Review of Water Supply Alternatives

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Purpose

The City of Waukesha is applying for Great lakes water in accordance with the Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact) and the Wisconsin Compact implementing statute (§ 281.346 and 281.348, Wis. Stats.). The *Application for Lake Michigan Water Supply* (May 2010) submitted by the City of Waukesha provides detailed information and analysis of water supply alternatives. This memorandum summarizes facts from the Application and presents supplemental information and analysis on a Waukesha water supply alternative using a combination of water sources.

Previous Water Supply Studies

Water resources in the Waukesha area have been studied extensively over the past several decades by the United States Geological Survey (USGS), Wisconsin Department of Natural Resources (WDNR), Southeastern Wisconsin Regional Planning Commission (SEWRPC), universities, engineers, scientists and planners.

In 2002, the Waukesha Water Utility completed a study with CH2M HILL and Ruekert & Mielke on future water supply. This study objectively evaluated a broad range of water supply alternatives to identify the most sustainable source of high quality drinking water for the long-term future. All the alternatives were evaluated openly by a broad spectrum of experts and stakeholders using applicable and appropriate criteria including reliability, regulatory impacts, legal implications, schedule and cost. There were no fore-gone conclusions during the analysis. Several water supply alternatives did not provide an adequate² supply of sustainable, high quality water and were not recommended. The study recommended further investigation of two water supplies – Lake Michigan and the shallow aquifer near Waukesha. At the time of the study, the Compact was not yet written and requirements for obtaining Lake Michigan water were not defined. Similarly, the environmental and legal impacts of pumping shallow groundwater near Waukesha were not defined. The study stated that "the current water supply situation is not critical", meaning that a new water supply did not have to be implemented immediately and

¹ CH2M HILL is an international engineering consulting company with over 23,000 employees in 175 offices covering 70 countries. With over \$6 billion in revenue, they were rated as the number 1 firm in Water Supply and Treatment by Engineering News Record in 2009. CH2M HILL has completed thousands of water supply and treatment studies in dozens of countries around the world. CH2M HILL was one of only 99 companies globally selected by an independent organization (www.ethisphere.com)for advancements in best practices in business ethics and corporate social responsibility.

² Economically and environmentally sustainable to meet reasonable water supply demands in quantity and quality, is protective of public health, is available at a reasonable cost, and does not have adverse environmental impacts greater than those likely to result from the proposed diversion.

Waukesha had time to determine requirements for a Lake Michigan supply and investigate environmental and legal aspects of developing a shallow aquifer supply. The following sentence in the Study stated "However, now is a prudent time to take proactive action and plan for the future." Since completion of the Future Water Supply report in 2002, requirements for a Lake Michigan water supply have been defined by the Compact, new laws have been implemented to further protect groundwater supplies in Wisconsin, a number of legal cases involving pumping groundwater for public water supply have been decided and the potential environmental impacts of using shallow groundwater have been further investigated and documented in Waukesha's Application for Lake Michigan Water. These regulatory, legal and scientific developments were used to objectively compare the water supply alternatives in the *Application for Lake Michigan Water Supply*.

After 5 years of study, SEWRPC drafted *A Regional Water Supply Plan for Southeastern Wisconsin* in 2008. This comprehensive study considered the body of scientific information available to evaluate water supply alternatives for Southeastern Wisconsin. The study concluded that the Lake Michigan water supply alternative for the City of Waukesha was the best alternative considering long term sustainability, protection of public health, economic and efficient systems and minimizing adverse environmental impacts to groundwater and surface water resources in the region. This conclusion was reviewed, and gained concurrence from 32 experts with a variety of interests and perspectives in the region.

Application for Lake Michigan Water Supply

The *Application for Lake Michigan Water Supply* summarized previous studies on water resources near the City of Waukesha, and evaluated water supply alternatives in more detail, specifically for a City of Waukesha water supply. The Compact requires that a community within a straddling county (i.e. City of Waukesha) applying for a diversion must have no *reasonable* water supply alternative within the basin in which the community is located (Article 4, Section 4.9.3.d). Reasonable water supply alternative is defined as "a water supply alternative that is similar in cost to, and as environmentally sustainable and protective of public health as the proposed new or increased diversion and that does not have greater adverse environmental impacts than the proposed new or increased diversion" (Wis. Stat. § 281.346(1)(ps)).

