To: Dan Austin
From: Will Kwan
Date: February 25th, 2025
RE: GISC480 Lab #5

This memo summarizes the methods, discussions, and results from Lab #5. The analysis models the 35-year and 350-year flood inundation return periods in Calgary, Alberta, to evaluate their potential impacts on the city and assess the affected population.

Introduction

A GIS analysis was performed on the client's provided data and location-based open datasets to determine the potential impacts of flooding on portions of the City of Calgary's rivers, specifically for the 35-year and 350-year inundation return periods. The study area, outlined in Figure 1, corresponds to the City of Calgary. Figure 1 highlights Calgary's major rivers and creeks, especially the Bow and Elbow Rivers, which significantly influence the cities flooding risk.

A flood return period is a statistical estimate of the average time between flood occurrences of a particular magnitude. It represents the probability that such an event will be equalled or exceeded in any given year (USGS, 2018). For instance, a flood with a 100-year return period has a 1% chance of occurring in any year. This analysis evaluates the potential impacts of affected areas and populations, facilitating estimates of damages to public and private infrastructure and risks to public safety.

Methods

The Hydrologic Engineering Center's River Analysis System (*HEC-RAS*) model, consisting of multiple river cross-sections with flood level elevations for several return periods (ranging from 2 to 1000 years), along with raster digital elevation model (DEM) data, was provided by the client. Additionally, census data by community for 2019 were obtained from the City of Calgary's Open Data Portal.

Initially, the HEC-RAS model required preprocessing to address integrity issues, specifically numeric values indicating flood level elevations incorrectly formatted as strings. After correction, a Triangular Irregular Network (TIN) was created using the flood level elevations for the 35-year and 350-year return periods, representing the variation in water levels for each respective event. These TINs were then converted to raster format to facilitate raster calculations. Each water level raster was subtracted from the DEM, and the resulting rasters were queried for elevations less than or equal to zero (indicating areas where the water level exceeded the land surface) to define the flooded areas.

To define potential impacts on the city and the affected population, population density (resident count per unit area) was first calculated for each neighbourhood. The flooded area rasters were then converted to polygons and intersected with the census data to determine the neighbourhood area inundated by each flood. The product of each neighbourhood's population density and the inundated area was used to estimate the population affected. This method assumes an even distribution of the population throughout the neighbourhood and defines the affected population as individuals living within a flooded area.

Results

Once the analysis was complete, the data could be meaningfully represented figuratively and tabularly. Figure 1 illustrates the study area—the City of Calgary—along with the city's significant river and creek systems. Figure 2 illustrates the 35-year and 350-year flood extents overlaid on one other, allowing a direct visual comparison between the two flood events.

Table 1 summarizes the affected area and estimated potential affected population for each neighbourhood for the 35-year flood return period. The flood is estimated to inundate 2,896 hectares within the city limits and affect 42,914 people. The neighbourhoods with the largest flooded areas were Glenmore Park (496 ha), Douglasdale/Glen (160 ha), and Haysboro (143 ha). The neighbourhoods with the highest number of people affected were Haysboro (3,802), Douglasdale/Glen (3,209), and Sunnyside (2,840).

Table 2 summarizes the affected area and estimated potential affected population for each neighbourhood for the 350-year flood return period. The flood is estimated to inundate 4,922 hectares within the city limits and affect 103,067 people. The neighbourhoods with the largest flooded areas were Glenmore Park (563 ha), Fish Creek Park (257 ha), and the Beltline (255 ha). The neighbourhoods with the highest number of people affected were the Beltline (21,798), the Downtown Commercial Core (5,982), and Douglasdale/Glen (4,918).

Figures

Table 1

Flooded Area and Affected Population by Neighbourhood for the 35-Year Flood Return Period

