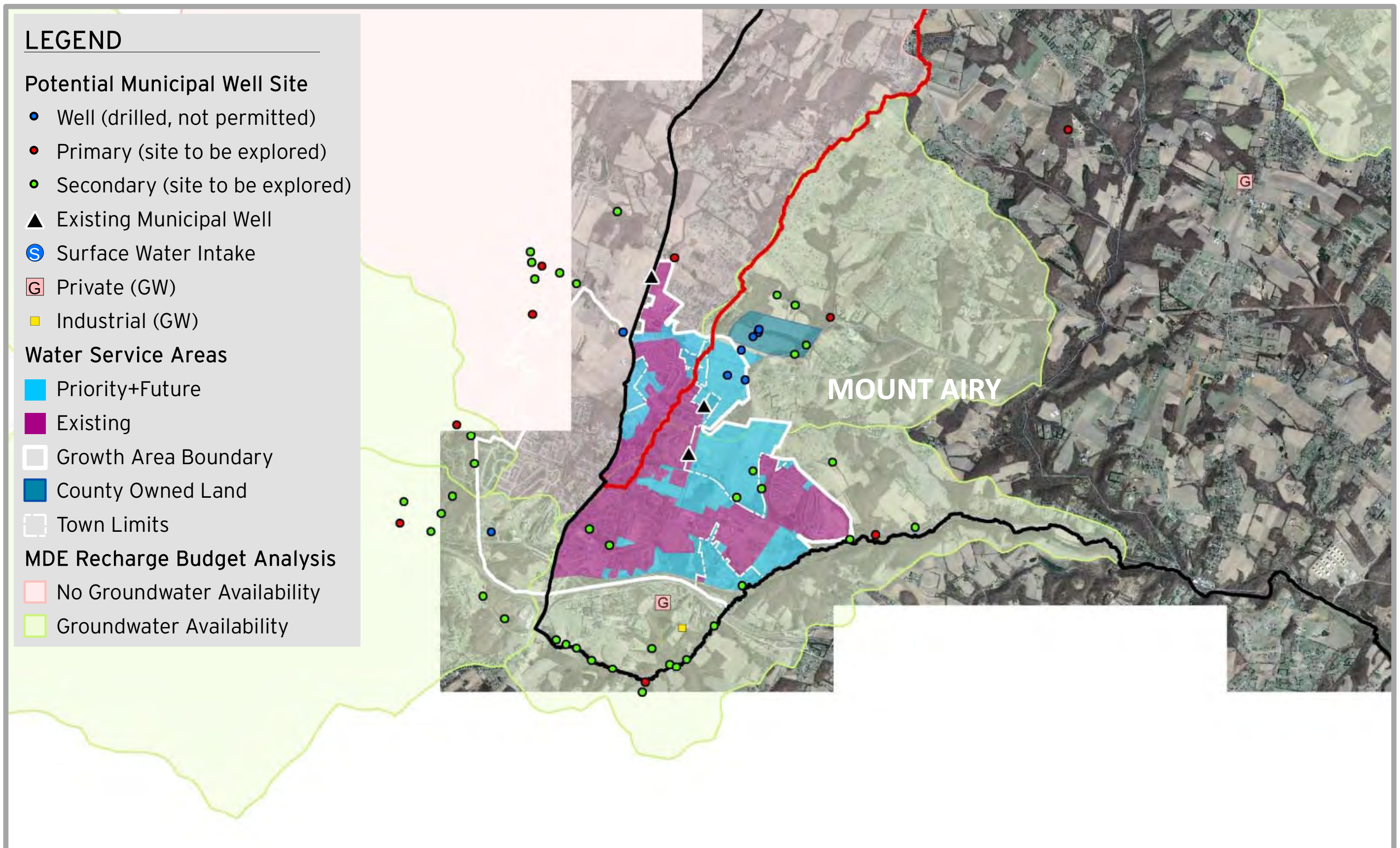
- Develop a sufficient number of additional groundwater wells in and around the Mount Airy Water Service Area to meet projected demands

Mount Airy Wells (G-2)		
Yield to offset future needs (mgd)	0.364	
# Wells (range)	4	7
# Wells (likely)	4	
# Wells (avg. MDE appropriation)	5	
# Well Exploration Sites†	8	
# Primary Well Sites Identified†	8	
# Secondary Well Sites Identified†	38	

Key Implementation Steps:

- Obtain own/control status of well site(s) and sufficient net recharge area by watershed, according to MDE methodology
- Begin MDE water appropriation permit process
- Drill and develop well site(s)
- Conduct pumping test(s) and source water quality analyses
- Finalize MDE water appropriation permit process
- Install permanent wellhead and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

† Sites explored in watersheds with groundwater availability given own/control of future service area acreages



Alternative G-3: New Windsor Wells

MALCOLM PIRNIE

Description of Alternative:

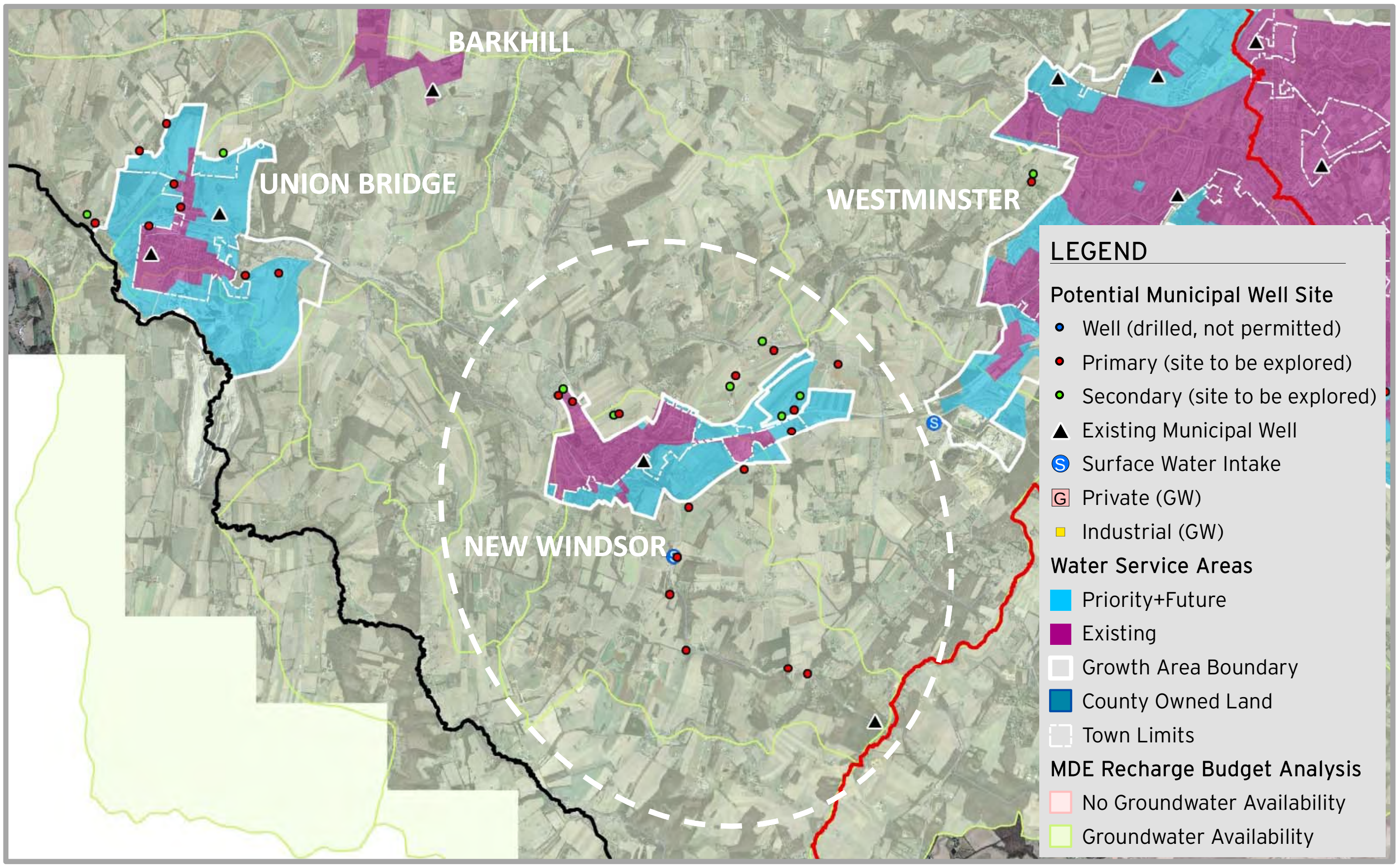
- Develop a sufficient number of additional groundwater wells in and around the New Windsor Water Service Area to meet projected demands

New Windsor Wells (G-3)		
Yield to offset future needs (mgd)	0.198	
# Wells (range)	2	3
# Wells (likely)	2	
# Wells (avg. MDE appropriation)	3	
# Well Exploration Sites†	--	
# Primary Well Sites Identified†	16	
# Secondary Well Sites Identified†	6	

Key Implementation Steps:

- Obtain own/control status of well site(s) and sufficient net recharge area by watershed, according to MDE methodology
- Begin MDE water appropriation permit process
- Drill and develop well site(s)
- Conduct pumping test(s) and source water quality analyses
- Finalize MDE water appropriation permit process
- Install permanent wellhead and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

† Sites explored in watersheds with groundwater availability given own/control of future service area acreages



Alternative G-4: Taneytown Wells

Description of Alternative:

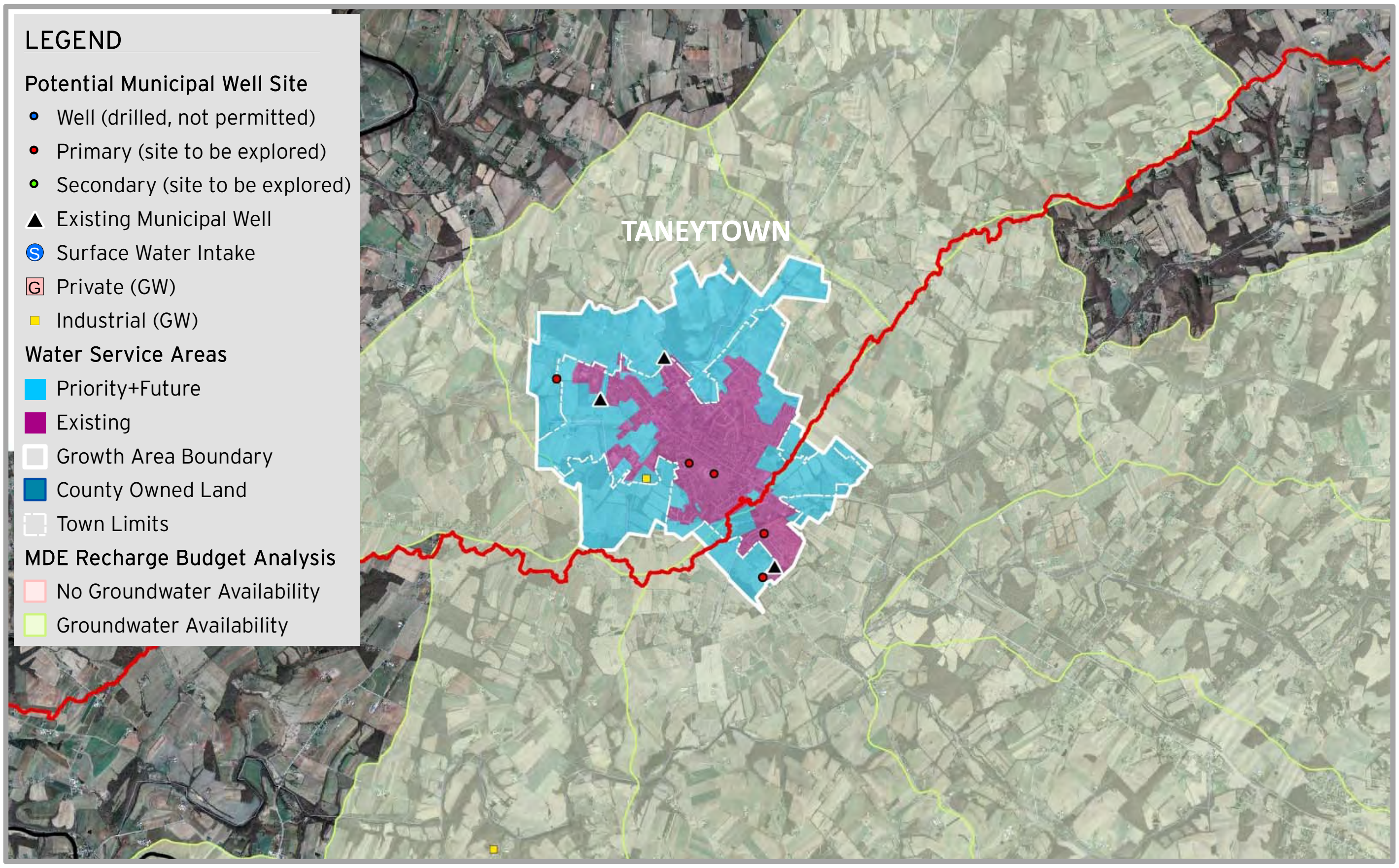
- Develop a sufficient number of additional groundwater wells in and around the Taneytown Water Service Area to meet projected demands

Taneytown Wells (G-4)		
Yield to offset future needs (mgd)	1.164	
# Wells (range)	3	21
# Wells (likely)	11	
# Wells (avg. MDE appropriation)	16	
# Well Exploration Sites†	--	
# Primary Well Sites Identified†	5	
# Secondary Well Sites Identified†	--	

Key Implementation Steps:

- Obtain own/control status of well site(s) and sufficient net recharge area by watershed, according to MDE methodology
- Begin MDE water appropriation permit process
- Drill and develop well site(s)
- Conduct pumping test(s) and source water quality analyses
- Finalize MDE water appropriation permit process
- Install permanent wellhead and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

† Sites explored in watersheds with groundwater availability given own/control of future service area acreages



Alternative G-5: Union Bridge Wells

MALCOLM PIRNIE

Description of Alternative:

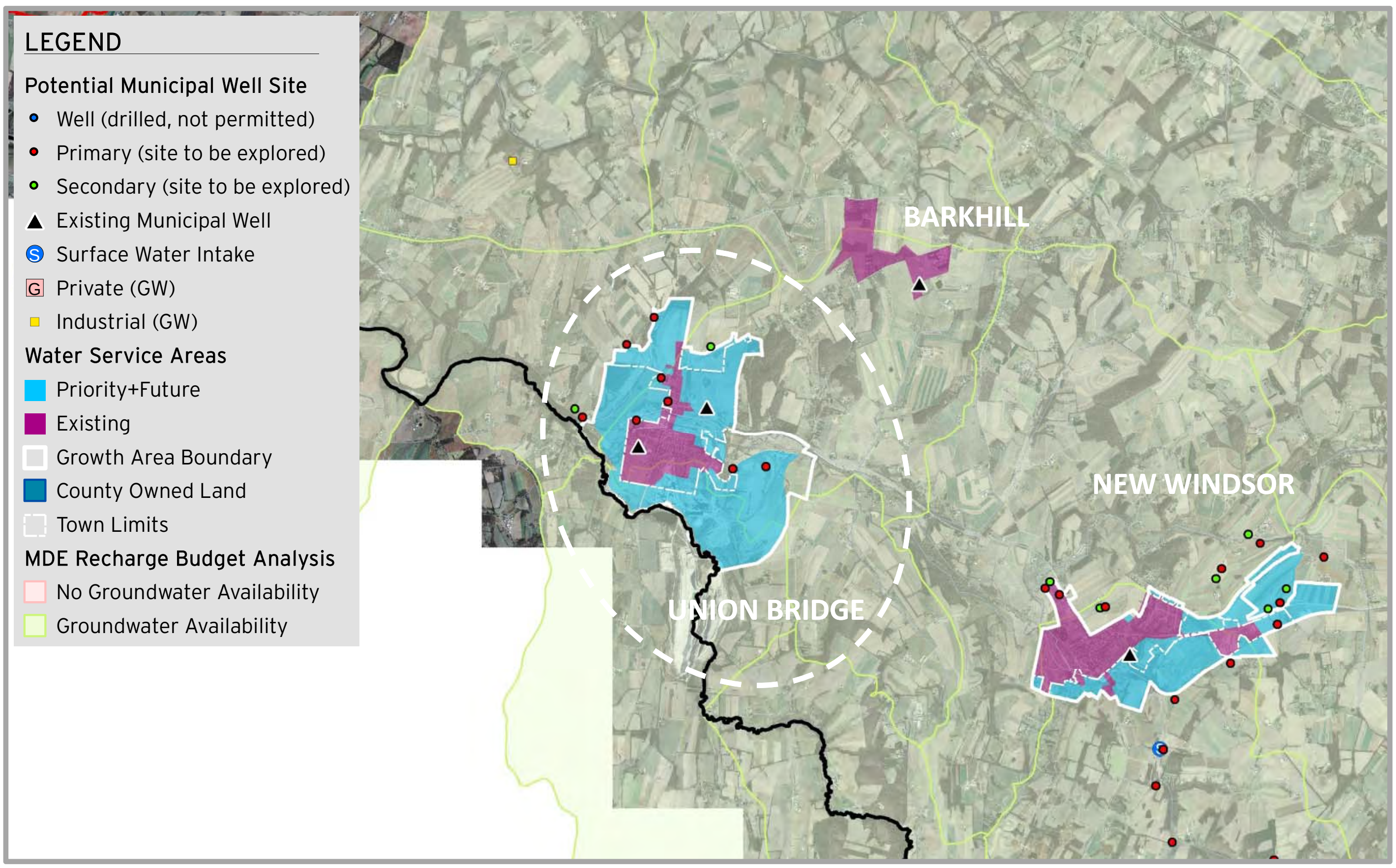
- Develop a sufficient number of additional groundwater wells in and around the Union Bridge Water Service Area to meet projected demands

Union Bridge Wells (G-5)		
Yield to offset future needs (mgd)	0.594	
# Wells (range)	3	9
# Wells (likely)	3	
# Wells (avg. MDE appropriation)	6	
# Well Exploration Sites†	--	
# Primary Well Sites Identified†	9	
# Secondary Well Sites Identified†	2	

Key Implementation Steps:

- Obtain own/control status of well site(s) and sufficient net recharge area by watershed, according to MDE methodology
- Begin MDE water appropriation permit process
- Drill and develop well site(s)
- Conduct pumping test(s) and source water quality analyses
- Finalize MDE water appropriation permit process
- Install permanent wellhead and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

† Sites explored in watersheds with groundwater availability given own/control of future service area acreages



Alternative G-6: Westminster Wells

MALCOLM PIRNIE

Description of Alternative:

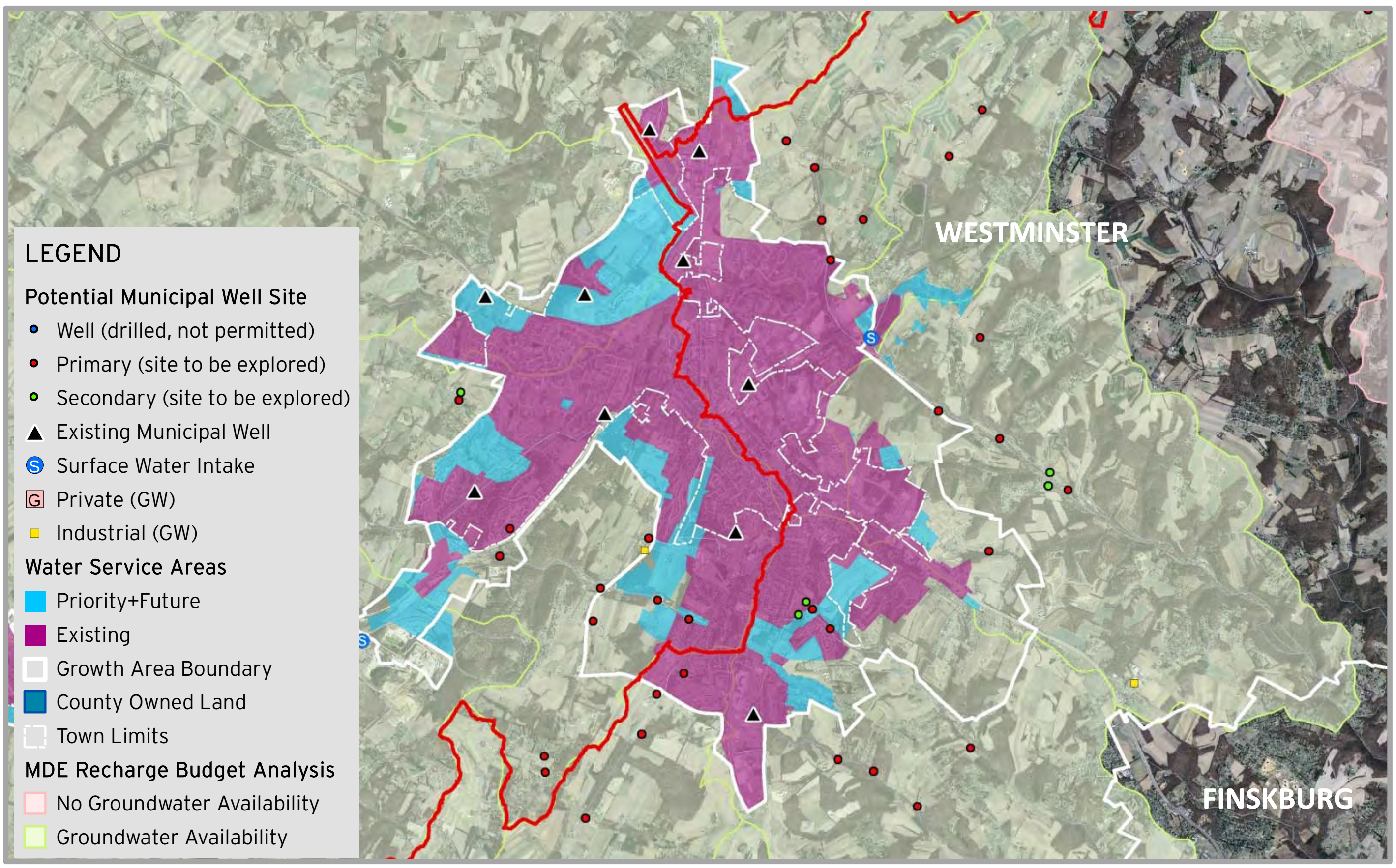
- Develop a sufficient number of additional groundwater wells in and around the Westminster Water Service Area to meet projected demands

Westminster Wells (G-6)		
Yield to offset future needs (mgd)	1.176	
# Wells (range)	2	19
# Wells (likely)	5	
# Wells (avg. MDE appropriation)	9	
# Well Exploration Sites†	--	
# Primary Well Sites Identified†	32	
# Secondary Well Sites Identified†	6	

Key Implementation Steps:

- Obtain own/control status of well site(s) and sufficient net recharge area by watershed, according to MDE methodology
- Begin MDE water appropriation permit process
- Drill and develop well site(s)
- Conduct pumping test(s) and source water quality analyses
- Finalize MDE water appropriation permit process
- Install permanent wellhead and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

† Sites explored in watersheds with groundwater availability given own/control of future service area acreages



Alternative G-7: Union Mills Area Wells

MALCOLM PIRNIE

Description of Alternative:

- Based on County-owned land, develop groundwater wells in and around the proposed Union Mills Reservoir area to meet a portion of the additional supply needed in the Westminster Water Service Area
- Construct 20-inch raw water transmission main to connect to Cranberry Reservoir

Union Mills Wells (G-7)		
Yield to offset future needs (mgd)	0.56	
# Wells (range)	1	9
# Wells (likely)	2	
# Wells (avg. MDE appropriation)	10	
# Well Exploration Sites†	--	
# Primary Well Sites Identified†	--	
# Secondary Well Sites Identified†	--	

Key Implementation Steps:

- Begin MDE water appropriation permit process
- Drill and develop well site(s)
- Conduct pumping test(s) and source water quality analyses
- Finalize MDE water appropriation permit process
- Install permanent wellhead and fencing and construct treatment/transmission infrastructure necessary to connect wells to the WSA distribution system

† Sites explored in watersheds with groundwater availability given own/control of future service area acreages

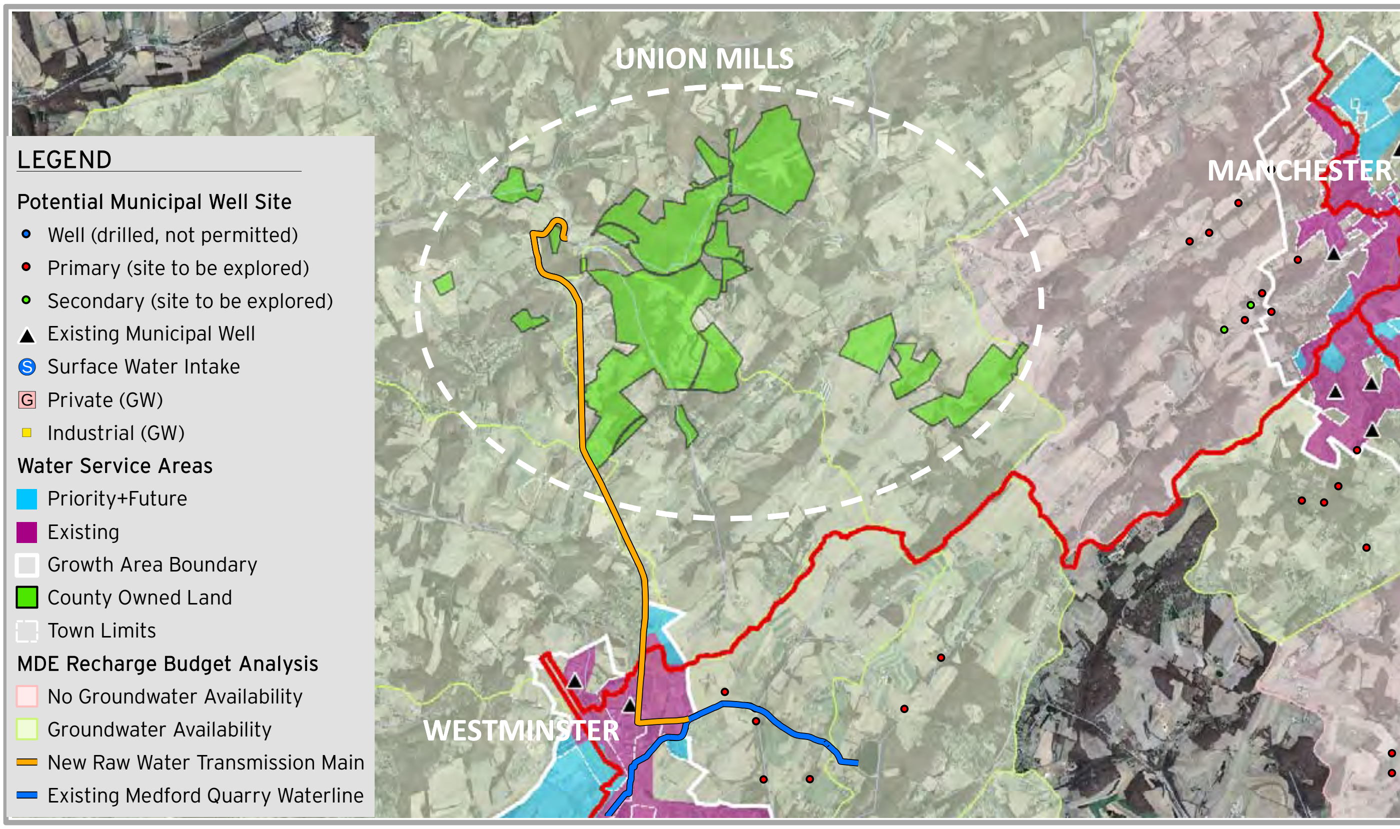


Table 3-5

Summary of Existing Demand Management Practices in Carroll County

	Public Education Measures	Water Loss Management	Drought Management Measures	Low-Flow Devices	Water Use Rate Schedule	Billing Cycle	Other Measures
Carroll County	Water saving brochures available through Bureau of Utilities		County has authority to restrict or limit water us in Freedom, Bark Hill and Pleasant Valley				
Hampstead	Water quality and quantity awareness conducted at festivals, newsletters and materials in Town Hall	Give out dye tablets and give credits for fixing leaks		Give out free low-flow devices	Progressive water rate schedule		
Manchester	Website postings, PSA's, newspapers, and brochures/flyers.	Own their own leak detection equipment. Current UAW at 7%. Meter replacement program	Drought Management Plan (adopted April 2007) with four stages from recommended to voluntary to mandatory.			Quarterly	City has code that prohibits lawn watering and filling of swimming pools.
Mt. Airy	Website postings, water conservation brochures and posters available at Town Hall.	Annually hire contractor to locate and repair leaks in their distribution system. All meters were replaced a couple of years ago. Perform quarterly water loss audits. Water loss currently 10-12%.	Drought Management - tiered approach to restrict use during water emergencies.	Give out free low-flow devices	Progressive water rate schedule	Quarterly	The Town provides rain barrels to residents at a discounted price.
New Windsor	Trying to shift attitude towards constant conservation, not just for emergencies.		Voluntary recommendations during drought conditions, but no official plan.				
Taneytown			Three-phased water conservation program has been adopted, which restricts use during a drought.				
Westminster	Community conservation education and outreach activities.	As part of Water Conservation Plan - water meter testing and replacement, leak monitoring, and water use audits. City owns their own leak detection equipment.	Three-staged drought management plan has been adopted.	Town is currently working on distributing low flow toilets to customers.	Progressive water rate schedule	Quarterly	
Union Bridge	Water use pamphlets are available at the Town Offices	Town hires a contractor to locate and repair leaks in their distribution system. All meters were replaced approximately 5 years ago.				Quarterly	

Sources:
1. Draft Carroll County Comprehensive Water Conservation Recommendations received from Carroll County on January 6, 2009
2. Discussions with representatives at May 21, 2009 progress meeting.
3. Phone conversations with water supply contacts.

