2024-06-18

Public

Director
Environmental Approvals Branch
Manitoba Environment and Climate
14 Fultz Boulevard
Winnipeg, MB R3Y 0L6

Subject: Environment Act Proposal - City of Dauphin Long-term Land Application Program

Dear Madam/Sir:

WSP Canada Inc. (WSP) has been retained by the City of Dauphin to submit an Environment Act Proposal (EAP) on their behalf, for a long-term residuals land application program. The Program will involve the periodic land application of residuals material from the City of Dauphin's wastewater treatment lagoon onto agricultural lands within proximity to the lagoon in the Rural Municipality of Dauphin. As per the *Classes of Development Regulation* under *The Environment Act*, we understand that this project would be considered a Class 2 Development.

The objective of this EAP is to provide documentation in support of attainment of an Environment Act License for this project.

For your consideration, please find enclosed an electronic copy (as a searchable .pdf file on a removable drive) of the EAP document, the application form and the application fee for $7,500.00 as required for an EAP submission for a Class 2 Development.

If you have any questions or concerns about this submission, please contact the undersigned at your convenience..

Yours sincerely,

[redacted]

Darren Keam, M.Sc., P.Ag.
Project Manager

DK/ds

cc: Mike VanAlstyne, City of Dauphin

Encl. City of Dauphin, Long-term Residuals Land Application Program, Environment Act Proposal

1600 Buffalo Place
Winnipeg, MB
Canada R3T 6B8

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wsp.com

Environment Act Proposal Form

Manitoba

Name of the development:
Long-Term Residuals Land Application Program - City of Dauphin

Type of development per Classes of Development Regulation (Manitoba Regulation 164/88):
Class 2

Legal name of the applicant:
City of Dauphin

Mailing address of the applicant: 100 Main Street South

Contact Person: Mr. Mike VanAlstyne

City: Dauphin Province: MB Postal Code: R7N 1K3

Phone Number: (204) 622-3212 Fax: email: mike.vanalstyne@dauphin.ca

Location of the development: RM of Dauphin, MB

Contact Person: Mr. Mike VanAlstyne

Street Address:

Legal Description: Section 23, Township 25, Range 19 WPM

City/Town: Dauphin Province: MB Postal Code: R7N 1K3

Phone Number: Fax: email: mike.vanalstyne@dauphin.ca

Name of proponent contact person for purposes of the environmental assessment:
Darren Keam

Phone: (204) 250-4010
Fax: (204) 474-2864

Mailing address: 1600 Buffalo Place
Winnipeg, MB
R3T6B8

Email address: darren.keam@wsp.com

Webpage address: https://www.wsp.com/

Date: JUNE 14, 2024

Signature of proponent, or corporate principal of corporate proponent:
[redacted]

Printed name:

PRINT RESET

A complete **Environment Act Proposal (EAP)** consists of the following components:

- ☐ **Cover letter**
- ☐ **Environment Act Proposal Form**
- ☐ **Reports/plans supporting the EAP** (see "Information Bulletin - Environment Act Proposal Report Guidelines" for required information)
- ☐ **Application fee** (Cheque, payable to Minister of Finance, for the appropriate fee)

Per Environment Act Fees Regulation (Manitoba Regulation 168/96):

Class 1 Developments	$1,000
Class 2 Developments	$7,500
Class 3 Developments:	
Transportation and Transmission Lines	$10,000
Water Developments	$60,000
Energy and Mining	$120,000

Submit the complete EAP to:
Director
Environmental Approvals Branch
Environment and Climate Change
Box 35, 14 Fultz Boulevard
Winnipeg MB R3Y 0L6
EABDirector@gov.mb.ca

For more information:
Toll-Free: 1-800-282-8069
Phone: 204-945-8321
Fax: 204-945-5229

https://www.gov.mb.ca/sd/permits_licenses_approvals/eal/licence/index.html

Internal Use Only
$1,000.....C1 B-02
$7,500.....C2 B-02
$10,000....TT B-02
$60,000.....WD B-02
$120,000...EM B-02

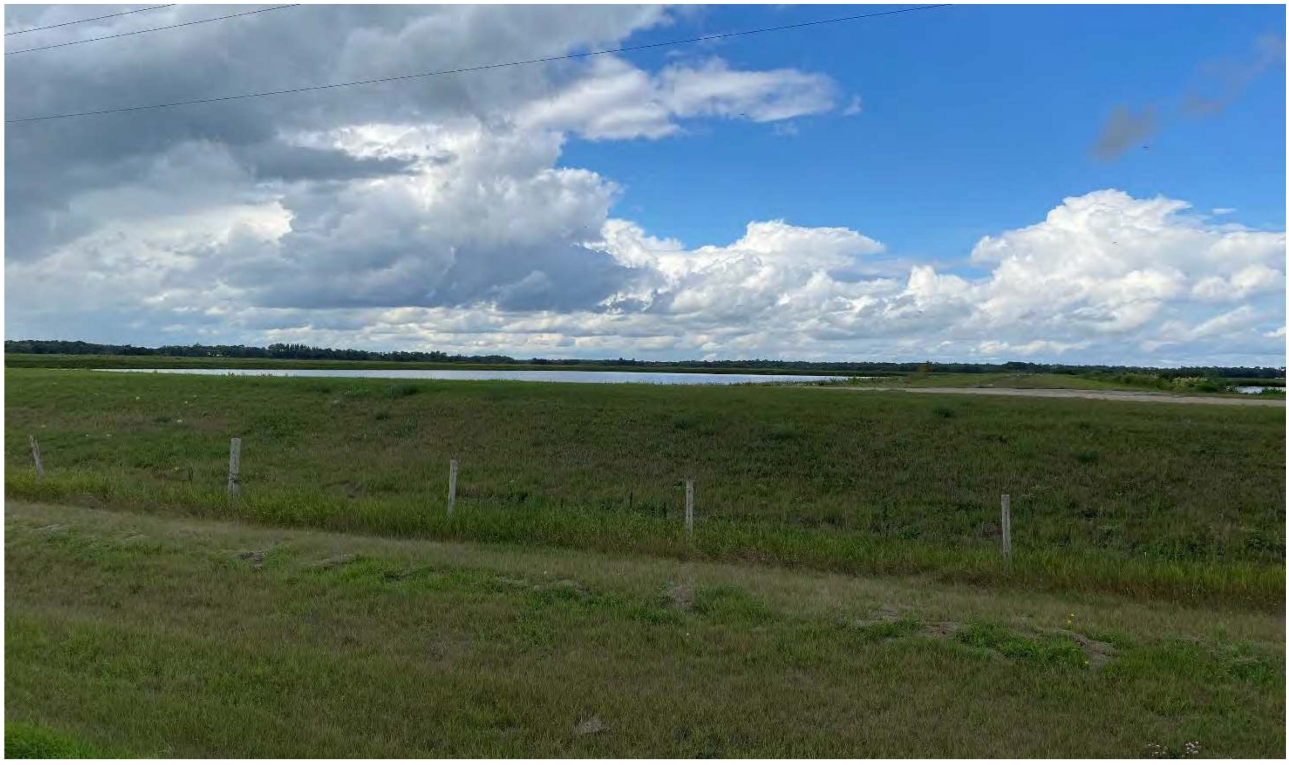
CITY OF DAUPHIN

ENVIRONMENT ACT PROPOSAL

LONG-TERM RESIDUALS LAND APPLICATION PROGRAM

DAUPHIN, MANITOBA

JUNE 2024 FINAL



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WSP PROJECT NO. CA0011326.9806

SIGNATURES

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Project Manager

PREPARED FOR:
City of Dauphin
100 Main Street South, Dauphin, Manitoba, R7N 1K3

[1] *Approval of this document is an administrative function indicating readiness for release and does not impart legal liability on to the Approver for any technical content contained herein. Technical accuracy and fit-for-purpose of this content is obtained through the review process. The Approver shall ensure the applicable review process has occurred prior to signing the document.*

WSP prepared this report solely for the use of the intended recipient, City of Dauphin, in accordance with the professional services agreement between the parties. In the event a contract has not been executed, the parties agree that the WSP General Terms for Consultant shall govern their business relationship which was provided to you prior to the preparation of this report.

The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment.

The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

WSP disclaims any obligation to update this report if, after the date of this report, any conditions appear to differ significantly from those presented in this report; however, WSP reserves the right to amend or supplement this report based on additional information, documentation or evidence.

WSP makes no other representations whatsoever concerning the legal significance of its findings.

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In preparing this report, WSP has relied in good faith on information provided by others, as noted in the report. WSP has reasonably assumed that the information provided is correct and WSP is not responsible for the accuracy or completeness of such information.

Benchmark and elevations used in this report are primarily to establish relative elevation differences between the specific testing and/or sampling locations and should not be used for other purposes, such as grading, excavating, construction, planning, development, etc.

WSP disclaims any responsibility for consequential financial effects on transactions or property values, or requirements for follow-up actions /or costs.]

Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.]

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This limitations statement is considered an integral part of this report.

EXECUTIVE SUMMARY

INTRODUCTION

This Environmental Act Proposal is submitted to the Manitoba Conservation and Climate Environmental Approvals Branch, as required under *The Environment Act* for the purpose of obtaining a Class 2 Environment Act License for the land application of residual materials from the City of Dauphin wastewater treatment lagoon.

The City of Dauphin is proposing to initiate a long-term land application program for residual materials from the City of Dauphin wastewater treatment lagoon located on the southeast quarter section 23, township 25, range 19 WPM. It is planned that residual material will be dredged from the bottom of the lagoon cell(s) and land applied via direct soil injection in a given year.

OBJECTIVE

The land application program will be completed in an agri-environmentally sustainable manner, comply with applicable regulatory requirements, be allied with participating agricultural producer fertilization and crop management practices, and implement best management practices that include good neighbour practices.

If license approval is granted by the fall of 2024, land application is anticipated to commence in September/October of 2024. Sampling for residual materials from the lagoon cells for nutrient and metal analysis was conducted in January 2024 to aid in determining land requirements and prescription rates for application. The biosolid material will be applied onto privately owned agricultural fields located on the outskirts of the City of Dauphin within 2 kilometres from the lagoon site.

PUBLIC ENGAGEMENT

An online public engagement program was completed for the land application program, which involved posting a webpage on the city's website that provided information on the program and a Frequently Asked Questions section. A public comments link for the program was provided on the webpage and was open for comment between November 1, 2023, and January 15, 2024. The comments post was monitored by the city, and questions, comments, and concerns received via the public post were addressed by the city.

