

Human Bacteria Source Tracking With Trained Dogs

Skagit County, 2015-2016

In 2015 and 2016, Skagit County worked with Environmental Canine Services (ECS) to identify sources of human sewage in the Samish and Padilla watersheds. ECS dogs are specially trained to locate sources of human sewage contamination in stormwater systems while ignoring non-human sources. The project was funded both years by a grant from the Washington Department of Health.

Methods

Our approach during each year was slightly different. In 2015, Crush was exposed to samples from our regular storm sampling sites representing large areas with many potential sources, in addition to two general areas where we were struggling with identifying which houses might be causing a water quality problem. In 2016, instead of focusing on regular storm sampling sites, we focused on smaller areas where we had found poor water quality results over the last year without an obvious source.

Neither years' visit was during a storm; a small amount of rain fell the day before Crush's 2015 visit (0.17 inches), and significant rain was not measured for 5 days prior to her 2016 visit.



Figure 1. Crush sits or lays down to indicate that she smells sewage in Bay View.

All samples that Crush sniffed were taken in the morning under the assumption that, on weekdays, most septic systems are used most heavily in the morning, and any scent would be strongest during those hours. While staff were out gathering samples for the afternoon session, Crush was taken out to several walkable areas where previous sampling indicated the possibility of nearby septic failures. Where Crush indicated sewage and enough water was present, a fecal coliform sample was taken and sent to a certified lab for analysis.

The afternoon session was done in a scent-neutral parking lot. Samples were collected in gallon-sized plastic jugs by staff wearing disposable gloves to reduce the chance of cross-contaminating samples. Jugs were rinsed three times with stream water before the sample was taken. After capping the sample, each jug was then rinsed with distilled water, placed inside a garbage bag to reduce the possibility of contamination, and transported to the parking lot. At the same time, a fecal coliform sample was taken at each site and sent to a certified lab for analysis. Once at the parking lot, samples were carefully poured into clean, shoebox-sized plastic containers for Crush to sniff. If a spill occurred and Crush indicated sewage in that sample, that area was not reused during successive rounds. The containers were set 10-20 feet away from each other to isolate the scent from each as much as possible. Crush was then brought to sniff each sample, and project managers recorded her response.

Throughout each day, Crush was exposed to quality assurance (QA) samples to ensure she was giving the proper response. In the field, QA samples consisted of distilled water. During the parking lot test, QA samples consisted of pure distilled water, horse or cow manure mixed with distilled water, tap water, and sewage from a local treatment plant.

Dog Response Results

Crush's response to each site is detailed in the reports that ECS produced after each visit (see Appendix A). In 2015, Crush detected sewage in 19 out of 42 samples from the Padilla and Samish watersheds, and at several field locations in downtown Bay View and in the Thomas Creek watershed. In 2016, Crush detected sewage in 45 of 71 samples from the Padilla and Samish watersheds, and at several locations in the mid-Samish and Thomas Creek watersheds.

Fecal coliform sampling in areas where Crush indicated sewage was present followed the same pattern we saw during our first visit with Crush in 2014: only rarely are fecal coliform levels high in locations where Crush indicates a problem, even in areas where a failure was later found nearby. Of the 90 sites during both years where Crush indicated sewage was present and a sample was taken, only 16 had a fecal coliform count over 100.

Follow Up Activities

Dye Tests

Following Crush's 2015 visit, 30 septic systems were identified for dye tests. Two property owners denied access and 28 dye tests performed. Six of those dye tests were confirmed failures (four in downtown Bay View and two in the Samish). Repairs are complete for several of the failures, and are in process for the rest. Follow up dye testing is still continuing in the downtown Bay View area.

After Crush's return in 2016, fourteen septic systems had been identified for dye tests by the time of this report, seven of which have been dyed. Of those seven, one septic system has been found to be a failure, and the design process has begun for a new system.

Because this spring has been dry, further dye testing is on hold until the fall. Staff will use this time to ensure that property owners near Crush-identified sites are up to date on inspections and identify more sites to dye test.



Figure 2. Crush indicates that she smells sewage during the parking lot trials.



Figure 3. A positive septic system dye test at a house previously indicated by Crush.

Enforcement of Septic System Inspection Regulations

Many of the results from Crush's early visits have been difficult to use because many locations where she indicated sewage was present received runoff from large areas, making it difficult to identify who should be dye tested. Additionally, the septic program has found that their staffing level makes it difficult to effectively enforce septic system inspection regulations throughout the watershed. As such, it made sense to identify smaller areas for the septic program to focus their enforcement efforts on.

Under the assumption that older septic systems are more likely to fail, and following the example of a similar mapping project done in Kitsap County, septic program staff worked with our GIS Department to produce a map that showed the density of 30+ year old septic systems in the Samish watershed. Those maps were then combined with Crush's results, and "septic focus areas" were drawn around areas that had a large density of old systems and positive results from Crush. Seven areas were identified following this method. In order to keep the number of letters to be mailed manageable, four were prioritized to receive enforcement first, and the remaining three would receive enforcement once the majority of the high priority areas had been completed.

As of the date of this report, letters were sent to the 232 property owners in the priority areas. Of those, 223 property owners got their septic systems inspected. No failures were found among those properties that were inspected, though several required minor repairs. The remaining nine properties are being referred for fines.

An estimated 200 letters for the next set of priority areas are expected to be sent in late May or early June.

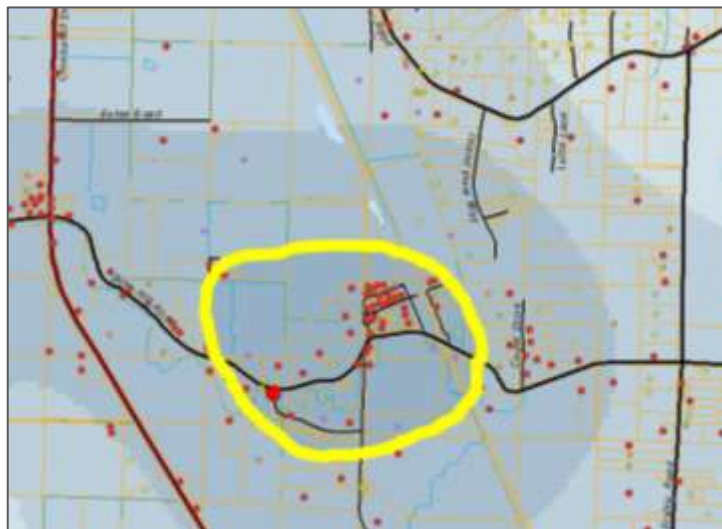


Figure 4. The Bow Cemetery Rd focus area. Darker blue colors are higher densities of 30+ year old septic systems, and dots are locations of septic systems. The focus area is highlighted in yellow.

