Illicit Discharge Detection and Elimination in Brattleboro

FINAL REPORT

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1. INTRODUCTION

The Brattleboro Illicit Discharge Detection and Elimination (IDDE) Project provided a comprehensive assessment of the occurrence of contaminated, non-stormwater flows in separated stormwater drainage systems discharging to Whetstone Brook, the West River, and the Connecticut River in Brattleboro. Prior to this project, there had been no assessment of stormwater infrastructure in Brattleboro for the presence of illicit discharges. The Town of Brattleboro had not initiated an IDDE program because it is not subject to the requirements of the EPA Phase II stormwater rule, which includes a requirement to perform IDDE. This project was funded by the Vermont Department of Conservation's Center for Clean and Clear, now the Ecosystem Restoration Program. The Town of Brattleboro was an able and responsive partner in this project.

In older town centers, the discharge of materials other than stormwater through the stormwater drainage system can be a source of bacteria and other contaminants of concern. Locating and eliminating illicit discharges can be a cost-effective element of a long-term strategy to reduce water pollution. Illicit discharges enter the stormwater drainage system through either direct connections or indirect connections. In past IDDE projects conducted in Vermont, Stone and its partners have documented and initiated correction of a variety of illicit discharges; the most common types have been infiltration or cross connections from the municipal sanitary wastewater sewer, contaminated discharges from industrial facilities, and petroleum contaminated groundwater from gas stations and former industrial sites. Municipal tap water leaks are also commonly identified, the correction of which reduces chlorine entering the environment and saves water.

Prior to this assessment, the Vermont Department of Conservation prepared a geodatabase of stormwater infrastructure in Brattleboro. The infrastructure mapping combined digitization of engineering plans with field survey in certain areas. This infrastructure mapping was used extensively throughout the IDDE assessment to identify outfalls, select appropriate assessment points, and trace suspected contaminants. In the course of infrastructure mapping, DEC identified an overflowing sanitary sewer manhole behind the Brattleboro Retreat complex. Due to a clogged line, sanitary sewage was discharging from the manhole down a short bank and into the West River. The Brattleboro Retreat quickly fixed the problem when DEC alerted them to it and has included inspection of the line on their periodic maintenance schedule. The area was revisited twice by the IDDE crew and no discharge was found.

1.1. Goal of the study

The goal of this project was to improve water quality by identifying and eliminating contaminated, non-stormwater discharges entering stormwater drainage systems and discharging to Whetstone Brook, the West River, Crosby Brook, and the Connecticut River in Brattleboro.

1.2. Project roles and responsibilities

Stone Environmental developed the testing protocol, led the field assessment, consulted with municipal officials regarding suspected contamination sources, and authored the final report.

The project team's primary municipal contacts were:

Stephen (Steve) Barrett, Public Works Director

Richard (Rick) Ethier, Highway/Utilities Superintendent

The stormwater infrastructure mapping prepared by DEC was used extensively throughout the project.

2. METHODS

2.1. Overview

The primary tasks were 1) to record observations and perform basic water quality tests at flowing outfalls, other discharge points, and selected catch basins and junction manholes during dry-weather periods; and 2) where monitoring indicated contamination, to work with the Town of Brattleboro to investigate potential pollutant sources through the stormwater drainage system. The geographic scope of this assessment, illustrated in Figure 1, included the entire extent of the municipal closed drainage system discharging to Whetstone Brook, the West River, and the Connecticut River in the Town of Brattleboro, including the village of West Brattleboro.

2.2. Preparations for the assessment

Preparations for the illicit discharge assessment included obtaining and assembling necessary equipment and supplies; preparing a field data form, field maps, a Health and Safety Plan, and other documents and organizing these in a project notebook; and meeting with municipal representatives to gather information and plan the project. Field equipment was assembled from Stone's inventory. Consumable supplies, including test reagents, were purchased to meet the needs of the project. The field data sheet included as Appendix A was prepared. Large format field maps were prepared by overlaying DEC's stormwater infrastructure mapping and the best available orthophotography. These maps were consulted in planning meetings with municipal representatives and were annotated in the field. A Health and Safety Plan was prepared with directions to emergency medical facilities. A project notebook was assembled containing all these documents plus contact information, laboratory chain of custody forms, standard operating procedures, and other documents.

Prior to commencing field work, members of the project team met with town officials on October 10, 2010 to gather information and plan the illicit discharge assessment. Poster sized maps of the stormwater drainage system were reviewed to plan the assessment in detail. Information collected during the kick off meeting included:

- Contact information for municipal managers and public works personnel.
- General schedules of road and wastewater and stormwater collection system projects to occur in 2010 (to avoid conflict with construction activities).
- Locations of any known, suspected, or potential cross connections, combined sewer overflows, and sanitary sewer overflows. These may be areas where there is a history of pipe back-ups or failures, or where complaints have been received about sewage smells or other nuisance conditions.
- The capabilities of the Public Works Department to inspect pipelines and perform other advanced investigation techniques, either with municipal staff and equipment or using a contractor specializing in such work.
- The Public Works Department's preferences concerning safe work practices in the public right-of-way.

2.3. Dry weather survey

Stormwater outfalls and other discharge points (earthen channels, groundwater seeps, pipes of indeterminate origin) were inspected during dry weather to minimize dilution by stormwater. This work was completed in the fall of 2010. Dry weather was defined as negligible rainfall (less than 0.1 inches) since approximately 12:00 p.m. on the previous day. In larger stormwater collection systems where the effects of dilution must be considered, selected catch basins and junction manholes were also assessed. Stormwater outfalls, catch basins, and manholes were accessed along the public right-of-way or from the receiving waterbody, as appropriate. In certain cases stormwater structures located on private property were assessed if these structures were connected to a municipal system and assuming permission was granted.

Every outfall or other stormwater structure assessed was assigned a unique identifying code. Scientists described the condition of each discharge point and the area immediately below each discharge point. If present, dry-weather flows were observed for color, odor, turbidity, and floatable matter. Dry weather flows were sampled directly into a sample container, by hand or using a telescoping pole. At catch basins and manholes located at junctions in the storm sewer, samples were collected independently from each inflowing pipe, when possible. Field data were entered on printed forms (see Appendix A) or noted on field maps.

Each dry weather discharge was tested for ammonia, methylene blue active substances (common anionic detergents), and the presence of optical brightener to identify wastewater discharges from laundry facilities, failing septic systems, leaking sanitary sewers, and cross-connections. Optical brighteners are fluorescent dyes contained in most laundry detergents. Specific conductance was measured as an indication of the dissolved solids content. For detection of treated municipal water leakage, total chlorine was analyzed. Fluoride was not used for this purpose because Brattleboro does not fluoridate its water supply.

With certain exceptions, structures where no dry-weather flow was observed were assumed not to have illicit connections and no further assessment was made. Our general procedure is to provide additional assessment of dry structures only if there is evidence of contamination in the area below the outfall or in a catch basin or manhole sump, such as deposits, staining, or offensive odors.

Water analysis methods

Ammonia was tested using Aquacheck ammonia test strips. Methylene blue active substances were tested using CHEMetrics test kit K-9400, a method consistent with APHA Standard Methods, 21st ed., Method 5540 C (2005). Total chlorine analysis was conducted with powdered DPD reagent (Hach Method 8167, equivalent to USEPA method 330.5) and a portable Hach DR/890 colorimeter. Specific conductance was measured using an Oakton model conductivity meter.

Optical brightener monitoring was performed at outfalls and selected catch basins and manholes that were flowing at the time of inspection. To test for optical brightener, a cotton pad was placed in the flow stream for a period of 4-8 days, after which the pad was rinsed, dried, and viewed under a long-wave ultraviolet light ("black light"). Florescence of the pad indicates the presence of optical brightener. Pads are held in a mesh sleeve, clipped to the outfall structure or secured with fishing line to a rock or other anchor. At catch basins and manholes located at junctions in the storm sewer, pads were deployed in incoming pipes if possible, but were more often hung from the catch basin grate or manhole rung into the sump. An advantage of optical brightener monitoring is that some intermittent or dilute wastewater discharges may be detected due to the multiple-day exposure of the pad, whereas the contaminant may not be detected in tests performed on grab samples.

Table 1 identifies water quality tests that scientists performed at all discharge points and selected catch basins and manholes that were flowing at the time they were inspected.

Table 1. Water quality tests performed at flowing structures

Parameter	Sample Container	Analytical Method
Ammonia	Plastic beaker	Aquacheck ammonia test strips
MBAS detergents (anionic surfactants)	Glass beaker	APHA Standard Methods, 21st ed., Method 5540 C (2005)
Total chlorine	Glass beaker	By DPD, Hach Method 8167 (EPA 330.5)
Specific conductance	Glass beaker	SEI SOP 5.23.3
Optical brighteners	Cotton test pads	SEI SOP 6.38.0

Follow-up testing of stormwater discharge points

At discharge points where wastewater contamination was suspected (because of a positive optical brightener test, elevated ammonia, and/or septic odor), water samples were collected for *E. coli* and total nitrogen analysis. Samples collected for *E. coli* analysis were collected in sterile, plastic 100-mL bottles. Samples collected for total nitrogen analysis were collected in plastic centrifuge tubes preserved with sulfuric acid. *E. coli* and total nitrogen analyses were performed by DEC's LaRosa Laboratory in Waterbury. Table 2 identifies the *E. coli* and total nitrogen methods used by the LaRosa Laboratory.

Table 2. Laboratory sample analyses

Parameter	Sample Container (vol. required)	Analytical Method	Sample Preservation	Holding Time
Total nitrogen	Plastic tube (50 mL)	SM 4500-N C Modified	Cool (≤6°C), H_2SO_4 to pH <2	28 days
E. coli	Plastic (100 mL)	SM 9223B (Colilert Quanti-Tray)	Cool (<10°C)	6 hours

Flow Measurement

At discharge points where wastewater contamination was suspected, at the same time that water samples were collected for *E. coli* and total nitrogen analyses, flow measurements were made to enable calculation of total nitrogen mass loading. Flow was measured by timing the filling of a container of known volume.

2.4. Isolating contaminant sources within storm sewer segments

If, based on the results of the dry weather survey, a storm sewer was suspected of passing illicit discharges, additional observations and testing were performed within the collection system to locate or bracket the origin of the contaminated flow. The goal was to bracket the contaminant source between adjacent structures, such as a stormline connecting a catch basin to a down-pipe manhole. DEC's stormwater infrastructure mapping was used to guide this effort. This phase of the project was begun in November 2010 and was continued between May and July 2011.

