6. Wetlands Monitoring Program

(1) Program Strategy and Objectives

Two key aspects of the DEQ non-tidal wetlands[34] program consist of ensuring that (1) there is no net loss of wetland acreage and function through permitted impacts, and (2) there is a net gain in wetland resources through voluntary programs. In order to accomplish these goals, it is critical to first know the status of wetland resources in Virginia, in terms of location and extent of wetlands in each watershed, and have a general knowledge of the quality of these wetland resources. Secondly, the functions of wetland resources impacted through the Virginia Water Protection (VWP) permitting program must be accurately evaluated to determine those functions to be replaced through compensatory mitigation. It is also important to assess the degree to which the required compensatory mitigation is performing in relation to those impacted functions. Characterizing and evaluating wetlands quality is a third key aspect of this monitoring program. Using this information, the agency can then track changes in wetland acreage and quality within the Commonwealth, target problematic watersheds, and help determine the effectiveness of compensatory mitigation to replace lost wetland acreage and function.

Since 2003, the overall wetland monitoring and assessment strategy has been to establish baseline conditions in various broad contexts, such as land use, watershed, and wetland type. This information can then be used to guide management decisions regarding wetland restoration efforts, programmatic compensatory mitigation, and integration with overall WQ Standards. This strategy provides the ultimate framework for an ongoing assessment of the status of the Commonwealth's wetland resources and the success of both wetland regulatory and voluntary programs. The wetlands monitoring strategy will be coordinated with Virginia's comprehensive water quality monitoring program strategy. The monitoring objectives are designed to support regulatory decision-making, allow reporting of wetland conditions, and provide information for policy development.

The wetland monitoring program will also meet the Clean Water Act objectives for water monitoring programs by addressing the quality of the Commonwealth's wetlands and their condition as part of the overall condition assessment of state waters. This information will support the regulatory program's required cumulative impact assessments, and will also form the basis for status and trend reporting for Clean Water Act Section 305(b).

DEQ, in partnership with the Center for Coastal Resources Management (CCRM) at Virginia Institute of Marine Science (VIMS), has developed a set of wetland assessment protocols for Virginia. The current set of protocols is designed to generate a nested (*i.e.*, hierarchical) data set in which a minimum amount of data is available for all identified wetlands in the state, and more extensive information is available for selected subsets of wetlands. The structure is designed to support the management program's need for comprehensive information to generate cumulative impact analyses. The hierarchical nature of the database allows for statistical tests of the simple management guidance models that extrapolate site-specific understandings to generalizations about classes of wetlands.

As currently designed, the assessment protocols consist of a three-level approach to wetlands sampling. Comprehensive coverage of all mapped wetlands is achieved with a GIS-based analysis of remotely sensed

[34] DEQ administers the wetland monitoring and assessment program in the Office of Wetlands and Stream Protection, and is the legal authority for the protection of non-tidal wetlands. The Code of Virginia designates the authority for tidal wetlands protection to the Virginia Marine Resources Commission (VMRC). See the VMRC Habitat Management WebPages at: http://www.mrc.state.va.us/hmac/hmoverview.shtm.

information. These data are summarized on the basis of small watersheds or hydrologic units. The summary provides a first order evaluation of the conditions and functional capacities of wetlands based on their landscape position. The second level assessment is intended for use in a statistically-selected (probabilistic) sub-sample of the watershed wetland population, and involves a more sophisticated analysis of remotely sensed information and a site visit for verification and additional data collection. The third level assessment involves very detailed analysis of wetlands performance of specific functions (habitat provision and water quality modification, in particular). This involves extensive sampling of a limited number of sites, specifically chosen to allow validation of the conceptual model of wetland functions that underlies the Level 1 and Level 2 assessments.

A critical part of the overall monitoring and assessment strategy is effective validation and calibration of the underlying models. The Level III assessments are designed to specifically evaluate performance of functions in wetlands under varying degrees of stress, as indicated by the Level I and Level II protocols.

The DEQ wetlands program, in coordination with the overall DEQ water quality monitoring program, continues to refine the ten-year plan for wetlands monitoring and assessment in Virginia. This work is being accomplished as a work product under several EPA State Wetland Development Grants to the Department of Environmental Quality. The development of this strategy follows the EPA October 2002 draft document "Elements of a Wetland Monitoring and Assessment Program Checklist" [III-C-6a.pdf] and will include a discussion of the following ten essential "Elements of a State Water Monitoring and Assessment Program" [I-0a.pdf] (USEPA, March 2003):

1. Monitoring Program Strategy
2. Monitoring Objectives
   Information derived from monitoring will be used to:
   - Report ambient wetland conditions in Virginia's Clean Water Act (CWA) Section 305(b) reports;
   - Assist in the evaluation of environmental impacts of proposed impacts to wetlands during permit review as part of Virginia's regulatory program;
   - Evaluate the performance of wetland restoration and compensatory wetland mitigation in replacing wetland acreage and function; and
   - Evaluate the cumulative impacts of wetland loss and restoration in watersheds relative to ambient ecological conditions.
3. Monitoring Design
4. Core and Supplemental Water Quality Indicators
5. Quality Assurance
6. Data Management
7. Data Analysis/Assessment

