Irrigation Infrastructure Upgrade

Phase One - Preliminary Assessment, Conceptual Design and Option Analysis – Final Report

Presented To: **Agriculture & Agri-Food Canada**
Summerland Research and Development Centre

Agriculture and Agri-Food Canada

Dated: April 2020

Ecora File No.: 191024

THIS PAGE IS INTENTIONALLY LEFT BLANK

Presented To:

Wayne Carlson,
Anthony Cesare, LEED AP, Facilities Manager
Scott Weatherhead, Irrigation Supervisor
Agriculture & Agri-Food Canada
400-303 Main Street
Winnipeg, MB, R3C 3G7

Prepared by:

PROFESSIONAL ENGINEER
N.D. WATERHOUSE
48992
2020-04-16

April 16, 2020
Nathan Waterhouse, P.Eng. — Date
Civil Engineer
Nathan.waterhouse@ecora.ca
250-469-9757 Ext 1074

Prepared by:

April 16, 2020
Graham Birds, AScT — Date
Sr. Civil Engineering Technologist
Graham.birds@ecora.ca
250-492-2227 Ext 1039

Reviewed by:

April 16, 2020
Mike Young, P.Eng. — Date
Vice President, Senior Engineer
Mike.young@ecora.ca
250-469-9757 Ext 1014

Reviewed by:

April 16, 2020
Dave Richards, BSc — Date
Irrigation Engineer
Rht-research@shaw.ca
250-494-5471

Version Control and Revision History

Version	Date	Prepared By	Reviewed By	Notes/Revisions
A	January 2020	Nathan Waterhouse	Dave Richards	
B	April 2020	Nathan Waterhouse	Mike Young	

Executive Summary

Foreword

The Agriculture and Agri-Food Canada (AAFC) retained Ecora Engineering & Resource Group Ltd. (Ecora) to undertake the conceptual design of four irrigation infrastructure upgrade options proposed at the Summerland Research and Development Centre. The scope of the design was to determine the most favourable design option and to determine the layout for a replacement irrigation system, including costs, so a budget can be determined for the detailed design and construction in 2020 or later.

Findings and Conclusions

Ecora recommends that the Option 4 Conceptual Design be selected as the preferred Irrigation Infrastructure Upgrade at the Summerland Research and Development Centre. This option utilizes a new trunk main alignment and recommends an automatic, gravity-fed Irrigation system utilizing a new booster station and a new reservoir.

The conceptual design proposes a booster station, resulting in an additional 500 GPM of flow for the irrigation system without having the expense of upgrading the existing pump house. The other benefits of this option include:

- The proposed trunk main alignment shows the minimal impact to existing crops and the line could be constructed at any time during the year without significant disturbance to the existing system or roads;
- Construction costs will be decreased if it can be completed during the off-peak construction season;
- The first of the proposed pressure reducing station and filtration system is located close to the maintenance shop to allow for ease of operation and maintenance;
- The proposed system utilizes the reservoir to reduce pressure surges and maintain consistent flows and pressure to the entire field;
- The use of the reservoir introduces a factor of safety into the system by having a backup water supply in case of power or pump failure; and
- The proposed system allows the pumps to run at maximum efficiency, and with the use of the reservoir, it allows the pumps from having to run full time.

Due to the cost of replacing the existing reservoir, Ecora provided a Contract Change Request #1 to the AAFC to provide a visual inspection, radar penetrating survey and report for the existing reservoir to confirm if it’s suitable for continued use in the future and/or if it should be replaced or rehabilitated. The reservoir inspection will take place after the submittal of this Final Report, so the cost of the new reservoir is included in the Option 4 cost estimate at this time. During detailed design, the potential use of the existing reservoir will be evaluated after testing of the reservoir has been completed.

Ecora will also be submitting a Contract Change Request #2 for a certified pump performance test, which is recommended after the reservoir inspection. The test will evaluate the performance of the three existing pumps at the pump house. It will appraise the performance condition of all the electrical controls for functionality in the pumphouse for safety and functionality. The pump test will determine the validity of the pump performance curves that we currently have and confirm our assumptions of available flow rates and pressures that our current design is based on.

A cost has also been included in this report for the lateral water mains, perimeter irrigation for each field and a new direct field sprinkler application for each field, which was not included in the 60% Progress Report. The total Class C Cost Estimate for Option 4 is $3,311,100 plus Field Irrigation $4,197,700 = **$7,508,800** including engineering and contingency.

Limitations of Report

This report and its contents are intended for the sole use of the Agriculture & Agri-Food Canada (Summerland Research and Development Centre), their agents and the applicable regulatory authorities. Ecora Engineering & Resource Group Ltd. (Ecora) does not accept any responsibility for the accuracy of any data, analyses, or recommendations contained or referenced in the report when the report is used or relied upon by any Party other than the Agriculture & Agri-Food Canada (Summerland Research and Development Centre, their agents, the applicable regulatory authorities or for any Project other than that described in this report. Any such unauthorized use of this report is at the sole risk of the user.

Where Ecora submits both electronic file and hard copy versions of reports, drawings and other project-related documents, only the signed and/or sealed versions shall be considered final and legally binding. The original signed and/or sealed version archived by Ecora shall be deemed to be the original for the Project. Both electronic file and hard copy versions of Ecora's deliverables shall not, under any circumstances, no matter who owns or uses them, be altered by any party except Ecora.

Table of Contents

Appendices

Appendix A	Cost Estimates
Appendix B	Drawings
Appendix C	Land Use Inventory
Appendix D	Climate Data
Appendix E	FortisBC Cost Savings

1. Introduction

Agriculture and Agri-Food Canada (AAFC) issued a Request for Quotation (RFQ) seeking consulting services for four preliminary design options, including cost estimates and reporting for proposed upgrades to the Summerland Research and Development Centre Irrigation System. The RFQ was issued to address an ageing irrigation system that utilized asbestos cement piping. The goal of the AAFC is to replace the existing irrigation system with the most water-efficient, fully adjustable, automatic irrigation system possible.

The AAFC retained Ecora Engineering & Resource Group Ltd. (Ecora) to undertake the conceptual design. The scope of the design was to determine the most favourable layout for a replacement irrigation system, including cost, so a budget can be determined for the detailed design and construction in 2020 or later.

The AAFC requested that four design layout options be considered for this project. The four system layouts are to include:

- Option 1 - One realigned, automatic, pressurized, gravity-fed irrigation system utilizing a new reservoir tank;
- Option 2 - One realigned, automatic, pressurized irrigation system utilizing variable speed drive motors;
- Option 3 - One dedicated mainline to a new reservoir with a complete gravity-fed irrigation system; and
- Option 4 - One realigned, automatic, pressurized, gravity-fed irrigation system utilizing a new reservoir and booster station.

The design layout options are included in Ecora's enclosed drawing set. The drawings show the existing and proposed layout of irrigation mains along with proposed pipe diameters and lengths. The drawings show the isolation valve, drain valve and metering valve for each of the 21 fields in drawing C5. Based on the topographic survey and LIDAR data, accurate elevation contours have also been added to the drawings.

The following report includes a brief description of the Summerland Research and Development Centre property, the existing irrigation system, and each zone/field description. A description of the four conceptual designs, including the pros and cons of each design, is included. A 'Class C' cost estimate has been prepared for each design layout, and a recommendation on the preferred design is also included in the report, which is Option 4.

1.1 Scope of Work

This project was based on the following scope of work.

1. Kick-off Meeting
2. Site Assessments
3. Review of Existing Documents and Drawings
4. Topographic Survey
5. List of Land Use (Zone/Field Inventory)
6. Four Preliminary Irrigation System Design Layouts (Design and Drafting)
7. Calculations and Water Demand Model for the Four Conceptual Designs
8. Cost Estimates
9. Reporting

2. Property Description

The Summerland Research and Development Centre is located in Trout Creek, British Columbia. The property is approximately 200 acres in size and doesn't appear to be located within the District of Summerland boundary or the Regional District of Okanagan Similkameen boundary, as per their respective mapping websites. The property is bisected by Highway 97 near the eastern limits as well as by the kettle Valley Railway near the western limits. The property ranges in elevation between 341.8 m at Okanagan Lake to 521.7 m at the top of the existing reservoir (elevations given are meters above sea level). There are 21 fields with seven different pressure zones located on the property, where experimental agricultural research and development are conducted on numerous crop types. Crop types and sprinkler types for each field are assumed to be variable depending on the required future experiments.

Trout Creek Park is located on the northern side of the property, crown land is located on the south and west sides of the property, and Okanagan Lake and Sun-Oka Beach Provincial Park is located on the east side of the property. Along the southeastern edge of the property, silt bluffs parallel the highway.

A laboratory building is located on the property, which has a potable water service tied into the District of Summerland Water System. This water service also provides fire protection for the building. On the roof of the laboratory building, there is a weather station that provides climatic data for laboratory research. There is also a public park (Ornamental Gardens) on the property with a care taker's residence.

2.1 Existing Irrigation System

As stated in the RFQ, the existing irrigation system at the Summerland Research and Development Centre is over 70 years old in some areas and is primarily comprised of asbestos cement piping. There are various crop and sprinkler types throughout the irrigation zones.

The irrigation system is fed via a lake intake suction line (License Number______) from Okanagan Lake to a booster station located on the shores of Sun-Oka Beach. Non-potable water is then pumped up to a balancing reservoir and the irrigation zones/fields west of Highway 97, through what is assumed to be 14-inch ductile iron water main. Lateral irrigation mains then tee-off from the primary supply main. The pressure on the outlet side of the pump station is approximately 265 pounds per square inch (psi).

There is also a 12-acre parcel on the east side of Highway 97 (Field C) that is fed water from the pump station through a water main that goes through the Sun-Oka Beach Provincial Park parking lot. There is a separate pressure reducing (PRV) inside the pumphouse to service this field.

There are currently two 180hp pumps located in the pump house that are each rated at 850 gallons per minute (GPM) at 180m of the head. The two pumps combined can provide between 1700 and 2200 GPM. When operated under ideal conditions, they will have an efficiency of 84%. See the pump curve for existing pumps below in figure 2.1. There is also a third pump available to use for back-up when maintenance is being performed on either of the main pumps. There are seven pressure zones located on the property, see drawings C2-C4 for reference.

Current design evapotranspiration for this area from environment Canada is 6.6mm / day, which equates to a required peak flow rate of 6.5 USGPM/acre. The existing pumps combined have a flow rate of 700 GPM / 200 acres = 8.5 GPM/ac, which equates to having 30% extra capacity in the system. This will be adding some factors of safety for extreme years as well as future expansion of the research station.

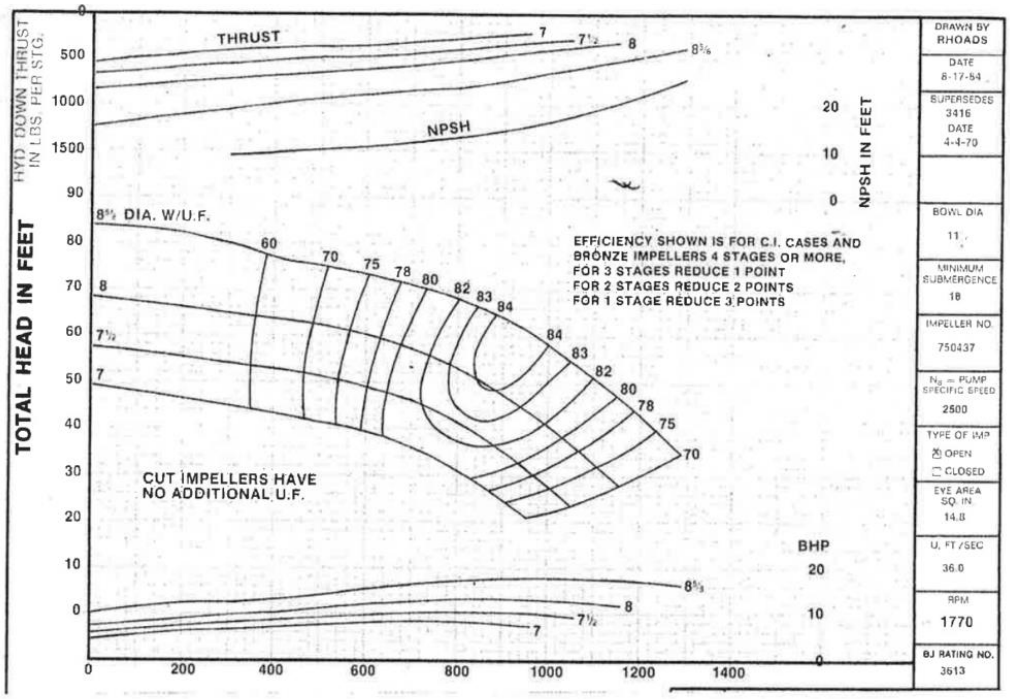


Figure 2.1 **Existing Pump Curve for similar 200Hp pumps.**

The existing irrigation system pumps water from Okanagan Lake (341.8 m) to a 536 cubic meter equalization reservoir located at 521.72m elevation. Water is then fed via a combined gravity/pump system to the 21 fields. Due to the extreme elevation difference between all the zones, there are two strategically located pressure reducing stations to control water pressure throughout the site. A third pressure reducing valve is located within the existing pumphouse.

Photo 2.1 **Existing PRV Station / Manhole**

Photo 2.2 Existing PRV Station / Manhole

Photo 2.3 Existing Pumphouse

Photo 2.3 Approximate location of mainline highway crossing/embankment looking upstream from the pumphouse

2.2 Field and Pressure Zone

There are 21 fields and seven pressure zones that require irrigation. A summary description of each field and zone is outlined in the table below. The table contains the field number, pressure zone, area, and average elevation. The field and zone location can be found in drawings C1-C4. Note that areas were not included for the Ornamental Gardens as well as fields 14 and 15, which we were informed are abandoned.

Table 2.1 Field and Pressure Zone

Pressure Zone	Field	Area		Ave Elev		Zone Elev Range	
		Ha	Ac	masl	ft	min (m)	max (m)
A	1	3.39	8.38	408.33	1339.67	408.33	417.24
	2	3.96	9.79	417.24	1368.90		
	4	3.82	9.45	415.11	1361.91		
	5	3.37	8.34	416.71	1367.16		
	7	3.33	8.22	416.03	1364.93		
	8	7.70	19.03	411.76	1350.92		
		25.58	**63.21**	**414.20**	**1358.91**		
B	3	0.51	1.25	435.19	1427.79	427.60	435.19
	6	0.90	2.23	427.60	1402.89		
		1.41	**3.49**	**431.40**	**1415.34**		
C	9	4.85	12.00	447.55	1468.34	441.86	453.97
	10	3.37	8.32	453.97	1489.40		
	11	3.70	9.14	441.86	1449.67		
	12	2.72	6.73	453.38	1487.47		
	13	3.73	9.23	448.56	1471.65		
		18.38	**45.42**	**449.06**	**1473.31**		
D	16	1.86	4.59	433.46	1422.11	421.76	433.46
	17	1.70	4.19	429.11	1407.84		
	18	0.47	1.16	428.78	1406.76		
	19	0.38	0.94	421.76	1383.73		
		4.40	**10.87**	**428.28**	**1405.11**		
E	20	**15.48**	**38.25**	**478.84**	**1571.00**	478.84	478.84
F	A	0.96	2.37	380.80	1249.34	380.80	380.90
	B	0.47	1.17	380.90	1249.67		
		1.43	**3.54**	**380.85**	**1249.51**		
G	C	**5.21**	**12.86**	**346.50**	**1136.81**	346.50	346.50
TOTAL		**71.89**	**177.64**				

2.3 Land Use Inventory

A Land Use Inventory table has been created for the Summerland Research and Development Centre. The table outlines the area of each field, the crop types in each field and the method of irrigation being utilized. Based on the sprinkler type, crop type and field area, we were able to estimate the amount of flow required for irrigation purposes. The table is located in Appendix C.

