Virginia Tech

Soil Genesis and Mined Land Reclamation

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Annual Monitoring Report for 2009 Calendar Year
Weanack Dredge Spoil Utilization

To: Raymond Jenkins, Virginia DEQ, Piedmont Regional Office

From: W. Lee Daniels and G. Richard Whittecar (Old Dominion Univ.)

Re: Weanack Ground & Surface Water Monitoring for VPA Permit No. VPA00579

Date: **February 15, 2010**

Cc: Mike Baker, PCC
Charles Carter, Weanack
Charles Saunders, Marshall Miller & Assoc.

This memorandum and associated maps, attachments and data sets comprise our Annual Monitoring Report for all work conducted in **calendar year 2009** for ground and surface water monitoring, hydrogeologic modeling and beneficial use study requirements for VPA Permit No. VPA00579 at Weanack Land LLP in Charles City County. The original monitoring plan submitted to DEQ by American Land Concepts (ALC) in November, 2000, 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 Fig. 2. In July of 2005, modifications to the Operations and Maintenance Manual and Monitoring Plans for both utilization areas were approved by DEQ.

In 2006, permit coordination and liaison responsibilities for this permit were transferred from ALC to Marshall Miller & Associates (MMA) who we have worked with closely over the past four years. Virginia Tech and Old Dominion University (ODU) continue to serve as subcontractors to Weanack Land LLP to carry out monitoring and research as specified in the approved plans. This report covers calendar year 2009 and one follow-up water sampling event in early January of 2010. This report includes data and analyses relative to both utilization areas (WWB and Earle) plus an overall assessment of site hydrologic conditions for both basins as detailed later.

Over the 2009 monitoring year we continued limited monitoring of a project installed by Science Applications International Corporation (SAIC) and the Norfolk District of the U.S. Army Corps of Engineers. This project is a small (35 x 120 feet) dredge sediment field experiment adjacent to the Earle Basin that is knows and the Landfarm Pilot Study (LPS). The SAIC/LPS study plan was approved on 7/25/07 to assess the ability of surfactants plus an added microbial consortium to degrade moderately contaminated (with PAH's) sediments from the nearby Appomattox River. A separate and detailed report on that project has presumably been submitted to DEQ by SAIC.

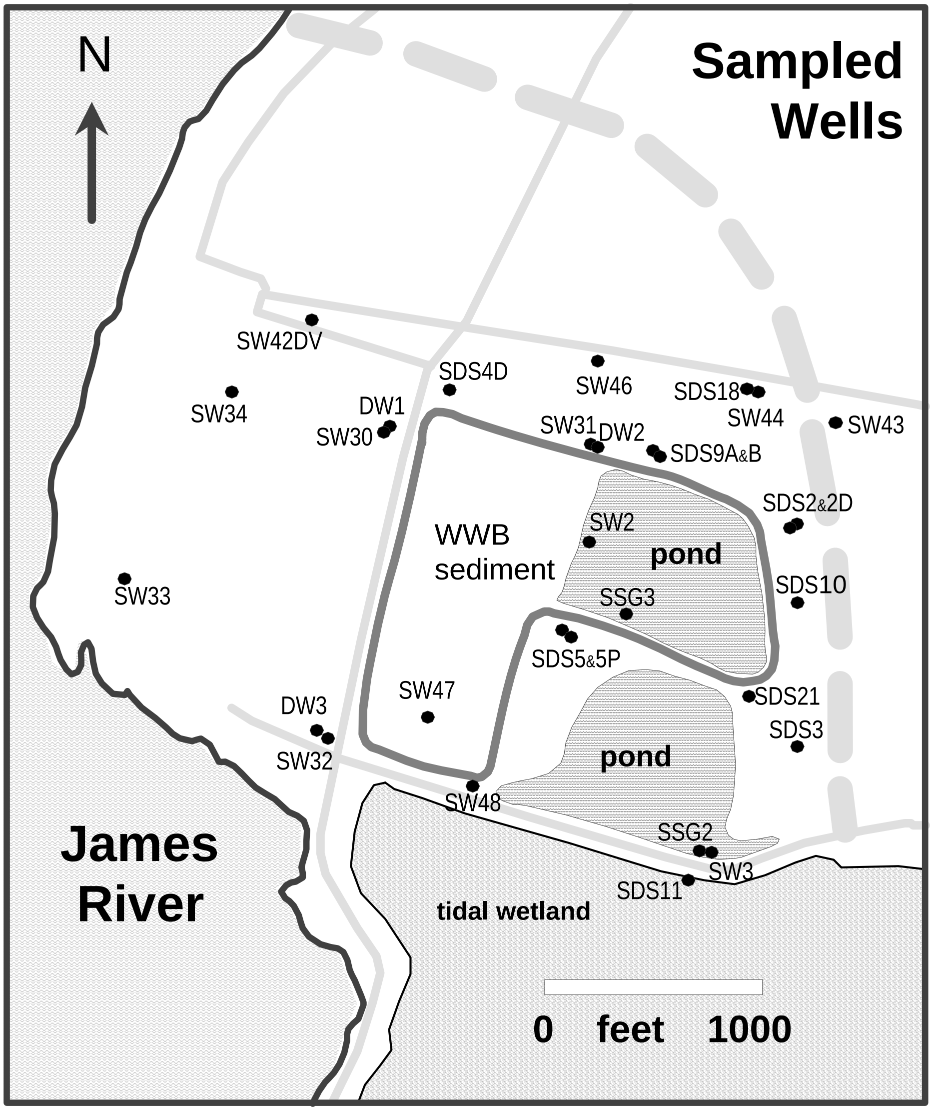

Figure 1. Map of basin location and monitoring wells around the Woodrow Wilson Bridge (WWB) sediments discussed in this report. The Shirley Plantation drinking well (SP) in the NW corner of the map area was also sampled but is not shown. The dashed line corresponds to a local terrace scarp which defines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