   Examples of different wetland quality data analyses may include:
   - Comparison of wetland quality within a watershed and among watersheds
   - Comparison of wetland quality within a locality and among different localities
   - Comparison of wetland quality within a watershed or locality over time
   - Comparison of wetland quality among wetland types

- Correlation of wetland type and specific stressor(s)
- Comparison of wetland quality within and among hydrogeomorphic (HGM) classes
- Comparison of wetland quality within a specific wetland over time

8. Reporting
9. Programmatic Evaluation
10. General Support and Infrastructure Planning

The first step in developing such a plan is to clearly articulate the goals and objectives of the assessment and monitoring of wetlands in Virginia. Virginia's focus is to use data generated under these grants to conduct reporting on status and trends of wetlands as part of Virginia's 305(b) Report, and to evaluate the effectiveness of regulatory and voluntary programs in meeting Virginia's mandate of no net loss of wetland resources through regulatory programs, and a net resource gain through voluntary programs. A final version of the Wetland Monitoring & Assessment Strategy [III-C-6d.pdf] was completed in October 2005, and was resubmitted to EPA on December 16, 2005, following response to and/or the incorporation of EPA comments.

As part of the development of a wetlands monitoring and assessment strategy, DEQ established an ad-hoc interagency committee of other state agencies involved in wetlands issues, including the Chesapeake Bay Local Assistance Department, the Virginia Marine Resources Commission, the Department of Game and Inland Fisheries, and various programs within the Department of Conservation and Recreation. The goal was to have this interagency committee available to review and comment on the monitoring and assessment strategy, and to provide DEQ with periodic updates on what their agencies are doing with regard to wetland resources. DEQ also obtained public input on the draft strategy through a public workshop, funded by the EPA grant, and incorporated many of those comments into the final strategy.

(2) Monitoring Design

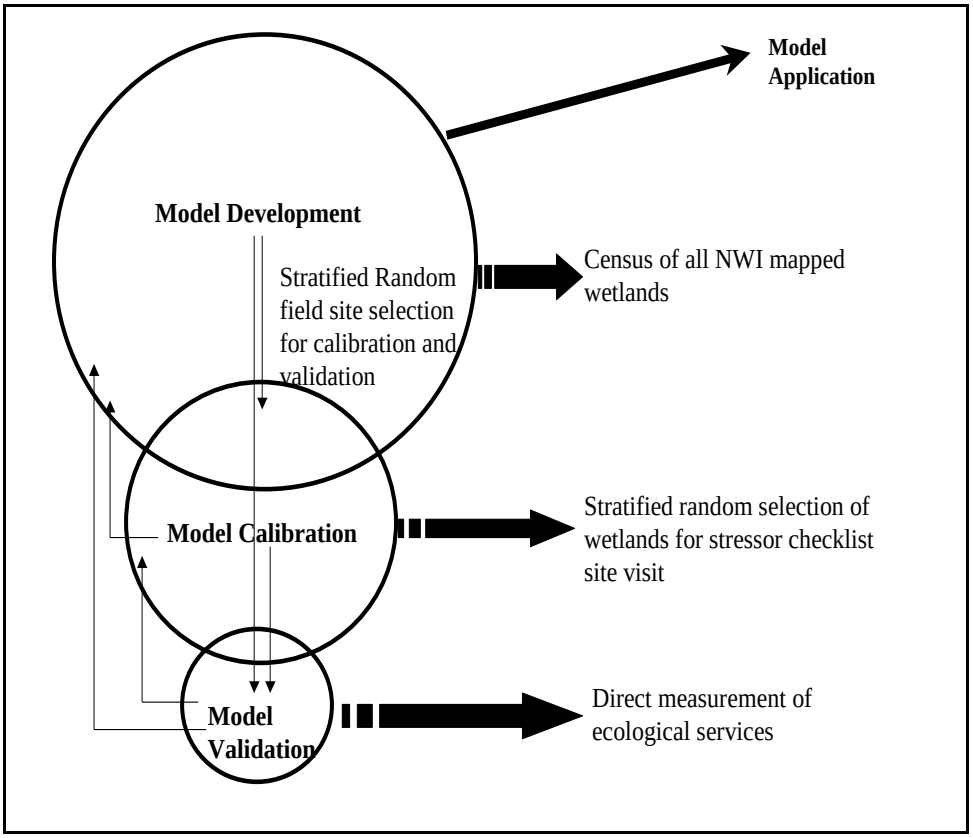
The protocols for the wetland monitoring and assessment developed in Virginia consist of a multi-tiered sampling design coupled with methods for regulatory updates and field office data delivery (see **Figure III.C.6-1** below). Each assessment level informs the other levels, and is essential in development of the final assessment protocol.

