Memorandum

To: *Project Staff*

From: *David Mason, P.E.*

Date: *April 30, 2011*

Subject: *Feasibility Study for Stormwater Reuse and/or "Rainwater Harvesting"*

Historically, Tennessee has enjoyed access to an abundant supply of potable water. However, the drought of 2007 forced many communities to begin to consider a more sustainable approach to using water resources. For example, the City of Franklin's Sustainable Community Action Plan of 2009 identifies the following action/goal:

> *Reduce potable water usage within the Franklin City Limits by 25 percent May through October and by 10 percent during the remaining months by 2014.*

Traditional water conservation measures have been implemented by the City to move toward this goal, such as the City's Water Hog public education program. The City's Sustainability Commission has also considered such concepts as an Irrigation Ordinance to reduce potable water demand. In conjunction with these initiatives, the Franklin Integrated Water Resource Plan (IWRP) also considers the role of sustainable stormwater management as an additional component to reduce reliance on potable water. The effective management of stormwater can provide multiple benefits to the City in terms of reduced demand for potable water and improved water quality through stormwater reuse or rainwater harvesting.

Rainwater harvesting includes the collection of rainwater from impervious surfaces and storing for later use. While this concept is still not widely employed throughout the country, many communities with more frequent water availability issues have re-assessed the role that rainwater harvesting can play for water supply planning. Rainwater reuse offers a number of benefits:

- Provides inexpensive supply of water;
- Augments drinking water supplies;
- Reduces stormwater runoff and pollution;

- Reduces erosion in urban environments;
- Provides water that needs little treatment for irrigation or non-potable indoor uses;
- Helps reduce peak summer demands; and
- Helps introduce demand management for drinking water systems.

Each of these benefits aligns closely with the issues being considered for the IWRP. Thus, the following sections quantify the potential benefits that may be achieved through the implementation of rainwater harvesting projects in the City.

Rainwater Harvesting Use

Society currently uses potable water to meet nearly every demand, particularly for domestic uses. This trend is similar for commercial water use. However, studies have shown that almost 80% of demand is often being utilized for end use that could be satisfied with lesser quality water. Rainwater harvesting offers an alternative water supply that can more appropriately match water use to the quality of water supplied.

The most common application of rainwater harvesting is the capture of runoff from rooftops. While rooftops do contain pollutants, testing has shown that those pollutants are generally in lower concentrations and absent of many toxins when compared to other sources of runoff. Therefore, rooftop runoff may be diverted to cisterns or rain barrels to capture and store the runoff for other uses, such as outdoor irrigation and/or indoor, non-potable plumbing (toilets, etc.).

Potential Water Demand Reduction

Depending on the policies or programs put in place by the City, there may be several possible avenues to pursue water demand reduction through the use or requirement of rainwater harvesting. Typically, rainwater harvesting programs are most easily implemented at local government owned facilities. However, some communities choose to implement programs that require the use of rainwater harvesting on all new construction or that provide benefits for businesses/homes that retrofit existing developed sites to include rainwater harvesting.

In order to estimate potential water demand reduction, an estimate must be made of the potential surface area from which rainwater will be captured and the "efficiency" of that surface to convert rainfall to runoff that can ultimately be collected. Studies show that approximately 0.62 gallons per square foot of collection surface per inch of rainfall can be collected. In practice, however, some rainwater is lost to first flush, evaporation, splash-out or overshoot from the gutters in hard rains, and possibly leaks. Rough collection surfaces are less efficient at conveying water, as water captured in pore spaces tends to be lost to evaporation. For these reasons, inherent inefficiencies of the system need to be factored into

the water supply calculation. Most studies recommend an efficiency capture rate of approximately 85%.

The City of Franklin receives approximately 54.33 inches of rain annually. Using this rainfall, along with the efficiency and capture rates noted above, the following equation can be used to estimate the total catchment potential (in gallons) for a specific catchment area:

Catchment Potential (gals) = Catchment Area (ft^2) x Runoff Conversion (0.62) x Capture Efficiency (0.85) x Annual Rainfall (54.33 inches)

The following sub-sections summarize the potential water savings for various rainwater harvesting strategies.

