

IntraDepartmental MEMORANDUM

TO: Director Brian Baker, Board Chairman, GLWA

FROM: Grant Gartrell, Director of Engineering
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COPY: Cheryl Porter, Chief Operating Officer, Water and Field Services

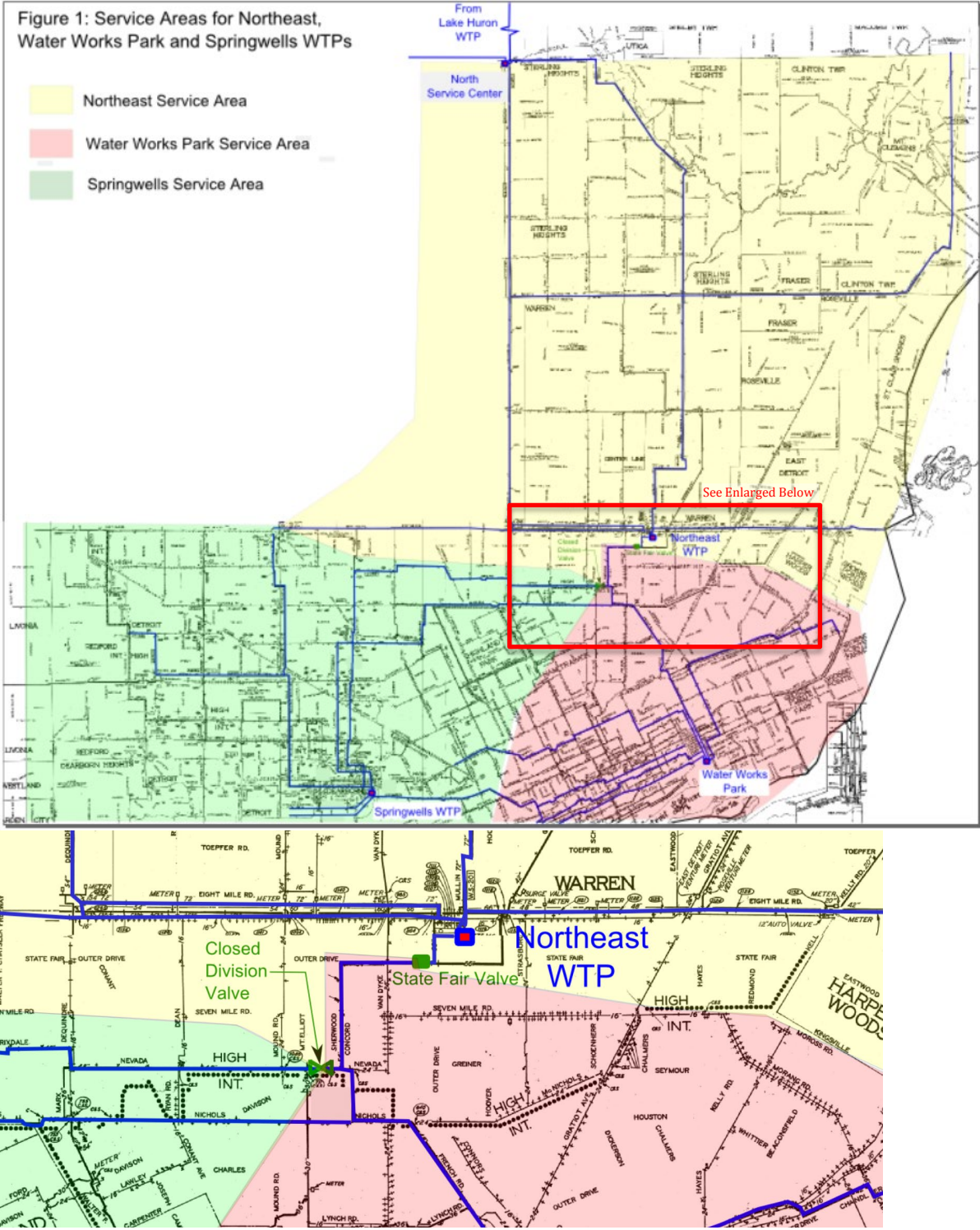
SUBJECT: Cost-Benefit and Risk Analysis for GLWA Contract No. 1803258, Northeast Flow Control Station

DATE: June 19, 2019

The purpose of this memorandum is to present a cost-benefit and risk analysis for the subject proposed contract that the GLWA Board will be asked to approve at its June 26, 2019 board meeting. As indicated in the board letter, the two principle drivers for this project are (1) it would provide finished water supply redundancy beyond what GLWA has today between the Northeast (NE), Springwells (SP) and Water Works Park (WWP) water treatment plants; and (2) re-align treatment capacity with projected water demands. This cost-benefit and risk analysis will focus on the first project driver, namely providing the additional finished water supply redundancy, as well as some other operational and system benefits not discussed in the board letter.

