

ST. ALBERT NATURAL AREAS ASSESSMENT - 2015 UPDATE

Prepared for:

City of St. Albert

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EXECUTIVE SUMMARY

The 2015 natural area inventory update and assessment was completed to provide foundational information for the City's new approach to natural area conservation and management that emphasizes conserving the best sites and managing conserved urban natural areas as a system to ensure natural area sustainability. The work consisted of two main parts. Part 1 focused on updating the natural areas inventory on City lands to reflect changes over the last 15 years, expanding natural area mapping to establish a regional context and assessing ecological connectivity. Part 2 comprised more detailed desktop and field investigations that focused on a corridor along Carrot Creek, the area of Big Lake and a short downstream reach of the Sturgeon River Valley.

The previous complete city-wide natural area inventory documented 230 natural areas (sites) having a combined total area of 406 ha. Since then, the landscape of the City has changed dramatically. Of the previously inventoried sites, 85 (37%) have been completely lost and 50 (22%) have experienced partial loss, largely as a result of rapid urban, residential development. With annexation in 2007, the City expanded its boundaries and the number of natural areas grew. Accordingly, the 2015 inventory update identified a total of 193 natural areas having a combined total area of 491 ha *within* the City limits. Within a larger Overall Study Area (OSA), identified by the City to encompass all City lands plus a 3 km buffer to the west, north and east extending into adjacent Sturgeon County and City of Edmonton lands, the 2015 inventory update identified a grand total of 350 natural areas having a combined total area of 1,810 ha.

Within the OSA, all identified natural areas were subject to an ecological connectivity analysis. That analysis revealed that the ecological network formed by OSA natural areas includes all the necessary components identified by landscape ecologists as essential to an effective ecological network (Forman 1995). At the highest level, Lois Hole Centennial Provincial Park and the natural areas located along the Sturgeon River directly downstream of the lake together function as a Regional Core Area, supporting entire populations of species and contributing to sustainable populations at the landscape scale. Although not as large and diverse as Big Lake and adjacent areas, Riverlot 56 provides sufficient and suitable habitat to act as a Local Core Area for many native species of plants and animals. Extending from these core areas, the Sturgeon River, upstream and downstream of Big Lake, and Carrot Creek extend for many kilometers across municipal boundaries, functioning as Regional Ecological Corridors. At a more local scale, the inventoried natural areas include numerous ravines and retained shelterbelts that extend for relatively short distances through neighbourhoods and across agricultural land, functioning as Local Ecological Corridors.

Throughout the ecological network, 21 sites were identified as potential priority restoration areas. Among those areas, many were identified primarily for their potential to benefit from riparian health enhancement, while others were identified for their potential to strengthen ecological connectivity along corridors or to create larger and more contiguous habitat patches. In many cases, restoration of the potential priority areas would result in multiple positive ecological impacts.

Part 2 of this study focused on a specifically delineated Detailed Study Area (DSA) that captured Carrot Creek, Big Lake and a short downstream reach of the Sturgeon River and some buffering uplands. These lands were targeted because of their recognized high ecological value, but also because they are expected to receive increased development pressure in the near future. Field investigations included surveys targeting amphibians, birds, plant communities and soils and documented a rich flora and fauna indicating a high level of biodiversity within the DSA. Most of the habitat and documented species within the DSA are fairly widespread in central Alberta. A few less common species of conservation interest were observed that warrant further consideration as conservation priorities. In particular, western toads (listed as Sensitive provincially and a species of Special Concern federally) documented along Carrot Creek are indicative of significant habitat quality and ecological corridor functionality. At a plant community level, the habitats of Big Lake and the Grey Nuns White Spruce Park are recognized for their uniqueness and value, for these reasons, both are already protected through provincial and municipal measures, respectively.

DSA desktop investigations included mapping features at the land unit scale, capturing more detail than mapping at the natural area scale. That exercise confirmed that natural features within the DSA are generally tightly concentrated within riparian corridors forming a diverse mosaic, with a general paucity of separate habitat patches on the buffering uplands. For these reasons, the natural riparian habitat within the DSA should be retained intact to the highest degree possible and, where possible, enhanced through careful land use planning and ecological restoration. Fortunately, within the City of St. Albert, much of the key DSA riparian habitat is already afforded some protection. The vast majority of natural land units along Carrot Creek and the Sturgeon River that are considered critical to the DSA's riparian corridor are also situated below the designated flood line and/or within the 50 m Carrot Creek setback. Despite this, some natural land units remain vulnerable to development. Accordingly, as development occurs adjacent to and within the DSA, the avoidance of existing natural areas, minimization of development impacts and incorporation of naturalization/ecological restoration efforts where possible will be important to sustainability of natural areas within the DSA.

PREFACE

The City of St. Albert (the City) has a long history of natural area management, beginning in 1990 with an ecological land classification in support of the Red Willow Park Master Plan. In 1999, in support of CityPlan 2000, that inventory was updated (Spencer Environmental 1999) in response to the rapid pace of urban development, with a stronger emphasis on smaller, tableland natural areas to reflect the value citizens placed on those features. The updated inventory captured many more natural areas of local significance. CityPlan 2000 ultimately included Policy Statement 10.2 indicating an intention to protect provincially and regionally significant areas and locally significant areas except where the protection compromised other necessary parks, trails and open space requirements. In 2007, the City expanded its boundaries to the west and north and updated their natural area inventory (Stantec 2008) to include the newly-annexed lands. The City's 2007 Municipal Development Plan (MDP 2007) reinforced the intention to conserve natural areas with a goal to "strengthen the protection of sustainable natural areas and minimize the negative impacts of development on natural areas". MDP 2007 also included other policies around natural area protection, integration and conservation. The City's 2011 and 2013 updates to MDP 2007 include a requirement to protect Carrot Creek and an associated greenway through establishment of a 50m setback above the creek's top of bank. In 2014, new natural area data were collected, in the form of land unit mapping (Stantec 2014) as part the Utility Master Plan (UMP) Update. That same year, the City also renewed their Environmental Master Plan (EMP). Consistent with natural area policies, the EMP includes a specific goal to preserve and manage trees, parks and natural areas.

St. Albert's current land base consists of relatively few areas that are unplanned and undeveloped and so the future will hold relatively few land-use planning decisions regarding retention of natural areas. Considering this, the City is adopting a revised approach to natural area conservation and management that not only emphasizes conserving the best sites but also managing conserved urban natural areas as a system to ensure natural area sustainability. The new approach explicitly recognizes the importance of adopting an ecological framework that considers the regional ecological context and identifies a need to focus on the provincially and regionally significant natural areas directly linked to Big Lake and Carrot Creek.

To provide foundational information for this new approach, in spring of 2015, the City retained Spencer Environmental Management Services Ltd. (Spencer Environmental) to undertake two separate but related assignments: 1) prepare a natural areas inventory update and assessment, and 2) develop a city-wide natural areas management plan. The natural area inventory update and assessment consisted of two main parts. Part 1 focused on updating the natural areas inventory on City lands to reflect changes over the last 15 years,



expanding natural area mapping to establish a regional context and assessing ecological connectivity. For that exercise the City delineated a study area referred to as the Overall Study Area (OSA), which comprised all City lands plus a 3 km buffer to the west, north and east. The OSA thus included some City of Edmonton and Sturgeon County lands. Part 2 comprised more detailed desktop and field investigations of a Detailed Study Area (DSA) that comprised a Carrot Creek corridor, Big Lake and a short downstream reach of the Sturgeon River Valley, as delineated by the City. Thus, the DSA also included some Sturgeon County lands. This report documents the results of Part 1 and Part 2. The city-wide natural area management plan comprises a document found under separate cover.

REPORT ORGANIZATION

This document comprises two parts, each of which is structured as a stand-alone segment. Part 1 pertains to the natural area inventory update and the OSA. Part 2 pertains to investigations undertaken that were specific to the DSA.



PART 1

NATURAL AREA INVENTORY UPDATE AND STATUS REPORT

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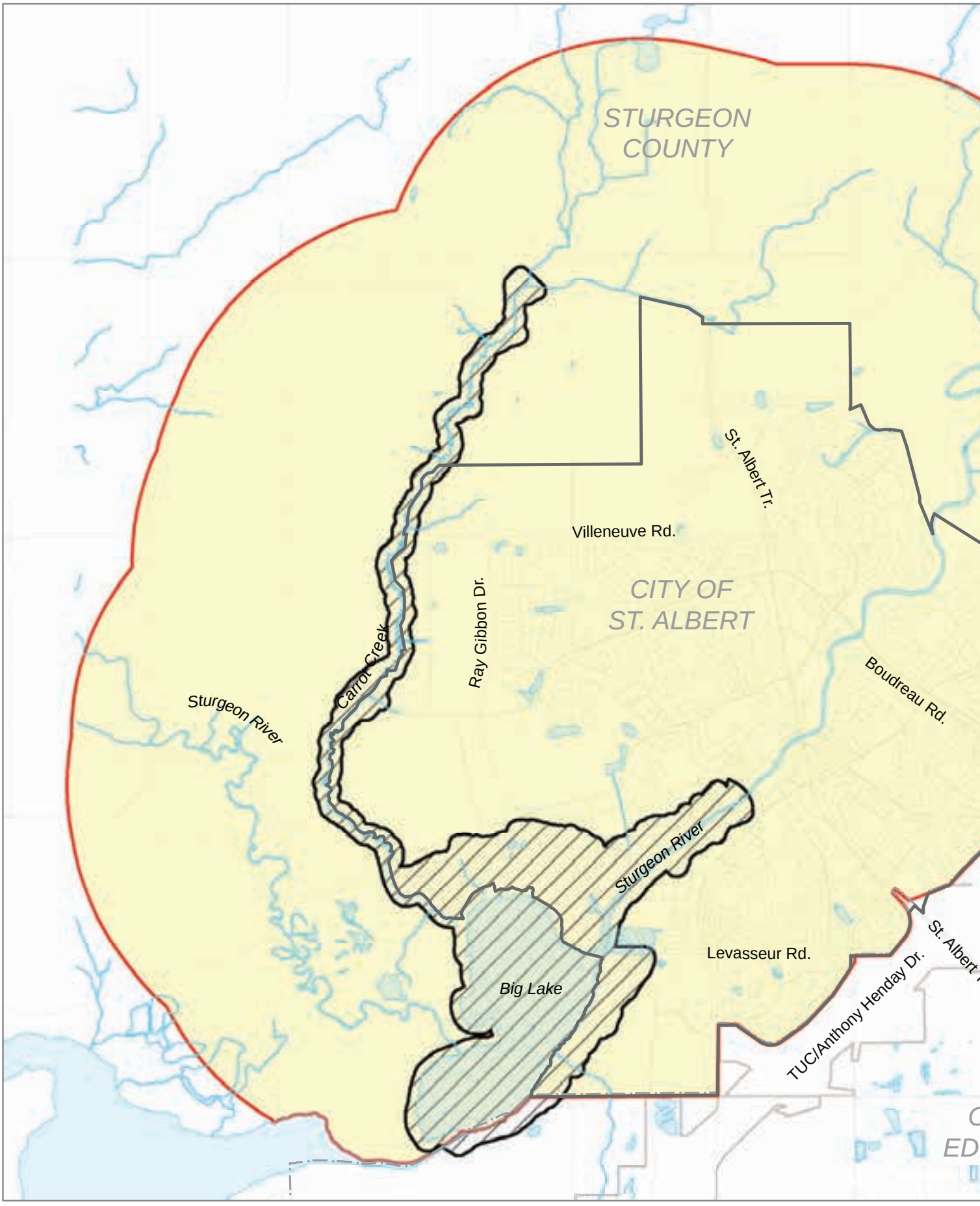
1.0 STUDY OBJECTIVES

The primary objectives of the natural area inventory update and status report (Part 1 exercise) were as follows:

- Update the City's natural area inventory to reflect natural area changes (losses/partial losses/ expansions) that have occurred since 1999 and 2007.
- Compile basic statistics for that current inventory and consider natural area losses.
- Map natural areas in adjacent buffer lands, within the OSA.
- Assess ecological connectivity within the OSA.
- Identify possible priority restoration areas in the OSA.

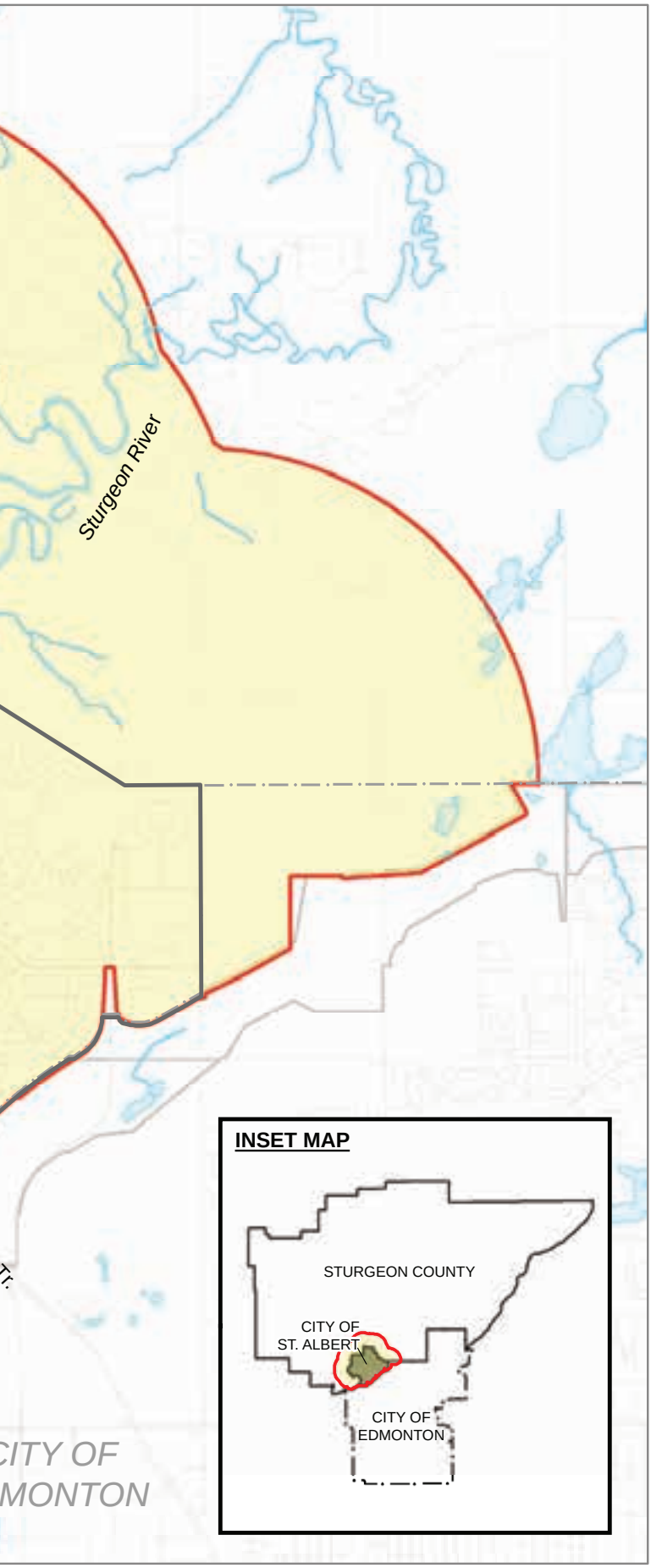
Secondary objectives were as follows:

- Discuss potential development impacts on natural areas.
- Assess the City's performance with respect to conservation and management recommendations in existing municipal documents.


STURGEON COUNTY
St. Albert Tr.
Villeneuve Rd.
CITY OF ST. ALBERT
Ray Gibbon Dr.
Carrot Creek
Sturgeon River
Boudreau Rd.
Sturgeon River
Big Lake
Levasseur Rd.
TUC/Anthony Henday Dr.
St. Albert

MAP 1.

REGIONAL CONTEXT AND LOCATION OF STUDY AREAS



Legend

- Overall Study Area (OSA)
- Detailed Study Area (DSA)
- City of St. Albert
- City of Edmonton
- Hydrology
- Road

N

0 500 1,000 2,000 Meters

1:54,000

Projection: 3TM 114 NAD83
Date: 13 November 2015

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.

2.0 METHODS

2.1 DEFINITIONS

As with previous inventory projects, an important first step was to review, and if necessary, refine the definition of "natural area" to ensure incorporation of current best practices and consideration of the City's current directions and policies. To that end, the definitions used for previous City of St. Albert inventories were reviewed and compared to those used for recent inventories in other jurisdictions. Following are documents reviewed for this purpose:

- St. Albert Natural Areas Review and Inventory (Spencer Environmental 1999)
- City of Edmonton State of Natural Areas Project (Spencer Environmental 2006)
- City of Edmonton Natural Connections Strategic Plan (City of Edmonton 2007)
- St. Albert Natural Areas Review and Inventory Addendum (Stantec 2008)
- Natural Areas Assessment and Preliminary Environmental Impact Assessment for the City of St. Albert Utility Master Plan (Stantec 2014)
- Parkland County Environmental Conservation Master Plans (O2 Planning and Design 2014)

This review revealed that recent definitions have tended to be more nuanced or detailed than those used in Alberta in the 1980s and 1990s, and have tended to refer to natural processes and patterns so as to more closely link the definition to interpretation applied when identifying and delineating natural areas. On that basis, the following definition was applied when identifying new areas for inclusion in the 2015 inventory:

> *Natural area: an area of naturally occurring surface water and/or land that is dominated by native plant species and subject to natural processes that result in naturally occurring vegetation patterns.*

This document also refers to the three natural area categories used in the 1999 and 2007 inventories, as defined by Spencer Environmental (1999):

> *Significant Natural Area (SNA): a natural area equal to or greater than 0.5 ha which, because of its features or characteristics, is significant from an environmental perspective to the community of St. Albert. SNAs can*

withstand various degrees of human use.

Environmentally Sensitive Area (ESA): an undisturbed or relatively undisturbed natural area equal to or greater than 0.5 ha which, because of its features, characteristics or ecological functions is significant and is highly sensitive to most forms of disturbance (i.e., its values and functions would be significantly altered by natural or human-caused disturbance such as development of surrounding lands or human use of the site).

Natural Area (NA): a natural area that does not meet the criteria of SNA or ESA.

2.2 INVENTORY UPDATE – OSA

The process of creating an updated natural area inventory for the OSA comprised several sequential steps. An important consideration was that the 2007 inventory update identified new sites in the annexed lands and then amalgamated those data with the original 1999 natural area inventory. As of 2015, the 1999 inventory map had never been updated. Accordingly, the updated 2015 OSA inventory consisted of updating the 1999 and 2007 natural area inventories, examining other existing data sets with potential to add to the inventory, and undertaking a desktop exercise to identifying new natural areas where data gaps existed. The following bullets describe the main steps employed in that process:

- Changes to the 1999 natural areas inventory were assessed by overlaying the 1999 natural area polygons, provided by the City of St. Albert, on 2014 aerial photography, analyzing discrepancies and adjusting boundaries to reflect natural area change.
- Changes to the 2007 natural areas inventory were assessed by overlaying the 2007 natural area boundaries, provided by the City of St. Albert, on 2014 aerial photography, analyzing discrepancies and adjusting boundaries to reflect natural area change.
- Natural features included in Stantec's (2014) natural land units were reviewed and those that met this study's definition of a natural area were identified and added to the inventory. Stantec's (2014) exercise used a smaller minimum size threshold of 0.125 ha compared to the previous minimum of 0.5ha, which resulted in identification of several small, new natural features in several areas of the City.
- Using City of Edmonton's natural area dataset (Golder 2010), natural areas located on City of Edmonton lands in the OSA were incorporated into the 2015 inventory.
- As only the largest Sturgeon County natural areas were recognized by previous county inventories, natural areas on Sturgeon County lands situated within the OSA were identified, delineated, and digitized using methods detailed in Appendix A.
- Recently approved St. Albert ASPs were analyzed to identify planned (future) natural area losses. These areas were included in the inventory but are identified on maps as planned (future) losses.
- All undeveloped lands within the City boundaries were reviewed using 2014 aerial photography in an effort to identify additional natural areas to ensure comprehensive coverage of the past 2014, 2007 and 1999 exercises. (No additional natural areas were identified through this review).

- Lastly, a road-side reconnaissance survey of the undeveloped lands in the OSA was performed on 14 August 2015. This coarse-level ground-truthing was done to verify the presence of natural areas identified in the aerial imagery analyses as present and to identify any additional, visually-discernible natural area loss that occurred between May 2014 and August 2015; this reconnaissance assessment was necessarily limited to sites that were visible from public roads.

Critical to all steps was the use of high resolution, colour aerial photography from the spring of 2014 provided by the City of St. Albert and the City of Edmonton. The City of St. Albert imagery did not cover all of the OSA so, to ensure use of a consistent photograph base for mapping across the entire OSA, the City of Edmonton photograph mosaic was relied upon where necessary. To a lesser degree, aerial photography from 2012 and Google Earth imagery were also cross-referenced. All aerial photography interpretation was completed by a professional biologist with over 10 years of experience in desktop and field inventories. The systematic analysis of the imagery was completed at a range of scales between 1:2,000 and 1:4,000.

Following the process outlined above, the OSA natural area inventory update reflects all natural areas present in spring 2014 imagery *and* reflects all known losses occurring since then through to August 2015.

This 2015 inventory retains the three natural area categories (SNA, ESA and NA), assigned in the 1999 and 2007 inventories for those sites or portions of sites remaining intact in 2015. Natural areas in the OSA outside of the City boundaries were not assigned categories. Those natural areas were mapped in the absence of field observations, using only aerial photography interpretation. The criteria necessary to complete an informed classification requires site-specific information that was beyond the scope of this exercise. Without more detailed information, any attempt at categorization would have been preliminary and thus would not have had the same rigour and precision as the previous inventories. Those sites are mapped as uncategorized NAs.

2.3 2015 INVENTORY STATISTICS

Once compiled, the 2015 OSA Natural Area Inventory GIS dataset was analyzed to generate the following natural area statistics:

- Total natural area land base (area in ha).
- Number of natural areas (sites) and area (ha) of natural area, by jurisdiction (City of St. Albert, City of Edmonton and Sturgeon County).
- Number of natural areas (sites) and total natural area land base (area in ha) within the current City boundary, by category - NA, SNA, and ESA.

Two important considerations influenced these analyses:

- Respecting ecological boundaries, natural areas straddling Carrot Creek and the City boundary were mapped as continuous areas without acknowledging the boundary and thus were counted as City natural areas.
- Some previously delineated natural areas are actually geographically contiguous. The statistical analysis included the original count.

2.4 NATURAL AREA STATUS (LOSS) ANALYSIS

Natural area loss was assessed in three separate exercises as described below.

2.4.1 1999 INVENTORY LOSSES

Changes (i.e., losses) to natural areas inventoried in 1999 were assessed through aerial photography overlay as described above. Each 1999 natural area was examined and the site boundaries re-digitized to reflect 2014 conditions. Unchanged sites were tagged as wholly intact, reduced sites were re-digitized and mapped as partially intact/partially lost and sites no longer present were mapped as wholly lost. The 2014 imagery was then cross-referenced with the 1998 aerial photography to ensure that areas identified as changed reflected true change as opposed to changed interpretation of natural area boundaries. The inventory was then further updated to reflect losses discovered during the August 2015 roadside reconnaissance survey. The resulting natural areas losses map was overlain on maps of the City's parks and the 1998 and 2014 developed urban extents. Detailed methods used to perform the 1999 inventory loss analysis are provided in Appendix A.

2.4.1.1 1999 Inventory Loss Statistics

The resultant GIS dataset was then analyzed to summarize natural area loss as follows:

- Number of natural areas (sites) and total landbase (in ha) of natural area lost and intact
- Total area (ha) of sites lost: within the 1998 urban extent; on lands developed between 1998 and 2014; to park development; and on lands that remained undeveloped as of August 2015.
- Number of natural areas (sites) and total natural area landbase (in ha) completely lost, completely intact, partially lost, and partially intact.
- Percent and area (ha) lost and intact for SNA, ESA and NA.
- Percent and area (ha) lost and intact for locally, regionally, and provincially significant natural areas.
- Percent natural areas lost in four quadrants of the City (SE, SW, NE, and NW) and the River Valley.

2.4.2 2007 INVENTORY LOSSES

Changes to natural areas added to the inventory in 2007 (Stantec 2008) were anticipated to be minor in comparison to losses since 1999, as the majority of those lands have remained largely undeveloped. Thus, loss of the 2007 natural areas inventory was assessed slightly more coarsely than the 1999 inventory losses. Loss of the 2007 inventory was analyzed by comparing the 2008 delineated polygons to May 2014 aerial photography and to observations of the August 2015 reconnaissance survey to identify 2007 natural areas that have been wholly lost. Partial losses were not included in the subsequent analysis, but partial losses were digitized and are reflected in the 2015 inventory maps.

2.4.3 PLANNED (FUTURE) LOSSES

Planned (future) loss of natural areas was assessed in the following five St. Albert neighbourhoods having approved Area Structure Plans (ASPs): South Riel, Riverside (formerly Timberlea), Erin Ridge North, Jensen Lakes, and Range Road 260 (Avenir and Elysian Fields). To do this, all natural areas in the 2015 inventory situated within the ASP boundaries were visually cross-referenced to ASP figures showing development concepts and lands to be set aside as Municipal Reserve (MR) or Environmental Reserve (ER). Natural areas that substantially overlapped with MR or ER in the ASP figures were assumed to be planned for retention, whereas those that did not were assumed to be planned for future loss. The number of natural areas (sites) and total area (ha)

of planned losses were then calculated for each ASP. For this exercise, important methodological considerations were as follows:

- MR and ER parcels depicted in ASP figures are not precisely located and were not available in GIS format, allowing for a preliminary assessment only.
- This analysis may have over-estimated planned partial or whole natural area retention, because while the depicted MR may be used for natural area parks, they may also be used for schools or more conventional open space. The type of MR was not specified.
- The "Potential Amendment Area" (north block) in the Range Road 260 neighbourhood was not assessed because the ASP maps do not include planned land use details for this area.

2.5 OSA ECOLOGICAL CONNECTIVITY ANALYSIS

Ecological networks allow native species to persist on a landscape by facilitating critical ecological processes, such as nutrient dispersal, genetic exchange and daily and seasonal movement among the habitat patches within the landscape (Forman 1995). Habitat patches are relatively unfragmented areas of habitat that differ from the surrounding matrix, which is non-habitat. In the context of ecological networks, connectivity refers to how the spatial arrangements and characteristics of habitat patches and matrix affect the movement of organisms among habitat patches in the network (Forman 1995). A successful ecological network achieves connectivity within a landscape through a linked system of habitat patches (Forman 1995, Hilty et al. 2006). Conservation science maintains that successful ecological networks comprise core areas, corridors, and stepping stones, as defined below (Forman 1995).

Core Area: An area that supports entire populations of species from which individuals, seeds, pollen, or spores can disperse to other smaller habitat patches, thus contributing to sustainable population at the landscape scale (Forman 1995).

Corridor: Any habitat patch or space, usually linear in shape, that improves the ability of organisms to move between/among other habitat patches (Hilty et. al 2006). Along with stepping stones (see below), corridors facilitate daily movements, seasonal migrations, dispersal of organisms among habitat patches. Riparian zones are often preferred corridors for wildlife.

Stepping Stone: A habitat patch that may provide resources to sustain an organism for some time, but is generally unable to sustain populations in isolation, especially for larger organisms. Stepping Stones are generally used temporarily by wide-ranging species while moving through a matrix en route to more suitable habitat patches. However, in an urban-agricultural context, Stepping Stones may sustain numerous adaptable, generalist, and/or smaller species for longer periods of time.

In addition to the above, landscape ecology considers lands that surround these network components to be a matrix. Examples are cultivated lands and urban parking lots. The quality of a matrix (how hostile/unsuitable it is to ecological processes) can affect the function of the network.

Using the above definitions, all natural areas within the OSA were qualitatively evaluated with respect to their size, shape and position in the landscape, and tagged as a core area, a corridor or a stepping stone. Natural areas were then further analysed from the perspective of regional or local function and assigned one of the following labels:

- Regional Core Area (RCA) or Local Core Area (LCA), based on a significant difference in size (total area) and previously recognized ecological

significance and their related, perceived, ability to support core populations of native species.

- Regional Ecological Corridor (REC) or Local Ecological Corridor (LEC), based on the following attributes: RECs cover long distances and extend beyond the boundaries of the City and/or the OSA, and are expected to be used by a wide range of native wildlife species, including larger species such as coyote, deer and moose. LECs are shorter in length and generally narrower in width and as a result, are expected to be used by a narrower suite of wildlife species.
- Stepping Stones, all natural areas not identified as part of a core area or corridor.

Review of draft OSA ecological network maps suggested that while Stepping Stones are scattered across much of the undeveloped lands, certain Stepping Stones may have higher ecological function because of their relatively large size in combination with their relative proximity to other Stepping Stones and/or corridors or core areas. Therefore, all stepping stones were subject to further analysis, based largely on four GIS Stepping Stone cluster analyses, applying different minimum patch size and Stepping Stone buffers (detailed methods are provided in Appendix A). The analysis resulted in identification of several Important Concentrations of Stepping Stones, which were included on the ecological network map.

To provide a fuller depiction of the ecological connectivity within the City boundaries, the following additional items were considered in the ecological connectivity analysis:

- Non-natural area parks, non-native grassland (in future Red Willow Park), and stormwater management facilities (SWMFs) were added to the ecological network map. These land-uses comprise relatively permeable matrices (non-habitat) with respect to wildlife movement, compared to land uses such as residential infrastructure, buildings and paved areas. The Parks polygons shown are the subset of the City's comprehensive Parks dataset that was labelled as parks, with sites labelled as schools and future schools removed. This distinction was made because those polygons included school buildings and school grounds as inseparable and these areas are less permeable to wildlife.
- Major roads that function as semi-permeable barriers in an ecological network were included on the map.
- Natural areas outside of the OSA and within the City of Edmonton were included on the map to provide additional context and were identified as Stepping Stones. The City of Edmonton (2007) similarly identifies all these depicted areas as natural linkages (a synonym for stepping stone).

2.6 POTENTIAL RESTORATION AREAS IN THE OSA

The Society for Ecological Restoration defines ecological restoration as an "*intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability*." The 2015 Natural Area Inventory and ecological network was reviewed through aerial photograph interpretation and qualitatively assessed for disturbances currently impacting natural areas. Considering the urban and agricultural nature of much of the OSA outside of the developed extent of the City, it was determined that almost all natural areas could benefit from at least a low level of ecological restoration (such as weed control). However, the objective was to identify areas within the OSA with the highest potential for ecosystem recovery through restoration (i.e., the greatest ecological gain). The review suggested that the kinds of disturbances and impacts present on the landscape fell into a few similar, yet subtly different categories, which if corrected or reversed would lead to a specific type of ecological benefit. These observations lead to the identification of the following:

- Areas where restoration could meaningfully enhance the health of riparian habitat and improve functionality of the associated Regional Ecological Corridors along Carrot Creek or the Sturgeon River.
- Areas where restoration could meaningfully enhance the functionality of Local Ecological Corridors and thereby result in improved ecological connectivity.
- Areas where restoration could enhance or create structural connectivity between natural areas and thereby result in larger, more contiguous patches of natural habitat that would be more sustainable and better able to maintain high levels of biodiversity.
- Areas where the reduction/removal of current disturbances could meaningfully improve the habitat quality within a natural area.

Natural areas or gaps between natural areas that fit these descriptions were identified on the inventory map as point source features. In many cases, there was more than one potential restoration benefit in a specific area. For the purpose of this exercise, the primary benefit was recorded and applied as an attribute to the point datum associated with each identified priority restoration area. Because this exercise was desktop only, priority restoration areas are referred to as *potential* priority restoration areas.

Degraded wetlands identified during inventory aerial photograph interpretation that were mapped as point features also represent restoration opportunities. Degraded wetlands comprised those wetlands that have been consistently tilled, cultivated or drained and are no longer considered to be a viable natural area. All degraded wetlands (including more ephemeral wetlands not yet identified as part of this exercise) would require a *Water Act* approval for their permanent removal and, as part of such an approval application, would be subject to the assessment and replacement (formerly known as compensation) requirements of the new Alberta Wetland Policy.

2.7 CITY PERFORMANCE REGARDING MUNICIPAL RECOMMENDATIONS

As a means of assessing the City's natural area conservation performance, numerous City documents were reviewed looking for recommendations that were relevant to both natural areas and the current update exercise. The review resulted in the following short-list of documents for further evaluation:

- City of St. Albert 2014 Environmental Master Plan 2014
- Red Willow Park West Master Plan Update 2003
- St. Albert Municipal Development Plan (MDP 2007)
- Sturgeon River State of the Watershed Report: Technical Report 2012
- Timberlea Development Guidelines 2007

2.8 IMPACTS OF DEVELOPMENT ON NATURAL AREAS

The requested high-level discussion of potential impacts of development on natural areas was developed based on the principles of conservation science, an understanding of the local ecology of St. Albert's landscape and the authors' comprehensive background in environmental impact analysis.

3.0 RESULTS AND DISCUSSION

3.1 OSA NATURAL AREA INVENTORY UPDATE

The 2015 inventory identified 350 natural areas[1] (sites) scattered across the OSA having a combined total area of 1,809.5 ha and comprising 14% of the OSA's total area (Map 2; Table 1). The majority of sites (193, 55% of sites) are situated within the City of St. Albert, but these sites comprise only 27% of the total natural area landbase in the OSA. By contrast, the number of sites identified in Sturgeon County (149, 43% of sites) are fewer but comprise 70% of the OSA natural area landbase and 10% of the total OSA. This discrepancy between municipalities is largely attributable to the fact that Sturgeon County includes the majority of the large, contiguous natural areas associated with Big Lake and the Sturgeon River. Finally, the portion of the OSA comprising City of Edmonton land is relatively small, and, accordingly, these lands contain relatively few natural area sites (8, 2% of sites) with a relatively small cumulative area (48.9 ha, 3% of the total natural area landbase) comprising less than 1% of the total OSA.

1 Because of the way natural areas were delineated in past inventories, some separately identified natural areas (sites) are geographically contiguous. Thus, the total number of sites (i.e., 350) is slightly greater than the total number of discrete natural habitat patches situated in the OSA.

Table 1. Natural area sites in the OSA, by municipality, August 2015

Municipality	Natural Area Sites		Natural Area Landbase		% of Total OSA Area*
	No. Sites	% of OSA Sites	Area (ha)	% of OSA	
St. Albert	193	55%	491.2	27%	4%
Sturgeon County	149	43%	1,269.4	70%	10%
Edmonton	8	2%	48.9	3%	<1%
OSA Total	**350**	**100%**	**1,809.5**	**100%**	**14%**

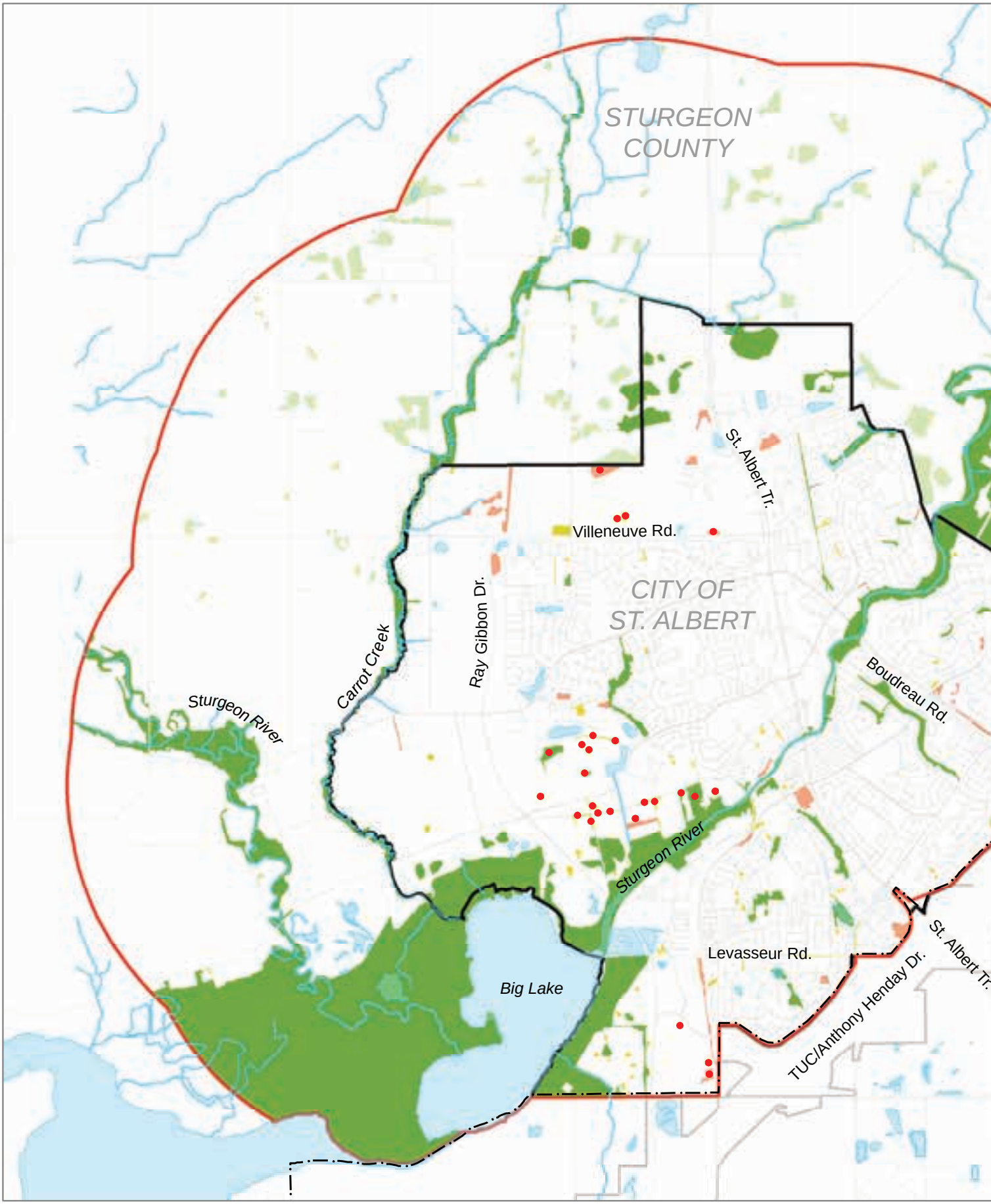
**Total area of the OSA is 12,938.0 ha*

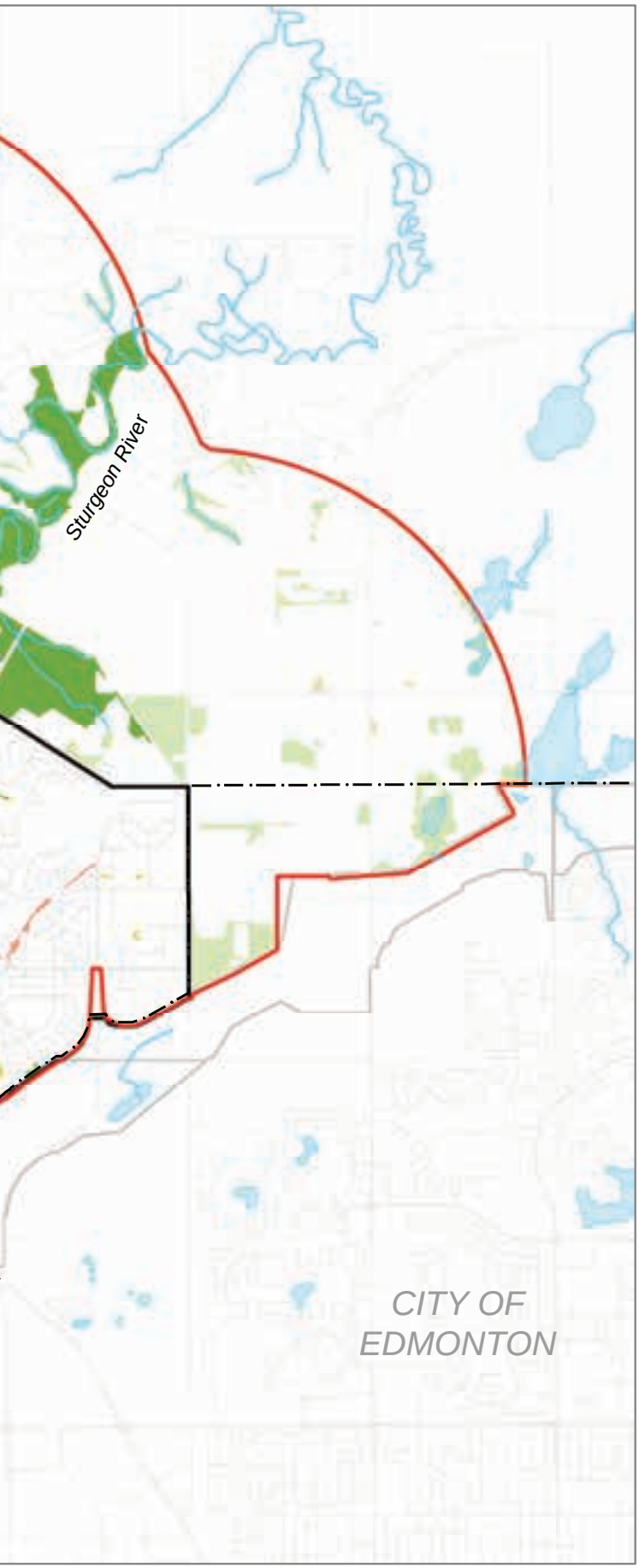
Of the 193 sites in the City of St. Albert, 95 sites (21.9 ha, 4% of total area) are categorized as Natural Area (NA), 36 sites (44.7 ha, 9% of area) are Significant Natural Area (SNA) and 62 sites (424.5 ha, 86% of area) are Environmentally Sensitive Area (ESA; Table 2). Thus, the City contains numerous, but very small NA sites and many fewer, but much larger ESA sites. Many of the ESAs in the City comprise riparian habitats and sizable wetlands. SNAs are less numerous than both NAs and ESAs, and tend to be of intermediate size. SNAs comprise mainly upland, woodland dominated sites and are widely scattered across the City's land base.

Table 2. Natural area types in the City of St. Albert, August 2015

Natural Area Category	No. Sites	Area (ha)	% of Natural Area Landbase
NA	95	21.9	4%
SNA	36	44.7	9%
ESA	62	424.5	86%
Total	**193**	**491.2**	**100%**




STURGEON COUNTY
St. Albert Tr.
Villeneuve Rd.
CITY OF ST. ALBERT
Ray Gibbon Dr.
Carrot Creek
Sturgeon River
Boudreau Rd.
Sturgeon River
Levasseur Rd.
St. Albert Tr.
TUC/Anthony Henday Dr.
Big Lake



MAP 2.

