2015 Annual Monitoring Report – Permit No. VPA00579

Permit Holder: Weanack Land LLC -- February 15, 2016

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Introduction and Permit History & Background

This report and associated maps, attachments and data sets comprise our Annual Monitoring Report for all work conducted in **calendar year 2015** for ground and surface water monitoring, hydrogeologic modeling and beneficial use study requirements for VPA Permit No. VPA00579 for Weanack Land LLC (Weanack) in Charles City County. The original monitoring plan was submitted to DEQ by American Land Concepts (ALC) in November, 2000, and focused on the Woodrow Wilson Bridge (WWB) sediment utilization area (Fig. 1). This approved monitoring plan served as the basis for our protocols and designs through mid-2004. On September 7, 2004, Virginia DEQ approved a modification to the monitoring plan as outlined below that reduced the number of water quality sampling points and frequency. Subsequently, in June 2005, DEQ approved further modifications to the permit and monitoring requirements to allow placement of a new source of dredge materials (Earle Naval Weapons Station - Earle) into a separate utilization basin as shown in Figure 2. In July of 2005, modifications to the Operations and Maintenance Manual (OMM) and Monitoring Plans for both utilization areas were approved by DEQ. Over time, the site originally designated as the Earle Basin has also received sediments from the Cheatham Annex on two occasions.

In 2006, permit coordination and liaison responsibilities for this permit were transferred from ALC to Marshall Miller & Associates (now Cardno) with whom we have worked closely over the past nine years. Virginia Tech and Old Dominion University (ODU) continue to serve as subcontractors to Weanack to carry out monitoring and research as specified in the approved plans. A new and extensive revision to the VPA permit was approved by DEQ in December of 2012. In December 2014, DEQ PRO approved an additional modification of VPA permit VPA00579, which was then reissued on December 1, 2012. The modifications included revisions to the Source Monitoring Table, a reduction of parameters for ground water and surface water monitoring as well as annual monitoring of ground water and surface water. This report therefore reflects the December 12, 2014, modified monitoring criteria and requirements.

Over the 2015 monitoring year, we continued monitoring water quality of bulk leachate collected from an experiment involving potentially acid forming materials from the Maryland Ports Administration (MPA) located between the Appomattox River Sediment Biodegradation and Beneficial Use Pilot Program (Landform Pilot Study) [LPS] research cells and the Earle basin. We have halted collection of water samples from the plot lysimeters. Detailed information on the installation of this experiment is available in the 2010 annual report.

On September 18, 2014, Weanack received approval from DEQ PRO for upland placement of freshwater dredge material from the City of Alexandria City Marina maintenance dredging project in the Potomac River. During December, three barges containing a total of 6,450 cubic yards of dredge material from the maintenance dredging of the City of Alexandria City Marina was placed in the Woodrow Wilson Basin (WWB). Due to the timing of that placement, not all of the characterization data for the Alexandria materials was available for last year's report and is therefore included in this report.

Monthly reports for this permit have been compiled by Charles (Chee) Saunders and we gratefully acknowledge his assistance in our monitoring efforts. The description of agronomic practices contained in this report is based upon input from Charles Carter III of Weanack Land LLC.

We certify under penalty of law that this document and all attachments were prepared under our direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on our inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of our knowledge and belief, true, accurate, and complete. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

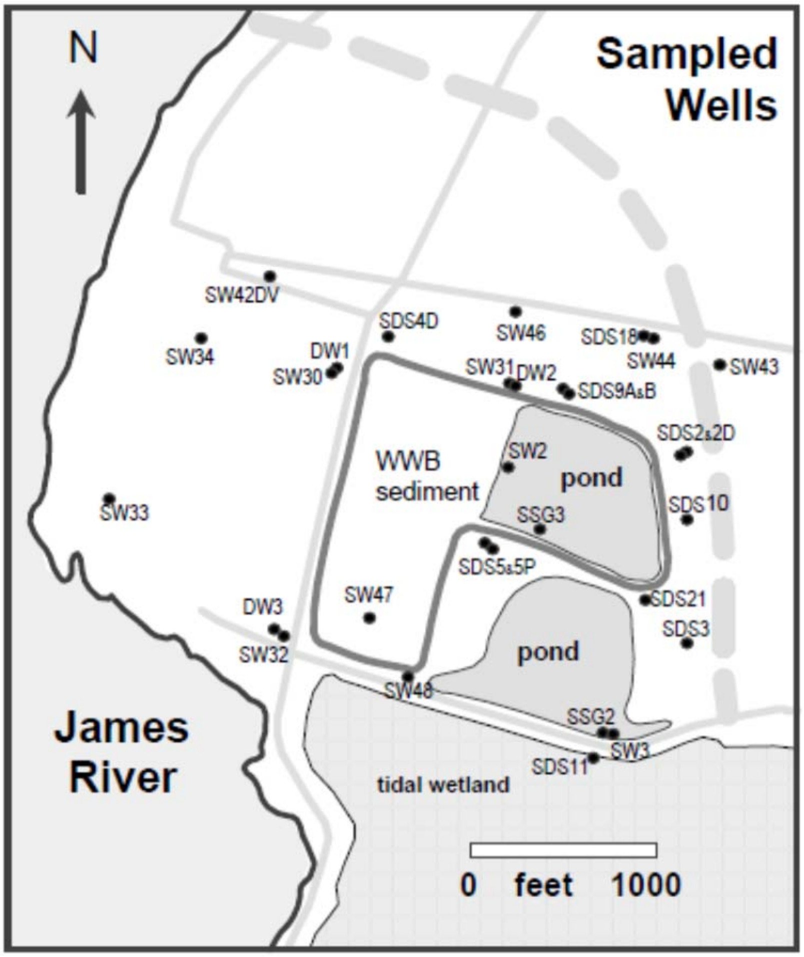

Figure 1. Map of basin location and monitoring wells around the Woodrow Wilson Bridge sediments discussed in this report. The Shirley Plantation (SP) drinking well in the NW corner of the map was also sampled but is not shown. The dashed line corresponds to a local terrace scarp which defines the base of older river sediments to the West. Please note that this map shows all wells installed over time at the WWB Basin and certain wells are not currently sampled. Monitoring locations are detailed below.

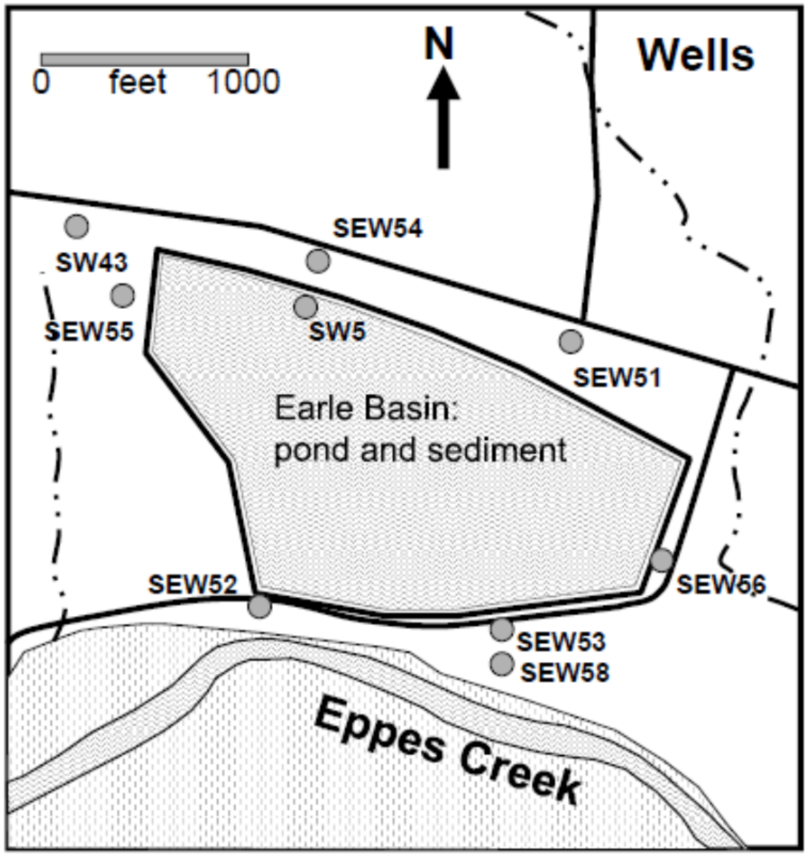

Figure 2. Map of basin location and monitoring wells sampled around the Earle sediment basin as discussed in this report. The WWB basin lies to west, across the ephemeral drain shown running south towards Eppes Creek. FYI: The LPS and MPA projects are located to the southeast of well SEW 51 and approximately 50 feet uphill from the original edge of sediments deposited into this basin. Another monitoring well (SEW 57) is not shown on this figure but lies just downgradient from the LPS cells very close to the NE corner of the Earle pond boundary.

Water Quality Monitoring Methods

WWB Monitoring Locations

In 2015 we conducted quarterly routine monitoring for temperature, pH, EC, and DOC. Under the approved December 2012 monitoring plan revision, we continued to perform the detailed water quality sampling annually. Furthermore, our detailed water quality sampling locations were modified from all wells available on-site to a minimum of the six specified below. These locations and labels were originally clarified via Email and memo interactions with DEQ over the summer of 2006 and were also detailed in an O&M Manual revision submittal (Oct. 2009) by Marshall Miller & Associates. The following set of locations (see Fig. 1) was used for sampling and annual water quality analysis (as required in the Dec. 2012 and 2014 revisions) in November of 2015. Water quality samples from the November sampling event were analyzed by AWS Labs of Richmond.