Neighbourhood Name	Area (Hectares)	Potential population affected (# of people)
GLENMORE PARK	496	0
DOUGLASDALE/GLEN	160	3,209
HAYSBORO	143	3,802
FISH CREEK PARK	131	0
EAST FAIRVIEW INDUSTRIAL	124	0
BURNS INDUSTRIAL	113	0
MANCHESTER INDUSTRIAL	109	0
DISCOVERY RIDGE	105	1,246
BOWNESS	93	1,842
BRIDGELAND/RIVERSIDE	92	2,060
INGLEWOOD	85	1,364
RIVERBEND	83	1,876
SOUTHWOOD	76	1,780
SUNNYSIDE	69	2,840
SILVER SPRINGS	62	1,073
MAPLE RIDGE	59	407
DOVER	58	1,445
MONTGOMERY	56	849
OGDEN	55	1,149
HILLHURST	55	1,733
SOUTHVIEW	45	508
01B	41	0
VARSITY	40	758
ELBOW PARK	37	690
WEST HILLHURST	33	905
WILLOW PARK	30	476
HASKAYNE	29	0
ALYTH/BONNYBROOK	27	0
ACADIA	25	660
BELTLINE	24	2,045
ALBERT PARK/RADISSON HEIGHTS	19	541
EAU CLAIRE	19	750
SCENIC ACRES	19	347
VALLEY RIDGE	19	313
MCKENZIE LAKE	19	492
KINGSLAND	16	572
HIGHFIELD	15	0
MISSION	14	1,179
POINT MCKAY	12	423
09D	12	0
09H	12	0
PARKDALE	11	276
SPRUCE CLIFF	11	467
RIDEAU PARK	11	238
PARKHILL	10	251
CRESCENT HEIGHTS	9	378
SHEPARD INDUSTRIAL	9	5
ROXBORO	9	138
CHINATOWN	8	823
DOWNTOWN EAST VILLAGE	8	602
ALTADORE	8	257
BAYVIEW	8	137
ERLTON	8	194
SHAGANAPPI	7	81
WILDWOOD	7	75
CHINOOK PARK	5	155
LOWER MOUNT ROYAL	5	656
ELBOYA	5	122
MANCHESTER	5	98
DIAMOND COVE	4	58
GLENDEER BUSINESS PARK	4	0
PUMP HILL	3	53
CLIFF BUNGALOW	2	114
RAMSAY	2	48
SUNALTA	2	72
DOWNTOWN COMMERCIAL CORE	2	121
WINDSOR PARK	2	64
01H	1	0
DOWNTOWN WEST END	1	82
BRITANNIA	1	10
BEL-AIRE	0	2
SCARBORO/ SUNALTA WEST	0	1
ROSEDALE	0	0
SIGNAL HILL	0	0
MAYFAIR	0	0
Grand Total	**2,896**	**42,914**

Note: Neighbourhoods are sorted in descending order by affected area. The affected population assumes even population distribution across each neighbourhood. Area and population values are rounded to the nearest whole number.

