Englishman River Water Service Water Treatment Plant Expansion – Redefining Project Scope and Phasing

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1. Summary

On July 7, 2014, staff from the City of Parksville prepared a Loan Authorization Bylaw Report to Council that reviewed different funding alternatives for the project to determine impacts on water rates and development cost charge rates, including the availability and magnitude of potential provincial and federal funding assistance. This report concluded that due to potential economic impact of the required rate increases on the community, it would not be fiscally responsible to proceed with the entire scope of the project as outlined in the pre-design report without provincial or federal government funding assistance. As an alternative, staff recommended a phased approach to develop the project that better matches the available funding and mitigates the impacts on current rates.

This technical memorandum summarizes advantages and disadvantages, criteria, technical scoring, and capital costs for four options to implement the project within the revised budget. The highest value phased option was then compared to the approach in the pre-design report scope to determine which provided the best financial outcome to Englishman River Water Service (ERWS).

Working with ERWS staff, a workshop was conducted to identify the four options and facilitate and document an objective and systematic review and evaluation of these options. Evaluation criteria were identified and categorized into one of four primary criteria: water quality, technical, social, and natural environment considerations. Weighting factors and guidelines to quantitatively apply each criterion to the options under consideration were developed during the workshop. Class 4 capital cost estimates were developed for each option that would be included in the Phase 1 and Phase 2 expansions.

At the end of the workshop, the team identified Option 4 as the best value to ERWS if the project was to be implemented in phases. This option consists of a first phase with 16 ML/d packaged filtration and disinfection water treatment plant (WTP) and full transmission mains for the City of Parksville (CoP) and the Regional District of Nanaimo (RDN). To meet the Phase 1 budget, this option, and any of the phased options, requires basing the initial capacity on un-factored demands projections (no safety factor) and assuming the existing groundwater wells capacity would remain at 11.8 ML/d for the next 8 years. To mitigate the inherit risk of these assumptions and to be able to meet water demands beyond 2026, ERWS would need to build Phase 2 to 24 ML/d in 2024 or 8 years after the 1st phase.

The initial and total capital costs for Option 4 would be $18,396,200 and $43,499,700, respectively. In comparison, building the infrastructure per the pre-design report (2016) costs $ 40,116,200 (Option 0). The cost for the 1st phase of the phased option is certainly lower but having to expand and upgrade the WTP within 8 years has no financial advantage over the pre-design report option given the ERWS would need to borrow money over a 20-year term. In other words, for the phased option to be more financially attractive compared to the pre-design option, the second phase would need to be implemented in 20 years or later to offset the higher total capital cost. Therefore, the team recommended to proceed with the approach outlined in the pre-design report.

2. Background

ERWS provides drinking water to the CoP and the Nanoose Bay Peninsula (NBP) in the RDN. Water for the CoP system is supplied from 19 wells and an intake in the Englishman River. Water treatment is limited to chlorination of the river water. Water for the NBP system is supplied from seven wells year-round and augmented in the summer from the CoP system.

With the limited availability of groundwater supply sources in the area, building the Arrowsmith dam in 1999 was the first part of the water supply system development, and a critical element. The dam collects and stores water during winter for release back to the Englishman River in the summer for fisheries enhancement and drinking water use.

The next part of the water system development was intended to address the CoP's and RDN's need for additional drinking water, and Island Health's (IH's) requirement for additional water treatment by December 31, 2016. The project scope, costs, and implementation plan were detailed in the Pre-design Report for the Water Intake, Treatment Plant and Supply Mains submitted on June 4, 2014. The report called for a new Englishman River intake structure; river pump station; raw water main; water treatment plant including filtration, disinfection, and high lift pumping; and two transmission mains, at a total cost of $32,244,602 (not including engineering during construction or tender costs). In addition, the cost would increase to $36,984,484 if the 2018 distribution system improvements were included.

On July 7, 2014, staff from the City of Parksville prepared a Loan Authorization Bylaw Report to Council that reviewed different funding alternatives for the project to determine impacts on water rates and development cost charge rates, including the availability and magnitude of potential provincial and federal funding assistance. This report concluded that due to potential economic impact of the required rate increases on the community, it would not be fiscally responsible to proceed with the entire scope of the project as outlined in the pre-design report without provincial or federal government funding assistance. As an alternative, staff recommended a phased approach to develop the project that better matches the available funding and mitigates the impacts on current rates. This phased approach would address immediate capacity issues for both the CoP and the RDN Nanoose area and would see the filtration component of the project be constructed at a later date beyond 2016. The revised capital budget for the first phase of this approach is approximately $19,340,000. CoP Council recognized the potential hardships to residents and recommended a delay in borrowing until government funding is secured. To date it remains clear that no financial assistance from senior government will be made available until the summer of 2015.

On August 1, 2014, the ERWS advised IH that due to financial constraints, the CoP and the RDN (NBP Water System) are not in a position to meet the December 31, 2016, date set out in the Operating Permit. On August 29, 2014, Island Health advised the City that if they are unable to comply with the December 31, 2016, compliance date, that we must submit a request to amend our Operating Permit that would include a revised schedule that would show the timeline when compliance is met with the construction of the WTP. In the interim, until the WTP is constructed, IH also requested that the ERWS provide a comprehensive review of the source water protection program and the emergency response plan in order to identify and respond to any activity that may impact or cause changes to the source water.

This technical memorandum summarizes advantages and disadvantages, criteria, technical scoring and capital costs for four options to implement the project within the revised budget. The highest value phased option would then be compared to the approach in the pre-design report scope to determine which provides the best financial outcome to ERWS, in order to gain direction from the ERWS Board and report back to Island Health on a revised compliance date.

Working with ERWS staff, a workshop was conducted to confirm four options to implement the revised phased project, the purpose of which was to facilitate and document an objective and systematic review and evaluation of these options. All options were developed on the basis of meeting the revised capital budget but not necessarily the same level of treatment or capacity.

Source water quality risks and IH treatment requirements identified in the pre-design report were used during the workshop. Evaluation criteria were identified and categorized into one of four primary criteria: water quality, technical, social, and natural environment considerations. Weighting factors and guidelines to quantitatively apply each criterion to the options under consideration were developed during the workshop.

Class 4 capital cost estimates were developed for each option that would be included in the Phase 1 and Phase 2 expansions. The “value” of each option was calculated based on the ratio of benefits to cost, the purpose of which was to identify the alternative that represents the greatest benefit at the lowest cost.

3. Water Demand and Planning Horizons

The pre-design report summarized the existing and projected future demands for ERWS. These projections account for a 25% safety factor (factored demands) to allow for uncertainties in future growth and population, changes in water use, and potential climate change and its effect on irrigation. The original factored projections justified an initial WTP of 24 ML/d that would address demand in the region until 2026 (actual factored demand of 22.2 ML/d).

Based on the new phasing approach and budgetary constraints, the initial capacity of the phased WTP would be 16 ML/d (Phase 1 built in 2016) based on un-factored demands. This assumes that the groundwater well system can supply 11.8 ML/d during peak demand periods and the initial WTP capacity meets regional demand until 2026. To mitigate the risk of using these assumptions, the Phase 2 expansion would occur in 2024 to meet the 24 ML/d factored demand by 2026. Table 3-1 summarizes the proposed phasing approach. Please note that the intake screen and raw water supply mains are provided for the ultimate capacity of 48 ML/d as it is not practical nor cost-efficient to build these in multiple phases.

TABLE 3-1
Proposed Sizing and Phasing of Infrastructure

Infrastructure	Nominal Capacity (millions of litres per day, ML/d)	
	Phase 1, 2016	Phase 2, 2024
Intake Screen and Weir	48	48
Raw Water Pump Station	16	24
Raw Water Supply Main to WTP	48	48
WTP and highlift pump station	16	24

4. Scope and Treatment Options

This section summarizes the four options that were identified to re-define the scope of Phase 1 of the project. The team initially considered building the Phase 1 treatment facility in the existing intake site, but this option received no further consideration. The existing intake is 40 years old and has limited capacity (less than 12 ML/d), is downstream of the majority of urban development, is prone to flooding because of its location in a flood plain and has limited land available to install the required WTP infrastructure. This change would also require revisions to the Change of Works application, water licence, and environmental assessment which would delay the project. Therefore, the team agreed to select options for Phase 1 on the basis of meeting the projected un-factored demands (16 ML/d), the Phase 1 budget, and minimizing the amount of re-work required in Phase 2 to match the scope in the pre-design report.

Table 4-1 summarizes the treatment train included with each option. Table 4-2 summarizes IH treatment requirements. Table 4-3 summarizes the scope of Phase 1 and 2 for each option. Figures 4-1 to 4-6 show a schematic representation of each option.

- Option 0 – Original pre-design report (filtration and disinfection process, full construction of transmission mains). See Figure 4-1 (pumping and treatment) and Figure 4-2 (distribution system)
- Option 1 – Original PDR process without filtration (disinfection process with full construction of transmission mains). See Figure 4-3
- Option 2 – Disinfection process with a single pump station and no WTP building (disinfection process with full construction of transmission mains). See Figure 4-4
- Option 3 – Smaller capacity packaged filtration and disinfection process, partial construction of transmission mains. See Figure 4-5 (pumping and treatment) and Figure 4-6 (distribution)
- Option 4 – Smaller capacity packaged filtration and disinfection process, full construction of transmission mains. See Figure 4-5

4.1 Option 0

This option is outlined in the pre-design report and provides ERWS with 24 ML/d (firm capacity) of membrane filtration, disinfection with ultraviolet (UV) and chlorine and corrosion control. All transmission mains to connect to the system reservoirs are included. Figures 4-1 and 4-2 show the phasing of Option 0.

4.2 Option 1

This option provides ERWS with 16 ML/d (firm capacity) of disinfection with UV and chlorine and corrosion control. Membrane filtration is deferred to Phase 2. In simple terms, Option 1 is the pre-design report without membrane filtration. Phase 1 includes the WTP building including foundations and buried tanks. All transmission mains to connect to the system reservoirs are included. Figures 4-2 and 4-3 show the phasing of Option 1. As part of the collaborative workshop, the team identified the following advantages and disadvantages with this option.

