2015 FINAL PROJECT REPORT

Microbial Source Tracking And Virginia's Beach Monitoring Program

MEMORANDUM OF AGREEMENT: (VPIMST617GY15)

Between

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Annual Project Report on Activities Relating to Sample Collection and Analyses at Virginia's Public Beaches, 2015.

Section 1: Description of 2015 Advisories

The VDH-VT Beaches Project began in 2004 when VDH initiated weekly monitoring and implemented EPA-approved sampling protocols. For the 2015 swimming season there were 26 total advisories covering 4 beaches and 97 days under advisory (Table 1, see http://www.vdh.virginia.gov/Epidemiology/dee/beachmonitoring/ - advisory data).

Table 1. Advisory results for years 2004 through 2015, all beaches. The number in parentheses indicates number of days under advisory for all beaches with Fairview Beach removed.

Year	# of Advisories	Days under Advisory	# of Beaches
2004	27	147 (122)	11
2005	14	42 (34)	8
2006	8	43 (10)	4
2007	14	50 (18)	8
2008	10	29 (5)	6
2009	14	51 (35)	9
2010	38	81 (63)	16
2011	28	69 (47)	15
2012	23	29 (19)	17
2013	21	30 (25)	13
2014	52	113 (96)	32
2015	26	97 (47)	4

Virginia's beaches had a "good" year in 2015, with only 4 beaches impacted by advisories. Since the VT-VDH project began in 2004, there have never been fewer than 4 beaches with advisories in any given year, and 2006 was the only other year where as few as 4 beaches posted advisories. The 2015 totals are a welcome change from 2010 through 2014, where the number of beaches impacted each year was in double digits. The 4 beaches in 2015 was an especially good outcome

when compared to 2014 where a record number of beaches were impacted (32). The average number of annual advisories over all 12 years in Table 1 is 21.75, so the 26 advisories in 2015 was just a little over that annual average. If Fairview is not included, the average number of days under advisory for all 12 years is 43, with 2015 being just a little over that average at 47 days.

Fairview Beach (on the Potomac River), usually an annual problem, was problematic again in 2015 with 8 advisories (all multi-day, 31% of the 2015 total) and 50 days under advisory (52% of the 2015 total, Table 2). Hilton Beach (on the James River) has also been an annual problem over most years since 2004, and in 2015 Hilton was a problem beach again with 9 advisories (5 were multi-day) covering 31 days under advisory (Table 2). Substantial efforts were made in the summers of 2014 and 2015 to determine where the sources of pollution at Hilton Beach originated (see Section 2). In 2015 the problems at Hilton appeared to have a direct impact on Huntington Beach, just 2 miles downstream on the James River below Hilton. Huntington Beach had 8 advisories (two were multi-day) and 15 days under advisory. The fourth beach was Dam Neck North, where a one day advisory occurred in August. For the 26 advisories in 2015, 11 were one day events and 15 were multi-day events.

Table 2. Individual beach results for the 2015 season (See http://www.vdh.virginia.gov/Epidemiology/dee/beachmonitoring/ - monitoring data).

Beach	Number of Advisories	Total Days Under Advisory	Days for Each Advisory
Fairview	8	50	7, 7, 7, 6, 2, 7, 7, 7
Hilton	9	31	1, 1, 7, 7, 4, 2, 1, 7, 1
Huntington	8	15	1, 6, 1, 1, 1, 3, 1, 1
Dam Neck	1	1	1
Totals	26	97	97

Fairview Beach was included for comparison to the annual totals for each year from 2004 through 2015 in Table 1, and to other beaches in 2015 in Table 2. Fairview was not included in the VDH-VT project in 2014 and 2015 and no samples were analyzed by VT from that beach. For that reason, Fairview is not included in the monitoring and source tracking results and discussion in the remainder of this report, and was likewise not included in 2014. Prior to 2014, Fairview was included in the project and exhaustively sampled and studied by VT and VDH personnel from 2004 through 2012. Multiple sources of input causing the beach contamination were located during the investigations and resolving those inputs will be an expensive and major

undertaking. Until such time as those inputs are dealt with, Fairview can be expected to have multiple advisories every summer.

In the neighborhoods around Hilton Beach, the sewer collection system is a patchwork of gravity and pressurized lines, and the system also serves to collect stormwater – especially the gravity lines. Intensive monitoring at Hilton Beach in previous years demonstrated that high flows generated by stormwater have a direct impact on *Enterococcus* levels at Hilton Beach. The sewer collection system around Hilton Beach is undergoing a series of repairs and upgrades that began in 2013 and are still underway at present. Hilton Beach experienced a higher than typical number of advisories in 2013 and the same happened in 2014 and 2015. The VT lab, in cooperation with HRSD, participated in dye tests and intensive sampling over both dry and wet periods at Hilton Beach in 2013 and 2014. The results of these efforts demonstrated that the source of pollution was predominately human in origin, indicating that water quality at Hilton Beach was impacted by precipitation-related overflow from the sewage collection system (see annual reports from 2013 and 2014).

