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REPORT

WaterSMART Solutions Ltd.

Greenview Industrial Gateway Raw Water Storage Ponds Concept



AUGUST 2023



Platinum
member

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1 INTRODUCTION

The Municipal District of Greenview (Greenview) is currently undertaking the development of the Greenview Industrial Gateway (GIG), a 7,500-hectare (18,600-acre) eco-industrial zone designed to promote value-added industrial growth in Alberta's natural gas supply chain. The GIG's first development zone, termed the Project Area for purposes of this report, spans approximately 810 hectares (2,000 acres) of land and is expected to host several petrochemical facilities. It is important to note that this report focuses exclusively on the Project Area of the GIG and does not encompass the entirety of the GIG.

To ensure a reliable and cost-effective raw water supply for the planned industrial processing operations, Greenview aims to establish an industrial water utility within the Project Area to provide a continuous raw water supply for its members. Operating under a single water diversion license, this utility will employ water management infrastructure, including intake structures, pumps, transmission pipelines, and water storage, to serve the facilities (Greenview Industrial Gateway, June 2021). Greenview's intent for the water diversion license is to secure 24,000,000 m³ per year for the Project Area.

This report outlines the conceptual design of the following infrastructure within the GIG:

- Raw water storage ponds;
- Raw water supply from the river to the storage ponds;
- Raw water supply from the storage ponds to a common distribution header;
- Raw water distribution to the industrial lots; and
- Return water line from the industrial lots to the river.

An Opinion of Probable Cost and recommendations for next steps are also included in the report.

2 DATA COLLECTION AND REVIEW

To prepare this report, we collected and reviewed a variety of data and background information, which included the following:

- Reports and documents listed in the Bibliography section of this report;
- LiDAR elevation data with a 15 m x 15 m horizontal resolution;
- Aerial photos and orthophotos from Greenview, dated 2016, as well as the latest images from Google Earth dated 2023;
- Cadastral and property lines from GIS data provided by Greenview, dated May 27, 2022;
- Existing pipeline alignments from GIS data provided by Greenview, dated May 27, 2022; and
- Boundaries for the GIG and the Project Area provided by Greenview.

We utilized this information to inform our conceptual design for the raw water storage and distribution system for the Project Area. The LiDAR elevation data and aerial photos offered valuable insights into the topography and existing features of the Project Area. The GIS data enabled us to accurately locate and map out the proposed infrastructure, including the suggested pipeline alignments and GIG boundaries. It is important to note that while the data we utilized was current as of the dates listed above, there may have been changes to the area since that time, which were not accounted for in our analysis.

3 DESIGN CRITERIA AND ASSUMPTIONS

This section provides an overview of the design criteria and assumptions used for the conceptual design of the raw water storage and distribution system. Limitations and uncertainties associated with the design criteria and assumptions are acknowledged in this report.

Phasing Approach

- An estimated six lots will be developed within the Project Area. These are planned to be developed over three phases, with two lots developed per phase. These phases are referred to as Phase 1, 2, and 3 in this report. Each phase adds on to the last with Phase 3 being the ultimate build-out.
- The storage ponds and distribution pipes will be phased to accommodate the lot development.

Pond Design

- The raw water storage ponds must be sized to meet the annual water demands from the Project Area, assuming that raw water withdrawal from the Smoky River will not be possible for up to 18 consecutive weeks per year due to low flow conditions in the river.
- It is estimated that each lot will require 10,000 m³ of water per day based on similar industrial use in the area. Consequently, the ultimate raw water storage capacity needed in the ponds amounts to 7,560,000 m³, or 2,520,000 m³ per phase which is equivalent to 18-weeks of storage. As the design progresses, it is important to consult with the proposed industrial users (i.e., Members) to ensure these estimates align with their specific water demands.
- The storage ponds will be constructed within the Project Area, south of the creek.
- The following physical criteria were used to conceptually design the ponds. These criteria should be refined during future design stages with considerations for geotechnical and environmental parameters.
 - The toe of the pond berms, or the top of slope of the pond if there are no berms, should be at least 50 m away from any existing water bodies to minimize environmental impacts and protect water quality.
 - The toe of the pond berms, or the top of slope of the pond if there are no berms, should be at least 30 m away from any existing pipelines to minimize the potential hazards and risks associated with pipeline damage or rupture.
 - The toe of the pond berms should maintain a minimum separation of 20 m to reduce the risks associated with berm failures and to provide sufficient space for infrastructure installation and maintenance.
 - The side slopes of the pond and pond berm should have a 3H:1V ratio to minimize the risk of geotechnical failure and ensure the long-term stability of the berm. This assumption should be confirmed with a detailed geotechnical investigation as part of future design stages.
 - A minimum berm top width of 3 m should be maintained to allow for vehicle access along the top of the berm.
 - A maximum water depth of 10 m was used to size the ponds. This assumption should be reviewed by a geotechnical engineer, in consideration of both the geotechnical conditions within the development area, and long-term slope stability..
 - A minimum freeboard of 0.6 m should be maintained to prevent over-topping of the pond and to provide sufficient buffer capacity in case of a large rainfall event.
 - Based on the proposed depth of the ponds, it is anticipated that a subdrain system will be required. This assumption should be confirmed through a detailed geotechnical investigation .

- An emergency pond overflow system should be incorporated into the pond design.

Pipe Design

- To ensure the longevity and efficient operation of the pipeline, velocity in the pipes should not exceed 1.5 m/s (Associated Engineering, October 2022). The system should be designed to achieve a minimum pipe velocity of 0.6 m/s for maintenance and cleaning purposes.
- The water pipes must be designed to withstand the regular operating water pressures as well as any surge pressures, such as water hammer, which may occur in the pipeline to prevent failures and ensure the reliability of the water supply.
- At locations where trenchless construction is required or suggested, the water pipe should be suitable for the specific trenchless construction method used.
- HDPE DR 11 and PVC DR 32.5 pipes are recommended for water pipeline sections near the ponds due to their durability, flexibility, strength, and resistance to corrosion and abrasion. The pipe material and pressure rating should be refined in later design phases.
- A Hazen-Williams roughness coefficient of 130 is used for both HDPE and PVC pipes to calculate the friction losses and ensure the accurate sizing of the pipelines.

Raw Water Supply Lines and Distribution

- The raw water supply line from the river to the ponds must be designed to a maximum flow rate of 1.06 m³/s, as per the Raw Water Pipeline Alignment Options Report (Associated Engineering, August 2023).
- To ensure that each lot is supplied with 10,000 m³/day of raw water for daily operations, a design flow rate of 0.694 m³/s (total of all six lots) has been chosen for the raw water distribution system running from the ponds to the common header, and 0.116 m³/s from the common header to each individual lots.
- Each lot is responsible for meeting its own fire flow requirements, which will depend on their specific needs and the requirements of the relevant regulatory agencies.
- To maintain adequate water pressure throughout the system, the minimum supply pressure for the water line to the ponds, the common header, and the industrial lots has been set at 138 kPa (20 psi), unless otherwise noted. This pressure should suffice for most users and will ensure that the water system operates reliably and effectively.

Return Water Line

- If necessary, the return water line must be designed to accommodate the necessary return flow for all members within the Project Area.
- This report assumes a return flow requirement of 5% of the ultimate water demand. Based on this assumption, the flow rate for the return water line has been designed to be 0.035 m³/s. This rate will have to be confirmed with the industrial lot return demands.

Existing Infrastructure

- We used cadastral, GIS data, and air photos to locate existing above and below ground infrastructure, such as pipelines, roads, and railways, along with existing developments, and wells.
- The latest available air photo, from 2023, indicates that more infrastructure and developments have occurred in the area over recent years. Consequently, it is possible that the latest air photo is also missing features

constructed since the photo was taken, which could impact the design and construction of the raw water storage and distribution system.

- As the project progresses, additional site surveys and field investigations may be necessary to verify the location and condition of existing infrastructure and to ensure that the design is compatible with the most recent information available.

Geotechnical Conditions and Considerations

- An initial geotechnical investigation was undertaken by MPE Engineering Ltd. (MPE) in June 2023. The investigation included five boreholes, three at the river intake site, one was at the proposed pond location, and one was adjacent to the proposed pond area. At the river intake, the ground was found to be primarily sandstone, and the pond location was found to be primarily clay material.
- Further geotechnical investigation is required for the pond storage area as two boreholes are not sufficient to determine the conditions across the entire pond development area (~165 hectares). The two pond site boreholes for the pond area found stiff clay which is typically suitable for 3H:1V side slopes and is likely suitable for impermeable clay liners; however more testing is still required.
- Once pond sizing and location have been confirmed, geotechnical services should be coordinated to conduct a site-specific geotechnical investigation. This investigation will help identify potential geotechnical issues that may affect the constructability of the ponds, the long-term stability of the berms, development costs, and other infrastructure.

Environmental Conditions and Considerations

- In 2022, Associated Engineering (September 2022) conducted an environmental overview of the Project Area to identify potentially environmentally sensitive areas, including wetlands, vegetation, fish and wildlife, and historical resources.
- In addition to the recent environmental overview, WSP conducted a Desktop Environmental Constraints Assessment in 2021.

Construction Methods

- Due to limited geotechnical information in the area, certain assumptions have been made regarding the construction methods, primarily for cost estimating purposes. As the design progresses, the construction method will be refined based on updated information and the detailed geotechnical investigation.
- It is assumed that existing soils contain sufficient suitable clay material to construct a compacted clay liner for the ponds, necessary to prevent water exfiltration from the ponds. If the existing soil is found to be unsuitable for constructing a clay liner, a geosynthetic liner could be used as an alternative.
- Open cut construction is assumed for all pipes, except when crossing existing pipelines, railways, and watercourses. In these cases, trenchless construction methods are assumed to minimize environmental impacts and reduce excavation-related risks.

4 OVERVIEW OF RAW WATER SERVICING CONCEPT

The following section provides an overview of the raw water servicing concept for the Project Area, with further details elaborated in subsequent sections.