3. Conceptual Design

Based on the topographic survey data, land use inventory data, existing irrigation system and water usage requirements for each zone, Ecora has modelled the existing irrigation system using EPANET software. The modelling has also considered the topography and layout for four alternative irrigation designs. The modelling was run with different scenarios and configurations to find the optimal pipe size and layout to meet the specified requirements. This will present the client with the most efficient and cost-effective layout that will meet their demands long into the future.

Utilizing Civil 3D CAD and EPANET software, Ecora has prepared four preliminary design options for the Irrigation System Layout. The design option drawings provided have identified the location of all mains, irrigation components, including the location of main pipelines, zoned isolation valves, water meters and drain lines. The drawings are on a metric scale and in A-1 format.

The four system layouts include:

- Option 1 - 1 realigned, automatic, gravity-fed irrigation system utilizing a new reservoir tank;
- Option 2 - 1 realigned, automatic, pressurized irrigation system utilizing three variable speed drive motors;
- Option 3 - 1 realigned, automatic, gravity-fed irrigation system utilizing a dedicated mainline to a new reservoir tank;
- Option 4 - 1 realigned, automatic, a gravity-fed irrigation system utilizing a new reservoir tank and booster station.

3.1 Common System Requirements for all Options

3.1.1 Pressure Reducing Stations / Metering Gauges

Each design alternative will include two above-ground pressure reducing stations that will house individual pressure reducing valves (PRV) to branch off for each pressure zone. Pressure reducing stations will be above ground and on a concrete slab that house pressure reducing valves to offtake for each pressure zone. Each PRV will drop the pressure from high mainline pressures (150+ psi) to operational pressures (60 psi) for each of the pressure zones. For design purposes, it has been assumed that each valve will reduce pressures to an average of 50-60 psi. However, they will have the capacity to be adjustable from 20-80 psi depending on individual field requirements. Pressure stations are planned in locations that are easily accessible for maintenance and operational purposes without the need for any confined space requirements. See Photo 3.1.1 below, showing a conceptual PRV Station. Ecora would propose a similar design for the PRV station.

PRV stations will be constructed of stainless steel pipe above ground and transitioning back to PVC below ground. All prv's will be either ductile iron or cast iron. Each prv station will be designed to be prefabricated offsite and then unloaded and installed by crane onsite.

Each PRV will also have a programable flow meter incorporated into the valve to allow for automatic shutoff if flows exceed a set value. These can be programmed to electronically notify operation staff when valves have been shut off, signalling a problem somewhere in the system.

Each branch off the prv station will be equipped with a flow meter to monitor the flows and pressures.

See flow diagram in attached drawing C6 for details on the layout of each station.

Photo 3.1.1 Conceptual pressure reducing valve station (similar PRV Station shown for illustration).

3.1.2 Lateral Pipes to Individual Fields

The 60% Progress Report did not account for lateral water mains for each zone. This Final Report has included the lateral water main design, including pipe diameters, pipe lengths, as well as the required valves and metering for each zone. The lateral pipe layout will essentially be the same for all design alternatives and won't affect the overall pricing for comparison purposes between options. Therefore, Ecora has only shown the lateral water mains and perimeter irrigation for each field on the preferred Option 4 design drawing. Ecora has also included a new flow chart drawing for the Option 4 design. The layout and cost for this portion of the system have been included as part of this final report in Appendix A. For budgetary purposes, we have also included a price per acre for individual field irrigation systems (Direct Field Sprinkler Application). This price is in addition to the cost of perimeter piping and fittings around each field.

Lateral pipes have been sized to meet the worst-case scenario and will be able to deliver 100 GPM per acre from overhead sprinklers anywhere in the system. This is assumed to be the form of irrigation with the highest flow requirements. A maximum mainline flow capacity of 107 litres per second (2200 GPM) and a velocity of 1.67 m/s (5.5 ft/s) have been used for design constraints, as this is the maximum that the pumphouse and optional booster station will be designed to supply. These sprinklers require an average of 50 psi. Variations in pressure throughout each zone will be limited to 40-60 psi for this worst-case scenario. Downstream of the main PRV's of each pressure zones, there will be small individual PRV's and automated control valves within the perimeter of each field to have complete control for each field. Shown in the flow chart illustrated on drawings C5 and C6 pipe layout and sizing is illustrated, typically leaving the PRV station in a 250mm or 150mm pipe to each field where looping of each field will occur. Looping around the perimeter of the fields with Iron Pipe Size (IPS) DR 21 class of pipe will allow for readily available parts and easy reconfiguration of each field when a different irrigation type is proposed.

Lateral pipes for each field were designed to go around each field to allow looping and increased flow capacity. Isolation valves are included in each loop shown in drawing C6 for conceptual location. Pipes were sized for each individual field to allow for 100gpm / ac (overhead sprinklers) if crops are rotated to require that style of irrigation.

3.1.3 Filtration

Filtration requirements will be the same for each of the proposed design alternatives. It is recommended to use an inline filtration system that will filter water before it enters any lateral mains. Locations of the proposed filtration system are indicated on design drawings for each alternative. A '*Typhoon Automatic, Self-Cleaning Water Filter'* is suggested as a possible option for filtration needs and can be seen in Figure 3.1.3 below. This recommended system has filtration capabilities from 705-15 microns, which would be acceptable for drip irrigation standards. Water enters through a filter inlet pipe, flows through screens, and outlets on the opposite side. Pressure transducers are placed on either side of the filter to monitor pressure differential across the filter, which is programmed to signal when cleaning is required. Once the pressure differential reaches a specified value, the filter will trigger the automatic self-cleaning process, which takes approximately 45 seconds to complete before it becomes operational again.

For design alternatives that use the reservoir, it would be recommended to include an additional filtration system for all water leaving the reservoir. This is to avoid any algae blooms from entering the system due to stagnant water in the reservoir during low flow seasons.

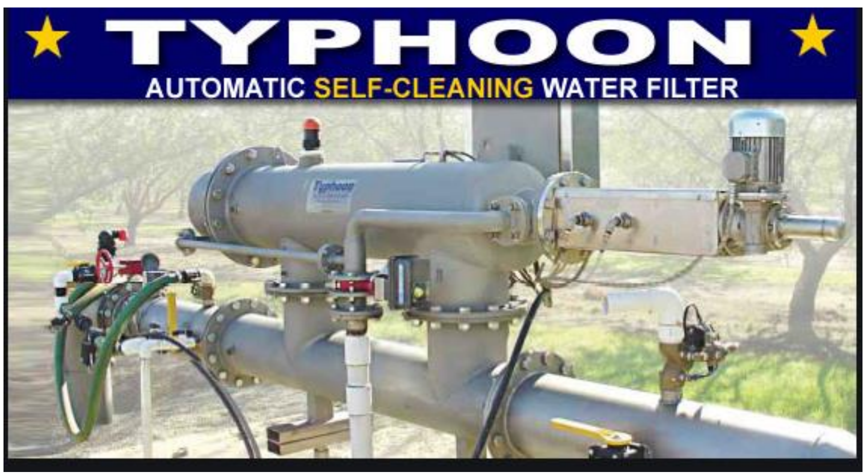


Figure 3.1.3 Typhoon Automatic Self-Cleaning Water Filter

3.1.4 Reservoir

Reservoirs are used for the storage of water and allow for an even distribution of pressure throughout the system. They provide a factor of safety by allowing pressure surges in the system to go into the reservoir. The reservoir will prevent pipes from bursting in a surge scenario. The Summerland Research and Development Center's irrigation system is under high pressure so ultimately the reservoir protects the irrigation system. Reservoirs will also allow for an emergency supply of water for critical test plots in cases of a power outage or pump failure. A primary advantage of reservoirs is the ability to run pumps at maximum efficiency, using pumps capable of being programmed to cycle at optimal rates regardless of flow requirements.

For the purposes of this assignment, it is assumed that the existing reservoir will be replaced, which is reflected in the cost estimates for each option that require the use of a reservoir. The size of the existing reservoir is 536 m3 (approximately 100,000 gallons), which is acceptable for future requirements. A Contract Change Request #1 has been issued to assess the condition of the reservoir by a professional to determine if it is necessary to be replaced at this time. See Table 3.1.4 below for the reservoir design table and cycling stages.

Table 3.1.4 Reservoir Sizing Chart

Irrigation Demand (GPM)	Fill Time (min)	Fill Time (hrs)	Fill Rate (GPM)
0	141	2.4	840
100	162	2.7	740
200	187	3.1	640
300	222	3.7	540
400	272	4.5	440
500	353	5.9	340
600	500	8.3	240
700	857	14.3	140

3.2 Option 1 - Realigned, Automatic, Gravity Fed Irrigation System Utilizing a New Reservoir Tank

The first option involves starting mainline replacement at the existing pumphouse by installing a 350 mm ductile iron (DI) pipe, auger boring under Highway 97, and climbing the steep bank with the use of either directional drilling or an approved construction method (175 m). At the top of the bank beside the existing asphalt road, static pressures will have decreased to an adequate level of approximately 160 psi. The reduced pressure will allow for a pipe material transition from DI to PVC C905 DR18, which is rated to withstand up to 235 psi. After this transition, the pipe will follow along the south side of the paved access road to the first paved intersection (450 m) where it will tee (350 mm x 350 mm x 350 mm) and branch down to PRV Station 1 (250 m), as can be seen on drawing C2.

Pressure Station 1 has an elevation of 423.0 m and a static of pressure 150 psi. Pressure Station 1 will consist of 2 pressure reducing valves. One of the PRV's will reduce the pressure for Zone A, which has a weighted average elevation of 414.0 m, and the second PRV is for Zone B, which has a weighted average elevation of 430.3 m. Zone A will also have a separate, in-line PRV valve to service the lower Zone F, which has a weighted average elevation of 380.8 m.

After the tee intersection, the 350 mm PVC line will continue along the south side and up the access road to Pressure Station 2 (283.0 m), which has an elevation of 452.3 m and static pressure of 102 psi. Pressure Station 2 will also have two separate PRV's coming off of the mainline, 1 to service Zone C, which has a weighted elevation of 448.7 m and 1 to service Zone D where there is a weighted elevation of 430.3 m.

From PRV Station 2, the 350 mm PVC line will continue up Service Field 20 and continue on to fill the reservoir (782.0 m). The reservoir's main purpose is to allow for the storage of approximately 100,000 gallons of water and to eliminate the need for pumps to be in constant use for low flow regimes. This will allow the pumps to operate at their maximum efficiency in the system, which is 84% taken from the pump curve. As previously mentioned, the reservoir also provides a safety factor in that it aids in pressure equalization of the lines, which prevents surges from bursting pipes.

Field 20 (Zone E) is at an elevation of 478.8 m and has a pressure of 60 psi, eliminating the need for an extra PRV station. Even when the reservoir is empty, there will be a minimum of 55 psi available to service Field 20 and Pressure Zone E.

A third PRV station and valve will be located inside the existing pumphouse at Okanagan Lake to service Field C, north of the pumphouse, through a PVC main.

Below is a list of the benefits as well as potential challenges and drawbacks of Option 1.

Benefits:

- Pumps are able to cycle and work at maximum efficiency (84%);
- built-in safety factor with the use of the reservoir to have emergency storage on demand in the event of sudden power or pump failure;
- minimum upgrades required to the existing pumphouse;
- mainline alignment is configured in a way to minimize low points and drain locations as well as minimal disturbance to existing crops;
- utilizes the reservoir to reduce pressure surges and allows consistent flow and pressure to the entire field;
- allows pumps to run at maximum efficiency.

Challenges and disadvantages:

- Boring under the highway and directional drilling up embankment could be technically challenging and expensive;
- the replacement of the reservoir increases the cost.

3.3 Option 2 - Realigned, Automatic, Pressurized Irrigation System Utilizing Variable Speed Drive Motors

Option 2 involves the same piping layout as Option 1, minus the distance from Field 20 to the reservoir, as it would not be required. Three variable speed-driven pumps in parallel will be used to meet the anticipated range of flow demands, anywhere from 20 to 1,700 GPM. The following configuration of pumps will be required to meet the existing flow regime (see Appendix XXX for the proposed pump curves):

- One variable speed, 30 Hp jockey pump will provide low flow from 20 GPM to 125 GPM;
- One variable speed, 125 Hp pump will provide 125gpm to 600gpm;
- One variable speed, 200 Hp pump will provide 200 GPM to 1,000 GPM;
- One variable speed, 200 Hp back-up pump; and
- One backup generator.

The combination of these pumps in parallel with each other will provide the required flow to the system without the need for a reservoir. This reconfiguration will require significant upgrades to the existing pumphouse. The existing pumphouse does not have enough space to accommodate the proposed configuration of the pumps. Extensive civil works will be required to either replace or renovate the existing pumphouse. Additionally, a separate control room of the pumphouse would be required in order to house all of the pump and variable speed drive controls to avoid any potential water or heat damage.

This option involves having the same pipe layout as Option 1, less the required piping to the reservoir. Below is a list of the benefits as well as potential challenges and drawbacks of Option 2:

Benefits:

- Avoids the need for a reservoir. This will eliminate maintenance costs for the reservoir and lowers the risk of algae blooms entering the pipeline from stagnant water in the reservoir;
- minimal disturbance to existing crops is involved in this alignment, and it could be constructed year-round without significant disturbance to the existing system.

Challenges and disadvantages:

- Boring under the highway and directional drilling up embankment could be technically challenging and expensive;
- replacement or a complete renovation of the pump house;
- should any of the three pumps fail, the entire system fails and won't be able to operate, potentially putting the highly controlled research plots at risk.
- a control programming malfunction or pump failure may cause pipes to burst due to multiple pumps on-line and potential high-pressure spikes;
- additional cooling inside the pumphouse will be required to compensate for heat rejection
- may require extensive costs and upgrades to the pumphouse including civil, electrical, mechanical, and new pumps and control systems;
- the pumps will be required to come online for all demands of water, both large and small; and
- the pumps will not operate at their maximum efficiency in order to accommodate the full flow regime at approximately 75 to 80% efficiency versus approximately 85% efficiency for an open system with a reservoir.

3.4 Option 3 - Realigned, Automatic, Gravity Fed Irrigation System Utilizing a Dedicated Mainline to a New Reservoir Tank

Option 3 involves starting at the existing pumphouse with 350 mm DI pipe and auger boring under Highway 97. As opposed to directional drilling up the steep bank as the other options suggest, the line will be run in the Highway 97 ditch until it meets the ravine. The pipeline will then proceed to travel up the gradual slope along the bottom of the ravine with an approved construction method (1,025 m). At the top of the ravine, pressures will have decreased enough to transition from DI to PVC C905 DR18. The line will continue by utilizing the most direct possible route to the reservoir (607 m). From the reservoir, the piping will be completely gravity fed to all pressure stations with a 350 mm PVC C905 DR18 pipe. The gravity line will run from the reservoir and through a filtration system before Field 20 and continue on to the proposed Pressure Station 2 (780 m).