In attempting to locate or bracket contaminant sources within storm sewer segments, the same testing methods or a subset were used as in the dry weather survey phase. Highly intensive optical brightener testing of storm sewer structures was performed to bracket the source of wastewater contamination in four drainage systems, including the two largest storm sewers draining downtown Brattleboro. The presence, appearance, and odor of dry-weather flows were also useful in isolating sources of contamination within storm sewer segments.

2.5. Advanced Investigation

After pollutant discharges had been characterized and bracketed to the degree possible through water quality testing, Stone visited each discharge location with Mr. Rick Ethier, Superintendent of Brattleboro Public Works. Mr. Ethier outlined plans for follow on investigation and contacts with various property owners. These plans are noted in Sections 3.1 and 3.2.

3. RESULTS

Initial illicit discharge assessment in Brattleboro was performed between October 10, 2010 and November 24, 2010. Of the 285 outfalls assessed, 73 were flowing or dripping when inspected. 37 other structures, primarily catch basins, were also assessed. Fifteen storm sewer systems were investigated in some detail. These systems are described in Sections 3.1 through 3.3, which are organized according to the type of discharge believed to be present. Fourteen of these systems are believed to have some type of illicit discharge. These are summarized in Table 3. One of these systems, the storm sewer draining North Main Street and side streets (BR-1160), appears to have illicit discharges in three locations.

In the initial discharge assessment, 10 systems were found to have low concentrations (0.2-0.5 mg/L) of MBAS detergents and non-detectable levels of the other measured constituents. Upon repeated sampling, we determined that the majority of these systems did not have chronic illicit discharges. Small amounts of detergents are commonly detected in dry weather flows due to transient sources, such as vehicle washing. Unless a chronic illicit discharge is suspected or bracket sampling was conducted, these systems are not discussed further in this report.

Table 3. Storm sewer systems with suspected or confirmed discharges

Structure ID	Indicator (discharge)	Description	Status
BR-920	OB, ammonia, MBAS (wastewater)	20-inch ceramic outfall from Canal St. storm sewer discharging to Whetstone Brook 150 feet east of Elm St. bridge. Leaking sewer service line identified.	Visited with Rick Ethier July 21, 2011. DPW performed an immediate temporary repair and the property owner has agreed to reroute and replace the failed sewer service line.
BR-1030	MBAS (washwater)	12-inch ceramic pipe from Flat/Elm/Elliot St. storm sewer, discharging to Whetstone Brook behind Dunklee and Sons building.	Truck washing at fire station on Elliot St. believed to be source of detergents. Referred to DPW.
BR-1160	OB, MBAS (wastewater)	42-inch diam. concrete outfall from North Main St. storm sewer; discharges to Whetstone Brook under Main St. bridge. Three discharges suspected: 1. High Street, east of Oak 2. Brown & Roberts lot 3. Brooks House lot	Visited each with Rick Ethier July 21, 2011. DPW committed to conducting follow on investigation and contacts with property owners as needed at High Street and regarding the pipe in the catch basin on the Brown & Roberts lot. The storm sewer behind the Brooks house is slated for reconstruction, which should eliminate the suspected discharge into the catch basin here.
BR-1950	OB (wastewater)	24-inch diam. corrugated metal outfall discharging to Ames Hill Brook opposite #238 Greenleaf Ave.	Visited with Rick Ethier July 21, 2011. DPW committed to conducting follow on investigation and contacting property owner(s) on Mather Road.
BR-2020	OB (wastewater)	24-inch ceramic outfall draining Greenleaf and Western Avenues, discharges to Bonnyvale Brook under the Western Ave. bridge	Visited with Rick Ethier July 21, 2011. DPW committed to conducting follow on investigation and contacting property owner(s) in the vicinity of the Greenleaf Avenue and Country Hill intersection.
BR-3000	Ammonia (washwater)	Catch basin BR-3000 in appliance store parking lot on Western Ave.; PVC pipe from direction of the appliance store discharges to catch basin.	Visited with Rick Ethier July 21, 2011. An intermittent discharge of washwater is suspected at this location.
BR-330	Chlorine (tapwater)	4-inch diam. PVC pipe discharging to stream at intersection of Chestnut and Locust Streets.	DPW fixed a leak in the water line in November 2010. Dry weather flow ceased after the repair.
BR-1140	Chlorine (tapwater)	1.5-inch diam. pipe next to AC unit behind Latchis Theater.	Visited with Rick Ethier July 21, 2011. DPW committed to follow up with property owner.

BR-1220	Chlorine (tapwater)	15-inch diam., white PVC pipe discharging to Whetstone Brook from Bridge St. retaining wall, east of Main St.	Visited with Rick Ethier July 21, 2011. DPW committed to conducting follow on investigation.
BR-910	Fuel odor/iron staining (petroleum)	4-inch diam. pipe discharging at base of concrete abutment, 150 feet east of Elm St. bridge	Known contaminated site.
BR-940	Fuel odor/iron staining (petroleum)	Groundwater seep forming stream around periphery of wetland area at base of slope.	Known contaminated site.
BR-2280	Fuel odor/iron staining (petroleum)	18-inch diam. corrugated metal outfall behind #7 Valley Rd.	Referred to DEC Sites Management Section.
BR-2370	Fuel odor/iron staining (petroleum)	Outfall behind #17 Valley Rd., buried in rubble.	Referred to DEC Sites Management Section.
BR-2960	Fuel odor/iron staining (petroleum)	Groundwater seep entering high flow channel in braided section of Whetstone Brook.	Referred to DEC Sites Management Section.

If follow-up sampling was conducted for total nitrogen and *E. coli* analysis and assuming it was possible to measure the flow rate, a total nitrogen mass loading rate was calculated. These data are tabulated in the report sections for certain outfalls. These mass loading rates are based on analysis of a single grab sample and an instantaneous measurement of flow rate. The instantaneous mass loading rate is expressed in grams per day.

To date, the Town of Brattleboro has made two confirmed corrections, fixing a tapwater leak discharging at outfall BR-330 and repairing a ruptured sewer service line to an apartment house on Canal Street, eliminating a source of raw wastewater discharged at outfall BR-920. Follow up work planned by the Brattleboro Department of Public Works is outlined in the sections describing each discharge.

3.1. Wastewater/washwater Discharges

Outfall BR-800

Outfall BR-800 discharges to Whetstone Brook immediately south of the intersection of Elliot Street and Frost Street. The system drains a portion of Elliot Street and side streets. The outfall is buried in large stone rip rap. Low concentrations (0.25 and 0.5 mg/L) of MBAS detergents was detected in dry weather flows on October 18 and December 10, 2010 (Table 4).

Table 4. Water analysis data for outfall BR-800

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation
10/18/10	0.0	526	0.04	0.5	Negative	Suds
12/10/10	0.0	NS	0.00	0.25	NS	
6/16/11	0.0	466	0.04	0.25	NS	Clear, no odor
NS = no sample collected						

On June16, 2011, a thorough assessment of the contributing drainage system was made to identify the source of the dry weather flow and the low levels of detergent. A sump pump was found discharging to the system at the end of Stewarts Place; this appeared to contribute most of the dry weather flow in the system. The outlet of this pump is shown in Photo 1. No MBAS detergent was found in this flow and no other sources of inflow were observed in the system except for groundwater seepage entering catch basins on Elliot Street at the toe of a steep slope. Because the primary source of the dry weather flow was found to be a sump pump and because only low levels of MBAS detergent and no optical brightener were found at the outfall, detection of MBAS detergent was attributed to outdoor washing.

Photo 1. Outlet of sump pump in system discharging at BR-800

Outfall BR-920

BR-920 is a 20-inch diameter ceramic outfall from the Canal Street storm sewer (Photo 2). It discharges to Whetstone Brook just east of the Elm Street bridge and drains much of the southern end of the town (Figure 2). Most of the dry weather flow passes through a gap between the final two pipe sections into the rocks below,

Photo 2. Outfall BR-920

A low concentration of MBAS detergent (0.2 mg/L) was detected during the assessment on October 19, 2010 (Table 5). However, the flow was clear and not malodorous and neither optical brightener nor ammonia was detected. Sampling on December 10, 2010 produced similar results. When the outfall was revisited on June 16-17, 2011, the flow had a septic odor and grayish cast and ammonia and optical brightener were detected. Duplicate samples collected on July 6, 2011 had *E. coli* levels exceeding the analytical range (>2,419.6 MPN/100 mL). Therefore, an extensive investigation of the Canal Street storm sewer for optical brighteners was performed to bracket the source(s) of contamination. Strong detections of optical brightener were found in the lower block, between the intersection of Brook Street and the outfall.

Table 5. Water analysis data for outfall BR-920

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Discharge (L/s)	*E. coli* (MPN/100 mL)	Total N conc. (mg/L)	Total N loading (g/d)
10/19/10	0.0	748	0.00	0.2	Negative	NA	NS	NS	NA
12/10/10	0.0	NS	0.00	0.25	NS	NA	NS	NS	NA
6/16/11	0.75	532	0.03	0.25	NS	NA	NS	NS	NA
6/17/11	NS	NS	NS	NS	Positive	NA	NS	NS	NA
7/6/11	0.5	NS	0.00	0.2	NS	0.12	>2,419.6	1.04	11
7/14/11	NS	NS	NS	NS	Positive	NA	NS	NS	NA
NA = Not applicable; NS = no sample collected									

On July 21, 2011, the system was inspected with Rick Ethier. A catch basin (catch basin BR-920C in Figure 3) that had been partially paved over was opened, revealing an obviously leaking iron sewer service line from an apartment house crossing through the catch basin (Photo 3). Feces and toilet paper were observed in the catch basin. Dye was added to a toilet in the apartment house to confirm the failure of the sewer line. According to Gary Corey, a neighbor of the apartment house who happens to work for Brattleboro DPW, the apartment house has seven permanent residents plus many regular guests. Mr. Corey noted that a drain cleaning company (Roto-Rooter or similar) cleared a clog in the service line during the winter or early spring of 2011; it is possible this work caused or increased leakage from the pipe subsequent to the December 2010 outfall sampling. Brattleboro DPW sleeved the broken sewer line the same day and has required the owner of the apartment house to reroute the sewer service line. The property owner plans to connect the building sewer to a different pipe serving a neighboring property.

