Technical Memorandum

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Subject: IDDE monitoring in Baltimore Watersheds

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CENTER FOR WATERSHED PROTECTION

Acknowledgments

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Section 1. Introduction and Project Goals

Introduction

CWP has been working with the City of Baltimore for a number of years on the identification and tracking of illicit discharges. Previous funding from the Rauch Foundation supported the development and implementation of illicit discharge detection and elimination (IDDE) training for local watershed group staff as well as a series of recommendations for the City's IDDE program. Goals of the current project complement the original effort and also include quantification of illicit discharge pollution loads to local watersheds. Specific goals include the following:

1) Collect data that is indicative of illicit discharges from flowing outfalls in the project area;
2) Quantify the load of bacteria, nitrogen, phosphorus and pollutant volume in the project area;
3) Prepare maps, summary data and a field findings report;
4) Work with the City to eliminate illicit discharges; and
5) Create a draft outreach and communication plan.

Section 2. Field and Lab Methods

Water Quality Sampling

Outfall screening was conducted for outfalls in the Western Run and Moores Run subwatersheds as well as a portion of the Jones Falls mainstem (Figure 1). Every effort was made to conduct sampling after 24 hours of dry weather, however, due to the complicated field logistics and the number of field crews being organized, this was not always feasible.

Western Run sampling took place over five days from 5/13/2010 – 5/27/2010. Moores Run sampling took place over four days from 6/2/2010 – 6/9/2010. An additional day of sampling was conducted on the Jones Falls mainstem on 7/12/2010. Field teams walked approximately 11 miles of stream in Western Run, approximately 5.5 miles of stream in Moores Run and approximately 1.7 miles in the Middle Jones Falls mainstem. In addition, manholes were sampled at strategic junctions of buried stream in Western Run and Moores Run and in-stream measurements were collected at the top, bottom and at a mid-point in these subwatersheds as well (Attachment A).

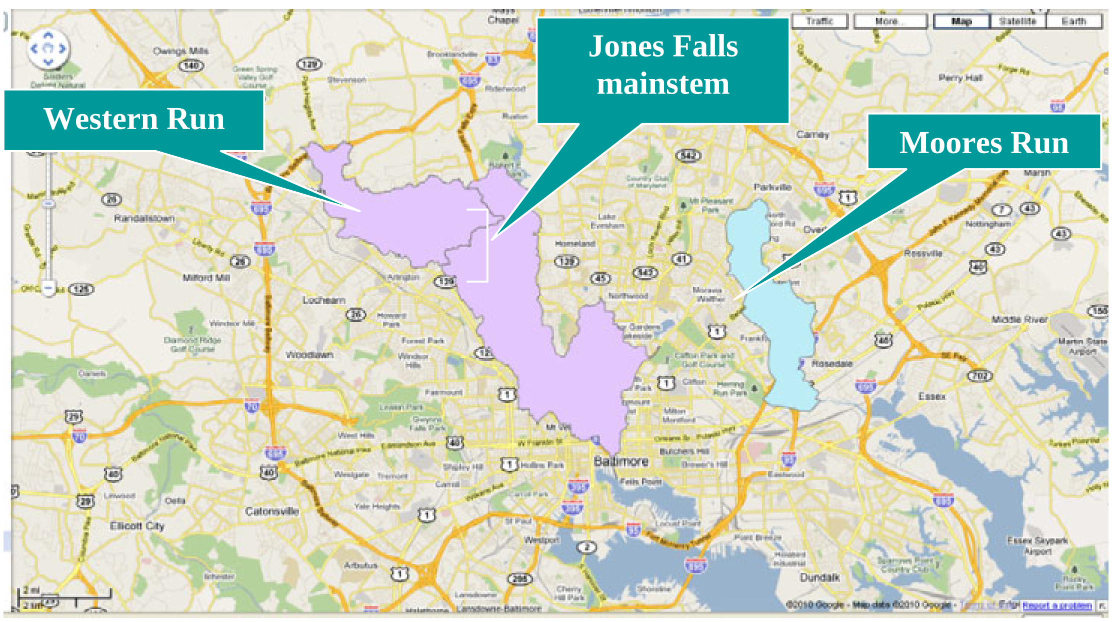


Figure 1. Project Study Area

Table 1 summarizes the number of samples and outfalls assessed in each subwatershed. Outfalls observed to have flow were investigated using the outfall reconnaissance inventory (ORI) technique described in Brown et al (2004) and screened for a number of illicit discharge indicators including flow, physical indicators and ammonia. Three samples were collected from each flowing outfall and analyzed as indicated in Table 2. Ammonia levels were measured on-site with a Hannah HI 93715 medium range photometer[i] and a threshold greater than 0.3 mg/L was used as an action level for further investigation.

Table 1. Outfall Summary

	Western Run	Moores Run	Jones Falls Mainstem
Total outfalls assessed	100	24	18
Flowing outfalls investigated	45	18	18
Manholes sampled	2	3	0
In-stream samples	5	3	0

Table 2. IDDE Lab Analysis

<table>
<tr><th></th><th>Parameters Analyzed</th><th>Equipment</th><th>Method</th><th>Location</th><th>Notes</th></tr>
<tr><td rowspan="3">Sample 1</td><td>Fluoride</td><td>Hannah HI 93729 Low Range Photometer</td><td>Adaptation of the SPADNS method</td><td rowspan="3">Baltimore City Ashburton Filtration Plant</td><td rowspan="3">Samples kept on ice for no more than 6 hours after collection</td></tr>
<tr><td>Anionic Surfactants</td><td>Chemetrics Detergent Kit</td><td>USEPA Methods for Chemical Analysis of Water and Wastes, Method 425.1 (1983)</td></tr>
<tr><td>Potassium</td><td>Horiba Cardy Compact Ion Meter C-131</td><td>Nitrate ion electrode method</td></tr>
<tr><td rowspan="2">Sample 2</td><td>Total Nitrogen</td><td>--</td><td>Alkaline Persulfate Digestion of Nitrogen to Nitrate and Measured Using Enzyme Catalyzed Reduction[ii]</td><td rowspan="2">Chesapeake Biological Laboratory, Solomons, MD</td><td rowspan="2">Samples kept on ice until end of field day, frozen, then shipped on ice to lab</td></tr>
<tr><td>Total Phosphorus</td><td>--</td><td>Alkaline Persulfate Digestion of Phosphorus to Orthophosphate[iii]</td></tr>
</table>

[i] Methodology uses an adaptation of the ASTM Manual of Water and Environmental Technology, D1426-92, Nessler Method

[ii] USEPA. 1979. Method No. 353.2 *in* Methods for chemical analysis of water and wastes. United States Environmental Protection Agency, Office of Research and Development. Cincinnati, Ohio. Report No. EPA-600/4-79-020 March 1979. 460pp.

[iii] USEPA. 1979. Method No. 353.2 *in* Methods for chemical analysis of water and wastes.

Table 2. IDDE Lab Analysis					
	Parameters Analyzed	**Equipment**	**Method**	**Location**	**Notes**
Sample 3	E. coli and Total coliform	3M Petrifilm plates	Incubated at 35° C for 24 h ± 1 h; red and blue colonies with gas enumerated manually or with a 3M Plate Reader	CWP office, Ellicott City, MD	Samples plated no more than 6 hours after collection

The Flow Chart Method (Figure 2) was used initially to distinguish between three major types of illicit discharges, wastewater, tap water and washwater discharges. Recommendations on revisions to these thresholds for Baltimore waters are discussed in the Section 4.

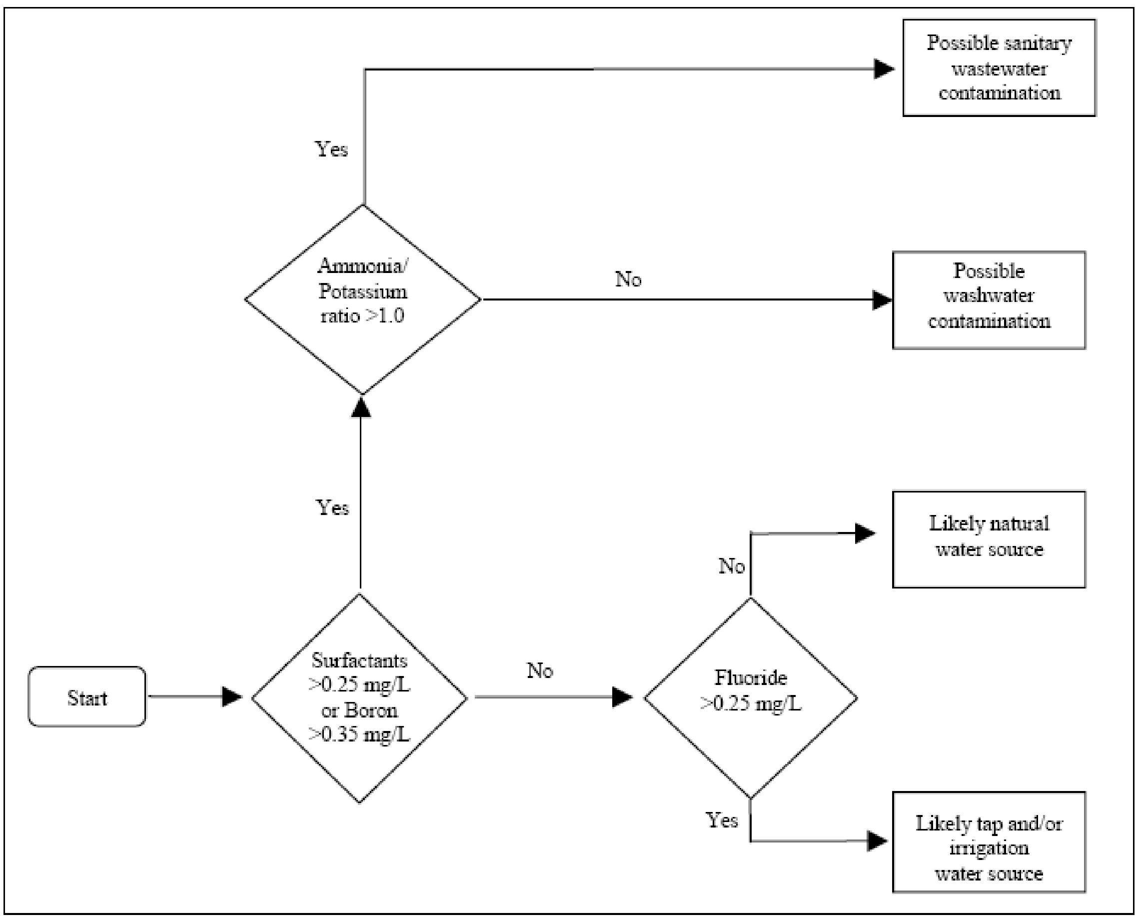


Figure 2: Flow Chart Method Used to Identify Illicit Discharges (Brown et al., 2004)

United States Environmental Protection Agency, Office of Research and Development. Cincinnati, Ohio. Report No. EPA-600/4-79-020 March 1979. 460pp.