Lessons Learned & Remaining Questions

We have learned much about how to use Crush most effectively. Possibly the most important lesson has been that Crush is extremely sensitive to scent, and can smell as little as one teaspoon of treated sewage effluent mixed into one gallon of water. Because of her sensitivity, we found that our ability to

identify septic system failures increased when we have previously bracket sampled down to an area where there are only a few possible sources. While it is important to know whether a large area may have septic system failures, identifying which systems may be at fault is difficult and time consuming when there are dozens or more possible sources upstream.

We have also found that Crush will still indicate sewage where septic repairs have occurred and been confirmed by a negative dye test. Though the repairs were completed as much as two years previous, the scent appears to remain in the soils.

When out in the field, ditches do not need to have water in them in order for Crush to identify areas that are affected by sewage. During both her 2015 and 2016 visits, Crush identified several areas in Bay View and the Steelhead Lane neighborhood affected by sewage, though the ditches were dry. In Bay View, her findings were subsequently confirmed by several positive dye tests.

Though one might expect fecal coliform results to be high in areas where Crush indicates sewage is present, we have found that the opposite is generally true. In most cases, grab samples of water in areas where Crush indicated sewage returned low fecal coliform levels, though in some cases, a failure was confirmed nearby. There are a number of possible reasons for this seeming inconsistency. First is that septic systems are most used in the mornings and evenings, and sewage from a failure may have already washed through the system, leaving only a scent behind. Another related possibility is that storms prior to Crush's visit washed the vast majority of the fecal contamination downstream, again leaving only the scent. Due to the obviously unpredictable nature of storms, our work with Crush has never coincided with a storm that would create runoff. We expect that in a storm, fecal coliform counts would correlate better with locations Crush indicates are impacted by sewage.

One remaining question is whether Crush indicates sewage is present when there is also cow manure present. Crush correctly identified all control samples offered to her during both years, except for when a small amount of treated sewage was added to a strong dilution of cow manure in 2016. When a little more sewage was added to the dilution, she hesitated in front of the sample, but did not sit to indicate that there was sewage in it. We do not know if the smell of sewage was masked by the much stronger solution of cow manure, or whether she has been inadvertently trained to ignore sewage if cow manure is present. We plan to explore this question further if and when we bring ECS back to Skagit County.



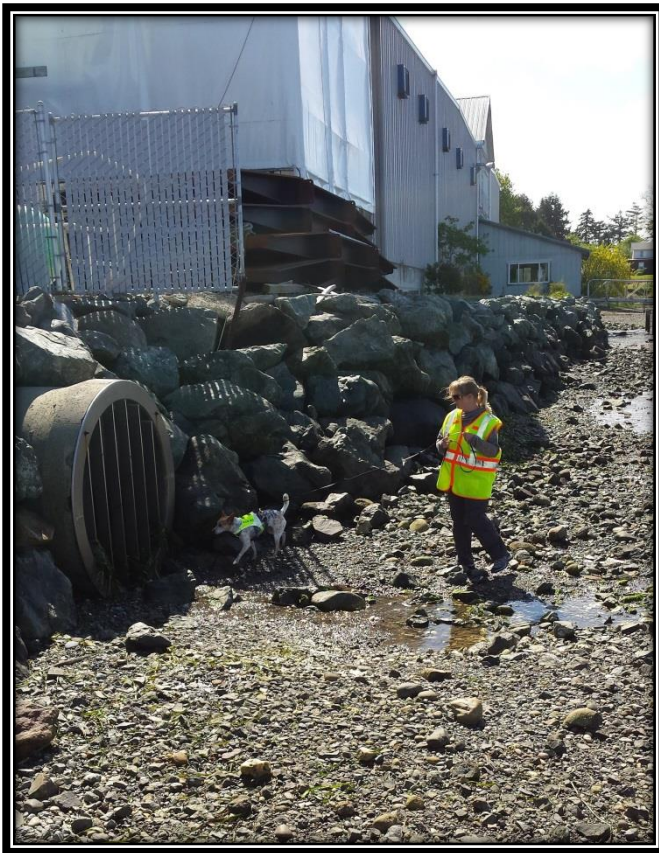
Figure 5. Crush and her handler, Aryn Havel.

Appendix A
Environmental Canine Services Reports, 2015-2016

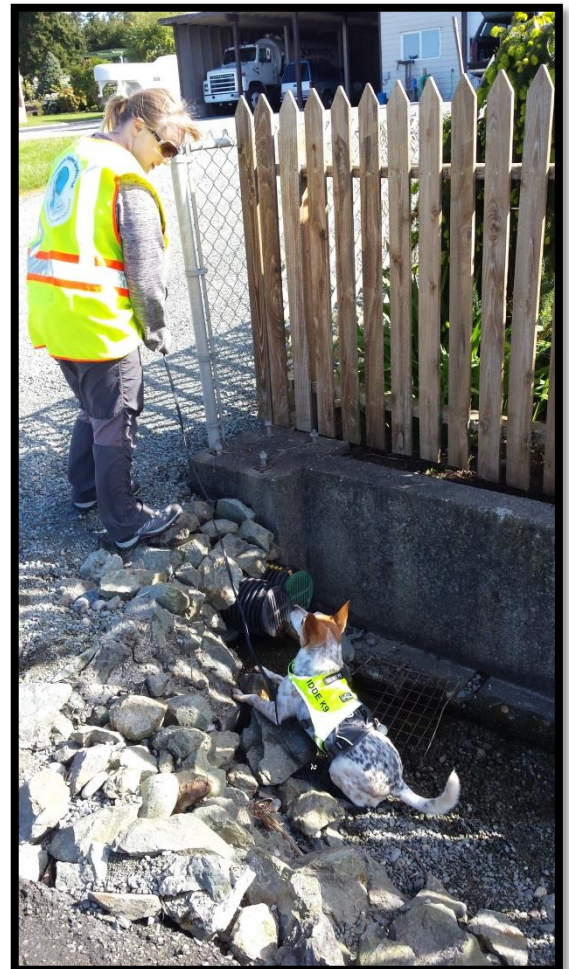
Skagit County, WA

Human Bacteria Source Tracking with Scent-Trained Canine April 22 and 23, 2015

Summary Report



Bay View Area



Thomas Creek Area

Prepared by:
Environmental Canine Services, LLC
2734 Auburn Road
Turner, ME 04282



Summary

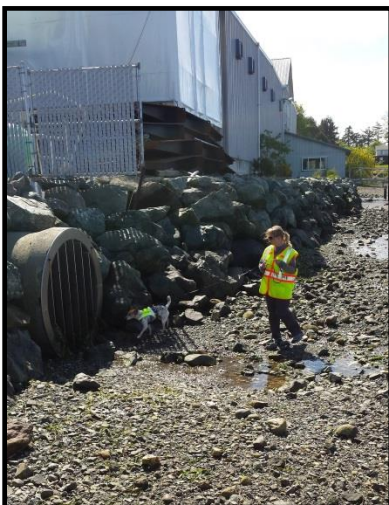
On April 22 and 23, 2015, Environmental Canine Services LLC (ECS) President and Project Manager, Karen Reynolds, and Handler/Canine team Aryn Havel/Crush worked with Skagit County Public Works (SCPW) to conduct targeted human bacteria source tracking in the Samish watershed. ECS canines are specially trained and experienced in locating and source tracking human sewage contamination in stormwater systems while ignoring non-human sources. Crush alerts to the presence of human sewage by lying down at the location of the scent.