Note: Several attempts were made to obtain information from Hampstead, New Windsor and Taneytown. Measures reflected for those municipalities do not reflect information provided by water supply contacts.

4. Water Reuse Alternatives and Evaluation

The recycling and reuse of WWTP effluent (or "reclaimed water") is a viable long-term strategy for overcoming wastewater disposal limitations. A discussion of reuse options was presented in the May 2009 Carroll County Wastewater Limitations report[5]. The most viable reuse option in Carroll County is water reuse on cropland and/or turfgrass, which is discussed in Section 4. Other options that were evaluated include using industrial WWTP excess capacity to treat wastewater for reuse applications, as well as industrial use of municipally treated wastewater for non-potable use as process water.

4.1. Water Reuse Alternatives

Water reuse of reclaimed water will likely require both surface water and groundwater NPDES permits and is subject to State requirements for effluent irrigation systems as documented in MDE's *Guidelines for Land Treatment of Municipal Wastewaters*[6]. Under these regulations, water used for irrigation must meet either Class I or Class II quality requirements, with associated buffer requirements (Table 4-1). Maryland has also proposed draft amendments to the land treatment guidelines, which include Class III requirements for systems to which the public would have access.

The slopes of land to be irrigated must be less than 15% on cultivated lands and less than 25% on forested lands. Irrigation of Class I and Class II effluent is limited to locations where the depth of groundwater is at least four feet.

Table 4-1

Maryland's Class I and Class II Effluent Quality and Buffer Requirements

Class	Quality Requirements	Buffer Requirements
I	■ 5-day Biochemical Oxygen Demand (BOD5) <70 mg/l ■ Suspended solids <90 mg/l ■ pH: 6.5-8.5 ■ Fecal Coliform < 200 MPN/100 ml, or <3 MPN/100 ml for golf course irrigation	■ Minimum of 200 feet from the wetted perimeter to property lines, waterways and public roads in open areas. ■ Minimum of 500 feet from the wetted perimeter to houses or other occupied structures. ■ 50% reduction in distance with tree buffers.
II	■ BOD5 <10 mg/l ■ Suspended solids <10 mg/l, pH: 6.5-8.5 ■ Fecal Coliform < 3 MPN/100 ml	■ Minimum of 25 feet from the wetted perimeter to property lines, housing structures, waterways and public roads. ■ Minimum of 50 feet to schools and playgrounds. ■ Minimum of 100 feet to potable wells and water intakes
III (proposed)	■ BOD-5 < 10 mg/L (30-day avg) ■ Turbidity < 2 NTU (daily avg) and 5 NTU (max) ■ Fecal Coliforms < 2.2 MPN per 100 mL (30-day geometric mean)	■ 50 ft for wells ■ 100 ft for outdoor public eating, drinking and bathing facilities

Seasonal reuse of treated effluent can benefit those localities whose discharge to surface water is limited by loading caps or other water quality parameters such as temperature (see Table 3-1 in Wastewater Limitation Evaluation, May 2009). Because a high level of treatment is still required, it does not provide relief for facilities that are primarily limited by treatment capacity. However, irrigative reuse is expected to be especially beneficial for (1) major WWTPs that would be limited by nutrient loading caps even after installation of ENR technology; (2) minor facilities that could implement reuse as an alternative to ENR technology. In most cases it will still be necessary to discharge to surface water in the winter, or in other seasons if the demand/land area for reused water is less than the total effluent generated. Facilities that have concentration-based nutrient limits would still be required to attain those limits when discharging to surface water.

4.1.1. Methodology

Reuse alternatives were evaluated through a GIS analysis of land use in the vicinity of each of the County's and town's major wastewater treatment plants (WWTP) with capacities exceeding 0.5 mgd. Potential reuse sites that would warrant additional study were identified within a 1-mile and 2-mile search radius from each evaluated WWTP using the 2007 MDE Land use/Land Classification spatial data layer and adjusted using more recent 2009 aerial photography (see Figure 4-1 for the location of WWTPs that were evaluated). Sites were also identified by examining existing agricultural and industrial water appropriation permits within the search radii. Land use categories identified as potential locations for wastewater reuse include athletic fields, croplands, golf courses, open urban land and pastures. For conceptual evaluation purposes, it was assumed that water reuse in the County could occur on public access sites under the newly adopted Maryland regulations for Class III Effluent. Small (less than 50 acres in size) and non-contiguous parcels were identified within the 1-mile and 2-mile radius areas, and were eliminated from the total land area due to limited demands in these areas. Construction of long water reuse pipelines to these small and non-contiguous parcels would not be economically feasible. For estimation purposes, it was assumed that 50% of the potentially usable land areas within the one and two-mile radius of each WWTP would be available for water reuse (i.e. 50% of the land is irrigable, while the remaining 50% of the land consists of impervious surfaces such as buildings and roadways or is otherwise unsuitable for use). Tables 4-2 and 4-3 summarize the total irrigable land available near each major WWTP, within the one and two-mile radius, respectively.

The quantities of irrigable land required to land apply 50% of the Projected Build-out wastewater flows for each plant were calculated. The projected Build-out flow is defined as the wastewater flows from the Designated Growth Areas (DGA), as presented in Table 3-1 of the Wastewater Limitations Report (Malcolm Pirnie, May 2009). In order to calculate the amount of land required, a water reuse rate was defined as 1 mgd per 585 acres of land. This rate assumes the following:

- Land buffers – assumed to be 10% of the site area.
- No long-term storage of reuse water during winter months - assumed that wastewater will be discharged to receiving water body during winter months. Winter months are defined as the three coldest months of the year when frozen ground conditions occur and vegetation is dormant.
- Assumes that the water reuse rate of reclaimed water is approximately 0.9 inches per week during periods when irrigation is feasible.
- 25% rainfall and other events shutoff factor during non-Winter months.

Table 4-4 summarizes the quantity of land required to meet 50% of the projected build-out wastewater flows through water reuse, assuming a water reuse rate of 1 mgd per 585 acres.

4.1.2. Potential Locations for Water Reuse

Based on the methodology and assumptions presented in Section 4.1.1, all of the municipalities have the irrigable land available to potentially accept 50% of the projected build-out flow for water reuse, with the exception of the Freedom Service Area. It should be noted that this analysis has been performed at the conceptual level, and a more detailed assessment of the potential sites would be required in order to obtain approval from MDE.

Taneytown and Manchester both have sufficient land available within a one-mile radius of their respective WWTPs to potentially reuse 50% of their projected build-out wastewater flows. The potential land available for Taneytown is shown on Figure 4-2, while the potential land available for Manchester is shown on Figure 4-3.

Westminster, Mount Airy and Hampstead all have sufficient land available within a two-mile radius of their respective WWTPs to potentially reuse 50% of their projected build-out wastewater flows. The potential land available for the three municipalities is shown in Figures 4-4, 4-5, and 4-6, respectively.

The Freedom Service Area does not have enough irrigable land available to meet 50% of the projected build-out demand for wastewater flows. As shown in Table 4-3, 573 acres of irrigable land are available; however, approximately 1,578 acres are required to meet the reuse demand of 2.7 mgd (see Table 4-4). Using the application rate of 1 mgd per 585 acres and 573 acres of available irrigable land (within a two-mile radius of the WWTP, see Figure 4-7), approximately 0.98 mgd of wastewater flow could potentially be reused (18% of the projected build-out flow of 5.4 mgd.)

It should be noted that the spatial accuracy of the land use used in the evaluation is such that it is most appropriate for planning purposes to indicate the sites most likely to be suitable for water reuse. More detailed investigations of a site's other potential land use limitations, as well as detailed field investigations of a site's hydraulic and nutrient assimilation capacity should be conducted following a site's selection as a preferred water reuse location.

4.2. Use of Excess Industrial Wastewater Capacity

The Task 3 Carroll County Wastewater Limitations report (Malcolm Pirnie, May 2009) briefly addressed the concept of using excess industrial wastewater treatment capacity to treat future municipal wastewater flows in Carroll County at two industrial facilities (BTR-Hampstead and Congoleum Corp.). For the Task 4 alternatives evaluation, additional inquiries were made with MDE and facility representatives to determine whether use of excess industrial wastewater treatment capacity is a viable alternative. The BTR-Hampstead plant is located in the southern part of the Hampstead Service Area, near the boundary with Baltimore County, while the Congoleum Corp. plant is located in Finksburg, near the northern tip of Liberty Reservoir.

4.2.1. BTR—Hampstead

Information on the BTR-Hampstead WWTP, also known as the Black and Decker plant, was obtained from the following sources:

- The latest available NPDES permit fact sheet, dated 2002.
- A telephone interview with Ed Gertler, MDE industrial permitter, June 23, 2009.
- A telephone interview with Doug Myers, Maryland Environmental Service (MES), June 30, 2009.
- A February 2008 report by the Maryland Environmental Service entitled *Black and Decker Wastewater Treatment Plan Condition and Capacity Evaluation Report.*

Evaluation of Excess Treatment Capacity: According to the NPDES fact sheet, the BTR-Hampstead plant is "engaged in warehousing, packaging, and manufacturing of powdered metal parts." The wastewater treatment plant, which is operated by MES, consists of an activated sludge process that currently receives 5,000-6,000 gpd of sanitary wastewater from the facility. The activated sludge treatment process was originally rated for 150,000 gpd, but MES has determined that the actual treatment capacity is in the 50,000 to 100,000 gpd range.

Effluent from the activated sludge process is directed to a holding pond that also receives stormwater, treated groundwater, and non-contact cooling water. Water in the holding pond is pumped to a physical/chemical (P/C) treatment process consisting of chemical flocculation, settling and filtration. Alum is added for phosphorus removal and suspended solids According to MES (2008), the P/C treatment process was operated at a rate of 300,000 gpd every other week in 2007.

Effluent from the P/C process is directed to a polishing pond, from which the facility pumps non-contact cooling water. Overflow from the polishing pond is discharged to an unnamed tributary to Deep Run, which is a tributary to the North Branch of the Patapsco River upstream of Liberty Reservoir. Although the combined treatment system does not have a flow rating, the daily average flow in 2007 was about 180,000 gpd, of which less than 5 percent was effluent from the activated sludge process.

BTR-Hampstead's activated sludge process is operating at only 6 to 12 percent of its design capacity, and so theoretically has the capability to accept additional sanitary flows. If the actual capacity is 50,000 to 100,000 gpd as estimated by MES, the system could treat an additional 44,000 to 94,000 gpd. However, challenges to the use of this system to treat additional municipal flows include the following:

- The facility has no formal nutrient wasteload allocation and was not designed for nitrogen removal. Therefore, nutrient loads from future municipal sources would still have to be offset in some fashion, and the plant would most likely have to be upgraded to improve the nutrient removal capabilities.

- Most of the wastewater treatment equipment is over 35 years old and was estimated by MES (2008) to have a projected service life of less than 10 years.

Required improvements were estimated to cost between $2.9 million and $4.75 million, not including nutrient removal upgrades and associated solids handling equipment.

- Diverting wastewater flows from the Town of Hampstead WWTP would require significant and costly additions/modifications of the collection system (D. Myers, pers. comm., 30 Jun 2009).

For the reasons cited above, the BTR-Hampstead plant is not considered a viable alternative for treating a large portion of the wastewater flows from the Town of Hampstead. Given the level of investment required to refurbish/upgrade the plant and modify the collection system, it would probably be more cost-effective to build a new plant or expand the existing Town of Hampstead WWTP. The BTR-Hampstead plant could be a viable option for treating small local sanitary wastewater flows that would require little modification of the plant or collection system.

Evaluation of Potential Demand for Effluent: BTR-Hampstead is already obligated to pump and treat groundwater, producing water that is sufficient both in quantity and quality to meet non-contact cooling water needs. As a result, there is little technical or economic incentive for the plant to purchase or accept wastewater effluent at this time.

4.2.2. Congoleum Corporation

Information on the Congoleum Corp. wastewater treatment system was obtained from the following sources:

- The latest available NPDES permit fact sheet, dated 2002.
- A telephone interview with Ed Gertler, MDE industrial permitter, June 23, 2009.
- Telephone interview with T.C. Garrod, Congoleum Corp., June 23, 2009 and July 6, 2009.

Evaluation of Excess Treatment Capacity: The Congoleum Corp. in Finksburg manufactures felt that is used as a backing for vinyl flooring. The felt product is produced from limestone, wood fibers, and mineral fillers. Most of the process wastewater is derived from water that is used to clean the felt manufacturing equipment and drainage from the felt drying process. Other wastewater streams include boiler blowdown and sanitary wastewater. However, sanitary wastewater represents a small fraction (≤1%) of the total wastewater generated. Wastewater is directed to a series of six lagoons for primary settling, which is followed by an activated sludge aeration tank, clarification, chlorination, and dechlorination. A floating bubbler is used seasonally to aerate the effluent prior to discharge to the North Branch of the Patapsco River, upstream of Liberty Reservoir.

The wastewater treatment system has a design capacity of 500,000 to 600,000 gpd, and was sized to account for a potential increase in manufacturing at the site. Due to economic/market conditions, manufacturing has not increased at the facility, and in fact has decreased from past years. Congoleum's average wastewater flow is currently about 216,000 gpd. Although changing market/economic conditions might cause a future increase in manufacturing, the wastewater treatment system is large enough that an undetermined amount of excess treatment capacity is expected to remain (T.C. Garrod, pers. comm., 23 June 2009).

Congoleum's process wastewater is very different from a municipal wastewater. The influent to the activated sludge process is low in solids and BOD, and much of the TOC is poorly degradable. In the opinion of both Congoleum and MDE staff, the biological wastewater treatment process would actually perform better with a higher proportion of sanitary wastewater. However, the wastewater treatment system would likely require engineering upgrades and process modifications to accommodate municipal wastewater influent. Additions that might be required include preliminary treatment equipment (grit chamber, screens, *etc*.), modified primary clarification facilities, and solids handling equipment.

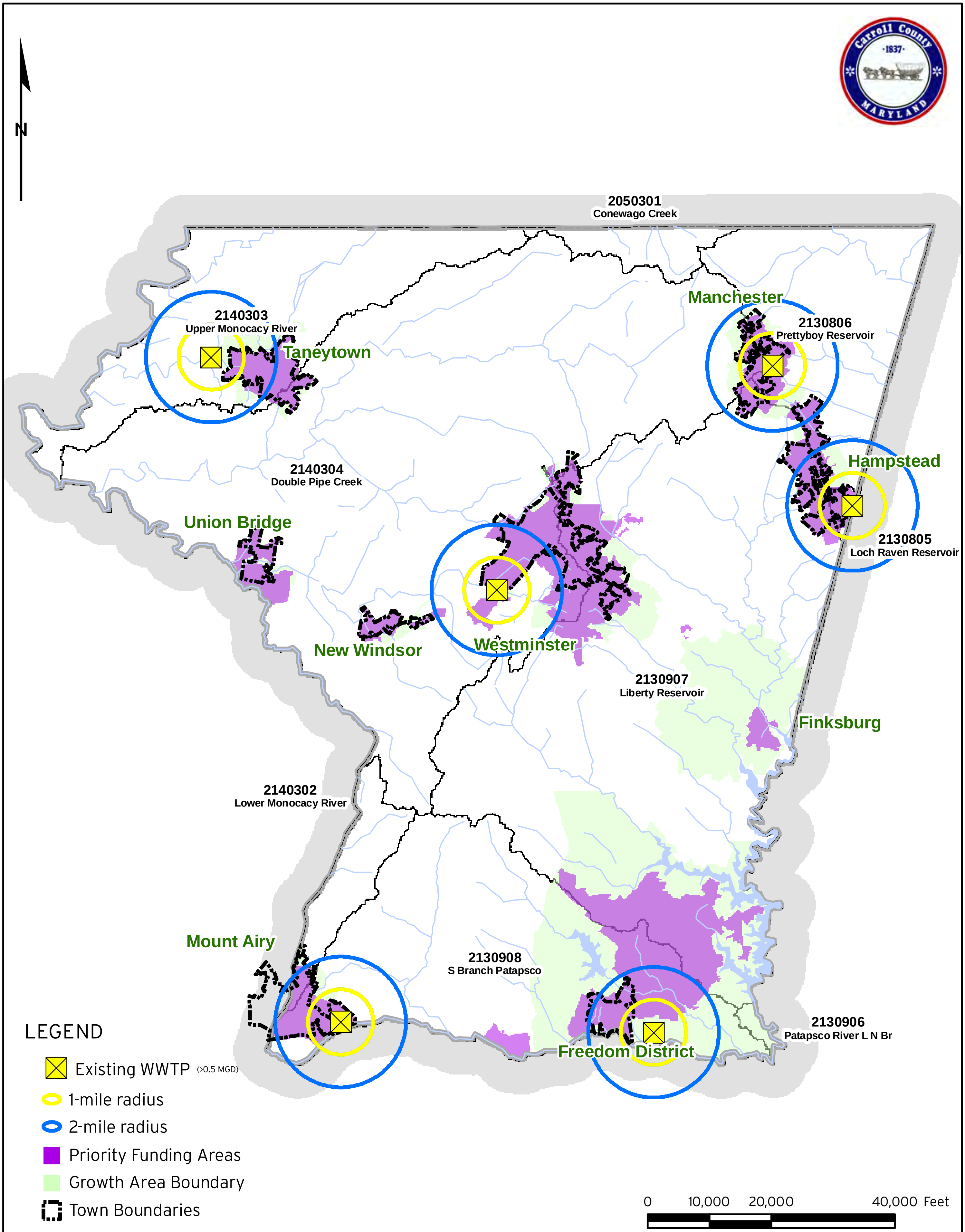
Nutrient load caps represent an important limitation to the ability of the system to accept municipal wastewater. Because the facility discharges upstream of Liberty Reservoir, its renewed NPDES permit is expected to have a total phosphorus limit of 0.3 mg/L in accordance with the *2005 Action Strategy for the Reservoir Watersheds*. The facility also has Chesapeake Bay-related nutrient caps of 4,005 lb/yr total nitrogen and 160 lb/yr total phosphorus. These loading caps were based on a flow of 263,000 gpd, a total nitrogen concentration of 5 mg/L, and a total phosphorus concentration of 0.2 mg/L.

The Congoleum wastewater influent is nutrient-poor, such that nutrient addition is required to facilitate the biological treatment process. The facility was not designed for nutrient removal, although it does have the capability of chemical addition and settling for some phosphorus removal. If Congoleum accepted a significant flow of municipal wastewater, it would probably be necessary to upgrade the treatment system with enhanced nutrient removal capabilities. At the generally-accepted limits of technology for nitrogen removal at municipal facilities (TN=3.0 mg/L), the plant flow could only discharge about 439,000 gpd, which is less than the design capacity.

In summary, the Congoleum Corp. has 100,000 to 200,000 gpd excess treatment capacity and is likely to have at least a portion of this excess capacity well into the future. Its process would actually benefit from additional sanitary wastewater. However, with regard to accepting additional sanitary flows, the nutrient load caps would be more limiting than the design capacity of the system. Congoleum Corp.'s wastewater treatment system should be considered a potentially viable option for treating small, local sanitary flows that Congoleum could accept without major upgrades to the treatment process or collection system. Use of the full excess capacity (100,000 to 200,000 gpd) would also be a viable option, but would likely require an ENR upgrade of the plant, treatability studies, additional preliminary/primary treatment capability, and other process modifications.

Evaluation of Potential Demand for Effluent: The Congoleum Corp. currently holds a water appropriation permit (CL1993S019) to withdraw an average of 500,000 gpd from the North Branch of the Patapsco River. This water source is filtered for use as process water. The facility does not have a history of experiencing manufacturing limitations with regard to water quantity or quality. However, Congoleum staff report the quality of the surface water supply does vary and might affect product quality (T.C. Garrod, pers. comm., 23 June 2009). Recent demands have averaged about 5 million gallons per month, but demand could average 9-10 million gallons per month if Congoleum's market conditions improve.

Because Congoleum does not currently pay a third party for this water supply, there is little financial incentive for the facility to pay for wastewater effluent. However, it cannot be ruled out that the facility would accept wastewater effluent to partially or fully replace its existing supply. Important factors would be the quality of the effluent, relative to their process needs, and the consistency of that quality. Congoleum would have to perform laboratory testing to determine if wastewater effluent would be compatible with their process. If wastewater effluent had higher or more consistent quality than their existing surface water supply, it would provide an incentive for Congoleum to accept free or low cost effluent.



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CARROLL COUNTY, MD
ALTERNATIVES EVALUATION

WWTP Locations &
Potential Reuse Locations

Aug 2009

Figure 4-1

Table 4-2: Summary of Land Available within 1-Mile Radius of WWTPs

Wastewater Treatment Plant	Land Available within 1-mile Radius of WWTP					Total Land Available within 1-mile Radius	Land Available for Water Reuse/Land Application (Assume 50% irrigable land)	Land Needed
	Athletic Field	Cropland	Golf Course	Open Urban Land	Pasture			
	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
Freedom	50.3	319.9	0.0	10.7	36.8	417.6	208.8	1,577.9
Hampstead	15.7	77.5	0.0	32.1	257.1	382.4	191.2	454.2
Manchester	28.7	541.1	0.0	29.6	27.6	627.0	313.5	245.1
Mt Airy	0.0	326.8	0.0	11.9	80.2	418.8	209.4	409.2
Taneytown	15.2	1271.0	0.0	0.0	123.1	1409.2	704.6	510.3
Westminster	0.0	440.3	181.3	54.2	115.6	791.3	395.6	1,669.0

Notes:
Available land excludes existing Manchester Spray Fields, as well as small (<50 acre and non-contingulous parcels)

Table 4-3: Summary of Land Available within 2-Mile Radius of WWTPs

Wastewater Treatment Plant	Land Available within 2-mile Radius of WWTP					Total Land Available within 2-mile Radius	Land Available for Water Reuse/Land Application (Assume 50% irrigable land)	Land Needed
	Athletic Field	Cropland	Golf Course	Open Urban Land	Pasture			
	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)	(acres)
Freedom	53.5	622.9	0.0	44.1	424.6	1145.1	572.5	1,577.9
Hampstead	101.5	684.5	3.0	39.7	1007.9	1836.6	918.3	454.2
Manchester	28.7	2860.8	87.8	46.8	371.6	3395.7	1,697.8	245.1
Mt Airy	44.3	955.6	0.0	50.1	383.6	1433.6	716.8	409.2
Taneytown	21.9	4890.2	0.0	15.4	426.3	5353.7	2,676.9	510.3
Westminster	0.0	2820.3	261.5	97.1	552.3	3731.3	1,865.6	1,669.0

Notes:
Available land excludes existing Manchester Spray Fields, as well as small (<50 acre and non-continguous parcels)

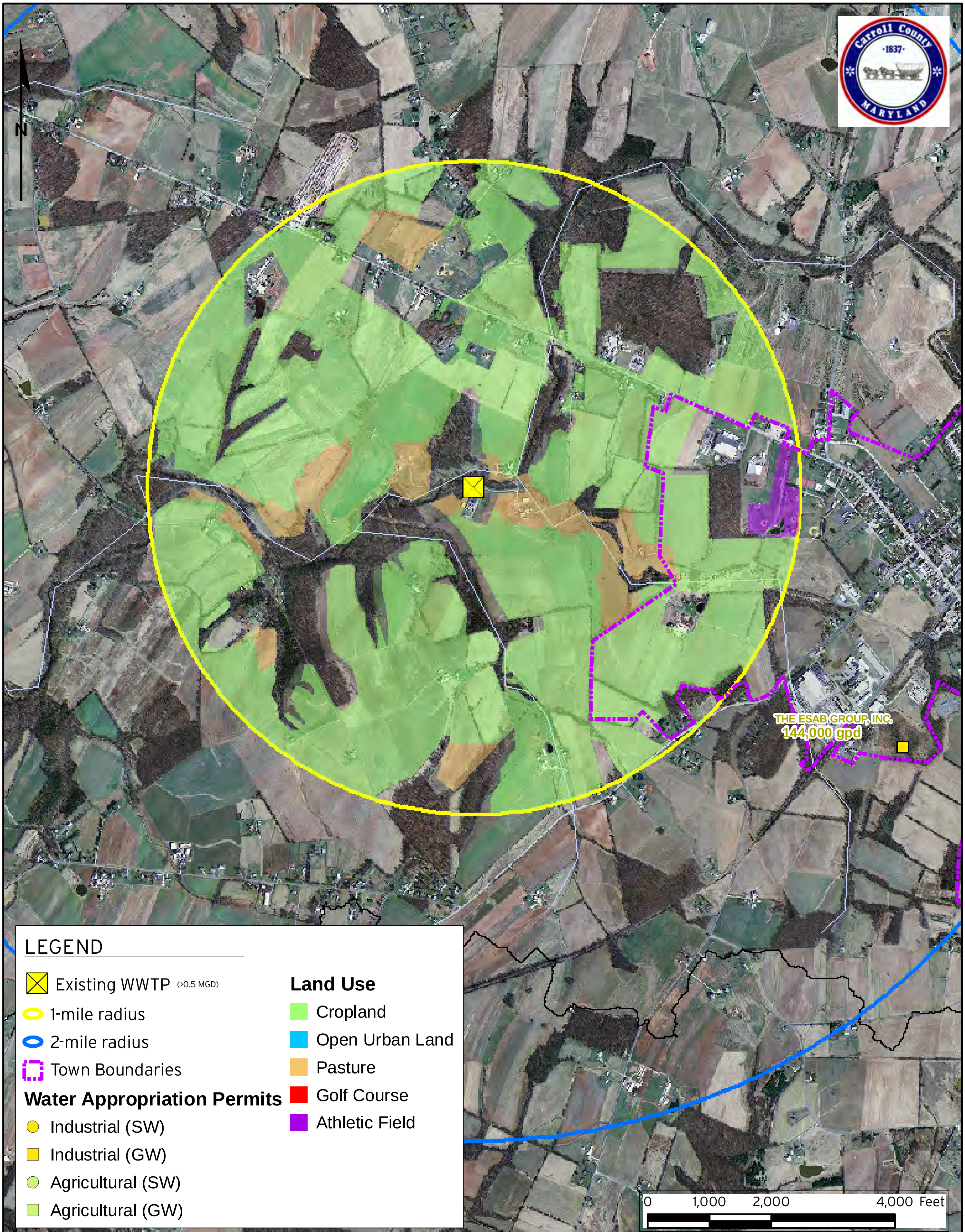
Table 4-4: Summary of Land Required for Reuse of 50% of Build-Out WWTP Flow

Wastewater Treatment Plant	Planned Design Capacity	Projected Build-Out Flow[1]	Reuse Flow (50% of Projected Build-Out Flow)	Assumed Land Application Rate[2]	Amount of Land Required to Reuse 50% of Build-Out Flow
	(mgd)	(mgd)	(mgd)	(1 mgd/585 acres)	(acres)
Freedom	3.50	5.39	2.70	585	1,578
Hampstead	0.90	1.55	0.78	585	454
Manchester	0.50	0.84	0.42	585	245
Mount Airy	1.20	1.40	0.70	585	409
Taneytown	1.10	1.74	0.87	585	510
Westminster	6.50	5.71	2.85	585	1,669

Notes:

[1] Projected build-out wastewater flows from the Designated Growth Areas (DGA), as presented in Table 3-1 of the Wastewater Limitations Report (Malcolm Pirnie, May 2009)

[2] Application Rate includes assumptions of land buffers, no long-term storage for winter months, and 25% rainfall and other events shutoff factor



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Taneytown WWTP &
Potential Reuse Locations

