Water Quality Monitoring Plan

CreekWatch
Alberta, Canada

Urban Tributary Monitoring and Stewardship
www.riverwatch.ab.ca/science/creekwatch

May, 2015

Whitemud Creek, Edmonton

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CreekWatch is sponsored by

Executive Summary

With the help of HSBC Water Programme, the RiverWatch Institute of Alberta (RiverWatch) is undertaking a two-year initiative to develop an Urban Tributary Monitoring and Stewardship (UTMS) Project, to be known as CreekWatch and located in the cities of Edmonton and Calgary, Alberta, Canada.

The purpose of Alberta CreekWatch is to collect reputable data on three urban tributaries of the Bow River in Calgary and three on the North Saskatchewan River in Edmonton, while at the same time generating citizen science involvement.

The specific goal is to collect baseline water quality data aiming to understand "How healthy are our creeks?" and to determine the impacts on these creeks as stormwater collectors. Through such data collection, a consistent baseline set of information will be established. This information will be available on the RiverWatch website for use by other professionals, governments and the general public who wish to know more about the health of their urban creeks.

Contacts have been established across Alberta in an effort to understand what has been done, what is being done, and what can be done regarding water quality monitoring. Contacts have been established who work across varying careers including municipal, provincial, non-governmental organizations, university, consultant, watershed planning and advisory councils (WPACS), and other professional designations. Substantial advice and input has been received on potential site locations, types and brands of sampling equipment, program methods and design, and water quality monitoring protocols.

Through the collection of three different levels of data – volunteer, technician and lab analysis – a comparison will be available between each of the techniques. This will offer valuable insight into the degrees of accuracy between each technique. Noting that lab analysis will be the most accurate and most expensive, a comparison will determine the realistic feasibility of using manual and electronic water quality monitoring equipment to acquire cost-efficient, accurate and presentable data.

In the first year, data will be collected weekly at the mouths of seven creeks through the efforts of technicians and citizen science volunteers. In Edmonton, data will be collected on Whitemud Creek, Mill Creek, and Blackmud Creek. In Calgary, data will be collected on Nose Creek, Fish Creek, Pine Creek, and West Nose Creek.

RiverWatch will work with twenty-five corporate and community groups sourcing citizen science volunteers, training them to collect water quality data as well as focusing on environmental education and awareness. A component of the project is connecting volunteers to the outdoors, increasing environmental knowledge and providing them with the means to make a difference in their community. Stewardship of local natural areas is very important, and creating that connection between citizens and the environment is critical.

CreekWatch is not a stand-alone initiative, but rather focuses on expanding the quantity of high quality baseline data to help better evaluate the health of our creeks in partnership with government agencies, corporations and community groups.

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1.0 The Urban Tributary Monitoring & Stewardship Project

With the help of HSBC Water Programme, the RiverWatch Institute of Alberta (RiverWatch) is undertaking an initiative to develop an Urban Tributary Monitoring and Stewardship (UTMS) Project, to be known as CreekWatch and located in the cities of Edmonton and Calgary, Alberta, Canada. CreekWatch is a program of the nonprofit RiverWatch Institute of Alberta.

1.1 The HSBC Water Programme

Water is a huge and growing global challenge. It is essential to all human activity and a fundamental driver of all socio-economic growth but, as a resource, it is under strain from population growth, development and climate change.

HSBC is investing US$150,000 over two years to support CreekWatch. Set to take place on urban tributaries in Edmonton and Calgary, CreekWatch will take a Citizen Science approach on water quality data collection and monitoring through 2015 and 2016.

The program is aimed at creating a knowledgeable public in Alberta that is able to understand science-based management of rivers and streams. Urban creeks function as stormwater collectors, draining water from the land into the creeks and further into larger water bodies. It is important to gather information on the cumulative impacts of our large urban population to better understand the impacts we have on our water.

A large part of this project will be connecting volunteers to the outdoors, increasing environmental knowledge, and providing participants with a means to make a difference in their community.

Photo 1 Calgary CreekWatch citizen science volunteers monitoring at Fish Creek.

To find out more information, visit www.thewaterhub.org

1.2 Project Support

In-kind support for CreekWatch has been received from contacts in both Edmonton and Calgary, as well as other resources out of province. Contacts have been established who work across varying careers including municipal, provincial, non-governmental organizations, university, consultant, watershed planning and advisory councils (WPACS), and other professional designations. Substantial advice and input has been received on potential site locations, types and brands of sampling equipment, program methods and design, and water quality monitoring protocols. (See Appendix I for a listing)

1.3 Purpose of Monitoring

The purpose of CreekWatch is to collect frequent and reputable data on urban tributaries that feed our larger rivers in Alberta. The goal of the project is to answer the question "How healthy are our creeks?" Through such data collection, a consistent baseline set of information will be established. This information will be available on the RiverWatch website for use by other professionals, governments and the general public who wish to know more about the health of their urban creeks.

Contact and discussion was made with numerous experts at the municipal, provincial, NGO, WPAC, and other professional levels. Two surveys were produced to collect information on the perceived value of CreekWatch, and the suggested urban tributaries of importance to be monitored in Edmonton and Calgary. See Appendix II.

Responses were received from 67% of emailed participants. It was found that 86% of respondents felt it important to collect water quality data on urban tributaries. The level of citizen education around stormwater quality was low, with a high perceived potential to train citizen volunteers for water quality data collection.

Regarding sampling locations, a total of 14 urban tributaries were identified in Edmonton and Calgary. Surveys were distributed to respondents in each city to allow them to rank each site based on their local knowledge and expertise. The results are found in Appendix III and Appendix IV, and have been taken into account and combined with personal preferences, other physical site attributes, and other received information to ultimately decide on three urban creeks in Calgary, and three in Edmonton.

Most monitoring to-date is done during high flow wet events on limited budgets with limited manpower. The City of Calgary Water Resources monitors 30 stations established on rivers, streams, and reservoirs in the Calgary region on a monthly basis. In Edmonton, efforts are focused on times of high flow. During 2014, a total of two samples were collected from each of the Edmonton urban tributaries. Presently, one was collected during the spring runoff, the other during a summer rainfall event. The 2013 North Saskatchewan River Water Quality Sampling Program (prepared for the City of Edmonton by Golder Associates Ltd, 2013) emphasizes recommendations on increased tributary sampling efforts for more accurate and apparent trends from a larger dataset.

2.0 Data Collection

Acknowledging the municipal budget and manpower constraints in each city, we plan to use our available resources to collect and supplement frequent and reputable data on urban tributaries that feed our larger rivers in Alberta.

2.1 Data Use

Through CreekWatch, a consistent baseline set of information will be established. Data reports will be developed after the open water season and will be provided to officials within each city, as well as made publicly available.

2.2 Levels of Data Collection

CreekWatch will involve three levels of sampling.

- Level One sampling involves the collection of data by volunteers with manual test kits.
- Citizen Science Coordinators hired by RiverWatch will collect Level Two sampling with handheld electronic measuring equipment.
- Level Three will involve lab analysis of water samples.

Photo 2 Level One sampling for turbidity.

2.3 Level One Monitoring

Citizen Science Volunteers will carry out Level One monitoring. Volunteers will be provided with Hach science kits equipped with manual tests to collect water quality data. The Citizen Science Coordinator will train the volunteers on how to use each kit.

2.4 Level Two Monitoring

Citizen Science Coordinators will carry out Level Two monitoring. This will involve the use of handheld multiparameter measurement equipment. This includes the use of a YSI Professional Plus instrument capable of measuring a wide range of parameters. Also included are two separate LaMotte 1200 Colorimeters, one for nitrate-nitrogen, and one for phosphorus.

2.5 Level Three Monitoring

RiverWatch is kindly provided with a base of operations at the Gold Bar Wastewater Treatment Plant in Edmonton, and the Bonnybrook Wastewater Treatment Plant in Calgary. Both of these facilities are equipped with labs for on-site monitoring. Partnerships have been established between the wastewater treatment plants and RiverWatch school programs over 20 years of operation, with opportunities being presented to have samples analyzed in their lab. Details are currently being reviewed.

2.6 Purpose of Three Levels of Monitoring

A unique element of this project will be the comparison of three different levels of monitoring techniques. There are advantages and disadvantages associated with each type of monitoring that include:

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- Instrument complexity
- Overall sampling technique cost
- Calibration and equipment maintenance
- Technique accuracy and precision
- Replacement costs of damaged equipment
- Transportability

Through the collection of three different levels of data – volunteer, technician and lab analysis - a comparison will be available between each of the techniques. This will offer valuable insight into the degrees of accuracy between each technique. Noting that lab analysis will be the most accurate and most expensive, a comparison will determine the realistic feasibility of using manual and electronic water quality monitoring equipment to acquire cost-efficient, accurate and presentable data.

2.7 Data Sheets

Data for all measured parameters will be recorded first on a hard copy data sheet prior to entry on-line. Data sheets will be mass printed and provided to all volunteers and technicians; used for data transfer to the on-line data base; and finally stored as back-up to the on-line database. See Appendix VIII for a sample data sheet.

3.0 Parameters to be Monitored

The chart below shows what physical and chemical parameters will be measured at each level.

Table 1 Parameters to be monitored at each level.

