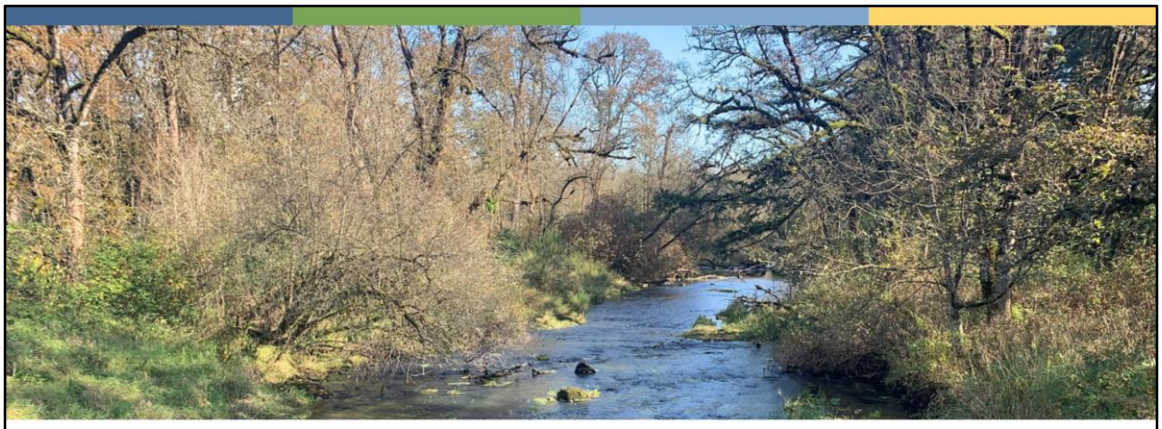


DEPARTMENT OF ECOLOGY
State of Washington

Lacamas Creek Source Assessment

April 16, 2021

Molly Gleason

I. Background
II. Source Assessment
III. Preliminary Results and 2021 Monitoring

2

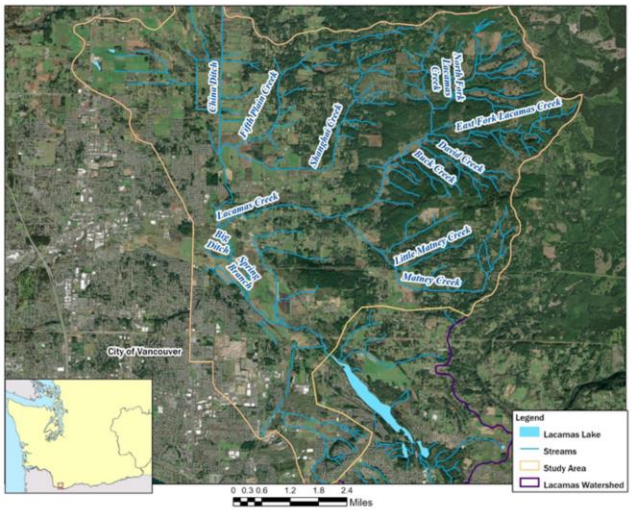
Lacamas Creek Watershed

Lacamas Creek's Major Tributaries:

- China Ditch
- Fifth Plain Creek
- Shanghai Creek
- Matney Creek
- Dwyer Creek

Mixed land uses

- Agriculture
- Commercial
- Residential
- Industrial
- Forested



The Lacamas Creek watershed is located in Southwest Washington in Clark County. The watershed makes up an area of 67 square miles that extends from Hockinson in the north to the City of Camas in the south with Vancouver bordering the eastern edge. Lacamas Creek flows 18 miles from forested headwaters through rural, agricultural, and residential areas before entering Lacamas and Round Lakes.

Below the lakes, the creek discharges to the Washougal River. There is also a fish passage barrier located at a dam below Lacamas Lake.

Along with Lacamas Creek, the watershed has five major tributaries. China Ditch, Fifth Plain, and Shanghai Creek are located in the northwest section of the watershed, and, Matney Creek and Dwyer Creek are located in the lower watershed.

There are also many smaller creeks and channelized streams that flow to Lacamas Creek. These channels were built in the late 1800s to drain the wetlands to create areas for farms and to increase the volume of water to Camas paper mills. The largest of the man-made drainages include China Ditch, Spring Branch, and Big Ditch which all drain to Lacamas Creek. Because of this development and channelization, wetlands make up only 4% of the watershed. With significantly fewer wetland areas to store runoff from rainstorms, higher volumes of stormwater now funnel more quickly into streams, eroding stream banks and causing increased flooding in low-lying lands.

Lacamas Creek Watershed

Land Cover

- 35% forestland
- 25% pasturelands and ag lands
- 16% development

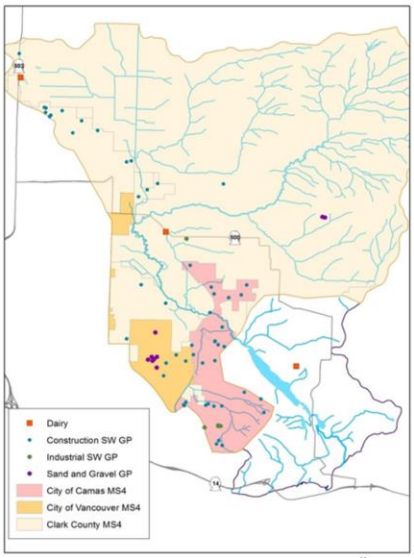
Only 22% of the watershed is publically owned

Permits

- 71 Construction Stormwater General Permit
- 26 Industrial Stormwater General Permit
- 3 Sand and Gravel General Permit

