DATE: February 2, 2005

TO: Project File

FROM: Aaron Keno

RE: Concept Development – James River Withdrawal

BACKGROUND AND CURRENT CONDITIONS

Rivanna Water and Sewer Authority (RWSA) is engaged in studies related to the selection of a preferred alternative for water supply expansion. Gannett Fleming Inc. completed a Water Supply Alternatives Supplemental Evaluation in July 2004, supplemented by technical memoranda on the Beaver Creek Reservoir in October 2004, and concluded that four water supply concepts have the most potential to provide the future raw water supply for the RWSA Urban System through the 2055 planning period. These four concepts include: a withdrawal intake on the James River, raising the Ragged Mountain Reservoir Dam, adding a crest gate to the South Fork Rivanna Reservoir (SFRR), and dredging the SFRR. The purpose of this technical memorandum is to provide additional information on the James River intake concept. It is presented in five sections including: Background and Current Conditions, Withdrawal and Conveyance Parameters, Cost, Environmental Impacts, and Cultural Resources Impacts.

The James River concept could be implemented by building a James River intake at a site to be determined between Scottsville and Bremo Bluff, VA. This could be accomplished either by the RWSA on its own, or through a joint venture organized with Fluvanna and Louisa Counties. Pumping and piping could be sized to either meet the RWSA's projected water supply deficit, or to meet the combined projected deficits of RWSA, Fluvanna County, and Louisa County. At the time this memorandum was completed, investigations of RWSA's needs were much more advanced and potential interest in a joint venture was unclear; however, it is expected that the results of this assessment could readily be applied to development of a joint project if such should become feasible. Under this framework, RWSA will first determine if the James River concept merits selection as the preferred alternative when compared to alternatives that include the other three water supply concepts (SFRR dredging, SFRR expansion, Ragged Mountain expansion). If the James River alternative emerges as preferred, the regional strategy can then be considered further as a variation of the concept provided other jurisdictions are interested and appropriate regulatory criteria are satisfied.

This evaluation of the James River water supply concept is intended to be representative of any James River water supply project and will be used for comparison with the other concepts under review by RWSA. The James River is assessed as a water supply source, and preliminary system features have been developed to satisfy the project requirements. Project costs and environmental impacts are estimated. If this concept emerges as the preferred alternative, detailed pipeline route studies and engineering design would be required. It is anticipated that the project would be configured to minimize environmental impacts and our evaluation indicates that the total impact would be similar regardless of configuration.

James River Description

The James River concept includes a withdrawal intake on the James River near Scottsville, VA. The James River drainage area at Scottsville is approximately 4,584 mi^2 and includes portions of Albemarle County, Buckingham County, Nelson County, Appomattox County, Amherst County, Campbell County and Bedford County.

Numerous central Virginia communities located upstream and downstream of Scottsville utilize the James River as a source for community drinking water. Sizable communities include Lynchburg (upstream), and Richmond and Henrico County (downstream). Cumberland County and Henrico County are jointly evaluating the feasibility of a pumped storage reservoir concept potentially using the James River above Richmond as a source.

Generally speaking, water quality improves as one moves upstream on the James, and water quantity increases as one moves downstream. The suitability of the James River as a water supply source for RWSA is discussed below.

Raw Water Quantity

According to the *Rivanna Water and Sewer Authority Water Supply Project – Analysis of Alternatives* report (VHB, February 2000), the James River at Scottsville has a 1Q30 flow of approximately 338 MGD. The 1Q30 is the lowest one-day average flow expected to occur once in thirty years based on the available period of record and is a common expression of low surface water flows in Virginia. Assuming a maximum RWSA withdrawal rate of approximately 15 MGD (discussed below), only 4% of the 1Q30 flow in the James at this location would be withdrawn. The majority of the water withdrawn would be returned to the Rivanna River, and through it to the James River, by means of treated wastewater discharges. Net water quantity impact to the James River downstream of the Rivanna River would be limited to the consumptive use of the RWSA customers and would be minimal. This data indicates there is more than adequate supply in the James River at all times to satisfy the projected RWSA water supply deficit.

Raw Water Quality

Raw water quality is a crucial factor in providing acceptable drinking water to consumers. The James River is used as a raw water source for numerous communities both upstream and downstream from the Scottsville area. Since water quality generally degrades downstream, two communities downstream of Scottsville were considered. The 132 MGD water treatment plant operated by the City of Richmond was in 100% compliance with all federal and state safe drinking water act requirements according to its 2003 water quality report. According to a 2003-04 Annual Report, Henrico County opened a new 55 MGD water treatment plant (WTP) in April 2004 and currently produces about 15-20 MGD. Conversations with Henrico County personnel have indicated that the water treatment plant has been in compliance with all federal and state safe drinking water act requirements since the plant was initially started.

The James River is a suitable water supply source for numerous communities all along the James including the new water treatment plant in Henrico County. Water quality is likely to be better in Scottsville and would be of suitable quality for a community water supply source.

Based on the experiences of other community water suppliers along the James River, conventional water treatment processes will likely provide appropriate treatment of this source to satisfy federal and state safe drinking water requirements. If this concept is selected as the preferred alternative, a detailed sampling plan of the James River could determine the optimal chemical and physical treatment processes required for the WTP.

WITHDRAWAL AND CONVEYANCE PARAMETERS

Project Selection

The James River concept will include at least an intake, pipeline from the James River to the existing Urban Service Area facilities, and pump stations. The location of treatment facilities for raw water from the James River will determine which portions of the pipeline from the James River intake to the Urban Service Area will be raw water and which will be finished water transmission mains. The exact location of the water treatment plant is not critical and need not be defined at this time. It is assumed the eventual site will be adjacent to the pipeline route and will be selected to minimize environmental impacts to aquatic resources.

In any event, the future water treatment plant site is likely to be at, or much closer to Charlottesville to the James River. It could be the site where the Observatory WTP is presently located. There are a couple of important reasons for this. First, U.S. Environmental Protection Agency regulations on disinfection by-products promulgated within the last ten years make it necessary that water systems minimize the transit time of water between the water plant and customer taps after chlorine has been added for disinfection. Second, most of the land area between Scottsville and Charlottesville is designated for rural use in the Albemarle County Comprehensive Plan, a use where the immediate availability of treated public water is not needed or desired.

For the purposes of this investigation, the entire length of the transmission main is assumed to transport only raw water; however, even if WTP improvements and ultimate locations should prove different, there would be negligible impact on cost and environmental impacts. For comparison purposes with other raw water concepts, only costs associated with raw water supply and transmission will be included in this analysis.

Supporting project selection information is presented below. Facility size is identified, raw and finished water pipeline implications are discussed, and an option for configuring the project to serve regional needs is presented.

System Capacity

The projected 2055 average daily water supply deficit, presented in the *Water Supply Alternatives Supplemental Evaluation*, dated July 2004, is 9.9 MGD assuming the projected SFRR, Ragged Mountain Reservoir, and Sugar Hollow Reservoir yield capabilities are maintained and no improvements or alternations are made. Intake and transmission features of community water supply systems are typically sized based on a peak day factor (peak daily demand divided by average daily demand). The Urban Area system peaking factor, presented in the above referenced report, is 1.5; therefore, the design capacity for the intake and transmission main is 14.85 (rounded to 15 MGD).

Raw Water

If a raw water transmission main is selected for the entire route, a termination point in the Urban Service Area must be selected. There are two logical options: discharging the raw water into an existing reservoir or WTP (e.g. Ragged Mountain Reservoir or Observatory WTP) or discharging the raw water into a new reservoir or WTP. Raw water delivery to an existing facility will require an expansion of treatment facilities in order to increase capacity and a modification of the existing facilities to optimize treatment of the new source water. Raw water delivery to a new WTP facility will require selection of a new site and determination of the appropriate location to connect finished water to the Urban Service Area.

