JOINT BOARD OF MANAGEMENT

Wednesday, July 19, 2023

9:00 AM

Kingsville Arena

ADDENUDUM

5. Report UW/19/23 dated July 17, 2023 re: New Reservoir and UV Facility Alternate Project Delivery Approach

   Pages 2 – 6 Report UW/19/23
   Pages 7 – 27 – Draft New Reservoir & UV Facility TM #7 Alternate Project Delivery Approach

/kmj

UW/19/23

To:	**Chair and Members of the Union Water Supply System Joint Board of Management**
From:	**Rodney Bouchard, UWSS General Manager**
Date:	**July 17, 2023**
Re:	**New Reservoir and UV Facility Alternate Project Delivery Approach**

Recommendation

It is recommended that the Union Water Supply System Joint Board of Management (UWSS JBM) authorizes the UWSS General Manager to proceed with the Construction Manager as Advisor/Agent and Construction Manager at Risk (CMA/CMAR) project delivery approach for the Reservoir #3 and Ultraviolet (UV) primary disinfection system project; and,

UWSS JBM authorizes a budget of $100,000, to be funded from UWSS reserves, to retain a Construction Manager, as part of the CMA/CMAR project delivery approach for the Reservoir #3 and Ultraviolet (UV) primary disinfection system project.

Background

In 2017, the UWSS completed a Water Quality Master Plan (WQMP) for the UWSS facilities. The results of WQMP indicated that implementation of additional primary disinfection processes would improve the efficiency of the Ruthven Water Treatment Plant, especially regarding anticipated future growth in treated water demand. Through a triple bottom line evaluation, the WQMP identified the integration of an ultraviolet (UV) system for primary disinfection with future expandability for Advanced Oxydation Processes (AOP) as the preferred solution for additional primary disinfection.

In October 2020, the UWSS Board approved the undertaking of the UWSS Infrastructure and Master Servicing Plan Review. UWSS retained the consultant team of Associated Engineering and C3 Water, Inc. to complete this work. The goals of the Infrastructure Review were to identify future water demands (5-year, 10-year, 10-year +) as based on anticipated growth in the UWSS serviced municipalities, and to identify infrastructure needs to accommodate the projected growth.

The results of the distribution system modelling completed as part of the UWSS Infrastructure Needs Study identified that UWSS currently has insufficient treated water storage capacity with a deficit of just over 10 megalitres (ML) in the south-east portion of the UWSS system. This deficit is projected to be approximately 20 ML by 2026 and up to 38 ML by 2031. As such, the Infrastructure Study highlighted the need for UWSS to increase storage capacity in its distribution system in the very short term.

Discussion

In September 2022, the UWSS awarded a contract to Associated Engineering (Associated) for the undertaking of conceptual and indicative design for new reservoir #3 and ultraviolet (UV) system for primary disinfection.

As part of this work to date, Associated has prepared a number of technical memoranda (TMs) including TM 1: UV Technology Options, TM 2: Hydraulic Assessment, and TM 3: Reservoir Structural Approach. The recommendations provided within these TMs indicated the need for a new 40 megalitre (ML) reservoir at the water treatment plant property and implementing UV disinfection on the filter effluent lines. The additional reservoir will help Ruthven WTP meet projected system demands, and implementing UV disinfection will provide a multi-barrier treatment strategy for Cryptosporidium and/or other pathogens.

The construction of the new reservoir and implementation of post filtration UV will involve different construction trades, work areas and timing restrictions. As such, Associated proposes that the work be split into two contracts as follows:

- **Contract 1 – Reservoir No. 3 with interconnections to Reservoirs No. 1 and No. 2.** This work would be given priority so that UWSS can meet increased system demands as soon as possible.

- **Contract 2 – UV Disinfection Retrofit**
  This work would be initiated upon completion of Reservoir No. 3. The increased water availability provided by Reservoir No 3, would allow for specific filters to be taken out of service for installation of UV systems.

As part of this project, Associated has prepared TM 7: Alternate Project Delivery Approach. A copy of TM 7 is attached to this report. The main purpose of TM 7 is to identify and evaluate project delivery methods that are used in the water infrastructure industry and recommend a preferred method that would achieve the desired outcomes, provide the best value for money, and result in a successful project.

Associated evaluated the following construction delivery methods as part of TM 7. It is to be noted that additional details on the benefits and drawbacks for each method are provided in attached TM 7.

- **Design Bid Build -** Design Bid Build (DBB) is the most commonly used delivery method for municipal infrastructure projects, particularly when a municipality has procurement restrictions. It is considered the conventional delivery method.

- **Construction Management -** Construction Management is a common delivery method used in the industry to fast-track projects. It typically consists of two phases: (1) Construction Manager as Advisor/Agent (CMA) and (2) Construction Manager at Risk (CMAR), and the Construction Manager is involved during design. CMA/CMAR is preferred for complex projects involving upgrades to existing facilities. As part of this delivery method, A Construction Manager (CM) is retained by the Owner during the early phase of the design work and works in a collaborative partnership arrangement with the Owner and Design Consultant. With the early involvement of the contractor, this contract approach provides an opportunity to realize savings from the contractor's input in constructability, assessment of availability of materials early in the project, timely pricing and procurement, minimizing project timelines, and appropriate assignment of risk between the parties.

- **Fixed Price Design Build -** Fixed Price Design Build (FPDB) is another common collaborative delivery method used in the industry to fast-track projects. It is best suited for projects with well defined desired outcomes with an Indicative Design developed or Performance Based criteria established. This approach requires the Owner to retain an Owner's Engineer for assistance and oversight. The Owner and Owner's Engineer define the project requirements and then the Owner solicits bids for technical proposals and fixed price that includes design, construction, commissioning based on the 30% design effort. This approach typically requires the Owner to pay a stipend to the unsuccessful bidders for their efforts developing at a 30% design.

- **Progressive Design Build -** Progressive Design Build (PDB) is best applied when a project has complex, less defined, scope typical of brownfield upgrades. A PDB approach is based on collaboration between a project team consisting of the Owner (Engineering, Operations and Maintenance representatives), a Design Consultant and a General Contractor. PDB includes Fixed pricing in the form of either a guaranteed maximum price or a lump sum by the Contractor once the project team has established the design, functional and performance specifics. This guaranteed price or lump sum is fixed to a level agreed upon, typically once the design has advanced to around 70% complete. PDB is similar to CMAR but with PDB, the Designer is retained by the Contractor or Design-Builder (DB). In CMAR the Designer is retained by the Owner.

- **Integrated Project Delivery -** Integrated Project Delivery (IPD) is typically used for projects that are complex and less defined. IPD requires high level of input from the end users and are typically used when the Owner has an affordability ceiling. IPD typically follows an iterative and time-consuming process to design to the identified price and is not used for fast-track projects. IPD can take longer to complete since the design is developed and refined to stay within an agreed upon target price, instead of designing and constructing in the most time effective method.

Preferred Alternative for Project Delivery

The work associated with the new reservoir construction (Contract 1) is largely greenfield civil works involving earthworks, dewatering, foundations, concrete works, underground piping, and valve installations. The primary driver for Contract 1 is increasing the amount of onsite storage volume in as little time as possible. As such, a fast-track construction management approach would be best suited for Contract 1.

