2018

Thornhill Irrigation Ltd.
Tobacco Creek Irrigation Project
Environment Act Proposal

Thornhill Irrigation Ltd.

PBS Water Engineering Ltd.

6/6/2018

PBS Water Engineering

Submission Sheet

The Thornhill Irrigation Ltd. – Tobacco Creek Irrigation Project Environmental Act Proposal, was prepared by PBS Water Engineering Ltd. for the Proponents; Thornhill Irrigation Ltd. and their shareholders Kroeker Farms Ltd. and Hespler Enterprises Ltd. The report reflects the opinion of PBS Water Engineering Ltd. based on information and data available at the time of the report preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. PBS Water Engineering Ltd. accepts no responsibility for damages suffered by any third party because of decisions and actions based on this report

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Accepted for:

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Hespler Enterprises Ltd.

APEGM
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No. 5696 Date: 06 06 2018

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PROVINCE OF MANITOBA
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06 06 18
REGISTERED PROFESSIONAL ENGINEER

Executive Summary

Thornhill Irrigation Ltd. is a joint development and operating arm of Kroeker Farms Ltd. and Hespler Enterprises Ltd. Thornhill Irrigation Ltd. is proposing to construct an irrigation system capable of providing water to 15 fields, encompassing some 877 ha (2165 acres), with future expansion to 24 fields encompassing 1311 ha (3239 acres). The Project proposes to store spring snowmelt and rainfall runoff water from South and West Tobacco Creeks in two reservoirs located beside the creeks (e.g. off-stream reservoirs). Application has been made to Manitoba Sustainable Development to divert water up to the current limit of availability from the two branches of the Tobacco Creek (e.g. 766 cubic decameters; 621 acre-feet). Current plans will store up to 667 cubic decameters (535 acre-feet) annually to service the available land base next to these two waterways. Given the size of the proposed water diversion, the project is considered a Class 2 development in relation to The Environment Act.

The purpose of the Project is to secure their potato production against moisture deficits, and to implement a production system that secures the quality of the produce. Cereals, oilseeds, legumes and specifically wheat and corn will be some of the crops grown in rotation with the irrigated potatoes. These other crops will not be irrigated at this time. Water will be pumped from the Tobacco Creek(s) to fill two reservoirs using high volume pumps. Water will be pumped and distributed to the irrigated areas using underground PVC piping. High efficiency irrigation systems (e.g. center pivots, linears) will be used to apply water to the fields. Three phase electric power is being considered for the pumping systems. Provincial highway and creek crossings will be directionally bored. Rural Municipality road crossings will be open cut where possible.

The project will be developed over a 3-5-year construction period. Engineering is continuing this June (2018), with further site investigations. The RM of Thompson has been contacted regarding permits for potential reservoirs in SW 33-5-6 (Site T1) and either SE 29-5-6 W, S 28-5-6 W, or NW, SE 20-5-6 W (Site T2). Neighbours to the project site have or will be consulted individually and can also request any information provided to the RM of Thompson. Construction of the first storage reservoir (Site T1) would begin in July 2018, pending environmental and Water Development Permit approvals. Construction of pipelines and pump works would be started in fall, 2018. Additional storage site(s), further pipeline and pumping would be constructed and commissioned over the projected construction period.

The existing environment is largely agricultural, and the loamy, non-stony soil landscape is well suited for potato production. The major constraint to the growing climate for potatoes is having adequate moisture for optimum growing conditions. Average moisture deficits are in the 100 mm range.

The landscape and geology largely are reflections of the glacial Lake Agassiz. The lacustrine sediments include pockets of relatively impervious clay, which is suited to water storage; but include surficial loams associated with near-shore environments, which are ideal for horticulture production. The 15 parcels of land are considered prime agricultural land with 97% of the land is rated Fair or better (83% Good; 14% Fair) for general irrigation suitability and 92% as Class 3 for irrigated potato production. Only one parcel requires a Phase II assessment prior to being recommended for irrigation by AgriEarth Consulting Ltd. The Phase II assessment will determine the degree and extent of existing salinity and provide recommendations for suitability for irrigation and mitigative options, as appropriate.

Given the nature of the Project area, that being largely cultivated, it is not anticipated to have 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. Similarly, contact has been made with Historic Resources Branch to determine the potential for archaeological impacts of the reservoir and pipeline construction.

The impacts of the Project on Fisheries are mitigated by the following considerations. The habitat value of the Tobacco Creek branches are mapped as marginal or are severely impacted (channelized) at the location of the reservoir withdrawals. The proposed withdrawals will be made during the rising limb of the spring freshet, when migration upstream from the Red River is typically is blocked by snow and manmade structures (e.g. drop structures). The withdrawals are considered a small percentage of the channel forming flows for these intermittent streams. The streams are intermittent and dry up yearly.

Minimum in stream flows will be maintained during pumping to support the recessional limb of the hydrograph. It is not proposed to screen the intakes on the creeks. Given the limited width and intermittent nature of the streams, navigation is not considered a primary activity in the area.

The project is not located overtop of a known aquifer and is not expected to impact groundwater.

The socio-economic effects of the project are either positive or mitigable. The construction project will create local jobs during construction, as well as help secure existing staff complements associated with Kroeker Farms Ltd. and Hespler Enterprises Ltd. Given that the producers currently grow potatoes (in rotation) on much of the identified land, it is not anticipated that significant increase in traffic will occur.

Potential adverse 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 Best Management Practices for growing of irrigated potatoes on the specific fields approved herein.
- Gearing any near water construction (e.g. intakes, stream crossings) to avoid timing windows specified by DFO.
- Provision of minimum instream flows during pumping to fill the reservoirs. Monitoring if required could be in relation to measured flows at the existing Water Survey of Canada flow stations on the Tobacco Creek.
- Comply with regulations respecting Storage and Handling of Gasoline and Associated Products.

The project is not considered to be a significant increase to Greenhouse Gas contributions, given that the farming activity is largely ongoing, construction is short term, and where economically feasible renewable Hydro-electric power will be employed for pumping.

Thornhill Irrigation Ltd.'s and its farming operations, Kroeker Farms Ltd. and Hespler Enterprises Ltd. are committed to sustainable potato production and to implementing steps to ensure that they are protecting the local environment during design, construction, operation and repairs.

- 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.
- Promptly report significant environmental incidents to Manitoba Sustainable Development for guidance in finding appropriate remedies.

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Tables

1.0 Introduction and Background

1.1 Proponents

Kroeker Farms Ltd. and Hespler Enterprises Ltd. are producers of potatoes for the processing, table, chipping, seed and organic markets. These companies have been growing potatoes in the project area, which is shown in Figure 1, for several years. They have an ethos and history of working closely with their neighbours and land owners within the project area. The two companies have formed a joint irrigation development and operating company known as Thornhill Irrigation Ltd. which will be referred to as "the Proponent" herein.

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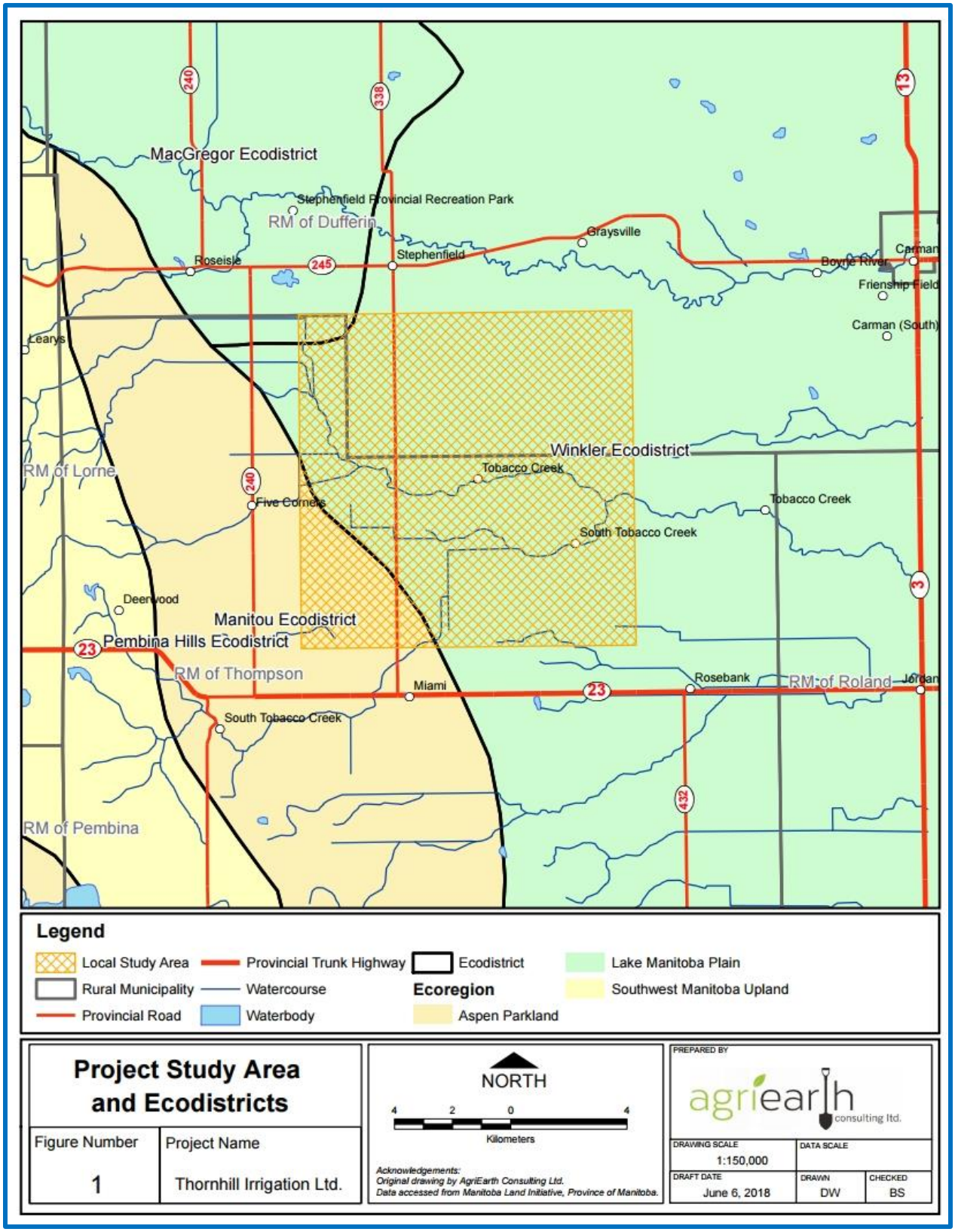
1.2 Project Overview

The project area is shown in Figure 1. The project area is north of Miami along PR 338 and includes land along the South Tobacco and (West) Tobacco Creeks. To secure production against the risk of drought, and to meet the quality requirements of their customer base, the Proponents need to develop the capacity to irrigate their production. The proposed water source for the irrigation project is the two branches of the Tobacco Creek watershed which are fed by the Manitoba Escarpment to the west.


MacGregor Ecodistrict
Stephenfield Provincial Recreation Park
RM of Dufferin
Graysville
Roseisle
Stephenfield
Boyne River
Carman
Friendship Field
Carman (South)
Learys
Winkler Ecodistrict
RM of Lorne
Tobacco Creek
Five Corners
Tobacco Creek
South Tobacco Creek
Deerwood
Manitou Ecodistrict
Pembina Hills Ecodistrict
RM of Thompson
Miami
Rosebank
RM of Roland
Jordan
South Tobacco Creek
RM of Pembina
240
338
13
245
23
3
432
Legend
Local Study Area
Provincial Trunk Highway
Ecodistrict
Lake Manitoba Plain
Rural Municipality
Watercourse
Ecoregion
Southwest Manitoba Upland
Provincial Road
Waterbody
Aspen Parkland
Project Study Area and Ecodistricts
Figure Number
1
Project Name
Thornhill Irrigation Ltd.
NORTH
4 2 0 4
Kilometers
Acknowledgements:
Original drawing by AgriEarth Consulting Ltd.
Data accessed from Manitoba Land Initiative, Province of Manitoba.
PREPARED BY
agriearth consulting ltd.
DRAWING SCALE
1:150,000
DATA SCALE
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June 6, 2018
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Irrigation will be used to offset peak moisture deficits to potato production of 125 to 150 mm (5 – 6 inches). Moisture deficits have implications for potato size, yield and quality. The Proponents plan to irrigate up to 800 acres of land a year in rotation (i.e. 3 or 4-year rotation). The total current water requirement is 500 cubic decameters (i.e. 400 acre-feet). Future expansion could add another 270 acres requiring an additional 135 acre-feet (167 cubic decameters). Thus, the total water to be developed for the project amounts to 535-acre feet or 667 cubic decameters.

The project will involve withdrawal of water from the South Tobacco and West Tobacco Creeks during spring snowmelt and large spring rainfalls and storing the water in two reservoirs; named Site T1 and Site T2 (Figure 2). A preferred location for Site T1 has been established (SE 33-5-6 W1), while several options are being explored for Site T2. Water will be distributed to up to 3239 acres (including future land locations to be confirmed) through buried pressure pipelines, pumping facilities, and moveable on farm irrigation systems.

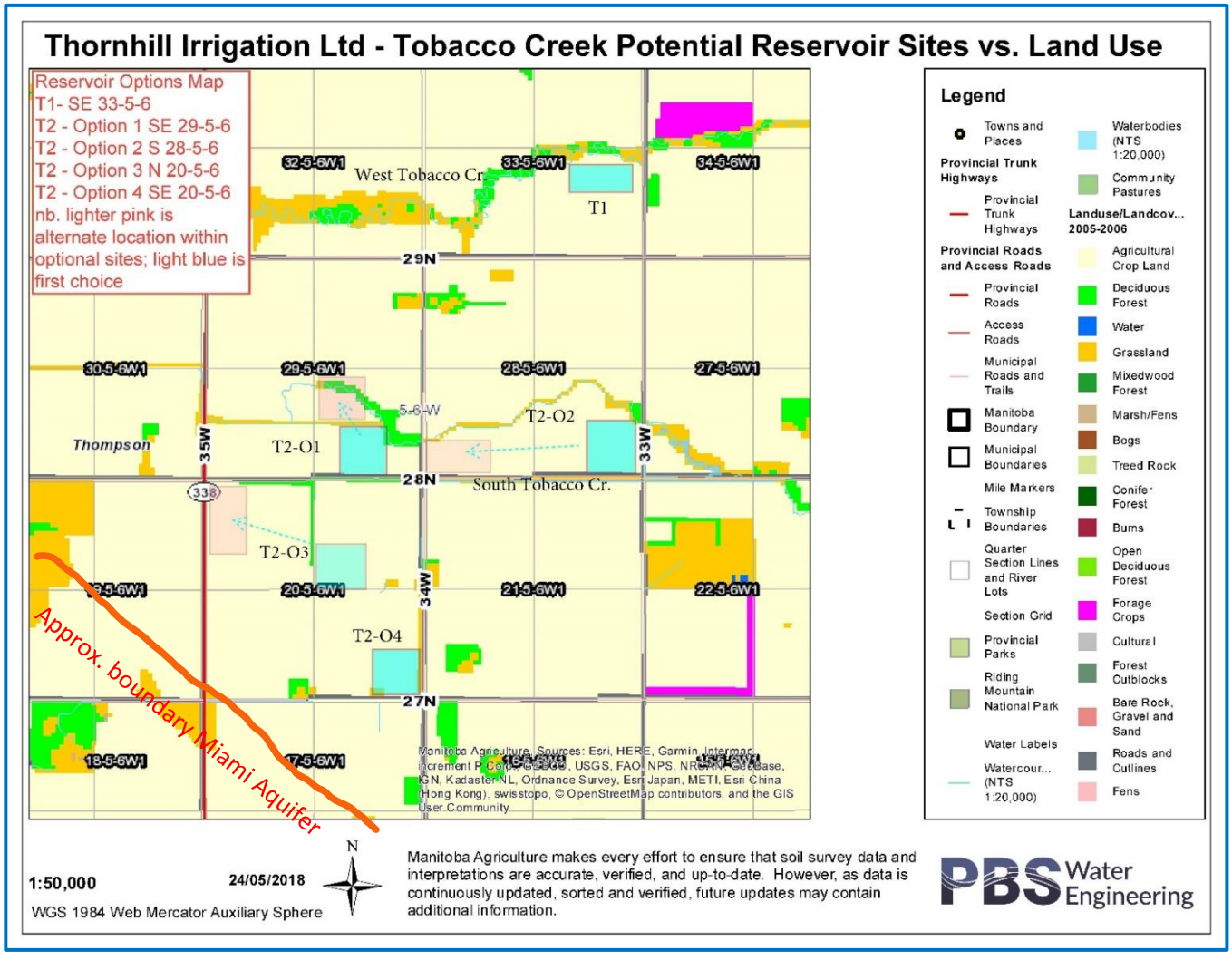


Figure 2 - Proposed Reservoir Sites Along (West) Tobacco Creek and South Tobacco Creek

The Proponents currently own and operate irrigation projects in the immediate area (i.e. along Shannon, Graham Creeks and the Boyne River) that service similar land types and production systems. The Proponents are experienced potato growers, irrigators and farming operators.

Kroeker Farms Ltd. and Hespler Enterprises Ltd. make use of the most current irrigation technologies, including highly efficient low pressure linear and center pivot irrigation systems, and travelling boom carts, as well as irrigation scheduling technologies, such as weather and soil moisture irrigation scheduling techniques. Precision control of inputs and risks is required to maintain profitable sustainable production.

1.3 Previous Studies and Licenses

This study area was included in the original Agassiz Irrigation Association master plan, circa 1993. Since then several reservoirs have been built in the vicinity along the Shannon and Graham creeks and the Boyne River by both Hespler Enterprises and Kroeker Farms and other potato growers. The most recent Environmental Act Proposals/Licenses issued to these two farms and partners are September 2014 Licence 3116 (Hespler Enterprises and Kroeker Farms); 2013 License 3062 (Hespler Enterprises Ltd.); October 2010 License 2939 (Agassiz Resource Management Ltd./Kroeker Farms); September 15, 2000 License 2480 (Agassiz Resource Management Ltd.). Copies of existing Environment Act Licenses are included in Appendix C.

Previous water supply studies in the area include studies of the Miami Aquifer which is located to the south of the proposed project and is traversed by the South Tobacco Creek (Manitoba Groundwater Section, 1982; MSTW, 1982).

Manitoba Sustainable Development has provided a review of the Tobacco Creek water availability, updated to 2018 (Memo; Delevau to Butterfield, Feb. 28, 2018). Excerpts from that analysis are presented herein.

1.4 Project Alternatives

The selected water source for the project is Tobacco Creek. Other available water sources in the area include groundwater, such as the Miami Aquifer, and treated water, such as the regional Pembina Valley Water Cooperative (PVWC). The potable water sources (PVWC) are either fully committed and unavailable or unaffordable for irrigation development of the scale proposed. The Miami Aquifer is actively being investigated by Thornhill Irrigation Ltd. (Hespler/Kroeker), but current indications are that licenced amounts are limited to 175 acre-feet, and water quality suitability for irrigation has yet to be firmly established as a function of the response of the aquifer to pumping. The nearest the Miami Aquifer comes to the project site is Section 17-5-6 W1 per Figure 2. The largest readily available source of water in the project area, is the local snowmelt and rainfall runoff that traverses the study area within the Tobacco Creek watershed (Figure 2). The most readily actionable option was determined to be capture of spring snowmelt and rainfall runoff in off stream reservoirs. Figure 2 shows optional locations for the proposed reservoirs.

2.0 Regulatory Submissions and Approval Status

2.1 Local Permits

2.1.1 RM of Thompson and RM of Dufferin

Thornhill Irrigation Ltd. (Hespler Enterprises Ltd. and Kroeker Farms Ltd.) have notified the RM of Thompson of their intentions to build off-stream reservoirs to capture spring runoff on the Tobacco Creek (see Appendix B). There is no by-law governing location of the reservoirs, so proposals will be made on case by case basis as to proximity to roads, creeks once preferred locations have been decided.

Separate submissions will be made to the RM's of Thompson and Dufferin regarding the location of irrigation pipelines within their ROW, and the details of road crossings and valve markings.

2.1.2 Building Permits

Morden, Stanley, Thompson, Winkler (MSTW) planning district and RM of Dufferin will be consulted regarding permits for construction of permanent buildings and other structures regarding their approvals (e.g. pump houses), if/as required.

2.2 Provincial Permits

2.2.1 Provincial Water Rights License Applications

Kroeker Farms Ltd. and Hespler Enterprises Ltd. have applied for Water Rights (i.e. Development Permits) through the Manitoba Sustainable Development for withdrawal of up to 1051 cubic decameters (852 acre feet) as per Appendix A. Neither farm has existing Water Rights licences on the Tobacco Creek or Miami Aquifer.

A copy of the existing Groundwater Exploration Permit issued to Hespler and Kroeker is available upon request, but currently not associated with this project.

2.2.2 Manitoba Infrastructure Permits

There is no anticipated impact on MI water infrastructure due to the development of the off-stream reservoirs. Submissions will be made to MI for access to install filling pumps and connecting fill piping from the Tobacco Creek, where MI dykes/channels exist. An initial meeting has yet to be scheduled.

The pipeline distribution system may include crossings of Provincial Roads and Drains. Individual applications will be made for all crossings and for location of pipeline delivery systems in MI right of way if required.

2.2.3 Provincial Environment Act License Applications

The Manitoba Environment Act applies to projects having significant impacts on the environment. The proposed Hespler-Kroeker Irrigation Project is considered a Class 2 project as it proposes to withdraw more than 200 cubic decameters of water. The Project requires a valid and subsisting licence from Manitoba Sustainable Development - Environmental Approvals Branch. This report forms the basis of the application.

2.2.4 The Water Protection Act

This act pertains to nutrient management requirements for the proposed irrigated potato fields within the study area. The regulations encourage nutrient management planning and prescribes nutrient management zones (N1-N5) which dictate the nutrient management practices that must be employed in growing a crop. The Act also defines the Nutrient Buffer zones around water sources (surface, ground). The buffer applies to any water body on the fields being proposed for irrigation and potato production. The proponents are responsible to adhere to the Water Protection Act as part of their operations. Discussion on nutrient management is provided in Section 5.1.5 and Appendix H.

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 a formal burial grounds are protected by the Act. The Act prescribes the processes to be followed by the Proponents and Authorities.

Correspondence the Heritage Resources Branch is included in Appendix D.

2.2.6 Provincial Drainage Permits

Application will be made to Manitoba Sustainable Development for a drainage license to allow for improved drainage around the reservoir dykes. The improved drainage will remove ponded water from the toe of the dykes and intercept downslope water movement off the adjacent uplands. The drainage will be HDPE tile drains c/w filter sock and will exit by gravity to existing waterways (i.e. Tobacco Creek). Any in-field tile drainage is required to be permitted individually by the farm/landowner in question.

2.3 Federal Regulations

2.3.1 Federal Department of Fisheries and Oceans Authorization

The Federal Fisheries Act was amended in June 2012 (http://www.dfo-mpo.gc.ca/pnw-ppe/changes-changements/index-eng.html). Under the Fisheries Act, harmful alteration, disruption or destruction (HADD) is only allowed with 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 fish*ery**, 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 may include consultation with Department of Fisheries. The Federal law regarding protection of fish habitat will be reviewed with respect to the withdrawals, sediment control, and intake development.

Under provisions of the current act intakes that don't change the width of the water body are exempt. Additionally, the DFO recently issued guidelines on the classification of fishery habitat in Southern Manitoba that indicate the potential habitat value of the Tobacco Creek at the proposed withdrawal points with respect to commercial, recreational or Aboriginal fisheries. These are discussed in Section 4.3.

2.3.2 Navigation Protection Act

The Federal law regarding navigable waterways was reviewed with respect to the intake design.

> *For the purposes of the NPA, "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. When a work is assessed as substantially interfering with navigation, section 6 of the NPA applies.*

It is not anticipated that the streams in question are navigable, and it is assumed that the Tobacco Creek is a minor water not intended for navigation and are therefore exempt. The Tobacco Creek is not listed in the schedule of waters under the revised Navigation Protection Act, enacted by Parliament in 2014. The list of scheduled waters is provided on the Transport Canada web site. The proponents do not intend to "opt in" for assessment.

https://www.tc.gc.ca/eng/programs-673.html

At this point no further consultation is considered necessary.

2.3.3 Migratory Birds Convention Act

Disturbance or destruction of migratory bird nest 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 Act is intended to prevent human activity from impacting species of special concern specific to the area of the project, to help prevent endangered or threaten their extinction. The Manitoba Conservation Data Center was informed of the project and asked for an opinion on Species at Risk at the three major construction sites, namely Site T1 and T2. Copy of the correspondence is included in Appendix E.

2.4 Other Permits and Considerations

2.4.1 Gas Pipeline

There are no known gas pipeline crossings required.

2.4.2 Local Conservation Groups

Pembina Valley Conservation District has been notified of the pending site feasibility studies. They will be part of consultations (section 2.5).

2.5 Consultations and Submissions

Information and informal presentations on the Tobacco Creek project will be offered to the RM of Thompson for their consideration and comments. No public hearing is currently planned.

A copy of the pertinent information (this report) will be made available at the RM office should for local government and public review. Copy of all feasibility reports on the reservoir projects are available on request.

Neighbours will be actively and directly consulted by PBS Water Engineering Ltd. on behalf of the proponents; to allay concerns and/or address mitigative items.

PBS Water Engineering Ltd. is responsible for filing these applications 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 Thornhill Irrigation Ltd., the joint development arm of the two Proponents whom will have sole responsibility to meet license conditions.

3.0 Description of Proposed Development

3.1 Project Summary

The Project will store up to 667 cubic decameters (i.e. 535 acre- feet) of water in 2 reservoirs, referred to as Sites T1 and T2. Water from the reservoir(s) will be piped in a common underground pipeline to up to 15 current parcels of land, encompassing 877 ha (2166 acres) of cultivated crop production. Additional acres are planned subject to land owner negotiations for lease or rental, which would bring the total acres to 1311 ha (3239 acres).

Figure 3 shows the currently proposed land base, alternative reservoir locations and currently proposed pipeline infrastructure. In any given year up to 5 - 6 parcels will be irrigated using modern sprinkler irrigation systems (e.g. center pivots, linears, travelling guns or drip irrigation). An additional 2 parcels will be irrigated in the future. A maximum annual irrigated acreage is associated with 7 - 8 parcels will be 433 ha (1070 acres).

Power sources will be electric and/or diesel power.

The system will be jointly managed by the Proponent, Thornhill Irrigation Ltd.

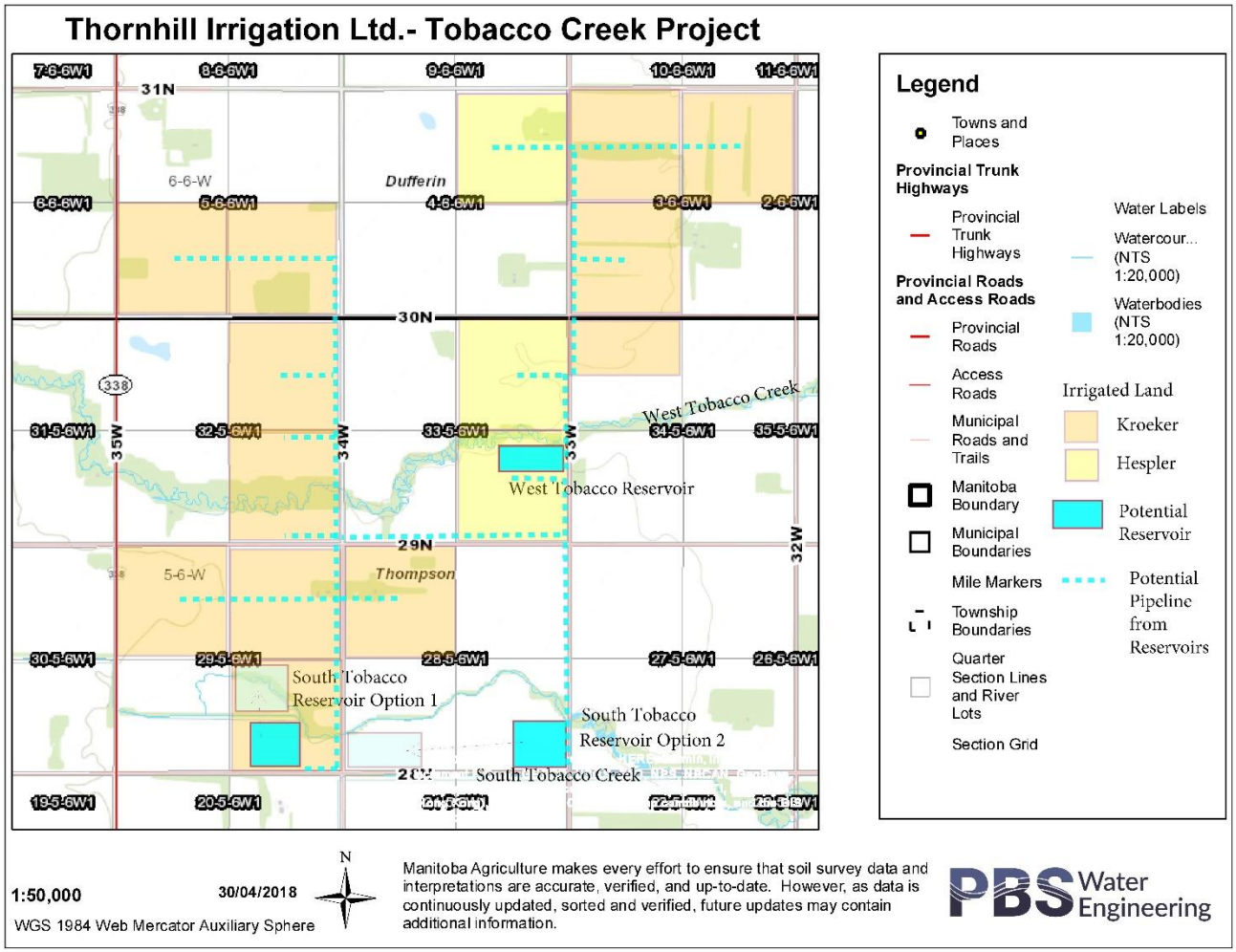


Figure 3 – Proposed Land Base and Infrastructure Components

3.2 Project Area

The project area is highlighted in Figure 1, located north of Miami on west side of PR 338 and along the Tobacco Creek watershed. The project area straddles two RMs, namely Thompson and Dufferin. The project area is located completely within the Winkler Ecodistrict portion of the Lake 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 Figure 3. The project components are illustrated in relation to the land base in Figure 2 and Figure 3. Those components include, irrigated land base, water delivery system, water storage, water diversion, 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 Cultivated Areas (ha, ac).