Section 3. Project Results

A summary of illicit discharges can be found in Table 3. Five discharges in Western Run, two discharges in Moores Run and one discharge in the Jones Falls mainstem were determined to be confirmed for sewage contamination. Confirmation of sewage contamination was determined based on concentrations of ammonia, detergents, or *E. Coli* that exceeded typical benchmark values or on the presence of gross physical indicators at the outfall or through source tracking efforts.

A summary of in-stream measurements can be found in Table 4. Instantaneous nitrogen and phosphorus loads as well as that for E. coli in Western Run show marked increases from upstream to downstream locations (Figure 3). Confirmed sewage discharges were detected between the middle and lower watershed measurements, including a significant sewer line break that was responsible for the majority of in-stream load and downstream high bacteria counts. Total nitrogen from potential illicit discharges in Western Run comprise approximately 17% of the in-stream load and 58% of the total phosphorus load (Figure 4). The contribution is significant particularly since the relative contribution of discharge from these outfalls is only 6% of the overall stream discharge.

A “snapshot” of the cumulative effect of illicit discharges on a watershed scale is shown in Figures 5 & 6 for both total nitrogen/phosphorus as well as E. coli bacteria. The graphics assume a lack of in-stream processing and illustrate the additive effect of polluted outfalls to receiving water bodies. The “problem area” in Western Run, around outfall ids WR255 and WR007 where a number of confirmed sewage contamination sites were found, is illustrated by a sharp increase in cumulative load at those points in Figure 5. The sharp increase in E. coli on the left side of the graph in Figure 6 portrays the lack of bacteria from two outfalls in the County (the first two points), and then an increase in bacteria from two outfalls (J214 and J208) in the City portion of the watershed and a third jump at outfall J199, which had an abnormally high amount of bacteria.

Table 3. Illicit Discharge Summary for Flowing Outfalls & Manholes

	Western Run (n=45)	Moores Run (n=21)	Jones Falls Mainstem (n=18)
No. of discharges with potential wastewater or other discharge of unknown origin (ammonia >0.3 mg/L)	11 (24%)	5 (24%)	9 (50%)
No. of potential tap water discharges (Fl >0.25 mg/L)	23 (51%)	16 (76%)	18 (100%)
No. of potential washwater discharges (anionic surfactants >0.25 mg/L)	11 (24%)	8 (38%)	6 (33%)
No. of samples with E. coli concentrations >235 CFU/100 ml	24 (53%)	11 (52%)	10 (56%)
No. of discharges exceeding ammonia, fluoride or detergents	33 (73%)	16 (76%)	18 (100%)

Table 4. In-stream Sample Summary[iv]				
		Upper	**Middle**	**Lower**
Western Run	Ammonia (mg/L)	0.03	0	0.13
	Fluoride (mg/L)	N/a	N/a	N/a
	Surfactants (mg/L)	N/a	N/a	N/a
	E. coli (CFU/100 ml)	0	0	20,000
	Instantaneous E. coli Load (CFU)	0	0	5,663,400
	Discharge (cfs)	0.21	0.74	4.29
	Total Nitrogen (mg/L)[v]	1.38	1.61	1.34
	Instantaneous TN Load (mg/s)	8.0	29.1	171.3
	Total Phosphorus (mg/L)	0.028	0.030	0.044
	Instantaneous TP Load (mg/s)	0.17	0.63	5.35
Moores Run	Ammonia (mg/L)	0	0.1	0.12
	Fluoride (mg/L)	0.4	0.64	0.52
	Surfactants (mg/L)	0.125	0.125	0.25
	E. coli (CFU/100 ml)[vi]	2400	1100	200
	Instantaneous E. coli Load (CFU)	N/a	5,918	N/a
	Discharge (cfs)	N/a	0.19	N/a
	Total Nitrogen (mg/L)	5.48	1.36	0.93
	Instantaneous TN Load (mg/s)	N/a	7.3	N/a
	Total Phosphorus (mg/L)	0.06	0.06	0.03
	Instantaneous TP Load (mg/s)	N/a	0.30	N/a

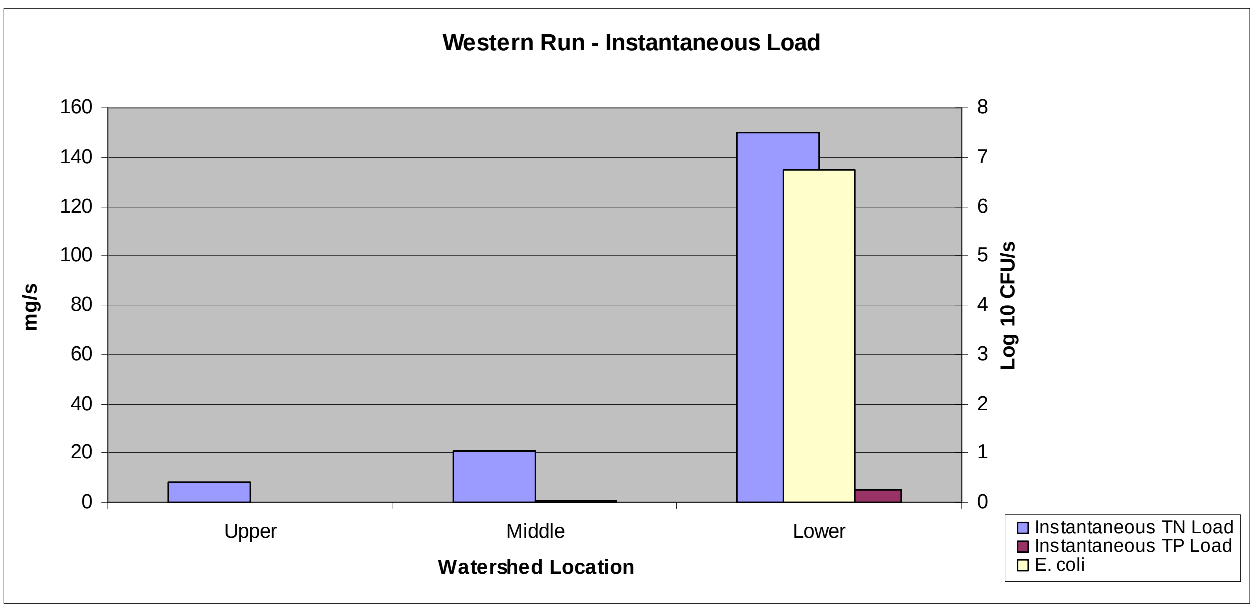


Figure 3. Instantaneous nitrogen and phosphorus load for Western Run.

[iv] No in-stream measurements were collected for the Jones Falls mainstem.
[v] TN and TP in Western Run was average of three samples.
[vi] Upper and middle/lower in-stream samples for Moores Run were taken on separate days – differences in discharge (dilution) between days may explain the decrease in E. coli with movement downstream.

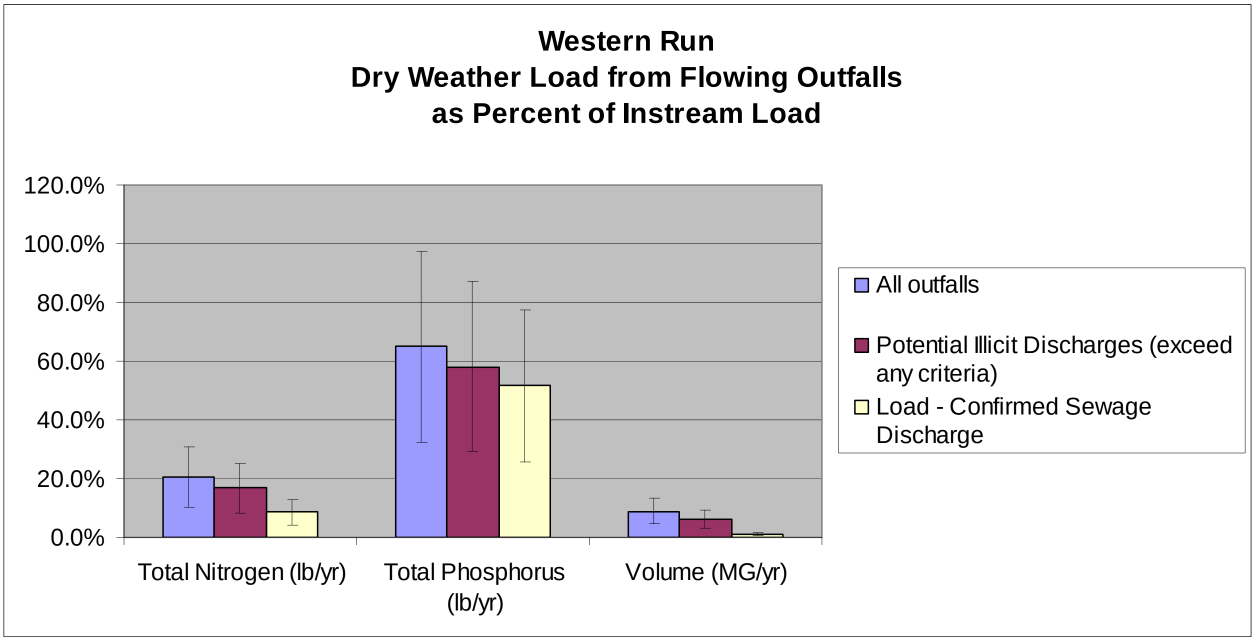


Figure 4. Contribution of illicit discharge pollution sources to in-stream nutrient load.