Dairies-WSDA Dairy Nutrient Management Act

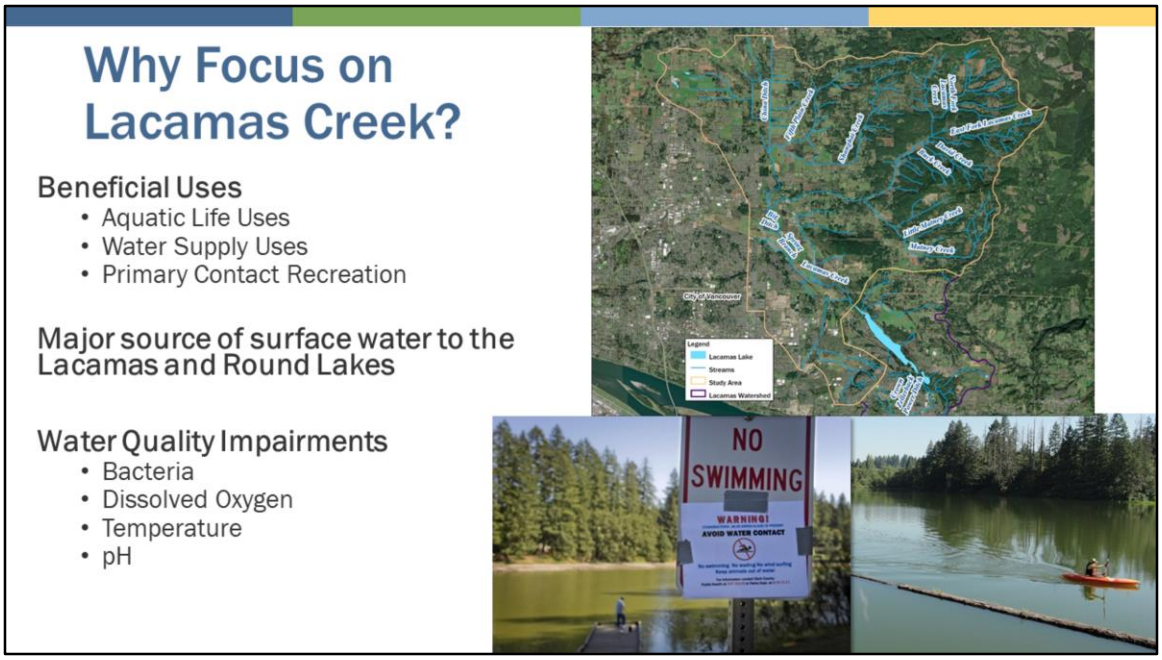
- Laglers Dairy – Large (551 to 900 acres)
- Anderson Dairy - Large (551-900 acres)
- Johnston Dairy LLC – Medium (121 to 300 acres)
  - *Soon to be decomissioned*



Currently, dominate land cover is forest, followed by pasturelands and agricultural lands, and then developed areas. There is definitely increasing development of high-density residential and commercial areas concentrated in the southern and western watershed near the Cities of Camas and Vancouver.

Only 22% of the watershed is public property. This means that implementation efforts for cleaning up the watershed will rely heavily on private landowners and encouraging voluntary implementation of best management practices (BMPs) in order for there to be long-term water quality improvement. In terms of permits, the majority are construction stormwater general permits which is clear indication of development and urbanization in the watershed. *Both the construction stormwater and sand and gravel general permits have effluent limit of 6.5 to 8.5 to segments of water bodies on Washington's 303d list (i.e. Matney Creek).

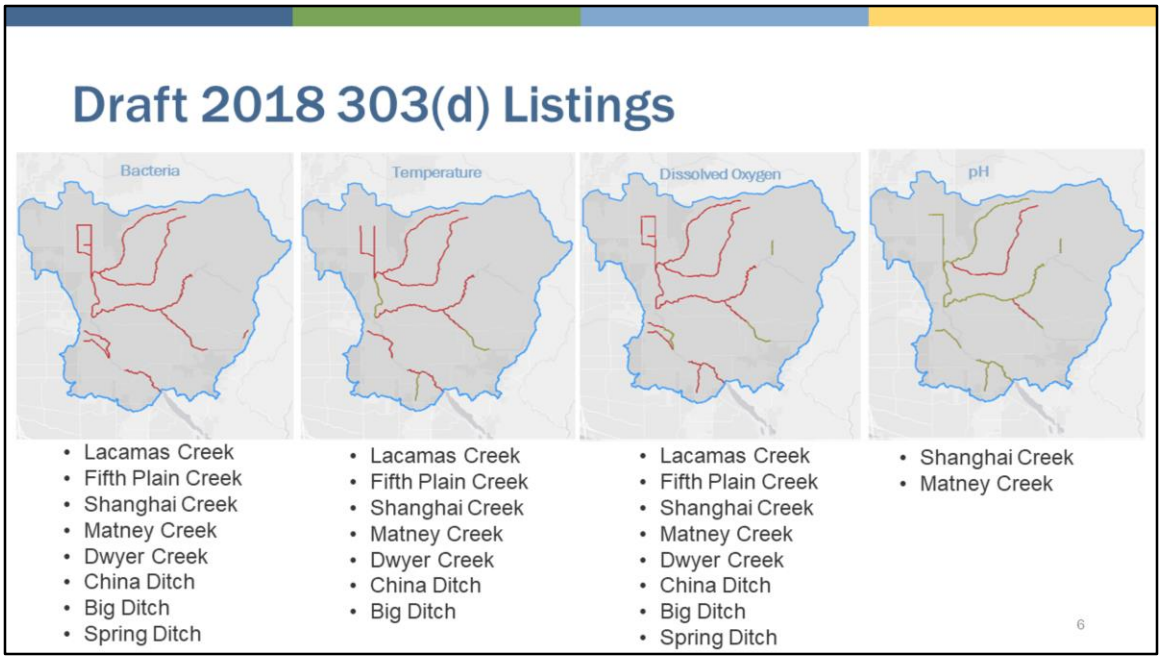
There are currently three dairies in the watershed; Laglers in the northwest, Anderson in the middle of the watershed, and Johnston Dairy close to the east side of Lacamas Lake. These dairies are regulated by Washington Department of Agriculture's (WSDA) Dairy Nutrient Management Act. Johnston dairy is outside of the study boundary and is currently being decommissioned. The owner of this dairy reached out to Ecology about properly decommissioning the manure lagoon to avoid mismanagement of the lagoon after the dairy shuts down and avoid potential discharge to the lake.