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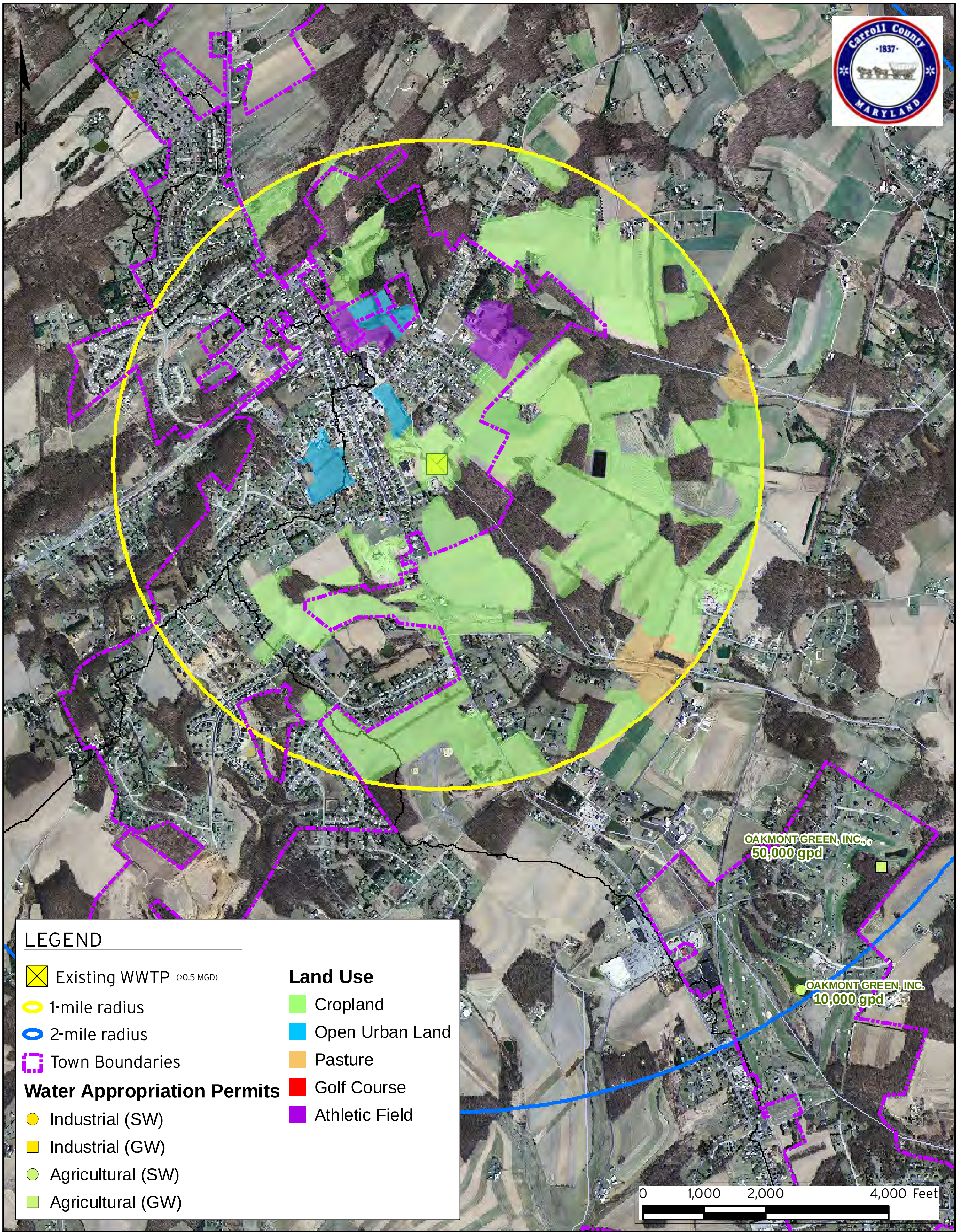
Figure 4-2



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Manchester WWTP & Potential Reuse Locations

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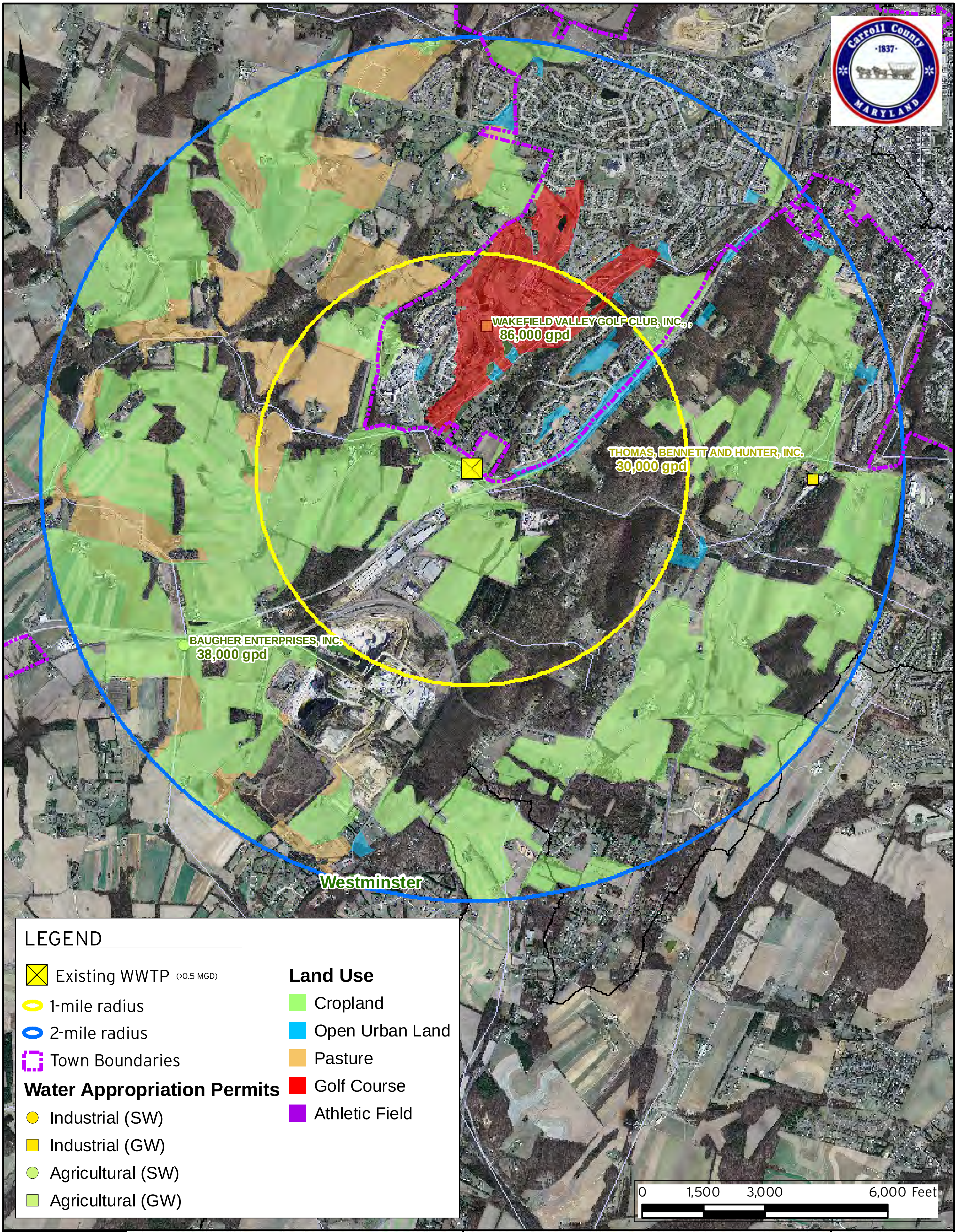
Figure 4-3



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Westminster WWTP & Potential Reuse Locations

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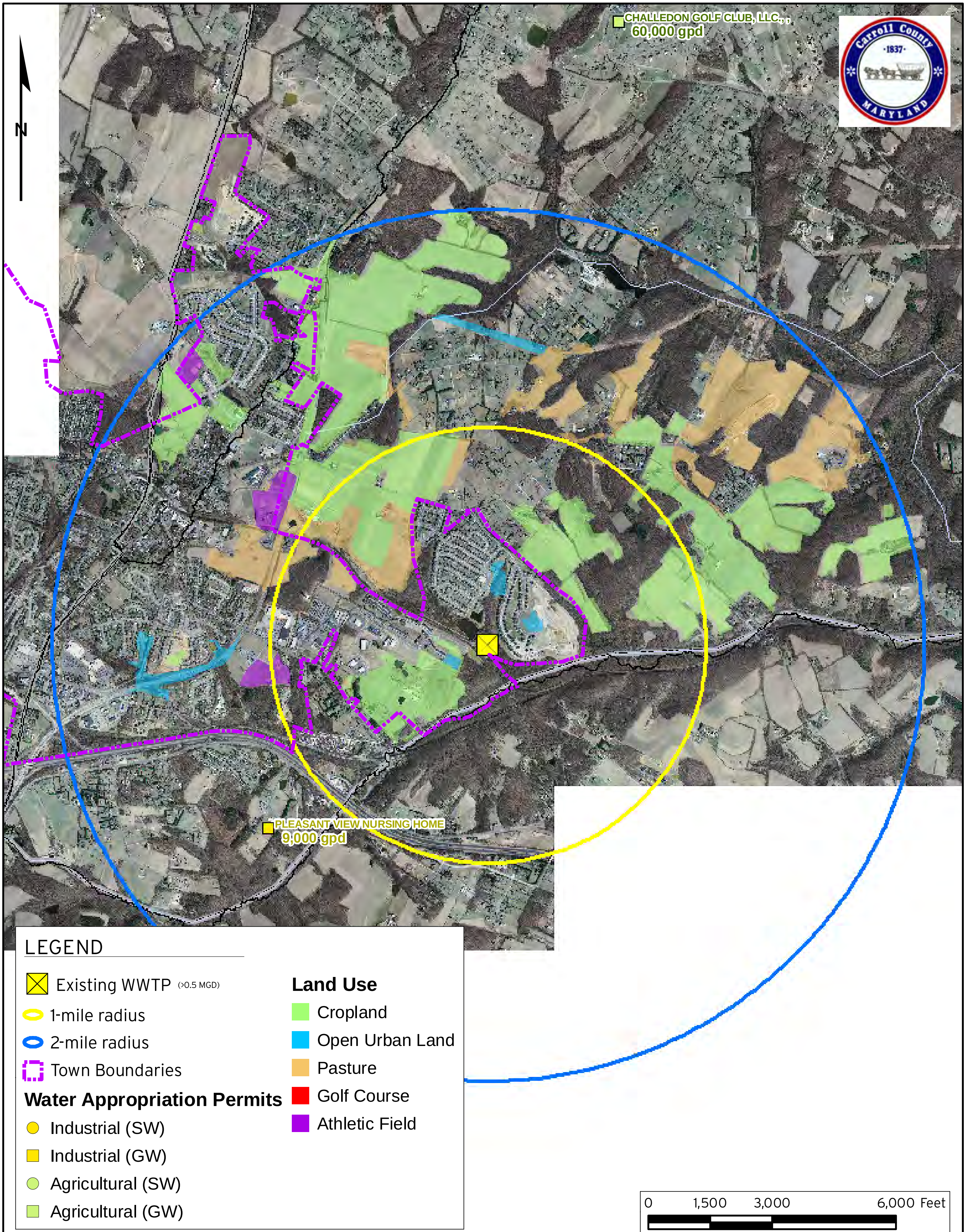
Figure 4-4



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ALTERNATIVES EVALUATION

Mount Airy WWTP &
Potential Reuse Locations

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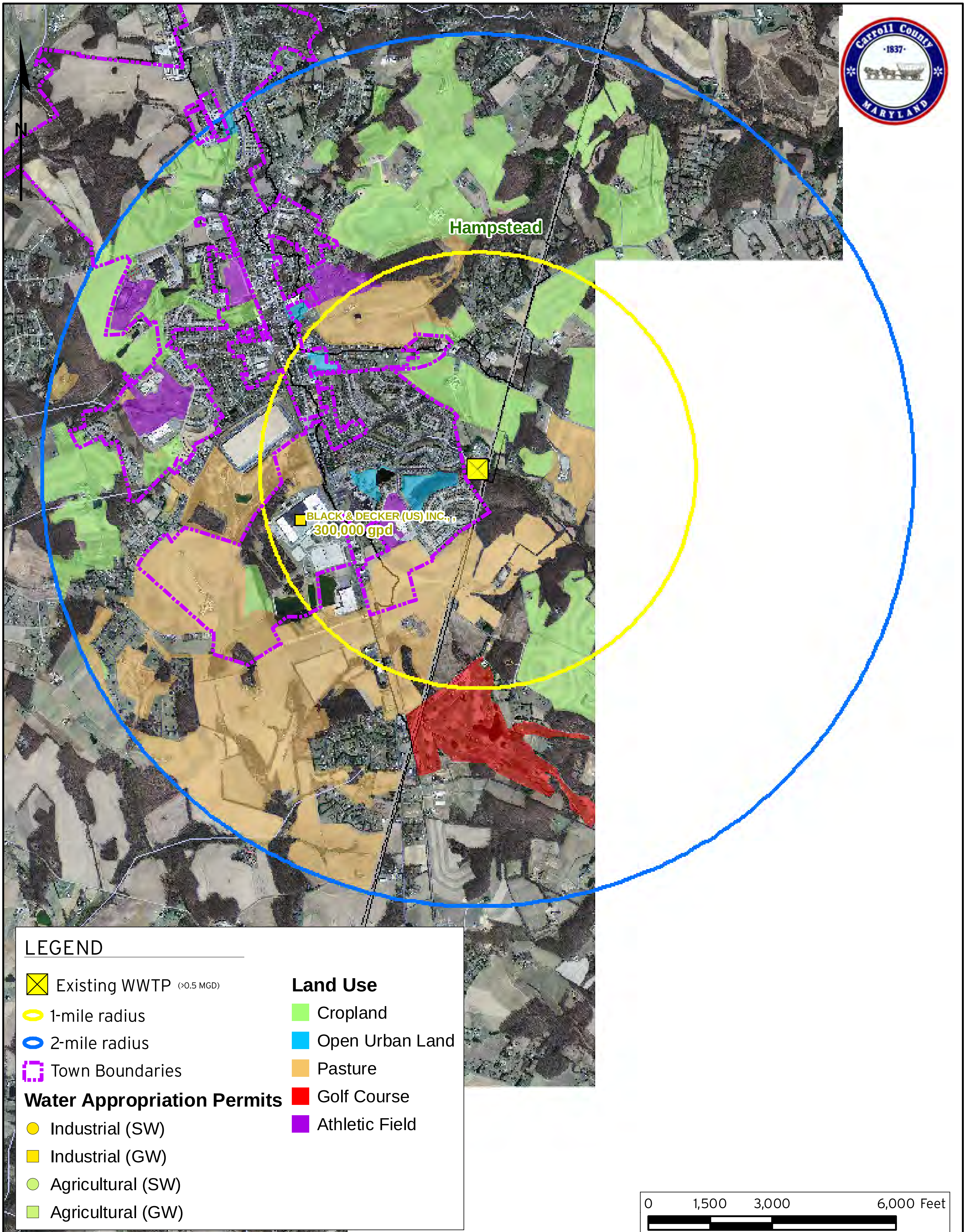
Figure 4-5



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Hampstead WWTP & Potential Reuse Locations

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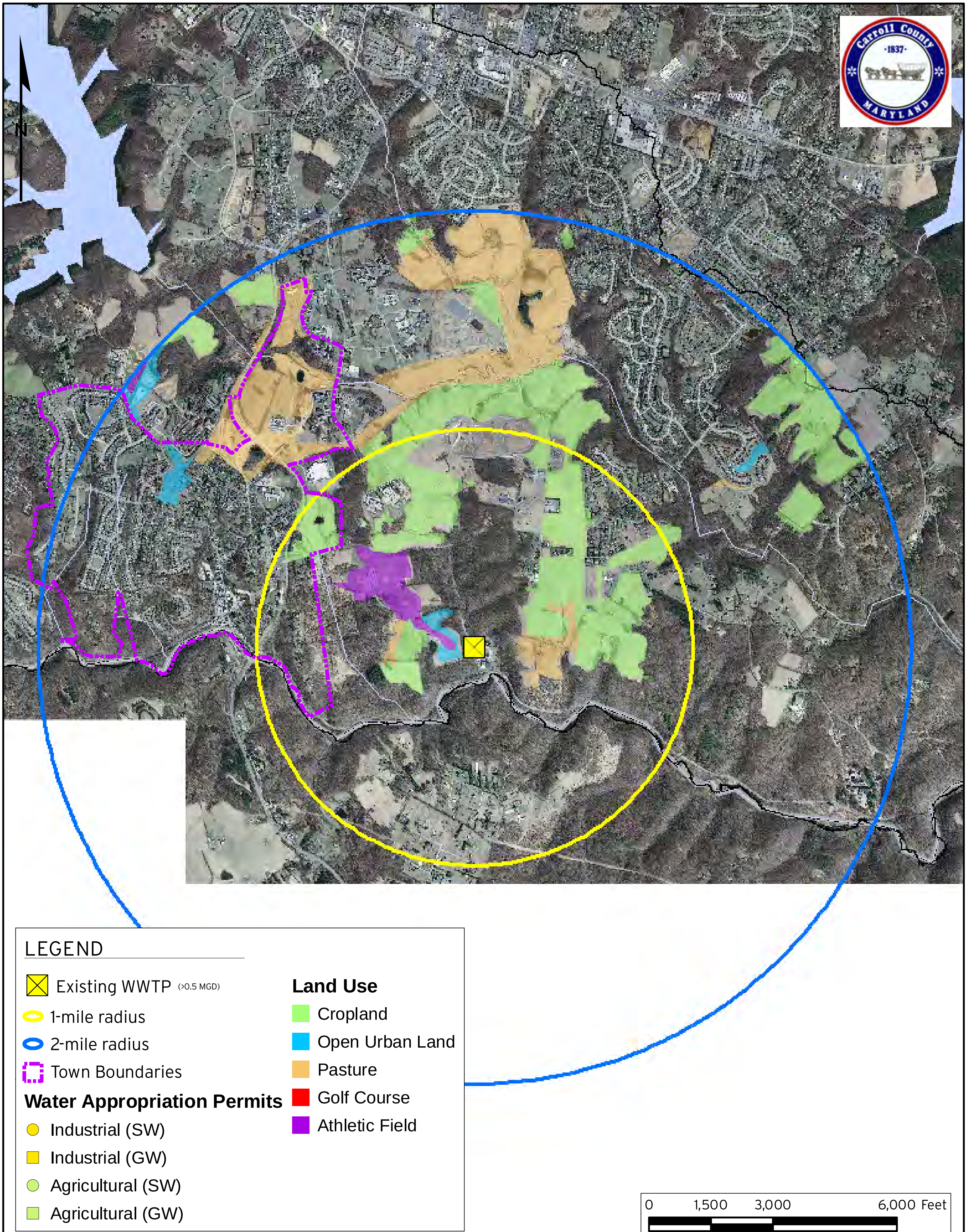
Figure 4-6



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ALTERNATIVES EVALUATION

Freedom District WWTP &
Potential Reuse Locations

Aug 2009

Figure 4-7

5. Evaluation Results/Recommended Alternatives

5.1. Summary of Evaluation

Table 5-1 presents cost estimates for water supply alternatives except for estimated groundwater alternative costs which are presented in Table 5-2. For some alternatives we have relied on prior cost estimates developed by other consultants working for the County or towns and we have noted such instances in Table 5-1. The cost estimates are conceptual in that no design level analysis has been conducted by Malcolm Pirnie to better confirm the specific facilities required for each alternative. Nevertheless, the range of costs for the various alternatives does allow them to be compared in terms of their relative cost, one to another.

For the alternatives presented in Tables 5-1 and 5-2 we have also included allowances for new pumping and transmission capacity and/or water treatment capacity that would be required to deliver water to the applicable service areas. This puts these alternatives on a more equal basis for purposes of comparing unit capital costs per gallon of safe yield benefit.

More detailed cost estimate breakdowns for the Gillis Falls, Union Mills and Piney Run Reservoir alternatives were prepared by Schnabel Engineering working in conjunction with Malcolm Pirnie to define and evaluate reservoir options (see Appendix B). Assumptions used for estimating aquatic habitat mitigation were based on Malcolm Pirnie's direction.

The individual evaluation scoring matrices for all alternatives are included in Appendix D. A summary of the overall evaluation scoring, as well as the rank (in relation to other alternatives) is presented in Table 5-3. Table 5-4 shows all water supply alternatives, sorted by overall rank.

5.2. Recommended Alternatives (based on scoring)

The following section summarizes the recommended water supply alternatives for each Carroll County WSA that is projected to experience a deficit under the Build-out scenario. These recommendations are based on the Evaluation Scoring Results presented in Tables 5-3 and 5-4. Continuing investigations of the recommended alternatives would be warranted to move these options forward. Depending on the relative importance individual communities place on the evaluation criteria used in this report, other lower-scoring alternatives may make more sense for those communities to pursue.

5.2.1. Hampstead WSA

In order to meet the 0.528 mgd projected Build-out water supply deficit, the following alternatives are recommended, in order of their scoring results:

1. Union Mills Reservoir – Expanded (R-4b)
2. Interconnection with the York Water Company (I-2)
3. Union Mills Reservoir – Proposed (R-4a)

5.2.2. Manchester WSA

In order to meet the potential 0.124 mgd projected Build-out water appropriation deficit (assuming continued reduced groundwater well capacities), the following alternatives are recommended, in order of their scoring results:

1. Union Mills Reservoir – Expanded (R-4b)
2. Interconnection with the York Water Company (I-2)
3. Union Mills Reservoir – Proposed (R-4a)

5.2.3. Mount Airy WSA

In order to meet the 0.364 mgd projected Build-out water supply deficit, the following alternatives are recommended, in order of their scoring results:

1. Piney Run Reservoir – Use as a Water Source (R-2)
2. Interconnection with Frederick County (I-1)

5.2.4. New Windsor WSA

In order to meet the 0.198 mgd projected Build-out water supply deficit, the following alternative is recommended:

1. New Windsor Wells (G-3) – drill and develop three additional groundwater wells to meet projected water supply needs.

5.2.5. Taneytown WSA

In order to meet the 1.164 mgd projected Build-out water supply deficit, the following alternatives are recommended, in order of their scoring results:

1. Union Mills Reservoir – Expanded (R-4b). This option involves flow augmentation of Big Pipe Creek from the Union Mills Reservoir, as well as a new intake near Taneytown, new raw water pipeline and a new WTP in Taneytown.

2. Union Mills Reservoir – Proposed (R-4a). This option involves flow augmentation of Big Pipe Creek from the Union Mills Reservoir, as well as a new intake near Taneytown, new raw water pipeline and a new WTP in Taneytown.

5.2.6. Union Bridge WSA

In order to meet the 0.594 mgd projected Build-out water supply deficit, the following alternatives are recommended, in order of their scoring results:

1. Lehigh Quarry – Union Bridge (Q-2)

2. Union Bridge Wells (G-5)

5.2.7. Westminster WSA

In order to meet the 1.176 mgd projected Build-out water supply deficit, the following alternatives are recommended, in order of their scoring results:

1. Union Mills Reservoir – Expanded (R-4b)

2. Medford Quarry – Use as a Permanent Supply (Q-4)

3. Westminster Wells (G-6)

Table 5-1
Alternative Cost Breakdown Summary

Alt. No.	Alternative Description	Project Yield	WTP Capacity [1]	Raw Water Pipeline			Treated Water Pipeline			Storage	Pump Stations	Land Acquisition	Schnabel Cost Estimates: Dam + Spillway	Schnabel Cost Estimates: Stream/Wetland Mitigation	Schnabel Cost Estimates: Road/Bridge Relocations & Other	WTP Cost [2]	Raw Water Pipe Cost	Treated Water Pipe Cost	Storage Cost	Pump Station Cost	Land Acquisition Cost	Cost Subtotal	Capital Cost [3]	Unit Capital Cost	Notes
		mgd	mgd	mgd	diam (in)	feet	mgd	diam (in)	feet	MG	No.	acres	$M	$M	$M	$M	$M	$M	$M	$M	$M	$M	Cost + Contingency ($M)	Capital Cost/Yield ($/gallon)	
R-1a	Gillis Falls Reservoir (Proposed - Elev 610)	3.85	2.0	2.0	16.0	10,560					1	587	$ 32.0	$ 35.0	$ 2.0	$ 8.0	$ 1.84	$ -	$ -	$ 0.70	$ 5.87	$ 48.4	$ 104.4	$ 27.1	Costs include Schnabel-based contingency for dam and spillway, with 40% contingency added for all other project cost components (excluding land acquisition costs).
R-1b	Gillis Falls Reservoir (Expanded - Elev 630)	5.00	2.0	2.0	16.0	10,560					1	1541	$ 43.0	$ 47.0	$ 2.0	$ 8.0	$ 1.84	$ -	$ -	$ 0.70	$ 15.41	$ 68.9	$ 141.8	$ 28.4	Costs include Schnabel-based contingency for dam and spillway, with 40% contingency added for all other project cost components (excluding land acquisition costs).
R-2	Piney Run Reservoir - Use as Water Source	3.65	2.0	2.0	16.0	1,000	2.0	16.0	55,440	3	2		$ -			$ 8.0	$ 0.17	$ 9.65	$ 1.65	$ 1.40	$ -	$ 20.9	$ 29.2	$ 8.0	
R-3	Expansion of Piney Run Reservoir	0.46											$ 4.2	$ 2.9	$ 0.4	$ -	$ -	$ -	$ -	$ -	$ -	$ 4.2	$ 8.8	$ 19.2	Costs calculated for incremental safe yield increase, which assume all other project improvements will have been made for Alternative R-2. Costs include Schnabel-based contingency for dam and spillway, with 40% contingency added for all other project cost components (excluding land acquisition costs).
R-4a	Union Mills Reservoir (Proposed - Elev 610)	3.76	5.0	4.0	20.0	31,680	1.5/0.25	12.0	41,278		3	781	$ 28.0	$ 25.0	$ 4.0	$ 20.0	$ 6.15	$ 4.21	$ -	$ 2.08	$ 7.81	$ 68.2	$ 121.8	$ 32.4	Costs include Schnabel-based contingency for dam and spillway, with 40% contingency added for all other project cost components (excluding land acquisition costs).
R-4b	Union Mills Reservoir (Expanded - Elev 630)	7.93	5.0	4.0	20.0	31,680	1.5/0.25	12.0	41,278		3	1738	$ 38.0	$ 40.0	$ 4.0	$ 20.0	$ 6.15	$ 4.21	$ -	$ 2.08	$ 17.38	$ 87.8	$ 162.4	$ 20.5	Costs include Schnabel-based contingency for dam and spillway, with 40% contingency added for all other project cost components (excluding land acquisition costs).
R-5	Increase Capacity of Cranberry Reservoir	0.10	0.0										$ -			$ -	$ -	$ -	$ -	$ -	$ -	$ 0.2	$ 0.3	$ 2.8	Cost for Cranberry Reservoir expansion provided by Westminster staff.
R-6	Prettyboy Reservoir	2.00	3.0	3.0	16.0	39,600	2.0/0.25	16.0	51,216		3		$ -			$ 12.0	$ 6.89	$ 7.49	$ -	$ 2.03	$ -	$ 28.4	$ 39.8	$ 19.9	
S-1	New Surface Water Intake in Gillis Falls Area	0.85	1.2		16.0	15,840	1.2	12.0	1,056	120.0	2		$ -			$ -	$ -	$ -	$ -	$ -	$ -	$ 40.0	$ 40.0	$ 47.1	Cost Estimate based on Hazen & Sawyer Water Supply Study for Mount Airy (April 2006)
S-2	New Intake on Big Pipe Creek in Union Mills Area (Westminster)	0.70	1.0	4.0	20.0	28,322				280	2		$ -			$ 4.0	$ 6.00	$ -	$ 5.39	$ 1.40	$ -	$ 16.8	$ 23.5	$ 33.6	
S-3	New Intake on Little Pipe Creek for Westminster	0.50	1.0	1.0	12.0	14,684				260	2		$ -			$ 4.0	$ 1.54	$ -	$ 5.47	$ 1.10	$ -	$ 12.1	$ 17.0	$ 33.9	
S-4	New Intake on Big Pipe Creek for Taneytown	0.40	1.0	1.0	12.0	14,735				125	2		$ -			$ 4.0	$ 1.55	$ -	$ 2.69	$ 1.10	$ -	$ 9.3	$ 13.1	$ 32.7	
Q-1	Hyde's Quarry - New Raw Water Reservoir	0.50	0.0	1.0	12.0	10,438					1		$ -			$ -	$ 1.10	$ -	$ -	$ 0.60	$ -	$ 1.7	$ 2.4	$ 4.7	
Q-2	Lehigh Quarry - Union Bridge	0.60	1.0	1.0	12.0	2,640					1		$ -			$ 4.0	$ 0.28	$ -	$ -	$ 0.60	$ -	$ 4.9	$ 6.8	$ 11.4	
Q-3	Lehigh Quarry - New Windsor	0.25	0.5	0.5	8.0	8,976					1		$ -			$ 2.0	$ 0.75	$ -	$ -	$ 0.55	$ -	$ 3.3	$ 4.6	$ 18.5	
Q-4	Medford Quarry - Use as Permanent Supply	0.14	0.0								1		$ -			$ -	$ -	$ -	$ -	$ 0.50	$ -	$ 0.5	$ 0.7	$ 5.0	
I-1	Mount Airy Interconnection with Frederick County	0.85	0.0				1.2	12.0	40,128		1		$ -			$ -	$ -	$ 4.21	$ -	$ 0.62	$ -	$ 12.3	$ 12.3	$ 14.4	Cost Estimate based on Hazen & Sawyer Water Supply Study for Mount Airy - Addendum No. 1 (April 17, 2007)
I-2	Interconnection with the York Water Company	0.90	0.0				1.5	12.0	43,084		1		$ -			$ -	$ -	$ 4.52	$ -	$ 0.65	$ -	$ 5.2	$ 7.2	$ 8.0	
I-3	Freedom to Supply Mount Airy with Use of Existing Sources	0.75	0.0				1.0	12.0	51,216		1		$ -			$ -	$ -	$ 5.38	$ -	$ 0.60	$ -	$ 6.0	$ 8.4	$ 11.2	