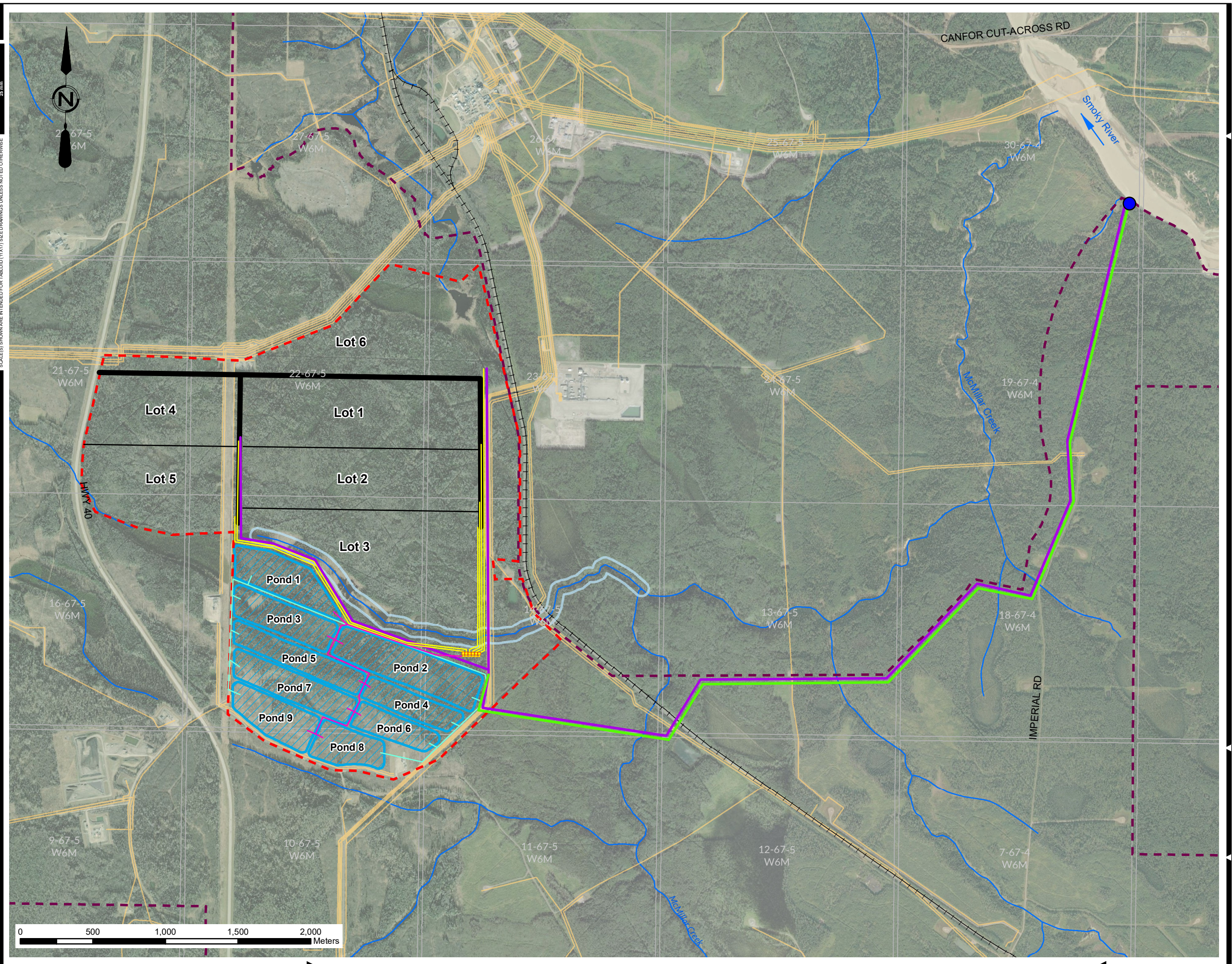
1. Raw water will be pumped through the raw water pipeline(s) from the Smoky River intake structure to the southeast corner of the Project Area, as discussed in the Raw Water Pipeline Alignment Options Report (Associated Engineering, August 2023). The overall site layout illustrated in **Figure 4-1**.
2. Raw water will be conveyed to the ponds via a common water supply line connected to each pond.
3. Raw water will be stored in the storage ponds for eventual use by the industrial users.
4. Raw water will exit the ponds through a gravity-fed raw water supply line which transports water from each pond to a common header located northeast of the ponds. The supply lines for filling and emptying the ponds area are illustrated in **Figure 4-2**.
5. Downstream of the common header, Greenview will install a water distribution pipe stub for each of the six lots. Each industrial user will be responsible for constructing a booster station at the end of the stub, as well as a water distribution pipe to their respective lot for water consumption.
6. If necessary, a return line may be constructed to release water back into the Smoky River. This would involve constructing a return line that each industrial user could tie into at a common connection point, which would be the responsibility of the industrial user. The return line from the connection point to the river would be constructed by Greenview.

Pipeline Hydraulic Analysis

To ensure that the water systems can deliver water at the required pressure and flow rate, we conducted a hydraulic analysis using the Hazen-Williams equation for pressurized systems, and the Manning's equation for gravity systems. The analysis determined appropriate pipe sizes and hydraulic profiles for conceptual design purposes. To facilitate the interpretation of the hydraulic analysis results, figures were produced to illustrate ground elevation, pipe invert elevation, hydraulic grade line (HGL), anticipated maximum surge pressure, and pipe rating. The x-axis of these figures indicates the starting point of the hydraulic analysis (i.e., where the water flows from). More details about the hydraulic analysis are presented in the following sections.

SAVE DATE: 3/30/2023 2:08:46 PM SAVED BY:
DRAWING PATH: C:\2022-3376_GIG_WaterApplication\GIGRawWaterPond\Fig4-1_RawWaterPondLocationPlanConcept.mxd
DATA SOURCE: Source: Esri, Maxar, Earthstar, Geographics, and the GIS User Community

IF NOT 25 mm AS SHOWN ON THIS SCALE
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



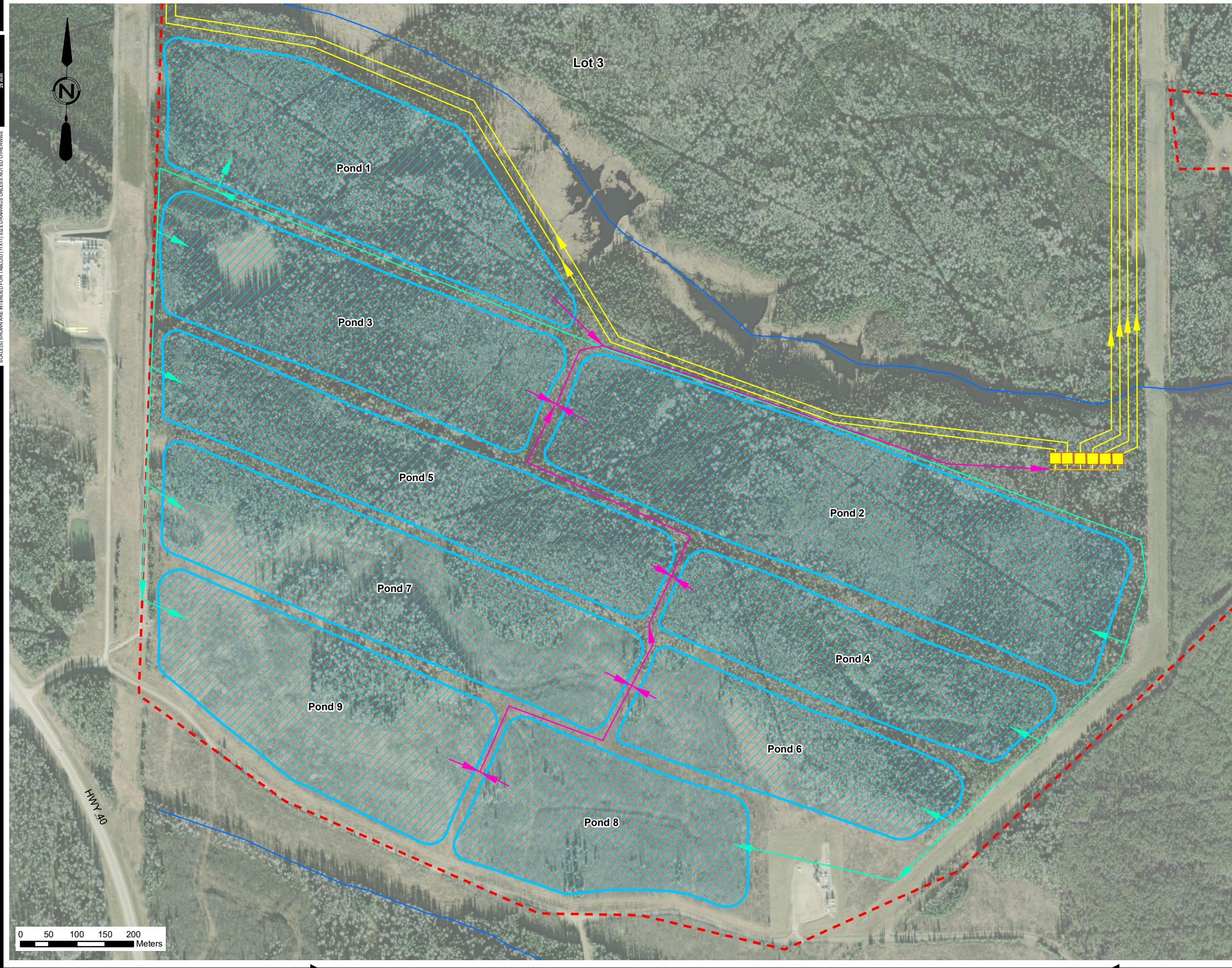
- Legend:**
- Smokey River Raw Water Intake Structure
 - Existing Pipelines
 - Raw Water Supply to the Common Header
 - Return Line
 - Raw Water Supply Line to the Ponds
 - Distribution Line to Lots
 - Common Header
 - Pipeline Alignment #2 (from Draft Raw Water Pipeline Alignment Options Report)
 - Road ROW
 - Property Lines
 - Watercourse
 - Railway
 - Booster Station
 - 50 m Buffer from Watercourse
 - Proposed Raw Water Pond
 - GIG First Development Area
 - GIG Boundary

FIGURE 4-1

MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART SOLUTIONS LTD

CONCEPTUAL RAW WATER STORAGE AND DISTRIBUTION SYSTEM

AE PROJECT No.	2022-3376-00
SCALE	1:25,000
APPROVED	
DATE	2023MAR30
REV	
DESCRIPTION	ISSUED FOR REVIEW



- Legend:**
- Raw Water Supply to the Common Header
 - Raw Water Supply Line to the Ponds
 - Distribution Line to Lots
 - Common Header
 - Watercourse
 - Booster Station
 - Proposed Raw Water Pond
 - GIG First Development Area

FIGURE 4-2

MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART SOLUTIONS LTD

RAW WATER POND CONCEPTUAL LOCATION
AND SUPPLY

AE PROJECT No.	2022-3376-00
SCALE	1:6,500
APPROVED	
DATE	2023MAR30
REV	
DESCRIPTION	ISSUED FOR REVIEW

5 RAW WATER STORAGE PONDS

5.1 Design Overview

The proposed raw water storage pond concept, shown on **Figure 5-1**, includes the construction of nine ponds designed to provide 18 weeks of water storage. The conceptual pond design considers existing topography, the project's phasing approach, and volume balance of earthworks. Constructing nine smaller ponds instead of a few large ones reduces the risks associated with dam failure, provides a more balanced earthworks (cut and fill), better phasing, and simplifies construction.

