KCI TECHNOLOGIES

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DATE:	September 14, 2012
SUBJECT:	Box Hill South Stream Monitoring 2012 KCI Job Order No. 16122305

TABLES

FIGURES

1.0 INTRODUCTION

Harford County completed the construction of an approximately 1100-linear foot stream restoration project in 2003 on the South Tributary to Bynum Run, which is situated along the southern boundary of the Box Hill North subdivision. Specifically, the project is located south of Kensington Parkway between Harrogate Way and Laurel Bush Road, in Harford County, Maryland (Figure 1).

The channel receives uncontrolled stormwater runoff from a closed storm drain system. The land use is predominantly medium- to high-density residential and commercial development. Prior to restoration, the stream channel was experiencing excessive bed and bank erosion and had become incised, exposing bedrock in some locations. Lateral channel migration into adjacent backyards was also occurring creating a hazardous situation and threatening adjoining property. To improve the conditions, various instream structures were utilized. In addition, the entire site was planted with native trees, shrubs, and live stakes.

Fish assemblage sampling was conducted before the restoration in the Summer of 2002 and after the restoration was completed in the Summer of 2006.

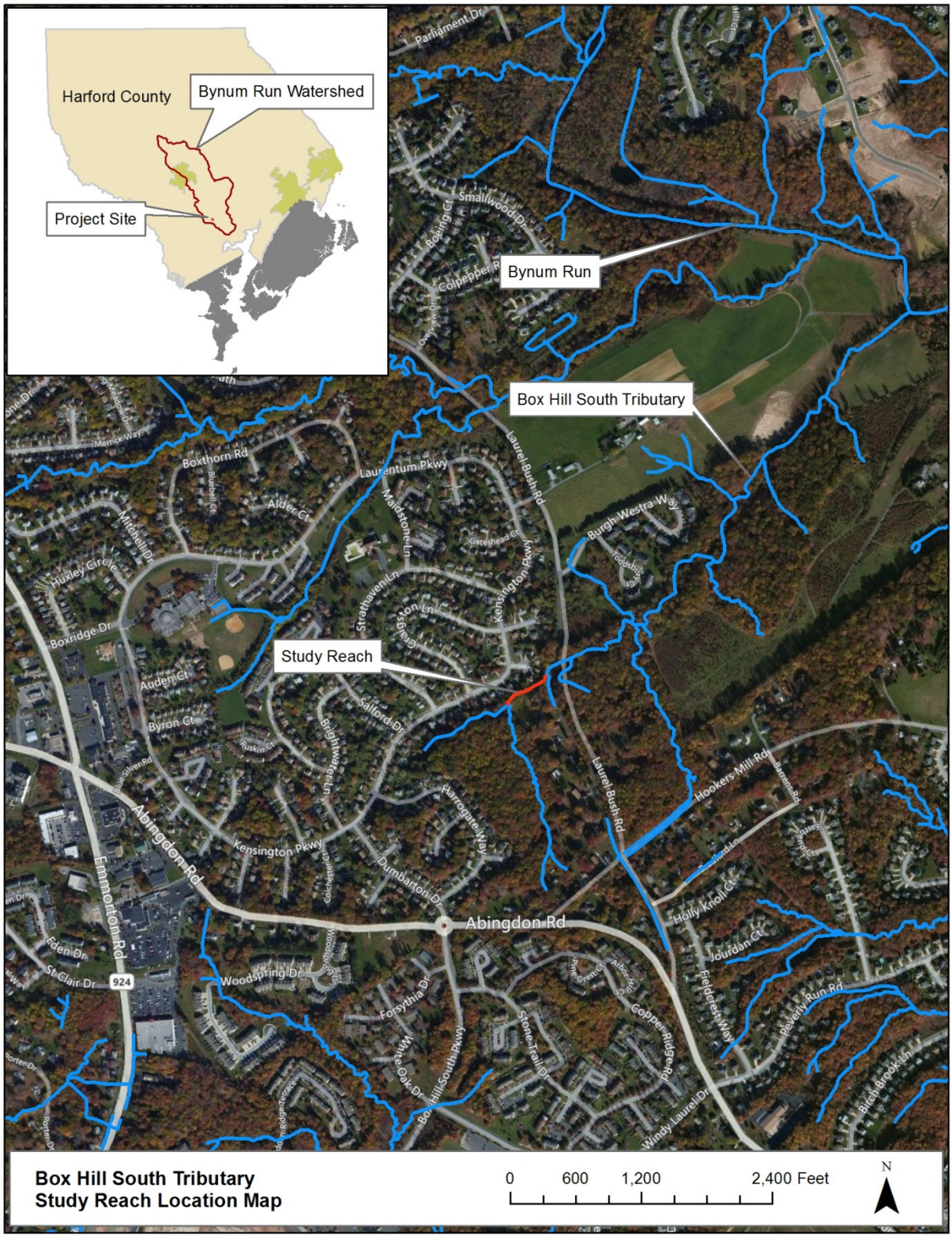
KCI Technologies, Inc. (KCI) conducted biological monitoring on August 24, 2012. Summer bioassessment monitoring involves the collection of *in situ* water quality data, sampling and analysis of the fish community, assessment of physical and habitat characteristics, and photo documentation of site conditions throughout the study reach.