Photo 3. Catch basin BR-920C. Note green dye from sewer system

Outfall BR-1030

Outfall BR-1030 is a 12-inch diameter ceramic pipe discharging at the north bank of Whetstone Brook behind the Dunklee and Sons building on Flat Street. A low concentration of MBAS detergent (0.2 mg/L) was detected during the assessment on October 19, 2010 (Table 6). However, the flow was clear and not malodorous and neither optical brightener nor ammonia was detected. Sampling on December 16, 2010 produced similar results. Because the optical brightener test was negative and no ammonia was present, a washwater source in the contributing drainage system was suspected.

Table 6. Water analysis data for outfall BR-1030

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener
10/19/10	0.0	738	0.02	0.2	Pad lost
10/26/11	NS	NS	NS	NS	Negative
12/16/10	0.0	NS	0.00	0.2	NS
6/16/11	0.1	687	0.03	0.25	NS
6/17/11	NS	NS	NS	NS	Negative
NS = no sample collected					

Extensive assessment of the contributing drainage system on June 16, 2011 indicated that elevated detergent was present in the catch basin directly in front of the fire station on Elliot Street. Detergent foam was observed in the catch basin. Flow from this catch basin, sampled where it entered the catch basin marked BR-1610 in Figure 4, had a high MBAS detergent concentration of 3.0 mg/L and a low detection of chlorine (0.05 mg/L). Fire trucks are reportedly washed on the small lot in front of the fire station, which slopes to the catch basin. The Town of Brattleboro was apprised of this finding.

Outfall BR-1160

Outfall BR-1160 is a 42-inch diameter concrete pipe that discharges to Whetstone Brook under the north side of the Main Street bridge (Photo 4). The contributing drainage system includes north Main Street and portions of Elliot, High, Grove, Linden, and other side streets (Figure 5). Optical brightener was found at the outfall during the initial assessment on October 20, 2010. Results of the initial assessment and follow-up sampling at outfall BR-1160 are presented in Table 7.

Photo 4. Outfall BR-1160

Table 7. Water analysis data for outfall BR-1160

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Discharge (L/s)	*E. coli* (MPN/100 mL)	Total N conc. (mg/L)	Total N loading (g/d)
10/20/10	0.0	179.3	0.04	0.0	Positive	NA	NS	NS	NA
11/30/10	NS	NS	NS	NS	NS	0.06	107	2.41	13
6/2/11	NS	NS	NS	NS	Positive	NA	NS	NS	NA
6/16/11	0.0	769	0.02	0.2	NS	NA	NS	NS	NA
7/6/11	0.0	NS	0.00	0.4	Positive	0.017	1730; >2419.6	2.72	4
NA = Not applicable; NS = no sample collected									

Due to the detection of optical brightener on October 20, 2010, an investigation was performed to bracket the source of the contamination. Intensive optical brightener monitoring of the BR-1160 storm sewer was performed on June 16 and again on July 14, 2011, with over 40 pads deployed in total. Fluorescence of the pads was observed in three areas: High Street between North Main Street and Oak Street; in the Brown & Roberts building parking lot off High Street; and in the lot behind the Brooks House (Figure 6).

High Street

Optical brightener was found in the main storm line on High Street from North Main Street up to the catch basin located approximately 350 feet east of Oak Street. On July 21, 2011, I visited the site with Rick Ethier. Wastewater infiltration was suspected between catch basin #36, which was dry, and catch basin #34 (Figure 6), which had a small amount of flow and a laundry odor. There are four houses between these catch basins. An apartment house close to the intersection of High Street and Brook Street was entered to perform dye testing. The apartment building appeared to have three sewer lines, only one of which could be easily tested. Within approximately 10 minutes, no dye was seen in catch basin #34. The other houses were not entered. Mr. Ethier committed to follow on investigation, possibly using a sewer line camera.

Brown & Roberts lot

Optical brightener was found in the catch basin in the driveway of the Brown & Roberts apartment building (#24) and in down-pipe catch basins. An 8-inch diameter PVC pipe enters this catch basin from the direction of the apartment building. On July 21, 2011, I visited the site with Rick Ethier. The PVC pipe was not flowing but there was a discolored pool of water in the basin (Photo 5). Mr. Ethier indicated that he would work with the owner, Hugh Barber, to determine the origin of the pipe.

Photo 5. Catch basin in the Brown & Roberts lot

Lot behind Brooks House

In back of the Brooks House is a catch basin that tested positive for optical brighteners. Two green PVC sewer lines cross the catch basin, although neither appeared to be flowing when visited with Rick Ethier on July 21, 2011. Mr. Ethier noted that the storm water drainage system in back of the Brooks House will be reconstructed soon, due to undermining during fire suppression of the Brooks House fire. We expect the problem will be solved by reconstruction of the system.

Outfall BR-1950

Outfall BR-1950 is a 24-inch diameter corrugated metal outfall discharging to Ames Hill Brook opposite #238 Greenleaf Ave. When assessed on November 1, 2010, no ammonia, MBAS detergents, or chlorine were found and the flow appeared clear, with no odor; therefore, we were surprised optical brightener was detected (Table 8). Extensive investigation and remapping of the contributing storm sewer was begun after a follow up optical brightener test also was positive. Optical brightener was traced from the outfall up a small stream channel to a collection system on Mather Road, as far as the first catch basin on the west side of the road (Figure 7). At this catch basin, monitoring pads were placed in each of three incoming pipes. A positive test was recorded in the center pipe, which had a slow, dry weather flow. The origin of this pipe and the flow is unknown but the alignment is in the direction of #75 Mather Road.

Table 8. Water analysis data for outfall BR-1950

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Discharge (L/s)	*E. coli* (MPN/100 mL)	Total N conc. (mg/L)	Total N loading (g/d)
11/1/10	0.0	165.2	0.01	0.0	Positive	NA	NS	NS	NA
11/30/10	NS	NS	NS	NS	Positive	0.37	1	0.79	26
6/16/11	NS	NS	NS	NS	Intermediate	NA	NS	NS	NA
NA = Not applicable; NS = no sample collected									

On July 21, 2011 the catch basin was visited with Rick Ethier, who indicated that #75 Mather Road is the only house north of the cemetery that is not connected to the municipal wastewater treatment system. We speculated that the septic system at #75 Mather Road is malfunctioning and wastewater is infiltrating into the storm sewer system. Mr. Ethier committed to conducting follow up investigation, possibly using a sewer camera or snake.

Outfall BR-2020

The storm sewer on Greenleaf Avenue in West Brattleboro discharges to Bonnyvale Brook via a 24-inch ceramic outfall located under the Western Avenue bridge. This system includes drainage from Western Avenue, Greenleaf Avenue, and Green Meadow Road (Figure 8). Ammonia, chlorine, and MBAS detergents were below limits of detection when the outfall was assessed on November 1, 2010; however, optical brightener was detected (Table 9).

Optical brightener monitoring pads were deployed throughout the system on November 30, 2010. The pad placed in the sump of catch basin Q, at the intersection of Greenleaf Avenue and Country Hill, and all down-pipe pads tested positive for optical brightener; no pads above catch basin Q tested positive (Figure 8). The pad at the outfall was lost. Three pipes enter catch basin Q (Photo 6), each of which was then tested independently. Ammonia, chlorine, and MBAS detergents were below detection in all three pipes and specific conductance was low. For pads collected on July 6, the catch basin sump and the two larger diameter pipes shown in Photo 6 tested negative for optical brightener and the smaller diameter pipe in the middle was indeterminate. We were surprised that a convincing positive detection was not found in one of the pipes entering catch basin Q, given the strong detection in the catch basin sump and at monitored catch basins down the storm line during bracket sampling. It is possible that the source of washwater was eliminated during the monitoring period, for instance, by disconnection of a washing machine.

Table 9. Water analysis data for outfall BR-2020

Date	Ammonia (mg/L)	Sp. conductance (μs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Discharge (L/s)	*E. coli* (MPN/100 mL)	Total N conc. (mg/L)	Total N loading (g/d)
11/1/10	0.0	329	0.00	0.0	Positive	NA	NS	NS	NA
11/30/10	NS	NS	NS	NS	Pad lost	0.95	42	1.82	149
NA = Not applicable; NS = no sample collected									

Photo 6. Catch basin Q in BR-2020 storm sewer

During deployment of optical brightener monitoring pads on November 30, 2010, many plastic bags apparently filled with dog waste were found in catch basins near #113, #132, and #139 Green Meadow Road. When alerted to this condition, the Brattleboro Public Works Department promptly placed a sign in the area discouraging pet waste dumping into the drainage system.

Catch basin Q was visited with Rick Ethier on July 21, 2011. Mr. Ethier suspected an intermittent gray water connection at one or more of the houses in the area and committed to follow on investigation with a pipe snake and/or contacting homeowners. At the time of this visit, no one was home at #13 County Hill, the house in alignment with the smaller diameter pipe shown in Photo 6.

Catch basin BR-3000

Catch basin BR-3000 is the furthest downstream structure that can be accessed in a collection system draining Western Avenue and adjacent commercial lots (Figure 9). The outfall is located on posted, private property. Three pipes discharge to the catch basin. When observed on November 15, 2010, only one pipe was flowing, a small diameter PVC pipe entering from the direction of the appliance store ("Pipe C"). This discharge had an elevated ammonia concentration (Table 10). Pipe C was dry on several return visits, including November 30 and December 10, 2010. The discharge was resampled on June 16, 2011 when a trickle of flow was observed from Pipe C. A low concentration of ammonia was detected on this date.

Table 10. Water analysis data for Pipe C discharge in catch basin BR-3000

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation
11/15/10	0.6	32.4	0.00	0.1	Negative	Clear, no odor
11/30/10	Not flowing					
12/10/10	Not flowing					
6/16/11	0.2	26.2	0.02	0.0	NS	
7/21/11	Not flowing					
NS = no sample collected						

We suspect there may be a floor drain or other drain in the building housing the appliance store that is connected to catch basin BR-3000. However, we rarely observed flow in the suspect pipe and never observed high concentrations of any measured parameter. The moderate level of ammonia (0.6 mg/L) measured on November 15, 2010 suggests that some type of discharge occurred at this time, possibly mop water added to an interior drain. However, with no additional support in the data we took no further steps to identify the problem.

