Soil Genesis and Mined Land Reclamation

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Annual Monitoring Report – 2005 - 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 14, 2006**

Cc: Mike Baker, PCC
Charles Carter, Weanack
George Junkin, American Land Concepts

This memorandum and associated maps, attachments and data sets comprise our Annual Monitoring Report for all work conducted in **calendar year 2005** for inbound sediment analyses, on-site soil analyses, ground and surface water monitoring, hydrogeologic modeling and beneficial use study requirements for VPA Permit No. VPA00579. The original monitoring plan submitted to DEQ by American Land Concepts 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 July 2005, DEQ approved a further modification to the permit and monitoring requirements to allow placement of a new source of dredge spoil (Earle Naval Weapons Station - Earle) into a separate utilization basin as shown in Fig. 2. Thus, this report for 2005 includes data and analyses relative to both utilization areas plus overall assessments of site hydrologic conditions detailed later.

Virginia Tech and Old Dominion University (ODU) continue to serve as subcontractors to Weanack Land LLC to carry out the monitoring and research specified in the plan. We are also providing additional monitoring data sets and results to Potomac Crossing Consultants (PCC) and MDOT that are considerably beyond the scope of DEQ's monitoring requirements, and are detailed in Attachment B of the PCC/MDOT/Weanack agreement. Those additional data are also included in this report, however, since they directly amplify and reinforce the overall monitoring data set and conclusions.

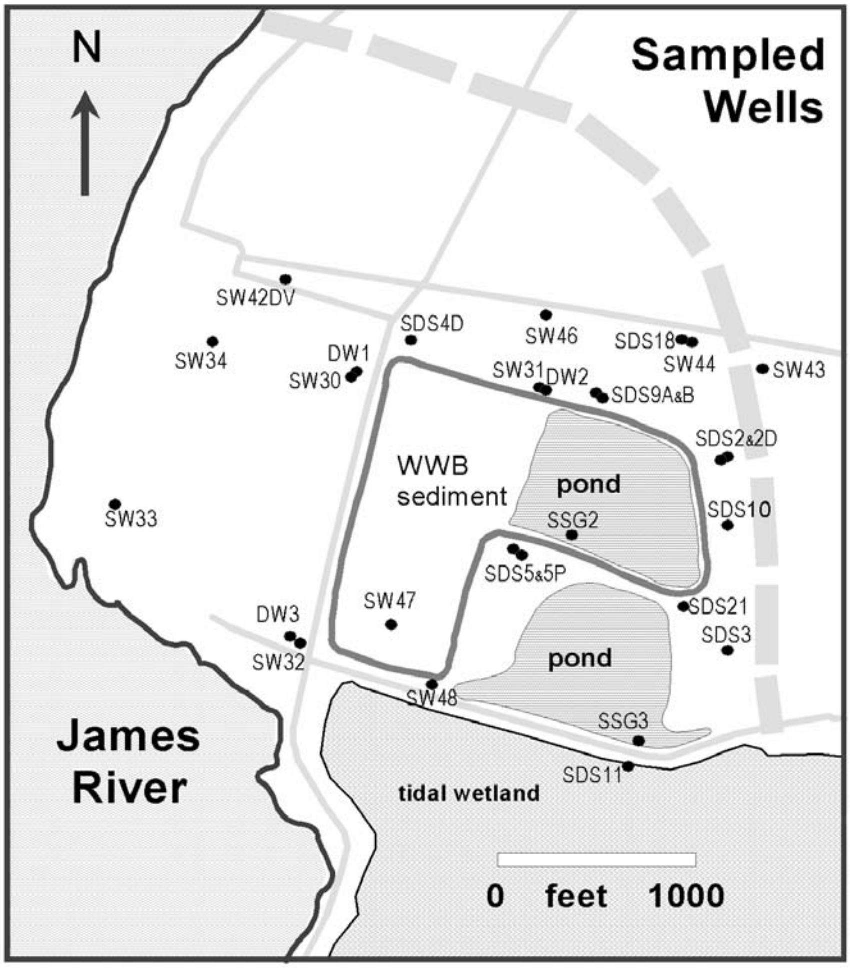

Figure 1. Map of basin location and monitoring wells around the Woodrow Wilson Bridge sediments discussed in this report. The Shirley Plantation drinking well (SP) in the NW corner of the map area was also sampled but is not shown.