Overview of Current System

The existing water supply system currently operates with distinct system boundaries. Figure 1 provides an overview of the service areas for the Water Works Park, Northeast, and Springwells service areas and an enlarged figure of the State Fair Valve, which currently provides the only means to transfer flows between the service areas. The State Fair Valve is typically closed but has been used to transfer flows from the Water Works Park WTP to the Northeast WTP. There is also a normally closed gate valve along Nevada Avenue that serves to isolate the Water Works Park and Springwells service areas. This valve which is always closed never transmits flows between these service areas.



Current Water Supply System Limitations

To understand the benefits of the proposed Northeast Flow Control Facility, it is important to understand the current limitations in the existing water supply system:

1. Excessive system pressures during Water Works Park low demand season
The Water Works Park WTP annual average production is about 60 million gallons per day (mgd). However, system demands for Water Works Park WTP during the wintertime can drop to as low as 40 mgd. During these low flow conditions, the Water Works Park high lift pumping units are oversized for this flow rate and cannot be turned down to the 40 mgd flow rate without causing excessive discharge pressures within the service area.
2. Limited flow capacity for existing 30-inch State Fair Control Valve
The existing State Fair Control Valve was primarily designed to transfer finished water from Water Works Park WTP to the Northeast WTP filtered water conduit. The State Fair Valve is 30-inch in diameter and cannot transmit more than 20 mgd of finished water without experiencing damaging cavitation to the control valve. This flow capacity limits the ability of the Water Works Park WTP to supplement flows to the Northeast WTP. Furthermore, this flow capacity severely limits the ability of Northeast to back up the Water Works Park service area during a loss of service scenario at the Water Works Park WTP.
3. Limited ability to take Northeast WTP filtration system out of service without severely impacting treatment capacity
The Northeast WTP filtration system has a single feed backwash system to both the east and west filtration systems at the WTP. This means that in order to perform maintenance and capital upgrades to the filtration backwash system, half of the filtration system must be taken out of service, which reduces the Northeast WTP capacity from 300 mgd to 150 mgd. The Northeast service area demands typically exceed 150 mgd during the months of May through September. If extensive maintenance and capital upgrades were performed on the filtration system at the Northeast WTP, the duration required to complete these upgrades would almost certainly require that the work be completed during the summer months. This means that the WTP would have a capacity shortfall during construction, and the existing State Fair Valve would not be able to make up the capacity shortfall during this condition.

Operational Overview of Finished Water Supply Redundancy

The proposed Northeast Flow Control Facility (CIP 122003 currently under review by GLWA Board for approval as part of Contract No. 1803258) coupled with the Carrie and Nevada Flow Control Facility (CIP 122017 to be submitted to the GLWA Board for approval as a separate contract) will provide the water supply system that ability to maintain service during:

1. Loss of service scenarios from the Springwells, Northeast, and Water Works Park WTPs
2. Construction periods for planned capital upgrades that may temporarily reduce the capacity of the WTPs (Northeast filter upgrades example as cited in previous section)

Figures 2-6 provide map overviews of the redundancy scenarios provided with the proposed transmission main upgrades to the system. The scenarios describe the existing conditions where treatment facilities are still in service at the Northeast site and potential future conditions where the treatment facilities at the Northeast site are decommissioned. The scenarios are described as follows:

1. Existing Condition - Normal Operations

Under this scenario, the Northeast flow control facility provides a supplemental finished water supply to the Northeast WTP to relieve high pressures from Water Works Park during low flow conditions.