Notes:
(1) WTP and pipeline capacities were based on supplying the Build-out scenario max. day demand (using max day factor of 1.5), regardless of excess source capacity.
(2) WTP cost (new or expansion) assumed to be $4M/mgd.
(3) Contingency of 40% added to all project components EXCEPT Schnabel Dam and Spillway Costs and Land Acquisition Costs. Contingencies already accounted for in the Hazen & Sawyer estimates for Alternatives I-1 and S-1.
(4) Cost estimates do not include water purchase costs for the alternatives involving water suppliers located outside of Carroll County

Table 5-2:
COST ESTIMATION FOR GROUNDWATER WELL OPTIONS
(based on average MDE groundwater appropriation)

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	UNITS	G-1 Hampstead	G-2 Mount Airy	G-3 New Windsor	G-4 Taneytown	G-5 Union Bridge	G-6 Westminster	G-7 Union Mills	G-8 Manchester
Yield	gpd	528,000	364,000	198,000	1,164,000	594,000	1,176,000	563,310	124,000
Average Well Depth	ft bgs	221	211	115	497	165	347	347	221
Average Casing Depth	ft bgs	51	46	75	63	50	135	135	51
Well Pumping Rate	gpm	18	51	46	51	69	91	39	18
Number of Wells	--	20	5	3	16	6	9	10	6
Well Cost	**$**	**$ 1,032,000**	**$ 256,000**	**$ 140,000**	**$ 1,049,000**	**$ 293,000**	**$ 529,000**	**$ 587,000**	**$ 310,000**
No. Pump Houses		**5**	**3**	**2**	**8**	**3**	**5**	**5**	**2**
Pump House Size	**sq. ft.**	**550**	**632**	**516**	**758**	**1031**	**1225**	**587**	**500**
Pump House & Treatment Cost	**$**	**$ 908,000**	**$ 626,000**	**$ 341,000**	**$ 2,001,000**	**$ 1,021,000**	**$ 2,022,000**	**$ 969,000**	**$ 330,000**
Electrical Cost	**$**	**$ 25,000**	**$ 15,000**	**$ 10,000**	**$ 40,000**	**$ 15,000**	**$ 25,000**	**$ 25,000**	**$ 10,000**
Average Pipe Length	**mile**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
Piping Costs	**$**	**$ 788,000**	**$ 473,000**	**$ 315,000**	**$ 1,260,000**	**$ 473,000**	**$ 788,000**	**$ 788,000**	**$ 315,000**
Additional Piping Cost	**$**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 6,496,800**	**$ -**
PH, Treatment, Piping & Elect. Cost	**$**	**$ 1,721,000**	**$ 1,114,000**	**$ 666,000**	**$ 3,301,000**	**$ 1,509,000**	**$ 2,835,000**	**$ 8,278,800**	**$ 655,000**
Total Cost (includes contingency)	**$**	**$ 3,304,000**	**$ 1,644,000**	**$ 968,000**	**$ 5,220,000**	**$ 2,163,000**	**$ 4,037,000**	**$ 11,939,000**	**$ 1,158,000**
Unit Cost	**$/gallon**	**$ 6.26**	**$ 4.52**	**$ 4.89**	**$ 4.49**	**$ 3.64**	**$ 3.43**	**$ 21.20**	**$ 9.34**

Assumptions

- Total costs based on average well properties in each water service area (WSA) rounded up to the nearest thousand dollar value
- Unit costs based on typical values in the Mid-Atlantic
- Costs associated with connecting new wells to the water supply grid are estimated at $5,000 per pump house. Assumed that power supply source is available at well sites.
- Cost estimation does not include land/easement acquisition costs
- Costs adjusted upward by a 20% contingency factor
- 8 inch production wells with approximately 1 to 4 wells per pump house. Based on previous studies, 4 wells per pump house was assumed for Hampstead (G-1), while 3 wells per pump house was assumed for Manchester (G-8).
- Number of wells based on projected additional demand divided by the average current MDE groundwater appropriation per well by service area
- Union Bridge casing depth assumed from the average county-wide ratio of well depth to casing depth as no data was available for Union Bridge WSA
- Manchester well depth, casing depth, and well pumping rate assumed to be the same as Hampstead, as no data was available for Manchester WSA
- Pump house size based on total gpm/pump house. Assume 7.5 sq. ft/ per gpm required (based on Manchester's Hallie Hills Station 2, which was 750 sq. ft for 100 gpm flow). A minimum pump house footprint of 500 sq. ft. was assumed.
- Additional storage requirements were not assessed, and therefore storage costs were not included in the estimates.
- Piping costs are ~$60/l.f. ($315,000/mile), based on 6-inch transmission main. An average new transmission main length of 0.5 miles was assumed for all alternatives.
- Pump houses are assumed to be masonry structures, equipped with chemical monitoring and dosing equipment and emergency generators. Cost per sq. ft. estimated at $300 for the structure and $30 for chemical monitoring and treatment equipment (disinfection and pH adjustment equipment).
- G-7 (Union Mills Area Wells) include cost estimates for a 5-mile raw water pipeline to the Westminster Service Area sized to meet proposed Union Mills Reservoir project needs and a new pump station (20-inch pipeline and 4 mgd pump station). Pipeline and pump station costs were adjusted upward by a 40% contingency factor.

	Unit Cost	Unit
Drilling	50	$/ft of well
Casing	10	$/ft of casing
Aquifer Test	20,000	$/well
Site Analysis + Permitting	20,000	$/well
Pump House & Chemical Treatment	330	$/pump house sq. ft.
Piping	315,000	$/mile
Electrical	5,000	$/pump house

Table 5-3
Alternatives Evaluation Scoring Summary and Rankings

Alternative No.	Alternative Description	Water Supply Benefits	Environmental Impacts	Implementability	Relative Cost Estimate	Overall Performance	Alternatives Base Rank
		Criteria Weights					
		0.40	0.20	0.20	0.20		
		Numerical Scores					
R-1a	Gillis Falls Reservoir (Proposed - Elev 610)	2.4	1.7	1.0	1.0	1.7	23
R-1b	Gillis Falls Reservoir (Expanded - Elev 630)	2.4	1.7	1.0	1.0	1.7	23
R-2	Piney Run Reservoir - Use as Water Source	2.6	3.0	2.3	2.5	2.6	1
R-3	Expansion of Piney Run Reservoir	1.6	2.4	1.8	1.5	1.8	19
R-4a	Union Mills Reservoir (Proposed - Elev 610)	2.8	1.8	1.5	1.0	2.0	6
R-4b	Union Mills Reservoir (Expanded - Elev 630)	3.0	1.8	1.5	1.5	2.2	2
R-5	Increase Capacity of Cranberry Reservoir	1.2	2.0	2.0	3.0	1.9	12
R-6	Prettyboy Reservoir	1.9	2.5	1.8	1.5	1.9	12
S-1	New Surface Water Intake in Gillis Falls Area	2.0	2.1	2.0	1.0	1.8	19
S-2	New Intake on Big Pipe Creek in Union Mills Area (Westminster)	1.4	2.3	1.5	1.0	1.5	26
S-3	New Intake on Little Pipe Creek for Westminster	1.4	2.4	2.0	1.0	1.6	25
S-4	New Intake on Big Pipe Creek for Taneytown	1.4	2.0	1.3	1.0	1.4	27
Q-1	Hyde's Quarry - New Raw Water Reservoir	1.4	2.4	2.0	3.0	2.0	6
Q-2	Lehigh Quarry - Union Bridge	1.8	2.4	1.8	2.0	1.9	12
Q-3	Lehigh Quarry - New Windsor	1.8	2.4	2.0	1.5	1.9	12
Q-4	Medford Quarry - Use as Permanent Supply	1.4	2.7	2.0	3.0	2.1	3
I-1	Mount Airy Interconnection with Frederick County	1.7	2.8	2.0	2.0	2.0	6
I-2	Interconnection with the York Water Company	1.7	2.8	1.8	2.5	2.1	3
I-3	Freedom to Supply Mount Airy Using Existing Sources	1.8	2.3	1.5	2.0	1.9	12
G-1	Hampstead Wells	1.4	2.7	1.0	2.5	1.8	19
G-2	Mount Airy Wells	1.4	2.7	1.5	3.0	2.0	6
G-3	New Windsor Wells	1.4	2.7	1.5	3.0	2.0	6
G-4	Taneytown Wells	1.4	2.7	1.0	3.0	1.9	12
G-5	Union Bridge Wells	1.4	2.7	1.0	2.5	1.9	12
G-6	Westminster Wells	1.4	2.7	2.0	3.0	2.1	3
G-7	Union Mills Area Wells	1.4	2.7	2.0	1.5	1.8	19
G-8	Manchester Wells	1.4	2.7	2.0	2.5	2.0	6

Note:
(a) Numerical Scores: Highest (3); Lowest (1)

Table 5-4
Alternatives Evaluation Scoring Summary and Rankings - SORTED BY RANK

Alternative No.	Alternative Description	Water Supply Benefits	Environmental Impacts	Implementability	Relative Cost Estimate	Overall Performance	Alternatives Base Rank
		Criteria Weights					
		0.40	0.20	0.20	0.20		
		Numerical Scores					
R-2	Piney Run Reservoir - Use as Water Source	2.6	3.0	2.3	2.5	2.6	1
R-4b	Union Mills Reservoir (Expanded - Elev 630)	3.0	1.8	1.5	1.5	2.2	2
Q-4	Medford Quarry - Use as Permanent Supply	1.4	2.7	2.0	3.0	2.1	3
I-2	Interconnection with the York Water Company	1.7	2.8	1.8	2.5	2.1	3
G-6	Westminster Wells	1.4	2.7	2.0	3.0	2.1	3
R-4a	Union Mills Reservoir (Proposed - Elev 610)	2.8	1.8	1.5	1.0	2.0	6
Q-1	Hyde's Quarry - New Raw Water Reservoir	1.4	2.4	2.0	3.0	2.0	6
I-1	Mount Airy Interconnection with Frederick County	1.7	2.8	2.0	2.0	2.0	6
G-2	Mount Airy Wells	1.4	2.7	1.5	3.0	2.0	6
G-3	New Windsor Wells	1.4	2.7	1.5	3.0	2.0	6
G-8	Manchester Wells	1.4	2.7	2.0	2.5	2.0	6
R-5	Increase Capacity of Cranberry Reservoir	1.2	2.0	2.0	3.0	1.9	12
R-6	Prettyboy Reservoir	1.9	2.5	1.8	1.5	1.9	12
Q-2	Lehigh Quarry - Union Bridge	1.8	2.4	1.8	2.0	1.9	12
Q-3	Lehigh Quarry - New Windsor	1.8	2.4	2.0	1.5	1.9	12
I-3	Freedom to Supply Mount Airy Using Existing Sources	1.8	2.3	1.5	2.0	1.9	12
G-4	Taneytown Wells	1.4	2.7	1.0	3.0	1.9	12
G-5	Union Bridge Wells	1.4	2.7	1.0	2.5	1.9	12
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S-1	New Surface Water Intake in Gillis Falls Area	2.0	2.1	2.0	1.0	1.8	19
G-1	Hampstead Wells	1.4	2.7	1.0	2.5	1.8	19
G-7	Union Mills Area Wells	1.4	2.7	2.0	1.5	1.8	19
R-1a	Gillis Falls Reservoir (Proposed - Elev 610)	2.4	1.7	1.0	1.0	1.7	23
R-1b	Gillis Falls Reservoir (Expanded - Elev 630)	2.4	1.7	1.0	1.0	1.7	23
S-3	New Intake on Little Pipe Creek for Westminster	1.4	2.4	2.0	1.0	1.6	25
S-2	New Intake on Big Pipe Creek in Union Mills Area (Westminster)	1.4	2.3	1.5	1.0	1.5	26
S-4	New Intake on Big Pipe Creek for Taneytown	1.4	2.0	1.3	1.0	1.4	27

Note:
(a) Numerical Scores: Highest (3); Lowest (1)

6. References

[1]Malcolm Pirnie, Inc., 2009. *Carroll County Water Demands and Availability*. July 2009.

[2] Hazen and Sawyer, 2006-2007. Water Supply Alternatives Study for Town of Mount Airy (April 2006) and Report Addendum No. 1 (April 2007).

[3] MDE, Date unknown. *Water Balance Summary*. Word Document provided by Pat Hammond of MDE on Feb 20, 2009.

[4] R.E. Wright Associates, 1988. *Carroll County Water Resources Study (Volumes I-II)*. May 1988.

[5] Malcolm Pirnie, Inc., 2009. *Carroll County Wastewater Limitations*. May, 2009

[6] MDE. 2003. *Guidelines for Land Treatment of Municipal Wastewaters*. 33 p.

Carroll County
Alternatives Evaluation

Appendix A

Telephone Conversation Logs

6531-001-400

MALCOLM PIRNIE

Phone Conversation Log

MALCOLM PIRNIE

Date: 4-22-09
Locality/Water System: Manchester
Contact: Steve Miller, Town Manager
Phone No: 410-239-3200
Email: sl_miller@comcast.net

Existing Source(s):

- 12 wells, one spring (Hillside Spring) and 10 pump stations
- Water treated at pump stations and sent to distribution system
- Three storage tanks (one brought online in the last four months)

Future Source Alternative(s):

- Continue to rely on groundwater to serve future growth – develop new wells as development takes place.
- Complete rehabilitation of Walnut Street Spring and Lippy Well
    - Rehab of the Walnut Street Spring will likely occur in the next few years.
    - Well field being developed in conjunction with the Carroll County Board of Education – 2 new wells plus the Lippy well should be in operation by November 2009, including nitrate treatment.
- Interconnection with York Water Company in York, PA
    - Manchester has had discussions with YWC in the past about purchasing water through an interconnection. Manchester wanted to purchase 50,000 – 100,000 gpd, but YWC said there was a minimum 150,000 gpd purchase required. Discussions stopped there.
    - Other issues: Transmission mains to the MD border + pump station to be paid for and installed by YWC. Mains from MD border to Manchester to be installed by Manchester. Town worried about maintenance of ~6 miles of pipe outside of their service area plus the requirement for fire hydrants along pipeline.
    - This alternative is still considered a viable option if details can be sorted out.
- Prettyboy Reservoir
    - Considered a potential option for the Town (after the interconnection)
- Union Mills Reservoir could serve as supplemental source
    - Confusion between Manchester and County – Manchester not sure if they would be receiving raw water from the reservoir that they would have to treat, or if they would be supplied treated water from a new County WTP.

Phone Conversation Log

Date: 4/27/09
Locality/Water System: Westminster
Contact: Jeff Glass, Director, DPW
Phone No: 410-848-4381
Email: jglass@westgov.com

Existing Source(s):

- Cranberry Branch/Cranberry Reservoir: 30-in transmission line to Cranberry WTP
- Surface water intake on the West Branch of the Patapsco (Hull Creek): 14-16-in gravity transmission line to Cranberry WTP
- 2.0 mgd combined appropriations permit from two surface water sources. The appropriation from these two sources was reduced to allow emergency withdrawals from Medford Quarry. Appropriations are 1.838 mgd AAD and 3.0 mgd max day.
- Koontz well – used for flow augmentation. Still in use (500,000 gpd AAD)
- Eight wells in service (Well 4, Well 6, Well 3, Well 5, Well 7, Wells 9 & 10, and Well 8). Wakefield Valley (Wells 1 & 2 – Wakefield wells). All still in use.
- Permanent emergency connection of the Medford (Genstar) Quarry – connected to existing system. According to Mr. Glass, this connection has been made, and lines are currently being tested. Anticipated to be ready to go in about one month.

Future Source Alternative(s):

- Continue well development
- Raise water elevation/increase capacity of Cranberry Reservoir
  - There are two ways of doing this that the City has looked into – purchasing additional property to increase the surface area of the reservoir or raising the dam by one foot to increase the volume vertically. City ran into many political and land owner problems with purchasing land to expand the reservoir horizontally. Raising the dam is still a viable option, but they had some leaks in the existing dam – fixed them – found more leaks and fixed those. They have not done anything more with pursuing the dam raising alternative. Both options COMBINED would not provide enough supply to meet their needs.
- Hyde's Quarry as a raw water reservoir – need a pipeline to connect to the Medford line. This would serve as a backup to Little Pipe Creek intake, but it is located downstream of WWTP and MDE is concerned that the water in the quarry is under the influence of WWTP effluent. Currently, MDE and Westminster disagree on the method of testing to prove/disprove that this is happening.
- Roop's Mill Well – adjacent Roop property development – currently under construction and is expected to be operational by July/August 2009.

Phone Conversation Log

Westminster, continued...

Date: 4/27/09
Locality/Water System: Westminster
Contact: Jeff Glass, Director, DPW
Phone No: 410-848-4381
Email: jglass@westgov.com

- Well on Dutterer property (City acquired) – no longer an option. This is within the same watershed, so they would not expect to receive an appropriation permit for this well without reducing appropriation from another source.
- Union Mills Reservoir – long term option. Ties in with Big Pipe Creek intake.
- Wells and intake from Big Pipe Creek in the Union Mills area – located near intersection of Route 97 and Sawmill Road. Plans for this alternative include starting with groundwater wells in the vicinity of Union Mills reservoir, and pumping water down to connect into the Medford line (connection already in place). Once approved, they plan to install a 2 mgd surface water intake on Big Pipe Creek, potentially along with a small offline reservoir. This alternative would already have infrastructure in place to support construction of the Union Mills reservoir for long-term supply. Westminster has applied for stimulus money for this project and hope to move forward with it.
- New surface water intake on Little Pipe creek – this potential alternative involves a 350 gpm intake on Little Pipe Creek, near the intersection of Route 31 and Old New Windsor Pike. Hyde Quarry would serve as a backup to use during low flow periods.
- Gaselle Well – has been drilled, tested and is undergoing the first round of water quality testing, which look good so far. Estimated yield of 300 gpm.
- Conversion of Koontz Creamery well to potable supply - an option investigated 3 or 4 years ago, by Carroll Land Services at the request of MDE and paid for by the City. The study evaluated options of on-site treatment, pumping directly to the water plant for treatment, and pumping to the Cranberry reservoir. On-site treatment resulted in an extremely high cost per gallon as it is 1. under the influence of surface water and will need to be filtered, 2. Contaminated by hydrocarbon and will need to be treated for VOC/packed tower etc. 3. Is high in Nitrate and will need ion exchange treatment. It was virtually more economical to buy bottled water than treat the Koontz well for direct pumping to the distribution system. Pumping to the plant or Reservoir. Very expensive due to miles of pipeline needed. The result of the study was to keep using the well as augmentation for the water plant, by pumping into the stream that feeds West branch Patapsco.

Phone Conversation Log

Date: 4/29/09
Locality/Water System: Hampstead
Contact: Roger Steger, Superintendent AND Ken Decker, Town Manager
Phone No: 410-239-6659 (Roger); 410-239-7408 (Ken)
Email: hampwork@comcast.com

Existing Source(s):

- 17 wells – chlorination and pH adjustment
  - They have been operating with 12 out of the 17 wells due to water quality issues (mainly nitrate).
- 3 storage tanks (100,000-gallon, 500,000-gallon and 400,000-gallon)

Future Source Alternative(s):

- Continue to rely on groundwater sources
  - Two existing wells and two new wells are currently being housed in a pump house and are getting ready to be tested. The design of the pump house, etc. is currently underway. The new wells should yield ~85 gpm combined.
  - Also looking at obtaining well at Oakmont Green Golf Course
- New well development focused on water quality as much as quantity
- Interconnection with York Water Company in York, PA
  - This option is still a possibility if Hampstead and Manchester purchased water together to meet the 150,000 gpd minimum from YWC.
- Prettyboy Reservoir
  - This option is also still a possibility, but the need does not exist at this time for such a large quantity of water. Again, regionalization may make this more of a realistic option.
- Other notes from conversation with Ken Decker:
  - MDE has no regulations for water reuse in MD. Ken thinks it may be difficult to get a water reuse project permitted.
  - Hampstead is approaching build-out, so their demands may not warrant large-scale supply projects. They feel more comfortable with increasing capacity in small increments via new groundwater wells.

- Mr. Decker has concerns that state agencies do not want growth in any areas outside of the Baltimore Beltway, so large scale projects may have a hard time being permitted in Carroll County.

Phone Conversation Log

MALCOLM PIRNIE

Date: 4-22-09
Locality/Water System: Taneytown
Contact: Rick Weaver, Director, DPW
Phone No: 410-751-1100
Email: rjweaver@taneytown.org

Existing Source(s):

- Currently using seven municipal wells
- Chlorination at pump houses
- Issues with PCE levels in Well 9 and Well 13 – carbon filtration may be needed to treat water from these wells.
    - According to Mr. Weaver, Well 13 is offline due to radio nuclide contamination problems.
    - Carbon filtration treatment was added to Well 9. This well should be online in a couple of weeks, bringing the number of Taneytown's well sources to eight.

Future Source Alternative(s):

- Expand production capacity of existing wells to overcome deficit from contamination of Well 13.
    - Taneytown recently drilled a new well, and drilled an existing well deeper. The pump tests from the new well show 400 gpm, but the appropriation permit has not been filed yet.
- 1.5 mgd surface water source, likely on Big Pipe Creek in vicinity of MD140. Would also require a new WTP. According to Mr. Weaver, this alternative is likely 5 to 7 years in the future.

Phone Conversation Log

Date: 4-22-09
Locality/Water System: Mt. Airy
Contact: Tom Roberson, WTP Supervisor
Phone No: 301-829-2674
Email: trobersonwwtp@fwbnet.net

Existing Source(s):

- Ten wells supply Town, unincorporated areas are on individual wells. Main well field is in Frederick County.

Future Source Alternative(s):

- Gillis Falls Reservoir – considered by Town of Mt. Airy to be a long term alternative. In order to meet the consent order, they need to find new sources immediately.
- Wells in vicinity of Gillis Falls (temporary)
    - To satisfy consent order, Mt. Airy is actively drilling wells. They have drilled 28-30 wells in the vicinity of Gillis Falls. They are looking to develop 1 or 2 wells in this area, but are currently waiting on water quality testing/pump testing. Groundwater wells are their 1st choice to meet their needs.
- Surface water intake in the vicinity of Gillis Falls
- Interconnection with Frederick County
- According to Mr. Roberson, the Town's next choice is either a surface water intake in the vicinity of Gillis Falls (see H&S report) or an interconnection with Frederick County. The interconnection point is only ~ 5 miles from the Carroll County border.

Phone Conversation Log

Date:
Locality/Water System: New Windsor
Contact: Wally Brown, Town Manager
Phone No: 410-635-6575
Email: WBrown@NewWindsorMD.org

Local Plumber with System Knowledge: Jack Coe
Cell No: 443-398-0321
Email: actionj@qis.net

Existing Source(s):

- Springs and wells supply municipal water system – several under the influence of surface water, so they are not utilized.
  - Have 6 or 7 wells, 3 or 4 under influence of surface water
  - Currently using 1 well and 1 spring

Future Source Alternative(s):

- Develop additional groundwater wells
  - Town is almost at buildout because they are landlocked by conservation and agriculture preservation lands. Two developments are currently planned, and then they are "pretty much done" according to Mr. Brown.
- Lehigh Quarry
  - This quarry will not even be developed for a few years – at least 10 years until there is a "hole" to begin dewatering. It is estimated that this could potentially be used as a source in 20-40 years if needed.

Phone Conversation Log

Date: 4-22-09
Locality/Water System: Union Bridge
Contact: Mayor Bret Grossnickle
Phone No: 410-775-2711 (Town Hall)
443-340-9266 (Cell)
Email: bretgrossnickle@hotmail.com

Existing Source(s):

- Two wells supply system – West Locust Street and Whyte Street. Both are tied into a new 0.30 mgd WTP
- Third well housed in a new WTP – online in 2006 (?). According to Mr. Grossnickle, this well (Phillips Well) belongs to the developer and is not in use. This well is not expected to meet buildout demands of this new development, and the timing of when this well will be on line is unknown at this time.

Future Source Alternative(s):

- Rehabilitate Well #1 (West Locust Street Well) in 2006. According to Mr. Grossnickle, this well has not been rehabilitated because they could not take it offline without having a third well (Phillips Well) available.
- Bowman property – new well, appropriation permit pending. This well will supply a new development, but does not provide enough supply to satisfy buildout demands of the development.
- Lehigh Quarry as a raw water reservoir. Mr. Grossnickle does not feel like this is a viable option, so long as the quarry is in operation due to the large potential for contamination. The quarry currently uses this water as cooling water.

Phone Conversation Log

Date: 4-22-09
Locality/Water System: Sykesville/Freedom
Contact: Frank Schaeffer, Dep. Director, Carroll County DPW
Phone No: 410-386-2035
Email: fschaeffer@ccg.carr.org

Existing Source(s):

- Purchase water from the Liberty Reservoir (max 6.0 mgd) – treated at County's WTP on Oakland Road. According to Mr. Schaeffer, the Liberty WTP has been expanded to 7.0 mgd and is currently online.
- Fairhaven Well 22B – 0.227 mgd annual average (max month 0.340 mgd)
- Also have another well, Well RC1 (Raincliffe Center area), with an AAD of 0.211 mgd

Future Source Alternative(s):

- Develop additional wells in the Freedom area including those at Springfield Complex and Freedom Park. According to Mr. Schaeffer, there are three additional wells that may be pursued by Freedom WD, but no agreements are currently in place. These wells have not yet been developed.
- Piney Run Reservoir – build WTP. Also alternative including raising dam to increase capacity. Mr. Schaeffer explained that this alternative is a political hot button issue. In the past, when they evaluated expanding the Freedom WTP on Liberty Reservoir, they also looked at using Piney Run Reservoir as a water supply source, with construction of a new WTP. Previous evaluations chose the Freedom expansion as the preferred alternative (and it has since been expanded). Current plans for the existing service area DOES NOT include use of Piney Run. Using Piney Run Reservoir as a source would only become viable if the service area expanded AND capacity was running out at the Freedom WTP.

Carroll County
Alternatives Evaluation

Appendix B

Preliminary Evaluation of Reservoir Alternatives

6531-001-400

MALCOLM PIRNIE

REPORT

Preliminary Evaluation of Reservoir Alternatives in Support of Water Resources Element of Comprehensive Plan Carroll County, Maryland

Schnabel Reference 09150009

June 11, 2009

Prepared for:

MALCOLM PIRNIE

Prepared by:

Schnabel

Schnabel Engineering, LLC

REPORT

Preliminary Evaluation of Reservoir Alternatives in Support of Water Resources Element of Comprehensive Plan Carroll County, Maryland

Schnabel Reference 09150009

June 11, 2009

Prepared for:

MALCOLM PIRNIE

Prepared by:

Schnabel

Schnabel Engineering, LLC

STATE OF MARYLAND GREGORY S. PAXSON No. 36468 PROFESSIONAL ENGINEER

John P. Harrison, P.E.
Senior Associate

Gregory S. Paxson, P.E.
Senior Associate

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

Schnabel Engineering, LLC (Schnabel) was engaged by Malcolm Pirnie to perform a desktop study to update the evaluation of two potential reservoir sites (Gillis Falls and Union Mills) and the possible expansion of Piney Run Reservoir in support of the County's Master Plan. Our scope for this study included review of previous reports, site visits, updated cost estimates, and development of a summary letter report relative to the feasibility of constructing a dam at the considered sites.

For the expansion of Piney Run, a historic structure on the northeast shore of the reservoir would be impacted by an increase in dam height. However, assuming a spillway design flood of ½ probable maximum flood (½ PMF), a labyrinth spillway could be constructed that would enable passage of the ½ PMF within the existing spillway width, and allow a 4-ft increase in normal pool without raising of the dam. This increase in pool level provides a 0.46 mgd increase in safe yield (computed by Malcolm Pirnie).

As noted in the previous studies, either an earth dam or roller compacted concrete dam (RCC) could be constructed at both the Gillis Falls or Union Mills site. Cost estimates (2009 dollars) were developed for each option consisting of dam/reservoir construction (RCC dam assumed), stream mitigation, wetland mitigation, road/bridge relocations, and in the case of Union Mills, landfill improvements. The cost for constructing a dam to EL 610 at Gillis Falls was estimated to be on the order of $69M, while a dam to EL 610 at Union Mills[1] was estimated to be on the order of $57M. Relative to the amount of safe yield that could be attained at each site, the Union Mills site could provide significantly more safe yield, with a relative cost of $11.3M/mgd of safe yield versus $18.0M/mgd of safe yield for Gillis Falls. In addition, relative to the safe yield provided by each site, the Union Mills site would have significantly fewer impacts to the natural and human environments. Estimates for construction of the reservoirs to EL 630 were also conducted and yielded similar conclusions relative to these two sites.

Of the three sites considered herein and for the limited factors considered in this study, the apparent preferred alternative for development is the Union Mills Reservoir. Of these options, it appears to be the least environmentally damaging, practicable alternative capable of providing the water supply needs of the County for all considered growth scenarios.

Notwithstanding the preferred alternative noted above, permitting a reservoir in this region of the United States is an extremely difficult, expensive, time-consuming, and frustrating endeavor. If other surface water supply options are available to the County (such as water purchase from the City of Baltimore, or use of existing quarries for raw water storage), these options should be fully investigated as well. Such options may be more cost effective and permittable than a new reservoir project.

Additional field investigations are discussed in Section 5 of this report.

[1] Common elevations for Gillis Falls and Union Mills are coincidental.

2.0 INTRODUCTION

2.1 Authority

By contract dated January 27, 2009, Schnabel entered into a consultant agreement with Malcolm Pirnie, Inc. to assist with evaluations of water resource issues for the Water Resources Element (WRE) of Carroll County's Comprehensive Plan, required by State Law HB 1141.