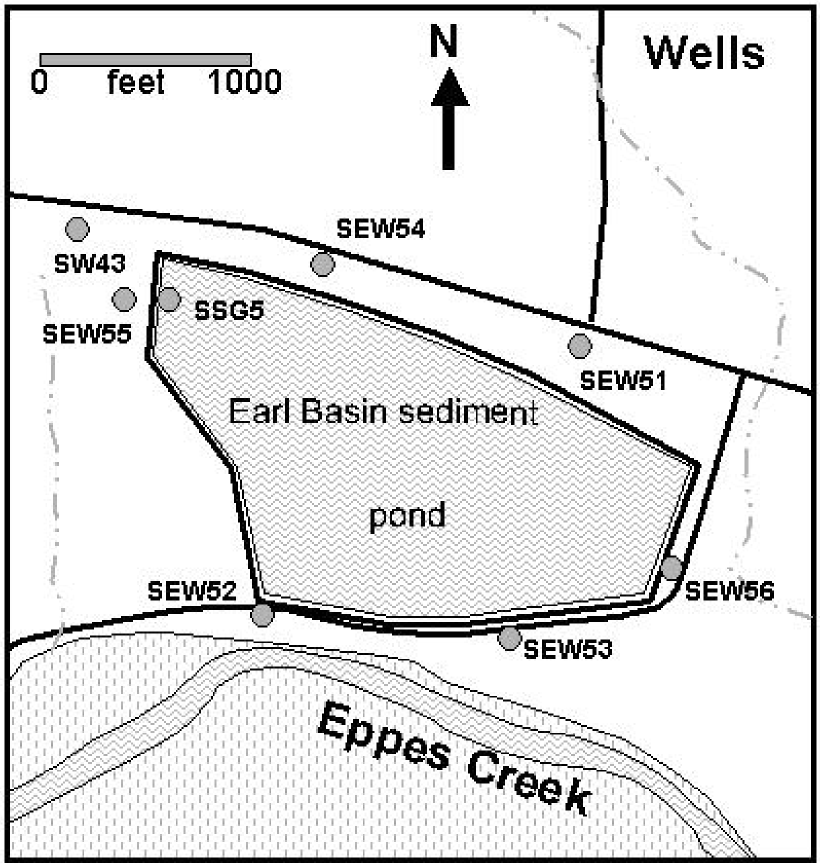

Figure 2. Map of basin location and monitoring wells sampled around the Earle sediment basin as discussed in this report. The WWB basin lies to east, across the ephemeral drain shown running south to Eppes Creek.

Water Quality Monitoring

Under the approved 9/7/04 monitoring plan revision, we reduced our routine monitoring frequency for temperature, pH, EC, and DOC to quarterly (Jan/Apr/July/Oct), and our water quality sampling locations were reduced from all wells available on-site to a minimum of the seven specified below for PCC/MDOT Attachment B. Thus, the following set of locations (see Fig. 1) was used for all water quality sampling through June of 2005:

Upgradient ground-water wells: SDS 02 and SDS 03

Downgradient ground-water wells: SW 30 and SW 31

Surface water: SSG1 and 2 are sampled from two separate ponded locations within the dikes, and **SSG3 3** is sampled at the discharge point of the large pre-existing sediment pond to the southeast of the diked area. Notes: Due to wet conditions, sampling points SSG1 and SSG2 were surface water connected and were sampled together as SSG 2.

