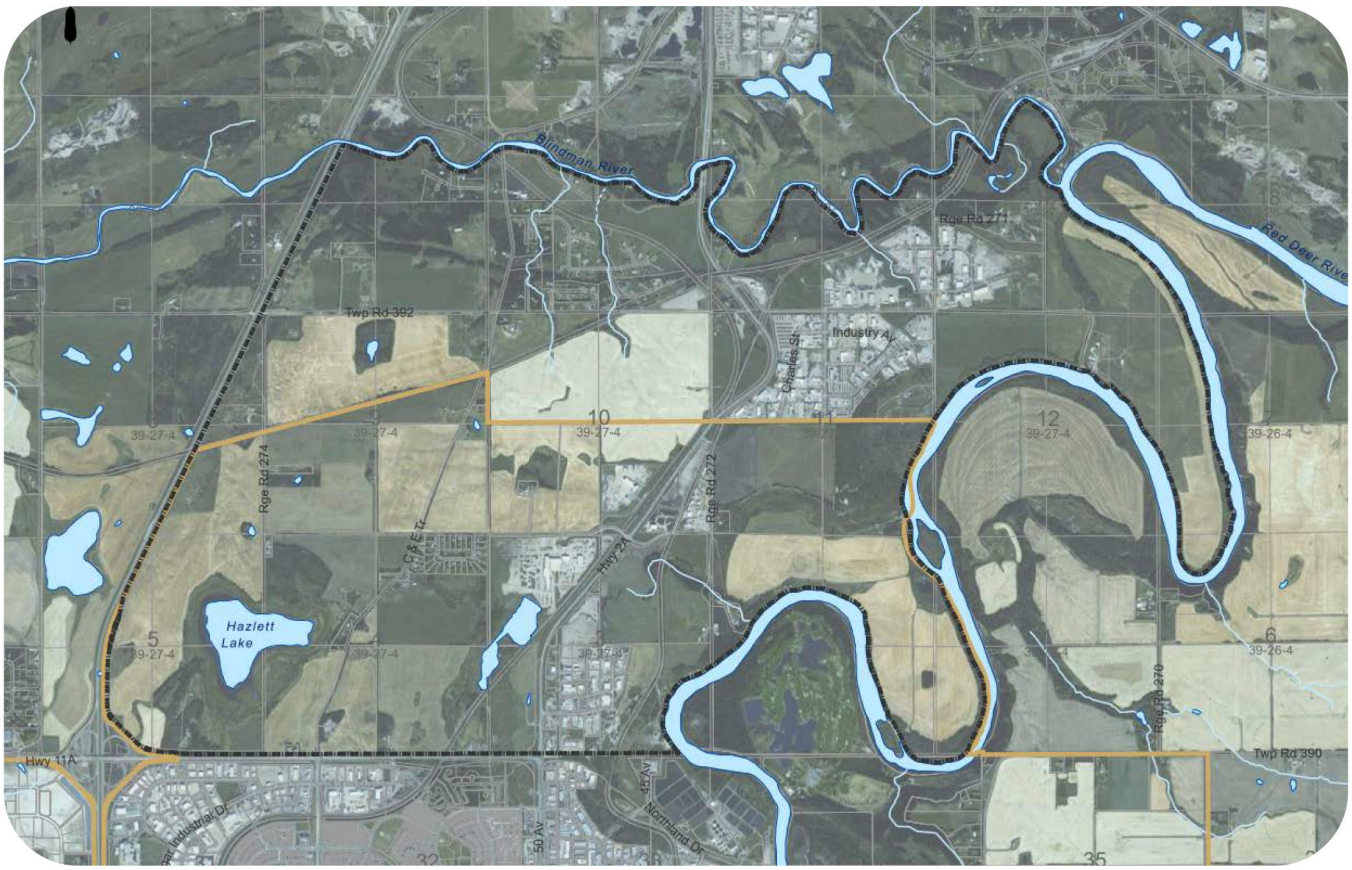
GLOBAL PERSPECTIVE.
LOCAL FOCUS.

REPORT

City of Red Deer

Master Drainage Plan
North of Highway 11A



June 2018

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Appendix A - Westhoff Model Results

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1 Introduction

1.1 BACKGROUND

The City of Red Deer has retained Associated Engineering to undertake a Master Drainage Plan (MDP) for lands located north of Highway 11A. The Master Drainage Plan provides an overview of the existing drainage area and the proposed stormwater drainage concept for the development of lands to the north of Highway 11A.

The study area encompasses approximately 2,804 ha and is located north of Highway 11A extending to the Blindman River, and from Highway 2 across to the Red Deer River. The area includes lands recently annexed by the City in 2009 as well as lands currently located within Red Deer County. Refer to **Figure 1-1** for the Study Area.

The project objective is to undertake a conceptual Master Drainage Plan (MDP) within the study area. A desktop environmental overview of the existing conditions in the area will be incorporated into the document. The MDP will identify the requirements of stormwater management infrastructure in the study area based on a conceptual-level analysis.

Municipal servicing requirements for the City of Red Deer are based on the projected land uses within the study boundary. A land use plan has been developed which includes the projected land uses as presented in the Generalized Land Use Concept of the North of Hwy 11A MASP (January 2016) for lands within the current City of Red Deer boundary. For lands within Red Deer County, the plan is loosely based on that presented in the 2013 Water Distribution Study (Stantec), however, has been modified to reflect findings of the desktop Biophysical Assessment.

The land use identified for areas outside of the City of Red Deer municipal boundary have not been approved and are for the purpose of establishing design flows and future servicing concepts.

Figure 1-2 presents the Land Use Plan developed for use on this project. Note that all residential lands will be considered to consist of single family residential development for this level of assessment.

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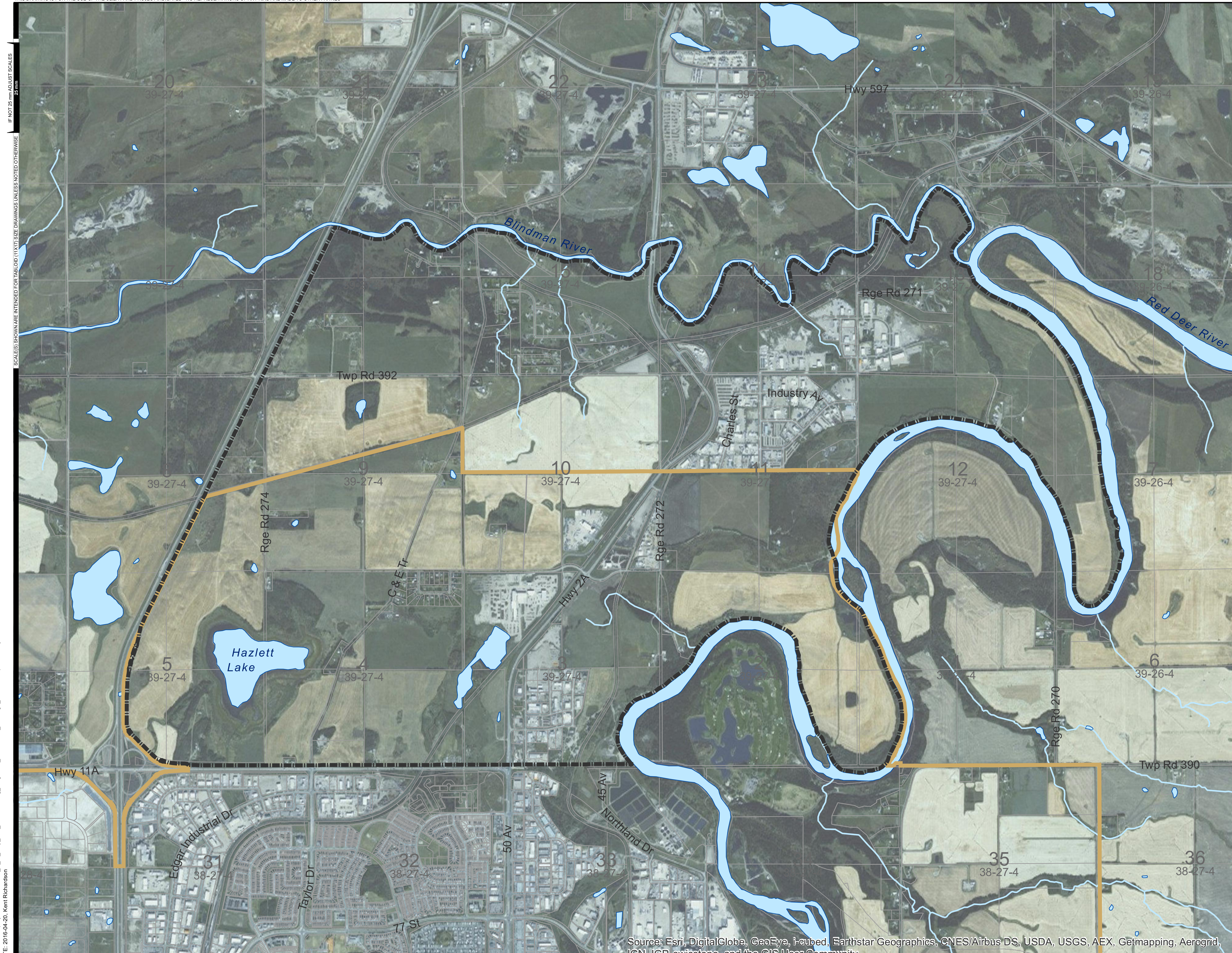

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IF NOT 25 mm ADJUST SCALES

25 mm

Associated Engineering

Legend:
- StudyArea
- City of Red Deer

THE CITY OF Red Deer

FIGURE No. 1-1

MASTER DRAINAGE PLAN

STUDY AREA

AE PROJECT No.	20153382
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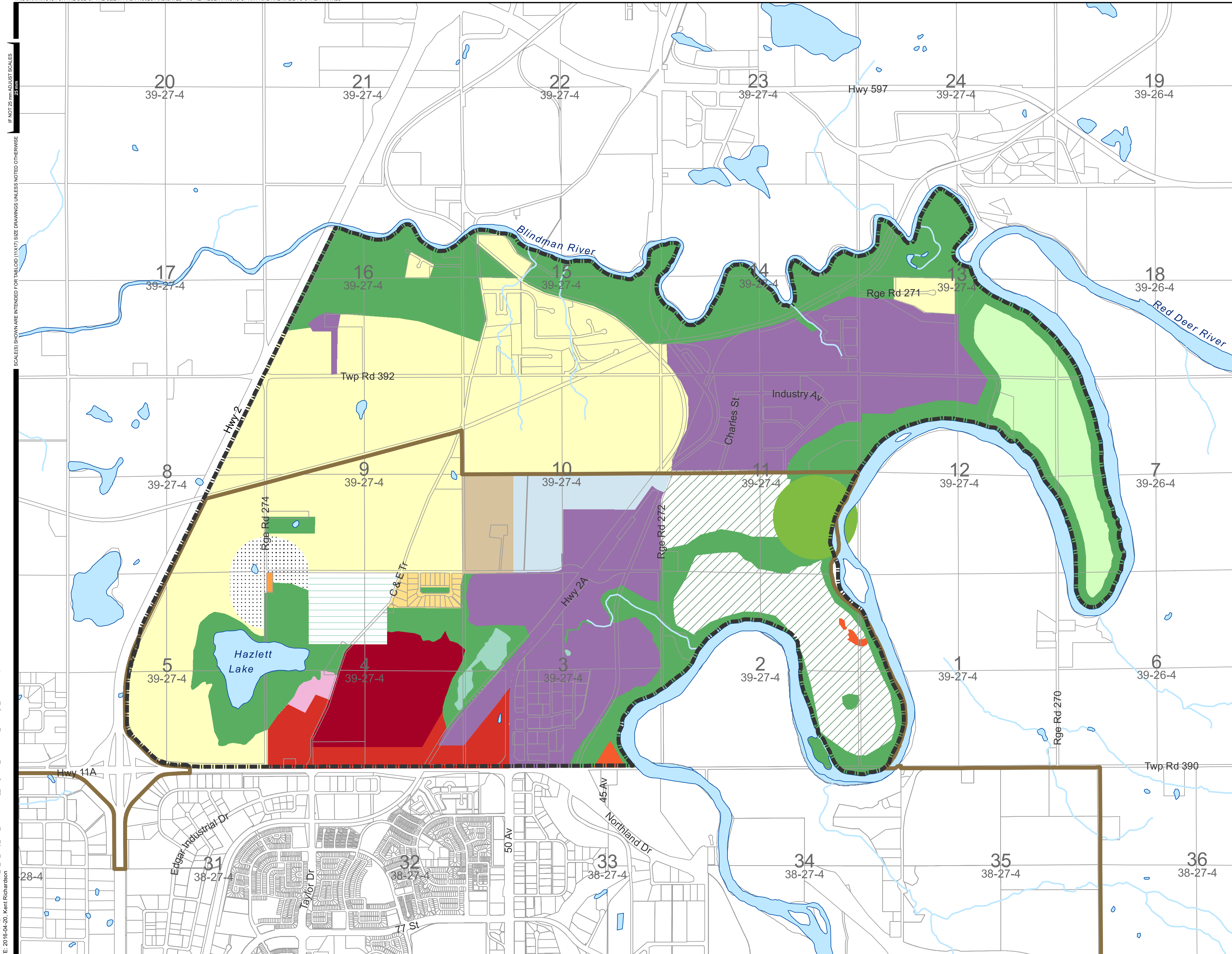
DATE: 2016-04-20, Kent Richardson



Associated Engineering

Legend:

- Natural Space
- Park
- Wetland
- Agriculture
- Potential Residential and Open Space
- Country Residential
- Residential
- Community Facility
- Mixed Residential/Commercial
- Commercial
- General Commercial and Light Industrial
- Light Industry
- Eco-Industrial
- Industrial
- Existing Landfill
- LandFill
- To Be Determined

- StudyArea
- City of Red Deer

Note:
Land use data within existing city boundary has been derived from MASP.
Land uses shown outside of the city boundary are not approved at this time (and are not within the scope of the MASP), but they have been added to this Servicing Study for the purpose of determining ultimate servicing requirements of the area.

THE CITY OF Red Deer

FIGURE No. 1-2

MASTER DRAINAGE PLAN

LAND USE

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Abbreviations & Acronyms

AEP	Alberta Environment and Parks
AC	Asbestos cement
ACIMS	Alberta Conservation Information Management System
AE	Associated Engineering Alberta Ltd.
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
ESA	Environmentally Significant Area
fps	Feet per second
ft^3/s	Cubic feet per second
ft^3	Cubic feet
FWMIS	Fish and Wildlife Management Information System
GoA	Government of Alberta
ha	Hectare
HDPE	High density polyethylene
ig	Imperial gallons
igpcd	Imperial gallons per capita day
igpm	Imperial gallons per minute
km	Kilometre
L/s	Litres per second
L	Litre
Lpcd	Litres per capita day
MASP	Major Area Structure Plan
m	Metre
m/s	Metres per second
m^3/s	Cubic metres per second
m^3	Cubic metres
mig	Million imperial gallons
mm	Millimetre
PRV	Pressure reducing valve
PVC	Polyvinyl chloride
RAP	Restricted activity period
s	second
USGPM	United States gallons per minute

2 Desktop Environmental Review

2.1 INTRODUCTION

The following environmental review is for the lands contained in the City of Red Deer North of Highway 11A service area (study area) bounded by the Blindman River to the north, Red Deer River to the east, Highway 11A to the south, and Highway 2 to the west (**Figure 1-1**). This review is based on the request for information from Alberta Environment and Parks (AEP; requested May 5, 2015) which includes a description of study area wetlands, associated features, environmental values, impacts, and recommendations for protecting, or mitigating impacts to those values.

A number of information sources were used as part of this review to assess the study area. These include:

- Environmentally Significant Areas of Alberta: 2014 Update (Government of Alberta [GoA] 2014a);
- Environmentally Significant Areas Master Plan (Golder Associates 2010);
- City of Red Deer Land Use Bylaw (City of Red Deer 2006);
- Red Deer County Land Use Bylaw (Red Deer County 2010);
- Fish and Wildlife Management Information System (FWMIS; GoA 2014b);
- Alberta Conservation Information Management System (ACIMS; GoA 2014c);
- Hazlett Lake 2014 Baseline Assessment (Westhoff Engineering Resources, Inc. 2015a; 2015b);
- *Water Act Code of Practice* Area Maps (GoA 2006);
- Alberta Flood Hazard Identification Program (GoA 2014d); and
- River Valley + Tributaries Park Concept Plan (O2 Planning + Design Inc. 2010).

The purpose of this environmental overview, when considering the Master Drainage Plan, is to identify environmental constraints with potential to impact the drainage plan and to provide recommendations for working with those constraints. Such environmental constraints are discussed in this section, and recommendations are provided later in this document.

2.2 ENVIRONMENTAL VALUES

Numerous environmental values were identified during this review. These values have a range of policy implications based on municipal, provincial, and federal policies/legislation. For this review, environmental values were considered in several contexts:

- Environmentally significant areas (ESAs) designated provincially / municipally;
- Environmentally sensitive areas;
- Wildlife movement corridors; and
- Water courses, wetlands, ephemeral draws and flood prone areas.

Each category is described in more detail in the following sections 2.2.1 to 2.2.4.

2.2.1 Environmentally Significant Areas

Environmentally significant areas (ESAs) are defined provincially by Alberta Parks, and in some cases by municipalities using similar or more stringent criteria (GoA 2014a).

At the provincial scale, ESAs are assessed by legal quarter section. Fiera Biological Consulting (2014) identified four quarter section units within the study area that are considered ESAs (**Figure 2-1**). None of these quarter sections are located entirely within the study area but straddle the boundary and are concentrated in the southeast portion of the study area in the Red Deer River Valley. These ESAs are located at: NW / SW / SE-2-39-27-W4M, and NW-1-39-27-W4M. Fiera Biological Consulting (2014) listed a variety of limitations to the provincial analysis model which are further discussed in the City of Red Deer North of Highway 11A Servicing Study (Associated Engineering - 2016).

Red Deer County has produced a fine scale municipal ESA inventory containing details on additional ESAs located within the County. Golder Associates (2010) developed three additional ESA criteria for the Red Deer County ESA Management Plan.

