POLICY OPTIONS FOR FINANCING DRINKING WATER INFRASTRUCTURE IN THE UNITED STATES

by

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ABSTRACT

Aging drinking water infrastructure in the United States is due to be replaced, with cost estimates ranging from $335 billion to more than $1 trillion over the next twenty years. Most of the financial capital will likely come from drinking water utility revenues, but there may be a role for the federal government to support infrastructure projects. Currently, the Drinking Water State Revolving Fund serves this purpose through state grants. This paper examines the current program using a regression analysis to determine which factors dictate a successful reduction in the needs of states for drinking water infrastructure. Results indicate that government funding is useful, but needs are influenced by many other demographic variables as well. A policy analysis, incorporating both quantitative and qualitative measures, compares the status quo option with two other federal policy alternatives: expanding the current program and adopting a proposed Water Infrastructure Finance and Innovation Act that would provide Treasury-backed loans directly to water utilities. Based on the policy analysis, the WIFIA proposal is the most favorable approach for the federal government. However, utility revenue will still play a large role, so water bills will assuredly increase over the coming years. The recommendation from this paper is a mix of adopting WIFIA along with other measures to soften the blow of higher water bills across the U.S., as well as further research that could examine specific case studies at the utility level.
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I. Introduction

On a frigid morning in late December, more than a dozen people were commuting to work in Bethesda, MD when they suddenly found themselves trapped by a cascade of water. 135 million gallons per minute spewed forth from a 66-inch water main pipe that had burst, flooding the roadways and trapping the commuters in their cars. Helicopter teams were dispatched and, luckily, everyone was rescued (Associated Press, 2008).

Reliable and convenient access to safe, clean drinking water is considered to be a matter of fact in the United States. Americans enjoyed unprecedented levels of economic growth and prosperity over the 20th century, in no small part due to the water distribution systems developed to fuel industry, agriculture, businesses, and general day-to-day life. Pipelines, water treatment plants, reservoirs, and other engineering feats serve as the backbone of life in the United States. Often unseen, our drinking water systems provide the sustenance for both our economy and our lives.

But, as with any artificial system, there is a finite lifetime before replacement is necessary. Many of the grand, complex water systems of the 20th century are all due to be replaced over the next 20 to 30 years (AWWA, 2009). The pipe that burst in Bethesda was more than 40 years old, and was just one of more than a thousand water main breaks that the local utility dealt with that year. At the same time, changing demographic patterns are altering the population distribution of the country. The EPA continuously develops and enhances regulations in order to provide safe drinking water, especially as new scientific studies further our understanding of the potentially dangerous effects of various pollutants. The combination
of infrastructure replacement, population growth, and safer regulations creates a situation that necessitates building newer, more advanced, and in some cases larger drinking water treatment and distribution systems as we thrive in the 21st century.

Traditionally, drinking water infrastructure investments have been largely financed by local water sale revenues and private market debt (US EPA, 2009b), with about 20% of capital funding coming from the federal government. However, current funding mechanisms to generate the financial capital to repair and replace our infrastructure systems are insufficient. According to the most recent Drinking Water Infrastructure Needs Survey and Assessment report released by the EPA in 2009, the gap between actual funding levels and those that are needed to provide adequate infrastructure amount to at least $334.8 billion through 2026 (US EPA, 2009a). Other assessments have cited figures ranging from a gap of $11 billion per year (ASCE, 2009) up to $1 trillion total through 2035 (AWWA, 2009).

Government often steps in when the private market cannot fulfill a required purpose. But due to federal budget cuts, many of the federal sources of financial capital are no longer viable, especially for larger systems that must rely more heavily on revenue and debt in the first place. To address the infrastructure gap, many experts agree that the water rates paid by customers will need to increase in order to keep up with the financial demands of providing this basic need. However, many people view water as a universal right because it is essential for life and should not be commoditized. As such, there will likely be significant resistance to driving up the costs of water bills to fully eliminate the infrastructure gap. With a limit on the capacity of rate increases, there is a need for some sort of government role to assist in the development of new drinking water infrastructure that is more effective than the current programs in place.
In order to adequately fund drinking water infrastructure in the coming years, it is time to reevaluate the federal policies in place. The primary source of financial capital from the federal government is the Drinking Water State Revolving Fund (US EPA, 2009b), which was established in 1996 and provides grants to states for funding various drinking water projects. In light of the shortcomings of the DWSRF, other policy options have been proposed via various Congressional bills, such as an investment bank that would provide credit assistance for large projects. None of the potential options for a new federal drinking water policy have gained much traction in any realm of the government, and there is no comprehensive analysis of the trade-offs among the policy options or the potential impacts beyond purely financial aspects.

The objective of this project is to compare federal policy options for financing drinking water infrastructure replacement and expansion in the context of a policy analysis, looking at both the financial ramifications of each policy as well as other, more qualitative impacts. This analysis relies largely on a qualitative analysis of various public policy criteria, as well as a regression analysis to determine if the state revolving fund grants actually lead to a statistically significant decrease in a state’s infrastructure gap. After analyzing the key differences and trade-offs among the different policy options, the paper concludes with a final recommendation for the most effective way to finance drinking water infrastructure at the federal level.

II. Background and Literature Review
The driving force behind the infrastructure gap is the age of water systems around the country. According to the EPA, the average lifespan of drinking water treatment plants is 20 to 50 years, and pipes can last anywhere from 15 to more than 100 years. A study released in 2000 found that the average age of the pipes in more than 20% of all water systems was over 40 years, and for those that serve over 100,000 people, almost 10% of the pipes are more than 80 years old (US EPA, n.d.). For example, in Washington, DC and Philadelphia, the average age of pipes are almost 80 years (Lichtman, 2012; Philadelphia Water Department, n.d.). An analysis by the American Water Works Association (AWWA) points out that, since pipes were constructed of different materials throughout American history, many pipelines are reaching the end of their useful lives at the same time regardless of when they were laid (AWWA, 2001).

Like any built system, it is not a surprise that there is a finite lifespan to the drinking water infrastructure currently in place. But what exacerbates the problem, and puts a strain on the financial resources available, is the convergence of replacement needs. In their “Buried No Longer” report, the American Water Works Association projected the annual financial capital needed for water infrastructure over a 50-year period and found that there was a dramatic increase as time progressed (AWWA, 2009). Many utilities are already behind schedule when it comes to replacing pipes. The average replacement cycle for infrastructure is about one half of one percent each year, which puts the average replacement cycle well over 100 years (Lichtman, 2012). Indeed, many cities are on 200 to 300 year replacement cycles, even though the average lifespan of the infrastructure is much less (Walton, 2013). The replacement shortfall has already begun to have serious repercussions. While the water main break in Bethesda was fairly dramatic (Associated Press, 2008), smaller events happen around the
country every day, adding up to 240,000 each year (ASCE, 2013; Kosik, 2011). If utilities continue to fall behind schedule, there will be a sizeable gap between what is spent on infrastructure replacement and what needs to be spent in order to maintain existing levels and quality of service. This is referred to in the literature as the infrastructure needs gap.

Several studies have attempted to capture an accurate estimate of the infrastructure needs gap, despite the obvious complexities involved. The EPA, American Water Works Association, and other organizations have pegged the gap to be anywhere from $11 billion annually to more than $1 trillion over 25 years. An analysis from the Mayors Water Council assumed an average gap of $500 billion based on the various studies (Anderson, 2010). It is essential to keep in mind that these estimates are only for drinking water infrastructure, and does not account for wastewater, storm water, and other water facilities. It is also independent of all other types of infrastructure, which are all facing funding shortfalls in the coming years. Not only is there not enough money for financing drinking water infrastructure, but the money available may have to deal with competing needs as well.

The benefits of maintaining and expanding drinking water infrastructure are mostly obvious. Water is an essential component of life that is used for basic necessities such as drinking, cooking, and sanitation. But aside from sustaining life, a reliable drinking water supply also sustains our livelihood. Practically all water systems in the U.S. are delivered from a centralized system that must be cleaned enough to meet drinking water standards created by the EPA to protect human health, even if the water is not used for human consumptive purposes. As such, drinking water is used to water our lawns and wash our cars. It is also an input for an enormous variety of consumer and industrial products and processes, from jeans to
paint to fertilizer. A Bureau of Economic Analysis report found that every $1 invested in water infrastructure leads to a growth of $2.62 in the private economy, while every job added to water industries corresponds to 3.68 jobs added to the overall national economy (AWWA, WEF, & AMWA, 2011; Krop et. al, 2008). The EPA is currently in the process of studying the importance of water to the U.S. economy in greater detail. Since drinking water systems are ultimately funneled into commercial, industrial, and institutional uses as well as domestic uses, water resources delivered from a water utility play a large role in driving different economic sectors (US EPA, 2012a). Their initial results highlight the complexities of doing so, especially because it is nearly impossible in some cases to truly measure how valuable water is due to the ubiquitous and necessary nature of it.

Improved infrastructure also avoids costs, some potentially damaging. From an economic standpoint, preventing the deterioration of water infrastructure may help certain businesses, such as beverage and semiconductor producers, avoid spending more money on developing a more reliable source of clean water. It also saves water that is currently lost to an old, leaking system. An estimated 7 billion gallons are lost to leaks every day, which adds up to roughly $2.6 billion lost every year (ASCE, 2009; Xylem, Inc., 2012).

Stable infrastructure also may help prevent widespread contamination of water resources and reduces the chance of waterborne disease outbreaks. Deteriorated infrastructure can lead to cross-contamination and backflow, which could introduce contaminants into distribution systems and lead to more widespread waterborne illnesses. These types of circumstances have been blamed for a salmonella outbreak in Colorado in 2008 (Kosik, 2011). To underscore the urgent nature, the Institute of Medicine cited investments in
renovating drinking water infrastructure as a “public health imperative.” (Beach et. al, 2009.) From economic and human health perspectives, it will be necessary to address aging drinking water infrastructure proactively rather than reactively.

