2013 SPRUCE CREEK TRIBUTARY SAMPLING AND CANINE DETECTION

FORT FOSTER BEACH & THE SPRUCE CREEK WATERSHED

KITTERY, MAINE

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

EXECUTIVE SUMMARY

In 2013, water quality sampling and investigation in Kittery, Maine included bracket sampling in the Chickering Creek watershed and continued outfall sampling at the Manson Avenue stormwater outfalls in Admiralty Village. Additionally, an investigation of the stormwater system in the Manson Avenue neighborhood to identify illicit discharges was conducted. On July 31, 2013, FB Environmental (FBE) and Environmental Canine Services (ECS) collaborated with the Town of Kittery, ME to conduct targeted bacteria source tracking at Fort Foster Beach, Chickering Creek, and the Manson Avenue stormwater system. Scott and Karen Reynolds of ECS, along with canines Sable and Logan, pioneered the canine detection method of identifying human sources of water quality pollution in the upper Midwest and California.

This report provides results from bacteria sampling in the Spruce Creek watershed and at Fort Foster State Park from July – November, 2013, canine detection conducted in July 2013, and an investigation of the stormwater system draining Manson Avenue. Recommendations for next steps are provided.

Summary of Bacteria Sampling and Canine Detection in the Chickering Creek Watershed

Chickering Creek is a small tributary to Spruce Creek and has a watershed area of 0.4 square miles. The watershed consists largely of residential development to the north, with dense commercial development to the south along Route 1. Bacteria concentrations in Chickering Creek are highest in the portion of the creek downstream of the I-95. Results from bacteria sampling in 2013 show that concentrations are well above the water quality standard at multiple locations along Chickering Creek with some sites over four times the acceptable limit for *E. coli* bacteria even during dry weather conditions.

In addition to regular bacteria sampling, canine detection was conducted in the Chickering Creek watershed. Eighteen locations in the Chickering Creek watershed were assessed for the presence of human sources of bacteria using canine detection. Five of the eighteen sites were positive for bacteria originating from humans. In addition to canine detection, two sampling locations ("Orvis Out" and "CC-Adams") were also sampled for *E. coli* bacteria. Samples from both of these sites exceeded Maine's bacteria standard for *E. coli* and had positive responses via canine detection.

Sources of bacteria include stormwater runoff (as indicated by high bacteria concentrations under wet weather conditions, malfunctioning septic systems in the upper portion of the watershed and/or issues with the sewer line near Route 1 (as indicated by high bacteria concentrations under dry weather conditions and positive response from canine detection), and pet or wildlife waste.

Summary of Bacteria Sampling and Canine Detection on Manson Avenue

The Manson Avenue stormwater system drains a dense residential area in Admiralty Village and flows into an intertidal estuarine wetland that flows to Spruce Creek. Previous high levels of bacteria in water

samples collected at this outfall prompted additional investigations of the stormwater system in the drainage area.

All sampling locations were consistently above the water quality standard for *E. coli* during both wet and dry weather conditions. The shoreline downstream of the stormwater outfall on Manson Avenue was assessed for the presence of human wastewater using canine detection. Canine response at many of these locations was positive for human sources of bacteria.

Though the Manson Avenue neighborhood is now serviced by a public sewer system, this area once had a combined storm/sewer network. This old infrastructure now serves as the stormwater system, though some older pipes are no longer in use. The interesting history of the storm and sewer network in this area, and the elevated bacteria concentrations during both dry and wet weather sampling events suggest that there may be potential sources of bacteria stemming from illicit discharges or storm/sewer cross connections in the Manson outfall drainage area. An investigation of the stormwater system in this neighborhood also revealed multiple catch basins in private back yards. Follow-up outreach to local residents and a more detailed investigation of the stormwater system in this neighborhood is recommended.

Summary of Bacteria Sampling and Canine Detection at Fort Foster Beach

A 2012 water quality study at Fort Foster Beach led to the discovery and removal of a potentially malfunctioning outhouse upstream of a marsh that drains to the beach. In that study, bacteria concentrations were found to exceed the water quality standard for enterococci bacteria in the marsh, surf zone, and in multiple locations along the shoreline. Through the use of canine detection, human sources of bacteria were discovered at all sampling sites in 2012 and were believed to originate from an outhouse upstream of the marsh.

Logan investigates Fort Foster Beach

In 2013, a follow-up investigation of the same sites was conducted to determine the effects of the removal of the outhouse. At all sampling locations, the strong positive responses in 2012 at five locations along Fort Foster beach were either negative in 2013 or positive as indicated by only one dog, indicating that the actual amount of human sources of bacteria in those seeps was relatively low. Though the removal of the outhouse upstream of the marsh in 2012 likely led to the decrease in human sources of bacteria reaching the beach, this area should be monitored continuously to prevent future contamination.

In this study, additional sites along the beach were investigated using both canine detection and water quality analysis where appropriate. Follow-up studies at these sites should include an investigation of both human and natural sources of bacteria, including pet and wildlife waste.

1. INTRODUCTION

Spruce Creek is listed in Maine's Integrated Water Quality Monitoring and Assessment Report (303d) as impaired under Category 4-A: Estuarine & Marine Water Impaired by Bacteria (TMDL complete) for nonpoint source pollutant sources. Efforts to reduce the bacteria load to Spruce Creek have increased in the past few years. The Town of Kittery, the Spruce Creek Association, and FB Environmental (FBE) have partnered to identify sources of bacteria to the creek in an effort to guide remediation efforts.

In 2009, FBE conducted a study of nine stormwater outfalls in the Spruce Creek watershed and investigated another 14 in 2011. From this work, two outfalls (Culvert on Picott and Culvert at Haley and Trafton) were identified as "primary hotspots" of bacterial contamination and were further investigated in 2012. Additional outfall sampling in 2012 resulted in the identification of more "hotspot" locations (the outlet of Chickering Creek and the Manson Avenue outfalls). Reducing the bacteria loading to these outfalls has become a priority. In 2013, bracket sampling was conducted in the Chickering Creek watershed, and continued outfall sampling was performed at the Manson Avenue outfalls. Additionally, a detailed investigation of the stormwater system in the Manson Avenue neighborhood was conducted.

On July 31, 2013, FBE and Environmental Canine Services (ECS) collaborated with the Town of Kittery to conduct targeted bacteria source tracking at Fort Foster Beach, Chickering Creek, and the Manson Avenue stormwater system. Scott and Karen Reynolds of ECS, along with canines Sable and Logan, pioneered the canine detection method of identifying pollution sources in the upper Midwest and California. Canine detection is recognized by EPA Region 5 as an effective, quality-assured tool able to rapidly detect human-source wastewater in the environment. FBE coordinated with ECS to conduct this second working visit to New England.

This report provides results from bacteria sampling in the Spruce Creek Watershed from July – October, 2013, canine detection investigations conducted in July 2013, and the Manson Avenue stormwater system investigation. Recommendations for next steps are provided.

2. BACTERIA SAMPLING

2.1 BACTERIA IN WATERBODIES

High concentrations of fecal indicator bacteria in waterbodies can lead to posted advisories at swimming beaches and closures of shellfish beds. These bacteria are used to signal human health risks such as gastrointestinal, respiratory, eye, ear, nose, throat, and skin infections transmissible to humans through consumption of contaminated fish and shellfish, skin contact, and/or ingestion of water.

E. coli bacteria are present in the intestinal tracts of warm-blooded animals and are used to indicate the presence of fecal contamination in waterbodies. Each gram of human feces contains approximately 12 billion bacteria, many associated with human health issues. Feces from other warm-blooded animals, including pets, farm animals, and wildlife may also contribute bacteria and associated disease vectors to waterbodies. *E. coli* bacteria are used by the State of Maine to assess the designated uses for freshwater streams, rivers and lakes. It is used to determine the need for closings and advisories at swimming beaches throughout the State. For this effort, *E. coli* bacteria sampling was conducted in addition to the canine detection efforts to understand levels of contamination in the water from various locations throughout the Spruce Creek watershed. The canines can detect human sources of bacteria at relatively low concentrations, so the conventional bacteria test provides an idea of the severity of pollution.

2.2 BACTERIA SOURCE TRACKING METHODS

Identifying the sources of bacteria to a waterbody is often difficult, as many sources are diffuse, may change over time, and can depend on weather conditions. Methods to track sources of bacteria include:

1. **Bacteria Sampling**: Regular water quality sampling of a waterbody at established sampling locations can provide general information about the sources of bacteria. For instance, high bacteria levels during wet weather may indicate that stormwater runoff is a primary source of bacteria, while dry weather sampling may indicate the presence of an illicit discharge.
2. **Bracket Sampling**: Bracket sampling is used to locate the sources of bacteria entering a storm drain system or tributary by sampling up gradient and down gradient of potential sources to "bracket" (or isolate) pollutant source locations. This type of testing can guide remediation efforts as it may reveal an isolated bacteria source or it may indicate that elevated bacteria levels are spread throughout the storm drain system or watershed.
3. **Mapping and Watershed Investigation**: Once areas of high bacterial pollution have been identified, creating a map of the watershed draining to a storm drain outfall or waterbody can provide additional information about sources of bacteria in the watershed. Through this method, the location of bacteria sources such as sewer lines, agricultural operations, and septic systems can be assessed and their potential contribution to the waterbody can be evaluated.
4. **Microbial Source Tracking**: Microbial Source Tracking refers to a broad range of genetic tests aimed at identifying specific sources of bacteria. These methods can often indicate the source

species of animal. A highly specialized laboratory is required, cost per sample can be high, and more time is required for this method. Some methods remain experimental.

5. **Canine Detection**: Environmental Canine Services (ECS) has trained dogs to identify human sources of bacteria through scent in a storm drain system or waterbody. This cost-efficient method provides a rapid screening method for illicit discharge detection.

Each of the above methods has its merits, and they are most effective when used in a coordinated, watershed-based, iterative approach to detecting sources of bacteria to waterbodies.

