2023

# Swansfleet Assiniboine River Irrigation Project Environment Act Proposal

Swansfleet Alliance

PBS Water Engineering Ltd.

*1/18/2023*

**Submission Sheet**

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# Executive Summary

Swansfleet Alliance (the Proponent) is proposing to construct an irrigation project in the Rural Municipality (RM) of Norfolk Treherne in Section 8-9-9 W1. The Project consists of an irrigation intake on the Assiniboine River, a buried pipeline system, and pumpworks for delivering water to overhead irrigation units on the proposed land base. The irrigation system will be capable of providing water to 4 quarter section fields, which are currently under annual or perennial crop production. The Project proposes to pump water on demand from the Assiniboine River from late spring (e.g., mid-June) to early fall (e.g., mid-September). The Proponent is currently seeking a Development Permit Authorization from Manitoba Environment, Climate and Parks department for up to 666 $dam^3$ (540 acre-feet), which would allow for irrigation of up to 540 acres annually. The Project is considered a Class 2 development in relation to The Environment Act (i.e., > 200 $dam^3$ diversion).

The proposed intake to the Assiniboine River will be located at an existing pump site (i.e., yet to be finalized) located on the east side of the Assiniboine River in NW 18-9-9W1. Proposed withdrawal rates are in the range of 151 to 189 L/s (2400 to 3000 USGPM).

The proposed river Intake system will be comprised of floating intakes which remove water through a rotating, self cleaning screen designed to protect fish from impingement and entrainment. The proposed intake will eliminate any requirement to modify the riverbed. The current proposal will utilize two (2) intakes manufactured by RiverScreen™ Inc., with each screen taking from 75 to 95 L/s (1200 to 1500 USGPM) plus backwash. The proposed Intake screen arrangement is being reviewed against Department of Fisheries and Oceans criteria.

The River pumping system will consist of two (or one) shore mounted mobile pump unit(s), with capacity to “lift” water from the intake screens and pressurize the water and deliver to a permanent River Booster pump station located on the upper bench (approximately 30 m above the river elevation). The River Booster pump station will re-pressurize the water and deliver to the irrigation systems located in Section 8-9-9 W1. Three phase electric power is being considered for the pumping systems, but diesel power (i.e., engine or generator) currently remains an option. There is no proposed water storage.

The Assiniboine River water will be conveyed between the pump stations and the irrigated areas using underground HDPE and PVC piping. High efficiency irrigation systems (e.g., center pivots) will be used to apply water to the fields. There are no creek or major utility or Provincial Road crossings. The only Municipal Road crossings will be open cut if possible. All regulations and by-laws will be adhered to (e.g., liner pipe, backfill, etc.).

The Project will be developed over a 2-year construction period starting in 2023. Engineering is ongoing and continuing this winter (2022-2023), with final selection of the pump site, and pipeline and pumping design.

The RM of Norfolk Treherne will be contacted regarding permits/approvals for the road crossing. Neighbours to the Project site will be consulted individually and/or can request any information provided to the RM and will have the opportunity to review this report online when it is posted to the Public Registry.

Construction of the pipeline network would begin in Fall, 2023 pending an Environmental License, RM permits (if any), and Water Development Permit Authorization. Pumping equipment may be ordered in spring or summer 2023, and any improvements to the intake site would be completed in summer or fall (e.g., levelling and stabilizing the pumping bench, erosion protection, transfer pipeline). The River Booster station is proposed to be competed in Fall 2023. Irrigation of up to 270 acres is planned for 2024.

The land use within the Project region has been historically altered for agricultural production, including the predominance of annual cropping fields, altered surface water drainage networks, and supporting infrastructure such as the road and power network. The nature and degree of development of the existing environment for annual crop production is owing to the soil-landscape and agri-climatic conditions that are well suited to a wide range of annual crops. The predominantly loamy, non-stony soil landscape is well suited for irrigated potato production. The major constraint to the growing climate for potatoes is having adequate moisture for optimum growing conditions. Given the sandy nature of the soils, average moisture deficits are anticipated to be in the 200 mm (8") range; with maximum demand projected at 300 mm (12").

The Project landscape and geology are largely reflections of the glaciation, especially Lake Agassiz and the Assiniboine Delta and the post glaciation Assiniboine River. The land proposed for irrigation is overtop of the Assiniboine Delta Aquifer, although wells in the area are very low yielding and unsuitable for irrigation. The alluvial and lacustrine sediments that underlay the site are deep (e.g., > 30 m) and overlay glacial till and shale bedrock at depth (e.g., 60 m). There is a level of impedance to vertical water movement as indicated by the imperfectly drained soils on the south ½ of Section 8-9-9 W1. The geologic review indicates two distinct water zones. A shallow perched near surface water table, which is mainly controlled by infiltration and evapotranspiration and impacts crop production (i.e., saturation). A deeper water table associated with a deep sand layer (e.g., at 20 – 25 m), is utilized locally for smaller diameter wells, and is of reasonable water quality.

The soil-landscape within the 4 fields comprising the Project study area is predominantly considered Good/Excellent (81%) to Fair (17%) for general irrigation suitability, with slight to moderate limitations for irrigation due to wetness (imperfect drainage), restricted soil water movement (low hydraulic conductivity) and topography (sloping land associated with minor surface water drainage courses). There are 7 acres considered as Poor for irrigation, due to poor drainage (e.g., depressional areas). The soil-landscape is generally suited to irrigated potato production, with approximately 88% of the soils within fields proposed for irrigation considered Class 1 to 3 for land suitability for irrigated potato production. The primary limitation in these soils is imperfect internal drainage and moisture holding capacity. Approximately 12% of the soils are rated as Class 4 and 5 due to the occurrence of complex slopes, poor drainage, and texture, generally affecting the western edge of the Section as well as some limited depressional areas. The Class 4 and 5 soils are considered to have low desirability for irrigated potato production.

Several Project fields, or portions thereof, have been identified for future tile drainage (i.e., require separate drainage approvals) to improve risk management, and agronomic and environmental performance (e.g., better use of inputs). No tile drainage will proceed prior to appropriate Provincial approvals.

The irrigated land base is approximately 2 km from the proposed River pump site(s), with potential to utilize a pre-existing pump site and previously cleared trails down into the Assiniboine River valley. Given that fact and that there is minimal undisturbed natural habitat associated with the irrigated parcels, the Project is not anticipated to disturb rare and endangered plants and/or birds, mammals, amphibians, reptiles or invertebrates. To confirm this assumption contact has been made with the Manitoba Conservation Data Center, and steps to confirm site conditions would be undertaken in 2023 as may be required by the EAP review.

Contact was also made with the Historic Resources Branch to determine the potential for archaeological impacts of the intake and pipeline construction. The proponents will undertake a historic resources field reconnaissance requested by the Historic Resources Branch prior to any construction activity (e.g., spring, 2023).

The Assiniboine River is known to support commercial, recreational, aboriginal, and species at risk (i.e., SARA) with complex habitat. The impacts of the Project on fisheries are mitigated by the following considerations. The proposed withdrawals from the Assiniboine River will be made during the late spring (post freshet) (e.g., mid – June), when fish size could be in the 25 mm (fork length) range. The main irrigation period would be July and August at which point fish size could be in the 100 mm (fork length) range. Intake screens will be sized to prevent impingement on the screens and entrainment into the irrigation pumps. During full demand scenarios (2400 – 3000 USgpm) intake approach velocities would be limited to less than 0.085 m/s (i.e., @ 75 mm from the screen face). The rotating screen system, shallow installation with significant sweeping flow, in combination with the self-cleaning spray bars will serve to further prevent and protect against impingement. In all instances the water withdrawal will be subject to maintaining minimum in-stream flows as dictated in the pending Water Rights license and as enforced by Manitoba Environment, Climate and Parks.

The Assiniboine River is considered a navigable waterway. A submission to Transport Canada will be made by the Proponent in Spring, 2023 to obtain approval for the floating intakes (2) and connecting pipe to the pump stations. The application will follow prescribed notifications and mitigation as required by Transport Canada.

The Project is located over the outer limits of the Assiniboine Delta Aquifer. No water is to be withdrawn from the aquifer for this Project. There appears to some geologic aquitards immediately below a portion of the Project area in the form of clay layers, with a shallow and deep-water level separated by the aquitard.

A significant percent (62%) of the Project soil units is considered imperfectly or poorly drained due to the upper water table resulting from near-surface aquitards (i.e., clay deposits). The remaining percentage (38%) is considered well or rapidly drained, presumably by the proximity to the Assiniboine River Valley transition. Swansfleet Alliance is considering options to tile the imperfectly drained Project fields.

The Project activities, including water use, irrigation and other crop production activities are not expected to impact groundwater quality. Swansfleet Alliance will adopt Beneficial Management Practices aimed at protecting surface water resources. These BMPs will include nutrient management (e.g., 4R, fertigation) and potentially drainage water management.

The socio-economic effects of the Project are either positive or mitigable. Project construction will support local jobs during the construction phase, as well as help secure the financial viability of the Proponent. Given that the producers currently grow crops (e.g., potatoes, canola, wheat, corn, soybeans) in rotation on much of the identified land, it is anticipated that a small but non-significant increase in traffic will occur, in the immediate Project area relative to pre-Project conditions. In the wider area, potato production occurs on large scale in the RM of Norfolk Treherne. Traffic routes include Road 50N, PR 242, and PTH 2.

Potential adverse environmental impacts of the Project during construction and/or operation can be mitigated as follows:

- Employing an appropriate sediment and erosion control plan on all construction sites.
- Employing engineered solutions to maintain riparian zone/ riverbank and pipeline stability.
- Employing Beneficial Management Practices for growing of irrigated potatoes on the specific fields approved under licenses.
- Gearing any near water construction (e.g., intakes, stream crossings) to avoid timing windows specified by DFO.
- Adherence to minimum instream flows, anticipated to be included in the Environment Act licence, during project pumping. Responding to requests from Manitoba Environment, Climate and Parks to modify or curtail withdrawals.
- Comply with regulations respecting Storage and Handling of Gasoline and Associated Products.
- Consulting with Municipal officials on routing of potato trucks.
- Adhering to other Provincial regulations, Municipal by-laws and other permits and approvals, as appropriate.

The Project is not anticipated to result in a significant increase to greenhouse gas contributions (GHG), given that the farming activity is largely ongoing, and construction is short term in duration. The proposed pumping would require 300 – 350 HP (i.e., electric motors) utilized for approximately 500 – 600 hours per year. If economically feasible, renewable hydro-electric power will be employed for pumping (e.g., long-term goal). If this is not feasible, and/or over the short-term, the use of diesel power for pumping will result in an incremental increase in emissions. If diesel generators are utilized, they could result in an additional 100 Tonne of $C0_2$ per year. The Proponents have several options to offset these increases in GHG production.

Swansfleet Alliance is committed to sustainable agricultural crop production and to implementing steps to ensure that they are protecting the local environment during design, construction, operation, and repairs of the Project to expand their current production system to include irrigation for potato production. These include:

- Implement measures identified in the Environment Act License related to monitoring and environmental protection.
- Build into each construction contract environmental protection and worker safety measures.
- Establish standard operating procedures for implementation of recommended BMPs for irrigated potato production.
- Maintain equipment, environmental controls, and monitoring devices in good working order.
- Provide access to environmental monitoring data on request.
- Correct any noted deficiencies in a timely manner.
- Protect the environment against hazards (e.g., fuel spills).
- Promptly report significant environmental incidents to Manitoba Environment, Climate and Parks for guidance in finding appropriate remedies.

Amendments to this proposal and/or additional information will be issued upon further investigations and engineering feasibility determinations for water storage site(s), as required, as well as to document any additional field investigations that may be required, if requested.

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# 1.0 Introduction and Background

## ***1.1 Proponents***

Swansfleet Alliance  are producers of seed potatoes since 1976 (www.swansfleet.com/about). Swansfleet Alliance have an extensive background in irrigated potato production utilizing both surface and groundwater. Swansfleet Alliance is committed to working closely with their neighbours and landowners within the Project area. Swansfleet Alliance will be referred to as "Swansfeet" or "the Proponent" herein.

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## ***1.2 Project Overview***

The Project area is shown in Map 1 (Appendix A). The Project area is north of Treherne, Manitoba and includes land west of PR 242 towards the Assiniboine River. To secure production against the risk of drought, and to meet the quality requirements of their customer base, the Proponent needs to develop the capacity to irrigate as part of their potato production. The proposed water source for the Project is the Assiniboine River which is fed by a watershed of close to 160,000 $km^2$ at this location (WSC Station 05MJ005). Water will be pumped directly from the Assiniboine River during irrigation season to the irrigated fields. No water storage is envisioned.

Irrigation will be used to offset peak moisture deficits to potato production of 200 to 300 mm (8 to 12 inches). Moisture deficits have implications for potato size, yield, and quality. The Proponent plans to irrigate up to 219 ha (540 acres) of land each year within a section of land, utilizing four (4) quarter section pivots OR one (1) section pivot. The total current water requirement is 666 cubic decameters (i.e., 540 acre-feet) to irrigate 219 ha (540 acres). An application to Manitoba Environment, Climate and Parks for the pump site in NW 18-9-9 W1 on the Assiniboine River has been filed for Water Rights of up to 620 acre-feet (765 cubic decameters) (see Appendix C.1).

The Project will involve withdrawal of water from the Assiniboine River during late spring, summer, and early fall directly from available stream flow. A preferred intake location for the intake has been established at one of two existing river access sites in (NW-18-9-9 W). Water will be distributed to up to a 219 ha (540 ac) irrigable land base (see Map 2, Appendix A). No future expansion of this intake site / irrigated land base is envisioned at this time. Water distribution will be through buried pressure pipelines, pumping facilities, and moveable on farm irrigation systems.

The Proponent currently owns and operates irrigation projects nearby at Treherne and Holland, and there is extensive potato production by nearby producers using water from the Assinboine River. The Proponent has projects that service similar land types and production systems and have been successfully operated for decades. Swansfleet Alliance are experienced farming operators.

Swansfleet Alliance plan to make use of the most current irrigation technologies, including highly efficient, low pressure center pivot irrigation systems, as well as irrigation scheduling technologies, such as weather and soil moisture irrigation scheduling techniques. Precision control of inputs and intensive risk management are required to maintain profitable and sustainable production.

### *1.3 Previous Studies and Licenses*

The Proponent does not have previous water rights licenses on the Assiniboine River related to irrigation. Their closest irrigation projects utilize water from the Treherne / Rathwell Aquifer and the Cypress River.

Manitoba Environment, Climate and Parks have provided a review of the Assiniboine River water availability and will issue a Development Authorization Permit for up to 666 cubic decameters (540 acre-feet) of water to be withdrawn from the Assiniboine River during the period June to September (Appendix C.1 contains correspondence related to this permit).

Swansfleet Alliance is the primary proponent covered by one previous Environment Act Proposal filed by Central Manitoba Resource Management Ltd. and approved as EAL 2781 in 2007. That license is currently being reviewed internally for amendment/additions. That review is separate to this application.

### *1.4 Project Alternatives*

The selected water source for the Project is the Assiniboine River. Other available water sources in the area include groundwater, such as the Assiniboine Delta Aquifer, and the Treherne Aquifer and local runoff such as comes from the surface runoff and discharge from tile drainage systems installed on the Project land base. The Assiniboine Delta Aquifer at this location is either fully allocated or cannot support high-capacity wells, while the Treherne Aquifer is understood to be fully allocated and is some distance from the project site. Local runoff and tile drainage outflow are limited due to the small drainage area and is insufficient to support the proposed level of irrigation without a supplemental water supply. The most readily actionable water supply option was determined to be pumping from the Assiniboine River.

# 2.0 Regulatory Submissions and Approval Status

## *2.1 Local Permits*

### *2.1.1 RM of Treherne Norfolk*

The Proponent has notified the RM of Treherne Norfolk of their intentions to build a pipeline network that will need to cross Road 50N and 53W (see Appendix B), including request for resolution or agreements that may be required. Follow up is required.

### *2.1.2 Building Permits*

Building permits will be sought as required by Municipal bylaws for any permanent buildings (e.g., pumphouses).

## *2.2 Provincial Permits*

### *2.2.1 Provincial Water Rights License Applications*

The Proponent has applied for Water Rights through the Manitoba Environment, Climate and Parks of up to 765 cubic decameters (620 acre-feet). The province maintains records of all Water Rights applications. The Proponent has not yet been issued a Development Authorization Permit (Appendix C (C.1); email T. Butterfield April 25, 2022).

### *2.2.2 Manitoba Infrastructure Permits*

No permits from Manitoba Infrastructure are required for the Project.

### *2.2.3 Provincial Environment Act License Applications*

*The Environment Act* outlines the environmental assessment and licensing process for developments in Manitoba that may have potential for significant effects on the environment. Under the Classes of Development Regulation (M.R. 164/88), the Project is considered a Class 2 development as it proposes to withdraw more than 200 cubic decameters of water. The Project requires a valid and subsisting Environment Act Licence from Manitoba Environment, Climate and Parks – Environmental Approvals Branch. This report forms the basis of the application. A cover letter, Environment Act Proposal Form, and application fee have been submitted separately to satisfy the requirements of a complete Environment Act Proposal (EAP).

### *2.2.4 The Water Protection Act*

The Nutrient Management Regulation (M.R. 62/2008) under *The Water Protection Act* is pertinent to nutrient management requirements for the Project. The regulations stipulate residual soil nitrogen limits according to nutrient management zones (N1-N5) and limit phosphorus applications based on residual concentrations, which necessitate nutrient management planning and other management practices be employed in growing a crop. The Act also defines the nutrient buffer zones around surface and groundwater features. The buffer applies to any surface water body (e.g., lake, river, creek, drains [Order 3, 4, 5], major wetlands) within or adjacent to fields receiving nitrogen or phosphorus. The Proponent is responsible to adhere to this regulation as part of their operations.

Discussion on hydrogeology and surface hydrology of the irrigated land base is provided in Sections 4.1 and 5.1. In addition, a discussion on nutrient management is provided in Sections 4.1 and 5.1 and Appendix F.

### 2.2.5 The Heritage Resources Act

A heritage site refers to a location that is protected under the provisions of *The Heritage Resources Act*, due to its known archaeological significance. In addition, human remains discovered outside formal burial grounds are protected by the Act. The Act prescribes the processes to be followed by the Proponents and Authorities.

Correspondence with the Historic Resources Branch is included in Appendix C (C.2). The Historic Resources Branch response is provided in Appendix C (C.2) along with Fact Sheets, flow chart and protocols. The Historic Resources Branch have requested a ground survey of the area. Swansfleet received a proposal for a Heritage Resource Impact Assessment (HRIA). The HRIA has yet to be scheduled.

### 2.2.6 Provincial Drainage Permits

Separate application may be made to Manitoba Environment, Climate and Parks for tile drainage permit(s) to allow for improved drainage of the irrigated fields in Section 8-9-9 W1 (imperfectly drained soils).

## 2.3 Federal Regulations

### 2.3.1 Federal Department of Fisheries and Oceans Authorization

The Federal *Fisheries Act* was last amended in August 2019 (available at: https://www.dfo-mpo.gc.ca/campaign-campagne/fisheries-act-loi-sur-les-peches/index-eng.html ). Under the Fisheries Act, harmful alteration, disruption or destruction (HADD) is prohibited and impacting fish and fish habitat is only allowed following an authorization.

If, after a project review, it is determined that a project will cause serious harm to fish that ***are part of or that support a commercial, recreational, or Aboriginal fishery***, the proponent can apply for an Authorization (Paragraph 35(2)(*b*) *Fisheries Act* Authorization from the Minister of Fisheries and Oceans).

Follow up to this Environment Act Proposal will include further consultation with Department of Fisheries. It is proposed to hire a Professional Biologist for the following purpose:

1. Review of the intake area for presence of and need for mitigation related to Mapleleaf Mussels.
2. Review of proposed intake development plan and associated erosion control and re-vegetation measures.
3. Review of the intake selection including operations and submitted intake attributes related to impingement (e.g., velocity, screen cleaning) and entrainment (e.g., screen mesh size).

4. Review current Federal law regarding protection of fish habitat with respect to the water withdrawals, sediment control, and intake development and operation.

Swansfleet has received a proposal from a Professional Biologist to guide the assessment of Fisheries impacts and mitigative strategies to be employed by the proponent to be compliant with Federal Regulations. This work would precede final intake site selection and design and may occur in Summer, 2023. A bathymetry survey of the Assiniboine River at the site would also potentially be completed at that time.

#### *2.3.2 Canadian Navigable Waters Act (CNWA)*

In 2019, the *Navigation Protection Act* was amended and renamed the *Canadian Navigable Waters Act* to better reflect its purpose. Changes in the Act were aimed at strengthening environmental protection, as well as protecting waters on which the public has the right to travel (navigable waters).

Under the *Canadian Navigable Waters Act* (CNWA), owners of works who propose to construct, place, alter, rebuild, remove or decommission works that are in, on, over, under, through or across any navigable water may be required to apply for an approval to Transport Canada (TC), or seek authorization through the public resolution process.

The CNWA, regarding navigable waterways, was reviewed with respect to the intake design.

> *For the purposes of the CNWA, "likely to substantially interfere with navigation" means that the work will, for example, significantly change the way vessels pass down a navigable waterway or may make passage dangerous to the public.*

***The Assiniboine River is listed in the schedule of waters under the revised Canadian Navigable Waters Act (circa 2019).*** The list of scheduled waters is provided on the Transport Canada web site (available at: https://laws.justice.gc.ca/eng/acts/N-22/page-7.html#docCont)

A project review tool (linked below) was utilized to determine what the application requirements are.

https://npp-submissions-demandes-ppn.tc.canada.ca/projectreview-outildexamenduprojet

The project review tool indicated the following:

> *You have indicated that your work may interfere with navigation, and that it is either located on a scheduled waterway or considered a major work. Under the CNWA, you are required to submit an Application for Approval to the NPP, in order for the program to review and approve your work.*

The permit process includes a 30-day public posting period and may take up to 90 days to be issued. No work can proceed until the letter of exemption is issued or the permit is in place.

The proponent will apply for Approval as soon as the engineering details are confirmed (e.g., intakes and pumps) but prior to any construction/ implementation / operation. This is currently scheduled for spring 2023.

#### *2.3.3 Migratory Birds Convention Act*

Disturbance or destruction of migratory bird nests or eggs is prohibited pursuant to this Act. Any construction will need to take this Act into consideration.

#### *2.3.4 Species at Risk Act*

The *Species at Risk Act* (SARA) is intended to prevent human activity from impacting species of special concern, to prevent them from becoming endangered or threatening their extinction. The Manitoba Conservation Data Center was informed of the Project and asked for an opinion on the potential for Species at Risk at areas of anticipated disturbances to the existing environment, namely resulting from construction of the intake, pumpstation and pipeline network (see Map 3). Copy of the correspondence is included in Appendix C (C.3).

The proposed review by the Professional Biologist will also address this issue as it relates to Aquatic species at risk.

### *2.4 Other Permits and Considerations*

#### *2.4.1 Water, Gas and Oil Pipelines*

There are no known gas or oil pipelines to cross.

There are other irrigation water pipeline networks close to the Project area including one owned by Haskett Growers. The RM of Treherne Norfolk will be queried with respect to water lines within the Project area.

Intake and pipeline design and construction will take all existing infrastructure crossings into account. All in ground construction will be cleared through Manitoba Click before you Dig process, including MTS, Manitoba Hydro, RM of Treherne Norfolk and Haskett Growers.

#### *2.4.2 Local Conservation Groups*

A request will be made to the Central Assiniboine Watershed District to identify any Watershed level issues that may apply to the project.

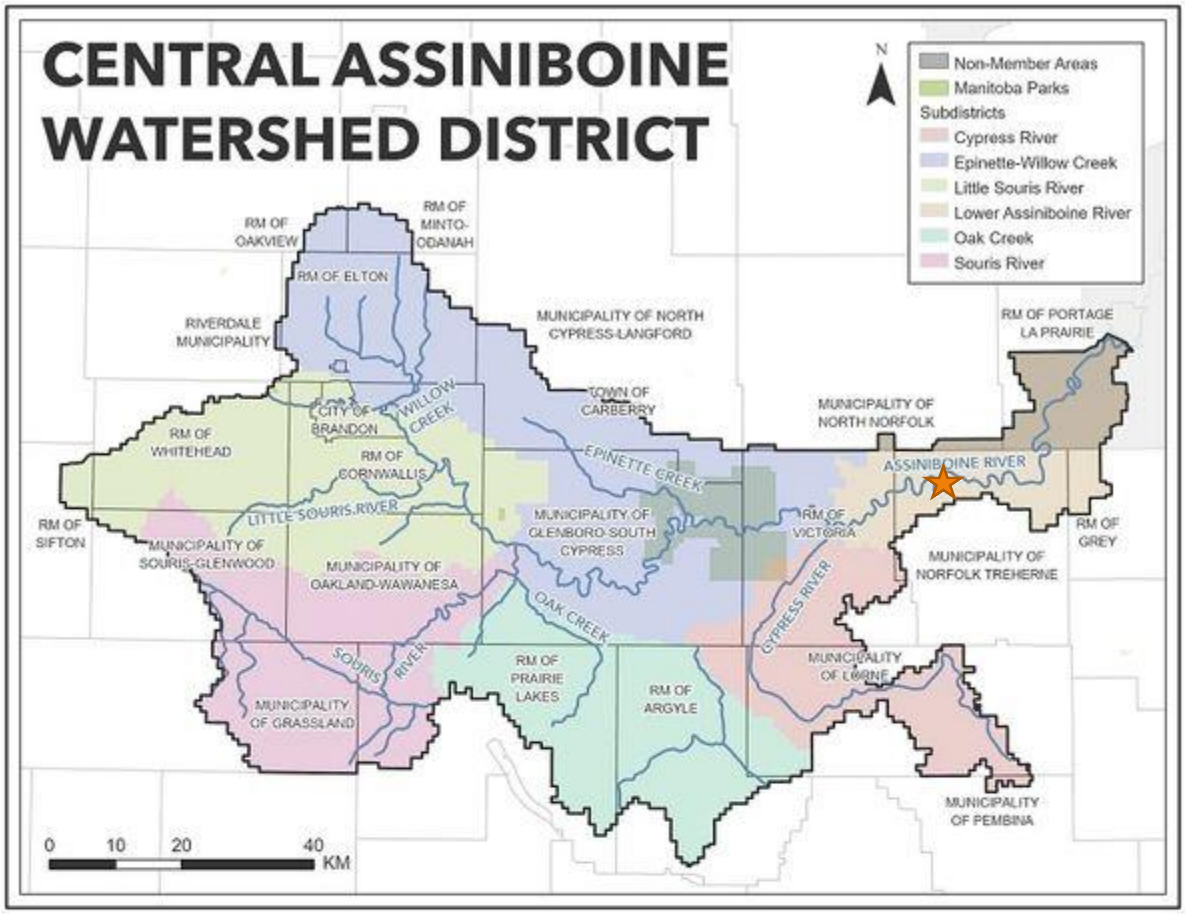



*Figure 1 - Central Assiniboine Watershed District Map - Project Site Noted* ★

### *2.5 Public Consultations and Submissions*

Information and informal presentations on the Swansfleet Alliance irrigation project will be provided upon request to the RM of Treherne Norfolk. A copy of the pertinent information (this report) can be made available at the RM office for local government and public review if required.

The Transport Canada application (Nav Waters) includes a public consultation process.

Neighbours will be actively and directly consulted by the Proponent; to allay concerns and/or address potential impacts and mitigative measures.

PBS Water Engineering Ltd. is responsible for filing this EAP on behalf of the Proponent. AgriEarth Consulting Ltd. has been given responsibility for assessing and recommending the land suitability for irrigation. Any licenses will be issued in the name of Swansfleet Alliance who will have sole responsibility to meet license conditions.

## 3.0 Description of Proposed Development

### 3.1 Project Summary

The Project will divert up to 666 cubic decameters of water (540 acre-feet) through appropriate intakes located in NW 18-9-9 W1. Water will be piped in a common underground pipeline to the 4 identified quarter sections in Section 8-9-9 W1. This allocation will provide sufficient water to irrigate up to 219 ha (540 acres) annually.

Map 3 (Appendix A) shows the currently proposed land base to be irrigated in 8-9-9W1, and the optional location of the intakes and pipeline routes under consideration. Starting in 2023 up to 4 modern sprinkler irrigation systems (e.g., center pivots) will be operated.

Power sources will be electric and/or diesel power. Hydro electric power is preferred.

The system will be managed by the Proponent, Swansfleet Alliance.

### 3.2 Project Area

The Project area is highlighted in Map 1 (Appendix A), located north of Treherne, Manitoba within the Central Assiniboine River watershed along the top of the Assiniboine River valley. The Project area is currently limited to the RM of Treherne Norfolk. The Project area is located within Stockton Eco District portion of the Manitoba Plain Ecoregion.

### 3.3 Land Base and Irrigation System Components

The land base to be irrigated is described in Table 1 and shown in Map 2 (Appendix A). The Project irrigation system infrastructure components are illustrated in relation to the land base in Map 3 (Appendix A). Those components include, irrigated land base, water delivery system, water diversion, and power supply. The following sections describe the proposed development components and reference the additional development information as required in the Environmental Act Proposal Guidelines.

***Table 1: Project Field Number, Land Parcel Description and Acres (Irrigated)***

| Legal Land Location | Field ID | Acres | Hectares |
|---|---|---|---|
| NW 8-9-9 W1 | 1 | 135 | 54.7 |
| SW 8-9-9 W1 | 2 | 135 | 54.7 |
| NE 8-9-9 W1 | 3 | 135 | 54.7 |
| SE 8-9-9 W1 | 4 | 135 | 54.7 |
| **Irrigated Area Totals** | | **540** | **219** |
| | | | |

### *3.3.1 Irrigation Systems*

Each of the quarter sections or portions of will be irrigated using an on-farm irrigation system, including but not necessarily limited to low pressure center pivot irrigation systems c/w end guns.

Each individual irrigation system is considered an irrigation parcel. There are 4 irrigation parcels (Table 1; Map 2, Appendix A) encompassing 219 ha (540 acres).

A single Section pivot may be employed in lieu of 4 individual quarter Section pivots. The irrigated acreage for this option is similar in magnitude to that of 4 individual pivots.

The maximum current farm irrigation will be 219 ha (540 acres) per year, at an average duty of 200 mm (8 inches) and a maximum duty of 300 mm (12 inches), for a total average demand of 444 decameters (360 acre-feet) and a peak demand of 666 decameters (540 acre-feet).

### *3.3.2 Pipeline Systems*

Water will be delivered to each irrigation parcel by means of pressurized pipeline. The preliminary pipeline routes are shown in Map 3 (Appendix A); subject to change associated with final intake and field locations, and land access. The pipeline system will be constructed of pressure rated PVC pipe, shallow buried using chain trenchers and backhoes. Turnouts to pipeline laterals and to irrigation parcels will consist of galvanized steel pipe fittings. Wet creek crossings and paved roads will be directionally bored. Dry waterway crossings and non gravelled or less travelled RM roads will be open cut where feasible and acceptable. All road crossings will be provided with encasement pipes to safely convey any leakage to the road ditches and ensure public safety (e.g., prevent sinkholes). Provincial Drain crossings will be accomplished by directional boring using fused HDPE pipe.

### *3.3.3 Water Storage*

No constructed water storage is planned.

### *3.3.4 Tile Drainage and Controlled Drainage*

The Project contains imperfectly drained soils which may respond well to sub-surface tile drainage. The purpose of tile drainage would be improved access in spring for planting and fall for harvest and reduced drown-out of plant roots.

Controlled Drainage could be considered for any tile drainage of imperfectly drained fields to improved planting conditions and conserve spring rainfalls after seeding to reduce irrigation demand (see Fact Sheet, Appendix H). Theoretically, approximately 25 mm (1 inch) or 55 decameters (45 acre-feet) of water could be saved using Controlled Drainage resulting in a reduced demand from the Assiniboine River. Controlled Drainage can also help with re-cycling of leached nutrients held in the shallow groundwater. Controlled Drainage may best benefit the lower value crops through reduction of pumping and fertilizer costs. This recognizes the higher degree of protection required for high value potato crops.

#### *3.3.5 River Intake and Pumping Systems*

Water will be withdrawn from the Assiniboine River utilizing floating intake systems attached to mobile centrifugal pumps.

The intakes are planned to be RiverScreen$^{TM}$ (2 total) per Figure 2. Features of the RiverScreen$^{TM}$ include:

1. Extract water from the top of the column, allowing for maximum sweeping velocity.
2. Screen mesh (8 gauge; 2.5 mm opening) designed to prevent entrainment of small fish fry.
3. Self cleaning spray bars to prevent clogging and localized intake velocities.
4. Rotating screen to allow impinged fish fry to be washed back to stream.
5. Light weight and non-contact on riverbed.


*Figure 2 – RiverScreen$^{TM}$ Intake - Self Cleaning, Rotating, Shallow Water*

The River pumping system will be two (or one) river pumps moving approximately 151 to 189 l/s (2400 to 3000 USGPM) or 1200 to 1500 USGPM per RiverScreen$^{TM}$. Consideration to a Tandem RiverScreen$^{TM}$ will be made during final engineering assessment (e.g., as option to 2 screen system).

The Booster Station pumping system will be two (or one) booster pump used to repressurize water to reach the upland elevation and meet the center pivot system pressure requirement.

Power supply to the Pump sites will be either Hydro-Electric OR diesel. Diesel fuel and / or electrical power drop would be located at the top of the Riverbank, above anticipated high-water level, as well as at the Booster Station. In the case of the diesel fuel, secondary spill containment and anti-syphon fuel lines would be employed to prevent spill. Also fuel tank would be remotely monitored to allow for early leak detection allowing containment. Swansfleet is actively pursuing a hydro-electric power option with Manitoba Hydro. If diesel generators are utilized, noise suppression enclosures will be considered.

### 3.4 Land Use and Access

Table 1 and Map 2 (Appendix A) provide a summary of the field locations and field areas for the fields proposed for irrigation.

#### 3.4.1 Certificates of Title and Mineral Rights

Certificates of Title for the land base will be compiled to document land ownership and forwarded separately ***if requested***. Swansfleet Alliance has ownership of all fields identified in Table 1 and Map 2 (Appendix A) as identified for irrigation. Swansfleet Alliance will secure easement for the water intake to the Assiniboine River AND the pipeline route across Section 18-9-9 W1. Mineral rights will be reported ***if required***, as they are not impacted by the Project.

#### 3.4.2 Existing Land Use

The immediate access to the Assiniboine River has been previously cleared and graded by others. Two optional locations are under consideration. Enhancements to the selected access site will include improving erosion control and providing a stabilized pumping pad (e.g., utilizing rock/ geo-matt/ concrete), at approximately 3 m above the minimum river water level. Design is ongoing and will be reviewed by the Professional Biologist to be sub-consulted.

Water delivery system (pipelines; Map 3 Appendix A) will not be crossing any significant water ways and will be routed to utilize existing trails from upland to lower benches. Where required these trails will be widened slightly, graded, and protected against surface water erosion.

The fields proposed for irrigation are all currently under annual, dryland agricultural crop production land use. The existing farmyard (Map 2, Appendix A) and the limited bush evident in air photos and land cover mapping (Map 2, Map 4, Appendix A) have previously been cleared for agricultural production (e.g., prior to project proposal). Portions of all 4 fields (62% in total) are under consideration for tile drainage improvements in the future (Map 5, Appendix A).

#### 3.4.3 Land Use Alterations

The Project does not propose to change the existing cultivated land base other than to provide irrigation to some proportion of the land depending on the irrigation system. The land was previously cleared for cultivation and the pre-existing residence was removed. The riparian zone associated the Assiniboine River valley will be maintained and only minimally modified to allow for access to site and installation of the buried pipeline system. Some overgrowth will be removed from existing trails and river access. The preferred intake locations are both already established trails to the river's edge. The preferred pipeline route(s) make use of existing trails through the bush on the valley walls between the lower bench and upper bench and the upper bench and the upland portions of the valley.

Figures 3 – 9 provide plan view and photos of alternative intake sites and pipeline routes (see Map 3 in Appendix A for overall route). The routes were selected to minimize impact on land use. While the routes will be disturbed during pipeline construction, they will be re-graded and re-vegetated to ensure limited opportunity for erosion and slope failure and to limit impact on adjacent forest habitat.

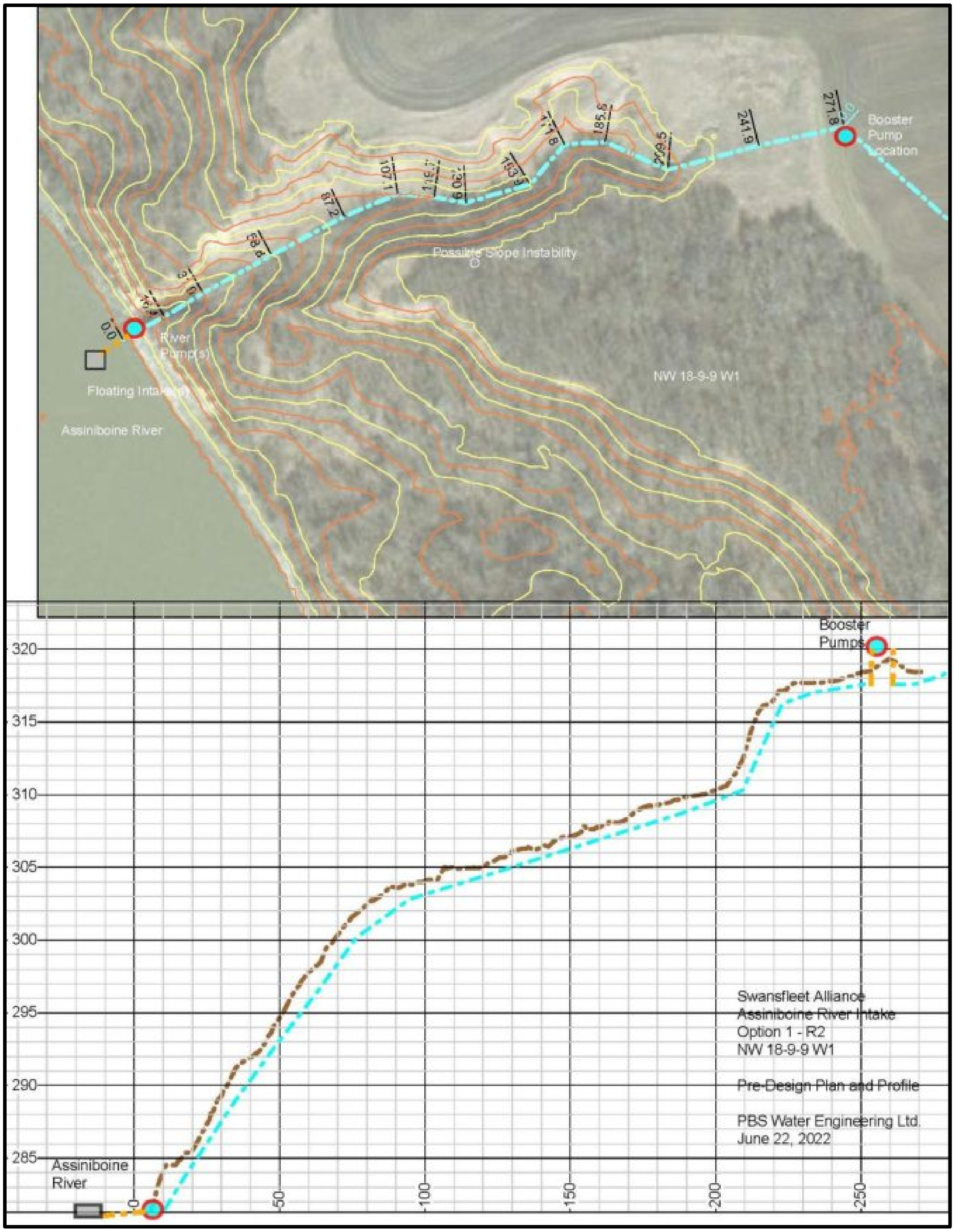



*Figure 3 - Swansfleet - Assiniboine River Intake Site - Option 1 - Plan and Profile*




*Figure 4 - Photos of Option 1 Intake and Access Trail – May, 2022*

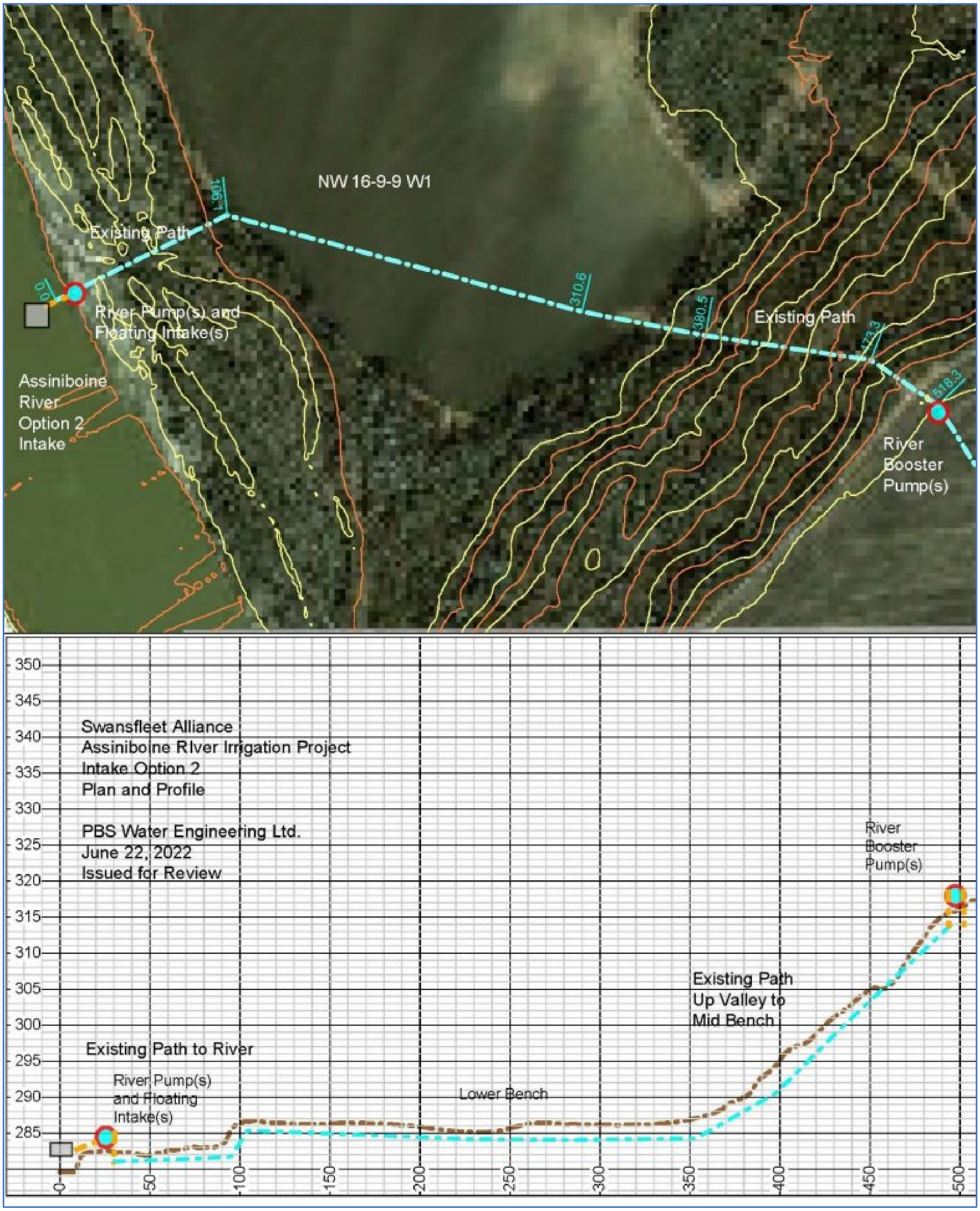



*Figure 5 – Swansfleet – Assiniboine River Intake Site – Option 2 - Plan and Profile*




***Figure 6 – Photos of Option 2 – Intake and Access (Lower Bench and Flood Plain) – May, 2022***




*Figure 7 - Photos of Option 2 - Pipeline Route - Trail from Lower Bench to Upper Bench - May, 2022*

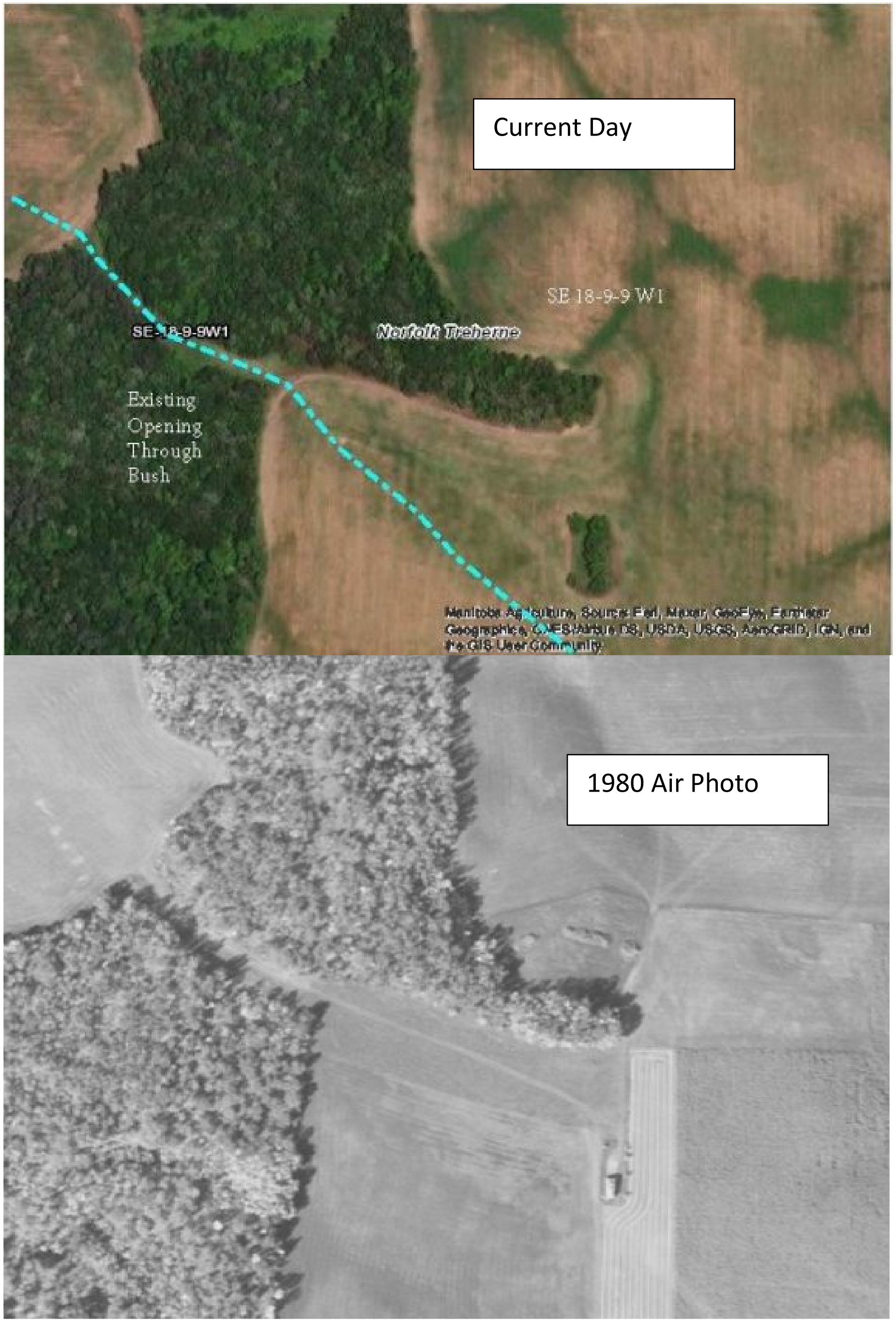



*Figure 8 - Existing Trail for Main Pipeline from Upper Bench to Upland - W 18-9-9 W1*

*Figure 9 - Looking from Upper Bench to Start of Existing Trail to Upland (see Figure 7) - W 18-9-9 W1*

### 3.5 Development Schedule / Phases

The following describes the currently proposed development schedules associated with the major components of the work.