Owner's drinking well: SP-well

The locations specified above were sampled for detailed "full suite" of water quality analyses in April of 2005 as set forth in Table 2 of the PCC/MDOT Attachment B monitoring protocol and DEQ Table 1 from the 2004 water quality monitoring revision. These locations were also monitored monthly for water level, temperature pH, EC and DOC through July of 2005. New wells (discussed below) added for the Earle basin were sampled for the full Safe Drinking Water (SDW) suite of parameters in June 2005, and then all primary monitoring wells were sampled in October of 2005 and analyzed for a "partial suite" of parameters.

2005 Monitoring Well Additions, Adjustments and Hydrogeologic Analyses

Virginia Tech and ODU maintained the well sites around the existing basin containing the WWB sediments (Fig. 1) and restored several wells that were damaged due to farming operations. Based on advice from DEQ, one of sites used to characterize "upgradient" water conditions for the WWB site was switched from SDS2 to SEW43. We also conducted routine quarterly monitoring (Jan/Apr/July/Oct) of wells around the WWB site for pH, conductivity, and DOC. We collected WWB water samples for a "full suite" of analyses in April 2005 and both the WWB and Earle wells for a "partial suite" of analyses in October 2005. Because a subcontractor doing some of the chemical analyses contaminated the initial samples submitted, we re-sampled the WWB wells in May 2005.

In preparation for the initiation of monitoring around the new Earle Basin sediment disposal site, we installed new monitoring wells SEW 51 – SEW 56 in June, 2005 (Fig. 2). SEW 51 and 54 are upgradient of the new containment area; SEW 52 and 53 are downgradient. SEW 55 is a shallow monitoring well used for water flow reconstructions only. SEW 56 is not used for analyses of water flow or water quality because it is in a saturated zone that is apparently perched above the regional water table being mapped. We also sample ponded water from the basin (when present) and that sample is designated as EB or SSG 5. Well construction and stratigraphic information are available upon request. In order to provide pre-construction baseline data for the Earle Basin site, we sampled the upgradient and down gradient wells in June 2005.

Site selection for the six Earle Basin wells was based on stratigraphic analyses of more than 35 deep borings made across the site during exploration of sand and gravel resources. This analysis indicated that the Earle Basin lies atop layers of compact silt-clay as much as 5 m thick (Fig. 3). Throughout the study area, beneath that fine-grained surface bed lies an extensive sand-and-gravel aquifer 2-3 m thick; at places the aquifer is more than 10 m thick. This aquifer is relatively complex in that it contains several discontinuous mud beds that form local aquitards, and SEW 56 is thought to be perched on one such bed.

Analyses of water flow direction for the WWB disposal site shown in Figure 4 show no important change in flow directions from previous analyses. Water levels in the pond inside of the berm dropped significantly during 2005 and re-exposed the staff gage in the pond. These lowered water levels reduced hydraulic gradients and thus total discharge leaving the disposal site during the year.

The groundwater flow analyses of the Earle Basin site (Figure 5) indicate that water flows laterally through the uppermost bed of coarse sediment underlying the surficial fine-grained sediment. According to our water level measurements, the water table in this aquifer has its highest elevations in the middle of the interfluve between incised stream valleys, and slopes radially from that crest towards tidal Eppes Creek and the adjacent valleys. This gentle ground water mound lies several meters below the level of the pond present in the containment basin at the end of 2005.

The water pH and conductivity readings for the monitoring wells around the Earle Basin are values typical for groundwater in this hydrogeologic setting. The water in the Earle Basin sediment retention basin is brackish, reflecting the pore water quality of the estuarine sediments placed in the basin. Water quality readings in the down gradient wells (SEW 52 and 53) suggest water from the basin has yet to reach those well sites. Sediments were placed in the basin between August 2005 and January 2006. Reportedly the clay-rich substrate across the floor of the basin was purposefully compacted and smeared to reduce its permeability. If the rate of downward seepage has been reduced significantly by this engineering effort, it may be many months before the saline water reaches the down gradient wells.