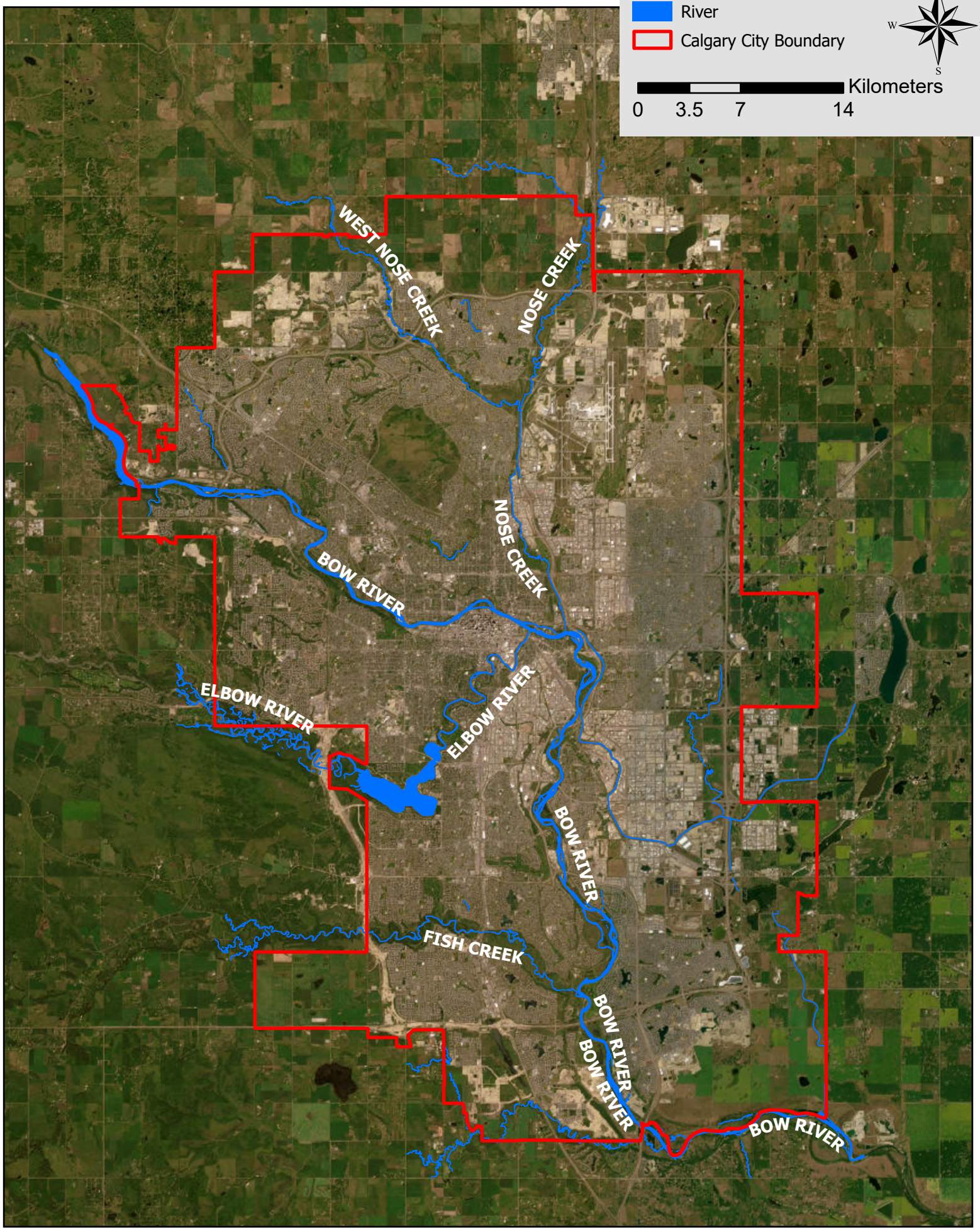
Table 2

Flooded Area and Affected Population by Neighbourhood for the 350-Year Flood Return Period

Neighbourhood Name	Area (Hectares)	Potential population affected (# of people)
GLENMORE PARK	563	0
FISH CREEK PARK	257	0
BELTLINE	255	21,798
DOUGLASDALE/GLEN	246	4,918
INGLEWOOD	198	3,185
HAYSBORO	176	4,670
EAST FAIRVIEW INDUSTRIAL	166	0
DISCOVERY RIDGE	156	1,855
MANCHESTER INDUSTRIAL	156	0
ALYTH/BONNYBROOK	149	0
BURNS INDUSTRIAL	140	0
RIVERBEND	133	3,012
OGDEN	132	2,768
BRIDGELAND/RIVERSIDE	132	2,956
BOWNESS	129	2,567
HILLHURST	119	3,785
ELBOW PARK	116	2,175
MONTGOMERY	99	1,517
DOWNTOWN COMMERCIAL CORE	92	5,982
SOUTHWOOD	88	2,060
SUNNYSIDE	86	3,539
WEST HILLHURST	79	2,144
MAPLE RIDGE	78	540
DOVER	67	1,676
SILVER SPRINGS	65	1,136
SOUTHVIEW	54	610
01B	48	0
EAU CLAIRE	46	1,797
VARSITY	44	832
MISSION	44	3,786
WILLOW PARK	43	670
DOWNTOWN EAST VILLAGE	41	3,051
KINGSLAND	38	1,332
HIGHFIELD	34	0
HASKAYNE	31	0
SUNALTA	30	1,022
ACADIA	29	784
VALLEY RIDGE	28	478
ALBERT PARK/RADISSON HEIGHTS	28	771
CLIFF BUNGALOW	25	1,301
WILDWOOD	25	262
CHINATOWN	24	2,382
09H	21	0
MANCHESTER	21	459
ERLTON	21	523
SCENIC ACRES	21	379
POINT MCKAY	21	718
SHEPARD INDUSTRIAL	20	12
ROXBORO	20	312
LOWER MOUNT ROYAL	20	2,442
MCKENZIE LAKE	19	506
RAMSAY	17	382
PARKHILL	17	445
DOWNTOWN WEST END	17	1,310
09D	16	0
RIDEAU PARK	16	351
SPRUCE CLIFF	15	664
ELBOYA	15	374
CRESCENT HEIGHTS	15	601
ALTADORE	12	404
CHINOOK PARK	12	350
PARKDALE	12	295
SHAGANAPPI	11	125
GLENDEER BUSINESS PARK	10	0
OGDEN SHOPS	10	0
BAYVIEW	9	154
WINDSOR PARK	7	267
DIAMOND COVE	5	75
PUMP HILL	5	89
FAIRVIEW INDUSTRIAL	5	0
LAKE BONAVISTA	5	94
BONAVISTA DOWNS	5	80
QUEENSLAND	3	97
BRITANNIA	2	21
SHAWNEE SLOPES	1	23
MIDNAPORE	1	35
MAYFAIR	1	18
01H	1	0
SCARBORO	1	17
CANYON MEADOWS	1	19
DEER RUN	1	20
BANKVIEW	0	25
BEL-AIRE	0	3
UPPER MOUNT ROYAL	0	5
SCARBORO/ SUNALTA WEST	0	2
FAIRVIEW	0	3
KELVIN GROVE	0	4
ROSEDALE	0	3
SIGNAL HILL	0	0
Grand Total	**4,922**	**103,067**

Note: Neighbourhoods are sorted in descending order by affected area. The affected population assumes even population distribution across each neighbourhood. Area and population values are rounded to the nearest whole number.