April 22 Field Investigations and Sample Scenting

During the morning of April 22, ECS and SCPW personnel conducted field investigations in the Bay View, WA area. The first investigations were conducted in Bay View residential areas. Crush alerted to the presence of human sewage contamination in several locations at roadside ditch drains, ditch pipes, and/or bottles of water samples collected at a site (see Exhibit A).



Additional investigations were conducted on the beach in Bay View near the Bayview Edison Road/B Street boat ramp. Crush did not alert to the presence of human sewage contamination at the large outfall near the ramp but did alert on a possible seep in the rock retaining wall between the ramp and a pier north of the ramp (see Exhibit A).



Final investigations in Bay View were conducted at the Bay View State Park beach. Crush was interested in the air scent in the area of the drain field located next to the parking lot, above the beach. She followed the scent down to the beach and alerted to the presence of human sewage contamination at a specific location on the north end of the beach. In addition to her alert, Crush dug in the sand at that location, indicating that the scent was probably coming from under the sand. The rest of the beach was investigated, and Crush alerted at a specific location on the south end of the beach and dug in the sand at that location. (See Exhibit A).



In the afternoon of April 22, Crush scented 22 water samples collected that morning by SCPW personnel in targeted locations in the watershed and six quality assurance (QA) samples. The QA samples contained distilled water, wastewater treatment plant sewage diluted in distilled water, cow fecal mixed with distilled water, and horse fecal mixed with distilled water. The watershed and QA samples were brought to an empty parking lot at the Skagit County office building, where shoebox sized clean plastic containers (“sample containers”) were arranged in two rows down the length of the parking lot. There was approximately 10 feet of separation between containers in each row and 30 feet of separation between the rows.

Contents of some of the watershed samples and some of the QA samples were poured into individual sample containers in one row. Crush was immediately taken to the sample container row to sniff each sample. This procedure was repeated for the second row with the remaining watershed and QA samples. ECS and SCPW personnel recorded the results.



Crush gave the correct response on all six of the QA samples by alerting on the sewage samples and not alerting on the cow, horse, and distilled samples. She alerted to the presence of human sewage contamination in 13 of the 22 watershed samples. (See Exhibit B).

April 23 Field Investigations and Sample Scenting

During the morning of April 23, ECS personnel worked with SCPW, Health Department, and Samish Indian Nation personnel on field investigations in the Thomas Creek area. Many of the sites were follow ups to field investigations conducted by ECS and SCPW in May 2014. New investigations on F & S Grade Road sites were also conducted. Crush alerted to the presence of human sewage contamination in several locations at roadside ditch drains, ditch pipes, and/or bottles of water samples collected at a site (see Exhibit C).



In the afternoon of April 23, Crush scented 19 water samples collected that morning by SCPW personnel in targeted locations in the watershed and four quality assurance (QA) samples. The QA samples contained distilled water, wastewater treatment plant sewage diluted in distilled water, cow fecal mixed with distilled water, and horse fecal mixed with distilled water. The watershed and QA samples were brought to an empty parking lot at the Skagit County office building, where the sample container arrangement, sample pouring, and canine scenting procedures were identical to those on April 22. ECS and SCPW personnel recorded the results.

Crush gave the correct response on five of the QA samples by alerting on the sewage samples and not alerting on the cow and horse samples. She initially alerted on the QA distilled water sample, but when cross-contamination of the container was suspected and a clean container with distilled water was substituted, she correctly did not alert to the distilled water on the second trial. Crush alerted to the presence of human sewage contamination in six of the 19 watershed samples. (See Exhibit D).

EXHIBIT A SKAGIT COUNTY, WA FIELD INVESTIGATION RESULTS					
Canine Response Legend:					
	N=No alert to the presence of human sewage				
	Y=Alerted to the presence of human sewage				
	I=Strong interest but no alert				
Sample #	Location	GPS N	GPS W	Canine Response	Comments
4/22/15 a.m.					
1	Josh Wilson Rd & Rector Rd	48.48739	122.46375	N	No alert at pipe in ditch or along both ditches.
	C Street & Josh Wilson - north ditch @12745	48.48526	122.47158	Y	Interest in ditch pipes, especially east on C St.
	C Street & Josh Wilson - south ditch			N	
	B Street & Bayview Edison Rd - rocky ditch S. side	48.4851	122.47847	Y	
	B Street & Bayview Edison - north ditch			Y	
2 & 3	N of B Strett & Bayview Edison @ 11065	48.48536	122.47874	Y	Sample 2 from black dripping pipe. Sample 3 from concrete pipe. Near home belonging to septic pumper.
4 & 5	Bayview Edison @ 1007	48.48622	122.47921	Y	Sample 4 from 6" green pipe. Sample 5 from concrete pipe. Canine alert may have been from airscent of sewage smell traveling up concrete pipe.
	10991 Bayview Edison			N	Entire ditch.
	12411 Farnham Rd	48.48686	122.47896	Y	Damp pipe.
	Farnham @ telephone pole east of 12411			N	
	Corner of Farnham and 2nd St			N	Ditch and pipe.
	2nd St east ditch all the way from Farnham to 11046	48.48585	122.47769	N	
	2nd St & B St - east ditch			N	
6	11105 2nd St	48.48508	122.47729	Y	Alerts on large drain pipe in ditch, both sides of driveway.
	11112 2nd St at corner			Y	Alert on white pipe.
	11112 2nd St - east ditch			N	No alert on pipe in ditch.
	2nd St and Josh Wilson - north ditch	48.4839	122.47649	I	Interest in north ditch, west of house with septic mound.
	2nd St and Josh Wilson - south ditch			N	
	E Street & 2nd St - ditch	48.48300	122.47656	Y	Pipe in ditch next to driveway to sheds on property. Odor of sewage in the air.
	Bayview Edison & E St	48.48284	122.47723	Y	Alert on drain pipe in south ditch.
7	Josh Wilson & Bayview Edison - SE corner @ 12450	48.4835	122.47765	Y	Alert on catch basin. Dave reported strong odor in water in catch basin.
	Bayview Edison & B St boat ramp - large outfall @ beach			N	
	S of Bayview Edison & B St boat ramp and north of pier along beach	48.48405	122.47862	Y	Alerted on possible seep in rock wall along beach.
	Bayview State Park beach - north end	48.48848	122.48224	Y	Canine interest starting near parking lot, area with drain field, then followed scent to north end of beach and alerted on the beach, digging in one location on the sand.
	Bayview State Park beach - south end	48.48727	122.48141	Y	Alert and digging on specific location on the sand.
8	Walker & Marihugh			Y	Alert at concrete ditch pipe east side.
	North ditch up Marihugh to end of ditch at driveway			I	Interest. Possible residual odor from rain flush.