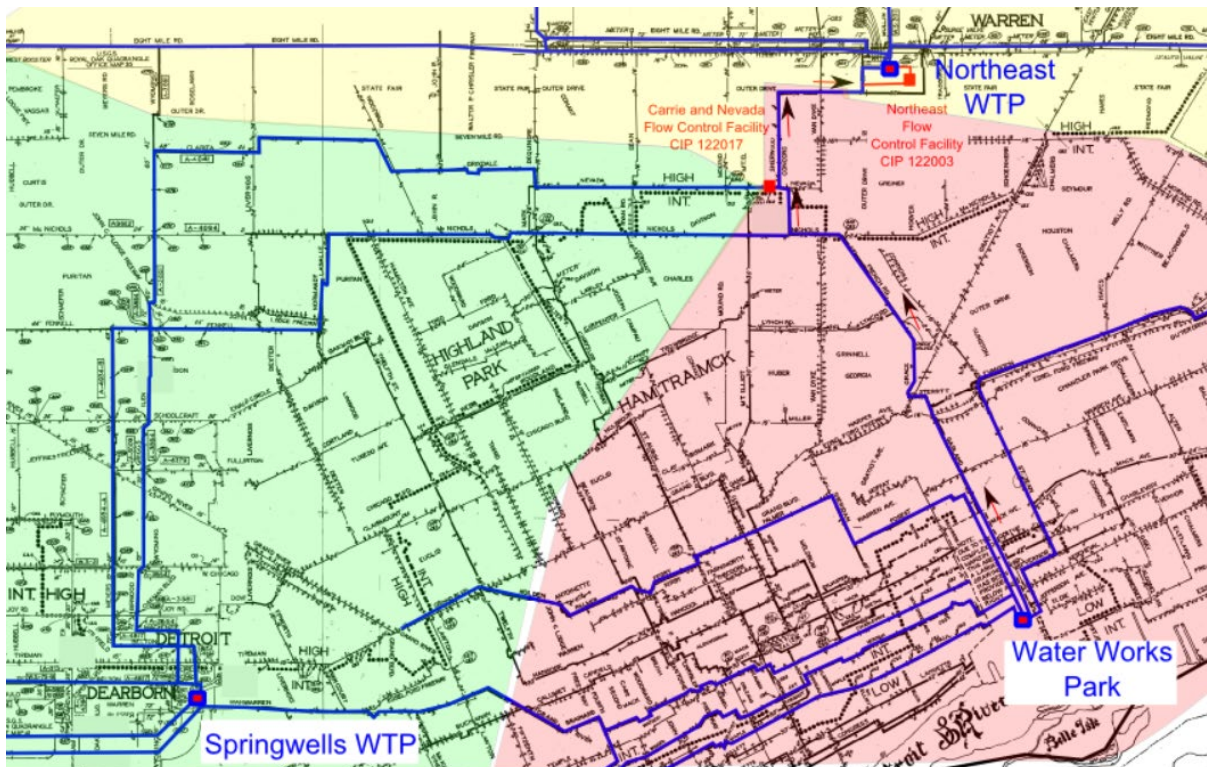


Figure 2: Existing Condition – Normal Operations

- 2. Existing Condition - Standby Operations with service disruption at Northeast WTP
Under this scenario, the Water Works Park and Springwells WTPs provide supplemental flow to the Northeast WTP through the Carrie/Nevada and Northeast flow control facilities.