This technical memo summarizes the procedures and findings associated with the collection of biological stream condition data for the 2012 monitoring of the South Tributary to Bynum Run and draws comparisons to the 2002 and 2006 results.

2.0 METHODOLOGIES

Sampling was performed adhering to MBSS protocols during the Summer Index Period. The MBSS Summer Index Period occurs between June 1st and September 30th. Field sampling during the summer of 2012 was completed on August 24th. The following section discusses sampling protocols followed during the assessment.

Figure 1 – Site Vicinity Map



2.1 In-situ Water Chemistry

Water quality measurements were collected *in situ* from the downstream end of the sampling reach. Most parameters (i.e., temperature, pH, specific conductivity, and dissolved oxygen) were measured with a YSI ProPlus® multiprobe, while turbidity was measured with a Hach 2100 Turbidimeter. The following *in situ* parameters were measured:

- pH (standard pH units)
- Temperature (degrees Celsius, °C)
- Dissolved Oxygen (milligrams per liter, mg/L)
- Specific Conductivity (microSiemans per cm, µS/cm)
- Turbidity (nephelometric turbidity units, NTU)

Water quality equipment was regularly inspected, maintained, and calibrated to ensure proper usage and accuracy of the readings. Calibration logs were kept by field crew leaders and checked by the project manager regularly.

2.2 Fish Sampling

The fish community was sampled during the Summer Index Period according to methods described in *Maryland Biological Stream Survey Sampling Manual: Field Protocols* (DNR, 2010). In general, the approach uses double-pass electro-fishing of the entire 75-meter study reach established during spring sampling. Block nets were placed at the upstream and downstream ends of the reach to obstruct fish movement into or out of the study reach. Two passes were completed along the reach to ensure the segment was adequately sampled. The time in seconds for each pass was recorded and the level of effort for each pass was similar. Stream segments having a wetted width of 10 feet or less required only one electro-fishing unit, while those greater than 10 feet wide required additional units (i.e., one unit per 10 feet of width). Box Hill South required only one electrofishing unit with a single anode.

Captured fish were identified to species and enumerated. A total fish biomass for each pass was measured. Unusual anomalies such as fin erosion, tumors etc., were recorded. Additionally, gamefish (i.e., bass, trout, pike, etc.) were measured in length. Photographic vouchers were taken in addition to select voucher specimens.

2.3 Summer Index Period Habitat Assessment

Several indicators of site conditions and instream and riparian habitat were assessed during the Summer sampling visit (Table 1).

Table 1 – Summer Habitat Assessment Parameters

Summer Habitat Parameters	
Instream Habitat	Embeddedness
Epifaunal Substrate	Percent Shading
Velocity/Depth Diversity	Woody Debris & Rootwads
Pool/Glide/Eddy Quality	Maximum Depth
Riffle/Run Quality	

The habitat assessment consisted of a review of selected biologically significant habitat parameters that assess a stream's ability to support an acceptable level of biological health. The habitat metrics assessed included instream habitat, epifaunal substrate, pool quality, riffle quality, and velocity/depth diversity. These parameters were given a numerical score ranging from 0-20 (20 = best, 0 = worst), and a categorical rating. In addition, embeddedness and shading parameters were evaluated as percentages, and the number of both instream and dewatered woody debris and rootwads present were recorded.

2.4 Data Analysis

Field data were entered into Excel spreadsheets for data analysis. Data for fish assemblages were used to develop the Fish Index of Biotic Integrity (FIBI). This index is described in detail below.

2.4.1 Water Quality

Data analysis of the water quality sampling results was completed by comparing field collected results with acceptable *COMAR* standards established by the MDE.

2.4.2 Fish Data

Fish data were analyzed using methods developed by MBSS as outlined in the *New Biological Indicators to Better Assess the Condition of Maryland Streams* (DNR, 2005). The IBI approach involved statistical analysis using metrics that have a predictable response to water quality and/or habitat impairment. Raw values from each metric were assigned a score of 1, 3 or 5 based on ranges of values developed for each metric. The results were combined into a scaled FIBI score from 1.0 to 5.0 and a corresponding narrative rating of 'Good', 'Fair', 'Poor' or 'Very Poor' is applied, again in accordance with standard practice.