In order to avoid the negative ramifications of deteriorating infrastructure and reap the benefits of an updated, expanded system, water utilities will need to secure additional funds to reduce the infrastructure needs gap. Currently, the primary federal source of funding for drinking water projects comes from the Drinking Water State Revolving Fund (DWSRF). However, in light of the need for increased financial capital, other proposals have been floated to provide more assistance. As recently as early 2013, a bill known as the Water Infrastructure Finance and Innovation Act was introduced in the Senate. Other programs have also been introduced in recent years that would attempt to secure more funding for drinking water projects. The different policy options are described in the following sections.

A. Drinking Water State Revolving Fund

The DWSRF was initially incorporated as part of the Safe Drinking Water Act amendments in 1996 (US EPA, 2000). Funding for the DWSRF provides each state with a grant based on infrastructure needs, as determined by EPA every four years from the Drinking Water Infrastructure Needs Survey and Assessment, at a minimum level of $1,000,000 annually. These needs only include projects that fall under DWSRF eligibility; for example, operation and maintenance costs as well as projects based on population growth are not accounted for in the
needs determination, despite a potentially large level of necessary funding for those projects (US EPA, 2009a).

The grant money can then be used to dole out financial assistance, often in the form of loans, to eligible drinking water programs and projects. It is a revolving fund because interest payments on the loans provide additional resources for future projects. About half of the states use leveraging to further increase the pool of money. All states, however, are required to provide a 20% match. DWSRF money is targeted towards smaller communities with fewer resources and can potentially be used by private entities. Since its implementation, the DWSRF has provided about $1 billion annually for drinking water projects around the country. Annual funding is based on the appropriations process in Congress. It also strikes a balance in power between federal and state agencies, since the money is appropriated by Congress and the EPA but distributed individually to each state to delegate to projects.

Despite the successes of the DWSRF program, there are still limitations to its efficacy. As a federal grant program, the amount of funding appropriated each year is subject to Congressional approval. In recent years, the drive to address the federal deficit through spending cuts has resulted in decreased levels of spending across the board, including in the DWSRF program and its partner Clean Water State Revolving Fund under the Clean Water Act (Copeland et. al, 2012; Walton, 2012c). Even without budget cuts, the current appropriation levels fall far below the levels that would eliminate the infrastructure gap. Therefore, a potential policy option is strengthening the DWSRF by appropriating more funding to the program, ultimately providing more funding for drinking water infrastructure projects around
the country. The implications and consequences of doing so are included in the policy analysis section.

B. Water Infrastructure Finance and Innovation Act

One of the more prominent proposals in Congress is to develop a water infrastructure lending entity that would be called the Water Infrastructure Finance and Innovation Act. The WIFIA proposal is based off of a similar mechanism used to finance transportation infrastructure projects, and has been pushed by groups such as the American Water Works Association and Water Environment Federation.

WIFIA would be designed to provide financial capital for drinking water projects at a low or negligible cost to the federal government. This would primarily be accomplished through the form of credit assistance, such as low-interest loans, that would help water utilities secure funding at a lower cost than on their own. WIFIA would use funding from the US Treasury to provide credit assistance either by directly funneling that money to water utilities or by sending it to the DWSRF program to be used for leveraging. There is also the potential for a water infrastructure bank to issue tax-exempt bonds, but this would require some sort of legislative exemption (Gomez, 2013). Interest generated from the credit assistance would be sent back to WIFIA, which would then send back both the principal and interest to the US Treasury. Since the money is repaid, ideally there would be no cost to the federal government. Default rates among water bonds are historically very low, at about 0.04% (AWWA, WEF, & AMWA, 2011), so the interest generated may even represent a net surplus to the federal budget.
This program would theoretically benefit water utilities because the loans come with a long term Treasury rate below the typical interest rate that water utilities can obtain from the municipal bond market. In an example provided by proponents of WIFIA, a water utility seeking to fund a $100 million project over 30 years would save more than $1 million annual by financing the project at a lower interest rate through WIFIA rather than on its own. (AWWA, WEF, & AMWA, 2011). Projects that do not receive financial support from the DWSRF could still benefit from a federal-level program like this, as it would ultimately reduce the repayment costs on loans secured for water infrastructure projects. The TIFIA program that it is modeled after has a ten-to-one leverage ratio, meaning that $1 of Treasury-backed loans would support about $10 in credit assistance. Given the low default rate among water projects, the AWWA and its partner organizations expect the leverage ratio under WIFIA to be even higher (AWWA, WEF, & AMWA, 2011).

C. Status Quo: Full-Cost Pricing

Under the status quo option, no more additional funding from the federal government would be made available to finance drinking water infrastructure. Given the size of the infrastructure gap, it is very likely that under this scenario, some other prospect for funding aside from federal programs would ultimately surface.

An important consideration is what levels of water rate increases are realistic and plausible. Xylem Inc. recently released a Value of Water Index that included an attempt at answering this question. They estimate that the average American would be willing to pay
$7.70 more per month on water bills for system upgrades (Xylem, Inc., 2012). On an annual basis, and with the 272,000,000 water customers as estimated by the EPA (US EPA, 2009b), this would translate into over $25 billion available each year for water system upgrades beyond current levels. Based on at least some estimates, this additional revenue would be more than enough to pay for new drinking water infrastructure needs.

Water rates are already increasing around the country. A survey by USA Today found that the water rates have doubled since 2000 in a quarter of the cities included in the survey (McCoy, 2012), and a similar analysis by Circle of Blue determined that water rates have increased by an average of 18% over the past few years in many large cities (Walton, 2012b). One of the primary drivers behind rising water rates is due to the pressing need to replace and expand water infrastructure (Hiltzik, 2012). Increasing rates is usually a controversial process, but necessary to provide the appropriate revenue to adequately repair systems, rather than temporarily patch them (Walton, 2012a). As aging infrastructure becomes a more prominent issue in the coming years (AWWA, 2012), higher water rates will become more of a reality across the country. The question for policy developers is not if, but by how much, will water rates increase.

While there may be other options available on a local basis, such as a recent infrastructure grant provided to Chicago by the state of Illinois for drinking water projects (Ali, 2013), the options are more limited at the federal level. Currently, these three policies—increasing DWSRF funding, creating a credit-assistance authority under WIFIA, and letting local water rates increase to reflect full-cost pricing—appear to be the most realistic federal options
for financing drinking water infrastructure. To determine which is the most effective policy to pursue, the next section includes a policy analysis comparing different criteria, both quantitative and qualitative.

III. Regression Analysis of Drinking Water State Revolving Fund

Every four years, EPA releases a new assessment of drinking water infrastructure needs in its Drinking Water Infrastructure Needs Survey and Assessment. As of early 2013, the most recent analysis was released in 2009 and featured data from 2007; the previous iteration from 2005 included data from 2003. One way to determine the efficacy of the DWSRF program in addressing infrastructure needs is through a multiple linear regression analysis of the changes in infrastructure needs for each state as measured in 2003 and 2007 on relevant variables, including funding through the DWSRF.

A. Variables and Data Sources

Table 1 provides a list of the response and explanatory variables included in the regression analysis, as well as the units, source, and expected sign of the estimated coefficients.

B. Hypotheses

<table>
<thead>
<tr>
<th>Variable</th>
<th>Label</th>
<th>Units</th>
<th>Source</th>
<th>Expected Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log of Total DWSRF Funding 2003-2007</td>
<td>logtot_0307</td>
<td>Dollars per capita</td>
<td>US EPA, 2010</td>
<td>Negative</td>
</tr>
<tr>
<td>Real GDP in 2007</td>
<td>rgdp_2007</td>
<td>2007 dollars per capita</td>
<td>State Science and Technology Institute, 2008</td>
<td>Negative</td>
</tr>
<tr>
<td>GDP Percent Change 2003 to 2007</td>
<td>gdp_pctchg</td>
<td>Percent</td>
<td>State Science and Technology Institute, 2008</td>
<td>Negative</td>
</tr>
<tr>
<td>GOP Control of State Government</td>
<td>gop_state</td>
<td>Binary</td>
<td>POLIDATA, 2006</td>
<td>Positive</td>
</tr>
<tr>
<td>Geographical Location</td>
<td>southwest and other</td>
<td>Binary</td>
<td>AWWA, 2012</td>
<td>Positive</td>
</tr>
<tr>
<td>Percent of Population in Urban Areas</td>
<td>poppcnt_urban</td>
<td>Percent</td>
<td>US Census Bureau, 2012</td>
<td>Unsure</td>
</tr>
<tr>
<td>Leveraging of DWSRF Funds</td>
<td>leverage</td>
<td>Binary</td>
<td>US EPA, 2010</td>
<td>Negative</td>
</tr>
<tr>
<td>State and Local Government Spending on Water</td>
<td>govt_exp_water_07</td>
<td>Thousands of 2007 dollars per capita</td>
<td>US Census Bureau, 2011</td>
<td>Negative</td>
</tr>
</tbody>
</table>
developed by EPA every four years. The most recent reports were released in 2009 and 2005, and are based on 2007 and 2003 data. The reported needs gap from each state was converted to a per capita measure using the average state population based on 2000 and 2010 census data. The difference between these two measures is the response variable for this regression. This can serve as a proxy estimate of the needs gap, as states with larger overall needs are also likely to have a larger gap between the needs and the amount actually spent on water projects. Since the measure is only of needs, and does not incorporate current spending, it is possible that the needs estimates do not accurately reflect the needs gap, since a state with large needs may just spend a large amount of money to fully fund those needs. A pairwise correlation between the needs estimates and actual spending levels, as denoted by log_water, indicates that there is a slightly positive but insignificant correlation between these two parameters. The insignificant correlation means that the needs estimates are not associated with spending levels, so it should be able to serve as a proxy for the needs gap without incorporating any spending behavior.