The proposed placement of the raw water storage ponds is primarily determined by the area's topography. The ponds are proposed to be located south of the creek as this area reduces the potential risk associated with a potential berm failure as the creek provides a physical barrier to the industrial lots and there are no large developments downstream from this area. Minimizing the risk associated with flooding is essential as the cost of damages from releasing millions of cubic metres of water onto the industrial lots is substantial.

Figure 5-1 displays the conceptual layout and dimensions of the raw water storage ponds. **Figure 5-2** shows the conceptual cross sections for further visualization. **Figure 4-2** shows the raw water supply lines to the ponds and the common header.

During high flow periods, the Smoky River may have sediment loads that are unfavourable for the industrial lots. This report does not consider settling requirements for the ponds as a design sediment limit for the industrial lots was not provided, as well the Smoky River intake structure will likely require screening for the pumps. The intake structure and the amount of screening at the intake structure would be required for settling considerations is outside AE's scope of work.. However, in later design phases, it can be considered to have one of the storage ponds be a settling pond. The settling pond would be the pond with the highest elevation, and it would be constructed in Phase 1. Incorporating a settling pond would alter the water distribution system and the phasing.

5.2 Pond Capacity, Size and Geometry

To provide 18 weeks of water storage for all three phases of the GIG requires 7,560,000 m³ of storage. To accommodate the proposed storage the following criteria were used:

- 3H:1V side slopes;
- Top berm widths of 3 m;
- Maximum water depth of the ponds is 10 m;
- Minimum freeboard of 0.6 m;
- Ponds were spaced with a minimum separation of 20 m; and
- Minimum setback from the creek of 50 m.

Based on the above criteria, nine ponds are proposed. This reduces the risks associated with berm failure, provides a more balanced earthworks (cut and fill), and simplifies construction. **Table 5-1** outlines the top of water elevation, surface area, and capacity of each pond.

Table 5-1 Pond Information

Pond Number	Water Surface Elevation (m)	Water Surface Area (m ²)	Water Storage Capacity (m ³)
1	723.1	145,000	1,191,000
2	724.6	188,000	1,533,000
3	729.4	107,000	826,000
4	729.4	74,000	526,000
5	733.3	104,000	738,000
6	732.9	67,000	479,000
7	739.2	119,000	902,000
8	741.8	77,000	597,000
9	743.7	108,000	861,000
Total	-	989,000	7,652,000

5.3 Pond Phasing

The development of the raw water storage ponds in the GIG is planned to be carried out in three phases. The phasing of the ponds is based on the current water demand and storage requirements. **Table 5-2** provides the details of the ponds proposed to be constructed during each phase, along with their available storage capacity and the required storage capacity for each phase. The numbering of the ponds reflects the proposed order in which they will be constructed, with Pond 1 being constructed first and Pond 9 being constructed last.

Table 5-2 Pond Phasing and Capacity

Phase	Storage Ponds	Available Capacity (m ³)	Required Capacity (m ³)
Phase 1	Pond 1, and Pond 2	2,720,000	2,520,000
Phase 2	Pond 3, Pond 4, Pond 5, and Pond 6	5,290,000	5,040,000
Phase 3	Pond 7, Pond 8, and Pond 9	7,650,000	7,560,000

Table 5-3 provides a summary of the earthworks balance for both Phase 1 and the combined three phases. The earthworks balance remains consistent, exhibiting similar amounts of cut and fill throughout the phases.

Table 5-3 Earthworks Balance Quantities

Component	Phase 1 – Storage Ponds (m ³)	All Phases – Storage Ponds (m ³)
Cut	993,000	3,000,000
Fill	993,000	2,996,000
Net	± 0	± 4,000

5.4 Pond Operation

The raw water pipeline transports raw water from the Smoky River to each storage pond via a common supply line. From the ponds, water is then directed to a common header that supplies raw water to the industrial lots, as discussed in [Section 7](#). The layout of the pond distribution system is depicted in [Figure 4-2](#).

To streamline the filling and emptying operations and account for varying water elevations in each pond, the ponds will be filled one at a time, up to a predetermined water elevation. Similarly, ponds will be emptied into the common header one at a time, until the pond water level reaches a predetermined drawdown elevation. The pond filling and emptying strategy will be determined during later design phases, in consultation with a geotechnical consultant to prevent pond berm failure due to rapid drawdown or filling. Most ponds should remain full, except during periods when water withdrawal from the river is not permitted.

The ponds are designed to have capacities ranging from 480,000 m³ to 1,530,000 m³. Using the maximum fill rate of 1.06 m³/s, it would take between 5 and 17 days to fill one of the ponds from empty to full. Employing the maximum drawdown rate of 0.694 m³/s, it would take between 8 and 25 days to empty each pond.

5.5 Pond Overflow

An overflow from the ponds to the adjacent creek should be provided in the event of unforeseen circumstances, such as significant snowmelt or rainfall that threatens to overflow the ponds. To facilitate this, an overflow pipe connecting the common header to an outfall in the creek should be constructed. Alberta Environment and Protected Areas should be consulted for discharge rates into the creek if required. This measure will help ensure the safety of the ponds and protect the surrounding infrastructure in the event of extreme situations. Additionally, emergency overland overflow paths should be established.

The overflow does not allow for additional storage and the emergency overflow runs overland to the creek. During maintenance, cleaning, or any time requiring a pond to be emptied, the pond should be emptied into lower elevation ponds instead of emptying using the pond overflow.

5.6 Dam Classification

The Alberta Water (Ministerial) Regulation (2021) defines a structure as a dam if it “provides a live storage capacity of 30 000 cubic metres or more and is 2.5 metres or more in heights when measured vertically to the top of the barrier.”

The proposed raw water storage ponds meet the criteria to be classified as dams since they will hold more than 30,000 m³ of water and will have berms greater than 2.5 m in height. During the detailed design phase, the ponds will

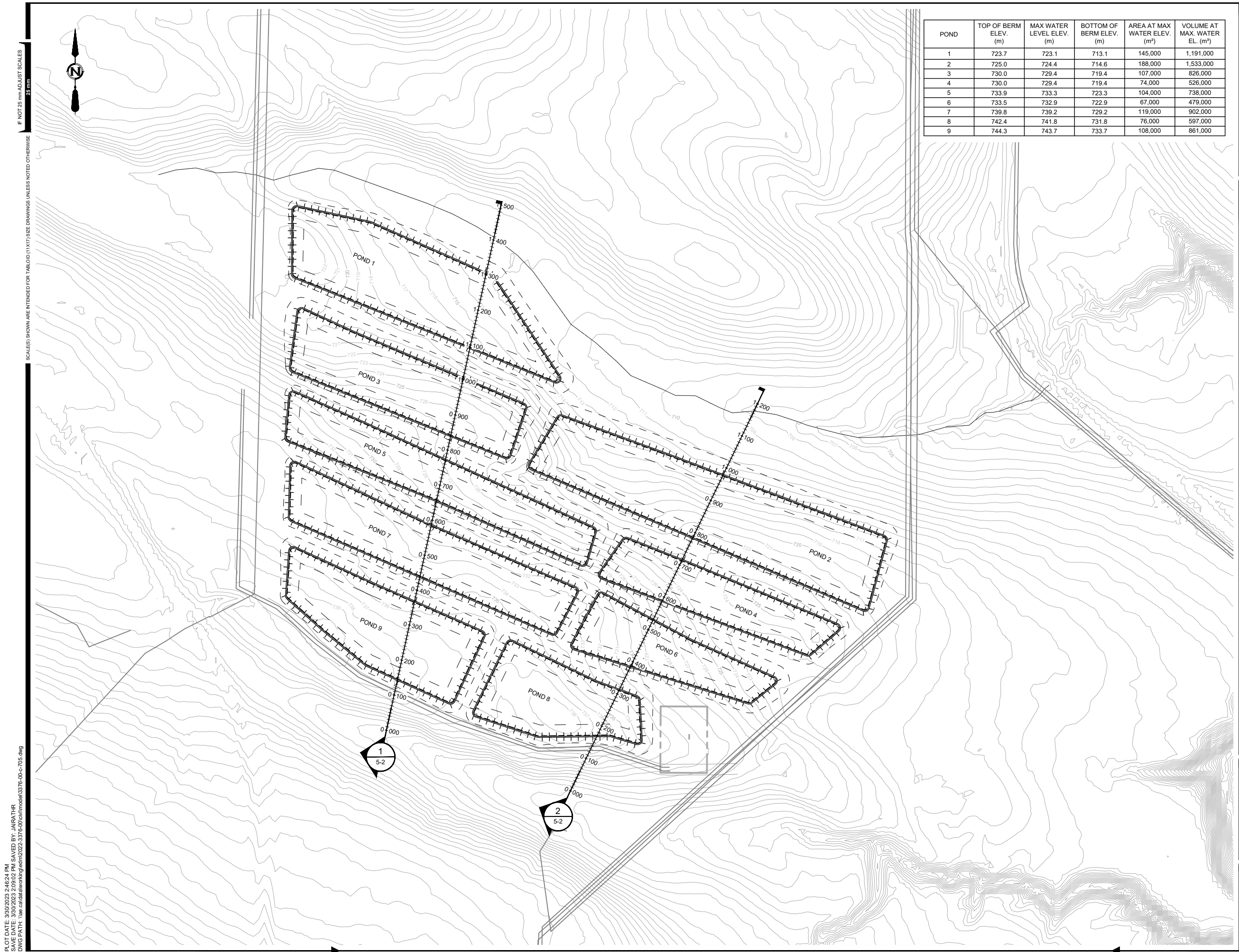
undergo dam classification to determine the level of controls required under the Alberta Dam and Canal Safety Directive.