2.2 Purpose

Schnabel was engaged by Malcolm Pirnie to perform a desktop study to update the evaluation of two potential reservoir sites (Gillis Falls and Union Mills) and the possible expansion of Piney Run Reservoir. The three reservoir sites are shown in Figure 1, Appendix A.

2.3 Scope

Our scope for this study included:

- Review of previous relevant reports
- Site visit to the three sites noted above
- Planning level construction cost estimates
- Letter Report, including feasible dam type for each site, major challenges to project development, photos of site visits

3.0 SITE DESCRIPTIONS

3.1 Piney Run Reservoir

Piney Run Reservoir is located in the southern portion of the county, about 1 mile north of Sykesville. The dam was constructed by Carroll County primarily as a drinking water supply for the southeastern portion of the county. It also provides flood control and recreation for local citizens. The reservoir was built in 1975 by the County under the Watershed Protection and Flood Prevention Act with the assistance of the US Department of Agriculture.

The existing volume of the reservoir is 1.97 billion gallons (BG) at normal pool EL 524. The normal surface area of the reservoir is 298 acres. A summary of the reservoir's pertinent data is presented in Section 4.

The drainage area to the reservoir is 10.43 square miles. The watershed is underlain primarily by schist, with lesser amounts of phyllite and gneiss. Land use is a mixture of agricultural, wooded and residential.

The dam impounding the reservoir is a 650-ft long earthen embankment with a maximum height of 73 ft. A standard NRCS covered riser and 36-inch conduit maintains the normal pool at EL 524 and provides discharge capacity for floods up to a 100-yr storm event. A 250-ft wide earthen emergency spillway at the right abutment (looking downstream) at EL 532 provides flood passage for floods in excess of a 100-yr event. The dam is classified as a "high hazard structure" according to MDE criteria; accordingly, the spillway design flood would be the probable maximum flood (See Section 4 for additional discussion).

A site visit was performed on February 27, 2009. Photos of the dam site and upstream area are included in Appendix B.

3.2 Gillis Falls Reservoir Site

In 1967, following a severe drought in the northeastern United States, the North Atlantic Basin Study proposed several water supply reservoirs of which Gillis Falls was one. In the 1970s and 1980s, the project progressed, and land was purchased as it became available. Since the early 1990s, the project has stalled due to environmental restrictions. A detailed chronology is contained in Reference 3.

The proposed Gillis Falls reservoir site is in the southern part of Carroll County. The site is just downstream of the confluence of Gillis Falls and Middle Run. The streams are tributary of the South Branch Patapsco River which drains to the Chesapeake Bay. This site was previously evaluated by Black & Veatch as part of the initial permitting effort for the reservoir (Reference 2).

The proposed reservoir would have a storage capacity of 4.15 BG and a surface area of 452 acres at a normal pool EL 610. A summary of the reservoir's pertinent data is presented in Section 4.

The drainage area to the reservoir is 17.4 square miles. The watershed is underlain primarily by schist and phyllite. Land use is a mixture of agricultural and wooded, with localized residential areas.

In Black & Veatch's 1989 Project Development Report, the proposed dam was an RCC structure with a maximum height of about 80 ft from the top of dam to the floodplain (about 95 ft from top of dam to rock foundation). The alternate location of the dam was based on a 1989 geotechnical report by Schnabel Engineering Associates (Reference 10). The dam would be classified as a "high hazard structure" according to MDE criteria; accordingly, the spillway design flood would be the probable maximum flood.

A site visit was performed on February 27, 2009. Photos of the dam site and upstream area are included in Appendix B.

3.3 Union Mills Reservoir Site

Union Mills is a proposed water supply reservoir site in the northern part of Carroll County. The site was envisioned as early as 1970 in the County Master Plan. The site is located about 4000-ft upstream of the confluence of Deep Run with Big Pipe Creek, which are tributary to the Monocacy River, and ultimately to the Potomac River.

Similar to Piney Run Dam, the site was originally contemplated to be a watershed dam, and in 1976 an environmental impact statement (EIS) was developed by the Soil Conservation Service (Reference 12). Accordingly, the dam was proposed as a multi-use reservoir for flood control, recreation, and water supply. This site was previously evaluated by the USDA as part of a watershed management plan for the Big Pipe Creek Watershed (Reference 11).

As originally proposed, the reservoir would have a storage capacity of 2.44 BG and a surface area of 298 acres at a normal pool EL 610. A summary of the reservoir's pertinent data is tabulated in Section 4.

The drainage area to the reservoir is 24.86 square miles. The watershed is underlain primarily by schist of the Marburg Formation. Land use is a mixture of agricultural and wooded, with localized residential areas.

In the southern part of the watershed, the John Owings Landfill lies adjacent to the proposed reservoir. The landfill was in private operation beginning about 1968, and in 1973 was purchased by the County, who operated the landfill until 1987. The site received commercial/residential refuse and dewatered sludge during that time. In 1993 an MDE-approved cap was installed to avoid further infiltration of water into the landfill. Monitoring wells around the site provide ground water quality data.

No geotechnical studies were performed for the Union Mills dam site. A brief overview of possible reservoir sizes was performed by Martin Covington, PE in 2006 (Reference 7).

A site visit was performed on February 27, 2009. Photos of the dam site and upstream area are included in Appendix B.

4.0 SURFACE WATER SUPPLY ALTERNATIVES

4.1 Raising of Piney Run Reservoir

The expansion of Piney Run Reservoir was evaluated as the first water supply alternative. During the site visit, it was observed that a historical structure (i.e., Waters Edge Farm) exists on the northeast shore of the reservoir, situated at roughly EL 541. Raising of the top of dam is not considered feasible, since it would place the historical structure below the crest level and therefore increase the potential for flooding during extreme events. Therefore, we assessed the potential to raise the pool level by 4 ft while maintaining the top of dam at EL 540.5. Table 4.1 summarizes pertinent data for the reservoir at the existing normal pool and the proposed 4-ft raise. A 4-ft raise would likely require modifications to the County Park and marina area.

We understand that the dam is currently classified as a "high hazard" structure, which means that there is significant potential for loss of life if the dam were to fail. For this hazard class and size structure, it is likely that the required spillway design flood would be the probable maximum flood (PMF). However, it is sometimes possible to reduce the spillway design flood to a fraction of the PMF based on an incremental inundation analysis. For the purposes of this report, we have assumed that the spillway design flood for Piney Run Dam could be reduced to approximately the ½ PMF. For a drainage area of 10.4 square miles, we estimate the PMF and ½ PMF inflows would be roughly 40,000 cfs and 20,000 cfs, respectively.

For a 4-ft increase in pool level, while maintaining flood discharges for all events up to the 100-year flood, the spillway riser and emergency spillway would also need to be raised by 4 ft. To safely pass the ½ PMF with 4.5 ft of overflow, an earth-cut spillway would need to be three times as wide as the existing, or roughly 750-ft wide. An alternative spillway that passes a large amount of flow with a relatively low depth of overflow is the labyrinth weir, which is zig-zagged in plan view. A conceptual layout of a labyrinth spillway that would essentially fit within the existing spillway width is shown in Figure 2. A 200-ft long armored channel and cutoff wall are included downstream of the weir to carry the flow past the toe of the dam and prevent headcutting erosion/breach of the emergency spillway.

Table 4.1 – Piney Run Reservoir – Summary of Pertinent Data*

Item	Piney Run (Existing)	Piney Run (Raised 4 Ft)
Volume (billion gal)	1.97	2.40
Surface Area (acres)	298	336
Normal Pool EL (ft)	524	528
Drainage Area (mi^2)	10.43	10.43
Estimated Safe Yield (mgd)	3.65	4.11
Average Min. Release (mgd)	1.0	1.0
Inundated Wetlands (acres)	N/A	12.6
Inundated Streams (miles)	N/A	1.05
Dam Height (ft)	73	73
Structure Impacts	N/A	N/A

* Data compiled by Malcolm Pirnie.

4.2 Gillis Falls Reservoir

The dam at Gillis Falls was envisioned by Black & Veatch to be an RCC structure (1989). Support for this assumption was provided by a geotechnical report by Schnabel Engineering Associates (SEA, 1989). Investigations in that report were performed at an upstream site. Due to high permeabilities revealed by packer testing in the right abutment, an alternate dam site was recommended about 1500-ft downstream of the original site. It is notable in SEA's report that rock quality based on recovery and rock quality designation (RQD) values was considered very poor. However, in-situ borehole pressure cell testing indicated a generally better quality rock mass, suitable for foundation support of either an earthfill or an RCC dam. Therefore, foundation grouting could be a significant cost item with the RCC dam.

In the Black & Veatch report, construction cost estimates were provided for both earth and RCC dams. The RCC dam was estimated to be about 10% less costly than the earthfill dam and structural spillway. For the purposes of this report, we have assumed construction of an RCC dam at the proposed site, with a normal pool at EL 610 and the top of dam at EL 620. For this layout, we estimated that the spillway would need to be approximately 400 ft wide to pass the PMF with 10 ft of overflow at the spillway (see Figures 3 and 5).

In conjunction with Malcolm Pirnie, Schnabel identified an expanded reservoir level at the same site that would be capable of providing additional safe yield. Table 4.2 summarizes pertinent data for the reservoir at the originally proposed and expanded elevations.

An additional smaller site was identified on Middle Run, which is a branch of the Gillis Falls Reservoir. To attain a similar volume, the Middle Run reservoir would need to be at a significantly higher elevation, and was noted to impact several dozen structures. Therefore, this alternative was excluded from further consideration.

Table 4.2 – Gillis Falls Reservoir – Summary of Pertinent Data*

Item	Originally Proposed EL 610	Possible Expansion EL 630
Volume (billion gal)	4.15	8.02
Surface Area (acres)	452	744
Normal Pool EL (ft)	610	630
Drainage Area (mi^2)	17.4	17.4
Estimated Safe Yield (mgd)	3.85	5.00
Average Min. Release (mgd)	5.45	5.45
Inundated Wetlands (acres)	177	225
Inundated Streams (miles)	10.1	14.2
Dam Height (ft above rock)	95	115
Structure Impacts (approx)	Aquaculture Facility; 5 homes	Aquaculture Facility; 16 homes

*Data compiled by Malcolm Pirnie, with the exception of dam height and structure impacts.

In addition, it should be noted that the Gillis Falls site at EL 610 and 630 would impact a total of about 2,500 and 4,000 LF of Tier II streams, respectively. One section of the Tier II stream is in the vicinity of the dam site, and the other is in the uppermost arm of the reservoir. Impacts to these stream segments would add a further level of permitting effort and complexity to this site.

4.3 Union Mills Reservoir

As noted previously, the dam at Union Mills was originally conceived to be an earthen dam according to NRCS design criteria. Since the reservoir is no longer proposed as a multi-use watershed project, flood control does not need to be considered in the selection of project elevations. The dam may be constructed as either an earth embankment or RCC structure.

During the site visit, rock outcrops were observed at the steep left abutment (looking downstream). According to the County Soil Survey, rock depth in the central valley is anticipated to be on the order of 10 to 20-ft deep, and 2 to 6 ft at the abutments. The observed rock outcrops at the left abutment appeared to be moderately hard mica schist. Based on these observations, we have assumed construction of an RCC dam at the proposed site, with a normal pool at EL 610 and the top of dam at EL 625. For this layout, we estimated that the spillway would need to be approximately 350-ft wide to pass the PMF with 14 ft of overflow at the spillway (see Figures 4 and 5).

There is a low saddle area in the right abutment of the dam. We have assumed that this length of dam could be constructed with an earth embankment on the order of 10 to 15 ft in height.

In conjunction with Malcolm Pirnie, Schnabel identified an expanded reservoir level at the same site that would be capable of providing additional safe yield. Table 4.3 summarizes pertinent data for the reservoir at the originally proposed and expanded elevations.

Table 4.3 – Union Mills Reservoir – Summary of Pertinent Data*

Item	Originally Proposed EL 610	Possible Expansion EL 630
Volume (billion gal)	2.44	5.49
Surface Area (acres)	298	633
Normal Pool EL (ft)	610	630
Drainage Area (mi^2)	24.86	24.86
Estimated Safe Yield (mgd)	5.01	10.18
Average Min. Release (mgd)	2.5	2.5
Inundated Wetlands (acres)	114	165
Inundated Streams (miles)	8.4	15.1
Dam Height (ft above rock)	80	100
Structure Impacts (approx)	3 homes	4 homes; chicken house

* Data compiled by Malcolm Pirnie, with the exception of dam height and structure impacts.

It should also be noted that part of the Whittaker Chambers farm is located within the reservoir area. The farm was the scene of the famous “pumpkin patch” Cold War espionage case in the 1940s, and was declared a national historic landmark under the Reagan Administration. It is our understanding that the actual “pumpkin patch” site is not within the proposed pool area; however, portions of the Whittaker Chambers property along Big Pipe Creek would be flooded by the proposed reservoir.

The County would need to confirm that any impacts to the Whittaker Chambers Farm (National Historic Landmark) can be addressed.

4.3.1 Planning-Level Dam Construction Cost Estimates

For the assumed dam and spillway types discussed above, we developed estimated dam construction costs for each project. The cost estimates contained herein are to be considered "order of magnitude" according to the following categories of cost estimates developed by the American Association of Cost Engineers:

- ***Order-of-Magnitude Estimate:*** This is an estimate made without detailed engineering data. Some examples would be an estimate from cost capacity curves, an estimate using scale-up or scale-down factors, and an approximate ratio estimate. It is normally expected that this type of estimate would be accurate within +50 percent to -30 percent.

- ***Budget Estimate:*** "Budget" in this case applies to the owner's budget and not to the budget as a project control document. A budget estimate is prepared using flow sheets, layouts, and equipment details. An estimate of this type is accurate within +30 percent to -15 percent.

- ***Definitive Estimate:*** As the name implies, this is an estimate prepared from very defined engineering data. As a minimum, the data must include fairly complete plot plans and elevations, piping and instrumentation diagrams, one-line electrical diagrams, equipment data sheets and quotations, structural sketches, soil data and sketches of major foundations, building sketches, and a complete set of specifications. The "maximum" definitive estimate would be made from "Approved for Construction" drawings and specifications. A definitive estimate is accurate within +15 percent to -5 percent.

Cost estimates were developed based on quantities derived from the conceptual designs. Following are explanations of individual cost items warranting explanation.

- ***Mobilization and Demobilization:*** The cost for mobilization and demobilization includes the contractor's cost to mobilize equipment and personnel, acquire bonds and insurance, provide field offices, and other miscellaneous costs. Mobilization and demobilization were estimated to be about ten percent of the total construction cost.

- ***Erosion and Sediment Control:*** This includes erosion and sediment control measures to meet local regulations.

- ***Control of Water:*** This cost assumes the lake can be lowered for construction. It also includes costs to construct cofferdams, divert surface water past the construction area, and dewater the foundations as needed.

- ***Clearing and Grubbing:*** This includes costs to clear and grub trees within the work area.

- ***Reservoir Clearing:*** Cost for clearing trees from the reservoir area. No grubbing was considered necessary in the reservoir area.

- ***Stripping:*** Stripping of topsoil from the work area required to construct the structures listed herein.

- ***Excavation:*** Quantities include volumes of soil and rock to be excavated for dam and spillway foundations.

- ***Grout Curtain:*** The foundation for Gillis Falls is anticipated to be highly fractured. Although no geotechnical information is available for Union Mills, it was also anticipated to be highly fractured for estimating purposes. A grout curtain is specified to inject cement grout to fill foundation voids and reduce seepage beneath the dam. This item includes drilling, pump testing, and grout injection.

- ***Foundation Drains:*** The RCC dams were assumed to have drains drilled into the foundation for reduction of uplift.

- ***Select Fill:*** Quantities include drainage material under/adjacent to spillway slabs and walls. This material would consist of processed sand and aggregate.

- ***Riprap:*** Quantities include volumes required for placing riprap on the abutments, as well as downstream of the spillway.

- ***Earthfill:*** This includes costs to backfill the RCC dam and spillway structures.

- ***Topsoil and Seed:*** This includes placement of topsoil and permanent turf establishment in disturbed areas.

- ***Reinforced Concrete:*** Concrete quantities include volumes for the new concrete spillway and training walls (labyrinth spillway), and the stepped concrete overlay of the RCC spillway. The cost of concrete includes concrete, steel reinforcement, formwork, pumped delivery, and miscellaneous related items.

- ***Roller Compacted Concrete:*** Mass concrete for dam construction. Volume includes RCC above grade and extending 10 to 20 ft below grade, and an apron extending 40 ft downstream.

- ***Pre-Cast Concrete Panel System:*** includes the cost for pre-cast concrete panel, membrane backing, and heat welding of seams.

- ***Outlet Works/Intake Structure:*** Costs for constructing or modifying an intake structure for water supply withdrawals, and for drawdown requirements for the dam.

- ***Contingency:*** A contingency cost of 25% of the dam construction cost was included in the total cost to provide for margins of error in the study level cost and quantity estimates, to account for numerous smaller items not specified above, to accommodate a reasonable amount for field changes during construction, and to recognize the effects of bidding climate and material availability.

Unit prices for the above items were estimated based on similar dam construction projects completed within the past five years and adjusted for inflation. The anticipated engineering cost was added to the dam construction cost for an estimated dam project cost. The itemized costs for the originally proposed and possibly expanded reservoirs are contained in Appendix C.

4.3.2 Comparative Project Cost Estimates

To assess the economic viability of each of the options discussed herein, we tabulated the primary project costs (except for land and impacted structures), as described below.

- ***Dam & Spillway:*** Computed as described above.

- ***Wetlands Mitigation:*** Costs for mitigating wetlands disturbed as part of the reconstruction of the embankment and reservoir. This unit cost can vary widely; an average value of $70,000 per acre was assumed for cost comparison.

- ***Stream Mitigation:*** Costs for mitigation of streams inundated by the proposed reservoir. This unit cost can vary widely; an average value of $250 per linear foot was assumed for cost comparison. This value assumes a large preservation component is part of the overall stream mitigation package.

- ***Road/Bridge Relocations:*** The cost for road and bridge relocations that may be required for construction of a new reservoir requires an in-depth planning study which is beyond the scope of this report. A nominal value was assumed for all options.

- ***Landfill Issues:*** At Union Mills, it may be necessary to construct additional mitigation measures to reduce the potential for contaminants to migrate from the landfill into the reservoir. This could take the form of a cutoff wall between the landfill and the reservoir, additional monitoring, enhanced seepage collection systems, or multiple measures.

The Comparative Project Costs for each option are tabulated below and also included in Appendix C.

Table 4.4 – Comparative Project Cost Estimates – Piney Run

Item	Raise Pool 4 Ft
Dam and Spillway	$4.2 M
Stream Mitigation	$1.4 M
Wetland Mitigation	$1.5 M
Road/Bridge Relocations	$0.4 M
Total	**$7.5 M**
Cost per MGD Safe Yield	**$16.3 M/mgd**

Table 4.5 – Comparative Project Cost Estimates – Gillis Falls

Item	Pool EL 610	Pool EL 630
Dam and Spillway	$32 M	$43 M
Stream Mitigation	$13 M	$19 M
Wetland Mitigation	$22 M	$28 M
Road/Bridge Relocations	$2 M	$2 M
Total	**$69 M**	**$92 M**
Cost per MGD Safe Yield	**$18.0 M/mgd**	**$18.3 M/mgd**

Table 4.6 – Comparative Project Cost Estimates – Union Mills

Item	Pool EL 610	Pool EL 630
Dam and Spillway	$28 M	$38 M
Stream Mitigation	$11 M	$20 M
Wetland Mitigation	$14 M	$20 M
Road/Bridge Relocations	$2 M	$2 M
Landfill Issues	$2 M	$2 M
Total	**$57 M**	**$82 M**
Cost per MGD Safe Yield	**$11.3 M/mgd**	**$8.0 M/mgd**

As can be seen in the cost estimates above, estimated mitigation costs are of similar magnitude as the dam construction cost in each case. For the purposes of site comparison, the assumption of an RCC dam at both Gillis Falls and Union Mills is reasonable for planning level estimates. In a difficult economy, cost competition may nominally favor the construction of an earthen dam, since there are more earthwork contractors than RCC contractors. If the County moves forward with either of the Union Mills or Gillis Falls option, an in-depth assessment of the two dam types should be performed based on geotechnical explorations and consideration of the economic climate.

5.0 CONCLUSIONS AND RECOMMENDED ACTIONS

5.1 Conclusions

For a reservoir site to be permittable according to Army Corps of Engineers' regulations, it must be the "least environmentally damaging practicable alternative." The site must also meet the threshold requirement of being capable of achieving the stated project purpose of providing the unmet water demand. Although the unmet water demand cannot be predicted with certainty at this time, it could fall within the range of safe yield available from individual reservoir options addressed in this letter report, depending on build-out assumptions and future regulatory policies concerning existing source appropriations. Based on these criteria, we conclude the following:

- The expansion of Piney Run would not be capable of significantly increasing supply and therefore would not meet a stated project purpose.
- The construction of Gillis Falls Reservoir would cost significantly more per mgd of safe yield than would the Union Mills Reservoir. It would also cause a greater level of environmental impacts for a given safe yield. Finally, Gillis Falls Reservoir would impact a greater number of structures, and would appear to cause more disruption to the human environment. For these reasons the Gillis Falls site appears to be less preferable and more difficult to permit.
- Of the three sites considered herein and for the limited factors considered in this study, the apparent preferred alternative is the Union Mills Reservoir. Of the three considered options, it appears to be the least environmentally damaging, practicable alternative capable of providing unmet water demand.
- Threatened and Endangered Species and Cultural Resources Impacts were not considered as part of this study, but should be assessed prior to final site selection.
- Notwithstanding the preferred alternative noted above, permitting a reservoir in this region of the United States is an extremely difficult, expensive, time-consuming, and frustrating endeavor. If other surface water supply options are available to the County (such as water purchase from the City of Baltimore, or use of existing quarries for raw water storage), these options should be fully investigated as well. Such options may be more cost effective and permittable than a new reservoir project.
- Other than the sites discussed herein, no other dam sites were identified that appeared capable of providing significant storage and safe yield for the County.

5.2 Recommended Field Investigations

The following additional investigations are recommended to better establish the feasibility of constructing a new reservoir at the potential reservoir sites:

- If not already completed, Threatened and Endangered Species surveys and Cultural Resource surveys should be conducted to identify any fatal flaws that could preclude development of the sites.

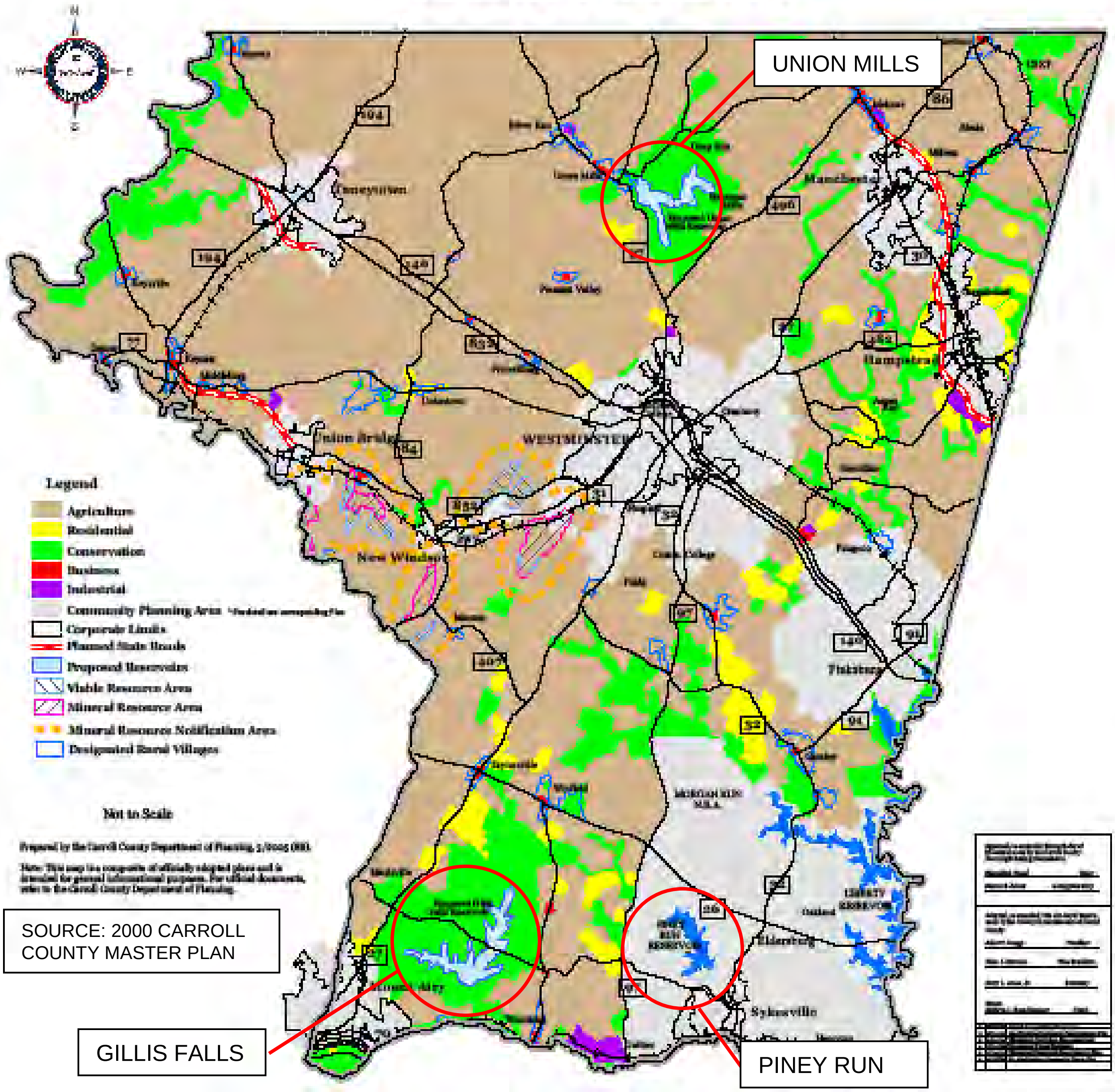
- As noted previously, estimated mitigation costs are of similar magnitude as estimated dam construction costs. If one of the sites evaluated in this report is found to be the preferred alternative for meeting the County's future demand, field investigations should be conducted to verify impacted stream and wetland quantities, and additional investigations should be pursued to identify potential mitigation sites. Judicious selection of potential mitigation sites can have a significant impact on mitigation costs. These preliminary studies would facilitate a more accurate planning level estimate of mitigation costs.

- At this point in the planning process, no subsurface investigations are recommended. Our desk-top study is considered valid for order of magnitude estimates and comparison of the sites. Following the environmental studies noted above, if one of the sites evaluated in this report is found to be the preferred alternative for meeting the County's future demand and is received more favorably by regulatory agencies, we recommend that a subsurface investigation be performed to better characterize the dam foundation, and identify the more favorable dam type for the site conditions. For the Gillis Falls or Union Mills site, an investigation consisting of 6 to 8 borings in conjunction with selected geophysical surveys would enable assessment of a rock profile along the dam and the general conditions anticipated for construction of the dam. If suitable rock is found to be significantly deeper than predicted, an earthen dam may prove to be more cost effective.