	Level One (Kit, 7 times a year per volunteer)	Level Two (Kit, once a week)	Level Three (Lab, once a month)
PHYSICAL			
Water Temperature (°C)	✓	✓	-
Turbidity (NTU)	✓	-	✓
Conductivity (mS/cm)	-	✓	✓
TDS (mg/L)	-	✓	✓
TSS (mg/L)	-	✓	✓
Salinity (ppt)	-	✓	✓
CHEMICAL			
Dissolved Oxygen (mg/L)	✓	✓	✓
Ammonia Nitrogen (mg/L)	✓	-	✓
Nitrate-Nitrogen (ppm)	-	✓	✓
Phosphate (Ortho) (mg/L)	✓	✓	✓
pH	✓	✓	✓

3.1 Monitoring Equipment

Background research was conducted to identify what other organizations were using in terms of water quality monitoring equipment in order to provide consistency with other ongoing monitoring programs. This involved learning the equipment used by consulting companies, municipal and provincial entities, other professionals, and other similar citizen science programs. This allowed for an understanding as to the expected level of equipment that CreekWatch would be interested in purchasing.

Requests for quotes were sent out to five different reputable companies who specialize in the manufacturing and distribution of high quality water quality monitoring equipment (See Appendix V). The companies included Osprey Scientific, Geo Scientific Ltd, Campbell Scientific, Hach Canada, and Hoskin Scientific Ltd.

After carefully comparing the select manufacturers and different types of electronic measurement equipment, it was decided that YSI equipment would be purchased for Level Two water quality monitoring purposes. Hoskin Scientific Ltd was selected as the distributing company and was able to provide us a government rate on our order that significantly reduced the overall costs.

Since we have a connection through Hach Canada for our RiverWatch student program, we decided to purchase Level One monitoring needs through them. This includes all the manual test kits that will be used by the trained citizen science volunteers. Equipment will be housed in travel coolers equipped with wheels for ease of volunteer use, as seen in the photo below. Each volunteer portable lab costs approximately $600 and each technician portable lab costs approximately $7000.An equipment checklist for all three levels of data collection can be found in Appendix VI.

Sonde equipment was not purchased as being too expensive and having a high risk of theft when left unattended. No testing kits were purchased that produced hazardous waste requiring processing at a treatment facility. No invertebrate collection or analysis was considered that required preserving specimens and lab analysis.

Photo 3 (left) Standard Test Portable Lab Level One

Photo 4 (right) Professional Test Portable Lab Level Two

Table 2 Level One Portable Lab contents purchased through Hach Canada

Parameter	Method	Cost
Dissolved Oxygen	Drop count titration	$100.00
pH	Colour-disc	$123.37
Phosphate (Ortho)	Colour-disc	$144.35
Ammonia-Nitrogen	Test strips	$32.87
Turbidity	Secchi tube	$57.77
Temperature	Thermometer	$18.30
Total Cost		**$476.66**

3.2 What are the Quality Control/Quality Assurance Measures?

Training will ensure that each of our citizen science volunteers are knowledgeable and comfortable performing the specific tests within their portable lab. Training days will be arranged and coordinated with site visits to ensure that volunteers understand the instructions in the kits, and know the locations.

Instructions will be provided for each kit, as well as contact information should there be any questions or concerns. Instructions will also involve the proper cleaning and disposal of wastewater produced from the chemical tests. The electronic measurement equipment will follow strict care and calibration procedures as necessarily identified within the equipment manuals.

Having three separate levels of monitoring will provide comparison between results to determine the overall accuracy of each select method, especially when all performed at the same sample location at the same time.

Data entry can be controlled from the Admin website login and will be checked regularly. Users must be added by Admin, reducing the chance of erroneous data. This allows accuracy of data loaded to the website. Should an error occur while inputting data, Admin has the authority to manage the users and trips on the site.

Data will be graphed as the median value whenever more than one level of data is recorded on any one day. Data for each creek and each parameter of each monitoring season will be presented as box and whisker graphs.

4.0 Data Management, Analysis and Reporting

Each user will be in charge of entering their collected data on the CreekWatch website. A data sheet has been prepared that will allow each volunteer to maintain hard copies of their data (See Appendix VII). This information will be collected by the Citizen Science Coordinator at season's end and stored as a backup copy. The Citizen Science Coordinator will have full access to the back-end of the site to monitor online data entry to check the accuracy and frequency of results. At the conclusion of each open-water sampling season, a report will be written detailing the specific outcomes and trends that can be identified within the data. This report will be made publicly available on our website.

4.1 Website

The RiverWatch website (www.riverwatch.ab.ca/science/data) has been developed to support a data input and graphing platform for CreekWatch. The creation of a database, by Web3 Marketing in Edmonton, allows for the uploading of water quality data and is an essential part of virtually preserving the data collected through CreekWatch. This will allow for ease of data collection, input, and synthesis amongst citizen science volunteers.

Our volunteers will be trained on how to input data to the website. This information will then be available for immediate viewing, allowing for trend analysis, graphing, and comparison amongst the creeks. Information will be available publicly on the website.

4.2 Data Entry

Each volunteer will be assigned a unique user ID with a secure pin in order to access the data entry portion of the website. This ensures accuracy of data inputted. Users will be prompted to fill in each page completely before moving forward to mitigate the chance of input error. A drop-down menu allows differing levels of equipment to be separated, or compared against other levels.

Having a user ID allows RiverWatch to track who is collecting information, determine the frequency and duration of each sample collected, and monitor the number of samples collected at each selected site. Administrators to the RiverWatch website have the ability to change entered data should there be an input error.

4.3 Data Viewing

Once data has been entered on the website, it becomes publicly available on the site. Anyone who visits www.riverwatch.ab.ca/science/data will be able to view the data. Simply select a site, an indicator, and timespan as seen in the photo below.

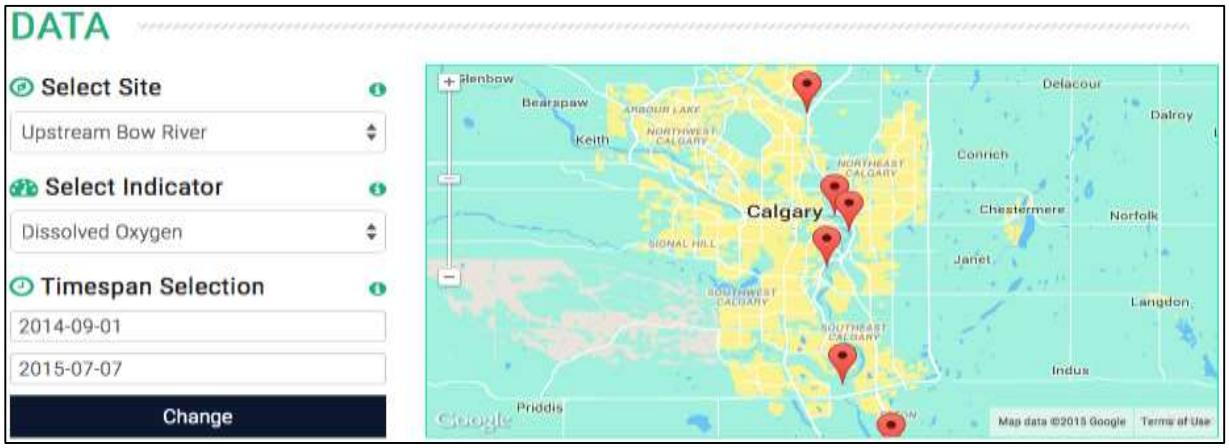


Photo 5 Website screenshot of public viewing platform.

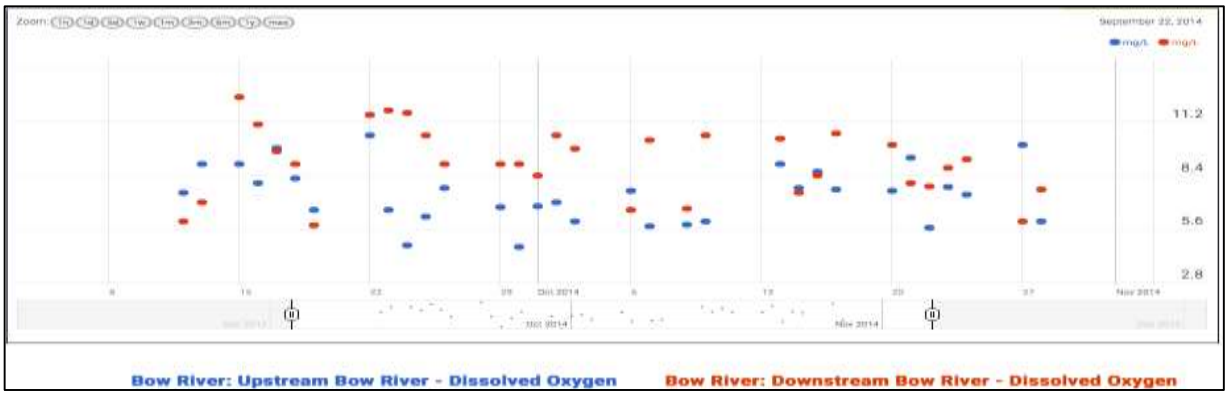


Photo 6 Website screenshot of two sites on the graphing platform

Our data viewing includes filtering options allowing data to be viewed in many ways. Users select a site, which then shows a GPS coordinate of the site location on a map. They can view any of the indicators that are collected at that site. Once a site has been selected, multiple sites can be added for comparison, or multiple indicators can be compared at the same site.

4.4 Our Volunteers

For year one of the project, we are focusing on HSBC employee participation in CreekWatch. The intent is to train a minimum of 20 HSBC staff the first year, and an additional 20 staff the second year. We have noticed opportunity and interest from other organizations wanting to participate, some of which include other RiverWatch sponsors along with other public groups. We are working to include them in CreekWatch to expand our reach of volunteers for data collection. Regarding management of the project, a RiverWatch Citizen Science Coordinator will be present in both Edmonton and Calgary to assist with data collection.