#### 3.5.1 Irrigation Systems

Irrigation systems will be purchased in 2023 for implementation in 2024. The project will be fully developed by 2024 or 2025. It is intended that permanently cropped land will be irrigated on this section, although corners may have rotation dryland crops or permanent cover.

#### 3.5.2 Water Delivery Systems

The pipeline delivery systems will start construction in the fall of 2023 and should be completed in 2023 excepting laterals to fields where irrigation pivots are scheduled for 2025.

#### 3.5.3 Water Storage Systems

No water storage is proposed.

#### 3.5.4 Water Intake/Pumping Systems

Water intake and pumping systems will be procured in Spring/Summar 2023, for installation in Fall 2023 and operation in 2024.

#### *3.5.5 Engineering*

PBS Water Engineering Ltd. has completed feasibility and pre-design with assistance from ProFessional Resources Assessment (PFRA) Ltd. (Hydrogeology). Plans for 2023 include river and route surveys, Heritage Resource field survey and Biologist review of fishery habitat protection.

Signed and stamped engineering plans will be submitted if/as they become available to appropriate agencies requiring approvals, including Transport Canada.

PBS Water Engineering Ltd. will coordinate the required final engineering investigations, reports, and designs. PBS Water Engineering Ltd. and partners will assist the owners through the construction and commissioning phases at their request.

### *3.6 <u>Operation Phase</u>*

Operation of the Project will commence with irrigation a minimum of two fields in spring, 2024. The project will be fully functional by spring, 2025. This plan is subject to change pending material supply and regulatory planning. IF a section pivot is utilized it will be implemented in spring, 2024.

### *3.7 <u>Repair, Renewal, Decommissioning Phase</u>*

The Project is designed to be sustainable over the long term. The life expectancy of the components is as follows:

Pumps – 20 years

Electrical (Hydro) - 30 years

Pipelines - 50 years (PVC); 25 years (steel fittings)

Irrigation systems - 25 years (aluminum)

Tile drainage – 50 years (HDPE)

The Project components will be maintained to ensure maximum life expectancy, and as required will be replaced. Where possible (e.g., steel, aluminum) parts will be recycled. PVC pipeline will be abandoned in place and replaced with new pipe.

## 4.0 Environmental Settings

### *4.1 Physical Environment*

The Project is in the Central Assiniboine River Watershed north of Treherne and west of PR242 on the southeast side of the Assiniboine River.

Map 1 (Appendix A) shows the Assiniboine River and its location in the Stockton Eco District, the Aspen Parkland Ecoregion and the Prairie Ecozone. The Assiniboine River carries surface water (snowmelt, rainfall runoff, groundwater springs) from Eastern Saskatchewan and Western Manitoba and joins the Red River within the City of Winnipeg.

Figure 10 shows the location of the Project intake and pipeline in relation to the contributing watersheds of the Assiniboine, Qu'Appelle and Souris Rivers.

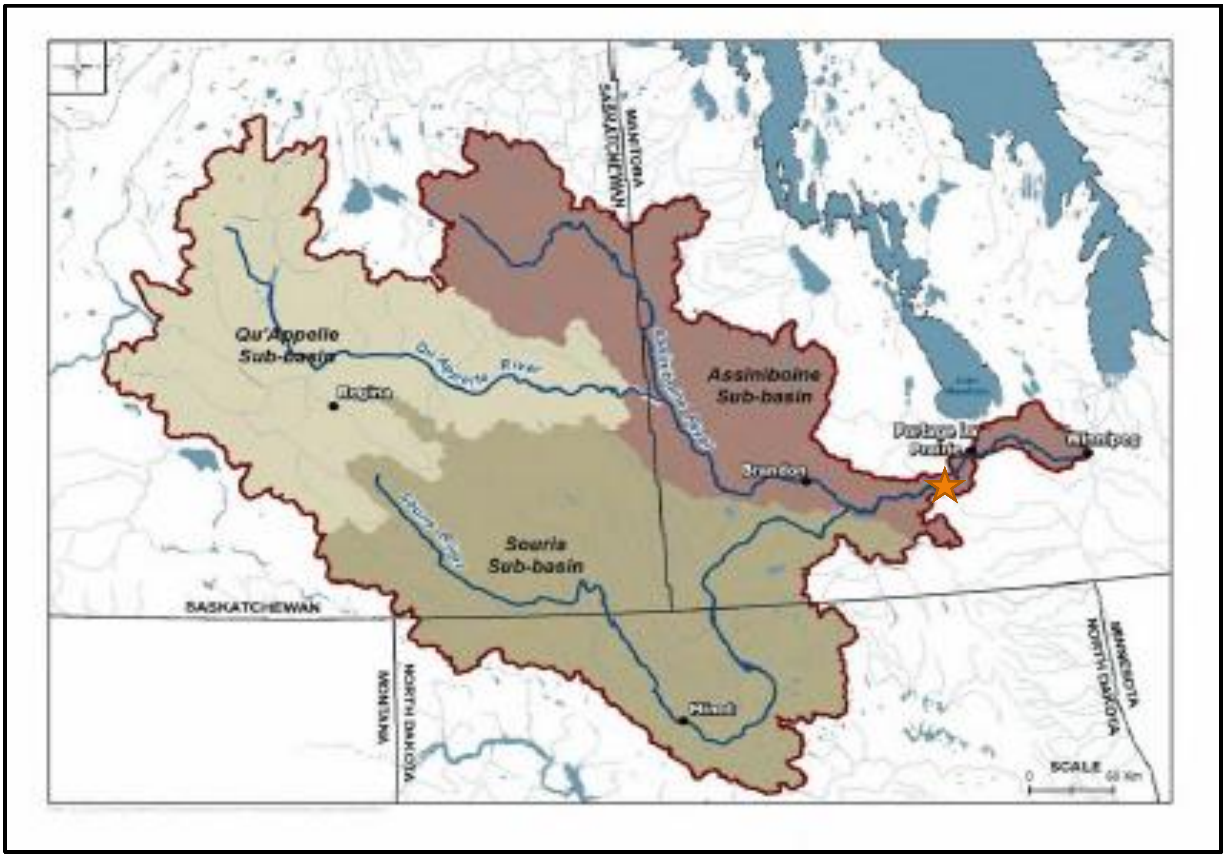



*Figure 10 - Assiniboine River Watershed in Relation to Project Intake Site(s)* ★

#### *4.1.1 Terrain, Soils and Landscape*

The Project area is contained within Upper Assiniboine Delta physiographic sub-section of the Assiniboine River Plain section within the Saskatchewan Plain (i.e., Section E9.5) (Michalyna et al., 1982; Podolsky, 1991). The Saskatchewan Plain represents the next to lowest level plain on the Prairies. It is underlain by bedrock and covered by glacial till and lacustrine clays and silts deposited in Lake Agassiz (Smith et al., 1998). The project site (Section 8-9-9 W1) is the furthest easterly edge of the Assiniboine Delta Aquifer. Figure 11 depicts these map units in relation to the Red River Plain to the east.

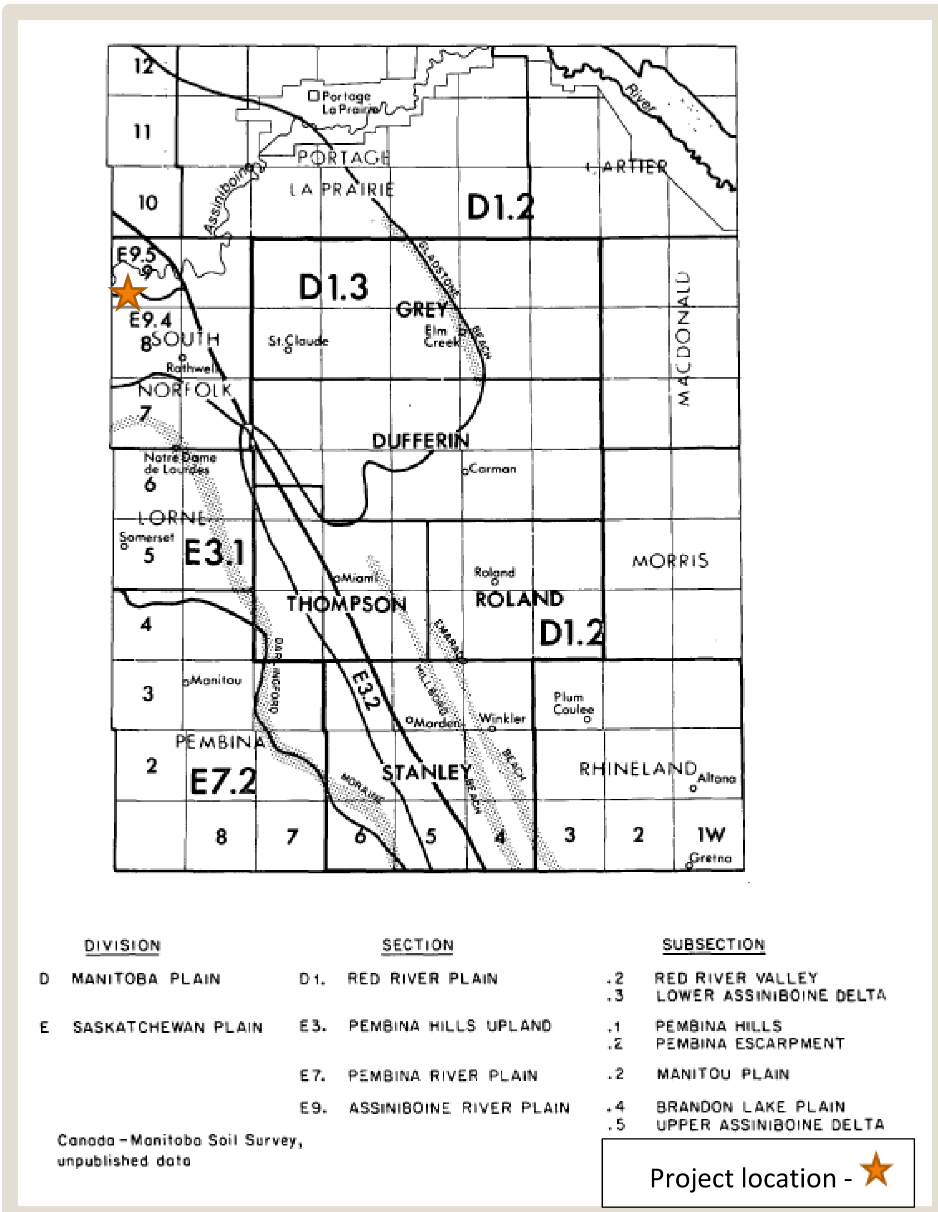



***Figure 11 - Physiographic Map of the Project Area (Michylana et al., 1982) and the Project Site in 8-9-9 W1 and 18-9-9 W1.***

Michalyna et al. (1982) describe the soils, landscape, and terrain of the Project area.

> *The Upper Assiniboine Delta which occurs between 305 and 396 masl is characterized by level to undulating sandy deltaic and loamy lacustrine sediments associated with Lake Agassiz. A considerable area of the sandy deposits to the south of the Assiniboine River have been modified to varying degree by wind action.*

The terrain, landscape and soils are major factors in the feasibility of the proposed Project. The major challenges to crop production are maintaining adequate surface and subsurface drainage and prevention of wind and water erosion. The soils in the study area are considered suitable for irrigation (Michalyna et al., 1982); with the main limitation being lower water holding capacity, restricted deep percolation and high-water table. Additional information on irrigation suitability and suitability for irrigated potato production, including mapping and evaluation of detailed suitability ratings, is provided in Sections 4.1.7 and 4.1.8.

The topography of the irrigated parcel (8-9-9W) is level (central, east) to very gently sloping (west, southwest). Surface runoff is slow, as is internal drainage due to restricted deep percolation. The soil parent material overlying the deep bedrock at this location is characteristic of alluvial and lacustrine sediments associated with glacial Lake Agassiz. The surficial soils are dominantly moderately coarse (sandy lacustrine). Soils within the study area range from well to imperfectly drained, mainly a function of topography and depth to restrictive clay layers. Figure 12 is a representation of the soil series of the Almassippi Association in a cross-section perpendicular to the Manitoba Escarpment (Michalyna et al., 1982). This is reasonably representative of Section 8-8-9 W1, which also has inclusions of other non-Almassippi soils (e.g., Dobin and Firdale).

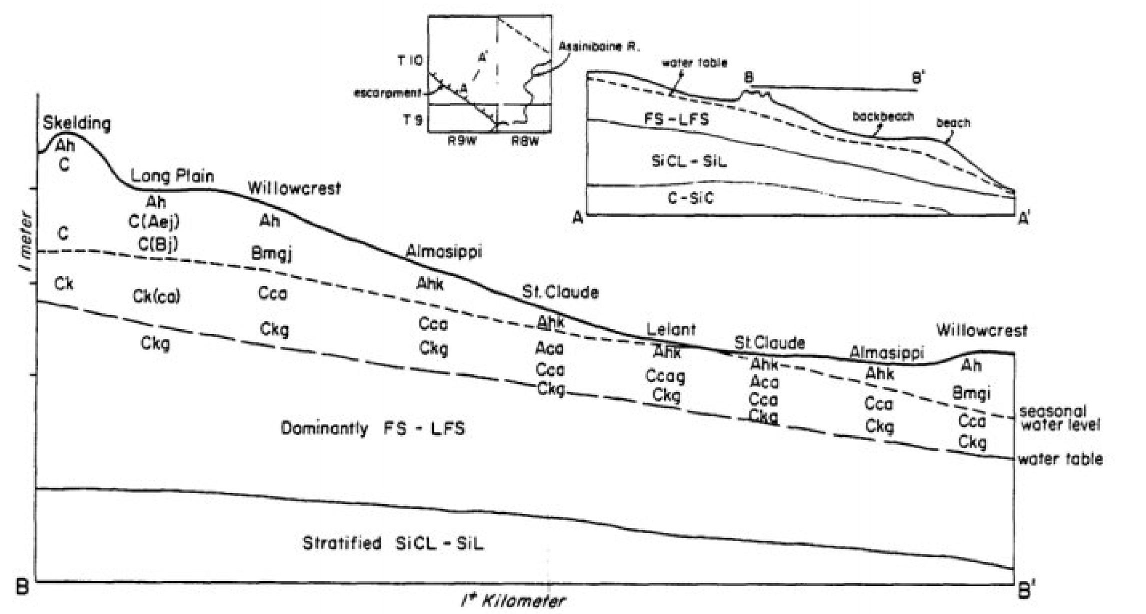



***Figure 12 – Typical Landscape of Almassippi Association Soils (Michalyna et al., 1982)***

Within the study area (Map 1; Appendix A) the significant surface feature is the Assiniboine River Valley. The Valley is incised into the deltaic materials and potentially the underlying till and bedrock. Surface drainage is controlled by the Assiniboine River Valley; ravines along the length of the valley convey surface water and groundwater (springs) from upland to the Assiniboine River. Within the irrigated parcel, water flows to the north via a ravine and east to PR 242 road ditch. Surface runoff on the irrigated parcel is limited due to topography and higher infiltration rates but can be exacerbated by periodic high water tables. Tile drainage would further limit surface runoff by creating storage through lowering of seasonal perched water tables.

Below the surficial soils in Section 8-9-9 W1 the stratigraphy is varies from surface sands, to underlying lacustrine clays, glacial till and bedrock. Section 4.1.2 describes the geologic profile in more detail.

The Assiniboine Delta Aquifer is a major surficial aquifer that extends into the project area. The footprint of the Assiniboine Delta Aquifer is outlined in Appendix A Map 1, and the aquifer is further described in Sections 4.1.2 and 4.1.3.

The suitability of the soils and landscape for high value agriculture has led to the predominance of annual agricultural crop production in current land use in the Project study area. Land use/ land cover is discussed in more detail in Section 4.1.6.

#### *4.1.2 Geology of the Project Area*

Michalyna et al. (1982) describes the bedrock geology of the area above the Manitoba Escarpment as follows.

> … the underlying bedrock in the west Portage and MacGregor areas consists dominantly of shales and sandstone of the Cretaceous Period and includes the following formations: Swan River, Ashville, Favel and Vermillion River. These bedrock formations underlie the surficial deposits at considerable depths ranging from 180 m in the escarpment area near Sidney and Jackson Lake, to 60 m towards the northeastern portion of the map area.
>
> The nature of the unconsolidated deposits overlying the Cretaceous bedrock have been strongly influenced by glaciation and deglaciation. ***The sequence of deposits over the bedrock consists of grayish, strongly calca-reous till, variable strata of sand and gravels, clays with silts, and sands with silts.***

PFRA Ltd. (John Oosterveen, P.Eng.) was engaged to review the Project geology as it relates to the irrigation parcel and the proposed pipeline route and intake location. The following are excerpts from their report.

> *Bedrock underlying 8-9-9W1 is dark grey and black calcareous shale of the Cretaceous Age Ashville Formation. According to a bedrock topography map (Figure 5, Groundwater Availability, Brandon Area, 1976) the shale surface occurs at about elevation 900 fasl (275 masl) beneath Section 8-9-9W1 and rises slightly to maybe 915 fasl (278 masl) beneath the proposed river intake site in NW18-9-9W1 on the south side of the Assiniboine River (see Figure 3-6). This indicates the overlying sediments are approximately 200 feet thick below upland level and could be exposed in the Assiniboine River bottom.*
>
> *Overlying the shale bedrock is a layer of stony clay glacial till approximately 20 to 25 feet thick. The glacial till is in turn overlain by a thick section (about 180 feet) of lacustrine clays associated with deep water deposition in Glacial Lake Agassiz. The surficial sediments are comprised by 20 feet of silty sand associated with shallower water deposition associated with late stages of Lake Agassiz. According to soils maps/reports for the area (Michalyna et al. (1982)) the surficial soils in Section 8-9-9 W1 are formed primarily of sandy lacustrine sediments (Map 5, Appendix A). However, in the NE 8-9-9 W1, surficial soils may be finer textured (e.g., clayey), represented by Firdale soils (20% sand) and to a lesser extend Dobbin and Halstead soils (~65% sand).*
>
> *GWDRill records were reviewed, based on record locations shown in Figure 13.*

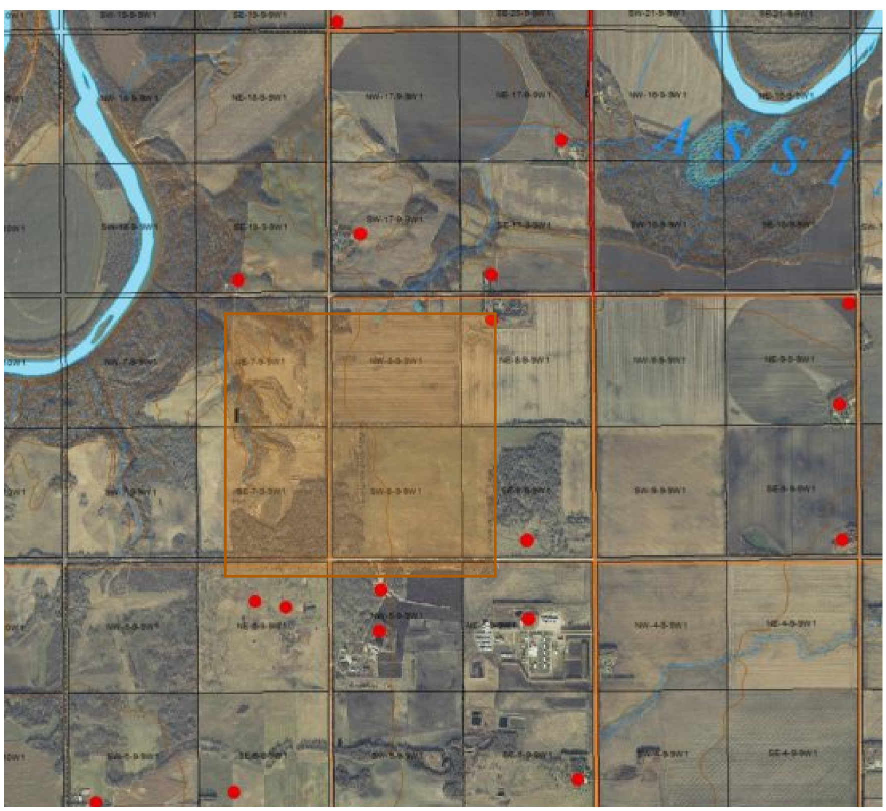


***Figure 13 - GWDrill Record Locations in Vicinity of Project Site***

*A GWDRILL Well Record in NE8-9-9W1 (Figure 14) shows sandy clay to 19 feet followed by silty clay to 202 feet, sandy till to 225 feet and shale to end of hole at 232 feet. This GWDrill log confirms the overall geological sequence and a bedrock depth at about 60+ m (200 + feet). A preliminary Geological cross-section along the proposed pipeline route (i.e., Option2 route) shown in Figure 15 illustrates the geology in the Project area.*

```
Location:  NE-8-9-9W

Well_PID:           33007
Owner:          D NESBITT
Driller:        LENARD DRILLING
Well Name:
Well Use:       TEST WELL
Water Use:
UTMX:       525316.1110
UTMY:       5509236.21
Accuracy XY:        UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1978 Feb 14

WELL LOG

  From   To        Log
  (ft.)  (ft.)
      0   15.0    BROWN SANDY CLAY
   15.0   19.0    BROWN SILTY SANDY CLAY
   19.0  202.9    GREY CLAY SILTY
  202.9  225.9    TILL, LIGHT GREY, SANDY
  225.9  231.8    SHALE, DARK GREY

No construction data for this well.

Top of Casing: 0 ft. below ground

No pump test data for this well.
```

***Figure 14 - GWDrill Record NE 8-9-9 W Illustrating Geology to Bedrock***

The geology of the proposed irrigation site and the intake (Assiniboine River) and pipeline route for the Project study area will be documented in the pre-design / feasibility studies being completed by PBS Water Engineering Ltd.

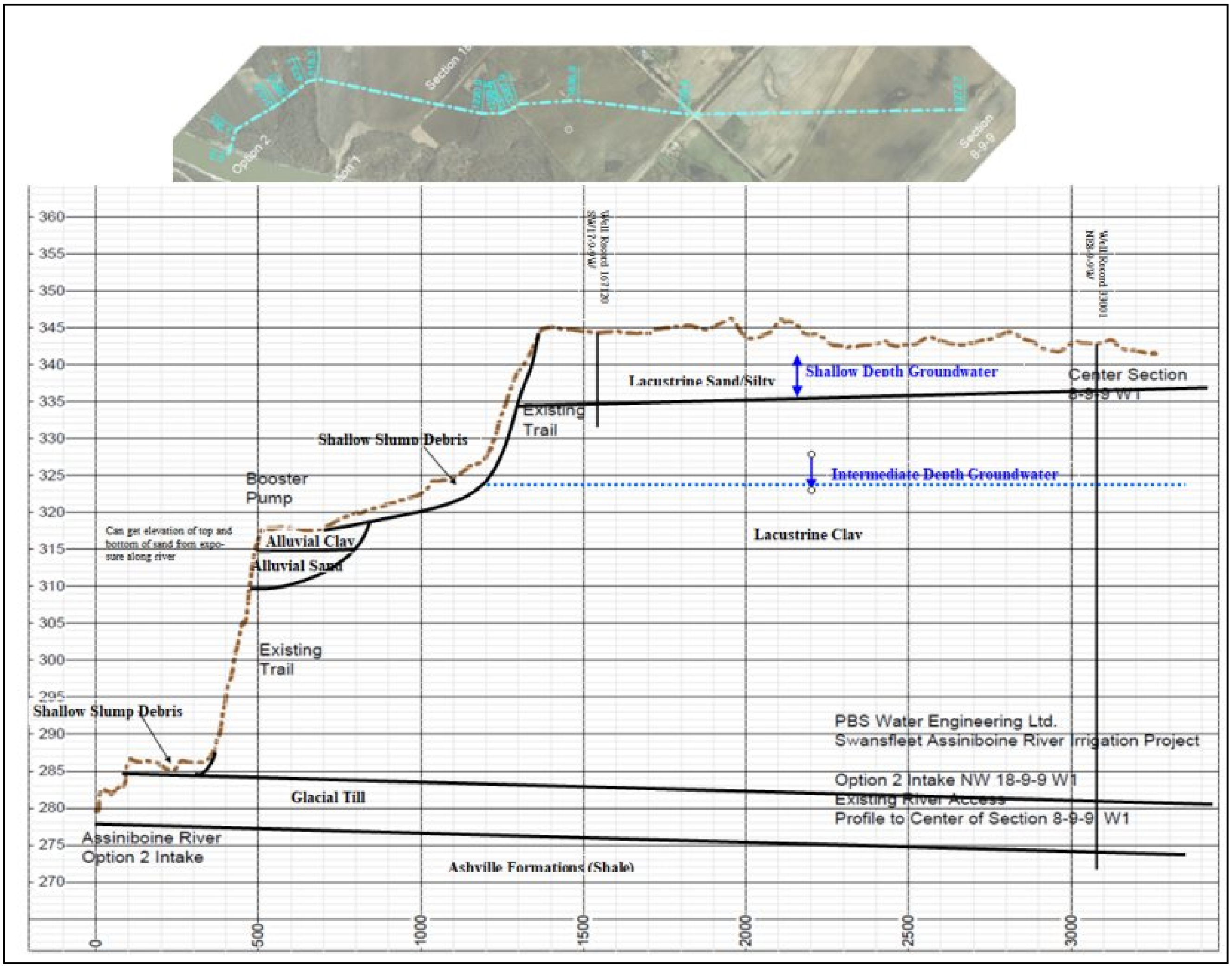



*Figure 15 - Geologic Cross-Section along Option 2 Pipeline Route*

#### *4.1.3 Groundwater*

PFRA Ltd. (John Oosterveen, P.Eng.) was engaged to provide a review of the local groundwater resources as it relates to the Project. The following are excerpts from their report.

> *This project is located on the extreme southeastern edge of the Assiniboine Delta Aquifer, which has insufficient aquifer thickness for high-capacity water wells required to service irrigation pivots (e.g., 600 – 1000 USgpm). GWDRILL records and site geology (Section 4.1.2) were reviewed to assess potential project impacts on local water.*

*Well Records from GWDRILL identify at least two distinct groundwater producing zones in the Project area can be characterized as follows.*

***Shallow Depth Groundwater*** *associated with the approximately 20 feet thick permeable lacustrine sands identified in the surficial geology which directly overlie the lacustrine clay. Water quantity and quality can vary significantly depending on the position in the landscape and the time of year. During spring snowmelt this perched water can cause issues with agricultural production, causing near surface water tables and hence imperfect drainage (see Map 5, Appendix A). The shallow perched water table typically falls during the growing season, due to crop evapotranspiration, to levels below 2 m; only to be recharged in the fall with rain or during the next spring season (Cordeiro, 2013). There are numerous large diameter wells (30 to 48 inch) which are often over drill to 40+ feet deep but which rely on slow seepage from the shallow sands. Typically, these shallow water tables wells have a limited supply capacity due to limited seepage and are sensitive to prolonged drought cycles, which further limit's reliability. Shallow large diameter water wells are often considered an unreliable for water supply.*

***Intermediate Depth Groundwater*** *associated with a sand layer within the lacustrine clay at about the 70-foot depth. Numerous smaller diameter (typically 5 inch diameter but up to 30 inch diameter) well records are reported in the area with water quality in the 750 ppm total dissolved solids range (NE5-9-9W) and well yields up to 15 igpm. There are no records available on the long-term performance of these water wells.*

*GWDRILL logs for the 30-inch water wells in NE9-9-9W and SE 18-9-9W (Figure 16), have perforations to 78 and 87 feet respectively and appear to potentially draw groundwater from both the shallow and intermediate depth groundwater zone. The well in NE9-9-9W has a static water level of 15 feet with drawdown to 70 feet (55 feet) in 90 minutes of pumping at 12 igpm (1080 gallons) which means that about 400 gallons came from casing storage while the remaining 680 (7.5igpm) came from groundwater. The well is SE18-9-9W was completed in August 1999 (i.e., late summer) and lies very near the edge of the Assiniboine River Valley, which may explain the relatively low static water level at 52 feet below ground.  At time of installation a pumping test was conducted at 20 igpm that resulted in 26 feet of drawdown in the well (82 feet), which means of the 2400 gallons pumped approximately 200 came from casing storage while the remaining 2200 gallons (18 igpm) came from groundwater.*

```
Location:  SE18-9-9W

Well PID:          113134
Owner:          LEON PEWARCHUK
Driller:        Paddock Drilling Ltd.
Well Name:
Well Use:       PRODUCTION
Water Use:      Domestic
Date Completed: 1999 Aug 05

WELL LOG

  From   To       Log
  (ft.)  (ft.)
     0    1.0     TOPSOIL
   1.0   16.0     SILTY SANDY BROWN CLAY
  16.0   45.0     SILTY BROWN CLAY
  45.0   74.0     SILTY GREY CLAY
  74.0   84.0     VERY FINE SILTY GREY SAND
  84.0   90.0     SILTY GREY CLAY

WELL CONSTRUCTION

  From   To    Casing       Inside   Outside  Slot      Type       Material
  (ft.)  (ft.) Type         Dia.(in) Dia.(in) Size(in)
     0   17.0 CASING          30.00                     CORRUGATED FIBERGLASS
  17.0   87.0 PERFORATIONS                      0.040 SAW CUT     FIBERGLASS
     0   87.0 GRAVEL PACK                                          WASHED SAND

Top of Casing: 1.000 ft. above ground

PUMPING TEST

Date:                           1999 Aug 05
Pumping Rate:                   20.000 Imp. gallons/minute
Water level before pumping:     56.0 ft. below ground
Pumping level at end of test: 82.0 ft. below ground
Test duration:                  2 hours,  minutes
```

*Figure 16 - GWDrill Record for Well (1999) SE 18-9-9 W*

*Large diameter seepage wells to the north are either on the "1050'" terrace (NE17-9-9W) or are shallow large diameter wells (only drawing water from surficial lacustrine sands) such as those installed in NE8-9-9 W, SW17-9-9 W and SE18-9-9W1. These "typical" large diameter wells have a diameter of 30 inches with perforations below the initial surficial soils (e.g.>18 feet) to depths as much as 40 feet. Based on the limited pump tests information these are slow seepage wells which rely on the volume of water stored within the well casing to supply even limited flows (e.g., 5 USgpm). These types of wells would likely be influenced by surface activities (e.g., farming practices), although they are filtered to a degree by the finer surface soils at this location. There is very little data available on existing water quality to determine the nature of this influence and baseline of the water quality situation.*

*GWDRILL logs are provided for NE and NW5-9-9 W (Figure 17) which represent conditions to the south and southwest of Section 8-9-9 W.  The well in NE 5-9-9 W (Figure 17) is a deeper smaller diameter (e.g., 5 inch) with screens at depth (e.g., 61- 71 feet), capable of slightly more flow (e.g., 10 USgpm). Water quality measured at time of drilling a deeper well in NW 5-9-9W1 is acceptable for agricultural use with EC ~ 400 – 500.*

Location: NE5-9-9W

Well PID: 78806
Owner: SHADYLANE COLONY
Driller: Watkins & Argue Well Drilling
Well Name:
Well Use: PRODUCTION
Water Use: Domestic,Livestock
UTMX: 525324.9880
UTMY: 5507598.75
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1994 Oct 19

WELL LOG

| From (ft.) | To (ft.) | Log |
|---|---|---|
| 0 | 10.0 | BROWN SAND |
| 10.0 | 14.0 | BROWN CLAY |
| 14.0 | 31.0 | BLUE CLAY |
| 31.0 | 45.0 | SANDY BLUE CLAY |
| 45.0 | 60.0 | BLUE CLAY |
| 60.0 | 65.0 | LAYERS OF SAND AND CLAY |
| 65.0 | 71.0 | FINE GREY SAND |
| 71.0 | 89.9 | BLUE CLAY |

WELL CONSTRUCTION

| From (ft.) | To (ft.) | Casing Type | Inside Dia.(in) | Outside Dia.(in) | Slot Size(in) | Type | Material |
|---|---|---|---|---|---|---|---|
| 0 | 61.0 | casing | 5.00 | | | INSERT | PVC |
| 61.0 | 71.0 | perforations | 5.00 | | 0.015 | WIRE WOUND S. S. | |
| 55.0 | 75.0 | gravel pack | | | | NO. 20-40 | SILICA S. |

Top of Casing: 1.000 ft. above ground

PUMPING TEST

Date: 1994 Oct 19
Pumping Rate: 8.496 Imp. gallons/minute
Water level before pumping: 18.0 ft. below ground
Pumping level at end of test: 60.0 ft. below ground
Test duration: 12 hours, minutes
Water temperature: ?? degrees F

Location: NW-5-9-9W

Well PID: 76240
Owner: D HIRD
Driller: Watkins & Argue Well Drilling
Well Name:
Well Use: PRODUCTION
Water Use: Domestic,Livestock
UTMX: 524518.9650
UTMY: 5507593.21
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1993 Jun 21

WELL LOG

| From (ft.) | To (ft.) | Log |
|---|---|---|
| 0 | 10.0 | BROWN SAND |
| 10.0 | 15.0 | GREY SAND |
| 15.0 | 84.9 | SANDY GREY CLAY |
| 84.9 | 94.9 | FINE GREY SAND |
| 94.9 | 101.9 | BLUE CLAY |

WELL CONSTRUCTION

| From (ft.) | To (ft.) | Casing Type | Inside Dia.(in) | Outside Dia.(in) | Slot Size(in) | Type | Material |
|---|---|---|---|---|---|---|---|
| 0 | 85.9 | casing | 5.00 | | | INSERT | PVC |
| 85.9 | 95.9 | perforations | 5.00 | | 0.015 | WIRE WOUND S. S. | |
| 75.0 | 97.9 | gravel pack | | | | NO. 20-40 | SILICA S. |
| 97.9 | 100.9 | gravel pack | | | | NO. 10-30 | SILICA S. |

Top of Casing: 1.000 ft. below ground

PUMPING TEST

Date: 1993 Jun 21
Pumping Rate: 15.000 Imp. gallons/minute
Water level before pumping: 14.0 ft. below ground
Pumping level at end of test: 62.0 ft. below ground
Test duration: 12 hours, minutes
Water temperature: ?? degrees F

*Figure 17 - GWDrill Records for NE, NE 5-9-9 W*

Some consideration to shallow tile drainage (e.g., perforated HDPE ~ 1 m depth) will be given to improving early season growing conditions within the imperfectly drained surficial soils (e.g., Map 5). The impact of this shallow tile drainage is mainly targeting early spring field access and crop production. When tile drainage is combined with Beneficial Management Practices such as Controlled Drainage (Appendix H), it can result in reduced surface runoff, increased infiltration, better crop growth and nutrient utilization and should have limited impacts on surrounding shallow water tables. Any tile drainage project is subject to approval by the Province, under separate licencing conditions.

#### *4.1.4 Climate and Meteorological Conditions and Eco-climate*

The long-term climatic stations define the Mid-Boreal temperate ecological region that the project resides in. Reported climatic parameters (Michalyna et al., 1982) are as follows:

| | |
|---|---|
| Temperature | 0.6 to 1.9 $^{0}$C (mean annual) |
| Precipitation | 425 to 545 mm (mean annual) |
| Rainfall | 280 to 365 mm (mean annual) |
| Frost Free Days | 100 to 114 |
| Corn Heat Units | 2050 to 2300 |

During the growing season, potato crop evapotranspiration generally exceeds available precipitation. Based on climate data available from Manitoba Agriculture (Table 2); the water deficit ranges from as little as 75 mm (3 inches) or less in half of the years to 150 mm (6 inches) or more in 1 year out of 10. This information along with local experience and coarse nature of the project soils has been utilized to estimate Project water demand. It is estimated that maximum irrigation demand will be in the order of 200 mm – 300 mm (8 - 12 inches).

***Table 2 – Growing Season Precipitation, Potato Water Demand and Water Deficit.***

| Variable | Risk Level (%) | Description | Water (inches (mm)) |
|---|---|---|---|
| Growing Season Precipitation | 50 | In 1 of 2 years precipitation will be less than given values | 9.5-10.5 (240 to 270) |
| | 25 | In 1 of 4 years precipitation will be less than given values | 7.1-8.0 (180 to 200) |
| | 10 | In 1 of 10 years precipitation will be less than given values | 4.6-5.5 (115 to 140) |
| Potato Water Demand | 50 | In 1 of 2 years water demand for potatoes at maturity will exceed the given value | 15.0 – 15.5 (381 to 395) |
| | 20 | In 1 of 4 years water demand for potatoes at maturity will exceed the given values | 16.6 – 17.0 (420 to 430) |
| | 10 | In 1 of 10 years water demand for potatoes at maturity will exceed the given values | 17.6 – 18.5 (447 to 470) |
| Potato Water Deficit | 50 | In 1 of 2 years water deficit will be exceed the given values | 2.6 – 3.5 (66 to 89) |
| | 25 | In 1 of 4 years water deficit will exceed the given values | 4.6 – 5.5 (116 to 140) |
| | 10 | In 1 of 10 years water deficit will be exceed the given values | 5.6 – 6.5 (142 to 165) |
| Source: Manitoba Agriculture - http://www.gov.mb.ca/agriculture/weather/climatic-information-for-potatoes-in-mb.html | | | |

Table 3 (Smith and Michalyna, 1973), reveals that water balance as represented by the ratio of precipitation to potential evaporation, ranges from a weekly high of 0.87 (precipitation/ potential evapotranspiration) in the first week of September to a weekly low of 0.37 (precipitation/potential evapotranspiration) in the last week in July. Short term moisture deficits are made up from soil moisture; but extended dry periods can quickly deplete available soil moisture and bring the crop under stress. Crop stress has impacts on potato yield, tuber diseases, and tuber quality.

The need for irrigation is clearly supplemental to the existing precipitation and soil moisture reserves, but none the less has been shown to be critical to optimal production conditions and to achieve more uniform product quality, and a level of quality that processing clients require.