3.2. Tapwater Discharges

Outfall BR-330

Outfall BR-330 is a 4-inch diameter PVC pipe near the intersection of Chestnut and Locust Streets (Figure 10). The outfall was flowing when assessed on October 11, 2010. The depth of flow was approximately ¼ inch. The measured chlorine concentration was 0.88 mg/L, indicating an undiluted tapwater source (Table 11). No ammonia, MBAS detergent, or optical brightener was detected and the water appeared clear. A water leak was identified in a nearby valve chamber.

The Brattleboro DPW reportedly fixed the water leak in November, 2010. The pipe was dry when checked again on June 6, 2011, indicating the repair was successful.

Table 11. Water analysis data for outfall BR-330

Date	Ammonia (mg/L)	Sp. conductance (μs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation
10/11/10	0.0	76.8	0.88	0.0	Negative	Clear, no odor

Outfall BR-1140

Outfall BR-1140 is a small diameter (1.5-inch) pipe next to the air conditioning unit behind the Latchis Theater (Figure 11; Photo 7). This small flow appears to be tapwater. When assessed on October 20, 2010, the chlorine concentration was high (0.53 mg/L) and no ammonia or MBAS detergent were detected (Table 12). The site was pointed out to Rick Ethier on July 21, 2011, who indicated that DPW would discuss the source of the flow with the property owner to seek its elimination.

Photo 7. Sampling outfall BR-1140

Table 12. Water analysis data for outfall BR-1140

Date	Ammonia (mg/L)	Sp. conductance (μs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation
10/20/10	0.0	90.4	0.53	0.0	NS	Clear, no odor
6/16/11	0.0	115.4	0.3	0.0	NS	
NS = no sample collected						

Outfall BR-1220

Outfall BR-1220 is a 15-inch diameter PVC pipe located high on the retaining wall below Bridge Street, east of the Bridge Street intersection. Dry weather flow sampled on October 20, 2010 had an elevated chlorine concentration of 0.12 mg/L. (Table 13). There was no ammonia, MBAS detergent, or optical brightener detected and specific conductance was low. Based on these data, we suspect that tapwater is entering this system. A detailed investigation of this source was not performed because we did not regard this as a significant water quality problem. This outfall was pointed out to Rick Ethier on July 21, 2011, who indicated that DPW would investigate it further.

Table 13. Water analysis data for outfall BR-1220

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation
10/20/10	0.0	88.5	0.12	0.0	Negative	Clear, no odor, strong flow

3.3. Petroleum Discharges

Outfall BR-910 / Seep BR-940

Outfall BR-910 (Photo 8) is a 4-inch diameter pipe discharging to the south bank of Whetstone Brook, 150 feet east of the Elm Street bridge (Figure 3). The pipe discharges at the base of a concrete abutment. Flow from the pipe had a distinct petroleum odor when observed on October 19, 2010 and again on June 16, 2011 (Table 14). Iron staining is present at the pipe outlet.

Table 14. Water analysis data for outfall BR-910

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation
10/19/10	0.0	810	0.00	0.2	Negative	Petroleum odor, iron staining
6/16/11	NS	NS	NS	NS	NS	Petroleum odor, iron staining

Photo 8. Outfall BR-910

Outfall BR-910 is suspected of passing contaminated groundwater, likely related to the gasoline release at Canal Street Mobile on Canal Street (DEC site #91-1005), which was identified in 1991. Monitoring wells located in the adjacent wetland area are part of DEC's response to this release. Water flowing around the edge of this wetland at the base of the slope also has a distinct petroleum odor. This flow, identified as BR-940, is shown in Photo 9. It is assumed to be contaminated groundwater from the same source as present in BR-910.

Photo 9. Seep BR-940 bordering wetland

Outfall BR-2280 / Outfall BR-2370

Outfalls BR-2280 and BR-2370 are located behind homes on Valley Road in West Brattleboro (Figure 12). Outfall BR-2280 behind #7 Valley Road is an 18-inch diameter corrugated metal pipe (Photo 10). Outfall BR-2370 behind #17 Valley Road is buried in rubble. When outfalls BR-2280 and BR-2370 were observed on November 2 and 8, 2010, respectively, petroleum odor and an orange floc attached to the substrate were evident (Tables 15 and 16). In the summer of 2011, the Brattleboro Department for Public Works made an excavation on Valley Road to complete a water line repair and noted a strong petroleum smell in the excavation, which corroborated our field observations and suggests a larger source rather than separate sources infiltrating into the BR-2280 and BR-2370 storm sewers.

Photo 10. Outfall BR-2280

Table 15. Water analysis data for outfall BR-2280

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation	*E. coli* (MPN/100 mL)	Total N conc. (mg/L)
11/2/10	0.25	566	0.01	0.0	Pad lost	Petroleum odor, iron staining	NS	NS
11/10/10	NS	NS	NS	NS	Negative		NS	NS
11/30/10	0.0	NS	NS	NS	NS		9	1.12
Note: Discharge measurement was not possible due to submerged conditions, therefore no data are provided on Total N loading.								

Table 16. Water analysis data for outfall BR-2370

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Optical brightener	Observation
11/8/10	0.1	488	0.00	0.2	Negative	Petroleum odor, iron staining

Seep BR-2960

BR-2960 is a seep area discharging to a secondary channel of Whetstone Brook (Figure 13). This channel (Photo 11) is located behind a lumber supply lot on Route 9 in West Brattleboro. The channel had a heavy accumulation of orange floc and a slight petroleum odor when assessed on November 25, 2010.

Contamination at this discharge location may be related to a documented release at Fleming Texaco, 328 Marlboro Road (Route 9) in West Brattleboro (site #88-0195). It is possible contaminated groundwater migrated to Whetstone Brook in this location.

Table 17. Water analysis data for seep BR-2960

Date	Ammonia (mg/L)	Sp. conductance (µs/cm)	Chlorine (mg/L)	MBAS (mg/L)	Observations
11/25/10	0.0	274	0.00	0.0	Iron staining, slight petroleum odor

Photo 11. Seep BR-2960

4. CONCLUSIONS

A thorough assessment was made of the storm sewer systems in Brattleboro for the presence of illicit discharges. Over 300 structures were assessed. Eleven sources of wastewater/washwater and tapwater were found, at least two of which have been corrected to date. The Brattleboro DPW has committed to further the investigations into these sources to seek their correction as described in the tables provided. Apparent petroleum contamination was observed in three areas. These areas have been referred to the DEC Sites Management Section for inspection.

We recommend that DEC periodically contact the Town of Brattleboro Public Works Department regarding the status of further investigations (such as intended camera investigation of the storm sewer on High Street, Mather Road, and Greenleaf Avenue) and resolution of the problems identified in this report. Follow up monitoring activities should be considered to confirm that future repairs result in water quality improvement. In particular, optical brightener monitoring of the BR-920, BR-1160, BR-1950, and BR-2020 storm sewers should be repeated to confirm all sources of wastewater and washwater have been eliminated from these systems. Lastly, the sanitary sewer behind the Brattleboro Retreat adjacent to the West River should be checked periodically to ensure that the facility does not allow the overflow problem DEC discovered to reoccur.

5. REFERENCES

American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 21th edition, Washington D.C., 2005.

Hach Company. Hach Method #8167. Loveland, CO.

Stone Environmental, Inc., SEI SOP 5.23.3: Maintenance and Calibration of the pH/Con 10 Meter. February 24, 2003.

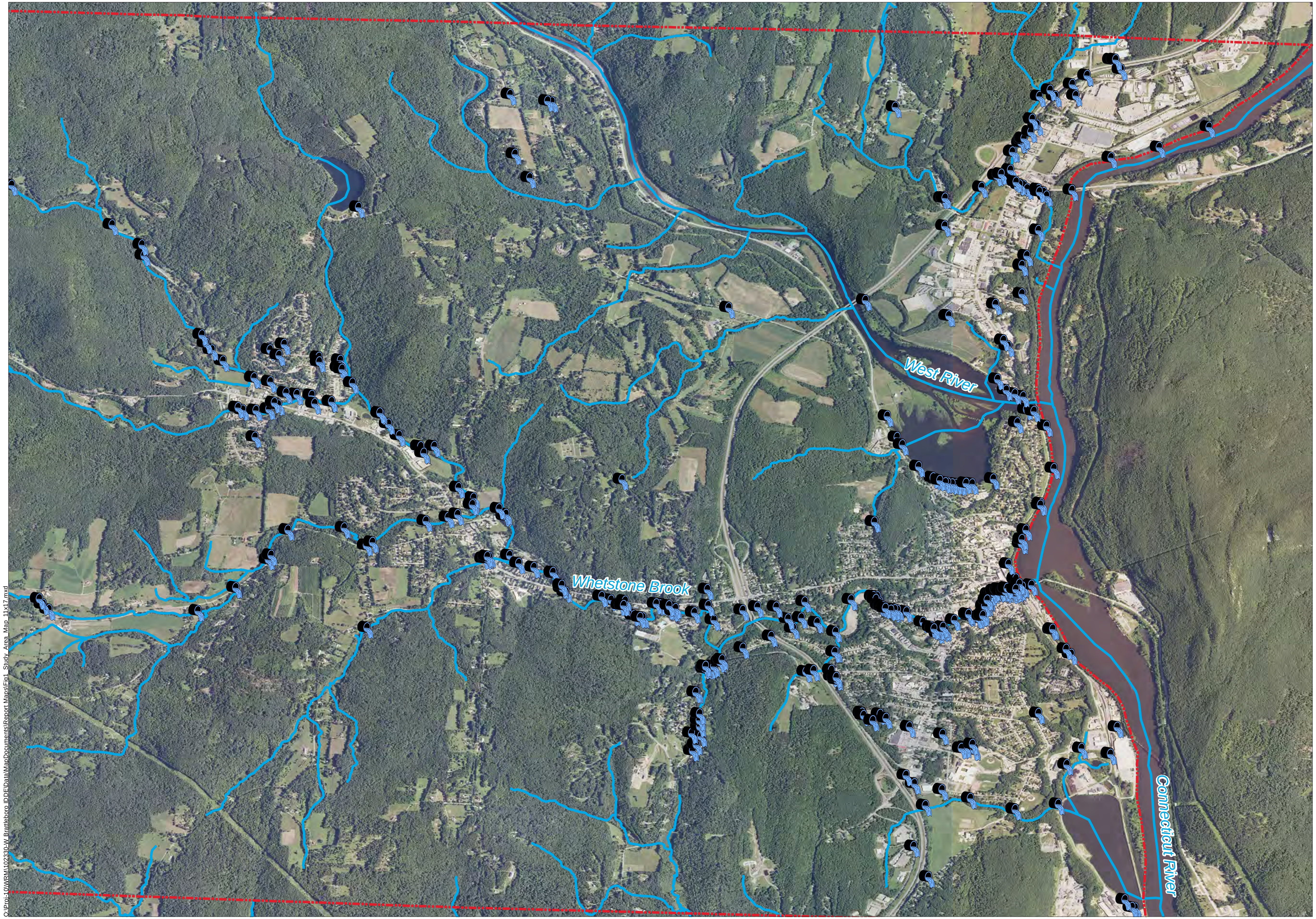
Stone Environmental, Inc., SEI SOP 6.38.0: Optical Brightener Testing, September 11, 2008.