Field ID	Land Parcel Description	Land Area	
		hectares (ha)	acres (ac)
1	SW&SE-5-6-6W1	116.0	286.7
2	NE-32-5-6W1	65.0	160.6
3	N portion of SE-32-5-6W1	31.6	78.0
4	S portion of SE-32-5-6W1	17.3	42.7
5	NW-29-5-6W1	63.4	156.8
6	NE-29-5-6W1	61.3	151.4
7	SE-29-5-6W1	53.1	131.2
8	NE-4-6-6W1	58.9	145.5
9	NE-33-5-6W1	65.0	160.5
10	SE-33-5-6W1	56.1	138.6
11	S portion of NW-28-5-6W1	57.8	142.7
12	NW-3-6-6W1	62.7	154.8
13	NE-3-6-6W1	63.7	157.5
14	SW-3-6-6W1	67.8	167.5
15	NW-34-5-6W1	36.9	91.3
	Totals	**876.5**	**2165.9**

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 limited to:

- Center pivot irrigation systems
- Linear irrigation systems
- Travelling boom carts or guns
- Drip irrigation

Each individual system is considered an irrigation parcel. There are 15 parcels (Figure 3) encompassing 877 ha (2166 acres). Additional parcels will add another 434 ha (1073 acres) for total of 1311 ha (3239 acres).

The maximum on farm irrigation will be 433 ha (1070 acres) per year, at a maximum duty of 150 mm (6 inches), for a total demand of 667 cubic decameters (535 acre-feet).

3.3.2 Water Delivery Systems

Water will be delivered to each irrigation parcel by means of pressurized pipeline. The preliminary pipeline routes are shown in Figure 3; subject to change associated with final reservoir and field locations and crop rotations. This pipeline 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 RM roads will be open cut where feasible and acceptable. All road crossings will be provided with liner pipes to safely convey any leakage to the road ditches and ensure public safety.

3.3.3 Water Storage

As the demand of water is in June to September period and spring snowmelt runoff occurs in March, April and May; there is a need to build water storage facilities. Three water storage sites are under active consideration. These sites are designated and located as per Figure 2 and 3, as follows:

T1 – SE 33-5-6 W

T2 – Option 1 SE 29-5-6 W

T2 – Option 2 S 28-5-6 W

T2 – Option 3 N 20-5-6 W

T2 - Option 4 SE 20-5-6 W

Pre-feasibility and feasibility studies (geology, geotechnical) are ongoing for these optional sites. Further pre-design work, including surveying, test drilling, and design are required to confirm feasibility, storage capacity and engineering details. All off stream cut/fill reservoir sites will be engineered with the following elements:

- Seepage control including clay keyway and clay liner
- Seepage interception and liner monitoring using a tile drainage system
- Wave and erosion protection, including flat slope, grass, gravel and freeboard.
- No penetrations (pipes) below full supply level

Pre-design and final design engineering is planned for Site T1 in spring, 2018. Pre-design and final design engineering for selected Site T2 will take place in fall, 2018. Total planned storage is 667 cubic decameters (535 acre-feet).

3.3.4 Water Diversion

Water to Site T1 will be the West Tobacco Creek and to Site T2 will be from the South Tobacco Creek.

Filling pump systems will be high volume low head transfer pumps. Total maximum withdrawal rates will be 1.9 cms (30,000 USGPM). Power to drive the filling pumps will come from tractor PTOs. Interconnecting pipeline will allow water sharing between the reservoirs.

3.4 Land Use and Access

Table 1 provides a summary of the field locations. Table 1 itemizes the cultivated acres of the field in question.

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***. Hespler and Kroeker have ownership of some fields and access through lease or other agreement to lands identified herein for irrigation or water storage. Mineral rights will be reported if required, as they are not impacted by the projects.

3.4.2 Existing Land Use

The land proposed for reservoir development, is currently cultivated for agricultural purposes (Figure 2), except for site T2- Option 1 (alternative) which would redevelop an abandoned branch of the Tobacco Creek adjacent to an isolated piece of cultivated land.

Water delivery system (pipelines) will cross natural features such as creeks. Potential creek crossings are evident on Figure 3.

3.4.3 Land Use Designation

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, and to convert some cultivated land to constructed irrigation reservoirs. There is no planned increase to cultivated acres. No change to riparian zone and vegetation as a function of the irrigation systems.

Both reservoirs will be developed on cultivated land; but to our knowledge no conditional use permit is required to change land use at these locations. Site T2 – Option 1 (alternative) would be developed to include an abandon creek bottom which contains some amount of wooded vegetation.

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 starting in fall, 2018 and extending approximately a three-year period until the water storage and delivery systems are fully developed.

3.5.2 Delivery Systems

The pipeline delivery systems will be scheduled to start construction in the fall of 2018, or spring of 2019.

3.5.3 Water Storage Systems

Site T1 is proposed for development in summer and fall, 2018, with first filling in spring, 2019. Site T2 is proposed for development in summer and fall, 2019, with first filling in spring, 2020. Alternate sites are being investigated for Site T2 to provide the best site from technical (e.g. soils) and economic (e.g. power, proximity to creek, land purchase, etc.).

3.5.4 Water Diversion

Water diversion facilities (e.g. creek access) will be developed in fall, 2018 for Site T1 and fall, 2019 for Site T2, which ever option proceeds.

3.5.5 Engineering

PBS Water Engineering Ltd. is currently undertaking feasibility and pre-design investigations with assistance from VRK Consulting Ltd. (Geotechnical) and PFRA Ltd. (Hydrogeology).

Site T1 feasibility report is scheduled for completion in June 2018. Site T2 feasibility report will be completed in October 2018.

Site T1 pre-design and final design will be completed in June and July 2018. Further T2 pre-design investigations will be completed in September 2018. Site T2 final design will be completed in fall/winter 2018/2019.

Signed and stamped engineering plans will be submitted as they become available to appropriate agencies requiring approvals.

PBS Water Engineering Ltd., VRK Consulting Ltd. and PFRA Ltd. have formed a partnership to complete the required engineering investigations, reports and designs. PBS Water Engineering Ltd. and partners will assist the owners through the construction and commissioning phases.

3.6 Operation Phase

First operation of the project will be filling of Site T1 reservoir in spring, 2019. First operation of irrigation systems will be summer, 2019.

Additional storage, irrigation systems and distribution pipeline will be brought on line over a three to five-year period.

Off stream reservoirs will become part of an existing Dam Safety program initiated by Agassiz Resource Management Ltd. and carried out in consultation with engineering consulting firms. Further details can be made available through VRK Consulting Ltd. The Dam Safety program will include inspection and monitoring of the embankments and associated elements (e.g. liners, crest, stability, and tile drainage interceptor).

3.7 Repair, Renewal, Decommissioning Phase

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

Pumps – 20 years

Hydro - 30 years

Off Stream Reservoirs – 50 years

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

Irrigation systems - 25 years (aluminum)

Tile drainage – 50 years (HDPE)

The project will 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. Off stream reservoirs will be drained and liner and excavation will be renewed; based on past projects net siltation is not expected to be a large issue.

3.8 Funding

The project is 100% funded by Hespler Enterprises Ltd. and Kroeker Farms Ltd. in a joint venture named Thornhill Irrigation Ltd.

4.0 Environmental Settings

4.1 Physical Environment

The project is in the Tobacco Creek Watershed in Southern Manitoba Red River Valley north of Miami, Manitoba.

Figure 1 shows the approximate extent of the Tobacco Creek Watershed into the Pembina Hills and Manitou Ecodistricts. The Tobacco Creek drains surface water from these uplands associated with the Manitoba Escarpment to the west of the project area, and from local fields within the project area, per Figure 4.

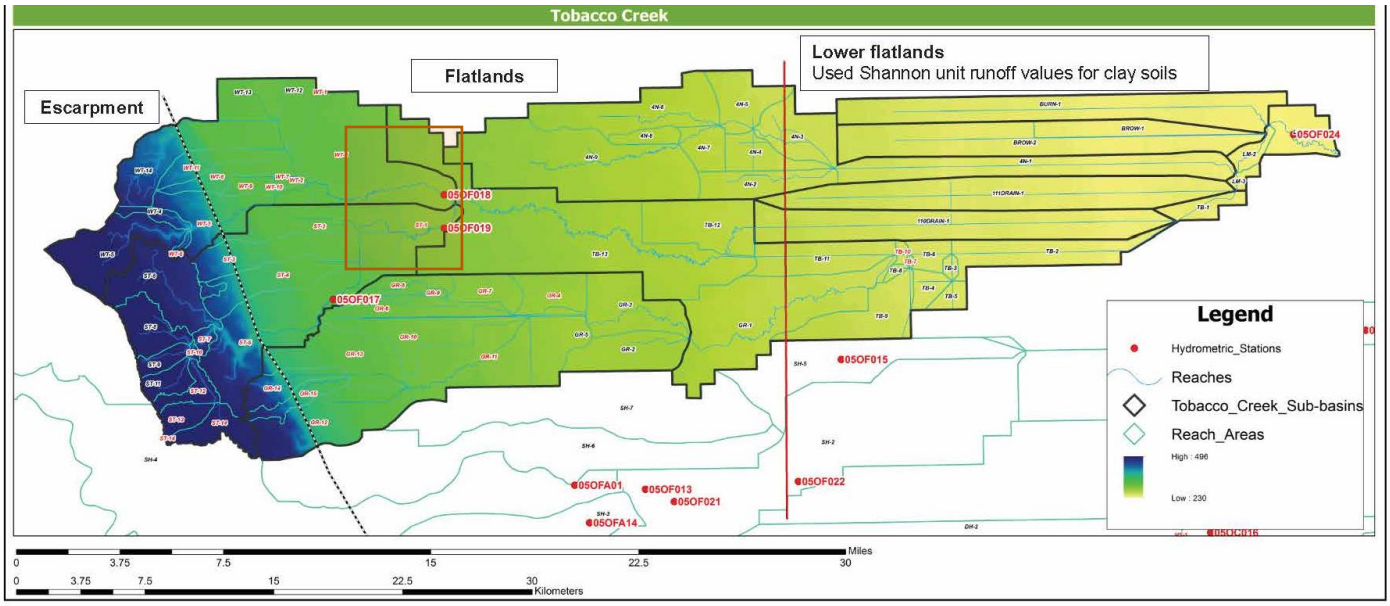


Figure 4 - Tobacco Creek Watershed (Manitoba Sustainable Development; Delavau, 2018); project area outlined in red box.

4.1.1 Terrain, Soils and Landscape

The project area is contained within the Red River Valley and Lower Assiniboine Delta physiographic subsections of the Manitoba Plain (Smith and Michalyna, 1973). The Lake Manitoba Plain represents the lowest level plain on the Prairies. It is underlain by limestone bedrock and covered by glacial till and lacustrine clays and silts deposited by Lake Agassiz (Smith et al., 1998). The project is flanked to the west by the uplands associated with the Pembina Hills and Manitou ecodistricts, known locally as the Manitoba Escarpment (Figure 1).

Smith and Michalyna (1973) describe the soils, landscape and terrain of the project area. The topography is smooth level to very gently sloping. Surface runoff is slow, as is internal drainage due to low permeability. The soil parent material overlying the deep bedrock at this location is characteristic of lacustrine sediments associated with glacial Lake Agassiz. The surficial soils range in texture from moderately coarse sandy to very fine clayey and are dominantly imperfectly drained. Within the study area the significant surface features are the oversized valleys along the Tobacco Creek, including natural and channelized sections running west to east. The relic beaches (e.g. Hillsboro

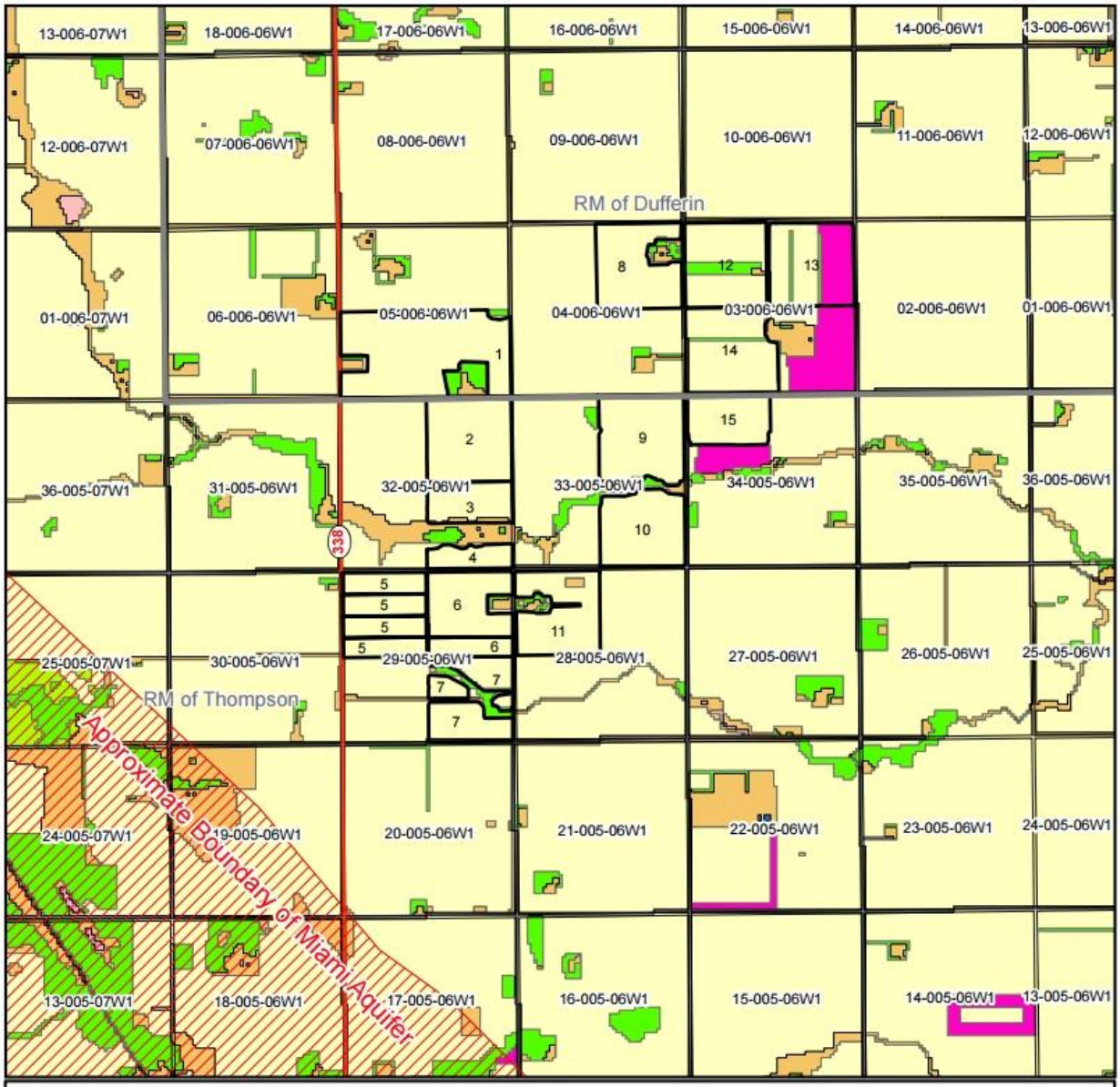
Beach to the south east) represent the successively lower water levels of Lake Agassiz, and the delta is a function of relatively coarse-textured deposits entering the lake from the glacial Assiniboine River at the Pembina Escarpment (Smith et al.,1998). The soils in the Red River Valley portion of the project area comprise finer-textured lacustrine sediments associated with the lake.

The terrain, landscape and soils are major factors in the feasibility of the proposed irrigation project. The project area is noted to have some of the most productive soils in the Province (Smith and Michalyna, 1973) with excellent yields of grains, oilseeds and horticultural crops (e.g. potatoes). The major limitations to crop production are maintaining adequate surface and subsurface drainage, maintaining soil fertility and tilth, and prevention of wind and water erosion of these fine soils. Most of soils in the area are considered suitable for irrigation (Smith and Michalyna, 1973); with the main limitation being slow permeability and high-water table. For the project, site-specific mapping is warranted, and is included herein for each parcel being considered for irrigation[1].

The suitability of the soils and landscape for high value agriculture has led to the current land use Figure 5 within the project area. Planted shelterbelts are utilized to minimize soil erosion and create micro climates for crop production. Riparian zones are often grazed grass lands; due to their typically wetter soils, and unsuitability for cultivation. Some remnants of natural bush are present on selected reaches of the Tobacco Creek, as shown in Figure 5. The portion of the South Tobacco Creek within the project area is channelized along Municipal roads, with limited riparian value and little to no trees or bush (see Figures 14 and 15).

The limits to the Miami Aquifer are to the south of the project area and it is suspected that the South Tobacco Creek interacts to recharge the Aquifer. Discharge areas for the Miami Aquifer are further to the south east near Rosebank.

[1] Detailed soil resource information exists for the project study area; therefore desktop mapping was completed and is presented herein.



Land Cover Classes

Figure Number	Project Name
5	Thornhill Irrigation Ltd.

NORTH

1,000 500 0 1,000

Meters

Acknowledgements:
Original drawing by AgriEarth Consulting Ltd.
Data accessed from Manitoba Land Initiative, Province of Manitoba.

PREPARED BY agriearth consulting ltd.

DRAWING SCALE	DATA SCALE	
1:50,000	N/A	
DRAFT DATE	DRAWN	CHECKED
June 6, 2018	DW	BS

4.1.2 Geology of the Project Area

The geology of the proposed reservoir sites and to an extent the area will be confirmed and reported on as part of the Feasibility studies for Sites T1 and T2 (pending PBS Water Engineering Ltd., June, 2018). Typically nearshore lacustrine and alluvial materials (clays, silts and sands) overlay lacustrine clay, which in turn overlays glacial till and finally black shale bedrock.

Localized geologic features modify this general stratigraphy. The major geologic feature of the area is the Miami Aquifer, which is a sand and gravel aquifer that is eroded through the lacustrine clay, the till and into the underlying shale. The approximate boundary of the Miami Aquifer in relation to the proposed project fields is outlined on Figure 5. The project lands are not located above the aquifer and the aquifer is located to the south of the proposed reservoirs as currently contempleted.

The proponents, under a separate investigation are conducting a Groundwater Exploration on the south easterly edge of the Miami Aquifer. Requirements for that investigation are established by Manitoba Sustainable Development. Currently, the Miami Aquifer development will be limited to an area not associated with the Tobacco Creek reservoirs.

The project irrigated area is north and west of the Hillsboro beach ridge and is north of the Miami Aquifer footprint (Figure 5) and it's primary recharge area which is upstream along the Tobacco Creek (Figure 4). The two reservoir sites, are not expected to interact with groundwater in any significant way. At the Site T1 and Site T2 locations the lacustrine clay is anticipated to be near surface, but will be the subject of detailed geologic (EM31) and geotechnical investigations (test drilling). Pre-design investigations are scheduled for June, 2018, in order to confirm the depth to and thickness of the lacustrine clay and overlying sands and silts.

The reservoirs are anticipated to be contained geologically against deep seepage by the lacustrine clay, this has proven to be an effective barrier.

4.1.3 Groundwater

The groundwater in the project area can be characterized as follows. Deep wells into the shale bedrock are typically saline (Smith and Michalayna, 1973) and hence remain undeveloped. Shallow groundwater associated with the near shore sediments, perched on top of the lacustrine clay, varies in quality 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. This water table 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). These water tables are typically unreliable for water supply and of low capacity with respect to recharge.

Significantly, the RM's of Thompson and Dufferin have developed rural water pipelines to service the farms in the project area, due to the lack of potable groundwater. The only other source of water is the Miami Aquifer. Currently the Miami Aquifer is only utilized by those farms, rural acreages and small businesses (e.g. golf course) directly over its footprint and is not a major source for nearby municipalities.

The Reservoir Sites T1 and T2 are approximately 1 – 2 miles to the north of the Miami Aquifer Boundary (Figure 5).

4.1.4 Climate and Meteorological Conditions and Eco-climate

The Morden CDA is a long term climatic station maintained in conjunction with Environment Canada. Reported climatic parameters (Smith and Michalyna, 1973)

Temperature	3.3^0C (mean annual)
Precipitation	530 mm (mean annual)
Rainfall	336 mm (mean annual)

During the growing season, potato crop evapotranspiration generally exceeds available precipitation. Based on climate data available from Manitoba Agriculture Food and Rural Development (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 has been utilized to estimate project water demand.

Table 2 – Growing Season Precipitation, Potato Water Demand and Water Deficit (MAFRD).

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	7.1-7.5 (180 to 190)
	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	14.6 – 15.5 (370 to 395)
	20	In 1 of 4 years water demand for potatoes at maturity will exceed the given values	16.1 – 17.0 (410 to 430)
	10	In 1 of 10 years water demand for potatoes at maturity will exceed the given values	17.1 – 18.0 (435 to 460)
Potato Water Deficit	50	In 1 of 2 years water deficit will be exceed the given values	3.1 – 4.0 (80 to 100)
	25	In 1 of 4 years water deficit will exceed the given values	4.1 – 5.0 (105 to 125)
	10	In 1 of 10 years water deficit will be exceed the given values	5.1 – 6.0 (130 to 150)

Reference --- 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 moving to more uniform product quality.

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 Mean	Maximum Temperature S.D.	Minimum Temperature Mean	Minimum Temperature S.D.	Precipitation Inches Mean	Precipitation Inches S.D.	PE** Inches	Water Balance Precipitation / PE
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.

4.1.6 Surface Water

The major water source to the project area is the Tobacco Creek. The Tobacco Creek watershed at the easterly edge of the project is represented by the Water Survey of Canada gauging station 050F017, 050F018 and 050F019 (Figure 6). These gauging stations have respective drainage areas of:

1. **05OF017 - South Tobacco Creek near Miami** (76.4 km^2);
   - 1964 – 2002 (recorded)
2. **05OF018 – Tobacco Creek near Rosebank** (130 km^2);
   - 1964 – 2002 (recorded; missing 1997 - 2000)
3. **05OF019 – South Tobacco Creek near Rosebank** (146 km^2);
   - 1964 – 1970 (recorded – 6 years of data)

Figure 6 and 7 show the sub drainage areas to each WSC station, and surface soil texture within the watershed (Figure 7). Texture along with topography and vegetation are major determinants of surface runoff.

The combined drainage area of the Tobacco Creek at this location is close to 280 square kilometers; draining water from the Escarpment to the west and flowing easterly towards the Red River near Morris. By the time the Tobacco Creek has reached Rosenort, it joins the Little Morris River and its' drainage area has more than tripled to 982 square kilometers (WSC 050F024), Figure 4.

The Tobacco Creek is intermittent in nature with large flows in spring associated with snow melt runoff and rainfall. Summer flows are typically curtailed by the significant excess of potential evaporation over precipitation (Table 3) and the lack of significant runoff, except in extreme rainfalls.

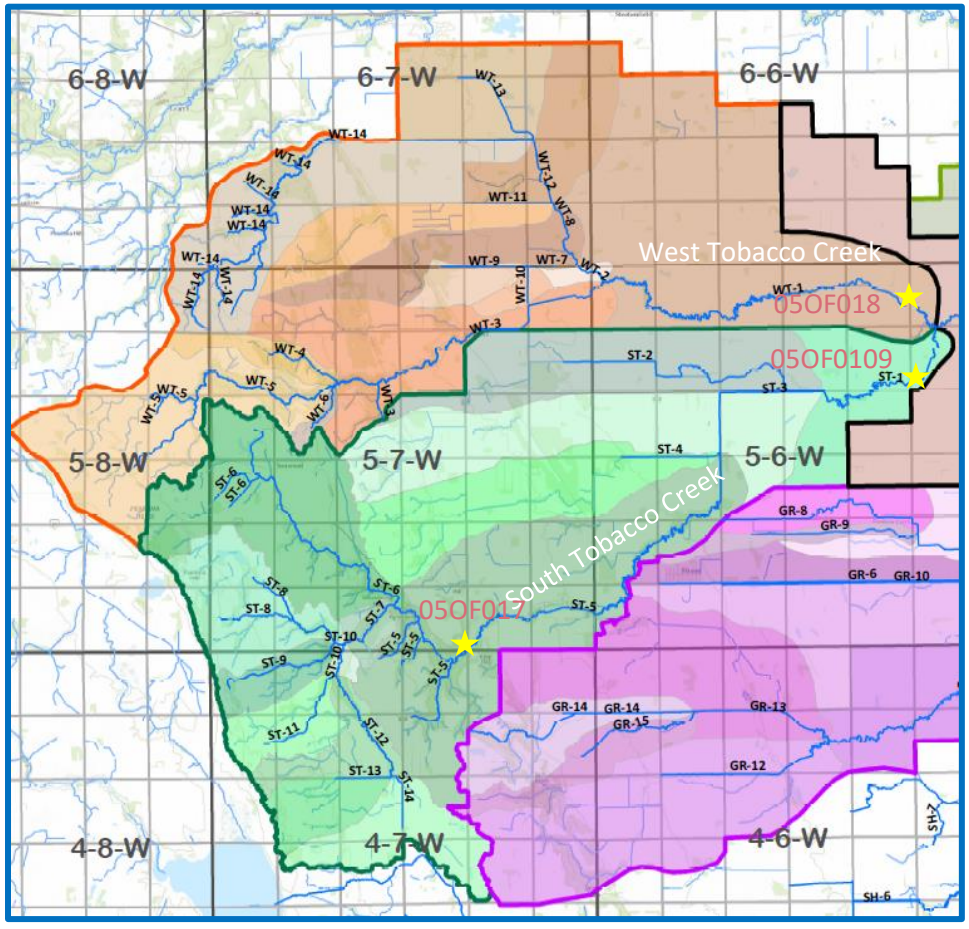


Figure 6 – Tobacco Creek Sub-Watershed Delineation - 280 KM^2 at Project Location (Manitoba Sustainable Development (2018))

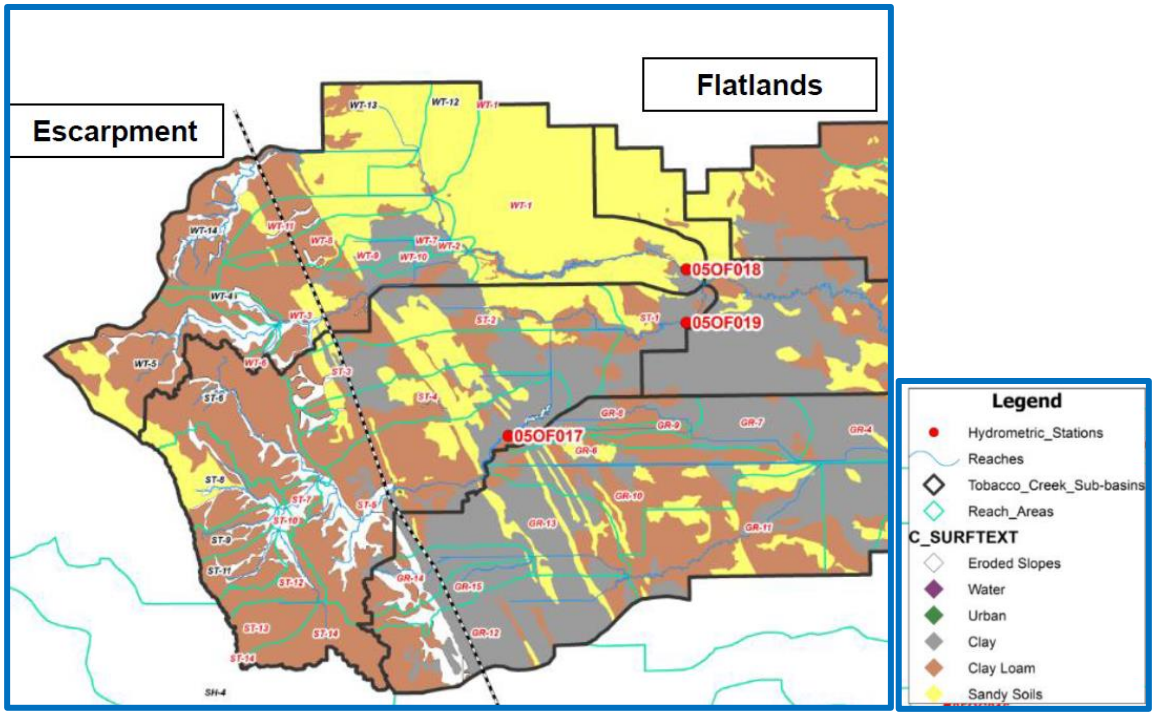


Figure 7 - Tobacco Creek Watershed Surface Texture (Manitoba Sustainable Development (2018))

The Manitoba Government and Agassiz Irrigation Association signed a development agreement in 1995 detailing water available for development. The general rule agreed to was allocation of up to ½ of volume available in 8 years out of 10.

For the Tobacco Creek at the Project sites, Manitoba Sustainable Development has indicated the following water is still available for allocation:

West Tobacco Creek - SE 33-5-6 W – 125 acre-feet

South Tobacco Creek - SW 28-5-6 W – 468 + 15 = 483 acre-feet

These volumes were confirmed available by email 05-25-2018 from Tamara Butterfield, Manitoba Sustainable Development (see Figure 8).