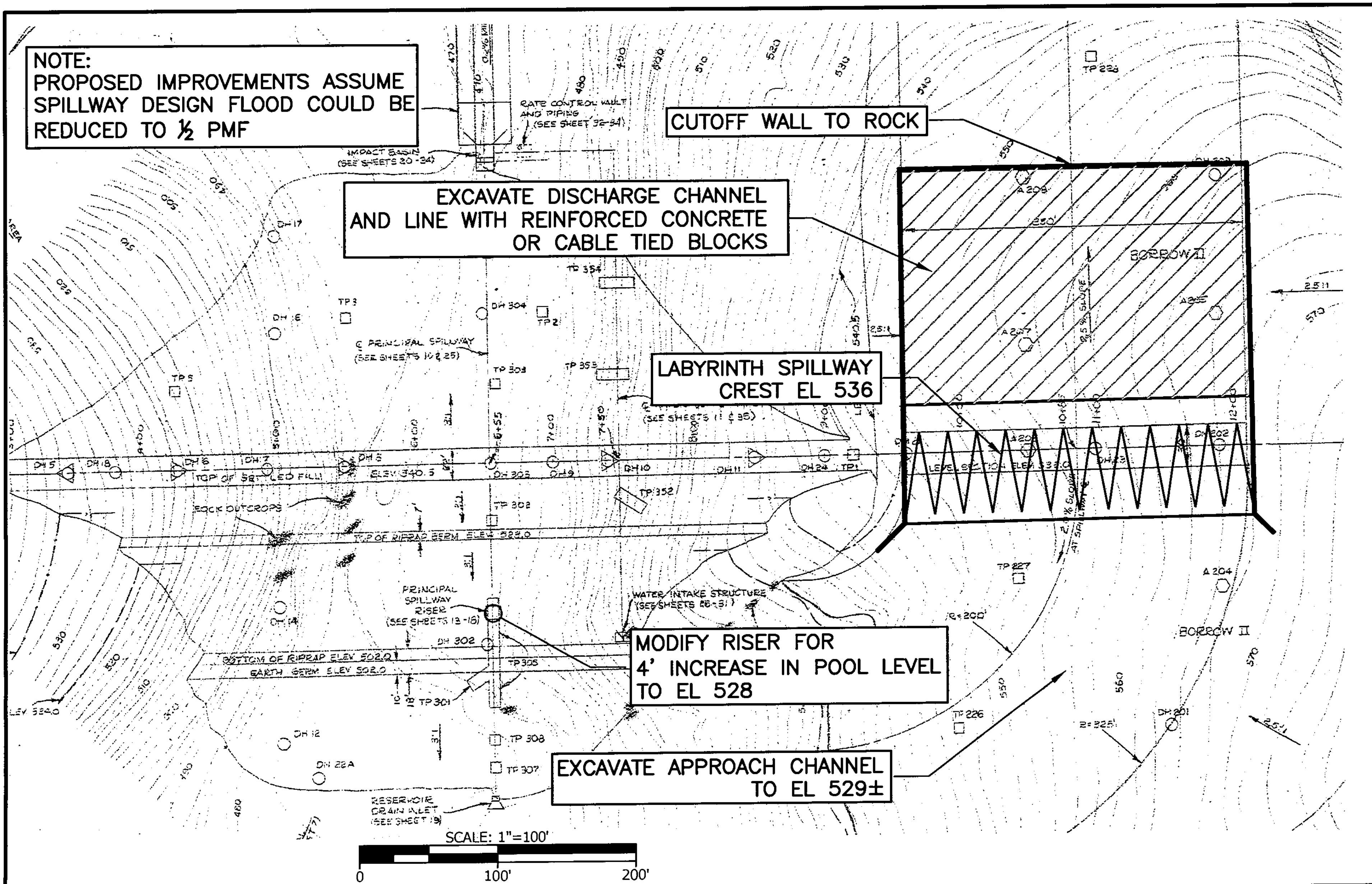
APPENDIX A

Figures

Carroll County
Master Plan 2000



Schnabel Schnabel Engineering	CARROLL COUNTY COMPREHENSIVE PLAN MARYLAND	SITE LOCATION PLAN FIGURE 1

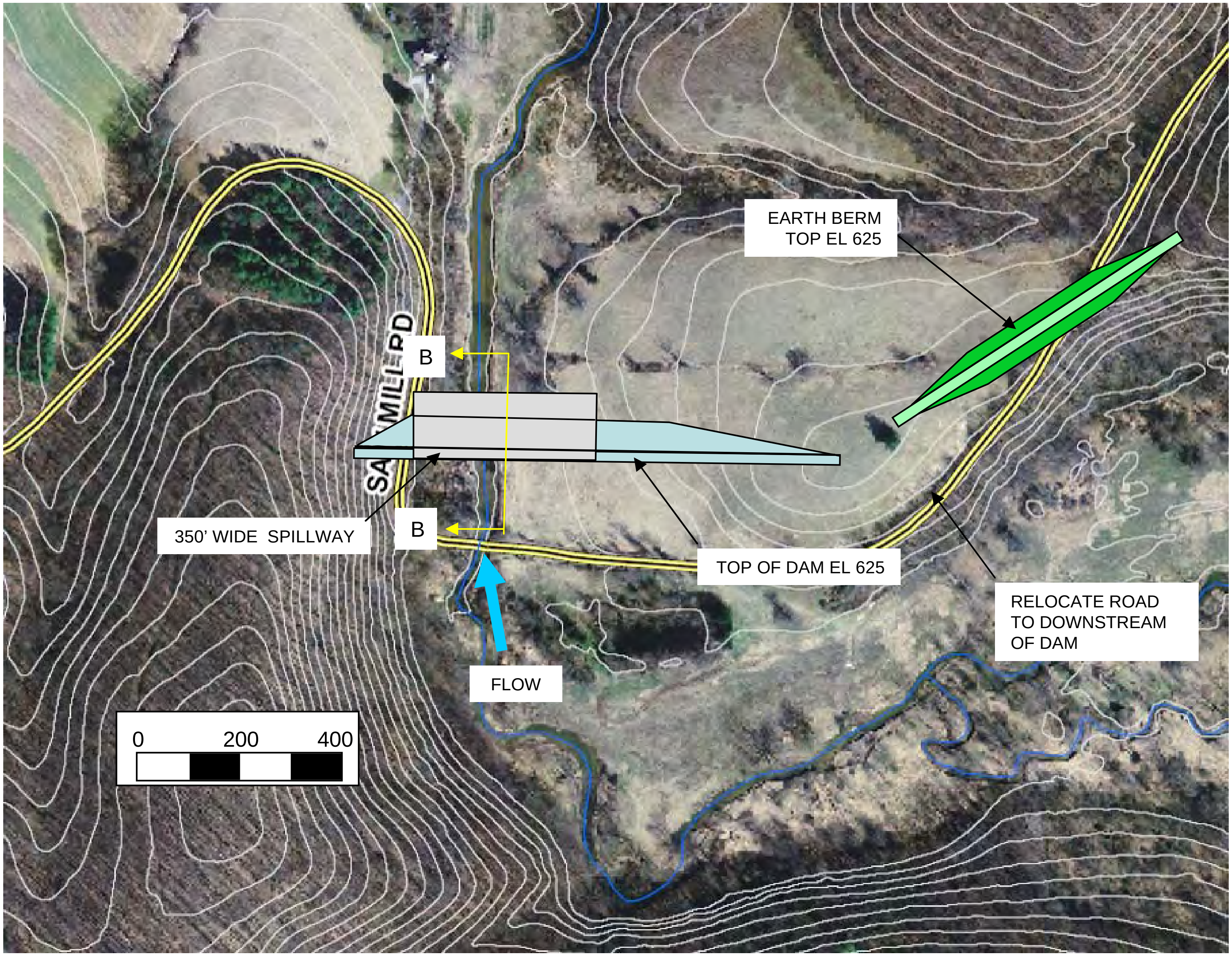


Schnabel Engineering	CARROLL COUNTY COMPREHENSIVE PLAN MARYLAND	DRAWN BY: MJM	DATE: MAY 2009	PINEY RUN PROPOSED MODIFICATIONS FOR 4-FT RAISE OF NORMAL POOL
		CHECKED BY: JPH	SCALE: 1"=100'	PROJECT 09150009.00 FIGURE 2

Schnabel Engineering

CARROLL COUNTY
COMPREHENSIVE PLAN
MARYLAND

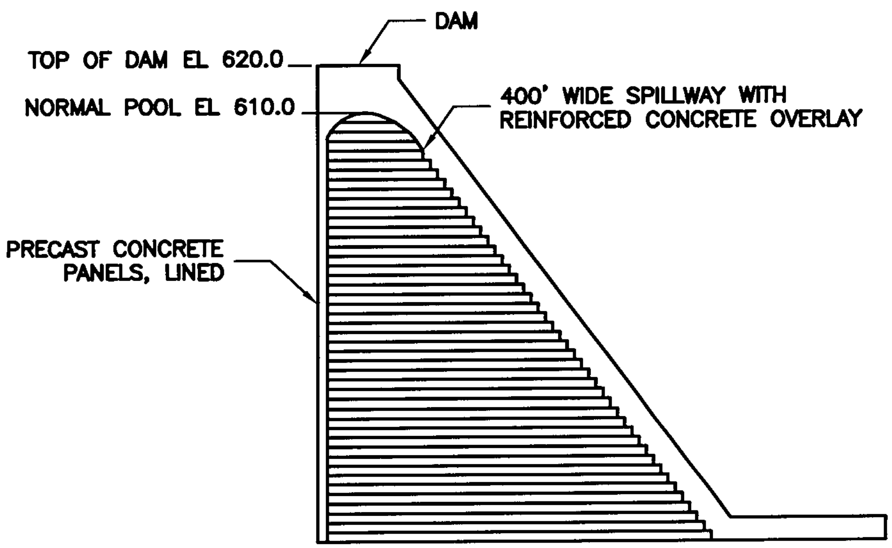
GILLIS FALLS
RCC DAM CONCEPTUAL LAYOUT
FIGURE 3



Schnabel Engineering

CARROLL COUNTY
COMPREHENSIVE PLAN
MARYLAND

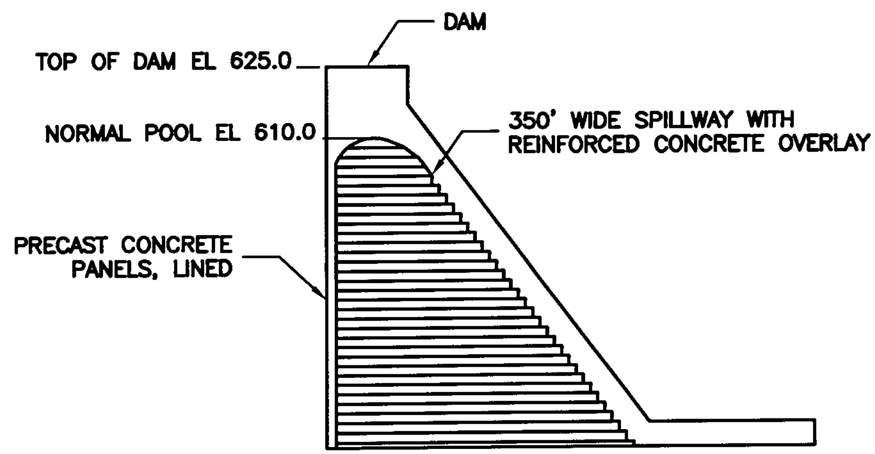
UNION MILLS
RCC DAM CONCEPTUAL LAYOUT
FIGURE 4



A GILLIS FALLS SECTION

SCALE: 1"=40'

0 40' 80'



B UNION MILLS SECTION

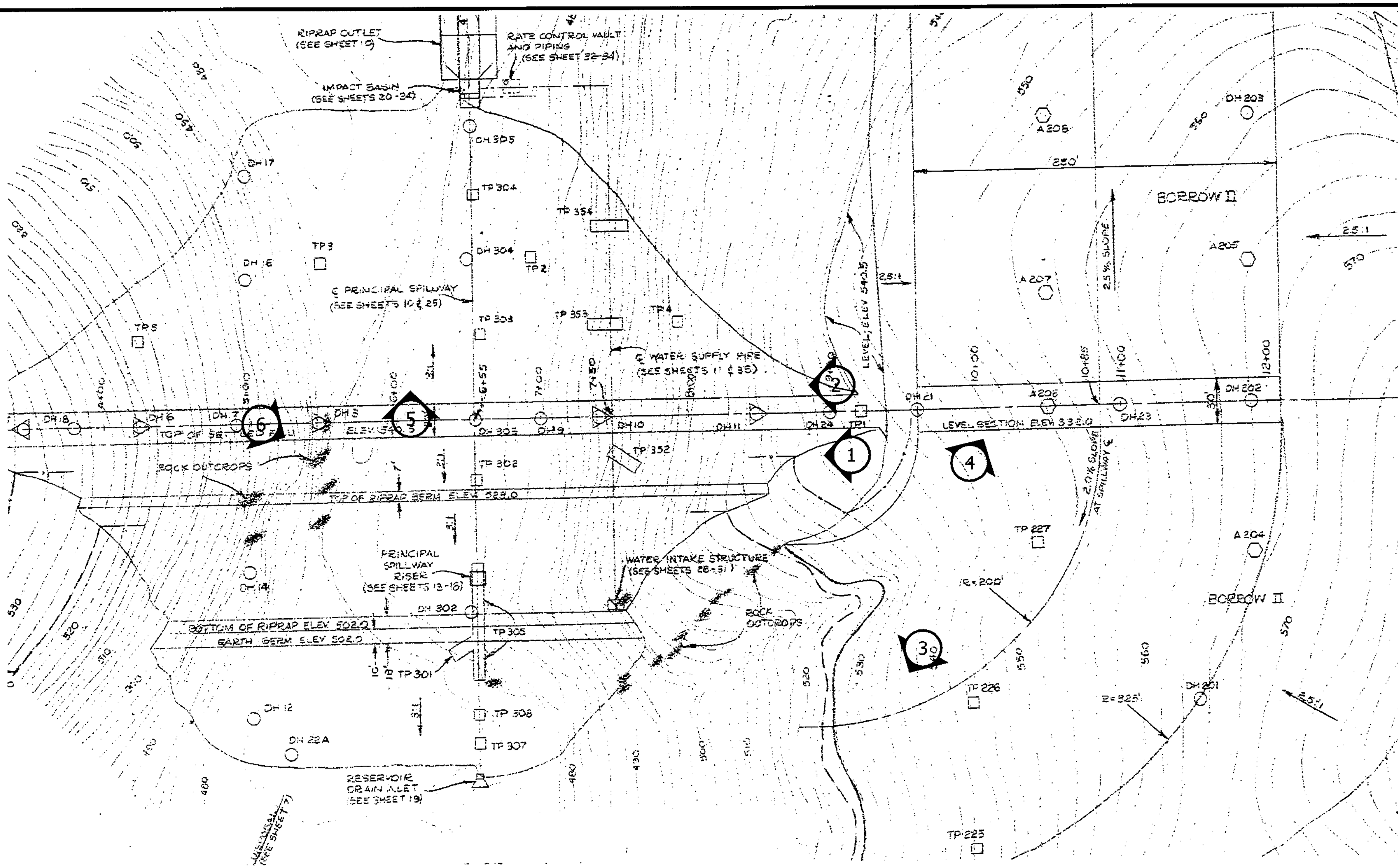
SCALE: 1"=40'

0 40' 80'

Schnabel Schnabel Engineering	CARROLL COUNTY COMPREHENSIVE PLAN MARYLAND	DRAWN BY: MJM	DATE: MAY 2009	RCC DAM-TYPICAL SECTIONS
		CHECKED BY: JPH	SCALE: AS SHOWN	PROJECT 09150009.00 FIGURE 5

APPENDIX B

Photographs

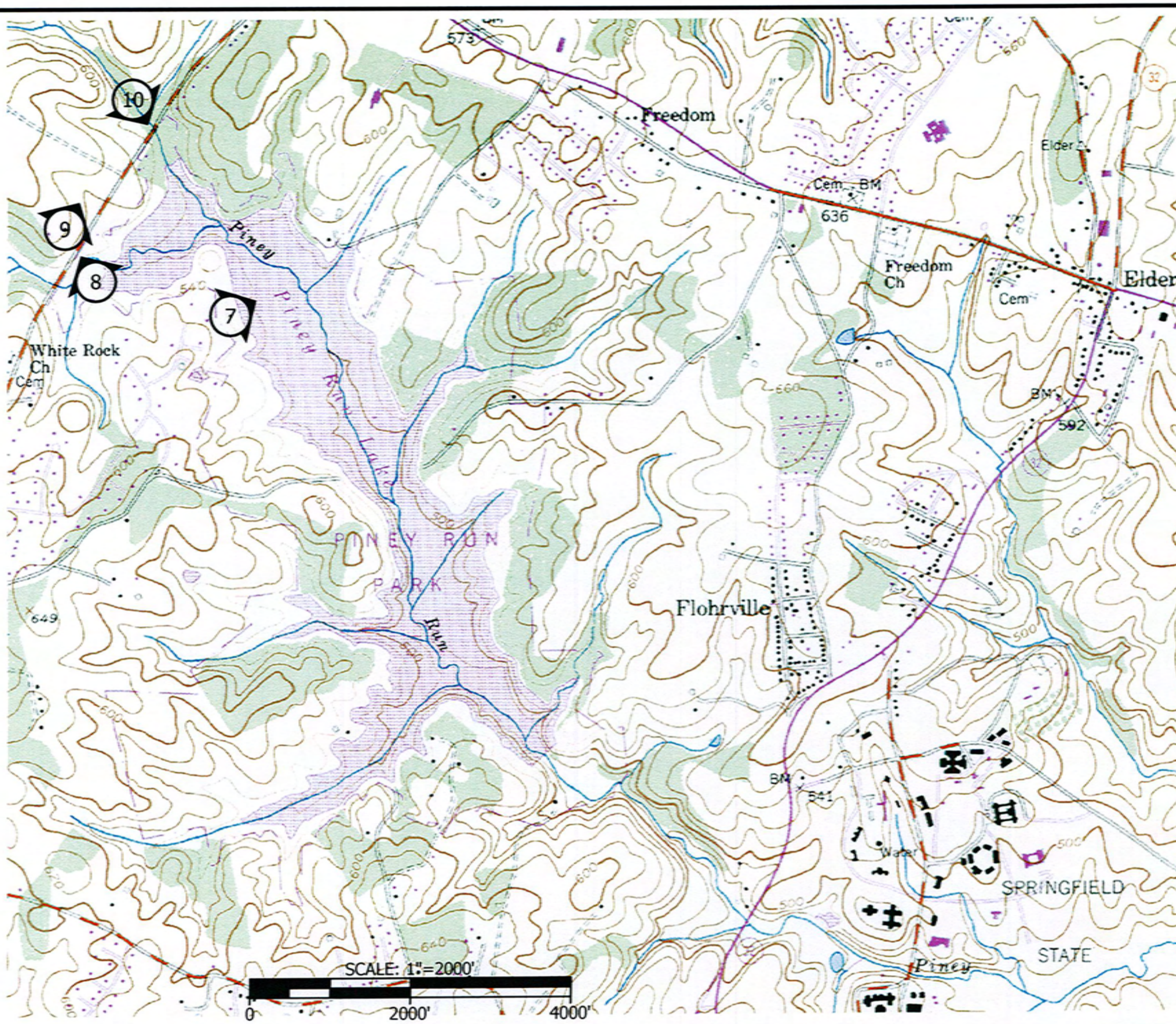


SCALE: 1"=100'

0 100' 200'

REFERENCE: Rummel, Klepper, and Kahl, 1972 provided the base plan for this drawing.

Schnabel Engineering	CARROLL COUNTY COMPREHENSIVE PLAN MARYLAND	DRAWN BY: MJM	DATE: MAY 2009	PINEY RUN PHOTO LOCATION PLAN 1
		CHECKED BY: JPH	SCALE: 1"=100'	PROJECT 09150009.00



Schnabel Engineering

CARROLL COUNTY COMPREHENSIVE PLAN MARYLAND	DRAWN BY: MJM	DATE: MAY 2009	PINEY RUN PHOTO LOCATION PLAN 2
	CHECKED BY: JPH	SCALE: 1"=2000'	PROJECT 09150009.00

Photo 1 – View upstream from emergency spillway.

Photo 2 – Downstream view of emergency spillway.

Photo 3 – Overview of upstream slope of dam.

Photo 4 – Overview of downstream slope of dam.

Photo 5 – Overview of impact basin at toe of dam.

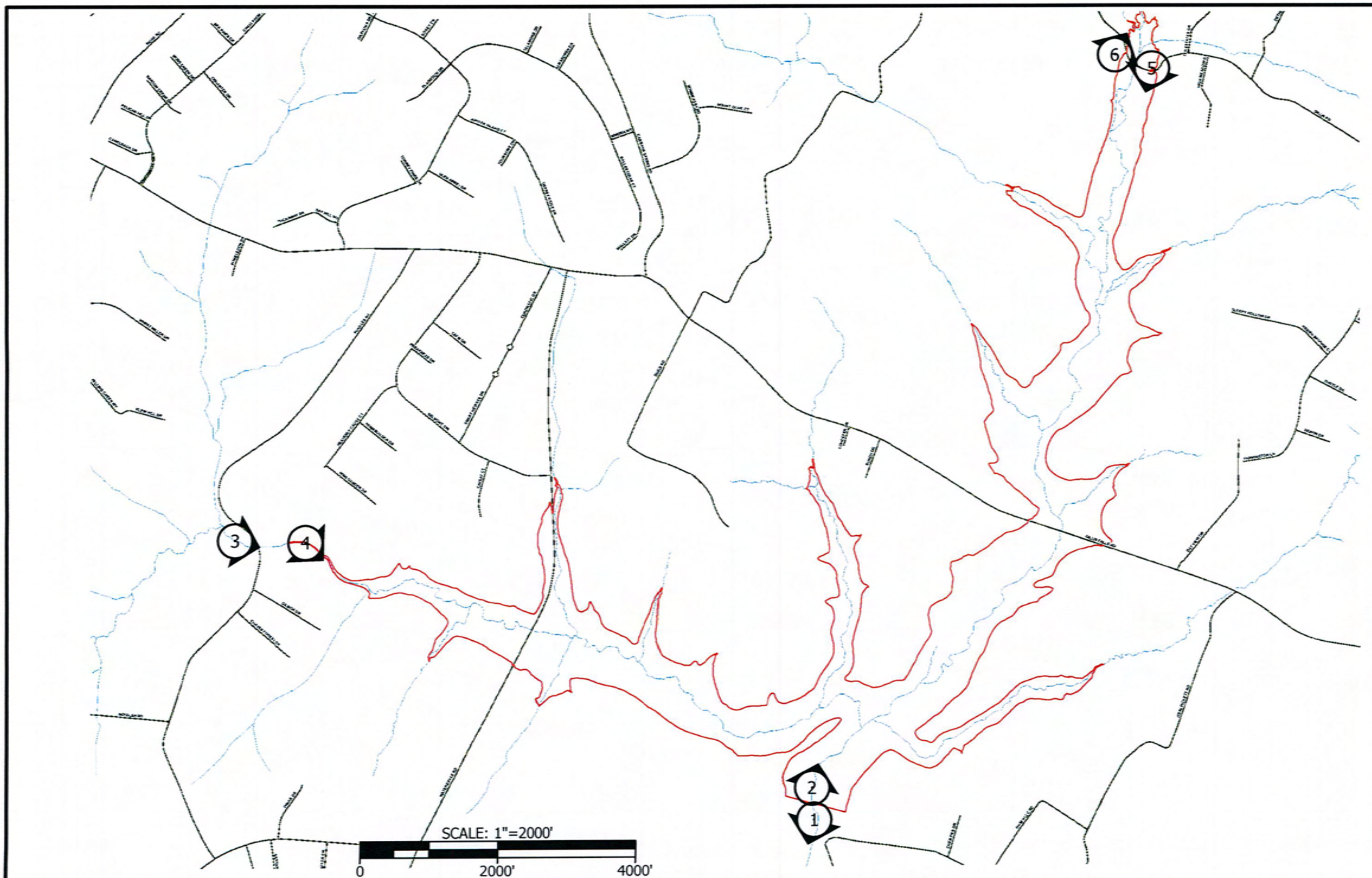
Photo 6 – Intake structure and pedestrian bridge.

Photo 7 – Historical structure on east side of reservoir.

Photo 8 – View of road culvert at White Rock Road.

Photo 9 – View east at White Rock Road.

Photo 10 – View towards reservoir at White Rock Road.



Schnabel Engineering	CARROLL COUNTY COMPREHENSIVE PLAN MARYLAND	DRAWN BY: MJM	DATE: MAY 2009	GILLIS FALLS PHOTO LOCATION PLAN
		CHECKED BY: JPH	SCALE: 1"=2000'	PROJECT 09150009.00

Photo 1 – View downstream at dam site.

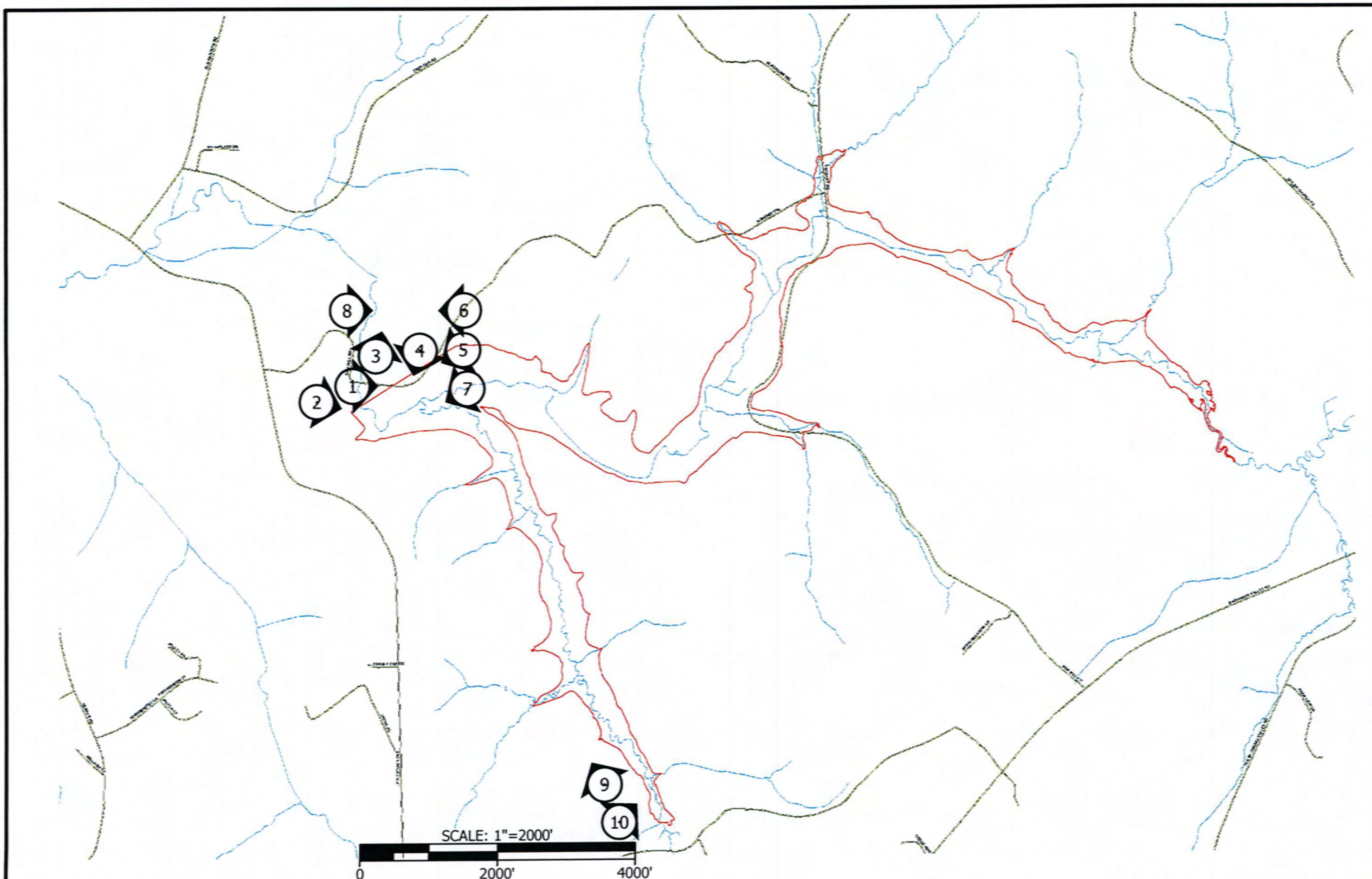
Photo 2 – View Upstream at dam site.

Photo 3 – View of road culvert at Runkles Road.

Photo 4 – Aquaculture business at Runkles Road.

Photo 5 – View downstream at Gillis Road.

Photo 6 – View upstream at Gillis Road.



Schnabel
Schnabel Engineering

CARROLL COUNTY COMPREHENSIVE PLAN MARYLAND	DRAWN BY: MJM	DATE: MAY 2009	UNION MILLS PHOTO LOCATION PLAN
	CHECKED BY: JPH	SCALE: 1"=2000'	PROJECT 09150009.00

Photo 1 – View across bridge at Saw Mill Road at dam site.

Photo 2 – View upstream from Saw Mill Road at dam site.

Photo 3 – View downstream from Saw Mill Bridge at dam site.

Photo 4 – View of valley slope downstream of dam site.

Photo 5 – View along proposed dam centerline from right abutment.

Photo 6 – View downstream from right abutment.

Photo 7 – View along steep valley slope upstream of proposed earth berm.

Photo 8 – View across valley to right abutment.