Upgradient groundwater wells: SDS 3 and SW 43

Downgradient groundwater wells: SW 30 and SW 31

Surface water: SW2 has been sampled over time from the continuous water body present within the dikes (SSG3 is the staff gage reading in that pond). The old mining slimes pond to the south of the WWB basin was dry for the vast majority of sampling dates between 2005 and 2009, and therefore reporting on that location (SSG 2/SW 3) was discontinued.

Owner's drinking well: SP-well (reported with Earle well array in this report).

Earle Monitoring Locations

Procedures and rationale for the location, installation and sampling of the primary water quality monitoring points for the Earle Basin were included in the 2005 permit revision materials, the 2006 annual report and the October 2009 revisions to the O&M Manual. The following set of locations (see Fig. 2) was used for sampling and annual water quality analysis in November of 2015. Water quality samples from the November sampling event were analyzed by AWS Labs of Richmond.

Upgradient groundwater wells: SEW 51 and SEW 54

Downgradient groundwater wells: SEW 52, SEW 53 and SEW 58

Surface water: SW 5 is sampled from within the Earle Basin ponded portion (Figure 2).

We continued quarterly monitoring (Feb/May/Aug/Nov) in 2015 of all wells around the WWB and Earle Basin sites for water level, pH, conductivity, temperature, and DOC.

Monitoring parameters for the November 2015 water quality sampling were specified in the December 2012 permit revision and differ in many ways from the older "partial suite" and "full suite" parameters that were applied differentially to the WWB and Earle Basin water quality monitoring schedules. As per the revisions of the December 2012 permit revision, and as approved in December 2014, sampling frequency for the water quality analysis was decreased to once per year for all primary locations and future monitoring will test for a reduced list of parameters.

Well Maintenance and Hydrogeologic Analyses

Virginia Tech and ODU maintained the well sites around the existing basin containing the Woodrow Wilson Bridge (WWB) and Earle Basin sediments. Several wells were damaged during the year due to clearing of woods in many places around the basins, and thus needed to be repaired or reconstructed and resurveyed. We conducted routine monitoring of wells and ponds around the WWB and Earle Basin sites for water levels, pH, conductivity, temperature, and DOC in February, May, August and November 2015. We collected water samples around both the Earle and WWB basins for prescribed comprehensive water quality analyses on November 15-16, 2015.

Water flow analyses for the two basins are combined on one map (Figure 3) due to the close proximity of the basins. This more comprehensive view gives a larger and better perspective of the relationships of water flow through this topographically and stratigraphically complex setting.

Woodrow Wilson Bridge Site

Relatively normal to wet conditions during 2015 caused water levels in the ponds and wells to fluctuate within levels observed during the past several years. Pond levels are maintained by a combination of direct precipitation and groundwater inflow from the sediment mound deposited in the western end of the disposal area.

Analyses of water flow direction for the WWB disposal site as shown in Figure 3 indicate no important change in flow directions from previous years. As is usual, minor changes were observed over time and over short distances. Shallow wells and wells close to stormwater drainage ditches proved to be the most responsive to rainfall events, being the most likely to rise after rain events associated with sampling dates. The close relationship between the shape of the berm and groundwater contours reflects the permeable connection between the fill sediments, the pond, and surrounding aquifer. Variations in hydraulic conductivity of these permeable sediments over short distances cause the locally steep gradients in the water table.

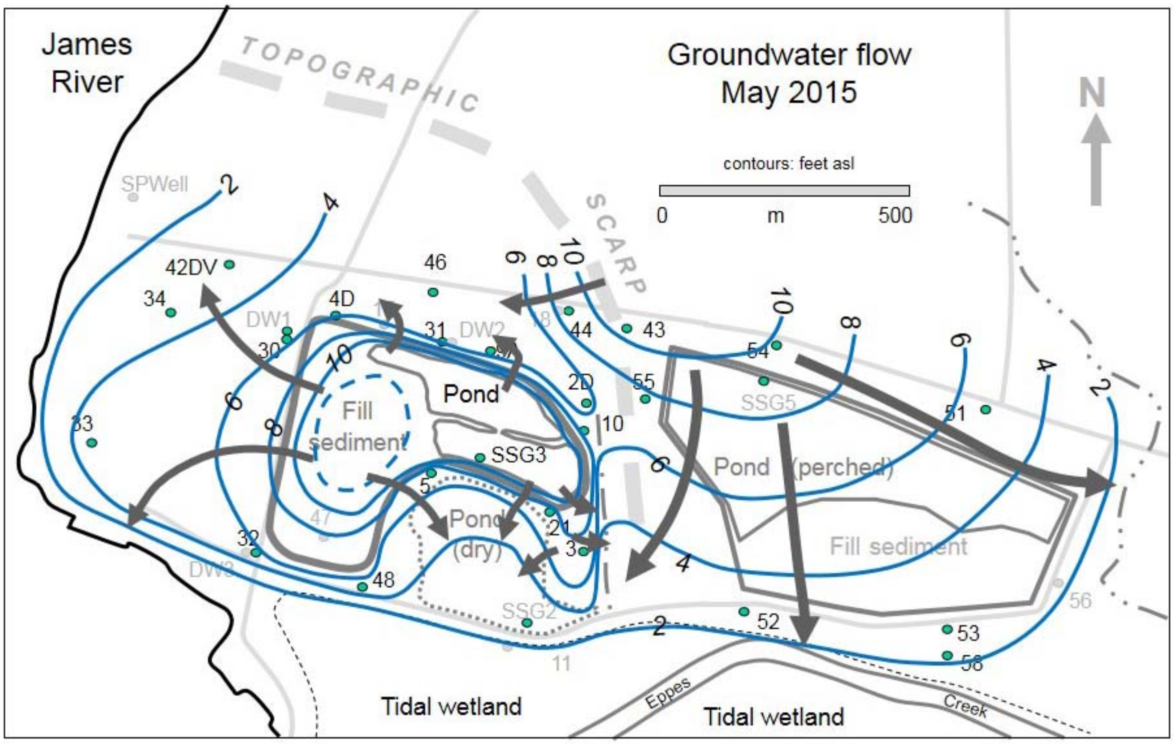

Figure 3. Groundwater flow around the disposal site for the Woodrow Wilson Bridge sediments (western disposal basin) and the Earle Basin sediments (eastern disposal basin). Wells are marked with the number of their label; wells and ponds marked with grey labels were not used in the analysis of flow for the days sampled (5/28/15). Contours show the shape of the water table surface and are in feet elevation. Grey lines denote roads, creeks, and the compacted sediment berms that contain the disposal sediment. The large dashed line notes location of a distinct scarp between a higher terrace that underlies the Earle Basin and the lower terrace that underlies the Woodrow Wilson Bridge sediment disposal site.

Earle Basin site

The groundwater flow analyses of the Earl Basin site (Figure 3) also show no important change in flow directions from previous analyses. As in the WWB basin pond, water in the Earle Basin pond inside of the berm (measured at SSG5) fluctuated between levels measured in past years. Water levels in monitoring wells indicate disposal pond water does not influence the groundwater flow patterns surrounding the Earle Basin sediments in any measurable way. The clay-rich substrate across the floor of the basin, purposefully compacted and smeared to reduce its permeability, effectively retains most basin water. The gentle groundwater ridge that lies several meters below the level of the pond existed before the sediment basin was constructed and our data do not indicate that it has changed in any important way due to the filling of the basin with dredge sediments over time.

Detailed Water Quality Results for 2015

The monitoring wells around the WWB and Earle Basins were sampled quarterly in 2015 for water level, pH, EC and DOC. Data are presented in Attachment 1 and no significant departures from previous years were noted beyond the conductivity data for SEW 53 and 58 as discussed below.

Woodrow Wilson Bridge Basin

Field tests of pH, EC and temperature in monitoring wells around the WWB site produced values that were similar to past readings. The two down-gradient wells – SW30 and SW31 – that showed significant increases in EC in 2013, but returned to pre-2013 levels in 2014, continued to show non-elevated EC values in 2015.

The detailed water quality data for the November 2015 sampling (Attachment 2) revealed no significant levels of concern for any parameters analyzed and no obvious changes from previous year results. The only parameters that continue to show a significant influence of the weathering dredge materials (via differential analysis of up- vs. down-gradient) wells are sulfate and TDS as discussed in previous annual reports. The downgradient levels remain moderate, however.

Earle Basin

The water pH and conductivity readings for most of the monitoring wells around the Earle Basin are values typical for groundwater in this hydrogeologic setting. The water in the ponded portion of the Earle Basin continues to be somewhat brackish, reflecting the pore water quality of the estuarine sediments placed in the basin and the overall ability of the compacted clay layers below to retard and retain the saline waters against losses to local groundwater. Fluctuations in pH and EC values also reflect the influence of rainfall events within a few days of sampling times, as well as the dry conditions during much of the year.

The conductivity values for SEW53 and SEW58; the down-gradient monitoring wells southeast of the disposal area, continued to be elevated during 2015. From July 2007 to February 2015 values at SEW53 rose from relatively stable values of approximately 300 µS to 7480 µS; however, later in 2015 EC values in that well dropped to 5870 and then rose again to 7350. At SEW58, during 2015, values at SEW58 rose from approximately 884 µS to 1451 µS. SEW53 sits 25 m directly south of the berm around the Earle basin; SEW58 is approximately 50 m down-gradient of SEW53. The trends in data from these wells continue to suggest that brackish seepage water from the basin has formed a salinity plume extending at least as far as Well 58. The salinity in waters from these two locations is clearly driven by chloride and sulfate, both of which are considered secondary water quality criteria parameters. Two conductivity readings during 2015 (378 and 274 µS) in SEW 52, the other down-gradient well, were slightly elevated above the range of values measured at that well since 2007 (131-250 μS), but do not indicate the presence of a significant salinity plume.