Although conventional WTP processes are anticipated, it is likely that, at certain times, there will be more turbidity in a river source than a reservoir. Provided that the raw water pipeline is designed to prevent settling in the pipe, turbidity can be easily removed as part of the water treatment process. These issues will be considered during the development of WTP improvements; however, the potential for siltation in the raw water pipeline must be considered as this raw water concept is developed. Maintaining flow velocities above approximately 2.5 feet per second (fps) will be necessary to prevent siltation in the pipeline. These facilities would be operated to provide such minimum velocity. An interim or booster pump station will help maintain adequate velocities in the pipeline and reduce the maximum operating pressure. Pumping raw water can be significantly more demanding on the pumps due to the raw water characteristics. This may result in higher long term operation and maintenance costs.

Finished Water

Pumping finished water from the Scottsville area could be accomplished although it would pose its own set of issues. The quality of the drinking water could potentially diminish over the approximately 22.9 -mile pipeline if it is treated in the Scottsville area. A finished water pipeline of this length will result in considerably longer residence times than typically seen in the distribution system. This would result in changes in water quality parameters including decreased disinfectant residual and the potential formation of disinfection by-products (DBPs). DBPs are created when natural organic matter in water reacts with the free chlorine disinfectant used in drinking water treatment. A free chlorine residual above 0.2 mg/L would be maintained via booster chlorination stations along the pipeline in order to maintain adequate water quality in the pipeline prior to delivery to the Urban Service Area.

There are also two potential solutions to the water quality issues associated with pumping finished water including: using alternative disinfectants or advanced water treatment. Some alternative disinfectants, such as chloramination, are proven to reduce the formation of DBPs; however, since the finished water will be connected to an existing distribution system, compatibility between the two waters would need to be verified. Advanced water treatment can include membrane systems in order to better remove natural organic matter from the raw water source. This will allow for the use of chlorination with diminished potential of DBP formation. These potential solutions will be addressed as WTP improvements are identified.

In the event the pipeline from Scottsville to Charlottesville is designed to carry finished water, the connection to the existing Urban Service Area distribution system must be considered. The hydraulics of the existing system must be evaluated to determine the best location to connect the 30” diameter pipeline. It is advisable for the 30” pipeline to be connected to an existing pipeline of sufficient size and capacity to optimize distribution of the increased flow.

Regional Cooperation

If the James River concept is selected as a preferred alternative, a regional implementation strategy could be jointly considered by RWSA, Louisa County, and Fluvanna County. At this point, some preliminary discussions have occurred and Fluvanna County has received a preliminary study through the consulting engineering services of R. Stuart Royer & Associates, Inc. A summary of current discussions is presented below.

The currently projected water supply deficits during the planning period are 9.9 MGD for RWSA, 3.0 MGD for Louisa County, and 3.0 MGD for Fluvanna County, for a total of 15.9 MGD. Each municipal entity has projected its own water supply deficit. The concept configuration could include an intake on the James River near Bremo Bluff, VA to provide this capacity, and a raw water pipeline to convey this water from Bremo Bluff northwest toward Albemarle County. As currently conceptualized, water used in Fluvanna County would be withdrawn from this pipeline and treated in Fluvanna County, and water for RWSA would continue to be conveyed as raw water into Albemarle County, with RWSA having the option of constructing a new water treatment plant on the east or southeast side of Charlottesville or piping raw water to the Observatory WTP. Treated water for Louisa County at Zion Crossroad could be supplied from a new RWSA water plant or from a water plant in Fluvanna County, to be determined in a later investigation. The initial raw water pipe size at Bremo Bluff would be 36-inch, but could be reduced to a 30-inch pipe at the point where it carries only RWSA flow. Possible options for routing the pipeline include the route of an existing power transmission line between Bremo Bluff and the southeast edge of Charlottesville, or a route in the vicinity of Highways 15, 53, and 729.

R. Stuart Royer and Associates, Inc. has prepared some cost estimates, but they are not directly comparable to the estimates in this memorandum for several reasons:

1. Royer used an assumption that RWSA would only need a maximum of 5.0 MGD, whereas, RWSA's water supply deficit is 9.9 MGD on an average day basis and 14.9 MGD (1.5 times the average day demand) for the highest peak day;
2. Royer's estimates only carry the pipeline close to the Fluvanna-Albemarle County line and do not complete a connection to the RWSA system; and
3. Royer uses estimates of unit pricing that are lower in value and less conservative than Gannett Fleming.

More detailed engineering investigations are needed before regional implementation could be described in the same level of detail as the RWSA project defined in this memorandum, or before preliminary estimates of project costs could be developed. The cost of such investigation would have to be shared by RWSA, Fluvanna County, and Louisa County; however, there is no current agreement to share cost for such an investigation, nor a contract authorization for an engineer to perform this investigation. If the James River concept is identified as the preferred alternative for RWSA it will determine the interest of Fluvanna and Louisa Counties in participating in the required studies for permitting of a joint project.

Potential Intake Site Locations

A river intake structure would need to be constructed in order to withdraw the approximately 15 MGD of water from the James River. The shortest reasonable route suggests that the intake structure be located near the town of Scottsville, VA, which is approximately 16 miles south of Charlottesville, VA. Figure 1 identifies various potential properties that could be purchased in order to construct the river intake structure along the northern banks of the James River.

As seen in Figure 1, there are numerous properties adjacent to the James River that would be large enough to handle the proposed intake structure. Some of the properties identified are smaller portions of larger parcels as identified on the Albemarle County tax maps viewed on the County website. The acreages listed on the drawings are estimates based on the portions of the parcels identified. As indicated below, only about 5 acres would be necessary for the intake and raw water pump station.

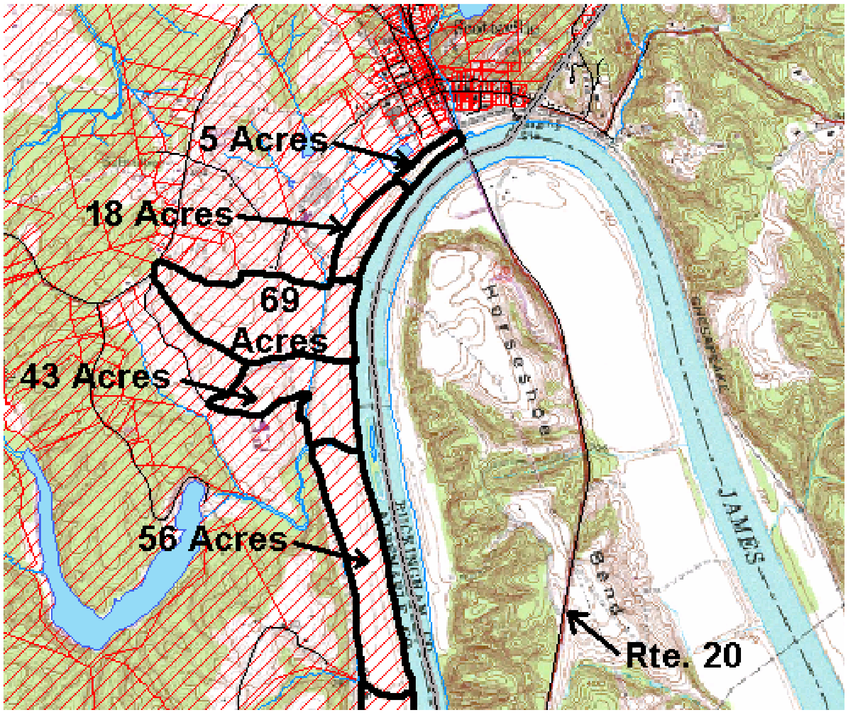

Figure 1: Potential Parcels for Purchase and Construction of River Intake Building

Basic Intake Structure Concepts

There are many types and forms of river intake structures used by water suppliers. The water can be collected via instream traditional intake structure or a passive screen intake structure, both of which include no moving parts, (reducing maintenance costs) and allowing the water to enter the intake at a low, uniform velocity. This minimizes the possibility of fouling due to suspended aquatic life and debris. It is assumed at this time that a passive screen intake structure will be used for this concept.