Golder Associates (2010) identified 26 ESAs within Red Deer County. Of these, two are located within the study area (when the Red Deer County ESA Management Plan was compiled, part of the study area was then located in Red Deer County): the Blindman River ESA and the Red Deer Canyon ESA (**Figure 2-1**). The Blindman River ESA (4,549 ha in size) includes 1,562 ha of the north portion of the study area, and the Red Deer Canyon ESA (28,521 ha in size) includes 5,085 ha of the east portion of the study area (**Figure 2-1**).

In a 1990 inventory of Red Deer County ESAs, Sweetgrass Consultants Ltd. also identified Hazlett Lake and its surrounding area as an ESA (**Figure 2-1**). The area has since been annexed and was not included in the Golder 2010 ESA inventory. This ESA surrounds the lake and contains most of E-5-39-27-W4M and areas west of Range Road 273A in W-4-39-27-W4M.

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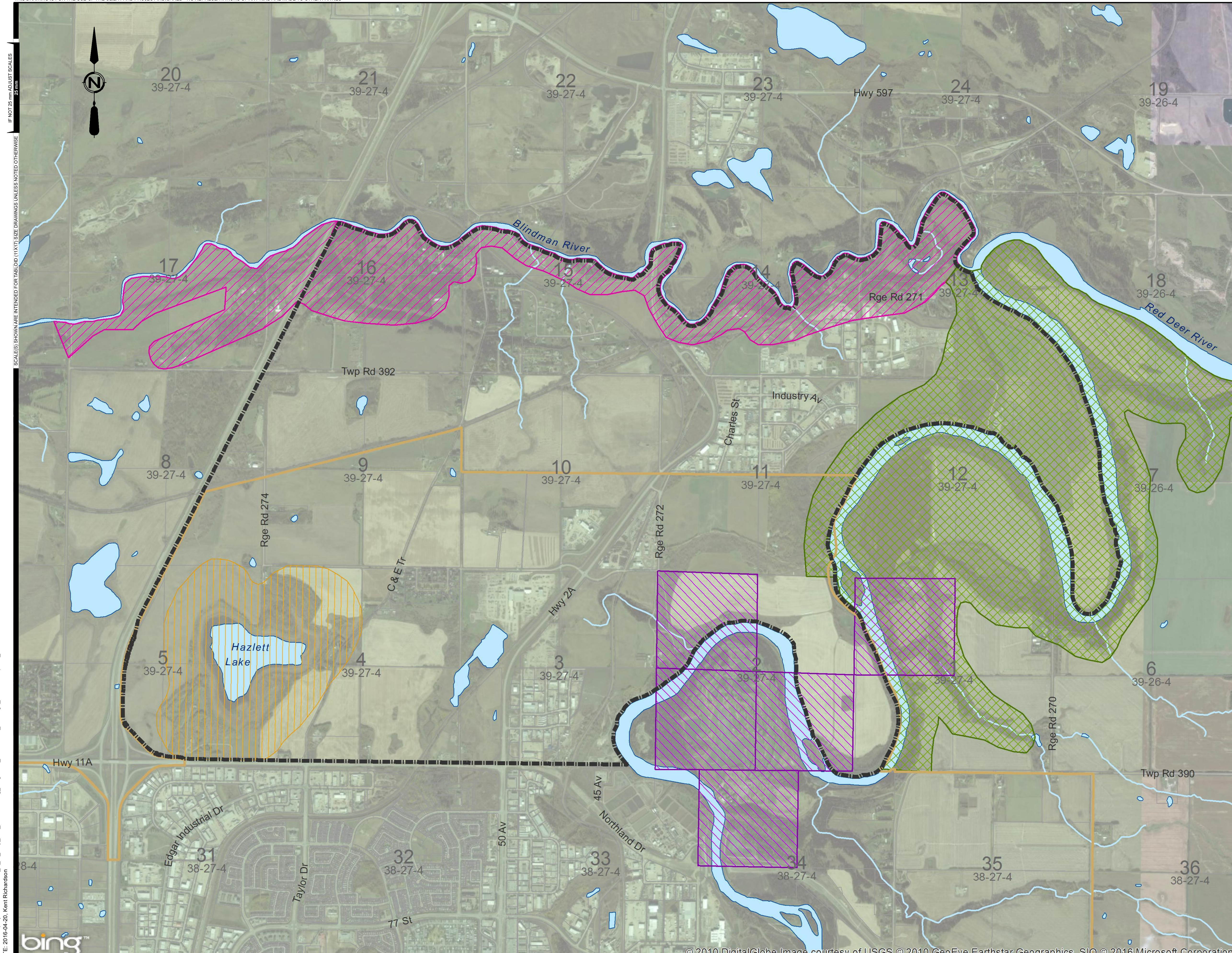

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Associated Engineering

Legend:

Red Deer County ESA

Golder Associates

- Red Deer Canyon ESA
- Blindman River ESA

Red Deer County ESA

Sweetgrass Consultants Ltd.

- Hazlett Lake ESA

Provincial ESA

Fiera Consulting Ltd.

- Alberta ESA

- Study Area
- City of Red Deer
- Hydrology

THE CITY OF Red Deer

FIGURE No. 2-1

MASTER DRAINAGE PLAN

ENVIRONMENTAL
ALBERTA AND RED DEER COUNTY
ENVIRONMENTALLY SIGNIFICANT AREAS (ESA)

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DESCRIPTION	ISSUED FOR REPORT

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DATE: 2016-04-20, Kent Richardson

The following locations within the study area are being considered environmentally valuable:

- Provincial ESAs located at: NW / SW / SE-2-39-27-W4M, and NW-1-39-27-W4M; and
- Red Deer County ESAs including the Blindman River ESA, Red Deer River ESA, and the former Hazlett Lake ESA.

2.2.2 Environmentally Sensitive Areas

For the purpose of this review, environmentally sensitive areas within the study area consist of areas fitting the ESA definitions above but not covered in 1) the provincial ESA inventory, or 2) the Red Deer County ESA Management Plan. Environmentally sensitive areas within the study area have the potential to provide habitat for the ecologically sensitive species discussed in the following Section 2.3.3, ecological goods and services, recreational spaces, and a number of other benefits.

Environmentally sensitive areas are shown in **Figure 2-1** and additional information is discussed in the North of Highway 11A Servicing Study (Associated Engineering - 2016).

The following landscape features are being considered environmentally valuable:

- Forested areas surrounding Hazlett Lake and in the Blindman and Red Deer River canyons – these may serve as habitat for bald eagle; and
- Wetlands and their surrounding lands– these may serve as habitat for bald eagle marsh muhly and crowfoot violet.

2.2.3 Wildlife Movement Corridors and Sensitive Species

A patchwork of forested areas exists in the Blindman and Red Deer River Canyons, surrounding wetlands, along property breaks, and within natural areas. These forested features, rolling terrain, and steep canyons provide heterogeneous mosaic habitats conducive to wildlife movement throughout the study area (**Figure 2-2**; MacDonald 2003). **Figure 2-2** displays the movement corridors which may currently be used by animals within the study area.

Aside from the provincially and federally listed sensitive species, migratory and breeding birds are also considered environmental values on a seasonal basis (Government of Canada 2014).

Changes in land use have the potential to impact water bodies by changing the interaction between aquatic and terrestrial ecosystems (Dodds and Whiles 2010). Pertaining to the study area, changes in surface water infiltration, sheet flow, soil compaction, stormwater release, and water detention are among the factors which have potential to impact aquatic ecosystems and environmentally sensitive species. The Province also designates Restricted Activity Periods (RAP) for these waters and certain activities are regulated. The Blindman River is a Class C waterbody with minimal sensitive habitat the Red Deer River is a Class B waterbody which contains some critical habitat (GoA 2006; **Figure 2-2**). Although these rivers are not contained within the study area, they are considered in this review because development on surrounding lands may change the terrestrial/aquatic interactions in these areas.

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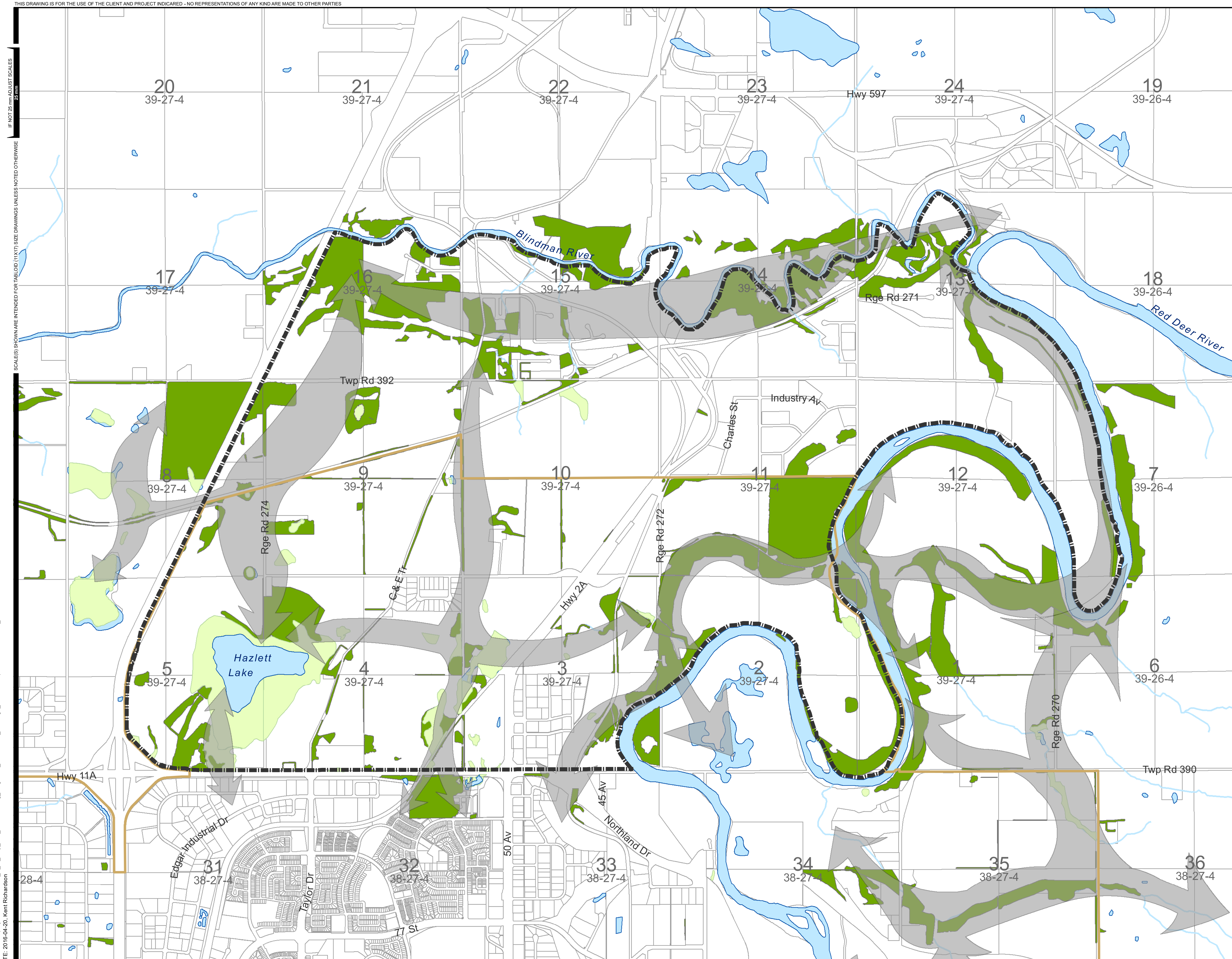

Associated Engineering

Legend:

- Potential Wildlife Corridor

Natural Ecological Space

- Waterbody
- Forested Area
- Wetland
- StudyArea
- City of Red Deer

THE CITY OF Red Deer

FIGURE No. 2-2

MASTER DRAINAGE PLAN

ENVIRONMENTAL
FORESTED AREAS, WETLANDS, AND POTENTIAL WILDLIFE CORRIDORS

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The following landscape features are being considered environmentally valuable:

- Forested areas – these may serve as habitat and movement corridors for environmentally sensitive species, amphibians, and migratory birds;
- Wetlands – these may serve as habitat for environmentally sensitive species, amphibians and migratory birds;
- Blindman and Red Deer River canyons – these areas provide significant wildlife habitat;
- Streams, rivers, and ephemeral draws – these serve as, or connect to habitat for sensitive fish species; and
- Wildlife movement corridors.

2.2.4 Water Courses, Wetlands, Ephemeral Draws and Flood Prone Areas

Waterbodies including rivers, streams, ephemeral draws, wetlands, and their associated riparian zones provide ecological goods and services, wildlife habitat; and frequently function as wildlife movement corridors and recharge areas for aquifers (MacDonald 2003), (Dodds and Whiles 2010). The study area contains numerous small and large wetlands and waterbodies, several small streams and ephemeral draws, and is bordered on two sides by rivers (**Figure 2-3**). There are 4 provincially mapped (*Water Act* applies) waterbodies draining north into the Blindman River, and one mapped waterbody draining east into the Red Deer River; these waterbodies may contain water year-round or serve as ephemeral draws, but are subject to the provincial *Water Act* (GoA 2014b). The major wetlands and lakes consist of Hazlett Lake, and a wetland located in W-3-39-27-W4M. Hazlett Lake is located in the southwest portion of the study area in E-5-39-27-W4M and W-4-39-27-W4M. Hazlett Lake was identified by the City of Red Deer as a potential receiving body for treated stormwater and is discussed in greater detail later in this document (Westhoff Engineering Resources, Inc. 2015a).

Steep slopes and escarpments are considered environmental values because they provide wildlife habitat and if disturbed can be the source of erosion and sediment control issues. Waterbodies are often located at the base of steep slopes, compounding their importance as environmental values. In this review, steep slopes are defined as any slope with a 15% or steeper grade. This grade is often considered the maximum grade allowable for development (O2 Planning + Design Inc. 2010; Red Deer County 2010; Trenhaile 2012). **Figure 2-4** shows all slopes in the study area with grades of 15% to 20%, and 20% or higher.

The Alberta Flood Hazard Identification Program was used to determine the floodway and flood fringe areas within the study area. Floodway and flood fringe mapping in the program is limited to sections 2 and 3 of 39-27-W4M and therefore much of the study area bounded by the Red Deer River is unassessed, as is the entire area bounded by the Blindman River. Of the area assessed, a large part of SE-3-39-27-W4M is considered a flood fringe zone. The outside bend of the Red Deer River in SE-3-39-27-W4M, and 2-39-27-W4M is considered floodway. The City of Red Deer Land Use Bylaw considers flood risk areas as those areas lying within the 1:100 year flood zone (City of Red Deer 2006).

The following landscape features are being considered environmentally valuable:

- Rivers, streams, ephemeral draws, wetlands, and their associated riparian zones and setbacks;
- All slopes with a 15% grade or steeper;
- Floodway and flood fringe areas assessed by the Alberta Flood Hazard Identification Program; and
- Areas lying within the 1:100 year flood zone.

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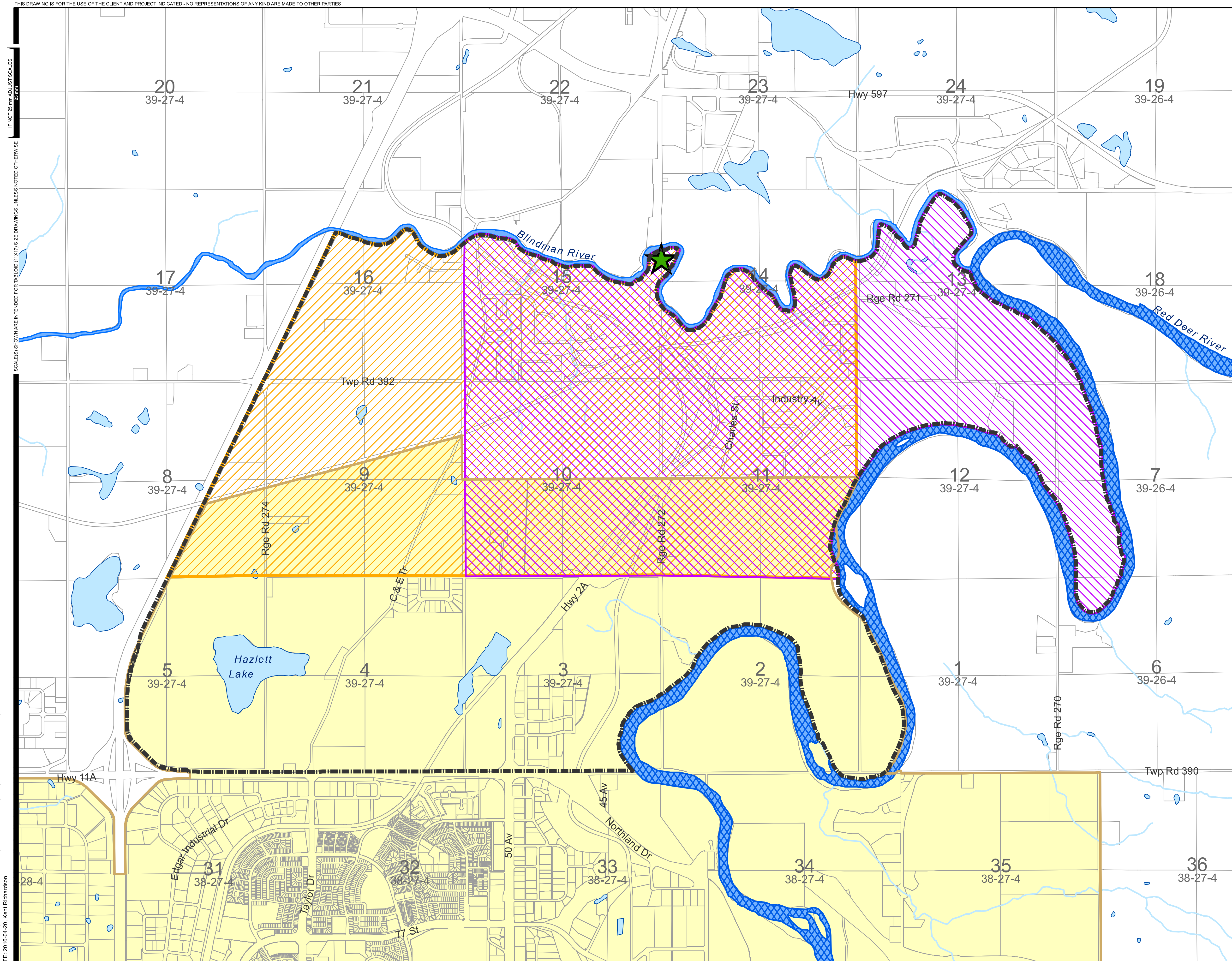

Associated Engineering

Legend:

- Protective Notation 960079 Ungulate Habitat Protection Area
- Blindman River *Water Act Code of Practice Class C*
- Red Deer River *Water Act Code of Practice Class B*
- Marsh Muhly *(Muhlenbergia Racemosa)*
- Crowfoot Viola *(Viola Pedafifida)*
- StudyArea
- City of Red Deer
- Hydrology

Note:
Best possible data resolution for rare plants is ATS 1/4 section.