Dye tests failed to resolve the exact location in the system where the cross-contamination occurred, but ruled out the sewer lines that were closest to the beach as the sources of fecal pollution. The open pipe that is present at Hilton Beach is a storm drain, but water flows out of it in all but the driest weather so it's likely intercepting groundwater somewhere in the system. Water samples collected from the outfall in dry weather typically are either negative for *Enterococcus* or the counts are minimal and below the 104 colony-forming units (CFU)/100mL standard. The flow increases in wet weather, and that's when the human-origin signature appears in water samples collected from the outfall. High *Enterococcus* counts resulting in an advisory at Hilton Beach usually precede an advisory downriver at Huntington Beach, depending on precipitation at the time and tidal conditions. Huntington Beach has also been investigated in detail over the years and there is no evidence of pollution that originates at Huntington, other than occasional advisories where the *Enterococcus* numbers were just slightly over the standard and these advisories were traced to birds. Both waterfowl (Canada geese and ducks) and shorebirds (gulls) are frequently found at Huntington Beach. No at-the-beach local sources of human-origin pollution have ever been found at Huntington Beach.

The advisory monitoring results (*Enterococcus* counts as CFU/100mL) for Hilton Beach ranged from 104 to 7,070, with 7 of 18 results being over 1,000 (Table 3). The advisory monitoring results (*Enterococcus* counts, colony-forming units as CFU/100mL) for Huntington Beach ranged from 108 to 2,005, with 2 of 12 results being over 1,000. The single advisory for Dam Neck North was 160, a moderately low count and it occurred on 8/15/2015, after the last advisories for the season had posted for Hilton and Huntington on 8/11/2015 (Table 3).

Table 3. Advisory monitoring results for the 2015 beach season. (See http://www.vdh.virginia.gov/Epidemiology/dee/beachmonitoring/ - monitoring data).

Date	*Enterococcus* counts (CFU/100mL)	Advisory	**Hilton Beach Storm Drain Outfall** (See Table 4)
Hilton Beach VDH Monitoring Site			
05/19/2015	2420	Swimming Advisory	No sample
05/20/2015	1289	Swimming Advisory	No sample
06/03/2015	406	Swimming Advisory	733
06/04/2015	7070	Swimming Advisory	>24196
06/08/2015	146	Swimming Advisory	1165
06/09/2015	2485	Swimming Advisory	13893
06/18/2015	251	Swimming Advisory	17698
06/23/2015	209	Swimming Advisory	1242
06/24/2015	835	Swimming Advisory	11638
06/25/2015	104	Swimming Advisory	2662
07/01/2015	718	Swimming Advisory	No sample
07/06/2015	1485	Swimming Advisory	1920
07/07/2015	1793	Swimming Advisory	1038
07/08/2015	670	Swimming Advisory	765
07/09/2015	127	Swimming Advisory	780
07/14/2015	231	Swimming Advisory	767
08/04/2015	281	Swimming Advisory	5119
08/11/2015	2834	Swimming Advisory	>24196
Huntington Beach			
05/19/2015	230	Swimming Advisory	

06/04/2015	166	Swimming Advisory
06/08/2015	302	Swimming Advisory
06/09/2015	2005	Swimming Advisory
06/15/2015	207	Swimming Advisory
06/24/2015	251	Swimming Advisory
07/01/2015	114	Swimming Advisory
07/06/2015	598	Swimming Advisory
07/07/2015	216	Swimming Advisory
07/08/2015	108	Swimming Advisory
08/04/2015	211	Swimming Advisory
08/11/2015	1268	Swimming Advisory
Dam Neck North		
08/15/2015	160	Swimming Advisory

The *Enterococcus* counts from the Hilton storm drain outfall in Table 3 for the fifteen samples collected on monitoring days were all above the regulatory standard. Eleven of the fifteen samples produced counts over 1,000; five samples had counts over 10,000 and two samples had counts over 24,000. These two very high samples on 6/4 and 8/11 also produced the highest counts in the Hilton monitoring site on those same dates. Considering the high counts entering the James River from the storm drain outfall, and the proximity of the regular monitoring site at Hilton Beach to the storm drain, it is a surprise that Hilton had as few advisories as it did in 2015. The James River at Hilton Beach is over a mile across and a noticeable strong current is typically present. Rapid dilution and dispersion of the contaminated water entering the river from the Hilton storm drain best explains the differences in counts between the two sampling sites, and also demonstrates the high level of fecal pollution that occurs in the storm drain system.