***Table 3 – Weekly Potential Evaporation (PE) and Water Balance (Precipitation/Potential Evapotranspiration) (Smith and Michalyna, 1973)***

Long-term Weekly Means of Maximum and Minimum Temperatures
and Weekly Totals of Precipitation for the Period May 1st to September 30th*

| Week Ending | Maximum Temperature | | Minimum Temperature | | Precipitation Inches | | PE** Inches | Water Balance Precipitation/PE |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | Mean | S.D. | | |
| May 7 | 60.1 | 13.5 | 37.2 | 9.6 | 0.49 | 0.66 | 1.04 | 0.47 |
| 14 | 62.4 | 12.4 | 37.3 | 8.8 | 0.43 | 0.53 | 1.02 | 0.42 |
| 21 | 66.5 | 11.7 | 41.3 | 7.8 | 0.40 | 0.45 | 1.11 | 0.36 |
| 28 | 68.9 | 11.7 | 44.2 | 8.0 | 0.69 | 1.07 | 1.23 | 0.56 |
| June 4 | 71.3 | 11.4 | 47.6 | 8.2 | 0.88 | 1.01 | 1.33 | 0.66 |
| 11 | 72.2 | 10.4 | 49.1 | 7.5 | 0.70 | 0.76 | 1.27 | 0.55 |
| 18 | 74.9 | 9.3 | 51.6 | 7.1 | 0.61 | 0.61 | 1.28 | 0.48 |
| 25 | 75.6 | 8.6 | 52.6 | 6.5 | 0.69 | 0.66 | 1.29 | 0.53 |
| July 2 | 78.0 | 8.4 | 54.6 | 6.6 | 0.64 | 0.71 | 1.35 | 0.47 |
| 9 | 80.0 | 8.2 | 56.3 | 6.6 | 0.77 | 0.77 | 1.39 | 0.55 |
| 16 | 81.6 | 8.2 | 57.4 | 6.5 | 0.69 | 0.75 | 1.43 | 0.48 |
| 23 | 82.6 | 7.6 | 58.4 | 5.8 | 0.56 | 0.60 | 1.39 | 0.40 |
| 30 | 82.3 | 8.1 | 56.9 | 6.4 | 0.52 | 0.61 | 1.40 | 0.37 |
| Aug. 6 | 82.0 | 8.2 | 57.1 | 5.7 | 0.81 | 0.82 | 1.35 | 0.60 |
| 13 | 80.3 | 8.9 | 55.4 | 6.7 | 0.56 | 0.64 | 1.27 | 0.44 |
| 20 | 79.6 | 8.9 | 54.1 | 6.9 | 0.51 | 0.71 | 1.22 | 0.42 |
| 27 | 77.3 | 9.6 | 53.4 | 7.4 | 0.48 | 0.63 | 1.09 | 0.44 |
| Sept. 3 | 74.1 | 9.6 | 51.5 | 6.9 | 0.82 | 1.17 | 0.94 | 0.87 |
| 10 | 71.7 | 10.5 | 48.8 | 7.8 | 0.42 | 0.60 | 0.86 | 0.49 |
| 17 | 68.6 | 10.1 | 45.8 | 8.0 | 0.37 | 0.40 | 0.71 | 0.52 |
| 24 | 64.6 | 10.4 | 42.8 | 7.5 | 0.48 | 0.63 | 0.54 | 0.89 |
| 30 | 61.5 | 12.9 | 38.9 | 8.3 | 0.29 | 0.35 | 0.38 | 0.76 |

Other Weather Parameters

| | | |
|---|---|---|
| Average Precipitation May 1st to September 30th | – | 12.7 inches |
| Average Annual Precipitation | – | 20.3 inches |
| Corn Development Units (C.D.U.) May 15 to date of first killing frost in autumn | – | 2497 |

*C. F. Shaykewich, Dept. of Soil Science, Univ. of Manitoba. Values were calculated using daily data from the Morden Research Station, C.D.A., for the period 1931 to 1968.

**PE = Potential evapotranspiration is the maximum quantity of water capable of being lost as water vapor in a given climate, by a continuous stretch of vegetation covering the whole ground and well supplied with water. PE was calculated on a daily basis by means of a formula that involved daily values of maximum temperature, temperature range, energy at the top of the atmosphere and vapor pressure deficit estimated from maximum and minimum temperatures.

#### *4.1.5 Surface Water*

The major surface water source to the Project area is the Assiniboine River. The Assiniboine River at this location has a drainage area of 160,000 km2. The nearest currently measured flow data provided are by the Water Survey of Canada at the Assiniboine River gauging station 05MH005 (near Holland PTH# 34) (Figure 18). The Province of Manitoba is responsible for allocation of Water Rights from the Assiniboine River.

Peak flows on the Assiniboine River at the Project intake site could reach 1460 $m^3/s$ while minimum August flows have been recorded as low as 4 $m^3/s$ and lower quartile August flows are in the order of 16 – 18 $m^3/s$ (Figure 19 a). The Province of Manitoba currently regulates Assiniboine River flows with releases from Shellmouth Dam (e.g., August, 2021).

A significant contribution to the minimum stream flows is provided by groundwater discharge from the Assiniboine Delta Aquifer (ADA) (Render, 1988). Render (1988) summarized the impacts of the ADA on the Assiniboine River flow referencing measurements from 1985 and the 1960's.

> *The stream flow monitoring on the Assiniboine River (Harrison, 1986) indicated that the groundwater discharge from the aquifer between Brandon and Holland was in the order of 100 cfs (2.8 $m^3/s$) during the period September 12 to October 14, 1985. Harrison calculated over this period for the reaches Brandon to Treesbank Ferry, 8.3 cfs (0.25 $m^3/s$), Treesbank to Stockton Ferry, 5.7cfs (0.16 $m^3/s$), Stockton Ferry to Province Trunk Highway No 5 Bridge, 28.7 cfs (0.81 $m^3/s$), and between Province Trunk Highways 5 and 34 Bridges, 57.8 cfs (1.6 $m^3/s$). Mattick and Wagner (1968) indicate that the groundwater inflow over this reach of the river for the years l963 to 1967 inclusive varied from 100 cfs (2.8 $m^3/s$) in the autumn to as high as 600 cfs (16.8 $m^3/s$) in June.*

Danielescu et al. (2021) studied flow and water quality contributions of the ADA to the Assiniboine River, and concluded the Assiniboine Delta Aquifer (ADA) contributed 15% of the Assiniboine River flow at Holland in the spring of 2018. During the fall of 2018 the ADA contributed 8% of the Assiniboine River flow at Holland (Danielescu et al., 2021). A simple review of flows on the Assiniboine River during October 12, 2022, shows an increase in flow from WSC 05MH001(at Brandon) at 14.7 $m^3/s$ (520 cfs) to WSC 05MH005[1] (near Holland) at 23.7 m3/s (835 cfs). This local increase in flow can be attributed to approximately 3 $m^3/s$ from the Souris River and the remaining approximately 6 $m^3/s$ from groundwater from the ADA[2]. Of importance in the fall is additional groundwater inflow into the Assiniboine after cessation of irrigation and plant growth (i.e., reduced evapotranspiration).

[1] This includes inflow from Souris River (Wawanesa) @ 2.9 m3/s and Oak Creek (Glenboro) @ 0.3 m3/s

[2] Wastewater releases may also contribute to flows, but this was beyond the scope of the study.

A minor contribution to the minimum instream flows is from the regulated Souris River portion of the watershed (e.g., 0.6 $m^3/s$ target minimum flow (West Souris River Watershed Planning Authority, 2012). It is assumed that the target minimum flow on the Assiniboine River is 200 cfs (5.7 $m^3/s$) at Headingly (personal communication Tamara Butterfield). The Proponent can monitor the Assiniboine River flow in real time at Holland (05MH005) to understand their direct impact on downstream flows (i.e., straight subtraction). There are other irrigation withdrawals in the immediate vicinity of this project.

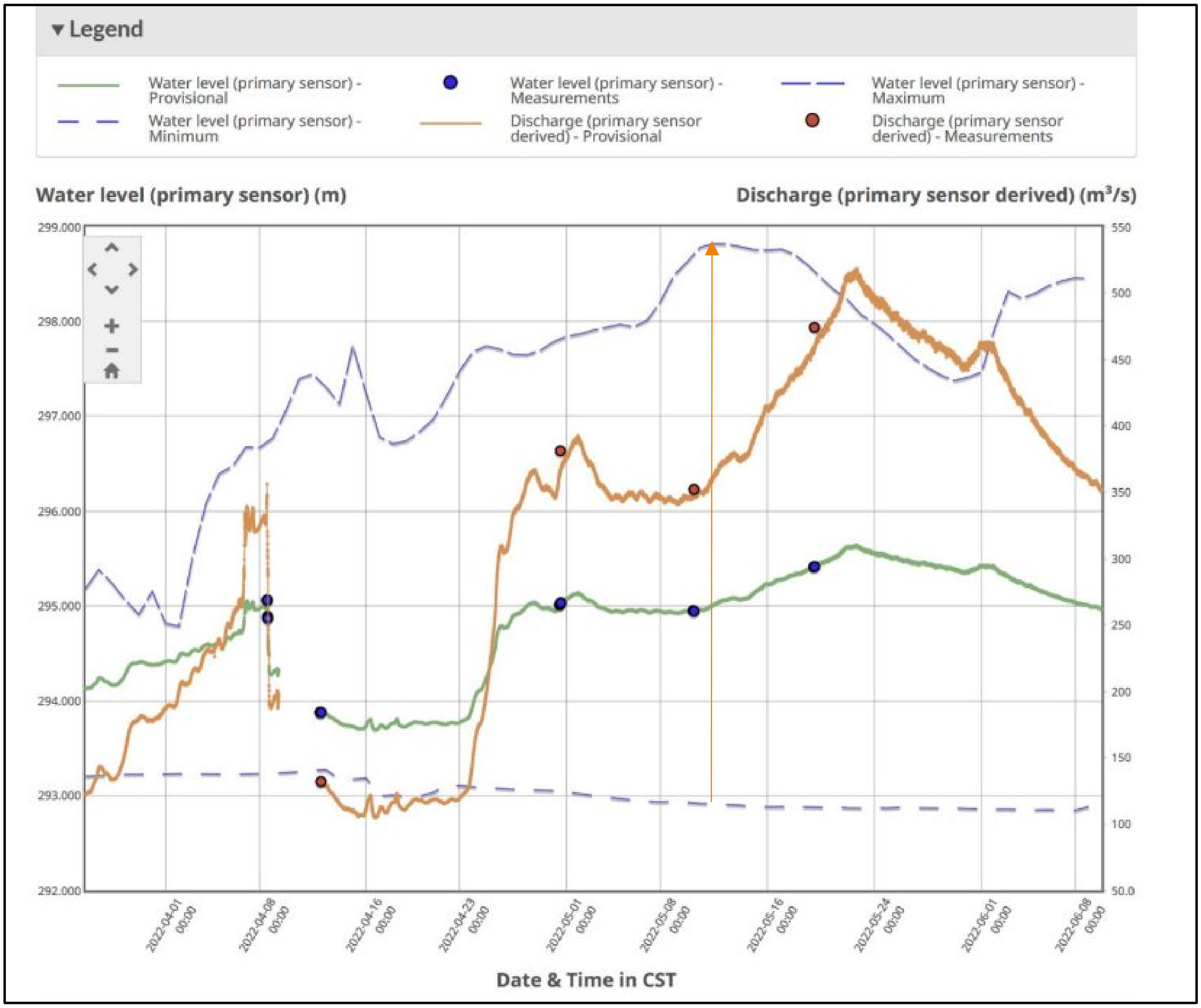
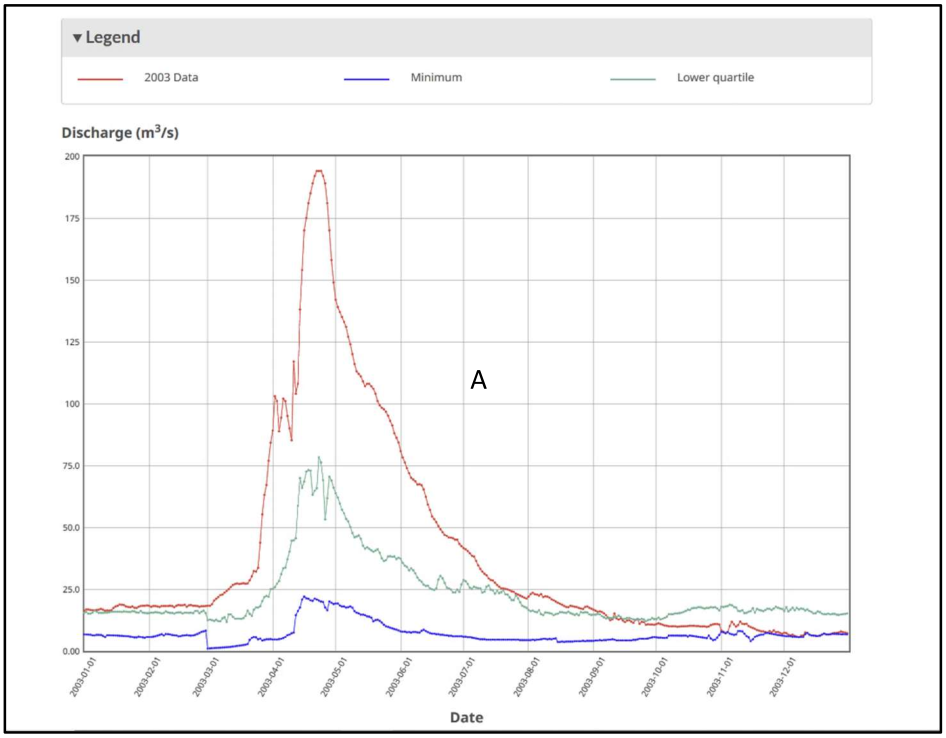



*Figure 18 - Assiniboine River - Real Time Stage-Discharge - WSC 05MH005 – Spring, 2022*



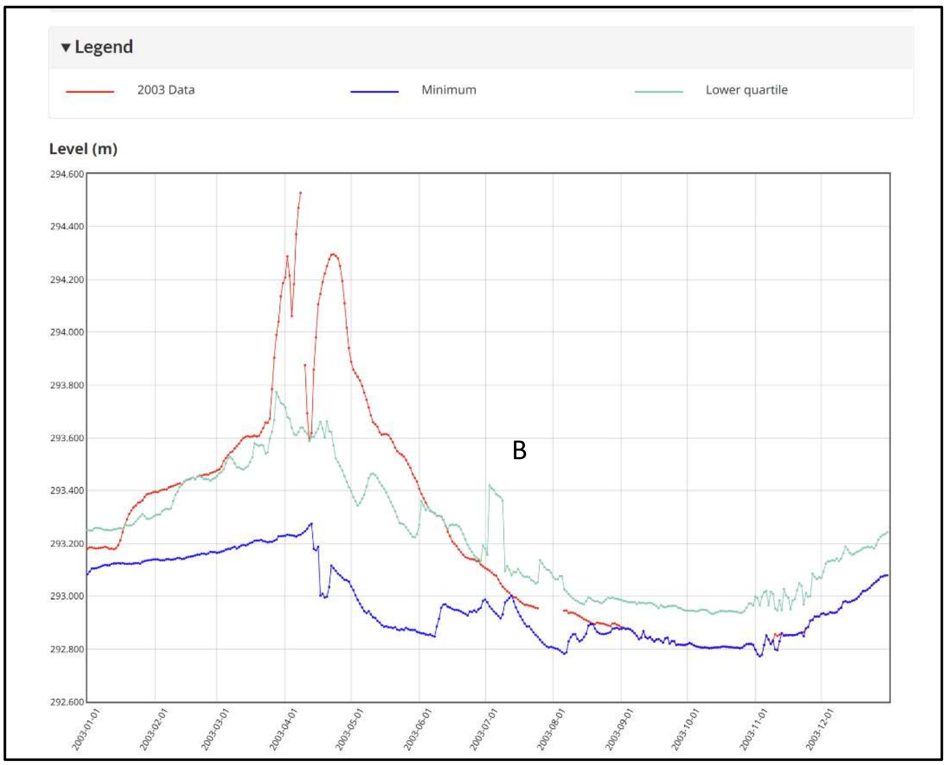




***Figure 19 - Assiniboine River – Historical Stage-Discharge – WSC 05MH005 – 2003 Discharge (a) and Stage (b) vs. Minimum and Lower Quartile Levels***

Peak water levels on the Assinibione River can rise up to 6 m above the minimum water levels (see arrow on Figure 18). Typical (median) August water levels are approximately 0.3 m above minimum water levels. Maximum August water levels can be over 2 m above minimum water levels. A topographic and bathymetric survey of the river bed and bank are planned for 2023 after flood levels subside.

A preliminary assessment of Assiniboine River stage in relation to observed May 10, 2022, water levels at site (See Figures 4, 6, 18) was undertaken. Based on May 10, 2022, flow of 350 m3/s at Holland AND an observed WSC water level of about 295 m; one could anticipate another 3.8 m to maximum Assiniboine River stage.

Based on Figure 18 (Q @ 350 cms) it appears the minimum water level could be about 2 – 2.2 m lower then on May 10, 2022. Total WL range is expected to be approximately 6 m.

It is not clear IF the lower bench (e.g., Figure 6) at Option 2 site is above the maximum flood level. This will be investigated relative to Assiniboine River floods of 2011 and 2014 (i.e., as represented in Figure 17, maximum WL).

The Provincial Government is responsible for allocation of water for the Assiniboine River. Representatives of the Province of Manitoba Drainage and Water Rights Licencing Branch have indicated an initial allocation of 620 acre-feet (765 cubic decameters) is available to Swansfleet Alliance. Given the recent (2021) low flows, it will be critical for Swansfleet Alliance to report on their pumping and observe and minimum flow requirements that may be required by the Province of Manitoba. A withdrawal rate of ***up to 0.2 $m^3/s$ (195 l/s; 3000 US gpm)*** is proposed to meet the needs of the irrigation system(s). This would allow pumping of 360 - 540 acre-feet (444 - 666 cubic decameters) in approximately 25 – 38 days (600 – 900 hours). Ultimately the Province will be responsible for establishing the maximum pump withdrawal rate and the minimum flow past this point. ***The final Water Rights license amount will be adjusted for actual irrigated acres.***

Utilizing quarter section pivots versus a single section pivot will provide flexibility in lower flow periods, to allow reduction in withdrawal rates (i.e., by rotating pivots and reducing pumping rates).

#### *4.1.6 Land Use/Land Cover Classes*

The soil landscape in the Project study area is largely suited to produce annual crops, hence the predominance of annual cropping in the current land use/land cover classes (Map 4, Appendix A). Other agricultural land cover classes, occupying a minor portion of the Project study area, include forage, grassland, and deciduous forest (Map 4, Appendix A). Deciduous forest cover in 2005-2006 (Map 4, Appendix A) consisted of natural block (in S 8-9-9 W1) and a planted shelterbelt utilized used to reduce soil erosion and create microclimates for crop production. Since the timing of the Land Cover Map 4 (Appendix A) the farm site was sold and cleared as was the natural bush on the SE 8-9-9 W and all the land is currently cultivated. The most SW portion of 8-9-9 W1 mapped as Skelding and Long Plain aeolian sands (Map 5, Appendix A) are generally less suited to cropping and may required special consideration with respect to land use going forward.

Riparian zones are often grazed grassland, due to their typically wetter soils, unsuitability for cultivation, to offer protection for surface water courses. There is a small riparian zone connected to a ravine which starts in NW 8-9-9 W1 and flows north to S 17-9-9 W1.

Cropping in the area includes the typical range of annual crops, including such crops as wheat and canola. High-value crop production also occurs, including such crops as corn, beans, and potatoes.

#### *4.1.7 Soil-Landscape Limitations*

The soil-landscape in its natural and modified forms determine capabilities and limitations for the intended purpose of the Project, namely irrigated potato production. The soil-landscape limitations are discussed in the context of the proposed irrigated crop production system. These limitations ultimately guide the land suitability assessment for irrigation (Stantec, 2011). To achieve this assessment, desktop mapping and interpretation was undertaken for the 4 proposed irrigation fields comprising the Project land base using existing soil resource information (Michalyna et. al., 1982). A general discussion of soil-landscape conditions within the Project study area is presented below and provides the basis for the subsequent effects assessment and beneficial management practices recommendations certified by a Professional Agrologist (Agriearth Consulting Ltd.).

##### 4.1.7.1 Soil Surficial Deposits, Drainage and Salinity

As described above, the soils in the Upper Assiniboine Delta consists of level to undulating sandy deltaic and loamy lacustrine sediments associated with Lake Agassiz. The deposits south of the Assiniboine River have been modified to varying degree by wind action. The surficial soils are loamy fine sands (78%) but have minor inclusions of medium textured loams and very fine sandy loams in the eastern and northern extents of the section, and medium textured fine sandy loams and coarse textured fine sands in the southwestern corner of the section.

Soil salinity is not indicated to be a limitation in fields proposed for irrigation based on existing soil resource information (Map 4, Appendix A), and, therefore, is not a management concern for this Project.

Slow surface runoff and low permeability sub-soils have resulted in a significant percent of imperfectly drained soils throughout the southern half of Section 8-9-9 W (61%; Table 4; Map 5, Appendix A). A minor portion of soils (4%) are considered rapidly drained (SKL -Skelding aeolian soils), and a minor portion of soils (1%) are depressional and poorly drained (LLT - Lelant). A significant portion of the Section 8-8-9 W (34%, Table 4; Map 5), predominantly in the north half, is considered well drained presumably a function of finer texture (less infiltration), topography (i.e., better defined surface drainage) and better deep percolation (also to surface drains to the north along the valley).

Producers in the region have long recognized the impact of variable soil-landscape conditions on their crop production system, and, where feasible, have implemented practices to remove limitations. For example, land levelling, surface drainage and tile drainage are commonly used in the region to minimize limiting areas (e.g., salinity, wetness). This results in more uniform crop production and improved crop productivity, and, in turn, makes better use of crop inputs, including nutrients, pesticides and soil water. These improvements practices can, therefore, improve overall environmental sustainability and performance of cropping systems in the soil-landscapes of the Project study area.

***Table 4 – Drainage Classes of Project Soils***

| Drainage Class | Areal Extent | | Proportion of Project Footprint (%) |
|---|---|---|---|
| | hectares (ha) | acres (ac) | |
| Very Rapid | | | |
| Rapid | 10 | 25 | 4.0% |
| Well | 89 | 219 | 34.1% |
| Moderately Well | | | |
| Imperfect | 158 | 390 | 60.6% |
| Poor | 4 | 9 | 1.4% |
| Very Poor | | | |
| **Totals:** | **260** | **643** | **100.0%** |

#### 4.1.7.2 Soil Erosion

The soils in the Project study area are prone to erosion losses by both wind and water, because of surficial soil textures and slope factors, as well as through management practices, namely tillage.

Existing erosion has been mapped in some of Section 8-9-9W1 (e.g., LOP/1cxx, WC/1xxx, COB8-FIR2/1dxx; Map 5). The dominantly coarse to moderately coarse (88.5% of Project footprint; fine sands to loamy fine sands to fine sandy loams) and medium (11.5%; very fine sandy loams to loams) textures throughout the section are generally subject to wind erosion losses, particularly if they are not well-structured (e.g., degraded structure by tillage and compaction) and if soils are left bare of cover and exposed to wind. Soils in the southwest corner of the field (e.g., Skelding are significantly wind modified).

The coarse (loamy sands) textured soils on level to nearly level slopes (i.e., 0-0.5 %) generally have ***low or none risk rating*** for water erosion; risk classes that represents approximately 83.5% of the Project footprint (Table 5). The 16.5% of soils under the Project footprint at moderate to severe risk of water erosion include the medium (loam, very fine sandy loam) textured soils and coarser textured soils on gently sloping topography (i.e., class “d” slopes with 5-9% slope gradient) that dissect the Section the Project study area as well as the complex slopes along the western edge of the Project area.

Manitoba producers have long recognized the inherent erosion risk in these soils, which is supported by the activities including shelterbelts, reduced tillage and cover crops. The agronomic assessment includes a recommendation for consideration of erosion BMPs for those soils most susceptible (see Table 11).

***Table 5 – Water Erosion Risk Classes of Project Soils***

| Water Erosion Risk Class | Areal Extent | | Proportion of Project Footprint (%) |
|---|---|---|---|
| | hectares (ha) | acres (ac) | |
| None | 193 | 478 | 74.4% |
| Low | 24 | 58 | 9.1% |
| Moderate | 33 | 80 | 12.5% |
| High | 8 | 19 | 2.9% |
| Totals: | 3 | 7 | 1.1% |

### *4.1.8 Soil-Landscape Irrigation Suitability Assessment*

The soils of the Project study area have been reviewed for irrigation suitability in accordance with a draft guideline developed in conjunction with Agriculture and Agri-Food Canada (AAFC) and Manitoba Agriculture Food and Rural Development (MAFRD) (Stantec, 2011).

#### 4.1.8.1 General Irrigation Suitability

General irrigation suitability ratings are based on guidelines published by AAFC (Working Group on Irrigation Suitability Classification 1987) and provide an indication of suitability of the soil-landscape for irrigated crop production of a range of crops. The ratings are developed based on consideration of a range of soil and landscape characteristics and limitations to irrigated crop production. Soils are rated as Excellent, Good, Fair or Poor.

Soils within the Project study area are generally suited for irrigation without significant limitations, as indicated by predominantly Good ratings (Map 6, Appendix A). Table 6 reveals that 78.2% of the soils in the Project footprint are rated as Good and 2.4% are rated as Excellent for irrigation suitability. These soils are considered to have slight to no limitations for general irrigation suitability, with slight limitations being due to restricted soil water holding capacity (“m”; moisture limitations or deficits), excess water/drainage limitations (“w”, drainage class), restricted soil water movement (“k” limitation; low hydraulic conductivity) and topography (“t” limitation; sloping land).

Approximately 16.8% of the soils are rated as Fair for general irrigation, due to limitations from restricted soil water holding capacity (“m”; moisture limitations or deficits), excess water/drainage limitations (“w”, drainage class) and topography (“t” limitation; sloping land). Approximately 2.5% of the soils are rated as Poor for general irrigation, due to excess water/drainage limitations (“w”, drainage class) and restricted soil water movement (“k” limitation; low hydraulic conductivity).

Site specific solutions are required to overcome limitations to general irrigation suitability. Poorly drained soils could be left in permanent cover (e.g., grass) or consideration to land improvements (e.g., levelling and drainage) if deemed cost effective by the producer and if topsoil/fill is available. Soils rated Fair for irrigation area generally too complex to land level so should only be irrigated with precautions for water erosion and in the case of finer soils application rate less than infiltration. Another option would be to avoid these areas for irrigation using precision or variable rate irrigation technologies.

Drainage improvements, particularly tile drainage, may be used to reduce the limitations associated with imperfect drainage. Consideration for these soils would be Beneficial Management Practices such as fertigation, variable rate irrigation and controlled drainage (if feasible).

***Table 6 - Irrigation Suitability Class of Project Soils***

| **Irrigation Suitability Class** | **Areal Extent** | | **Proportion of Project Footprint (%)** |
|---|---|---|---|
| | **hectares (ha)** | **acres (ac)** | |
| Excellent | 6 | 16 | 2.4% |
| Good | 204 | 503 | 78.2% |
| Fair | 44 | 108 | 16.8% |
| Poor | 7 | 16 | 2.5% |
| **Totals:** | 260 | 643 | 100.0% |

4.1.8.2 Suitability for Irrigated Potato Production

The soils of the Project area have been reviewed for land suitability for irrigated potato production in accordance with Manitoba Agriculture (1999). This system provides ratings to produce irrigated potatoes based on soil and landscape limitations, and rates soils from Class 1 (most desirable characteristics) to Class 5 (least desirable characteristics).

Soil landscapes rated as Class 1 – 3 are well suited for potato production. The soils in the proposed irrigated areas are predominantly Class 1 to 3 (Map 7, Appendix A), with approximately 88% of the Project soils in these classes (Table 7). Approximately 10% of the Project soils are rated as Class 4 due to topographic, water holding capacity or hydraulic conductivity concerns. It is likely that these may be avoided for planting of potatoes given the variable growing and production resulting from rapidly changing texture and moisture conditions, as well as the increased risk of water erosion. As a minimum special consideration should be given to water application rates (e.g.,Variable Rate Irrigation), nutrient management and soil erosion prevention. Approximately 2-3% of the Project soils are rated as Class 5 due to the poor drainage rating (e.g., depressional areas; see Lelant soils in Figure 12). These small depressions can be avoided when planting potatoes or reclaimed using land levelling if feasible.

***Table 7 – Land Suitability for Irrigated Potato Production Class of Project Soils***

| Land Suitability for Irrigated Potato Production | Areal Extent | | Proportion of Project Footprint (%) |
|---|---|---|---|
| | hectares (ha) | acres (ac) | |
| 1 | 6 | 16 | 2.4% |
| 2 | 65 | 160 | 24.8% |
| 3 | 158 | 390 | 60.6% |
| 4 | 25 | 62 | 9.7% |
| 5 | 7 | 16 | 2.5% |
| **Totals:** | **260** | **643** | **100.0%** |

#### 4.1.8.3 Soil Water and Nutrient Holding Capacity

The ability of soils to hold water and nutrients with the soil matrix allows the plant to draw on these as needed for growth and determines, in part, the environmental risk associated with the potential for nutrient loss. Individual soil-landscape units have specific water holding capacities that relate to soil structure and texture. Water holding capacity can be utilized to determine the frequency and amount of irrigation required to maintain optimum crop growth. Generally, the higher the water holding capacity in a given soil, the higher the nutrient holding capacity and lower the risk of soluble nutrient (i.e., nitrogen) leaching losses.

The predominantly coarse to moderately coarse (to medium) textured soils in the Project study area are considered to have low (to medium) water holding capacity. Water holding capacities can predominantly be expected to range from approximately 13 to 17% (1.3 to 1.7 mm/cm or 1.6 to 2.0 in/ft). Soil water holding capacity should be considered in relation to irrigation management. Irrigation volumes should be tailored to how much water soils within a given soil management unit or field can hold considering water holding capacity and residual soil water content.

The Nutrient Management Regulation (M.R. 62/2008) makes use of basic soil information (including soil water holding capacity/soil moisture limitations accounted for in agricultural capability ratings and classes) to determine allowable soil nutrient residual concentrations for nitrogen and nutrient application rates for phosphorus. Management practices should be tailored as appropriate considering nutrient management zones within each field. Soil-landscapes in the Project study area are predominantly in nutrient management zone N1 and N2 (93.5%; Table 8; Map 8, Appendix A) owing to the soil and topographic factors favourable for annual cropping and nutrient management. Approximately 2.5 % of the Project study area is in zone N3 due to limitations in soil water holding capacity, topography and wetness limitations. The remaining 4% of the section is classified as N4 – these are associated with steeply sloping lands and aeolian soils at margins of proposed irrigated fields and in association with wind shaped topography in the southwestern portion of the Project study area.

***Table 8 – Nutrient Management Zones of Project Soils***

| Nutrient Management Zone | Areal Extent | | Proportion of Project Footprint (%) |
|---|---|---|---|
| | hectares (ha) | acres (ac) | |
| N1 | 35 | 86 | 13.3% |
| N2 | 209 | 516 | 80.2% |
| N3 | 7 | 16 | 2.5% |
| N4 | 10 | 25 | 4.0% |
| **Totals:** | 260 | 643 | 100.0% |

4.1.8.4 Beneficial Management Practices

The soil landscape assessment guideline (Stantec, 2011) provides a list of Beneficial Management Practices (BMPs) that can be adopted by producers to address the noted limitations associated with irrigated crop production, including potatoes. These BMPs form part of the mitigation strategy to minimize environmental effects from irrigated cropping activities while optimizing productivity and production. Adherence to BMPs is crucial to maintaining contracts with processors and clients who are requiring their products be grown in an environmentally sustainable manner (e.g., Unilever, 2010).

## ***4.2 Terrestrial Environment***

The Stockton Ecodistrict (Maps 1, 2,3 & 4, Appendix A) is a mixture of grassland, forages, cropland, and deciduous forest. The overall natural habitat within this Ecodistrict is impacted by its dispersed nature in the uplands and continuity provided by the Assiniboine River valley. The Project area is largely confined to the cultivated, grassland and forage areas of the Project footprint (Map 4, Appendix A ), including all irrigated lands and most of the planned pipelines routes, which will be typically across cultivated acres except where rising between the lower and upper benches (Map 2, Appendix A ). Intake site(s) access will impinge on riparian zones, but impact will be mitigated through careful construction methods. The one road crossing is through two well maintained roads with established drainage ditches.

#### *4.2.1 Vegetation*

The Central Assiniboine River is part of the Stockton Ecodistrict, the Aspen Parkland Ecoregion and the Prairie Ecozone. Assiniboine Hills Conservation District described the EcoDistrict vegetation as follows:

> *Aspen bluffs are usually associated with the wetter sites, oak and grasses are usually associated with drier sites. Some of the grassland species found in the watershed include Junegrass, Kentucky Bluegrass, junipers, and a variety of fescue and wheatgrasses. Undisturbed, numerous areas also support American elm, basswood, Manitoba maple, green ash, white birch, balsam poplar, and willow tree species. Common ground cover species include vetches, sarsaparilla, and wood strawberry. Willow is a common shrub in wetter areas and along small waterways, along with Manitoba maple, dogwood, and green ash. Wet sites and riparian areas in this watershed support slough grass, marsh reed grass, sedge, cattail, and willow.*
>
> *Manitoba's mixed grass prairie ecosystem is composed of shorter species of grass which thrive in more arid conditions, and tall grass species which are more dominant to the east. These temperate grassland communities occur on well-drained, sandy or gravelly soils. The mixed-grass prairies support increasingly threatened species designated under Manitoba's Endangered Species Act (ESA) and the federal Species at Risk Act (SARA). The mixed grass prairie is a meadowland rich in plant diversity which covers rich soils underlying the parklands, making it suitable for agricultural development. In Canada, more than 70% of mixed-grass prairie has been converted to annual or forage crop, or human infrastructure.*

Assiniboine Hills Conservation District (IWRM) characterized the riparian areas along the Assiniboine River:

> *Riparian areas are the transitional areas between land and water and serve many important functions. These areas are typically more densely vegetated and retain sediment, filter water, store flood water and energy, recharge groundwater, and increase biodiversity. Riparian areas along the Assiniboine River support slough grass, marsh reed grass, sedge, cattail, and willow (Smith et al. 1998, AAFC - PFRA 2004). Healthy riparian areas contribute to healthy aquatic ecosystems.*

Crops have largely replaced the native vegetation except along the existing stream channels, the Assiniboine River Valley slopes and portions of the Assiniboine River flood plains. At the Project site, the vegetation on the irrigated field has been completely agricultural for the past half decade, which included removal of remnant deciduous forest in S 8-9-9 W1 (Map 4, Appendix A) and the yard site in NW 8-9-9 W1. Along the pipeline route the flat lower and upper benches have been cultivated for annual cropping and the steeper Valley slopes are forested with exception of some grassed access trails/roads, and incised creeks/ravines. The proposed intake sites are both currently grassed, with minimal forest, and have pre-existing manmade (grassed) trails. The proposed pipeline route takes advantage of the existing intake locations and connects to pre-existing trails and slopes between the lower and upper benches and the upper bench and the upland (see Figure 7 and 8) . Most of the pipeline route is located on cultivated land.

#### 4.2.2 Wildlife

Smith et al. (1998) described the wildlife of the Prairie Ecozone as follows:

> *Because of the size of the Ecozone, characteristic mammals of the zone may not be present throughout. In Manitoba, characteristic mammals include elk (wapiti), coyote, badger, white-tailed jack rabbit, Richardson's ground squirrel and northern pocket gopher. While farther west, pronghorn antelope and mule deer are present. The whitetailed deer is a recent addition to the fauna and is especially well established in Manitoba, where it thrives in the mixture of cultivated fields, pastures, and aspen-oak bluffs. Bird species characteristic of all or parts of the Ecozone include ferruginous hawk, sage grouse, American avocet and burrowing owl, but their numbers are often severely reduced through habitat loss. Great blue heron, black-billed magpie, Baltimore oriole, veery and brown thrasher are other representative birds. This Ecozone continues to provide major breeding, staging, and nesting habitat for ducks, geese, other waterfowl and shore birds, even though a significant reduction in acreage and numbers of wetlands has occurred. The red-sided and western plains garter snakes are common and widespread. Other reptiles and amphibians present in the Manitoba section of the Ecozone include the blue-tailed skink found in the Spruce Woods, the western painted turtle, gray salamander and various toads and frogs.*

#### 4.2.3 Species at Risk

Contact was made with the Manitoba Conservation Data Centre (CDC) manager to determine the potential for existence of rare and endangered species, or other species of conservation concern (Appendix C [C.3]). A response is included in Appendix C.3. There is no listed species at risk within the project area, albeit various species within the vicinity of the project.

***Table 9 – Species at Risk Identified by Manitoba Conservation Data Center (CDC)***

| SEARCH CRITERIA | SITE | SCINAME | COMNAME | S_RANK | ESEA | SARA | COSEWIC |
|---|---|---|---|---|---|---|---|
| Within | NW-18-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | SE-18-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | SE-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | NE-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | SW-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | NW-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within 2km radius of site boundary of | Six quarters combined | Plestiodon septentrionali | Northern Prairie Skink | S1 | Endangered | Special Concern | Special Concern |
| Within 2km radius of site boundary of | Six quarters combined | Sanguinaria canadensis | Bloodroot | S2 | | | |
| Within 2km radius of site boundary of | Six quarters combined | Riparia riparia | Bank Swallow | S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Ambystoma mavortium | Western Tiger Salamander | S4S5 | | Special Concern | Special Concern |
| Records in general area of | Six quarters combined | Carex prairea | Prairie Sedge | S3S4 | | | |
| Records in general area of | Six quarters combined | Plestiodon septentrionali | Northern Prairie Skink | S1 | Endangered | Special Concern | Special Concern |
| Records in general area of | Six quarters combined | Quadrula quadrula | Mapleleaf Mussel | S1 | Endangered | Threatened | Threatened |
| Records in general area of | Six quarters combined | Circaea canadensis ssp. c | Large Enchanter's-nightshade | S2 | | | |
| Records in general area of | Six quarters combined | Osmorhiza claytonii | Hairy Sweet Cicely | S2? | | | |
| Records in general area of | Six quarters combined | Contopus virens | Eastern Wood-pewee | S3B | | Special Concern | Special Concern |
| Records in general area of | Six quarters combined | Strophitus undulatus | Creeper | S5 | | | |
| Records in general area of | Six quarters combined | Dolichonyx oryzivorus | Bobolink | S3S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Sanguinaria canadensis | Bloodroot | S2 | | | |
| Records in general area of | Six quarters combined | Hirundo rustica | Barn Swallow | S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Riparia riparia | Bank Swallow | S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Phryma leptostachya var | American Lopseed | S3 | | | |
| Records in general area of | Six quarters combined | Cornus alternifolia | Alternate-leaved Dogwood | S3 | | | |

The Project is mainly being constructed on cultivated land as detailed above. Attention to Species within the vicinity of the project will be given for pipeline installation within the valley slopes with natural (e.g., non cultivated) vegetation.

Section 4.3.1 discusses aquatic species at risk (e.g., Mapleleaf Mussel, Table 9).

## *4.3 <u>Aquatic Environment</u>*

Many aquatic studies have been completed for the Assiniboine River which provide a background to the aquatic environment (Assiniboine Hills Conservation District):

> *The Assiniboine River is home to a wide array of aquatic species and ecosystems. Fish species found within the Assiniboine River include lake sturgeon, walleye, yellow perch, northern pike, mooneye, burbot, channel catfish, brown bullhead, rock bass, white sucker and common carp. The main stem of the Souris River contains a high diversity of fish species and is the most popular fishing spot for local fishermen. Tributaries of the Assiniboine River and the Souris River include white suckers, fathead minnows, darters, sticklebacks, shiners, yellow perch, walleye, and northern pike. Those provide a large biomass of forage fish upon which the predacious fish within the Assiniboine River depend.*

Further information relative to the aquatic considerations for the Project site follow.

### *4.3.1 Aquatic Species at Risk*

Tetres (2006) identified eight species at risk for the Red and Assiniboine Rivers near Winnipeg, that may also inhabit the Assiniboine River in the vicinity of Portage la Prairie, including:

***Bigmouth Buffalo***
***Lake Sturgeon***
***Chestnut Lamprey***
***Silver Lamprey***
North Brook Lamprey
Carmine Shiner
Silver Chub
Shortjaw Cisco

Toews et al. (2022) also identified the top four species above (in bold) as well as:

***Mapleleaf Mussel***

as aquatic species at risk in the vicinity of Portage La Prairie. A proposal has been received from a Professional Biologist by the Proponent with respect to addressing site specific aquatic concerns and to review mitigative and engineering strategies for the Project intake(s).

Assiniboine Hills Conservation District described the Lake Sturgeon situation as follows:

> *Lake sturgeon are an evolutionary ancient fish historically found in North America's large lakes and rivers within the Hudson Bay, the Great Lakes, the Mississippi and the St. Lawrence drainage basins. Among freshwater fish, they have a unique life history which has made them culturally important to almost any First Nation located on lake sturgeon bearing waters. Their long life, large size, slow growth, and late onset of sexual maturity combined with an intermittent reproductive cycle make them vulnerable to many human influences including overharvesting, pollution, and loss of habitat. In most jurisdictions, commercial fisheries in the late 19th and early 20th centuries depleted lake sturgeon stocks to the point where many have not recovered.*
>
> *The outlook for lake sturgeon has improved significantly since the first Manitoba lake sturgeon strategy was launched in 1992 and there continues to be progress towards achieving the goals identified in the Province's 1997, and 2012 strategies. Possibly one of the most successful management measures put in place was the closure of the Manitoba commercial lake sturgeon fishery in 1999. The closure demonstrated limiting mortality is the single most effective means of sustaining lake sturgeon stocks. There is evidence that most of the major rivers in Manitoba have lake sturgeon stocks that are no longer considered to be declining which may be related to the elimination of harvest by recreational and commercial fisheries province-wide.*

#### *4.3.2 DFO Classification Maps*

The Project area is situated on a major oxbow of the Assiniboine River just upstream of PR242 bridge (Map 1, Appendix A). The Assiniboine River at this site is a natural waterway. Fishery is not limited by the habitat value and distance from the Red River or Lake Winnipeg, or lack of overwinter flows (and ice). A major downstream barrier is the Portage Dam/Diversion.

The Government of Canada and the Province of Manitoba convened the Manitoba Drain Maintenance Committee to better understand the nature of agricultural drains and rivers as supporting fish communities. Subsequently, in January 2014, the Department of Fisheries and Oceans (Milani, D.W. 2013) released classifications of streams throughout Manitoba, including the area of interest along the Assiniboine River within the Project area. Appendix E provides a copy of relevant report figures and questions and answers with respect to the reference.

Milani (2013) summarizes five years of field surveys (2002-2006) and presents a first iteration of classified fish habitat maps. The classified fish habitat maps break the habitat of agricultural waterways into 5 habitat types, A, B, C, D or E, based on gross measurements of fish habitat complexity (complex, simple, indirect) and the fish species presence (captured or expected) and whether the habitat supports Commercial, Sport/Recreational, Domestic or Indigenous, or SARA listed Fish vs. Forage Fish vs. No Fish).