RESIDUALS APPLICATION LOGISTICS

A Local Study Area was defined for the program that includes lands targeted to receive residual materials. These lands are located to the north of the wastewater treatment lagoon site and include parcels:

- Quarter sections SW, NW, and NE of 23-25-19WPM
- Full section of 24-25-19WPM
- Half sections of S1/2 SW26-25-19WPM, S1/2 SE26-25-19WPM
- Half sections of S1/2 SW25-25-19WPM and S1/2 SE25-25-19WPM

Specific agricultural fields utilized in the land application of residual materials will be confirmed annually. Under the program, if future additional lands are required, these additional parcels will be reviewed for suitability (e.g., soil suitability, setback distances, sensitive features, and public concern).

Residuals prescription rates will be developed to target optimum available nitrogen and phosphorus levels for small grain and oil seed crops and set metal loading limits for the agricultural fields in the application program for a given year. Application rates will comply with applicable regulatory requirements, guidelines, and best management practices. This objective meets the principals of environmentally sustainable land application outlined by Manitoba Environment and Climate Change and the Canadian Council of Ministers of the Environment Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage (December 2012).

For a given application event, residual slurry materials will be directly pumped from the applicable lagoon cell(s) to the receiving field(s) and applied through direct injection into the soil after crop harvest (September – November).

POTENTIAL ENVIRONMENTAL EFFECTS

Potential environmental effects associated with the proposed land application program include:

- Biophysical Effects:
  - Soil Quality Effects
    - Nutrient loading
    - Metals
    - Salinity and sodicity
    - Soil compaction
  - Water Quality Effects:
    - Surface water
    - Groundwater pollution
  - Natural vegetation, wildlife and species of conservation concern
- Socio-economic Effects:
  - Pathogens
  - Odour
  - Emerging substances of concern
  - Metal accumulation in crops
  - Accidents and malfunctions

MITIGATION MEASURES

Appropriate mitigation measures will be employed to minimize risk to human and environmental health and safety from the land application of biosolids, including such measures as:

- Biosolids will only be applied to agricultural lands with a Canada Land Inventory Agricultural Capability of Class 1 to 4 and within Nutrient Management Zones N1, N2 or N3.
- Biosolids prescription rates will be developed based on targeted crop uptake, residual soil nutrient levels and participating agriculture producers' soil fertility management programs.

- Applicable setback distances around residential areas, residences, groundwater wells, surface water drainage systems and sensitive areas/features will be established as outlined in the provincial *Nutrient Management Regulation* under *The Water Protection Act* and the Farm Practices Guidelines for Pig Producers in Manitoba (April 2007).
- Best management practices, including good neighbour practices, will be employed, and a spill response plan will be developed as part of the land application program.
- The program will comply with all other applicable regulatory requirements including any additional permits/approvals.

FOLLOW-UP ACTIONS, MONITORING AND REPORTING

The City of Dauphin is committed to completing the following monitoring and reporting requirements for the land application program:

- Completion of a yearly program review/start-up meeting between the city, Applicator contractor and consultant (if applicable) to review the procedure and requirements of the program, including requirements outlined in the Environment Act Licence. Yearly meetings will be completed in January-February of each application year.
- At least two weeks prior to the commencement of the residuals land application, the city will provide details of the residuals and receive field soil analysis as well as proposed prescription rates for residuals application to the Director of the Manitoba Environment and Climate Change, Environmental Approvals Branch.
- By March 31 of each year following the application of residuals for the program, the city will submit a report to the Director of the Manitoba Environment and Climate Change, Environmental Approvals Branch that summarizes soil fertility analytical results, prescribed residual application rates, and application activities completed for the program in a given year.
- Post-harvest soil monitoring will be conducted on the participating agricultural fields for three years post application of residuals to monitor nutrient loading within the soil. Soil samples will be collected at depths of 0-15 centimetres and 15-60 centimetres, and the analysis will include sodium bicarbonate extractable phosphorus in nitrate-nitrogen and total nitrogen. Participating agricultural producers will be required to manage their nutrient program based on the annual soil residual nitrogen and phosphorus levels assessed through the monitoring program. This information will be supplied to the Director of the Manitoba Environment and Climate Change, Environmental Approvals Branch by March 31 of each year following the application of biosolids.

SUMMARY

When applied at balance rates, the land application of wastewater residuals is a sustainable means to reuse nutrients within an agriculture system. The application of residual organic material enhances the water holding capacity, structure and tilth of soils, thereby providing benefits to land utilized for agricultural production. The objective of this project is for the City of Dauphin to complete a land application of residual materials collected from their wastewater treatment lagoon cells in an agronomically and environmentally sustainable manner. All applicable regulatory requirements, guidelines and good neighbour policies and procedures will be adhered to for the City of Dauphin residuals land application program. With the employment of appropriate mitigation measures, potential negative effects associated with the City of Dauphin's residuals land application can be minimized.

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TABLES (IN REPORT BODY)

APPENDICES

1 INTRODUCTION

This Environmental Act Proposal (EAP) is submitted to the Manitoba Environment and Climate Change (MECC) Environmental Approvals Branch (EAB), as required under *The Environment Act* of Manitoba for the purpose of obtaining a Class 2 Environment Act License (EAL) in support of a residuals land application program for the City of Dauphin's wastewater treatment lagoon (the "Project").

1.1 Proponent

The proponent for this Project is the City of Dauphin (Dauphin). The Project work has been approved by the Director of Public Works & Operations for the City of Dauphin, Mr. Mike VanAlstyne, P.Eng.

City of Dauphin
100 Main Street South
Dauphin, Manitoba
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1.2 Project Location

The existing Dauphin Lagoon is located at SE 23-25-19 WPM, approximately 1 kilometre (km) north-northwest of the city, on Road 147 North, within the Rural Municipality (RM) of Dauphin, Manitoba (**Figure 1, Appendix A**).

1.3 Background

Dauphin is proposing to initiate a land application program for residuals from the wastewater treatment lagoon cells located on the southeast quarter of Section 23, Township 25, Range 19 WPM (**Figure 2, Appendix A**). Upon receipt of an EAL, (fall 2024), it is planned that biosolid materials will be dredged from the bottom of the lagoon cells and included in a land application program. Sampling for residuals from the lagoon cells for nutrient and metal analysis was conducted in January 2024. The residual materials will be applied onto privately owned agricultural fields located in the RM of Dauphin within a distance of 2 km from the lagoon site.

The original four cells of the wastewater lagoon were constructed in the 1960s, the fifth in 1970, and the sixth in 1978, which included a clay cut-off wall on the north and east sides of cell 6 and the south side of cells 1 and 2. In 2004, a sludge quantity survey indicated that 117,294 cubic metres (m3) of sludge had built up in the lagoon cells. In 2008, EAL 1782R for residuals removal and disposal was issued to Dauphin, and approximately 88,252 m^3 of residuals were removed between 2005 and 2008. In accordance with the Clean Environment Commission (CEC) Order, the lagoon operates with a 122-day storage period.

The wastewater collection system includes gravity sewer piping and two sewage lift stations. The main lift station is equipped with a flow meter, and the second records pump hours.

1.3.1 Current EAL

Dauphin's wastewater treatment lagoon currently operates under EAL No. 3239 (issued December 1, 2017).

1.4 Objective

The objective of this EAP is to provide documentation in support of the attainment of an EAL for Dauphin to establish an agronomically and environmentally sustainable land application program for residuals from their wastewater treatment lagoon. It is anticipated that land application may be required every two to three years to ensure lagoon storage capacity is maintained.

In addition to being completed in an agri-environmentally sustainable manner, the land application program will comply with all applicable regulations, will be allied with participating agricultural producer fertilization and crop management practices and will implement best management practices, including incorporating good neighbour practices. Residuals loading limits will be determined to target optimum available nitrogen and phosphorus levels for small grain – oil seed crops and set metal loading limits for the agricultural fields in the application program. This objective meets the principals of environmentally sustainable land application outlined by MECC and within the Canadian Council of Ministers of the Environment (CCME) *Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal Sludge and Treated Septage* (December 2012a).

2 DESCRIPTION OF PROPOSED DEVELOPMENT

The proposed project involves the development of a long-term land application program for wastewater residuals that target application every two to three years based on lagoon storage capacity. The first land application event scheduled as part of this program is targeted for the fall of 2024 and would include:

- The removal and land application in the fall of 2024 of approximately 40,000 m^3 (+15% contingency factor) of residual materials dredged from the Dauphin wastewater treatment lagoon aeration cell.
- The residual materials from the lagoon cells will be land applied based on appropriate agronomic rates calculated for each of the agricultural fields participating in the application program. All of the proposed receiving agricultural fields are located within 2 km of the lagoon. The main components and activities of the project are described in the sections below.

2.1 Project Need, Purpose, Alternatives and Benefits

2.1.1 Project Needs and Alternatives

Dauphin has not completed a land application event since 2007 and now requires land application from their aeration cell (southeast corner of the lagoon) of their seven existing lagoon cells to maintain storage capacity within the lagoon. The city wishes to complete a future lagoon upgrade and, as such, would like to implement a land application program to allow for application events of residuals from other cells to occur in subsequent years to accommodate the future upgrade.

Dauphin owns 26 hectares (ha) (65 acres [ac]) of land north of the existing lagoon that would be utilized as part of the land application program, with additional lands sourced as needed from cooperating farm producers/landowners within 2 km of the lagoon.

2.1.2 Land Application Benefits

Land application is a sustainable way to manage lagoon residuals. It provides an opportunity to re-use the residuals, keeping them out of the landfill. Land application of residuals:

- Meets regulatory requirements.
- Returns much-needed nutrients to local agricultural land (nitrogen, phosphorus, potassium, sulfur and micronutrients).
- Provides organic matter that improves soil structure, drainage, aeration and erosion protection.
- Reduces greenhouse gases (GHGs) through carbon sequestration.
- Provides economic value for agricultural producers for multiple years, in reduced fertilizer cost and improved crop yields.
- Removes significant volume of material from the landfill.