CITY OF ST. ALBERT AND ADJACENT LANDS, NATURAL AREAS INVENTORY 2015

Legend

2015 Natural Area Inventory

- Natural Area (NA)
- Significant Natural Area (SNA)
- Environmentally Sensitive Area (ESA)
- Uncategorized NA
- Overall Study Area (OSA)
- City of St. Albert
- City of Edmonton
- Hydrology
- Road
- Planned (Future) Loss of Site

N

0 500 1,000 2,000 Meters

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Projection: 3TM 114 NAD83
Date: 13 November 2015

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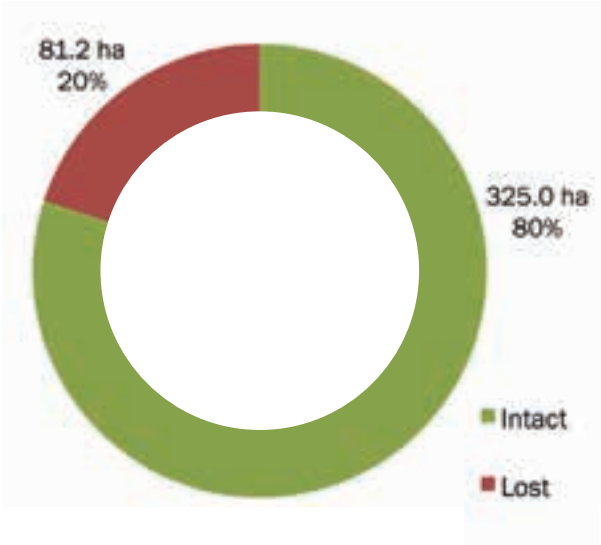
3.2 NATURAL AREA STATUS (LOSS) ANALYSIS

3.2.1 1999 INVENTORY

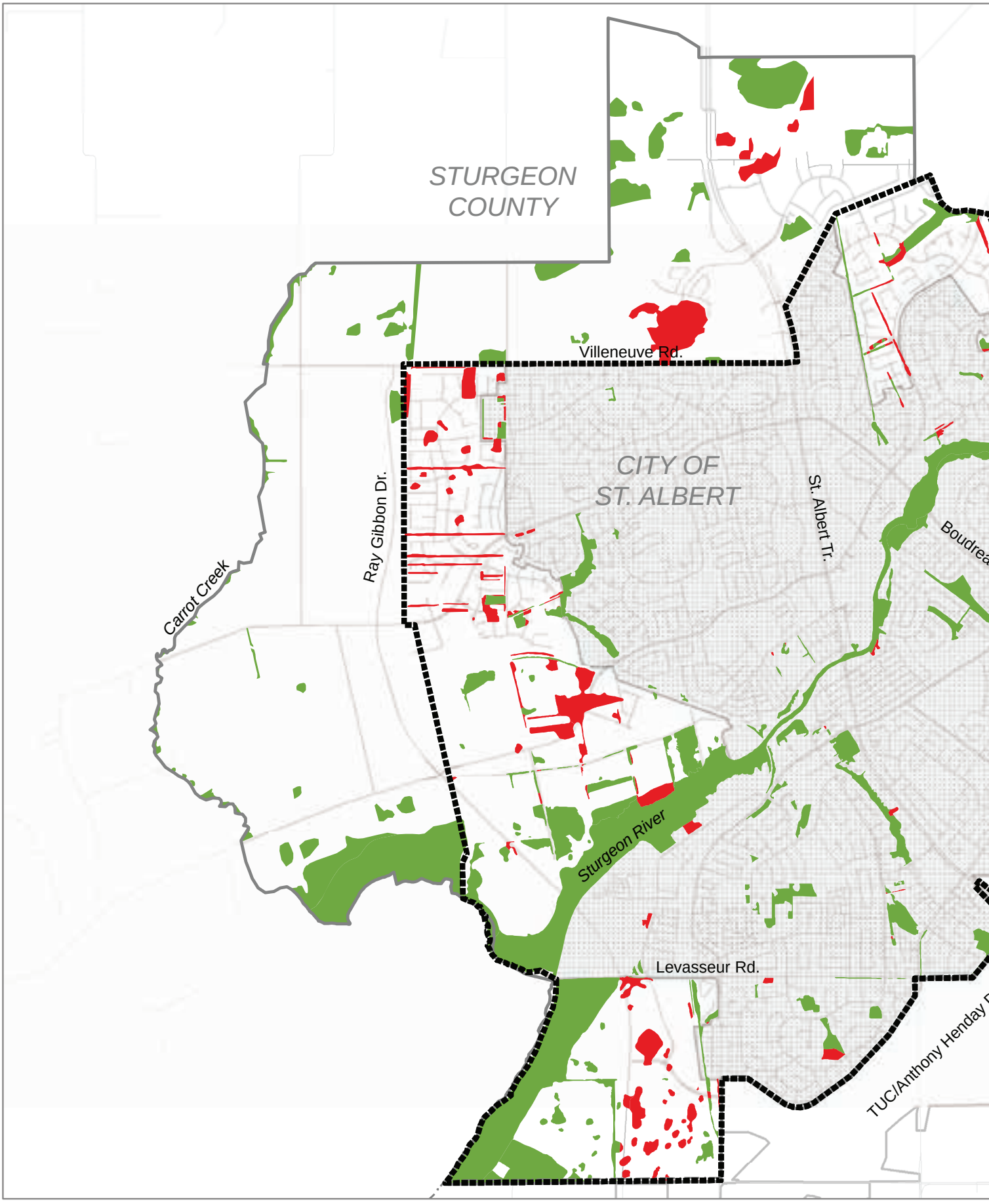
The 1999 natural area inventory identified 230 natural areas (sites) having a combined total area of 406.3 ha. In 2015, 95 (41%) of those 230 natural areas remained completely intact, 85 (37%) of those sites had been completely lost and 50 (22%) had experienced partial loss (Map 3). In terms of area lost, the magnitude is seemingly less significant: 81.2 ha, representing only 20% of the natural area land base has been converted into non-natural land use. Stated conversely, 80% (325.0 ha) of the 1999 natural area land base remained intact in August 2015 (Figure 1, Map 3).

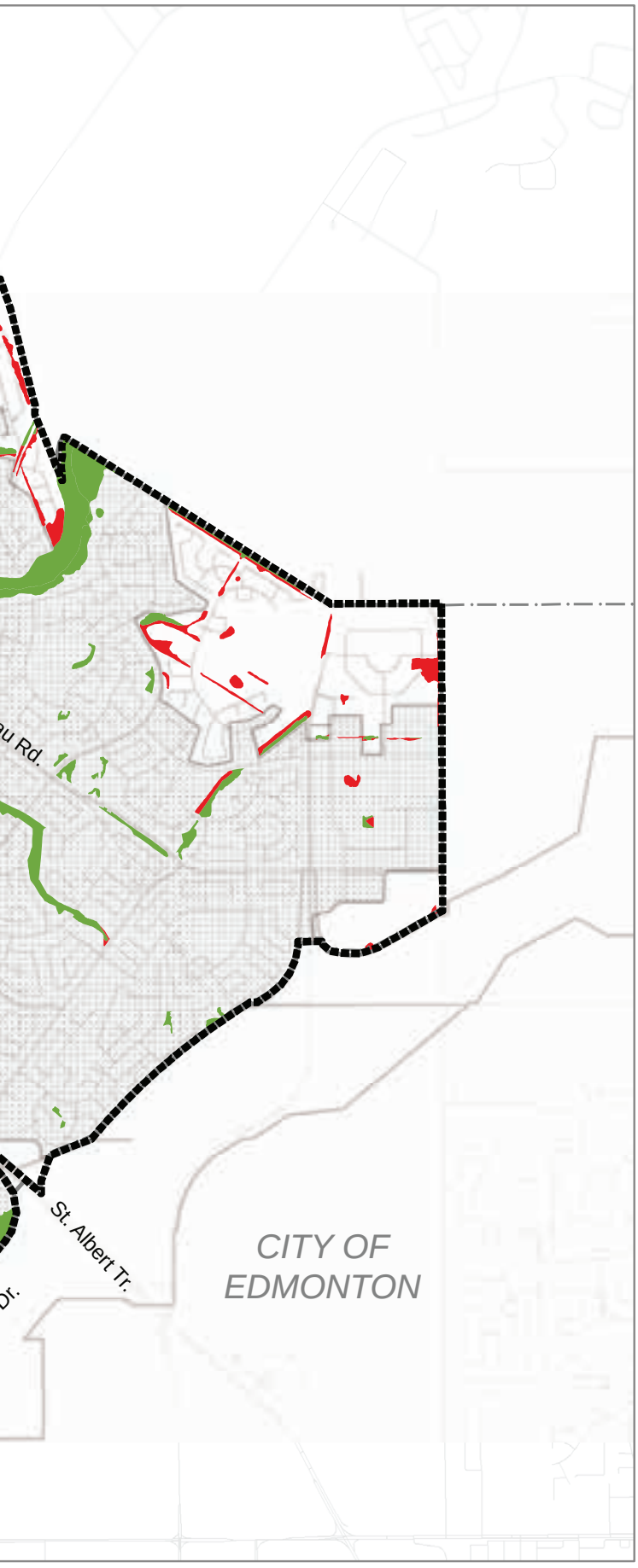


Figure 1. Total natural area in August 2015 relative to 1999 inventory



Of the 81.2 ha of lost natural area, slightly more than half (48.1 ha, 59%) is accounted for by sites that were fully lost and the remaining losses (33.2 ha, 41%) represent partial losses of natural areas. Similarly, of the 325.0 ha of intact natural areas, half (163.6 ha, 50%) is represented by sites that remained completely intact (i.e., have experienced no reduction since 1999) and the other half (161.5 ha, 50%) is represented by sites that have experienced partial losses (i.e., reduced in size) (Figure 2). This last statistic is heavily influenced by one site and may be misleading, as the majority (67%) of the total area that was categorized as partially intact in 2015 comprises one large natural area stretching along the Sturgeon River valley that still remains 96% intact; three very small portions were developed between 1999 and 2015 such that its area decreased from 112.5 ha to 108.4 ha.


STURGEON
COUNTY
Villeneuve Rd.
CITY OF
ST. ALBERT
Ray Gibbon Dr.
St. Albert Tr.
Carrot Creek
Sturgeon River
Levasseur Rd.
TUC/Anthony Henday



MAP 3.
NATURAL AREA INVENTORY LOSSES, AUGUST 2015

Legend

Natural Area Status in 2015

- Intact
- Lost (Partial or Total Area)
- 1998 Urban Extent
- 1999 City of St. Albert Boundary/ Inventory Boundary
- 2015 City of St. Albert Boundary
- City of Edmonton
- Road

N

0 250 500 1,000 Meters

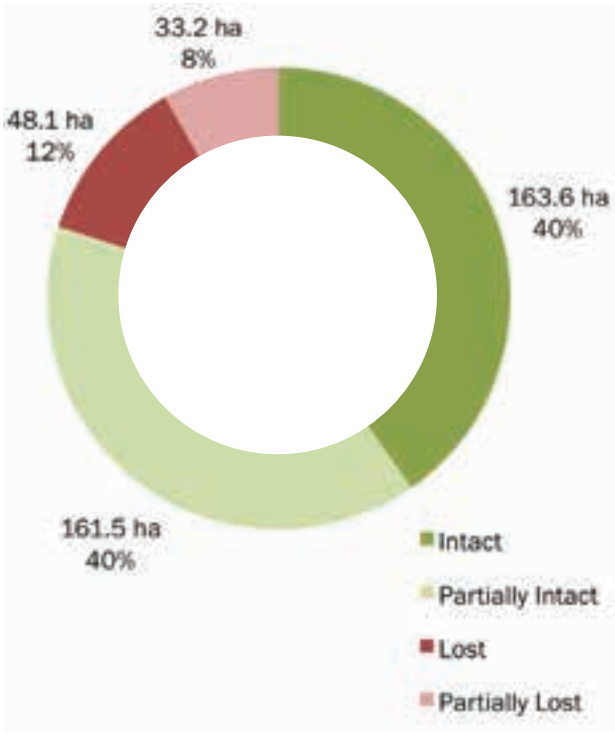
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Date: 13 November 2015

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Figure 2. Natural area by status in 2015 relative to 1999 inventory



Of the 81.2 ha of natural area lost since 1999, the majority of losses (58.5 ha, 72%) occurred on lands that were developed between 1998 and 2014. Only 10% of the total losses (7.8 ha of natural area) occurred within already developed parts of the city. A similarly small proportion of total natural area loss occurred on undeveloped lands (7.4 ha, 9% of total area loss) between 1999 and 2014. These losses appear to be the result of non-urban development related activities undertaken by private landowners. Finally, the 2015 road-based reconnaissance survey identified 15 relatively small natural areas (totaling 7.5 ha, 9% of total loss) that had been lost between May 2014 and August 2015, all of which were located on lands under active development in the South Riel ASP (Table 3).

Table 3. Breakdown of natural area loss from 1998-2015

Development Period	Area Lost (ha)	% of Loss
Original (1998) developed urban extent	7.8	10
Lands developed from 1998-2014	58.5	72
Developing lands (South Riel) 2014/15	7.5	9
Undeveloped land as of August 2015	7.4	9
Total	**81.2**	**100**

A total of 23 natural area sites have been lost to park development. Most losses to parks occurred in the developing areas of the City, but a few were located in the developed City core. In most (but not all) of those cases, affected sites were smaller, woodland natural areas. Some of the losses were for development of stormwater facilities that are situated within parks.

The proportion of SNA, ESA, or NAs lost between 1999 and 2015 was considerably different for each category (Table 4, Figure 3). The total area of ESAs decreased only by 12%, while the total area of SNAs decreased by 38% and the total area of NAs decreased by 62%.

Table 4. Breakdown of natural area loss by NA, SNA and ESA from 1998-2015

Natural Area Category	1999 Inventory		2015	
	Number	Total Area (ha)	Area Intact in ha (% area intact)	% Area Lost
NA	155	46.0	17.6 (38)	62
SNA	29	41.5	25.7 (62)	38
ESA	46	318.8	281.8 (88)	12
All NAs	**230**	**406.3**	**325.0 (80)**	**20**

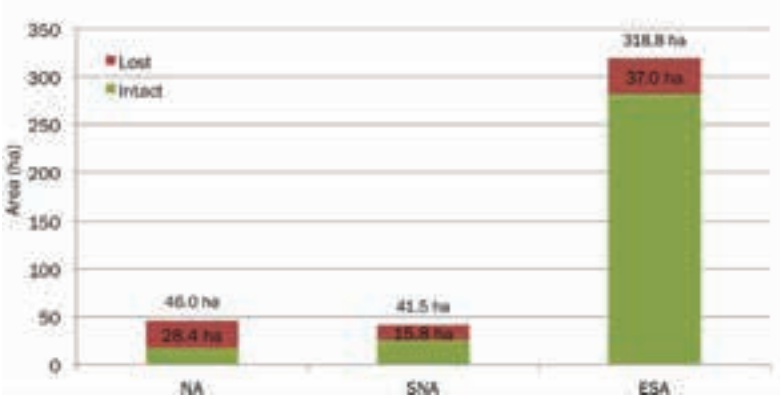


Figure 3. Area of NAs, SNAs, and ESAs in August 2015 relative to 1999 inventory

The 1999 inventory further categorized each SNA and ESA (but not NA) as locally, regionally, or provincially significant. By 2015, the total area of locally significant ESAs and SNAs decreased by 31% from 154.7 ha to 107.4 ha. In contrast, the total area of regionally significant ESAs and SNAs decreased by only 4% from 145.7 ha to 140.1 ha. The two provincially significant areas identified in the 1999 inventory (totaling 59.9 ha) both remained completely intact in 2015 (Figure 4).

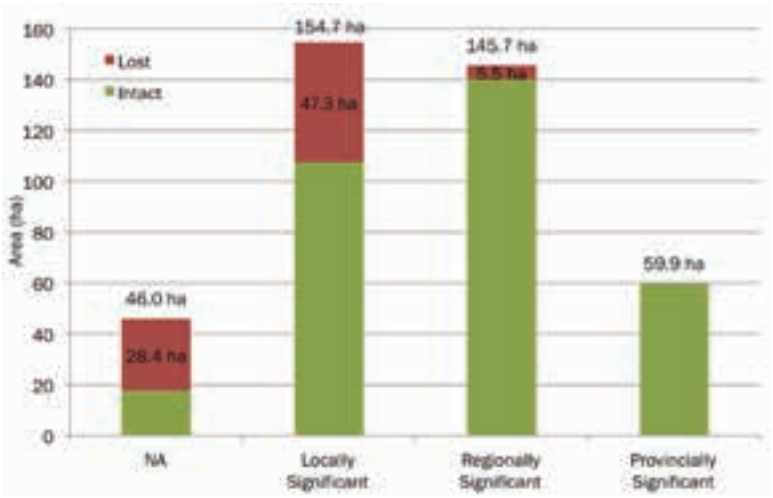


Figure 4. Area of locally, regionally, and provincially significant ESAs and SNAs in August 2015 relative to 1999 inventory

The 1999 inventory also assigned natural areas to one of four quadrants (SE, SW, NE, or NW) separated by St. Albert Trail and the Sturgeon River valley, plus one natural area that comprised the entire river valley. Between 1999 and 2015, the greatest proportion of natural area loss occurred in the NW quadrant (45% of the total area lost); this corresponds to the quadrant that supported the greatest amount of urban development during this period. During the same period, natural areas losses in the SW, SE and NE City quadrants accounted for 23%, 15% and 11 %, respectively, of total area lost. Approximately 5% of total natural area losses occurred in the Sturgeon River Valley.

3.2.2 2008 INVENTORY

Between 2008 and 2015, the City lost six of the natural areas, totaling 24.5 ha, identified on annexed lands (Map 3). All of these losses occurred to the north of the current developed extent of the City, on either side of St. Albert Trail/Highway 2. The largest natural area lost (16.1 ha) was a wetland in the Jensen Lakes Neighbourhood.

3.2.3 PLANNED (FUTURE) LOSS

As of August 2015, a total of 25 natural areas (totaling a combined area of 19.4 ha) are planned for loss, according to approved ASPs for five developing neighbourhoods. Those 25 natural areas are not identified as MR, ER, or natural area in the ASPs (Map 3). The majority of affected natural areas (18 sites covering 13.1 ha and representing 67% of planned loss), occurs in the Riverside (formerly Timberlea) neighbourhood. This proportion is in large part the result of a high incidence of natural area in this neighbourhood. Despite this, the Riverside ASP does plan for the protection of the majority of the land below the Sturgeon River flood line as either ER or MR.

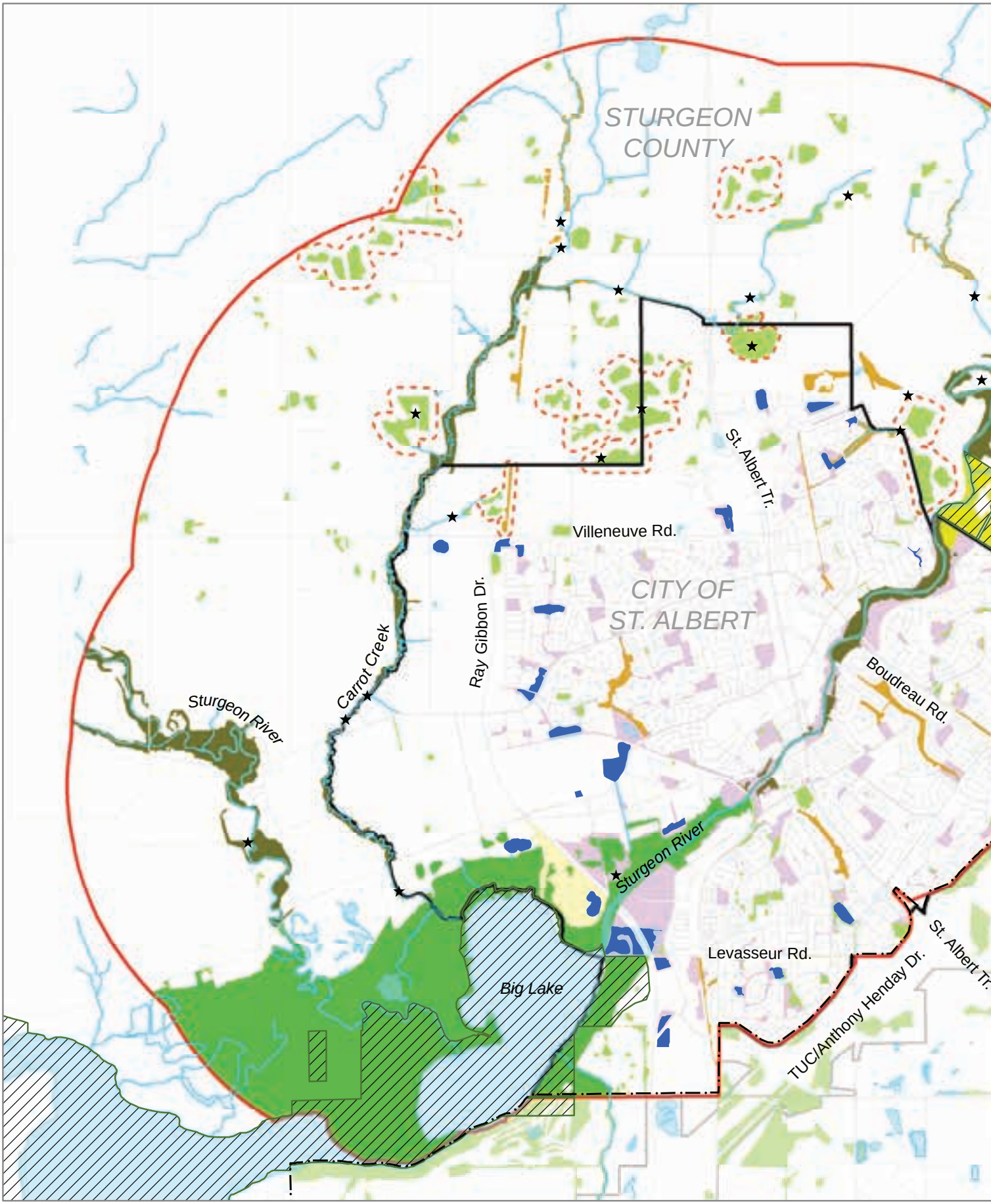
The other planned losses include four natural areas totaling 4.8 ha (25% of planned loss) located in the Jensen Lakes neighbourhood and three natural areas (totaling 1.6 ha and 8% of the total planned loss) in South Riel (note: many of the planned natural area losses in that ASP just recently occurred, between 2014 and August 2015). Two of the natural areas planned for future partial loss are relatively large wetlands – one in northwest Riverside (3.0 ha of planned loss) and the other in north Jensen Lakes (3.6 ha of planned loss).

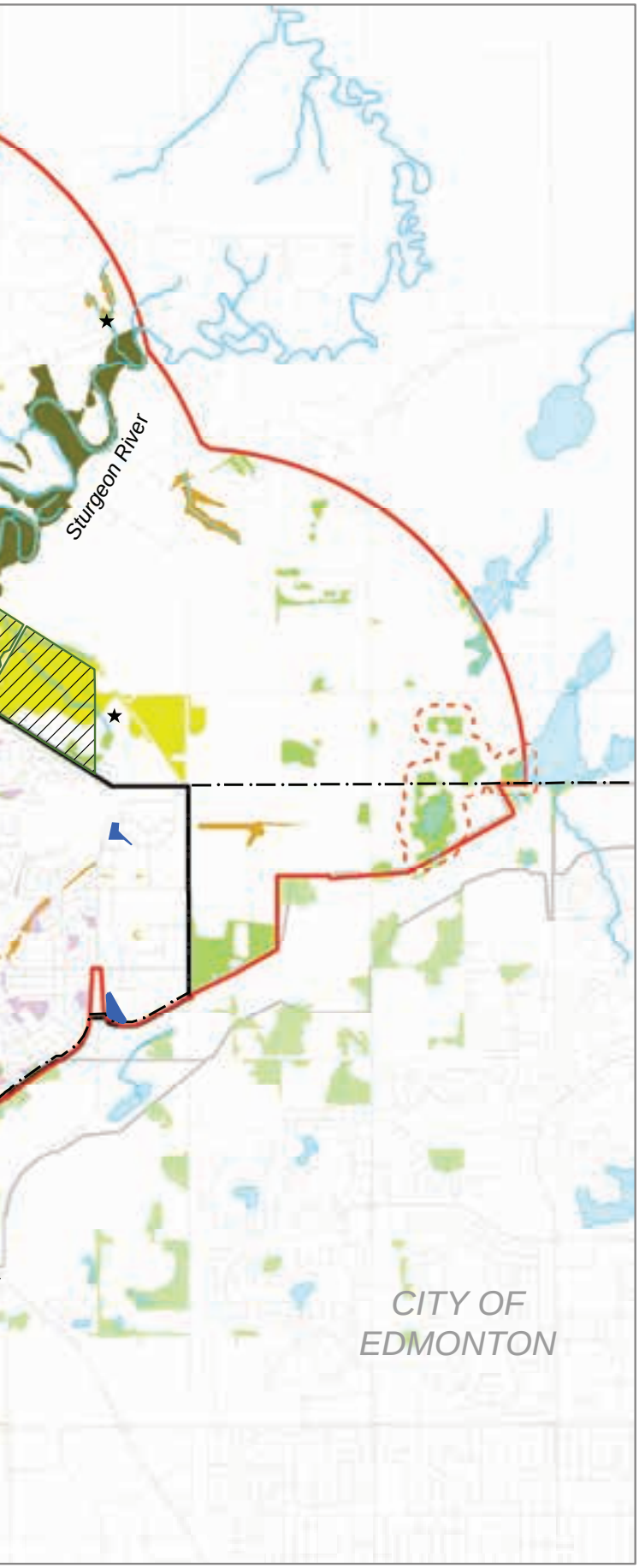
3.3 ECOLOGICAL CONNECTIVITY ANALYSIS

The process of assigning each natural area within the OSA to an ecological connectivity functional group identified an ecological network within the OSA. St. Albert natural areas are an integral part of that network (Map 4). The identified OSA ecological network comprises one Regional Core Area (REC), one Local Core Area (LCA), three Regional Ecological Corridors (RECs), several Local Ecological Corridors (LECs), and numerous Stepping Stones, including eight clusters of Important Stepping Stones (Map 4). The identified network includes all the components identified by landscape ecology science as required for an effective and functional ecological network (Forman 1995). Key to this is the presence of a confirmed regionally important area large enough to act as core habitat for specialist species.

Big Lake, the natural areas surrounding Big Lake, and the natural areas located along the Sturgeon River downstream of the lake together function as the RCA for the City's ecological network and the OSA. Big Lake has been recognized as a significant natural feature at both the provincial level (Lois Hole Centennial Provincial Park) and federal level (Important Bird Area of Canada). Its protected status, large expanse – straddling several municipal boundaries – high degree of habitat diversity, high ecological value and structural connectivity to more than one corridor means that it can support entire populations of species that can disperse and populate other near and distant habitat patches.

The next largest and best-connected natural area in the identified ecological network is the patch comprising Riverlot 56 Natural Area and the immediately adjacent natural areas (Map 4). These lands comprise a significant area of woodland habitat connected directly to the Sturgeon River. Although not as large and diverse as Big Lake and adjacent areas, Riverlot 56 provides sufficient and suitable habitat to act as a LCA for many native plant and animal species.


STURGEON COUNTY
CITY OF ST. ALBERT
St. Albert Tr.
Villeneuve Rd.
Ray Gibbon Dr.
Carrot Creek
Sturgeon River
Boudreau Rd.
Sturgeon River
Levasseur Rd.
Big Lake
TUC/Anthony Henday Dr.
St. Albert Tr.



MAP 4.
ECOLOGICAL NETWORK IN ST. ALBERT AND SURROUNDING LANDS

Legend

Ecological Connectivity Function

- Regional Core Area (RCA)
- Regional Ecological Corridor (REC)
- Local Core Area (LCA)
- Local Ecological Corridor (LEC)
- Stepping Stone (SS)*
- Important Concentration of Stepping Stones
- ★ Potential Priority Restoration Area
- Parks and Protected Areas Alberta
- Park
- Grassland/Future Red Willow Park
- Municipal Storm Water Management Facility (SWMF)
- Overall Study Area (OSA)
- City of St. Albert
- City of Edmonton
- Hydrology
- Road

* All stepping stones in Edmonton provided by City of Edmonton

N

0 500 1,000 2,000 Meters

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Projection: 3TM 114 NAD83
Date: 13 November 2015

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Connected to the Big Lake RCA are several watercourses with associated riparian communities that function as important ecological corridors. The Sturgeon River upstream and downstream of Big Lake (including through the City) and Carrot Creek, all extend across municipal boundaries, stretch for many kilometers across the landscape and provide connectivity to and from the RCA. Accordingly, these features are considered to function as RECs.

At the local scale, the City and Sturgeon County lands include numerous ravines and retained shelterbelts that extend for relatively short distances through neighbourhoods and across agricultural land. These LECs provide ecological connectivity between smaller natural areas and are most likely used by a smaller suite of species compared to the larger RECs.



Beyond these core areas and ecological corridors, the OSA includes a number of widely scattered natural areas that function as Stepping Stones for ecological processes, including wildlife movement, across the landscape. The GIS analyses identified six clusters of Important Stepping Stones in the OSA. Another two areas were identified as being notable for different reasons beyond the GIS analysis and thus were also identified and mapped as Important Stepping Stones. The first of these is a relatively large (~19 ha) wetland located in the centre of a loosely connected arc of natural areas straddling the northern boundary of the City. The wetland was identified as an Important Stepping Stone because it is strategically located between a LEC and a large cluster of Important Stepping Stones. The second additional cluster comprises two small (< 2 ha) Stepping Stones situated within less than 50 m of a LEC just north of Villeneuve Road at Ray Gibbon Drive; clustering these two small Stepping Stones with the LEC strengthens the ecological value of the LEC; they were, therefore, identified as Important Stepping Stones. The two additional clusters are depicted on the map as Important Stepping Stones with 20 m buffers.

The areas shown as Important Stepping Stones may support improved sustainability and resilience of local populations of native plants and animals because of the increased local connectivity within the clusters and between other surrounding ecological network components. Of particular note is the loose configuration of Important Stepping Stones and LECs that forms an arc straddling the northern boundary of the City between the area of the Sturgeon River and Riverlot 56 (LCA) in the east and the northern reaches of Carrot Creek in the west. Although not comprised of contiguous natural area, this configuration of ecological network components may provide higher ecological connection between Carrot Creek and Sturgeon River RECs, creating an alternative connection that exists in addition to the nexus of the two RECs at Big Lake. Alternate pathways, such as the one formed by this arc, are important for ecological network resiliency because they offer multiple routes for movement of species in and out of core areas (Forman and Godron 1981).

Semi-permeable and semi-natural land-uses in the matrix can serve to enlarge core areas, provide for some connectivity between natural components and widen corridors in the ecological network. Temporary or occasional use by some species or allowing for certain ecological processes, such as seed dispersal, means that parks and stormwater management facilities, as semi-permeable and semi-natural features, can act as Stepping Stones that complement natural network linkages. In St. Albert, this is particularly apparent at the southwest of the City, where park lands (including the non-native semi-natural grassland of future Red Willow Park) on either side

of the Sturgeon River and partially-naturalized SWMFs along Ray Gibbon Drive serve to increase connectivity within the northeast end of the RCA. As another example, along much of the Sturgeon River throughout the City, areas of semi-natural and semi-permeable park space border more natural ecological network components, simultaneously widening the effective width of the REC along the River and buffering the natural components from the potential impacts of the adjacent development. At a smaller scale, good examples of park space that provides improved ecological connectivity are: 1) two SWMFS and a greenway in Erin Ridge North that extend between two Local Ecological Corridors; and 2) a park situated between the LEC formed by Grandin Ravine and the habitat surrounding Grandin Pond.

The OSA includes numerous features that function as ecological barriers. Most notably, the extensive developed areas and wide-ranging road network generally reduce the functionality of the ecological network. The developed, urban matrix is at best only semi-permeable to many terrestrial species, but remains relatively permeable to the movement of many landbirds and some small mammal species. Many of the roadways within the OSA, particularly the larger, wider roads (e.g., Highway 2, Ray Gibbon Drive), can function as formidable barriers to smaller terrestrial wildlife. They may be less formidable to larger species, such as moose deer and coyote, which can successfully cross these roads (Spencer Environmental 2013), but the presence of roads, especially in more urban settings, is known to have an effect on movement choices. The potential ecological impact of roads should remain an important consideration in transportation planning as well as natural area land use decision making.

Lastly, although just outside of the OSA, the Transport Utility Corridor (TUC) between the City of St. Albert and City of Edmonton also provides a large swath of semi-permeable land. Despite containing a major roadway (i.e., Anthony Henday Drive) that presents a barrier to some wildlife movement, the relatively permeable land along either side of the roadway includes several Stepping Stone natural areas, semi-naturalized SWMFs and relatively large expanses of open undeveloped land. Accordingly, the generally semi-permeable nature of the TUC along its long access may provide some level of ecological connectivity between the south side of the Big Lake RCA and the lands to the east and northeast of St. Albert. In a few locations, natural areas in the City of St. Albert are closely connected to the lands within the TUC (e.g., woodland west of St. Albert and Anthony Henday Drive).

3.4 POTENTIAL RESTORATION AREAS

3.4.1 POSSIBLE PRIORITY RESTORATION AREAS

A total of 21 possible priority restoration areas were identified within the OSA (Map 4). Of the 21 areas, 10 restoration areas were identified primarily for riparian health enhancement, five were identified to strengthen ecological connectivity along corridors, four were identified to create larger and more contiguous habitat patches and two were identified to improve the habitat quality of more significant habitat patches.

Eight of the riparian restoration areas are located along Carrot Creek, including its upper reaches and the tributary that extends east across Highway 2. In general, the identified restoration areas represent reaches of the creek that have been realigned (i.e., channelized) and/or where the presence of a natural riparian community has been nearly eliminated. In all cases, riparian restoration could involve efforts to provide a more natural meandering channel and a more robust riparian community comprising native trees and shrubs. In addition to improving riparian health, restoration along the upper reaches of Carrot Creek, particularly the tributary that extends east across Highway 2, would serve to enhance the ecological connectivity between Carrot Creek and the Sturgeon River along the north edge of the City. The other two riparian restoration areas are located along the

Sturgeon River, one upstream of Big Lake and the other downstream of the City of St. Albert. As an example, the area downstream of the City represents a large floodplain area within a tight meander along the Sturgeon River that appears cultivated. In its current state, the area provides relatively little habitat value and the proximity of agricultural activity could be impacting water quality in the river; both aspects could be greatly improved if the area was restored to a natural community.

Four of the five ecological corridor restoration areas are located just northwest of the City, where several remnant ravines are present, yet none of them connect directly to the natural areas along the Sturgeon River Valley. In all cases, there are opportunities for naturalization efforts to extend the plant communities beyond the ravines and thereby provide a more direct connection to the Sturgeon River. The fifth corridor restoration area is in northwest St. Albert where an ephemeral drainage appears to connect to Carrot Creek. If restored, this corridor could provide for a strong ecological connection between the creek and a small collection of nearby natural areas identified as Important Stepping Stones.

Four restoration areas are located where restoration could create larger, more contiguous habitat patches. Conservation science principles generally dictate that larger, less fragmented habitat patches provide greater habitat value, are more resilient to ecosystem change and, ultimately, are more sustainable in the long term. Accordingly, four restoration areas were identified where gaps between sizable and significant natural areas could be reduced or eliminated. In each case, if habitat contiguity could be achieved, the resulting combined natural area would become comprise more significant habitat at the scale of the OSA.

Lastly, two restoration areas were identified at existing natural areas where aerial photograph review suggested current disturbance or ongoing environmental impact that could be reversed, resulting in ecological recovery and improved habitat quality. One area is currently being impacted by what appears to be encroachment from an adjacent junkyard, the other is a wetland currently impacted by drainage efforts. In each case, removal of the existing disturbance would allow for a natural plant community to establish and improve natural area sustainability.

3.4.2 DEGRADED WETLANDS

OSA inventory mapping resulted in the identification of 232 degraded wetlands (Map 5) that vary considerably in terms of apparent basin size and degree of degradation. Some wetlands have been impacted fairly recently, through encroaching land use, as a result of a drier climate, while many of the smaller identified wetlands have been consistently degraded by years of repeated agricultural impacts. Most of the wetland degradation appeared to be the direct result of agricultural activity (i.e., tilling/cultivation) or efforts to drain or divert surface water (sometimes for agricultural use). The degraded wetlands subject to agricultural disturbance appear to be those that are naturally less wet and more likely to dry out late in the growing season or in periods of low precipitation. As a result, they become sufficiently dry to enable the passage of farm equipment which, in turn, leaves them vulnerable to tilling/cultivation. Agricultural disturbance and draining can be reversed and, because of this, each degraded wetland presents an opportunity for wetland restoration. Despite their level of degradation, all identified degraded wetlands are expected to require *Water Act* approval for their removal and related replacement pursuant to the Alberta's Wetland Policy.



3.5 CITY PERFORMANCE REGARDING MUNICIPAL RECOMMENDATIONS

The review of existing municipal documents identified many natural area-related and conservation-oriented recommendations. Many of those recommendation statements were, however, focused on specific subject areas that were not specifically investigated as part of this project. Accordingly, it was not possible to comment on many of the existing recommendations using the information gained during this project. The following sections outline those recommendations for which it was possible to make some meaningful assessment of implementation success. Each section comprises a recommendation statement, referenced to the source document followed by a brief comment on the City's implementation performance to date.

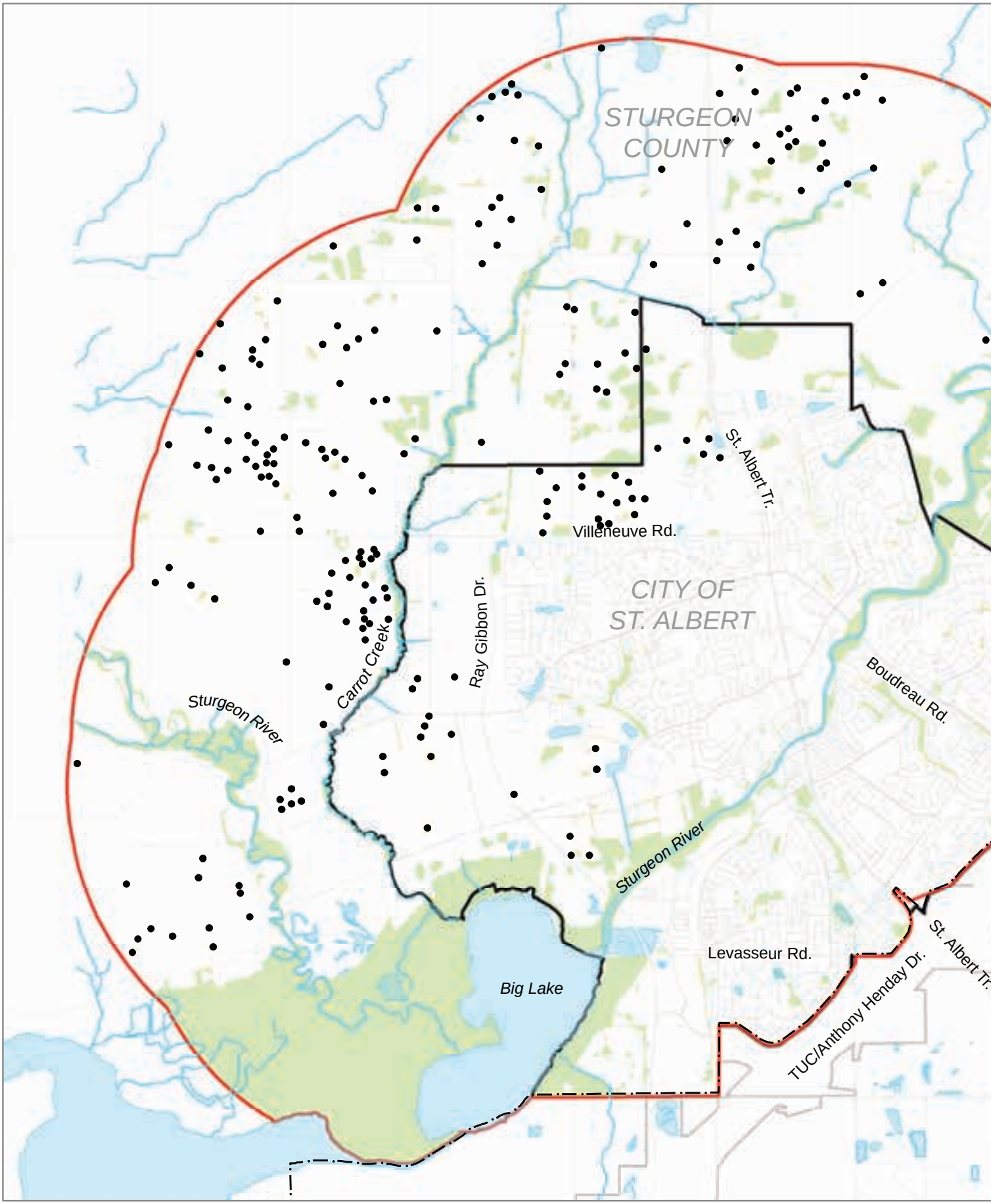
RECOMMENDATION:

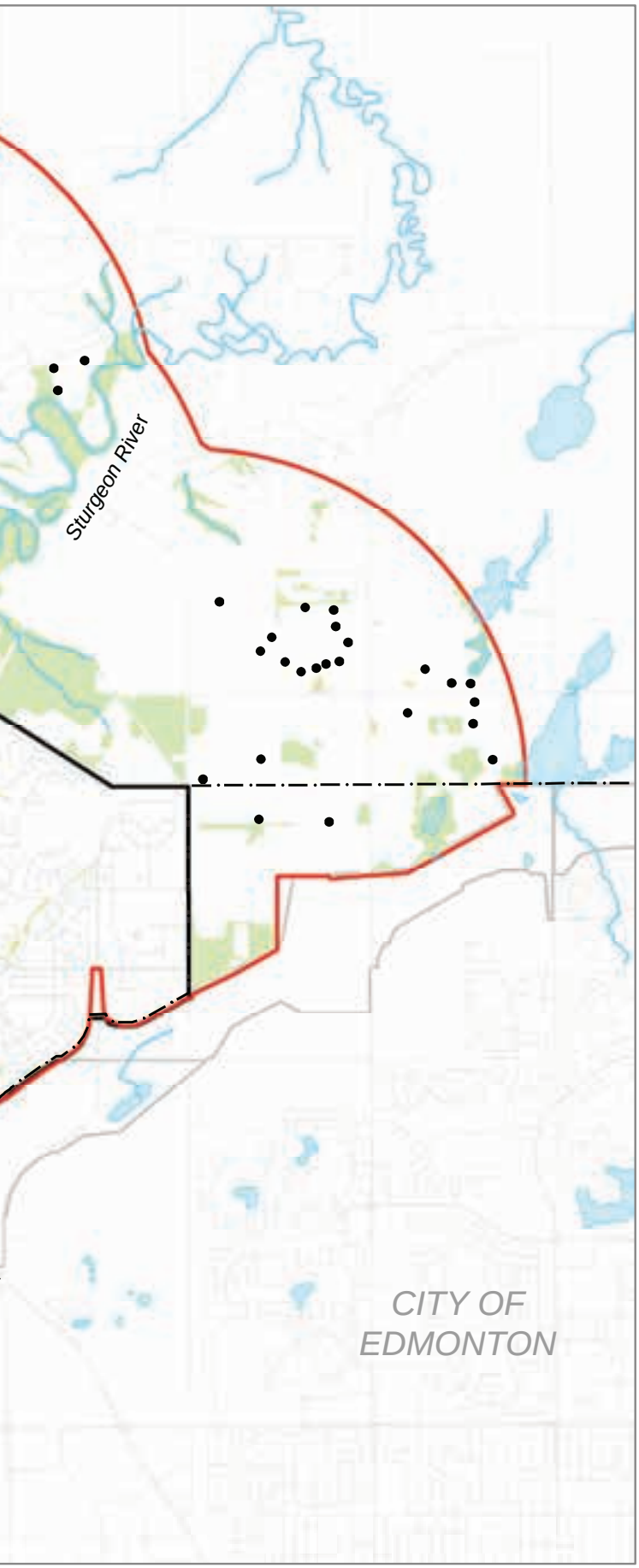
Preserve and protect the Sturgeon River Valley and Carrot Creek corridors. Specifically, the Carrot Creek corridor includes a 50-metre wide development buffer from the top of the bank of the creek (Environmental Master Plan; MDP 2007; mentioned in Sturgeon River State of the Watershed Report).

COMMENT:

The Riverside ASP, approved in 2012, extends along the north side of the Sturgeon River Valley between Ray Gibbon Drive and the CN Railway. That plan protects the vast majority of the lands below the designated flood line as Environmental Reserve or Municipal Reserve; one area below the floodline has been converted to a stormwater management facility.

Only one Area Structure Plan (ASP) has been approved for lands adjacent to Carrot Creek: the Range Road 260 ASP approved in 2014. That plan includes a "*minimum 50-metre setback from the top of bank of Carrot Creek... to protect the riparian area and provide space of potential trail development*", suggesting a strong performance to date.


STURGEON COUNTY
CITY OF ST. ALBERT
St. Albert Tr.
Villeneuve Rd.
Ray Gibbon Dr.
Carrot Creek
Sturgeon River
Boudreau Rd.
Sturgeon River
Levasseur Rd.
St. Albert Tr.
TUC/Anthony Henday Dr.
Big Lake



MAP 5.
DEGRADED WETLANDS IN THE OVERALL STUDY AREA

Legend

- Degraded Wetland
- 2015 Natural Area Inventory
- Overall Study Area (OSA)
- City of St. Albert
- City of Edmonton
- Hydrology
- Road

N

0 500 1,000 2,000 Meters

1:54,000

Projection: 3TM 114 NAD83
Date: 13 November 2015

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RECOMMENDATION:

Undertake a drained wetland inventory for future restoration projects (Environmental Master Plan and Sturgeon River State of the Watershed Report).

