4.0 ALTERNATIVES ANALYSIS

4.1 Summary of Alternatives

JRWA has prepared this Alternatives Analysis to comply with 33 CFR § 325.1(e), 33 CFR § 230.10(b), and 40 CFR § 1502.14. In total, JRWA has evaluated a dozen primary alternatives and numerous additional sub-alternatives that incorporate minor water main route variations, as follows: (1) five alternative water supply sources; (2) six build alternatives and 12 water line route variations; and (3) the no-action/no-permit alternative. This analysis represents a reasonable range of alternatives that potentially could accomplish the purpose and need of the proposed Project. All documents pertaining to the alternative analysis can be found in Appendix H: Alternative Analysis.

4.1.1 Alternative Water Supply Sources

An alternatives screening process was used to determine the reasonableness of specific alternatives to be considered for detailed analysis. Reasonable alternatives were those that were considered to potentially meet the project purpose and need while still being reasonably practicable when considering overall factors associated with engineering and cost. As a first step, JRWA evaluated five alternative water sources that would not involve a direct surface water withdrawal from the James River including: the Rivanna River, Lake Anna, Cobbs Creek Reservoir, groundwater, and purchased water from neighboring communities. As explained below, however, each of these potential alternative water sources have readily apparent drawbacks that allow them to be screened from further detailed consideration as practicable alternatives. Appendix H-1 includes additional information supporting the review of these potential alternative water sources. Accordingly, these alternatives are discussed in this Section 4.1.1 but are not carried forward for additional detailed consideration and evaluation.

4.1.1.1 Alternative Water Supply 1: Rivanna River

The Rivanna River's watershed is 769 square miles, approximately 13% of the total combined James River and Rivanna River watershed of 5,844 square miles at the confluence of the two rivers at Columbia. As such, the Rivanna River watershed does not provide a sufficient quantity of water to meet the JRWA members' long-term water supply demand.

The Rivanna River watershed is already taxed as it currently serves as the primary water source for the City of Charlottesville and Albemarle County, as well as the Fluvanna Correctional Facility and Lake Monticello subdivision. The Rivanna Water and Sewer Authority (RWSA) currently maintains five reservoirs in the Rivanna watershed which serve as the primary water source for the Charlottesville and Albemarle region. In addition, the Virginia Department of Corrections maintains an off-line reservoir and withdraws from Mechunk Creek to serve the Fluvanna Correctional Facility. Lake Monticello maintains a reservoir that serves as the primary water source for the Lake Monticello community. As indicated by the *Water Study for Fluvanna County* (Anderson & Associates, Inc, 2003), the Rivanna River was severely taxed by the Lake Monticello system during the droughts of 2002, resulting in the

report conclusion that the James River was the best long-term solution to meet the County's water demands.

Furthermore, the Virginia Department of Health (VDH) limits the acceptable withdrawal of a public water supply without a reservior, to 10% of the generally lowest flow of record at the point of withdrawal. Timmons Group staff spoke with DEQ Office of Water Supply – Water Withdrawal Permitting Department staff (Mr. Josh Rader) to discuss how safe yield and withdrawal limits are determined. A summary of those discussions follows:

> DEQ performs a simulation of the stream of interest on the lowest day of flow of the period of record. This simulation considers several factors including surface water withdrawals and discharges along the stream. This simulation produces a number that is DEQ's interpretation of the lowest flow of record. This number is then used by the Virginia Department of Health (VDH) to determine the 'safe yield', which VDH has defined as 10% of the lowest flow of record.
>
> As an example, the lowest flow of record for the Rivanna River at the confluence to the James is 6 CFS or 3.9 MGD according to USGS stream gage data. For the sake of the example, it is assumed the DEQ simulation also produces a low flow of 3.9 MGD. In this case VDH would say the safe yield is 0.39 MGD. Mr. Rader indicated this process is typical for DEQ permitting surface water withdrawals throughout the state.

The nearest stream gage on the Rivanna River upstream of the confluence with the James River, is located at Palmyra. Below is a graph from the U.S. Geological Survey (USGS) website of daily flows at the gage starting in 1960.

Based upon an ultimate withdrawal capacity for the JRWA, a source with a safe yield of 12 MGD is required for a proposed intake location on the Rivanna River at Columbia, Virginia, to meet the long-term needs of JRWA's member communities. A safe yield of 5.73 MGD would be required to meet JRWA's short-term needs. Based upon the VDH 10% low flow requirement, this would equate to 57.3 MGD (short-term needs) or 120 MGD (long-term needs) as the minimum historical flow required at the intake structure. This equates to a minimum flow rate of 88.7 to 185.7 CFS for an intake structure located on the Rivanna River in the vicinity of Columbia. The area of the drainage shed at Palmyra is 663 SQ MI as compared to 769 SQ MI drainage area of the Rivanna River at the confluence with the James River at Columbia. As such, a conversion factor of 0.862 (see Table 3 below) must be applied to relate the required flows at Palmyra to a potential intake at Columbia.

Table 3. Rivanna Drainage Areas

Rivanna Drainage Area @ Palmyra Stream Gage	663 SQ MI
Rivanna Drainage Area @ Columbia	769 SQ MI
Conversion Factor (663 / 769)	0.862

Table 4. Minimum Low Flow Rates

JRWA Withdrawal @ Columbia (MGD)	JRWA Withdrawal @ Columbia (CFS)	Req'd Flow Rate @ Columbia for 10% low flow (CFS)	Conversion Factor for Stream Gage @ Palmyra	Req'd Flow Rate @ Palmyra Stream Gage for 10% low flow (CFS)
5.73	8.87	88.7	0.862	76.4
12	18.57	185.7	0.862	160.1

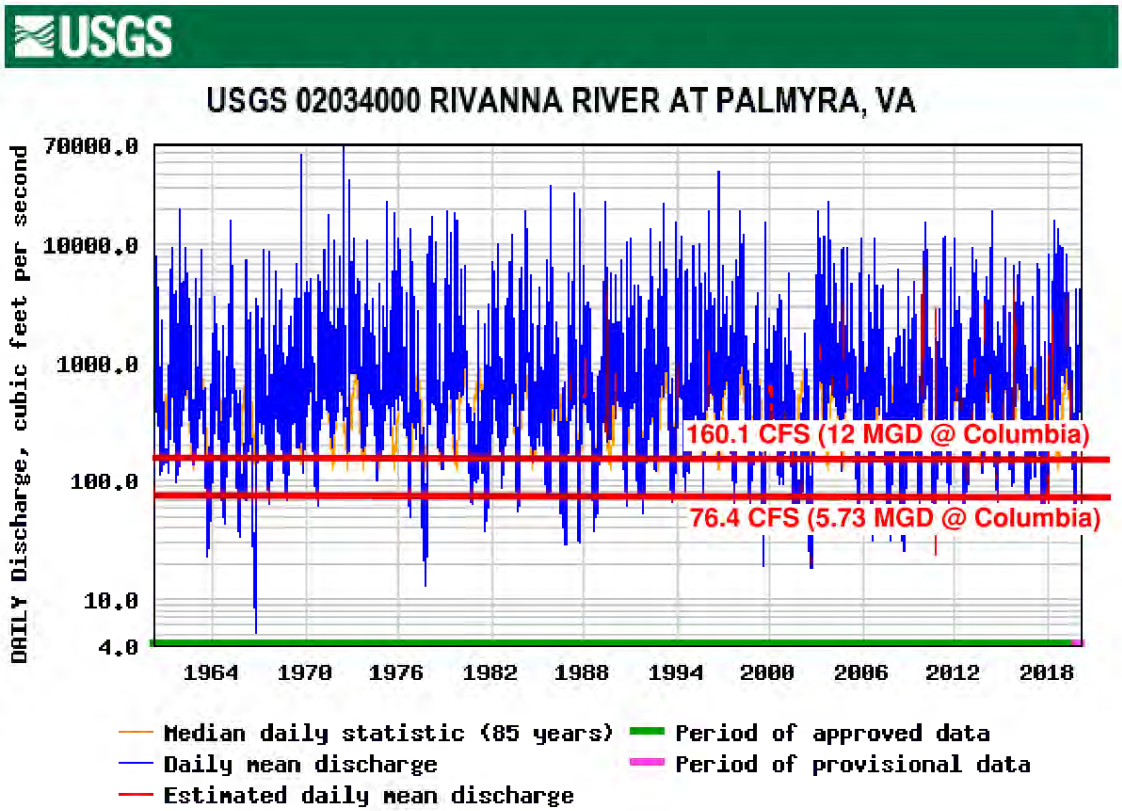


Figure 5. Daily discharge (CFS) from the Rivanna River gauge in Palmyra from 1960 through 2020 (graph obtained from the USGS website on March 17, 2020)

Based on this conversion factor, a minumum low flow of record of 160.1 CFS would be required at Palmyra to consider the safe yield acceptable to support the JRWA 12 MGD ultimate withdrawal capacity, as shown in Table 4. As is evident in the USGS graph (see Figure 5 above), the daily discharge at the Palmyra stream gage is routinely well below the required minimum flows to meet the project's long-term needs. During the October 2002 drought, the discharge at the Palmyra stream gage was as low as 18.1 CFS and 1966, from September 9th through September 11th, the flow was 5.2 CFS; the lowest flow of recod. Therefore the safe yield of the Rivanna River is 0.52 CFS, or 0.34 MGD at the Palmyra gage. Indeed, these flows would be insufficient to meet the much lower short-term needs of the

project without the construction of a reservoir. Therefore, a direct withdraw intake located anywhere on the Rivanna River will not support the Project needs.

This conclusion is supported by previous studies as outlined in the *Water Resources Study for the Zion Crossroads Area* (1996) jointly commissioned by the Counties and the *Water & Wastewater Preliminary Engineering Report and Facilities Master Plan* (1998) prepared for Fluvanna County. Both documents indicate that, without a storage reservoir, a direct water withdraw from the Rivanna River would not provide sufficient water volumes necessary to meet the regional public water supply needs. Development of an off-line reservoir for raw water storage would be the only way to meet the JRWA water supply demands from the Rivanna River. However, a raw water storage reservoir would add substantial land acquisition, construction, permitting, and maintenance costs. Planning, design, permitting, and construction of a reservoir would take significant time, in some cases 20 years or longer, as was the case for the Cobbs Creek Reservoir. Construction of a reservoir would also result in alternations of natural systems beyond what would be necessary for a direct withdraw and waterline. Therefore, a storage reservoir was considered impracticable for detailed consideration in this analysis.

In addition to the limits of available direct withdraw, excessive siltation and sedimentation in the Rivanna River presents a water quality issue. Withdraws from the Rivanna would require adding a pre-settling basin and clarifiers at the Louisa WTP which would include additional capital costs as well an increase in annual operations and maintenance costs. Detailed information regarding the siltation issues and additional equipment necessary is addressed in Section 4.2.1.2.1 Adequate Water Quality.

In sum, the Rivanna River does not have sufficient quantity of water to meet the JRWA members' short-term or long-term water supply demand, and issues of water quality from the Rivanna would of concern. Therefore, the Rivanna River as a water supply does not fulfill the project purpose and can be excluded from further analysis.

4.1.1.2 Alternative Water Supply 2: Lake Anna

Lake Anna is currently owned by Dominion Energy and is located on the north side of Louisa County and is split between Louisa and Spotsylvania Counties. Lake Anna is used for the North Anna Nuclear Power Stations hydro-power and cooling system, which is a "once-through" system that returns the full amount of the withdrawal to the Lake. The North Anna Power Station uses over 500 times the amount of the entire county of Louisa's average water demand for its cooling system and hydro units. Lake Anna cannot be used as a water supply due to its purpose of supporting the Dominion North Anna Power Station. Louisa County unsuccessfully attempted to establish a water withdrawal intake on Lake Anna in 2012. Dominion denied Louisa County access to Lake Anna for this purpose. A copy of this letter is included in Appendix H-1-1 with the following excerpt provided below:

> *"Using Lake Anna for public water supply conflicts with Dominion's rights and responsibilities for reasons, including:*

1. *Allowing another entity to control withdrawals from Lake Anna would interfere with Dominion's ability to safely and efficiently operate the Station's existing and proposed units.*
2. *Additional withdrawals would alter lake levels and downstream flows, with Dominion controls at the Lake Anna Dam in compliance with permit conditions designed to ensure protection of other beneficial uses such as recreation.*
3. *The Virginia Water Quality Standards (9VAC25-260) establish public water supply numeric criteria that are more restrictive than the existing criteria in Lake Anna could (a) result in additional restrictions on waste water discharges from the Station requiring material changes to Station operations, (b) impact Dominion's ability to perform pest/invasive species control measures, if needed, and (c) result in restrictions to existing recreational uses on Lake Anna.*
4. *By agreeing to grant access to Louisa County for a water withdrawal, Dominion may be compelled to consider future requests for additional water withdrawals from the County or other entities – which would further undermine Dominion's interest in managing Lake Anna for the reasons stated above.*

For these and other reasons, Dominion will not grant access to Louisa County, or any other entity, for the competing purpose of establishing a water withdrawal intake and infrastructure."

Lake Anna is also a significant distance from a number of key designated service areas in Fluvanna and Louisa County, to include approximately 30 miles of water main routing to Zion Crossroads and approximately 42 miles of water main routing to Fork Union (see Figure 6).

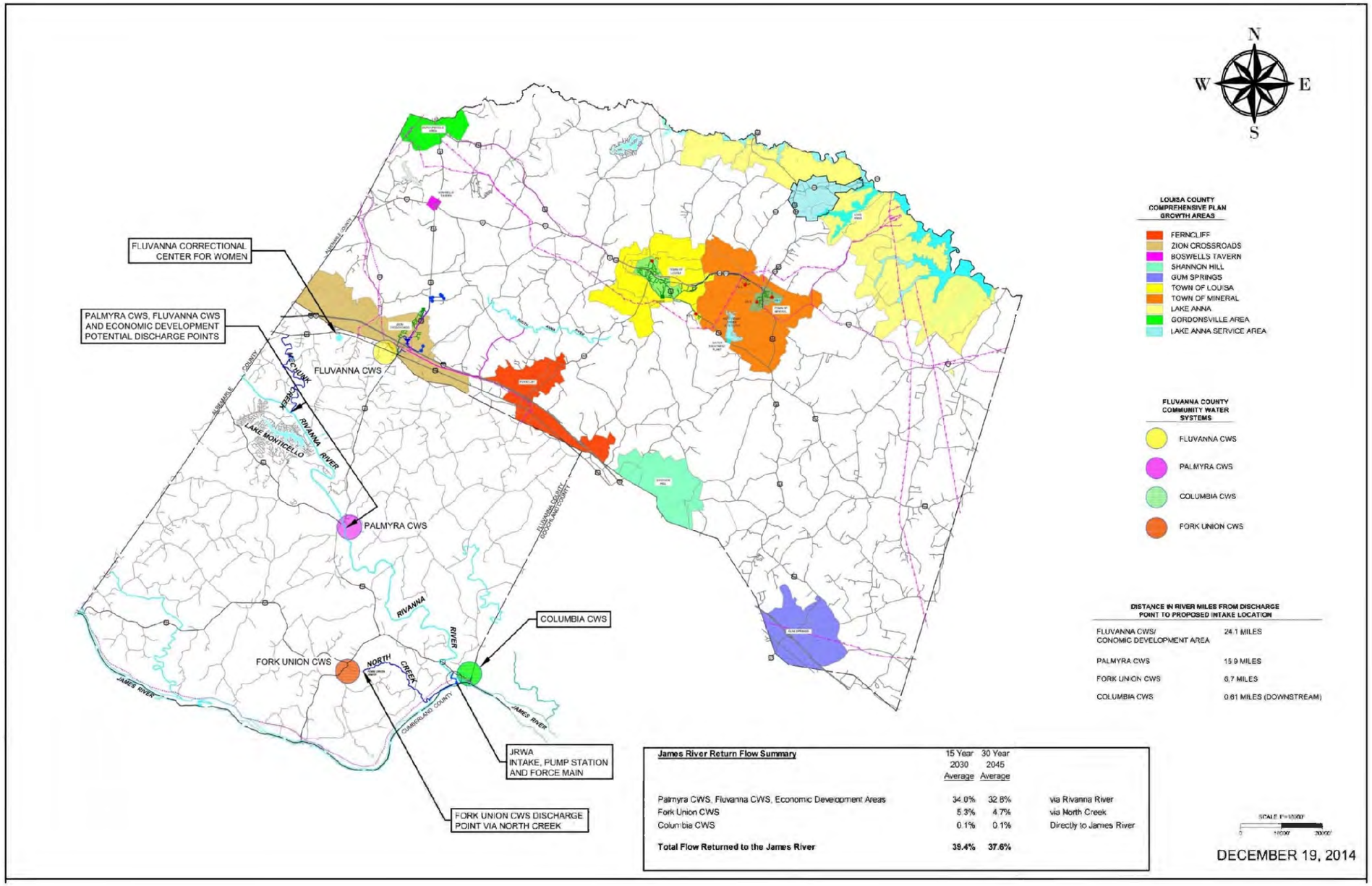


Figure 6. Demand Centers of Fluvanna and Louisa Counties

In sum, given the location of Lake Anna in the north side of Louisa County and Dominion's specific use of the lake for cooling water for the North Anna Power Station and subsequent denial for use as a public water supply, it is not a feasible nor available option for the James River Water Authority and Louisa and Fluvanna's long-term water supply demand and has been excluded from further analysis.

4.1.1.3 Alternative Water Supply 3: Cobbs Creek Reservoir

Cobbs Creek Reservoir (CCR) is a Henrico County project that will serve as a side stream reservoir and pumping facility that pumps and stores water from the James River during high flow conditions and releases this water back to the river during low-flow and drought conditions. Cobbs Creek Reservoir cannot be used as a water supply due to its purpose to provide extra water to the flow of the James River during drought or near drought conditions. Specifically, this extra water is intended to supply drinking water to Henrico County via the James River during droughts or near droughts.

Cobbs Creek Reservoir is a $280 million construction project according to the Henrico County website, last updated January 30, 2020, and has a safe yield of 47 million gallons per day (MGD). This represents approximately $6 per gallon ($280 million / 47 MGD = $5.96 per gallon) for capital costs to construct the reservoir. Should the JRWA need to buy capacity from Henrico County, it is anticipated it would cost a minimum of $6 per gallon to purchase the capacity in Cobbs Creek Reservoir. That would be in addition to the costs that would be incurred to extend a water main across the James River and construct an intake and pump station on the reservoir. Below are estimated capital costs for various capacities should they be purchased by JRWA:

Potential Capital Costs for Desired Capacities:

- 8 MGD x $6 / gal = $48 million
- 12 MGD x $6 / gal = $72 million

In addition, the JRWA would need to construct a raw water intake and pump station on the Cobbs Creek Reservoir and install a water main along Columbia Road and cross the James River in close proximity to Columbia and then tie-in to the agreed-upon T interconnection point. Given the prohibitive capital costs for purchasing reservoir capacity, no further costs were evaluated for the intake, pump station, water main, and James River crossing.

In summary, Cobbs Creek Reservoir is not considered a practicable alternative and is not a viable option for the James River Water Authority.

4.1.1.4 Alternative Water Supply 4: Groundwater

Groundwater cannot be used as a water supply because existing groundwater sources in the Fluvanna and Louisa County are insufficient to meet the project need.

As the 2010 Fluvanna Regional Water Supply Plan states, groundwater resources have largely been already maximized for community scale uses. This is evidenced by the multi-year significant decrease of groundwater resources in 2002 due to lack of precipitation and droughts. This modern episode indicates unpredictable and insufficient groundwater supplies within the County and demonstrates that water demands in the more densely developed areas of the County can only be met by a surface water driven community water system.

The 2011 Louisa County Long Range Regional Water Supply Plan states much of the County, like Fluvanna, has an overreliance on groundwater wells. Given the County's goal of preserving its rural character, it is imperative to preserve groundwater resources for rural residents in the future while providing a community water system for densely developing areas. For example, the Louisa County Water Authority (LCWA) utilizes water from wells in the Zion Crossroads area to serve commercial and industrial development that are adjacent to the Green Springs National Historic District. However, the large scale use of groundwater in this area has taxed reserves and the right to withdraw water from wells has faced numerous legal challenges throughout the years and has been the subject of numerous lawsuits including Historic Green Springs, Inc., Louisa County, LCWA, the USEPA and a number of private citizens in various capacities. Reducing dependency on and use of groundwater in this general area has been a major driver behind the James River Water Project. This, in addition to a growing water demands of the Louisa County in general, support the need for a public water source supplied by surface waters to service high growth areas while preserving the rural nature of much of the County.

Beyond preserving groundwater supplies for current and rural uses, the groundwater yields within the Counties appear to be insufficient to meet the needs of the JRWA. The 1998 *County of Louisa Water Quality Management Plan and Groundwater Study* (Appendix H-1-2-1) indicates the average yield of public water supply wells in the County were about 42 gallons per minute (GPM), three times greater than the average yield of 14.5 GPM for all wells in the County. However, in order to achieve these maximum yields, significantly greater well depths (>300 feet) are required than typically well depths (<300 feet). Similarly, the *Fluvanna County Geology and Water Well Productivity* study produced by the Virginia Department of Mines Mineral and Energy (Appendix H-1-2-2) indicates that the most productive wells in Fluvanna County can be found to occur in wells > 300 feet in depth within specific rock families (slate and quartzite) and have, on average, a yield of 89 GPM. This is further validated when you look at each County's demand centers relative to their location in the respective watersheds. Per the attached Hydrologic Unit Code map (see Page 13, Figure 2), the growth areas of Zion Crossroads (both Fluvanna and Louisa), Ferncliff, Shannon Hill and Gum Springs all are located at the "head of a watershed" and adjacent to Interstate 64, which appears to be a "ridge road" as constructed.

Using the most productive figures with wells of 89 GPM as a baseline estimates (from the *Fluvanna County Geology and Water Well Productivity* study), an average deep well (> 300 feet) within an area of high productivity could produce on average of 128,160 gallons per day (GPD). Under this scenario, nearly 100 highly productive deep wells would be required.to meet the 12 million gallons per day (MGD) ultimate needs of JRWA. The development of 100 highly productive deep wells across the Counties would require multiple site-specific

groundwater studies, multiple test wells and the development of well fields, individual water treatment units at the wells and/or associated infrastructure to connect these fields to a central water treatment plant and related distribution networks. The planning, logistics, testing, permitting, and costs associated with such an endeavor make groundwater withdraws impractical to meet the long-term needs of the JRWA.

In sum, groundwater is not considered to be a practicable alternative and is not a viable option for the James River Water Authority.

4.1.1.5: Alternative Water Supply 5: Purchased Water from Neighboring Communities

Fluvanna and Louisa development corridors are adjacent to Albemarle County to the west and Goochland and Hanover Counties to the east. Rivanna Water & Sewer Authority (RWSA) provides water to the City of Charlottesville and Albemarle County Service Authority and currently has a limited water supply. When the RWSA was considering water supply options in the early 2000's, it evaluated constructing a water line along Route 20 to get direct access to the James River at Scottsville and also partnering with Fluvanna and Louisa Counties to expand the water withdrawal from the James River to include additional demands for the RWSA as the RWSA expressed that it did not have an adequate water supply to serve its residents' needs and the needs of Fluvanna and Louisa Counties. Ultimately RWSA concluded they could meet their long-term water demands utilizing the existing Rivanna watershed by improving their existing reservoirs and abandoned the idea of utilizing the James River as a long-term water source.

JRWA has been informed that RWSA has currently developed their water supply system to exclusively meet the long-term needs of the City of Charlottesville and Albemarle County Service Authority and are not in a position to sell water to Louisa or Fluvanna Counties. Please see attached letter from RWSA dated March 11, 2020 (see Appendix H-1-3).

The next closest municipal water system to Fluvanna and Louisa service areas is Goochland County. Goochland County currently purchases water from Henrico County to serve the Tuckahoe Creek Service District, which is generally located along the east end of Goochland County serving multiple properties along Route 288 and I-64 up to the Manakin-Sabot/Rockville area located just off of exit 173 on I-64. The Tuckahoe Creek Service District would be the closest connection point for Louisa and Fluvanna Counties to purchase water from Goochland/Henrico and is approximately 35 miles east from Zion Crossroads and approximately 38 miles southeast from the Town of Louisa, thereby making it unfeasible to construct a line to this area and purchase water from Henrico or Goochland.

Based upon the items noted above, purchasing water from neighboring communities is not practicable alternative and therefore not a viable option.

For the reasons stated above, JRWA was not able to identify any alternative sources of water that presented a potentially feasible alternative to the James River. As such, these alternatives were not carried forward for a more detailed analysis.

4.1.2 Build Alternatives

Six alternative raw water intake locations (i.e., the Build Alternatives) were evaluated for the Project. For each Build Alternative, one or more water main route variations were evaluated as sub-alternatives. An overall map of each alternative (Figure 8) and summaries of each Build Alternative follows.

The Build Alternatives included in this analysis were developed to represent a wide-range of options for locating an intake and pump station along the James River within a reasonable radius of the agreed-upon T interconnection point. The upstream and downstream extents of the analysis were guided by a reasonable consideration of constraints. The upstream extent was established at a location near Bremo Bluff, which was the location of the original JRWA withdraw permit. This extent represents the furthest alternative to be evaluated from the agree-upon interconnection point. The downstream extent was determined to be a site in Goochland County approximately one mile downstream from the Columbia Bridge and just upstream of Elk Island. This extent was established based on multiple factors, including distance, water quality (see Section 4.2.1.2.1), and the high occurrence of known cultural resources near Elk Island. Alternative intake locations within the overall extents were also developed based on reasonable considerations including ease of access via existing CSX rail crossings and distances from wastewater treatment plant (WWTP) discharges into the James River. Locations of existing Dominion and Fork Union WWTP discharge points on the James River are shown in Figure 7. Section 4.2.1.2.1 Adequate Water Quality further details raw water withdrawals with regard to the 5-mile discharge in accordance with the Virginia Waterworks Regulations. Routing alternatives were developed to avoid sensitive resources and to be co-located with existing VDOT roads, utility corridors, or CSX right-of-way to the maximum extent feasible and / or practicable. The Build Alternatives selected for detailed analysis are summarized in the Sections below.

The evaluation of Build Alternatives has been prepared using the best available information and field investigations where practicable. This analysis is believed to be comparatively reasonable for each of the alternatives evaluated. Should additional information be acquired or due diligence be completed, it could slightly alter the results of the analysis, however, we don't believe it will alter the final conclusions of the analysis.

The proposed action, Alternative 6, has been extensively studied over a period of years, and the analysis of that alternative is based on known conditions of the currently designed intake and pump station site. For Build Alternatives 1 through 5, 6-1 and 6-2, the best available information was gathered from mapping data, online data, other reliable sources, and visual inspections where accessible. For elements that would not be materially different between alternatives—such as pump station construction costs—the information developed for Alternative 6 was used to inform the related elements of the other alternatives. The available information for the alternatives that have comparatively less information available than the proposed action is sufficient to determine whether there are any known factors that make construction *impracticable*. That is, if an alternative is demonstrated to be impracticable based on one or more factors, no further analysis is warranted. However, it must be recognized that additional information and further analysis could result in the identification of additional factors that may make a given alternative impracticable. Information on the considerations listed below was not fully developed for the Build Alternatives (other than the proposed alternative), and

therefore this analysis *assumes* that these considerations would not make an alternative impracticable but additional information could change that conclusion:

- Topography. The elevation of pump station sites must be suitable in relation to the elevation of the river bottom.
- Bathymetry. The depth and shape of the river bottom must be suitable for a submerged water intake.
- Geology. Presently unknown information about the type and depth of soils and rock could lead to constructability challenges.
- Availability of Land for Pump Station Construction, Temporary Construction Easements, Access and Water Line Easements. Fluvanna and Goochland County GIS data has been used to assess the availability of land for alternative sites, access to the sites and associated easements. However, no boundary survey, title investigations, or appraisals have been performed.

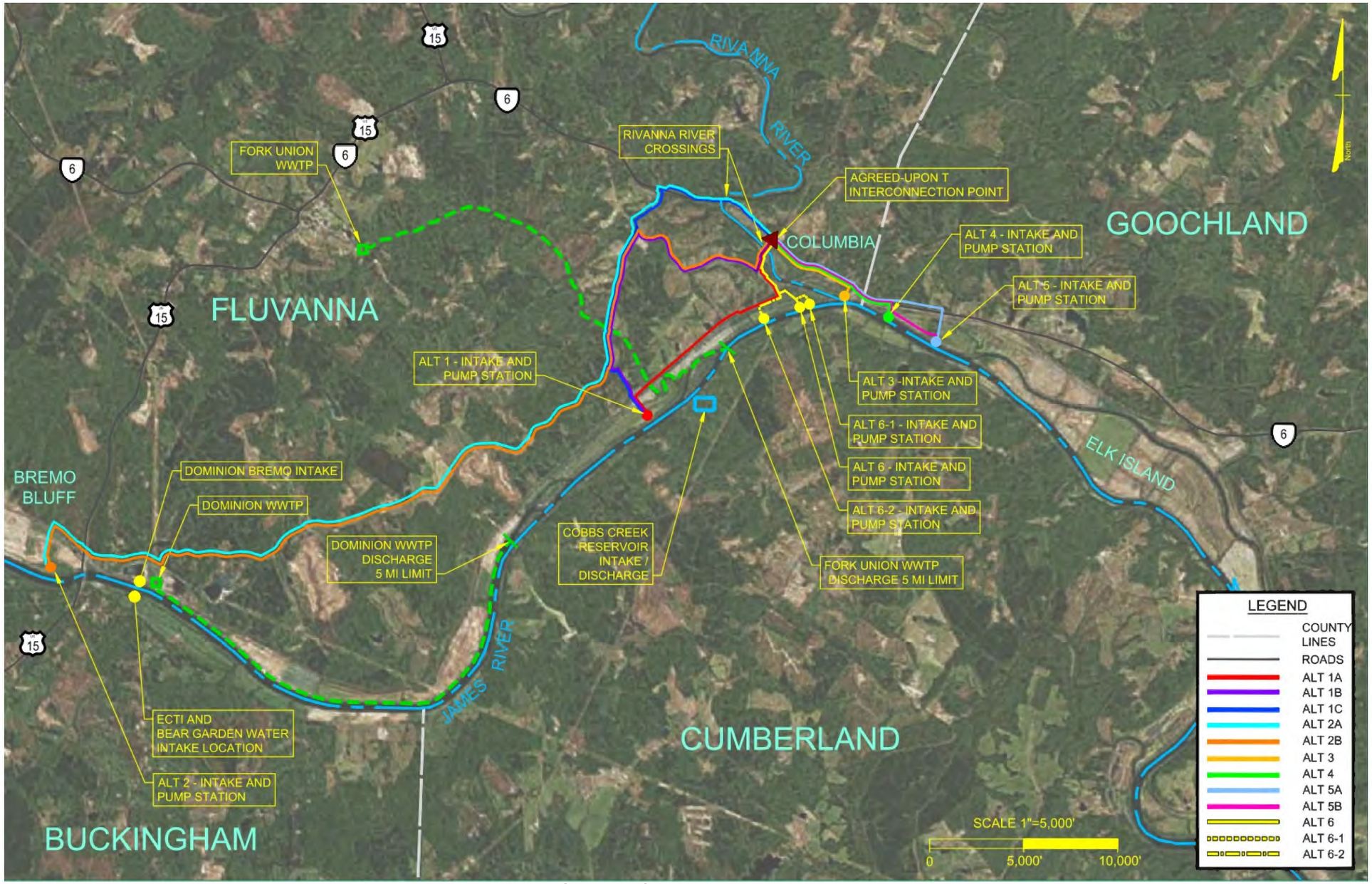


Figure 7. Overview of Build Alternatives and Routing

4.1.2.1 Build Alternative 1: Forsyth

- **Build Alternative 1** is approximately 2.3 miles upstream of the confluence of the James River and Rivanna River on property owned by Forsyth (TM 61 1 6). The evaluation considers three water main routes to this site as follows:
    - **Sub-alternative 1A**; crossing the Rivanna River and following the Colonial Pipeline and Dominion Power utility corridor as currently designed, then following the CSX rail to the alternative site.
    - **Sub-alternative 1B**; crossing the Rivanna River and following the Colonial Pipeline utility corridor as currently designed to Point of Fork Road (Route 624); then following Point of Fork Road and Bremo Road (Route 656) to the Forsyth property; then extending into the Forsyth property, crossing the CSX rail to the alternative site.
    - **Sub-alternative 1C**; following Route 6 and crossing the Rivanna River at Route 6 and continuing to Bremo Road (Route 656) to the Forsyth property; then extending into the Forsyth property, crossing the CSX rail to the alternative site.

    See Figure 9. Build Alternative 1 Evaluated Routing Options for details

4.1.2.2 Build Alternative 2: Bremo

- **Build Alternative 2** is in the vicinity of Bremo Bluff west of the US 15 Bremo Bridge. It is approximately 0.35 miles upstream of the Route 15 Bridge on property owned by Orf (TM 58 A 9). The site is situated such that the intake location avoids rapids and sand bars in the vicinity. This evaluation considers two water main routes to the site as follows:
    - **Sub-alternative 2A**; following Route 6 and crossing the Rivanna River at Route 6 and continuing to Bremo Road (Route 656) to the west of the Route 15 bridge at Bremo Bluff onto CSX Road, then crossing the CSX rail and extending into the alternative site.
    - **Sub-alternative 2B**; crossing the Rivanna River and following the Colonial Pipeline utility corridor as currently designed to Point of Fork Road (Route 624) and continuing to Bremo Road (Route 656) to the wet of the Route 15 bridge at Bremo Bluff onto CSX Road, then crossing the CSX rail and extending into the alternative site.

    See Figure 10. Build Alternative 2 Evaluated Routing Options for details

4.1.2.3 Build Alternative 3: Columbia

- **Build Alternative 3** is in the vicinity of Columbia, downstream of the confluence of the James and Rivanna Rivers; approximately 0.4 miles downstream of the current site on the properties owned by Harry (TM 54A 1 96, TM 54A 1 79, TM 54A 1 80, and TM 54A 1 97) and Kidd (TM 54A 1 80A). The water main route is as follows:
    - Following Route 6 east to Columbia and extending into the alternative site in Columbia.

  See Figure 11. Build Alternative 3 Evaluated Routing Options for details

4.1.2.4 Build Alternative 4: Goochland 1

- **Build Alternative 4** is in Goochland County, downstream of the confluence of the James and Rivanna Rivers; approximately 1/2 miles downstream of the existing Columbia Bridge on property owned by Valentine (TM 24 1 1). The water main route is as follows:
    - Following Route 6 east to Columbia and into Goochland; then crossing the CSX rail and extending into the alternative site.

