

**REPORT**

# Flood Risk Assessment and Inventory Report

## Upper Red Deer River Hazard Study

Submitted to:

**Alberta Environment and Parks**

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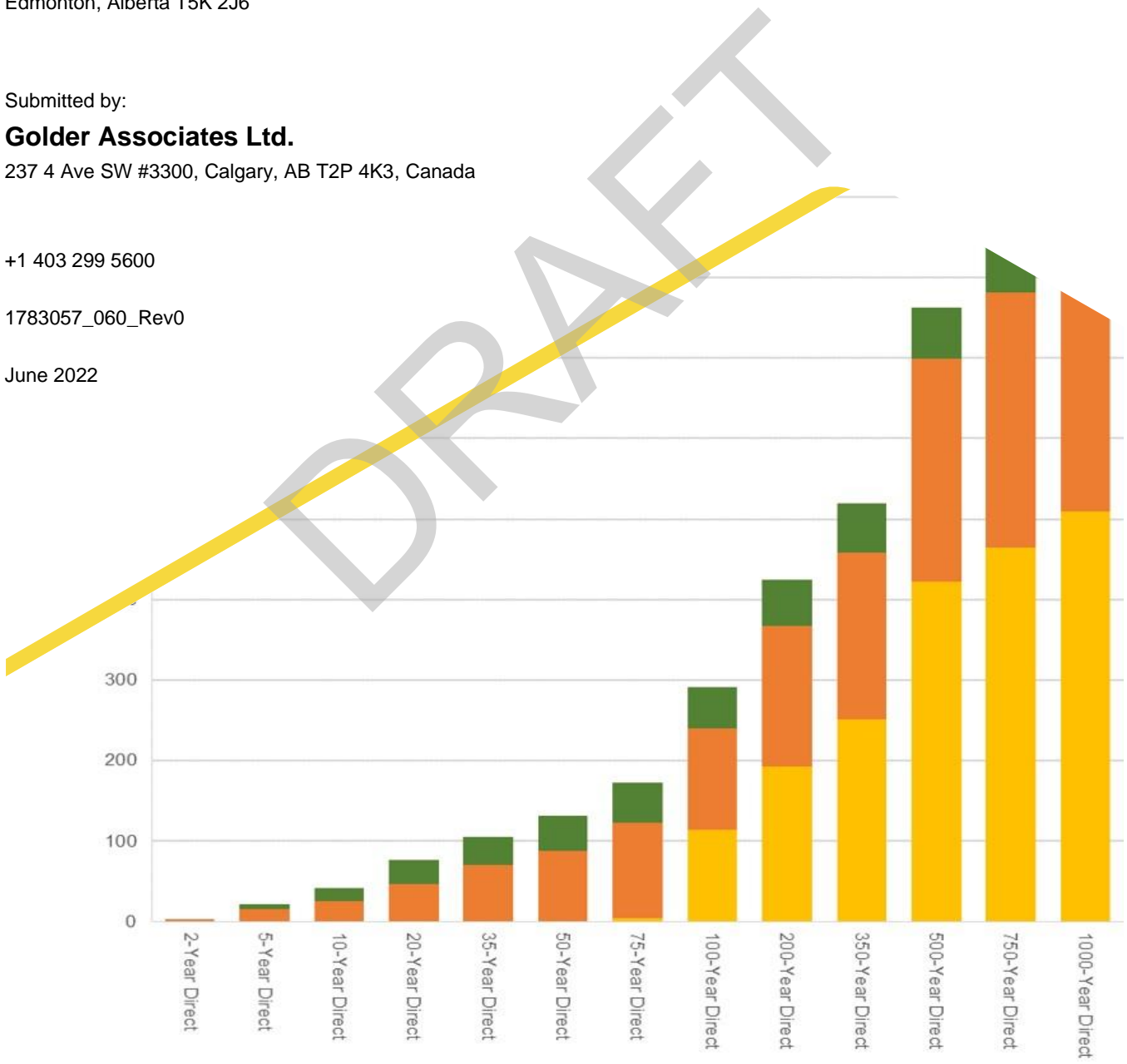
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## Executive Summary

Alberta Environment and Parks (AEP) commissioned Golder Associates Ltd. (Golder) in September 2017 to conduct the Upper Red Deer River Hazard Study. The primary purpose of the study is to assess and identify river and flood hazards along the Red Deer River reach from Coal Camp to Gleniffer Lake and the Bearberry Creek reach from Range Road 62 to its confluence with the Red Deer River in Sundre.

The study is conducted under the provincial Flood Hazard Identification Program (FHIP), the goals of which include enhancement of public safety and reduction of future flood damages through the identification of river and flood hazards. Project stakeholders include the Government of Alberta, the Town of Sundre, Mountain View County, Clearwater County, Red Deer County, and the public.

The Upper Red Deer River Hazard Study includes multiple components and deliverables. This report documents the methodology and results of the flood risk assessment and inventory component. The assessment involved comparison of the flood extents created as part of the open water flood inundation and design flood hazard mapping components of the study, with the collected and interpreted spatial data that contains an inventory of land parcels, buildings, major transportation infrastructure, and population. Flood risk statistics were calculated to quantify flood vulnerabilities for each of the 13 open water flood scenarios and the design flood scenario (floodway and flood fringe). The statistics pertain to the number of affected parcels, buildings, and population, as well as the length of affected road and railroad infrastructure, including bridges and culverts.

The main results of the flood risk assessment for the 13 open water flood scenarios are summarized below:

- The number of land parcels, buildings and population, as well as the length of roads affected increase steadily from the 2-year flood to the 1,000-year flood.
- A large increase in the affected population occurs in the Town of Sundre between the 75-year and 100-year floods, as residential neighbourhoods between Bearberry Creek and Main Avenue West are affected. A second large increase occurs between the 350-year and 500-year floods as residential neighbourhoods behind the Sundre East Dike are affected.
- No critical, non-residential buildings (i.e. hospitals, schools, or water treatment facilities) in the study area would be affected by any of the flood scenarios.
- The length of roads affected by direct flood inundation remains low at the 2-year flood and then increases steadily from the 5-year flood to the 1,000-year flood. Some of the major roads that would be affected by floods in the study area include the following:
  - Highway 766 south of Township Road 355 at return periods 20 years and higher;
  - Main Avenue West and Highway 27 in the Town of Sundre at return periods 75 years and higher;
  - Highway 584 west of the intersection with Highway 22 at return periods 100 years and higher;
  - Highway 22 between the intersection with Highway 27/Highway 584 and Bearberry Creek at return periods 200 years and higher;
  - Main Avenue East in the Town of Sundre east of the Red Deer River crossing at return periods 500 years and higher;
  - Centre Street North in the Town of Sundre south of 2nd Avenue Northeast at return periods 500 years and higher; and
  - Highway 760 at return periods 500 years and higher.

The main results of the flood risk assessment for the design flood are summarized below:

- There are 68 residential buildings and 2 non-residential buildings located in the floodway.
- There are 196 residential and 39 non-residential buildings located in the flood fringe (including high hazard flood fringe and protected flood fringe).
- There is a total population of 31 located in the floodway, and a total population of 381 located in the flood fringe (including high hazard flood fringe and protected flood fringe).
- No critical, non-residential buildings (i.e. hospitals, schools, or water treatment facilities) in the study area would be affected by the design flood.
- Some of the major roads that would be affected are Highway 766 south of Township Road 355, Highway 587 east of the Red Deer River crossing, Range Road 52 between Township Roads 334 and 332, Main Avenue West and Highway 27 in the Town of Sundre, Highway 760 south of the intersection with Main Avenue East and Highway 584 west of the intersection with Highway 22.

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## Acknowledgements

This component of the Upper Red Deer River Hazard Study was led by Mr. Peter Thiede. Overall project management was provided by Wolf Ploeger with direction by Dejiang Long. The flood risk inventory and assessment were conducted by Mr. Peter Thiede.

The authors express their special thanks to Ms. Jane Eaket, project manager for Alberta Environment and Parks, who provided overall study management, background data, and technical guidance.

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## 1.0 INTRODUCTION

### 1.1 Study Background and Objectives

Alberta Environment and Parks (AEP) commissioned Golder Associates Ltd. (Golder) in September 2017 to conduct the Upper Red Deer River Hazard Study (the study). The primary purpose of the study is to assess and identify river and flood hazards along the Red Deer River reach from Coal Camp to Gleniffer Lake and the Bearberry Creek reach from Range Road 62 to its confluence with the Red Deer River in Sundre.

The study is conducted under the provincial Flood Hazard Identification Program (FHIP), the goals of which include enhancement of public safety and reduction of future flood damages through the identification of river and flood hazards. Project stakeholders include the Government of Alberta, the Town of Sundre, Mountain View County, Clearwater County, Red Deer County, and the public.

The study includes multiple components and deliverables. This report documents the methodology and results of the flood risk assessment and inventory component. The assessment compares the flood extents, which were created as part of the open water flood inundation and design flood hazard mapping components of the study, with the collected and interpreted spatial data that contains an inventory of land parcels, buildings, major transportation infrastructure, and population. Flood risk statistics were calculated to quantify flood vulnerabilities for each of the 13 open water flood scenarios and the design flood scenario (floodway and flood fringe). The statistics pertain to the number of affected parcels, buildings, and population, as well as the length of affected road and railroad infrastructure, including bridges and culverts.

### 1.2 Study Area and Reaches

The study area includes approximately 85 km of the Red Deer River, and about 17 km of Bearberry Creek. The study area includes the Town of Sundre, Mountain View County, Clearwater County and Red Deer County (see Figure 1).



