Illicit Discharge Track Down Protocol and Sampling Procedure

Step 1 – Visual Inspection of Outfall

- The visual inspection routinely will be done during the summer, when the area is driest, to minimize the possibility of general groundwater input. A 72 hour antecedent dry period should be observed prior to the site visit to reduce the possibility of observing storm water runoff rather than illicit connections. This 72 hour period also acts to standardize conditions to facilitate between-site comparisons.

- Complete an Outfall Reconnaissance Inventory (ORI)/Sample Collection Field Sheet (see attached) for each outfall. Developed by Pitt (2004) and field-tested in this project, the ORI serves two purposes. First, it provides a QA/QC check on the mapping and outfall inspection conducted by Bergmann Associates. It is important to confirm site coordinates with a GPS unit. Second, it allows a rapid determination of the potential need for additional investigation, based on the relative rankings: Unlikely (i.e. no illicit connection); Potential (possible illicit connection); Suspect (greater possibility of illicit connection); and Obvious (clearly an illicit connection problem).

- The rankings in assessing the potential for illicit connection are based on the presence and relative severity of several indicator conditions: a) *Flowing Outfalls* – flow, odor, color, turbidity, presence of floatables; and b) *Physical Indicators (both flowing and non-flowing outfalls)* – outfall damage, deposits/stains, abnormal vegetation, poor pool quality, pipe benthic growth. As a general rule of thumb, any outfall rated at the Potential level or higher should be scheduled for follow-up sampling.

- If flow at the outfall is observed, flow rate (Q) will be measured using one of two methods. With smaller flows, a bucket will be used to collect water for a timed period and the volume of water will be measured in a graduated 1 L beaker (a number of creative approaches to channeling the flow into the bucket may need to be considered). With larger flows, the velocity will be measured using some type of velocity meter (e.g. Marsh McBirney model 2000 meter; Price AA meter). For the second approach, the width and depth of flow also will be measured to calculate flow rate:

    - Q (m^3/s) = width of flow (m) x average depth of flow (m) x velocity of flow (m/s)
        - 1 m^3/s = 1,000 L/s
        - average depth of flow computed from several measurements taken across the width of flow in the pipe

- Flow temperature, pH, and ammonia *were not* measured in this visual inspection (although this is suggested by Pitt (2004)).

Step 2 – Sample Flowing Outfalls with "Potential" Illicit Rating or Higher

- A 72 hour antecedent dry period should be observed prior to the sampling to avoid cross-contamination or dilution associated with storm water runoff. This 72 hour period also acts to standardize conditions to facilitate between-site comparisons.

- Using a certified clean, wide mouth, 1L amber glass bottle, collect a sample directly from the flow (always wear lab gloves when sampling and conducting analytical tests). Rinse the bottle once with the flow for conditioning and discard. Collect a second 1 L sample to retain for laboratory analysis. In a separate, clean, 1 L amber glass bottle, collect a sample for on-site analysis of pH, temperature, and dissolved oxygen. Use a certified clean dipper or bailer if the flow cannot be reached to fill the 1L amber bottles. As with the bottles, the dipper or bailer should be 'conditioned' prior to collecting a sample.

- Measure and record flow rate again, per the methods described in Step 1.

- From the "laboratory analysis" bottle extract 1 mL of sample using a disposable, sterile, plastic pipette and dispense the 1 mL sample into the Coliscan Easygel growth media screw-top plastic vial.

- From the "on-site" 1 L amber bottle pour a sufficient sample volume (following kit instructions) to complete the pH and dissolved oxygen tests. Waste water (after addition of reacting chemicals) should be poured into a waste bottle for proper disposal at the lab. The biochemical oxygen demand (BOD_5) test (bottle collection) should be taken last from the 1L amber on-site bottle as a small amber bottle must be filled by submersion.

- Make certain the sample bottles are labeled with the site ID and that the site ID on the bottle matches that of the site ID written on the Trackdown Field Report.

- Temperature should be taken from the on-site 1 L amber bottle no later than 10 minutes after its collection. The thermometer should be allowed to equilibrate in the sample for at least one minute. The thermometer's digital readout should be watched and a reading taken only after the reading stabilizes. Avoid placing the bottle and thermometer in direct sunlight.