EXHIBIT B		SKAGIT COUNTY, WA SAMPLE SCENTING RESULTS
Canine Response Legend:		
	N=No alert to the presence of human sewage	
	Y=Alerted to the presence of human sewage	
	Quality Control Sample	
Sample #	Canine Response	Comments
4/22/2015 p.m.		
A6	Y	
COW	N	
ED1	Y	10 ml sewage dillution
Anderson Outfall	Y	
FC FBR	N	Friday Crk at Frankie Bob Rd
A1	N	
Distilled Water	N	
BC-FCR	Y	
WCPR	Y	
ED-2	Y	100 ml sewage dillution
HORSE	N	
BSUP	N	
FRTRIB99	N	
BS Creek	N	
Distilled Water	N	
MD-FCR	N	
BUT99	Y	
WILDESFCR	Y	
CORBELL	N	
WILDESPCR	Y	
FRIDAY CREEK UP	Y	
WILDES99	Y	
BC-BCR	Y	
SILVER HALL	Y	
SILVER EAST	Y	
CHDR-1	N	
CHDR-2	Y	
CROP-1	N	
Total Samples 4/22 = 28		

EXHIBIT C SKAGIT COUNTY, WA FIELD INVESTIGATION RESULTS					
Canine Response Legend:					
	N=No alert to the presence of human sewage				
	Y=Alerted to the presence of human sewage				
	I=Strong interest but no alert				
Sample #	Location	GPS N	GPS W	Canine Response	Comments
4/23/15 a.m.					
	Garden of Eden @ Willard Creek	48.51968	122.25027	N	No alert at ditch pipe and ditch.
Cully Rd	Willard Creek @ Garden of Eden & Cully Rd	48.52845	122.25089	Y	
Cully pipe	Willard Creek @ Garden of Eden & Cully Rd - pipe at creek north of Cully Rd			Y	Pipe at creek between Cully Rd and "Cully upstream".
Cully upstream	Willard Creek @ Garden of Eden & Cully Rd - upstream sample north of Cully Rd			Y	Sample from creek upstream of Cully pipe.
Cully way up	Willard Creek @ Garden of Eden & Cully Rd - farther upstream sample north of Cully Rd			Y	Sample taken from creek north of Cully upstream, between house and garage.
	Grip Rd south of 22895 - ditch			N	No alert at east ditch near abandoned house.
TC4	Mosier Rd near 23162			Y	Alerted on creek.
	Thomas Trib on Grip Rd			Y	Sample from trib.
	Bridgewater @ N. Fork Thomas Creek			N	Sample from creek.
	Hoogdal near 23145			N	Walked down ditch past brown house.
	Grip Rd @ 22227 - ditch			Y	Alert in ditch in front of house but not east past house.
	Grip Rd - ditch west of 22227	48.55791	122.25459	Y	Runoff path from septic field flows into ditch at ditch area where canine alerted.
	22199 Grip Rd			Y	Alerted on a rocks. Lush green vegetation next door where septic system is close.
	F & S Grade Rd near 7451			Y	Sample from trib of Thomas Creek.
	7765 to 7759 F & S Grade Rd - north ditch			Y	Pipe in ditch and seep in bank near 7759.
	7759 to 7735 F & S Grade Rd - north ditch			N	No alerts in ditch.
	F & S Grade Rd - trib across street from 7768			N	At trib at road.
	F & S Grade Rd - near 7939 Rathvon house			N	Corrugated black pipe in ditch.
	F & S Grade Rd - at 7939 between large corrugated black pipe in ditch and concrete pipe in yard	48.53087	122.28252	Y	No alert at pipes, but alert and digging in dirt at road next to ditch.

EXHIBIT D		SKAGIT COUNTY, WA SAMPLE SCENTING RESULTS
Canine Response Legend:		
	N=No alert to the presence of human sewage	
	Y=Alerted to the presence of human sewage	
	Quality Control Sample	
Sample #	Canine Response	Comments
4/23/2015 p.m.		
SAM BELL	N	
F & S -2	N	
F & S - 1	N	
ED-1	Y	5 ml sewage dillution
SITE 4	N	
TC-3	N	
ALICE A6	N	
Distilled Water	N	Alerted on first trial, but cross contamination with sewage containing samples suspected. No alert on 2nd trial with new sample container and distilled water.
PR LANE	N	
HARRISON	N	
PR PLACE	N	
BOW CEM	Y	
SAM JOL	Y	
COW	N	
WOOD 2	N	
BLANCH	Y	Y on 2 trials. 2nd trial after repour due to possible cross contamination.
SITE 3	N	Y on 1st trial. N on 2nd trial after repour due to possible cross contamination.
SITE 32	Y	Y on 2 trials. 2nd trial after repour due to possible cross contamination.
HORSE	N	
SAM CD	N	
BCCR	N	
F & S - 3	Y	
SAM 99	Y	
Total Samples 4/23 = 22		



REPORT OF ILLICIT DISCHARGE DETECTION CANINE INVESTIGATION RESULTS

SKAGIT COUNTY, WA
MARCH 17-18, 2016

Prepared For: Skagit County Public Works
Prepared By: Environmental Canine Services LLC
Report Date: March 31, 2016

Introduction: Canine Source Tracking

Founded in 2009, Environmental Canine Services LLC (ECS) uses scent trained canines to identify and source track human sewage contamination in stormwater systems and surface waters while ignoring animal fecal contamination sources. The canines alert to the presence of human sewage and/or wastewater in containers of collected water samples and at the locations of the scent during field investigations, such as at outfalls, stormwater manholes or catch basins, drains, creeks, rivers, or shorelines. This rapid detection can lead to immediate source tracking in the field and provide valuable information for future monitoring and investigations. Combining the canine results with concurrent and/or historical bacterial, surfactant, and/or other testing results for sites investigated provides further information on the type and significance of the contamination.