Dredge Spoil Testing

Reclamation Material Sediment Chemistry: Samples representing every 30,000 yards of inbound material were taken by Weeks Marine personnel and splits were submitted to Microbac Labs/Gascoyne and Virginia Tech for comprehensive analyses. Microbac was shipped an evenly weighted composite of each 30,000 yards that was subjected to an extensive testing protocol. Virginia Tech received 5,000 yard composites (six 5000-yard samples each time a Microbac sample was shipped) that we tested for potential acidity (PPA) by the hydrogen peroxide oxidation method and calcium carbonate equivalence (CCE) by acid back-titration. We also maintain an archive of all samples in our freezer.

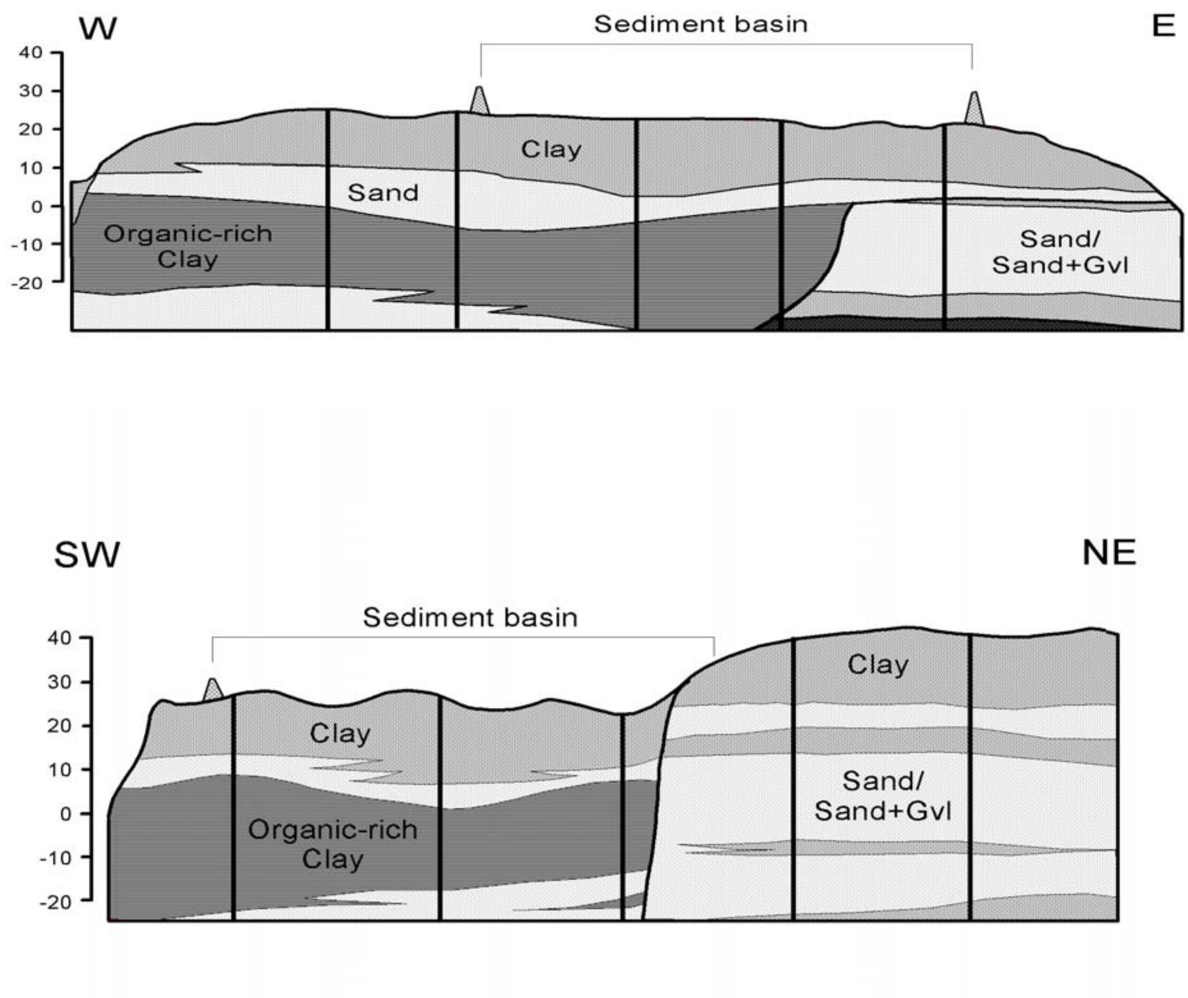

Figure 3. Geologic cross-sections of site containing the Earl Basin sediment disposal basin. Both cross sections are taken through the middle of the basin. Analyses based on borehole data collected during exploration for sand and gravel resources; vertical lines mark the location of the boreholes used for that cross-section.

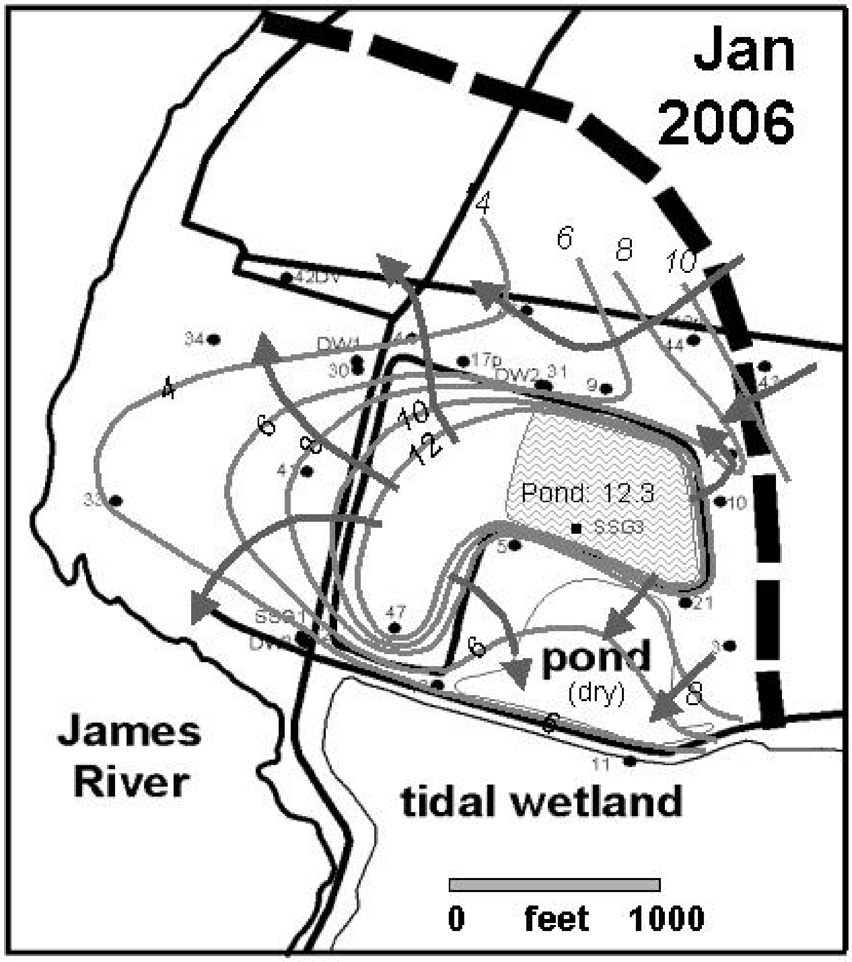

Figure 4. Ground water flow around the disposal site for the Woodrow Wilson Bridge sediments. Wells are marked with the number of their label. Contours are in feet elevation. Dashed line notes location of a distinct scarp between a higher terrace to the north and east of the study site.