From the intake structure, the water would be pumped from an on-shore river intake building to a water treatment plant facility and eventually to the Urban Service Area. The on-shore building would house the pumps and pumping controls for the river intake system. An estimated land area for the intake and pumping station structure is 5 acres to accommodate access, security, and screening concerns.

Figures 2 and 3 are examples of typical river intake structures. While these figures are not exact reflections of what would be used for this particular concept, they provide a proper frame of reference for a James River intake.

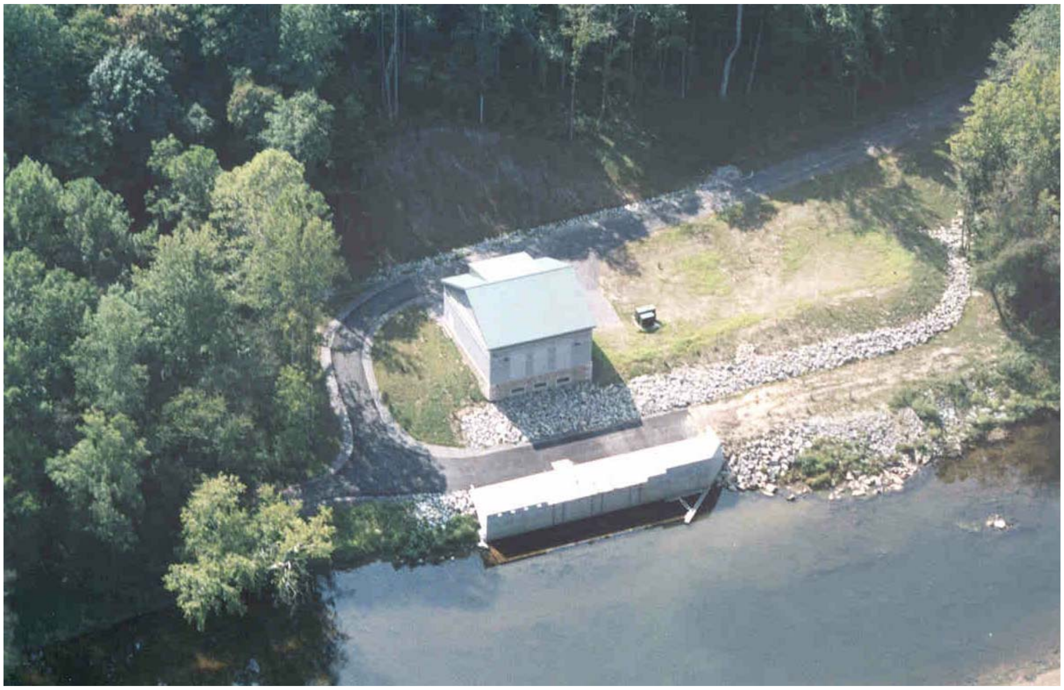

Figure 2: Typical Side River Intake Structure and Raw Water Pump Station

Figure 3: Side River Intake Structure Under Construction (Pump Station Off Picture to Right)

Pipeline from Scottsville to Charlottesville

Pump Stations

According to United States Geological Survey (USGS) quad maps, there is a significant increase in elevation between Scottsville and Charlottesville that would affect the transport of water. The elevation at the river intake would be approximately 260 feet above mean sea level (M.S.L.), while the elevations in Charlottesville range from approximately 400-600 feet (M.S.L.). At the highest point along Route 20 between the two cities, an elevation of approximately 680 feet is reached. Considering the additional dynamic head, these elevation differences dictate the use of at least three pump stations including the intake pump station.

Sizing of Pipeline

Selecting the appropriate size of piping to meet short-term and long-term needs is important. A larger diameter pipe may result in lower head loss, but the velocity and pressure may be too low causing siltation problems in the raw water pipeline. Conversely, a smaller pipeline will result in higher flow velocity and higher pressures, but the head loss associated with the pipeline will be significantly higher.

The Hazen-Williams Equation can be used to analyze water flows in pressure conduits. For circular pipes flowing full, the equation takes the form:

$$Q = 0.279CD^{2.63}S^{0.54}$$

where: Q = flow rate, mgd

C = roughness coefficient

D = pipe diameter, feet; and

S = slope of energy gradient, feet/feet

For this discussion of the James River intake, the projected flow is 15 MGD; the roughness coefficient is 130, which is a standard value for new pipes; and a slope of energy gradient equal to 420 ft elevation over 121,000 feet of proposed pipeline. Based on these values, it is possible to solve for the pipe diameter, which is determined to be approximately 27 inches. Since 27 inches is not a standard pipe size, a nominal 30 inch diameter pipe is recommended for this application. If this concept is identified as the preferred alternative, and selected operating conditions dictate periodic pumping and/or the use of storage, this pipeline size may be reconsidered.

Pipeline Route

A pipeline could follow VA Route 20 from Scottsville to the Urban Service Area. This report presents a discharge location at the Observatory WTP. Figure 4 illustrates the generic pipeline routing. As identified in Figure 4, the pipeline could follow Route 20 north from Scottsville, VA until reaching I-64, where the pipeline could turn west until reaching Route 780. At that point, the pipeline could head north to the intersection with Fontaine Avenue/Park Avenue. After crossing Fontaine Avenue/Park Avenue, the pipeline could follow Maury Avenue, which becomes Alderman Road. The pipeline could then follow Alderman Road until it reaches McCormick Road. The pipeline could follow McCormick Road west until it reaches Edgemont Road, which the pipeline could follow to the Observatory WTP. This pipeline route would be approximately 22.9 miles in length.

Many issues may influence the final pipeline route location. It may be possible to parallel existing RWSA pipeline routes, take advantage of land development patterns, or otherwise optimize the route. A route study would be completed during the early stages of final design if this concept is advanced as the preferred alternative. The pipeline route would be finalized at that time. It is anticipated that any modifications made would reduce cost and minimize environmental impacts. Nevertheless, this example is considered to provide a very accurate approximation of the actual costs and impacts that would be associated with any final design.