The UV retrofit contract (Contract 2) is largely brownfield in-plant works that includes process, mechanical, electrical and a limited amount of building mechanical works. The primary drivers for Contract 2 are maintaining production capacity and treated water quality during construction activity while minimizing operational interruptions. Installation of UV reactors will need to be completed during off-peak seasons and will likely require two seasons for the work to be completed. This work will be somewhat complex in nature.

Considering the project objectives, drivers and site constraints and the nature of the work involving different construction trades, work areas and timing restrictions, it is recommended to consider a CMA/CMAR collaborative delivery method that utilizes early contractor involvement and a partnership approach to deliver the project.

The CMA/CMAR delivery model is recommended over DBB to allow for early contractor involvement and to expedite the delivery schedule.

The CMA/CMAR delivery model is recommended over PDB (and FPDB) since UWSS has already retained Associated Engineering as their design engineer. Thus, hiring a DB Designer, as is typical with PDB, would not be required and would only extend the project duration to allow for the DB Designer to gain familiarity with UWSS treatment plant and associated facilities.

Additionally, CMA/CMAR provides more options with off-ramping since UWSS has a direct agreement with the Associated Engineering and can keep them engaged if a new CM or GC is required.

Next Steps

Associated Engineering is in process of completing the indicative design. It is anticipated that this work will be complete by early August 2023. Once the indicative design is complete, UWSS proposes to issue a Request for Proposal (RFP) to select a Construction Manager as Advisor/Agent (CM) to work collaboratively with the Associated Engineering and UWSS through the design development phase. The qualifications of the preferred CM would have broad experienced in delivering multi-discipline works for water treatment and storage facilities and would have in-house expertise to advise on constructability issues, procurement, multi-discipline cost estimating and scheduling. Once financing has been established for construction of the reservoir and UV system, the CM would then retain General Contractors (GCs) for the two different Contracts with trade skills aligned to the nature of the proposed works.

Financial Impact

UWSS Board of Management does not have an approved budget item within the 2023 UWSS Budget to retain a Construction Manager for the reservoir #3 and UV system project. It is noted that the construction of reservoir and UV project will be completed by funding retained and approved by the newly incorporated UWSS Inc. Board of Directors. However, UWSS Inc. is still in the process of soliciting funding for this project and it is anticipated that funding will be in place in October 2023. It is imperative that the design work for the reservoir keep moving forward to minimize delays with expansion of reservoir capacity for UWSS.

The UWSS General Manager is seeking approval from UWSS Board of Management for a budget in the amount of $100,000 to retain a Construction Manager so that the project team can move forward with the recommended CMA/CMAR approach to delivery of the project. It is noted that a Construction Manager will be selected through a competitive Request for Proposal (RFP) approach and that services of the Construction Manager will be based on a Fee for Service approach and not a lump sum basis.

UWSS Board of Management has sufficient reserves to fund this budget.

Respectfully submitted,

Rodney Bouchard, General Manager
Union Water Supply System
/kmj

Draft

REPORT

Union Water Supply System
Ruthven WTP

New Reservoir and UV Facility
Technical Memorandum #7
Alternate Project Delivery Approach

UNION WATER SUPPLY SYSTEM

JUNE 2023

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1 INTRODUCTION

Associated Engineering (Associated) was retained by Union Water Supply System (UWSS) to complete a conceptual design for the implementation of a new treated water reservoir at the Ruthven Water Treatment Plant (WTP) with the integration of an ultraviolet (UV) system for primary disinfection with future expandability for taste and odour (T&O) control as recommended in the Water Quality Master Plan completed in 2017.

The main objectives of this brief are as follows:

- Summarize the key project drivers and site constraints;
- Provide a high-level overview of available delivery models;
- Provide an overview of delivery methods best suited for this project;
- Assess the applicable delivery methods for this project for alignment with the key drivers, site constraints and desired outcomes; and,
- Recommend next steps.

2 BACKGROUND

2.1 Existing Facility

The Ruthven WTP was commissioned in 1959 and supplies potable water to 65,000 people in the Town of Kingsville, the Municipality of Leamington, a portion of the Town of Essex, and a portion of the Town of Lakeshore. It is operated by the Ontario Clean Water Agency (OCWA) under contract to the Joint Board of Management of the UWSS upon which sit representatives from each of the municipalities.

The Ruthven WTP has a rated capacity of 124 ML/d. It draws water from Lake Erie, and the treatment process consists of pH adjustment, coagulation, flocculation, and sedimentation in four circular up-flow solids contact clarifiers, followed by gravity filtration to on-site treated water reservoirs (10.63 ML Reservoir No. 1 and 15.73 ML Reservoir No. 2) whereby free chlorine disinfection for primary and secondary disinfection is achieved/provided. On a seasonal basis, chlorine is added at the intake for mussel control, and powdered activated carbon is applied for taste and odour (T&O) control.

The distribution system consists of one in-ground reservoir (9.89 ML) and booster pumping station (BPS) at Cottam and four elevated storage tanks: Union Tower, Kingsville Tower, Essex Tower, and Leamington Tower. Chlorine boosting to assist with maintenance of a secondary residual can be performed at Cottam. There are approximately 100 km of trunk mains throughout the distribution system. Due to the presence of many greenhouses that operate in the area, UWSS must meet high water demands during the growing season. Based on historic data from 2020 analyzed under the UWSS Infrastructure Needs Study, system demands can range from 25 ML/d to 97 ML/d, with an average demand of 55 ML/d.

In order to improve the resilience of the drinking water system, UWSS has embarked on a series of upgrades over the last few years. The most recent plans include construction of a new onsite treated water storage reservoir expansion (Reservoir No. 3) with a capacity of 40 ML and implementing UV disinfection on the filter effluent lines. These options were discussed in more detail in the other tech memos in this series, particularly, TM 1: UV Technology Options, TM 2: Hydraulic Assessment, and TM 3: Reservoir Structural Approach. The additional reservoir will help Ruthven WTP meet projected system demands, and implementing UV disinfection will provide a multi-barrier treatment strategy for Cryptosporidium.

2.2 Scope of Work

Due to the nature of the proposed works involving different construction trades, work areas, and timing restrictions, Associated proposes the required works to expand the onsite treated water storage capacity with the addition of Reservoir No. 3, and the implementation of UV disinfection be split into two contracts:

- **Contract 1- Reservoir No. 3 with interconnections to Reservoir No. 1 and No.2.** This will give the increased onsite storage priority for meeting the expected increased system demands as soon as possible.
- **Contract 2- UV Disinfection Retrofit.** By increasing the onsite storage first, there will be additional flexibility in using the three reservoirs during off-peak seasons to allow some of the filters to be taken out of service for the UV retrofit upgrades.

2.3 Project Objectives, Key Drivers, and Constraints

To assess and select an appropriate project delivery method, it is important to first identify the project objectives, key drivers, and constraints. Below are some of the aforementioned considerations relevant to this project.

2.3.1 Objectives

The project objectives are as follows:

- Provide increased onsite treated water storage to relieve plant production stresses during higher system demand periods (with provisions for a future second high lift/distribution pumping facility);
- Provide UV primary disinfection as a multi-barrier approach to protecting against protozoa; and,
- Reserve plant site real estate for a future peaking WTP.