6. FIGURES

Figure 1

Brattleboro IDDE

Brattleboro, VT



Stormwater Infrastructure

Outfall

River or Stream

Brattleboro Town

0 0.25 0.5 Miles

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Figure 2
Brattleboro IDDE
Brattleboro, VT

Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream
- Detention pond
- Infiltration basin
- Infiltration gallery
- Other
- Pooling area
- Sedimentation basin
- Storage treatment structure
- Stormwater storage tanks

0 50 100 200 Feet

N W E S

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

O:\Proj-10\WRM\102330-W Brattleboro IDDE\Data\MapDocuments\Report Maps\Fig2_Discharge_BR920_11x17.mxd

Figure 3
Brattleboro IDDE
Brattleboro, VT

Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 50 100 200 Feet

N E S W

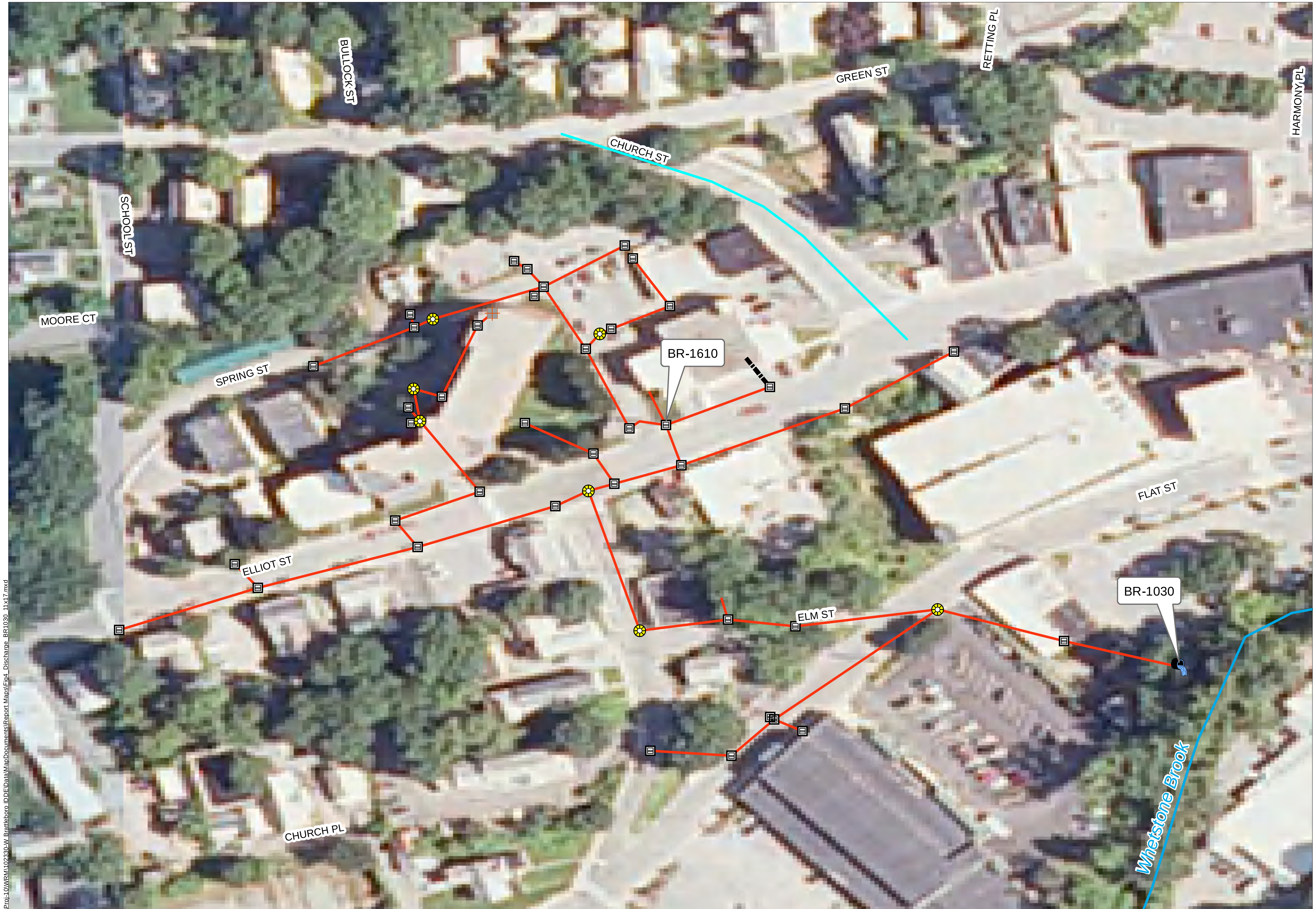
Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Figure 4

Brattleboro IDDE

Brattleboro, VT



Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 25 50 100 Feet

N W E S

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Figure 5
Brattleboro IDDE
Brattleboro, VT

Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 100 200 400 Feet

N W E S

Sources: ESRI: Imagery; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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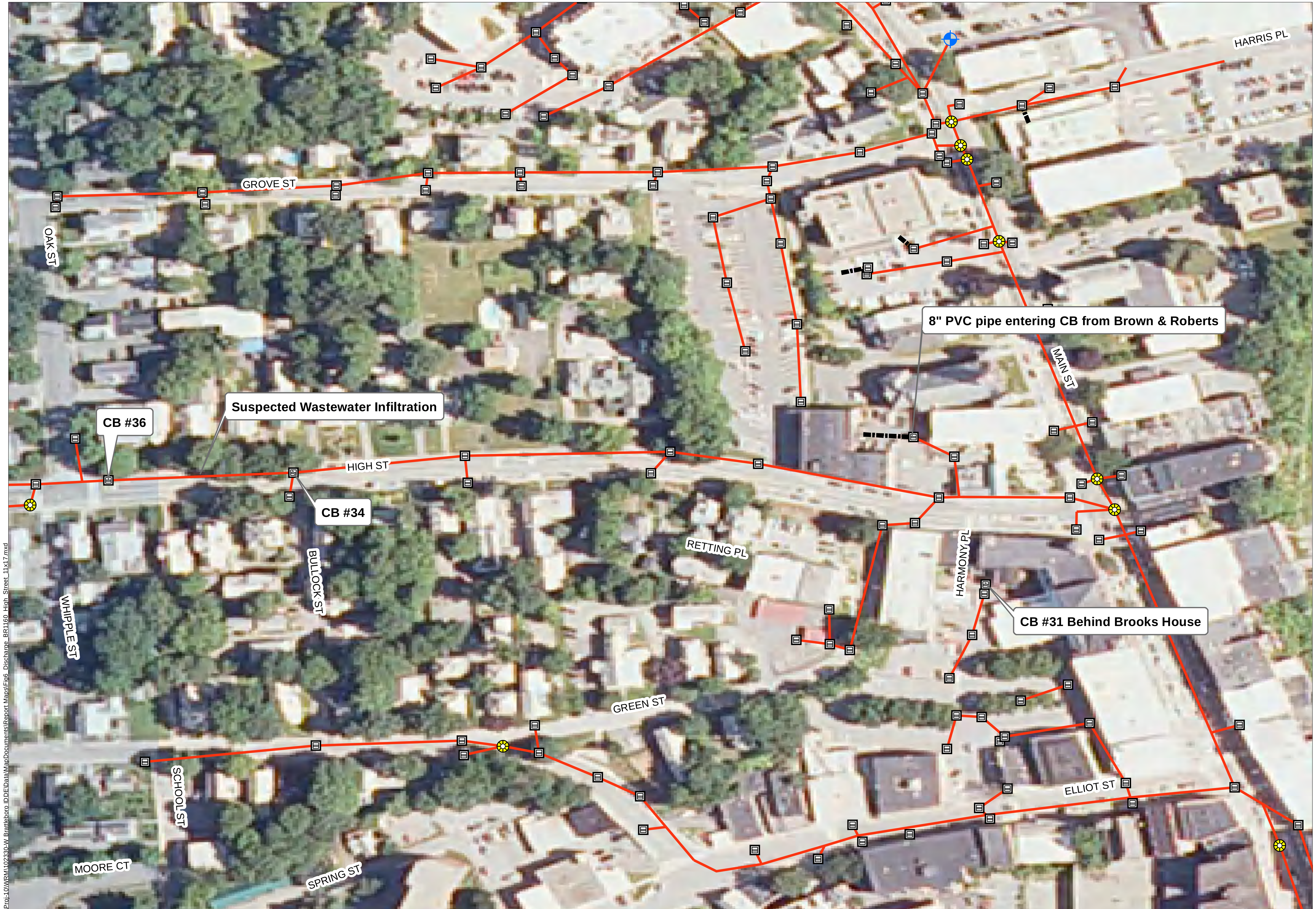

Figure 6
Brattleboro IDDE
Brattleboro, VT

Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 50 100 200 Feet

N W E S

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Figure 7
Brattleboro IDDE
Brattleboro, VT

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Figure 8
Brattleboro IDDE
Brattleboro, VT

Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 50 100 200 Feet

N W E S

Sources: ESRI: Imagery; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

O:\Proj-10\WRM\102330-W Brattleboro IDDE\Data\MapDocuments\Report Maps\Fig8_Discharge_BR2020_11x17.mxd