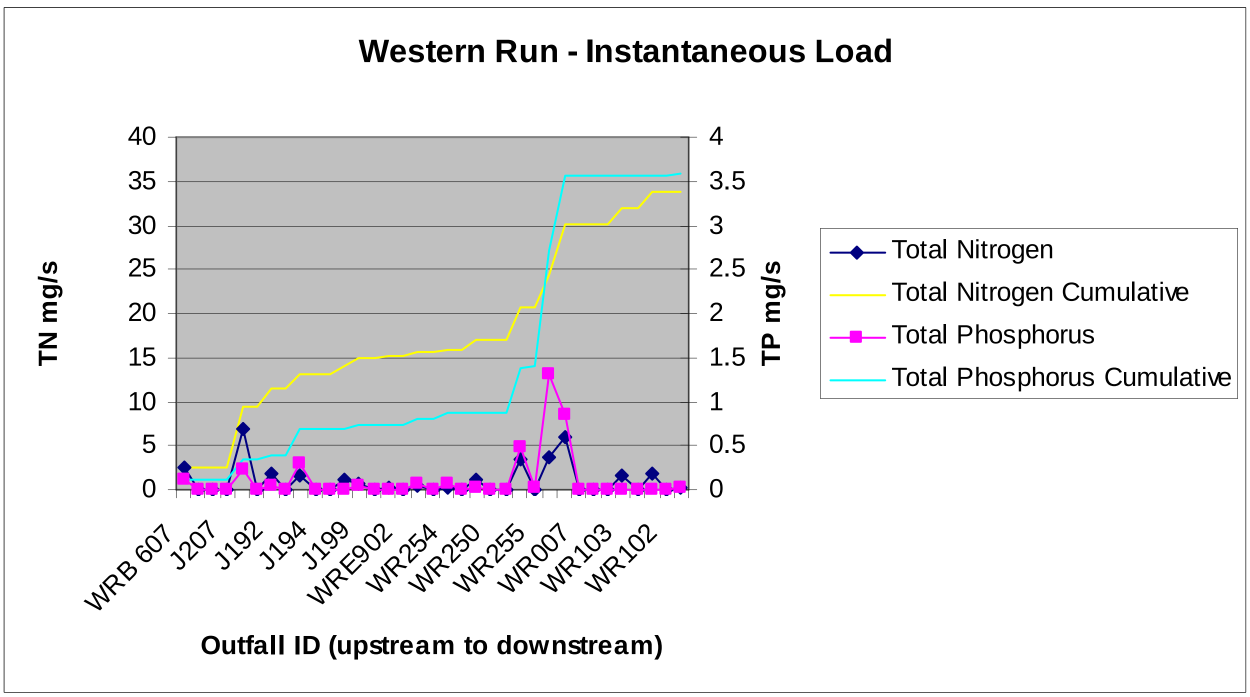


Figure 5. Cumulative impact of total nitrogen and total phosphorus from illicit discharges with movement from upstream to downstream in Western Run.

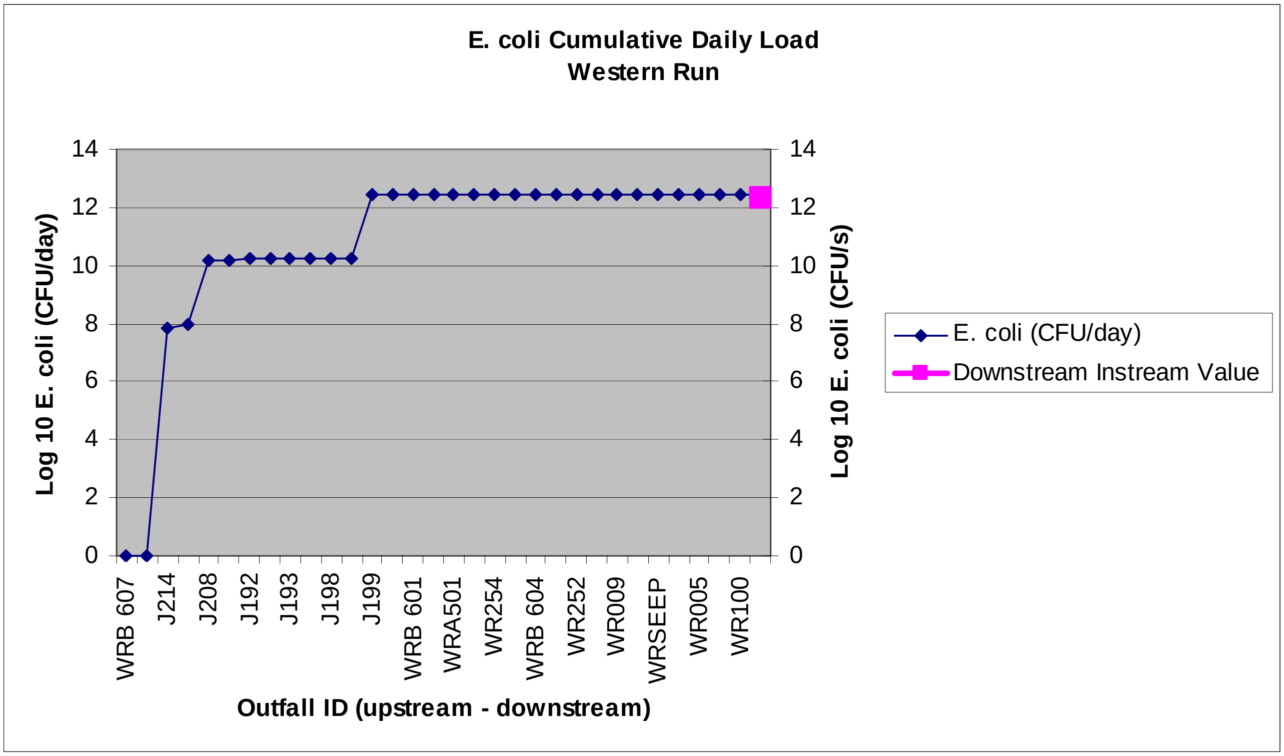


Figure 6. Cumulative impact of E. coli from illicit discharges with movement from upstream to downstream in Western Run.

Illicit Discharge Source Tracking

City Water Quality Management Section staff, with the assistance of the project team, tracked the source of several of the illicit discharges identified during field work. City Water Quality Management Section staff as well as Baltimore County's Department of Environmental Protection and Resource Management also followed up independently on many of the illicit discharges detected. Information tracked for some of the known illicit discharges is contained in the summary below.

- WR008 (Figure 7) - Broken sewer line; found on Friday and fixed over the weekend; plastic pipe placed perpendicular to culvert blew out in a storm (it had been replaced two months earlier); was replaced with another plastic pipe;
- WR702 (Figure 8) - Pipe was inaccessible by field crew but noticeably broken with sewage smell and discolored water; City followed up and found high ammonia; ammonia was traced upstream to school and the problem was fixed;
- WR256 (Figure 8) - Broken sewer pipe behind residential townhomes; City called in to maintenance for repair; inspection of sewer line that crossed stream revealed that plastic elbow on the other end of the pipe was also broken;
- WR254 (Figure 9) - Discharge determined to be a broken sewer line between the outfall and 300' wooded area to Uffington Rd; City staff used dye testing from Uffington Rd - came back several hours late and red dye was coming from outfall; will refer to engineering dept in the City to determine best course of action

- WRSEEP (Figure 9) – sewage seepage from a hillside reported in the past by Guy Holliday; City is relining sanitary lines in adjacent neighborhood as the source could not be located with dye testing and other means;
- WRB616 (Figure 10) – High ammonia; County referred to their Environmental Health Section for follow-up;
- MRC111 (Figure 10) - Obvious sewage contamination from odor and indicators; under Hwy 40; reported to City onsite; a number of re-visits indicates that this is an intermittent problem as flow is not always consitent;
- MR701 (Figure 10) – High ammonia, fluoride, detergents and bacteria; County followed up with another visit but outfall was not high for ammonia; and
- JF201 – High ammonia with sewage smell determined to be a sanitary sewer overflow west along a tributary; the same sanitary stack was observed overflowing about a month later.

(a) (b) (c)

Figure 7. (a) WR008: Broken sewer line discharging to small tributary of Western Run. (b) Toilet paper apparent in gray discharge. (c) The black substance was unknown.

(a) (b) (c)

Figure 8. (a) WR702: Sanitary leakage into Western Run traced upstream to one of two private units. (b-c) WR256: Sanitary line broken in two locations behind residential townhome development.

(a) (b) (c)

Figure 9. (a-b) WR254: Dye testing revealed infiltration from a sanitary line into the storm drain system in an outfall behind a residential home. (c) Sanitary seepage from a hillside has not been successfully traced in an adjacent neighborhood.

(a) (b) (c)

Figure 10. (a) WRB616: High ammonia detected in an odd pipe in upper Western Run. (b) MRC111: Intermittent sewage contamination from 8" pipe under Highway 40 in Moores Run. (c) MR701: A potential intermittent discharge high for parameters during field work but not on a follow-up visit.

Illicit Discharge Load Estimates

Illicit discharge loads for total nitrogen (TN) and total phosphorus (TP) were estimated for potential wastewater, drinking water and other contamination (Table 5). Average bacteria concentrations were also calculated. Some illicit discharges may contain a "blend" of different discharge types (various combinations of groundwater, tap water, sewage and washwater) however; distinguishing among the various types within each outfall was beyond the scope of this project. Loads are presented for outfalls that meet the criteria described in each column of the table; as such, some outfalls may be counted in more than one column. Assumptions and caveats made to generate these estimates are listed below.

- Estimates were made from grab samples and assumed to remain constant over an entire year;
- Outfall and in-stream samples for each watershed were collected over a period of several days, as field schedules and weather permitted;
- To account for background nutrient concentrations in surface waters, 0.02 mg/L was subtracted from the value obtained from each outfall for total phosphorus (TP) and 1.0 mg/L was subtracted from the value of each total nitrogen (TN) sample. In-stream load calculations were made without this more conservative approach. This background level was determined from nutrient data collected by the USGS National Water-Quality Assessment (NAWQA) program for nutrients in "natural watersheds[vii]" as well as data collected from this project from "clean" outfalls, that is, those that did not exceed any of the identified parameters.
- A range of 50-150% of the calculated value is also displayed to account for the diurnal flow associated with some outfalls.

