DRAFT

Reservoir Replacement PER

Town of Boonsboro

Boonsboro, MD

2021.12.2

Project No. 14421-004

Table of Contents

List of Tables

List of Figures

Appendices

1 Introduction and Background

The Town of Boonsboro (the Town), located in the mountains of western Maryland is home to roughly 3,553 people. It has a rich history dating back to its inception in 1792. Currently, the Town continues to grow in size and population. The Town of Boonsboro and the neighboring Town of Keedysville, MD share a jointly owned, operated, and maintained water system. The Boonsboro portion of the water system consists of a well, a spring and well-fed water treatment facility, and a 1.5 million-gallon (MG) reservoir. The Keedysville system has its own spring-fed water treatment plant and elevated storage tank. The two systems are connected via the Keedysville Pump Station. Water can flow in both directions, but most of the water is pumped from Keedysville into Boonsboro.

1.1 Purpose of Project

The existing reservoir was built in 1954 and a new liner and cover was installed in 1989. However, the Town continues to deal with high system water loss. The Town performed metering tests at the existing reservoir which indicated that the reservoir may be one source of the Town's water loss. Due to the age of the existing reservoir, the possibility of leakage, and the need for redundancy in water storage, the Town is interested in pursuing options for replacement of the reservoir.

The following options are considered in this preliminary engineering report:

- A single AWWA D115 precast post-tensioned concrete structure with two 0.5 MG water storage basins
- Two 0.5 MG AWWA D110 prestressed concrete tanks
- Two 0.5 MG AWWA D103-19 bolted steel tanks
- A single 1.0 MG elevated tank
- Two concentric circular tanks (tank in a tank)

2 Existing Facilities

2.1 Location

The Town produces its own water at the James Beeler Water Treatment Plant – which is fed by the Warrenfeltz Spring and the Shafer Park well – and at Well No. 8. The Town also receives water from the neighboring Town of Keedysville. The two towns are connected via the Keedysville Pumping Station and a water main that runs between the towns along Shepherdstown Pike (State Route 34). Boonsboro has a 1.5 MG reservoir on Boonsboro Mountain Road and Keedysville has a 0.3 MG elevated tank for its water storage. Boonsboro's water distribution system can be found in **Figure 2.1.**

Figure 2.1 Boonsboro Water Distribution System

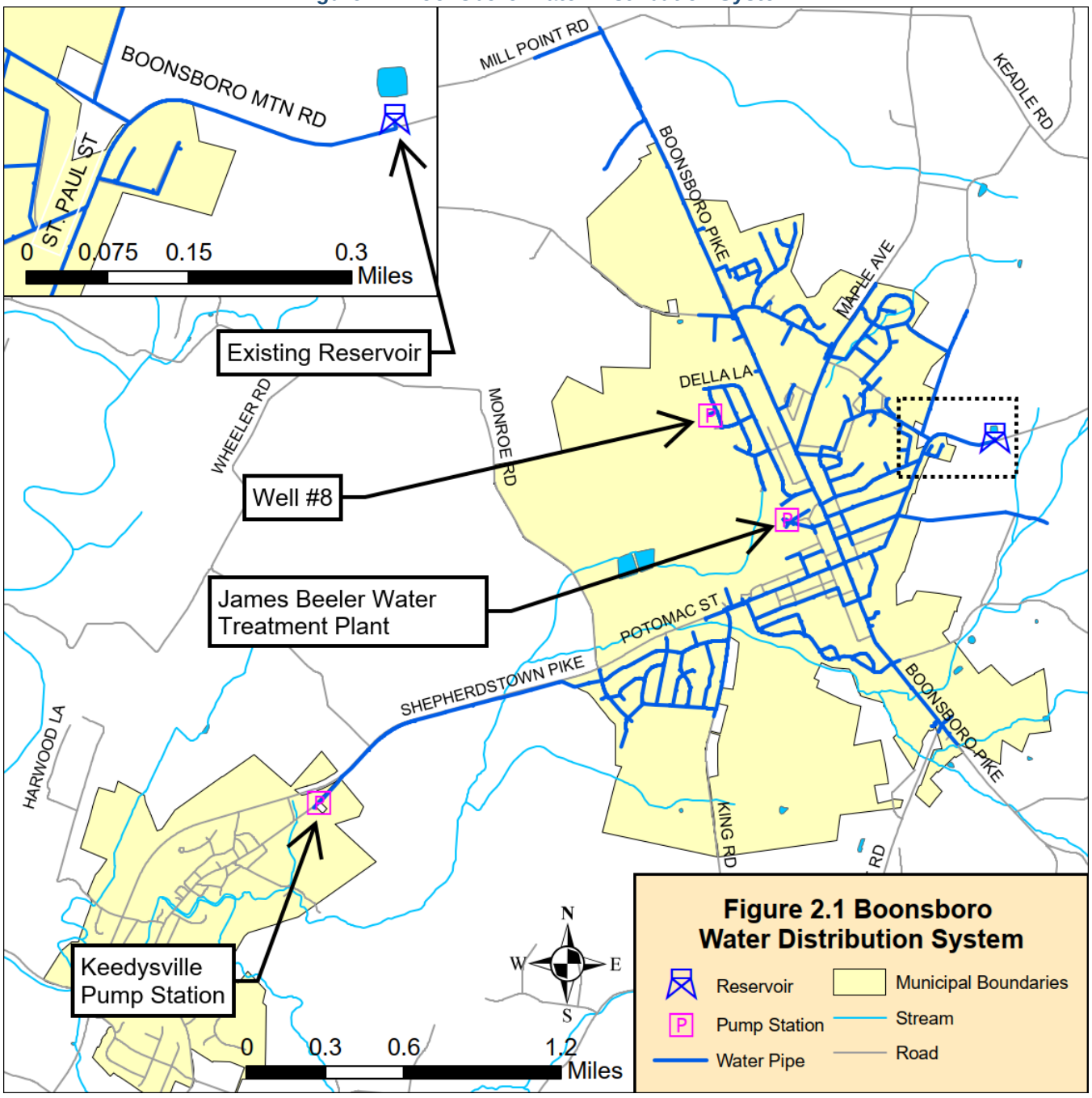
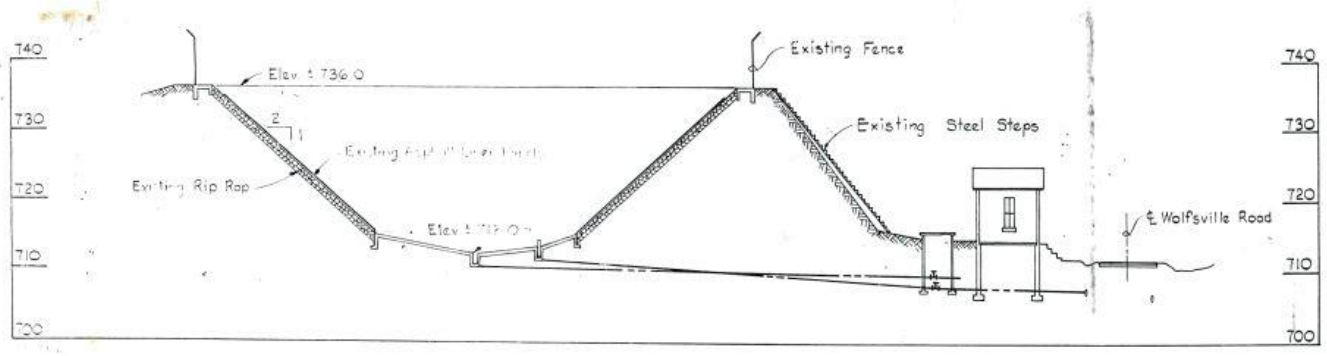


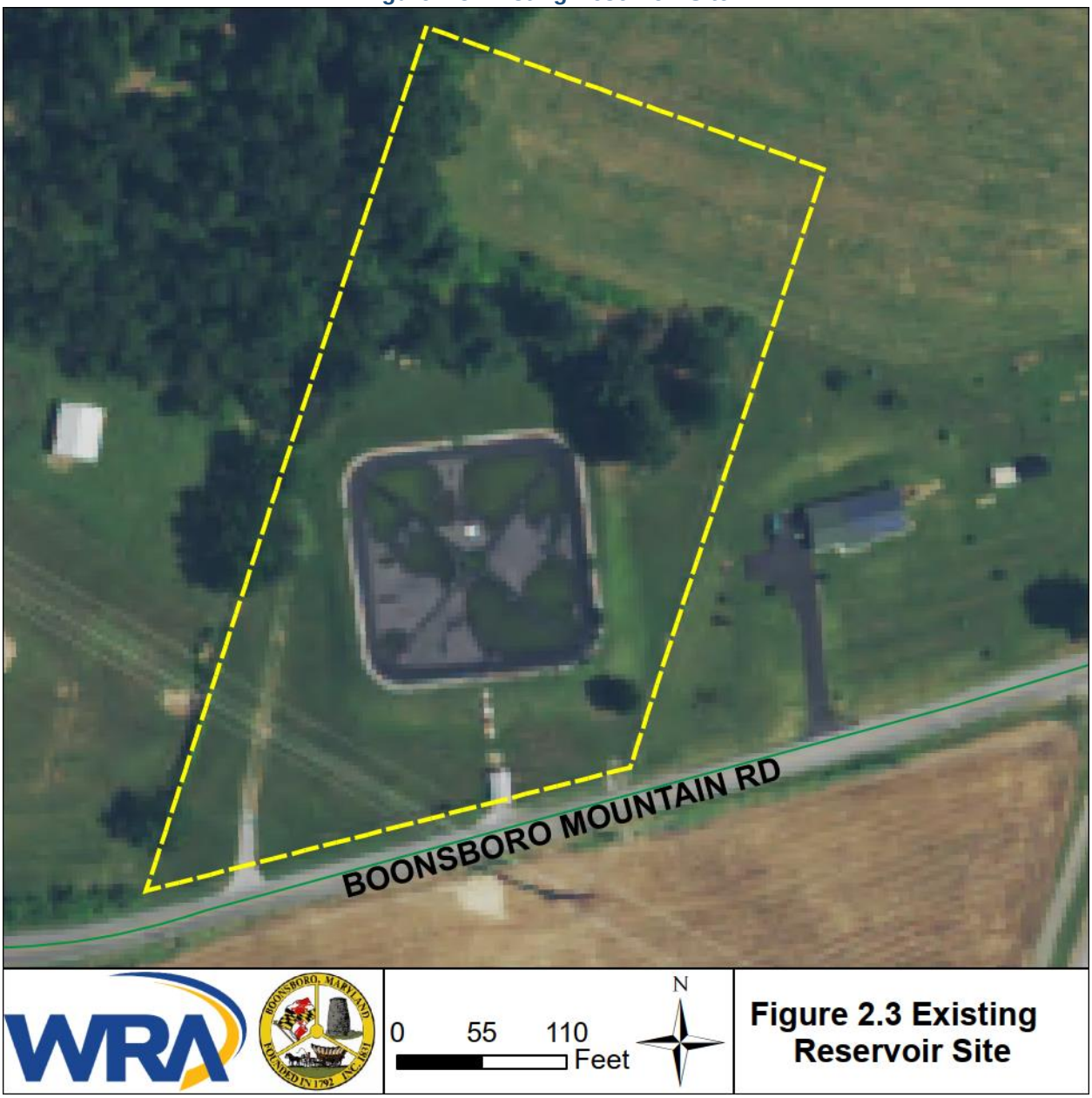
Figure 2.1 above shows a map of the Town's water distribution system. A water transmission main runs from the existing reservoir, west along Boonsboro Mountain Rd, and connects to the water distribution system at Mountain Laurel Rd and St. Paul St. The existing reservoir is an earthen dam structure with a base elevation of 712 feet (ft) and a top elevation of 736 ft. A section of the existing reservoir can be seen in **Figure 2.2.**

