October 4, 2002

Mr. Lawrence Tropea, Executive Director
Rivanna Water & Sewer Authority
200 Franklin Street
Charlottesville, VA 22901

Re: Emergency Water Supply
Draft Letter Report

File: 10312.23517 #5

Dear Mr. Tropea,

O'Brien & Gere Engineers, Inc. (O'Brien & Gere) is pleased to submit the following draft letter report regarding emergency water supply alternatives for the Rivanna Water & Sewer Authority (RWSA). This draft letter report builds on the "Doomsday Crisis" whitepaper developed by RWSA. Some of these options need further study or regulatory approval. However, it is intended that this report would allow RWSA to determine which options to pursue. It should be noted that O'Brien & Gere's efforts have been highly expedited (initiated September 23) and further work on the implementation plan for the recommended alternatives is planned.

**Background**

The Rivanna Water & Sewer Authority operates four reservoirs as part of the Urban Service Area water supply system. These reservoirs include the South Fork Rivanna Reservoir, Sugar Hollow Reservoir and Upper and Lower Ragged Mountain Reservoirs. The reservoirs have an available water supply capacity of approximately 1,676,000,000 gallons. The current reservoir levels are at approximately 55 percent of capacity, which means that the Rivanna Water & Sewer Authority has about 952,000,000 gallons of water remaining for water supply. The current average daily water demand in the Urban Service Area has been reduced from approximately 12 million gallons daily to about 7 million gallons per day as a result of demand management. Therefore, if dry conditions persist, the Rivanna Water & Sewer Authority has approximately 136 days of water supply remaining at the current 7 million gallons per day demand level.

**Purpose of Plan**

The overall purpose of the plan is to develop a strategy to implement emergency water supplies prior to depleting the remaining reserves in the existing reservoirs (i.e., preserving the remaining storage). Several key questions to be answered in this plan include:

- What water supply options are available (i.e., where is the water and how much is available)?
- How long will it take to implement the options and who needs to be involved?
- When should the options be implemented?
- How much will it cost?

**Overall Water Supply Objective**

The water supply objective for this plan ("Doomsday Crisis") is to provide the quantity of water needed for human consumption and sanitation needs, fire protection, and hospital and health care purposes. None of the options discussed below will meet unrestricted water demands in the Urban Service Area (average day demand of 12 mgd) and that should not be the objective in any event.

**Maintaining a Storage Balance in Reservoirs**

For the past year, the Rivanna Water & Sewer Authority has been managing the reservoirs to maintain a balance in storage, and to ensure that both the Observatory and South Fork Rivanna water treatment plants could be kept running. There is currently more storage in the Sugar Hollow/Ragged Mountain Reservoirs than in the South Fork Rivanna Reservoir (SFRR).

If either reservoir system is totally depleted, the associated water plant will cease to be operable. For example, if the Sugar Hollow/Ragged Mountain Reservoirs empty, RWSA will not be able to operate the Observatory Water Treatment Plant (WTP). This is an important constraint, and requires an analysis of the ability to move finished water from these emergency supply scenarios throughout the Urban Service Area. It is our understanding that the South Fork Rivanna WTP can deliver water to anywhere the Observatory WTP can, but there are some places that cannot be served by the Observatory WTP. In general, that means it becomes increasingly important to preserve some storage in SFRR.

**Viable Emergency Water Supply Alternatives**

North Fork Water Treatment Plant/Chris Greene Lake

Chris Greene Lake is located on Jacobs Run approximately 9 miles north of Charlottesville. Jacobs Run flows directly into the North Fork Rivanna River upstream of the existing North Fork WTP intake. The lake has a volume of approximately 334 MG, is owned by the County, and was constructed as a drinking water supply in 1967-1968. In 1970, the Board of Supervisors approved recreational use and development around the lake. Funding for recreational improvements was obtained in 1971 through the Land and Water Conservation Fund.

Streamflows in the North Fork Rivanna River can be supplemented by releases from storage in Chris Greene Lake to allow treatment up to the 2 mgd capacity of the North Fork WTP. Currently, the plant has some pumping and treatment process units under repair, and can treat about 1 – 1.25 mgd. The plant typically treats only the quantity needed to serve the North Fork Zone, which uses about 0.25 mgd. In order to use the full 2 mgd of treatment capacity, some temporary valving changes are required, and have been discussed with Paul Shoop at the Albemarle County Service Authority. These changes will require close monitoring to assure proper pressures are maintained in the water distribution system.