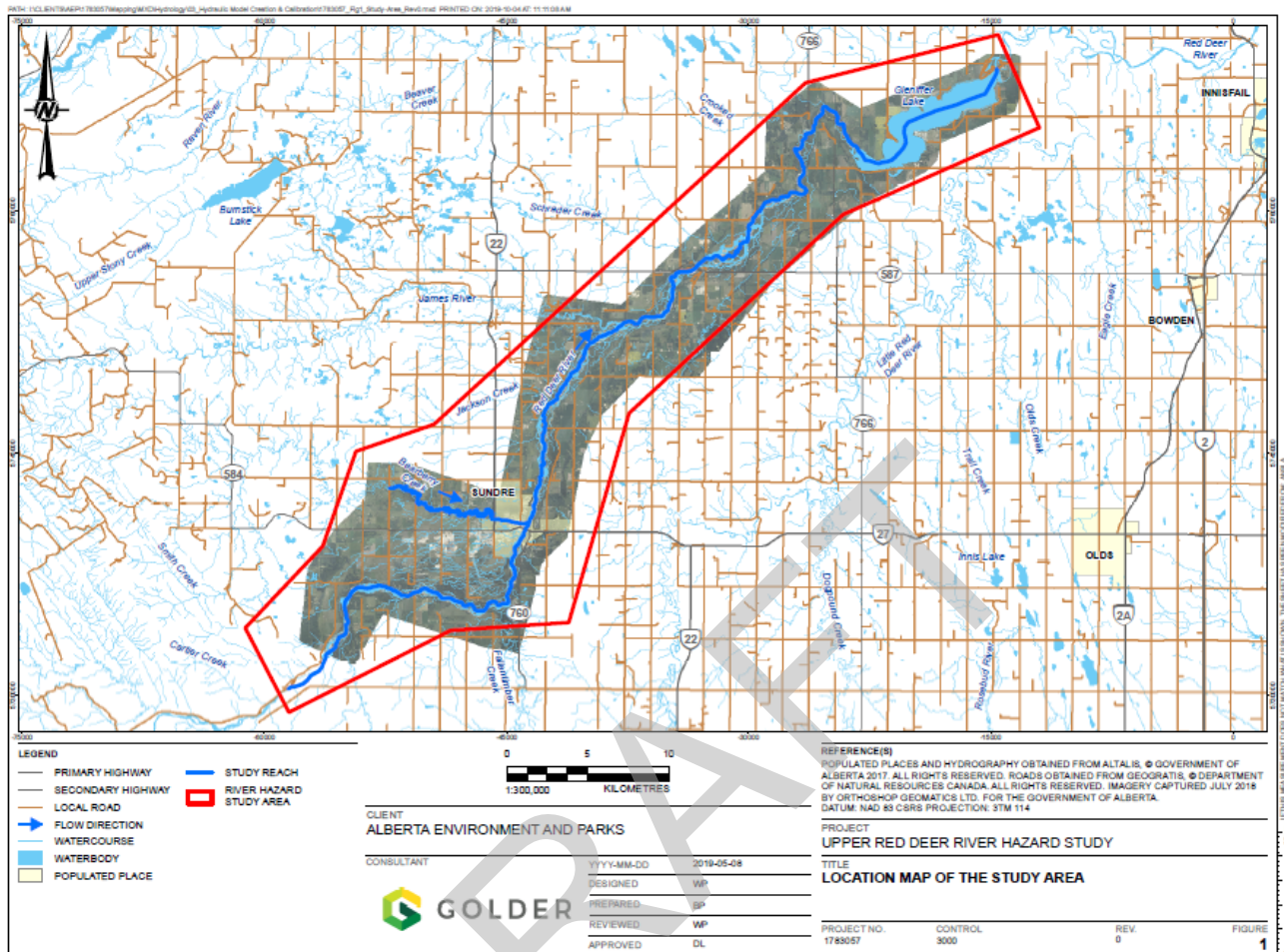


Figure 1: Study Area

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## 2.0 AVAILABLE SPATIAL DATA

### 2.1 Cadastral

Cadastral data (i.e. boundaries of registered land parcels) was downloaded from AltaLIS, a commercial provider of Alberta base mapping data. Additional data including registered land parcels and land use information was provided by Mountain View County and the Town of Sundre.

### 2.2 Infrastructure

#### 2.2.1 Data Sources

Infrastructure features such as hospitals, schools and water treatment facilities were interpreted from aerial imagery (see Section 3.1). Hospitals, and water treatment facilities included in the flood risk inventory are detailed in the following sections.

#### 2.2.2 Buildings

Buildings were digitized using the provided aerial imagery (see Section 3).

#### 2.2.3 Hospitals

The flood risk inventory includes the Sundre Hospital and Care Centre which is located within the study area.

#### 2.2.4 Water Treatment Facilities

The flood risk inventory includes the Sundre Wastewater Treatment Facility.

#### 2.2.5 Roads, and Railroads

Road data for the study area was obtained from AltaLIS. No railroads are located within the study area.

#### 2.2.6 Bridges

Bridge locations were identified manually based on the collected survey data (Golder 2022a).

### 2.3 Population

Population statistics were obtained from the Statistics Canada 2016 census dissemination blocks (Statistics Canada 2017). The census tallies the number of people whose usual place of residence is in the area. Dissemination blocks are the smallest geographic area for which population counts are disseminated in Canada.

## 3.0 INTERPRETED SPATIAL DATA

### 3.1 Aerial Photography

Aerial imagery for the study area was collected for AEP by OGL Engineering on July 13, 2018 and provided to Golder. The imagery has a 0.30 m Ground Sampling Distance (GSD) resolution and was provided as 4-band orthophotos.

The imagery was used to derive building points where no other spatial data was provided. It was also used to check and update roads throughout the study area.

### 3.2 Residential Structures

Residential structures were categorized as:

- Single Family
- Multifamily
- Retirement Home

To more accurately estimate the population affected by each flood scenario, the population count for each dissemination block was evenly distributed between all residential buildings that fall into the block. Where multifamily buildings existed, it was assumed that their average number of residents would be ten times that of the single family homes within the block. Retirement homes were treated as multifamily buildings. Spot checks showed reasonable estimates of residents per building.

Distributing the population numbers to the residential buildings ensures that residents are only counted as affected when their building falls within the inundation extent.

### 3.3 Non-Residential Structures

Non-residential structures were categorized as:

- Commercial
- Industrial
- Hospital
- School
- Water Treatment Facility
- Other

All hospitals and water treatment facilities in the study area were reduced to single points for the flood risk assessment.

Considering the size and importance of these features, manual checks were performed to determine whether they would be affected by flood scenarios, instead of relying on a point-based overlay analysis (see Section 4.1).

## 4.0 FLOOD RISK ASSESSMENT AND INVENTORY

After the spatial data was compiled, features affected by floods were identified by overlaying flood polygon datasets with the parcel, building, or infrastructure datasets. Features falling within a flood extent were flagged as being affected or potentially affected by the flood scenario.

Flood statistics were then generated by tallying all affected features for the following categories:

- land parcels;
- residential buildings;
- non-residential buildings;
- major transportation infrastructure; and
- population (based on residential buildings and census data).

The following sections provide further information on the analysis methodology and the results of the assessment.

### 4.1 Methodology

Using the inventory datasets developed and described in Sections 2.0 and 3.0, flood statistics were generated for the various flood scenarios considered in this study. The method to generate these flood statistics consisted of the following four steps:

- Flood polygons for the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year flood scenarios and the design flood scenario (floodway and flood fringe) were generated as part of the flood inundation and flood hazard mapping work undertaken for this study (Golder 2022b and 2022c).
- For each scenario, the flood polygons were compared to the inventory dataset in GIS. Land parcels, buildings, and infrastructure were classified as being “affected” if they were located within a mapped flood extent (centroid for parcels). Road and railroad lengths affected by a flooding were also calculated.
- The population affected in each flood scenario was calculated by tallying the number of residents assigned to each affected residential building (see Section 3.5).
- The flood statistics for each category were summarized in a series of Microsoft Excel tables.

A manual check using aerial imagery was performed for non-residential buildings classified as hospital and water treatment facilities. As these large facilities are represented by single points in the flood risk inventory dataset, the result of the GIS-based overlay analysis may show the structure as not affected, even though some of the actual building footprint is located within the flood extent. The flood statistics were changed accordingly, to include buildings which footprints would be affected.

Flood statistics were calculated separately for two areas of flooding based on flood inundation mapping (Golder 2022b) and two areas of flooding based on design flood hazard mapping (Golder 2022c), as summarized below:

**Flood Inundation Mapping:**

- Direct flood inundation areas: These are areas expected to be inundated for various flood scenarios and have a direct overland connection to the main river/creek channels.
- Flood control structure failure inundation areas: These are areas that would be flooded if the flood control structure protecting the area would fail.

**Flood Hazard Mapping:**

- Floodway areas: The floodway generally includes areas where the water is 1 m deep or greater and/or the local velocities are 1 m/s or faster. Typically, the floodway includes the river channel and adjacent overbank areas.
- Flood Fringe areas: The flood fringe is the portion of the design flood hazard area outside the floodway. The flood fringe is divided into three zone:
  - Flood Fringe: Inundated areas outside of the floodway that are shallower and flow velocities are slower.
  - High Hazard Flood Fringe: Areas of deeper or faster-moving water outside of the floodway.
  - Protected Flood Fringe: Low lying areas behind dedicated flood control structures that are at risk of flooding if the structures would fail.

All results are reported by local authority and aggregate total. The local authorities include the following:

- Town of Sundre;
- Mountain View County;
- Clearwater County; and
- Red Deer County.