2.2 Local Study Area

To facilitate direct pumping of the residuals to the receiving agricultural fields from the lagoon site (refer to Section 6.4 for additional details), the land application program Local Study Area (LSA) is proposed to be located within 2 km of the wastewater treatment lagoon site and to include land to the south of the Vermilion River and Salt Creek to eliminate the need for crossing of waterways. As such, the LSA is comprised of the following parcels (refer to **Figure 2, Appendix A**):

- Quarter sections SW, NW and NE of 23-25-19WPM
- Full section of 24-25-19WPM
- Half sections of S1/2 SW26-25-19WPM, S1/2 SE26-25-19WPM
- Half sections of S1/2 SW25-25-19WPM and S1/2 SE25-25-19WPM

These parcels are provided in this EAP as the targeted LSA for the land application program. Under the program, if future additional lands are required, these additional parcels will be reviewed for suitability (e.g., soil suitability, setback distances, sensitive features, public concern) and submitted to MECC for validation.

2.3 Land Ownership

Currently, no cooperating farm producers or landowners have been approached to receive residual materials from the Dauphin wastewater treatment lagoons. Under the land application program, when a land application event is being prepared for execution, cooperating farm producers and landowners will be approached, engaged with a land use agreement, and the proposed land parcels and associated landowner information will be submitted to MECC for their records (including Manitoba Land Title Certificates).

No Manitoba Land Title Certificates are being submitted for the agricultural land for this EAP submission.

2.3.1 Current Land Use Development Controls

The agricultural fields of the LSA are zoned as Agricultural General Zone – AG under the Municipality of Dauphin Zoning By-Law No. 3042. Under the Zoning By-Law, AG Zone is defined as: "a wide range of agricultural activities on large parcels of land in a fairly unrestricted manner. Special and intensive agricultural uses may be permitted on smaller parcels of land. Some small holding and non-agricultural uses, such as farmsteads and supporting agricultural industries, which are compatible in the agricultural area, may be accommodated in the zone."

2.3.2 Dauphin Wastewater Treatment Lagoon

The Dauphin wastewater treatment lagoon is located at SE 23-25-19 WPM, on the north side of Dauphin (**Figure 2, Appendix A**). The lagoon is comprised of seven cells. It is anticipated that the residuals will be dredged from the aeration cell with the granting of an EAL and subsequent cells (Cell 1 to 6) in the following years.

2.4 Regulatory Framework

The following Acts and Regulations apply to the project and will be adhered to throughout the completion of the project:

1. *The Environment Act C.C.S.M. c. E125 (1987)*
    a. *Licensing Procedures Regulations* 163/88
    b. *Classes of Development Regulation* 164/88
    c. *Environment Act Fees Regulation* 168/96
    d. *Livestock Manure and Mortalities Management Regulation* 42/98
    e. Environmental Regulations for Treatment and Disposal of Biosolids in Manitoba, Mike Van Den Bosch, P.Eng., Municipalities & Industrial Approvals, Manitoba Environment
2. *The Water Protection Act C.C.S.M. c. W65 (2005)*
    a. *Nutrient Management Regulation* 62/2008

2.5 Project Schedule

The project tasks and schedule of events for the proposed project are outlined below in **Table 1**.

Table 1. Project Tasks and Schedule

Task	Timeline
Biosolid and sludge quality sample collection for laboratory analysis of physical and chemical parameters.	January 2024
Desktop review of land sustainability in the LSA.	April – May 2024
Submission of EAP for the project.	May 2024
EAP approval and granting of EAL by EAB[1].	September 2024
Soil sample collection for laboratory analysis of physical and chemical parameters for biosolid application.	September 2024
Land application of biosolid materials from primary Cell 1.	September – October 2024
Continuation of Land Application Program, Monitoring & Reporting	2025 and on, as applicable

Notes: [(1)]Based on current estimated review time by the EAB Technical Advisory Committee (TAC) and the public review timeframe of 3-6 months.

3 DESCRIPTION OF EXISTING ENVIRONMENT

3.1 Existing Land Use

The parcels of land that are to receive the residuals are classified as agricultural and are used to produce annual crops such as cereals and oilseeds. Dauphin is located within 1 km to the south and southwest of the wastewater treatment lagoon site. Several rural residential properties are also located with the LSA.

3.2 Ecostratification

The proposed project is located within the Dauphin Ecodistrict of the Lake Manitoba Plain Ecoregion, which is covered by the broader Prairies Ecozone (Smith, Velduis, Mils, Eilers, Fraser and Lelyk, 1998).

3.3 Climate

The Dauphin Ecodistrict is found within the most humid subdivision of the Grassland Transition Ecoclimatic Region in southern Manitoba. The ecodistrict is characterized by short, warm summers and long, cold winters with a mean average temperature of 1.8ºC (Smith et al., 1998). The average crop growing season is 177 days with approximately 1545 growing degree-days. Mean annual precipitation is 500 millimetres (mm), one quarter of which is in the form of snowfall. The Dauphin Ecodistrict has a moderately cold to cold, humid, Cryoboreal soil climate (Smith et al., 1998).

3.4 Soils and Terrain

Soils in the ecodistrict consist primarily of imperfectly drained Gleyed Rego Black Chernozems that have been developed on shallow, very strongly calcareous, loamy sand to clayey sediments. Drainage of these soils internally is slowed due to clay surface textures in the south and clay substrate to the north, thus producing a high-water table (Smith et al., 1998). The occurrence of poorly drained Gleysolic, imperfectly drained Regosolic soils, and poorly structured Solonetzic Black Chernozems may also be present in the area (Smith et al., 1998). Additional information pertaining to soils within the LSA (e.g., soil texture and agricultural capability) is provided in Section 5.1.2.

3.5 Surficial and Bedrock Geology

The dominant bedrock type of the area is of the Swan River Formation, which consists of sandstone, kaolinitic shale, with channel and karst infill within the Paleozoic outcrop belt while locally missing from the outcrop sequence due to nondeposition (McRitchie et al., 1979).

Surficial geology of the area consists of offshore glaciolacustrine sediments of clay, silt, and minor sand approximately 1-20 metres (m) thick with very low relief massive and laminated deposits. The deposits are from suspension in the offshore, deep water of glacial Lake Agassiz, commonly scoured and homogenized by icebergs (Matile and Keller, 2006).

3.6 Regional and Local Hydrology

The LSA is located within the Dauphin Lake Watershed, within the larger Lake Winnipegosis / Lake Manitoba drainage basin. This watershed consists of seven sub-watersheds whose headwaters originate in the Manitoba Escarpment to the west of the LSA, including the Vermillion River sub-watershed. The Vermilion River sub-watershed drains approximately 743 km^2 and is noted as having “rapid runoff with heavy silt load due to extremely steep northern slope of the Riding Mountain” (Dauphin Lake Integrated Watershed Management Plan [DLIWMP], n.d.).

Dauphin sources its raw water supply for its public water system from the Vermilion River Reservoir, which supplies Dauphin residents and several water cooperatives in the RM of Dauphin with treated drinking water. Water is piped 6.5 km from the Vermilion River Reservoir, south of Dauphin, to the city’s water treatment plant. Treated water is distributed by pipe to residential and commercial consumers. Edwards Creek is a secondary or back-up source of raw water when required (DLIWMP, n.d.). As the contributing area to the Vermilion River is upstream of the reservoir and is located entirely within the Riding Mountain National Park, consistent water quality has been able to be maintained (DLIWMP, n.d.).

There are no natural lakes within the LSA; the nearest lake is Lake Dauphin, located approximately 10 km to the east of the LSA. Wetlands in the region and LSA have been reduced to small ephemeral depressions and small dugouts as historic drainage patterns in the region have been altered over time to accommodate agricultural production. The Vermillion River runs along the western and northern portions of the LSA and is surrounded by a wooded (primarily mixed deciduous forest) riparian zone (riparian zone ranges from 0 m to approximately 250 m in width) and agricultural land (**Figure 8, Appendix A**). In addition, the Salt Creek is located across the north quarters of the LSA and is defined as an Order 6 stream[2]. The Dauphin Drain and Dead Lake Drain both occur within the LSA and are both classified as Order 2 streams.

3.7 Groundwater

Some rural residents within the RM of Dauphin source water from groundwater within shallow aquifers in sands and gravel deposited by glaciers. Deeper bedrock aquifers of limestone, sandstone, and shale from the Jurassic Formations are considered to be saline and are likely an insignificant source of domestic groundwater use in the LSA. These aquifer zones, however, may have significant flow zones. The saline water in the area may contain dissolved solids concentrations between 5,000 and 100,000 milligrams per litre (mg/L) (Rutulis, 1986).

The aquifers overlaying bedrock within the region are within the lenses of the sand and gravel of the surficial deposits. Bedrock aquifers consist of sandstone and sand as part of the Cretaceous Swan River Formation. The depth to these aquifers can range from a metre to tens of metres. It is reported that wells generally yield around 1.0 litres per second (L/s), but more than 10 L/s is not unusual. However, within the region, water quality is reported to range from excellent to poor to slightly salty and salty water in some areas. The total dissolved solids range from 5,000 to greater than 100,000 mg/L (Rutulis, 1986).

A search of the Manitoba GWDrill (2022) logs for groundwater wells within the LSA found thirteen (13) registered groundwater wells. Outlined in **Table 2** are the well identification number and groundwater use. The groundwater well search results are included in **Appendix B**.

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[2] Drainage systems may be classified in terms of " stream order" and range in size from 1st order to 7th order with the higher the number indicating the largest and most complex size of stream. Examples of first and second order streams include small swales, depressions or anthropogenic ditches in which water runs only sprig or after heavy rains; this may include ditches along municipal roads. Third order streams are larger in size, many are anthropogenic in origin including municipal and highway road drains and have significantly measurable flow of surface water runoff during spring and after heavy rains. Fifth order and higher streams typically have year-round flows, and are large, "natural" waterways such as the Assiniboine and Red Rivers.

Table 2. Groundwater Use Well Records within the LSA

Legal Land Location	Well PID (GWDrill, 2022)	Groundwater Use
SW-23-25-19W	5682	Production
	162642	Production
SW-24-25-19W	12542	Test Well
NE-24-25-19W	193215	Production
	13906	Test Well
	45506	Test Well
SE-25-25-19W	7159	Test Well
NW-24-25-19W	173194	Production
	176594	Production
SE-23-25-19W	155200	Production
SE-26-25-19W	7158	Test Well
NE-23-25-19W	7160	Test Well
NW-23-25-19W	162640	Production

3.8 Vegetation, Wildlife and Habitat

The native vegetation of the Dauphin Ecodistrict originally consisted of trembling aspen stands and bluffs separated by shrubs, dominantly beaked hazelnut, red-osier dogwood, high bush cranberry, rose, pin cherry and saskatoon. As a result of cultivation, much of the native vegetation in the district has been replaced by agricultural development (Smith et al., 1998).