2.3.2 Key Drivers

The project drivers are as follows:

- Schedule Drivers:
  - Treated water system demands have been (and are projected to continue) increasing resulting in the need for additional system storage at the plant site to meet diurnal and seasonal demands;
  - The limited system storage is causing production stresses on the WTP and restricting unit process downtime for maintenance; and,
  - The existing high lift pumping facility will be maintained with timing for an additional high lift/distribution facility uncertain at this time.

- Quality and Risk Drivers:
  - Maintaining production capacity and treated water quality during construction activities;
  - Minimizing operational interruptions during construction activities; and,
  - Resulting unit process upgrades that meet the Owner's desired functionality, operability and maintainability functions.

2.3.3 Constraints

The project constraints are as follows:

- Limited available hydraulic profile (head) within the WTP for incorporating the UV reactors and the onsite storage reservoir;
- Production demands and limited system storage result in limited shutdown time available for tie-ins and incorporating the works;

- Limited space available within the existing filter galleries for incorporating new UV reactors, piping and ancillary systems;
- Limitations on when and how many filters can be taken offline and isolated to facilitate the UV reactor installations and piping modifications;
- An abandoned gas well located west of Reservoir No 2;
- Significant underground piping and utilities west of the existing reservoirs;
- Routing and dechlorination considerations for new reservoir overflow provisions;
- Existing greenhouses currently on the site proposed for Reservoir No. 3;
- Uncertain geotechnical and high groundwater conditions in the vicinity of the proposed Reservoir No. 3 (Reservoir No. 2 foundation was raised during construction, apparently due to undesirable soil conditions); and,
- Reservation of designated spaces for future upgrade projects (e.g. peaking facility, stormwater pond, and community engagement features).

2.4 Proposed Project Delivery Strategy

Based on the above noted project objectives, drivers, and constraints, and the nature of the work involving different construction trades, work areas and timing restrictions, it is recommended to consider splitting the works into two contracts as each has slightly different drivers and constraints.

Contract 1- Reservoir No. 3 with interconnections to Reservoir No. 1 and No. 2.
For the construction of Reservoir No. 3, the primary driver is compressing the schedule for increasing onsite storage volume as soon as possible.

The key considerations include:

- Demolition and clearing of existing greenhouse facilities;
- Confirmation of geotechnical foundation conditions to validate the foundation design;
- Groundwater management;
- Coordination of tie-ins to existing piping and reservoirs; and,
- Construction of a combined valve house and future highlift/distribution pump station partially outfitted to allow future installation of pumping, mechanical and electrical equipment.

Contract 2- UV Disinfection Retrofit
For the installation of UV reactors on the filter effluent lines, the primary drivers are minimizing operational interruptions, maintaining production capacity and treated water quality during construction activities, and the resulting unit process upgrades that meet UWSS's desired functionality, operability, and maintainability features.

The key considerations include:

- The limited available hydraulic profile;
- The limited space available in the filter galleries to accommodate the retrofits;
- Logistics of removing existing piping and installing new piping and equipment;
- Limitations on when and how many filters can be taken offline and isolated; and,
- An extended schedule required to allow phased implementation of the works potentially over two low demand (winter) seasons.

3 OVERVIEW OF DELIVERY METHODS

There are several project delivery methods available and in use across our infrastructure industry and choosing the right method for the right project is a critical first step towards achieving desired outcomes, the best value for money, and a successful project. This section provides a high-level overview of the most applicable delivery methods that could be considered for a project of this nature and highlights the common project characteristics of when and where they are used.

3.1 Design Bid Build

Design Bid Build (DBB) is the most commonly used delivery method for municipal infrastructure projects, particularly when a municipality has procurement restrictions. It is considered the conventional delivery method.

Characteristics of this delivery method include:

- The project not being schedule driven;
- The Owner wanting input and control over the pace of the project;
- There is greenfield construction where there are very few or definable site constraints;
- Relatively low risks on the project that can be retained and controlled by the Owner;
- A larger pool of contractors available. Contractors are very familiar with this delivery method;
- A simple contractual relationship. The Designer and Contractor each have a contract with the Owner;
- Uncertain construction costs and schedule. They are not fixed until after tendering and award;
- Typically awarded to the lowest pre-qualified bidder to construct the works (may not be the preferred bidder unless an RFP approach is used instead of a price driven tender);
- Potential for higher number of RFI's, contractor initiated change requests, and communication issues or delays because there is no collaboration between Designer and Contractor during design; and,
- There are more unknowns going into construction compared to a collaborative, early contractor involvement delivery method.

This project could be delivered following a conventional DBB delivery method but that would not fast track construction for the contracts. In DBB, construction does not begin until the design is complete i.e. there is no overlap between design and construction.

The workflow for a conventional DBB contract is summarized below in **Figure 3-1**. The anticipated schedule for this project using DBB method and including some overlap between the two aforementioned contracts, is summarized in **Figure 3-2**. It is anticipated that the overall project delivery following DBB would be around 41 months.

Contract 1 (Complete within 27 months):

- 9 months to complete detailed design, prequalify contractors, issue the tender and award; and,
- 18-20 months to construct and commission Reservoir No. 3, and interconnections to Reservoir No. 1 and No. 2.

Contract 2 (Complete within 31 months):

- 11 months to complete the design, prequalify contractors, pre-purchase the UV system, issue the tender and award; and,

- 18-20 months to construct and commission the works. UV reactors will be installed in the filter effluent lines, and will need to be completed during low demand periods (spread over two winter seasons), and each filter will need to be out of service for approximately 1 month.

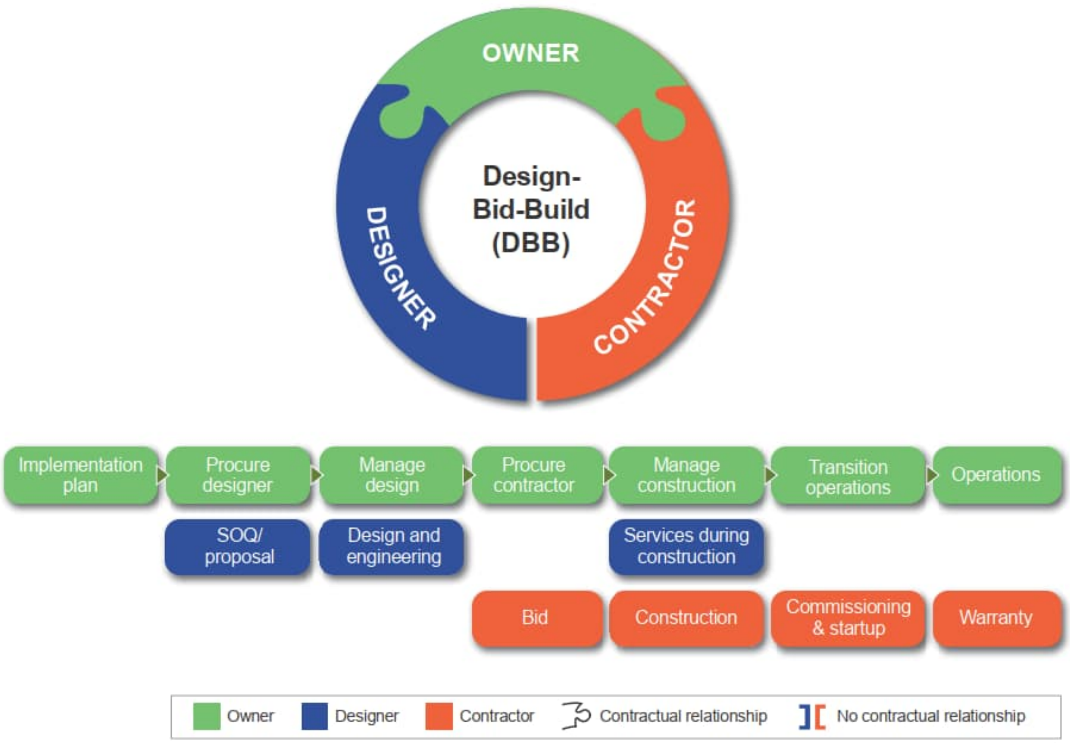

Figure 3-1: Summary of the Design, Bid, Build (DBB) Process (Water Design Build Council, 2019)