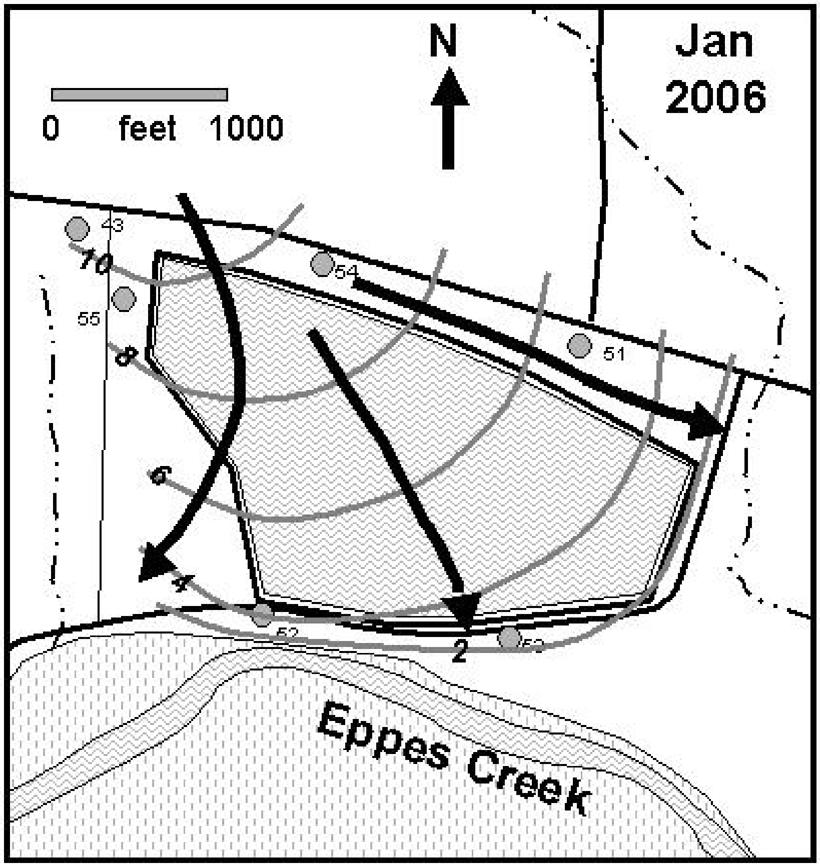

Figure 5. Ground water flow around the disposal site for the Earl Basin sediments. Wells are marked with the number of their label. Contours are in feet elevation. Dot-and-dashed line marks position of streams in valleys.

Overall Sediment Quality Results

No new WWB sediments were received in 2005. However, over 230,000 yards of Earle sediments were received between August and December of 2005. As specified in permit conditions, Weeks Marine personnel took composite samples of every 30,0000 yards at the dredge site for combined analyses by Microbac and Virginia Tech. Complete analytical data on the composite samples and the Virginia Tech splits are contained in Attachment 1.

Eight detailed 30,000 yard analytical data sets were received from Microbac in 2005. Overall, the average analyses for metals, pesticides and organics were quite similar to those provided by Weeks Marine in the permit review and approval process. Due to the essentially full marine environment where these materials were dredged, the inbound sediments were considerably higher in chloride, sodium and sulfate content than the freshwater riverine WWB sediments received in earlier years. Several PAH's (Fuoroanthene, Pyrene, Benzo(a)anthracene, and several other related compounds) were detected in three composites, and appeared to be higher in the later sediments received. Similarly, Bis(2-ethylhexyl)phthalate was detected in the two later samples. These compounds were noted as being detectable and present at similar levels in permit review materials, however. The vast majority of the remaining organics and pesticides analyzed for in the inbound sediments continue to be either non-detectable or present at very low background levels.