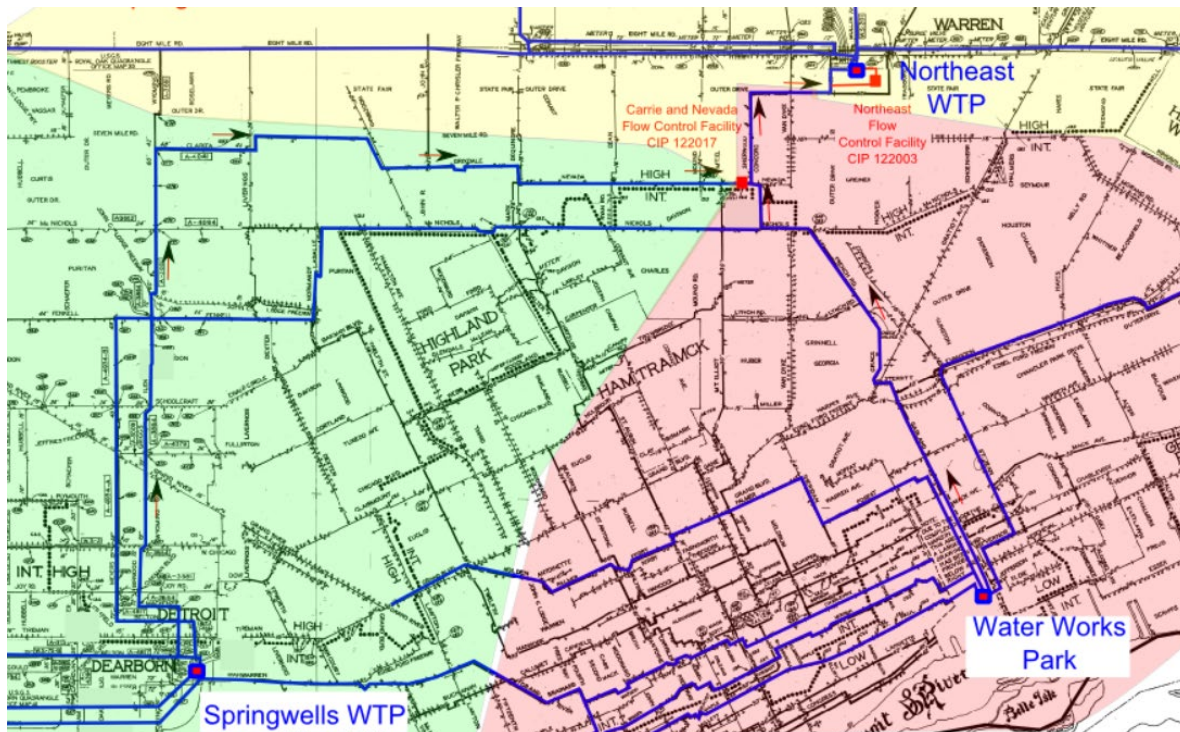


Figure 3: Existing Condition – Standby Service

3. Northeast Re-purposed Condition - Normal Operations

This scenario represents a potential future condition where treatment is decommissioned at the Northeast WTP, the new transmission main is constructed between Water Works Park and Northeast, and the Water Works Parks/Springwells WTPs provide all finished water supply to the Northeast WTP through the Carrie/Nevada and Northeast flow control facilities.