Log of Total DWSRF Funding 2003-2007 (logtot_0307): The log transformation of the total sum of money appropriated to each state under the DWSRF for 2003 through 2007. This information is listed on the EPA’s website via the DWSRF National Information Management System (US EPA, 2010). I hypothesize that states receiving more money under DWSRF would have more funding to develop water infrastructure projects, so this coefficient is expected to have a negative sign, controlling for other variables.
Percent Population Change 2000-2010 (pct_popchg): The percent population change from 2000 to 2010 based on US Census data (US Census Bureau, 2010 & 2000). A faster growing state would be projected to have a greater need for developing water infrastructure projects in the future, so this coefficient is expected to have a positive sign, holding all else constant.

Real GDP in 2007 (rgdp_2007): Real GDP per capita in 2007, based on data from the Bureau of Economic Analysis (State Science and Technology Institute, 2008). States with stronger economies would be more likely to have funding available for infrastructure projects, so this coefficient is expected to have a negative sign, holding all else constant.

GDP Percent Change 2003-2007 (gdp_pctchg): Percent change in real GDP from 2003 to 2007, based on data from the Bureau of Economic Analysis (State Science and Technology Institute, 2008). Similar to rgdp_2007, states with a faster growing economy would be expected to have more resources for funding infrastructure projects, so this coefficient is also expected to have a negative sign, controlling for other variables.

Percent of State Vote for Bush in 2004 Election (bush_2004): Percent of the vote George W. Bush received in the 2004 Presidential election (Federal Election Commission, 2005). This variable serves as a proxy for political ideology of the state. More conservative states may not be as willing to embrace government funding of drinking water infrastructure, which could drive up the costs that will need to be paid at some point down the road. These states are also
likely to vote for a Republican President, so the expected sign for this coefficient is positive, holding all else constant.

GOP Control of State Government \((gop\_state)\): This variable also serves as a political proxy and controls for which party dominates the state level of government. Out of the governor’s office, state senate, and state house (or relevant alternatives), if the GOP controlled more than one after the 2004 elections, \(gop\_state\) takes on a value of one; if not, zero. Note that since Nebraska has a unicameral, nonpartisan legislature, the governor’s office was the sole factor. Two other states—Iowa and Montana—had split control in one house, so the majority party in the other house was used as the deciding factor. A summary of this information was available from POLIDATA (2006). Similar to \(bush\_2004\), this coefficient is expected to have a positive sign, holding all else constant, because states that are controlled by the GOP may be less likely to accept federal funding, thus limiting the number of sources available to fund drinking water infrastructure projects.

Geographical Location \((southwest\ and\ other)\): According to the Buried No Longer report, the South and West regions of the states are expected to face the greatest financial needs for replacing and expanding drinking water infrastructure in the coming years (AWWA, 2012). Based on the report, southwest takes on a value of one for states that are located in the South and West, and other takes on a value of one for states located in the Northeast and Midwest. The expected sign for southwest is positive, since those states are expected to need to pay
more in the future to account for projected population growth and emigration from the Northeast and Midwest regions.

Percent of Population in Urban Areas (*poppct_urban*): The percent of a state’s population living in urban areas, based on data from the US Census Bureau (2012). If the urban areas are dominated by older cities, such as those in the Northeast with infrastructure almost 100 years old, then the expected sign for this variable is positive. However, if the urban areas are newer and serve as alternatives to sprawling suburban areas, then the expected sign is negative. In order to try and account for the age of infrastructure, an interaction term between *poppct_urban* and southwest was introduced. If a state with large cities is not located in the southwest, it is likely to be an older city in the Midwest or Northeast, such as Philadelphia or Chicago, that has a large need for replacing old infrastructure. Thus, the interaction term is expected to have a negative sign.

Leveraging of DWSRF Funds (*leverage*): States that leverage DWSRF money on the bond market take on a value of one. Since leveraging generates more money in the long run for infrastructure projects, this coefficient is expected to have a negative sign, holding all else constant. This variable was constructed based on leveraging data available from the DWSRF National Information Management System (US EPA, 2010).

State and Local Government Spending on Water (*govt_exp_water_07*): Per capita state and local government spending on water supply through utilities, in thousands of 2007 dollars (US
Census Bureau, 2011). States that spend more money on water supply are more likely to be spending money on drinking water infrastructure projects, so the coefficient on this variable is expected to have a negative sign, holding all else constant.

C. Regression Analysis and Conclusions

Based on an initial regression analysis including all variables, several parameters were dropped from the final regression analysis. Both southwest and leverage were found to have no significant impact on the results. Neither bush_2004 nor gop_state were significant either, but gop_state was left in the final regression to ensure that state politics was not omitted from the analysis.

Additionally, an analysis of the residuals and fitted values of the regression revealed that the observation for Washington, DC was somewhat of an outlier compared to the other observations. Given that the nature of DC may indeed make it inherently different from the fifty states, a final regression was run both including and excluding DC. Results for the final regressions are listed below in Table 2. Significance of each variable is indicated next the coefficient. The mean VIF score for this model is 1.90.

Other than the significance of real GDP, there does not appear to be any large differences between the two regression analyses. Funding levels under the DWSRF is significant and negative in both cases, which lends credence to the argument that more funding through the revolving fund program does indeed reduce the needs gap over time.

However, every other variable in this analysis besides gop_state is also significant,
Table 2. Regression Results for Models Including and Excluding Washington, DC.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model Including DC</th>
<th>Model Excluding DC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Robust SE</td>
</tr>
<tr>
<td>log_tot0307</td>
<td>-261.3**</td>
<td>119.4</td>
</tr>
<tr>
<td>pctpop_change</td>
<td>-2314.4***</td>
<td>901.9</td>
</tr>
<tr>
<td>rgdp_2007</td>
<td>0.0173***</td>
<td>0.0041</td>
</tr>
<tr>
<td>poppct_urban</td>
<td>-20.42***</td>
<td>5.287</td>
</tr>
<tr>
<td>gdp_pctchg</td>
<td>26.34**</td>
<td>10.22</td>
</tr>
<tr>
<td>govt_exp_water_07</td>
<td>5493.9***</td>
<td>1920.1</td>
</tr>
<tr>
<td>gop_state</td>
<td>168.6</td>
<td>114.0</td>
</tr>
<tr>
<td>_cons</td>
<td>1005.1**</td>
<td>404.5</td>
</tr>
</tbody>
</table>

Number of Observations 37 36
R-squared 0.5252 0.3982
Prob > F 0.0000 0.0003

***, **, and * denote significance at 1%, 5%, and 10% levels, respectively.

meaning that there are many other parameters than can have a bearing on the infrastructure needs gap. Factors that appear to increase the needs gap are real GDP per capita and percent change in GDP per capita, which is opposite of the original hypothesis. It may instead be that larger economies are spending money on resources besides water infrastructure projects. Curiously, higher government spending on water supply is also associated with an increased needs gap, holding all else constant. It may be that states with larger needs are already devoting more resources to the problem. This could be the case in places like Washington, DC, which has the highest per capita increase in the needs gap and already devotes a large amount of resources to replacing water infrastructure (Lichtman, 2012).

In addition to DWSRF funding levels, a larger percent population change and percent of population in urban areas are also associated with a decrease in the needs gap. Combining these two population parameters may be indicative of reurbanization in America as the population moves from suburbs back into cities (Farrar, 2008). Increased growth in major
metropolitan areas would increase both of these parameters while potentially reducing the needs gap since a smaller system is needed in a more densely populated area. Future studies could delineate the needs gap related to replacement compared to expansion and how the results of this analysis might be affected.

Federal funding through the DWSRF program is clearly one way to finance drinking water infrastructure projects and has a statistically significant impact on reducing the needs gap state will face in the coming years. However, other parameters have a significant bearing on the needs gap, such as demographic shifts in the U.S. population and the degree of urbanization. The DWSRF program is just one piece of the puzzle and current funding levels may not be enough to provide the necessary support to rebuild our water infrastructure. Potential policy options to further the financial support available for water utilities are examined in the next section.

IV. Policy Analysis

As indicated by many water industry professionals, there is an urgent need for a new and more effective source of financing drinking water infrastructure projects in the coming years. The DWSRF program is already in place, and as demonstrated in the previous section, it appears to have a significant impact on reducing the needs gap faced by individual states. However, there are other parameters that significantly contribute one way or another to the needs gap, which could confound efforts to reduce the needs gap strictly through increased DWSRF funding. The legislative proposal currently receiving the most attention is the Water
Infrastructure Finance and Innovation Act (WIFIA). Some analyses on the financial merits of the program have been published, along with discussions about other advantages and shortcomings, but a robust examination of the tradeoffs of the program is absent from the literature. Alternatively, increased water rates have been floated as a perhaps unavoidable outcome (Maxwell, 2012). But, water has been cheap for so long in the United States, that it may be difficult to ascertain the ramifications of solely relying on this stream of revenue.

This section presents a policy analysis that compares these three alternatives for financing drinking water infrastructure. Two are federal policies—the DWSRF and WIFIA—while rate increases would be the likely outcome from pursuing the status quo of minimal federal involvement. The following subsections delve into further detail about the intended goals of drinking water finance policies and the associated criteria for evaluating policy options, followed by an analysis of how each of the three alternatives performs based on the criteria. Given that the needs survey is conducted on a twenty-year time horizon, each criteria measure is examined using the same timespan.

A. Goals

Prior to developing or evaluating any drinking water infrastructure policies, it is important to first determine what the goals of such a policy should be. This section delineates the four primary goals of financing drinking water infrastructure at the federal level, and sets up the basis for the rest of the policy analysis.
Generate a large amount of financial capital for drinking water projects: Perhaps the most obvious desired outcome of any drinking water infrastructure finance policy is to eliminate the needs gap, or at least reduce it as much as possible. The idea behind the needs gap is that the level of funding currently employed for infrastructure projects is far below the necessary levels of funding to maintain the current level of service quality. Since it may be hard to truly determine how much funding will be needed for that, the goal of an infrastructure finance policy should be to generate as much capital for infrastructure projects, in hopes that it will indeed allow for replacement and expansion projects to occur at the appropriate pace.