Habitat for wildlife species is limited within the LSA due to the predominance of agricultural production and is primarily associated with the riparian zones of the Vermilion River and Salt Creek. Species which persist in the LSA and the surrounding region have adapted to the agricultural landscape and include species such as white-tailed deer, jack rabbit, racoon, skunks, red fox, voles and mice, as well as various bird species such as crows, blackbirds, and songbirds.

3.9 Aquatic Habitat

A fish community and fish habitat inventory of streams and drains conducted between 2002 and 2006 by the Department of Fisheries and Oceans Canada (DFO) Central and Arctic Region in agricultural areas of Manitoba identified the Vermilion River as a Type A fish habitat, indicating it has complex habitat that may support indicator fish species[3]. An assessment of the Vermilion River was completed as part of this report at a location approximately 1.8 km west of the Dauphin Lagoon with fish sampling effort resulting in the capture of several forage fish species, including: common shiner (*Luxilus cornutus*) , creek chub (*Semotilus atromaculatus*), fathead minnow (*Pimephales promelas*), Johnny darter (*Etheostoma nigrum*), longnose dace (*Rhinichthys cataractae*), river darter (*Percina shumardi*) and western black nose dace (*Rhinichthys atratulus*) with common carp (*Cyprinus carpio*) in the area also detected (Milani, 2013).

[3] Indicator species = those fish species of sport, commercial, domestic value and at-risk species.

3.10 Potential Species of Conservation Concern

For the purposes of this EAP, Species of Conservation Concern (SOCC) are identified as floral or faunal species that are:

- protected by the Federal *Species at Risk Act* (SARA);
- protected by Manitoba's *Endangered Species and Ecosystems Act* (MBESEA);
- those listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as threatened, endangered, or special concern; and,
- those that are tracked as S1, S2, and S3 by the Manitoba Conservation Data Centre (MBCDC).

As previously mentioned, habitats that may support wildlife and aquatic species are primarily associated with the riparian areas of the Vermilion River and Salt Creek. A request was submitted to the MBCDC on May 16, 2024, for a search of any records they may have for SOCC historically found to occur within the LSA and within 2 and 5 km of the LSA (refer to **Appendix C** for a complete listing of species). No listed or tracked species occurrences have been recorded for the LSA. Six historic observations for SOCC have been recorded within 2 km of the LSA, including four bird species (Sprague's pipit, bobolink, barn swallow and prairie loggerhead shrike), one amphibian species (plain's spadefoot toad), and one invertebrate species (yellow-banded bumblebee); the most recent recorded observation was for the yellow-banded bumblebee in 1962.

The very southern portion of the LSA (SW and SE 23-25-19WPM and SW 24-25-19WPM) is located within a critical wildlife habitat block for the red-headed woodpecker (*Melanerpes erythrocephalus*). This species is listed as "Threatened" both under Schedule 1 of the SARA (S.C. 2002, c. 29) and Manitoba's ESEA. In Manitoba, red-headed woodpecker breeding habitat consists of open mature woodlots; aspen dominated forests with small amounts of elm and oak; bluffs (clumps or grove of trees) in pasture or cropland that have an open or grazed understory; farmyards and shelterbelts with mature and dying trees (elm, maple, ash); and riparian habitat with aspen (*Populus tremuloides*), cottonwood (*Populus deltoides*), and oak (*Quercus macrocarpa*) (ECCC 2019).

Red-headed woodpeckers are cavity nesters of large, decadent deciduous tree species (diameter breast height of 50 cm or more). The removal of decadent trees in urban areas and decreased snag abundance is a leading cause of decline in species abundance (ECCC 2019).

It should also be noted that as much of the LSA consists of agricultural land, potential SOCC within the LSA are likely limited to wooded natural areas primarily located along stream channels and in small areas/pockets in non-cultivated areas where setback distances will be accounted for as part of the land application program.

4 DESCRIPTION OF THE SOCIOECONOMIC ENVIRONMENT

Any future agricultural lands participating in the land application program not discussed in this EAP, will be reviewed for proximity to parks, protected areas, and Indigenous and Crown Lands prior to inclusion in the program.

4.1 Public Engagement

Dauphin has undertaken public engagement for the proposed land application program through the posting of a webpage on the city's website https://www.dauphin.ca/p/city-of-dauphin-biosolids. The webpage provides information on the program as well as a *Frequently Asked Questions* section. **Appendix D** provides a screenshot of the webpage as well as a copy of the Program Details provided in the link on the webpage. A public comments link for the program was provided on the webpage and was open for comment between November 1, 2023, and January 15, 2024. The comments post was monitored by the city, and questions/comments/concerns were received via the public post. To date, only one comment has been received and reviewed by Dauphin officials. The respondent wished to express their concern about the pharmaceutical and non-pharmaceutical drugs that are disposed through Dauphin wastewater treatment system.

Dauphin has also held an informal discussion with local landowners to gauge interest in their participation in the program and future land application events.

4.2 Population and Economic Characteristics

The settled populations within and adjacent to the LSA include Dauphin, with a population of 8,368 individuals (Statistics Canada, 2021), and rural residents, with a total population in the RM of Dauphin of approximately 2,136 individuals (Statistics Canada, 2021).

4.3 Parks, Open Spaces, and Trails

There are several community green spaces and parks located within Dauphin, including the Vermilion Park Campground. No provincial parks, protected areas or wildlife management areas were identified within or adjacent to the LSA.

4.4 Heritage Resources

No heritage resources are anticipated to be affected by the land application program as the LSA includes primarily agricultural land influenced by farming practices (e.g., tillage), and setback distances will be established from the Vermilion River and Salt Creek so that residuals/soil disturbance from the application will only be occurring on existing agricultural land.

4.5 Quarries and Leases

According to a review of the iMaQs integrated online mapping resource (Manitoba Mines Branch n.d.), there are no quarries, mineral dispositions, or quarry leases within the LSA.

4.6 Indigenous Communities

In addition, according to the iMaQs integrated online mapping resource, there are no Indigenous communities or Treaty Land Entitlements/claims within the LSA (Manitoba Mines Branch n.d.).

5 RESIDUALS QUANTITY AND QUALITY

5.1 Residuals Quantity

The quantity of residuals was assessed in the lagoon cells by a subcontractor (Assiniboine Injections) retained by the Dauphin in the winter of 2024. Quantification of the residuals volume was completed on January 4, 2024, for the aeration cell and cells 3, 4, 5 and 6 and on February 13, 2023, for cells 1 and 2 by drilling holes through the frozen surface of the lagoon cells with an ice auger in a grid pattern. Surveyors used a sludge gun to find the top layer or the sludge blanket. Surveyors then probed the bottom of the cell to detect the depth of the lagoon cell floor. The sludge depth was then determined by gauging the top of the sludge blanket to the lagoon cell floor. The average sludge depth was then calculated for each lagoon cell, and the sludge volume was calculated based on depth and cell area (refer to **Appendix E** for maps of lagoon cell sludge depth). **Table 3** provides a summary of estimated residual quantities in the lagoon cells.

Table 3. Estimated Residuals Quantity from Dauphin Lagoon Cells

Description	Unit	Aeration Cell	Cell 1	Cell 2	Cell 3	Cell 4	Cell 5	Cell 6
Average Residual Depth	m	1.516	0.277	0.286	0.3	0.378	0.176	0.1524
Reported Volume	m^3	65,600	15,785	16,280	19,890	24,324	12,320	20,662
15% Contingency Factor	m^3	9,840	2,367	2,442	2,983	3,648	1,848	3,099
Volume with Safety	m^3	75,440	18,152	18,722	22,873	27,972	14,168	23,761
Mass	Tonne	75,440	18,152	18,722	22,873	27,972	14,168	23,761

Note: Assume a specific gravity of 1 g/cm^3

5.2 Residuals Quality

A composite sample of residual materials from each lagoon cell was also collected and submitted to ALS Laboratory Group for analysis of nutrients and metals. The Certificate of Analysis is presented in **Appendix F**.

5.2.1 Nutrient Content

To determine environmentally sustainable and agronomically appropriate biosolid prescription rates, it is important to determine nutrient quality for the biosolid material and then tailor the application rate based on targeted crop uptake and removal rates and soil fertility concentrations. The nutrient values currently determined will be utilized to evaluate the prescription rates and are outlined in **Table G.3** in **Appendix G**.

When utilizing an organic source as a fertilizer, only a portion of the total nitrogen is immediately available. A portion of the total nitrogen is in the organic form and goes through a mineralization process. Mineralization is the conversion of organic nitrogen to ammonium nitrogen. Like livestock manure, the anticipated mineralization rate for year one is 25 percent, for year two is 12 percent and for year three is 6 percent. Residual nutrients are typically not in balance with the nutrient requirements of most crops and while phosphorus is usually found in residuals in smaller quantities than nitrogen, crops also require significantly less phosphorus than nitrogen to achieve target yields. Thus, when land application of residuals occurs, the application rate is typically based on phosphorus and target a multiple of a crop's phosphorus removal rate.

5.2.1.1 Nitrogen

At a Carbon to Nitrogen (C:N) ratio that exceeds 30:1, N becomes a limiting nutrient for decomposer organisms, and this can reduce the rate of decomposition and results in N immobilization. The C:N ratio for the Aeration Cell and Cells 1 through 6 residual material is below the 30:1 threshold thus mineralization will continue at anticipated rates.

The plant available nitrogen in year 1 for the Aeration Cell and Cells 1 to 6 are between 6.4 and 0.8 kg per Tonne (**Appendix G, Table G.3**). In the subsequent year (year 2), the estimated plant available nitrogen is estimated to be between 2.3 and 0.3 kg per Tonne for Aeration Cell and Cells 1 to 6 and in year 3, the estimated plant available nitrogen is between 1.2 and 0.1 kg Tonne for Aeration Cell and Cells 1 to 6.

5.2.1.2 Phosphorus

With a Carbon to Phosphorus (C:P) ratio between 200:1 and 300:1, mineralization and immobilization balance each other to result in no net release of P from the decomposing manure. When C:P is below this range, P is released, and when above this range, P will be tied up and not released for crop use. The residuals of the Aeration Cell and Cells 1 to 6 C:P ratios are below this range, and therefore, P is anticipated to be released (**Appendix G**, **Table G.3**).