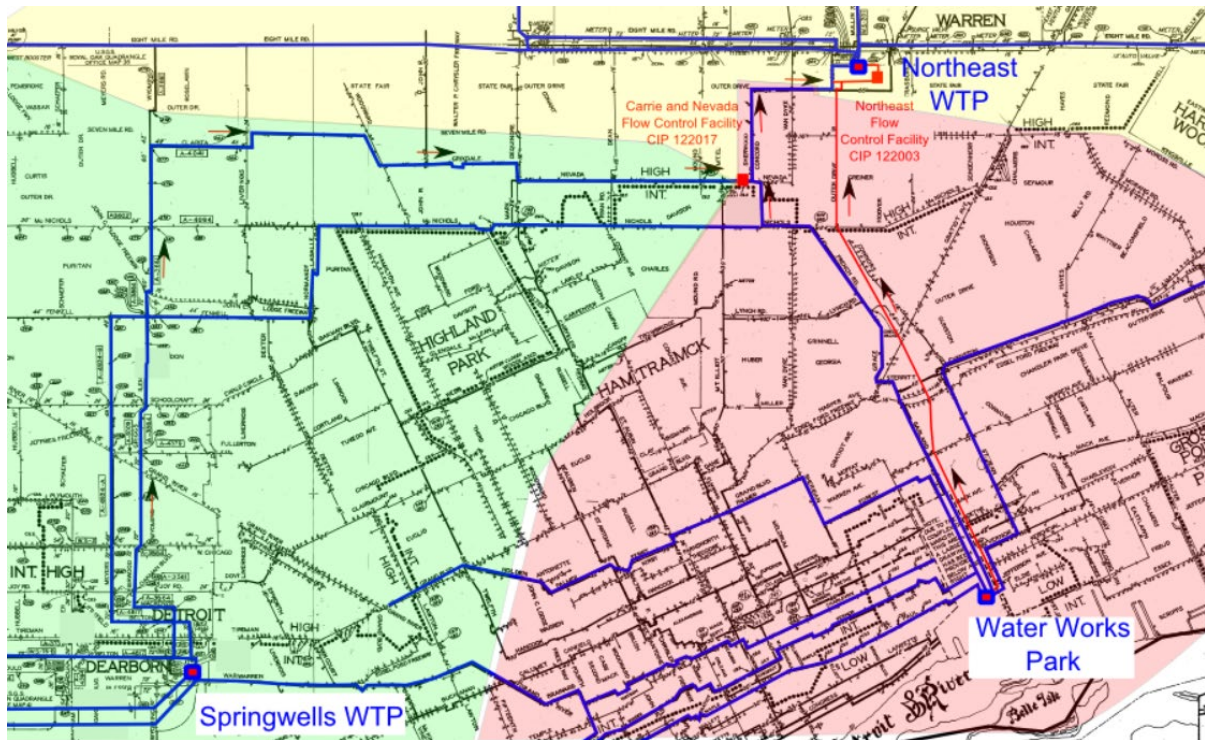


Figure 4: Future Condition – Normal Operations

4. Northeast Re-purposed Condition - Standby Operations with loss of service at Water Works Park WTP

This scenario represents a potential future condition where treatment is decommissioned at the Northeast WTP, the new transmission main is constructed between Water Works Park and Northeast, and a loss of service to the Water Works Park WTP. Under this condition, the Springwells WTP provides all finished water supply to the Water Works Park/Northeast service area through the Carrie/Nevada and Northeast flow control facilities.

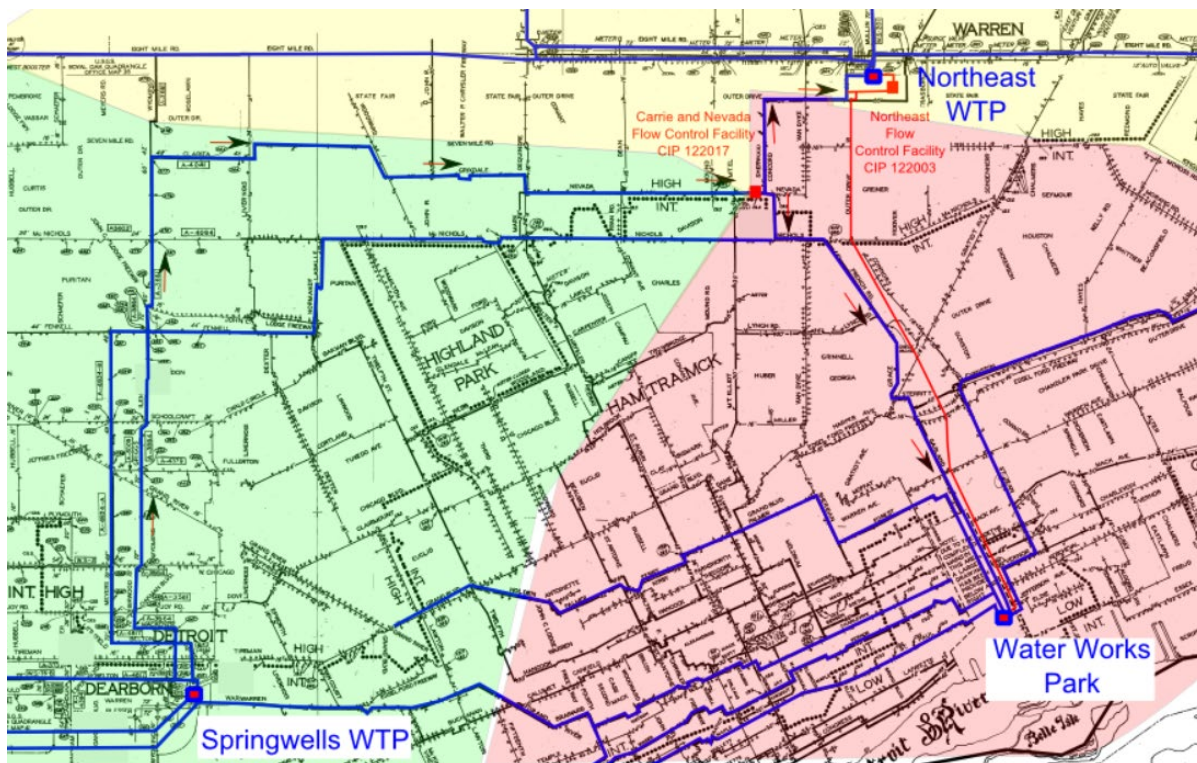


Figure 5: Future Condition – Standby Operations

5. Northeast Re-purposed Condition - Standby Operations with loss of service at the Springwells WTP

This scenario represents a potential future condition where treatment is decommissioned at the Northeast WTP, the new transmission main is constructed between Water Works Park and Northeast, and a loss of service to the Springwells WTP. Under this condition, the Water Works Park WTP provides all finished water supply to the Springwells service area through the Carrie/Nevada and Northeast flow control facilities.