THE CITY OF Red Deer

FIGURE No. 2-3

NORTH OF HIGHWAY 11A
MASTER DRAINAGE PLAN

ENVIRONMENTAL
RARE PLANTS, PROTECTED AREAS,
& WATERBODY CLASSES

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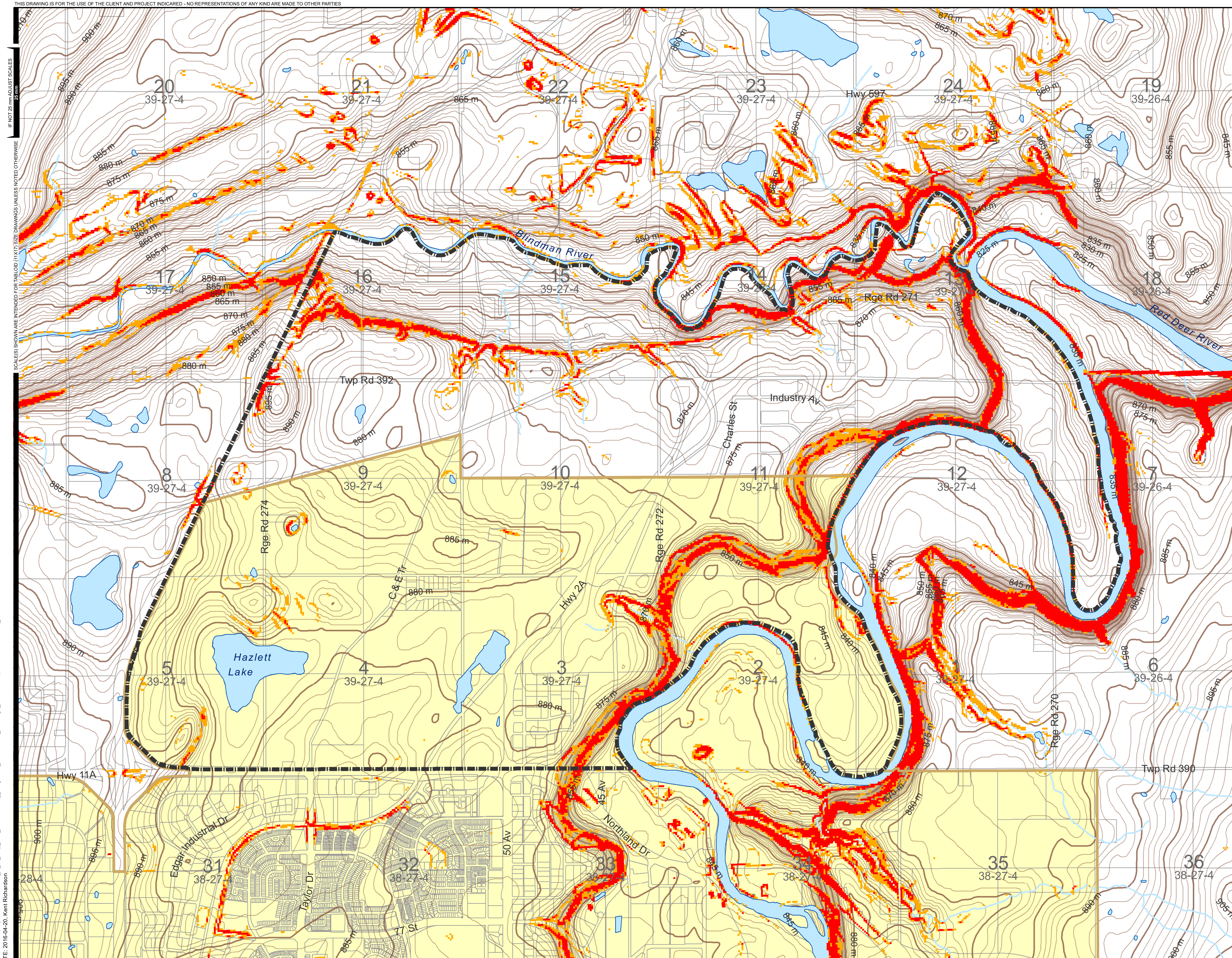

Associated Engineering

Legend:

Slope

- 15-20%
- >20%

- Contour 5m
- Contour 1m

- StudyArea
- City of Red Deer
- Hydrology

THE CITY OF Red Deer

FIGURE No. 2-4

MASTER DRAINAGE PLAN

ENVIRONMENTAL
STEEP SLOPES

AE PROJECT No.	20153382
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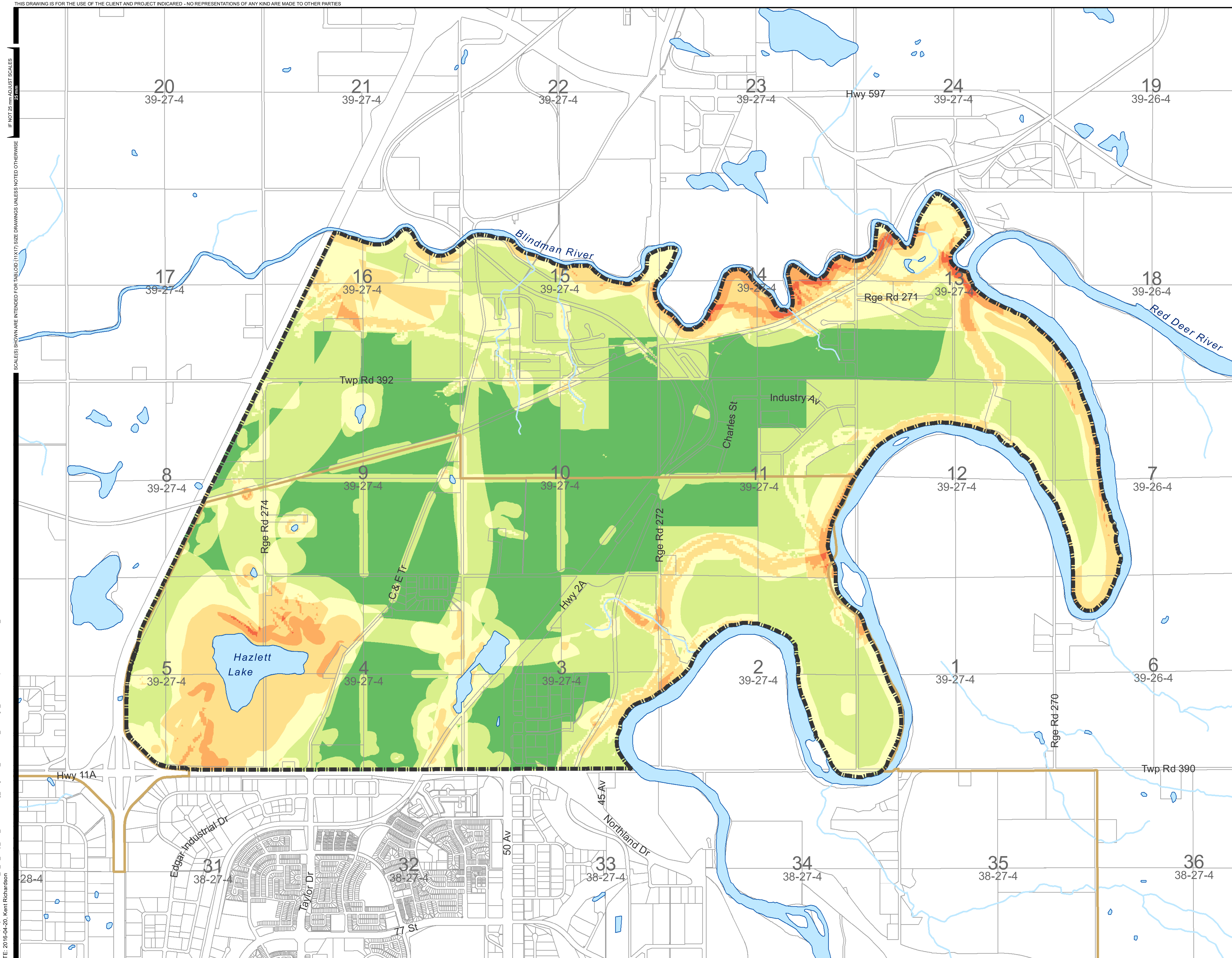
2.3 POTENTIAL IMPACTS TO ENVIRONMENTAL VALUES

To illustrate each environmental value, all features noted in the previous section (ESAs, sensitive areas, valuable wildlife habitats, movement corridors, water features, steep slopes, and the associated spatial data attributed to each) were analyzed spatially to determine areas where environmental values were concentrated. This analysis is represented by a map (**Figure 2-5**) where red shading indicates high concentrations of environmental values and therefore, high sensitivities to development. Similarly, areas shaded in green are less environmentally sensitive to development or contain relatively fewer known environmental values. **Figure 2-5** was used to identify areas where the expansion of service areas could have the greatest environmental impact.

The map (**Figure 2-5**) may be interpreted as graphic representation of varying magnitudes of potential environmental impacts. Numerous potential impacts were assessed and include the loss of wildlife movement corridors, wildlife habitat, wetlands, rare plants, environmental productivity, and increases in waterbody eutrophication, pollution loading, and flood risk. The North of Highway 11A Servicing Study provides extensive details on the potential environmental impacts in the study area (Associated Engineering - 2016). Generally, **Figure 2-5** may be used when developing a Master Drainage Plan in conjunction with other environmental considerations such as the evaluation of wetland Crown-claimability which is discussed in the following section of this document.

Numerous mitigation strategies are available to avoid or reduce impacts to the environmental values discussed. Recommendations for managing environmental values can be found in Section 5.



Associated Engineering

Legend:

Concentration of Environmental Values

- High
- Moderate
- Low
- No Variables Identified
- Study Area
- City of Red Deer
- Hydrology

THE CITY OF Red Deer

FIGURE No. 2-5

MASTER DRAINAGE PLAN

ENVIRONMENTAL
ENVIRONMENTAL VALUES

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2.4 GENERAL PRACTICES FOR IDENTIFYING CROWN CLAIMABLE WETLANDS

This subsection is intended to serve as a preliminary planning tool for the City of Red Deer to be used when reviewing neighborhood drainage plans where wetlands are present and must be modified or removed for infrastructure development and drainage purposes. This information should be used to assist in the identification of wetlands within the study area, which will require replacement, in the form of an in-lieu fee program or compensation, if impacts cannot be avoided or minimized. Wetlands which are considered Crown claimable or of significant environmental importance will require higher compensation values if modified or removed. With this knowledge, the City of Red Deer can design drainage plans in a way to selectively preserve, modify, or remove wetlands in a resource effective way.

Under the *Alberta Wetland Policy* (ESRD 2013) and the *Alberta Wetland Assessment and Impact Report Directive* (AEP 2015a), the proponent is required to obtain all relevant authorizations under the *Water Act* and *Public Lands Act* for any activity within a wetland or near a wetland that will potentially impact its area or water management. Wetlands must also be characterized using the *Alberta Wetland Identification and Delineation Directive* (AEP 2015b) and the *Alberta Wetland Rapid Evaluation Tool-Actual (ABWRET-A) Guide* (AEP 2015c). The Alberta Wetland Policy provides the framework for assessing wetlands, the mitigation hierarchy, and the regulatory process for impacting wetlands. The mitigation hierarchy outlines three stages to be followed during project planning near wetlands. Listed in order of priority, these include avoidance, mitigation, and replacement for any unavoidable wetland impacts.

Permanent wetland impacts require submission of a Water Act Approval Application as well as a Wetland Assessment and Impact Report (WAIR) including a proposal for wetland replacement. Replacement is determined though the Alberta Wetland Rapid Evaluation Tool (ABWRET). The wetland value rating is determined based on the ABWRET-Actual (ABWRET-A) field assessment submitted to AEP, after which a final value rating is issued. Possible value ratings listed from high value to low value include four (4) categories: A, B, C, or D. Depending on the wetland values provided by AEP, the compensation ratio for the wetlands that would be lost to development can range from 8:1 to 1:1 for affected wetlands. Impacted wetlands will be compensated by the monetary value of the total of the impacted area.

The *Public Lands Act* stipulates that the Crown owns the bed and shores of all permanent, naturally occurring, waterbodies. Proposed impacts on any permanent Crown-claimable wetlands require application for a title disposition under this Act. A determination whether the Crown plans to claim any portion of the wetlands to be disturbed. This Crown-claimability result is provided, upon request, by a lands officer with Alberta Environment and Parks (AEP; this process may take between 4 and 8 months). To expedite the lands officer’s review of wetlands, an “assessment of permanency”, or “primary assessment” may be completed by a qualified professional, and submitted to AEP. The remainder of this subsection discusses the process for determining wetland permanency for a Crown-claimability outcome under the Public Lands Act.

The Province of Alberta has jurisdiction over the bed and banks of all waterbodies in the province. Waterbodies determined to be permanent are likely to have their ownership claimed by the Province of Alberta under Section 3 of the Public Lands Act. It is important to note that Crown claimable status may exist for wetlands that were historically drained or filled without authorization from the Province of Alberta and must be included in the assessment process. The three criteria for the Province to assert ownership are as follows: the wetland must be:

- A body of water;
- Naturally occurring; and
- Permanent (or reasonably so).

A "primary assessment" of wetland permanence may begin with a desktop review of available data. The assessor should possess a range of knowledge and skills including:

- Strong skills in aerial photography interpretation;
- Basic understanding of geomorphology and landscape formation;
- Basic understanding of obtaining and interpreting precipitation trends;
- Moderate skills in wetland botany; and
- Moderate skills in wetland ecology.

The general procedure for delineating wetlands requires the historical comparison of aerial photographs of a wetland cross-referenced with historical and seasonal precipitation data (ESRD 2014). The general procedure is as follows:

1. Obtain historical precipitation data for the area containing the wetland(s) of interest and determine periods of lower and greater than normal precipitation.
2. Obtain aerial photographs representing the earliest and latest photographs of the areas containing wetland(s) of interest and obtain interim photographs corresponding with periods of lower than and greater than normal precipitation.
3. Compare aerial photographs to reveal topography and identify wetlands, low areas and depressions which have potential to collect water. Note how these water prone areas respond to inundation by water during periods of lower and greater than normal precipitation. Determine seasonal extent of surface cover by water during varying periods of precipitation. These data will begin to show the permanence of each wetland.
4. Note any features which may alter the way water inundates water prone areas; features to look for include:
   - Ditching;
   - Dugouts;
   - Roads and impoundments;
   - Constructed and treatment wetlands;
   - Wetlands created by leaky irrigation;
   - Abrupt changes in wetland class; and
   - Any other features which may alter the natural dispersal of water on the land scape.
5. Based on the information available in the aerial photography, identify the number of weeks each wetland is flooded annually with consideration to periods with precipitation that is less than and greater than normal precipitation, and periods of normal precipitation. If sufficient data has been gathered, fit each wetland into the appropriate wetland class to determine the preliminary classification of each wetland.

Approximate wetland boundaries and permanence results may be obtained from the desktop review and confirmed during a field visit. The field professional should have the additional skills of:

- wetland vegetation identification; and
- field techniques and procedures.

Prior to 2015, two major classification systems have been used in Alberta for wetland impact assessments: Stewart and Kantrud (1971) for wetlands within the white zone of Alberta and Cowardin Classification System for wetlands within the green zone of Alberta (GoA 2015b). The new wetland policy references a new GoA-produced classification system, heavily based upon the above two systems (GoA 2015b). If a full Wetland Impact Assessment is completed on a wetland to be disturbed, the new GoA classification should be used. If only a “primary assessment” is completed for permanency determination, the Steward and Kantrud system may be used, as it is potentially a simpler process, and the GoA has provided permanency guidance based on this classification system (ESRD 2014). In other words, the GoA has identified those classes of Stewart and Kantrud wetlands that are most Crown claimable.

Using the Stewart and Kantrud system, wetlands can be classified into seven classes (**Table 2-1**) which correspond to permanence and can be used as a proxy to evaluate potential Crown claimability. Wetland class can be broadly estimated during the desktop portion of the assessment; however, in some cases completing only the desktop portion of the assessment may not provide the breadth of detail required by the Province of Alberta to determine permanence.

Table 2-1
Stewart and Kantrud Wetland Classes and their Potential Crown Claimability (GoA 2014h)

Major Wetland Class and Dominant Vegetation Zone		Permanency	Weeks Flooded (/year)	Potential Crown Claimability
Class I	Local vegetation	Ephemeral	N/A	No
Class II	Wet meadow	Temporary	1 – 4	No
Class III	Shallow marsh	Seasonal	5 – 7	Possibly
Class IV	Deep marsh	Semi-permanent	18 – 51	Yes
Class V	Open water	Permanent	52	Yes
Class VI	Open water and bare ground	Saline	N/A	Case-by-case
Class VII	Fen	Fen	N/A	No

The complete assessment of Crown claimability of all wetlands that may be disturbed can be resource intensive. With these general practices for determining potential Crown claimability, drainage plans can be developed in a way that reduces the number of complete wetland assessments required to complete drainage plan designs. Note: if the crown claims ownership of a wetland, a disposition may still be obtained to disturb a portion of that wetland, similar to a disposition for disturbing the bed and shore of any other waterbody, however, in extreme cases, a disposition may also be refused by AEP, resulting in no further development of a Crown-claimed wetland.