[vii] http://water.usgs.gov/nawqa/nutrients/pubs/awra_v36_no4/

Table 5. Illicit Discharge Load Summary[viii]

		In-stream Load[ix]	Load – "clean" outfalls (ammonia, fluoride and detergents do not exceed threshold)	Load - All outfalls exceeding ammonia, fluoride or detergent threshold	Potential wastewater or other discharge of unknown origin (ammonia >0.3 mg/L)	Potential tap water discharges (Fl >0.25 mg/L, ammonia <0.3 mg/L, detergents < 0.25 mg/L)	Potential other discharges (anionic surfactants >0.25 mg/L, ammonia <0.3 mg/L)
Western Run[x]	TN (lb/yr)	11,325	696 (348-1,044)	1,897 (949-2846)	970 (485-1455)	792 (396-1188)	135 (67-202)
	TP (lb/yr)	374	19 (10-29)	217 (109-326)	195 (98-293)	19 (9-28)	3 (2-5)
	E. coli (average CFU/100 ml)	20,000	240	321,462	26,409	1,175[xi]	3,233
	Volume (MG/yr)	1,013	44.6 (22.2-66.9)	61.7 (30.9-92.6)	11.7 (5.9-17.6)	41.7 (20.8-62.5)	8.3 (4.2-12.5)
Moores Run[xii]	TN (lb/yr)	509	24 (12-36)	1,973 (986-2959)	441 (221-662)	1,534 (767-2302)	0.7 (0.3-1.0)
	TP (lb/yr)	21	0	32 (16-47)	21 (10-31)	11 (5-16)	0
	E. coli (average CFU/100 ml)	200	550	12,987	37,020	922	3,550
	Volume (MG/yr)	44.8	1.5 (0.8-2.3)	147 (74-221)	16.8 (8.4-25.2)	130 (65-196)	0.2 (0.08-0.24)

[viii] Pollutant load calculations utilized a conservative whereby 0.02 mg/L was subtracted from each total phosphorus grab sample and 1.0 mg/L was subtracted from each total nitrogen grab sample; TN/TP numbers in parenthesis represent a range of 50-150% due to diurnal flow.

[ix] Did not use "conservative approach" for in-stream load calculations.

[x] Western Run in-stream loads represented by farthest downstream measurements.

[xi] Discounts outlier outfall id #J199 with exceptionally high bacteria.

[xii] In-stream TN, TP and E. coli based on midstream in-stream measurements, upstream of most illicit discharges.

Table 5. Illicit Discharge Load Summary[viii]

		In-stream Load[ix]	Load – "clean" outfalls (ammonia, fluoride and detergents do not exceed threshold)	Load - All outfalls exceeding ammonia, fluoride or detergent threshold	Potential wastewater or other discharge of unknown origin (ammonia >0.3 mg/L)	Potential tap water discharges (Fl >0.25 mg/L, ammonia <0.3 mg/L, detergents < 0.25 mg/L)	Potential other discharges (anionic surfactants >0.25 mg/L, ammonia <0.3 mg/L)
Jones Falls[xiii]	TN (lb/yr)	-	No clean outfalls	21,806 (10,903-32,710)	14,433 (7,216-21,650)	7,369 (3,685-11,054)	none[xiv]
	TP (lb/yr)	-	No clean outfalls	777 (388-1,165)	774 (387-1,161)	3 (1-4)	none
	E. coli (average CFU/100 ml)	-	No clean outfalls	2,003	3,561	444	none
	Volume (MG/yr)	3,840[xv]	No clean outfalls	994 (497-1,491)	378 (189-567)	616 (308-924)	none

Complementary Efforts

The Jones Falls Watershed Association currently monitors 5 persistently contaminated outfalls in the City. CWP visited two of these outfalls as well as a small tributary with historical pollution problems on 6/22/2010. The two outfalls tested for the suite of parameters discussed above were the "Streetcar" outfall, near the Streetcar Museum on Falls Rd, and an outfall located at the corner of

[xiii] No in-stream samples taken.
[xiv] Detergents not measured for these outfalls.
[xv] Discharge estimated from USGS stream gage upstream of project area + total discharge of all outfalls sampled in project area.

Greenspring and Coldspring Ave. The tributary that was assessed was Gwynns Run at the Carroll Park golf course. Results of the assessment are presented below in Table 6. The Streetcar outfall is a double, box-style outfall; both outfalls were tested and are presented as the upstream Streetcar and downstream Streetcar.

Table 6. Illicit discharge results for additional outfalls in the Jones Falls watershed.

Site ID	Size	Discharge (cu ft/sec)[xvi]	Ammonia (mg/L)	Fluoride (mg/L)	Detergents (ppm)	E. coli (CFU/100 ml)	TN (mg/L)	TP (mg/L)
Streetcar – upstream	4' x 6'	0.04	1.03	1.23	0.25	20,000	5.05	0.2557
Streetcar – downstream	4' x 6'	0.04	0.7	1.13	0.25	70,000	5.12	0.2372
Coldspring	48"	0.02	0.87	0.76	0.4	8,000	5.15	0.1817
Gwynns Run	n/a	Not collected	0.54	0.71	0.75	50,000	3.67	0.1731

Section 4. Discussion

One aspect of the study was to consider the relationship between the standard NPDES parameters that are used to identify illicit discharges and compare these results with the parameters that are outlined by Brown et al (2004) and utilized in this study. The NPDES parameters suggested for monitoring illicit discharges include pH, copper, phenols, temperature and chlorine. These parameters may be useful for identifying certain industrial discharges but are not useful for identifying sewage contamination. We did not encounter any confirmed sewage sources on County property where we were making this comparison, although we did find a number of "hits," some of which have been described above. We did encounter hits for fluoride in four instances where there were no hits for chlorine. Since, in this case, the County does not regulate irrigation or car washing activities, it may be beneficial to set thresholds and criteria that will eliminate these sources but gain detect hits for small pipe leakages. Any protocol will exhibit difficulties when encountering "blended" flows, those made up of multiple illicit discharges. In one outfall, MR700, the crew found hits for ammonia, fluoride, detergents and phenols, which may suggest a mixture of sewage and industrial contamination. The ammonia to potassium ratio at this site was also high (0.598) and may suggest a potential sewage source.

NPDES protocols also suggest monitoring of outfalls greater than 36" in diameter. Results from this study suggest that a significant amount of pollution comes from pipes smaller than this threshold. Pipes less than 36" in diameter represented 36% of all dry weather flows and 45% of all flows with potential illicit discharges. All pipes less than 36" in diameter exceeded one or more of the established parameters. Nutrient loads calculated for pipes less than 36" in diameter are displayed in Table 7.

[xvi] Rate of flow was estimated for discharge in the office since pipe was inaccessible.

Table 7. Potential nutrient load from pipes < 36" in diameter[xvii]		
	Exceed ammonia threshold (>0.3 mg/L; n=13)	**Exceed 1 or more criteria (n=30)**
Total Nitrogen (lb/yr)	392 (196-588)	1,452 (726-2179)
Total Phosphorus (lb/yr)	52 (26-78)	52 (26-78)
Volume (myn gal/yr)	8 (4-12)	97 (49-146)

Brown et al (2004) recommends utilizing a ratio of ammonia to potassium to confirm sewage contamination. The suggested ratio of >1.0 was based on data collected in Alabama watersheds, however, it does not appear that Baltimore waters follow this same trend with regards to potassium in sewage contaminated waters. All confirmed sewage sources exhibited a ratio with a range from 0.36-0.81 and an average of 0.59. Only one outfall had a ratio exceeding the criteria established by Brown et al (2004). This source was an industrial outfall, the Fleischmann's Vinegar plant, and the ratio from this outfall was 2.14. Clean outfalls, those not exceeding the criteria established for ammonia, fluoride or detergents did not have a potassium level greater than 6 ppm. The known wastewater sources had a potassium range between 5 and 23 ppm with an average of 13 ppm. Further data should be collected to understand the ammonia to potassium ratio that should be used for sewage contamination in Baltimore waters. A conservative measure using a ratio of 0.36 or 0.4 may be suggested for use in the meantime.

Based on project results, a modified IDDE flow chart for source detection is suggested for Baltimore watersheds (Figure 11). E. coli or other bacteria can be used as a co-indicator for sewage contamination. The modified chart considers the following:

- Lower ammonia to potassium ratio threshold for sewage from >1.0 to >0.36 based on confirmed sewage discharges found in Baltimore.
- Increase surfactant threshold from >0.25 mg/L to >0.5 mg/L for washwater due to the seemingly high background level of surfactants in Baltimore waters
- Increase fluoride threshold from 0.25 mg/L to 0.7 mg/L for tap water and 0.15-0.7 for a smaller tap water leak that may be blended with groundwater or other sources. Fluoride is present naturally in Baltimore waters and, based on in-stream samples collect by Baltimore City Water Quality Management staff, the average level detected is 0.14 mg/L.
- An additional source is added, "Discharge of Unknown Origin or Blend" for instances of high ammonia, without high surfactants and/or fluoride levels between 0.15-0.7 mg/L. Ammonia levels between 0.01 and 0.29

[xvii] Pollutant load calculations utilized a conservative whereby 0.02 mg/L was subtracted from each total phosphorus grab sample and 1.0 mg/L was subtracted from each total nitrogen grab sample; TN/TP numbers in parenthesis represent a range of 50-150% due to diurnal flow.

mg/L are likely also indicative of a problem and may indicate a discharge of unknown origin or blended flow and, if resources allow, should be investigated as well.

These thresholds can be adjusted as additional data from known sources is collected.