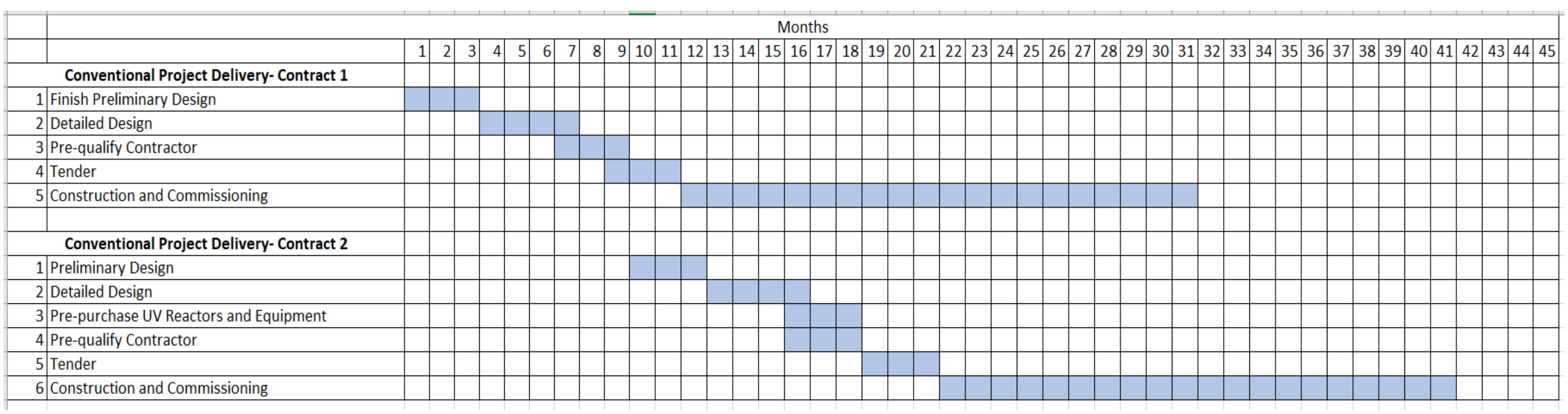

Figure 3-2: Anticipated Schedule Using a Traditional Project Delivery

3.2 Construction Management

Construction Management is a common collaborative delivery method used in the industry to fast-track projects. It typically consists of two phases: (1) Construction Manager as Advisor/Agent (CMA) and (2) Construction Manager at Risk (CMAR), and the Construction Manager is involved during design. CMA/CMAR is preferred for complex projects involving brownfield construction or upgrades to existing facilities. This approach provides an opportunity to realize savings based on early contractor involvement for constructability input, early pricing, assessment of market availability of materials and early procurement, minimizing project timelines, and the appropriate risk assignment between the parties. A Construction Manager (CM) is retained by the Owner during the early phase of the design work. The CM works in a collaborative partnership arrangement with the Owner and Design Consultant and is responsible for early procurement of long lead materials and issuing Tender packages on behalf of the Owner. The Consultant is responsible for reviewing the CM's work package pricing, invoicing and quality assurance of the work, and keeping the Owner's best interest in mind. The Owner's Operations and Maintenance involvement during the design development is particularly beneficial in ensuring project success in meeting the overall project drivers, objectives and goals.

A summary of the two phases of a CMA/CMAR contract are noted below. Further details are noted in **Sections 3.2.1 and 3.2.2**:

- **Phase I -** Construction Manager as Advisor/Agent (CMA): preconstruction services encompass constructability reviews, estimating, and scheduling activities. Preconstruction is completed when there is agreement on the project schedule and price—whether it be a guaranteed maximum price (GMAX) or a fixed price— usually when the design is approximately 60% to 90% complete. Open-book cost estimating is used to allow the Owner to make informed decisions on the overall cost, schedule, design, scope, and quality of the project.
- **Phase II -** Construction Manager at Risk (CMAR): the CM firm assumes the General Contractor (GC) role (or assigns a GC), procurement of subcontractors and vendors, self-performance of certain elements of the construction (where permitted and at the Owner's discretion), and completes the full construction and commissioning based on the agreed GMAX or fixed price and schedule.

Characteristics of this delivery method include:

- The Owner is already working with a Design Consultant and/or wants direct longer-term design support services;
- Higher Owner/Stakeholder input desired in design development through collaboration with the Designer and early Contractor involvement;
- The CMA firm is selected using a qualifications based selection or best value approach, similar to professional services contracts using qualifications as a selection criterion rather than low price;
- O&M life-cycle costs are considered in the design development and equipment selections (rather than just lowest capital cost);
- CMA can facilitate to inform design or address long delivery issues. CMA helps to better inform constructability, logistics, costs, design, and tender specifications;
- Appropriately allocated risk transfer, based on who is best suited to control the risk and carry the mitigating costs;
- A higher level of cost control from the beginning. During the design process, the CMA provides realistic market informed cost estimates at contractually established points (e.g. 30%, 50%, 70% design phases) then provides a contractually binding Guaranteed Maximum Price (GMAX) or fixed (lump sum) fee and schedule before construction award;
- Potential for reduced costs on supplies as equipment pricing can be secured early for multi-year contracts with suppliers;

- More communication between all parties and theoretically a lower risk of re-work during construction. With this collaborative model, the Owner, Consultant, and Contractor inform the design together. Generally, this mitigates surprises during construction and helps the project run more smoothly;
- Allows for a fast-tracked schedule. There is reduced tender bidding time required and opportunity for staged construction work packages to accelerate the construction schedule;
- Typically CMAR projects are more cost effective than DBB projects;
- Owner should have the project funds available to pre-purchase equipment in the first year of construction (to maximize cost certainty and mitigate against potential market increases); and,
- Owner may be at risk to pay claims if operational delays cause delay in contractor's schedule or executing within the CM's GMAX.

3.2.1 Phase 1- Construction Management as Advisor (CMA)

In Phase 1 - CMA, the CM is only serving in an advisory role (sometimes referred to as pre-construction services). The CM is typically engaged during pre-design or once pre-design is complete to collaborate on the detailed design and equipment selection/procurement approaches, transparent capital estimating and schedule development. Once agreed upon, select equipment pre-purchase RFPs can be issued and awarded. This method allows for shop drawings to be obtained and detailed design to proceed based around the actual equipment, while having a Contractor's input in constructability and incorporation into the works. For additional confidence on anticipated self-performed work by the CM, a third party cost consultant can also be retained to validate the CM's pricing.