5.7 Impact of Evaporation and Precipitation on Storage

To assess the potential impact of evaporation and precipitation on the raw water storage ponds, a high-level water balance was conducted. The calculation was based on the total water surface area of the proposed nine ponds compared to the total storage requirements, and using the following assumptions:

- The ponds' bottom and side slopes are assumed to be lined, meaning negligible infiltration or exfiltration will occur.
- No vegetation is present in the raw water storage ponds; therefore, no evapotranspiration is expected.
- The water balance calculation considers full pond conditions (i.e., maximum surface area) to capture the maximum potential evaporation.
- The calculation does not include raw water inflow from the river and distribution to the lots.
- According to the Canadian Climate Normals 1981-2010, annual precipitation in the Grande Prairie area is 445 mm.
- The annual potential evaporation for the Grande Prairie area is 896 mm, as reported in the 2013 publication "Evaporation and Evapotranspiration in Alberta."

Based on these assumptions, the water balance calculation estimates that the ponds will lose approximately 885,000 m³ of water per year to evaporation, while the annual precipitation will contribute about 440,000 m³ of water to the ponds. This results in a net annual water loss of approximately 445,000 m³. The average net water loss of 154,000 m³ over 18 weeks represents about 2% of the total required storage capacity of the ponds which is negligible. To compensate for evaporation losses during the 18-week period when water cannot be pumped from the river, the ponds could be oversized during detailed design.



POND	TOP OF BERM ELEV. (m)	MAX WATER LEVEL ELEV. (m)	BOTTOM OF BERM ELEV. (m)	AREA AT MAX WATER ELEV. (m²)	VOLUME AT MAX. WATER EL. (m³)
1	723.7	723.1	713.1	145,000	1,191,000
2	725.0	724.4	714.6	188,000	1,533,000
3	730.0	729.4	719.4	107,000	826,000
4	730.0	729.4	719.4	74,000	526,000
5	733.9	733.3	723.3	104,000	738,000
6	733.5	732.9	722.9	67,000	479,000
7	739.8	739.2	729.2	119,000	902,000
8	742.4	741.8	731.8	76,000	597,000
9	744.3	743.7	733.7	108,000	861,000

FIGURE 5-1
WATERSMART SOLUTIONS LTD.

CIVIL
RAW WATER STORAGE POND
CONCEPTUAL LAYOUT

AE PROJECT No.	2022-3376-00
SCALE	1:10000
APPROVED	S. NICOLL
DATE	2023MAR29
REV	A
DESCRIPTION	ISSUED FOR REVIEW

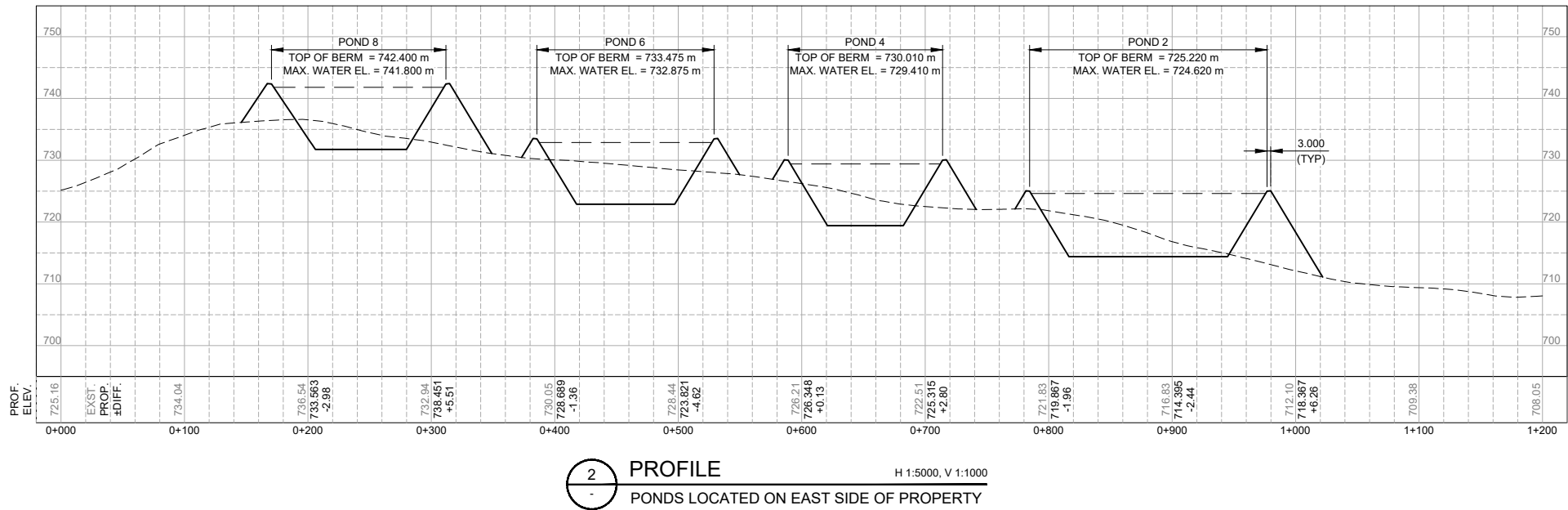
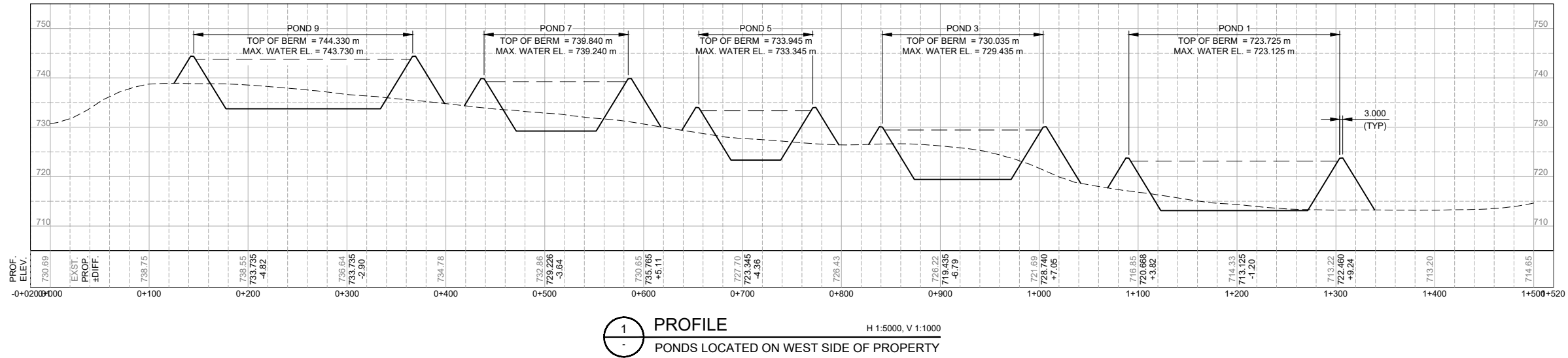


FIGURE 5-2
WATERSMART SOLUTIONS LTD.
CIVIL
RAW WATER STORAGE POND
CONCEPTUAL CROSS SECTIONS

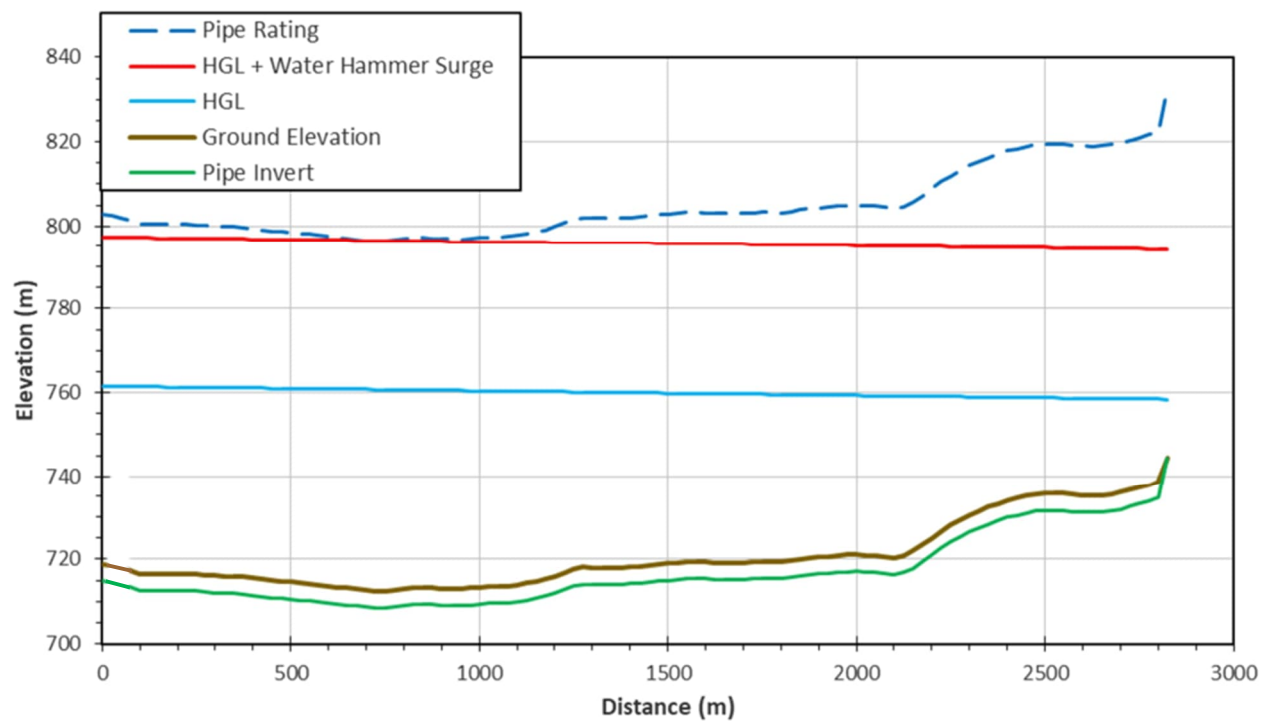
AE PROJECT No.	2022-3376-00
SCALE	AS SHOWN
APPROVED	S. NICOLL
DATE	2023MAR29
REV	A
DESCRIPTION	ISSUED FOR REVIEW

6 RAW WATER SUPPLY FROM THE RIVER TO THE STORAGE PONDS

The proposed conceptual raw water supply system from the Smoky River to the storage ponds, is depicted in **Figure 4-1**. To streamline construction beyond the entry point of the raw water pipeline(s) into the GIG, a single raw water supply line, sized to meet demands for all phases of the development, will be constructed to convey water from the raw water pipeline(s) to each pond. Remote controlled valves will be installed on each line connecting the mainline to the ponds to manage pond filling operations.