Pressure Station 2 will have an elevation of 452.3 m and a static pressure of 102 psi. Pressure Station 2 will also have two separate PRV's coming off the mainline, 1 to service Pressure Zone C with a weighted elevation of 448.7 m and one to service Pressure Zone D where there is a weighted elevation of 430.3 m.

From Pressure Station 2, the line will continue along the south side of the paved access road to the first paved intersection, where it will tee and branch down to PRV Station 1 (580m).

PRV Station 1 has an elevation of 423.0 m and a static of pressure 150 psi. Pressure Station 1 will consist of 2 PRV's. One of the PRV's will reduce the pressure for Pressure Zone A which has a weighted average elevation of 414.0 m, and the second PRV will reduce pressure in Pressure Zone B, which as a weighted average elevation of 430.3 m. Pressure Zone A will also have a separate in-line PRV to service Pressure Zone F, which has a weighted elevation of 380.8 m.

Below is a list of the benefits as well as potential challenges and drawbacks of Option 3:

Benefits:

- The ability to continue to use the existing pumps in the system without having to upgrade the pumphouse, besides adding an additional pump for Field C;
- the direct line to the reservoir will allow an additional factor of safety and allow the system to run as gravity-fed;
- utilizes the reservoir to reduce pressure surges and maintain a consistent flow and pressure to the entire field;
- allows the pumps to run at maximum efficiency;
- the use of the reservoir will keep the pumps from having to run full time;
- minimal disturbance to the existing crops; and
- the ability to be constructed year-round without significant disturbance to the existing system.

Challenges / disadvantages.

- Boring under highway may be technically challenging and expensive;
- possible environmental challenges with placing a pipeline in the ravine; and
- the mainline must be able to maintain the full flow rate of 1,700 gal/min all the way to the reservoir and back down to Pressure Station 1, increasing the cost.

3.5 Option 4 - Recommended, Automatic, Gravity Fed Irrigation System Utilizing a New Booster Station to the Reservoir Tank

Option 4 is Ecora's recommended option for the Summerland Research and Development Centre Irrigation Upgrade. Option 4 is similar to Option 1, where it involves starting at the existing pumphouse with 350 mm ductile iron (DI) pipe and auger boring under Highway 97, followed by climbing the steep bank with the use of directional drilling or an approved construction method. At the top of the bank, pressures will have decreased enough to grant the transition from DI to PVC C905 DR18. From the top of the bank, the waterline will continue northwest along the south side of the paved access road avoiding the existing retaining wall until the waterline nears the access road to the south side of the main parking lot. The line will continue west, towards the south side of the maintenance yard to Pressure Station 1. This alignment can be seen in Drawing C5 and flow schematic in C6. The proposed pressure reducing station will be close in proximity to the maintenance shops and will be easily accessible. It will also allow the filtration station to be incorporated into Pressure Station 1, making it an advantageous location for cleaning and maintenance purposes.

PRV Station 1 has an elevation of approx 423.0 m and a static of pressure 150 psi. Pressure Station 1 will consist of 5 PRV's. Three of the PRV's will reduce the pressure for Pressure Zone A which has a weighted average elevation of 414.0 m, and the other two PRV's will decrease pressure for Pressure Zone B which has a weighted average elevation of 430.3 m. Zone A will also have a separate PRV to service the lower Zone F (fields A and B), which have a weighted elevation of 380.8 m. There will be an inline master flow meter to gauge when allowable flows are exceeded. See flow chart schematic attached in Drawing C6 for a detailed diagram of valves, pipe sized and flows for each distribution line coming off of the station.

After Pressure Station 1, the 350 mm PVC line will continue along the access road before cutting across the vineyards to PRV Station 2. Pressure Station 2 will have an elevation of approx 452.3 m and a static pressure of 102 psi. Pressure Station 2 will also have five separate PRV's coming off the mainline, three to service Pressure Zone C, which has a weighted elevation of 448.7 m, one to service Pressure Zone D where there's a weighted elevation of 430.3 m and one to service the ornamental gardens.

It should be noted that it would be recommended to explore the possibility of connecting a backup water source from the Research Centre's potable water supply originating from the District of Summerland's water system located near the fire hydrant by PRV Station 2 to the irrigation system. This would allow for a back up water source in the event of a power failure, and the pumps could not run. Confirmation of available pressure from the district of Summerland at that hydrant would be required to determine if this would be a viable option for an alternate water source. Backflow preventers and cross-connections would be required at this potential connection.

This option will also incorporate a new 40 hp booster station within close proximity to pressure Station 2, where it will allow the pumps to increase the overall maximum flow rate to 2,200 GPM. This is a more cost-effective alternative to increase system capacity, as opposed to performing significant upgrades to the pumphouse to achieve the same results.

The booster station will also allow for the option of running the pumps fully during off-peak power times. Off-peak times are from 9 pm-10 am and 24hrs a day on weekends. This would allow for the pumps to run at a less expensive power rate and it will allow for staff to conduct experiments during the day without getting wet. See Appendix E for potential cost savings of running at off-peak power rates.

From PRV Station 2, the 350 mm PVC line will be directionally drilled under the KVR and continue up to Field 20 and into the reservoir to allow for pressure equalization and storage. There will be a second filtration station located at the start of field 20 to filter water coming out of the reservoir and back into the system.

A PRV will be located inside the existing pumphouse to service Field C, north of the pumphouse, through a PVC Main. For the purposes of this study, we will assume that this PRV station will need to be replaced at the pumphouse. See schematic on C6 for further details

Below is a list of the benefits as well as potential challenges and drawbacks of Option 4:

Benefits:

- Incorporating a booster station into PRV Station 2 will give an additional 500 GPM of available flow for irrigation without having the expense of upgrading the pumphouse;
- The addition of the booster station will allow the system to have enough capacity to fully operate pumps during off-peak power times (9 pm – 10 am and weekends). This will allow for a power-saving of approx. $10,000 per year. This will also benefit those conducting experiments on plots as irrigation will occur at night and weekends and be more convenient.

- The first pressure station and filtration system is located close to the maintenance shop to allow for ease of maintenance;
- There is minimal disturbance to existing crops, and the mainline and laterals could be constructed year-round without significant disturbance to the existing system and test plots;
- Utilizes the reservoir to reduce pressure surges, maintain consistent flows and pressure to all fields while offering a backup water supply if pumps fail, and
- Allows the pumps to run at maximum efficiency and for the use of the reservoir to keep the pumps from having to run full time.

Challenges and disadvantages:

- Boring under the highway and directional drilling up the embankment and under the KVR may be technically challenging and add to the cost, and
- Reservoir replacement may increase the cost. (to be determined by visual and radar penetrating survey)

4. Cost Estimates

Ecora has prepared a Class C cost estimate for the four different design layout options. Ecora's Schedule of Quantities and Unit Prices Spreadsheet, found in Appendix A, outlines the supply and installation cost for all proposed water infrastructure. The cost estimate takes into consideration historical contractor's rates over the past six years. The cost estimate will be in an Excel format, so the spreadsheet can be utilized in a future procurement package when the AAFC issues an Invitation to Quote for the construction of the proposed irrigation system.

The cost estimate has been updated since the 60% Progress Report. The cost of the new reservoir, the proposed booster station and directional drilling have increased. A section for controls has also been included in each option to run a fully controlled/programable system. A cost estimate has been prepared for the field/zone irrigation and associated lateral mains and valves, and direct field sprinkler application for the individual fields has been included. A summary of the cost estimates is shown below.

4.1 Option 1 - Realigned, Automatic, Gravity Fed Irrigation System Utilizing a Properly Sized Reservoir Tank

Table 4.1 Class C Cost Estimate – Option 1

Summary - Option 1		
1.0 - Transmission Main - 350 mm DIA to Reservoir	SUBTOTAL	$1,184,850
2.0 - Pressure Reducing Stations	SUBTOTAL	$300,000
3.0 - Filtration Station	SUBTOTAL	$100,000
4.0 - Reservoir - 536 cu.m	SUBTOTAL	$800,000
5.0-Controls	SUBTOTAL	$180,000
	TOTAL	**$2,564,850**
	Engineering (15%)	$384,728
	Contingency (15%)	$384,728
	Total Class C Cost	**$3,334,305**

*The cost for irrigating fields/zones has not been included in this cost estimate but has been included in the recommended Option 4 Cost Estimate

4.2 Option 2 - Realigned, Automatic, Pressurized Irrigation System Utilizing Variable Speed Drive Motors

Table 4.2 Class C Cost Estimate – Option 2

Summary - Option 2		
1.0 Pumphouse upgrades	SUBTOTAL	$980,000
2.0 350 mm DIA	SUBTOTAL	$1,129,275
3.0 Pressure Reducing Stations	SUBTOTAL	$300,000
4.0 Filtration Station	SUBTOTAL	$50,000
5.0-Controls	SUBTOTAL	$170,000
	TOTAL	**$2,629,275**
	Engineering (15%)	$394,391
	Contingency (15%)	$394,391
	Total Class C Cost	**$3,418,058**

*The cost for irrigating fields/zones has not been included in this cost estimate but has been included in the recommended Option 4 Cost Estimate

4.3 Option 3 - Realigned, Automatic, Gravity Fed Irrigation System Utilizing a Direct Line through Ravine to New Reservoir

Table 4.3 Class C Cost Estimate – Option 3-Additional Design By Ecora

Summary - Option 3		
1.0 - Transmission Main - 350 mm DIA to Reservoir	SUBTOTAL	$940,825
2.0 - Reservoir	SUBTOTAL	$800,000
3.0 - Return Supply Main	SUBTOTAL	$470,000
4.0 - Pressure Reducing Stations	SUBTOTAL	$300,000
5.0 - Filtration Stations	SUBTOTAL	$100,000
6.0 -Controls	SUBTOTAL	$180,000
	TOTAL	**$2,790,825**
	Engineering (15%)	$418,624
	Contingency (15%)	$418,624
	Total Class C Cost	**$3,628,073**

*The cost for irrigating fields/zones has not been included in this cost estimate but has been included in the recommended Option 4 Cost Estimate

4.4 Option 4 – Engineers Recommendation – Re-Aligned, Automatic, Gravity Fed Irrigation System Utilizing a New Pump House to a New Reservoir

Table 4.4 Class C Cost Estimate – Recommended Design By Ecora

Summary - Option 4		
1.0 - Transmission Main - 350 mm DIA to Reservoir	SUBTOTAL	$792,000
2.0 - Pressure Reducing Stations	SUBTOTAL	$300,000
3.0 - Booster Station	SUBTOTAL	$375,000
4.0 - Filtration Station	SUBTOTAL	$100,000
5.0 - Reservoir - 536 cu.m	SUBTOTAL	$800,000
6.0- Controls	SUBTOTAL	$180,000
	TOTAL	**$2,547,000**
	Engineering (15%)	$382,050
	Contingency (15%)	$382,050
	Total Class C Cost	**$3,311,100**

*The cost for irrigating fields/zones, laterals and valves is shown below.

Summary - Option 4 (Field Irrigation)		
7.0 - Field Irrigation Mains Downstream of PRV Stations	SUBTOTAL	$3,229,000
	TOTAL	**$3,229,000**
	Engineering (15%)	$484,350
	Contingency (15%)	$484,350
	Total Class C Cost	**$4,197,700**

5. Recommendations

Ecora recommends that the detailed design be carried out for Option 4 as the construction for this design can proceed at any time during the year. There are minimal construction impacts to the existing irrigation system and research plots with this design. Ecora also recommends that reservoir inspection and pump performance certification be implemented as soon as possible. The results of these test will validate assumptions made in this report. The existing condition of the reservoir and pumps will have a significant impact on the detailed design and cost estimate. There will be significant cost savings if they are deemed adequate.

The use of the booster station is highly recommended to increase flow to allow for off-peak power consumption that will allow for significant cost savings throughout the year. Exact details would need to be discussed with FortisBC to determine the exact conditions of the off-peak power agreement. The FortisBC cost savings are outlined in Appendix E.

Ecora also recommends that the research station discusses with the District of Summerland about connecting to their water main where the onsite hydrant is currently located, as well as where PRV 2 is proposed. This will introduce a backup water source in case of a power outage. A back up generator at the pump house is discouraged as it could be located within the Okanagan Lake riparian area.

6. Closure

We trust this draft report meets your present requirements. Please contact Dave Richards if you have any questions or comments concerning this report.

ENGINEERS & GEOSCIENTISTS BRITISH COLUMBIA OQM CERTIFIED

Appendix A

Cost Estimates

ecora
a resourceful company

Agriculture & Agri-Food Canada - Class C Cost Estimate

Option 1 - Re-Aligned, Automatic, Gravity Fed Irr. System Utilizing New Reservoir					
Section	**Specification Title**	**Unit**	**Quantity**	**Average Unit Price**	**Total**
1.0 - Transmission Main - 350 mm DIA to Reservoir					
1.01	350mm Ductile Iron Supply & Install	LM	175	$500	$87,500
1.02	350mm PVC C905 DR 18 Supply & Install c/w sand bedding	LM	1910	$275	$525,250
1.03	Highway Permits and Traffic Control	LS	1	$10,000	$10,000
1.04	PVC & DI Bends, Tees Supply & Install	EA	13	$2,200	$28,600
1.05	350 mm Gate Valves Supply & Install	EA	3	$8,500	$25,500
1.06	Air Release Valves	Ea	4	$10,000	$40,000
1.07	350 x ____Reducer Supply & Install	EA	18	$2,500	$45,000
1.08	Pipe Anchors (>15% Grade)	EA	10	$500	$5,000
1.09	Irrigation Zone Tie-in	EA	18	$1,000	$18,000
1.1	Directional Drilling (Highway, Slope & KRV)	LS	1	$400,000	$400,000
				Subtotal - Transmission	**$1,184,850**

2.0 - Pressure Reducing Stations					
2.01	Pressure Reducing Station (Valves and Kiosk) Supply & Install	EA	2	$150,000	$300,000
				Subtotal - Pressure Reducing Stations	**$300,000**

3.0 - Filtration Station					
3.01	Filtration Station Supply & Install	EA	2	$50,000	$100,000
				Subtotal - Filtration Stations	**$100,000**
2.0 Reservoir - 536 cu.m					
2.01	Reservoir - Double Cell	cu.m	536	$1,000	$536,000
2.02	Site Grading c/w Gravels	LS	1	$10,000	$10,000
2.03	Demolition of Existing Reservoir	LS	1	$10,000	$10,000
2.04	Excavation for Cell	LS	1	$10,000	$10,000
2.05	Access Road c/w excavation and gravels (790m x 6m)	LS	1	$90,000	$90,000
2.06	Supply & Install - Inlet, Outlet, Overflow & Drain, Valves	LS	1	$26,000	$26,000
2.07	Overflow Ditching - or 350 mm Pipe C/W MHs	m	200	$400	$80,000