The major conclusions from Waukesha's Application on water supplies are as follows:

• Deep Aquifer - Within City of Waukesha. The deep aquifer is being mined. Water is being withdrawn faster than it can be replenished. The evidence of this situation is the extensive drawdown of the aquifer. Groundwater modeling demonstrates that the extensive drawdown of the deep aquifer adversely impacts other water resources and ecosystems by diverting water toward deep aquifer pumping centers. Continued or expanded use of the deep aquifer is not sustainable. The Wisconsin Legislature has designated Waukesha County as a groundwater management area due to concerns about adverse environmental impacts of the current deep aquifer drawdown (2003 Wisconsin Act 310). One hundred fifty feet of drawdown is the trigger for a groundwater management area and Waukesha has over 600 feet of drawdown. WDNR will not allow Waukesha or any other Wisconsin community to completely deplete the aquifer, and could curtail its use now. Deep aquifer groundwater also exceeds radium

regulations and water quality deteriorates with depth. The deep aquifer is also susceptible to contamination. Several of Waukesha's deep wells are not in use today due to contamination. The deep aquifer is not as environmentally sustainable nor protective of public health as a Lake Michigan supply. Therefore, it is not a reasonable long-term source of drinking water.

- Shallow Aquifer South of the City of Waukesha. The shallow aquifer near Waukesha is providing a small portion of the City's current water supply. Groundwater modeling indicates continued and expanded pumping of the shallow aquifer near the City of Waukesha will cause significant groundwater drawdown and environmental harm to wetlands and cold water trout streams. WDNR considers these factors when deciding whether or not to permit new wells (2003 Wisconsin Act 310). The shallow aquifer is not in the Waukesha City limits, making wellhead protection for public health difficult and subjecting the City of Waukesha to lawsuits over environmental harm and adverse impacts to private and municipal wells or surface water bodies. Other similar lawsuits have already arisen in Wisconsin. The shallow aquifer is also more susceptible to contamination than the deep aquifer or Lake Michigan, and not as protective of public health. The shallow aquifer is not a reasonable or reliable long-term source of drinking water.
- Deep Unconfined Aquifer West of the City of Waukesha. The deep unconfined aquifer west of Waukesha has similar environmental, public health and legal concerns as the shallow aquifer. However, because it is even farther from the Waukesha City limits the environmental and legal issues, as well as construction and operation/maintenance costs, will be greater. This alternative was ranked low during the Future Water Supply study because of adverse environmental impacts, impacts to other water users, potential lawsuits and high costs. Since that time, the concerns over environmental impacts and lawsuits have become much greater due to new groundwater laws and lawsuits filed in court over groundwater pumping.
- Surface Water Quarries North of the City of Waukesha. Potential surface water supplies north of the City of Waukesha include three active stone quarries (Payne and Dolan, Vulcan Materials Co. and Halquist Stone Co. quarries). The Payne and Dolan quarry was reported to provide about 2 million gallons per day (mgd) of water in the 2002 Future Water Supply report. However, recent pumping information indicates that only about 0.7 mgd is now available from this quarry. Less water would be available from all quarries during a drought since some of the water comes from rainfall. These quarries are owned and operated by private companies and not planned for future drinking water use. Even if Waukesha were able to purchase the quarries or obtain use of their water, there are significant water quality and public health concerns. Quarry operations use a number of drinking water contaminants such as fuels and solvents that contaminate groundwater. There are numerous potential contamination sources near the quarries that could risk public health. Also, urban runoff (stormwater) has the potential for carrying contaminants into the quarries. Supplementing quarry water with water directly from the Fox River may increase the quantity of water available, but the water quality, public health and regulatory concerns increase. Storing river water in a quarry would cause stagnation and adverse water quality impacts such as algae growth, lack of oxygen and release of undesirable compounds such as iron, manganese and hydrogen sulfide that

can cause "rotten egg" odors in the water. In addition, there are regulatory and environmental issues with injecting surface water into a groundwater source. To potentially develop this water supply source, the permitting process would be extensive because there are no other drinking water quarry supplies in the State. The concerns, unknowns and risks associated with this source make it an unreasonable water supply.