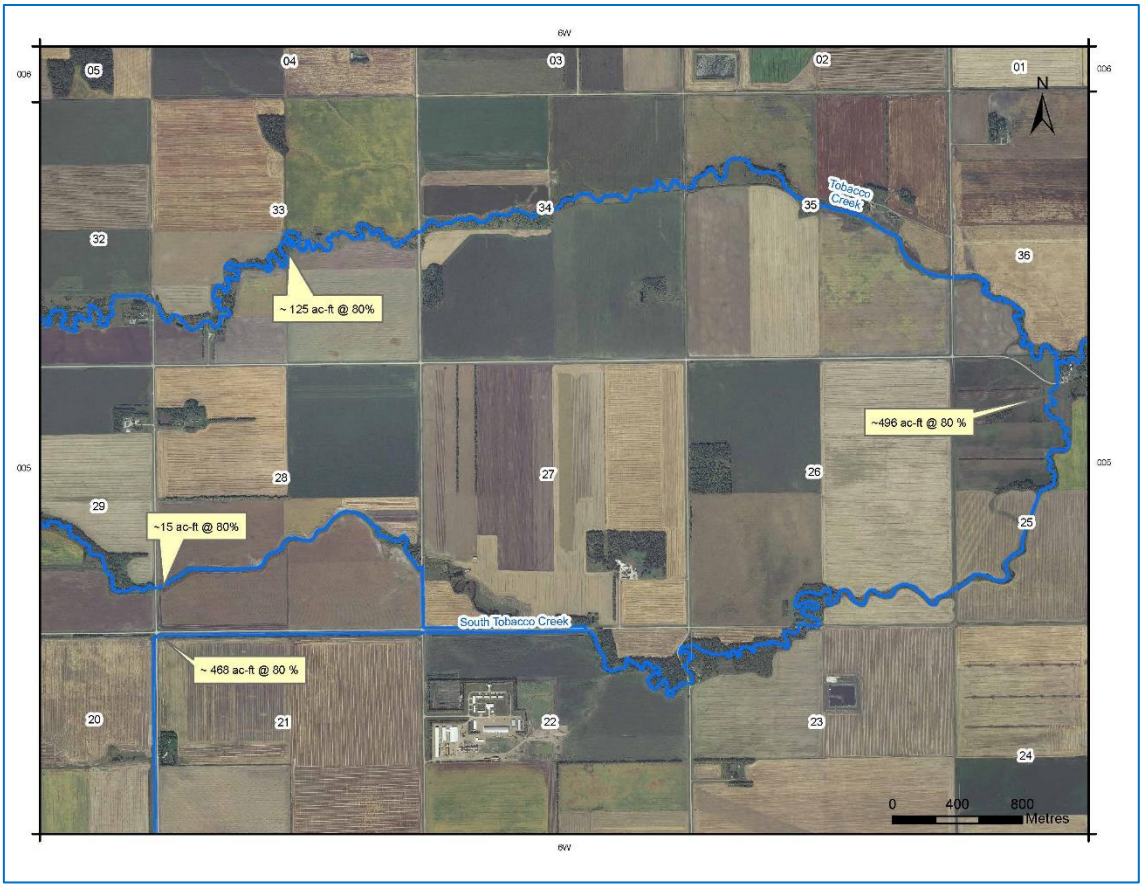


Figure 8 - Water Availability South Tobacco and (West) Tobacco Creeks (Manitoba Sustainable Development, 2018)

The Memorandum of Understanding allows for consideration of allocation additional water up to that flow available 7 years out of 10. The memorandum also allows for increasing the stored volume by 50% over the allocation to allow for carry over from wet years. The available storage is 1.5 x 621 = 931 acre-feet, whereas Thornhill Irrigation Ltd. only plans to develop 535 acre-feet currently.

The median (exceeded 50% of the time) Mar – May (MAM) spring runoff on the Tobacco Creek at the project site is estimated from existing records and hydrologic extensions to be about 6700 cubic decameters (from 1964 – 2014; stations 05OF018 + 05OF017) (Manitoba Sustainable Development, 2018). Spring runoff volumes for this location exceed 34,000 cubic decameters in flood years. Peak daily flows at WSC 050F017 and 05OF018 (Figure 9) are in the order of 28 cubic meters per second each; which equates to excess of 4800 cubic decameters per day total. These peak flows are the channel forming considering their energy levels and are the flows that define the size of the downstream drainage system to the Red River. At these peak runoff channel forming events (e.g. occurring 50% of the time or more) the impact of withdrawal of 667 cubic decameters is clearly minimal (e.g. about 10% of volume).

Figure 9 illustrates the similar hydrologic reaction of the two branches of Tobacco Creek; including response to late spring rainfall events, and peak flow events.

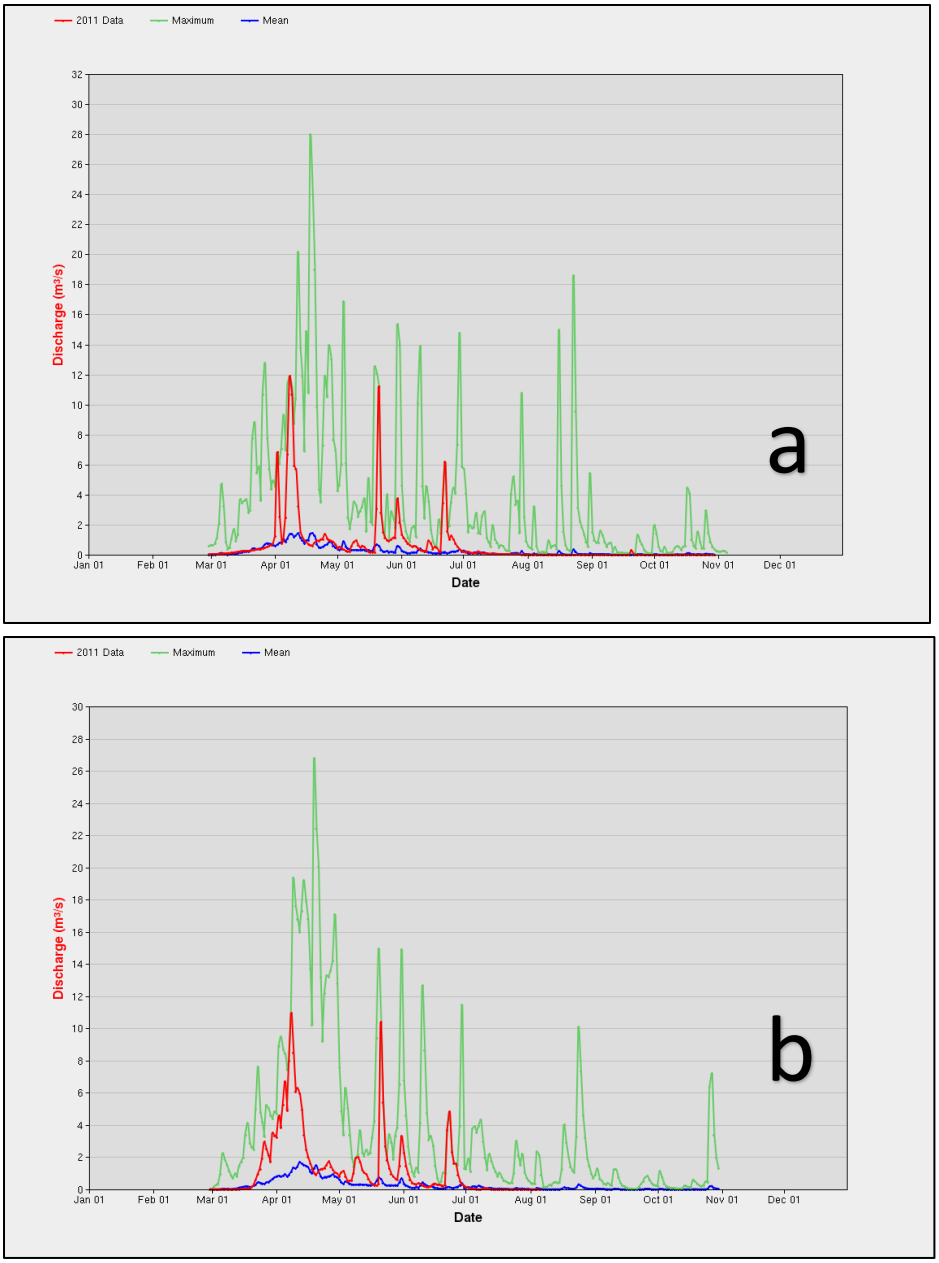


Figure 9 – 2011 Daily Flows on a. South Tobacco Creek (05OF017) and b. West Tobacco Creek (05OF018) vs. Maximum and Mean Flows

The flashy, intermittent nature of the Tobacco Creek is depicted in the hydrographs from 1988 to 1992 at the WSC Gauging Station O5OF017 Figure 10 a - e. During consultations around the formation of the Agassiz Irrigation Association Inc. (i.e. circa 1990's) meetings were held with fisheries experts. It was agreed during those consultations that the allocation strategy would be to withdraw as much as possible on the rising limb of the hydrograph, to maintain the recessional limb. This is accomplished by sizing the withdrawal pumps as large as practical.

In addition, consideration to maintaining a minimum in-stream flow was made (AIA, 1996). Figure 10 shows that the peak daily discharge over a five-year period from 1988 – 1992 varied between 0.4 and 4.8 cubic meters per second on South Tobacco Creek Based on Figure 9 it is anticipated the West Tobacco Creek records would be similar in magnitude. The daily volume of water for the peak day cumulatively (both branches) was from 70 dam3 (56 acre-feet) per day to 830 dam3 (670 acre-feet) per day.

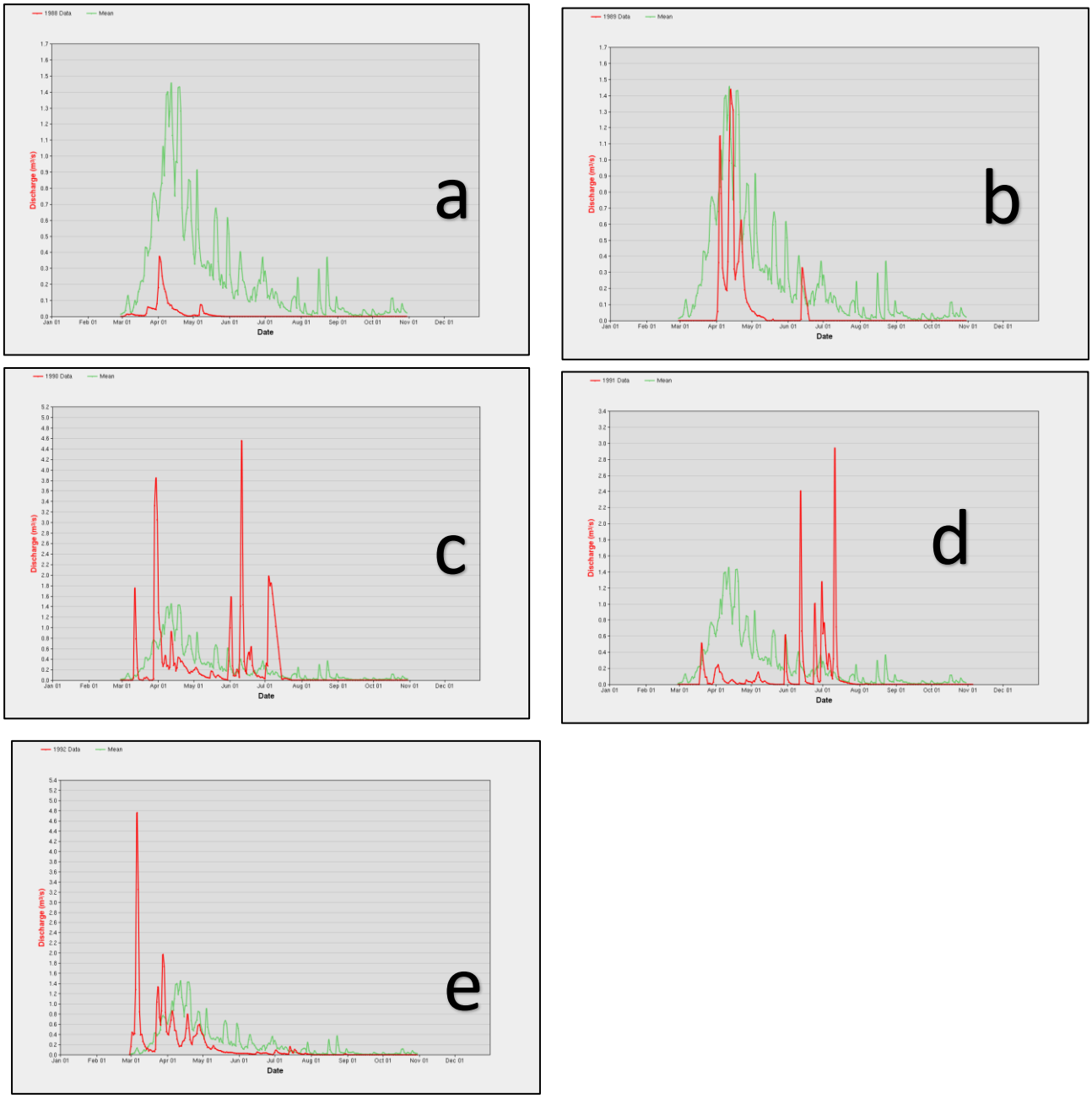


Figure 10 a to e – South Tobacco Creek Near Miami (O5OF017) Daily Flows 1998 - 1992

Figure 11 illustrates, in comparison with Figure 9, that peak runoff downstream towards the Red River are coincident in nature to the upstream peaks, larger by factor of up to 4-5 (per the drainage area) and delayed by up to a week. The recessional limb of the hydrograph also extends for a longer period then the upstream hydrographs (Figure 9), indicting in-channel storage on the flatter portions of the drainage system (e.g. Figure 4). In the Tobacco Creek watershed snow and ice block the waterways, culverts and bridges after a long winter, and water must typically make its way from upstream to downstream prior to any connection being made to overwintering fisheries (e.g. the Red River and Lake Winnipeg). This reinforces the importance of the recessional limb.

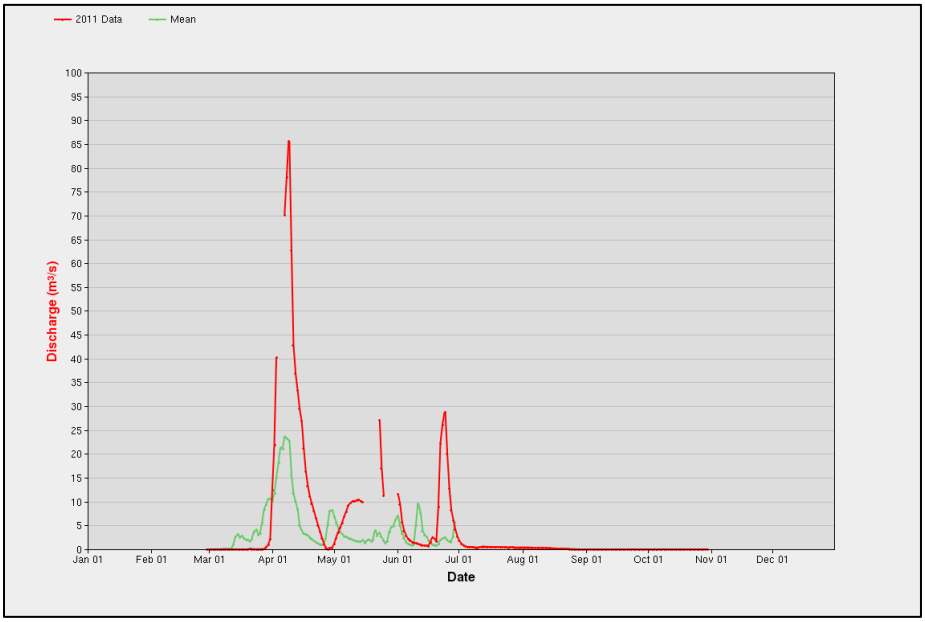


Figure 11 – Little Morris River (Tobacco Creek) Near Rosenort (050F024) Daily Flows 2011

Table 4 presents the tabular data for 1990 (West) Tobacco Creek near Rosebank. The Table reveals the large and quick initial rise in flow, with a large increase from 0 cms to 1.2 cms over a day (e.g. coinciding with breaking through the snow packed channel). This initial peak is followed by a short period of high flows (e.g. 12 days above 0.15 m3/sec; or 0.3 if combine with South Tobacco) and a longer drawn out recessional limb which keeps water flowing in the slower, flatter downstream reach (e.g. 61 days between 0.01 and 0.3 m3/s). Spring rains in June, revive the flow for a period of about a month in June and into early July. Consultations in the 1990's by Agassiz Irrigation Association (AIA, 1996) determined that fisheries experts considered the recessional limb the most important part of the hydrograph with respect to maintaining opportunities for spawning. If, as observed, the water works its way through snow and ice from upstream to downstream, this makes sense. Water withdrawal rates need to be geared to take advantage of the larger spring freshet flows (e.g. above 0.3 m3/sec; cumulative both reaches) and the short time frame (e.g. between 5 to 10 days). Maintaining a downstream flow during withdrawal will ensure continuity to the recessional limb of the hydrograph (AIA, 1996).

Table 4 - Typical Daily Discharge Hydrograph for Tobacco Creek Near Rosebank (05OF018) – 1990

(Green highlights potential withdrawal period; yellow highlights extended recessional limb of the hydrograph)

Day	Mar	Apr	May	Jun
1	0.00 B	2.74 B	0.034 E	0.300 A
2	0.00 B	2.71 B	0.040 E	0.850 E
3	0.00 B	1.68 B	0.076 E	1.22 E
4	0.00 B	0.930 B	0.088 E	1.41 E
5	0.00 B	0.941 B	0.068 E	0.879 A
6	0.00 B	0.328 B	0.060 E	0.062 E
7	0.00 B	0.232 B	0.054 E	0.205 E
8	0.00 B	0.179 B	0.050 E	0.095 E
9	0.00 B	0.300 B	0.041 A	0.052 E
10	0.002 B	0.176	0.040	0.035 E
11	0.025 B	0.119	0.037	0.412 E
12	0.049 B	0.083	0.031	0.550 E
13	0.137 B	0.134	0.025	0.678 E
14	0.665 B	0.310 A	0.022	0.420 E
15	0.840 B	0.291 A	0.021	0.140 E
16	1.01 B	0.198	0.027	0.098 E
17	0.859 B	0.187 A	0.037	0.255 E
18	0.599 B	0.147	0.177	0.405 E
19	0.202 B	0.247	0.140	0.356 E
20	0.151 B	0.351	0.095	0.490 E
21	0.143 B	0.276 A	0.070	0.390 E
22	0.123 B	0.300 E	0.069	0.160 E
23	0.066 B	0.228 E	0.043	0.090 E

24	0.034 B	0.207 E	0.026	0.060 E
25	0.013 B	0.188 E	0.034	0.025 E
26	0.00 B	0.134 A	0.026	0.042 E
27	0.00 B	0.063	0.023	0.030 E
28	0.00 B	0.063	0.018	0.190 E
29	0.00 B	0.042 A	0.014	0.198 E
30	1.20 B	0.038 E	0.010	0.025 E
31	2.24 B		0.007	
Mean	0.270	0.461	0.048	0.337
Max	2.24	2.74	0.177	1.41
Min	0.00	0.038	0.007	0.025
Total	8.36	13.8	1.50	10.1
Total Dam^3	722	1,190	130	875

Figures 12 – 15 present representative photos illustrating the condition and nature of the West and South Tobacco Creek channels near the proposed reservoirs T1 and T2.

Figure 12 – South Tobacco Creek – SW 28-5-6 W Looking South - Channelized

Figure 13 – South Tobacco Creek – SW 28-5-6 W – Looking East - Channelized

Figure 14 – West Tobacco Creek – SE 33-5-6 W – Looking West

Figure 15 – West Tobacco Creek – SE 33-5-6 W – Looking East

4.1.5 Soil-Landscape Limitations

The soil-landscape in its natural and modified forms dictate limitations for the intended purpose of the project, namely irrigated potato production. The soil-landscape limitations are discussed in the context of the proposed agricultural systems. These limitations ultimately guide the land suitability assessment for irrigation (Stantec, 2011). Desktop mapping was undertaken for the 15 fields comprising the project landbase. A soil-landscape map, soil polygon ID map and accompanying database is included in Appendix I (Figure A.I.1, Figure A.I.2 and Table A.I, respectively).

A general discussion of soil-landscape conditions, including limiting factors, 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., 2018).

4.1.5.1 Soil Surficial Deposits, Drainage and Salinity

The project study area is located just below the Pembina Escarpment and encompasses portions of the Red River Valley and Lower Assiniboine Delta physiographic subsections. Soils have developed on predominantly medium-textured lacustrine sediments to moderately-coarse to coarse-textured fluvial-lacustrine deposits (Michalyna et al., 1988). Minor areas of moderately-fine to fine-textured sediments occur in association with surface drainage channels.

The soils in the project study area are almost completely imperfectly drained (Table 5; Figure 16). The imperfect drainage results from the geology of the relatively impervious lacustrine clay soils that underlay the surficial fine sandy loams. Given these inherent limitations producers have firstly attempted to enhance surface drainage and more recently have taken the next step of installing subsurface drainage, in some of these soils. Subsurface drainage only operates during the high-water table conditions during the spring and fall or following unusually high rainfalls. These systems are designed to drain saturated root zones to promote crop and soil health. The result is increased crop productivity, a reduction in root-zone salinity, and overall reduction in surface runoff and associated water erosion of soils. Many of the existing fields have been improved with tile drainage, and plans include additional tile drainage. It is reasonable to assume that all fields included in the project will be improved with tile drainage at some point in the future to remove the drainage limitations.

Soil salinity is closely related to internal drainage, ponding of water, and landscape position (e.g. topography, drainage). Where salinity exists, it is usually associated with higher water tables, upward capillary rise of water from the surface of the water table and evapotranspiration of salts at the soil surface causing an accumulation of salts over time. This in turn results in negative impacts on crop productivity and crop uptake of water.

Recent studies (Cordeiro, 2013) have verified that the shallow groundwater table contributes extensively to crop production in these types of soils. One can conclude that preventing early-season drown-out aids in improving late-season water table draw-down due to crop water use. Improving crop uniformity and lowering the water table and associated depth of upward salt flux will generally imply that: 1) the mechanism of salt build-up in the root zone will be reduced over time in tile drained lands, and 2) existing built-up salts will be flushed through the root zone and discharged in tile water. Unpublished data from Kroeker's main farm south of Winkler, confirm that this is in fact what happens.

The agronomic assessment considers the existing or mapped salinity levels and recommends the need for additional mitigation strategies which could include Phase II field investigations (e.g. Veris salinity mapping), site specific irrigation (e.g. avoiding certain areas of a field), or site-specific drainage improvements (e.g. targeted surface or tile drainage). Existing salinity identified by Smith and Michalyna (1988) is presented in Figure 17. Based on this information, Field 13 (NE-3-6-6W1) has been identified for a Phase II investigation.

The Proponents have long recognized the impact of variable soil-landscape conditions and where feasible have implemented land levelling and tile drainage to eliminate limiting hot spots (salinity, wetness, nutrient), make productivity more uniform and thereby make better use of crop inputs, including nutrients, water and pesticides. This production system can improve the sustainability and environmental performance.

Table 5 – Drainage Classes of Project Soils

Drainage Class	Areal Extent		Proportion of Project Footprint (%)
	hectares (ha)	acres (ac)	
Very Rapid	0	0	0
Rapid	0	0	0
Well	1	1	0
Moderately Well	0	0	0
Imperfect	858	2120	98
Poor	18	44	2
Very Poor	0	0	0
Totals:	**877**	**2166**	**100**

4.1.5.2 Soil Erosion

The soils in the project study area are prone to erosion losses by both wind and water.

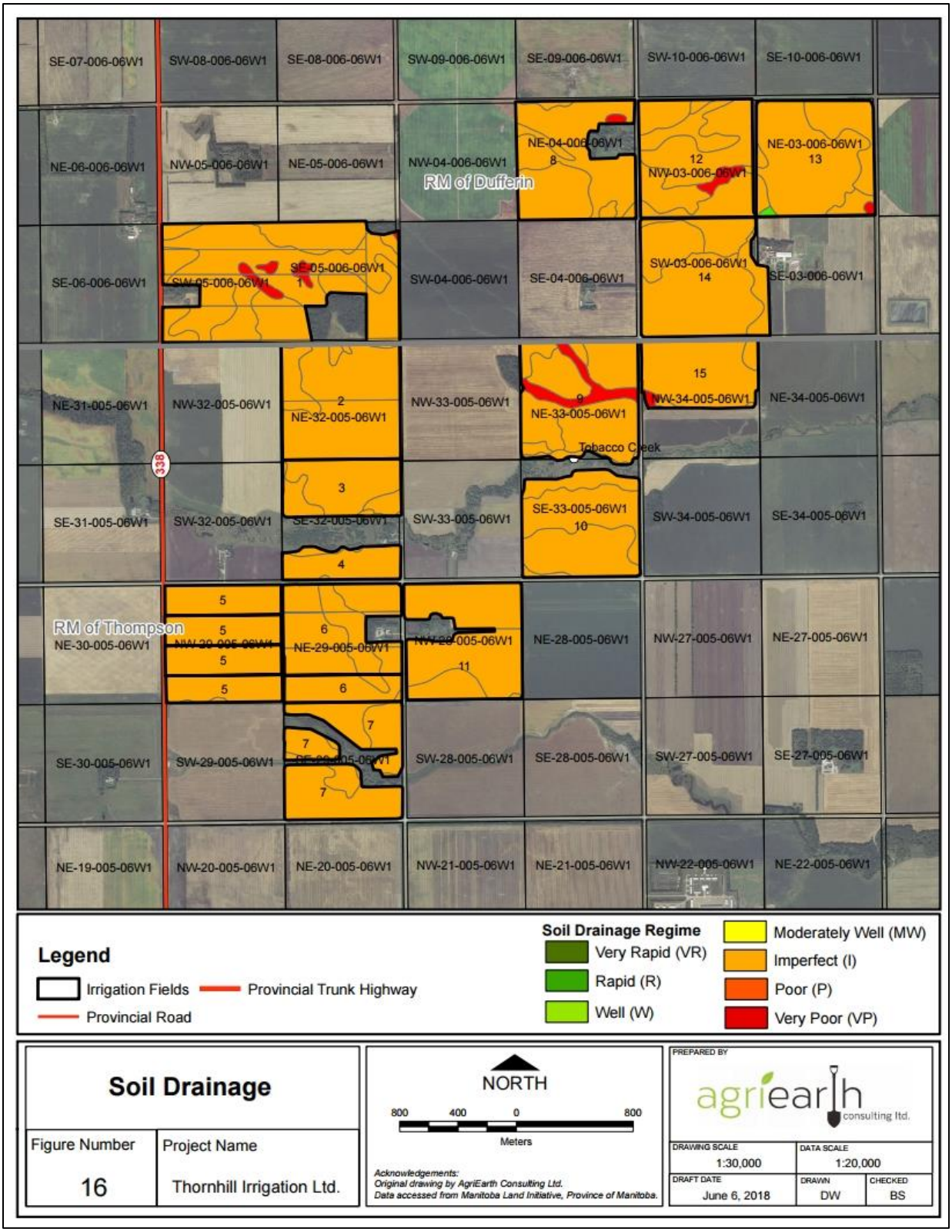
The coarse (fine sand to loamy fine sand) and moderately coarse (very fine sand to loam) textured soils have a low to moderate risk rating for water erosion; risk classes that represent approximately 80% of the project study area (Table 6).

The majority of soils in the project study area can be considered to have a high to severe risk rating for wind erosion, owing to the moderately coarse to coarse textured surficial soils.

Producers have long recognized the inherent erosion risk in these soils, which is supported by the significant number of mature shelterbelts within the project area. The agronomic assessment includes a recommendation for consideration of erosion BMPs for those soils most susceptible (see Table 10).

Table 6 – Water Erosion Risk Classes of Project Soils

Water Erosion Risk Class	Areal Extent		Proportion of Project Footprint (%)
	hectares (ha)	acres (ac)	
Non	174	430	19.9
Low	550	1359	62.8
Moderate	152	376	17.4
High	0	0	0.0
Totals:	***877***	***2166***	***100***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RM of Dufferin
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SW-05-006-06W1
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NW-33-005-06W1
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15
NW-34-005-06W1
NE-34-005-06W1
Tobacco Creek
338
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SW-32-005-06W1
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RM of Thompson
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NE-20-005-06W1
NW-21-005-06W1
NE-21-005-06W1
NW-22-005-06W1
NE-22-005-06W1
Legend
Irrigation Fields
Provincial Trunk Highway
Provincial Road
Soil Drainage Regime
Very Rapid (VR)
Rapid (R)
Well (W)
Moderately Well (MW)
Imperfect (I)
Poor (P)
Very Poor (VP)
Soil Drainage
Figure Number
16
Project Name
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NORTH
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Meters
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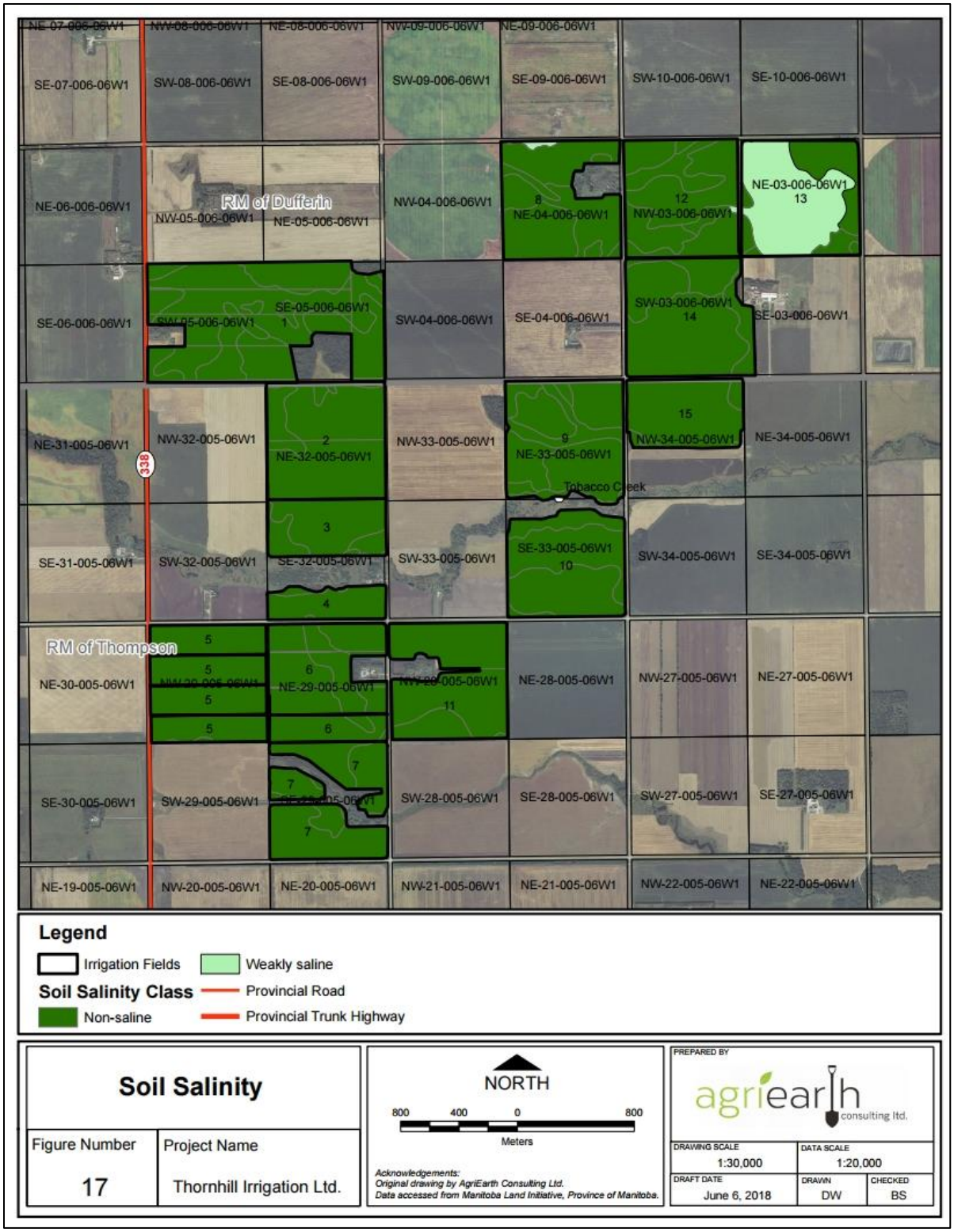
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RM of Thompson
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NW-22-005-06W1
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Legend
Irrigation Fields
Weakly saline
Soil Salinity Class
Provincial Road
Non-saline
Provincial Trunk Highway
Soil Salinity
Figure Number
17
Project Name
Thornhill Irrigation Ltd.
NORTH
800
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Meters
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4.1.5.4 Soil Water and Nutrient Holding Capacity

The ability of soils to hold significant quantities of water and nutrients with the soil matrix allows the plant to draw on these as needed for growth. 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. The project soils are considered to have medium to low water holding capacity. The medium to moderately coarse textured soils that occupy most of the project area (and are predominant in the southern portion of the project area as represented by NBG, KOT and RLD soil series; Figure A.I.1, Appendix I) have estimated available water holding capacities ranging from 12 to 22% (1.2 to 2.2 mm/cm or 1.4 to 2.6 in/ft). The coarse textured soils that are predominantly found in the northern portion of the project (represented by ASS, WWC soil series) have estimated available water holding capacities ranging from 10-13% (1.0 to 1.3 mm/cm or 1.2 to 1.6 in/ft). Irrigation water management should be conducted with consideration to residual soil water content and how much water soils within a given field can hold.