  See Figure 12. Build Alternative 4 Evaluated Routing Options for details

4.1.2.5 Build Alternative 5: Goochland 2

- **Build Alternative 5** is in Goochland County, downstream of the confluence of the James and Rivanna Rivers; approximately 1 mile downstream of the existing Columbia Bridge on properties owned by Welch (TM 24 2 7A). The evaluation considers two water main routes to this site as follows:
    - **Sub-alternative 5A**; following Route 6 east to Columbia and into Goochland, then crossing the CSX rail and entering the Welch property into the alternative site.
    - **Sub-alternative 5B**; following Route east to Columbia and into Goochland, then crossing the CSX rail and entering the Valentine property; extending east towards the Welch property into the alternative site.

  See Figure 13. Build Alternative 5 Evaluated Routing Options for details

4.1.2.6 Build Alternative 6: Hammond 1 (Proposed Action)

- **Build Alternative 6** is the Preferred Alternative. This alternative is described more fully above in Section 2, which is incorporated here by reference.

  For the purposes of this Alternatives Analysis, JRWA evaluated two variations on the proposed Project that were not sufficiently different to warrant evaluation as independent alternatives. Additional actions to avoid and minimize impacts associated with the Build Alternative 6 are discussed in Section 6 below.

4.1.2.7 Build Alternative 6-1: POF Farm

- **Build Alternative 6-1** is the original property considered in the Joint Permit Application with the intake structure approximately 0.4 miles upstream of the confluence of the James River and Rivanna River with the water transmission line following an old roadbed until it intersects with the existing Dominion Power easement. This intake and water main location are located on Point of Fork Farm LP (parcel 53-A-62C) and was included in the original Joint Permit Application. It was anticipated at the time of the application that the JRWA would be able to acquire the pump station site from Point of Fork Farm LP, however, JRWA was not able to acquire the site. Subsequently the JRWA was able to

negotiate the acquisition of a pump station parcel from the adjacent landowner, William Hammond (parcel 61-A-4), just upstream of this pump station location. Once the JRWA acquired this parcel, they requested a minor modification from DEQ to move the proposed pump station and intake structure upstream approximately 250 liner feet.

This alternative would realize the purpose and need of the project in the required configuration. However, this alternative site presented issues due to breakdowns in property owner negotiations regarding the placement of the intake structure and water main. Shifting the station upstream to the location of the Preferred Alternative minimizes property acquisition from reluctant parties and better utilizes existing easements without increasing any environmental impacts.

4.1.2.8 Build Alternative 6-2: Hammond 2

- **Build Alternative 6-2** is the intake structure approximately 0.8 miles upstream of the confluence of the James and Rivanna River with the intake and pump station located adjacent to the Colonial Gas Pipeline easement.

  This alternative would realize the purpose and need of the project in the required configuration but presents issues due to safety concerns. The proximity of the pump station to the existing Colonial Gas pipeline was determined to be unsafe for blasting necessary for construction. Additionally, there is also no existing rail crossing to easily access this site, which would increase the overall cost and time needed for the project.

See Figure 14. Build Alternative 6, 6-1, and 6-2 Evaluated Routing Options for details.

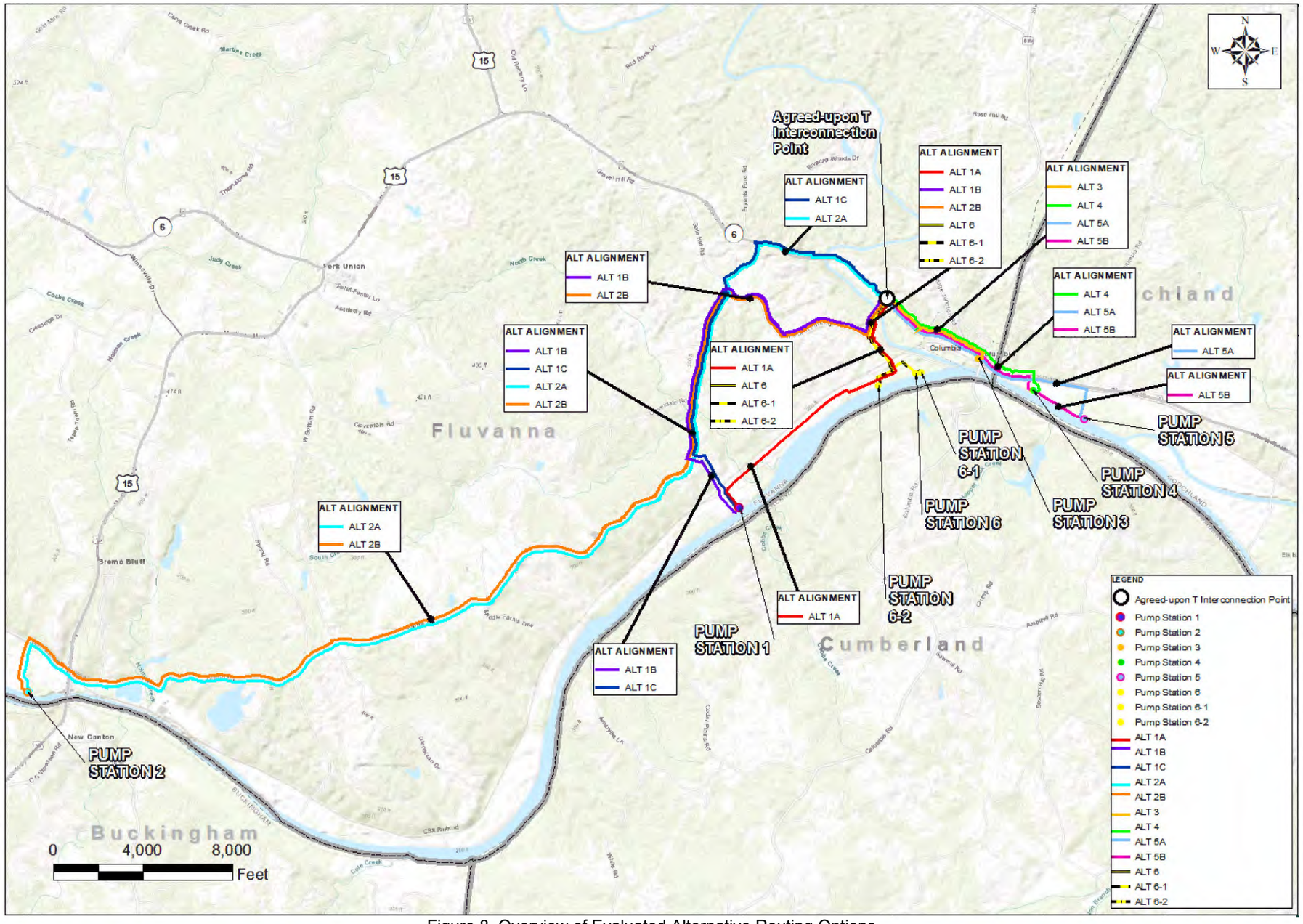


Figure 8. Overview of Evaluated Alternative Routing Options

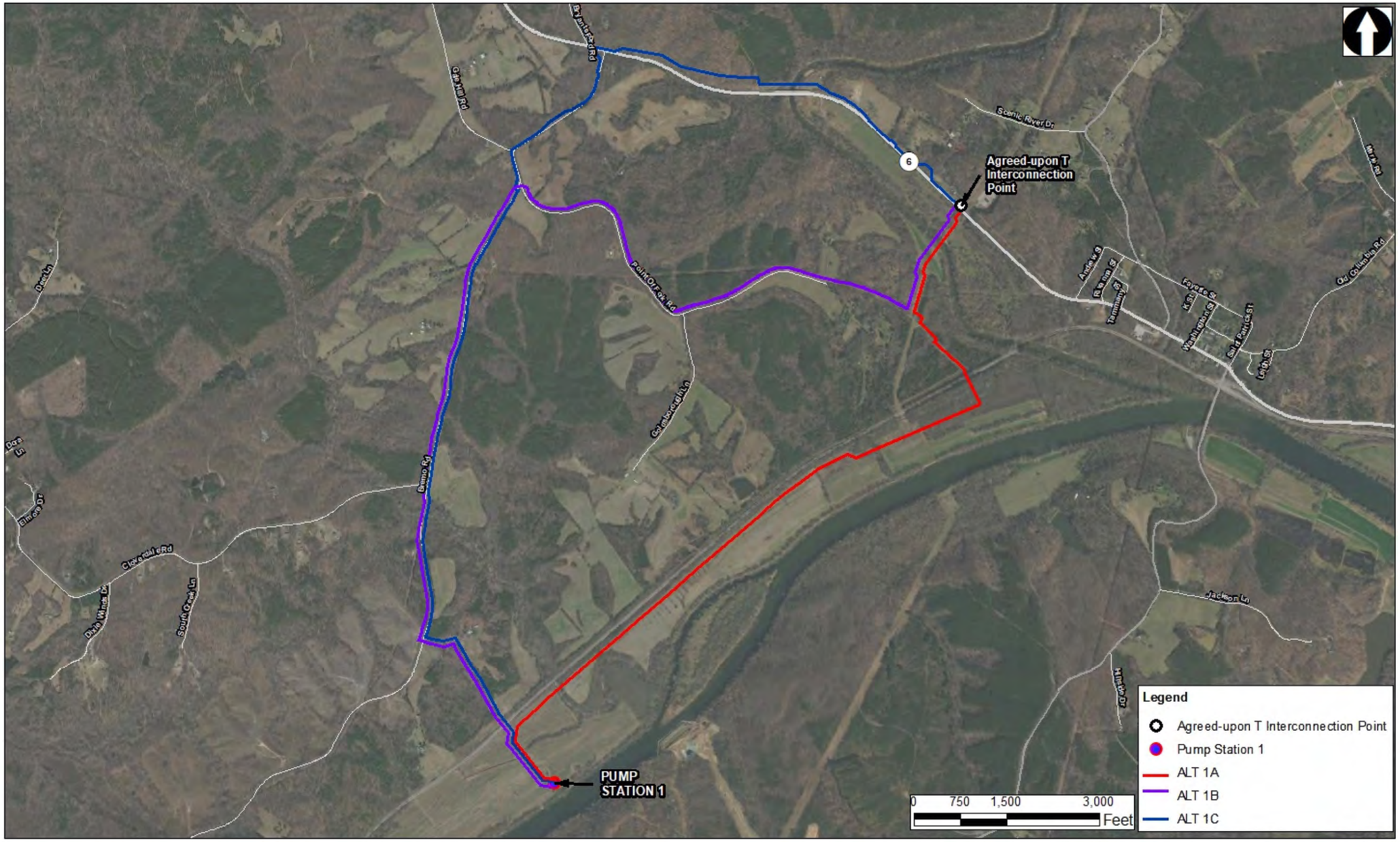


Figure 9. Build Alternative 1 Evaluated Routing Options

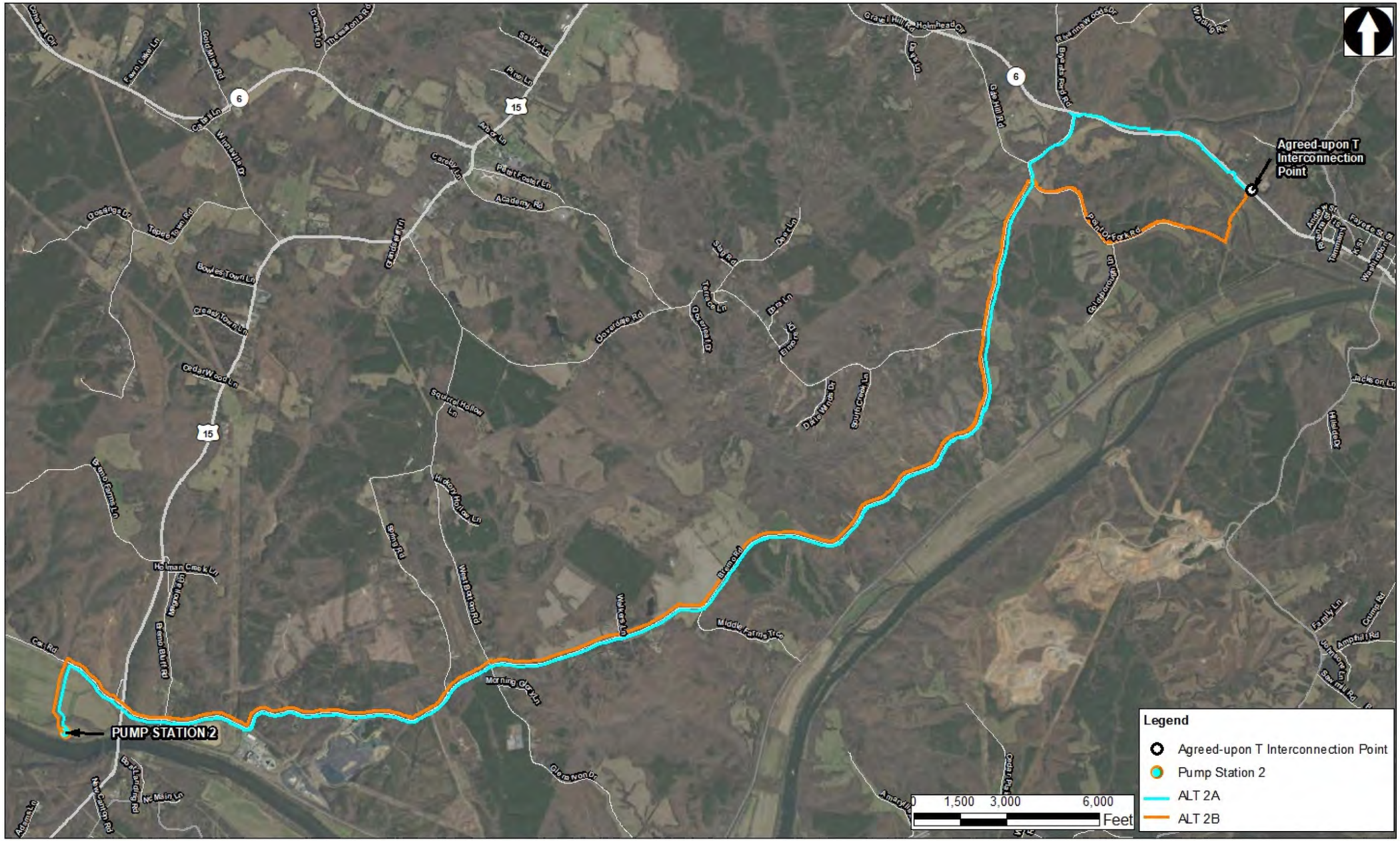


Figure 10. Build Alternative 2 Evaluated Routing Options

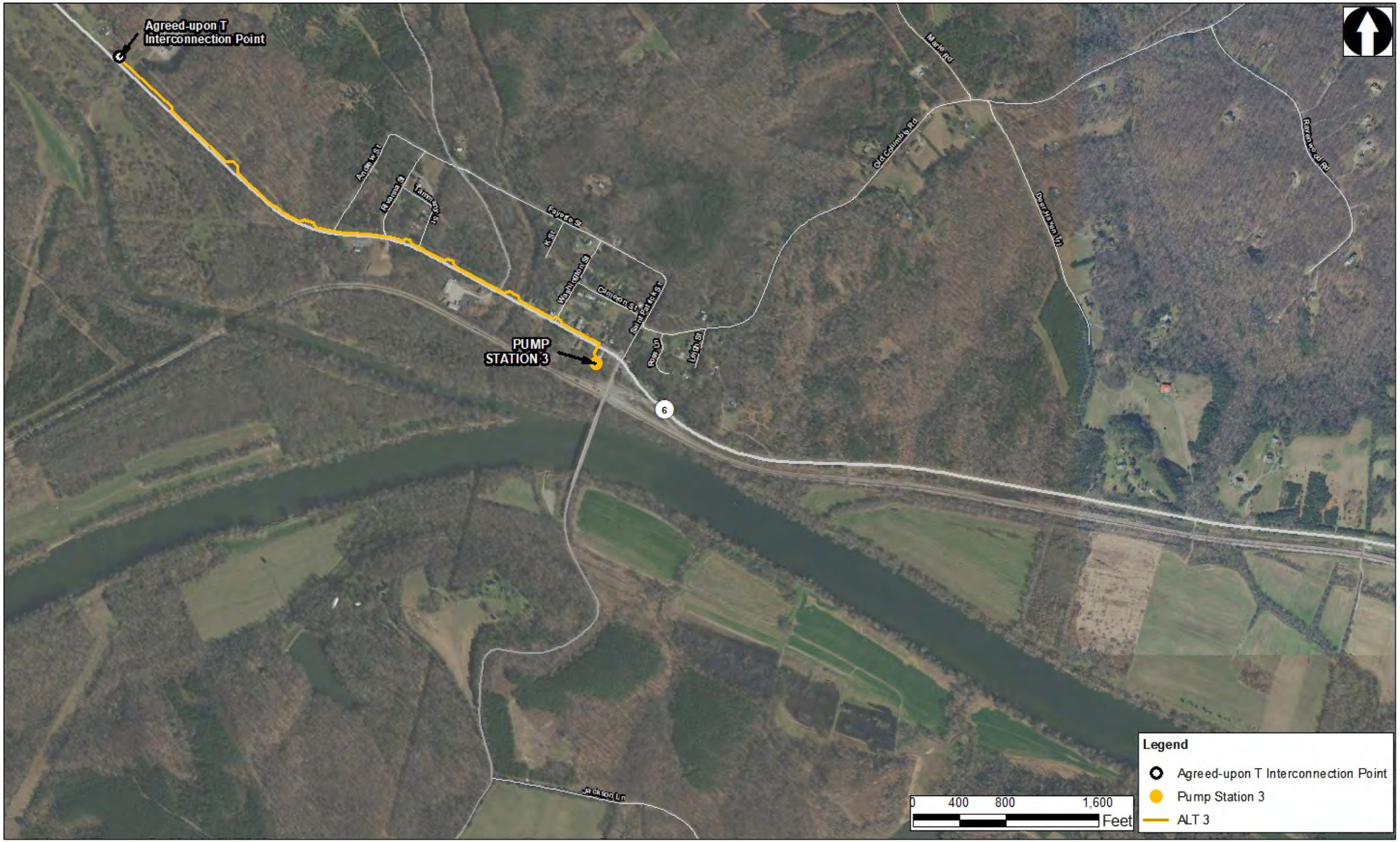


Figure 11. Build Alternative 3 Evaluated Routing Options

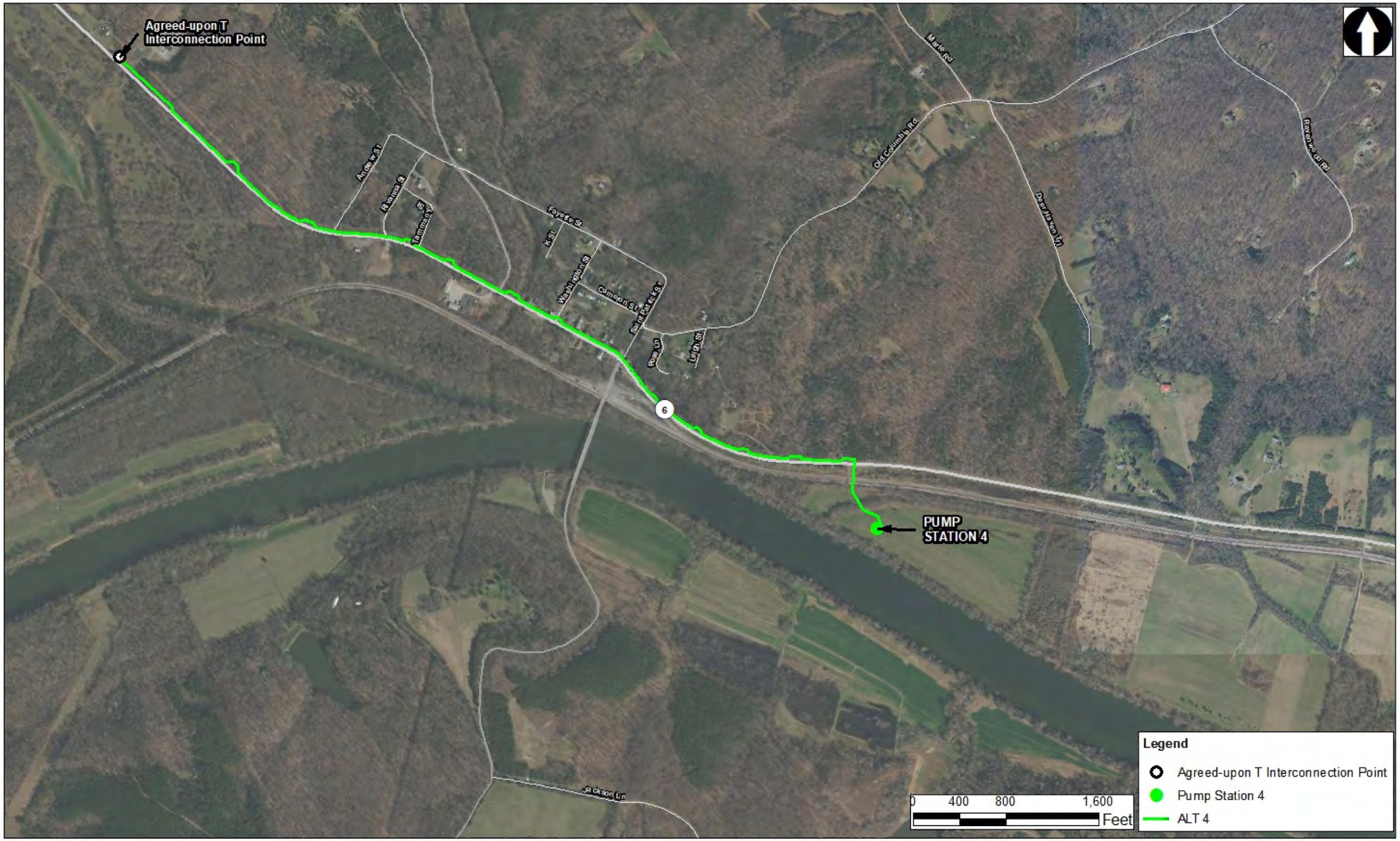


Figure 12. Build Alternative 4 Evaluated Routing Options

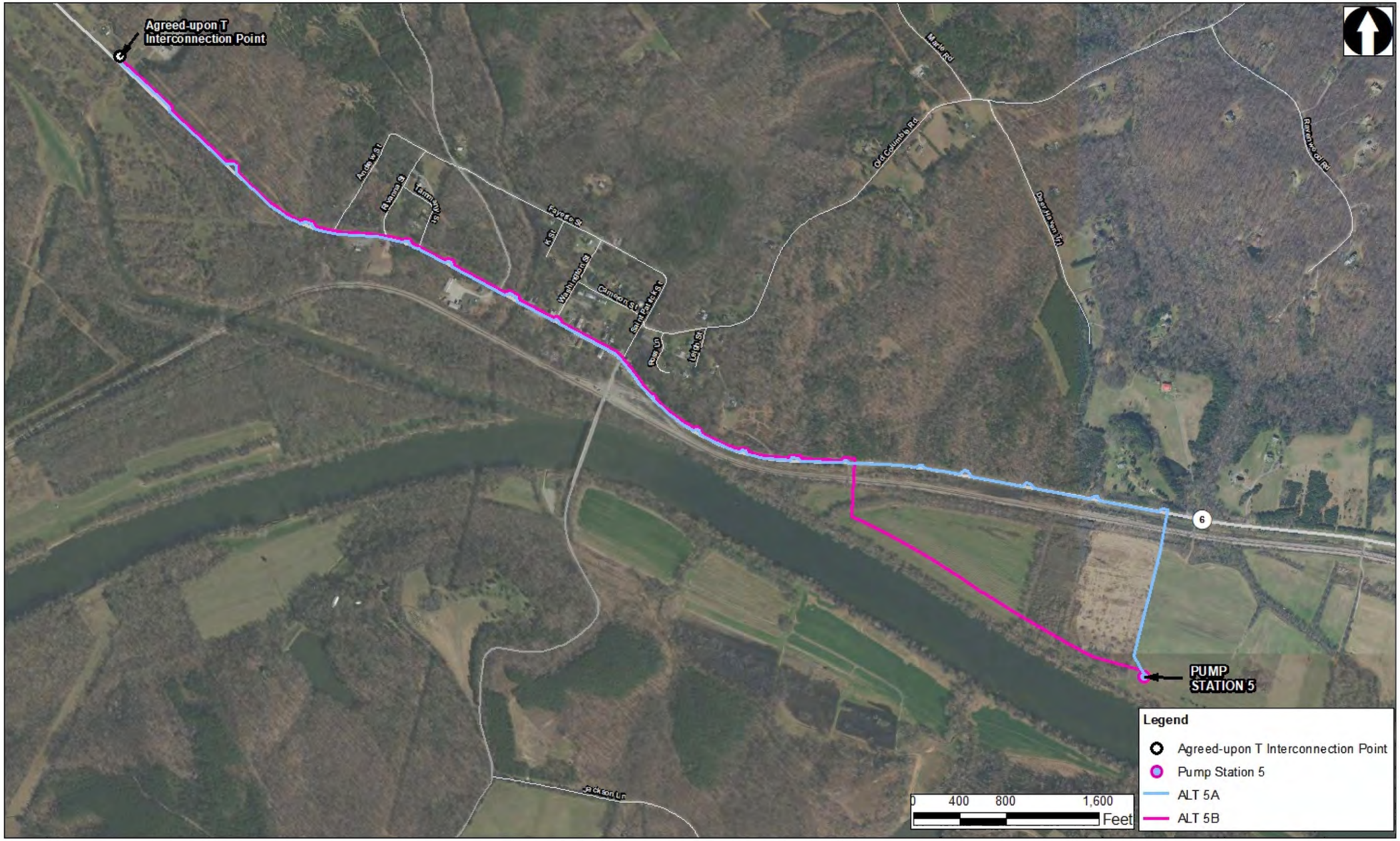


Figure 13. Build Alternative 5 Evaluated Routing Options

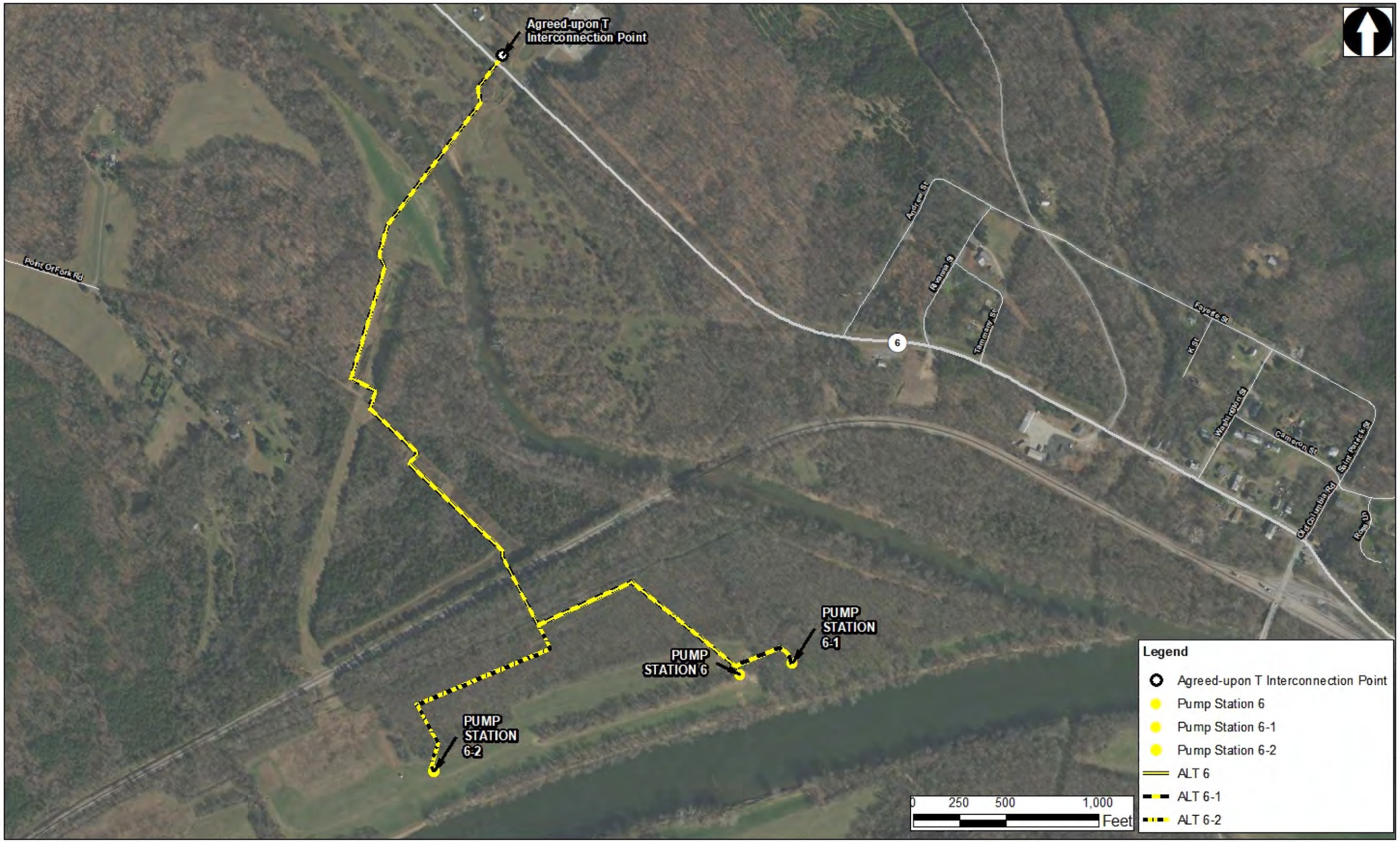


Figure 14. Build Alternative 6, 6-1, and 6-2 Evaluated Routing Options

4.1.3 No-Permit and No-Action Alternative

There is no feasible way to get an adequate quantity of water from the James River, or any other potential source of surface water, to the interconnection point without impacting jurisdictional waters. Boring under all jurisdictional waters would not represent a No-Permit Alternative because there is no technologically feasible way to construct the raw water intake in a surface water in a manner that would avoid the need for a permit. Although drilling a groundwater supply well immediately adjacent to the connection point could theoretically avoid jurisdictional impacts, groundwater does not provide a sufficient supply of water to meet the Project purpose. Thus, that option cannot be considered a true alternative. Accordingly, the No-Permit Alternative and No-Action Alternative are the same. The No-Action/No-Permit Alternative entails not constructing the water supply Project in any form.

4.2 Alternatives Evaluation Criteria

4.2.1 Practicability Considerations

An alternative is “practicable” if it is “available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.” 40 C.F.R. § 230.10(a)(2). This analysis applies each of the evaluation criteria noted below to each Build Alternative.

The first set of criteria evaluated were construction logistics. These criteria pertain to whether it is practicable to construct all elements of the project at the particular location. These criteria include:

- Size and Configuration of Site Suitable for Construction of a Pump Station
- Heavy Equipment Access to Pump Station Site from Public Right-of-Way
- Presence of Rock
- Constructability of Water Main
- Suitable Railroad Track Crossing Location
- Acquisition of Land and Easements

The second set of criteria evaluated were site suitability logistics. These criteria include factors that bear on whether a site is suitable for the operation and maintenance of public water supply infrastructure. These criteria include:

- Adequate Water Quality
- Intake and Pump Station Proximity and Depth of Wetwell
- River Bottom Depth at Intake Location
- Access to Suitable Power Supply
- Proximity to Residential Dwellings

The third criterion evaluated is cost. That evaluation tallies the capital construction and financing costs to determine total probable project costs.

From an engineering standpoint, the technology exists to construct a pump station and water main at any of the six build alternatives. Because technology is not a relevant basis upon which to differentiate among the alternatives it is not considered in this analysis.

4.2.1.1 Construction Logistics Considerations

4.2.1.1.1 Size and Configuration of Site Suitable for Construction of a Pump Station

The overall size and configuration of the site available for purchase must be sufficiently large to contain the pump station and offer enough additional laydown area adjacent to the structure to allow for the operation and movement of construction equipment. The site must offer favorable conditions to permit the construction of the project at a reasonable cost and in a safe manner that minimizes the impacts to traffic safety, the environment, and clearing and rock excavation. Below is a site diagram and description of each Build Alternative. An alternative would be deemed impracticable on this criterion if would not allow for the safe construction of the project. For further detail see Appendix H-2 for intake structure to wetwell cross section exhibits.

Build Alternative 1 offers enough area to construct and maintain the proposed facilities. Figure 15 below shows the access road path and configuration of the site.

Figure 15. Build Alternative 1 Pump Station Plan View

Build Alternative 2 offers enough area to construct and maintain the proposed facilities. Figure 16 below shows the access road path and configuration of the site. A culvert will be installed near the site beneath the access road to provide safe access to the pump station site.

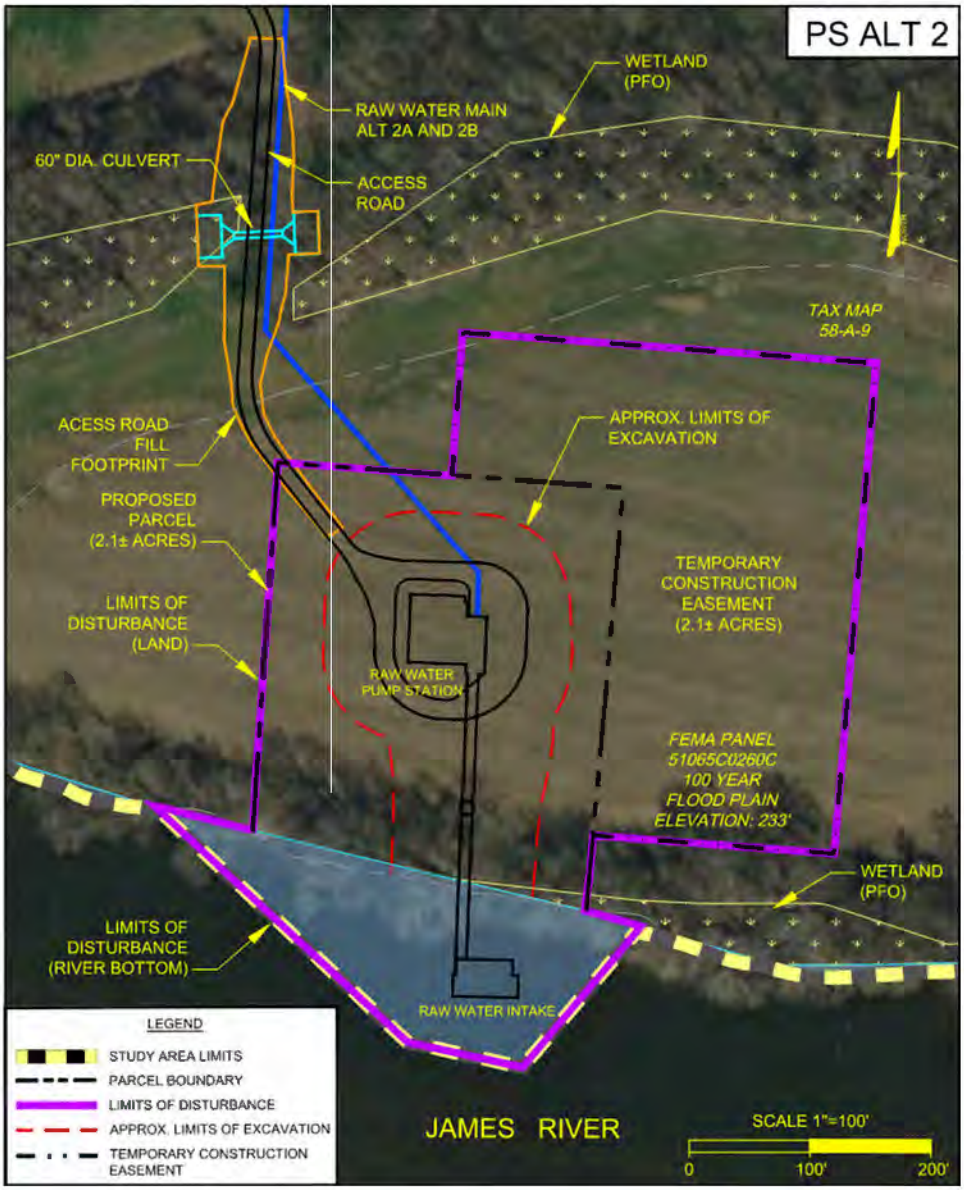


Figure 16. Build Alternative 2 Pump Station Plan View

Build Alternative 3 offers limited area to construct and maintain the proposed pump station. Figure 17 shows the access road path and the configuration of the site. The site is immediately adjacent to residential structures and the CSX rail line. Construction at this site is not practicable due to the lack of space and proximity to existing structures and rail. The construction and maintenance of the intake is not practicable due to lack of accessibility to the river. Accessing the river from Columbia Bridge was considered as an option, but that is deemed infeasible due to maintenance of traffic difficulties.