Four sets of FIBI metric calculations have been developed for Maryland streams based on DNR (2005). These include the coastal plain, Eastern piedmont and warmwater and coldwater highlands. The study area is located in the piedmont region therefore the following piedmont metrics listed in Table 2 were used for the FIBI scoring and analysis. Table 3 provides the FIBI scoring ranges and corresponding narrative ratings.

Table 2 – Fish Metric Scoring for the Eastern Piedmont FIBI (DNR, 2005)

Metric	Score		
	5	3	1
Abundance per Square Meter	≥ 1.25	0.25 – 1.24	< 0.25
Number of Benthic Species*	≥ 0.26	0.09 – 0.25	< 0.09
% Tolerant	≤ 45	46 – 68	> 68
% Generalist, Omnivores, Invertivores	≤ 80	81 – 99	100
Biomass per Square Meter	≥ 8.6	4.0 – 8.5	< 4.0
% Lithophilic Spawners	≥ 61	32 – 60	< 32

*Adjusted for catchment size

Table 3 – Biological Condition Rating Using FIBI Score (Roth et al. 2000)

FIBI Score	Narrative Rating	Description
4.0 – 5.0	Good	Comparable to reference streams considered to be minimally impacted.
3.0 – 3.9	Fair	Comparable to reference conditions, but some aspects of biological integrity may not resemble the qualities of these minimally impacted streams.
2.0 – 2.9	Poor	Significant deviation from reference conditions, with many aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating some degradation.
1.0 – 1.9	Very Poor	Strong deviation from reference conditions, with most aspects of biological integrity not resembling the qualities of minimally impacted streams, indicating severe degradation.

2.4.3 Habitat Assessment and Physical Characteristics

In order to assess the stream's ability to support an acceptable level of biological health, the aforementioned parameters were compared to the previous post restoration habitat assessment conducted in 2006.

3.0 RESULTS AND DISCUSSION

3.1 Water Quality

The Maryland Department of the Environment (MDE) has established acceptable standards for several of the water chemistry parameters measured in this study for each designated Stream Use Classification. Water quality data were compared to acceptable standards for Use I streams listed in the *Code of Maryland Regulations (COMAR) 26.08.02.03-.03 - Water Quality* (Table 4). Specific designated uses for Use I streams include water contact sports, fishing, the growth and propagation of fish, and agricultural, and industrial water supply. Currently, there are no standards available for conductivity. However, Morgan et al., (2007) identified a critical threshold between 'Fair' and 'Poor' stream quality for Maryland streams at 247 µS/cm.

Table 4 - Maryland COMAR Standards for Use I Waters

Parameter	Standard
pH (SU)	6.5 to 8.5
Dissolved Oxygen (mg/L)	Minimum of 5 mg/L
Conductivity (µS/cm)	No State standard
Turbidity (NTU)	Maximum of 150 Nephelometric Turbidity Units (NTU's) and maximum monthly average of 50 NTU
Temperature (°C)	Maximum of 32°C (90°F) or ambient temperature of the surface water, whichever is greater

Source: Code of Maryland Regulations (COMAR) 26.08.02.03-3 – Water Quality

Water quality data is presented in Table 5. For 2012, all regulated parameters fell within acceptable COMAR ranges. Although not regulated under COMAR, specific conductance was elevated signifying possible effects of impervious surface upstream in the watershed.

Table 5 – Surface Water Quality

Site	pH	Temperature (°C)	Dissolved Oxygen (mg/L)	Turbidity (NTU)	Specific Conductivity (µS/cm)
Box Hill South	7.35	20.5	7.68	1.57	321.3

3.2 Fish

The results of the fish community assessment are presented in Table 6. The overall FIBI score was rated 'Poor' for 2012, with a score of 2.67, which is the highest FIBI score of all years sampled. In addition to blacknose dace (*Rhinichthys atratulus*) and creek chub (*Semotilus atromaculatus*), one rosyside dace (*Clinostomus funduloides*) was collected this year, which was not collected during pre-restoration in 2002 or post restoration sampling in 2006 (Table 7). The total number of individuals collected was also highest in 2012. When compared to 2002 and 2006 sampling results, 176 and 107 more individuals, respectively, were collected in 2012. Because of the increased abundance of creek chub and the addition of rosyside dace, Lithophilic Spawner values increased from 18.4% in 2006 to 34.9% in 2012 (32 creek chub and 0 rosyside dace in 2006). Given the difference in the number of individuals collected this year, the score for Biomass per square meter also increased.