4.5 Data Collection Frequency and Duration

Water sampling will be completed during the open-water season in Alberta, from May-October. Sampling will begin in June of 2015, on account of citizen science training and an EcoFloat trip in both Edmonton and Calgary happening mid-May and into the beginning of June. The goal each year is to train an additional 10 volunteer citizen science volunteers in Edmonton, and 10 in Calgary.

Our trained volunteers will collect **Level One** data using standard equipment. This will involve the use of manual Hach kits that are housed in wheeled coolers for ease of transport and access. We are expecting weekly data collection on each creek, with each individual to collect data on their own free time at least 7 times throughout the open-water season.

Level Two data will be collected on a weekly basis between May-October by a Citizen Science Coordinator in both Edmonton and Calgary. This will involve professional electronic measuring equipment purchased from Hoskin Scientific Ltd.

The details of collecting **Level Three** data have not been finalized, but hopes would be to submit lab samples at minimum once per month.

4.6 Annual Reporting

A format for annual reporting of data results will be determined using an existing or newly created water quality index. The report will be sent out for peer review and finally posted on-line prior to the beginning of the next monitoring season.

5.0 Sampling Locations

Sampling sites will involve urban tributaries of the North Saskatchewan River Watershed in Edmonton, and the Bow River Basin in Calgary. Samples will be collected at the mouth of each selected tributary, as well as at the city limits. Sites were selected based on numerous considerations including accessibility, perceived value of tributary importance, and the extent of the resources to which we have prepared for each kit. See Appendix VIII for a list of selected creeks within Edmonton and Calgary.

5.1 The Bow River Basin

The Bow River Basin is one of four sub-basins within the encompassing South Saskatchewan River Basin. The area has a population of over one million people and it drains an area of 25,000km^2 beginning with its headwaters at Bow Lake in the Rocky Mountains. In addition to extensive activities of irrigation, agriculture, industry, and hydropower generation, the Bow River serves the communities of Lake Louise, Banff, Canmore, Cochrane, and the City of Calgary. Calgary represents the largest urban centre in the Bow River watershed with river inputs of stormwater and three wastewater treatment plant effluents.

5.2 The North Saskatchewan River Basin

The North Saskatchewan River Basin drains 55,000 km^2 of Alberta, with an estimated population of 1.25 million people. Its headwaters are within Banff and Jasper National Parks and it travels east towards the Saskatchewan provincial border. There are two major dams located in the area, the Big Horn Dam and the Brazeau Dam. In addition to extensive activities of agriculture, industry, and hydropower generation, the North Saskatchewan River supplies raw water to the communities of Rocky Mountain House, Drayton Valley, Edmonton and surrounding suburban municipalities, Smoky Lake, and Lloydminster. The Edmonton Region, home to the provincial capital, contains the largest urban centre in the North Saskatchewan River Basin with river inputs of stormwater and two wastewater treatment plant effluents.

5.3 Site Selection

Research was conducted through professional correspondence, online investigation, and previous watershed reports to identify creeks of potential consideration. Site visits were undertaken to each of the mouths of identified urban tributaries within Edmonton and Calgary. Each urban tributary was ranked based on numerous selection factors. A survey was then distributed to watershed experts and contacts, allowing each participant to rank all identified urban tributaries and comment on each site. The results of the survey were then combined with creek accessibility and parking near the mouth, other physical site attributes and additional expert advice to ultimately decide on seven total urban creeks. Where two upper tributaries joined to form one creek, the fork was considered the mouth for the lesser sized creek. See Appendix IX for a list of potential creeks.

5.4 Limited Site Menu

During the first year of CreekWatch roll out, only a limited number of creeks will be monitored and only at the mouth of each tributary as it enters the mainstem river or creek. This limited site menu will allow for a concentrated effort and produce a significant number of data points in the first year. Subsequent years with more volunteers may consider more creeks and/or more monitoring sites along any existing creek already being monitored. There has been interest expressed in monitoring the change in water quality from where a creek first enters the city limits and along its length to the point where it leaves the city or enters the mainstem river, and this context may be considered in future years. See Appendix X for a map of the sampling locations and the creek profiles.

Calgary Creeks:

- Nose Creek
- Fish Creek
- West Nose Creek
- Pine Creek

Edmonton Creeks:

- **Whitemud Creek**
- **Mill Creek**
- **Blackmud Creek.**

Photo 7 Whitemud Creek, 2014.

6.0 Conclusion

The purpose of Alberta CreekWatch is to collect reputable data on three urban tributaries of the Bow River in Calgary and three on the North Saskatchewan River in Edmonton, while at the same time generating citizen science involvement.

The specific goal is to collect baseline water quality data aiming to understand "How healthy are our creeks?" and to determine the impacts on these creeks as stormwater collectors.

In Edmonton, data will be collected on Whitemud Creek, Mill Creek, and Blackmud Creek. In Calgary, data will be collected on Nose Creek, Fish Creek, Pine Creek, and West Nose Creek.

RiverWatch will work with citizen science volunteers, training them to collect water quality data as well as focusing on environmental education and awareness. A component of the project is connecting volunteers to the outdoors, increasing environmental knowledge and providing them with the means to make a difference in their community. Stewardship of local natural areas is very important, and creating that connection between citizens and the environment is critical.

Contacts have been established across Alberta in an effort to understand what has been done, what is being done, and what can be done regarding water quality monitoring. CreekWatch is not a stand-alone initiative, but rather focuses on expanding the quantity of high quality baseline data to help better evaluate the health of our creeks in partnership with government agencies, corporations and community groups.

7.0 Appendices

Appendix I – Project Contacts

Contact	Organization
Andrew Liu	The City of Edmonton
Ashley Wallis	Evergreen
Aurora Bonin	HSBC
Bob Chrumka	Eastern Irrigation District
Brad Jones	Hoskin Scientific
Cal Kullman	RiverWatch Institute of Alberta
Catriona Laird	The City of Calgary
Cecilia Chung	Alberta ESRD
Chris Bjornson	Golder Associates Ltd
Chris Saunders	The City of Edmonton
Dana McDonald	Evergreen
Daniel Laubhann	The City of Edmonton
Darren Oko	HSBC
David Trew	NSWA
Dustin Lockwood	The City of Calgary
Erin Brown	The City of Calgary
Flora Geisbrecht	Elbow River Watershed Partnership
Gord Thompson	NSWA
Harry Stelfox	The City of Edmonton
Howard Heffler	RW Board of Directors
Jamie Dixon	The City of Calgary
Jason Smith	CH2M
Jason Weiler	Matrix Solutions
Jim Gendron	LTG Consulting
Joanne Steinmann	RW Board of Directors
Kathryn Hull	Cows and Fish
Katie Pearson	Friends of Fish Creek
Kerri O'Shaughnessy	Cows and Fish
Laurence Andriashek	Alberta Energy Regulator
Lesley Peterson	Trout Unlimited Canada
Maggie Nelson	The City of Calgary
Margaret Phelan	Environment Canada
Margo Redelback	Eastern Irrigation District
Marissa Adams	HSBC
Mark Bennett	BRBC
Michael Tyler	RW Board of Directors
Mike Murray	BRBC
Mike Sullivan	The City of Edmonton
Nicole Fraser	The City of Edmonton
Oliver Woods	CURA H2O
Phil Jerome	The City of Calgary

Rachelle Haddock	Miistakis Institute
Randy Neumann	Exova
Rick Martin	Eastern Irrigation District
Rob Wolfe	Alberta ESRD
Robyn Saude	Bow Habitat Station
Roland Kirzinger	Fish Creek Provincial Park
Ron Buchan	The City of Calgary
Ross Bulat	The City of Edmonton
Ruth Legg	HSBC
Ryan Fahl	Hach Canada Company
Sandi Riemersma	Nose Creek Watershed Partnership
Shane Harnish	Rossdale WWTP
Shannon Meyer	The City of Edmonton
Stacey Zhao	The City of Calgary
Steph Neufeld	EPCOR Water Service
Terry Antoniuk	Salmo Consulting Inc
Vanessa Kumpula	Exova
Vanessa Swarbrick	Alberta ESRD
Wendell Koning	Alberta ESRD

Appendix II – Perceived Project Value

Analyses of Survey Monkey responses are tabulated on the chart below.

Alberta CreekWatch Survey #1 "Perceived Project Value"				
Invitations	Responses	Anonymous	Response Rate	
43	29	5	67%	
#1 In the context of watershed management, how important is it to obtain water quality data for urban tributaries?				
Not Important	Somewhat Important	Important	Very Important	Not sure/No Response
0	1	2	25	1
#2 How well informed are citizens regarding stormwater quality?				
Not informed	Somewhat informed	Informed	Very informed	Not sure/No response
10	17	1	0	1
#3 How well informed are citizens regarding their stormwater stewardship role?				
Not informed	Somewhat informed	Informed	Very informed	Not sure/No response
11	16	1	0	1
#4 Is there potential for trained volunteers to contribute meaningful water quality data and stewardship actions to help maintain urban tributary health?				
Not much potential	Some potential	Good potential	Excellent potential	Not sure/No response
0	5	11	13	0

Appendix III - CreekWatch Survey #2 Calgary Results

The following table depicts the raw information received from the Survey Monkey that was distributed to Calgary-based contacts.