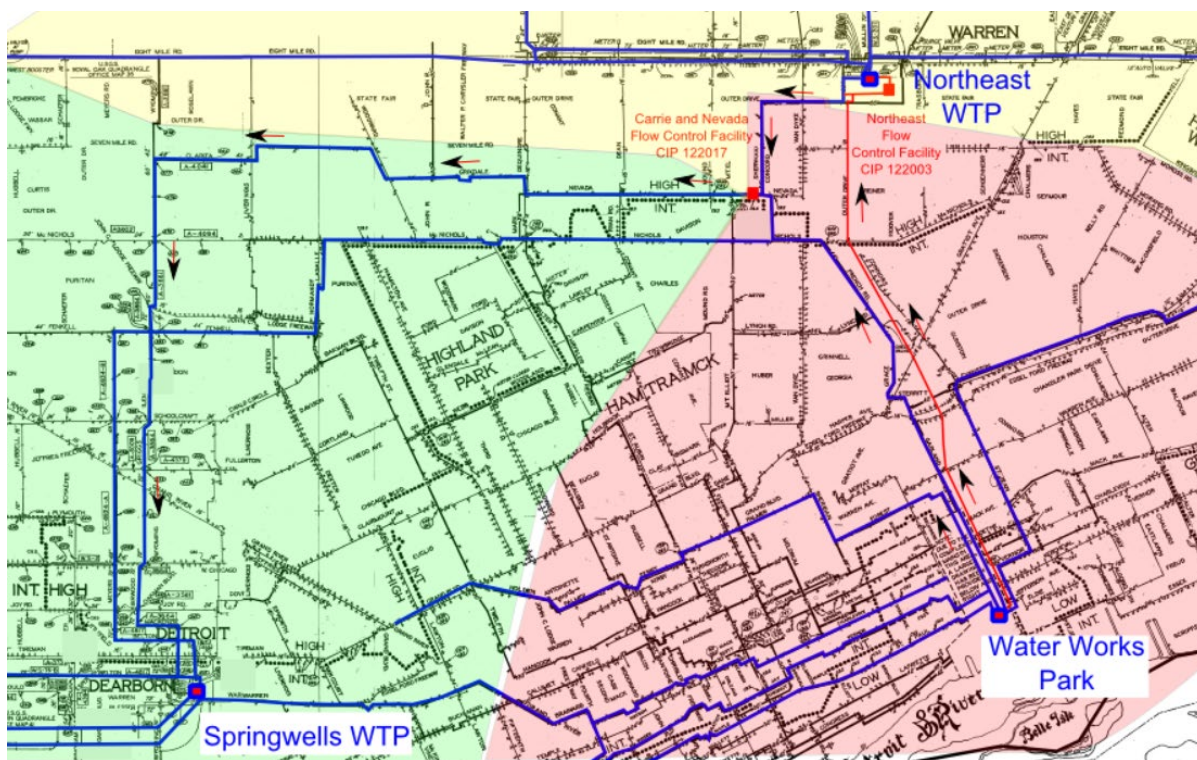


Figure 6: Future Condition – Standby Operations

Operational and System Benefits

1. *Off-Loading Capability* – The proposed Northeast Flow Control Station will provide the ability to off-load excess water production capacity from WWP to the NE service area remotely by GLWA’s Systems Control Center (SCC). This capability does not exist today. The nominal minimum water production of the WWP is about 60 million gallons per day (mgd). The WWP service area has seen its system demands in the wintertime drop well below 60 mgd. Night-time demands during the wintertime regularly approach 40 mgd, which poses significant challenges in not over-pressurizing transmission and downstream water mains during these times. The addition of the Northeast Flow Control Station will allow GLWA’s SCC group to remotely off-load excess water production from WWP to the NE during the wintertime, as system demands warrant. Therefore, the Northeast Flow Control