MPA Study Plots

In November 2009, 150 cubic yards of dredge material were transported from the Cox Creek Dredged Material Containment Facility of the Maryland Ports Authority to Weanack. Samples of the delivered dredge sediment were analyzed and it was determined that 12.5 tons of $CaCO_3$ were needed to treat each 1000 tons of material (125% of the predicted acid-forming potential). Because of the predicted acid-forming nature of the sediment, the primary concern was to control the acidity of the sediment to minimize leaching of metals such as Fe and Mn. In May 2010, three research cells were constructed to determine whether bulk-blending or layering agricultural limestone with the acid-forming sediments was more effective in reducing acidity and leaching of metals (primarily Mn and Fe).

Before dredge placement, three zero-tension lysimeters were installed at -75 cm to allow the sampling of downward percolating waters leaching through the sediment. Research cells were lined with a compacted clay liner and all drain into a catchment tank to control the release of leachate into the Earle Basin. The first cell received untreated dredge material to serve as a control, the second was blended with 381 kg of agricultural lime before placement, and the third was placed with 6 alternating layers of lime and dredge sediment as it was placed. None of the lysimeters were sampled in 2015, but storage tank releases were monitored.

MPA Storage Tank Releases in 2015

The permit modification that pertains the MPA experiment requires that the leachates from the MPA cells are captured in a holding tank and treated to achieve a pH between 6.5 and 8.5; total Fe <3.0 mg L^{-1}, and total Mn <3.5 mg L^{-1} before release over the surface of the Earle Basin sediments. The water in the MPA storage tank tends to be acidic and very high in Mn (>80 mg L^{-1}) when it leaves the MPA research cells, particularly from the control cell. Weanack's lime treatment protocol for the water has been to raise the tank pH to ≥10 which quickly generates very low levels (<0.1 mg L^{-1}) of Fe and Mn in solution. However, Weanack is then required to re-acidify the water (using commercial grade muriatic acid) to pH 8.5 or less to meet the release criteria. This allows Mn to resolubilize to some extent from the sludge in the tank bottom and this behavior makes it very difficult for Weanack to meet the Mn release criteria.

Mr. Carter has been collecting samples of the treated leachate from the storage tank and sending splits to AWS and Virginia Tech for analysis. A summary of collection results corresponding to the reported (by Cardno monthly reports) tank releases is presented in Table 1. The water entering the tank continues to be rather acidic and high in Fe and Mn. Despite the initial difficulties adjusting the tank pH, the applications of lime and muriatic acid have become fine-tuned and have minimized concentrations of Mn (< 3.5 mg L^{-1}) and iron (<3.0 mg L^{-1}).

Table 1. Water quality data for the MPA storage tank and volumes of leachate released into the Earle Basin.

Date	pH	Fe (mg L^{-1})	Mn (mg L^{-1})	Release
5/2015	8.45	0.620	6.44	2800 gallons
11/2015	7.79	0.027	0.33	3150 gallons

Dredge Sediment Placement Activities

Placement of dredge sediment from the City of Alexandria City Marina into the Woodrow Wilson Basin began in mid-December and 6,450 yd^3 were placed as of December 31, 2014. This material was approved by DEQ PRO on September 18, 2014. The remaining material was placed in early 2015, with 15,000 yd^3 placed in January 2015 and 5,050 yd^3 placed in February 2015 for a total of 26,500 yd^3 of material placed in the Woodrow Wilson Basin. Prior to placement, the material was tested for potential pollutants, nutrients and other parameters of agronomic concern and screened using the Virginia Tech (DEQ approved) dredge analysis template. The full pre-dredging dataset of analyte concentrations can be found in Attachment 4 of the 2014 Annual Report. All parameters clearly met our “clean fill” criteria except for several SVOCs. However, those parameters were reported out by their analytical lab at less than their respective reporting levels (RLs), and even with that arbitrary reporting convention, were still well below our permit exclusion criteria for placement. During dredging, an additional set of composites (one composite per 30,000 yd^3) was collected and sent to AWS to test for all potential contaminants. The material’s results were screened by our new screening template criteria to confirm that it is “clean fill” (Attachment 3). Additionally, samples were analyzed in our labs at Virginia Tech for several other important agronomic parameters including pH, EC, and calcium carbonate equivalent (CCE) content where we determined the material did not require liming (Attachments 4 - 8).

Summary of Agronomic Practices by Placement Site

Woodrow Wilson Basin:

Half of the upper 44 acres of the Woodrow Wilson Basin had enough dredged material to be farmed in 2015. The unfarmed area included 10 acres of low elevation and 12 acres that were ponded. Fertilizer was applied according to soil lab recommendations (250, 100, and 150 lbs/ac of N, P_2O_5, and K_2O, respectively), as well as 1 ton/ac of agricultural lime. The WWB had not needed agricultural lime until 2014 when the pH of the upper 6” of soil dropped to 6.3. 2015 saw relatively good weather for corn in the WWB and a very productive yield of 235 bu/ac vs. the national average of 175 bu/ac and the native Pamunkey soil at Shirley yielded 199 bu/ac. The 235 yield across the 22 acre WWB field includes lower-yielding edge-of-field areas (edge of dike), internal roads (internal dikes) and sandy areas (discharge pipe sites). The internal 'pure sediment' areas of the field produced yields of approximately 250 bu/ac.

Earle Basin:

Cells 1, 2, and 3 of the Earle Basin were farmed in 2015 for winter wheat and soybeans. Fertilizer was added for the winter wheat in cell 2 according to soil lab recommendations (30, 80, and 80 lbs/ac of N, P_2O_5, and K_2O, respectively). Quicklime was added for the winter wheat in cell 1 at a rate of 300 lbs/ac. No fertilizer or lime was added for the soybeans. The weather in 2015 was problematic for crops on the saline sediments in the ENWS. Winter wheat yields (sown in November 2014) were harmed by heavy spring rains, temporarily flooding in low areas of the fields, and salts wicking upward from deeper in the soil profile. The Earle Basin yielded 57 bu/ac of winter wheat in 2015, compared in the WWB to 77 bu/ac in 2014, 67 bu/ac on local native soils, and 80+ bu/ac on freshwater sediments. This year stressed the crops on saline materials while the better-drained native and freshwater crops showed little evidence of water or salt stress. Furthermore, heavy rains from late June to mid-July delayed wheat harvest past the optimum time with resultant loss of grain due to shatter (loss of grains off the head before harvest).

However, winter wheat continues to be a very good crop in saline dredged materials in terms of yield, salt tolerance, and furthering soil development. Continued settling of the Earle Basin surface elevations (due to drying of deeper sediments) resulted in uneven slopes and flat areas. Better management of surface drainage from cells 1-3 into cell 4 should alleviate much of the problem. Weather (heavy late rains) at harvest and planting times on fine-grained sediments cannot be controlled, but as the soil dries and develops deeper over time, soil structure and water-handling capacity are improving.

Short-season salt-excluder soybeans on the Earle were also impacted by the heavy rain event and resultant late planting in the third week of July which was 2.5-3 weeks later than recommended. Salt tolerant (salt-excluder) soybeans have been tested and initial results show a 5 bu/ac improvement over standard soybeans. The yield of 29 bu/ac is below the adjacent native fields' 52 bu/ac, the national average of 47 bu/ac, and the 2014 yield on the Earle of 44.5 bu/ac. The soybeans were limited by salinity, excessively wet soils, and a shortened growing season; all issues that should improve over time and in future growing seasons.

Cell 2 is the most productive of all of the ENWS cells while the other cells limit the average calculated yield in Earle Basin as a whole. Cell 4 is ponded and not farmed (Figure 4). Cell 3 is very low and flat leading to ponding in heavy rains – and lowered average productivity. Cell 1 contains the "youngest" (least developed) material, which is the Cheatham 2012 placement on top of the Earle sediments. The Cell 2 surface has slope/surface-drainage and is composed of the

Cheatham 2010 material on top of the Earle sediments. The expectation is that cell 1, with its greater elevation (than cell 2), will develop into a better-drained and more productive field.
In 2016, the Earle Basin will be planted with full-season soybeans rather than the winter wheat / short season soybean double crop. This is largely in reaction to the last two wet summers affecting both the wheat and soybean crops. Full-season soybeans are planted earlier and are expected to be less susceptible to a wet summer. With improved soil development and internal drainage, we anticipate returning to the double crop rotation in the future.

Figure 4. Aerial image of the Earle Basin showing the four separate cells (Google Earth 2012). The LPS and MPA plots are visible along the northeast edge of Cell 3.

Summary of Agronomic Practices and Expectations:

Corn yields on the WWB were quite good, despite a wet spring and summer. To date, there have been no issues with the freshwater sediments for agricultural production, from either the Potomac or James Rivers. Those sediments continue to match or beat the best native farm soils in the local area, which are considered to be some of the most productive soils in the nation.