The level I assessment, which has been completed for all wetlands in Virginia, is based on wetland type and surrounding landscape. The Level II and Level III sampling are intended to calibrate and validate the model that is applied at the Level I (model development) stage. The data collections are not designed to operate independently. The method characterizes the capacity of the wetland to provide water quality and habitat services using remotely sensed data. The underlying models are based on existing research. They specify the combination of landscape level parameters that are most likely predictive of these capacities. The model application produces a relative score for each wetland for each service. The scores are then refined and calibrated by site visits to randomly selected wetlands. The relationship between structure and function is validated by intensive study of ecological service endpoints.

The level I assessment was done using existing data sets from the National Wetlands Inventory (NWI), Landsat Thematic Mapper (TM) satellite, protocols developed by the Coastal Change Analysis Program (CCAP) of the National Oceanic and Atmospheric Administration (NOAA), U.S. Geologic Survey National Elevation Dataset (NED), and Digital OrthoPhoto Quads. The parameters chosen for Virginia's Level I assessment wetland quality score include: (i) wetland size, (ii) wetland type, (iii) wetland

hydroperiod; (iv) proximity to other wetlands; (v) proximity to roads and highways, (vi) density of roads and highways; and (vii) percent land cover (immediately adjacent to the study wetland, at a 200 meter radius from the study wetland, and at 200-1000 meter radius from the study wetland). The data set will be updated periodically, when resources allow, as revised land cover and NWI maps are updated.

Figure III.C.6-1. Multi-tiered sampling design.



A comprehensive analysis of Virginia's wetlands was conducted using the Level 1 protocol. As a result of the U.S. Fish and Wildlife Service's 'National Wetland Inventory' (NWI) recent completion of the re-mapping of all Virginia's wetlands, it became possible to use this NWI information along with other recent remotely sensed data to develop a first order characterization of wetlands based on wetland types and the surrounding landscapes. This Level 1 characterization established a conservative evaluation of wetland conditions based on landscape position and the potential of that wetland to perform certain functions, such as flood control, nutrient and sediment retention, habitat provision, etc. This analysis was accomplished entirely within a GIS framework, and has been completed for the entire state, by 14-digit hydrologic unit (1995 DCR/NRCS delineation). The total number of polygons, arcs, and points and the representative acres of wetlands processed by region are shown in **Table III.C.6-1**.

The original assessment was based on the 14-digit hydrological units (HUs) of the 1995 delineation. However, wetland conditions scores are now provided for 8, 10, and 12-digit National Watershed Boundary Dataset (NWBD) HUs, as well as being based on the newly available land cover information from the NOAA Coastal Change Analysis Program. The recent update of the land cover classification for the coastal plain of Virginia provides a 2006 land cover that can be used in conjunction with the 1996 and 2001 land

cover data sets to assess change for the Wetland Condition Trend Analysis [III-C-6e.pdf] completed by VIMS in October 2012.

Physiographic Region	Number of Polygons, arcs, points	Wetland Acreage	Percentage
Coastal Plain	118,935	920,084	76.60%
Piedmont	66,646	268,836	22.38%
Ridge & Valley	10,213	12,190	1.01%
TOTAL	195,794	1,201,110	100.00%

Table III.C.6-1. GIS analysis of NWI database.

The level I (model development) analysis, combined with validation and calibration from the level II and level III assessments, will provide an evaluation of the condition of wetlands based on their position in the landscape. This information is directly applicable to status and trends reporting under Clean Water Act Section 305(b), and can be utilized in permitting programs to assess cumulative impacts to wetlands within watersheds.

Also under the EPA grants, field analysis of wetlands in selected areas throughout the Coastal Plain was conducted using the Level 2 assessment. This protocol involves a much more detailed analysis of the landscape setting and functional condition of individual wetlands using a stressor inventory. VIMS and DEQ adopted the EPA probabilistic sampling protocol (developed for EMAP and revised for wetlands) to characterize wetlands by type and landscape setting within hydrologic units in the Coastal Plain, Piedmont, and Ridge and Valley. This implied a relatively high number of sampling sites in order to meet the desired level of statistical precision. Because this information is collected in a statistically robust design, it can be used to characterize the condition of wetlands within a hydrologic unit, such as the James River basin or the Appomattox River sub-basin. The initial Level 2 Assessment for Coastal Plain sites (total 1,225 sites sampled) was completed in June 2005. It immediately became useful to the regulatory program as a basis for minimizing impacts, defining compensation requirements, and tracking cumulative consequences of regulatory decisions.

Based on the sampling design developed for the Level 2 assessments, the program identified sites for Level 3 assessments. This much more extensive assessment approach was used on a selective basis to document habitat and water quality functions of a particular wetland, but is not practical for widespread use due to its intensive data collection requirements. To the extent possible, the agency coordinated the design of this sampling program with wetlands hydrogeomorphic (HGM) model development and related reference site monitoring in Virginia. The Level 3 sampling for the Coastal Plain, Piedmont, and Ridge and Valley was completed in September 2008. Validation of the scoring protocol has been completed for the Coastal Plain. Average habitat wetland condition and average water quality wetland condition per 14-digit HUC has been completed (**Figures III.C.6-2 and III.C.6-3**).