Advantages

- All infrastructure built in Phase 1 is re-usable for the future expansion. There is little waste and/or re-work to implement Phase 2.
- This option provides dedicated transmission mains to the existing reservoirs which allows for improved operation of distribution system by mixing different water qualities at the reservoirs. Distribution system pipes that are exposed to consistent water quality (particularly pH and alkalinity) and flow direction will result in fewer aesthetic issues (and consumer complaints) compared to when these are variable. For example, blending Englishman River water with the groundwater directly into the distribution system has shown to increase consumer complaints. Mixing the two water sources at the reservoirs would help mitigate these impacts by providing a more consistent blended water quality.

Disadvantages

- This option does not meet all IH 4.3.2.1.0 requirement. To implement this option ERWS would need to negotiate a waiver to avoid filtration and not require monitoring of disinfection by products (DBP) in the distribution system. The DBPs of primary concern are trihalomethanes (THMs), which are regulated. An analysis of applicable regulation and treatment objectives was presented in the pre-design report.
- Historical water quality shows elevated turbidity and colour in the Englishman River during the fall and winter. Since there would be no means to reduce turbidity and colour, WTP operation would be limited to summer operation when DBP precursors and turbidity are lower in the river. However, this would also expose ERWS to having to issue a boil water advisory or require water restrictions in the summer if river turbidity is such that the WTP cannot operate and ERWS has to rely on the groundwater supply only.
- This option provides less flexibility to control water blend (river/groundwater) because the amount of river water will be highly dependent on the river turbidity (which is highly variable). Therefore, this

option could result in a higher number of consumer complaints due to aesthetic issues in the distribution system as a result of the variable blended water quality.

- Conversely, ERWS operators would require a higher level of effort to operate the distribution system to maintain a consistent blended water quality.
- While this option builds most of the treatment infrastructure outlined in the pre-design report. Adding filtration would still require an additional 1.5 years for delivery, installation, and commissioning, which may not be acceptable to ERWS and/or IH.

4.3 Option 2

This option provided ERWS with 16 ML/d (firm capacity) of disinfection with UV and chlorine and corrosion control. Membrane filtration is deferred to Phase 2. Option 2 provides the same treatment performance and capacity as Option 1, but it defers construction of the WTP foundations and building, except for a chemical storage facility. Figures 4-4 and 4-6 show the phasing of Option 2. As part of the collaborative workshop, the team identified the following advantages and disadvantages with this option.

Advantages

- This option provides dedicated transmission mains to the existing reservoirs which allows for improved operation of the distribution system by mixing different water qualities at the reservoirs. Distribution system pipes that are exposed to consistent water quality (particularly pH and alkalinity) and flow direction will result in fewer aesthetic issues (and consumer complaints) compared to when these are variable. For example, blending Englishman River water with the groundwater directly into the distribution system has shown to increase consumer complaints. Mixing the two water sources at the reservoirs would help mitigate these impacts by providing a more consistent blended water quality.

Disadvantages

- Same disadvantages as Option 1.
- The WTP building and equipment would be deferred to Option 2. This would require an additional 2.5 year period to tender, deliver, construct, and commission the WTP. This timeframe may not be acceptable to ERWS and/or IH.

4.4 Option 3

This option provides ERWS with 8 ML/d (firm capacity) of coagulation and packaged membrane filtration and 16 ML/d of disinfection with UV and chlorine and corrosion control. Figures 4-5 and 4-6 show the phasing of Option 3. To be able to keep this option affordable to ERWS, we have made the following modifications:

1. The membrane filtration system would be purchased as a standard packaged system as opposed to a customized engineered system (per the pre-design report). The standard packaged system is limited in capacity, but because it uses standard components it is more economical at the smaller capacities (<8-16 ML/d). At larger capacities, such as required in Phase 2, using packaged systems would not be economical because it would require too many packages (limited capacity). Instead, Phase 2 would use a custom-made engineered system that used larger capacity components and therefore is more economical. We have assumed a standard membrane package for Phase 1 and an engineered system for Phase 2.
2. The WTP building for 16 ML/d is slab on grade. The second stage membrane have been deferred to Phase 2 and all required process tankage is constructed as standard steel tanks.
3. This option also defers the construction of the water main to the industrial reservoir and connects instead at the front of the WTP property at Herring Gull Way. The second water main is partially

constructed to Martindale Avenue, where it then ties directly into the distribution system as opposed to connecting into the Springwood Reservoir (see Figure 4-6 for Phase 1 transmission mains).

As part of the collaborative workshop, the team identified the following advantages and disadvantages with this option.

Advantages

- This option meets all IH 4.3.2.1.0 requirements when operating with filtration.
- The WTP could operate year-round due to the lower demand in winter and the use of filtration. This process would have greater flexibility to operate when river turbidity or DBP precursors are elevated. This option would also give some relief to the groundwater wells during the winter when the river WTP is running.
- Year-round operation would provide better control of the blended water quality in the distribution system, except that the different water qualities would be blended in the pipelines which could cause some initial aesthetic issues.
- Filtration capacity can be expanded quickly from 8 to 16 ML/d because of the use of standard packaged systems. Past project experience shows that this system can be implemented, from issuing a purchase order (PO) to producing water, in 4 to 5 months.

Disadvantages

- Additional effort and costs would be required to incorporate the infrastructure for the 16 ML/d packaged WTP with a Phase 2, custom-engineered WTP.
- The rapid expansion in Phase 1 is limited to 16 ML/d.
- ERWS operators would require a higher level of effort to operate the distribution system to maintain a consistent blended water quality during initial operation. The watermain route on the southeast side of the river and along Martindale Road are within floodplain and thus prone to frequent flooding.
- Adding the Phase 2 infrastructure would still require an additional 1.5 to 2 years for delivery, installation, construction, and commissioning. The cost of the watermain on Martindale would not be recovered and result in it being abandoned.

4.5 Option 4

This option provides ERWS with 8 ML/d (firm capacity) of coagulation, packaged membrane filtration, and 16 ML/d of disinfection with UV and chlorine and corrosion control. Option 3 and 4 are the same except that Option 4 builds all the transmission mains required to connect to the reservoir. Therefore, all the modifications for affordability outlined in Option 3 are the same, except for the construction of the transmission mains. Figures 4-2 and 4-5 show the phasing of Option 4. As part of the collaborative workshop, the team identified the following advantages and disadvantages with this option.

Advantages

- Same advantages as Option 3.
- The inclusion of transmission mains that connect to the reservoirs coupled with the coagulation filtration process provide ERWS with the best flexibility to provide a consistent blended water quality in the distribution system that achieves public health protection and addresses potential aesthetic concerns.

Disadvantages

- Additional effort and costs would be required to incorporate the infrastructure for the 16 ML/d packaged WTP with a Phase 2, custom engineered WTP.

- The rapid expansion in Phase 1 is limited to 16 ML/d.
- Adding the Phase 2 infrastructure would still require an additional 1.5 to 2 years for delivery, installation, construction, and commissioning.

TABLE 4-1
Treatment Provided – Phase 1

Process	PDR	Option 1	Option 2	Option 3	Option 4
Vortex sand separators – The sand separators will remove sand and heavy suspended solids during high turbidity events.	Yes	Yes	No	Yes	Yes
Fine strainers – The fine strainers can remove materials greater than 300 microns prior to membrane filtration.	Yes	Yes	No	Yes	Yes
Coagulation – Coagulation is used in conjunction with membrane filtration for removal of color and disinfection by-product precursors.	Yes	No	No	Yes	Yes
Membranes – UF or MF membranes will remove suspended particles, including pathogens, turbidity, and coagulated colored particles, from water. The membrane package supplied will have a minimum performance guarantee of 3-log removal of *Cryptosporidium* and *Giardia* and 0.5-log removal of viruses. The membrane system will consist of two filtration stages. The first (primary) stage will provide filtered water directly to the UV disinfection system. Spent backwash water from the primary stage will be equalized in UF backwash equalization tanks, filtered by a secondary-stage membrane system, and blended with the primary-stage filtered water prior to UV disinfection.	Yes, 2 stage	No	No	Yes, single stage only	Yes, single stage only
UV disinfection – UV units downstream of the membranes will inactivate pathogens such as *Cryptosporidium* and *Giardia*. The design dosage for the PDR is 10 millijoule per centimetre squared (mJ/cm^2) based on 1-log *Cryptosporidium* inactivation. In the absence of filtration, the UV is required to deliver 3-log inactivation (at a greater dose of 30-40 mJ/cm^2. This requires more powerful units and more energy.	Yes, 1-log inactivation	Yes, 3-log inactivation	Yes, 3-log inactivation	Yes, 1-log inactivation	Yes, 1-log inactivation
Chlorination – Chlorine will be applied to inactivate viruses (4-log minimum inactivation) and subsequently for residual maintenance in the distribution system.	Yes	Yes	Yes	Yes	Yes
Corrosion control – Sodium hydroxide and carbon dioxide will be added to the treated water to raise the alkalinity to 30 mg/L and adjust pH to 9.2.	Yes	Yes	Yes	Yes	Yes
Residuals – Process drains, neutralized chemical solutions, and backwash will be equalized and pumped to the sewer.	Yes	Yes	Yes	Yes	Yes

TABLE 4-2
Treatment Requirements and WTP Performance

Parameter	Virus Reduction	*Giardia* Reduction	Cryptosporidium Reduction	Turbidity Reduction (NTU)
IH requirements	≥ 4 log (Σ)	≥ 3 log (Σ)	≥ 3 log (Σ)	< 0.1 (100% membrane)
Membrane UF/MF	≥ 0.5 log (I)	≥ 3 log (R)	≥ 3 log (R)	< 0.1 (IFE)
UV (7-24 mJ/cm^2) for 1-log, 20-40 mJ/cm^2 for 3-log		1 log (I) with filtration, 3-log in the absence of filtration)	1 log (I) with filtration, 3-log in the absence of filtration)	
Chlorination (@ 1°C)	> 4 log (I)			

Σ = total I and R
IFE = individual filter effluent
NTU = nephelometric turbidity unit
I = inactivation
mJ/cm^2 = millijoule per centimetre squared
R = removal