The wet weather resulted in a reduced yield for all crops on the Earle Basin sediments. Wet weather also impacted yields on nearby native soil in both 2015 and 2014, although well-drained fields performed somewhat better. Surface drainage of the farmed areas with small ditches in early 2016 should reduce the field ponding potential seen in the past two years. The saline sediments have shown great potential in years with favorable weather, and while not equaling the freshwater sediments in yields, have matched or exceeded yields for local native farm soils under the right conditions and management practices. Overall, there is nothing in the 2015 crop results that alters our view that these saline sediments will eventually out-produce lower quality local farm soils and reclaimed mined lands, and provide an opportunity to increase overall crop productivity on many areas. As the cells fill, sediment develops, and management improves, it is expected that the full potential of these sediments can be realized.

The ability to remove the improved sediments from the basins at some point in the future for placement onto nearby native farm fields should be considered for enhancing the overall productivity of the local farmed lands. Harvester monitor yield measurement taken from many of the local native soil fields show considerable variability across a given transect. Typically, areas of erosion, changes in soil types, elevation changes, field edges, and other differences are revealed by the yield monitor zones producing less than the field average. Amending these low-output areas with higher-quality dredged sediments from a basin or project can boost the total yield of a field considerably. A future demonstration of dredge sediment amendment to low productivity native soils is recommended to study the depth of amendment needed, effects of dredge soil salinity, underlying native soil characteristics, elutriates, runoff potential, before- and after-amendment crop productivity, and other parameters.

Overall Summary and Conclusions

Overall, we continue to observe no significant short- or long-term impacts of dredge material placement into either the WWB or Earle Basin on overall water quality with respect to metals, organics, nutrients, pH, etc. That being said, the elevated EC levels observed in SEW 53 (outside of the Earle Basin berm) over the past four years, and to a much more limited extent in SEW 58 (further downgradient), continue to indicate that a plume of brackish groundwater migrated out of that basin. As reported in the last several years of annual reports, remedial corrective measures were applied in 2012 and we will continue to monitor the water quality in these wells to determine whether additional corrective measures are needed.

In 2013, we noted an increase in EC and sulfate levels in two downgradient wells for the WWB basin, but that response was clearly due to unintended consequences of the import of moderately sulfidic construction sediments. Since 2013, the EC and sulfate levels have dropped again as expected, and in 2015 approached pre-2013 levels. The 2015 detailed water quality data analysis showed no obvious changes from previous years. Sulfate and TDS continue to remain elevated in certain downgradient wells due to weathering and oxidation of the dredge materials, however, these parameters are not at levels of concern.

The cured sediments in the WWB basin continue to be some of the best agricultural lands in Charles City County and clearly demonstrate the beneficial use potential of upland placement of appropriately screened and placed dredge materials. Similarly, despite some difficulties in 2015 due to wet weather and the original saline nature of the dredge material, all areas of the Earle Basin sediments continue to improve in their ability to support normal agricultural rowcrop production within several years after placement and dewatering. This further supports our overall conclusions regarding beneficial use potentials.

ATTACHMENT 1
2015 Quarterly Water Quality Analyses

2015 Quarterly Water Levels

	02/25/15	05/28/15	08/21/15	11/15/15
SDS 2	11.71	9.87	10.56	10.87
SDS 2D	4.23	4.8	4.77	4.29
SDS 3	8.68	7.87	na	na
SDS 4D	4.32	5.82	4.17	3.6
SDS 5	6.72	4.72	4.53	5.5
SDS 5P	6.35	4.98	4.53	5.65
SDS 9A	4.08	4.79	4.68	4.11
SDS 9B	dry	dry	dry	dry
SDS 10	6.9	6.65	6.6	6.02
SDS 11	na	na	na	na
SDS 18	na	na	na	15.44
SDS 21	7.31	6.8	na	6.95
SW 30	2.9	3.62	4.31	2.99
SW 31	3.15	3.6	3.68	3.05
SW 32	3.03	2.8	3.75	2.7
SW 33	5.11	4.63	4.55	4.55
SW 34	2.58	2.98	3.47	2,64
SSG 2	na	na	na	na
SSG 3	na	na	na	na
SW42DV	2.06	2.2	2.97	2.2
SW43	11.24	11.12	11.54	11.12
SW44	8.27	7.52	7.18	7.52
SW46	4.2	4.26	4.96	4.26
SW47	na	na	na	na
SW48	5.94	na	4.34	5.52
SEW51	5.02	5.2	5.1	4.85
SEW52	4.55	3.73	2.91	3.19
SEW53	2.19	2.14	2.07	1.99
SEW54	8.31	9.99	9.49	9.49
SEW55	7.95	7.36	7.35	7.3
SEW56	na	na	na	na
SEW58	2.1	2.12	2.04	1.97
SSG5	na	25.41	na	22.01

(Reported as feet above sea level)
na = not available

2015 Quarterly pH

WWB	**02/25/15**	**05/28/15**	**08/21/15**	**11/15/15**
SDS 3	5.29	5.78	na	5.66
SW 30	6.14	6.25	6.16	6.03
SW 31	5.84	5.82	5.79	5.84
SW43	5.3	5.67	5.41	5.36
SW3	dry	dry	dry	dry
SW2	5.86	na	9.94	6.16
Earle				
SP Well	6.32	7.44	6.86	7.46
SEW 51	5.18	5.58	5.43	5.4
SEW52	5.58	5.85	5.86	6.09
SEW53	5.01	6.36	5.34	5.26
SEW54	5.64	5.95	7.85	5.63
SEW58	5.27	5.35	5.27	5.32
SW5	5.74	8.66	9.02	5.77

na = not available

2015 Quarterly DOC

DOC (ppm)

WWB	**February**	**May**	**August**	**November**
SDS 3	4.06	3.75	na	4.39
SW 30	6.78	6.92	4.12	5.8
SW 31	3.83	3.73	3.36	3.09
SW 43	2.53	2.45	2.48	1.77
SW 2	3.67	12.84	8.70	6.23
Earle				
SP Well	2.09	2.45	2.12	1.49
SEW 51	2.46	2.17	2.68	1.52
SEW 52	12.11	3.76	12.90	2.36
SEW 53	7.29	6.06	6.97	4.84
SEW 54	2.54	2.18	3.14	1.72
SEW 55	8.15	10.09	9.28	na
SEW 57	2.01	na	na	na
SEW 58	2.55	2.79	3.44	2.03
SW 5	4.48	27.85	29.38	8.26

na = not available

2015 Quarterly Temperature

Temp in °C				
WWB	**02/25/15**	**05/28/15**	**08/21/15**	**11/15/15**
SDS 3	13.8	20.1	na	17.6
SW 30	13.5	17.3	18.7	22.1
SW 31	14.4	15.8	17.1	15.9
SW43	14.4	17.9	15.7	15
SW3	dry	dry	dry	dry
SW2	12.2	33.3	31.7	13.7
Earle				
SP Well	13.8	19.5	23.5	13.7
SEW 51	14.6	18.3	17.9	16.8
SEW52	12.6	16.6	18.1	20.4
SEW53	1.90	19.0	18.7	22.6
SEW54	9.70	20.2	16.6	17.1
SEW58	14.2	17.3	18.9	21.7
SW5	4.90	35.5	34.8	15.2

na = not available

2015 Quarterly EC

EC - μS cm^{-1}				
WWB	**02/25/15**	**05/28/15**	**08/21/15**	**11/15/15**
SDS 3	19.7	137	na	305
SW 30	937	1015	568	946
SW 31	562	640	546	585
SW43	186	162	171	180
SW3	dry	dry	dry	dry
SW2	649	800	748	1023
Earle				
SP Well	519	443	424	421
SEW 51	189	199	172	173
SEW52	150	151	374	278
SEW53	7480	5870	6380	7350
SEW54	168	305	334	237
SEW58	884	997	1248	1415
SW5	894	7450	6590	5950

na = not available

ATTACHMENT 2
2015 Annual Water Quality Analyses

				Earle Basin	
		Date:	11/15/2015	11/15/2015	11/15/2015
		Well ID:	SEW 51	SEW 52	SEW 53
Analyte	**Method**	**Units**	**Results**	**Results**	**Results**
Arsenic	SW6010C	mg/L	<0.0090 †	<0.0090	<0.0180
Barium	SW6010C	mg/L	0.126	0.0818	0.0536
Cadmium	SW6010C	mg/L	<0.0020	<0.0020	0.0180
Chromium	SW6010C	mg/L	0.0012, (0.0100)*	0.0019, (0.0100)	0.0026, (0.0100)
Copper	SW6010C	mg/L	<0.0030	0.0034, (0.0100)	0.0047, (0.0100)
Iron	SW6010C	mg/L	0.754	7.99	2.33
Lead	SW6010C	mg/L	0.0087, (0.0100)	0.013	<0.0060
Manganese	SW6010C	mg/L	0.115	1.41	2.53
Mercury	SW7470A	mg/L	<0.00020	<0.00020	<0.00020
Selenium	SW6010C	mg/L	<0.0080	<0.0080	0.0127, (0.0500)
Silver	SW6010C	mg/L	<0.0020	<0.0020	0.0021, (0.0100)
Zinc	SW6010C	mg/L	0.0163	0.0205	0.187
4,4-DDT [2C]	SW8081B	µg/L	<0.005	<0.005	<0.006
Aldrin	SW8081B	µg/L	<0.005	<0.005	<0.006
Chlordane	SW8081B	µg/L	<0.215	<0.211	<0.225
Dieldrin	SW8081B	µg/L	<0.003	<0.003	<0.003
Endrin	SW8081B	µg/L	<0.002	<0.002	<0.002
Gamma-BHC (Lindane)	SW8081B	µg/L	<0.003	<0.003	<0.003
Heptachlor	SW8081B	µg/L	<0.003	<0.003	<0.003
Heptachlor epoxide	SW8081B	µg/L	<0.002	<0.002	<0.002
Methoxychlor [2C]	SW8081B	µg/L	<0.004	<0.004	<0.004
Mirex	SW8081B	µg/L	<0.002	<0.002	<0.002
Toxaphene	SW8081B	µg/L	<0.215	<0.211	<0.225
2,4,5-TP (Silvex)	SW8151A	µg/L	<0.1	<0.1	<0.1
2,4-D [2C]	SW8151A	µg/L	<0.1	<0.1	<0.1
Chloride	EPA300.0/R2.1	mg/L	13.4	19.8	1960
Fluoride	EPA300.0/R2.1	mg/L	<0.100	0.121	0.230
Sodium	SW6010C	mg/L	8.93	26.9	948
Cyanide	SW9012	mg/L	<0.01	<0.01	<0.01
Nitrate	Calc.	mg/L	8.08	0.94	3.90
Nitrate+Nitrite	SM 18/4500-NO3 F	mg/L	8.08	0.94	3.90
Nitrite	SM 18/4500-NO2 B	mg/L	<0.05	<0.05	<0.05
Sulfate	EPA-300.0/R2.1	mg/L	14.5	18.9	1240
Total recoverable phenolics	EPA420.1	mg/L	<0.05	<0.05	<0.05
Total Organic Carbon	SW9060	mg/L	<1.0	2.1	3.6
Total Dissolved Solids	SM18/2540C	mg/L	121	154	5250
TPH-Volatiles (GRO)	SW8015C	mg/L	<0.10	<0.10	<0.10
Kepone	SW8270D	µg/L	<2.15	<2.06	<2.20
TPH-Semi-Volatiles (DRO)	SW8015C	mg/L	<0.30	<0.30	<0.30