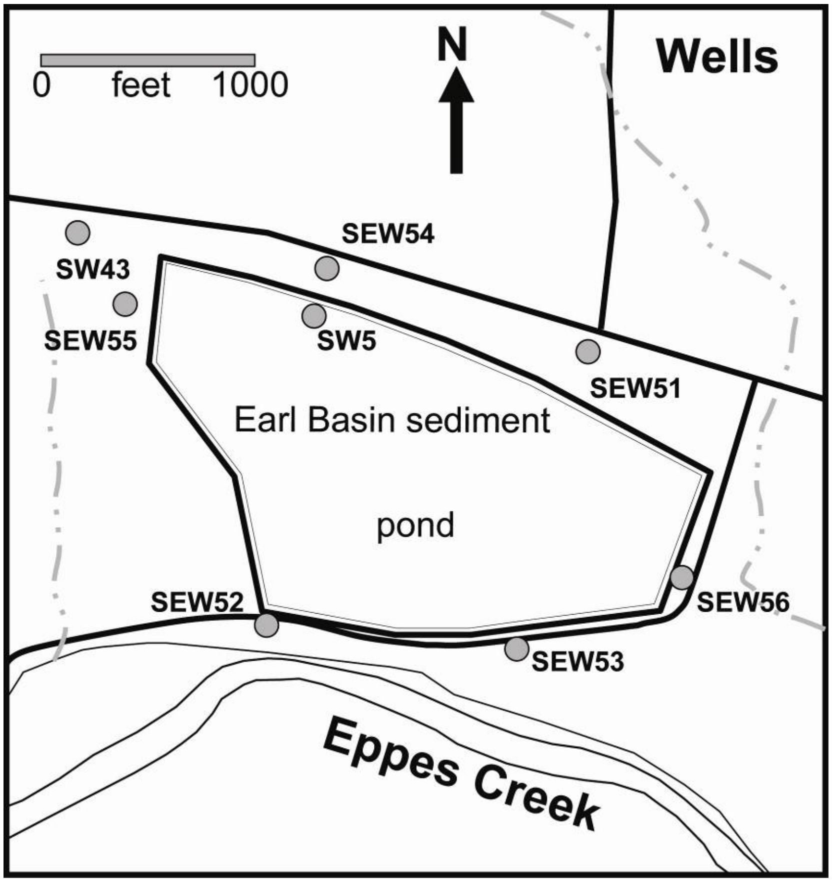

Figure 2. Map of basin location and monitoring wells sampled around the Earle sediment basin as discussed in this report. The WWB basin lies to west, across the ephemeral drain shown running south towards Eppes Creek. FYI: The LPS project is located to the southeast of well SEW 51 and approximately 50 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

Under the approved 9/7/04 monitoring plan revision for WWB, we reduced our routine monitoring frequency for temperature, pH, EC, and DOC to quarterly (Jan/Apr/July/Oct). 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 further clarified via Email and memo interactions with DEQ over the summer of 2006 and were also detailed in a recent O&M Manual revision submittal (Oct. 2009) by Marshall Miller & Associates

Upgradient ground-water wells: **SDS 3 and SW 43**

Downgradient ground-water 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 has been dry for the vast majority of sampling dates since 2005, and therefore reporting on that location (SSG 2/SW 3) was discontinued.

Owner's drinking well: **SP-well**

The locations specified above were sampled for detailed "partial suite" of water quality analyses in October of 2009 as set forth in Table 6 of the revised O&M Manual. This sampling was not required by permit conditions for 2009 (see Table 5 in revised O&M), but was done on a voluntary basis to allow a better analysis of overall water quality versus previous years.

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 "partial suite" sampling and analysis in October of 2009. However, as discussed later, several parameters (e.g. Fe, Cl and SO_4) at several groundwater locations were either higher than anticipated or appeared aberrant. Therefore, we returned to the site in January, 2010, and re-sampled a number of points for Fe, Cl and SO_4 for further confirmation.

Upgradient ground-water wells: **SEW 51 and SEW 54**

Downgradient ground-water wells: **SEW 52 and SW 53**

Surface water: **SW 5** is sampled from within the Earle Basin ponded portion as shown in Fig. 2.

In addition to the detailed sampling events described above, we conducted routine quarterly monitoring (Jan/Apr/July/Oct) of wells around the WWB and Earle Basin sites for water level, pH, conductivity, temperature, and DOC.

Inbound Dredge Spoil Testing

No inbound sediments were received or tested in 2009.

Hydrogeologic Analyses and Results for 2009

Virginia Tech and ODU maintained the well sites around the existing basin containing the Woodrow Wilson Bridge (WWB) and Earle Basin sediments. One well site (SW 47, in the middle of a cropped field) was destroyed by farming activity and has yet to be replaced. We conducted routine quarterly monitoring (Jan/Apr/July/Oct) of wells and ponds around the WWB and Earle Basin sites for water levels, pH, conductivity, temperature, and DOC.

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 perspective of the relationships of water flow through this topographically and stratigraphically complex setting.

Woodrow Wilson Bridge Site

After dropping steadily through 2007 and then stabilizing during 2008 at an average level lower than during any previous year, water levels in the pond inside of the WWB berm (measured at SSG3) dropped during 2009 to another record low (8.7 feet) by October. 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. Water levels in most monitoring wells dropped throughout the year. These declines reflect the low rainfall afflicting many states in the Southeastern U.S. during 2007, 2008, and the summer of 2009, as well as seasonal evaporation. Heavy rainfall during the late fall and winter resulted in raised lake levels (11.0 feet) by January 2010.

Analyses of water flow direction for the WWB disposal site shown in Figure 3 indicate no important change in flow directions from previous analyses, despite the general lowering of the water table system due to the drought. As is usual, minor changes were observed over time and over short distances. Shallow wells and wells close to storm water drainage ditches proved to be the most responsive to rainfall events, being the most likely to rise after one of the few rain showers. 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.

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. Overall, water levels in the pond inside of the berm (measured at SSG5) dropped throughout 2009 to 23.9 feet in October, but rebounded to 26.2 feet by January 2010. 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 ground water 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.