Generally, Type A and B habitat types support Commercial, Sport/Recreational, Domestic or Indigenous, or SARA species with Type A habitat being complex and Type B habitat being simple. Habitat Type C and D habitats support Forage Fish species with Type C habitat being complex and Type D habitat being simple. Habitat Type E drains can be simple or complex but provide indirect fish habitat.

The maps provide a risk assessment for the potential of impacts to fish and fish habitat in agri-Manitoba from a variety of works that occur in and near water, to be supplemented with local knowledge. According to Figure 20 the Assiniboine River adjacent to the Project area is considered to be Class A habitat.

Milani (2013) provides further detailed information on methodologies, techniques, channel photos and fishing results. This extensive report is clearly the best information currently readily available for making an initial determination of impact of the Project.

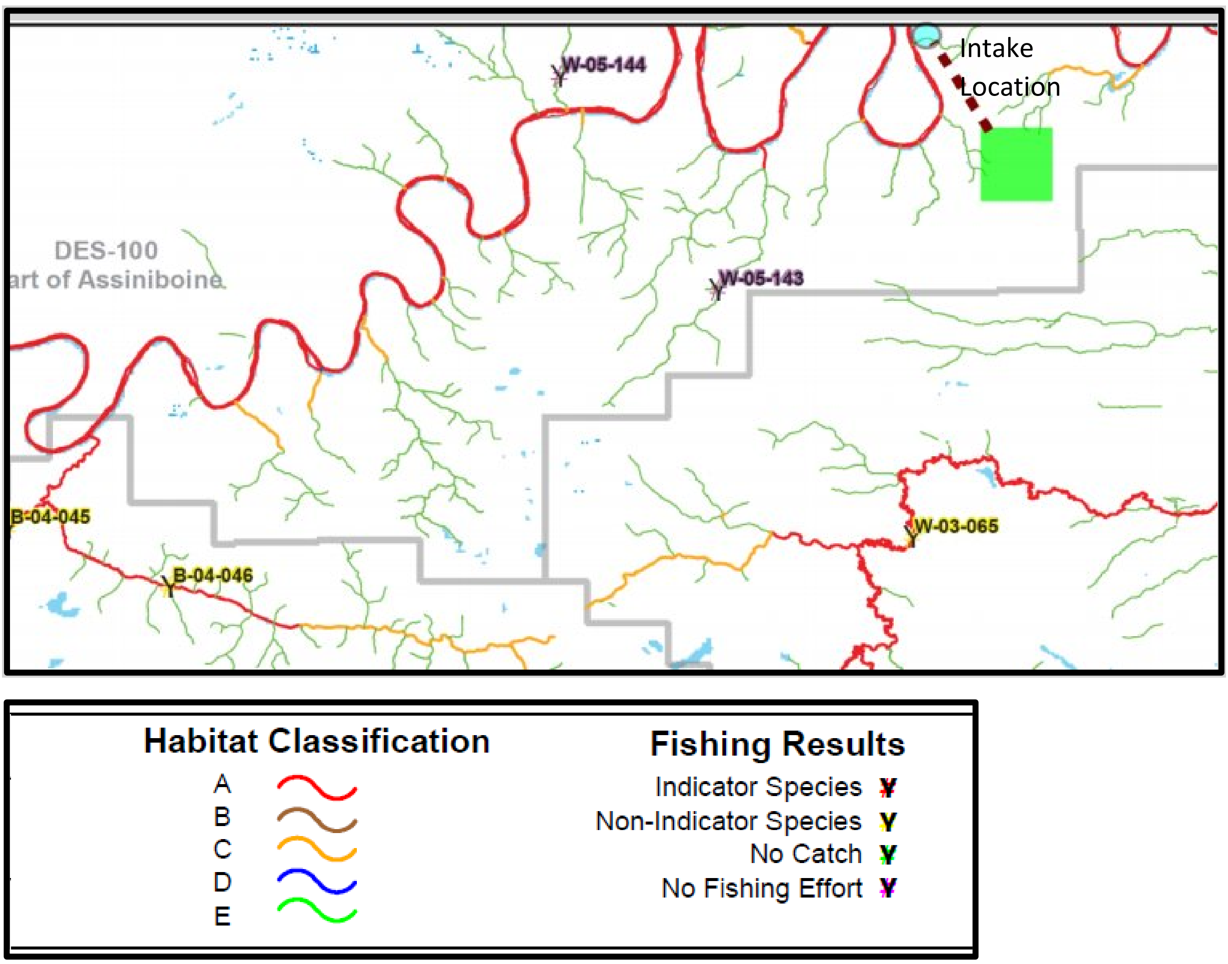



*Figure 20 – DFO Habitat Classification of Streams and Constructed Drains on Assiniboine River near Project Location*

### *4.4 Socio Economic Environment*

The Project area in the RM of Treherne Norfolk is largely agricultural in nature. Treherne is located to the south of the Project area and the villages of Lavenham, and Rosendale are located to the north of the Project area.

The Project area is traversed by RM of Norfolk Treherne Road 50N and 53 W which are connecting municipal roads that lead to PR242 and PTH 2 which are regional arteries leading from the Project area to the Proponents' main potato storage off of PTH 34.

The Project will generate significant economic activity and will have total irrigation system expenditures in the order of $1.7 M (not including the potato shed and farm equipment). A significant portion of the expenditure (approaching 50%) will be spent on goods and services from outside the Project. Estimated expenditures are as follows.

| | |
|---|---|
| On Farm | $0.5 M |
| Pipelines | $0.6 M |
| Power | $0.2 M |
| Pumps | $0.4 M |

Currently there is three phase power in proximity to the Project area. The preferred power source for the river intake and booster pumps, based on environmental impact and long-term cost, is Hydro-electric power; but capital costs will have to be evaluated to determine payback on investing in Hydro-electric power vs. Diesel engines or generators. An option that will be evaluated would be electric motors with diesel generator which could be converted in the future. The pivot(s) can be run off single phase power, which is part of the plan.

Swansfleet Alliance is a long-time agricultural producer operating in the RMs of Norfolk Treherne, Victoria, Glenboro South Cypress, Lorne and Argyle. Swansfleet Alliance employs a significant workforce involved with all aspects of farm operations. The Project is geared to enhance the environmental and economic security of this farm operations, and to maintain and enhance their employment opportunities. Incremental employment due to the Project is associated with construction (short term) and operations (long term).

### *4.5 Public Safety and Human Health*

Public safety is a primary concern for Swansfleet Alliance. This starts with on farm safety for their employees but extends to off farm safety associated with truck traffic from the Project area to the potato storage sites. Swansfleet Alliance maintains existing potato storage and grain handling facilities at several locations, then main one being south of Holland on PTH 34.

All truck drivers are provided with ongoing safety training, including defensive driving, follow standard operating procedures and are subject to scheduled performance reviews.

All irrigation pipelines are mapped with GPS and as-constructed plans can be filed with the RM of Norfolk Treherne as required. The majority of pipeline will be located on easement on private property. The RM will be approached to allow the pipelines to be buried in their road allowances. Pipelines will be duly marked on each ½ mile (per their location).

Pipeline crossings are of special consideration for irrigation projects. All road crossings include an encasement pipe, which is intended to contain pipeline water breaks to outside the travelled road and to prevent sink holes on the traffic area. All creek crossings will be marked on either site of the creek. All other crossings will adhere to appropriate regulations (e.g., Transport Canada, Manitoba Infrastructure), and will require approval by the appropriate authorizing agency.   The irrigation intake is a special consideration, Transport Canada will be notified of the project plans and designs per requirements of the Canadian Navigable Waters Act.

Riser pipes are used to bring water to the edge of fields and to allow for venting of air and water. All riser pipes (turnouts, air valves, valves) are protected with wooden bollards which are painted white and include reflectors and signage. Special care needs to be taken where known off road activity is occurring (e.g., quads, snowmobiles).

The raw water being pumped in the pipelines poses no risk to human health as it is not modified in any form. Backflow prevention devices will be provided on farm where fertigation systems are employed at the pivots, to prevent uncontrolled discharge of fertilizer in the event of pipeline breaks.

The irrigation systems are automated and are complete with safety shut offs to prevent them from moving off farm.

The remaining farming processes (e.g., planting, spraying, harvest) are carried out in accordance with Provincial farm safety regulations; and Swansfleet Alliance have ongoing safety programs for their members.

All contractors operating on the construction sites will be required to be COR certified or equivalent (Construction Safety Association of Manitoba, 2014).

### *4.6 Protected Areas*

There are no parks or protected areas located with the Project area. There are several protected Wildlife Management Areas along the Assiniboine River in the vicinity of the Project area (e.g., within 10 km); these are all associated with the Whitemud Watershed Wildlife Management Area – Lower Assiniboine Sub-Unit. The nearest provincial park is the Spruce Woods provincial park which is approximately 25 km west of the Project area.

Assiniboine Hills Conservation District (IWRM) identified the following priority conservation areas which are located at distances > 25 km from the Project.

> *The Central Assiniboine and Lower Souris River Watershed contains a number of ecologically important sites, some of which are legally protected areas. Spruce Woods Provincial Park and the Spruce Woods Provincial Forest Reserve offer excellent mixed grass prairie habitat, and are home to endangered and threatened species including the northern prairie skink, hognose snake, and burrowing owl. The Brandon Hills Wildlife Management Area is a large hilly region situated upon a large glacial moraine. The well drained soils support a diverse range of prairie wildlife. The Souris River Bend Wildlife Management Area was originally established as a whitetail deer haven, but also serves to conserve valuable riparian habitat along the lower Souris River. The Alexander - Griswold Marsh and Douglas Marsh are two nationally renowned wetland complexes that serve as important staging and nesting habitat for migratory birds. Both marshes are designated as Important Bird Areas, and Douglas Marsh Protected Area is protected through provincial legislation.*

### *4.7 Indigenous Communities*

The nearest Indigenous communities to the Project consist of First Nation communities of Dakota Tipi, Dakota Plains and Long Plain First Nation to the east, Swan Lake to the south, and Rolling River to the north. Sioux Valley First Nation, Long Plain First Nation and Dakota Tipi First Nation are located along the Assiniboine River. Long Plain has previously developed irrigation project withdrawing water from the Assiniboine River. All First Nation communities are greater than 15 kms from the Project area and have no known interest in Project.

### *4.8 Heritage Resources*

Contact was made with Manitoba Historic Resources Branch (HRB) in to ascertain what existing heritage resources exist within the Project area. A copy of the correspondence is included in Appendix C (C.2).

The HRB has heritage concerns with the proposed development due to its proximity to the Assiniboine River, and its tributaries that form its watershed all of which have several archaeological sites along and near their margins (See correspondence AAS-22-18775; Appendix C.2).

A Heritage Resource Impact Assessment (HRIA) is required for the project with the requirement to include a systematic pedestrian survey and shovel testing of the water pipeline route and water intake in NW and SE-18-9-9 WPM, as well as the in Section 8-9-9 WPM.

It is understood from the communication with the Proponent that, apart from the pipeline installation, they are not anticipating any significant ground disturbance within the irrigation field (8-9-9W1) which will eliminate the need for an HRIA in the entire quarter section, except for the pipeline route.

A proposal for an HRIA was received and put on hold for spring/summer 2023. The HRIA will include obtaining a Heritage Permit from the HRB and conducting a background review to determine areas of archaeological potential. The fieldwork component will entail ground-truthing via pedestrian survey and conducting a systematic shovel testing program to determine the presence of surface and sub-surface heritage resources to satisfy Provincial requirements.

Under provisions of *The Heritage Resources Act* (1986), land developers may be called upon to provide for, at their own cost, the mitigation of impacts on Manitoba heritage resources.

## ***4.9 Greenhouse Gas Emissions and Climate Change***

### ***4.9.1 Agriculture and Greenhous Gas Emissions***

Agriculture is a major industry and key driver of the Canadian economy and Manitoba's economy alike. The agriculture sector is also a major contributor to greenhouse gas (GHG) emissions, representing approximately 10% of total emissions in Canada (Fouli et al., 2021).

The main GHGs emitted from agricultural activities are carbon dioxide ($CO_2$), methane ($CH_4$) and nitrous oxide ($N_2O$). Of agricultural emissions, Fouli et al., (2021) note:

- Methane represents about 38% of the total and originates from livestock activities (enteric fermentation and manure management).
- Nitrous oxide represents about 36% of the total and comes from direct emissions from agricultural soils (24.5%), manure management (6.5%) and indirect emissions agricultural soils (5.0%).
- Carbon dioxide represents the remaining 26% of the total and comes from fertilizer supply (8.6%), field work (6.8%), machinery supply (4.7%), on-farm transport (2.1%), electricity supply (2.0%) and heating fuel (1.7%).

Agricultural soil is considered both a source and a sink of GHGs. The primary source mechanism is $N_2O$ emission because of nitrogen fertilizer application and decomposition of biomass. Wet soil conditions can exacerbate $N_2O$ losses. Agricultural soils can also be a sink (i.e., net reduction of GHG) through carbon sequestration or the removal of atmospheric $CO_2$ by soils. This can be a significant mechanism and resulted in a decline in net GHG emissions (emissions minus removals by soil) between 1981 and 2011, a trend largely the result of the adoption of beneficial management practices in the Canadian prairies (Fouli et al., 2021).

BMPs to reduce GHG emissions include reduced tillage, decreased summerfallow, and the inclusion of cover crops and perennial forages into the annual crop rotation. While carbon sequestration can result in a reduction of GHG emissions, it is a reversible process whereby land use changes or changes in management practices can result in de-sequestration or the loss of $CO_2$ from soils.

John Deere (2021) provides an example of how the agricultural industry is responding to the challenge of sustainability. Deere technology (e.g., Exact Apply, AutoSteer, etc.) can reduce $CO_2$ output substantially (e.g., 489 Tonnes on 3000 Acre Cotton Farm).

Options for offsetting increasing $CO_2$ production include on-farm technology and operations as well as purchasing carbon credits (Janzen, 2021).

Tile Drainage should result in reduction in saturated soils and therefore reduction in $N_2O$ losses. BMPs (Appendix H) are available to reduce the impact of tile drainage on tile outflow water quality.

#### *4.9.2 Climate Change Implications for Agriculture*

Climate change is expected to bring both challenges and opportunities to Canada's agricultural sector because of increased temperatures, longer growing seasons, shifting precipitation patterns and an increase in frequency and intensity of extreme weather events. Agriculture and Agri-Food Canada (AAFC, 2020) provides a summary of predicted trends from climate change for the Prairie region, as follows:

- Increased frost-free periods may provide opportunities for the expansion of warm weather crops such as corn and soybeans as well as a potential northwards expansion of agricultural production where soils permit.
- Reduced precipitation later in the growing season, coupled with increased heat will cause stress to plants and may have a negative impact on yields.
- More frequent spring flooding, summer droughts and extreme weather events are expected.
- Reduced streamflow, less snowmelt to recharge rivers and earlier peak flows could lead to reduced access to water for irrigation during the summer and greater competition for groundwater reserves.
- A warmer climate may bring new pests and diseases.
- Increased temperatures could affect livestock health, resulting in reduced milk, egg and meat production and even fatalities, increased cooling costs for producers.
- Higher $CO_2$ levels may result in greater productivity from crops such as wheat, barley, canola, soybeans, and potatoes.

Climate change projections suggest the potential for a more diversified cropping system across the Prairie region, including the incorporation of crops requiring a longer growing season and higher crop heat units. Projections also suggest that crop water may become more limiting with reduced precipitation later in the growing season in combination with higher temperatures (i.e., increased evaporation and evapotranspiration). This, coupled with more extreme events (e.g., higher proportion of growing season precipitation in fewer, larger rainfall events and more frequent drought) provides an argument for increased crop water demand and increased crop water deficits across the region. The benefits associated with supplemental irrigation should, therefore, increase over time. The predicted trends and irrigation need discussed above also suggest irrigation water storage needs may increase over time. The Proponent is committed to work with Provincial regulators to optimize use of the allocated water resource.

# 5.0 Environment Effects

Potential impacts of the development on the environment, are described in detail in this section, including recommendation of mitigation measures and subsequent significance of the impact on the environment of the Project area.

## 5.1 *Impact and Mitigation on Physical Environment*

### 5.1.1 *Impact on Geology and Groundwater*

There is no planned groundwater withdrawal associated with the project. There are no direct groundwater users on the parcels planned for irrigation.

There are domestic/farm wells on all sides of the irrigated land base. Follow up by the Proponent could include inventory of existing wells and one on one discussions any nearby well owners to obtain baseline water quality sampling (e.g., to define pre-Project conditions) of any nearby (e.g., < 500m) groundwater users.

The major unique geologic features near the Project are the Assiniboine Delta Aquifer, the Assiniboine River and the river Valley slopes. Care will be taken with pipeline construction to identify any potential for downslope groundwater movement in trenches, and provide interception and disbursements (e.g., clay plugs and sand filters) to prevent severe erosion of the pipeline trench or valley slope instability. This will be documented in the pre-design report by PBS Water Engineering Ltd.

The irrigated lands will follow Beneficial Management Practices regarding wind and water erosion and Provincial nutrient management guidelines based on individual field by field basis (see nutrient management zones Map 7; Appendix A). These practices have the benefit of protecting underlying groundwater quality.

***There are no significant impacts anticipated on geology and / or groundwater because of the proposed construction or operation activities.***

### 5.1.2 *Impact Surface Water Hydrology and Water Quality*

Surface water will be diverted and pumped into the pipeline distribution and irrigation application systems. The intake and pipeline network will be engineered by qualified professional engineers registered with their Association of Professional Engineers and Geoscientists in Manitoba.

Water diversion rates will vary at a rate of up to a maximum of 189 liters per second (3000 US gpm). Diversions would last for up to 38 days depending on the irrigation requirement and the water rights limits (666 $dam^3$; 540 acre-feet applied for). The water to be diverted is largely post freshet and includes local snowmelt and rainfall runoff, releases from Shellmouth Dam and a component of groundwater baseflow from the Assiniboine Delta Aquifer. Allocation will be made by Manitoba Environment, Climate and Parks from available water allocation budgets, based on careful consideration of economic and environmental uses of water. The Project is still awaiting a Development Authorization Permit for construction (Appendix C [C.1]).

The Project will be issued a Water Rights Licence after construction. All Water Rights License conditions will be adhered to by the Proponent.

The Project will have little impact on the large channel forming flows on the Assiniboine River, with maximum diversion rates at less than 0.6% of observed median August daily flows (e.g., median August flow of Assiniboine River at Holland (29 $m^3/s$)). Maximum Assiniboine River flows can reach to > 1400 $m^3/s$ during major floods. Minimum in stream flows (MIF) will be maintained in accordance with any EAL and Water Rights Licenses issued; it is anticipated the MIF will be in the order of 6 $m^3/sec$. Variable rate pumping can be utilized to maintain minimum required flows (e.g., based on request from Province), especially IF multiple quarter section pivots are utilized in lieu of the section pivot. The minimum in-stream flow will help to maintain downstream flow during withdrawals. The Proponent can monitor Assiniboine River flows on Water Survey Canada website for Gauging Station 05MH005 in real time.

The impact of tile drainage and irrigation on runoff are described in Section 5.1.3 (Impact and Mitigation on Soil-Landscape Resources). That section also describes the impact of irrigation and drainage on nutrient management. Swansfleet Alliance will make some consideration of tile drainage water management going forward, with reference to recent BMPs issued by Manitoba Agriculture through PAMI (available at: http://pami.ca/beneficial-management-practices-for-agricultural-tile-drainage-in-manitoba/) (Appendix I). It is possible that Controlled Drainage may be beneficial on a portion of the Project area.

Measures to prevent sediment runoff from Project construction sites is described under Section 5.2.3 (Impact on Fisheries) and Section 5.1.4 (Impact on Soil Erosion and Transport).

Backflow prevention will be included on all irrigation systems, and those employing fertigation systems; to prevent backflow of fertilizer into the distribution pipelines. Discharge from irrigation pipeline to waste (e.g., ditches) will be controlled and only undertaken during filling, commissioning, and draining of the pipelines.

***There are no significant impacts anticipated on surface water hydrology or surface water quality because of proposed construction or operation activities.***

### *5.1.3 Impact and Mitigation on Soil – Landscape Resources*

Stantec (2011) established guidelines for assessing the suitability of soil-landscapes for irrigated crop production in Manitoba. In accordance with that guideline, individual field by field assessments were made for the 4 fields being considered for irrigation development. The land suitability assessment, certification of irrigation suitability and recommendation of Best Management Practices was completed by a Professional Agrologist (AgriEarth Consulting Ltd.).

Table 11 provides a summary of recommendations for irrigation suitability for each field. Generally, the fields proposed for irrigation are well-suited for irrigation and the production of potatoes, as discussed in Section 4.1.8 and summarized in tables 6 and 7, and no additional field investigations are recommended to confirm suitability at this time.

However, some limitations to irrigated crop production, specifically potatoes, require special consideration prior to development and/or require special management consideration if developed for irrigation. Specifically, the occurrence of coarse textured soils in depressional and complex slope areas along with associated ratings of Fair and Poor for general irrigation suitability and Class 4 and 5 for land suitability for irrigated potato production affect a portion of the Project area in each field. Class 4 soils are less desirable for irrigated potato production in this case due to water holding capacity and complex slope class, leading to difficulty in maintaining uniform growing conditions, and in-efficiency in irrigation and nutrient applications. Class 5 soils are considered to have the least desirability for potato production in this case due to wetness, drainability, and soil water movement. The agronomic limitations these soils pose for irrigated potato production are difficult to mitigate through improvement or other management practices. The field areas affected by these limiting sandy soils are considered to have a precautionary recommendation for irrigation development.

Assessment of irrigation suitability includes consideration of the impact of the addition of supplemental water through irrigation on soil drainage limitations. The Project study area has a significant percentage of imperfectly drained soils (Map 5, Appendix A). A significant portion of the soils are considered well drained, primarily in the northern portion of the Project study area. A very small area is considered poorly drained (i.e., depressions), while a portion of the study area in the eastern extent of SE-8-9-9-W1 is considered rapidly drained.

Due to the limitations associated with imperfectly drained soils, the proponent is considering tile drainage improvements in areas affected by imperfect drainage in the future. The primary benefit of tile drainage would be relief of high-water tables in early spring, and allowing for earlier planting, easier access for implementation of best production practices, and prevention of crop drown out (Sands, 2013). Secondary benefits to the environment would be reduced surface runoff (Sands, 2013) and associated sediment and phosphorus loading to the streams. Improved crop production uniformity and crop productivity resulting from tile drainage improvements are generally considered beneficial to environmental sustainability of the crop production system in this region, as previously discussed in Section 4.1.7.

***There are no significant impacts anticipated on soil landscape resources resulting from proposed irrigation (and associated drainage) development. The guidelines through which BMPs were identified are described in more detail in Stantec (2011).***

#### *5.1.4 Impact on Soil Erosion and Transport*

Wind and water-driven soil erosion is an important consideration in the soils of the Project study area. Traditionally, BMPs implemented in the Project study area include shelterbelts, cover crops and reduced tillage of crops in rotation with potatoes. The implementation of tile drainage is considered a relatively new measure to reduce the potential for soil erosion due to water, as it increases the available storage of infiltrated water and reduces surface ponding and runoff. In addition, saturation levels are reduced on tile drained land, conditions favourable for soil compaction are reduced, and water infiltration is increased, adding to crop water utilization, and again reducing water erosion.

The land being proposed for irrigation is already under annual crop production, the development of irrigation for potato production results in an incremental change to potential impact on soil erosion. The production of potatoes represents an intensification of the annual cropping system, including, typically, more intensive soil disturbance (seedbed preparation, hilling, harvesting, etc.). Therefore, BMPs are recommended to mitigate the potential for increases in soil erosion risk and potential for increased soil loss.

Specific BMPs that should be incorporated include, but are not limited to:

- Residue Management and Tillage
  - Reduced/conservation tillage practices will be adopted where feasible.
  - Anchoring of potato vines with light disking following harvest.
  - Crop rotation will include high residue crops, namely fall rye following potato crops.
  - Stubble and trash (e.g., corn stalks) will be managed to minimize fall tillage, promote incorporation and/or maintain stubble.
  - In extreme situations straw will be spread to increase trash on field after potato harvest (e.g., where cover crops not possible and erosion potential significant).

- Fall Cover Crops
  - Fall rye or other non-traditional cover crops are planned for the crop rotation and will be planted following potato harvest (e.g., on early harvested fields), whenever timing permits.

- Shelterbelts and Permanent Cover
  - Shelterbelt planting will be maintained where feasible (e.g., edge of field, block plantings) depending on the nature of the irrigation system and field shape.
  - Permanent grass cover will be maintained along edges of waterways, in depressional areas and potentially on highly erodible sand knolls.

- Irrigation and Drainage
  - Irrigation of dry soils in spring in extreme conditions to mitigate wind erosion risk.
  - Prevent over-irrigation (e.g., saturate soils) by monitoring soil moisture and following irrigation scheduling, to prevent irrigation from contributing to runoff events.
  - Irrigate at application rates below the infiltration rate of the field specific soil.
  - Incorporation of tile drainage in the future to improve soil potential for infiltration and improve water usage.
  - Use of dammer-diker system to create surface water storage in rows to improve soil capacity to infiltrate larger rainfalls and reduce runoff.

Construction activities must also account for the potential erosion of bare soil exposed or modified during construction of the proposed pipelines. Best construction practices to be followed to manage erosion and sedimentation related to pipeline development are documented in Appendix E. Contractors will be required to follow the prescribed measures for erosion and sediment control. Protection of soils exposed during excavation and installation of pipelines should also be considered. If pipelines are installed through areas of permanent cover (e.g., grassed areas), these areas should be re-seeded with an appropriate seed mix following the completion of pipeline installation, and temporary erosion control measures implemented during re-vegetation phase (e.g., erosion control mats on steeper slopes; surface water diversion berms to control downslope water movement).

***Given the implementation of the Best Management Practices as outlined above and as summarized in Table 11, there are no significant impacts anticipated on Soil Erosion and Transport anticipated because of the Project.***

#### *5.1.5 Soil Nutrients*

Most of the soils in the Project area are rated as nutrient management zone N1 (13%) or N2 (80%) in accordance with the Nutrient Management Regulation (M.R. 62/2008). This legislation dictates the allowable residual soil nitrogen according to soil-landscape properties and allowable phosphorus application rates based on residual phosphorus concentrations. The regulation is intended to guide sustainable production systems that will minimize nutrient losses to surface water and groundwater.

Agronomic management influences the nutrient balance in the soil and potential risk of leaching and/or runoff losses. In recent years, a better understanding has developed of the benefits to potato yield and quality from tailoring fertilizer to crop demand (i.e., "spoon-feeding"). Fertigation systems have become a common element of irrigation systems designs for delivering supplemental nitrogen needs. Fertigation allows lower starter nitrogen applications and, combined with the timing of small, subsequent applications, minimizes the potential for leaching losses following early season rainfall events. Combined with advanced methods such as variable rate nutrient application systems there is now advanced capacity to better precision farm for optimized nutrient use efficiency. Generally, 4R nutrient stewardship should be followed for sound nutrient management for the cropping system on fields associated with the Project.

Some BMP guidelines for potato production and soils under tile drainage are available, as follows:

- University of Minnesota (2008) documents BMPs for Nutrient Management on Irrigated Potatoes (see Appendix G), available at:
  https://conservancy.umn.edu/bitstream/handle/11299/198232/n-bmps-irrigated-potatoes-2008.pdf?sequence=1&isAllowed=y

- BMPs for nutrient management under tile in Manitoba, including considerations for nitrogen, phosphorus and manure nutrient sources, are provided through the Prairie Agricultural Machinery Institute (PAMI), available at:

  http://pami.ca/beneficial-management-practices-for-agricultural-tile-drainage-in-manitoba/

The suite of BMPs available for producers include the following:

- Application rates for nitrogen fertilizer should be based on recommended rates for potato variety and yield anticipated and should be appropriate for the Manitoba climate.
- Account for spring soil nutrient status determined from soil sampling.
- Meet the requirements of the Nutrient Management Regulation (62/2008) including managing nitrogen to meet allowable nutrient residual concentrations, considering limiting nutrient management zone classifications, and following phosphorus application limits based on soil residual concentrations.
- Plan nitrogen application to achieve high efficiency of N use and minimal leaching to shallow groundwater and tile outflow.
  - Split application of N during planting and hilling
  - Fertigation of N during remainder of year where equipment is utilized.
  - Petiole analysis of potato crop after emergence to track nutrient status of plant and indicate demand for split applications.
  - No nitrate in starter N.
- Practice irrigation scheduling and tailor irrigation applications to soil water holding capacity to avoid over-irrigation to minimize the potential for creating leaching conditions and/or events.
- Track performance of nutrient management through water quality testing using groundwater monitoring and tile outflows, if applicable.
- Consider University of Minnesota Irrigation Water Management Considerations for Sandy Soils; AG-FO-3875 (see Section 5.1.6 below).
- Consider PAMI Nutrient Management BMPs for Tile Drainage (IF-01) (as introduced above and included in Appendix F).
- Keep comprehensive field by field record keeping.
- If manure is utilized:
  - Test manure for nutrient content.
  - Calibrate manure application equipment.
  - Apply manure uniformly through the field.
  - Incorporation of manure.
  - Follow Manitoba Nutrient Management Regulations related specifically to manure.

- Establish fall cover crops to utilize residual nitrogen, maintain soil health, and increase moisture infiltration in spring (Kahimba et al. 2008). Kahimba et al. (2008) found that during the spring, the cover crop treatment warmed and thawed earlier enabling more snow melt infiltration. If cover crops are used, removal of vegetative material prior to freeze up should be considered to reduce the potential for surface phosphorus losses from decaying vegetative material.

***Given the implementation of the Best Management Practices as outlined above and as summarized in Table 11, there are no significant incremental impacts anticipated on unintended loss of soil nutrients anticipated because of the Project.***

### *5.1.6 Impact of Water Conservation Methods on Water Usage*

Managing irrigation systems for optimal use of allocated water resources requires a detailed assessment of crop water demands, field soil and topographic variability, irrigation and monitoring equipment technologies, and advanced agronomic techniques.

Variable rate irrigation technology is still in the early adoption phase (Evans et al., 2013), but none the less is being actively pursued by manufacturers and producers in many jurisdictions (including the Proponent). The future promise of this technology is for better utilization of available water resource, which is limited and increasingly expensive to develop. The Proponents are committed to using the latest irrigation technologies as it becomes technically and economically feasible.

Irrigation scheduling relies on first understanding the soil-landscape and the available water holding capacity. The University of Minnesota Publication – Irrigation Water Management Considerations for Sandy Soils in Minnesota (AG-FO-3875) provides an excellent summary of the concepts and technologies for managing water in the types of soils within the Project area.

The concepts that must be understood are summarized here about the information contained in the individual field by field agronomic/irrigation suitability assessments.

#### 5.1.6.1 Soil Texture and Infiltration

Soil texture is a major determining factor in the ability of a soil to hold water. Detailed soils survey information was available for all Project fields, resulting in suitable mapping of the soil polygons for the entire Project. As slopes are predominantly level to nearly-level, or in some cases gently rolling soil texture largely determines infiltration rates in this soil-landscape. The predominantly coarse to moderately coarse (loamy fine sands to fine sandy loams) textured soils would be expected to have infiltration rates in the range of 5 to 13 cm/hr (1.9 to 5.2 in/hr).

The irrigation systems will be designed to ensure that application rates do not exceed infiltration rates to minimize the potential for surface ponding and runoff and ponding due to the application of irrigation water.

Future considerations could include variable rate irrigation specifically geared to zoned variation of irrigation amounts to better match water holding capacity, soil slopes, irrigation demand variation and risk of surface water runoff.

#### 5.1.6.2 Internal Drainage Class and Water Table Contribution

Soils in the Project are rated as imperfectly drained (61% of the Project study area). The need for irrigation on imperfectly drained soils will be to some degree mitigated by the contribution of shallow groundwater to crop growth through capillary rise into the crop rooting zone (Cordiero, 2013). Typically, imperfectly drained soils require less water than well drained soils due to this effect. The impact for water conservation is that irrigation scheduling and applications should be adjusted to account for this contribution (i.e., when groundwater conditions are such that water is being supplied through capillary rise).

Estimated heights of capillary rise above the surface of the groundwater table for different soil texture classes are provided in Table 10. The predominantly coarse to moderately coarse textured soils in the Project study area would be expected to experience capillary rise in the range of only 17 to 41 cm (7 to 16 in).

The elevation of the water table can be determined by a couple of methods. Tile drainage flow indicates water table within the depth of tile. For deeper measurements, test piezometers may be required. Typically, the shallow water table is regenerated each spring. However, situation may exist where the initial water table is significantly lower than the tile (e.g., preceding conditions). In this instance one could anticipate a higher irrigation demand.

***<u>Table 10 – Estimated Height of Capillary Rise in Different Soil Textures</u>***

| Soil Texture | Capillary Rise |
|---|---|
| Very coarse sand (VCoS) | 0.8" (2.0 cm) |
| Coarse sand (CoS) | 1.6" (4.1 cm) |
| Medium sand (S) | 3.2" (8.1 cm) |
| Fine sand (FS) | 6.8" (17.3 cm) |
| Very fine sand (VFS) | 16.0" (40.6 cm) |
| Silt (Si) | 40.0" (101.6 cm) |
| Clay (C) | >40.0" (>101.6 cm) |
| Source: Handbook of Drainage Principles, OMAFRA, Publication 73 taken from https://www.gov.mb.ca/agriculture/environment/soil-management/soil-management-guide/soil-salinity.html | |

#### 5.1.6.3 Available Water Holding Capacity

The available water holding capacity (AWHC) provides a measure of the amount of water that a soil can hold and make available for crop use. It is a useful measure to support irrigation scheduling and application depths. This is usually reported in inches per foot or mm per meter. Available water holding capacity is determined as the difference between field capacity and permanent wilt point. This is the total amount available to the plant and, when multiplied by the effective plant rooting depth, provides an estimate of the allowable depletion factor, or the amount of soil water drawdown that should be allowed prior to an irrigation application.

Irrigation applications should be tailored to replace the same amount of water that has been depleted to bring soil the soil water content back to field capacity.

The irrigation interval is simply the allowable water depletion divided by the rate of evapotranspiration less water supplied through rainfall and/or capillary rise. Irrigation systems must be designed to meet the peak water demands associated with maximum root depth, maximum evapotranspiration, and minimum precipitation. Short-term water deficits drive this design (e.g., Table 3). Variable application rates (timing intervals and/or application depths) over time and between fields can be utilized to account for variable evapotranspiration rates, variable effective rooting depth, changes in soil texture and AWHC, and landscape position/drainage class (e.g., proximity to capillary fringe).

For example:

- Applications of smaller amounts (reduced application depth) are favourable early in the growing season when effective rooting depths are relatively shallow and ET rates are relatively low.
- More frequent applications of smaller amounts (reduced application depth) are favourable on coarse textured soils with lower AWHC and allowable depletion.
- Less frequent and larger amounts (increased application depth) may be favourable on medium textured soils with high AWHC later in the growing season when effective rooting depths are relatively deep and ET rates are relatively high.

#### 5.1.6.4 Irrigation Scheduling Approaches

University of Minnesota (2008) documents the basic irrigation scheduling approaches:

- Feel method.
- Check book method.
- Soil water measurement (e.g., tensiometers, TDR).

Currently the producers actively use field specific climatic information and soil water measurement devices to assist in scheduling decisions.

The check book method (for example the Alberta Irrigation Management Model (Alberta Agriculture and Rural Development, 2014)) is not well suited to the Project area because it does not account for capillary rise (Ayers et al., 2006). The soil water measurement technology has recently taken on renewed interest due to the number of companies now offering real-time, telemetric monitoring solutions. This technology can improve the performance of the irrigation scheduler.

New technology is available to producers, to supplement and calibrate their field knowledge of soil water status. Real time irrigation sensors are being actively marketed by industry. These technologies not only provide real time instantaneous data but allow producers to see spatial and temporal trends as well as to document responses to rain and irrigation events, and the impacts of capillary rise.

The proponent will employ the services of  a professional agronomists (e.g., Certified Crop Advisor, Professional Agrologist) to help with evaluation of scheduling and irrigation technology in the context of the Project area soils. Producers in Manitoba have been actively involved with AAFC and University of Manitoba researchers, and local agro-meteorological companies and have experience in the application of this technology. While it is early in the process of technology adoption, there is no doubt that this type of data has led to an increased understanding of the water balance in these soils. An example of this approach is provided in Cordiero (2013), which is a Ph.D. thesis issued from the BioSystems Engineering department at the University of Manitoba, based on data from Hespler Enterprises Ltd. farm south of Winkler, MB.

***Given the implementation of the Best Management Practices as outlined above and as summarized in Table 11, there are no significant impacts anticipated on Conservation and Beneficial Use of Water Resources resulting from over-irrigation anticipated because of the Project.***

*__Table 11 – Proposed Irrigated Fields, Irrigation Suitability Recommendation and Recommended BMPs for Major Considerations__*

| Field ID | Legal Land Location | Irrigation Suitability Recommendation | Recommended Beneficial Management Practices (BMPs) | | | | | | | | | | | | | | | | | | | | | | Existing Tile Drainage Yes/No |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Nutrient Management | | | | Soil Erosion | | | | Soil Salinity | | | | Drainage Management | | | | Irrigation Management | | | Other | | | |
| | | | Nutrient Management Planning | Fertigation | Split Application | Other: Enhanced Efficiency Nitrogen | Residue Management | Fall-seeded Cereal Cover Crops | Reduced/Conservation Tillage | Other: | Subsurface Drainage Improvements | Salinity Monitoring Program | Permanent Cover Crop | Other: | Subsurface Drainage Improvements | Surface Drainage Management | Drainage Assessment | Other: | Irrigation Scheduling | Soil Moisture Monitoring | Other: | Other: | Other: | |
| 1 | NW 8-9-9 W1 | Recommended, precautionary[1] | x | x | x | x | x | x | x | | x | | | | x | x | x | | x | x | | | | no, future planned |
| 2 | NE 8-9-9W1 | Recommended | x | x | x | x | x | x | x | | x | | | | x | x | x | | x | x | | | | no, future planned |
| 3 | SW 8-9-9W1 | Recommended, precautionary[2] | x | x | x | x | x | x | x | | x | | | | x | x | x | | x | x | | | | no, future planned |
| 4 | SE 8-9-9W1 | Recommended, precautionary[3] | x | x | x | x | x | x | x | | x | | | | x | x | x | | x | x | | | | no, future planned |

**Notes:**
Refer to Stantec 2011 for more detailed information on the guidelines for irrigation suitability recommendations and determination of recommended beneficial management practices.

1. Recommended, precautionary due the occurrence of a significant portion of the field being either poorly drained soils or variable texture soils with complex slopes and associated ratings of Fair and Poor for general irrigation suitability and Class 4 and 5 for land suitability for irrigated potato production affecting a portion of fields. The agronomic limitations these soils pose for irrigated potato production are difficult to mitigate through improvement or other management practices within the designated soils zones.
2. Recommended, precautionary due to the occurrence of a significant portion of the field being coarse texture soils on complex slopes with associated ratings of Fair for general irrigation suitability and Class 4 for land suitability for irrigated potato production. The agronomic limitations these soils pose for irrigated potato production are difficult to mitigate through improvement or other management practices within the designated soils zones.
3. Recommended, precautionary due to the occurrence of a very small portion of the field being poorly drained (e.g., depressional) of Poor for general irrigation suitability and Class 5 for land suitability for irrigated potato production. The agronomic limitations these soils pose for irrigated potato production may be mitigate through improvement or other management practices within the designated soils zones.

## *5.2 Impact and Mitigation on Terrestrial and Aquatic Environments*

### *5.2.1 Impact on Terrestrial Habitat and Wildlife*

The existing wildlife habitat is part of the Assiniboine River valley corridor that dominates the Project area. Map 4 (Appendix A) highlights the existence of the natural valley habitat dispersed amongst cultivated land base within the Project area.

There will be no loss of trees on the irrigated parcel, with efforts to maintain/add to existing field shelterbelts, and/or replace any disturbed by the irrigation systems installations. Shelterbelt plantings could add marginally to the habitat value in the SW corner of the SW 8-9-9 W1 (e.g., Skelding soils)

The pipeline route has been selected to avoid or minimize disruption of valley habitat (e.g., Figure 8), and care will be taken to revegetate any disturbed areas to prevent erosion and allow continuity of wildlife access across the pipeline route. There will be a narrow loss of mature tree habitat (10 m wide x 125 m long) on the lower portion of the pipeline (upper bench to lower bench); which will be re-vegetated to permanent cover (i.e., grass).

There are no proposed Creek crossings.

***The adverse effects on vegetation and wildlife and wildlife habitat are expected to be short-term in duration (limited to the construction phase and less than one year in duration for any given phased construction area) and of low magnitude. Significant adverse effects to the terrestrial environment are not anticipated because of the Project.***

### *5.2.2 Impact on Species at Risk*

The Manitoba Conservation Data Center have been consulted regarding the potential for species at risk being reported in the Project area. There are no occurrences within the Project area. Fourteen species at risk have been identified in the general area in the vicinity of the Project. The Proponent will consult a specialist on how to identify and avoid impact on these species as part of project construction planning.

The Proponent is currently proposing to engage a Professional Biologist to undertake an assessment of the Assiniboine River intake site development plan, including the impact of any bank stabilization for the intake; to ensure revegetation and prevention of erosion / slumping. The Professional Biologist will also consider the impact of the proposed intakes on Assiniboine River aquatic species and especially species at risk (e.g., Mapleleaf Mussels).

***The potential for species at risk or of conservation concern has been confirmed through a CDC search and in the case of Aquatic species through consultation with a Professional Biologist. However, due to the nature of Project activities and the current land use in the Project area species at risk not currently anticipated to be significantly impacted by Project activities.***

#### *5.2.3 Impact on Fisheries*

The Assiniboine River in the Project area is known to support Commercial, Sport/Recreational, Domestic or Indigenous, and SARA fish species.

A Professional Biologist will be engaged to assess the project impact on Fisheries and Aquatic Species at Risk (e.g., Mapleleaf Mussels) and review plans and specifications for intake systems and riverbank and riparian area stabilization if/as required to prevent negative impact of fisheries (e.g., prevent erosion and slumping).

The project as designed will not reduce the width of the Assiniboine River at the site.

General DFO guidelines for minimizing impact of construction activities on Fisheries will be followed including but not limited to:

***General activities around water***

- Plan activities near water such that materials such as paint, primers, blasting abrasives, rust solvents, degreasers, grout, or other chemicals do not enter the watercourse.
- Develop a response plan that is to be implemented immediately in the event of a sediment release or spill of a deleterious substance and keep an emergency spill kit on site.
- Ensure that building material used in a watercourse has been handled and treated in a manner to prevent the release or leaching of substances into the water that may be deleterious to fish.