A CMA contract (CCDC-2 type between the Owner and Contractor) can be converted to a Construction Management at Risk (CMAR) contract (CCDC-3 type contract between the Owner and Contractor). If the CM were to prepare a guaranteed maximum price (GMAX) and schedule, the CMA contract would be converted to CMAR and the project would move to Phase 2.

In the event that
the Owner and the CMAR firm cannot agree on a price, schedule, and risk allocation to construct the project, (whether it be a GMAX or fixed price), the Owner can terminate the contract by using the "off-ramp" option. Should this off-ramp be taken, the Owner may negotiate, subject to any applicable provincial law, with another CMAR firm seeking to reach agreement on a price or to have the design completed and proceed with a DBB procurement.

3.2.2 Phase 2- Construction Management at Risk (CMAR)

In Phase 2 - CMAR, the CM takes on monetary risks for the construction of the project, and responsibilities to keep the project on schedule. The CM commits to a GMAX or executes the work as a lump sum contract.

The Contractor's in-house team could begin work while other subcontractors are retained. In this case, UWSS would extend the CM's purchase order (PO), and then the Contractor would issue POs to subcontractors, and they would be responsible for managing all subcontracts.

The CMAR process is summarized in **Figure 3-3** below.

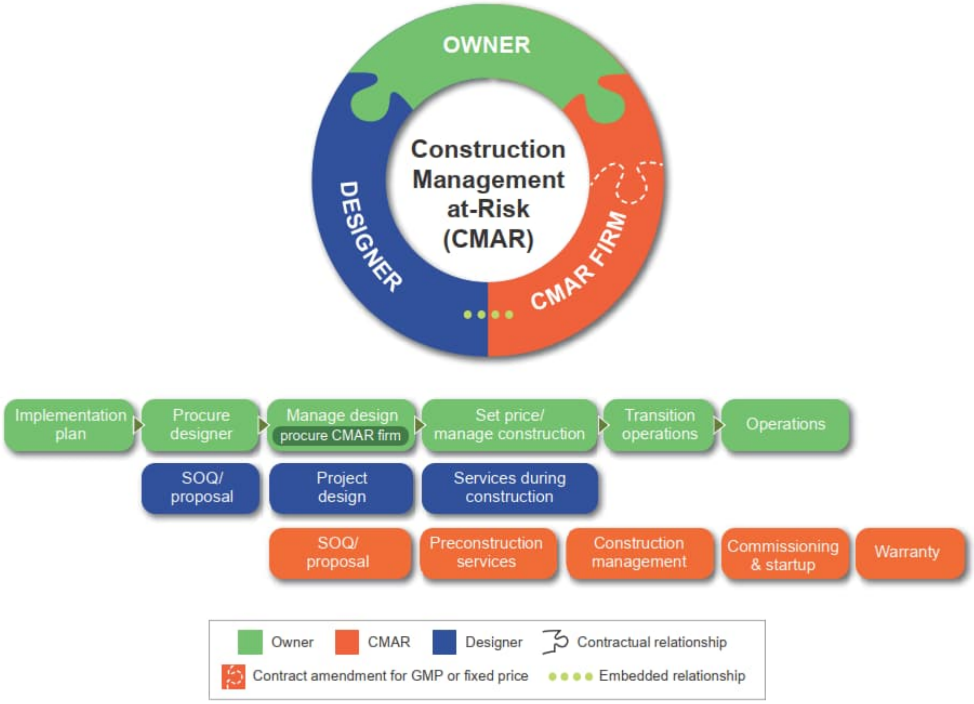

Figure 3-3: Summary of the Construction Management at Risk (CMAR) Process (Water Design Build Council, 2019)

3.3 Fixed Price Design Build (FPDB)

Fixed Price Design Build (FPDB) is another common collaborative delivery method used in the industry to fast-track projects. It is best suited for projects with well defined desired outcomes with an Indicative Design developed or Performance Based criteria established.

Characteristics of this delivery method include:

- Requiring the Owner to retain an Owner's Engineer for assistance and oversight;
- The Owner and Owner's Engineering define the project requirements and scope of work sufficiently for proposing firms to accurately predict the project cost early in the procurement process;
- The Owner looking for single fixed price encompassing the design, construction, commissioning and acceptance testing prior to design build (DB) selection based on minimal (30%) design effort by the proponents;
- Requires bidders to submit a technical proposal and fixed price based on an indicative design or defined performance criteria;
- The Owner is willing to pay a stipend to the unsuccessful bidders for their efforts developing at a 30% design;
- Most beneficial when the project is schedule driven and looking for a quick start to construction;
- Lower Stakeholder input is required during detail design development and construction;
- The Owner prefers risk transfer;
- Best suited for greenfield construction where there are very few or definable site constraints; and,
- More costly for the Owner compared to the other collaborative-delivery methods due to the cost of design detail in procurement documents and payment of a stipend to the unsuccessful proponents.

The FPDB process is summarized in **Figure 3-4** below.