- Place the 1 L amber glass sample bottle for the laboratory analysis and the Coliscan Easygel growth media (containing the 1 mL water sample) on ice for preservation in the field.

- Make sure the Trackdown Field Report has been completed (see attached). It is important to record the coordinates of each sample site with a GPS unit for mapping and data interpretation purposes.

Step 3 – Laboratory Analysis of Selected Parameters

- Test the sample, immediately (within a maximum of 6 hours) upon return to the laboratory, for a set of indicator water quality parameters as described in Table 1. These sample parameters and analytical methods were selected through a review of Pitt (2004), Pomeroy et al. (1996), and through our own experience in evaluating water quality with community groups (e.g. http://www.buffalostate.edu/orgs/aqua/ ; Irvine et al., 2004; Wills and Irvine, 1996). The guiding principle for the sampling program is to assess meaningful parameters that can be analyzed easily and inexpensively (particularly important for municipalities with limited resources) with reasonable accuracy.

- All laboratory results must be entered and stored immediately in the MS4 Permit Manager database.

- Laboratory methodologies are not described in detail here, but are documented fully in Irvine and Vermette (in prep.).

Table 1 – Suggested Indicator Analytical Parameters

Parameter	Analytical Method	Parameter	Analytical Method
Dissolved oxygen	CHEMetrics, Indigo Carmine	Potassium	Turbidimetric method, Hanna colorimeter
BOD_5	CHEMetrics, Indigo Carmine	Total Dissolved Solids	Oakton Instruments, TDSTestr
Water temperature	Thermometer	Detergents	CHEMetrics, methylene blue
pH	pHydrion, one drop indicator	Phenols	CHEMetrics, 4-Aminoantipyrine
Hardness	Aquarium Pharm. (Ca&Mg titration)	Pesticides	Nat. Safety Prod. (atrazine and simazine)
Turbidity	Cole Parmer, titration	Petroleum	Hanby Environmental Labs
Suspended Solids	Filtration (0.45 µm filters)	Fluoride	SPADNS, Hanna colorimeter
Nitrate	CHEMetrics, Cadmium Reduction	Chlorine	DPD, Hanna colorimeter
Phosphate	CHEMetrics, Indigo Carmine	Chromium	Diphenylcarbo-hydrazide, Hanna colorimeter
E. coli	Coliscan Easygel		
Ammonia	Nessler method, Hanna colorimeter	Copper	Bicinchoninate, Hannna colorimeter