The raw water supply line to the ponds should be designed to fill the storage ponds sequentially and be sized to convey $1.06 \text{ m}^3/\text{s}$, which corresponds to the maximum design flow rate from the river to the ponds upon completion of Phase 3. The hydraulic analysis suggests using a 1050 mm PVC DR 32.5 pipe for the pond supply lines, with the diameter primarily determined by the maximum allowable velocity of 1.5 m/s. The conceptual layout of the raw water supply lines to the ponds is illustrated in **Figure 4-2**.

Figure 6-1 presents the hydraulic profile for the raw water distribution into Pond 9. Pond 9 was selected as the basis for analysis because it is the furthest pond from the raw water pipeline and has the highest elevation, representing the worst-case scenario. The hydraulic analysis identified that a supply pressure of 457 kPa (47 m of water head) at the raw water pipeline alignment tie-in is required to fill Pond 9. However, the Raw Water Pipeline Alignment report (Associated Engineering, August 2023) utilized a minimum supply pressure of 138 kPa to the GIG tie-in, which is insufficient for supplying Pond 9. Therefore, the raw water pipeline design must be refined during subsequent design phases to accommodate the increased supply pressure and effectively deliver 457 kPa (47 m of water head) at the Project Area boundary.

Figure 6-1 Hydraulic Profile for Supply Line from Raw Water Pipeline to Pond 9

7 RAW WATER SUPPLY FROM STORAGE PONDS TO COMMON HEADER

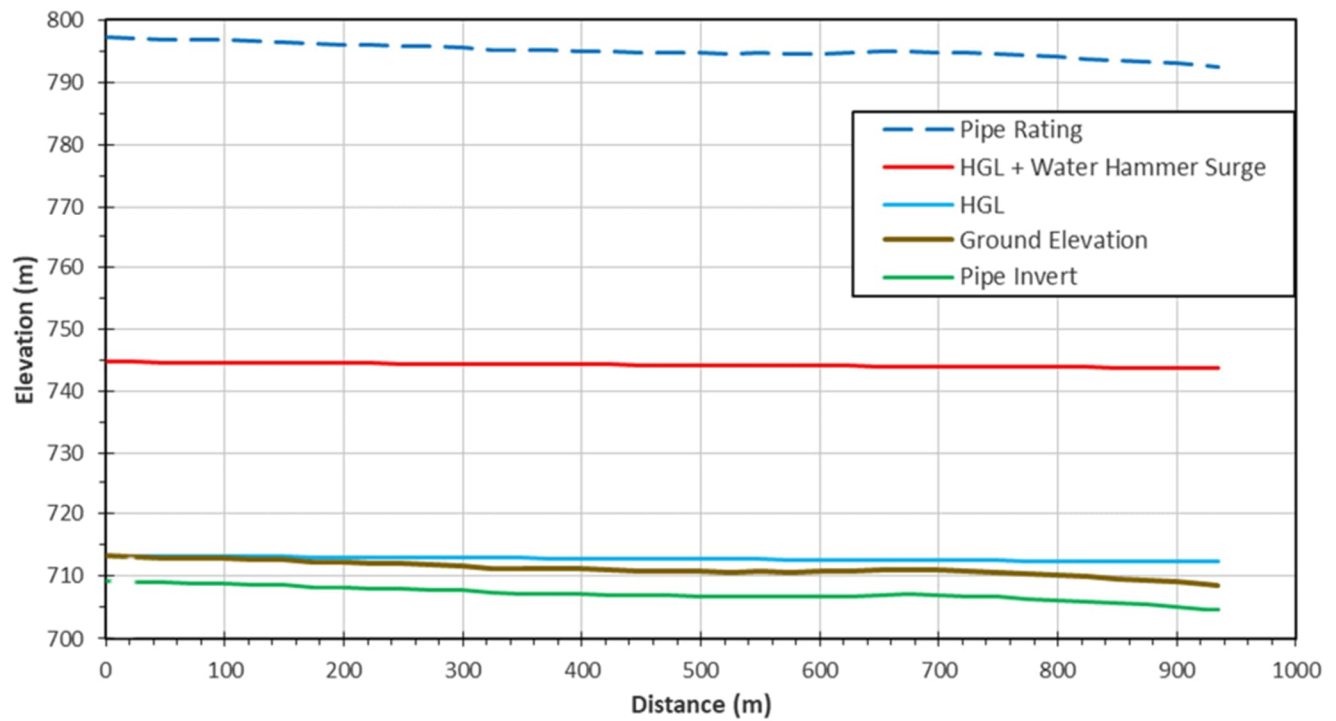
To provide raw water to each of the industrial lots, each industrial user will be required to build a booster station near the ponds. Each booster station will be connected to the common header that is connected to each of the ponds via gravity. **Figure 4-2** shows the proposed supply line from each of the ponds to the common header, and the proposed location of the booster stations.

A hydraulic analysis was conducted using the ultimate water demand of $0.694 \text{ m}^3/\text{s}$, with a 900 mm PVC DR 32.5 pipe proposed for the pipes leading to the common header. To ensure that the storage ponds can supply the common header through gravity, the common header and booster stations are proposed to be situated at a lower elevation than the pond bottoms.

The analysis indicates that the pipe from Pond 1, which has the lowest elevation of all ponds, could potentially supply the common header through gravity. However, the estimated supply pressure of 76 kPa falls short of the minimum targeted supply pressure of 138 kPa at the common header. Similarly, if the supply line from Pond 2 is through gravity alone, its estimated supply pressure at the common header is 127 kPa. These low pressures are when the water level is at the pond bottom. A more detailed hydraulic analysis should be conducted in subsequent design phases to verify whether Pond 1, and Pond 2, can supply the header via gravity, or if the pond design needs to be modified to provide a minimum pressure of 138 kPa to the common header. **Figure 7-1** shows the hydraulic analysis results from Pond 1 to the common header.

The supply line from Pond 3 to the common header can provide the targeted supply pressure of 138 kPa at the common header through gravity. Similarly, the remainder of the ponds have more available elevation head and would be able to supply the common header through gravity.

Figure 7-1 Hydraulic Profile for Supply Line from Pond 1 to Common Header



8 RAW WATER DISTRIBUTION WITHIN THE GIG

Figure 4-1 shows the conceptual raw water distribution system to each of the proposed industrial lots. As the final layout of the industrial lots within GIG remains unconfirmed, the raw water distribution line will be adapted to align with the final lot arrangement in future design phases.

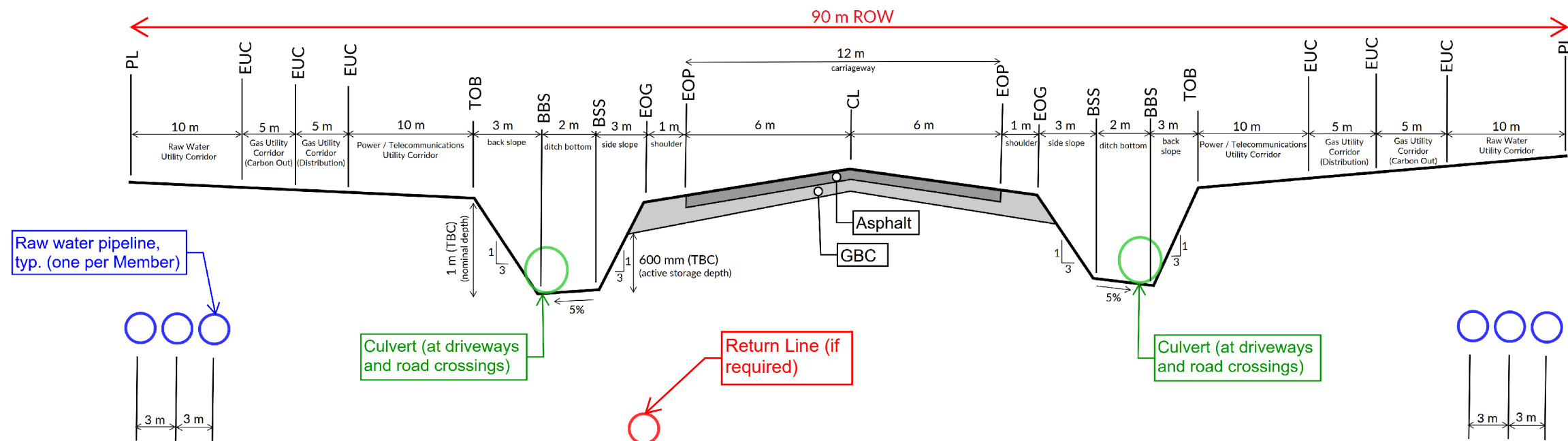
Each industrial user will require a booster station which connects in the common header. The design, construction, maintenance, and operation of the booster station is the responsibility of the Members.

Figure 8-1 shows the proposed location of the raw water distribution system within the 90 m road right of way (ROW), which is the typical GIG transportation utility corridor. For simplicity, the road ROW is shown on both the west and east side of the GIG even though currently there is only one planned paved road to the west. Since each phase has two industrial lots, there will be two distribution lines constructed per phase.

Greenview will install meters at the Point of Metering on the distribution lines to measure and bill members for water usage. Point of Transfer, located 1 m beyond the Point of Metering, designates where members assume responsibility for their distribution lines, which must be constructed along the designated water utility corridor within the road ROW. Both the Point of Metering and Point of Transfer for each distribution line will be housed within their corresponding booster stations.

Figure 8-2 displays the hydraulic profile for the distribution line to Lot 4, originating from the common header. Lot 4 serves as an example due to its elevated ground elevation and greater distance from the proposed booster station location. To meet the flow and pressure requirements, the proposed raw water distribution system utilizes 400 mm HDPE DR 11 pipes. To service Lot 4 with a minimum pressure of 138 kPa, a supply pressure of 620 kPa (63 m of water) will be required at the booster station.