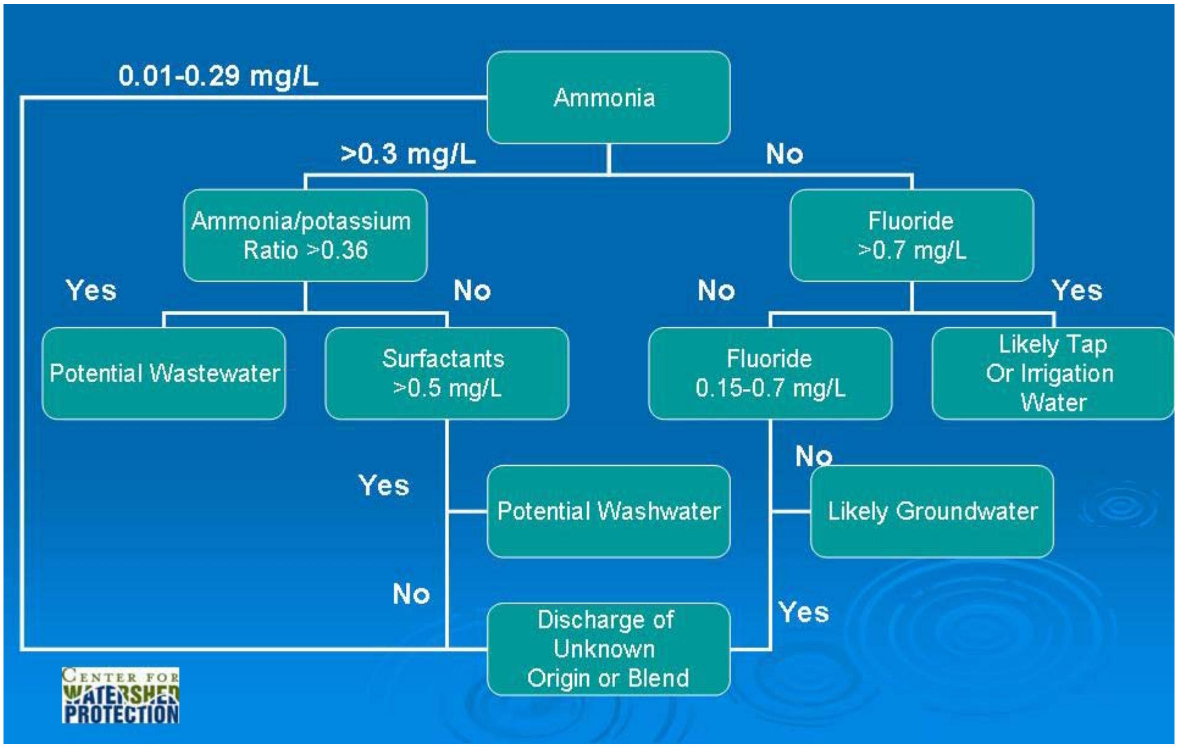


Figure 11. Modified IDDE flow chart for Baltimore waters.

A summary of pollutant load from illicit discharges is displayed in Table 8. This table includes pollutant loads detected from all outfalls that exceeded one or more criteria for illicit discharges as well as the pollutant reduction that has resulted from problems being fixed.

Table 8. Total Dry Weather Discharge from all Pipes with Potential Illicit Flow

	TN (lb/yr)	TP (lb/yr)	Volume (MG/yr)
Detected	25,000	1,020	1,160
Fixed	18,300 (73%)	820 (80%)	690 (59%)

Section 5. Communication Strategy

Multiple agencies and stakeholder groups can benefit from understanding the impact that illicit discharges have on a local water quality and, cumulatively, on regional water quality. The types of stakeholders and agencies that would benefit from this information and a message strategy for the group are proposed below.

- *General public and Elected Officials* - Illicit discharge detection and elimination can be a new and somewhat confusing endeavor for elected officials and the general public. However, the financial, political and community support of these groups is extremely important to the success of any IDDE efforts. Educating elected officials and the general public about the importance of finding and fixing illicit discharges in these watersheds should be an integral piece of the messaging strategy. A number of methods can be used to raise overall public awareness about illicit discharges in the Herring Run, Jones Falls and Baltimore Harbor watersheds, including:

    - *Post Warning Signs:* The partner organizations should post warning signs near known illicit discharges to alert the general public about the presence of these discharges. This will help prevent children and pets from playing in the stream and coming in contact with harmful bacteria and other pathogenic organisms.

    - *Post Maps, Videos and Other Information on Websites:* The partner organizations should post maps, videos and other information about illicit discharges on their websites to help educate elected officials and the general public about the importance of finding and fixing them. As part of this project, a web-based interactive map was developed that depicts an icon for each outfall with a potential illicit discharge. When the icon is clicked, the user sees a picture, if available, of the site/outfall, a brief description of what was found at the site and any follow-up actions that occurred by the City or County after field work. The map was used to communicate information between field teams, the watershed groups and the City. Such a map can be used as a template to meet other objectives as well, such as: 1) Problem outfalls can be accurately mapped and their location communicated to a regulatory authority. 2) Multiple groups that are collecting illicit discharge data can easily collaborate and share data about sites. 3) Problems can be tracked and the information can be displayed to intended users. 4) The information can be made publicly available on web-sites so that citizens can be aware of the location of contaminated areas.
    - *Engage the Public through a Stream Watch program:* The central idea behind the Stream Watch Program is that a watershed organization, working with citizen volunteers, will track the health of County streams and identify potential restoration and protection projects. This program is a useful source for learning of illicit connections. A majority of the time citizens call while they are actually observing a problem and often can provide immediate local information that increases the chance of eliminating illicit connections. This is an additional strategy other local jurisdictions may want to know about, for illicit detection and elimination.

- *Local Jurisdictions* - Local governments should be made aware of the value of IDDE as a best management practice for meeting TMDLs and water quality goals, along with satisfying MS4 permit requirements. IDDE is a tool that can be utilized by communities with and without stormwater permits to track down problems in their local watersheds. Collaboration is key between municipalities and within divisions of the municipality to ensure an adequate and efficient fix of identified problems. Likewise, collaboration between municipalities and watershed groups is beneficial, since each of the same end goal – improved water quality – and each can increase the capacity of the other to find problems. In urban watersheds, IDDE appears critical in meeting bacteria and nutrient TMDLs based on our data collected in this and other studies (Brown et al 2004, Shergill and Pitt 2004).

To increase the City's ability to track down and remove illicit discharges from the storm drain system in a timely fashion, the City Water Quality Management Section staff should be provided with right-of-entry, which will enable them to continue tracking illicit discharges onto private property. Currently, City Water Quality Management Section staff are able to track the source of an illicit discharge through the public storm drain and sanitary sewer system. However, once an illicit discharge is traced to private property, the investigation must be stopped and the discharge reported to another City agency for further follow-up. This process should be corrected, as it results in an unnecessary delay in tracking illicit discharges to their source and in removing them from the storm drain system. This is particularly true with respect to intermittent discharges due to the temporary nature of these flows.

- *Academics/Foundations/others* – Additional research is needed with regards to illicit discharges. Some of these are described below.

    - Further documentation is needed to quantify the impact of illicit discharges to watersheds in other communities throughout the Chesapeake Bay. A lot of research has been conducted in Baltimore City and a national literature search and survey was conducted during the production of Brown et al (2004), however, additional field surveys would help to quantify the issue and provide an understanding of the effects to jurisdictions with different land use, population densities, age of infrastructure, etc.

    - *Compile an Illicit Discharge "Fingerprint" Library:* An illicit discharge "fingerprint" library is a database of the chemical signature of the many different types of discharges that can be found in a particular watershed. An illicit discharge "fingerprint" library should include sewage, septage, washwater and common industrial flows, as well as clean water flows, such as tap water, groundwater, spring water and irrigation water. Stakeholders in Baltimore should work together to identify the particular chemical signatures unique to Baltimore waters so that illicit discharges may be tracked more efficiently and effectively. An example includes the ammonia to potassium ratio for sewage discharges discussed above.

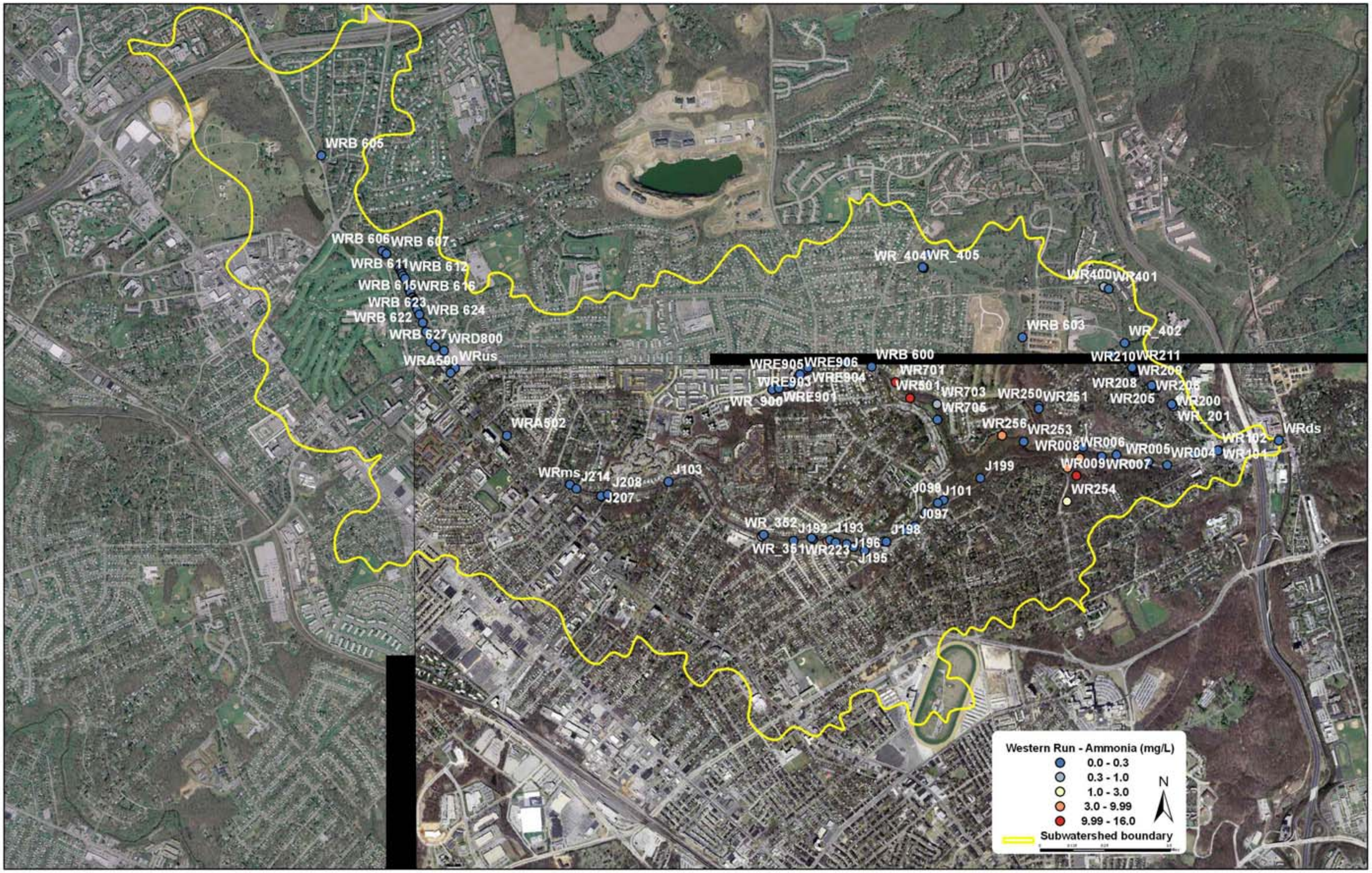
- *Regulatory Agencies* – Regulatory agencies should understand the value of IDDE as a best management practice for meeting TMDLs and water quality goals, along with satisfying MS4 permit requirements. Regulatory agencies should also understand the value of utilizing the parameters identified in Brown et al (2004) for detecting sewage in surface waters as well as the value of monitoring pipes less than 36" in diameter. Both local governments and regulatory agencies should be made aware of the cost effectiveness of fixing illicit discharges as compared to, for example, stream restoration and stormwater treatment practices. For example, the sanitary seep described in the illicit discharge source tracking section (WRSEEP) has been ongoing problem. The annual nutrient input from this one discharge has been estimated at approximately 239 lb/yr of total nitrogen and 85 lb/yr of total phosphorus. Treating this same amount of nutrient input with traditional bioretention would require the installation of 143 0.5-acre practices to treat the phosphorus or 49 to treat the nitrogen at a cost of between $590,000 and $1,700,000. This discharge along with several other confirmed sewage discharges was found on a small tributary of Western Run, which met the main channel just below an extensive stream restoration project. Fixing illicit discharges can be an inexpensive to a very expensive process for a local jurisdiction, depending on the problem. Likewise, tracking illicit discharges incurs expense from staff time to equipment and analysis of water samples. While the expense incurred from finding and fixing illicit discharges can be significant, it is logical that these problems be permanently remedied at the source before attempting to treat stormwater and nonpoint sources of pollution in the stream or through retrofitting stormwater treatment practices.