3. 2013 SAMPLING IN KITTERY, MAINE

3.1 SAMPLING METHODS AND LOCATIONS

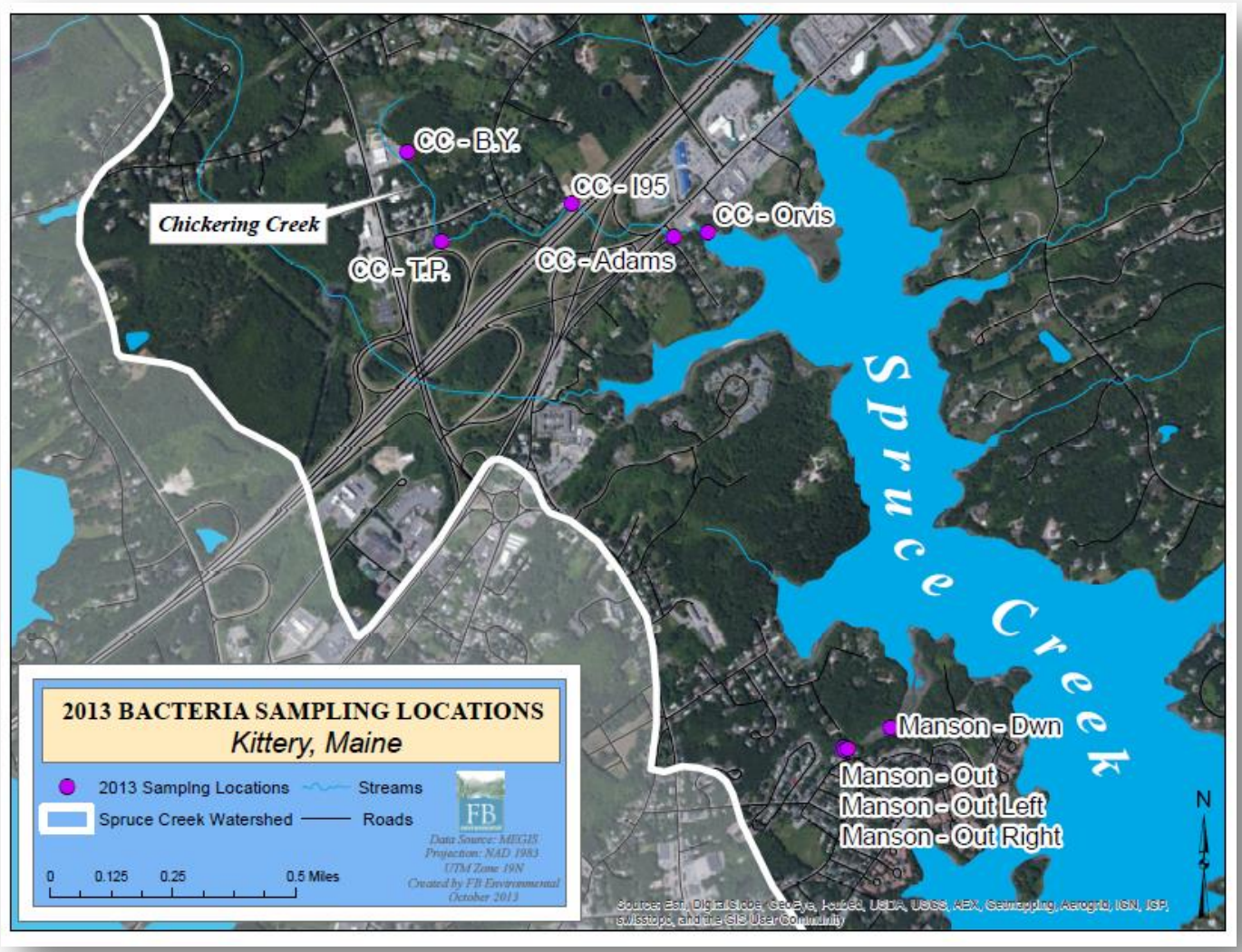
3.1.1 Bacteria Sampling

FBE conducted bacteria sampling on six dates under various weather conditions (three under wet weather conditions and three under dry weather conditions) at eight locations throughout the Spruce Creek watershed (Figure 1) from July to November 2013. Dissolved oxygen and temperature data were also collected during most sample events at each sampling location. All bacteria samples were analyzed for *E. coli* bacteria at Nelson Analytical Water Testing Laboratory in Kennebunk, Maine. In Maine, the state water quality standard for *E. coli* is 236 colonies/100mL for an instantaneous sample and 64 colonies/100mL for the geometric mean of multiple samples.

Of the eight sampling locations, five sites were located in the Chickering Creek watershed. Chickering Creek is a small tributary to Spruce Creek with a watershed area of 0.4 square miles. The watershed consists largely of residential development to the north, with dense commercial development to the south along Route 1 (Figure 1).

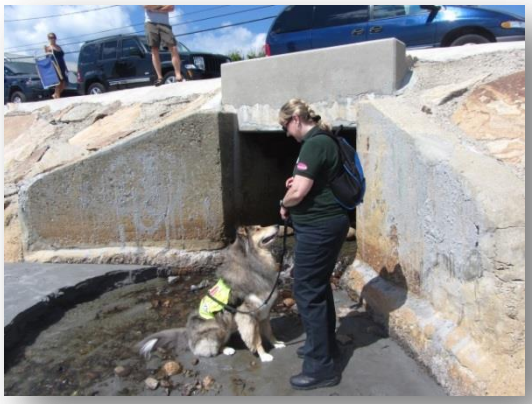
The other sampling locations were located at the stormwater outfalls on Manson Avenue. The Manson Avenue outfalls drain a dense residential area and flow into an intertidal estuarine wetland that flows to Spruce Creek. High bacteria levels in water samples collected at this outfall prompted additional investigations of the stormwater system.

Figure 1: Routine Spruce Creek Bacteria Sample Locations in Kittery, Maine in 2013



3.1.2 Canine Detection

On July 31, 2013, Emily DiFranco and Whitney Baker from FB Environmental Associates (FBE), Scott and Karen Reynolds from Environmental Canine Services (ECS), and Fred Dixon from the Kittery Department of Public Works investigated and sampled tributaries and outfalls discharging to Spruce Creek and areas along Fort Foster Beach (Figure 2).

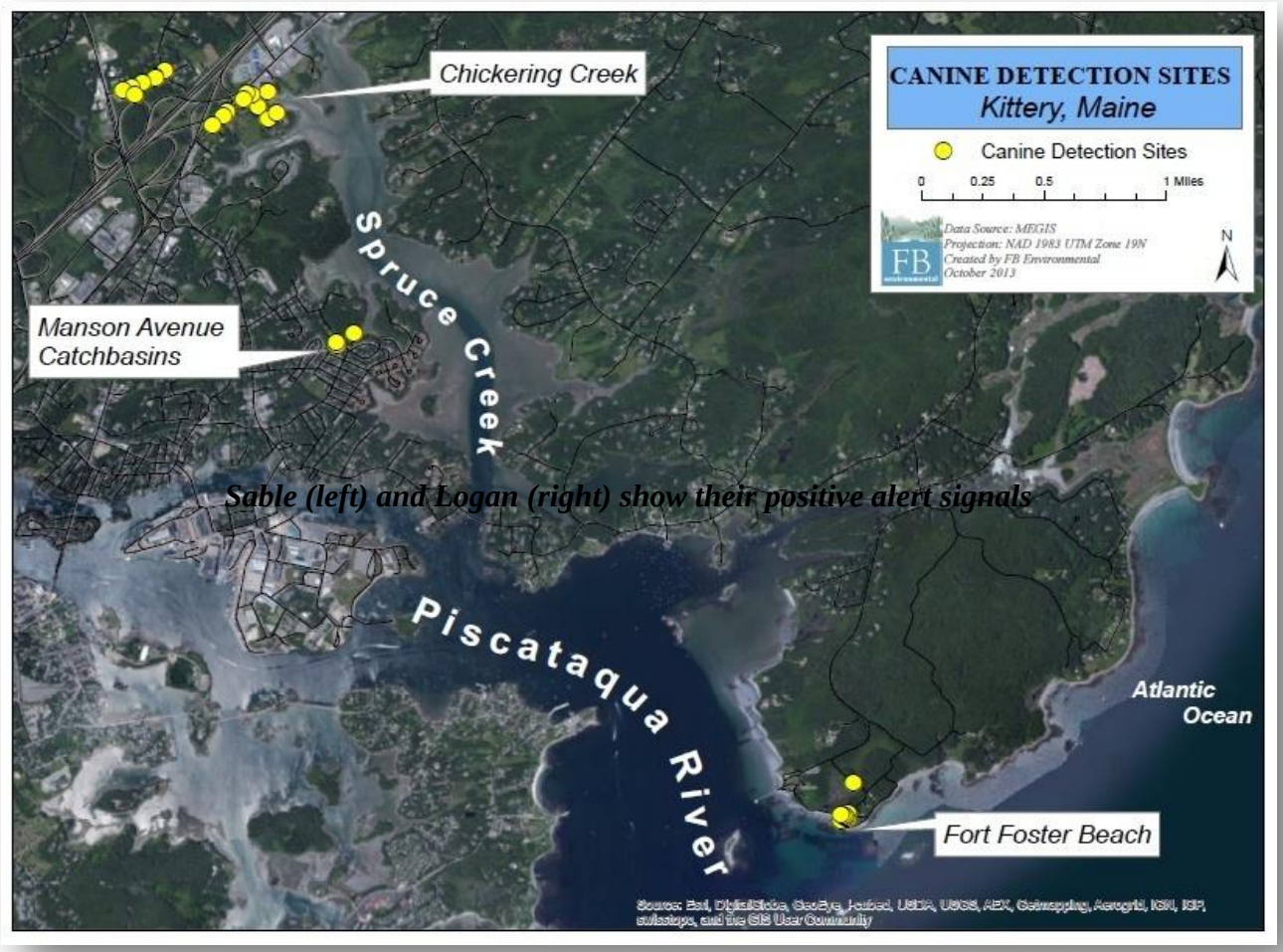


Logan indicates a positive response

At all sampling locations, at least one dog was brought to the catch basin, outfall, or tributary to determine the presence of human sources of bacteria. When possible, both

dogs were used to provide a check of the results. Sable, indicated the presence of human sources of bacteria by barking, while Logan indicated by sitting down. All in-field responses were recorded on field sheets. In some locations, samples were collected using plastic buckets with lids. All buckets were triple-rinsed at the collection site. Buckets were presented at a neutral location to Sable and Logan and responses were recorded on field sheets. Buckets were handled with gloves upon opening and removed from the area after analysis. At many locations, bacteria samples were collected in Whirl-pak bags for analysis at Nelson Analytical Laboratory in Kennebunk, ME. Samples were preserved with ice and transported to the laboratory following chain of custody protocol to be analyzed for *E. coli* bacteria. Sampling was conducted under low tide conditions.

Figure 2: Canine Detection Locations in Kittery, ME



3.2 BACTERIA RESULTS

As shown in Table 1, *E. coli* concentrations ranged from 35 to over 2,420 colonies/100 mL. The geometric mean ranged from 63 to 1,214 colonies/100 mL. Geometric mean values for all but one site (CC-BY) were above the Maine water quality standard for *E. coli* bacteria. This site is located on Chickering Creek in a forested area upstream from the residential development north of I-95 and Route 1. Sites CC-I95 and Manson Down had the highest geometric mean concentrations of all samples collected in 2013 (Table 1, Figure 3).