## 4.2 Open Water Flood Inundation Scenarios

Flood inundation extents were delineated for thirteen (13) open water flood scenarios (Golder 2022b). Flood statistics for direct and flood control structure failure inundation areas were calculated for each flood scenario, and the results are presented in the following sections.

### 4.2.1 Land Parcels

A summary of land parcels affected by direct inundation is presented in Table 1, including total number, as well as a breakdown of parcels affected in each local authority. A summary of land parcels potentially affected by flood control structure failure is presented in Table 2, including total number, as well as a breakdown of parcels affected in each local authority. Figure 2 shows the affected parcels per flood scenario.

**Table 1: Affected Land Parcels – Open Water Flood Inundation Scenarios, Direct Inundation**

Scenario	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	Total
2-Year	3	35	17	2	57
5-Year	8	87	37	4	136
10-Year	12	132	50	12	206
20-Year	13	193	62	19	287
35-Year	13	359	67	23	462
50-Year	13	451	77	28	569
75-Year	15	552	82	53	702
100-Year	15	644	86	114	859
200-Year	16	725	95	191	1,027
350-Year	16	778	98	260	1,152
500-Year	16	922	102	425	1,465
750-Year	16	962	103	530	1,611
1000-Year	16	977	107	611	1,711

**Table 2: Affected Land Parcels – Open Water Flood Inundation Scenarios, Flood Control Structure Failure**

Scenario	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	Total
10-Year	0	0	0	1	1
20-Year	0	0	0	2	2
35-Year	0	1	0	56	57
50-Year	0	2	0	76	78
75-Year	0	2	0	106	108
100-Year	0	56	0	115	171
200-Year	0	93	0	103	196
350-Year	0	103	0	110	213

The number of land parcels in the study area affected by direct flood inundation increases steadily from the 2-year flood to the 1,000-year flood. The number of land parcels potentially affected by flood control structure failure remains low until the 20-year flood and then increases steadily until it reaches its maximum at the 350-year flood. At higher floods, the flood control structures within the study area are overtopped and affected land parcels are counted as part of direct inundation.

In the Town of Sundre, the number of land parcels affected by direct flood inundation increases steadily between the 2-year flood and the 1000-year flood. Most affected parcels are located along Main Avenue East, Main Avenue West (Downtown), between Bearberry Creek and Main Avenue West and south of Main Avenue West.

For Mountain View County, the number of land parcels affected by direct flood inundation increases steadily between the 2-year flood and the 1,000-year flood. Most affected parcels are located west of Sundre, in the McDougal flats area (Sundre Airport and Coyote Creek Golf and RV Resort), and in the Hamlet of Coal Camp. The number of land parcels potentially affected by flood control structure failure remains low until the 75-year flood and then rises steadily between the 100-year and 350-year floods. The potentially affected parcels are located along Highway 760 behind Sundre East Dike close to the town limits of Sundre.

For Clearwater County, the number of parcels affected by direct flood inundation remains low for all flood scenarios, since only a small and sparsely populated part of the county is located within the study area. No parcels in the county are potentially affected by flood control structure failure.

For Red Deer County, the number of affected parcels increases steadily between the 2-year flood and the 1000-year flood. Red Deer County within the study area is sparsely populated with the exception of Woodland Estates (near the intersection of Highway 587 and Range Road 41), where most affected parcels are located. No parcels in the county are potentially affected by flood control structure failure.

The number of land parcels potentially affected by flood control structure failure remains low until the 20-year flood, rises steadily between the 35-year and 75-year floods, and then changes little between the 100-year and 350-year floods. The potentially affected parcels are mostly located behind Sundre East Dike.

For the 100-year flood, a total of 859 land parcels would be directly inundated in the study area and 171 would be potentially inundated in the case of flood control structure failure. In comparison, a total of 1,711 land parcels would be directly inundated in the study area for the 1,000-year flood.

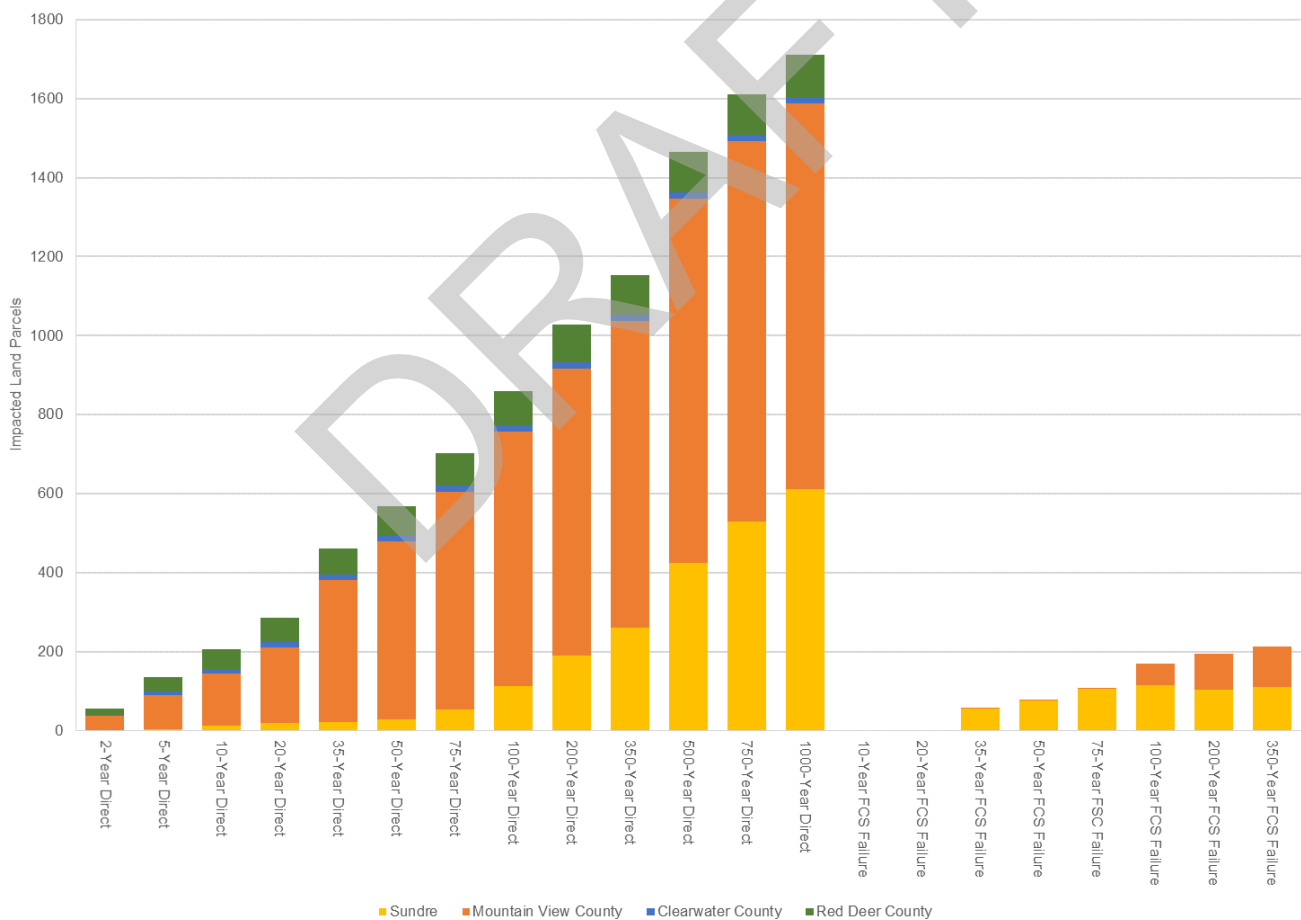


Figure 2: Affected Land Parcels for the Open Water Flood Inundation Scenarios

## 4.2.2 Buildings and Infrastructure

### *Residential Buildings*

A summary of affected residential buildings for each local authority is presented in Tables 3 to 5, including total number, as well as a breakdown of residential buildings affected by direct inundation and potential flood control structure failure inundation. Figures 3 to 5 show affected residential and non-residential buildings per flood scenario (see Section below for non-residential buildings).

The number of residential buildings affected by direct flood inundation in the study area remains low at the 2-year flood and then increases steadily from the 5-year flood to the 1,000-year flood. The number of residential buildings potentially affected by flood control structure failure in the study area is zero for the 2-year to 20-year flood. It then increases steadily from the 35-year flood to the 350-year flood. At the 500-year flood and higher, no residential buildings are potentially affected by flood control structure failure, as the flood control structures would be overtopped and these areas are affected by direct flood inundation instead.

In the Town of Sundre, the number of residential buildings affected by direct flood inundation remains low until the 50-year flood. It then increases steadily between the 75-year flood and the 1000-year flood. Most affected residential buildings are located along Main Avenue East, between Bearberry Creek and Main Avenue West and south of Main Avenue West. The number of residential buildings potentially affected by flood control structure failure remains low until the 50-year flood and then rises steadily to a maximum of 35 at the 350-year flood. The potentially affected residential buildings are mostly located behind the Sundre East Dike.

For Mountain View County, the number of residential buildings affected by direct flood inundation increases steadily between the 2-year flood and the 1000-year flood. Most affected residential buildings are located west of Sundre, in the McDougal flats area and in the Hamlet of Coal Camp. The number of residential buildings potentially affected by flood control structure failure is zero until the 75-year flood and then rises between the 100-year and 350-year floods to a maximum of 12. The potentially affected residential buildings are located along Highway 760 behind the Sundre East Dike.

No residential buildings would be affected by any flood scenarios in Clearwater County.