It is recommended that this option be undertaken immediately which would make about 1 mgd of additional finished water supply available to the Main Zone immediately and the full 2 mgd of supply available in approximately one month when the pumping and treatment plant work is complete. No capital costs are anticipated for this option, although, if the control of system pressure requires excessive operator attention, RWSA may decide to install a pressure sustaining valve in the 12-inch main along Route 29 at a cost of roughly $50,000. Under the proposed approach, the 300 MG would be exhausted in

April 2003 assuming a "worst case" scenario (i.e., no inflow to the lake or North Fork Rivanna River through April 2003).

Beaver Creek Reservoir/Lake Albemarle

Beaver Creek Reservoir is located approximately 2 miles east of Crozet. Beaver Creek flows directly into the Mechums River upstream of the abandoned Mechums River Pumping Station (approximately 2.7 miles) and the Mechums River eventually drains to the South Fork Rivanna Reservoir. The drainage area for Beaver Creek Reservoir is about 10 square miles. The reservoir is used for both flood control and water supply. The total storage of the reservoir is 1,100 MG and the storage available for water supply is about 520 MG. The reservoir is used by RWSA as a drinking water supply for Crozet, which is not in the Urban Service Area. The water demand for Crozet is estimated to be about 1 mgd. The reservoir is currently about 5 feet below the normal pool. We assume that this translates to roughly 400 MG of currently available water supply storage, and will verify the storage volume with RWSA.

Lake Albemarle is located on Spring Creek approximately 4 miles northeast of Crozet. Spring Creek flows directly into the Mechums River approximately 0.7 miles upstream of the abandoned Mechums River Pumping Station. The lake is owned by the Virginia Department of Game and Inland Fisheries. The lake has an estimated capacity of 150 MG and is currently full.

This option consists of releasing water from Beaver Creek and Lake Albemarle to the Mechums River for withdrawal at a temporary pumping station at the abandoned Mechums River Pumping Station site. Alternatively, the flows could be released to the South Fork Rivanna Reservoir, although this is not preferred because considerable loss could be realized en route to the reservoir. The proposed releases include approximately 200 MG from Beaver Creek and 150 MG from Lake Albemarle, if the drought continues to persist during the drawdown period. The 200 MG release from Beaver Creek Reservoir would leave about one years supply (200 MG) in the reservoir for Crozet. Our initial hydrologic analyses indicate that Beaver Creek Reservoir should refill as quickly as the Sugar Hollow/Ragged Mountain Reservoirs system. If these releases were initiated in January 2003 using temporary pumping, it is predicted that the estimated volumes (200 MG and 150 MG) would be exhausted in April 2003 based on the "worst case" scenario (i.e., no inflow to the reservoirs). The critical path items for this option will be securing approvals, particularly from the US Army Corps of Engineers for the temporary pumping at the Mechums River Pumping Station site, and providing temporary pumping, piping and power. It appears that temporary pumping will be required, because a more permanent restoration of the Mechums River Pumping Station would take too long.

Costs for this option range from $65,000 to $650,000 as shown below.

| Component | Low Range | High Range |
|---|---|---|
| Temporary Pumping and Power at abandoned Mechums River Pumping Station site – 3 months | $60,000 | $75,000 |
| Temporary Piping at Dams | $5,000 | $5,000 |
| Temporary Piping at Beaver Creek to abandoned Mechums River Pumping Station | $0 | $570,000 |
| **Total** | **$65,000** | **$650,000** |

Since time is of the essence, we recommend implementing the "Low Range" components immediately, and starting the controlled releases from Beaver Creek Reservoir to the Mechums River. If there is an unacceptable loss en route to the temporary Mechums River Pumping Station, terminate the release at Beaver Creek Reservoir, continue releasing from Lake Albemarle, and install approximately 2.7 miles of temporary piping to Beaver Creek Reservoir.

South Fork Rivanna Reservoir "Heel"

When the water level in the South Fork Rivanna and Sugar Hollow Reservoirs drops below the lowest gate on the intake structure, the water supply storage will be at "zero". When this condition occurs, there will be a pool or "heel" of water present in the South Fork Rivanna Reservoir and the Sugar Hollow Reservoir. The heel of the South Fork Rivanna Reservoir contains approximately 350 MG. The water will not be available from the existing water intake structure and it will clearly be poor quality water. In the case of Sugar Hollow Reservoir, RWSA has estimated that there will be a pool of about 50 to 70 million gallons of water remaining at the "zero" intake level. In the case of Sugar Hollow Reservoir, it was decided that extracting the small volume of storage remaining in the heel would not be worthwhile. The Ragged Mountain Reservoirs will be empty.