Avoid infrastructure failure: The intended outcome of these policies is to generate the necessary financial capital to fund drinking water infrastructure projects. But replacing infrastructure on a timely schedule, while also fully meeting the demands of growth expectations and planning for uncertainties like climate change, may be too tall of an order to satisfy completely. The problem is exacerbated by the fact that drinking water infrastructure is only one aspect of the nation’s infrastructure woes, which overall received a nearly failing grade from the American Society of Civil Engineers (2009, 2013). However, the inherent uncertainty built into the needs estimates, along with a fairly long time span of at least twenty years, means that it may not be entirely necessary to fully meet the projected needs. Rather, a more realistic goal for drinking water policy should be to generate enough financial capital to avoid infrastructure failure. Failure is not clearly defined; it could range from steady leaks all the way to catastrophic failures that lead to widespread water boil alerts or more dire safety concerns, such as the burst water main in Montgomery County (Associated Press, 2008).
Nonetheless, from a practical standpoint, it is more reasonable to institute a policy that at least avoids the most severe outcomes rather than any negative outcome, no matter the severity.

*Strive for equity:* Equity insures that no individual stakeholder benefits or loses disproportionately compared to the other stakeholders. For a federal policy, one option is to strike a balance between the federal and state funding and responsibilities. In the case of drinking water infrastructure, equity may also address how a policy will affect large utilities versus smaller utilities or stakeholders with different socioeconomic backgrounds.

*Limit costs to stakeholders:* In an era of budget concerns, the cost of a policy to the relevant stakeholders is one of the most important considerations. Governments, both federal and state, are just one category of stakeholders in the water infrastructure discussion. Water utility customers are also important stakeholders and likely to face increasing water bills to supply adequate revenue in the coming years (Walton, 2013). If the only purpose of these policies were to generate enough financial capital for infrastructure projects, the most direct solution would be to simply let water rates increase accordingly to generate the necessary revenue. However, raising water rates is a contentious process, and if doing so were more politically feasible, it is plausible that there wouldn’t be a looming infrastructure crisis. A disproportionate impact on low-income households and broader economic concerns, among others, are just two of the reasons why it is difficult to raise water rates, and are also two reasons why preventing water rates from becoming overwhelmingly expensive should be a priority for any water infrastructure policy.
B. Criteria

The four goals previously listed are the basis for evaluating the policy alternatives. However, these can each be broken down into specific criteria that allow for a more nuanced analysis. Many of the criteria are qualitative measures. While a quantitative value is often desirable, in some circumstances there is no numerical basis for comparing the different water infrastructure policies. However, a qualitative analysis of the differences among policy options can still help to further inform the process. In most cases, some sort of range, such as Low to High, is used as a basis for comparison. In order to avoid vague labels, a detailed explanation of the reasoning behind these categorical assignments is included. The projected outcomes are analyzed based on these criteria over a twenty-year timeframe, which is taken from the assessments conducted by EPA (2009a, 2005).

Cost to the federal government: Since this is an analysis of federal-level policies, the cost to the federal government is an important measure to consider, especially in the current political climate that is focused on government debt reduction (Calmes, 2013). Any policy that has been submitted to Congress is likely to have some sort of analysis of how much it would contribute to the federal deficit. This measure is one of the few quantitative measures in this analysis, and under some circumstances, may be one of the only criteria actually considered by the relevant stakeholders for implementation.
Cost to state and local governments: While technically a federal policy, the water infrastructure finance policies under consideration in this analysis have ramifications for state and local government spending as well. These are important for the same reasons as federal spending, especially in light of similar budget deficits at the state and local levels (Kurtzleben, 2011). Again, this is one of the few quantitative measures in this analysis. However, legislative options might only include a Congressional Budget Office analysis for the cost at the federal level, so more of the state and local costs may need to be inferred rather than directly estimated.

Impact on infrastructure needs gap: An important consideration is a measure of how much money a program can raise for drinking water infrastructure projects, and is essentially the sum of all costs paid under a given policy compared to the estimated needs.

Effect on water rates: At the end of the day, one of the primary concerns for any water infrastructure policy is how the customers will be affected. Any costs for water infrastructure not paid for by government institutions will need to be paid for by water utilities. Utilities would, in turn, pass the costs down to their customers through water rate increases. While there is no consensus on the issue, a measure of the effect on water rates is an important aspect to consider when implementing a water financing policy. Depending on the relative contributions from other funding sources, the necessary water rate increases could be large enough such that households notice the effect on their budget and must adjust accordingly. For some policies where there is a definite and tangible increase in rates, this may be easily
measured. In other cases, it may be a secondary effect that results from implementation of the policy, so the actual measurable outcomes are not as clearly determinable.

*Impact on low-income households:* Tied into the effect on water rates is a measure specifically of the potential effect on low-income households. If the policy in place requires households to contribute more money, low-income households will be forced to spend more of their budget on water bills relative to richer households. While it is not a standalone criterion, this consideration is an important subset of the effect on water rates that should be considered when designing an infrastructure finance policy.

*Equity between small and large water systems:* Due to differences in needs and the ability to raise revenue from a customer base, water finance policies are likely to affect small and large systems differently. Smaller utilities often have trouble paying for large infrastructure investments because they have a smaller customer based to distribute costs to and lack as much of an access to bond markets when compared to larger utilities (Gomez, 2013). This has been observed in the current DWSRF program. Ensuring equity between small and large systems is important to recruit as much support as possible from potential stakeholders.

*Equity among states:* A federal policy might affect states differently depending on various factors, such as state budgets and political leadership. This is especially the case for funding issues, since the appropriations process may be subject to political pressure from members of Congress that could direct a disproportionate amount of funding to a specific state. The fairness
of a policy among states is a qualitative measure, but due to the political ramifications, could help or hinder its likelihood of becoming law.

_**Political feasibility:**_ A qualitative measure of the political feasibility is crucial for any policy analysis. Even the most professionally crafted policy has no hope of implementation if the political climate is unfavorable to its contents. For a federal level policy, this can incorporate a range of stakeholders, from the political leanings of Congressional representatives to the opinions of the local constituents that they represent.

_**Administrative feasibility:**_ For programs that involve large sums of money, the administrative hurdles and necessary bureaucracy to implement the policy may prove to be a logistical nightmare. A measure of the administrative aspects of a policy and how easy or burdensome it may be to carry out the intended goals is an important criterion to include, as this is one of the key aspects that could dictate the success of the policy.

_**Time delay of desired outcomes:**_ The intent of these infrastructure financing policies is to prevent drinking water system failures and deterioration of drinking water quality and service levels. Thus, it is important for a program to deliver the desired results before any significant, negative health effects can occur.
Adaptability: This is a qualitative measure of how flexible the program would be to changes in the future. A more adaptable program can meet unforeseeable needs in the future, whereas a less flexible program may not be sustainable over its desired lifetime.

C. Alternatives

The three alternatives under consideration in this policy analysis have already been introduced. This section examines each policy based on the aforementioned criteria to inform the decision-making process and provide a basis for comparison among the policy options.

1. Status Quo: No Further Federal Assistance

The policy option under the status quo is to simply keep DWSRF fund levels at current levels. Since the current DWSRF appropriations cannot meet the full needs of any state, the vast majority of the water infrastructure needs will be met through other means. This policy option operates under the assumption that water rates will increase enough to sufficiently fund all water infrastructure needs as water utilities seek out additional revenue to cover expenses.

Cost to the federal government: Except for the current funding for DSWRF programs, there will be no additional cost to the federal government since all of the additional funding will come from local sources, i.e. water utility customers. Based on FY2009 appropriations, this amounts to approximately $830 million each year, or roughly $16.6 billion over the course of twenty years (US EPA, 2012b).
Cost to state and local governments: Similar to the federal government, increased water rates will require no additional funding from state or local governments since the money will all come from water utility customers. It may be the case that specific states or municipalities wish to supplement water revenues, but that is an independent decision from the basis of this policy measure. Since the DWSRF was first introduced, states have contributed about 11% of total funding compared to 58% directly from the DWSRF capitalization grants (Copeland et al, 2012). Based on these ratios, states would contribute a little over $3 billion over 20 years.

Impact on infrastructure needs gap: Since just a small amount of government money is used under this policy option, any additional funding would need to be generated through water utilities, most likely via increases in water rates. This assumption is based on the idea that if the responsibilities for funding water infrastructure are placed entirely in the hands of water utility managers, they will do so. Since capital improvements are fixed costs that are unaffected by any other changes, policy tools for water managers are limited. Thus, by relying on higher water rates, water utilities are likely to fully meet their infrastructure needs.

Effect on water rates: After factoring in the business-as-usual levels of funding from the DWSRF contributions, there are still more than $300 billion in needs over the twenty-year timespan. Assuming that there are approximately 80 million residential customers (US EPA, 2009b), the required monthly contribution from each customer in addition to current bills is $15.95 (see Appendix B). There are roughly 3.4 people per residential customer (US EPA, 2009b), so on a
per-person basis this amounts to $4.69. There are of course several assumptions built into this calculation. The first is that needs estimated by DWINSA will not be paid for by current revenue streams and are distributed evenly over both the twenty-year estimation period and geographical locations. Based on the analysis from AWWA (2012), costs will vary by region, and in any case, more of the cost should be paid up front to prevent even further increases in infrastructure needs. As such, a distribution other than uniform may be more realistic. It also neglects any customer classes besides residential. However, approximately 89% of water retail revenue comes from residential customers (US EPA, 2009b), so this is not entirely misleading. Finally, this calculation assumes that water rates will be increased in one fell swoop. Rather, the likely approach is to gradually increase rates as many municipalities have done in recent years (McCoy, 2012; Walton, 2012b).