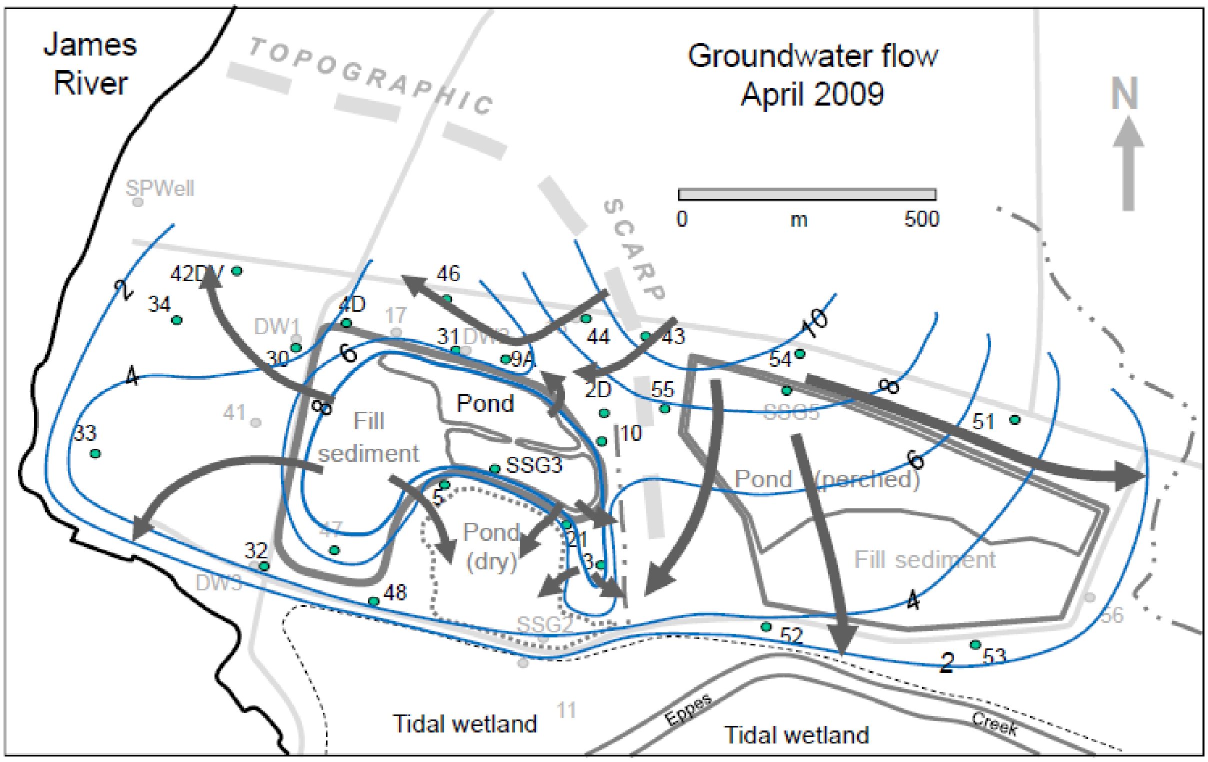

Figure 3. Ground water flow around the disposal site for the Woodrow Wilson Bridge sediments (western disposal basin) and the Earle Basin sediments (eastern disposal basin). Wells are marked with the number of their label; wells and ponds marked with grey labels were not used in the analysis of flow on this day (04/30/09). 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.

Water Quality Results for 2009

Woodrow Wilson Bridge Basin

With the exception of moderate sulfate levels discussed in the last several years' reports, we have not been able to detect any significant detrimental effects of sediment placement upon ground- or surface-water quality in or around the WWB dredge utilization area (see Attach. 1.1A). All quarterly data for water levels, EC, pH and DOC are reported in Attachment 1.2. As reported for the past several years, quarterly ground-water levels of DOC appear to be dropping with time relative to previous years, although the DOC levels continue to be quite variable. Similarly, pH and EC levels continue to reflect what appears to be background sulfur oxidation to a limited extent in either the surrounding Shirley formation or possibly the dewatering and oxidation of lower portions of the WWB sediments.

Review of the October 2009 partial suite data (Attach. 1.1A) reveals no notable up- vs. down-gradient effects of the dredge materials weathering and leaching over time with the exception of total sulfate, which as reported last year, continues to be significantly higher in both downgradient wells when compared to monitoring values from 2001 to 2006. These higher sulfate levels also continue to be reflected in somewhat higher EC values at two downgradient locations (SW 30 and SW 31). However, one upgradient well (SDS 3) also showed appreciable sulfate levels in the October 2009 sampling event which were not observed in previous years at this level. Thus, we continue to believe that this is the result of background oxidation of sulfides in the Shirley Formation during periodic drawdown of the saturated zone.

As pointed out in previous reporting, the presence of appreciable amounts of sulfidic materials in the directly underlying Shirley Formation sediments greatly complicates this analysis and also appears to contribute to higher levels of Al, Fe and Mn at many WWB locations and occasional detectable levels of Ni, Zn and Pb. We have noted and reported similar wide fluctuations in pH, Fe and Al in ground-water at various well locations around the site on several occasions since 2001 and several of the WWB and Earle wells again appeared to contain high levels of Fe (> 20 mg/L) in the October 2009 partial suite sampling. Observed sulfate levels in 2009 for well SW 31 were considerably lower than reported in 2008, however, one location (SW 30) remained above the secondary drinking water standard of 250 mg/L. We also detected low levels (12 mg/L) of sulfate in the Shirley drinking water well in 2009 which was below reporting levels in previous years. We continue to presume these overall variations are due to well bore disturbance/oxidation and water level fluctuations interacting with the sulfidic sediments at depth.

Earle Basin

The water pH and conductivity readings (Attachment 1.2) for the monitoring wells around the Earle Basin are values typical for groundwater in this hydrogeologic setting. The water in the Earle sediment retention basin is brackish, reflecting the pore water quality of the estuarine sediments placed in the basin. Fluctuations in pH and EC values during the year 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 one exception is that the conductivity values for SEW53 - the down-gradient monitoring well closest (~ 75 feet) to the disposal area – continued to increase during 2009. From July 2007 to October 2009 it has risen from relatively stable conductivity values of approximately 300 uS to 1480 uS. This trend suggests that seepage water from the basin has reached that monitoring well site. However, downgradient well SEW 52 still appears unaffected. The observed Cl levels in well SEW 53 (378 mg/L in October and 428 in January) are above the secondary drinking water standard.

Detailed water quality samples were taken in October 2009 (partial suite) per the approved monitoring plan and reported in Attachment 1.1 B. Differential analysis (up- vs. down-gradient) of the October 2009 partial suite analysis reveals no significant effect of dredge spoil placement on ground-water quality to date other than the possibility of elevated Cl at SEW 53. It is interesting to note that similar to the 2006 and 2007 data for this basin (and the WWB wells), a number of up- and down-gradient wells generated high Fe + sulfate levels and several wells were moderately high in nitrate-N. We assume that similar mechanisms (well disturbance/sulfidic sediment interactions and agriculture) are probably responsible.