When animal and municipal wastes have N:P ratios ranging from 1:1 to 1:2 and are applied based on N rates on soils, over time, P will accumulate. The Aeration Cells and Cells 1 to 6 residual material N:P ratios are determined to be 3.4:1, 2.8:1, 3.6:1, 2.8:1, 1.5:1, 3.1:1 and 3.4:1, respectively; thus it is anticipated that P will not accumulate when applied at a sustainable rate.

5.2.2 Salinity

The residual materials from the aeration cell and Cells 1, 2, 3, 4, 5 and 6 have electrical conductivity (E.C.) values of 2.48, 1.7, 1.39, 2.15, 2.39, 1.89 and 2.37milisiemens per centimetre (mS/cm), respectively, and Sodium Absorption Ratios (SAR) of 3.86, 1.64, 4.7, 1.82, 2.11, 3.3, and 1.7, respectively. The residual materials may be considered as "slightly-saline" and, as such, pose a slight environmental risk for soil salinization, as soil E.C., soluble ions (e.g., sodium, potassium, chloride, and sulfate), and SAR increase directly with the rate application. Comparatively, the reported salinity is less than or similar to hog manure as reported by Racz and Fitsgerald (2001), where it was found that the mean E.C. (based on 145 Manitoba hog manure samples) has a value of 16.0 dS m^{-1} and a SAR of 5.1. It is reported by Sullivan et al. (2007) that repeated biosolid applications in soil did not result in detrimental salt accumulations in soil even at locations with low precipitation and no irrigation. Sullivan et al. (2007) reported that annual applications of dewatered cake biosolids (80 percent moisture) that have been made for over 10 years have not increased soil salinity above 1 mmho cm^{-1}.

Salinity analysis results for the lagoon cells' residuals are found in **Table G.1** in **Appendix G**.

5.2.3 Trace Metals

In "The Effect of Biosolids on Crops, Soil and Environmental Quality, A Summary of the Research" conducted by the Department of Soil Science at the University of Manitoba, Fitzgerald and Racz (1999) reported that for loading rates for City of Winnipeg biosolids (i.e., 0, 50, 100, and 200 tonnes per hectare) cadmium was not mobile and was not plant available and that very little of the cadmium was taken up by wheat plants. It was also reported that for concentrations of other heavy metals (e.g., copper, zinc, nickel, and lead), no consistent effect on the heavy metal content of wheat grain was observed due to increasing rates of added biosolids. Fitzgerald and Racz concluded that heavy metals in the biosolids-treated soils were similar to that of wheat produced in the Canadian Prairies and that loading rates as high as 200 tons per hectare (t ha^{-1}) did not affect grain quality.

For the residual materials in the Dauphin Lagoon cells, the metals of principal concern to agriculture include arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Manitoba Conservation and Water Stewardship (MCWS) previously established cumulative loading rates for each of these metals. The cumulative weight per hectare of each heavy metal in the soil is calculated by adding the amount of each metal in the biosolid at the prescription rate to the background soil level of the same metal. As the EAP has not determined actual soil metal concentrations at this time, mean trace element concentrations were obtained from the Haluschak et al. (1998) study for selected trace elements in agricultural soil of southern Manitoba. Actual metal loading rates to the soil within LSA will be determined based on infield soil results and prescription application rates, as discussed in Section 6.3. Based on an application rate of 14 tonnes per ha for Aeration Cell, and the mean concentrations of trace elements, the metal loading rates will be below the limit criteria (**Table G.4 in Appendix G).** As Cells 1 through 6 are comparable in trace element concentrations to the Aeration Cell, it is anticipated that the residual trace element loading will be similar.

5.2.4 Emerging Substances of Concern

Emerging substances of concern (ESOC), including pharmaceuticals, antibiotics, endocrine-disrupting chemicals (EDCs), hormones and personal care products (PPCPs), continue to be studied in Canada and around the world to assure environmental and public safety (CCME, 2012a). ESOCs continue to emerge due to the development of new detection methods and changes in technologies (McCarthy, 2015). In general, most ESOCs are found in very low concentrations (nanograms) in wastewater residuals and do not necessarily imply risk to the environment or human health based on detection (CCME, 2012a). In 2009, CCME reviewed ESOC Concentrations and Effects of Treatment Processes in major Cities across Canada and identified 22 significant findings, of which seven are reported below:

- Of the 24 pharmaceutical, alkyklphenolic and fragrance compounds found in detectable concentrations in more than 75% of the in-going sludge, only 14 of 71 pharmaceutical, alkyklphenolic and fragrance compounds (20%) were found in more than 75% of the treated biosolids samples likely to be land applied.
- The antibacterial compounds triclosan and triclocarban, the antibiotic ciprofloxacin and the fragrance compound HHCB were the compounds most frequently detected (9 of 11 sites) above 1,000 nanograms per gram ng/g TS (dry).
- A few pharmaceutical compounds appear to be removed readily by either aerobic or anaerobic biological treatment, including sulfamethoxazole, trimethoprim, caffeine and diltiazem.
- A limited number of pharmaceutical compounds appeared to be difficult to remove in almost all processes examined when present at detectable concentrations. These included the diuretic furosemide, the anti-epileptic carbamazepine, and the antibiotic ofloxacin.

- Naproxen appears to increase substantially through aerobic composting, possibly due to biotransformation from other compounds, but it appears to be more efficiently removed by anaerobic digestion.
- While many of the ESOC remain associated with the solid phase of the sludges and residuals, a number of compounds can be lost in any aqueous process sidestream (e.g., dewatering filtrate, leachate, digester supernatant), including furosemide, ibuprofen and 2-hydroxy-ibuprofen, naproxen, acetaminophen, caffeine, carbamazepine, clarithromycin, dehyrdronifedipine, erythromycin-H2O, sulfamethoxazole and trimethoprim.
- Less than 1% of the mass of fragrance compounds in feed sludge resides in the process sidestreams or leachates from the treatment processes, while between 1% and 6% of the mass of Bisphenol A in the feed sludges were transferred to the process sidestreams or leachates.

The Canadian Municipal Water Consortium (Canadian Water Network) commissioned Dr. Lynda McCarthy with Ryerson University to complete a literature review for information pertaining to ESOC that was entitled: *Risks Associated with Application of Municipal Biosolids to Agricultural Lands in a Canadian Context*. The literature review was conducted in order to summarize current knowledge on the occurrence, fate and potential risks of ESOC and pathogens present in biosolids after application to agricultural land (in conditions relevant to Canada). Based on the few existing risk assessments it is suggested that the presence of ESOC and pathogens poses a low risk to human and environmental health. It was found that the limited number of risk assessments is due to limited data; toxicity and ecotoxicity data for ESOC is generally not available.

McCarthy's literature review evaluated the fate of biosolids related ESOC and pathogens after land application. It was concluded that determining the fate of ESOCs and pathogens after land application is complex, site-specific to ESOC and pathogen characterizations and properties (e.g., water solubility and partition coefficient) and environmental variables (e.g., temperature, moisture, pH and organic matter content), and application methods, each factor of which limit the success of understanding the true fate. Generally, studies have concluded that most of the compounds found in biosolids do not reach groundwater after land application and that the concentrations ESOCs and pathogens in tile drainage and surface runoff are much lower than typical concentrations found in wastewater treatment plant effluent.

McCarthy's literature review also concluded that ESOC uptake by plants may be an overestimate due to the proof-of-concept approach to demonstrating the uptake. The limited number of risk assessments has demonstrated, however, that the risk to human health from the consumption of plants grown in biosolids-amended soils under relevant conditions was considered minimal risk and that although the presence of ESOC in soil, crops or soil organisms may not be desirable, the sole presence of chemicals does not constitute proof of negative impact to the soil ecosystem.

While ESOC are likely to present in the Dauphin wastewater treatment lagoon residuals, as Dauphin is not a major centre of industrial manufacturing or chemical processing, the direct source of ESOC is from residential sources and would be limited even more in concentration than major cities. Currently, there are no federal or provincial requirements to address ESOC in residuals land application programs.

6 RESIDUALS LAND APPLICATION PROGRAM

To assess whether lands within the LSA are suitable to receive residuals, a desktop assessment of the LSA soils was completed that included a review of the dominant soil series, agricultural capability, nutrient management zone classes and anticipated agronomic practices of the participating landowner as outlined below.

6.1 Agricultural Land Requirements

6.1.1 Selection of Agricultural Land

A list of agricultural producers from the RM of Dauphin (within 2 km of the existing lagoon site) that have expressed interest in receiving residuals onto their agricultural fields is being developed. Agricultural fields put forward by these producers will be assessed for suitability based on soil characteristics (e.g., agricultural capability, residual soil nutrient levels) and agronomic practices (e.g., crop rotation, nutrient management). This information will then be mapped to select agricultural fields to be used in a four-year rotation for the program.

Currently, the land parcels identified in the LSA are under consideration for application events for the program.

6.1.2 Canada Land Inventory – Soil Capability for Agriculture

The Water Protection Act (C.C.sMc W65, 2005) Nutrient Management Regulation (62/2008) outlines nutrient application restrictions based on Canada Land Inventory Soil Capability Classification for agriculture ratings (Government of Manitoba, 2008). The Canada Land Inventory (CLI) is a dry-land agriculture capability inventory for rural Canada. The CLI limitations are based on climate, geology, soil chemical and physical characteristics (salinity and structure), draughtiness, inundation, erosion, stoniness and landscape topography of the soils.

The CLI groups mineral soils into seven classes with the same relative degree of limitation and then delineates subclasses within each class based on the type of limitation (Fraser et al., 2001). Classes one to seven are based on increasing degree of limitation; the first three classes are capable of sustained cultivated crop production, class four is marginal for sustained arable cropping, class five is capable of pasture or hay, class six is capable of permanent pasture and class seven has no capability for arable drop of permanent pasture. There are thirteen different subclasses or limitations. Soils series within the LSA are identified as being of Classes 1, 2, 3, and 4 with subclass designations of D, N and W. The class descriptions are as follows:

- Class 1 – Soils in this class have no significant limitations when used for irrigation with a fine sandy loam to clay loam texture. The soils have good water retention capacity, good permeability, low salt content, good drainage and satisfactory gradient of land.
- Class 2 – Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The soils are deep and hold moisture well. The limitations are moderate, and the soils can be managed and cropped with little difficulty. Under good management, they are moderately high to high in productivity for a fairly wide range of crops.