City-Wide Rainwater Harvesting Potential

Using the City's GIS system, CDM estimated the total possible catchment area associated with rooftops in Franklin. Based on the most recent GIS data, approximately 84 million square feet of rooftop exists in the City. Using the equation from the previous section, 84 million square feet could generate approximately 2.4 billion gallons of water annually. If the City were able to achieve a 10 percent harvest rate for all rooftops, the City could reduce overall water demands in the City by approximately 240 million gallons annually (or 660,000 daily). The current water demand in the City is approximately 7.2 MGD. Therefore, harvesting water from only 10 percent of the rooftops in the City could result in a 9 percent reduction in daily water usage city-wide.

Municipal Rainwater Harvesting

While the potential for rainwater harvesting city-wide is significant, applying the concepts of rainwater harvesting to municipal buildings throughout the City is the easiest way for communities to realize water demand reductions. For example, the City has already implemented this strategy for the Police Station, where rainwater is captured for irrigation and toilet flushing to reduce demand on the drinking water system. This strategy not only provides the benefit of reduced water use, but it also provides a model of stewardship to the community.

CDM has estimated the potential for water savings from a municipally-focused rainwater harvesting program. As an example, the City could establish a long-term goal of retrofitting all existing municipal facilities to include rainwater harvesting practices. Using the City's GIS information, CDM extracted data related to the total square footage of rooftop on all City-owned properties. Based on the evaluation of 100 City-owned properties, CDM estimated a total rooftop area of approximately 1.71 million square feet. This area represents the total potential rainfall catchment surface area. Applying the equation noted above, the estimated water available for harvesting is approximately 49 million gallons annually. If the City were

to pursue an aggressive retrofit program (retrofit 100% of all City-owned facilities), the City may achieve an average day water demand reduction of approximately two percent.

Neighborhood/Watershed-Scale Rainwater Harvesting

Many Cities throughout the country encourage rainwater harvesting at the neighborhood or watershed scale through incentive programs. For example, the City of Austin, TX purchases rainbarrels in bulk and sells the rainbarrels to citizens at a $20 savings per barrel. Other cities simply offer rain barrels free to interested citizens through neighborhood/watershed scale pilot programs. In order to estimate the potential water savings from one of these strategies, CDM selected a neighborhood in Franklin to use as a demonstration.

The Chestnut Bend subdivision off Hillsboro Road includes approximately 185 homes with a total square footage of rooftop of approximately 600,000 square feet. Studies of rainbarrel programs in other portions of the country have shown that communities may achieve a 40% participation rate. Also, due to residential roof configuration, a typical capture rate for residential homes is approximately 60 percent. Applying the same formula as above, the potential stormwater capture rate for the Chestnut Bend subdivision is approximately 4.8 million gallons annually. Assuming two rainbarrels per home at a cost of $150 per barrel, the cost for this neighborhood-scale example is approximately $22,000.

Commercial Rainwater Harvesting

The same principles of residential and municipal rainwater harvesting may also be applied to commercial areas in Franklin. For example, the Galleria Mall has a rooftop square footage of approximately 700,000 square feet. Using the equations above, the estimated annual rainwater capture for the mall is approximately 20 million gallons.

Conclusions and Recommendations

Rainwater harvesting holds the potential to conserve on-site potable water use, protect surface water quality, and reduce the risk of flooding within the City. Examination of the local rainfall records reveals an average annual rainfall amount of 54.33 inches and conditions are relatively constant throughout the year. Therefore, systems need not be designed to address large fluctuations in demands and availability.

Results from the four scenarios above indicate a significant amount of rainfall available for capture and reuse. However, there is a significant cost for implementation of these systems, which may cause this strategy to be cost prohibitive at current, relatively low water rates. An opportunity does exist for the City to implement projects on City property to capture and reuse stormwater runoff, which can serve as demonstration projects for other businesses/industries to consider and also serve as a public education component for the citizens.