Alberta CreekWatch Survey #2 - Calgary "Creek Selection"						
Invitations	Responses		Anonymous		Response Rate	
35	12		5		34%	
Respondent ranking totals for each creek.						
Rank	1	2	3	4	5	6
Nose Creek	5	3	2	1	1	0
Coldwater/Effluent	2	0	1	2	2	5
Fish Creek	2	2	3	3	0	2
West Nose Creek	1	3	3	1	1	3
Pine Creek	1	2	3	3	1	2
Bonnybrook Creek	1	2	0	2	7	0
What sector do you work in?						
Federal			0			
Provincial			5			
Municipal			1			
Non-Governmental			3			
WPAC			0			
Other Professional			3			
No Response			0			
Additional comments and/or suggestions.						
"It is difficult to rank the creeks that I know little about. Bonnybrook and Pine"						
"In Cochrane there is Big Hill Springs Creek that would also be an option as no one is monitoring that creek, and if flows very near the Cochrane Ranch meeting facilities that many of us use from time to time, so higher profile. I've never heard of Bonnybrook Cr, nor know much about the Pearce Estate Park discharge - interesting. No one is monitoring Pine Cr - but it may not flow all year - but these orphans might be good places to start; the others are already being monitored by the City, monthly -but is there room for more on those creeks? Maybe, I'm curious what you have been hearing from others. So my choices could change if you and I discuss further."						
"My rankings are based on what I've heard from the modellers, and where data gaps have been identified!"						
"Lower Elbow River (in Calgary) High River? Sheep River?"						

Calgary Urban Creek	Overall Rank
Nose Creek	1
Fish Creek	2
West Nose Creek	3
Pine Creek	4
Bonnybrook Creek	5
BP Coldwater Stream/Hatchery Effluent	6

Appendix IV - CreekWatch Survey #2 Edmonton Results

The following table depicts the raw information received from the Survey Monkey that was distributed to Edmonton-based contacts.

Alberta CreekWatch Survey #2 - Edmonton "Creek Selection"								
Invitations	Responses		Anonymous		Response Rate			
17	10		7		59%			
Respondent ranking totals for each creek.								
Rank	1	2	3	4	5	6	7	8
Mill Creek	4	2	4	0	0	0	0	0
Wedgewood Creek	1	1	1	1	4	1	0	1
Gold Bar Creek	0	2	0	1	1	2	3	1
Blackmud Creek	0	2	3	2	1	1	0	1
Oldman Creek	0	0	0	0	0	1	3	6
Whitemud Creek	4	2	0	2	0	1	0	1
Fulton Creek	0	1	0	2	3	3	1	0
Horsehills Creek	1	0	2	2	1	1	3	0
What sector do you work in?								
Federal	0							
Provincial	2							
Municipal	6							
Non-Governmental	1							
WPAC	1							
Other Professional	0							
No Response	0							
Additional comments and/or suggestions.								
"Mill Creek is significantly altered as is Fulton. The level of study or engagement will depend on the project's desired outcomes. There are lots of opportunities for improvement."								
"Outfall of Goose Creek (where Groat Road filled ravine) could be restored back to a short delta"								
"Difficult to assess water quality in Urban Creek without understanding the quality of the headwaters of these watersheds. What are your scientific qualifications?"								
"Please look in to work previously done. no need to duplicate work."								
"Erosion should also be considered as part of the project."								

Edmonton Urban Creek	Overall Rank
Mill Creek	1
Whitemud Creek	2
Blackmud Creek	3
Wedgewood Creek	4
Horsehills Creek	5
Fulton Creek	6
Gold Bar Creek	7
Oldman Creek	8

Appendix V – Level Two Monitoring Equipment Quotes

The table below depicts the results of research into different equipment supply companies based on a Request for Quote sent to each company. We compared equipment that would cover our intended parameters from each company to see what would be work for the project.

Company	Campbell Scientific	Hoskin Scientific LTD	Geo Scientific LTD	Hach Canada	Osprey Scientific
Location	Edmonton, AB	Burnaby, BC	Vancouver, BC	London, ON	Mississauga, ON
Alberta Representative?	No	No, rental option from Burnaby	No	Yes	Yes
Not-for-profit / Educational Discount?	No	15%	No	10%	No
Delivery Time	5 weeks	N/A	2-3 weeks	1-2 weeks	N/A
Notes	Errors on quote; focus more on selling sondes than handhelds, final email stated they would not be able to help us.	YSI equipment	Hanna equipment. Quotes multiple sets of equipment options	Ryan Fahl contact – Alberta rep in Calgary. Quotes multiple sets of equipment options	Alyssa Koch – contact for quote
Total Quote Cost	$18,300.00 + tax	$4,974.90 (tax incl.)	Included multiple options, price would vary	$6,349.20 + tax	$5,389.00 + tax
Sets of Equipment	1	1	1	1	1
Number of Devices	1	3	4	3	3

Appendix VI – Equipment Checklists

The following equipment checklists are for each of the three levels of monitoring. All of the listed materials are included in every kit.

	Level One Equipment Checklist	Level Two Equipment Checklist	Level Three Equipment Checklist
General Equipment	>Field sheet and clip board >Pencil/pen >Instruction sheets >Trash bag >Wastewater bottles >Wheeled portable cooler	>Field sheet and clip board >Wastewater bottles >Instruction sheets	>Field sheet and clip board
Location and Reach Data	>Camera >Sampling sites map	>Camera >Sampling sites map	>Camera >Sampling sites map
Water Chemistry Sampling	>pH kit >Dissolved oxygen kit >Phosphate kit >Thermometer >Turbidity tube >Ammonia nitrogen test strips	>YSI Pro Plus with Quattro Cable >LaMotte Nitrate-Nitrogen Colorimeter >LaMotte Phosphate Colorimeter	>Glass bottles with preservatives for each of dissolved oxygen, pH, turbidity, and nutrients
Benthic Sampling		>Kicknet >Sieve >White tub >Isolation tray >Invertebrate collection device >Invertebrate ID Sheet	
Safety Equipment	>First Aid kit >Sharps Container >Safety glasses	>First Aid kit	>First Aid kit

Appendix VII – CreekWatch Data Sheet

RiverWatch
Science. Education. Adventure

How Healthy is Your River?

www.riverwatch.ab.ca

Trip ID

School/Group _____ Date (mm/dd/yy) ____/____/____

River/Creek _____ City/Town _____

Put-In/Take-Out _____ Program/Level _____

Guide/Volunteer Name: _____ Supervisor _____

		Test Site #1			Test Site #2			Test Site #3		
Site ID	Site Location/GPS									
	Bank Left or Right									
	Time	Arrival	Depart	Total	Arrival	Depart	Total	Arrival	Depart	Total
	Indicators	**Sample #1**		**Sample #2**	**Sample #1**		**Sample #2**	**Sample #1**		**Sample #2**
Physics	Discharge (cms)									
	Water Temperature (°C)									
	Turbidity (NTU)									
	Conductivity (mS/cm)									
	TDS (mg/L)									
	TSS (mg/L)									
	Salinity (ppt)									
Chemistry	Dissolved Oxygen (mg/L)									
	Nitrogen (mg/L)									
	Phosphorous (mg/L)									
	pH									
Biology	Mayfly Nymph (PS)									
	Stonefly Nymph (PS)									
	Caddisfly Larva (MPT)									
	Midge Larva (PT)									
	Water Boatman (PT)									
	# Invertebrates Total									
	# Invertebrate Types Total									
	Overall Health Rating	1 2 3 4 5			1 2 3 4 5			1 2 3 4 5		
	Observations and Notes Land Use, Pollution, Activities, Bank Vegetation, Aquatic Plants, Birds, Animals, Flow Level, Water Color, Algae									
Keys	**Invertebrates**	PS = Pollution Sensitive			MPT = Moderately Pollution Tolerant			PT = Pollution Tolerant		
	River Health Scale	#1 or #2 = Unhealthy			#3 = Borderline Healthy			#4 or #5 = Healthy		

Appendix VIII – Final Creek Selections and Profiles

Mill Creek
Mill Creek flows through south central Edmonton before entering the North Saskatchewan River. Named after a flourmill established in 1878 near the creek's mouth, it enters Edmonton's City limits through passing beneath Anthony Henday Drive. It eventually opens up into Mill Creek Ravine that offers scenic views and hiking opportunities within the bustling City of Edmonton. Sections of the creek are engineered underground to accommodate City infrastructure, and this includes the final section of the creek that enters the North Saskatchewan River through a raised culvert. The City of Edmonton is currently exploring the potential of resurfacing the north portion of the creek.

Whitemud Creek
Whitemud Creek is a local tributary of the North Saskatchewan River and provides many vital terrestrial and aquatic ecological functions in the southwest portion of Edmonton. Whitemud Creek was named during the Palliser Expedition for the white-coloured mud along the creek's banks. The ravine provides ample opportunity for hiking and interactions with nature through old growth coniferous forests, deciduous and mixed-wood forests, meadows, and riparian communities.

Blackmud Creek
The headwaters of Blackmud Creek are located southeast of the City of Leduc. It meanders northwest, crossing Highway 2 before entering the Edmonton City limits. Within the City limits, Blackmud Creek offers ample opportunities to enjoy nature through interactions made available at numerous urban parks. The eventual confluence is located in Mactaggart Sanctuary where it joins Whitemud Creek before traveling the final distance to the North Saskatchewan River.

Nose Creek
Nose Creek's headwaters extend all the way through the northern reaches of Rocky View County and into Mountain View County. Covering such a large geographical area at roughly 75 kilometers in length, there are many different land uses that have the potential to impact the creek. The land coverage is primarily agricultural, with urban influences as it travels through the town of Crossfield, and the cities of Airdrie and Calgary. It final stretch travels past the Calgary Zoo before reaching the Bow River.

West Nose Creek
West Nose Creek is a significant and permanent tributary to Nose Creek that drains a third of the entire Nose Creek Watershed. Originating in the northwestern portion of the watershed, it travels 65 kilometers before joining Nose Creek near the Calgary International Airport.