Summary

On March 17 and 18, 2016, Environmental Canine Services LLC (ECS) Project Manager, Stephanie Burns, and Handler/Canine team Aryn Havel/Crush worked with Skagit County Public Works (SCPW) to conduct targeted human bacteria source tracking in Skagit County. The investigations included field work in the mornings at various locations in Skagit County and canine scent testing in the afternoons of water samples collected by field personnel. Crush alerts to the presence of human sewage by lying down at the location of the scent.

March 17 Field Investigations and Sample Scenting

During the morning of March 17, ECS and SCPW personnel conducted field investigations in the Burlington and Mt. Vernon, WA areas. The first investigations were conducted in Steelhead Lane and Fisherman Loop in the Burlington area. This is a residential area that is adjacent to Samish River. Crush alerted to the presence of human sewage contamination in two locations at roadside ditch drains on Steelhead Lane. The first location was at the ditch and culvert going under the driveway at 6928 Steelhead Lane. Crush was interested in both sides of the driveway but alerted on the west side of the driveway. The second location was at the culvert crossing Steelhead Lane at 6920 Steelhead Lane. Crush alerted on both the culvert on sides of the road. The team then drove to Bowhill Road. A sample was taken from Bobsmith Creek at Bowhill Road and Old Highway 99, Crush did not alert to the presence of human sewage contamination.



K9 Crush

Additional investigations were conducted in Mt Vernon. The team parked in the parking lot on Anderson Road and Crush investigated the ditches and catch basins along Anderson Road, View Ave, Melody Land and Park Ave. Crush alerted on a concrete cover over a catch basin at 19728 Anderson Road. She did not alert on the ditch with running water across the road from 19728. Crush alerted in two locations in front of 19696 Anderson Road, one alert was at a pipe going from the property into the ditch and the second alert was at the west end of the property. She showed interest at the intersection of View and Anderson (SE side of intersection) but did not alert. Crush investigated the ditches along View Avenue and alerted on the south side of the culvert going under the driveway at 17063 View Ave. She showed interest at 17101 View Avenue but did not alert. Crush alerted on the catch basin at 19672 Melody Land. The catch basin is on the south side of the road, east of the 19672 driveway. There is a culvert going under the driveway and a small pipe coming from the property into the culvert. Crush alerted again on the 19696 Anderson Road property on the way back to the car.



In the afternoon of March 17th, Crush scented tested water samples collected that morning by SCPW personnel in targeted locations in the watershed, field blanks, and quality assurance (QA) samples. The field blanks contained DI water. One QA sample contained cow fecal mixed with DI water and another QA sample contained detergents (eco friendly dish and laundry soap). The samples were brought to an empty parking lot at the Skagit County office building, where shoebox sized clean plastic containers (“sample containers”) were arranged in a circle in the parking lot.

There was approximately 10 feet of separation between containers in each row and 30 feet of separation between sides of the circle.

Contents of some of the samples were poured into the individual containers and Crush was immediately taken to the containers to scent each sample. This procedure was repeated for the remaining samples in a different location in the same parking lot. ECS and SCPW personnel recorded the results.

Three samples were placed in another location and replicate scented by Crush. The same results were given on these three samples as on the initial scenting.

March 18 Field Investigations and Sample Scenting

During the morning of March 18, ECS personnel worked with SCPW in the Sedro Woolley area. Crush alerted to the presence of human sewage contamination in several locations at roadside streams, ditch drains, ditch pipes, and/or water samples collected at a site. Crush alerted on the Willard Creek at the intersection of Garden of Eden and Cully Road at the Houghton Property. She did not alert on the ditch across the street on the North side of the Cully. A sample was pulled from the creek on Grip Road on the west side of the Grip which Crush did not alert on, nor did she alert on the ditch across the street on the east side of Grip Road. Crush alerted on Thomas Creek at 23170 Grip Road at the Schuirman property.



Alderson Trickle

The creek was followed to the east and Crush alerted on a muddy/boggy area that feeds into the creek. Crush alerted at a trickle coming from the Alderson property (Alderson trickle site ID) at 23034 Moiser near the crossroad with Grip Road. She alerted on a second location (Alderson pipe site ID) at the culvert going under Moiser (at the 45 mile/hour sign). At this location there was a corrugated metal pipe entering the ditch



Alderson Pipe

from the property. She did not alert on this pipe but did alert on the ditch at the culvert going under the road. Crush alerted on the east side of the driveway at 22211 Grip Road on the north side of the road in the ditch near a pipe entering the ditch (Garcia site ID).

Crush alerted on Wildes Creek where it crosses Parson Creek Road, on the N/NW side of the road (WC5 site ID). She was interested but did not alert on the stream entering Wildes creek that crosses Butler Creek Road (WC8 site ID). Crush alerted on the small tributary creek that crosses Butler Creek Road at 3339 Butler Creek Road (BC4 site ID) and alerted on the small creek on the NE side of Butler Creek Road at the abandoned house at 3149 Butler Creek Road (BC7 site ID). She did not alert at the creek crossing Butler Creek Road at site BC3. On the way back to the vehicle, Crush alerted again on 3149 Butler Creek Road.

Investigations continued along Friday Creek Road. Crush did not alert on the ditch on the Northeast side of the road between 2014 and 2098 Friday Creek Road. She was interested in a small creek entering the ditch but did not alert. A sample was taken and placed in a bucket for her to scent, and she did not alert on the sample (FC 16 site ID). Crush alerted farther down the street on the ditch at a low spot where the owner of the property said water collects when it rains (FC 15 site ID). Crush alerted on the ditch on both sides of Minnie Road where Minnie intersects with the east side of Friday Creek Road (FC 17 site ID). Crush was interested but did not alert on the ditch at the intersection of Old Highway 99 and Minnie Road (NW corner). She alerted again on FC 17 on the way back to the vehicle.

In the afternoon of March 18, Crush scented water samples collected that morning by SCPW personnel in targeted locations in the watershed, field blanks, and quality assurance (QA) samples. The field blanks contained DI water. The QA samples contained human sewage (from wastewater treatment plant influent) diluted with DI water, horse fecal mixed with DI water, cow fecal mixed with DI water, horse fecal mixed with DI water and human sewage, and cow fecal mixed with DI water and human sewage. The watershed samples, field blanks, and QA samples were brought to an empty parking lot at the Skagit County office building, where the sample container arrangement was the same as on March 17, except not all the samples were poured into sample containers. The samples were left in the field collection containers and plastic bags were left on some of the sample containers, with the container lids and bags open. ECS and SCPW personnel recorded the results.