2.4.1 Flowing Waterbodies

Aside from the specific regulations governing wetlands in Alberta, the Water Act and Public Lands Act also regulate all flowing waterbody types. These include permanent stream and rivers (i.e., the Red Deer and Blindman Rivers), seasonally wet streams, and ephemeral draws. All flowing waterbodies can be classified as A, B, C, or D (mapped or unmapped) per their influence on fisheries resources when a scheduled work is proposed on these waterbodies. These classes and proposed activities apply only under the Codes of Practice established under the Water Act. Proposed work that is not scheduled in a Code of Practice requires Authorization under the Water Act and is subject to the permanence of the waterbody in question.

When considering natural waterbodies in a drainage plan context, the Water Act and Public Lands Act are applied in establishing the crown claimable status of the waterbody. As defined by the Water Act, a waterbody is “any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent or occurs only during a flood”. Considering this definition, it is important to evaluate the permanence, and potentially avoid certain waterbodies in the development of a drainage plan. If disturbance to a waterbody cannot be avoided, then Water Act Authorizations are required prior to undertaking any activity that may impact a waterbody.

2.5 ENVIRONMENTAL CONSIDERATIONS FOR DEVELOPMENT

2.5.1 Wetland Protection: Habitat for Rare Plant Species

Natural wetlands and forested areas should remain intact in future development plans because they are likely the only remaining areas that could contain rare plant species. Barring these conservation measures, it is suggested that rare plant surveys be completed in these areas prior to development or ground disturbance at the multi-neighborhood structure plan stage. If found, rare plants can be transplanted to a suitable area, or the area could be designated ecologically significant and conservation measures employed.

2.5.2 Wetland Protection: Avoiding Eutrophication and Loss of Productivity

Wetlands should be maintained as sensitive landscape features during the land use planning process. Wetlands will require delineation to determine their precise boundaries, and a no-development buffer should be applied to each wetland. Buffer distance may vary depending on the productivity and class of each wetland, but are necessary to intercept and sequester pollution and nutrients flowing towards each wetland. A literature review by Hawes and Smith (2005) indicates a minimum buffer distance of 30 m is required in most cases to remove 90% of common pollutants and sediment entering waterbodies during normal precipitation conditions. Depending on the conservation goal(s), a larger no-development buffer could be designated around certain wetlands where the maintenance of functional wildlife habitat is considered important (such as wetlands located within or near to a potential wildlife corridor). In such case, the minimum recommended buffer width is 100 m or more (Chase et al. 1997).

2.5.3 Wetland Protection: Avoiding Pollution and Nutrient Input

It is recommended that stormwater management infrastructure be designed such that runoff from developed areas does not enter natural waterbodies untreated. At minimum, stormwater should pass through pollution traps where sediments and petroleum products can be removed from water. Stormwater runoff must not enter a waterbody at a flow rate higher than the pre-development release rate (2.0L/s/ha). Stormwater should be diverted to ponds for primary treatment and discharged slowly to waterbodies. In some cases where the risk for pollution to enter the environment is high, consideration should be given to diverting runoff to water treatment facilities.

Pollution may also enter waterbodies by overland runoff flow. This vector of introduction can be mitigated by maintaining the existing riparian buffer strips around waterbodies, and planting vegetation where none presently exists to preserve their long term value and function. The minimum recommended buffer width, measured from the top of the bank, required to intercept pollution is 30 m when vegetation consists of forest (shrubs, trees, grasses). Where only grasses are present, the recommended buffer width should be doubled (Chase et al. 1997; Hawes and Smith 2005).

When considering the location of riparian buffer strips, it is recommended that all natural water conveyance features are protected from the introduction of pollution. All ephemeral draws, and first, second, and third order tributaries should be considered with equal importance to the Blindman and Red Deer Rivers, and protected using riparian buffer strips with minimum width of 30 m (Hawes and Smith 2005). Similarly, it is important that riparian buffer strips extend along the entire length of each waterbody. In certain cases, privately owned lands have maintained lawns to the waterbody's edge. In such cases, the benefits of the surrounding riparian buffer strips are negated; landowners with un-buffered properties leading to waterbodies should be encouraged to re-vegetate those areas to maintain a contiguous buffer along the waterbody (Hawes and Smith 2005).

To inhibit solar pollution to waterbodies (which raises water temperatures and reduces concentration of available oxygen), vegetation should be left intact on river banks, near to watercourses, and wetlands. The height of the vegetation is more important than the width of the buffer strip, provided that the buffer is at minimum 30 m wide to mitigate pollutant laden overland runoff. In the Red Deer region, vegetation along rivers should consist of natural forest with mature trees and adequate regeneration to maintain the forest (Chase et al. 1997).

The above noted recommendations are reflected in a provincial document, Stepping Back from the Water which contains guidelines for land use planners, developers, landowners, and any person interested in limiting their impact on Alberta's waterbodies. The document contains best management practices for preserving and enhancing the ecological function of wetlands, streams, rivers, and lakes, and also contains technical information necessary to implement the discussed best management practices. It is recommended that the City of Red Deer consider the Stepping Back from the Water document an important component in future drainage and land use planning exercises (Government of Alberta 2012).

2.5.4 Mitigating Flood Risk

There are some areas within the North of Highway 11A service area that may be within flood plains. Prior to development, a flood risk analysis should be completed for areas adjacent to the rivers considering the 1:100 flood elevation currently referenced in the City of Red Deer Land Use Bylaw. Given the increased frequency of flood events in recent years, flood analysis could be completed to include flood events of greater magnitude. Development within the flood risk area should be limited to recreational trails, open space, natural park, or environmental reserve, and the required infrastructure should be designed to accommodate and withstand flood inundation. To reduce the risk of erosion during flood conditions, it is recommended that the flood-risk area remain entirely vegetated. Wide vegetated buffers surrounding wetlands and waterbodies should be kept intact to buffer the impacts of floods against infrastructure. Drainage plans which include wetlands should be designed so that the volume of water entering and leaving a waterbody reflects the natural volumes expected in that waterbody.

2.5.5 Hazlett Lake: The Importance of Protection and Management

The habitat features surrounding Hazlett Lake are unique to the Red Deer area and provide significant habitat for 53 documented migratory birds, birds of prey, shore birds, waterfowl, and one mammal; all are species of environmental concern. Of these, 7 are designated species at risk and protected federally under the Species at Risk Act. Because of the environmental significance associated with Hazlett Lake, it is recommended that development surrounding Hazlett Lake be restricted and that the lake and surrounding area be designated as environmental reserve, urban park, or protected area. The Hazlett Lake Management Recommendation Repot (Westhoff Engineering – 2015) has provided setback width options for Hazlett Lake based on documented species and the guidelines outlined in “Stepping Back from the Water” (AEP).

2.5.6 Rivers and Streams: Implementing Development Setback

Considering the habitat contained within the Red Deer and Blindman River valleys, and the abundance of documented rare, sensitive, and important species supported within these habitats, it is recommended that development setbacks be implemented which encompass the entire valley (i.e., from the river’s edge to the top of the valley slope), especially in presently naturalized areas.

Additional buffers should be considered from the top of the valleys, and also applied to ephemeral streams and draws where they are selected for protection / maintenance in area drainage plans. Generally, the recommended setback is based on the desired outcome for areas with rivers, streams, and ephemeral features: maintain buffer strips around waterbodies to prevent pollution entering waterbodies by overland runoff flow. The minimum recommended buffer width, measured from the top of the bank, required to intercept pollution is 30 m when vegetation consists of forest (shrubs, trees, grasses). Where only grasses are present, the recommended buffer width should be doubled (Chase et al. 1997; Hawes and Smith 2005). The aforementioned typical setbacks should be reviewed during a development’s detailed planning stage to ensure site specific conditions are taken into account. Design should be in accordance with the guidelines noted in AEP’s document titled Stepping Back from the Water (Government of Alberta 2012).

3 Storm Drainage System

3.1 INTRODUCTION

In order to service the future development area, a series of stormwater management facilities are required within the project boundary to provide water quantity control, and to prevent any increase of erosion and downstream flooding to existing receiving streams.

The detention ponds also provide benefits in improving stormwater quality by promoting the settlement of runoff pollutants. Alberta Environment´s stormwater management guidelines require control of water quality in urban stormwater. The minimum requirements are to remove at least 85% of the suspended sediments larger than 75 micron (0.75 mm) in size.

As shown in **Figure 1-2** (land use), the servicing area includes the development of approximately 2,804 ha of a mix of industrial, commercial and residential land uses.

Approximately 836 ha of the total area include natural zones, designated as parks and natural reserves, which also provide attenuation of peak flows during a storm event.

The following sections provide a summary of the stormwater management requirements and the ultimate servicing drainage concept to assist with the planning of the future development areas within the servicing study area.

3.2 STORM SERVICING DESIGN CRITERIA

Design criteria from the City of Red Deer Design Standards (2013) and Alberta Environment stormwater management guidelines will be adopted for the analysis of the existing and proposed conditions.

The following section summarizes the design criteria relevant to this project.

3.2.1 Design Storm

The design standard for the City of Red Deer requires that the minor system be designed to have capacity for the 1:5 year storm and the major drainage system be designed to accommodate the 1:100 year storm.

Upgrades will be proposed to meet the following criteria:

- Prevent storm sewer from surcharging to ground during a minor storm event (1:5 year storm event), and
- Limit the potential for flooding of private property in a major event (1:100 event storm event).

The Intensity-duration-frequency (IDF) rainfall data from the Red Deer Industrial Airport (period 1964-2006) will be used for the analysis of the proposed systems. **Table 3-1** provides the IDF parameters used in the model for the 1:5 and 1:100 return frequencies.

Table 3-1
Red Deer Industrial Airport IDF Parameters – Update to current standards

Frequency (Year)	a	b	c	Formula
5	203	0	-0.60	$203(t+0)^{-0.60}$
100	200	-26	-0.52	$200(t-26)^{-0.52}$

"a", "b" and "c" – Constants developed for each IDF curve.
"t" – Storm duration in minutes
Source: City of Red Deer 2013 Design Standards

Design storm hyetograph will be developed using the Chicago Method. The duration of the storm will depend on the type of system being analysed.

- Storm sewer system - 4 hours storm;
- Detention pond and major system components - 24 hours storm.

3.2.2 Runoff Coefficients

The runoff coefficients, shown in **Table 3-2**, were used for the conceptual sizing of the future stormwater management facilities using the Modified Rational Method.

Table 3-2
Runoff Coefficients (C)

	Storm Frequency	
Land Use	**1:5 Year Storm**	**1:100 Year Storm**
Residential	0.35	0.60
Apartments	0.70	0.80
Downtown Commercial	0.85	0.90
Neighbourhood Commercial	0.65	0.80
Lawns, Parks, Playgrounds	0.20	0.30
Undeveloped Land (Farmland)	0.10	0.20
Paved Streets	0.90	0.95
Gravel Streets	0.25	0.65

A weighted average of impervious and pervious area runoff coefficient will be used in developed areas where mixtures of lands uses are proposed.

3.2.3 Model Development

A PCSWMM model was used to evaluate the capacity of the existing and proposed storm drainage systems and alternatives to improve its performance. PCSWMM is a fully dynamic computer model designed for simulating flows and water levels in sewer systems. It is capable of simulating real storm events, design flows, surcharging and backwater conditions, as well as stormwater pond operation and reverse flows in complicated storm systems. **Table 3-3** outlines the model parameters that will be used in the PCSWMM model for the proposed systems.

Table 3-3
PCSWMM Model Parameters

Parameter	Value
Ground Slope	Average catchment slope calculated based on DEM
Impervious Area Manning's n	0.015
Pervious Area Manning's n	0.25
Impervious Depression Storage	2 mm
Pervious Depression Storage	5 mm
Percent of area with zero detention	25%
Maximum Infiltration Rate	75 mm/hr
Minimum Infiltration Rate	5 mm/hr
Decay Constant	4 (1/hr)

Horton infiltration parameters depend on the type of soil and their saturated hydraulic conductivity. Values shown in Table 3-3 were referenced from the “User’s Guide to SWMMS, 2010” and “Rawls, W.J. et at., 1983”.

Table 3-4 provides the imperviousness values used in the computer modeling of the proposed drainage system.

Table 3-4
Imperviousness Values

Land Use Description	Percentage Impervious
General Residential	40
Commercial	90
Industrial	70
Public/Park/Recreation	0
Agriculture	0

The percent imperviousness refers to the anticipated amount of surface runoff generated based on the land use of an area. Development of land (paving, buildings, etc.) increases the imperviousness of an area, thus reducing the surface runoff infiltrating into the ground. The increased volume and rate of runoff produces larger peak discharges in developed watersheds than would have occurred before development.

The percent imperviousness values provided in **Table 3-4** are based on the type of soil, and they are typical values for the land uses applicable to the project area.

The following Manning's "n" values are used in the assessment of the storm drainage system:

- Impervious areas: 0.015
- Pervious areas: 0.25 - 0.50 (typical for agricultural/undeveloped areas)
- Grassed ditches: 0.035

Manning's "n" value describes the resistance of the bed of a channel (or the surface of a pipe) to the flow of water in it.

3.2.4 Model Catchments

Catchment areas will be delineated from the LIDAR 15 DEM data obtained from AltaLIS. As the name suggested, the data comprises 15 m resolution Digital Elevation Model (DEM), with a vertical accuracy of 0.3 m. Manifold GIS software was used to calculate the average slope for each catchment.

The impervious percentage for each catchment will be calculated by overlaying the land-use map over the catchment map in PCSWMM and calculating the weighted impervious area based on land-use.

3.2.5 Stormwater Management Facilities

Stormwater management ponds will be required for all new developments to control flows and prevent any increase of erosion and downstream flooding to existing receiving streams. Detention ponds also provide benefits in improving stormwater quality by promoting the settlement of runoff pollutants.

Where practical, existing wetlands and waterbodies may be incorporated into stormwater management plans. The Alberta wetland policy must be followed for any changes to naturally occurring wetlands. Additionally, the provincial *Water* and *Public Lands Acts* may be triggered when incorporating wetlands and waterbodies into stormwater management.

Stormwater management facilities, including all inlet and outlet points at waterbodies, will require appropriate erosion protection measures to be included in the detailed design stage. For the design of the stormwater management facilities, the following criteria, derived from the City of Red Deer design standards, was used:

3.2.5.1 Dry Detention Ponds

- Design storage volume: 1:100 year – 24 hour storm
- Maximum storage depth: 1.5 m
- Pond side slopes: 5H:1V
- Minimum freeboard: 0.6 m
- Minimum longitudinal slope: 1%

3.2.5.2 Wet Detention Ponds

- Design storage volume: 1:100 year – 24 hour storm
- Permanent pool depth: 2 m
- Maximum active storage depth: above normal water level (NWL) 1.5 m
- Minimum freeboard: 0.6 m
- Pond side slope: 5H:1V

3.2.5.3 Forebay Design

According to AEP, wet pond water quality control can be improved by providing pre-treatment sump or forebay. The following is the general design parameters to determine sizing and dimensions of sedimentation forebay as per Alberta Environment and Parks Guidelines.

- Length to width of 2:1 or greater
- Surface area not to exceed one-third of the permanent pool surface area
- Forebay length, L_{fb} = L_{fb}= $[rQ_p/V_s]$^0.5

  Where:

  r = Length to width ratio of forebay

  Q_p = Peak flow rate from the pond during the design quality storm (m^3/s)

  V_s = Settling velocity (dependent on the desired particle size to settle

- Dispersion length, L_{dis} = L_{dis}= $(8Q)/(dV_f)$

Where:

Q = Inlet flow rate (m^3/s)

D = Depth of permanent pool in the forebay (m)

V_f = Desired velocity at the end of the forebay

- Forebay bottom width, W = $L_{dis}/8$
- Forebay berm = 0.15 to 0.3 m below permanent pool elevation

3.2.6 Culverts and Ditches

- Manning's "n" for grassed ditches: 0.035
- Design Storm 1:100 year: 4 hour storm
- Manning "n" value of: 0.013 for concrete culverts, and 0.024 for corrugated steel pipe (CSP)
- Culvert minimum nominal diameter 400 mm

3.2.7 New Storm Sewers

- Minimum manning "n" value of 0.013 for concrete and PVC pipes
- Design storm: 1:5 year – 4 hour storm
- Flow velocity range: 0.6 – 3.0 m/s
- Storm sewer inverts to be set at an elevation at least 2.7 m below finished grade
- Spacing between manholes no greater than 150 m along the length of the sewer
- Obvert elevation of the lowest upstream pipe equal to or higher than obvert of the downstream pipe
- Depth of water at curbside should be less than 300 mm during the 1:100 year storm event

3.3 EXISTING TOPOGRAPHY AND NATURAL FEATURES

Manifold GIS software and DEM data were used to generate detailed contours, overland drainage paths and sag locations to assess the major drainage system for the project area. The DEM data was also used to delineate general and detailed catchment boundaries for the existing and future conditions. The existing topography of the project area is shown in **Figure 3-1**.

Figure 3-1 shows the topography using 1 and 5 m contour intervals. Based on the contours, the future development area is divided into two drainage basins, the Blindman basin and the Red Deer River basin. Both basins seem to have a good natural drainage system which will facilitate the intersection of surface runoff through a series of ditches, culverts and storm sewer systems (where necessary) towards the proposed stormwater management facilities.

There are few sags areas within the project boundaries, as shown in **Figure 3-1**. The most significant sags (not including existing wetlands and lakes) has approximate ponding depths between 0.5 m – 1m, specifically south of Central Park subdivision which is consistent with observed ponding issues in previous years.

The Hazlett Lake and the lake on the IPSCO property are also part of the natural features present within the project area. The surface runoff of the Red Deer River basin drains through these two natural lakes, and eventually discharges east towards the Red Deer River.