COMMENT:

This report identifies, at a coarse level, degraded wetlands within the City of St. Albert boundaries and the greater OSA (see Map 5). All degraded wetlands represent an opportunity for future wetland restoration projects, although some will likely prove to be more suitable for restoration than others.

RECOMMENDATION:

When a site, under consideration for conservation, could be displaced or compromised by a development proposal, the following should be undertaken to gain an understanding of potential effects of development... additional field evaluations including a spring bird survey, a rare plant survey and, if a wetland is involved, an amphibian survey (Red Willow Park West Master Plan Update).

COMMENT:

The ASPs for the five St. Albert neighbourhoods under active development (i.e., Riverside, Jensen Lakes, South Riel, Erin Ridge North, and Range Road 260) indicate that natural area vegetation community characterizations, and in some cases bird and rare plant surveys, have been performed as part of the development planning and assessment process. However, amphibian surveys were generally not performed and bird/rare plant surveys, when performed, were not always done in the appropriate season or sampling conditions

Part 2 of this document reports on the field program undertaken for this exercise in the Detailed Study Area (DSA) comprising calling amphibian surveys, breeding bird surveys, vegetation surveys and soil surveys. The findings of those surveys will provide the City with data that can be used to inform conservation and land use planning decisions for development affecting DSA lands. Land access restrictions prohibited surveying in all parts of the DSA, thus additional site investigations will still be required for some future proposals. Additionally, no rare plant surveys were undertaken. These may be required in the future.

RECOMMENDATION:

Protect provincially, regionally, and locally significant sustainable areas except where the protection compromises other necessary parks, trails and open space requirements in a neighbourhood. Preserve sustainable locally significant natural areas, where possible, when developing parks and open space (MDP 2007).

COMMENT:

Between 1998 and 2015 only 4% of the total area of regionally Significant ESAs and SNAs identified in 1999 were lost as a result of urban development. This rate of loss is low compared to the overall natural area loss of 20% incurred over the same time period. None of the provincially significant ESAs (all associated with the shoreline/floodplain of Big Lake) experienced any loss between 1999 and 2014. This low level of loss over a period of 17 years suggests a high level of success implementing municipal development plan policies, for areas of regional and provincial significance.

The 58.5 ha of natural area lost from the lands developed between 1999 and 2014 represents 60% of the total natural area land base that was present within those lands in 1998, meaning 40% of natural areas within those lands have been retained on the landscape. This suggests some success in protection of locally significant natural areas. The analysis of natural area loss to park development indicated that in some cases, portions of

natural areas have been incorporated into manicured parks, but in most cases manicured parks were established at the expense of natural areas.

3.6 IMPACTS OF DEVELOPMENT ON NATURAL AREAS

3.6.1 OVERVIEW

Urban development typically has potential to result in natural area loss, fragmentation, and/or ecological degradation of retained areas. That notwithstanding, there are, many cases in which proactive development planning can avoid, minimize, or mitigate some of these adverse impacts and potentially even enhance, restore, and create natural areas.

Direct Impacts (Loss/Reduction)

As development converts land to new uses, it can reduce the area and type of natural habitat on the landscape and can isolate retained natural features from each other. The overall end result is reduction of biodiversity. This loss is greatest when large habitat patches that can support wildlife species less tolerant of humans and requiring specialized habitat are involved. In peri-urban areas, this effect is less common as most natural areas are already so small and or fragmented that all habitat is effectively edge or non-interior habitat that can sustain only generalist species that tend to continue to make use of urban natural areas. Nonetheless, partial loss and fragmentation of a natural area may still reduce its ability to provide previously available resources to wildlife (e.g., nest sites, food sources and mate availability). In addition, changes in species composition alter food webs and other relationships among species.

At the regional scale, fragmentation of natural areas or increase in gaps between them can alter habitat connectivity and impact species movement and dispersal within the wider landscape. Conversion of relatively permeable land cover types separating natural areas (e.g., agricultural land) to less permeable hard surface urban areas will increase isolation, making wildlife movement, pollination and seed dispersal more challenging. Habitat loss combined with fragmentation generally results in a decreased ability to support high levels of biodiversity (i.e., smaller populations of fewer species) and remaining species are likely to be less able to exchange genes and more vulnerable to local extinction. Overall, development tends to reduce regional biodiversity and ecosystem resiliency.

Indirect Impacts

Ecological degradation of natural areas as a result of development on adjacent lands may occur via a suite of potential indirect impacts. Among the more common impacts are the introduction of invasive species, chemical contamination, increased nutrient loading, changes in hydrology, introduction of linear barriers to wildlife movement and increased anthropogenic disturbance through encroachment. The following list briefly discusses each of these potential indirect impacts.

- Development can result in the introduction of non-native and often invasive species into natural areas. Once introduced, exotic species can displace native species. For example, invasive bird species that often use human structures for nesting (e.g., house sparrow and European starling) may spread into natural areas where they often out-compete native species for natural nest sites (e.g., tree cavities). Invasive plant species that are intentionally planted as ornamentals, or weeds that establish temporarily during construction, often encroach into natural areas and out-compete endemic species.

- Chemical contaminants, nutrients, and sediments from developed or developing areas have the potential to collect in surface runoff and impact downstream wetlands and water bodies. Pesticides and herbicides that are applied in developed areas to control weeds or

insect pests can have toxic effects on species that are sensitive to chemical contaminants (e.g., amphibians). Similarly, trace amounts of petroleum, hydrocarbons, and other chemicals that are spilled at residential, commercial, and industrial sites can pollute natural areas in the vicinity. Increased sediment, contaminant and nutrient loadings can also occur as a result of snow management and application of fertilizer on lands adjacent to natural areas.

- Development can alter the volume, timing, and routes of local and regional water flow with consequences for surrounding natural areas, especially those with water bodies and water course features. If not adequately controlled, stormwater runoff from developed areas, can cause increased total volume, flow rate, and, particularly during active development, increased sediment loading in natural areas including ravines and downstream receiving water bodies. Conversely, human water use and retention may reduce the flow rate and volumes received by some natural areas, resulting in dryer conditions. Flooding and/or desiccation of natural areas outside of the normal range of variability may create conditions to which ecosystem components are unable to adapt. One common manifestation is tree mortality. Moreover, the impacts on the ecological functions of wetlands, water bodies, and riparian zones (e.g., moderation of water flow, water filtration, and nutrient absorption) can extend to other downstream hydrologically-connected natural areas.

- Urban development is almost invariably associated with an increase in road density. Increased road density in proximity to natural areas can result in various secondary impacts including increased wildlife mortality as a result of wildlife-vehicle collisions, increased noise disturbance and reduced permeability of the surrounding landscape for wildlife movement.

- The increased density and proximity of development to retained natural areas can result in increased human disturbance. A larger human population and greater road access may result in increased recreational use of natural areas. This in turn can lead to disturbance of wildlife, trampling of vegetation, introduction of weeds and the accumulation of litter and garbage. Wildlife can also be disturbed by noise associated with increased recreational use of natural areas (e.g., noise from ATVs, motorboats, sound systems, or voices), by noise generated by nearby roads, industrial facilities, utility facilities, residential and commercial areas. Finally, nearby development can result in increased cat predation, which can be a significant source of mortality for birds (Blancher 2013).

3.6.2 THE CASE OF THE CITY OF ST. ALBERT

Future development within the City of St. Albert is expected to comprise new residential, commercial, and light industrial areas and accompanying road, utility, stormwater management, and recreational infrastructure. Development of unplanned lands will consist largely of expansion into agricultural-dominated lands to the north and the west. Development in recently planned areas will include lands near retained wetlands and important riparian corridors.

3.6.2.1 Development Challenges for Natural Area Sustainability

Development will undoubtedly result in increased pressures on the remaining natural areas in the City, especially Carrot Creek, Big Lake, the Sturgeon River, and their surrounding riparian zones and floodplains. With more development, increased human activity, less

undeveloped land and few other sizeable natural areas planned for retention, the ecological functions that these three major natural systems provide will become even more important, and simultaneously more difficult to sustain.

- Wildlife populations are likely to become more restricted to Carrot Creek, Sturgeon River, and Big Lake natural areas as smaller refugia and permeable land cover shrinks or disappears.
- Any new road crossings of Carrot Creek will impact its ability to function as an effective corridor for wildlife moving through the area, particularly from less developed areas to the north of St. Albert into Big Lake and its floodplain.
- As wetlands are lost or become further degraded, moderation of regional surface water flow will decrease while municipal stormwater volume runoff increases (along with the accompanying contaminants, sediments, and nutrients); this will likely increase total surface water volumes received by Carrot Creek, Sturgeon River, and Big Lake, although release rates will be regulated.

3.6.2.2 Development Opportunities for Natural Area Sustainability

Despite the many adverse impacts that are often associated with development, development within the City may also offer opportunity to restore or enhance natural areas.

- Agricultural land generally has low habitat value (although it is relatively permeable to wildlife compared to urban areas) and its surface water runoff often contributes high levels of nutrients and chemical contaminants to surrounding wetlands and water bodies. In many cases along Carrot Creek and the perimeter of various wetlands throughout the undeveloped area of the City, agricultural practices take place within meters of the surface water features and often encroach directly into areas that would otherwise support native plant communities.
- Through the development process, it will be possible to identify appropriate development setbacks to respect the ecological sensitivity of natural areas and to buffer them against the potential impacts of future development. Development setbacks can be naturalized and enhanced such that they provide complementary habitat function and improve, not hinder, the quality and functionality of adjacent natural areas. For example, the incorporation of naturalized stormwater management facilities (NSWMFs) into future urban developments adjacent to Carrot Creek could create new, adjacent wildlife habitat and improved water quality relative to the area's current agricultural land use. This could mitigate some overall development effects by simultaneously improving the ecological functionality provided by the Carrot Creek, Sturgeon River, and Big Lake natural areas and reducing the nutrients, sediments, and contaminants contributed to them.

In many ways, the City of St. Albert is already well positioned to realize these potential positive impacts of development through the Land Use Bylaw restrictions imposed on development below the floodline as well as the requirement that urban development (excluding recreational and stormwater infrastructure) along Carrot Creek respect at least a 50 m buffer beyond the top-of-bank. If implemented to their full potential, these restrictions offer an excellent opportunity to improve the quality and function of Carrot Creek as development progresses in west St. Albert. The benefits would be even greater if Sturgeon County mirrored this policy in their Carrot Creek riparian zone.

4.0 SUMMARY

This update and analysis of the natural areas inventory has resulted in the following key observations regarding the system of natural areas present within the OSA:

- Much of the City of St. Albert land base is already developed or has approved statutory plans guiding future development. Further, there are relatively few natural areas that remain within the undeveloped areas of the City. In contrast, OSA lands outside of the City are largely agricultural and support numerous scattered natural areas. The most important features in those lands are the previously-recognized riparian systems that also form part of or are linked to features in St. Albert.

- Since the 1999 inventory, natural area losses in St. Albert have been significant, but some important conservation work has also occurred. Across all natural area types, 20% of natural areas (sites) have been lost, but this means 80% of the original inventory remains. For areas originally identified as NA, 62% of area has been lost since 1999. In contrast, the larger, regionally and provincially significant ESAs and SNAs within and adjacent to the City have suffered only very minor losses. These statistics indicated that the City has had some successes complying with the conservation direction set out in past guiding documents.

- Despite some losses since 1999, the current system of natural areas within the OSA forms a functional ecological network. Of primary importance to this network are areas both *within and adjacent* to the City of St. Albert that are identified as a Regional Core Area (Big Lake and surrounding natural areas, and a downstream reach of Sturgeon River Valley), a Local Core Area (Riverlot 56 and connected woodland) and Regional Ecological Corridors (Sturgeon River and Carrot Creek upstream of Big Lake). Beyond these key features, the remaining scattered natural areas provide other linkages that facilitate connectivity across the landscape. Some particularly important Stepping Stone clusters also exist. The spatial layout of the natural area system emphasizes the importance of management in a regional context. In several

locations, the combination of St. Albert's urban natural areas and established parks and storm facilities has also created additional, linear features that, at least in theory, add to network function within the City limits.

- Many natural areas, both within the City of St. Albert and beyond its boundaries, would benefit from ecological restoration. In particular, the ecological function and riparian health of several reaches of Carrot Creek could be improved. Restoration efforts at these locations, as well as many others, would also serve to strengthen the degree of connectivity within the ecological network.

The City is well positioned to advance its planning and management of natural areas, in cooperation with surrounding municipalities, to maintain and potentially improve a sustainable and ecologically valuable regional network of urban natural areas.



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APPENDIX A. PART 1
DETAILED METHODS

NATURAL AREAS MAPPING IN STURGEON COUNTY

Sturgeon County's 1989 Environmentally Sensitive Areas Study was designed to identify relatively large areas, and the minimum threshold size of that study did not align with the present inventory purposes. With the exception of Big Lake, the Sturgeon River and Riverlot 56, none of the 1989 County natural areas are situated in the OSA. Thus, a new aerial photograph delineation exercise was required for this study. Rules used in the exercise are described below.

- Delineate all observed natural features meeting the 2015 natural area definition and measuring ≥0.125 ha, consistent with Stantec (2014).
- Map adjacent natural areas separated by less than 10 m as a single natural area.
- Conversely, treat nearby natural areas separated by unvegetated or manicured lands (e.g., gravel road or turf) greater than 10m in width as distinct natural areas.
- In cases of uncertainty regarding species composition of dominant vegetation, adopt a conservative approach, assume native species and include as a natural area.
- Include shelterbelts if they meet the definition of a natural area and are at least 15 m in width. A 15 m width minimum was selected on the basis that such shelterbelts provide added habitat value beyond the ecological connectivity function and some potential for long-term sustainability in a developed context.
- Include shelterbelts extensions within the boundaries of a natural area if they meet the definition of natural area, measure 10 m or wider and structurally connected to (contiguous with) that natural area.
- Map wetlands but do not classify wetlands.
- Include degraded wetland features if they align with the definition of a natural area (i.e., support native plant communities, as opposed to wet depressions that are totally cultivated) *in both* the 2014 and 2012 aerial photography. Degraded wetlands having some native wetland vegetation in 2014 but showing no native wetland plant community in 2012 were not identified as natural areas and were instead identified as a point-feature and an opportunity for wetland restoration.

1999 INVENTORY NATURAL AREA LOSS ANALYSIS

Changes (i.e., losses) to natural areas inventoried in 1999 were assessed by overlaying the original natural area boundaries on high resolution, true-color 2014 aerial photography and analyzing in detail at a scale of between 1:2,000 and 1:4,000. Each natural area was identified as being wholly intact, partially intact or wholly lost and the boundaries re-digitized to reflect 2014 conditions. For each natural area that had been reduced in area, boundary adjustment included tagging the lost area as partially lost. The 2014 imagery was then cross-referenced with the 1998 aerial photography to ensure that areas identified as having experienced change reflected true change as opposed to changed interpretation of natural area boundaries.

To provide further context for the interpretation of known losses, the St. Albert 1998 and 2014 developed urban extents, derived from interpretation of 1998 and 2014 aerial photography, respectively, were overlain on the natural area losses map. This allowed assessment of loss of 1999 inventory located within the 1998 developed urban limits, loss occurring concurrent with urban development beyond the 1998 boundary, and loss occurring on undeveloped lands and thus deemed as unrelated to urban development.

In addition, natural area loss that occurred as a result of park development was coarsely assessed by overlaying lost polygons (including total and partial losses) over the Parks Only subset of the Parks dataset provided by the City (this excluded school/future school polygons). The overlap between parks and natural area losses was then manually reviewed to identify the number of occurrences where a substantial area of natural vegetation had been cleared to allow for a the development of manicured park use such as turf, a pathway or a stormwater management facility (SWMF). Park-related occurrences of natural area loss were counted and their spatial distribution was briefly described.

The road-side reconnaissance survey performed in the undeveloped lands on 14 August 2015 for the OSA Inventory Update was also used to inform the 1999 inventory natural area loss assessment (i.e., to verify the presence of natural areas identified as intact and partially intact and to identify any additional, visually discernible natural area loss that occurred between May 2014 and August 2015). Ground-truthing was limited to sites that were visible from public roads.

IMPORTANT STEPPING STONE CLUSTER ANALYSES

The following steps were employed to identify important Stepping Stone clusters:

- Four GIS Stepping Stone clustering analyses were undertaken using two minimum patch sizes and two buffer widths: patches ≥ 1 ha buffered by 50 m, patches ≥ 1 ha buffered by 100 m, patches ≥ 2 ha buffered by 50 m, and patches ≥ 2 ha buffered by 100 m. For each iteration, Stepping Stones larger than the minimum patch size with overlapping buffers were considered to be clustered. Stepping Stones that were below the minimum patch size but overlapped with clustered Stepping Stone buffers were added to the pertinent cluster.
- Results were qualitatively compared to identify the option with the most ecologically-meaningful clusters, i.e., having functional connectivity to the other network components (other Stepping Stones, other Stepping Stone clusters, corridors, and core areas). Increasing connectivity (i.e., closing gaps between network components) was more heavily weighted than increasing the total number of important Stepping Stone patches.

  Both options using ≥ 1 ha patches (50 m and 100 m buffers) resulted in few clusters additional to the options with ≥ 2 ha patches, and tended to extend cluster boundaries to include even smaller patches. This did not necessarily improve connectivity value as many of the new patches were very small (less than 1.0 ha) and more distant from other network components. Thus the 2 ha iterations were judged to be more meaningful. Additionally, by identifying fewer clusters, the options with ≥ 2 ha patches were more discriminating and thus a more powerful tool for identifying conservation *priorities*. On that basis, the options with ≥ 2 ha patches were favoured over options with ≥ 1 ha patches. Of the two options using ≥ 2 ha patches, the 100 m buffer did not identify clusters additional to the 50 m buffer but did extend cluster boundaries to capture sites that were qualitatively deemed to increase connectivity. Therefore, the options with ≥ 2 ha patches buffered by 100 m identified the most relevant Stepping Stone clusters, from the perspective of constituent patches and location on the landscape. Stepping Stones within these clusters were identified and mapped as Important Stepping Stones.
- All non-clustered stepping stones were reviewed to assess if any warranted identification as Important Stepping Stones for reasons beyond the GIS analysis.

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PART 2

DETAILED STUDY AREA INVESTIGATION

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1.0 STUDY OBJECTIVES

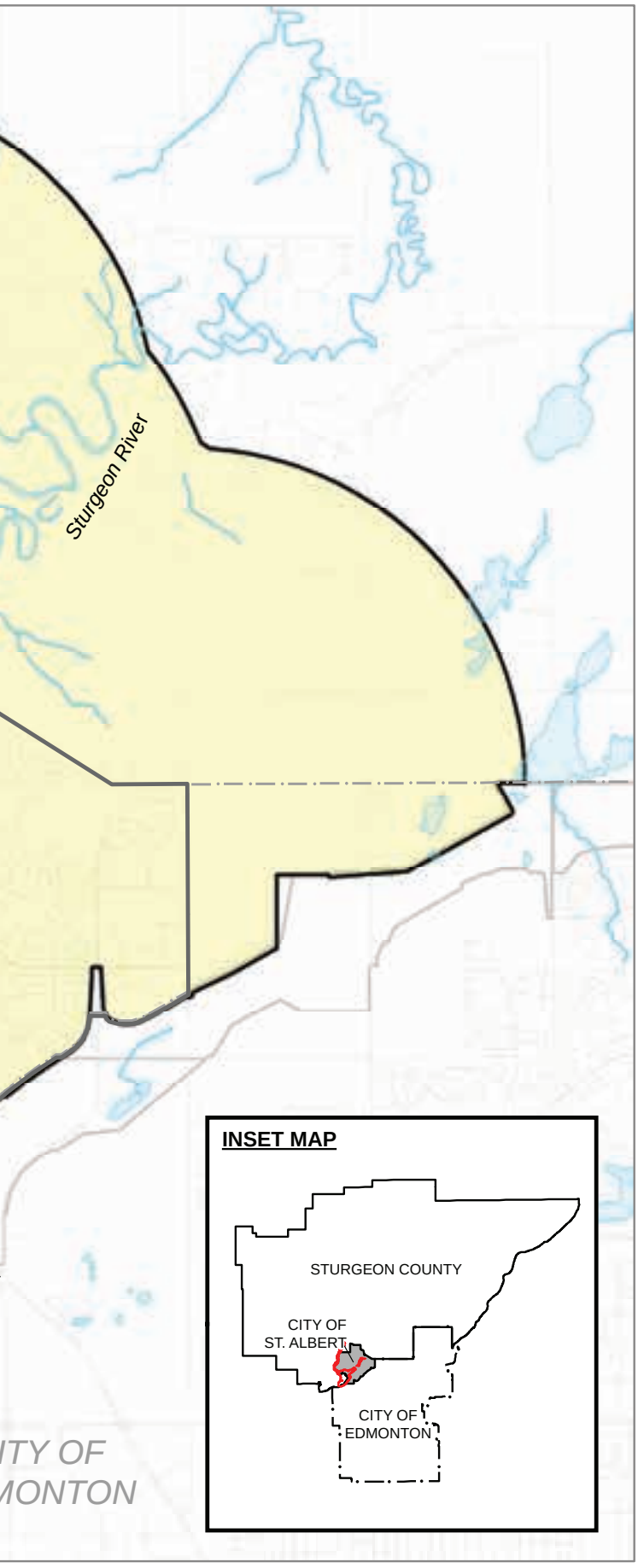
The City's intention in commissioning detailed investigations within the Detailed Study Area (DSA; Map 1) was to generate new, site-specific data that could be used to inform future planning decisions involving DSA lands. Specific primary objectives of the Part 2 exercise were as follows:

- Map all land units within the DSA.
- Undertake a multi-disciplined field sampling program to collect detailed information on flora, fauna and soils within the DSA.
- Use desktop and field derived information to identify natural areas of significance and environmental sensitivities.
- Identify candidate sites for ecological restoration that will contribute to the enhancement of ecological services and/or natural connections.




STURGEON COUNTY
St. Albert Tr.
Villeneuve Rd.
CITY OF ST. ALBERT
Ray Gibbon Dr.
Carrot Creek
Sturgeon River
Boudreau Rd.
Sturgeon River
Levasseur Rd.
St. Albert Tr.
TUC/Anthony Henday Dr.
Big Lake

MAP 1.
LOCATION OF DETAILED STUDY AREAS



Legend

- Detailed Study Area (DSA) - Field Surveys & Land Unit Mapping Completed
- Extended Detailed Study Area - Land Unit Mapping Completed
- Overall Study Area (OSA)
- City of St. Albert
- City of Edmonton
- Hydrology
- Road

N

0 500 1,000 2,000 Meters

1:54,000

Projection: 3TM 114 NAD83
Date: 13 November 2015

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2.0 METHODS

2.1 STUDY AREA

Early in the exercise, the following refinements were made to the DSA at the request of/ in consultation with the City:

1. Portions of the DSA overlapping with Lois Hole Centennial Provincial Park (LHCPP) were removed from the area subject to field surveys.

2. For the land unit mapping exercise only, the DSA was extended downstream to include the entire Sturgeon River Valley within the boundaries of the City. The extended DSA was delineated by buffering the designated flood line downstream of the DSA by 100 m (Map 1). The northeast City boundary formed the downstream limit of the extension.

2.2 LAND UNIT MAPPING IN EXTENDED DSA

As part of the 2015 natural area inventory update a single delineated natural area (site) could be heterogeneous in character and contain more than one land unit, or plant community or habitat type, provided those units were contiguous. Accordingly, the 2015 natural area inventory does not provide site information at a finer scale than the natural area delineation. Some finer scale information does, however, exist. In 2014, the Utility Master Plan update included a land unit mapping exercise for all City lands (Stantec 2014). That exercise used a minimum size threshold of 0.125 ha for natural land units, an area smaller than the previous natural area minimum size of 0.5 ha. Furthermore, the City-wide exercise focused on mapping land units *within previously inventoried* natural areas; a small number of new, isolated natural land units were also identified. Mapping focused only on natural upland and wetland land units; non-natural or anthropogenic land units were not included. At the request of the City, the 2015 DSA land unit mapping exercise covered the original and extended DSA, and thus included portions not previously mapped at all and expanded the concept of land unit to include natural and non-natural land units.

The Stantec (2014) study did not define the concept of a land unit, however, their land unit classifications were generally described as being adaptations of previously created plant community classification systems. For the purpose of the 2015 mapping exercise the term “land unit” was retained and more specifically defined as **a continuous area of a single land cover or land use** discernible at a scale ranging from 1:3,000 to

1:5,000, using high resolution aerial photographs. Using the Stantec (2014) land unit mapping dataset and aerial photographs as base layers, a new land unit mapping exercise was performed that identified eight natural and six anthropogenic land unit types and delineated their distribution in the DSA (original and extended); detailed land unit identification and mapping methods are provided in Appendix A. Mapped land units were later ground-truthed using information collected during subsequent field surveys.

2.3 FIELD SURVEYS IN DSA

DSA field studies were conducted on select lands to characterize soils, describe plant communities and survey for select wildlife taxa. Methods and sample site selection criteria for each set of field surveys are described in the pertinent sections, below. In all cases, sample sites were limited to locations that were on City land or on private lands for which access had been secured. For auditory surveys these constraints were tempered as some additional privately owned lands could be surveyed by establishing survey station centers on nearby public roads. Sampling locations for each set of field surveys are depicted on Map 2. Within accessible lands, the concentration of surveys was relatively high, however, for soil and vegetation surveys the percent of the DSA covered by the surveys was relatively small. For wildlife, surveyed areas were more extensive as a result of the advantage of the auditory surveys allowing for wider coverage. For all survey types, each natural land unit (representative habitat type) within the DSA was sampled at least once.

2.3.1 SOILS

Spencer Environmental retained Paragon Soil and Environmental Consulting Inc. (Paragon) to map and characterize soils in the DSA. The full soil survey report prepared by Paragon, including detailed methods, is included as a stand-alone document (Appendix B). Methods employed by Paragon are briefly summarized below.

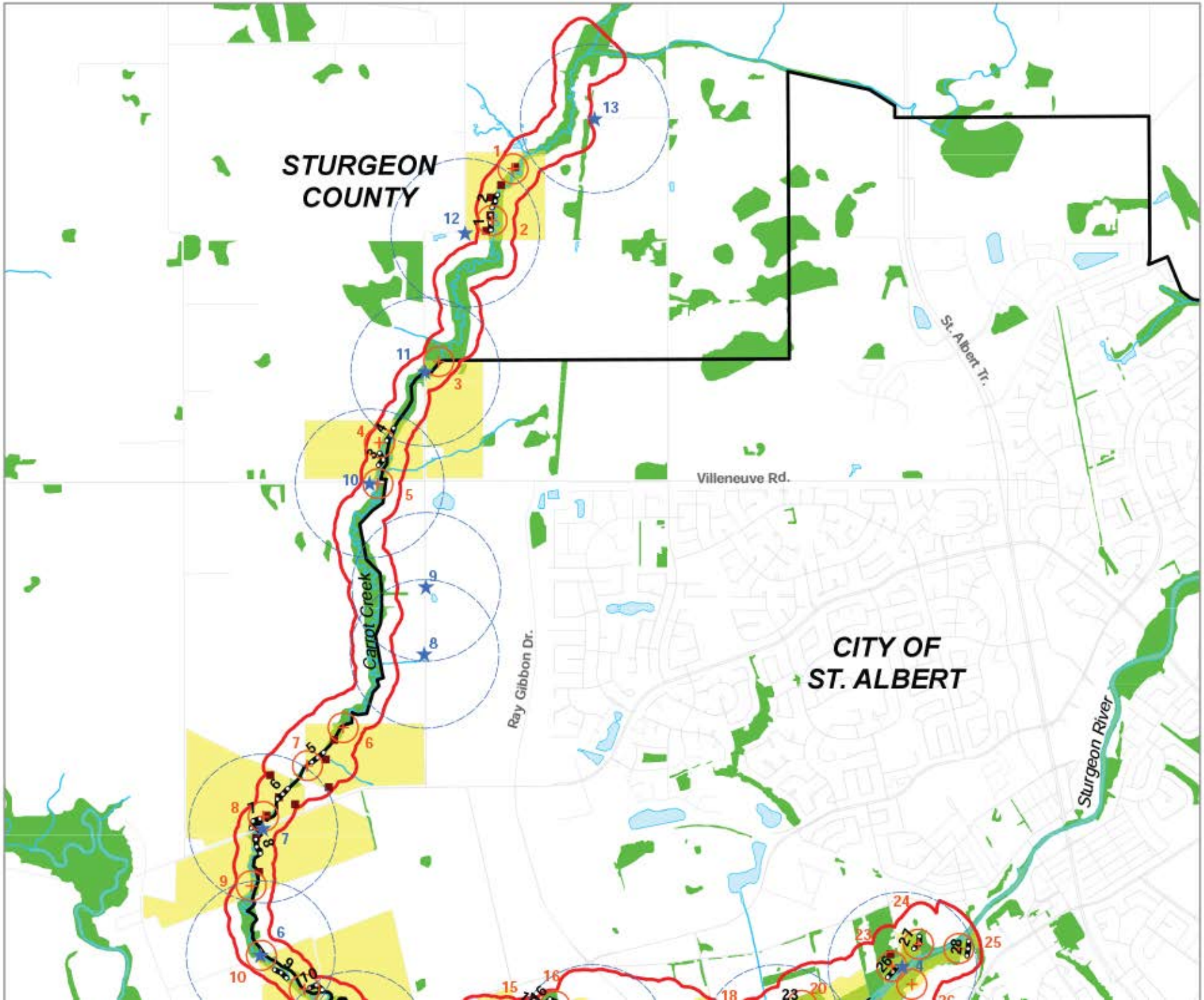
Paragon conducted field surveys on July 9 and 10, 2015, on select, accessible, private and public properties in the DSA. In total, 25 inspection sites were sampled (Map 2), 20 of which were deep inspection sites (depths of 1.2 m or 1.8 m) and the remainder of which were shallow inspection sites. Landform, land use, and soil profiles were assessed at each inspection site. In combination with information derived from this field data and desktop review of existing regional datasets, Paragon used principles of geomorphology and surficial geology to extrapolate delineations and map soil units throughout the DSA. Paragon also assessed the reclamation suitability, agricultural suitability, wind and water erosion risk, and compaction risk for each identified soil unit.

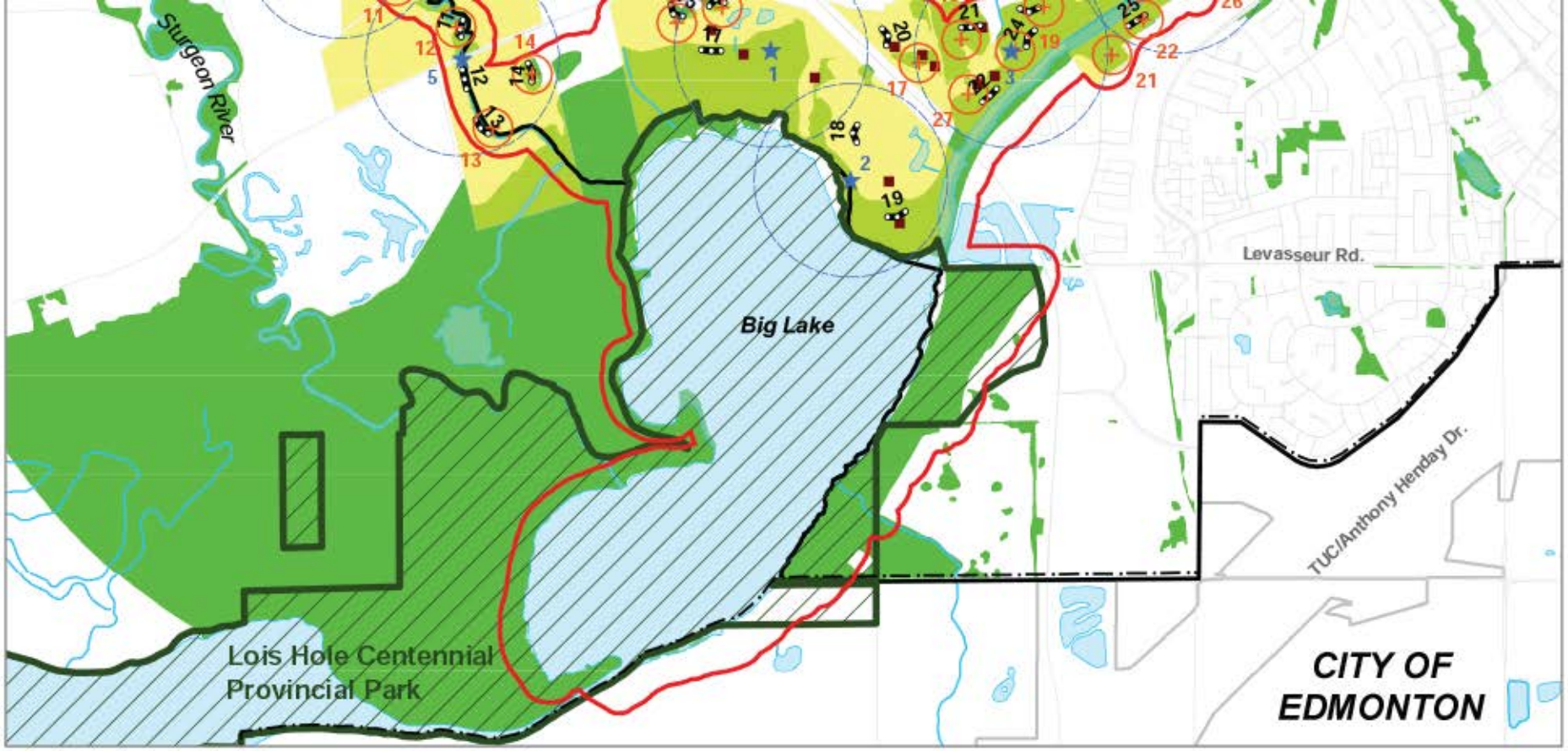


2.3.2 VEGETATION

Vegetation surveys were undertaken by a professional plant ecologist between July 14 and 20, 2015. Survey objectives were to systematically collect detailed, site-specific vegetation data that would inform future natural area management and planning decisions and establish a baseline that could be used in longer-term site/land unit condition monitoring. Vegetation data were also used to ground-truth the desktop land unit mapping exercise.

Rather than developing a comprehensive floral inventory,


STURGEON COUNTY
CITY OF ST. ALBERT
Villeneuve Rd.
St. Albert Tr.
Ray Gibbon Dr.
Carrot Creek
Sturgeon River



Legend

- Amphibian Point Count Centre (500m Radius)
- Bird Point Count (100m Radius)
- Vegetation Sample Site
- Soil Sample Site
- Accessible Land Parcels
- Natural Area
- Detailed Study Area (DSA)
- Protected Areas
- City of St. Albert
- City of Edmonton
- Hydrology
- Road

0 250 500 1,000 Meters

1:33,000

MAP 2.
LOCATION OF FIELD SURVEY SAMPLING SITES

Projection: 3TM 114 NAD83
Date: 13 November 2015

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data collection focused on facilitating a high level but comprehensive characterization of encountered vegetation. The emphasis was on characterizing tree, shrub, and herb strata, and describing overall site conditions, including moisture regime, site health, edge conditions and overall level of disturbance. In this way, the data describe vegetation from the perspective of form, dominant species, condition, successional stage, and features important as wildlife habitat. Existing survey protocols developed by the Alberta Biodiversity Monitoring Institute (ABMI; Alberta Biodiversity Monitoring Institute 2015) and the Alberta Native Plant Council (ANPC; Alberta Native Plant Council 2012) provided the foundation for the current survey methods. However, unlike these protocols, the current survey was not intended to be a comprehensive assessment of each land unit; therefore, select survey parameters from these established programs were utilized to represent the greatest variety of representative land unit characteristics, including plant communities, moisture and disturbance (Appendix C). Specific vegetation sampling methods and measured parameters are described in Appendix A; sample point and transect locations are depicted in Map 2.

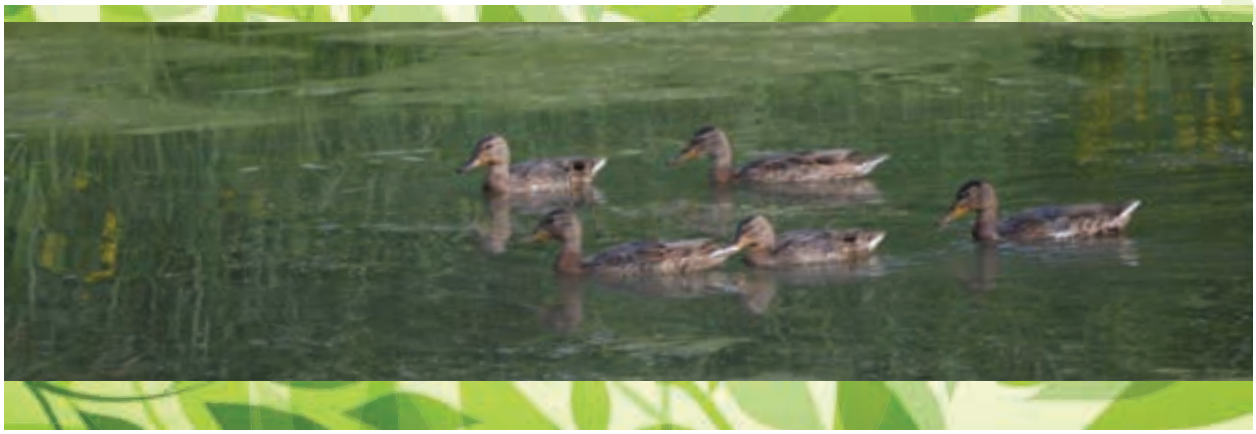
For reporting purposes, to summarize the data compiled from each plot and transect, data were pooled to the level of the land unit. To do so, numerical parameters, such as canopy closure, diameter at breast height (DBH), or the number of snags and coarse woody debris (CWD) were averaged to generate a measurement at the land unit level. Estimates of tree and shrub heights, although assigned to a pre-defined category, were also averaged, and the result was assigned to an equivalent category at the land unit level. For species abundance parameters, the data at each plot were reviewed, and using information from the three plots, qualitative observations made along the transect, and professional judgment, the three dominant species in each stratum were determined. Similarly, for qualitative site observations, such as edge characteristics and overall health and disturbance, site data from plots and along the transect were used to inform a description for the land unit as a whole.

Species common and scientific nomenclature follows ACIMS (Alberta Environment and Parks 2015a). Common names are used throughout the main body of this report. Common species are listed in the summary table provided in Appendix D with both common and scientific names; for less common species discussed in the text but not listed in the Appendix, scientific names are provided in parentheses.

2.3.3 BIRDS

Breeding bird point count surveys were conducted at 27 stations throughout the DSA (Map 2). Point count stations were established to maximize coverage across the DSA and sample the maximum possible number of natural land units, given land-access limitations. As such, 13 of the 27 stations were located along Carrot Creek and the remaining 14 stations were located in the Big Lake floodplain and the Sturgeon River valley. Natural land units sampled at stations along Carrot Creek included Aspen Poplar, Seasonal/Temporary Marsh, Riparian Meadow, and Riparian Willow Shrub. Because of the small areas covered by these natural land units relative to the point count station area, surveyed lands along Carrot Creek included, and were dominated by, anthropogenic land units, particularly, Agriculture and Developed lands (roads). The Big Lake/Sturgeon River point count stations included all eight natural land units, plus the semi-natural, anthropogenic Grassland unit, and, because these natural land units were broader, each station included much less anthropogenic area.

Point counts were performed by a wildlife biologist with extensive avian survey experience on June 24 and 25, 2015; these dates fall within the peak breeding season for the majority of bird species that occur in Alberta's Central Parkland Natural Region (Federation of Alberta Naturalists 2007). Point counts are best suited to sampling landbird (especially songbird) species richness



and abundance; however, waterfowl, waterbirds, and shorebirds that are visible and/or audible from point count stations can also be enumerated. Data analyses included calculation of the total abundance, total species richness, and average Shannon-Wiener diversity index (H') for the bird communities at 13 stations along Carrot Creek, 14 stations within the Big Lake/Sturgeon River floodplain, and all stations combined (i.e., 27) in the DSA. Surveyors noted any incidental bird observations (i.e., observations outside of 10-minute point count surveys) that they made while conducting bird, amphibian, or vegetation fieldwork in the DSA.

The point count methods employed in this project allow for data comparisons with other projects' avian datasets, such as the Northern Alberta Institute of Technology (NAIT) Sturgeon River Research Project along Carrot Creek (NAIT 2008) and the ongoing avian monitoring activities of ABMI throughout the province. Surveys generally followed the methods recommended for point counts in the USDA Forest Service Handbook for Field Methods for Monitoring Landbirds (Ralph et al. 1993); pertinent details on survey methods and data analyses are described in Appendix A. The locations of point count stations are depicted on Map 2.

Bird species common and scientific names follow the nomenclature and taxonomy of the American Ornithologists' Union (AOU) Checklist of North and Middle American Birds (55th Supplement; AOU 2015). Common names are used throughout the main body of this report; scientific names of species observed during surveys <100 m from the observer are provided in Appendix E and scientific names of species that were only detected > 100 m from stations, as flyovers, or incidentally are specified in the text.

2.3.4 AMPHIBIANS

Auditory amphibian surveys were conducted at 13 stations in the DSA (Map 2). Surveys were conducted prior to acquiring access permission to any private lands, so amphibian survey sites were restricted to public lands and lands that could be surveyed from public roads. Within these access restrictions, site selection targeted habitat in the DSA that was most likely to provide suitable toad breeding habitat, which is typically found on the margins of ponds, streams, and lakes (Russell and Bauer 2000). Site selection and survey timing targeted western and Canadian toads because these Special Status species are designated as *Sensitive* and *May Be At Risk*, respectively, under the provincial General Status of Alberta Wild Species 2010 list and because western toad is designated as a species of *Special Concern* under Schedule 1 of the federal *Species at Risk Act* (Alberta Environment and Parks 2015b, Government of Canada 2015). Surveys were conducted on 27 May an again on 01 June and followed the protocols of the Alberta Volunteer Amphibian Monitoring Program (AVAMP; ACA

and ASRD 2010). Survey method details are described in Appendix A. All incidental amphibian observations made while conducting amphibian, bird, and vegetation fieldwork in the DSA were also recorded as such.



2.3.5 INCIDENTAL MAMMAL OBSERVATIONS

Formal mammal surveys were not conducted as part of this study. However, project biologists recorded incidental observations of mammals and indirect evidence of mammals (e.g., tracks, scat, dens, etc.) while conducting vegetation, bird, and amphibian fieldwork in the DSA.

2.4 NATURAL AREA SIGNIFICANCE/ ENVIRONMENTAL SENSITIVITIES ASSESSMENT

The DSA is of particular interest to the City of St. Albert because of its high ecological value, but also because the lands bordering Carrot Creek, Big Lake and Sturgeon River are anticipated to experience urban development pressure in the near future. Specifically, the City aims to minimize indirect impacts resulting from development of DSA non-natural land units on DSA natural land units and minimize direct impacts on natural land units that may be proposed for development. The greatest development pressures on natural land units are expected to be associated with future park and stormwater management facilities. Data collection was also identified as critical to future on-the-ground natural area management. In short, DSA studies were intended to support sound land use decision-making that incorporates ecological planning considerations, facilitate conservation of the most important natural areas and direct future natural area management.

The first high level step in exploring means of achieving the above-noted outcomes for the DSA was to review the mapped natural land units, through the lens of conservation science principles. The second step was to review the level of protection already afforded these areas by existing municipal planning bylaw and policies. Step three was to review the 2015 GIS ecological connectivity analyses to identify important structural and functional connections between DSA and OSA natural areas. Lastly, the findings of the field sampling program were reviewed to further inform discussion of significant natural areas. All of the above resulted in identification of natural areas that are key to sustainability of current ecological function, areas most vulnerable to direct impacts of development and a list of criteria for evaluating environmental sensitivities in the context of development proposals. Natural Area management considerations resulting from DSA investigations are discussed in the city-wide natural area management report. The following sections provide additional methodological detail for each of these steps.

2.4.1 DSA LAND UNIT REVIEW

This qualitative review examined the detailed land unit maps, and assessed the spatial distribution, abundance, diversity and connectivity of the mapped natural land units, through the lens of conservation science principles and in the context of the regional ecological network, to understand the ecological role(s) that the natural and non-natural land units play within the DSA. Results were used to identify areas that should be retained (conserved) to protect current ecological functions. Results were also used in the separate analysis of potential restoration sites (see section 2.5).