***Construction of Access to the River***

- Clearing of riparian vegetation should be kept to a minimum: use existing trails, roads or cut lines wherever possible to avoid disturbance to the riparian vegetation and prevent soil compaction. When practicable, prune or top the vegetation instead of grubbing/uprooting.
- Minimize the removal of natural woody debris, rocks, sand or other materials from the banks, the shoreline, or the bed of the waterbody below the ordinary high-water mark. If material is removed from the waterbody, set it aside and return it to the original location once construction activities are completed.
- Immediately stabilize shoreline or banks disturbed by any activity associated with the Project to prevent erosion and/or sedimentation, preferably through re-vegetation with native species suitable for the site.
- Restore bed and banks of the waterbody to their original contour and gradient; if the original gradient cannot be restored due to instability, a stable gradient that does not obstruct fish passage should be restored.
- If replacement rock reinforcement/ armoring is required to stabilize eroding or exposed areas, then ensure that appropriately sized, clean rock is used; and that rock is installed at a similar slope to maintain a uniform bank/shoreline and natural stream/shoreline alignment.
- Remove all construction materials from site upon Project completion.

***Using Deisel Generators or Engines for Pumping***

- Ensure that machinery arrives on site in a clean condition and is maintained free of fluid leaks, invasive species and noxious weeds.
- Whenever possible, operate machinery on land above the high-water mark, in a manner that minimizes disturbance to the banks and bed of the waterbody. Have a plan to remove equipment prior to site flooding.
- Wash re-fuel and service machinery and store fuel and other materials for the machinery in such a way as to prevent any deleterious substances from entering the water.

***During Creek/Drain Crossings***

- Limit machinery fording of the watercourse to a one-time event (i.e., over, and back), and only if no alternative crossing method is available. If repeated crossings of the watercourse are required, construct a temporary crossing structure.
- Use temporary crossing structures or other practices to cross streams or waterbodies with steep and highly erodible (e.g., dominated by organic materials and silts) banks and beds. For fording equipment without a temporary crossing structure, use stream bank and bed protection methods (e.g., swamp mats, pads) if minor rutting is likely to occur during fording.
- Time works in water to respect timing windows to protect fish, including their eggs, juveniles, spawning adults and/or the organisms upon which they feed. Guidance on timing is provided by the Department of Fisheries and Oceans at: http://www.dfo-mpo.gc.ca/pnw-ppe/timing-periodes/mb-eng.html
- Minimize duration of in-water work.
- Conduct in-stream work during periods of low flow, or at low tide, to further reduce the risk to fish and their habitat or to allow work in water to be isolated from flows.
- Schedule work to avoid wet, windy and rainy periods that may increase erosion and sedimentation.
- Design and plan activities and works in waterbody such that loss or disturbance to aquatic habitat is minimized and sensitive spawning habitats are avoided.
- Design and construct approaches to the waterbody such that they are perpendicular to the watercourse to minimize loss or disturbance to riparian vegetation.
- Avoid building structures on meander bends, braided streams, alluvial fans, active floodplains, or any other area that is inherently unstable and may result in erosion and scouring of the stream bed or the built structures.
- Undertake all instream activities in isolation of open or flowing water to maintain the natural flow of water downstream and avoid introducing sediment into the watercourse.

***During Construction of Intake Access and Pipeline Distribution Systems***

- Develop and implement an Erosion and Sediment Control Plan for the site that minimizes risk of sedimentation of the waterbody during all phases of the Project. Erosion and sediment control measures should be maintained until all disturbed ground has been permanently stabilized, suspended sediment has resettled to the bed of the waterbody or settling basin and runoff water is clear. The plan should, where applicable, include:
    - Installation of effective erosion and sediment control measures before starting work to prevent sediment from entering the water body.
    - Measures for managing water flowing onto the site, as well as water being pumped/diverted from the site such that sediment is filtered out prior to the water entering a waterbody. For example, pumping/diversion of water to a vegetated area, construction of a settling basin or other filtration system.
    - Site isolation measures (e.g., silt boom or silt curtain) for containing suspended sediment where in-water work is required (e.g., dredging, underwater cable installation).
    - Measures for containing and stabilizing waste material (e.g., dredging spoils, construction waste and materials, commercial logging waste, uprooted or cut aquatic plants, accumulated debris) above the high-water mark of nearby waterbodies to prevent re-entry.
    - Regular inspection and maintenance of erosion and sediment control measures and structures during construction.
    - Repairs to erosion and sediment control measures and structures if damage occurs.
    - Removal of non-biodegradable erosion and sediment control materials once site is stabilized.

***Design of Intake Systems***

- Ensure that all in-water activities, or associated in-water structures, do not interfere with fish passage, constrict the channel width, or reduce flows below required in-stream levels.
- The Assiniboine River fishery will require the intakes to be be screened, to prevent impingement and/or entrainment of juvenile fish species. The proposed screening size and model (self – cleaning) will be reviewed by the Professional Biologist and submitted to DFO if/as required.

***The potential for impacts on riparian habitat will be limited to a small area (i.e., < 500 m2) and of low magnitude.  The potential for impact on Fisheries due to construction or operation activities will be mitigated by employing best practices when constructing and operating in proximity to the Assiniboine River, by limiting withdrawal rates to maintain the minimum instream flow rate (rate to be confirmed), and by employing appropriate intake screens to prevent impingement and/or entrainment of fish species.***

## 5.3 Impact and Mitigation on Socio Economic Conditions

### 5.3.1 Impact and Mitigation on Heritage Resources

Heritage Resources Branch have been consulted and have recommended a field survey given the nature of the site relative to the potential for the presence of Historic resources. A Professional consultant will be engaged to carry out the reconnaissance of the site and recommendations for Heritage Resource avoidance and preservation will be followed.

### 5.3.2 Economic Activity and Employment

Swansfleet Alliance employees work full time within the RMs of Norfolk-Treherne, Victoria, Glenboro-South Cypress, Argyle and Lorne. Swansfleet Alliance is a taxpayer, and an active member of the rural communities within which it resides and farms.

Construction activity will involve members of the Swansfleet Alliance, local construction companies, Provincial utilities (e.g., Manitoba Hydro), regional and local suppliers, international, national, regional and local manufacturers.

All contractors will be advised of environmental protection requirements and will be required to maintain safe working conditions for employees and the public.

### 5.3.3 Traffic

The Project already generates traffic from the Project area to the nearby Provincial Roads and Highways (e.g., PR 242, PTH 2) in the vicinity of Treherne and Holland, Manitoba. The implication of construction of the Project will mean a short-term increase in traffic during construction within the Project area (Map 1, Appendix A). The current levels of traffic associated with seeding, crop protection and harvest will be maintained or increased slightly due to additional crop production. However, this increase should be manageable within the rural environment and with consultation with neighbours and the RM of Norfolk Treherne and Victoria.

Every effort will be made to reroute truck traffic around points of congestion during high traffic periods. Swansfleet Alliance drivers will be given standards of operation for this purpose.

### 5.3.4 Utilities

Existing utilities will not be interrupted because of the construction of the Project. All utilities will be located in the field prior to any / all site investigations, underground construction and boring. There are no planned Highways or Provincial Drain crossings. The RM Road crossings will be pre-approved by the RM and will be lined with an encasement pipes to prevent caving of the roadway in the event of a pipeline failure. Crossings of rural water pipelines (if any) will be made above them at right angles. MTS and Manitoba Hydro underground cables will be avoided by pipeline routing where feasible or crossed below at right angles if pipelines must traverse these utilities. There are no planned railway or oil/gas pipeline crossings currently.

Manitoba Hydro will be approached regarding provision of three phase power to the intake site, in NW 16-9-9 W1.

### *5.3.5 Recreation and Parks*

There are no recreation facilities or parks impacted by the Project.

### *5.3.6 Impact on Human Health and Safety*

The Project has some considerations regarding Human Health and Safety.

- Operators will be trained by the Proponents on the safe operation of pumps, pipelines and irrigation systems, and on the proper transport, storage and use of fuel and chemical products, to ensure no waterways are contaminated.
- Fuel storage on sites will meet Manitoba regulations (e.g., double wall, anti-syphon). Spill response will be developed, around any potential to contaminate land or the Assiniboine River.
- All on farm practices are subject to Provincial regulations regarding safe handling of fuel, chemicals, and fertilizers.
- All irrigation systems utilizing fertigation will employ backflow prevention.
- All truck drivers will be given stringent standard operating procedures and routing instructions, and their performance will be monitored.
- All construction sites will be Cor certified or equivalent (Construction Safety Association of Manitoba, 2014) and in accordance with appropriate Manitoba Farm Safety regulations.

### *5.3.7 Impact on Navigation*

The project has potential to impact navigation activities on the Assiniboine River, which are mainly limited to pleasure crafts (e.g., kayaks, canoes, Jet Skis), due to the shallow nature of the waterway.

An application will be filed with Transport Canada once the final engineering of the intake system is approved.

***There are no significant adverse impacts anticipated on Human Health and Safety as a result of construction or operation activities.***

***An application will be made to Transport Canada for approval of the proposed intake system, including plans for anchoring the floating intakes to the river bank, and for safety marking for purpose of people navigating the Assiniboine River.***

***There are no significant impacts anticipated on Socio Economic issues as a result of construction or operation activities.***

## 5.4 Pollutants, Hazardous Wastes and Fuel Products

The Project is not anticipated to release significant pollutants or hazardous wastes. Pollutants would be limited to exhaust emissions from diesel engines required to operate distribution pumps. Active consideration is being given to electric pumps which would make use of clean renewable energy (hydro electricity). Smaller diesel generators are typically utilized to power the mobile center pivot and linear irrigation systems. In this case, permanent hydro electric power will be utilized for the irrigation (pivot) systems.

Fuel for all pumping and power equipment will be transported, stored, and utilized in accordance with all Provincial regulations. Diesel generators or engines used to power intake pumps will be refueled in a means to prevent contamination of the watercourse.

Standard operating procedures for fuel handling and safety will be developed to ensure employees follow the requirements of the Environment Act License. Spill response procedures will be developed.

Sediment and erosion control measures were documented elsewhere (e.g., Section 5.1.4).

***There are no significant releases of Pollutants or Hazardous Wastes anticipated as a result of construction or operation activities.***

## 5.5 Greenhouse Gas Emissions and Climate Change Implication

### 5.5.1 Greenhouse Gas Emissions from the Project

As the Project land base is already under annual crop production, the Project will not result in a major land use change or significant change in crop production systems beyond the addition of supplemental water. However, the Project will result in greenhouse gas emissions during construction and operation phases.

During construction, there will be a small, incremental increase in $CO_2$ emissions due to construction equipment usage. These emissions will be like the types of $CO_2$ emissions from other machinery used in agricultural operations.

During operations, the Project may result in increased greenhouse emissions, however, quantifying the changes in greenhouse gas emissions over the current dryland farming operation is not practically feasible. IF diesel generation is required for pumping systems (e.g., 350 HP), online tools estimate the additional annual (600 hours) $CO_2$ emissions at 100 Tonnes.

The implementation of mitigation and beneficial practices can reduce GHG emissions from the Project, and in some cases may result in fewer GHG emissions than the current dryland crop production operation.

Key mitigation measures to reduce or mitigate for GHG emissions from Project activities include:

- Minimize idling of construction equipment to reduce fuel usage and associated $CO_2$ emissions.
- Use of hydro-electric power for pumps and pivots, as feasible, to reduce $CO_2$ emissions relative to the alternative diesel power generators (for pumps and pivots power supply).
- Use of 4R nutrient stewardship to reduce $N_2O$ emissions. For example, the implementation of irrigation allows for the integration of split application of nitrogen fertilizer through in-crop fertigation, which can mitigate $N_2O$ emissions.
- Use of irrigation scheduling and management to reduce the potential for saturated soil conditions, which favor direct $N_2O$ emissions from soil.
- Inclusion of low input crops (e.g., legumes such as soybeans) to reduce fertilizer requirements and associated $N_2O$ emissions.
- Implementation of tile drainage to reduce soil saturation, and mitigate $N_2O$ emissions.
- Purchase of carbon credits
- Block and shelterbelt tree plantings
- Advance equipment technology (e.g., John Deere, 2021) to optimize planting, spraying and irrigation to reduce $C0_2$ emissions on a farm scale.

While there is uncertainty related to the effect the Project will have on net GHG emissions, it is anticipated that the change will be minor and incremental in nature relative to the current GHG emissions from the existing dryland crop production operation. The Proponent is committed to examining climate change implications of their operations and implementing affordable technology to reduce the impact of the Project on greenhouse gas emissions.

### *5.5.2 Climate Change Implications for the Project*

As previously presented, climate change predictions for the Prairie region suggest that crop water may become more limiting with reduced growing season precipitation and higher temperatures. The supplemental irrigation proposed under this Project will provide an improved resilience to climate change for the crop production operation.

However, the changing environment may affect the Project in the future as the same environmental factors resulting in increased benefit of irrigation over time may result in lower flows and water availability in the Assiniboine River. This may result in more imposed in-season limits to withdrawals rates and may at some point increase the need for off-stream water storage (i.e., irrigation reservoir[s]). The Proponent is committed to working with the Province to maximize water use efficiency, scheduling and recycling (e.g. tile water) and other technological means (e.g. variable rate irrigation) to reduce direct impacts of the Project withdrawals on Assiniboine River flow under climate change scenarios.

***There is no significant long-term increase of greenhouse gas emissions anticipated because of construction or operation activities, given reasonable implementation of mitigation strategies. The Proponent is committed to work with the Province to address climate change impacts on water availability and instream flows on the Assiniboine River as it impacts timing and amount of Project withdrawals.***

### 5.6 ***Impact on Indigenous Rights***

There are no known implications arising from the implementation of Project activities with respect to Indigenous rights. There are no Indigenous communities in the Project area, with the closest community more than 15 kms away. There is no known Indigenous hunting, fishing or trapping in the Project area. There are no known cultural or traditional activities in the Project area. Manitoba Heritage Resources has been consulted regarding any further field work that may be required to assess presence of and protection of Indigenous Historical Resources within the Project areas.

***There are no significant adverse impacts anticipated on Indigenous rights as a result of Project construction or operation activities. Mitigation will include undertaking a Heritage Resources survey of the proposed intake and pipeline route.***

### 5.7 ***Accidents and Malfunctions***

The effects of accidents and malfunctions for the Project are primarily related to the potential for accidental power outages, pump and pipe failure, and fuel and/or chemical (fertilizer, pesticide) spills. Given the seasonal-based operational nature of this project, such malfunctions would be limited to the cropping and season (typically May/June to September). The following provides a summary of potential accidents and malfunctions:

- *Pump or power failure – in the event of such a failure, mechanical check valves/backflow preventers will automatically prevent backflow into the pipeline from the pivots and into the Assiniboine River from the pipeline(s). Check valves and manual gate or butterfly valves will be located strategically throughout the pump-pipe network (i.e., at river pumps, booster pumps and aboveground connection points [e.g., lateral pipeline connection to mainlines, pivot points]). Maintenance checks on equipment including pumps and pipes will be conducted regularly to minimize the risk of breakdowns and accidents associated with pump/pipe failures.*
- *Pipeline failure – in the event of a pipeline failure (break), pumps will be shut-down as soon as possible to limit overland flow, sedimentation and erosion. Pump shut down for pipeline failures will be based on low pressure/high flow rates and will be automated. In the event of a pipeline failure at a road crossing or other infrastructure crossings, installed encasement pipe liners will prevent damage to infrastructure. It is recommended that automated, solenoid valves be used to regulate pipeline flow and allow for automated and/or remote monitoring and shutdown.*
- *Accidental release of pollutant or hazardous materials – measures to prevent accidental releases are described above. In the unlikely event a release does occur, the Proponent will initiate spill response action as required under The Environment Act and according to conditions prescribed in the Environment Act License. This will include action to safely minimize and contain the spill and report the spill to Manitoba Environment, Climate and Parks Environmental Emergency Response Program.*

# 6.0 Environmental Risk Management, Mitigation Measures and Follow Up

The Proponent is committed to managing the environmental risk during all phases of design and construction, to implement mitigation measures and to follow up with regulatory agencies as indicated in the sections below.

In general, the Proponent is prepared to commit to all environmental protection measures and mitigations specified within the Environment Act License, the water Development Authorization Permit, Water Rights License, the Water Resource Administration Act, and the RM of North Norfolk Permits, and those dictated by other regulatory bodies (e.g., DFO, Historic Resources Branch). Specific remaining tasks are provided below.

## *6.1 Design*

### *6.1.1 Consultation with DFO on intakes and Transport Canada on navigation.*

Consultations with DFO will be led by sub-consultant, namely a registered Professional Biologist (e.g., habitat protection, SARA), and a registered Professional Engineer (PBS Water Engineering Ltd., PFRA Ltd.) (e.g., screen, intake, bank protection).

Consultations with Transport Canada will be led by PBS Water Engineering Ltd. regarding impacts on navigation and mitigation requirements.

Consultations will be ongoing winter/spring 2023 to design appropriate measures to protect fisheries and river navigation. Spring (post run-off) site inspection and surveys are required to be completed in advance of final design and submissions to Fisheries and Oceans and Transport Canada.

### *6.1.2 Review of Minimum In-Stream Flows with Manitoba Conservation and Climate*

Manitoba Environment, Climate and Parks will provide guidance on Minimum In-Stream Flows (MIFs). The Proponent will actively monitor in-stream flows which are recorded in real time at upstream Water Survey of Canada Assiniboine River site near Holland (05MH005).

### *6.1.3 Investigation of Potential Heritage Resources on Construction Sites*

Manitoba Historic Resources Branch is being consulted on the potential for historic or heritage resources at the proposed Project locations. Recommendations will be incorporated into the Project design and/or construction phases, as appropriate. A Professional Consultant will be engaged to undertake a reconnaissance of the intake and pipeline routes in Spring, 2023.

### *6.1.4 Investigation of Potential Species at Risk on Construction Sites*

Manitoba Conservation Data Center has been consulted on potential for Species at Risk at the proposed Project sites. The Professional Biologist will also offer a recommendation about protection of aquatic species at risk. Recommendations will be incorporated into Project design and/or construction phases, as appropriate.

### *6.1.5 Detail Sediment and Erosion Control Plans*

Detailed sediment and erosion control plans will be included in all contracts and/or construction specifications.

### *6.1.6 Detail Specifications for Backflow Prevention*

Backflow prevention equipment will be specified for all fertigation systems by equipment supplier(s).

### *6.1.7 Intakes and Valley Pipeline Construction*

Develop riparian zone protection plans for intake(s) and pipeline route out of the Assiniboine River valley.

## *6.2 Construction*

### *6.2.1 Detailed Contract Specifications*

All installation contracts will be governed by generic contract specifications and specific drawings (e.g., drainage intercepts, ditch plugs) and inspected by an owner's representative.

### *6.2.2 Safety*

All contracts will contain a workplace safety component meeting the intent of COR and Manitoba Farm Safety guidelines.

### *6.2.3 Erosion and Sediment Control*

All methods proposed will be reviewed and approved by the engineer of record and the sub-consulting Professional Biologist with respect to Fishery habitat protection.

## *6.3 Operations*

### *6.3.1 Soil and Water BMPs*

The Proponent will employ BMPs for soil erosion, nutrient management, and irrigation water management. The Proponent will report on all water use with accurate records of fields irrigated and amounts of water used, diverted, and otherwise employed.

### *6.3.2 Fuel BMPs*

The Proponent will employ fuel management BMPs in accordance with EAL requirements.

### *6.3.3 Traffic BMPs*

Training of all truck driver staff will be completed as to company Standard Operating Procedures on truck routes, truck safety and public safety.

#### *6.3.4 Environmental Management*

The following are the primary environmental follow-up and monitoring commitments of the Proponent:

- Monitor the work site (i.e., pump station, irrigation equipment and the fields under irrigation) to ensure effectiveness of measures put in place to protect the environment.
- Maintain all environmental control and protection devices, and other equipment (e.g., regular checks and maintenance of backflow prevention/check valves).
- Take appropriate and timely action (e.g., shut-down pumps) to correct any Project-related deficiencies that may result in an adverse effect to the environment, including infrastructure and human health and safety.
- Report all environmental incidents to Manitoba Environment, Climate and Parks Environmental Emergency Response Program, as soon as possible after they occur.

### *6.4 Repair, Renewal, Decommissioning*

#### *6.4.1 Pipelines*

The Proponent will replace worn underground PVC pipelines and abandon pipes in place. The Proponent will monitor the pipeline for leakage and quickly repair to prevent erosion or stability issues on the Assinboine River Valley slopes.

#### *6.4.2 Mechanical and Electrical Equipment*

The Proponent will replace worn equipment and recycle parts as feasible or dispose in landfill.

## 7.0 Conclusions and Closure

This report represents the environmental assessment, a part of the Environment Act Proposal (EAP) for the Swansfleet Alliance Irrigation Project (the Project). This report has been compiled by PBS Water Engineering Ltd. on behalf of the Proponent, Swansfleet Alliance in accordance with the guidelines of Manitoba Environment, Climate and Parks. The report was compiled using professional judgment and the information available at the time this assessment was completed.

The development is expected to be consistent with the current land use in the Project development area and will add value to the Proponent's current agricultural crop production operation, and to the local and regional economy. Based on the evaluations undertaken to date and the commitments made by the Proponent and documented herein, the Project is not anticipated to result in significant or un-mitigable adverse impacts on the local environment.

Based on the information gathered and presented, PBS Water Engineering Ltd. believes that the conditions and the guidelines for an Environment Act Proposal for this Class 2 Development have been met. The Proponent is committed to meeting all requirements of authorizations, licenses, permits and by-laws that will be granted to them as part of development of this Project or that are otherwise applicable to it.

This report is prepared for the use of Swansfleet Alliance and is intended to form part of their Environment Act Proposal for submission to and review by Manitoba Environment, Climate and Parks. Any third-party use of this report and any reliance or decision made based on it, are the responsibilities of the third parties.

The information and conclusions of this report as presented are the opinion of PBS Water Engineering Ltd. based on the Project as described and an office-based assessment of the environment within which it is located.

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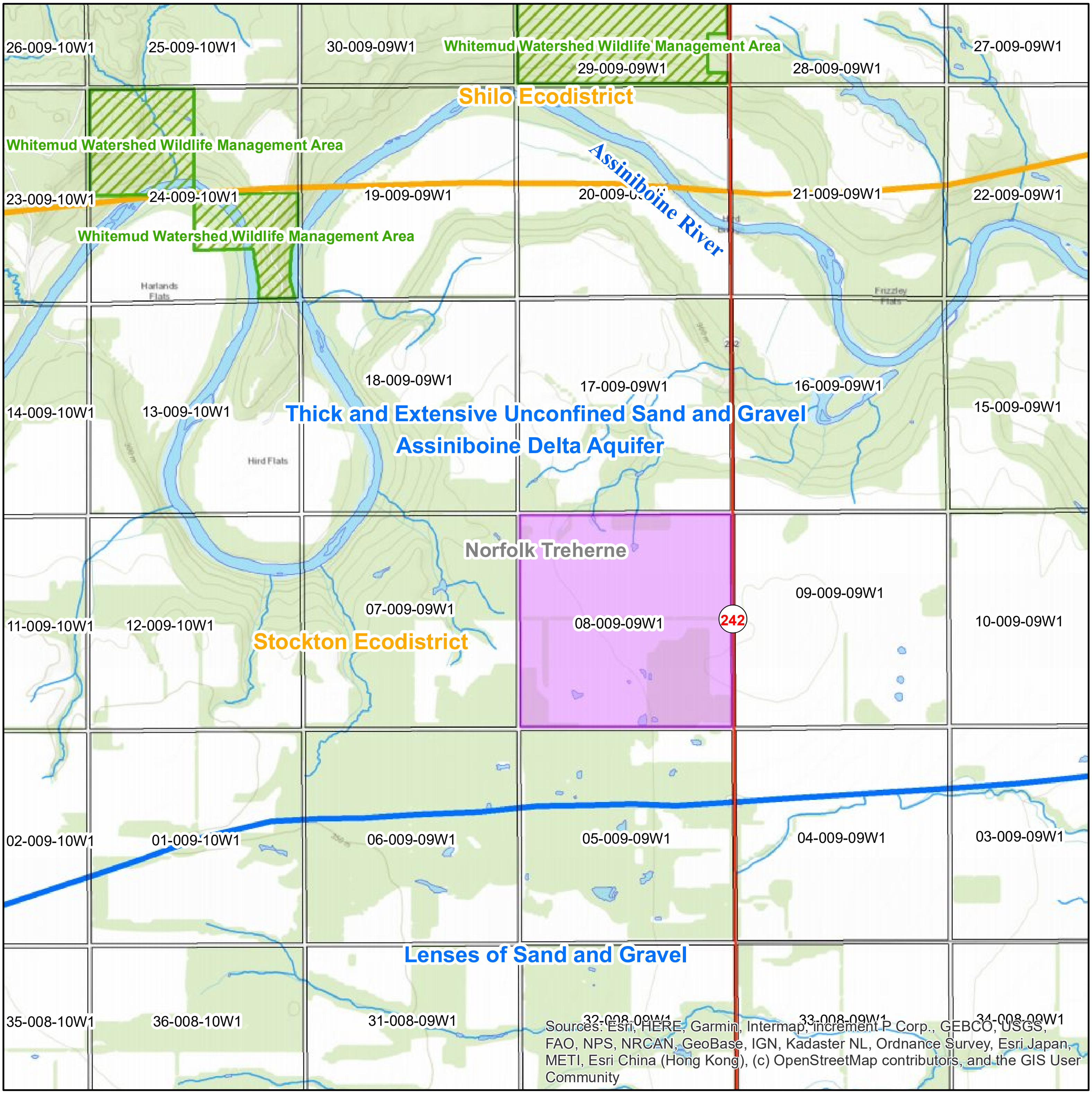
# APPENDICES

# APPENDIX A - Maps




Map Number

Map Name

**1** **Project Regional Context**

N

0 0.5 1 2

Kilometers

Project Name

Swansfleet Irrigation Project

## Legend

- Irrigation fields
- Municipality
- Provincial roads
- Protected area
- Aquifers
- Ecodistricts
- Water bodies
- Water courses

| PREPARED BY | DRAWING SCALE | DATE | DRAWN/CHECKED |
|---|---|---|---|
| PBS Water Engineering<br>agriearth consulting ltd. | 1:40,000 | May 11, 2022 | DAW/PBS |


*Acknowledgements:*
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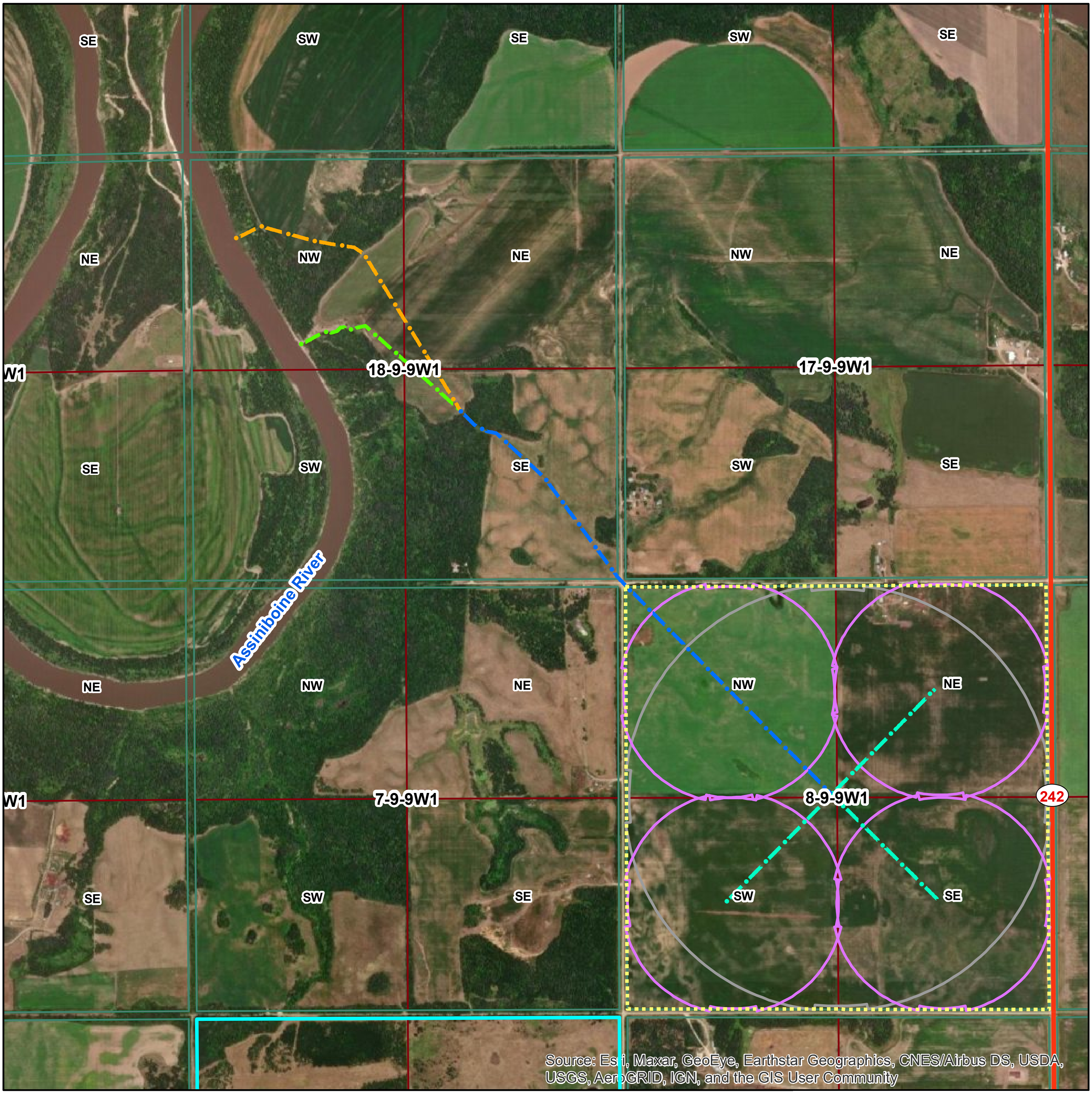
*Data accessed from Manitoba Land Initiative, Province of Manitoba.*




Map Number

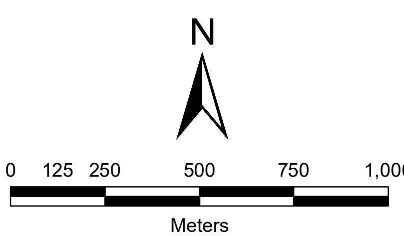
2

Map Name

**Project Overview**

Project Name

Swansfleet Irrigation Project




## Legend

- Irrigation assessment area
- Intake and Pipeline - Option 1
- Intake and Pipeline - Option 2
- Mainline
- Laterals
- Pivot - Planned
- Pivot - Alternate
- Provincial roads

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PBS Water Engineering

agriearth consulting ltd.

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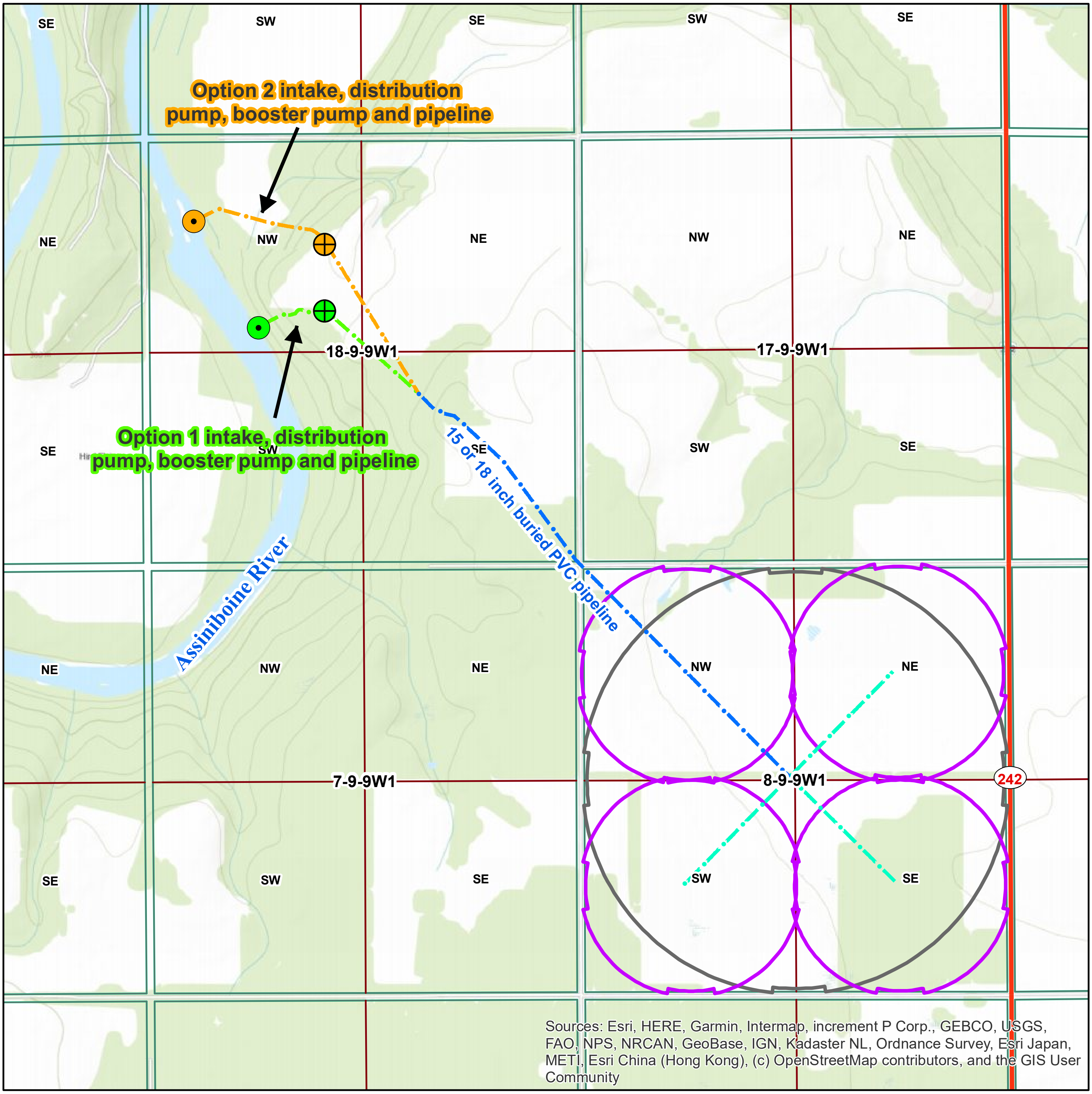


Map Number

**3**

Map Name

# Project Infrastructure

Project Name

## Swansfleet Irrigation Project

N

0 125 250 500 750 1,000

Meters

## Legend

- Intake and Pipeline - Option 1
- Intake and Pipeline - Option 2
- Mainline
- Laterals
- Pivot - Planned
- Pivot - Alternate
- Provincial roads

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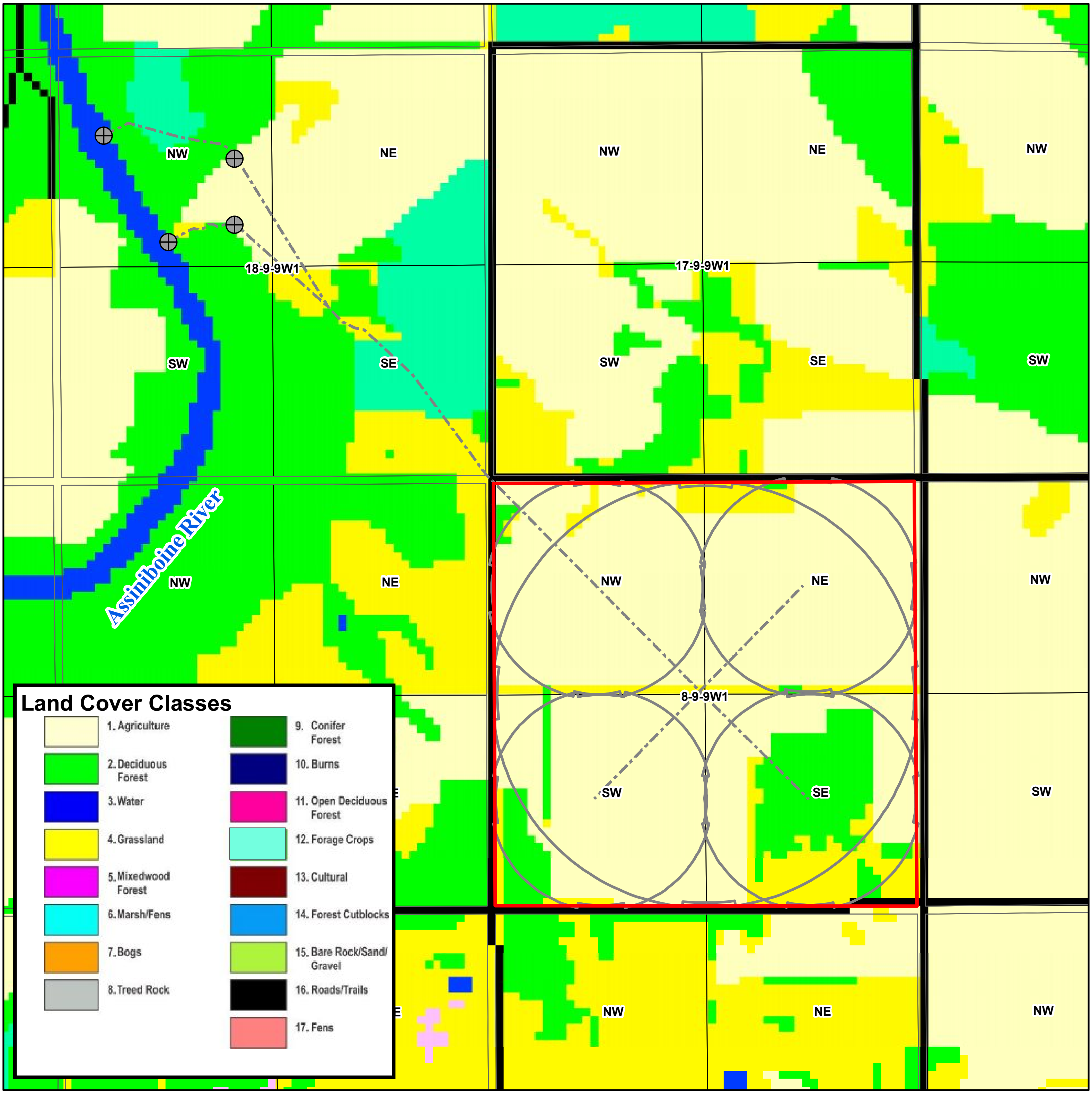


Map Number

**4**

Map Name

# Land Cover Classes

Project Name

## Swansfleet Irrigation Project

N

0 125 250 500 750 1,000

Meters

**Legend**

Pump

**Polylines**

Pipelines

Pivots

Irrigation assessment area

| PREPARED BY | DRAWING SCALE | DATE | DRAWN/CHECKED |
|---|---|---|---|
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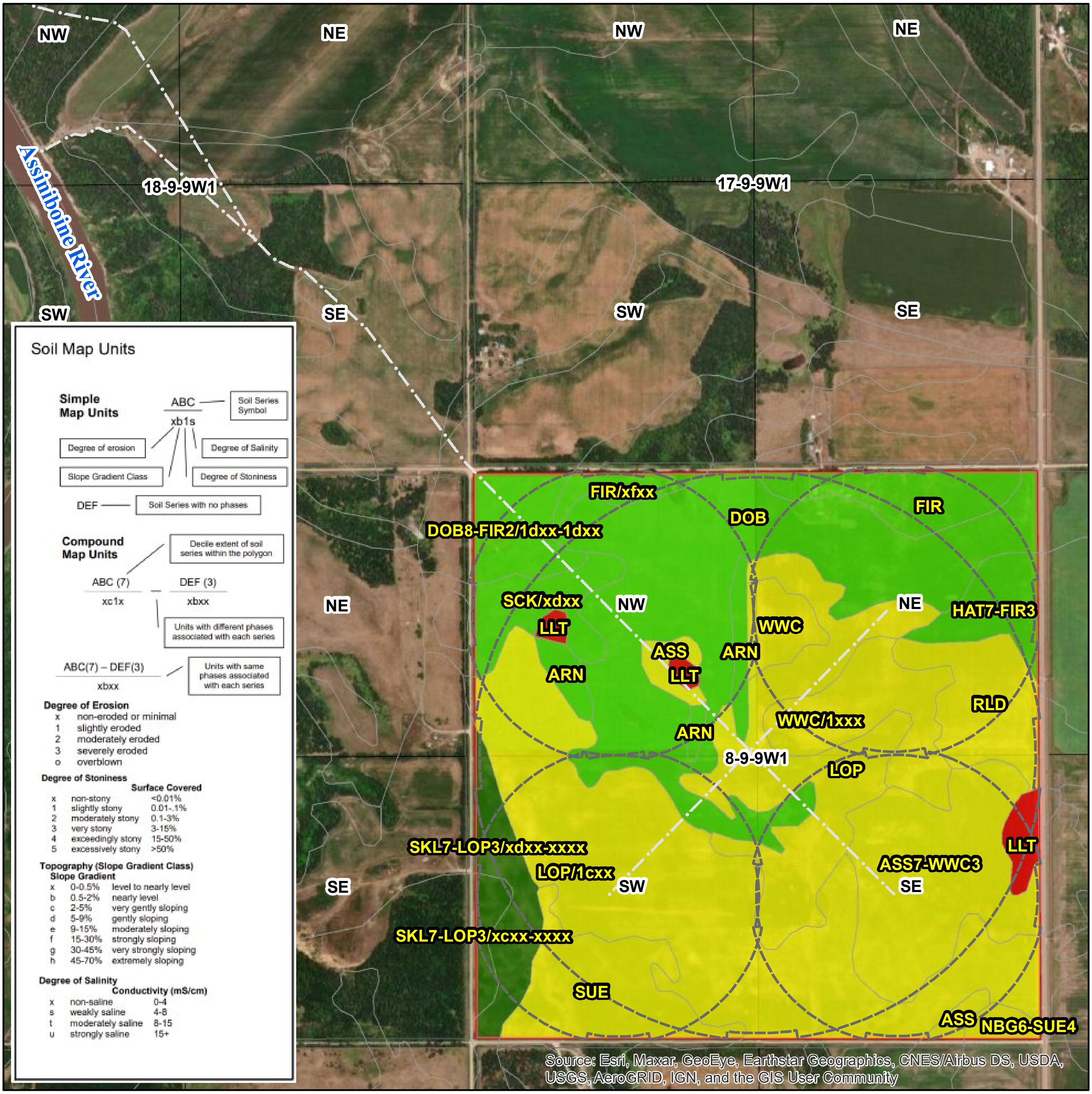