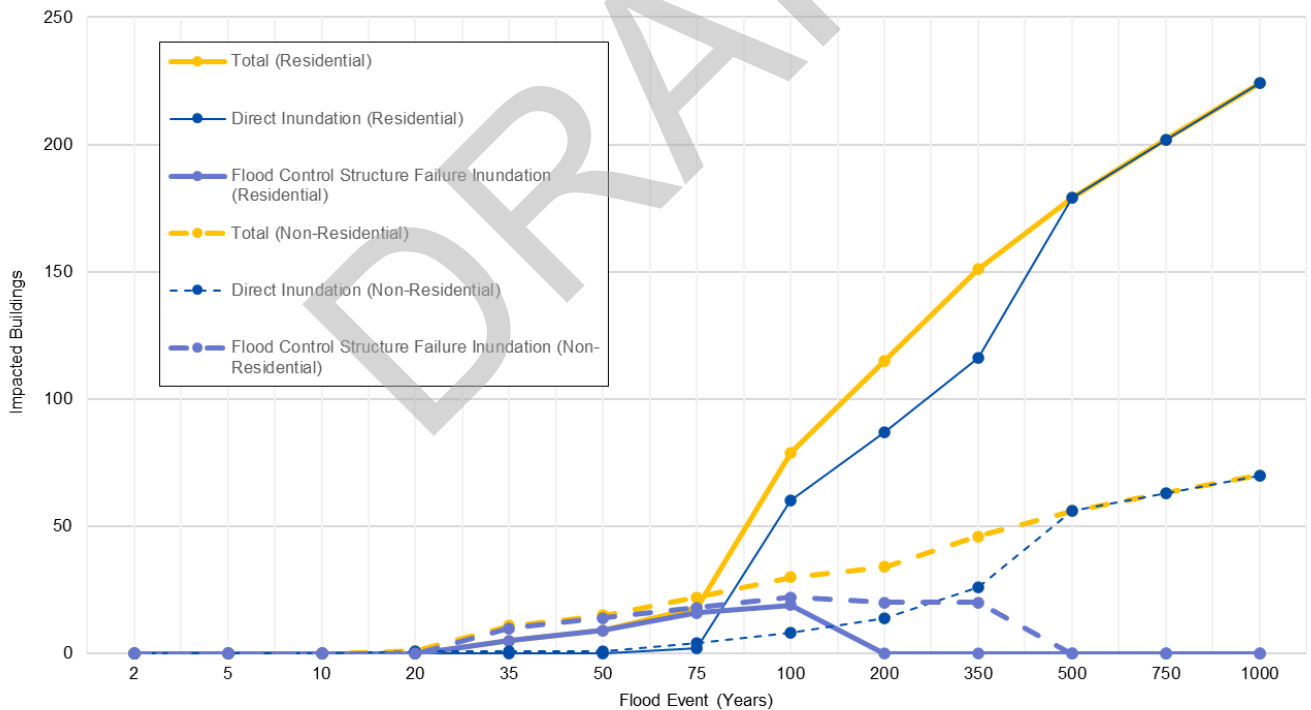
For Red Deer County, the number of residential buildings affected by direct flood inundation increases steadily between the 2-year flood and the 75-year flood and then changes little between the 100-year and 1000-year floods. Most residential buildings are located at Woodland Estates (near the intersection of Highway 587 and Range Road 41). No residential buildings in the county are potentially affected by flood control structure failure.

At the 100-year flood, a total of 233 residential buildings would be directly inundated in the study area, and 22 would be potentially inundated in the case of flood control structure failure. In comparison, a total of 519 residential buildings would be directly inundated in the study area for the 1,000-year flood.



**Table 3: Affected Residential Buildings Town of Sundre– Open Water Flood Inundation Scenarios**

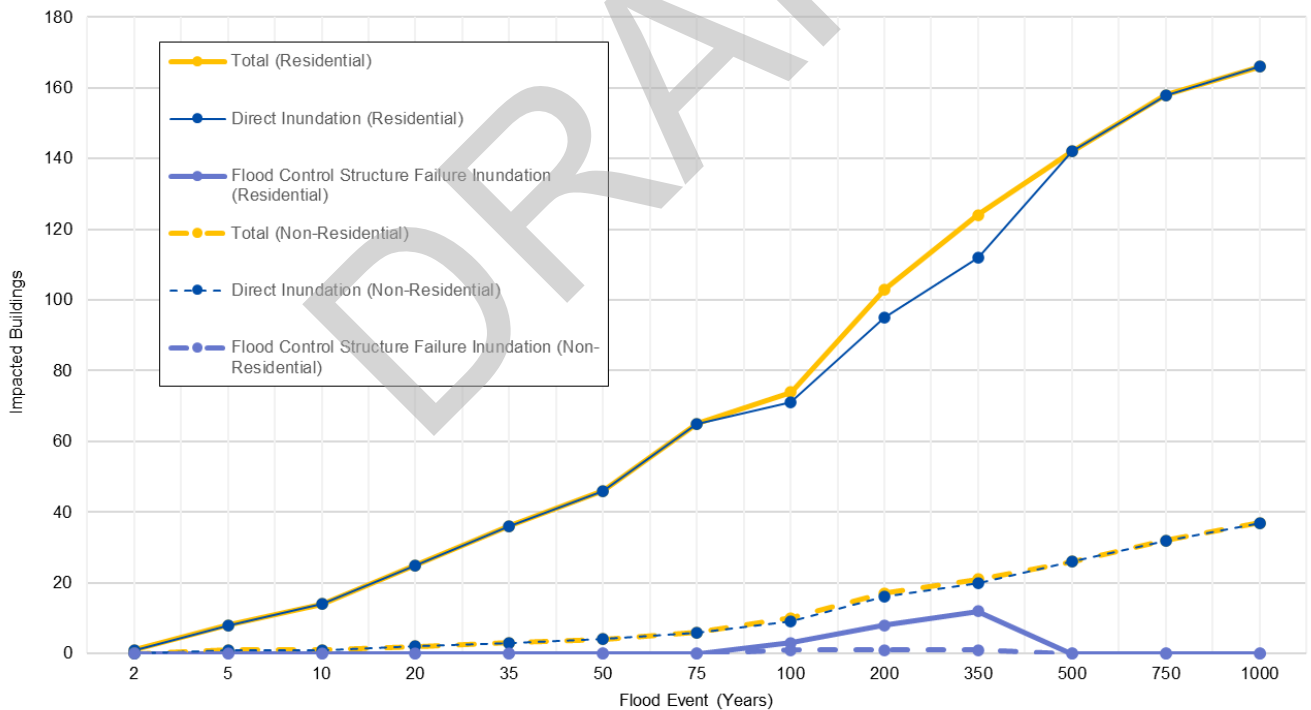
Scenario	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>9</b>	<b>18</b>	<b>79</b>	<b>115</b>	<b>151</b>	<b>179</b>	<b>202</b>	<b>224</b>
Single Family	0	0	0	0	5	8	16	76	112	148	176	197	219
Multifamily	0	0	0	0	0	1	2	3	3	3	3	4	4
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	1	1
<b>Direct Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>60</b>	<b>87</b>	<b>116</b>	<b>179</b>	<b>202</b>	<b>224</b>
Single Family	0	0	0	0	0	0	2	59	84	113	176	197	219
Multifamily	0	0	0	0	0	0	0	1	3	3	3	4	4
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	1	1
<b>Flood Control Structure Failure Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>9</b>	<b>16</b>	<b>19</b>	<b>28</b>	<b>35</b>	<b>0</b>	<b>0</b>	<b>0</b>
Single Family	0	0	0	0	5	8	14	17	28	35	0	0	0
Multifamily	0	0	0	0	0	1	2	2	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0