There are many reasons why we are focusing on Lacamas Creek. The creek provides beneficial uses, and the state establishes water quality criteria to protect those uses. There are aquatic life use protections, since the creek could provide habitat for fish and supports natural wildlife. The creek is a potential source of water supply for agriculture, livestock and domestic use. Lacamas Creek is also a major input to the downstream Lacamas Lake, which is a popular area for recreation.

Since the creek is a major input of surface water to those lakes, Lacamas Creek water quality influences the water quality of Lacamas Lake. Past studies have determined that the primary phosphorous loading to Lacamas Lake originates from nonpoint pollution sources to Lacamas Creek (BCI, 1985). Also, the City of Camas and supporting agencies are developing a lake management plan to address pollution sources that are directly discharging to the Lake. Ecology will focus on targeting watershed sources of pollution from Lacamas Creek while the City and local stakeholders will focus efforts in the Lacamas Lake area. This is an effective strategy to address pollution issues from multiple sources that are affecting both the watershed and the lakes.

An important reason for focusing on Lacamas Creek and its tributaries is that they currently do not meet Washington State's water quality standards for multiple parameters. bacteria, dissolved oxygen, pH and temperature. This emphasizes the importance for prioritizing Lacamas Creek for water quality improvement.



Ecology just released a draft 2018 water quality assessment and a draft 303(d) list of waterbodies that are considered impaired or do not meet standards. This assessment involved reviewing data from 2006-2017 which included the data initially collected for the Lacamas TMDL. This new review resulted in the listing of new tributaries and stream segments that were not previously listed at the start of this study. The assessment shows the need to evaluate these 303(d) listed parameters and assess the conditions across this watershed.

Lacamas Creek TMDL

Objective:

- Identify pollution problems.
- Determine how much pollution needs to be reduced to achieve clean water.

2010-11 Monitoring:

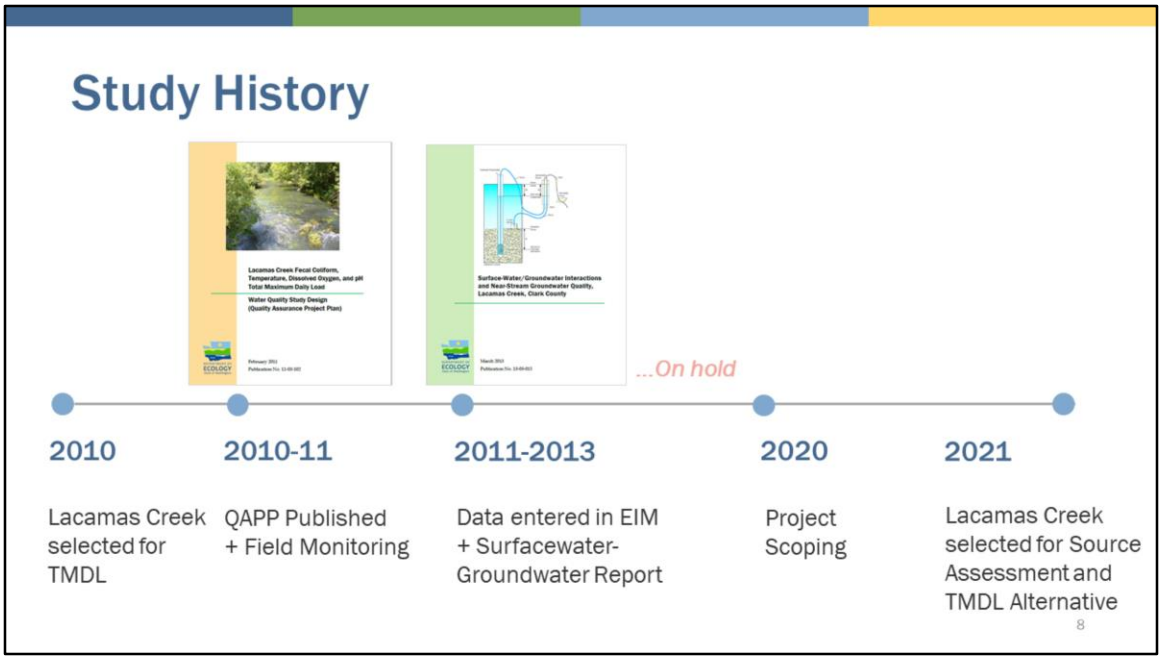
	2010	2011										
Survey type and frequency	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
FC bacteria sampling	2	2	2	2	2	2	2	2	2	2	2	2
Piezometer water level measurements and thermistor downloads	1*	1*	1*	1*	1*	1	1	1	1	1	1	1*
Air and surface water thermistor downloads						1	1	1	1	1	1	
Stormwater*					1	1	1	1	1	1	1	1
Dissolved oxygen, pH, and nutrient synoptic surface water and groundwater sampling^								1		1		
Time-of-travel (dye) study								1		1		
Habitat and channel geometry								1	1			
Periphyton sampling										1		

* If possible. Water levels may be too high to access some piezometers.
* Weather permitting. The goal is to sample one summer storm for nutrients and FC and three fall through spring storms for FC.
^ Includes Hydrolab and benthic flux chamber deployment

7

Due to the historical water quality impairments, Lacamas Creek Watershed was considered a high priority watershed and was selected for a TDML in 2010. This TMDL intended to identify pollution problems in the watershed and then calculate the amount of pollutant needed to be reduced to bring the waterbody into compliance.