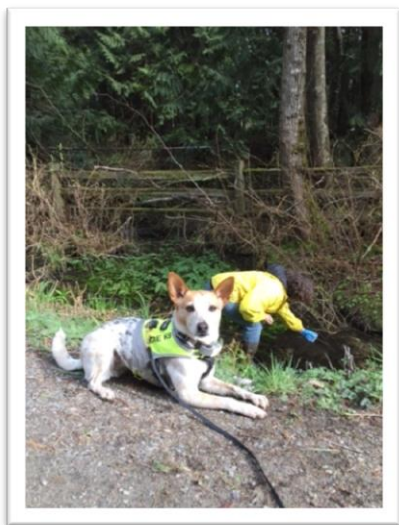
Crush gave the correct response by not alerting on the four distilled water QA samples prepared in the parking lot. She initially alerted on the QA distilled water sample prepared in the field, but when cross-contamination by the bag was suspected, the bag was removed and the sample was moved to a different location and re-run, Crush did not alert on the field blank the second time.

Several samples were replicate tested by moving the samples to a new location in the parking lot and having Crush scent them again. Samples were re-scented if Crush ran by the container without scenting the sample. The QA distilled water sample prepared in the field was re-scented after the plastic bag removed and Crush did not alert on the sample. The Kulshan creek sample was re-scented to verify the initial alert result, and Crush alerted again on the sample.

Summary of Results: Field Investigations

A total of 41 field sites were investigated over two days (23 the first day and 18 the second day). Crush alerted at 20 of the 41 sites (nine the first day and 11 the second day).

It is standard ECS procedure to have a field blank, consisting of a sample bottle filled with distilled or DI water, scent tested by the canine at approximately one out of ten sites and replicate scent testing of approximately 10% of the total sites for quality assurance and to help determine the validity of the canine results. Four field blanks of DI water (two the first day and two the second day) were scent tested by Crush during the two days, and she correctly did not alert on any of them.



Replicate scent testing was conducted at three sites alerted on during field investigations by taking Crush to the sites again while walking back after conducting further site investigations in the area. Crush alerted again on all three replicate sites.

The correct responses to the field blanks and consistent responses during replicate scenting demonstrate good quality control and lend validity to Crush's responses during the field investigations.

The results for each of the sites, field blanks, and replicate scenting during field investigations are presented in Table 1 on pages 6-7.

Summary of Results: Scenting of Collected Samples

A total of 71 collected water samples were scent tested by Crush over two days (31 the first day and 40 the second day). Crush initially alerted on 42 of the 72 samples (11 the first day and 31 the second day).

Eight field blanks (two with DI water and one with tap water the first day and five with DI water the second day) were placed in lineups of the samples and scent tested by Crush. There were three separate scent testing lineup sets on the first day. Crush correctly did not alert to any of the three field blanks on the first day. There were three separate scent testing lineup sets on the second day. Crush correctly did not alert to four of the five field blanks. Those blanks had been prepared on site at the testing area. However, Crush did alert on one field blank in the second lineup set that had been prepared during field investigations in the morning. It had been placed in a sealed bag while

being transported in the field and was later placed in the second lineup set with the bag still on and the container and bag tops open. Not removing the field blank from its bag may have resulted in scent cross-contamination by other samples which impacted Crush's response. Therefore, the bag was removed and the field blank was moved to a different location and re-scented. Crush correctly did not alert on the field blank the second time, which supports the theory that the bag had been cross-contaminated.

Due to the large number of collected samples alerted on by Crush on the second day and a few unexpected results, two samples that were still available were replicate scented (samples KUL and SCMP 04). On re-scenting, Crush alerted on the sample KUL, as she had done on the initial scenting and did not alert on sample SCMP 04, which was the same response as the initial scenting.

During both the second and third lineup sets on the second day, Crush was observed bypassing some of the sample bottles and not scenting them on her way to other sample bottles down the line. This happens with ECS canines occasionally when they smell a strong scent of human sewage from a sample farther down the lineup because they want to source track the strongest scent first. The sample that was bypassed by Crush in the second set (Wear Lane) and the two that were bypassed in the third set (WC2 and TC3) were re-scented by Crush, and she alerted on all three samples.

Six QA samples over two days (two the first day and four the second day) were placed in lineups of the collected samples and scent tested by Crush. She correctly did not alert on either of the QA samples the first day. One contained cow manure and the other contained detergents. Crush correctly did not alert on QA sample the second day that contained horse manure, and she correctly alerted on the QA sample the second day that contained human sewage diluted with DI water. Crush did not alert on the horse or cow manure samples that had been combined with human sewage



(approx. 5 mls human sewage/4 liters horse or cow manure). The samples were re-scented after additional human sewage was added (an additional 10 mls was added), and Crush also did not alert on these samples. It is not known why no alerts were given on the QA samples of cow or horse manure mixed with human sewage. It is possible that the higher amount of cow and horse manure in those samples created a scent that overpowered the scent of the human sewage.

The correct responses to all the field blanks (after re-scenting the one that was cross contaminated) demonstrate good quality control and lend validity to Crush's responses during the scenting of collected samples.

The results for each collected sample, field blanks, QA samples, and replicate scenting during the scenting of collected samples are presented in Table 2 on pages 8-10.

Table 1 – Results of Canine Field Investigations

3/17/2016 Field Investigations

Legend: Field Blank Replicate

Site ID	Location description	Lat	Long	K9 Response	Comments
1	Steelhead at Jolly Road			-	ditches on both sides of road
2	7022 Steelhead Ln			-	catchbasin
3	6976 Steelhead Ln			-	ditch on north side of driveway
4	6963, 6954, 6947 Steelhead Ln			-	ditches
5	6928 Steelhead Ln	48.544980	-122.339480	+	left side of driveway
6	6920 Steelhead Ln	48.544607	-122.339572	+	Steelhead Ln @ culvert running under road, interested on east side of culvert, alerted on west side
7	6920 Steelhead Ln	48.544554	-122.339467	+	south side of property line, can see black pipe behind 6920
8	6909 Steelhead Ln			-	followed ditch to 6909
9	6972-6976 Steelhead Ln			-	ditch
10	6976 Steelhead Ln			-	catchbasin
11	Fisherman Loop			-	walked ditches on both side of road
12	7188 Steelhead Ln			-	catchbasin
FB	FIELD BLANK Steelhead parking area			-	
13	Bob Smith Creek at Bow Hill Rd	48.55915	-122.335632	-	pulled sample for Crush to scent
14	19728 AND 19728 Anderson Rd	48.399250	-122.319370	+	in concrete basin with traffic cone on top
15	ditch on N side of Anderson Road across from 19728			+	running water in ditch
16	19696 Anderson Rd	48.399282	-122.319826	+	indicated concrete pipe is the source; known failure
17	19696 Anderson Rd	48.399291	-122.320216	+	fence on west side of driveway
18	Intersection of View and Anderson (SE corner)			-	interest but did not alert
19	17063 VIEW 17063 View	48.398381	-122.321148	+	lots of interest on north side of property, alerted on culvert going under driveway on south side of driveway.
20	17101 View			-	interest but did not alert
21	19672 MELODY 19672 Melody	48.397703	-122.320870	+	regular catch basin and stream flowing west to catch basin, there was a culvert going under the driveway with a small pipe entering the culvert from the property.
22	Park Ave			-	walked from Melody to Park Ave to Anderson Rd.
R	19696 Anderson Rd			+	
23	Intersection of Park Ave and Anderson Rd			-	catch basin
FB	FIELD BLANK Blank - Anderson			-	