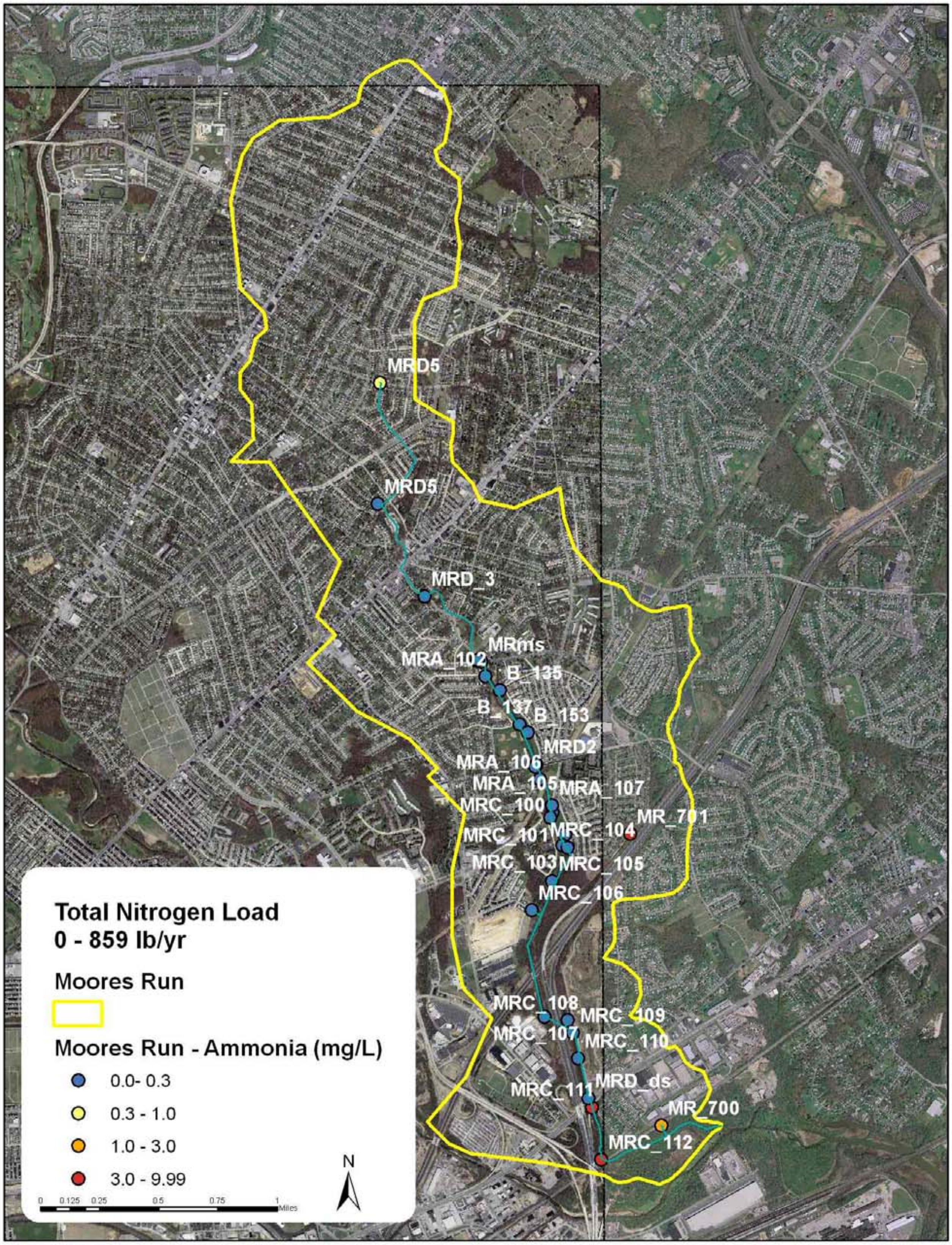
References

Shergill, Sumandeep and Robert Pitt. 2004. Quantification of Escherichia Coli and Enterococci levels in wet weather and dry weather flows. WEFTEC, New Orleans. http://rpitt.eng.ua.edu/Publications/Inappropriate_Discharges/Bacteria%20levels%20wet%20weather%20vs%20dry%20weather%20Suman%20and%20PItt%20WEFTEC%202004.pdf

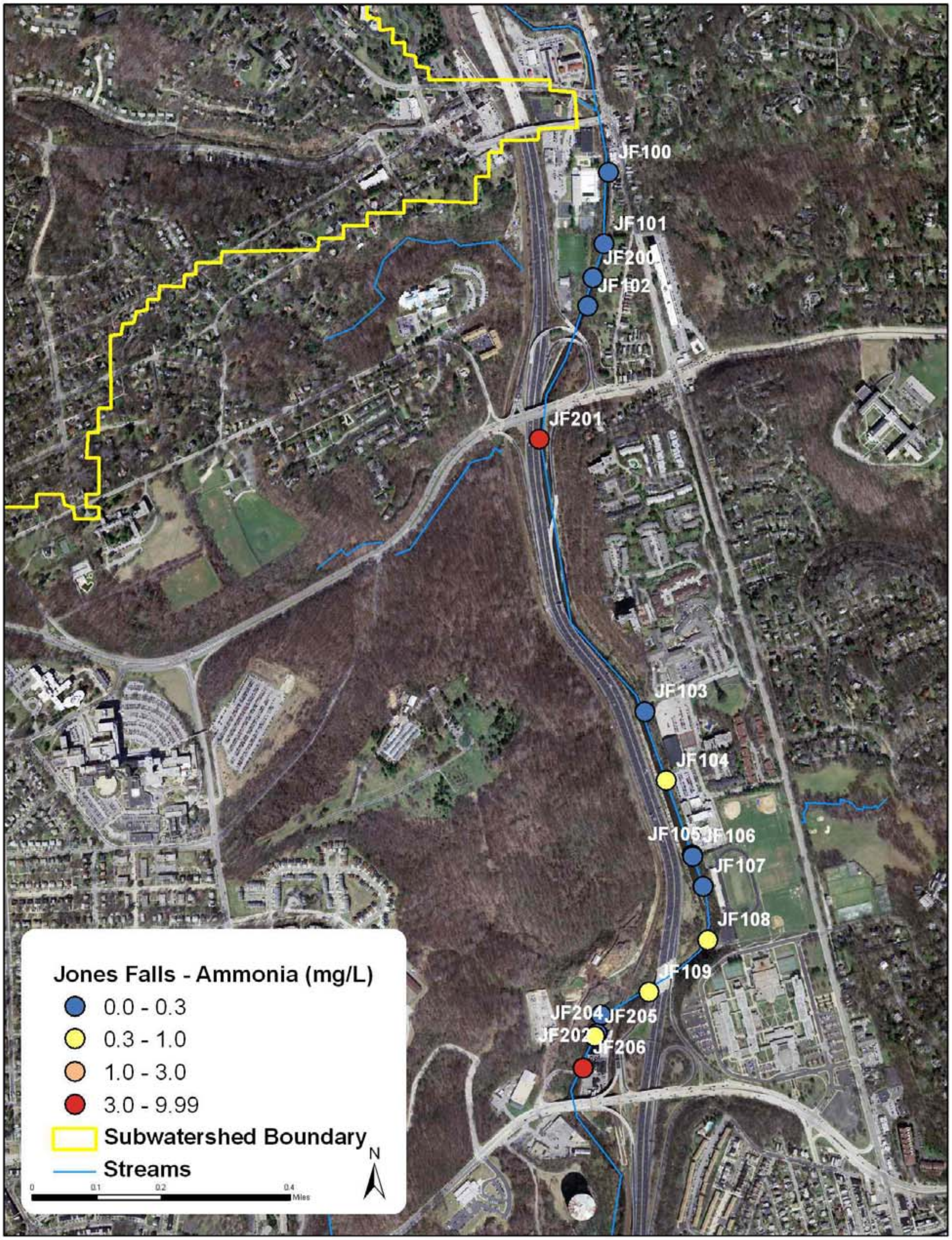
Brown, E., D. Caraco and R. Pitt. 2004. *Illicit Discharge Detection and Elimination: a guidance manual for program development and technical assessments*. Center for Watershed Protection and University of Alabama. EPA X-82907801-0.U.S. EPA Office of Wastewater Management, Washington, D.C.