This involved an intensive monitoring plan:
-Sampling was conducted at 30 fixed sites and 9 investigative sites for FC bacteria
-Dissolved oxygen, pH and nutrients were also collected for synoptic surveys of surfacewater and groundwater
-Continuous temperature
-Riparian habitat data and channel measurements were collected
-Flow monitoring at 3 sites
-Storm sampling during a single dry season storm and at least 3 wet season storms



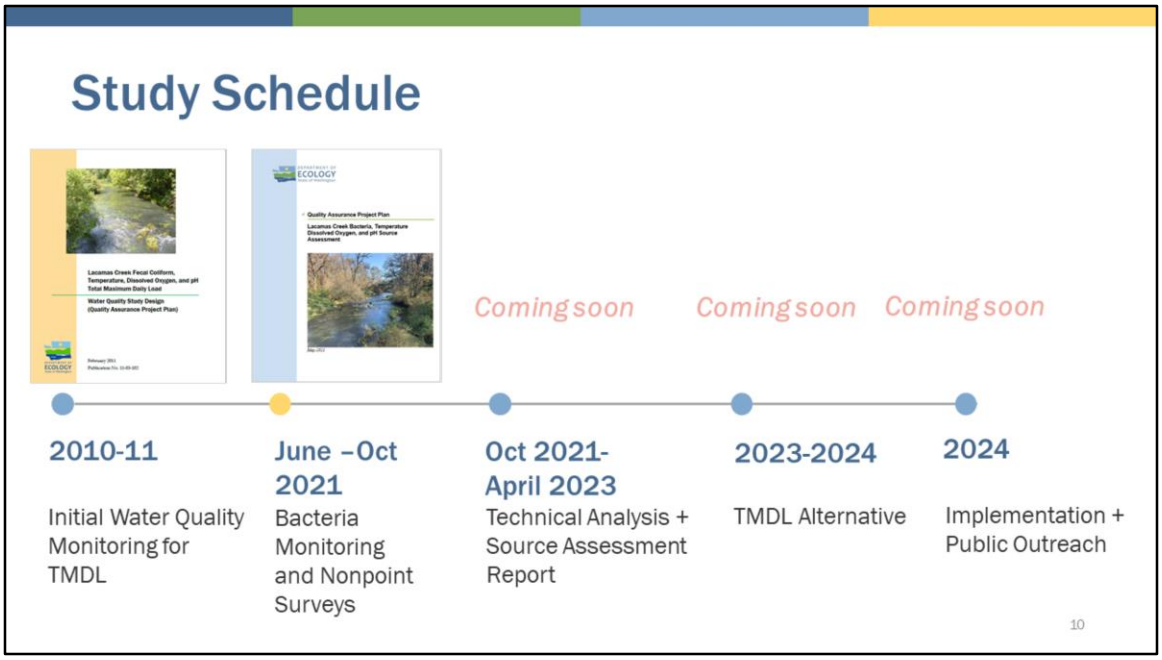
Field work was finished by 2011. The groundwater assessment was completed to determine how groundwater influences stream flows and surface water quality in Lacamas Creek, and a report was published in 2013 summarizing those findings. Yet, a complete assessment of the surface water quality conditions was not completed due to schedule limitations and staff turnover.

It was selected as a worthwhile project to scope out, since resources have been devoted to this study and valuable water quality data needs to be assessed. Sheelagh McCarthy did an initial scoping of data and a preliminary review of the bacteria data. Just earlier this year, we proposed it to management, and we received approval to move forward with the source assessment and TMDL alternative.

Source Assessment Study Goals

1. **Complete** the assessment of data collected in **2010-11.**
2. **Collect** additional bacteria data in 2021.
3. Develop a ***Source Assessment*** for Lacamas Creek.
4. **Identify priority areas** for water quality improvement.
5. Support development of ***TMDL Alternative Restoration Plan*** for Lacamas Creek.

The specific goals of this source assessment are to complete the evaluation of the 2010-2011 water quality data. We also will collect additional bacteria data this summer to find current sources of pollution and evaluate changes since the initial data collection. The technical analysis of both datasets will be used to develop a source assessment report, which will identify priority areas for water quality improvement.
This source assessment will serve as the technical foundation for the Lacamas Creek TMDL alternative restoration plan.



We will start the supplementary bacteria monitoring this summer 2021. Sheelagh McCarthy and Molly Gleason will complete the technical analysis and Source Assessment report by 2023. Devan Rostorfer develop a Water Cleanup Plan or TMDL Alternative restoration plan, which will help guide future Implementation and outreach.

Source Assessment Study Objectives

Bacteria

- Determine current bacteria impairments.
- Determine how fecal coliform has changed over time.
- Calculate targets for fecal coliform reduction.
- Connect bacteria with land use and land cover patterns.
- Develop a relationship between fecal coliform and *E. coli* data.

Dissolved Oxygen, pH, Temperature, Nutrients

- Summarize results and compare to 2021 data.
- Determine water quality impairments.
- Characterize stream temperatures through spatial analysis.
- Determine shade deficits.
- Connect nutrient results with land use and land cover patterns.

11

These are the specific study objectives we hope to achieve from our technical analysis and package in our source assessment report.

Why a Source Assessment and TMDL Alternative?

- Watershed is dominated by nonpoint sources.
- Watershed is primarily rural (less than 50% is developed).
- There are local resources available to support implementation and water cleanup efforts.
- TMDLs are complex and resource intensive.

Instead of adopting a TMDL that was originally designed for the study, the study will be completed as a source assessment that will work towards a TMDL alternative. TMDL alternatives are increasingly important tools for water quality improvement as an alternative to TMDLs. This decision was made based on specific criteria that this watershed met.

TMDL Alternatives are suitable for addressing nonpoint sources of pollution especially in a more rural landscape. Official TMDLs work well to address urban watersheds dominated by point sources, primarily industrial dischargers and WWTPs. However, TMDLs struggle to adequately address nonpoint sources, primarily because nonpoint sources aren't covered by the enforcement controls of the NPDES program. Due to the rural landscape and the limited industrial discharges, the water quality challenges in the watershed are likely associated with nonpoint pollution.