Fish Creek
Fish Creek originates in the Tsuu T'ina First Nation southeast of Calgary and enters Calgary before flowing into the Bow River. The upper sections of Fish Creek are primarily forested, while the middle section is more agricultural and grassland coverage, and urban land use is more prominent near the creek mouth. The lower portion also receives stormwater discharge from the City of Calgary's encompassing residential neighborhoods. Within Calgary's city limits, Fish Creek is popularly known as the largest urban park in Canada, stretching 19 kilometers from east to west. Offering a variety of trail networks for walking, biking, or hiking, the park offers an easily accessible urban resource.

Pine Creek
Little is known about Pine Creek. Its headwaters extend west just south of Priddis into the foothills. It meanders its way towards its confluence at the Bow River passing through pastures, foothils, forests, golf courses, and the communities of Academy and Heritage Pointe. It is of special concern because there is relatively little data available on this creek.

Appendix IX - Potential Urban Tributary Sites in Calgary and Edmonton

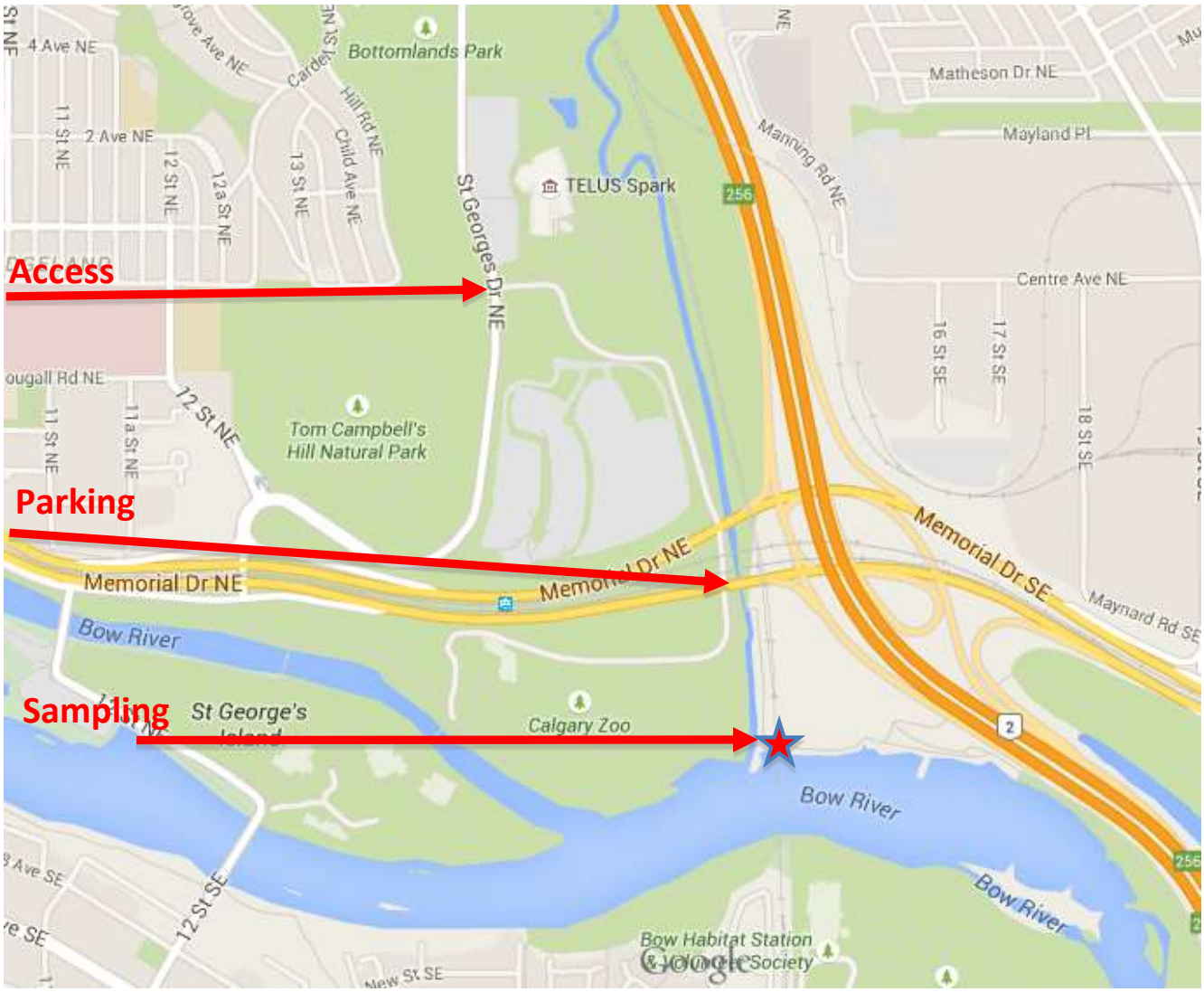
Calgary Urban Tributaries

Site Name	Description of Site Location	GPS Coordinates	Pros	Cons	Access	Rank
Nose Creek	Located beside (east) of the Calgary Zoo, sampling at the mouth of the creek before it enters the Bow River	51.044963, -114.019647	AESRD / City of Calgary suggestions High rates and volumes of stormwater discharge Significant urban and rural land use, golf courses Easy access, maintained trails	Unable to drive right to the mouth, some walking may be involved Potential to monitor just upstream (800m) of river mouth	Access needs to be evaluated, walking distance could be close to 1km	1
West Nose Creek	Located in West Nose Creek Park, sampling at the creek mouth before it joins Nose Creek	51.130073, -114.047870	AESRD / City of Calgary suggestions Easy access High rates and volumes of stormwater discharge Significant urban and rural land use, golf courses	700m walk from parking lot to creek mouth	Access at Nose Creek Parkway (Confluence Park), at the parking lot at the end of Beddington Blvd NE	3
Fish Creek	Located in Fish Creek Provincial Park, sampling at the mouth of the creek before it enters the Bow River	50.904326, -114.010253	AESRD suggested Easy access, washrooms, maintained trails The City has constructed engineered wetlands to treat stormwater, compare data with Friends of Fish Creek (if they finish their evaluation)	Provincial Park, therefore an Application for a Research and Collection Permit is required	Access at Fish Creek Provincial Park, at the end of Bow Bottom Trail SE. First parking lot on the left once you cross bridge over Fish Creek.	2
BP Coldwater Stream & Bow Habitat Station Effluent	Located in Pearce Estate Park, sampling at mouth of creek before it enters the Bow river	51.040485, -114.012182	Easy access, washrooms, maintained trails Bow Habitat Station effluent and BP Coldwater Stream (Bow Diversion)	BP Coldwater stream is water diverted from the Bow River Monitoring effluent of Bow Habitat Station	Access at Pearce Estate Park in the SE	6
Pine Creek	Flows just south of Calgary City limits, sampling off road bridge 500m from the Bow River near Policeman's Flats	50.844988, -113.961947	Not a lot of data collected AESRD suggested	Outside city limits Long distance to travel Hard to access mouth of creek	Access through heading towards Policeman's Flats, continue on past until you cross Pine Creek bridge	4
Bonnybrook Creek	Located downstream of the Bonnybrook Wastewater Treatment Plant between Deerfoot Trail and train bridge	51.006054, -114.022315	No recorded data able to be found	Difficult access Unstable banks, 200m long Located on an old dump site – shards of glass, metal	Raft	5

Edmonton Urban Tributaries

Site Name	Description of Site Location	GPS Coordinates	Pros	Cons	Access	Rank
Whitemud Creek	Located in Whitemud Park, sampling at the mouth of the creek before it enters the North Saskatchewan River	53.505454, -113.561679	NSWA / City of Edmonton suggestion Potential site for other stewardship events with easy access, washrooms, maintained trails, centrally located Drains one of the largest watersheds that feeds the NSR in Edmonton	Large events held through the summer at Whitemud Park, could disrupt volunteers on some weekends	Access on Keillor Rd NW, parking lot right near the creek.	2
Blackmud Creek	Located at Mactaggart Sanctuary, sampling at the mouth of the creek before it enters Whitemud Creek	53.454896, -113.546976	NSWA / City of Edmonton suggestion Easy access, would be a great comparison against data from Whitemud Creek	Rugged trails, no pavement	Access at Mactaggart Sanctuary 13069 23 Ave NW, Edmonton, AB	3
Mill Creek	Due to the buried nature of Mill Creek, feasible access is 2.5km upstream	53.520047, -113.473965	NSWA suggestion Proposed project to uncover Mill Creek, our data could be very important	Flows into NSR from a pipe 6 feet above ground Enters NSR through a stormwater pipe Large city snow dump site on upper part of the creek Can't directly access mouth, upstream location	Access at Mill Creek Ravine Park 8120 93 St NW, Edmonton, AB T5G 1P1	1
Horsehills Creek	Enters the NSR in the NW. Private land on one side, other side marked no trespassing	53.633756, -113.344399	City of Edmonton suggestion; more of a rural creek that could provide comparison of rural and urban	Difficult access to creek mouth Not a lot of flow when visited in October	Access at bridge crossing on Meridian St NW – 1km from the creek mouth	5
Fulton Creek	Due to the buried nature of Fulton Creek, access is restricted	53.546984, -113.439589	One of Edmonton's 'Lost' creeks	Runs dry as observed Fall 2014 Enters NSR through pipe, much of the creek is buried	Access along Fulton Dr in the NW, about 1 km from the mouth	6
Oldman Creek	Located north of Sherwood Park at the city limits	53.607364, -113.299624	Determine the impact of Sherwood Park on water quality	Unclear whether or not it is within City limits Rural area, hard to access the mouth, buried beneath road Would have to trespass on private property, fenced	Difficult. Would have to access upstream on the Service Rd along HWY 21	8
Wedgewood Creek	Located in the Wedgewood Heights neighborhood, sampling at the mouth of the creek	53.480669, -113.627750	City of Edmonton suggestion Great hiking trail, well maintained Confluence of two creeks	Fairly steep downhill component	Access via Wedgewood Crescent NW or Drysdale Run NW. 500m walk downhill	4
Gold Bar Creek	Located in Gold Bar Park, sampling at the mouth of the creek before it enters the North Saskatchewan River	53.553849, -113.398759	RW student stop	Access from Gold Bar Park Has not been suggested Rugged, unmaintained trail once you leave pathway	Access from the Gold Bar parking lot at the east side of Gold Bar Wastewater Treatment Plant.	7