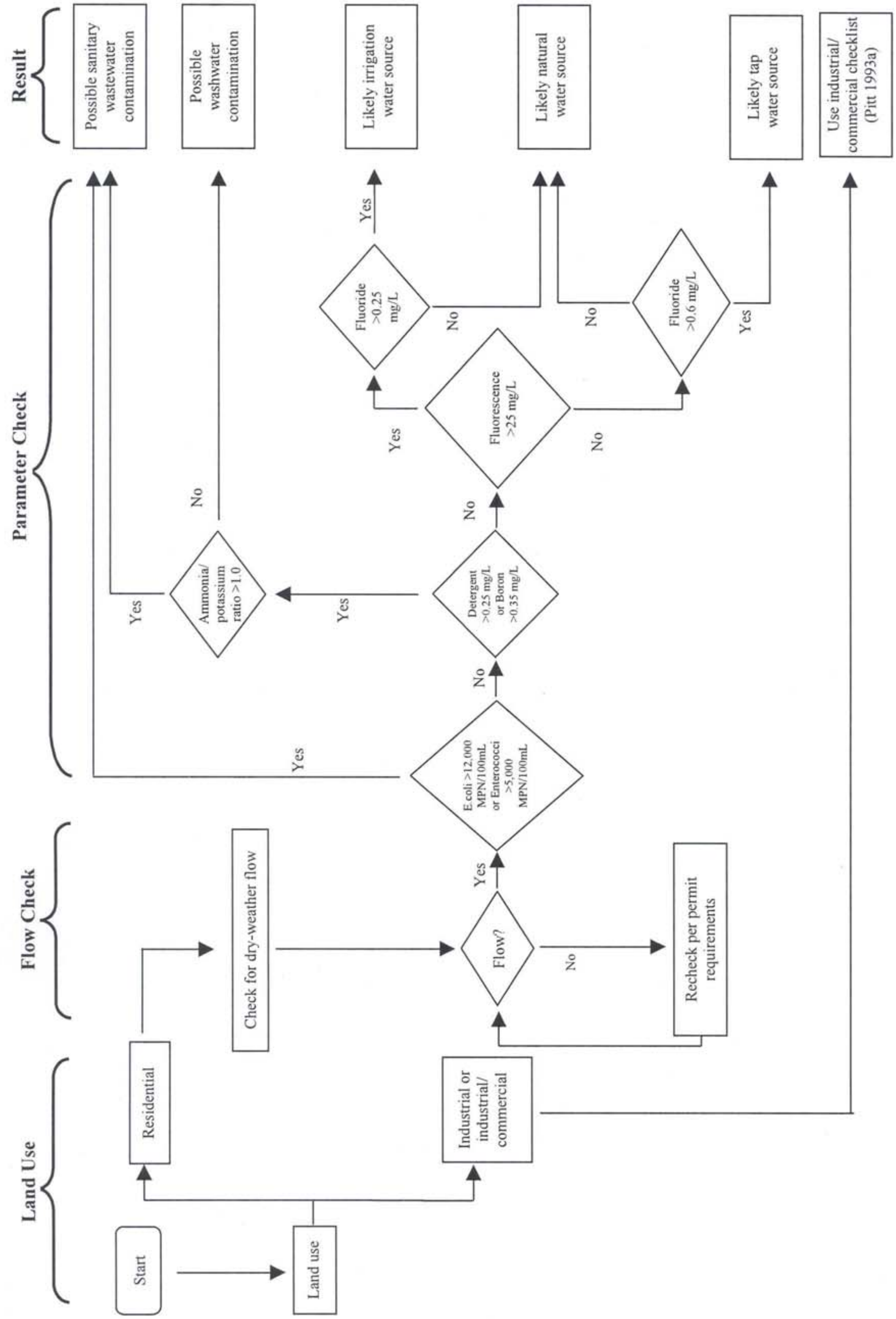
Step 4 – Determine if Further Trackdown Sampling is Required

- After a review of the results for the outfall, determine whether a further source trackdown is needed. To assist in this determination, the flow chart method, enhanced with industrial benchmark data (when appropriate) should be used, as recommended by Pitt (2004). The flow chart method is summarized in Figure 1. For outfalls that have a large number of industrial sites, additional indicator parameters to those shown in Figure 1 may be needed because industrial discharges may not be composed of sewage or washwater (e.g. industrial process water or wash down water from a floor drain). Pitt (2004) identified seven parameters that can be used as industrial flow benchmarks and these are summarized in Table 2. Additional benchmarks may be developed through this project.

Table 2 Benchmark Concentrations to Identify Industrial Discharges (after Pitt, 2004)

Indicator Parameter	Benchmark Concentration	Notes
Ammonia (mg/L)	≥50	• Existing "Flow Chart" parameter • Concentrations higher than the benchmark can identify a few industrial discharges
Color (units)	≥500	• Supplemental parameter that identifies a few specific industrial discharges; should be refined with local data
Conductivity (µS/cm)	≥2,000	• Identifies a few industrial discharges • May be useful to distinguish between industrial sources
Hardness (mg/L as $CaCO_3$)	≤10 ≥2,000	• Identifies a few industrial discharges • May be useful to distinguish between industrial sources
pH (units)	≤5	• Only captures a few industrial discharges • High pH values also may indicate an industrial discharge but residential wash waters also can have high pH
Potassium (mg/L)	≥20	• Existing "Flow Chart" parameter • Excellent indicator of a broad range of industrial discharges
Turbidity (NTU)	≥1,000	• Supplemental parameter that identifies a few specific industrial discharges; should be refined with local data

Figure 1 Flow Chart Method for Trackdown (from Pitt, 2004)



Step 5 – Additional Trackdown Sampling

- If the outfall sample results suggest there may be an issue of illicit connection, then additional trackdown sampling must be done to identify the source.