TABLE 4-3
Scope of Work for Phases 1 and 2

Scope	PDR	Option 1	Option 2	Option 3	Option 4
Phase 1					
Initial WTP capacity	24 ML/d filtration and disinfection (firm capacity)	16 ML/d (firm capacity)	16 ML/d (firm capacity)	8 ML/d filtration, 16 ML/d disinfection (provision for an additional 8 ML/d of filtration)	8 ML/d filtration, 16 ML/d disinfection (provision for an additional 8 ML/d of filtration)
River intake	48 ML/d	48 ML/d	48 ML/d	48 ML/d	48 ML/d
Low lift pump station	Infrastructure for 48 ML/d Pumps for 24 ML/d (2x16 ML/d, 1x8 ML/d)	Infrastructure for 48 ML/d Pumps for 16 firm ML/d (2x16 ML/d)	Infrastructure for 48 ML/d Pumps for 16 firm ML/d (2x16 ML/d) Single set of pumps for lowlift and highlift	Infrastructure for 48 ML/d Pumps for 16 firm ML/d (2x16 ML/d)	Infrastructure for 48 ML/d Pumps for 16 firm ML/d (2x16 ML/d)
Raw water main	48 ML/d	48 ML/d	48 ML/d	48 ML/d	48 ML/d
Transmission main W1	W1 600 mm to springwood reservoir	W1 600 mm to springwood reservoir	W1 600 mm to springwood reservoir	W1 600 mm to Martindale Ave. New 300 mm W1 north on Martindale to connect directly into downtown water main. Defer 600 mm pipeline to Springwood reservoir.	W1 600 mm to springwood reservoir
Transmission main W2	W2 to industrial reservoir	W2 to industrial reservoir	W2 to industrial reservoir	Connect new line in front at Herring Gulf 200 mm water main. Build W2 to LLPS. Defer construction to industrial res	W2 to industrial reservoir
2018 Distribution system improvements	Included	Not included (build in future)	Not included (build in future)	Not included (build in future)	Not included (build in future)
WTP	24 ML/d sand separators, strainers, coagulation, UF, UV, chlorine, caustic/CO2. Building and concrete substructure for 48 ML/d, process for 24 ML/d. 24" UV for 4-log virus inactivation	24 ML/d sand separators, UV, chlorine, caustic/CO2. Building and concrete substructure for 48 ML/d, process for 24 ML/d. 24" UV now for 3-log Crypto inactivation (higher connected load)	Equipment located at LLPS/HLPS 24 ML/d of UV, chlorine, caustic/CO2. 12" UV (3-log Crypto) located at LLPS/HLPS station Use raw water main (to WTP) as chlorine contact tank. Store and dose chemicals in new chemical facility at the yard.	Skid mounted package plant constructed on slab on grade. Same treatment process as PDR. UF sized for 8 ML/d initially and client can add skids as required in the future. No second stage membranes.	Skid mounted package plant constructed on slab on grade. Same treatment process as PDR. UF sized for 8 ML/d initially and client can add skids as required in the future. No second stage membranes.
Chlorine contact tank	48 ML/d, buried concrete	48 ML/d, buried concrete	Use raw water pipe to WTP as a contactor	16 ML/d, 300-400 m^3 above grade steel tank or buried concrete	16 ML/d, 300-400 m^3 above grade steel tank or buried concrete
Highlift pump station	Infrastructure for 48 ML/d Pumps for 24 ML/d (2x16 ML/d, 1x8 ML/d)	Infrastructure for 48 ML/d Pumps for 16 ML/d (2x16 ML/d)	Use LLPS pump as HLPS	Skid mounted pump station Pumps for 16 ML/d (2x16 ML/d)	Skid mounted pump station Pumps for 16 ML/d (2x16 ML/d)
WTP building envelope	Built for 48 ML/d	Layout reconfigured to minimize size of "24 ML/d" building. Building envelope extended when plant goes to 48 ML/d.	No WTP building. LLPS marginally bigger. footprint. New chemical facility that can be reused once WTP is built.	Layout configured for a 16 ML/d building. Building envelope extended when plant goes to 24 or 48 ML/d.	Layout configured for a 16 ML/d building. Building envelope extended when plant goes to 24 or 48 ML/d.
Operations building	Included	Not included (build in future)	Not included (build in future)	Not included (build in future)	Not included (build in future)
Standby power	Included	Not included (build in future)	Not included (build in future)	Not included (build in future)	Not included (build in future)
Site Improvements	Include multiple upgrades	Keep to minimum	Keep to minimum	Keep to minimum	Keep to Minimum

TABLE 4-3
Scope of Work for Phases 1 and 2

Scope	PDR	Option 1	Option 2	Option 3	Option 4
Phase 2					
Future work to match pre-design	None required	Add Standby power. Add 1 more lowlift pump and associated mechanical, electrical and I&C infrastructure. Add 1 more highlift pump and associated mechanical, electrical and I&C infrastructure. Add membrane filtration system, expand building envelope, add operations building, add 2018 distribution system improvements, add remainder of site improvements	Add Standby power. Add 3 new lowlift pump to replace existing. Move 2 'old' lowlift pumps and 1 new highlift pump into new highlift pump station. Build entire WTP and HLPS, except for chemical facility. add operations building, add 2018 distribution system improvements, add remainder of site improvements	Add Standby power. Add 1 more lowlift pump and associated mechanical, electrical and I&C infrastructure. Add operations building, add 2018 distribution system improvements, add remainder of site improvements, add 1 pumps and associated equipment to lowlift, expand WTP to incorporate building envelope for an additional 32 ML/d with 8 ML/d of equipment (new CCT for 32 ML/d, membranes, strainers, and sand separators for 8 ML/d), complete transmission mains W2 from LLPS to industrial reservoir and W1 from Martindale to Springwood reservoir.	Add Standby power. Add 1 more lowlift pump and associated mechanical, electrical and I&C infrastructure. Add operations building, add 2018 distribution system improvements, add remainder of site improvements, add 1 pumps and associated equipment to lowlift, expand WTP to incorporate building envelope for an additional 32 ML/d with 8 ML/d of equipment (new CCT for 32 ML/d, membranes, strainers, and sand separators for 8 ML/d),

FIGURE 4-1
Option 0: Original Pre-design Report

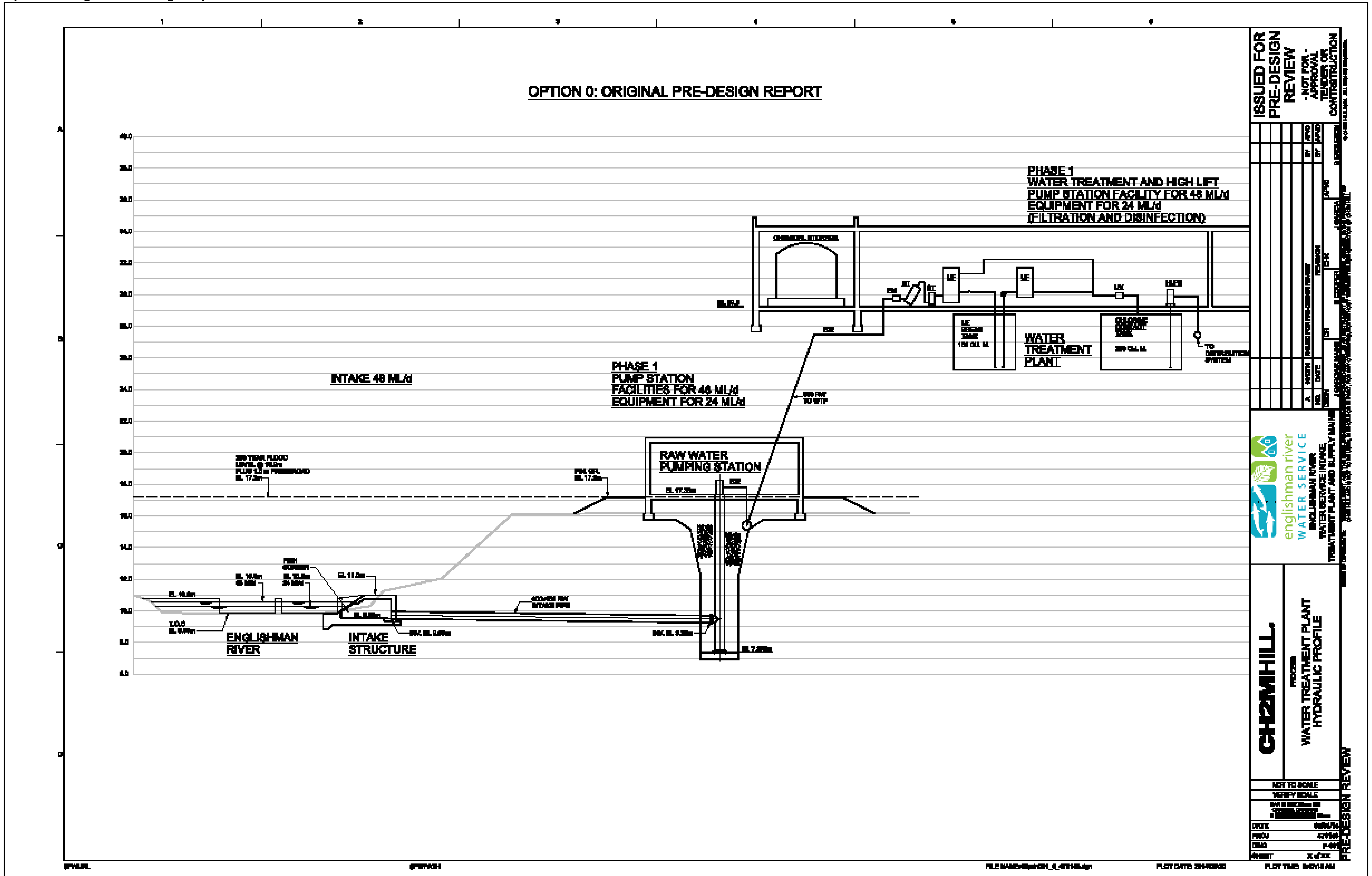


FIGURE 4-2
Transmission Mains for Pre-design Report and Phased Option 1, 2, and 4