The Nutrient Management Regulation (62/2008) makes use of basic soil information (including soil texture as part of agricultural capability ratings) to determine allowable soil nutrient residual concentrations (nitrogen) and nutrient application rates (phosphorus). Management practices should be tailored as appropriate considering dominant and limiting soil-landscape units and associated nutrient management zones within each field. Soil-landscapes in the project study area are predominantly in nutrient management zone 1 and 2, with a minor portion in zone 3; owing to the relatively level topography and variable textures and water holding capacities.

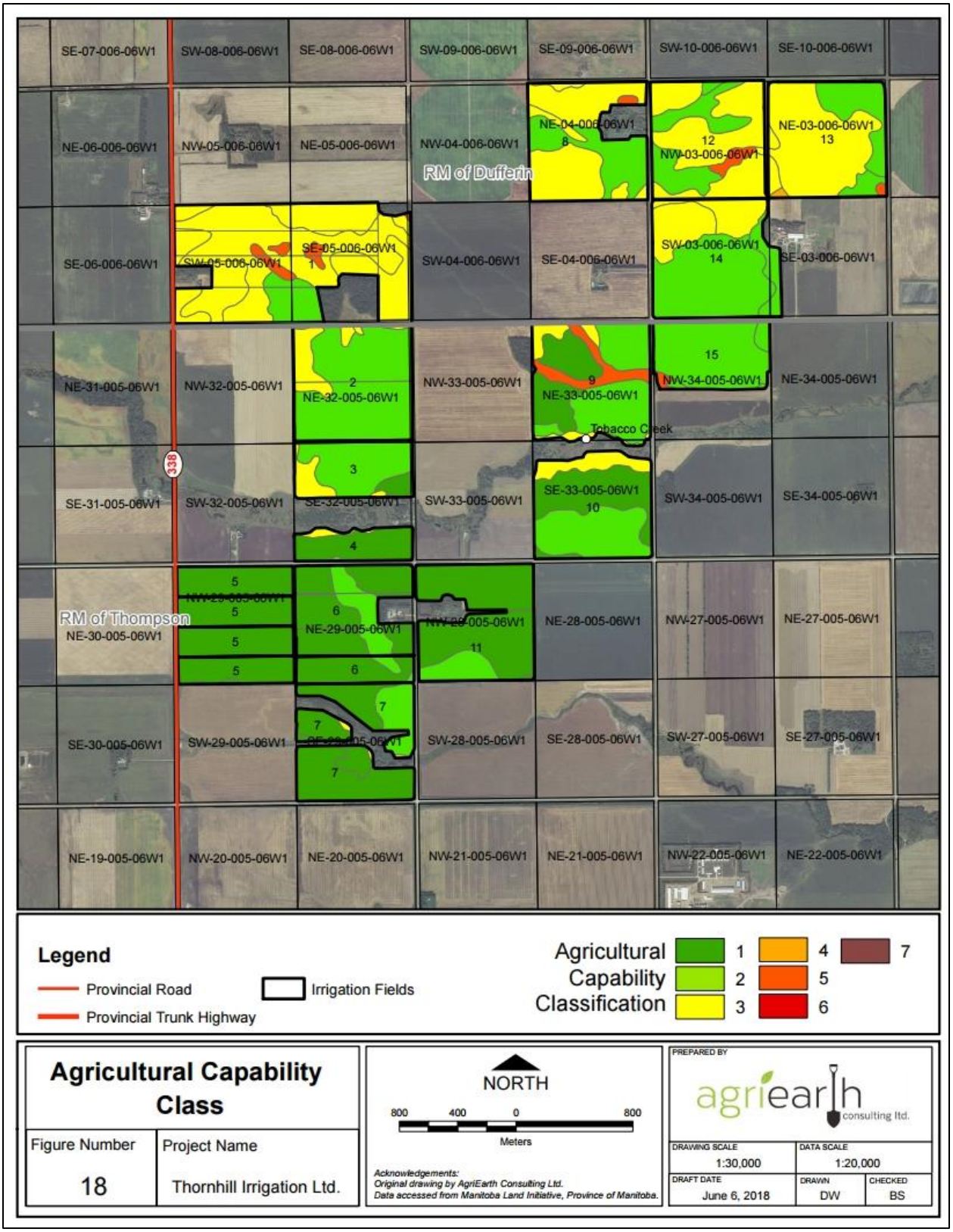
4.1.6 Soil-Landscape Suitability Assessments

4.1.6.1 Agricultural Capability

The soils of the project area are predominantly considered prime agricultural land. Table 7 shows that 98% of the project study area is rated as within Class 1 – 3 for agricultural capability. The small area of Class 5 soils generally unsuited for potatoes and irrigation should be farmed in an alternative fashion.

Table 7 - Agricultural Capability of Project Soils

Agricultural Capability Class	Areal Extent		Proportion of Project Footprint (%)
	hectares (ha)	acres (ac)	
1	265	656	30.3
2	312	771	35.6
3	281	693	32.0
4	1	2	0.1
5	18	44	2.0
6	0	0	0.0
7	0	0	0.0
Totals:	***877***	***2166***	***100***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Tobacco Creek
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SE-33-005-06W1
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SW-34-005-06W1
SE-34-005-06W1
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RM of Thompson
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NE-20-005-06W1
NW-21-005-06W1
NE-21-005-06W1
NW-22-005-06W1
NE-22-005-06W1
Legend
Provincial Road
Provincial Trunk Highway
Irrigation Fields
Agricultural Capability Classification
1
2
3
4
5
6
7
Agricultural Capability Class
Figure Number
18
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NORTH
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Meters
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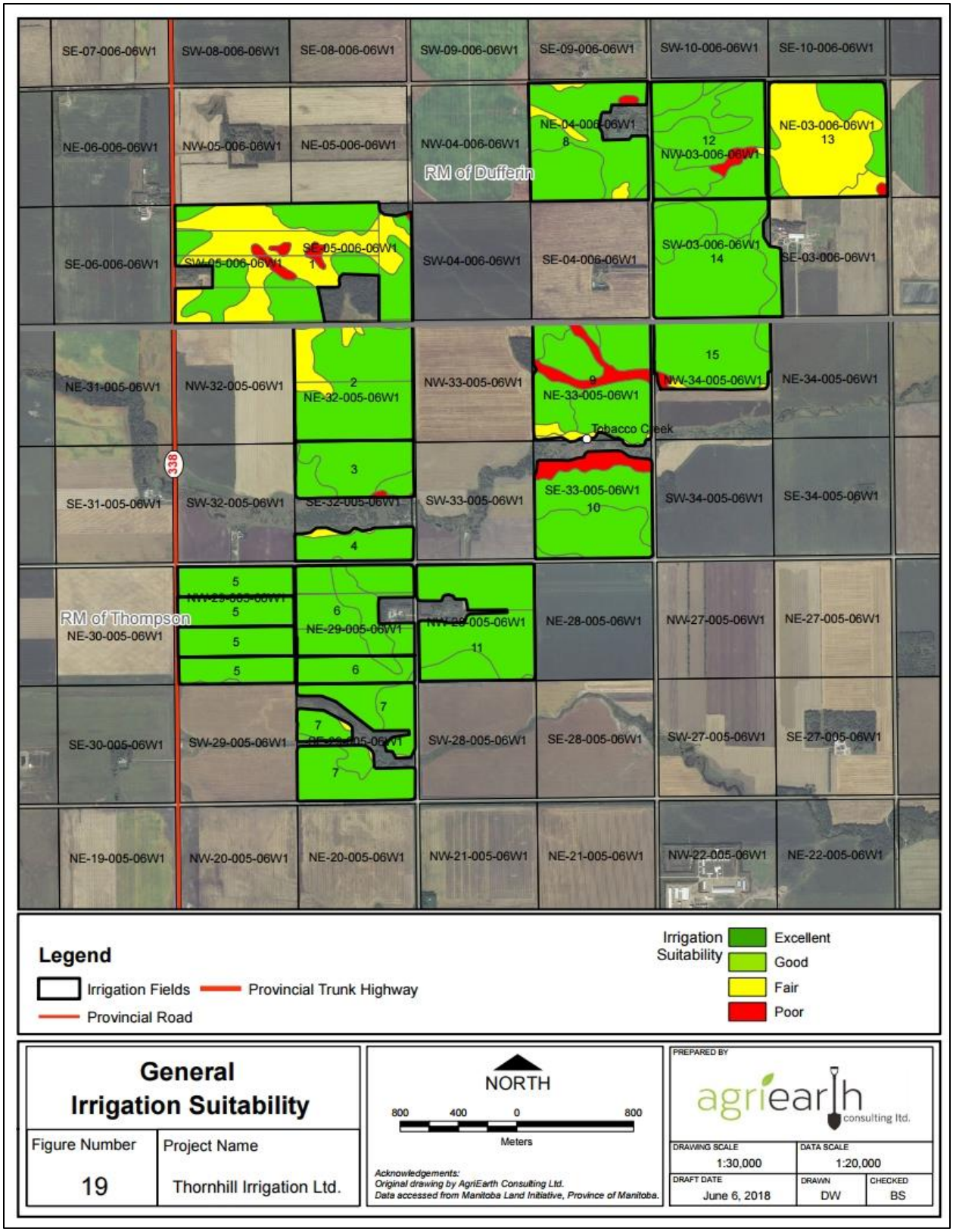
4.1.5.2 General Irrigation Suitability

The soils of the project area have been reviewed for irrigation suitability in accordance with a guideline developed in conjunction with Agriculture and Agri-Food Canada (AAFC) and Manitoba Agriculture Food and Rural Development (MAFRD) (Stantec, 2011). The general irrigation suitability ratings are based on guidelines published by AAFC (Working Group on Irrigation Suitability Classification 1987).

Soils are generally suited for irrigation if they are rated excellent or good. Table 8 reveals that 83% of the Project soils are rated as good. A fair rating on 14% of project soils, due to drainage class and salinity. These soils can be irrigated but with precaution. Drainage improvements, particularly tile drainage, will reduce the limitations associated with drainage and, over the long term, salinity. Approximately 3% of the project soils are considered poor for irrigation due to poor drainage and drainability. These portions of the project landbase should not be irrigated.

Table 8 - Irrigation Suitability Class of Project Soils

Irrigation Suitability Class	Areal Extent		Proportion of Project Footprint (%)
	hectares (ha)	acres (ac)	
Excellent	0	0	0.0
Good	728	1799	83.1
Fair	122	302	13.9
Poor	26	65	3.0
Totals:	***877***	***2166***	***100***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NE-21-005-06W1
NW-22-005-06W1
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Legend
Irrigation Fields
Provincial Trunk Highway
Provincial Road
Irrigation Suitability
Excellent
Good
Fair
Poor
General Irrigation Suitability
Figure Number
19
Project Name
Thornhill Irrigation Ltd.
NORTH
800
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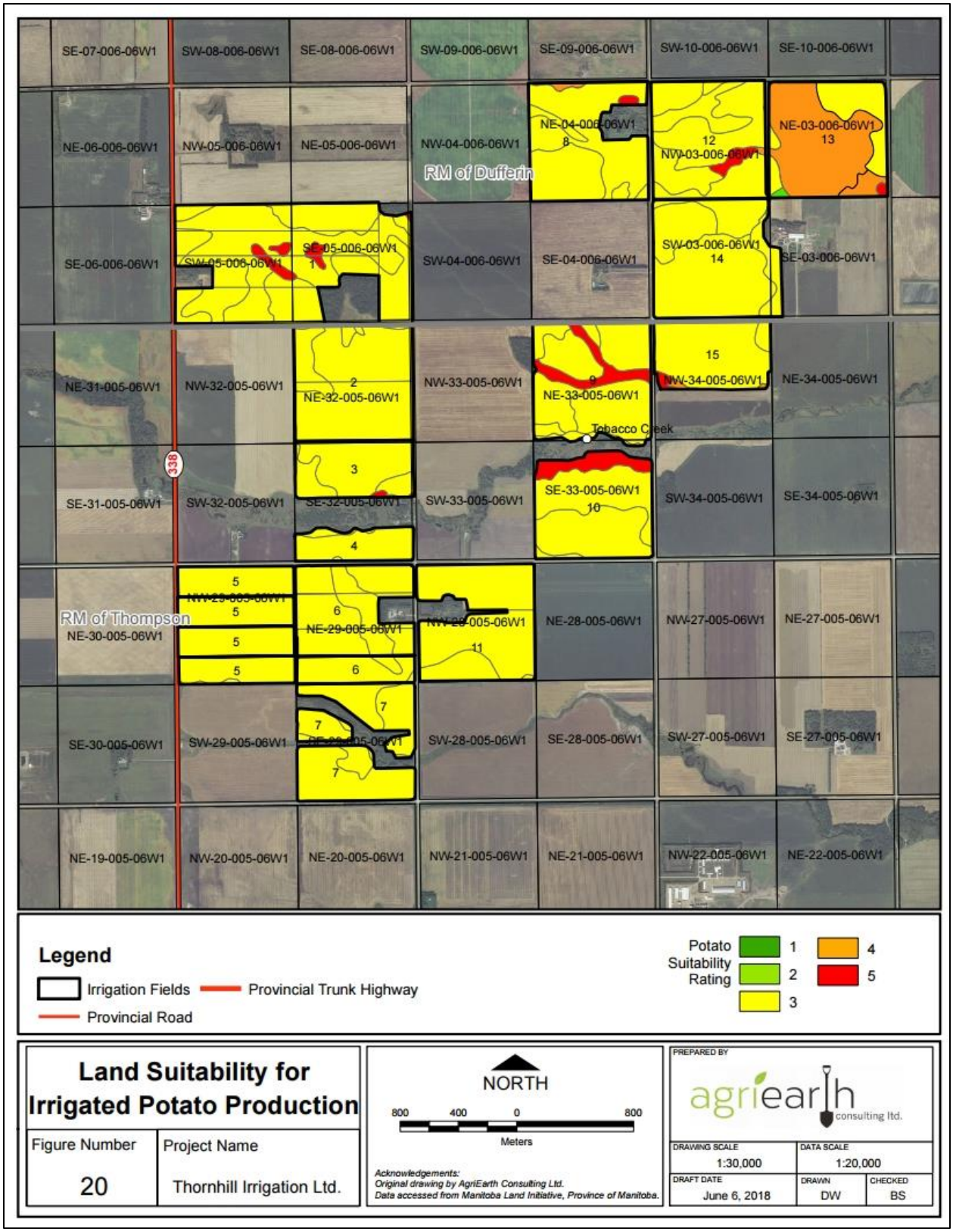
4.1.5.3 Suitability for Irrigated Potato Production

The soils of the project area have been reviewed for irrigated potato production in accordance with a guideline developed in conjunction with Manitoba Agriculture Food and Rural Development (Stantec, 2011). The basis of this is the irrigated potato production guidelines published by Manitoba Agriculture Food and Rural Development.

Soil landscapes rated as Class 1 – 3 are well suited for potato production. Table 9 reveals Class 1 – 3 represent 91.7% of the project soils. Approximately 5.4% of the project soils are marginal (Class 4) primarily due to limitations associated with salinity and drainability. A small portion (2.9%) of the project soils are rated as Class 5 due to poor drainage and should be considered unsuitable for irrigated potato production.

Table 9 – 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	0	0	0.0
2	1	1	0.1
3	801	1980	91.4
4	48	119	5.5
5	26	65	3.0
Totals:	***877***	***2166***	***100***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Provincial Trunk Highway
Provincial Road
Potato Suitability Rating
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Land Suitability for Irrigated Potato Production
Figure Number
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4.1.5.4 Beneficial Management Practices

The soils landscape assessment guideline (Stantec, 2011), provides a list of Best Management practices that can be incorporated by producers to address the noted limitations associated with irrigated potato production. These BMPs are part and parcel of the strategy to minimize environmental impact while maximizing production. Progressive farms like the Proponents are aware of BMPs and have adopted them as part and parcel of their production methods. These BMPs are also crucial to maintaining contracts with processors and clients whom are requiring their products be grown in a manner that respects the environment (e.g. Unilever, 2010).

4.2 Terrestrial Environment

The majority of the Winkler Eco District (Figure 1, 5) is cropland (Smith et al., 1998). The value of the remaining natural habitat is limited due to its' disperse nature and lack of continuity. The project area is mainly confined to the cultivated areas of the project footprint (Figure 5), including all irrigated lands, Site T1 and T2 and most of the planned pipelines, which will be typically located along road allowances and/or in easement (Figure 3). Creek crossings and intakes will impinge on riparian zones, but impact will be mitigated through careful construction methods. Road crossings are mainly through maintained road/drainage ditches.

4.2.1 Vegetation

Smith and Michalyna (1973) and Smith et al (1998) describe the native vegetation of the area.

> *The native vegetation within the Red River Valley is dominantly mixed tall prairie grasses, meadow prairie grasses and herbs. This has largely disappeared due to cultivation (Smith et al, 1998). Groves of white elm, Manitoba maple and green ash occur along many of the better developed streams and creeks through the area (Smith et al., 1998). Bur oak is found on banks not prone to flooding. Poorly drained areas support slough and marsh grasses, willows, cattails and sedges. (Smith et al., 1998).*

Crops and planted shelterbelts have largely replaced the native vegetation except along the existing stream channels and oversized valleys and particularly along the West Tobacco Creek (Figure 5). Along the reach of the South Tobacco Creek where site T2 is proposed, the vegetation is largely dyke/pasture land; devoid of any wooded vegetation (Figures 12 and 13). This stretch of the Tobacco Creek has be reconstructed to pass water more efficiently with little consideration of aquatic or wildlife habitat. Erosion in this reconstructed creek, is controlled by concrete/rock drop structures which also act as a barrier to fish migration. There are a few stretches of native wooded riparian zones along the West Tobacco Creek SE 33-5-6W (Figure 14 and 15) and along the tributary to the South Tobacco Creek in 29-5-6 W in the abandon oxbow next to the channelized bypass.

Common grass and grass like species reported in the Winkler-Morden area (Smith and Michalyna, 1973), included blue grass, cord grass, june grass, sedges, spear grass, and wheat grass. Commonly reported herbaceous plants (Smith and Michalyna, 1973) included prairie crocus, asters, banberry, cinquefoil, fireweed, sage, strawberry, thistle, violets and wormwood.

4.2.2 Wildlife

The region includes habitat for white-tailed deer, coyote, rabbits, ground squirrels, and waterfowl. (Smith et al., 1998). The MSTW Planning Study contained as part of Bylaw 4-05 contains a description of the wildlife with the majority of the study area (e.g. RM of Thompson and RM or Stanley) (http://www.mstw.ca/PDF/MSTW_Development_Plan_ByLaw_4-05.pdf):

> *The Canada Land Inventory rates the Planning District as having moderate limitations for the production of waterfowl because of either adverse topography, poor water holding soil capacity, poor distribution or interspersion of marshes or basins or a combination thereof. This should not suggest however, that the Planning District does not provide habitat to other wildlife species. In fact, the Escarpment* (i.e. upslope from the Project in the Manitou Eco District in Figure 1) *is the most critical wildlife habitat in the Planning District, as it provides varied habitats to wildlife, ranging from wetlands, oak-aspen forest to sheltered river valleys. It is important for deer and wild turkey habitats since the slopes are attractive for warmth and winter shelter. The transition between the Escarpment and arable cropland is also noted for sharp-tailed grouse, ruffed grouse, fox, coyote and various songbirds, while the Tobacco Creek, Shannon Creek, Dead Horse Creek and the Pembina River provide for vegetated wildlife habitat, with potential for songbirds, shorebirds, small game and furbearers such as muskrat, beaver, mink and weasel.*

4.2.3 Species at Risk

Contact was made with Chris Friesen of the Manitoba Conservation Data Base to determine the potential for existence of Rare and Endangered Species. Copy of the correspondence included in Appendix E confirms the MCDC database contains no rare species occurences in the area of interest. The project is mainly being constructed on cultivated land as detailed above. Section 4.3 discusses aquatic species at risk.

4.3 Aquatic Environment

Previous Environment Act Licenses in this vicinity were reviewed with respect to Federal Department of Fisheries and Oceans (DFO) requirements, and the license clauses pertaining to fisheries. Minimum in stream flows were not identified in most of the recently issued licenses near this project (e.g. on the Shannon Creek).

A recent EAL issued on a similar stream (EAL 2480; Shannon Creek) was reviewed with respect to conditions. In the summary to the EAL 2480 it was noted (http://www.gov.mb.ca/conservation/eal/archive /2000/summaries/4542.pdf):

> *With respect to intake screening, it is believed that the project location is well upstream of the fisheries area of interest. DFO has jurisdiction over intake screens, so will approve any necessary screen design directly.*

Previous applications by Agassiz Irrigation Association in the mid -1990's (AIA, 1995) considered the withdrawal of water on intermittent streams coming off the Manitoba Escarpment and concluded that no fish screens were required due to the distance of the projects from the Red River.

Previous licenses issued to AIA Inc on the Hespler Drain (e.g. EAL 2093) (AIA, 1995) for a similar drainage area accepted an in-stream flow of 0.36 m3/sec (Appendix C). This would indicate in-stream flow of about 0.15 to 0.18 m3/s for each reach of the Tobacco Creek (e.g. 6 cfs at each pump site).

4.3.1 DFO Classification Maps

The project area is traversed by South and West Tobacco Creek (Figure 1). Near the project the South Tobacco Creek has been reconstructed or modified to increase capacity and to control or prevent overland flooding of adjacent farm lands (Figure 12 and 13). The South Tobacco is diked along the reaches where water withdrawal would be made for Site T2. Site T1 is located on the upland adjacent to the oversized valley which is generally grassland and small trees (Figure 14 and 15; Figure 2). The existing creek at this location has very limited habitat capacity, given its' limited watershed, clay substrate (Figure 7), lack of riparian zone and limited channel capacity.

The Government of Canada and the Province of Manitoba convened the Manitoba Drain Maintenance Committee to better understand the nature of agricultural drains 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 Tobacco Creek within the project area. Appendix F provides a copy of figures and questions and answers with respect to the reference.

Milani (2013) summarizes five years of field surveys (2002-2006) and develops 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 and the fish species presence (captured or expected) (***Commercial, Recreational, Aboriginal or SARA listed*** Fish species vs. **Forage** Fish species vs. ***No Fish***).

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

The maps provide a quick risk assessment for the potential of impacts to fish and fish habitat in Agro-Manitoba from a variety of works that occur in and near water, to be supplemented with local knowledge (e.g. Figures 12 and 13).

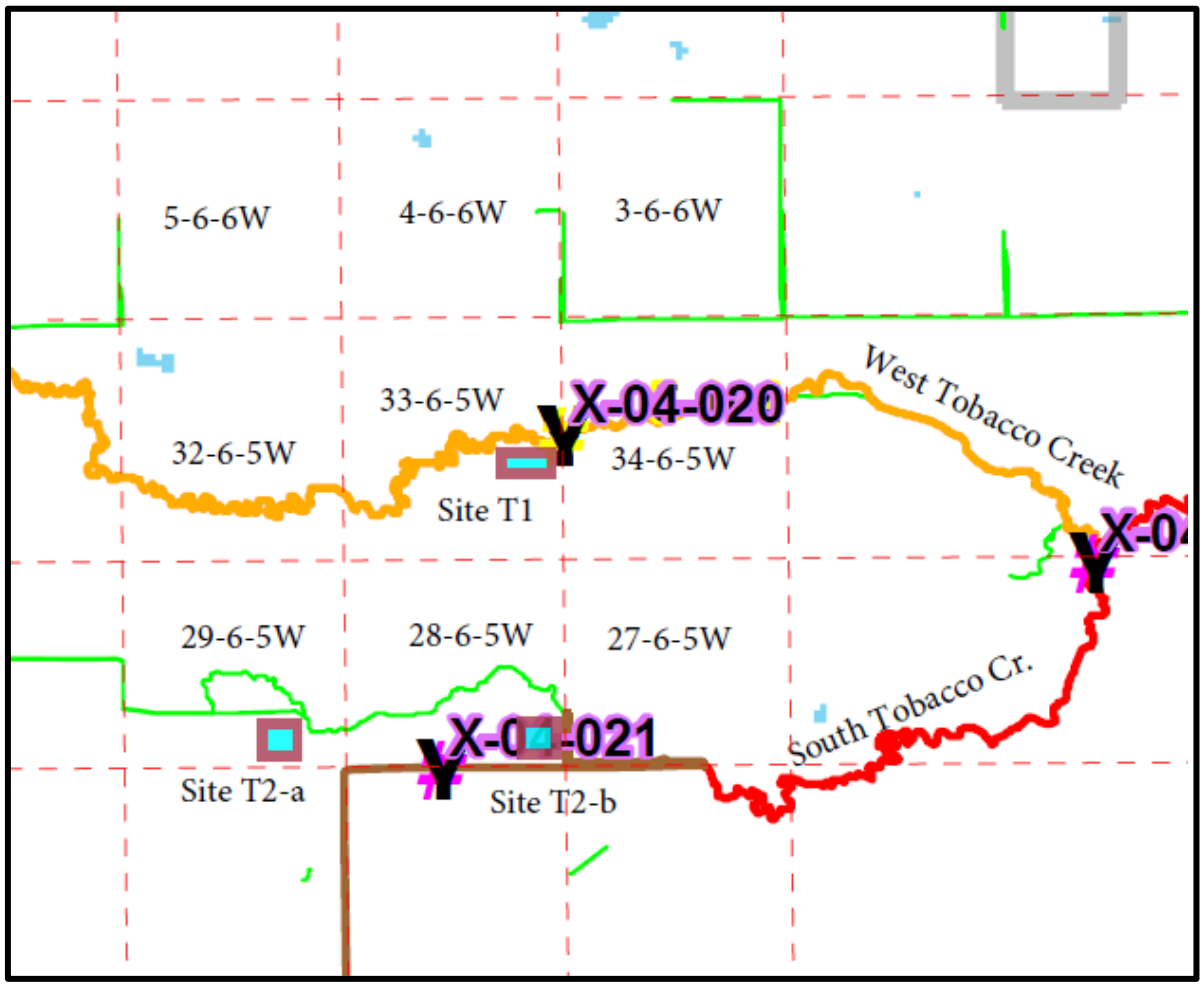

Figure 21 - DFO Habitat Classification of Streams and Constructed Drains in the Tobacco Creek Project Area

According to Figure 21, Tobacco Creek adjacent to Sites T1 and T2 are currently considered to be Class C and Class B habitat respectively. Site T2 is adjacent to a channelized, diked, straight reach of the Shannon Creek (Figures 12 and 13). Site T1 is a meandering deep narrow clay channel in an oversized, grassland valley bottom; that has limited drainage area and little to no non-clay substrate (Figures 14 and 15).

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. Figures 12 – 15 provide some visual context that aids in understanding the interpretations.

4.4 Socio Economic Environment

The Project area is largely agricultural in nature. Some small industries and cooperatives co-exist along-side working farms. The Village of Miami is also located to the south of the project area.

The project area is traversed by the PR 338 which is a significant artery leading to Hwy 23 and then to Hwy 3 and also provides northern access to Carman and Notre Dame. The main travel routes for the Project area includes PR 338 and Hwy 23, 3, and 34. which lead from the Project area to the Kroeker Boyne River Farm (to the north), the Kroeker Main Facility (at City of Winkler) and to Hespler Farms (at the Village of Schanzenfeld); as this is where potato storage sheds owned by the Proponents are located.

Building activity for RM of Stanley for 2011 was $106 M as reported by the MSTW (http://www.mstw.ca/building_permit_stats/2011%20Permit%20Report.pdf). The Project will generate significant economic activity and will have total expenditures in the order of $4 M. A significant portion of the expenditure (approaching 50%) will be spent on goods and services from outside the MSTW planning area. Estimated expenditures are as follows.

Reservoirs	$1.8 M
On Farm	$1.2 M
Pipelines	$1.0 M
Power	$0.1 M
Pumps	$0.3 M

Currently there is three phase power in the Project area. The preferred power source based on environmental impact is Hydro-electric power; but capital costs will have to be evaluated to determine payback on investing in Hydro-electric power vs. Diesel engines.

Both Hespler Enterprises Ltd. and Kroeker Farms Ltd. are long time producers operating in the MSTW area and Kroeker Farms Ltd. has operated in the RM of Dufferin for decades; and more recently within the RM of Thompson (e.g. along Rosebank Road). They each employ full time staff, as well as short term (seasonal) employees. The Project is geared to enhance the environmental and economic security of these 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 both Hespler Enterprises Ltd. and Kroeker Farms Ltd. 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. Kroeker Farms Ltd. main storage is on the east side of Winkler and along PR 338 near the Boyne River and Hespler Enterprises Ltd. main storages are on Highway 3 west of the City of Winkler and on the home farm near the village of Schanzenfeld. All truck drivers are provided with ongoing safety training including defensive driving, standard operating procedures and scheduled performance reviews.

The Winkler Morden Carman area has been developing off stream reservoirs of this nature since the early 1990's. The nearest reservoirs are 3 miles north along the Boyne River and 1 mile east and 3 ½ miles north west along the Tobacco Creek. All reservoir sites would be designated with signage warning of dangers and prohibiting trespassing. There are no reports of safety issues with existing reservoirs.