For the other five lots, a supply pressure ranging from 345 to 483 kPa (35 to 49 m of water) will be required.



Raw water pipeline,
typ. (one per Member)

Culvert (at driveways
and road crossings)

Return Line (if
required)

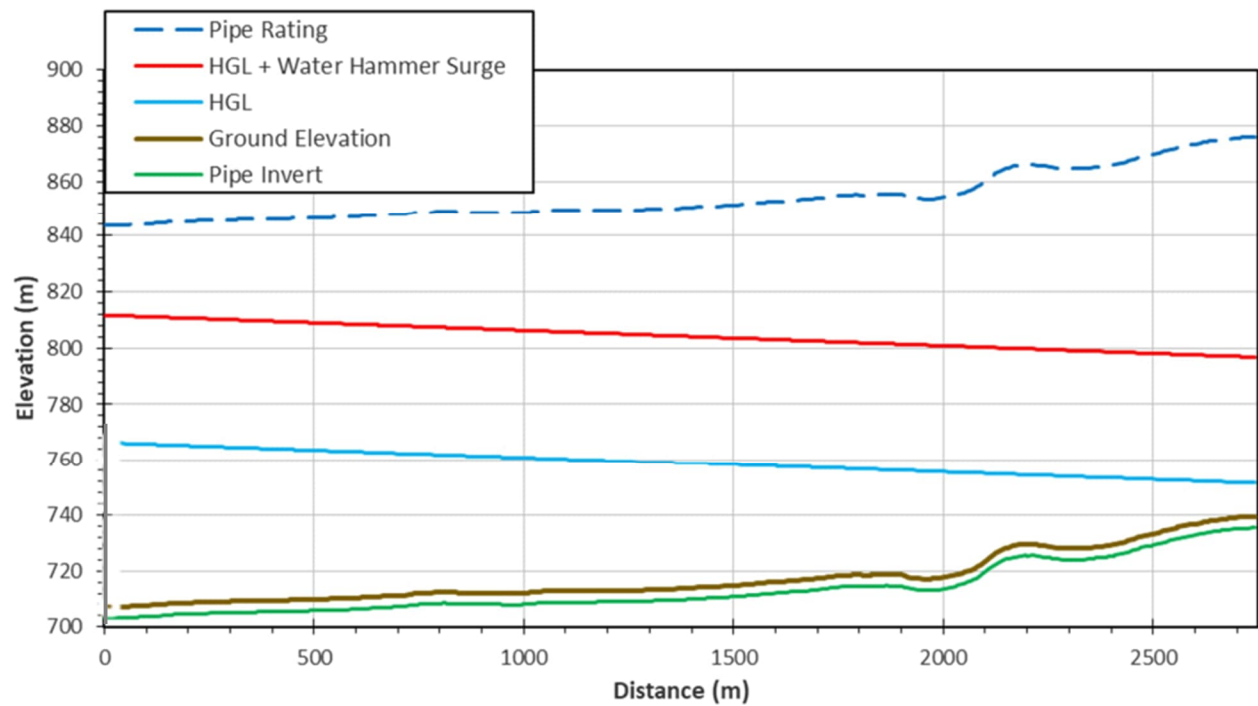
Culvert (at driveways
and road crossings)

ROW = right-of-way
EUC = edge of utility corridor
PL = property line
TOB = top of bank
BBS = bottom of back slope
BSS = bottom of side slope
EOG = edge of gravel shoulder
EOP = edge of pavement
CL = roadway centreline

FIGURE 8-1
MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART SOLUTIONS LTD
TYPICAL GIG ROAD ROW

AE PROJECT No.	2022-3376-00
SCALE	1:25,000
APPROVED	
DATE	2023MAR30
REV	
DESCRIPTION	ISSUED FOR REVIEW

Figure 8-2 Hydraulic Profile for the Distribution Line from the Common Header to Lot 4



9 RETURN LINE FROM INDUSTRIAL LOTS TO RIVER

If required by the members, a return line may be constructed to release unconsumed or treated water from industrial processes back into the Smoky River. Industrial users will be responsible for ensuring and proving their effluent water meets the criteria for discharge into the river. However, it is currently assumed that each member will have 100% consumptive water usage, rendering a return line unnecessary.

Since the flow requirements for the return line are presently unknown, the conceptual design accommodates a 5% return of the ultimate water demand. Based on this assumption, the return water line is designed for a flow rate of $0.035 \text{ m}^3/\text{s}$.

Return water lines from individual lots will converge at a connection point within the Project Area before continuing as a single pipeline to the Smoky River. **Figure 4-1** illustrates the collection network from the industrial lots for the return line. The return line will be situated within the road ROW, as displayed in **Figure 8-1**.

For Lot 4, the return line can be gravity-fed, as demonstrated in the hydraulic profile in **Figure 9-1**. However, Lot 6 may necessitate a low-pressure system to convey the return water to the connection point, as depicted in **Figure 9-2**. A pressure of 374 kPa (38 m of water) may be required at Lot 6 to convey the return water to the connection point. In summary, the design of the return line from each lot to the connection point may vary.

The proposed return line from the connection point to the Smoky River will consist of a single pipe following the selected Raw Water Pipeline Alignment #2 from the Associated Engineering (August 2023) report, using 300 mm HDPE DR 11 pipes. **Figure 9-3** shows the ground elevation along the return line to the Smoky River. The elevation difference between the connection point and the top of the river bank (~6 km) is 35 m, the estimated head loss between those points is 13 m using the Hazen-Williams equation. Therefore, the return line to the river should operate through gravity. A more detailed hydraulic analysis should be undertaken as part of detailed design to confirm system velocities, and pipe size. An energy dissipator may be required at the top of the hill to manage the high flow velocities and will be designed in a later project phase.

The outlet structure design at the end of the return line will be conducted in a subsequent design phase, as it is not required at this stage.

This return line concept is only one possibility and in future design phases other options for return water should be investigated. These options include directing the return water to fill the ponds or directing the return water to an overland off lease towards the creek. The design of the return line is heavily dependant on the quality and quantity of return water. Once more information is available for the return water, the best option for the return line can be selected and designed.

Figure 9-1 Hydraulic Profile for the Return Line from Lot 4 to the Return Line Connection Point

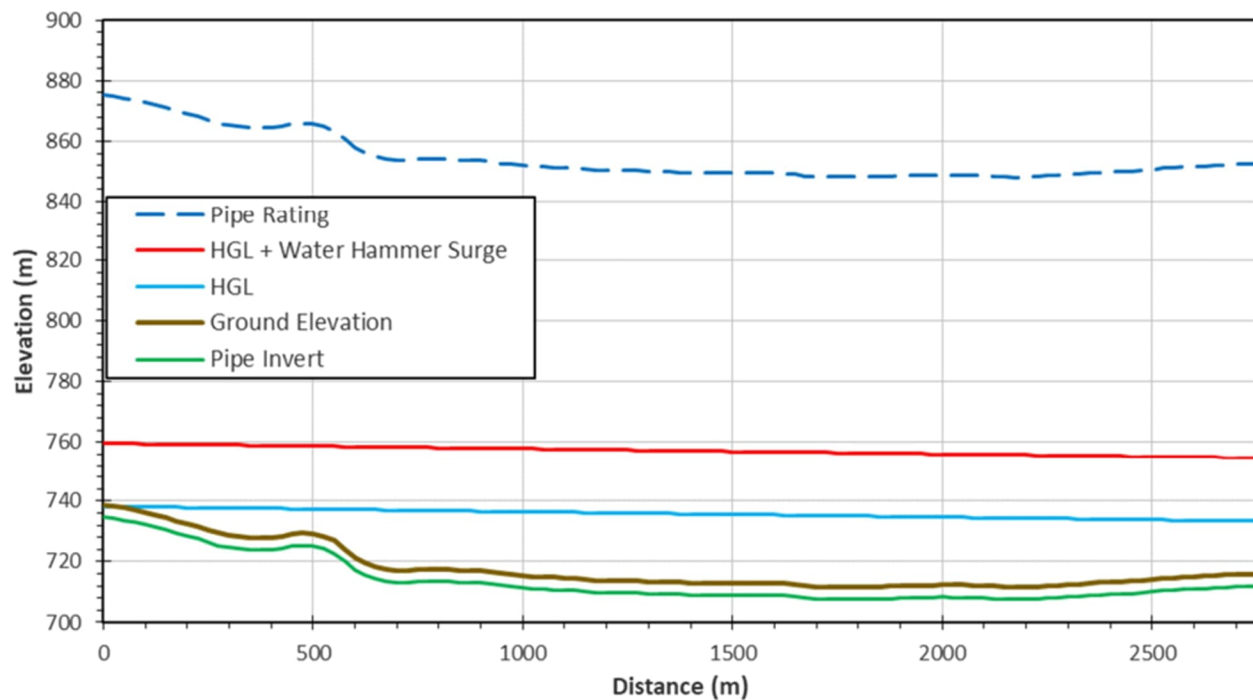


Figure 9-2 Hydraulic Profile for the Return Line from Lot 6 to the Return Line Connection Point