Table 1: *E. coli* (colonies/100mL) results & geometric mean concentrations for all sampling locations in the Spruce Creek watershed in Kittery, Maine from August – November 2013 (sites organized upstream to downstream)

Sample ID	Site Location	8/13/2013	9/20/2013	9/23/2013	9/26/2013	10/7/2013	10/23/2013	11/1/2013	Geometric Mean
		0" in 48 hours	0" in past 96 hours	0.6" in past 48 hours	0" in past 48 hours	0.2" in past 24 hours	0" in past 96 hours	0.1" in past 24 hours	
		Dry	Dry	Wet	Dry	Wet	Dry	Wet	
Chickering Creek Sites									
CC-BY	Chickering Creek behind Boat Yard facility	99	65	157	35	68		27 *	63
CC-T.P.	Off Dana Ave. - Downstream of the trailer park	52	140	249	70	228 *		>2420	203
CC I95	I-95 at end of Manson Road		>2420	2420	1203	>2420		1046	1214
CC-ADAMS	Culvert downstream of Adams Dr.	99	649	1414 *	770	1986		166	534
CC-ORVIS OUT	Outlet of Chickering Creek	93	687	1414	381 *	2420		108	456
Manson Avenue Sites									
LEFT-MANSON OUT	Left culvert				87	2420	250	>2420	597
RIGHT-MANSON OUT	Right culvert				115	>2420	108	>2420	519
MANSON OUT	Outfall at Manson Ave	770	181 *	435					399
MANSON DWN	Downstream of outfall in wetland/marsh	1300	261	285	236	1203	1986	308	602

Gray cells indicate an exceedance of WQS for *E. coli* (Single sample = 236 colonies/100 mL; Geometric Mean = 64 colonies/100 mL).

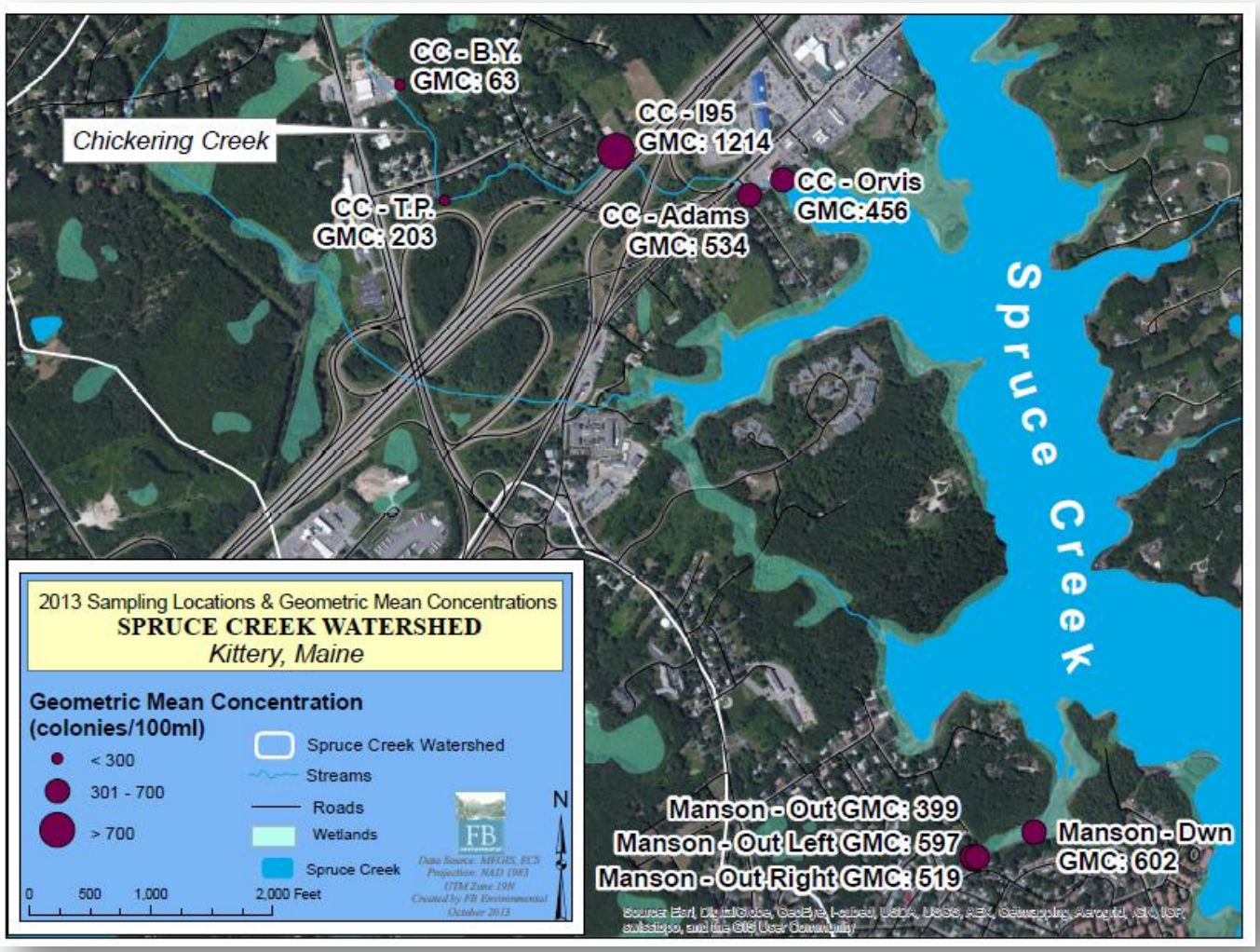
*** indicates that a field duplicate was collected. Result is the average of two samples.**

Wet weather sampling is determined using the following parameters for precipitation in Kittery, ME.

Precipitation totals must meet at least 1 of the 3 parameters to be a wet weather sample:

> 2.0 inches in the past 96 hours >0.25 inches in the past 48 hours >0.1 inches in the past 24 hours

Figure 3: Geometric Mean Concentrations (colonies/100 ml) at all 2013 Spruce Creek Sampling Locations in Kittery, Maine



3.2.1 Wet and Dry Weather Analysis

The geometric means for wet weather and dry weather samples were also calculated in an effort to understand the sources of bacteria in the watershed (Table 2). Both wet and dry weather geometric mean values exceeded the water quality standard for *E. coli* at all sites in the Spruce Creek watershed except for site CC-BY during dry weather. At this location, the dry weather geometric mean did not exceed the water quality standard while the wet weather geometric mean value was only slightly elevated above the state water quality standard. At sampling location CC-I95, the wet and dry weather geometric means were over 20 times the water quality standard.

Table 2: *E. coli* (colonies/100mL) wet weather, dry weather, and total geometric mean and response from canine detection for all sampling locations in the Spruce Creek watershed from August – November 2013.

Sample ID	Site Location	DRY	WET	TOTAL	CANINE RESPONSE
		Weather Geometric Mean	Weather Geometric Mean	Geometric Mean	Sable
Chickering Creek Sites					
CC-BY	Chickering Creek behind Boat Yard facility	61	66	63	--
CC-T.P.	Off Dana Ave. - Downstream of the trailer park	80	522	203	No
CC I95	CC- I95	1706	1217	1214	--
CC-ADAMS	Culvert downstream of Adams Dr.	367	775	534	Yes
CC-ORVIS OUT	Outlet of Chickering Creek	303	718	456	Yes
Manson Avenue Sites					
LEFT-MANSON OUT	Left culvert			597	--
RIGHT-MANSON OUT	Right culvert			519	--
MANSON OUT	Outfall at Manson Ave			399	Yes
MANSON DWN	Downstream of outfall in wetland/marsh	631	710	602	Yes

Gray cells indicate an exceedance of WQS for *E. coli*(Geometric Mean = 64 colonies/100mL)

--Indicates no sample was taken due to time or accessibility issues

Indicates less than three wet or dry samples were collected - could not calculate a wet/dry geometric mean.