Table 1 – Results of Canine Field Investigations (Continued)

3/18/2016 Field Investigations

Legend: Field Blank Replicate

Site ID	Location description	Lat	Long	K9 Response	Comments
1	Ditch across from Cully site			-	North side of street, algae growing in ditch
2	CULLY at Houghton	48.528532	-122.250869	+	Before stream crosses under Cully Rd, no fecal sample
3	GRIP up from Houghton	48.52264	-122.24815	-	Upstream of Cully
4	ditch across from Grip site			-	East side of road, suds in ditch
5	SCHUIRMAN north of house, Thomas Creek	48.542788	-122.244835	+	North of street/house 23170 Grip Rd
6	SCHUIRMAN east	48.543056	-122.243333	+	NE end of property; wetland with flow that collects to a central trib to creek
7	ALDERSON at corrugated pipe	48.542769	-122.24702	+	
8	ALDERSON trickle at 23034 Moiser near intersection with Grip	48.542760	-122.247960	+	Upstream of nearby culvert with positive hit
9	GARCIA 22199 Grip Rd (22211 Grip Rd)	48.55799	-122.25467	+	White pipe discharging into ditch
10	WC5 Wildes Creek at Parsons Creek Rd	48.59253	-122.31777	+	Wildes at Parson Creek Rd N/NE side of road; could not explore trib coming from west
11	WC8 Wildes at Butler Creek Road	48.592871	-122.316953	-	Tributary stream entering Wildes. Negative, but lots of interest on both sides of road, tried to enter pipe.
FB	FIELD BLANK			-	
12	BC4 3339 Butler Creek Rd	48.59691	-122.317728	+	NE side of road, small tributary creek crossing road
13	BC7 3149 Butler Creek Rd	48.59962	-122.31712	+	creek in front of abandoned house, NE side of road
14	BC3 Butler Creek Rd	48.598484	-122.317222	-	no interest, tributary creek going under road, checked both sides
R	BC7 3149 Butler Creek Rd			+	
15	2014-2098 Friday Creek Rd			-	ditch along NE side of the road
16	FC16	48.614422	-122.337365	-	Small creek entering ditch - lots of interest but no alert, took sample and scented at the car, no alert
17	FC15 Friday Creek Rd 250' south of Minnie Rd	48.614047	-122.3377068	+	owner reported that water collects here when rains
18	FC17 Minnie at Friday Creek Rd	48.614894	-122.337409	+	East side of Friday Creek Rd at intersection with Minnie, Crush alerted on both sides of Minnie at culvert going under road.
FB	FIELD BLANK			-	
R	FC17 Minnie at Friday Creek Rd			+	

Table 2 – Results of Canine Scenting of Collected Samples

3/17/2016 Scenting of Collected Samples

Legend: Field Blank QA Replicate

	Site ID	Location description	Lat	Long	K9 Response	Comments
1	BS1	Bob Smith Creek at WDFW access	48.547255	-122.339543	-	
2	BS2	Bob Smith Creek EF at Bow Hill Rd	48.55915	-122.335632	-	
3	ERSH	Ershig Rd ditch near big barn, north of Samish Heights Rd	48.550690	-122.378520	+	
4	COLFLINN	Colony Creek at Flinn Rd	48.593631	-122.415746	-	
5	ESTES	Estes Rd 200 m east of Chuckanut Dr	48.569879	-122.418973	+	
6	ESBCR	Edison Slough at Bow Cemetery Rd	48.557513	-122.406405	-	
7	SCMP38	North Edison pump station	48.571654	-122.441833	+	
8	SCMP37	Edison pump station	48.560668	-122.445351	-	
9	SCMP33	Alice Bay pump station	48.555042	-122.484605	-	
FB	FIELD BLANK	tap water			-	
10	SQUIRES	Samish Island Road ditch	48.558520	-122.492330	+	
11	GRIP	West side, north of Brock	48.832450	-122.248190	-	
QA	COW MANURE				-	
FB	FIELD BLANK	distilled water			-	
12	CULLY	Near Houghton property	48.528580	-122.251190	-	
13	HC-1	Hansen Creek at Hoehn Rd	48.503723	-122.198469	-	
14	CC-1	Coal Creek at Hoehn Rd	48.506851	-122.170466	-	
15	CC-2	Coal Creek at Burmaster Rd	48.514540	-122.163457	-	
16	CC-3	Coal Creek at Minkler Rd	48.524490	-122.152746	-	
	Moved to new area and ran these samples:					
17	35	Joe Leary Slough	48.519336	-122.462649	-	
18	7253	Bayview-Edison Rd	48.541135	-122.471838	-	
19	NN18	Rector Rd	48.493966	-122.455798	-	
20	APEX-E	Josh Wilson Rd	48.486717	-122.449966	-	
21	APEX-W	Josh Wilson Rd	48.486709	-122.455347	-	
22	NN15	Marihugh Rd at No Name Creek	48.479566	-122.449661	+	south side of road
FB	FIELD BLANK	Distilled water			-	
23	NN9	Marihugh and Bayview-Edison Rd	48.479396	-122.468312	+	north side of Marihugh
24	BV10	Bayview-Edison Rd at 11405 culvert	48.480278	-122.472778	+	flow from three pipe outlets
25	NN20	Bayview-Edison Rd at Bayview Rd	48.471999	-122.460548	+	south side of Bayview Rd, flow coming off of BE Road east side
26	BETZ	Betz house at 12129 Bayview-Edison Rd	48.470154	-122.459926	+	at seep with clay pipe
27	NN11	Egbers Bridge	48.465101	-122.455330	+	flow from No Name Creek and manufacturing area
28	CC-4	Coal Creek at Hwy 20	48.530976	-122.150216	-	
29	SAM-3	Chuckanut Dr	48.535390	-122.396055	-	
30	SAM-7	Sunset Rd	48.545011	-122.404925	-	
31	GEAR-7.5	Gear Rd	48.493084	-122.326407	+	
QA	LAUNDRY + DISH SOAP				-	
	Moved to new area and ran these replicates:					
R	SAM-3	Chuckanut Dr			-	Same as 1st response
R	GEAR-7.5	Gear Rd			+	Same as first response
R	APEX-E	Josh Wilson Rd			-	Same as first response