- Station will benefit the WWP service area and GLWA's transmission mains proximate to WWP in terms of pressure control.
2. *Supplemental Supply to NE Service Area* – The proposed Northeast Flow Control Station will increase GLWA's capacity and efficiency to back up the NE service area whenever NE's capacity is limited or when there are service disruptions at NE. The NE service area includes nearly 500,000 people in Macomb County and nearly 190,000 people in Oakland County. Presently, the NE finished water supply may be supplemented by WWP through the existing State Fair Valve as well as a manually operated butterfly valve inside the NE plant. The flow capacity of this existing infrastructure is no more than 20 mgd. The existing State Fair Valve and butterfly valve have sometimes been used during the summer since 2007 to supplement demands out of NE. The existing 20 mgd capacity is equivalent to about 20% of NE's average day demand. The design capacity of the proposed Northeast Flow Control Station would be 200 mgd, which would supplement the average and maximum day demands of the NE service area.
 3. *Backup Supply to NE during Construction* – The proposed Northeast Flow Control Station would provide backup supply to NE if the decision is made to retain treatment at Northeast. If NE treatment is retained, the all treatment processes will need to be reconstructed. This construction effort would require that major portions of the treatment plant be shutdown during construction. There would be extended periods of time when only half the plant's capacity (about 100 to 150 mgd depending on the process) would be available. Moreover, at times when critical treatment-related infrastructure is replaced that the firm capacity of the plant would be zero. Therefore, the 200-mgd design capacity of the Northeast Flow Control Station would be needed during the multi-year long process of reconstructing the treatment facilities at NE.

Benefit Analysis

There is little industry data that places a value on the above-mentioned benefits associated with avoiding boiled water notices. We have attempted to assign a reasonable value based on the cost of avoiding a typical boiled water notice. Avoided costs include estimated lost revenue from water sales, potential income losses to the affected employment base, and the estimated cost of post boiled water notice actions. The value associated with these avoided costs are presented below. They are all based on an assumed 7-day boiled water notice (BWN).

Avoiding Lost Revenue – GLWA's water charges are comprised of fixed costs and variable costs. Under a boiled water notice or disruption of service, water usage reduces so we assumed that the variable charges would be zero. Using the average day demand of the NE service area, the approximate lost revenue would be \$350,000 during a 7-day BWN.

Avoiding Income Loss to Affected Employment Base – using employment figures and median household income data from Deloitte, Datawheel and Collective Learning available at <https://datausa.io> the potential income loss is about \$90-million over a 7-day BWN if the service disruption is severe enough to close businesses. This figure is based on employment numbers in the cities of Warren, Sterling Heights, Fraser, St. Clair Shores, and Roseville. Additional impacts would be noticed in Clinton Township (data not available) and a few Oakland County communities such as Madison Heights, Hazel Park, Oak Park, Royal Oak Township and Pleasant Ridge.

Avoiding Post Boiled Water Notice Actions – businesses, food establishments, healthcare facilities, pool operators, residents, and schools and daycares all have actions that should be taken after a BWN has ended. There is a cost associated with these actions. The Oakland County Health Division has developed action item checklists specific to these entities. Post-BWN actions that are common to these entities flushing premise water plumbing, replacing aerators, clearing hot water tanks and piping, replacing water filters, clearing dishwashers, discarding ice from ice machines, etc. The total number of businesses and households in the Centerline, Warren, Sterling Heights, St. Clair Shores, Roseville, Fraser, Hazel Park, Ferndale, Oak Park, and Madison Heights were obtained from the U.S. Census Bureau. The estimated cost of post-BWN actions is \$12-million assuming a unit cost of \$50 per business and household to conduct the recommended actions.

The value of these benefits will be estimated by the product of the total benefit value and the PoF (0.88 per the BCE). Therefore, the benefit values are as follows:

Benefit	Value	PoF	Assigned Value (rounded)
<i>Avoiding Lost Revenue</i>	\$350,000	0.88	\$300,000
<i>Avoiding Income Loss to Affected Employment Base</i>	\$90,000,000	0.88	\$79,000,000
<i>Avoiding Post BWN Actions</i>	\$12,000,000	0.88	\$10,500,000
Total Estimated Benefit Value			\$90,000,000