Level III involved a very detailed analysis of wetland performance of specific functions (habitat provision and water quality modification) with an extensive sampling of a limited number of sites. The level III assessments are designed to specifically evaluate performance of functions in wetlands under varying degrees of stress, as indicated by the level I and level II protocols. This project completed validation within the Coastal Plain and provided a direct measurement of the selected sites' performance of habitat (avian and amphibian) functions to allow testing for correlations between ecological service and stressor levels.

Figure III.C.6-2. Average wetland habitat condition by 14-digit HUC.

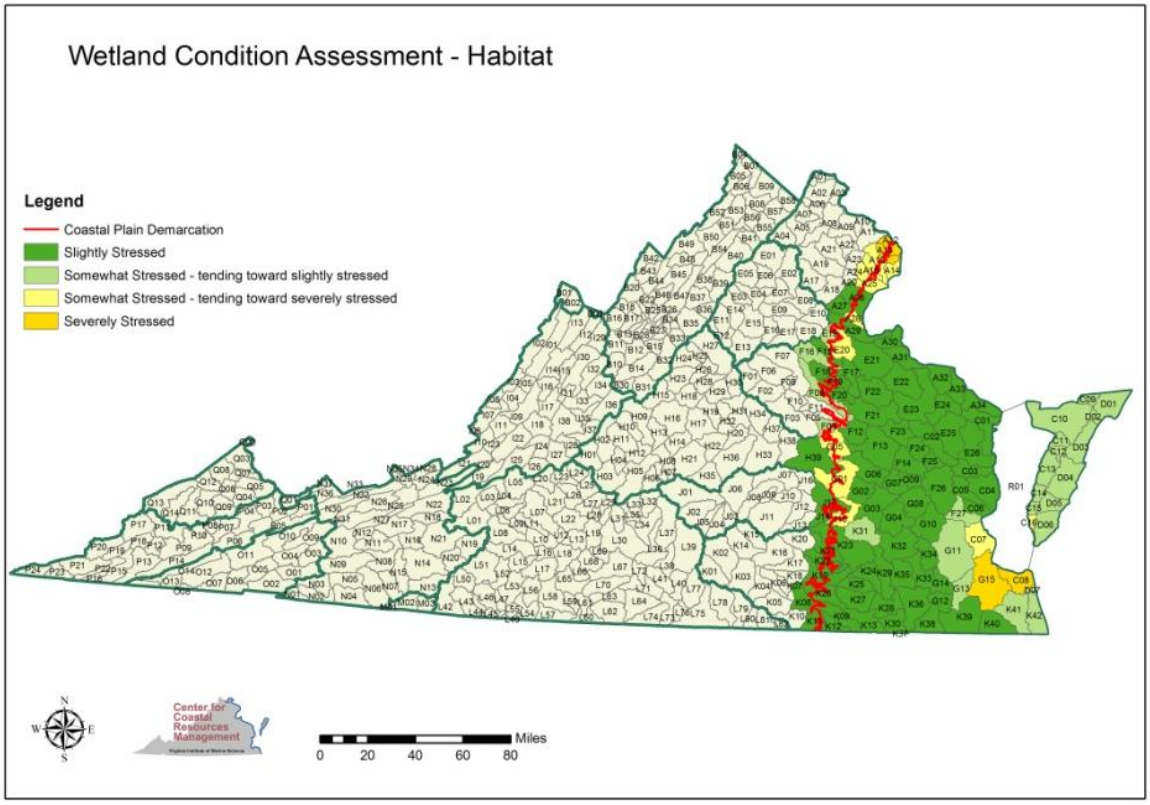
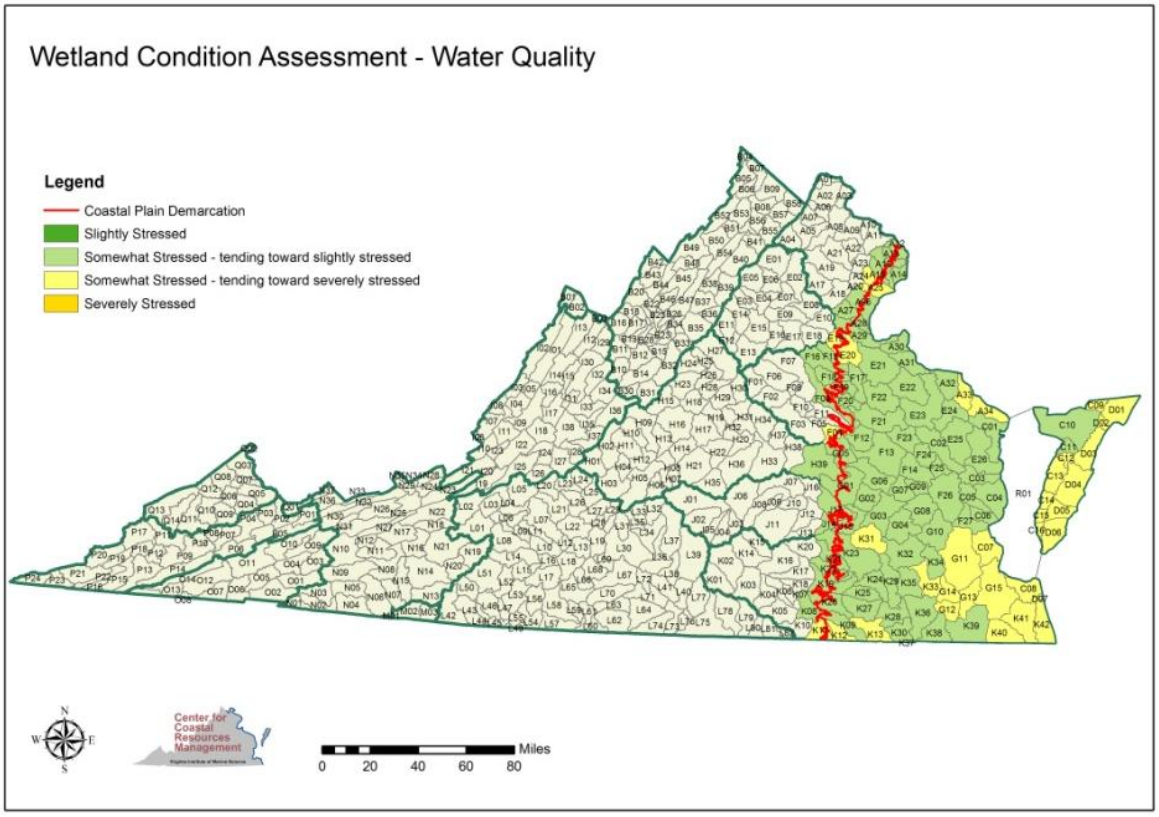