Table 2 – Results of Canine Scenting of Collected Samples (Continued)

3/18/2016 Scenting of Collected Samples

Legend: Field Blank QA Replicate

	Site ID	Location description	Lat	Long	K9 Response	Comments
1	SILCORB	Silver Creek east of Corbell Ln	48.619867	-122.337918	-	
2	FR5	Silver Creek trib ("Corbell Creek")	48.619940	-122.338060	+	
3	FR4	Silver Creek at Alger Hall	48.618720	-122.340920	+	
4	FCTRIB	Friday Creek trib on Friday Creek Rd	48.612470	-122.336270	+	
5	FR7	Friday Creek north of Parsons Creek Rd	48.595620	-122.328280	+	
6	FR8	Butler Creek at Friday Creek Rd	48.595240	-122.328370	+	
7	W99	Wildes Creek at Old Hwy 99	48.588000	-122.323000	+	
8	FR15	Friday Creek south of Donovan Park	48.587240	-122.329550	+	
9	FR9	Wildes Creek at Friday Creek Rd	48.577170	-122.337560	+	
10	FR14	Friday Creek just above Wildes Creek	48.576260	-122.337720	+	
11	GEAR 9.5	Angled clay tile	48.493059	-122.324786	+	
12	GEAR 10	White tile	48.493060	-122.324696	+	
FB	FIELD BLANK	distilled water			-	
13	GEAR 10.5	Black tile	48.493060	-122.324643	+	
QA	HORSE	Horse manure (~15 g) + distilled water			-	
14	GEAR 12	Green tile	48.493059	-122.324227	+	
	Moved to new area and ran these samples:					
15	TCTRIB	Thomas Creek trib off F&S Grade Rd ("Old Car Creek")	48.533940	-122.302180	-	
16	SAMGRIP	Samish River at Grip Rd	48.555030	-122.289589	+	
17	SKAR	Skarrup Creek at Double Cr Ln	48.568840	-122.307404	+	
18	WCPR	Weir/Wear Creek at Prairie Rd	48.560019	-122.320218	+	
19	WEARLANE	Weir/Wear Creek trib at Park Ridge Ln	48.560580	-122.313380	-	Crush ran past sample first time and did not scent sample
20	6	Friday Creek at Prairie Rd (SCMP 06)	48.558468	-122.328351	+	
FB	FIELD BLANK	distilled water			+	Container left in plastic bag during canine scenting. Possible cross-contamination.
21	KULSHAN	NF Kulshan Creek at office	48.437500	-122.324589	+	
QA	HUMAN	Edison treatment system solution (5 ml) in 4 L distilled water			+	
22	4	Thomas Creek at F&S Grade Rd (SCMP 04)	48.527867	-122.277866	-	
FB	FIELD BLANK	distilled water			-	
QA	HORSE + HUMAN	Horse manure (~15 g) + distilled water + 5 ml Edison treatment system solution			-	
23	FRIDAY KOA	Friday Creek at KOA	48.552210	-122.331980	-	
24	BCCR	Butler Camp Creek at Kelleher Rd	48.528346	-122.319165	-	
QA	COW + HUMAN	Cow manure (~15 g) + distilled water + 5 ml Edison treatment system solution			-	

Table 2 – Results of Canine Scenting of Collected Samples (Continued)

3/18/2016 Scenting of Collected Samples

Legend: Field Blank QA Replicate

Site ID	Location description	Lat	Long	K9 Response	Comments
Moved to new area and ran these replicates:					
R	COW + HUMAN Cow manure (~15 g) + distilled water + 15 ml Edison treatment system solution			-	repeat of previous sample but with higher human dose, dog did not detect or respond
R	HORSE + HUMAN Horse manure (~15 g) + distilled water + 15 ml Edison treatment system solution			-	repeat of previous sample but with higher human dose, dog did not detect or respond
R	WEARLANE Weir/Wear Creek trib at Park Ridge Ln			+	Crush ran past sample first time and did not scent sample
R	FIELD BLANK Was in plastic bag during 1st test			-	first bucket assumed to be cross-contaminated by plastic bag, bag removed for second test
R	4 Thomas Creek at F&S Grade Rd (SCMP 04)			-	Same as 1st response
R	KULSHAN NF Kulshan Creek at office			+	Same as 1st response
Moved to new area and ran these samples:					
25	DITCH Kelleher Rd ditch	48.52938	-122.298071	+	
26	WC2 Willard Creek	48.527719	-122.278014	-	Crush ran past sample first time
27	TC3 Thomas Creek	48.532225	-122.272933	-	Crush ran past sample first time
28	TR1 Thomas Creek trib	48.550314	-122.273094	+	
FB	FIELD BLANK distilled water			-	
29	TR2 Thomas Creek trib	48.549075	-122.270569	+	
30	TR3 Thomas Creek	48.547928	-122.269261	+	
31	TC4 Thomas Creek trib	48.546914	-122.268333	-	interest in outside of container, no alert
FB	FIELD BLANK distilled water			-	
32	TC6 Thomas Creek	48.550470	-122.256475	+	
33	TR3BW Bridgewater Rd	48.549538	-122.260777	+	
34	TCER Erna Ln	48.541866	-122.259726	+	
35	MINNIE UP at end of Minnie Rd - trickle from the east	48.614807	-122.334385	+	
36	MINNIE 99 Minnie ditch at Old Hwy 99	48.615063	-122.336522	+	
37	ALGERWP 1745 Old Hwy 99	48.37243	-122.20477	+	
38	ALGERNF 1667 Old Hwy 99	48.37292	-122.20531	+	
39	ALGERSF 1605 Old Hwy 99	48.622436	-122.343149	+	
40	CHUCKJONES ditch in front of Jones on Chuckanut Dr	48.581189	-122.422145	+	
Moved to new area and ran these replicates:					
R	WC2 Willard Creek			+	Crush ran past sample first time
R	TC3 Thomas Creek			+	Crush ran past sample first time
R	TC4 Thomas Creek trib			-	Same as 1st response