NOSE CREEK AT MOUNTH



Stream Profile

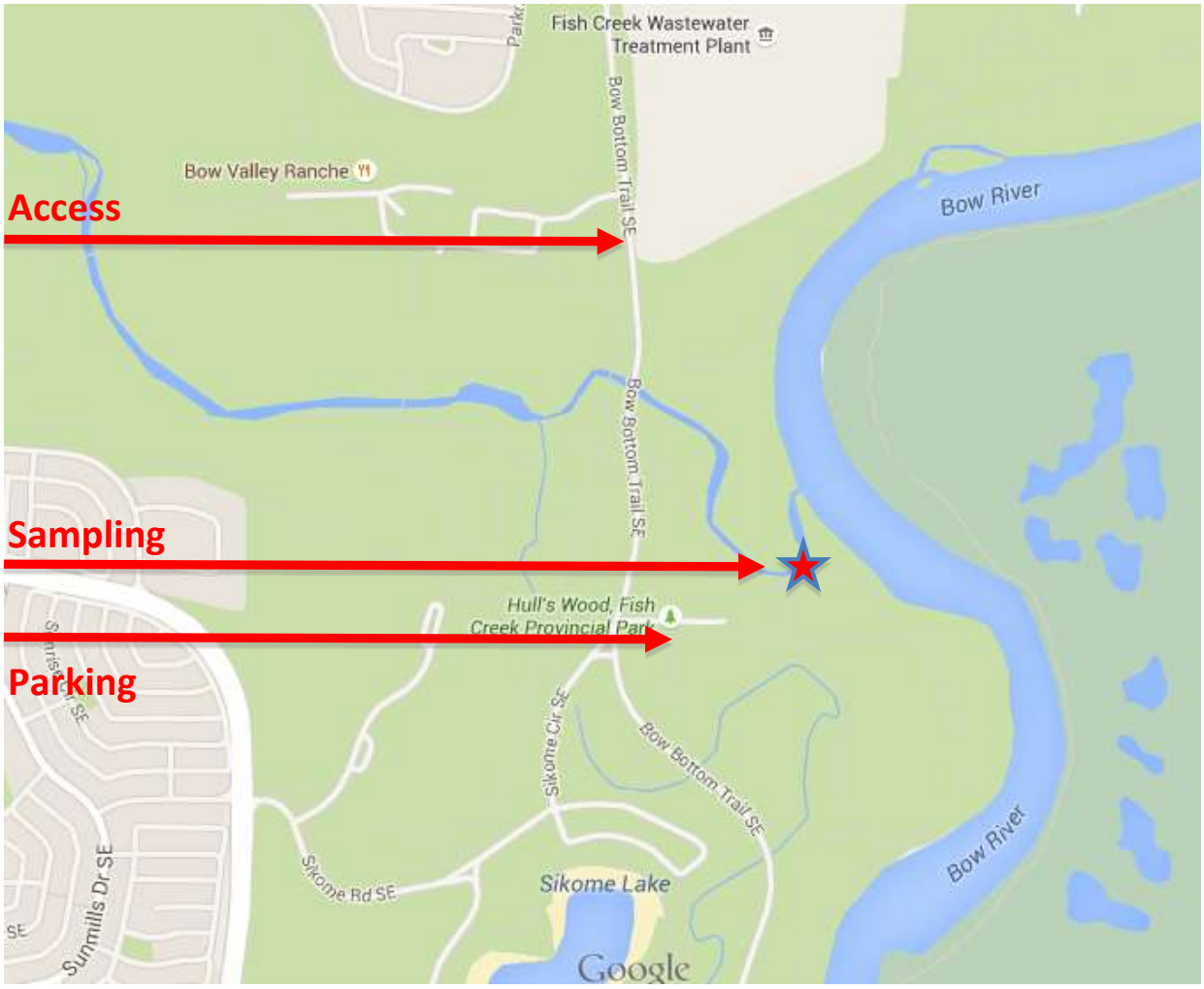
Nose Creek's headwaters extend all the way through the northern reaches of Rocky View County and into Mountain View County. Covering such a large geographical area at roughly 75 kilometers in length, there are many different land uses that have the potential to impact the creek. The land coverage is primarily agricultural, with urban influences as it travels through the town of Crossfield, and the cities of Airdrie and Calgary. It final stretch travels past the Calgary Zoo before reaching the Bow River.

Access (See Map)

Located east of the Calgary Zoo. Access via a road between the zoo overflow parking and the Telus Spark, parking in the area beneath Memorial Dr bridge. Travel down the bike path to the mouth of the creek before it enters the Bow River. Find a safe location to collect samples.

GPS Coordinates at mouth: 51.044963, -114.019647

FISH CREEK AT MOUTH



Stream Profile

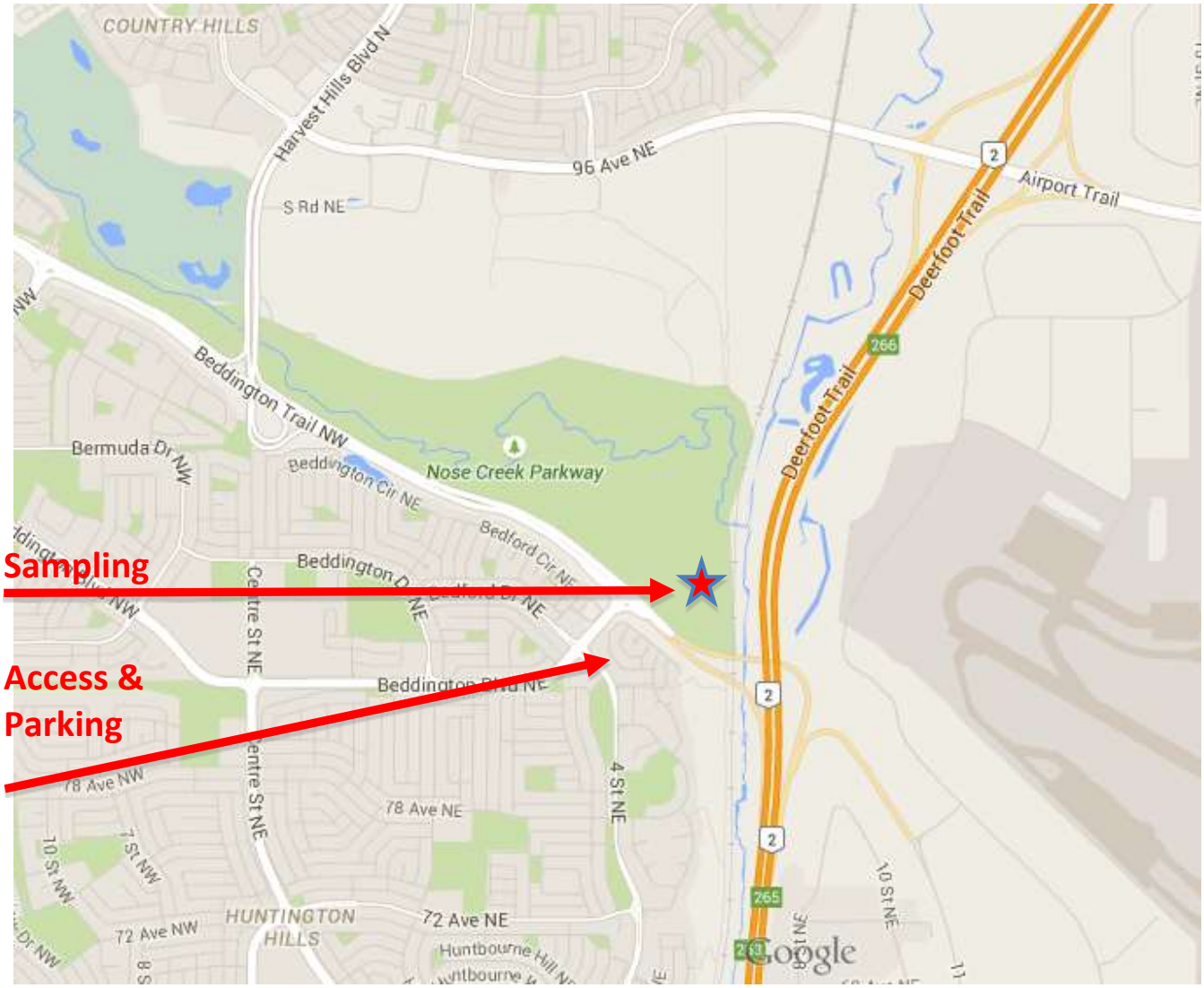
Fish Creek originates in Kananaskis Country before traveling east through Tsuu T'ina First Nation and then ultimately reaching Calgary before entering the Bow River. The upper sections of Fish Creek are primarily forested, while the middle section is more agricultural and grassland coverage, and urban land use is more prominent near the creek mouth. The lower portion also receives stormwater discharge from the City of Calgary's encompassing residential neighborhoods. Within Calgary's city limits, Fish Creek is popularly known as the largest urban park in Canada, stretching 19 kilometers from east to west. Offering a variety of trail networks for walking, biking, or hiking, the park offers an easily accessible urban resource.