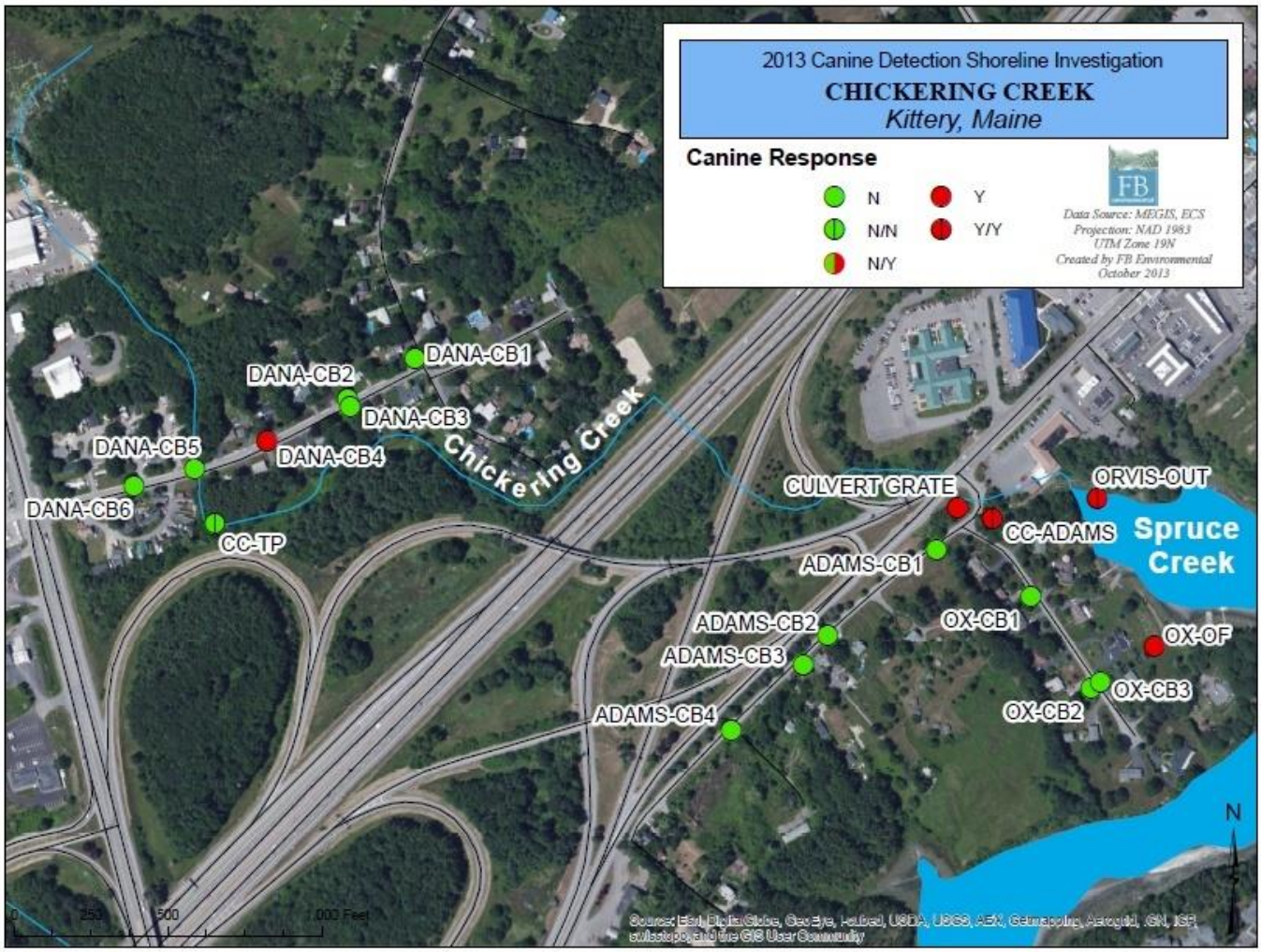
3.3 CANINE DETECTION

3.3.1 Chickering Creek Results

Chickering Creek was investigated by Scott Reynolds and canine Sable from Environmental Canine Services, Fred Dixon from the Town of Kittery Department of Public Works, and Whitney Baker from FB Environmental. The field team investigated the shoreline and all outfalls at the outlet of Chickering Creek at its convergence with Spruce Creek. Catch basin investigations were conducted on Adams Drive, Ox Point Drive, and Dana Avenue. As shown in Figure 4, 18 locations in the Chickering Creek watershed were assessed for the presence of human wastewater using canine detection including catch basins on Adams Drive, Oxpoint Drive and Dana Avenue. Five of the 18 sites were positive for human sources of

bacteria. These sites include a catch basin on Dana Road, a culvert grate near the intersection of Adams and Oxpoint Drive, an outfall in the Oxpoint Drive neighborhood, and the two downstream sampling locations along Chickering Creek (CC-Adams and Orvis Out).

Figure 4: Sampling locations on Chickering Creek in Kittery, ME (July 31, 2013). Colored dots indicate canine response.



3.3.2 Manson Avenue Results

Manson Avenue was investigated by Scott Reynolds and canine Sable from Environmental Canine Services, Fred Dixon from the Town of Kittery Public Works Department, and Whitney Baker from FB Environmental. The field team investigated the area surrounding two large outfalls located off of Manson Avenue. These outfalls empty into an estuarine marsh and ultimately into Spruce Creek.

As shown in Figure 5, the shoreline downstream of the stormwater system outfall at Manson Avenue was assessed for the presence of human wastewater using canine detection. Canine response at the stormwater outfall and the downstream location were positive for human sources of bacteria (Table 2).

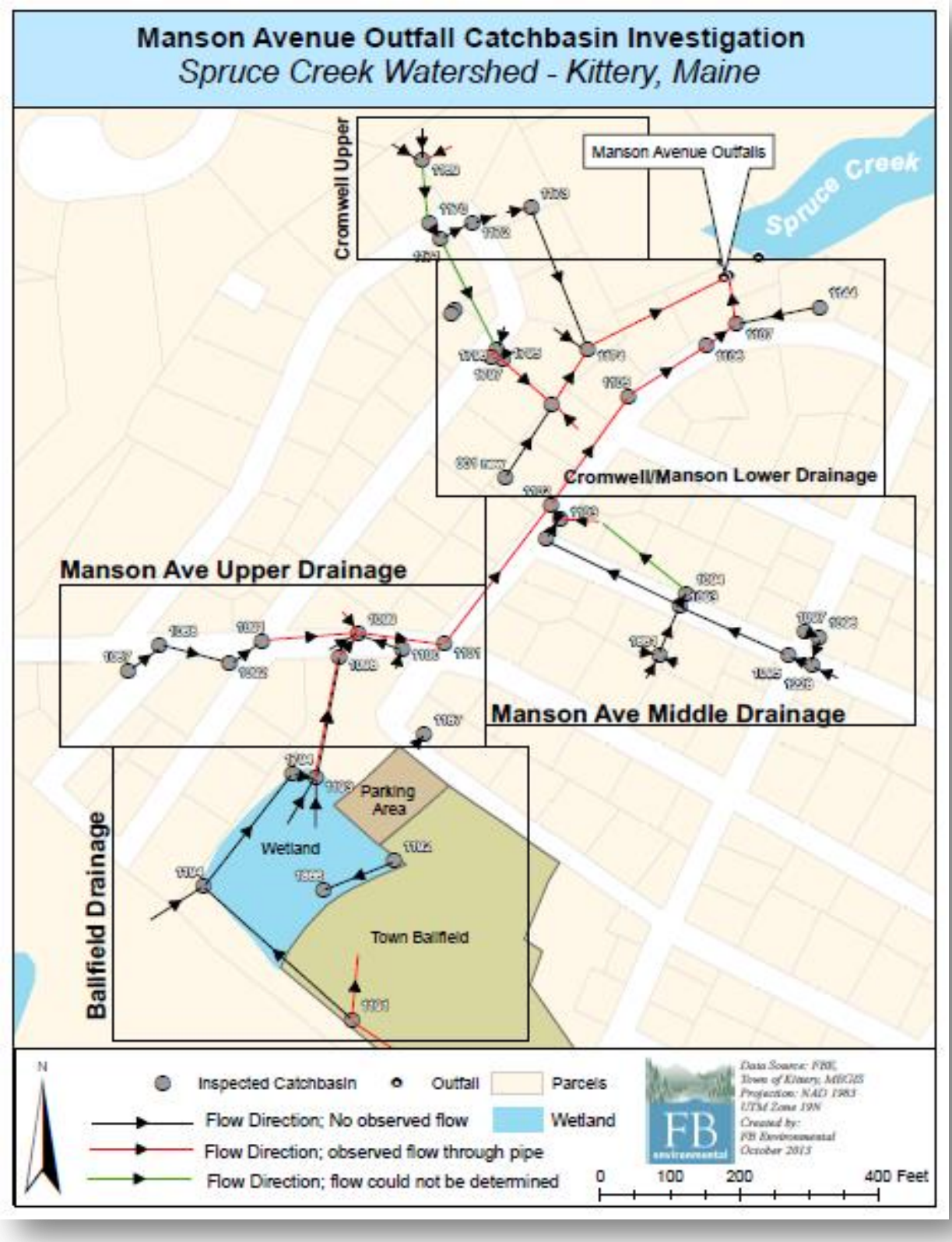
Figure 5: Sampling locations at the Manson Avenue Outfalls in Kittery, ME (July 31, 2013). Colored dots indicate canine response.

3.4 MANSON AVENUE CATCH BASIN INVESTIGATION

On September 27 and October 24, 2013, Whitney Baker and Logan Cline from FBE, and Fred Dixon from the Town of Kittery Department of Public Works, investigated the stormwater system that drains to the Manson Avenue outfalls. The purpose of the catch basin investigation was to identify potential illicit discharges, document flow patterns, and map all existing catch basins in the drainage area.

Beginning at the two Manson Avenue outfalls, each storm drain was opened and investigated. In-flow and out-flow pipes were documented and a photo was taken. Based on current stormwater system data and information from knowledgeable staff at the Kittery Department of Public Works, connections between catch basins were documented. Some pipes observed within catch basins were of unknown origin. These are presented in the maps below with "??" next to the pipe line. Unknown pipes with observed flow into a catch basin are of particular concern as they may indicate illicit discharges. Figure 6 displays the entire drainage area investigated in the Manson Avenue area on the above dates. The drainage area was divided into five segments for detailed analysis. This analysis can be found in Appendix A.

Figure 6: Manson Avenue Catch Basins draining to the "Manson Out" sampling location in Admiralty Village, Kittery, ME.



3.5 CHICKERING CREEK DISCUSSION OF RESULTS AND NEXT STEPS

3.5.1 Discussion of Results for Chickering Creek

As shown in Table 2, four of the five sampling locations along Chickering Creek exceeded the water quality standard for bacteria. At the sampling location adjacent to I-95, bacteria concentrations ranged from 16 to 38 times the water quality standard throughout the study period in both wet and dry weather. Bacteria concentrations remained elevated from this location to the mouth of the creek. Though no sample was available from the I-95 location for canine detection due to accessibility issues, the two downstream sites, CC-Adams and Orvis Out were both positive for human sources of bacteria.

Bacteria in Chickering Creek could be from stormwater, malfunctioning septic systems in the upper portion of the watershed and leaking sewer line or illicit discharges to the stormwater system in the lower portion. Though present, the actual amount of human-derived bacteria at these sites is unknown and other sources such as animal waste from pets and wildlife should be considered. Much of the Chickering Creek watershed is residential with commercial development around Route 1 and I-95 channeling the creek through culverts and sending additional inputs of untreated stormwater into Chickering Creek. Large areas of impervious surfaces and high concentrations of bacteria during wet weather sampling events suggest that stormwater runoff is an important source of bacteria pollution in the Chickering Creek watershed.

A catch basin on Dana Avenue (Dana-CB4) had signs of a laundry connection into the catch basin. Water within this basin was grey and cloudy. An obvious fabric softener odor was observed during the investigation of this catch basin. Connections to washers or other wash stations within a residence can be a source of bacteria, surfactants and other chemicals to Chickering Creek.

3.5.2 Recommended Next Steps for Chickering Creek

1. Continue bacteria monitoring throughout the Chickering Creek watershed under varying weather conditions to monitor changes in bacteria concentrations
2. Investigate the stormwater system draining into Chickering Creek from commercial areas along Route 1.
3. Conduct an investigation (such as a smoke test) of the sewer line on Route 1 to ensure there are no leaks in the system.
4. Determine the septic system history of any residential neighborhoods in the watershed to identify potentially failing systems.
5. Add bacteria sampling locations upstream of existing sampling locations in an effort to further bracket the sources of bacteria.
6. Walk the watershed to determine the extent of pet waste and to identify areas where wildlife (such as birds) may congregate.
7. Investigate potential illicit discharge to Dana- CB4.