This alternative is unique compared to others in that it would require construction immediately adjacent to the CSX rail and existing residential structures. These factors would result in significant additional cost and project risks as follows:

a. Due to the lack of area to layback excavations, the construction of the wetwell will require that the excavation be sheeted and braced to the elevation of bedrock (approximately 28.4 feet deep). This sheeted excavation will require extensive lateral bracing that will impede the progress of excavation, and construction of the structure. Implementing the project using a sheeted excavation will result in significant cost and schedule increases and greater safety risks during construction.

b. Due to there being active rail lines between the wetwell and intake, it will be required that the gravity intake pipe be installed by jack and bored through rock with a casing pipe approximately 500 feet in length. A boring through rock of this length, while working in a sheeted excavation, will result in significant cost and schedule increases and greater safety risks during construction.

c. Similarly, due to there being active rail lines between the wetwell and intake, it will be required that an additional casing be install approximately 500 feet in length to carry the air-burst piping used for cleaning the intake screens. A boring of this length, while working in a sheeted excavation, will result in significant cost and schedule increases and greater safety risks during construction.

d. There is no practical way to construct an access road between the pump station and intake, thus a crane must be utilized to deliver equipment and materials to the intake locations. Considering there is not practical location other than the existing bridge at Columbia, the crane would be positioned on the bridge for the duration of the intake construction, thus requiring a lane closure and temporary traffic lights to manage traffic on a 24/7 basis during construction. Positioning a crane on the bridge, will result in significant cost and schedule increases and greater safety risks to construction workers and the public. In addition, the crane will need to be positioned such that if it were to fall, it would not land on the rail line and impede rail operations.

e. A concrete pump truck would be required to deliver concrete to the intake site. This truck would also need to be staged on the bridge. Positioning a concrete pump struck on the bridge, will result in significant cost and schedule increases and greater safety risks to construction workers and the public.

f. The site is very confined, thus reducing turn around space for vehicles. This will result in additional traffic control on Route 6 to allow long body vehicles to back in or out of the site. This condition will result in cost and schedule increases and greater safety risks to construction workers and the public.

g. One or more residential structures will require demolition, this will also require residents to be relocated following federal guidelines. In addition to the human and environmental impacts, this would add additional costs, timing, and logistical obstacles to construction at this site.

Figure 17. Build Alternative 3 Pump Station Plan View

Build Alternative 4 offers enough area to construct and maintain the proposed facilities. Figure 18 below shows the access road path and configuration of the site. A culvert will be installed near the site beneath the access road to connect the existing stream feature and provide safe access to the pump station.

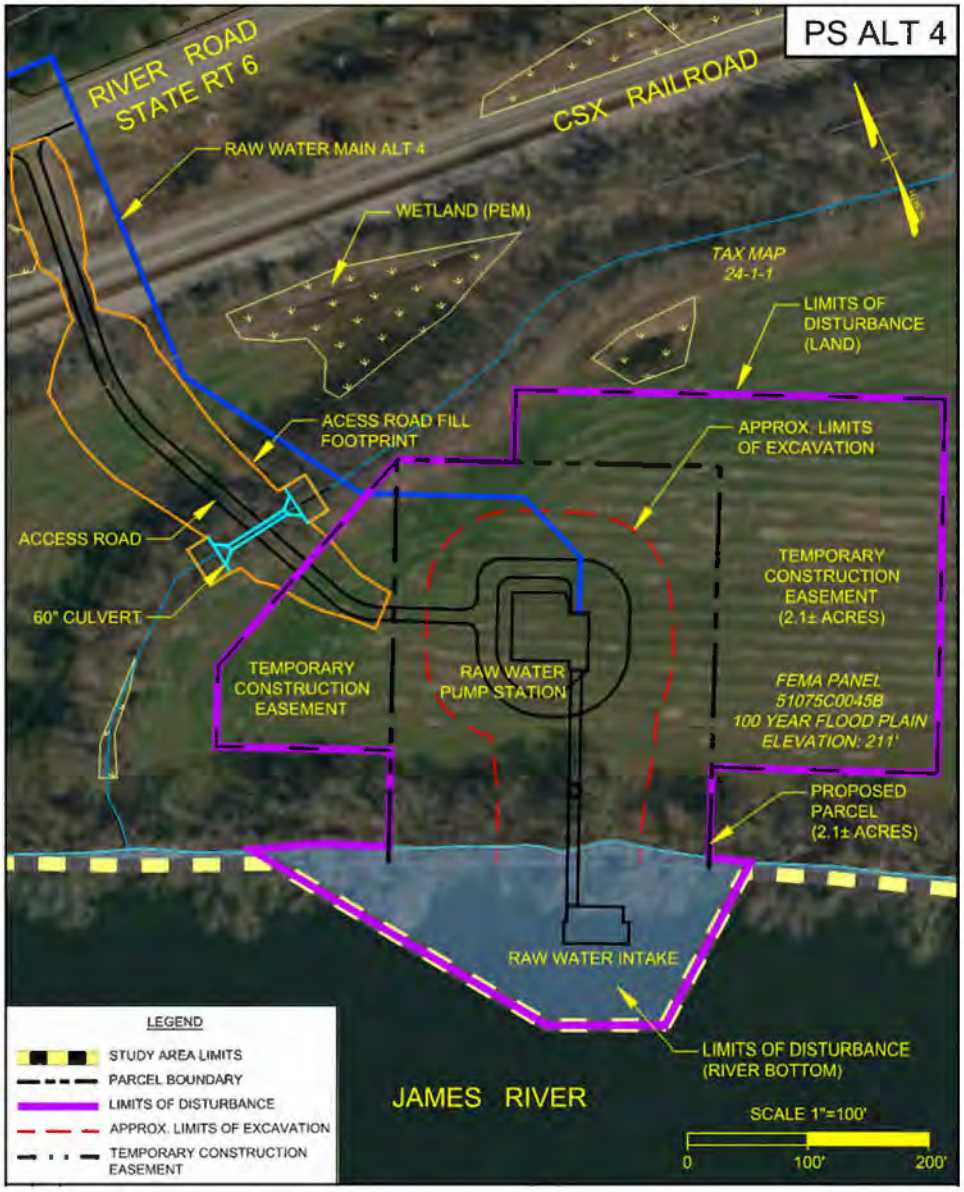


Figure 18. Build Alternative 4 Pump Station Plan View

Build Alternative 5 offers enough area to construct and maintain the proposed facilities. Figure 19 below shows the access road path and configuration of the site.

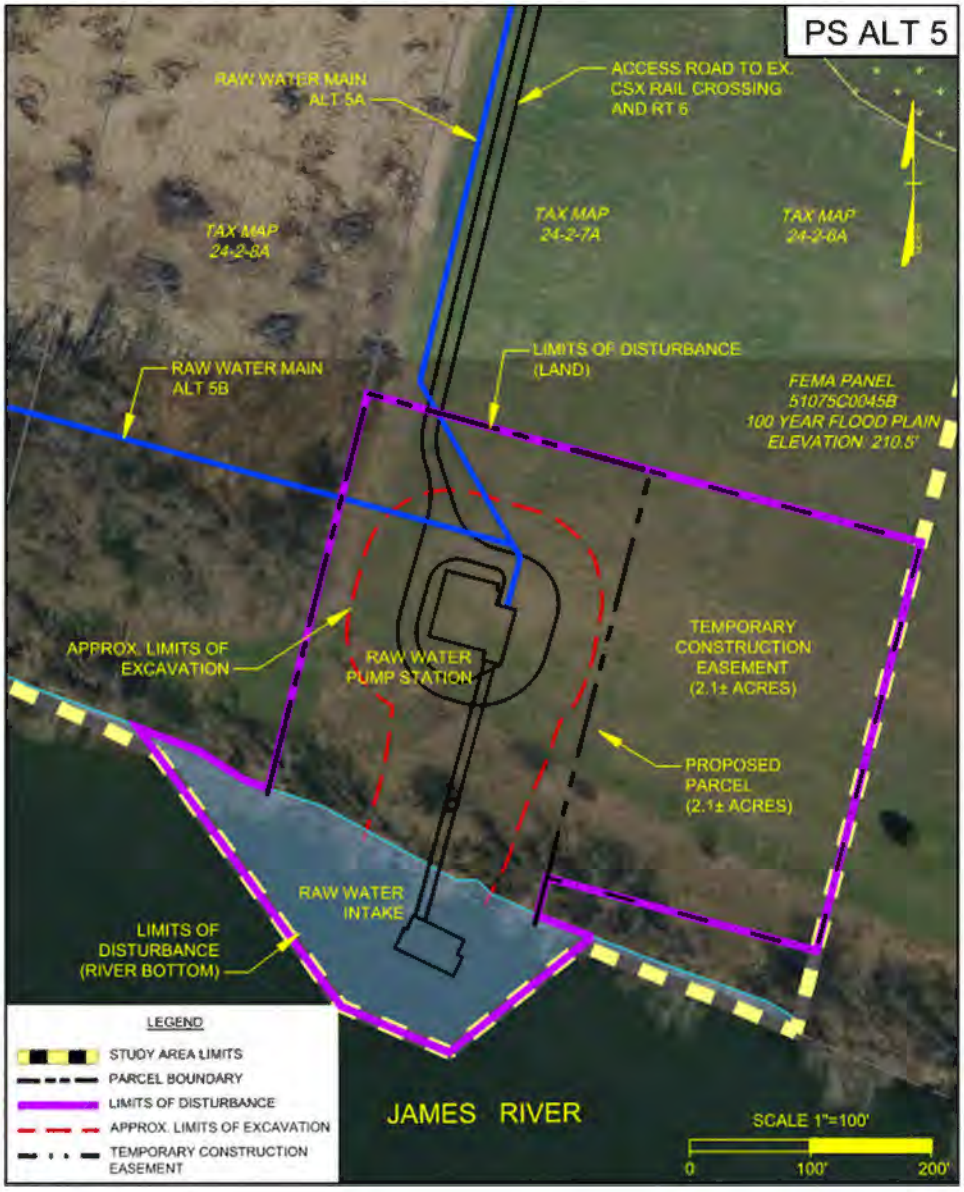


Figure 19. Build Alternative 5 Pump Station Plan View

Build Alternative 6 offers enough area to construct and maintain the proposed facilities. Figure 20 below shows the access road path and configuration of the site.

Figure 20. Build Alternative 6 Pump Station Plan View

Build Alternative 6-1 offers enough area to construct and maintain the proposed facilities, however this site is located on land owned by an unwilling landowner. Figure 21 below shows the access road path and configuration of the site.

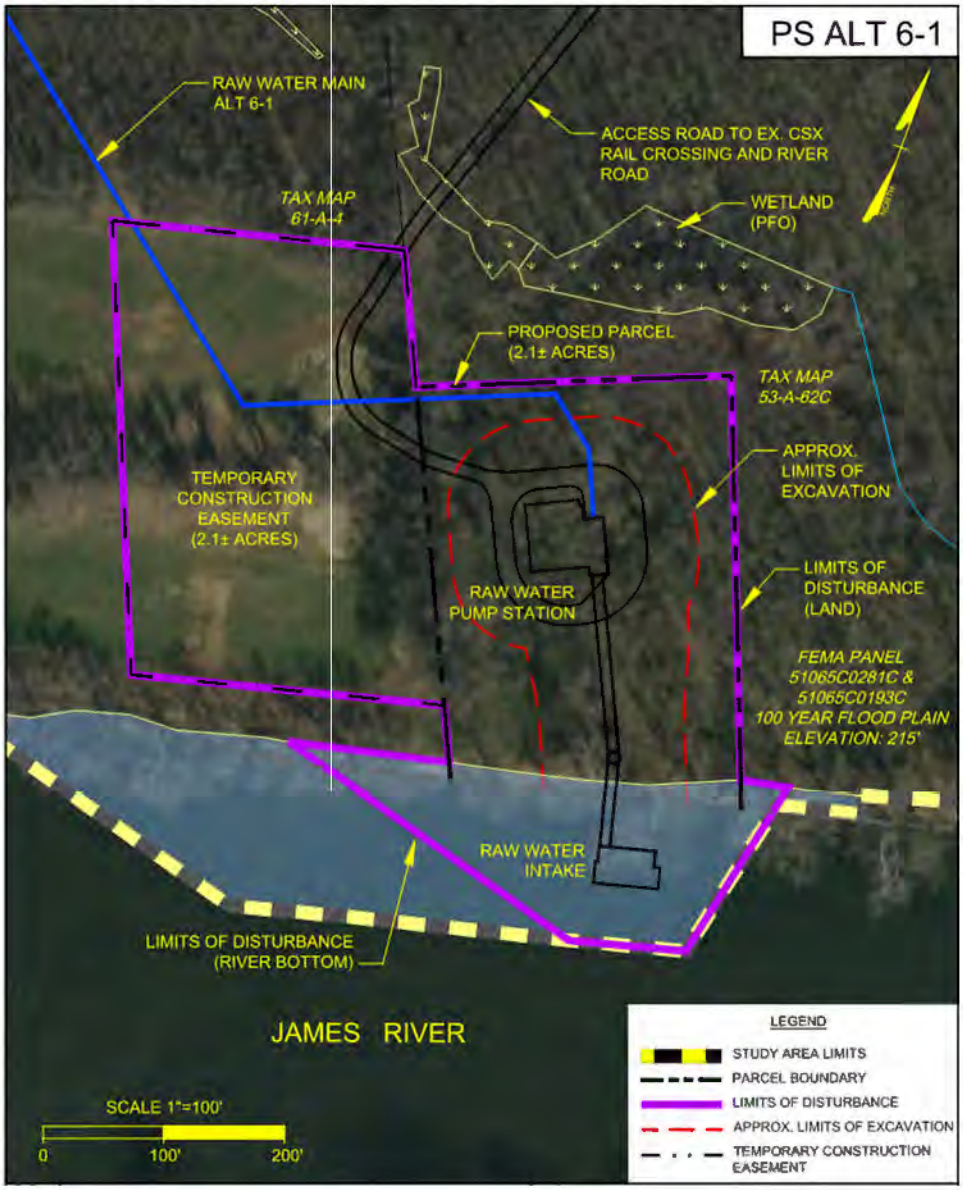


Figure 21. Build Alternative 6-1 Pump Station Plan View

Build Alternative 6-2 offers enough area to construct and maintain the proposed facilities. However, this site is very near the existing Colonial Gas pipeline. There is some risk associated with necessary blasting for excavation of the deep wetwell in proximity to the gas pipeline. Additionally, there is no close existing rail crossing to easily access this site, which would inhibit the ability to bring heavy equipment to the site. Figure 22 below shows the access road path and configuration of the site.

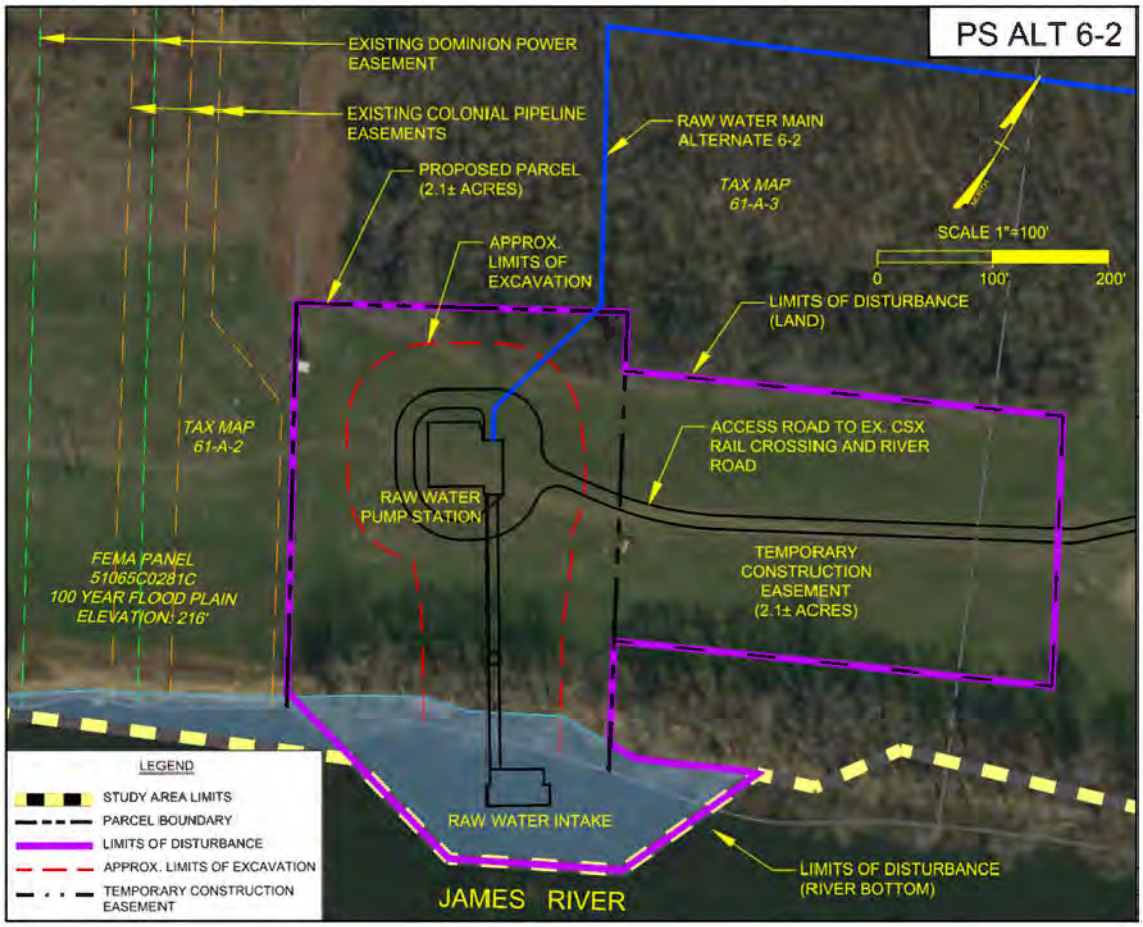


Figure 22. Build Alternative 6-2 Pump Station Plan View

4.2.1.1.2 Heavy Equipment Access to Pump Station Site

Constructing a pump station and water main requires that heavy equipment, such as cranes, excavators, and dump trucks, be brought to the site. This necessitates that the project area has an existing or newly constructed all-weather road to allow heavy equipment access from a public road. An alternative is not practicable if heavy equipment cannot safely reach the project area.

1) **Build Alternative 1** has an existing agricultural road with an existing single rail crossing that could be improved to an all-weather road to access the site.
2) **Build Alternative 2** would ultimately have access to Bremo Road via an existing private gravel road and an existing agricultural road with an existing dual rail crossing that could be improved to all-weather conditions to access the site. Given the approximate 12" vertical top of rail differential (see Table 7), it will difficult for a "low-boy" trailer (necessary to transport heavy equipment to the site) to cross the rail lines at this location. Therefore, the contractor and associated sub-contractors will need to unload heavy construction equipment prior to crossing the rail line, and then "walk" the equipment across the rail line to get to the site. This could prove to be problematic and possibly unacceptable to CSX operations for the duration of construction, presenting challenges to the practicability of this alternative.
3) **Build Alternative 3** pump station site would have direct access to Route 6 (Columbia Road) and would not require an access road. Construction of the intake structure would require a crane to be located on the Columbia Bridge and positioned such that the crane would not fall across the CSX rail line during construction operations. In addition, the Columbia Bridge will most likely need to be shut down for significant construction activities. A more detailed description is provided in Section 4.2.1.1.1. This could present challenges to the practicability of this alternative.
4) **Build Alternative 4** would have direct access to Route 6 via an existing agricultural road with an existing dual rail crossing that could be improved to an all-weather road to access the site. Given the approximate 11" vertical top of rail differential (see Table 7), it will difficult for a "low-boy" trailer (necessary to transport heavy equipment to the site) to cross the rail lines at this location. Therefore, the contractor and associated sub-contractors will need to unload heavy construction equipment prior to crossing the rail line, and then "walk" the equipment across the rail line to get to the site. This could prove to be problematic and possibly unacceptable to CSX operations for the duration of construction, presenting challenges to the practicability of this alternative.
5) **Build Alternative 5** would have direct access to Route 6 via an existing agricultural road with an existing dual rail crossing that could be improved to

an all-weather road to access the site. Given the approximate 11" vertical top of rail differential (see Table 7), it will difficult for a "low-boy" trailer (necessary to transport heavy equipment to the site) to cross the rail lines at this location. Therefore, the contractor and associated sub-contractors will need to unload heavy construction equipment prior to crossing the rail line, and then "walk" the equipment across the rail line to get to the site. This could prove to be problematic and possibly unacceptable to CSX operations for the duration of construction, presenting challenges to the practicability of this alternative.

6) **Build Alternative 6** would have direct access to Point of Fork Road via an existing access road and formerly state maintained Old Columbia Road (State Route 624) with an existing single rail crossing, of which JRWA currently owns a utility and access easement.

7) **Build Alternative 6-1** would have direct access to Point of Fork Road via an existing access road and formerly state maintained Old Columbia Road (State Route 624) with an existing single rail crossing, of which JRWA currently owns a utility and access easement.

8) **Build Alternative 6-2** would have direct access to Point of Fork Road via an existing access road and formerly state maintained Old Columbia Road (State Route 624) with an existing single rail crossing, of which JRWA currently owns a utility and access easement.

4.2.1.1.3 Excavation at Pump Station Site

The presence of rock presents a significant logistical challenge to construction of the project with regard to the Build Alternative site locations. The pump station site requires excavation of a deep vertical wetwell, thus JRWA gathered available geological information regarding the Alternative Build analyses sites to evaluate whether the presence of rock would present a logistical challenge.

Evaluation of each alternative site was based on available geological and geotechnical information in the general vicinity of each alternative. VDOT geotechnical records associated with the construction of the Columbia Bridge in Columbia and US 15 Bridge in Bremo Bluff and geotechnical reports for proposed build alternative 6 and 6-1 were used to make reasonable determinations of the depth of rock for each pump station site regarding depth to bedrock. The presence of rock is reasonably confirmed for each pump station build alternative and there are several locations where there is visible rock along the alternative water main alignments. As such, this assessment makes reasonable conclusions for the potential impact of rock excavation for the pump station construction for each alternative.

Geotechnical information is provided for Build Alternative 6 as it was obtained as part of the original Proposed Action Build Alternative analysis. The Geotechnical boring logs (see Appendix E-3-1) yielded bedrock at approximately Elevation 171, or approx. 23 feet below

ground surface in this area. The build alternatives without precise geotechnical information were reviewed with focus on the allowance for rock excavation activity such as blasting and heavy equipment access in order to construct and install the wetwell and intake structure.

1) **Build Alternative 1** is anticipated to have some rock excavation conditions requiring minimal excavation in the area. This does not present a significant obstacle to construction.

2) **Build Alternative 2** site is situated near visible rock outcroppings and thus will likely require excessive rock blasting and excavation in the area. This does not present a significant obstacle to construction.

3) **Build Alternative 3** site is situated near visible rock outcroppings and thus will likely require excessive rock blasting and excavation in the area. Given the site configuration, sheeted and braced excavation will be required (See Section 4.2.1.1.1). Given the likely presence of rock at the site excavation is anticipated to be problematic and a potential safety concern.

4) **Build Alternative 4** is anticipated to have rock excavation conditions requiring some excavation in the area. This does not present a significant obstacle to construction.

5) **Build Alternative 5** is anticipated to have rock excavation conditions requiring some excavation in the area. This does not present a significant obstacle to construction.

6) **Build Alternative 6** is anticipated to have rock excavation conditions requiring some excavation in the area. Based on the geotechnical report, bedrock is reached approximately 23 feet below ground surface. This does not present a significant obstacle to construction.

7) **Build Alternative 6-1** is anticipated to have rock excavation conditions requiring some excavation in the area. This does not present a significant obstacle to construction.

8) **Build Alternative 6-2** is anticipated to have rock excavation conditions requiring some excavation in the area. This does not present a significant obstacle to construction.

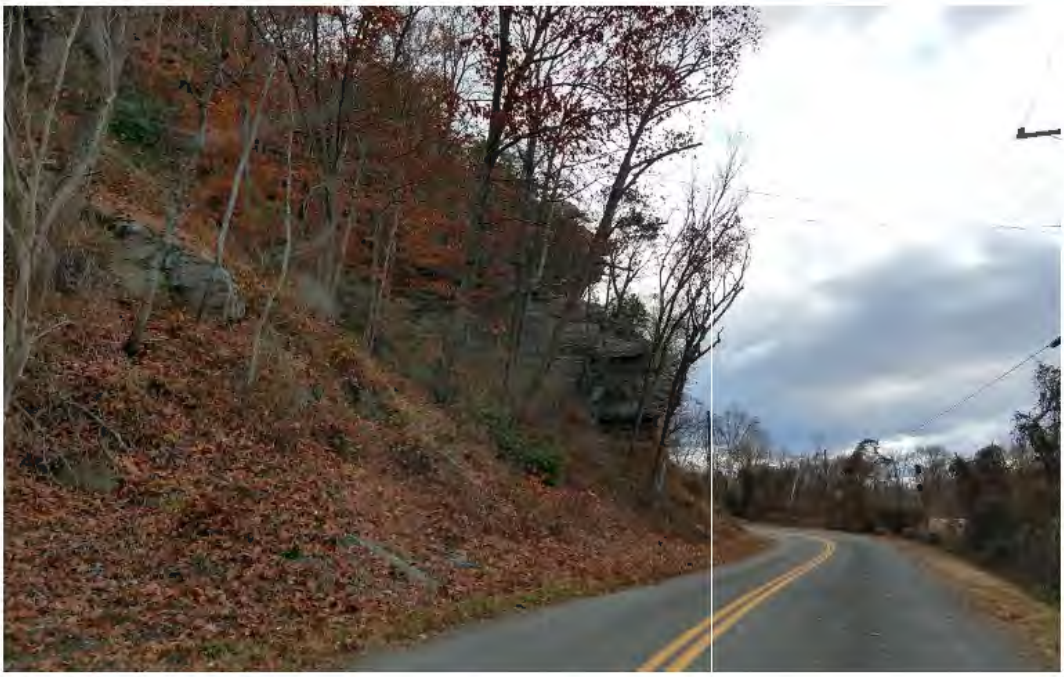
4.2.1.1.4 Constructability of Water Main

Constructability The construction requires excavation of long, but shallow, trench as well as excavation of deep bore pits for crossings of road and railroad features; therefore routing for the water main must offer favorable conditions to permit construction in a safe manner that minimizes the impacts to traffic safety, tree clearing, and rock excavation. Pipeline construction requirements with regard to VDOT R/W was provided during a meeting with VDOT December 18, 2019 (see Appendix H-3). The evaluation of water main routing was guided by these meeting notes to ensure the most effective routing without involving survey work for design means. Approximate lengths of water main production along VDOT R/W is summarized in Table 5.

Table 5. Pipeline Production Along VDOT Right-of-Way

Sub-Alternative ID	Pipeline Production Along VDOT R/W
	LF
1A	100
1B	13,100
1C	11,000
2A	46,100
2B	48,000
3	4,000
4	6,600
5A	9,500
5B	6,600
6	100
6-1	100
6-2	100

The constructability criterion also considers whether the water line route provides a practicable means of crossing the Rivanna River, CSX rail line, or other features. Potential Sub-alternative route alignments must offer favorable excavation conditions given the geological information provided in Section 4.2.1.1.3 Excavation at Pump Station Site. An exhibit (see Appendix H-4) shows the approximate limits of rock excavation required for each Sub-alternative and is summarized in Table 6 below. Photographs below illustrate examples of visible rock outcroppings that present difficulties during construction.



Photograph: Rock outcropping visible on Bremo Road near Bremo Bluff

Photograph: Rock outcroppings visible on Route 6 near Columbia and Goochland

Table 6. Approximate Lengths of Rock Excavation

Sub-Alternative ID	Approx. Length of Rock Excavation
	LF
1A	0
1B	0
1C	4,500
2A	9,200
2B	4,700
3	1,300
4	3,800
5A	6,700
5B	3,800
6	0
6-1	0
6-2	0

1) **Build Alternative 1** is divided into three sub-alternative water main routes. Sub-alternatives 1A and 1B permit the construction of pipe with minimal impact to traffic, clearing, and rock excavation; minimally impacting these factors results in more favorable construction conditions. Sub-alternative 1C however requires an extremely difficult crossing of the Rivanna River requiring a cofferdam open-cut method of installation at the Route 6 bridge, excessive rock excavation, and tree clearing.

2) **Build Alternative 2** is divided into two sub-alternative water main routes. Alternative sites 2A and 2B require excessive rock excavation along Bremo Road where high rock walls line portions of the roads resulting in challenging conditions during construction. Additionally, sub-alternative 2A requires an extremely difficult crossing of the Rivanna River requiring a cofferdam open-cut method of installation at the Route 6 bridge, excessive rock excavation, and tree clearing.

3) **Build Alternative 3** requires excessive rock excavation, tree clearing, and construction in close proximity to existing dwellings. These combined construction challenges result in low practicability in terms of construction.

4) **Build Alternative 4** requires excessive rock excavation, tree clearing, and construction in proximity of existing dwellings. These combined construction challenges result in low practicability in terms of construction.

5) **Build Alternative 5** is divided into two sub-alternative water main routes. Alternative sites for 5A and 5B both require excessive rock excavation, tree clearing, and construction in proximity of existing dwellings. These combined construction challenges result in low practicability in terms of construction.

6) **Build Alternative 6** permits the construction of pipe with minimal impact to traffic, tree clearing, and rock excavation. Minimally impacting these factors results in more favorable construction conditions.

7) **Build Alternative 6-1** permits the construction of pipe with minimal impact to traffic, tree clearing, and rock excavation. Minimally impacting these factors results in more favorable construction conditions.

8) **Build Alternative 6-2** permits the construction of pipe with minimal impact to traffic, tree clearing, and rock excavation. Minimally impacting these factors results in more favorable construction conditions.

4.2.1.1.5 Suitable Railroad Track Crossing Location

The access road to each site must be free from obstructions that would endanger equipment. Each of the alternative pump station sites except Alternative 3 would require equipment to cross CSX's rail lines, which run parallel to the James River. Road crossings of the rail lines may not be suitable for heavy equipment in all cases. Although not a construction consideration per se, the same crossing location must be suitable for providing access to the pump station on a long-term basis for operation and maintenance.

In order to allow for construction vehicles and equipment, construction traffic, and long-term operations and maintenance of the pump station and intake site, improvements to the CSX rail crossing would be required at four of the existing rail crossings (Alternatives 1, 2, 4 and 5) for the proposed pump station sites. Improvements anticipated would include upgrading the road to allow for adequate vertical curvature to accommodate this type of traffic, which would include filling in sections of the road, installing culverts as necessary to provide adequate drainage across these roads and making necessary crossing improvements such that short-term and long-term rail operations would not be disrupted. As part of this analysis, JRWA developed preliminary net fill volumes and maximum depth for any road fill required to upgrade the rail crossing that were calculated based on cross sections (see Appendix H-5-3).

It's important to note that the Alternative 6 rail crossing is in the former Old Columbia Road (Route 624) alignment and requires no improvements. CSX previously provided a permit to cross in this area (see Appendix H-5-1). All of the other existing rail crossing

locations (Alternatives 1, 2, 4 and 5) will require the execution of private road access agreement with CSX.

Below is a table summarizing the key elements to be considered when designing access road improvements across the existing rail lines:

Table 7. Rail Line Crossing Considerations

Build Alternative Location	Single or Dual Rail Crossing	Vertical Rail Separation (Dual Rail)	Estimated Net Fill Needed at Crossing	Maximum Depth of Fill
			Cubic Yards	Feet
1	Single Rail	N/A	1,466	5.8'
2	Dual Rail	Approx 12"	2,795	8.2'
3	N/A	N/A	0	N/A
4	Dual Rail	Approx 11"	1,761	10.1'
5	Dual Rail	Approx 11"	3,904	8.8'
6	Single Rail	N/A	0	N/A
6-1	Single Rail	N/A	0	N/A
6-2	Single Rail	N/A	0	N/A

1) **Build Alternative 1** has an existing rail crossing that has an excessive grade differential to the adjacent finished grade. For a cross-section see Appendix H-5-3 Sheet 1. This condition will necessitate the construction of permanent approach ramps on each side of the crossing to permit safe access to the site with construction and maintenance equipment. Additionally, the existing rail crossing will likely require upgrades for long-term use of the crossing.

2) **Build Alternative 2** has an existing rail crossing that has an excessive grade differential to the adjacent finished grade. This condition will necessitate the construction of permanent approach ramps on each side of the crossing to permit safe access to the site with construction and maintenance equipment. The existing rail crossing will likely require upgrades for long-term use of the crossing. Additionally, forgoing a dual rail crossing is an avoidable risk for future operations personnel and maintenance operators that can be avoided with a single rail crossing.

   In addition to approach ramps, consideration must be given to the differential in elevation between the two rail lines of approximately 12 inches. For cross-section see Appendix H-5-3 Sheet 2. This differential may prove to be problematic for access of construction vehicles that could bottom out on the rails, thus creating an extremely dangerous situation considering that these are active CSX rail lines (see Section 4.2.1.1.2).