All irrigation pipelines are mapped with GPS and as – constructed plans can be filed with the RM of Dufferin and the RM of Thompson. The majority of pipeline will be located on easement on private property. Where necessary, the Rural Municipalities 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 a liner pipe, which will have equal or greater pressure rating to the carrier 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), and will require approval by authorizing agency.

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. snowmobiles).

Intake systems to the Creeks (Tobacco Creek) are marked to maintain safety for users of the public waterways (e.g. canoes).

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, 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 both Hespler Enterprises Ltd. and Kroeker Farms Ltd. have ongoing safety programs for their employees.

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 and First Nations

The nearest Protected areas to the Project area are the Stephenfield Provincial Park, the Deerwood Wildlife Management Area, and the Wellington Wildlife Management Area, Lizard Lake (Ducks Unlimited). All of these are well outside the Project Area (Figure 1). There are no local improvement districts.

The MSTW Planning Report (MSTW, 2007) also highlights these areas and the constructed Lake Minnewasta as significant local features, but well outside of the Project area (Figure 1):

> *Of special note, Lake Minnewasta, which originated with the damming of the Dead Horse Creek, is located in the southwest quadrant of the Town of Morden and also extends into the RM of Stanley. It provides for various outdoor nature-related and recreational activities. Furthermore, the Pembina Valley Provincial Park as well as the Pembina Valley, Deerwood and Wellington Wildlife Management Areas serve to protect and manage fish and wildlife habitat as well as sensitive areas.*

It is assumed that Stephenfield Lake has similar local significance to Lake Minnewasta, enhanced by it's Provincial Park status.

The nearest First Nations are Swan Lake to the west, Roseau River to the east and Long Plain to the North. All are greater than 30 miles from the project site and have no known interest or impact on the project.

4.7 Heritage Resources

Contact was made with Manitoba Historic Resources Branch in to ascertain what existing heritage resources exist within the project area. A copy of the correspondence is included in Appendix D. There has been no response at time of printing. The Proponents will follow up after submitting this report.

There is published and marked Historical sites in the rural areas, mainly demarking school districts and other more recent cultural resources. None of these occur at the three proposed reservoir sites. Pipeline construction will avoid such marked sites.

More ancient sites associated with Aboriginal activities are less documented and always possible. A book titled *Uncovering Early Aboriginal History in Southern Manitoba* (2011), could be consulted. It is a 128 page book with 74 illustrations comprising maps, artifact photos and drawings, and "people pictures" showing living scenes and imagery based on the findings at a recently excavated site near the Pipestone Creek in Southwest Manitoba and other sites in southern Manitoba and elsewhere. The volume describes the objectives of conducting excavation of archaeological sites in general. It relates what happened at a certain locale on the prairie landscape.

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. The Proponents are aware of this responsibility.

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

5.1.2 Impact on Geology and Groundwater

There is currently no planned groundwater withdrawal. The separate Groundwater Exploration Permit issued to Thornhill Irrigation Ltd. and associated report will deal with the feasibility and impact of potential groundwater withdrawals from the Miami Aquifer further south east of the Project area.

The reservoirs will not leak into underlying bedrock and are located to the north of the surficial Miami Aquifer footprint.

The irrigated lands will follow Best Management Practices regarding wind and water erosion and Provincial Nutrient Management Guidelines based on individual field by field basis. The shallow surficial groundwater is poor quality, drought prone and has been replaced by rural water pipelines from Pembina Valley Water Coop and the RM of Dufferin and Thompson. The deep shale groundwater is protected from contamination by overburden of lacustrine clay and till, and in any case is poor quality.

The only unique geologic features within the project area are the Hillsboro Beach and the Miami Aquifer. None of the proposed reservoir sites will negatively impact these features, as they are not with in the planned footprint of those sites. Care will be taken with pipeline construction to identify any potential downslope groundwater movement in trenches (e.g. clay plugs).

Care is provided (see Sections below) to prevent contamination of surface water sources (e.g. Tobacco Creek).

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 stored in the planned reservoirs. The reservoirs will be engineered by qualified professional engineers registered with the Association of Professional Engineers and Geoscientists in Manitoba.

Water diversion rates will vary at a rate of up to a maximum of 1.9 cubic meters per second. Diversions would last for about 4 – 7 days in length. The water to be diverted is largely spring freshet runoff from snowmelt and rainfall. Allocation will be made by Manitoba Sustainable Development from available water allocation budgets, based on careful consideration of economic and environmental uses of water. The projects will be issued Development Permits prior to construction. The projects will be issued Water

Rights licences after construction. All Water Rights license conditions will be adhered to by the Proponents.

The Project will have little impact on the large channel forming flows and associated downstream flooding along the Shannon Creek below Highway; with maximum diversion rates at less than 2% of observed peak daily flows. Minimum in stream flows will be maintained in accordance with any EAL and Water Rights Licenses issued. After review of Figures 8, 9 and 10, and Table 4, it is suggested that 0.15 cubic meters per second would be a reasonable minimum in-stream flow during pumping along each branch of the Tobacco Creek. The minimum in- stream flow would help to maintain downstream flow during withdrawals and support the duration of the recessional limb of the hydrograph downstream of the Project area.

The impact of tile drainage and irrigation on runoff are described in the section on Impact and Mitigation on Soil-Landscape Resource. This section also describes the impact of irrigation and drainage on nutrient management.

Measures to prevent sediment runoff from project construction sites is described under the section Impact on Fisheries and on 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 water quality because of construction or operation activities.

5.1.3 Impact and Mitigation on Soil – Landscape Resource

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 15 parcels of land being considered for irrigation development. The assessment was conducted by AgriEarth Consulting Ltd., and certification of irrigation suitability and recommendation of Best Management Practices was completed by a Professional Agrologist (pedologist).

Table 10 provides a summary of the assessment for each field and the recommendation with respect to suitability for irrigation. Tables 7, 8 and 9 provide summaries of land suitable for dryland agriculture, irrigated crop production and potato production. Generally, the project landbase is well-suited for irrigation and production of potatoes. One field (field 13; NE-3-6-6W1) was identified as requiring a follow-up Phase II level field investigation due to salinity identified by existing soil resource information. The Stantec (2011) guideline includes procedures for identification of Phase II investigation requirements and the standards for carrying out and reporting on those Phase II investigations.

Assessment of irrigation suitability includes consideration of the impact of additional water on soil drainage. A large portion of the study area is considered imperfectly drained (Figure 16). There are limited portions of the project landbase with poorly drained soils. These are associated with the creeks that dissect the project area and with some low-lying areas.

Due to the imperfectly drained soils, the Proponents have developed tile drainage throughout most of the project fields and have planned to install tile on the remaining fields in the future (Table 10). The main benefit of tile drainage in the Red River Valley is 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). A side benefit to the environment will be to reduce surface runoff (Sands, 2013) and associated sediment and phosphorus loading to the streams. Reduced flood peaks will result in reduction in downstream flooding, and longer recessional limb on the hydrograph of the Tobacco Creek. The longer recessional limb is also supported by a net increase in total water yield of close to 10% (Sands, 2013) for average conditions. This should help to improve conditions for downstream fisheries.

The next three sections provide further with respect to the implementation of BMPs and anticipated outcomes.

There are no significant impacts anticipated on soil landscapes because of irrigation and drainage activities. 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-initiated soil erosion is a factor in the near shore fine sandy loams that dominate the soil-landscape of the Project area. Producers have traditionally implement BMPs to account for this fact. Traditional BMPs implemented in the Project area include, shelterbelts, annual barriers, and cover crops and reduced tillage of crops in rotation with potatoes. The implementation of tile drainage is 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, on tiled land saturation levels are reduced, conditions for soil compaction are reduced and water infiltration is increased; adding to crop water utilization and again reducing water erosion.

As the Project is not proposing to develop new land and much of the land being proposed for irrigated potato production is already being farmed for potatoes under dry land conditions, it could be argued that the incremental impacts of the Project on Soil Erosion and Transport are negligible to improving.

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

- Residue Management and Tillage
    - Minimum tillage practices will be adopted where feasible.
    - Anchoring of potato vines with light disking
    - Crop rotation will include high residue crops such as wheat and corn
    - 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
    - Both Kroekers and Hespler plant fall cover crops whenever possible after potato harvest (e.g. on early harvested fields); typically fall rye or barley would be utilized.
- 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
- 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 leaching
    - Employ tile drainage to improve soil potential for infiltration and adsorption of water
    - Irrigate at application rates below the infiltration rate of the field specific soil.
    - 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 erosion of bare soil exposed or modified during construction of the proposed reservoirs and pipelines. Best construction practices to be followed are documented in Appendix G and discussed further under the section on Impact on Fisheries. Contractors will be required through contract specifications to follow the prescribed measures for erosion and sediment control.

Given the implementation of the Best Management Practices as outlined above and as summarized in Table 10, there are no significant incremental impacts 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 N1 or N2 in accordance with the Manitoba Nutrient Management Regulations. This legislation dictates the allowable residual soil nitrogen according to soil-landscape properties and allowable phosphorus application rates based on residual concentrations. The regulation is intended to guide sustainable production systems that will minimize nutrient losses to surface water and groundwater.

Two factors will further influence the nutrient balance in the crop and potential for leaching. In recent years, production of potatoes has recognized the yield and quality benefits of spoon feeding nitrogen fertilizer to the potatoes as demand requires it. Fertigation systems have become a common element of irrigation systems designs. Fertigation allows lower starter nitrogen applications and timing the application to avoid early season rains and leaching events. The implementation of tile drainage has led to more uniform crop production, ensuring fewer hotspots of underutilized nutrients, and lowering chance of nutrient leaching. Combined with advanced methods such as variable rate nutrient systems there is an advanced capacity today to better farm each acre and input for optimum productivity.

University of Minnesota (2008) documents Best Management Practices for Nutrient Management on Irrigated Potatoes (see Appendix H). The active link is

http://www.extension.umn.edu/agriculture/nutrient-management/nitrogen/docs/08559-potatoesMN.pdf

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.
- Follow Nutrient Management Regulations for the individual fields, considering limiting nutrient management zone classifications.
- 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
- Do not overirrigate causing leaching.
- Track performance using groundwater monitoring and tile outflows.
- Consider University of Minnesota Irrigation Water Management Considerations for Sandy Soils; AG-FO-3875 (see Section 5.1.6 below).
- 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.

Given the implementation of the Best Management Practices as outlined above and as summarized in Table 10, there are no significant incremental impacts 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 experimental stage (Evans et al., 2013), but none the less is being actively pursued by manufacturers and producers in many jurisdictions. To date the incremental investment has not proven its return to the producer. 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 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

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 nearly-level to gently sloping, soil texture largely determines infiltration rates in this soil-landscape. 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.

5.1.6.2 Drainage and Infiltration

Most of the soils in the project are rated as imperfectly drained. Irrigation on these soils will be to some extent mitigated by capillary rise (Cordiero, 2013). The impact for water conservation is to require effective adjustments to the irrigation scheduling methods. Typically, soils in the Winkler Area require less water than other areas of the Province due to this effect.

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 as represented in Table 2 and 3.

5.1.6.3 Available Water Holding Capacity

The Available Water Holding Capacity determines the amount of irrigation that a soil can hold. This is usually reported in inches per foot or mm per meter. Available Water Holding Capacity is measured as the difference between field capacity and permanent wilt point. This is the total amount available to the plant and is multiplied by the plant rooting depth and an allowable depletion factor to determine the amount of water that can be replaced by irrigation.

The irrigation interval is simply the allowable water depletion divided by the rate of evapotranspiration less water supplied through 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 deficits drive this design (e.g. Table 4). Variable application rates can be utilized to account for reduced evapotranspiration rates, more frequent irrigations (less amounts), changes in soils texture and AWHC, and landscape position (e.g. proximity to capillary fringe).

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 practice the feel method. 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 solutions. This technology can improve the performance of the irrigation scheduler.

5.1.6.5 Technology – Sensors and Telemetry

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 several Canadian, USA and International Companies. 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. An online example is provided by the McCrometer and Adcon companies on the McCrometer web site. (http://www.mccrometer.com/news_media/case_studies/studies_connect-black-gold.asp)

Hespler Enterprises Ltd. and Kroeker Farms Ltd. are leaders in the evaluation of this technology in the context of the project area soils. Both producers have been actively involved with AAFC and U of Manitoba researchers, and local agro-meteorological companies to evaluate the utility of this technology. While it is early in the process, 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 PhD thesis issued in Fall, 2013 from the BioSystems Engineering department at the University of Manitoba, based on data from Hespler Enterprises Ltd. farm.

Given the implementation of the Best Management Practices as outlined above and as summarized in Table 10, there are no significant impacts on Conservation and Beneficial Use of Water Resources resulting from over-irrigation anticipated because of the Project.

Table 10 - 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)																				Tile Drainage Installed
			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 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	SW&SE-5-6-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
2	NE-32-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
3	N portion of SE-32-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
4	S portion of SE-32-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
5	NW-29-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Future (planned)
6	NE-29-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
7	SE-29-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
8	NE-4-6-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Future (planned)
9	NE-33-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
10	SE-33-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Future (planned)
11	S portion of NW-28-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
12	NW-3-6-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
13	NE-3-6-6W1	Phase II Required	x	x	x	x	x	x	x		x	x		x	x	x			x	x				Yes
14	SW-3-6-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes
15	NW-34-5-6W1	Recommended	x	x	x	x	x	x	x						x	x			x	x				Yes

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

5.2 Impact and Mitigation on Terrestrial and Aquatic Environments

5.2.1 Impact Terrestrial Habitat and Wildlife

There is no planned alteration to habitat, other than the optional Site T2. At Site T2, the existing "abandon" drainage channel does not run water and is effectively cut off from other habitat within the area. The creation of a off stream reservoir would add to the wetland habitat, which according to the MSTW report (MSTW, 2007) is limited in the project area. Site T1 will also add significant open water habitat within the project area. Figure 5 highlights the lack of wetland habitat and the significance of the proposed water bodies within the Project area.

There will be little to no loss of trees, other than potentially for the intake site at Site T2 to the West Tobacco Creek and the proposed Creek crossings along wooded portions of Tobacco Creek. Creek Crossings are proposed to take place within the RM Road Allowances and every attempt will be made to keep damage to riparian zones to a minimum. The habitat at these locations are already disturbed in any case due to RM roads and other utilities (e.g. rural water lines).

There are no significant impacts anticipated on Terrestrial Habitat and Wildlife because of construction or operation activities.

5.2.2 Impact on Species at Risk

The reaches of the Tobacco Creek have either been classified as NOT supporting Species at Risk (i.e. West Tobacco - Class C) or have been significantly modified by man (e.g. channelized – South Tobacco) to the point of being of limited habitat value. The Manitoba Conservation Data Center did not list any rare species in the area of interest.

There are not expected to be significant impacts anticipated on Species at Risk because of construction or operation activities.

5.2.3 Impact Fisheries

The West Tobacco Creek in the Project area is considered to be class C and as such does not support Commercial, Recreational, Aboriginal or SARA fish species. The South Tobacco Creek in the project area is channelized, restricted by drop structures, and considered here to be of limited value to support Commercial, Recreational, Aboriginal or SARA fish species; despite being class B.

Furthermore, according to the DFO web site, a project does not require DFO review if it meets the following criteria:

Water Extraction

Surface water extraction for commercial bottling, drinking and sanitary, industrial use, thermal/nuclear generation, agricultural irrigation and other uses.

There is no reduction in the width of nearby water bodies.

All the off-stream reservoirs will only extract water during spring freshet and will not impact the stream width on the West or South Tobacco Creeks.

None the less DFO could be contacted for a review of the project, if required, and/or as a minimum the 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 intakes

- 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 PTO Driven Tractors for Filling

- 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.
- Wash refuel 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 work in water to respect timing windows to protect fish, including their eggs, juveniles, spawning adults and/or the organisms upon which they feed.
- 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 Reservoirs 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.
- Consider whether screening of water intakes is required given that the streams in question are none fish bearing and the timing is such that water extraction occurs prior to spawning. IF it is determined fish spawning will occur during the withdrawal period, then consider screening water intakes or outlet pipes to prevent entrainment or impingement of fish. Entrainment occurs when a fish is drawn into a water intake and cannot escape. Impingement occurs when an entrapped fish is held in contact with the intake screen and is unable to free itself.

If intake screens are required, the DFO generic guidelines for screening will be followed.

There are no significant impacts anticipated on Fisheries because of construction or operation activities.

5.3 Impact and Mitigation on Socio Economic Conditions

5.3.1 Impact and Mitigation on Heritage Resources

There are no known impacts on Heritage Resources at this juncture of the planning studies. Final investigations for each reservoir site will follow recommendations of Heritage Resources Branch regarding potential significance.

5.3.2 Economic Activity and Employment

Both the farming companies involved offer full time employment within the RM's of Stanley, Thompson, Roland, Dufferin and Rhineland, and the City of Winkler, and the nearby Village of Schanzenfeld.

Construction activity will involve local construction companies, regional and local suppliers, international, national, regional and local manufacturers.

5.3.3 Traffic

The project already generates traffic from the project area to the City of Winkler, the Morden – Winkler Corridor, and the Village of Schanzenfeld. Highways utilized include PR 338, PR432, Highways 3, 14 and 32. The implication of construction of the project will mean a short-term increase in traffic during construction within the Project area (Figure 1). 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 not be noticeable.

Given the nature of traffic congestion through the City's of Morden and Winkler on PR432, Highway 3, and Highway 32; every effort will be made to reroute truck traffic around these congestion areas during high traffic periods (e.g. via Hwy 23, 3 and 14 vs. PR 432 and Hwy 3). Company drivers are 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 in the field prior to any / all site investigations, underground construction and boring. Highways crossings on PR338 will be pre-approved by MI and will be lined to prevent piping of the roadway. Crossings of rural water pipelines will be made above them at right angles. MTS and Hydro underground cables will be avoided where feasible or crossed below at right angles. There are no planned railway or oil pipeline crossings.

Manitoba Hydro will be approached regarding provision of three phase power to Site T1 and T2, once and if they are determined feasible. Three phase power exists at Site T1, and Sites T2 – O1, O2, O3.

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, reservoirs 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, in particular around any potential to contaminate Tobacco Creek.

All on farm practices are subject to regular farm practices; regarding safe handling of fuel, chemicals and fertilizers.

All irrigation systems utilizing fertigation will employ backflow prevention.

All truck drivers are given stringent standard operating procedures and routing instructions, and their performance is monitored.

All construction sites will be Cor certified or equivalent (Construction Safety Association of Manitoba, 2014).

All reservoirs will be designed and constructed to the approved engineering standards qualified engineers registered with the Association of Professional Engineers and Geoscientists of Manitoba. The Proponents will implement a dam safety program, including annual inspection and emergency response plans for the water storage structures.

There are no significant adverse impacts on Human Health and Safety because of construction or operation activities.

There are no significant impacts anticipated on Socio Economic issues because of construction or operation activities.

5.4 Pollutants, Hazardous Wastes and Fuel Products

The irrigation project will not release significant pollutants or hazardous wastes. Pollutants would be limited to exhaust emissions from diesel engines required to operate filling and distribution pumps. Active consideration is being given to Hydro-electric pumps which would make use of clean renewable energy. Smaller diesel generators are utilized to power the mobile center pivot and linear irrigation systems. Due to the need for this power unit to be mobile Hydro-electricity is not currently a viable option. Solar power systems have been tested for smaller size irrigation systems for remote locations where fuel costs are prohibitive. Booster pumps may be required for the irrigation pipeline system and for certain on farm irrigation systems, including travelling guns and boom carts. The travelling reel is typically powered by gas engine.

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

Standard operating procedures for fuel handling and safety will 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.

There are no significant release of Pollutants or Hazardous Wastes because of construction or operation activities.

5.5 Climate Change Implications

MSTW recently undertook to understand Green House gas production by both residential and commercial sources within the four regions (CLER, 2010). Short term increase in greenhouse gas production will be associated with the construction project. The incremental ongoing emissions from this project will be associated with operation of the reservoir filling, the irrigation pumping system and the on-farm irrigation systems power sources.

The system will be operated to apply approximately 4 inches of water which will take an average of 300 to 400 hours per year. Re-filling will take place over an approximately 5 day period (5 x 80 acre feet = 400 acre feet per year).

The following are examples of the incremental energy consumption of the project.

1. Filling 3 x 150 HP tractors running for 5 days.
2. Pumping 400 hours x 7 x 60 hp.
3. Irrigation 400 hours x 7 x 10 hp.

IF all of these were diesel units they would certainly generate additional CO2. However, given the number of hours, the HP, and the number of units, this is insignificant within the Project area and the Region (e.g. in comparison to truck and car traffic alone).

None the less, the Proponents recognize the following strategies to reduce these emissions:

1. Switching to Hydro-electric power.
2. Water conservation to ensure optimal water application.
3. Planting trees in form of edge of field shelterbelts.

The construction activities will also generate additional CO2. These emissions are unavoidable and can only be mitigated by keeping all equipment in good working order.

The proponents are committed to examining climate change implications of their operations and implementing affordable technology to reduce the impact of the project on Green House gas production.

There is no significant long-term increase of Greenhouse Gases because of construction or operation activities.

5.6 Impact on Aboriginal Rights

There are no known implications with respect to Aboriginal Rights arising from implementation of the project. There are no Aboriginal communities in the project area. There is no known Aboriginal 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 the historical Aboriginal use within the Project areas to be disturbed.

There are no significant adverse impacts on Aboriginal Rights because of construction or operation activities.

6.0 Environmental Risk Management and Mitigation Measures and Follow Up

The proponents are 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 proponents are prepared to commit to all environmental protection measures and mitigations specified within the Environment Act License, the Water Development Permit, the Water Resource Administration Act, and the RM of Dufferin and Thompson Conditional Use Permits, and those dictated by other regulatory bodies (e.g. DFO, Historic Resources Branch).

6.1 Design

6.1.1 Consultation of DFO on intakes

DFO standards will be followed as outlined above.

6.1.2 Review of MIFs with Manitoba Sustainable Development

Manitoba Sustainable Development will be consulted on Minimum In-Stream Flows.

6.1.3 Investigation of Potential Heritage Resources on Construction Sites

Manitoba Historic Resources Branch will be consulted on potential for Historic Resources on the proposed reservoir sites. Incorporate recommendations into design and or construction phases.

6.1.4 Detail Sediment and Erosion Control Plans

Detailed sediment and erosion control plans will be included in all contracts.

6.1.5 Detail Specifications for Backflow Prevention

Detailed backflow prevention equipment will be specified for all fertigation systems.

6.1.6 Intakes and Creek Crossings

Develop riparian zone protection plans for intake(s) and pipeline crossings on wooded portions of the Tobacco Creek.

6.2 Construction

6.2.1 Detailed Contract Specifications

All contracts will be governed by detailed contract specifications and inspected by the engineer of record.

6.2.2 Safety

All contracts will contain a workplace safety component meeting intent of Cor.

6.2.3 Erosion and Sediment Control

All methods proposed by Contractors will be reviewed and approved by the engineer of record.

6.3 Operational

6.3.1 Soil and Water BMPs

Employ BMPs for soil erosion, nutrient management and irrigation water management. 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

Employ fuel management BMPs in accordance with EAL requirements.

6.3.3 Traffic BMPs

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

6.3.4 Dam Safety

Establish a Dam Safety monitoring and evaluation plan, to be overseen by a Professional Geotechnical Engineer

6.4 Repair, Renewal, Decommissioning

6.4.1 Pipelines

Replace worn underground PVC pipelines. Abandon damaged pipes in place.

6.4.2 Mechanical and Electrical Equipment

Replace worn equipment. Recycle parts as feasible or dispose in landfill.

6.4.3 Reservoirs

Maintain reservoirs in good shape. Renew liner system to limit seepage and maintain safety. Remove silt as required and place on nearby agricultural fields. Breach dykes and fill in reservoirs IF no longer utilized or maintained in good order.

7.0 Conclusions and Closure

PBS Water Engineering Ltd. has compiled the data and information presented in this Environmental Act Proposal report, in accordance with the requirements of Manitoba Sutainable Development, using the best information available at the time of writing. The report will form an attachment to the Environment Act Licence Application for the Thornhill Irrigation Ltd. – Tobacco Creek Irrigation Project.

Based on the studies undertaken to date and the commitment of the producers to employ best known practices and technologies during construction and operation, the project is not anticipated to result in significant or immitigable adverse impacts on the local biophysical environment. The development is expected to be consistent with the current land use, adding value and stability to the land base for agricultural production purposes. Economic activity, including securing long-term employment in the region will result. Both producers are committed to long term sustainability of the soil landscape employing management techniques consistent with the soil landscape resources and the recommended BMPs for erosion, nutrient management, and irrigation water management, using the latest and best available technologies.

Based on the information gathered and presented, PBS Water Engineering Ltd. feels that the conditions and the requirements of the Environment Act Guidelines have been met. The producers are committed to following the letter of the law with respect to any Development Permits and Licenses that will be granted to them as part of this Project planning.

This report is prepared for the expressed purpose of Thornhill Irrigation Ltd., Hespler Enterprises Ltd. and Kroeker Farms Ltd. Any third-party use of this report, 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 assessment of the environment which it is located.

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APPENDIX A – WATER RIGHTS APPLICATIONS ON TOBACCO CREEK

FORM C

Application for Licence to Divert and Use Surface Water

Water Stewardship Division
Water Use Licensing Section
200 Saulteaux Crescent
Winnipeg MB R3J 3W3

Manitoba
Conservation and Water Stewardship

Pursuant to *The Water Rights Act*

APPLICANT'S NAME: HESPLER ENTERPRISES	CONTACT NAME: Wayne Derksen		PHONE: 204 325 9591
POST OFFICE ADDRESS: Box 2700 Winkler			MOBILE: 204 362 0648
CITY or TOWN: Winkler	PROV: MB	POSTAL CODE: R6W 4A1	E-MAIL ADDRESS: Wayne@hesplerfarms.com

Hereby applies for authority to divert **Spring Flow** ☑ -OR- **Firm Flow** ☐ water from / Tobacco Creek
(name of river, creek, channel, etc)

by means of a pump located on the following described land:

QUARTER	SECTION	TOWNSHIP	RANGE	E OR W
SE	33	5	6	W

or otherwise described as _____

for Irrigation use purposes,
(municipal, agricultural, industrial, irrigation, other uses)

on the following described land:

QUARTER	SECTION	TOWNSHIP	RANGE	E OR W
SE+NE	33	5	6	W
NE	4	6	6	W
SW	14	5	6	W

or otherwise described as: _____

at the following rates: _____ cubic metres per second (pumping rate)

_____ cubic decametres per day (daily usage)

200 cubic decametres per year (annual usage)

Total number of acres to be irrigated: _____ (if applicable)

Transaction #: 42432
6-15: APPL & WATER USE FEES
(Name HESPLER ENTERPRISES LTD)
1 @ $100.00
2015-01-22 12:05:45 PM
Cashier / Caissier: 105
Cheque (Q)

The above described lands are held as follows: (check applicable box)

☑ as registered owner ☐ purchased under agreement for sale ☐ lessee ☐ to be determined

Attach copy(s) of the certificate(s) of title or title number(s).

Is this application for the renewal of an existing licence? ☐ YES ☑ NO **Existing Licence No.** _____

Is this application for the transfer of an existing licence? ☐ YES ☑ NO **Existing Licence No.** _____

Is this application to amend an existing licence? ☐ YES ☑ NO **Existing Licence No.** _____

Date: January 15 2015

(Signature of applicant)

**** IMPORTANT ****

FEE OF $100.00 MUST ACCOMPANY THIS APPLICATION, CHEQUE AND APPLICATION MUST BE MAILED TO:

MANITOBA CONSERVATION
CASHIER'S OFFICE
BOX 42, 200 SAULTEAUX CRESCENT
WINNIPEG MB R3J 3W3

CHEQUES TO BE MADE PAYABLE TO MINISTER OF FINANCE

FOR OFFICE USE ONLY: -4

JAN 16 2015

FORM C

Application for Licence to Divert and Use Surface Water

Water Stewardship Division
Water Use Licensing Section
200 Saulteaux Crescent
Winnipeg MB R3J 3W3

Manitoba
Conservation and Water Stewardship

Pursuant *to The Water Rights Act*

APPLICANT'S NAME: Kroeker Farms		CONTACT NAME: Eric Klassen	PHONE: 325 4333
POST OFFICE ADDRESS: Box 1450			MOBILE: 362 7067
CITY or TOWN: Winkler	PROV: MB	POSTAL CODE: R6W 4B4	E-MAIL ADDRESS: dirtmover@kroekers.com

Hereby applies for authority to divert **Spring Flow** ☑ -OR- **Firm Flow** ☐ water from / South Tobacco Creek
(name of river, creek, channel, etc)

by means of a pump located on the following described land:

QUARTER	SECTION	TOWNSHIP	RANGE	E OR W
SE	32	5	6	

or otherwise described as _____

for Agricultural, irrigation use purposes,
(municipal, agricultural, industrial, irrigation, other uses)

on the following described land:

QUARTER	SECTION	TOWNSHIP	RANGE	E OR W

or otherwise described as: See attachment

at the following rates: 690 acre Feet cubic metres per second (pumping rate)
_____ cubic decametres per day (daily usage)
_____ cubic decametres per year (annual usage)

Total number of acres to be irrigated: _____ (if applicable)

Transaction #: 28907
6-15: APPL & WATER USE FEES
(Name KROEKER FARMS)
1 @ $100.00
2014-03-12 9:10:17 AM
Cashier / Caisser: 105
Account / Client: 107
Blanket
MRC #MES803

The above described lands are held as follows: (check applicable box)

☑ as registered owner ☐ purchased under agreement for sale ☐ lessee ☐ to be determined

Attach copy(s) of the certificate(s) of title or title number(s).

Is this application for the renewal of an existing licence? ☐ YES ☐ NO **Existing Licence No.** _____

Is this application for the transfer of an existing licence? ☐ YES ☐ NO **Existing Licence No.** _____

Is this application to amend an existing licence? ☐ YES ☐ NO **Existing Licence No.** _____

Date: Feb 28, 2014 20___ Eric Klassen
(Signature of applicant)

** IMPORTANT **

FEE OF $100.00 MUST ACCOMPANY THIS APPLICATION, CHEQUE AND APPLICATION MUST BE MAILED TO:

MANITOBA CONSERVATION
CASHIER'S OFFICE
BOX 42, 200 SAULTEAUX CRESCENT
WINNIPEG MB R3J 3W3

CHEQUES TO BE MADE PAYABLE TO MINISTER OF FINANCE

FOR OFFICE USE ONLY:

24

APPENDIX B - RM CORRESPONDENCE

From: shewfelt@mymts.net
To: "R.M. of Thompson"
Bcc: "Wayne Derksen"; "Frank Elias"
Subject: RE: Hespler Kroeker Groundwater Investigation and Tobacco Creek Reservoirs
Date: May 2, 2018 4:33:00 PM

Good day Nicole.