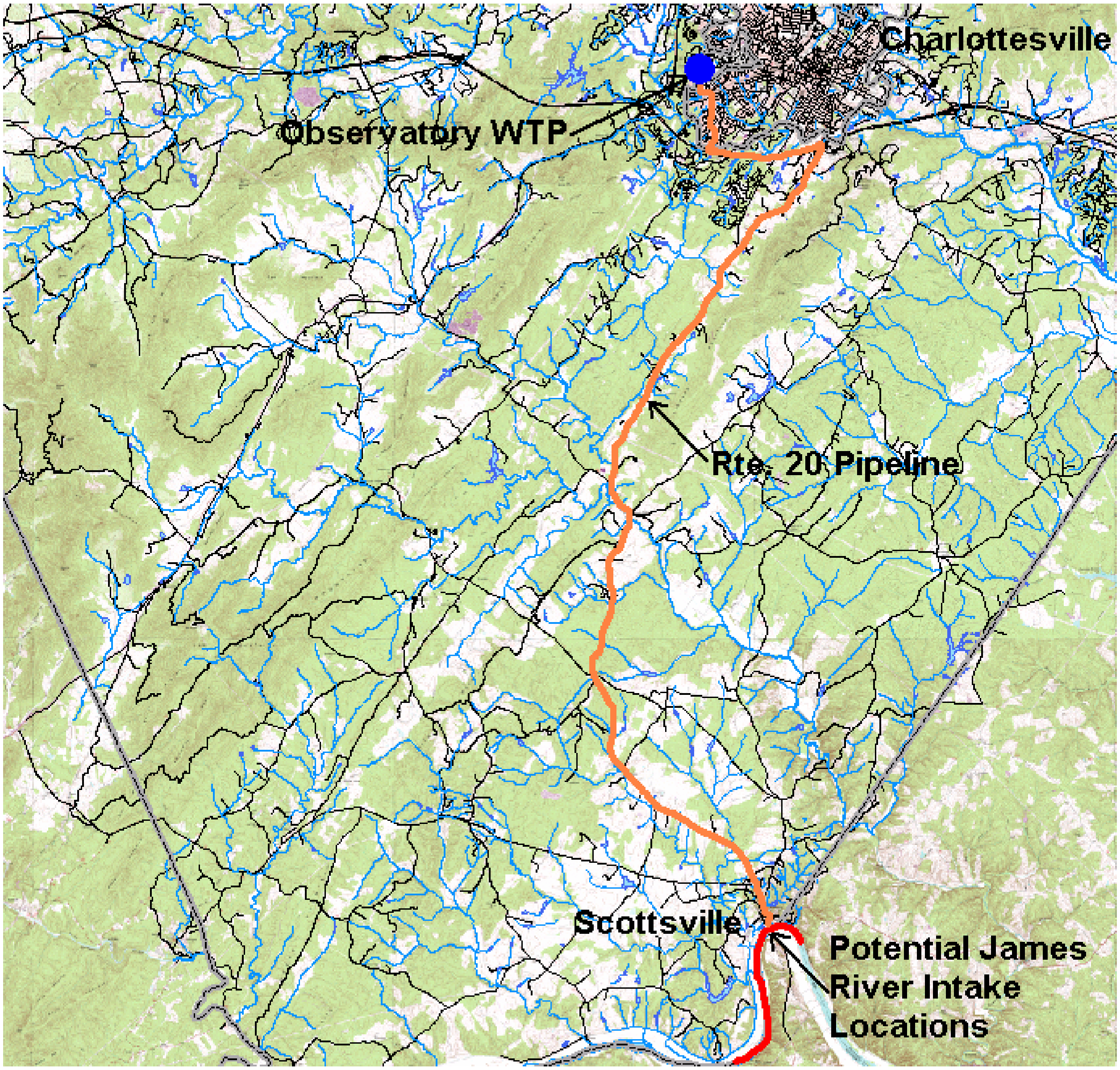

Figure 4: Currently Proposed Raw Water Transmission Pipeline from James River to Observatory WTP

Generally, water transmission piping is installed below grade (under ground) by "open-cut" method which means a trench is excavated from the ground surface to the depth required, the pipe is installed, and the trench is backfilled to the original ground surface. Traditional excavation within and alongside of a roadway are presented in Figures 5 and 6, respectively.

Figure 5: Traditional "Open-Cut" Piping Installation in a Road

Figure 6. Traditional "Open-Cut" Piping Installation in a Roadway Shoulder

The open-cut method of pipeline installation will not be appropriate for some road crossings, stream crossings and a railroad crossing. "Trenchless" technologies would be the most feasible method for these locations. Trenchless technologies allow the pipe to be installed between two points with no disruption of the ground surface. Pits are excavated on both ends of the crossing and the pipe is installed between these points. The specific trenchless method will be dependent on the soil conditions encountered in the installation area, size of the pipeline, materials used for the pipeline, and the pipe route. With pipe installations of this size, the primary technologies used would be jack and bore, tunneling, and horizontal directional drilling (HDD). Jack and bore refers to installing a casing pipe between two pits, then inserting the actual water-carrying pipe inside the casing pipe. Tunneling is used in installing large-diameter, long-length pipe through rock conditions and HDD combines elements of both tunneling and jack and bore techniques. At this time it is not expected that tunneling will be necessary; however, there is potential at the crossing of Interstate-64 and Route 29 Business. Based on the proposed pipeline route and review of the 6th Edition *ADC Map Book for Albemarle County*, there are numerous road crossings, of which 10 are considered major through routes or interstates, including Interstate-64 and Route 29 Business. Trenchless crossings could avoid any lane closures or negative impacts to traffic patterns.

There are also approximately 30 stream crossings along the example pipeline route, including the Hardware River, Miller Creek, Harris Creek, Biscuit Run, and Moores Creek. Regardless of the size of the stream to be crossed, any section of pipeline that intersects these streams will result in higher installation costs due to environmental concerns and protection. In these instances HDD technologies may be appropriate.

Also affecting the installation costs of the pipeline will be the subsurface conditions located along the route. An allowance is provided in the cost estimate for encountering rock along the pipeline route; however, the costs of the pipeline may vary depending on the type of rock formations encountered. A subsurface exploration plan during final design is recommended to refine this estimate.

The sample route has been presented to VDOT for comment and at this point no comments have been received.

Property Acquisition

It is preferable to construct subsurface pipelines within existing public right-of-ways or adjacent to existing right-of-ways to minimize impacts to nearby property owners. In this case, there are no existing right-of-ways between Scottsville and Charlottesville on Route 20, which was constructed within prescriptive easements. In order for the pipeline to follow this route, RWSA would be responsible for purchasing easements along the majority of Route 20. Following the eastern side of Route 20 would minimize environmental impacts. Following the eastern side (northbound lane) of Route 20 would require obtaining easements for approximately 150 properties.

The width of the easements will depend on several factors, however, the most important being the size of the pipe and the depth of cover over the pipe. In this case, a 30" diameter pipe with a depth of cover of 36" to 42" would require a permanent access easement width of approximately 20 feet and a construction easement width of approximately 20 feet. These widths will vary depending on stream crossings, road crossings, construction access requirements, depth to rock, and other utility crossings.

Pipeline Materials

There are various issues associated with the different types of pipe materials available for large diameter piping (typically piping 24" diameter and larger). The three common pipe materials for this size piping are steel, ductile iron (DIP), and pre-stressed concrete cylinder pipe (PCCP). Each of the three materials will meet the requirements of the project and each has advantages and disadvantages. RWSA will be able to select any of the above materials and receive a pipeline capable of meeting the needs of the project. If this water supply concept is pursued through design and construction, it is recommended that RWSA design and specify at least two of the pipe materials for competitive bidding in order to secure the most cost effective project or determine in advance which material is favorable.

In the past, steel and PCCP were the most common pipe materials used in water supply pipelines of the size expected for this project; however, due to recent price fluctuations in the steel market and improved manufacturing capabilities, DIP is becoming as common.

The advantages of steel are that the pipe is generally less expensive to purchase and easier to install. Disadvantages of steel pipe are that it relies on designed bedding and backfill to provide sidewall support and potentially can collapse under vacuum conditions. Steel pipe can also be delivered "out of round" resulting in more difficult joining between pipe sections. Related to out of round issues is the fact that there is no standard pipe outer diameter or joint design for steel pipe. In the current world market for steel there is an unpredictable lead time and as mentioned above steel prices have had significant fluctuation.