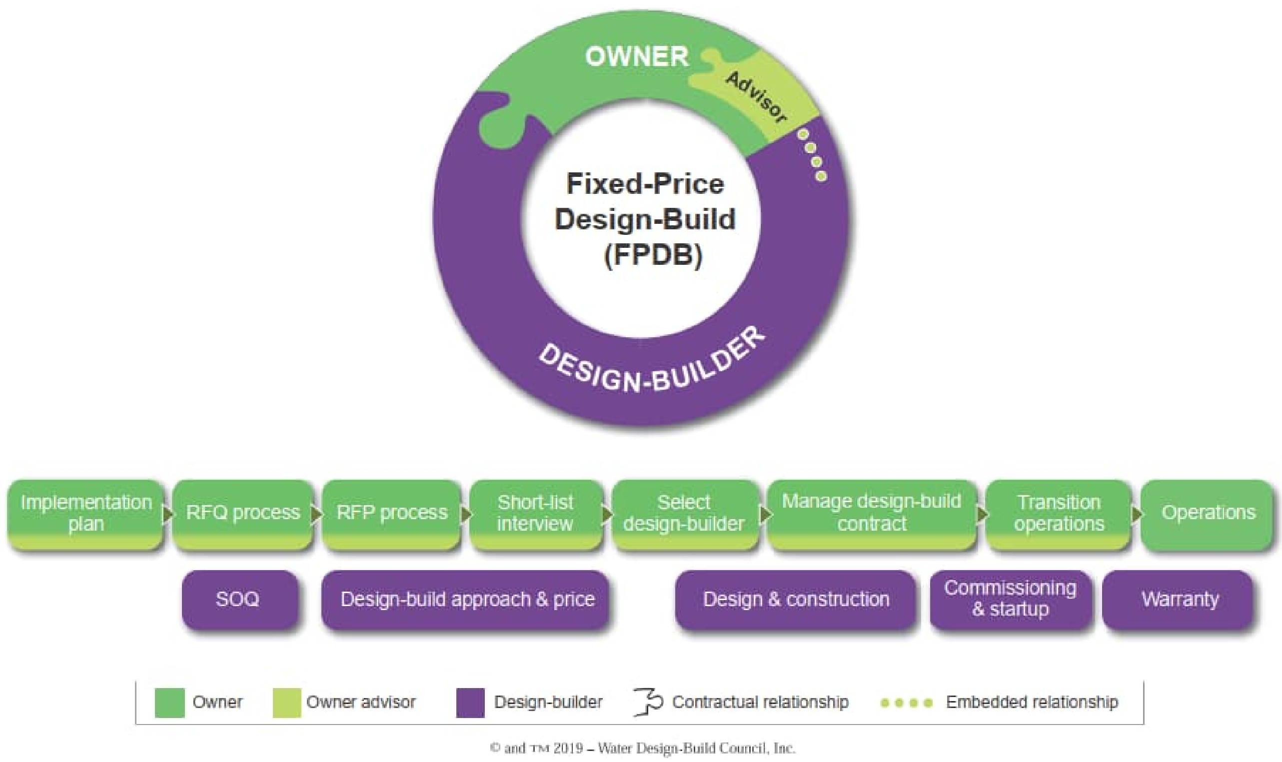

Figure 3-4: Summary of the Fixed Price Design Build (FPDB) Process (Water Design Build Council, 2019)

3.4 Progressive Design Build (PDB)

Another commonly used collaborative delivery method is Progressive Design Build (PDB). PDB is best applied when a project has complex, less defined, brownfield upgrades. Progressive Design Build is a slight deviation from the more traditional FPDB approach of a fixed lump sum pricing model based on either prescriptive or performance-based goals. A PDB approach is rooted on collaboration between a project team consisting of the Owner (Engineering, Operations and Maintenance representatives), a Design Consultant and a General Contractor. Following a collaborative partnership approach, the collective team works together to provide input and define the project scope, quality, functionality, operability, performance, price and schedule as the technical solution develops. The Owner's Operations and Maintenance involvement during the design development is particularly beneficial in ensuring project success in meeting the overall project drivers, objectives and goals.

Fixed pricing in the form of either a GMAX or a lump sum would be provided under this approach once the project team collaboration establishes the design, functional and performance specifics, fixed to a level agreed upon, typically once the design has advanced to around 70% complete. The target project cost or affordability limit forms the baseline to which design and construction decisions are made while total project costs and schedule are tracked using an open and transparent model.

PDB is similar to CMAR but with PDB, the Designer is retained by the Contractor or Design-Builder (DB). In CMAR the Designer is retained by the Owner.

The PDB approach leverages the benefits of both FPDB and CMAR. The FPDB component brings the Contractor and the Engineer together as a single point of accountability for the Owner, maximizing functionality and efficiency while maintaining construction cost within the previously established construction budget. The CMAR component brings the Contractor's preconstruction, constructability, scheduling and pricing skills to the design stage of the project, with a seamless transition into the construction management of the project work packages while maintaining the schedule and cost incentives that are a critical part of fixed price construction contracting.

Characteristics of this delivery method include:

- Requiring the Owner to retain an Owner's Advisor for assistance and oversight;
- Owner involvement desired in the design though collaboration with the Designer and early Contractor involvement;
- The General Contractor (GC) and design team are under a single DB contract, but they are brought into the development process earlier than is typical;
- Usually selecting and awarding the contract to the PDB Contractor based solely on qualifications;
- Offering more opportunities for innovation. Similar to CMA/CMAR, the Progressive DB approach allows a high level of collaboration between the Owner, Engineer, and Contractor, in developing a design that is the most time and cost efficient within the schedule and budget constraints of the project;
- O&M life-cycle costs are considered in the design development and equipment selections (rather than just lowest capital cost);
- Appropriate risk transfer, based on who is best suited to control the risk and carry the mitigating costs;
- The Owner maintaining a hands-on interest in how the design develops to achieve the desired functionality, operability, maintainability and quality before a GMAX is determined;
- GMAX based on a 60-90% design before proceeding with construction – with option for an off-ramp. Off-ramp is a contractually defined option for the Owner to end services with the PDB delivery firm prior to agreement on price;
- Complexities with off-ramping, as the engineer of record is under contract with the DB and is lost during the off-ramp (i.e. the designer is lost if you off-ramp);
- Once the design criteria has been defined and agreed to, additional workshops focusing on risk, risk allocation, construction and operational safety, operability, maintainability and resiliency would allow the project team to be fully engaged and informed on the design, operating and maintenance, schedule and cost considerations related to the project; and,
- The fundamental cornerstone of the PDB approach is the recognition that any change in design or project scope, will impact other aspects such as function and performance.

Similar to CMA/CMAR, there are two phases for a PDB contract:

- Phase I, preconstruction services encompass constructability reviews, value-engineering, estimating, and scheduling activities. Preconstruction is completed when there is agreement on the project schedule and price—whether it be a GMAX or a fixed (lump sum) price— usually when the design is approximately 60% to 90% complete. Open-book cost estimating is used to allow the Owner to make informed decisions on the overall cost, schedule, design, scope, and quality of the project.

- Phase II, in which the GMAX is agreed upon and the DB completes the design, obtains permits, procures subcontractors and vendors, self-performance of certain elements of the construction (where permitted and at the Owner's discretion), and full construction and commissioning.

The workflow for a PDB contract is summarized below in **Figure 3-5**.