**Figure 3: Affected Residential and Non-Residential Buildings Town of Sundre – Open Water Flood Inundation Scenarios**

**Table 4: Affected Residential Buildings Mountain View County – Open Water Flood Inundation Scenarios**

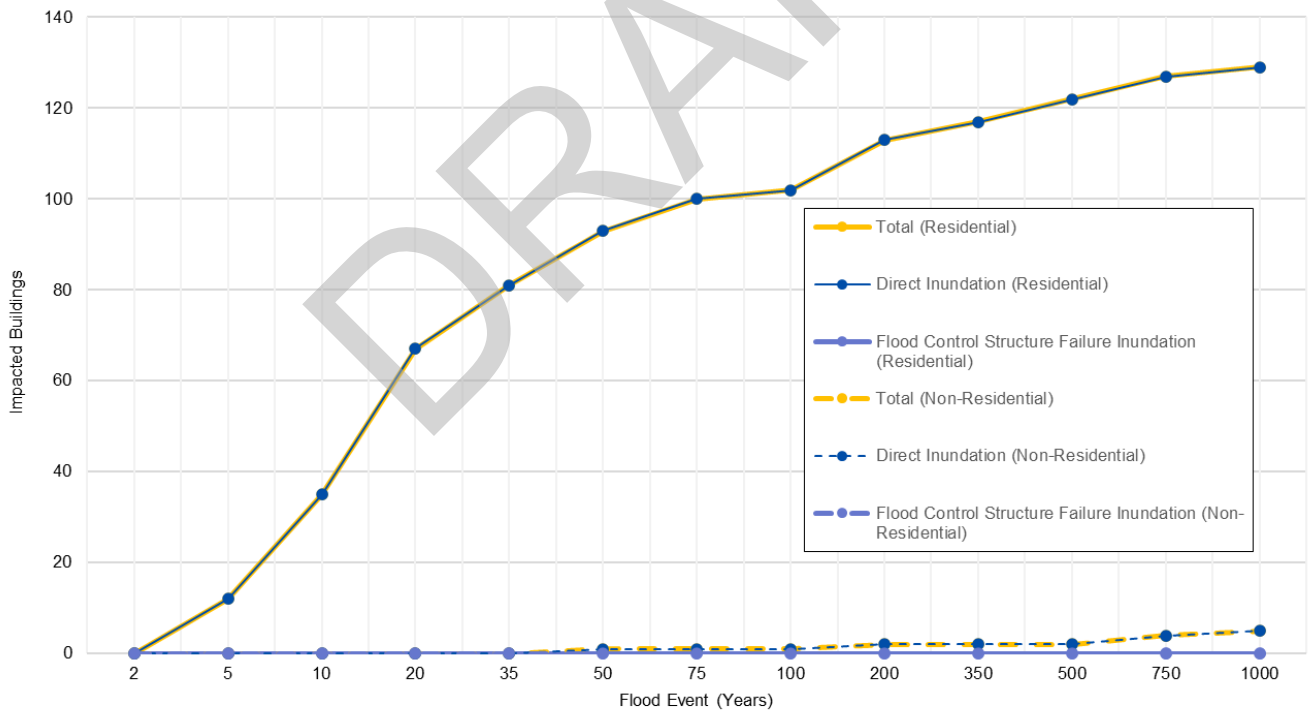
Scenario	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
<b>Total</b>	<b>1</b>	<b>8</b>	<b>14</b>	<b>25</b>	<b>36</b>	<b>46</b>	<b>65</b>	<b>74</b>	<b>103</b>	<b>124</b>	<b>142</b>	<b>158</b>	<b>166</b>
Single Family	1	8	14	25	36	46	65	74	103	124	142	158	166
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Direct Inundation</b>	<b>1</b>	<b>8</b>	<b>14</b>	<b>25</b>	<b>36</b>	<b>46</b>	<b>65</b>	<b>71</b>	<b>95</b>	<b>112</b>	<b>142</b>	<b>158</b>	<b>166</b>
Single Family	1	8	14	25	36	46	65	71	95	112	142	158	166
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Flood Control Structure Failure Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>8</b>	<b>12</b>	<b>0</b>	<b>0</b>	<b>0</b>
Single Family	0	0	0	0	0	0	0	3	8	12	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0



**Figure 4: Affected Residential and Non-Residential Buildings Mountain View County – Open Water Flood Inundation Scenarios**

**Table 5: Affected Residential Buildings Red Deer County – Open Water Flood Inundation Scenarios**

Scenario	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
<b>Total</b>	<b>0</b>	<b>12</b>	<b>35</b>	<b>67</b>	<b>81</b>	<b>93</b>	<b>100</b>	<b>102</b>	<b>113</b>	<b>117</b>	<b>122</b>	<b>127</b>	<b>129</b>
Single Family	0	12	35	67	81	93	100	102	113	117	122	127	129
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Direct Inundation</b>	<b>0</b>	<b>12</b>	<b>35</b>	<b>67</b>	<b>81</b>	<b>93</b>	<b>100</b>	<b>102</b>	<b>113</b>	<b>117</b>	<b>122</b>	<b>127</b>	<b>129</b>
Single Family	0	12	35	67	81	93	100	102	113	117	122	127	129
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Flood Control Structure Failure Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Single Family	0	0	0	0	0	0	0	0	0	0	0	0	0
Multifamily	0	0	0	0	0	0	0	0	0	0	0	0	0
Retirement Home	0	0	0	0	0	0	0	0	0	0	0	0	0



**Figure 5: Affected Residential and Non-Residential Buildings Red Deer County – Open Water Flood Inundation Scenarios**

## Non-Residential Buildings

A summary of affected non-residential buildings for each local authority is presented in Tables 6 to 8, including total number, as well as a breakdown of non-residential buildings affected by direct inundation and potential flood control structure failure inundation. Figures 3 to 5 show affected buildings per flood scenario, including non-residential buildings.

The number of non-residential buildings affected by direct flood inundation in the study area remains low between the 2-year flood and the 20-year flood. It then increases steadily from the 35-year flood to the 1,000-year flood. The number of non-residential buildings potentially affected by flood control structure failure in the study area is zero for the 2-year to 20-year flood. It then increases from the 35-year flood to the 350-year flood to a maximum of 21 structures. At the 500-year flood and higher, no non-residential buildings are potentially affected by flood control structure failure as these areas are affected by direct flood inundation instead.

In the Town of Sundre, the number of non-residential buildings affected by direct flood inundation remains low until the 20-year flood. It then increases steadily between the 35-year flood and the 1,000-year flood. Most affected non-residential buildings are located along Main Avenue West (Downtown). The number of non-residential buildings potentially affected by flood control structure failure is zero until the 20-year flood and then rises to a maximum of 20 at the 350-year flood. The potentially affected non-residential buildings are located behind the Sundre East Dike south of Main Avenue East.

For Mountain View County, the number of non-residential buildings affected by direct flood inundation increases steadily between the 5-year flood and the 1,000-year flood. Most affected non-residential buildings are located west of Sundre and in the McDougal flats area. The number of non-residential buildings potentially affected by flood control structure failure is zero until the 75-year flood and then reaches its maximum of 1 at the 100-year to 350-year floods. The potentially affected non-residential building is located along Highway 760 behind the Sundre East Dike.

No non-residential buildings would be affected by any flood scenarios in Clearwater County.

For Red Deer County, the number of non-residential buildings affected by direct flood inundation is zero until the 35-year flood and then remains low for all other flood scenarios. It reaches its maximum of 5 at the 1,000-year flood. No non-residential buildings in the county are potentially affected by flood control structure failure.

At the 100-year flood, a total of 18 non-residential buildings would be directly inundated in the study area, and 23 would be potentially inundated in the case of flood control structure failure. In comparison, a total of 112 non-residential buildings would be directly inundated in the study area during the 1,000-year flood.

No critical, non-residential buildings (i.e., hospitals, schools, or water treatment facilities) would be affected by any of the flood scenarios in the study area.

**Table 6: Affected Non-Residential Buildings Town of Sundre – Open Water Flood Inundation Scenarios**

Scenario	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>11</b>	<b>15</b>	<b>22</b>	<b>30</b>	<b>34</b>	<b>46</b>	<b>56</b>	<b>63</b>	<b>70</b>
Commercial	0	0	0	0	10	14	21	29	33	45	55	62	68
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	1	1	1	1	1	1	1	1	1	2
<b>Direct Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>4</b>	<b>8</b>	<b>14</b>	<b>26</b>	<b>56</b>	<b>63</b>	<b>70</b>
Commercial	0	0	0	0	0	0	3	7	13	25	55	62	68
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	1	1	1	1	1	1	1	1	1	2
<b>Flood Control Structure Failure Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>10</b>	<b>14</b>	<b>18</b>	<b>22</b>	<b>20</b>	<b>20</b>	<b>0</b>	<b>0</b>	<b>0</b>
Commercial	0	0	0	0	10	14	18	22	20	20	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	0	0	0	0	0	0	0	0	0	0

**Table 7: Affected Non-Residential Buildings Mountain View County – Open Water Flood Inundation Scenarios**

Scenario	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
<b>Total</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>6</b>	<b>10</b>	<b>17</b>	<b>21</b>	<b>26</b>	<b>32</b>	<b>37</b>
Commercial	0	1	1	1	1	1	3	5	8	10	13	16	20
Industrial	0	0	0	1	2	3	3	4	8	9	11	14	15
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	0	0	0	0	1	1	2	2	2	2
<b>Direct Inundation</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>6</b>	<b>9</b>	<b>16</b>	<b>20</b>	<b>26</b>	<b>32</b>	<b>37</b>
Commercial	0	1	1	1	1	1	3	4	7	9	13	16	20
Industrial	0	0	0	1	2	3	3	4	8	9	11	14	15
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	0	0	0	0	1	1	2	2	2	2
<b>Flood Control Structure Failure Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>
Commercial	0	0	0	0	0	0	0	1	1	1	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	0	0	0	0	0	0	0	0	0	0

**Table 8: Affected Non-Residential Buildings Red Deer County – Open Water Flood Inundation Scenarios**

Scenario	2-Year	5-Year	10-Year	20-Year	35-Year	50-Year	75-Year	100-Year	200-Year	350-Year	500-Year	750-Year	1000-Year
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>4</b>	<b>5</b>
Commercial	0	0	0	0	0	1	1	1	1	1	1	1	1
Industrial	0	0	0	0	0	0	0	0	1	1	1	3	4
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Direct Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>4</b>	<b>5</b>
Commercial	0	0	0	0	0	1	1	1	1	1	1	1	1
Industrial	0	0	0	0	0	0	0	0	1	1	1	3	4
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Flood Control Structure Failure Inundation</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
Commercial	0	0	0	0	0	0	0	0	0	0	0	0	0
Industrial	0	0	0	0	0	0	0	0	0	0	0	0	0
Government Building	0	0	0	0	0	0	0	0	0	0	0	0	0
Hospital	0	0	0	0	0	0	0	0	0	0	0	0	0
School	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Treatment Facility	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Non-Residential	0	0	0	0	0	0	0	0	0	0	0	0	0

### 4.2.3 Major Transportation Infrastructure

#### Roads

A summary of roads affected by direct inundation is presented in Table 9, including total length, as well as a breakdown of roads affected in each local authority. A summary of roads potentially affected by flood control structure failure is presented in Table 10, including total length, as well as a breakdown of roads affected in each local authority. Figure 6 shows the affected roads per flood scenario.