Figure III.C.6-3. Average wetland water quality condition by 14-digit HUC.



Validation of the relationship between stressors, surrounding land cover metrics, and ecological service endpoints is a necessary step in any condition assessment model. Validation of stressor and surrounding land cover metric effect on ecological service endpoints was conducted by randomly selecting 27 sites for intensive study. Two ecological service endpoints were selected for analysis: (1) water quality and (2) habitat quality. The assessment of water quality services was obtained by analyzing Total Dissolved Nitrogen (TDN), Total Dissolved Phosphate (TDP), and Total Suspended Solids (TSS) in water samples from wetlands with flowing surface water. Water samples were obtained from wetland systems monthly and after rain events and compared with surrounding land cover metrics.

To independently validate the wetland water quality condition assessment scores, wetland scores in drainages contributing to impaired waterway segments were compared with those scores in unimpaired segments. Virginia Department of Environmental Quality water quality monitoring stations were used to determine impaired versus unimpaired segments.

Habitat service was determined by assessing avian and amphibian community structure metrics. Visual encounter surveys (VES) and nighttime frog call surveys were conducted at each site in the spring and summer for amphibian community structure. Three rounds of stratified point count surveys conducted from 0.5 and 4.5 hours after sunrise between late May and mid July for avian community structure.

Data collected at each point included, site, date, start time, species of birds detected, distance from point center (within 50m, and >50m) of each detection, time period of detection (0-3, 3-5, 5-7, 7-10, and 10-15min), and detection method (visual, aural, both). Amphibian species richness and avian priority wetland species abundance, neotropical abundance, and Partners in Flight (PIF) scores were compared with stressor level and percent surrounding land use type. The PIF score is a priority ranking system for North American birds designed for conservation purposes. The PIF system consists of six vulnerability criteria: relative abundance, size of breeding range, size of non-breeding range, degree of breeding range threat, degree of non-breeding range threat, importance of the area of consideration, and population trend in the area of consideration (Mehlman et al. 2004). High PIF scores showed a negative linear relationship with stressors and percent developed land within 200m and a positive linear relationship with percent natural land within 200m. Amphibian community structure showed no relationship with stressors or surrounding landuse.

The hierarchical nature of the database allows for both general reporting on status and trends, as well as providing for more intense analysis of select watersheds for assessment of cumulative impacts to wetland habitat and water quality functions.

Level II and Level III assessments have proceeded by physiographic province from the coastal plain to piedmont to the ridge and valley, with a sampling effort succeeded by model validation. Re-calibration of the stressors by landcover to verify the correlation of stressor type to landcover and validate the use landcover for condition assessment scoring has been completed.