Figure 2.2 Existing Reservoir Section



The existing reservoir site is shown in **Figure 2.3**. The reservoir is situated in the middle of the site, with an overflow elevation of 736 ft. The south portion of the site is protected from construction activities due to overhead high voltage power lines. Boonsboro Mountain Rd runs along the south edge of the site and is at an elevation of approximately 712 ft. The north end of the site is cleared of trees and looks to be an ideal place for new construction. The north end of the site slopes from an elevation of 755 ft on the northwest corner to 735 ft on the northeast corner. Access to this part of the site will likely require the removal of trees.

Figure 2.3 Existing Reservoir Site



2.2 Condition of Existing Facilities

The 1.5 MG reservoir was initially constructed in 1954, with a major renovation completed in 1989. The 1989 renovation consisted of piping upgrades, construction of a new overflow structure, and installation of a new fabric liner and floating cover. More recently, The Town has been experiencing a loss of up to 30% of the water it produces. A portion of this loss has been attributed to a leak in the reservoir. The reservoir is tied into the water distribution system with a 12-inch ductile iron pipe which is more than 50 years old and will also be replaced as part of this project.

Boonsboro is in the mountains of western Maryland and has significant elevation changes throughout its water distribution system. Its existing reservoir operates at an average hydraulic grade line (HGL) of 731 ft. The lowest point in the system is at approximate elevation of 450 ft. This difference in elevation causes significant variance in

water pressure throughout the system; where the lower elevations see pressures as high as 163 PSI and the higher elevations see pressures as low as 7 PSI.

3 Project Planning

3.1 Environmental Resources Present

Figure 3.1 shows an overview of the environmental resources present near the proposed project area. The site is a part of the Upper Potomac River and Antietam Creek Watershed, with a Combined Index of Biotic Integrity of 2.58. The site also contains lands classified as significant and highly significant for biodiversity conservation (BioNet Tier 5 and 3).

3.1.1 Wetland Delineation

The existing reservoir is technically considered a Palustrine Unconsolidated Bottom (PUBKx) wetland. However, it is a serviceable facility and does not fall under the jurisdiction of Water of the U.S. or Waters of the State.

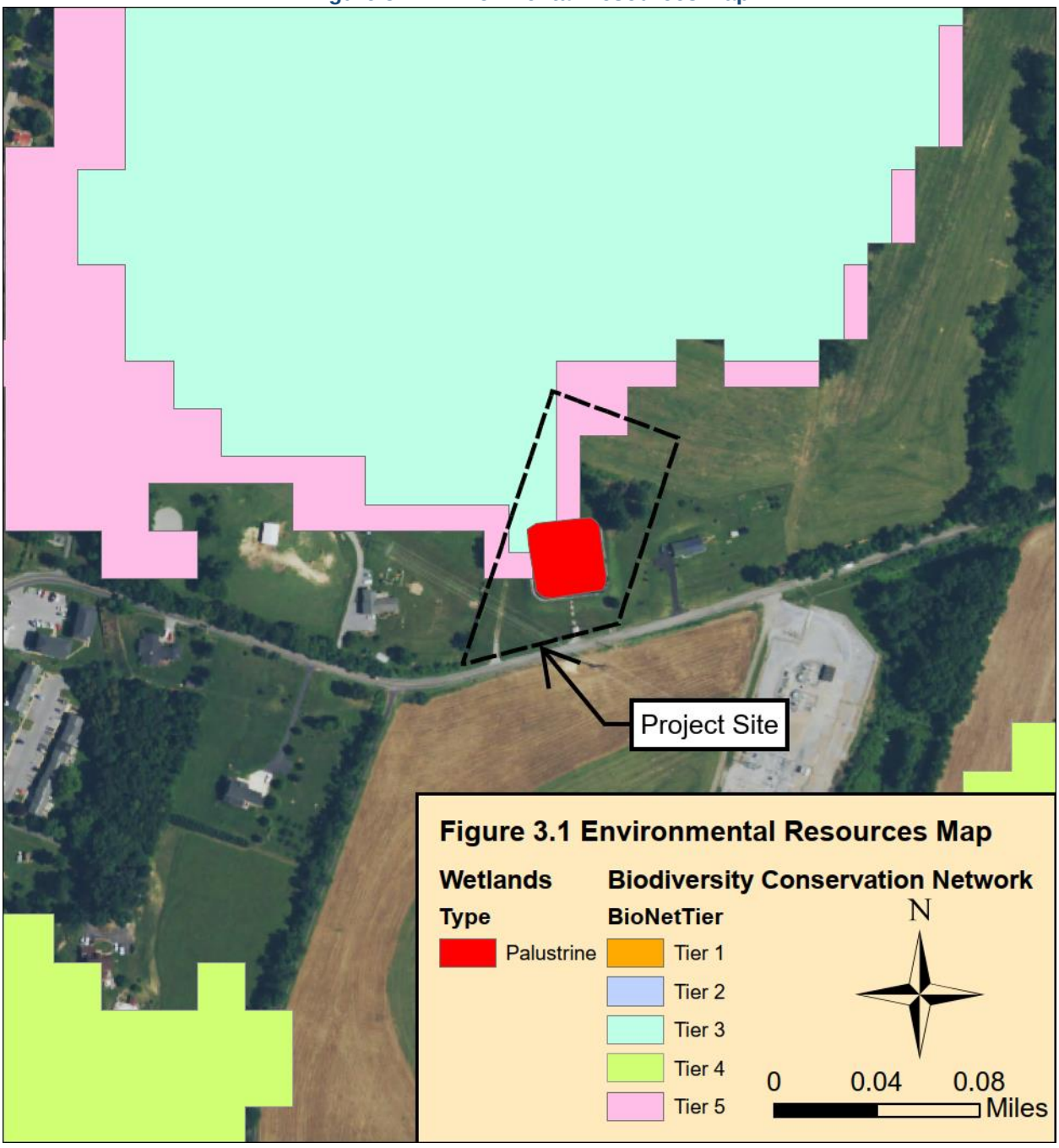
3.1.2 Critical Area Study

The site contains areas that are both significant and highly significant for biodiversity conservation based on the Maryland Department of Natural Resources' Biodiversity Conservation Network, which prioritizes lands based on the below ranking system:

Tier 1 – Critically Significant for Biodiversity Conservation
Tier 2 – Extremely Significant for Biodiversity Conservation
Tier 3 – Highly Significant for Biodiversity Conservation
Tier 4 – Moderately Significant for Biodiversity Conservation
Tier 5 – Significant for Biodiversity Conservation

These classifications, however, will not limit construction activities on the project site.

Figure 3.1 Environmental Resources Map



3.1.3 100 Year Floodplain

The nearest 100-year floodplain is from an unnamed tributary to Little Antietam Creek and is east of the project site. The project will not disturb the 100-year floodplain.

3.1.4 Endangered or Threatened Species

A preliminary search for endangered species was performed through the U.S. Fish and Wildlife Services (USFWS) Information for Planning and Consultation (IPAC) system. The search showed two endanger mammals

and one endangered insect. The Indiana Bat, the Northern Long-eared Bat, and the Monarch Butterfly may be found near the project site, but there are no critical habitats on the project site. A complete list of endangered species can be found in **Appendix 1**.

3.1.5 Migratory Bird Species

A preliminary search for migratory bird species was performed through the U.S. Fish and Wildlife Services (USFWS) Information for Planning and Consultation (IPAC) system. The search showed 10 bird species whose breeding season may impact site activities. The list and breeding season dates can be found **Table 3.1** below. Any impacts and time of year construction limitations (if applicable) will be coordinated with State and Federal regulators as part of the permitting process. A complete list of migratory birds can be found in **Appendix 1**.

Table 3.1 Breeding Seasons Migratory Bird Species

Bird Type	Breeding Season
Bald Eagle	September 1 – August 31
Black-Billed Cuckoo	May 15 – October 10
Black-capped Chickadee	April 10 – July 31
Bobolink	May 20 – July 31
Canada Warbler	May 20 – August 10
Cerulean Warbler	April 27 – July 20
Golden Eagle	N/A
Kentucky Warbler	April 20 – August 20
Red-headed Woodpecker	May 10 – September 10
Wood Thrush	May 10 – August 31

3.1.6 Historical Sites

Much of downtown Boonsboro is comprised of registered historic buildings, but the project site has no historic designations.