3) **Build Alternative 3** does not have an existing rail crossing between the pump station and intake structure. Based upon a preliminary review of the Build Alternatives, CSX discourages locating the pump station and intake at this site due to the existing electrical infrastructure and active switching yard (see Appendix H-5-2). It is strongly recommended to avoid this particularly due to the nearby electrical equipment and safety concerns.

4) **Build Alternative 4** has an existing rail crossing that has an excessive grade differential to the adjacent finished grade. This condition will necessitate the construction of permanent approach ramps on each side of the crossing to permit safe access to the site with construction and maintenance equipment. The existing rail crossing will likely require upgrades for long-term use of the crossing. Additionally, forgoing a dual rail crossing is an avoidable risk for future operations personnel and maintenance operators that can be avoided with a single rail crossing.

   In addition to approach ramps, consideration must be given to the differential in vertical top of rail elevation between the two rail lines of approximately 11 inches. For cross-section see Appendix H-5-3 Sheet 3. This differential may prove to be problematic for access of construction vehicles that could bottom out on the rails, thus creating an extremely dangerous situation considering that these are active CSX rail lines.

5) **Build Alternative 5** has an existing rail crossing that has an excessive grade differential to the adjacent finished grade. This condition will necessitate the construction of permanent approach ramps on each side of the crossing to permit safe access to the site with construction and maintenance equipment. The existing rail crossing will likely require upgrades for long-term use of the crossing. Additionally, forgoing a dual rail crossing is an avoidable risk for future operations personnel and maintenance operators that can be avoided with a single rail crossing.

   In addition to approach ramps, consideration must be given to the differential in vertical top of rail elevation between the two rail lines of approximately 11 inches. For cross-section see Appendix H-5-3 Sheet 4. This differential may prove to be problematic for access of construction vehicles that could bottom out on the rails, thus creating an extremely dangerous situation considering that these are active CSX rail lines.

6) **Build Alternative 6** offers access across the CSX rail line at an existing crossing of acceptable condition. For cross-section see Appendix H-5-3 Sheet 5. This crossing location is currently permitted for a water main crossing and

will not require an upgrade to the road and rail crossing in CSX Right-of-Way, as such this is CSX's preferred Build Alternative (see Appendix H-5-2).

7) **Build Alternative 6-1** offers access across the CSX rail line at an existing crossing of acceptable condition. This crossing location is currently permitted for a water main crossing and will not require an upgrade to the road and rail crossing in CSX Right-of-Way, as such this is CSX's preferred Build Alternative (see Appendix H-5-2).

8) **Build Alternative 6-2** offers access across the CSX rail line at an existing crossing of acceptable condition. This crossing location is currently permitted for a water main crossing and will not require an upgrade to the road and rail crossing in CSX Right-of-Way, as such this is CSX's preferred Build Alternative (see Appendix H-5-2).

4.2.1.1.6 Acquisition of Land and Easements

Due to the time and cost of acquisition, an alternative that requires fewer easements generally presents fewer obstacles to construction. Where feasible, the water main routes were place in or adjacent to existing public rights-of-way. Each Build Alternative would require the acquisition of property for the intake and pump station (note that the property for Build Alternative 6 has already been purchased), along with ingress / easements for access to the site. For the purposes of this analysis is was determined that land and easement acquisition costs greater than 2X the lowest costs would be impracticable (see Section 4.2.1.3 for Cost Considerations).

The pump station parcel size required for each pump station site is approximately 2 acres, which is the current size of the parcel owned by the JRWA for Build Alternative 6. For the purposes of this alternatives evaluation, JRWA assumed that each of the pump station sites would be 2 acres.

A temporary construction easement will be required around each pump station site for construction staging, laydown, equipment storage, parking for contractors, and storage of spoils materials for the excavation for construction of the pump station. For the purposes of this analysis, it was determined that the contractor would need approximately 2.1 acres for temporary construction easement, unless site conditions dictated otherwise. Based upon our evaluation it appears that site conditions will allow for all of the alternatives to be able to accommodate a 2.1-acre temporary construction easement, with the exception of Alternative 3, which is located within the town of Columbia.

Table 8. Easement Requirements

Alternative Alignment	Estimated Easements Required (1)	Total Estimated Easement Area Required (2)	
		SF	AC
1A	11	941,200	21.61
1B	18	1,051,700	24.14
1C	26	941,700	21.62
2A	81	1,928,900	44.28
2B	73	2,040,400	46.84
3	16	142,500	3.27
4	18	232,600	5.34
5A	19	307,400	7.06
5B	23	365,100	8.38
6	5 (3)	621,300	14.26
6-1	6	621,300	14.26
6-2	6	553,300	12.70

Notes:
(1) Estimated Easements Required based upon Fluvanna County GIS database from August 2019.
(2) Estimated Easement Area includes permanent and temporary construction easements required.
(3) All easements currently owned by JRWA (see Appendix P).

1) **Build Alternative 1** has three Sub-alternative routes. Sub-alternative 1A travels parallel along the CSX rail, sub-alternative 1B travels partially along the Bremo Road right-of-way and Point of Fork Road prescriptive easement; sub-alternative 1C travels partially along the Bremo Road right-of-way and Route 6 right-of-way; it would require a temporary construction easement for crossing the Rivanna River on Route 6. Sub-alternatives 1B and 1C are impracticable as they are estimated to exceed 2X the lowest costs.

2) **Build Alternative 2** has two sub-alternative routes. Sub-alternative 2A travels along the Bremo Road right-of-way and (partially prescriptive easement) and travels along the Route 6 right-of-way; it would require a temporary construction easement for crossing the Rivanna River on Route 6, sub-alternative 2B travels along the Bremo Road right-of-way (partially prescriptive easement) and along the Point of Fork Road prescriptive easement. Both sub-alternatives are impracticable as they are estimated to exceed 2X the lowest costs.

3) **Build Alternative 3** would require an encroachment agreement from CSX. Easements for constructing the water main along building fronts in Columbia along Route 6 will be difficult to configure.

4) **Build Alternative 4** travels along the Route 6 right-of-way. However, easements for constructing the water main along the building fronts in Columbia along Route 6 will be difficult to configure.

5) **Build Alternative 5** has two sub-alternative routes. Sub-alternatives 5A and 5B both travel along the Route 6 right-of-way, however easements for constructing the building fronts in Columbia along Route 6 will be difficult to configure.

6) **Build Alternative 6** currently offers approximately 14.3 acres of easements. These easements have already been obtained from prior permitting for this project.

7) **Build Alternative 6-1** currently offers easements already obtained from this project, except for the portion along the Point of Fork Farms property. This additional easement may be difficult to obtain due to prior property conflicts with the current owner.

8) **Build Alternative 6-2** currently offers easements already obtained from this project, and additional pipeline and permanent access easement required to reach the pump station from the location of Build Alternative 6.

4.2.1.2 Site Suitability Considerations

4.2.1.2.1 Adequate Water Quality

Public water supplies need to withdraw high-quality water. Utilizing low-quality water can present a public health concern and/or present challenges for the treatment of the water. The intake location must be able to withdraw water of suitable quality for treatment without excessive pre-treatment. Due to issues with excessive siltation and sedimentation, locations located downstream of the confluence of the James River and Rivanna River are not desirable. The Rivanna River suspends silt which is carried to the confluence with the James River. At the confluence much of this silt is deposited on the left bank (Columbia side) of the James River thus resulting in visible plumes of silt. These silt deposits are in proximity to Build Alternatives 3, 4, and 5. The occurrence of increased siltation downstream of the confluence can be seen consistently through historic aerial imagery. Examples are provided in Appendix E-1 (see images associated with the years 1958, 1969, 1977, 1984, 2009 and 2016). In addition, Figure 23 (2013 VGIN aerial imagery) and Figure 24 (2013 VGIN Infrared Imagery) below provides a visualization of a plumes of silt along the left (north) bank of the James River in the vicinity of Build Alternatives 3, 4, and 5.

Figure 23. Rivanna River Confluence Sediment Plume - 2013 VGIN Aerial Imagery

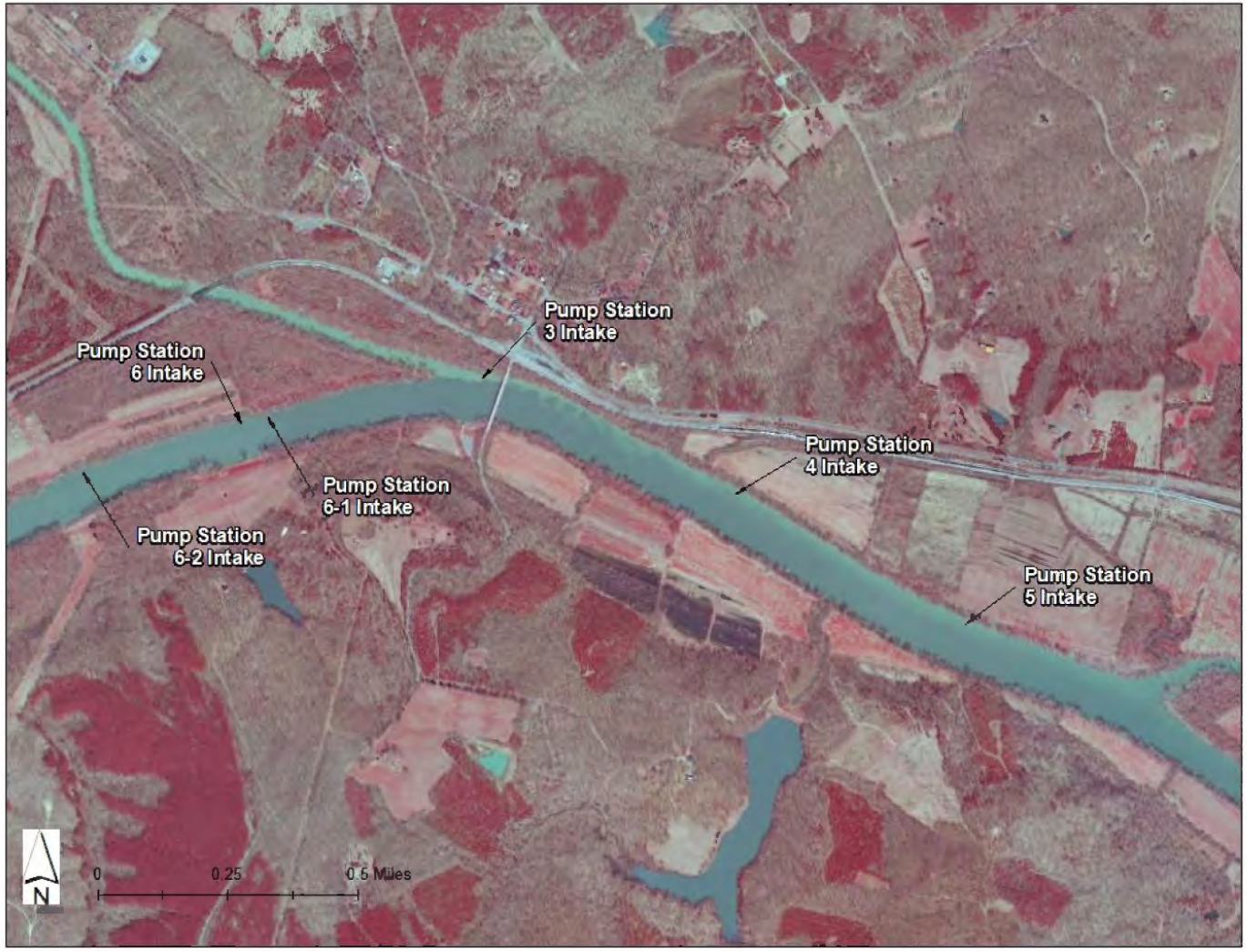


Figure 24. Rivanna River Confluence Sediment Plume - 2013 VGIN Infrared Imagery

Sediment Plume from Rivanna and James Confluence - Secondary / Induced Capital and Long-term Operational Costs to Project Partners. As discussed in Section 4.2.1.2.1, a well-defined sediment plume exists at the confluence of the Rivanna River with the James River and along the north bank of the James River for approximately 1.4 miles downstream to Elk Island. Any intake located along this section of the James River, which includes Alternatives 3, 4 and 5, would require both Fluvanna County and Louisa County to address these sedimentation issues at their respective water treatment plants.

In order to address this sedimentation issue from a water treatment process perspective, a water treatment plant would need to install an additional or enlarged pre-settling basin and clarifiers to ensure the removal of the sediment, which is considered a secondary / induced capital and long-term operational costs for each respective County. For the purposes of this evaluation, we have included the additional capital costs for the installation of an additional pre-settling basin and clarifiers at the Louisa Ferncliff WTP. The construction costs of these additional facilities are approximately $6.1 million.

Since Fluvanna County has not yet determined the size and / or location of their future water treatment plant as of this report, the potential capital costs to improve the facilities for Fluvanna have not been included in the analysis. For this analysis to be truly complete, the costs to Fluvanna County to address the sedimentation issue at a future WTP would need to be incorporated into the cost estimates, therefore, the numbers presented in this analysis will only increase from the current analysis.

Five-Mile Discharge Path for Wastewater Treatment Plants. A second important water quality consideration is that raw water withdrawals should be located in an area that does not result in compliance issues with wastewater outfalls up to a distance of five miles upstream. As stated in the Virginia Waterworks Regulations, when applying for a construction permit with the VDH, plans must be submitted for the waterworks that includes location of all sources of pollution five miles upstream from surface water intakes (see Appendix H-6-1). Additionally, any water intake located within an area five miles upstream of the intake will need to be reviewed on a case-by-case basis in order to protect the water supply (see Appendix H-6-2). As such, the consideration for selecting alternative locations was based upon avoiding locating the intake within five miles of the existing Dominion Bremo Bluff coal ash impoundment discharge and Fork Union Wastewater Treatment Plant discharge. These lengths can be found on Figure 7.

The five-mile discharge constraint served as guidance for the selection of appropriate alternative pump station and intake structure locations along the James River. The Bremo Bluff site was chosen to be upstream of the coal ash impoundment discharge point into the James River. The downstream extent was defined to locations: (1) Past the end of the coal ash impoundment discharge point five-mile discharge path, (2) Past the end of the Fork Union Wastewater Treatment Plant's five-mile discharge path, and (3) Before the beginning of Elk Island divergence point on the James River. This divergence point would

create potential siltation issues; remaining upstream of this point is advantageous from a water quality as well as quantity viewpoint

1) **Build Alternative 1** is upstream of the confluence of the James River and Rivanna River and is unaffected by excess siltation or wastewater discharges.

2) **Build Alternative 2** is upstream of the confluence of the James River and Rivanna River and is unaffected by excess siltation or wastewater discharges.

3) **Build Alternative 3** is located adjacent to the confluence of the Rivanna and James River. Excessive siltation may occur due to its proximity to the confluence and would compel upgrades to the Ferncliff WTP and future water treatment plants utilizing water from the project.

4) **Build Alternative 4** is located downstream of the confluence of the James River and Rivanna River. Excessive siltation may occur due to its proximity to the confluence and would compel upgrades to the Ferncliff WTP and future water treatment plants utilizing water from the project.

5) **Build Alternative 5** is located downstream of the confluence. Excessive siltation may occur due to its proximity to the confluence and would compel upgrades to the Ferncliff WTP and future water treatment plants utilizing water from the project.

6) **Build Alternative 6** is upstream of the confluence of the James River and Rivanna River and is unaffected by excess siltation or wastewater discharges.

7) **Build Alternative 6-1** is upstream of the confluence of the James River and Rivanna River and is unaffected by excess siltation or wastewater discharges.

8) **Build Alternative 6-2** is upstream of the confluence of the James River and Rivanna River and is unaffected by excess siltation or wastewater discharges.

4.2.1.2.2 Intake and Pump Station Proximity and Depth of Wetwell

To be suitable for this water supply project, a site must offer the ability to construct the intake and pump station in close proximity to minimize the potential of sediment depositing in the intake piping. The intake pipe for each alternative is gravity fed and needs to be a sufficient depth and slope to allow for adequate scouring of any potential siltation and/or sedimentation that will enter through the intake screen.

To protect aquatic life and recreational users of the James River (see Section 2.4.2), the screened raw water intake is designed to receive and flow water by gravity into the wetwell

at the pump station. The depth of the wetwell is dependent on elevation change from the river bottom to the pump station site. Because the intake pipe must be installed at a declined angle to allow gravity flow, the change in elevation necessarily increases the farther the pump station is from the river. This elevation difference must be of reasonable depth to avoid excessively deep wetwells. As a result, pump stations generally must be constructed as close to the riverbank as feasible.

In addition it appears that each intake and pump station alternative will require the intake and pump station to be constructed in rock (see Section 4.2.1.1.3), thereby further supporting the need for the intake and pump station to be located in close proximity to avoid excessive construction costs due to additional unnecessary rock excavation.

River bottom and bedrock information for Build Alternative 6 is verified by geotechnical and bathymetric data previously surveyed as part of the original Proposed Action Build Alternative analysis (see Appendix E-3). Information for Build Alternative 1 was also based on these findings due to its proximity to Build Alternative 6.

River bottom and bedrock shown in the table below for Build Alternatives 2, 3, 4, and 5 are approximations based on two geotechnical reports conducted in the vicinity of the sites. The geotechnical reports for the Bremo Bluff Bridge Plans (see Appendix H-7-1) was used for Build Alternative 2, and the Columbia Bridge Plans (see Appendix H-7-2) was used for Build Alternatives 3, 4, and 5. The results in the table below are based on the proximity of each site to either bridge. However, this information may be imprecise as the assumption has been made that site characteristics will be similar due to proximity.

Exhibits were created based on the geotechnical reports information from above for an approximation on the relative depth and heights associated with each pump station site summarized below in Table 9. Based on the table, the depth of bedrock excavation required for each site is comparable. Excavation into bedrock is expected for all Build Alternatives. For further detail and profile views, see Appendix H-2 for intake structure to wetwell cross section exhibits.

Table 9. Intake and Wetwell Data

Build Alternative Location	Intake Pipe Invert at Intake	Wetwell Floor	Total Height of Wetwell Walls	Pump Station Height Above Grade	Depth of Bedrock Excavation	Total Depth of Excavation
	FT	FT	FT	FT	FT	FT
1	172.3	166.0	54.0	35.8	13.8	42.5
2	194.0	187.0	47.5	36.8	14.5	35.0
3	165.6	158.0	56.0	36.8	15.1	43.5
4	165.6	159.0	53.5	33.3	14.1	44.5
5	165.6	159.0	52.5	33.3	14.1	43.5
6	165.6	159.0	57.0	36.8	14.1	44.5
6-1	165.6	159.0	57.0	36.8	14.1	44.5
6-2	165.6	159.0	57.0	36.8	14.1	44.5

1) **Build Alternative 1** is anticipated to permit the construction of the intake and pump station within acceptable proximity of each other. Likewise, the wetwell depth is approximately 54 feet as shown in (see Appendix H-2 Sheet 1).

2) **Build Alternative 2** is anticipated to permit the construction of the intake and pump station within acceptable proximity of each other. The depth of the wetwell is approximately 47.5 feet from finished floor to the bottom of the wetwell as shown in (see Appendix H-2 Sheet 2).

3) **Build Alternative 3** has an active CSX line running perpendicular to the intake piping. This will require the intake and pump station to be constructed at a greater distance from one another. Additionally, the pump station has a higher relative elevation to the river bottom, thus will also require an excavation depth of approximately 56 feet (see Appendix H-2 Sheet 3) for the wetwell.

4) **Build Alternative 4** is anticipated to permit the construction of the intake and pump station within acceptable proximity of each other. Likewise, the wetwell depth is approximately 53.5 feet as shown in (see Appendix H-2 Sheet 4).

5) **Build Alternative 5** is anticipated to permit the construction of the intake and pump station within acceptable proximity of each other. Likewise, the wetwell depth is approximately 52.5 feet as shown in (see Appendix H-2 Sheet 5).

6) **Build Alternative 6** permits the construction of the intake and pump station to be of reasonable proximity to one another. The depth of the wetwell is appropriate at 57 feet deep as shown in in (see Appendix H-2 Sheet 6).

7) **Build Alternative 6-1** is assumed to be comparable to Build Alternative 6 due to its proximity to the site.

8) **Build Alternative 6-2** is assumed to be comparable to Build Alternative 6 due to its proximity to the site.

4.2.1.2.3 River Bottom Depth at Intake Location

The river bottom at the site must have a suitable profile to avoid causing the intake to be exposed during low-flow or drought conditions. That would inhibit its ability to withdraw water and increase the risk that the intake would be damaged. A bathymetric survey was completed for Alternative 6 (see Appendix E-3-4). The remaining Build Alternative intake sites were evaluated based on geotechnical reports from existing bridge plans near Bremo and Columbia (see Appendix H-7) due to their proximity to the sites.

Aerial imagery of the James River was also used to aid in avoiding undesirable river bottom characteristics. As shown in the example photograph below, undulating waters and rapids visible in aerial view are typically indicative of rocky river bottom terrain which should be avoided; conversely, flat waters are indicative of areas without rock outcroppings along the river bottom which is desirable for intake location. The geotechnical reports and aerial imagery assessments were used as an approximation of the river bottom characteristics in lieu of a more site-specific bathymetric survey.

Photograph: Esri World Imagery near Bremo Bluff; undulating vs. flat waters

1) **Build Alternative 1** currently does not have bathymetric survey therefore it is currently unknown if the site definitively offers favorable river bottom conditions; however, the Bremo Bridge plan and Build Alternative 6 geotechnical reports were used to approximate river bottom characteristics for analysis. Conditions based on

this approximation do not present difficulties regarding the river bottom and intake structure placement.

2) **Build Alternative 2** currently does not have bathymetric survey therefore it is currently unknown if the site definitively offers favorable river bottom conditions; however, the Bremo Bridge plan geotechnical report was used to approximate river bottom characteristics for analysis. Conditions based on this approximation do not present difficulties regarding the river bottom and intake structure placement.

3) **Build Alternative 3** currently does not have bathymetric survey therefore it is currently unknown if the site definitively offers favorable river bottom conditions; however, the Columbia Bridge plan geotechnical report was used to approximate river bottom characteristics for analysis. Conditions based on this approximation do not present difficulties regarding the river bottom and intake structure placement.

4) **Build Alternative 4** currently does not have bathymetric survey therefore it is currently unknown if the site definitively offers favorable river bottom conditions; however, the Columbia Bridge plan geotechnical report was used to approximate river bottom characteristics for analysis. Conditions based on this approximation do not present difficulties regarding the river bottom and intake structure placement.

5) **Build Alternative 5** currently does not have bathymetric survey therefore it is currently unknown if the site definitively offers favorable river bottom conditions; however, the Columbia Bridge plan geotechnical report was used to approximate river bottom characteristics for analysis. Conditions based on this approximation do not present difficulties regarding the river bottom and intake structure placement.

6) **Build Alternative 6** offers a river profile that is relatively flat across the width of the river, thus the river depth during drought conditions should be relatively consistent across the river.

7) **Build Alternative 6-1** offers a river profile that is relatively flat across the width of the river, thus the river depth during drought conditions should be relatively consistent across the river.

8) **Build Alternative 6-2** currently does not have bathymetric survey therefore it is currently unknown if the site definitively offers favorable river bottom conditions; however, the Build Alternative 6 geotechnical report was used to approximate river bottom characteristics for analysis due to the proximity of the site. Conditions based on this approximation do not present difficulties regarding the river bottom and intake structure placement.

4.2.1.2.4 Access to Suitable Power Supply

The pump station must have access to a 3-Phase power source. Sites that require long extensions of 3-Phase power will result in significant increases in cost of power installation. More distant sites could require partial routing with overhead power (i.e. along Bremo Road), necessitating additional coordination with VDOT regarding colocation of easements adjacent to VDOT right-of-way. These segments would also be at higher risk of a loss of power during high wind and icing conditions, as more of the existing overhead power lines are exposed to weather elements. Table 10 and Figure 25 on the following pages shows the approximate distance and routing to 3-phase power for each Build Alternative site location. Existing tie-in connection points for 3-Phase power were confirmed based on photographs of the existing power poles and consultation with William R. Jennings, Jr., PE, Electrical Engineer for the project (see Appendix H-8). It is anticipated that underground power would be routed from either the tie-in point or the beginning of the access road to reach the pump station on the site.

Please note that cost of getting power to the site has not been included in projected project costs (Section 4.2.1.3).

Table 10. Pump Station Site Distance to 3-Phase Power

Build Alternative Location	Approximate Distance
	Mi
1	1.0
2	1.1
3	0.08
4	0.12
5	0.34
6	0.57
6-1	0.57
6-2	0.64

1) **Build Alternative 1** has 3-phase power within approximately 1.0 miles of the pump station site and would need to be partially routed along Bremo Road. Additional coordination with VDOT will be required.
2) **Build Alternative 2** has 3-phase power within approximately 1.1 miles of the pump station site and would be partially routed along Bremo Road. Additional coordination with VDOT will be required.
3) **Build Alternative 3** has 3-phase power within approximately 0.08 miles of the pump station site and could be routed underground to the site.

4) **Build Alternative 4** has 3-phase power within approximately 0.12 miles of the pump station site and could be routed underground to the site.
5) **Build Alternative 5** has 3-phase power within approximately 0.34 miles of the pump station site and could be routed underground to the site.
6) **Build Alternative 6** has 3-phase power within approximately 0.57 miles of the pump station site and could be routed underground to the site.
7) **Build Alternative 6-1** has 3-phase power within approximately 0.57 miles of the pump station site and could be routed underground to the site.
8) **Build Alternative 6-2** has 3-phase power within approximately 0.64 miles of the pump station site and could be routed underground to the site.

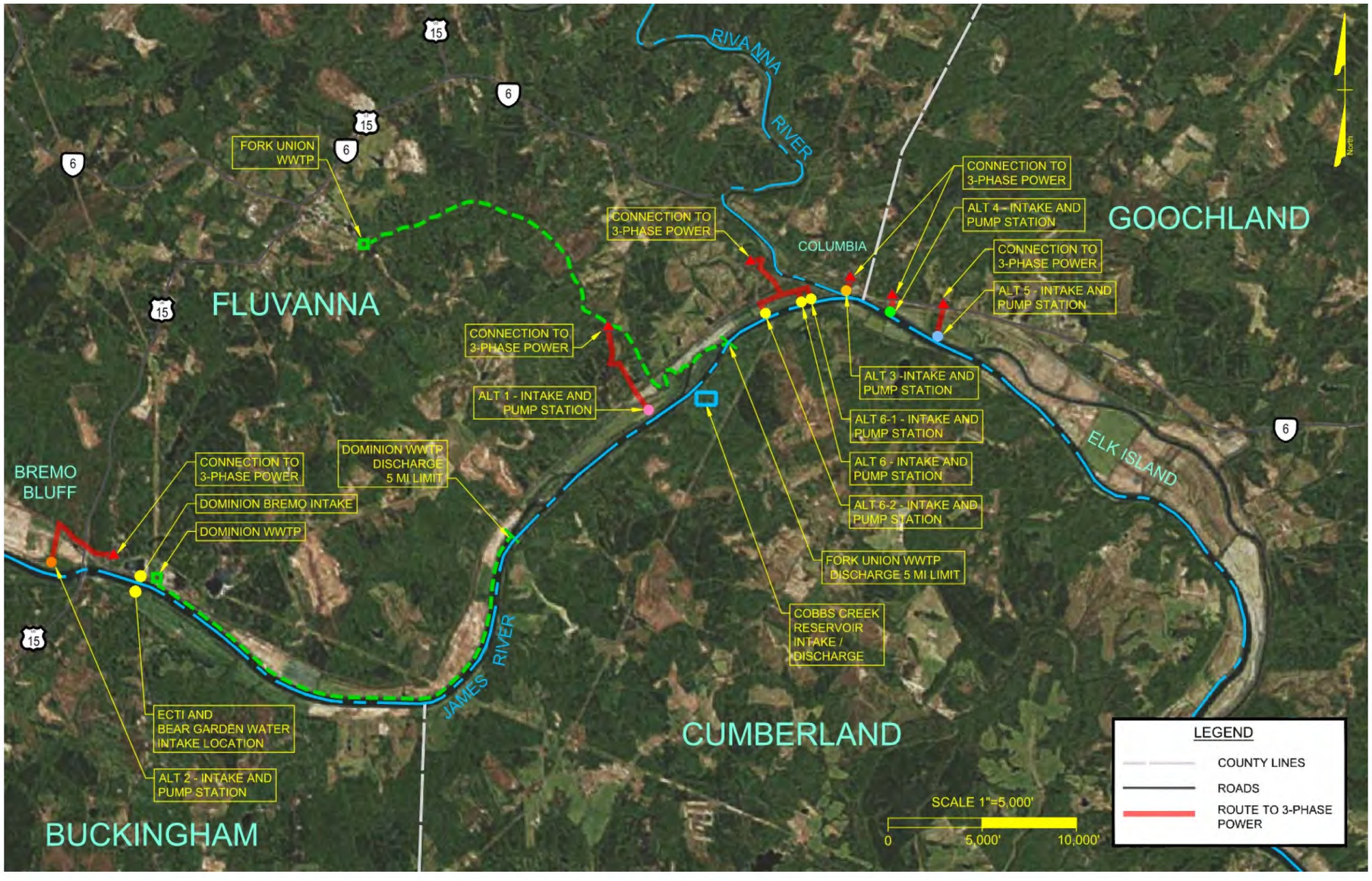


Figure 25. Routes to 3-Phase Power Tie-in Locations

4.2.1.2.5 Proximity to Residential Dwellings / Homes

It is highly undesirable to locate the intake and pump station in close proximity to residential dwellings. That avoids the pump station becoming a nuisance and minimizes hazards to public and the pump station. The approximate distance between site and residential buildings is summarized below.

Table 11. Proximity to Residential Dwellings

Build Alternative Location	Approximate Distance	Additional Comments
	LF	LF
1	2,700	Large parcel - Single Family Dwelling
2	1,300	Multiple Dwellings in Bremo Bluff
3	150	Multiple Dwellings in Columbia
4	2,000	Multiple Dwellings in Columbia
5	1,900	Large parcel - Single Family Dwelling
6	1,500	Large parcel - Single Family Dwelling
6-1	1,250	Large parcel - Single Family Dwelling
6-2	2,150	Large parcel - Single Family Dwelling

4.2.1.3 Cost Considerations

JRWA is a public water authority that is wholly funded by the approximately 63,000 residents of Louisa County and Fluvanna County. A project of this magnitude is a major undertaking for communities of this size. The ability to fund the total construction costs and the debt service on those costs, is a significant limiting factor on whether any given alternative is feasible, much less practicable. As USACE's guidance states, "If an alleged alternative is unreasonably expensive to the applicant, the alternative is not 'practicable.'" 45 Fed. Reg. 85336, 85343 (Dec. 24, 1980). Accordingly, the USACE may consider the circumstances of the applicant in determining what costs may be practicable. RGL 93-02 (Aug. 23, 1993).

In determining what costs are practicable, however, relatively greater weight is typically afforded to the "characteristics of the project and what constitutes a reasonable expense for these projects." RGL 93-02 (Aug. 23, 1993). The total costs of water supply projects are highly variable and dependent on a large number of case-specific factors. Examples of variables that can significantly affect the total cost of a water supply project include the volume of water withdrawn, local power costs, spot construction and materials costs, size and length of water lines, water storage costs, local geology, easement and land acquisition costs, environmental mitigation costs, treatment technology costs, and debt financing costs. For this reason, JRWA was not able to identify any comparable projects that would provide

a basis to determine a reasonable baseline cost for projects similar to the proposed project. The most reasonable basis to determine a threshold of unreasonable expense is to compare the relative costs of the various alternatives reviewed for this project—each of which has a detailed cost estimate—with due consideration of the circumstances of the applicant and applicable judicial precedent. See Appendix H-9 for Cost Consideration Supporting Documents.

JRWA asserts that any alternative that is more than 25% greater in total project costs than the proposed alternative is impracticable. The selection of a 25% cost increase as the threshold for impracticability is conservative and consistent with recent examples that have been subjected to judicial review. *E.g.*, *Friends of the Santa Clara River v. United States Army Corps of Eng'rs*, 887 F.3d 906, 921 (9th Cir. 2018) (finding 13% increase in cost sufficient to demonstrate impracticability of alternative for proposed development). Moreover, any material increase in cost arguably is unreasonably expensive given that the purpose of this project is public water supply and that the communities bearing these costs are small in relation to the costs and unable to absorb a significant increase in cost for this vital pubic service. A 25% cost increase in total project costs is therefore a reasonably conservative measure of impracticability in this context.

Total Project Costs Summary

The cost estimates presented below and in Appendix H-9-2 take into consideration Total Project Costs to include construction and support services costs as well as additional costs that would be induced by and borne by JRWA's member communities. The categories of costs included in the estimates are as follows:

A. Total Construction and Support Services costs to include the following elements:

1) Raw water intake and pump station construction
    i. Intake structure and gravity pipe to wetwell
    ii. Pump station; to include all features within the building envelope
    iii. Pump station site work
    iv. Pump station excavation and rock removal
    v. New access road on agricultural fields; based on length of road to be constructed
    vi. Upgrade existing gravel access road; based on length of newly constructed road
    vii. Rail crossing improvements per track; based on cost to construct/improve rail post construction
    viii. Rail crossing approach fill; based on cubic yards of net fill required to grade road for equipment access to site
    ix. Culvert/stream crossing approach fill; based on cubic yards of net fill required for culvert installation

2) Raw water main construction
    i. Class 350 ductile iron pipe; based on length and diameter
    ii. Clearing; based on length of water main requiring tree clearing for construction
    iii. Rock excavation; based on length of water main in areas of expected rock presence
    iv. Pipeline production adjustment along VDOT R/W
    v. Pipeline adjustment for construction in travel lane; special conditions of construction in travel lanes such as Columbia and Bremo Bluff
    vi. Maintenance of traffic Route 6; based on length of water main
    vii. Maintenance of traffic secondary roads; based on length of water main
    viii. Stream crossing (temporary); based on length of temporary stream crossings due to construction
    ix. Jack & bore rail crossing; based on length and diameter of pipe and casing pipe
    x. Jack & bore road crossing; based on length and diameter of pipe and casing pipe
    xi. Rivanna River crossing; based on length and diameter of piping
    xii. road for equipment access to site

3) Professional support and administrative services; due diligence, survey, design, construction administration, permitting (VDH, VDOT, Fluvanna County, VDEQ land disturbance) and administrative services, Contractor general conditions, and Construction quality control.