Resampling of NWI mapped wetlands has been completed in the Coastal Plain and the Piedmont, to investigate possible changes between surrounding land use and wetland stressors. This information is critical in the Virginia assessment protocol as the foundation of the stressor prediction algorithm in the Level I assessment model. It is essential to revisit the relationship between land use practices and stressors impacting wetlands as the pattern of development changes. Evolving best management practices in agriculture, and changing stormwater and site development regulations in suburban communities alter the probable occurrence of selected stressors. Since the Level I protocol uses remotely sensed land cover information to predict stressor occurrence, it is critical to periodically reassess the prediction algorithms.

This task involved re-sampling the Piedmont region with the Level II protocol. Sixty sites, 1/10th of the original sample number, were randomly sampled to detect potential significant changes in the relationships established in the original sample set. The major stressors found within wetlands remained similar between sample periods, with mowing, brush cutting, roads, eroding banks, and unfenced livestock predominating. There was a slight increase in the prevalence of the ditch/drain stressor in the 2011 sample and a decrease in the presence of potential nonpoint discharge.

A critical part of the overall monitoring and assessment strategy is effective validation and calibration of the underlying models. The level III assessments are designed to specifically evaluate performance of functions in wetlands under varying degrees of stress, as indicated by the level I and level II protocols. This project completed Level III validation within the Piedmont and Ridge and Valley in 2010 and began the wetlands condition status and trends analysis for the Coastal Plain. The more recent completion of the Coastal Plain analysis (2012) [III-C-6e] provided a direct measurement of the selected sites' performance of habitat (avian and amphibian) functions to allow testing for correlations between ecological service and stressor levels.

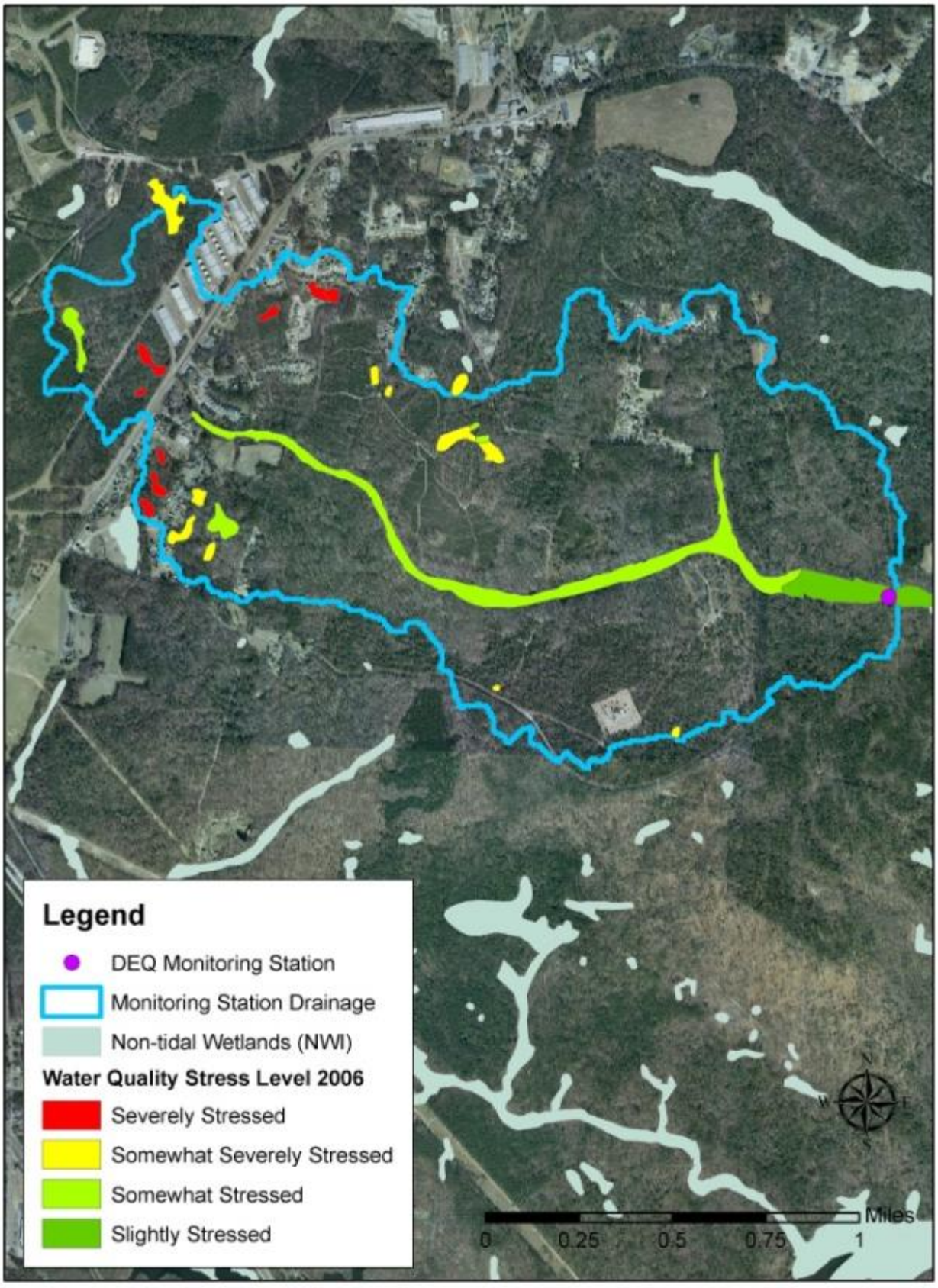
One of the potential advantages of the Virginia protocol for monitoring and assessment of nontidal wetlands is the opportunity to develop a comprehensive assessment of the functional condition of all mapped wetlands whenever there is updated land cover information. This information is particularly useful for evaluating the performance of the regulatory program. It is also useful for indicating cumulative impacts to wetland resources arising from development activities that do not directly impact wetlands. This information can help to raise awareness of consequences and motivate essential change in general land use management and planning that affects lands outside wetland jurisdictional boundaries. Linking decisions in these areas to wetlands policy will be essential to attainment of the no net loss goal.