APPENDIX C

Cost Estimates

Piney Run Reservoir Raise 4 Ft
Comparative Project Cost Estimate
Carroll County, Maryland

Work	Quantity	Unit	Unit Price	Amount
Dam and Spillway	1	LS	$4,210,000	$4,210,000
Stream Mitigation	1.05	Mile	$1,320,000	$1,386,000
Wetlands Mitigation*	22	Acre	$70,000	$1,540,000
Road/Bridge Improvements	1	LS	$350,000	$350,000
	Total			**$7,486,000**
	Added Safe Yield (mgd)			**0.46**
	Cost Per MGD Safe Yield			**$16,270,000**

*Assumes an average wetland mitigation ratio of 1.75:1

Gillis Falls Reservoir EL 610
Comparative Project Cost Estimate
Carroll County, Maryland

Work	Quantity	Unit	Unit Price	Amount
Dam & Spillway	1	LS	$32,410,000	$32,410,000
Stream Mitigation	10.1	Mile	$1,320,000	$13,332,000
Wetlands Mitigation	310	Acre	$70,000	$21,700,000
Road/Bridge Relocations	1	LS	$2,000,000	$2,000,000
	Total			**$69,442,000**
	Safe Yield (mgd)			**3.85**
	Cost Per MGD Safe Yield			**$18,040,000**

*Assumes an average wetland mitigation ratio of 1.75:1

Gillis Falls Reservoir EL 630
Comparative Project Cost Estimate
Carroll County, Maryland

Work	Quantity	Unit	Unit Price	Amount
Dam & Spillway	1	LS	$43,000,000	$43,000,000
Stream Mitigation	14.2	Mile	$1,320,000	$18,744,000
Wetlands Mitigation*	394	Acre	$70,000	$27,580,000
Road/Bridge Relocations	1	LS	$2,000,000	$2,000,000
	Total			**$91,324,000**
	Safe Yield (mgd)			**5.00**
	Cost Per MGD Safe Yield			**$18,260,000**

*Assumes an average wetland mitigation ratio of 1.75:1

Union Mills Reservoir EL 610
Comparative Project Cost Estimate
Carroll County, Maryland

Work	Quantity	Unit	Unit Price	Amount
Dam & Spillway	1	LS	$27,750,000	$27,750,000
Stream Mitigation	8.4	Mile	$1,320,000	$11,088,000
Wetlands Mitigation*	200	Acre	$70,000	$14,000,000
Address Landfill Issues	1	LS	$2,000,000	$2,000,000
Road/Bridge Relocations	1	LS	$2,000,000	$2,000,000
	Total			**$56,838,000**
	Safe Yield (mgd)			**5.01**
	Cost Per MGD Safe Yield			**$11,340,000**

*Assumes an average wetland mitigation ratio of 1.75:1

Union Mills Reservoir EL 630
Comparative Project Cost Estimate
Carroll County, Maryland

Work	Quantity	Unit	Unit Price	Amount
Dam & Spillway	1	LS	$37,700,000	$37,700,000
Stream Mitigation	15.1	Mile	$1,320,000	$19,932,000
Wetlands Mitigation*	289	Acre	$70,000	$20,230,000
Address Landfill Issues	1	LS	$2,000,000	$2,000,000
Road/Bridge Relocations	1	LS	$2,000,000	$2,000,000
	Total			**$81,862,000**
	Safe Yield (mgd)			**10.18**
	Cost Per MGD Safe Yield			**$8,040,000**

*Assumes an average wetland mitigation ratio of 1.75:1

Piney Run Dam
Raise Normal Pool 4 ft
Carroll County, Maryland

COST ESTIMATE

Work	Quantity	Unit	Unit Price	Amount
Mobilization and Demobilization	1	LS	$300,000	$300,000
Erosion and Sediment Control	1	LS	$10,000	$10,000
Control of Water	1	LS	$10,000	$10,000
Demolition	1	LS	$5,000	$5,000
Clearing and Grubbing	2.0	Acre	$10,000	$20,000
Stripping	5.0	Acre	$5,000	$25,000
Common Excavation	14,000	CY	$15	$210,000
Rock Excavation	1,000	CY	$100	$100,000
Select Fill	2,500	CY	$60	$150,000
Riprap		CY	$100	$0
Articulated Concrete Blocks	50,000	SF	$15	$750,000
Topsoil & Seed	2.0	Acre	$15,000	$30,000
Drain pipe	700	LF	$25	$17,500
Structural Concrete	1,500	CY	$750	$1,125,000
Riser & Intake Modifications	1	LS	$100,000	$100,000

Values Rounded to Nearest $1000

Subtotal		$2,853,000
25% Contingency		$713,000
Est. Total Const. Cost		**$3,566,000**
Engineering	**18%**	**$641,880**
Est Total Dam Cost		**$4,210,000**

Gillis Falls Dam
RCC Dam - Normal Pool EL 610
Carroll County, Maryland

COST ESTIMATE

Work	Quantity	Unit	Unit Price	Amount
Mobilization and Demobilization	1	LS	$2,000,000	$2,000,000
Erosion and Sediment Control	1	LS	$300,000	$300,000
Control of Water	1	LS	$800,000	$800,000
Reservoir Clearing	450	Acre	$4,000	$1,800,000
Clearing and Grubbing	8	Acre	$10,000	$80,000
Stripping	7	Acre	$5,000	$35,000
Common Excavation	45,000	CY	$10	$450,000
Rock Excavation	2,000	CY	$100	$200,000
Grout Curtain	1	LS	$1,000,000	$1,000,000
Foundation Drains	3,000	LF	$75	$225,000
RCC	110,000	CY	$80	$8,800,000
Reinforced Concrete	3,100	CY	$700	$2,170,000
Unreinforced Concrete	2,800	CY	$450	$1,260,000
PreCast Panel System	63,000	SF	$25	$1,575,000
Outlet Works	1	LS	$1,000,000	$1,000,000
Backfill	20,000	CY	$10	$200,000
Topsoil & Seed	8	Acre	$10,000	$80,000

Values Rounded to Nearest $1000

Subtotal		$21,975,000
25% Contingency		$5,494,000
Est. Total Const. Cost		**$27,469,000**
Engineering	**18%**	**$4,944,420**
Est Total Dam Cost		**$32,410,000**

Gillis Falls Dam
RCC Dam - Normal Pool EL 630
Carroll County, Maryland

COST ESTIMATE

Work	Quantity	Unit	Unit Price	Amount
Mobilization and Demobilization	1	LS	$2,000,000	$2,000,000
Erosion and Sediment Control	1	LS	$350,000	$350,000
Control of Water	1	LS	$900,000	$900,000
Reservoir Clearing	745	Acre	$4,000	$2,980,000
Clearing and Grubbing	12	Acre	$10,000	$120,000
Stripping	12	Acre	$5,000	$60,000
Common Excavation	60,000	CY	$10	$600,000
Rock Excavation	4,000	CY	$100	$400,000
Grout Curtain	1	LS	$1,200,000	$1,200,000
Foundation Drains	4,000	LF	$75	$300,000
RCC	165,000	CY	$75	$12,375,000
Reinforced Concrete	4,000	CY	$700	$2,800,000
Unreinforced Concrete	3,500	CY	$450	$1,575,000
PreCast Panel System	75,000	SF	$25	$1,875,000
Outlet Works	1	LS	$1,200,000	$1,200,000
Backfill	30,000	CY	$10	$300,000
Topsoil & Seed	12	Acre	$10,000	$120,000

Values Rounded to Nearest $1000

Subtotal		$29,155,000
25% Contingency		$7,289,000
Est. Total Const. Cost		**$36,444,000**
Engineering	**18%**	**$6,559,920**
Est Total Dam Cost		**$43,000,000**

Union Mills
RCC Dam - Normal Pool EL 610
Carroll County, Maryland

DAM COST ESTIMATE

Work	Quantity	Unit	Unit Price	Amount
Mobilization and Demobilization	1	LS	$2,000,000	$2,000,000
Erosion and Sediment Control	1	LS	$350,000	$350,000
Control of Water	1	LS	$800,000	$800,000
Reservoir Clearing	300	Acre	$4,000	$1,200,000
Clearing and Grubbing	10	Acre	$10,000	$100,000
Stripping	10	Acre	$5,000	$50,000
Common Excavation	35,000	CY	$10	$350,000
Rock Excavation	2,000	CY	$100	$200,000
Grout Curtain	1	LS	$1,000,000	$1,000,000
Foundation Drains	3,000	LF	$75	$225,000
RCC	83,000	CY	$85	$7,055,000
Reinforced Concrete	2,500	CY	$700	$1,750,000
Unreinforced Concrete	2,400	CY	$450	$1,080,000
PreCast Panel System	50,000	SF	$25	$1,250,000
Outlet Works	1	LS	$1,000,000	$1,000,000
Backfill	30,000	CY	$10	$300,000
Topsoil & Seed	10	Acre	$10,000	$100,000

Values Rounded to Nearest $1000

Subtotal		$18,810,000
25% Contingency		$4,703,000
Est. Total Const. Cost		**$23,513,000**
Engineering	**18%**	**$4,232,340**
Est Total Dam Cost		**$27,750,000**

Union Mills
RCC Dam - Normal Pool EL 630
Carroll County, Maryland

DAM COST ESTIMATE

Work	Quantity	Unit	Unit Price	Amount
Mobilization and Demobilization	1	LS	$2,000,000	$2,000,000
Erosion and Sediment Control	1	LS	$350,000	$350,000
Control of Water	1	LS	$800,000	$800,000
Reservoir Clearing	633	Acre	$4,000	$2,532,000
Clearing and Grubbing	15	Acre	$10,000	$150,000
Stripping	15	Acre	$5,000	$75,000
Common Excavation	50,000	CY	$10	$500,000
Rock Excavation	2,000	CY	$100	$200,000
Grout Curtain	1	LS	$1,200,000	$1,200,000
Foundation Drains	3,000	LF	$75	$225,000
RCC	130,000	CY	$78	$10,140,000
Reinforced Concrete	3,700	CY	$700	$2,590,000
Unreinforced Concrete	3,000	CY	$450	$1,350,000
PreCast Panel System	68,000	SF	$25	$1,700,000
Outlet Works	1	LS	$1,200,000	$1,200,000
Backfill	40,000	CY	$10	$400,000
Topsoil & Seed	15	Acre	$10,000	$150,000

Values Rounded to Nearest $1000

Subtotal		$25,562,000
25% Contingency		$6,391,000
Est. Total Const. Cost		**$31,953,000**
Engineering	**18%**	**$5,751,540**
Est Total Dam Cost		**$37,700,000**

APPENDIX D

References

References

1. Black & Veatch, *Gillis Falls Reservoir Environmental Report*, January 1990.

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3. Carroll County, *Gillis Falls Chronology and Update*, March 1993.

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6. Carroll County Board of Commissioners, *Reservoir Watershed Management Agreement, Piney Run Reservoir and Related Issues in Freedom Community*, August 2000.

7. Martin Covington, PE, *Memorandum, Re-evaluation of Union Mills Reservoir*, November 20, 2006 (3 sheets).

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Carroll County
Alternatives Evaluation

Appendix C

Groundwater Assessment

6531-001-400

MALCOLM PIRNIE

Alt	Growth Area	DEMAND ❶ Probable Maximum Additional Water Requirement [gpd]	SERVICE AREA MDE AVAILABLE RECHARGE — Priority + Future Service Area ❶ Area [ac]	❷ Total Available Recharge [gpd]	❸ Remaining Available Recharge [gpd]	❹ Projected Water Surplus [gpd]	❺ Total Required MDE GW Recharge Area [ac]	ESTIMATED WELL REQUIREMENTS ❶ Number of Additional Wells based on Average MDE Appropriation per Groundwater Well [-]	❷ Total Exploration Sites [-]
G-1	***Hampstead***	***528,000***	***2,656***	***934,979***	***214,364***	*-313,636*	***891***	***20***	***28***
G-2	*Mount Airy*	*364,000*	*3,543*	*1,197,463*	*532,598*	*168,598*	*0*	*5*	*54*
G-3	***New Windsor***	***198,000***	***953***	***290,665***	***94,665***	*-103,335*	***339***	***3***	***22***
G-4	***Taneytown***	***1,164,000***	***3,274***	***949,460***	***366,460***	*-797,540*	***2,750***	***16***	***5***
G-5	***Union Bridge***	***594,000***	***1,430***	***436,150***	***227,850***	*-366,150*	***1,200***	***6***	***11***
G-6	*Westminster*	*1,176,000†*	*8,543*	*3,007,136*	*1,531,136*	*355,136*	*0*	*9*	*38*
G-7	*Union Mills*	*N/A*	*1,600*	*563,310*	*563,310*	*563,310*	*0*	*10*	*--*
G-8	*Manchester*	*124,000††*	*0*	*0*	*0*	*0*	*0*	*6*	*--*
	WSA Totals	**4,148,000**	**20,399**	**6,815,853**	**2,967,073**	**-1,056,927**	**5,180**	**75**	**158**

Notes:

- ❶ (Demand) Projected maximum groundwater requirement (see Table 2-1)
- ❶ (Recharge) Area of Priority+Future Service Area (GIS layer supplied by County)
- ❷ Total Available Recharge in Priority+Future Service Areas based on recommended MDE method (Recharge = 1yrQ10 - 7Q10 by hydrogeomorphic region)
- ❸ Adjusted Available Recharge in Piority+Future Service Areas (Total Available adjusted by subtracting existing allocations)
- ❹ Projected Surplus of Available Recharge (Max(❸,0)-❶)
- ❺ The amount of additional land that a given WSA would need to own/control to obtain an appropriation permit to meet total projected demands by groundwater (-MIN(❶/,0)*❷/❶)
- ❶ (Wells) Estimated number of wells needed to meet maximum probable GW demands ❶
- ❷ (Wells) Total number potential wells sites identified by the County and its water service areas for exploration

† Assumed existing withdrawals in Westminster are equal to actual yield because existing wells are known to have significantly lower yields than the permitted amount

†† Manchester needs additional wells to access water that is already appropriated, but cannot be used due to reduced well capacities.

Hampstead Groundwater Budget

Prepared by: Carroll County Staff **Date:** 5/21/2009

	Appropriation Watershed			WSA Totals
Own & Control Type	**Patapsco**	**Gunpowder**	**Loch Raven**	
Size (ac)				
WSA Priority+Future	1,060	1,189	407	**2,656**
GAB	1,815	1,193	413	**3,421**
Recharge Rate (gpd/ac)	**352**	**352**	**352**	
Own/Control Water (gpd)				
WSA Priority+Future	373,215	418,609	143,155	**934,979**
GAB	638,880	419,936	145,376	**1,204,192**
Existing Appropriations (gpd)	**583,000**	**206,400**	**141,000**	**930,400**
Net Availability (gpd)				
WSA Priority+Future	-209,785	212,209	2,155	**214,364**
GAB	55,880	213,536	4,376	**273,792**

Existing Appropriations		**930,400**	**Comment**
Patapsco		**583,000**	
County Wells		*283,000*	
	11		*N Main Street*
	12		*N Main Street*
	20		*Hospital Well*
	21		*Hospital Well*
	28		*Corbin Well Field*
	29		*Corbin Well Field*
	31		*Widerman Well Field*
	32		*Widerman Well Field*
Black & Decker		*300,000*	*Remediation Well*
Gunpowder		**206,400**	
County Wells		*156,000*	
	19		*Greenmount Church*
	24		*Small Crossings*
	25		*Small Crossings*
	TWC		
	PWC-1		
	33		*North Carroll Farm*
	34		*North Carroll Farm*
Oakmont Green Golf Course		*50,400*	
Loch Raven		**141,000**	
13			*Route 88*
15			*Route 88*
22			*Roberts Field*
23			*Roberts Field*
26			*Roberts Field*
27			*Roberts Field*

Mount Airy Groundwater Budget

Prepared by: Carroll County Staff **Date:** 5/27/2009

	Appropriation Watershed				WSA Totals
Own & Control Type	**Middle Run**	**South Branch Patapsco**	**Woodville Branch**	**Upper Bush Creek**	
Size (ac)					
WSA Priority+Future	220	1,524	1,393	406	**3,543**
GAB	253	1,737	1,393	398	**3,781**
Recharge Rate (gpd/ac)	**372**	**372**	**305**	**305**	
Own/Control Water (gpd)					
WSA Priority+Future	81,840	566,928	424,865	123,830	**1,197,463**
GAB	94,116	646,055	424,865	121,390	**1,286,426**
Existing Appropriations (gpd)	**38,000**	**90,000**	**625,000**	**112,000**	**865,000**
Net Availability (gpd)					
WSA Priority+Future	43,840	476,928	-200,135	11,830	**532,598**
GAB	56,116	556,055	-200,135	9,390	**621,561**

Existing Appropriations	**865,000**
Middle Run (NE Basin)	**38,000**
Well 5	*38,000*
South Branch (SE Basin)	**90,000**
Well 6	*90,000*
Woodville Branch (NW basin)	**625,000**
Wells 1, 2, 3, 4	*307,000*
Well 8	*162,000*
Well 9	*79,000*
Well 10	*77,000*
Upper Brush Creek (SW Basin)	**112,000**
Well 7	*112,000*

New Windsor Groundwater Budget

Prepared by: Carroll County Staff **Date:** 5/27/2009

	Appropriation Watershed			WSA Totals
Own & Control Type	**Dickerson Run**	**Little Pipe Creek**	**Turkeyfoot Run**	
Size (ac)				
WSA Priority+Future	654	98	201	**953**
GAB	658	101	201	**960**
Recharge Rate (gpd/ac)	**305**	**305**	**305**	
Own/Control Water (gpd)				
WSA Priority+Future	199,470	29,890	61,305	**290,665**
GAB	200,690	30,805	61,305	**292,800**
Existing Appropriations (gpd)	**196,000**	**0**	**0**	**196,000**
Net Availability (gpd)				
WSA Priority+Future	3,470	29,890	61,305	**94,665**
GAB	4,690	30,805	61,305	**96,800**

Existing Appropriations	**196,000.00**	
Dickerson Run	**196,000.00**	
Main spring/Dennings	*143,000.00*	
Roops Meadow/Hillside	*53,000.00*	
Dickerson Run	*0.00*	*emergency use only*
Little Pipe Creek	**0.00**	
Turkeyfoot Run	**0.00**	

Taneytown Groundwater Budget

Prepared by: Carroll County Staff **Date:** 5/27/2009

	Appropriation Watershed		WSA Totals
Own & Control Type	**Big Pipe Creek**	**Piney Creek**	
Size (ac)			
WSA Priority+Future	540	2,734	**3,274**
GAB	539	2,730	**3,269**
Recharge Rate (gpd/ac)	**290**	**290**	
Own/Control Water (gpd)			
WSA Priority+Future	156,600	792,860	**949,460**
GAB	156,310	791,700	**948,010**
Existing Appropriations (gpd)	**103,000**	**480,000**	**583,000**
Net Availability (gpd)			
WSA Priority+Future	53,600	312,860	**366,460**
GAB	53,310	311,700	**365,010**

Existing Appropriations	**583,000**
Piney Creek	**103,000**
wells 15 & 16	*103,000*
Big Pipe Creek	**480,000**
wells 8,9,11,12,13	*390,000*
well 14	*90,000*

Union Bridge Groundwater Budget

Prepared by: Carroll County Staff **Date:** 5/28/2009

	Appropriation Watershed			WSA Totals
Own & Control Type	**Sams Creek**	**Priestland Branch**	**Cherry Branch / Little Pipe**	
Size (ac)				
WSA Priority+Future	393	767	270	**1,430**
GAB	427	921	292	**1,640**
Recharge Rate (gpd/ac)	**305**	**305**	**305**	
Own/Control Water (gpd)				
WSA Priority+Future	119,865	233,935	82,350	**436,150**
GAB	130,235	280,905	89,060	**500,200**
Existing Appropriations (gpd)	**0**	**208,300**	**0**	**208,300**
Net Availability (gpd)				
WSA Priority+Future	119,865	25,635	82,350	**227,850**
GAB	130,235	72,605	89,060	**291,900**

Existing Appropriations	**208,300**
Sams Creek	**0**
Priestland Branch	**208,300**
PW 1 & PW3	*166,000*
Philips	*42,300*
Cherry Br./Little Pipe	**0**
Bowman Well	*0*

Westminster Groundwater Budget

Prepared by: Carroll County Staff **Date:** 5/26/2009

	Appropriation Watershed			WSA Totals
Own & Control Type	**Patapsco**	**Big Pipe Creek**	**Little Pipe Creek**	
Size (ac)				
WSA Priority+Future	4,256	1,129	3,158	**8,543**
GAB	5,855	1,260	3,736	**10,851**
Recharge Rate (gpd/ac)	**372**	**305**	**352**	
Own/Control Water (gpd)				
WSA Priority+Future	1,498,112	397,408	1,111,616	**3,007,136**
GAB	2,060,960	443,520	1,315,072	**3,819,552**
Existing Appropriations (gpd)	**519,000**	**360,000**	**597,000**	**1,476,000**
Net Availability (gpd)				
WSA Priority+Future	979,112	37,408	514,616	**1,531,136**
GAB	1,541,960	83,520	718,072	**2,343,552**

Existing Appropriations	**1,476,000**	
Patapsco	**519,000**	
4	*170,000*	*Air Business Center*
5	*230,000*	*Krider's Church*
8	*119,000*	*Vo-Tech*
Big Pipe Creek	**360,000**	
3	*100,000*	*County Maintenance*
9	*125,000*	*Koontz Well*
10		*Koontz Well*
11	*135,000*	*Roops mill*
Little Pipe Creek	**597,000**	
1	*197,000*	*Wakefield Well 1*
2		*Wakefield Well 2*
6	*100,000*	*S. Center Street*
7	*300,000*	*Carfaro*

notes:

1. *does not account for discharge from Koontz Creamery well which is 500,000 gpd flow augmentation in the Patapsco watershed*

2. *does not include Wakefield Valley golf course at 86,000 gpd in the Little Pipe Creek watershed*

3. *does not include existing Medford Quarry appropriation for mining.*

Union Mills Groundwater Budget

Prepared by: Malcolm Pirnie **Date:** 8/17/2009

	Appropriation Watershed	WSA Totals
Own & Control Type	**Big Pipe Creek**	
Size (ac)		
WSA Priority+Future	1,600	**1,600**
GAB	1,600	**1,600**
Recharge Rate (gpd/ac)	**305**	
Own/Control Water (gpd)		
WSA Priority+Future	563,310	**563,310**
GAB	563,310	**563,310**
Existing Appropriations (gpd)	**0**	**0**
Net Availability (gpd)		
WSA Priority+Future	563,310	**563,310**
GAB	563,310	**563,310**

Existing Appropriations **0**

Big Pipe Creek **0**

Manchester Groundwater Budget

Prepared by: Carroll County Staff **Date:** 5/21/2009

	Appropriation Watershed			WSA Totals
Own & Control Type	**Middle Potomac**	**Patapsco**	**Gunpowder**	
Size (ac)				
WSA Priority+Future	310	352	1,102	**1,764**
GAB	970	665	2,112	**3,747**
Recharge Rate (gpd/ac)	**352**	**352**	**352**	
Own/Control Water (gpd)				
WSA Priority+Future	109,219	123,728	388,055	**621,002**
GAB	341,292	234,094	743,554	**1,318,940**
Existing Appropriations (gpd)	**134,000**	**123,000**	**324,000**	**581,000**
Net Availability (gpd)				
WSA Priority+Future	-24,781	728	64,055	**64,783**
GAB	207,292	111,094	419,554	**737,940**

Existing Appropriations	**581,000**
Middle Potomac	**134,000**
Bachman Road	
Crossroads 1	
Crossroads 2	
Hallie Hills	
Patapsco	**123,000**
Patricia Ct	*38,000*
Manchester Farms D	*69,700*
Manchester Farms B	
Park Ridge	*6,000*
Chauncey Hill	*9,300*
Gunpowder	**324,000**
walnut st spring/well	
route 30 (Lippy)	
Holland Drive	
Ferrier Road	
Black Farm	

ESTIMATED WELL REQUIREMENTS - ASSUMPTIONS

Drawdown Factor of Safety | 10%

General Assumptions

- data based on 1988 Carroll County Water Resources Study by R.E. Wright Associates
- maximum drawdown based on the measured distance between static water level and top of water bearing zone with a 10% factor of safety
- maximum pump rates based on septic capacities measured in WSA wells and calculated maximum drawdown
- total demand based on values presented in the GW Demands spreadsheet.
- number of wells is the total demand divided by the average pump rate of the well rounded up to the nearest integer value

- likely yield scenarios based on the MDE's understanding of hydrogeology in the vicinity of each of the WSAs
- median yield scenarios based on the median of published information
- optimistic yield scenarios based on the median of the maximum values for a given parameter where a range was specified
- lower yield scenarios based on the median of the minimum values for a given parameter where a range was specified

Instructions

1. set demands in blue box
2. adjust pump rates in red box to ensure total drawdown does not exceed acceptable drawdown

HAMPSTEAD GROUNDWATER OPTION - ESTIMATED WELL REQUIREMENTS

WITHDRAWAL SCENARIO

	LOWER YIELD	MEDIAN YIELD	OPTIMISTIC YIELD	AVG MDE APPROPRIATION	UNITS
Static Head	4	28	149	--	ft - above aquifer bottom
Aquifer Thickness	60	67	193	--	ft
Specific Capacity	1.30	1.78	2.25	--	gpm/ft
Acceptable Drawdown	19.8	34.1	47.7	--	ft
Absolute Max Pump Rate	25.7	60.5	107.3	--	gpm
Pumping Rate	25	55	100	19	gpm
Total Demand	528,000	528,000	528,000	528,000	gpd
Well Drawdown	19.2	31.0	44.4	--	ft
Daily Pump Volume	36,000	79,200	144,000	27,619	gpd
Total Daily Pump Volume	540,000	554,400	576,000	552,381	gpd
Number of Wells	15	7	4	20	--

Notes:

- Aquifer data based on Hampstead information presented in the 1988 Water Resources Study of Carroll County by R.E. Wright Associates

MOUNT AIRY GROUNDWATER OPTION - ESTIMATED WELL REQUIREMENTS

	WITHDRAWAL SCENARIO				
	LOWER YIELD	MEDIAN YIELD	OPTIMISTIC YIELD	AVG MDE APPROPRIATION	UNITS
Static Head	23	145	266	--	ft - above aquifer bottom
Aquifer Thickness	7	137	266	--	ft
Specific Capacity	8.00	8.00	8.00	--	gpm/ft
Acceptable Drawdown	11.7	14.4	18.0	--	ft
Absolute Max Pump Rate	93.6	115.2	144.0	--	gpm
Pumping Rate	40	75	75	60	gpm
Total Demand	364,000	364,000	364,000	364,000	gpd
Well Drawdown	5.0	9.4	9.4	--	ft
Daily Pump Volume	57,600	108,000	108,000	86,500	gpd
Total Daily Pump Volume	403,200	432,000	432,000	432,500	gpd
Number of Wells	7	4	4	5	--

Notes:

- Aquifer data based on Mount Airy information presented in the 1988 Water Resources Study of Carroll County by R.E. Wright Associates

- Storage coefficient values were estimated from regional values presented in Chapter 4 of 1988 study

NEW WINDSOR GROUNDWATER OPTION - ESTIMATED WELL REQUIREMENTS

	WITHDRAWAL SCENARIO				
	LOWER YIELD	MEDIAN YIELD	OPTIMISTIC YIELD	AVG MDE APPROPRIATION	UNITS
Static Head	64	64	64	--	ft - above aquifer bottom
Aquifer Thickness	1	1	1	--	ft
Specific Capacity	15.00	15.00	15.00	--	gpm/ft
Acceptable Drawdown	56.7	56.7	56.7	--	ft
Absolute Max Pump Rate	850.5	850.5	850.5	--	gpm
Pumping Rate	50	100	100	68	gpm
Total Demand	198,000	198,000	198,000	198,000	gpd
Well Drawdown	3.3	6.7	6.7	--	ft
Daily Pump Volume	72,000	144,000	144,000	98,000	gpd
Total Daily Pump Volume	216,000	288,000	288,000	294,000	gpd
Number of Wells	3	2	2	3	--

Notes:

- Aquifer data based on New Windsor information presented in the 1988 Water Resources Study of Carroll County by R.E. Wright Associates

TANEYTOWN GROUNDWATER OPTION - ESTIMATED WELL REQUIREMENTS

	WITHDRAWAL SCENARIO				
	LOWER YIELD	MEDIAN YIELD	OPTIMISTIC YIELD	AVG MDE APPROPRIATION	UNITS
Static Head	22	295	496	--	ft - above aquifer bottom
Aquifer Thickness	25	89	141	--	ft
Specific Capacity	0.90	1.10	1.60	--	gpm/ft
Acceptable Drawdown	45.9	72.9	243.0	--	ft
Absolute Max Pump Rate	41.3	80.2	388.8	--	gpm
Pumping Rate	40	80	380	51	gpm
Total Demand	1,164,000	1,164,000	1,164,000	1,164,000	gpd
Well Drawdown	44.4	72.7	237.5	--	ft
Daily Pump Volume	57,600	115,200	547,200	72,875	gpd
Total Daily Pump Volume	1,209,600	1,267,200	1,641,600	1,166,000	gpd
Number of Wells	21	11	3	16	--

Notes:
- Aquifer data based on Taneytown information presented in the 1988 Water Resources Study of Carroll County by R.E. Wright Associates

UNION BRIDGE GROUNDWATER OPTION - ESTIMATED WELL REQUIREMENTS

	WITHDRAWAL SCENARIO				
	LOWER YIELD	MEDIAN YIELD	OPTIMISTIC YIELD	AVG MDE APPROPRIATION	UNITS
Static Head	64	216	530	--	ft - above aquifer bottom
Aquifer Thickness	1	21	374	--	ft
Specific Capacity	0.80	8.00	97.00	--	gpm/ft
Acceptable Drawdown	59.4	137.7	252.9	--	ft
Absolute Max Pump Rate	47.5	1101.6	24531.3	--	gpm
Pumping Rate	47	200	200	72	gpm
Total Demand	594,000	594,000	594,000	594,000	gpd
Well Drawdown	58.8	25.0	2.1	--	ft
Daily Pump Volume	67,680	288,000	288,000	104,150	gpd
Total Daily Pump Volume	609,120	864,000	864,000	624,900	gpd
Number of Wells	9	3	3	6	--

Notes:

- Aquifer data based on Union Bridge information presented in the 1988 Water Resources Study of Carroll County by R.E. Wright Associates