Figure 9
Brattleboro IDDE
Brattleboro, VT

Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Groundwater Seep
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 25 50 100 Feet

N W E S

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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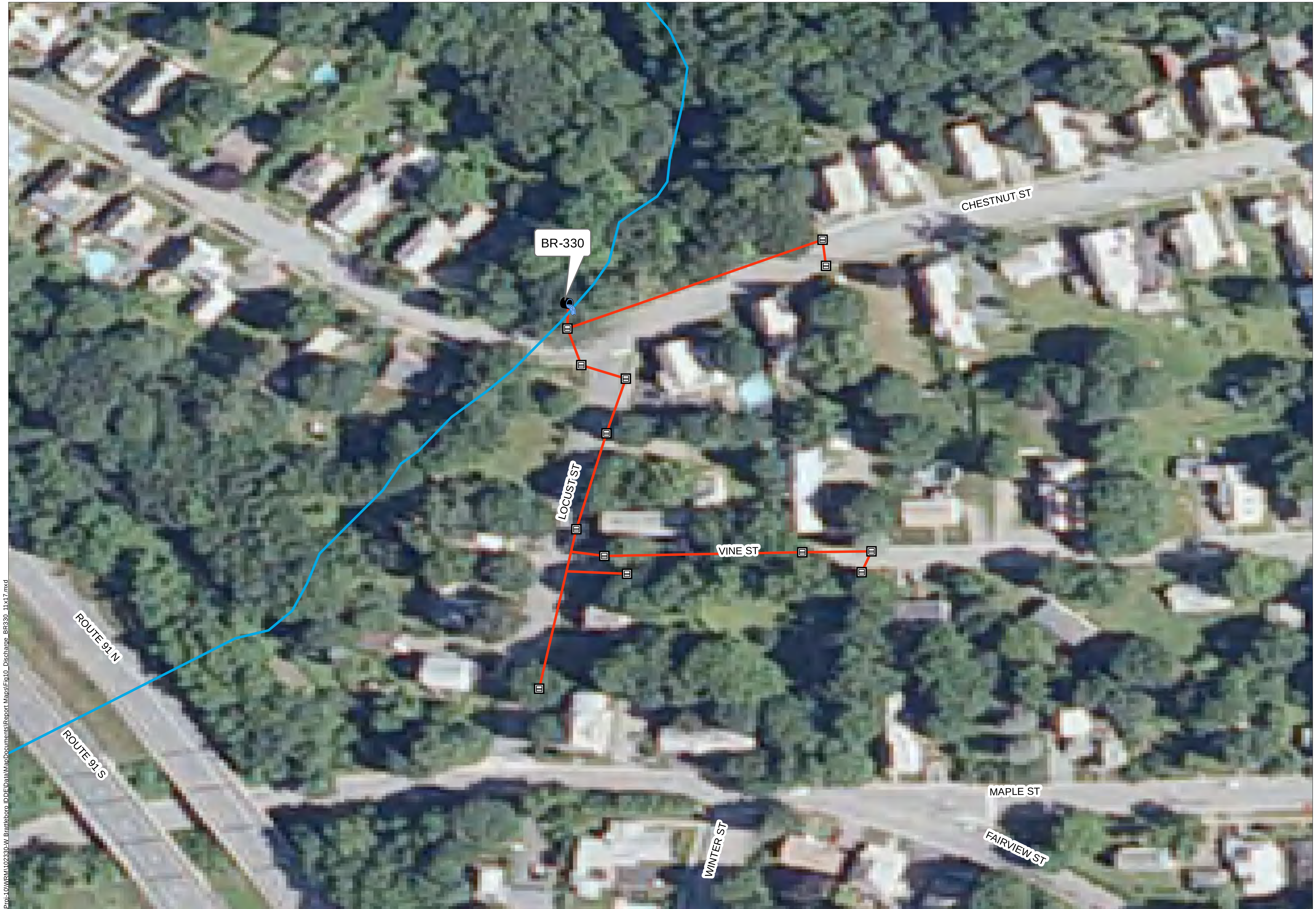
Figure 10
Brattleboro IDDE
Brattleboro, VT



Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 25 50 100 Feet

N E S W

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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Figure 11
Brattleboro IDDE
Brattleboro, VT

Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

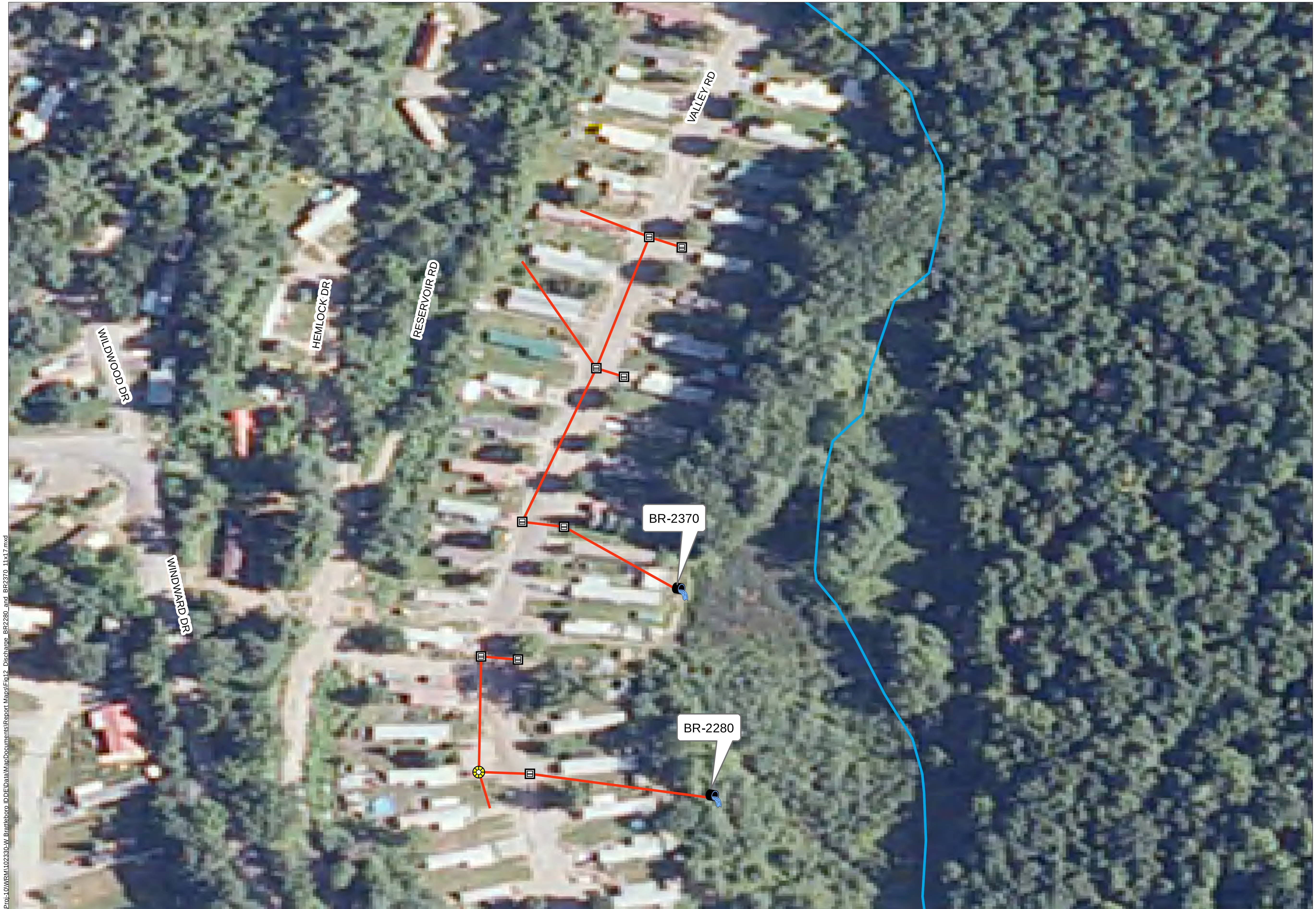
0 12.525 50
Feet

N W E S

Sources: ESRI: Imagery;
DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

Figure 12
Brattleboro IDDE
Brattleboro, VT



Stormwater Infrastructure

- Culvert Outlet
- Catch Basin
- Catch Basin tied to sanitary
- Stormwater manhole
- Combined sewer manhole
- Outfall
- Known CSO outfall
- Retrofit
- Grate/Curb inlet
- Dry well
- Drop inlet
- Stormline
- Stormline (old sanitary)
- Combined sewer
- Swale
- Footing drain
- Under drain
- Roof drain
- River or Stream

0 25 50 100 Feet

N W E S

Sources: ESRI: Imagery; DEC: Stormwater Infrastructure

STONE ENVIRONMENTAL INC

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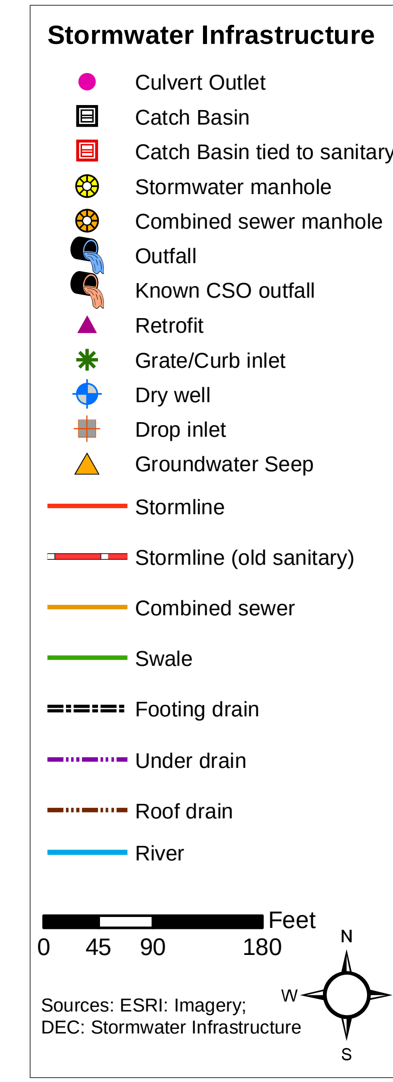
Figure 13
Brattleboro IDDE
Brattleboro, VT