Agriculture & Agri-Food Canada - Class C Cost Estimate

Option 1 - Re-Aligned, Automatic, Gravity Fed Irr. System Utilizing New Reservoir					
Section	**Specification Title**	**Unit**	**Quantity**	**Average Unit Price**	**Total**
2.08	Level Controls & SCADA Supply & Install c/w Kiosk	LS	1	$10,000	$10,000
2.09	Railing & Stairs on Reservoir	LS	1	$15,000	$15,000
2.1	Double Acting Air Valve Supply & Install c/w Housing Chamber	LS	1	$13,000	$13,000
				Subtotal - Reservoir	**$800,000**
5.0 - Controls					
5.01	Pump House / Pump Station	LS	1	$50,000	$50,000
5.02	PRV Station	EA	2	$50,000	$100,000
5.03	Reservoir	LS	1	$10,000	$10,000
5.04	Shop / Office	EA	2	$10,000	$20,000
				Subtotal - Reservoir	**$180,000**

Summary - Option 1		
1.0 - Transmission Main - 350 mm DIA to Reservoir	SUBTOTAL	$1,184,850
2.0 - Pressure Reducing Stations	SUBTOTAL	$300,000
3.0 - Filtration Station	SUBTOTAL	$100,000
4.0 - Reservoir - 536 cu.m	SUBTOTAL	$800,000
5.0-Controls	SUBTOTAL	$180,000
	TOTAL	**$2,564,850**
	Engineering (15%)	$384,728
	Contingency (15%)	$384,728
	Total Class C Cost	**$3,334,305**

*The cost for irrigating fields/zones has not been included in this cost estimate but has been included in the recommended Option 4 Cost Estimate

ecora a resourceful company

Option 2 - Realigned Pressurized Irrigation System Utilizing VSD Motors

Section	Specification Title	Unit	Quantity	Average Unit Price	Total
1.0 Pumphouse Upgrades					
1.01	Pumphouse Upgrades and cooling (New Electrical Room)	LS	1	$150,000	$150,000
1.02	1 - 125Hp Variable Speed Vertical Turbine Pump c/w Electrical Drive Supply & Install	EA	1	$100,000	$100,000
1.03	1 - 200Hp VS Pump c/w Electrical Drive Supply & Install	EA	1	$135,000	$135,000
1.04	1- 200Hp VS Back up Pump c/w Electrical Drive Supply & Install	EA	1	$135,000	$135,000
1.05	Mechanical Valves & Fittings	LS	1	$75,000	$75,000
1.06	Electricals & Controls/SCADA Upgrades	LS	1	$150,000	$150,000
1.07	Pressure Tank	LS	1	$25,000	$25,000
1.08	VS - 30Hp Jockey Pump Supply & Install	EA	1	$80,000	$80,000
1.09	Diesel Gen-Set	LS	1	$110,000	$110,000
1.10	Water tie-in	LS	1	$20,000	$20,000
				Subtotal - Booster Station	**$980,000**
2.0 Transmission Main-350 mm DIA					
2.01	350mm Ductile Iron Supply & Install	LM	175	$500	$87,500
2.02	350mm PVC C905 DR 18 Supply & Install c/w sand bedding	LM	1717	$275	$472,175
2.03	Highway Permits and Traffic Control	LS	1	$10,000	$10,000
2.04	PVC & DI Bends, tees Supply & Install	EA	13	$2,200	$28,600
2.05	350 mm Gate Valves Supply & Install	EA	3	$8,500	$25,500
2.06	Air Release Valves	Ea	4	$10,000	$40,000
2.07	350 x ____Reducer Supply & Install	EA	18	$2,500	$45,000
2.08	Pipe Anchors (>15% Grade)	EA	5	$500	$2,500
2.09	Irrigation Zone Tie-in	EA	18	$1,000	$18,000
2.1	Directional Drilling (Highway, Slope & KRV)	LS	1	$400,000	$400,000

Option 2 - Realigned Pressurized Irrigation System Utilizing VSD Motors

Section	Specification Title	Unit	Quantity	Average Unit Price	Total
				Subtotal - Transmission	**$1,129,275**
3.0 - Pressure Reducing Stations					
3.01	Pressure Reducing Station Supply & Install	EA	2	$150,000	$300,000
				Subtotal - Pressure Reducing Stations	**$300,000**
4.0 - Filtration Station					
4.01	Filtration Station Supply & Install	EA	1	$50,000	$50,000
				Subtotal - Filtration Stations	**$50,000**
5.0 - Controls					
5.01	Pump House / Pump Station	LS	1	$50,000	$50,000
5.02	PRV Station	EA	2	$50,000	$100,000
5.03	Shop / Office	EA	2	$10,000	$20,000
				Subtotal - Reservoir	**$170,000**

Summary - Option 2

1.0 Pumphouse upgrades	SUBTOTAL	$980,000
2.0 350 mm DIA	SUBTOTAL	$1,129,275
3.0 Pressure Reducing Stations	SUBTOTAL	$300,000
4.0 Filtration Station	SUBTOTAL	$50,000
5.0-Controls	SUBTOTAL	$170,000
	TOTAL	**$2,629,275**
	Engineering (15%)	$394,391
	Contingency (15%)	$394,391
	Total Class C Cost	**$3,418,058**

*The cost for irrigating fields/zones has not been included in this cost estimate but has been included in the recomended Option 4 Cost Estimate

ecora
a resourceful company

Agriculture & Agri-Food Canada - Class C Cost Estimate

Option 3 - Re-Aligned, Automatic, Gravity fed Irr. System Utilizing a Direct Line through Ravine to a New Reservoir

Section	Specification Title	Unit	Quantity	Average Unit Price	Total
1.0 - Transmission Main - 350 mm DIA to Reservoir					
1.01	350mm Ductile Iron Supply & Install	LM	67	$500	$33,500
1.02	350mm Ductile Iron Supply & Install	LM	956	$300	$286,800
1.03	350mm PVC C905 DR 18 Supply & Install c/w sand bedding	LM	607	$275	$166,925
1.05	Air Release Valves	Ea	4	$10,000	$40,000
1.06	PVC & DI Bends Supply & Install	EA	13	$2,200	$28,600
1.07	Pipe Anchors (>15% Grade)	EA	10	$500	$5,000
1.08	Highway Permits and Traffic Control	LS	1	$20,000	$20,000
1.09	Environment Assessment & Monitoring	LS	1	$30,000	$30,000
1.1	Geotechnical Assessment & Inspection	LS	1	$30,000	$30,000
1.11	Directional Drilling Highway, KRV)	LS	1	$300,000	$300,000
				Subtotal - Transmission	**$940,825**
2.0 Reservoir - 536 cu.m					
2.01	Reservoir - Double Cell 536 cu.m	cu.m	536	$1,000	$536,000
2.02	Site Grading c/w Gravels	LS	1	$10,000	$10,000
2.03	Demolition of Existing Reservoir	LS	1	$10,000	$10,000
2.04	Excavation for Cell	LS	1	$10,000	$10,000
2.05	Access Road c/w excavation and gravels (790m x 6m)	LS	1	$90,000	$90,000
2.06	Supply & Install - Inlet, Outlet, Overflow & Drain, Valves	LS	1	$26,000	$26,000
2.07	Overflow Ditching - or 350 mm Pipe C/W MHs	m	200	$400	$80,000
2.08	Level Controls & SCADA Supply & Install c/w Kiosk	LS	1	$10,000	$10,000
2.09	Railing & Stairs on Reservoir	LS	1	$15,000	$15,000
2.1	Double Acting Air Valve Supply & Install c/w Housing Chamber	LS	1	$13,000	$13,000
				Subtotal - Reservoir	**$800,000**
3.0 - Return Supply Main - 350 mm					
3.01	350mm PVC C905 DR 18 Return Pipe Supply & Install c/w sand bedding	LM	1316	$275	$361,900

Agriculture & Agri-Food Canada - Class C Cost Estimate

Option 3 - Re-Aligned, Automatic, Gravity fed Irr. System Utilizing a Direct Line through Ravine to a New Reservoir					
Section	**Specification Title**	**Unit**	**Quantity**	**Average Unit Price**	**Total**
3.02	PVC & DI Bends, tees Supply & Install	EA	13	$2,200	$28,600
3.03	350 mm Gate Valves Supply & Install	EA	3	$8,500	$25,500
3.04	350 x ____Reducers Supply & Install	EA	18	$2,000	$36,000
3.05	Irrigation Zone Tie-in	EA	18	$1,000	$18,000
				Subtotal - Return Supply Main	**$470,000**
4.0 - Pressure Reducing Stations					
4.01	Pressure Reducing Station (Valves and Kiosk) Supply and Install	EA	2	$150,000	$300,000
				Subtotal - Pressure Reducing Stations	**$300,000**
5.0 - Filtration Station					
5.01	Filtration Station Supply & Install	EA	2	$50,000	$100,000
				Subtotal - Filtration Stations	**$100,000**
6.0 - Controls					
6.01	Pump House / Pump Station	LS	1	$50,000	$50,000
6.02	PRV Station	EA	2	$50,000	$100,000
6.03	Reservoir	LS	1	$10,000	$10,000
6.04	Shop / Office	EA	2	$10,000	$20,000
				Subtotal - Reservoir	**$180,000**

Summary - Option 3		
1.0 - Transmission Main - 350 mm DIA to Reservoir	SUBTOTAL	$940,825
2.0 - Reservoir	SUBTOTAL	$800,000
3.0 - Return Supply Main	SUBTOTAL	$470,000
4.0 - Pressure Reducing Stations	SUBTOTAL	$300,000
5.0 - Filtration Stations	SUBTOTAL	$100,000
6.0 -Controls	SUBTOTAL	$180,000
	TOTAL	**$2,790,825**
	Engineering (15%)	$418,624
	Contingency (15%)	$418,624
	Total Class C Cost	**$3,628,073**

*The cost for irrigating fields/zones has not been included in this cost estimate but has been included in the recommended Option 4 Cost Estimate

Agriculture & Agri-Food Canada - Class C Cost Estimate

Option 4 - Engineers Recommendation - Re-Aligned, Automatic, Gravity fed Irr. System Utilizing a New Pump House to the New Reservoir

Section	Specification Title	Unit	Quantity	Average Unit Price	total
1.0 - Transmission Main - 350 mm DIA to Reservoir					
1.01	350mm Ductile Iron Supply & Install	LM	205	$500	$102,500
1.02	350mm PVC C905 DR 18 To PRV's Supply & Install c/w sand bedding	LM	1900	$275	$522,500
1.04	Highway Permits and Traffic Control	LS	1	$10,000	$10,000
1.05	PVC & DI Bends, Tees Supply & Install	EA	13	$2,500	$32,500
1.06	350 mm Gate Valves Supply & Install	EA	3	$8,500	$25,500
1.07	Air Release Valves	Ea	4	$10,000	$40,000
1.07	Pipe Anchors (>15% Grade)	EA	10	$500	$5,000
1.08	Irrigation Zone Tie-in	EA	18	$1,000	$18,000
1.09	350 x ____Reducer Supply & Install	EA	18	$2,000	$36,000
1.10	Directional Drilling (Highway, Slope & KRV)	LS	1	$400,000	$400,000
				Subtotal - Transmission	**$792,000**
2.0 - Pressure Reducing Stations					
2.01	Pressure Reducing Station (Valves, fittings and Kiosk) Supply & Install	EA	2	$150,000	$300,000
				Subtotal - Pressure Reducing Stations	**$300,000**
3.0 - New Booster Station					
3.01	Pump House Bldg	LS	1	$75,000	$75,000
3.02	VS - 40Hp Jockey Pump Supply & Install	EA	2	$20,000	$40,000
3.03	Mechanical Valves & Fittings	LS	1	$40,000	$40,000
3.04	Electricals & Controls/SCADA Upgrades	LS	1	$200,000	$200,000
3.05	Pressure Tank	LS	1	$20,000	$20,000
				Subtotal - Booster Station	**$375,000**
4.0 - Filtration Station					
4.01	Filtration Station Supply & Install	EA	2	$50,000	$100,000

a resourceful company

Agriculture & Agri-Food Canada - Class C Cost Estimate

Option 4 - Engineers Recommendation - Re-Aligned, Automatic, Gravity fed Irr. System Utilizing a New Pump House to the New Reservoir

Section	Specification Title	Unit	Quantity	Average Unit Price	total
				Subtotal - Filtration Stations	**$100,000**
5.0 Reservoir - 536 cu.m					
5.01	Reservoir - Double Cell	cu.m	536	$1,000	$536,000
5.02	Site Grading c/w Gravels	LS	1	$10,000	$10,000
5.03	Demolition of Existing Reservoir	LS	1	$10,000	$10,000
5.04	Excavation for Cell	LS	1	$10,000	$10,000
5.05	Access Road c/w excavation and gravels (790m x 6m)	LS	1	$90,000	$90,000
5.06	Internal/External Mechanical Piping	LS	1	$26,000	$26,000
5.07	Overflow Ditching - or 350 mm Pipe C/W MHs	m	200	$400	$80,000
5.08	Level Controls & SCADA	LS	1	$10,000	$10,000
5.09	Railing & Stairs on Reservoir	LS	1	$15,000	$15,000
5.1	Double Acting Air Valve Supply & Install c/w Housing Chamber	LS	1	$13,000	$13,000
				Subtotal - Reservoir	**$800,000**
6.0 - Controls					
6.01	Pump House / Pump Station	LS	1	$50,000	$50,000
6.02	PRV Station	EA	2	$50,000	$100,000
6.03	Reservoir	LS	1	$10,000	$10,000
6.04	Shop / Office	EA	2	$10,000	$20,000
				Subtotal - Reservoir	**$180,000**

Summary - Option 4

1.0 - Transmission Main - 350 mm DIA to Reservoir	SUBTOTAL	$792,000
2.0 - Pressure Reducing Stations	SUBTOTAL	$300,000
3.0 - Booster Station	SUBTOTAL	$375,000
4.0 - Filtration Station	SUBTOTAL	$100,000
5.0 - Reservoir - 536 cu.m	SUBTOTAL	$800,000
6.0- Controls	SUBTOTAL	$180,000
	TOTAL	**$2,547,000**
	Engineering (15%)	$382,050
	Contingency (15%)	$382,050
	Total Class C Cost	**$3,311,100**

*The cost for irrigating fields/zones, laterals and valves is shown below

ecora
a resourceful company

Agriculture & Agri-Food Canada - Class C Cost Estimate

Option 4 - Engineers Recommendation - Re-Aligned, Automatic, Gravity fed Irr. System Utilizing a New Pump House to the New Reservoir (Field Irrigation)

Section	Specification Title	Unit	Quantity	Average Unit Price	total
7.0 - Field Irrigation Mains Downstream of PRV Stations					
7.01	250mm PVC IPS DR 21 Supply & Install c/w sand bedding	LM	600	$210	$126,000
7.02	150mm PVC IPS DR 21 Supply & Install c/w sand bedding	LM	7500	$110	$825,000
7.03	100mm PVC IPS DR 21 Supply & Install c/w sand bedding	LM	6300	$80	$504,000
7.04	PVC & DI Bends, Tees Supply & Install	EA	100	$1,200	$120,000
7.05	150mm Gate Valves Supply & Install	EA	30	$1,200	$36,000
7.06	100mm Gate Valves Supply & Install	EA	8	$1,000	$8,000
7.07	75mm Gate Valves c/w valve box Supply & Install	EA	200	$200	$40,000
7.08	Direct Field Sprinkler Application	Acre	200	$7,850	$1,570,000
				Subtotal - Transmission	**$3,229,000**