Analysis of the 48 inbound sediment samples by Virginia Tech for potential acidity (lime requirement) indicated that an average of one ton of agricultural lime (per acre 6 inches) would be required over the "weathering lifetime" of this material to offset all acidity produced (Attachment 1). There were a number of samples received, particularly in the early portion of the sample stream, that did contain significant (> 5.0 tons) levels of acidity. The highest observed potential acidity (14 tons) was observed in late September in load 30. Beyond that point, our laboratories also tested all inbound samples for lime content (CCE – Attachment 1) and found that the average was 6.83 tons per thousand. Thus, due to large amount of inherent CCE in these materials and the presumption that any acid forming materials would be mixed, diluted, and "sandwiched" by higher CCE sediments, we do not expect net acid forming conditions to develop as these materials dewater.

Soil Formation/Beneficial Use Conversion Studies

The fully dewatered portion (W and SW) of the WWB basin area was disked for weed control in the spring of 2005 and planted to corn by Mr. Carter's contract farmer. Using conventional management and inputs, the farmer estimated 2005 average corn yield at approximately 180 bushels per acre. Regional averages on better soils are 160 to 180 bushels per acre. No management limitations were noted.

In June of 2005, and in accordance with our monitoring agreements, we transect sampled the dry and arable portions of the WWB sediments as shown in Figure 6. The soils were sampled with a 3.5 inch diameter bucket auger to a depth of 60 inches. Basic soil horizonation, color, structure and rooting were carefully described before bulk samples were taken of the 0-6" plow layer and the deeper, least weathered sediments at 60". The soils were transported to our laboratories and analyzed for particle size analysis and dilute acid extractable nutrients and metals. That data set in presented in Attachment 2.

The particle size analysis data reinforce the positive physical quality of these materials as discussed in earlier reports. The average soil texture observed is a silt loam with a few sample points falling into the loam and silty clay loam classes. The surface horizons were well aggregated while deeper structural development was primarily from the large downward developing polygonal prisms discussed in earlier reports. The depth of oxidation varied quite a bit, but most soils showed browner oxidized colors to a depth of at least 18 inches. Most of the deeper horizons were still very dark grayish-blue in color. Detailed pedon descriptions are available upon request.