As mentioned above, the partial suite sampling of October 2009 for both the WWB and Earle locations revealed levels of Fe in several wells (e.g. SEW 43) that seemed abnormally high and we wanted to reconfirm localized occurrences of chloride and sulfate that appeared elevated relative to previous years. Therefore, we returned to Weanack in early January and re-sampled several locations for Cl, Fe and $S0_4$ and those data are presented in Attachment 1.1 C. This re-sampling did confirm that the Cl, Fe and SO_4 levels from October were probably correctly specified. We are not sure why the October SO_4 level for the SP well was slightly elevated, but we have reported aberrant Fe+SO_4 values at many locations around this property in past years.

<u>LPS Study</u>

As mentioned earlier, we continued general monitoring of soil and water quality associated with the Landfarm Prototype Study (LPS) cells through the fall of 2009. As a part of our study component, we monitored water quality in external upgradient (SEW 51) and downgradient (SEW 57) wells and within the bottom of each cell (Lysimeters A&B). No effects of the LPS cells were noted on downgradient water quality even though high levels of nitrate-N and EC continued to be noted in the lower portion of the soil remediation zone (in Lysimeters A&B) due to the addition of N fertilizers that were used to stimulate the bacterial consortium used to enhance PAH degradation. As mentioned earlier, the detailed results of the LPS monitoring regime are contained in a separate report submitted by SAIC.

<u>Soil Formation/Beneficial Use Conversion Studies</u>

Vegetation Establishment on Amended Saline Dredge Materials

In 2009, per our monitoring agreement with DEQ, we installed a replicated revegetation experiment on the Earle Basin sediments as described below. The Earle sediments are much higher in soluble salts than those in the WWB basin due to their marine origin. Thus, our primary goal in this new research effort is to determine the best ways of amending and converting them into usable agricultural soils. This work is designed and supervised by Dr. Abbey Wick who is working with us as a post-doctoral Research Associate.

Crop establishment on the Earle Basin sediments is challenging not only because of soluble salt influences on plant establishment and growth, but also because of adverse physical properties (e.g. high silt and lack of structure) of the dredge material. There are two “active” approaches feasible to the situation at Weanack, where use of locally available soil resources is highly desirable. The first is the addition of a topsoil cap (approximately 20 cm) from nearby topsoil stockpiles and berms. This will provide a growth medium suitable for root development of a cover crop followed by succeeding annual crops or perennial vegetation. The second solution is to utilize stockpiled sand dredged from the James River channel and mix this material with the surface of the Earle dredge material to achieve 15-30% sand by volume. Salt leaching from the surface of the dredge material and macroporosity would be improved by this approach. A more “passive” approach is simple surface tillage of the existing sediments.

Objectives:

-To evaluate the influences of: (1) a topsoil cap over the Earle Basin dredge material vs. (2) sand incorporation into existing Earle Basin dredge material on cover crop establishment followed by annual crops or perennial vegetation .

-To evaluate the effects of additions of: (1) compost + N + P fertilizer and (2) standard N + P fertilizer applications on each soil treatment via split plot applications on cover crop establishment and succeeding annual crops or perennial vegetation.

Experimental Design:

Physical Soil Treatments:

(1) Loamy topsoil from reclaimed sand mine topsoil stockpiles used as a cap (20 cm deep - tilled) over tilled Earle dredge material.

(2) Local sand from dredging the James River channel mixed into the surface (0-20 cm) of Earle dredge material with a roto-tiller at 30% by volume.

(3) Existing surface of dredge material – tilled.

Amendments (split plots):

(1) Surface application of N (40 ppm) and P (100 ppm) fertilizer.

(2) Local compost (Grind-All) applied at 78.4 Mg ha^{-1} (35 dry T ac^{-1}) incorporated with a roto-tiller + surface application of N (40 ppm) + P (100 ppm) fertilizer.

Cover crop:

(1) *Setaria Italica* L. (German millet, spring seeding 2009) followed by winter wheat established in fall of 2009.

The control for this experiment is the existing surface dredge material (tilled) with N + P fertilizer at same rates as above. All plots were limed at a rate of 0.1% dry weight (2.24 Mg CCE ha^{-1}). Lime was be incorporated into surface 15 cm of soil with a roto-tiller.

Preliminary Field Sampling:

Preliminary soil samples were collected from the 0-20 cm depth from 6 locations in the proposed plot area on 2-27-09 (Fig. 4). These samples were analyzed for EC and pH in the lab to determine if statistical blocking of the field plot design would be necessary and for soil nutrient analysis to provide a basis for fertilizer applications (Table 1). Additionally, samples of sand and topsoil designated for use as soil treatments as well as Earle sediments were collected on 2-27-09. These samples are being used in a greenhouse experiment to observe the effects of the proposed field treatments on crop establishment in a controlled environment.

Figure 4. Preliminary sample locations for proposed plot area (sampled on 2-27-09).

Table 1. Soil properties from preliminary samples collected from proposed plot area on 2-27-09.

Sample Location	EC	pH	P	K	Ca	Mg
	dS m^{-1}		-- Acid Extractable in mg kg^{-1} --			
1	3.61	5.18	12	316	3211	904
2	1.41	5.98	15	242	3479	411
3	1.49	5.62	10	244	3458	519
4	3.33	5.30	13	296	3281	656
5	3.60	6.75	2	323	3533	668
6	3.09	5.89	9	282	3147	667
Topsoil Stockpile	-	5.30	10	92	937	200

Greenhouse Experiment:

A parallel greenhouse experiment was initiated on 3-20-09. Four treatments (similar to the proposed field treatments) in four replicates were mixed and placed in plastic lined pots (15 cm in diameter) at equal weights. Treatments included: (1) Earle dredge material + N + P + lime, (2) Earle dredge material + 15% sand by volume + N + P + lime, (3) Earle dredge material + 30% sand by volume + N + P + lime, and (4) Earle dredge material covered with 5 cm of topsoil material (20 cm not added due to the small size of the pots). Nitrogen fertilizer was applied to all pots in splits (rate of 25 mg kg^{-1} at initial seeding and 25 mg kg^{-1} after plant establishment) as ammonium nitrate; phosphorous fertilizer (triple superphosphate) was also applied at a rate of 100 mg kg^{-1} prior to seeding. Calcium hydroxide was applied (0.1% dry weight) to increase the pH prior to seeding. Evaluation of the two sand treatments will be important in determining how much sand is necessary to achieve adequate plant growth prior to installation of the experiment in the field. Results from the greenhouse confirmed our assumptions on necessary field soil amendment strategies and will be reported in detail in next year's annual report.