Access (See Map)

Located in Fish Creek Provincial Park, travel down the Bow Bottom Trail SE and after crossing a bridge over Fish Creek, turn left into Hull's Wood parking lot. Walk down the pathway, sampling at the mouth of the creek before it enters the Bow River.

GPS Coordinates at mouth: 50.904326, -114.010253

WEST NOSE CREEK AT MOUTH



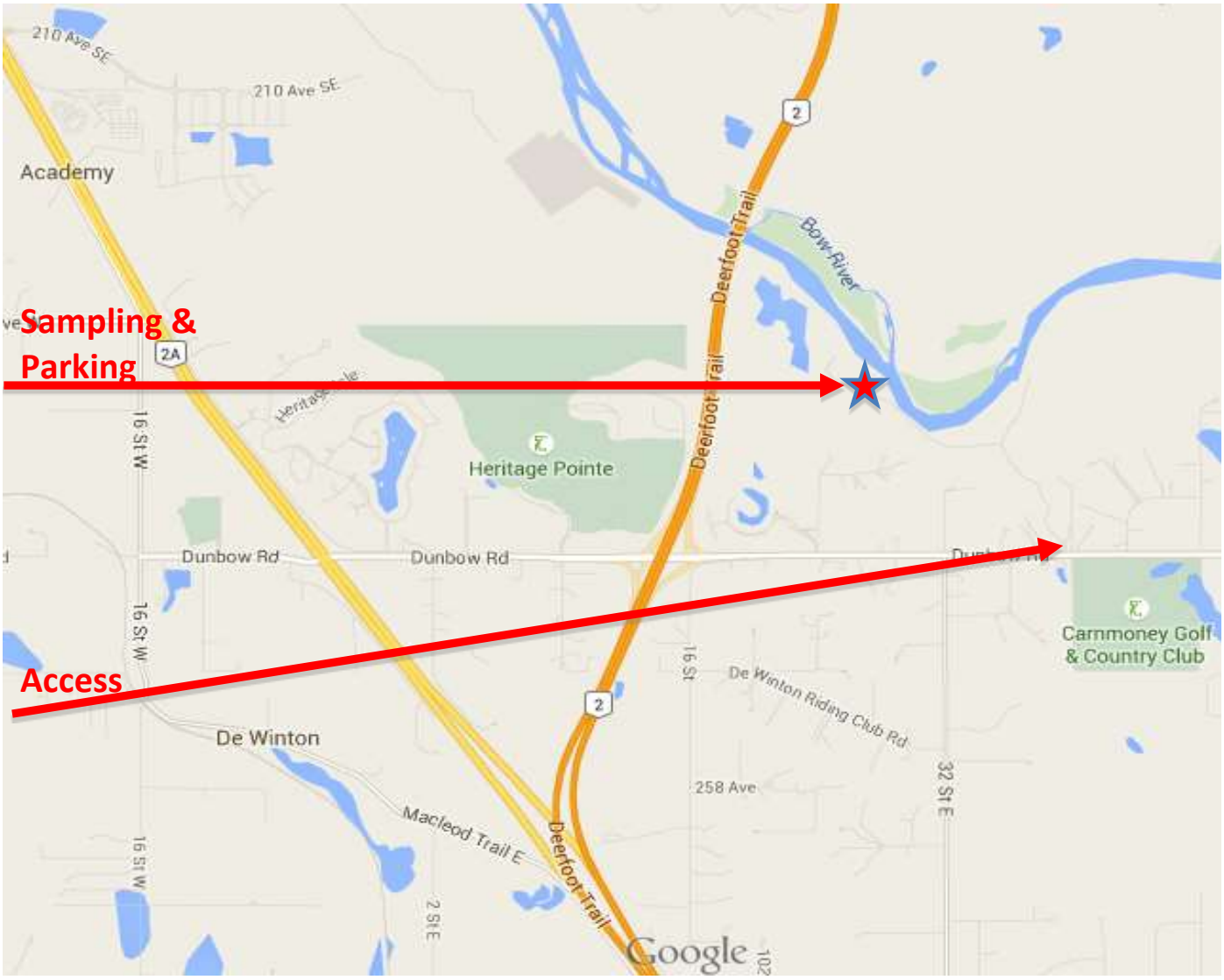
Stream Profile
West Nose Creek is a significant and permanent tributary to Nose Creek that drains a third of the entire Nose Creek Watershed. Originating in the northwestern portion of the watershed, it travels 65 kilometers before joining Nose Creek near the Calgary International Airport.

Access (See Map)
Access at Nose Creek Parkway via Confluence Park. Parking at the end of Beddington Blvd NE and Beddington Trail NW. From parking, travel down the pathway towards Nose Creek before heading north on the Nose Creek Pathway. Cross the bridge over West Nose Creek and sample at the mouth.

NOTE: Great opportunity to collect two sets of data; West Nose Creek at mouth and Nose Creek before it reaches West Nose Creek!

GPS Coordinates at mouth: 51.130073, -114.047870

PINE CREEK AT MOUTH

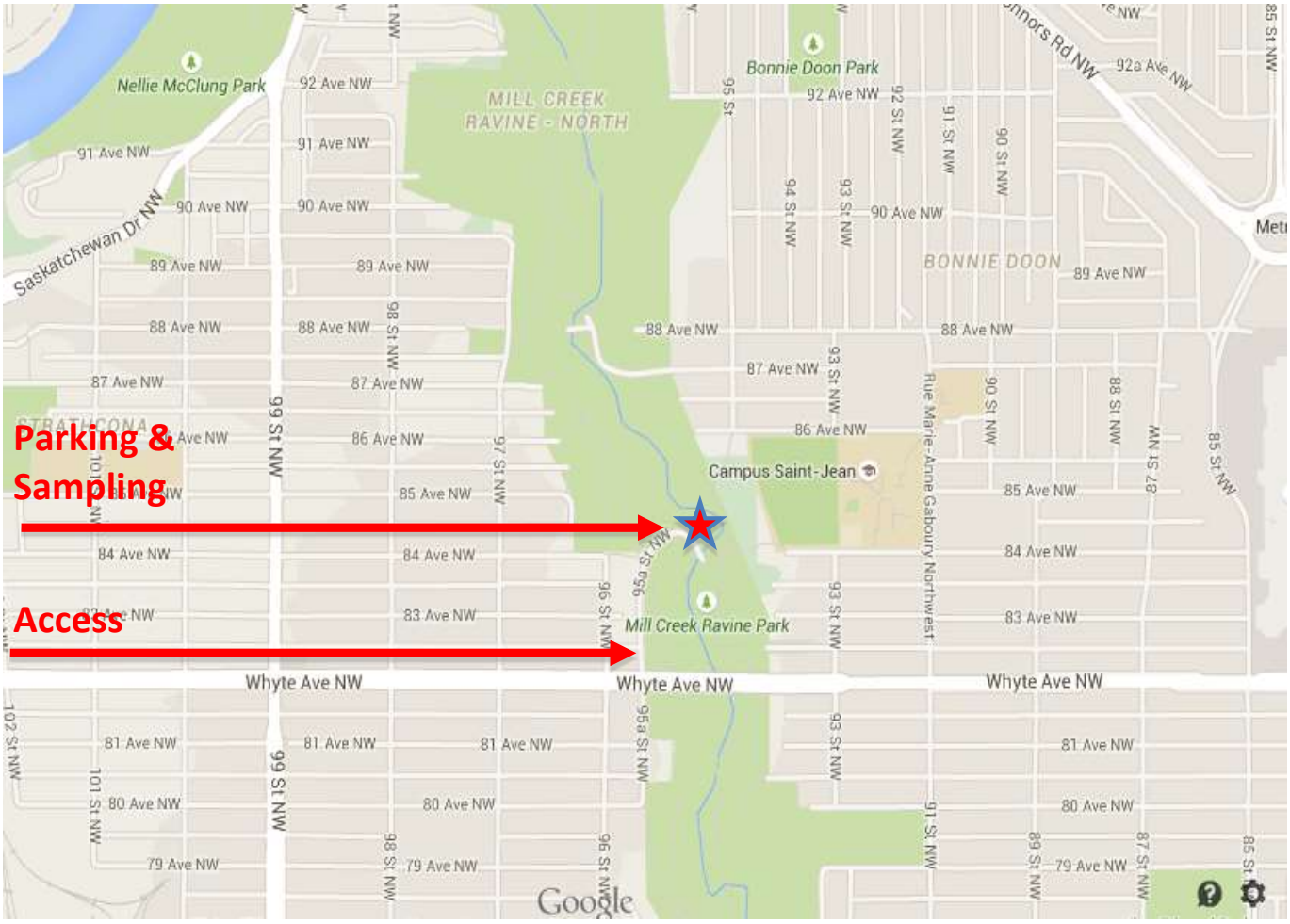


Stream Profile
Little is known about Pine Creek. Its headwaters extend west just south of Priddis into the foothills. It meanders its way towards its confluence at the Bow River passing through pastures, foothils, forests, golf courses, and the communities of Academy and Heritage Pointe. It is of special concern because there is relatively little data available on this creek.

Access (See Map)
Head south of Calgary on the 2A, turning onto Dunbow Rd. Turn left towards Policemen's Flats and travel down the road until you come to the bridge over the creek. You can pull off to the side of the road. Sample at this spot. It is a dead end, you will have to turn around and exit the same way. (NOTE: can be a tricky turnoff to find, look for signs for Policemen's Flats!)