Unlike steel pipe, DIP is a heavy wall, flexible conduit that does not rely on the pipe bedding or backfill for structural support. DIP also has several standard joint designs and the material is often readily available. The use of DIP will require careful corrosion protection design depending on the nature of the existing soils. DIP does have a higher material cost than other types of pipe, although the current market is relatively stable with respect to cost.

PCCP also is a more structurally sound pipe option relative to steel pipe. One disadvantage of PCCP is the fact that there is one manufacturer in the Mid-Atlantic States, Price Brothers, which creates a virtual monopoly. PCCP also is subject to carbonation of the mortar coating, as well as corrosion of the steel joints. Another disadvantage seen in PCCP is the breakage of the prestressing wires.

ENVIRONMENTAL IMPACTS

Wetlands

Methodology

Scientists assessed the presence of wetland areas utilizing the three parameter approach outlined in the 1987 Corps of Engineers Wetland Delineation Manual, as modified by subsequent regulatory guidance. The area of coverage included various locations along the James River as a potential site for a future pump station and approximately 100 feet from both sides of Route 20, Interstate 64, Old Lynchburg Road, and other neighborhood roads in Charlottesville leading to the Observatory WTP.

A review of the pump station sites presented in Figure 1 indicates they are concentrated along the northern shoreline upstream from the town of Scottsville. The inspection of these private properties, however, was restricted by limited vehicular access. Scientists evaluated the properties using the combination of limited site access and aerial photo interpretation to approximate the extent of wetlands in this area of the project.

Wetland boundaries were mapped in the field using 1994 color infrared aerial photographs at a 1 inch to 200-foot scale and topographic information. Field investigations included the confirmation of the presence or absence of hydric soils, hydrophytic vegetation and wetland hydrology. Widths and lengths of wetland areas were measured in the field and transposed to the maps for a higher degree of accuracy. Wetland habitat types (i.e., emergent, scrub-shrub, forested) were mapped during the field inspections using the aerial photographs in-hand, and relating the photographic vegetative signatures with the field conditions.

Stream channels were preliminarily mapped in the office using a combination of aerial photographs and USGS quadrangle mapping. The preliminary maps were used in the field to verify the presence of stream channels. Once a channel was field verified, scientists utilized the U.S. Corps of Engineers Norfolk District Stream Attributes Methodology to qualitatively assess stream channel stability and function (see the stream results below).

After the streams and wetlands were inventoried, an evaluation of the data was performed to determine which side of Route 20 presented the least amount of impacts. The east side was found to have fewer streams/wetlands, and as such, this side was chosen for the alignment and impact analysis.

Results of the Wetland Assessment

Pump Station – The water from the James River near the town of Scottsville is contained within steep banks and shorelines during normal flow volumes. Only during rare, catastrophic flood events will waters crest the banks and reach the floodplain. Because of this physical characteristic, uplands dominate most of the James River floodplain upstream from Scottsville. The uplands are being utilized primarily as pastureland with scattered pockets and linear strips of wetland depressions. These wetlands function as a result of seeps, ditches and small channels that provide surface water inputs from the surrounding hillsides into the depressions that have been carved into the floodplain.

Pipeline - A total of twelve (12) individual wetlands were observed adjacent to both sides of the roadways along the proposed pipeline route. Five (5) of the wetlands are forested systems and seven (7) are emergent. All wetlands are considered to be small pockets ranging in size from approximately 0.75

acre to as small as 0.01 acre. In addition to the wetlands, a total of three (3) man-made ponds were observed within the study area.

An evaluation of potential wetland impacts was performed based on a preliminary alignment of the pipeline being located along the east side of Route 20 and north side of Interstate 64. The impacts analysis makes four assumptions which are believed to be reasonable – 1) no loss of wetlands resulting from the pump station near Scottsville (i.e., it is assumed a location for the pump station can be found that avoids impacts to wetlands); 2) impacts are limited to the 20-foot wide permanent easement paralleling the east side of Route 20; 3) impacts to emergent systems will be temporary and restored to their full functioning character resulting in a no net loss of wetland functions and values, and 4) impacts to forested systems within the 20-foot wide permanent easement will be restricted to a conversion from forested habitat to emergent habitat.

Impacts to wetlands would occur at 4 different locations, with 2 of these impacts being temporary disturbances to emergent wetlands, and 2 of the impacts resulting in the conversion of forested wetlands to emergent wetlands. The total amount of temporary wetland disturbance is estimated to be approximately 0.23 acre. The location and description of the wetland impacts are provided below.

- Just north of Interstate 64 lies a forested system between Biscuit Run and the Holiday Inn just east of the Route 631 interchange. The area of conversion would be approximately 0.11 acres.
- Approximately 2.2 miles south of Interstate 64 along Route 20 is an emergent wetland seep that occurs near the drive entrance to several houses. Temporary impacts to this system would equate to 0.04 acre.
- A very small emergent wetland occurs approximately 1.3 miles south of Carters Bridge. Temporary impacts to this system would equate to 0.01 acre
- Approximately 2 miles north of Scottsville lies a small forested wetland immediately adjacent to Route 20. The 20-foot wide permanent easement would result in approximately 0.07 acre of conversion impacts.

The total area of temporary disturbance is summarized below.

Temporary disturbance with no conversion – 0.05 acre
Temporary disturbance and a conversion of habitat – 0.18 acre

Wetland Functional Values

VHB evaluated the functional values for the single, forested wetland system that would be impacted by the pipeline. The functional values were assessed solely on the basis of a wetland type offering that particular function (a “yes” or “no”) based on the professional opinion of the experienced scientist performing the assessment. No attempt was made to measure the degree, or level, of each function. Those functions analyzed included sedimentation/erosion control, water quality, flood-flow attenuation (storage), wildlife habitat, and recreation. A brief description of each function analyzed is provided below followed by a statement summarizing the functional abilities of the two wetland categories (fringe and non-fringe).

Sedimentation/Erosion Control

This function is closely tied to the water quality function. The difference lies with the analysis of a wetland’s ability to retain sediments that are already present in the system, rather than the analysis of a wetland’s ability to filter sediments coming in from non-point sources. The presence of the sedimentation/erosion control function is largely based on the presence of vegetation, organic debris, and root matter that hold sediments in place. Water velocity, topography, flood frequency, and energy dissipation are also contributing factors to sedimentation/erosion control. Wetlands were viewed to contain this function when the vegetative composition and structure were observed to be stable. Highly eroded wetlands or wetlands with exposed soils were viewed as lacking this function.

The forested wetlands are mature forested systems with understory plant life, stumps, organic topsoil, and fallen trees within a relatively flat landscape. These conditions are favorable for the wetlands ability to provide high quality sediment and erosion control.

The emergent systems are associated with small seeps that feed into nearby stream channels. One system occurs within a pasture, while the other is near the pavement to the roadway. Both systems provide some degree of sedimentation and erosion control because of the shallow root systems that help to hold the soil in place. Yet, the level of function is weakened by constant disturbances due to cattle and or mowing equipment.

Water Quality

This function relates to the wetland's ability to maintain clean water by filtering/retaining nutrients, sediments, and toxicants from incoming runoff from the surrounding watershed before water moves through the system to downstream areas. The capture and filtering of nutrients, sediments, and other pollutants is dictated by such features as soil absorption, soil particle size, water retention, water velocity, and plant/root uptake. Connecting wetlands with stable, natural soils and vegetative cover are viewed as having this function.