4 Need for Project

4.1 Redundant Storage

During construction of this project, the Town must continue to supply water to its customers. Previous hydraulic modelling has shown that water can be supplied when the existing reservoir is out of service but operating the system in this way puts unnecessary stress on the lower elevations of the water system. Due to this, the Town has expressed interest in redundant storage to perform routine maintenance in the future without loss of potable water storage. For this reason, WRA suggests projects where new storage can be constructed before the existing reservoir is taken offline and where redundant storage is provided via two storage tanks operating in parallel.

4.2 Aging Infrastructure

This project is considered necessary to fix the aging reservoir and distribution main. The Town has traced significant water loss back to the existing 1.5 MG reservoir but removing the reservoir from service requires significant coordination between the Towns of Boonsboro and Keedysville and leaves the Towns vulnerable to a fire event. Additional and redundant water storage will alleviate this issue and allow for routine maintenance while still providing emergency water storage.

4.3 Projected Growth

The service area of the Town of Boonsboro has seen moderate growth over the past 50 years, growing from 1,410 people in 1970 to 3,553 residents in in 2018. That number is projected to grow to 6,581 residents by the year 2050. The Town's most recent water master plan estimates a current necessary storage volume of 500,000 gallons of water and a necessary volume of 800,000 gallons in the year 2050. Total storage of 800,000 gallons is just over half of what is currently in service with the 1.5 MG reservoir. To accommodate these trends in growth, WRA recommends only installing 1.0 MG of water storage, rather than replacing the entire 1.5 MG reservoir.

5 Project Alternative Evaluations

There are multiple alternatives to replace the existing reservoir. The Town has requested that new storage options be built in duplicate, such that a portion of the total storage volume can be taken offline while the other is still able to serve the Town. The five different alternatives discussed in this report are as follows:

- One AWWA D115 precast post-tensioned concrete structure with two 0.5 MG water storage basins
- Two 0.5 MG AWWA D110 prestressed concrete tanks
- Two 0.5 MG AWWA D103-19 bolted steel Tanks
- A single 1.0 MG elevated tank
- Two concentric circular tanks (tank in a tank)

Each option was graded based on the criteria found in **Table 5.1**. Grading criteria were chosen based on the unique requirements of this project, and criteria weights were chosen based on each criterion's relative importance to the project. Each criterion was graded on a scale of one (1) to three (3) – one being the least desirable and three being the most desirable. The grades were then multiplied by the predetermined criteria weight and normalized to the number 10. The written equation can be found below. The sum of the weighted criteria was used as an objective measurement to determine how well each option matches project requirements.

- Weighted Criteria Points = (Assigned Grade) * (Percent Fraction for each subcategory) * 10/3

Table 5.1 Project Evaluation Criteria and Weights

Criteria	Description	Weight
Redundant Design	Tanks function independently of each other	0.10
Constructability	Ease of construction	0.10
Construction Costs	Cost of construction	0.10
O&M Access Difficulty	Accessibility for maintenance	0.10
O&M Lifetime Costs	Lifetime cost for operations and maintenance	0.20
Aesthetics	Visual Appeal	0.05
Impact to residents	Daily effect on residents' lives	0.15
Easement Acquisition	Additional private easements required	0.10
Environmental Impact	Impact to site and surrounding	0.10

The final score for each alternative was determined by summing the individual Weighted Criteria Points for each criterion. A maximum score of 10 was possible. Of the three alternatives analyzed in detail, the highest-ranking option was the two 0.5 MG prestressed concrete tanks with a score of 8.50. The second highest ranking option, the single prestressed concrete structure split into two 0.5 MG basins, scored 8.17 total points. The two 0.5 MG bolted steel tanks scored the lowest of the three main alternatives under consideration at 7.50 total points. A detailed discussion of the alternatives can be found in the following sections. **Table 6.1** found in **Section 6** shows the complete list of criteria rankings and the sum of total weighted criteria points.

5.1 Water Main Replacement

Running from the existing reservoir west along Boonsboro Mountain Road is roughly 1,400 linear feet (lf) of aging 12-inch water transmission main. The Town has requested that this water main be replaced as a part of the reservoir replacement project. The estimated cost for water main replacement is **$315,000**. A map of the Boonsboro Mountain Road transmission main can be found in **Figure 2.1**.

5.2 Alternatives Evaluation

5.2.1 1.0 Million Gallon Post-Tensioned Concrete Tank

Rectangular and Elliptical AWWA D115 precast post-tensioned concrete tanks are available for an array of water and wastewater functions, including potable water reservoirs. They are available in a variety of custom configurations. Dutchland, Inc. out of Gap, PA is a local supplier of these tanks.

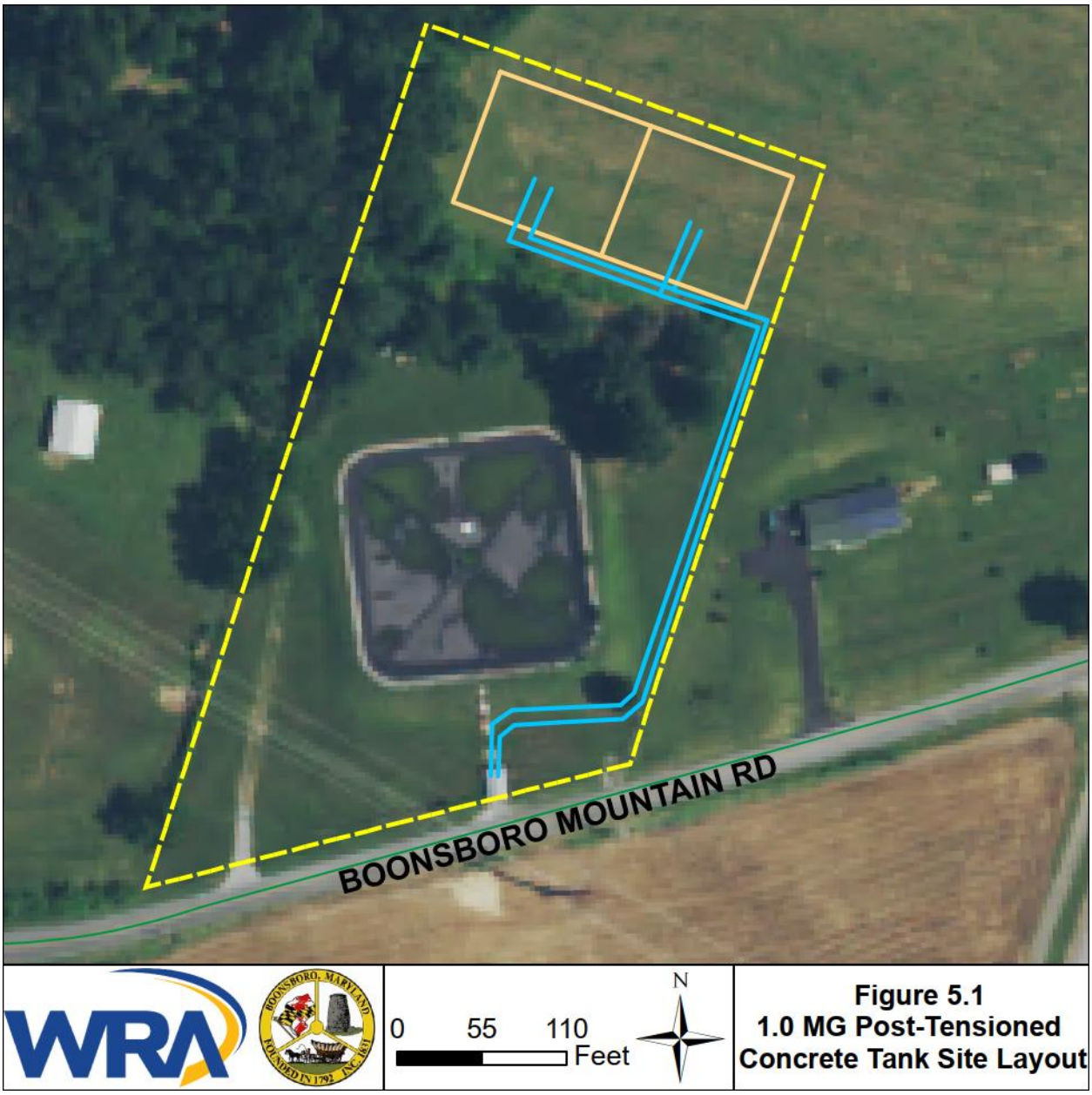
The 1.0 MG post-tensioned concrete tank consists of a single structure, divided in the middle to create two separate 500,000 gallon basins. An advantage to this orientation is it saves on construction costs as only one structure and one roof must be erected. This also provides two individual storage basins under the same roof, allowing the Town to take one basin offline, while still providing water from the second basin. If placed on the back of the existing site, the entire tank could be constructed and put in service before the existing reservoir is taken out of service. This would ensure that no lapse of service occurs. Post-tensioned concrete tanks do not need regular inspection and coating, allowing them to be be partially or completely buried. This saves on lifetime costs and gives the Town more freedom to set the base of the tank at an elevation which is optimal for hydraulic performance. **Table 5.2** breaks down each evaluation criterion of the AWWA D115 tank.

See **Figure 5.1** for a site plan showing the suggested location and piping configuration. The total cost of this option is estimated at **$3,356,000.** An entire cost breakdown for this option can be found in **Appendix 2**.