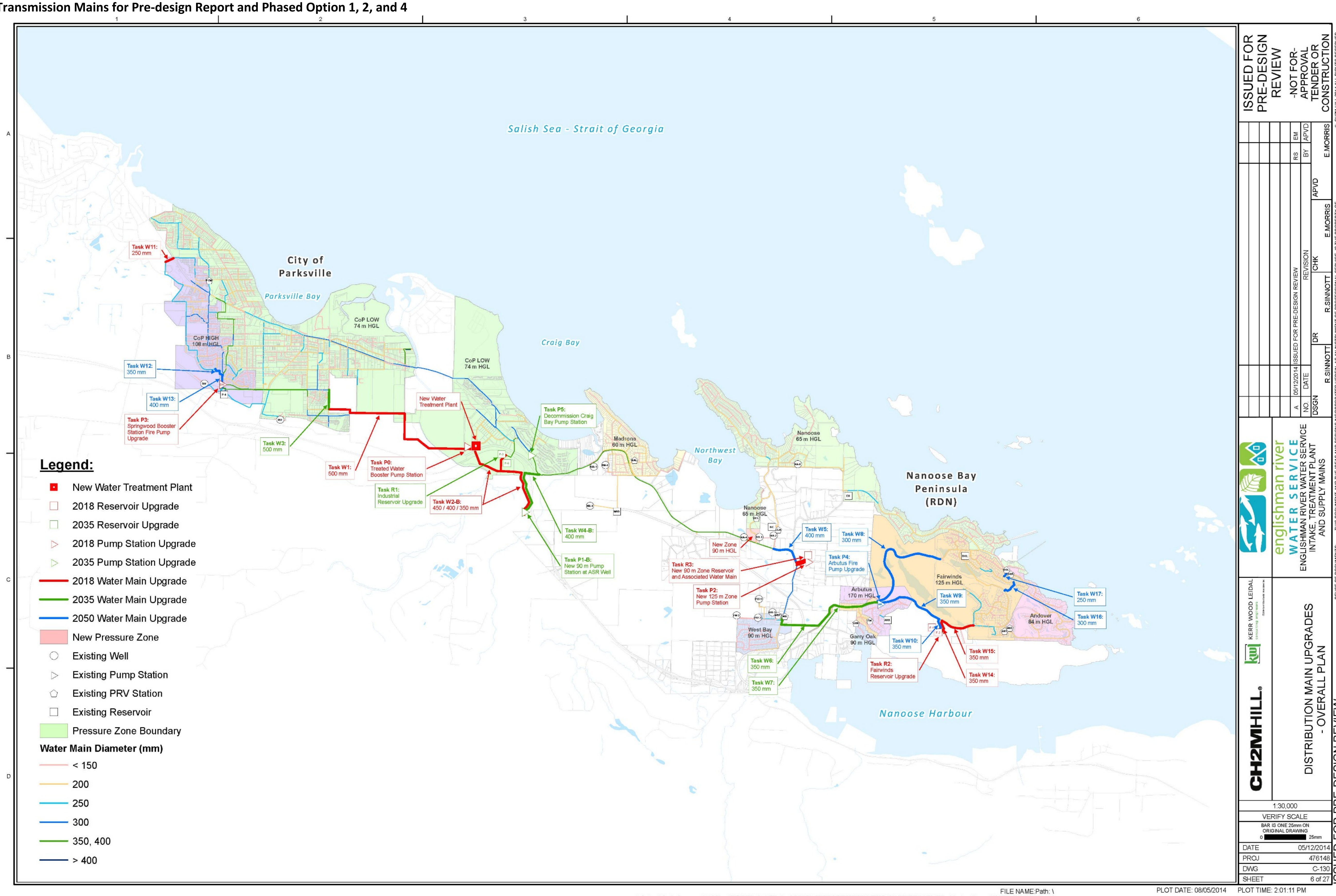


FIGURE 4-3
Option 1: Pre-design Option Without Filtration

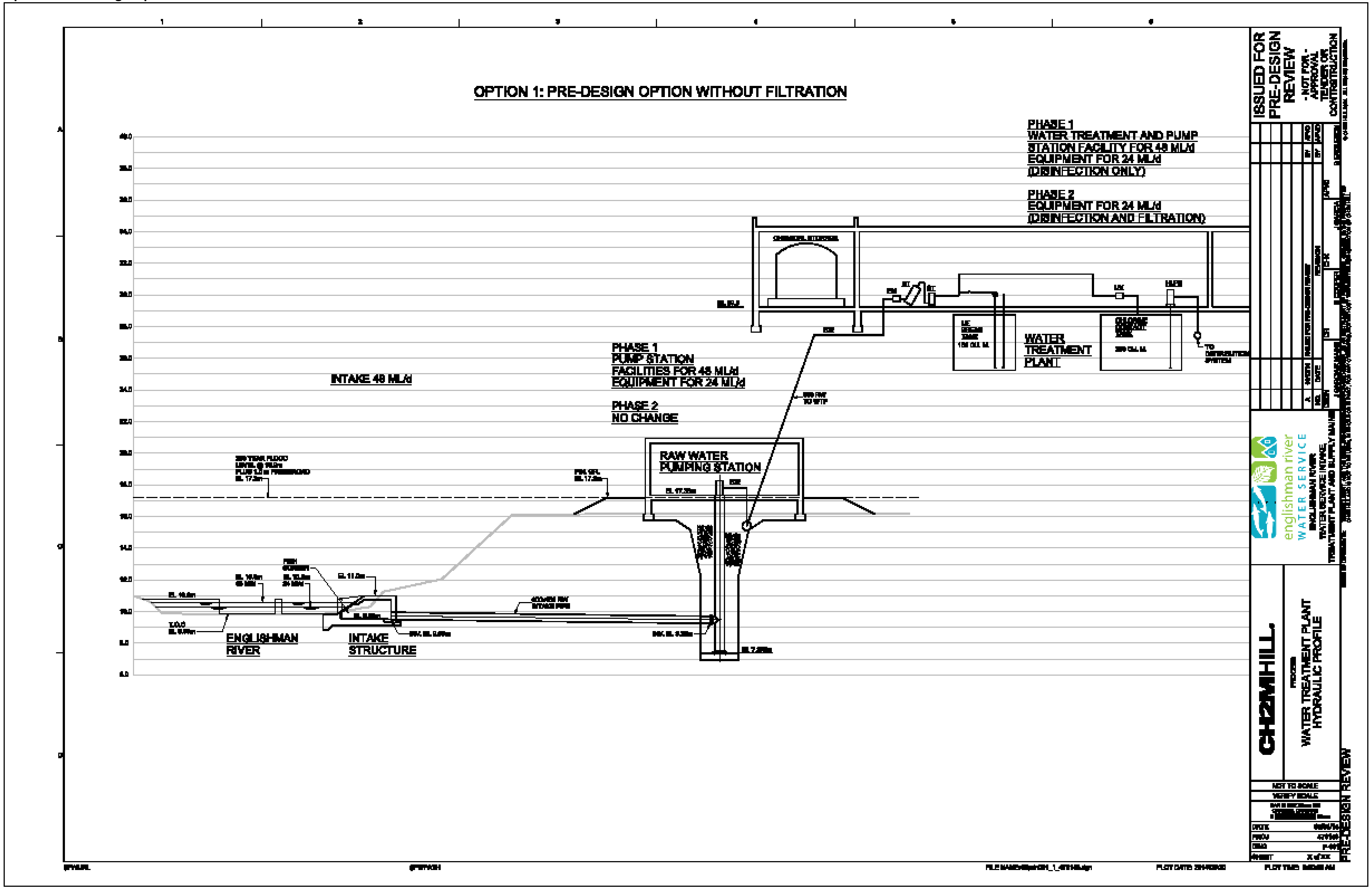


FIGURE 4-4
Option 2: Single Pump Station with Disinfection

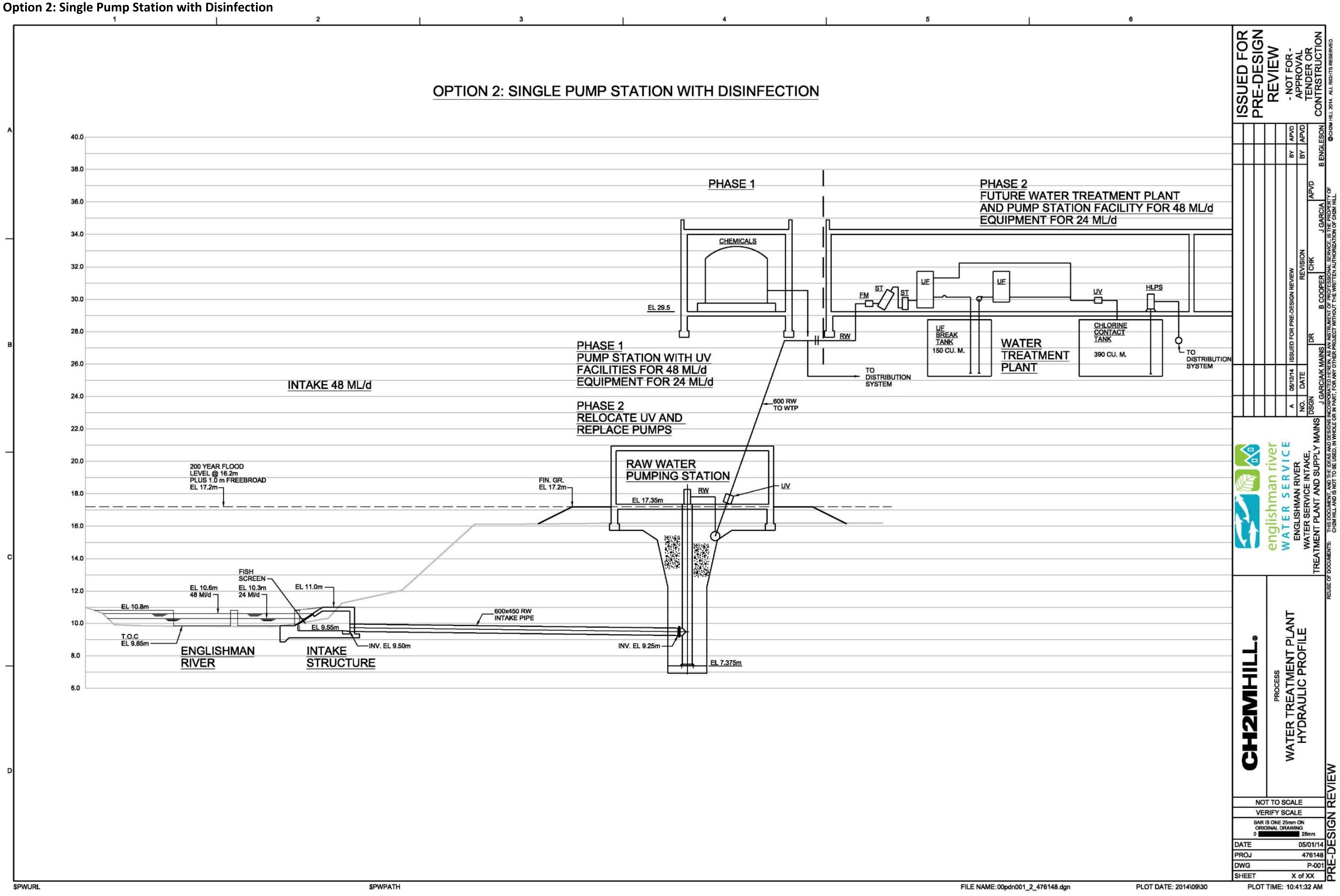


FIGURE 4-5
Options 3 and 4: Smaller WTP

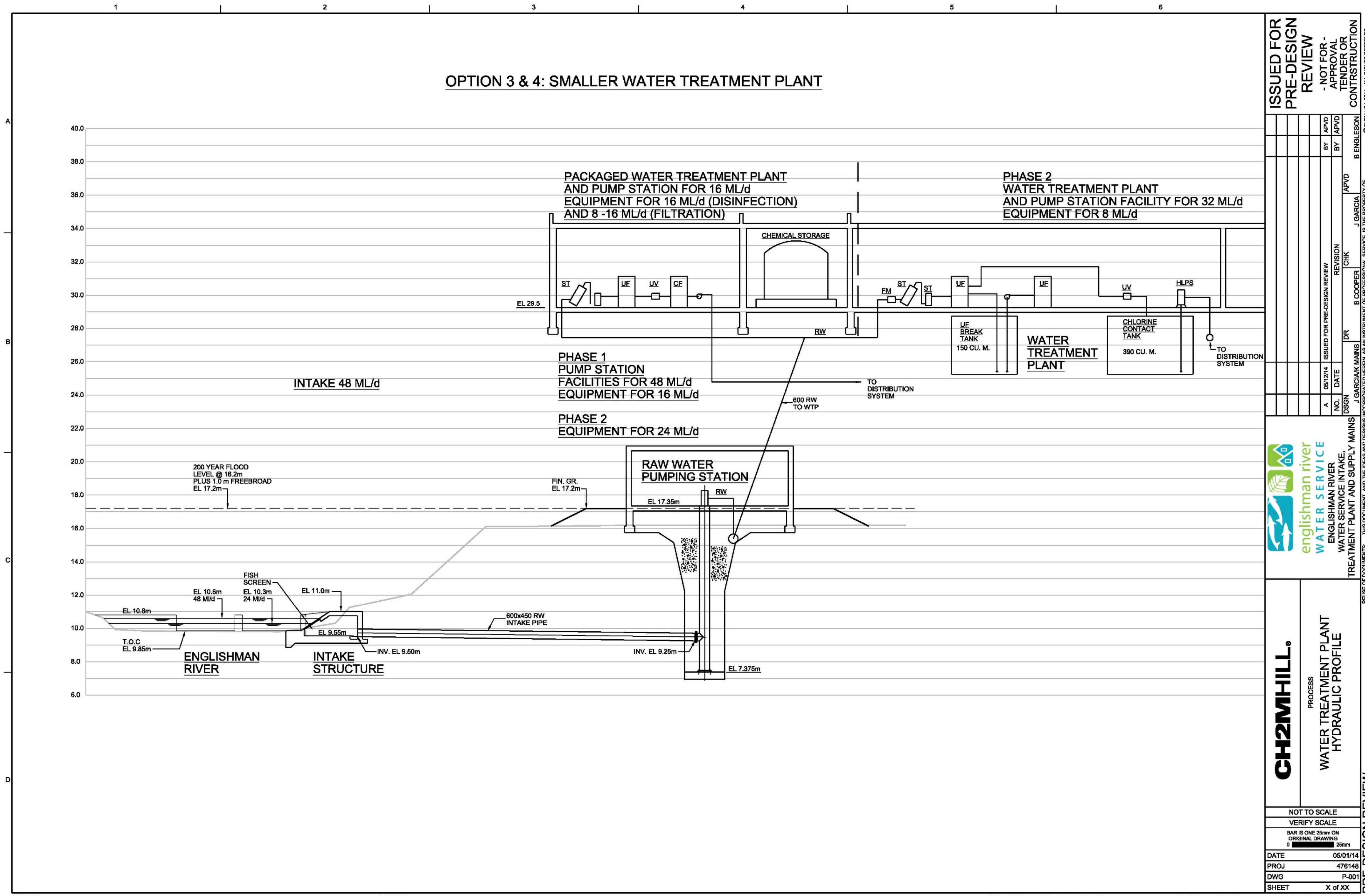
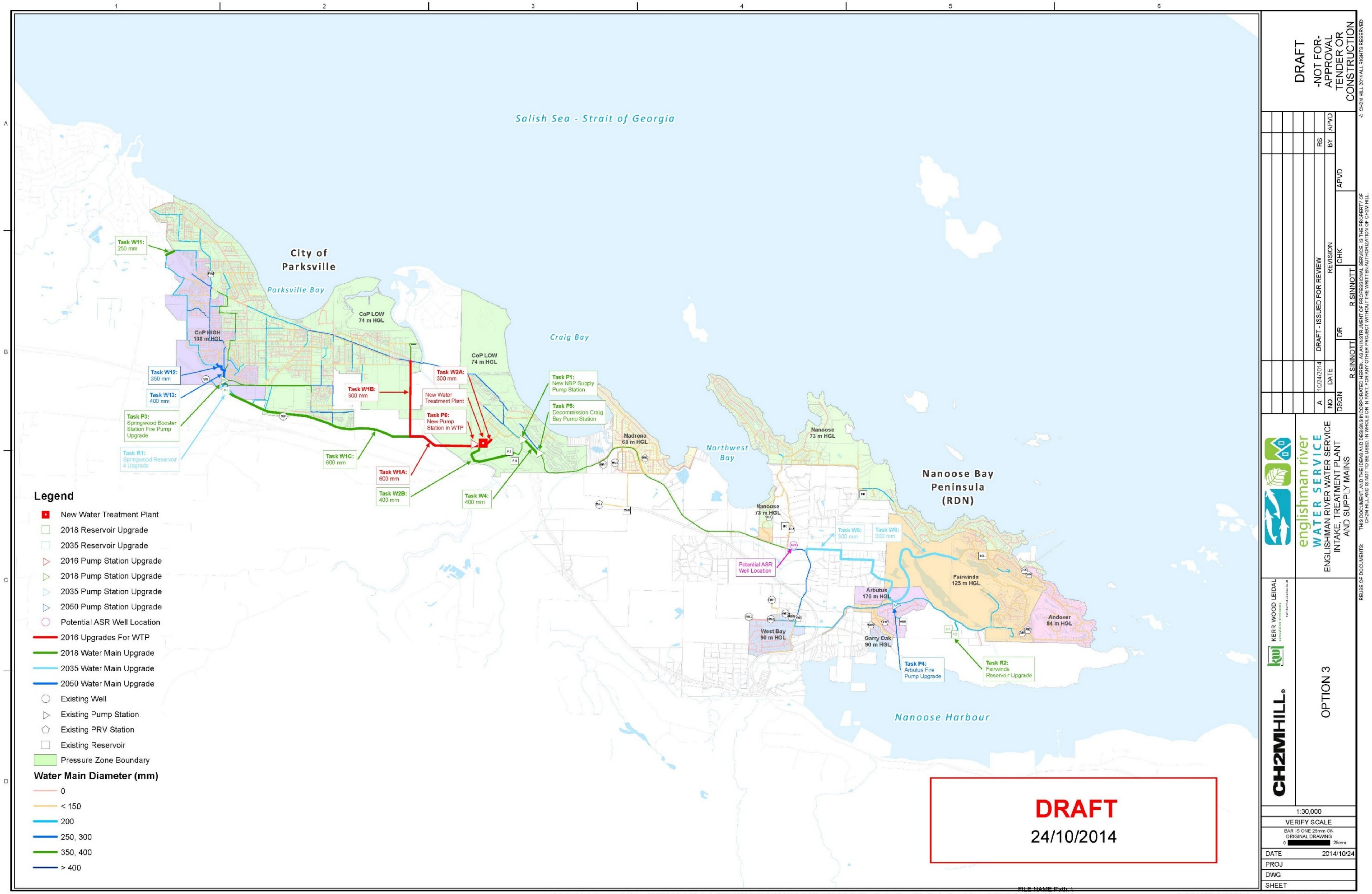


FIGURE 4-6
Transmission Mains for Phased Option 3



5. Evaluation Criteria and Weighting

Once the options were identified and discussed, the team developed primary and secondary evaluation criteria on the basis of representing important non-monetary benefits or attributes of an alternative that are independent, provide differentiation, and are measurable in a quantitative fashion. Table 5-1 summarizes the primary and secondary evaluation criteria.