† Values measured below detection limit are reported as <Limit of Detection (LOD)

* Value in parentheses represents lab reporting limit. Shown for samples >LOD and <Limit of Quantitation

			Earle Basin		
		Sample Date:	11/15/2015	11/15/2015	11/15/2015
		Well ID:	SEW 54	SP Well	SW 5
Analyte	**Method**	**Units**	**Results**	**Results**	**Results**
Arsenic	SW6010C	mg/L	<0.0090 †	<0.0090	<0.0180
Barium	SW6010C	mg/L	0.483	0.0119	0.0498
Cadmium	SW6010C	mg/L	<0.0020	<0.0020	<0.0020
Chromium	SW6010C	mg/L	0.0021, (0.0100)*	<0.0010	0.0254
Copper	SW6010C	mg/L	0.0199	<0.0030	<0.0030
Iron	SW6010C	mg/L	1.54	0.0442	2.14
Lead	SW6010C	mg/L	0.0382	<0.0060	<0.0060
Manganese	SW6010C	mg/L	0.214	0.0197	<0.0020
Mercury	SW7470A	mg/L	<0.00020	<0.00020	<0.00020
Selenium	SW6010C	mg/L	<0.0080	<0.0080	0.0282, (0.0500)
Silver	SW6010C	mg/L	<0.0020	<0.0020	0.0186
Zinc	SW6010C	mg/L	0.0598	<0.0100	0.162
4,4-DDT [2C]	SW8081B	µg/L	<0.005	<0.005	<0.005
Aldrin	SW8081B	µg/L	<0.005	<0.005	<0.005
Chlordane	SW8081B	µg/L	<0.208	<0.200	<0.206
Dieldrin	SW8081B	µg/L	<0.003	<0.003	<0.003
Endrin	SW8081B	µg/L	<0.002	<0.002	<0.002
Gamma-BHC (Lindane)	SW8081B	µg/L	<0.003	<0.003	<0.003
Heptachlor	SW8081B	µg/L	<0.003	<0.003	<0.003
Heptachlor epoxide	SW8081B	µg/L	<0.002	<0.002	<0.002
Methoxychlor [2C]	SW8081B	µg/L	<0.004	<0.004	<0.004
Mirex	SW8081B	µg/L	<0.002	<0.002	<0.002
Toxaphene	SW8081B	µg/L	<0.208	<0.200	<0.206
2,4,5-TP (Silvex)	SW8151A	µg/L	<0.1	<0.1	<0.1
2,4-D [2C]	SW8151A	µg/L	<0.1	<0.1	<0.1
Chloride	EPA300.0/R2.1	mg/L	24.3	17.5	528
Fluoride	EPA300.0/R2.1	mg/L	<0.100	1.49	<0.100
Sodium	SW6010C	mg/L	17.6	89.4	1850
Cyanide	SW9012	mg/L	<0.01	<0.01	0.01
Nitrate	Calc.	mg/L	15.9	<0.07	<0.07
Nitrate+Nitrite	SM 18/4500-NO3 F	mg/L	15.9	<0.02	<0.02
Nitrite	SM 18/4500-NO2 B	mg/L	<0.05	<0.05	<0.05
Sulfate	EPA-300.0/R2.1	mg/L	13.3	12.3	2610
Total recoverable phenolics	EPA420.1	mg/L	<0.05	<0.05	<0.05
Total Organic Carbon	SW9060A	mg/L	4.2	<1.0	7.8
Total Dissolved Solids	SM18/2540C	mg/L	215	266	4860
TPH-Volatiles (GRO)	SW8015C	mg/L	<0.10	<0.10	<0.10
Kepone	SW8270D	µg/L	<2.08	<2.00	<4.26
TPH-Semi-Volatiles (DRO)	SW8015C	mg/L	<0.30	<0.30	<0.30

† Values measured below detection limit are reported as <Limit of Detection (LOD)

* Value in parentheses represents lab reporting limit. Shown for samples >LOD and <Limit of Quantitation

			Earle Basin	
		Sample Date:	11/15/2015	11/15/2015
		Well ID:	SEW 58	Field Blank
Analyte	**Method**	**Units**	**Results**	**Results**
Arsenic	SW6010C	mg/L	<0.0090 †	<0.0090
Barium	SW6010C	mg/L	0.491	<0.0020
Cadmium	SW6010C	mg/L	0.0021, (0.0050)*	<0.0020
Chromium	SW6010C	mg/L	0.0041, (0.0100)	<0.0010
Copper	SW6010C	mg/L	<0.0030	<0.0030
Iron	SW6010C	mg/L	3.30	0.0089, (0.0100)
Lead	SW6010C	mg/L	<0.0060	<0.0060
Manganese	SW6010C	mg/L	0.841	<0.0020
Mercury	SW7470A	mg/L	<0.00020	<0.00020
Selenium	SW6010C	mg/L	0.0104, (0.0500)	<0.0080
Silver	SW6010C	mg/L	<0.0020	<0.0020
Zinc	SW6010C	mg/L	0.0846	<0.0100
4,4-DDT [2C]	SW8081B	µg/L	<0.005	<0.005
Aldrin	SW8081B	µg/L	<0.005	<0.005
Chlordane	SW8081B	µg/L	<0.208	<0.213
Dieldrin	SW8081B	µg/L	<0.003	<0.003
Endrin	SW8081B	µg/L	<0.002	<0.002
Gamma-BHC (Lindane)	SW8081B	µg/L	<0.003	<0.003
Heptachlor	SW8081B	µg/L	<0.003	<0.003
Heptachlor epoxide	SW8081B	µg/L	<0.002	<0.002
Methoxychlor [2C]	SW8081B	µg/L	<0.004	<0.004
Mirex	SW8081B	µg/L	<0.002	<0.002
Toxaphene	SW8081B	µg/L	<0.208	<0.213
2,4,5-TP (Silvex)	SW8151A	µg/L	<0.1	<0.1
2,4-D [2C]	SW8151A	µg/L	<0.1	<0.1
Chloride	EPA300.0/R2.1	mg/L	344	<1.0
Fluoride	EPA300.0/R2.1	mg/L	<0.250	<0.100
Sodium	SW6010C	mg/L	105	0.39
Cyanide	SW9012	mg/L	<0.01	<0.01
Nitrate	Calc.	mg/L	5.78	<0.07
Nitrate+Nitrite	SM 18/4500-NO3 F	mg/L	5.78	<0.02
Nitrite	SM 18/4500-NO2 B	mg/L	<0.05	<0.05
Sulfate	EPA-300.0/R2.1	mg/L	46.0	<1.0
Total recoverable phenolics	EPA420.1	mg/L	<0.05	<0.05
Total Organic Carbon	SW9060A	mg/L	1.7	<1.0
Total Dissolved Solids	SM18/2540C	mg/L	832	12
TPH-Volatiles (GRO)	SW8015C	mg/L	<0.10	<0.10
Kepone	SW8270D	µg/L	<2.08	<2.08
TPH-Semi-Volatiles (DRO)	SW8015C	mg/L	<0.30	<0.30

† Values measured below detection limit are reported as <Limit of Detection (LOD)

* Value in parentheses represents lab reporting limit. Shown for samples >LOD and <Limit of Quantitation