The following are key notes based on the analysis of the existing topography and 1 m contours:

- Approximately 1169 ha of the total area drains towards the Blindman River;
- Approximately 1635 ha of the total area drains towards the Red Deer River;
- A major trapped area is observed south of the Central Park subdivision;
- Approximately 273 ha and 417 ha drains directly to the Hazlett Lake and lake on the IPSCO property respectively; and
- Existing wetlands should be preserved as stormwater management facilities to provide additional storage within the future development area. A more detailed environmental study will be required during the development phase to confirm wetland classification and to establish environmental values for preservation.

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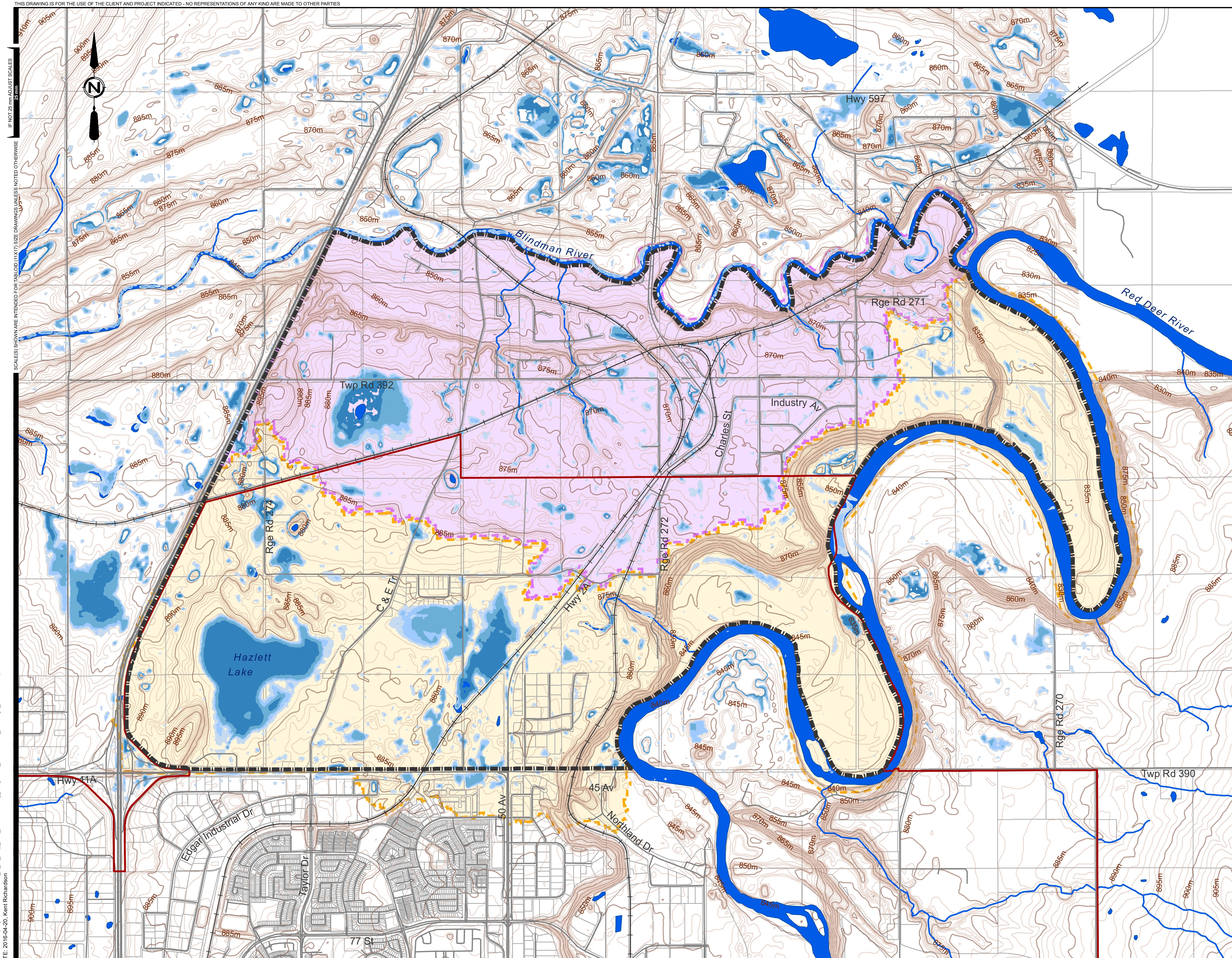

Associated Engineering

Legend:

Trapped Areas

- 0.1m - 0.3 m
- 0.3m - 0.5m
- 0.5m - 1.0 m
- 1.0m - 1.5m

- Blindman River Catchment
- Red Deer River Catchment

- Contour 1m
- Contour 5m

- Study Area
- City of Red Deer

THE CITY OF Red Deer

FIGURE No. 3-1

MASTER DRAINAGE PLAN

STORMWATER
GENERAL TOPOGRAPHY

AE PROJECT No.	20153382
SCALE	1:30,000
APPROVED	
DATE	2016 APRIL
REV	
DESCRIPTION	ISSUED FOR REPORT

IF NOT 25 mm ADJUST SCALES 25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-edm-fs-01\projects\20153382\00_N_of_Hwy_11A_Serv\Working_Dwgs\010_GIS\Master_Drainage_Plan\ArcMap\3-1 Stormwater.mxd
DATE: 2016-04-20, Kent Richardson

3.4 EXISTING DRAINAGE CONDITIONS

In general, the project area is approximately 80% undeveloped with the exception of small subdivisions such as Central Park, Chiles Industrial Park, Blindman Industrial Park and Spruce Lane Acres. The project area is mainly being serviced through surface drainage systems. Existing tributaries of the Blindman River and Red Deer River are utilized along with a series of drainage culverts, culverts/bridges structures and connecting ditches. The project area has a formal stormwater management facility, a dry pond, and an outlet storm sewer located on the east side of Highway 2A in the Chiles Industrial Subdivision.

As previously mentioned, the project area is divided into two major basins:
- Red Deer River Basin; and
- Blindman River Basin.

These basins are described further in the following sections.

3.4.1 Red Deer River Basin

The basin has a total drainage area of approximately 1635 ha with natural slopes ranging 1% to 6%. The basin includes:
- Two major natural features, the Hazlett Lake and a lake on the IPSCO property located in NW and SW of 3-39-27 W4 and in the SW of 4-39-27 W4;
- Approximately 1,028 ha of undeveloped area and approximately 607 ha of developed area (mainly residential and industrial);
- An overland drainage route from Hazlett Lake to the Red Deer River. Flows from the Lake drain through a ditch which runs along the south boundary of the Central Park subdivision, and then cross Range Road 273 via an 600 mm diameter culvert, and towards to the unnamed east lake through a natural channel;
- Two 900 mm diameter culverts located under the Canadian Pacific Railway. Water from the lake on the IPSCO property is currently pumped through these culverts which have inverts set to 1 m above the bottom of the existing ditch; and
- A stormwater management facility (dry pond) that provides water quality and quantity control to the Chiles Industrial Park Subdivision and eventually discharges to the Red Deer River through an existing storm sewer pipe.

The following sections provide additional background information of the existing drainage conditions of Hazlett Lake, the unnamed east lake, and Chiles Industrial Park's stormwater management facility.

3.4.1.1 Hazlett Lake

Photo 1: Hazlett Lake

Hazlett Lake has been identified by Alberta Environment and the City of Red Deer as a natural feature with high environmental significance. The Lake has an approximate surface area of 37 ha and is habitat to a number of sensitive wildlife species and supports a number of wetlands and plant communities. Westhoff Engineering classified the lake as a Class V wetland in their Hazlett Lake 2014 Baseline Assessment. For these reasons, preservation of the Hazlett Lake is a priority and it has been assigned as natural “green spaces” in the proposed land use for future development.

Photo 1 shows an overall view of Hazlett Lake taken during a site visit on May 2015 and **Figure 3-2** provides an illustration of the key components of the Hazlett Lake system.

A number of reports have been completed in the past that describe the overall drainage characteristics of the Lake, and also provide recommendations for conservation of the Hazlett Lake. A summary of the most relevant information is described below:

- ***“Master Drainage Plan for Queens Business Park” – Westhoff Engineering Resources, Inc., May 2007”.***

  According to the report, the Hazlett Lake is considered an “overflow” facility since it receives runoff for the Queens Business Park in extremely severe storm events. The majority of the time, the runoff from the development area is controlled on-site through stormwater management facilities and flows are conveyed by a storm trunk that directly discharges into the Edgar storm sewer system.

  Hazlett Lake also receives runoff from the Highway 11A and Highway 2A interchange; however, according to the report this configuration will remain a status quo in the future.

  Figure 3-3 shows the upstream drainage areas of Hazlett Lake that were identified in the Westhoff report.

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Legend:

- Existing Drainage Route
- Existing Stormwater Trunk
- Existing Stormwater Pond
- Proposed Transportation
- Existing Transportation
- Contour 1m
- Contour 5m
- Hazlett Lake Gauge Station
- StudyArea

Notes:

1. Based on the City of Red Deer water level monitoring data, the average water level of Hazlett Lake between 2008 and 2017 is 877.60 m.
2. Natural Drainage Route elevation is higher than the HWL of the lake. Discharge from the lake would only occur during catastrophic events (1-300 year event for example) as noted in the 2007 Al-Terra Engineering Report.

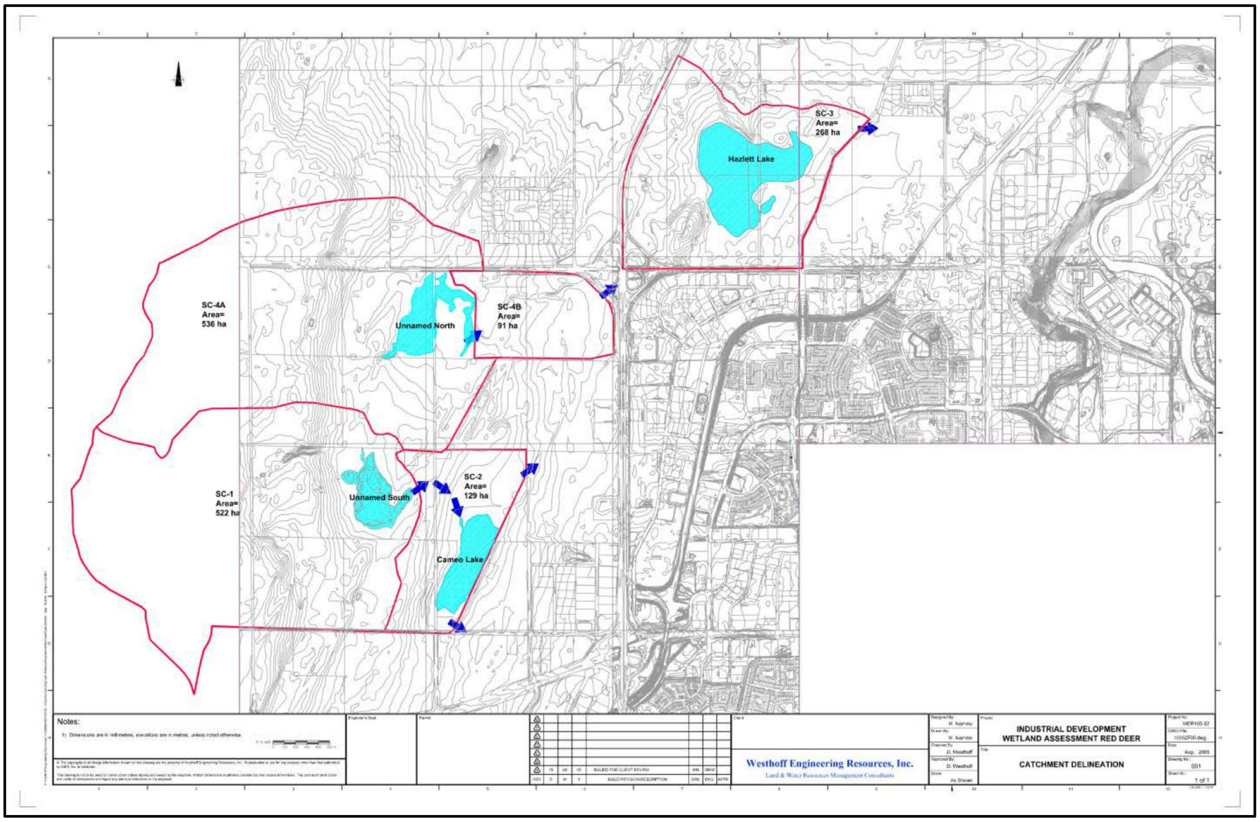
FIGURE No. 3-2

MASTER DRAINAGE PLAN

STORMWATER
HAZLETT LAKE INLET & OUTLET CONFIGURATIONS

AE PROJECT No.	20153382
SCALE	1:10,000
APPROVED	
DATE	2016 APRIL
REV	
DESCRIPTION	ISSUED FOR REPORT

Figure 3-3
Catchment Delineation Provided in Westhoff Report



- ***"Queen Industrial Park & Future Industrial Lands Sanitary Sewer and Storm Sewer Trunks Projects" Pre-Design Report, Al-Terra Engineering Ltd., May 2007"***

  The drainage analysis included the tributary areas of the water bodies of Cameo Lake, Hazlett Lake and various unnamed wetlands. According to the report, "the principal idea for the proposed stormwater drainage plan is to utilize all the available detention within these existing water bodies, maintain pre-development overland flow rates, and either provide additional detention onsite or pass the drainage onto the Red Deer River via existing overland drainage routes and/or proposed trunk mains."

  As part of the drainage analysis, a XPSWMM model was developed to include the natural waterbodies and the proposed Queen Business Industrial Park Area. According to the Al-Terra report, an extensive amount of time was spent in modelling the Hazlett Lake system in order to simulate the lake water levels in particular storm events; however, it was not possible to produce a detailed model that was able to simulate the field (or recorded) water levels in the Lake.

Upgrades to the existing Hazlett Lake drainage route was also recommended in the report. According to the report's reference, "Hazlett Lake should never overflow through this drainage channel again except for catastrophic events such as a 1 in 300 year event for example; the drainage upgrades should be completed regardless."

- ***"Stormwater Management Analysis Results", Westhoff Engineering Resources Inc., September 2005"***

  This report provides preliminary modelling results for four main wetlands including Hazlett Lake. The analysis was based on an impervious value of 75%, 1:100 year 24 hour Chicago Storm, and contours provided by the City of Red Deer.

  According to the report, the Normal Water Level (NWL) of the Hazlett Lake was estimated to be 877.30 m which is consistent with the NWL estimated based on air photos (extend of water edge).

  Two scenarios were run for Hazlett Lake with different contributing areas and release rates. The model results show that the maximum High Water Level (HWL) elevation for a zero release rate (worst case scenario) was estimated to be in the range of 877.70 m and 877.82 m (post-development conditions).

  For pre-development conditions, dry and wet years of 1979 and 1999 respectively were used to estimate the water levels in the wetlands. As shown in the report, the Hazlett Lake resulted in HWLs in the range of 877.52 m and 878.20 m during the wet year. These results are relatively higher than the post-development conditions.

  The report suggested that a continuous simulation model should be used to confirm the storage requirements since they are being underestimating by using single event analysis (for release rates lower than 3 l/s/ha). According to the report, a continuous simulation uses recorded climate data over a continuous period instead of a single synthetic data (IDF curves).

  Westhoff model results are shown in **Appendix A**.

- ***"Hazlett Lake Monitoring Plan", Westhoff Engineering Resources Inc., January 2015".***

  As previously mentioned, the City of Red Deer has identified the Hazlett Lake as a wetland of regional environmental significant. In order to preserve the habitat of endangered species and plants communities, a monitoring program of the pond ecological integrity and health was planned by the City.

  According to the report, "Monitoring of Hazlett Lake is an important step in managing for the Lake's long-term sustainability. The City initiated the Hazlett Lake Monitoring Program to track observed changes within Hazlett Lake and to identify any negative impacts associated with encroaching urban development."

Several identified parameters to be monitored in the program includes wildlife, water quality, trophic state index, sediment quality, Lake water levels and wet meadow Index of biological integrity. In terms of water quality, the program looks for impacts to the lake's water quality due to additional surrounding developments and direct discharge of surface runoff to the Lake. It also targets the increase of pollutants in the Lake and source of pollution. Lake water levels are monitored at the staff gauge installed at the concrete outfall located south of the Lake.

A photo of the Hazlett Lake outfall and gauge, taken on May 2015, is shown in Photo 2.

Photo 2: Hazlett Lake Gauge Station

In general, based on the background information of the Hazlett Lake and the existing topography of the project area, the Lake has a contributing area of approximately 273 ha (mainly undeveloped).

The normal water level (NWL) and top of lake elevations were estimated to be 877.3 m and 878.2 m respectively, based on available DEM data. Note that these elevations are consistent with the data provided in the "Stormwater management analysis results" report completed by Westhoff Engineering Resources Inc. and the "2005 Industrial Lands Sanitary and Storm Trunk Project" completed by Al-Terra Engineering Ltd.

As noted above, flows from the Highway 11A storm sewer "overflow" to the Lake only during severe storm events. Since these flows are relatively small and do not have an impact to the Lake water levels, and proposed downstream storm system, any upstream flows will not be incorporated in the PCSWMM model. The Majority of the flows from Queen Business and Edgar Industrial Parks are currently being intercepted by a 1050 mm diameter storm sewer and routed directly to the Red Deer River as noted in the "Master Drainage Plan for Queens Business Park" completed by Westhoff Engineering Resources, Inc.

Currently, Hazlett Lake does not have a proper outlet structure. Discharge from the Lake occurs through a natural drainage ditch located along the NE corner of the Lake. Based on the existing topography, the elevation of the NE ditch is higher than the Lake's HWL elevation of 878.2 m, indicating that the lake would not overflow in the 1:100 year storm event. This information is consistent with the 2007 Al-Terra Engineering Report which noted that Hazlett Lake should only overflow into the drainage channel to the NE in the case of a storm event that exceeds the 1:100 year storm. No outflow from Hazlett Lake has been included in the stormwater model for this area.

An outlet structure and drainage channel is required for Hazlett Lake and will be incorporated into the system. The drainage outlet is likely to be placed on the NE corner of the Lake and will outlet to a drainage channel or piped stormwater system. The channel or pipe will ultimately discharge into the Red Deer River. The design of this outlet will be completed separately from this master drainage plan report. Once complete, the outlet design will be submitted to AEP for review and approval.