TABLE 5-1
Primary and Secondary Evaluation Criteria

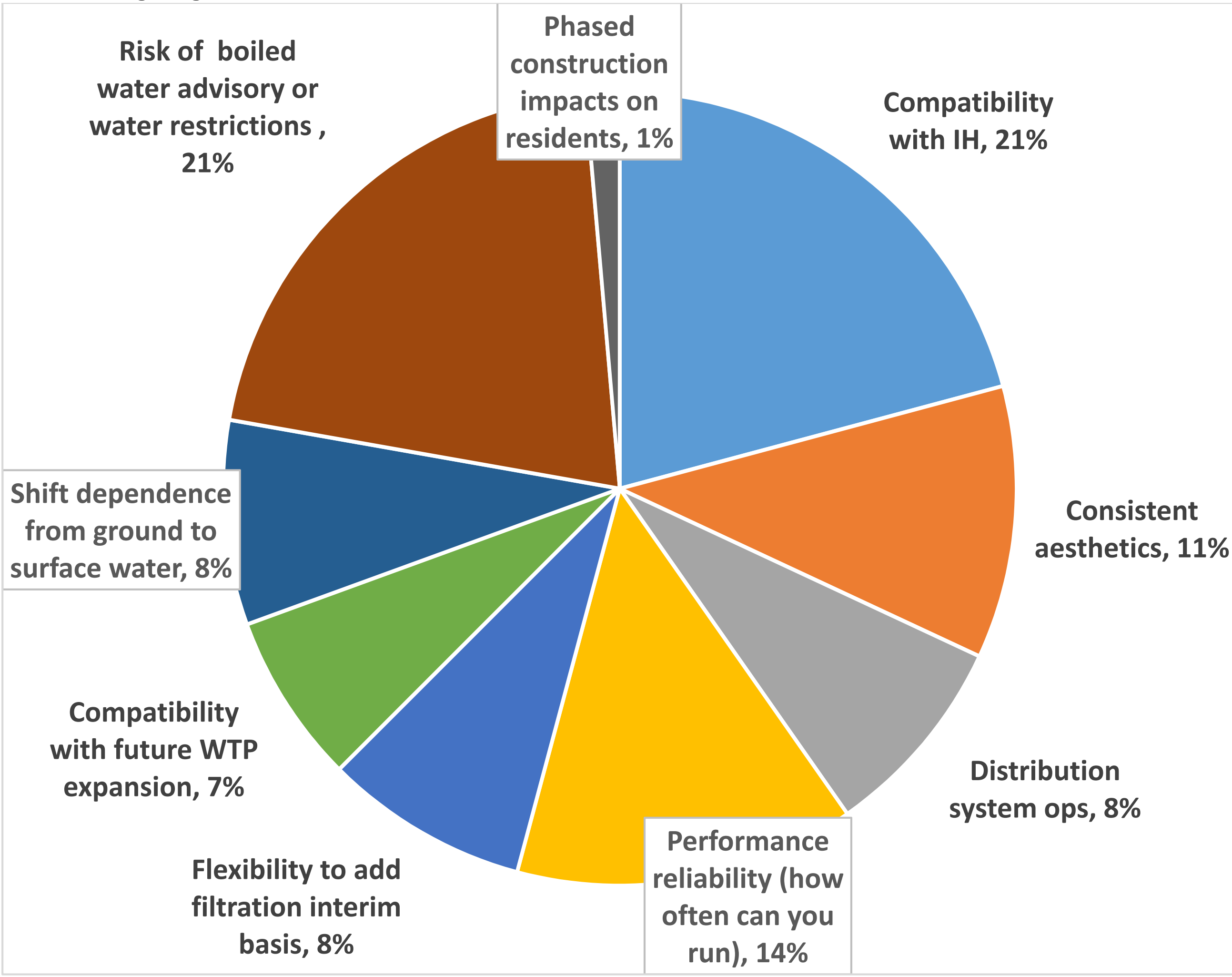
Primary Criteria	Secondary Criteria
Water Quality	Compatibility with IH 4.3.2.1.0 and disinfection by product requirements
	Consistent aesthetics (less consumer complaints)
Technical Considerations	Ease of operation of distribution system
	Performance reliability (how many days a year can the plant operate due to elevated turbidity, colour, or DBP precursors in the raw water)
	Flexibility for interim expansion (how quickly can filtration be added)
	Compatibility with site (can the option be easily incorporated into the future plans for the site)
	Shift dependence from groundwater to surface (river) water
Social Considerations	Relative risk and impact of requiring boil water advisory or water restrictions
	Impacts to residents by phasing construction of water transmission mains
Natural Environmental Considerations	Not required – all options deemed equal in this category
Economic Considerations	Not considered – captured in capital cost estimate

Weighting for each criteria was developed on the basis of comparing the relative importance of each individual criteria against each other and assigning a score. The individual scores and resulting weighting are presented in Table 5-2. If the criteria on the column is more important than the row, the scoring is a 2, if they are equal, the score is 1, and if the criteria in the row is more important than the column, the score is a 0. For example, in the first column/row combination, compatibility with IH (column) was more important to the team than consistent aesthetics (row). Hence, the score of 2. Overall, the two most important criteria for the team based on the rankings were compliance with IH and the relative risk and impact of requiring a boiled water advisory or water restrictions. Figure 5-1 shows the criteria and relative weighting based on the priorities identified by ERWS.

TABLE 5-2
Criteria Trade-off and Weight Calculator

	Compliance with IH	Consistent aesthetics	Distribution system ops	Performance reliability (how often can you run)	Flexibility to add filtration interim basis	Compatibility with future WTP expansion	Shift dependence from ground to surface water	Risk of boiled water advisory or water restrictions	Phased construction impacts on residents
Compliance with IH	↵								
Consistent aesthetics	2	↵							
Distribution system ops	2	1	↵						
Performance reliability (how often can you run)	2	0	1	↵					
Flexibility to add filtration interim basis	2	1	0	2	↵				
Compatibility with future WTP expansion	2	2	1	2	0	↵			
Shift dependence from ground to surface water	2	2	1	1	2	0	↵		
Risk of boil water advisory or water restrictions	1	0	0	0	0	0	0	↵	
Phased construction impacts on residents	2	2	2	2	1	2	2	2	↵
Total	**15**	**8**	**6**	**10**	**6**	**5**	**6**	**15**	**1**
Rank/Priority	**1**	**4**	**5**	**3**	**5**	**8**	**5**	**1**	**9**
Weighting	**21%**	**11%**	**8%**	**14%**	**8%**	**7%**	**8%**	**21%**	**1%**

FIGURE 5-1
Relative Weighting for Each Evaluation Criteria



6. Technical Scoring

Once the criteria and weighting were developed, the team proceeded to score each option on the technical merits. Table 6-1 summarizes the evaluation of each option. For each criteria, options were assigned a value (9 – exceeds the criteria, 3 meets the criteria, 0 underperforms). The table also presents the raw and weighted scores for each criteria. Raw scores represent the total number of points without factoring the weighting criteria. The weighted scores take each individual score and multiply these by the weighting. Therefore, an option that scores a 9 in compliance with IH has the same raw score than an option that scores 9 in compatibility with future expansion, but the former has a much higher weighted score. Based on the technical scoring, Options 4 and 3 received the highest weighted technical scores.

TABLE 6-1
Criteria Trade-off and Weight Calculator

Criteria	Weight	Scoring and Comments	Option 1	Option 2	Option 3	Option 4
Compliance with IH	**21%**	Score	3	3	9	9
		Comment				
Consistent aesthetics	**11%**	Score	1	1	3	9
		Comment				
Distribution system ops	**8%**	Score	3	3	3	9
		Comment				
Performance reliability (how often can you run)	**14%**	Score	1	1	9	9
		Comment				
Flexibility to add filtration interim basis	**8%**	Score	3	1	9	9
		Comment				
Compatibility with future WTP expansion	**7%**	Score	9	1	3	3
		Comment				
Shift dependence from ground to surface water	**8%**	Score	3	3	9	9
		Comment				
Risk of boiled water advisory or water restrictions	**21%**	Score	3	3	9	9
		Comment				
Phased construction impacts on residents	**1%**	Score	9	9	3	9
		Comment				
Raw Score			**35**	**25**	**57**	**75**
Weighted Score			**3.0**	**2.3**	**7.3**	**8.6**
Rank by Weighted Score			**3**	**4**	**2**	**1**

7. Capital Cost Estimates

Table 7-1 shows a breakdown of the cost estimate. All costs are shown in millions of Canadian dollars. This is a Class 4 cost estimate as defined by the Association for the Advancement of Cost Engineering International (AACEI). The expected accuracy range for a Class 4 estimate is –30 percent to +50 percent. The methodology for the cost estimates is presented in Attachment A. The capital cost estimates account for markups and escalation referenced to the midpoint of each construction period (2016, 2018, 2024). However, no financial components have been included (cost of borrowing or servicing debt).

Table 7-2 to 7-6 provides a detailed breakdown of the Preliminary Design Report option and each of the four phased options.

TABLE 7-1
Summary Table, PDR and Options

	Funding Source	PDR Est. Cost	Option 1 Est. Cost	Option 2 Est. Cost	Option 3 Est. Cost	Option 4 Est. Cost
Intake and Raw Water Pump Station	ERWS	$3,226,000	$2,886,800	$3,034,300	$2,906,500	$2,906,500
Raw Watermain	ERWS	$1,296,600	$1,296,600	$1,296,600	$1,296,600	$1,296,600
WTP	ERWS	$15,883,500	$5,778,300	$1,972,300	$7,063,000	$7,063,000
Siteworks	ERWS	$3,773,600	$1,849,000	$2,128,200	$2,128,200	$2,128,200
Operations Building	CoP, RDN	$1,471,400	–	–	–	–
Transmission Mains	CoP, ERWS	$6,593,400	$6,593,400	$6,593,400	$3,079,500	$3,514,000
Subtotal – 2016		$32,244,500	$18,404,100	$22,537,200	$16,473,800	$16,908,300
Total – 2016		**$32,244,500**	**$20,023,700**	**$16,347,000**	**$17,923,500**	**$18,396,200**
Distribution System Improvements in 2018	RDN	$4,520,700	–	–	–	–
Distribution System Improvements in 2018	CoP	$106,400	–	–	–	–
Intake and Raw Water Pump Station	ERWS	–	$555,200	$555,200	731,400	$731,400
WTP	ERWS	–	$11,549,400	$15,740,500	$10,835,800	$10,835,800
Siteworks	ERWS	–	$2,258,500	$1,826,600	$1,826,600	$1,826,600
Operations Building (RDN)	RDN	–	$169,900	$169,900	$169,900	$169,900
Operations Building (CoP)	CoP	–	$1,463,600	$1,463,600	$1,463,600	$1,463,600
Transmission Mains	ERWS	–	$0	$0	$3,901,100	$3,418,700
Distribution System Improvements from 2018 deferred to 2024	ERWS	–	$4,627,100	$4,627,100	$4,627,100	$4,627,100
Subtotal – 2018/2024		$4,627,100	$20,623,700	$24,382,900	$23,555,400	$23,073,100
Total – 2018/2024		**$4,627,100**	**$22,438,600**	**$26,528,600**	**$25,628,400**	**$25,103,500**
Total Tendering and Engineering SDC		$3,244,600	$3,434,500	$3,137,100	$3,264,600	$3,302,900
Total		***$40,116,200***	***$42,462,300***	***$42,875,600***	***$43,551,900***	***$43,499,700***

[d] Tendering cost calculated at 2% of sub-total and Engineering SDC calculated at 6.8% of sub-total amount
SDC = services during construction

TABLE 7-2
Cost Estimate Breakdown (PDR)