Summary - Option 4 (Field Irrigation)		
7.0 - Field Irrigation Mains Downstream of PRV Stations	SUBTOTAL	$3,229,000
	TOTAL	**$3,229,000**
	Engineering (15%)	$484,350
	Contingency (15%)	$484,350
	Total Class C Cost	**$4,197,700**

Note ALL PIPING DOWNSTREAM OF PRV STATION TO BE IPS DR 21

Appendix B

Conceptual Design Drawings

IRRIGATION INFRASTRUCTURE UPGRADE

AGRICULTURE & AGRI-FOOD CANADA

SUMMERLAND RESEARCH AND DEVELOPMENT CENTRE

SUMMERLAND, BC

APRIL 7, 2020

LOCATION MAP
SCALE 1 : 5000

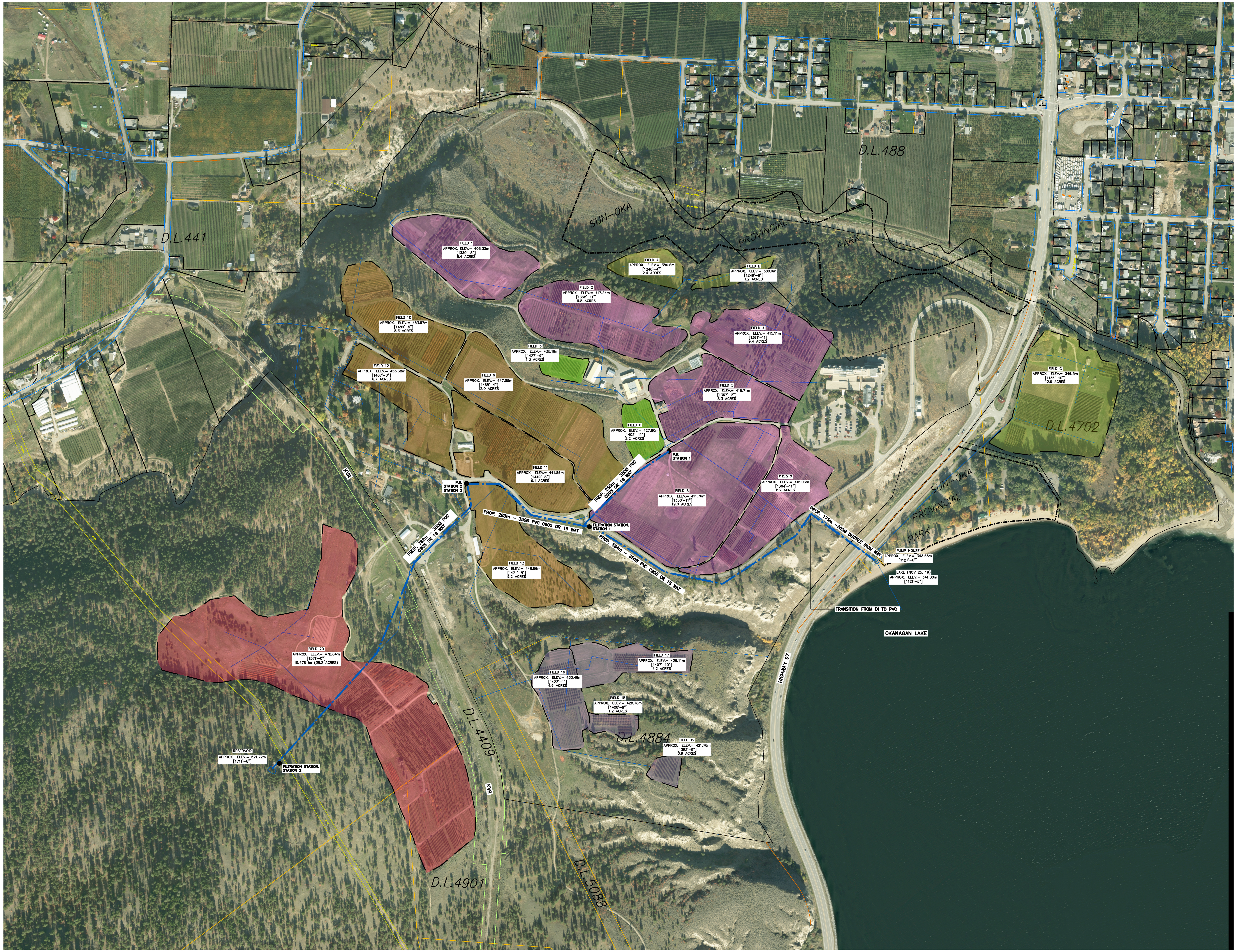
DRAWING LIST	
PRJ NO.-PHASE-SHEET	SHEET TITLE
191024-P-C1	TITLE SHEET
191024-P-C2	OPTION 1 - GRAVITY FED IRRIGATION SYSTEM
191024-P-C3	OPTION 2 - PRESSURIZED IRRIGATION SYSTEM
191024-P-C4	OPTION 3 - GRAVITY FED WITH DIRECT LINE TO RESERVOIR
191024-P-C5	OPTION 4 - GRAVITY FED WITH BOOSTER STATION
191024-P-C6	OPTION 4 - FLOW CHART & NOTES

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Pacific Region
SERVICES IMMOBILIERS
Région de Pacifique

#201-284 MAIN STREET
PENTICTON, B.C.
V2A 5B2
PHONE: 250-492-2227
www.ecora.ca

Drawing No.	Rev.No
191024-C1	1



Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Pacific Region
SERVICES IMMOBILIERS
Région de Pacifique

N

FIELD ZONE LEGEND

- ZONE A (FIELDS 1, 2, 4, 5, 7, 8)
- ZONE B (FIELDS 3, 6)
- ZONE C (FIELDS 9. 10, 11, 12, 13)
- ZONE D (FIELDS 16, 17, 18, 19)
- ZONE E (FIELDS 20)
- OTHER FIELDS - ZONE F (FIELDS A, B)
- OTHER FIELDS - ZONE G (FIELDS C)

Revision/Revision	Description/Description	Date/Date
5		
4		
3		
2		
1	Design for Approval	20/04/07
0	Preliminary Design	20/02/07

Client/client

AGRICULTURE & AGRI-FOOD CANADA RESEARCH & DEVELOPMENT CENTRE

4200 HIGHWAY 97 P.O. BOX 5000
SUMMERLAND, BC V0H 1Z0

Project title/Titre du projet
SUMMERLAND, BC
SUMMERLAND RESEARCH CENTRE

IRRIGATION UPGRADES

Consultant Signature Only

Designed by/Concept par
NW

Drawn by/Dessine par
KD

PWGSC Project Manager/Administrateur de Projets TPSGC
GB

Regional Manager, Architectural and Engineering Services
Gestionnaire régionale, Services d'architectural et de génie, TPSGC

Drawing title/Titre du dessin

SITE PLAN
OPTION 1
GRAVITY FED IRRIGATION SYSTEM

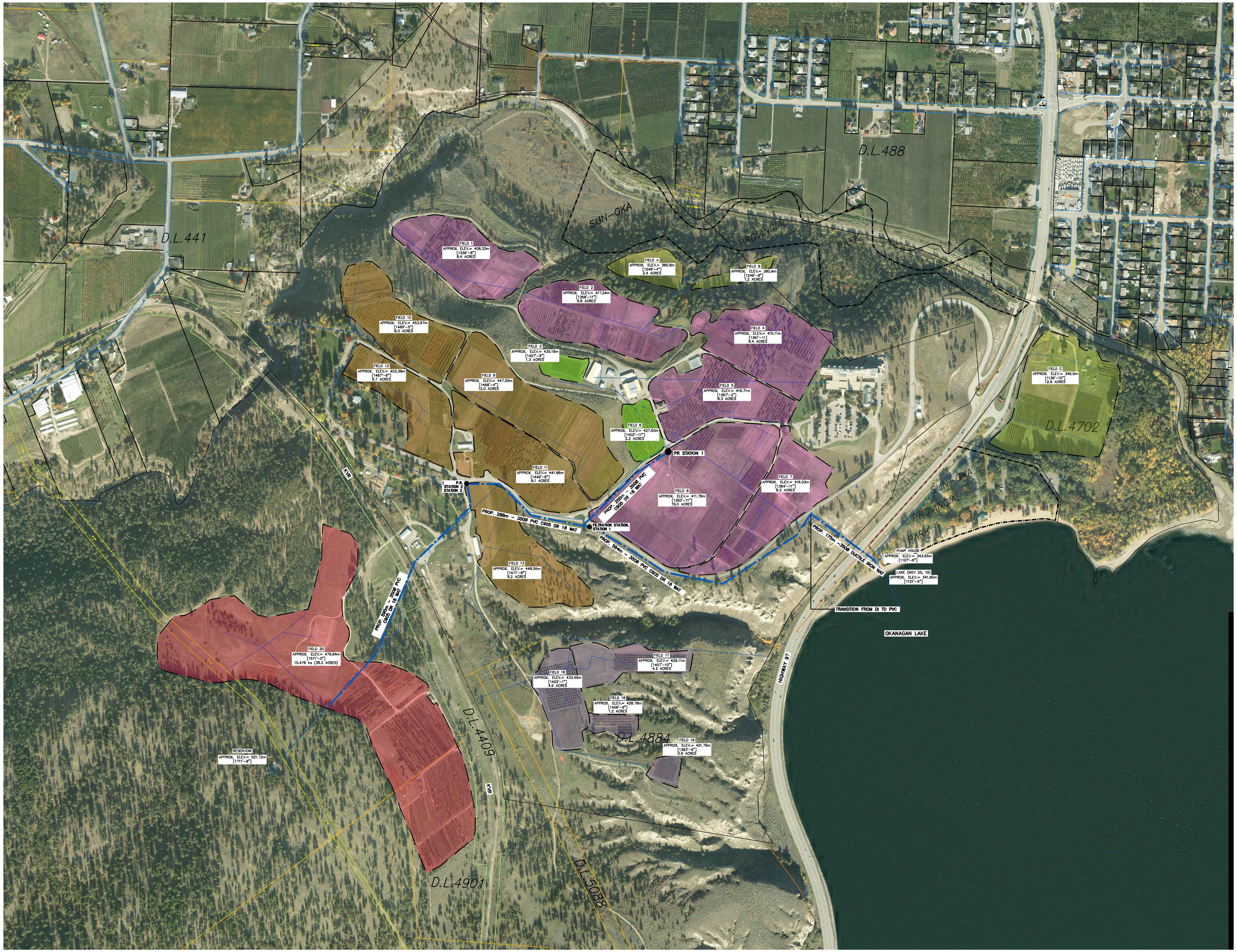
SCALE: 1 TO 4000

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
191024	C2 OF 6	1

DM5XXXXXX

PWGSC - A1 - 841X594

0 10 20 30 40 50 60 70 80 90 100mm



Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Pacific Region
SERVICES IMMOBILIERS
Région de Pacifique

N

FIELD ZONE LEGEND

- ZONE A (FIELDS 1, 2, 4, 5, 7, 8)
- ZONE B (FIELDS 3, 6)
- ZONE C (FIELDS 9. 10, 11, 12, 13)
- ZONE D (FIELDS 16, 17, 18, 19)
- ZONE E (FIELDS 20)
- OTHER FIELDS - ZONE F (FIELDS A, B)
- OTHER FIELDS - ZONE G (FIELDS C)

Revision/ Revision	Description/Description	Date/Date
5		
4		
3		
2		
1	Issued for Approval	20/04/07
0	Preliminary Design	20/02/07

Client/client

AGRICULTURE & AGRI-FOOD CANADA
RESEARCH & DEVELOPMENT CENTRE

4200 HIGHWAY 97 P.O. BOX 5000
SUMMERLAND, BC V0H 1Z0

Project title/Titre du projet
SUMMERLAND, BC
SUMMERLAND RESEARCH CENTRE

IRRIGATION UPGRADES

Consultant Signature Only

Designed by/Concept par
NW

Drawn by/Dessine par
KD

PWGSC Project Manager/Administrateur de Projets TPSGC
GB

Regional Manager, Architectural and Engineering Services
Gestionnaire régionale, Services d'architectural et de génie, TPSGC

Drawing title/Titre du dessin

SITE PLAN
OPTION 2
PRESSURIZED IRRIGATION SYSTEM

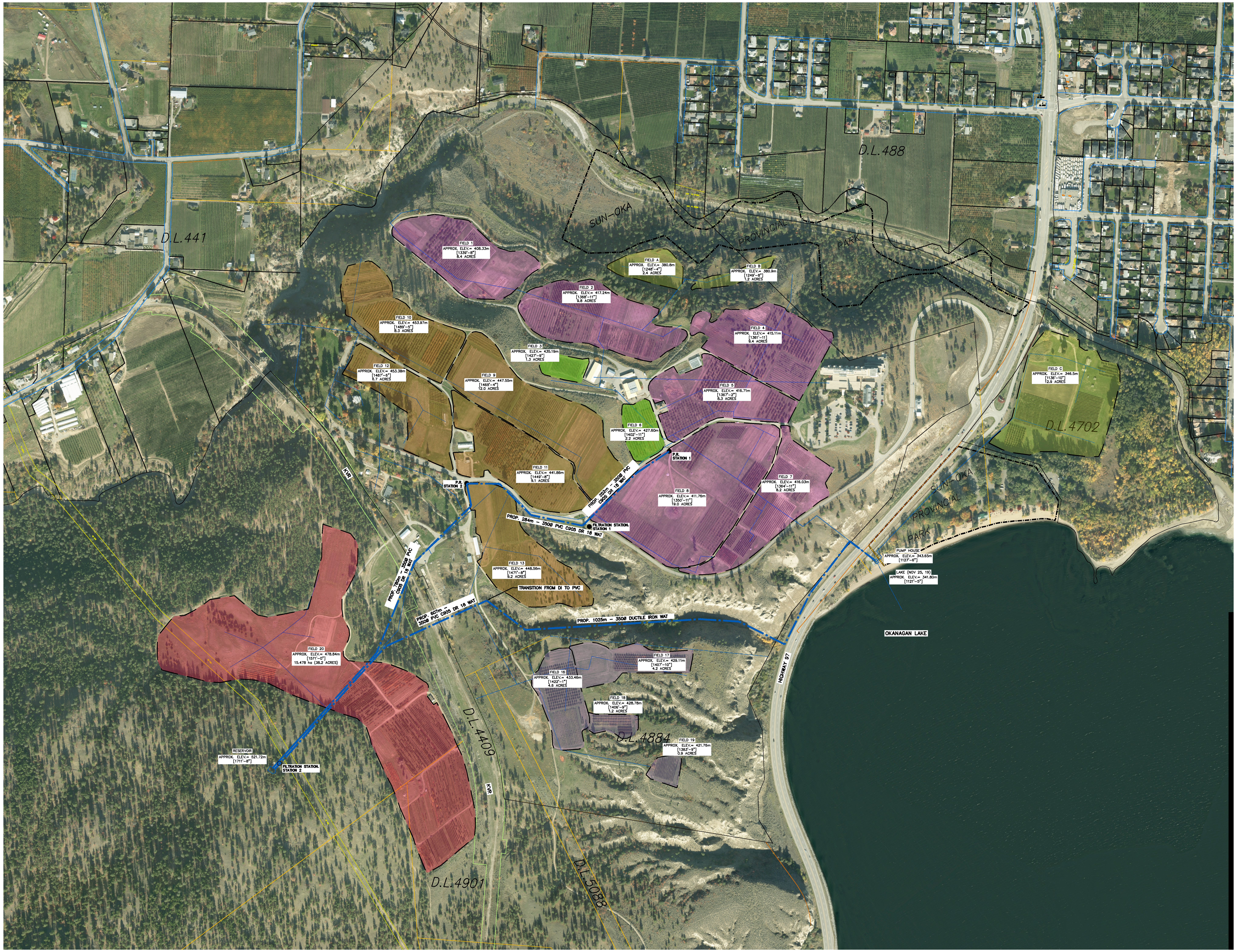
SCALE: 1 TO 4000

Project No./No. du projet	Sheet/Feuille	Revision no./ La Révision no.
191024	C3 OF 6	1