B. Property and Easement Acquisition Costs:
    1) Easement acquisition services; plats, offer packages, appraisals, negotiation, recordation
    2) Easement purchase; per acre
    3) Property acquisition; intake and pump station site

C. Environmental Costs:
    1) Wetland delineation and confirmation
    2) Aquatic resources impacts permits (§ 401, § 404, & State-Owned Bottomlands)
    3) Protected species investigations
    4) Compensatory mitigation

D. Cultural Resource Phase 1 Costs:
    1) Cultural resources phase I survey
    2) ***Due to the potential unknowns and variability of costs, Phase II and Phase III Recovery costs WERE NOT CONSIDERED as part of this cost summary.***

E. Project Finance Costs:
    1) 3% Loan origination fee
    2) 3.75% Interest on loan over a 30-yr period

Table 12 provides a comparative summary of the total project costs for each of the twelve sub-alternatives with percent increase above the least cost alternative (Build Alternative 6 highlighted below). See Appendix H-9-2 for a detailed Opinion of Probable Project Cost (OPPC) for each alternative.

Table 12. Opinion of Probable Costs - Total Project Costs Summary

Alternative	1A Forsyth	1B Forsyth	1C Forsyth	2A Bremo	2B Bremo	3 Columbia	4 Goochland 1	5A Goochland 2	5B Goochland 2	6 Hammond 1	6-1 POF Farm	6-2 Hammond 2
Total Construction & Support Services	$ 17,960,000	$ 22,306,000	$ 23,531,000	$ 50,179,000	$ 49,089,000	$ 27,903,000	$ 24,052,000	$ 27,220,000	$ 25,528,000	$ 12,870,000	$ 13,072,000	$ 13,197,000
Property and Easement Acquisition Costs	$ 857,000	$ 1,111,000	$ 1,211,000	$ 3,076,000	$ 2,979,000	$ 971,000	$ 686,000	$ 802,000	$ 803,000	$ 529,000	$ 552,000	$ 577,000
Environmental Costs	$ 343,000	$ 329,000	$ 341,000	$ 426,000	$ 416,000	$ 167,000	$ 210,000	$ 225,000	$ 219,000	$ 219,000	$ 219,000	$ 219,000
Cultural Resource Ph I Costs	$ 381,000	$ 300,000	$ 255,000	$ 329,000	$ 368,000	$ 258,000	$ 270,000	$ 282,000	$ 309,000	$ 291,000	$ 292,000	$ 310,000
Project Finance Costs												
- 3% Loan Origination Fee	$ 586,200	$ 721,400	$ 760,100	$ 1,620,300	$ 1,585,600	$ 879,000	$ 756,500	$ 855,800	$ 805,700	$ 417,300	$ 424,100	$ 429,100
- 3.75% Interest on 30-yr loan	$ 13,727,000	$ 16,892,000	$ 17,798,000	$ 37,939,000	$ 37,127,000	$ 20,581,000	$ 17,715,000	$ 20,040,000	$ 18,867,000	$ 9,771,000	$ 9,930,000	$ 10,047,000
Total Project Costs	**$ 33,854,000**	**$ 41,659,000**	**$ 43,896,000**	**$ 93,569,000**	**$ 91,565,000**	**$ 50,759,000**	**$ 43,690,000**	**$ 49,425,000**	**$ 46,532,000**	**$ 24,097,000**	**$ 24,489,000**	**$ 24,779,000**
% Increase	**40%**	**73%**	**82%**	**288%**	**280%**	**111%**	**81%**	**105%**	**93%**	**--**	**2%**	**3%**

Below are supplemental explanations for the elements of the projects that account for differences in cost between the alternatives.

Property and Easement Acquisition Cost Analysis

For the purposes of this Alternatives Analysis, we evaluated the existing pump station parcel and easements which were purchased by the JRWA for the current Proposed Action (Build Alternative 6) to determine comparative costs for the alternatives considered. These comparative costs including evaluating the costs per acre for permanent and temporary easement acquisition, pump station land acquisition, and a costs per easement for acquisition services. For the purposes of this evaluation, we utilized the exact numbers and unit costs expended by the JRWA for each alternative considered. A detailed breakdown of the JRWA easement cost analysis can be found in Appendix H-9-4 and line item estimated costs of property and easement acquisition costs for each Build Alternative can be found in Appendix H-9-2.

Water Main Sizing. To minimize operations costs, construction costs, and impacts to the environment, it is desirable to minimize the length and size of the water main between the pump station and the agreed-upon point of connection at Route 6. Due to operating pressures, all piping is required to be Class 350 Ductile Iron. A list of water main requirements is below in Table 13. Pipe diameters for sub-alternatives 1A, 1B, 1C, 3, 4, 5A, 5B, 6, 6-1, and 6-1 are 24 inches. The approximate lengths of each water main route are also shown below. Sub-alternatives 2A and 2B, however, are located much farther from the agreed-upon T interconnection point; these pipe diameters will need to be 30 inches to handle the higher pressures associated with the greater pumping distance.

Table 13. Pipeline Requirements

Sub-Alternative ID	Length	Diameter
	LF	Inches
1A	14,500	24
1B	20,900	24
1C	21,300	24
2A	55,500	30
2B	55,200	30
3	5,300	24
4	8,500	24
5A	12,200	24
5B	11,200	24
6	5,100	24
6-1	5,400	24
6-2	5,100	24

Water Pumps. Table 14 below is a summary of the pump calculations for the future 12 MGD pumping rate. The pump selection submittal (see Appendix F-1) was developed for each alternative using information and costs obtained for the proposed Project.

The need to upsize pipe diameters for sub-alternative 2A and 2B is to account for the future operating conditions of the raw water pump station. The initial scenario for the pump station is to install three 350 HP pumps with a rated capacity of 3 MGD each. At any given time, two of the three pumps will be running for a total rated pumping capacity of 6 MGD. Redundancy is necessary to ensure there is no interruption in the public water supply in the event a pump must be taken offline for maintenance or experiences an unexpected failure. In this scenario, 24-inch piping is an appropriate diameter for all sub-alternatives with regard to piping and pump capabilities.

As explained above, the project has been designed to accommodate future expansion of JRWA's permitted withdrawal volume to a maximum of 12 MGD. As demand increases in the future, four 500 HP pumps will be installed with a rated capacity of 4 MGD each. At any given time, three out of the four pumps will be running for a total pumping capacity of 12 MGD. At this pumping rate, the capacity of the 24-inch piping is notably exceeded for Sub-alternatives 2A and 2B, and the pump will exceed 600 HP in order to overcome the 217 feet and 218 feet, respectively, of additional frictional head loss per Sub-alternative. This exceeds the capability of the 500 HP pump motors due to the excessive pressure head conditions. The maximum impeller size for this pump is limited to providing 145 feet more than what is currently needed for the proposed pump station, considerably exceeding the pumps capabilities.

Table 14 below shows that at 24-inch piping, 2A and 2B exceed the 145 feet increase limit the future pumps can achieve. Assuming 650 HP motors are used in the future pumps to overcome this limit, typically these motors of this size are custom made. The increase in motor size would require upgrading electrical equipment, the generator, as well as electrical service. Therefore, sub-alternatives 2A and 2B should be upsized to 30-inch diameter pipe in order to able to meet both the present and future pressure demands without requiring water main or pump upgrades.

In both scenarios, the pumping configuration allows for maintenance procedures as well as special conditions such as high turbidity events where it is desirable to shut down one or more pumps in the event of an emergency or operational shut down. The pump station would be able to make up any additional demand while offline without running any one pump for a full 24-hour duty cycle.

Table 14. 12 MGD Design Flow Rate Pump Calculations

Sub-Alternative ID	Length	Nominal Diameter	Inside Diameter	Flow Rate	Friction Loss per 100 FT	Total Friction Loss	Increase in Head from Sub-Alt 6	Increase in Pressure from Sub-Alt 6
	LF	Inches	Inches	GPM	FT H2O / 100 ft pipe	FT	FT	PSI
1A	14,500	24	24.94	8,333	0.43	62.8	40.7	17.6
1B	20,900	24	24.94	8,333	0.43	90.6	68.5	29.6
1C	21,300	24	24.94	8,333	0.43	92.3	70.2	30.4
2A	55,500	30	31.02	8,333	0.15	83.2	61.1	26.4
2B	55,200	30	31.02	8,333	0.15	82.7	60.6	26.3
3	5,300	24	24.94	8,333	0.43	23.0	0.9	0.38
4	8,500	24	24.94	8,333	0.43	36.8	14.7	6.4
5A	12,200	24	24.94	8,333	0.43	52.9	30.8	13.3
5B	11,200	24	24.94	8,333	0.43	48.5	26.4	11.4
6	5,100	24	24.94	8,333	0.43	22.1	0.0	0.0
6-1	5,400	24	24.94	8,333	0.43	23.4	1.3	0.56
6-2	5,100	24	24.94	8,333	0.43	22.1	0.0	0.0
Sub-Alternative ID	**Length**	**Nominal Diameter**	**Inside Diameter**	**Flow Rate**	**Friction Loss per 100 FT**	**Total Friction Loss**	**Increase in Head from Sub-Alt 6**	**Increase in Pressure from Sub-Alt 6**
	LF	Inches	Inches	GPM	FT H2O / 100 ft pipe	FT	FT	PSI
2A	55,500	24	24.94	8,333	0.43	240.5	218.4	94.5
2B	55,200	24	24.94	8,333	0.43	239.2	217.1	94.0

Costs Reviewed but NOT Included as part of Total Project Cost Analysis Above

Depending on the selected alternative and overall alternative project schedule, other costs beyond those noted above will be incurred but the JRWA and its partner Counties. These additional costs HAVE NOT been included in the overall Total Project Costs Analysis considered above. However, these additional costs have been reviewed below to demonstrate the impact of these additional considerations.

Operations and Maintenance (O&M) Cost Considerations

Costs to operate and maintain utility infrastructure are important considerations while establishing design parameters. There are both fixed and variable costs to consider. Fixed costs are those that the Owner/Operator will incur regardless of the amount of product that is produced over a period; these include labor, transportation, permitting, repair parts, laboratory testing, etc. Variable costs are those that increase or decrease based on the production output; primarily, these include electrical power and chemicals.

For each Alternative, the JRWA Pump Station would have slightly different pumping head conditions which would result in variability of the electrical costs at the pump station. It is assumed for this evaluation that all other O&M fixed costs would remain the same for the JRWA on an annual basis. As such, we have prepared a comparative table (see Table 15 below) of anticipated annual electrical costs for each build alternative for 6 MGD and 12 MGD utilizing Dominion's Schedule GS-2 Intermediate General Service rate schedule. For the purpose of this evaluation O&M fixed costs remain constant over an annual period.

Table 15. Increase in Annual Pumping Costs to T Interconnect

Alternative	Pipeline Length	Pipeline Diameter	Pumping Head To T Interconnect		Annual Pumping Cost to T interconnect		Increase in Annual Pumping Costs above Cheapest to T Interconnect		% Increase in Annual Pumping Costs above Cheapest	
	LF	Inches	6 MGD	12 MGD	6 MGD	12 MGD	6 MGD	12 MGD	6 MGD	12 MGD
1A	14,500	24	20.59	74.39	$6,364	$45,981	$4,126	$29,808	184%	184%
1B	20,900	24	29.68	107.22	$9,173	$66,276	$6,934	$50,103	310%	310%
1C	21,300	24	30.25	109.27	$9,348	$67,544	$7,110	$51,372	318%	318%
2A	55,500	30	26.64	96.02	$8,234	$59,351	$5,995	$43,179	268%	267%
2B	55,200	30	26.50	95.50	$8,189	$59,031	$5,951	$42,858	266%	265%
3	5,300	24	7.53	27.19	$2,326	$16,807	$88	$634	4%	4%
4	8,500	24	12.07	43.61	$3,731	$26,954	$1,492	$10,782	67%	67%
5A	12,200	24	17.32	62.59	$5,354	$38,687	$3,116	$22,515	139%	139%
5B	11,200	24	15.90	57.46	$4,916	$35,516	$2,677	$19,344	120%	120%
6	5,100	24	7.24	26.16	$2,238	$16,173	--	--	--	--
6-1	5,400	24	7.67	27.70	$2,370	$17,124	$132	$951	6%	6%
6-2	5,100	24	7.24	26.16	$2,238	$16,173	--	--	--	--

Secondary / Induced Operations and Maintenance (O&M) Costs to the Project Partners

Should the intake structure and pump station be located downstream of the confluence of the James and Rivanna Rivers, which includes Alternatives 3, 4 and 5, each County would need to account for increased treatment processes at their respective water treatment plants (WTP) due to the siltation and sedimentation anticipated along this section of the James River. As such, each locality would need to incorporate additional or enlarged pre-settling basins and clarifiers with associated chemical treatment processes to remove the excess sediment.

A major variable to consider in operating a WTP is the complexity of the treatment process and the amount and type of chemicals required to meet treatment goals. The Louisa Ferncliff WTP is

designed based on a raw water intake on the James River above the confluence of the Rivanna River, where water quality is more favorable, thus an additional pre-settling basin and clarifiers are not required based upon anticipated water quality. If the intake were to be located downstream of the confluence where excessive siltation and sedimentation occurs (Alternatives 3, 4 and 5), Louisa and subsequently Fluvanna (upon construction of a future WTP) would need to install these facilities. From a long-term O&M perspective, the clarifiers and appurtenant equipment, pumps, and chemical feeders will result in increased power, and increased chemical and labor costs. Since the pre-settling basin acts as a gravity settling basin, it is anticipated there will be minimal or negligible additional O&M costs above and beyond that of a normal WTP operation. For the purposes of this analysis, we have estimated the anticipated increase in annual O&M costs for the Ferncliff WTP based upon a 6 MGD average annual flowrate. Table 16 below summarizes the O&M costs with and without clarifiers at the WTP.

Table 16. Estimated Increase in Annual WTP Operation Costs

6 MGD Average Daily Demand		Without Clarifiers	With Clarifiers	$ Increase	% Increase
O&M Variable Costs per Year					
RWPS		$ 164,678.68	$ 164,678.68	$ -	0%
WTP		$ 1,784,425.91	$ 1,845,265.61	$ 60,839.70	3%
O&M Fixed Costs per year					
RWPS		$ 103,000.00	$ 103,000.00	$ -	0%
WTP		$ 255,500.00	$ 333,125.00	$ 77,625.00	30%
Total O&M Costs					
RWPS	Total Annual O&M Costs	$ 267,678.68	$ 267,678.68	$ -	0%
	Total O&M Costs per 1000 gal	$ 122.23	$ 122.23	$ -	0%
	Estimated Annual Budget per year	$ 0.12	$ 0.12	$ -	0%
WTP	Total Annual O&M Costs	$ 2,039,925.91	$ 2,178,390.61	$ 138,464.70	7%
	Total O&M Costs per 1000 gal	$ 931.47	$ 994.70	$ 63.23	7%
	Estimated Annual Budget per year	$ 0.93	$ 0.99	$ 0.06	7%
Estimated Total Cost per 1000 gal		$ 1.05	$ 1.12	$ 0.06	6%
Estimated Annual Budget at 6 MGD Average Daily Demand		**$ 2,308,000.00**	**$ 2,446,000.00**	**$ 138,000.00**	**6%**

With the addition of clarifiers at the Ferncliff WTP, annual O&M costs are increased by approximately $138,000 per year, or an approximate 6% increase in annual O&M costs. The O&M unit cost to deliver water to customers would increase from $1.05 per 1,000 gallons to $1.12 per 1,000 gallons. This increase in cost will be incurred for the duration of the WTP operations. The primary cause for this increase is due to the cost of the Alum used as a coagulant and one additional full-time operator.

Assumptions for Treatment Processes and Associated Costs:

1. Alum dosage was assumed to be 40 PPM (Parts Per Million) using 48.5% liquid alum with a specific gravity of 1.33.
2. The Louisa County Water Authority (LCWA) purchases Alum by bulk delivery at a current contract price of $0.175 per gallon. This equates to an additional cost of $10.68 per million gallons of water produced.
3. One full time operator is assumed to cost $60,000 per year based on current (LCWA) salaries.

Potential Construction Cost Escalations for the Alternatives Analysis

To provide a reasonably equivalent foundation for the comparison of build alternatives, all Opinions of Probable Construction Cost Estimates are based upon the assumption of the project starting major construction in 2021. However, as a practical matter, it is anticipated the start of major construction will be delayed an additional three to four years for any alternative other than the proposed alternative (Build Alternative 6) due to factors associated with relocating the intake structure, pump station, and pipeline such as due diligence, easement and property acquisition, design and approvals, permitting timelines, and cultural resources investigations and recovery efforts. Therefore, it would be reasonable to assume that major construction for Build Alternatives 1, 2, 3, 4, and 5 would start in 2024 or 2025 and Build Alternatives 6-1 and 6-2 would start in 2023. As such, a reasonable construction cost increase for each of these alternatives should be considered due to the likely delay in construction as compared with Build Alternative 6.

While it is difficult to predict future construction market conditions, it is accepted industry practice to rely on previous historical data to reasonably predict future increases. Based upon the most recent Turner Construction Cost Index (CCI), the average annual CCI increase from the most recent five-year period, 2015 to 2019, is 5.1% (see CCI information below from the Turner 2019 4th Quarter Report).

Quarter	Index	△%
4th Quarter 2019	**1177**	**1.29**
3rd Quarter 2019	1162	1.13
2nd Quarter 2019	1149	1.23
1st Quarter 2019	1135	1.34

Year	Average Index	△%
2019	1156	5.5
2018	1096	5.6
2017	1038	5.0
2016	989	4.8
2015	943	4.5
2014	902	4.4
2013	864	4.1
2012	830	2.1
2011	812	1.6
2010	799	-4.0
2009	832	-8.4
2008	908	6.3
2007	854	7.7

The Turner Building Cost Index is determined by the following factors considered on a nationwide basis: labor rates and productivity, material prices and the competitive condition of the marketplace.

Turner

While the average CCI has risen 5% or greater since 2017, for the purposes of this analysis, we will utilize 5% average annual CCI for the cost adjustments. As such the appropriate multiplier would need to be applied to each of the alternatives based on the anticipated construction start date. Table 17 below identifies the appropriate multiplier that would need to be added for construction delays from 1 to 5 years:

Table 17. Estimated Construction Cost Escalation Multiplier by Year

Time Period	Annual % Increase	Multiplier	% Increase above 2021 Costs
1 year	5%	1.05 ^ 1 = 1.05	5%
2 years	5%	1.05 ^ 2 = 1.10	10%
3 years	5%	1.05 ^ 3 = 1.16	16%
4 years	5%	1.05 ^ 4 = 1.22	22%
5 years	5%	1.05 ^ 5 = 1.28	28%

For the purposes of the Opinions of Probable Construction Cost Estimates included in this supplemental information, JRWA did not assume any construction cost escalations for any of the Alternatives analyzed. However, this exercise illustrates an additional costs JRWA likely would incur to construct the project at Build Alternatives 1, 2, 3, 4, 5, 6-1, or 6-2. The total estimated construction and support services costs for these alternatives, adjusted for construction cost escalations, are summarized in Table 18:

Table 18. Total Estimated Cost by Alternative Adjusted for Construction Cost Escalation

Alternative	Total Construction & Support Services Cost		
	Estimate from Table 10 (2021 Start)	Estimate Adjusted for CCI Increase (Anticipated Start Date)	Potential Increase due to Delay in Start
1A	$17,960,000	$20,833,600 (2024)	$2,873,600
1B	$22,306,000	$25,874,960 (2024)	$3,569,000
1C	$23,531,000	$27,295,960 (2024)	$3,765,000
2A	$50,179,000	$58,207,640 (2024)	$8,028,600
2B	$49,089,000	$56,943,240 (2024)	$7,854,200
3	$27,903,000	$32,367,480 (2024)	$4,464,500
4	$24,052,000	$27,900,320 (2024)	$3,848,300
5A	$27,220,000	$31,575,200 (2024)	$4,355,200
5B	$25,528,000	$25,528,000 (2024)	$4,084,500
6	$12,870,000	$12,870,000 (2021)	$0
6-1	$13,072,000	$14,379,200 (2023)	$1,307,200
6-2	$13,197,000	$14,516,700 (2023)	$1,319,700

2015 Memo vs. 2020 Alternatives Analysis

In December of 2015, Timmons Group was asked to prepare a preliminary evaluation for potentially moving the pump station from the proposed Point of Fork Farm, LP location to property owned by Forsyth approximately 2 miles upstream from the proposed alternative. As such, Timmons Group prepared a limited review of the routing alternatives and potential impacts to the pump station construction. This December 2015 Memorandum (2015 Memo) was entitled "ALTERNATE INTAKE AND PUMP STATION SITE - PRELIMINARY Evaluation of the Potential Cost and Schedule Implications". The opening paragraph of the 2015 Memo states:

> *"Below is a PRELIMINARY evaluation of the potential cost and schedule implications to relocating the JRWA intake further upstream as proposed by Fluvanna County. Please note this is limited review based upon a limited timeline."*

It is important to note that this evaluation was based upon a high-level overview of potential routing alternatives. This evaluation did not include an in-depth review and evaluation of the environmental impacts and routing alternative alignments as presented in this current analysis. The James River Water Authority requested that Timmons prepare a comparative analysis of the two evaluations (2015 Memo vs. 2020 Analysis) to address any potential questions or concerns that might arise during the review of this analysis regarding the difference in costs. The comparative analysis is included in Appendix H-9-3.

4.2.2 Ability to Meet the Project Purpose

The practicability considerations discussed above must, of course, be evaluated "in light of overall project purposes." 40 C.F.R. § 230.10(a)(2). An option is not a true practicable alternative if it does not fulfill the overall project purpose. The overall project purpose "is to provide a new and reliable raw water supply of sufficient quantity to meet the short- and long-term needs of Fluvanna and Louisa Counties for delivery to an agreed-upon T interconnection point planned for use by Fluvanna and Louisa Counties." To meet this purpose, and alternative must be able to provide a raw water supply that can yield enough water to meet the current and future needs of the Counties over a 50-year planning horizon. That supply must be reliable, which means that it is not susceptible to interruptions due to droughts, storms, or other causes. Lastly, to meet the needs of the Counties, the project must be able to deliver that water to the agreed-upon T interconnection point so that both Counties—which are each paying 50% of the project costs—will have access to their share of the water from JRWA.

4.2.2.1 Water Quantity

The project must be able to meet the raw water needs of the communities. The VWP permit process requires an applicant to demonstrate to DEQ's satisfaction that there is a need and beneficial use for any requested water withdrawal amounts over the period of the 15-year permit term. JRWA's VWP permit authorizes a maximum withdrawal of 5.73 MGD initially, with preauthorized increases up to 8.39 MGD as water from the project is used to serve additional areas of the Counties (see Appendix D-1). A purpose of the project is to meet the Counties'

long-term water demands, which entails a much longer planning horizon than the 15 years covered by the VWP permit. That is why is why the project infrastructure has been designed to accommodate a future expansion to 12 MGD. JRWA and its member Counties believe that withdrawal will be sufficient to meet their water needs over a longer, 50-year planning horizon.

A surface water source's ability to provide a given quantity of water is primarily a function of its drainage area. A raw water intake location must have an adequate upstream drainage-shed to support the withdrawal of water during all conditions to include severe drought periods. The drainage area for the Rivanna River (approximately 800 square miles as shown in Table 19 below) is significantly less than would be necessary to support a withdrawal of the volume necessary to meet the project purpose. Furthermore, the Rivanna already supports a number of upstream withdrawals by RWSA and Lake Monticello which limit the flows available to JRWA. Therefore, withdrawing from the Rivanna River would not meet the project purpose. By comparison, the James River's drainage area is greater than 5,000 square miles in the vicinity of the project area. That is more than adequate to accommodate the quantity of water needed to be withdrawn during all conditions, including drought periods, to meet both the short- and long-term needs of the Counties.

Table 19. Contributing Drainage Areas

Build Alternative Location	Contributing Drainage Area	Comments
	Sq. Miles	
1	5,054	
2	5,014	
3	5,842	Includes Rivanna River Watershed
4	5,843	Includes Rivanna River Watershed
5	5,845	Includes Rivanna River Watershed
6	5,073	
6-1	5,073	
6-2	5,072	

Supporting documentation on drainage areas can be found in Appendix H-12-1 Sheets 1-32.

4.2.2.2 Reliability of Water Supply

As public water suppliers, JRWA and its member localities have the "duty and authority to provide for a secure water supply" for their citizens. *Tidewater Ass'n of Homebuilders Inc. v. City of Va. Beach*, 400 S.E.2d 523, 529 (Va. 1991). Being unable to supply a reliable source of potable water to citizens is not an option for a public water supplier. There are multiple potential risks to a public water supply. The most common concern is drought. To mitigate against interruptions in supply from drought conditions, the water source should sufficient flow (meaning the size of the watershed plus wastewater discharges, less water withdrawals) to continue providing water during predictable low-flow conditions. Reservoirs can help mitigate drought conditions by storing water during high-flow conditions to augment instream flows during dry periods.

To ensure the reliability of JRWA's supply, it is most desirable to locate the intake downstream of the Cobbs Creek Reservoir (CCR). The CCR will serve as a side-stream reservoir and pumping facility that pumps and stores water from the river during high-low conditions and releases this water back to the river during low-flow and drought conditions. This is a very important consideration due to the increasing severity and frequency of drought conditions such as those that occurred in the 2002 to 2004 period and in 2019. Because JRWA is not proposing to construct their own reservoir, water must be pumped from the James River without interruptions due to prolonged drought conditions. The VWP permit 14-0343 issued to the JRWA (see Appendix D-1) requires that the JRWA coordinate with CCR operators to manage water withdrawals during low flow conditions.

1) **Build Alternative 1** is upstream of the CCR, thus there would be no beneficial use of the CCR during extreme droughts to assure that the intake is submerged.

2) **Build Alternative 2** is upstream of the CCR, thus there would be no beneficial use of the CCR during extreme droughts to assure that the intake is submerged.

3) **Build Alternative 3** is downstream of the CCR and thus could benefit from the release of water from the reservoir.

4) **Build Alternative 4** is downstream of the CCR and thus could benefit from the release of water from the reservoir.

5) **Build Alternative 5** is downstream of the CCR and thus could benefit from the release of water from the reservoir.

6) **Build Alternative 6** is downstream of the CCR and thus could benefit from the release of water from the Reservoir. Additionally, it is upstream of the confluence of the rivers; thus, situating it in the most desirable location of the James River regarding drought risk and water quality.

7) **Build Alternative 6-1** is downstream of the CCR and thus could benefit from the release of water from the Reservoir. Additionally, it is upstream of the confluence of the rivers; thus, situating it in the most desirable location of the James River regarding drought risk and water quality.

8) **Build Alternative 6-2** is downstream of the CCR and thus could benefit from the release of water from the Reservoir. Additionally, it is upstream of the confluence of the rivers; thus, situating it in the most desirable location of the James River regarding drought risk and water quality.

4.2.2.3 Short-Term Water Supply Needs

As discussed in Section 3.3, there is an immediate need for a new water source to be brought online. A purpose of this project is to meet that need by completing construction and commencing the flow of water in the shortest possible duration. To meet this purpose, an alternative must be capable of being constructed on a reasonable timeline.

The following steps must be completed in preparation for constructing a new water supply within the area reviewed for this project:

- Topographic survey of water main route and intake and pump station site, and access roads.
- Bathymetric survey of river bottom.
- Project design for the intake, pump station and water main
- Geotechnical investigation and report.
- Acquisition of easements and intake and pump station site.
- Obtain necessary permit and approvals from DEQ (VWP permit/401 certification, VPDES Construction General Permit), VMRC (State-owned bottomland permit), Virginia Department of Transportation (Land Use Permit), Fluvanna County (Zoning approval, floodplain permit, and building permit).
- Coordination and approvals from CSX for crossing its rail lines (see Appendix H-5).
- Environmental investigations, permitting, and mitigation.
- Completion of Phase I, and if necessary, Phases II and III, cultural resource investigations.

For each alternative, the estimated construction time is between approximately 24 and 36 months—with difference based primarily on the length of the water main and any other site-specific construction obstacles. A conservative estimate of 36 months is assumed to resolve all preliminary design, investigation, and regulatory approvals for previously unstudied sites. Based on the cultural resources revise summarized in Section 5.1.10, each alternative is expected to affect multiple cultural resources. However, given the difficulty in anticipating the extent of possible archeological investigations, the timelines associated with Cultural Resources efforts were not included in the evaluation for Alternatives 1-5, 6-1 or 6-2. As it is known that Phase III investigations would be required as part of Alternative 6, timelines associated with these efforts have been included.

Following is a table with estimate construction times for each alternative:

Table 20. Estimated Project Timelines by Alternative

Build Alternative	Add'l Due Diligence, Investigations, Design, Permitting and Approvals	Estimated Construction Time	Total Time
1A, 1B, 1C	36 months	24 months	60 months
2A, 2B	36 months	36 months	72 months
3	36 months	36 months	72 months
4	36 months	24 months	60 months
5A, 5B	36 months	24 months	60 months
6	6 months (Ph III CR Work)	24 months	30 months
6-1	12-18 months	24 months	36-42 months
6-2	12-18 months	24 months	36-42 months

JRWA estimates project completion dates as follows:

1) **Build Alternative 1** could be available to meet short-term water supply needs by 2025. That timeline assumes (1) 36 months for due diligence, preliminary design, investigation, property acquisition, final designs, permitting and approvals; and (2) 24 months for construction.

2) **Build Alternative 2** could be available to meet short-term water supply needs by 2026. That timeline assumes (1) 36 months for due diligence, preliminary design, investigation, property acquisition, final designs, permitting and approvals; and (2) 36 months for construction.

3) **Build Alternative 3** could be available to meet short-term water supply needs by 2026. That timeline assumes (1) 36 months for due diligence, preliminary design, investigation, property acquisition, final designs, permitting and approvals; and (2) 36 months for construction.

4) **Build Alternative 4** could be available to meet short-term water supply needs by 2025. That timeline assumes (1) 36 months for due diligence, preliminary design, investigation, property acquisition, final designs, permitting and approvals; and (2) 24 months for construction.

5) **Build Alternative 5** could be available to meet short-term water supply needs by 2025. That timeline assumes (1) 36 months for due diligence, preliminary design, investigation, property acquisition, final designs, permitting and approvals; and (2) 24 months for construction.

6) **Build Alternative 6** is "shovel ready" except for Phase III archeological study. This alternative could be online by 2023, assuming 6 months for Phase III work and 24 months for construction.

7) **Build Alternative 6-1** could be available to meet short-term water supply needs by 2024. That timeline assumes (1) 12-18 months for due diligence, preliminary design, investigation, property acquisition, final designs, permitting and approvals; and (2) 24 months for construction.

8) **Build Alternative 6-2** could be available to meet short-term water supply needs by 2024. That timeline assumes (1) 12-18 months for due diligence, preliminary design, investigation, property acquisition, final designs, permitting and approvals; and (2) 24 months for construction.

4.2.3 Environmental Impacts

Environmental impacts for the various Build Alternatives are more fully evaluated below in Section 5. That analysis is incorporated by reference into this section for the purpose of the make the LEDPA determination.

4.2.3.1 Build Alternatives Route Avoidance

Environmental impacts, including aquatic resources and cultural resources, were considered and avoided to greatest extent practicable in the development to alternative routing options, given practicability considerations and the purpose and need of the Project. Factors considered limiting to practicability included presence of rock, acquisition of land and easements, suitable railroad track crossing, impacts to adjacent land use, and co-location of utilities, among others.

4.3 Determination of Least Environmentally Damaging Practicable Alternative

The LEDPA analysis was conducted to document the review of the Build Alternatives and No-Permit/No-Action Alternative in compliance with 33 C.F.R. Part 230 and to identify the LEDPA in accordance with the the 404(b)(1) Guidelines, 40 CFR Part 230. A potential alternative is excluded from consideration as the LEDPA if it is found to not be a practicable alternative under one or more of the relevant review criteria as detailed above and/or if it fails to meet the overall project purpose. If more than one alternative is considered practicable under all criteria and meets the overall project purpose, the alternative with the least environmental impact would be deemed the LEDPA. The analysis concludes that Build Alternative 6 is the LEDPA.

4.3.1 No-Permit and No-Action Alternative

As discussed in Section 4.1.3, there is no feasible No-Permit scenario that could provide a new water supply capable of meeting the project purpose. Therefore, the No-Permit Alternative is the No-Action Alternative. Although the No-Action Alternative would avoid all impacts to aquatic resources, it is not a viable option given the purpose and need of the Project, which is to provide a new raw water supply of sufficient quantity and quality to meet the identified short- and long-term needs of Fluvanna and Louisa Counties. The No-Action Alternative is therefore eliminated from consideration as the LEDPA.

4.3.2 Build Alternative 1: Forsyth

Build Alternative 1 is not the LEDPA for any of the flowing reasons: it (1) is not practicable; (2) does not fully satisfy the overall project purpose; and (3) is not less environmentally damaging.

This alternative presents several construction logistics challenges. The need to construct ramp structures across the CSX rail line to provide heavy equipment access to the pump station site significantly complicates construction. That would necessitate additional review and negotiation with, followed by final approval by CSX, to enable JRWA to reengineer a portion of CSX's right-of-way to allow a new, permanent elevated road crossing. This entails additional cost, timing, and risk for the project. Similarly, Build Alternative 1 would require that JRWA obtain easements from between 11 and 26 landowners, which adds further cost, timing, and risk. The water main routing for this alternative are generally practicable to construct, with the exception of Sub-Alternative 1C, which would require an excessive amount of rock excavation.

Based on available information, it is assumed that this site would be suitable for construction and operation of a long-term water supply. The water quality in the James River at the location of the intake is assumed to be sufficiently unencumbered by sediment loads and the pump station could be constructed relatively close in proximity and elevation to the river. No bathymetric study has been conducted for the James River bottom at this location, and JRWA therefore assumes it is suitable. From a site suitability perspective, this site has the disadvantage of being the second farthest distance from the nearest 3-phase power source. A route would need to be extended 1.1 miles to reach the pump station site, which would require additional coordination regarding VDOT rights-of-way and would marginally increase the risk of outages at this site due to power failure.

Build Alternative 1 is unreasonably expensive to JRWA. Depending on the water main route, this alternative is between 40% and 82% more costly than the preferred alternative. The increased cost is attributable to several factors. Most significantly, this alternative would require construction of a water main that is approximately three to four times the length of the preferred route, depending on the route variation. Additional costs would be necessary for coordination with CSX and to acquire easements from between two and five times the number of landowners as compared to the preferred alternative.

Build Alternative 1 only partially meets the overall project purpose. This alternative provides a sufficient quantity and quality of water to meet the Counties' long-term water supply needs. However, the intake location upstream of the CCR release makes this intake more vulnerable to disruption during drought and low-flow conditions. Lastly, this alternative does not meet the Counties' short-term need for an increased water supply because the project would not be in service for at least 60 months.