STONE ENVIRONMENTAL INC

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APPENDICES

APPENDIX A: FIELD DATA SHEET

IDDE ID: ______________________________________				DEC ID Cross Ref.:______________________________		
Date: ___________________	Time: __________________			Inspector: ____________________________________		
Structure type: ___________________________________				Inner diameter (outfall only)__________________________in.		
Material (outfall only):	corrugated metal	concrete	corrugated black plastic	smooth plastic	other (describe): ____________________	
Flow depth (outfall only)::	dry	Wet (no flow)	dripping	Flowing depth __________________________________(in.)		
Pipe position (outfall only):	Free flow	partially submerged	submerged	If partially submerged, surcharged? YES NO		
Erosion at outfall	none	If present, describe: ____				
Discharge characteristics (observations on color, turbidity, and odor of flow):						
Floatables:	none	sheen	sewage	suds	other ______________________________	
Deposits or staining:	none	sediment	oily	iron staining	other_______________________________	
Damage to structure:	none	cracking, spauling	corrosion	crushed	other_______________________________	
Obstructions:	none	partially obstructed		fully obstructed	other___________________________	
OB pad set? YES NO			Date OB pad retrieved________________________________			
Ammonia________________ mg/L			Specific conductance ____________________μS/cm			
Total chlorine________________ mg/L			Free chlorine________________ mg/L			
Anionic surfactants________________ mg/L						
Sample collected for *E. coli* analysis: YES NO NA				Time: ______________________________		
Sample collected for N analysis: YES NO NA				Time: ______________________________		
Flow measurement (if *E. coli* and/or nutrients sample collected):						
Comments:						

APPENDIX B: STONE STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE

SEI-5.23.3

MAINTENANCE AND CALIBRATION OF THE pH/CON 10 METER

SOP Number: SEI-5.23.3 Date Issued: 05/14/99
Revision Number: 3 Date of Revision: 02/24/03

1.0 OBJECTIVE

This standard operating procedure (SOP) explains the calibration and maintenance of the Oakton pH/Con 10 meter and the Cole-Parmer pH/Con 10 meter. The meters are identical except for the distributor's names. The meter is manufactured by Cole-Parmer and distributed by Cole-Parmer and Oakton. The operator's manual should be referred to for the applicable procedures described below. The pH/Con 10 meter is used for measuring the pH, conductivity, and temperature of water. The pH/conductivity meters generate and measure data, and thus must meet the requirements of 40 CFR part 160 subpart D.

2.0 POLICIES

1. According to 40 CFR Part 160, Subpart D, Section 160.61, Equipment used in the generation, measurement, or assessment of data and equipment used for facility environmental control shall be of appropriate design and adequate capacity to function according to the protocol and shall be suitable located for operation, inspection, cleaning, and maintenance.
2. Personnel will legibly record data and observations in the field to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

3.0 SAFETY ISSUES

1. If necessary and appropriate, a site-specific health and safety plan shall be created for each study site. A template for creating a proper health and safety plan is provided on the SEI network.
2. If necessary and appropriate, all chemicals are required to be received with Material Safety Data Sheets (MSDS) or appropriate application label. These labels or MSDS shall be made available to all personnel involved in the sampling and testing.

4.0 PROCEDURES

4.1 Equipment and Materials

1. The pH/Con 10 meter, pH/conductivity/ temperature probe. The probe cable has a notched 6-pin connector to attach to probe meter.

2. If necessary and appropriate, standard solutions (e.g., standard pH 4.0 and 7.0, conductivity standards)

3. Clean beakers or other appropriate containers

4. Log or other appropriate medium to record calibration.

4.2 Meter Set-up and Conditioning

1. The pH/Con 10 meter uses a combination pH/conductivity/temperature probe. The probe cable has a notched 6-pin connector to attach the probe meter. Keep connector dry and clean.

2. To connect the probe, line up the notches and 6-pins on the probe connector with the holes in the connector located on the top of the meter. Push down and the probe connector will lock into place.

3. To remove probe, slide up the metal sleeve on the probe connector. While holding onto metal sleeve, pull probe away from the meter. Do not pull on the probe cord or the probe wires might disconnect.

4. Be sure to decontaminate the probe prior to use. The probe shall be tripled rinsed with distilled or deionized water. Further decontamination and cleaning procedures may be called for in special situations or outlined in approved protocols or work plans. This will be documented in field notes or in an appropriate logbook.

5. Be sure to remove the protective rubber cap of the probe before conditioning, calibration, or measurement. If the probe is clean, free of corrosion, and the pH bulb has not become dehydrated, simply soak the probe in tap water for ten minutes before calibrating or taking readings to saturate the pH electrode surface to minimize drift. Wash the probe as necessary in a mild detergent solution. If corrosion appears on the steel pins in the conductivity cell, use a swab soaked in isopropyl alcohol to clean the pins. Do not wipe the probe; this causes a build-up of electrostatic charge on the glass surface. If the pH electrode has dehydrated, soak it for 30 minutes in a 2M-4M KCI boot solution prior to soaking in tap water.

6. Wash the probe in deionized water after use and store in pH 4.0 standard solution or an approved boot solution (per the manufacturer's instruction).

4.3 pH Calibration

1. The meter is capable of up to 3-point pH calibration to ensure accuracy across the entire pH range of the meter. At the beginning of each day of use, perform a 2 or 3-point calibration with standard pH buffers 4.00, 7.00, and 10.00. Calibration standards that bracket the expected sample range should be used. Never reuse buffer solutions; contaminants in the solution can affect the calibration.

2. Press the MODE key to select pH mode. The pH indicator appears in the upper right corner of the display.

3. Dip the probe into the calibration buffer. The end of the probe must be completely immersed into the buffer. Stir the probe gently to create a homogeneous buffer solution. Tap probe to remove any air bubbles.

4. Press CAL/MEAS to enter pH calibration mode. The primary display will show the measured reading while the smaller secondary display will indicate the pH standard buffer solution.

5. Press □ or □ keys to scroll up or down until the secondary display value is the same as the pH buffer value (pH 4.00, 7.00 or 10.00).

6. Wait for the measured pH value to stabilize. The READY indicator will display when the reading stabilizes. After the READY indicator turns on, press ENTER to confirm calibration. A confirming indicator (CON) flashes and disappears. The meter is now calibrated at the buffer indicated in the secondary display.

7. Repeat steps 3, 5, and 6 using a second or third pH standard.

8. Press CAL/MEAS to return to pH measurement mode.

4.4 Conductivity Calibration

1. Select a conductivity standard with a value near the sample value expected. The meter should be calibrated by the user(s) at the beginning of each day of use.

2. Pour out two separate portions of your calibration standard and one of deionized water into separate clean containers.

3. Press MODE key to select Conductivity. The ΦS or mS indicator will appear on the right side of the display.

4. Rinse the probe with deionized water, and then rinse the probe in one of the portions of calibration standard. Record the calibration standard on the per use maintenance form or other appropriate medium.

5. Immerse the probe into the second portion of calibration standard. The meter♣s autoranging function selects the appropriate conductivity range (four ranges are possible). Be sure to tap the probe to remove air bubbles. Air bubbles will cause errors in calibration.

6. Wait for the reading to stabilize. The READY indicator lights when the reading is stable. Press the CAL/MEAS key. The CAL indicator appears above the primary display. The primary display shows the measured reading and the secondary display shows the temperature. Record the initial calibration standard on the per use maintenance form or other appropriate medium.

7. Press the □ or □ keys to scroll to the value of your conductivity standard. Press and hold the □ or □ keys to scroll faster. The meter automatically compensates for temperature differences using a factor of 2.00% per BC.

8. Press ENTER key to confirm calibration. Upon confirmation, the CON indicator appears briefly. The meter automatically switches back into Measurement mode. The display now shows the calibrated, temperature compensated conductivity value. However, if the calibration value input into the meter is different from the initial value displayed by more than 20% , the ERR annunciator appears in the lower left corner of the display

4.5 Temperature Calibration/Verification

1. The built-in temperature sensor is factory calibrated. Therefore, no additional calibration is necessary. However, the temperature may be verified against another working thermometer. However, if errors in temperature readings are suspected or if a replacement probe is used. Refer to the operating instructions if temperature calibration is necessary.

4.6 General and annual Maintenance

Individual users are responsible for the calibration, cleaning, repair, and maintenance of the instrument.

Routine inspection and maintenance schedules vary from each piece of equipment. Typically there are minor maintenance needs each piece of equipment will need to undergo prior to use in the field (such as cleaning or conditioning). Always consult the manufacturer♣s instructions for general maintenance.

Specific per use maintenance needs for the pH /Con 10 meter include but are not limited to:

1. Inspect probe for physical damage and debris

2. Inspect meter for physical damage and debris
3. Clean probe w/ mild detergent
4. Rinse probe in distilled water
5. Clean conductivity pins with isopropyl alcohol (if necessary)
6. Condition probe
7. Calibrated to pH 7.0
8. Calibrated to pH 4.0
9. Calibrated to pH 10.0

The pH /con 10 meter shall be stored in a clean dry place, usually the padded box that it came in. Care should be given to keep the instrument from dust and contamination.

Wash the probe in distilled water after use, and store in pH 4 solution.

All maintenance, repairs, and calibrations are to be documented on an equipment maintenance log or other appropriate medium. Follow the checklist provided on the equipments maintenance log for regular use maintenance needs. Any maintenance must include documentation of whether the maintenance was routine and followed the SOP or not.

Equipment logs shall be brought to the field for documenting use and calibration. The logs will be returned to the office after each field use and filed in the equipment records filing cabinet.

In the event of failure due to breakage or loss of parts, an attempt will be made to repair or replace the necessary parts by the field personnel who discover the malfunction. All repairs will be documented in field notes and/or on a non-routine maintenance log. If the instrument is rendered “out of service” or “broken”, it should be tagged as such. If further repair is necessary, return the instrument to the manufacturer following proper shipping procedures.

Non-routine repairs must include documentation of the nature of the defect, how and when the defect was discovered, and any remedial action taken in response to the defect.

5.0 RESPONSIBILITIES

1. All personnel will legibly record data and observations (including phone conversations) in accordance with this SOP to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

2. Prior to use and after use, all equipment will be appropriately cleaned, decontaminated, calibrated (if necessary) and stored in accordance with the manufacturer’s instructions and this SOP.