PWGSC - A1 - 841X594

0 10 20 30 40 50 60 70 80 90 100mm

DM5XXXXXX



Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Pacific Region
SERVICES IMMOBILIERS
Région de Pacifique

N

FIELD ZONE LEGEND

- ZONE A (FIELDS 1, 2, 4, 5, 7, 8)
- ZONE B (FIELDS 3, 6)
- ZONE C (FIELDS 9. 10, 11, 12, 13)
- ZONE D (FIELDS 16, 17, 18, 19)
- ZONE E (FIELDS 20)
- OTHER FIELDS - ZONE F (FIELDS A, B)
- OTHER FIELDS - ZONE G (FIELDS C)

Revision/ Revision	Description/Description	Date/Date
5		
4		
3		
2		
1	Issued for Approval	20/04/07
0	Preliminary Design	20/02/07

Client/client

AGRICULTURE & AGRI-FOOD CANADA RESEARCH & DEVELOPMENT CENTRE

4200 HIGHWAY 97 P.O. BOX 5000
SUMMERLAND, BC V0H 1Z0

Project title/Titre du projet
SUMMERLAND, BC
SUMMERLAND RESEARCH CENTRE

IRRIGATION UPGRADES

Consultant Signature Only

Designed by/Concept par
NW

Drawn by/Dessine par
KD

PWGSC Project Manager/Administrateur de Projets TPSGC
GB

Regional Manager, Architectural and Engineering Services
Gestionnaire régionale, Services d'architectural et de génie, TPSGC

Drawing title/Titre du dessin

**SITE PLAN
OPTION 3
GRAVITY FED WITH
DIRECT LINE TO RESERVOIR (RAVINE)
SCALE: 1 TO 4000**

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
191024	C4 OF 6	1

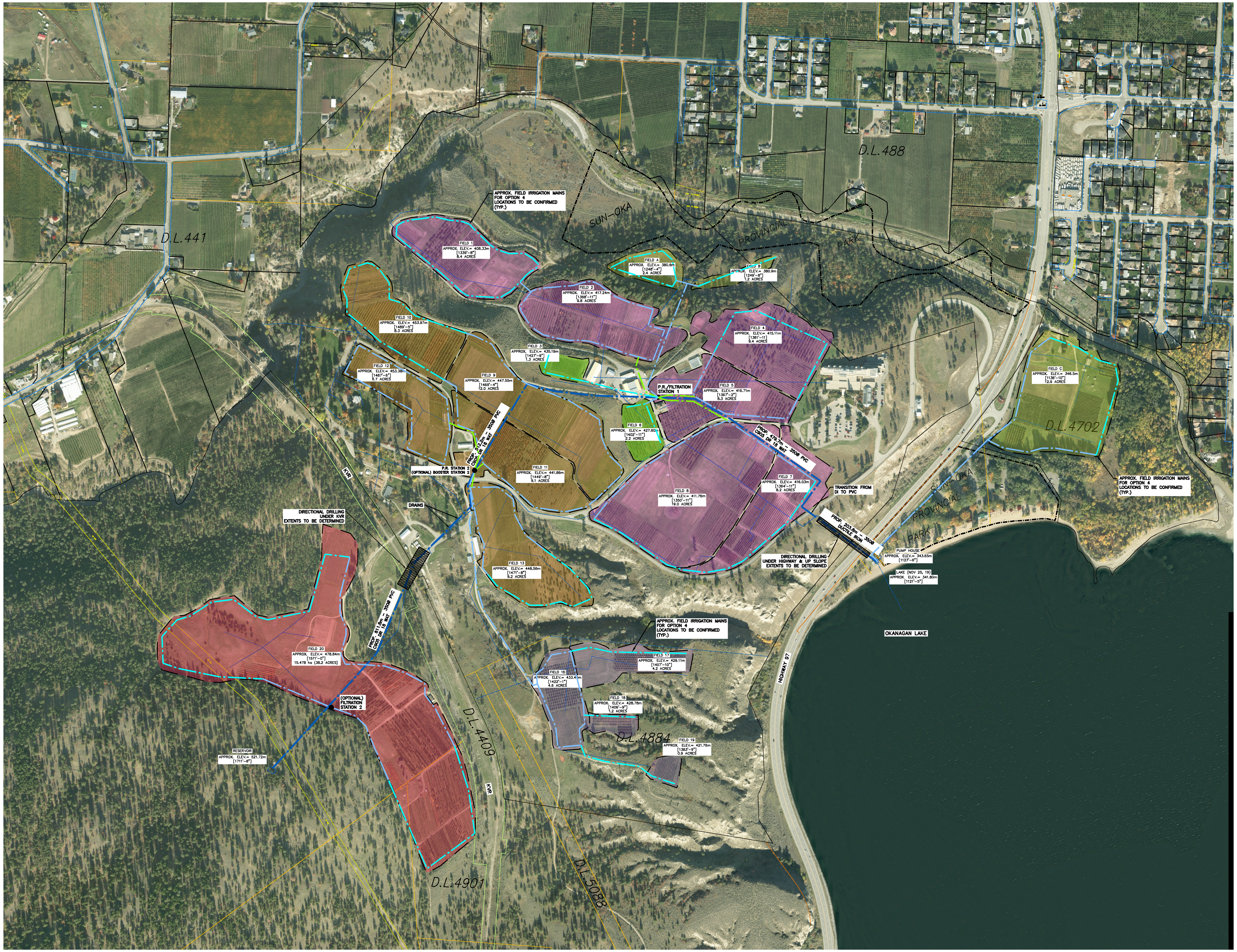
DM5XXXXXX

PWGSC – A1 – 841X594

0 10 20 30 40 50 60 70 80 90 100mm

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Pacific Region
SERVICES IMMOBILIERS
Région de Pacifique



N

FIELD ZONE LEGEND

- ZONE A (FIELDS 1, 2, 4, 5, 7, 8)
- ZONE B (FIELDS 3, 6)
- ZONE C (FIELDS 9, 10, 11, 12, 13)
- ZONE D (FIELDS 16, 17, 18, 19)
- ZONE E (FIELDS 20)
- OTHER FIELDS - ZONE F (FIELDS A, B)
- OTHER FIELDS - ZONE G (FIELDS C)

WATER MAIN LEGEND

- 350mm DI/PVC PIPE
- 250mm PVC PIPE
- 150mm PVC PIPE
- 100mm PVC PIPE
- IPS PVC

Revision/Révision	Description/Description	Date/Date
5		
4		
3		
2		
1	Issued for Approval	20/04/16
0	Preliminary Design	20/02/07

Client/client

AGRICULTURE & AGRI-FOOD CANADA
RESEARCH & DEVELOPMENT CENTRE

4200 HIGHWAY 97 P.O. BOX 5000
SUMMERLAND, BC V0H 1Z0

Project title/Titre du projet
SUMMERLAND, BC
SUMMERLAND RESEARCH CENTRE

IRRIGATION UPGRADES

Consultant Signature Only

Designed by/Concept par
NW

Drawn by/Dessine par
KD

PWGSC Project Manager/Administrateur de Projets TPSGC
GB

Regional Manager, Architectural and Engineering Services
Gestionnaire régionale, Services d'architectural et de génie, TPSGC

Drawing title/Titre du dessin

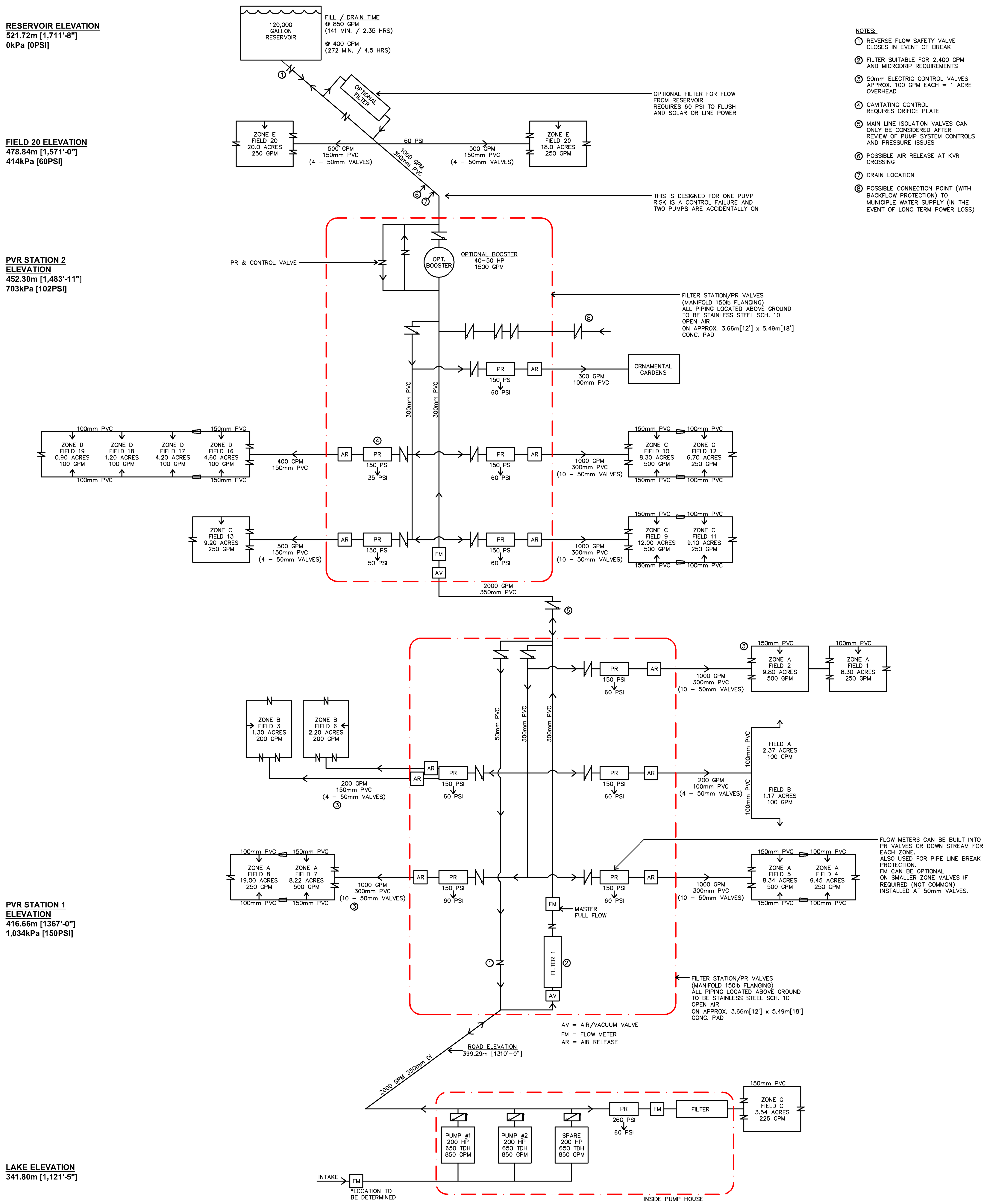
SITE PLAN
OPTION 4
GRAVITY FED
WITH BOOSTER STATION
SCALE: 1 TO 4000

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
191024	C5 OF 6	1

PWGSC - A1 - 841X594

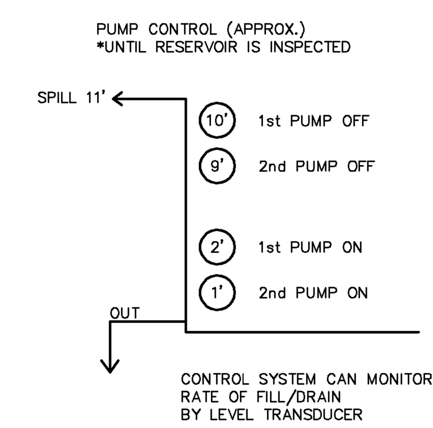
0 10 20 30 40 50 60 70 80 90 100mm

DM5XXXXXX



NOTES:

1. REVERSE FLOW SAFETY VALVE CLOSES IN EVENT OF BREAK
2. FILTER SUITABLE FOR 2,400 GPM AND MICRODRIP REQUIREMENTS
3. 50mm ELECTRIC CONTROL VALVES APPROX. 100 GPM EACH = 1 ACRE OVERHEAD
4. CAVITATING CONTROL REQUIRES ORIFICE PLATE
5. MAIN LINE ISOLATION VALVES CAN ONLY BE CONSIDERED AFTER REVIEW OF PUMP SYSTEM CONTROLS AND PRESSURE ISSUES
6. POSSIBLE AIR RELEASE AT KVR CROSSING
7. DRAIN LOCATION
8. POSSIBLE CONNECTION POINT (WITH BACKFLOW PROTECTION) TO MUNICIPLE WATER SUPPLY (IN THE EVENT OF LONG TERM POWER LOSS)



RESERVOIR INFORMATION			
CAPACITY =	120,000 USG		
FILL RATE @ 840 GPM (1) PUMP OPERATING			
IRRIGATION DEMAND (GPM)	FILL TIME (MIN.)	FILL TIME (HRS.)	DRAIN DOWN FLOW RATE (GPM)
0	141	2.35	840
100	162	2.7	740
200	187	3.1	640
300	222	3.7	540
400	272	4.5	440
500	353	5.8	340
600	500	8.3	240
700	857	14.2	140

Public Works and Government Services Canada / Travaux publics et Services gouvernementaux Canada

REAL PROPERTY SERVICES
Pacific Region
SERVICES IMMOBILIERS
Région de Pacifique

N

Revision/Révision	Description/Description	Date/Date
5		
4		
3		
2		
1	Issued for Approval	20/04/07
0	Preliminary Design	20/02/07