Regardless, this back of the envelope calculation merely serves as an estimate of how much water rates would need to increase to fully pay for the estimated infrastructure needs, and at least gives a sense of the magnitude. This estimate is in line with previous calculations done by the AWWA, which suggest that the average yearly water bill of $335 could increase up to a total of $550 (Ellis, 2012). This is larger than the $7.70 per month estimate from Xylem, Inc. that people would be willing to pay (2012), which indicates that even though Americans are willing to pay more for water infrastructure, they may not be willing to pay the full and necessary costs. However, respondents may have undervalued their true willingness to pay due to the nature of self-reported values, so there may be some uncertainty in just how much Americans might truly be willing to pay before concerns arise (Mansfield, 1999). Whatever the true outcome, simply operating on a business-as-usual path will surely lead to much higher
water rates as water utilities pass on infrastructure costs to customers (AWWA, 2012; Black and Veatch, 2012; McCoy, 2012).

*Impact on low-income households:* Unsurprisingly, since this policy option relies entirely on water rates to make up the infrastructure needs, low-income households are likely to be hit hard by higher water bills. An additional increase of $15.95 per month on water bills (see Appendix B) may not be feasible for low-income households, especially since this is an average estimate across the entire nation and it is possible that higher costs may be more localized, depending on the specific infrastructure needs of the community.

*Equity between small and large water systems:* Under the status quo option, small systems are likely to face more problems generating financial capital compared to larger systems due to differences in the size of their customer base and subsequent revenue stream. Larger systems have greater needs in general, but because they also have more customers, it is easier for them to make up the costs through revenues. Alternatively, small systems may have small or large costs, depending on the state of the infrastructure and expansion needs. Small systems with large needs don't have the customer base necessary to fund infrastructure improvements without dramatically increasing rates, and in some cases, even increased rates may not be enough to adequately provide the necessary drinking water infrastructure for the community.

*Equity among states:* Relying on water rates is unlikely to have any differential impact at the state level since the revenue is coming from local water utility customers.
**Political feasibility:** Although water rate increases are beginning to become the norm in many areas of the country (McCoy, 2012), it is rarely met without opposition. Realistically, since water rates are subject to political processes via public utility commissions, the feasibility of increasing them appropriately is small since elected officials are likely to be punished at the polls for introducing higher water rates (Maxwell, 2012). Additionally, the American public is not aware of the true value of water services provided by water utilities, and may undervalue it to a point that passing necessary rate increases is difficult (Water Research Foundation, 2011; Black and Veatch, 2012). This is compounded by the fact that water usage rates have declined over the years, and many people may not understand that lower usage rates and higher water bills could occur simultaneously (Water Research Foundation, 2011). Therefore, the political feasibility of increasing water rates to fully fund water infrastructure needs is very low.

**Administrative feasibility:** Water utilities would most likely not require any additional administrative capacity to administer a rate increase, since higher water rates would simply just increase the value of the revenue streams that they already handle. There could be more administrative needs in cases where increased water rates are contentious, especially those that could result in complaints or even litigation, but these events are uncertain and outside of the scope of this analysis.

**Time delay of desired outcomes:** Increasing water rates is not an immediate process due to political and bureaucratic hurdles. A prolonged rate increase process also prolongs the revenue
stream necessary to pay for infrastructure, which may potentially lead to failures on a grand scale. Maxwell (2012) points out that such a catastrophic public health concern may need to happen to serve as the focusing event for the necessary investments in aging water infrastructure. The uncertainty behind when water infrastructure failures could occur may also prevent any rate increases from proceeding in a timely fashion. Once a rate increase is in place, the water utility will immediately see increased revenues that it can then in turn funnel towards infrastructure capital. Water utilities may also be able to sell bonds in advance of a rate increase if the certainty of that increase occurring down the road is high. However, these rate increases are dependent on water utilities communicating the increased need to support water infrastructure funding and the public understanding this need more than in the current scenario. This is possible, but is clouded by uncertainty, and as a result, simply relying on rate increases would likely delay the necessary investments in infrastructure as long as possible.

Adaptability: Though a contentious and politically-charged process, water rate changes can be revisited as need be. In recent years, cities across the nation have increased water rates repeatedly (Walton, 2012b), and this trend is likely to continue into the future, despite concerns that it will become a larger fraction of household expenditures (McCoy, 2012). The purpose of increasing water rates for infrastructure needs also captures more of the true value of water services delivered by water utilities. Relying on the economic nature of drinking water is more likely to be an adaptive process that reflects the financial needs of the water utility.
2. Increase DWSRF Appropriations

The Drinking Water State Revolving Fund appropriations for FY2009 were approximately $830 million, but as part of the American Recovery and Reinvestment Act, an additional $2 billion was added to the program in 2009 using the same allotment formula as regular appropriations (US EPA, 2012b). If the EPA chooses to directly address our water infrastructure needs by increasing DWSRF appropriations, it is reasonable to assume it would be the same magnitude as the ARRA funding since the purpose of that program was to spur infrastructure investment. Under this assumption, a total of approximately $56.6 billion in today’s dollars would be funneled towards the DWSRF over a twenty-year period. Even though this is a large sum of money from the federal government for drinking water projects, it is still only 17% of the total projected needs during this same time period. Since utilities will pay for the infrastructure costs somehow, this policy option also includes the assumption that the remaining $278.2 billion will be paid for by raising water rates in a similar manner as the status quo option.

Cost to the federal government: Maintaining ARRA funding levels to the DWSRF will require federal capitalization grants of almost $3 billion annually, or about $56.6 billion in today’s dollars over the course of twenty years (US EPA, 2012b).
**Cost to state and local governments:** The state contributions, based on a 20% matching requirement, under the ARRA-based spending levels outlined above would be roughly $10.7 billion over twenty years.

**Impact on infrastructure needs gap:** Even though more government funding is used under this policy when compared to the status quo, a majority of the infrastructure needs must still be paid for through increased water rates. Avoiding investment and increased rates may no longer be an option as the number of pipelines reaching the end of their useful lives increases dramatically over the coming years (AWWA, 2012). Since water utilities develop the rates, and will seek to pay for any capital investments they make, it is likely that at least a majority of the infrastructure needs gap will be paid for under this scenario. It may not be quite as effective as the status quo since the increased government funding may take some of the pressure off of utilities to increase rates sufficiently, potentially reducing at least the initial revenue streams.

**Effect on water rates:** Under this alternative, the remaining needs not paid for through the DWSRF program by either the federal or state government is about $237 billion. Using a similar analysis as in the status quo option, water rates would be expected to increase by about $12.35 per customer each month, or almost $150 each year (see Appendix B).

**Impact on low-income households:** While higher water rates would still disproportionately affect low-income households, an increase of about $150 per household annually is more manageable than more than $200 under the status quo option.
Equity between small and large water systems: With more federal funding, small systems that don’t have as large of a customer base to rely on could receive more assistance through the DWSRF program. The program already emphasizes helping smaller systems, so an additional $40 billion over twenty years could go a long way towards providing those systems with the capital they need. However, a majority of the needs would still be met through utility revenue, so there might still be some difficulties for smaller systems to adequately fund infrastructure projects.

Equity among states: Appropriation levels under the DWSRF are determined for each state according to the DWINS survey published every four years (EPA, 2009a). Under this policy, there would be more than three times as much money flowing into the DWSRF program as before, so there is a greater need for EPA to ensure that the appropriation formula is accurate and fair.

Political feasibility: The DWSRF program has been around since 1997 and is supported by many members of the water industry (Arndt, 2013). However, this alternative would dramatically increase the funding levels of the Fund. Even though infrastructure needs have received greater attention in the wake of severe weather episodes such as Hurricane Sandy, the highly divisive and bitter debate about controlling federal spending to decrease the deficit is also front and center in the current political climate (Gregory, 2013). An additional $2 billion annually would be difficult to enact, especially given that the entire EPA budget in the most recent fiscal year
was less than $9 billion and EPA as a whole is often targeted by the GOP for further budget reductions (or, in some cases, complete shutdown). The $2 billion additional funding allocated to the DWSRF was also a part of the 2009 stimulus package (US EPA, 2012b), which is not viewed favorably by many members of the GOP and, as Vedachalam et al. points out, “likely contributed to Democratic losses in the [2010] midterm poll” (2013). Overall, the political climate in Congress would likely be at odds with a funding increase of this magnitude coming from the EPA, despite the fact that it would support local investments in water infrastructure.

Administrative feasibility: The additional funding levels might require more personnel to carry out the program, but the DWSRF is already in place, so no new policies or institutions would need to be developed.

Time delay of desired outcomes: Under this policy, all utilities could increase rates as necessary. This may be a lengthy and contentious process due to the political nature of doing so. However, those utilities with dire needs could apply for the increased DWSRF loans to begin developing the necessary water infrastructure. Thus, a boost in DWSRF appropriations would likely lead to water infrastructure projects developing ahead of the status quo schedule.

Adaptability: EPA reviews appropriation levels under the DWSRF every four years according to the DWINSFA report. Since the EPA budget is reviewed annually, there is a high degree of adaptability in pursuing an amplified DWSRF to funding water infrastructure projects.
3. Water Infrastructure Finance and Innovation Act

The Water Infrastructure Finance and Innovation Act (WIFIA) would provide credit assistance to water utilities for infrastructure projects. The funding would be in the form of Treasury-backed loans; since Treasury interest rates are lower than what utilities could obtain in the bond market, interest paid on the loans would be smaller and result in direct savings to the water utility over the lifetime of the project. This proposal would replace the DWSRF, though it would still need to be supplemented by increased water rates.