Build Alternative 1 is not less environmentally damaging. Because the water main route is relatively longer and has fewer opportunities to be co-located with existing utility easements (between 25% for Sub-Alternative 1A to 0% for 1C) than other alternatives, it has two times or more greater permanent aquatic impacts compared to the preferred alternative or Alternative 3. Nor does it offer other environmental advantages. It has a comparable number of potential

historical resources impacts. Sub-alternative 1A impacts the second the greatest number of known archeological sites of any alternative (some of which overlap with Build Alternative 6) and a similar number of architectural properties. Sub-alternatives 1B and 1C impact comparatively fewer *known* archeological sites and comparable number of archeological properties. Because these alternatives traverse more landowners' properties, they have a greater potential to impact property owner rights and land uses. Sub-alternatives 1B and 1C also would necessitate nearly ten times the area of permanent tree-clearing compared to the least forested route (Build Alternative 3) and nearly six times the area of permanent clearing compared to Build Alternative 6.

In conclusion, Build Alternative 1 is not practicable on the basis of cost. Although it is not deemed impracticable under any single logistical criterion, it presents several disadvantages that, considered in concert, are sufficient to deem this alternative logistically impracticable. This alternative does not fully satisfy the overall project purpose. Lastly, none of its routing alternatives can be considered the least environmentally damaging. Accordingly, Build Alternative 1 is not the LEDPA.

4.3.3 Build Alternative 2: Bremo Bluff

Build Alternative 2 is not the LEDPA for any of the flowing reasons: it (1) is not practicable; (2) does not fully satisfy the overall project purpose; and (3) is not less environmentally damaging.

This alternative presents substantial construction logistics obstacles. In particular, both route alternatives (sub-alternatives 2A and 2B) traverse areas where significant amount of rock is expected, including along Bremo Road where a high rock wall adjacent to the road is present. The need to construct ramp structures across the CSX rail line to provide heavy equipment access to the pump station site significantly complicates construction. That would necessitate additional review and negotiation with, followed by final approval by CSX, to enable JRWA to reengineer a portion of CSX's right-of-way to allow a new, permanent elevated road crossing. This entails additional cost, timing, and risk for the project. This CSX line at this location is a dual rail with a significant elevation differential between the two rails. This situation presents an unacceptable risk to heavy equipment that would have to cross the rails during construction and to smaller vehicles (e.g., pickup trucks) that would need to access the pump station site on a long-term basis for operation and maintenance purposes. Additionally, Build Alternative 2 would require that JRWA obtain the greatest number of easements: between 73 and 81 easements. That is a unique logistical and unpredictable hurdle that adds considerable further cost, timing, and risk to the project.

Based on available information, it is assumed that this site would be suitable for construction and operation of a long-term water supply. The water quality in the James River at the location of the intake is assumed to be sufficiently unencumbered by sediment loads and the pump station could be constructed relatively close in proximity and elevation to the river. No bathymetric study has been conducted for the James River bottom at this location, and JRWA therefore assumes it is suitable. From a site suitability perspective, this site has the disadvantage of being approximately twice the distance from the nearest 3-phase power source as the preferred alternative, which would require additional coordination regarding VDOT rights-of-way

and would marginally increase the risk of outages at this site due to power failure. In the absence of information to the contrary, it is assumed that the river bottom conditions are would accommodate the intake structure.

Build Alternative 2 is unreasonably expensive to JRWA. Depending on the water main route, this alternative is between 280% and 288% more costly than the preferred alternative. The increased cost is attributable to several factors. Most significantly, this alternative would require construction of the longest water main of any alternative, at over 10 miles (over 10 times the length of the preferred alternative). At this length, the pipe size and pumping capacity would need to be upgraded as well to accommodate the same volume of flow. Additional costs would be necessary for coordination with CSX and to acquire approximately 14 to 16 times easements from as compared to the preferred alternative.

Build Alternative 2 only partially meets the overall project purpose. This alternative provides a sufficient quantity and quality of water to meet the Counties' long-term water supply needs. However, the intake location upstream of the CCR release makes this intake more vulnerable to disruption during drought and low-flow conditions. Lastly, this alternative does not meet the Counties' short-term need for an increased water supply because the project would not be in service for at least 72 months.

Build Alternative 2 is the most environmentally damaging alternative. Because the water main route is significantly longer and has fewer opportunities to be co-located with existing utility easements (between 0% for sub-alternative 2A to 4% for 2B) than other alternatives, it has more than ten times greater permanent aquatic impacts than the preferred alternative, and more than that when compared to Alternative 4. Neither route studied for this alternative offers any clear environmental advantages. Due to its length, this alternative would require extensive permanent tree-clearing—roughly eleven times the total area of the preferred alternative. Construction of this alternative would impact few previously identified archeological sites but a greater number of architectural properties than the preferred alternative. Because this alternative traverses many times more landowners' properties, it has a greater potential to impact property owner rights and land uses. This alternative also would require construction of an intake within the proposed critical habitat of the Atlantic Pigtoe, a species that is proposed for listing as threatened under the Endangered Species Act.

In conclusion, Build Alternative 2 is not practicable on the basis of cost. Its length coupled with the amount of rock and number of landowners from whom easements must be obtained makes construction logistically impracticable. This alternative does not fully satisfy the overall project purpose. Lastly, theses routing alternatives can be considered the most environmentally damaging. Accordingly, Build Alternative 2 is not the LEDPA.

4.3.4 Build Alternative 3: Columbia

Build Alternative 3 is not the LEDPA for any of the flowing reasons: it (1) is not practicable and (2) does not fully satisfy the overall project purpose.

This alternative presents major—and potentially insurmountable—construction logistics challenges. The pump station for this alternative would have to be constructed in a tight space

in the town of Columbia immediately adjacent to an active railroad line. This creates a substantial hazard to the construction crew and freight traffic and would require extensive coordination with CSX—which would have to approve the project (notwithstanding that CSX has expressed its opposition to construction at this site). Because there is no feasible direct road access to the riverbank, heavy equipment and materials would have to be lowered into position by cranes staged on the adjacent bridge for the duration of the intake construction. That would substantially increase the time, cost, and safety hazards associated with construction, not to mention present foreseeable technical challenges that could ultimately make this method unworkable. Long-term inspections and maintenance of the intake would be similarly challenging. Construction at this site will be made additionally challenging by the fact that the pump station would require sheeted and braced excavation and will require a significant amount of rock blasting to occur in close proximity to occupied residences. Because this would require construction through a more populated area, at least three times the number of easements would have to be acquired relative to the preferred alternative. At least one occupied residence would have to be acquired and demolished to allow construction of the pump station to proceed.

Long-term operation and maintenance of a water supply at this location presents significant challenges. Because this site is located immediately downstream of where the Rivanna River empties into the James River, it will be impacted by siltation and sedimentation as well as excessive suspended solids loads in the Rivanna River, especially during precipitation events. This will lead to increased siltation and sedimentation at the intake. This lower-quality water will require additional capital upgrades and increased operation and maintenance costs for the existing Ferncliff Water Treatment Plant ($6.1 million construction cost plus additional design and support services) and future water treatment plants that utilize this water supply. Because the pump station structure will be located in the heart of Columbia, with the nearest occupied home only 150 feet way, this site will be exposed to addition risk of vandalism and damage. In the absence of information to the contrary, it is assumed that the river bottom conditions would accommodate the intake structure.

Build Alternative 3 is unreasonably expensive to JRWA. This alternative is 111% more costly than the preferred alternative. The increased cost is attributable to several factors to include increased property acquisition costs—largely driven by the cost of relocating a family—and numerous cost increases necessitated by attempting construct the project under such challenging conditions.

Build Alternative 3 does not fully meet the overall project purpose. This alternative provides a sufficient quantity of water to meet the Counties' long-term water supply needs. However, the intake location immediately downstream of the Rivanna River discharge makes this water supply less reliable during high-flow conditions and less beneficial as a long-term supply due to the increased treatment costs. Lastly, this alternative does not meet the Counties' short-term need for an increased water supply because the project would not be in service for at least 72 months.

Build Alternative 3 has the least impact to the aquatic environment due to its location almost wholly within a built-up town. It has no permanent wetland impacts and only 64 linear feet of permanent stream impacts. However, the limited aquatic impacts are offset by other impacts. Construction and operation at this location would require intrusive short-term and permanent impacts—including the demolition of one or two family homes—in a designated environmental justice community. Although only one previously identified archeological site is found within the

footprint of this alternative, its proximity to the riverbank suggests a probability that additional sites will be found. Construction at this location also would entail constructing a new, modern structure in full view of a potentially eligible district, as well as the demolition of one or more potentially contributing architectural resources.

In conclusion, Build Alternative 3 is not practicable on the basis of construction logistics or cost. There are significant logistical challenges to construction that call into question whether this alternative can be deemed available, must less practicable. Nor does this alternative fully satisfy the overall project purpose. Although this alternative could be characterized as the least environmentally damaging, it is not the LEDPA.

4.3.5 Build Alternative 4: Goochland 1

Build Alternative 4 is not the LEDPA for any of the flowing reasons: it (1) is not practicable; (2) does not fully satisfy the overall project purpose; and (3) is not less environmentally damaging.

This alternative presents moderate construction logistics challenges. This alternative would require only limited rock excavation for the pump station but potentially excessive rock excavation for the water main. The need to construct ramp structures across the CSX rail line to provide heavy equipment access to the pump station site significantly complicates construction. That would necessitate additional review and negotiation with, followed by final approval by CSX, to enable JRWA to reengineer a portion of CSX's right-of-way to allow a new, permanent elevated road crossing. This entails additional cost, timing, and risk for the project. This CSX line at this location is a dual rail with a significant elevation differential between the two rails. This situation presents an unacceptable risk to heavy equipment that would have to cross the rails during construction and to smaller vehicles (e.g., pickup trucks) that would need to access the pump station site on a long-term basis for operation and maintenance purposes. Additionally, construction at this location would require JRWA to obtain 18 easements. Lastly, adding additional risk to this alternative, JRWA would need to obtain the consent of Goochland County to construct a water supply at this location in accordance with Virginia Code § 15.2-2143.

Long-term operation and maintenance of a water supply at this location presents significant challenges. Because this site is located immediately downstream of where the Rivanna River empties into the James River, it will be impacted by siltation and sedimentation as well as excessive suspended solids loads in the Rivanna River, especially during precipitation events. This will lead to increased siltation and sedimentation at the intake. This lower-quality water will require additional capital upgrades and increased operation and maintenance costs for the existing Ferncliff Water Treatment Plant ($6.1 million construction cost plus additional design and support services) and future water treatment plants that utilize this water supply. In the absence of information to the contrary, it is assumed that the river bottom conditions would accommodate the intake structure.

Build Alternative 4 is unreasonably expensive to JRWA. This alternative is 81% more costly than the preferred alternative. Most significantly, this alternative would require construction of a water main that is approximately two times longer than the length of the preferred route. Additional

costs would be incurred acquiring easements from nearly four times the number of landowners as compared to the preferred alternative.

Build Alternative 4 does not fully meet the overall project purpose. This alternative provides a sufficient quantity of water to meet the Counties' long-term water supply needs. However, the intake location shortly downstream of the Rivanna River discharge makes this water supply less reliable during high-flow conditions and less beneficial as a long-term supply due to the increased treatment costs. Lastly, this alternative does not meet the Counties' short-term need for an increased water supply because the project would not be in service for at least 60 months.

Build Alternative 4 is not less environmentally damaging. Because the water main route is relatively longer and has no opportunity to be co-located with existing utility easements, it has greater permanent stream and wetland impacts than the preferred alternative. Nor does it offer other significant environmental advantages. Although there are no previously identified archeological sites within the footprint of this alternative, this alternative would require construction within the floodplain of the James River in an area with numerous recorded sites along the banks. Thus, there is a material likelihood of discovering new sites. This alternative also is tied with Build Alternative 5's two routes for the highest number of previously recorded architectural properties within the limits of disturbance. This alternative would necessitate nearly three times the area of permanent tree-clearing compared to the least forested route (Build Alternative 3) and nearly twice the area of permanent clearing compared to Build Alternative 6.

In conclusion, Build Alternative 4 is not practicable on the basis of cost and site-suitability logistics. This alternative does not fully satisfy the overall project purpose and it is not the least environmentally damaging. It is not the LEDPA.

4.3.6 Build Alternative 5: Goochland 2

Build Alternative 5 is not the LEDPA for any of the flowing reasons: it (1) is not practicable; (2) does not fully satisfy the overall project purpose; and (3) is not less environmentally damaging.

This alternative presents moderate construction logistics challenges. This alternative would require only limited rock excavation for the pump station but potentially excessive rock excavation for the water main under either route sub-alternative. The need to construct ramp structures across the CSX rail line to provide heavy equipment access to the pump station site significantly complicates construction. That would necessitate additional review and negotiation with, followed by final approval by CSX, to enable JRWA to reengineer a portion of CSX's right-of-way to allow a new, permanent elevated road crossing. This entails additional cost, timing, and risk for the project. This CSX line at this location is a dual rail with a significant elevation differential between the two rails. This situation presents an unacceptable risk to heavy equipment that would have to cross the rails during construction and to smaller vehicles (e.g., pickup trucks) that would need to access the pump station site on a long-term basis for operation and maintenance purposes. Additionally, construction at this location would require JRWA to obtain 19 or 23 easements, depending on the route. Lastly, adding additional risk to this alternative, JRWA would need to obtain the consent of Goochland County to construct a water supply at this location in accordance with Virginia Code § 15.2-2143.

Long-term operation and maintenance of a water supply at this location presents significant challenges. Because this site is located immediately downstream of where the Rivanna River empties into the James River, it will be impacted by siltation and sedimentation as well as excessive suspended solids loads in the Rivanna River, especially during precipitation events. This will lead to increased siltation and sedimentation at the intake. This lower-quality water will require additional capital upgrades and increased operation and maintenance costs for the existing Ferncliff Water Treatment Plant ($6.1 million construction cost plus additional design and support services) and future water treatment plants that utilize this water supply. In the absence of information to the contrary, it is assumed that the river bottom conditions are would accommodate the intake structure.

Build Alternative 5 is unreasonably expensive to JRWA. This alternative is between 93% and 105% more costly than the preferred alternative, depending on the project route. Most significantly, this alternative would require construction of a water main that is approximately twice as long as the preferred route. Additional costs would be incurred acquiring roughly four times the easements from roughly as compared to the preferred alternative.

Build Alternative 5 does not fully meet the overall project purpose. This alternative provides a sufficient quantity of water to meet the Counties' long-term water supply needs. However, the intake location shortly downstream of the Rivanna River discharge makes this water supply less reliable during high-flow conditions and less beneficial as a long-term supply due to the increased treatment costs. Lastly, this alternative does not meet the Counties' short-term need for an increased water supply because the project would not be in service for at least 60 months.

Build Alternative 5 is not less environmentally damaging. Because the water main route is relatively two times longer and has no opportunity to be co-located with existing utility rights-of-way, it has comparable permanent stream impacts but between five and eight times the permanent wetland impacts as compared to the preferred alternative. Nor does it offer other significant environmental advantages. Although there is only one previously identified archeological sites within the footprint of this alternative (both routes), this alternative would require construction within the floodplain of the James River in an area with numerous recorded sites along the banks. Thus, there is a material likelihood of discovering new sites. This alternative's two routes also are tied with Build Alternative 4 for the highest number of previously recorded architectural properties within the limits of disturbance. This alternative would necessitate approximately four to six times the area of permanent tree-clearing compared to the least forested route (Build Alternative 3) and two to three times the area of permanent clearing compared to Build Alternative 6 (depending on route).

In conclusion, Build Alternative 5 is not practicable on the basis of cost and site-suitability logistics. This alternative does not fully satisfy the overall project purpose and it is not the least environmentally damaging. It is not the LEDPA.

4.3.7 Build Alternative 6: Hammond 1 (Proposed Action/Preferred Alternative)

Build Alternative 6 is the LEDPA.

This alternative presents minimal construction logistics challenges. This alternative would require only limited rock excavation. It could take advantage of an existing single-rail crossing of the CSX rail line, which avoids the otherwise potentially significant hazards associated with Build Alternatives 2, 4, and 5. This alternative affects the fewest number of property owners (5).

There are no long-term operation and maintenance issues associated with using this location site for a water supply. From a water quality perspective, this location is at the “sweet spot”—it is downstream of the CCR release point and upstream of the Rivanna River confluence. No additionally upgrades or drought mitigation measures (beyond those reasonable measures in the VWP permit) will be necessary. The river bottom at this location is known to be suitable for the intake structure.

Build Alternative 6 is the most affordable option to JRWA. This location is more than 40% less expensive than the next least cost alternative (excluding the variations in Build Alternatives 6-1 and 6-2, discussed below). The costs of this vital public water supply project have already exceeded budgeted projections, and any additional costs above and beyond that amount are not reasonable.

Build Alternative 6 fully meets the overall project purpose. It is a “shovel ready” project that represents the shortest timeline to begin fulfilling the immediate, short-term water supply needs of Fluvanna County (supplying fire hydrants) and Louisa County (supplying Ferncliff WTP). There is an adequate quantity and quality of flow in the James River at this location to reliably meet both Counties’ long-term water supply needs.

Build Alternative 6 is the second least environmentally damaging alternative overall and the least environmentally damaging of the practicable alternatives. Only Build Alternative 3 has less impact on the aquatic environment. Although Build Alternative 6 has the second most known archeological sites within the footprint, it also is the most extensively studied route as it has a complete Phase I survey and Phase II evaluation. This alternative is also in close proximity to the fewest number of architectural resources. This alternative has the highest percentage of co-location (67%) and the second lowest area of permanent tree-clearing (behind alternative 3, which is primarily in the town of Columbia). There are no adverse environmental justice or known critical habitat impacts for this location.

In conclusion, Build Alternative 6 accommodates the specific logistical requirements of the JRWA water supply project while fully meeting the project purpose and need. The Preferred Alternative offers convenient access to James River for the JRWA water supply project and by locating the withdrawal structure in Fluvanna County, the Applicant can realize increased distribution efficiency, as Fluvanna County and Louisa County are the intended clientele. Additionally, the specific location on Point of Fork provides the water quality and quantity needed for the project. Accordingly, Build Alternative 6 is the LEDPA.

4.3.8 Build Alternative 6-1: POF Farm

Build Alternative 6-1 is not the LEDPA for any of the flowing reasons: it (1) is not practicable; and (2) is not less environmentally damaging.

This alternative presents one significant construction logistics challenge. This alternative only required limited rock excavation and could take advantage of an existing single-rail crossing of the CSX rail line, which avoids a potentially significant hazard associated with Build Alternatives 2, 4, and 5. However, JRWA has already tried unsuccessfully to obtain land from one of the property owners for the pump station site (immediately adjacent to the currently proposed site) although this alternative requires the acquisition of the second fewest number of easements (6).

There are no long-term operation and maintenance issues associated with using this location site for a water supply, which is similar to Build Alternative 6 in this respect.

Build Alternative 6-1 partially meets the overall project purpose. This alternative may not meet the Counties' short-term need for an increased water supply because the project would not be in service for at least 36-42 months.

Build Alternative 6-1 is practicable as a function of cost. It is approximately 2% more costly than the preferred alternative.

The environmental impacts of Build Alternative 6-1 are comparable to Build Alternative 6.

In conclusion, this minor variation on Build Alternative 6 is not the LEDPA. Although it is similar in many respects, it presents one practicability challenge (easement acquisition) and one limitation on fulfilling the project purpose (does not meet short-term need). Moreover, this alternative does not avoid any of the sensitive areas that have a drawn third-party criticism of Build Alternative 6.

4.3.9 Build Alternative 6-2: Hammond 2

Build Alternative 6-2 is not the LEDPA for any of the flowing reasons: it (1) is not practicable; and (2) is not less environmentally damaging.

This alternative presents one significant construction logistics challenge. This alternative would require only limited rock excavation. It could take advantage of an existing single-rail crossing of the CSX rail line, which avoids a potentially significant hazard associated with Build Alternatives 2, 4, and 5. This alternative requires the acquisition of second fewest number of easements (6). However, this alternative presents a substantial safety concern unique to this location. Constructing a pump station at this location would require a significant amount blasting to be conducted in close proximity to the Colonial Gas pipelines. This was deemed an unacceptable hazard to construction by the project's engineers.

There are no long-term operation and maintenance issues associated with using this location site for a water supply, which is similar to Build Alternative 6 in this respect.

Build Alternative 6-2 partially meets the overall project purpose. This alternative may not meet the Counties' short-term need for an increased water supply because the project would not be in service for at least 36-42 months.

The environmental impacts of Build Alternative 6-1 are comparable to Build Alternative 6, with only a minor additional temporary wetland impact. This alternative does not offer any advantages from a cultural resources perspective, however. Although it is relatively close to Build Alternative 6, this alternative would intersect three additional previously identified archeological sites.

Build Alternative 6-1 is practicable as a function of cost. It is approximately 3% more costly than the preferred alternative.

In conclusion, this minor variation on Build Alternative 6 is not the LEDPA. Although it is similar in many respects, it presents one practicability challenge (blasting next to petroleum pipelines). Moreover, this alternative does not avoid any of the sensitive areas that have a drawn third-party criticism of Build Alternative 6.

Table 21 provides a summary of the practicality considerations considered for each Build Alternative.

Table 21. Practicability Criteria Evaluated for Project Alternatives

Section	Description	Alternatives											
		1A	1B	1C	2A	2B	3	4	5A	5B	6	6-1	6-2
4.1.2	Intake Location (Name)	Forsyth	Forsyth	Forsyth	Bremo	Bremo	Columbia	Goochland 1	Goochland 2	Goochland 2	Hammond 1	Point of Fork Farm	Hammond 2
4.2.1.1 - Construction Logistics Considerations													
4.2.1.1.1	Size and Configuration of Site Suitable for Construction of a Pump Station	Yes	Yes	Yes	Yes	Yes	Size, safety	Yes	Yes	Yes	Yes	Yes	Petroleum Pipeline
4.2.1.1.2	Heavy Equipment Access to Pump Station Site	Yes	Yes	Yes	Difficult Rail Xing	Difficult Rail Xing	Difficult Rail Xing	Difficult Rail Xing	Difficult Rail Xing	Difficult Rail Xing	Yes	Yes	Yes
4.2.1.1.3	Excavation at Pump Station Site	Yes	Yes	Yes	Yes	Yes	Rock	Yes	Yes	Yes	Yes	Yes	Yes
4.2.1.1.4	Constructability of Water Main	Yes	Yes	Rivanna Xing, Rock	Rivanna Xing, Rock	Rock	Homes, Rock	Rock	Rock	Rock	Yes	Yes	Yes
4.2.1.1.5	Suitable Railroad Track Crossing Location	Single Rail	Single Rail	Single Rail	Dual Rail	Dual Rail	N/A	Dual Rail	Dual Rail	Dual Rail	Single Rail	Single Rail	Single Rail
4.2.1.1.6	Acquisition of Land and Easements; Total Acres (Total Easements)	21.75 (11)	25.36 (18)	21.87 (26)	45.1 (81)	48.63 (73)	4.96 (16); Homes	8.39 (18)	12.08 (19)	11.39 (23)	14.26 (5)	15.23 (6); Site not available	15.25 (6)
4.2.1.2 - Site Suitability Considerations													
4.2.1.2.1	Adequate Water Quality; Location Relative to Rivanna River	Upstream	Upstream	Upstream	Upstream	Upstream	Down-stream	Down-stream	Down-stream	Down-stream	Upstream	Upstream	Upstream
4.2.1.2.2	Intake and Pump Station Proximity and Depth to	Yes	Yes	Yes	Yes	Yes	Rail line	Yes	Yes	Yes	Yes	Yes	Yes
4.2.1.2.3	River Bottom Depth at Intake Location	Assumed	Assumed	Assumed	Assumed	Assumed	Assumed	Assumed	Assumed	Assumed	Yes	Yes	Assumed
4.2.1.2.4	Access to Suitable Power Supply 3-Phase Power; Miles	1 mi; overhead power	1 mi; overhead power	1 mi; overhead power	1.1 mi; overhead power	1.1 mi; overhead power	0.08 mi	0.12 mi	0.34 mi	0.34mi	0.57 mi	0.57 mi	0.64 mi
4.2.1.2.5	Proximity to Residential Dwellings/Homes; linear feet	2,700 lf	2,700 lf	2,700 lf	1,300 lf	1,300 lf	150 lf	2,000 lf	1,900 lf	1,900 lf	1,500 lf	1,250 lf	2,150 lf
4.2.1.3 - Cost Considerations													
4.2.1.3	Cost Considerations; Total Cost (% increase)	$33.9M (40%)	41.7M (73%)	43.9M (82%)	$93.6M (288%)	$91.6M (280%)	$50.8M (111%)	$43.7M (81%)	$49.4M (105%)	$46.5M (93%)	$24.1M (--)	$24.5M (2%)	$24.8M (3%)
4.2.2 - Ability to Meet the Project Purpose													
4.2.2.1	Water Quantity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4.2.2.2	Reliability of Water Supply; Location Relative to Cobb's Creek Reservoir	Upstream	Upstream	Upstream	Upstream	Upstream	Down-stream	Down-stream	Down-stream	Down-stream	Down-stream	Down-stream	Down-stream
4.2.2.3	Short-Term Water Supply Needs (Delays past 2020)	5-Yr Delay	5-Yr Delay	5-Yr Delay	6-Yr Delay	6-Yr Delay	6-Yr Delay	5-Yr Delay	5-Yr Delay	5-Yr Delay	2.5 - Yr Delay	3 to 3.5 -Yr Delay	3 to 3.5 -Yr Delay

5.0 AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

5.1 Affected Environment

5.1.1 Land Use

The construction of water supply infrastructure has the potential to affect land above and adjacent to the site. Construction of a pump station will require a permanent, though localized, change to land use for the structure, associated parking area, and, if necessary, new access road. The water main will be buried, and the surface will be restored following construction, which will allow the land to return to its preconstruction uses. Thus, the land use impact is temporary.

To minimize temporary land use impacts, the length of the water line route should be reduced. To reduce permanent land use impacts, it is desirable to locate the intake and pump station in locations that have low-intensity uses, such as agriculture. Existing homes, businesses, and other structures also should be avoided to minimize land use impacts.

1) **Build Alternative 1** is positioned near agricultural land use parcels. Locating the site in this area would result in minimal impacts to the adjacent land uses.
2) **Build Alternative 2** is positioned near agricultural land use parcels. Locating the site in this area would result in minimal impacts to the adjacent land uses.
3) **Build Alternative 3** is in proximity of Route 6 and parcels of industrial and residential land uses. Locating the site in this area, especially in proximity to historic homes of Columbia, would result in significant impacts to land use. Construction at this location would require the demolition of one and possibly two occupied homes.
4) **Build Alternative 4** is positioned near agricultural land use parcels. Locating the site in this area would result in minimal impacts to the adjacent land uses.
5) **Build Alternative 5** is positioned near agricultural land use parcels. Locating the site in this area would result in minimal impacts to the adjacent land uses.
6) **Build Alternative 6** is positioned near agricultural land use parcels. Locating the site in this area would result in minimal impacts to the adjacent land uses.
7) **Build Alternative 6-1** is positioned near agricultural land use parcels. Locating the site in this area would result in minimal impacts to the adjacent land uses.
8) **Build Alternative 6-2** is positioned near agricultural land use parcels. Locating the site in this area would result in minimal impacts to the adjacent land uses.

5.1.2 Co-location of Utilities

It is desirable to locate new utilities in or immediately adjacent to existing utility corridors with previously cleared and encumbered rights-of-way. Working in or immediately adjacent to previously disturbed areas is desirable to minimize environmental impacts including by reducing the visual impact of a new linear utility corridor on the landscape, minimizing tree-clearing, avoiding the creation of forest fragments. Table 22 summarizes the percentage of water main that may be co-located in or immediately adjacent to existing utility corridors as shown in (see Appendix H-10)

Table 22. Water main Co-Location of Utilities

Sub-Alternative ID	Percentange of Pipeline Co-located in Existing Utility Corridor
1A	25% +/-
1B	10% +/-
1C	0% +/-
2A	0% +/-
2B	4% +/-
3	0% +/-
4	0% +/-
5A	0% +/-
5B	0% +/-
6	67% +/-
6-1	63% +/-
6-2	67% +/-

1) **Build Alternative 1** has three sub-alternative routes. Sub-alternative 1A and 1B permit the co-location of approximately 25% and 10%, respectively, of water main within or adjacent to previously cleared and encumbered right-of-way. Sub-alternative 1C does not permit the opportunity to co-locate utilities.

2) **Build Alternative 2** has two Sub-alternative routes. Sub-alternative 2A does not permit the opportunity co-locate utilities. Sub-alternative 2B permits the co-location of approximately 4% of water main within or adjacent to previously cleared and encumbered right-of-way.

3) **Build Alternative 3** does not permit the opportunity to co-locate utilities.

4) **Build Alternative 4** does not permit the opportunity to co-locate utilities.

5) **Build Alternative 5** has two Sub-alternative routes. Sub-alternative 5A and 5B do not permit the opportunity to co-locate utilities.

6) **Build Alternative 6** permits the co-location of majority (67%) of water main within or adjacent to previously cleared and encumbered right-of-way.

7) **Build Alternative 6-1** permits the co-location of majority (63%) of water main within or adjacent to previously cleared and encumbered right-of-way.

8) **Build Alternative 6-2** permits the co-location of majority (67%) of water main within or adjacent to previously cleared and encumbered right-of-way.

5.1.3 Tree Clearing

Permanent clearing of trees will be required along the length of the water main. Maintaining an area above the buried pipe clear of trees protects the pipe from damage by tree roots and allows the pipe to be accessed for maintenance and repairs. A 30-foot clearing width was assumed to calculate the total area of clearing required; this included clearing for the purposes of equipment access, installation, and easement access. Areas outside of the 30-foot wide permanently maintained easement will be allowed to return to preconstruction land uses, which includes returning previously forested areas to that state (subject to the independent decisions of the landowner).

Temporary and permanent tree clearing can be minimized by avoiding forested areas. If forested areas must be impacted, the effect is reduced by avoiding the fragmentation of large forest cores. The alternatives for this project were developed to avoid forest clearing and fragmentation where feasible.

Permanent clearing information is summarized in the list and table below.

Table 23. Tree Clearing Requirements

Sub-Alternative ID	Length	Width	Area
	LF	LF	AC
1A	2,200	30	1.5
1B	9,300	30	6.4
1C	9,900	30	6.8
2A	20,100	30	13.8
2B	19,400	30	13.4
3	1,000	30	0.69
4	2,900	30	2.0
5A	5,900	30	4.1
5B	4,100	30	2.8
6	1,800	30	1.2
6-1	2,100	30	1.4
6-2	1,900	30	1.3

1) **Build Alternative 1** has three sub-alternatives routes. Sub-alternative 1A would require some clearing near historic canals; the total length of clearing is minimal at 2,200 LF. Sub-alternative 1B would require clearing in areas along rocky areas of Bremo Road; the total length of clearing is 9,300 LF. Sub-alternative 1C would also require clearing in rocky areas along Bremo Road as well as rocky portions of Route 6; the total length of clearing is 9,900 LF.

2) **Build Alternative 2** has two Sub-alternative routes. Sub-alternative 2A and 2B both encounter many rocky areas and narrow roads along Bremo Road which will be

difficult for clearing activities. Sub-alternative 2B also has rocky areas along Route 6. Clearing for sub-alternatives 2A and 2B are 20,100 and 19,400 LF, respectively.

3) **Build Alternative 3** has minimal clearing of 1,000 LF, however clearing in this area will be difficult or unachievable due to its proximity to the historic buildings in the town of Columbia.

4) **Build Alternative 4** has minimal clearing of 2,900 LF, however clearing along this path will be difficult or unachievable due to its proximity to the historic buildings in the town of Columbia.

5) **Build Alternative 5** has two Sub-alternative routes. Sub-alternative 5A and 5B both have minimal clearing lengths of 5,900 and 4,100 LF, respectively, however clearing along this path will be difficult due to its proximity to the historic buildings in the town of Columbia.

6) **Build Alternative 6** has minimal clearing of 1,800 LF. The clearing activities along this path have relatively little disturbance consequences to the nearby areas along the route.

7) **Build Alternative 6-1** has minimal clearing of 2,100 LF, however clearing in this area may be difficult or unachievable due to conflicts with the owner of the Point of Fork Farms property.

8) **Build Alternative 6-2** has minimal clearing of 1,900 LF, however clearing in this area may be difficult or unachievable due to the existing Columbia gas line presenting safety concerns during clearing activities.

5.1.4 River Flow Impact

This project proposed to withdraw up to 5.73 MGD initially, with a capacity to expand to 12 MGD at a future date. Water withdrawals have the potential to impact stream flow and beneficial uses downstream of the point of withdrawal. Downstream beneficial uses that depend on the volume of water include (1) public and industrial water supplies; (2) support of aquatic life; (3) recreation; (4) navigation; and (5) assimilative capacity to manage wastewater discharges.

Potential impacts to downstream beneficial uses can be mitigated through compliance with the Virginia VWP surface water withdrawal regulations. Those regulations mandate that a VWP permit be obtained for any new or expanded surface water withdrawal greater than 10,000 GPD. To obtain a VWP permit, an applicant must demonstrate to the Virginia State Water Control Board that the proposed withdrawal will not adversely affect downstream beneficial uses (9VAC25-210-340(5), -370(D)). Any proposed James River water withdrawal associated with the project will require a VWP permit. Build Alternative 6 has already revised a VWP permit for withdraw (see Appendix D-1).

The Rivanna River naturally adds additional flow at the James River confluence. Additionally, the location of the Cobbs Creek Reservoir (CCR) in relation to the intake site is important as the CCR may release water in times of drought or low flow conditions. River flow characteristics are summarized in the list and table below.

Table 24. Potential River Impacts

Build Alternative Location	Distance to Confluence	Downstream of CCR	Distance Upstream of CCR
	Miles		Miles
1	2.3	No	0.4
2	10.1	No	7.8
3	0.1	Yes	--
4	0.4	Yes	--
5	1.1	Yes	--
6	0.4	Yes	--
6-1	0.4	Yes	--
6-2	0.8	Yes	--

1. **Build Alternative 1** is situated 0.4 miles upstream of the CCR and 2.3 miles upstream of the confluence, thus the site location may potentially expose the river to adverse impacts that cannot be mitigated by the release of water from the CCR during drought conditions.

2. **Build Alternative 2** is situated 7.8 miles upstream of the CCR and 10.1 miles upstream of the confluence, thus the site location is very likely to expose the river to adverse impacts that cannot be mitigated by the release of water from the CCR during drought conditions.

3. **Build Alternative 3** is positioned downstream of the CCR and situated 0.1 miles downstream of confluence, thus the site location minimizes the potential adverse impacts to the James River during drought conditions.

4. **Build Alternative 4** is positioned downstream of the CCR and situated 0.4 miles downstream of confluence, thus the site location minimizes the potential adverse impacts to the James River during drought conditions.

5. **Build Alternative 5** is positioned downstream of the CCR and situated 1.1 miles downstream of confluence, thus the site location minimizes the potential adverse impacts to the James River during drought conditions.

6. **Build Alternative 6** is positioned downstream of the CCR and situated 0.4 miles upstream of confluence, thus the site location minimizes the potential adverse impacts to the James River during drought conditions.