Client/client

AGRICULTURE & AGRI-FOOD CANADA
RESEARCH & DEVELOPMENT CENTRE

4200 HIGHWAY 97 P.O. BOX 5000
SUMMERLAND, BC V0H 1Z0

Project title/Titre du projet
SUMMERLAND, BC
SUMMERLAND RESEARCH CENTRE

IRRIGATION UPGRADES

Consultant Signature Only

Designed by/Concept par
NW

Drawn by/Dessine par
KD

PWGSC Project Manager/Administrateur de Projets TPSGC
GB

Regional Manager, Architectural and Engineering Services
Gestionnaire régionale, Services d'architectural et de génie, TPSGC

Drawing title/Titre du dessin

FLOW CHART & NOTES
OPTION 4
GRAVITY FED
WITH BOOSTER STATION
SCALE: 1 TO 4000

Project No./No. du projet	Sheet/Feuille	Revision no./La Révision no.
191024	C6 OF 6	1

PWGSC – A1 – 841X594

0 10 20 30 40 50 60 70 80 90 100mm

DM5XXXXXX

Appendix C

Land Use Inventory

Summerland Research and Development Center -Land Use Inventory

Pressure Zone	Field	Area (Ha)	Area (Ac)	Crop Type: Apples	Crop Type: Cherry	Crop Type: Grape	Irrigation Method - Sprinkler: Overhead	Irrigation Method - Sprinkler: Micro Sprinkler	Irrigation Method - Sprinkler: Under Tree	Irrigation Method - Drip: Surface	Irrigation Method - Drip: Above	
A	1	3.39	8.38	☑	☐	☐	☑	☐	☐	☑	☑	
	2	3.96	9.79	☑	☑	☐	☐	☐	☑	☐	☐	
	4	3.82	9.45	☐	☑	☐	☐	☐	☑	☐	☐	
	5	3.37	8.34	☐	☑	☐	☐	☐	☑	☐	☐	
	7	3.33	8.22	☑	☐	☑	☑	☑	☐	☑	☐	25% apples = overhead and surface drip/75% grapes = surface drip and Micro sprinkler 50%/50%
	8	7.70	19.03	☑	☑	☐	☑	☐	☑	☑	☐	
		25.58	**63.21**				**35**	**8.22**	**46**	**16.5**		
B	3	0.51	1.25	☑	☐	☐	☑	☐	☐	☑	☐	25% Block is dual system overhead & drip
	6	0.90	2.23	☐	☑	☐	☐	☐	☑	☐	☐	
		1.41	**3.49**				**1.25**		**2.23**	**1.25**		
C	9	4.85	12.00	☑	☐	☐	☑	☐	☐	☐	☐	
	10	3.37	8.32	☐	☑	☐	☐	☑	☑	☐	☐	50%/50% under tree/micro
	11	3.70	9.14	☐	☑	☐	☐	☐	☑	☐	☐	
	12	2.72	6.73	☑	☑	☐	☐	☑	☑	☐	☐	50%/50% under tree/micro
	13	3.73	9.23	☑	☑	☐	☑	☐	☑	☐	☐	25% apple overhead/ 75% cherry undertree
		18.38	**45.42**				**21.23**	**15.05**	**39.4**			
D	16	1.86	4.59	☑	☐	☐	☐	☐	☑	☐	☐	
	17	1.70	4.19	☐	☑	☐	☐	☐	☑	☐	☐	
	18	0.47	1.16	☐	☑	☐	☐	☐	☑	☐	☐	
	19	0.38	0.94	☑	☐	☐	☑	☐	☐	☑	☐	dual system overhead+drip
		4.40	**10.87**				**0.94**		**9.94**	**0.94**		
E	20	**15.48**	**38.25**	☐	☑	☑	☐	☑	☐	☑	☐	Dual system micro+drip
								38.25		**38.25**		
F	A	0.96	2.37	☑	☐	☐	☑	☐	☐	☐	☐	
	B	0.47	1.17	☐	☑	☐	☑	☐	☐	☐	☐	
		1.43	**3.54**				**3.54**					
G	C	**5.21**	**12.86**	☑	☑	☑	☐	☐	☑	☑	☐	25% of field is under tree / 75% is drip
									12.86	**12.86**		
TOTAL			**177.64**				**61.96**	**61.52**	**110.43**	**69.8**		

Approximate Flows for Irrigation Type

Irrigation Type	Total Acres	Approx. Flow Demand (GPM/Acre)	Flow (GPM)
Overhead Sprinkler	61.96	100	6196
Under Tree Sprinkler	110.43	50	5521.5
Micro Sprinkler	61.52	35	2153.2
Drip	69.8	20	1396

Appendix D

Climate Data

2 CLIMATE

Climate plays an important part in determining crop water use. It determines the rate at which the crop uses water and how much water the crop will require over the entire irrigation season. Climate information for over 80 locations in British Columbia is available online at www.farmwest.com.

www.farmwest.com

2.1 Climate Information

Evapotranspiration

Evapotranspiration (ET) is a combination of the evaporation of moisture from the soil and plant surfaces and water transpired through the plant. ET can be measured by using evaporation pans or atmometers, or calculated using climate data from a weather station. The amount of ET depends on temperature, solar radiation, relative humidity and wind speed (Figure 2.1). The hotter and windier it is, the higher the ET rate will be. ET is important to know because it is directly related to crop water use and therefore irrigation water requirement.

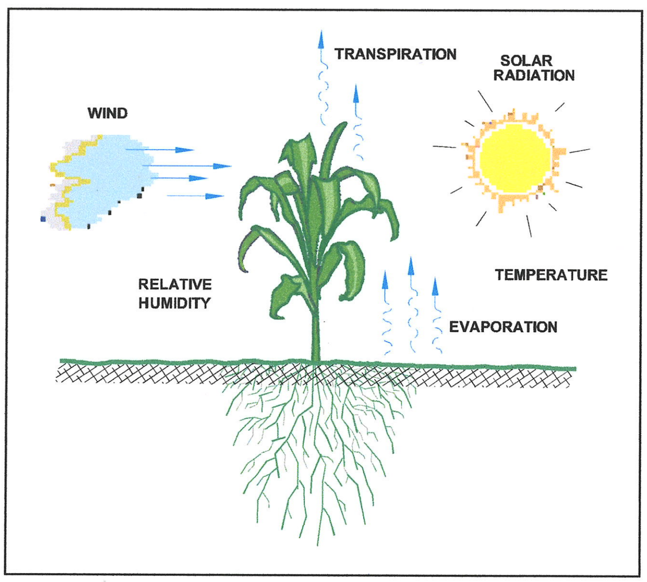


Figure 2.1 Elements of Evapotranspiration

ET may be reported in a number of different ways depending on how it is measured or calculated:

- ET_o is a reference ET for a well-watered grass crop of 10 to 15 cm
- ET_R is ET for an alfalfa reference crop
- ET_p is ET measured from a pan or atmometer

The type of reference crop used to report ET is important because this determines the crop coefficient that is used to convert the measured ET into the actual crop water use. This document and Farmwest use ET_o values.

Effective Precipitation

Effective precipitation (EP) is the amount of precipitation that is actually added and stored in the soil. The calculation for effective precipitation may need adjustments for drier periods to periods of wet weather as described below. In drier periods, not all rainfall is considered effective, but for extended periods of cool wet weather, most rainfall over a couple of millimetres may be considered effective. Very large rainfall events may not all be effective as more moisture than the soil's available water storage capacity (AWSC) may be applied to the soil.

Dry Periods

During extended warm dry periods, rainfall of less than five mm may not add any moisture to the soil reservoir because the precipitation would most likely evaporate from the soil surface before soaking into the groumd. This rainfall is therefore not considered effective as it does not provide any moisture to the plant. Consequently, on the Farmwest website (www.farmwest.com), if daily rainfall is less than five mm, a value of zero is reported for effective precipitation. In addition, only 75% of the rainfall over five mm is considered as effective precipitation. During dry periods, no changes need to be made to the effective precipitation reported on Farmwest. Equation 2.1 shows how to determine EP.

Equation 2.1 Effective Precipitation (EP)

$$EP = (RAIN - 5) \times 0.75$$

where:

EP = effective precipitation [mm]
RAIN = measured rainfall [mm]

Wet Periods

During prolonged cool wet periods, more of the rainfall that falls as daily showers may be considered to be effective. This is because the soil and air temperatures are cooler and humidity is higher, allowing the rainfall to soak into the soil before it evaporates. The judgement of whether or not rainfall is effective would be made after a number of days. Soil moisture monitoring can be helpful in determining how much of the rainfall is effective during the irrigation season.

Large Amounts of Precipitation

Very large rainfall events may apply more moisture than the soil's holding capacity, or exceed the soil's infiltration capabilities. Large amounts of rainfall may move moisture beyond the plant's root zone making the water unavailable to the plant. If rainfall intensity is greater than the soil infiltration rate, precipitation will be lost to runoff and will not be stored in the root zone. Therefore, the effective amount of rainfall recorded during periods of heavy precipitation may be much more than what is actually being stored in the field. A portion of the precipitation may have been lost to deep percolation or runoff.

2.2 Historical Climate Information for Irrigation Planning

Historical regional climate information that can be used for irrigation planning is summarized in this section. This information is used for planning water requirements for the farm, and to set up a basic irrigation schedule that can be adjusted using real-time climate data and soil moisture measurements.

Peak Flow Rate and Annual Crop Water Requirements

Tables 2.1 through 2.4 are used to estimate peak flow rates and annual crop water requirements for sprinkler irrigation systems. The peak flow rate values should also be used for trickle systems; however, annual requirements can be reduced due to a smaller application area and higher system efficiencies. Chapter 3 includes methodology to reduce the annual water requirements for crops irrigated with a drip/trickle system.

Table 2.1 lists the historical peak evapotranspiration (ET) rates for locations in B.C. using an average maximum soil water deficit (MSWD) of 3-inch or 7.5-cm. The irrigation system flow rate requirement can be estimated using the peak ET value chosen in Table 2.1 and comparing with the flow rates assigned to the peak ET values in Table 2.2. The values shown are for a risk factor of 10% (the crop will be short of water once every 10 years). Table 2.3 provides a quick reference for peak flow rates for various British Columbia locations.

The estimated annual crop water requirements for various B.C. locations are listed in Table 2.4. The irrigation system application efficiency must be applied to the values in Table 2.4 to determine annual water use. An efficiency of 72% should be used for licensing purposes.

When planning the annual amount and peak flow of water required for a farm, the values in these tables should be used regardless of the type of irrigation system or crop grown. This way, enough water will be available for the land to be productive regardless of the crop grown and the type of irrigation system used.

The values in these tables are used to estimate a licensed water requirement for irrigation throughout the province, and to ensure sufficient water is available to manage the irrigation system effectively.

Peak flow rate and annual crop water requirements will vary depending on:

- crop type
- soil type
- rooting depth
- irrigation system efficiency
- climate and field elevation that determine peak ET rates (farms at the bottom of valleys have higher peak ET rates than those in the same area but at a higher elevation)

Table 2.1 Peak Evapotranspiration Rates for B.C. Locations with Average (3 in or 7.5 cm) Maximum Soil Water Deficit

Location	ET [in/d]	ET [mm/d]	Location	ET [in/d]	ET [mm/d]	Location	ET [in/d]	ET [mm/d]
Abbotsford	0.15	3.8	Golden	0.15	3.8	Oliver	0.24	6.1
Agassiz	0.15	3.8	Grand Forks	0.19	4.8	100 Mile House	0.23	5.8
Alexis Creek	0.15	3.8	Grandview Flats	0.25	6.4	Osoyoos	0.28	7.1
Armstrong	0.21	5.3	Grasmere	0.22	5.6	Oyster River	0.12	3.0
Ashcroft	0.30	7.6	Grindrod	0.14	3.6	Parksville	0.16	4.1
Aspen Grove	0.21	5.3	Hazelton	0.19	4.8	Pitt Meadows	0.13	3.3
Barriere	0.20	5.1	Hixon	0.16	4.1	Port Alberni	0.20	5.1
Baynes Lake	0.25	6.4	Hope	0.22	5.6	Prince George	0.15	3.8
Campbell River	0.20	5.1	Invermere	0.23	5.8	Princeton	0.25	6.4
Canal Flats	0.26	6.6	Kamloops	0.28	7.1	Quesnel	0.26	6.6
Castlegar	0.31	7.9	Kelowna	0.24	6.1	Radium	0.20	5.1
Cawston	0.32	8.1	Keremeos	0.29	7.4	Riske Creek	0.28	7.1
Chase	0.21	5.3	Kersley	0.22	5.6	Saanichton	0.16	4.1
Cherryville	0.21	5.3	Kettle Valley	0.27	6.9	Salmon Arm	0.17	4.3
Chilliwack	0.17	4.3	Kimberley	0.30	7.6	Smithers	0.15	3.8
Clinton	0.23	5.8	Ladner	0.13	3.3	Spillimacheen	0.19	4.8
Cloverdale	0.14	3.6	Langley	0.14	3.6	Sumas	0.17	4.3
Comox	0.20	5.1	Lillooet	0.28	7.1	Summerland	0.26	6.6
Creston	0.18	4.6	Lister	0.21	5.3	Terrace	0.30	7.6
Dawson Creek	0.19	4.8	Lumby	0.23	5.8	Vancouver	0.18	4.6
Douglas Lake	0.21	5.3	Lytton	0.30	7.6	Vanderhoof	0.20	5.1
Duncan	0.16	4.1	Malakwa	0.19	4.8	Vernon	0.22	5.6
Ellison	0.23	5.8	Merritt	0.26	6.6	Walhachin	0.29	7.4
Fort Fraser	0.19	4.8	Nanaimo	0.19	4.8	Westwold	0.27	6.9
Fort Steele	0.22	5.6	Natal	0.18	4.6	Williams Lake	0.28	7.1
Fort St. John	0.19	4.8	Notch Hill	0.20	5.1			

Peak Flow Rate

Figure 2.2 gives a general overview of flow rates in B.C. The flow rates provided in tables and figures in this section are for general guidance only. Use one of the following methods to obtain peak flow rate:

1. If an irrigation water licence indicates a peak flow rate, use the flow rate stated on the licence.
2. If water is supplied by a water purveyor, use the flow rate established by the purveyor.
3. Otherwise, use Table 2.3 to estimate the peak irrigation flow rate of a location listed in the table and is closest to the farm.