Plot Construction:

Plot construction occurred in May of 2009 (see Fig. 5). Each main treatment was replicated 4 times for a total of 12 randomly assigned plots. Each plot is 15 x 15 m with a 5 m wide alley between plots. The twelve plots were split (into a north and south side) and the compost amendment was incorporated into one randomly selected split (7.5 m wide) in each plot. The location of the experiment within the basin was selected based on several parameters: (1) depth to water in basin and depth of sediment which was determined via Haus and Wick field sampling, (2) soil texture to avoid abrupt changes with distance from original discharge point, (3) surface EC (0-20 cm), (4) equipment access, and (5) ability to separate plots with a berm from the rest of the basin. The cover crop established very well on the plots along with a variety of local weedy species (see Figure 6). The plots were seeded to winter wheat in October of 2009 (see Fig. 7 for a winter view).

Field Sampling and Lab Analyses

Crop yields will be measured at peak biomass and the soil sampling will occur post-harvest (referred to as "post-harvest" samples in following text). Soil morphology vs. depth was described following harvest of the cover crop in the fall of 2009. Two random samples from each split plot will be collected every fall from the 0-5 and 5-20 cm depth (in the tillage zone) and at 75 cm depth post-harvest. If feasible, bulk density samples will be collected at the contact between each of the plot treatments and the "untreated" Earle (approximately at 20 cm, total of 24 samples).

a) Pre-treatment composite samples collected in mid-April from the 0-5, 5-20 and 75 cm depths and all post-harvest samples will be analyzed for EC, pH, Exchangeable Ca, Mg, K and Na, Total Carbon and Nitrogen, and Mehlich III extractable nutrients and metals (total of 216 samples + 10% duplication for QA/QC).
b) Particle size analysis will be conducted on pre-treatment samples and a composite of the two post-harvest samples collected from each split for all three depths (total of 144 samples+10% duplicates).
c) Aggregate size distribution, particulate organic matter (POM) and microbial biomass carbon (MBC) will be measured on the pre-treatment samples, post-installation samples and a composite of the two post-harvest samples for surface depths only (0-5 and 5-20; total of 120 samples+10% duplicates). Carbon and nitrogen will be measured on aggregates and each aggregate POM fraction.

Repeated measures t-tests will be used to compare between pre-treatment and post-harvest sampling times within plots and a two-way ANOVA will be utilized to analyze for treatment effects.

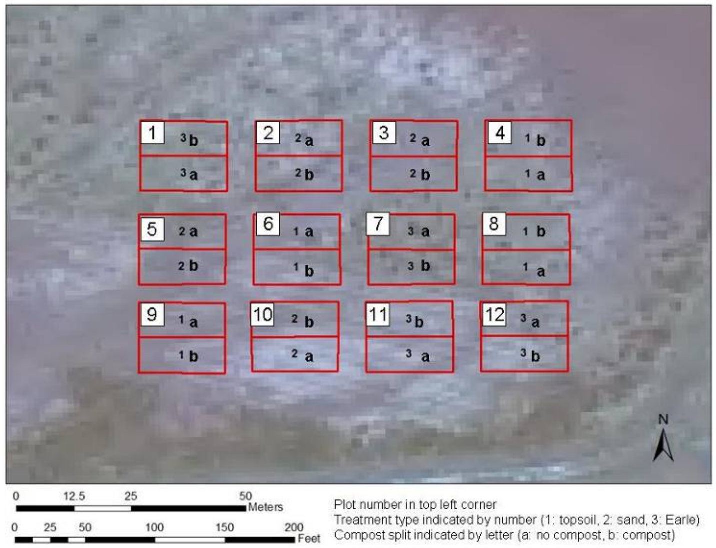

Figure 5. Treatment assignments. 1: topsoil cap, 2: 30% sand mix, 3: Earle surface. Compost splits on each plot are shown as a: no compost, b: compost.

Figure 6. View of cover crop on plots within experimental block. View is looking south; vehicles in background are on top of berm wall around basin and well SEW 53 in immediately beyond the parked vehicles.

Parameters to measure:

(1) Bulk density samples will be collected from the contact between dredge and surface amendments (~20 cm) with the hammer driven core method. This will help us evaluate issues with compaction from construction of the plots that might inhibit root development or result in lateral root growth. Bulk density sampling may be limited by the "consistency" of the dredge sediments and this method may be altered in the field.

(2) EC and pH will be determined on all samples with 1:1 soil:water mixtures.

(3) Exchangeable Ca, Mg, K, and Na will be performed via standard Soil Survey lab techniques. This will involve extraction with 1N NH_4OAc and subsequent determination via AAES.

(4) Basic soil fertility will be evaluated via the Mehlich III extraction technique in the Virginia Tech Extension Soil Testing Lab for P, Ca, Mg, K, Cu, Zn, Fe and Mn.

(5) Particle Size Analysis will be conducted via the pipette method. Organic matter in each sample will have to be oxidized prior to analysis.

(6) Water stable aggregate size distribution (WSA) will be conducted via wet sieving. Aggregates in the following size classes will be isolated: microaggregates (53-250 μm), small macroaggregates (250-2000 μm), and large macroaggregates (2000-8000 μm). Each aggregate size class will be corrected for sand to compare across treatments. A 5 g subsample of each aggregate sample will be dispersed with hexametaphosphate and sieved with the corresponding sieve for the aggregate size class. Sand collected on the sieve is transferred to a tin, dried and weighed.

(7) Particulate organic matter (Inter- and Intra-aggregate POM) will be determined using a density floatation method. In this method, inter-aggregate POM is floated using a 1.85 g cm^{-3} density sodium polytungstate (SPT) solution and aspirated through a nylon filter to isolate the organic matter pool available for microbial decomposition. Intra-aggregate POM is released from the aggregates through mechanical disruption, floated using a 1.85 g cm^{-3} density SPT solution and aspirated through a nylon filter to isolate the physically protected POM pool. The remaining soil pellet is rinsed and sieved to separate sand and silt+clay (POM bound to the fine fraction). All soil fractions isolated by this method will be dried, weighted and stored for total carbon and nitrogen analysis.