GPS Coordinates at sampling location: 50.845036, -113.961926

MILL CREEK AT MILL CREEK RAVINE PARK SWIMMING POOL



Stream Profile

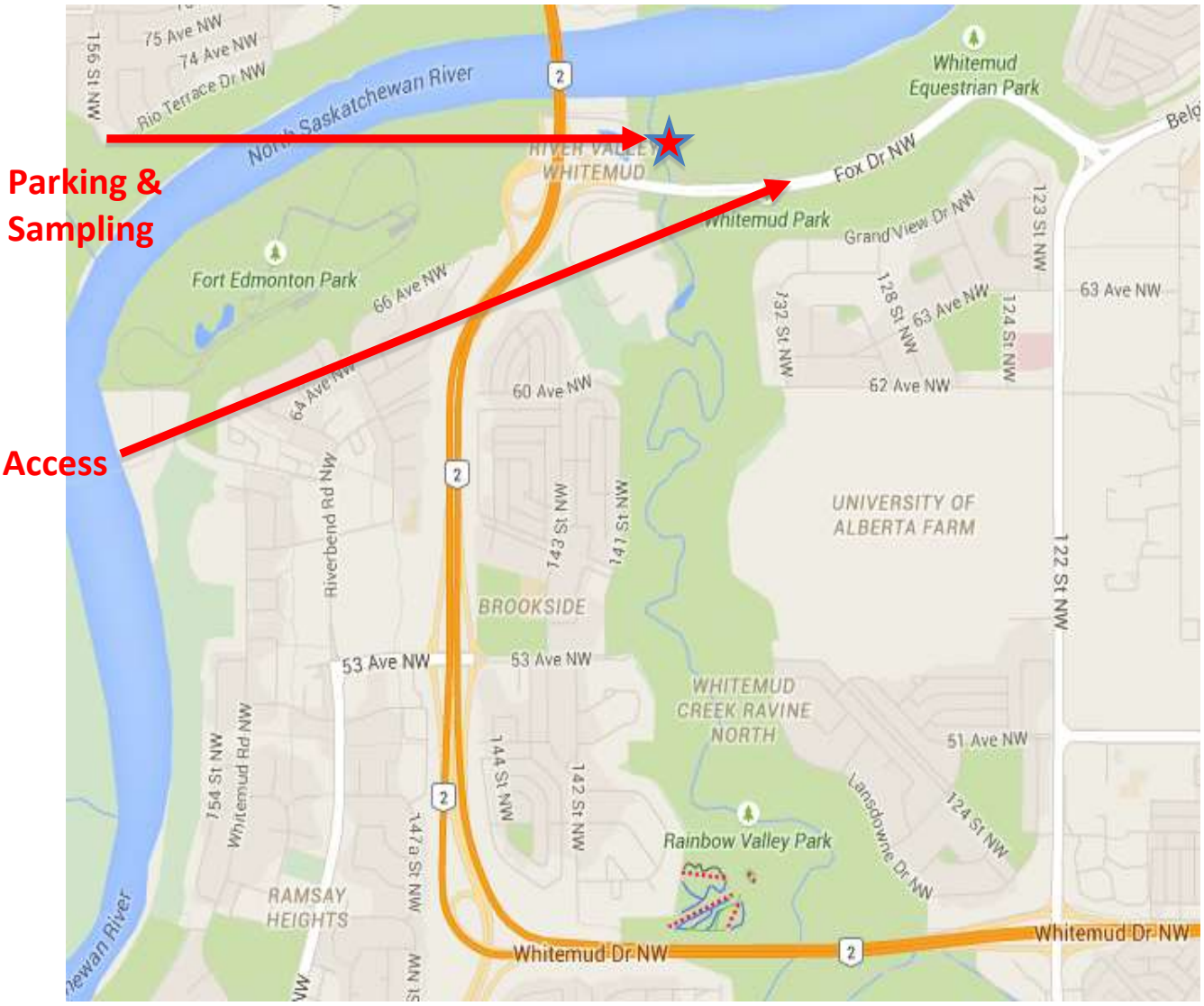
Mill Creek flows through south central Edmonton before entering the North Saskatchewan River. Named after a flourmill established in 1878 near the creek's mouth, it enters Edmonton's City limits through passing beneath Anthony Henday Drive. It eventually opens up into Mill Creek Ravine that offers scenic views and hiking opportunities within the bustling city of Edmonton. Sections of the creek are engineered underground to accommodate City infrastructure, and this includes the final section of the creek that enters the North Saskatchewan River through a raised culvert. The City of Edmonton is currently exploring the potential of resurfacing the north portion of the creek.

Access (See Map)

Access at Mill Creek Ravine Park, Mill Creek Swimming Pool: 9555 84 Ave NW
Edmonton. Turn onto 95A St NW and park at the Mill Creek Swimming Pool. Sample at the bridge over Mill Creek.

GPS Coordinates at sampling location: 53.520047, -113.473965

WHITEMUD CREEK AT MOUTH

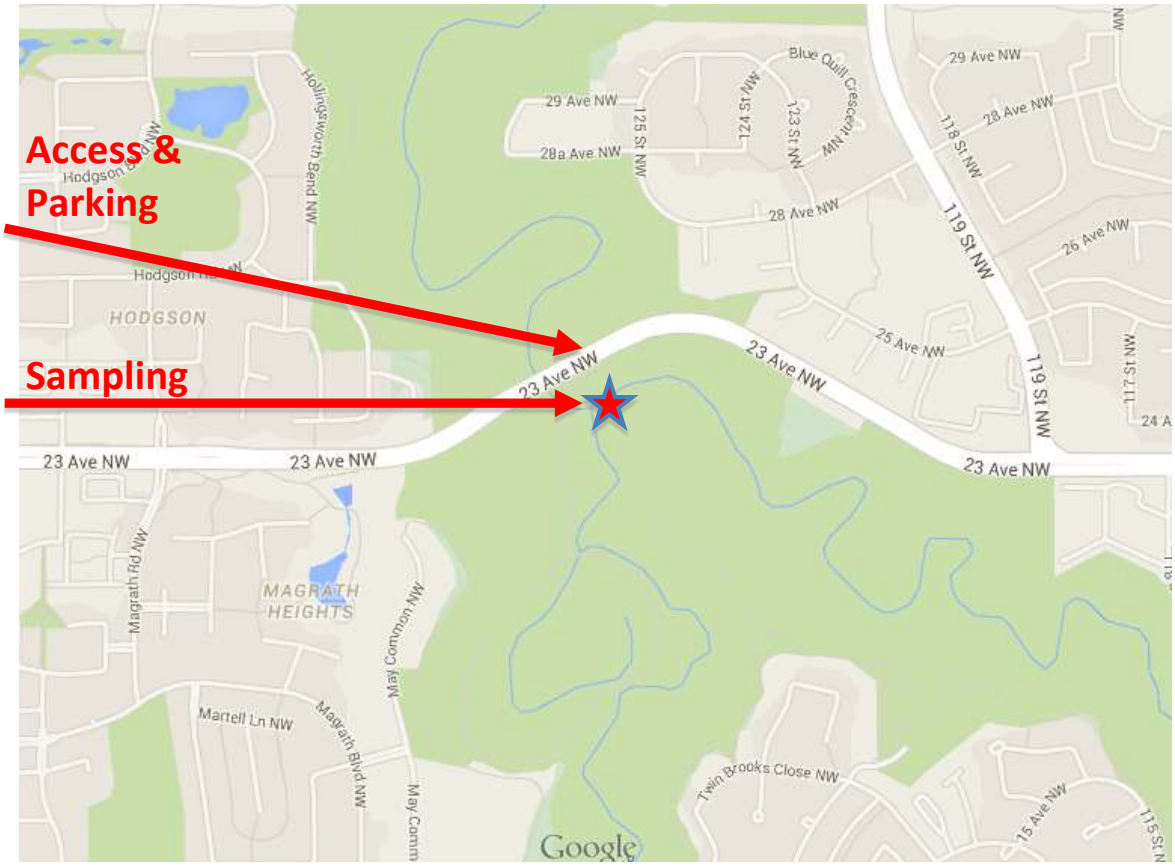


Stream Profile
Whitemud Creek is a major tributary of the North Saskatchewan River and provides many vital terrestrial and aquatic ecological functions in the southwest portion of Edmonton. Whitemud Creek was named during the Palliser Expedition for the white-coloured mud along the creek's banks. The ravine provides ample opportunity for hiking and interactions with nature through old growth coniferous forests, deciduous and mixed-wood forests, meadows, and riparian communities.

Access (See Map)
Turn off of Fox Drive onto Keillor Rd, head WEST and park along the creek. Easy sampling access directly beneath Fox Drive bridge.

GPS Coordinates at sampling location: 53.505454, -113.561679

BLACKMUD CREEK AT MOUTH



Stream Profile
The headwaters of Blackmud Creek are located near the town of Nisku. It meanders north, crossing Highway 2 before entering the Edmonton city limits. Within the City limits, Blackmud Creek offers ample opportunities to enjoy nature through interactions made available at numerous urban parks. The eventual confluence is located in Mactaggart Sanctuary where it joins Whitemud Creek before traveling the final distance to the North Saskatchewan River.

Access (See Map)
Access at Mactaggart Sanctuary, 13069 23 Ave NW, Edmonton. There is a parking lot off of 23 Ave NW, and a short 50m walk to the mouth of Blackmud Creek.

GPS Coordinates at sampling location: 53.454896, -113.546976

NOTE: If you cross the footbridge over Whitemud Creek at this location, you can collect a second sample of Whitemud Creek before it is joined by Blackmud Creek! This would provide a great comparison of both creeks on the same day!