3.6 MANSON AVENUE DISCUSSION OF RESULTS AND NEXT STEPS

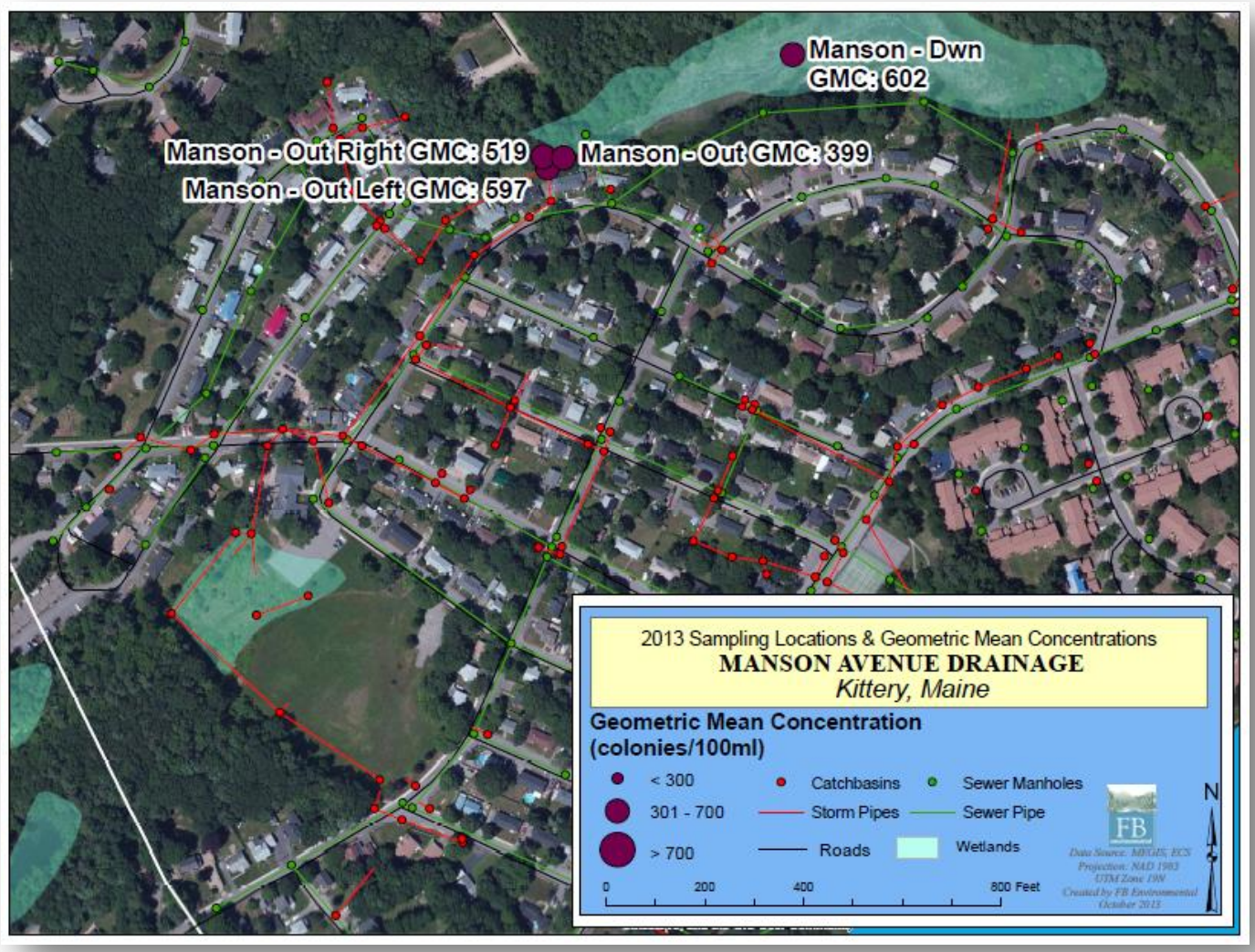
3.6.1 Discussion of Results for Manson Avenue

The two outfalls ("Manson out Left" and "Manson out Right") receive stormwater from the neighborhood along Manson Avenue and Cromwell Street, respectively, in Admiralty Village (Figure 7). As shown in Tables 1 and 2 bacteria concentrations at the Manson Avenue outfalls and the "Manson Down" sample location have been consistently high; consistently exceeding the state standard for *E. coli* during both wet and dry weather conditions and were positive for human sources of bacteria (Table 2).

As bacteria concentrations exceeded the water quality standard under varying weather conditions, sources of bacteria likely include a mix of sources including stormwater runoff, malfunctioning septic systems, pet waste, and wildlife. Overall, bacteria concentrations were higher under wet weather conditions than under dry weather conditions though dry weather concentrations continuously exceeded the water quality standard as well, indicating that bacteria sources are derived not only from stormwater runoff (Table 2).

The Manson Avenue neighborhood is now serviced by a public sewer system. This area once had a combined storm/sewer network. This old infrastructure still exists as the current stormwater system, though some older pipes are no longer in use. The interesting history of the storm and sewer network in this area and the elevated bacteria concentrations during both dry and wet weather sampling events suggest that there may be potential sources of bacteria stemming from illicit discharges or storm/sewer cross connections in the Manson outfall drainage area. Figure 7, below, shows the interconnected storm and sewer network throughout this drainage area along with the geometric mean concentrations at the sample sites in 2013.

Figure 7: Manson Avenue Outfalls and the storm/sewer network drainage area in Admiralty Village - Kittery, Maine



3.6.2 Recommended Next Steps in the Manson Avenue Drainage Area

Though this investigation led to the development of a more accurate map of the stormwater system in the Manson Avenue neighborhood (Figure 6 and Appendix A), further investigation is necessary to determine the origin of bacteria within the stormwater system. A list of prioritized next steps is presented below:

1. Contact and notify all property owners with mapped catch basins on their property.

2. Generate educational materials for all landowners within the drainage area about the presence of backyard catch basins asking landowners to contact the Town of Kittery or the Spruce Creek Association if they believe they have a catch basin on their property.

3. Conduct bacteria sampling in all prioritized catch basins in this neighborhood to determine where bacteria could be entering the system.
4. Conduct a smoke test or dye test of prioritized catch basins to determine potential illicit connections. Camera inspections of pipes with unknown origins will also provide valuable information on pipe origin and potential illicit discharges.
5. Focus investigations at prioritized catch basins (Appendix A).

4. CANINE DETECTION AT FORT FOSTER

As a follow-up to sampling completed in 2012, Fort Foster Beach was investigated by Scott and Karen Reynolds and dogs Sable and Logan from Environmental Canine Services, Jessa Kellogg from Kittery Department of Public Works, and Emily DiFranco and Whitney Baker from FB Environmental. The field team investigated the shoreline, culvert outfalls, and the marsh located inland to the north. In 2012, high bacteria concentrations and human sources of bacteria were found along the beach in wet seeps, in the surf zone, and in the marsh upstream of the beach. After sampling in 2012, two outhouses located above the marsh were discovered and removed by Kittery Department of Public Works.

4.1.1 Fort Foster Beach Results

In 2013, eight locations were assessed for the presence of human sources of bacteria using canine detection at Fort Foster Beach (Figure 8). Many of these locations were assessed also assessed in 2012, though additional sites were chosen in 2013 as new wet seeps were found (Table 3). Human sources of bacteria were found at three of the eight sampling locations (indicated by one or both dogs). In addition to canine detection, water quality samples were taken at all but one location. At this location (Outfall-FF), there was insufficient flow to sample. Three of seven samples collected exceeded the water quality standard (Table 3). Maine's enterococci water quality standards (WQS) for determining beach closures are:

- 104 colonies/100 mL for instantaneous samples
- 35 colonies/100 mL for a geometric mean of multiple samples.

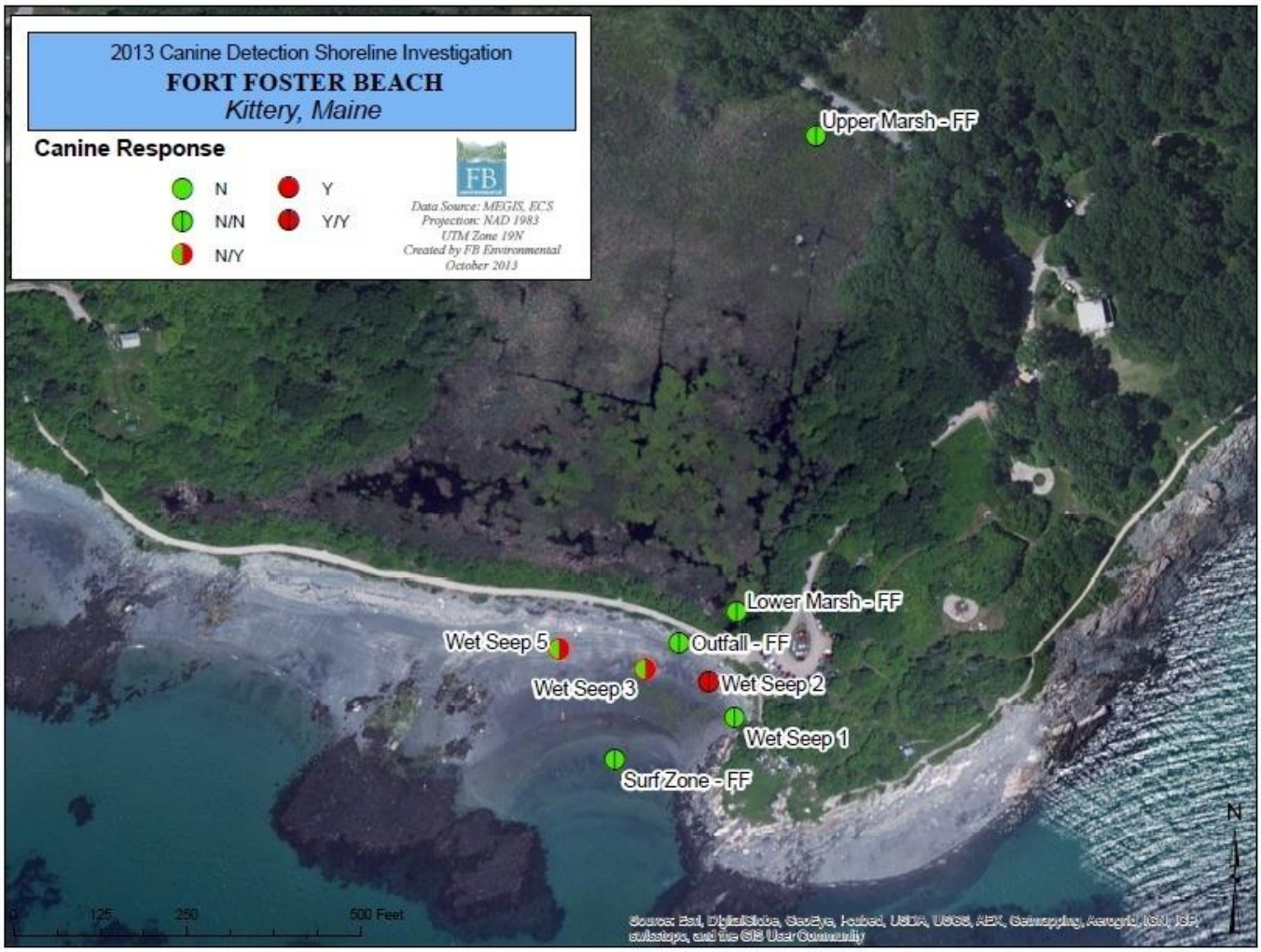
As shown in Table 3, multiple sites that were positive for human sources of bacteria in 2012 were negative in 2013. In some cases**,** Logan alerted to the presence of human sources of bacteria while Sable did not. In a 2011 Water Environment Research Foundation study, it was shown that Logan is more sensitive to low levels of human sources of bacteria than Sable. In these cases of a positive alert by Logan only and if other indicators of human sources of bacteria (e.g. suds, toilet paper, visible sewage) were not present, it is likely that the actual amount of human sources of bacteria present at the time of detection were also relatively low. However, human sources should still be included as potential sources of bacteria in follow-up investigations.