The forested wetland north of Interstate 64 appears to receive some surface runoff from the interstate and the neighboring developments. As such, water moves through the wetland and is filtered by the trees, brush, and soil before the runoff reaches Biscuit Run. The wetland provides water quality functions.

Likewise, the forested wetland adjacent to Route 20 appears to receive overflow waters from a nearby pond. The water spreads across the landscape where it is filtered by vegetation, leaves, roots, stems, and other debris before re-entering the stream channel on the other side of the roadway.

The emergent wetlands within the study area provide similar water quality functions due to the absorption and trapping of nutrients by the plantlife before the water enters the nearby channels.

Flood-Flow Attenuation

In addition to retaining and remediating sediments and other pollutants, wetlands also provide flood flow storage. The wetland's ability to attenuate flood waters can serve to calm flood peaks and/or retain water over long periods of time, minimizing catastrophic flood events, and thereby allowing downstream areas to maintain their flow rates and stream geometry. This functional value also serves to protect ecological, social, and economic structures located downstream. Where surface water runoff flows from higher elevations down to the lower elevations, wetlands associated with overbank flooding from bankfull stream discharges, ponds, and depressions are viewed as having this function.

Both forested wetlands serve to provide flood-flow attenuation during severe storm events. It appears Biscuit Run has been channelized many years ago, and it is questionable if the water ever overtops the banks. If so, the neighboring wetland is available to store these floodwaters within a larger floodplain. The forested wetland adjacent to Route 20 also serves to store flood waters, although the amount of storage is very small.

The two emergent systems occur on gently sloping land where groundwater seeps from the soil and emerges at the surface before flowing down the slope. These systems, because of their landscape position, do not offer flood flow attenuation values.

Wildlife Habitat

Wetlands may provide food, cover, and reproductive habitat for numerous species of wildlife. This particular function is determined by the degree to which it serves various habitat needs for wetland dependent species only. Assessing this function can be complex due to the wide variety of wetlands (emergent, scrub/shrub, forested), each of which have their own habitat benefits. Wetlands with surface water, longer hydroperiods, and multiple vegetative layers, snags, and fallen debris (sticks, logs) tend to offer the greatest level of habitat diversity for a greater level of species richness and abundance.

The forested wetlands provide habitat for a variety of terrestrial wildlife species, but not necessarily wetland dependent species. Because the hydrological character tends to be reliant upon immediate rain events and a high groundwater table, the wetlands do not provide sufficient surface water for aquatic species. However, evidence of raccoons, beavers, and white-tailed deer were observed.

The smaller emergent systems experience constant disturbances from cattle and mowing, and as a result, provide very little wildlife habitat functions for wetland dependent species.

Recreation

Wetlands, by their unique characteristics, can attract people as a setting for various outdoor recreational activities such as canoeing, kayaking, fishing, hunting, trapping, swimming, hiking, birding, etc. The recreation function is measured by the ability of a wetland to offer these types of active and passive recreational opportunities to the public. Qualities such as size, aesthetics, access, value as wildlife/fisheries habitat, and uniqueness help to rate whether this function is available.

All of the wetlands occur on private property adjacent to the interstate and Route 20, and do not provide recreational value due to limited access by the public and the infringement of disturbances by the roadways, neighboring developments, and also because of their small size.

Streams

The Norfolk District of the U.S. Army Corps of Engineers has developed a protocol for evaluating the quality of streams in the Piedmont physiographic region of Virginia (*Stream Attributes Crediting Methodology: Impact and Compensation Reaches*). The purpose of the protocol is to establish a reasonable approach to determining the mitigating needs for stream impacts, realizing that not all streams are the same. The protocol utilizes five variables determined to be reasonable indicators of the overall stream's health and stability. These variables include channel incision, riparian condition, bank erosion, channelization, and instream habitat. Using an index ranging between 0 and 1.0, each of the five variables are assigned a score, with 1.0 being the highest possible score per variable. Variable scores are then added to determine the final index score (called the "Reach Condition Index"), with a 5.0 being the highest total score for any stream. The Reach Condition Index is then multiplied by the linear footage of stream impact for a particular stream. The product of the attributes score and the linear footage provides a "Total Reach Condition Units" that can then be compared to another stream targeted for mitigation. The Norfolk District's stream mitigation policy is for applicants to achieve an equivalent "Total Reach Condition Units" score through stream restoration activities.

The Corps's stream attributes methodology was applied for each stream channel in the study area of the pipeline alignment. We observed that the health and stability of stream reaches varied widely. Typically, streams within pastures and clearings were incised/channelized and lacked quality riparian buffers. These conditions resulted in scores around 1.7 to 2.5, with the lowest score being 1.2. Stream channels in undisturbed forested sections were observed to be more stable, exhibited less erosion, and maintained high quality riparian buffers sufficient to receive scores around 3.0 to 4.0, with the highest being 4.8.

No streams for this concept plan will be lost completely. Where stream encroachments will occur, the pipe will be installed using the typical cut and backfill technique, with the exception of Hardware River and Biscuit Run where underground directional drilling will occur. Once the pipe is installed using the cut and backfill technique, the stream channel will be restored, resulting in only temporary impacts. Only minor, but permanent, modifications to the buffer habitat will occur from the permanently maintained easement after the pipe is installed. An assessment was performed, therefore, to determine the permanent modifications in habitat quality, which is the impact that will require compensatory mitigation.

To determine the level of impacts to habitat values, several assumptions needed to be made regarding the realistic length of stream impact at each crossing and the extent of the impact (loss of habitat function). The first assumption involves the length of stream impact relative to the width of the easement crossing. The proposed easement width is assumed to be 60 feet wide, which incorporates a 40-foot wide temporary construction access easement and a 20-foot wide permanent easement. It is not practical to assume that the entire stream within the 60-foot easement will be disturbed, when in reality, disturbance from the backhoe to lay down the pipe will occur only within a 10 to 15-foot wide trench. For most streams that have a narrow channel width (less than 5 feet), a 15-foot width impact is reasonable, but for the sake of providing a conservative impact width, we have assumed that the entire 20-foot wide permanent easement will affect stream channels.

The second assumption involves a distinction between permanent and temporary stream impacts. The Corps stream attributes methodology provides a way to measure qualitatively the character and stability of streams. Because the disturbance to stream channels from the cut and backfill will be temporary, the character and stability of the actual channels will not change; each channel will be restored to its original condition. As such, the before-disturbance and after-disturbance score attributed to the channel banks and bed will be the same, resulting in a no net loss of habitat function provided by the channel. On the other hand, the 20-foot wide permanent easement will cause the alteration of riparian habitat when shrub and forested stream buffers are converted to grass. In these instances, the before and after habitat value will slightly decrease, thereby resulting in a permanent change (impact) to stream habitat.

Each stream reach proposed for impact was analyzed to determine if the pre-construction habitat quality will be lowered after the easement is established. Streams with existing grass or impervious riparian buffers will not incur any change in habitat values. Streams with shrub/forested riparian buffers will experience a change in habitat when the trees/shrubs are removed as part of the permanently maintained easement.

Approximately 6,930 linear feet of channel from 44 streams will incur some form of encroachment by the pipeline and easement. Of these 44 streams, approximately 10 stream channels comprising 910 linear feet currently maintain riparian buffers consisting of pasture (i.e. grass) or impervious structures, which will result in no change in riparian habitat values after the pipe is installed. An estimated 34 channels with shrub/forested riparian buffers totaling 6,020 linear feet will incur permanent changes to riparian buffers as part of the easement. The differences between the pre- and post construction riparian scores for these 34 streams were used to calculate the Total Reach Condition Units, which were then used to determine the number of units needed for mitigation. The conclusion of the study is that approximately 1,283 Total Reach Condition Units associated with 6,020 linear feet of channel would be lost as a result of the pipeline.