				WWB Basin	
		Sample Date:	11/15/2015	11/15/2015	11/15/2015
		Well ID:	SW 2	SW 30	SW 31
Analyte	Method	**Units**	**Results**	**Results**	**Results**
Arsenic	SW6010C	mg/L	<0.0090 †	0.0094, (0.0100)*	<0.0090
Barium	SW6010C	mg/L	0.0577	0.129	0.0998
Cadmium	SW6010C	mg/L	<0.0020	<0.0020	<0.0020
Chromium	SW6010C	mg/L	<0.0010	0.0040, (0.0100)	0.0044, (0.0100)
Copper	SW6010C	mg/L	<0.0030	<0.0030	<0.0030
Iron	SW6010C	mg/L	0.774	3.29	5.05
Lead	SW6010C	mg/L	<0.0060	<0.0060	<0.0060
Manganese	SW6010C	mg/L	0.254	9.35	0.891
Mercury	SW7470A	mg/L	<0.00020	<0.00020	<0.00020
Selenium	SW6010C	mg/L	0.0168, (0.0500)	0.0200, (0.0500)	<0.0080
Silver	SW6010C	mg/L	,0.0020	0.0026, (0.0100)	<0.0020
Zinc	SW6010C	mg/L	<0.0100	<0.0100	0.0227
4,4-DDT [2C]	SW8081B	µg/L	<0.005	<0.005	<0.005
Aldrin	SW8081B	µg/L	<0.005	<0.005	<0.005
Chlordane	SW8081B	µg/L	<0.215	<0.211	<0.206
Dieldrin	SW8081B	µg/L	<0.003	<0.003	<0.003
Endrin	SW8081B	µg/L	<0.002	<0.002	<0.002
Gamma-BHC (Lindane)	SW8081B	µg/L	<0.003	<0.003	<0.003
Heptachlor	SW8081B	µg/L	<0.003	<0.003	<0.003
Heptachlor epoxide	SW8081B	µg/L	<0.002	<0.002	<0.002
Methoxychlor [2C]	SW8081B	µg/L	<0.004	<0.004	<0.004
Mirex	SW8081B	µg/L	<0.002	<0.002	<0.002
Toxaphene	SW8081B	µg/L	<0.215	<0.211	<0.206
2,4,5-TP (Silvex)	SW8151A	µg/L	<0.1	<0.1	<0.1
2,4-D [2C]	SW8151A	µg/L	<0.1	<0.1	<0.1
Chloride	EPA300.0/R2.1	mg/L	53.6	73.6	9.8
Fluoride	EPA300.0/R2.1	mg/L	<0.250	<0.100	<0.100
Sodium	SW6010C	mg/L	27.1	20.4	11.9
Cyanide	SW9012	mg/L	<0.01	<0.01	<0.01
Nitrate	Calc.	mg/L	<0.07	<0.07	4.04
Nitrate+Nitrite	SM 18/4500-NO3 F	mg/L	<0.02	0.05, (0.10)	4.04
Nitrite	SM 18/4500-NO2 B	mg/L	<0.05	<0.05	<0.05
Sulfate	EPA-300.0/R2.1	mg/L	271	105	174
Total recoverable phenolics	EPA420.1	mg/L	<0.05	<0.05	<0.05
Total Organic Carbon	SW9060	mg/L	5.3	4.3	2.0
Total Dissolved Solids	SM18/2540C	mg/L	626	570	378
TPH-Volatiles (GRO)	SW8015C	mg/L	<0.10	<0.10	<0.10
Kepone	SW8270D	µg/L	<2.00	<2.04	<2.00
TPH-Semi-Volatiles (DRO)	SW8015C	mg/L	<0.30	<0.30	<0.30

† Values measured below detection limit are reported as <Limit of Detection (LOD)

* Value in parentheses represents lab reporting limit. Shown for samples >LOD and <Limit of Quantitation

			WWB Basin	
		Sample Date:	**11/15/2015**	**11/15/2015**
		Well ID:	**SW 43**	**SDS 3**
Analyte	**Method**	**Units**	**Results**	**Results**
Arsenic	SW6010C	mg/L	<0.0090 †	<0.0090
Barium	SW6010C	mg/L	0.359	0.0706
Cadmium	SW6010C	mg/L	0.0043, (0.0050)*	<0.0020
Chromium	SW6010C	mg/L	0.0465	0.0016, (0.0100)
Copper	SW6010C	mg/L	0.0218	<0.0030
Iron	SW6010C	mg/L	53.3	2.60
Lead	SW6010C	mg/L	0.0353	<0.0060
Manganese	SW6010C	mg/L	0.414	0.119
Mercury	SW7470A	mg/L	<0.00020	<0.00020
Selenium	SW6010C	mg/L	0.0093, (0.0500)	0.0087, (0.0500)
Silver	SW6010C	mg/L	<0.0020	<0.0020
Zinc	SW6010C	mg/L	0.144	0.0115
4,4-DDT [2C]	SW8081B	µg/L	<0.005	<0.005
Aldrin	SW8081B	µg/L	<0.005	<0.005
Chlordane	SW8081B	µg/L	<0.202	<0.200
Dieldrin	SW8081B	µg/L	<0.003	<0.003
Endrin	SW8081B	µg/L	<0.002	<0.002
Gamma-BHC (Lindane)	SW8081B	µg/L	<0.003	<0.003
Heptachlor	SW8081B	µg/L	<0.003	<0.003
Heptachlor epoxide	SW8081B	µg/L	<0.002	<0.002
Methoxychlor [2C]	SW8081B	µg/L	<0.004	<0.004
Mirex	SW8081B	µg/L	<0.002	<0.002
Toxaphene	SW8081B	µg/L	<0.202	<0.200
2,4,5-TP (Silvex)	SW8151A	µg/L	<0.1	<0.1
2,4-D [2C]	SW8151A	µg/L	<0.1	<0.1
Chloride	EPA300.0/R2.1	mg/L	22.7	26.0
Fluoride	EPA300.0/R2.1	mg/L	<0.100	<0.100
Sodium	SW6010C	mg/L	8.02	9.17
Cyanide	SW9012	mg/L	<0.01	<0.01
Nitrate	Calc.	mg/L	1.26	2.43
Nitrate+Nitrite	SM 18/4500-NO3 F	mg/L	1.26	2.43
Nitrite	SM 18/4500-NO2 B	mg/L	<0.05	<0.05
Sulfate	EPA-300.0/R2.1	mg/L	26.5	38.8
Total recoverable phenolics	EPA420.1	mg/L	<0.05	<0.05
Total Organic Carbon	SW9060A	mg/L	1.6	4.4
Total Dissolved Solids	SM18/2540C	mg/L	178	148
TPH-Volatiles (GRO)	SW8015C	mg/L	<0.10	<0.10
Kepone	SW8270D	µg/L	<2.04	<2.11
TPH-Semi-Volatiles (DRO)	SW8015C	mg/L	<0.30	<0.30

† Values measured below detection limit are reported as <Limit of Detection (LOD)

* Value in parentheses represents lab reporting limit. Shown for samples >LOD and <Limit of Quantitation

ATTACHMENT 3
Detailed City of Alexandria City Marina Dredge Sediment Analyses

Attachment 3, page 1: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26,500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

		Criteria								
		NJDEP (1997) Residential Soil Cleanup Criteria[3]	EPA Region 3 Screening Levels (EPA, 2014)[4]		EPA Part 503 Biosolids	USGS soil background metals[5]	Exclusion Criteria[6]	Clean Upland Fill Criteria[7]	VA DEQ 305 (b) Screening Criteria	More stringent of preceding two columns[8]
Average Value[1,2]	PARAMETER		Industrial Soil	Residential Soil	Exceptional Quality	VA background metal levels				
	Metals ($mg\ kg^{-1}$)									
	Aluminum	NA	110,000	7,700			NA	NA		
<0.48	Antimony	14	47	3.1			410	14		14
5.94	Arsenic	20	3.0	0.67	41	5	41	20	33	20
166	Barium	700	22,000	1,500		244	19,000	700		700
1.21	Beryllium	1	230	16		<1	2,000	160		160
0.70	Cadmium	39	98	7	39	<0.1	810	39	4.98	4.98
	Calcium	NA	NA	NA			NA	NA		
30.4	Chromium	NA	NA	NA	0.3	23	1,200	200	111	111
22.2	Cobalt	NA	35	2.3			300	NA		
51.9	Copper	600	4,700	310	1,500	9	4,300	1,500	149	149
30,100	Iron	NA	82,000	5,500			150,000	150,000		150,000
50	Lead	400	800	400	300	26	800	300	128	128
	Magnesium	NA	NA	NA			NA	NA		
1059	Manganese	NA	NA	NA		295	NA	NA		
0.24	Mercury	14	12	0.78	17	0.06	100	14	1.06	1.06
31.98	Nickel	250	1,100	82	420	9	1,000	250.0	48.6	48.6
	Potassium	NA	NA	NA			NA	NA		
0.445	Selenium	63	580	39	100		5,100	63		63
0.57	Silver	110	580	39			5,100	110	NA	110
94.87	Sodium	NA	NA	NA			NA	NA		
0.26	Thallium	2	NA	NA		0.5	5	1		1
37.2	Vanadium	370	580	39			5,200	370		370
215	Zinc	1,500	35,000	2,300	2,800	41	7,500	1,500	459	459

Attachment 3, page 2: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26,500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