6.0 DEFINITIONS

1. *Decontamination* – Procedures followed to ensure cross contamination does not occur between sampling points or that potential contamination of equipment does not pose a hazard to sampling personnel.

2. *EPA* the U.S. Environmental Protection Agency.
3. *FIFRA* the Federal Insecticide, Fungicide, and Rodenticide Act as amended.
4. *Maintenance* – Actions performed on equipment to standardize and/or correct the accuracy and precision of a piece of equipment to ensure that the equipment is operating within the manufacturer's specifications and standard values.
5. *Study* means any experiment at one or more test sites, in which a test substance is studied in a test system under laboratory conditions or in the environment to determine or help predict its effects, metabolism, product performance (pesticide efficacy studies only as required by 40 CFR 158.640) environmental and chemical fate, persistence, or residue, or other characteristics in humans, other living organisms, or media. The term "study" does not include basic exploratory studies carried out to determine whether a test substance or a test method has any potential utility.

7.0 REFERENCES

40 CFR Part 160 Good Laboratory Practice Standards, August, 1989.

8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

9.0 AUTHORIZATION

Revised by:______________________________________ Date:_____________

Michael Nuss, Staff Scientist

Approved by:______________________________________ Date:_____________

Christopher T. Stone, President

10.0 REVISION HISTORY

Revision number 1:

1. Changed title and references to Oakton in Sections 1.0 and 2.0 to enable this standard operating procedure to apply to both the Oakton pH/Con 10 meter and the Cole-Parmer pH/Con 10 meter, as these are identical meters.
2. Added instructions about cleaning and re-hydrating the probe to Section 3.1.
3. Added Section 9.0.
4. Reformatted.
5. Minor word editing.

Revision number 2:

1. Changed the title.
2. Removed sections 7.0 (Measurement) and 8.0 (Maintenance/Repairs).
3. Added section called (General and Annual Maintenance).
4. Minor editing.
5. Reformatted.

Revision number 3:

1. Minor wording edits in Section 1.0, Objective.
2. Updated style to match SEI Style Guide – font and text. Reformatted using MS Word.
3. Added standardized section headers: 2.0 Policies, 3.0 Safety, 5.0 Responsibilities, 6.0 Definitions, 7.0 References, 8.0 Tables, Diagrams, Flowcharts and Validation data. Authorization moved to Section 9.0, andSection10.0 Revision History.
4. Deleted section on logs being given to the QAU.
5. Other minor wording edits.

STANDARD OPERATING PROCEDURE

SEI-6.38.0

OPTICAL BRIGHTENER TESTING

SOP Number: SEI-6.38.0	Date Issued: 09/11/08
Revision Number: 0	Date of Revision: NA

1.0 OBJECTIVE

Optical brighteners are fluorescent dyes used in almost all laundry soaps and detergents. When optical brightener is applied to cotton fabrics, they will absorb ultraviolet rays in sunlight and release them as blue rays. These blue rays interact with the natural yellowish color of cottons and give the garment the appearance of being "whiter than white". Optical brightener dyes are generally found in domestic wastewaters that have a component of laundry effluent. Because optical brighteners are fluorescent white dyes that absorb ultraviolet "U.V." light and fluoresce in the blue region of the visible spectrum, they can therefore be detected by use of a long wave ultraviolet light (a "black" light).

Optical brightener monitoring can be used to indicate the presence of wastewater in stormwater drainage systems, streams, and other water courses. Since optical brighteners are removed by adsorption onto soil and organic materials as effluent passes through soil and aquifer media, optical brightener monitoring may also be used to identify incompletely renovated wastewater effluent in groundwater at wastewater dispersal sites.

To test for optical brightener, a cotton pad is placed in a flow stream for a period of 4-8 days, after which the pad is rinsed, air dried, and viewed under a long range ultraviolet light. Florescence indicates the presence of optical brightener. Optical brighteners may be monitored in a wide range of structures and flow streams. For example, monitoring pads may be placed in stormwater outfall pipes, within catchbasins and manholes, or in any other man-made or natural water conveyance. Optical brightener pads may be placed in dry pipes or other dry structures to monitor possible intermittent flow streams. However, the more common application is to monitor discharge points that are flowing under dry weather conditions.

2.0 POLICIES

1. According to 40 CFR Part 160, Subpart E, Section 160.81, a testing facility shall have standard operating procedures in writing setting forth study methods that management is satisfied are adequate to ensure the quality and integrity of the data generated in the course of a study.
2. Personnel will legibly record data and observations in the field to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

3.0 SAFETY ISSUES

1. If necessary and appropriate, a site-specific health and safety plan shall be created for each study site. A template for creating a proper health and safety plan is provided on the SEI network.
2. Care must always be taken when approaching a sampling location. Do not, under any circumstances, place yourself in danger to collect a sample.
3. If necessary and appropriate, all chemicals are required to be received with Material Safety Data Sheets (MSDS) or appropriate application labels. These labels or MSDS shall be made available to all personnel involved in the sampling and testing.

4.0 PROCEDURES

4.1 Equipment and Materials

1. Untreated cotton pad measuring approximately 10 cm by 10 cm (e.g., VWR cat no. 21902-985 or equivalent).
2. Fiberglass or nylon screen to enclose the cotton pad (sewn or stapled).
3. Monofilament fishing line (approximately 20 to 50 lb. test).
4. Field notebook, sample collection form, or other acceptable medium for recording field data.
5. Protective gloves if contamination is suspected in the water to be sampled, or if cold weather may be hazardous with wet hands.

4.2 Sampling Procedure and Sample Handling

4.2.1 Optical Brightener Pad Assembly

To assemble an optical brightener monitoring pad, place an untreated cotton pad measuring approximately 10 cm by 10 cm (e.g., VWR cat no. 21902-985) in an envelope made of a screen material. A light fiberglass screen is preferred. The pad may be folded in half to double its thickness. Sew, staple, or otherwise secure all open sides of the screen envelope to enclose the pad.

4.2.2 Optical Brightener Pad Placement

1. Secure the pad at the monitoring point using high test nylon fishing line (20 - 50 lb. test). The pad may be attached to any convenient anchor, provided the pad is as well exposed to the flow stream as possible and the anchor point appears stable enough to resist the force of high flow events.

2. If a suitable anchor is not present, a heavy object may be placed in the flow stream or channel to anchor the pad. For example, a pad may be anchored in a stream by tying it to a concrete block. When sampling culverts or stormwater outfall pipes, the pad may be attached to a rock or other heavy object placed in the end of the pipe. When placed in a culvert or outfall pipe, the pad should trail several inches from the anchor point and lie flat against the bottom surface of the pipe.

3. Two or more optical brightener monitoring pads may be placed at monitoring points if appropriate. If more than a single pad is used, the pads should be anchored so that they do not become entangled.

4. Record the date each pad is deployed and any other relevant information in a field logbook or on a specified sample collection form.

4.2.3 Optical Brightener Pad Retrieval and Handling

1. After a 4-8 day period of exposure, optical brightener pads should be collected. The collection of each pad should be recorded in a field logbook or on a specified sample collection form.

2. Any object inserted in a pipe or other structure to anchor the pad should be removed.

3. Pads should be placed in individually labeled resealable bags. The sample label should indicate the monitoring point identification.

4. The pad should be gently rinsed using the monitored flow stream, cold tap water, or bottled water. Do not rinse the pad in the receiving water body. Lightly squeeze out excess water with a clean hand. Do not wring out the pad.

5. The pad should be removed from the screen envelope using scissor to cut open the envelope. The pad should then be returned immediately to the labeled bag.

6. Pads should be air dried. The pad may be hung on a line to dry within the labeled bag. If a resealable plastic bag is used, cut the bottom corners of the bag and perforate the bag to allow airflow to the pad.

4.3 Optical Brightener Analysis

1. When the pad is dry, expose the pad under a high quality long range ultraviolet light ("black" light) in a room that is completely dark. A non-exposed and an exposed pad are used as controls and compared to each test pad as it is exposed to the U.V. light.

2. There are three qualitative results: Positive, Negative, and Retest. A pad will very definitely glow (fluoresce) if it is positive. If it is negative it will be noticeably drab and similar to the control pad.

All other tests are undetermined or retests. Pads may be sorted into the basic categories: positive test, negative test, and retest. Further, for positive tests, the pads may be sorted into categories by the relative strength of the fluorescence. A pad that is fluoresces brightly over most or all of its surface may be considered a strongly positive test, whereas a pad on which fluorescence appears patchy or faint may be considered a weakly positive test.

3. In some instances, only a portion of the pad or simply the outer edge will fluoresce after being exposed to optical brightener. This can be caused by many factors but is usually the result of an uneven exposure to the dye in the flow stream due to sedimentation or the way the pad was placed in water. Regardless, as long as a portion of the pad fluoresces, it should be considered positive.

4. Since paper and cotton dust is so pervasive, it is common to see specks or spots of fluorescence on the test or control pads. These should be ignored and not used to indicate a positive result.

5. With the lights back on, record the identification number and the test result for each pad.

6. It is advisable to have a second reader perform the pad observations independently. The results are then compared. Any conflicting interpretations may be resolved though repeated observation of the pad in question, or a by a third observer.

5.0 RESPONSIBILITIES

1. All personnel will legibly record data and observations (including phone conversations) in accordance with this SOP to enable others to reconstruct project events and provide sufficient evidence of activities conducted.

6.0 DEFINITIONS

1. *Study* means any experiment at one or more test sites, in which a test substance is studied in a test system under laboratory conditions or in the environment to determine or help predict its effects, metabolism, product performance (pesticide efficacy studies only as required by 40 CFR 158.640) environmental and chemical fate, persistence, or residue, or other characteristics in humans, other living organisms, or media. The term “study” does not include basic exploratory studies carried out to determine whether a test substance or a test method has any potential utility.

7.0 REFERENCES

40 CFR Part 160 Good Laboratory Practice Standards, August, 1989.

MASS Bay Program. 1998. An Optical Brightener Handbook. http://www.thecompass.org/8TB/pages/SamplingContents.html

8.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

None

9.0 AUTHORIZATION

Revised by:_______________________________________ Date:_____________

Dave Braun, Project Scientist/Water Quality Specialist

Approved by:______________________________________ Date:_____________

Christopher T. Stone, President

10.0 REVISION HISTORY