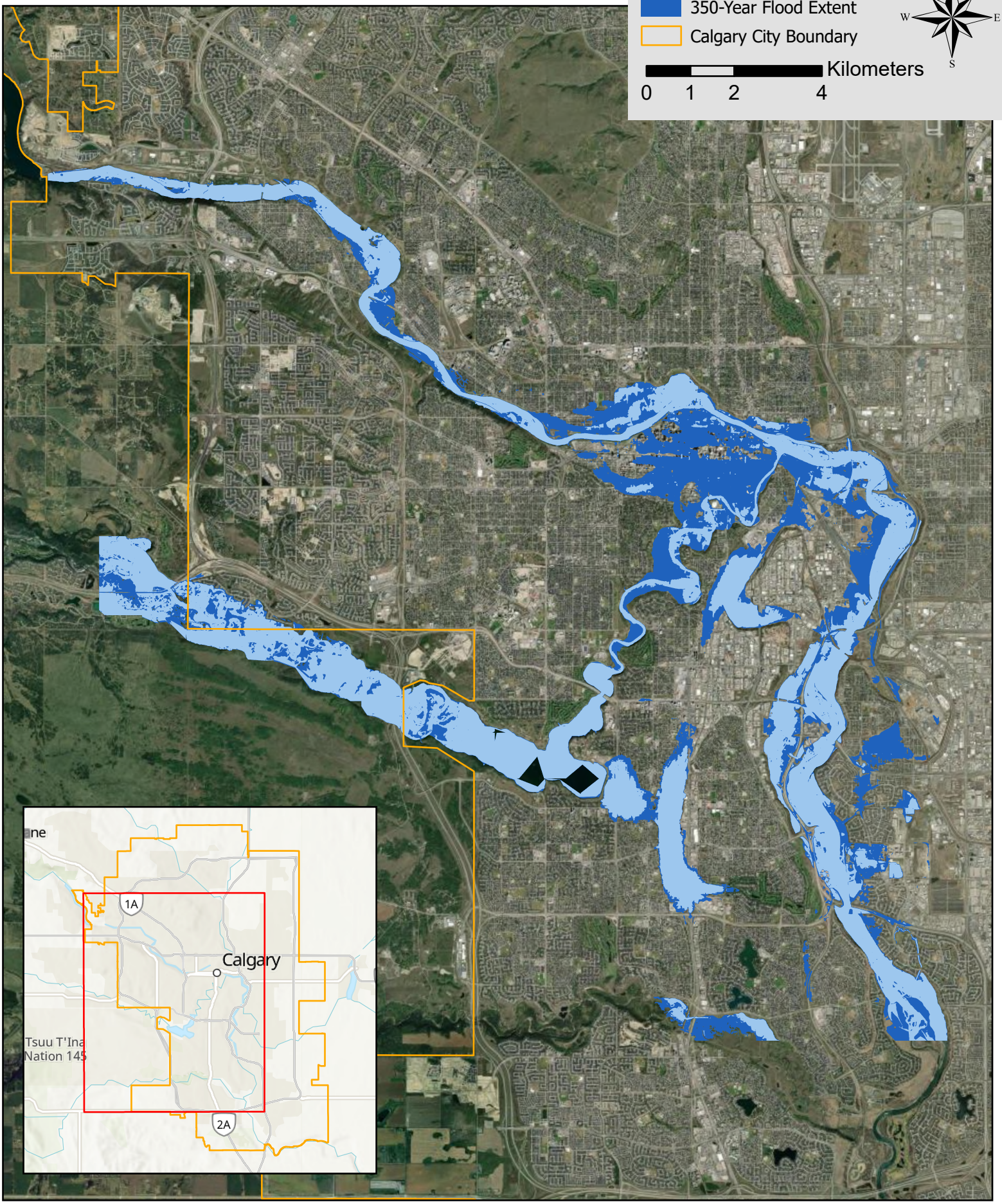
Figure 1: Project Location



Projection: NAD 1983 Transverse Mercator

Earthstar Geographics

Figure 2: 35- and 35-Year Flood Extents



Projection: NAD 1983 Transverse Mercator

Esri, CGIAR, USGS, Southern Alberta, Earthstar Geographics, Esri Canada, Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, NRCan, Parks Canada

References

U.S. Geological Survey. (2018, February 13). The 100-year flood. U.S. Department of the Interior. https://www.usgs.gov/special-topics/water-science-school/science/100-year-flood