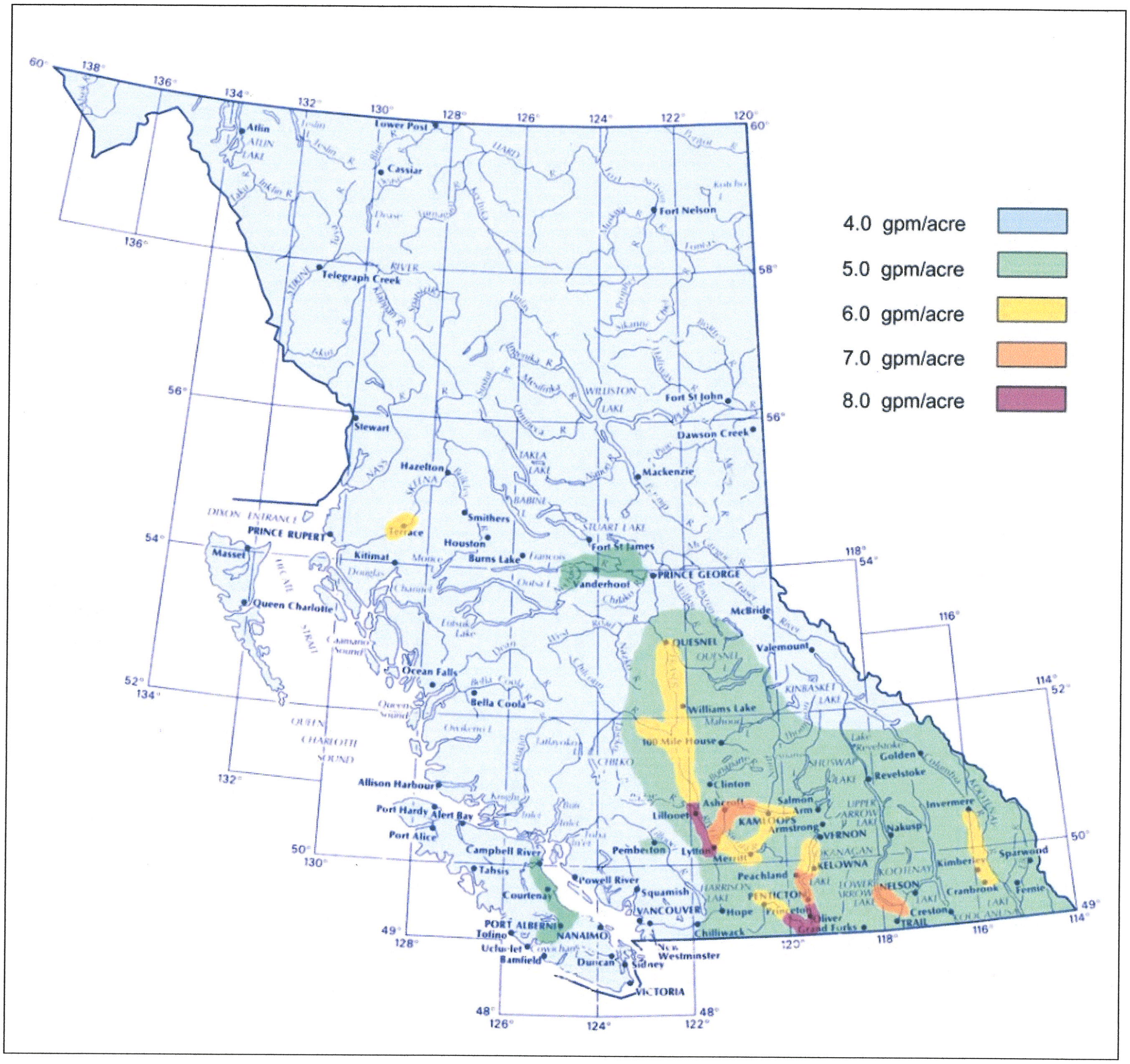


Figure 2.2 Estimated Peak Irrigation Flow Rate Requirements in B.C. [US gpm/acre]

Table 2.2 Estimated Peak Irrigation System Flow Rate Requirements Based on Peak ET Rates (with 10% risk factor)

ET		Irrigation System Flow Rates	
[in/d]	[mm/d]	[US gpm/acre]	[m^3/hr/ha]
0.16	4.1	4.0	2.24
0.18	4.6	4.5	2.52
0.20	5.1	5.0	2.80
0.22	5.6	5.5	3.10
0.23	5.8	6.0	3.36
0.25	6.4	6.5	3.64
0.27	6.9	7.0	3.92
0.29	7.4	7.5	4.20
0.31	7.9	8.0	4.48

Table 2.3 Estimated Peak Irrigation Flow Rate Requirements for B.C. Locations[1,2]

Location	Flow Rate [US gpm/acre][3]	Location	Flow Rate [US gpm/acre][3]	Location	Flow Rate [US gpm/acre][3]
Abbotsford	4.0	**Golden**	4.0	**Oliver**	6.5
Agassiz	4.0	**Grand Forks**	5.0	**100 Mile House**	5.5
Alexis Creek	4.0	**Grandview Flats**	5.5	**Osoyoos**	7.5
Armstrong	5.0	**Grasmere**	5.5	**Oyster River**	4.0
Ashcroft	8.0	**Grindrod**	4.0	**Parksville**	4.0
Aspen Grove	5.0	**Hazelton**	5.0	**Pitt Meadows**	4.0
Barriere	5.0	**Hixon**	4.0	**Port Alberni**	5.0
Baynes Lake	6.5	**Hope**	5.0	**Prince George**	4.0
Campbell River	5.0	**Invermere**	6.0	**Princeton**	6.0
Canal Flats	6.0	**Kamloops**	6.5	**Quesnel**	6.0
Castlegar	8.0	**Kelowna**	6.0	**Radium**	5.0
Cawston	8.0	**Keremeos**	7.5	**Riske Creek**	7.0
Chase	5.0	**Kersley**	5.5	**Saanichton**	4.0
Cherryville	5.0	**Kettle Valley**	7.0	**Salmon Arm**	4.5
Chilliwack	4.5	**Kimberley**	7.0	**Smithers**	4.0
Clinton	6.0	**Ladner**	4.0	**Spillimacheen**	5.0
Cloverdale	4.0	**Langley**	4.0	**Sumas**	4.5
Comox	5.0	**Lillooet**	7.5	**Summerland**	6.5
Creston	4.5	**Lister**	5.0	**Terrace**	5.5
Dawson Creek	4.0	**Lumby**	5.5	**Vancouver**	4.5
Douglas Lake	5.0	**Lytton**	8.0	**Vanderhoof**	5.0
Duncan	4.0	**Malakwa**	5.0	**Vernon**	5.0
Ellison	6.0	**Merritt**	6.5	**Walhachin**	6.5
Fort Fraser	5.0	**Nanaimo**	5.0	**Westwold**	6.5
Fort Steele	5.5	**Natal**	4.5	**Williams Lake**	6.0
Fort St. John	4.0	**Notch Hill**	5.0		

[1] Based on peak evapotranspiration rates on an average deep-rooted crop in a medium-textured soil (values in Table 2.1), as well as overall topographic knowledge of each location.
[2] Based on 10% risk factor, i.e., water shortage once in 10 years.
[3] Multiply values in US gpm/acre by 0.156 to convert to L/s/ha.

Annual Crop Water Requirement

Figure 2.3 gives a general overview of annual crop water requirements in B.C. If a farm is near one of the locations listed in Table 2.4, use the annual crop water requirement from this table in the worksheet calculations.

High summer temperatures mean a high peak flow rate. An area with a high peak flow rate does not necessarily give a high annual irrigation requirement. However, the annual crop water requirement is lower for a short irrigation season than a longer one. For example, Terrace and Kelowna have the same peak flow rate, but Kelowna has a much longer growing season; thus, a larger annual crop water requirement.

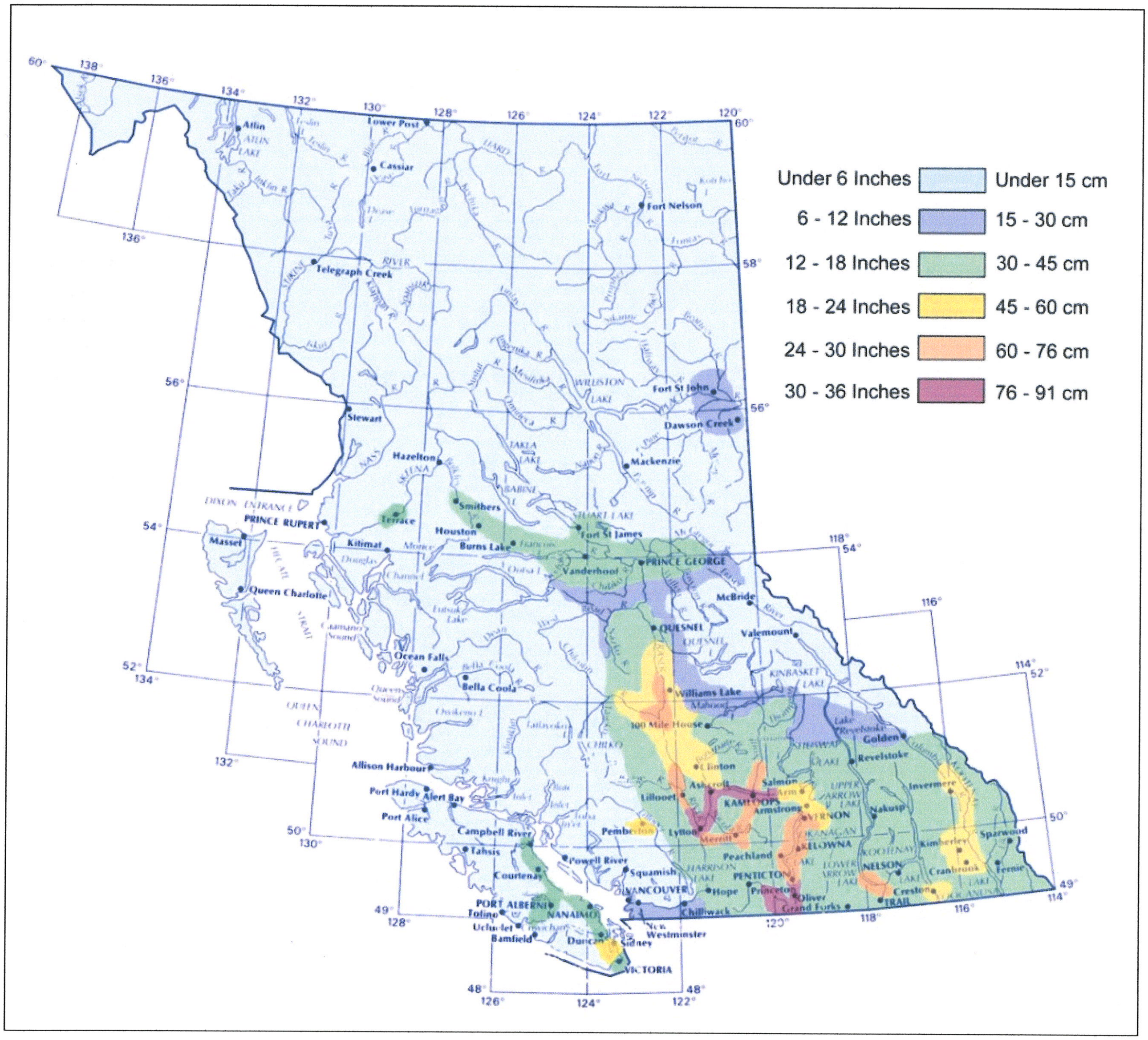


Figure 2.3 Estimated Annual Crop Water Requirements in B.C. [inches or cm]

Table 2.4 Estimated Annual Crop Water Requirements for B.C. Locations with Average (3 in or 7.5 cm) Maximum Soil Water Deficit								
Location	Water		Location	Water		Location	Water	
	[in]	[mm]		[in]	[mm]		[in]	[mm]
Abbotsford	9	220	**Golden**	11	274	**Oliver**	24	622
Agassiz	4	109	**Grand Forks**	11	274	**100 Mile House**	17	439
Alexis Creek	11	274	**Grandview Flats**	18	457	**Osoyoos**	25	640
Armstrong	12	311	**Grasmere**	13	329	**Oyster River**	6	165
Ashcroft	25	640	**Grindrod**	7	183	**Parksville**	10	256
Aspen Grove	13	329	**Hazelton**	2	55	**Pitt Meadows**	6	146
Barriere	13	329	**Hixon**	6	165	**Port Alberni**	12	292
Baynes Lake	17	420	**Hope**	9	238	**Prince George**	10	256
Campbell River	10	256	**Invermere**	17	439	**Princeton**	18	457
Canal Flats	14	366	**Kamloops**	23	585	**Quesnel**	9	238
Castlegar	21	531	**Kelowna**	19	475	**Radium**	12	311
Cawston	25	640	**Keremeos**	23	585	**Riske Creek**	16	402
Chase	15	384	**Kersley**	9	238	**Saanichton**	10	256
Cherryville	14	348	**Kettle Valley**	18	457	**Salmon Arm**	13	329
Chilliwack	5	128	**Kimberley**	17	439	**Smithers**	9	220
Clinton	17	439	**Ladner**	8	201	**Spillimacheen**	14	348
Cloverdale	7	183	**Langley**	6	165	**Sumas**	6	165
Comox	12	292	**Lillooet**	19	494	**Summerland**	19	494
Creston	16	402	**Lister**	16	402	**Terrace**	9	220
Dawson Creek	7	183	**Lumby**	15	384	**Vancouver**	11	274
Douglas Lake	16	402	**Lytton**	25	640	**Vanderhoof**	8	201
Duncan	9	220	**Malakwa**	9	220	**Vernon**	16	402
Ellison	17	420	**Merritt**	21	531	**Walhachin**	20	512
Fort Fraser	8	201	**Nanaimo**	10	256	**Westwold**	20	512
Fort Steele	10	256	**Natal**	10	256	**Williams Lake**	13	329
Fort St. John	7	183	**Notch Hill**	14	366			

Note: An irrigation system efficiency needs to be applied to the figures to obtain the gross annual requirements.

Appendix E

FortisBC Energy Savings

APPENDIX E - FORTISBC ENERGY SAVINGS

ESTIMATE ANNUAL CROP WATER REQUIREMENTS
SUMMERLAND BC
BASED ON 200 ACRES

	PEAK ET RATE	
	in/day	mm/day
SUMMERLAND	0.26	6.6

PEAK FLOW RATE	USGPM/acre	
SUMMERLAND	6.5	1.0 L/sec/ha

*1 Based on ET 0.26
2 10% Risk Factor

EQUIVALENT TOTAL PUMPING HOURS
ANNUAL CROP WATER REQUIREMENTS

	in/season	mm/season
	19	499

POWER COSTS
1 acre inch = 27,154 US gallons
19 inch required = 515,926 US gallons/season/acre

PUMP COST PER SEASON
BASED ON ORCHARD USE @ ET OF 0.26 /day 6.6 mm/day

515,926 US gallons/season/acre
@ 650 Pumping Head
@ 850 GPM = 607 min = 10.1 Hr

x 160 KW
200 HP = 1,618 KW Hr/acre

APPROX. KW PER SEASON FOR ORCHARD
x 200 acres = 323,718 KW

RATE SCH 61	@	7.312 cents/KWH	= $23,670.00
RATE OFF PEAK	@	4.039 cents/KWH	= $13,074.00
		POTENTIAL SAVINGS	$10,596.00

PER RATE SCHEDULE 61 AND 60
ADDITIONAL SAVING FOR SHOULDER
RATES @ 3.356 cents/KWH

SYSTEM IS DESIGNED FOR 9 GPM/acre BASED ON 200 ACRES AND 1800 GPM
IF CURRENT PUMPS ARE PERFORMING TO CURVE.
WITH THE PRESENT PLANTING AND VACANT LAND IN ROTATION IT WOULD
BE POSSIBLE TO OPERATE IN OFF PEAK HOURS.
SYSTEM SHOULD UTILIZE SOIL MOISTURE SENSORS AND CURRENT WEATHER
DATA TO INSURE ADEQUADE IRRIGATION.
ALSO THE ADDITION OF A 40 - 50 HP BOOSTER WILL INCREASE THE PEAK FLOW
TO 2000 - 2200 GPM.