Another crucial component of addressing nonpoint pollution is that there are be local resources available to support implementation and water cleanup efforts. Partners in Clark County already have established programs to address these nonpoint issues and to provide technical and financial support to encourage best practices and voluntary compliance to fix problems related to agriculture and septic systems.

TMDLs have proven to be complex and resource intensive. By adopting a source assessment design, this study can work towards improving water quality efficiently and more timely.

Nonpoint Pollution Sources

- Livestock
- Manure piles and application in fields
- Animal boarding facilities
- Dog parks
- Wildlife
- Golf courses
- Septic tanks
- Stormwater runoff

13

In preparation for this study, we've done initial surveys throughout the watershed and noted relevant nonpoint observations. It's clear from initial surveys this watershed has potential nonpoint sources to consider, and we hope to track the impact with our bacteria sampling.

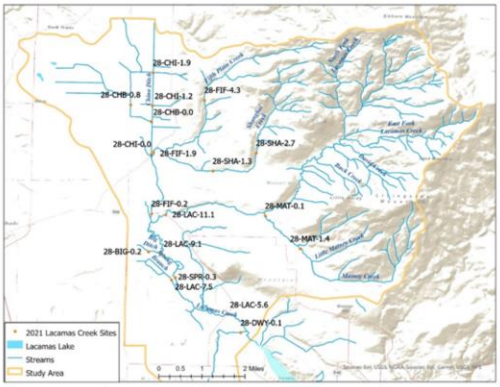
2021 Source Assessment Bacteria Monitoring

Network of 19 Fixed Sampling Sites

- Sampling June-October, ***twice a month.***
- Sampling ***fecal coliform*** and ***E. coli.***
- Focused in areas with historically high bacteria levels.

Investigative Sampling Sites

- Added based on bacteria results.



Month	Dates
June	7, 21
July	6, 19
August	9, 23
September	6, 20
October	11, 25

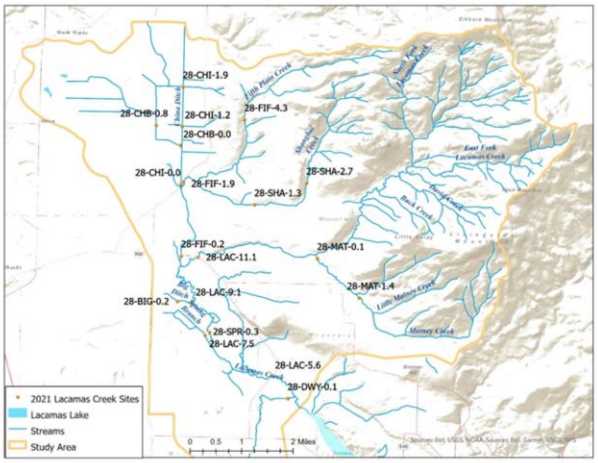
For the planned field work for this summer, Ecology will collect *E. coli* and FC at a fixed-network of 19 sites, twice a month from June to October. These are sites that were previously monitored by Ecology. Opportunistic sampling at investigative sites will happen on a need-to basis in order to explore potential areas of concern and sources of pollution.

2021 Monitoring

- Ecology's Ambient Monitoring Program:
  WQ Station 28I120 - LACAMAS CREEK AT GOODWIN ROAD

  Sampling October 2020 - September 2021, **once a month** for:
  - E. coli and Fecal coliform
  - Nutrients
    Nitrate+nitrite, Ammonium, Total nitrogen, Total phosphorus, orthophosphate
  - Suspended solids, Turbidity
  - Metals
  - Dissolved Oxygen, pH, Conductivity, Temperature

- Clark County LISP Monitoring
  - Matney Creek- most downstream site
  - Sampling once a month



In addition to the planned our field work, Ecology's Ambient Monitoring Program lead by the Freshwater Monitoring Unit has been collecting samples and measurements at a site located right before Lacamas Creek enters Lacamas Lake. The data collected at this site will be complementary to this source assessment by providing current water quality data at a downstream location and providing valuable nutrient data from a site right above the lake.

Clark County has collected monthly FC and water quality data at a long-term Matney Creek site since 2001 as part of a long term index monitoring program which is an effort to track water quality trends in important watersheds across Clark County. They will continue to collect monthly samples at Matney Creek this summer.
There is already foundational data from Ecology and Clark County that will serve as a guide for this planned monitoring and helped us prioritize where we should sample.

Preliminary Results

- Dry season bacteria exceedances at a majority of sites
- High fecal coliform levels at:
  - China Ditch
  - Shanghai Creek
  - Fifth Plain Creek
  - Big Ditch

Results supported by Clark County fecal coliform monitoring

Preliminary results:

https://storymaps.arcgis.com/stories/9da4d4afbb06449d85c67b932776911a/edit

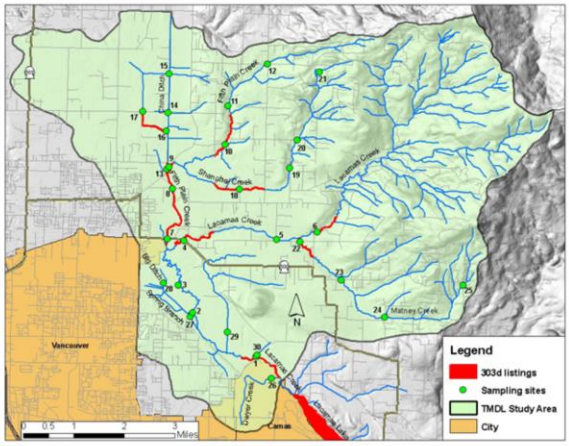


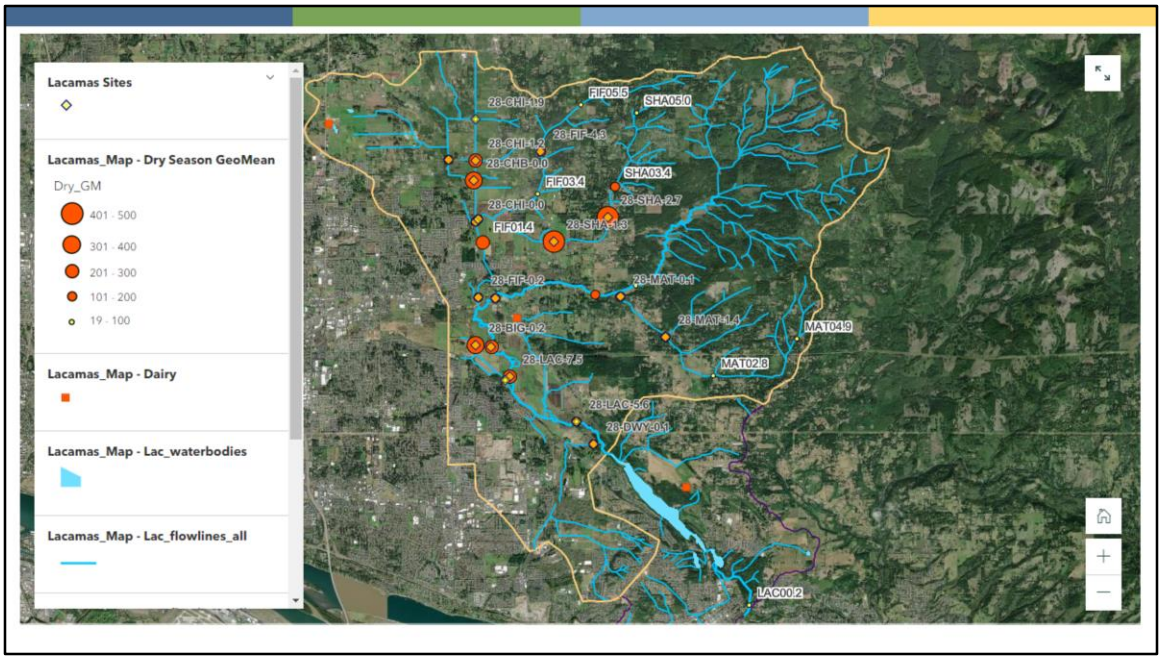
Figure 3. Fixed-network sampling locations in the Lacamas Creek watershed.

To prepare for this study, Sheelagh McCarthy has already done the initial scoping and review of Ecology's bacteria data.

She found that most of the exceedances happened during the dry season over the summer. This is why we are focusing on summer monitoring since it was shown to be a critical season. And she was able to find the high priority areas that had the highest exceedances.

Clark County has provided more recent fecal coliform data that confirms there still are high levels of bacteria in these areas of concern.

*The StoryMap will be published soon once it has been approved by Ecology ArcGIS administer.



**Story map will be published once approved; for now here is a snapshot of the map.*

China Ditch

China Ditch is located in the northwest corner of the watershed located in Hockinson and Bush Prairie. It was one of the areas that was heavily channelized. Some of the study's highest bacteria levels were detected here. The highest geomean calculated for a core site **in this area** was at the most downstream location of a tributary that flows to the main China Ditch Channel. Upstream of this tributary is Hockinson Meadows Park, an open leash dog park with evidence of wildlife. Further upstream in between the channelized tributaries is the golf course, hobby farms, and Lagler's dairy. Investigate samples will be collected along these areas; they were not chosen as core sites due to low flow conditions already this April.

Fifth Plain Creek and Shanghai Creek

Both China Ditch and Shanghai Creek flow to Fifth Plain Creek which flows to Lacamas Creek. We are sampling upstream and downstream of the confluences of both to see their potential influences.

Shanghai Creek is another high priority stream, since the highest geomeans out of all core sites were found at the two downstream sites. The landscape of this area is more forested with private properties right up to the bank.