7. **Build Alternative 6-1** is positioned downstream of the CCR and situated 0.4 miles upstream of confluence, thus the site location minimizes the potential adverse impacts to the James River during drought conditions.

8. **Build Alternative 6-2** is positioned downstream of the CCR and situated 0.8 miles upstream of confluence, thus the site location minimizes the potential adverse impacts to the James River during drought conditions.

5.1.5 Viewshed Impact

Construction of a new pump station structure roughly the size of a house in a scenic riverbank setting has the potential to cause aesthetic impacts to local residents, tourists, and recreational users of the river. Depending on the site elevation relative to the 100-year flood elevation, the pump station building may be elevated above existing grade. For further detail see Appendix H-2 for intake structure to wet well cross section exhibits.

To minimize viewshed impacts, the design of the pump station building can utilize façade materials, color, and architectural treatments that will lessen visual impacts. At each Build Alternative site, the pump station is set back from the riverbank to minimize the viewshed impact from the river. Additionally, vegetative screening also can be employed to shield the pump station from view.

1. **Build Alternative 1** provides enough space to install vegetative screening to minimize viewshed impacts and the structure can be designed to minimize visual impacts.

2. **Build Alternative 2** provides enough space to install vegetative screening to minimize viewshed impacts and the structure can be designed to minimize visual impacts.

3. **Build Alternative 3** will be difficult to screen due to its small footprint and proximity to adjacent structures.

4. **Build Alternative 4** provides enough space to install vegetative screening to minimize viewshed impacts and the structure can be designed to minimize visual impacts.

5. **Build Alternative 5** provides enough space to install vegetative screening to minimize viewshed impacts and the structure can be designed to minimize visual impacts.

6. **Build Alternative 6** provides enough space to install vegetative screening to minimize viewshed impacts and the structure can be designed to minimize visual impacts.

7. **Build Alternative 6-1** provides enough space to install vegetative screening to minimize viewshed impacts and the structure can be designed to minimize visual impacts.

8. **Build Alternative 6-2** provides enough space to install vegetative screening to minimize viewshed impacts and the structure can be designed to minimize visual impacts.

5.1.6 Noise Abatement

The operation of water pumps and backup generators (run periodically for testing) can create ambient noise in the area surrounding a pump station.

The following are measures can be taken to minimize audible noise from the pump station site for **all Build Alternatives**. As a result of these measures, during normal operating conditions, the pump station will be far less impactful than noise from existing CSX rail, auto/truck traffic and agricultural equipment in the proximity of these sites.

1) Except for the generator, mechanical equipment related to pumping of water and maintenance of the intake screens will be enclosed in a building constructed of concrete masonry units (CMU) walls and will be enclosed by a standing seam metal roof with insulation.
2) The generator will be enclosed within a CMU screen wall and will be provided with inlet and exhaust mufflers that will minimize audible noise.

5.1.7 Environmental Justice

Executive Order 12898 requires federal agencies to identify and address disproportionately high and adverse human health or environmental effects of federal actions on minority and low-income populations. These groups are traditionally referred to as Environmental Justice (EJ) populations.

To identify the potential presence of EJ populations within the vicinity of the considered alternatives, a review of the Environmental Protection Agency (EPA) EJ screening tool, (EJSCREEN) was conducted (see Appendices H-11). EJSCREEN provides data regarding EJ populations with demographic data provided from the latest five-year average American Community Survey (ACS) estimates, which is maintained by the US Census Bureau. Although the Census Bureau collects data at the household level, the most detailed demographic data ACS provides is through census Block Groups, which represents a subdivision of a county with population generally between 600 and 3,000 people. The considered alternatives are located across five (5) census Block Groups (see Figure 26 below). For the purpose of the EJ analysis, these five census Block Groups constitutes the Environmental Justice Study Area (see Appendix H-11-3).

To determine whether EJ populations are present within the EJ Study Area, a review of minority (see Appendix H-11-1) and low-income populations (see Appendix H-11-2) was conducted. EJSCREEN provides data on these groups and provided the following definitions:

Minority: The number or percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino. That is, all people other than non-Hispanic white-alone individuals. The word “alone” in this case indicates that the person is of a single race, since multiracial individuals are tabulated in another category – a non-Hispanic individual who is half white and half American Indian would be counted as a minority by this definition.

Low-Income: The number or percent of a block group’s population in households where the household income is less than or equal to twice the federal poverty level.

In accordance with Executive Order 12898 and Council on Environmental Quality guidance, an EJ Population is considered present where one or both of the following conditions were met within an EJ Study Area:

1. The minority or low-income population of the EJ Study Area exceeds 50 percent; or
2. The minority or low-income population percentage of a Census Block is meaningfully greater (greater than 10%) than the minority or low-income population percentage of the EJ Study Area.

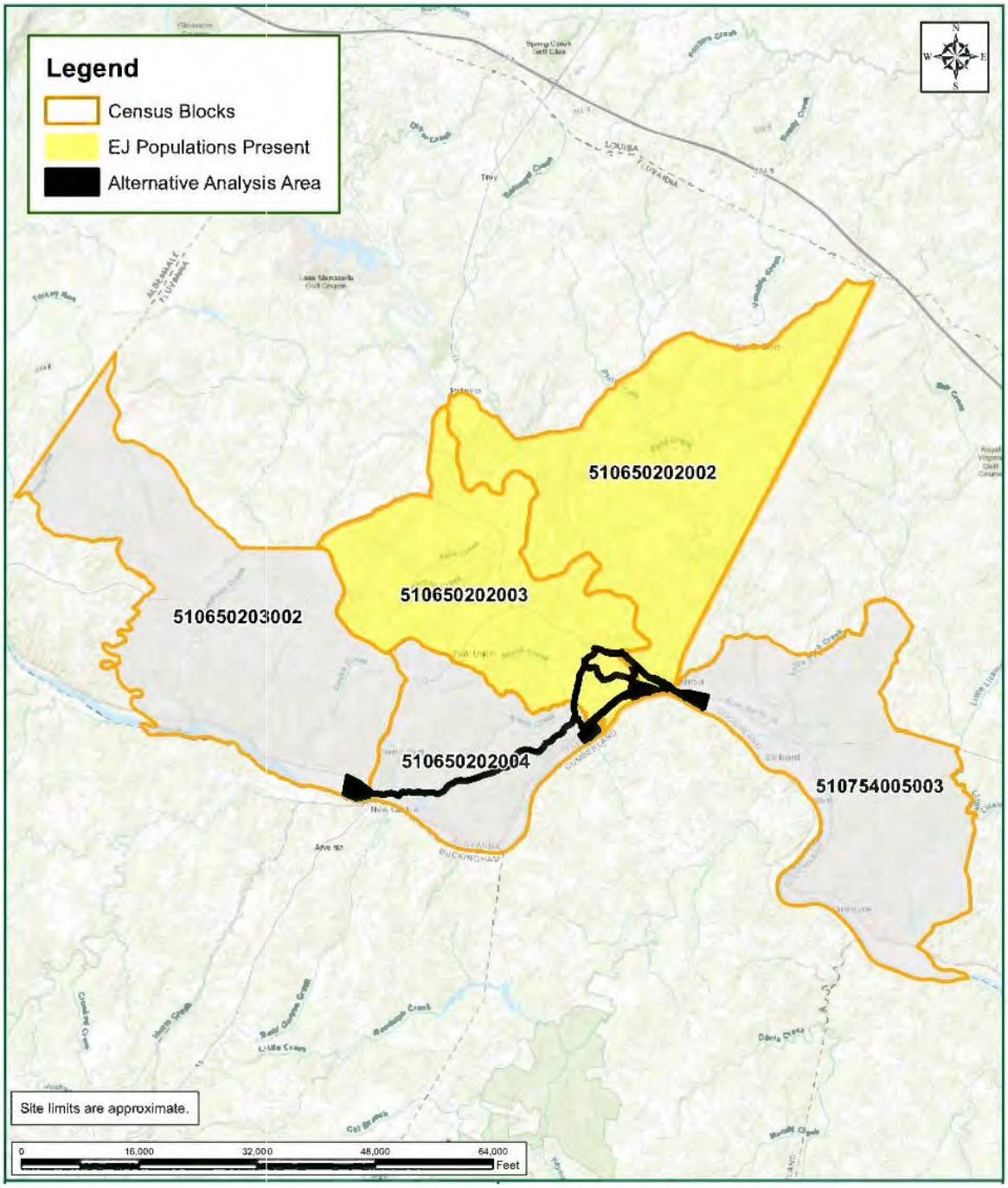


Figure 26. Environmental Justice Study Area

Data for each census Block Group and the EJ Study area are provided below:

Table 25. Analysis of EJ Populations within EJ Study Area

Census Block Group ID	Total Population	Minority Population	Minority %	Low Income Population	Low Income %
510650202002	837	48	5.7%	368	44.0%
510650202003	2204	1360	61.7%	679	30.8%
510650202004	695	238	34.2%	59	8.5%
510650203002	1873	420	22.4%	433	23.1%
510754005003	1278	435	34.0%	281	22.0%
EJ Study Area	**6887**	**2501**	**36.3%**	**1820**	**26.4%**
EJ Evaluation Factor (1.1 x EJ Study Area percentage)			**39.9%**		**29.1%**

Based on the EJSCREEN data, EJ populations are present within the Study Area. Census Block Groups 510650202002 and 5106502003 both contains low income populations meaningfully greater than the low-income population percentage of the EJ Study Area. In addition, census Block Group 5106502003 contains a minority population which exceeds 50 percent of the total population and is meaningfully greater than the EJ Study Area population.

Although EJ populations are present within the Study Area, it is unlikely that any of the proposed alternatives would cause significant adverse health or environmental harm to Environmental Justice communities. Water quality impacts are not anticipated and will be addressed through Clean Water Act § 401 certification review. Adverse impacts from construction activities and changes to the viewshed are not anticipated for any Alternatives, except for Build Alternative 3 (see discussion below). Impacts related to river flow and noise have been addressed elsewhere in this document (See Sections 5.1.4 and 5.1.6). Finally, meaningful public involvement has been incorporated into the overall project planning providing residents with the opportunity to participate in decision-making related to Environmental concerns. As discussed in Sections 2.1 and 8.0, there have been many opportunities for public involvement during the project review process. Therefore, adverse impacts to Environmental Justice populations is not anticipated, with the exception of Build Alternative 3.

1) **Build Alternative 1** includes direct water main impacts within census Block Groups containing EJ populations. Adverse impacts are not anticipated.
2) **Build Alternative 2** includes direct water main impacts within census Block Groups containing EJ populations. Adverse impacts are not anticipated.
3) **Build Alternative 3** includes direct pump station and water main impacts within census Block Groups containing EJ populations. Adverse impacts from construction activities and changes to the viewshed are possible due to the location of the pump station within a town with a predominantly low-income population. Additionally, between one and two homes within the town likely would be demolished to allow construction of the pump station.

4) **Build Alternative 4** includes direct water main impacts within census Block Groups containing EJ populations. Adverse impacts are not anticipated.
5) **Build Alternative 5** includes direct water main impacts within census Block Groups containing EJ populations. Adverse impacts are not anticipated.
6) **Build Alternative 6** includes direct pump station and water main impacts within census Block Groups containing EJ populations. Adverse impacts are not anticipated.
7) **Build Alternative 6-1** includes direct pump station and water main impacts within census Block Groups containing EJ populations. Adverse impacts are not anticipated.
8) **Build Alternative 6-2** includes direct pump station and water main impacts within census Block Groups containing EJ populations. Adverse impacts are not anticipated.

5.1.8 Aquatic Resources

Construction of the water supply infrastructure has the potential to affect aquatic uses. Construction of the pump station, parking areas, access roads can represent permanent changes to the land. Construction of the water main can cause temporary impacts to aquatic resources it crosses. Installation of the water intake structure entails both temporary and permanent impacts to the riverbank and bed.

Impacts to aquatic resources is mitigated siting infrastructure and using construction techniques to avoid or minimize impacts to those resources. Unavoidable impacts can be compensated under the relevant USACE and VWP regulations.

5.1.8.1 Approximation of Resource Limits

Timmons Group utilized a combination of confirmed jurisdictional determination delineations, desktop analysis, and field verification to identify potential jurisdictional areas within proximity of the alternative alignments. A previously confirmed wetland delineation developed for the proposed project was used as a basis for this evaluation (NAO-2014-0708). In addition, areas were reviewed within a general 400-foot corridor around each alternative alignment and within parcel utilized by alternative pump stations (Study Area). An on-screen process was then utilized to digitize potential wetlands within the Desktop Delineation Area (see Appendix H-12: Aquatic Resource Documentation).

The on-screen process utilized GIS imaging software (ArcMap) by technical users with years of experience in desktop visualization of wetlands. Publicly available overlay geospatial layers were used to aid in determining and digitizing potential jurisdictional areas within the Desktop Delineation Area. Data sources utilized included Virginia Geographic Information Network (VGIN) 2017/2018 aerial imagery, shaded elevation layers, USGS maps for hydrographic/cultural/contour information, National Wetlands Inventory (NWI) from U.S. Fish and Wildlife, and hydric soils information from USDA (see Appendix H-12-4).

Potential jurisdictional features were initially indicated by the presence of NWI or National Hydrography Data within the Desktop Delineation Area. NWI was used as the base linework and then adjusted based on supplemental data layers and information. USDA Hydric soils

data was then reviewed; however, based on professional experience these areas generally represent an overestimate of wetland areas. Using LiDAR generated Digital Elevation Models from the Virginia Geographic Information Network (VGIN), wetland limits were further estimated by identifying landscape depressions likely to collect water and create wetlands. Streams channels were also estimated by identifying LiDAR based incised linear features for smaller stream and sharp topographic contours for larger streams such as the James and Rivanna Rivers. Although County GIS property boundaries were reviewed, they were not used to determine the extent of jurisdictional features. Leaf-off aerial imagery was then utilized to determine traces of aquatic resources through discoloration, changes in vegetation, and other indications of wetlands and streams. Finally, aerial imagery was used to estimate Cowardin Classifications of wetland features.

State-owned bottomlands were also approximated within the Desktop Delineation Area. State-owned bottomlands include all navigable waters in Virginia and under VRMC guidelines, all perennial streams with a drainage basin of greater than 5 square miles are considered navigable-in-fact unless evidence is provided showing otherwise. Drainage areas for all streams identified in the National Hydrography Dataset (NHD) which corresponded to proposed impacts were reviewed and drainage areas were calculated using the USGS StreamStats website (see Appendix H-12-1) to determine likely reaches of state-owned bottomlands.

Following the desktop analysis, a site visit was conducted to review limits of the possible features identified in the desktop review. On-site observations were limited to visual inspections from public roads and accesses. The end product represents an approximation of the limits of jurisdictional areas within the Desktop Delineation Area (see Appendix H-12-2). Formal delineation field work and confirmation of findings by the US. Army Corps of Engineers was outside the scope of this analysis and would be required to determine the actual extents of jurisdictional areas.

5.1.8.2 Impacts to Aquatic Resources

Impact areas were estimated for each alternative alignment based on the Desktop Delineation (see Appendix H-12-3). Impact corridors were determined based on required design criteria. Alternative alignments were adjusted where reasonable to avoid and minimize jurisdictional impacts. The table below provides a summary of jurisdictional impacts for each of the proposed alternatives

Table 26. Estimated Impacts to Aquatic Resources by Build Alternative

NAO-2014-00708 - James River Water Authority - Supplemetal Information Package													
Alternate ID	Wetland Impact										Stream Impact		
	Temporary			Permanent					Total Wetland Impacts		Temporary	Permanent	Total Stream Impacts
	PEM	PFO	POW	PEM	PSS	PFO	POW	Conversion PFO to PEM			L.F.	L.F.	L.F.
	S.F.	S.F.	S.F.	S.F.	S.F.	S.F.	S.F.	S.F	S.F.	Ac			
1A	14,096			596	1,768	764		1,362	**18,586**	**0.43**	930	287	**1,217**
1B	12,542			596	1,768	764		9,923	**25,593**	**0.59**	908	287	**1,195**
1C	13,439			596	1,768	764		10,320	**26,887**	**0.62**	837	287	**1,124**
2A	4,295			2,621		5,658		13,528	**26,102**	**0.60**	885	341	**1,226**
2B	3,398			2,621		5,658		13,131	**24,808**	**0.57**	956	341	**1,297**
3									**-**	**-**	378	64	**442**
4						56		2,068	**2,124**	**0.05**	510	163	**673**
5A			1,026			5,352	1,306	6,450	**14,134**	**0.32**	493	149	**642**
5B						5,352	1,306	2,068	**8,726**	**0.20**	489	149	**638**
6	367	296				1,015		248	**1,926**	**0.04**	796	148	**944**
6-1	367	296				1,015		248	**1,926**	**0.04**	796	148	**944**
6-2	367	296				1,015		449	**2,127**	**0.05**	796	148	**944**

PFO=Palustrine Forested Wetland; PSS=Palustrine Scrub-Shrub Wetland; PEM=Palustrine Emergent Wetland; POW=Palustrine Open Water

Table 27. Estimated Permanent Impacts to Aquatic Resources by Build Alternative

Alternate ID	Permanent Wetland Impacts	Permanent Stream Impacts
	Ac	L.F.
1A	**0.10**	**287**
1B	**0.30**	**287**
1C	**0.31**	**287**
2A	**0.50**	**341**
2B	**0.49**	**341**
3	**0**	**64**
4	**0.05**	**163**
5A	**0.30**	**149**
5B	**0.20**	**149**
6	**0.03**	**148**
6-1	**0.03**	**148**
6-2	**0.03**	**148**

1) **Build Alternative 1** has three sub-alternative routes. Sub-alternative 1A proposes impacts to 0.43 acres of wetlands and 1,217 linear feet of stream. Sub-alternative 1B proposes impacts to 0.59 acres of wetlands and 1,195 linear feet of stream. Sub-alternative 1C proposes impacts to 0.62 acres of wetlands and 1,124 linear feet of stream.
2) **Build Alternative 2** has two sub-alternative routes. Sub-alterative 2A proposes impacts to 0.60 acres of wetlands and 1,226 linear feet of stream. Sub-alternative 2B proposes impacts to 0.57 acres of wetlands and 1,297 linear feet of stream.
3) **Build Alternative 3** proposes no wetland impacts. Additionally, this route proposes impacts to 442 linear feet of stream.
4) **Build Alternative 4** proposes impacts to 0.05 acres of wetlands and 673 linear feet of stream.
5) **Build Alternative 5** has two sub-alternative routes. Sub-alternative 5A proposes impacts to 0.32 acres of wetlands and 642 linear feet of stream. Sub-alternative 5B proposes impacts to 0.20 acres of wetlands and 638 linear feet of stream.
6) **Build Alternative 6** proposes impacts to 0.04 acres of wetlands and 944 linear feet of stream.
7) **Build Alternative 6-1** proposes impacts to 0.04 acres of wetlands and 944 linear feet of stream.
8) **Build Alternative 6-2** proposes impacts to 0.05 acres of wetlands and 944 linear feet of stream.

5.1.8.3 Aquatic Resource Impact Permitting

Authorization for impacts to aquatic resources is required through three separate permitting agencies for the proposed project as outlined below. Each agency's permitting program mandates avoidance, minimization, and mitigation measures to mitigate aquatic resource impacts within its respective jurisdiction.

1) Certification under Section 401 of the Clean Water Act from DEQ via a VWP permit for water withdrawals and impacts to waters under state jurisdiction.

2) Authorization under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899 (RHA) from the USACE is required for impacts to jurisdictional waters.

3) Authorization from the Virginia Marine Resources Commission to use state-owned bottomlands.

Table 28. Summary of anticipated State-owned Bottomland Impacts by alternative

Alternative ID	State-owned Bottomland Impacts
1A	3
1B	3
1C	3
2A	3
2B	3
3	1
4	1
5A	1
5B	1
6	2
6-1	2
6-2	2

Build Alternative 6 (Proposed Action) has already received a VMRC permit for the intake structure impact in the James River and the crossing of the Rivanna River (see Appendix D-2).

1) **Build Alternative 1** has three sub-alternative routes; 1A, 1B, and 1C. All three sub-alternatives are assumed to require a VWP IP from DEQ, an IP from the USACE, and a VMRC permit to impact state-owned bottomlands at three (3) separate locations.
2) **Build Alternative 2** has two sub-alternative routes; 2A and 2B. Both sub-alternatives are assumed to require a VWP IP from DEQ, an IP from the USACE, and a VMRC permit to impact state-owned bottomlands at three (3) separate locations.
3) **Build Alternative 3** is assumed to require a VWP IP from DEQ, an IP from the USACE, and a VMRC permit to impact state-owned bottomlands at one (1) location (the intake).
4) **Build Alternative 4** is assumed to require an a VWP IP from DEQ, an IP from the USACE, and a VMRC permit to impact state-owned bottomlands at one (1) location (the intake).
5) **Build Alternative 5** has two sub-alternative routes; 5A and 5B. Both sub-alternatives are assumed to require a VWP IP from DEQ, an IP from the USACE, and a VMRC permit to impact state-owned bottomlands at one (1) location (intake location).
6) **Build Alternative 6** has received a VWP IP from DEQ for the intake structure and associated impacts. This permit is currently pending modification. This alternative has also received a VMRC permit for crossings of the James River and Rivanna River. JRWA is submitting this package to supply the USACE with supplemental information necessary to review the Project in accordance with the standard individual CWA § 404 permit process and obtain § 404 CWA Authorization.

7) **Build Alternative 6-1** may be able to modify the existing VWP IP DEQ permit to obtain CWA § 401 authorization. This alternative may also be able to modify the existing VMRC permit as the James River and utilize the existing authorization for the Rivanna River. It is assumed that this alternative will require an Individual Permit from the USACE.
8) **Build Alternative 6-2** may be able to modify the existing VWP IP DEQ permit to obtain CWA § 401 authorization. This alternative may also be able to modify the existing VMRC permit as the James River and utilize the existing authorization for the Rivanna River. It is assumed that this alternative will require an Individual Permit from the USACE.

5.1.8.4 Avoidance and Minimization

A detail alternatives analysis was conducted which provides details on how impacts have been avoided to the maximum extent practicable (see Section 4.0 and 5.1). The Applicant also utilized the Desktop Delineation (see Appendix H-12-2) to ensure all estimated jurisdictional features within the Project Area were mapped to aid in impact avoidance during the early phases of project planning and layout (see Section 4.2.3.1).

Impacts will be avoided to the greatest extent practicable given the Project's purpose and need. Complete avoidance of jurisdictional waters is not possible due to the linear nature of the project, location of the interconnection point, the necessity of access the James River for water withdrawal, and the utilization of existing easements or right-or-ways to reduce the burden on local landowners. Each crossing of jurisdictional features has been strategically placed to minimize and/or avoid additional wetland and stream impacts where practicable. Where possible, wetlands and streams were crossed perpendicularly to minimize impacts. Multiple layouts were examined to develop the water supply project in a manner that avoids and minimizes impacts to environmentally sensitive areas to the maximum extent practicable, while meeting the configuration requirements necessary to provide operation of the facility.

Furthermore, a project-specific Erosion and Sediment Control (ESC) plan will be developed and submitted to Fluvanna County for the selected build alternative for approval of the land disturbing activity. The ESC plan will be prepared in accordance with the Virginia Erosion & Sediment Control Law (VESCL) and Regulations (VESCR) and the most current version of the *Virginia Erosion & Sediment Control Handbook*. The ESC plan will be approved by the locality prior to any land-disturbing activity at the Site. All regulated land-disturbing activities associated with the Project, including on- and off- site access roads, staging areas, borrow areas, stockpiles, and soil intentionally transported from the Project Area will be covered by the project specific ESC plan. During construction activities, the ESC Best Management Practices (BMPs) will be inspected and maintained throughout the life of the construction activity providing for enhanced protection for the avoided jurisdictional areas.

5.1.8.5 Compensatory Mitigation for Impacts

The compensatory mitigation requirement for unavoidable impacts associated with the project would be achieved through the purchase of off-site mitigation credits from wetland and stream mitigation banks.

Compensation for the 64 linear feet of permanent stream channel impacts associated with each alternative intake structure have are not proposed in this analysis. During § 401 permitting review, DEQ staff determined impacts to the stream channel from construction of the proposed intake will be minimal and the channel's existing functions and values will not be adversely affected.

Mitigation credits have been estimated based on standard mitigation ratios as detailed in Table 29.

Table 29. Estimated Jurisdictional Aquatic Resources Mitigation Summary by Build Alternative

	Impacts Type			Alternate ID											
				1A	1B	1C	2A	2B	3	4	5A	5B	6	6-1	6-2
Wetlands	PEM Impacts	Impact Area	Square Feet	596	596	596	2,621	2,621							
			Acres	0.01	0.01	0.01	0.06	0.06							
		Credits Required (1:1 Ratio)		***0.01***	***0.01***	***0.01***	***0.06***	***0.06***							
	PSS Impacts	Impact Area	Square Feet	1,768	1,768	1,768									
			Acres	0.04	0.04	0.04									
		Credits Required (1.5:1 Ratio)		***0.06***	***0.06***	***0.06***									
	PFO Impacts	Impact Area	Square Feet	764	764	764	5,658	5,658		56	5,352	5,352	1,015	1,015	1,015
			Acres	0.02	0.02	0.02	0.13	0.13		0.001	0.12	0.12	0.02	0.02	0.02
		Credits Required (2:1 Ratio)		***0.04***	***0.04***	***0.04***	***0.26***	***0.26***		***0.002***	***0.24***	***0.24***	***0.04***	***0.04***	***0.04***
	PFO to PEM Conversions	Impact Area	Square Feet	1,362	9,923	10,320	13,528	13,131		2,068	6,450	2,068	248	248	449
			Acres	0.03	0.23	0.24	0.31	0.30		0.05	0.15	0.05	0.01	0.01	0.01
		Credits Required (1:1 Ratio)		***0.03***	***0.23***	***0.24***	***0.31***	***0.30***		***0.05***	***0.15***	***0.05***	***0.01***	***0.01***	***0.01***
	Total Wetland Credits			**0.14**	**0.34**	**0.35**	**0.63**	**0.62**	**-**	**0.05**	**0.39**	**0.29**	**0.05**	**0.05**	**0.05**
Streams	Stream Impacts (1:1 Ratio)*	Impact Total ‡	Linear Feet	223	223	223	277	277		99	85	85	84	84	84
		Total Stream Credit		**223**	**223**	**223**	**277**	**277**	**-**	**99**	**85**	**85**	**76***	**76***	**76***

*Stream mitigation ratios can vary and are determined by the Unified Stream Methodology (USM). USMs have been completed for the stream impacts associated with Alt. 6, 6-1 & 6-2, which determined a compensation ratio of 0.90:1 for all stream impacts. Analysis assumes a ratio of 1:1 for all other stream impacts.
‡ Stream impact totals for each alterntative excludes the 64 LF of intake stucture impacts as compensation for these impacts is not proposed.

1) **Build Alternative 1** has three Sub-alternative routes. Sub-alternative 1A requires the purchase of 0.14 wetland credits and 223 stream credits. Sub-alternative 1B requires the purchase of 0.34 wetland credits and 223 stream credits. Sub-alternative 1C requires the purchase of 0.35 wetland credits and 223 stream credits.
2) **Build Alternative 2** had two Sub-alternative routes. Sub-alternative 2A requires the purchase of 0.63 wetland credits and 277 stream credits. Sub-alternative 2B requires the purchase of 0.62 wetland credits and 277 stream credits.
3) **Build Alternative 3** excluding the 64 LF of stream impact for the intake structure that compensation is not proposed for, this build alternative has no permanent impacts, and thus no wetland or stream credits to be purchased.
4) **Build Alternative 4** requires the purchase of 0.05 wetland credits and 99 stream credits.
5) **Build Alternative 5** has two Sub-alternative routes. Sub-alternative 5A requires the purchase of 0.39 wetland credits and 85 stream credits. Sub-alternative 5B requires the purchase of 0.29 wetland credits and 85 stream credits.
6) **Build Alternative 6** requires the purchase of 0.05 wetland credits and 76 stream credits. The United Stream Methodology was used to determine the compensation ratio for these stream impacts.
7) **Build Alternative 6-1** requires the purchase of 0.05 wetland credits and 76 stream credits. The United Stream Methodology was used to determine the compensation ratio for these stream impacts.
8) **Build Alternative 6-2** requires the purchase of 0.05 wetland credits and 76 stream credits. The United Stream Methodology was used to determine the compensation ratio for these stream impacts.

5.1.9 Threatened and Endangered Species

Construction of a water supply project has the foreseeable potential to affect threatened and endangered (T&E) species or their habitat, if present, in several respects. Upland construction and tree-felling has the potential to disturb birds, bats, and other terrestrial species. Tree-clearing and land disturbance can temporarily or permanently change habitat for birds, bats, and other species. Instream construction of a water intake structure or water main can temporarily affect aquatic life through direct disturbance, temporary loss of habitat, and increased suspended sediment and turbidity levels. The long-term operation of a water intake structure has the potential to entrap or entrain aquatic species.

The selection of an intake site and water main route should consider the impacts to populations of federally recognized T&E species. The U.S. Fish and Wildlife Service (USFWS) IPaC Trust Resource List database was reviewed for likely populations of federal T&E species within the project vicinity with additional information supplemented from the Virginia Department of Game and Inland Fisheries (DGIF), Virginia Fish and Wildlife Information Service (VaFWIS), and the Center for Conservation Biology (see Appendix H-13). The results of the IPAC database are summarized in Table 30.

Table 30. Summary of IPAC Results for Federal Protected Species by Build Alternative

Alternative ID	Northern Long-eared Bat (*Myotis septentrionalis*) FT	Atlantic Pigtoe (*Fusconaia masoni*) FP	James Spinymussel (*Parvaspina collina*) FE	Proposed Critical Habitat Present (Atlantic Pigtoe)
1A	X	X	X	
1B	X	X	X	
1C	X	X	X	
2A	X	X	X	X
2B	X	X	X	X
3	X	X	X	
4	X	X		
5A	X	X		
5B	X	X		
6	X	X	X	
6-1	X	X	X	
6-2	X	X	X	

FE - Federally Endangered, FP - Federally Proposed, FT - Federally Threatened

The IPaC search results identified the federally threatened Northern Long-Eared Bat (*Myotis septentrionalis*) as having potential habitat within all alternatives. Review of available VDGIF NLEB location mapping indicates there are no known Northern Long-eared Bat winter hibernacula/maternity roosts within the vicinity of any of the alternatives. Therefore, reliance upon the findings of the January 6, 2016, Programmatic Biological Opinion for Final 4(d) Rule on the Northern Long-Eared Bat and Activities Exempted from Take Prohibitions to fulfill the project-specific section 7 responsibilities should be applicable to all alternatives. Tree clearing estimates for each alignment are provided in Section 5.1.3.

The IPaC search also identified two protected mussel species having potential habitat within each alternative alignment, with the exception of alternatives associated with Pump Stations 4 and 5, which are only associated with the potential for one protected mussel species. In addition, Pump Station 2 is located within a reach of the James River which has been proposed to be listed as Critical Habitat for the Atlantic Pigtoe. Per the USFWS's proposed critical habitat ruling this proposed stretch of critical habitat (Unit JR3) encompasses a three-mile segment of the James River starting at the confluence of the Slate River and extending downstream under the crossing of VA Hwy 15 (James Madison Highway) (see Figure 27). USFWS states this stretch of the James River currently supports all breeding, feeding, and sheltering needs for the Atlantic Pigtoe.

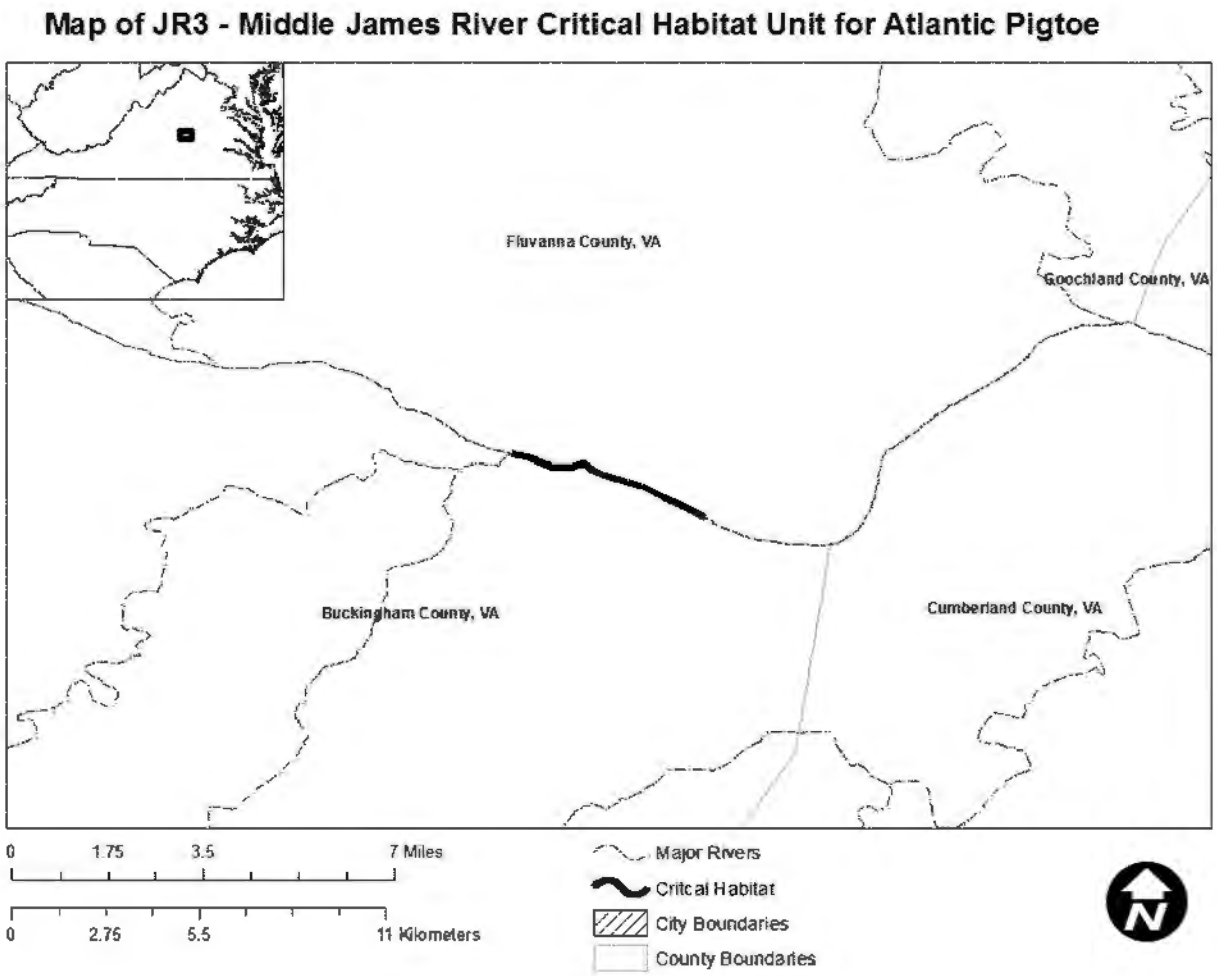


Figure 27. Limits of Proposed Atlantic Pigtoe Critical Habitat along James River. (Source: 83 Fed. Reg. 51570, 51596 [Oct. 11, 2018])

To further determine if protected mussel species will be affected by the proposed Project, additional coordination with USFWS will be required and mussel surveys of streams with suitable habitat, as determined by the USFWS, will likely be necessary. This analysis assumes surveys will be necessary at all alternative intake locations and at identified impacted crossing of streams which are identified as NHD streams regardless of drainage area size (see Appendices H-12-1 and H-12-4). The estimated number of stream crossing and proposed mussel surveys required per alternative is summarized in Table 31.