- Class 3 – Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. The limitations are more restrictive that affect timing and ease of tillage, planting and harvesting, and the choice of crops and maintenance of conservation practices. One or more of the following limitations may include: moderate climatic limitation, erosion, structure, permeability, low fertility, topography, overflow, wetness, low water holding capacity or slowness in release of water of plants, stoniness, and depth of soil to consolidated bedrock. Under good management, they are fair to moderately high in productivity for a wide range of field crops.
- Class 4 – Soils in this class have severe limitations that restrict the choice of crops or require special conservation practices, or both. Only a few crops may be suited due to such limitations or low crop yields or higher risk of crop failure. These soils are low to medium in productivity for a narrow range of crops but may have high productivity for a specially adapted crop.

The subclass descriptions are as follows:

- "D" – Structure and/or Permeability – this subclass includes soils with adverse structure or permeability and may have a root zone restriction due to inherent soil characteristics. Class 2 soils include massive clay and till soils, class 3 soils are Solonetzic intergrades, and class 4 includes Solonetzic soils.
- "N" – Salinity – this subclass includes soils adversely affected by the presence of soluble soils. Soils are classed according to the most saline depth that are determined between 0-60 cm and 60-120 cm.
- "W" – Excess Water – this subclass includes soils where excess water other than brought about by inundation is a limitation to agricultural use. Excess water may result from inadequate soil drainage, a high-water table, seepage or runoff from surrounding areas.

Agricultural soil capability within the LSA is dominated by Classes 2 and 3, imperfectly drained soils with some poorly drained Class 5 soils in association with the intermittent drains present in the LSA. **Table 4** provides a summary of soils series, texture and CLI rating for soils within the LSA (also refer to **Figures 5 - 7, Appendix A**).

Table 4. Soil Series, Texture and CLI Rating within LSA

Soil Series	Surface Texture	Description	Area in LSA (ha)	CLI Rating
Halicz (HCZ)	Clay	imperfectly drained Gleyed Rego Black Chernozem	43.7	Class 2
Dauphin (DPH)	Clay	imperfectly drained Gleyed Rego Black Chernozem	103.8	
McClernon (MND xbxx)	Clay, very gently sloping	imperfectly drained, Gleyed Rego Black Chernozem	80.6	
Daly (DLY)	Clay	imperfectly drained, Gleyed Rego Black Chernozem	130.0	Class 3
Daly (DLY xxxs)	Clay, weakly saline		25.3	
Edwards (EWS)	Clay	imperfectly drained Gleyed Cumulic Regosol soils	173.8	
Hansen Creek (HEK)	Very fine sandy loam	imperfectly drained Gleyed Cumulic Regosol soils	7.4	
Fork River (FKV)	Fine silt clay to clay	Poorly drained Rego Humic Gleysolic soils	11.5	
Paulson (PUO)	Clay	poorly drained Carbonated Rego Gleysol soils	26.4	Class 5

6.2 Agronomy

Crops that can be grown on lands receiving wastewater residual materials include cereals and oil seeds. Application of residual materials will increase soil health (water-holding capacity, tilth) and provide beneficial macro (nitrogen, phosphorus, potassium, sulfur) and micronutrients (boron, copper, zinc, magnesium) to the soil for crop production. Any farm producer participating in the program (including those renting agricultural land from the City of Dauphin) will be advised of the benefits of residuals application and that the application of commercial fertilizers should only be completed to supplement nutrient levels from the residuals at agronomically sustainable rates.

Any agricultural producers that participate in the land application program will be required to sign a land use agreement that meets the terms and conditions of the program. Listed below are a few of the articles included in the agreement:

- Maintain an appropriate crop rotation for three years with cereal, oil seed, pulse, soybean and corn crops. No livestock grazing for a period of three years post application growing season (i.e., grazing can occur in 2028 if land applied in 2024);
- Conducting a nutrient management program that accounts for residual nutrients from the residuals application;
- Incorporation of residuals into the soil within 48 hours of application;
- Farm producers will permit soil sampling and analysis monitoring for a period of 3 full years after application; and,
- Land application occurs at no cost to the producer.

6.3 Land Application Rate Parameters

The prescription rate calculations are based on several key pieces of information and the basics of nutrient management with assumptions for determining available nutrient calculations. **Table 5** provides a summary of these inputs and assumptions.

Table 5. Land Application Nutrient Management Inputs and Assumptions

Categories	Inputs
Information Requirements	– Target crop and anticipated yield – this information is provided by the participating agricultural producer for three years following application. – Target nutrient recommendations to achieve the desired yield – this is based on the understanding of crop uptake and removal. Source of this information is typically sourced from the Manitoba Soil Fertility Guide. – Soil testing – soil sampling for nutrient and metals profile is completed (0-15 cm and 15-60 cm). – Residuals testing – testing of the nutrient and trace elements (metals) profile for the residuals is completed pre-application.
Assumptions	– Nitrogen Mineralization rates: – Estimated at 25% in year one. – Less than 12% in year two and less than 6% in year 3. – Plant available phosphorus: – Between 5 and 25% of total phosphorus.

Table 5. Land Application Nutrient Management Inputs and Assumptions

Categories	Inputs
Methods	– Residuals are directly injected into the soil; therefore, the estimated volatilization of ammonia loss is 0% regardless of weather (cool/wet, cool/dry, warm/wet and warm/dry, respectively).
Indicators	– If C:N exceeds 30:1 in the residuals, then N becomes a limiting nutrient for decomposer organisms, and this can reduce the rate of decomposition and results in N immobilization and loss of plant available nitrogen. – When C:P ratio is between 200:1 and 300:1 in the residuals, mineralization and immobilization balance each other to result in no net release of P from decomposing residuals. When C:P is below this range, P is released. – When animal and municipal wastes with N:P ratios ranging from 1:1 to 1:2 are applied based on N rates on soils, over time P will accumulate.

An example of the prescription calculation worksheet is provided in **Table G.3, Appendix G**.

6.4 Nutrient Management and Setback Distances

The Water Protection Act (C.C.sMc W65, 2005), *Nutrient Management Regulation (*NMR) (62/2008) outlines criteria for the application of nutrients (nitrogen and phosphorus) to agricultural land. The purpose of the NMR is to protect water quality by encouraging responsible nutrient planning. The objective to regulate the application of substances containing nitrogen or phosphorus to land is a protective measure for sensitive water bodies and/or groundwater.

To minimize risk to human and environmental health and safety from the land application of wastewater residuals, buffer zones will be established as outlined in the *Nutrient Management Regulation* and the Farm Practices Guidelines for Pig Producers in Manitoba (April 2007). Buffer zones around residential areas, residences, groundwater wells and surface water drainage systems will be established as outlined in **Table 6.**

Table 6. Nutrient Buffer Zones to be Established for Biosolid Application

Description	Recommended Buffer Zone Distance
No application on land where there is less than 1.5 m of clay or clay till between the soil surface and the water table	Exclusion of such areas from the program
Identifiable boundary of an aquifer which is exposed to the ground surface	100 m (328 ft)
On soils with a pH of less than 6.0	Exclusion of such areas from the program
On land where the slope is greater than 5%	Exclusion of such areas from the program
Setback Distances on Land Adjacent to Surface Water or a Surface Water Course[1]	
A roadside ditch or an Order 1 or 2 drain	No direct application to ditches and Order 1 and 2 drains
A groundwater feature	15 m (49 ft) – vegetated buffer 20 m (66 ft) – non vegetated buffer
A wetland, bog, marsh or swamp other than a major wetland, bog, marsh or swamp[a]	Distance between the water's edge and the high-water mark[b]
A lake or reservoir designated as vulnerable[c]	30 m (98 ft) - vegetated buffer 35 m (115 ft) – non vegetated buffer

Table 6. Nutrient Buffer Zones to be Established for Biosolid Application

Description	Recommended Buffer Zone Distance
A lake or reservoir (not including a constructed storm water retention pond) not designated as vulnerable[(c)] **A river, creek or stream designated as vulnerable**[(c)]	15 m (49 ft) - vegetated buffer 20 m (66 ft) – non vegetated buffer
A river, creek or stream not designated as vulnerable[©] **An Order 3, 4, 4 or 6 drain**[(d)] **A major wetland, bog, marsh or swamp**[(d)] **A constructed storm water retention pond**	3 m (10 ft) – vegetated buffer 8 m (26 ft) – non vegetated buffer
Setback Distances from Neighbours	
Designated residential areas, parks and protected areas[(2)]	1,000 m (3,280 ft)
Occupied Residence (other than the residence occupied by the owner of the land on which the residuals are to be applied)[(2)]	75 m (246 ft)
Property line with residence[(2)]	10 m (33 ft)
Property line without residence[(2)]	1.0 m (3.3 ft)

Notes:

[(1)] As outlined in the *Nutrient Management Regulation*

[(a)] As defined in 1(2) in the *Nutrient Management Regulation* under *The Water Protection Act*. "For the purposes of this regulation, a wetland, bog, marsh or swamp is major if:

- It has an area greater than 2 ha (4.94 acres);
- It is connected to one or more downstream water bodies or groundwater features; and
- It contains standing water or saturated soils for periods of time sufficient to support the development of hydrophytic vegetation.

[(b)] Nutrient Buffer Zone is measured from the water body's high-water mark or the top of the outermost bank on that side of the waterbody, whichever is further from the water.

[(c)] Designated as vulnerable if listed in the Schedule in the *Nutrient Management Regulation*

[(d)] Designated on a Manitoba Water Stewardship plan that shows the designation of drains.

[(2)] As outlined in: Farm Practice for Pig Producers in Manitoba (April 2007).

6.5 Best Management and Good Neighbour Practices

The following best management and good neighbour practices will also be implemented for the land application program:

- Informing both the RM and residents of properties adjacent to the agricultural field, which is to receive the residuals of the date of the commencement of the land application event and approximate timeline to complete the event. Notifications will include map of the application fields, application start date for the residuals, and contact information for the City of Dauphin will also be included. Notices will be provided door-to-door or via direct mail delivery.
- Restricting delivery, handling and application of residuals to weekdays.
- Addressing any odour or other concerns by the RM and local residents in a timely manner.