3.4.1.2 Lake on the IPSCO property

The lake on the IPSCO property is located approximately in the center of the Red Deer River Basin. The contributing area was estimated to be 417 ha and consists of a mixture of industrial, country residential and undeveloped areas.

The following are the Lake characteristics based on the available DEM data:

- Approximately Lake footprint Area: 11.3 ha
- Estimated NWL Elevation: 876.6 m
- Estimated Top of Berm Elevation: 877.0 m

As previously noted the lake on the IPSCO property connects to Hazlett Lake through a series of drainage culverts and ditch systems long the south side of the Central Park Subdivision, as shown in Photo 3. The lake on the IPSCO property inlet consists of a 600 mm diameter culvert located under Range Road 273.

Photo 3: Connecting Ditch between Hazlett Lake and lake on the IPSCO property

Based on the Queens Industrial Park & Future Industrial Lands Sanitary Sewer and Storm Sewer Trunks Project (Al-Terra Engineering Ltd. – 2007) report, the outlet of the Lake consists of two 900 mm culverts with inverts set 1 m higher than the bottom of the ditch. Flows from the lake on the IPSCO property are pumped through these culverts located under the Canadian Pacific Railway and the downstream two 1,200 mm culverts crossing Highway 2A. From Highway 2A, water drains through an industrial area to a natural stream, and eventually to the Red Deer River. Highway 2A culvert crossings and downstream ditch configuration are shown in Photo 4. Al-Terra Engineering drawing titled “Existing Overland Drainage Route for Hazlett Lake with Proposed Easements” is shown in **Appendix B.**

Photo 4: Highway 2A Culvert Crossings and Downstream Ditch

3.4.1.3 Chiles Industrial Park Subdivision

The Chile Industrial Park Subdivision is located in the southeast area of the Red Deer River Basin. The existing storm drainage system of the subdivision consists of a series of drainage culverts and ditches which direct flows towards an existing stormwater management facility (dry pond).

According to ISL as-built drawings, the pond has an approximately footprint area of 0.47 ha and an average pond of depth of approximately 3 m (average depth from pond bottom to maximum water level). The estimated maximum storage capacity provided by the pond is approximately 14,100 m^3.

Flows from the dry pond are controlled by a 350 mm diameter HDPE storm pipe before connecting to an existing 600 mm storm pipe, and eventually draining towards the Red Deer River.

ISL as-built drawings can be found in **Appendix C**.

3.4.1.4 Blindman River Basin

The basin has a total drainage area of approximately 1169 ha with natural slopes ranging from 1.5% to 3.5%. The basin includes the following:

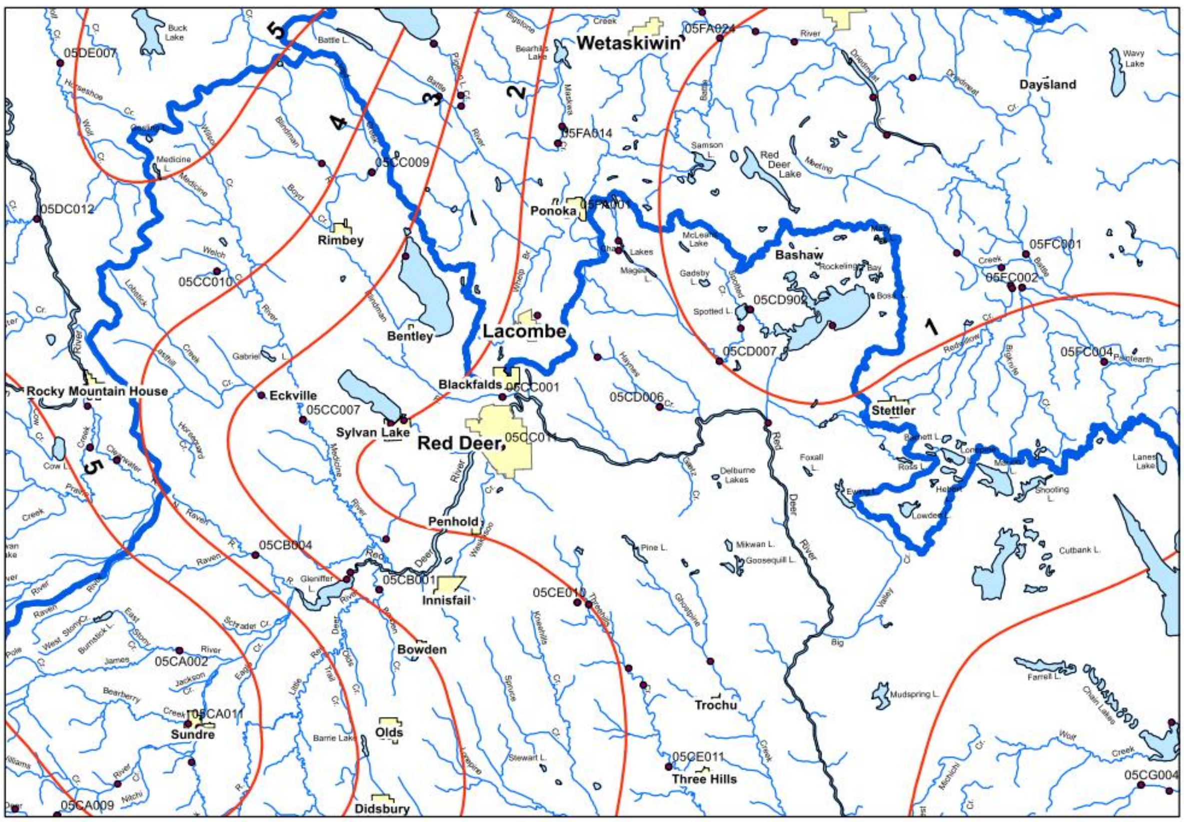
- Approximately 618 ha of undeveloped area and approximately 551 ha of developed area (mainly residential and industrial).;
- Several natural drainage route tributaries to the Blindman River;
- A large natural wetland, approximately 1.04 ha, located in the southwest area of the basin.

Currently, the basin does not have storm sewer systems or stormwater management facilities for water quality and quantity control. Currently runoff from the industrial and country residential areas are being discharged directly to the existing natural streams through a series of culverts/bridges and ditch systems.

3.5 PRE-DEVELOPMENT RELEASE RATE

The construction of houses, commercial buildings, paved roads and parking lots increases the imperviousness of a watershed and reduces the infiltration of rainwater, increasing the volume and rate of runoff. In order to minimize the impact to the environment, stormwater management facilities are used to control the rate of flow to the rates expected prior to development of the land (pre-development flow rates). Alberta Environment and Parks (AEP) have developed a 1:100 year pre-development runoff rate for the Red Deer Region based on nearby hydrometric station instantaneous flow records. Based on the AEP preliminary chart, shown in **Figure 3-4**, the maximum pre-development rate for the project area is approximately 2.0 l/s/ha.

Figure 3-4
AEP Preliminary 1:100 Pre-Development Release Rate Chart



Associated Engineering conducted a preliminary review of the pre-development rate base on the Water Survey of Canada (WSC) gauges. A Regional Analysis was completed using gauge data for a number of rivers and creeks within the vicinity of the Red Deer area, including Threehills Creek, Renwick Creek, Haynes Creek, and Parlby Creek, as summarized in **Table 3.5**. A flood frequency analysis was conducted using the flow data for each stream, and then the flood statistics were correlated with the basin area to generate a regional curve that can be used to estimate flows in un-gauged basins.

Figure 3-5 shows the preliminary regional curve for the1:100 year flood. The analysis showed an R^2 of 0.6 which indicated a relatively a good data correlation between the effective drainage area (area which excludes portions of the basin that do not contribute runoff during small events and contribute at a lower rate than the norm for larger events) and the maximum outflow rate. The scatter around the best-fit regional line is due primarily to the effects of surface storage (lakes, depressions, and ineffective poorly drained areas), differences in record length, and differences in topography between the individual basins.

The correlation equation indicates that the peak low can be estimated as a function of the effective drainage area. For the pre-development study area of 2804 ha, the regional curve indicates an approx. maximum outflow rate of 2.8 l/s/ha for the 1:100 year storm event. Estimates were also made for the 1:5 year storm which resulted in a outflow rate of 0.34 L/s/ha.

Figure 3-5
Regional Flood Frequency Analysis – WSC Gauges

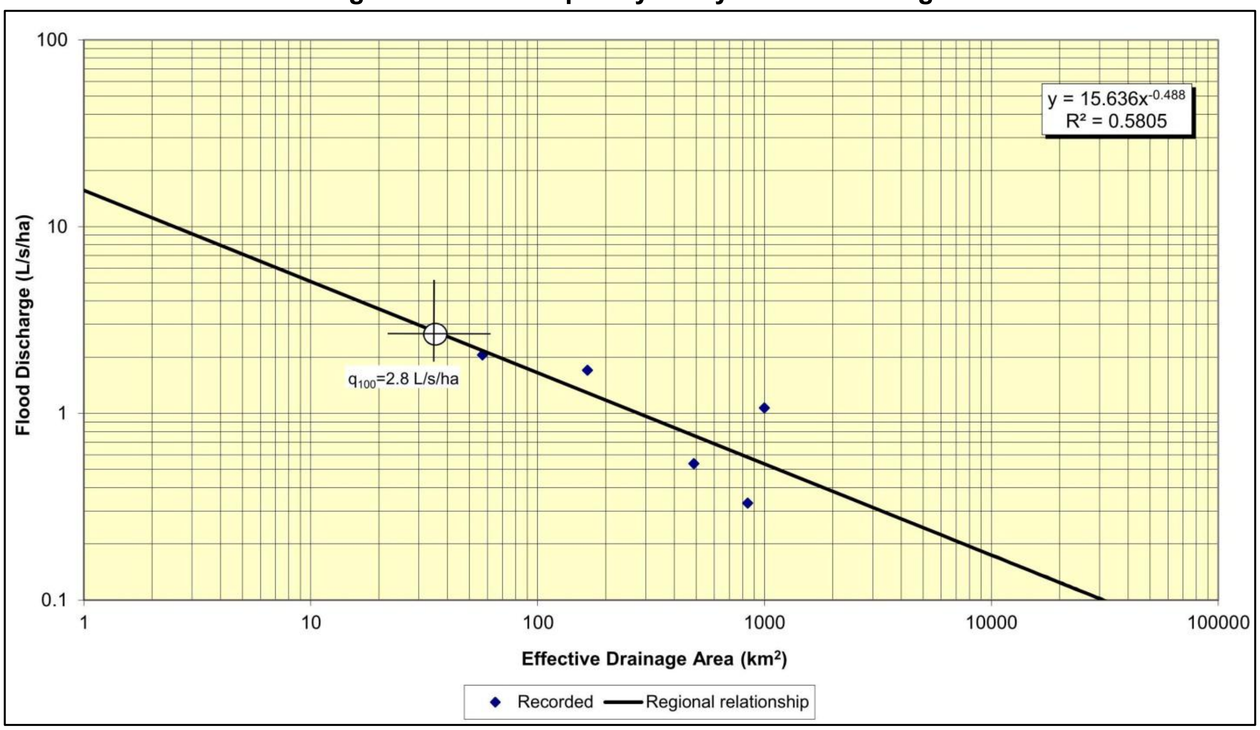


Table 3-5 summarizes the gauge data and flows for different return periods.

Table 3-5: Gauge Data and Flows

No.	Name	DA (km^2)	Return Period (Years)						Design	L/s/ha
			2	5	10	25	50	100	100	
			1	2	3	4	5	6	6	
05CD006	Haynes Creek Near Haynes	166	1.98	5.33	7.35	12.88	19.18	28.22	28.22	1.70
05CD007	Parlby Creek at Alix	488	6.81	12.34	14.85	19.26	22.69	26.23	26.23	0.54
05CD902	Parlby Creek Near Mirror	843	6.86	13.63	13.93	18.72	22.96	27.83	27.83	0.33
05CE007	Threehills Creek Near Carbon	999	13.71	29.43	41.29	62.35	82.35	106.87	106.87	1.07
05CE011	Renwick Creek Near Threehills	57.2	3.03	3.82	7.02	8.96	10.37	11.75	11.75	2.05

As shown in Figure 3-5 and Table 3-5 and based on the regional analysis, the peak flows per unit area decrease as the drainage area increases. Analysis completed in The Greater East Hill Master Drainage Plan (Matrix Solutions, April 2017) is in agreement with this relationship. The Matrix Solutions study indicated that the reduction in flow rate per unit area is due to routing and storage effects as water flows through natural watercourses and water bodies.

Taking the above noted information into account, a 100 year pre-development release rate of 2.0 L/s/ha has been assumed for the North of 11A Study Area.

3.6 CONCEPTUAL FLOOD FRINGE FOR AREA OF CONCERN

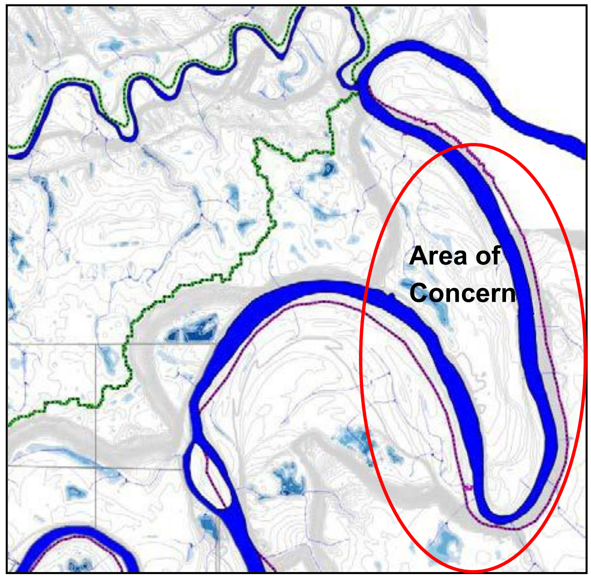
The City of Red Deer has identified an area of concern within the Red Deer River basin, as shown in Figure 3-6. In previous reports, a land use of “green spaces” was assigned to this area but reasoning behind this assumption was unclear. In order to confirm the feasibility of future development in the area of concern, an estimate of the conceptual flood fringe zone within the area was completed.

Please note that the flood fringe areas are conceptual in nature and are only presented to draw attention to an area of concern. Detailed modelling and analysis will be required to establish the flood fringe in these areas.

The conceptual flood fringe elevations were calculated based on the following assumptions:

- The 1:100 year flood elevation for the Red Deer River was taken from the AEP’s Hazard Map.
- An average slope of 0.14% for the Red Deer River was calculated based on the existing flood elevations.
- A linear correlation between elevation and slope was used to estimate the conceptual flood fringe elevations for five (5) points within the area of concern as shown in Figure 3-6.

Figure 3-6
Area of Concern



The conceptual extents of the flood fringe based on the available LIDAR data and calculated flood elevations are shown in **Figure 3-7**. Note that the illustrated flood fringe area is conceptual only. A more detailed analysis of the Red Deer River channel parameters and rainfall events should be completed in subsequent planning stages for the area.

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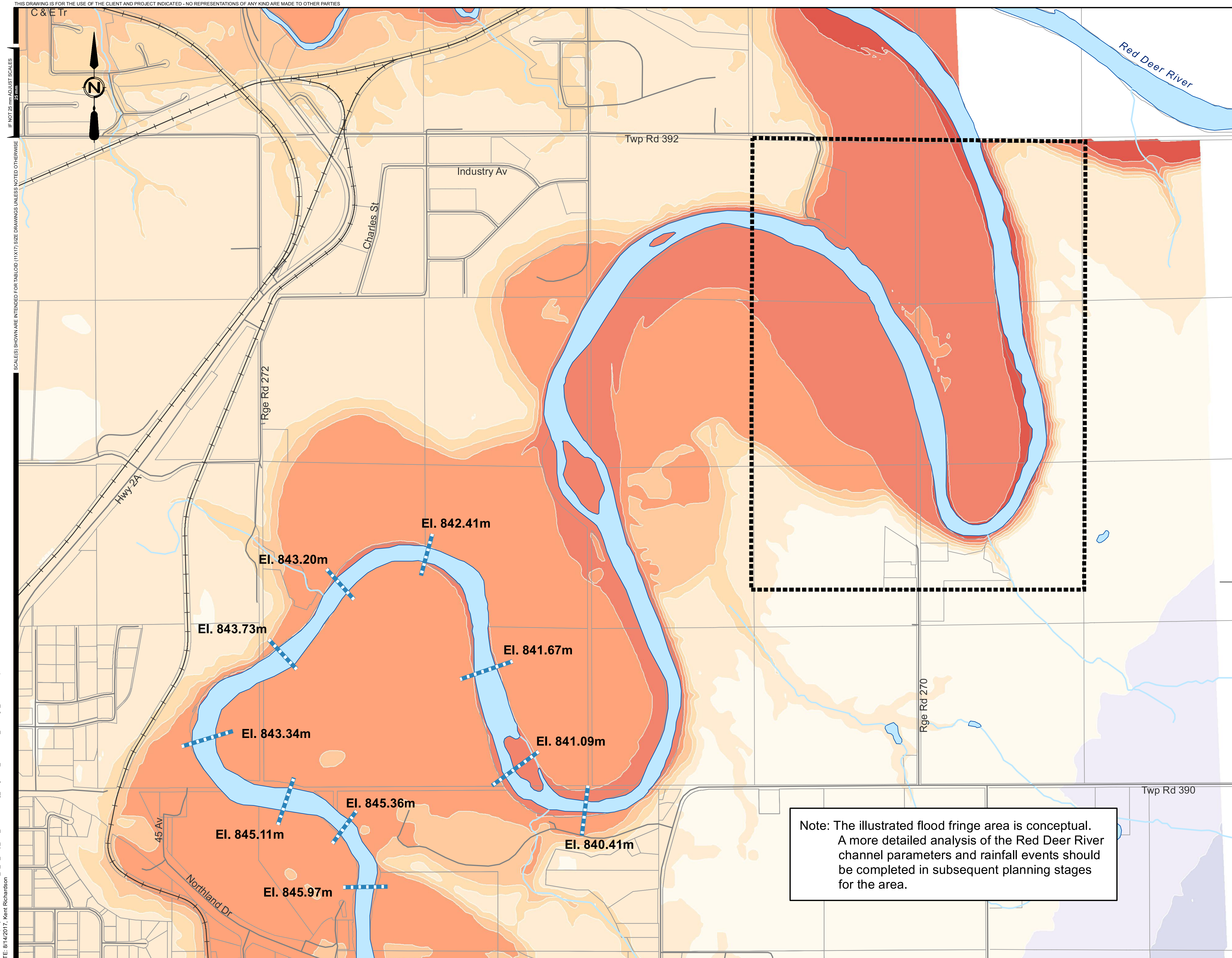

Note: The illustrated flood fringe area is conceptual. A more detailed analysis of the Red Deer River channel parameters and rainfall events should be completed in subsequent planning stages for the area.