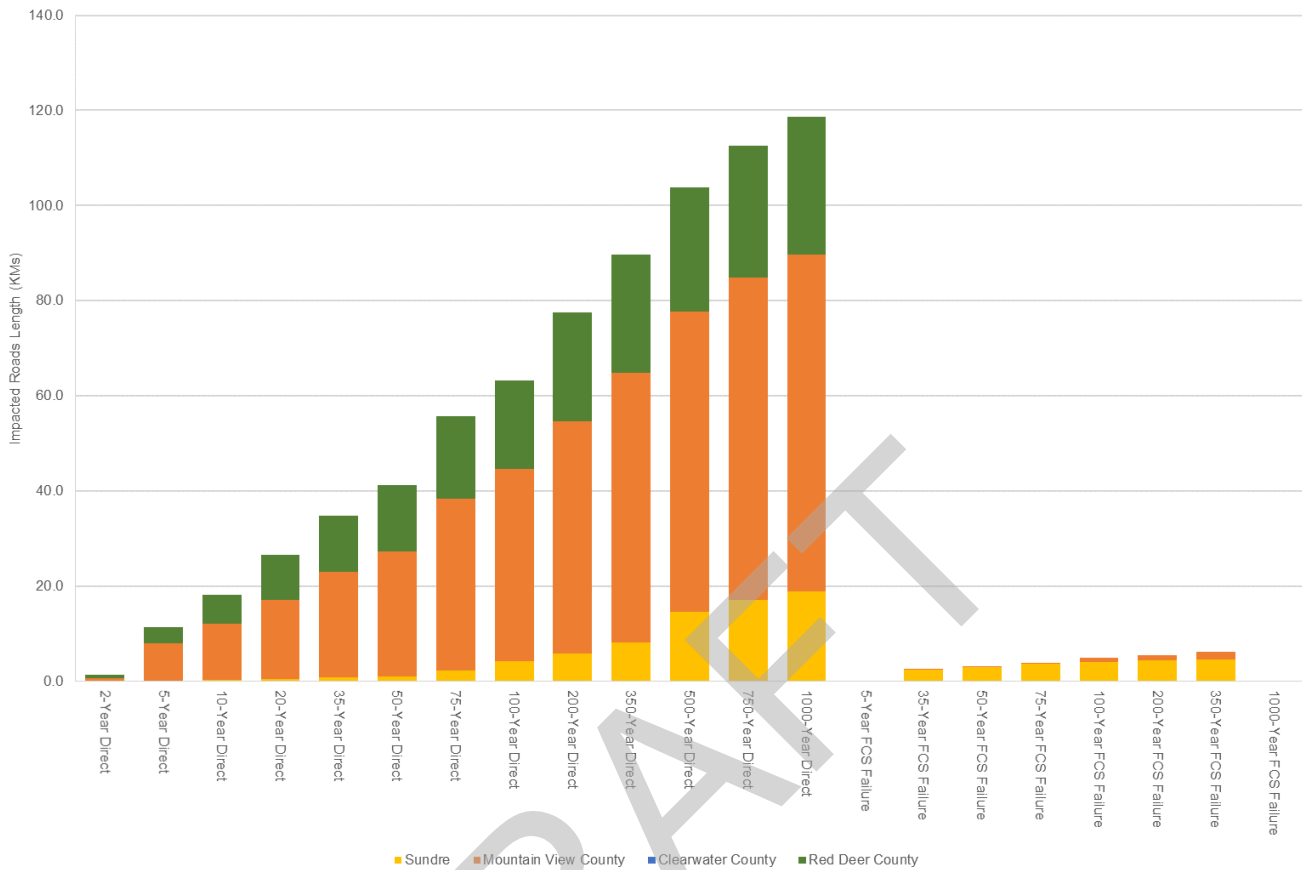
**Table 9: Length of Affected Roads – Open Water Flood Inundation Scenarios, Direct Inundation**

Scenario	Affected Length (km)				Total
	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	
2-Year	0.0	0.6	0.9	0.0	1.5
5-Year	0.0	7.9	3.4	0.1	11.4
10-Year	0.0	11.9	6.0	0.3	18.2
20-Year	0.0	16.6	9.5	0.6	26.7
35-Year	0.0	22.2	11.7	0.9	34.8
50-Year	0.0	26.3	13.9	1.0	41.3
75-Year	0.0	36.1	17.4	2.3	55.7
100-Year	0.0	40.4	18.6	4.3	63.3
200-Year	0.0	48.7	22.9	5.9	77.5
350-Year	0.0	56.7	24.9	8.2	89.7
500-Year	0.0	63.0	26.2	14.6	103.8
750-Year	0.0	67.7	27.7	17.2	112.5
1000-Year	0.0	70.8	28.9	18.9	118.6

**Table 10: Length of Affected Roads – Open Water Flood Inundation Scenarios, Flood Control Structure Failure**

Scenario	Affected Length (km)				Total
	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	
35-Year	0.0	0.1	0.0	2.4	2.6
50-Year	0.0	0.1	0.0	3.1	3.2
75-Year	0.0	0.2	0.0	3.7	3.8
100-Year	0.0	0.9	0.0	4.0	4.9
200-Year	0.0	1.1	0.0	4.4	5.5
350-Year	0.0	1.6	0.0	4.6	6.2
1000-Year	0.0	0.0	0.0	0.1	0.1





**Figure 6: Length of Affected Roads – Open Water Flood Inundation Scenarios**

The length of roads affected by direct flood inundation in the study area remains low at the 2-year flood and then increases steadily from the 5-year flood to the 1,000-year flood. The length of roads potentially affected by flood control structure failure in the study area is zero until the 20-year flood and reaches its maximum at the 350-year flood (6.2 km of road that would be affected). At the 500-year flood and higher, roads are not affected by flood control structure failure, as the flood control structures would be overtopped and these roads would be affected by direct flood inundation instead.

In the Town of Sundre, the length of roads affected by direct inundation remains low until the 20-year flood. It then increases steadily between the 35-year and 1,000-year floods. The length of roads potentially affected by flood control structure failure in the Town of Sundre is zero until the 20-year flood and reaches its maximum at the 350-year flood at a length of 4.6 km. The potentially affected roads are mostly located behind the Sundre East Dike.

For Mountain View County the length of roads affected by direct inundation increases steadily between the 2-year and 1,000-year floods. The length of roads potentially affected by flood control structure failure in Mountain View County is zero until the 20-year flood and then increases between the 35-year and 350-year floods to a maximum length of 1.6 km. The potentially affected roads are located behind the Sundre East Dike.

The length of roads affected in Clearwater County is zero for all flood scenarios.

For Red Deer County, the length of roads affected by direct inundation increases steadily between the 2-year and 1,000-year floods. No roads are potentially affected by flood control structure failure in Red Deer County.

The following major roads within Sundre would be affected by direct inundation:

- Main Avenue West and Highway 27 at return periods 75 years and higher;
- Main Avenue East, west of the Red Deer River crossing at return periods 200 years and higher;
- 10<sup>th</sup> Street Southwest at return periods 200 years and higher;
- Highway 22 between the intersection with Highway 27/Highway 584 and Bearberry Creek at return periods 200 years and higher;
- Main Avenue East, east of the Red Deer River crossing at return periods 500 years and higher;
- 5<sup>th</sup> Street Southeast at return periods 500 years and higher; and
- Centre Street North, south of 2<sup>nd</sup> Avenue Northeast at return periods 500 years and higher.

The following major roads within Sundre would be affected by flood control structure failure inundation:

- Main Avenue East, east of the Red Deer River crossing at return periods 50 to 350 years;
- 5<sup>th</sup> Street Southeast at return periods 50 to 350 years; and
- Main Avenue East, west of the Red Deer River crossing at the 100-year flood.

The following roads outside of Sundre would be affected by direct inundation:

- Range Road 55 south of the Sundre Airport at return periods 5 years and higher;
- Range Road 60 between Highway 584 and Township Road 332 at return periods 5 years and higher;
- Range Road 52 between Sundre and Township Road 334 at return periods 10 years and higher;
- Highway 587 east of the Red Deer River crossing at return periods 10 years and higher;
- Range Road 43 south of the intersection with Highway 587 at return periods 10 years and higher;
- Highway 766 south of Township Road 355 at return periods 20 years and higher;
- Highway 584 west of the intersection with Highway 22 at return periods 100 years and higher;
- Township Road 350 between Range Road 35 and Highway 766 at return periods 200 years and higher;
- Highway 760 at return periods at return periods 500 years and higher; and
- Township Road 315A west of Coal Camp at the 1000-year flood.

In addition, the following major road outside of Sundre would be affected by flood control structure failure inundation:

- Highway 760 at return periods at return periods 75 years to 350 years.

At the 100-year flood, about 64 km of roads would be directly inundated and 5 km would be potentially inundated in the case of flood control structure failure. In comparison, 119 km of roads would be directly inundated for the 1,000-year flood.

## **Bridges**

A summary of bridge clearances during floods is presented in Table 11.