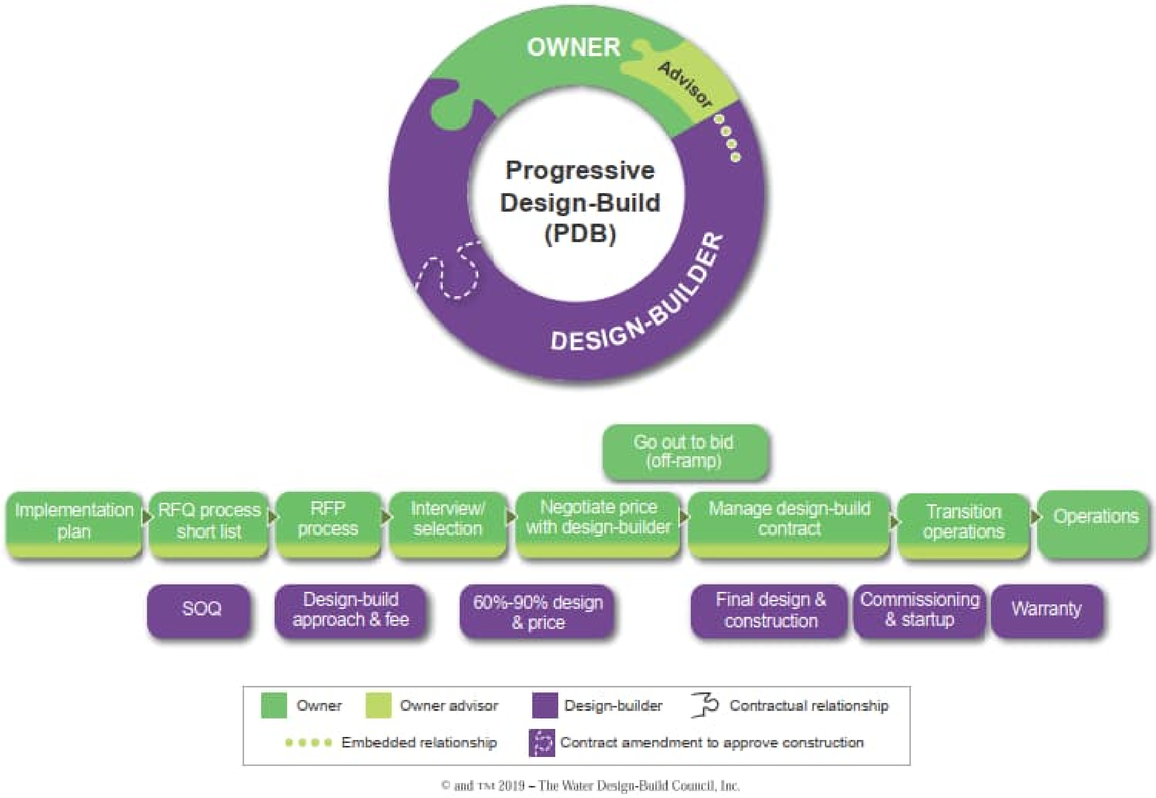

Figure 3-5: Summary of the Progressive Design Build (PDB) Process (Water Design Build Council, 2019)

3.4.1 Integrated Project Delivery (IPD)

The last common collaborative delivery method that will presented in this memo is Integrated Project Delivery (IPD). IPD is typically used for projects that are less defined but complex, require high level of input from the end users, and the Owner has an affordability ceiling. It is not used to fast-track a project as it follows an iterative, time consuming method to design to a target price. IPD can take longer to complete as it is more iterative with the goal of completing the works at the lowest price. The design is developed and refined to stay within an agreed upon target price, instead of designing and constructing in the most time effective method. Because the main driver for both Contract 1 and Contract 2 is time, IPD is not explored in detail in this memo.

Characteristics of this delivery method include:

- Requiring the Owner to retain an Owner's Advisor or IPD Coach for assistance and oversight;
- The project having complex implementation logistics that would significantly benefit from early subtrade input;
- The Owner is looking for appropriate risk share and transfer;
- The Owner is looking for risk/reward incentives from all parties;
- All major parties are bound under one contract;

- Requiring time and effort upfront to onboard and educate all the team members;
- The team works collaboratively through the Validation Phase to develop a 30-40% design and set a Target Price for the project for the Owner to agree to; and,
- The team then designs and builds to the Target Price.

4 BEST SUITED DELIVERY METHODS

The nature of the reservoir contract (Contract 1) is largely greenfield civil works involving earthworks, dewatering, foundations, water retaining concrete works, underground piping and valve installations, limited amount of process mechanical piping and valve installations for the valve chamber and future high lift pump station, plus building envelop works for the superstructure. The primary driver for Contract 1 is compressing the schedule for increasing onsite storage volume as soon as possible.

The nature of the UV retrofit contract (Contract 2) is largely brownfield in-plant works that includes process mechanical, electrical and a limited amount of building mechanical works. The primary drivers for Contract 2 are minimizing operational interruptions, maintaining production capacity and treated water quality during construction activities, and the resulting unit process upgrades meeting UWSS's desired functionality, operability, and maintainability features. Additionally, Contract 2 requires two seasons for the UV reactor installation during off-peak seasons.

Considering the above noted project objectives, drivers and site constraints and the nature of the work involving different construction trades, work areas and timing restrictions, it is recommended to consider a CMA/CMAR collaborative delivery method that utilizes early contractor involvement and a partnership approach to deliver the project.

The CMA/CMAR delivery model is recommended over DBB to allow for early contractor involvement and to expedite the delivery schedule. The CMA/CMAR delivery model is recommended over PDB (and FPDB) as the Owner already has a Designer retained that is familiar with the Owner's objectives, desired outcomes and plant site constraints. Hiring a DB Designer would not be required and would only extend the project duration to gain familiarity. Additionally, CMA/CMAR provides more options with off-ramping as the Owner has a direct agreement with the Designer and can keep them engaged if a new CM or GC is required.

Once the conceptual or indicative design is complete, an RFP would be issued to select a CMA to work collaboratively with the designer and Owner through the design development phase. The qualifications of the preferred CM would have broad experienced in delivering multi-discipline works for water treatment and storage facilities and would have in-house expertise to advise on constructability issues, procurement, multi-discipline cost estimating and scheduling. The CM would then retain GCs for the two different Contracts with trade skills aligned to the nature of the proposed works.

Since it is recommended to split the scope of work into two contracts, one common Construction Manager could be retained to manage two separate sets of trades to complete the works. There would be some overlap between the two contracts to minimize downtime.

4.1 Contract 1

There are two options Contract 1 could be delivered under a CMA/CMAR contract.

4.1.1 Option 1- CMAR with One Work Package

In this option, the CM would be retained as soon as possible to collaborate on the reservoir design as an advisor. A CM that has in-house GC qualifications for reservoir and linear work would be preferred. The CM would work in collaboration with Associated and UWSS for pricing, scheduling, and construction logistics.

The CM would manage a subcontract for the demolition and site clearing of the existing greenhouses. This would allow concurrent work to occur with design of the reservoir while proceeding with the additional geotechnical investigation to validate the foundation conditions and inform the detailed design of the reservoir.

As the design progresses to 60-70%, the CM would issue a Request for Tender to secure the rebar and concrete required for design and lock-in pricing. The CM would also issue a Request for Tender for earthworks to excavate the reservoir area and subsequent backfilling and lock in the pricing.

Once the design reaches 80%, the CM would prepare a GMAX (or Lump Sum) to be negotiated and agreed upon before commencing construction.

This method would save time with early procurement of site clearing, earthworks pricing and locking-in concrete and rebar pricing. After award, the CM could start ordering piping and valving for the required interconnections between the three reservoirs.

This option saves time compared to a DBB contract but is not as fast as Option 2 below.

4.1.2 Option 2- CMAR with Sub-packages (Fast-Tracked CMAR)

In this option, the CM would be retained as soon as possible to collaborate on the reservoir design as an advisor, similar to option 1. However, the work would be setup in multiple work packages.

- The first work package would be the demolition and site clearing of the existing greenhouses, and additional geotechnical investigations to validate the foundation conditions and inform detailed design of the reservoir.
- The next work package would be for excavating the new reservoir which would occur following the demolitions/site clearing and while the structural design is being completed.
- A material supply package would be issued to lock-in pricing for the rebar supply and concrete supply.
- A work package would then be issued for the mudslab foundation and the base slab construction to commence while the remainder of the reservoir design is being completed.
    - Construction of the reservoir could progress from south to north, meaning the details for the valve chamber could be finalized while the reservoir base slab is being constructed. This allows construction to proceed while the more complex design work is finished.
- Another work package would be issued for the remainder of the concrete works including the reservoir walls, roof slab and valve chamber construction.
- A mechanical work package for the in-reservoir piping, discharge header, and the superstructure of the valve chamber/pump station would be issued. The highlift pumps and MCCs will be installed under a future contract.
- Lastly, a civil work package would be issued for the underground piping and interconnections for Reservoir 1 and 2 along with final site grading works

This option provides the fastest method to complete the works as construction can start and material procurement can start while design details are being finalized. However, with this option there would only be a construction Target

Price (TP) not a GMAX. The TP is still expected to be within at least 10-20% accuracy. The CM would be advising on pricing throughout preliminary design and design development. By 30-40% design development the concrete and steel supply contracts and earthworks pricing could be locked-in; which make up the majority of the reservoir costs.