Cost to the federal government: Funds for WIFIA loans would come from the Treasury, but since all money would theoretically be paid back to the federal government, there would likely be very little cost to the federal government over the lifetime of the program. There could be some cases of default, but water projects are among the lowest default rates at approximately 0.04% (AWWA, WEF, and AMWA, 2011; Arndt, 2013). Additionally, the interest repaid on the loans might even generate revenue for the federal government. Depending on how the system is structured administratively, there might be some costs to set up an agency or hire employees to run the program, but this would likely be negligible to the billions of dollars in funding that could be appropriated through a water infrastructure bank. In sum, it is likely that a WIFIA program would have a negligible cost to the federal government (AWWA, WEF, and AMWA, 2011; Arndt, 2013).
Cost to state and local governments: WIFIA loans would likely be made directly to water utilities, so state and local governments would not be involved in the program.

Impact on infrastructure needs gap: Ideally, loans through the WIFIA program would sufficiently fund enough infrastructure projects to completely erase the needs gap. However, the WIFIA program is only a proposal at this point, even though it is based on the TIFIA program already in place. There would likely be logistical issues to work out to move the proposal from a legislative idea and into reality, and there could be some unforeseen shortcomings in the policy model that would prevent it from functioning as envisioned. For example, project eligibility is one aspect that stakeholders have cited as a potential concern with the current WIFIA model (Gomez, 2013). The potential to fully meet infrastructure needs is there, but given the novelty of the approach, there is a good amount of uncertainty as well.

Effect on water rates: AWWA, WEF, and AMWA assumed a 15.9% rate of debt service savings in their analysis of how WIFIA would work (2011). This value is based on the May 2011 market conditions for interest rates of a typical 30-year municipal bond—about 5.4%—and a Treasury-backed interest rate of 4.04%. Based on this assumption (which in reality would change as the market changes over time), water utilities would save more than $53 billion over twenty years in paying for water infrastructure needs. The remaining costs would likely then be passed onto customers through increased rates. Using the same formulas from the previous two policy options, the average customer would see an increase in their annual water bill of about $176, or $14.66 each month, an estimate that falls between the status quo and DWSRF options.
*Impact on low-income households:* Even though water utilities receive federal financial support and save money on infrastructure projects at essentially no cost to the government, in the end the projects are still largely paid for by customers. This would disproportionately affect low-income households, as it carves out a larger relative share of their household budget (McCoy, 2012). The increase in water bills is closer to that under the status quo, so low-income households would likely have a harder time paying the higher water bills under this scenario than other households.

*Equity between small and large water systems:* One of the criticisms of the DWSRF program is that large projects are often excluded from the process. Utilities with large capital projects could apply for WIFIA loans, which would alleviate the financial burden they face. WIFIA loans could also theoretically go to support DWSRF programs, which have traditionally helped smaller systems. Stakeholders are divided on whether or not a water infrastructure bank should be accessible to all projects or only larger ones that are traditionally excluded from other federal support programs (Gomez, 2013). Stakeholders also emphasize that funding should be directed towards projects with the greatest needs and potential benefits. It is unclear whether small or large systems might be favored under this approach, since smaller systems have fewer resources but also benefit fewer people. Depending on how the project eligibility is structured, a utility with a project of any size could potentially find some way of using WIFIA support to its advantage.
Equity among states: WIFIA loans would be disbursed directly to utilities, so equity among states would likely be a non-issue. It is possible that some states could receive more money because the utilities in those states receive more money, but project eligibility could be structured similar to the current DWSRF to ensure that all states receive at least some minimum level of support.

Political feasibility: WIFIA seems to be a favorable policy at the federal level because it promises a negligible impact on the federal deficit while providing benefits for water utilities, and in turn their customers, around the country. WIFIA and programs similar to it are currently up for debate in the Congressional arena, so the true political feasibility of this policy will be tested. Vedachalam, et al. performed a study of public opinion on water infrastructure financing and found that a plurality of relevant stakeholders preferred local government sources, especially among Republicans (2013). However, almost 20% of total respondents still preferred federal government funding sources, and since WIFIA would use federal money to support local government investments, this policy would likely be favorable among the general public.

Administrative feasibility: Creating the WIFIA program would likely require the development of some sort of government institution specifically tasked with administering the program. Gomez points out that there is a difference in opinions among stakeholders about how the bank created through WIFIA would operate, which would ultimately impact how it would operate and its connection to the federal budgeting process (2013). The same stakeholders are also split on the concept of including the WIFIA bank under a larger bank that would deal with various
types of infrastructure issues. While creating a water infrastructure bank is certainly feasible, it would require more a more in-depth discussion of how the WIFIA program would operate and any legal and budgetary ramifications.

*Time delay of desired outcomes:* WIFIA would require creating the government department or agency that would carry out the responsibilities outlined under WIFIA, as well as fully developing the intricacies of the lending programs and policies. These legal and bureaucratic hurdles would require time. How long this might take is uncertain, but there would almost certainly be a lag between passing the legislation and the first loan. Once the program is in place, however, loans could immediately begin flowing to water utility projects, allowing for immediate progress on needed infrastructure.

*Adaptability:* Given that it would take time to set up the program in the first place, it is unlikely that the policies could readily be changed, aside from inherent variables such as Treasury interest rates. However, loan applications would be on an as-needed basis, so the program would lend itself well to meet a wide variety of needs across the country with variable loan terms based on the project at hand.

**D. Summary of Comparisons Among Alternatives**

Table 3 includes a matrix of the different criteria for each of the three drinking water infrastructure finance policy options. In order to indicate some level of preference, shading was

<table>
<thead>
<tr>
<th>Goals</th>
<th>Criteria</th>
<th>Policy Alternatives</th>
<th>Goals</th>
<th>Criteria</th>
<th>Policy Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit Costs to</td>
<td>Cost to federal</td>
<td>Status Quo (higher rates)</td>
<td>Increase SRF Funding</td>
<td>WIFIA</td>
<td></td>
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<td>$56.6 billion</td>
<td>Negligible</td>
<td></td>
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<tr>
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<td>Cost to state and local</td>
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<td>Increase SRF Funding</td>
<td>WIFIA</td>
<td></td>
</tr>
<tr>
<td>Stakeholders</td>
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<td></td>
<td>$10.7 billion</td>
<td>0 (not applicable)</td>
<td></td>
</tr>
<tr>
<td>Effect on water rates</td>
<td>Increase of $15.95/month</td>
<td>Increase of $12.35/month</td>
<td>Increase of $14.66/month</td>
<td>Increased EPA budget</td>
<td></td>
</tr>
<tr>
<td>Generate Financial</td>
<td>Impact on Infrastructure</td>
<td>Likely to fully meet need since</td>
<td>Potential to fully meet needs, but</td>
<td>Medium: no federal or state policy,</td>
<td>Medium: no federal or state policy,</td>
</tr>
<tr>
<td>Capital for Drinking Water</td>
<td>Gap</td>
<td>majority of costs are captured</td>
<td>uncertainty due to combination of</td>
<td>but local rate increases might be</td>
<td>but local rate increases might be</td>
</tr>
<tr>
<td>Infrastructure Projects</td>
<td></td>
<td>through revenue</td>
<td>revenue and government funding</td>
<td>contentious</td>
<td>contentious</td>
</tr>
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<td>Political Feasibility</td>
<td>Political Feasibility (Federal)</td>
<td>Low: likely to fully meet needs, but</td>
<td>High: in addition to rate increases,</td>
<td>Low: in addition to rate increases,</td>
<td>High: in addition to rate increases,</td>
</tr>
<tr>
<td>(Federal)</td>
<td></td>
<td>majority of costs are captured</td>
<td>unlikely that Congressional GOP</td>
<td>unlikely that Congressional GOP</td>
<td>unlikely that Congressional GOP</td>
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<td></td>
<td></td>
<td>through revenue</td>
<td>would allow for increased EPA</td>
<td>would allow for increased EPA</td>
<td>would allow for increased EPA</td>
</tr>
<tr>
<td></td>
<td>Administrative Feasibility</td>
<td>High: utilities already handle rate</td>
<td>High: DWSRF already in place</td>
<td>Medium: need to fully develop</td>
<td>Medium: need to fully develop</td>
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<td></td>
<td></td>
<td>increases and revenue streams</td>
<td></td>
<td>new government institution</td>
<td>new government institution</td>
</tr>
<tr>
<td>Strive for Equity</td>
<td>Impact on Low-Income</td>
<td>Low equity: Poorer households pay</td>
<td>Medium equity: low-income</td>
<td>Low equity: poorer households pay</td>
<td>Low equity: poorer households pay</td>
</tr>
<tr>
<td>Households</td>
<td>Households</td>
<td>greater proportion of income for</td>
<td>households disproportionately</td>
<td>greater proportion of income for</td>
<td>greater proportion of income for</td>
</tr>
<tr>
<td></td>
<td></td>
<td>water bills</td>
<td>affected, but to a lesser extent than</td>
<td>water bills, though less than under</td>
<td>water bills, though less than under</td>
</tr>
<tr>
<td>Small vs. Large Systems</td>
<td>Small vs. Large Systems</td>
<td>Low equity: Higher costs for small</td>
<td>Medium: small systems could rely</td>
<td>Medium: pending project eligibility,</td>
<td>Medium: pending project eligibility,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>systems</td>
<td>more heavily on DWSRF loans</td>
<td>may or may not favor large projects</td>
<td>may or may not favor large projects</td>
</tr>
<tr>
<td>State Equity</td>
<td>State Equity</td>
<td>Negligible since utilities are local</td>
<td>Moderately low: increased need to</td>
<td>Negligible since loans would</td>
<td>Negligible since loans would have</td>
</tr>
<tr>
<td></td>
<td></td>
<td>institutions</td>
<td>ensure fairness of DWSRF</td>
<td>be disbursed to utilities</td>
<td>be disbursed to utilities</td>
</tr>
<tr>
<td>Avoid Infrastructure</td>
<td>Time Delay (risk of health</td>
<td>Low: uncertainty that rate increases</td>
<td>Medium: same concerns as status</td>
<td>Medium: new government</td>
<td>Medium: new government</td>
</tr>
<tr>
<td>Failure</td>
<td>issues</td>
<td>could be put in place in a timely</td>
<td>quo, but utilities with dire needs</td>
<td>institution and policies would</td>
<td>institution and policies would</td>
</tr>
<tr>
<td></td>
<td></td>
<td>manner</td>
<td>could use increased DWSRF loans to</td>
<td>require time to fully develop</td>
<td>require time to fully develop</td>
</tr>
<tr>
<td>Adaptability</td>
<td>Adaptability</td>
<td>High: flexible for local needs, rates</td>
<td>Medium: reviewed at least every</td>
<td>Medium: WIFIA would not be</td>
<td>Medium: WIFIA would not be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>can be adjusted</td>
<td>four years</td>
<td>adaptable, but specific loan</td>
<td>adaptable, but specific loan</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>conditions could be</td>
<td>conditions could be</td>
</tr>
</tbody>
</table>

Green shading indicates that, for that criterion, the policy option represents the best choice out of the three alternatives. Red shading indicates the worst choice. In both cases, if two policies were rated the same, no shading was assigned.
used to indicate the best and worst options for each criterion based on the projected outcomes of the three alternatives. If two options were equally preferred (e.g. one policy is bad and the other two appear to be equally good), then only the one that is not preferred was shaded. The same was done if two policies were equally undesirable.