Table 5.2 Evaluated Project Criteria, Post-Tensioned Precast Concrete Tank

Criteria	Grade (1-3)	Weighted Grade	Rationale
Redundant Design	2	0.2	Multiple tanks and the ability to alternate operating tanks. Limited options for location on site, however.
Constructability	3	0.3	Construction process is typical.
Construction Costs	2	0.2	Construction costs are average for all options considered.
O&M Access Difficulty	3	0.3	Tank is easily accessible for maintenance.
O&M Lifetime Costs	3	0.6	Post-tensioned precast concrete requires very minimal lifetime maintenance.
Aesthetics	2	0.1	Site aesthetics are neutral compared to existing conditions.
Impact to residents	3	0.45	Tank construction can be completed without impact to residents' water supply.
Easement Acquisition	1	0.1	Project construction will likely require additional easements.
Environmental Impact	2	0.2	Construction will have a neutral impact to the surrounding environment.
Sum of Weighted Grades		2.45	
Total Adjusted Criteria Points		8.17	

Figure 5.1 Post-Tensioned Concrete Tank Site Layout



5.2.2 Two 0.5 Million Gallon Circular Concrete Tanks

Circular AWWA D110 prestressed concrete tanks are constructed utilizing a cylindrical concrete wall placed in permanent compression by wrapping the cylinder with high strength steel wire. The wire is then protected by sprayed-on concrete (“shotcrete”). Suppliers for this style of tank include DN Tanks and Preload, Inc.

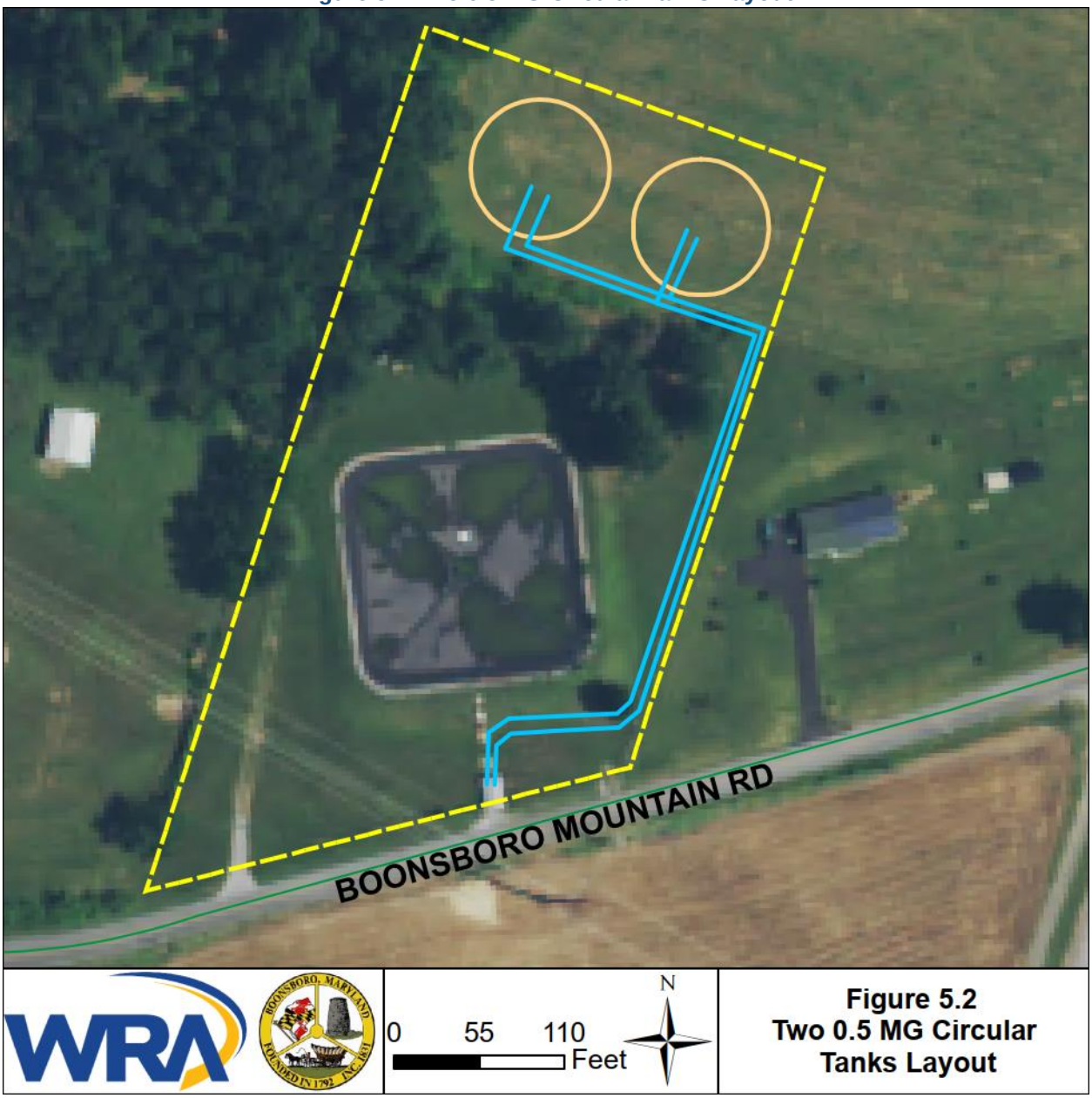
Two circular concrete tanks will be constructed separately and allow for flexibility in terms of construction timeline and location. Two general layout options exist when building the two individual tanks. The first option is constructing both tanks on the back of the existing site, then demolishing the existing reservoir. This initial site layout can be found in **Figure 5.2**. The second option will be further discussed in **Section 5.2.3**. Prestressed concrete tanks, like Post-tensioned concrete tanks do not require regular coatings and can be partially or completely buried. Again, this saves on lifetime costs and gives the Town more freedom to set the base of the tanks at an elevation which is optimal for hydraulic performance

Two 0.5 MG AWWA D110 prestressed concrete tanks are estimated to be **$2,881,000**. A complete cost breakdown can be found in **Appendix 2.** Ranked project criteria can be found in **Table 5.3** below.

Table 5.3 Evaluated Project Criteria, Prestressed Concrete tanks

Criteria	Grade (1-3)	Weighted Grade	Rationale
Redundant Design	3	0.3	Tanks are completely redundant and independent.
Constructability	3	0.3	Construction process is typical.
Construction Costs	2	0.2	Construction costs are average for all options considered.
O&M Access Difficulty	3	0.3	Tank is easily accessible for maintenance.
O&M Lifetime Costs	3	0.6	Prestressed concrete requires very minimal lifetime maintenance.
Aesthetics	2	0.1	Site aesthetics are neutral compared to existing conditions.
Impact to residents	3	0.45	Tank construction can be completed without impact to residents' water supply.
Easement Acquisition	1	0.1	Project construction will likely require additional easements.
Environmental Impact	2	0.2	Construction will have a neutral impact to the surrounding environment
Sum of Weighted Grades		2.55	
Total Adjusted Criteria Points		8.5	

Figure 5.2 Two 0.5 MG Circular Tanks Layout



5.2.3 Two 0.5 Million Gallon Circular Steel Tanks

Circular AWWA D103-19 factory-coated bolted carbon steel tanks are available in different sizes, heights, and roof types. Tank Connection, with local representation out of Rosemont, PA is a supplier of bolted steel tanks.

Two circular steel tanks will be constructed separately and allow for flexibility in terms of construction timeline and location. The second layout alternative for circular tanks is to first build one tank on the back of the existing site. Once constructed that tank can serve as the primary water tank for the Town, the existing reservoir can be demolished, and the second tank built for additional long-term storage. This option frees up site space, allowing greater freedom for placement of the second tank. An initial site layout for this option can be found in **Figure 5.3**. The layout options found in **Figures 5.2** and **5.3**, once complete, allow for either tank to be taken offline at any time, as the second tank can serve as a backup tank.

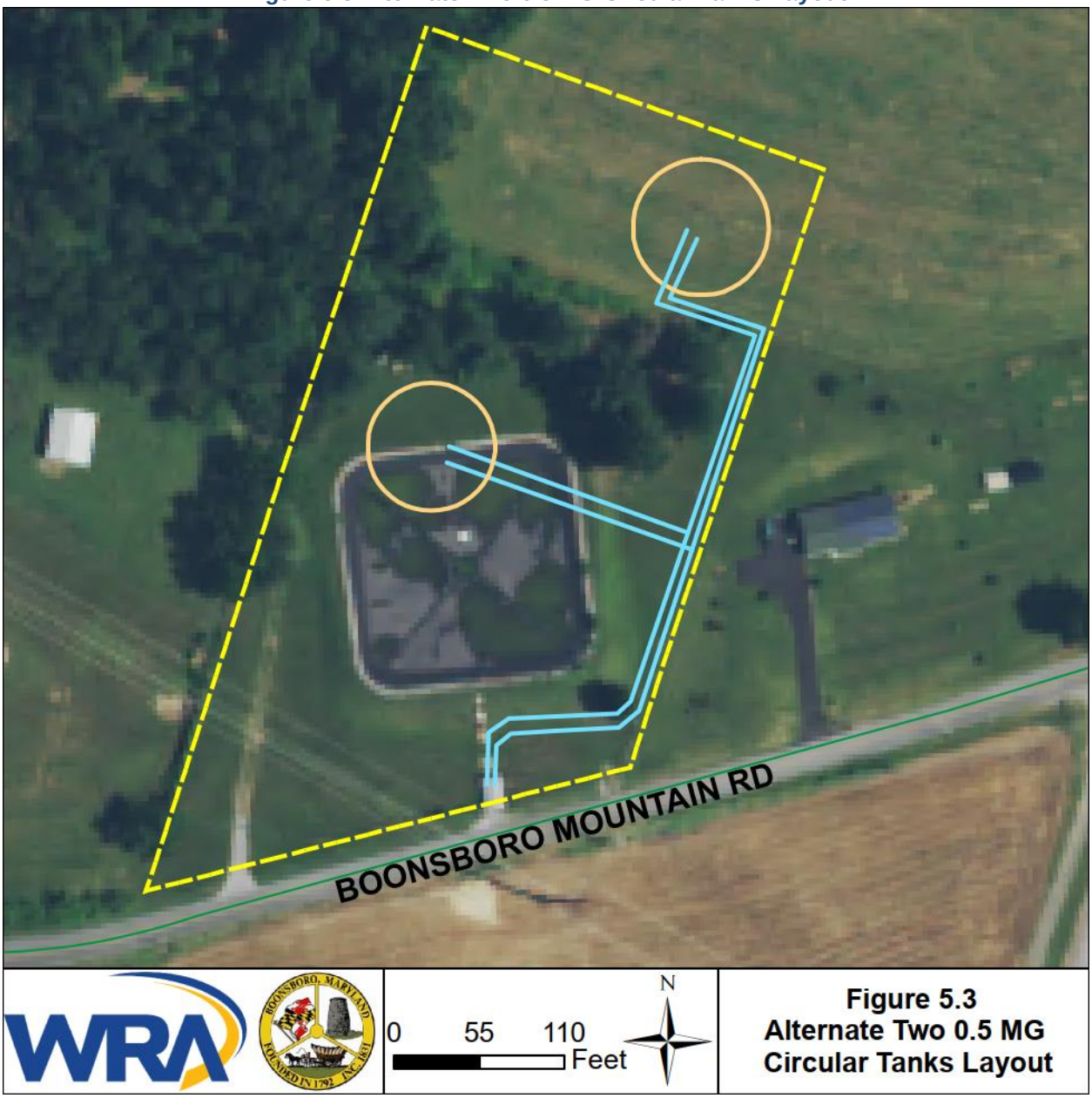
Steel tanks offer less expensive construction costs but require continued inspections and coating refurbishment throughout the lifespan of the tanks to prevent corrosion. These tanks must be constructed above ground, as well, limiting tank placement options.