Table 3: Bacteria sampling and canine detection results from 2012 and 2013 at Fort Foster Beach in Kittery, Maine

Site Name	Site Description	2012 Bacteria Concentration Enterococci *(colonies/ 100 mL)*	2012 Canine Response *(Logan/Sable)*	2013 Bacteria Concentration Enterococci *(colonies/ 100 mL)*	2013 Canine Response *(Logan/Sable)*
Wet Seep 1	Seep furthest east on Fort Foster Beach	--	--	**>2420**	No/No
Wet Seep 2	Seep west of 'Wet Seep 1'	--	--	78	**Yes/Yes**
Wet Seep 3	In front of outfall on beach	--	--	**613**	**Yes/No**
Outfall - FF	Outfall draining marsh	--	**Yes/Yes**	--	No/No
Wet Seep 5	Seep furthest west	146	**Yes/Yes**	31	**Yes/No**
Upper Marsh – FF	South side of access road	569	**Yes/Yes**	101	No/No
Lower Marsh - FF	Above culvert to beach	109	**Yes/Yes**	29	No/No
Surf Zone - FF	Ocean	40	**Yes/Yes**	**516**	No/No

-- Indicates that no sample was collected due to insufficient flow
Grey cells indicate an exceedance of the water quality standard (104 colonies/100 mL)
Red cells indicate a positive canine response from both dogs
Blue cells indicate a positive canine response from one dog

Figure 8: Sampling locations at Fort Foster Beach in Kittery, ME on July 31, 2013. Colored dots indicate canine response.



4.1.2 Fort Foster Beach Discussion

At one location (Wet Seep 1), enterococci concentrations were over 20 times the water quality standard (Table 3). However, the dogs indicated that there were no human sources of bacteria present at this location. This may be a result of wildlife activity or other non-human sources inland and northeast of the beach. 'Wet Seep 3' also had bacteria concentration of over six times the state bacteria standard for enterococci. A white substance was present in this seep. Though Sable did not indicate the presence of human wastewater at this site, high bacteria results, and a positive response from Logan indicate that human sources may be

contributing to the contamination at this location. Both dogs gave positive responses at the 'Wet Seep 2' location on Fort Foster Beach. However, bacteria concentrations were below the water quality standard indicating that the extent of contamination at this site may be low.

As shown in Table 4, the strong positive responses in 2012 at five locations along Fort Foster beach were either negative in 2013 or positive as indicated by only one dog (Logan). As described above, Logan is more sensitive to low levels of human sources of bacteria than Sable indicating that the actual amount of human sources of bacteria in that seep was relatively low. Though the removal of the outhouse upstream of the marsh in 2012 likely led to the decrease in human sources of bacteria reaching the beach, this area should be monitored continuously to prevent future contamination.

4.1.3 Recommended Next Steps for Fort Foster Beach

1. Continue to conduct regular sampling (bacteria and canine detection) along Fort Foster Beach.

2. Investigate other potential human sources of bacteria near the beach including the bath house.

3. Investigate areas throughout Fort Foster State Park for areas of concentrated pet waste and where wildlife congregates (such as birds).

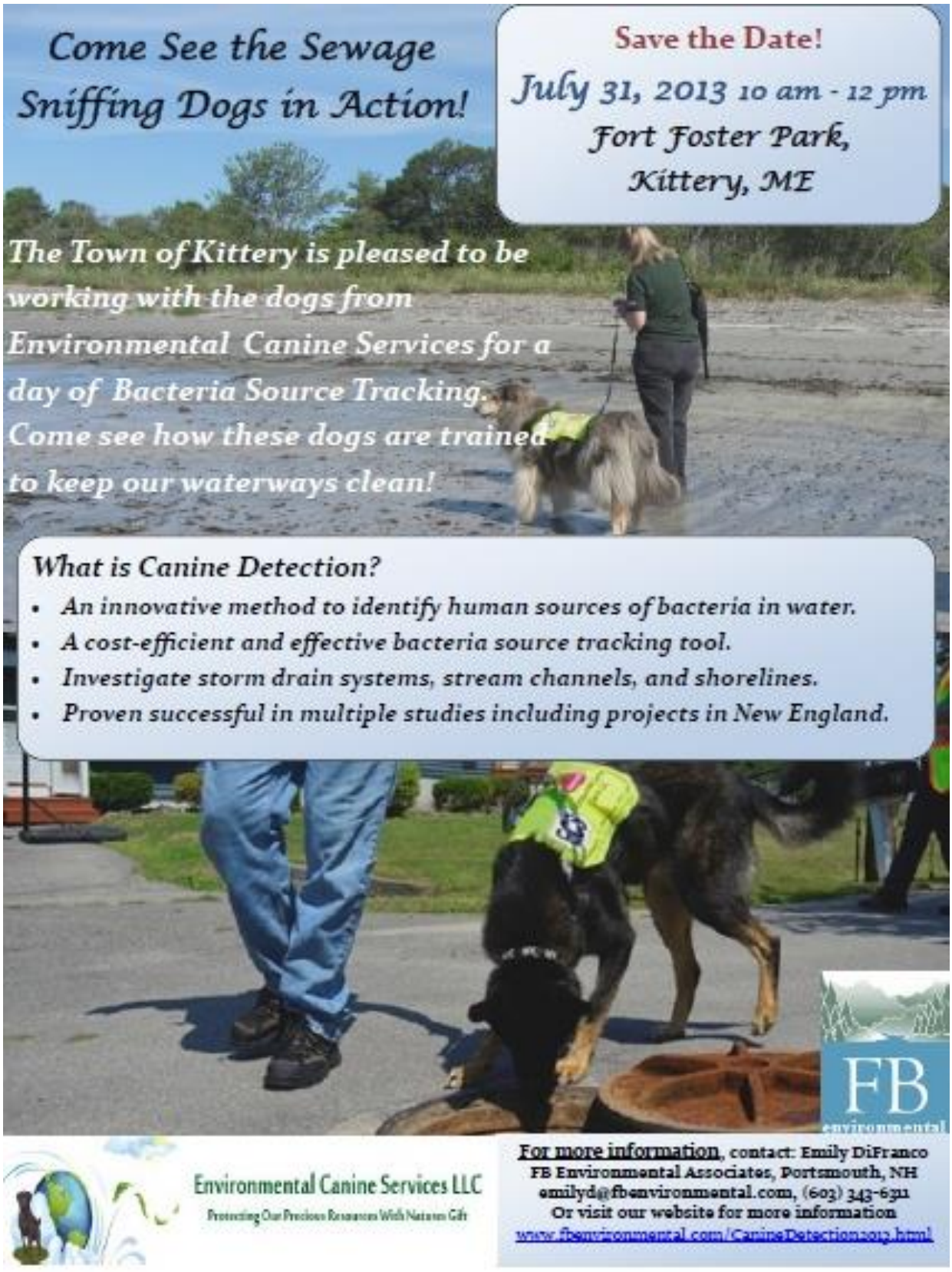
4. Examine the pattern of wet weather vs. dry weather bacteria counts, conducting additional sampling as needed. High counts in wet weather can indicate a connection to surface hydrology (street runoff, pet or wildlife waste, pipes or systems subject to overflow from rain) while high counts in dry weather suggest a source fed by a domestic water supply (leaking sewer pipes or septic systems).

4.2 PUBLIC OUTREACH

A public outreach event was held at Fort Foster Beach in Kittery, Maine from 10 AM – 12 PM on July 31, 2013 (Figure 9). The Town of Kittery held the event and set up a booth displaying past and present work that the town has completed in efforts to improve water quality in Spruce Creek and throughout the Town of Kittery. The event included demonstrations from the dogs and a discussion of water quality in Kittery.