As discussed in the Wetland Condition Trend Analysis [III-C-6e.pdf], the current grant work took advantage of the recently updated coastal plain assessment protocol, and the newly available land cover information from the NOAA Coastal Change Analysis Program. The recent update of the land cover classification for the coastal plain of Virginia provides a 2006 land cover that can be used in conjunction with the 1996 and 2001 land cover data set to assess change. All three land cover data sets were analyzed using the Level 1 assessment model. CCRM then summarized the changes in wetland condition output by the model. This represents the first comprehensive assessment of trends in wetland condition over a relatively modern time interval. Analysis of wetland water quality condition and habitat condition scores by 12-digit hydrologic unit code (NWBD 6th Order sub-watersheds) showed some changes in average water quality and average habitat condition over time.

Using the analysis of wetland condition change, the water quality data was analyzed for Virginia's coastal plain. By determining the catchment areas for the various water quality monitoring stations, the primary objective of this task was to search for relationships between water quality condition recorded at DEQ water quality stations and the condition of wetlands in the contributing drainage.

To test wetland water quality condition scores, Virginia Department of Environmental Quality coastal plain water quality stations (n=99) were used to determine possible trends between wetland water quality condition scores and in-stream water quality metrics (E. coli, fecal coliform, total nitrate nitrogen, DO, pH, and turbidity). Contributing drainage areas were determined for water quality stations using the same protocol for development of individual wetland drainage areas (**Figure III.C.6-4**). Water quality station data was compared to contributing drainage wetland water quality condition scores for multiple years (1996, 2001, and 2006).

Figure III.C.6-4. Wetland water quality stress condition within the contributing drainage to a Virginia Department of Environmental Quality water quality station.



While there were no obvious trends between wetland water quality condition score and average DO, pH, and turbidity, there were trends in total nitrate nitrogen, fecal coliform levels, and E. coli levels. As shown in **Figure III.C.6-5**, the higher the wetland water quality condition score in the contributing drainage the lower the levels of nitrate, fecal coliforms, and E. coli, suggesting a relationship between those water quality parameters and wetland condition.

GIS Wetland Data Viewer

Coordination between VIMS and DEQ staffs is ongoing to design and implement procedures to facilitate the routine application of inventory and monitoring data for regulatory decisions on wetland permits. The data collected has been compiled into a wetland data viewer created by CCRM with substantial input from DEQ. The goal is to automate the processing of database information necessary to support DEQ's regulatory decision-making, allow reporting of wetland condition, and provide information for policy development through the use of GIS.

The additions of data sets and GIS layers will allow Virginia to continue to develop a GIS-based wetland data viewer for use by regulatory agencies and the general public (see **Figure III.C.6-6**). Our success will be measured by an increasing trend in the statistically-reliable Level I protocol and a decreasing trend in cumulative wetland impacts. By having a statistically-validated tool that measures wetland quality as a function of habitat and water quality parameters, our permit staff will be able to make better permit decisions relative to potential cumulative impacts. Further, we will also be able to measure how well we are protecting the function of our more vulnerable wetlands (i.e. isolated wetlands, vernal pools, Atlantic white cedar swamps), by comparing the condition of wetland habitat and water quality parameters, as a function of the assessment scoring over time.

The wetland data viewer is currently undergoing design modifications and testing, and is not expected to be available for general use until late 2013 or early winter of 2014. Development of mechanisms for formatting desk-top delivery of assessment material for permit review are ongoing, with meetings with DEQ permit writing staff and beta testing. This includes adding capacity for automated assessment of:

- local wetland conditions and cumulative impacts
- proximity to impaired waters
- opportunities for compensatory mitigation