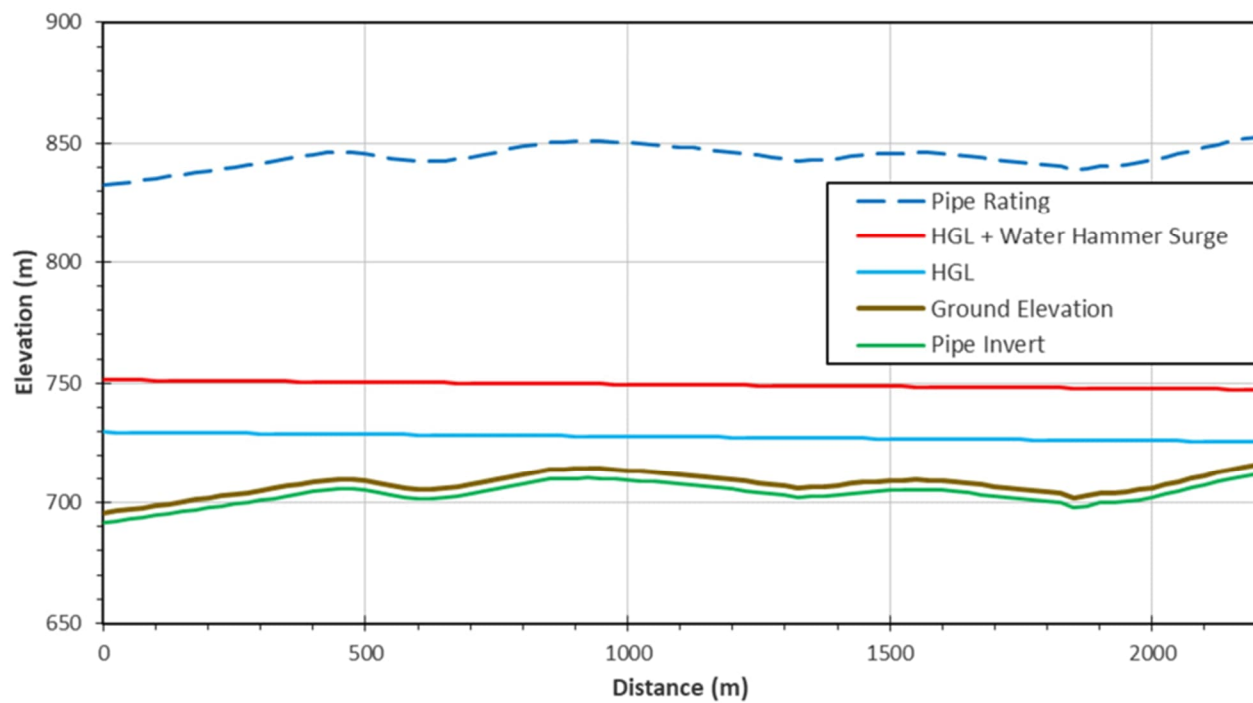
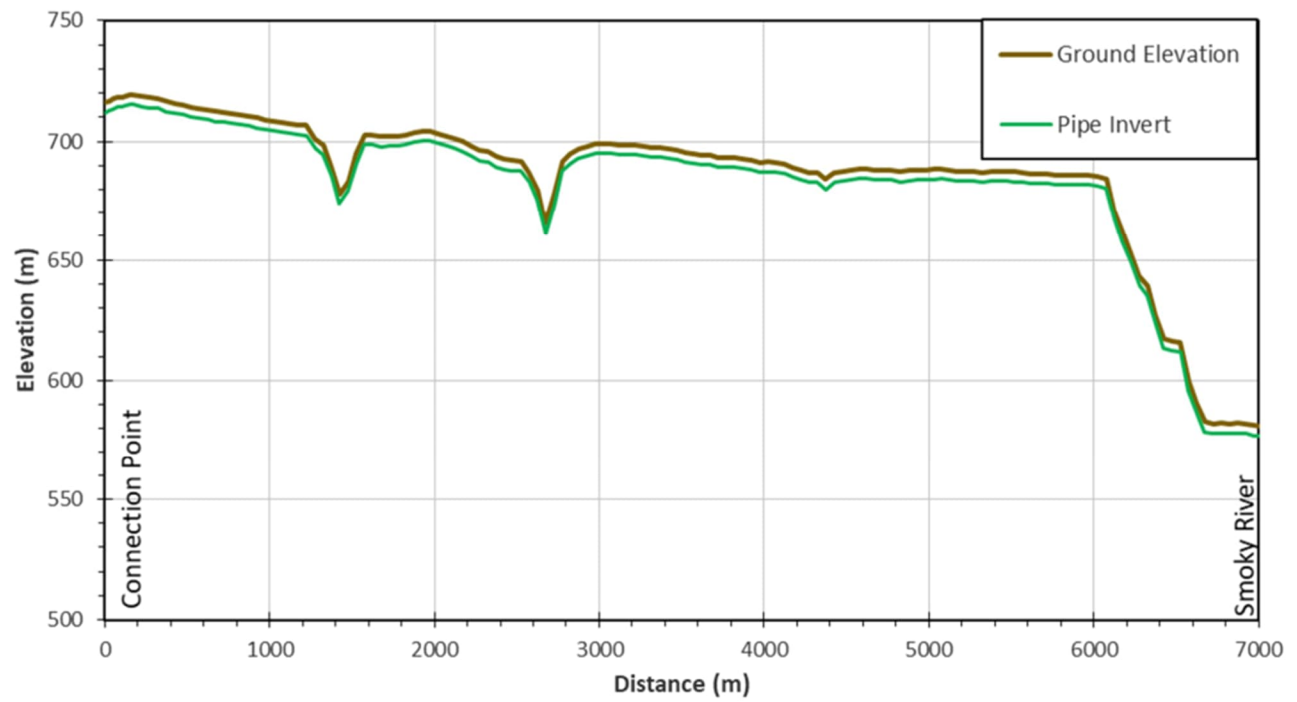


Figure 9-3 Return Line from the Return Line Connection Point to the Smoky River



10 ENVIRONMENTAL CONSIDERATIONS

This section highlights some of the key environmental factors to be considered in this project.

Tree Clearing and Protection of Sensitive Species

- Tree clearing is required for the construction of the ponds and pipelines.
- Pileated woodpeckers (Provincial Status: Sensitive) reside in the GIG area (Associated Engineering, September 2022). The Associated Engineering report indicates that active woodpecker nests require buffers, which may constrain the areas that can be developed in the short term. The report also highlights that a woodpecker nest must be abandoned for 36 months before it can be damaged, destroyed, removed, or disturbed. If active or inactive nests are present in the work area, additional steps will be necessary, directed by a qualified professional. As a result, the configuration of the ponds and the alignment of the pipelines may need to be adjusted, which could increase design and construction costs or cause construction delays.

Watercourses and Restricted Activity Periods

- Smoky River and McMillar Creek, both Class C waterbodies, have a restricted activity period from August 1 to July 15, according to the Alberta Government's Code of Practice for Watercourse Crossing (March 2019) and the Grande Prairie Management Area Map (November 2006).
- Since all other watercourses or waterbodies within the GIG are unmapped, they are also considered Class C with restrictive period from August 1 to July 15, as per the Code of Practice (Alberta Government, March 2019).

Public Lands Act Green Area

- The GIG is located in the Green Area, which is forested public land managed by Alberta Sustainable Resources Development under the *Public Lands Act*. This designation means that the pipelines are not required to obtain approval under EPEA (Alberta Government, December 2002).

11 CLIMATE CHANGE

Climate change factors to consider for the design of the raw water storage and distribution system include increased intensity and frequency of rainfall events, potential prolonged low water levels in the Smoky River, increased evaporation rates, and changes in seasonal water demand patterns.

To mitigate the risks associated with more intense and frequent rainfall events, the design concept already incorporates a 0.6 m freeboard for each pond and an overflow system that can be utilized to draw down the ponds and prevent over-topping. In subsequent design phases, the freeboard should be refined and validated based on updated design storm intensity rates, durations, and potential climate change scenarios to ensure the system's capacity to accommodate large storm events. Furthermore, the operational procedures for the ponds should be refined to determine the appropriate levels at which the pond overflow should be employed to minimize the risk of over-topping.

Climate change may significantly affect the flow rate in the Smoky River, leading to longer periods when withdrawal from the river is not permitted due to more frequent droughts or low flow conditions. Although a design parameter of an 18-week design storage capacity was provided, it is suggested to periodically review and adjust this parameter based on updated climate projections and water demand patterns to ensure a reliable water supply. This task falls beyond the scope of Associated Engineering's current work.

A robust monitoring and evaluation framework within the system design would enable continuous assessment of system performance and identification of areas requiring improvement or adaptation in response to evolving climatic conditions. This could involve implementing adaptive measures such as efficient water management and promoting water conservation. This approach will help ensure the long-term sustainability and effectiveness of the raw water storage and distribution system in the face of climate change.

12 OPINION OF PROBABLE COST

We have developed a conceptual Opinion of Probable Cost (OPC) for Phase 1's common infrastructure, which includes the following components, illustrated in **Figure 12-1**:

- Construction of Ponds 1 and 2;
- Supply pipeline to fill Ponds 1 and 2;
- Supply pipeline from Ponds 1 and 2 to the common header;
- Common header and distribution lines to the Point of Transfer; and
- Return line from the connection point to Smoky River.

Table 12-1 summarizes the Phase 1 OPC, including contingency and engineering costs. The detailed cost breakdown can be found in **Appendix A**.

The following assumptions were made to arrive at this estimate:

- The OPC is in 2023 dollars.
- The unit costs are based on recent tender prices for similar projects.
- The pipes used are 300 mm and 400 mm diameter HDPE DR 11, as well as 900 mm and 1050 mm diameter PVC DR 32.5.
- General requirements, such as insurance, bonding, mobilization, demobilization, and commissioning, were estimated to account for 15% of the construction cost.
- A 40% contingency was included to account for cost uncertainty due to the conceptual nature of this OPC and the lack of geotechnical data.
- Engineering services, including design, geotechnical investigation, and construction management, were allocated 15% of the costs.
- The alignment for the return line has already been cleared of vegetation from constructing the raw water pipeline from the Smoky River.
- Land costs and the establishment of rights-of-way were not included.