I have started working on a new project that ***may require*** the RM's consideration. Hespler Farms and Kroeker Farms are proposing to jointly build two off stream reservoirs (e.g. similar to the one on Rosebank Road and Hwy 23). I am just working on the project description and will be filing an Environment Act Proposal on their behalf. I am expecting Development Permits from Water Stewardship to develop projects on the West Tobacco and South Tobacco Creeks (north of Miami).

Hespler is proposing to develop the first site in SE 33-5-6 W with construction this summer. We will be undertaking surveying, geologic and geotechnical investigations in June in parallel to the Environmental Act submission. Our plan is to complete design in June.

My question today is whether the RM has ***any by-laws pertaining to the location of an off stream reservoir project in relation to the property line*** (e.g. Municipal ROW, creek or neighbouring land). Also I would be happy to make a presentation to council on the plans that will be presented with in the Environment Act Proposal (to be filed in late May).

Thanks for your help. I can certainly stop by if that would facilitate better communications on these two projects.

Regards

Bruce Shewfelt, P.Eng.

From: R.M. of Thompson <rmthomp@mymts.net>
Sent: October 23, 2017 8:33 AM
To: shewfelt@mymts.net
Subject: Re: Hespler Kroeker Groundwater Investigation

Good Morning,

I had 2 of our Councillors take a look into this well yesterday, apparently it had been used for a feedlot, there is a building to the south of it that houses the electrical and the pump as far as they know was removed from the well.

That is about all we know and there is no Municipal interest in the well, so it must belong to Rosebank Colony?

Thank you

Nicole Enns, CMMA
Chief Administrative Officer
RM of Thompson
204-435-2114

Bruce Shewfelt, MSc., P.Eng.
204 362 5666
shewfelt@mymts.net

PBS Water Engineering

APPENDIX C - EXISTING EAL ON SHANNON CREEK AND HESPLER DRAIN

Manitoba
Conservation and Water Stewardship
Environmental Stewardship Division
Environmental Approvals Branch
123 Main Street, Suite 160, Winnipeg, Manitoba R3C 1A5
T 204 945-8321 **F** 204 945-5229
www.gov.mb.ca/conservation/eal

CLIENT FILE NO.: 5720.00

September 3, 2014

Wayne Derksen
Hespler Enterprises Ltd.
Box 2700
Winkler MB R6W 4C3

Dear Mr. Derksen:

Enclosed is **Environment Act Licence No. 3116** dated September 3, 2014 issued to **Agassiz Irrigation Association Inc.** for the construction and operation of the Development being the Hespler Kroeker irrigation project in the rural municipalities of Stanley, Thompson and Roland, with water from spring runoff on Shannon Creek and the Thornhill Coulee, in accordance with the Proposal filed under *The Environment Act* dated March 28, 2014, and additional information dated August 13, 2014.

In addition to the enclosed Licence requirements, please be informed that all other applicable federal, provincial and municipal regulations and by-laws must be complied with. A Notice of Alteration must be filed with the Director for approval prior to any alteration to the Development as licensed.

For further information on the administration and application of the Licence, please feel free to contact Tyler Kneeshaw, Environment Officer at 204-239-3608.

Pursuant to Section 27 of *The Environment Act*, this licensing decision may be appealed by any person who is affected by the issuance of this Licence to the Minister of Conservation and Water Stewardship within 30 days of the date of the Licence.

Yours truly,

"original signed by"

Tracey Braun, M.Sc.
Director
Environment Act

c: Don Labossiere, Director, Environmental Compliance and Enforcement Branch
Donna Smiley, Tyler Kneeshaw; Environmental Compliance and Enforcement Branch
Bruce Shewfelt, PBS Water Engineering Ltd; Public Registries

NOTE: Confirmation of Receipt of this Licence No. 3116 *(by the Licencee only)* is required by the Director of Environmental Approvals. Please acknowledge receipt by signing in the space provided below and faxing a copy (letter only) to the Department by September 17, 2014.

On behalf of Agassiz Irrigation Association Inc. **Date**

****A COPY OF THE LICENCE MUST BE KEPT ON SITE AT THE DEVELOPMENT AT ALL TIMES****

THE ENVIRONMENT ACT
LOI SUR L'ENVIRONNEMENT

LICENCE

Manitoba

Licence No. / Licence n° **3116**

Issue Date / Date de délivrance **September 3, 2014**

In accordance with *The Environment Act* (C.C.S.M. c. E125) /
Conformément à *la Loi sur l'environnement* (C.P.L.M. c. E125)

Pursuant to Section 11(1) / Conformément au Paragraphe 11(1)

THIS LICENCE IS ISSUED TO: / CETTE LICENCE EST DONNÉE À:

AGASSIZ IRRIGATION ASSOCIATION INC.;
"the Licencee"

for the construction and operation of the Development being the Hespler Kroeker irrigation project in the rural municipalities of Stanley, Thompson and Roland, with water from spring runoff on Shannon Creek and the Thornhill Coulee, in accordance with the Proposal filed under *The Environment Act* dated March 28, 2014, and additional information dated August 13, 2014, and subject to the following specifications, limits, terms and conditions:

GENERAL TERMS AND CONDITIONS

This Section of the Licence contains requirements intended to provide guidance to the Licencee in implementing practices to ensure that the environment is maintained in such a manner as to sustain a high quality of life, including social and economic development, recreation and leisure for present and future Manitobans.

1. The Licencee shall collect and dispose of all used oil products and other regulated hazardous wastes generated by the machinery used in the construction and operation of the Development in accordance with applicable Manitoba Conservation and Water Stewardship and legislation requirements.

2. The Licencee shall submit all information required to be provided to the Director or Environment Officer under this Licence, in writing, in such form (including number of copies) and of such content as may be required by the Director or Environment Officer, and each submission shall be clearly labeled with the Licence Number and Client File Number associated with this Licence.

3. The Licencee shall revegetate areas disturbed by the construction of the Development with a mixture of native or introduced grasses or legumes. These areas shall be revegetated as quickly as

possible following construction to prevent soil erosion and the establishment of noxious weeds. Native species shall be used to revegetate areas where native species existed prior to construction.

SPECIFICATIONS, LIMITS, TERMS AND CONDITIONS

Project Scope

4. The Licencee shall, unless otherwise approved by the Director in writing, construct the water diversion and management works and irrigate the lands as described on Figure 1, attached to this Licence. Proposed amendments to this project must be submitted to the Director for approval with an accompanying discussion of the nature and purpose of the amendments.

Construction

5. The Licencee shall, not less than two weeks prior to beginning construction of the Development, provide notification to the Environment Officer responsible for the administration of this Licence of the intended starting date of construction and the name of the contractor responsible for the construction.

6. The Licencee shall establish any fuel storage areas required for the construction and operation of the Development:
   a) a minimum distance of 100 metres from any waterbody unless double containment is provided; and
   b) in compliance with the requirements of *Manitoba Regulation 188/2001* respecting *Storage and Handling of Petroleum Products and Allied Products* or any future amendment thereof.

7. The Licencee shall, during construction of the Development, operate, maintain, and store all materials and equipment in a manner that prevents any deleterious substances (fuel, oil, grease, hydraulic fluids, coolant, etc.) from entering any waterbodies, and have an emergency spill kit for in-water use available on site during construction.

8. The Licencee shall, in the case of physical or mechanical equipment breakdown or process upset where such breakdown or process upset results or may result in the release of a pollutant in an amount or concentration, or at a level or rate of release, that causes or may cause a significant adverse effect, immediately report the event by calling 204-944-4888 (toll-free 1-855-944-4888). The report shall indicate the nature of the event, the time and estimated duration of the event and the reason for the event.

9. The Licencee shall, following the reporting of an event pursuant to Clause 8:
   a) identify the repairs required to the mechanical equipment;
   b) undertake all repairs to minimize unauthorized discharges of a pollutant;
   c) complete the repairs in accordance with any written instructions of the Director; and
   d) submit a report to the Director about the causes of breakdown and measures taken, within one week of the repairs being done.

10. The Licencee shall dispose of non-reusable construction debris and solid waste from the construction and maintenance of the Development at a waste disposal ground operating under the authority of a permit issued under *Manitoba Regulation 150/91* respecting *Waste Disposal Grounds* or any future amendment thereof, or a licence issued pursuant to *The Environment Act*.

11. The Licencee shall not remove, destroy or disturb species listed as rare, endangered, or of special concern, or their habitats. These species are listed in *Manitoba Regulation 25/98* respecting *Threatened, Endangered and Extirpated Species* or any future amendment thereof, and in the federal Species at Risk Act.

12. The Licencee shall, during construction of the Development, take all appropriate measures to prevent erosion and the deposition of sediment into waterways.

13. The Licencee shall not undertake instream construction activities in connection with the Development between April 1 and June 30 of any year.

14. The Licencee shall not undertake instream construction activities in connection with the Development during periods of high streamflow.

15. The Licencee shall install buried pipelines on cultivated land or land in its natural state in accordance with the methodology illustrated in Figures 2 to 4, attached to this Licence. These procedures do not apply when a plough, continuous trencher or directional drill is used to install a pipeline.

Operation – Matters Respecting Water Management and Water Quality Protection

16. The Licencee shall screen the pump intakes associated with the Development in accordance with the Department of Fisheries and Oceans publication "Freshwater Intake End-of-Pipe Fish Screen Guideline" (March, 1995).

17. The Licencee shall alter the screens on the pump intakes associated with the Development if future research indicates that different design criteria are appropriate with respect to water withdrawals prior to July 1 of any year.

18. The Licencee shall divert water into the reservoirs of the Development at the diversion points on Shannon Creek in NW 3-4-5W (Site C) and on the Thornhill Coulee in SW 34-3-5W (Site A) and E 32-3-5W (Site B) as specified in Water Rights Licences issued for the Development by Manitoba Conservation and Water Stewardship.

19. The Licencee shall, on a daily basis while diverting water into the reservoirs of the Development, record volumes and rates of water pumped, and durations of pumping.

20. The Licencee shall, on a daily basis while irrigation of the Development is occurring, record volumes and rates of water pumped, and durations of pumping.

21. The Licencee shall install backflow prevention devices and maintain them in operational condition at all times if fertilizer or crop protection products are applied through the irrigation systems of the Development.

22. The Licencee shall, if fertilizer or crop protection products are applied through the irrigation systems of the Development, not allow irrigation water containing these materials to be applied to or drain to surface water bodies.

23. The Licencee shall comply with the requirements of *Manitoba Regulation 62/2008*, respecting *Nutrient Management* or any future amendment thereof.

24. The Licencee shall not apply nutrients within eight metres of Nutrient Buffer Zones, including roadside ditches and drains.

Operation – Matters Respecting Land Management and Soil Quality Protection

25. The Licencee shall manage phosphorus as well as nitrogen in all nutrient management plans developed pursuant to Clause 26 of this Licence.

26. The Licencee shall implement agronomic practices described in the following documents:
    a) Section 6.3 of the Environment Act Proposal;
    b) "Land Assessment Reports for the Hespler Kroeker Irrigation Development Project" prepared by Stantec Consulting Ltd., May 27, 2014; and
    c) "Draft Best Management Practices Manual 1999" by the Central Manitoba Irrigators Association and Central Manitoba Resource Management Ltd., concerning general agronomic practices, or future versions thereof.

Monitoring

27. The Licencee shall, upon the request of the Director:
    a) sample, monitor, analyze or investigate specific areas of concern regarding groundwater, surface water and soil for such duration and at such frequencies as may be specified;
    b) determine the environmental impact associated with the specific areas of concern;
    c) conduct specific investigations in response to the data gathered during environmental monitoring programs; or
    d) provide the Director, within such time as may be specified, with such reports, drawings, specifications, analytical data, descriptions of sampling and analytical procedures being used, and such other information as may from time to time be requested.

28. The Licencee shall provide an annual report on monitoring for the Development, including the information required in Clauses 19 and 20 of this Licence, as well as soil test results, nutrient application information, and tile drainage quantity and quality information. The annual report shall be provided, by March 1 of the following year, to the Environment Officer responsible for the administration of this Licence and the Environmental Approvals Branch. The report shall be provided in a format approved by the Environment Officer.

29. The Licencee shall, prior to the commencement of operation of the Development, meet with the Environment Officer responsible for the administration of this Licence and the contact person for the Environmental Approvals Branch of Manitoba Conservation and Water Stewardship to review the monitoring and reporting requirements of this Licence.

REVIEW AND REVOCATION

A. If, in the opinion of the Director, the Licencee has exceeded or is exceeding or has or is failing to meet the specifications, limits, terms, or conditions set out in this Licence, the Director may, temporarily or permanently, revoke this Licence.

B. If construction of the development has not commenced within three years of the date of this Licence, the Licence is revoked.

C. If, in the opinion of the Director, new evidence warrants a change in the specifications, limits, terms or conditions of this Licence, the Director may require the filing of a new proposal pursuant to Section 11 of *The Environment Act.*

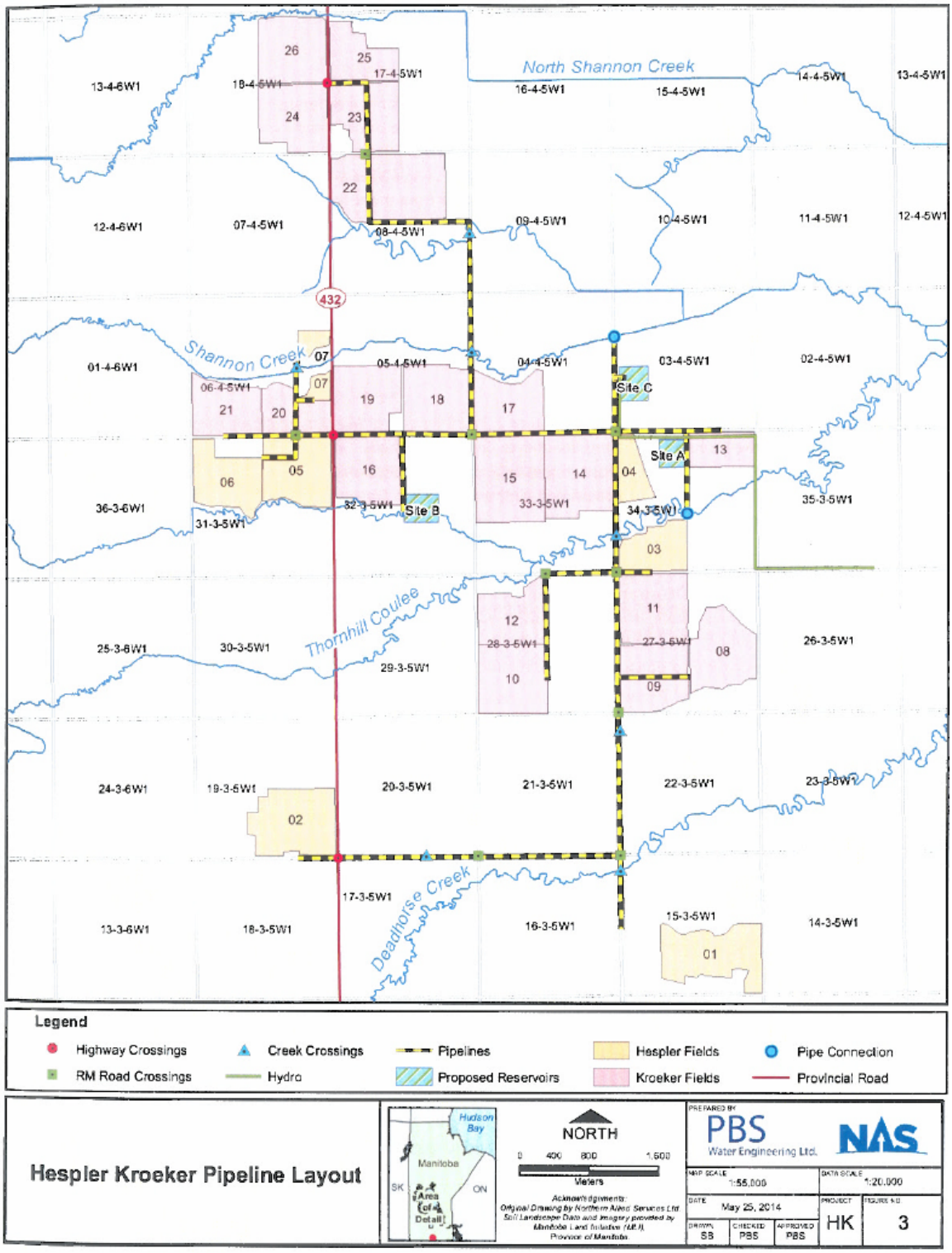
"original signed by"

Tracey Braun, M.Sc.
Director
Environment Act

Client File: 5720.00

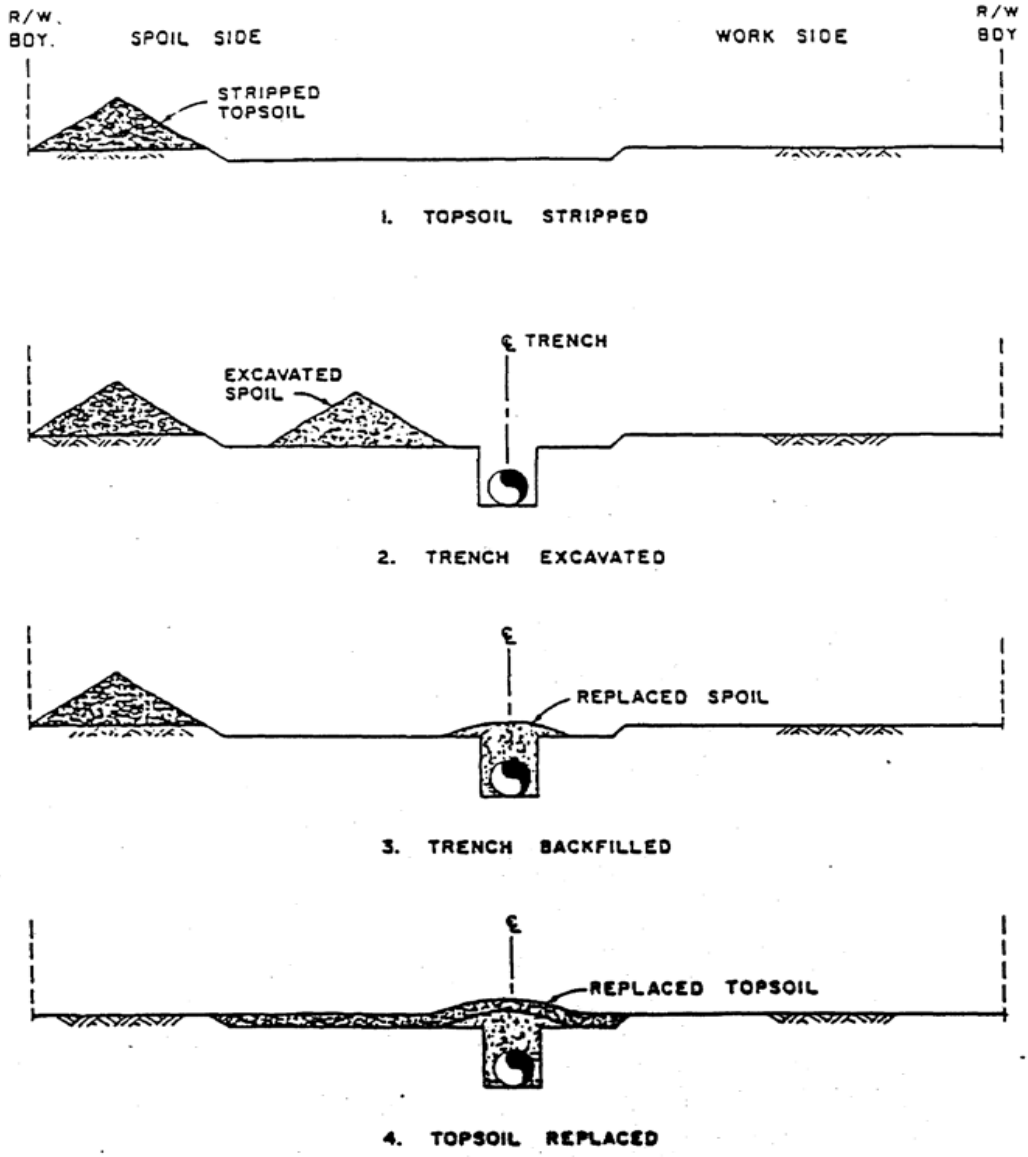
Figure 1 to Environment Act Licence No. 3116

Agassiz Irrigation Association Inc. - Hespler Kroeker Irrigation Project



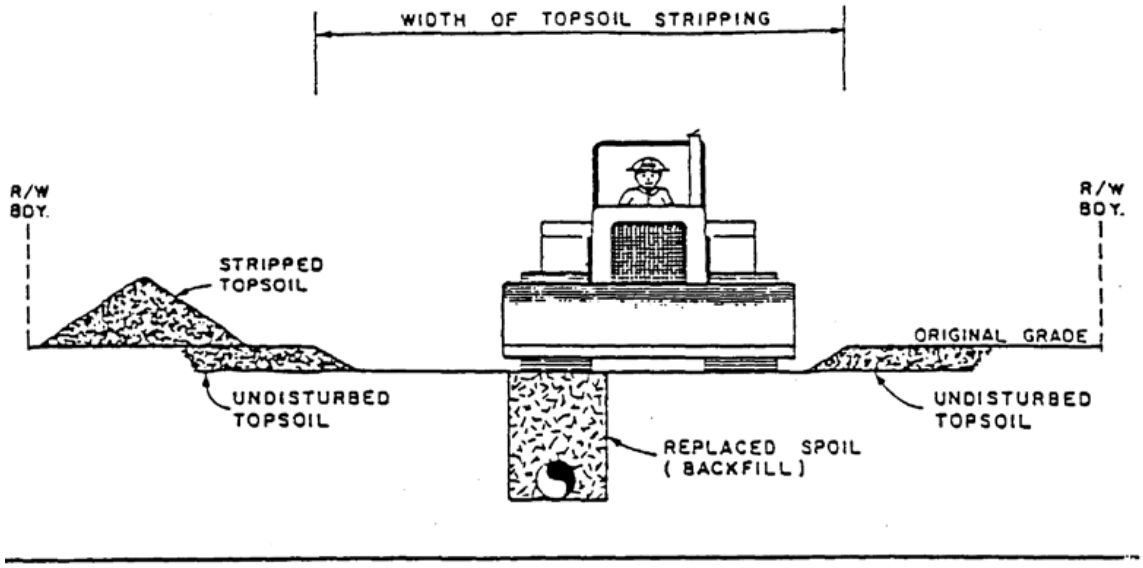
** A COPY OF THIS LICENCE MUST BE KEPT ON SITE AT THE DEVELOPMENT AT ALL TIMES **

Figure 2 to Environment Act Licence No. 3116



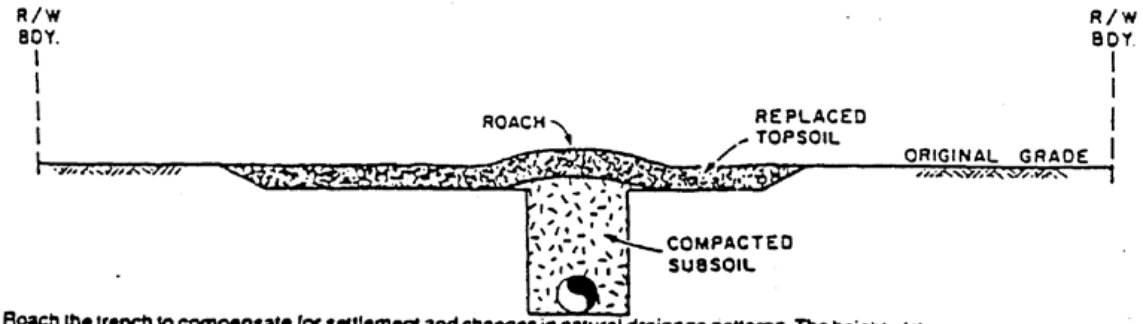
SEQUENCE OF TOPSOIL HANDLING

Figure 3 to Environment Act Licence No. 3116



COMPACTION OF BACKFILL

Figure 4 to Environment Act Licence No. 3116



Roach the trench to compensate for settlement and changes in natural drainage patterns. The height of the roach depends upon land use, the degree of compaction achieved.

ROACHING THE TRENCH

Manitoba

Conservation

Environmental Stewardship Division

123 Main Street, Suite 160
Winnipeg MB R3C 1A5
CANADA

Fax: (204) 945-5229

Internet: http://www.gov.mb.ca/environ

FAXED
CLIENT FILE NO.: 4542.00

COPY

September 15, 2000

Doug Smallwood
Agassiz Resource Management Ltd.
PO Box 750
Winkler MB R6W 4A8

Dear Mr. Smallwood:

Enclosed is Environment Act **Licence No. 2480** dated September 15, 2000 issued in accordance with the Manitoba Environment Act to **Agassiz Resource Management Limited** in connection with the construction and operation of the Development being an irrigation reservoir in SW 11-4-5W in the Rural Municipality of Roland, in accordance with the Proposal filed under The Environment Act dated July 31, 2000.

In addition to the enclosed Licence requirements, please be informed that all other applicable federal, provincial and municipal regulations and by-laws must be complied with.

For further information on the administration and application of the Licence, please feel free to contact Glenn Ritchie at 325-1753.

Pursuant to Section 27 of The Environment Act, this licencing decision may be appealed by any person who is affected by the issuance of this Licence to the Minister of Conservation within 30 days of the date of the Licence.

Yours truly,

Larry Strachan, P. Eng.
Director
Environment Act

Enc.

c: L. MacCallum/attn: G. Ritchie, South-Central Region, Conservation
Centennial Public Library/Manitoba Eco-Network/South Central Regional Library
R.M. of Roland
D. Menon, Manitoba Water Services Board

NOTE: Confirmation of Receipt of this Licence *(by the Licencee only)* is required by the Director of Approvals. Please acknowledge receipt by signing in the space provided below and faxing back to the Department by September 22, 2000.

On behalf of Agassiz Resource Management Ltd. **Date**

Environment Act Licence
Loi sur l'environnement Licence

Manitoba Conservation
Conservation Manitoba

Licence No./Licence n° 2480

Issue Date/Date de délivrance September 15, 2000

IN ACCORDANCE WITH THE MANITOBA ENVIRONMENT ACT (C.C.S.M. c. E125) THIS LICENCE IS ISSUED PURSUANT TO SECTION 11(1) TO:

AGASSIZ RESOURCE MANAGEMENT LIMITED; "the Licencee"

for the construction and operation of the Development being an irrigation reservoir in SW 11-4-5W in the Rural Municipality of Roland, in accordance with the Proposal filed under The Environment Act dated July 31, 2000, and subject to the following specifications, limits, terms and conditions:

GENERAL TERMS AND CONDITIONS

This Section of the Licence contains requirements intended to provide guidance to the Licencee in implementing practices to ensure that the environment is maintained in such a manner as to sustain a high quality of life, including social and economic development, recreation and leisure for present and future Manitobans.

1. The Licencee shall ensure that all used oil products and other regulated hazardous wastes generated by the machinery used in the construction and operation of the Development are collected and disposed of in accordance with applicable Manitoba Conservation and legislation requirements.

2. The Licencee shall revegetate areas disturbed by the construction of the Development with a mixture of native or introduced grasses or legumes. These areas shall be revegetated as quickly as possible following construction to prevent soil erosion and the establishment of noxious weeds. Native species shall be used to revegetate areas where native species existed prior to construction.

3. The Licencee shall:
   a) prepare "As Constructed" drawings for the Development and shall label the drawings "As Constructed"; and
   b) provide to the Director, within three months of the completion of construction of the Development, two sets of "As Constructed" drawings.

SPECIFICATIONS, LIMITS, TERMS AND CONDITIONS

Construction

4. The Licencee shall, prior to beginning construction of the Development, provide four copies of detailed construction plans for the approval of the Director.

5. The Licencee shall provide notification to the Environment Officer responsible for the administration of this Licence not less than two weeks prior to beginning construction of the Development of the intended starting date of construction and the name of the contractor responsible for the construction.

6. The Licencee shall ensure that fuel storage areas established for the construction of the Development:
   a) are located a minimum distance of 100 metres from any waterbody; and
   b) comply with the requirements of ***Manitoba Regulation 97/88R*** respecting ***Storage and Handling of Gasoline and Associated Products.***

7. The Licencee shall not undertake instream construction activities in connection with the Development between April 1 and June 15 of any year.

8. The Licencee shall not undertake instream construction activities in connection with the Development during periods of high streamflow.

9. The Licencee shall ensure that buried pipelines which are installed on cultivated land or land in its natural state are installed in accordance with the methodology illustrated in Figures 1 to 3, attached to this Licence. These procedures do not apply when a plough or a continuous trencher is used to install a pipeline.

Operation – Matters Respecting Water Management and Water Quality Protection

10. The Licencee shall, during operation of the Development, take all precautions necessary to prevent fuel from entering any waterbody. Diesel pump units, other than tractors, shall be placed on drip trays and all fuel tanks, other than those on tractors, shall be double walled or contained in larger non drainable containers. Fuel spills in excess of 100 litres shall be immediately reported to an Environment Officer.

11. The Licencee shall ensure that pump intakes associated with the Development are screened, if necessary, in accordance with the Department of Fisheries and Oceans publication "Freshwater Intake End-of-Pipe Fish Screen Guideline" (March, 1995). Final screen designs shall be approved by the Department of Fisheries and Oceans prior to the operation of the Development.

12. The Licencee shall ensure that a minimum instream flow is maintained below the diversion point of the Development at all times while water is being diverted into the Development. The minimum instream flow at the diversion point shall be as determined by Manitoba Conservation and specified in a Water Rights Licence issued for the Development.

13. The Licencee shall immediately cease diverting water from Shannon Creek or reduce the diversion rate if the minimum instream flow provided for in Clause 12 of this Licence is not equalled or exceeded.

14. The Licencee shall, on a daily basis while irrigation is occurring from the Development, record volumes of water pumped, and durations of pumping. A report on this information shall be provided, by March 1 of the following year, to the Environment Officer responsible for the administration of this Licence, the Environmental Approvals Branch, and the Water Resources Branch of Manitoba Conservation. The report shall be provided in the format shown in Table 1, attached to this Licence.

15. The Licencee shall ensure that backflow prevention devices are installed and are operational at all times if fertilizer or crop protection products are applied through the irrigation systems of the Development.

Operation – Matters Respecting Land Management and Soil Quality Protection

16. The Licencee shall ensure that irrigation does not occur, with water diverted by the Development, on a land parcel other than a land parcel identified in the Environment Act Proposal, dated July 31, 2000.