	Funding Source	-30% Estimated Costs	Predesign Estimated Costs	+50% Estimated Costs	GST[a]	PST[b]
Intake and Raw Water Pump Station	ERWS	$2,258,200	**$3,226,000**	$4,839,000	$144,000	$201,600
Raw Watermain	ERWS	$907,600	**$1,296,600**	$1,944,900	$57,900	$81,000
WTP	ERWS	$11,118,400	**$15,883,500**	$23,825,200	$709,100	$992,700
Siteworks	ERWS	$2,641,500	**$3,773,600**	$5,660,500	$168,500	$235,900
Operations Building	RDN	$107,100	**$153,000**	$229,500	$6,800	$9,600
Operations Building	CoP	$922,900	**$1,318,400**	$1,977,600	$58,900	$82,400
Transmission Mains	CoP	$4,065,900	**$5,808,400**	$8,712,600	$259,300	$363,000
Transmission Mains	ERWS	$549,500	**$785,000**	$1,177,500	$35,000	$49,100
Subtotal – 2016		**$22,571,200**	**$32,244,500**	**$48,366,900**	**$1,439,500**	**$2,015,300**
Total – 2016 (incl. est. SDC and Commissioning Fee)		**$24,557,400**	**$35,082,000**	**$52,623,000**		
Distribution System Improvements	RDN	$3,164,500	**$4,520,700**	$6,781,000	$201,800	$282,500
Distribution System Improvements	CoP	$74,500	**$106,400**	$159,700	$4,800	$6,700
Subtotal – 2018		**$3,239,000**	**$4,627,100**	**$6,940,700**	**$206,600**	**$289,200**
Total – 2018 (incl. est. SDC and Commissioning Fee)		**$3,433,300**	**$4,904,700**	**$7,357,100**	***$206,600***	***$289,200***
Total estimated SDC and Commissioning Fee[c]			$3,244,600			
Total		**$25,810,200**	**$40,116,200**	**$60,174,300**	***$1,646,000***	***$2,304,500***

Notes:
[a] GST calculated as 5% of Predesign Estimated Costs
[b] PST calculated as 7% of Predesign Estimated Costs
[c] Estimated SDC and commissioning fee calculated as 8.8% (2% Tendering and 6.8% Engineering SDC) of Total Predesign Estimated Costs
SDC = services during construction

TABLE 7-3
Cost Estimate Breakdown (Option 1)

	Funding Source	-30% Est. Costs	Estimated Costs	+50% Est. Costs	GST[a]	PST[b]
Intake and Raw Water Pump Station	ERWS	$2,020,800	$2,886,800	$4,330,200	$128,900	$180,400
Raw Watermain	ERWS	$907,600	**$1,296,600**	$1,944,900	$57,900	$81,000
WTP	ERWS	$4,044,800	**$5,778,300**	$8,667,500	$258,000	$361,100
Siteworks	ERWS	$1,294,300	**$1,849,000**	$2,773,500	$82,500	$115,600
Transmission Main		$4,615,400	**$6,593,400**	$9,890,100	$294,300	$412,100
Subtotal – 2016		$12,882,900	**$18,404,100**	$27,606,200	$920,200	$1,288,300
Total – 2016 (incl. Tendering and Engineering SDC[d])		**$14,016,600**	**$20,023,700**	**$30,035,600**	***$920,200***	***$1,288,300***
Intake and Raw Water Pump Station	ERWS	$388,600	**$555,200**	$832,800	$24,800	$34,700
WTP	ERWS	$8,084,600	**$11,549,400**	$17,324,100	$515,600	$721,800
Siteworks	ERWS	$1,581,000	**$2,258,500**	$3,387,800	$100,800	$141,200
Operations Building (RDN)	RDN	$118,900	**$169,900**	$254,900	$7,600	$10,600
Operations Building (CoP)	CoP	$1,024,500	**$1,463,600**	$2,195,400	$65,300	$91,500
Transmission Main	ERWS	$0	**$0**	$0	$0	$0
Distribution System Improvements from 2018 deferred to 2024	ERWS	$3,239,000	**$4,627,100**	$6,940,700	$231,400	$323,900
Subtotal – 2024		**$14,436,600**	**$20,623,700**	**$30,395,550**	$1,031,200	$1,443,700
Total – 2024 (incl. Tendering and Engineering SDC[d])		**$15,707,000**	**$22,438,600**	**$33,657,900**	***$1,031,200***	***$1,443,700***
Total Tendering and Engineering SDC			$3,434,500			
Total		**$26,199,600**	**$37,027,300**	**$56,142,000**	***$1,951,400***	***$2,732,000***

Notes:
[a] GST calculated as 5% of Predesign Estimated Costs
[b] PST calculated as 7% of Predesign Estimated Costs
[d] Tendering cost calculated at 2% of subtotal and SDC fee calculated at 6.8% of subtotal amount
SDC = services during construction

TABLE 7-4
Cost Estimate Breakdown (Option 2)

	Funding Source	-30% Est. Costs	Estimated Costs	+50% Est. Costs	GST[a]	PST[b]
Intake and Raw Water Pump Station	ERWS	$2,124,000	**$3,034,300**	$4,551,500	$135,500	$189,600
Raw Watermain	ERWS	$907,600	**$1,296,600**	$1,944,900	$57,900	$81,000
WTP	ERWS	$1,380,600	**$1,972,300**	$2,958,500	$88,000	$123,300
Siteworks	ERWS	$1,489,700	**$2,128,200**	$3,192,300	$95,000	$133,000
Transmission Main		$4,615,400	**$6,593,400**	$9,890,100	$294,300	$412,000
Subtotal – 2016		**$10,517400**	**$15,024,800**	**$22,537,200**	$751,240	$1,051,700
Total – 2016 (incl. Tendering and Engineering SDC[d])		**$11,442,900**	**$16,347,000**	**$24,520,500**	***$751,240***	***$1,051,700***
Intake and Raw Water Pump Station	ERWS	$388,600	**$555,200**	$832,800	$24,800	$34,700
WTP	ERWS	$11,018,400	**$15,740,500**	$23,610,800	$702,700	$983,800
Siteworks	ERWS	$1,278,600	**$1,826,600**	$2,739,900	$81,500	$114,200
Operations Building (RDN)	RDN	$118,900	**$169,900**	$254,900	$7,600	$10,600
Operations Building (CoP)	CoP	$1,024,500	**$1,463,600**	$2,195,400	$65,300	$91,500
Transmission Main	ERWS	$0	**$0**	$0	$0	$0
Distribution System Improvements from 2018 deferred to 2024	ERWS	$3,239,000	**$4,627,100**	$6,940,700	$231,400	$323,900
Subtotal – 2024		**$17,068,000**	**$24,382,900**	**$36,574,350**	$1,219,100	$1,706,800
Total – 2024 (incl. Tendering and Engineering SDC[d])		**$18,570,000**	**$26,528,600**	**$39,792,900**	***$1,219,100***	***$1,706,800***
Total Tendering and Engineering SDC			$3,137,100			
Total		**$30,012,900**	**$42,875,600**	**$56,762,000**	***$1,970,300***	***$2,758,500***

Notes:
a GST calculated as 5% of Predesign Estimated Costs
b PST calculated as 7% of Predesign Estimated Costs
d Tendering cost calculated at 2% of subtotal and SDC fee calculated at 6.8% of subtotal amount
SDC = services during construction

TABLE 7-5
Cost Estimate Breakdown (Option 3)

	Funding Source	-30% Estimated Costs	Predesign Estimated Costs	+50% Estimated Costs	GST[a]	PST[b]
Intake and Raw Water Pump Station	ERWS	$2,034,600	**$2,906,500**	$4,359,800	$129,800	$181,700
Raw Watermain	ERWS	$907,600	**$1,296,600**	$1,944,900	$57,900	$81,000
WTP	ERWS	$4,944,100	**$7,063,000**	$10,594,500	$315,300	$441,400
Siteworks	ERWS	$1,489,700	**$2,128,200**	$3,192,300	$95,000	$133,000
Transmission Main		$2,155,700	**$3,079,500**	$4,619,300	$137,500	$192,500
Subtotal – 2016		**$11,531,700**	**$16,473,800**	**$24,710,700**	$823,690	$1,153,200
Total – 2016 (incl. Tendering and Engineering SDC[d])		**$12,546,500**	**$17,923,500**	**$26,885,300**	***$823,690***	***$1,153,200***
Intake and Raw Water Pump Station	ERWS	$512,200	**731,400**	$1,097,100	$32,700	$45,700
WTP	ERWS	$7,585,100	**$10,835,800**	$16,253,700	$483,700	$677,200
Siteworks	ERWS	$1,278,600	**$1,826,600**	$2,739,900	$81,500	$114,200
Operations Building (RDN)	RDN	$118,900	**$169,900**	$254,900	$7,600	$10,600
Operations Building (CoP)	CoP	$1,024,500	**$1,463,600**	$2,195,400	$65,300	$91,500
Transmission Main	ERWS	$2,730,800	**$3,901,100**	$5,851,700	$174,200	$243,800
Distribution System Improvements from 2018 deferred to 2024	ERWS	$3,239,000	**$4,627,100**	$6,940,700	$231,400	$323,900
Subtotal – 2024		**$16,488,900**	**$23,555,500**	**$35,333,300**	$1,177,800	$1,648,900
Total – 2024 (incl. Tendering and Engineering SDC[d])		**$17,939,900**	**$25,628,400**	**$38,442,600**	***$1,177,800***	***$1,648,900***
Total Tendering and Engineering SDC			$3,264,600			
Total		**$30,486,300**	**$43,551,900**	**$65,327,900**	***$2,001,500***	***$2,802,100***

Notes:
[a] GST calculated as 5% of Predesign Estimated Costs
[b] PST calculated as 7% of Predesign Estimated Costs
[d] Tendering cost calculated at 2% of subtotal and SDC fee calculated at 6.8% of subtotal amount
SDC = services during construction

TABLE 7-6
Cost Estimate Breakdown (Option 4)

	Funding Source	-30% Estimated Costs	Predesign Estimated Costs	+50% Estimated Costs	GST[a]	PST[b]
Intake and Raw Water Pump Station	ERWS	$2,034,600	**$2,906,500**	$4,359,800	$129,800	$181,700
Raw Watermain	ERWS	$907,600	**$1,296,600**	$1,944,900	$57,900	$81,000
WTP	ERWS	$4,944,100	**$7,063,000**	$10,594,500	$315,300	$441,400
Siteworks	ERWS	$1,489,700	**$2,128,200**	$3,192,300	$95,000	$133,000
Transmission Main		$2,459,800	**$3,514,000**	$5,271,000	$156,900	$219,600
Subtotal – 2016		**$11,835,800**	**$16,908,300**	**$25,362,500**	**$845,415**	**$1,183,600**
Total – 2016 (incl. Tendering and Engineering SDC[d])		**$12,877,300**	**$18,396,200**	**$27,594,300**	***$845,415***	***$1,183,600***
Intake and Raw Water Pump Station	ERWS	$512,000	**$731,400**	$1,097,100	$32,700	$45,700
WTP	ERWS	$7,585,100	**$10,835,800**	$16,253,700	$483,700	$677,200
Siteworks	ERWS	$1,278,600	**$1,826,600**	$2,739,900	$81,500	$114,200
Operations Building (RDN)	RDN	$118,900	**$169,900**	$254,900	$7,600	$10,600
Operations Building (CoP)	CoP	$1,024,500	**$1,463,600**	$2,195,400	$65,300	$91,500
Transmission Main	ERWS	$2,393,100	**$3,418,700**	$5,128,100	$152,600	$213,700
Distribution System Improvements from 2018 deferred to 2024	ERWS	$3,239,000	**$4,627,100**	$6,940,700	$231,400	$323,900
Subtotal – 2024		**$16,151,200**	**$23,073,100**	**$34,609,700**	$1,153,700	$1,615,100
Total – 2024 (incl. Tendering and Engineering SDC[d])		**$17,572,500**	**$25,103,500**	**$37,655,300**	***$1,153,700***	***$1,615,100***
Total Tendering and Engineering SDC			$3,302,900			
Total		**$30,449,800**	**$43,499,700**	**$65,249,600**	***$1,999,100***	***$2,798,700***