**Table 11: Bridge Clearances – Open Water Flood Inundation Scenarios**

Stream	Description	Name	Minimum Low Chord/ Road Surface Elevation (m)	2-Year		5-Year		10-Year		20-Year		35-Year		50-Year		75-Year		100-Year		200-Year		350-Year		500-Year		750-Year		1,000-Year	
				Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)	Water Level (m)	Clearance (m)
Red Deer River	Highway 27	Main Avenue E Bridge (Sundre)	1093.3	1089.6	3.8	1090.1	3.2	1090.6	2.8	1091.0	2.3	1091.4	2.0	1091.6	1.7	1091.9	1.4	1092.1	1.2	1092.7	0.6	1093.2	0.1	1093.5	-0.2	1094.1	-0.8	1094.4	-1.1
	Highway 587	Bridge at Garrington	1006.5	1002.3	4.2	1002.9	3.6	1003.4	3.1	1003.8	2.7	1004.2	2.3	1004.5	2.0	1004.7	1.8	1004.9	1.6	1005.5	1.0	1006.0	0.5	1006.3	0.2	1006.7	-0.2	1007.0	-0.5
Bearberry Creek	Range Road 60	Range Road 60 Bridge and Culvert	1124.9	1122.5	2.4	1122.9	2.0	1123.2	1.7	1123.5	1.4	1123.7	1.3	1123.7	1.2	1123.8	1.2	1123.8	1.1	1123.9	1.0	1124.0	1.0	1124.0	0.9	1124.1	0.9	1124.1	0.8
	Highway 22	Cowboy Trail Bridge and Culvert	1105.7	1102.9	2.8	1103.4	2.3	1103.7	2.0	1104.1	1.6	1104.4	1.3	1104.6	1.1	1104.9	0.8	1105.1	0.6	1106.0	-0.3	1106.5	-0.8	1106.8	-1.1	1107.4	-1.7	1107.8	-2.1
	Above Centre Street North	Sundre Footbridge	1095.9	1093.2	2.7	1093.6	2.3	1093.9	2.0	1094.3	1.6	1094.6	1.3	1094.8	1.1	1095.1	0.8	1095.3	0.6	1095.6	0.3	1096.0	-0.1	1096.3	-0.4	1097.3	-1.3	1097.5	-1.6
	Centre Street North	Centre Street Bridge	1094.2	1091.0	3.1	1091.5	2.7	1091.8	2.3	1092.2	2.0	1092.4	1.7	1092.6	1.5	1092.9	1.3	1093.0	1.2	1093.4	0.7	1093.8	0.3	1094.5	-0.3	1094.9	-0.8	1095.2	-1.1

Note: The clearances are the elevation differences between bridge low chord and simulated water levels. A negative value indicates the water depth above the low chord.

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#### 4.2.4 Population

Each residential building in the study area (including single family, multifamily, and retirement homes) was assigned a number of residents based on the population count of the census block they are located in (see Section 3.2). The population affected by a flood scenario was estimated based on a tally of the residents of all affected residential buildings.

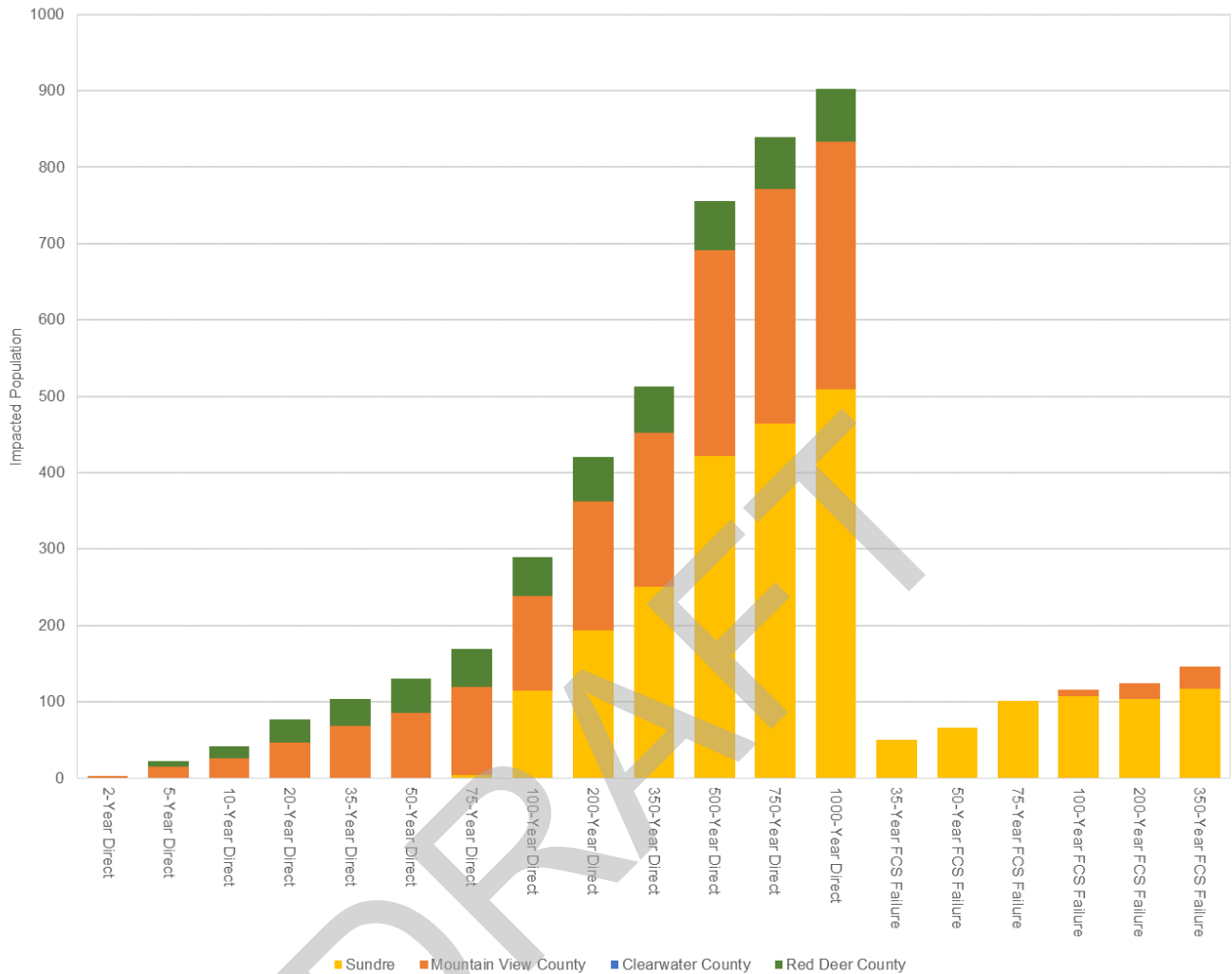
A summary of the population affected by direct inundation is presented in Table 12, including total numbers, as well as a breakdown of population affected in each local authority. A summary of the population potentially affected by flood control structure failure is presented in Table 13, including total population, as well as a breakdown of population affected in each local authority. Figure 7 shows the affected population per flood scenario.

**Table 12: Affected Population – Open Water Flood Inundation Scenarios, Direct Inundation**

Scenario	Impacted Population				Total
	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	
2-Year	0	3	0	0	3
5-Year	0	15	7	0	22
10-Year	0	26	16	0	42
20-Year	0	46	30	0	77
35-Year	0	69	35	0	104
50-Year	0	86	44	0	130
75-Year	0	115	50	4	170
100-Year	0	124	51	114	290
200-Year	0	170	58	193	420
350-Year	0	202	61	251	513
500-Year	0	270	64	422	755
750-Year	0	307	68	464	839
1000-Year	0	324	69	510	902

**Table 13: Affected Population – Open Water Flood Inundation Scenarios, Flood Control Structure Failure**

Scenario	Impacted Population				Total
	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	
35-Year	0	0	0	50	50
50-Year	0	0	0	66	66
75-Year	0	0	0	101	101
100-Year	0	9	0	107	116
200-Year	0	21	0	104	125
350-Year	0	30	0	117	147



**Figure 7: Affected Population – Open Water Flood Inundation Scenarios**

The population affected by direct flood inundation in the study area remains low at the 2-year flood and then increases from the 5-year flood to the 1,000-year flood. Significant increases occur between the 75-year and 100-year floods as well as between the 350-year flood and the 500-year flood. The population potentially affected by flood control structure failure in the study area is zero for the 2-year to 20-year flood. It then increases steadily from the 35-year flood to the 350-year flood. At the 500-year flood and higher, no people would be potentially affected by flood control structure failure as these areas are affected by direct flood inundation instead.

In the Town of Sundre, the population affected by direct flood inundation remains low until the 75-year flood. It increases significantly between the 75-year and 100-year floods, as residential neighbourhoods between Bearberry Creek and Main Avenue West are affected, and again between the 350-year and 500-year floods as residential neighbourhoods behind the Sundre East Dike are affected. The population potentially affected by flood control structure failure is zero until the 20-year flood and then rises steadily to a maximum of 117 at the 350-year flood. The potentially affected population is mostly located behind the Sundre East Dike.

For Mountain View County, the population affected by direct flood inundation increases steadily between the 2-year flood and the 1,000-year flood. Most of the affected population is located west of Sundre, in the McDougal flats area and in the Hamlet of Coal Camp. The population potentially affected by flood control structure failure is zero until the 75-year flood and then rises between the 100-year and 350-year floods. The potentially affected people are located along Highway 760 behind the Sundre East Dike.

No population would be affected by any flood scenarios in Clearwater County.

For Red Deer County, the population affected by direct flood inundation increases steadily between the 2-year flood and the 75-year flood and then changes little between the 100-year and 1,000-year floods. Most of the affected population is located at Woodland Estates (near the intersection of Highway 587 and Range Road 41). No population in the county is potentially affected by flood control structure failure.

At the 100-year flood, a total of 290 people would be affected by direct inundation in the study area and 116 people would be potentially affected in the case of flood control structure failure. In comparison, a total of 902 people would be affected by direct flood inundation in the study area at the 1,000-year flood.

## 4.3 Design Flood Hazard Scenario

### 4.3.1 General

Flood statistics were generated for the design flood scenario using the flood hazard maps prepared as part of this study (Golder 2022c), and the results are presented in the following sections.