Monitoring

17. The Licencee shall provide a listing of annual groundwater, surface water and soil monitoring activities to be carried out for the Development. The plan shall include a monitoring schedule, and shall be provided to the Director for approval by May 1, 2001.

18. The Licencee shall, prior to the commencement of operation of the Development, meet with the Environment Officer responsible for the administration of this Licence and the contact person for the Environmental Approvals Branch of Manitoba Conservation to review the monitoring and reporting requirements of this Licence.

19. The Licencee shall, on an annual basis, undertake the monitoring plan approved by Clause 17 of this Licence. A report summarizing the monitoring results for the previous year shall be submitted to the Director by March 1 of each year.

REVIEW AND REVOCATION

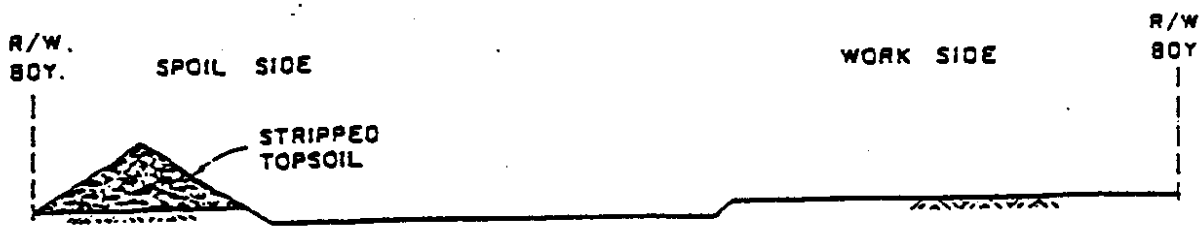
A. If, in the opinion of the Director, the Licencee has exceeded or is exceeding or has or is failing to meet the specifications, limits, terms, or conditions set out in this Licence, the Director may, temporarily or permanently, revoke this Licence.

B. If construction of the development has not commenced within three years of the date of this Licence, the Licence is revoked.

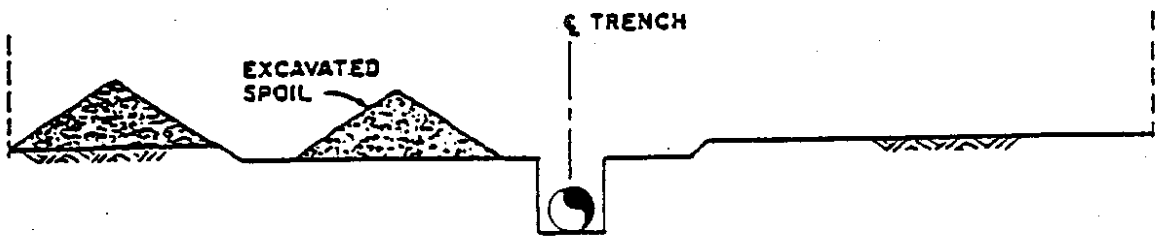
C. If, in the opinion of the Director, new evidence warrants a change in the specifications, limits, terms or conditions of this Licence, the Director may require the filing of a new proposal pursuant to Section 11 of The Environment Act.

Larry Strachan, P. Eng.
Director
Environment Act

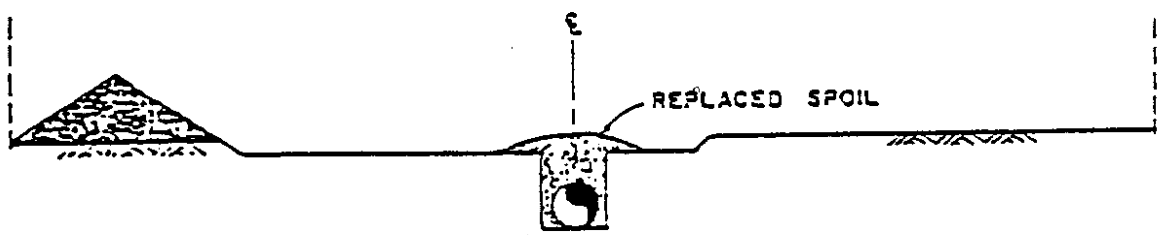
Client File: 4542.00



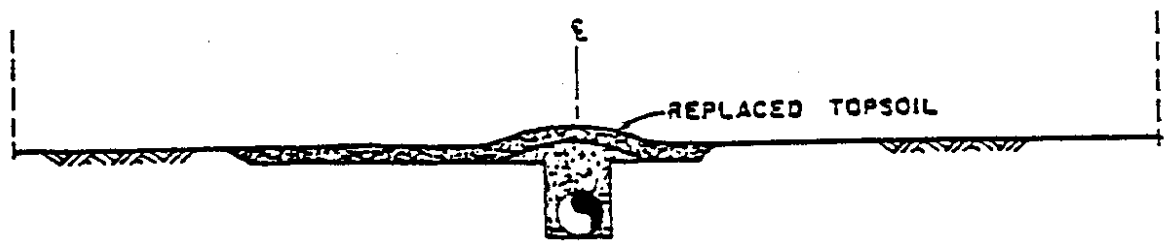
1. TOPSOIL STRIPPED



2. TRENCH EXCAVATED



3. TRENCH BACKFILLED

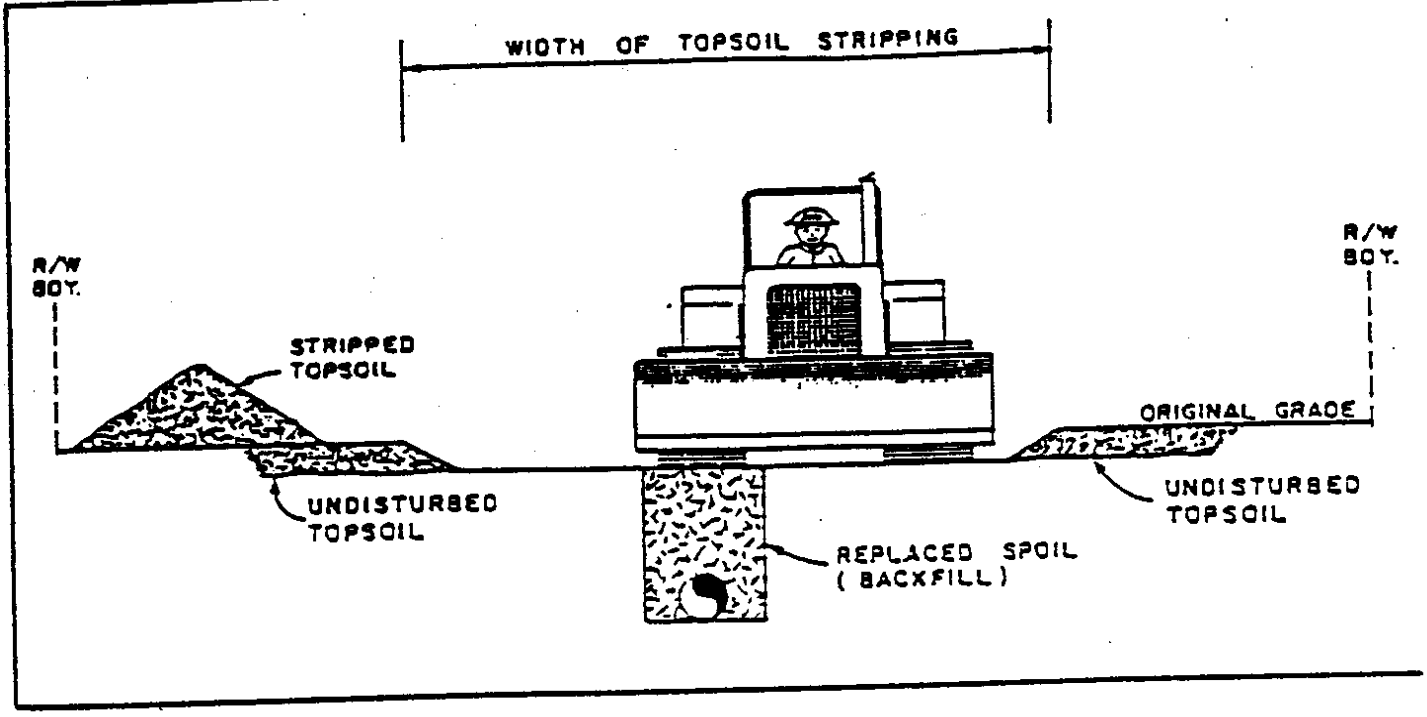


4. TOPSOIL REPLACED

SEQUENCE OF TOPSOIL HANDLING

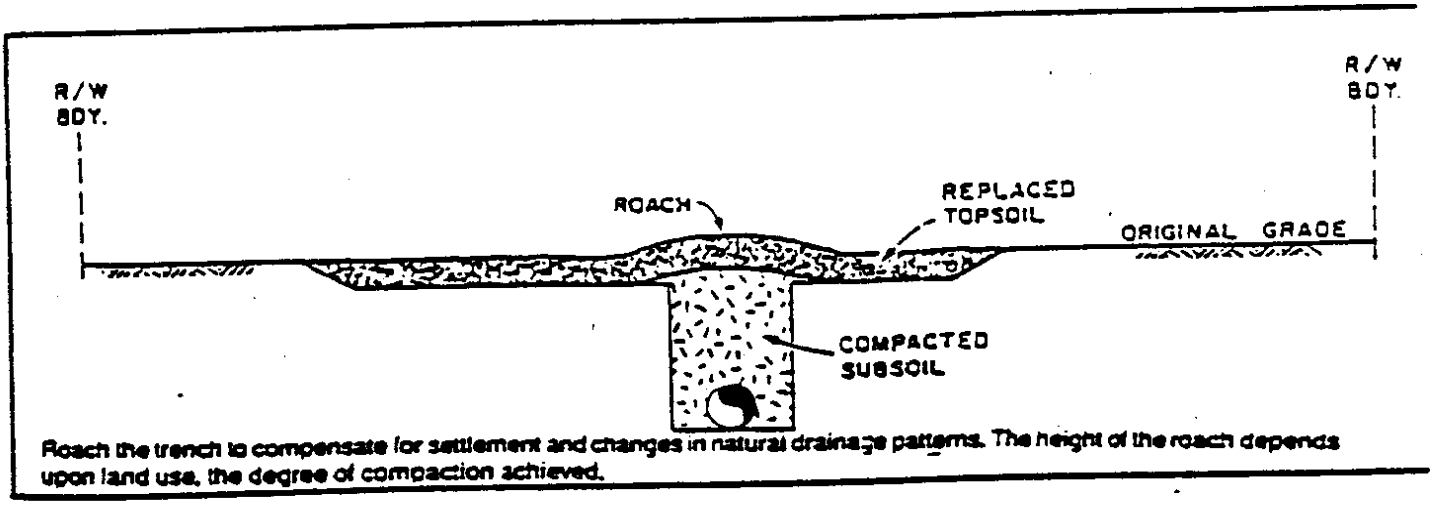
Figure 1

To Environment Act Licence No. 2480



COMPACTION OF BACKFILL

Figure 2



Roach the trench to compensate for settlement and changes in natural drainage patterns. The height of the roach depends upon land use, the degree of compaction achieved.

ROACHING THE TRENCH

Figure 3

Table 1
To Environment Act Licence No. 2480

Agassiz Resource Management Ltd. - Shannon Creek Reservoir SW11-4-5W

Year: _____

Dugout capacity: _____ dam3 or acre-feet
Operator: _____
Pump Capacity: Filling: _____ m3/s or cfs
Use: _____ m3/s or cfs
Minimum instream flow: _____ m3/s or cfs
MIF Monitoring Location: _____

Notes:

1. d/s Q - Flow measured at downstream point of interest (specify _____)
   or downstream of pump intake _____
2. Elevation - dugout elevation (Geodetic - metres)
3. Volume Pumped - as measured by change in reservoir elevation _____
   or pumping rate x time pumped _____

1. Filling

Day	Date	d/s Q (1)	Elevation (2)	Hours Pumped	Vol. Pumped (3)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
Total				0.00	0.00

Table 1
To Environment Act Licence No. 2480

2. Use						
Day	Date		Elevation (2)	Hours Pumped	Vol. Pumped (3)	
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
Total				0.00	0.00	
3. Other Monitoring						
Specify other monitoring carried out at this site: seepage, salinity, flow, etc.						

SUMMARY OF COMMENTS/RECOMMENDATIONS

PROPONENT:	**Agassiz Resource Management Limited**
PROPOSAL NAME:	**Shannon Creek Irrigation Reservoir**
CLASS OF DEVELOPMENT:	**Two**
TYPE OF DEVELOPMENT:	**Water Development and Control**
CLIENT FILE NO.:	**4542.00**

OVERVIEW:

The Proposal was received on July 31, 2000. It was dated July 31, 2000. The advertisement of the proposal was as follows:

"A Proposal has been filed by Agassiz Resource Management Ltd. (a holding company formed by the Agassiz Irrigation Association) to develop an irrigation reservoir adjacent to Shannon Creek in SW 11-4-5W in the Rural Municipality of Roland. The reservoir would be a replacement water source for the adjacent irrigation operation which has previously used the Winkler Aquifer as a water source. The capacity of the reservoir would be 160 acre-feet, and it would be filled from spring runoff in Shannon Creek. Construction is proposed for the fall of 2000."

The Proposal was advertised in the Winkler Times on Monday, August 14, 2000. It was placed in the Main, Centennial, Eco-Network and South Central Regional Library (Morden) public registries. It was distributed to TAC members on August 4, 2000. The closing date for comments from members of the public and TAC members was August 28, 2000.

COMMENTS FROM THE PUBLIC:

No public comments were received.

COMMENTS FROM THE TECHNICAL ADVISORY COMMITTEE:

Manitoba Conservation - Water Quality Management Although the project description indicates that there will be a minimum 10 metre riparian zone setback from Shannon Creek to the toe of the reservoir, the Appendix includes an illustration of the reservoir location as being in the creek. Provided that the minimum 10 m setback from

the high water mark of Shannon Creek is adhered to, then the proposal appears to be a preferable alternative to using groundwater for irrigation purposes. Providing that the reservoir is filled during spring runoff as indicated in the proposal, then the water quality for irrigation purposes should be better than that of groundwater. However, it should be noted that evapotranspiration over the summer will increase the concentration of total dissolved solids and salts relative to concentrations noted for data collected in April.

…/2

Disposition:

Discussions with the Proponent indicate that the reservoir would be an off-channel water storage facility. The approval of plans prior to construction can be required as a licence condition. The comment regarding summer water quality will be brought to the attention of the proponent for information and monitoring.

Manitoba Conservation - Terrestrial Quality Management Is this area going to be surveyed to see if there are any undisturbed areas and, if so, will these areas be assessed for rare and endangered floral and fauna species? As there are little riparian areas left and what is left is important, the construction work should attempt to keep the disturbance to a minimum. Finally, if possible, use native grass seed when seeding the flat slopes of the reservoir.

Disposition:

The project site was inspected on August 30, 2000. The area is a heavily grazed pasture with a willow grove on the eastern side. There is no undergrowth in the willow grove and only grass in the riparian zone of the stream, which is channelized and dry in this reach. Accordingly, no further assessment of flora and fauna is needed. The proposed setback of 10m will provide adequate protection to the creek to prevent sedimentation during construction. The comment about seeding with native grass seed can be addressed as a licence condition.

Manitoba Conservation – Policy Coordination This proposal does not cumulatively review the proposed water withdrawal in light of other licenced and pending allocations of water from Shannon Creek and the downstream minimum flow requirements for fisheries and other riparian needs. The proposal concludes that although there is good to excellent flows, the fish habitat is limited. This conclusion does not take into consideration the value of the habitat if fish were able to access the area. Input is needed from the Department of Fisheries and Oceans on the screening of the water intake.

Disposition:

The Water Resources Branch is in the process of completing a cumulative assessment of water withdrawals from Shannon Creek in connection with the project. It is anticipated that the assessment will be completed by mid-September, 2000, and that the requested allocation would be available. Instream flow requirements will be specified in a Water Rights Licence for the project. This matter can be addressed in an Environment Act Licence through a standard licence condition. With respect to fish habitat, a site visit indicates that the waterway is frequently dry, and the reach of interest is heavily pastured.

It is unlikely that access would be provided further downstream to allow fish movement into a low value reach of a highly intermittent stream. DFO comments on fish screening follow below.

Historic Resources Branch No concerns.

Mines Branch No concerns.

Highway Planning and Design No concerns.

Canadian Environmental Assessment Agency An environmental assessment under The Canadian Environmental Assessment Act will be conducted by PFRA. Environment Canada, and Health Canada have offered to provide specialist advice in accordance with Section 12(3) of the Act. Fisheries and Oceans has requested more information prior to making their determination.

Fisheries and Oceans Additional information is required – there are possible intake screening needs, detailed construction drawings were not provided, instream works may or may not occur, clarification is required respecting the cumulative water allocation, instream flow needs have not been determined, erosion and sediment control planning is not complete, and possible flow regime changes have not been described.

Disposition:

Some of the requested information will be addressed in final construction drawings. The remainder can be addressed as licence conditions. With respect to intake screening, it is believed that the project location is well upstream of the fisheries area of interest. DFO has jurisdiction over intake screens, so will approve any necessary screen design directly.

PUBLIC HEARING:

As no public comments were received, a public hearing is not recommended.

RECOMMENDATION:

All comments received on the Proposal can be addressed as licence conditions. Therefore, it is recommended that the Development be licensed under The Environment Act subject to the limits, terms and conditions as described on the attached Draft Environment Act Licence. It is further recommended that enforcement of the Licence be assigned to the South-Central Region.

PREPARED BY:

Bruce Webb
Environmental Approvals - Environmental Land Use Approvals
September 11, 2000

Telephone: (204) 945-7021
Fax: (204) 945-5229
E-mail Address: bwebb@gov.mb.ca

Environment Act Licence

Manitoba Environment

Licence No. 2093

Issue Date August 22, 1995

In accordance with the Manitoba Environment Act (C.C.S.M. c. E125)

THIS LICENCE IS ISSUED TO:

AGASSIZ IRRIGATION ASSOCIATION INCORPORATED:
"the Licencee"

for the construction and operation of the Development being fifteen water storage dugouts and related intake and outlet works for irrigation water supply in various locations on the Hespeler, North Rosenheim, South Rosenheim, and Buffalo drains and Buffalo Creek in the Rural Municipalities of Rhineland and Stanley, subject to the following specifications, limits, terms and conditions:

SPECIFICATIONS, LIMITS, TERMS AND CONDITIONS

1. The Licencee shall construct and operate the Development in accordance with The Environment Act Proposal dated May 17, 1995 and the supplementary information submitted to Manitoba Environment on July 27, 1995, except as otherwise required by this Licence.

2. The Licencee shall ensure that no construction occurs at the S15 site in SW 32-2-3W unless specific written authorization has been received from the Director. The Licencee shall provide, at the time of application for approval to construct a dugout and related works at this site, letters from affected landowners indicating their agreement with proposed design details.

3. The Licencee shall submit, for the approval of the Director, detailed construction plans prepared by a professional engineer for each site prior to beginning construction at each site.

4. The Licencee shall consult with regional staff of Manitoba Natural Resources in the design of the engineered works of the Development. Design features included as a result of these consultations shall be noted on the detailed construction plans.

5. The Licencee shall incorporate recommendations of Manitoba Highways and Transportation in the design of works at the E8A site in SW 10-1-4W, the S14 site in SE 2-2-3W and the S11b site in SE 26-1-3W.

6. The Licencee shall not undertake construction activities at any site until that site has been examined by staff of the Historic Resources Branch. The Licencee shall follow the directions of the Historic Resources Branch respecting archaeological resources found at any site.

7. The Licencee shall obtain authorization from the Manitoba Water Resources Branch for works undertaken on Provincial Waterways.

8. The Licencee shall not undertake construction activities which may result in siltation or sediment deposition on or immediately adjacent to waterways between April 1 and June 15 of any year.

9. The Licencee shall ensure that measures are taken during the construction of the Development to minimize the deposition of sediment in waterways.

10. The Licencee shall plant dykes, stream banks and other areas disturbed by the construction of the Development with varieties of native or domestic grass and forb mixes. Species chosen shall be capable of rapid revegetation.

11. The Licencee shall submit "as built" drawings of each component of the Development to the Director following construction.

12. The Licencee shall ensure that the capacity of pumps used to divert water into the Development does not exceed 0.75 m^3/s at each site with a storage capacity less than 125 cubic decametres. Pumping capacity shall not exceed 1.5 m^3/s at sites with storage capacities of 125 to 313 cubic decametres, and pumping capacities shall not exceed 2.25 m^3/s at sites with storage capacities greater than 313 cubic decametres.

13. The Licencee shall ensure that minimum instream flows are maintained in each waterway below the diversion points of the Development at all times while water is being diverted into the Development. These minimum instream flows (including allowances for domestic use as noted) shall be:

- Hespeler Drain: 0.36 m^3/s below the S15 site in SW 32-2-3W
- Rosenheim Drain: 0.18 m^3/s (including 0.05 m^3/s domestic) below the S16 site in NE 5-2-3W
- Buffalo Drain: 0.09 m^3/s (including 0.05 m^3/s domestic) below the S14 site in SE 2-2-3W
- Buffalo Creek: 0.40 m^3/s below the S11F site in SE 29-1-2W

Prior written approval from the Director shall be required to reduce these flows.

14. The Licencee shall ensure that buried pipelines which are installed on cultivated land or land in its natural state are installed in accordance with the methodology illustrated in Figures 1 to 3, attached to this Licence.

15. The Licencee shall monitor instream flows, seepage from reservoirs, and land impacts as proposed. All data shall be forwarded to Manitoba Environment, Manitoba Natural Resources, the Prairie Farm Rehabilitation Administration and the Department of Fisheries and Oceans. Data required on an annual basis shall be submitted prior to March 1 of the following year.

16. The Licencee, shall, at the request of the Director, prepare and implement a remediation plan to address seepage from the Development if monitoring results indicate that seepage losses substantially exceed anticipated amounts.

17. The Licencee shall on a daily basis monitor streamflows, diversion rates and pumping durations when dugout filling is occurring. Dugout water levels and pumping rates and durations shall be monitored when water is being used from the dugouts. An annual report on this operating data for each dugout shall be provided to Manitoba Environment, Manitoba Natural Resources, the Prairie Farm Rehabilitation Administration and the Department of Fisheries and Oceans. This report shall be submitted prior to March 1 of the following year.

18. The Licencee shall ensure that all used oil products and other regulated hazardous wastes generated by the machinery used in the construction and operation of the Development are collected and disposed of in accordance with applicable Manitoba Environment and legislative requirements.

19. The Licencee shall ensure that fuel storage areas established for the construction and operation of the Development shall comply with the requirements of ***Manitoba Regulation 97/88R*** respecting ***Storage and Handling of Gasoline and Associated Products.***

REVOCATION

If, in the opinion of the Director, the Licencee has exceeded or is exceeding the limits, or has not complied or is not complying with the specifications, terms or conditions set out herein, the Director may revoke this Licence either temporarily or permanently.

Larry Strachan, P. Eng.
Director
Environment Act

File No: 3636.20

APPENDIX D – CORRESPONDENCE TO MANITOBA HISTORIC RESOURCES BRANCH

From:	shewfelt@mymts.net
To:	"Sitchon, Myra (INR)"
Cc:	"Tsukamoto, Suyoko (SCH)"; "David Whetter"
Subject:	RE: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts
Date:	June 6, 2018 10:11:30 AM

Hello Suyoko. Just confirming you have received this request. Just to let you know we are submitting Environment Act Proposal tomorrow, and will reference this contact, and certainly look forward to your feedback during the project review process.

Please feel free to call if any questions.

Regard

Bruce Shewfelt, P.Eng.
PBS Water Engineering Ltd.

From: Sitchon, Myra (INR) <Myra.Sitchon@gov.mb.ca>
Sent: May 25, 2018 2:42 PM
To: shewfelt@mymts.net
Cc: Tsukamoto, Suyoko (SCH) <Suyoko.Tsukamoto@gov.mb.ca>
Subject: Fwd: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts

Hello Bruce,
I'm no longer with HRB. I've forwarded your email to Suyoko Tsukamoto who will be able to assist you.
Have a good weekend.
Myra

Myra Sitchon, *Ph.D.*
Manager of Indigenous Policy, Programs and Community Initiatives Unit

Policy and Strategic Initiatives Branch,
Manitoba Indigenous and Northern Relations
300-352 Donald Avenue
Winnipeg, MB R3B 2H8

Email: myra.sitchon@gov.mb.ca
Phone: (204) 792-7592
Fax: (204-945-3689

Please Note: Effective October 16, 2017, our offices have relocated to 300 – 352 Donald Street, Winnipeg MB

Sent from my iPhone

Begin forwarded message:

From: "shewfelt@mymts.net" <shewfelt@mymts.net>
To: "Sitchon, Myra (INR)" <Myra.Sitchon@gov.mb.ca>, "Friesen, Chris (SD)" <Chris.Friesen@gov.mb.ca>
Cc: "Webb, Bruce (SD)" <Bruce.Webb@gov.mb.ca>, "'Frank Elias'" <Frank@kroekers.com>, "'Wayne'" <wayne@hesplerfarms.com>, "'David Whetter'" <david.whetter@agriearth.ca>, "Butterfield, Tamara (SD)" <Tamara.Butterfield@gov.mb.ca>
Subject: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts

Dear Myra and Chris:

PBS Water Engineering Ltd. is working on a project for Thornhill Irrigation Ltd. (joint venture of Kroeker Farms Ltd and Hespler Enterprises Ltd.). The project will involve the construction of two irrigation ponds (T1 – West Tobacco Creek ; T2 – South Tobacco Creek) for purpose of storing spring snowmelt and rainfall runoff water, for later application to their potato fields to reduce moisture stress.

The reservoir sizes will trigger the need for a Environment Act License. PBS Water Engineering Ltd. with consultation from AgriEarth Consulting Ltd. will be filing an Environment Act Proposal for the project.

One of the requirements is to do a search of Manitoba Sustainable Development and Heritage Resources data bases for occurrences of rare and endangered species and/or historic resources.

A total of 8 sites are being considered for the two reservoirs locations. The attached map of the potential areas to be investigated in the next three weeks for technical suitability associated with engineering and geology considerations (e.g. clay soils). Land locations are shown on the maps.

All sites with the exception of an alternative to the T2-Option 1; are to be be fully developed on currently cultivated land. It is not clear if T2 – Option 1 will even proceed at this time. Water will be withdrawn from the South Tobacco Creek and West Tobacco Creek using temporary pumping equipment (e.g. PTO pumps and tractors), approximate locations shown on the water allocation map.

The foot print of T1 will be approximately 10 – 12 acres. The foot print of T2 will be 40 – 50 acres.

The South Tobacco Creek and West Tobacco Creeks are in the upper watershed and are fed by flashy spring runoff from the Manitoba Escarpment; these streams are intermittent; drying up in the summer and fall; except during extreme rainfall events. South Tobacco Creek is channelized along the southern extent of the project.

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 feel free to call to discuss any questions or concerns.

Regards

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

CC: Wayne Derksen, Frank Elias, David Whetter, Bruce Webb, Tamara Butterfield

APPENDIX E - CORRESPONDENCE TO MANITOBA CONSERVATION DATA CENTER

David Whetter

From: Bruce Shewfelt <shewfelt@mymts.net>
Sent: June 8, 2018 7:29 AM
To: David Whetter
Subject: Fwd: RE: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts

---------- Forwarded message ----------
From: "Friesen, Chris (SD)" <Chris.Friesen@gov.mb.ca>
Date: Jun 7, 2018 8:26 AM
Subject: RE: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts
To: "'shewfelt@mymts.net'" <shewfelt@mymts.net>
Cc:

Bruce

Thank you for your information request. I completed a search of the Manitoba Conservation Data Centre's rare species database and found no occurrences at this time for your area of interest.

The information provided in this letter is based on existing data known to the Manitoba Conservation Data Centre 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 in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present**; in many areas, comprehensive surveys have never been completed. Therefore, this information should be regarded neither as a final statement on the occurrence of any species of concern, nor as a substitute for on-site surveys for species as part of environmental assessments.

Because the Manitoba CDC's 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 pass before it is utilized.

Third party requests for products wholly or partially derived from Biotics 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 Biotics data, as follows as: Data developed by the Manitoba Conservation Data Centre; Wildlife & 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 please contact me directly at (204) 945-7747.

Chris Friesen

Coordinator

Manitoba Conservation Data Centre

204-945-7747

chris.friesen@gov.mb.ca

http://www.manitoba.ca/sd/cdc/

From: shewfelt@mymts.net [mailto:shewfelt@mymts.net]
Sent: May-25-18 2:06 PM
To: Sitchon, Myra (INR) <Myra.Sitchon@gov.mb.ca>; Friesen, Chris (SD) <Chris.Friesen@gov.mb.ca>
Cc: Webb, Bruce (SD) <Bruce.Webb@gov.mb.ca>; 'Frank Elias' <Frank@kroekers.com>; 'Wayne' <wayne@hesplerfarms.com>; 'David Whetter' <david.whetter@agriearth.ca>; Butterfield, Tamara (SD) <Tamara.Butterfield@gov.mb.ca>
Subject: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts

Dear Myra and Chris:

PBS Water Engineering Ltd. is working on a project for Thornhill Irrigation Ltd. (joint venture of Kroeker Farms Ltd and Hespler Enterprises Ltd.). The project will involve the construction of two irrigation ponds (T1 – West Tobacco Creek ; T2 – South Tobacco Creek) for purpose of storing spring snowmelt and rainfall runoff water, for later application to their potato fields to reduce moisture stress.

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One of the requirements is to do a search of Manitoba Sustainable Development and Heritage Resources data bases for occurrences of rare and endangered species and/or historic resources.

A total of 8 sites are being considered for the two reservoirs locations. The attached map of the potential areas to be investigated in the next three weeks for technical suitability associated with engineering and geology considerations (e.g. clay soils). Land locations are shown on the maps.

All sites with the exception of an alternative to the T2-Option 1; are to be be fully developed on currently cultivated land. It is not clear if T2 – Option 1 will even proceed at this time. Water will be withdrawn from the South Tobacco Creek and West Tobacco Creek using temporary pumping equipment (e.g. PTO pumps and tractors), approximate locations shown on the water allocation map.

The foot print of T1 will be approximately 10 – 12 acres. The foot print of T2 will be 40 – 50 acres.

The South Tobacco Creek and West Tobacco Creeks are in the upper watershed and are fed by flashy spring runoff from the Manitoba Escarpment; these streams are intermittent; drying up in the summer and fall; except during extreme rainfall events. South Tobacco Creek is channelized along the southern extent of the project.

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 feel free to call to discuss any questions or concerns.

Regards

Bruce Shewfelt, P.Eng.

PBS Water Engineering Ltd.

Morden, MB.