Map Number

**5**

Map Name

## Soils & Drainage Class

Project Name

# Swansfleet Irrigation Project

N

0 100 200 400 600 800

Meters

## Legend

Pipelines

Pivots

Irrigation assessment area

### Drainage Class

Rapid

Well

Imperfect

Poor

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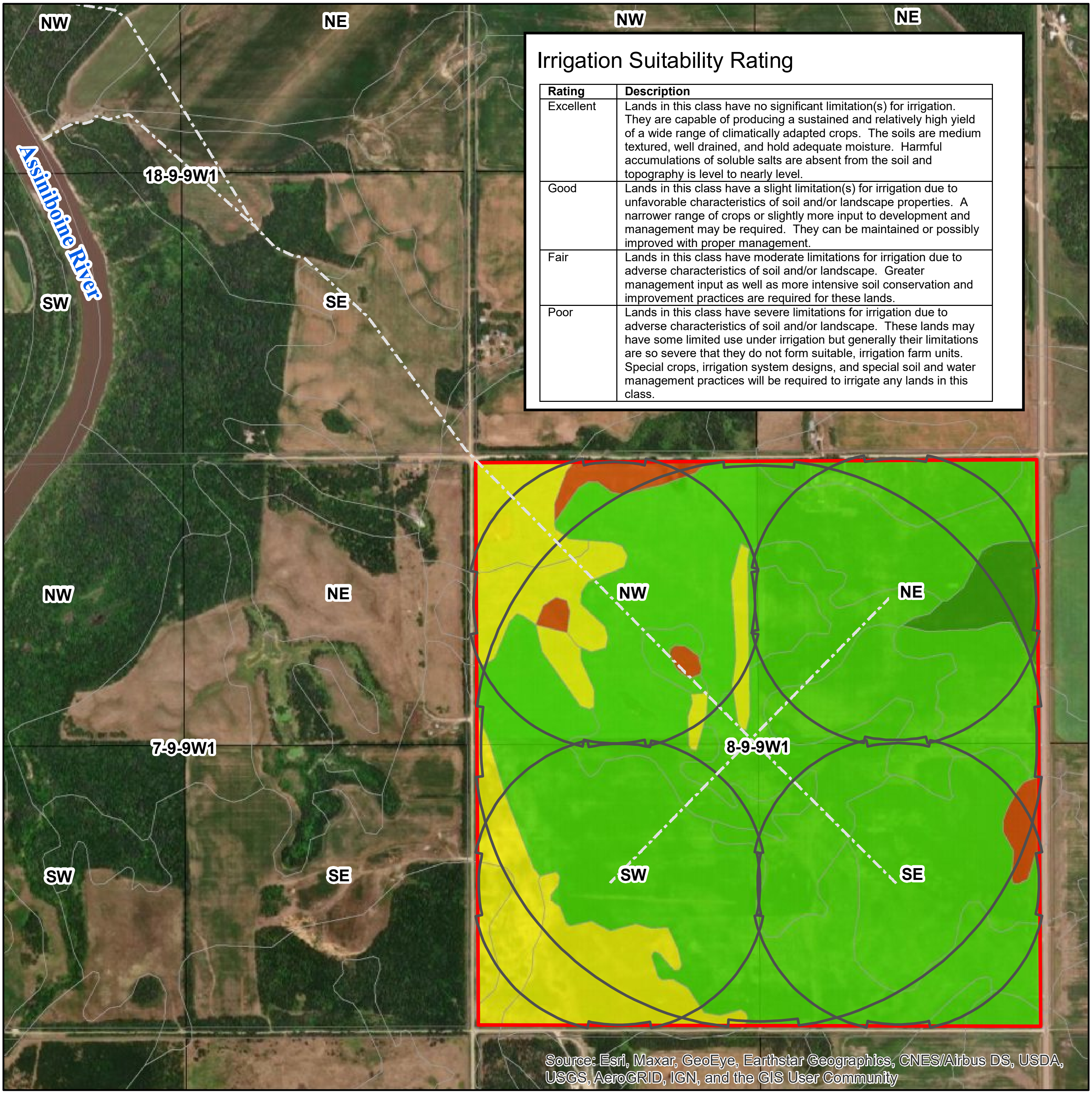


## Irrigation Suitability Rating

| Rating | Description |
|---|---|
| Excellent | Lands in this class have no significant limitation(s) for irrigation. They are capable of producing a sustained and relatively high yield of a wide range of climatically adapted crops. The soils are medium textured, well drained, and hold adequate moisture. Harmful accumulations of soluble salts are absent from the soil and topography is level to nearly level. |
| Good | Lands in this class have a slight limitation(s) for irrigation due to unfavorable characteristics of soil and/or landscape properties. A narrower range of crops or slightly more input to development and management may be required. They can be maintained or possibly improved with proper management. |
| Fair | Lands in this class have moderate limitations for irrigation due to adverse characteristics of soil and/or landscape. Greater management input as well as more intensive soil conservation and improvement practices are required for these lands. |
| Poor | Lands in this class have severe limitations for irrigation due to adverse characteristics of soil and/or landscape. These lands may have some limited use under irrigation but generally their limitations are so severe that they do not form suitable, irrigation farm units. Special crops, irrigation system designs, and special soil and water management practices will be required to irrigate any lands in this class. |

Map Number

**6**

Map Name

# Irrigation Suitability

Project Name

Swansfleet Irrigation Project

N

0 100 200 400 600 800

Meters

**Legend**

Pipelines

Pivots

Irrigation assessment area

**Irrigation Suitability**

Excellent

Good

Fair

Poor

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DATE

January 15, 2023

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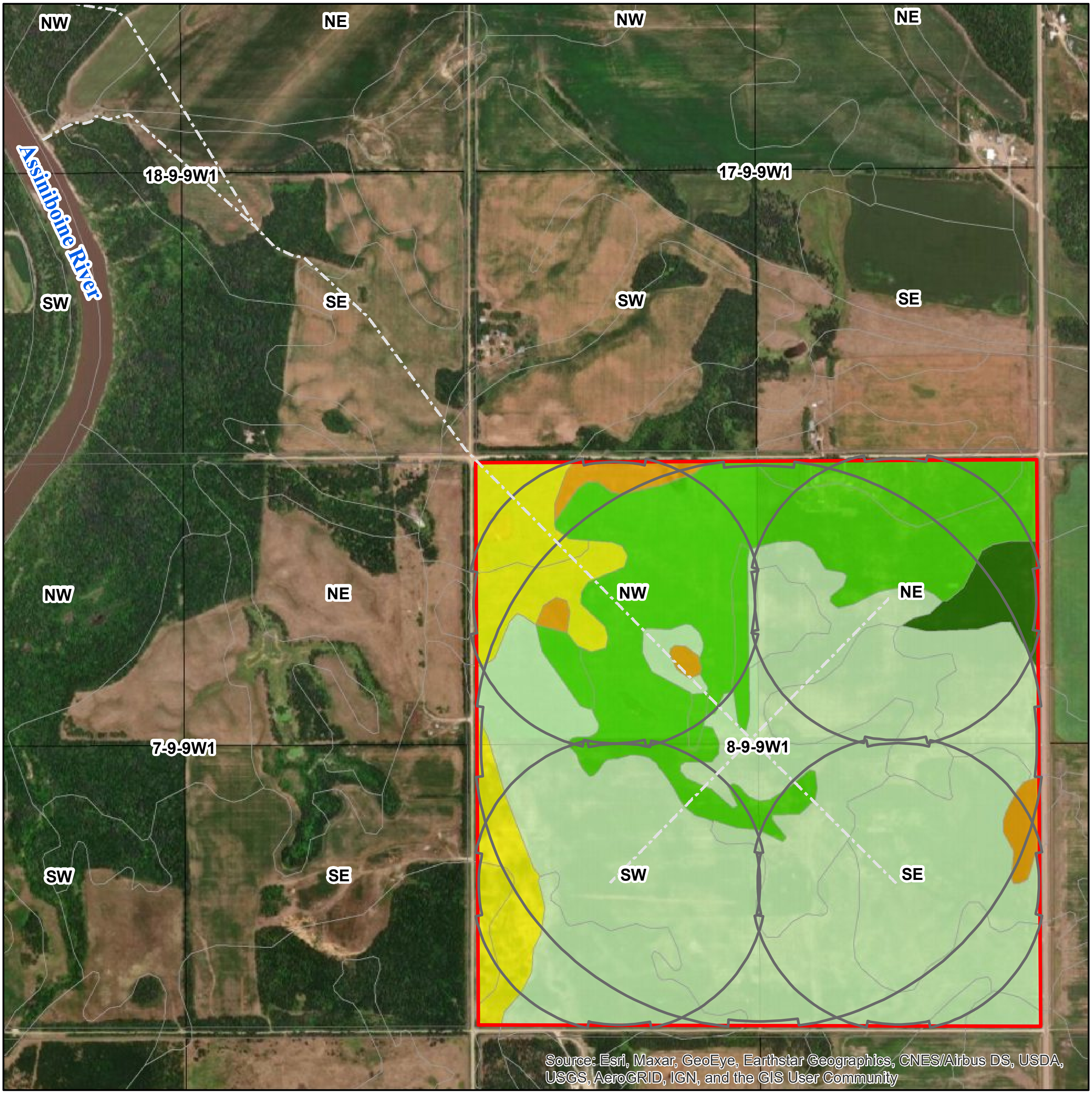


Map Number

7

Map Name

**Land Suitability for Irrigated Potato Production**

Project Name

Swansfleet Irrigation Project

N

0 100 200 400 600 800

Meters

## Legend

Pipelines

Pivots

Irrigation assessment area

**Potato Suitability Ratings**

1

2

3

4

5

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| 1:15,000 | January 15, 2023 | DAW/PBS |


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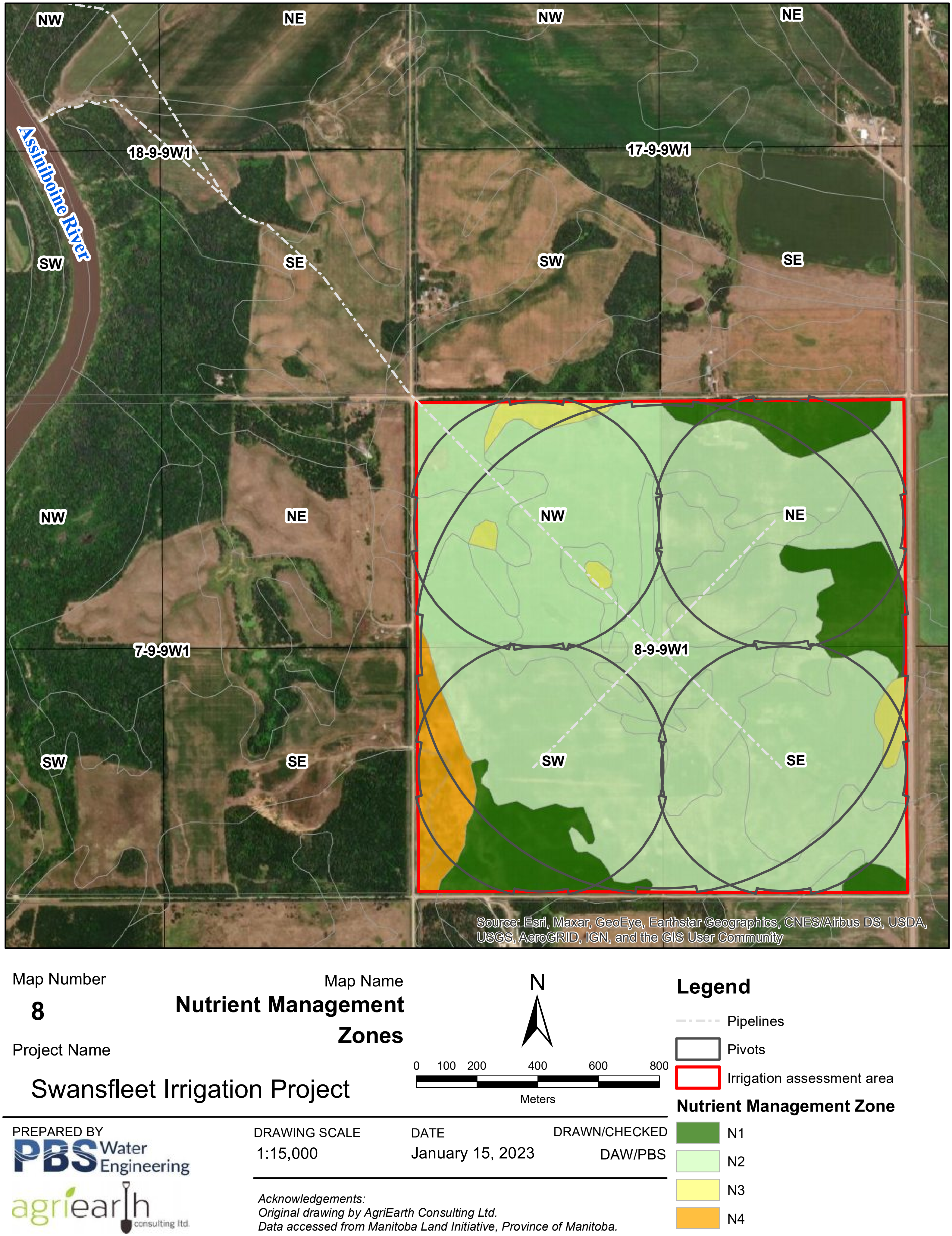


Map Number

**8**

Project Name

Swansfleet Irrigation Project

Map Name

**Nutrient Management Zones**

PREPARED BY

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*Data accessed from Manitoba Land Initiative, Province of Manitoba.*

# APPENDIX B - RM Correspondence

**From:** Bruce Shewfelt
**To:** "cao@norfolktreherne.ca"
**Cc:** "Russell Jonk"; "Graham Copithorn"; "David Whetter"
**Subject:** Swansfleet Alliance Ltd. --- Asinniboine River Irrigation Project
**Date:** Thursday, July 21, 2022 8:11:18 AM

To Jackie Clayton, CAO:

PBS Water Engineering Ltd. is in process of filing an Environmental Act Proposal for Swansfleet Alliance Ltd. for a proposed irrigation project on Section 8-9-9 W1 (adjacent to PR 242), northwest of Treherne. The project would pump water from an intake on the Assiniboine River in Section 18-9-9 W1 via buried pipeline to the irrigated parcel (Section 8-9-9 W1).

The purpose of my email is two-fold.

1. To advise of intent to file and to make RM of Treherne Norfolk aware of pending project should they have concerns.
2. To advise of intent to submit for approval a request to allow road crossing Road 50 N and 53 W with an irrigation pipeline. The proposed crossing would be provided with a DR35 PVC Encasement pipe to prevent any damage to the road in the event of a pipeline leak.
3. To gauge what if any additional information RM of Treherne Norfolk may require in way of permits, approvals.

Thank you in advance for your assistance.

I will forward more detailed project information upon completion of our Environmental Act Proposal.

In the meantime should you have any questions, please feel free to call.

Regards

Bruce Shewfelt, P.Eng.
PBS Water Engineering Ltd.
shewfelt@mymts.net
(204) 362-5666

# APPENDIX C – Provincial Correspondence

# APPENDIX C.1 – Provincial Licensing Correspondence

**From:** Butterfield, Tamara (CC)
**To:** Bruce Shewfelt; Webb, Bruce (CC); Kapty, Rose (CC)
**Cc:** "David Whetter"; "John Oosterveen"; "Russell Jonk"
**Subject:** RE: Swansfleet Alliance -- Assiniboine RIver NW 18-9-9 --- Irrigation Section 8-9-9 W
**Date:** Monday, April 25, 2022 3:07:45 PM

Hi Bruce,

I do not have an application for NW 28-9-9 WPM, I do have one for NW 18-9-9 WPM that covers the land base 8-9-9 WPM. The application is for 620 acre-feet. As the project was applied for online, I do not have a PDF copy of the application and the project does not have a permit at this time.

Thanks,

Tamara

Cell 204-918-6273

**From:** Bruce Shewfelt <shewfelt@mymts.net>
**Sent:** April 25, 2022 2:24 PM
**To:** Webb, Bruce (CC) <Bruce.Webb@gov.mb.ca>; Kapty, Rose (CC) <Rose.Kapty@gov.mb.ca>; Butterfield, Tamara (CC) <Tamara.Butterfield@gov.mb.ca>
**Cc:** 'David Whetter' <david.whetter@agriearth.ca>; 'John Oosterveen' <oosterveenj@hotmail.com>; 'Russell Jonk' <rjonk@hotmail.com>
**Subject:** Swansfleet Alliance -- Assiniboine RIver NW 18-9-9 --- Irrigation Section 8-9-9 W
**Importance:** High

Hello Rose, Tamara, Bruce:

PBS Water Engineering with assistance from AgriEarth Consulting and PFRA Ltd. are preparing an Environment Act Proposal for Russell Jonk, Swansfleet Alliance for an irrigation intake on the Assiniboine River at NW 28-9-9 W to irrigate up to 540 acres in Section 8-9-9 W (upstream of PR242 Bridge).

The purpose of this email is to give Bruce W. a heads up that the report should be filed in May, AND to see confirmation of the status of the Water Development Permit for this project. Our preference is to append any permits/applications to the EAP Report in order to have complete information available to reviewers.

The initial thought is to use a previously developed river access site (by others) which will hopefully limit bank activities. We will be reviewing the engineering of the site and pipeline route in early May. David Whetter is currently reviewing the soils for irrigation suitability.

From all accounts this should be a straight forward project, Russell is hoping to construct the project this fall with permits in place.

Please advise if any questions.

Regards

Bruce Shewfelt, P.Eng.

Ps. We will be approaching Heritage Resources, Manitoba Conservation Data Center, DFO and Transport Canada (Nav Waters) shortly and will cc you on all correspondence. We will be approaching the RM of Treherne Norfolk for permission to cross road(s). Please advise of any other regulatory bodies or consultations you would like to see.

Bruce

APPENDIX C.2 – Correspondence with Historic Resources Branch

Manitoba
Sport, Culture and Heritage

# Memorandum

**DATE:** **2022-05-09**

**TO:** **Bruce SHEWFELT**
PBS Water Engineering Ltd.
Morden, MB

**FROM:** **Reid GRAHAM**
Impact Assessment Archaeologist
Archaeological Assessment Services Unit
Historic Resources Branch
Main Floor – 213 Notre Dame Avenue
Winnipeg, Manitoba, R3B 1N3

T: (204) 945-2118
F: (204) 948-2384
C: (204) 451-7034
e: Reid.Graham@gov.mb.ca

**SUBJECT:** **PBS Water Engineering Ltd. – Swansfleet Alliance Section 8 Irrigation**
**HRB File #: AAS-22-18775**

### Concerns

Further to your e-mail regarding the above noted irrigation project, the Archaeological Assessment Services Unit (AASU) has examined the locations in conjunction with Branch records for areas of potential concern. There are concerns with the current proposed plan to impact potential heritage resource sites. The proposed water pipelines and irrigated fields are in close proximity to elevated terrain along the Assiniboine River. The Assiniboine, and the tributaries that form its watershed, have a number of known archaeological sites along and near the margins, including large Precontact Indigenous campsites, Bison Kill sites, Fur Trade Posts, and Precontact and Historic burial locations. These factors, to name a few, suggest that any planned development within the area has the potential to impact heritage resources, therefore, the Historic Resources Branch has concerns with the project at this time.

### Legislation

Under Section 12(2) of The Heritage Resources Act, if there is reason to believe that heritage resources or human remains are known, or thought likely to be present, on lands that are to be damaged or destroyed by reason of any work, activity, or project that is being proposed to carried out, then the proponent is required to conduct at his/her own expense, a heritage resource impact assessment (HRIA) and mitigation, if necessary, prior to the project's start.

The developer must contract a qualified archaeological consultant to conduct a Heritage Resources Impact assessment (HRIA) of the proposed development location, in order to identify and assess any heritage resources that may be negatively impacted by development. If desirable, the Branch will work with the developer/land owners and its consultant to draw up terms of reference for the project.

### HRIA Expectations

1. Systematic pedestrian survey and judgemental shovel testing of the water pipeline route and water intakes based on in-field observations and assessment of footprint, to identify the presence and extent of heritage resources along these routes and to determine if further mitigation is required, within the following sections:
   a. 18-09-09-W1
   b. 08-09-09-W1

2. If the identified irrigation fields require ground disturbance (i.e. native vegetation clearing, slope modification and landscape leveling, etc.) in order to facilitate the installation and operation of the centre pivot irrigation systems, then an HRIA will be required for the areas in which this ground disturbing activities will occur. Subsurface testing and pedestrian survey will be expected for these areas in following quarter-sections if this is to occur:
    a. NW-08-9-9-W1

**Other Recommendations**

**Please Implement an HRPP.**

We recommend a heritage resource protection plan (HRPP) be included in planning and construction in the event heritage resources (including human remains and palaeontological resources) are accidentally encountered. The HRPP consists of operational procedures to limit damage or destruction of heritage resources accidentally found during site work. This document assists informing managers, employees, contractors on what to do and whom to call should heritage resources accidentally be encountered when testing and development is underway on site.

Please find attached a Heritage Resources Protection Plan (HRPP) template that proponents/contractors/operators can use as a guide, as well as a fact sheet outlining the legal provisions involving found human remains.

If you have any questions or comments, please feel free to contact the Branch as above.

Historic Resources Branch
Archaeological Assessment Services

Enclosed:
Heritage Consultants List
HRIA Process Flowchart
Heritage Resource Protection Plan Template
Provisions regarding Human Remains

## Heritage Resources Protection Plan (HRPP) Guidelines

**Purpose of HRPP – Preventative Action:**

To assist [insert company name] with informing managers, employees, contractors on what to do and whom to call should heritage resources accidentally be encountered when testing and development is underway on site. The HRPP consists of operational procedures to limit damage or destruction of heritage resources accidentally found during site work.

**Key Steps:**

1. All workers on-site should be informed of the HRPP in advance of work proceeding and who to contact should there be a chance encounter during on-site activity.
2. If heritage objects or human remains are discovered on site, activities are to stop at that location immediately and the Historic Resources Branch be notified. (HRB.archaeology@gov.mb.ca, (204) 945-2118)
3. In the case of human remains, the nearest law enforcement agency (i.e., RCMP or local police department) must be contacted to first rule out any forensic issues.

**Why Report? :**

Many people find heritage objects accidentally. If these items are reported to the Historic Resources Branch, their significance can be assessed and the resulting information can generally shared with the public. Some heritage objects can be several thousand years old.

**Legislation and Policy:**

*The Heritage Resources Act* (The Act) and the *Province of Manitoba Policy Concerning the Reporting, Exhumation and Reburial of Found Human Remains* (Burials Policy) apply to protecting heritage resources.

### Preparing the HRPP

*These are basic guidelines to help developers draft an HRPP. This is a non-exhaustive guideline involving a single stakeholder. Projects involving multiple stakeholders/ community partners will require more detail.*

*Provide purpose/intent of HRPP to general user.*

*Explicitly state key message/ takeaway for user*

*All on-site workers should be aware of or briefed about the protocol.*

*Introduce the need to report findings.*

*Identify the relevant legislation pertaining to heritage resource protection.*

**What are Heritage Resources? :**

Heritage resources and heritage objects are defined under the *Heritage Resources Act*:

**"heritage resource"** includes

(a) a heritage site,

(b) a heritage object, and

(c) any work or assembly of works of nature or of human endeavour that is of value for its archaeological, palaeontological, pre-historic, historic, cultural, natural, scientific or aesthetic features, and may be in the form of sites or objects or a combination thereof

**"heritage object"** includes

(a) an archaeological object,

(b) a palaeontological object,

(c) a natural heritage object, and

(d) an object designated as a heritage object by the Lieutenant Governor in Council under subsection (2);

**"archaeological object"** means an object

(a) that is the product of human art, workmanship or use, including plant and animal remains that have been modified by or deposited due to human activities,

(b) that is of value for its historic or archaeological significance, and

(c) that is or has been discovered on or beneath land in Manitoba, or submerged or partially submerged beneath the surface of any watercourse or permanent body of water in Manitoba;

**"palaeontological object"** means the remains or fossil or other object indicating the existence of extinct or prehistoric animals, but does not include human remains.

**"natural heritage object"** means a work of nature consisting of or containing evidence of flora or fauna or geological processes;

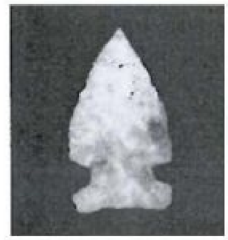
**"human remains"** means remains of human bodies that in the opinion of the minister have heritage significance and that are situated or discovered outside a recognized cemetery or burial ground in respect of which there is some manner of identifying the persons buried therein;



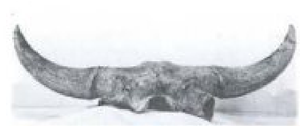
Notes/Comments

*Provide verbatim definitions of heritage language as presented within The Heritage Resources Act.*

Examples of heritage resource objects (below)



Examples of Archaeological Objects (above)



Example of a Palaeontological Object

**Discovery and notification structure:**

*Better safe than sorry: do not hesitate to report potential or suspected finds. The Historic Resources Branch is here to provide advice and expertise **at no cost to the developer**.*

1. If heritage resources, including human remains are encountered, stop work immediately.

2. Notify the on-site manager about the discovery.

   [Insert contact information here, including names, position, and phone numbers]

3. Mark-off area with "flagging tape" to identify and restrict the area.

4. The on-site manager will contact the Historic Resources Branch at (204) 945-2118

5. In the case of possible found human remains, the on-site manager will contact

   a. Historic Resources Branch at (204) 945-2118

   b. [Insert local police authority name and contact information here.]

## Notes/Comments

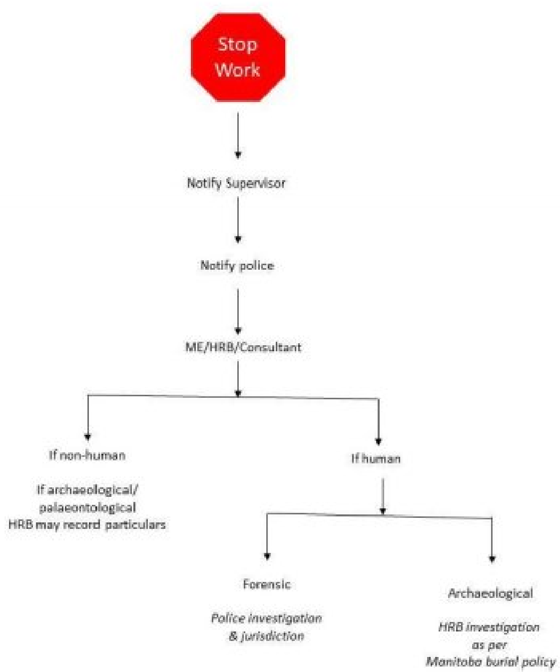
*Provide step-by-step instruction on what to do and who to contact should heritage resources be accidentally encountered.*

- *Who is the site supervisor?*
- *Who do you contact if supervisor is unavailable?*
- *What are the phone numbers for these individuals?*

- *What is the name of the local police authority?*
- *What is the phone number during the day and after hours?*

**What to expect after notification for possible found human remains:**

1. The local police authority will immediately attend the site and further secure the site.
2. The local police authority may notify the Medical Examiner's (M.E.) Office of a potential case of founding human remains as per *The Fatalities Inquiries Act*.
3. The local police authority and/or the ME's office may contact the Historic Resources Branch (HRB) or their own forensic anthropology consultant.
4. The police and their consultant will determine if the remains are:
    a. Human or animal
    b. Forensic or archaeological in nature.
5. If the remains are forensic in nature or cannot be immediately assessed, the police authority and ME will have jurisdiction over the area.
6. If remains are determined to be non-forensic (i.e., archaeological) in nature and their removal is required, HRB will be responsible for their exhumation and reburial as per Manitoba Burial Policy




Page 4 of 6

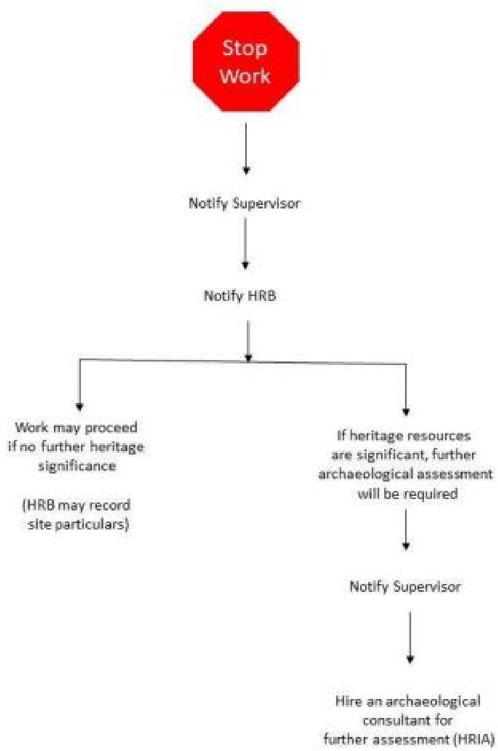
## Notes/Comments

*Under no circumstances should site information be shared with the media or the public. Site locations are protected by the Freedom of Information and Protection of Privacy Act (FIPPA).*

*Communication should be limited to the local police authority or the Historic Resources Branch.*

**What to expect after notification for heritage objects other than human remains:**

1. The Historic Resources Branch (HRB) will visit the site
2. The HRB will determine if additional heritage mitigation work will be required.
3. If further mitigation work is required, the developer may need to contract a qualified archaeological consultant to conduct a Heritage Resources Impact assessment (HRIA) of the proposed development location, in order to identify and assess any heritage resources that may be negatively impacted by development. If desirable, the Branch will work with the developer/land owners and its consultant to draw up terms of reference for this project.






Notes/Comments

*The HRB will determine if a heritage resource management strategy needs to be implemented by the developer to mitigate the effects of the development on the heritage resources.*

**Potential penalties**

Under the *Manitoba Heritage Resources Act* 69(1), *any person who contravenes or fails to observe a provision of this Act or a regulation, order, by-law, direction or requirement made or imposed thereunder is guilty of an offence and liable, on summary conviction, where the person is an individual, to a fine of not more than $5,000 for each day that the offence continues and, where the person is a corporation, to a fine of not more than $50,000 for each day that the offence continues.*

**Useful Resources:**

Government of Manitoba

Heritage Objects: A Precious Resource for all Manitobans. Winnipeg, Manitoba: Manitoba Culture, Heritage and Citizenship, 1996. Accessible online at: www.gov.mb.ca/chc/hrb/pdf/heritage_objects.pdf

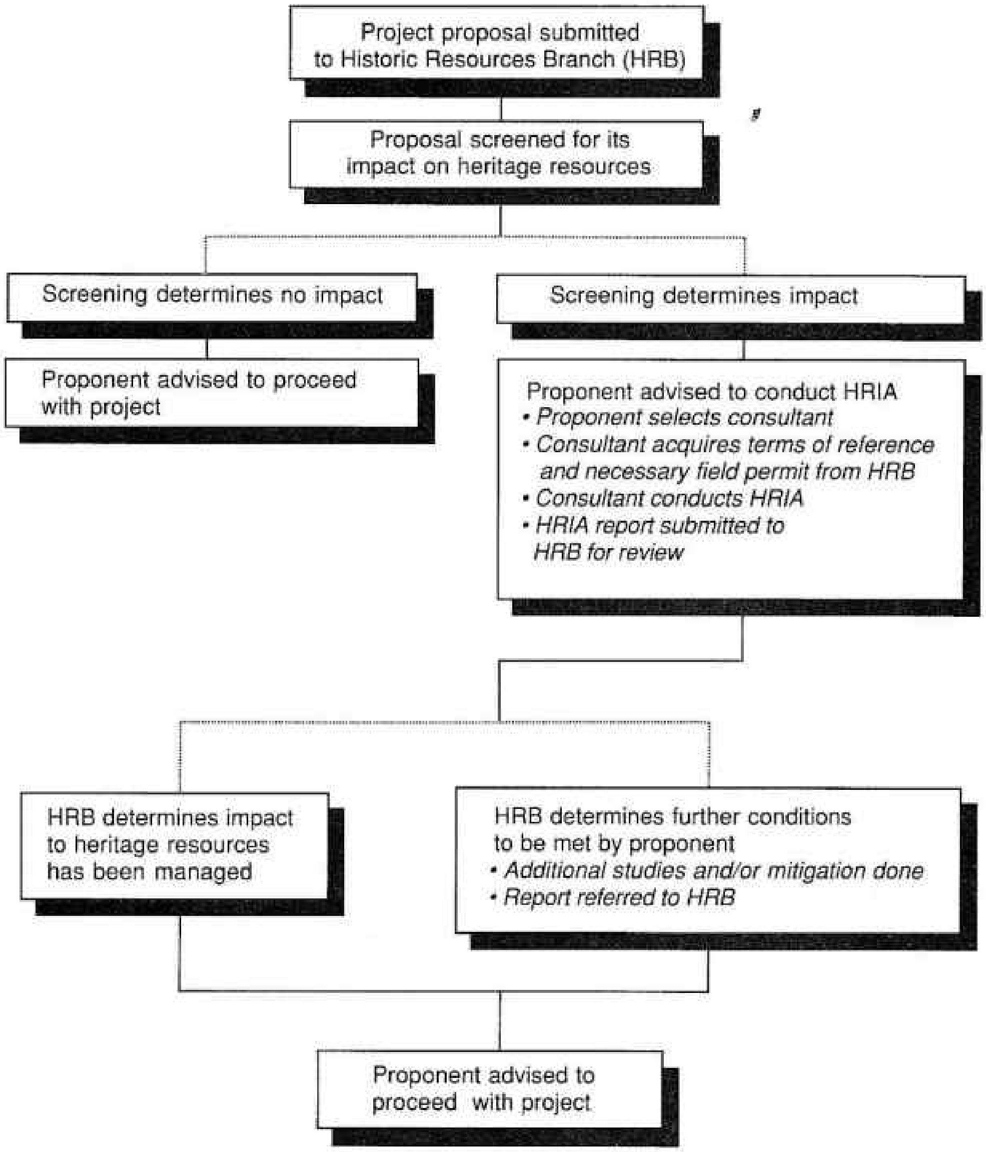
Managing Our Heritage Resources: Impact Assessment. Winnipeg, Manitoba: Manitoba Culture, Heritage and Citizenship, 1993. Accessible online at: www.gov.mb.ca/chc/hrb/pdf/impact_assessment_booklet.pdf

Notes/Comments

*Identifying potential penalties serves to emphasize the importance of this legislation*

*Additional information about heritage objects or the heritage resource impact assessment process can be found online*

# Heritage Resource Impact Assessment (HRIA) Process




Manitoba
Culture, Heritage
and Recreation

MAKE HISTORY. Preserve Manitoba's Past.

# Provisions Regarding Found Human Remains

The discovery and recovery of human remains is a sensitive issue, but one that is governed by provincial laws and process. Therefore, it is the responsibility of any individual encountering human remains to ensure that, upon discovery, actions are undertaken consistent with provincial legislation and policy. Failure to comply may result in legal action being taken.

This information is being provided to all persons conducting fieldwork under a Manitoba Heritage Permit. It outlines the Province of Manitoba's requirements and procedures consistent with *The Heritage Resources Act* (1986) and Manitoba's "*Policy Respecting the Reporting, Exhumation and Reburial of Found Human Remains*" (1987) to be followed in the event that human remains are discovered.

References herein to *The Heritage Resources Act* (1986) are not meant to supplant the *Act*, a copy of which may be obtained online or from:

Queen's Printer, Statutory Publications
Lower level, 200 Vaughan Street, Winnipeg, MB R3C 1T5
In Winnipeg: (204) 945-3101 Toll free in MB: 1-800-321-1203
Email: statpub@gov.mb.ca

## Responsibility Rests with the Historic Resources Branch

The Historic Resources Branch is responsible for the administration of *The Heritage Resources Act* (1986) and to oversee the disposition of found human remains of an archaeological nature from the moment of discovery. Accordingly, the protection, preservation and disposition of found human remains and associated heritage objects will be overseen by personnel designated by the Historic Resources Branch (*Burials Policy*: Legal Provision G).

Any human remains occurring outside recognized cemeteries may potentially be forensic in nature, that is, remains associated with past behaviors, actions or events which are a concern of other legal agencies (for example, missing persons). For this reason it is always advisable to notify the nearest police or RCMP detachment in addition to the Historic Resources Branch upon the discovery of human remains.

## Definition of Human Remains

*The Heritage Resources Act* (1986), Section 43 (1) states that "human remains" means:

> "remains of human bodies that in the opinion of the minister have heritage significance and that are situated or discovered outside a recognized cemetery or burial ground in respect of which there is some manner of identifying the persons buried therein."

## Heritage Permits

Heritage Permits issued by the Historic Resources Branch are subject to prescribed terms and conditions, and unless specifically stated, do not permit the handling or disturbance or possession of human remains upon discovery:

*The Heritage Resources Act* (1986), Sections 53; 45; and 46 state:

53 No person shall search or excavate for heritage objects or human remains except pursuant to a heritage permit and in accordance with such terms and conditions as may be prescribed by the minister and set out in or attached to the heritage permit.

45 The property in, and the title and right of possession to, any human remains found by any person after May 3, 1967, is and vests with the Crown.

46 Every person who finds an object that is or that the person believes to be a heritage object, or remains that are or that the person believes to be human remains, shall forthwith report the find to the minister and shall not handle, disturb or do anything to the object or the remains except in accordance with such requirements as the minister may prescribe.

## Manitoba's Burials Policy

In 1987, the Province of Manitoba approved the *Policy Respecting the Reporting, Exhumation and Reburial of Found Human Remains* (otherwise known as: Manitoba's "Burials Policy"). The *Burials Policy* establishes what is to be done upon discovery of found human remains in accordance with *The Heritage Resources Act* (1986). A copy of the *Burials Policy* will be provided upon request to the Historic Resources Branch.

The essentials of the *Burials Policy* constitute the best practice following discovery of human remains:

1. Unless unavoidable and necessary human remains are not to be removed from their original resting place.
2. When human remains are discovered a) all work ceases and the Historic Resources Branch is notified immediately; b) no further disturbance of the remains occurs until the arrival of personnel designated by the Historic Resources Branch.
3. Community consultation takes place before exhumation or removal of human remains or associated grave goods.
4. Personnel designated by the Historic Resources Branch shall carry out the exhumation, and as much as possible, out of the public eye.
5. Identification procedures will be undertaken only by personnel designated by the Historic Resources Branch.
6. Reburial of human remains when a First Nation is involved is arranged by the Aboriginal Liaison Officer of the Historic Resources Branch in conjunction with the community. Reburial in all other cases will be handled only by personnel designated by the Historic Resources Branch.

**Manitoba Sport, Culture, and Heritage**
**Historic Resources Branch**
Main Floor, 213 Notre Dame Avenue
Winnipeg, MB R3B 1N3
In Winnipeg : (204) 945-2118
Emergency : (204) 792-5730
Toll free in MB : 1-800-282-8069 ext. 2118
Email : hrb@gov.mb.ca

Website:www.manitoba.ca/heritage

Manitoba

## APPENDIX C.3 – Correspondence with Manitoba Conservation Data Center

**From:** Murray, Colin (ARD)
**To:** Bruce Shewfelt
**Subject:** DR B Shewfelt PBS 20220425 Swanfleet irrigat proj
**Date:** Friday, May 20, 2022 10:37:59 AM
**Attachments:** image003.png
DR B Shewfelt PBS 20220425 Swanfleet irrigat proj.xlsx;
Swanfleet irrigat proj and h2k.zip;

---

Hi Bruce

Thank you for your information request. I completed a search of the Manitoba Conservation Data Centre's (CDC) rare species database for your area of interest. This includes the six quarter sections listed in the request; and a 2km radius buffer from the overall footprint boundary.

I am attaching a Microsoft Excel spreadsheet summarizing these occurrences. The spreadsheet includes scientific and common names, the provincial (SRank) rank for each species as well as the Manitoba Endangered Species and Ecosystem Act, and the federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and Species at Risk Act (SARA) designations. I'm also including the ESRI Shapefiles used to fulfill the request.

Further information on this ranking system can be found on our website at: http://www.natureserve.org/conservation-tools/conservation-status-assessment.
These designations can be found at:
http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php,
https://www.cosewic.ca/index.php/en-ca/ and
http://www.sararegistry.gc.ca/default.asp?lang=En&n=24F7211B-1.

Manitoba's recommended setback distances can be found at:
https://www.gov.mb.ca/sd/pubs/conservation-data-centre/mbcdc_bird_setbacks.pdf.

The information provided in this letter is based on existing data known to the Manitoba Conservation Data Centre of the Wildlife and Fisheries Branch at the time of the request. These data are dependent on the research and observations of CDC staff and others who have shared their data, and reflect our current state of knowledge. An absence of data does not confirm the absence of any rare or endangered species. Many areas of the province have never been thoroughly surveyed, therefore, the absence of data in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present. The information should not be regarded as a final statement on the occurrence of any species of concern, nor should it substitute for on-site surveys for species or environmental assessments. Also, because our Biotics database is continually updated and because information requests are evaluated by type of action, any given response is only appropriate for its respective request.

Please contact the Manitoba CDC for an update on this natural heritage information if more than six months passes before it is utilized.

Third party requests for products wholly or partially derived from our Biotics database must be approved by the Manitoba CDC before information is released. Once approved, the primary user will identify the Manitoba CDC as data contributors on any map or publication using data from our database, as the Manitoba Conservation Data Centre; Wildlife and Fisheries Branch, Manitoba Sustainable Development.

**This letter is for information purposes only - it does not constitute consent or approval of the proposed project or activity, nor does it negate the need for any permits or approvals required by the Province of Manitoba.**

We would be interested in receiving a copy of the results of any field surveys that you may undertake, to update our database with the most current knowledge of the area.

If you have any questions or require further information contact me directly at (204) 945-7760.

Colin

Reference screen clip:

| SEARCH CRITERIA | SITE | SCINAME | COMNAME | S_RANK | ESEA | SARA | COSEWIC |
|---|---|---|---|---|---|---|---|
| Within | NW-18-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | SE-18-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | SE-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | NE-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | SW-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within | NW-08-009-09W1 | No listed or tracked species occurrences found at this time | | | | | |
| Within 2km radius of site boundary of | Six quarters combined | Plestiodon septentrionali | Northern Prairie Skink | S1 | Endangered | Special Concern | Special Concern |
| Within 2km radius of site boundary of | Six quarters combined | Sanguinaria canadensis | Bloodroot | S2 | | | |
| Within 2km radius of site boundary of | Six quarters combined | Riparia riparia | Bank Swallow | S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Ambystoma mavortium | Western Tiger Salamander | S4S5 | | Special Concern | Special Concern |
| Records in general area of | Six quarters combined | Carex prairea | Prairie Sedge | S3S4 | | | |
| Records in general area of | Six quarters combined | Plestiodon septentrionali | Northern Prairie Skink | S1 | Endangered | Special Concern | Special Concern |
| Records in general area of | Six quarters combined | Quadrula quadrula | Mapleleaf Mussel | S1 | Endangered | Threatened | Threatened |
| Records in general area of | Six quarters combined | Circaea canadensis ssp. c | Large Enchanter's-nightshade | S2 | | | |
| Records in general area of | Six quarters combined | Osmorhiza claytonii | Hairy Sweet Cicely | S2? | | | |
| Records in general area of | Six quarters combined | Contopus virens | Eastern Wood-pewee | S3B | | Special Concern | Special Concern |
| Records in general area of | Six quarters combined | Strophitus undulatus | Creeper | S5 | | | |
| Records in general area of | Six quarters combined | Dolichonyx oryzivorus | Bobolink | S3S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Sanguinaria canadensis | Bloodroot | S2 | | | |
| Records in general area of | Six quarters combined | Hirundo rustica | Barn Swallow | S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Riparia riparia | Bank Swallow | S4B | | Threatened | Threatened |
| Records in general area of | Six quarters combined | Phryma leptostachya var | American Lopseed | S3 | | | |
| Records in general area of | Six quarters combined | Cornus alternifolia | Alternate-leaved Dogwood | S3 | | | |



**Colin Murray**
Information Manager - Manitoba Conservation Data Centre
Fish and Wildlife Branch, Natural Resources and Northern Development
200 Saulteaux Crescent, Winnipeg, MB R3J3W3
T: 204-945-7760 F: 204-945-3077


---

**From:** Bruce Shewfelt <shewfelt@mymts.net>
**Sent:** April 25, 2022 5:39 PM
**To:** Murray, Colin (ARD)<Colin.Murray@gov.mb.ca>
**Cc:** Webb, Bruce (CC) <Bruce.Webb@gov.mb.ca>; 'David Whetter' <david.whetter@agriearth.ca>; 'Russell Jonk' <rjonk@hotmail.com>
**Subject:** RE: DR B Shewfelt PBS 20210513 JP Wiebe Irrigation Proj Pine Cr
**Importance:** High

**CAUTION: This email originated from an External Sender. Please do not click links or open attachments unless you recognize the source.**
**ATTENTION: ce courriel provient d'un expéditeur externe. Ne cliquez sur aucun lien et n'ouvrez pas de pièce jointe, excepté si vous connaissez l'expéditeur.**

Manitoba Conservation Data Center:

To whom it may concern (cc: Colin Murray, Bruce Webb):

PBS Water Engineering Ltd. is working on a project for Swansfleet Alliance (north of Treherne MB). The project involves a water intake (NW 18-9-9W1) and buried pipeline (NW, SE 18-9-9 W1; 8-9-9 W1) from the Assiniboine River to irrigate land in Section 8-9-9 W1. The project in its entirety is shown on the attached, comprises an intake and pumpstations at the Assiniboine River and shallow buried PVC pipeline per the blue dashed lines to service the fields shown.