### 4.3.2 Land Parcels

A summary of affected land parcels is presented in Table 14, including the total number, the number for each local authority, as well as a breakdown of parcels located in the floodway, flood fringe (neither high hazard nor protected flood fringe), high hazard flood fringe and protected flood fringe.

**Table 14: Affected Land Parcels – Design Flood Hazard Scenario**

Scenario	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	Total
Floodway	12	132	51	8	<b>203</b>
Flood Fringe	2	495	26	98	<b>621</b>
High Hazard Flood Fringe	1	19	9	8	<b>37</b>
Protected Flood Fringe	0	56	0	115	<b>171</b>

For the design flood, there are 203 land parcels located in the floodway, 621 in the flood fringe, 37 in the high hazard flood fringe and 171 in the protected flood fringe.

### 4.3.3 Buildings and Infrastructure

#### *Residential Buildings*

A summary of affected residential buildings for each local authority is presented in Tables 15 to 18, including total number, as well as a breakdown of residential buildings located in the floodway, flood fringe (neither high hazard nor protected flood fringe), high hazard flood fringe and protected flood fringe.

**Table 15: Affected Residential Buildings Town of Sundre – Design Flood Hazard Scenario**

Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Multifamily	0	1	0	2
Single Family	0	58	1	17
Retirement Home	0	0	0	0
<b>Total</b>	<b>0</b>	<b>59</b>	<b>1</b>	<b>19</b>

**Table 16: Affected Residential Buildings Mountain View County – Design Flood Hazard Scenario**

Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Multifamily	0	0	0	0
Single Family	11	61	3	3
Retirement Home	0	0	0	0
<b>Total</b>	<b>11</b>	<b>61</b>	<b>3</b>	<b>3</b>

**Table 17: Affected Residential Buildings Clearwater County – Design Flood Hazard Scenario**

Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Multifamily	0	0	0	0
Single Family	0	0	0	0
Retirement Home	0	0	0	0
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Table 18: Affected Residential Buildings Red Deer County – Design Flood Hazard Scenario**

Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Multifamily	0	0	0	0
Single Family	57	43	7	0
Retirement Home	0	0	0	0
<b>Total</b>	<b>57</b>	<b>43</b>	<b>7</b>	<b>0</b>

For the design flood, there are a total of 68 residential buildings located in the floodway, 163 in the flood fringe, 11 in the high hazard flood fringe and 12 in the protected flood fringe.,

### Non-Residential Buildings

A summary of affected non-residential buildings for each local authority is presented in Tables 19 to 22, including total number, as well as a breakdown of non-residential buildings located in the floodway, flood fringe (neither high hazard nor protected flood fringe), high hazard flood fringe and protected flood fringe

**Table 19: Affected Non-Residential Buildings Town of Sundre – Design Flood Hazard Scenario**

Non-Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Commercial	0	7	0	22
Industrial	0	0	0	0
Government Building	0	0	0	0
Hospital	0	0	0	0
School	0	0	0	0
Water Treatment Facility	0	0	0	0
Other Non-Residential	0	0	1	0
<b>Total</b>	<b>0</b>	<b>7</b>	<b>1</b>	<b>22</b>

**Table 20: Affected Non-Residential Buildings Mountain View County – Design Flood Hazard Scenario**

Non-Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Commercial	0	3	1	1
Industrial	1	3	0	0
Government Building	0	0	0	0
Hospital	0	0	0	0
School	0	0	0	0
Water Treatment Facility	0	0	0	0
Other Non-Residential	0	1	0	0
<b>Total</b>	<b>1</b>	<b>7</b>	<b>1</b>	<b>1</b>

**Table 21: Affected Non-Residential Buildings Clearwater County – Design Flood Hazard Scenario**

Non-Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Commercial	0	0	0	0
Industrial	0	0	0	0
Government Building	0	0	0	0
Hospital	0	0	0	0
School	0	0	0	0



**Table 21: Affected Non-Residential Buildings Clearwater County – Design Flood Hazard Scenario**

Non-Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Water Treatment Facility	0	0	0	0
Other Non-Residential	0	0	0	0
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Table 22: Affected Non-Residential Buildings Red Deer County – Design Flood Hazard Scenario**

Non-Residential Category	Floodway	Flood Fringe	High Hazard Flood Fringe	Protected Flood Fringe
Commercial	1	0	0	0
Industrial	0	0	0	0
Government Building	0	0	0	0
Hospital	0	0	0	0
School	0	0	0	0
Water Treatment Facility	0	0	0	0
Other Non-Residential	0	0	0	0
<b>Total</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>

For the design flood, there are a total of 2 non-residential buildings located in the floodway, 14 in the flood fringe, 2 in the high hazard flood fringe and 23 in the protected flood fringe.,.

No critical, non-residential buildings (i.e. hospitals, schools, or water treatment facilities) in the study area would be affected by the design flood.

#### 4.3.4 Major Transportation Infrastructure

##### Roads

A summary of affected roads is presented in Table 23, including total length, the length for each local authority, as well as a breakdown of roads located in the floodway, flood fringe (neither high hazard nor protected flood fringe), high hazard flood fringe and protected flood fringe.

**Table 23: Lengths of Affected Roads – Design Flood Hazard Scenario**

Scenario	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	Total
Floodway	0.0	7.3	7.7	0.0	<b>14.9</b>
Flood Fringe	0.0	30.5	10.6	3.7	<b>44.8</b>
High Hazard Flood Fringe	0.0	2.8	0.7	0.6	<b>4.0</b>
Protected Flood Fringe	0.0	0.9	0.0	4.0	<b>5.0</b>

For the design flood, there are 14.9 km of roads located in the floodway, 44.8 km in the flood fringe, 4.0 km in the high hazard flood fringe and 5.0 km in the protected flood fringe in the study area.

## Bridges

A summary of bridge clearances for the design flood hazard scenario is presented in Table 24.

**Table 24: Bridge Clearances – Design Flood Hazard Scenario**

River	Name	Minimum Low Chord / Road Surface Elevation (m)	Water Level (m)	Clearance <sup>(a)</sup> (m)
Red Deer River	Highway 27 Bridge	1093.3	1092.12	1.2
Red Deer River	Highway 587 Bridge	1006.5	1004.93	1.6
Bearberry Creek	Range Road 60 Bridge	1124.9	1123.81	1.1
Bearberry Creek	Highway 22 Bridge	1105.7	1105.16	0.5
Bearberry Creek	Sundre Footbridge	1095.9	1095.29	0.6
Bearberry Creek	Centre Street Bridge	1094.2	1093.04	1.1

(a) The clearances for the 100-year design flood scenario are the elevation differences between bridge low chord and simulated water levels. A negative value indicates the water depth above the low chord.

## 4.3.5 Population

A summary of affected population is presented in Table 25, including total number, the number for each local authority, as well as a breakdown of population located in areas falling into the floodway, flood fringe (neither high hazard nor protected flood fringe), high hazard flood fringe and protected flood fringe.

**Table 25: Affected Population – Design Flood Hazard Scenario**

Scenario	Clearwater County	Mountain View County	Red Deer County	Town of Sundre	Total
Floodway	0	15	16	0	31
Flood Fringe	0	110	30	112	252
High Hazard Flood Fringe	0	6	5	2	13
Protected Flood Fringe	0	9	0	107	116

For the design flood, within the study area, there are a total of 31 people located in the floodway, 252 in the flood fringe, 13 in the high hazard flood fringe and 116 in the protected flood fringe in the study area

## 5.0 CONCLUSIONS

The main results of the flood risk assessment for the 13 open water flood scenarios are summarized below:

- The number of land parcels, buildings and population, as well as the length of roads affected increase steadily from the 2-year flood to the 1,000-year flood.
- A large increase in the affected population occurs in the Town of Sundre between the 75-year and 100-year floods, as residential neighbourhoods between Bearberry Creek and Main Avenue West are affected. A second large increase occurs between the 350-year and 500-year floods as residential neighbourhoods behind the Sundre East Dike are affected.
- No critical, non-residential buildings (i.e. hospitals, schools, or water treatment facilities) in the study area would be affected by any of the flood scenarios.
- The length of roads affected by direct flood inundation remains low at the 2-year flood and then increases steadily from the 5-year flood to the 1,000-year flood. Some of the major roads that would be affected by floods in the study area include the following:
  - Highway 766 south of Township Road 355 at return periods 20 years and higher;
  - Main Avenue West and Highway 27 in the Town of Sundre at return periods 75 years and higher;
  - Highway 584 west of the intersection with Highway 22 at return periods 100 years and higher
  - Highway 22 between the intersection with Highway 27/Highway 584 and Bearberry Creek at return periods 200 years and higher;
  - Main Avenue East in the Town of Sundre east of the Red Deer River crossing at return periods 500 years and higher;
  - Centre Street North in the Town of Sundre south of 2nd Avenue Northeast at return periods 500 years and higher; and
  - Highway 760 at return periods 500 years and higher.

The main results of the flood risk assessment for the design flood are summarized below:

- There are 68 residential buildings and 2 non-residential buildings located in the floodway.
- There are 196 residential and 39 non-residential buildings located in the flood fringe (including high hazard flood fringe and protected flood fringe).
- There is a total population of 31 located in the floodway, and a total population of 381 located in the flood fringe (including high hazard flood fringe and protected flood fringe).
- No critical, non-residential buildings (i.e. hospitals, schools, or water treatment facilities) in the study area would be affected by the design flood.
- Some of the major roads that would be affected are Highway 766 south of Township Road 355, Highway 587 east of the Red Deer River crossing, Range Road 52 between Township Roads 334 and 332, Main Avenue West and Highway 27 in the Town of Sundre, Highway 760 south of the intersection with Main Avenue East and Highway 584 west of the intersection with Highway 22.

## Signature Page

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