Table 31. Summary of Proposed Mussel Survey Needs by Build Alternative

Alternative ID	Number of Stream Crossings and Intake Impacts	NHD Identified Stream Impacts (Assumed Locations of Mussel Surveys)
1A	13	5
1B	12	4
1C	17	5
2A	17	9
2B	12	8
3	3	2
4	5	2
5A	7	2
5B	7	2
6	8	2
6-1	8	2
6-2	8	2

To help minimize potential impacts to protected mussels this analysis assumes all alterative intake screen openings on the intake structure will be sized to protect aquatic life and be compliant with the standards developed by the U.S. Environmental Protection Agency under Section 316(b) of the Clean Water Act for intake velocities for avoidance of impingement and entrainment of aquatic life. The minimum criterion is a screen size of 1 mm and an intake velocity of 0.5 Feet Per Second (FPS). The Virginia Department of Game and Inland Fisheries (VDGIF) recommend an intake velocity of not more than 0.25 FPS and thus this criterion has been assumed for this analysis.

Finally, no alternatives are within 660 feet of a known bald eagle nest nor do any intersect with eagle concentration areas.

1) **Build Alternative 1** has three sub-alternative routes. Sub-alternatives 1A, 1B, and 1C have three (3) federally protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. Additionally, two impacts to T&E Waters are proposed for these alternatives. The intake structure and the crossing of the Rivanna River will both impact Federal Waters. Five (5) mussel surveys are proposed for Sub-alternative 1A. Four (4) mussel surveys are proposed for Sub-alternative 1B. Five (5) mussel survey are proposed for Sub-alternative 1C.
2) **Build Alternative 2** has two Sub-alternative routes. Sub-alternatives 2A and 2B both have three (3) federally protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. Two impacts to T&E Waters are proposed for these alternatives; an impact to State Waters for the intake structure and impact to Federal Waters for the crossing for the Rivanna River. Both Sub-alternatives would result in intake structure impacts to proposed critical habitat for the Atlantic Pigtoe. Nine (9) mussel surveys are proposed for Sub-alternative 2A. Eight (8) mussel surveys are proposed for Sub-alternative 2B.

3) **Build Alternative 3** has three (3) federally protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. This alternative has only one impact to T&E waters; an impact to Federal Waters for the intake structure. Two (2) mussel surveys are proposed.
4) **Build Alternative 4** has two (2) federally protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. This alternative has one impact to T&E waters; an impact to Federal Waters for the intake structure. Two (2) mussel surveys are proposed.
5) **Build Alternative 5** has two sub-alternative routes. Sub-alternative 5A and 5B both have two (2) federally protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. These alternatives have one impact to T&E waters; an impact to Federal Waters for the intake structure. Two (2) mussel surveys are proposed for both Sub-alternatives.
6) **Build Alternative 6** has three (3) federally protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. Additionally, two impacts to T&E Waters are proposed for this alternative. The intake structure and the crossing of the Rivanna River will both impact Federal Waters. Two (2) mussel surveys are proposed.
7) **Build Alternative 6-1** has three (3) federally protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. Additionally, two impacts to T&E Waters are proposed for this alternative. The intake structure and the crossing of the Rivanna River will both impact Federal Waters. Two (2) mussel surveys are proposed.
8) **Build Alternative 6-2** has three (3) protected species with known occurrences and/or the potential to exist within the vicinity of the Project Area. Additionally, two impacts to T&E Waters are proposed for this alternative. The intake structure and the crossing of the Rivanna River will both impact Federal Waters. Two (2) mussel surveys are proposed.

5.1.10 Cultural Resources

JRWA conducted background research to identify previously recorded cultural resources in the vicinity of the Project alternatives. Data were collected on previously recorded archaeological sites, architectural and historical resources, and previous cultural resource studies. Data were gathered from the online Virginia Cultural Resources Information System (V-CRIS) as well as previous fieldwork conducted as part of this Project. VCRIS mapping of known cultural resources in relation to alternative alignments is included for review by regulatory agencies in Appendix H-14. A comparison of the background research results for each of the 12 alternatives for the Project is presented in Table 32.

Mitigation of impacts to cultural resources can be accomplished through avoidance during the siting process and through the development of mitigation through the NHPA Section 106 consultation process

5.1.10.1 Area of Potential Effect

The Area of Potential Effect (APE) is the “geographic area or areas within which an undertaking may directly or indirectly cause changes in the character of or use of historic properties, if any such properties exist” (36 CFR 800.16(d)). The APE is defined based on the potential for effect,

which may differ for aboveground cultural resources (historic structures and landscapes) and subsurface resources (archaeological sites). Specific APE boundaries for each Project alternative have not been defined. Those limits will be developed in consultation with the US Army Corps of Engineers, as the lead federal agency. The Virginia Department of Historic Resources (DHR), as the State Historic Preservation Office (SHPO) for Virginia, also will be offered an opportunity to comment on the APE after a preferred alternative has been selected. To allow consistent comparison among alternative Project alignments, standardized study areas were generated for each alternative, as described below.

The APE for direct impacts includes all areas where ground-disturbing activities may take place. This is primarily investigated for archaeological resources but is also considered for historic architectural resources. The indirect APE is the area within which cultural resources (including individual resources, historic districts, or cultural landscapes) might be within view of proposed vegetation clearing or construction of aboveground Project facilities, or otherwise potentially affected by proposed Project activities beyond direct impact on structures.

For this alternative analysis, known site locations were gathered within a three-mile radius of preliminary alternatives. A study corridor—generally 200-feet wide centered on each preliminary water main alternative plus larger expanses at river crossings and around attendant pump station locations—was used to examine cultural resources in the project vicinity and assess possible impacts. Within the study corridor, the draft limits-of-disturbance (LODs) were designed to minimize or avoid direct and indirect impacts on cultural resources and environmental features, while also considering constructability and usefulness from an engineering perspective. Once the LOD was defined for each alternative, potential direct and indirect impacts on archaeological and historic architectural resources were tabulated. The direct APE consists of the footprint of each LOD, while the indirect APE consists of the footprint of each LOD as well as a 0.25-mile buffer extending from that LOD and a 0.5-mile buffer around the attendant pump station location. While the clearing of a water main corridor is considered for visual impacts in the vicinity of recorded historic architectural resources, the potential visual impacts related to the proposed aboveground Project components such as the pump station were considered for a wider area, whether or not the pump station workspace itself is located within a recorded resource. This comparison does not take into account vegetation or topography that may screen the viewshed and ultimately reduce the extent of the indirect APE to a smaller buffer than the 0.5-mile buffer.

5.1.10.2 Cultural Resource Setting

The larger region surrounding this Project contains a plethora of previously recorded archaeological sites, as well as a number of historical farms/plantations. A majority of the recorded archaeological sites in this area are precontact-period in age, although there are also a fair number of nineteenth century sites as well. The archaeological sites tend to be located along the lowlands of the James River. It is unclear if this pattern is solely based on settlement selection or if it is partially a bias of where people have looked for archaeological sites. For this alternative analysis, it is presumed the more complex and/or significant precontact-period archaeological sites will be located on the lowlands of the James and Rivanna rivers. The architectural resources appear more scattered across the area. Most of the sites seem to have been recorded either by avocational archaeologists/historians or through private research not prompted by Section 106 of the National Historic Preservation Act (NHPA). In the vicinity of the

Project alternatives, relatively little formal survey related to Section 106 compliance studies has been conducted. Given the number of sites recorded in the area, many archaeological sites more readily discernable at or near the current ground surface may have been recorded, and the more significant architectural resources already may have been documented; however, more formal systematic survey may reveal additional archaeological sites (both at the surface and buried), as evidenced by previous studies associated with this Project, and may identify additional architectural properties for consideration.

Any location on the floodplain has a high potential to contain archaeological resources and will almost certainly require deep testing. Further, the fact that many areas have not been formally surveyed means the full potential impact is unknown for any alternative. Only Alternative 6 (Proposed Action) has been subjected to extensive formal study, and by default also portions of other overlapping alternatives. Small portions of water main Alternatives 2A and 1C, as well as minor amounts of Alternatives 1A and 2B, have been subjected to study from previous surveys; however, substantially less study has been conducted along each of those compared to Alternative 6.

Each of the water main corridor alternatives, with the exception of Alternative 4, would impact the mapped boundary of at least one previously recorded archaeological site. Many of these sites have not been formally investigated, thus the true boundaries may be larger or smaller than the boundaries recorded at the DHR. Further, most of the archaeological sites have not been evaluated by the DHR for their significance or at least no significance finding is recorded. As stated previously, only Alternative 6 has been fully subjected to systematic archaeological survey and DHR review, thus data for that route are somewhat biased when comparing quantity and type of recorded cultural resources within the Project. All the pump station alternatives are located on a floodplain. These settings have potential to contain buried archaeological sites that may not be manifested on or just below the current ground surface.

5.1.10.3 Impacts to Cultural Resources

Impacts were reviewed for each alternative alignment. Alternative alignments were adjusted where reasonable to avoid and minimize cultural impacts. Table 32 provides a summary of cultural impacts for each of the proposed alternatives.

Table 32. Comparison of Cultural Resources Background Research by Build Alternative

Description	1A	1B	1C	2A	2B	3	4	5A	5B	6	6-1	6-2
Limits-of-Disturbance* (LOD) [ac]	21.90	25.68	23.32	47.14	49.50	7.00	11.14	13.86	13.24	16.02	16.18	16.53
LOD Previous Archaeological Studies [ac]	8.14	6.31	4.25	4.55	6.61	0.00	0.00	0.00	0.00	14.04	11.72	8.59
LOD Previous Archaeological Studies [%]	37.17	24.57	18.22	9.65	13.35	0.00	0.00	0.00	0.00	87.64	72.44	51.97
LOD Higher Archaeological Potential [ac]**	19.71	13.17	10.40	15.98	18.75	4.55	7.06	8.89	9.18	14.17	14.33	14.68
LOD Higher Archaeological Potential [%]**	90.00	51.29	44.60	33.90	37.88	65.00	63.38	64.14	69.34	88.45	88.57	88.81
Study Corridor Recorded Archaeological Sites [#]	15	4	2	17	9	2	2	3	3	10	10	13
LOD Recorded Archaeological Sites [#]	10	4	1	2	5	1	0	1	1	9	9	12
LOD Recorded Archaeological Sites [ac]	5.11	4.44	0.26	0.28	4.47	0.05	0.00	0.28	0.28	9.63	8.06	6.95
LOD Recorded Archaeological Sites [NRHP-eligibility]	3 eligible; 1 not eligible; 6 unevaluated	2 eligible; 2 unevaluated	1 unevaluated	2 unevaluated	2 eligible; 3 unevaluated	1 unevaluated	0	1 unevaluated	1 unevaluated	3 eligible; 1 not eligible; 5 unevaluated	3 eligible; 1 potentially eligible; 5 unevaluated	3 eligible; 1 not eligible; 8 unevaluated
Study Corridor Recorded Architectural Sites [#]	5	7	9	23	21	31	32	33	33	3	3	3
LOD Recorded Architectural Sites [#]	4	4	4	7	7	13	14	14	14	3	3	3
LOD Recorded Architectural Sites [ac]	5.95	4.37	0.61	13.24	17.00	3.93	1.95	1.95	1.95	12.17	12.3	12.52
LOD Recorded Architectural Sites [NRHP-eligibility]	2 NRHP; 1 eligible; 1 unevaluated	3 NRHP; 1 eligible	1 NRHP; 1 eligible; 2 not eligible	1 NHL; 1 NRHP; 3 eligible; 2 not eligible	1 NHL; 3 NRHP; 3 eligible	1 eligible; 1 potentially eligible; 11 unevaluated	1 potentially eligible; 13 unevaluated	1 potentially eligible; 13 unevaluated	1 potentially eligible; 13 unevaluated	1 NRHP; 1 eligible; 1 unevaluated	1 NRHP; 1 eligible; 1 unevaluated	1 NRHP; 1 eligible; 1 unevaluated
Potential-ViewshedRecorded Architectural Sites [#]	8	9	11	37	35	58	58	59	59	20	30	7
Potential-Viewshed Recorded Architectural Sites [ac]	349.73	443.44	341.63	807.39	909.21	125.96	118.95	126.09	126.10	245.47	254.00	245.13
Potential-Viewshed Recorded Architectural Sites [NRHP-eligibility]	2 NRHP; 1 eligible; 5 unevaluated	3 NRHP; 1 eligible; 5 unevaluated	3 NRHP; 1 eligible; 3 not eligible; 4 unevaluated	1 NHL; 3 NRHP; 8 eligible; 4 not eligible; 20 unevaluated	1 NHL; 3 NRHP; 8 eligible; 1 potentially eligible; 2 not eligible; 21 unevaluated	1 NRHP; 1 eligible; 1 potentially eligible; 55 unevaluated	1 NRHP; 1 eligible; 1 potentially eligible; 1 not eligible; 54 unevaluated	1 NRHP; 2 eligible; 1 potentially eligible; 1 not eligible; 54 unevaluated	1 NRHP; 2 eligible; 1 potentially eligible; 1 not eligible; 54 unevaluated	1 NRHP; 1 eligible; 1 potentially eligible; 17 unevaluated	1 NRHP; 1 eligible; 1 potentially eligible; 27 unevaluated	1 NRHP; 1 eligible; 1 potentially eligible; 4 unevaluated

* Assumes entire LOD will be considered part of the permitted Project.
** Based on FEMA flood hazard data.

1) **Build Alternative 1A** would impact the most recorded archaeological sites (three (3) eligible, one (1) not eligible, six (6) unevaluated). Many of the unevaluated sites appear to have arbitrary boundaries drawn around culverts under the railroad and the Project may not impact cultural material at each of those locations. Further, two other sites were discovered by the current Project (Alternative 6), and three were expanded; thus, prior to the current Project, this alternative would not have been shown to have as high a potential to impact recorded archaeological sites as is indicated in the data table. The crossing of the Rivanna River and its approach have already been surveyed for the current Project. This alternative does traverse the greatest amount of unsurveyed lowlands which are believed to have a higher potential to contain unrecorded archaeological sites, both near surface and deeply buried. Two (2) NRHP-listed architectural resources would be crossed. One (1) would only contain a small portion of an existing access road; the other would be crossed by the water main immediately adjacent to an existing cleared utility corridor, which would likely limit the possible visual impacts related to the water main component.

2) **Build Alternative 1B** would impact four (4) recorded archaeological sites (two (2) eligible, two (2) unevaluated). Of the unevaluated sites, one could likely be avoided and the other may not have an archaeological component beyond the culvert under the railroad that defines the site (as discussed above). Two (2) other sites are also crossed by the current Project (Alternative 6)—one (1) was newly discovered and the other was expanded—thus, prior to the current Project, this alternative would not have been shown to have as high a potential to impact recorded archaeological sites as is indicated in the data table. The crossing of the Rivanna River and its approach have already been surveyed for the current Project. Three NRHP-listed architectural resources would be crossed by this alternative. One (1) resource would only be impacted by a small portion of an access road, one is skirted by this alternative and avoidance may be possible, and for the third resource half of the water main route is immediately adjacent to an existing cleared utility corridor which would likely limit the possible visual impact related to that project component. The skirted resource is recorded as the location of a Revolutionary War-era armory, thus the potential for additional archaeological remains may be greater in that vicinity.

3) **Build Alternative 1C** would impact one (1) recorded archaeological site that has not been evaluated. The site is recorded as a bridge (presumably for the railroad) and appears to have a somewhat arbitrary boundary drawn to encompass the structure; the Project may not impact archaeological remains at this location. The water main for this alternative would be situated primarily adjacent to existing roadways, thus may have a reduced likelihood of impacting intact archaeological remains. The section of this alternative leading to and crossing the Rivanna River has been previously surveyed for a bridge replacement project unrelated to the current studies; however, that survey did not sample deep deposits, thus that area still has potential for buried archaeological sites in the floodplain. One (1) NRHP-listed architectural resource would be crossed by this alternative, but primarily would be impacted by only a small portion of an access road or a turn in the water main. The eligible resource that would be affected is a canal in the vicinity of the Rivanna River crossing; however, the previous survey for the bridge replacement did not find intact remains in that area. A

Revolutionary War-era armory property would not be crossed, but this alternative skirts one side of that resource, thus the potential for additional archaeological remains may be greater in that vicinity.

4) **Build Alternative 2A** would impact two (2) recorded archaeological sites that have not been evaluated. Both sites are related to a canal and appear to have somewhat arbitrary boundaries drawn to encompass culverts or bridges; the Project may not impact archaeological remains at these locations. The water main for this alternative would be situated primarily adjacent to existing roadways, thus may have a reduced likelihood of impacting intact archaeological remains. The section of this alternative leading to and crossing the Rivanna River has been previously surveyed for a bridge replacement project unrelated to the current studies; however, that survey did not sample deep deposits, thus that area still has potential for buried archaeological sites in the floodplain. The pump station would be located within the property boundary of a National Historic Landmark (NHL). This may create both direct and indirect impacts on the NHL, requiring additional consultation with the National Park Service. The water main would cross one (1) NRHP-listed architectural resource and three (3) eligible resources. One (1) of the eligible resources is a bridge and can likely be avoided by constructing underneath the overpass. Another eligible resource is a canal in the vicinity of the Rivanna River crossing; however, the previous survey for a bridge replacement did not find intact remains in that area. A Revolutionary War-era armory property would not be crossed, but this alternative skirts one side of that resource, thus the potential for additional archaeological remains may be greater in that vicinity.

5) **Build Alternative 2B** would impact five (5) recorded archaeological sites (two (2) potentially eligible, three (3) evaluated). The two (2) eligible sites are also crossed by the current Project (Alternative 6) — one (1) was newly discovered and the other was expanded — thus, prior to the current Project, this alternative would not have been shown to have as high a potential to impact archaeological sites. The crossing of the Rivanna River and its approach have already been surveyed for the current Project. Two (2) of the unevaluated sites are related to a canal and appear to have somewhat arbitrary boundaries drawn to encompass culverts or bridges; the Project may not impact archaeological remains at these locations. The water main for this alternative would be situated primarily adjacent to existing roadways, thus may have a reduced likelihood of impacting intact archaeological remains. The pump station would be located within the property boundary of a NHL. This may create both direct and indirect impacts on the NHL, requiring additional consultation with the National Park Service. The water main would cross three NRHP-listed architectural resources and three (3) eligible resources. For one of the NRHP-listed resources, the water main corridor would again be situated adjacent to existing roadways, which may reduce the likelihood of impacting intact archaeological remains. For the second NRHP-listed resource, half of the water main route would be immediately adjacent to an existing cleared utility corridor, which would likely limit the possible visual impacts related to that portion of this alternative. The third NRHP-listed resource is a Revolutionary War-era armory property. The armory property would be skirted on one side along an existing roadway and avoidance might be possible, but the presence of the resource may also mean the potential for additional archaeological remains could be greater in that vicinity. One (1) of the eligible resources is a bridge and can likely be avoided by

constructing underneath the overpass. The other two (2) eligible resources are a canal and a historic district; adverse effect to both of those may be avoidable.

6) **Build Alternative 3** would impact one recorded archaeological site that has not been evaluated. That site is a ditch that appears to be related to a railroad culvert canal and appears to have a somewhat arbitrary boundary drawn; the Project may not impact archaeological remains at this location. The pump station may impact a NRHP-eligible canal. Further, the pump station would be located within the boundary of a potentially eligible historic district and one (1) or two (2) recorded contributing architectural resources would be removed. The road frontage of nine other unevaluated contributing architectural resources within the historic district also likely would be impacted by the water main; however, these impacts likely would not be considered adverse, given the water main's location along an existing roadway. This pump station alternative could pose one of the greater potentials for visual impact on architectural resources; however, given the decline of many structures in the potentially eligible historic district, an updated survey of that district may result in a determination that the district is not eligible, although a recent formal assessment of the district has not been conducted.

7) **Build Alternative 4** would have no impact on recorded archaeological sites; however, the pump station is located on the leading end of a floodplain that contains numerous recorded archaeological sites. The water main would be located adjacent to an existing roadway. Although that route would traverse a NRHP-eligible historic district and the road frontage of 13 unevaluated contributing architectural resources within the historic district, these impacts likely would not be considered adverse, given the water main's location along an existing roadway.

8) **Build Alternative 5A** would impact one (1) recorded archaeological site that has not been evaluated. This site appears to be another railroad culvert that has a somewhat arbitrary boundary drawn to encompass the structure. The Project may not impact recorded archaeological remains at this location, especially because the project component would be an access road. Like Alternative 4, the pump station would be located on the leading end of a floodplain in the vicinity of numerous recorded archaeological sites. The water main would be located adjacent to an existing roadway. Although that route would traverse a NRHP-eligible historic district and the road frontage of 13 unevaluated contributing architectural resources within the historic district, these impacts likely would not be considered adverse, given the water main's location along an existing roadway.

9) **Build Alternative 5B** is similar to Alternative 5A, except the water main traverses more of the floodplain. Alternative 5B would impact one recorded archaeological site that has not been evaluated. This site appears to be another railroad culvert that has a somewhat arbitrary boundary drawn to encompass the structure. The Project may not impact recorded archaeological remains at this location, especially because the project component would be an access road. Like Alternatives 4 and 5A, the pump station would be located on the leading end of a floodplain in the vicinity of numerous recorded archaeological sites. The first third of the water main also would be located along that same floodplain before then running adjacent to an existing roadway. Although that route would traverse a NRHP-eligible historic district and the road

frontage of 13 unevaluated contributing architectural resources within the historic district, these impacts likely would not be considered adverse, given the water main's location along an existing roadway.

10) **Build Alternative 6.** Almost the entirety of Alternative 6 (except for a small portion of access road) was surveyed as part of the current Project; therefore, potential impacts are more fully known. This alternative would impact nine recorded archaeological sites (three (3) eligible, five (5) unevaluated, one (1) not eligible). Three (3) of the sites were discovered by the current Project and three (3) others were expanded; thus, prior to the current Project, this alternative would not have been shown to have as high a potential to impact recorded archaeological sites as is indicated in the data table. Two (2) of the unevaluated sites would only be crossed by a proposed access road following an existing roadway, which likely would limit direct impacts related to that project component. Given the previous survey, it is unlikely this alternative would impact additional archaeological sites. The pump station would be located within the property boundaries of a NRHP-listed architectural resource; however, studies for the current Project resulted in a determination that the Project would have no adverse effect to that NRHP-listed resource. Much of the water main would be located immediately adjacent to existing cleared utility corridors, which limits the potential for visual impacts. The water main would cross two other recorded architectural resources: an eligible canal corridor and an unevaluated canal/railroad corridor. The water main may have direct impacts on both of those resources.

11) **Build Alternative 6-1** is essentially the same as Alternative 6, except the pump station is shifted slightly downstream to possibly reduce archaeological impacts. Almost the entirety of Alternative 6 (except for a small portion of access road and half of the pump station workspace) has been previously surveyed for the current Project. This alternative would impact the same nine recorded archaeological sites (three (3) eligible, five (5) unevaluated, one (1) not eligible). Three (3) of the sites were discovered by the current Project and three (3) others were expanded; thus, prior to the current Project, this alternative would not have been shown to have as high a potential to impact recorded archaeological sites as is indicated in the data table. Two (2) of the unevaluated archaeological sites would only be crossed by a proposed access road following an existing roadway, which likely would limit direct impacts related to that project component. Given the previous survey, it is unlikely this alternative would impact additional archaeological sites, although one of the eligible sites may extend further into the additional downstream area. The pump station building would still be located in the same footprint within the property boundaries of a NRHP-listed architectural resource; however, studies for the current Project resulted in a determination that the Project would have no adverse effect to that NRHP-listed resource. Much of the water main would be located immediately adjacent to existing cleared utility corridors, which limits the potential for visual impacts related to that project component. The water main would cross two (2) other recorded architectural resources: an eligible canal corridor and an unevaluated canal/railroad corridor. The water main may have direct impacts on both of those resources.

12) **Build Alternative 6-2** is similar to Alternative 6, except the pump station is shifted approximately 1,800 feet upstream. Most of the water main and all of the Rivanna River crossing has been previously surveyed for the current Project. The proposed pump station location has not been surveyed. This alternative would impact the same nine recorded archaeological sites as Alternative 6 (three (3) eligible, five (5) unevaluated, one (1) not eligible); however, three (3) additional recorded unevaluated archaeological sites would also be crossed. Impacts on one of the eligible sites would be dramatically reduced compared to Alternative 6, although impacts on the three additional sites may be cumulatively greater than that reduction. Three (3) of the sites crossed by this alternative were discovered by the current Project and three (3) others were expanded; thus, prior to the current Project, this alternative would not have been shown to have as high a potential to impact recorded archaeological sites as is indicated in the data table. Two (2) of the unevaluated sites would only be crossed by a proposed access road following an existing roadway, which likely would limit direct impacts related to that project component. The pump station would still be located within the property boundaries of a NRHP-listed architectural resource; however, studies for the current Project resulted in a determination that the Project would have no adverse effect to that NRHP-listed resource. The setting of the Alternative 6-2 pump station is similar and may result in the same effects determination. Much of the water main would be located immediately adjacent to existing cleared utility corridors, which limits the potential for visual impacts related to that project component. The water main would cross two (2) other recorded architectural resources: an eligible canal corridor and an unevaluated canal/railroad corridor. The water main may have direct impacts on both of those resources.

5.2 Preferred Alternative Jurisdictional Impacts

The proposed site was delineated in accordance with the U.S. Army Corps of Engineers (USACE) 1987 Delineation Manual and subsequently issued USACE guidance to identify the presence and location of jurisdictional wetlands and streams within the Project limits. The wetland delineations were confirmed on August 29, 2016 (USACE Project number NAO-2014-0708) (see Appendices D-4).

Following confirmation of features, streams within the project area were located via traditional survey. In addition, refinements to GPS data post processing were implemented to provide a more accurate depiction of confirmed wetland features within the project boundary. Following linework refinements, Timmons Group conducted a site field to verify the corrected data. The refined linework associated with the previously confirmed delineation, including survey located streams and updated GPS data, has been incorporated into this submittal and represents an update from previous submittals. This revised linework included the most accurate representation of impacts areas currently available.

5.2.1 Proposed Jurisdictional Impacts

The information in this section is provided per 33 C.F.R. § 325.1 (d) (4).

The development of the Project will require unavoidable impact to jurisdictional features. The proposed wetland and stream impacts are associated with the construction and operation of the proposed intake, pump station and water main for the JRWA water supply project. These

impacts have been previously discussed with the USACE in prior information submittals. However, updates to these impacts are being included as part of this supplemental information material. These changes incorporate updated feature linework, County-required erosion and sediment control measures, as well as refinements to the limits of disturbance to minimize impacts where possible (see Section 6.1 for Avoidance and Minimization). Supporting documentation can be found in Appendix I: Jurisdictional Resource Impact Details.

An updated exhibit showing the location of the proposed jurisdictional impacts is provided as Appendix I-4. Additionally, design details are provided in Appendix I-1. The functions and values of all wetlands and streams associated with permanent impacts were evaluated using the United Stream Methodology (USM) and the Highway Methodology respectively (see Appendix I-2). The total impacts for the proposed Project are summarized in Table 33:

Table 33. Proposed Aquatic Resources Impacts Table

Project	Impact ID	Wetland (sq. ft) Impact					Stream (lf and sq.ft.) Impact			
		Temporary (Construction Easement)		Permanent Conversion (15' Maintained Easement)	Permanent (Excavation/Fill)		Temporary		Permanent	
		PEM	PFO	PFO to PEM	PEM	PFO	L.F.	Sq.Ft.	L.F.	Sq. Ft.
JRWA	1						355	39,000		
	2								64	3,470
	3			161						
	4			87						
	5						21	84		
	6	367								
	7						21	105		
	8						161	23,911		
	9						155	620		
	11						83	415		
	200 (access road)		255			352			12	24
	201 (access road)								72	144
	202 (access road)		41			663				
	Sub-Total	**367**	**296**	**248**	**0**	**1,015**	**796**	**64,135**	**148**	**3,638**
	Total	**663 sq ft**		**248 sq ft**	**1,015 sq ft**		**796 lf**	**64,135 sq ft**	**148 lf**	**3,638 sq ft**
		0.015 ac		**0.006 ac**	**0.023 ac**			**1.472 ac**		**0.084 ac**

* PFO=Palustrine Forested Wetland; PEM=Palustrine Emergent Wetland

Impact 1: This impact would result in the temporary impact of 355 linear feet of perennial (R3) stream channel (James River). This impact is associated with a temporary cofferdam and is necessary for the construction of the raw water intake.

Impact 2: This impact would result in the permanent impact of 64 linear feet of perennial (R3) stream channel (James River). This impact is associated with the placement of the intake structure and necessary for the construction of the raw water intake.

Impacts 3 & 4: These impacts would result in the temporary excavation and permanent conversion of 248 square feet (0.006 acres) of palustrine forested wetlands (PFO) to palustrine emergent wetlands (PEM). All elevations will be returned to preconstruction contours. These impacts are necessary for the construction, installation, and maintenance of the raw water transmission pipe.

Impacts 5, 7, 9 & 11: These impacts would result in the temporary disturbance of 280 linear feet of stream channel. All elevations will be returned to preconstruction contours. These impacts are necessary for the construction and installation of the raw water transmission pipe.

Impact 10: This impact has been avoided and is no longer proposed for the Project

Impact 6: This impact would result in the temporary impact of 367 square feet (0.008 acres) of palustrine emergent wetlands (PEM). These impacts are necessary for the construction and installation of the raw water transmission pipe. All elevations will be returned to preconstruction contours and allowed to return to an emergent wetland state following construction.

Impact 8: This impact would result in the temporary disturbance of 161 linear feet of perennial (R3) stream channel (Rivanna River). This impact is necessary for the construction and installation of the raw water transmission pipe. The crossing will be constructed through the use of inflatable coffer dams to ensure sufficient follow is continuously provided downstream of the impact area and in accordance with the previously issued VMRC permit for state-owned bottomlands impacts (VMRC #2014-0343). All elevations will be returned to preconstruction contours.

Impacts 200: This impact would result in the temporary impact of 255 square feet (0.006 acres) of palustrine forested wetlands (PFO), the permanent impact of 352 square feet (0.008 acres) of PFO, and the permanent impact of 12 linear feet of stream channel. This impact is necessary for improvements to the access road. Improvements are necessary to provide safe access for construction, supply and maintenance vehicles required for the construction and maintenance of the pump station and raw water intake. For temporary impact areas, all elevations would be returned to preconstruction contours and allowed to return to a forested wetland state following construction.

Impact 201: This impact would result in the permanent impact of 72 linear feet of stream channel. This impact is necessary for improvements to the access road. Improvements are necessary to provide safe access for the construction and maintenance of the pump station and raw water

intake. An existing culvert would be extended to allow for the widening of the existing access road to allow large construction vehicle to reach the pump station.

Impact 202: This impact would result in the temporary impact of 41 square feet (0.0009 acres) of palustrine forested wetlands (PFO) and the permanent impact of 663 square feet (0.0015 acres) of PFO. This impact is necessary for improvements to the access road. Improvements are necessary to provide safe access for construction, supply and maintenance vehicles required for the construction and maintenance of the pump station and raw water intake. For temporary impact areas, all elevations would be returned to preconstruction contours and allowed to return to a forested wetland state following construction.

5.2.2 Non-Jurisdictional Impacts

One ditch feature, identified as Feature G on the confirmed Jurisdictional Determination (JD), would be temporarily traversed as part of the proposed project. This ditch is located along the raw water transmission main between the intake structure and Impact 3. Crossing the ditch would be necessary for the construction and installation of the raw water transmission pipe. A hydrologic connection will be maintained between the jurisdictional features connected by this ditch and all elevations will be returned to preconstruction contours. As connectivity will be maintained between all jurisdictional features, the proposed ditch crossing should not constitute a jurisdictional impact.

5.2.3 Secondary and Cumulative Impacts

Secondary and cumulative impacts were considered in regard to the proposed project. Secondary, or indirect, impacts are those impacts which cannot occur without the implementation of the proposed Project and its related activities. Cumulative impacts are environmental impacts resulting from past, present, and reasonably foreseeable future activities regardless of the entities undertaking them, which may be individually minor but collectively significant.

The proposed project has minimized the possibility of adverse secondary impacts through implementation of planning practices that reduce the influence of direct impacts on water quality. These efforts include:

- Avoidance/minimization of direct wetlands/waters impacts through innovative site planning and utilization of confirmed wetland delineation
- Minimization of partial wetland/stream impacts
- Strict adherence to all state and local stormwater and sediment control measures

Although minor secondary impacts may occur including temporal loss of function at temporary impact locations, the overall scope and nature of these impacts are believed to be minimal in comparison to the overall scope of the proposed Project. Adverse secondary impacts are not expected to significantly contribute to cumulative impacts.

Positive secondary effects are foreseeable from the project. By enabling the Counties to provide a public water supply, existing and future use of overly taxed groundwater systems are expected

to be transitioned to the public water system. This is expected to have a beneficial impact on groundwater resources. As discussed in Section 3.3, water from this project will enable increased growth and economic activity to occur in areas of the Counties slated by local planning authorities for that purpose. However, that growth is not considered a secondary effect per se because it will not be “caused by” this project (40 CFR 1508.8); instead, water from this project will eliminate an impediment or limiting factor for planned growth and economic development.

Cumulative impacts for the proposed Project are to be minimal. The overall environmental footprint of this project is unusually small. The temporary and permanent impacts to aquatic resources are well below the thresholds typically associated with nationwide permits. There are no other significant direct or secondary environmental impacts to the natural or human environment to speak of. The only other potentially significant impact is to cultural resources, although those impacts are capable of mitigation below a level of significance.

Although cumulative and secondary impacts may occur as a result of the proposed Project, these impacts should be minimal as a result of appropriate land planning and strict adherence to all state and local stormwater regulation and sediment and erosion controls. The overall scope and nature of these impacts are believed to be minimal in comparison with the overall nature of the proposed Project.