- Surface Water Fox River Alluvium South of the City of Waukesha. Another surface water supply near the City of Waukesha is the Fox River alluvium (an aquifer near the Fox River where wells can extract both Fox River and groundwater). The Fox River alluvium is part of the shallow aquifer and pumping this source has similar adverse environmental impacts, public health contamination and legal concerns described previously. This water source was modeled and evaluated in the Application, along with the shallow aquifer. Water could also be obtained directly from the Fox River. This water supply is limited during drought periods (see Future Water Supply study), and a high percentage of the flow would be wastewater plant discharge. This causes both water quantity and water quality concerns. There are no drinking water supplies from the Fox River in the State, and approval from WDNR would be required. Using the Fox River as a drinking water source could also increase the wastewater treatment requirements and costs for all the wastewater plants that discharge into the Fox River. The surface water supplies near the City of Waukesha (Quarries and Fox River) are not reliable or protective of public health, and using them can cause more adverse environmental impacts than a Lake Michigan supply. They are not reasonable water supply alternatives.
- **Great Lakes Water**. A Lake Michigan water supply provides Waukesha with the most reliable, sustainable source of high quality drinking water, and the least adverse environmental impacts. Lake Michigan water would be recycled back to it's source, making it fully sustainable, drought proof and reliable for the foreseeable future. By not having to rely on deep or shallow aquifers, quarries or the Fox River, the environmental, public health and legal issues associated with those supplies are eliminated. Furthermore, a Lake Michigan supply provides a positive environmental impact by restoring natural groundwater flows toward, rather than away from the Great Lakes basin. Compared to the other water supply alternatives, Lake Michigan is the only reasonable water supply.
- Increased Water Conservation. Water conservation is a key water supply component. Waukesha leads the State in water conservation implementation and has already reduced its water demand significantly. Water conservation will continue into the future and is projected to save another 1mgd. These savings in water use have already been factored into the future water demand projections in the Application. Although conservation helps reduce the amount of water required, additional water is still required to safely meet both current and future water demands.
- **Rainwater Infiltration**. Land can be modified to attempt to increase rainwater infiltration and supplement shallow aquifers. SEWRPC evaluated this in the Regional Water Supply Plan. Modifying over 265 acres over the entire Waukesha county would only increase infiltration by about 1.4 mgd. Although this may be part of a larger scale

water management program, it would be costly, difficult to implement and not provide significant water for a municipal water supply.

Community Water Supply Planning Requirements

Community water supplies are planned for the long-term (50 years or more) and must use reliable, sustainable water sources. Failing to invest in water supply infrastructure that serves a community for the long term results in paying for water supply development twice – the second investment coming due when water sources are depleted or cannot be accessed due to regulations or lawsuits. Water supply planners and designers must also comply with codes written by WDNR and other governing bodies. One such code requires a water supply to meet maximum day water demands 100 percent of the time with the largest well or pump out of service (NR 811). This protects against inevitable equipment failure and provides the needed water for drinking, businesses, and fire protection. Waukesha and every water utility have experienced equipment failures that have limited water production capacity. Not planning for an equipment failure or assuming that water demands will be met 95 percent of the time is not in compliance with codes and not responsible water system planning. Such a plan would not be approved by WDNR and therefore could not be implemented.

A main principal of public drinking water supply is to obtain the water supply source with the highest quality and most reliability. If the highest quality water supply does not have adequate quantity, the next highest quality water supply source is obtained. Using multiple sources of water is possible when necessary, but increases costs along with operational and maintenance complexity. In general, water utilities rarely have more than two primary water supply sources. Impacts to the environment can increase if unsustainable sources are used, and public health protection can decrease if lower quality water sources are used.

Multiple Water Supply Sources

This alternative looks at combining water supply sources from continued use of the deep aquifer in the City of Waukesha (30 percent of average day demand), and other sources outside Waukesha including quarry water (25 percent), shallow aquifer and Fox River (25 percent) and the unconfined deep aquifer west of Waukesha (20 percent). This alternative also assumes that it is possible to reduce future average day water demand by 2 mgd through aggressive conservation efforts.

The sustainability, environmental impact, and public health issues with these water sources were discussed previously and detailed in the Application. Although adverse environmental impacts would be reduced if less water is drawn from each source, they would not be eliminated. Lawsuits based on environmental harm have been filed for water withdrawals much less than what Waukesha requires (i.e. *Lake Beulah Mgmt. Dist. v. Dep't of Nat. Res.*, No. 2008AP3170, 2010 WL 2383903, at ¶ 39 (Wis. Ct. App. June 16, 2010). The City of Waukesha's proposed expansion of their current shallow aquifer supply is already drawing opposition.