Two 0.5 MG AWWA D1033 factory-coated bolted steel tanks are estimated to be **$1,909,000**. A complete cost breakdown can be found in **Appendix 2.** Ranked project criteria can be found in **Table 5.4 b**elow.

Table 5.4 Evaluated Project Criteria, Bolted Steel Tank

Criteria	Grade (1-3)	Weighted Grade	Rationale
Redundant Design	3	0.3	Tanks are completely redundant and independent.
Constructability	3	0.3	Construction process is typical.
Construction Costs	3	0.3	Construction costs are lower than any other alternative considered.
O&M Access Difficulty	3	0.3	Tank is easily accessible for maintenance.
O&M Lifetime Costs	1	0.2	Bolted steel tanks require inspections every 2-3 years, as well as coating touchups as necessary.
Aesthetics	2	0.1	Site aesthetics are neutral compared to existing conditions.
Impact to residents	3	0.45	Tank construction can be completed without impact to residents' water supply.
Easement Acquisition	1	0.1	Project construction will likely require additional easements.
Environmental Impact	2	0.2	Construction will have a neutral impact to the surrounding environment
Sum of Weighted Grades		2.25	
Total Adjusted Criteria Points		7.5	

Figure 5.3 Alternate Two 0.5 MG Circular Tanks Layout



5.2.4 Elevated Tank

The fourth alternative considered was construction of a 1.0 MG elevated spheroid storage tank at an alternate location in the system. Potential locations were evaluated based on available space and property ownership. The optimal sites were at the school complex and/or at Shafer Park. Elevations in these areas are approximately 580 ft and 510 ft, respectively. To maintain current operating levels, the resulting tanks would be at approximately 150 ft or 220 ft tall. Construction of a single 1.0 MG elevated tank will provide the Town with required long-term storage volume and replace the aging earthen dam infrastructure; however, a single tank does not meet the project objective of redundancy. Construction of two (2) 0.5 MG elevated storage tanks would be required to meet project objectives which could be cost prohibitive. In addition, construction of elevated tanks within the

Town may impact Town aesthetics. Construction of a 1.0 MG elevated tank would cost approximately **$4,300,000**. **Table 5.5** shows the ranked evaluation criteria for an elevated tank. Overall, the single elevated tank option does not meet all identified project criteria. Therefore, the project was not evaluated further.

Table 5.5 Evaluated Project Criteria, Elevated Tank

Criteria	Grade (1-3)	Weighted Grade	Rationale
Redundant Design	1	0.1	Tank is not redundant.
Constructability	1	0.1	More difficult construction process than any other alternative.
Construction Costs	1	0.1	Construction cost is the highest of any alternative considered.
O&M Access Difficulty	1	0.1	Tank maintenance must be completed 100+ feet in the air at the elevated tank.
O&M Lifetime Costs	1	0.2	Elevated steel tanks require regular inspections and coating touchups as necessary.
Aesthetics	2	0.1	Site aesthetics are neutral compared to existing conditions.
Impact to residents	3	0.45	Tank construction can be completed without impact to residents' water supply.
Easement Acquisition	3	0.3	Project construction can likely be completed without additional easements.
Environmental Impact	2	0.2	Construction will have a neutral impact to the surrounding environment
Sum of Weighted Grades		1.65	
Total Adjusted Criteria Points		5.5	

5.2.5 Circular Tanks – Concentric

Concentric circular tanks were considered as an alternative as two 0.5 MG spaces could be constructed on the existing reservoir site. Manufacturers recommended the "tank-in-a-tank" option as a less-expensive alternative to building a vertical structural wall within a circular tank. However, in depth evaluation was not completed, as the inner tank cannot be accessed for service without removing the outer tank from service. Concentric circular tanks would cost approximately **$4,100,000**. **Table 5.6** on the following page shows the ranked evaluation criteria for an elevated tank.

Table 5.6 Evaluated Project Criteria, Concentric Circular Tanks

Criteria	Grade (1-3)	Weighted Grade	Rationale
Redundant Design	1	0.1	Tanks can be operated redundantly but cannot be serviced redundantly.
Constructability	2	0.2	Construction is more complex than the other concrete tanks, but less complex than the elevated tanks.
Construction Costs	1	0.1	Construction costs are among the highest of any alternative considered.
O&M Access Difficulty	1	0.1	Tanks can be accessed, but the outer tank must be out of service in order to access the inner tank.
O&M Lifetime Costs	3	0.6	Prestressed concrete requires very minimal lifetime maintenance.
Aesthetics	2	0.1	Site aesthetics are neutral compared to existing conditions.
Impact to residents	3	0.45	Tank construction can be completed without impact to residents' water supply.
Easement Acquisition	1	0.1	Project construction will likely require additional easements.
Environmental Impact	2	0.2	Construction will have a neutral impact to the surrounding environment
Sum of Weighted Grades		1.95	
Total Adjusted Criteria Points		6.5	

5.3 Additional Considerations

Additional considerations assessed as part of the project alternative evaluation include system hydraulics and geotechnical considerations. System hydraulics must be considered, as new tank locations and elevations can cause the water distribution system to operate differently. In addition to hydraulics, the site's subsurface geotechnical characteristics must be accounted for to accurately design the foundations of the tanks.

5.3.1 System Hydraulics and Hydraulic Modelling

The Town's existing water model was used to evaluate the performance of the alternative tank options. Those evaluations were compared to the performance of the existing reservoir to ensure that the new alternatives will behave comparably to the existing reservoir.

The existing 1.5 MG reservoir sits at a base elevation of 712 ft with a maximum level of 736 ft. With the current arrangement, lower elevations in the water distribution system experience pressures as high as 163 PSI, and higher elevations experience pressures as low as 7 PSI. See **Table 5.7** below detailing the minimum and maximum pressures throughout the existing water system under maximum day demands (MDD), as well as the projected future water system.

Table 5.7 Existing Reservoir MDD Pressure Distributions

	Present (2020)		Future (2050)	
Junction Pressure Range	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)
Less Than 20 PSI	2	2	2	2
20-40 PSI	33	27	33	27
40-60 PSI	129	122	135	122
60-80 PSI	325	311	330	318
80-100 PSI	325	**334**	320	**333**
100-120 PSI	81	**97**	83	**100**
120+ PSI	11	13	11	12
Absolute Min./Max. Pressure	7.7	132.02	8.42	131.27

The pressure distributions in the above table were used as a baseline of comparison when evaluating the new tank alternatives. Maximum day demand scenarios were used to demonstrate the extreme high and low pressures of the water distribution system. Present and future conditions were used to ensure the tanks will function as designed as the Town continues to grow.

Concrete tank alternatives discussed in **Sections 5.2.1** and **5.2.2** were modelled together. This was done for two reasons. The first reason is that the tanks are in a similar location on the site. The second reason is that the concrete tanks can be buried, allowing for uniform base elevations. The alternatives were modeled in both present and future timesteps. The base elevation of each tank was modeled at 730 ft, with a maximum tank level of 748 ft. This represents a 22 ft maximum elevation gain from the existing reservoir. Each timestep was modelled with one 0.5 MG tank active and with both 0.5 MG tanks active. **Table 5.8** shows the system's pressure distribution when modeled with the above assumptions and present (2020) maximum day demands.

Table 5.8 Concrete Tank Pressure Distribution - Current

	Current Demands (2020)			
	Both Tanks Active		One Tank Active	
Junction Pressure Range	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)
Less Than 20 PSI	1	1	1	1
20-40 PSI	23	20	26	19
40-60 PSI	92	84	96	85
60-80 PSI	290	257	298	254
80-100 PSI	345	**358**	335	**358**
100-120 PSI	137	**160**	134	**163**
120+ PSI	20	28	16	26
Absolute Min./Max. Pressure	12.31	138.16	10.79	138.39

The concrete tank arrangement under current (2020) maximum day conditions results in slightly higher pressures throughout the distribution system. The system pressure distribution increases, with the number of nodes between a maximum 80 and 120 PSI growing from 431 to 518 when both tanks are active, and 521 when only one tank is active. The system maximum pressure also increases by 6 PSI with minimum pressures increasing by 3-5 PSI, depending on if one or two tanks are active.

Results are similar for concrete tanks under future maximum day demand conditions. **Table 5.9** below shows the pressure distributions in the projected future distribution system (2050) under maximum day demands.