ATTACHMENT A. Watershed Maps





MRD5
MRD5
MRD_3
MRms
MRA_102
B_135
B_137
B_153
MRD2
MRA_106
MRA_105
MRA_107
MRC_100
MR_701
MRC_101
MRC_104
MRC_103
MRC_105
MRC_106
MRC_108
MRC_109
MRC_107
MRC_110
MRC_111
MRD_ds
MR_700
MRC_112
Total Nitrogen Load
0 - 859 lb/yr
Moores Run
Moores Run - Ammonia (mg/L)
0.0- 0.3
0.3 - 1.0
1.0 - 3.0
3.0 - 9.99
N


JF100
JF101
JF200
JF102
JF201
JF103
JF104
JF105
JF106
JF107
JF108
JF109
JF204
JF205
JF206
Jones Falls - Ammonia (mg/L)
0.0 - 0.3
0.3 - 1.0
1.0 - 3.0
3.0 - 9.99
Subwatershed Boundary
Streams
N

ATTACHMENT B. Raw Data

Western Run Illicit Discharge Survey May 2010												Exploratory Calculations				
													High		Low	
Outfall ID	Pipe diame-ter (in)	Ammo-nia (mg/L)	Potassi-um (ppm)	Ammonia Potassium ratio	Fluoride (mg/L)	Detergents (ppm)	Notes	Total coliforms (cfu/100 ml)	E. coli (cfu/100 ml)	TP (mg/L)	TN (mg/L)	Gallons/ yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
In-stream, middle	In-stream	0	NA	NA	NA	NA		20000	0	0.0298	1.4	173,733,424	869.99	19.82	290.00	6.61
J101	27	0	2	0	0.2	0.14		2300	0	0.0253	4.86	2,381,731	115.09	0.15	38.36	0.05
WR004	18	0	3	0	0.28	0.125		600	0	0.0146	3.34	166,721	4.88	0.00	1.63	0.00
WR005	4	0	2	0	0.18	0.25		0	0	0.0056	2.59	27,787	0.55	0.00	0.18	0.00
WR100	21	0	3	0	0.82	0		0	0	0.0133	2.53	9,693,090	185.66	0.00	61.89	0.00
WR251	40	0	4	0	0.12	0.125		900	0	0.0562	1.13	NA	NA	NA	NA	NA
WR401	15	0	5	0	0.58	0.25		10000	0	0.0851	2.01	NA	NA	NA	NA	NA
WRB 601	60	0	3	0	0	0		9500	0	0.0448	3.2	763,660	21.03	0.22	7.01	0.07
WRB 607	4	0	5	0	0.24	0		0	0	0.1127	2.94	10,619,181	257.91	11.46	85.97	3.82
In-stream, upper	In-stream	0.03		NA	NA	NA		10000	0	0.0292	1.38	48,626,475	231.33	5.21	77.11	1.74
WRE900	60	0.28	4	0.07	0.5	0.03		400	0	0.0946	2.23	NA	NA	NA	NA	NA
WR400	18	0.55	10	0.055	0.43	0.1		10000	0	0.2785	2.2	854,980	12.84	2.57	4.28	0.86
WR703	30	0.9	5	0.18	0.39	0.08		3600	0	0.0567	1.29	17,012	0.06	0.01	0.02	0.00
WRB 616	4	2.59	5	0.518	0.2	0.1		9700	0	0.2845	4.56	2,829	0.13	0.01	0.04	0.00
J198	32	0	3	0	.33/.32	0		3000	100	0.0148	1.33	416,803	1.72	0.00	0.57	0.00
WR250	25	0	4	0	0.21	0.25		500	100	0.0183	6.09	41,680	2.66	0.00	0.89	0.00
WR252	31.5	0	4	0	0.12	0.125		3400	100	0.0607	0.93	8,336	0.00	0.00	0.00	0.00
WR253	16	0	6	0	0.23	0.125		900	100	0.04	1.92	75,782	0.87	0.02	0.29	0.01
WR255	In-	0	7	0	0.11	0.25		800	100	0.0458	0.91	5,236,468	0.00	1.69	0.00	0.56

Western Run Illicit Discharge Survey May 2010												Exploratory Calculations				
													High		Low	
Outfall ID	Pipe diameter (in)	Ammonia (mg/L)	Potassium (ppm)	Ammonia Potassium ratio	Fluoride (mg/L)	Detergents (ppm)	Notes	Total coliforms (cfu/100 ml)	E. coli (cfu/100 ml)	TP (mg/L)	TN (mg/L)	Gallons/ yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
	stream															
WRB 602	30	0	2	0	0.32	0		12900	100	0.2367	4.6	53,969	2.43	0.15	0.81	0.05
J099	23	0.02	5	0.004	0.91	0		4800	100	0.0116	2.17	NA	NA	NA	NA	NA
WRE906	95*		3	0	0.33	0.02		3200	100	0.0488	2.35	NA	NA	NA	NA	NA
J193	27	0	2	0	0.19			5300	300	4.1718	23.37	595,433	166.75	30.95	55.58	10.32
WRB 604	42	0	3	0	0.16	0		12000	400	0.0366	2.29	7,748,242	125.13	1.61	41.71	0.54
WRA502	Man-hole	0.06	6	NA	0	0.125		1800	400	0.0533	1.68	NA	NA	NA	NA	NA
J194	28	0.01	3	0.0033333	.34/.33	0		2100	500	0.0803	3.07	20,840	0.54	0.02	0.18	0.01
WRA500	Man-hole	0.14	2		0.52	0	Manhole on Charlesworth Ave	7800	600	0.2252	3.01	NA	NA	NA	NA	NA
WR254	7	5.55	8	0.69375	0.75	1.85	Broken sewer pipe behind residential townhomes; City was to call into maintenance for repair; inspection of sewer line that crossed stream revealed that plastic elbow on the other end of the pipe was also broken	1800	600	0.7677	5.04	641,235	32.43	6.00	10.81	2.00
WRE902	4	0	3	0	0.21	0.07		2500	700	0.1081	1.05	10,317	0.01	0.01	0.00	0.00
J103	70	9*	NA	NA	NA			3400	700	0.0501	2.72	94,088	2.03	0.04	0.68	0.01
J207	18	0	3	0	0.25	0.1		2400	800	0.0793	2.06	304,347	4.04	0.23	1.35	0.08
J192	73	0.01	4	0.0025	0.2	0.25		29300	1000	0.0665	2.93	8,235,953	199.00	4.79	66.33	1.60
WR701	NA	13.9	NA	NA	NA	0.17		11600	1300	0.1278	1.21	NA	NA	NA	NA	NA
WR352	24		2	0	0	0.25		7400	1300	0.146	2.39	NA	NA	NA	NA	NA

Western Run Illicit Discharge Survey May 2010												Exploratory Calculations				
													High		Low	
Outfall ID	Pipe diameter (in)	Ammonia (mg/L)	Potassium (ppm)	Ammonia Potassium ratio	Fluoride (mg/L)	Detergents (ppm)	Notes	Total coliforms (cfu/100 ml)	E. coli (cfu/100 ml)	TP (mg/L)	TN (mg/L)	Gallons/ yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
WR SEEP	In-stream	9.99	18		0.57	0.75		5900	1600	3.5753	11.02	3,073,579	385.55	136.80	128.52	45.60
J214	NA	0	6	0	1.28	0		5700	3900	0.1506	3.64	185,246	6.12	0.30	2.04	0.10
WR351	48	0.55	2	0.275	0.23	0.125		30900	4100	0.1203	4.33	NA	NA	NA	NA	NA
J208	70	0	6	0	0.32	0		43100	7900	0.1157	3.97	19,364,215	719.99	23.20	240.00	7.73
WR010	24	0.51	3	0.17	0.17	0.125		1600	10300	0.0311	1.4	NA	NA	NA	NA	NA
WR195	27	9.99[xviii]	23	0.4343478	1.07	0.75	Drainage for this outfall was limited to two nearby inlets; a standing pool of turbid water was found between one inlet and the outfall; a nearby SSO was checked and all sanitary manholes were checked for chokes; City flushed the two inlets/stromdrains and were going to return later to see if any water was found in the system	13500	11000	0.0367	2.45	9,725	0.18	0.00	0.06	0.00
J197		0.19	9	0.0211111		0.63	Outfall discharged milky white substance during investigation which turned to a very turbid discharge; City checked ongoing road construction within the same drainage but could not find anything	15700	17000	0.0252	4.02	NA	NA	NA	NA	NA

[xviii] Meter likely not working properly

Western Run Illicit Discharge Survey May 2010												Exploratory Calculations				
													High		Low	
Outfall ID	Pipe diameter (in)	Ammonia (mg/L)	Potassium (ppm)	Ammonia Potassium ratio	Fluoride (mg/L)	Detergents (ppm)	Notes	Total coliforms (cfu/100 ml)	E. coli (cfu/100 ml)	TP (mg/L)	TN (mg/L)	Gallons/ yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
In-stream, lower	In-stream	0.13		NA	NA			60000	20000	0.0458	1.41	1,012,658,138	5197.78	327.08	1732.59	109.03
WR254	24	1.82	5	0.364	0.19	1.5	Discharge determined to be a broken sewer line between outfall and 300' wooded area to Uffington Rd; City staff used dye testing from Uffington Rd - came back several hours late and red dye was coming from outfall; will refer to engineering dept in the City to determine best course of action (does it need a liner or replacement?)	20000	50000	1.4779	11.41	2,814,270	366.77	51.36	122.26	17.12
WRA501	30	16	22	0.7272727	1.76		Pipe was inaccessible by field crew but noticeably broken with sewage smell and discolored water; City followed up and found high ammonia; ammonia was traced upstream to either a Jewish Montessori school or private residence	400000	210000	3.0768	18.09	NA	NA	NA	NA	NA
WR009	NA	NA	12	0	0	3		200000	1400000	1.7034	12.01	NA	NA	NA	NA	NA
J199	36	0.25	3	0.0833333	0.37	0.02		20000000	9000000	0.1477	3.33	2,778,686	81.05	4.44	27.02	1.48
WR007	18	0	3	0	0	0		NA	NA	0.0055	0.34	595,433	0.00	0.00	0.00	0.00
WR102	18	0	6	0	1	0	Potential	NA	NA	0.005	2.56	208,401	4.07	0.00	1.36	0.00