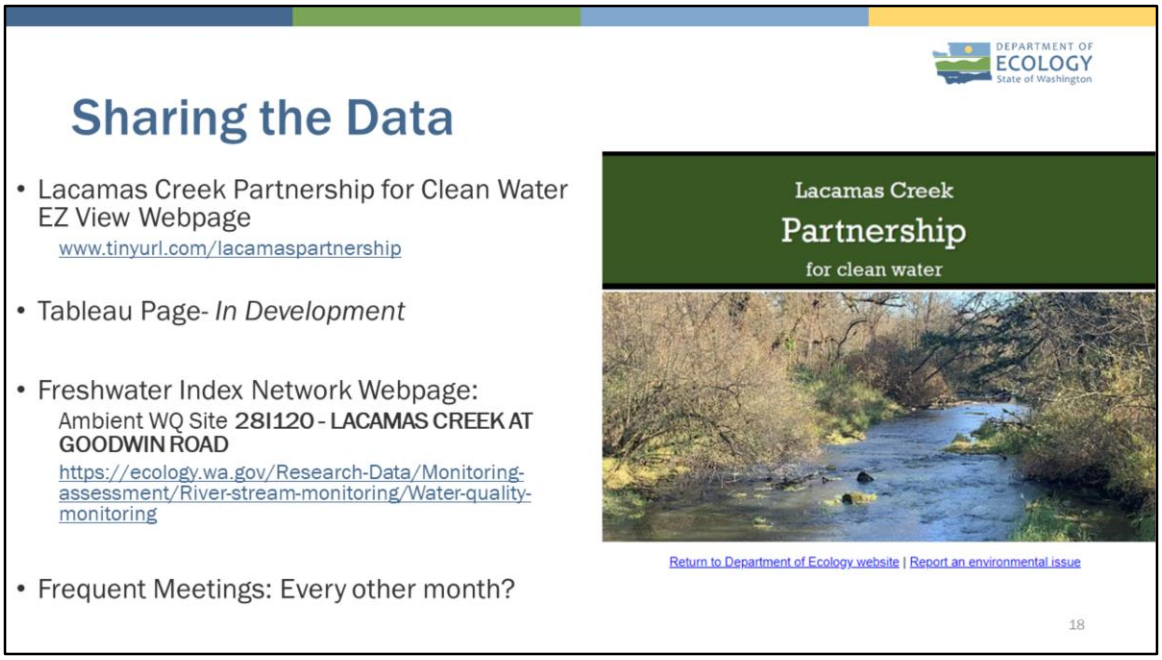
Lacamas Creek, Big Ditch, Spring Branch

Lower in the watershed, Fifth Plain enters the mainstem of Lacamas Creek as do smaller channelized streams, such as Big Ditch and Spring Branch. We're interested in seeing the bacteria influences of these ditches, since the highest bacteria levels in Lacamas Creek were located at these two sites below Big Ditch. Big Ditch had the next highest geomean in the watershed following Shanghai Creek. In this area, we have a dairy upstream of Spring Ditch and Andersen Dairy is just east of these sites.

Matney Creek
One of the eastern tributaries to Lacamas Creek that we're including in our monitoring is Matney Creek. In 2011, there weren't as high fecal levels compared to the surrounding tributaries, but both of the downstream sites exceeded criteria for the dry season. More recent data has shown higher levels of bacteria. Clark County has collected monthly FC data at a long-term Matney Creek site. Their data has shown exceedances in the annual geometric mean over the past 3 water years. We hope to further explore that creek by sampling upstream of a tributary to find potential sources of bacteria.

Lacamas Creek and Dwyer Creek
We will be sampling at the most downstream location of Lacamas Creek twice a month, which had lower bacteria than the upstream sites. This could be due to dilution from additional inputs of surface water.
In addition to our sampling efforts, the Ambient Monitoring Program will be collecting monthly bacteria, nutrients and metal samples including in-situ measurements of conventional water quality parameters.

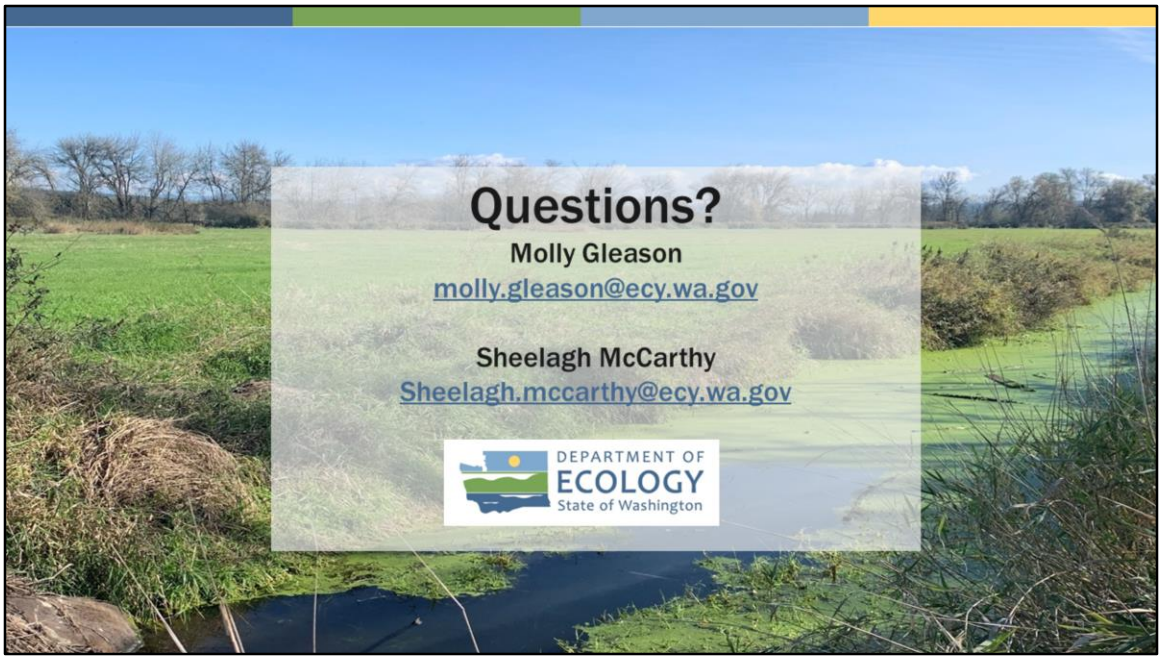
We are also collecting bacteria at Dwyer Creek which is another input of surface water to Lacamas Lake. There weren't as many high bacteria levels at this site, but it's would be comprehensive to include all major inputs Lacamas Lake. Dwyer Creek runs through the Camas Meadows Golf course. And on the other side of the lake, Johnston Dairy is no longer licensed, and a well-managed decommissioning of it's manure lagoon could prevent a direct discharge to Lacamas Lake.



For more information about the study, Devan created a Lacamas Partnership webpage which has all of the relevant publications such as the older TMDL QAPP, the groundwater study, and the QAPP for this source assessment will be uploaded by end of May, early June. Devan has also created a FAQ sheet which provides quick overview of our study plan which can be used for outreach.

And a tableau page that will be in development once we start gathering data. My plan is to provide a virtual platform to display the maps and charts of preliminary bacteria data throughout the monitoring and provide ongoing monthly updates

Ecology's Ambient Monitoring updates their water quality at their Freshwater Index Network Webpage. They typically update 2-3 months after sampling.


Questions?
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State of Washington

TMDL

- A total maximum daily load is a CWA-defined allocation of pollutant loads that will meet water quality standards.
- TMDLs establish the loading capacity of a waterbody and set wasteload allocations for point sources and load allocations for nonpoint sources.
- TMDLs work well to address urban watersheds dominated by point sources, primarily industrial dischargers and WWTPs.

TMDL Alternative

- A TMDL Alternative is focused on implementing corrective actions directly, rather than relying on modelling or the assignment of load allocations and wasteload allocations.
- When waters are clean enough to meet water quality standards, they are delisted.
- TMDL Alternatives work well to address rural watersheds dominated by nonpointpoint sources.