Public outreach event at Fort Foster in Kittery, Maine, July 31, 2013

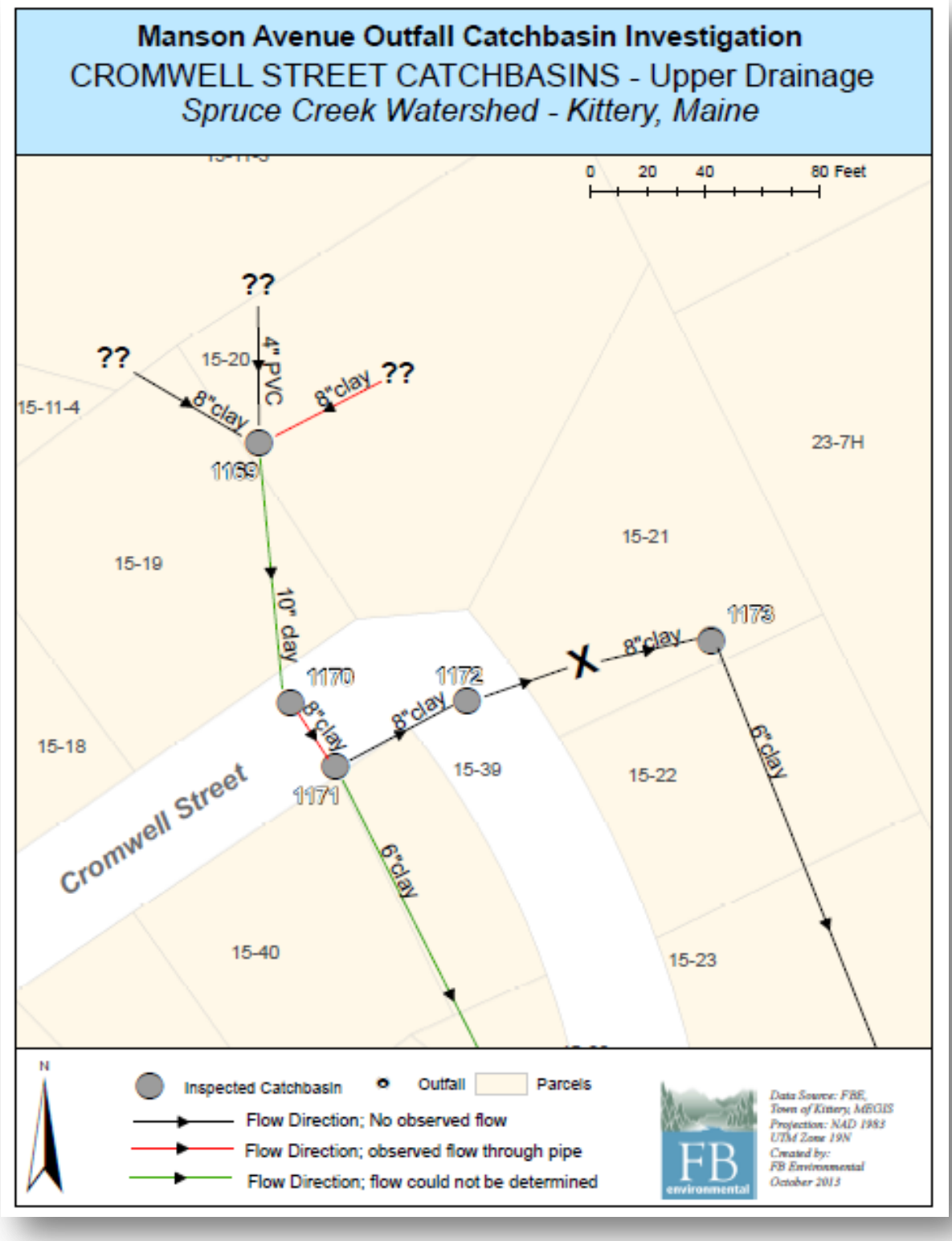
Figure 9: Public outreach flyer for canine detection in Kittery



5. APPENDIX A: DETAILED ANALYSIS OF THE CATCH BASIN SYSTEM IN THE MANSON AVENUE NEIGHBORHOOD

The first area investigated in the Manson Avenue area was the section of storm system that drains the houses along Cromwell Street. An unmapped backyard catch basin was also identified behind a residence on the south side of Cromwell Street (001new). Figure 10 summarizes the results of the upper portion of the Cromwell Street drainage area. Figure 11illustrates the findings in the lower portion of this drainage area.

Figure 10: Manson Avenue Outfall Catch Basin Investigation – Upper Cromwell Street Drainage Area



Findings of the upper Cromwell Street drainage area are as follows (Figure 10):

1. Inside catch basin (CB) 1169 a source of flow was documented. An 8-inch clay pipe was observed with an unknown origin. This pipe may potentially be from a perimeter drain discharging from the adjacent residence. A potential illicit discharge was also discovered at this location. A small PVC pipe was observed just above the storm drain cover. This may be used as a laundry drain or basement sump pump. The origins of both pipes should be investigated.

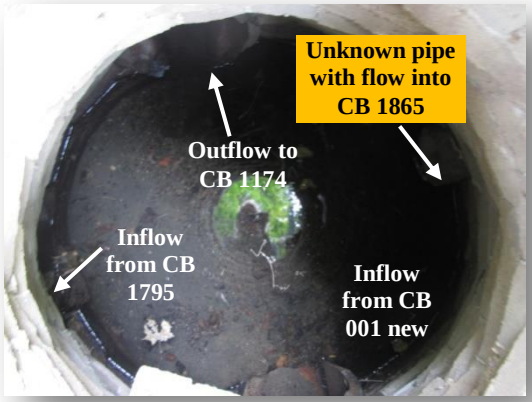
Catch Basin 1169 in the Upper portion of the Cromwell Street Drainage area.

2. A potential disconnect was discovered between CB 1172 and CB 1173. Based on observed pipes and current storm system data, water should flow from CB 1172 to CB 1173, and then on to 1174. However, during the Cromwell Street investigation, water was emptied into CB 1172 for a period of about 5 minutes. No flow was observed into CB 1173. CB 1173 is an older catch basin located in a backyard on Cromwell Street. It may be disconnected from the system as it observed to be dry.

Findings from the investigation of the lower Cromwell Street / Manson Avenue drainage area are as follows (Figure 11):

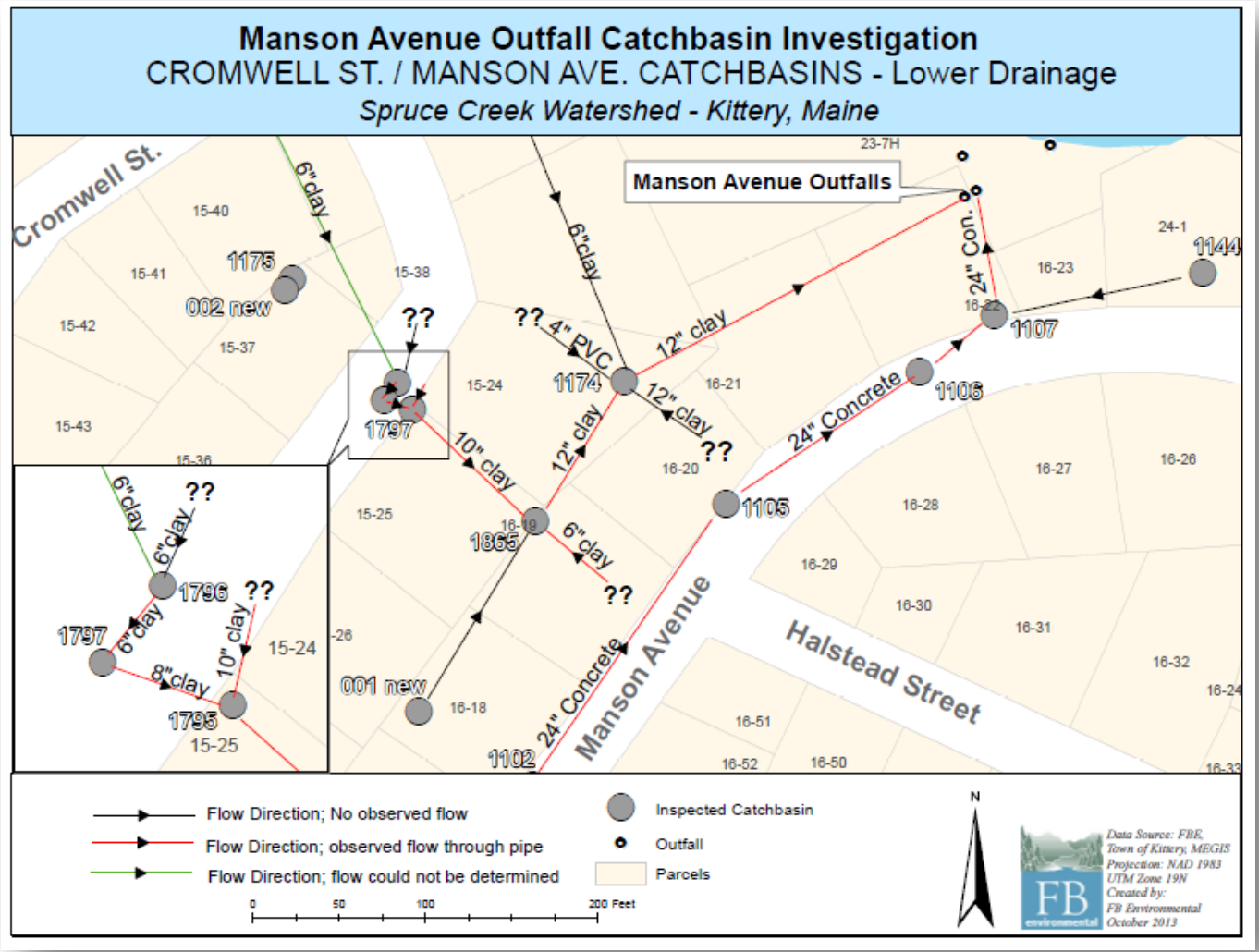
1. A 10-inch clay pipe with observed flow into CB 1975 was observed during the Cromwell Street investigation. The origin of this pipe is unknown and should be investigated as moderate flow was observed from this pipe into CB 1795.

2. A 6-inch clay pipe with observed flow into CB 1865 was observed during the Cromwell Street investigation. The origin of this pipe is unknown.



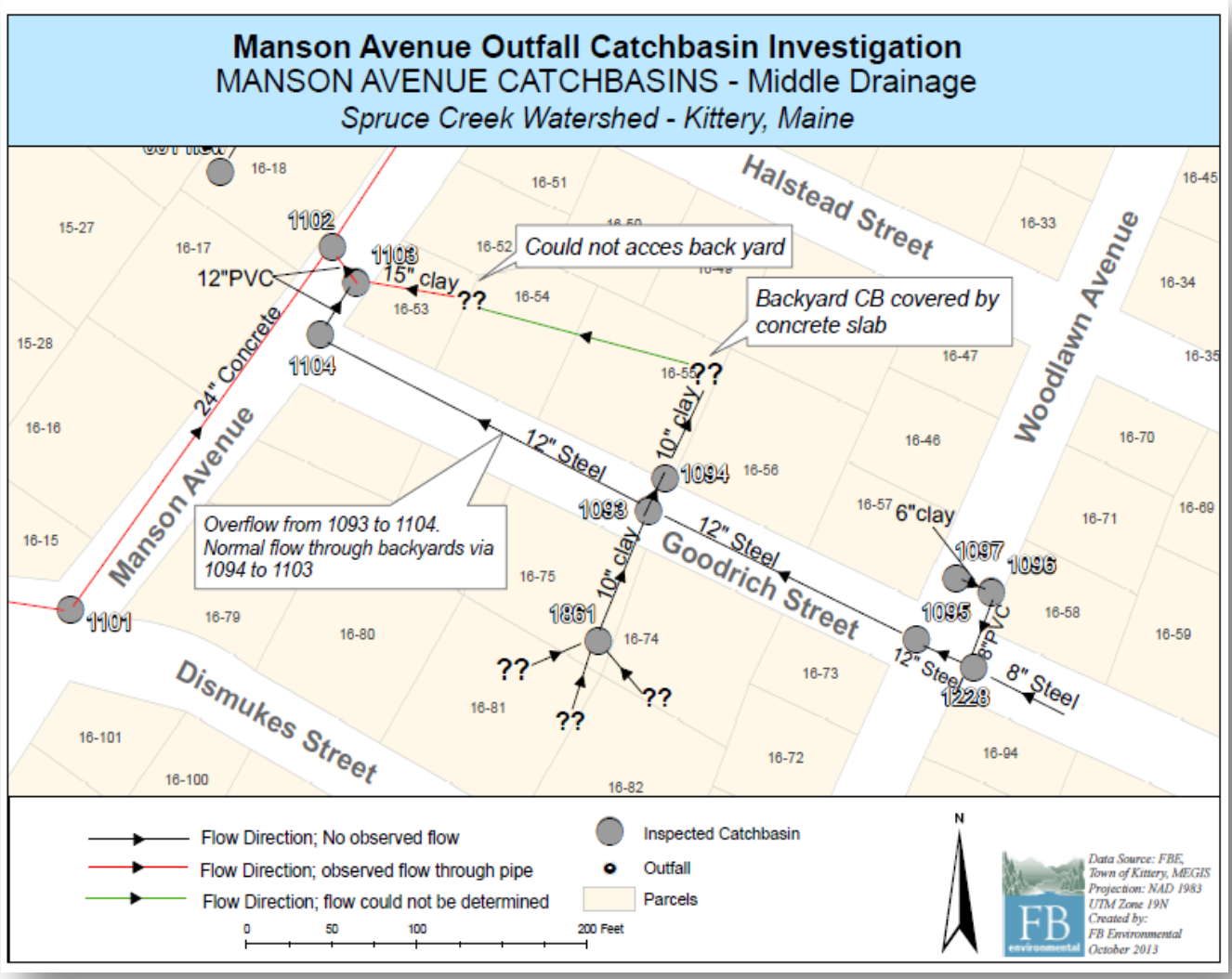
CB 1865 (left) with three inflow pipes and one outflow pipe to CB 1174.