Associated Engineering

Legend:

- Area of Concern
- Flood Fringe Elevation (Alberta Environment Flood Hazard Map)

Elevation

- <830m
- 830m - 840m
- 840m - 850m
- 850m - 860m
- 860m - 870m
- 870m - 880m
- 880m - 890m
- 890m - 900m
- 900m - 910m

THE CITY OF Red Deer

FIGURE No. 3-7

MASTER DRAINAGE PLAN

STORMWATER
CONCEPTUAL FLOOD FRINGE ELEVATIONS

AE PROJECT No.	20153382
SCALE	1:18,000
APPROVED	
DATE	2017 AUGUST
REV	
DESCRIPTION	ISSUED FOR REPORT

IF NOT 25 mm ADJUST SCALES

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

\\s-edm-fs-01\projects\20153382\00_N_of_Hwy_11A_Serv\Working_Dwgs\010_GIS\Master_Drainage_Plan\ArcMap\3-7 Stormwater.mxd
DATE: 8/14/2017, Kent Richardson

3.7 STORMWATER MANAGEMENT REQUIREMENTS

AEP´s stormwater management guidelines require control of water quality in urban stormwater. The minimum requirements are to remove at least 85% of the suspended sediments larger than 75 micron (0.75 mm) in size. According to AEP's guidelines, wet ponds and stormwater wetlands typically remove 80-90% of the suspended solids and 40-60% of the suspended and dissolved nutrients in urban stormwater. Therefore, best management practice implies that wet facilities be used. Existing wetlands and waterbodies should be preserved as part of the stormwater management system for the area. If this is not possible, AEP will require replacement or compensation.

The conceptual design of stormwater management ponds will be based on a maximum outflow rate of 2.0 l/s/ha (pre-development release rate) and storage for the 1:100 year – 24 hours storm event.

It is important to note that the storage volumes shown on **Figure 3-8** are conceptual only. The size of each pond should be confirmed during the design stage when details of the pond design and the development concept are finalized.

3.8 PROPOSED STORMWATER DRAINAGE CONCEPT

Figure 3-8 provides an overall view of the stormwater management concept for the future development area. The proposed concept plan was defined based on the following:

- Stormwater management guidelines described above to prevent flooding and erosion of downstream system, and to protect the quality of water in the receiving streams;
- Existing topography. Follow the existing drainage systems; and
- Preservation of existing wetlands and streams.

A PCSWMM model was developed to evaluate the existing drainage conditions within the City of Red Deer boundaries based on as-built drawings and previous engineering reports. The Rational Method was used to conceptually size all the proposed stormwater management facilities and storm trunks within the project boundary. In order to service the future development area, a series of stormwater management (SWM) facilities are required within the project boundary to provide water quantity control, and to prevent any increase of erosion and downstream flooding to existing receiving streams.

The future stormwater management facilities were conceptually sized by using the modified rational method. The active storage requirements were determined by using the Intensity-duration-frequency (IDF) rainfall data from the Red Deer Industrial Airport (period 1964-2006) for the 1:100 year storm event and a release rate of 2.0 l/s/ha.

As noted in Section 3.5, the 5 year unit area release rate was estimated to be 0.34 l/s/ha for the North of 11A basin based on the Regional Analysis. A pre/post development comparison of the 5 year flows was completed for each stormwater management pond (Appendix D). The results of the 5 year analysis show that using an orifice sized for the 100 year release rate results in approximately 92% of the ponds discharging equal or less than the 1:5 year pre-development rate. The Matrix Solutions Greater East Hill Master Drainage Plan also demonstrated that sizing pond outlets based on the allowable 100 year flow rate resulted in 5 year post development flow rates closely resembling 5 year predevelopment flow rates.

Individual stormwater management facilities in this study area are not required to *size* orifices solely based on the 5 year unit area basin flow rate. During detailed design, the 5 year predevelopment flows should be compared with the 5 year post development flows to assist with the selection of the pond orifice configuration.

The preliminary size of the ponds were then calculated by an AE "Wet Pond Design" excel spreadsheet which take in consideration the different ponds depths, minimum freeboard and side slope requirements from the City of Red Deer design standards. Depth-area curves were developed for each pond, and imported into the PCSWMM model to confirm pond capacity and to determine the pre/post development hydrographs.

Table 3-7 (pages 3-24 and 3-25) summarizes the characteristics for the stormwater management facilities. **Appendix D** provides detailed calculations of the ponds sizes, storage volumes, and outfall rates (1:5 and 1:100 year storm event). These are all subject to review in the design stage based on the design standards that apply at the time and based on the details of the servicing of those areas.

As shown in **Figure 3-8**, twenty nine (29) stormwater management facilities are proposed within the project area in order to provide water quality and quantity control before discharging to existing waterbodies. In addition to the ponds, two (2) major storm trunks with diameter ranging from 1200 mm to 1800 mm are proposed along the future divided arterial and collector roads. The main objective of the proposed storm trunks is to reduce the length of overland flow and intercept runoff from the future SWMFs. The proposed storm trunks and stormwater management ponds will be discharging (at pre-development release rate) to the existing tributaries in order to promote preservation of the existing drainage system.

The stormwater management facilities were included in the PCSWMM model to confirm that the post-development rates do not exceed the pre-development rates. Hydrographs for each proposed pond outfall were developed and included in **Appendix F**.

Based on the project area boundary, there will not be any impacts to downstream stormwater infrastructure since the project area is, and will continue draining directly to the Red Deer River and the Blindman River with a maximum discharge rate of 2.0 L/s/ha (pre-development release rate).

Due to the significant environmental characteristics of the Hazlett Lake, runoff from the future development surrounding the Lake will be intercepted through a series of ditches or pipes which will direct the flows to the proposed stormwater management facilities (Pond 1, 2 and 3), located around the perimeter of the Lake. Runoff will not be discharged directly into the Lake. It will be treated (meeting AEP's water quality guidelines) prior to release in order to maintain the natural ecosystem of the Lake. The size of Hazlett Lake and adjacent topography has the potential to provide a large stormwater detention volume. While the ponds directly adjacent to Hazlett Lake could be sized using the 2 l/s/ha release rate, it may be desirable to allow an increased release rate for these ponds. If a larger release rate is used, the same volume of water will enter the lake, just in a shorter time. While this study has assumed that Ponds 1, 2, and 3 will release water at 2 l/s/ha, during the more detailed planning stage of individual developments, larger release rates should be considered as long as the associated stormwater management facility provides adequate water quality treatment.

Based on the topography of the area and according to the model results, if no outlet structure is installed, no flow will be released from the Hazlett Lake during the 1:100 year storm. This result is consistent with Al-Terra Engineering report which noted that the Hazlett Lake should never overflow through the drainage channel except for catastrophic events (1:300 year event for example). Construction of an outlet control structure and regrading of portions of the watercourse east of Hazlett lake will be required to provide an overland outlet for the lake. Design of an outlet structure and drainage channel modifications will be completed by the City as a separate project. The outlet structure and channel will ensure that post development lake levels mimic pre-development levels.

Downstream of the lake on the IPSCO property, the existing system seems to be performing adequately for the 1:100 year storm. Grading of the existing ditch, downstream of the existing 2 × 900 mm diameter culverts under Highway 2A is required to provide additional capacity and minimize ponding levels along the ditch.

The existing dry pond located in the Chiles Industrial Subdivision has the capacity to provide the 1:100 year storage capacity for the contributing area. Minor grading of the existing ditches is recommended to provide positive drainage to the dry pond.

The proposed stormwater management concept plan sets out the primary parameters that will guide future development. It is not meant to be prescriptive, and it is subject to further review in subsequent stages of the development process.

The capacity of the existing local and highway drainage culverts and ditches should be reviewed during the design stage to ensure that adequate capacity is available for the proposed developments.

It is recommended that existing wetlands and streams be preserved to provide additional storage within the development area, and to reduce the construction of additional stormwater management facilities.

Figure 3-9 shows the pre-development and post-development outflow rates for the 1:5 year storm.

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IF NOT 25 mm ADJUST SCALES 25 mm

SCALE(S) SHOWN ARE INTENDED FOR TABLOID (11X17) SIZE DRAWINGS UNLESS NOTED OTHERWISE

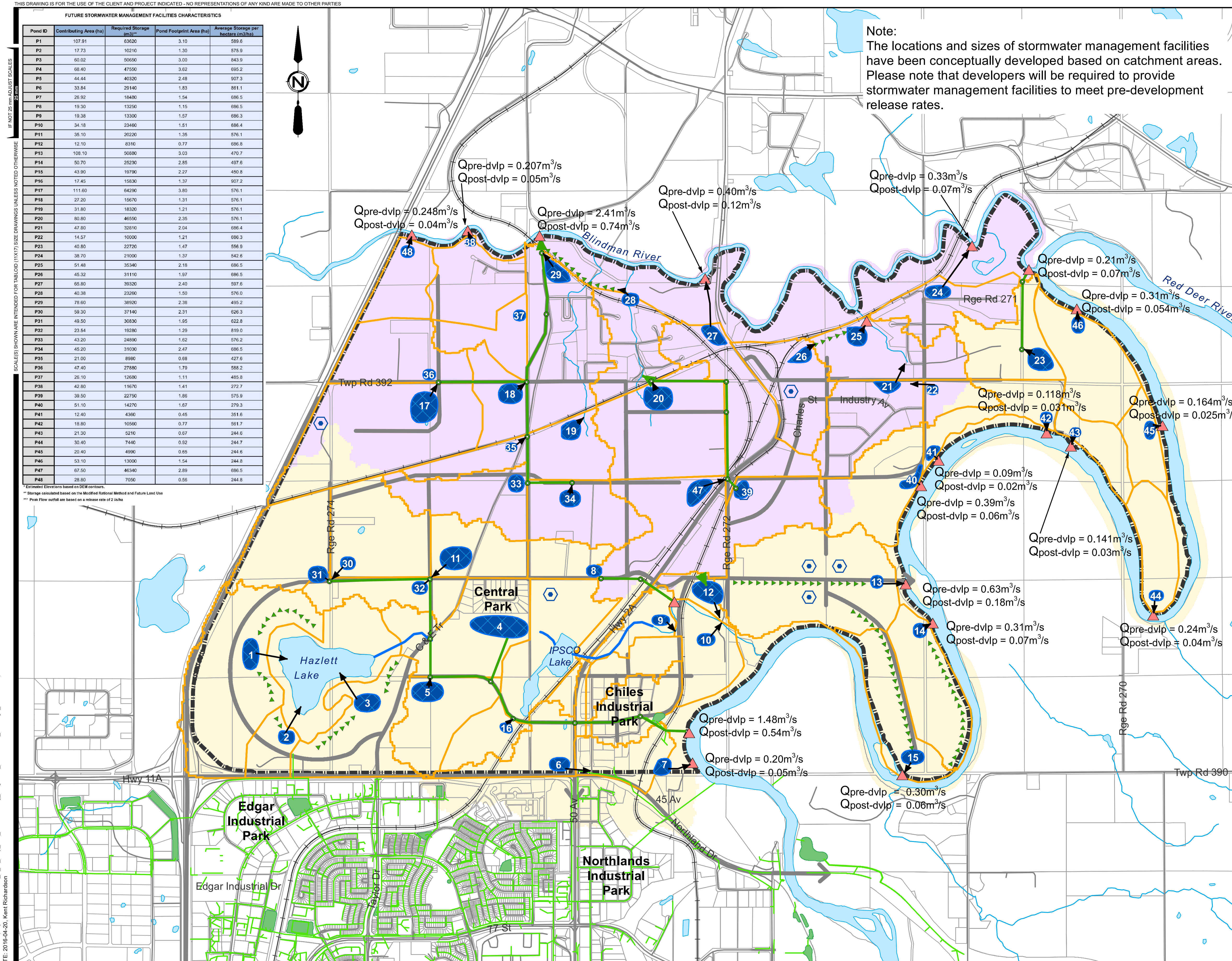
FUTURE STORMWATER MANAGEMENT FACILITIES CHARACTERISTICS

Pond ID	Contributing Area (ha)	Required Storage (m3)**	Pond Footprint Area (ha)	Average Storage per hectare (m3/ha)
P1	107.91	63620	3.10	589.6
P2	17.73	10210	1.30	575.9
P3	60.02	50650	3.00	843.9
P4	68.40	47550	3.62	695.2
P5	44.44	40320	2.48	907.3
P6	33.84	29140	1.83	861.1
P7	26.92	18480	1.54	686.5
P8	19.30	13250	1.15	686.5
P9	19.38	13300	1.57	686.3
P10	34.18	23460	1.51	686.4
P11	35.10	20220	1.35	576.1
P12	12.10	8310	0.77	686.8
P13	108.10	50880	3.03	470.7
P14	50.70	25230	2.85	497.6
P15	43.90	19790	2.27	450.8
P16	17.45	15830	1.37	907.2
P17	111.60	64290	3.80	576.1
P18	27.20	15670	1.31	576.1
P19	31.80	18320	1.21	576.1
P20	80.80	46550	2.35	576.1
P21	47.80	32810	2.04	686.4
P22	14.57	10000	1.21	686.3
P23	40.80	22720	1.47	556.9
P24	38.70	21000	1.37	542.6
P25	51.48	35340	2.18	686.5
P26	45.32	31110	1.97	686.5
P27	65.80	39320	2.40	597.6
P28	40.38	23260	1.50	576.0
P29	78.60	38920	2.38	495.2
P30	59.30	37140	2.31	626.3
P31	49.50	30830	1.95	622.8
P32	23.54	19280	1.29	819.0
P33	43.20	24890	1.62	576.2
P34	45.20	31030	2.47	686.5
P35	21.00	8980	0.68	427.6
P36	47.40	27880	1.79	588.2
P37	26.10	12680	1.11	485.8
P38	42.80	11670	1.41	272.7
P39	39.50	22750	1.86	575.9
P40	51.10	14270	1.67	279.3
P41	12.40	4360	0.45	351.6
P42	18.80	10560	0.77	561.7
P43	21.30	5210	0.67	244.6
P44	30.40	7440	0.92	244.7
P45	20.40	4990	0.65	244.6
P46	53.10	13000	1.54	244.8
P47	67.50	46340	2.89	686.5
P48	28.80	7050	0.56	244.8

* Estimated Elevations based on DEM contours.

** Storage calculated based on the Modified Rational Method and Future Land Use

*** Peak Flow outfall are based on a release rate of 2 l/s/ha



Legend:

- Preliminary Outfall
- Possible Future Pond Location *(Ponds to be designed to meet pre-development rates)*
- Ultimate Manhole
- Ultimate Ditch
- Ultimate Stormwater Trunk
- Ultimate SWMF
- Pond Outlet
- Pond Catchment Area
- Existing Drainage Route
- Existing Stormwater Trunk
- Existing Stormwater Pond
- Proposed Transportation
- Existing Transportation
- Blindman River Catchment
- Red Deer River Catchment
- StudyArea

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THE CITY OF Red Deer

FIGURE No. 3-8

MASTER DRAINAGE PLAN

STORMWATER
ULTIMATE STORMWATER CONCEPT
1:100 YEAR OUTFLOW RATE

AE PROJECT No.	20153382
SCALE	1:30,000
APPROVED	
DATE	2016 APRIL
REV	
DESCRIPTION	ISSUED FOR REPORT

\\\edm-fs-01\projects\2015338200_N_of_Hwy_11A_Serv\Working_Dwgs\010_GIS\Master_Drainage_Plan\ArcMap\3-8 Stormwater.mxd
DATE: 2016-04-20, Kent Richardson