The advisory counts and dates at Hilton and Huntington in 2015 demonstrate the connection between the two beaches (Table 3). Hilton experienced its first advisory on 5/19 and 5/20, and counts for both days were over 1,000 (over 2,000 on 5/19). Huntington also had its first advisory on 5/19, but the count was only 230. Precipitation for 5/19 – 5/21 was 3.15cm, likely contributing to the May advisories. Hilton then went under advisory from 6/3 through 6/9, and

on 6/4 the counts were over 7,000. Huntington followed with advisories on 6/4, 6/8, and 6/9, with the counts on 6/9 over 1,000. These advisories in early June were precipitation-related and occurred during a wet week where 4.1cm of rain occurred on 6/2 and 11.2cm was recorded over the week of 6/2 to 6/9. The 6/15 advisory at Huntington occurred when there was no advisory at Hilton and was not related to a rainfall event. The average count at Huntington on 6/15 was 207, a moderately low number. After that date, Hilton posted advisories on 6/18 and 6/23, 6/24, and 6/25. During this period Huntington only had one advisory on 6/24. This multi-day advisory at Hilton was also associated with precipitation as there was 0.8cm on 6/18, then 2.54cm of rain on both 6/24 and 6/27, and 7.0cm total for the week.

Another wet week occurred over the first week of July, and both beaches posted advisories on 7/1, 7/6, 7/7, and 7/8, while Hilton had an additional advisory on 7/9. For the period 6/30 through 7/2 a total of 5.6cm of rain occurred, followed by an additional 2.4cm for the week of 7/5 – 7/11. The remainder of July was much drier, with a total of 1.1cm occurring over the rest of the month after 7/11. Huntington had no further advisories for July and Hilton had a one-day advisory on 7/14 when Huntington did not. August was a much drier month than June and July, and each beach had just two advisories, both on 8/4 and 8/11. Neither of these August advisories appeared to be related to rainfall as there was no precipitation on 8/4 and just 0.96cm of rain occurred on 8/11. No further advisories occurred at either beach after 8/11.

Section 2: Microbial Source Tracking (MST) on 2015 Water Samples

To test for the presence of human-source pollution at beaches that experienced advisories, 71 water samples were collected during the 2015 advisories and shipped to the Hagedorn lab at VT over the course of the season (Table 4). Of the 71 samples, 62 (87.3%) were and positive 9 (12.7%) were negative for the GenBac DNA marker (general *Bacteroides,* an indicator of fecal pollution but not source specific), indicating that fecal pollution was present and widespread in the samples mailed to the VT lab. For the HF183 *Bacteroides* human-specific DNA marker, 57 (80.3%) were positive and 14 (19.7%) were negative. All 57 positive HF183 samples were also positive for GenBac, and this agreement between the two DNA markers indicates that these 57 samples should be considered as positive for both fecal and human-origin contamination. Only five samples were positive for GenBac but negative for HF183, indicating that some fecal source other than human was present in those samples. The *Enterococcus* counts for these five samples were not high when compared to the majority of the counts from the storm drain and ranged from 104 to 454.

Over the summer of 2015, 41 water samples were collected from the storm drain outfall at Hilton Beach (Table 4). Of the 41 samples, none were below the 104 regulatory standard, fourteen (34%) produced counts above 1,000, five were above 10,000 and two were above 24,000. Only four samples were negative for HF183. This is the most important result from Table 4 – the storm drain outfall at Hilton Beach was flowing every time that a stop was made at that location to collect a sample, and the outfall was a consistent source of human-origin fecal contamination

throughout the 2015 season. For the nine samples from Huntington Beach, only three were positive for HF183 and *Enterococcus* counts were much lower, as should be expected for a beach that is impacted by Hilton but has no human-origin pollution that originates at that location. Work on the sewer system around Hilton Beach has continued this past fall and into the present. Sampling in the 2016 season will help determine if the infrastructure upgrades have been successful at reducing or elliminating the fecal bacterial pollution seen at Hilton in previous years. If during the 2016 season the pollution persists, it is likely that continued investigation of the infrustrature is necessary so that solutions can eventually be identified and implemented