Western Run Illicit Discharge Survey May 2010												Exploratory Calculations				
													High		Low	
Outfall ID	Pipe diame-ter (in)	Ammo-nia (mg/L)	Potassi-um (ppm)	Ammonia Potassium ratio	Fluoride (mg/L)	Detergents (ppm)	Notes	Total coliforms (cfu/100 ml)	E. coli (cfu/100 ml)	TP (mg/L)	TN (mg/L)	Gallons/ yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
WR103	30	0.05	3	0.0166667	0.93	0	Suspect	NA	NA	0.0132	2.68	8,336,057	175.32	0.00	58.44	0.00
WR101	4	0.08	4	0.02	1.09	0	Unlikely	NA	NA	0.0047	2.66	126,304	2.62	0.00	0.87	0.00
WR008	48	8.07	10	0.807	0.42	3	Broken sewer line; Found on Friday and fixed over the weekend; plastic pipe placed perpendicular to culvert blew out in a storm (it had been replaced two months earlier); was replaced with another plastic pipe	NA	NA	1.7157	12.8	4,168,029	615.72	88.48	205.24	29.49
Sum												1,324,688,464	9792.27	716.62	3264.09	238.87

Moores Run Illicit Discharge Survey June 2010												Exploratory Calculations				
													High		Low	
Outfall ID	**Pipe diameter (in)**	**Ammonia (mg/L)**	**Potassium (ppm)**	**Ammonia/ Potassium ratio**	**Fluoride (mg/L)**	**Detergents (mg/L)**	**Notes**	**Total coli-forms (cfu/100 ml)**	**E. coli (cfu/100 ml)**	**TP (mg/L)**	**TN (mg/L)**	**Gallons/yr**	**TN (lb/yr)**	**TP (lb/yr)**	**TN (lb/yr)**	**TP (lb/yr)**
MRC111	8	9.99	23	0.4343478	1.33	1.5	Obvious sewage contamination from odor and indicators; under Hwy 40; reported to City on site	410000	180000	5.3295	30.76	94,728	35.29	6.30	11.76	2.10
MRA105	28	0	12	0	0.31	0.125		3700	0	0.0086	1.11	720,899	0.99	0.00	0.33	0.00
MRC112	30	6.02	25	0.2408	0.61	0.5	Nearby an EPA Superfund site although this was on the other side of the railroad tracks; could see daylight at end of pipe, which may orginate on County land	10000	0	0.0018	6.39	138,934	9.37	0.00	3.12	0.00
MRC103	32	0.11	1	0.11	0.88	0.125		0	0	0.0074	2.28	46,449,274	744.32	0.00	248.11	0.00
MRC101	36	0	11	0	0.33	0.5		3700	5700	0.018	1.44	138,934	0.77	0.00	0.26	0.00
MRC105	36	0.14	2	0.07	0.12	0.125		24000	0	0.0075	3.54	438,740	13.95	0.00	4.65	0.00
MRA106	45	0.05	5	0.01	0.37	0.125		12000	100	0.0556	2.18	16,644,216	245.88	7.42	81.96	2.47

Moores Run Illicit Discharge Survey June 2010													Exploratory Calculations				
														High		Low	
Outfall ID	**Pipe diameter (in)**	**Ammonia (mg/L)**	**Potassium (ppm)**	**Ammonia/ Potassium ratio**	**Fluoride (mg/L)**	**Detergents (mg/L)**	**Notes**	**Total coli-forms (cfu/100 ml)**	**E. coli (cfu/100 ml)**	**TP (mg/L)**	**TN (mg/L)**	**Gallons/yr**	**TN (lb/yr)**	**TP (lb/yr)**	**TN (lb/yr)**	**TP (lb/yr)**
MR700	48	2.99	5	0.598	0.48	0.25	Tracked the high ammonia to a stormdrain manhole at intersection of 64th and Biddle. Storm drain was too deep to sample at the time (8 ft). Will bring equipment to try to sample, and if unsuccessful will bring someone certified in confined spaces to enter system.	7200	600	0.2762	5.55	NA	0.00	0.00	0.00	0.00
MRA102	48	0	6	0	0.2	0.125		8200	0	0.0334	2.5	574,900	10.80	0.10	3.60	0.03
B135	54	0	4	0	0.25	0.125		32000	100	0.0058	2.15	0	0.00	0.00	0.00	0.00
MRA100	54	0	4	0				35700	2200	0.0272	2.81	2,360,508	53.49	0.00	17.83	0.00
MRA107	60	0.07	5	0.014	0.48	0.2		500	0	0.0065	1.65	6,329,342	51.50	0.00	17.17	0.00
MRC104	60	0.05	4	0.0125	0.42	0.25		3700	1400	0.0778	1.92	22,530	0.26	0.02	0.09	0.01
MRA101	75	0	4	0	0.59	0.175		12500	200	0.0313	2.67	52,455,744	1096.7	7.42	365.56	2.47
MRC102	84	0.04	1	0.04	0.73	0.125		16000	1600	0.0119	1.97	208,401	2.53	0.00	0.84	0.00
B153	120	0.04	9	0.0044444	0.54	0.25		19100	600	0.036	2.69	7,515,040	159.00	1.51	53.00	0.50
MRD1	Instream (downstream)	0.12	6	0.02	0.52	0.25		1900	200	0.0309	0.93	0	0.00	0.00	0.00	0.00
MRD2	Instream	0.1	6	0.0166667	0.64	0.125		3200	1100	0.0564	1.36	44,849,661	202.13	20.44	67.38	6.81

Moores Run Illicit Discharge Survey June 2010													Exploratory Calculations				
														High		Low	
Outfall ID	Pipe diameter (in)	Ammonia (mg/L)	Potassium (ppm)	Ammonia/ Potassium ratio	Fluoride (mg/L)	Detergents (mg/L)	Notes	Total coli-forms (cfu/100 ml)	E. coli (cfu/100 ml)	TP (mg/L)	TN (mg/L)	Gallons/yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
	(midstream)															
MRA101a	Instream (upstream)	0	11	0	0.4	0.125	Instream discharge measurement	NA	2400			0	1150.17	7.42	383.39	2.47
MRD3	manhole	0.19	8	0.02375	0.67	3		NA	NA	NA	4.87	NA	0.00	0.00	0.00	0.00
MRD4	manhole	0.05	10	0.005	0.22	0.25		2100	0	0.0081	2.66	NA	0.00	0.00	0.00	0.00
MRD5	manhole	0.6	7	0.0857143	0.34	0.25		20000	1500	0.1395	3.96	16,523,559	612.30	24.72	204.10	8.24
MR701	Instream	3.61	5	0.722	0.77	0.375	Returned to site to investigate. Retested and ammonia was below detection limit. This is not an outfall, but a culvert that runs under 95.	5300	3000	0.2043	6.83	63,248	4.62	0.15	1.54	0.05
Sum												**195,528,660**	**4394.05**	**75.48**	**1464.68**	**25.16**

Jones Falls Mainstem Illicit Discharge Survey July 2010												Exploratory Calculations				
													High		Low	
Outfall ID	Pipe diam-eter (in)	Am-monia (mg/L)	Potas-sium (mg/l)	NH4/K ratio	Fluor-ide (mg/L)	Deter-gents (mg/L)	Total Coliforms (cfu/100ml)	E.Coli (cfu/100ml)	TP (mg/L)	TN (mg/L)	Notes	Gallons/yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
JF100	54	0	3	0.00	0.39	NA	7300	1300	0.01	1.3		46,192,636	516.60	5.24	131.08	0.00
JF101	8	0	5	0.00	0.3	NA	2300	1500	0.07	3.1		833,606	21.78	0.46	14.82	0.33
JF102	60	0	5	0.00	0.7	NA	2900	600	0.05	3.3	Smelled like sewage	8,422,557	231.27	3.17	160.98	1.76
JF103	98	0	3	0.00	1.07	NA	0	0	0.02	2.4		311,813,242	6297.82	39.04	3695.41	0.00
JF104	24	0.84	4	0.21	4.69	0.125	3200	1600	0.27	3.5		92,623	2.73	0.21	1.96	0.19
JF105	19	1.71	25	0.07	2.46	0.25	0	0	2.08	16.5		148,271	0.00	0.00	19.17	2.55
JF106	24	0	3	0.00	1.26	NA	0	0	0.01	2.3		1,667,211	31.73	0.12	17.81	0.00
JF107	90	0.08	2	0.04	0.32	NA	5400	500	0.02	3.1	Smelled like sewage	10,332,850	268.20	1.91	181.96	0.18
JF108	78	0.92	4	0.23	0.87	0.25	NA	250	0.27	3.5		6,250,781	179.98	14.12	127.81	13.07
JF109	48	0.35	2	0.18	0.25	0.25	3900	100	0.02	3.1		119,087	3.08	0.02	2.09	0.00
JF200	66	0	4	0.00	0.36	NA	4700	0	0.02	0.9		6,020,103	44.72	1.12	0.00	0.12
JF201	8'x12'	3.23	6	0.54	1.1	0.25	4500	2100	0.27	5.7	Smelled like sewage; suds present; poor pool quality	354,076,272	16726.05	792.86	13770.92	733.76
JF202	60	0.08	4	0.02	0.37	NA	2000	100	0.03	2.0		1,667,211	28.11	0.46	14.19	0.19
JF204	8	0.03	NA		1.23	NA	0	0	0.01	2.7	Vinegar odor (slight)	21,006,864	464.61	1.19	289.28	0.00
JF205	8	0.5	2	0.25	1.23	0.125	0	0	0.01	2.5	Intermittent discharge; caught while in field	3,159,366	66.98	0.13	40.61	0.00
JF206	42	4.13	2	2.07	0.68	0.125	100	0	0.36	2.0	Sewage and lacquer odor noticable from a distance	263,280	4.39	0.79	2.20	0.75
Street-	4x6x1	1.03	10		1.23	0.25	100000	20000	0.26	5.1		8,336,057	351.34	17.79	281.77	16.40

Jones Falls Mainstem Illicit Discharge Survey July 2010												Exploratory Calculations				
													High		Low	
Outfall ID	Pipe diam-eter (in)	Am-monia (mg/L)	Potas-sium (mg/l)	NH4/K ratio	Fluor-ide (mg/L)	Deter-gents (mg/L)	Total Coliforms (cfu/100ml)	E.Coli (cfu/100ml)	TP (mg/L)	TN (mg/L)	Notes	Gallons/yr	TN (lb/yr)	TP (lb/yr)	TN (lb/yr)	TP (lb/yr)
Car 2 US																
Cold Spring	48	0.87	5		0.76	0.4	14000	8000	0.18	5.2		5,511,317	236.89	8.36	190.89	7.44
Sum												**785,913,333**	**25476**	**887**	**18943**	**777**