In understanding how the stream mitigation protocol works, one must understand that the stream being impacted may lose some of the stream features calculated in terms of condition units. A stream targeted for mitigation, however, will exhibit a level of condition units before any work is done to improve the stream. The same protocol is applied to the mitigation stream reach to determine the condition units before and after mitigation is performed. The net gain in condition units obtained after mitigation is performed can then be used to offset the total condition units being impacted.

Wetland/Stream Mitigation

Mitigation Requirements – Wetlands

The Norfolk District, U.S. Army Corps of Engineers (COE) and the Virginia Department of Environmental Quality (DEQ) rely on set mitigation ratios to serve in-lieu of various wetland functions offered by emergent, scrub-shrub, and forested systems. The in-lieu ratios for the complete fill and loss of wetlands include 1 to 1 mitigation for emergent systems, 1.5 to 1 for scrub-shrub wetlands, and 2 to 1 for forested wetlands. The forested wetland within the pipeline corridor, however, will not be fully lost, but will experience a change in habitat function resulting from the conversion of forested habitat to an emergent habitat. In these instances, the Corps and DEQ rely on a 1 to 1 mitigation ratio. Therefore, the wetland mitigation requirements for impacted wetlands along the pipeline corridor will be the same as the impact acreage, or approximately 0.18 acre.

Mitigation Requirements – Streams

As previously described, the COE's *Stream Attributes Crediting Methodology* was applied for all streams, and an estimated total of 1,280 reach condition units will be required to offset stream impacts. If we assume a net gain of 2.0 stream condition units per linear foot (for instance, raising the condition units from 2.0 to 4.0 through restoration improvements), then approximately 640 linear feet of stream channel would be necessary to offset the impacts due to the pipeline.

Mitigation Opportunities

During field studies to analyze stream and wetland impacts, VHB scientists observed several locations along Route 20 and adjacent to the James River where wetland and stream mitigation could be performed. The relatively few mitigatable impacts resulting from the pipeline (0.18 acre of wetlands and 1,280 reach condition units) should make finding an appropriate mitigation site uncomplicated. As an example, approximately 12,500 linear feet of degraded stream channel occurring on 5 to 6 landholdings are present near the proposed pipeline corridor between Scottsville and Interstate 64.

Other options for performing wetland and stream mitigation include the use of local entrepreneurial mitigation banks servicing the area or use of the Corps of Engineers Wetlands Trust Fund. Three known private mitigation banks include the following.

James River Mitigation Landbank – Goochland Co. 15.5 credits
Byrd Creek Wetland Mitigation Bank – Goochland Co. 4.93 credits
Willis River Mitigation bank – Buckingham Co., 4.4 credits, 685 l.f. stream

Potential Mitigation Costs

Wetlands: The ample supply of wetland mitigation sites to achieve the restoration/creation of 0.18 acre in the vicinity will greatly narrow the cost of locating a suitable site. As such, the cost will be dedicated to land value, design, construction, and monitoring. If we assume the previously reported conservative estimate of $50,000 per acre-credit, the cost of performing wetland mitigation for the pipeline is estimated to be $9,000.

Stream: As reported in the Water Supply Alternatives Supplemental Evaluation (July 2004), stream corridor restoration, at the high end of the range, would involve land or easement acquisition, stream design, construction, and performance monitoring at an estimated cost of $300 per linear foot. We believe this to be a conservative estimate that captures all potential expenditures. Applying the COE *Stream Attributes Crediting Methodology* suggests that the project will require restoration of approximately 640 linear feet of stream channel, if we assume that improvements to the target channel and riparian buffer will net an increase of 2 credits per linear foot. Again, several degraded streams occur adjacent to the pipeline, such that the restoration of any one of these streams using natural channel design concepts will provide for the necessary credits to offset the stream impacts. The total cost to perform stream mitigation would be approximately $192,000 (640 linear feet X $300/l.f.).

Similar to the wetland mitigation, the COE also has a Stream Trust Fund, where an in-lieu fee is paid to compensate for stream impacts. The COE reports that the range of fees charged for participation is highly dependent on the character of the impacted stream and can range from $90 per linear foot for degraded streams to over $200 per linear foot for higher quality systems. Again, the use of this fund is determined by the agencies, and the applicant must document that there are no suitable opportunities available for on-site or watershed area compensation before they will allow the applicant to use the fund. Accordingly, we believe the costing approach described in the preceding paragraphs to be a reasonable and conservative estimate for budgeting and alternative evaluation purposes at the current level of study.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service (USFWS) and Virginia Game and Inland Fisheries (VGIF) identify the endangered James spinymussel as the only potential listed species in the area of the pipeline corridor. Data obtained from Mr. Brian Watson with the Virginia Game and Inland Fisheries indicate that the James spinymussel has been documented as occurring within the Hardware River, but not near the Route 20 bridge crossing. A survey for mussels in 1989 revealed no mussels present at two locations just upstream from the Route 20 bridge. We have been informed, however, that the two surveys were not intensive investigations, but instead were quick “spot checks.” More intensive surveys performed further downstream at the Route 622 bridge in Fluvanna County did reveal the presence of the spinymussel there, which confirms that the species is present in the river watershed. The VDGIF has informed us that the survey outcome at the Route 20 crossing in 1989 may be attributed more to the survey method rather than a true absence of the species. For this reason, they would require an intensive search for the James spinymussel at the Route 20 bridge location if this concept plan is selected.

In addition, VDGIF records indicate the historical presence of the James spinymussel within the James River near the Scottsville area; however, recent scientific studies indicate a lack of presence within the James River. The recent scientific studies indicate the habitat now occurs primarily in the James River headwater streams. No other survey information is available for other stream reaches bisected by the pipeline corridor, and additional surveys may be required for other stream reaches.

CULTURAL RESOURCES IMPACTS

Architectural Resources

The following information represents likely architectural resources encountered within this concept and recommendations by the consultant concerning the extent to which such resources may be encountered during construction of the James River Intake Concept. If this alternative is selected, consultation with the VDHR is recommended regarding the specific level of architectural work needed. Pipeline routes can also typically be adjusted to avoid or minimize such impacts.

There are two historic districts located within the Area of Potential Effect (APE) of the James River Intake alternative, the Scottsville Historic District (VDHR No. 298-0024) and the Southern Albemarle Rural Historic District (VDHR No. 002-5045). Of these, the Scottsville Historic District is listed on the National Register of Historic Places (NRHP), and the Southern Albemarle Rural Historic District has been determined eligible for the NRHP (Table 1). Both of these districts possess a high degree of integrity with few modern intrusions. There are also several individually surveyed architectural properties within these districts that have been determined to be contributing resources to the districts and are also considered eligible to the NRHP. These have not been listed separately in the table below because the project's effects, if any, would likely be seen as affecting the district and not individual properties. The introduction of any permanent above-ground facilities such as the two proposed above-ground pump stations within the boundaries of either of these districts could represent an adverse effect to these districts and should be avoided if possible. If such construction cannot be avoided, then it will likely be necessary to consult with the Virginia Department of Historic Resources (VDHR) to create designs that avoid, minimize, or mitigate for the adverse effect.