		Criteria								
		NJDEP (1997) Residential Soil Cleanup Criteria[3]	EPA Region 3 Screening Levels (EPA, 2014)[4]		EPA Part 503 Biosolids	USGS soil background metals[5]	Exclusion Criteria[6]	Clean Upland Fill Criteria[7]	VA DEQ 305 (b) Screening Criteria	More stringent of preceding two columns[8]
Average Value[1,2]	**PARAMETER**		**Industrial Soil**	**Residential Soil**	**Exceptional Quality**	**VA background metal levels**				
	PCBS (mg kg^{-1})									
<0.032	Aroclor 1016	NA	5.2	0.4			21	NA		
<0.032	Aroclor 1221	NA	0.66	0.15			0.62	NA		
<0.032	Aroclor 1232	NA	0.66	0.15			0.62	NA		
<0.032	Aroclor 1242	NA	1.0	0.24			0.74	NA		
<0.032	Aroclor 1248	NA	1.0	0.24			0.74	NA		
<0.032	Aroclor 1254	NA	1.0	0.11			0.74	NA		
<0.032	Aroclor 1260	NA	1.0	0.24			0.74	NA		
<0.032	Total Aroclor[9]	0	10.5	1.50			25.2	0.49		0.49
	Total PCBs, all cogeners	0.49					NA	0.676	0.676	0.676
	Pesticides (mg kg^{-1})									
0.0018833	4,4'-DDD	3	9.6	2.2			7.2	3	0.028	0.028
0.0015757	4,4'-DDE	2	6.8	1.6			5.1	2	0.0313	0.0313
<0.00241	4,4'-DDT	2	8.6	1.9			7	2	0.0629	0.0629
	DDT, Total								0.5720	*
<0.000842	Aldrin	0.04	0.14	0.031			0.11	0.04		0.04
	alpha-Chlordane	NA	NA	NA			NA	NA		
	gamma-Chlordane	NA	NA	NA			NA	NA		
<0.00155	Chlordane	NA	8.0	1.8					0.0176	0.0176
	Chloropyrifos	NA	82.0	6.2						
	delta-BHC	NA	NA	NA			NA	NA		
	Diazinon	NA	58	4						
<0.000884	Dieldrin	0.042	0.14	0.03			0.11	0.042	0.0618	0.042
<0.00108	Endosulfan	NA	490	37			3,700	NA		

Attachment 3, page 3: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26,500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

		Criteria								
		NJDEP (1997) Residential Soil Cleanup Criteria[3]	EPA Region 3 Screening Levels (EPA, 2014)[4]		EPA Part 503 Biosolids	USGS soil background metals[5]				
Average Value[1,2]	PARAMETER		Industrial Soil	Residential Soil	Exceptional Quality	VA background metal levels	Exclusion Criteria[6]	Clean Upland Fill Criteria[7]	VA DEQ 305 (b) Screening Criteria	More stringent of preceding two columns[8]
	Pesticides cont. (mg kg^{-1})									
<0.000875	alpha-Endosulfan	NA	NA	NA			NA	NA		
<0.00108	beta-Endosulfan	NA	NA	NA			NA	NA		
<0.00132	Endosulfan sulfate	NA	NA	NA			NA	NA		
<0.00171	Endrin	17	25	1.8			180	17	0.207	0.207
<0.00152	Endrin aldehyde	NA	NA	NA			NA	NA		
	Guthion		250	18						
	Endrin ketone	NA	NA	NA			NA	NA		
<0.00103	Heptachlor	0.15	0.51	0.12			0.38	0.15		0.15
<0.000968	Heptachlor epoxide	NA	0.25	0.059			0.19	NA	0.016	0.016
<0.00121	alpha-BHC (Hexa-chlorocyclohexane)	NA	NA	NA						
<0.00106	beta-BHC (Hexa-chlorocyclhexane)	NA	NA	NA						
<0.00125	gamma-BHC (Lindane, Hexachlorocyclhexane)	0.52	NA	NA			0.52	0.52	0.00499	0.00499
	Kepone	NA	0.23	0.053						
	Malathion		1300	120						
<0.00334	Methoxychlor	280	410	31			3,100	280		280
	Mirex	NA	0.13	0.03						
	Parathion	NA	490	37						
<0.010	Toxaphene	0.1	2.1	0.48			1.6	0.1		0.1
	Base Neutral Extractables (mg kg^{-1})									
0.217	Acenaphthene	3,400	4,500	350			33,000	3,400	NA	3,400
	Acenaphthylene	NA	NA	NA			NA	NA	NA	
0.179	Anthracene	10,000	23,000	1,700			170,000	10,000	0.845	0.845
	Benzidine	NA	0.01	0.00052			NA	NA		

Attachment 3, page 4: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26,500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

		Criteria								
		NJDEP (1997) Residential Soil Cleanup Criteria[3]	EPA Region 3 Screening Levels (EPA, 2014)[4]		EPA Part 503 Biosolids	USGS soil background metals[5]	Exclusion Criteria[6]	Clean Upland Fill Criteria[7]	VA DEQ 305 (b) Screening Criteria	More stringent of preceding two columns[8]
Average Value[1,2]	PARAMETER		Industrial Soil	Residential Soil	Exceptional Quality	VA background metal levels				
	Base Neutral Extractables cont. ($mg\ kg^{-1}$)									
0.550	Benzo(a)anthracene	0.9	2.9	0.15			2.1	0.9	1.05	0.9
<0.120	Benzo(b)fluoranthene	0.9	2.9	0.15			2.1	0.9		0.9
<0.094	Benzo(k)fluoranthene	0.9	29	1.5			21	0.9		0.9
	Benzo(ghi)perylene	NA	NA	NA			NA	NA		
<0.076	Benzo(a)pyrene	0.66	0.29	0.015			0.66	0.21	1.45	0.21
<0.014	bis(2-Chloroethoxy)methane	NA	250	18			1,800	NA		
<0.031	bis(2-Chloroethyl) ether	0.66	1.0	0.23			0.9	0.66		0.66
<0.0175	2,2'-oxybis(1-Chloropropane) (Bis-2-Chloroisopropyl ether)	2,300	NA	NA			2,300	2,300		2,300
0.135	bis(2-Ethylhexyl) phthalate	49	160	38			120	49		49
	4-Bromophenyl phenyl ether	NA	NA	NA			NA	NA		
0.014	Butyl benzyl phthalate	1,100	1,200	280			1,100	910		910
	Carbazole	NA	NA	NA			NA	NA		
0.013	4-Chloroaniline	230	NA	NA			230	230		230
0.022	2-Chloronaphthalene	NA	NA	NA			NA	NA		
	4-Chlorophenyl phenyl ether	NA	NA	NA			NA	NA		
0.485	Chrysene	9	290	15			210	9	1.29	1.29
0.036	Dibenz(a,h)anthracene	0.66	0.29	0.015			0.66	0.21	NA	0.21
	Dibenzofuran	NA	100	7.2			NA	NA		
0.069	Di-n-butyl phthalate	5,700	NA	NA			5,700	5,700		5,700
<0.017	1,2-Dichlorobenzene	5,100	930	180			10,000	5,100		5,100
<0.032	1,3-Dichlorobenzene	5,100	NA	NA			5,100	5,100		5,100
<0.021	1,4-Dichlorobenzene	570	820	62.0			570	13		13
<0.077	3,3'-Dichlorobenzidine	2	5.1	1.2			3.8	2		2

Attachment 3, page 5: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26,500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

		Criteria								
		NJDEP (1997) Residential Soil Cleanup Criteria[3]	**EPA Region 3 Screening Levels (EPA, 2014)[4]**		**EPA Part 503 Biosolids**	**USGS soil background metals[5]**	**Exclusion Criteria[6]**	**Clean Upland Fill Criteria[7]**	**VA DEQ 305 (b) Screening Criteria**	**More stringent of preceding two columns[8]**
Average Value[1,2]	**PARAMETER**		**Industrial Soil**	**Residential Soil**	**Exceptional Quality**	**VA background metal levels**				
	Base Neutral Extractables cont. ($mg\ kg^{-1}$)									
<0.030	Diethyl phthalate	10,000	66,000	4,900			490,000	10,000		10,000
<0.012	Dimethyl phthalate	10,000	NA	NA			10,000	10,000		10,000
<0.011	Di-n-octyl phthalate	1,100	820	62			1,100	1,100		1,100
<0.016	2,4-Dinitrotoluene	NA	7.4	1.7			1,200	NA		
<0.030	2,6-Dinitrotoluene	1	1.5	0.36			620	61		61
<0.016	1,2-Diphenylhydrazine	NA	2.9	0.67						
0.834	Fluoranthene	2,300	3,000	230			22,000	2,300	2.23	2.23
0.151	Fluorene	2,300	3,000	230			22,000	2,300	0.536	0.536
<0.031	Hexachlorobenzene	0.66	1.4	0.33			1.1	0.66		0.66
<0.021	Hexachlorobutadiene	1	30	6.2			22	1		1
<0.170	Hexachlorocyclopentadiene	400	490	37			3,700	400		400
<0.038	Hexachloroethane	6	58	4.3			120	6		6
<0.147	Indeno(1,2,3-cd)pyrene	0.9	2.9	0.15			2.1	0.9		0.9
<0.014	Isophorone	1,100	2,400	560			1,800	1,100		1,100
0.028	2-Methylnaphthalene	NA	300	23			4,100	NA	NA	
0.03	Naphthalene	230	17	3.8			230	20	0.561	0.561
	2-Nitroaniline	NA	NA	NA			NA	NA		
<0.011	3-Nitroaniline	NA	82	18			82	NA		
<0.010	4-Nitroaniline	NA	120	25			82	NA		
<0.042	Nitrobenzene	28	22	5.1			280	28		
	2-Nitrophenol	NA	NA	NA						
	4-Nitrophenol	NA	NA	NA						
<0.028	N-Nitroso-dimethylamine	NA	0.045	0.0023						

Attachment 3, page 6: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26,500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