2.4.2 IDENTIFICATION OF LANDS CURRENTLY PROTECTED

Lands currently protected were identified by reviewing existing maps and St. Albert's two highest-level municipal planning documents, the Municipal Development Plan (MDP 2007, Updated 2013) and the 2015 Land Use Bylaw. Each of these documents contains a key directive that affords some protection to certain lands within the DSA:

- **City of St Albert's Municipal Development Plan (MDP 2007, Updated 2013)**: *Policy 9.8* - The Carrot Creek Greenway shall be considered an extension of the Red Willow Park and subject to all considerations in Section 9.7. Lot boundaries must maintain a minimum 50 m setback from the top of the bank of Carrot Creek.

- **City of St Albert's Land Use Bylaw (9/2005)**: *Section 6.10 (2)* - Developments including, but not limited to, new construction and substantial improvements are prohibited below the designated flood line. *Section 6.10 (3)* - The designated flood line is the boundary of any filling of land. *Section 6.10 (4)* - Notwithstanding *Section 6.10.(2)*, development permitted below the designated flood line shall require the approval of the Development Officer in consultation with the City Engineer, and is restricted to *(f)* pedestrian walkways, parks and trails; *(i)* outdoor recreation service use that would not obstruct the area below the designated flood line; and *(j)* naturalized stormwater management facility that meets the approval of the City Engineer. (City of St. Albert 2005)

To illustrate the potential implication of these municipal directives on natural areas protection in the DSA, a GIS analysis was performed using the following data and steps:

- Overlay of a GIS shapefile delineating the designated flood line, (file derived and provided by the City of St. Albert), on mapped land units. The file applied only to lands within St. Albert. The St. Albert flood line has not been developed for lands within other municipalities (and therefore does not offer natural area protection).

- Top of bank exercise: The 50 m Carrot Creek setback is referenced in the Land Use Bylaw (LUB) as extending back from the top of the bank (TOB) of Carrot Creek; TOB surveys are generally only done in association with urban development land use planning, to date the Carrot Creek TOB has been formalized only within the approved Range Road 260 ASP. Therefore, to illustrate the TOB for this conservation planning exercise a preliminary TOB was derived using existing information. Within the City of St. Albert 0.5 m contour data provided by the City was used to delineate the TOB. The TOB was identified as the break in slope between the adjacent upland area and the Carrot Creek ravine. Beyond St. Albert boundaries, where contour data were not available, the TOB was very conservatively delineated as the outside edge of the riparian meadow land unit. This approach included the relatively flat areas immediately adjacent to the creek channel as within the TOB, but did not attempt to define the separation between ravine and upland in areas within the shrubby and treed slopes adjacent to the riparian meadow. Once a TOB was delineated along the entire reach of Carrot Creek, a 50 m buffer was applied to the TOB. The resulting boundary was used to represent the approximate extent of the 50 m setback outlined in the LUB (and extrapolated to County lands).

The combination of these two lines – the designated flood line and the 50 m Carrot Creek TOB – identified lands within which only very limited development should be allowed, and only with the approval of City Engineering, if the City's policy and bylaw were applied throughout the DSA.

2.4.3 REVIEW OF ECOLOGICAL CONNECTIVITY

The City defined the DSA largely by applying a 100 m buffer beyond the designated flood line surrounding Big Lake, Sturgeon River and Carrot Creek (with some apparent minor modifications). As such, the boundary of the DSA is a useful study boundary but does not conform to boundaries of natural features. Because of this, and because components of the DSA function as Regional Core Areas and Regional Ecological Corridors (see Part 1) within an ecological network that extends well beyond the boundaries of the DSA, it was important to consider the spatial position of the DSA natural areas in the broader ecological network. DSA land units/natural areas, having strong ecological connections to natural areas in the OSA that are or may be protected, have enhanced network value and therefore conservation significance. Two kinds of connectivity were important to this exercise: 1) structural connectivity, represented by natural areas situated within the DSA and straddling the DSA boundary into the OSA; and 2) functional connectivity, represented by natural areas wholly outside of the DSA but in close proximity. Straddling natural areas were identified through examination of land unit and natural area inventory maps. The identification of functional connectivity required the application of an objective, science-based approach. For this, the GIS-based stepping stone cluster analyses described in Part 1 of this document was used. Of the four analyses undertaken, the ≥ 1 ha patch and 100 m buffer analysis was most relevant to this exercise. The 1.0 ha patch analysis was the best fit with the smaller geographic area of the DSA and the small minimum area threshold of mapped land units. The 100 m buffer remained relevant for use in this analysis because of the broad suite of species to which this scale applies and the 100 m buffer used in delineating the DSA. Natural areas straddling the DSA boundary and those identified through GIS analysis were labelled *Important connected natural areas beyond the DSA*.

2.4.4 REVIEW OF FIELD DATA

The field sampling program included surveys for amphibians, birds, plants and soils. Across the plant and wildlife taxa, the surveys documented several species that carry a Special Status ranking assigned by either the provincial or federal government. As such, those species are of conservation interest and warrant further consideration when identifying areas of environmental sensitivities. Therefore, the location and distribution of documented special status species was reviewed and the implications of these occurrences on future land use planning and identification of conservation opportunities was considered. The implications of soils mapping on development decisions was qualitatively considered.

2.5 DSA RESTORATION OPPORTUNITIES

Restoration opportunities within the DSA were identified by re-examining those areas already identified as *Potential priority restoration areas* (see Map 4, Part 1), and adding a series of potential restoration areas at existing road crossing locations along Carrot Creek. Through aerial photograph interpretation for the land unit mapping exercise, all Potential Priority Restoration Areas *in the DSA* were confirmed as requiring restoration. The addition of road crossings over Carrot Creek as potential restoration areas was deemed relevant to this exercise because the crossings impede wildlife movement to some degree and future roadway improvements present an opportunity to mitigate the barrier effect and maximize connectivity under roads. As such, restoration at those areas could lead to enhanced ecological services and natural connections along Carrot Creek, an objective previously identified as a priority of the City.

3.0 RESULTS

3.1 LAND UNIT MAPPING – EXTENDED DETAILED STUDY

The land unit analysis identified 233 distinct patches belonging to the 8 natural and 6 anthropogenic land units in the DSA and Extended DSA (hereafter referred to as the DSA in this section), totaling 1,220.3 ha (i.e., the total area of the DSA; Table 1). Approximately two-thirds (756.7 ha, 62%) of the DSA comprises natural land units and one third (463.6 ha, 38%) anthropogenic land units (Table 1, Figure 1). An overview of all DSA land units is depicted in Map 3. Greater detail is depicted in Maps 3A, 3B, 3C, 3D and 3E.

Open Water is the most extensive land unit, by area, covering 349.7 ha, or 29% of the DSA. This is the result of inclusion of Big Lake and the Sturgeon River. If Open Water is excluded, the proportion of natural land Units declines from 62% to 47% of the DSA's remaining 870.6 ha. Open water is also present in variable widths at Carrot Creek but the narrow ribbon of creek (generally 2 m to 5 m wide) is not mappable at the scale of the DSA. The second most extensive (total area) natural land units are Riparian Meadow and Semi-permanent Marsh, covering 14% and 7% of the DSA, respectively; both are concentrated in relatively large patches around the edges of Big Lake and its outflow into the Sturgeon River. Not surprisingly, Riparian Meadow also extends in smaller, narrower, patches along much of the Carrot Creek and Sturgeon River corridors. Riparian Willow Shrub and the three treed land units (Aspen Poplar, Mixedwood, and White Spruce) comprise relatively small proportions of the DSA, with a combined total area of 141.7 ha (12%). Riparian Willow Shrub and Aspen Poplar patches are dispersed throughout the riparian corridors and along the eastern side of Big Lake. The majority of the White Spruce is concentrated north of Big Lake in the Grey Nuns White Spruce Park and the majority of Mixedwood is concentrated in a few patches along the Sturgeon River and the southeast side of Big Lake. Seasonal/Temporary Marsh is the least extensive natural land unit, occurring in a few small sites north and east of Big Lake and along Carrot Creek.

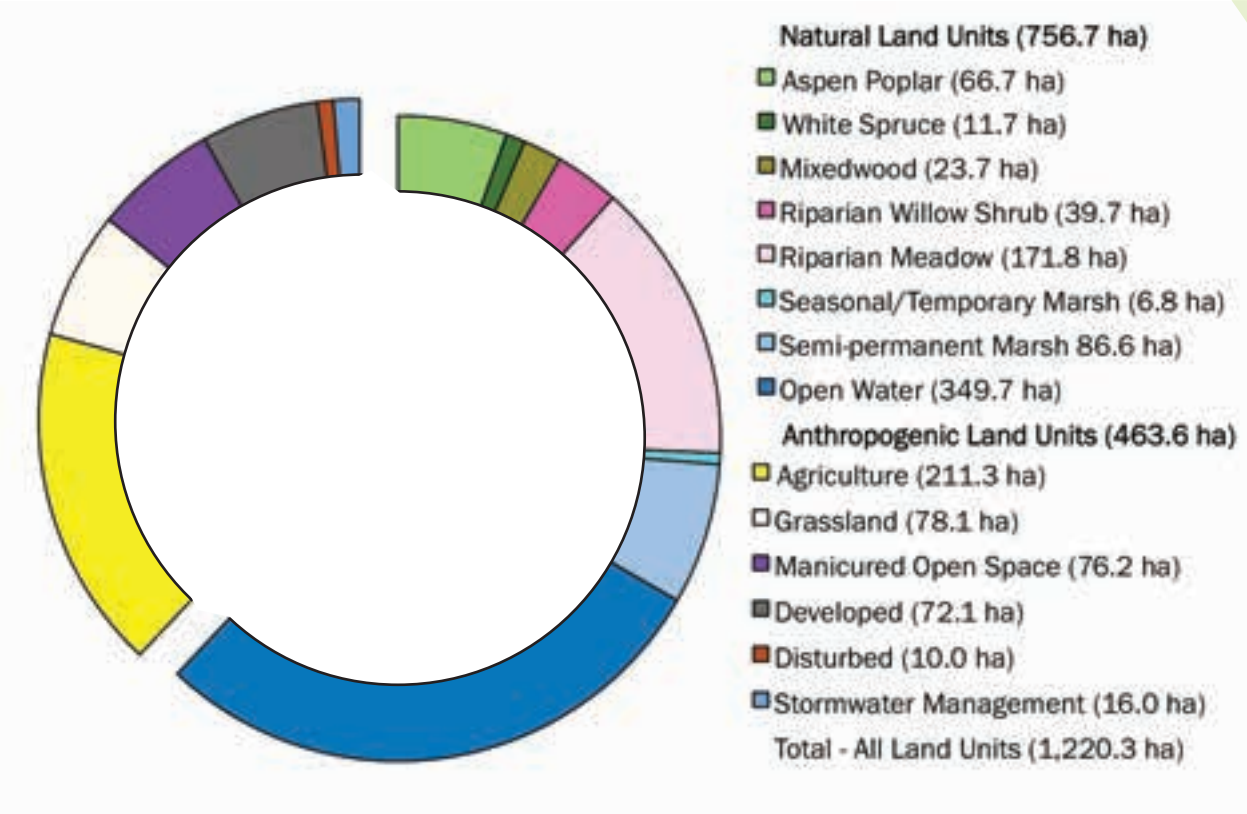
The extent of anthropogenic land units in the DSA is largely a function of the buffer distance (100 m) from the designated flood line that was used to delineate the DSA boundary. Most, though not all, of the total anthropogenic land unit area occurs on the outer margins of the DSA. Agriculture is by far the dominant anthropogenic land unit (covering 17%) and is found only along Carrot Creek and to the north and east of Big Lake. Grassland is the second most dominant anthropogenic land unit and is concentrated north of Big Lake in lands planned as part of the future Red Willow Park. Six separate Stormwater Management land unit sites were identified. Four of those comprise stormwater facilities located along Ray Gibbon Drive; the remaining two are constructed water

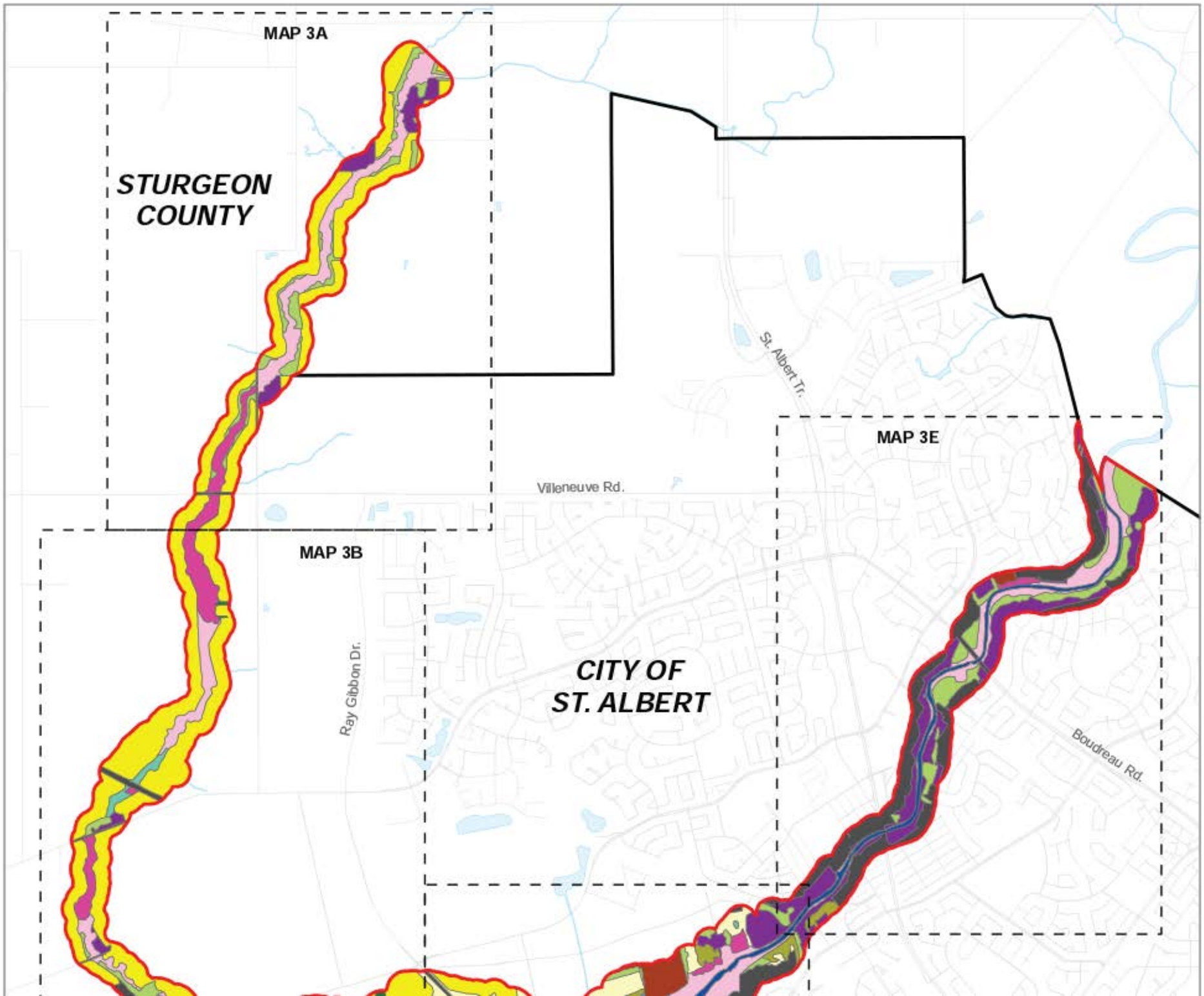
impoundments near the mouth of Carrot Creek (function unknown). Developed Land, Disturbed Land, and Manicured Open Space within the DSA is primarily found along the Sturgeon River but, to a lesser extent, is also scattered in small patches along Carrot Creek. Within the DSA, 6 road/railway crossings exist along Carrot Creek. There are 4 road/railway bridge crossings of the Sturgeon River throughout the City.

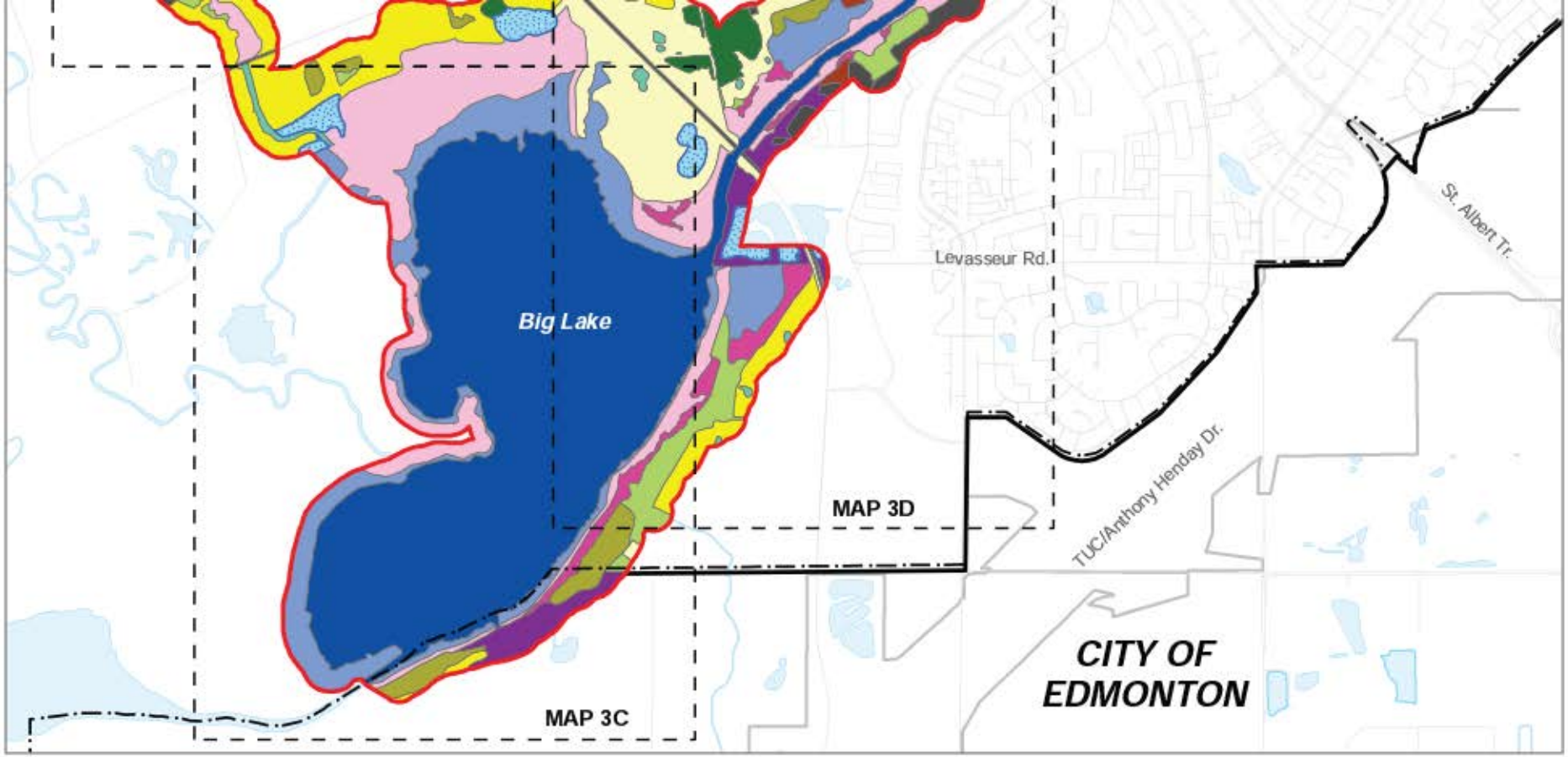
Table 1. Breakdown of Land Units in the Extended DSA

Category	Land Unit	Number of Patches	Area (ha)
Natural	Aspen Poplar	50	66.7
	White Spruce	6	11.7
	Mixedwood	9	23.7
	Riparian Willow Shrub	15	39.7
	Riparian Meadow	25	171.8
	Seasonal/Temporary Marsh	13	6.8
	Semi-permanent Marsh	8	86.6
	Open Water	1	349.7
	Total – Natural Land Units	127 (55%)	756.7 (62%)
Anthropogenic	Agriculture	31	211.3
	Grassland	11	78.1
	Manicured Open Space	26	76.2
	Developed	28	72.1
	Disturbed	3	10.0
	Stormwater Management	7	16.0
	Total – Anthropogenic Land Units	**106 (45%)**	**463.6 (38%)**
Total – All Land Units		**233 (100%)**	**1,220.3 (100%)**

Figure 1. Breakdown of Land Units in the Extended DSA




MAP 3A
STURGEON COUNTY
St. Albert Tr.
MAP 3E
Villeneuve Rd.
MAP 3B
Ray Gibbon Dr.
CITY OF ST. ALBERT
Boudreau Rd.



Legend

Land Units

Natural

- Aspen Poplar
- White Spruce
- Mixedwood
- Riparian Willow Shrub
- Riparian Meadow
- Seasonal/Temporary Marsh
- Semi Permanent Marsh
- Open Water

Anthropogenic

- Agriculture
- Grassland
- Manicured Open Space
- Developed
- Disturbed
- Stormwater Management

- Extended Detailed Stu
- City of St. Albert
- City of Edmonton
- Hydrology
- Road

N

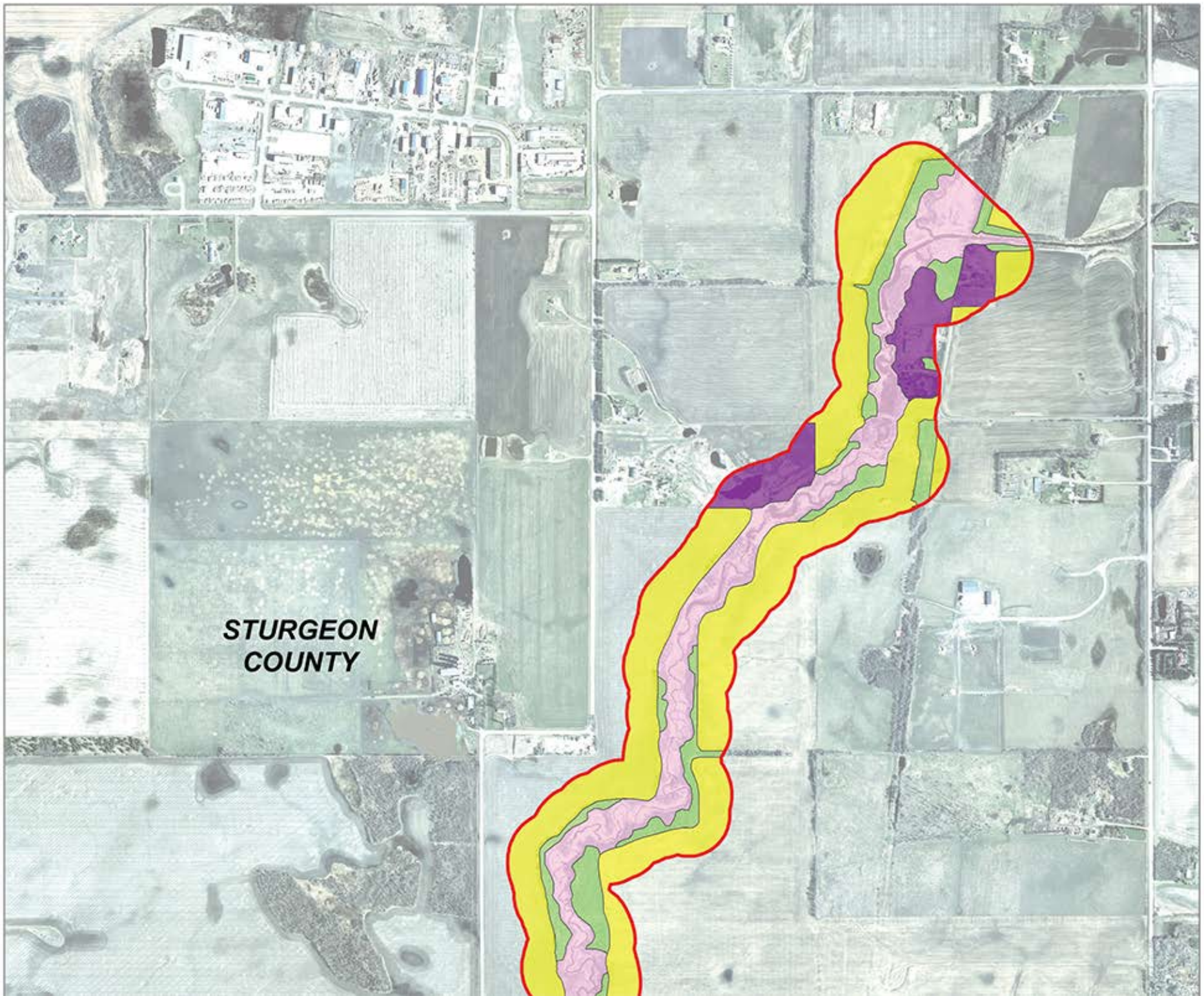
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MAP 3.
EXTENDED DETAILED STUDY AREA LAND UNITS OVERVIEW

Projection: 3TM 114 NAD83
Date: 13 November 2015

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.


STURGEON
COUNTY



Legend

Land Units

Natural

- Aspen Poplar
- White Spruce
- Mixedwood
- Riparian Willow Shrub
- Riparian Meadow
- Seasonal/Temporary Marsh
- Semi Permanent Marsh
- Open Water

Anthropogenic

- Agriculture
- Grassland
- Manicured Open Space
- Developed
- Disturbed
- Stormwater Management

Extended Detailed Stu

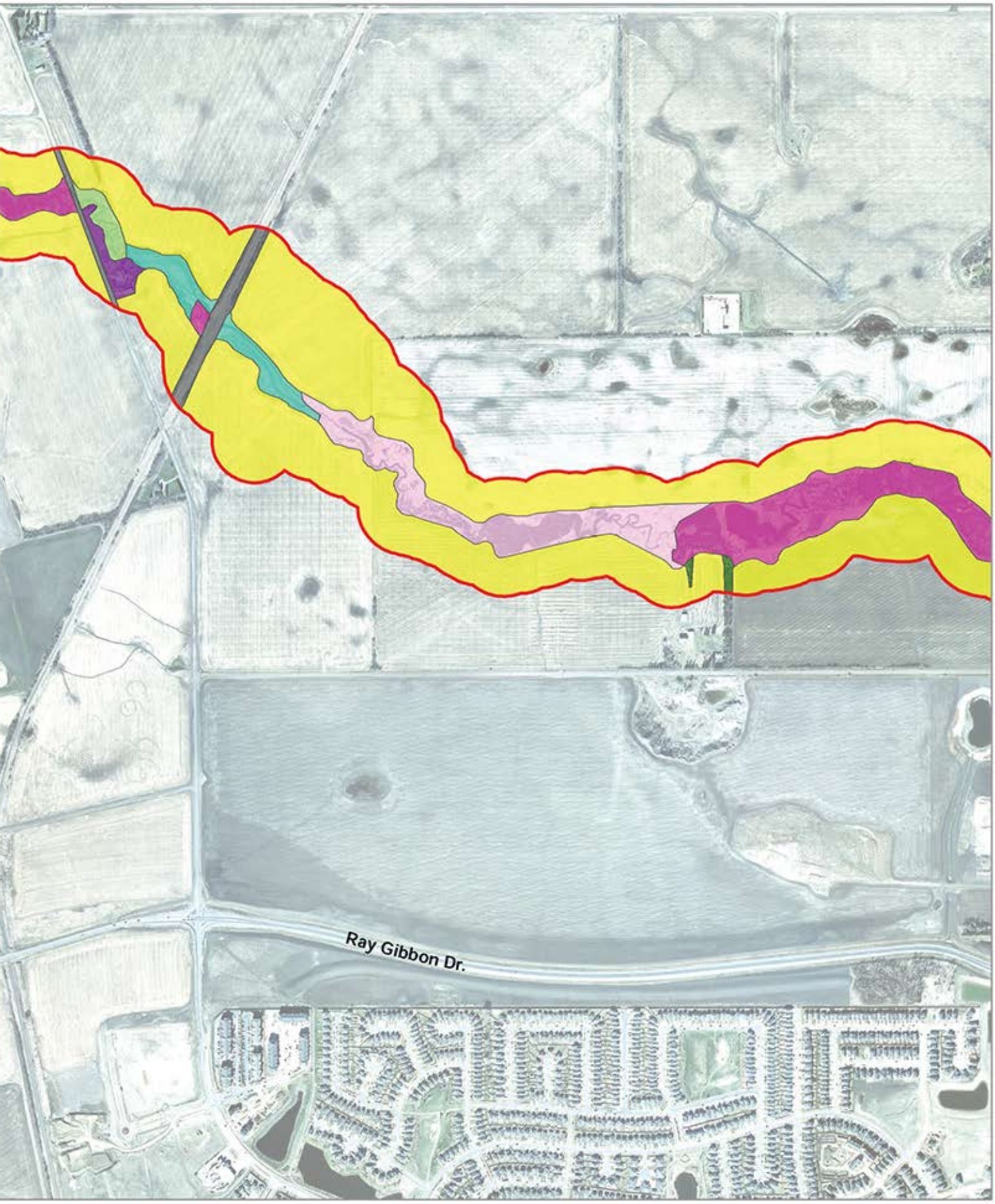
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MAP 3A.
EXTENDED DETAILED STUDY AREA LAND UNITS

Imagery Date: 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.


Ray Gibbon Dr.



Legend

Land Units

Natural

- Aspen Poplar
- White Spruce
- Mixedwood
- Riparian Willow Shrub
- Riparian Meadow
- Seasonal/Temporary Marsh
- Semi Permanent Marsh
- Open Water

Anthropogenic

- Agriculture
- Grassland
- Manicured Open Space
- Developed
- Disturbed
- Stormwater Management

Extended Detailed Study Area

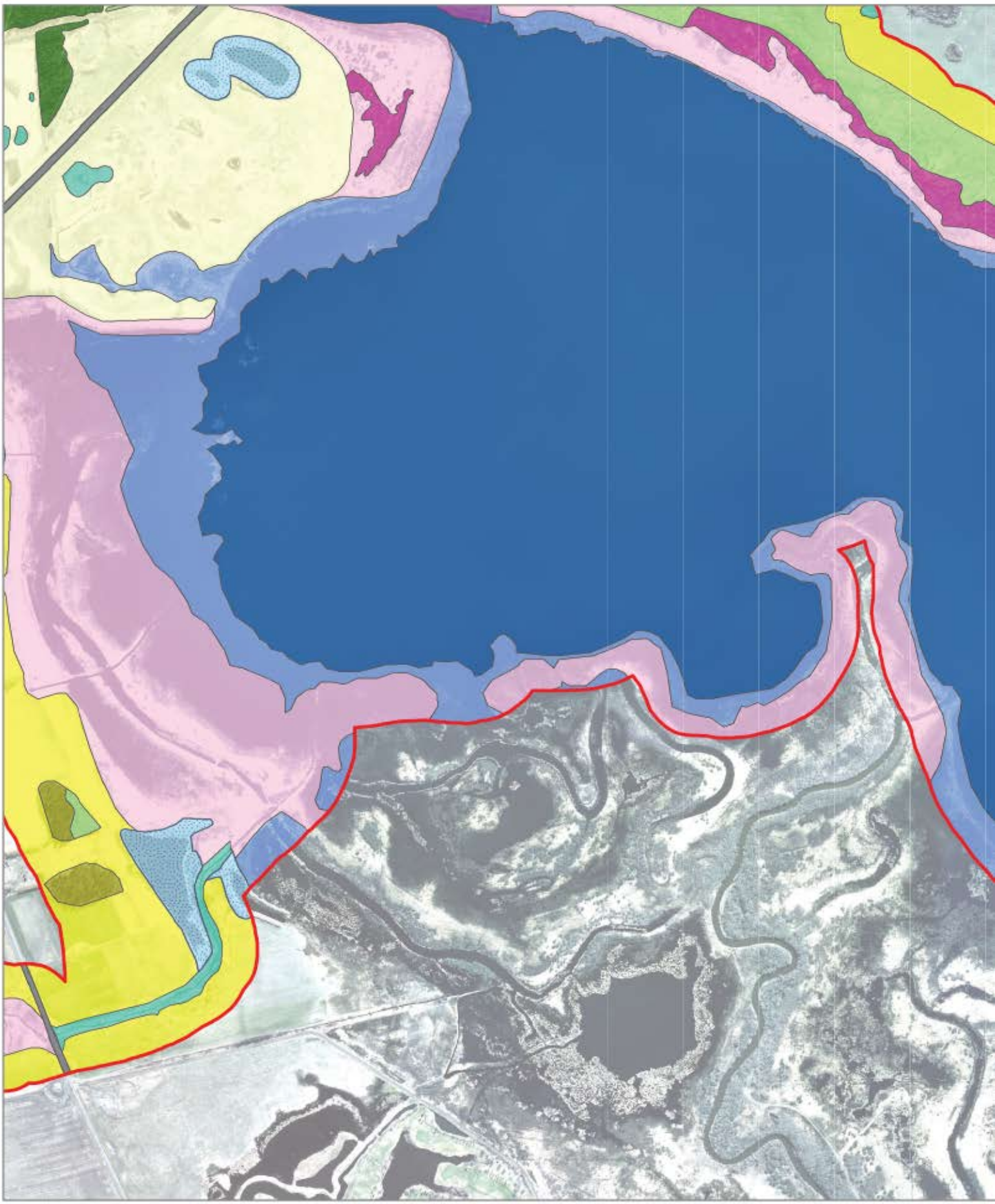
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MAP 3B.
EXTENDED DETAILED STUDY AREA LAND UNITS

Imagery Date: 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.





Legend

Land Units

Natural

- Aspen Poplar
- White Spruce
- Mixedwood
- Riparian Willow Shrub
- Riparian Meadow
- Seasonal/Temporary Marsh
- Semi Permanent Marsh
- Open Water

Anthropogenic

- Agriculture
- Grassland
- Manicured Open Space
- Developed
- Disturbed
- Stormwater Management

Extended Detailed Study Area

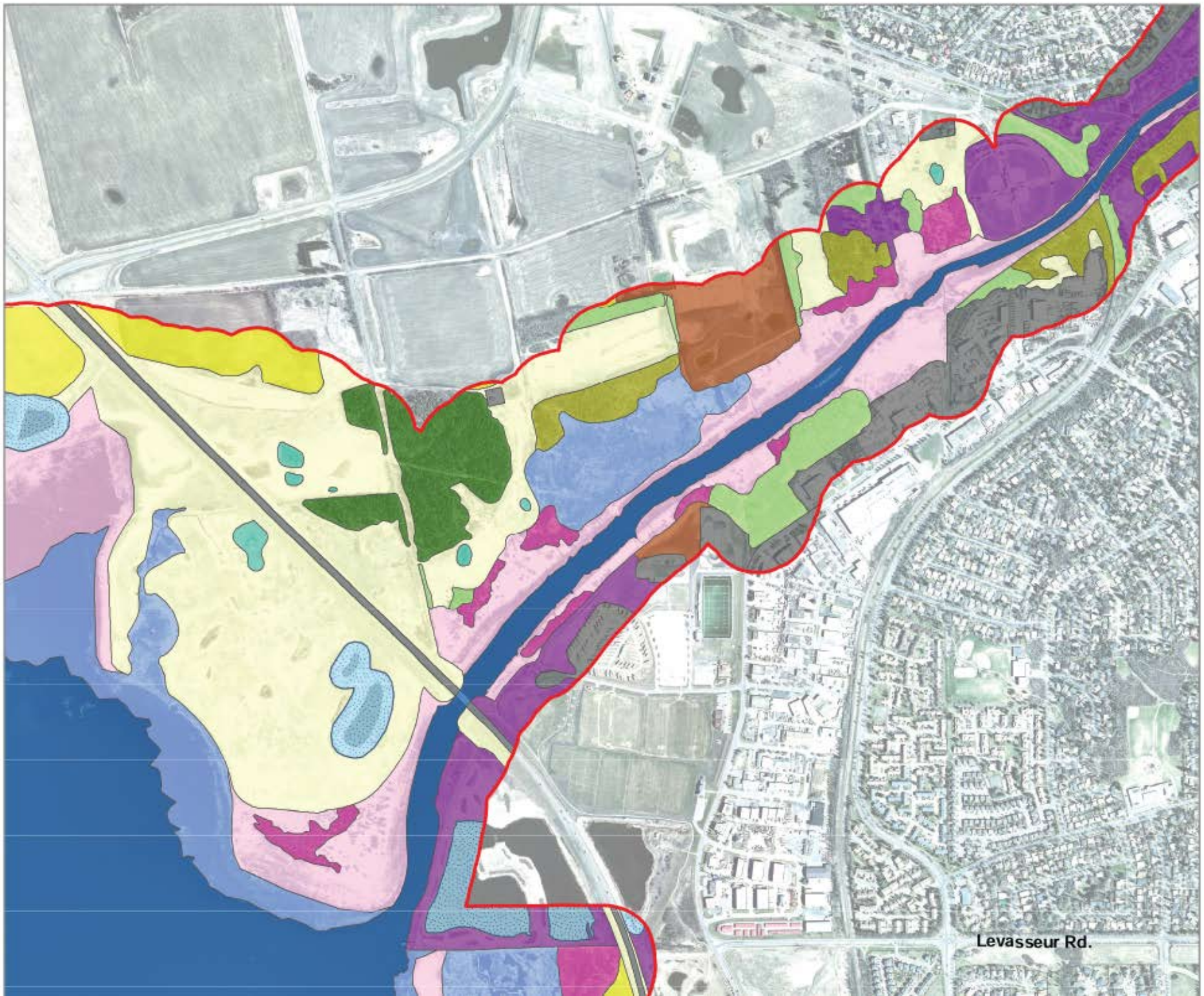
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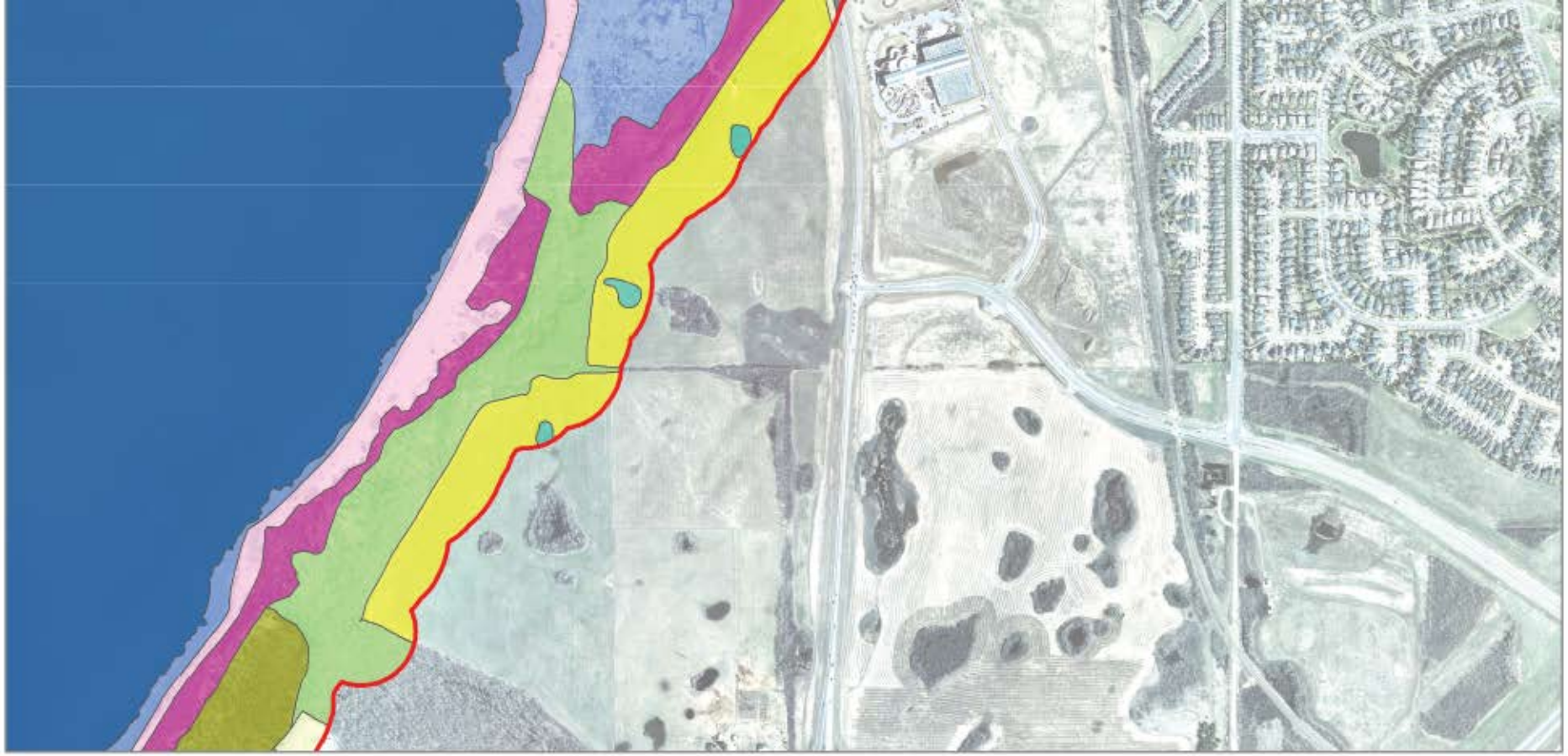
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MAP 3C.
EXTENDED DETAILED STUDY AREA LAND UNITS

Imagery Date: 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.


Levasseur Rd.