There are several possible methods for extracting the remaining heel of water into the South Fork Rivanna Reservoir intake, including:

- Floating barges with pumps which could pump to the intake structure.
- Placing pumps along the shoreline and relocating as needed to account for water level fluctuations.
- Placing the pumps on a rail perpendicular to the shoreline for ease of relocating pumps.
- Pumping from the hydro tunnel to the intake.
- Hanging submersible pumps from the dam structure.

While any of these approaches could be workable, the first approach is favored, as it allows the pumps to be readily moved to best position them over the heel, and would "automatically" move up and down with the water level changes. In our review of the raw water pumps, we noted that the elevation of the pumps is several feet higher than expected, meaning that the existing intake cannot draw the reservoir as far down as expected (i.e., the bottom intake port at 367 feet). As a result, the above temporary pumping arrangement should be in place when the pool is several feet above the bottom intake port.

Treating the residual water at the South Fork Rivanna WTP will need to be addressed due to its anticipated poor quality. Based on our limited review, it appears that the South Fork Rivanna WTP has appropriate treatment processes and chemical feed systems to reasonably treat this water. When the pool draws down nearer the heel, we suggest collecting samples for some bench tests. It may be desirable to reactivate the aeration system near the South Fork Rivanna Reservoir intake to refresh the water prior to treatment.

It is recommended that this option (use of the heel) be exercised only after more promising options described below are implemented. The cost for implementing this option is roughly $150,000 which includes the cost renting and operating pumps, piping, and floating barges for 3 or 4 months.

Indirect Reuse of Wastewater Treatment Plant Effluent – Pumpback to Mechums River

The Moore's Creek Advanced Treatment Plant produces a high-quality effluent. The Rivanna Water & Sewer Authority is currently expanding the reuse of this water with the City and at RWSA facilities. In a

Doomsday Crisis, RWSA could offset the use of potable water at hospitals and emergency facilities by using treated effluent for cooling or other non-contact purposes. However, the long lead-time and the potential reduction in water use make this option non-viable under the current Doomsday Crisis.

An option also exists to pipe the treated effluent to the Ragged Mountain Reservoirs or the South Fork Rivanna Reservoir by piping the treated effluent down the median of I-64. The most likely discharge point would be to Mechums River, requiring about 12.5 miles of piping. This option would augment water available for withdrawal at the South Fork Rivanna Reservoir Intake which is located approximately 8 miles downstream. It is believed that the State Health Department would not approve the direct reuse of this wastewater but in a crisis (and as a last resort) would allow RWSA to use it after it flowed through the natural purification process of the stream and reservoir system. The costs and logistics of this option would be considerable. However, temporary quick coupling pipe, placed above ground, and hung from the bridges, could make this a viable option. The impacts on the water supplies downstream of Charlottesville also need to be considered. Specifically, RWSA may be required to discharge some effluent to Moore's Creek, since that water essentially is the source of potable supplies for downstream users during extremely dry conditions. This is not considered to be a desirable option until more promising alternatives are exhausted. It is however, the ultimate "last resort".

Indirect Reuse of Wastewater Treatment Plant Effluent – Rivanna River Withdrawal

Mobile water treatment plants can be rented and installed at water supply locations such as the Rivanna River. The main drawback is that they have limited treatment capacity and flow in the Rivanna River is currently very low. However, it may be possible to withdraw water about 5 miles downstream of the Moore's Creek WWTP, near the Village of Rivanna (Glenmore), and use the existing 16-inch transmission main in reverse to push up to about 5 mgd back into the Urban Service Area. This is a variation of indirect reuse, and given the high concentration of wastewater effluent in the river at that location under current flow conditions, should employ a high-end water treatment process such as membranes. Temporary piping will be required to connect to the existing 16-inch water main. Sandbagging of the river would be required to create a temporary suction pool.

This option is considered less desirable than the pumpback to Mechums River because the Mechums River Pumpback:

- has a longer run of natural stream purification,
- allows mixing with South Fork Rivanna River Reservoir water prior to treatment,
- uses the existing South Fork Rivanna WTP which is fully instrumented and manned and has a well established operating record,
- would not require a new intake or impoundment structure,
- would probably be less costly.

Based on these factors, the Rivanna River withdrawal option is screened from further consideration.