(8) Total C and N: Bulk soil samples from all three depths (168 samples), aggregates from surface depths (0-5 and 5-20 cm depths; 216 samples) and POM fractions (216 samples) will be powder ground (<53μm) and analyzed via dry combustion on an Elementar CN analyzer (Hannau, Germany). Soil samples will be pre-treated with HCl to remove carbonates before combustion.

(9) Microbial biomass carbon will be determined via the chloroform fumigation-extraction technique. Samples collected in the field will be kept on ice and in the refrigerator upon return to

the lab.

(10) Crop yields will be obtained either via use of small farm equipment or harvesting by hand from 3 x 3 m random yield strips taken within at least 1 m from the edge of each plot. Appropriate bulk crop and/or leaf tissue samples will be taken for lab elemental analyses if necessary.

(11) Soil morphology vs. depth and rooting patterns will be examined, described and sampled from 3 pits excavated into the edge of each main treatment plot in the fall of the first year (2009) and again in 2011 and 2013.

(12) Basin water levels will be monitored in additional wells installed within the study area to assess changes in the water table (see Fig. 7).

Figure 7: View of northeast corner of Earle plot experiment in January 2010. The plot corners are marked by the visible flags. Rows of established winter wheat are visible as is one of shallow water level monitoring wells in the background. Water levels rose appreciably in the basin over the fall and early winter of 2009/2010.

Overall Monitoring Summary

Our overall long-term conclusion remains that the WWB materials appear benign with respect to potential ground- or surface water degradation. We have yet to detect any significant contaminants in inbound dredge spoils, dewatered dredge soils, or water samples in and around the disposal/utilization area. The elevated levels of sulfate observed in 2007 and 2008 remain in several wells, but appear to be moderating over time.

The Earle basin materials differ from the WWB dredge sediments in that they contain a much higher inbound salt load, are slightly higher in total heavy metals, and do contain detectable levels of certain organics (PAHs) as discussed in previous reports. Future soil and water quality monitoring efforts will be focused on these parameters to determine net degradation, attenuation, or any potential for movement with time. It does appear that bulk soluble salts (particularly Cl) from this basin have migrated a relatively short distance to one of the downgradient wells (SEW 53). The ponded water within the Earle Basin remains high in salts (Cl and SO_4), but the pH of both the surrounding dewatered sediments and surface water is declining as expected.

Despite their initially saline nature, dewatered Earle basin sediments have been converted to support conventional agricultural cropping practices and their near-surface pH and salinity levels are dropping over time. The Woodrow Wilson Bridge sediments continue to be cropped by the local farmer and produce yields typical of surrounding prime farmlands.

Acknowledgments

We deeply appreciate the continuing support of Mr. Charles Carter of Weanack/Shirley and Mr. Mike Baker of Potomac Crossing Consultants/Woodrow Wilson Bridge Project in our efforts. The assistance in the field of Julie Burger, Nick Haus, Steve Nagle, W.T. Price, Emmett Rafferty, Wesley Powell, Matt Richardson, Dani Morgan-Smith, Tanique Rush, and Abbey Wick was also essential to our continuing efforts. The sediment and water data sets contained herein were compiled by Sue Brown. Finally, thanks to Chee Saunders of Marshall Miller & Associates for coordination of permit monitoring requirements and to Carmela Tombes of Air, Water & Soil Labs in Richmond for assistance with the waters quality analyses.

ATTACHMENT 1

Detailed Water Quality Analyses

Attachment 1.1 A – Woodrow Wilson Basin

				Woodrow Wilson Bridge		
			Sample Date:	**10/13/09**	**10/13/09**	**10/13/09**
Water Partial Suite			**Well ID:**	**SW43**	**SP Well**	**Field Blank**
Metals	Method	Reporting Limit	Units	Results	Results	Results
Aluminum	EPA 200.7	0.05	mg/L	34.2	ND	ND
Antimony	EPA 200.9	0.005	mg/L	ND	ND	ND
Arsenic	EPA 200.7	0.01	mg/L	0.016	ND	ND
Beryllium	EPA 200.7	0.01	mg/L	ND	ND	ND
Cadmium	EPA 200.7	0.01	mg/L	ND	ND	ND
Chromium	EPA 200.7	0.01	mg/L	0.047	ND	ND
Copper	EPA 200.7	0.01	mg/L	0.023	ND	ND
Iron	EPA 200.7	0.01	mg/L	67.1	ND	ND
Lead	EPA 200.7	0.01	mg/L	0.029	ND	ND
Manganese	EPA 200.7	0.01	mg/L	---	ND	ND
Mercury	EPA 245.1	0.0002	mg/L	ND	ND	ND
Nickel	EPA 200.7	0.01	mg/L	0.028	ND	ND
Selenium	EPA 200.9	0.003	mg/L	ND	ND	ND
Silver	EPA 200.7	0.01	mg/L	ND	ND	ND
Thallium	EPA 200.9	0.002	mg/L	ND	ND	ND
Zinc	EPA 200.7	0.01	mg/L	0.143	0.012	ND
4,4-DDT	EPA608	0.01	µg/L	---	ND	ND
Gamma-BHC	EPA608	0.02	µg/L	---	ND	ND
Chloride	EPA300.0/R2.1	1.0	mg/L	---	19.0	ND
Cyanide	Kelada-01	0.01	mg/L	ND	ND	ND
Nitrate	Calculated	0.1	mg/L	1.5	ND	0.1
Nitrate+Nitrite	SM 18/4500-NO_3 F	0.1	mg/L	1.46	ND	0.14
Nitrite	SM 18/4500-NO_2B	0.05	mg/L	ND	ND	ND
Phosphorus, Ortho	SM 18/4500-P E	0.01	mg/L	0.02	0.37	ND
Sulfate	EPA-300.0/R2.1	1.0	mg/L	29.0	12.1	ND
Sulfide	SM 18/4500-S2 E	1.0	mg/L	ND	ND	ND
TKN	EPA 351.2	0.2	mg/L	2.0	ND	ND
Phenolics (Total)	EPA 420.1	0.05	mg/L	---	ND	ND
Total Organic Carbon	SM18/5310C	1.0	mg/L	1.5	ND	ND