		Criteria								
		NJDEP (1997) Residential Soil Cleanup Criteria[3]	EPA Region 3 Screening Levels (EPA, 2014)[4]		EPA Part 503 Biosolids	USGS soil background metals[5]	Exclusion Criteria[6]	Clean Upland Fill Criteria[7]	VA DEQ 305 (b) Screening Criteria	More stringent of preceding two columns[8]
Average Value[1,2]	PARAMETER		Industrial Soil	Residential Soil	Exceptional Quality	VA background metal levels				
	Base Neutral Extractables cont. ($mg\ kg^{-1}$)									
<0.035	N-Nitroso-di-N-propylamine	0.66	0.33	0.076			0.66	0.25		0.25
<0.017	N-Nitrosodiphenylamine	140	470	110			350	140		140
1.097	Phenanthrene	NA	NA	NA			NA	NA	1.17	1.17
1.001	Pyrene	1,700	2,300	170			17,000	1,700	1.52	1.52
<0.025	1,2,4-Trichlorobenzene	68	26	5.8			400	68		68
	Acid Extractables ($mg\ kg^{-1}$)									
<0.018	4-Chloro-3-methylphenol	10,000	NA	NA			10,000	10,000		10,000
<0.018	2-Chlorophenol	280	580	39			5,100	280		280
<0.023	2,4-Dichlorophenol	170	250	18			1,800	170		170
<0.016	2,4-Dimethylphenol	1,100	1,600	120			12,000	1,100		1,100
<0.055	2,4-Dinitrophenol	110	160	12			1,200	110		110
<0.043	4,6-Dinitro-2-methylphenol	NA	NA	NA			NA	NA		
<0.025	2-Methylphenol	2,800	NA	NA			2,800	2,800		2,800
<0.030	4-Methylphenol	2,800	NA	NA			2,800	2,800		2,800
	Nonylphenol	NA	NA	NA						
<0.018	Pentachlorophenol	6	4.0	0.99			9	6		6
<0.022	Phenol	10,000	25,000	1,800			180,000	10,000		10,000
<0.025	2,4,5-Trichlorophenol	5,600	8,200	620			62,000	5,600		5,600
<0.028	2,4,6-Trichlorophenol	62	82	6.2			160	62		62
	Miscellaneous ($mg\ kg^{-1}$)									
	Ammonia as NH_3-N	NA	NA	NA						
	Chloride	NA	NA	NA						
	Cyanide, Free									

Attachment 3, page 7: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26,500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

		Criteria								
		NJDEP (1997) Residential Soil Cleanup Criteria[3]	EPA Region 3 Screening Levels (EPA, 2014)[4]		EPA Part 503 Biosolids	USGS soil background metals[5]				
Average Value[1,2]	PARAMETER		Industrial Soil	Residential Soil	Exceptional Quality	VA background metal levels	Exclusion Criteria[6]	Clean Upland Fill Criteria[7]	VA DEQ 305 (b) Screening Criteria	More stringent of preceding two columns[8]
	Miscellaneous cont. ($mg\ kg^{-1}$)									
0.102	Cyanide, Total	1,100	20,000	1,600			20,000	1,100		1,100
	2,4-Dichlorophenoxy Acetic Acid (2,4-D)	NA	970	69.0						
	Fluoride	NA	4,700	310						
	Hydrogen sulfide		1,200,000	280,000						
	Nitrate (as N)	NA	190,000	13,000						
	Nitrite (as N)	NA	12,000	780						
	Total PAHs	NA	NA	NA			NA	23		
	Total phenols (phenolic compounds)	NA	NA	NA			NA			
	Low molecular weight PAHs	NA	NA	NA			NA			
	High molecular weight PAHs	NA	NA	NA			NA			
	Total PAHS	NA	NA	NA					22.8	22.8
	Sulfate	NA	NA	NA						
	2-(2,4,5 Trichlorophenoxy) Proprionic acid (Silvex)	NA	660	49			NA	NA		
	Dioxin and Furans ($ng\ kg^{-1}$)									
	2,3,7,8-TCDD	NA	22	4.9			18	4.3		4
	Tributyltin ($mg\ kg^{-1}$)									
4.07	Tributyltin Compounds	N	25	1.8						
	Petroleum ($mg\ kg^{-1}$)									
248.65	Total petroleum hydrocarbons (TPH)									
	TPH-DRO									

Attachment 3, page 8: Brief Description: City of Alexandria City Marina 2014 sediment results appear in left-hand column. Total volume was 26500 yd^3, values from all analytical reports received by Virginia Tech. Average value is the mean of six composite samples.

Average Value[1,2]	Additional Analyses[10]		Units and Reporting convention	Method	Exclusion Criteria[6]	Clean Fill Criteria[7]
0.050	Acid-Base Accounting (all samples > 0.25% total S) or H2O2 Potential Acidity		Tons CCE acid demand per 1000 Tons Material	EPA 600-2-78-054	-10 unless under water table	-5
0.13	Pyritic S		% or g kg^{-1}		2.00	0.25
2.77	Calcium Carbonate Equivalence		%CCE	AOAC 955.01	NA	NA
7.91	pH					
89.67	Soluble Salts		mmhos cm^{-1} or dS m^{-1}	Saturated paste extract	NA	4.0 after leaching
5.27	Total Organic Carbon		% or g kg^{-1}		NA	≤ 5%
29.0	Particle Size Analysis	(<2 mm)	%Sand	<2 mm samples	NA	NA
58.7			% Silt		NA	NA
12.0			% Clay		NA	NA
0	Coarse fragments (>2 mm)			>2 mm samples	NA	

NA= Indicates that criteria are not available.

1. Samples <RL are reported as 50% of RL for data entry column and are written in *italics* with <; however, these values will not be used for exclusionary purposes unless other evidence indicates such. Values in *italics* are not "real" values, but an arbitrary entry.
2. B**old highlight** indicates average sample values that exceed the "proposed VA upland fill criteria" in far right column. **Bold highlight red** indicates that values exceed proposed VA exclusion criteria.
3. New Jersey Department of Environmental Protection, The Management and Regulation of Dredging Activities and Dredged Material in New Jersey's Tidal Waters. 1997. http://www.njstatelib.org/digit/r588/r5881997.html
4. EPA Region 3 SSLs have been merged into a regional document developed with input from Regions III, VI, and IX. Values from May 2014 version. Values listed for: antimony (metallic), arsenic (inorganic), chromium VI (particulates), lead and compounds, manganese and cadmium values are for diet, methyl mercury, nickel refinery dust, vanadium and compounds. Website: http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
5. Background metal levels specific to the state of Virginia based on Smith, D.B. et al. 2005. Major- and Trace-Element Concentrations in Soils from Two Continental-Scale Transects of the United States and Canada. USGS Open File Report 2005-1253.http://pubs.usgs.gov/of/2005/1253/pdf/OFR1253.pdf
6. The proposed Virginia exclusion standards generally represent the higher of EPA RBC Industrial, NJDEP or EPA 503 EQ levels for a given parameter. Values exceeding these limits are questionable for acceptance.
7. Proposed VA clean fill criteria are based primarily on NJDEP residential cleanup criteria and manually adjusted for known issues with agricultural production/bioavailability. Values between the clean fill and exclusion criteria require a variation of the current management strategy.
8.More stringent of VA DEQ and clean fill criteria. These values carried forward to Part I.A of draft 2012 permit.
9. Total Aroclor concentrations are reported as sum of seven individual aroclors.
10. Additional analyses for these basic properties are essential for determining the management or acceptance of dredge material.
Note: Minimum sampling is one composite sample per 50,000 yards of material in situ. A minimum of three samples per material is required regardless of volume. Specific information on sampling procedures should go into the brief descriptions box at the top of the spreadsheet.

ATTACHMENT 4
City of Alexandria City Marina Dredge Sediment Potential Peroxide Acidity (PPA) Analyses

Brief description: Potential peroxide acidity (PPA) for composites of all pre-dredging material received in 2014 from the City of Alexandria City Marina. Values equate to net lime demand expressed as tons of 100% Calcium Carbonate Equivalent (CCE) agricultural lime per 1000 dry tons of inbound material.

Sample ID	Tons $CaCO_3$/1000 Tons Material
SL-1/2	0.10
SL-3/5	0.06
SL-4/6	0.00

ATTACHMENT 5
City of Alexandria City Marina Dredge Sediment Calcium Carbonate Equivalent (CCE) Analysis

Brief description: Calcium carbonate equivalent (CCE) for composites of all City of Alexandria City Marina dredge material received in April 2014.

Sample ID	**%CCE**
SL-1/2	3.40
SL-3/5	1.96
SL-4/6	2.95

ATTACHMENT 6
City of Alexandria City Marina Dredge Sediment pH and Soluble Salts Analyses

Brief description: Sample pH and soluble salts for composites of all City of Alexandria City Marina dredge material received in April 2014.

Sample ID	pH	Soluble Salts (ppm)
SL-1/2	8.91	< 50
SL-3/5	7.38	< 50
SL-4/6	7.45	269

ATTACHMENT 7
City of Alexandria City Marina Dredge Sediment Total Organic Matter Analysis

Brief description: Total organic matter (loss on ignition) for composites of all City of Alexandria City Marina dredge material received in April 2014.

Sample ID	Total organic matter (%)
SL-1/2	5.7
SL-3/5	5.5
SL-4/6	4.6

ATTACHMENT 8
City of Alexandria City Marina Dredge Sediment Particle Size Analysis

Brief description: Particle size analyses for composites of all City of Alexandria City Marina dredge material received in April 2014.

Sample ID	Coarse fragments (% >2mm)	% Sand	% Silt	% Clay	Texture Class
SL-1/2	0	27	63	10	Silt loam
SL-3/5	0	20	72	8	Silt loam
SL-4/6	0	40	42	18	Loam