2021 Sampling Sites

Site	Waterbody	Latitude	Longitude	Description
28-FIF-0.2	Fifth Plain Creek	45.67198	-122.49457	5th Plain Ck at 4th Plain Rd NE (SR 500). Most downstream Fifth Creek location.
28-CHI-0.0	China Ditch	45.69203	-122.49551	China Ditch at NE Ward Rd and 172nd Ave intersection.
28-FIF-1.9	Fifth Plain Creek	45.6928	-122.49449	5th Plain Ck at NE Ward Rd and 172nd Ave intersection.
28-CHB-0.0	China Ditch	45.70299	-122.49603	China Ditch tributary at Hokinson Meadows Park.
28-CHI-1.2	China Ditch	45.70839	-122.4956	China Ditch at intersection of NE 172nd Ave and NE 119th St.
28-CHB-0.8	China Ditch	45.70848	-122.50595	China Ditch tributary at NE corner of Hokinson Meadows Park.
28-CHI-1.9	China Ditch	45.71945	-122.49564	China Ditch north of 131st St on NE 172nd Ave.
28-FIF-4.3	Fifth Plain Creek	45.71064	-122.47061	5th Plain Ck at Sliderberg Rd and 122nd Circle.
28-SHA-1.3	Shanghai Creek	45.68683	-122.46579	Shanghai Ck at NE 202nd Ave.
28-SHA-2.7	Shanghai Creek	45.69327	-122.4452	Shanghai Ck at NE 222nd Ave.
28-DWY-0.1	Dwyer Creek	45.63267	-122.45051	Dwyer Ck at golf course maintenance shop.
28-LAC-5.6	Lacamas Creek	45.63878	-122.45697	Lacamas Ck at Goodwin Rd.
28-LAC-7.5	Lacamas Creek	45.65071	-122.4825	Lacamas Ck upstream of Spring Branch off 182nd and 38th.
28-SPR-0.3	Spring Ditch	45.64985	-122.48429	Spring Branch Ck near 182nd Ave and 38th Way.
28-BIG-0.2	Big Ditch	45.65913	-122.49566	Big Ditch near Lacamas Ck.
28-LAC-9.1	Lacamas Creek	45.65872	-122.4895	Lacamas Ck near Big Ditch.
28-LAC-11.1	Lacamas Creek	45.6717	-122.48783	Lacamas Ck at 4th Plain Rd NE (SR 500).
28-MAT-0.1	Matney Creek	45.67218	-122.4401	Matney Ck at NE 68th St.
28-MAT-1.4	Matney Creek	45.66142	-122.42297	Matney Ck at NE 53rd St.

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The table represents the Ecology's site list for bacteria sampling in 2021. *The final list will be confirmed in the final Lacamas Creek Source Assessment QAPP.*

Preliminary analysis of 2010-11 fecal coliform data

Site	Waterbody	Annual Geometric Mean	Annual % Exceed	Wet Geometric Mean	Wet % Exceed	Dry Geometric Mean	Dry % Exceed
LAC00.2	Lacamas Creek	18	5%	18	8%	19	0%
LAC05.6	Lacamas Creek	74	16%	50	14%	123	18%
LAC07.5	Lacamas Creek	99	28%	53	14%	221	45%
LAC09.1	Lacamas Creek	82	32%	37	14%	227	55%
LAC11.1	Lacamas Creek	55	16%	32	14%	108	18%
LAC13.3	Lacamas Creek	29	8%	11	0%	104	18%
LAC14.8	Lacamas Creek	19	8%	6	0%	74	18%
BIG02.0	Ditch	109	40%	47	14%	315	73%
DWY00.1	Dwyer Creek	45	10%	27	0%	126	29%
GOL00.0	Unnamed Tributary	5	0%	3	0%	68	0%
MAT00.1	Matney Creek	54	7%	28	0%	150	18%
MAT01.4	Matney Creek	53	20%	22	0%	162	45%
MAT02.8	Matney Creek	25	8%	9	0%	96	18%
MAT04.9	Matney Creek	28	8%	12	0%	87	18%
SPR00.3	Spring Branch Creek	62	8%	44	7%	97	9%
CHB00.0	China Ditch Tributary	71	20%	19	0%	379	45%
CHB00.8	China Ditch Tributary	29	12%	9	0%	124	27%
CHI00.0	China Ditch	55	16%	30	7%	120	27%
CHI01.2	China Ditch	87	28%	41	0%	229	64%
CHI01.9	China Ditch	36	12%	18	0%	86	27%
FIF00.2	Fifth Plain Creek	56	13%	33	4%	115	26%
FIF01.4	Fifth Plain Creek	83	24%	36	7%	238	45%
FIF01.9	Fifth Plain Creek	72	18%	39	0%	186	45%
FIF03.4	Fifth Plain Creek	41	8%	21	0%	97	18%
FIF04.3	Fifth Plain Creek	41	20%	15	0%	153	45%
FIF05.5	Fifth Plain Creek	15	4%	5	0%	58	9%
SHA01.3	Shanghai Creek	156	44%	74	21%	402	73%
SHA02.7	Shanghai Creek	157	44%	69	14%	453	82%
SHA03.4	Shanghai Creek	53	24%	23	7%	151	45%
SHA05.0	Shanghai Creek	16	5%	10	0%	39	14%

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This table represents the preliminary fecal coliform data analysis and comparison to the water quality criteria for Primary Contact Recreation. The numeric criteria were calculated for the year, for the wet season (November- May) and dry season (June-October). The Primary Contact Recreation criteria are as follows:

1) Geometric Mean should not be above 100 cfu/100mL.

2) No more than 10% of samples, or any single sample when less than ten, should exceed 200 cfu/100 ml.

Exceedance of the criteria is represented in red. A final statistical analysis of these FC results will be a part of this source assessment.