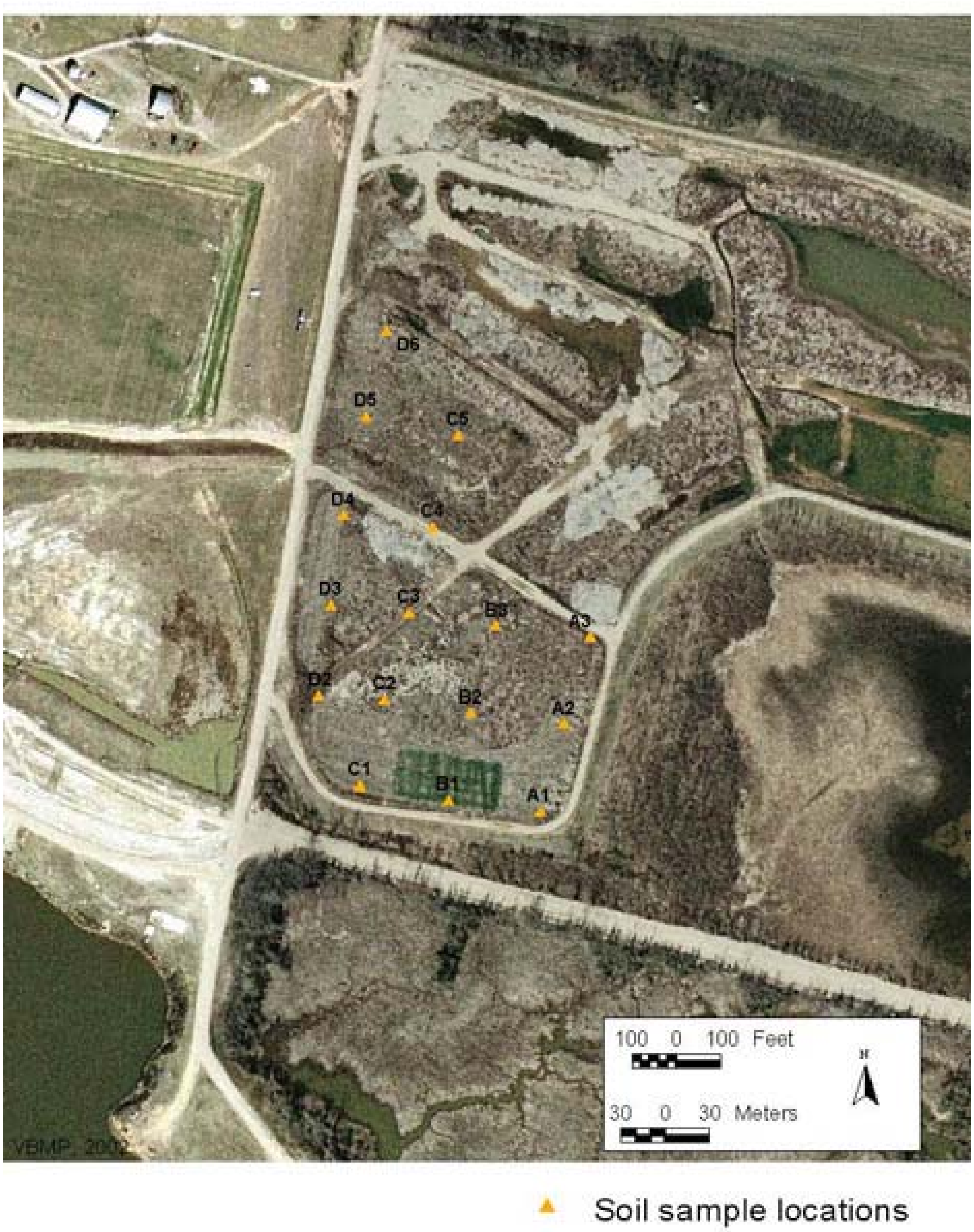

Figure 6. Soil boring and sampling locations in agricultural area of WWB basin in June of 2005. This photograph was taken in 2002 and the original row-crop experimental area can be seen at point B1.

From a standpoint of soil chemical properties and fertility, these newly developed soils are outstanding and actually superior to most native agricultural soils. The pH of the surface soil ranges from 6.6 to 7.4, despite over three years of oxidation and weathering. Extractable cations (Ca, Mg and K) are very high, extractable P is moderate, and levels of essential micronutrients like Zn and Mn are moderate, but not high.

Once dewatered, we expect the balance of the sediments in the WWB basin to behave in similar fashion. Thus, once cured and aggregated for some period of time, we predict that these will be very good agricultural soils.

Water Quality

In concordance with all annual monitoring reports to date, 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 disposal area (see Attach. 3). As expected, ground water levels of DOC and sulfates also appear to be dropping with time relative to previous years, although the DOC levels continue to be quite variable. As discussed in last year's report, neither of these parameters is present at levels of concern for drinking water quality in the downgradient wells.

Review of the baseline (June 2005) Earle basin well data revealed no notable pre-existing water quality issues, although several locations approached or exceeded the nitrate-N drinking water standard of 10 mg/L. This is certainly due to the long term history of intensive agriculture in this area. The water quality data set from the October 2005 sampling indicates no net effect of the placement of the Earle dredge sediments on the downgradient ground water sampling locations. However, as expected, the water samples taken from the ponded basin (SSG 5 and/or EB1) were quite high in EC, chloride, sulfate and DOC as would be expected from the porewaters of saline dredge materials. The chlorides from this water should be relatively mobile, and we will watch the downgradient wells carefully over the next several years to note any migration.

Overall Monitoring Summary

Our combined conclusion to date 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 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 as discussed earlier. 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.

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 Steve Nagle, Mike Nester, Nicole Ginnis, Aaron Despres, Daniel Raines, and Paula Zimmerman was also essential to our continuing efforts. The sediment and water data sets contained herein were compiled by Sue Brown.