Withdraw Water from the James River

An option exists to withdraw water from the James River in a Doomsday Crisis. The logistics and the cost for pumping and piping water approximately 29 miles would be considerable. However, temporary piping would be proposed under this option to get the system on-line more quickly compared to permanent piping.

It is recommended that the James River Withdrawal option be exercised only after more promising options are implemented. The cost for implementing this option is roughly $18 million.

**Emergency Water Supply Alternatives Eliminated from Further Investigation**

Interconnections with Other Water Suppliers
The water supplier in the region worthy of consideration for an interconnection is the Rapidan Service Authority which serves Greene, Orange and Madison Counties to the north and east of Charlottesville. Interconnecting with the Rapidan Service Authority would require constructing temporary piping to the north along Route 29 to the Ruckersville area. The length of the pipeline is approximately 3.5 miles. This is not considered to be a viable option due to the shortage of water supplies in the region.

Transport of Water to the Reservoirs from Sources Outside RWSA
An option exists to withdraw water from the James River and transport the water to the Rivanna Water & Sewer Authority's reservoirs. It would not be feasible to do this with tanker trucks. However, while it would be challenging, an option exists to transport the water in rail tanker cars that have greater capacity and do not travel on area roads. This approach would require extensive coordination with CSX rail personnel. It appears that based on rail service logistics as well as refill and unload times for the rail tankers this is not a viable option.

Supplemental Groundwater
Ground water levels in the Charlottesville region are falling. However, it is possible that the deep groundwater has not yet suffered to the degree of the upper aquifers. Area geologists believe that productive aquifers can be identified and can be used to supplement water supplies in the reservoirs or used as a finished water supply.

This is not considered to be a viable option due to the lack of actual production data from these deep aquifers.

Cloud Seeding
One Colorado community is investing $700,000 to seed clouds to induce rainfall or snow. This is an option that RWSA does not favor.

**Recommended Emergency Water Supply Plan**

The timing for the use of the supplies included in the Recommended Emergency Water Supply Plan is shown in Figures 1 and 2 at the 7 mgd and 5 mgd demand levels, respectively. Figure 3 shows the options included in the Recommended Emergency Water Supply Plan. The plan for utilizing the available supplies is summarized below:

- Remaining storage in the existing reservoirs from October 2002 through August 2003.
- 300 MG from Chris Greene Lake from October 2002 through April 2003.
- 150 MG from Lake Albemarle from January 2003 through April 2003.
- 200 MG from Beaver Creek Reservoir from January 2003 through April 2003 at the 7 mgd demand level or July 2003 at the 5 mgd demand level.
- 350 MG from South Fork Rivanna Reservoir heel in June 2003 at the 7 mgd level and August 2003 at the 5 mgd level.

This approach uses the best quality water at the lowest expenditure first and defers use of the heel of the South Fork Rivanna Reservoir until June or August 2003 – well after potential Spring storms events which could refill the reservoir system.

**Project Schedule**

A preliminary implementation schedule is attached. Based on the information available at this time, the major elements of the implementation schedule include:

- Chris Greene Lake should be initiated at the reduced level (1 mgd) as soon as possible and continue through the end of October at which point the North Fork WTP improvements are expected to be complete and the production can be increased to 2 mgd.
- Approvals, designs and improvements should be undertaken immediately for Lake Albemarle, Beaver Creek Reservoir, and the temporary Mechums River Pumping Station in order to initiate withdrawals from these supplies by January 2003. If temporary piping from Beaver Creek Reservoir to the temporary Mechums River Pumping Station is deemed necessary, the withdrawals from Beaver Creek Reservoir should be initiated in February 2003.
- Design of pumping facilities and development of an implementation plan for removal of the heel from South Fork Rivanna Reservoir should be initiated immediately. The pumping and associated facilities should be procured in mid-December allowing adequate time for testing prior to initiation in Spring.

We trust that this study meets the immediate needs of RWSA. Please feel free to contact Thomas Dumm or myself if you have any questions regarding this letter report.

Very Truly Yours,

O'BRIEN & GERE ENGINEERS, INC.

George B. Rest, P.E.
Senior Vice President

Attachments
Project Implementation Schedule
Figure 1: RWSA Emergency Water Supply Plan - Demand/Supply Source vs. Time (7 MGD System Demand)
Figure 2: RWSA Emergency Water Supply Plan - Demand Supply Source vs. Time (5 MGD System Demand)
Figure 3: Recommended Plan

cc: Thomas Dumm (OBG)