6.6 Application Logistics

In January/February of a given year in which residuals will be land applied, Dauphin will host a meeting with the Applicator contractor to discuss logistics of the application event (which lagoon cell[s] are scheduled for residual removal, equipment, transportation of residuals, spill management, schedule, etc.). Sensitive features and applicable buffer zones (refer to Section 6.4) will be identified around the receiving field(s), and georeferenced maps will be provided to the Applicator for upload to their application equipment that identifies sensitive features /setback distances.

The residuals will be dredged using a floating dredge, which pumps the slurry directly from the lagoon bottom through pipes to a nurse tank typically located at the lagoon berm. Through an umbilical pipe, the residuals are then pumped to the injection equipment at the agricultural field. These materials are then directly injected into the soil sub-surface in the fall after crop harvest at the calculated prescribed agronomic rates for the residual materials from the lagoon cell(s). Applicator equipment will be equipped with a Global Positioning System (GPS) and volume control measures to facilitate accurate land application.

Application events are expected to occur over a 5-to-7-day period. Application will only occur under favourable conditions (e.g., no rainfall; no excess soil moisture to prevent tracking and compaction) and after crop harvest.

6.7 Transportation, Route Planning and Spill Control

Six parcels of agricultural land (SW and SE25-25-19WPM, and NW, NE, SW, and SE24-25-19WPM) within the LSA that will receive the residual materials are located east of the wastewater treatment lagoon site, across a municipal road, while the other land parcels are located adjacent to the north and west sides of the lagoon site (SW and SE26-25-19WPM, and NW, NE, SW, and SE23-25-19WPM) (**Figure 2, Appendix A**). In order to direct pump, the residuals slurry material to the receiving lands and eliminate the need for tanker trucks to transport the materials, a review of available culvert locations will be conducted during a pre-application site visit to the area to identify culvert crossings that would accommodate a hose to pass under the municipal road to connect with the applicator's equipment. Any applicable permits/approvals required from Manitoba Transportation and Infrastructure, and/or the RM of Dauphin will be obtained for passing of application hoses through culvert crossings prior to the land application.

6.8 Greenhouse Gases

There are 10 primary greenhouse gases (GHGs), 4 of which are naturally occurring, including water vapour (H_20), carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Although the most abundant and dominant GHG in the atmosphere, water vapour is not used to assess GHG emissions as its presence is dependent on temperate and other meteorological conditions and not directly from anthropogenic activities (Centre for Sustainable Systems, 2022). The main GHG emissions associated with residuals managment include CO_2, CH_4 and N_2O (CCME, 2012b).

7 EFFECTS AND MITIGATION MEASURES

The following sections outline the potential environmental and socio-economic effects associated with the residuals land application program as well as the proposed mitigation measures that will be implemented for the program to minimize potential negative effects. A summary of the potential effects is provided in **Table 8**.

Table 7. Summary of Effects and Mitigation Measures

Potential Biophysical Effects	Proposed Mitigation Measures
Soil Quality Effects	
Nutrient Loading	Targeted prescriptions, cropping systems, soil monitoring, participating agricultural producer nutrient management, uniform application procedures, GPS tracking of application loads, auto-steer equipment, calibrated equipment.
Metals	Residuals monitoring, soil monitoring, soil chemistry, CCME guidelines.
Salinity and Sodicity	Residuals monitoring, soil monitoring, CCME guidelines.
Soil Compaction	Restrict travel to field entrance and field edges, heavy equipment fitted with flotation tires, calibrated equipment and wide row spacing.
Water Quality Effects	
Groundwater	Compliance with all Provincial regulations and the establishment of setback distances of 20-15 m from groundwater wells[4] and 100 m from an identifiable boundary of an aquifer which is exposed to the ground surface or gravel and sand lenses, 1.5 m clay underlay at application sites, targeted prescription rates, soil monitoring.
Surface Water	Compliance with all Provincial regulations. Targeted prescription rates, setback distance of 30 m from lakes and 15 m from rivers, creeks and Order 3 or greater drains, direct injection, cropping systems, soil monitoring.
Socio-economic Effects	
Pathogens	Tillage, climate exposure, setback distances, restricted access, exposure time between application events and harvest.
Odour	Setback distances, tillage.
Emerging Substances of Concern	Climate exposure, microbial degradation, photo-degradation, direct injection, setback distances, restricted access, separation in time between land application event (fall) and crop harvest (the next fall).
Noise and Dust from Residuals Transport	Use of paved roads where possible, hauling during regular work hours, maintain equipment in good working order, regular inspections.
Accidents and Malfunctions	Maintain equipment in good working order, spill control/response plan.

[4] Dependent upon presence of vegetative cover in buffer area surrounding feature.

7.1 Potential Biophysical Effects

7.1.1 Soil Quality Effects and Mitigation

7.1.1.1 Nutrient Loading to Soil

The objective of the proposed program is to manage nitrogen and phosphorus based on beneficial farm management practices and following prescription rates based on residual soil nutrient levels and residuals quality, as well as, per applicable regulations. Residuals will be applied based on nutrient requirements for each agricultural field.

Prescribed nitrogen and phosphorus rates will target the uptake and removal ability of small grains, oil seed, pulse and soybean crops and corn. The land application program will be compliant with the regulatory requirements outlined in the *Nutrient Management Regulations* of *The Water Protection Act* for both maximum residual nitrogen and phosphorus criteria in nutrient management zones N1, N2 and N3.

Post-harvest soil monitoring will be conducted on the participating agricultural fields for three years post application of residuals to monitor nutrient loading within the soils. Soil sampling and analysis will be completed as follows: sodium bicarbonate extractable phosphorus in 0-15 cm and nitrate-nitrogen and total nitrogen in 0-15 cm and 15-60 cm. Participating agricultural producers will be required to manage their nutrient program based on the annual soil residual nitrogen and phosphorus levels assessed through the monitoring program. This information will be supplied to the Director of the Environmental Approvals Branch by March 31 of each year following the application of residuals.

Nitrogen leaching to groundwater is not a significant concern (refer to Section 3.7) within the LSA as the soils are primarily clay textured, imperfectly drained soils. In addition, by applying the residuals at prescribed rates that optimize crop uptake and by establishing buffer zones around sensitive features, the risk of surface runoff into the Vermilion River drainage system will be minimized.

Mitigation Measures: Targeted prescriptions, cropping systems, soil monitoring, participating agricultural producer nutrient management, direct injection.

7.1.1.2 Metals Accumulation in Soil and Crops

To prevent overloading of trace elements (i.e., metals) into soils, the prescribed application rates provide cumulative weight criteria for metals that are below the permitted soil guidelines established by the CCME.

The loading rates for trace elements in the residuals from wastewater treatment cells have been determined based on the theoretical maximum application of 14 dry tonnes per hectare, respectively, as presented in **Table G.4** in **Appendix G**. These calculated heavy metal loading rates to the soil in the LSA are all below the cumulative weight criteria.

Mitigation Measures: Benchmark soil sampling, residuals analysis, mass balance calculations, direct injection, CCME guidelines.

7.1.1.3 Salinity and Sodicity

The residual materials may be considered as “none-saline” and, as such, does pose a slight environmental risk for soil salinization, as soil E.C., soluble ions (e.g., sodium, potassium, chloride, and sulfate) and SAR increase directly with rate application. The residual materials’ salinity is less than hog manure (Racz and Fitzgerald, 2001) and it is reported by Sullivan et al. (2007) that repeated residuals applications in soil have not resulted in detrimental salt accumulations in soil even at locations with low prescription and no irrigation.

The majority of the land base within the LSA is non-saline, and only the Daly (DLY xxxs) soil series is identified as weakly saline (4-8 dS m^{-1}) (Langman, 1984). The Daly (DLY xxxs) soil series is limited in extent (25.3 ha) (**Figure 4**, **Appendix A**), and with the Daly (DLY xxxs) soil series included, the cumulative effect of salinity is not considered significant with the limited application of residuals.

To prevent overloading of salts in the soils, the prescribed application rates will limit salinity loading to agricultural fields. Benchmark soil sampling will aid in the identification of soils where natural salinity may be present and if additions through the residuals land application may demonstrate a risk.

Mitigation Measures: Benchmark soil sampling, land rotation, CCME guidelines

7.1.1.4 Soil Compaction

Soil compaction is the clasping together of soil particles, reducing the space available for air and water, thus increasing the density of the soil. Soil compaction impacts water and air movement, seedling emergence, root growth and may reduce yield potential of a field. The soil series identified within the LSA may be susceptible to physical compaction due to the clay texture.

Soil compaction may occur at entrances to the fields within the LSA due to heavy equipment traffic entering fields for residuals application. As these entrances are typically utilized by farm producers with heavy farm equipment for crop production activities, soil compaction in these areas is likely not of great concern. In addition, winter frost action also aids in the mitigation of soil compaction. However, should the farm producer have a concern with the potential compaction, field entrances may be deep ripped to mitigate compaction.

It should also be noted that the field equipment utilized to complete the land application of the residual materials is equipped with large floatation tires to minimize the compaction potential. Land application is completed with a single pass of direct injection equipment towing an umbilical pipe, and therefore, there is no large mass of equipment passing over repeated tracks.

Mitigation Measures: Restrict travel to field entrance and field edges, heavy equipment fitted with flotation tires, application equipment capable to provide even application with a wide row spacing, umbilical pipe to pump residual liquid.

7.1.2 Water Quality Effects and Mitigation

7.1.2.1 Surface Water and Fisheries Impacts

Of primary concern associated with the land application of residuals is the leaching and/or surface runoff of nitrogen and phosphorus into the ground or surface water if application rates exceed crop removal rates and soil storing capacity. Nitrogen and phosphorus levels in the residual materials and soil will be managed through the annual development of targeted prescription rates.

Potential impacts to surface water and fish within the Vermilion River/Salt Creek drainage system include nutrient loading from surface runoff. However, the impact to surface water and fish is considered low as residual material will be applied at agronomically appropriate rates and will be injected directly into the soil, thereby minimizing the potential of overland flow to the drainage system. In addition, appropriate setback distances of 8 m will be established around all Order 3 or higher drains (**Figure 8**, **Appendix A**).

Mitigation Measures: Targeted prescriptions, setback distances, 1.5 m clay underlay, direct soil injection of residuals, cropping systems, soil monitoring and compliance with Manitoba Acts and Regulations.