Figure 11: Manson Avenue Outfall Catch Basin Investigation – Lower Cromwell Street / Lower Manson Avenue Drainage Area



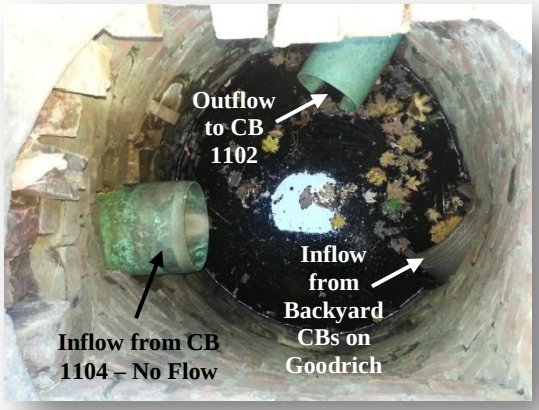
The next area investigated in the Manson Avenue neighborhood was the section of storm system along Goodrich Street. An important section of storm system was not investigated in this area as we could not gain access the backyards of the houses on parcels 16-53 and 16-54. The storm drain line that runs east to west at the most western end of Goodrich Street is actually an overflow for water flowing into CB 1093. Stormwater flows into CB1093, then to CB 1094 and through the backyards of parcels 16-55, 16-54 and 16-53. Flow continues to CB 1103 and then downstream on Manson Avenue. The mapped backyard catch basin located on parcel 16-55 was covered by a concrete slab and could not be accessed. Figure 12 displays the flow patterns in this portion of the storm system on Goodrich Street.

Figure 12: Manson Avenue Outfall Catch Basin Investigation – Middle Avenue Drainage Area at Goodrich Street



Findings from the investigation of the Middle Manson Avenue drainage area are as follows (Figure 12):

1. Further investigation of the portion of storm system located on parcels 16-55, 16-54, and 16-53 should be conducted to determine source of flow observed into CB1103.



CB 1103 located on the corner of Manson Ave and Goodrich Street – Observed flow through catch basin.

2. Catch basin1861 is located in the backyard of parcel 16-75 and has three inflow pipes of unknown origin. According to homeowners, this catch basin receives a large amount of stormwater during rain events and often floods. Though the basin was dry during the investigation, the origins of these three pipes should be further investigated.

CB 1861 located on parcel 16-75 on Goodrich Street.

The catch basins located in the upper drainage area on Manson Avenue were also investigated for flow patterns and potential illicit discharges. This section of stormwater system starts at the corner of Manson Avenue and Boush Street to the corner of Dismukes Street. Figure 13 displays flows patterns through catchbasins in the upper drainage area on Manson Avenue.

Findings from the investigation of the Upper Manson Avenue drainage area are as follows (Figure 13):

1. CB1091 is source of flow into CB 1099, but no flow was observed through the CB 1091 during the investigation. There are a total of five pipes that flow into CB 1099 and one outflow pipe that connects to CB 1101. Flow was observed from three of the five pipes flowing into CB 1099. One pipe drains from the town ball field, parking area, and wetland. Another pipe receives stormwater from CB1091 on Manson Avenue. The last of these three pipes is a 10-inch transit pipe of unknown origin.

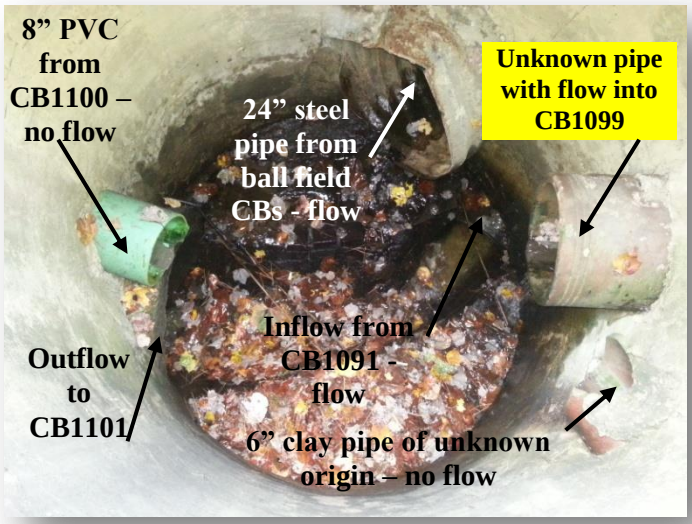
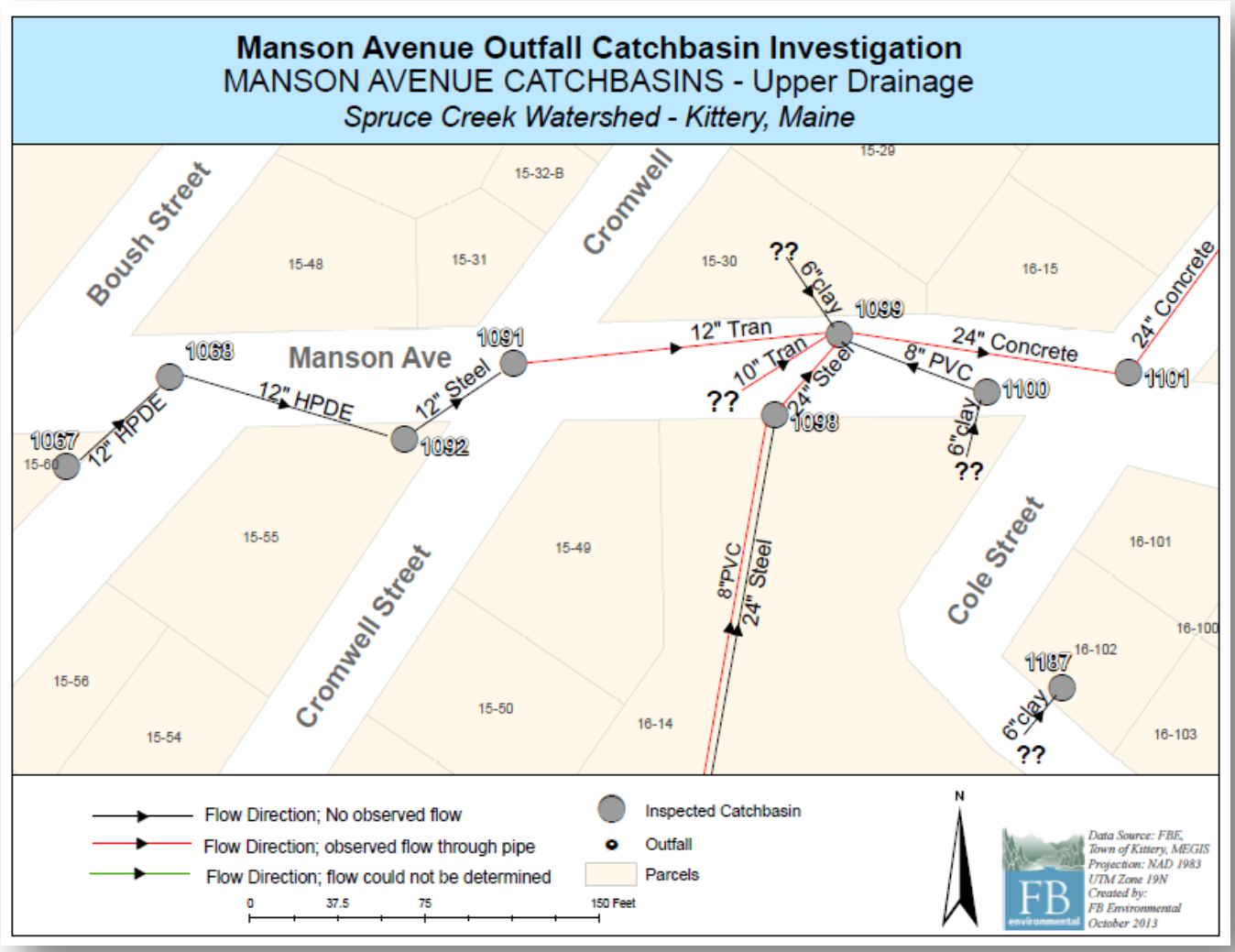


Figure 13: Manson Avenue Outfall Catch Basin Investigation – Upper Drainage Area



The next area included catch basins located around the town's ball park. Though there was flow into the catch basins, in many cases the outflow pipe was located high up in the basin. The catch basin would have to fill almost completely before water would drain out to the next downstream catch basin. Figure 14 summarizes the flow conditions in the ball field area and parking lot off of Cole Street in Kittery.

Findings from the investigation of the town ball field drainage area are as follows (Figure 14):

1. No signs of illicit discharges were discovered in the ball park area. Flow through CB 1193 is suggested to be solely stormwater driven. CB 1866 and CB 1192 receive water from perforated pipes that run underground along the perimeter to the ball fields. These collect water draining into the ditches along the field and drain into these two catch basins. The town installed these pipes to help prevent standing water on the fields.

Figure 14: Manson Avenue Outfall Catch Basin Investigation - Ball field Catch basins