Legend

Land Units

Natural

- Aspen Poplar
- White Spruce
- Mixedwood
- Riparian Willow Shrub
- Riparian Meadow
- Seasonal/Temporary Marsh
- Semi Permanent Marsh
- Open Water

Anthropogenic

- Agriculture
- Grassland
- Manicured Open Space
- Developed
- Disturbed
- Stormwater Management

Extended Detailed Study Area

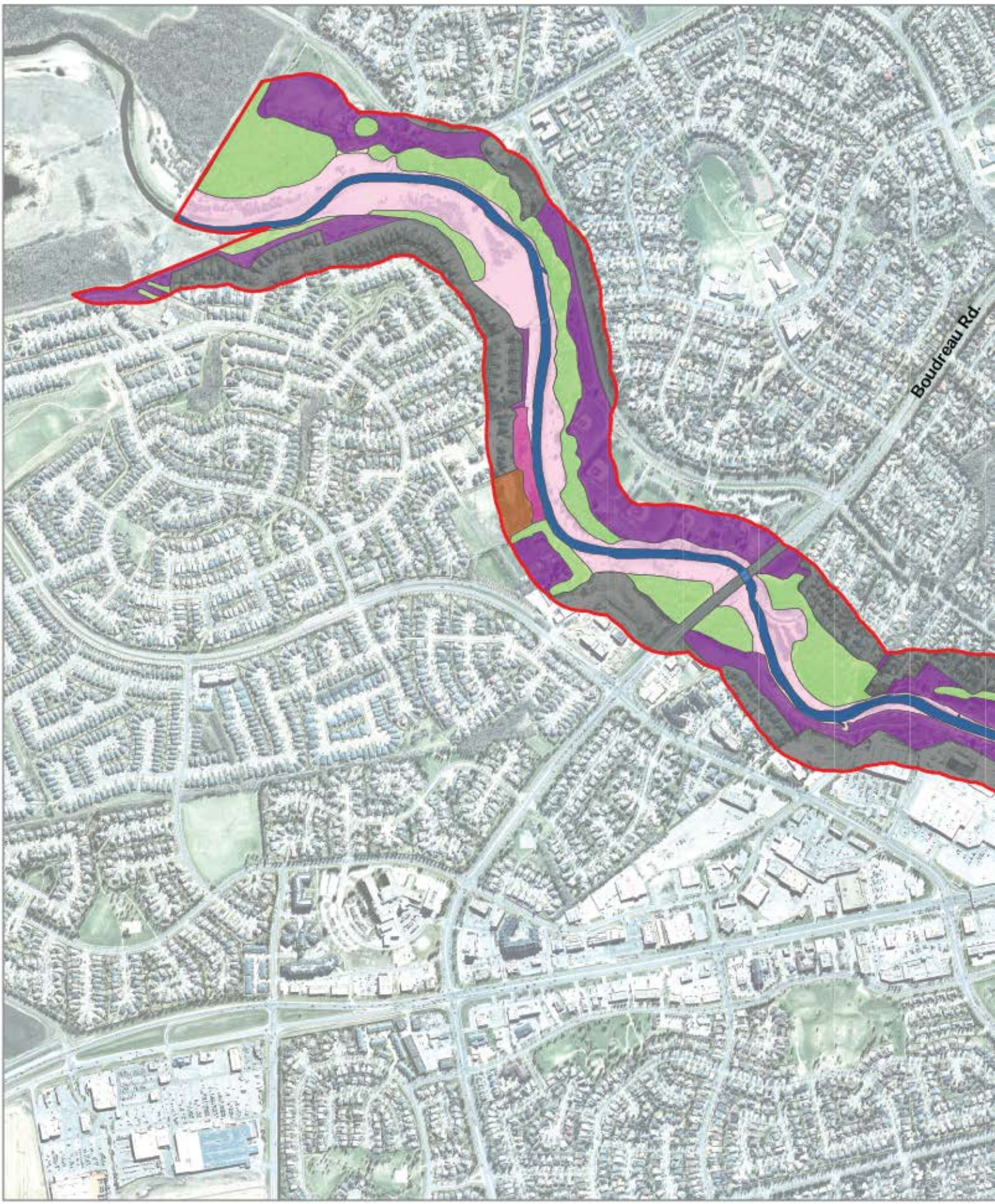
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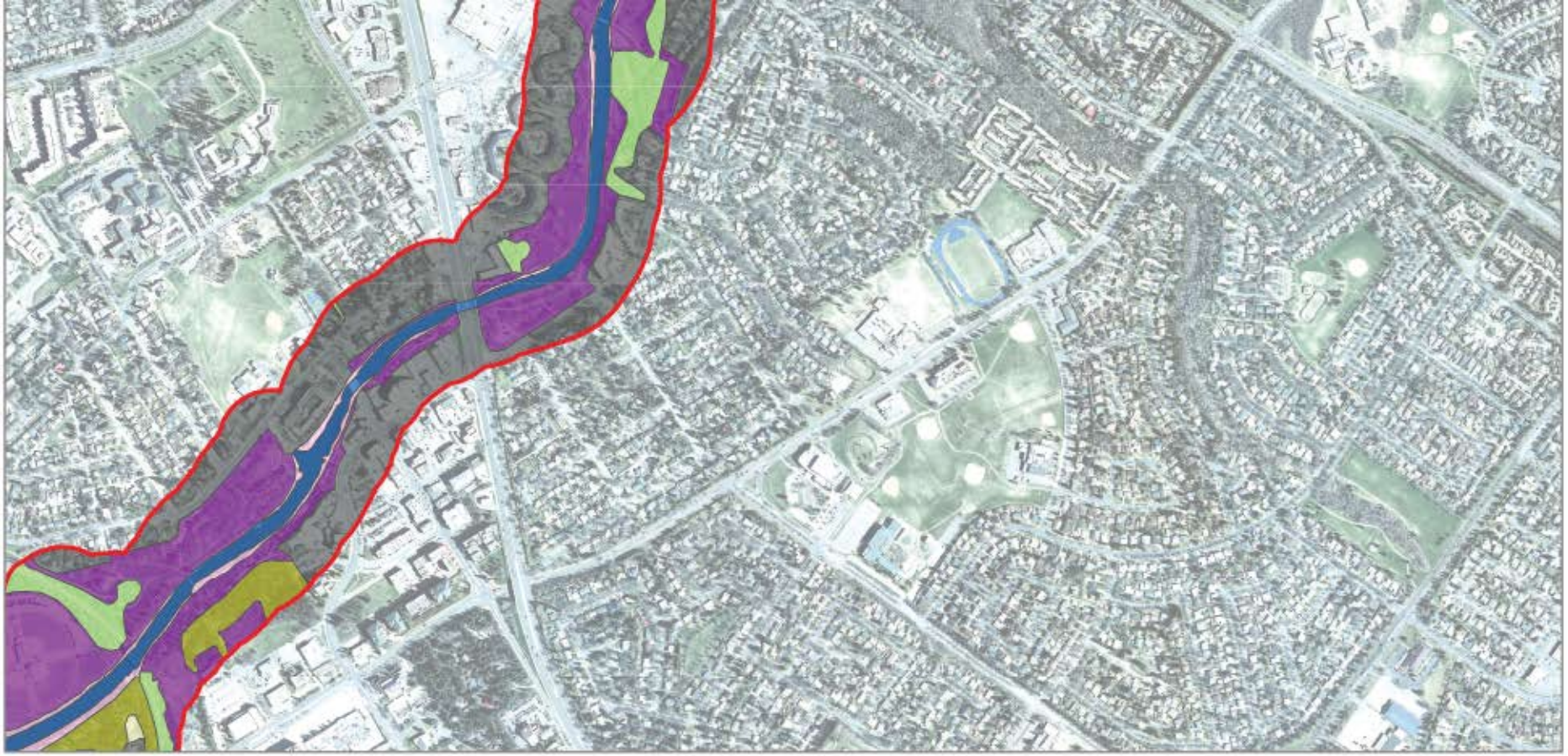
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MAP 3D.
EXTENDED DETAILED STUDY AREA LAND UNITS

Imagery Date: 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015

SPENCER ENVIRONMENTAL
MANAGEMENT SERVICES LTD.


Boudreau Rd.



Legend

Land Units

Natural

- Aspen Poplar
- White Spruce
- Mixedwood
- Riparian Willow Shrub
- Riparian Meadow
- Seasonal/Temporary Marsh
- Semi Permanent Marsh
- Open Water

Anthropogenic

- Agriculture
- Grassland
- Manicured Open Space
- Developed
- Disturbed
- Stormwater Management

Extended Detailed Study Area

0 100 200 400 Meters

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MAP 3E.
EXTENDED DETAILED STUDY AREA LAND UNITS

Imagery Date: 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015

SPENCER ENVIRONMENTAL
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3.2 FIELD SURVEYS

3.2.1 SOILS

Paragon mapped five soil units in the DSA: Haight (HGT), Mico (MCO), Gleyed Mico (MCOgl), Malmo (MMO), and Navarre (NVR). The Haight (HGT) Soil Unit was identified as the dominant soil type within the DSA. Associated with low-lying natural areas, Haight soils are generally wet year-round and characterized as having severe agricultural limitations, poor reclamation suitability and poor trafficability. They are high risk with respect to wind and water erosion and compaction. As a result, Paragon recommended that development within Haight soil units be avoided. This recommendation extends to stormwater facilities, although for these, some limitations can be overcome through engineered drainage (Waterman, pers. comm.). Other soil units were characterized as having fair-to-poor reclamation suitability, slight limitations for specified crop production and high to moderate risk with respect to wind erosion, water erosion and compaction.

Paragon's full soil survey report and detailed maps are provided in (Appendix B). Their report describes and tabulates parent material, soil textures, topography, surface stoniness, drainage class, topsoil depths, sod quality, and existing land use for each soil unit.

3.2.2 VEGETATION

Land Unit Descriptions

Regional Vegetation

The DSA is located within the Central Parkland Subregion of the Parkland Natural Region, which is characterized by a mosaic of aspen groves and prairie vegetation (Natural Regions Committee 2006). The aspen-prairie mosaic is the product of till plains and hummocky uplands, with moisture availability determining the proportion of grass and aspen, under natural conditions. Aspen forests dominate the subregion with balsam poplar stands occurring on poorly drained sites. Both forest types generally have a well-developed and diverse shrub layer, dominated by species such as snowberry, prickly rose, red-osier dogwood and willow (Natural Regions Committee 2006). Much of the native vegetation within this subregion has been cleared for urban and agricultural development, with remnant communities found in ravines and valleys, such as those found in the DSA.

Local Vegetation

In total, 28 sample sites were surveyed, representing seven natural land unit types and one anthropogenic (but semi-natural) land unit type:

- Aspen Poplar Forest (six sample sites)
- Mixedwood Forest (four sample sites)
- White Spruce Forest (two sample sites)
- Riparian Meadow (five sample sites)
- Riparian Willow Shrub (four sample sites)
- Seasonal/Temporary Marsh (five sample sites)
- Semi-Permanent Marsh (one sample site)
- Grassland (semi-natural; one sample site)

The following sections provided brief descriptions of select components of each natural land unit. Table 2 summarizes key points.

Table 2. Summary Descriptions of Vegetation in Natural Land Units In the Detailed Study Area

Land Unit Type	Key Attributes	Typical Disturbance Level	Presence of Rare/ Uncommon Species
Aspen Poplar Forest	Mesic deciduous forest with a closed canopy	Moderate; edges somewhat disturbed and weedy, some trails and cutlines	Yes
Mixedwood Forest	Mesic mature forest with patchy canopy	Low to moderate; edges somewhat disturbed and weedy, some signs of human use of sites	Yes
White Spruce Forest	Mesic mature forest with a high closed canopy	Low; few weeds little sign of human activities	No
Riparian Meadow	Hygric graminoid meadow with occasional willows	Low; occasional weed patches and garbage	No
Riparian Willow Shrub	Hygric riparian area with dense willows and graminoids	Low; occasional weed patches	No
Seasonal/ Temporary Marsh	Hydric graminoid marsh with small, scattered trees and shrubs	Low; occasional weeds, some garbage and dirt piles noted	No
Semi-Permanent Marsh	Hydric graminoid marsh with scattered trees and shrubs and pools of open water	Low; very few weeds	Yes
Grassland	Open, dominated by exotic forbs	High; site dominated by exotic species	No

Aspen Poplar Forest

Six Aspen Poplar Forest land unit sites were surveyed, making this the most frequently surveyed land unit type. These sites were mesic and were characterized by a canopy dominated by aspen, with varying amounts of balsam poplar and occasional white spruce (Plate 1). The forests surveyed at these sites varied in age, with both young and old stands included. The canopy varied in height but was mostly closed, with an average cover of 92%. The dominant shrubs included prickly rose, red-osier dogwood and wild red raspberry. The herb layer was highly variable; some sites had an understory dominated by smooth brome, while others supported a variety of native forbs, including wild sarsaparilla, star-flowered Solomon's-



Plate 1. An Aspen Poplar land unit site with a somewhat open canopy dominated by aspen and diverse shrub and herb layers (Site #25; July 15, 2015)

seal and western Canada violet. One site (Site #25) supported two uncommon species: round-leaved hawthorn (*Crataegus chrysocarpa*; S3) and high-bush cranberry (*Viburnum opulus*; S3S4). Along transects, noxious weeds occurred only occasionally, generally as scattered individuals or small patches. The most frequently encountered noxious weed species were creeping thistle (*Cirsium arvense*), perennial sow-thistle (*Sonchus arvensis*) and common tansy (*Tanacetum vulgare*).

In general, the sampled edges of the aspen stands were those situated adjacent to agricultural lands or roads (rather than edges contiguous with a natural land unit). These edges tended to be somewhat disturbed, characterized by relatively high occurrences of weeds and occasional fallen trees.

Mixedwood Forest

Four Mixedwood Forest land unit sites were surveyed. These sites were generally mesic and were characterized by a canopy of white spruce, balsam poplar and aspen in varying amounts. The forests surveyed at these sites tended to be mature, with a high canopy (averaging approximately 20 m), and moderate canopy cover of 70% (Plate 2). The dominant shrubs included wild red raspberry, buckbrush and red-osier dogwood. The herb layer was highly variable; some sites were dominated by smooth brome, while others supported a variety of native forbs, including wild sarsaparilla, common nettle and common fireweed. Two sites (Sites #23 and #28) supported occurrences of high-bush cranberry, an uncommon species (S3/S4). Noxious weed occurrences ranged from scattered individuals to widespread infestations. Frequently encountered noxious weeds included creeping thistle, creeping bellflower (*Campanula rapunculoides*) and ox-eye daisy (*Leucanthemum vulgare*).



Plate 2. A Mixedwood Forest land unit site, with a high forest canopy and relatively open shrub layer (Site #23; July 16, 2015)

In general, the edges of the Mixedwood Forest sites were somewhat disturbed, with most of the sampled edges situated adjacent to agriculture or roads. Sampled edges tended to have increased occurrences of fallen trees, noxious weeds and exotic grasses, relative to the interior. One site (Site #15) was bisected by a pipeline, resulting in cleared vegetation and encroachment of exotic species. Two other sites (Sites #23 and #28) showed informal human use in the form of campfire debris, some constructed log shelters and trails throughout. Nonetheless, overall, site health was generally ranked as fair to good, and disturbance was generally considered low to moderate in the interior of the sites.

White Spruce Forest

Two White Spruce Forest land unit sites were surveyed. These sites were mesic to hygric and characterized by a canopy of white spruce, with aspen and balsam poplar in varying amounts. The canopy was generally high (averaging approximately 20 m) and closed, with an average of 93% canopy closure (Plate 3). The forests surveyed at these sites were considered mature, and the trees tended to be some of the largest in the DSA, with an average DBH of 46 cm, compared to 36 cm in the Mixedwood Forest and 24 cm in the Aspen Poplar Forest. The dominant shrubs included wild red raspberry, red-osier dogwood and red elderberry. The herb layer differed considerably between the two sites; Site #16 supported a mixed herb layer with smooth brome, common nettle and northern bedstraw, while Site #21 supported a forb-dominated understory with western jewelweed and common nettle. Noxious weeds were observed occasionally, mainly as scattered individuals or small patches. Frequently encountered noxious weeds included creeping thistle, common burdock (*Arctium minus*), common tansy and perennial sow-thistle.



Plate 3. A White Spruce land unit site, with a high, closed canopy and a herb layer dominated by spotted jewelweed, a native, invasive species (Site #21; July 16, 2015)

The White Spruce Forest sites were considered to have low disturbance in the interior of the stands and good health overall. Sampled edges were characterized by increased presence of exotic species and some fallen trees; however, the exotic species were generally confined to the edges. Weeds were generally sparse in stand interiors.

Riparian Meadow

Five Riparian Meadow land unit sites were surveyed, three of which were situated along Carrot Creek, and two on the floodplain north of the Sturgeon River. These sites were hygric and characterized by graminoid-dominated communities (Plate 4). Trees were generally sparse, with some sites lacking a tree stratum entirely and other sites having scattered small balsam poplar, aspen and Manitoba maple trees. Where a tree stratum was present, canopy height averaged approximately 10 m with an open canopy (approximately 2% canopy closure). Shrubs also tended to be sparse, with several species of willow, including shining willow, sandbar willow and beaked willow, comprising the majority of the shrub layer. The herb layer was dominated by reed canary grass, awned sedge and water sedge. Noxious weed occurrences ranged from none observed to abundant and widespread infestations. No rare or uncommon species were observed at any of the riparian meadow sites. Frequently observed weeds included creeping thistle, perennial sow-thistle, common tansy and leafy spurge (*Euphorbia esula*).



Plate 4. A Riparian Meadow land unit site at Carrot Creek, characterized as an open, graminoid-dominated community with occasional willows (Site #11; July 14, 2015)

In general, the sampled edges were somewhat disturbed, although weed encroachment from the edges was minimal. Compared to the sites along Carrot Creek, which were relatively undisturbed, the sites along the Sturgeon River tended to experience more disturbance from human activities, with informal trails and large areas dominated by creeping thistle and yellow and white sweet-clover. The meadow communities along Carrot Creek tended to be buffered by steep slopes with dense shrubbery, resulting in relatively undisturbed conditions.

Riparian Willow Shrub

Four Riparian Willow Shrub land unit sites were surveyed, two of which were situated along Carrot Creek, and two on the floodplain north of the Sturgeon River. These sites were hygric and characterized by a sparse tree stratum, abundant shrubs and a graminoid-dominated herb layer with occasional forbs (Plate 5). Commonly observed trees included balsam poplar and Manitoba maple, which averaged 10 m in height. The tree canopy was relatively open (averaging approximately 15% cover); however, the shrub layer was dense. Dominant shrubs included sandbar willow, shining willow and basket willow, with red-osier dogwood and prickly rose in slightly drier areas. The herb layer was dominated by reed canary grass, with common tall manna grass, water sedge and awned sedge. Noxious weeds were frequently observed in small to large patches. Creeping thistle, perennial sow-thistle and common tansy were the most commonly occurring noxious weeds.



Plate 5. A Riparian Willow Shrub land unit site with patches of dense willows interspersed with open, graminoid-dominated areas (Site #19; July 20, 2015)

Sampled edges of these sites tended to be weedy, with increased noxious weeds and other exotics along the margins, especially where the sites bordered on agricultural fields. Weed encroachment into the dense shrub communities tended to be minimal, despite the presence of exotics along the edge. Overall site health was fair, and overall disturbance within the land unit was generally low. One exception was Site #8, where adjacent agriculture situated locally on the TOB, encroached on the native riparian community and appeared to contribute to slope instability in some areas along the bank of Carrot Creek.

Seasonal/Temporary Marsh

Five Seasonal/Temporary Marsh land unit sites were surveyed, four of which were situated along Carrot Creek, and the remaining one located in a disturbed area east of Ray Gibbon Drive. These sites were hydric and characterized by minimal tree cover, sparse shrubs and a graminoid-dominated herb layer (Plate 6). Only two of the sites had a tree stratum, with occasional balsam poplar and Manitoba maple trees. The trees tended to be small (average height of 5 m) and sparse (average canopy cover of 1%). Shrubs were also somewhat sparse, with the most common species being sandbar willow, prickly rose and red-osier dogwood; however, two sites lacked shrubs entirely. The herb layer was consistently dominated by several species of graminoid, including reed canary grass, common cattail



Plate 6. A Seasonal/Temporary Marsh land unit site with a graminoid-dominated herb layer and occasional, scattered willows (Site #13; July 14, 2015)

and smooth brome in the relatively drier areas. Noxious weed occurrences ranged from occasional to abundant, typically occurring in small to large patches. Commonly occurring noxious weeds included creeping thistle, perennial sow-thistle and common tansy.

Sampled marsh edges tended to be relatively disturbed, as these land units tended to be situated adjacent to agricultural lands or surrounded by disturbed lands dominated by exotic vegetation. Thus, the edges were characterized by exotic species, with varying degrees of exotic species encroachment into marsh interiors. Overall site health varied widely, ranging from poor – where the site (Site #5) was characterized by agricultural cultivation encroaching on the marsh area and exotic species were frequent and widespread – to good, where the site (Site #12) was characterized by low disturbance and predominantly native species, despite proximity to a sod farm.

Semi-Permanent Marsh

One Semi-Permanent Marsh land unit site was surveyed, located north of the Sturgeon River and east of the Grey Nuns White Spruce Forest (Site #21). This site was hydric, with scattered small pools of open water present (Plate 7). Trees tended to be sparse and relatively small, with scattered balsam poplar and occasional aspen and white spruce. Overall, trees had an average height of 8 m and an average canopy closure of 4%. Shrubs formed occasional dense thickets, comprised of several species of willow (sandbar willow, shining willow, beaked willow, basket willow). The herb layer was graminoid dominated, with reed canary grass and water sedge, with concentrations of common cattail around open water areas. Tufted loosestrife (*Lysimachia thyrsiflora*), an uncommon species recently downgraded from S3 to S4, was also scattered through the area. Noxious weeds were rare, and occurred as scattered individuals, with creeping thistle the most commonly occurring noxious weed species.



Plate 7. A Semi-Permanent Marsh land unit site, with abundant shrubs and graminoids and common cattail at scattered open water pools (Site #24; July 16, 2015)

Sampled edges of this land unit tended to be relatively undisturbed, with occasional fallen trees, especially on the north edge, but few weeds. The overall site health was considered good, having a low abundance of exotic species and negligible disturbance within the site.

Grassland

One semi-natural Grassland land unit site was surveyed, located west of Ray Gibbon Drive, north of the Sturgeon River. This site was mesic and characterized by a community of predominantly exotic forbs (Plate 8). There were no trees or shrubs documented along the survey transect. The dominant species in the herb-layer included yellow and white sweet-clover, alsike clover and alfalfa. Occasional exotic and native grasses were observed, although they did not form the dominant vegetation at any of the three sample plots. Noxious weeds were frequent and widespread, with the most common species being creeping thistle, perennial sow-thistle and scentless chamomile.

Overall, this community was highly disturbed and in poor health overall, with abundant exotic species throughout the site. Site edges were not specifically assessed, due to the prevalence of weedy species throughout.



Plate 8. A Grassland land unit site, characterized by widespread exotic forbs, including species of sweet-clover (Site #18; July 16, 2015)



3.2.3 BIRDS

In total, 42 bird species were detected at point count stations (i.e., observed within 100 m or less of station locations) during the breeding bird surveys (Appendix E). Of these 42 species, five are listed provincially as *Sensitive* under the General Status of Alberta Wild Species 2010 (common yellowthroat, least flycatcher, Baltimore oriole, sora, and great blue heron; Alberta Environment and Parks 2015b) and one species (barn swallow) has been recommended by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to be listed at the federal level as *Threatened* under SARA (Government of Canada 2015). One detected species (European starling) is an exotic/alien species. Two waterbird species (great blue heron and sora) and three shorebird species (killdeer, spotted sandpiper, and Wilson's snipe) were detected and the remaining 37 species are landbirds, although several of the landbird species are typically associated with wetland habitats. Most of the detected species are considered songbirds (31 of 42 species). Seven resident species were detected and the remaining species are migrants that winter outside of Alberta.

In addition to the 42 species detected at point count stations, an additional three species (dark-eyed junco [*Junco hyemalis*], northern flicker [*Colaptes auratus*], and great horned owl [*Bubo virginianus*]) were detected beyond the point count stations. Another five species (mallard [*Anas platyrhynchos*], common goldeneye [*Bucephala clangula*], gadwall [*Anas strepera*], ring-billed gull [*Larus delawarensis*], and pileated woodpecker [*Dryocopus pileatus*]) were detected only as flyovers. Additionally, great horned owl and Nelson's sparrow [*Ammodramus nelsoni*] were observed incidentally during amphibian surveys on June 1, 2015. These additional observations bring the total species count to 52, however, birds detected incidentally, as flyovers, and beyond the limits of survey stations were excluded from further analyses.

The surveyed bird community was not homogenous throughout the DSA. Of the 42 bird species detected at survey stations, roughly half (20) were widespread, occurring both along Carrot Creek and in the Big Lake/Sturgeon River floodplain. In total, 27 species occurred at stations along Carrot Creek, 7 of which did not occur in the Big Lake/Sturgeon River floodplain. A total of 35 species occurred at stations in the Big/Lake Sturgeon River floodplain, 15 of which did not occur along Carrot Creek. Accordingly, bird diversity was slightly higher in the Big Lake/Sturgeon River floodplain (richness = 35, average H' = 2.02) than along Carrot Creek (richness = 27, average H' = 1.87).

There are several explanatory factors that likely account for the differences between the bird diversities along Carrot Creek and the Big Lake/Sturgeon River floodplain. Due to the narrowness of the Carrot Creek corridor and predominance of road-accessed stations, a significant portion of the area sampled at all of the Carrot Creek stations consisted of anthropogenic land units (mainly agricultural land and, to a lesser extent, roads), which are generally of low avian habitat quality. Moreover, only four natural land units occurred in the Carrot Creek corridor within 100 m of avian point count stations (Aspen Poplar, Seasonal/Temporary Marsh, Riparian Meadow, and Willow Shrub). In contrast, Big Lake/Sturgeon River floodplain stations included a lower proportion of anthropogenic land units than the Carrot Creek stations and included all eight natural land units, plus the semi-natural Grassland land unit (a habitat well used by birds). Thus, the higher avian richness and diversity of the Big Lake/Sturgeon River floodplain likely reflects the greater range and area of natural land units sampled relative to Carrot Creek. For example, the sampling of Mixedwood and White Spruce forest land units within the Big Lake/Sturgeon River floodplain increased the number of forest-associated songbird species that were detected relative to Carrot Creek. Nonetheless, considering the relatively similar habitat composition and predominance of anthropogenic land units bordering the Carrot Creek corridor, it is striking that its bird diversity was still so similar to the more habitat-diverse Big Lake/Sturgeon River floodplain. This suggests that the Carrot Creek corridor provides valuable bird habitat despite its relatively narrow configuration and the relative homogeneity of the constituent land units.

Other recent studies in the area suggest that this study underestimated the avian richness and diversity of the DSA. This is expected as avian data for this study were collected over relatively brief, though standard, periods (10-minute counts at 27 sites sampled once over two mornings). For example, a biodiversity assessment conducted by NAIT in the Grey Nuns White Spruce Park (GNWSP) as part of that natural area's recommended management plan (Brierly 2014) found 19 bird species, whereas the two point counts conducted in GNWSP for this study found only 13 species. A Biodiversity and Riparian Health Assessment of the Carrot Creek Corridor (NAIT 2008) found higher bird species richness and Shannon-Wiener diversity along Carrot Creek than the present study (richness = 43 and average H' = 2.36, versus richness = 27 and average H' = 1.87, respectively). That study included 10-minute point counts at 9 stations, but each station was sampled three times over the season and the maximum number of individuals of each species from any one survey was used for that analysis. This approach means more species in total are likely to be detected and at higher abundances.

3.2.4 AMPHIBIANS

Western toads were detected at low abundances at five of the thirteen amphibian survey stations (all records were at Carrot Creek) and boreal chorus frogs were detected at medium-to-high abundances at six of the thirteen amphibian survey stations; wood frogs and Canadian toads were not detected at any station (Table 3). Boreal chorus frogs were also incidentally observed at low abundance in the vicinity of Big Lake (Station 1) but were not detected *during* the survey at that station. No other incidental observations of amphibians were made over the course of fieldwork conducted in the DSA.

Table 3. Toads and frogs detected during auditory amphibian surveys in the DSA, May/June 2015

Nearest Water Body	Station Number	Call Level* by Species	
		Western Toad (*Anaxyrus boreas*)	Boreal Chorus Frog (*Pseudacris maculata*)
Big Lake	1		
	2		
Sturgeon River	3		
	4		
Carrot Creek	5	1	2
	6		3
	7		
	8	1	3
	9	1	3
	10	1	2
	11	1	2
	12		
	13		
Count of Station Occurrence		**5**	**6**

Table 3. Toads and frogs detected during auditory amphibian surveys in the DSA, May/June 2015

*Call level codes:

1 = individuals can be counted, no overlapping calls (approximately 1-3 animals)

2 = individuals can be counted, some calls overlap (approximately 4-7 animals)

3 = individuals cannot be counted, full chorus, calls overlapping (> 8 animals)

The amphibian survey results reflect the fact that survey station site-selection and timing targeted toad habitat and the peak calling period for toads In particular, the lack of wood frog detections is likely a reflection of the survey timing and habitat at the survey stations rather than an indication of this species' absence from the DSA: the wood frog calling period is briefer and peaks earlier in the year than the toad calling period and, although wood frogs are dependent on surface water for reproduction, outside of the breeding period they often inhabit relatively dry environments that are well away from open water (Russell and Bauer 2000). Canadian toads are also one of Alberta's most terrestrial amphibian species (Alberta Environment and Parks 2015c), which may partially explain the lack of detections of this species during surveys; however, Canadian toads do congregate at open water during roughly the same calling period as western toads, so their absence during surveys may in fact indicate that this species is uncommon in the DSA. Canadian toads have been recorded in Lois Hole Provincial Park (Alberta Environment and Parks 2015d). Unlike the wood frog, the calling period of the boreal

chorus frog extends later into the spring and has more overlap with the toad calling period. Moreover, boreal chorus frogs and western toads are more dependent on moisture and surface water throughout the year than wood frogs and Canadian toads, and thus boreal chorus frogs are more likely to be present at the same water bodies as western toads during the time of year that surveys were conducted. Accordingly, boreal chorus frogs and western toads were detected at the same five survey stations (plus one additional station at which boreal chorus frogs were detected but western toads were not detected). The five stations at which western toads were detected were all located along Carrot Creek. Those five stations are, however, only representative of four different potential breeding areas; toads calling from the same area were detected at two different survey stations. At two of these four stations, beavers have dammed Carrot Creek to create areas of ponded water, which is consistent with western toad and boreal chorus frog preference for slower moving or still water. The other two assumed breeding areas also included ponded water, but both were created as a result of human-constructed water impoundments.

The occurrence of western toad along Carrot Creek is indicative of its significant habitat quality and ecological corridor functionality. Indeed, although western toads are generally considered to be uncommon in the province, they occurred at nearly the same number of stations (albeit in lower abundances) along Carrot Creek as the relatively common boreal chorus frog. The areas of open ponded water preferred by western toads may be dependent upon beaver activity in many locations along Carrot Creek, including and additional to the beaver ponds surveyed as part of this study. Beaver ponds are temporally dynamic: ponds that were being actively maintained by beavers in 2015 may eventually be abandoned and new ones may be created elsewhere in the future. As such, there would be little efficacy in attempting to identify specific beaver ponds along Carrot Creek that provide critical western toad habitat; however, ensuring that beavers persist in Carrot Creek in general will likely help to ensure that western toads also persist there. Furthermore, western and Canadian toads have been recorded as occurring in LHCPP (Alberta Environment and Parks 2015d); the persistence of suitable toad habitat in Carrot Creek and the continuous aquatic connectivity along the water course allows for the creek to serve as a toad dispersal corridor from the Regional Core Area associated with Big Lake and LHCPP. The connection between Carrot Creek and Big Lake may be critical for supporting a wider regional toad population.

3.2.5 INCIDENTAL MAMMAL OBSERVATIONS

Several mammals and signs of mammals were observed incidentally during vegetation, bird, and amphibian fieldwork in the DSA. These include moose, white-tailed deer, coyote, porcupine, beaver, and red squirrel. It is likely that other small mammals (e.g., various species of mouse, vole, and hare) are common throughout the DSA, but their small size combined with their inconspicuous and, for many, nocturnal habits makes them difficult to detect unless rigorous targeted sampling methods are employed; this is especially true in the snow-free periods of the year when track evidence is less available.

3.3 NATURAL AREA SIGNIFICANCE/ ENVIRONMENTAL SENSITIVITIES ASSESSMENT

3.3.1 ECOLOGICAL ROLE AND PROTECTED STATUS

Land unit mapping indicates that lands within the DSA can be grouped into two types: 1) tightly clustered natural areas concentrated in riparian corridors along the three water bodies of the DSA; and 2) agricultural or developed lands supporting a few scattered, isolated natural areas. The closely connected nature of the riparian corridors in the DSA and the general paucity of nearby, separate habitat patches, is an important consideration in the

process of identifying areas of ecological significance and assessing which natural or semi-natural areas should be prioritized for retention.

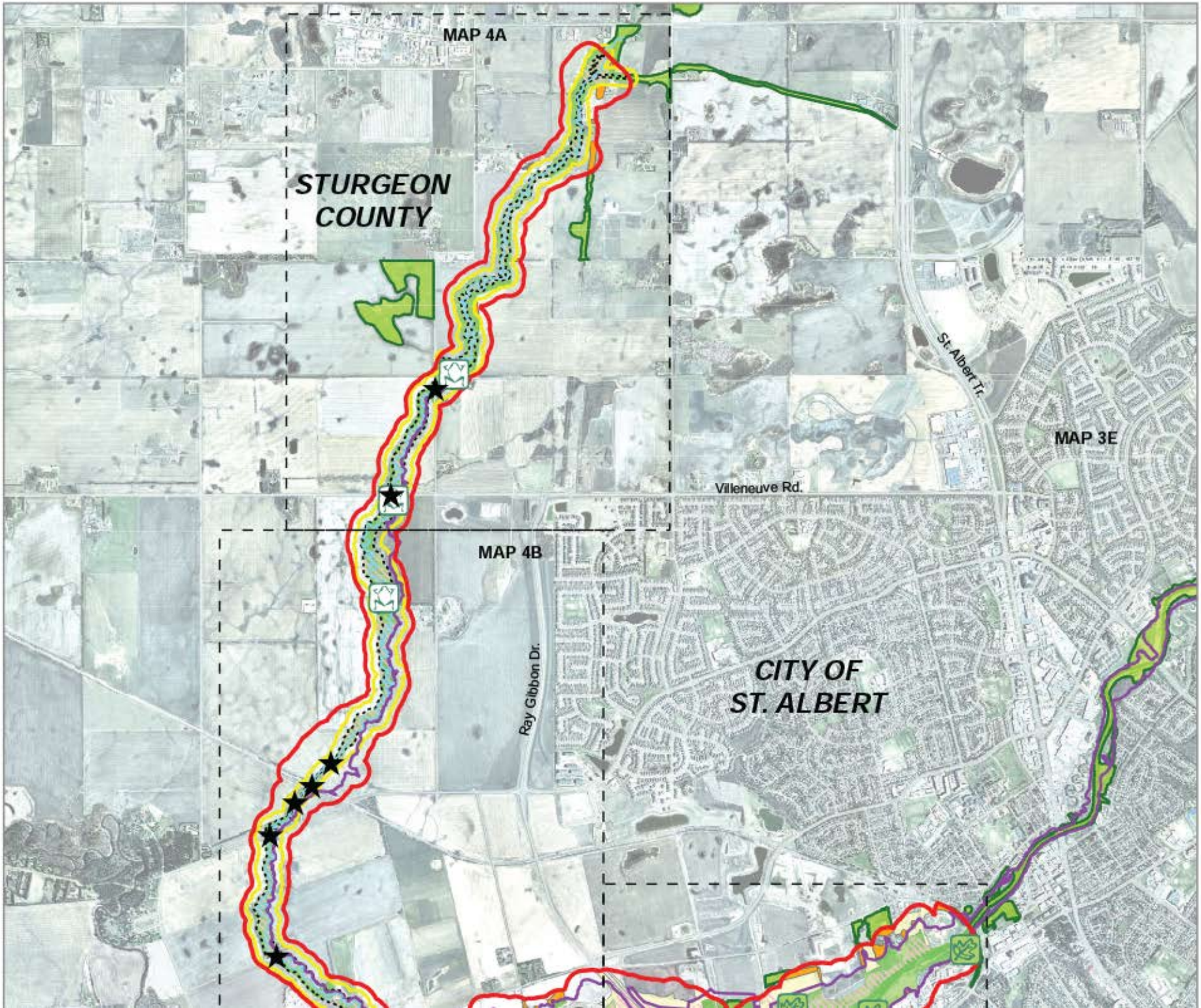
Riparian corridors or zones are well documented as highly important ecological systems for the roles they play in binding soils; filtering sediments and nutrients; retaining pollutants; providing critical habitat for fish, amphibians and aquatic invertebrates; and providing corridors for wildlife movement (Adams and Fitch 1998). Within much of the DSA, the existing natural areas appear to fulfill these functions. But the quality and spatial distribution of habitat is variable. For example, along much of Carrot Creek the width of the natural riparian zone varies between approximately 5 m and 50 m. In some reaches the creek has been channelized and completely lacks a natural riparian zone. Along the north shore of Big Lake (within the DSA) there are only a few scattered patches of riparian woodland habitat; much of the north perimeter of the lake transitions directly into agricultural fields. The riparian zone along the Sturgeon River is generally wider and comprises large areas of riparian meadow and patches of adjacent woodland. In a meta-analysis of studies that attempted to identify minimum riparian zone width necessary to augment or initiate various ecological functions, the minimum zone width, measured across a suite of seven function groups, averaged approximately 60 m (Hansen et al. 2010). Some of the naturally vegetated riparian zone along Carrot Creek comes close to achieving this minimum standard. The riparian zone of Big Lake (within the DSA) falls below this standard and the Sturgeon River's riparian zone generally meets the standard, but there are several areas where the riparian zone along the river is much narrower. Because the existing riparian zones in the DSA are generally quite narrow compared to what is considered to be ecologically ideal, and the efficiency of riparian functioning is known to increase with width (Hansen et al. 2010), any further diminishment of the existing riparian zones within the DSA would begin to

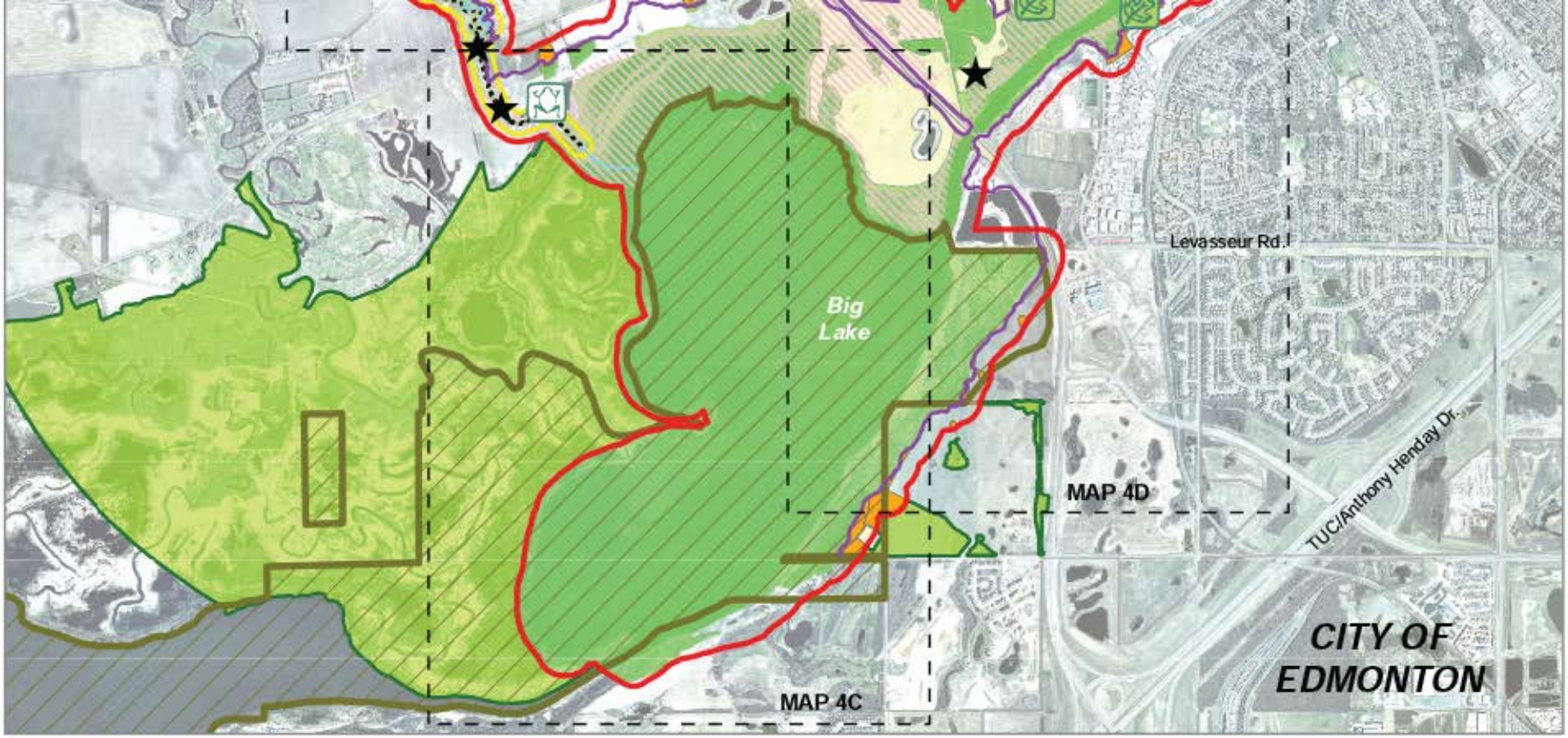


impede the provision of ecological functions. For this reason, the natural riparian habitat within the DSA should be retained intact to the highest degree possible and, where possible, enhanced through careful land use planning and ecological restoration. Within the DSA, each of the natural land unit components of the riparian corridors have been classified as a component of a key element in the OSA ecological network, part of a Regional Ecological Corridor or the Regional Core Area centered on LHCPP.

Within St. Albert, much of the key DSA riparian habitat is already afforded some protection. Provincial park lands overlapping DSA lands are protected from outside development. In fact, protection of the central part of the park was recently increased with purchase of buffer lands that formerly occupied St. Albert's South Riel area and a corner of the City of Edmonton. For lands within St. Albert's jurisdiction, the vast majority of natural land units along both water ways that are considered critical to the DSA's riparian corridor are also situated below the designated flood line and/or within the 50 m Carrot Creek setback. This spatial relationship is illustrated in Map 4. Thus, the Carrot Creek setback and the LUB designated flood line restrictions support the City's desire to protect these key areas. Along Carrot Creek, lands protected by both of these boundaries adequately protect the core riparian zone (from most development). Notably, the core riparian zone located in Sturgeon County is not similarly protected. In contrast, natural land units in St. Albert (and in Sturgeon County), that are located beyond the jurisdiction of those two municipal tools are much less protected. In fact, for these upland habitats, the City has few tools to require that they be retained. (Unlike wetlands and ravines they cannot be dedicated as Environmental Reserve.) To illustrate this, natural areas above the flood line and beyond the 50 m TOB setback, but still within the boundaries of the DSA, have been identified as vulnerable to loss or change during future development (Map 4). Along the Sturgeon River, where most adjacent lands are already developed, the only tool available is the flood line restriction, which has recently proven generally adequate for protection of the core riparian zone; however some vulnerable land units occur above that line.

Although each vulnerable land unit holds some ecological value, the potential conservation value of all vulnerable land units is not equal. The vulnerable land units that are contiguous (physically connected) with the core riparian zone are deemed to be highest priority because of the direct benefit they contribute to the width and functionality of the overall riparian system. Vulnerable natural land units within the DSA that are not contiguous with the core riparian area, which are fewer in number, can generally be considered to be of less direct ecological value. However, considering the relatively small scale of the DSA (i.e., approximately 100 m buffer beyond the flood line) and the presence of only a few adjacent upland patches, those present within that 100 m buffer do contribute to ecological function and hold value and conservation interest for that reason.


MAP 4A
STURGEON COUNTY
St. Albert Tr.
MAP 3E
Villeneuve Rd.
MAP 4B
Ray Gibbon Dr.
CITY OF ST. ALBERT



Legend

- DSA Natural Land Unit
- DSA Vulnerable Natural Land Unit
- Important Connected Natural Areas Beyond DSA
- HGT Soil Series
- Grassland Land Unit (Semi-Natural)
- Potential Priority Restoration Area
- Toad Breeding Habitat
- Location of Listed Plant Species
- DSA Boundary
- Designated Flood Line
- Carrot Creek Top-of-Bank (TOB)
- 50m Carrot Creek TOB Setback
- Protected Area

N

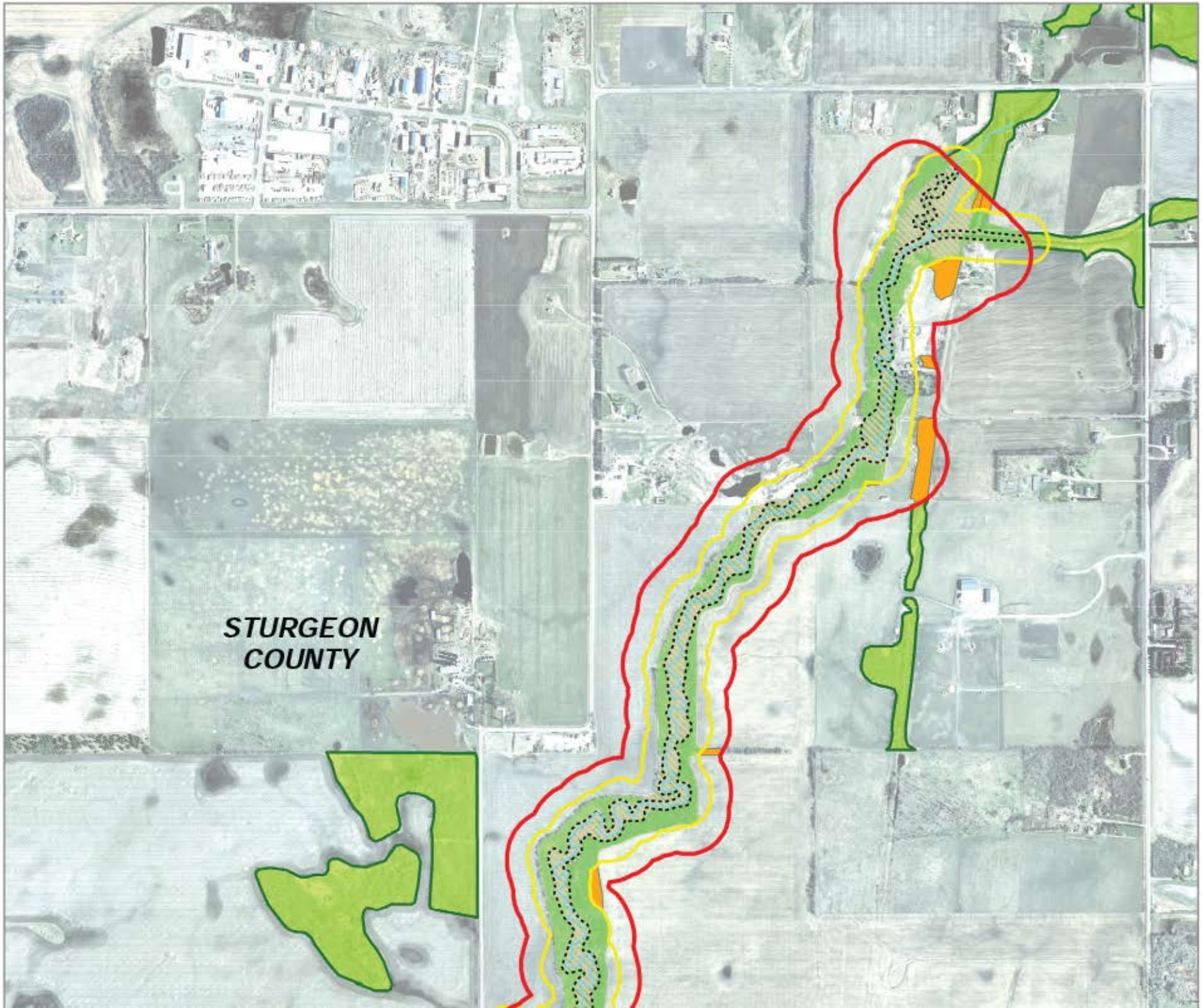
0 250 500 1,000 Meters

1:33,800

MAP 4.
ENVIRONMENTAL SENSITIVITIES AND LAND USE PLANNING CONSIDERATIONS – OVERVIEW

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Imagery Date: May 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015


STURGEON
COUNTY



Legend

- DSA Natural Land Unit
- DSA Vulnerable Natural Land Unit
- Important Connected Natural Areas Beyond DSA
- HGT Soil Series
- Grassland Land Unit (Semi-Natural)
- Potential Priority Restoration Area
- Toad Breeding Habitat
- Location of Listed Plant Species
- DSA Boundary
- Designated Flood Line
- Carrot Creek Top-of-Bank (TOB)
- 50m Carrot Creek TOB Setback
- Protected Area

N

0 100 200 400 Meters

1:12,000

MAP 4A.
ENVIRONMENTAL SENSITIVITIES AND LAND USE PLANNING CONSIDERATIONS

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Imagery Date: May 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015


Ray Gibbon Dr.