ND=below Reporting Limit

Attachment 1.1 A Cont. – Woodrow Wilson Basin

				Woodrow Wilson Bridge			
			Sample Date:	**10/13/09**	**10/13/09**	**10/13/09**	**10/13/09**
Water Partial Suite			**Well ID:**	**SDS3**	**SW2**	**SW30**	**SW31**
Metals	Method	Reporting Limit	Units	Results	Results	Results	Results
Aluminum	EPA 200.7	0.05	mg/L	2.57	1.20	1.00	0.195
Antimony	EPA 200.9	0.005	mg/L	ND	ND	ND	ND
Arsenic	EPA 200.7	0.01	mg/L	ND	ND	ND	ND
Beryllium	EPA 200.7	0.01	mg/L	ND	ND	ND	ND
Cadmium	EPA 200.7	0.01	mg/L	ND	ND	ND	ND
Chromium	EPA 200.7	0.01	mg/L	ND	ND	0.0115	ND
Copper	EPA 200.7	0.01	mg/L	ND	ND	ND	ND
Iron	EPA 200.7	0.01	mg/L	14.0	3.07	2.58	0.897
Lead	EPA 200.7	0.01	mg/L	ND	ND	ND	ND
Mercury	EPA 245.1	0.0002	mg/L	ND	ND	ND	ND
Nickel	EPA 200.7	0.01	mg/L	ND	ND	0.011	ND
Selenium	EPA 200.9	0.003	mg/L	ND	ND	ND	ND
Silver	EPA 200.7	0.01	mg/L	ND	ND	ND	ND
Thallium	EPA 200.9	0.002	mg/L	ND	ND	ND	ND
Zinc	EPA 200.7	0.01	mg/L	0.021	ND	0.020	ND
Cyanide	Kelada-01	0.01	mg/L	ND	ND	ND	ND
Nitrate	Calculated	0.1	mg/L	ND	ND	ND	4.20
Nitrate+Nitrite	SM 18/4500-NO_3 F	0.1	mg/L	ND	ND	ND	4.24
Nitrite	SM 18/4500-NO_2B	0.05	mg/L	ND	ND	ND	ND
Phosphorus, Ortho	SM 18/4500-P E	0.01	mg/L	ND	ND	0.03	0.02
Sulfate	EPA-300.0/R2.1	1.0	mg/L	42.7	93.7	306	52.1
Sulfide	SM 18/4500-S2 E	1.0	mg/L	ND	ND	ND	ND
TKN	EPA 351.2	0.2	mg/L	1.8	3.7	2.5	ND
Total Organic Carbon	SM18/5310C	1.0	mg/L	4.0	24.2	5.5	1.0

ND=below Reporting Limit

Attachment 1.1 B – Earle Basin

				Earle				
			Sample Date:	**10/13/09**	**10/13/09**	**10/13/09**	**10/13/09**	**10/13/09**
Water Partial Suite			**Well ID:**	**SEW51**	**SEW52**	**SEW53**	**SEW54**	**SW5**
Metals	Method	Reporting Limits	Units	Results	Results	Results	Results	Results
Aluminum	EPA 200.7	0.05	mg/L	12.8	6.44	6.61	24.6	0.096
Antimony	EPA 200.9	0.005	mg/L	ND	ND	ND	ND	ND
Arsenic	EPA 200.7	0.01	mg/L	ND	ND	ND	0.0102	ND
Beryllium	EPA 200.7	0.01	mg/L	ND	ND	ND	ND	ND
Cadmium	EPA 200.7	0.01	mg/L	ND	ND	ND	ND	ND
Chromium	EPA 200.7	0.01	mg/L	0.019	0.010	0.014	0.024	ND
Copper	EPA 200.7	0.01	mg/L	ND	0.013	ND	0.021	ND
Iron	EPA 200.7	0.01	mg/L	44.2	7.56	11.4	30.0	0.91
Lead	EPA 200.7	0.01	mg/L	0.012	ND	ND	0.020	ND
Manganese	EPA 200.7	0.01	mg/L	0.753	0.709	0.148	0.444	0.992
Mercury	EPA 245.1	0.0002	mg/L	ND	ND	ND	ND	ND
Nickel	EPA 200.7	0.01	mg/L	0.020	0.019	0.026	0.019	ND
Selenium	EPA 200.9	0.003	mg/L	ND	0.0032	ND	ND	ND
Silver	EPA 200.7	0.01	mg/L	ND	ND	ND	ND	ND
Thallium	EPA 200.9	0.002	mg/L	ND	ND	ND	ND	0.002
Zinc	EPA 200.7	0.01	mg/L	0.227	0.062	0.064	0.100	ND
4,4-DDT	EPA608	0.010	µg/L	ND	ND	ND	ND	ND
Gamma-BHC	EPA608	0.020	µg/L	ND	ND	ND	ND	ND
Chloride	EPA300.0/R2.1	1.0	mg/L	12.8	25.7	378.0	28.0	2960.0
Cyanide	Kelada-01	0.01	mg/L	ND	ND	ND	ND	0.03
Nitrate	Calc	0.1	mg/L	8.5	2.2	7.7	14.8	ND
Nitrate+Nitrite	SM 18/4500-NO_3 F	0.1	mg/L	8.50	2.18	7.72	14.8	ND
Nitrite	SM 18/4500-NO_2B	0.05	mg/L	ND	ND	ND	ND	ND
Phosphorus, Ortho	SM 18/4500-P E	0.01	mg/L	ND	0.01	0.06	0.02	0.32
Sulfate	EPA-300.0/R2.1	1.0	mg/L	16.2	30.7	15.2	10.4	2280
Sulfide	SM 18/4500-S2 E	1.0	mg/L	ND	ND	ND	ND	7.1
TKN	EPA 351.2	0.2	mg/L	1.8	2.8	1.5	0.9	14.9
Phenolics (Total)	EPA420.1	0.05	mg/L	ND	ND	ND	ND	ND
Total Organic Carbon	SM18/5310C	1.0	mg/L	3.4	7.1	2.3	ND	13.3