Table 6 – Fish Metric and FIBI Scores for Pre-Restoration (2002) and Post Restoration Sampling (2006 and 2012)

Metric	2002	2006	2012
Metric Values			
Abundance per square meter	*1.01	1.63	2.78
Adjusted Number of Benthic species	0.00	0.00	0.00
% Tolerant	100.00%	100.00%	99.64%
% Generalist, Omnivores, Invertivores	100.00%	100.00%	100.00%
Biomass per square meter	*2.98	7.54	11.46
% Lithophilic Spawners	50.48%	18.39%	34.88%
Metric Scores			
Abundance per square meter	3	5	5
Adjusted Number of Benthic species	1	1	1
% Tolerant	1	1	1
% Generalist, Omnivores, Invertivores	1	1	1
Biomass per square meter	1	3	5
% Lithophilic Spawners	3	1	3
FIBI Score	***1.67***	***2.00***	***2.67***
Narrative Rating	***Very Poor***	***Poor***	***Poor***

*Note: Average wetted width unavailable for 2002 assessment. The average of 2006 and 2012 values was used to calculate metric

Table 7 – List of fish species from Box Hill South

Sampling Year		
2002	2006	2012
Species Present		
Blacknose dace Creek chub	Blacknose dace Creek chub	Blacknose dace Creek chub Rosyside dace
Total Number of Species		
2	2	3
Number of Individuals		
105	174	281

3.3 Habitat Assessment

The habitat assessment results are in Table 8.

Habitat for both fish (instream habitat) and macroinvertebrates (epifaunal substrate) was rated at the higher range of marginal in 2012, which is comparable to 2006 scores which were at the lower range of sub-optimal. The number of instream rootwads has increased since the 2006 assessment. The assessment reach has a channel substrate consisting mostly of cobble and gravel with sand.

Table 8 – Habitat Assessment Results

Parameter	2006 Score	2012 Score
Instream Habitat	12	10
Epifaunal Substrate	11	10
Velocity/Depth Diversity	8	7
Pool/Glide/Eddy Quality	8	7
Riffle/Run Quality	6	8
Embeddedness	50	60
Percent Shading	90	60
Number of Woody Debris/ Rootwads	0	8
Maximum Depth (cm)	40	45

4.0 FINAL ASSESSMENT

Water quality parameters indicate that the study reach is within *COMAR* regulations. The habitat and physical parameters indicate that the study reach has generally remained constant after restoration. Although marginal diversity of habitat types and flow regimes (pools, riffles, runs) provide adequate instream habitat for fish, habitat availability still remains less than desirable.

The bioassessment results for 2012 indicated a 'Poor' biological community for fish. The sample was dominated by pollution-tolerant taxa, making up 99.6 percent of the sample. The addition of one intolerant species (rosyside dace) shows that biological conditions in the restored channel may be improving. However, the current species composition may be limited due to a fish blockage at the downstream end of the culvert at Laurel Bush Road (Figure 2). This blockage is 1.5 feet in height and is a double barrel concrete culvert road crossing. Multiple intolerant northern hogsuckers (*Hypentelium nigricans*) were observed in the large pool downstream of the blockage at the time of sampling.

Figure 2 – Fish blockage at Laurel Bush Road

5.0 REFERENCES

DNR. 2005. New Biological Indicators to Better Assess the Condition of Maryland Streams. Maryland Department of Natural Resources Monitoring and Non-Tidal Assessment Division. Annapolis, MD.

DNR. 2010. Maryland Biological Stream Survey Sampling Manual: Field Protocols. (Rev Jan. 2010) CBWP-MANTA-EA-07-01. Published by the Maryland Department of Natural Resources, Annapolis, MD. Publication # 12-2162007-190.

Maryland Department of the Environment. Code of Maryland Regulations (COMAR). Continuously updated. Code of Maryland Regulations, Title 26- Department of the Environment. 26.08.02.03- Water Quality.

Morgan R.P., K.M. Kline, and S.F. Cushman. 2007. Relationships among nutrients, chloride, and biological indicies in urban Maryland streams. Urban Ecosystems 10:153-177

Roth, N.E., Southerland, M.T., Chaillou, J.C., Kazyak, P.F., Stranko, S.A. 2000. Refinement and Validation of a Fish Index of Biotic Integrity for Maryland Streams. Report to Monitoring and Non-Tidal Assessment Division, Maryland Department of Natural Resources, Annapolis, Maryland.

Box Hill—South Tributary
March 2012

Upstream from Sta 11+00

Downstream from Sta 10+75

Downstream from Sta 10+20

Downstream from Sta 09+25

Downstream from Sta 08+75

Downstream from Sta 08+60

Downstream from Sta 08+00

Downstream from Sta 07+75

Left Bank at Sta 07+30

Downstream from Sta 06+10

Downstream from Sta 05+50

Downstream from Sta 04+40

Box Hill—South Tributary
October 2012


Upstream from Sta 11+25


Downstream from Sta 10+85


Downstream from Sta 10+20


Downstream from Sta 09+50


Downstream from Sta 08+65


Downstream from Sta 08+60


Downstream from Sta 08+00


Downstream from Sta 07+75


Downstream from Sta 07+30


Downstream from Sta 07+10


Downstream from Sta 05+50


Downstream from Sta 04+25