Table 5.9 Concrete Tank Pressure Distribution - Future

	Future Demands (2050)			
	Both Tanks Active		One Tank Active	
Junction Pressure Range	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)
Less Than 20 PSI	1	1	1	1
20-40 PSI	25	20	26	19
40-60 PSI	93	85	106	86
60-80 PSI	301	260	304	254
80-100 PSI	340	**363**	351	**367**
100-120 PSI	136	**159**	112	**161**
120+ PSI	18	26	14	26
Absolute Min./Max. Pressure	11.31	137.51	10.26	137.96

The concrete tanks under future conditions experience a very similar pressure increase to the tanks under current conditions. With both tanks active, the number of nodes experiencing pressures between 80 and 120 PSI increases from 433 to 522. With one tank active, that number increases from 433 to 528. Maximum pressures throughout the system only increase by 6-7 PSI. Either of the concrete tank options discussed in **Sections 5.3.1** and **5.3.2** could adequately replace the existing reservoir with only a small impact to system hydraulics.

The alternative tank layout discussed in **Section 5.2.3** was modelled with both tanks at a base elevation of 740 ft. It was modelled this way to reflect the fact that steel tanks cannot be buried, and thus elevations are more dependent on existing surface conditions than concrete tanks. **Table 5.10** below shows the system's pressure distribution when modeled with the above assumptions and present maximum day demands.

Table 5.10 Steel Tank MDD Pressure Distribution - Current

	Current Demands (2020)			
	Both Tanks Active		One Tank Active	
Junction Pressure Range	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)
Less Than 20 PSI	1	0	1	0
20-40 PSI	18	5	19	5
40-60 PSI	80	64	80	64
60-80 PSI	227	196	226	195
80-100 PSI	368	357	369	355
100-120 PSI	185	226	184	229
120+ PSI	27	58	27	58
Absolute Min./Max. Pressure	17.46	144.62	17.28	144.7

The steel tanks under current maximum day conditions cause a much greater increase in pressure than the concrete tanks. The number of nodes experiencing 80-120 PSI under current MDD conditions increased from 431 with the existing reservoir to 583 with two steel tanks, and 584 with one steel tank. Nodes experiencing more than

120 PSI increased from 13 to 58 in both scenarios, and the maximum system pressure increased nearly 12 PSI from 132 PSI to 144 PSI.

Table 5.11 below shows the effect of the steel tanks on pressure distributions in the projected future distribution system (2050) under maximum day demands.

Table 5.11 Steel Tank MDD Pressure Distribution - Future

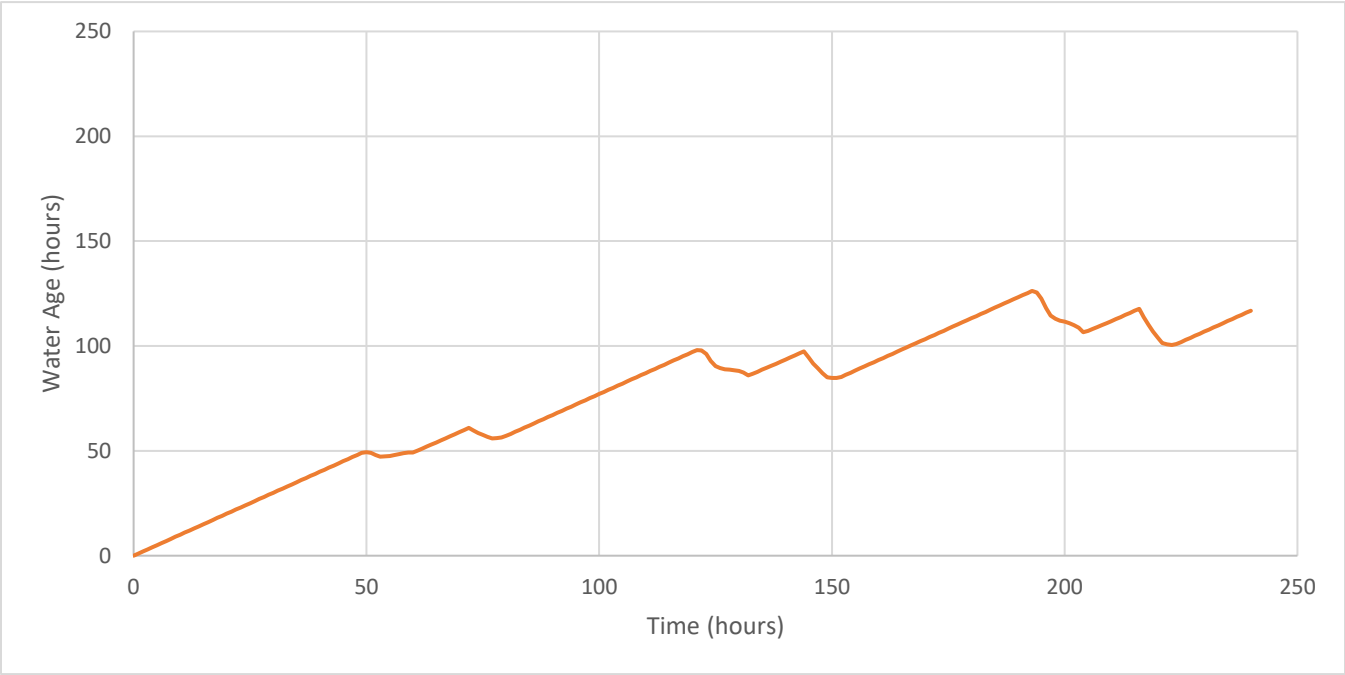
	Future Demands (2050)			
	Both Tanks Active		One Tank Active	
Junction Pressure Range	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)	Minimum Pressure (No. of Nodes)	Maximum Pressure (No. of Nodes)
Less Than 20 PSI	1	1	1	1
20-40 PSI	19	11	21	8
40-60 PSI	86	78	85	76
60-80 PSI	249	207	270	204
80-100 PSI	367	380	357	388
100-120 PSI	166	202	156	202
120+ PSI	26	35	24	35
Absolute Min./Max. Pressure	15.95	141.67	17.28	142.15

With the steel tanks are under future maximum day demand conditions, the water system experiences less extreme pressure increases than it did with the steel tanks under current MDD, but more extreme increases than any of the concrete tank simulations. The number of nodes with pressures ranging from 80-120 PSI increased from 433 with the existing reservoir active to 582 with two active steel tanks, and 590 with only one active steel tank. Maximum system pressures increased 11 PSI to 142 PSI from the already high 131 PSI it experiences with the existing reservoir. Hydraulically, the Town's water system can function with the steel tanks; however, he steel tanks amplify the Town's existing high-pressure issues.

Tank levels were analyzed with both tanks active under future maximum day conditions. These conditions were used to provide the most conservative estimate of tank performance. Tank levels were used to determine if both the total 1.0 MG of storage volume is adequate to serve the Town during future maximum day demands and if the water supply system is adequate to maintain tank levels at a higher elevation than the existing tank. The model determined that the water storage is adequate to serve the Town. It also confirmed the recommendation for more water supply to in the Town's 2020 Master Plan.

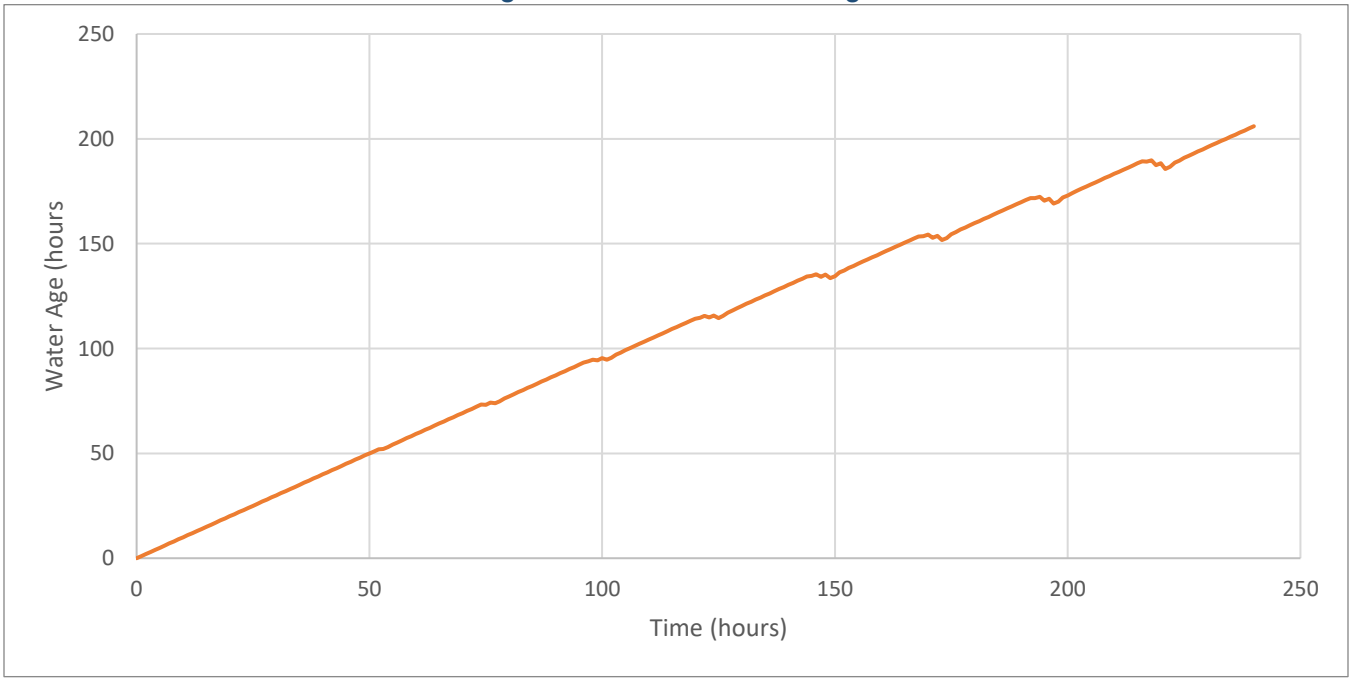
Water age in a water distribution system is used as a measure of water quality, where the maximum recommended water age is 5 days (120 Hours) old. The system's water age was analyzed with one tank active and two tanks active under current (2020) average day demands. Water age was analyzed under these conditions to provide the most conservative representation of water age, as these are the lowest demand conditions in the Town's existing model. **Figures 5.4** and **5.5** show the water age over a 10 day simulation with one tank active and both tanks active, respectively. Each of the alternatives discussed in **Sections 5.3.1**, **5.3.2**, and **5.3.3** have tanks of the same size, so water age is assumed to be consistent across all three alternatives.