- Consult sewer maps and land use maps to evaluate the potential contributing area and characteristics of the contributing area.

- The simplest, timely, and least costly approach to determine the contributing area is to conduct a visual field inspection. Working back from the outfall, examine key access junctions, as displayed on the sewer map, to visually determine the presence or absence of flow (a crowbar and flashlight are needed). Frequently, such inspections will identify potential contributing areas having no flow and these areas can be eliminated from further consideration in the trackdown.

- Once the "flow contributing area" has been determined through visual inspection, additional trackdown sampling can be done using two possible approaches. It only may be necessary to use one of the approaches, although both approaches used in tandem may provide more certain results. The first approach is to progressively sample up-pipe at manholes or other access points. Samples will be collected and analyzed per Steps 2 and 3 and sample results will be assessed per Step 4. The presence of one or more indicators, along with the examination of land use maps, can be used to suggest a contributing source. If no indictor is apparent from the lab tests, a groundwater source may be considered. It is important to record the coordinates of each sample site with a GPS unit for mapping and data interpretation purposes. The second approach to identify possible cross-connections and leaks will be to use a sewer camera. Several MS4s in the Western New York Stormwater Coalition have camera capabilities and have expressed a willingness to share their technology with those MS4s who do not have such capability.

Step 6 - Depending on the Suspected Source of the Illicit Discharge, a Course of Action will be Determined

References

Irvine, K.N., Vermette, S.J., Tang, T., Sampson, M., and Murphy, T.P. 2004. Partnering to provide water quality and GIS training in Cambodia. *Proceedings, 25th Asian Conference on Remote Sensing,* Asian Association on Remote Sensing, Bangkok.

Irvine, K.N. and Vermette, S.J. In prep. *Demonstration of Illicit Connection Trackdown and Receiving Water Impact Evaluation for MS4s.* Report to U.S. EPA, Region 2.

Pitt, R. 2004. *Illicit Discharge Detection and Elimination, A Guidance Manual for Program Development and Technical Assessments,* Center for Watershed Protection, MD.

Pomeroy, C., Cave, K., and Tuomari, D. 1996. *Technical Memorandum, Summary of Illicit Connection Detection Programs in Michigan,* Rouge River National Wet Weather Demonstration Project.

Wills, M. and Irvine, K.N. 1996. Application of the National Sanitation Foundation Water Quality Index to the Cazenovia Creek pilot watershed management study. *Middle States Geographer,* 29: 105-113.

Outfall Reconnaissance Inventory/ Sample Collection Field Sheet

Section 1: Background Data

Subwatershed:		Outfall ID:	
Today's date:		Time (Military):	
Investigators:		Form completed by:	
Temperature (°F):	Rainfall (in.): Last 24 hours:	Last 48 hours:	
Latitude:	Longitude:	GPS Unit:	GPS LMK #:
Camera:		Photo #s:	

Land Use in Drainage Area (Check all that apply):

- ☐ Industrial
- ☐ Ultra-Urban Residential
- ☐ Suburban Residential
- ☐ Commercial
- ☐ Open Space
- ☐ Institutional
- Other: ______
- Known Industries: ______

Notes (e.g., origin of outfall, if known):

Section 2: Outfall Description

LOCATION	MATERIAL	SHAPE		DIMENSIONS (IN.)	SUBMERGED
☐ Closed Pipe	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other: ______	☐ Circular ☐ Eliptical ☐ Box ☐ Other: ____	☐ Single ☐ Double ☐ Triple ☐ Other: ____	Diameter/Dimensions: ______	In Water: ☐ No ☐ Partially ☐ Fully With Sediment: ☐ No ☐ Partially ☐ Fully
☐ Open drainage	☐ Concrete ☐ Earthen ☐ rip-rap ☐ Other: ____	☐ Trapezoid ☐ Parabolic ☐ Other: ____		Depth: ____ Top Width: ____ Bottom Width: ____	
☐ In-Stream	(applicable when collecting samples)				
Flow Present?	☐ Yes ☐ No	*If No, Skip to Section 5*			
Flow Description (If present)	☐ Trickle ☐ Moderate ☐ Substantial				