Notes:
[a] GST calculated as 5% of Predesign Estimated Costs
[b] PST calculated as 7% of Predesign Estimated Costs
[d] Tendering cost calculated at 2% of subtotal and SDC fee calculated at 6.8% of subtotal amount
SDC = services during construction

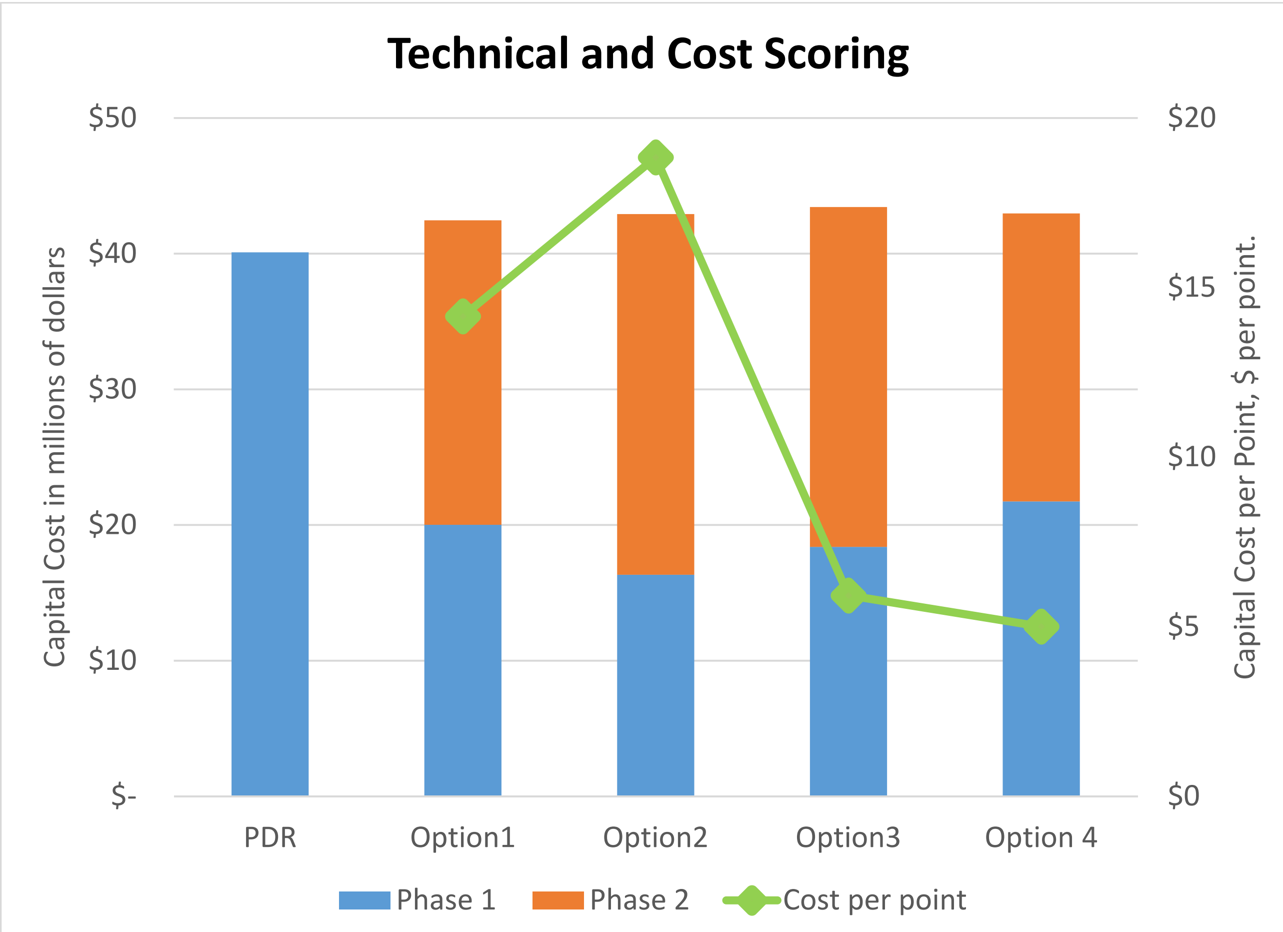
8. Best Value Phased Option

To determine the phased option that represents the best value to the ERWS, the benefits and costs identified for each option were compared using the following approach:

- The total cost for Phases 1 and 2 for each option were compared to each other
- The ratio of the total benefit point to total capital cost was calculated for each option (this is referred to as the "value" of each option)

Figure 8-1 summarizes the total costs and value for each phased option. The costs for Option 0 are provided as a reference, but no technical scoring was provided. The phase option that provides the greatest benefit per unit of cost is deemed to offer the best value. Presented in this manner, Option 4 with a 16 ML/d package filtration WTP and full construction of the transmission mains offers the best value to the ERWS (lowest cost per point).

FIGURE 8-1
Technical and Cost Scoring for Phased Options



9. Recommendation

Each of the phased options provides a lower cost for Phase 1 compared to the pre-design report, but also provide a higher overall project cost. These phased options also require expanding and upgrading the WTP (Phase 2) within 8 years of completing Phase 1 to meet the projected water demands for 2026. This short planning horizon in conjunction with the higher total costs offers no financial advantage over the pre-design report given that ERWS would have to borrow money over a 20-year term regardless of the option selected. In other words, for a phased option to be more financially attractive compared to the pre-design report, Phase 2 would need to be implemented in 20 years or later to offset the additional total project costs. Therefore, the team recommends to proceed with the project approach outlined in the pre-design report.

Attachment A
Cost Estimate Methodology

The methodology to develop the capital cost estimates is outlined in this section.

1. Estimate Classification

This is a Class 4 cost estimate as defined by the Association for the Advancement of Cost Engineering International (AACEI). The expected accuracy range for a Class 4 estimate is –30 percent to +50 percent.

2. Scope of Estimate

This estimate provides costs for the following components of the project:

- Intake
  - Obermeyer weir
  - Intake structure with fish screens
  - Piping from intake structure to the RWPS
- Raw water pump station
  - RWPS building
  - Wet well
  - Vertical turbine pumps
- Water treatment plant
  - Pre-engineered WTP building
  - MF/UF system
  - Chemical systems
  - UV disinfection system
  - Chlorine disinfection
  - Clearwell
  - Treated water pump station
- Operations building
  - Wood-framed, two-story building
  - Office space
  - Meeting rooms
  - Lockers
  - Lavatories
  - Storage
- Siteworks
  - Yard piping
  - Electrical ducts
  - Earthworks
  - Roads
  - Sidewalks
  - Landscaping
- Distribution System Improvements (2016 and 2018)
  - Reservoirs and reservoir upgrades
  - Transmission mains
  - Pump stations

3. Methodology

This is a "bottom rolled up" estimate with cost items and breakdown of labour, materials, and equipment. Vendor price quotations for equipment were used where available.

CH2M HILL compiled this estimate, with input from KWL and Golder. The project elements were categorized according to the following areas of responsibilities:

CH2M HILL
- Intake
- Raw water pump station
- Water treatment plant
- Operations building

KWL
- Distribution upgrades
- Treated water pump station
- Site civil

Golder
- Geotechnical
- Landscaping
- Archaeological

4. Assumptions

The following assumptions were made in developing this estimate:

The contractors will be considered equal and will be selected using a competitive bidding process
Construction duration will be reasonable (an “accelerated schedule premium” will not be required)
Construction materials and equipment will be available domestically.

Tender cost have been estimates as 2% of the capital cost for each phase.

Engineering services during construction have been estimated at 6.8% of the capital cost for each phase.

5. Markups

Table A-1 shows the assumed contractor markups that will be applied to the project.

TABLE A-1
General Contractor Markups

	Markup (%)
Subcontractor markup	15.00
Prime contractor general conditions	7.00
Prime contractor overhead	10.00
Prime contractor profit	5.00
Builders risk and liability	2.00
Payment performance bond	1.50
Level of design contingency	25.00
Escalation to midpoint of construction (February 2016)	2.71
Escalation to midpoint of construction (2024)	20.45
Escalation to midpoint of construction (February 2018)	6.51

The actual markup percentages will vary depending on the contractor and market conditions.

6. Escalation Rate

This estimate uses an escalation rate based on forecasted economic data for the next 10 years from Global Insight Inc. and historical labour cost data from the United States Bureau of Labor Statistics. The escalation is based on a construction duration of 21 months, from April 2015 to December 2016. The escalation rate is applied on the estimate up until the midpoint of the construction schedule.

7. Labour Costs

This cost estimate has been adjusted for local area labour rates, based on 2014 RSMeans rates for Vancouver, British Columbia.

The labour unit prices reflect a burdened rate, including workers compensation, unemployment taxes, fringe benefits, and medical insurance.

8. Taxes

Provincial sales tax (PST) and goods and services tax (GST) will apply to this project. At this stage, PST was applied to the entire cost estimate amount. In practice, PST will only be applicable to certain items in the project.

9. Allowances

This estimate includes allowances for known work for which the design has not been sufficiently developed at this time:

Electrical work
I&C work

10. Excluded Costs

This estimate excludes the following costs:

Design costs
Land, legal, and other owner administration costs
Material adjustment allowances

11. Cost Resources

The following resources were used in developing this estimate:

RSMeans
CH2M HILL historical data
KWL historical data
Golder historical data
Vendor quotes on equipment and Materials
Estimator judgment