The request of the Water Right > 200 dam3 triggered the need for an Environment Act License. PBS Water Engineering Ltd. with consultation from AgriEarth Consulting Ltd. will be filing an Environment Act Proposal in May, 2022.

One requirement of the EAP will be is to do a search of Manitoba Environment Climate and Parks and Heritage Resources data bases for **occurrences of rare and endangered species** and/***or historic resources***.

Please consider this request to review your records and provide any concerns arising from the potential project/project sites; especially that may impact the choice of optional locations.

Please fee free to call to discuss and questions or concerns.

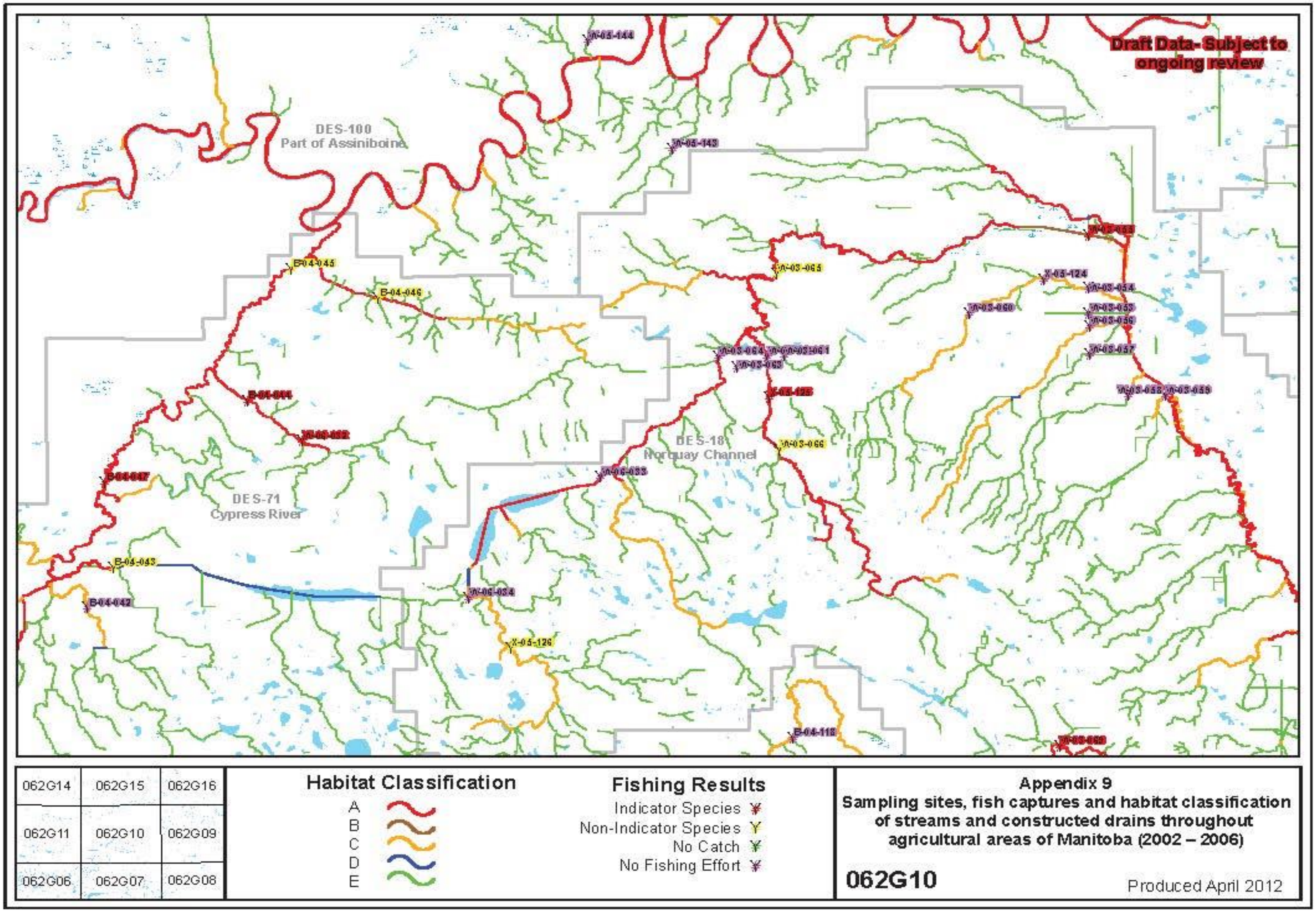
Please acknowledge receipt of this request.

Regards


Bruce Shewfelt, P. Eng.
PBS Water Engineering Ltd.
Morden, MB
R6M 1R4

204 362 5666
shewfelt@mymts.net

# APPENDIX D – DFO Habitat Maps




**Appendix 9**
**Sampling sites, fish captures and habitat classification of streams and constructed drains throughout agricultural areas of Manitoba (2002 – 2006)**

**062G10**

Produced April 2012

# APPENDIX E – Sediment and Erosion Control Measures

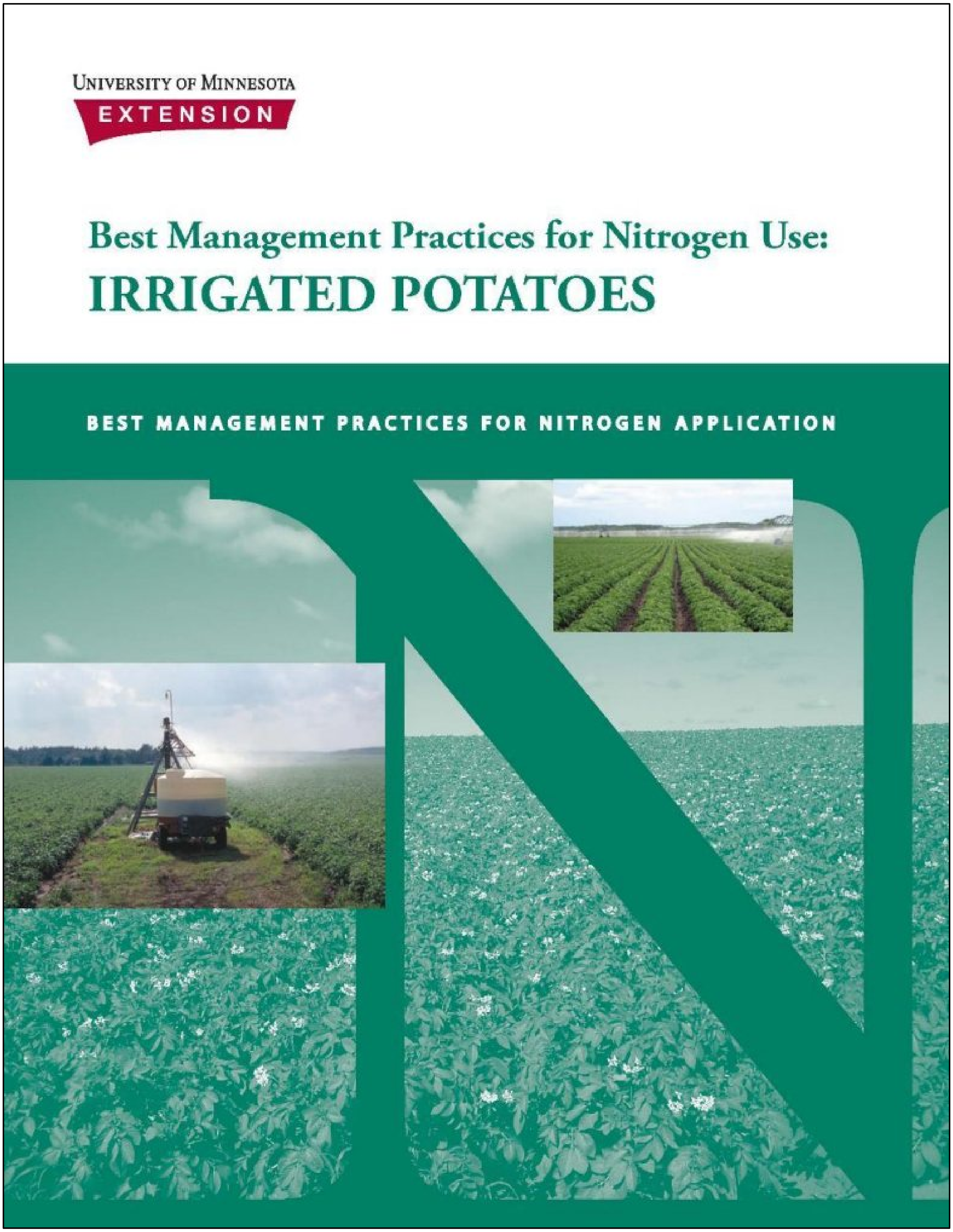
***Sediment Control Plan for Construction of Irrigation Pipeline and Intake***

The recommendations outlined herein are generic considerations for irrigation pipeline and intake construction and are based on the requirements defined in Manitoba Stream Crossing Guidelines for Protection of Fish and Fish Habitat (DFO and MNR, 1996).

The recommendations are provided to the contractors as part of the construction specifications, to provide them with specific measures that will reduce the amount of sediment that enters water bodies adjacent to construction sites to the lowest possible levels practical.

1. Prior to commencement of construction, the contractor will be prepared to control sediment from the construction site with a general plan based on an understanding of the site conditions and will have the materials on site that are needed to implement the plan.
2. The areal extent of the disturbance will be limited to the minimum needed for construction.
3. Existing vegetation, especially adjacent to waterways, shall be left intact wherever possible.
4. Grubbing will not commence until the latest possible time before the actual construction.
5. Materials to be wasted shall be removed from the construction site at the earliest convenience.
6. Materials to be stockpiled shall be done in a pre-approved location, with appropriate silt fencing perimeter to intercept runoff from the stockpile.
7. Area selected for the stockpiled materials shall be sufficiently removed from the natural stream channel to prevent direct runoff.
8. Grading of the site shall be away from the stream channel to a sump or field or, where possible, into grass or bush areas where sediment will be filtered through the natural vegetation and terrain.
9. Pumping of ponded water from the sump or any excavation where the water has been collected will be to a field or natural terrain and not directly into a stream channel; so that sediment will be filtered through the natural vegetation and terrain.
10. Site grading will be to the most stable inclination possible such that the velocity of runoff flow and associated erosion of exposed soils is minimized.
11. Runoff will be diverted away from exposed soils using berms and appropriate grading.
12. The duration of soil exposure will be minimized through the application of appropriate construction scheduling including the re-establishment of vegetation at the earliest opportunity.
13. Construction scheduling will incorporate concepts to minimize erosion during construction of in stream works including temporary or permanent diversion channels, weirs or any other features which affects flow of water in the stream channel.

# APPENDIX F – University of Minnesota – Nutrient Management BMPs for Irrigated Potatoes



UNIVERSITY OF MINNESOTA
EXTENSION

# Best Management Practices for Nitrogen Use: IRRIGATED POTATOES

BEST MANAGEMENT PRACTICES FOR NITROGEN APPLICATION

# Best Management Practices for Nitrogen Use: Irrigated Potatoes

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## Summary

Nitrogen (N) is an essential plant nutrient that contributes greatly to the economic viability of irrigated potato production. Unfortunately, the nitrate form of N can leach into groundwater if N is not managed properly. Contamination of water resources by agricultural production systems will not be tolerated by the public and could lead to laws regulating the use of N fertilizers if this contamination is not minimized.

Research-based Best Management Practices (BMPs) have been developed specifically for irrigated potatoes and integrated into the BMPs that were developed previously for other agronomic crops on coarse-textured soils. Various strategies are provided that take into account N rate, timing of application, method of application, and N source. Optimum N management also depends on the variety grown and its harvest date, so basic principles are similar but specific recommendations differ for early, mid-season, and late-season varieties.

The main objectives of these BMPs are to maintain profitability and minimize nitrate leaching. By following these recommendations, the threat of fertilizer regulations can be avoided and a more profitable and better community can be attained.


## Introduction

Nitrogen is an essential plant nutrient that is applied to Minnesota crops in greater quantity than any other fertilizer. In addition, vast quantities of N are contained in the ecosystem, including soil organic matter. Biological processes that convert N to its mobile form, nitrate ($NO_3$), occur continuously in the soil system. (For greater understanding see: ***Understanding Nitrogen in Soils* AG-FO-3770**). Unfortunately, nitrate can move (leach) below the rooting zone and into groundwater.

In response to the Comprehensive Groundwater Protection Act of 1989, a Nitrogen Fertilizer Management Plan was developed with the purpose of managing N inputs for crop production to prevent degradation of Minnesota water resources while maintaining farm profitability. The central tool for achievement of this goal is the adoption of Best Management Practices for Nitrogen. Best management practices for N are broadly defined as economically sound, voluntary practices that are capable of minimizing nutrient contamination of surface and groundwater. The primary focus of the BMPs is commercial N fertilizers; however, consideration of other N sources and their associated agronomic practices is necessary for effective total N management.

## General BMPs for all Regions of the State

The use of BMPs is based on the concept that accurate determination of crop N needs is essential for profitable and environmentally sound N management decisions. General BMPs that apply to all cropping regions in the state are listed below:

- Adjust the N rate according to a realistic yield goal (for all crops except corn and sugar beets) and the previous crop
- Do not apply N above recommended rates
- Plan N application timing to achieve high efficiency of N use
- Develop and use a comprehensive record-keeping system for field specific information.
- If manure is used, adjust the N rate accordingly and follow proper manure management procedures to optimize the N credit:
    - Test manure for nutrient content
    - Calibrate manure application equipment
    - Apply manure uniformly throughout a field
    - Injection of manure is preferable, especially on steep sloping soils
    - Avoid manure application to sloping, frozen soils
    - Incorporate broadcast applications whenever possible

For more detailed information on making the most efficient use of manure nutrients and avoiding potential adverse effects on water quality, see the University of Minnesota Extension publications listed at the end of this bulletin.

## The Need for Best Management Practices for Irrigated Potatoes

Most of the BMPs developed for crop production in Minnesota have been based on research with corn and small grains. Management strategies for coarse-textured soils can be found in: ***Best Management Practices for Nitrogen Use on Coarse Textured Soils* (08556, revised 2008)**. In contrast to most agronomic crops, potatoes are a relatively shallow rooted crop and require intensive management to promote growth and yield. In addition, adequate N needs to be available to maintain both yield and tuber quality. The shallow root system of potatoes, the need for adequate N, and the extensive production on sandy soils greatly increase the potential of nitrate contamination of shallow aquifers under irrigated potato production. Fortunately, University of Minnesota research strongly suggests that environmental impacts can be minimized by using nitrogen BMPs specifically designed for potatoes.

While the general BMPs developed for corn and small grains listed above will also apply to irrigated potato production, BMPs focused on irrigated potato production are described within this bulletin so that more precise management practices can be followed. The research-based nitrogen BMPs discussed here, therefore, have been tailored specifically for potato production on irrigated, coarse-textured soils. These BMPs are not only environmentally sound, they are also potentially more profitable. When N leaches below the potato root zone, where it can degrade water quality, it also becomes a purchased input that is lost from the crop production system. Efficient N management that minimizes losses provides both economic and environmental benefits.

## Specific Nitrogen Best Management Practices for Irrigated Potatoes

Nitrogen management considerations for irrigated potatoes include decisions regarding: 1) N rate, 2) timing of N application, 3) use of diagnostic procedures to determine N needs during the growing season, 4) effective water management, 5) sources of N, and 6) establishment of a cover crop after harvest. Suggested N management approaches for different varieties and harvest dates of irrigated potatoes are presented following the discussion on BMPs.

### *Selecting a Realistic Nitrogen Rate*

The rate of N to apply to irrigated potatoes primarily depends on the cultivar and date of harvest, expected yield goal, amount of soil organic matter, and the previous crop. Rates of N recommended for potatoes can be found in ***Nutrient Management for Commercial Fruit and Vegetable Crops in Minnesota*** (**AG-BU-5886-F**) and in Appendix A of this document. Response to N by potato is typical of other crops in that the first increment of fertilizer usually brings about the greatest response in yield, followed by a more gradual increase with succeeding increments of N (Table 1). As the N rate increases, however, the potential for losses also increases. In addition to environmental concerns due to excessive N applications, high rates of N can detrimentally affect potato production by promoting excessive vine growth, delaying tuber maturity, reducing yields, decreasing specific gravity, increasing brown center, and inducing knobby, malformed, and hollow tubers. Selecting a realistic N rate is therefore important from both a production and an environmental standpoint. Unfortunately, the effect of excess N on tuber quality is dependent on soil moisture and temperature as well as the cultivar grown. This means that the N rate at which detrimental effects will occur is difficult to predict.

#### Base N rate on variety, harvest date, and realistic yield goals

Different potato varieties and differences in harvest date will have a pronounced effect on yields and yield goals. Because of lower yield and earlier harvest, early maturing varieties like Red Norland (Table 2) generally require less N than later maturing varieties, such as Russet Burbank (Table 1). A definition of harvest date is as follows: Early - vines are killed or the crop is green dug before August 1; Mid-season - vines are killed or the crop is green dug before September 1; Late -vines are killed or the crop is green dug September 1 or later. Unlike corn and sugar beets, the yield goal concept is still being used to guide N recommendations for potatoes, in conjunction with variety and harvest date, until a more complete measure of the N supplying capacity of the soil is available. Currently N recommendations are also adjusted for the amount of soil organic matter, with higher rates for low organic matter soils than for medium to high organic matter soils which have a greater capacity to release plant-available N. Yield goal for potatoes is based on the total yield obtained rather than the marketable yield, but the two are generally well-correlated. An overestimation of the yield goal will result in excessive applications of N, which can potentially result in nitrate losses to groundwater.

**Table 1. Response of Russet Burbank potatoes to nitrogen rate at Becker MN, 2004-2005.**

| N rate | Marketable* | Total |
|---|---|---|
| lb N/A | ............. cwt/A ............. | |
| 0 | 299 | 377 |
| 30 | 326 | 485 |
| 80 | 423 | 550 |
| 120 | 547 | 651 |
| 160 | 531 | 629 |
| 180 | 583 | 667 |
| 240 | 611 | 690 |
| 320 | 594 | 663 |

*Marketable tubers are greater than 3 oz in size with no visible defects.

**Table 2. Response of early harvested Red Norland potatoes to nitrogen rate at Becker MN, 1995-1997.**

| N rate | Total and Marketable |
|---|---|
| lb N/A | -- cwt/A -- |
| 125 | 336 |
| 165 | 325 |
| 205 | 324 |
| 245 | 317 |
| 285 | 303 |

#### Account for nitrogen from previous crops

Previous crop can also affect N needs. Legumes in a crop rotation can supply significant N to subsequent crops. Research in Wisconsin on sandy soils (Kelling, et al., 1991) found that maximum potato yields following sorghum sudangrass required 40 lb/A more N than following red clover and 80 lb/A more N than when following alfalfa. Similar results from a 20 year study in the Netherlands found that N requirements for optimum potato yield following oats were 60 lb N/A greater than following red clover and 90 lb N/A greater than following alfalfa (Neeteson, 1989). Failing to account for N supplied by legumes can lead to a buildup of soil N and increase the potential for nitrate leaching.

#### Test irrigation water for nitrogen content and adjust N fertilizer accordingly

The amount of N in the irrigation water should also be considered when adjusting N rates. Nitrate in irrigation water can supply a portion of the N required for crop production. In N calibration studies on potatoes at Becker MN, the nitrate-N concentration in irrigation water ranged from 7 to 10 ppm (parts per million). This concentration of N in the water should be considered as background, but amounts above 10 ppm should be credited as fertilizer N. Additionally, the time to credit N from irrigation water is when the plant is actively growing and taking up N. For late season potatoes this occurs from 20 to 60 days after emergence (Figure 1). Because nitrate-N levels in irrigation water can vary, samples of irrigation water need to be tested annually during the pumping season to determine approximate nitrate-N concentrations.

If nitrate-N in irrigation water is one ppm, then each inch of irrigation water applied is equal to 0.225 pounds of N applied per acre. As an example, if irrigation water is found to have 20 ppm nitrate-N and 9 inches of water are applied during the active part of the growing season, then about 40 lbs of N/A would be supplied with the water (0.225 * 9 * 20). After subtracting the background amount of 20 lb N/A, the remaining 20 lb N/A should be credited toward the total amount of N applied. In practice, you will not know how much N was applied in irrigation water until after the active growth period when all or most of the N fertilizer has already been applied, so for the current growing season you will have to estimate the N credit for irrigation water from records of previous years.

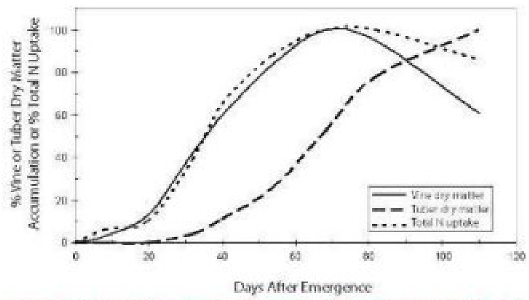


**Figure 1. Relative tuber growth, vine growth and total nitrogen uptake by the potato crop. Based on data from the Russet Burbank variety.**

## Timing of Nitrogen Application: Match N Application with Demand by the Crop

One of the most effective methods of reducing nitrate leaching losses is to match N applications with N demand by the crop.

Do not fall apply N on sandy soils (sands, loamy sands, and sandy loams)

Do not use more than 40 lbs N/A in the starter for mid/late season varieties

Do not use more than 60 lbs N/A in the starter for early harvested varieties

Nitrogen applied through the hilling stage should be cultivated/incorporated into the hill

Plan the majority of soluble N inputs from 10 to 50 days after emergence

Nitrogen applications in the fall are very susceptible to leaching. Nitrogen applied early in the season when plants are not yet established is also susceptible to losses with late spring and early summer rains. Most nitrification inhibitors are not registered for potatoes and therefore cannot be recommended. Peak N demand and uptake for late season potatoes occurs between 20 and 60 days after emergence (Figure 1). Optimum potato production depends on having an adequate supply of N during this period. The recommendation is to apply some N at planting for early plant growth and to apply the majority of the N in split applications beginning slightly before (by 10 days) the optimum uptake period. This assures that adequate N is available at the time the plants need it and avoids excess N early in the season when plant growth is slow and N demand is low.

Research at the Sand Plain Research Farm at Becker, with full season varieties like Russet Burbank, demonstrates that nitrate movement below the root zone can be reduced by lowering the amount of N in the starter fertilizer without affecting yields (Table 4). Starter fertilizer should contain no more than 40 lb N/A for full season varieties. Uptake of N by the crop (vines plus tubers) increases when split N applications are used compared with large applications applied before emergence. Nitrogen applied through the hilling stage should be incorporated into the hill to maximize availability of the N to the potato root system.

Just as N fertilizer applied too early in the season can potentially lead to nitrate losses, so can N fertilizer applied too late in the season. Nitrogen applied beyond 10 weeks after emergence is rarely beneficial and can lead to nitrate accumulation in the soil at the end of the season. This residual nitrate is then subject to leaching.

For determinate early harvested varieties like Red Norland, higher rates of N in the starter may be beneficial (Table 5). These varieties tend to respond to higher rates of early N than indeterminate varieties, but the total amount of N required is generally lower because of lower yield potential and early harvest. In addition, late application of N to these varieties will tend to delay maturity and reduce yields, particularly if the goal is to sell for an early market. In many cases it is not possible to know when the exact harvest date will be as this will depend on market demands as well as weather conditions during the season. Because of these unknowns it is important to have some flexibility in both rate and timing of N application.

**Table 4. Nitrogen starter effects on Russet Burbank potato yield and nitrate-N leaching to the 4½ ft depth. Means of 1991 and 1992.**

| Timing of N application | | | Yield | | $NO_3$-N |
|---|---|---|---|---|---|
| Planting | Emergence | Hilling | Total | Marketable | Leaching |
| lb N/A | | | cwt/A | | lb/A |
| 0 | 0 | 0 | 359.9 | 292.3 | 18 |
| 0 | 120 | 120 | 602.7 | 532.8 | 76 |
| 40 | 100 | 100 | 594.0 | 518.5 | 114 |
| 80 | 80 | 80 | 612.9 | 519.7 | 134 |
| 120 | 60 | 60 | 589.4 | 493.5 | 158 |

Errebhi et al., 1998.

**Table 5. Nitrogen starter effects on Red Norland potato yield, Becker - 1995-1997.**

| Timing of N application | | | Total Yield |
|---|---|---|---|
| Planting | Emergence | Hilling | |
| lb N/A | | | cwt/A |
| 25 | 70 | 70 | 325 |
| 45 | 60 | 60 | 328 |
| 65 | 50 | 50 | 338 |
| 85 | 40 | 40 | 337 |

Use petiole analysis to aid in making post-hilling nitrogen applications

Increases in N use efficiency have been shown when some of the N is injected into the irrigation water after hilling (fertigation). Because the root system of the potato is largely confined to the row area during early growth, do not fertigate until plants are well established and potato roots have begun to explore the furrow area between rows. This is usually about three weeks after emergence. Nitrogen applications after this time are most beneficial in years when excessive rainfall occurs early in the growing season (Tables 6 and 7). In dry years with minimal leaching, N applications later than 16 days after emergence show little if any advantages from a production standpoint over applying all of the N by that stage (Tables 7 and 8). However, leaching losses can still be reduced.

**Table 6. Effect of N applications later than 16 days after emergence on Russet Burbank yield, Becker – 1991 (high leaching year).**

| Timing of N application[1] | | | | Tuber Distribution | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Plant. | Emerge. | Post Emerge. | Late PE | Culls | <3 oz | 3-7oz | 7-14oz | >14oz | Total |
| lb N/A | | | | cwt/A | | | | | |
| 40 | 40 | 40 | 0 | 23 | 51 | 240 | 158 | 5 | 477 |
| 80 | 80 | 80 | 0 | 28 | 47 | 224 | 179 | 8 | 486 |
| 40 | 40 | 40 | 80 | 36 | 42 | 221 | 200 | 13 | 512 |

[1]Planting, emergence, 16 days post-emergence, and two late post-emergence applications more than 16 days after emergence of 40 lb N/A per application.

**Table 7. Effects of excessive irrigation and nitrogen rate, source, and timing on cumulative $NO_3$-N leaching to the 4 ft depth (Zvomuya et al., 2003).**

| N Rate | N Source | Irrigation | |
|---|---|---|---|
| | | Standard | Excessive |
| | | $NO_3$-N leaching | |
| lb N/A | | lb N/A | |
| 0 | --- | 46 | 61 |
| 125 | urea[1] | 59 | 88 |
| 125 | PCU[2] | 55 | 84 |
| 250 | urea[3] | 75 | 204 |
| 250 | PCU[2] | 50 | 128 |
| 250 | posthill[4] | 80 | 121 |

[1]25 lb N/A at planting, 50 lb N/A at emergence, and 50 lb N/A at hilling.
[2]Polyolefin-coated urea in a single application at planting.
[3]25 lb N/A at planting, 112 lb N/A at emergence, and 112 lb N/A at hilling.
[4]25 lb N/A as urea at planting, 72 lb N/A as urea at emergence, 72 lb N/A as urea at hilling, and 40 lb N/A as equal amounts of N from urea and ammonium nitrate at 3 and 5 weeks after hilling.

**Table 8. Effect of N applications later than 16 days after emergence on Russet Burbank yield, Becker – 1992 (low leaching year).**

| Timing of N application[1] | | | | Tuber Distribution | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Plant. | Emerge. | Post Emerge. | Late PE | Culls | <3 oz | 3-7oz | 7-14oz | >14oz | Total |
| lb N/A | | | | cwt/A | | | | | |
| 40 | 40 | 40 | 0 | 32 | 58 | 267 | 158 | 3 | 518 |
| 80 | 80 | 80 | 0 | 31 | 53 | 281 | 223 | 12 | 601 |
| 40 | 40 | 40 | 80 | 29 | 58 | 246 | 195 | 14 | 541 |

[1]Planting, emergence, 16 days post-emergence, and two late post-emergence applications more than 16 days after emergence of 40 lb N/A per application.

If applications of N later than 16 days after emergence are used, then 2/3 to 3/4 of the recommended N fertilizer should be applied by that stage. Timing of the remainder of the N applications should be based on petiole nitrate-N levels determined on either a dry weight or sap basis. Table 9 shows suggested sufficiency ranges for Russet Burbank potatoes through the growing season. Other potato varieties may vary slightly in their sufficiency ranges. However, the ranges in Table 9 are still a suitable starting point to adjust post-emergence N applications for other varieties. Typically if N is needed, 20 to 40 lb N/A can be injected per application.

Another potential in-season monitoring tool is soil testing for plant-available inorganic N in the upper 12 to 18 inches of the soil. Samples should be collected from the hill area in sets of five soil cores and analyzed for nitrate-N and ammonium-N. One core should be from the top of the hill, one core from each side of the hill half-way up the side slope, and one core from each side at the base of the hill. Initial research on in-season soil testing suggests that sufficiency levels for total inorganic N (nitrate-N + ammonium N) in the 0-1 ft depth for Russet Burbank are about 140 lb N/A (35 ppm) during initial bulking (June) and 80 lb N/A (20 ppm) during early bulking (July). Additional research is necessary to calibrate in-season soil tests and determine how much N to apply at specific soil test levels. Soil testing should be viewed as a tool to help fine tune N management and used in conjunction with, not as a substitute for, petiole testing.

One danger of relying on N applications through the irrigation system occurs when rainfall patterns during the time for fertigation are adequate or excessive. Applying N through the system in this case may potentially lead to an increase in nitrate leaching if high amounts of irrigation water are also applied. In situations where there is a demand for N, but rainfall has been adequate or excessive, low amounts (less than 0.3 inch) of water should be applied with the N fertilizer. Another potential problem with delayed N application occurs when the potato crop dies back early due to insects or diseases. In this situation, N applied more than 16 days after emergence may not be used as efficiently and they may increase N leaching losses. It is essential therefore, that an integrated cropping approach be taken to minimize nitrate leaching losses.

## Selecting Appropriate Nitrogen Sources

**Do not use fertilizers containing nitrate in the starter**

Each fertilizer N source used for potatoes has advantages and disadvantages, depending on how they are managed. However, because leaching often does occur in the spring, fertilizer sources containing nitrate (i.e. UAN-28 and ammonium nitrate) should be avoided at planting. Ammonium sulfate, diammonium phosphate, monoammonium phosphate, poly ammonium phosphate (10-34-0), or urea are the preferred N sources for starter fertilizer. Advantages of urea compared with ammonium nitrate are greater availability, lower cost, and delayed potential for leaching. Disadvantages of urea are that it is hygroscopic (attracts water), it must be incorporated after application or ammonia volatilization losses may occur, and its slow conversion to nitrate in cool seasons may reduce yields. Anhydrous ammonia may be beneficial in delaying the potential for leaching losses; however, positional availability of the N in relation to the hill may be a problem with sidedress applications. Further research needs to be conducted on the use of anhydrous ammonia for potato.

**Table 9. Petiole nitrate-N sufficiency levels for Russet Burbank potatoes on a dry weight and sap basis.**

| Time of Season/ Stage of Growth | Sap $NO_3$-N | Dry wt. $NO_3$-N |
|---|---|---|
| | ppm | |
| Early Vegetative/tuberization (June 15 - June 30) | 1200 – 1600 | 17,000 - 22,000 |
| Mid Tuber growth/bulking (July 1 - July 15) | 800 – 1100 | 11,000 - 15,000 |
| Late Tuber bulking/maturation (July 15 - August 15) | 400 – 700 | 6,000 - 9,000 |

**Table 10. Effect of a controlled release N source on potato (Russet Burbank) yield, Becker – 2005.**

| N rate[1] | N source | | | |
|---|---|---|---|---|
| | Urea | ESN[2] | Urea | ESN[2] |
| | Total Yield | | Marketable Yield | |
| ---- lb N/A ---- | cwt/A | | | |
| 80 | 643 | 679 | 499 | 526 |
| 160 | 698 | 695 | 579 | 582 |
| 240 | 676 | 677 | 583 | 560 |
| 320 | 660 | 625 | 576 | 519 |
| 240 (ESN emergence) | - | 737 | - | 631 |

1All treatments received 40 lb N/A from diammonium phosphate at planting.
2ESN was applied at planting, except for the second 240 lb N/A rate which was applied at emergence.

Substantial reductions in nitrate leaching can occur if controlled release sources of N are used (Table 7). Controlled release N sources include polymer coated urea that can be formulated to release N over various time intervals. These controlled release sources can also be applied earlier in the season without the fear of nitrate leaching losses. The main disadvantages of controlled release N fertilizer are delayed release to ammonium and nitrate when soil temperatures are cool and the higher cost of many of the products compared to conventional quick release N fertilizers. However, there are some newer slow release fertilizers on the market that are more economical and the cost savings of being able to make a single N fertilizer application rather than multiple applications is another factor to consider. Table 10 shows the yield response to ESN, a relatively low cost controlled release N fertilizer, compared to quick release urea applied using standard split application practices. When ESN was applied at planting there was a reduction in marketable yield at the higher N rates compared with urea, but ESN (240 lb N/A) applied at emergence produced the highest total and marketable yields in the study. Further research with low cost controlled release sources needs to be conducted to evaluate effects on tuber quality and nitrate leaching.

For mid to late season varieties, apply ESN no later than emergence.

ESN for early harvested potatoes (vines killed or green dug before August 1) is not recommended due to slow release of N.

### Water Management Strategies

Follow proven water management strategies to provide effective irrigation and minimize leaching

Water management has a profound effect on N movement. While leaching of nitrate due to heavy rainfall cannot be completely prevented, following the N management strategies discussed above will minimize these losses. However over-irrigation, even with optimum N rate applied and proper timing of N application, can cause substantial leaching losses. Therefore, effective water scheduling techniques based on soil moisture content and demand by the crop should be followed to prevent such losses. For more information on irrigation scheduling, refer to: ***Irrigation Water Management Considerations for Sandy Soils in Minnesota*, AG-FO-3875**.

### Cover Crops Following Potatoes

Establish a cover crop following potatoes whenever possible

For early harvested potatoes (July/August), any nitrate remaining in the soil is subject to leaching with rainfall. Establishing a cover crop such as winter rye will take up residual N to minimize this potential loss. An additional benefit of the cover crop is to reduce wind erosion. After the cover crop is killed or plowed under, N will be released from the vegetation the following spring. Cover crops can also be planted after potatoes harvested in September/October, although the purpose here is more for erosion control than to reduce N losses.

## Specific Best Management Practices for Irrigated Potatoes on Coarse-Textured Soils

Best management strategies for irrigated potatoes need to be somewhat flexible because of differences due to soil type, unpredictable weather, and the numerous potato cultivars grown. However, some general guidelines should be followed with the understanding that modifications may be necessary to fit specific situations and that fine-tuning BMPs for N is an ongoing process. Based on the research conducted with potatoes on sandy soils, the following best management options for N are suggested (these suggestions are based on research with Russet Burbank, an indeterminate late season variety and Red Norland, a determinate early season variety; response may vary with other varieties):

### Mid/late season varieties - Vines killed or green dug August 1 or later

**Option 1** - when fertigation is available:

- Apply up to 40 lb N/A in the starter (this amount should be included in meeting the total recommended N rate)
- Apply one-third to one-half of the recommended N at or around emergence and cultivate/incorporate the fertilizer into the hill; if ESN is used, apply no later than emergence and incorporate in the hill
- If hilling at emergence is the final hilling operation, begin fertigation 14-21 days later and apply the remainder of the recommended N in increments not exceeding 40 lb N/A
- If a final hilling operation is done 10-14 days after emergence, apply one-third of the recommended N at that time and cultivate/incorporate the fertilizer into the hill. On

heavier textured soils during rainy periods, it may not be possible to time this application properly due to row closure; in this situation, the N can be applied using fertigation

- Base timing of subsequent N applications on petiole analysis; apply up to 40 lb N/A per application through the irrigation system
- Establish a cover crop after harvest whenever possible

**Option 2** - for mid/late season varieties when fertigation is not available:

- Apply up to 40 lb N/A in the starter (this amount should be included in meeting the total recommended N rate)
- Apply one-third to one-half of the recommended N at or around emergence and cultivate/incorporate the fertilizer into the hill; if ESN is used, apply no later than emergence and incorporate in the hill
- Apply the remainder of the recommended N rate at final hilling and cultivate/incorporate the fertilizer into the hill
- Establish a cover crop after harvest whenever possible

Option 1 has generally shown better N use efficiency, particularly during years when excessive rainfall has occurred before hilling. Remember that best management practices are based on the most current research available. As more information becomes available through research efforts, some modification of BMPs may be necessary.

### *Early season varieties, with or without fertigation - Vines killed or green dug before August 1*

- Apply up to 60 lb N/A in the starter (this amount should be included in meeting the total recommended N rate)
- Apply one-third to two-thirds of the recommended N at or around emergence and cultivate/incorporate the fertilizer into the hill
- Apply the remainder of the recommended N rate at final hilling and cultivate/incorporate the fertilizer into the hill
- If fertigation is available, base timing of subsequent N application on petiole analysis; if needed, apply up to 30 lb N/A per application through the irrigation system; avoid late applications of N, because that will delay maturity
- Establish a cover crop after harvest

## References


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Kelling, K.A., D. Hero, C.R. Grau, D.I. Rouse, and A.C. MacGuidwin. 1993. Potato responses to nitrogen following various legumes. Proceedings of the Wisconsin Annual Potato Meetings. pp. 93–103.

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Zvomuya, F., C.J. Rosen, M.P. Russelle, and S.C. Gupta. 2003. Nitrate leaching and nitrogen recovery following application of polyolefin-coated urea to potato. Journal of Environmental Quality. 32:480-489.


## Publications on Manure Management

Manure Management in Minnesota, FO-3553

Fertilizing Cropland with Swine Manure, FO-5879

Fertilizing Cropland with Dairy Manure, FO-5580

Fertilizing Cropland with Poultry Manure, FO-5881

Fertilizing Cropland with Beef Manure, FO-5582

Self-assessment Worksheets for Manure Management Plans

## Appendix A

**Nitrogen recommendations for irrigated potato production.**

| | | Previous Crop and Organic Matter (O.M.) Level | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | alfalfa (good stand)[1] -O.M.[2]- | | soybeans field peas -O.M.- | | any crop in group 1 -O.M.- | | any crop in group 2 -O.M.- | |
| Yield Goal[3] | Harvest Date[4] | low | medium to high | low | medium to high | low | medium to high | low | medium to high |
| cwt/A | | N to apply (lb/A) | | | | | | | |
| <250 | Early | 0 | 0 | 80 | 60 | 60 | 40 | 100 | 80 |
| 250-299 | | 25 | 0 | 105 | 85 | 85 | 65 | 125 | 105 |
| 300-349 | | 50 | 30 | 130 | 110 | 110 | 90 | 150 | 130 |
| 350–399 | Mid | 75 | 55 | 155 | 135 | 135 | 115 | 175 | 155 |
| 400–449 | | 100 | 80 | 180 | 160 | 160 | 140 | 200 | 180 |
| 450–499 | Late | 125 | 105 | 205 | 185 | 185 | 165 | 225 | 205 |
| 500+ | | 150 | 130 | 230 | 210 | 210 | 190 | 250 | 230 |

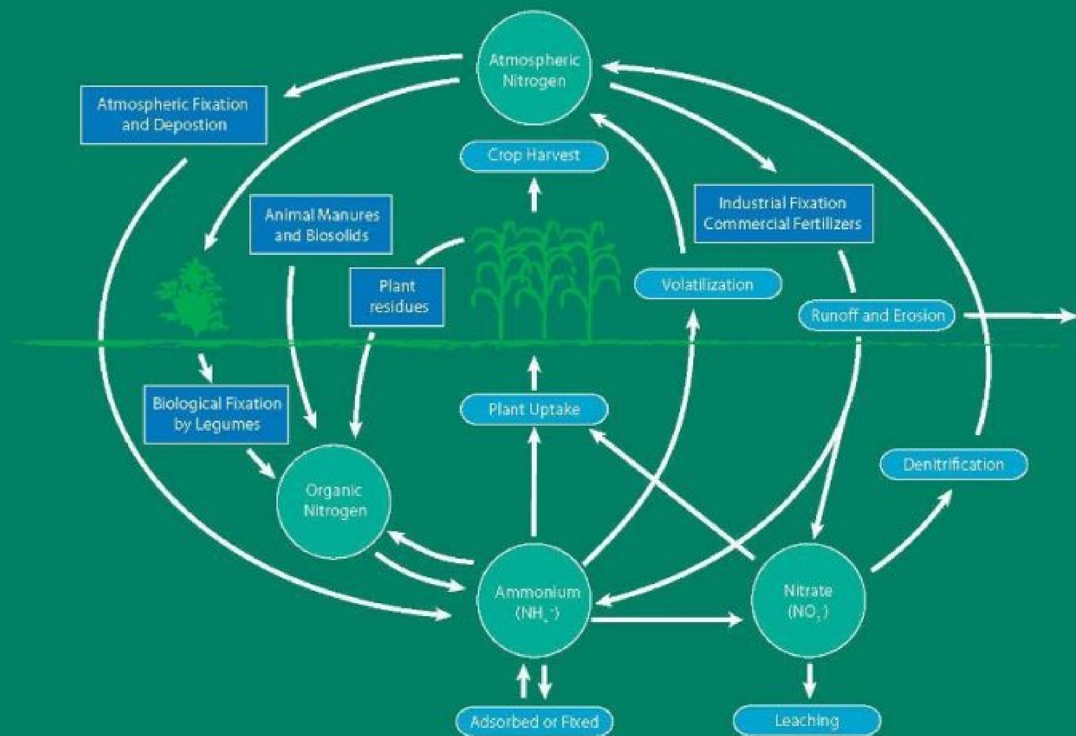
| Crops in Group 1 | Crops in Group 2 | | |
|---|---|---|---|
| alfalfa (poor stand)[1] | barley | grass hay | sorghum-sudan |
| alsike clover | buckwheat | grass pasture | sugarbeets |
| birdsfoot trefoil | canola | millet | sunflowers |
| grass-legume hay | corn | mustard | sweet corn |
| grass-legume pasture | edible beans | oats | triticale |
| red clover | flax | potatoes | wheat |
| fallow | | rye | vegetables |

[1]Poor stand is less than 4 crowns per sq. ft.