WESTMINSTER GROUNDWATER OPTION - ESTIMATED WELL REQUIREMENTS

	WITHDRAWAL SCENARIO				
	LOWER YIELD	MEDIAN YIELD	OPTIMISTIC YIELD	AVG MDE APPROPRIATION	UNITS
Static Head	75	216	530	--	ft - above aquifer bottom
Aquifer Thickness	1	21	374	--	ft
Specific Capacity	0.80	8.00	97.00	--	gpm/ft
Acceptable Drawdown	59.4	137.7	252.9	--	ft
Absolute Max Pump Rate	47.5	1101.6	24531.3	--	gpm
Pumping Rate	45	200	550	93	gpm
Total Demand	1,176,000	1,176,000	1,176,000	1,176,000	gpd
Well Drawdown	56.3	25.0	5.7	--	ft
Daily Pump Volume	64,800	288,000	792,000	134,182	gpd
Total Daily Pump Volume	1,231,200	1,440,000	1,584,000	1,207,636	gpd
Number of Wells	19	5	2	9	--

Notes:

- Aquifer data based on Westminster information presented in the 1988 Water Resources Study of Carroll County by R.E. Wright Associates

UNION MILLS AREA GROUNDWATER OPTION - ESTIMATED WELL REQUIREMENTS

	WITHDRAWAL SCENARIO				
	LOWER YIELD	MEDIAN YIELD	OPTIMISTIC YIELD	AVG MDE APPROPRIATION	UNITS
Static Head	75	216	530	--	ft - above aquifer bottom
Aquifer Thickness	1	21	374	--	ft
Specific Capacity	0.80	8.00	97.00	--	gpm/ft
Acceptable Drawdown	59.4	137.7	252.9	--	ft
Absolute Max Pump Rate	47.5	1101.6	24531.3	--	gpm
Pumping Rate	45	200	550	43	gpm
Total Demand	563,310	563,310	563,310	563,310	gpd
Well Drawdown	56.3	25.0	5.7	--	ft
Daily Pump Volume	64,800	288,000	792,000	61,750	gpd
Total Daily Pump Volume	583,200	576,000	792,000	617,500	gpd
Number of Wells	9	2	1	10	--

Notes:

- Aquifer data based on Westminster information presented in the 1988 Water Resources Study of Carroll County by R.E. Wright Associates

Appendix D

Criteria Scoring Tables for Water Supply Alternatives

6531-001-400

MALCOLM PIRNIE

Alternative R-1a: Gillis Falls Reservoir (Proposed - Elev 610)

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**2.4**
Safe Yield	Safe yield of 3.85 mgd exceeds needs of Mt Airy and Sykesville/Freedom	*0.40*	2.5
Improved Reliability	Drought resilient and could significantly decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	Low - Moderate potential. Limited potential to serve areas outside of Mount Airy due to lack of need in Sykesville/Freedom service area.	*0.40*	2.0
Environmental Impacts		***0.20***	**1.7**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime. However, +/- 2,500 ft of Tier II streams inundated.	--	1.0
Groundwater Impacts	Potential recharge of local aquifers. Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Large wetland (177 acres) and stream (+/- 10.1 miles) footprints inundated.	--	1.0
Impacts to Current Land Use	Large footprint (452 acres) inundates forested/agricultural lands, aquaculture facility and +/- 5 homes	--	1.0
Infrastructure Impacts	Would require road/bridge relocations.	--	2.0
Cultural and Historical Impacts	Moderate number of historical and architectural sites based on surveys conducted for 1990 Environmental Report.	--	2.0
Implementability		***0.20***	**1.0**
Opposition from Environmental Organizations	Since Piney Run Reservoir is not currently used as water supply, expect opposition to another reservoir in the southern part of the County.	--	1.0
Potential Permitting Delays/Issues	Second largest aquatic habitat impacts of any reservoir option.	--	1.0
Other Legal or Institutional Challenges	Would be very difficult to obtain federal and state agency support for new reservoir in southern part of the County.	--	1.0
Relative Cost Estimate		***0.20***	**1.0**
Unit Capital Cost	$27.1/gallon is very high relative to other options	--	1.0
Overall Performance		***1.00***	**1.7**

Alternative R-1b: Gillis Falls Reservoir (Expanded - Elev 630)

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**2.4**
Safe Yield	Safe yield of 5.0 mgd exceeds needs of Mt Airy and Sykesville/Freedom	*0.40*	2.5
Improved Reliability	Drought resilient and could significantly decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	Low - Moderate potential. Limited potential to serve areas outside of Mount Airy due to lack of need in Sykesville/Freedom service area.	*0.40*	2.0
Environmental Impacts		***0.20***	**1.7**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime. However, +/- 4,000 ft of Tier II streams inundated.	--	1.0
Groundwater Impacts	Potential recharge of local aquifers. Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Large wetland (+/- 225 acres) and stream (+/- 14.2 miles) footprints inundated.	--	1.0
Impacts to Current Land Use	Large footprint (744 acres) inundates forested/agricultural lands, aquaculture facility and +/- 16 homes	--	1.0
Infrastructure Impacts	Would require road/bridge relocations.	--	2.0
Cultural and Historical Impacts	Moderate number of historical and architectural sites based on surveys conducted for 1990 Environmental Report.	--	2.0
Implementability		***0.20***	**1.0**
Opposition from Environmental Organizations	Since Piney Run Reservoir is not currently used as water supply, expect opposition to another reservoir in the southern part of the County.	--	1.0
Potential Permitting Delays/Issues	Largest aquatic habitat impacts of any reservoir option.	--	1.0
Other Legal or Institutional Challenges	Would be very difficult to obtain federal and state agency support for new reservoir in southern part of the County.	--	1.0
Relative Cost Estimate		***0.20***	**1.0**
Unit Capital Cost	$28.4/gallon is very high relative to other options	--	1.0
Overall Performance		***1.00***	**1.7**

Alternative R-2: Piney Run Reservoir - Use as Water Source

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**2.6**
Safe Yield	Safe yield of 3.65 mgd exceeds needs of Mt Airy and Sykesville/Freedom	*0.40*	2.5
Improved Reliability	Drought resilient and could significantly decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	Moderate potential. Could ultimately serve areas between Piney Run and Mount Airy, as well as the Mount Airy service area.	*0.40*	2.5
Environmental Impacts		***0.20***	**3.0**
Surface Water Impacts	Existing reservoir. Impacts already incurred.	--	3.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Existing reservoir. Impacts already incurred.	--	3.0
Impacts to Current Land Use	Existing reservoir. Impacts already incurred.	--	3.0
Infrastructure Impacts	Existing reservoir. Impacts already incurred.	--	3.0
Cultural and Historical Impacts	Existing reservoir. Impacts already incurred.	--	3.0
Implementability		***0.20***	**2.3**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	Expect support from MDE	--	3.0
Other Legal or Institutional Challenges	Local residents may object to greater reservoir drawdown and water use outside Sykesville/Freedom service area	--	1.5
Relative Cost Estimate		***0.20***	**2.5**
Unit Capital Cost	$8.0/gallon is moderate relative to other options	--	2.5
Overall Performance		***1.00***	**2.6**

Alternative R-3: Expansion of Piney Run Reservoir

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.6**
Safe Yield	Incremental safe yield benefit of only 0.46 mgd. Needs of Mt Airy and Sykesville/Freedom can be met by existing Piney Run Reservoir.	*0.40*	1.0
Improved Reliability	Drought resilient and could significantly decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	Low potential beyond that already provided by existing Piney Run Reservoir.	*0.40*	1.5
Environmental Impacts		***0.20***	**2.4**
Surface Water Impacts	Existing reservoir. Impacts already largely incurred.	--	3.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Moderate wetland (+/- 12.6 acres) and stream (+/- 1.05 miles) footprints inundated.	--	2.0
Impacts to Current Land Use	Moderate increase (38 acres) in inundated lands. County park/marina may be affected.	--	2.0
Infrastructure Impacts	Would require minor road/bridge relocations.	--	2.5
Cultural and Historical Impacts	May have minor effect on Waters Edge Farm. Other impacts unknown.	--	2.0
Implementability		***0.20***	**1.8**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Expect permitting delays due to MDE dam safety issues, as well as local and political opposition to acquiring nearby lands.	--	2.0
Other Legal or Institutional Challenges	Local residents may object to greater reservoir drawdown and water use outside Sykesville/Freedom service area	--	1.5
Relative Cost Estimate		***0.20***	**1.5**
Unit Capital Cost	$19.2/gallon is high relative to other options	--	1.5
Overall Performance		***1.00***	**1.8**

MALCOLM PIRNIE

Alternative R-4a: Union Mills Reservoir (Proposed - Elev 610)

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**2.8**
Safe Yield	Safe yield of 3.76 mgd exceeds the needs of Westminster, Hampstead, Manchester and Taneytown	*0.40*	2.5
Improved Reliability	Drought resilient and could significantly decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	High potential. Could ultimately serve large portions of northern half of County.	*0.40*	3.0
Environmental Impacts		***0.20***	**1.8**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime. Confirm closed landfill not a water quality issue.	--	2.0
Groundwater Impacts	Potential recharge of local aquifers. Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Large wetland (+/- 114 acres) and stream (+/- 8.4 miles) footprints inundated.	--	1.0
Impacts to Current Land Use	Large footprint (298 acres) inundates forested/agricultural lands and +/- 3 homes.	--	1.0
Infrastructure Impacts	Would require road/bridge relocations.	--	2.0
Cultural and Historical Impacts	Portions of Whittaker Chambers Farm inundated. Cultural resources survey likely needed. USDA-SCS EIS is 33 yrs old.	--	2.0
Implementability		***0.20***	**1.5**
Opposition from Environmental Organizations	Opposition expected at local project-area level.	--	2.0
Potential Permitting Delays/Issues	Large aquatic habitat impacts will require extensive mitigation effort.	--	1.0
Other Legal or Institutional Challenges	Unknown	--	
Relative Cost Estimate		***0.20***	**1.0**
Unit Capital Cost	$32.4/gallon is very high relative to other options	--	1.0
Overall Performance		***1.00***	**2.0**

Alternative R-4b: Union Mills Reservoir (Expanded - Elev 630)

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**3.0**
Safe Yield	Safe yield of 7.93 mgd far exceeds the needs of Westminster, Hampstead, Manchester and Taneytown	*0.40*	3.0
Improved Reliability	Drought resilient and could significantly decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	High potential. Could ultimately serve large portions of northern half of County.	*0.40*	3.0
Environmental Impacts		***0.20***	**1.8**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime. Confirm closed landfill not a water quality issue.	--	2.0
Groundwater Impacts	Potential recharge of local aquifers. Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Large wetland (+/- 165 acres) and stream (+/- 15.1 miles) footprints inundated.	--	1.0
Impacts to Current Land Use	Large footprint (633 acres) inundates forested/agricultural lands and +/- 4 homes.	--	1.0
Infrastructure Impacts	Would require road/bridge relocations.	--	2.0
Cultural and Historical Impacts	Portions of Whittaker Chambers Farm inundated. Cultural resources survey likely needed. USDA-SCS EIS is 33 yrs old.	--	2.0
Implementability		***0.20***	**1.5**
Opposition from Environmental Organizations	Opposition expected at local project-area level.	--	2.0
Potential Permitting Delays/Issues	Large aquatic habitat impacts will require extensive mitigation effort.	--	1.0
Other Legal or Institutional Challenges	Unknown	--	
Relative Cost Estimate		***0.20***	**1.5**
Unit Capital Cost	$20.5/gallon is high relative to other options	--	1.5
Overall Performance		***1.00***	**2.2**

Alternative R-5: Increase Capacity of Cranberry Reservoir

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.2**
Safe Yield	Additional safe yield of 0.1[1] mgd does not meet the long-term needs of Westminster.	*0.40*	1.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	2.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.0**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime.	--	2.0
Groundwater Impacts	Decreases reliance on GW.	--	2.0
Wetland and Stream Impacts	Unknown.	--	
Impacts to Current Land Use	Would inundate unknown quantity of existing agricultural land.	--	2.0
Infrastructure Impacts	Unknown.	--	
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	Expect permitting delays due to MDE dam safety issues, as well as local and political opposition to acquiring nearby lands.	--	2.0
Other Legal or Institutional Challenges	Unknown	--	
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$2.8/gallon is low relative to other options	--	3.0
Overall Performance		***1.00***	**1.9**

[1] Safe yield is based on ratio of current safe yield (1.17 mgd based on Stearns & Wheler, City of Westminster Flow Mass Analysis, Table F-1) to current usable volume (115 MG) and the proposed capacity increase (8 MG) from a 1-foot vertical expansion of Cranberry Reservoir.

Alternative R-6: Prettyboy Reservoir

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.9**
Safe Yield	Safe yield (purchase) of 2 mgd meets needs of Hampstead, Manchester and Westminster	*0.40*	2.0
Improved Reliability	Drought resilient, but from water source controlled by Baltimore.	*0.20*	1.5
Potential as Regional Supply	Low-Moderate potential.	*0.40*	2.0
Environmental Impacts		***0.20***	**2.5**
Surface Water Impacts	More extensive drawdown in Prettyboy Reservoir is possible.	--	2.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Expect temporary wetland and stream impacts during pipeline construction.	--	2.5
Impacts to Current Land Use	Expect temporary land use impacts during pipeline construction.	--	2.5
Infrastructure Impacts	Unknown	--	
Cultural and Historical Impacts	Unknown	--	
Implementability		***0.20***	**1.8**
Opposition from Environmental Organizations	Opposition expected from Prettyboy Reservoir area.	--	2.0
Potential Permitting Delays/Issues	Surface water appropriation from MDE. Potential for USACE/MDE permits for temporary wetland and stream impacts.	--	2.0
Other Legal or Institutional Challenges	Unknown outcome of negotiation (and fee structure) with Baltimore.	--	1.5
Relative Cost Estimate		***0.20***	**1.5**
Unit Capital Cost	$19.9/gallon is high relative to other options	--	1.5
Overall Performance		***1.00***	**1.9**

Alternative S-1: New Surface Water Intake in Gillis Falls Area

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**2.0**
Safe Yield	Safe yield of 0.85 mgd exceeds needs of Mount Airy	*0.40*	2.5
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.1**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime.	--	2.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Expect small to moderate wetland and stream impacts from storage impoundment. Impacts on Tier II streams possible.	--	1.5
Impacts to Current Land Use	Storage impoundment footprint size unknown, but expected to inundate forested/agricultural lands.	--	2.0
Infrastructure Impacts	Would require minor road/bridge relocations.	--	2.0
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Aquatic habitat impacts (from storage impoundment) will require mitigation effort.	--	2.0
Other Legal or Institutional Challenges	Unknown	--	
Relative Cost Estimate		***0.20***	**1.0**
Unit Capital Cost	$47.1/gallon is very high relative to other options	--	1.0
Overall Performance		***1.00***	**1.8**

Alternative S-2: New Intake on Big Pipe Creek in Union Mills Area (Westminster)

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.7 mgd does not meet the long-term needs of Westminster.	*0.40*	1.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.3**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime.	--	2.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Moderate wetland (+/- 3.5 acres) and stream (+/- 1.1 miles) footprints inundated.	--	2.0
Impacts to Current Land Use	Small footprint (34.3 acres) inundates forested/agricultural lands.	--	2.0
Infrastructure Impacts	No road or bridge relocations expected	--	2.5
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**1.5**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Aquatic habitat impacts (from storage impoundment) will require mitigation effort.	--	1.5
Other Legal or Institutional Challenges	Unknown	--	
Relative Cost Estimate		***0.20***	**1.0**
Unit Capital Cost	$33.6/gallon is very high relative to other options	--	1.0
Overall Performance		***1.00***	**1.5**

Alternative S-3: New Intake on Little Pipe Creek for Westminster

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.5 mgd does not meet the long-term needs of Westminster.	*0.40*	1.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.4**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime.	--	2.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Expect minimal wetland and stream impacts from storage impoundment.	--	2.5
Impacts to Current Land Use	Small footprint (13.6 acres) inundates forested lands.	--	2.0
Infrastructure Impacts	No road or bridge relocations expected	--	2.5
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Aquatic habitat impacts (from storage impoundment) will require mitigation effort.	--	2.0
Other Legal or Institutional Challenges	Unknown	--	
Relative Cost Estimate		***0.20***	**1.0**
Unit Capital Cost	$33.9/gallon is very high relative to other options.	--	1.0
Overall Performance		***1.00***	**1.6**

Alternative S-4: New Intake on Big Pipe Creek for Taneytown

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.4 mgd does not meet the long-term needs of Taneytown.	*0.40*	1.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.0**
Surface Water Impacts	Minimum release provisions can maintain acceptable flow regime.	--	2.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Moderate wetland (+/- 9.1 acres) and stream (+/- 0.8 miles) footprints inundated.	--	2.0
Impacts to Current Land Use	Small footprint (25.1 acres) inundates forested/agricultural lands. Impoundment and pipeline impact County Agricultural Land Easements	--	1.0
Infrastructure Impacts	Would require minor road/bridge relocations.	--	2.0
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**1.3**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Aquatic habitat impacts (from storage impoundment) will require mitigation effort.	--	1.5
Other Legal or Institutional Challenges	Conflicts with County Agriculture Land Preservation Easements, which represents a major obstacle to implementing this alternative	--	1.0
Relative Cost Estimate		***0.20***	**1.0**
Unit Capital Cost	$32.7/gallon is very high relative to other options.	--	1.0
Overall Performance		***1.00***	**1.4**

MALCOLM PIRNIE

Alternative Q-1: Hyde's Quarry - New Raw Water Reservoir

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.5 mgd does not meet the long-term needs of of Westminster.	*0.40*	1.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.4**
Surface Water Impacts	May be used as back-up supply for Little Pipe Creek intake during low flow periods.	--	2.0
Groundwater Impacts	Indirectly impacts GW since quarry withdrawals rely on groundwater discharge.	--	1.5
Wetland and Stream Impacts	Existing quarry. Impacts already incurred. Expect temporary wetland/stream impacts during pipeline construction.	--	3.0
Impacts to Current Land Use	Existing quarry. Impacts already incurred. Expect temporary land use impacts during pipeline construction.	--	3.0
Infrastructure Impacts	Unknown.	--	
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Need to obtain MDE appropriation permit.	--	2.0
Other Legal or Institutional Challenges	Expect delays due to testing required to confirm no impacts from WWTP effluent upstream of quarry.	--	2.0
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$4.7/gallon is low relative to other options	--	3.0
Overall Performance		***1.00***	**2.0**

MALCOLM PIRNIE

Alternative Q-2: Lehigh Quarry - Union Bridge

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.8**
Safe Yield	Safe yield of 0.6 mgd meets the needs of Union Bridge.	*0.40*	2.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.4**
Surface Water Impacts	Current quarry discharges to Sams Creek, therefore, use of quarry water would decrease flows.	--	2.0
Groundwater Impacts	Indirectly impacts GW since quarry withdrawals rely on groundwater discharge.	--	1.5
Wetland and Stream Impacts	Existing quarry. Impacts already incurred. Expect temporary wetland/stream impacts during pipeline construction.	--	3.0
Impacts to Current Land Use	Existing quarry. Impacts already incurred. Expect temporary land use impacts during pipeline construction.	--	3.0
Infrastructure Impacts	Unknown.	--	
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**1.8**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Need to obtain MDE appropriation permit.	--	2.0
Other Legal or Institutional Challenges	Delays expected to confirm adequate supply to meet 0.6 mgd needs. Develop agreement with quarry owner.	--	1.5
Relative Cost Estimate		***0.20***	**2.0**
Unit Capital Cost	$11.4/gallon is moderate relative to other options	--	2.0
Overall Performance		***1.00***	**1.9**

Alternative Q-3: Lehigh Quarry - New Windsor

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.8**
Safe Yield	Safe yield of 0.25 mgd meets the needs of New Windsor.	*0.40*	2.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.4**
Surface Water Impacts	Potential to release quarry water to nearby stream, to be withdrawn at WTP downstream.	--	2.0
Groundwater Impacts	Indirectly impacts GW since quarry withdrawals rely on groundwater discharge.	--	1.5
Wetland and Stream Impacts	Will be existing quarry at time of implementation. Impacts will have already been incurred.	--	3.0
Impacts to Current Land Use	Will be existing quarry at time of implementation. Impacts will have already been incurred.	--	3.0
Infrastructure Impacts	Unknown.	--	
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Need to obtain MDE appropriation permit. Approval required for release of quarry water to stream.	--	2.0
Other Legal or Institutional Challenges	Expect delays due to water quality testing of quarry discharge water.	--	2.0
Relative Cost Estimate		***0.20***	**1.5**
Unit Capital Cost	$18.5/gallon is high relative to other options	--	1.5
Overall Performance		***1.00***	**1.9**

MALCOLM PIRNIE

Alternative Q-4: Medford Quarry - Use as Permanent Supply

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.14 mgd does not meet the long-term needs of of Westminster.	*0.40*	1.0
Improved Reliability	Drought resilient and could decrease County's long-term reliance on GW	*0.20*	3.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	None expected.	--	3.0
Groundwater Impacts	Indirectly impacts GW since quarry withdrawals rely on groundwater discharge.	--	1.5
Wetland and Stream Impacts	Existing quarry and pipeline. Impacts already incurred.	--	3.0
Impacts to Current Land Use	Existing quarry and pipeline. Impacts already incurred.	--	3.0
Infrastructure Impacts	None expected. Pipeline already constructed for use of quarry as emergency supply.	--	3.0
Cultural and Historical Impacts	Unknown.	--	
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Obtain approval from MDE to change the conditions of existing appropriations permit.	--	2.0
Other Legal or Institutional Challenges	Unknown.	--	
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$5.0/gallon is low relative to other options	--	3.0
Overall Performance		***1.00***	**2.1**

Alternative I-1: Mount Airy Interconnection with Frederick County

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.7**
Safe Yield	Safe yield (purchase) of 0.85 mgd exceeds needs of Mount Airy	*0.40*	2.0
Improved Reliability	Drought resilient, but from water source controlled by Frederick County.	*0.20*	1.5
Potential as Regional Supply	Low potential.	*0.40*	1.5
Environmental Impacts		***0.20***	**2.8**
Surface Water Impacts	None known.	--	3.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Expect temporary wetland and stream impacts during pipeline construction.	--	2.5
Impacts to Current Land Use	Expect temporary land use impacts during pipeline construction.	--	2.5
Infrastructure Impacts	Unknown	--	
Cultural and Historical Impacts	Unknown	--	
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Potential for USACE/MDE permits for temporary wetland and stream impacts.	--	2.5
Other Legal or Institutional Challenges	Unknown outcome of negotiation (and fee structure) with Frederick County.	--	1.5
Relative Cost Estimate		***0.20***	**2.0**
Unit Capital Cost	$14.4/gallon is moderate relative to other options	--	2.0
Overall Performance		***1.00***	**2.0**

Alternative I-2: Interconnection with the York Water Company

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.7**
Safe Yield	Safe yield (purchase) of 0.90 mgd meets the long-term needs of Hampstead and Manchester.	*0.40*	1.5
Improved Reliability	Drought resilient, but from water source controlled by York Water Company.	*0.20*	1.5
Potential as Regional Supply	Low-Moderate potential.	*0.40*	2.0
Environmental Impacts		***0.20***	**2.8**
Surface Water Impacts	None known.	--	3.0
Groundwater Impacts	Decreases reliance on GW.	--	3.0
Wetland and Stream Impacts	Expect temporary wetland and stream impacts during pipeline construction.	--	2.5
Impacts to Current Land Use	Expect temporary land use impacts during pipeline construction.	--	2.5
Infrastructure Impacts	Unknown	--	
Cultural and Historical Impacts	Unknown	--	
Implementability		***0.20***	**1.8**
Opposition from Environmental Organizations	Unknown	--	
Potential Permitting Delays/Issues	Possible coordination with SRBC. Potential for permits for temporary wetland/stream impacts.	--	2.0
Other Legal or Institutional Challenges	Unknown outcome of negotiation (and fee structure) with York Water Company.	--	1.5
Relative Cost Estimate		***0.20***	**2.5**
Unit Capital Cost	$8.0/gallon is moderate relative to other options	--	2.5
Overall Performance		***1.00***	**2.1**

Alternative I-3: Freedom to Supply Mount Airy Using Existing Sources

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.8**
Safe Yield	Safe yield (purchase) of 0.75 mgd meets the needs of Mount Airy	*0.40*	1.5
Improved Reliability	Drought resilient, but from water source controlled by Freedom.	*0.20*	2.0
Potential as Regional Supply	Low-Moderate potential.	*0.40*	2.0
Environmental Impacts		***0.20***	**2.3**
Surface Water Impacts	More extensive drawdown in Liberty Reservoir is possible.	--	2.0
Groundwater Impacts	Decreases reliance on GW in Mount Airy but may increase dependence on groundwater in Freedom.	--	2.0
Wetland and Stream Impacts	Expect temporary wetland and stream impacts during pipeline construction.	--	2.5
Impacts to Current Land Use	Expect temporary land use impacts during pipeline construction.	--	2.5
Infrastructure Impacts	Unknown	--	
Cultural and Historical Impacts	Unknown	--	
Implementability		***0.20***	**1.5**
Opposition from Environmental Organizations		--	
Potential Permitting Delays/Issues		--	
Other Legal or Institutional Challenges	Unknown outcome of negotiation (and fee structure) with Freedom.	--	1.5
Relative Cost Estimate		***0.20***	**2.0**
Unit Capital Cost	$11.2/gallon is moderate relative to other options	--	2.0
Overall Performance		***1.00***	**1.9**

Alternative G-1: Hampstead Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.528 mgd meets needs of Hampstead	*0.40*	2.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**1.0**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Requires additional own and control area of +/- 891 acres for GW recharge.	--	1.0
Relative Cost Estimate		***0.20***	**2.5**
Unit Capital Cost	$6.26/gallon is low relative to other options, but GW cost estimates exclude land acquisition and storage.	--	2.5
Overall Performance		***1.00***	**1.8**

Alternative G-2: Mount Airy Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.364 mgd meets needs of Mount Airy	*0.40*	2.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**1.5**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Requires no additional own and control area for GW recharge, but some watersheds may not have sufficient recharge area.	--	2.0
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$4.52/gallon is very low relative to other options, but GW cost estimates exclude land acquisition and storage.	--	3.0
Overall Performance		***1.00***	**2.0**

Alternative G-3: New Windsor Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.198 mgd meets needs of New Windsor	*0.40*	2.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**1.5**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Requires additional own and control area of +/- 339 acres for GW recharge.	--	2.0
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$4.89/gallon is very low relative to other options, but GW cost estimates exclude land acquisition and storage.	--	3.0
Overall Performance		***1.00***	**2.0**

Alternative G-4: Taneytown Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 1.164 mgd meets needs of Taneytown	*0.40*	2.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**1.0**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Requires additional own and control area of +/- 2,750 acres for GW recharge.	--	1.0
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$4.49/gallon is very low relative to other options, but GW cost estimates exclude land acquisition and storage.	--	3.0
Overall Performance		***1.00***	**1.9**

Alternative G-5: Union Bridge Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.594 mgd meets needs of Union Bridge	*0.40*	2.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**1.0**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Requires additional own and control area of +/- 1,200 acres for GW recharge.	--	1.0
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$3.64/gallon is very low relative to other options, but GW cost estimates exclude land acquisition and storage.	--	3.0
Overall Performance		***1.00***	**1.9**

Alternative G-6: Westminster Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 1.176 mgd meets needs of Westminster	*0.40*	2.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Should require no additional own and control area for GW recharge.	--	3.0
Relative Cost Estimate		***0.20***	**3.0**
Unit Capital Cost	$3.43/gallon is very low relative to other options, but GW cost estimates exclude land acquisition and storage.	--	3.0
Overall Performance		***1.00***	**2.1**

Alternative G-7: Union Mills Area Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.563 mgd does not meet the long-term needs of Westminster	*0.40*	1.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	Alternative could serve as first phase of additional regional water supply serving northern half of County if Union Mills Reservoir is developed.	*0.40*	2.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Should require no additional own and control area for GW recharge.	--	3.0
Relative Cost Estimate		***0.20***	**1.5**
Unit Capital Cost	$21.20/gallon is high relative to other options, which includes pipeline costs. Cost estimate excludes land acquisition and storage.	--	1.5
Overall Performance		***1.00***	**1.8**

Alternative G-8: Manchester Wells

	Description	Weight	Rating
Water Supply Benefits		***0.40***	**1.4**
Safe Yield	Safe yield of 0.124 mgd meets needs of Manchester (deficit due to reduced well yields)	*0.40*	2.0
Improved Reliability	Continues County's high degree of reliance on GW.	*0.20*	1.0
Potential as Regional Supply	No potential.	*0.40*	1.0
Environmental Impacts		***0.20***	**2.7**
Surface Water Impacts	Expect very limited impacts to surface water.	--	3.0
Groundwater Impacts	Some degree of impacts is likely, however, proper well siting can mitigate such impacts.	--	2.0
Wetland and Stream Impacts	Expect very limited impacts to wetlands and streams.	--	3.0
Impacts to Current Land Use	Land use restrictions within wellhead protection areas.	--	2.0
Infrastructure Impacts	Impacts can be avoided through proper well siting.	--	3.0
Cultural and Historical Impacts	Impacts can be avoided through proper well siting.	--	3.0
Implementability		***0.20***	**2.0**
Opposition from Environmental Organizations	Unknown.	--	
Potential Permitting Delays/Issues	MDE GW appropriation procedures are very involved and could become even more stringent in the future.	--	1.0
Other Legal or Institutional Challenges	Should require no additional own and control area for GW recharge.	--	3.0
Relative Cost Estimate		***0.20***	**2.5**
Unit Capital Cost	$9.34/gallon is low relative to other options, but GW cost estimates exclude land acquisition and storage.	--	2.5
Overall Performance		***1.00***	**2.0**