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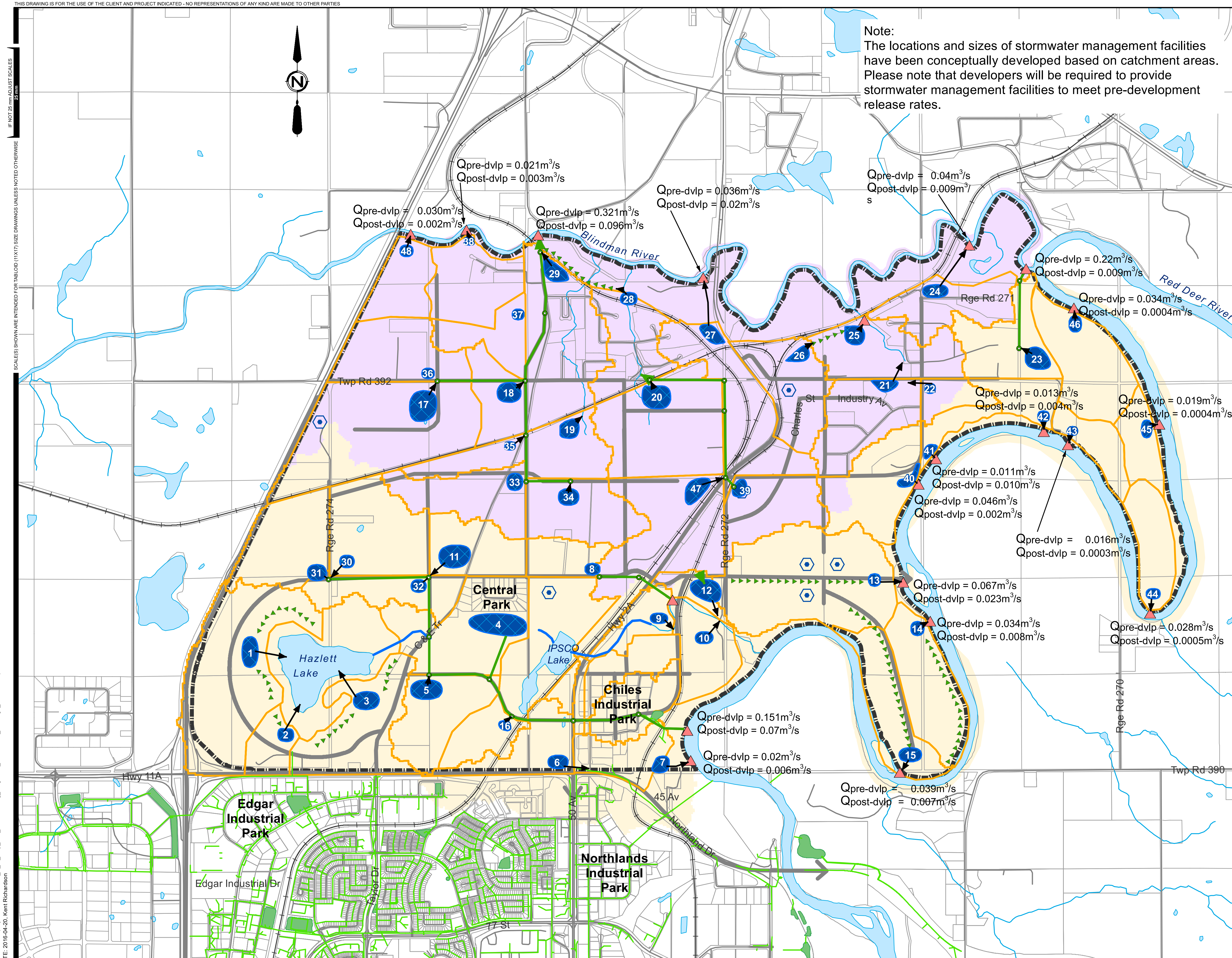

Legend:

- Preliminary Outfall
- Possible Future Pond Location *(Ponds to be designed to meet pre-development rates)*
- Ultimate Manhole
- Ultimate Ditch
- Ultimate Stormwater Trunk
- Ultimate SWMF
- Pond Outlet
- Pond Catchment Area
- Existing Drainage Route
- Existing Stormwater Trunk
- Existing Stormwater Pond
- Proposed Transportation
- Existing Transportation
- Blindman River Catchment
- Red Deer River Catchment
- StudyArea

Associated Engineering

THE CITY OF Red Deer

FIGURE No. 3-9

MASTER DRAINAGE PLAN

STORMWATER
ULTIMATE STORMWATER CONCEPT
1:5 YEAR OUTFLOW RATE

AE PROJECT No.	20153382
SCALE	1:30,000
APPROVED	
DATE	2016 APRIL
REV	
DESCRIPTION	ISSUED FOR REPORT

Table 3-6
Characteristics of Future Stormwater Management Facilities

Pond ID	Contributing Area (ha)	Required Storage (m3)**	Peak Outfall (m3/s)***	Pond Footprint Area (ha)	Pond Bottom EL. (m)	NWL EL. (m)*	HWL EL. (m)*	Top of Berm EL. (m)*	Pond Active Depth (m)	Orifice Size (mm)
P1	107.91	63,620	0.216	3.10	876.0	878.0	880.5	881.0	2.5	259
P2	17.73	10,210	0.035	1.30	875.3	877.3	878.3	878.8	1.0	131
P3	60.02	50,650	0.120	3.00	875.5	877.5	879.5	876.0	2.0	210
P4	68.40	47,550	0.136	3.62	872.0	874.0	875.5	876.0	1.5	236
P5	44.44	40,320	0.089	2.48	874.4	876.4	878.4	879.0	2.0	173
P6	33.84	29,140	0.068	1.83	870.8	872.8	874.8	875.3	2.0	152
P7	26.92	18,480	0.054	1.54	840.9	842.9	844.4	845.0	1.5	146
P8	19.30	13,250	0.039	1.15	875.0	877.0	878.5	879.1	1.5	123
P9	19.38	13,300	0.039	1.57	871.8	873.8	874.8	875.3	1.0	137
P10	34.18	23,460	0.068	1.51	870.6	872.6	874.6	875.1	2.0	154
P11	35.10	20,220	0.070	1.35	875.0	877.0	879.0	879.6	2.0	156
P12	12.10	8,310	0.024	0.77	871.9	873.9	875.4	876.0	1.5	98
P13	108.10	50,880	0.216	3.03	838.5	840.5	842.5	843.0	2.0	275
P14	50.70	25,230	0.101	2.85	833.0	835.0	836.0	836.5	1.0	227
P15	43.90	19,790	0.088	2.27	838.0	840.0	841.0	841.6	1.0	210
P16	17.45	15,830	0.035	1.37	873.0	875.0	877.0	877.6	2.0	125
P17	111.60	64,290	0.223	3.80	873.0	875.0	877.0	877.6	2.0	280

Pond ID	Contributing Area (ha)	Required Storage (m3)**	Peak Outfall (m3/s)***	Pond Footprint Area (ha)	Pond Bottom EL. (m)	NWL EL. (m)*	HWL EL. (m)*	Top of Berm EL. (m)*	Pond Active Depth (m)	Orifice Size (mm)
P18	27.20	15,670	0.054	1.31	870.0	872.0	873.5	874.0	1.5	147
P19	31.80	18,320	0.064	1.21	871.5	873.5	875.5	876.0	2.0	148
P20	80.80	46,550	0.162	2.35	865.0	867.0	869.5	870.0	2.5	224
P21	47.80	32,810	0.096	2.04	866.5	868.5	870.5	871.0	2.0	179
P22	14.57	10,000	0.029	1.21	867.5	869.5	870.5	871.0	1.0	120
P23	40.80	22,720	0.082	1.47	863.5	865.5	867.5	868.0	2.0	167
P24	38.70	21,000	0.077	1.37	860.5	862.5	864.5	865.0	2.0	163
P25	51.48	35,340	0.103	2.18	860.5	862.5	864.5	865.0	2.0	188
P26	45.32	31,110	0.091	1.97	863.5	865.5	867.5	868.1	2.0	177
P27	65.80	39,320	0.132	2.40	854.5	856.5	858.5	859.0	2.0	214
P28	40.38	23,260	0.081	1.50	849.5	851.5	853.5	854.0	2.0	166
P29	78.60	38,920	0.157	2.38	844.5	846.5	848.5	849.0	2.0	234
P30	59.30	37,140	0.119	2.31	876.0	878.0	880.0	880.6	2.0	203
P31	49.50	30,830	0.099	1.95	876.0	878.0	880.0	880.6	2.0	185
P32	23.54	19,280	0.047	1.29	875.0	877.0	879.0	879.6	2.0	119
P33	43.20	24,890	0.086	1.62	871.5	873.5	875.5	876.1	2.0	173
P34	45.20	31,030	0.090	2.47	871.9	873.9	875.4	876.0	1.5	191
P35	21.00	8,980	0.042	0.68	871.4	873.4	875.4	876.0	2.0	120

Pond ID	Contributing Area (ha)	Required Storage (m3)**	Peak Outfall (m3/s)***	Pond Footprint Area (ha)	Pond Bottom EL. (m)	NWL EL. (m)*	HWL EL. (m)*	Top of Berm EL. (m)*	Pond Active Depth (m)	Orifice Size (mm)
P36	47.40	27,880	0.095	1.79	873.0	875.0	877.0	877.6	2.0	181
P37	26.10	12,680	0.052	1.11	857.9	859.9	861.4	862.0	1.5	145
P38	42.80	11,670	0.086	1.41	843.0	845.0	846.0	846.6	1.0	208
P39	39.50	22,750	0.079	1.86	869.5	871.5	873.0	873.6	1.5	179
P40	51.10	14,270	0.102	1.67	842.0	844.0	845.0	845.5	1.0	228
P41	12.40	4,360	0.025	0.45	844.5	846.5	848.0	848.6	1.5	98
P42	18.80	10,560	0.038	0.77	863.4	865.4	867.4	868.0	2.0	113
P43	21.30	5,210	0.043	0.67	832.5	834.5	835.5	836.0	1.0	145
P44	30.40	7,440	0.061	0.92	829.5	831.5	832.5	833.0	1.0	174
P45	20.40	4,990	0.041	0.65	829.0	831.0	832.0	832.5	1.0	141
P46	53.10	13,000	0.106	1.54	825.5	827.5	828.5	829.0	1.0	232
P47	67.50	46,340	0.135	2.89	869.0	871.0	873.5	874.0	2.5	230
P48	28.80	7,050	0.058	0.56	844.0	846.0	848.0	848.6	2.0	140

* Estimated Elevations based on DEM contours.

** Storage calculated based on the Modified Rational Method and land use.

*** Required storage volume and peak outfall flow rate are based on a release rate of 2 L/s/ha.

4 Conclusions

4.1 DESKTOP ENVIRONMENTAL REVIEW

- The study area bounded by Highways 2 and 11A, and the Blindman and Red Deer Rivers, contains many environmental values which should be considered when designating land uses in the study area. Of significant value are the Blindman River and Red Deer River canyons, Hazlett Lake and its surrounding lands, wetlands, and potential wildlife corridors that link these features. Their significance is illustrated by a number of factors including valuable habitat for a diverse number of documented species including 276 bird species, 10 mammal species, and 3 amphibian species.
- The greatest potential environmental impacts of modifying or removing wetlands is likely the loss of habitat for species of environmental concern, loss of wildlife connectivity corridors, loss of rare plant species, eutrophication of wetlands, loss of wetland productivity, pollution of waterbodies, and heightened flood risks. A number of mitigation strategies are recommended for each; most note the importance of riparian buffer strips, forested habitat corridors, and the value of designating protected environmentally significant areas or environmental reserves. Implementing one mitigation recommendation will typically serve to mitigate multiple potential impacts.
- Hazlett Lake has been identified as a natural feature with high environmental significance. Preservation of Hazlett Lake has become a priority in future development of the area.

4.2 STORMWATER MANAGEMENT SYSTEM

- The project area is divided into two major drainage basins: Red Deer River Basin and Blindman River Basin. Both basins have good natural drainage systems that can be incorporated into the stormwater management design for the North of 11A Area.
- The existing project area is serviced by surface drainage (i.e. culverts and ditches). A stormwater management facility (dry pond) located in the Chiles Industrial Park Subdivision provides water quality and quantity control and has a storage capacity for the 1:100 year storm.
- High flows from the Highway 11A storm sewer "overflow" to the lake only during severe storm events. These flows are not included in the PCSWMM model since they do not have an impact on the Hazlett Lake water levels, and proposed downstream stormwater system. The majority of the flows from Queen Business Park and Edgar Industrial Parks are currently being intercepted by existing storm sewer pipes and routed directly to the Red Deer River.
- Stormwater management will be required in all new developments to control peak runoff rates and to provide water quality control.
- A pre-development release rate of 2.0 L/s/ha has been assumed for the North of Highway 11A Study Area. The pre-development release rate is based on AEP's 1:00 pre-development release rate chart.
- Best management practice implies that wet facilities be used as they provide higher water quality control.
- Existing wetlands should be preserved.

- Proposed stormwater management ponds will be discharging to the existing creeks and tributaries in order to promote preservation of the existing drainage system.
- The piping and pond sizing shown in this study are based on a conceptual-level analysis. The specific sizing and location of stormwater infrastructure should be confirmed through a detailed design process.

5 Recommendations

5.1 DESKTOP ENVIRONMENTAL REVIEW

Wetland Protection: Habitat for Rare Plant Species

- It is recommended that natural wetlands and forested areas remain intact in future development plans to protect areas that could contain rare plant species.
- Barring conservation measures, it is suggested that rare plant surveys be completed in these areas prior to development or ground disturbance at the multi-neighborhood structure plan stage. If found, rare plants can be transplanted to a suitable area, or the area could be designated ecologically significant and conservation measures employed. The NatureServe organization should be consulted prior to moving a rare plant.

Wetland Protection: Avoiding Eutrophication and Loss of Productivity

- It is recommended that wetlands are maintained as sensitive landscape features during the land use planning process.
- Delineate wetlands to determine their precise boundaries and establish a no-development buffer for each wetland depending on productivity and class. A literature review by Hawes and Smith (2005) indicates a minimum buffer distance of 30 m is required in most cases to remove 90% of common pollutants and sediment entering waterbodies during normal precipitation conditions.

Wetland Protection: Avoiding Pollution and Nutrient Input

- Design stormwater management infrastructure such that runoff from developed areas does not enter natural waterbodies untreated.
- Provide stormwater ponds for primary treatment.
- Use pollution traps where sediments and petroleum products can be removed from stormwater.
- With the exception of Hazlett Lake, stormwater runoff must not enter a waterbody at a flow rate higher than the pre-development release rate (2.0L/s/ha). Higher flow rates may be discharged into Hazlett Lake as long as the water released meets AEP’s water quality guidelines and outfalls are appropriately designed to prevent erosion and sediment transport.
- In some cases where the risk for pollution to enter the environment is high, consideration should be given to diverting runoff to water treatment facilities.
- Maintain buffer strips around waterbodies to prevent pollution from entering waterbodies by overland runoff flow (thus preserving the long term value and function of the wetland). The minimum recommended buffer width, measured from the top of the bank, required to intercept pollution is 30 m when vegetation consists of forest (shrubs, trees, grasses). Where only grasses are present, the recommended buffer width should be doubled (Chase et al. 1997; Hawes and Smith 2005). Design should be in accordance with the guidelines noted in AEP’s document titled Stepping Back from the Water (Government of Alberta 2012) as well as the Hazlett Lake Management Recommendation report (Westhoff 2017).

- Leave vegetation intact on river banks to inhibit solar pollution to waterbodies (which raises water temperatures and reduces concentration of available oxygen). The height of the vegetation is more important than the width of the buffer strip, provided that the buffer is at minimum 30 m wide to mitigate pollutant laden overland runoff. In the Red Deer region, vegetation along rivers should consist of natural forest with mature trees and adequate regeneration to maintain the forest (Chase et al. 1997).

Mitigating Flood Risk

- Complete a flood risk analysis for areas adjacent to the rivers considering the 1:100 year (or greater magnitude) flood elevation currently referenced in the City of Red Deer Land Use Bylaw.
- Limit development within the flood risk areas to recreational trails, open space, natural park, or environmental reserve.
- Flood-risk areas should remain entirely vegetated to reduce the risk of erosion during flood conditions.
- Wide vegetated buffers surrounding wetlands and waterbodies should be kept intact to buffer the impacts of floods against infrastructure.
- Drainage plans which include wetlands should be designed based on pre-development release rates.

Hazlett Lake: The Importance of Protection and Management

- It is recommended that development surrounding Hazlett Lake be restricted and that the lake and surrounding area be protected because of the environmental significance associated with Hazlett Lake.
- The Westhoff Engineering Hazlett Lake Management Recommendation Repot has provided setback width options for Hazlett Lake based on documented species and the guidelines outlined in “Stepping Back from the Water” (AEP).
- It is recommended that the City of Red Deer continue the environmental monitoring currently being conducted at Hazlett Lake by Westhoff Engineering Resources, Ltd. Westhoff Engineering Resources, Ltd. (2015b) lists 95 management recommendations for Hazlett Lake.
- Due to the environmentally significant nature of Hazlett Lake, it is also recommended that detailed biophysical assessment of the area be conducted specific to the desired development.

5.2 STORMWATER MANAGEMENT SYSTEM

The following are the principal recommendations of the storm Master Drainage Plan:

Stormwater Management Facilities

- Design for all stormwater management infrastructure should address flow control and water quality.

Pre-development Release Rate

- All stormwater management facilities in the North of Highway 11A Study Area should be designed for an outlet flow that is equivalent or less than the 100 year pre- development release rate. An exception of stormwater management facilities discharging directly into Hazlett Lake will be considered as long as the facilities provide adequate water quality treatment before discharging into the Hazlett Lake.
- For the North of Highway 11A Area, a pre-development release rate of 2.0 L/s/ha was assumed based AEP’s 1:100 year runoff rates for the Red Deer Region in addition to a review of gauge data from the Water Survey of Canada for areas near to the City of Red Deer. The 1:5 year storm pre-development release rate was estimated to be of 0.34 L/s/ha based on the Regional Analysis.

Stormwater Management Facilities

- Design for all stormwater management infrastructure should address flow control and water quality control.
- Stormwater management facilities discharging to Hazlett Lake may release water at rates higher than the 100 year pre-development rate as long as the water quality meets AEP requirements.
- Stormwater management facilities discharging water to storm trunks or other water courses shall restrict the release to 2.0 l/s/ha.

Stormwater Management Infrastructure

- It is recommended that the stormwater management plan shown in **Figure 3-8** be adopted as the conceptual servicing basis for future development. The conceptual-level plan will be subject to review and modification during the detailed design phase of future developments.

Water Quality

- Provide stormwater management facilities for primary treatment of stormwater.
- Stormwater management facilities should include pre-treatment forebays designed in accordance with the current guidelines from Alberta Environment and Parks.
- Provide a minimum 24 hour detention time to capture at least 85% of all sediments of a 75-micrometer particle size or larger.

Preservation of Existing Waterbodies

- Where possible, existing wetlands and waterbodies should be preserved.
- If existing wetlands or waterbodies are proposed to be used as part of the stormwater management system for the area, the Alberta wetland policy must be followed. Proposed projects should be reviewed under the *Water* and *Public Lands Acts* for potential triggers.
- The northeast outlet of Hazlett Lake should be improved by regrading the existing channel and/or constructing an outlet control structure to ensure post development water levels mimic pre-development conditions.

Detailed Design

- A more reliable source of data, such as, ground survey, should be used during the future design of the stormwater trunks and management facilities to confirm pond characteristics and elevations of outlets pipes.

Closure

This report was prepared for the City of Red Deer to provide an overall picture of the existing drainage area and proposed development concept for lands located north of Highway 11A.

The services provided by Associated Engineering Alberta Ltd. in the preparation of this report were conducted in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty expressed or implied is made.

Respectfully submitted,
Associated Engineering Alberta Ltd.

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