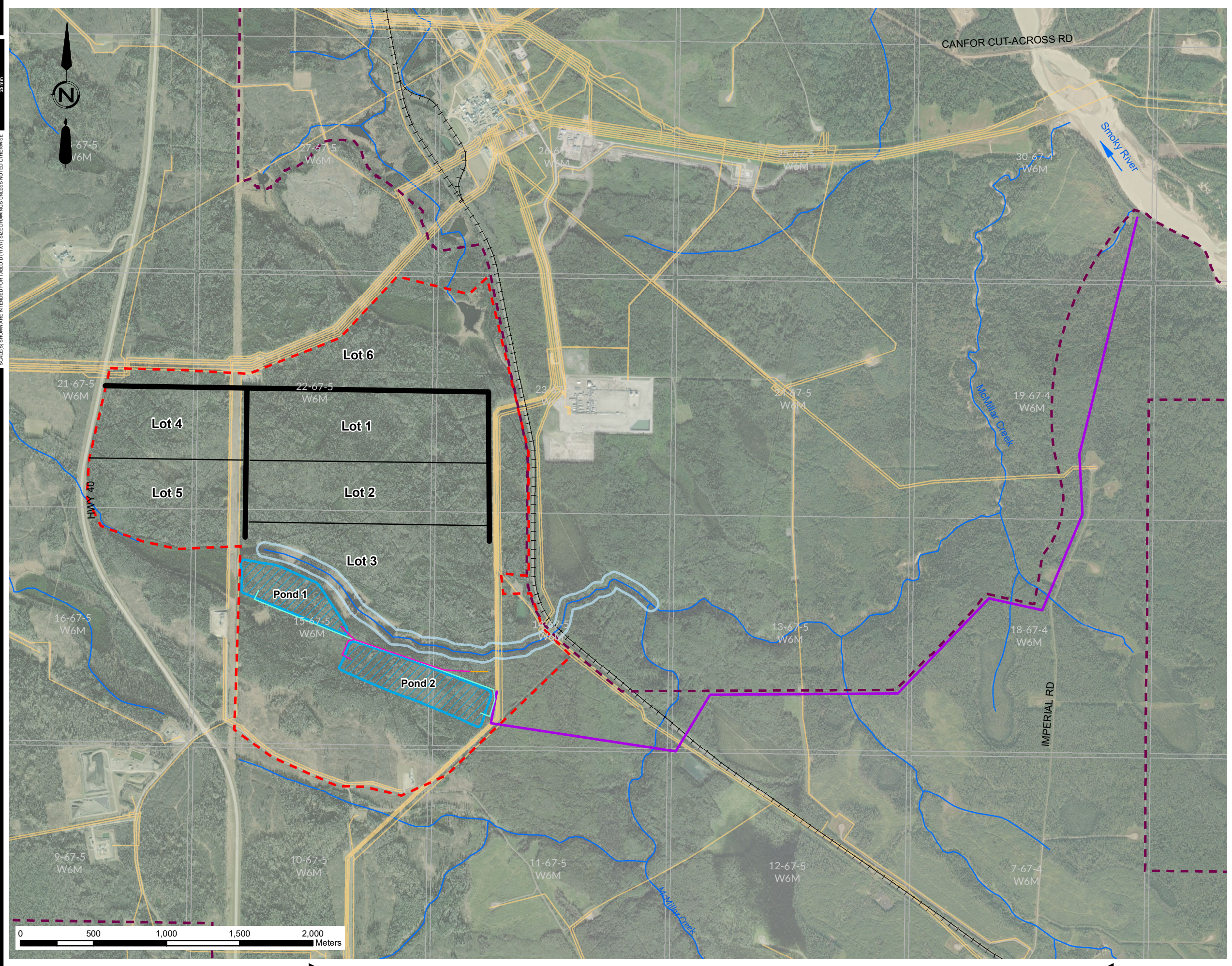
Please note that these assumptions are subject to change as the project progresses and more information becomes available.

Table 12-1 Opinion of Probably Cost Summary for Phase 1

Component	Opinion of Probable Cost
Distribution System (from Raw Water Pipeline to the Ponds, Ponds to the Common Header, and Common Header to Point of Transfer)	\$33,000,000
Return Water Line	\$28,000,000
Raw Water Storage Ponds	\$60,000,000
Total	\$121,000,000

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DRAWING PATH: C:\2022-3376_GIG_WaterApplication\GIGRawWaterPond\Fig11-1_Phase1.mxd
DATA SOURCE: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

IF NOT 25 mm ADJUST SCALES
SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE



Legend:

- Existing Pipelines
- Raw Water Supply to the Common Header
- Return Line
- Raw Water Supply Line to the Ponds
- Common Header
- Road ROW
- Property Lines
- Watercourse
- Railway
- 50 m Buffer from Watercourse
- Proposed Raw Water Pond
- GIG First Development Area
- GIG Boundary

FIGURE 12-1

MUNICIPAL DISTRICT OF GREENVIEW
WATERSMART SOLUTIONS LTD

PHASE I RAW WATER STORAGE AND
DISTRIBUTION COMMON INFRASTRUCTURE

AE PROJECT No.	2022-3376-00
SCALE	1:25,000
APPROVED	
DATE	2023MAR30
REV	
DESCRIPTION	ISSUED FOR REVIEW

13 RECOMMENDATIONS AND NEXT STEPS

The following are key recommendations and next steps for this project, as they relate to the scope of work presented in this report.

- **Geotechnical Investigation:** Perform detailed geotechnical investigations to gather data on soil and groundwater conditions, which are essential for refining the design of ponds and water pipelines, and for reducing cost uncertainties. Obtain geotechnical recommendations to further inform the project's constructability, including liner material and construction methods.
- **Environmental Considerations:** Conduct an Environmental Impact Assessment (EIA) to address potential impacts on sensitive species, tree clearing, watercourses, and restricted activity periods. Implement necessary mitigation measures and obtain required permits before construction begins.
- **Topographical Survey and Site Investigation:** Conduct a comprehensive topographical survey of the pond area to verify existing ground elevations. Accurately identify and survey the location of existing pipelines, watercourses, and railway crossings to determine their precise horizontal and vertical positions. Coordinate crossing requirements and agreements with the owner(s) of those infrastructures.
- **Design Flow and Storage Optimization:** Collaborate with industrial lot members to finalize their water demands, and refine the design of the storage ponds, pond supply line, supply line to the common header, and return line to the river. Additionally, confirm the phasing approach for the ponds and water pipelines.
- **Detailed Design:** Develop detailed designs for raw water storage ponds, water pipelines, common header, return line, and emergency pond overflow, incorporating the findings from the EIA and geotechnical investigations. Complete further hydraulic analysis to verify that the proposed design will function as intended.
- **Cost Estimate Revisions:** Update the Opinion of Probable Cost based on the results of the EIA, geotechnical investigation, and detailed design to provide a more accurate cost estimate for the project.
- **Land Acquisition and Rights-of-Way:** Secure land and establish rights-of-way required for constructing the project components, including ponds, water pipelines, and return lines.

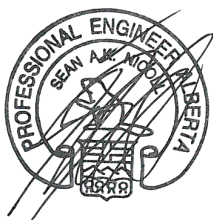
CLOSURE

This report was prepared for WaterSMART Solutions Ltd. to evaluate and recommend a preferred raw water storage pond layout design concept and associated raw water pipelines alignment concept in support of the Greenview Industrial Gateway project.

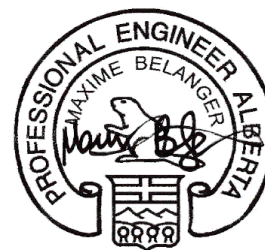
The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,

Associated Engineering Alberta Ltd.



Sean Nicoll, P.Eng.
Project Manager



Maxime Belanger, M.Sc., P.Eng.
Project Engineer

A handwritten signature in black ink that reads "Raeanna Born".

Raeanna Born, E.I.T.
Civil Engineer-In-Training

PERMIT TO PRACTICE
ASSOCIATED ENGINEERING ALBERTA LTD.

Signature

ID: 84469

21 Aug. 2023

PERMIT NUMBER: P 03979

The Association of Professional Engineers
and Geoscientists of Alberta

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APPENDIX A – OPINION OF PROBABLE COST - DETAILED BREAKDOWN

Table A-1 Opinion of Probable Cost for the Raw Water Distribution System (Phase 1 Only)

	Unit Cost	Quantity	Unit	Cost
Fill Ponds from Raw Water Pipeline				
1050 mm PVC DR 32.5	\$5,000	2060	m	\$10,300,000
Valves	\$250,000	2	ea.	\$500,000
			Subtotal	\$10,800,000
Supply Common Header from Ponds				
900 mm PVC DR 32.5	\$5,000	1195	m	\$5,975,000
Valves	\$200,000	2	ea.	\$400,000
Air Release	\$75,000	1	ea.	\$75,000
			Subtotal	\$6,450,000
Common Header and Distribution				
Common Header Steel Pipe	\$7,000	170	m	\$1,190,000
Pipes to Booster Stations	\$2,000	20	m	\$40,000
Meters	\$10,000	2	ea.	\$20,000
			Subtotal	\$1,250,000
General Requirements (Mobilization, Demobilization, Commissioning, etc.)				
All Distribution Lines	\$15%	1	LS	\$2,775,000
			Subtotal	\$21,275,000
			Engineering (15%)	\$3,191,300
			Contingency (40%)	\$8,510,000
			TOTAL	\$32,980,000

Table A-2 Opinion of Probable Cost for the Return Line (Phase 1 Only)

		Return Line
Total Length of the Route (m)		7500
Trenchless Bedrock (HDPE)	Length (m)	1375
	Cost (\$2,500/m)	\$3,437,500
Trenchless Crossings (HDPE)	Length (m) Pipeline Crossings	350
	Length (m) Creek Crossings	850
	Cost (\$2,000/m)	\$2,400,000
Railroad Crossing (HDPE with Steel Casing)	Length (m)	50
	Cost (\$3,500/m)	\$175,000
Open Cut – Some Bedrock (HDPE)	Length (m)	2100
	Cost (\$2,500/m)	\$5,250,000
Standard Open Cut (HDPE)	Length (m)	2775
	Cost (\$1,500/m)	\$4,162,500
CAV	# CAV	5
	Cost (\$2,500 ea.)	\$12,500
General Requirements, Mobilization, Demobilization, Commissioning		
	Cost 15%)	\$2,300,000
	TOTAL	\$17,737,500
	Engineering (15%)	\$2,700,000
	Contingency (40%)	\$7,100,000
	PROJECT TOTAL	\$27,537,500

Table A-3 Opinion of Probable Cost for the Raw Water Storage Ponds (Phase 1 Only)

	Unit Cost	Quantity	Unit	Cost
Earthworks				
Tree Clearing	\$10,000	72	ha	\$720,000
Excavate, Fill, and Place Material	\$20	993000	m ³	\$19,860,000
Strip, Stockpile, and Place Topsoil	\$5	730000	m ²	\$3,650,000
			Subtotal	\$24,230,000
Liner				
Supply and Place Liner and Subdrain	\$25	363000	m ²	\$9,075,000
Supply and Place Subdrain Manhole	\$250,000	1	ea.	\$250,000
			Subtotal	\$9,325,000
General Requirements (Mobilization, Demobilization, Commissioning, etc.)				
All Distribution Lines	\$15%	1	LS	\$5,033,250
			Subtotal	\$38,588,250
			Engineering (15%)	\$5,788,300
			Contingency (40%)	\$15,435,300
			TOTAL	\$59,820,000