Legend

- DSA Natural Land Unit
- DSA Vulnerable Natural Land Unit
- Important Connected Natural Areas Beyond DSA
- HGT Soil Series
- Grassland Land Unit (Semi-Natural)
- Potential Priority Restoration Area
- Toad Breeding Habitat
- Location of Listed Plant Species
- DSA Boundary
- Designated Flood Line
- Carrot Creek Top-of-Bank (TOB)
- 50m Carrot Creek TOB Setback
- Protected Area

N

0 100 200 400 Meters

1:12,000

MAP 4B.
ENVIRONMENTAL SENSITIVITIES AND LAND USE PLANNING CONSIDERATIONS

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Imagery Date: May 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015





Legend

- DSA Natural Land Unit
- DSA Vulnerable Natural Land Unit
- Important Connected Natural Areas Beyond DSA
- HGT Soil Series
- Grassland Land Unit (Semi-Natural)
- Potential Priority Restoration Area
- Toad Breeding Habitat
- Location of Listed Plant Species
- DSA Boundary
- Designated Flood Line
- Carrot Creek Top-of-Bank (TOB)
- 50m Carrot Creek TOB Setback
- Protected Area

N

0 100 200 400 Meters

1:12,000

MAP 4C.
ENVIRONMENTAL SENSITIVITIES AND LAND USE PLANNING CONSIDERATIONS

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Imagery Date: May 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015

Levasseur Rd.



Legend

- DSA Natural Land Unit
- DSA Vulnerable Natural Land Unit
- Important Connected Natural Areas Beyond DSA
- HGT Soil Series
- Grassland Land Unit (Semi-Natural)
- Potential Priority Restoration Area
- Toad Breeding Habitat
- Location of Listed Plant Species
- DSA Boundary
- Designated Flood Line
- Carrot Creek Top-of-Bank (TOB)
- 50m Carrot Creek TOB Setback
- Protected Area

N

0 100 200 400 Meters

1:12,000

MAP 4D.
ENVIRONMENTAL SENSITIVITIES AND LAND USE PLANNING CONSIDERATIONS

SPENCER ENVIRONMENTAL MANAGEMENT SERVICES LTD.

Imagery Date: May 2014
Projection: 3TM 114 NAD83
Date: 13 November 2015

3.3.2 ECOLOGICAL CONNECTIVITY

The ecological value of natural areas (natural land units) within the DSA is not solely a function of their value as riparian habitat. Value is also derived from ecological connectivity both within and beyond the DSA boundaries. The results of the GIS analysis using ≥ 1 ha patches and 100 m buffer identified five natural areas as *Important Connected Natural Areas Beyond the DSA* (Map 4). These OSA sites are also vulnerable to future development impacts as they are currently unprotected. Within the ecological network, four of these sites play the role of Stepping Stones and the fifth is a component of a LEC. The proximity of these sites to natural areas in the DSA increases the value of the closest DSA natural areas to the network as a whole. Thus, their loss would also have an effect on the ecological function of DSA lands. This connective, ecological network value should be an important consideration when assessing lands that warrant conservation. Natural areas and intervening lands closest to these five sites should receive strong consideration for retention and restoration.

Twelve natural areas straddle the DSA boundary. The portions situated beyond the boundary are also identified as *Important Connected Natural Areas Beyond the DSA*. These portions have no statutory or policy protection and thus are also vulnerable to development loss, although not shown as such on Map 4. These vulnerable, connected areas should be considered in their entirety when making land use planning decisions and assigning conservation priorities.

3.3.3 FIELD-DOCUMENTED ENVIRONMENTAL SENSITIVITIES

The wide range of land units in the DSA provides for a high level of biodiversity. The habitat types found in the DSA are fairly typical of central Alberta and fairly widespread in that region, with two notable habitat exceptions – Big Lake and the Grey Nuns White Spruce Park. These two exceptions are currently protected through provincial and municipal measures, respectively. The other existing natural habitats within the DSA are smaller in area but much of their value derives from the concentrated mosaic of different habitat patches and their location along water bodies (Carrot Creek, Big Lake and Sturgeon River).

This study's field sampling program documented a rich flora and fauna. Most species observed are typical of similar central Alberta habitats but several less common species of conservation interest were observed that warrant further consideration as conservation priorities. The amphibian surveys documented western toads calling from four areas along Carrot Creek (Map 4). The western toad is designated as Sensitive provincially and a species of Special Concern federally. Populations of western toads are known to be decreasing in many regions of Canada, but little is known about the status or abundance of populations in Alberta (Alberta Environment and Parks 2015b). Western toads are generally uncommon in the greater Edmonton area and the presence of a breeding population along Carrot Creek is noteworthy. The toads were recorded in the vicinity of ponded creek water, including areas upstream of active beaver dams. Future land use decisions and practices should ensure that Carrot Creek is managed such that ponded water and the natural habitat diversity it creates can continue.

Breeding bird surveys documented five species that are listed provincially as Sensitive (common yellowthroat, least flycatcher, Baltimore oriole, sora, and great blue heron; Alberta Environment and Parks 2015b). Each of these species has been listed as a result of population declines in Alberta or elsewhere in their range, but all are still relatively widespread and common in the Central Parkland. The riparian habitat that these species use is already noted as highly valuable.

Vegetation surveys documented two shrub species of potential conservation interest: high-bush cranberry (Viburnum opulus) and round-leaved hawthorn (Crataegus chrysocarpa). Those two species are ranked provincially as S3S4 and S3, respectively. High-bush cranberry was documented at three sites while round-leaved hawthorn was document at one site. All three



sites were in upland woodland land units (Aspen Poplar or Mixedwood Forest) located along the Sturgeon River. S3 species are known from 100 or fewer occurrences in the province or are otherwise somewhat vulnerable due to other factors, such as restricted range or relatively small population sizes. S3S4 species are more secure and known from more occurrences than S3 species, but there is potentially cause for long term concern due to declines or other factors (Alberta Environment and Parks 2015a). Although neither species is particularly sensitive to disturbance, their ranking should be considered when evaluating proposed development.

3.4 DSA RESTORATION OPPORTUNITIES

The ecological restoration opportunities identified within the DSA comprise four types: creek and riparian restoration; habitat connectivity restoration; wildlife crossing restoration; and grassland restoration. The following sections provide further detail on the specific restoration activities that could be undertaken as part of a desired restoration program.

Creek and Riparian Restoration

In several places Carrot Creek has been channelized (straightened and ditched) and all natural riparian vegetation has been removed (Map 4). In these locations, restoration activities could include the realignment of the creek into a more natural, meandering configuration and the planting of a native shrubby and treed riparian community. The potential benefits that could be achieved as a result of this restoration are many, including: slowed water flow, decreased erosion potential, increased riparian habitat, lowered water temperatures, improved surface runoff filtration and absorption capacity, and improved wildlife connectivity.

Habitat Connectivity Restoration

In certain locations within the DSA, there are natural land units (i.e., natural areas) in close proximity to one another, but separated by an anthropogenic land unit or a semi-natural Grassland. Naturalization efforts in the form of native plantings and the removal of consistent mowing/haying activities could provide for improved ecological connectivity between nearby natural land units. With time, establishment of native plant communities where gaps currently exist could achieve an increase in the effective size of a natural land unit patch, which could provide for improved suitability to a wider range of native wildlife species.

Wildlife Crossing Restoration

At the various road crossings along Carrot Creek, none of which are recent additions, the existing creek crossing structures were designed, constructed and installed with little consideration given to the impacts they could have on ecological connectivity and, more specifically, wildlife movement. In many cases, the crossing structure provides only sufficient passage for the creek channel and flow of surface water. In those cases, most terrestrial wildlife travelling along the creek corridor would be forced to cross the road in order to continue travelling along the creek. Restoration activities, most likely to be implemented at the time of future road upgrades, could include wider aperture or wider span crossing structures that provide for some degree of terrestrial wildlife movement beneath the road. Provision of specific structures or material intended to facilitate the movement of specific taxa could also be provided (e.g., inclusion of small tubes can provide for small mammals connectivity; provision of dry benches, placement of coarse woody debris within crossing structures can improve functionality for small mammals and amphibians).



Grassland Restoration

The Grassland land unit, mainly situated north of Big Lake and the Sturgeon River (Map 4), is generally characterized by non-native forbs and grasses with a scattering of native species. Despite being largely non-native in species composition, the open and unmanicured nature of the grassland areas allows for the easy movement of certain terrestrial wildlife species and provides habitat for a range of small mammals and bird species that prefer open grassy areas. The areas of grassland hold great potential as potential restoration areas. Planting of native shrub and tree species would encourage the establishment of early successional shrub and woodland communities that could provide habitat for a greater suite of wildlife species and promote improved wildlife movement across the landscape and among surrounding natural land units.

4.0 SUMMARY

DSA investigations have resulted in a comprehensive assessment of the DSA that provides the City with data that can be used to inform land use planning decisions and to prioritize conservation opportunities in the face of future urban development. For lands within the DSA, the ultimate goal is to ensure long-term sustainability (i.e., maintenance of high ecological value and function) of the natural lands along Carrot Creek, Sturgeon River and the perimeter of Big Lake. The City's current MDP (MDP 2007, Updated 2013) and LUB already provide certain tools to achieve natural area protection, a 50 m Carrot Creek setback and development restrictions below the designated flood line. Continued information exchange with Sturgeon County will be integral to ensuring similar levels of protection are assigned to DSA lands in that County. Despite the City having certain protection tools in hand, development pressures with potential to result in direct and indirect impacts are still anticipated. Accordingly, the data collected during this project and the recommendations embedded throughout this document should provide the City with additional resources to guide sound land use planning decisions as development within the DSA progresses. Key results and recommendations of DSA investigations can be summarized by way of a few key guiding principles:

- The natural areas of the DSA are confirmed as playing key roles (Regional Core Area and Regional Ecological Corridor) in the City's ecological network.
- Long-term sustainability and ecological value of natural areas within the DSA will be maximized if they are retained intact to the highest degree possible and, where possible, enhanced through careful land use planning and ecological restoration.



- The natural areas along Carrot Creek form a structurally connected, nearly continuous mosaic of different natural habitat types. Any diminishment of the natural riparian zone along Carrot Creek will reduce ecological function. All natural areas that are contiguous to the core riparian zone along the creek should be considered of high ecological value and prioritized for protection.
- Natural areas within the DSA identified as connected to components of the City's ecological network beyond the DSA should be considered of high ecological value and prioritized for protection.
- As development proceeds and extends into the DSA, the avoidance of existing natural areas, minimization of development impacts and incorporation of naturalization/ecological restoration efforts where possible will facilitate sustainability of natural areas within the DSA.
- If development of any kind is proposed within a DSA, additional natural area/natural land unit site-specific biological data should be required and careful consideration of environmental sensitivities should be given during site selection, project design and construction.

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5.2 PERSONAL COMMUNICATIONS

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APPENDIX A.
DETAILED METHODS

LAND UNIT IDENTIFICATION AND MAPPING METHODS

The land unit mapping exercise began by closely examining the existing, 2014 land unit mapping provided to us by the City. The boundaries of the land units in that dataset were determined to be quite coarse relative to the natural area delineations of other base datasets. Accordingly, the following steps were taken in completing the land unit mapping in the extended DSA.

- The updated 2015 OSA natural area inventory was used as the base layer for all land unit mapping in the extended DSA.
- The Stantec (2014) land unit mapping dataset was overlaid on the updated 2015 natural area inventory and the 2014 land unit types were applied to the underlying natural areas. Where necessary, inventoried natural areas were subdivided to illustrate the different land units identified by Stantec (2014).
- The Stantec (2014) natural land unit types were refined to provide an improved level of detail made possible because of the detailed 2014 aerial photography available for this exercise. In some cases, this involved creation of new land unit types; in others, amalgamation of land unit types was necessary to reflect limitations of the desktop mapping exercise. Specific changes to land unit types included the following:
    - Tall and short shrubland alliance land units (Stantec 2014) were merged with shrubby willow swamp to form a Riparian Willow Shrub land unit.
    - Aspen woodland alliance, aspen poplar alliance and balsam poplar alliance (Stantec 2014) were merged to form an Aspen Poplar (i.e., comprehensive deciduous woodland) land unit.
    - A Riparian Meadow land unit was created by extracting and combining similar areas from both the semi-permanent marsh land unit (Stantec 2014) and the newly created Riparian Willow Shrub land unit. The Riparian Meadow land unit is defined as a community dominated by grasses and other graminoid species, possibly including scattered shrubs, in an area immediately adjacent to a water body and, thus, subject to saturated soils and/or periodic flooding.
    - Permanent Marsh (Stantec 2014) was removed as a land unit type because it was not relevant to the extended DSA.
- An Open Water land unit was created to capture the areas of open water of Big Lake and the Sturgeon River.
- A new semi-natural Grassland land unit was created to capture the open, unmanicured grass-dominated areas within the DSA.
- Non-natural land units were identified and delineated based on observable continuous land cover/land use types. Non-natural land units identified and mapped included:
    - Agriculture; defined as land dominated by cultivated crops or hayfields.
    - Disturbed; defined as land dominated by unvegetated, exposed soils, most often as a result of active development/ construction activity.
    - Developed; defined as land dominated by hard developed infrastructure (e.g., roads, commercial development, residential development)

- Manicured Open Space; defined as land dominated by open space subject to regular maintenance, primarily in terms of grass/turf mowing. This land unit generally comprises parkland maintained by the City and private residences.
- Stormwater Management; defined as land comprising facilities constructed and managed primarily for the purpose of stormwater management.
- Lastly, natural land unit types were ground-truthed using data derived from the field survey program. Field data on dominant and abundant plant species were reviewed and, in just one case, the land unit type was changed to better reflect the documented species composition.

VEGETATION SURVEY METHODS

Vegetation survey effort was influenced by land-access limitations and the desire to ensure that each natural land unit *type* was sampled at least once. For more widespread land unit types, or land unit types that were expected to be variable, more than one land unit was sampled. This resulted in a total of 28 vegetation sample sites. Through a desktop analysis utilizing aerial photographs, transects were positioned within a land unit so as to capture representative vegetation and conditions in the interior of the land unit, avoiding sampling at land unit edges. To standardize survey effort among land units, the basic component of each sample site comprised one 100 m long transect. Selected metrics were assessed at the 0 m, 50 m and 100 m marks on the transect within a dedicated radius around the point, with the radius length depending on the metric (Table 1). Coarser metrics were assessed through a meandering survey along the whole length of the transect (Table 1). GPS coordinates were recorded at each of the three transect points (0 m, 50 m, 100 m) to facilitate potential site monitoring in the future.

Table 1. Assessment Area for Vegetation Metrics

Metric	Point (0 m, 50 m, 100 m)	Transect
Dominant Trees	✓ (assessed within 25 m of point)	
Dominant Shrubs	✓ (assessed within 10 m of point)	
Dominant Forb/Graminoids	✓ (assessed at point)	
Canopy Height	✓ (assessed within 25 m of point)	
Canopy Closure	✓ (assessed at point)	
DBH of Largest Tree	✓ (largest tree within 10 m of point)	
Snags	✓ (assessed within 25 m of point)	
Coarse Woody Debris	✓ (assessed within 10 m of point)	
Rare Species Occurrence	✓	✓
Understorey Composition		✓
Noxious Weed Occurrence	✓	✓
Noxious Weed Abundance		✓
Noxious Weed Distribution		✓
Moisture Regime		✓
Terrain		✓
Human Disturbance		✓
Site Health		✓
Edge conditions		✓

VEGETATION SAMPLING POINTS

Tree Stratum

At each of the three sample points, the three most common tree species occurring within 25 m of the point were recorded and their relative abundances ranked as dominant, abundant, frequent, occasional or rare (all relative to plot occurrence). Canopy height was visually estimated at each point and assigned to pre-defined height categories, and the number of snags within 25 m of each point was recorded. To estimate canopy cover at each point, four readings were taken using a spherical densiometer and then averaged. The diameter at breast height (DBH) of the largest tree within 10 m of each point was measured.

Shrub Stratum

At each of the three sample points, the three most common shrub species occurring within 10 m of the point were recorded and their relative abundances ranked as dominant, abundant, frequent, occasional or rare (all relative to plot occurrence). Approximate shrub height was visually estimated at each point and assigned to pre-defined height categories.

Herb Stratum/Groundcover

At each of the three sample points, the three most common herb species (i.e., forb or grass) occurring within 2 m of the point were recorded and their relative abundances were ranked as dominant, abundant, frequent, occasional or rare (all relative to plot occurrence). The presence of exposed soil in the ground layer was assessed as a percentage of total cover and assigned to pre-defined percent classes. Bryophytes were not formally surveyed; however, when bryophytes contributed to overall groundcover in more than trace amounts, their presence was noted. Finally, the presence of coarse woody debris (CWD) was assessed as the number of fallen trees within 10 m of the point.

Vegetation Transect Sampling

While walking the transect, the surveyor noted dominant species encountered in the herb layer and then classified the site as forb-dominated, grass-dominated, or mixed (i.e., with both forbs and grasses). The overall site moisture regime was classified as hydric, hygric, mesic or xeric, based on the plant species present and the presence of standing water and/or moist soils at the time of the surveys.

Noxious weed species encountered at survey points and along transects were recorded and noxious weed abundance and distribution were noted for the transect as a whole using pre-defined categories. Incidental observations of provincially rare or uncommon species were documented. A full rare plant survey was not conducted. These include species ranked as S1, S2, S3 according to the Alberta Conservation Information Management System (ACIMS; Alberta Environment and Parks 2015a). Species ranked as S1 or S2 are provincially tracked, and although S3 species are not tracked, their occurrence is classified as uncommon and is considered of interest.

For the site as a whole, human disturbance and overall site health were qualitatively assessed and classified in pre-defined categories. Low disturbance/good health indicated a relatively undisturbed, natural community comprising predominantly native species. High disturbance/poor health indicated a site experiencing considerable disturbance from any of a variety of sources, contributing to an increased occurrence of exotic species, increased soil exposure or increased litter and garbage throughout the site.

Sampled land unit edges were also coarsely characterized in recognition that land unit edges, especially when bounded by non-natural land units, can be adversely affected by surrounding land uses and are prone to weed colonization or other disturbances that can then penetrate into land unit interiors. Upon entering and exiting a land

unit to/from a sample site, conditions at the land unit edges were qualitatively assessed at selected points along the edge of entry, with key edge effects, such as wind damage, weed establishment or garbage presence noted. These observations will provide insight into land unit (and natural area) management needs.

BIRD SURVEY METHODS

Point counts were performed by a wildlife biologist with extensive ornithological field experience on June 24 and 25, 2015; these dates fall within the peak breeding season for the majority of bird species that occur in Alberta's Central Parkland Natural Region (Federation of Alberta Naturalists 2007). All point counts were performed between one half-hour before sunrise and 10:00 AM, to correspond with the time of day when landbirds are most active and vocalize most frequently. Point counts were conducted in suitable weather conditions (i.e., no precipitation and light to no wind). The surveyor remained silent and still for one minute upon arrival at each station, allowing birds to recover from any disturbance associated with the surveyor's approach. The surveyor then proceeded to conduct a 10-minute count in which all birds heard or seen were recorded. The surveyor used binoculars to aid with identifying visible birds and to scan vegetation and open water. The distance between the surveyor and each bird seen and/or heard was estimated as <50 m, 50-100 m, or >100 m. Birds were identified to species-level, and, when possible, the sex (male or female) and age (adult or juvenile) was noted. The detection types (song, call, and/or visual) for each bird detected was also noted[1]. Any observed behaviors indicative of breeding activity were also noted (e.g., carrying food, carrying nesting material, territorial displays, aggressive interactions with other birds, etc.). Birds that were observed only flying over during the survey were noted as such, as they were not necessarily using the habitat at the sample site; aerial insectivore species (e.g., swallows) observed foraging in flight over the sample sites were considered to be using the habitat and thus not categorized as flyovers.

Point count data analyses included calculation of the total abundance, total species richness, and average Shannon-Wiener diversity index for the bird communities at the 13 stations along Carrot Creek, the 14 stations within the Big Lake/Sturgeon River floodplain, and all stations combined (i.e., 27) in the DSA. All analyses excluded flyovers and birds >100 m from stations. Abundance is the total number of individual birds detected, whereas species richness is the number of species detected. Because species richness does not provide any information about the evenness of a community (i.e., the relative abundance of individuals among species), diversity was calculated using the Shannon-Wiener index (H'); this index is sensitive to differences in both species richness and evenness by incorporating the proportion of species relative to the total number of individuals observed. H' is calculated using the following equation:

$$H' = -\sum_{i=1}^{s} p_i \ln p_i$$

Where S is the number of species and p_i is the proportion of individuals consisting of the ith species within the total population (Schemnitz 1980). A higher diversity indicates a higher degree of uncertainty in predicting which species will be represented when selecting an individual at random from a community. In other words, diversity gives information about community structure and the weight of a single species within a community. The average H' index value across the 13 stations along Carrot Creek, the 14 stations in the Big Lake/Sturgeon River floodplain, and all 27 stations in the DSA are reported.

1 For most songbird species, only adult males can sing whereas adults and juveniles of both sexes can call. As such, individuals detected and identified by song during the breeding season can be assumed to be territorial males even if they are not visually observed. Visual evidence is required to determine the age and sex of birds detected by call.

AMPHIBIAN SURVEY METHODS

Following the taxonomy and nomenclature of Frost et al. (2006), the amphibian species potentially occurring in the St. Albert area that can be effectively surveyed using auditory methods include wood frog (*Lithobates sylvaticus*), boreal chorus frog (*Pseudacris maculata*), Canadian toad (*Anaxyrus hemiophrys*), and western (boreal) toad (*Anaxyrus boreas*) (ACA and ASRD 2010, Russel and Bauer 2000). Auditory amphibian surveys were conducted by a wildlife biologist with experience identifying amphibian calls, on May 27 and again on June 1, 2015. Observations made by Spencer Environmental in the Central Parkland Subregion in the past and other local records indicate that this period coincides with the local period of peak calling for western and Canadian toads and overlaps the boreal chorus frog calling period; the wood frog calling period peaks earlier in the spring and often has subsided by mid-May. Site selection and survey timing targeted western and Canadian toads because these Special Status species are designated as *Sensitive* and *May Be At Risk*, respectively, under the provincial General Status of Alberta Wild Species 2010 list and because western toad is designated as a species of *Special Concern* under Schedule 1 of the federal *Species at Risk Act*. Wood frog and boreal chorus frog are much more commonly distributed in the area and are listed as *Secure* provincially and are not federally listed (Alberta Environment and Parks 2015b, Government of Canada 2015). Auditory amphibian surveys followed the protocols of the Alberta Volunteer Amphibian Monitoring Program (AVAMP; ACA and ASRD 2010).

Surveys began one half hour after sunset, in weather conditions that would not inhibit amphibians from calling or the surveyor from hearing calls (i.e., calm winds, no rain, temperature >5°C). The surveyor remained silent and still for one minute upon arrival at each amphibian station, allowing any frogs/toads present to recover from any disturbance associated with the surveyor's approach. The surveyor then proceeded to listen for five minutes, recording all amphibian species heard and an estimate of each species' abundance using the following Alberta Volunteer Amphibian Monitoring Protocol call level codes (ACA and ASRD 2010):

1 = individuals can be counted, no overlapping calls (approximately 1-3 animals)

2 = individuals can be counted, some calls overlap (approximately 4-7 animals)

3 = individuals cannot be counted, full chorus, calls overlapping (> 8 animals)

All field project personnel also recorded incidental amphibian observations (i.e., observations outside of 5-minute auditory amphibian surveys) made while conducting amphibian, bird, and vegetation fieldwork in the DSA.

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APPENDIX B.
SOIL SURVEY REPORT

PARAGON
soil & environmental consulting

Soil Survey for the CITY OF ST. ALBERT NATURAL AREAS ASSESSMENT UPDATE AND MANAGEMENT PLAN

Prepared for:

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November 2015

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1 INTRODUCTION

The City of St. Albert (the City) recently contracted a City-wide Natural Areas Assessment update and management plan with the objective of improving the sustainability potential of identified natural areas within the Overall Study Area (OSA). The City is an urban municipality located immediately northwest of Edmonton, Alberta and is home to approximately 63,000 residents. The OSA encompasses the area within the municipal limits of the City, as well as a three kilometre buffer to the west, north, and east. The update also includes environmental assessments within a refined Detailed Study Area (DSA) that includes the planned Red Willow Urban Park corridor and Carrot Creek. The biophysical assessments conducted within the DSA will support development, trail planning, design and placement of storm water management infrastructure, as well as potential restoration opportunities for semi-natural and disturbed areas.

Paragon Soil and Environmental Consulting Inc. (Paragon) was contracted by Spencer Environmental Management Services Ltd. (Spencer) to conduct a desktop review and soil survey of the DSA and develop soil mapping and a summary soil report to support the DSA assessment.

The objectives of the soil survey are to: map the soil resources; provide baseline data; and identify potential areas of concern during development, reclamation and restoration.

The soil survey was conducted on July 9th and 10th, 2015 on several quarter-sections, including select private properties and some land owned by the City. The soil and landscape conditions at each inspection site were described in terms of landform, surficial materials, slope, texture, stoniness, topsoil thickness, depth of the upper subsoil (B horizon), drainage, and profile morphology. Deep inspection sites were pre-assigned and were completed to depths of either 1.2 m or 1.8 m. The data collected at these inspection sites were supplemented with shallow inspection sites located in the field and completed to the upper boundary of the lower subsoil (BC or C) horizon.

All soil units mapped within the DSA were assessed for reclamation suitability, agricultural suitability, wind and water erosion risk and compaction risk. Results of these assessments are provided in Section 4. The distribution and extent of the various soils in the DSA are depicted on various figures in this report and are provided in shapefiles provided to Spencer Environmental. Figures presenting agricultural suitability, wind and water erosion risk, and compaction potential are also included. The soil units delineated on the soil maps are described in further detail in this report.

The following sections provide a description of the study area and an explanation of the methods for the soil survey and subsequent soil assessments. They also include summary tables and comments for individual soil series mapped in the DSA, plus general comments regarding soil handling, reclamation suitability, restoration opportunities, placement of storm water infrastructure, plus end land use development. Details from site inspections and other summary soil data, maps and photos are included in the appendices of this report.

2 THE STUDY AREA

2.1 Location and Extent

The City is located in central Alberta, immediately northwest of Edmonton. The municipality currently houses approximately 63,000 residents. Located on the west side of the City, adjacent to Big Lake and along Carrot Creek and the Sturgeon River, the DSA includes the planned Red Willow Urban Park Corridor, which is located wholly within the White Zone of Alberta and encompasses a total area of roughly 566 hectares. Figure 1 shows the location of the DSA relative to Big Lake, Carrot Creek, and the City.



Figure 1. Detailed Study Area - Overview

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

- Road
- Water
- Townships
- City of St. Albert
- Detailed Study Area

0 500 1,000 2,000 Metres

Date: 27/07/2015 Time: 1:33:45 PM

2.2 Surficial Geology and Landforms

As determined from field surveys and the *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005), the surficial geology of the DSA consists of weakly to moderately calcareous, non-saline, moderately-fine to very fine-textured glaciolacustrine deposits. The majority of the DSA consists of level to very nearly level and very gently sloping undulating topography; however, slopes increase in prevalence in portions of the DSA located furthest from Big Lake and the Sturgeon River - towards the north and west. Very short, gentle slopes are present within the northern portion of the DSA and adjacent to Carrot Creek where the creek is more deeply incised. Within some portions of the DSA, the surficial glaciolacustrine material may be overlying moderately fine to fine-textured till deposits that may account for the undulating topography observed. Glaciolacustrine material was generally free of coarse fragments while the till deposits occasionally encountered at depth contained minor amounts of gravel (less than five percent by volume).

2.3 Bedrock Geology

According to Hamilton et al. (1999), the DSA is underlain by the Horseshoe Canyon Formation. This formation is mainly non-marine in origin and consists of: grey, feldspathic, clayey sandstone; grey bentonitic mudstone and carbonaceous shale; concretionary ironstone beds, scattered coal and bentonite beds of variable thickness; and minor limestone beds. The Horseshoe Canyon Formation dates from the Upper Cretaceous.

2.4 General Soil Patterns

The DSA is located in the Thick Black/Dark Gray-Gray Soil Zone of Central and East-Central Alberta (SCA 10) within the Aspen Parkland Ecoregion and Central Parkland Subregion (Agriculture and Agri-Food Canada 2006; Natural Regions Committee 2006). The soils encountered within the DSA are correlated with the *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005), *Alberta Soil Names Generation 3 Users' Handbook* (Agriculture and Agri-Food Canada 2006) and the *Soil Series Information for Reclamation Planning in Alberta, Volume 2* (SCA 10; Alberta Conservation and Reclamation Council 1993).

As identified in the field, poorly drained Orthic Humic Gleysols and Rego Humic Gleysols developed on moderately fine to fine-textured glaciolacustrine deposits are characterized by Haight (HGT) soils and are the most common soils within the DSA (Appendix A, Figures 2 through 7). HGT soils are generally found immediately adjacent to Carrot Creek and the Sturgeon River. HGT soils also occupy the low-lying, level areas surrounding Big Lake. These low-lying areas are likely inundated with water during wet years and periodically saturated during other years. HGT soils were mapped on 32% of the DSA.

Imperfectly drained Gleyed Black Chernozems developed on fine to very fine-textured glaciolacustrine deposits occupy a very significant portion of the DSA (30%). These soils are characterized by the Navarre (NVR) soil series. NVR soils are generally found in mid to lower slope positions in close association with HGT soils. NVR soils are commonly present within agricultural, wooded, and semi-natural land uses.

Malmo soils (MMO) represent moderately well to well drained Orthic Black Chernozems developed on moderately fine to fine-textured glaciolacustrine deposits. These soils occupy approximately 18% of the DSA. MMO soils are often found on mid to upper slope positions in close association with NVR soils. They may also be found adjacent to HGT soils, with a sharp, well defined transition from well drained to poorly drained soils. MMO soils are generally confined to agricultural land uses since their improved drainage makes them more conducive to agriculture.

Mico (MCO) and Gleyed Mico (MCOgl) soils are respectively characterized by Orthic Dark Gray Chernozems and Gleyed Dark Gray Chernozems developed on fine to very fine-textured glaciolacustrine material. MCO and MCOgl soils occupy a minor portions of the DSA (6% and 4%, respectively) and are generally found within the wooded portions of the DSA (Appendix A, Figures 2 through 7). MCO and MCOgl soils occupy the majority of the wooded areas adjacent to Carrot Creek in the DSA.

Disturbed Land (ZDL) occupies a small portion of the DSA (5%) and consists of commercial, industrial, residential and recreational developments within the City. A very small extent (5%) of the DSA is comprised of Open Water (NWR); this includes a small portion of Big Lake and the Sturgeon River, as well as several ponds (Appendix A, Figures 2 through 7).

All soils are described in further detail in Section 4.1.

3 METHODS

3.1 Soil Investigation Methods

Access to some private properties within the DSA was arranged by Spencer prior to planning the soil survey. Soil survey was restricted to lands for which access was granted by private landowners or to land owned by the City. Preliminary inspection site locations were assigned through a review of available satellite imagery and existing soil mapping to target notable variation within the DSA and to minimize conflicts with existing underground utilities. Inspection sites were located within representative areas within the DSA so the data could be extrapolated and used to map the remainder of the DSA that was not accessible. Where warranted, additional shallow inspection sites were completed during the field program to capture previously unidentified features.

Soil survey was conducted on July 9th and 10th, 2015 and included a total of 25 inspection sites, 20 of which were deep inspection sites completed to either 1.2 m or 1.8 m. The remaining sites were shallow inspection sites completed by hand to the top of the lower subsoil (BC or C horizon). Inspection sites were accessed on foot and were completed by hand using a shovel and hand auger.

Each location was described according to attributes described in the *Canadian System of Soil Classification* (Soil Classification Working Group 1998). Information collected at each inspection site to describe the location included:

- survey site location (UTMs collected using a Trimble Juno 3B GPS Unit);
- surface expression;
- slope position, aspect and gradient;
- drainage regime;
- land use;
- colour change and sod quality (where applicable);
- moisture and nutrient regime;
- ecosite (where applicable);
- surface stoniness; and
- parent geologic material.

Soil profiles at each site were described according to soil attributes in the *Manual for Describing Soils in the Field* (Expert Committee on Soil Survey 1983) and were classified to the subgroup level according to the *Canadian System of Soil Classification* (Soil Classification Working Group 1998). Soil attributes described for each horizon include:

- horizon designation;
- depth;
- moisture;
- colour;
- mottling (if present);
- structure;
- consistence;
- texture;
- coarse fragment content; and
- root abundance.

Soils were then assigned a series name, correlated with the *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005) and the *Alberta Soil Names Generation 3 Users' Handbook* (SCA 10; Agriculture and Agri-Food Canada 2006).

Information collected from soil inspections is extrapolated using the principles of geomorphology and surficial geology to delineate individual soil units for the DSA. Portions of the DSA not inspected in the field were mapped using desktop methods. Soil is inherently variable and exists as a continuum across the landscape. As a result, individual soil units have a range of properties or defining characteristics.

Detailed inspection site data is presented in Appendix C and summarized in Section 4.1 within each soil unit summary.

3.2 Soil Suitability for Reclamation

Soil suitability for reclamation of each soil unit mapped within the DSA is assessed against criteria established in *Soil Quality Criteria Relative to Disturbance and Reclamation* (Alberta Agriculture, Food and Rural Development 1987). Topsoil, upper subsoil and lower subsoil are assigned a rating of Good, Fair, Poor or Unsuitable, based on the most limiting parameter according to the criteria. Table 1 presents these four ratings and a brief description of their limitations. The DSA is located within the Plains Region of Alberta (which is closely aligned with the agricultural White Zone); therefore, the reclamation suitability of soils mapped within the DSA were assessed using the criteria for that region. The topsoil quality criteria for the Plains Region are presented in Table 2, with subsoil quality criteria presented in Table 3.

Table 1. Reclamation suitability ratings.

Reclamation Suitability Rating	Degree of Limitation
Good (G)	None to slight soil limitations that affect use as a plant growth medium.
Fair (F)	Moderate soil limitations that affect use but which can be overcome by proper planning and good management.
Poor (P)	Severe soil limitations that make use questionable. Soil remains suitable but careful planning and very good management is required to overcome limitations.
Unsuitable (U)	Chemical or physical properties of the soil are so severe reclamation would not be economically feasible or in some cases impossible.

Adapted from *Soil Quality Criteria Relative to Disturbance and Reclamation* (Alberta Agriculture, Food and Rural Development 1987).

Table 2. Criteria for evaluating suitability of topsoil in the Plains Region

Rating/Property	Good	Fair	Poor	Unsuitable
Soil reaction (pH)	6.5 to 7.5	5.5 to 6.4 7.6 to 8.4	4.5 to 5.4 8.5 to 9.0	<4.5 >9.0
Salinity	<2	2 to 4	4 to 8	>8
Sodicity (SAR)	<4	4 to 8	8 to 12	>12[1]
Saturation (%)	30 to 60	20 to 30 60 to 80	15 to 20 80 to 120	<15 >120
Stoniness Class	S0, S1	S2	S3, S4	S5
Texture[4]	fSL, vfSL, L, SL, SiL	CL, SCL, SiCL	LS, SiC, C[2], S, HC[3]	
Moist Consistency	Very friable, friable	Loose	Firm, very firm	Extremely firm
Organic Carbon (%)	>2	1 to 2	<1	
$CaCO_3$ Equivalent (%)	<2	2 to 20	20 to 70	>10

Sourced from Table 6 in *Soil Quality Criteria Relative to Disturbance and Reclamation* (Alberta Agriculture, Food and Rural Development 1987).

[1] Materials characterized by an SAR of 12 to 20 may be rated as poor if texture is SL or coarser and saturation % is less than 100.

[2] C – May be upgraded to fair or good in some arid areas.

[3] HC – May be upgraded to fair or good in some arid areas.

[4] fS = fine sand; SL = sandy loam; vfSL = very fine sandy loam; L = loam; SiL = silt loam; CL = clay loam; SCL = sandy clay loam; SiCL = silty clay loam; S = sand; LS = loamy sand; SiC = silty clay; C = clay; HC = heavy clay

Table 3. Criteria for evaluating suitability of subsoil in the Plains Region

Rating/Property	Good	Fair	Poor	Unsuitable
Soil reaction (pH)	6.5 to 7.5	5.5 to 6.4 7.6 to 8.5	4.5 to 5.4 8.6 to 9.0	<4.5 >9.0
Salinity	<3	3 to 5	5 to 10	>10
Sodicity (SAR)	<4	4 to 8	8 to 12	>12[1]
Saturation (%)	30 to 60	20 to 30 60 to 80	15 to 20 80 to 120	<15 >120
Stone Content (%)	<3	3 to 25	25 to 50	>50
Texture[2]	fSL, vfSL, L, SL, SiL	CL, SCL, SiCL	LS, SiC, C, S, HC	Bedrock
Moist Consistency	Very friable, friable	Loose, firm	Very firm	Extremely firm

Sourced from Table 7 in *Soil Quality Criteria Relative to Disturbance and Reclamation* (Alberta Agriculture, Food and Rural Development 1987).

[1] Materials characterized by a SAR of 12 to 20 may be rated as poor if texture is SL or coarser and saturation % is less than 100.

[2] fS = fine sand; SL = sandy loam; vfSL = very fine sandy loam; L = loam; SiL = silt loam; CL = clay loam; SCL = sandy clay loam; SiCL = silty clay loam; S = sand; LS = loamy sand; SiC = silty clay; C = clay; HC = heavy clay.

Chemical and physical properties of the soils are assessed against the guidelines presented in Tables 2 and 3 and then assigned overall suitability ratings. Since no soil samples were collected during the soil survey, the soil ratings are based on laboratory data contained in the soil layers file of the *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005) and from *Soil Series Information for Reclamation Planning in Alberta* (Alberta Conservation and Reclamation Council 1993). The laboratory data used to assign ratings is presented in Appendix E. Reclamation suitability ratings are meant to predict general suitability of the soil and do not consider the various tolerances of individual plant or crop species or the impacts of various management techniques.

Reclamation suitability ratings for each soil unit mapped in the DSA are discussed in Section 4.2 and included in the soil legend in Appendix F.

3.3 Land Suitability Rating System for Agricultural Crops

Each mapped soil unit was assigned an agricultural capability rating according to the *Land Suitability Rating System for Agricultural Crops; 1. Spring-seeded small grains* (Agronomic Interpretations Working Group 1995). Ratings were adapted from the *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005).

The guidelines consider climate, soil and terrain factors independently as a result of the potential for each to severely limit the ability of a tract of land to produce crops. Each rating consists of a "Class" that indicates the severity of the limitations on the land and "Subclasses" that indicate the kinds of limitations. Deductions for climate, soil and landscape are compiled into a final value which corresponds to one of seven land capability classes. Classes 1 through 3 are considered suitable for agriculture, Class 4 is considered marginal and Classes 5 through 7 are considered incapable of supporting an agricultural land use without significant inputs and management. Classes 1 through 7 are defined in Table 4. Table 5 presents the various subclasses and their descriptions.

Table 4. Agricultural suitability classes

Suitability Class	Index Points	Limitations for Specified Crop	Degree of Limitation
1	80-100	none to slight	Land in this class has no significant limitations for production of the specified crops
2	60-79	slight	Land in this class has slight limitations that may restrict the growth of the specified crops or required modified management practices
3	45-59	moderate	Land in this class has moderate limitations that restrict growth of the specified crops or require special management practices
4	30-44	severe	Land in this class has severe limitations that restrict the growth of the specified crops or require special management practices or both. This class is marginal for sustained production of the specified crops
5	20-29	very severe	Land in this class has very severe limitations for the sustained production of the specified crop. Annual cultivation using common cropping practices is not recommended
6	10-19	extremely severe	Land in this class has extremely severe limitations for sustained production of the specified crops. Annual cultivation is not recommended even on an occasional basis
7	0-9	unsuitable	Land in this class is not suitable for the production of the specified crops

Sourced from Agronomic Interpretations Working Group (1995).

Table 5. Agricultural suitability subclasses

Subclasses	Kind of Limitation
C- Climate	A general climate description
H- Temperature	This subclass indicates inadequate heat units for the optimal growth of a specified crop
A- Moisture	This subclass indicates inadequate moisture for the optimal growth of a specified crop
S- Soil	A general soil restriction
M- Water holding capacity	This landscape indicates land areas where the specified crops are adversely affected by lack of water due to inherent soil characteristics
D- Soil structure	This subclass indicates land areas where the specified crops are adversely affected either by soil structure that limits the depth of rooting, or by surface crusting that limits the emergence of shoots. Root restriction by bedrock and by high water table are considered separately
F- Organic matter	This subclass indicates mineral soil with a low organic matter content in the Ap or Ah horizon
E- Depth to topsoil	This subclass indicates mineral soils with a Ap or Ah horizon
V- Soil reaction	This subclass indicates soils with a pH value either too high or too low for optimum growth of the specified crops
N- Salinity	This subclass indicates soils with amounts of soluble salts sufficient to have an adverse effect on growth of the specified crop
Y- Sodicity	This subclass indicates soils having amounts of exchangeable sodium sufficient to have an adverse effect on soil structure or on the growth of the specified crops. It's use is restricted to construct soils
O- Organic surface	This subclass indicates mineral soils having a peaty surface layer up to 40cm thick
W- Drainage	This subclass indicated soils in which excess water (due to inundation) limits the production of specified crops. Excess water may result from a high water table or inadequate soil drainage
Z- Organic soil temperature	This subclass recognizes the additional temperature limitation associated with organ soils- particularly where the regional climate has less than 1600 Effective Growing Degree Days (EGDD)
R- Rock	This subclass indicates soils having bedrock sufficiently close to the surface to have an adverse effect on the production of specified crops
B- Degree of decomposition or fiber content	This subclass identifies organic soils in which the degree of decomposition of the organic material is not optimum for the production of the specified crops
G- Depth and substrate	This subclass indicates shallow organic soils with underlying material that is not optimum for the production of the specified crops
L- Landscape	A general landscape restriction
T- Slope	The subclass indicates landscapes with slopes steep enough to incur a risk of water erosion or to limit cultivation
K- Landscape pattern	This subclass indicates land areas with strongly contrasting soils and/or non-arable obstacles that limit production of the specified crops or sustainability impact on management practices
P- Stoniness and coarse fragments	This subclass indicates land that is sufficiently stony (fragments smaller than 7.5cm) or gravelly (fragments smaller than 7.5cm diameter) so as to hinder tillage or limit the production of a specified crops

Sourced from Agronomic Interpretations Working Group (1995).