[2]Low = less than 3.1% O.M., medium to high = 3.1-19% O.M.; greater than 19% O.M. would be an organic soil and not a coarse-textured soil.

[3]Yield in this table refers to total yield not marketable yield.

[4]Early = vines killed or green dug before August 1; Mid = vines killed or green dug August 1-August 31; late = vines killed or green dug after Sept 1.




UNIVERSITY OF MINNESOTA
EXTENSION

**Best Management Practices for Nitrogen Use: Irrigated Potatoes**

**PUBLICATION # 08559**

# APPENDIX G – Pre-Design Pipeline, Intake and Pump Computations

## Swansfleet Irrigation Investigations

### Background

PBS Water Engineering was requested to investigate options for irrigation of Section 8-9-9-W1. The water source is the Assiniboine River. Two irrigation options were investigated, quarter section pivots or a single section pivot. Two potential river intake sites have been identified for the project. The Option 2 site has been assumed in the preliminary analyses described in this report, as this intake site results in a slightly longer pipeline route so will be the most critical for the sizing of pumps for the project.

### Irrigation Options

Two options (2.1 and 2.2) were considered for irrigating Section 8-9-9-W1. From examination of the topography of the section, it appears that the highest elevation within the irrigation area is 345 m, so this was the elevation to which the pressure requirement for each option was referenced. Option 2.1 would involve utilizing four quarter section pivots to irrigate the section. Each pivot would deliver a flow of 800 usgpm and require a minimum pivot point pressure of 35 psi. Assuming only three pivots would be operated at one time, the pipeline and pump system for this option has been sized to deliver 2400 usgpm.

Option 2.2 would involve utilizing one section pivot to irrigate the section. This section pivot would deliver 3000 usgpm and require a minimum pivot point pressure of 65 psi. The pipeline and pump system for this option has been sized to deliver 3000 usgpm.

### River Intake Screens

It is proposed to utilize Riverscreen floating and self-cleaning intake screens for this project. These screens have been used successfully on many installations along the Assiniboine River and other rivers in Manitoba. DFO has previously approved the use of a single Riverscreen intake screen for a withdrawal of 1600 usgpm, with an associated approach velocity at 3" from the screen face of 0.29 ft/s, so that criteria has been utilized to estimate the number of intake screens that would be required for the withdrawal rates of this project. Based on this, either irrigation option would require the use of a minimum of two intake screens at the river. Each intake screen requires 20 usgpm at minimum 40 psi to clean and rotate the screen. As the discharge pressure at the river will be greater than 40 psi, the flow back to the screen will increase, and 30 usgpm has been assumed for the calculations included in this study. Thus the diversion flow for each intake screen in Option 1 would be 1230 usgpm with an approach velocity at 3" from the screen face of 0.22 ft/s, and for Option 2 would be 1530 usgpm with an approach velocity at 3" from the screen face of 0.28 ft/s. Detailed calculations relating to the intake screens for each option are attached.

### Pumps

It is proposed to use a trailer mounted river pump (or pumps) located on the river bank (roughly elevation 282 m), and a booster pump (or pumps) on an intermediate bench (roughly elevation 318 m) part way up the valley slope. The water level in the river has been assumed as 279 m. If a single river pump is used, twin intake screens will be required on the river pump. If twin river pumps are utilized, each pump would employ a single intake screen. Sample pump selections for each option are attached and summarized in the table at the end of the section.

For Option 2.1, single 150 hp river and 150 hp booster pumps could be utilized. These pumps could be identical. The large motor sizes would require either diesel or three phase power to operate. If twin river and booster pumps were used, all pumps could be identical 75 hp units. The advantage of going to the twinned units would be that single phase power could potentially be used to power the pumps, through the use of variable frequency drives as phase converters. It would have to be confirmed with the power utility that usage of single phase power for this purpose was acceptable in this location. Using the proposed river pumps would result in a suction pressure of approximately 20 psi at the booster station.

For Option 2.2, single 200 hp river and 200 hp booster pumps could be utilized. These pumps could be identical. The large motor sizes would require either diesel or three phase power to operate. If twin river and booster pumps were used, all pumps could be identical 100 hp units. The advantage of going to the twinned units would be that it may be possible to utilize single phase power to power the pumps, through the use of variable frequency drives as phase converters. It would have to be confirmed with the power utility that usage of single phase power for this purpose was acceptable in this location. Using the proposed river pumps would result in a suction pressure of approximately 28 psi at the booster station.

| Option | # Pumps | Model | Flow usgpm | Head ft | Eff | HP | $NPSH_R$ ft |
|---|---|---|---|---|---|---|---|
| **2.1** | 1@River | 6HH | 2460 | 186 | 85.7% | 135 | 13.3 |
| **2.1** | 1@Booster | 6HH | 2400 | 188.5 | 85.6% | 133 | 13 |
| **2.1** | 2@River | 5H | 1230 | 187.5 | 81.5% | 71.3 | 13.2 |
| **2.1** | 2@Booster | 5H | 1200 | 189 | 81.3% | 70.4 | 13.0 |
| **2.2** | 1@River | 8H | 3060 | 210 | 86.2% | 188 | 12.3 |
| **2.2** | 1@Booster | 8H | 3000 | 211.5 | 85.8% | 187 | 12.2 |
| **2.2** | 2@River | 5HH | 1530 | 215 | 84.1% | 98.4 | 11.7 |
| **2.2** | 2@Booster | 5HH | 1500 | 216.5 | 83.9% | 97.3 | 11.6 |

### Option 2.1 Pipeline System

It is assumed that the pipeline systems for transporting the water to Section 8-9-9-W1 would be buried PVC pipe. For the Option 2.1 system, 15" PIP pipe would be required. Pipe with an 80 psi pressure rating would be required between the river and the booster station. Downstream of the booster station, 15" PIP pipe in pressure ratings of 125 psi down to 80 psi would be required to deliver water to the centre of the section. From the centre of the section, 10" PIP pipe with an 80 psi pressure rating would be used to deliver water to each quarter section pivot. The approximate totals of PIP pipe in each size and pressure rating would be as follows: 2300 ft of 15" S125, 500 ft of 15" S100, 8000 ft of 15" S80, and 7500 ft of 10" S80 pipe.

The discharge pressure at the river pump station for this option would be approximately 72 psi. This would result in a suction pressure at the booster pump station of 16 psi. The booster station discharge pressure would be 94 psi. The estimated pressure at the pivot would be roughly 36 psi.

## Option 2.2 Pipeline System

For the Option 2.2 system, 18" PIP pipe would be required. Pipe with a 100 psi pressure rating would be required near the river, with the remainder of the pipe to the booster station having an 80 psi pressure rating. Downstream of the booster station, 18" PIP pipe in pressure ratings of 125 psi down to 80 psi would be required to deliver water to the centre of the section. The approximate totals of PIP pipe in each pressure rating would be as follows: 2300 ft of 18" S125, 700 ft of 18" S100, and 7800 ft of 18" S80.

The discharge pressure at the river pump station for this option would be approximately 82 psi. This would result in a suction pressure at the booster pump station of 27 psi. The booster station discharge pressure would be 115 psi. The estimated pressure at the pivot would be roughly 66 psi.

## System Operation

A typical way that pump operation is controlled, when utilizing a single pump station, is to keep the pipeline system pressurized through the use of a small pressure maintenance pump, and start a larger pump on a pressure drop caused by a valve opening in the downstream pipeline system. The addition of a booster station complicates this method of operation because the pressure drop caused by opening a downstream valve will only be sensed at the booster station, and not back at the river pump station. Thus, when the pressure drop is sensed at the booster station, a signal would need to be transmitted from the booster station back to the river station to start a large pump. Then once a pump is started at the river, a booster pump can be started. The signal to start a river pump could be transmitted either using a buried signal wire between the stations, or wirelessly via radio or cell. Once the pumps are started, discharge pressure at each station would be controlled either by variable speed operation or through use of a control valve. In the case of Option 2.1, where operation of a single pivot would require operation of a single river and booster pump (if twin pumps utilized), the second pump would be started and operation synchronized once the first could no longer maintain the desired discharge pressure as station flowrate is increased. In the case of Option 2.2, twin pumps would have to be started simultaneously and run synchronously.

Alternately, a signal to both pump stations could be sent from the pivot point when it is desired to start operation of a pivot. Again, this could be done via signal wire or wirelessly. The river pump (or pumps) would be started first, followed by the booster station on a time delay.

In either case, safety shutdowns for low suction pressures (plugged intake screen or leak in suction line), low discharge pressure (high flow due to line break) and high discharge pressure (flow stoppage) would be incorporated at each pump station.

## Conclusions

1. Either irrigation option is feasible for this project.
2. If twin river and booster pumps are utilized, there is potential that single phase power could be used to power the pump stations.
3. The proposed locations of the river and booster pump stations allow for identical pumps to be used at each station, which will simplify maintenance and operation.
4. Prior to final design of the selected option, a survey of the chosen intake site and pipeline route will have to be undertaken to confirm lift, system pressures and suction conditions for the at the river.

Intake Information

**Screen Velocity Calculations For Swansfleet Project - Option 1 - Standard (Shallow Water) Riverscreen**

| | | |
|---|---|---|
| Pump Stn Capacity | 2400 | usgpm |
| Riverscreen Backwash | 30 | usgpm |
| Diameter of screen | 32 | in |
| Radius of Screen | 16 | in |
| Length of screen | 48 | in |
| Longitudinal Angle | 1 | in |
| # Longitudinal Angles | 12 | |
| End Band Width | 2 | in |
| Open Area of Screen | 60.2% | |

**Standard (Shallow Water) Riverscreen**

| | | | | | |
|---|---|---|---|---|---|
| Depth Submerged | 7 in | 22% Submergence | | | |
| Cosine Half Exposure Angle | 0.5625 | | | | |
| Half Exposure Angle | 55.77 | | | | |
| Total Exposure Angle | 111.54 | | | | |
| Total Circumference | 100.5 in | | | | |
| Exposed Circumference | 69.38 in | | | | |
| Net Submerged Circumference | 27.15 in | | Gross Submerged Circumference | 31.15 in | |
| Net Surface Area Submerged | 1194.5 $in^2$ | 8.30 $ft^2$ | Gross Submerged Surface Area | 1495.13 $in^2$ | 10.38 $ft^2$ |
| Net Open Area Submerged | 719.1 $in^2$ | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **# of Pumps** | **1** | **1** | **1** | **2** | **2** |
| **# of Screens per Pump** | **2** | **3** | **4** | **1** | **2** |
| Flowrate per Screen (usgpm) | 1230 | 830 | 630 | 1230 | 630 |
| Through Screen Velocity (ft/s) | 0.549 | 0.370 | 0.281 | 0.549 | 0.281 |
| **Approach Velocity Based On Net Submerged Area** | | | | | |
| Distance from Screen (in) | 0 | 0 | 0 | 0 | 0 |
| Approach Velocity (ft/s) | 0.330 | 0.223 | 0.169 | 0.330 | 0.169 |
| Distance from Screen (in) | 3 | 3 | 3 | 3 | 3 |
| Approach Velocity (ft/s) | 0.278 | 0.188 | 0.142 | 0.278 | 0.142 |
| **Approach Velocity Based On Gross Submerged Area** | | | | | |
| Distance from Screen (in) | 0 | 0 | 0 | 0 | 0 |
| Approach Velocity (ft/s) | 0.264 | 0.178 | 0.135 | 0.264 | 0.135 |
| Distance from Screen (in) | 3 | 3 | 3 | 3 | 3 |
| Approach Velocity (ft/s) | 0.222 | 0.150 | 0.114 | 0.222 | 0.114 |

| | | |
|---|---|---|
| Single Suction Pipe | | |
| # Pumps | 1 | |
| # Screens | 2 | per pump |
| Diameter | 14.005 | inch |
| Velocity | 5.12 | ft/s |

| | | |
|---|---|---|
| Single Suction Pipe | | |
| # Pumps | 2 | |
| # Screens | 1 | per pump |
| Diameter | 9.82 | inch |
| Velocity | 5.21 | ft/s |

DFO through screen velocity limits: are 0.125 ft/s (0.038 m/s) before July 1st, and 0.217 ft/s (0.066 m/s) after.

DFO Northern Pike Approach Velocity 0.055 m/s 0.18 ft/s

| | | Distance from screen face = | 0 inch | | 3 inch | |
|---|---|---|---|---|---|---|
| | Number of screens = | 1 | 1 | 1 | 1 | 1 |
| | | Through Screen | Net Area Approach Screen | Gross A Approach Screen | Net Area Approach Screen | Gross A Approach Screen |
| Prior to July 1 | 0.125 ft/s; Max Flow= | 280.2 | 465.4 | 582.5 | 552.7 | 691.7 |
| Northern Pike | 0.18 ft/s; Max Flow= | 404.4 | 671.8 | 840.9 | 797.8 | 998.6 |
| After July 1 | 0.217 ft/s; Max Flow= | 486.4 | 807.9 | 1011.2 | 959.4 | 1200.9 |
| US criteria | 0.4 ft/s; Max Flow= | 896.6 | 1489.3 | 1864.1 | 1768.5 | 2213.6 |

| | | Distance from screen face = | 0 inch | | 3 inch | |
|---|---|---|---|---|---|---|
| | Number of screens = | 2 | 2 | 2 | 2 | 2 |
| | | Through Screen | Net Area Approach Screen | Gross A Approach Screen | Net Area Approach Screen | Gross A Approach Screen |
| Prior to July 1 | 0.125 ft/s; Max Flow= | 560.3 | 930.8 | 1165.0 | 1105.3 | 1383.5 |
| Northern Pike | 0.18 ft/s; Max Flow= | 808.9 | 1343.7 | 1681.8 | 1595.6 | 1997.1 |
| After July 1 | 0.217 ft/s; Max Flow= | 972.8 | 1615.9 | 2022.5 | 1918.9 | 2401.7 |
| US criteria | 0.4 ft/s; Max Flow= | 1793.1 | 2978.6 | 3728.1 | 3537.1 | 4427.1 |

**Screen Velocity Calculations For Swansfleet Project - Option 2 - Standard (Shallow Water) Riverscreen**

| | | |
|---|---|---|
| Pump Stn Capacity | 3000 | usgpm |
| Riverscreen Backwash | 30 | usgpm |
| Diameter of screen | 32 | in |
| Radius of Screen | 16 | in |
| Length of screen | 48 | in |
| Longitudinal Angle | 1 | in |
| # Longitudinal Angles | 12 | |
| End Band Width | 2 | in |
| Open Area of Screen | 60.2% | |

**Standard (Shallow Water) Riverscreen**

| | | | | |
|---|---|---|---|---|
| Depth Submerged | 7 in | 22% Submergence | | |
| Cosine Half Exposure Angle | 0.5625 | | | |
| Half Exposure Angle | 55.77 | | | |
| Total Exposure Angle | 111.54 | | | |
| Total Circumference | 100.5 in | | | |
| Exposed Circumference | 69.38 in | | | |
| Net Submerged Circumference | 27.15 in | | Gross Submerged Circumference | 31.15 in |
| Net Surface Area Submerged | 1194.5 $in^2$ | 8.30 $ft^2$ | Gross Submerged Surface Area | 1495.13 $in^2$ / 10.38 $ft^2$ |
| Net Open Area Submerged | 719.1 $in^2$ | | | |

| | | | | | |
|---|---|---|---|---|---|
| **# of Pumps** | **1** | **1** | **1** | **2** | **2** |
| **# of Screens per Pump** | **2** | **3** | **4** | **1** | **2** |
| Flowrate per Screen (usgpm) | 1530 | 1030 | 780 | 1530 | 780 |
| Through Screen Velocity (ft/s) | 0.683 | 0.460 | 0.348 | 0.683 | 0.348 |
| **Approach Velocity Based On Net Submerged Area** | | | | | |
| Distance from Screen (in) | 0 | 0 | 0 | 0 | 0 |
| Approach Velocity (ft/s) | 0.411 | 0.277 | 0.209 | 0.411 | 0.209 |
| Distance from Screen (in) | 3 | 3 | 3 | 3 | 3 |
| Approach Velocity (ft/s) | 0.346 | 0.233 | 0.176 | 0.346 | 0.176 |
| **Approach Velocity Based On Gross Submerged Area** | | | | | |
| Distance from Screen (in) | 0 | 0 | 0 | 0 | 0 |
| Approach Velocity (ft/s) | 0.328 | 0.221 | 0.167 | 0.328 | 0.167 |
| Distance from Screen (in) | 3 | 3 | 3 | 3 | 3 |
| Approach Velocity (ft/s) | 0.276 | 0.186 | 0.141 | 0.276 | 0.141 |

| Single Suction Pipe | |
|---|---|
| # Pumps | 1 |
| # Screens | 2 per pump |
| Diameter | 15.755 inch |
| Velocity | 5.04 ft/s |

| Single Suction Pipe | |
|---|---|
| # Pumps | 2 |
| # Screens | 1 per pump |
| Diameter | 11.82 inch |
| Velocity | 4.47 ft/s |

DFO through screen velocity limits: are 0.125 ft/s (0.038 m/s) before July 1st, and 0.217 ft/s (0.066 m/s) after.

DFO Northern Pike Approach Velocity 0.055 m/s 0.18 ft/s

| | | Distance from screen face = | 0 inch | | 3 inch | |
|---|---|---|---|---|---|---|
| | Number of screens = | 1 | 1 | 1 | 1 | 1 |
| | | Through Screen | Net Area Approach Screen | Gross A Approach Screen | Net Area Approach Screen | Gross A Approach Screen |
| Prior to July 1 | 0.125 ft/s; Max Flow= | 280.2 | 465.4 | 582.5 | 552.7 | 691.7 |
| Northern Pike | 0.18 ft/s; Max Flow= | 404.4 | 671.8 | 840.9 | 797.8 | 998.6 |
| After July 1 | 0.217 ft/s; Max Flow= | 486.4 | 807.9 | 1011.2 | 959.4 | 1200.9 |
| US criteria | 0.4 ft/s; Max Flow= | 896.6 | 1489.3 | 1864.1 | 1768.5 | 2213.6 |

| | | Distance from screen face = | 0 inch | | 3 inch | |
|---|---|---|---|---|---|---|
| | Number of screens = | 2 | 2 | 2 | 2 | 2 |
| | | Through Screen | Net Area Approach Screen | Gross A Approach Screen | Net Area Approach Screen | Gross A Approach Screen |
| Prior to July 1 | 0.125 ft/s; Max Flow= | 560.3 | 930.8 | 1165.0 | 1105.3 | 1383.5 |
| Northern Pike | 0.18 ft/s; Max Flow= | 808.9 | 1343.7 | 1681.8 | 1595.6 | 1997.1 |
| After July 1 | 0.217 ft/s; Max Flow= | 972.8 | 1615.9 | 2022.5 | 1918.9 | 2401.7 |
| US criteria | 0.4 ft/s; Max Flow= | 1793.1 | 2978.6 | 3728.1 | 3537.1 | 4427.1 |

# APPENDIX H – Beneficial Management Practices for Agricultural Tile Drainage in Manitoba (PAMI)

# Controlled Tile Drainage

IF-04

**Figure 1. Operating a water control structure (USDA-NRCS).**

## What can controlled tile drainage accomplish?

The objectives of controlled tile drainage, also known as drainage water management, are ***Improving Water Quality*** and ***Conserving Water***. Controlled tile drainage systems make it possible to retain water in the soil profile, reducing the amount discharged from the tiles to downstream receiving waters. Crops benefit from the stored water and any nutrients contained in it during dry periods. At other times, such as seeding and harvest, excess water is allowed to flow freely from the tiles to achieve favourable field conditions.

Leading US researchers (e.g. Christianson et al., 2016) consider controlled drainage a cost-effective water management tool.

## Overview of controlled tile drainage

Controlled drainage is the use of one or more flow restricting devices (such as stop logs, risers, gates, and valves) placed inline with the tile drainage pipes, allowing the water level in the field to be artificially set. Pump level controllers on lift stations located at the main outlet, can also be used to set the water level. Each control structure will influence a portion of the field called a water management zone.

Although an existing tile drainage network can be retrofitted to include controlled drainage, ideally this practice should be considered during the initial design phase. Field elevations must be mapped for the appropriate placement of the tiles, control structures and the establishment of the water management zones. Usually, one control structure is needed for every 30 to 45 cm (1 to 1.5 ft) elevation change along the main line.

The current industry standard is the inline stop log control structure (Figures 1 and 2). By manipulating the settings of the control structure, water is held back to raise the height of the water table within a water management zone. When all stop logs have been removed, the system reverts to free (conventional) tile drainage. Stop logs can be adjusted manually (Figure 1); however, automation and remote controls are also available. A controlled tile drainage system is expected to last as long as a conventional tile drainage system (>50 years).

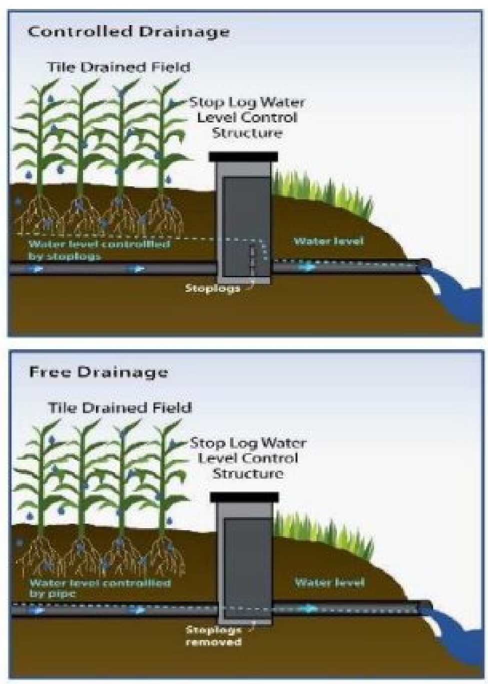



**Figure 2. Controlled drainage using stop log control structures (top) and free drainage with stop logs removed (bottom).**

## Applicability of controlled tile drainage in Manitoba

Manitoba often has too much water when it is not needed, such as in the spring, and not enough water when it is dry. In most years, agri-Manitoba is subject to crop-water deficit during the growing season, meaning that soil moisture reserves and growing season precipitation are often inadequate to meet crop needs. Controlled drainage provides a means of storing water in the ground for crop use in dry periods.

Controlled drainage is best-suited to nearly-level land, ideally with an average slope of less than 0.5% (Christianson et al., 2016). A significant portion of agri-Manitoba meets this slope criterion; however, the suitability of this practice for any given field will depend on additional site-specific characteristics and economics.

## Current research findings on controlled tile drainage

Controlled drainage has been studied extensively in the USA, especially in the upper Midwest. Crop yield and nitrate reduction benefits from various states are illustrated in Figure 3 (Christianson et al., 2016). The benefits of controlled drainage in Manitoba are expected to be different than in the upper Midwest due to differences in hydrology between the two regions. The overall drainage volume in Manitoba is lower and the overall water deficit in Manitoba is typically higher.

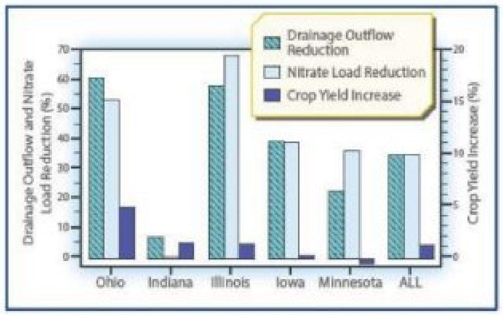



**Figure 3. Drainage outflow and nitrate load reduction and crop yield increase resulting from controlled drainage vs. conventional drainage systems (Christianson et al., 2016).**

Cordeiro (2013) confirmed that during short periods of water deficit, the shallow water table can meet a significant portion of crop water demand (Figure 4). Crop water demand is reflected in the measurements of hourly ETc (dashed line). Increases in hourly ETc correspond with observed drops in the water table (solid line), confirming shallow groundwater usage by the crop. As the shallow water table often contains elevated nitrate levels, holding back groundwater with controlled drainage can also supply nutrients to the crop.

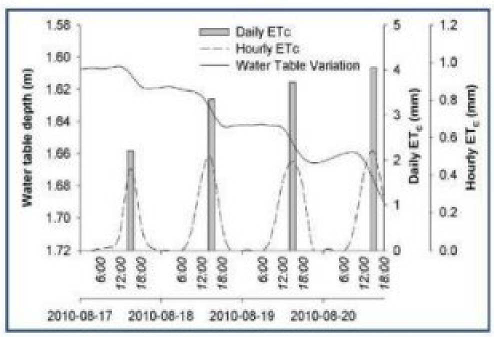



**Figure 4. Contribution of shallow water table to meeting crop water demand (Daily $ET_c$) (Corderio, 2013).**

Controlled drainage systems can be designed to include sub-irrigation, which involves feeding water back through the tile to supply the crop from below. Cordeiro (2013) and Satchithanantham (2013) studied sub-irrigation of corn and potatoes in Manitoba. While both studies confirmed the contribution of the shallow water table to crop production, they also revealed obstacles to adoption of sub-irrigation, such as lateral seepage. Several technical issues (e.g. water treatment) need to be addressed prior to adopting sub-irrigation as a BMP in Manitoba.

There is significant research in California showing shallow water tables within 1.8 m (6 ft) of the surface benefit crop yield (University of California, 2015; Ayers et al., 2006); supporting that controlled tile drainage in semi-arid regions such as Manitoba will also increase yields.

## What are some design and operational considerations?

Controlled drainage can add significantly to the capital cost and operational complexity of a tile drainage system warranting *Professional Services* (see *BMP EA-01*).

Figure 5 shows the layout of a 300-acre controlled drainage system near Homewood, MB. Differences in design features of a control drainage system vs a conventional system include:

- Shorter lateral lines;
- Extra sub-mains to create water management zones;
- Multiple in-line stop log structures and buried control valves to establish and maintain water levels in each zone.

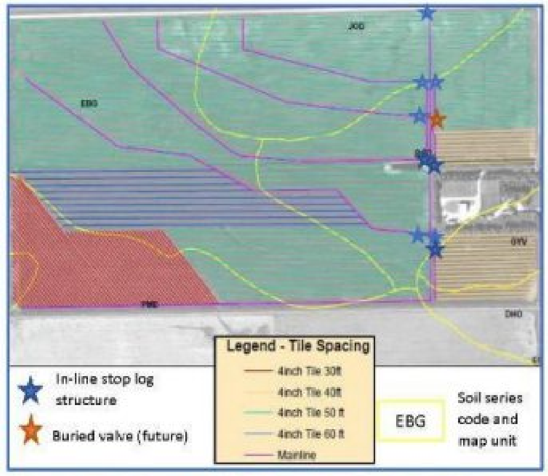



**Figure 5. Typical controlled drainage design in Manitoba.**

In addition to field elevations, engineering design should consider water table elevations, soil type and variability, locally-measured flow rates, drainage intensity (i.e depth/spacing tiles) and potential for lateral flow. Sub-irrigation adds further design complexity and requires a source of irrigation water.

Controlled drainage is best designed to capture a portion of the tile flow, after allowing tile water to flow freely early in the growing season. Based on a modelling exercise by Sands (2013) and the results of the Cordeiro (2013) and Satchithanantham (2013) studies, a reasonable target for Manitoba would be to save up to 25 mm (1 in) of tile drainage water for crop use, by holding back 300 mm (12 in) of water depth. Establishing a rough schedule for holding back and releasing tile water is an important component of controlled drainage. A properly managed controlled drainage system could have reduced the amount of irrigation that was otherwise required in the summer of 2011 (Figure 6).

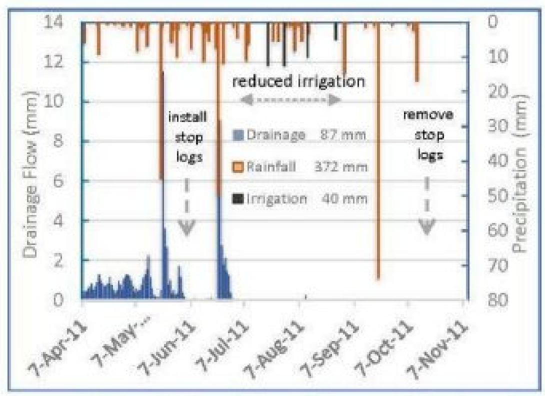



**Figure 6. Illustrative free drainage flow vs. precipitation and irrigation (Cordeiro, 2013); showing potential to install stop logs at start of June to conserve water for July/August and removal of stop log in late October.**

The performance of a controlled drainage system should be monitored. Crop response, soil moisture levels, and the use of piezometers to track changes in the water table can aid in optimizing performance. Guidance for the design and operation of a controlled drainage system is provided in the Drainage Water Management chapter of the Conservation Practice Standards series published by USDA–NRCS.

## Outstanding questions and potential future improvements

Controlled drainage is a proven technology, with most experience gained in the Upper Midwest of the USA, Ontario and Quebec. Optimizing design and performance for Manitoba conditions requires additional research and development, including:

- Further information is required on timing of stop log adjustments relative to crop stage and/or growing season parameters (e.g. planting date, heat units), as well as water table response to evapotranspiration.
- The implications of controlled tile drainage for greenhouse gas emissions and adaptation to climate change should be studied.
- Site selection and design criteria based on soil texture and stratigraphy, hydraulic conductivity, and existing ground and groundwater gradients should be established.
- Field measurements at local research and demonstration sites, and modelling (Skaggs et al., 2012) are needed to assess:
  - the agronomic benefits of controlled drainage, particularly crop yield;
  - other potential benefits including water quality improvement;
  - performance monitoring and operation protocols.

**Complementary practices**

Controlled tile drainage is complementary with other BMPs that reduce nutrients in tile outflow or drainage volume:

- *IF-01 – Nutrient Management;*
- *IF-02 – Cover Crops.*

Controlled tile drainage can be supplemented by other BMPs as noted:

- *WS-01 – Tile Water Recycling; EF-01 – Bioreactors; EF-02 – Saturated Buffers; WS-02 – Constructed Wetlands).*

**Design aids**

USDA-NRCS Conservation Practice Standard Drainage Water Management Code 554. Access on USDA-NRCS website.

**Additional BMP resources**

ADMC and NRCS, 2013. Drainage water management; a tool that interacts with the 4Rs. Conservation Innovation Grant 68-3A75-6-116. Poster on 4R Tomorrow website.

Christianson, L.E., J. Frankenberger, C. Hay, M. J. Helmers and G. Sands, 2016. Ten ways to reduce nitrogen loads from drained cropland in the Midwest. Pub. C1400. University of Illinois Extension.

Frankenberger, J., E. Kladivko, G. Sands, D. Jaynes, N. Fausey, M. J. Helmers, R. Cooke, J. Strock, K. Nelson and L. Brown, 2006. Questions and answers about drainage water management for the Midwest. Pub. WQ-44. Purdue University Cooperative Extension Service

USDA-NRCS, 2013. Drainage water management benefits landowners (video). Access on USDA-NRCS website.

**References**

Ayers, J.E., E.W. Christen, R.W.O. Soppe and W.S Meyer, 2006. Resource potential of shallow groundwater for crop water use; a review. Irrigation Science: 24:147-160.

Cordeiro, M.R.C., 2013. Agronomic and environmental impacts of corn production under different water management strategies in the Canadian Prairies. Ph.D. Thesis, Dept. of Biosystems Engineering, University of Manitoba.

Sands, G., 2013. Developing optimum drainage design guidelines for the Red River Basin. University of Minnesota.

Satchithanantham, S., 2013. Water management effects on potato production and the environment. Ph.D. thesis, Dept. of Biosystems Engineering, University of Manitoba.

Skaggs, R.W., M.A. Youssef and G.M. Chescheir, 2012. DRAINMOD: Model use, calibration, and validation. Trans. of the American Society of Agricultural and Biological Engineers: 55(4): 1509-1522.

University of California, 2015. Use of shallow groundwater for crop production. Agriculture and Natural Resources Publication 8251.

# Nutrient Management

IF-01

**Figure 1. Soil sampling for lab analysis.**

## What does nutrient management accomplish?

Agricultural nutrients that enter surface and groundwater pose concerns for ecological and human health. The objective of nutrient management is to fertilize the crop in a manner that minimizes nutrient losses to the environment and ***Improving Water Quality***. Nutrient management strategies are used to retain nutrients within the root zone for crop use and reduce nutrient loss from the field via tile flow.

Keeping nutrients in the field and available for crop use also makes good agronomic and economic sense!

> ***Nutrient management requires the implementation of practices that optimize fertilizer use – matching supply with crop requirements to minimize nutrient losses from fields.***
>
> Source: modified from www.nutrientstewardship.com

## Overview of nutrient management

Nutrient management principles should be followed when fertilizing any agricultural field. For tile drained lands, special consideration should be given to the change in hydrology that the practice achieves.

4R Nutrient Stewardship is an internationally recognized framework that includes all of the components of comprehensive nutrient management. Applying fertilizers according to the principles of Right Source, Right Rate, Right Time and Right Place (the 4Rs; Figure 2) minimizes greenhouse gas emissions and losses of nutrients to surface and ground waters. The installation of tile drainage may require adjustment of any or all of the 4Rs.

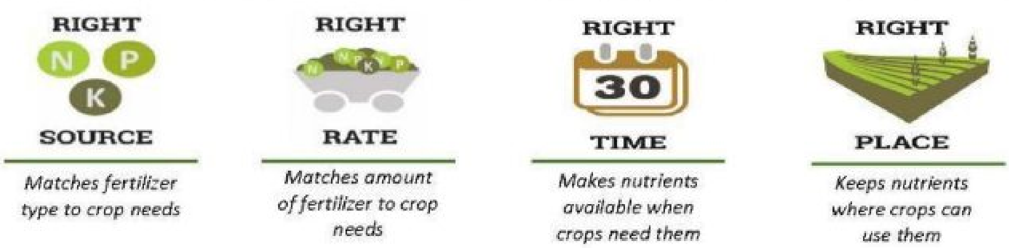



**Figure 2. *4R Nutrient Stewardship (Right Source @ Right Rate, Right Time, Right Place ®).***

## Applicability

Nutrient management is key to sustainable agriculture and is an important complementary practice when adopting tile drainage. While nutrient management is broadly applicable in Manitoba, individual practices should be customized to fit each farm's unique combination of climate, soil and landscape features, crop rotation, equipment and overall management system.

## Nitrogen issues and management

Nitrogen (N) is one of the most intensively-managed crop nutrients. Once applied to soil, some N is converted to nitrate ($NO_3^-$), which is highly soluble in water and very prone to leaching (downward movement through the soil profile) (Figure 3). Once below the root zone, nitrate can enter tile drains and discharge to surface water. Numerous studies in the U.S. and Canada link subsurface drainage and increased nitrate movement from fields to surface waters (Christianson et al., 2016). Each of the 4Rs is important to reduce N in tile outflow.

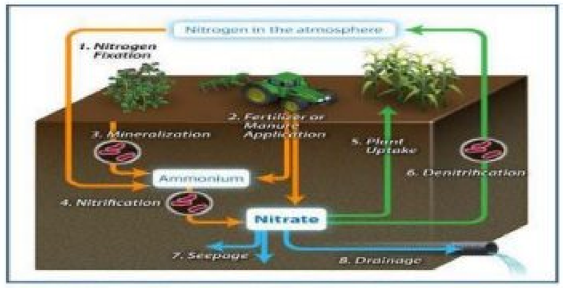


Figure 3. Nitrogen (N) cycle and tile drainage (Christianson et al., 2016).

***Right Source.*** Sources include N fertilizers and animal manures. While there are many types of commercial N fertilizers, Enhanced Efficiency Fertilizers that contain controlled release or inhibitor technology have a particular fit in imperfectly and poorly drained soils. Their use should be reassessed when tile drainage is adopted.

***Right Rate.*** Determining the correct application rate is an essential component of nutrient management. As tile drainage increases productive capacity of the field, a higher rate of N may be appropriate. Producers should soil test every field annually to determine appropriate fertilization rates that consider residual soil nutrients and crop requirements.

Variable rate application technology can be used to reduce application on areas requiring little or no additional N or on sensitive areas if in-field variability is adequately understood (Dinnes et al., 2002).

***Right Time.*** The risk of nitrate leaching to the tiles is higher if soil nitrate levels are elevated when water is moving through the profile. This risk is minimized when N is applied as close as possible to when the crop needs it.

Fall application of ammonium fertilizers is a common practice in Manitoba. Late fall application reduces the risk of nitrate accumulation in the soil because the conversion of ammonium to nitrate slows in cold temperatures. Spring application presents less risk of nitrate leaching during spring snowmelt and early rainfall events, however, spring application is not always feasible.

Perennial forage crops and some annuals receive split applications of N rather than supplying the full N requirement of the crop in a single application. Split applications can also reduce the risk of nitrate leaching. Fertigation, the application of nutrients in irrigation water, is a recognized practice for high-input crops under irrigation management (e.g. potatoes). This practice meters out smaller amounts of N as the crop is growing and reduces the potential for high soil nitrate levels that could be at risk of nitrate leaching.

Within the chosen season, weather conditions and the forecast should be taken into account when timing N applications to avoid excess water moving through the root zone and taking nitrate with it.

***Right Place.*** Applying N in concentrated bands beneath the surface of the soil is more efficient than broadcasting N onto the soil surface. This allows the producer to reduce the overall N application rate to achieve the same yield potential and also reduces the risk of elevated N levels in the soil that could be leached to the tiles.

## Phosphorus issues and management

Phosphorus (P) is naturally deficient in Manitoba soils and must be supplied to sustain commercial crop production. In soil, P is less soluble than nitrate and is not particularly susceptible to leaching. It can, however, reach drainage tiles via preferential flow through macropores, such as soil cracks, earthworm holes and root channels (Figure 4).

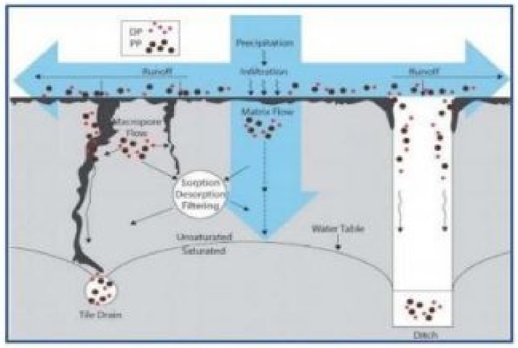



**Figure 4. Representation of processes controlling P losses, DP, dissolved phosphorus; PP, particulate phosphorus (Kleinman et al., 2015).**

The main concern associated with P loss from agricultural fields is the accelerated eutrophication of surface water. Phosphorus is primarily transported to surface water via runoff, especially during spring snowmelt. Tile drainage partially shifts the hydrology from surface to subsurface drainage and results in trade-offs between P losses in overland flow versus tile flow.

4R Nutrient Stewardship should be followed for P management. The Right Source, Right Rate, Right Time and Right Place should be considered for P application to each field. In addition, incorporating P via tillage should reduce the risk of loss via surface runoff and disrupt macropore networks connecting the field surface to the tiles.

## What about manure application on tile drained lands?

The water and nutrient content of manure varies greatly, making it more challenging and costly to manage than synthetic fertilizer. Nutrients from synthetic fertilizers and livestock manure are both susceptible to loss through tile drainage. The 4Rs of nutrient management should be followed when applying manure to tile drained land.

***Right Source.*** Unlike synthetic fertilizer, manure is not a balanced nutrient source. As well, not all of the nutrients in manure are immediately available for crop uptake. Supplying the nutrient needs of the crop requires estimation of the fertilizer value of the manure. Due to its ability to flow, liquid manure is inherently more likely than solid manure to reach tile drains if macropores are present.

***Right Rate.*** Manure is most often applied based on the N requirement of the crop. This often results in over application of P and buildup of soil test P, which increases the risk of P loss via leaching or runoff. At low soil test P levels, accumulation of P is beneficial, but must be well managed by establishing sustainable manure application rates based on soil testing and crop requirements.

**Figure 5. Example of manure injection technology.**

***Right Time.*** In Manitoba, manure is most commonly applied in the fall to ensure sufficient over-winter manure storage capacity and because favourable conditions for application in the fall generally last longer than in the spring. Application timing should always consider soil moisture levels and the weather forecast. Manure cannot be applied in the winter when ground is frozen, and should not be applied when soil is saturated, tile water is running, or just prior to a rain event.

***Right Place.*** Manure should be placed beneath the soil surface, as much as possible, to maximize nutrient use efficiency and minimize the risk of surface runoff losses. The optimal placement practice includes injection or immediate incorporation of manure that involves disturbance of macropore networks concurrent with application. This is of particular importance for application of liquid manures to reduce the potential for losses via preferential flow (Cooley et al., 2013).

## Outstanding questions and potential future improvements

Tillage disrupts the macropore network and the hydrologic connectivity between the soil surface and tile drains. Tillage prior to manure application can reduce preferential flow of nutrients to tiles through cracks and other macropores. More research is required to determine the most effective tillage practices and quantify impacts on tile water quality.

### Complementary practices

Nutrient management is complementary with other BMPs that can reduce the volume of tile outflow and drainage intensity, in turn reducing nutrient export from the field:

- *IF-04 – Controlled Tile Drainage;*
- *IF-05 – Site-Specific Tile Drainage Design.*

Similarly, reduction in nutrient loading using nutrient management will lead to improved performance of other nutrient reduction BMPs:

- *EF-01 – Bioreactors;*
- *EF-02 – Saturated Buffers;*
- *WS-01 – Tile Water Recycling;*
- *WS-02 – Constructed Wetlands.*

### General nutrient management resources

Manitoba Agriculture, 2007, Manitoba Soil Fertility Guide

### Additional BMP resources

Christinson, L.E., J. Frankenberger, C. Hay, M.J. Helmers, and G. Sands, 2016. Ten Ways to Reduce Nitrogen Loads from Drained Cropland in the Midwest. Pub. C1400, University of Illinois Extension.

Cooley, E.T., Ruark, M.D., and Panuska, J.C. 2013. Managing Tile-Drained Landscape to Prevent Nutrient Losses, University of Wisconsin Discovery Farms, Fact Sheet No. 3 GWQ064- Madison, Wisconsin.

### Manure management on tile drained land

Manure management on tile drained lands in Manitoba – literature reviews by Stantec Consulting Ltd./PBS Water Engineering Ltd. and University of Manitoba.

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Kleinman, P., D. Smith, C. Bolster, and Z. Easton, 2015. Phosphorus Fate, Management, and Modeling in Artificially Drained Systems. Journal of Environmental Quality 44:460-466.