Given that many of the criteria are qualitative in nature, relying on a cost-benefit analysis that selects alternatives based on the net present value is not a reasonable approach. Rather, a multigoal analysis that accounts for the fact that there are multiple goals along with a mix of quantitative and qualitative measures is a more practical approach (Weimer and Vining, 2011). Under this framework, it is important to focus on the criteria as ways to measure how each alternative performs in terms of the outlined goals. Though there is no hard rule for selecting an alternative, a decision must be made. Since there will almost always be trade-offs when making a final policy selection, a thorough description of the rationale and pros and cons for selecting a specific alternative as the preferred policy choice is a necessary component of this analysis (Weimer and Vining, 2011).

In terms of costs to stakeholders, the WIFIA proposal seems poised to cost nothing, or at least a negligible amount of money, for the federal government, due to both the lending nature of the program and the very low default rate for water infrastructure projects. Similarly, there is currently no state or local government component to WIFIA, though these entities would likely still contribute to water infrastructure projects in some other fashion. Increasing the DWSRF appropriations would cost water customers the least amount of money in terms of increased water bills, but at a considerable cost to the federal government since money would be granted
to states with no terms of repayment. Alternatively, the status quo option would cost stakeholders the most, and WIFIA fares somewhat moderately, relative to the two other options.

Based largely on the costs to stakeholders, WIFIA appears to be the most politically favorable option as well, though there are some questions about how it would pan out administratively. It is also uncertain how effectively it could generate all of the necessary financial capital, at least without supplemental programs, whereas under the assumptions in this analysis, the status quo option would almost assuredly generate the necessary financial capital eventually through increased rates. All three policies would result in higher water bills to varying degrees, pointing to some level of concern about the disproportionate effect on low-income households. However, the status quo would likely favor larger utilities that have the capacity to generate more revenue through water bills from a larger tax base, while smaller utilities would likely fall short. Additionally, an increased DWSRF would favor states with a more pronounced needs gap, despite a widespread infrastructure crisis in the coming years.

Both the DWSRF and WIFIA approaches moderately address the infrastructure gap over the next twenty years. Pursuing the status quo is likely to be the most adaptable approach, since it would be based on local water rates that could be adjusted as necessary. However, if it were easy to do so, we would already be increasing rates to meet our needs. Rather, higher water rates are politically contentious. Despite the necessity to increase water rates, doing so will take a long time, especially with no federal policy or initiative for promoting water infrastructure financing as a national priority.
Based on these series of trade-offs, WIFIA appears to be the most favorable policy option. Overall, WIFIA provides cost-neutral solution for the federal government to support drinking water infrastructure projects, while still relying on local communities to fund a large portion of local infrastructure projects, and this characterization plays out in the policy matrix. It is also likely to be the most equitable of these three policies, though an important caveat is the impact on low-income households. As such, the recommendation of this paper is to pursue WIFIA, as long as supplemental policies are given consideration as well. Funding programs to support low-income households with heating bills during winter already exist, so it is possible that something like this could also be adopted to soften the blow of higher water bills under any of these policies. WIFIA would provide the lowest cost solution to governments, so pursuing it could provide more flexibility for government-sponsored aid to low-income households. Additionally, local solutions should be pursued alongside the adoption of WIFIA, perhaps as part of a larger national initiative to promote a conversation about the country’s infrastructure needs to increase awareness among the public.

Uncertainty interspersed throughout the criteria (e.g. how large the time delay would be to generate enough financial capital to fully fund the needs gap) could alter the final outcomes either more positively or negatively for any of the three approaches. Due to the inherent uncertainty, perhaps the most salient talking points for stakeholders are the potential costs involved in a water infrastructure policy. A large part of the appeal of the WIFIA approach is the negligible federal government costs that in turn lower the amount that water utility customers will have to pay through higher water rates. Since the low cost of this policy is purely theoretical at this point, it is possible that it could cost the government more than a negligible
amount to implement WIFIA. If this approaches the amount of funding dedicated to the DWSRF under the other two options, then WIFIA may not be as favorable.

These results are not that sensitive to the estimated costs of the three options. WIFIA is very unlikely to result in any substantial government costs, while the other two would by definition necessitate disbursement of federal grants, so it is almost guaranteed to be the cheapest pursuit at the federal level. WIFIA also seems poised to be more politically favorable under any circumstance compared to the other two options. However, the uncertainty in implementation and administrative feasibility could hinder WIFIA in the short term, especially if negative health effects become much more visible. For example, if a series of severe water main breaks occurs and draws public attention to the issue, it is possible that Congress would simply expand the DWSRF program since it is already in place rather than take time to craft, develop, and institute a completely new program. Under this hypothetical scenario, the time delay of risks and health effects would receive much more weight in the decision-making process and could tilt the decision in favor of expanding the DWSRF.

This highlights the issue that, under the multigoal policy analysis framework, the criteria are not weighted in terms of importance. For example, cost to the federal government is likely a much more important criterion for any federal policy than the adaptability, even though adaptability is an important consideration for policy implementation. If this analysis were redone using a decision analysis framework with multi-attribute utility theory as the underlying foundation of the analysis, different methods for weighting the criteria accordingly could be used to develop a more robust model for choosing among the policy alternatives. However,
such an analysis is beyond the scope of this paper and is based more in the social survey methods.

V. Discussion and Future Recommendations

Based on the policy analysis outlined in the previous section, the WIFIA proposal appears to be the best choice for the federal government to pursue for financing drinking water infrastructure projects at the federal level. This is largely due to the cost differences among the policies. Though fairly theoretical at this point, the proponents of WIFIA argue that it would be a cost-neutral policy since it would loan money rather than provide grants, and water utilities very rarely default on loans. The savings from using Treasury-backed loans will help utilities save about 16% on the costs of infrastructure projects, resulting in lower costs that are passed down to customers. These benefits of the program, over a federal grant program like the DWSRF or simply raising rates per the status quo, are what propel it forward as the best option.

However, simply enacting WIFIA legislation won’t solve the infrastructure woes of our country. A large degree of uncertainty in how a WIFIA program might actually work could derail the program from achieving its goals in a timely manner. Additionally, even with the savings created by the federal government, water rates are still projected to increase, which could hamper economic growth and hit low-income households more directly since everyone has at least some lower threshold of necessary water use. Finally, many of these assumptions are aggregated across the entire country and over the twenty-year time horizon. There are
certainly hot spots around the country that have more urgent infrastructure needs and may require stronger and swifter action than WIFIA could deliver.

For these reasons, WIFIA legislation (or any drinking water infrastructure finance policy, for that matter) should include additional measures to ensure the success of the policy. Since setting up a new federal institution for managing WIFIA loans would require some time to do correctly, the process should be structured so that obtaining WIFIA loans is streamlined and efficient to reduce the delay between applying for loans and using those funds to begin construction. Though it may jeopardize state equity to some extent, this could include some sort of prioritization process to select the utilities with the most urgent needs as the first recipients.

One key aspect of the WIFIA proposal, as well as the status quo and DWSRF options, apparent in the analysis results is that water utility customers will still be expected to pay for a sizeable share of the infrastructure costs. WIFIA “simply” reduces the costs of projects by letting utilities borrow at Treasury rates, thus reducing the interest paid on capital. But there will still be some interest paid, and no policy in the world could change how much a given water treatment plant or distribution system will cost in absolute terms. In sum, water utility customers will pay higher water bills in the future no matter what.

This conclusion is not surprising, and has been a talking point of the water industry for many years (Maxwell, 2012). Various water organizations and groups have pursued communication strategies in recent years, and the concept of the “value of water” has popped up in reports from water utilities, consulting firms, and the federal government (Xylem, Inc., 2012; US EPA, 2012a). The impetus comes from the need to communicate to the public that
water rates will go up and why they must go up. Therefore, in addition to any federal legislation, the water industry should promote effective communication strategies with relevant stakeholders, especially water utility customers. Part of this communication strategy should focus on low-income households, since they will be the most impacted by higher water rates. Proposals that provide support for low-income households, such as a subsidy system, could help the water industry garner support among those individuals who cannot realistically adjust their water use to accommodate higher prices.

The large amount of project costs remaining after any federal intervention also leaves the door open for other innovative finance policies to take place at state or local levels. For example, Chicago recently developed an infrastructure trust fund to bring in private investment for public infrastructure projects (Ali, 2013). This move represents a shift towards public-private partnerships that may be part of a larger trend in the water industry as a whole. Ali points out that while PPP’s are popular in many other countries, it may be necessary to develop some sort of federal institution to oversee this type of project in the United States (2013). Future policy proposals could explore the potential of PPP’s to address infrastructure challenges by bringing in private funding for public goods and how the federal government might be involved. More broadly, future research could also look at the role that private entities and privatization in general has in shaping the future of water infrastructure management.