Figure 5.4 Single Tank Water Age



Under current average day conditions, a single 0.5 MG tank maintains a maximum water age of 126 hours – or 5.08 days. One 0.5 MG tank is able to provide water to the 2020 average day demand system model, while keeping the stored water at an adequate water age. Below, **Figure 5.5** shows the tank water age when both new tanks in the system are active.

Figure 5.5 Dual Tank Water Age



In the 240-hour (10-day) simulation run to analyze the dual tank water age, water age peaks at 211 hours, with the age trendline still moving upward. Two 0.5 MG tanks can provide water to the water distribution system under

2020 ADD conditions, but the water age is above the recommended age. However, this is comparable to water age with the existing reservoir.

The water model was used to confirm the viability of WRA's recommended tank alternatives. The model ultimately confirmed that two 0.5 MG water tanks are adequate water storage alternatives for the Town.

5.3.2 Geotechnical Preliminary Recommendations

At the time of this report, a geotechnical investigation has not been performed.

A review of the geologic setting indicated that shallow rock is a potential concern at the project site. According to reviewed geologic maps, the project area is underlain by the Antietam Formation which has an upper stratum consisting of granular sandstone conglomerate and quartzite. The sandstone conglomerate or residual soils might not extend significantly below ground surface until top of bedrock is encountered.

Based on the anticipated subsurface conditions, the anticipated foundation type for the proposed water tanks is a spread foundation bearing on dense soil or bedrock. If structural loading requirements require uplift or overturning resistance, a mat foundation supported by short piles or rock anchors may be required.

A subsurface investigation performed at the project site will shed light on the soil and rock (or lack thereof) conditions and will facilitate further design of the tanks' foundation.

All three alternatives presented contain piping configurations that run adjacent to the southeastern corner of earthen dam. During construction, special attention should be paid to pipe work operations in order to avoid impacts to the dam that could result in breaching the in-service reservoir. Techniques such as: setting the pipes at a minimum burial depth, limiting the length of open trenches, requiring dewatering well points along the toe of the dam, or lowering the reservoir depth are potential means of protecting the reservoir.

6 Recommendations

The recommendation matrix in **Table 6.1** on the following page recognizes the two 0.5 MG prestressed concrete tanks as the highest ranked alternative for the Town based on the project criteria. The higher ranking as comparted the other two alternatives analyzed in depth is based on two primary reasons.

1. This alternative scored a higher redundancy score than the 1.0 MG multi-basin prestressed concrete tank as two separate tanks allow for more freedom during the design and construction phases than a single structure allows.

2. The two 0.5 MG prestressed concrete tanks scored higher than the two 0.5 MG steel tanks in the O&M Lifetime Costs category. The prestressed concrete tanks require minimal lifetime maintenance compared to the steel tanks, which require the tanks to drained and inspected at least once every three years and require coating touchup to ensure structural integrity.

Based on WRA's review, two 0.5 MG circular prestressed concrete tanks are the most economical and long-lasting option to replace the Town's existing reservoir. The estimated construction cost for tank construction is approximately $2,881,000. The estimated construction cost for pipeline replacement is approximately $315,000 resulting is a total estimated project cost of **$3,196,000**.

Table 6-1 Evaluation Matrix

	Redundant Design	Constructability	Cost of Construction	O&M Access Difficulty	O&M Lifetime Costs	Aesthetics	Impact to residents	Easement Acquisition	Environmental Impact	
	10%	10%	10%	10%	20%	5%	15%	10%	10%	
Description	Assigned Rank (1=Least Favorable, 3=Most Favorable)									
1.0 MG Split Tank	2	3	2	3	3	2	3	1	2	
Two 0.5 MG Concrete	3	3	2	3	3	2	3	1	2	
Two 0.5 MG Steel	3	3	3	3	1	2	3	1	2	
Elevated Tank	1	1	1	1	1	2	3	3	2	
Concentric Circular Tank	1	2	1	1	3	2	3	1	2	
Description	Weighted Criteria Points									Total (Max. 10)
1.0 MG Split Tank	0.67	1.00	0.67	1.00	2.00	0.33	1.50	0.33	0.67	8.17
Two 0.5 MG Concrete	1.00	1.00	0.67	1.00	2.00	0.33	1.50	0.33	0.67	8.50
Two 0.5 MG Steel	1.00	1.00	1.00	1.00	0.67	0.33	1.50	0.33	0.67	7.50
Elevated Tank	0.33	0.33	0.33	0.33	0.67	0.33	1.50	1.00	0.67	5.50
Concentric Circular Tank	0.33	0.67	0.33	0.33	2.00	0.33	1.50	0.33	0.67	6.50

Appendix 1
Endangered and Migratory Species

IPaC **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Washington County, Maryland

Local office

Chesapeake Bay Ecological Services Field Office

(410) 573-4599
(410) 266-9127

177 Admiral Cochrane Drive
Annapolis, MD 21401-7307

http://www.fws.gov/chesapeakebay/
http://www.fws.gov/chesapeakebay/endsppweb/ProjectReview/Index.html

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Indiana Bat Myotis sodalis Wherever found There is **final** critical habitat for this species. The location of the critical habitat is not available. http://ecos.fws.gov/ecp/species/5949	Endangered
Northern Long-eared Bat Myotis septentrionalis Wherever found This species only needs to be considered if the following condition applies: • Projects with a federal nexus that have tree clearing = to or > 15 acres: 1. REQUEST A SPECIES LIST 2. NEXT STEP: EVALUATE DETERMINATION KEYS 3. SELECT EVALUATE under the Northern Long-Eared Bat (NLEB) Consultation and 4(d) Rule Consistency key No critical habitat has been designated for this species. http://ecos.fws.gov/ecp/species/9045	Threatened

Insects

NAME	STATUS

Monarch Butterfly Danaus plexippus — Candidate

Wherever found

This species only needs to be considered if the following condition applies:

- The monarch is a candidate species and not yet listed or proposed for listing. There are generally no section 7 requirements for candidate species (FAQ found here: https://www.fws.gov/savethemonarch/FAQ-Section7.html).

No critical habitat has been designated for this species.
http://ecos.fws.gov/ecp/species/9743

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php

- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)

Bald Eagle Haliaeetus leucocephalus — Breeds Sep 1 to Aug 31
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
http://ecos.fws.gov/ecp/species/1626

Black-billed Cuckoo Coccyzus erythropthalmus — Breeds May 15 to Oct 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
http://ecos.fws.gov/ecp/species/9399

Black-capped Chickadee Poecile atricapillus practicus — Breeds Apr 10 to Jul 31
This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA

Bobolink Dolichonyx oryzivorus — Breeds May 20 to Jul 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Canada Warbler Cardellina canadensis — Breeds May 20 to Aug 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Cerulean Warbler Dendroica cerulea — Breeds Apr 27 to Jul 20
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.
http://ecos.fws.gov/ecp/species/2974

Golden Eagle Aquila chrysaetos — Breeds elsewhere
This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.
http://ecos.fws.gov/ecp/species/1680

Kentucky Warbler Oporornis formosus — Breeds Apr 20 to Aug 20
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Red-headed Woodpecker Melanerpes erythrocephalus — Breeds May 10 to Sep 10
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Wood Thrush Hylocichla mustelina — Breeds May 10 to Aug 31
This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is

the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

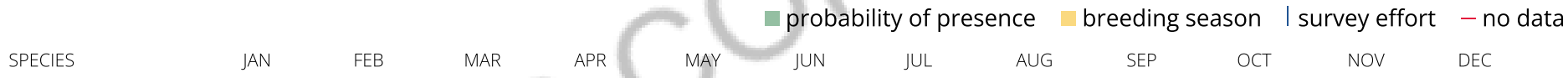
Breeding Season (▪)
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

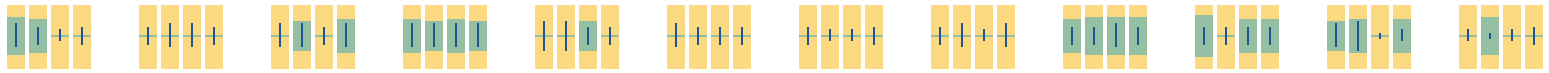
To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

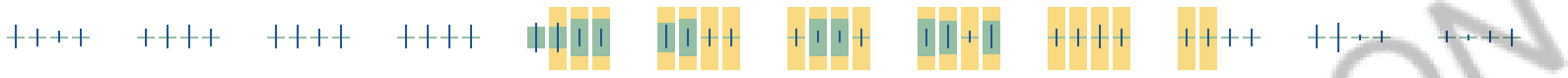
Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.