CC: Wayne Derksen, Frank Elias, David Whetter, Bruce Webb, Tamara Butterfield

shewfelt@mymts.net

To: 'chris.friesen@gov.mb.ca'
Cc: 'Webb, Bruce (SD)'; 'Frank Elias'; 'Wayne'; 'David Whetter'; 'Butterfield, Tamara (SD)'
Subject: RE: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts

Hello Chris. Just confirming you received this email. We will be submitting Environment Act Proposal tomorrow and look forward to receiving your input during the project review phase.
If you have any questions, please feel free to call.

Bruce Shewfelt, P.Eng.
PBS Water Engineering Ltd.
204 362 5666

From: shewfelt@mymts.net <shewfelt@mymts.net>
Sent: May 25, 2018 2:06 PM
To: 'myra.sitchon@gov.mb.ca' <myra.sitchon@gov.mb.ca>; 'chris.friesen@gov.mb.ca' <chris.friesen@gov.mb.ca>
Cc: 'Webb, Bruce (SD)' <Bruce.Webb@gov.mb.ca>; 'Frank Elias' <Frank@kroekers.com>; 'Wayne' <wayne@hesplerfarms.com>; 'David Whetter' <david.whetter@agriearth.ca>; 'Butterfield, Tamara (SD)' <Tamara.Butterfield@gov.mb.ca>
Subject: Thornhill Irrigation Ltd. - Tobacco Creek Irrigation Project - Historic Resources Impacts

Dear Myra and Chris:

PBS Water Engineering Ltd. is working on a project for Thornhill Irrigation Ltd. (joint venture of Kroeker Farms Ltd and Hespler Enterprises Ltd.). The project will involve the construction of two irrigation ponds (T1 – West Tobacco Creek ; T2 – South Tobacco Creek) for purpose of storing spring snowmelt and rainfall runoff water, for later application to their potato fields to reduce moisture stress.

The reservoir sizes will trigger the need for a Environment Act License. PBS Water Engineering Ltd. with consultation from AgriEarth Consulting Ltd. will be filing an Environment Act Proposal for the project.

One of the requirements is to do a search of Manitoba Sustainable Development and Heritage Resources data bases for occurrences of rare and endangered species and/or historic resources.

A total of 8 sites are being considered for the two reservoirs locations. The attached map of the potential areas to be investigated in the next three weeks for technical suitability associated with engineering and geology considerations (e.g. clay soils). Land locations are shown on the maps.

All sites with the exception of an alternative to the T2-Option 1; are to be be fully developed on currently cultivated land. It is not clear if T2 – Option 1 will even proceed at this time. Water will be withdrawn from the South Tobacco Creek and West Tobacco Creek using temporary pumping equipment (e.g. PTO pumps and tractors), approximate locations shown on the water allocation map.

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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 feel free to call to discuss any questions or concerns.

Regards

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

CC: Wayne Derksen, Frank Elias, David Whetter, Bruce Webb, Tamara Butterfield

APPENDIX F – DFO HABITAT MAPS FOR SHANNON CREEK

BACKGROUND AND FREQUENTLY ASKED QUESTIONS
FOR FISHERIES AND OCEANS DATA REPORT

Milani, D.W. 2013. Fish community and fish habitat inventory of streams and constructed drains throughout agricultural areas of Manitoba (2002-2006). Can. Data Rep. Fish. Aquat. Sci. 1247: xvi + 6,153 p.

Background:

After the creation of the Province of Manitoba in 1870, networks of surface ditches were constructed in several areas of wetland and wet prairie in the south to increase arable lands, facilitate rapid spring runoff, and prevent flooding of crops during heavy summer downpours. The constructed channels often drained fish bearing wetlands used by many large bodied fish seasonally for spawning and rearing, and providing year round habitat for forage fish. The increased speed of runoff from draining these wetland areas often resulted in downstream flooding, and the continuation of drainage works to include channelizing and diking natural waterways to increase flow capacity. Many of these drains continue to be utilized seasonally by fish, and some perennial drains provide permanent habitat for forage fish, and often for large bodied fish species as well.

While the Governments of Canada and the Province of Manitoba recognize the important socio-economic benefits derived from well-drained agricultural land, both governments also share the mandate to conserve and protect water resources and fish habitat. In 2001, the Manitoba Drain Maintenance Committee (DFO, Manitoba Conservation and Water Stewardship) was convened to gain a better understanding of the role of drains as fish habitat and to document the mechanical processes required for effective drain maintenance.

This report documents the results of five years of field surveys (2002-2006) and summarizes the data and methods used to develop the first iteration of classified fish habitat maps for the study area. 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 and the fish species presence (Commercial, Recreational, Aboriginal or SARA listed fish species captured or expected vs. Forage Fish species captured or expected vs. no fish captured or expected).

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

The maps provide information that can be used for a quick risk assessment for the potential of impacts to fish and fish habitat in Agro-Manitoba from a variety of works that occur in and near water, not just drain maintenance. While the maps can help to inform DFO and other regulators of potential risks, they cannot anticipate all situations. Site specific information should always be used in conjunction with the maps to make informed regulatory and management decisions.

Frequently Asked Questions:

Q: My project is on Type A habitat, does that mean I can't do it?
A: While Type A habitat is generally the highest quality fish habitat, projects will be considered based on the type of work proposed, the scale of the project, and site specific information. Generally if your work is not covered by a DFO Operational Statement or other standard or guideline then you should talk to DFO about site specific assessment and review on Type A habitats.

Q: What if I disagree with the assessed habitat type on a stream and feel that it should be a different habitat type?
A: The habitat classifications have been completed based on large scale assessments of habitats and fish presence/absence. Should site specific information and more detailed information on a watercourse or watershed lead to the conclusion that the habitat type should be different, then that information should be presented to DFO and other regulators in your environmental assessment when you are seeking approvals. DFO will make management decisions based on the information that is available. The maps have been labeled as "Draft Data subject to ongoing review" to highlight to users that the information on the maps could change.

Q: Are Type A habitats considered pristine?
A: Generally Type A habitats have the best combination of stream and riparian habitat characteristics to provide the highest quality fish habitat in Manitoba. Many streams with Type A habitat have been impacted and degraded by human activities, often with reduced water quality from nutrient and sediment runoff, and from dams, perched culverts and water management issues. If these issues are addressed however these habitats are often very resilient and will recover their productive capacity.

Q: Does DFO have any concerns about works in Type E habitats:
A: Generally Type E watercourses provide water and nutrients to downstream portions of the watercourse but fish don't live there directly. Pollution and sediment can run down a Type E watercourse and impact fish and habitat downstream and need to be properly considered and managed. Similarly projects that remove all water from a type E (e.g. dam and pump) or projects that greatly increase flows in a Type E (e.g. a water diversion) can greatly affect fish use in the watershed, and should be considered carefully. Generally projects such as a drain clean out, and culvert installation and maintenance can occur in Type E watercourses following best management practices. DFO is working on a Standard Advice document for drain cleanouts in Type D and E habitats.

Q: The watercourse I am interested in is not covered by any of these maps. How do I know the habitat?
A: This inventory program only covered the parts of Manitoba that are currently used for agriculture, approximately 20% of the province. Watercourses outside of these areas were not inventoried by this program. The methods used in this assessment program can be applied to areas outside of those assessed in Agro-Manitoba to determine habitat type. Caution should be used if you wish to apply this assessment methodology outside of Manitoba, as several other provinces have their own habitat classification and mapping methods and requirements (e.g. Alberta Codes of Practice maps).

Q: The drain that I am interested in is not drawn on the map which shows other drains around it. How do I get the habitat classification?
A: Since drain construction is a dynamic process in Manitoba, the base electronic maps are not always up to date. Certain drains can be missed on the maps (e.g. the floodway around the town of Rosenort on the Morris River) and have not been classified. To be cautious the unmapped waterway should be considered the same classification as the watercourse it flows into unless a qualified aquatic environment specialist (e.g. a fisheries consultant) has good information to decide otherwise or if you receive guidance on your project from DFO.

Q: Will the maps be updated with new information?
A: While it is the intention of DFO to update maps periodically there is no fixed schedule for this. The maps have been labeled as “Draft Data subject to ongoing review” to highlight to users that the information on the maps could change. If maps are updated they will likely be released in a new Data or Technical Report, or potentially through the provincial Manitoba Land Initiative (MLI) website. DFO is looking to partner with the Province of Manitoba to have maps placed on the MLI website.

Q: How will these maps be used with the amended Fisheries Act?
A: These maps are useful tools for making quick risk management decisions. They may be referred to in future guidelines, Operational Statements or Standards that are made for Manitoba. Regulatory decisions will be made based on several factors including the fish species, habitat sensitivity, and the type and scale of project being proposed. Site specific information and factors will always be used to inform DFO’s regulatory decisions.

Q: How do I know where aquatic species at risk are on this map?
A: While fish species listed under the Species At Risk Act (SARA) as threatened or endangered were considered as indicator species during this inventory, the list of aquatic species at risk is under constant review. Please visit the SARA registry website for details and recovery plans for distribution maps. If an aquatic SARA species is known or suspected in a drain then the habitat of that drain should be considered Type A until site specific review can be completed and information provided by the DFO Fisheries Protection Program and/or Species at Risk Program.

Q: I wish to use the raw data in the Excel spreadsheet, and the GIS shape files for the habitat classifications. How should I cite this information?
A: All of the data tables and classified line segments are found in the data report. The original report should be cited if you use the shape files or Excel spreadsheet to make maps in your GIS, or to present that information in a report. You should indicate that it was adapted from Milani, D.W. 2013. Fish community and fish habitat inventory of streams and constructed drains throughout agricultural areas of Manitoba (2002-2006). Can. Data Rep. Fish. Aquat. Sci. 1247: xvi + 6,153 p.

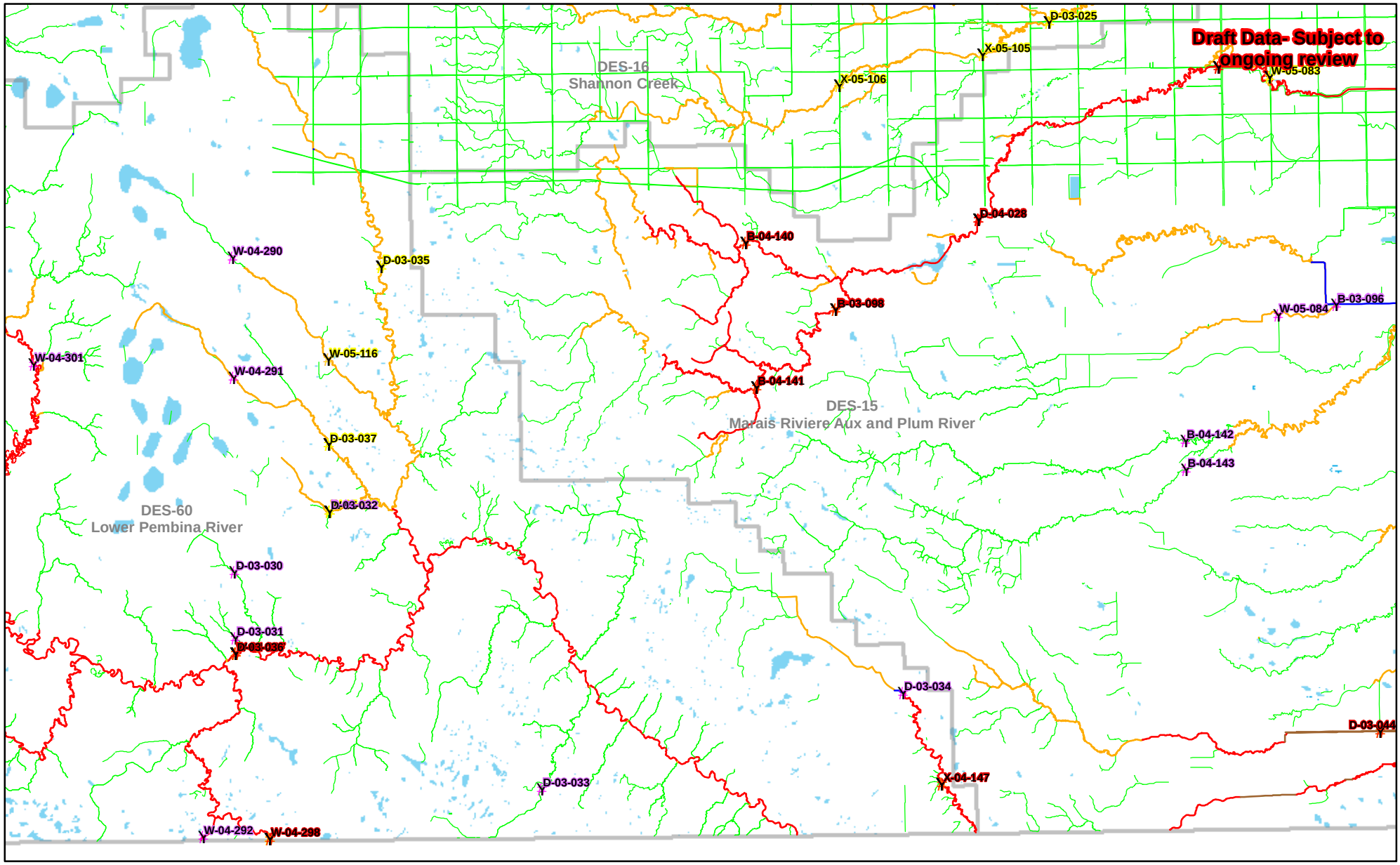
Q: I have downloaded some of the shape files but they are not displaying properly on my GIS. What could be the problem?
A: Be sure to download the “Project File” or .apr file, and all five of the files associated with each of the shape files. Each file (e.g. indicator_species, non_indicator_species, no_catch, des_lines etc.) has a series of similarly named files with different formats including .dbf, .sbn, .sbx, shx, and .shp. Place all the files into the same registry as all are needed to properly display the data. Then when you open the .apr file and point to all the included .shp files when prompted the map is built and displays properly.

The ESRI files that include “basemap” in their name do not need to be downloaded but do provide the study area as “clip” of the entire province. All of the “basemap” ESRI files are public but will not likely be required if inputting the shape files into an existing GIS.

Note: The files are geo-referenced in decimal degrees. If you are using UTM referencing you will need to convert the files from decimal degrees to UTM coordinates (NAD 83, Zone 14).

Q: Our GIS guy is going to add the DFO habitat map layers to Google Earth for us but he had a question about one of the data folders called DES_Line_Data which contains three categories called “Type”, “New Type”, and “Type 08”. He was assuming they refer to the new and old habitat classifications for the watercourses and was wondering which one should he use?
A: To properly display the Type A to Type E classifications have your GIS specialist input the DES lines, the NHN (NTS) lines and the NHN polygons. In each of these data sets the field to the far right side of the tables displays the most recent classification (A to E). Each of these unique values has to be assigned a colour; my colours used in the data report were A= Red, B= Brown, C= Orange, D= Blue, E= Green. Do that for each data set then stack the data so that it displays properly (i.e bottom layer = NHN polygons, next layer NHN lines, then top layer = DES lines).

Q: I have found some typo’s in the report, or want to suggest changes to stream classifications based on site specific assessments. Who should I report this to?
A: Please direct your comments in an email to Todd.Schwartz@DFO-MPO.GC.CA and I will record them. Should significant mistakes be brought to our attention we will add an errors/errata page to the report or otherwise update it on WAVES (the DFO library site).



062G07	062G08	062H05
062G02	062G01	062H04

Habitat Classification

A
B
C
D
E

Fishing Results

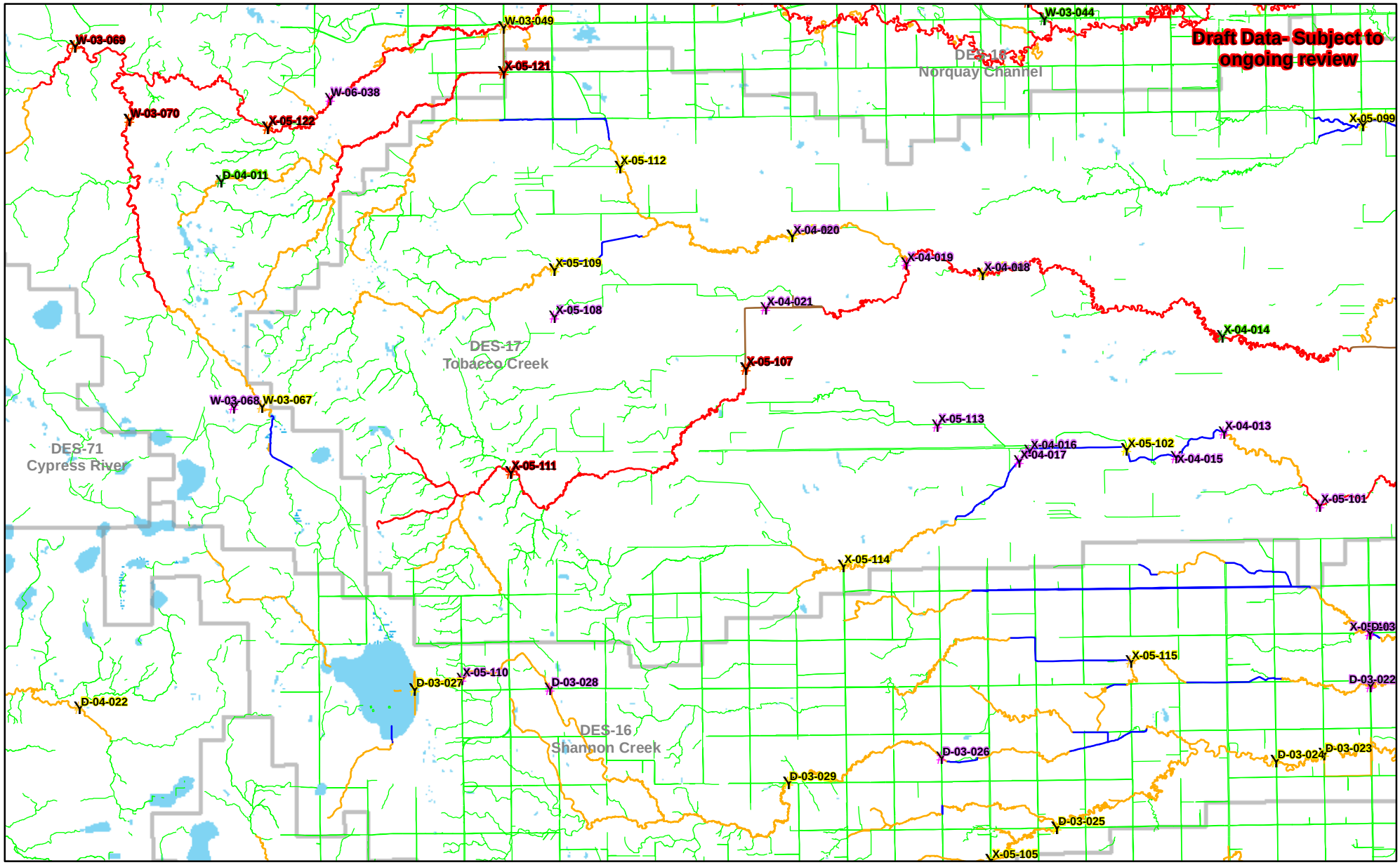
Indicator Species
Non-Indicator Species
No Catch
No Fishing Effort

Appendix 9

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

062G01

Produced April 2012



062G10	062G09	062H12
062G07	062G08	062H05
062G02	062G01	062H04

Habitat Classification

A
B
C
D
E

Fishing Results

Indicator Species
Non-Indicator Species
No Catch
No Fishing Effort

Appendix 9

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

062G08

Produced April 2012

APPENDIX G – SEDIMENT AND EROSION CONTROL MEASURES

Sediment Control Plan for Construction of Pumped Storage Irrigation Reservoirs

The recommendations outlined herein are specific to pumped storage irrigation reservoirs 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 by the use of 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

APPENDIX H – 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

Carl J. Rosen and Peter M. Bierman, Department of Soil, Water, and Climate, University of Minnesota

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.

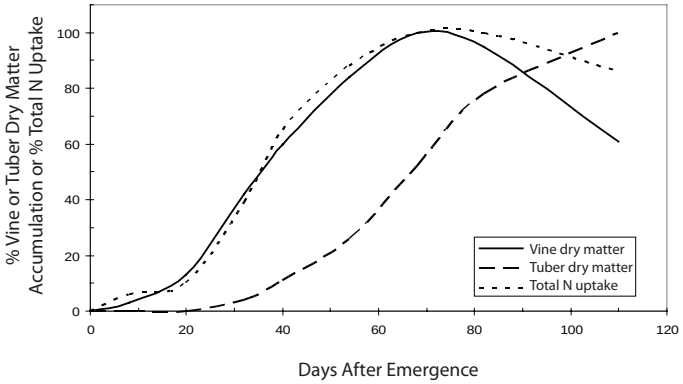


Figure 1. Relative tuber growth, vine growth and total nitrogen uptake by the potato crop. Based on data from the Russet Burbank variety.

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 Leaching
Planting	Emergence	Hilling	Total	Marketable	
---------- 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

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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

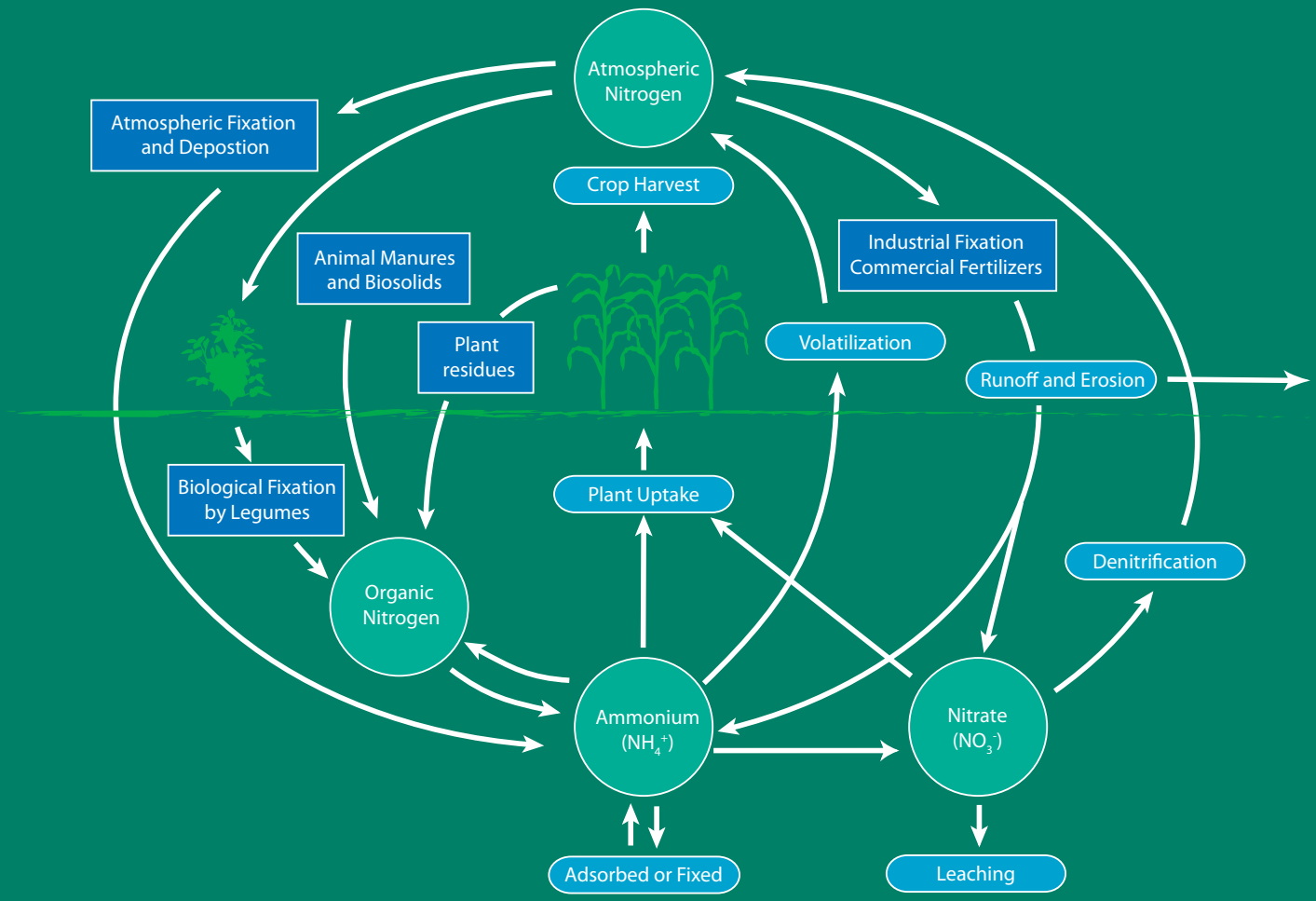
Appendix A

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.

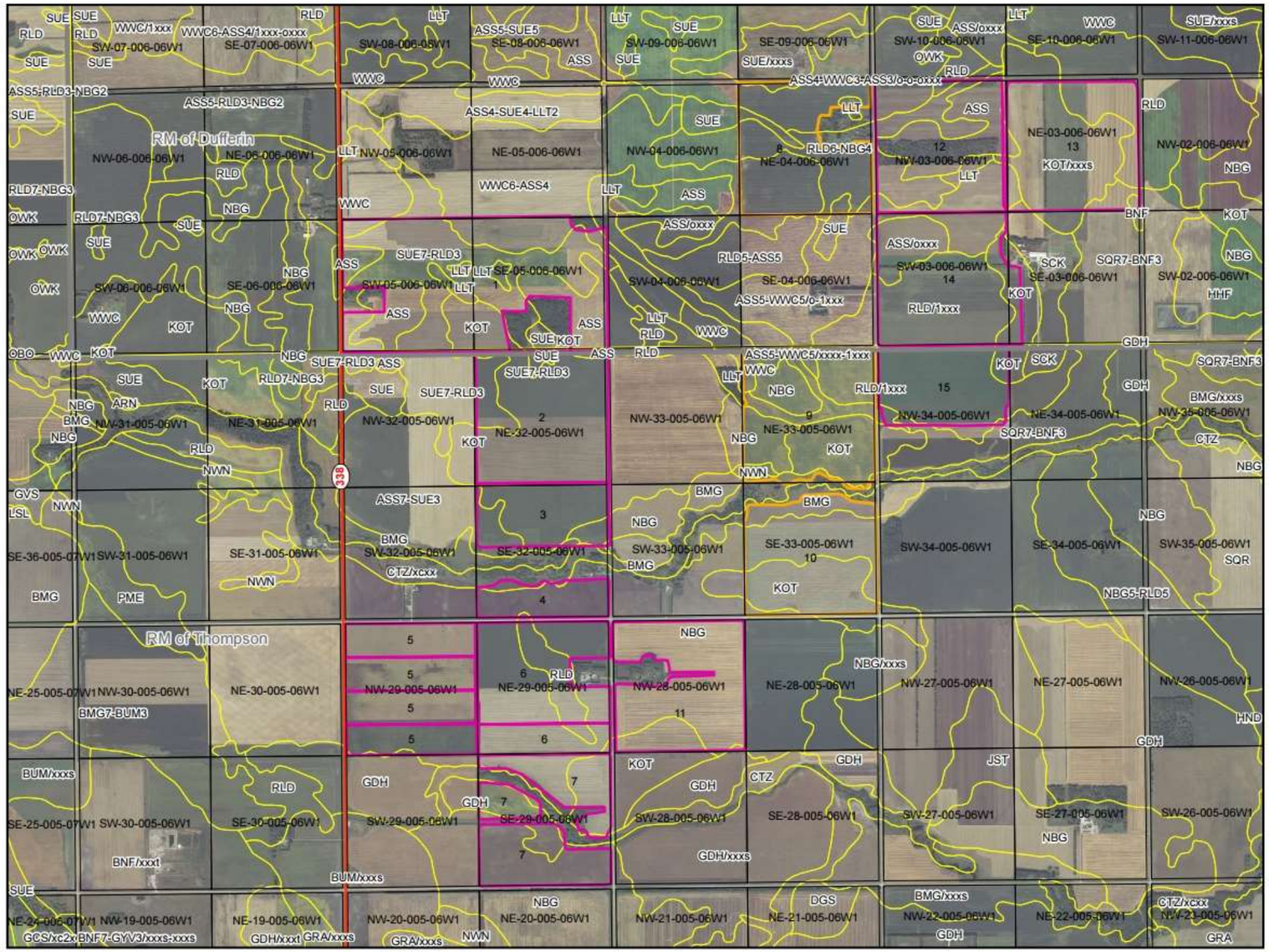


UNIVERSITY OF MINNESOTA
EXTENSION

Best Management Practices for Nitrogen Use: Irrigated Potatoes

PUBLICATION # 08559

APPENDIX I – SOIL RESOURCE INFORMATION



Soil-Landscape Map

Figure Number	Project Name
A.I.1	Thornhill Irrigation Ltd.

NORTH

800 400 0 800

Metres

Acknowledgements:
Original drawing by AgriEarth Consulting Ltd.
Data accessed from Manitoba Land Initiative, Province of Manitoba.

PREPARED BY agriearth consulting ltd.

DRAWING SCALE	DATA SCALE	
1:25,000	1:20,000	
DRAFT DATE	DRAWN	CHECKED
June 6, 2018	DW	BS

Legend

- Rural Municipality
- Provincial Road
- Provincial Trunk Highway
- Soil-Landscape Polygons

Irrigation Fields
Ownership
- Hespler
- Kroeker

Simple Map Units

ABC — Soil Series Symbol

xb1s
- Degree of erosion
- Degree of Salinity
- Slope Gradient Class
- Degree of Stoniness

DEF — Soil Series with no phases

Compound Map Units

ABC (7) / xc1x — DEF (3) / xbxx

- Decile extent of soil series within the polygon
- Units with different phases associated with each series

ABC(7) – DEF(3) / xbxx — Units with same phases associated with each series

Degree of Erosion

x	non-eroded or minimal
1	slightly eroded
2	moderately eroded
3	severely eroded
o	overblown

Degree of Stoniness

		Surface Covered
x	non-stony	<0.01%
1	slightly stony	0.01-.1%
2	moderately stony	0.1-3%
3	very stony	3-15%
4	exceedingly stony	15-50%
5	excessively stony	>50%

Topography (Slope Gradient Class)

Slope Gradient

x	0-0.5%	level to nearly level
b	0.5-2%	nearly level
c	2-5%	very gently sloping
d	5-9%	gently sloping
e	9-15%	moderately sloping
f	15-30%	strongly sloping
g	30-45%	very strongly sloping
h	45-70%	extremely sloping

Degree of Salinity

		Conductivity (mS/cm)
x	non-saline	0-4
s	weakly saline	4-8
t	moderately saline	8-15
u	strongly saline	15+