4.2 Contract 2

Similar to Contract 1, there are different ways Contract 2 could be delivered as a CMA/CMAR contract. It would not be beneficial to complete Contract 2 under a DBB contract as it would prolong construction, and would not provide a Contractor's perspective for constructability for the staged demolition and installations required in the filter pipe gallery.

Depending on the lag between completing Contract 1 and starting Contract 2 the same CM could be used for both contracts. A CM who can perform in-house mechanical and electrical works would be preferred. There is an advantage to bring on a CM as an advisor early to procure the UV equipment and associated shop drawings. Associated could complete the detailed piping design around the actual UV equipment and designing the incorporation of the electrical equipment.

The CM would advise on implementation logistics and a GMAX to complete the works. The work could be organized in two work packages that would be completed over two off-peak seasons: Filters 1-4 and then Filters 5-8.

Alternatively, depending on when UWSS prefers to implement the plant electrical upgrades and install the standby generators, these upgrades could be included under a work package of Contract 2. In this case, once the reservoir is commissioned, construction of the UV retrofit in the first pipe gallery could commence the following fall/winter of that year. During the summer the electrical upgrades and standby generator work could commence as it is not dependant on off-peak seasons. Lastly, the following fall/winter the UV retrofit in the second pipe gallery could be completed.

4.3 Anticipated Schedule

CMAR introduces the possibility of overlapping design and construction timelines. Hiring one CM for both contracts is preferred, and the CM should be able to advise and estimate mechanical and electrical works with the option to self perform the actual work itself. The anticipated schedule for this project using CMAR method and including some overlap between the two aforementioned contracts, is summarized in **Figure 4-1**. It is anticipated that the overall project delivery following DBB would be around 34 months. **Note, this is a preliminary estimate on the schedule which will be refined during detailed design.**

- Contract 1 (Complete within 29 months):
  - 3 months to complete preliminary design, and engage the contractor/ construction manager;
  - 4-6 months to complete detailed design with the contractor; and,
  - 18-20 months to complete detailed design, and construct and commission Reservoir No. 3, and interconnections to Reservoir No. 1 and No. 2.
- Contract 2 (Complete within 28 months):
  - 8 months to pre-purchase the UV system, complete the design (preliminary and detailed), develop a detailed implementation schedule, tender (or negotiate pricing) for the seasonal work packages; and,
  - 18-20 months to construct and commission the works. UV reactors will be installed in the filter effluent lines, and will need to be completed during low demand periods (spread over two winter seasons), and each filter will need to be out of service for approximately 1 month.

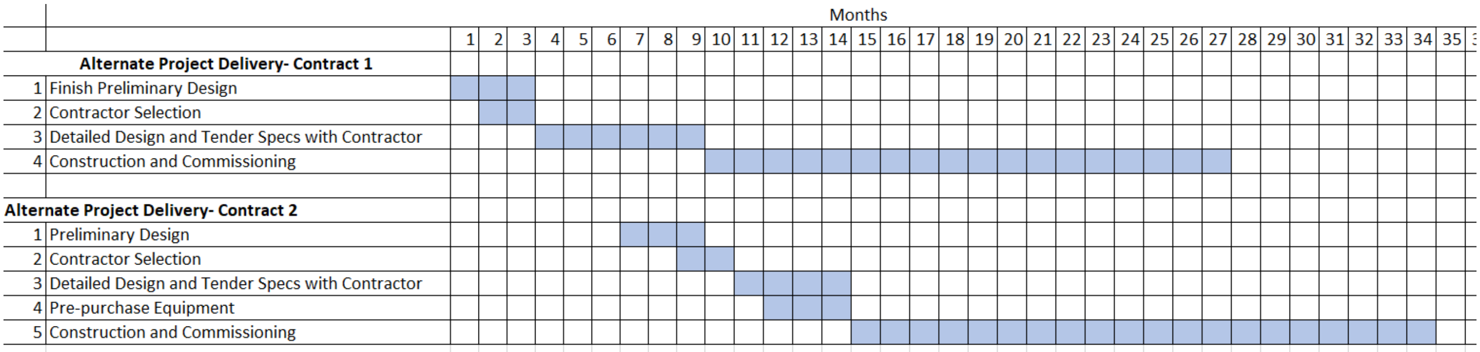

Figure 4-1: Anticipated Schedule Using a Progressive Design Build Project Delivery

5 RECOMMENDATIONS

Associated has the following recommendations:

- A CM (CMA/CMAR) delivery model is recommended over DBB to allow for early contractor involvement and to expedite the delivery schedule.
- A CM (CMA/CMAR) delivery model is recommended over PDB (and FPDB) as the Owner already has a Designer retained that is familiar with the Owner's objectives, desired outcomes and plant site constraints. Hiring a DB Designer would not be required and would only extend the project duration to gain familiarity.
- Finding a qualified, capable CM should be thoroughly considered. A detailed selection process should be followed to ensure the best candidate is chosen. For Ruthven WTP, a Contractor with in-house experience in mechanical and electrical design (at minimum), and experience with CMAR delivery method will be favoured;
- For Contract 1- Construction of Reservoir No. 3, it is recommended to proceed with a fast-tracked, multi-package CM approach as it is a critical path item and needs to be constructed as soon as possible to meet system demands. Having a CM on board early will provide a collaborative approach to ensure constructability and any associated risks are discussed during design. It also provides the Owner more confidence, as the CM is contractually obligated to complete the works they propose once a guaranteed maximum price is agreed to. It also allows the design to be retained by the Owner, opposed to through the Contractor.
- For Contract 2- UV Reactor Retrofit, it is recommended to proceed with a CMA or CMAR approach. The main challenge with this contract will be the work sequencing to accommodate operational challenges with the filters being out of service to allow the piping upgrades and UV reactor installations. Once the design of both pipe galleries is complete, the construction fee could be locked-in. It is recommended to install, test and commission the first pipe gallery before starting the second.
- For scheduling, it is recommended to start preliminary design of Contract 2 while completing detailed design for Contract 1. Hiring one CM for both contracts is preferred, and the CM should have in-house expertise for mechanical and electrical estimating and advising on the implementation of the staged works.

Associated recommends the following next steps:

- Determine if having a GMAX or more accelerated scheduled is preferred to determine if a CMAR or fast-tracked CM approach is best for Contract 1 and 2.
- Determine which contractors in southern Ontario have experience in collaborative early contractor involvement projects and Construction Management expertise, and who should be approached to engage in this project.
- Determine when the plant electrical upgrades and standby generators project would start to see if it could be tied into Contract 2.

6 REFERENCES

Design Build Institute of America. (2015). Design Build Best Practices.
Water Design Build Council. (2019). Water and Wastewater Design-Build Handbook.

7 CLOSURE

This technical memorandum was prepared for the Union Water Supply System Ruthven WTP to provide a review of project delivery methods and recommend next steps.

The services provided by Associated Engineering (Ont.) Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
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