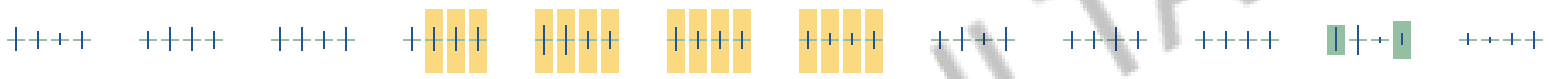
Bald Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



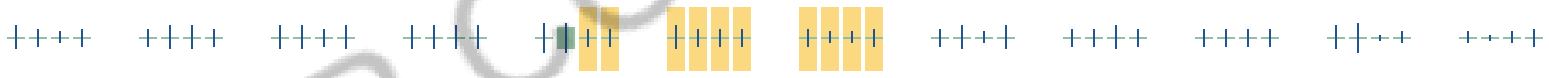
Black-billed Cuckoo
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



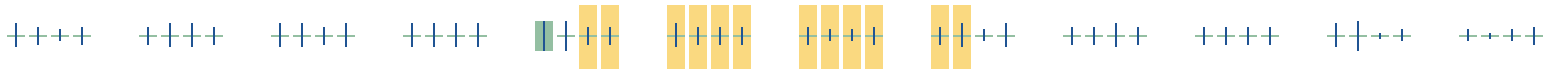
Black-capped Chickadee
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



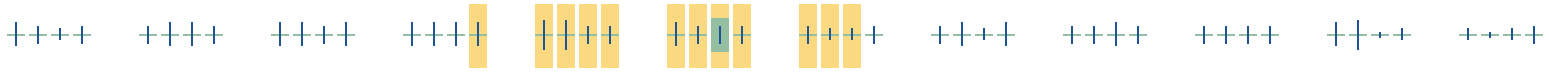
Bobolink
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Canada Warbler
BCC Rangewide (CON)
(This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

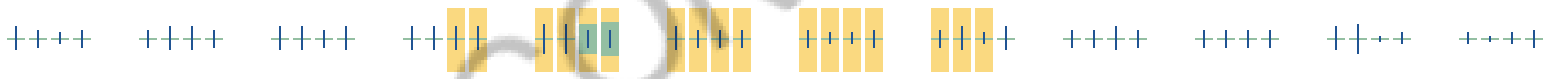


Cerulean Warbler
BCC Rangewide (CON)
(This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

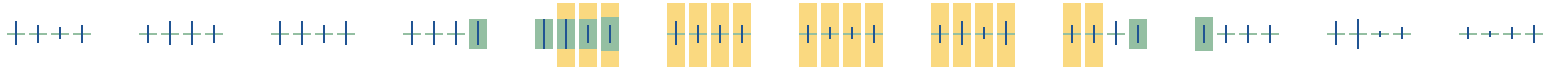


Golden Eagle
Non-BCC Vulnerable
(This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)

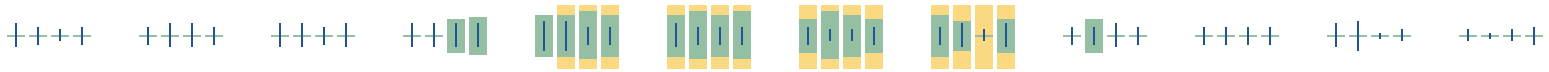
Kentucky Warbler
BCC Rangewide (CON)
(This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Red-headed Woodpecker BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Wood Thrush BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

Wildlife refuges and fish hatcheries

REFUGE AND FISH HATCHERY INFORMATION IS NOT AVAILABLE AT THIS TIME

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

This location overlaps the following wetlands:

FRESHWATER POND

PUBHh

A full description for each wetland code can be found at the National Wetlands Inventory website

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix 2
Cost Estimate

DETAILED COST: BASE BID, DIVISION 01 - GENERAL REQUIREMENTS

PROJECT NAME: **Drinking Water Reservoir Replacement**
CLIENT: Town of Boonsboro
ESTIMATED BY: JRL
PROJECT LOCATION: **Boonsboro, MD**
DESIGN SUBMISSION: Preliminary
WORK ORDER NUMBER: 14421.004

SOURCE	ITEM DESCRIPTION	QUANTITY	UNIT OF MEASURE	UNIT COSTS			TOTAL COSTS			TOTAL
				MATERIAL	LABOR	EQUIPMENT	MATERIAL	LABOR	EQUIPMENT	
	Sitework - Used with Options 1 - 5									
	DEMOLITION									
Costworks	Initial Grading (Excavation+Hauling)	6100	CY	$ -	$ 4.58	$ 7.92	$ -	$ 27,938	$ 48,312	$ 76,250
"	Existing Reservoir Demo	1010	CY	$ -	$ 26.50	$ 5.95	$ -	$ 26,765	$ 6,010	$ 32,775
"	Existing Reservoir Backfill	12788	CY	$ -	$ 0.57	$ 1.53	$ -	$ 7,289	$ 19,566	$ 26,855
				$ -	$ -	$ -	$ -	$ -	$ -	$ -
	NEW WORK									
Recent projects	Site Piping (12" DIP)	1500	LF	$ 135.00	$ 15.00	$ 5.00	$ 202,500	$ 22,500	$ 7,500	$ 232,500
Costworks	Fencing	2400	LF	$ 15.50	$ 3.26	$ -	$ 37,200	$ 7,824	$ -	$ 45,024
"	Altitude Valve + Vault	2	LS	$ 25,000.00	$ -	$ -	$ 50,000	$ -	$ -	$ 50,000
Recent projects	Transmission Main Pipe Replacement (12" DIP)	1400	LF	$ 135.00	$ 15.00	$ 5.00	$ 189,000	$ 21,000	$ 7,000	$ 217,000
	SUBTOTAL DIRECT COSTS						$ 478,700	$ 113,316	$ 88,387	$ 680,403
	SUBCONTRACTOR MARKUP	20%					$ 95,740	$ 22,663	$ 17,677	$ 136,081
	SUBTOTAL						$ 574,440	$ 135,979	$ 106,065	$ 816,484
	PRIME CONTRACTOR MARKUP	20%					$ 114,888	$ 27,196	$ 21,213	$ 163,297
	BASE COSTS						**$ 689,328**	**$ 163,175**	**$ 127,277**	**$ 979,781**
	Option 1 - Post-Tensioned Concrete Tank									
	NEW WORK									
Dutchland	One 1,000,000 Gal, Multi-Basin Rectangular Tank	1	LS	$ 1,650,000.00	$ -	$ -	$ 1,650,000	$ -	$ -	$ 1,650,000
	SUBTOTAL DIRECT COSTS						$ 2,128,700	$ 113,316	$ 88,387	$ 2,330,403
	SUBCONTRACTOR MARKUP	20%					$ 425,740	$ 22,663	$ 17,677	$ 466,081
	SUBTOTAL						$ 2,554,440	$ 135,979	$ 106,065	$ 2,796,484
	PRIME CONTRACTOR MARKUP	20%					$ 510,888	$ 27,196	$ 21,213	$ 559,297
	TOTAL COSTS - RECTANGULAR TANK						**$ 3,065,328**	**$ 163,175**	**$ 127,277**	**$ 3,355,781**
	Option 2 - D110 Prestressed Concrete Tanks, 2-500K Gallon Tanks									
	NEW WORK									
DN Tanks	Two 500,000 Gal Circular Tanks (concrete wire-wrapped)	2	EA	$ 660,000.00	$ -	$ -	$ 1,320,000	$ -	$ -	$ 1,320,000
	SUBTOTAL DIRECT COSTS						$ 1,798,700	$ 113,316	$ 88,387	$ 2,000,403
	SUBCONTRACTOR MARKUP	20%					$ 359,740	$ 22,663	$ 17,677	$ 400,081
	SUBTOTAL						$ 2,158,440	$ 135,979	$ 106,065	$ 2,400,484
	PRIME CONTRACTOR MARKUP	20%					$ 431,688	$ 27,196	$ 21,213	$ 480,097
	TOTAL COSTS - 500,000 GAL CIRCULAR TANKS						**$ 2,590,128**	**$ 163,175**	**$ 127,277**	**$ 2,880,581**
	Option 3 - D103 Bolted Steel Tank - 2-500K Gallon Tanks									
	NEW WORK									
Tank Connection	Two 500,000 Gal Circular Tanks (bolted steel)	1	LS	$ 600,000.00	$ -	$ -	$ 600,000	$ -	$ -	$ 600,000
RS Means	Concrete Foundation	150	CY	$ 300.00	$ -	$ -	$ 45,000	$ -	$ -	$ 45,000
	SUBTOTAL DIRECT COSTS						$ 1,123,700	$ 113,316	$ 88,387	$ 1,325,403
	SUBCONTRACTOR MARKUP	20%					$ 224,740	$ 22,663	$ 17,677	$ 265,081
	SUBTOTAL						$ 1,348,440	$ 135,979	$ 106,065	$ 1,590,484
	PRIME CONTRACTOR MARKUP	20%					$ 269,688	$ 27,196	$ 21,213	$ 318,097
	TOTAL COSTS - 500,000 GAL CIRCULAR TANKS (STEEL)						**$ 1,618,128**	**$ 163,175**	**$ 127,277**	**$ 1,908,581**
	Option 4 - D100 Steel Spheroid Tank									
	NEW WORK									
CBI/McDermott	1,000,000 Elevated Tank	1	LS	$ 2,900,000.00	$ -	$ -	$ 2,900,000	$ -	$ -	$ 2,900,000
	SUBTOTAL DIRECT COSTS						$ 3,378,700	$ 113,316	$ 88,387	$ 3,580,403
	SUBCONTRACTOR MARKUP	20%					$ 675,740	$ 22,663	$ 17,677	$ 716,081
	SUBTOTAL						$ 4,054,440	$ 135,979	$ 106,065	$ 4,296,484
	PRIME CONTRACTOR MARKUP	0%					$ -	$ -	$ -	$ -
	TOTAL COSTS - 1,000,000 ELEVATED TANK						**$ 4,054,440**	**$ 135,979**	**$ 106,065**	**$ 4,296,484**
	Option 5 - D110 Prestressed Concrete Tank - Tank in a Tank									
	NEW WORK									
DN Tanks	750,000 Gal Circular Tank (concrete wire-wrapped)	750000	Gal	$ 1.70	$ -	$ -	$ 1,275,000	$ -	$ -	$ 1,275,000
DN Tanks	250,000 Gal Circular Tank (concrete wire-wrapped)	250000	Gal	$ 3.50	$ -	$ -	$ 875,000	$ -	$ -	$ 875,000
	SUBTOTAL DIRECT COSTS						$ 2,628,700	$ 113,316	$ 88,387	$ 2,830,403
	SUBCONTRACTOR MARKUP	20%					$ 525,740	$ 22,663	$ 17,677	$ 566,081
	SUBTOTAL						$ 3,154,440	$ 135,979	$ 106,065	$ 3,396,484
	PRIME CONTRACTOR MARKUP	20%					$ 630,888	$ 27,196	$ 21,213	$ 679,297
	TOTAL COSTS - 750,000 & 225,000 CIRCULAR TANKS						**$ 3,785,328**	**$ 163,175**	**$ 127,277**	**$ 4,075,781**