Benefit-Cost Ratio

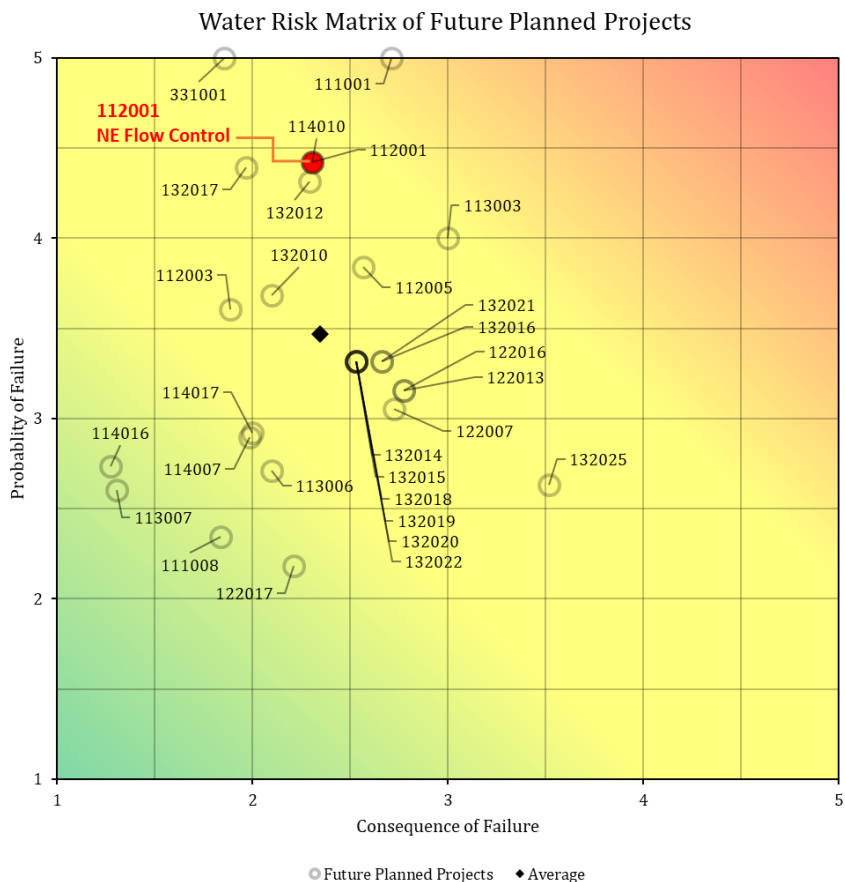
The benefit-cost ratio (B/C ratio) is calculated by dividing the benefit value by the project cost. The B/C ratio for this proposed project is 3.7 using the total estimated benefit value and the proposed contract amount.

Risk Analysis

The product of the probability that a failure will occur and the consequence of failure when that event occurs is the measure of risk by which the proposed Northeast Flow Control Station will be evaluated. Therefore, the measure of risk in equation form would be:

$$\begin{aligned} \text{Risk} &= \text{PoF} \times \text{CoF}, \text{ where} \\ \text{PoF} &= \text{probability of failure} \\ \text{CoF} &= \text{consequence of failure} \end{aligned}$$

The scores for both *PoF* is calculated based on the business case evaluation (BCE) review committee scores in the categories of condition, performance/reliability, and operation and maintenance impacts. The *CoF* is calculated based on BCE review committee scores in the categories of regulatory, public health/safety, public benefit, financial, and efficiency/innovation impacts of the proposed project. The BCE scores were used to calculate a *PoF* of 4.4 and a *CoF* of 2.3 for the CIP #112001, Northeast Flow Control Station. The *PoF* score is reflective of the fact that this project would eliminate single feed systems between three WTPs, provide backup finished water supply to the WTPs, and also provide backup to the transmission systems that emanate from these WTPs. The *CoF* is reflective of the large population served by the WTPs. These scores are plotted on the water risk matrix below excerpted from the FY20 CIP. Compared to other future planned projects, the Northeast Flow Control Station ranks 4th in priority on a risk basis. The overall ranking of this project is representative of the relative effectiveness of interconnecting (looping) WTPs and their associated transmission systems versus other capital improvement projects such as rehabilitating individual pipes.



Additional Considerations

In addition to the criteria considered in the BCE scores, there are the intangible impacts caused by boiled water notices that deserve mentioned - most notably, public trust and confidence. The issuance of boiled water notices is always a difficult message to deliver to the public and to manage during and after the notice if lifted. As GLWA’s infrastructure continues to age, the incidents of failures that result in boiled water notices may become more frequent. Therefore, proposed projects such as the Northeast Flow Control Station that improve system redundancy also serve to protect public confidence and trust in the water utility.