Land suitability ratings for soil units within the DSA are presented in Section 4.3 and are included in the soil legend in Appendix F.

3.4 Wind Erosion Risk Ratings

Wind erosion risk ratings are estimated for each soil unit within the DSA based on their potential for "maximum instantaneous soil movement by wind", which is known as the Chepil wind erosion index (E) (Coote and Pettapiece 1989).

Wind erosion risk ratings are calculated using the following equation:

$$E = KC(V_*^2 - yW^2)^{1.5}$$

Where:

E = maximum instantaneous soil movement by wind (dimensionless)

K = surface roughness and aggregation factor (dimensionless)

C = factor representing soil resistance to movement by wind (dimensionless)

V_* = drag velocity of wind at the soil surface (cm s^{-1})

y = soil moisture shear resistance (dimensionless)

W = available moisture of the surface soil (m^3 water m^{-3} soil)

To minimize inconsistencies and allow for comparisons of wind erosion risk ratings across different areas, the method utilized by Coote and Pettapiece (1989) sets the soil moisture shear resistance at 5,000 for all soil types. Therefore, assuming that wind velocity and surface soil available moisture are equal (or similar) for all upland soils encountered along the proposed route, then relative wind erosion risk ratings can be determined by multiplying the dimensionless soil roughness (K) and the soil resistance to erosion (C) constants provided in Coote and Pettapiece (1989). Table 6 provides a range of KC values associated with various soil textures. Each KC range is associated with a range of values for "E" and is assigned a low, moderate or high relative risk rating.

Wind erosion risk ratings for each soil unit within the DSA are based on typical topsoil textures for that unit. Gleysols are automatically assigned a low risk rating regardless of their KC value due to the high moisture content of these soils. Erosion risk ratings assume bare, unprotected, non-vegetated soils as would be the case during development and reclamation within the DSA.

Table 6. Relative susceptibility of soil to wind erosion based on soil texture

Wind Erosion Risk Rating	KC Range	Associated Soil Texture	E (Dimensionless Index of Wind Erosion Risk)
Low	0.000587 – 0.000722	Loam, silt loam, clay loam, silty clay loam	<100 – 249.9
Moderate	0.00147 – 0.001945	Fine sandy loam, gravelly sandy loam, very fine sandy loam, silty clay, heavy clay, clay	250 – 399.9
High	0.002358	Sand, loamy sand, fine sand, loamy fine sand, gravelly sand, sandy loam	>400

Adapted from Coote and Pettapiece (1989).

Wind erosion risk ratings for each soil unit are discussed in the soil unit summaries contained in Section 4.1 and are presented in the Soil Legend in Appendix F.

3.5 Water Erosion Risk Ratings

The risk of water erosion at a specific location is proportional to the erodibility of the soil, the slope properties (slope length and gradient) and the amount of precipitation at the location. Water erosion risk ratings for the soil units present within the DSA are estimated based on the *Revised Universal Soil Loss Equation for Application in Canada (RUSLEFAC)* (Wall et al. 2002).

Water erosion risk ratings are based on the following equation:

$$A = R \times K \times L \times S \times C \times P$$

Where:

A = the potential long term average soil loss (tonnes ha^{-1} $year^{-1}$)

R = rainfall factor (MJ mm ha^{-1} h^{-1}) (assumed to be the same for the entire Project)

K = soil erodibility factor (t h MJ^{-1} mm^{-1}) (based primarily on soil texture)

L = slope length factor (dimensionless) (estimated slope length based on landform)

S = slope steepness factor (dimensionless) (maximum slope gradient for each slope classes)

C = cropping management factor (dimensionless) (assumed to be bare, recently replaced soil with no management)

P = support practice factor (dimensionless) (assumed to be bare, recently replaced soil with no management)

The rainfall factor (R) is derived from isoerodent maps for the Prairies region presented in Wall et al. (2002). These maps indicate average annual R values for an area and are used to calculate average annual soil losses. An adjustment to provide for winter conditions and the high erosivity potential of precipitation falling on frozen or thawing ground is also provided. The soil erodibility factor (K) for each soil unit mapped along the proposed project is determined by the typical soil texture of the topsoil within that unit. As shown in Table 7, soil texture plays a significant role in a soil's resistance to water erosion.

Table 7. Relative susceptibility to water erosion based on soil texture

Surface Soil Texture	Relative Susceptibility to Water Erosion	K Ranges	Potential Soil Loss (tonnes ha^{-1} $year^{-1}$)
Heavy clay, sandy loam, loamy fine sand, fine sand, coarse sandy loam, loamy sand, sand	Low	<0.007 – 0.03	<6 – 11
Clay loam, loam, silty clay, clay, sandy clay loam	Moderate	0.03 – 0.04	11 – 22
Very fine sand, loamy fine sand, silt loam, very fine sandy loam, silty clay loam	High	0.04 - >0.05	22 - >33

Adapted from Wall et al. (2002).

Slope gradient (S) and slope length (L) heavily influence the potential long term average soil loss (A). The upper range of slope gradients for each mapped slope class is used when completing the calculations to estimate the maximum potential for soil loss and thus allow for a conservative estimation of the water erosion risk potential. Average slope length is estimated based on slope class and surface expression along the proposed Project and is correlated with typical slope lengths associated with various parent materials and landforms as presented in Table 8.

Table 8. LS values associated with various landforms of Alberta

Landform	Slope (%)	Estimated Average Length (m)	Range of LS Values[1]
Undulating or terraced (Mu, Ft, Lu, Lv/Lu)	0-5	25	0.04 – 0.61
Level (Ll, Fl)	0-5	50	0.04 – 0.91
Level to inclined (Ll, Li)	0-5	200	0.05 – 2.00
Hummocky or ridged (Mh, Mr)	>5-10	25	0.72 – 1.19
Rolling or inclined (Mm, Mi, Mb, Rm)	>5-10	100	1.67 – 3.08
Inclined (Mi, Li, Mv/Ri)	>5-10	200	2.54 – 4.94
Hummocky or ridged (Mh, Mr)	>10-15	50	2.66 – 3.28
Rolling or inclined (Mm, Mi)	>10-15	100	4.33 – 5.42
Steeper Slopes	>15%	25	>2.34

Adapted from Alberta Conservation and Reclamation Council (1993) and Wall et al. (2002).
F = fluvial, L = lacustrine, M = morainal, R = rock
b = blanket, h = hummocky, i = inclined, l = level, m = rolling, r = ridged, t = terraced, u = undulating, v = veneer
[1] LS values are taken from Table LS-3 in Wall et al. (2002) and are for highly disturbed soil conditions and recently prepared construction sites, with little or no cover.

The cropping management factor (C) and support practice factor (P) are assumed to equal 1 while determining water erosion risk ratings since the estimates are for recently disturbed sites with little or no cover that are not being actively managed to minimize or reduce erosion. Taking this approach estimates the maximum potential soil loss that may occur given the other assumptions remain constant.

Water erosion risk ratings for each soil unit are discussed in the soil unit summaries contained in Section 4.1 and are presented in the Soil Legend in Appendix F.

3.6 Compaction Risk Ratings

In order to estimate compaction potential of soils encountered within the DSA, a generalized rating system was developed using professional judgment and a combination of two compaction systems designed for forestry applications. The two systems used to develop the compaction risk rating matrix presented in Table 9 below include the Soil Compaction and Puddling Hazard Key contained within *Hazard Assessment Keys for Evaluating Site Sensitivity to Soil Degrading Processes Guidebook* (British Columbia Ministry of Forests 1999) and the table of Compaction and Rutting Hazard for Soil in Ontario from *Forest Management Guidelines for the Protection of the Physical Environment* (Archibald et al. 1997). The compaction risk rating matrix considers soil texture and drainage regime as wetter soils and soils with higher clay content are more susceptible to compaction.

Soils within the DSA were assessed for compaction potential, based on the typical soil texture of the upper subsoil.

Table 9. Compaction risk rating matrix

Drainage Regime	Soil Texture					
	Very Coarse (Sand, Loamy Sand)	Moderately Coarse (Sandy Loam)	Medium (Loam, Silt Loam, Sandy Clay Loam)	Moderately Fine (Clay Loam, Silty Clay Loam)	Fine to Very Fine (Clay, Silty Clay, Heavy Clay)	Organic
Rapid	L	L	-	-	-	-
Well	L	L	M	M	M	-
Imperfect	L	L	H	H	H	-
Poor	M	M	H	H	H	-
Very poor	M	M	H	H	H	H

Adapted from British Columbia Ministry of Forests (1999) and Archibald et al. (1997)
"-" = Not applicable
"L" = Low. Minimal risk of compaction provided the industry accepted procedures are exercised during construction and operations.
"M" = Moderate. Normal construction and operating procedures may cause compaction; however, these effects can be mitigated through management practices.
"H" = High. Normal construction and operating procedures are likely to cause soil degradation through compaction. If possible, it is recommended that construction and operation procedures not commence until conditions change (i.e. soils dry out, frozen ground). If this is not possible, effects may be partially mitigated through management practices, however some long term degradation of soils may results.

Soil compaction ratings are discussed in the soil unit summaries in Section 4.1 and in the soil legend in Appendix F.

4 RESULTS

4.1 Soil Units

Summary tables and relevant comments for individual soil series are presented in the following sections and consist of a summary of data collected at the field level, the results of the various assessments described in the Section 3 and additional information taken from *Alberta Soil Names Generation 3 Users' Handbook* (Agriculture and Agri-Food Canada 2006), and the *Soil Series Information for Reclamation Planning in Alberta, Volume 1* (SCA 10; Alberta Conservation and Reclamation Council 1993).

The summary tables provide typical characteristics and ranges for a number of soil features, including parent material, soil textures, topsoil depths and land use. Comments are included to describe issues related to soil handling during soil salvage and stockpiling such as colour change between topsoil and subsoil, erosion risk ratings, and the potential for compaction, rutting and/or trench instability. Maps illustrating wind and water erosion risk ratings and compaction potential within the DSA are included in Appendix B.

4.1.1 Haight (HGT) Soil Unit

Haight (HGT) soils are the dominant soil within the DSA and are commonly found adjacent to Carrot Creek, Big Lake, and the Sturgeon River as well as within depressions and low-lying level areas (Appendix A, Figures 2 through 7). HGT soils are classified as poorly drained Orthic Humic Gleysols and Rego Humic Gleysols developed on moderately fine to fine-textured glaciolacustrine deposits. Further details and a typical soil profile are provided in Table 10, with additional comments in the bulleted list below.

- Topsoil depths encountered in the field range from 18 to 55 cm, but are most commonly between 25 and 40 cm. Topsoil depths include only mineral A horizons and exclude surficial organic horizons, if present. Colour change between topsoil and upper subsoil is usually indistinct.
- The wind and water erosion risk is low for HGT soils due to the high moisture content of the soil and their position in the landscape. They are generally restricted to level to nearly level topography and rarely occur on very gentle slopes thus there is limited potential for soil loss.
- Poor trafficability, rutting and compaction are concerns. The potential for compaction to occur is high due to the moderately fine to fine texture and high moisture content of the soil. If compaction does occur, mitigation measures to repair the compaction should be implemented.
- HGT soils are wet year-round and exposed faces are unstable. Instability is a concern during excavation due to the elevated moisture content of the soil.

Table 10. Haight (HGT) soil unit summary

Extent of DSA (hectares / percentage)	186 ha / 32%				
Soil Classification	Orthic Humic Gleysols, Rego Humic Gleysols				
Parent Material	Glaciolacustrine				
Texture: (topsoil / upper subsoil)	Clay loam, loam, silt loam / clay, silty clay, clay loam				
Topography / Percent Slope	1 – 3 / 0% to 5%				
Surface Stoniness	S0 (non-stony)				
Drainage Class	Poorly drained				
Topsoil Depth / Relationship to Topography	18 to 55 cm / confined to depression, floodplains, channel bottoms				
Sod Quality	Poor				
Colour Transition (topsoil / upper subsoil)	Black, very dark grayish brown, very dark brown / dark grayish brown, dark to very dark gray (indistinct colour change)				
PROFILE SITE #14			**Orthic Humic Gleysol**		
Horizon	**Depth (cm)**	**Colour**	**Texture**	**Structure**	**Consistence**
Ap	0 – 28	Black	Clay loam	Granular	Friable
Bg	28 – 55	Dark grayish brown	Clay loam	Subangular blocky	Friable
Cg	55 – 180	Very dark gray	Silty clay	Massive	Slightly sticky

4.1.2 Mico (MCO) and Gleyed Mico (MCOgl) Soil Units

Mico (MCO) and Gleyed Mico (MCOgl) soils occupy undisturbed wooded areas along Carrot Creek and throughout the DSA (Appendix A, Figures 2 through 7) and are characterized respectively by moderately well drained Orthic Dark Gray Chernozems and imperfectly drained Gleyed Dark Gray Chernozems developed on moderately fine to fine-textured glaciolacustrine deposits. Further details and a typical soil profile are presented in Table 11, with additional comments in the bulleted list below.

- Topsoil depths encountered in the field range from 25 to 32 cm. The depth of LFH and/or organic horizons on the surface range from 8 to 13 cm. Topsoil depths include only mineral A horizons and exclude surficial organic horizons. Colour change between topsoil and subsoil is generally distinct, which will help identify stripping depths when areas are being developed.
- The wind erosion risk is moderate for MCO and MCOgl soils while the water erosion risk is low for slopes less than 10% and moderate for slopes greater than 10%. Slopes in excess of 10% were not encountered within the DSA thus the water erosion risk for MCO and MCOgl soils within the DSA is low. Mitigation measures may be required for any development that occurs within areas of moderate wind erosion risk.
- MCO soils have moderate potential for compaction due to the moderately fine to fine texture of the soil. The potential for compaction to occur within MCOgl soil units is high due to the moderately fine to fine texture and imperfect drainage of the soil. If compaction does occur, mitigation measures to repair the compaction should be implemented when the development type includes parkland or other areas intended for trees. Compaction impedes rooting and also reduces free drainage through the soil profile, potentially affecting drainage plans

Table 11. Mico (MCO) and Gleyed Mico (MCOgl) soil units summary

Extent of DSA (hectares / percentage)			MCO: 33 ha / 6% MCOgl: 24 ha / 4%		
Soil Classification			MCO: Orthic Dark Gray Chernozem MCOgl: Gleyed Dark Gray Chernozem		
Parent Materials			Glaciolacustrine, glaciolacustrine over morainal		
Texture: (topsoil / upper subsoil)			Loam, silt loam, clay loam, silty clay loam / clay loam, clay		
Topography / Percent Slope			2 – 4 / 0.5% to 10%		
Surface Stoniness			S0 to S1 (non-stony to slightly stony)		
Drainage Class			MCO: Moderately well drained MCOgl: Imperfectly drained		
Topsoil Depth / Relationship to Topography			25 to 32 cm / no relationship to topography		
Sod Quality			Poor		
Colour Transition (topsoil / upper subsoil)			Black, dark to very dark gray, very dark grayish brown, grayish brown / dark gray, brown (distinct colour change)		
PROFILE SITE #04			**Gleyed Dark Gray Chernozem**		
Horizon	**Depth (cm)**	**Colour**	**Texture**	**Structure**	**Consistence**
LFH	10 – 0	-	Organic	-	-
Ah	0 – 14	Very dark gray	Clay loam	Granular	Friable
Ahe	14 – 29	Dark gray	Silty clay loam	Granular	Friable
Btgj	29 – 55	Brown	Clay	Subangular blocky	Firm
Ckg	55 – 110	Brown	Silty clay	Massive	Firm
IICkg	110 – 180	Dark grayish brown	Clay	Massive	Firm

4.1.3 Malmo (MMO) Soil Unit

Malmo (MMO) soils occupy a large portion of the DSA and are most commonly found within agricultural areas (Appendix A, Figures 2 through 7). These soils are characterized by well to moderately well drained Eluviated Black Chernozems developed on moderately fine to fine-textured glaciolacustrine deposits. Further details and a typical soil profile are presented in Table 12, with additional comments in the bulleted list below.

- Topsoil depths encountered in the field range from 11 to 52 cm but are most commonly between 20 and 30 cm. Topsoil depths include only mineral A horizons and exclude surficial organic horizons, if present. Colour change between topsoil and upper subsoil is usually indistinct, so a soil specialist should advise on stripping depth during pre-development soil salvage.
- The wind erosion risk is low for MMO soils while the water erosion risk is low for slopes less than 10% and moderate for slopes greater than 10%. Slopes in excess of 10% were not encountered within the DSA thus management practices to reduce the potential for soil loss due to wind or water erosion may not be required.
- MMO soils have moderate potential for compaction due to the moderately fine to fine texture of the soil.

Table 12. Malmo (MMO) soil unit summary

Extent of DSA (hectares / percentage)	101 ha / 18%				
Soil Classification	Eluviated Black Chernozem				
Parent Material	Glaciolacustrine				
Texture: (topsoil / upper subsoil)	Loam, silt loam, clay loam / clay loam, clay, silty clay				
Topography / Percent Slope	2 – 3 / 0.5% to 5%				
Surface Stoniness	S0 (non-stony)				
Drainage Class	Well to moderately well drained				
Topsoil Depth / Relationship to Topography	11 to 52 cm / no relationship to topography				
Sod Quality	Poor				
Colour Transition (topsoil / upper subsoil)	Black, very dark brown, very dark grayish brown, very dark gray / brown, dark grayish brown, very dark gray (indistinct colour change)				
PROFILE SITE #20			**Eluviated Black Chernozem**		
Horizon	**Depth (cm)**	**Colour**	**Texture**	**Structure**	**Consistence**
Ap	0 – 36	Very dark gray	Clay loam	Granular	Firm
Bt	36 – 60	Dark grayish brown	Clay	Subangular blocky	Firm
Ck	60 – 180	Brown	Silty clay	Massive	Firm

4.1.4 Navarre (NVR) Soil Unit

Navarre (NVR) soils are found within wooded natural areas, cleared semi-natural areas, and agricultural areas and occupy a significant portion of the DSA (Appendix A, Figures 2 through 7). These soils are characterized by imperfectly drained Gleyed Black Chernozems developed on fine to very fine-textured glaciolacustrine deposits. Further details and a typical soil profile are presented in Table 13, with additional comments in the bulleted list below.

- Topsoil depths range from 24 cm to greater than 41 cm. Topsoil depths include only mineral A horizons and exclude surficial organic horizons. Colour change between topsoil and subsoil is variable.
- The wind erosion risk is low MMO soils while the water erosion risk is low for slopes less than 10% and moderate for slopes greater than 10%. Slopes in excess of 10% were not encountered within the DSA thus management practices to reduce the potential for soil loss due to wind or water erosion may not be required.
- The potential for compaction to occur within NVR soil units is high due to the moderately fine to fine texture and imperfect drainage of the soil.

Table 13. Navarre (NVR) soil unit summary

Extent of DSA (hectares / percentage)	167 ha / 30%				
Soil Classification	Gleyed Black Chernozem				
Parent Material	Glaciolacustrine				
Texture: (topsoil / upper subsoil)	Loam, silt loam, clay loam, clay / clay loam, clay				
Topography / Percent Slope	2 – 3 / 0.5% to 5%				
Surface Stoniness	S0 (non-stony)				
Drainage Class	Imperfectly drained				
Topsoil Depth / Relationship to Topography	24 to 41 cm / no relationship to topography				
Sod Quality	Poor				
Colour Transition (topsoil / upper subsoil)	Black, very dark gray / dark to very dark grayish brown, dark gray, very dark brown (variable colour change)				
PROFILE SITE #12			**Gleyed Black Chernozem**		
Horizon	**Depth (cm)**	**Colour**	**Texture**	**Structure**	**Consistence**
Ap	0 – 31	Very dark gray	Clay loam	Granular	Firm
Bt	31 – 40	Very dark gray	Clay loam	Subangular blocky	Firm
Ckgj1	40 – 110	Very dark grayish brown	Clay	Massive	Firm
Ckgj2	110 – 180	Dark gray	Clay	Massive	Firm

4.2 Soil Suitability for Reclamation

The topsoil, upper subsoil and lower subsoil of the soil units mapped within the DSA were assessed for soil suitability for reclamation. Soil profiles described in the field were supplemented with representative laboratory data from the soil layers file of the *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005) and from *Soil Series Information for Reclamation Planning in Alberta* (Alberta Conservation and Reclamation Council 1993). The laboratory data used to assess reclamation suitability is presented in Appendix E. Organic carbon was estimated based on colour of the topsoil horizon and a table contained within *Land Suitability Rating System for Agricultural Crops; 1. Spring-seeded small grains* (Agronomic Interpretations Working Group 1995). Results of the assessment are presented in Table 14.

Table 14. Soil suitability for reclamation assessment by soil series and soil quality parameter

Series	Site ID	Horizon	EC	pH	SAR	Sat. (%)	Moist Consistence	Coarse Fragments (%)	Surface Stoniness	Org. C (%)[4]	Texture	Overall Suitability[1] and Limiting Factors[2]
HGT	03	Ap	G	**F**	G	G	G	-	G	G	**F**	F (2,9)
		Bg	G	**G**	G	**F**	**F**	**G**	-	-	**F**	F (4,5,9)
		Ckg	G	F	G	G	F	G	-	-	**F**	F (2,5,9)
HGT	11	Ap	G	**F**	G	G	G	-	G	G	**F**	F (2,9)
		Bg	G	**G**	G	**F**	**G**	**G**	-	-	**F**	F (4,9)
		Cg	G	F	G	G	P	G	-	-	**P**	P (5,9)
MCO	-	Ap	G	G	G	F	P	G	G	G	**F**	P (5)
		Btj	G	F	G	P	F	G	-	-	**P**	P (4,9)
		Ck	G	F	G	-	F	G	-	-	**P**	P (9)
MCOgl	04	Ah/Ahe	G	F	-	-	G	G	G	G	**F**	F (2,9)
		Bt	G	P	-	-	F	G	-	-	**P**	P (2,9)
		Ckg	G	G	-	-	F	G	-	-	**P**	P (9)
		IICkg	G	G	-	-	F	G	-	-	**P**	P (9)
MMO	18	Ap	G	**F**	G	G	G	G	G	G	G	F (2)
		Bt	G	**F**	G	G	G	G	-	-	F	F (2,9)
		Ck	G	**F**	G	G	F	G	-	-	F	F (2,9)
MMO	21	Ap	G	**F**	G	G	P	G	G	G	P	P (5,9)
		Bt	G	**F**	G	G	F	G	-	-	P	P (9)
		Ck	G	**F**	G	G	F	G	-	-	P	P (9)
NVR	01	Ap	G	F	G	F	**G**	G	G	G	**P**	P (9)
		Bt	G	G	G	F	**G**	G	-	-	**P**	P (9)
		Ckgj	G	P	F	F	**F**	G	-	-	**P**	P (9)
NVR	06	Ah	G	F	G	F	**F**	G	G	G	**F**	F (2,4,5,9)
		Bt	G	G	G	F	**F**	G	-	-	**P**	P (9)
		Ckgj	G	P	F	F	**F**	G	-	-	**P**	P(2,9)

[1] G = Good, F = Fair, P = Poor, U = Unsuitable

[2] Limitations : (1) = EC (dS/m), (2) = pH, (3) = SAR, (4) = Saturation percent (%), (5) = Moist consistence, (6) = Coarse Fragments (%), (7) = Surface stoniness, (8) = Organic carbon (%), (9) = Texture

[4] Estimated based on Table 4.6 in Agronomic Interpretations Working Group (1995).

Reclamation suitability ratings for topsoil within the DSA varies from Fair to Poor depending on soil series. Topsoil within Haight (HGT) and Gleyed Mico (MCOgl) soil units is generally rated Fair, with moderate soil limitations due to pH and moderately fine textures (clay loam, silty clay loam). The reclamation suitability rating for topsoil within Malmo (MMO) and Navarre (NVR) soil units ranges from Fair to Poor. Where the topsoil is rated Fair, it is generally due to pH and moderately fine textures. Where the topsoil is rated Poor, it is the result of firm consistence and fine textures (clay, silty clay). Due to the lack of precipitation prior to conducting the field study, the firm consistence may be due to the dryness of the soil, however the fine

texture would still impose severe soil limitations on some MMO and NVR soils. Mico (MCO) soils have topsoil that is rated Poor for use in reclamation due to firm consistence which may also be attributed to a lack of precipitation.

Soil reclamation suitability of upper subsoil for soils within the DSA ranges from Fair to Poor. The upper subsoil of HGT soils is rated Fair for reclamation with moderate limitations due to saturation percent, wet consistence, and moderately fine textures. Upper subsoil within MMO soil units ranges from Fair to Poor; MMO soils with Fair upper subsoil are limited by pH and moderately fine textures while those with Poor subsoil are limited by fine textures. The upper subsoil within MCO, MCOgl, and NVR soil units is rated Poor due to pH and fine to very fine textures.

The reclamation suitability of the lower subsoil within HGT and MMO soil units ranges from Fair to Poor and is limited by pH, consistence, and moderately fine textures. MCO, MCOgl, and NVR soil units have lower subsoil rated Poor for use in reclamation as a result of fine to very fine textures.

Soil suitability for reclamation ratings for each soil unit are summarized in the Soil Legend in Appendix F. Reclamation suitability ratings are presented in Figures 8 through 10 in Appendix B.

4.3 Land Suitability

Agricultural suitability ratings for each soil series mapped within the DSA were adapted from *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005) and are presented in Table 15. Agricultural suitability ratings are presented in Figure 11 in Appendix B.

Table 15. Agriculture suitability ratings

Soil Series	Soil Series Symbol	Agricultural Capability Class	Agricultural Capability Subclass
Haight	HGT	5	W
Mico	MCO	2	H
Gleyed Mico	MCOgl	2	W
Malmo	MMO	2	H
Navarre	NVR	2	W

The majority of the soils within the DSA are Class 2 soils with slight limitations that may restrict their use for some crops. Mico (MCO) and Malmo (MMO) soils are Class 2 soils limited by the low annual temperatures characteristic of the climate in central Alberta (subclass H). Gleyed Mico (MCOgl) and Navarre (NVR) soils are Class 2 soils limited by their imperfect drainage which reduces the production of certain crops (subclass W). Haight soils (HGT) occupy a significant portion of the DSA and are Class 5 soils with very severe limitations for agriculture. HGT soils are limited by their poor drainage (subclass W).

5 DISCUSSION

5.1 Soil Handling Recommendations and Implications for Development

Topsoil depths within the DSA are highly variable with depths ranging from 11 cm to 55 cm, however topsoil depths are most commonly between 25 and 40 cm. Topsoil salvage is required for any new developments planned within the DSA and significant room may be required to store topsoil during the construction phase of projects. Development plans should include sufficient space for storage, using mapped soil unit extents, and typical topsoil depths to estimate volumes. The significant volume of topsoil

may also help facilitate restoration projects within disturbed land where topsoil may be absent or lacking. Topsoil may be borrowed from an area where a permanent development is planned in order to help restore disturbed or semi-natural areas within the DSA. However, consideration should be given to the following:

1. Matching the type of donor area with that of the receiver – for example, using upland topsoil on an upland restoration area (e.g. not using wet HGT topsoil for upland parkland)
2. Taking advantage of the natural seedbank and plant propagules. For example, if an area is planned for restoration to forested parkland, we recommend stripping topsoil – and the surface leaf litter – from a forested area that is slated for development, then placing that soil directly on the restoration area. When this method is used, the diversity of natural revegetation is higher. The soil should be left rough and loose on the placement area, as opposed to being track-packed by the equipment. Track-packing often compacts the soil and reduces natural revegetation emergence.
3. Reducing weed transmission by requiring earthworks contractors to use clean equipment, and by doing weed surveys prior to topsoil stripping. Areas with noxious or prohibited noxious weeds should not be used to provide topsoil for restoration areas.

The agricultural suitability rating for the majority of soils present within the DSA is Class 2, with only slight limitations for agriculture. MMO and MCO soil units are limited by the low annual temperatures characteristic for the region. While NVR and MCOgl soils are limited to the same extent by the temperature, the imperfect drainage of the soil represents a slightly greater limitation. HGT soils are severely limited by the poor drainage of the soil and this are Class 5 soils. Where possible, new developments within the DSA should be prioritized for less productive land. However, as a result of their poor drainage and location within local, regional, and provincially significant areas along Carrot Creek and adjacent to Big Lake, development within HGT soil units should be avoided.

Where possible, restoration efforts should be focused within soil units that are better suited for use in reclamation. Soil units with Fair or Fair-Poor topsoil and subsoil will be more conducive to restoration and reclamation efforts.

The entire DSA has either moderate or high potential for compaction (Appendix B, Figure 14). Restoration and reclamation following the completion or decommissioning of developments within the DSA will be inherently more difficult within soil units with high compaction potential. Management practices may be required to minimize the potential for compaction to occur, or to mitigate compaction that arises as a result of activity within the DSA. Examples of such practices include ripping subsoil prior to replacing topsoil; this may be applicable to parks, restoration areas and any other areas slated for intensive landscaping.

The entire DSA consists of moderately-fine to fine-textured soils. Storm water management infrastructure such as ponds might not require liner material since the fine-textured soil, when compacted, may act as a sufficient aquitard. Trench stability and face stability of excavations is not a particular concern for MCO, MCOgl, MMO, and NVR soil units; HGT soil units are wet year-round and exposed faces may be unstable.

The water erosion risk for all of the soils within the DSA is low; the wind erosion risk is also low for all soils except MCO and MCOgl (Appendix B, Figures 12 and 13). Management practices to minimize the potential for soil loss from wind erosion may need to be implemented for developments or restoration projects within MCO and MCOgl soil units if bare topsoil will be left for significant periods of time.

6 CLOSURE

We trust the contents of this report of this report meet your requirements. Please do not hesitate to contact the undersigned should you have any questions or require further assistance.

Report Prepared by:

PARAGON SOIL & ENVIRONMENTAL CONSULTING INC.

PER _____

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Appendix A Detailed Study Area Soil Mapping

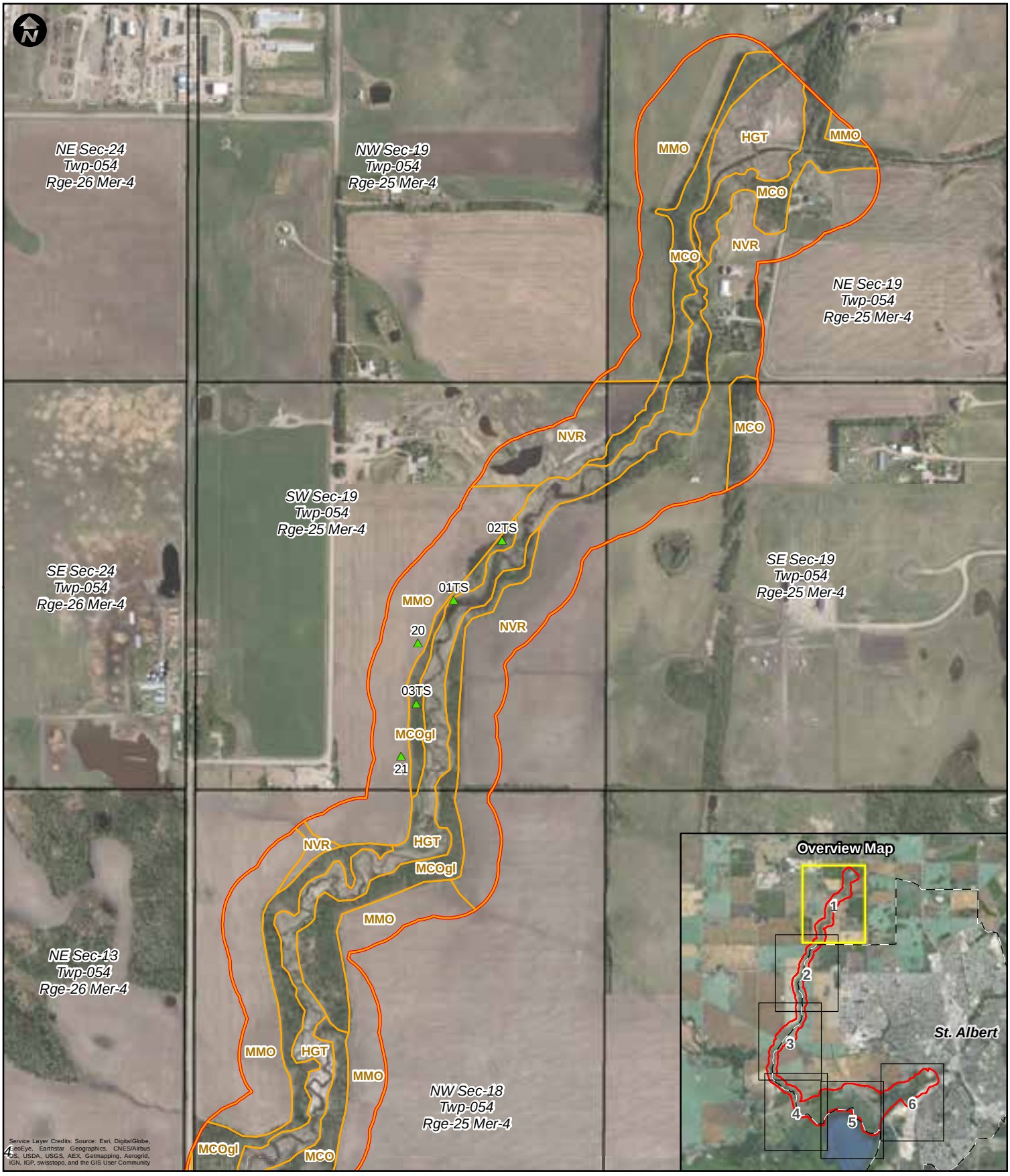


Figure 2. Detailed Study Area - Soil Mapping (Page 1 of 6)

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:10,000
Drawn: SD	Approved: SM

Legend

- Completed Inspection Site
- Road
- Detailed Study Area
- Soil Series
- Quarter Section
- City of St. Albert

0 125 250 500 Metres

Date: 27/07/2015 Time: 1:38:47 PM

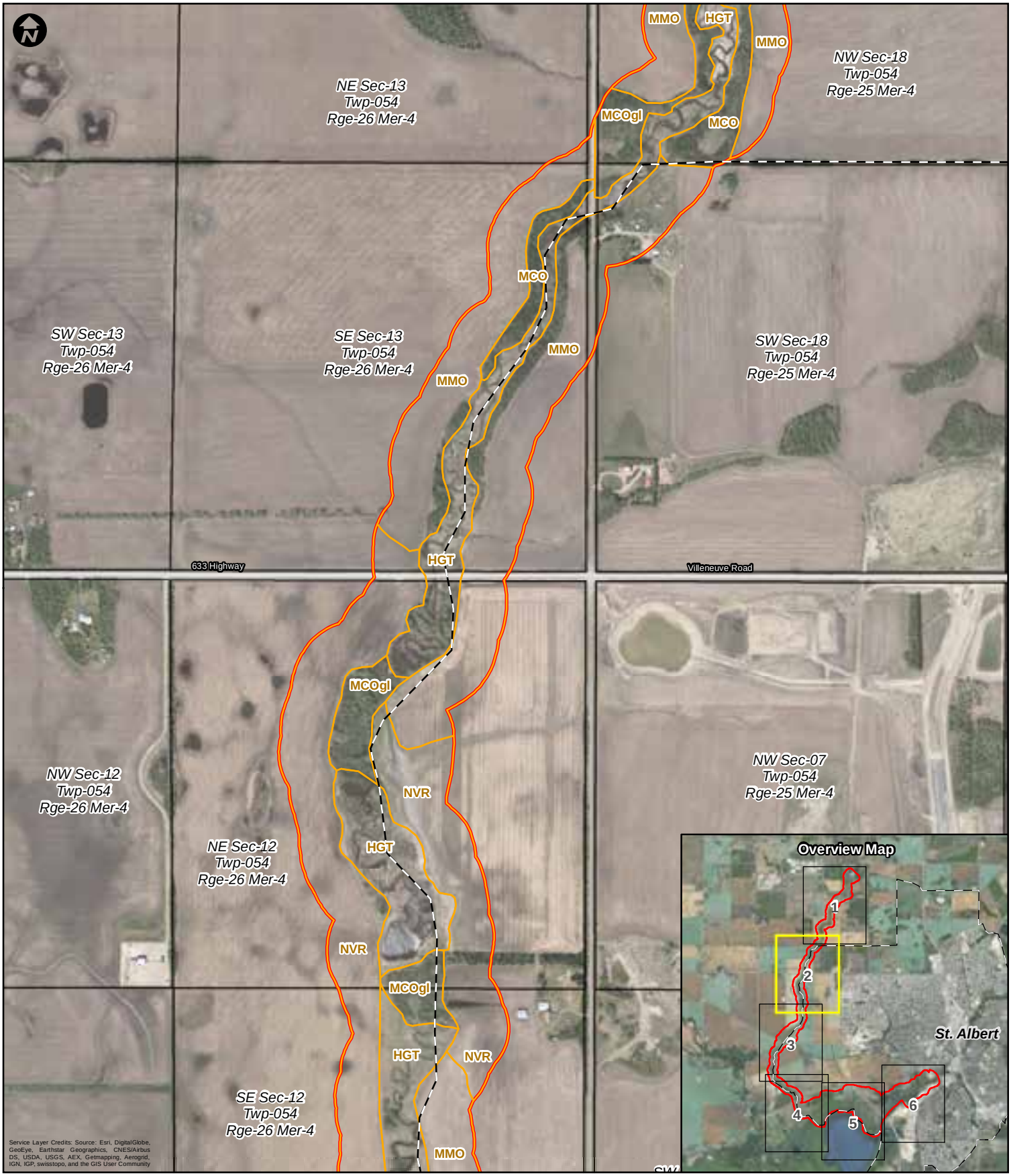


Figure 3. Detailed Study Area - Soil Mapping (Page 2 of 6)

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:10,000
Drawn: SD	Approved: SM

Legend

- Completed Inspection Site
- Road
- Detailed Study Area
- Soil Series
- Quarter Section
- City of St. Albert

0 125 250 500 Metres

Date: 27/07/2015 Time: 1:38:52 PM

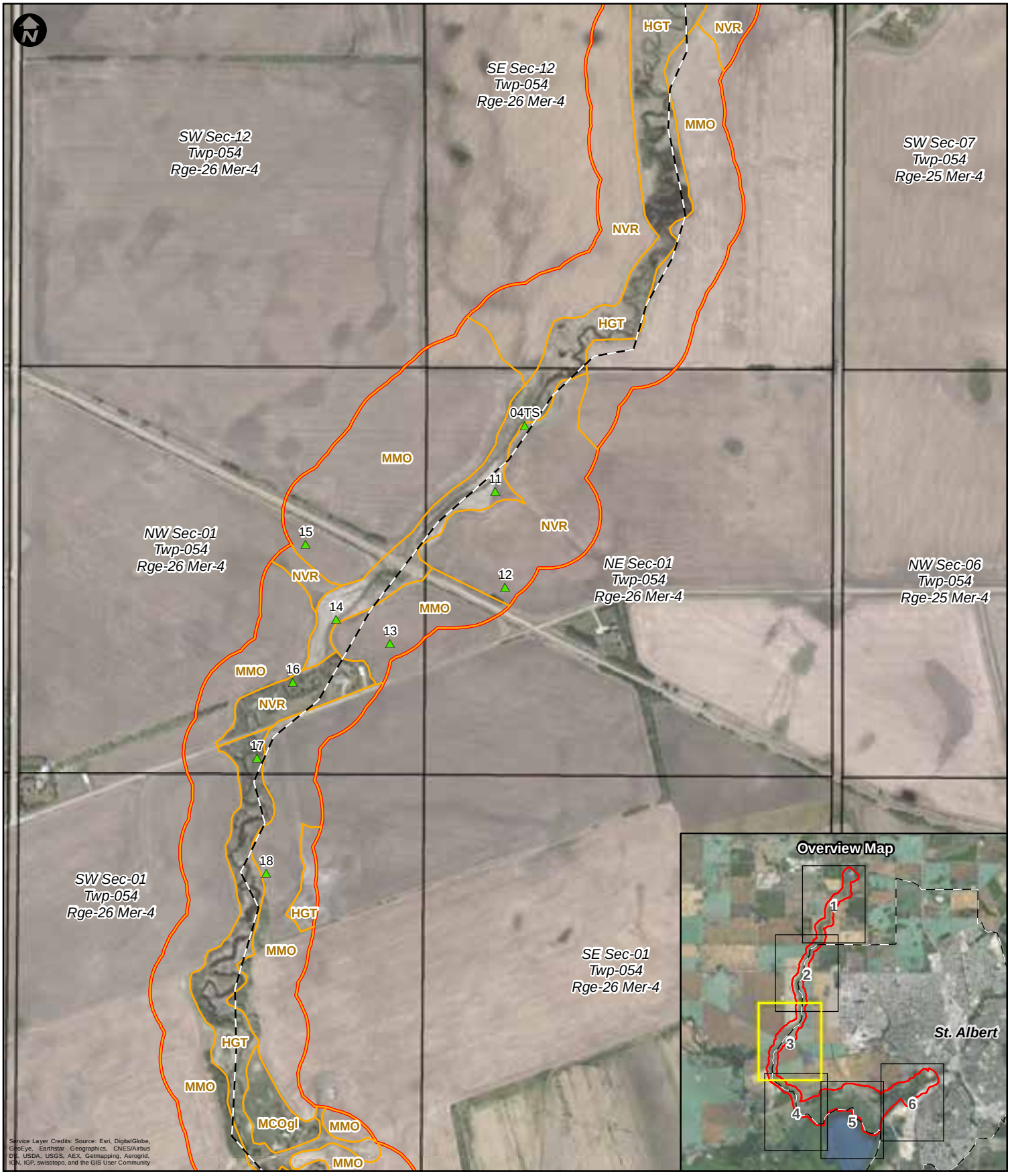


Figure 4. Detailed Study Area - Soil Mapping (Page 3 of 6)

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:10,000
Drawn: SD	Approved: SM

Legend

- Completed Inspection Site
- Road
- Detailed Study Area
- Soil Series
- Quarter Section
- City of St. Albert