ND=below Reporting Limit

Attachment 1.1 C – Follow-up Sampling – January 2010

Woodrow Wilson Bridge

Water Partial Suite			Sample Date: / Well ID:	01/06/10 SW2	01/06/10 SW30	01/06/10 SP Well
	Method	Reporting Limits	Units	Results	Results	Results
Iron	EPA 200.7	0.01	mg/L	1.85	0.291	0.023
Chloride	EPA 300.0	1.0	mg/L	8.1	22.6	16.4
Sulfate	EPA 300.0	1.0	mg/L	185.0	286.0	9.5

Earle Basin

Water Partial Suite			Sample Date: / Well ID:	01/06/10 SW5	01/06/10 SEW51	01/06/10 SEW52	01/06/10 SEW53
	Method	Reporting Limits	Units	Results	Results	Results	Results
Iron	EPA 200.7	0.010	mg/L	0.79	47.7	11.2	8.71
Chloride	EPA 300.0	1.0	mg/L	582.0	12.2	21.9	428.0
Sulfate	EPA 300.0	1.0	mg/L	1070.0	14.1	24.7	13.7

Attachment 1.2 – Water Level, pH, EC, temperature and DOC for all Wells

	Water Levels in Feet Above Sea Level				
Monitoring Wells	**1/26/09**	**4/30/09**	**7/28/09**	**10/13/09**	**1/6/10**
SDS 2	10.82	10.88	8.17	6.56	11.93
SDS 2D	4.29	4.81	4.1	2.99	5.52
SDS 3	7.96	8.37	7.04	5.8	8.98
SDS 4D	4.52	5.83	2.68	dry	7.84
SDS 5	5.15	5.02	3.03	2.97	6.02
SDS 5P	5.32	5.27	2.9	1.65	5.7
SDS 9A	4.27	4.96	na	na	5.72
SDS 9B	dry	3.95	na	na	4.73
SDS 10	6.35	6.9	4.61	3.15	7.94
SDS 11	na	na	na	na	na
SDS 18	dry	14.58	15.14	9.28	15.87
SDS 21	dry	dry	dry	dry	8.03
SW 30	2.96	3.42	3.25	2.56	4.25
SW 31	3.3	3.9	3.24	2.29	4.67
SW 32	3.52	4.01	3.53	3.56	3.28
SW 33	3.84	4.72	2.5	0.42	6.07
SW 34	2.54	2.92	2.84	2.28	3.81
SSG 2	dry	dry	dry	dry	dry
SSG 3	10.04	9.7	9.1	8.69	11.04
SW42DV	2.12	2.5	2.4	1.87	3.34
SW43	19.91	11.33	11.37	11	11.18
SW44	7.7	8.8	7.51	6	8.93
SW46	4.44	5.03	4.56	3.63	5.83
SW47	na	na	na	na	na
SW48	4.94	5.04	dry	dry	5.19
SEW51	4.46	4.8	5.02	4.59	4.94
SEW52	3.56	4.04	2.06	1.56	4.57
SEW53	1.82	2.08	2.16	1.77	2.5
SEW54	9.87	10.03	9.81	9.53	9.94
SEW55	7.35	7.69	7.64	7.13	7.68
SEW56	8.43	9.04	na	na	na
SSG5	25.49	24.86	24.44	22.91	26.2

na = not available

pH

WWB	**1/26/09**	**4/30/09**	**7/28/09**	**10/13/09**	**1/6/10**
SDS 3	5.93	5.72	5.87	5.41	5.63
SW 30	6.10	6.02	5.88	5.84	5.80
SW 31	5.66	5.73	5.67	5.49	5.66
SW43	5.02	5.43	5.28	5.52	5.30
SW3@SSG 2	dry	dry	dry	dry	dry
SW2@SSG 3	5.70	8.77	9.39	7.86	7.37
SPWell	7.07	7.42	7.48	7.58	6.56
Earle					
SEW51	5.25	5.34	5.26	5.11	5.30
SEW52	5.79	5.61	5.73	5.63	5.33
SEW53	5.22	5.22	5.12	5.11	5.00
SEW54	5.38	5.55	5.48	5.43	5.21
SW5@SSG5	9.11	9.3	9.46	7.79	8.26

Electrical Conductance (EC - uS/cm)

WWB	**1/26/09**	**4/30/09**	**7/28/09**	**10/13/09**
SDS 3	295	242	243	324
SW 30	1318	1148	1124	1272
SW 31	575	617	612	324
SW 43	221	163	178	153
SW3@SSG 2	dry	dry	dry	dry
SW2@SSG 3	471	374	152	489
SPWell	423	447	440	465
Earle				
SEW51	216	191	182	175
SEW52	158	153	187	248
SEW53	1080	908	1005	1480
SEW54	323	305	225	276
SW5@SSG5	8690	7790	9150	13380

DOC (mg/L)

WWB	**1/9/09**	**4/1/09**	**7/28/09**	**10/13/09**
SDS 3	4.70	5.16	2.81	3.23
SW 30	7.55	11.40	5.94	9.61
SW 31	3.05	5.11	3.10	4.32
SW 43	2.33	2.07	1.60	4.49
SW2@SSG 3	14.8	13.1	16.4	22.6
SPWell	1.70	2.22	1.19	0.71
Earle				
SEW51	1.49	1.84	1.28	1.54
SEW52	3.79	3.06	4.90	2.92
SEW53	2.89	2.44	1.95	2.04
SEW54	1.28	2.23	1.36	1.26
SW5@SSG5	10.7	12.0	52.5	42.0

Water Temperature degrees C

	1/26/09	**4/30/09**	**7/28/09**	**10/13/09**	**1/6/10**
WWB					
SDS 3	9.0	14.3	23.8	24.0	7.6
SW 30	15.3	21.9	19.6	21.3	13.9
SW 31	14.9	15.8	20.1	15.8	15.2
SW 43	13.1	15.6	19.1	25.6	13.4
SW3@SSG 2	dry	dry	dry	dry	dry
SW2@SSG 3	4.8	20.6	32.8	23.1	2.0
SPWell	6.2	17.4	25.6	29.0	4.2
Earle					
SEW51	12.5	16.3	21.1	23.8	11.6
SEW52	13.7	14.8	22.6	28.0	11.5
SEW53	14.1	16.0	19.3	20.0	10.9
SEW54	13.9	16.7	18.4	30.4	10.0
SW5@SSG5	7.8	20.8	34.0	30.5	2.90