Section 3: Quantitative Characterization

FIELD DATA FOR FLOWING OUTFALLS				
PARAMETER		**RESULT**	**UNIT**	**EQUIPMENT**
☐Flow #1	Volume		Liter	Bottle
	Time to fill		Sec	
☐Flow #2	Flow depth		In	Tape measure
	Flow width	____' ____"	Ft, In	Tape measure
	Measured length	____' ____"	Ft, In	Tape measure
	Time of travel		S	Stop watch
Temperature			°F	Thermometer
pH			pH Units	Test strip/Probe
Ammonia			mg/L	Test strip

Outfall Reconnaissance Inventory Field Sheet

Section 4: Physical Indicators for Flowing Outfalls Only
Are Any Physical Indicators Present in the flow? ☐ Yes ☐ No *(If No, Skip to Section 5)*

INDICATOR	CHECK if Present	DESCRIPTION	RELATIVE SEVERITY INDEX (1-3)		
Odor	☐	☐ Sewage ☐ Rancid/sour ☐ Petroleum/gas ☐ Sulfide ☐ Other:	☐ 1 – Faint	☐ 2 – Easily detected	☐ 3 – Noticeable from a distance
Color	☐	☐ Clear ☐ Brown ☐ Gray ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other:	☐ 1 – Faint colors in sample bottle	☐ 2 – Clearly visible in sample bottle	☐ 3 – Clearly visible in outfall flow
Turbidity	☐	See severity	☐ 1 – Slight cloudiness	☐ 2 – Cloudy	☐ 3 – Opaque
Floatables -Does Not Include Trash!!	☐	☐ Sewage (Toilet Paper, etc.) ☐ Suds ☐ Petroleum (oil sheen) ☐ Other:	☐ 1 – Few/slight; origin not obvious	☐ 2 – Some; indications of origin (e.g., possible suds or oil sheen)	☐ 3 - Some; origin clear (e.g., obvious oil sheen, suds, or floating sanitary materials)

Section 5: Physical Indicators for Both Flowing and Non-Flowing Outfalls
Are physical indicators that are not related to flow present? ☐ Yes ☐ No *(If No, Skip to Section 6)*

INDICATOR	CHECK if Present	DESCRIPTION	COMMENTS
Outfall Damage	☐	☐ Spalling, Cracking or Chipping ☐ Peeling Paint ☐ Corrosion	
Deposits/Stains	☐	☐ Oily ☐ Flow Line ☐ Paint ☐ Other:	
Abnormal Vegetation	☐	☐ Excessive ☐ Inhibited	
Poor pool quality	☐	☐ Odors ☐ Colors ☐ Floatables ☐ Oil Sheen ☐ Suds ☐ Excessive Algae ☐ Other:	
Pipe benthic growth	☐	☐ Brown ☐ Orange ☐ Green ☐ Other:	

Section 6: Overall Outfall Characterization

☐ Unlikely ☐ Potential (presence of two or more indicators) ☐ Suspect (one or more indicators with a severity of 3) ☐ Obvious

Section 7: Data Collection

1. Sample for the lab?	☐ Yes	☐ No		
2. If yes, collected from:	☐ Flow	☐ Pool		
3. Intermittent flow trap set?	☐ Yes	☐ No	If Yes, type: ☐ OBM	☐ Caulk dam

Section 8: Any Non-Illicit Discharge Concerns (e.g., trash or needed infrastructure repairs)?

Trackdown Field Report
Buffalo State/Erie County MS4 Stormwater Project

Date: ________________________ Sample Time: _____________________________

Tributary Outfall I.D.: ___________________ Sample I.D.:________________________

Sample Site Description:

Sample Site UTM (WGS84 datum): _______________________________________

On-site Measurements:

pH: ____________; Temperature (C): ______________; D.O., mg/L: _______________

Flow rate: __________________________________

Sample Volume Collected for Conventional Parameters:___________________________

Sample Volume Used for E. coli Analysis: ______________________________________

Sample Preservation: __________________________________

Weather Conditions:

Sample Team:____