0 125 250 500 Metres

Date: 27/07/2015 Time: 1:38:57 PM

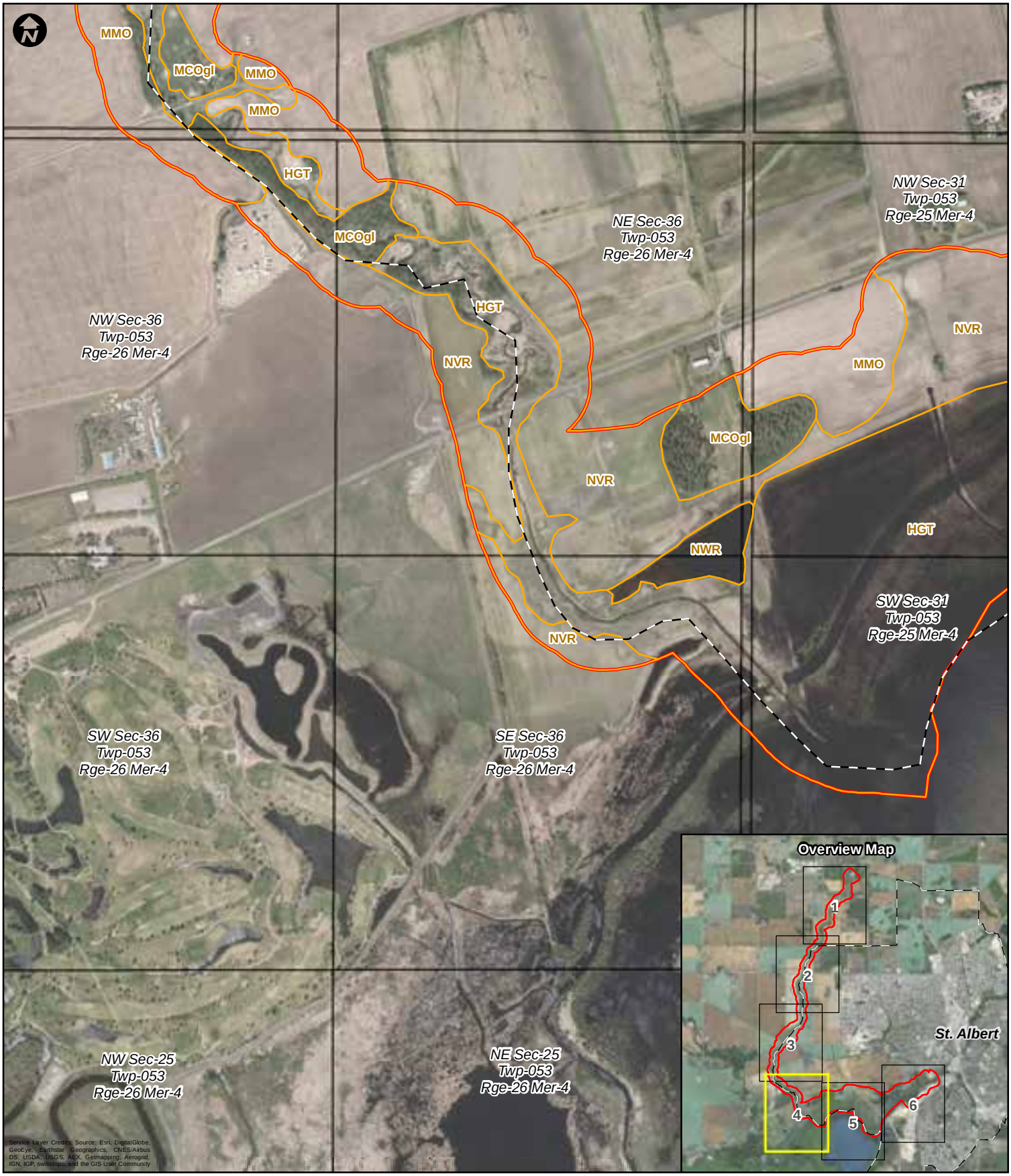


Figure 5. Detailed Study Area - Soil Mapping (Page 4 of 6)

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:10,000
Drawn: SD	Approved: SM

Legend

- Completed Inspection Site
- Road
- Detailed Study Area
- Soil Series
- Quarter Section
- City of St. Albert

0 125 250 500 Metres

Date: 27/07/2015 Time: 1:39:02 PM



Figure 6. Detailed Study Area - Soil Mapping (Page 5 of 6)

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:10,000
Drawn: SD	Approved: SM

Legend

- Completed Inspection Site
- Road
- Detailed Study Area
- Soil Series
- Quarter Section
- City of St. Albert

0 125 250 500 Metres

Date: 27/07/2015 Time: 1:39:07 PM

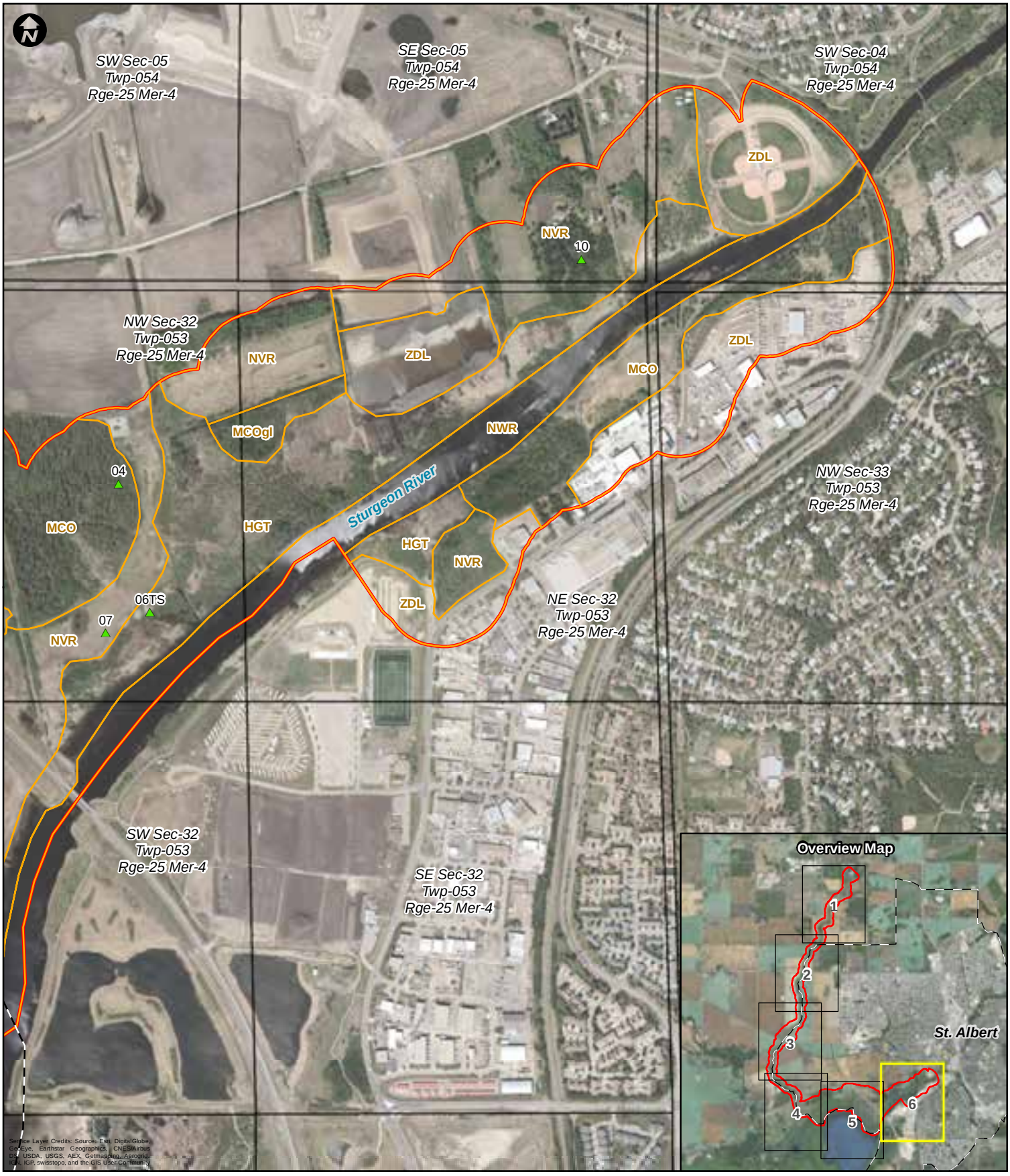


Figure 7. Detailed Study Area - Soil Mapping (Page 6 of 6)

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:10,000
Drawn: SD	Approved: SM

Legend

- Completed Inspection Site
- Road
- Detailed Study Area
- Soil Series
- Quarter Section
- City of St. Albert

0 125 250 500 Metres

Date: 27/07/2015 Time: 1:39:12 PM

Appendix B Detailed Study Area Soil Assessment Maps

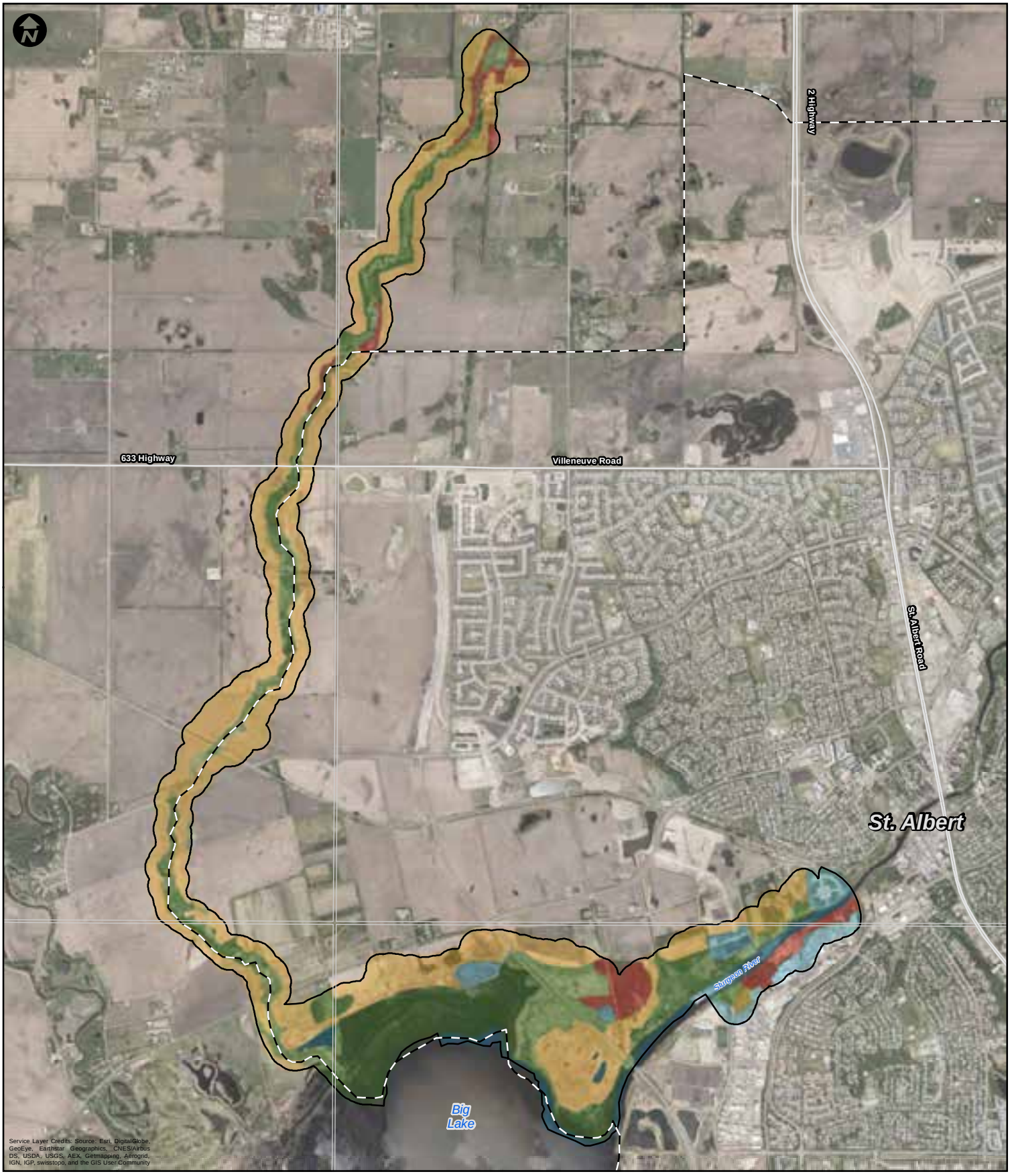


Figure 8. Detailed Study Area - Topsoil Reclamation Suitability Rating

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

Topsoil Reclamation Suitability Rating

- Fair
- Fair to Poor
- Poor
- No Rating (Water/Disturbed Land)

- Road
- Townships
- City of St. Albert
- Detailed Study Area

0 250 500 1,000 Metres

Date: 27/07/2015 Time: 1:39:54 PM



Figure 9. Detailed Study Area - Upper Subsoil Reclamation Suitability Rating

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

Upper Subsoil Reclamation Suitability Rating

- Fair
- Fair to Poor
- Poor
- No Rating (Water/Disturbed Land)

- Road
- Townships
- City of St. Albert
- Detailed Study Area

0 250 500 1,000 Metres

Date: 27/07/2015 Time: 1:50:08 PM

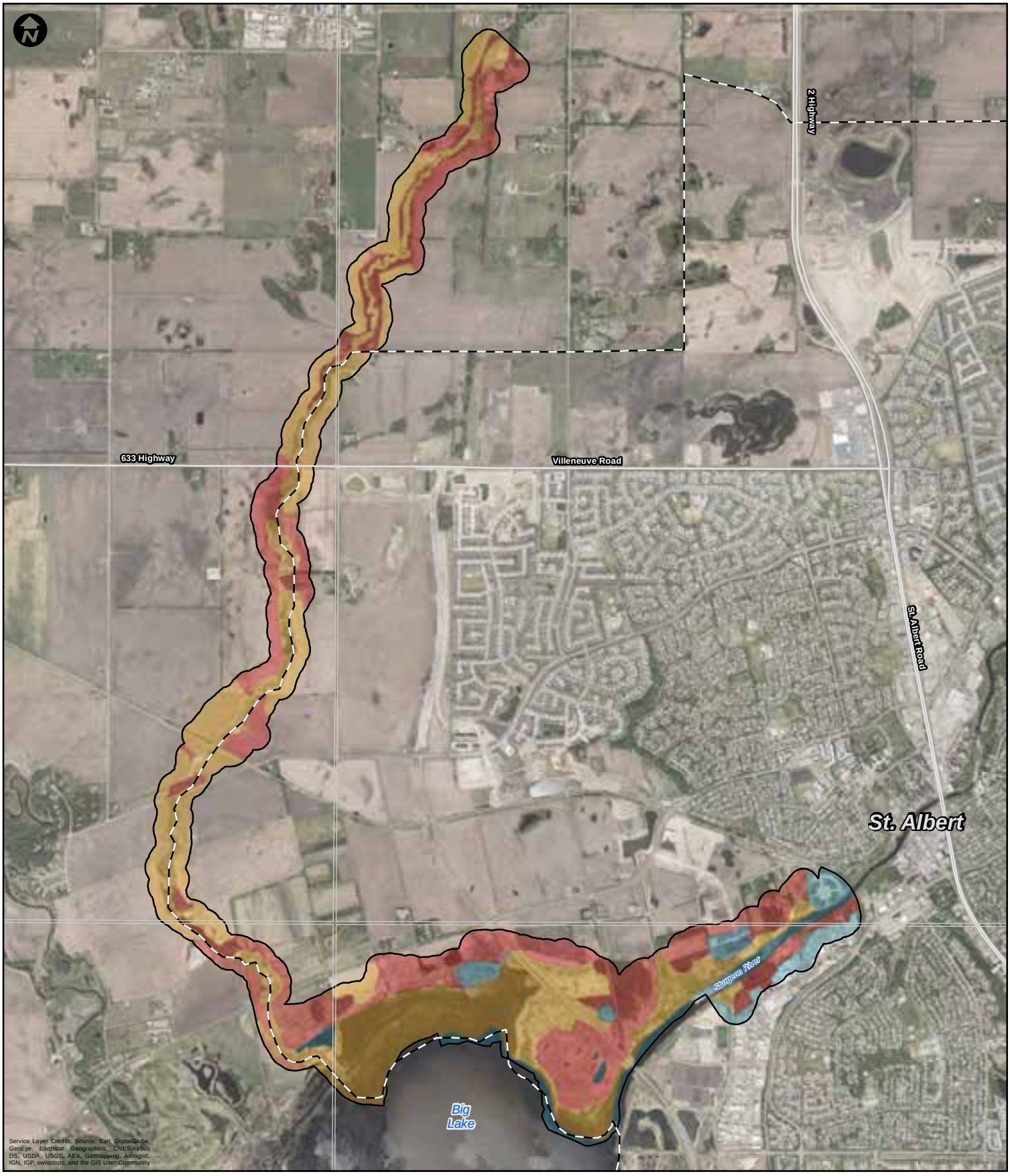


Figure 10. Detailed Study Area - Lower Subsoil Reclamation Suitability Rating

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

Lower Subsoil Reclamation Suitability Rating

- Fair to Poor
- Poor
- No Rating (Water/Disturbed Land)
- Road
- Townships
- City of St. Albert
- Detailed Study Area

0 250 500 1,000 Metres

Date: 27/07/2015 Time: 1:42:57 PM

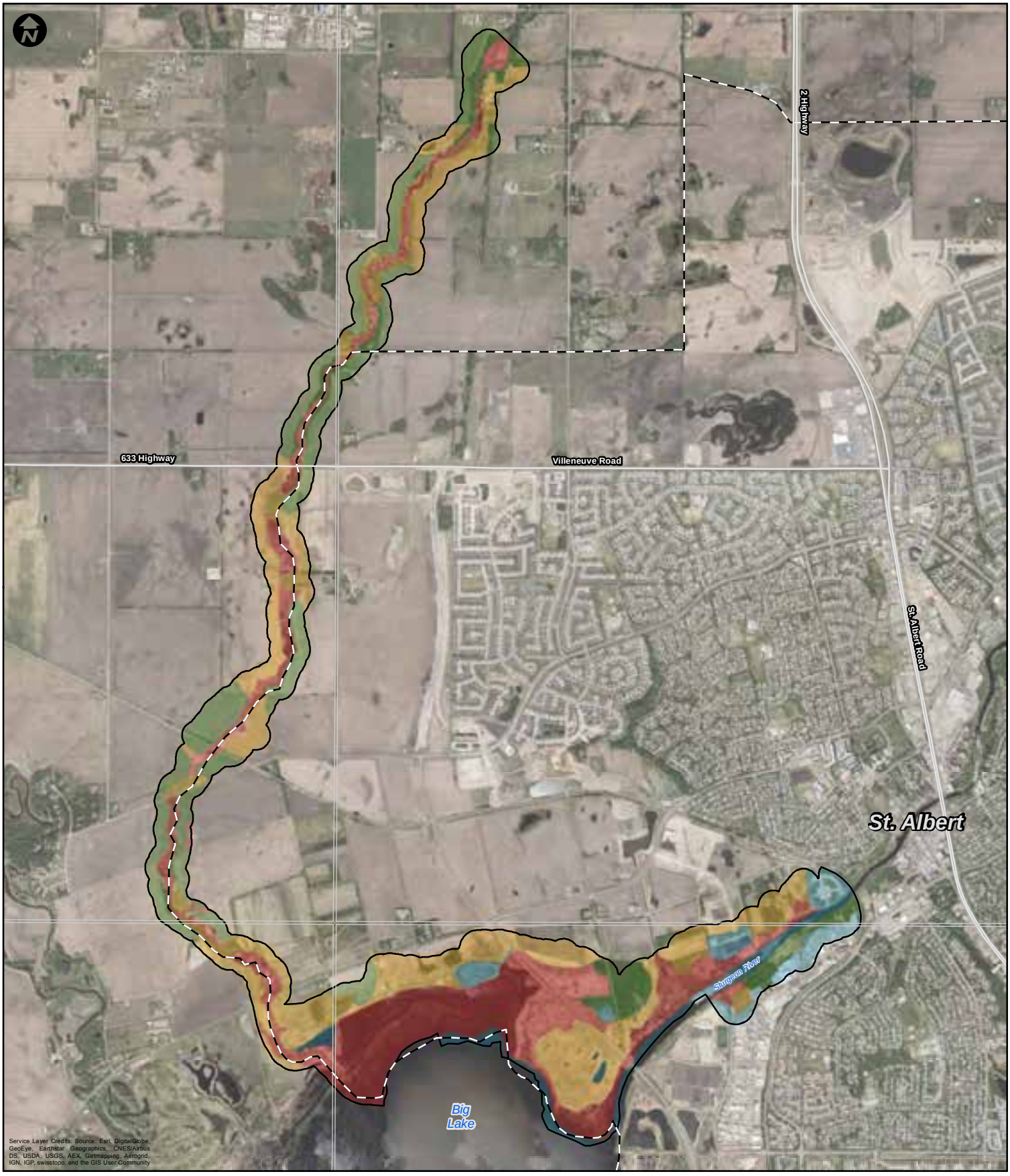


Figure 11. Detailed Study Area - Agricultural Suitability Rating

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

Agricultural Suitability Rating

- Very severe limitations – excess water (5W)
- Slight limitations – excess water (2W)
- Slight limitations – inadequate heat for optimal growth (2H)
- No Rating (Water/Disturbed Land)

- Road
- Townships
- City of St. Albert
- Detailed Study Area

0 250 500 1,000 Metres

Date: 27/07/2015 Time: 1:44:39 PM



Figure 12. Detailed Study Area - Wind Erosion Rating

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

Wind Erosion Rating
- Moderate
- Low
- No Rating (Water/Disturbed Land)

- Road
- Townships
- City of St. Albert
- Detailed Study Area

0 250 500 1,000 Metres

Date: 27/07/2015 Time: 1:45:58 PM



Figure 13. Detailed Study Area - Water Erosion Rating

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

Water Erosion Rating
- Low
- No Rating (Water/Disturbed Land)

- Road
- Townships
- City of St. Albert
- Detailed Study Area

0 250 500 1,000 Metres

Date: 27/07/2015 Time: 1:47:02 PM

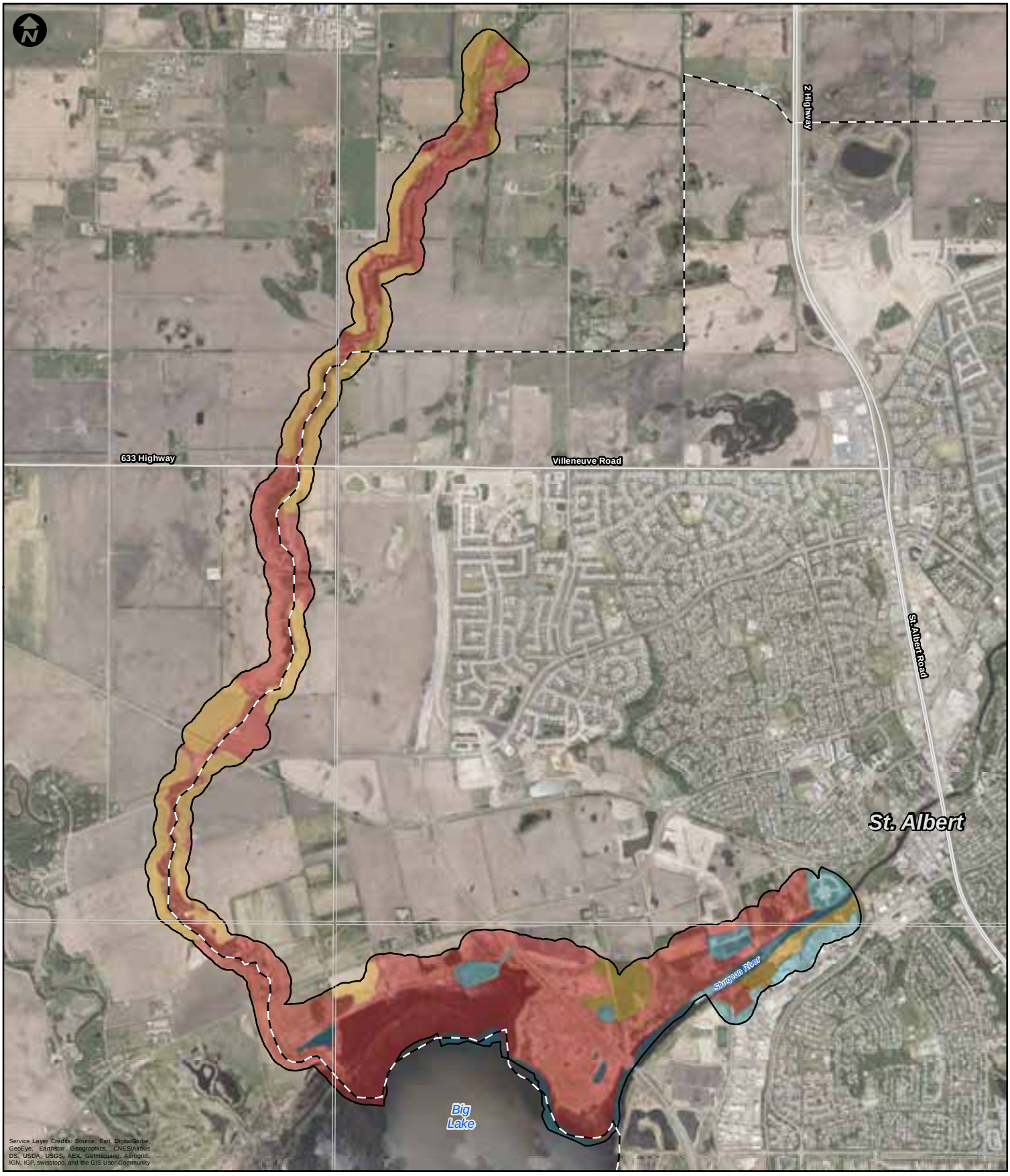


Figure 14. Detailed Study Area - Compaction Risk Rating

PARAGON

Paragon Project No. 15-053

Projection:	Scale:
UTM 12N NAD83	1:36,000
Drawn: SD	Approved: SM

Legend

Compaction Risk Rating
- High
- Moderate
- No Rating (Water/Disturbed Land)

- Road
- Townships
- City of St. Albert
- Detailed Study Area

0 250 500 1,000 Metres

Date: 27/07/2015 Time: 1:49:01 PM

Appendix C Site Inspection List

Table B-1. Site inspection data

Site ID	Series	Subgroup	Parent Material	Slope Position	Slope Class	Stoniness	Drainage	Land Use	Surface Expression	TS Depth (cm)	B Horizon Depth (cm)	TS Texture	US Texture	LS Texture
01	NVR	GL.BLC	GLLC	Upper	2	S0	I	C	u	24	46	C	C	SiC
01TS	HGT	O.HG	GLLC	Lower	3	S0	P	WT	l	18	-	SL	CL	-
02	HGTyt	R.HG	GLLC / M	Mid	3	S0	I	CL	u	42	-	CL		C/SiC
02TS	MMO	E.BLC	GLLC	Upper	3	S0	MW	W	u	11	45	L	C	SiC
03	HGT	O.HG	GLLC	Level	2	S0	P	CL	l	31	70	CL	CL	SCL
03TS	MCOgl	GL.DGC	GLLC	Lower	4	S0	I	W	i	32	70	L/SIL	CL	C
04	MCOglyt	GL.DGC	GLLC / M	Lower	2	S0	I	W	u	29	55	CL/SiCL	C	SiC/C
04TS	NVR	GL.BLC	GLLC	Lower	3	S0	I	C	u	24	-	L	SiL	-
05TS	MCOgl	GL.DGC	GLLC	Mid	2	S1	I	W	u	25	-	L/CL	C	-
06	NVR	GL.BLC	GLLC	Upper	3	S0	I	CL	u	32	48	CL	C	C
06TS	HGT	O.HG	GLLC	Level	1	S0	P	WT	l	31	-	SiL	CL	-
07	NVR	GLCA.BLC	GLLC	Mid	2	S0	I	CL	u	25	68	CL	C	CL
10	NVRca	GLCA.BLC	GLLC	Mid	3	S0	I	W	u	38	75	SiL	CL	CL
11	HGT	O.HG	GLLC	Lower	3	S0	I	C	u	55	80	CL	CL	C
12	NVR	GL.BLC	GLLC	Mid	3	S0	I	C	u	31	40	CL	CL	C
13	MMO	E.BLC	GLLC	Lower	3	S0	MW	C	u	19	55	CL	CL	C
14	HGT	O.HG	GLLC	Mid	3	S0	I	C	u	28	55	CL	CL	SiC
15	MMO	E.BLC	GLLC	Mid	2	S0	W	C	u	21	48	SiL	CL	CL
16	NVR	GL.BLC	GLLC	Mid	2	S0	I	W	u	41	80	C	C	SiC
17	HGT	O.HG	GLLC	Lower	3	S0	I	WT	u	52	80	C	SiC	SiC
18	MMO	E.BLC	GLLC	Mid	3	S0	W	CL	u	52	70	SiL	CL	CL
20	MMO	E.BLC	GLLC	Mid	3	S0	MW	C	u	36	60	CL	C	SiC
21	MMO	E.BLC	GLLC	Mid	3	S0	MW	C	u	26	55	C	SiC	SiC
24	HGT	O.HG	GLLC	Level	1	S0	P	WT	l	37	55	L	CL	C
25	HGT	O.HG	GLLC	Level	1	S0	P	WT	l	36	58	L	CL	SCL

Appendix D Site Inspection List Key

SOIL SERIES:	
HGT – Haight	MMO – Malmo
MCO – Mico	NVR – Navarre

SOIL CLASSIFICATION:	
Chernozemic Order	**Gleysolic Order**
E.BLC – Eluviated Black Chernozem	O.HG – Orthic Humic Gleysol
GL.BLC – Gleyed Black Chernozem	R.HG – Rego Humic Gleysol
GLCA.BLC – Gleyed Calcareous Black Chernozem	
GL.DGC – Gleyed Dark Gray Chernozem	
MODIFIERS:	**TOPOGRAPHY CLASSES:**
ca - calcareous	1 - 0-0.5% level
gl – gleyed	2 - >0.5-2% nearly level
yt – till at 100 – 200 cm	3 - >2-5% very gentle slopes
	4 - >5-10% gentle slopes
	5 - >10-15% moderate slopes
	6 - >15-30% strong slopes
	7 - >30-45% very strong slopes
	8 - >45-70% extreme slopes
	9 - >70-100% steep slopes
	SLOPE POSITION:
	C – Crest
	U – Upper
	M – Mid
	L – Lower
	T – Toe
	D – Depression
	LEVEL – Level

DRAINAGE CLASSES:	LAND USE:
R - rapidly	C – Cultivated
W - well	CL - Cleared
MW - moderately well	DL – Disturbed land
I - imperfectly	W – Wooded
P - poorly	WT – Wetland
VP - very poorly	

SURFACE STONINESS CLASSES:	PARENT MATERIAL:
S0 - non-stony	GLLC – Glaciolacustrine
S1 - slightly stony (stones 10-30 m apart)	M – Till (Morainal)
S2 - moderately stony (stones 2-10 m apart)	
S3 - very stony (stones 1-2 m apart)	
S4 - exceedingly stony (stones .01-1 m apart)	
S5 - excessively stony (stones <.01 m apart)	

Appendix E Analytical Data for Soils within the Detailed Study Area

Soil samples were not collected during the soil survey completed within the DSA. Analytical data for the soil mapped within the DSA was taken from the soil layers file of the Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0 (Alberta Soil Information Centre 2005) and from Soil Series Information for Reclamation Planning in Alberta (Alberta Conservation and Reclamation Council 1993). The laboratory data used to complete reclamation suitability ratings and agricultural suitability ratings is presented in Table D-1.

Table D-1. Analytical data for soil units within the DSA

Series	Horizon	Depth (cm)	EC (dS/m)	pH	SAR	Saturation Percent (%)	Org. C (%)
HGT[2]	Ap	0 – 15	1.1	6.0	0.1	47	3.0
	Btg	15 – 80	0.4	6.9	0.3	61	-
	BCg	80 – 100	0.1	6.4	0.6	59	-
MCO[2]	Ap	0 – 18	0.5	6.9	0.2	68	-
	Btj	18 – 60	0.1	6.3	0.4	86	-
	Ck	60 – 100	0.5	7.8	0.4	-	-
MCOgl[1]	LH	3 – 0	0.0	5.5	-	-	40.0
	Ah	0 – 5	0.0	5.7	-	-	6.0
	Ahe	5 – 15	0.0	5.2	-	-	2.5
	AB	15 – 20	0.0	5.0	-	-	1.5
	Btgj	20 – 40	0.0	5.0	-	-	1.0
	BCg	40 – 75	0.0	6.6	-	-	0.5
	Ckg	75 – 100	0.0	7.1	-	-	0.0
MMO[2]	Ap	0 – 20	0.5	6.0	0.2	59	5.0
	Btj	20 – 100	0.4	6.2	0.7	41	-
	Ck	100 – 180	0.9	7.6	0.7	44	-
NVR[2]	Ap	0 – 15	1.1	5.7	3.7	64	-
	Bm	15 – 50	0.3	7.2	0.6	72	-
	Ccagj	50 – 80	2.0	8.6	2.8	48	-
	Ckgj	80 – 120	1.1	8.8	4.8	78	-

1 Taken from *Agricultural Region of Alberta Soil Inventory Database (AGRASID) Version 3.0* (Alberta Soil Information Centre 2005).
2 Taken from *Soil Series Information for Reclamation Planning in Alberta* (Alberta Conservation and Reclamation Council 1993).

Appendix F Soil Legend for the St. Albert Natural Areas Soil Assessment

Table E-1. Soil Legend for the St. Albert Natural Areas Soil Assessment

Soil Unit	Soil Symbol	Dominant/ Significant Soil	Parent Material	Drainage	Texture Topsoil/ Subsoil	Topsoil Depth (cm)	Colour differentiation between topsoil and subsoil	Wind Erosion Hazard	Water Erosion Hazard	Soil Compaction Potential	Reclamation Suitability (TS / US / LS)	Agricultural Suitability	Trench Instability Potential	Slope (%)	Surface Stoniness	Extent (ha / %)
Haight	HGT	Orthic Humic Gleysol, Rego Humic Gleysol	Glaciolacustrine	Poor	CL, L, SiL / C, SiC, CL	18 to 55 cm	Black, very dark grayish brown, very dark brown / dark grayish brown, dark to very dark gray (indistinct colour change)	Low	Low	High	F / F / F-P	5W	Yes	0 – 5	S0	190 ha / 32%
Mico	MCO	Orthic Dark Gray Chernozem	Glaciolacustrine, glaciolacustrine over morainal	Moderately well	L, SiL, CL, SiCL / CL, C	25 to 32 cm	Black, dark to very dark gray, very dark grayish brown, grayish brown / dark gray, brown (distinct colour change)	Moderate	Low	Moderate	P / P / P	2H	No	2 – 10	S0 – S1	33 ha / 6%
Gleyed Mico	MCOgl	Gleyed Dark Gray Chernozem		Imperfect						High	F / P / P	2W	No			24 ha / 4%
Malmo	MMO	Eluviated Black Chernozem	Glaciolacustrine	Well to moderately well	L, SiL, CL / CL, C, SiC	11 to 52 cm	Black, very dark brown, very dark grayish brown, very dark gray / brown, dark grayish brown, very dark gray (indistinct colour change)	Low	Low	Moderate	F-P / F-P / F-P	2H	No	0.5 – 5	S0	101 ha / 18%
Navarre	NVR	Gleyed Black Chernozem	Glaciolacustrine	Imperfect	L, SiL, CL, C / CL, C	24 to 41 cm	Black, very dark gray / dark to very dark grayish brown, dark gray, very dark brown (variable colour change)	Low	Low	High	F-P / P / P	2W	No	0.5 – 5	S0	167 ha / 30%

Appendix G Photos



Photo 1 Carrot Creek (Site 01TS)



Photo 2 Subangular blocky structure of upper subsoil of MMO soil (Site 02TS)



Photo 3 Level to nearly level topography within cultivated fields (Site 12)



Photo 4 Prominent mottling within the subsoil of a HGT soil (Site 17)



Photo 5 **Very gently sloping, undulating topography within a cultivated field (Site 14)**



Photo 6 **Shrubby riparian area within a HGT soil unit, adjacent to Carrot Creek (Site 17)**



Photo 7 **Semi natural area within a NVR soil unit (Site 07)**



Photo 8 **Wooded land use within a MCOgl soil unit (Site 04)**



Photo 9 Low-lying area adjacent to Big Lake within HGT soil unit (Site 24)



Photo 10 Thick topsoil within MMO soil unit (Site 13)



Photo 11 Topsoil and upper subsoil of a MCOgl soil (Site 04)



Photo 12 Lower subsoil from a MMO soil (Site 20)

APPENDIX C.
VEGETATION SITE FIELD FORM

City of St. Albert Natural Areas 2015 – Vegetation Site Field Form

Site		UTMs	Pt 1/Start (0m)		Photos	Pt 1	
Date			Pt 2 (50m)			Pt 2	
Surveyor			Pt 3/End (100m)			Pt 3	

Tree Stratum

	Pt 1		Pt 2		Pt 3	
	Spp	Ab	Spp	Ab	Spp	Ab
Tree Sp 1						
Tree Sp 2						
Tree Sp 3						

	Pt 1	Pt 2	Pt 3		Pt 1	Pt 2	Pt 3
Canopy height				Canopy closure			
Snags				DBH			
Other tree spp							

Shrub Stratum

	Pt 1		Pt 2		Pt 3	
	Spp	Ab	Spp	Ab	Spp	Ab
Shrub Sp 1						
Shrub Sp 2						
Shrub Sp 3						
Avg Shrub height						

Herb Stratum

	Pt 1		Pt 2		Pt 3	
	Spp	Ab	Spp	Ab	Spp	Ab
Herb Sp 1						
Herb Sp 2						
Herb Sp 3						

Overall comp	Forb dom		Grass dom		Mixed	
Noxious weeds	1		2		3	
	4		5		6	
Weeds abund	Dominant		Abundant		Frequent	
	Occasional		Rare			
Weeds distribution	None		Scat Ind.		Few/sm. patch	
	Many/lrg. patch		Common; widespread			
Incidental S1-S3						

Ground Cover

	Pt 1						Pt 2						Pt 3					
Bare grd/exp soil	<1	1-10	10-20	>20	Nat	Hum	<1	1-10	10-20	>20	Nat	Hum	<1	1-10	10-20	>20	Nat	Hum

CWD	Pt 1	Pt 2	Pt 3	Sign Bryophyte	Pt 1	Pt 2	Pt 3
					Y / N	Y / N	Y / N

Overall Site/Transect Characteristics

Moisture regime	Xeric		Mesic		Hygric		Hydric	
Moisture comment								
Terrain	Flat		Gently sloping/rolling		Steep slopes present			
Human disturbance	Low		Medium		High			
Disturbance comment								PH
Site health	Good		Fair		Poor			
Health comment								PH
Beaver sign	Yes – active		Yes – old		None			
Edge impacts	Weed invasion		Wind damage		Encroachment		Garbage	
Edge comments								

COMMENTS

Human Disturbance
Comment:

Site Health
Comment:

Other
Comment:

Other
Comment:

APPENDIX D.
SUMMARY OF PLANT SPECIES RECORDED IN THE DSA

Species				Aspen Forest						Mixed	
Scientific Name	ACIMS Common Name	ACIMS Rank	Origin	1	3	7	9	10	25	14	15
Tree											
Acer negundo	Manitoba maple	SU	Exotic								
Picea glauca	white spruce	S5	Native							D	A
Populus balsamifera	balsam poplar	S5	Native	O	F	A	O	A	F		
Populus tremuloides	aspen	S5	Native	D	A	A	D	D	D	A	A
Shrub											
Alnus incana ssp. *tenuifolia*	river alder	S5	Native						A		
Amelanchier alnifolia	saskatoon	S5	Native								
Cornus stolonifera	red-osier dogwood	S5	Native	A	A	A	F	A	A		
Ribes oxyacanthoides	northern gooseberry	S5	Native								
Rosa acicularis	prickly rose	S5	Native	D	A	A	A	A		F	F
Rubus idaeus	wild red raspberry	S5	Native							A	F
Salix bebbiana	beaked willow	S5	Native								
Salix interior	sandbar willow	S4S5	Native								
Salix lasiandra	shining willow	S5	Native								
Salix petiolaris	basket willow	S5	Native								
Sambucus racemosa	red elderberry	S4	Native								
Symphoricarpos occidentalis	buckbrush	S5	Native								
Viburnum edule	low-bush cranberry	S5	Native								
Viburnum opulus	high-bush cranberry	S3S4	Native								
Forb											
Anemone canadensis	Canada anemone	S5	Native				F				
Aralia nudicaulis	wild sarsaparilla	S5	Native	D					A		
Cirsium arvense	creeping thistle	SNA	Noxious								F
Chamerion angustifolium	common fireweed	S5	Native								
Equisetum sylvaticum	woodland horsetail	S5	Native								
Galeopsis tetrahit	hemp-nettle	SNA	Exotic								
Impatiens noli-tangere	western jewelweed	S4	Native								
Maianthemum canadense	wild lily-of-the-valley	S5	Native					A			
Melilotus albus	white sweet-clover	SNA	Exotic								
Melilotus officinalis	yellow sweet-clover	SNA	Exotic								
Mentha arvensis	wild mint	S5	Native								
Mertensia paniculata	tall lungwort	S5	Native			F					
Smilacina stellata	star-flowered Solomon's-seal	S5	Native						F		
Solidago altissima	tall goldenrod	S5	Native								
Urtica dioica	common nettle	S5	Native		F					A	

aled Up to Sampled Land Unit (Sample Site)*

dwood		White Spruce		Riparian Meadow					Riparian Willow Shrub				Seasonal/Temporary Marsh					Semi-Permanent Marsh	Grassland
23	28	16	21	2	11	17	22	26	4	8	19	27	5	6	12	13	20	24	18
A	A	D	D																
	D		O	O				O	O	A	R				O	R		O	
F		F			A			R		O						O		O	
	F																		
			F																
A	A		A	O	F										R				
										F			O		O	A			
		A		O															
											F	O							
					F		F	O	O	A	A	A				F		F	
								O				D						O	
									A										
		F																	
F																			
					F														
	A																		
A																			
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D			D																
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																			A
																	A		
	A																		
																F			
		A	A									A							

APPENDIX E.
SUMMARY OF BIRD OBSERVATIONS IN THE DSA

Abundance, species richness, and average Shannon-Weiner diversity index (H') of birds detected within 100 m of point count stations (excluding flyovers) during breeding bird surveys in the DSA, June 24-25, 2015, ordered taxonomically.

Common Name	Scientific Name	Carrot Creek (n = 13 stations)	Big Lake / Sturgeon River (n = 14 stations)	Total (n = 27 stations)
Great blue heron†	*Ardea herodias*	0	1	1
Red-tailed hawk	*Buteo jamaicensis*	2	1	3
Sora†	*Porzana carolina*	0	3	3
Killdeer	*Charadrius vociferus*	1	1	2
Spotted sandpiper	*Actitis macularius*	1	0	1
Wilson's snipe	*Gallinago delicata*	1	1	2
Yellow-bellied sapsucker	*Sphyrapicus varius*	0	1	1
Downy woodpecker	*Picoides pubescens*	1	5	6
Hairy woodpecker	*Picoides villosus*	1	0	1
Alder flycatcher	*Empidonax alnorum*	5	7	12
Least flycatcher†	*Empidonax minimus*	10	5	15
Warbling vireo	*Vireo gilvus*	7	1	8
Red-eyed vireo	*Vireo olivaceus*	0	7	7
Black-billed magpie	*Pica hudsonia*	2	4	6
American crow	*Corvus brachyrhynchos*	0	3	3
Tree swallow	*Tachycineta bicolor*	2	2	4
Barn swallow‡	*Hirundo rustica*	3	0	3
Black-capped chickadee	*Poecile atricapillus*	9	21	30
White-breasted nuthatch	*Sitta carolinensis*	0	1	1
House wren	*Troglodytes aedon*	12	5	17
American robin	*Turdus migratorius*	7	6	13
Gray catbird	*Dumetella carolinensis*	3	0	3
European starling∫	*Sturnus vulgaris*	9	0	9
Cedar waxwing	*Bombycilla cedrorum*	14	11	25
Yellow warbler	*Setophaga petechia*	14	30	44
Magnolia warbler	*Setophaga magnolia*	0	1	1
Yellow-rumped warbler	*Setophaga coronata*	0	1	1
Common yellowthroat†	*Geothlypis trichas*	2	7	9
Chipping sparrow	*Spizella passerina*	0	4	4
Clay-colored sparrow	*Spizella pallida*	26	21	47
Savannah sparrow	*Passerculus sandwichensis*	7	10	17

Le Conte's sparrow	*Ammodramus leconteii*	0	7	7
Song sparrow	*Melospiza melodia*	26	12	38
Lincoln's sparrow	*Melospiza lincolnii*	0	5	5
Swamp sparrow	*Melospiza georgiana*	0	1	1
White-throated sparrow	*Zonotrichia albicollis*	0	6	6
Red-winged Blackbird	*Agelaius phoeniceus*	22	9	31
Brewer's blackbird	*Euphagus cyanocephalus*	1	0	1
Brown-headed cowbird	*Molothrus ater*	9	15	24
Baltimore oriole†	*Icterus galbula*	2	0	2
White-winged crossbill	*Loxia leucoptera*	0	2	2
American goldfinch	*Spinus tristis*	0	3	3
	Total Abundance	**199**	**220**	**410**
	Total Species Richness	**27**	**35**	**42**
Average Shannon-Wiener Diversity Index (H')		**1.87**	**2.02**	**1.95**

† denotes species listed as *Sensitive* according to the General Status of Alberta Wild Species 2010

‡ denotes species recommended by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) for listing as *Threatened* under the Species at Risk Act (SARA)

ʃ denotes alien/invasive species



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