7.1.2.2 Groundwater Impacts

Groundwater pollution within the RM of Dauphin may be a concern as much of the area has sand and gravel deposit aquifers, however well records for the LSA indicate that depth of wells developed into the sand and gravel aquifers ranges from 18 to 46 m below grade. In addition, soil texture in the LSA ranges from silty clay to fine clay material with depths greater than 1.5 m.

Application of the residual materials at agronomically appropriate rates for nitrogen and phosphorus will ensure plant uptake of these nutrients over the growing season, thereby further minimizing the potential of leaching to the groundwater. In addition, appropriate setback distances will be established around all residences and domestic wells, as outlined in **Table 6** in **Section 6.3**.

Mitigation Measures: Targeted prescriptions, setback distances, 1.5 m clay underlay, cropping systems, soil monitoring and compliance with Manitoba Acts and Regulations.

7.1.3 Vegetation, Wildlife and Species of Conservation Concern

Impact to wildlife and wildlife habitat is considered to be low as land within the LSA primarily consists of cultivated land with minimal natural vegetative cover available as habitat located primarily along the Vermilion River and Salt Creek. In addition, the timing of residuals application will occur in the fall, outside of the breeding bird window.

Based on the MBCDC search results and limited natural habitat within and adjacent to the LSA, the potential for SOCC to be located within the LSA is low. However, should SOCC or their habitat be identified within 100 m of a selected agricultural field, appropriate mitigation measures will be developed and implemented (e.g., establishment of setback distances from natural area/habitat).

The wooded area associated with the Vermilion River and Salt Creek may have the potential to provide habitat for red-headed woodpeckers; however, setback distances from these waterways will be accounted for as part of the land application program. Thus, potential negative effects to red-headed woodpecker habitat from the land application program would be anticipated to be negligible to minimal.

Mitigation Measures: Existing land use, timing of application, setback distances, cropping system.

7.1.4 Greenhouse Gases

GHG emissions within the context of this residuals land application program are carbon dioxide, methane and nitrous oxide. The activities related to GHG contributions are limited to the equipment emissions that will be used to transport, and direct inject residual materials as well as natural decomposition of land applied organic matter in the soil. Land application of residuals provides significant benefits through the reduction of GHG production that occurs with landfill disposal, carbon sequestration in soil organic matter and reduced use of inorganic commercial fertilizers from petroleum-based sources within the LSA. These three benefits are reported to counterbalance the potential emissions due to mechanical needs for the land application program (CCME, 2012b).

7.2 Socio-Economic Effects

The application of residuals to agricultural land provides a positive economic benefit to both the farm producer and Dauphin. The objective of providing prescription application rates for residuals to crops is to provide an organic source for nutrient management. As outlined, residuals provide macro nutrients (nitrogen, phosphorus, potassium, and sulfur) and micro-nutrients (boron, copper, iron, chloride, manganese, molybdenum, and zinc), all of which provide economic value to the farm producer. For example, based on the average fertilizer commodity price between October 2020 and February 2024 for Urea (46-0-0) and Triple Super Phosphate (0-45-0), the

following economic value, as presented in **Table 9,** can be recognized from the prescribed residual land application of two times crop removal of P_2O_5.

Table 8. Economic Value for Nitrogen and Phosphorus in Applied Residuals

Nutrient	Average Market Price (Oct. 2020-Feb. 2024)	Application Rate	Value of Applied Residuals
Available Nitrogen	$0.81/kg	157 kg/ha	$127.17/ha
Total Available P_2O_5	$1.37/kg	101 kg/ha	$138.37/ha

The residual materials is being provided at no charge to the farm producer, thus reducing his fertilizer bill by approximately $265.54 per hectare depending upon the source of residuals (Aeration Cell or Cells 1 to 6) (**Table 9**). For example, for the Aeration Cell with an anticipated 2,263 dry tonnes of residuals, at an application rate of 14 dry tonnes per hectare, this would require approximately 161 hectares of land. This equates to approximately $40,612 of nutrient value in year one and does not account for multiple years of available nitrogen and phosphorus. It also does not account for the added benefit of potassium, sulfur, and additional micro-nutrients in year one or for multiple years. Hence, the economic benefit to the farm producer is substantial based on the savings the farm producer will incur for crop fertilizer amendments in year one and subsequent years. It should also be noted that the economic benefit to the RM of Dauphin is recognized from no land use fees being paid to the farm producer for the application of the residuals, whereas, if the residuals were disposed of in the local landfill, the tipping fee would represent a significant cost to the RM of Dauphin.

7.3 Public Safety, Health Effects

7.3.1 Public Engagement and Perception

The City of Dauphin undertook an online (dedicated webpage) public engagement program to inform the public of what is involved with a residuals land application program and solicit feedback of public perceptions and legitimate concerns regarding the program.

To ensure continued public engagement and transparency the city is committed to ensuring all annual reporting is made publicly available.

7.3.2 Biological Pathogens

Biological pathogens such as *E. coli* and fecal coliforms, as well as nuisance odour associated with land application of residuals may be considered to pose a public health and safety risk. However, the human health and safety risks will be managed through the application of the residuals onto private lands that have restricted public access. In addition, direct injection of the residuals into the soil will minimize odour and eliminate human exposure to pathogens. Pathogens from residuals are often killed by exposure to sunlight UV, drying conditions, unfavourable pH and other macro and micro environmental conditions. Lands that receive residuals will also be managed on a crop rotation system for three years, which includes non-root/vegetable crops and excludes livestock grazing.

As well, appropriate setback distances including 1,000 m from residential areas, 75 m from occupied residences (other than the residence occupied by the owner of the land on which the residuals are to be applied), 10 m from property lines with a residence and 1 m from property lines without a residence will be adhered to throughout the application program.

Mitigation Measures: Direct soil injection of residuals, climate exposure, setback distances, restricted access, separation in time between land application event (fall) and crop harvest (the next fall).

7.3.3 Odour Management

While it is not possible to entirely eliminate odour as an effect from the program, mitigation measures that include the use of best management and good neighbour practices will be employed to minimize odour issues associated with the land application of residuals. Best management practices that will be employed include the direct injection of residuals into the soil to reduce odour as well as the establishment of applicable setback distances from residences. Examples of good neighbour practices are to respect complaints; this includes recording the complaint details, investigating the complaint, identifying corrective actions and responding back to the complainant about the findings and the corrections imposed.

Additional examples of odour management include addressing concerns within a short time frame, restricting delivery, handling and application of residuals to weekdays and providing a city contact for odour issues to neighbours.

Mitigation Measures: Good neighbour policy, complaint resolution procedures, city contact for odour issues, setback distances, direct injection.

7.3.4 Emerging Substances of Concern (ESOC)

ESOC include pharmaceuticals, antibiotics, endocrine-disrupting chemicals (EDCs), hormones, and personal care products (PPCPs) continue to be studied in Canada and around the world to assure environmental and public safety (CCME, 2012a). ESOC continues to emerge due to the development of new detection methods (e.g., culture and identification of pathogens) and changes in technologies (McCarthy, 2015). In general, most ESOC are found in very low concentrations (nanograms) in wastewater residuals and do not necessarily imply risk to the environment or human health based on detection (CCME, 2012a).

Mitigation Measures: Climate exposure, microbial degradation, photo-degradation, direct injection into soil, setback distances, restricted access, separation in time between land application event (fall) and crop harvest (the next fall).

7.3.5 Metal Accumulation in Crops

Heavy metal bioaccumulation in agricultural crops consumed by humans poses a minimal human health risk as uptake, removal and accumulation of metals by the harvested portions of crops is minimal. Harb (1999) concluded that the health risk to humans from the consumption of heavy metals in wheat and oats grown on land treated with residuals is negligible and that there are environmental and economic benefits.

Mitigation Measures: Soil monitoring, soil chemistry, CCME guidelines and crop rotation.

7.3.6 Accidents and Malfunctions

As part of the land application program, a spill response will be developed. The plan will include instructions to the land application contractor on what to do in the case of an accidental release of residuals during transport and at the field sites including reporting requirements to provincial regulators.

Mitigation Measures: Maintain equipment in good working order and develop a spill control/response plan.

8 MONITORING, AND REPORTING

The following monitoring and reporting requirements are proposed for the program:

1. Completion of an on-site project start-up meeting between the proponent and the contracted land applicator to review the requirements of the EAL and procedure for the land application of the residuals prior to each application event. Yearly meetings will be completed in January-February of each application year. Participating agricultural producers will be engaged late winter/early spring to establish potential field sites for residuals land application.
2. At least two weeks prior to the commencement of the residuals land application in a given year, the City will provide details of the residuals and receive field soil analysis as well as proposed prescription rates for residuals application to the Director of the MECC EAB.
3. Recording of residuals percent solids, residual volumes and the land application area during land application process.
4. Completion of weekly on-site inspections and monitoring of residuals application, including:
   - Monitoring adherence by the Applicator to buffer zones.
   - Monitoring of application rates.
5. Providing a summary report to MECC EAB for the program by March 31 of each year following the application of residuals that includes:
   - Description of each land parcel on which the residuals were applied.
   - Pre-application soil parameters.
   - Dry weight of residuals applied per hectare of land.
   - Weight of each heavy metal (in mg/kg of soil) added to the receiving land parcels.
   - Cumulative weight (kg/ha) of each heavy metal for each land parcel as calculated by adding the amount of each heavy metal applied to the soil background level of the same metal.
   - Amount of nitrogen, phosphorus and potassium applied per hectare for each land parcel.
   - Copy of the residuals and soil sampling and analysis methods and results.
   - Type of crops grown on the land parcels in the program for the three years post-application.
6. Post-harvest soil monitoring of application fields for three (3) years post-application for residual nutrients including: nitrate-nitrogen (0-60 cm soil depth) and phosphorus (Olsen-P test 0-15 cm soil depth), as well as information relating to the amounts of nutrients from other sources that are being applied by the participating agricultural producer.

9 SUMMARY

When applied at balanced agronomic rates, the land application of residuals is a sustainable means to reuse nutrients within an agriculture system. The application of residual organic materials enhances the water holding capacity, structure, and tilth of soils, thereby providing benefits to land utilized for agricultural production. The objective of this project is for Dauphin to implement an agronomically and environmentally sustainable, long-term land application program for residual materials collected from the city's wastewater treatment lagoon (Aeration Cell and Cells 1 through 6). All applicable regulatory requirements, guidelines, and good neighbour policies and procedures will be adhered to for Dauphin's residuals land application program. With the employment of appropriate mitigation measures, potential negative effects associated with the land application can be minimized.

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