Table 4. MST results for Hilton and Huntington Beaches

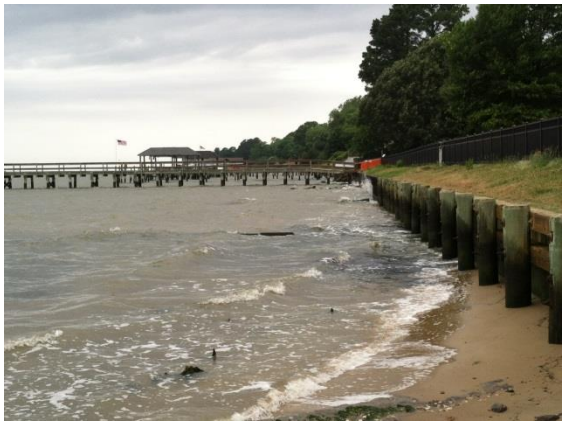
Sample	*Enterococcus* counts (CFU/100mL)	GenBac*	HF183
Hilton Beach – VDH sampling site			
5/19	2420	**Positive**	**Positive**
5/20	1289	**Positive**	**Positive**
5/26	102	**Positive**	**Positive**
5/27	64	Negative	Negative
6/3	406	**Positive**	Negative
6/4	7070	**Positive**	**Positive**
6/8	146	**Positive**	**Positive**
6/9	2485	**Positive**	**Positive**
6/18	251	**Positive**	**Positive**
6/23	209	**Positive**	**Positive**
6/24	835	**Positive**	**Positive**
6/25	104	**Positive**	Negative
7/1	718	**Positive**	**Positive**
7/6	1485	**Positive**	**Positive**
7/7	1793	**Positive**	**Positive**
7/8	670	**Positive**	**Positive**
7/9	127	**Positive**	**Positive**
7/14	231	Negative	Negative
7/15	718	**Positive**	**Positive**
8/4	281	**Positive**	**Positive**
8/11	2834	**Positive**	**Positive**
Hilton #1 – Storm Drain Outfall			
5/26	652	**Positive**	**Positive**
5/27	438	**Positive**	**Positive**
5/28	598	**Positive**	**Positive**

6/1	306	**Positive**	**Positive**
6/2	251	Negative	Negative
6/3	733	**Positive**	**Positive**
6/4	>24196	**Positive**	**Positive**
6/8	1165	**Positive**	**Positive**
6/9	13893	**Positive**	**Positive**
6/10	1429	**Positive**	**Positive**
6/11	1157	**Positive**	**Positive**
6/15	454	**Positive**	Negative
6/16	499	**Positive**	**Positive**
6/18	17698	**Positive**	**Positive**
6/22	1634	**Positive**	**Positive**
6/23	1242	**Positive**	**Positive**
6/24	11638	**Positive**	**Positive**
6/25	2662	**Positive**	**Positive**
6/29	805	**Positive**	**Positive**
6/30	414	**Positive**	Negative
7/2	310	**Positive**	**Positive**
7/6	1920	**Positive**	**Positive**
7/7	1038	**Positive**	**Positive**
7/8	765	**Positive**	**Positive**
7/9	780	**Positive**	**Positive**
7/13	282	**Positive**	**Positive**
7/14	767	**Positive**	**Positive**
7/15	1448	**Positive**	**Positive**
7/16	823	**Positive**	**Positive**
7/20	178	Negative	Negative
7/22	448	**Positive**	**Positive**
8/4	5119	**Positive**	**Positive**
8/6	329	**Positive**	**Positive**
8/10	363	**Positive**	**Positive**
8/11	>24196	**Positive**	**Positive**
8/12	497	**Positive**	**Positive**
8/13	146	**Positive**	**Positive**
8/17	110	**Positive**	**Positive**
8/18	417	**Positive**	**Positive**
8/19	359	**Positive**	**Positive**
8/25	176	**Positive**	**Positive**

Huntington Beach			
6/4	166	Negative	Negative
6/8	302	Negative	Negative
6/9	2005	**Positive**	**Positive**
6/15	207	**Positive**	Negative
7/1	114	Negative	Negative
7/6	598	**Positive**	**Positive**
7/7	216	Negative	Negative
8/4	211	Negative	Negative
8/11	1268	**Positive**	**Positive**

*GenBac and HF183 are DNA markers that indicate fecal pollution regardless of source (GenBac) and human-origin fecal pollution (HF183). These markers are detected and measured by qPCR (quantitative polymerase chain reaction).

Images of Hilton Beach in 2014



The above images of the storm drain outfall (left) and Hilton Beach (right) show the conditions of the beach in 2014. The photographer stood at the same location for both pictures, he just turned away from the storm drain and faced west for the beach picture. The public fishing pier can also be seen in the right image. Considerable work was done on the outfall in 2015 and a new set of images will be taken and made available in May 2016.

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