The project area also contains a high concentration of eighteenth century to early twentieth century architectural resources that have been surveyed but have not been evaluated for their eligibility to the NRHP. The construction of a below-ground facility, such as that proposed with the James River Intake Concept, would involve only a temporary effect to such structures during construction. These resources may not be adversely affected by the project, and additional cultural resources studies may not be necessary. These have not been included in the table below, because they may not be affected depending on how the project is aligned. The construction of any above-ground permanent facilities such as the two proposed pump stations along the pipeline route would represent a potential adverse effect to any historic properties within view of those structures. An architectural survey would be needed for any of the previously-identified structures within view of a proposed pump station location. Likewise, any structures that are at least 50 years old that have not been previously surveyed, and are within view of a proposed pump station location would need to be surveyed at the reconnaissance level to determine if they are eligible for the NRHP or have potential to be eligible for the NRHP and require intensive level survey.

Archaeological Resources

Potential archaeological resources to be encountered by the James River Intake Concept are greatest along the floodplain of the James River at the proposed intake locations, within downtown Scottsville, at stream crossings along the proposed route, and adjacent to historic architectural resources. The following information represents recommendations by the consultant concerning the extent to which archaeological resources may be encountered during construction of the James River Intake Concept. If this alternative is selected, consultation with the VDHR is recommended regarding the specific level of archaeological work needed. Pipeline routes can also typically be adjusted to avoid or minimize such impacts.

Numerous archaeological sites have been identified along the James River within all of the properties under consideration for the construction of the River Intake and Pump facility. Three of these sites are quite large and were identified after a large flood in 1985 that apparently scoured the river bank. These include Sites 44AB0286 (69-acre tract), 44AB0287 (18-acre/69-acre tracts), and 44AB0288 (5-acre/18-acre tracts). Due to their size, it is likely that at least one of these resources will be encountered during construction of the Intake and Pump facility if the tract within which any are present is chosen. Several additional archaeological resources have been recorded within the other tracts under consideration as well, but they are much smaller and may be easily avoided so they have not been specifically included in the table. Generally, the floodplain of the James River should be considered to have a high potential for containing archaeological resources that are eligible for the NRHP due to the preference of such settings by Piedmont Virginia Native Americans for large, permanent prehistoric villages and the potential for archaeological deposits to be deeply buried below alluvial deposition.

In downtown Scottsville, Site 44AB0495 is a multi-component Late Woodland prehistoric and nineteenth century historic site that has previously been determined to be eligible for the NRHP individually and as a contributing element of the Scottsville Historic District. It was identified during construction activities in Bruce Park and was found to contain archaeological remains of a pharmacy, a hotel, a brick kiln, and a domestic residence. Evidence of Native American occupation also was identified. Additional resources like this are likely in the downtown Scottsville area, and any construction that exceeds the depth of modern fill has the potential to encounter them.

Construction at all stream crossings along the route has the potential to encounter archaeological resources because prehistoric and historic archaeological resources are commonly found within proximity to perennial water sources and because construction at these locations will require additional excavations for the implementation of jack and bore tunneling. Phase I archaeological survey at such locations may be necessary depending on the extent of such activities. Similarly, the presence of an architectural resource often indicates the presence of an adjacent historic archaeological resource of similar age and is an indication of a high probability area for archaeological resources. Phase I archaeological survey may be necessary in proximity to such resources where the pipeline will be excavated within undisturbed soils.

Cultural Resources Summary

Preliminary investigations reveal architectural and archeological resources that may be impacted by the James River concept features. These resources are enumerated in Table 1 below. None of these features appear to threaten the feasibility of this concept. Should this concept advance as the preferred alternative, additional investigations are necessary to firmly identify cultural resource constraints. It is likely that project features may be manipulated to avoid cultural resources impacts or, if necessary, mitigation measures implemented. Project design costs and contingencies include an allowance for such measures.

Table 1: Cultural Resources and Locations Likely Affected

RESOURCE NUMBER	RESOURCE TYPE	NAME	NRHP STATUS	PROJECT EFFECT
298-0024	Historic District	Scottsville Historic District	Listed on the National Register of Historic Places	Affected
002-5045	Historic District	Jefferson-Carter Historic District; Southern Albemarle Rural Historic District; Southwest Mountain Rural Historic District Extension	Recommended Eligible by the VDHR	Affected
44AB0495	Site	N/A	NRHP Eligible	Potentially Affected
44AB0286	Site	N/A	Not Evaluated	Potentially Affected
44AB0287	Site	N/A	Not Evaluated	Potentially Affected
44AB0288	Site	N/A	Not Evaluated	Potentially Affected
Architectural resources (recorded and unrecorded)	N/A	N/A	N/A	Affected where above-ground facilities will be constructed
Archaeological Sites (recorded and potential site locations)	N/A	N/A	N/A	Potentially Affected on James River floodplain, in Downtown Scottsville, at stream crossings, and at the locations of architectural resources

COST ANALYSIS

Development of Cost Estimate

A cost estimate for a James River pipeline was included in the *Water Supply Alternatives Supplemental Evaluation* report (GF – July 2004). In cost estimates developed for the referenced report, all water supply features for the complete alternative including raw water supply, transmission, and treatment were included. For comparison purposes with other raw water concepts, only costs associated with raw water supply and transmission will be included in this analysis.

The cost estimate has been modified to address only the raw water conveyance requirements (eliminating any reference to water treatment) and to reflect additional findings presented in this technical memorandum. Assumptions used in the cost estimates are defined below.

- The intake structure will include a 15 MGD intake and an intake pump station with a capacity of 15 MGD.
- 121,000 linear feet of 30-inch pipeline (increased from 79,200 linear feet in the referenced report) to include transmission to Observatory WTP.
- Forty (40) road, stream or railroad crossings will be required, at an estimated total length of 2,000 linear feet. The cost of crossings is estimated at $200 per linear foot above typical installation.
- Land acquisition quantities will address the need for land to construct the river intake structure, intake pump station, and two (2) intermediate pump stations
- Easement acquisition costs will include costs to obtain property rights along the entire pipe route. Easement acquisition is based upon $2,500 per plat (one plat per property impacted) and a cost of $10 per linear foot of easement.
- It is assumed that there will be 2 intermediate pump stations to overcome the gravity head between Scottsville and Charlottesville.
- Electrical costs revised based on the horsepower required to handle the flow rate and the head losses predicted over the length of the Route 20 pipeline. Due to the fact that the James River Intake alternative would take several years to construct and bring on-line, the electrical cost is a total cost over a 40-year period. The cost per kW/hr is assumed to be $0.06 and it is assumed that the pump stations will be operating, on average, at 30% capacity for 12 hours a day.

Conceptual Level Cost Estimate

Table 2 presents the cost estimate for the James River Intake concept.

Table 2: James River Intake Conceptual Cost Estimate

Item	Cost (2004$)
Intake Structure and Pump Station	$2,500,000
Pump Stations (2 pump stations @ $2,000,000 each)	$4,000,000
Electrical Costs	$2,927,000
Pipeline (121,000 l.f. of 30" Diameter @ $180/l.f.)	$21,780,000
Road, Stream & Railroad Crossings (2,000 lf @ $200/lf)	$400,000
Environmental Mitigation	$201,000
Engineering, Permitting, and CM (20%)	$6,362,000
Land Acquisition (Intake Structure and intermediate pump stations – 15 acres @ $10,000/acre)	$150,000
Easement Acquisition (150 properties and 121,000 linear feet)	$1,585,000
Subtotal	$39,905,000
Project Contingencies (25%)	$9,976,000
TOTAL PROJECT COST	$49,881,000
Average Cost Per GPD of Safe Yield (Provides 9.9 MGD)	$5.04/GPD