The cost of obtaining and treating water from five sources (deep aquifer, shallow aquifer, Fox River alluvium, quarries, west unconfined aquifer) is compared to the other water supply alternatives in Table 1, using the same cost criteria as the Application. This multiple water supply alternative would have a capital cost about 75 percent more than the Lake

Michigan alternative. In addition, operational complexity and operation/maintenance costs would be greatly increased because Waukesha would have to obtain and treat different water qualities and blend them to provide a consistent water quality to customers.

Water Supply Alternative	Capital Cost ^a (\$ million)	Annual Operation/Maintenance Cost (\$ million)	20 yr. Present Worth Cost (\$ million, 6%)	50 yr. Present Worth Cost (\$ million, 6%)
Deep and shallow aquifers	189	7.2	272	302
Shallow aquifer and Fox River alluvium	184	7.4	269	301
Lake Michigan and Shallow Aquifer	238	7.5	324	356
Lake Michigan with return flow to Underwood creek	164	6.2	235	262
Deep, shallow aquifers, Fox River, quarries	286	7.6	373	406

TABLE 1

Water Supply Alternative Cost Estimates

^aIncludes direct construction cost, contractor administrative costs (insurance, bonds, supervision etc), 25% contingency, and costs for permitting, legal, engineering, administrative.

Figure 1 shows the cost per thousand gallons of water from each of the water supply sources in the multiple source alternative, and compares it to Lake Michigan costs. Lake Michigan is clearly the most economical water supply source.



Figure 1 – Cost of Water Sources

The impact on residential water rates from the water supply alternatives is shown in Figure 2. Again, Lake Michigan is the most economical water supply alternative. The multiple water source alternative is the most expensive.



Figure 2 – Residential Water Rate Impacts of Water Supply Alternatives

Using these multiple water supply sources provide less public health protection because the supplies are exposed to a number of contaminants over a wider area. Adverse impacts to the environment from using this water are still present, and Waukesha is still exposed to legal challenges due to continuing or increased adverse environmental impacts for using water outside their City limits (all these sources are outside Waukesha City limits except the deep aquifer). Even the deep aquifer wells in the City of Waukesha are subject to groundwater management area regulations and their use could be curtailed in the future. A comparison of this multiple water supply alternative to the other alternatives, using the same criteria evaluated in the Application (Table 2). The multiple water source alternative is the lowest ranked alternative. This water supply alternative, individually or in combination, is not a reasonable water supply alternatives in terms of adverse environmental impact, public health, sustainability and cost.

TABLE 2

Comparison of Water Supply Alternatives

Water Supply Alternative	Environmental Impact	Long-Term Sustainability	Public Health	Implementability		
Deep and shallow aquifers	•	•	0	•		
Shallow aquifer and Fox River alluvium	•	•	0	•		
Lake Michigan, deep and shallow aquifers	•	0	\odot	•		
Lake Michigan	0	0	\odot	0		
Deep, shallow aquifers, Fox River, quarries	•	•	•	•		

No negative impactMinor negative impact

Moderate negative impact
Significant negative impact

Conclusions

A detailed and scientific analysis of Waukesha's water supply alternatives, using criteria required by the Great Lakes Compact, applicable Wisconsin laws and national drinking water standards demonstrates that a Lake Michigan water supply is the only reasonable water supply alternative for the City of Waukesha (Wis. Stat. § 281.346(1)(ps)). It provides the most reliable, economically and environmentally sustainable long-term water supply to meet the reasonable demands for a safe potable water supply for the City of Waukesha. A Great Lakes water supply protects the environmental integrity of the Great Lakes basin ecosystem. A Lake Michigan water supply will result in termination of deep aquifer pumping which will restore the natural flow regime of the groundwater towards the Lake Michigan Basin instead of away from it. This will materially reduce the negative environmental impacts of using groundwater and improve the Great Lakes groundwater and surface water-related ecosystems.

This analysis also demonstrates that that there is no reasonable water supply alternative to a Lake Michigan supply within the basin in which Waukesha is located. The groundwater, surface water and quarry water supply options near Waukesha have much greater negative environmental impacts than using Lake Michigan, are not sustainable long-term and are not as protective of public health.