Future analyses could also look at policy proposals from the utility perspective rather than at the federal level. As previously mentioned, a future policy analysis could be grounded in a decision analysis framework that relies on multi-attribute utility theory to capture the key aspects of a good federal finance policy from a water utility manager’s perspective. A case
study on the potential policy options for a specific water utility, including possible federal options that may provide additional support, could expand on some of the more general principles included in this analysis. A case study has the added benefit of providing a more detailed and rigorous analysis, though it may only be relevant to other utilities in certain circumstances.

VI. Conclusion

In light of a dire need for financing drinking water infrastructure projects around the country, an analysis of the federal level policy options can help inform the process on how to best proceed. Currently the Drinking Water State Revolving Fund provides grants to states to in turn loan out to utilities through a revolving fund system. Various members of the water industry have proposed another option, the Water Infrastructure Finance and Innovation Authority, to Congress. Inaction by the federal government would most likely result in water rate increases across the board. A statistical analysis indicates that the DWSRF does indeed have a significant impact on reducing the infrastructure needs for states. But many other characteristics are also drivers of the trends in the needs gap, so simply relying on the DWSRF may not be the most effective or efficient way to provide federal support for water infrastructure projects. A policy analysis of multiple quantitative and qualitative criteria indicates that from a broad water management perspective, the WIFIA proposal provides a favorable federal policy option for driving down the cost of infrastructure projects through
lower interest payments when compared to the status quo. It also avoids large expenditures on behalf of the federal government, as is the case of the DWSRF.

However, the WIFIA program is certainly not the sole answer financing drinking water infrastructure in the U.S. Rather, it represents a way to allow the federal government to alleviate some of the stress that water utilities around the country will face over the next twenty years and beyond. Local solutions, such as the Chicago Infrastructure Trust, will still be necessary. And, perhaps most importantly, water utility customers will face higher water bills under any scenario.

The looming water infrastructure crisis is a classic example of an opportunity for a federalism-based policy approach to solving problems in the United States. Complete federal intervention makes no sense and would be an extraordinarily expensive endeavor. Likewise, expecting water utility customers to bear the entire responsibility for funding water infrastructure is unlikely to gain any traction either. While infrastructure projects are indeed local in nature, the activities they support in addition to drinking water and residential uses are innumerable. The economic support that water infrastructure systems provide is absolutely necessary for the United States to succeed in the 21st century, so developing a financial support mechanism for water utility customers is in our best interest as a country. Rebuilding our water infrastructure systems is also a way to spur job growth and economic activity during a slow recovery period. For such an ambitious project, the role of the federal government will be crucial. But, the best solution will likely involve stakeholders at all levels of government and society, and require everyone to contribute at least some portion of the costs and responsibilities. Safe and reliable access to clean drinking water has been a hallmark of
American society in the modern era, and with the proper policies in place, our water system will continue to be one of the crowning achievements of our country.
VII. References


Appendix A: Regression Analysis Supplements

Figures 1A-1H. Variable Transformation Plots.

These figures were used to determine the appropriate transformation for each variable, based on which transformation fit the distribution most closely. For example, TOT_0307 was transformed to LOGTOT_0307 because the log transformation fit the data more closely.
Table A1. Initial Regression Results for Model Including All Variables.

In this initial model, all variables were including. Very few of them were significant, so subsequent models excluded variables that did not seem to be significant (e.g. leverage).

**Linear regression**

|               | Coef. | Std. Err. | t    | P>|t| | [95% Conf. Interval] |
|---------------|-------|-----------|------|-----|----------------------|
| log_tot0307   | -290.785 | 149.1303  | -1.95 | 0.062 | [-597.9245, 16.35459] |
| pctpop_change | -1335.958 | 1550.938 | -0.86 | 0.397 | [-4530.174, 1858.259] |
| rgdp_2007     | 0.0169324 | .0079944  | 2.12  | 0.044 | [.0004678, .0333971]  |
| bush_2004     | -5.570857 | 12.10134  | -0.46 | 0.649 | [-30.49402, 19.35231] |
| poppct_urban  | -26.06397 | 9.521754  | -2.74 | 0.011 | [-45.67439, -6.453548] |
| southwest     | 143.507 | 1002.508  | 0.14  | 0.887 | [-1921.196, 2208.211] |
| gdp_pctchg    | 30.93854 | 11.63719  | 2.66  | 0.013 | [6.971291, 54.90578] |
| leverage      | 7.510688 | 115.3769  | 0.07  | 0.949 | [-230.1126, 245.1339] |
| gop_state     | 122.5482 | 129.1979  | 0.95  | 0.352 | [-143.5398, 388.6361] |
| govt_exp_wat-07 | 5786.904 | 2246.111  | 2.58  | 0.016 | [1160.954, 10412.85] |
| age_inf       | .3615088 | 13.42911  | 0.03  | 0.979 | [-27.29627, 28.01929] |
| _cons         | 1597.243 | 1013.103  | 1.58  | 0.127 | [-489.2817, 3683.769] |

Figures 2A-2B. Residuals versus Fitted Plots for Final Model, Including and Excluding D.C.
Appendix B: Policy Analysis Cost Calculations

The following appendix details the calculations used in the qualitative criteria: cost to federal governments, cost to state governments, and the effect on water rates. These calculations have several assumptions built into them, detailed throughout this analysis, and as such serve as more of a rough estimate of the magnitude of these different parameters.

Table B1 compares the projected support from the Drinking Water State Revolving Fund (DWSRF) and the subsequent cost to water utility customers for policies where the DWSRF is utilized.


<table>
<thead>
<tr>
<th></th>
<th>National 20-year needs (Billions USD)</th>
<th>DWSRF Federal Grant over 20 years (Billions USD)</th>
<th>Aggregate Impact of DWSRF over 20 years (Billions USD)</th>
<th>Remaining Needs (Billions USD)</th>
<th>State Share (Billions USD)</th>
<th>Annual Needs Per Customer (USD)</th>
<th>Monthly Needs Per Customer (USD)</th>
<th>Monthly Needs Per Person (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status quo</td>
<td>334.8</td>
<td>16.6</td>
<td>28.6</td>
<td>306.2</td>
<td>3.1</td>
<td>191.36</td>
<td>15.95</td>
<td>4.69</td>
</tr>
<tr>
<td>SRF</td>
<td>334.8</td>
<td>56.6</td>
<td>97.6</td>
<td>237.2</td>
<td>10.7</td>
<td>148.26</td>
<td>12.35</td>
<td>3.63</td>
</tr>
</tbody>
</table>

The first column is the estimated needs gap from the EPA’s Drinking Water Infrastructure Needs Survey and Assessment (2009a). The second column provides the projected DWSRF expenditures for the federal government under the particular policy scenarios over a 20-year time horizon, as detailed in the policy analysis section. The third column determines the aggregate funding generated through the DWSRF by federal governments, state governments, and leveraging. The relative contributions are estimated to be 58%, 11%, and 28%, respectively (Copeland et al., 2012). As such, the actual amount granted by the federal government in the second column is only 58% of the total funding generated by
the program. Subtracting this from the 20-year needs gap estimated by the EPA results in the remaining needs to be paid for by increased water rates. The state share of aggregate funding under the DWSRF policies is also calculated using the figures provided by Copeland, et al.

To determine the necessary increases in water rates, these calculations assume that the costs are evenly distributed over 80,000,000 residential customers, which is based on information from the EPA’s 2006 Community Water System Survey (2009b). A further assumption built into these calculations is a uniform rate increases spanning the 20-year time horizon. These calculations lead to the estimated annual needs per customer, which would be analogous to the needed increase in each customer’s water bill every year. Monthly water bill increases, as well as the effect on a per-person basis (based on 3.4 people per household, again from the 2006 Community Water System Survey) are also calculated. The results indicate that monthly water bills under the status quo would go up by an average of $15.95, whereas under the increased DWSRF policy, they would increase by $12.35.

Under the Water Infrastructure Finance and Innovation Authority (WIFIA) policy, a 10:1 leverage ratio is assumed based on the similarities to the TIFIA program already in place (AWWA, WEF, & AMWA, 2011). Thus, approximately $33.4 billion in Treasury-backed funding could theoretically be loaned out under this program, or about $1.6 billion every year for 20 years. Assuming a 0.04% default rate (AWWA, WEF, & AMWA, 2011), the potential cost to the federal government for defaults on these loans is about $13.4 million, or roughly $670,000 each year.
Calculations similar to those for the DWSRF program are shown below in Table B2 for WIFIA. Again, the 20-year drinking water infrastructure needs gap is shown in the first column. Based on the 15.9% debt savings ratio as calculated by AWWA, WEF, & AMWA using market data for municipal bonds and Treasury-backed interest rates (2011), the projected savings to utilities is shown in the second column. With more than $50 billion in savings over 20 years, the remaining needs add up to just over $281 billion. From that point, the exact same method illustrated in Table B1 is used to derive the projected increase in water bills, which is about $14.66 per customer each month over 20 years.

### Table B2. Cost Estimates Under Water Infrastructure Finance and Innovation Authority.

<table>
<thead>
<tr>
<th>National 20-year needs (Billions USD)</th>
<th>Savings to Utilities (Billions USD)</th>
<th>Remaining Needs (Billions USD)</th>
<th>Annual Needs Per Customer (USD)</th>
<th>Monthly Needs Per Customer (USD)</th>
<th>Monthly Needs Per Person (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>334.8</td>
<td>53.2</td>
<td>281.6</td>
<td>175.98</td>
<td>14.66</td>
<td>4.31</td>
</tr>
</tbody>
</table>