In support of these efforts, DEQ worked with botanical experts from various regions of Virginia to develop a Floristic Quality Assessment Index (FQAI) for specific wetland areas as a qualitative indicator of that wetland's relative condition. The FQAI has been shown in other states to be a reliable means of assessing wetland quality with minimal data collection. Development of a FQAI specific to Virginia involved determining a coefficient of conservatism (C) for a subset of the tidal and non-tidal vascular wetland plant species known to occur in Virginia. A list of tidal and non-tidal wetland vascular plants was developed using the "National List of Plant Species Occurring in Wetlands: Region 1", adjusted for those species known to occur in Virginia using existing published literature (Harvill, 1992; Silberhorn, 1999; Reed, 1988; Radford, et al., 1968; Beal, 1985). Also, unpublished literature associated with the "Manual of the Virginia Flora" project (project in progress) was consulted when necessary. A committee of four botanical experts, with a fifth botanist from DEQ, established a consensus "coefficient of conservatism" (C) for each plant species on the list. The C-value ranged from 0 (a non-native species) to 10 (most likely to occur in undisturbed landscapes). Intermediate integers were assigned to each species, based upon its tolerance to disturbance. The program is now in the process of determining whether there is a significant correlation between the FQIA and the stressor checklist used in the Level 2 analysis, and if so whether the FQIA can

Figure III.C.6-5. Comparison of wetland water quality condition scores (mode) and in-stream water quality parameters (mean).

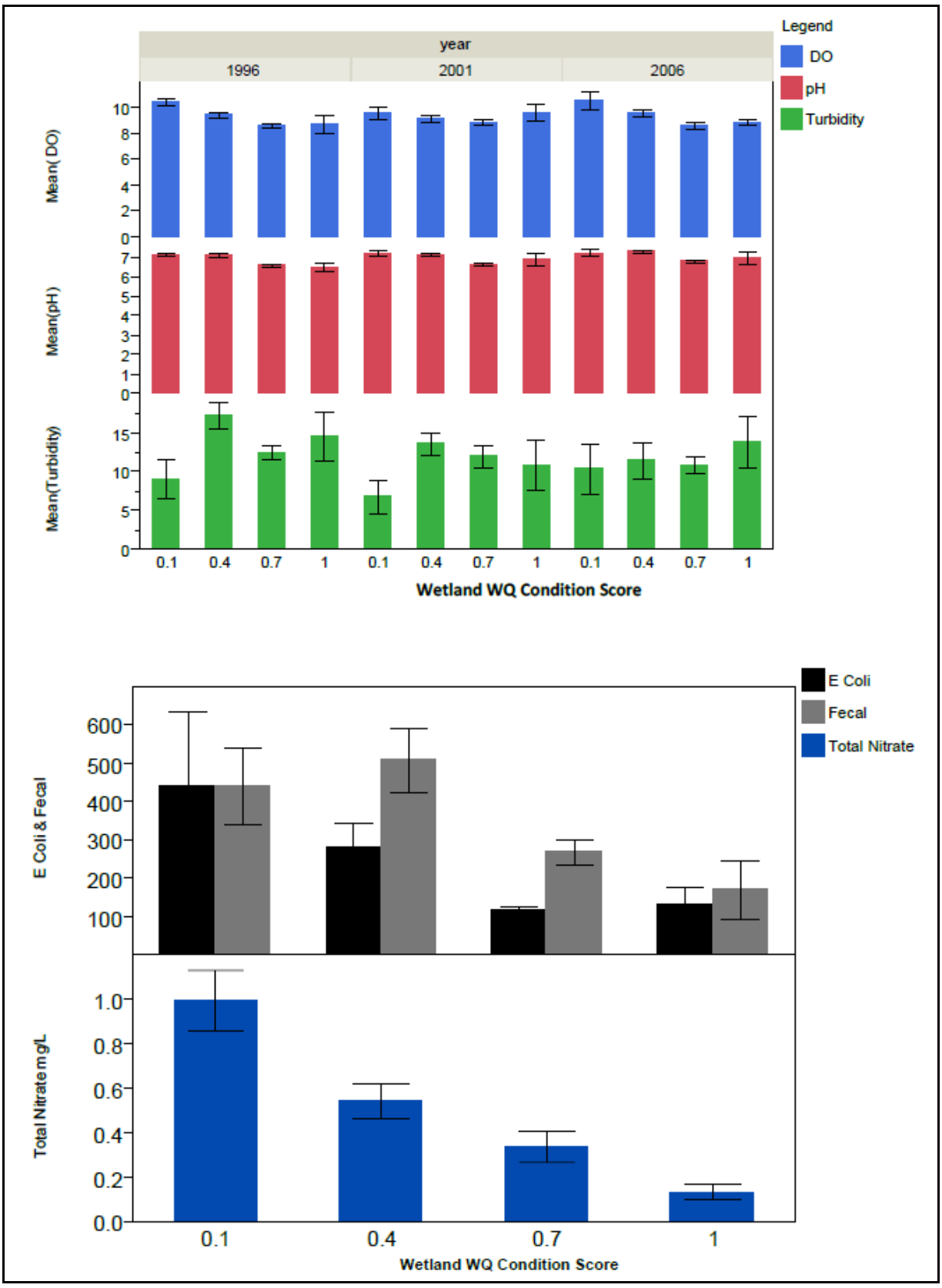
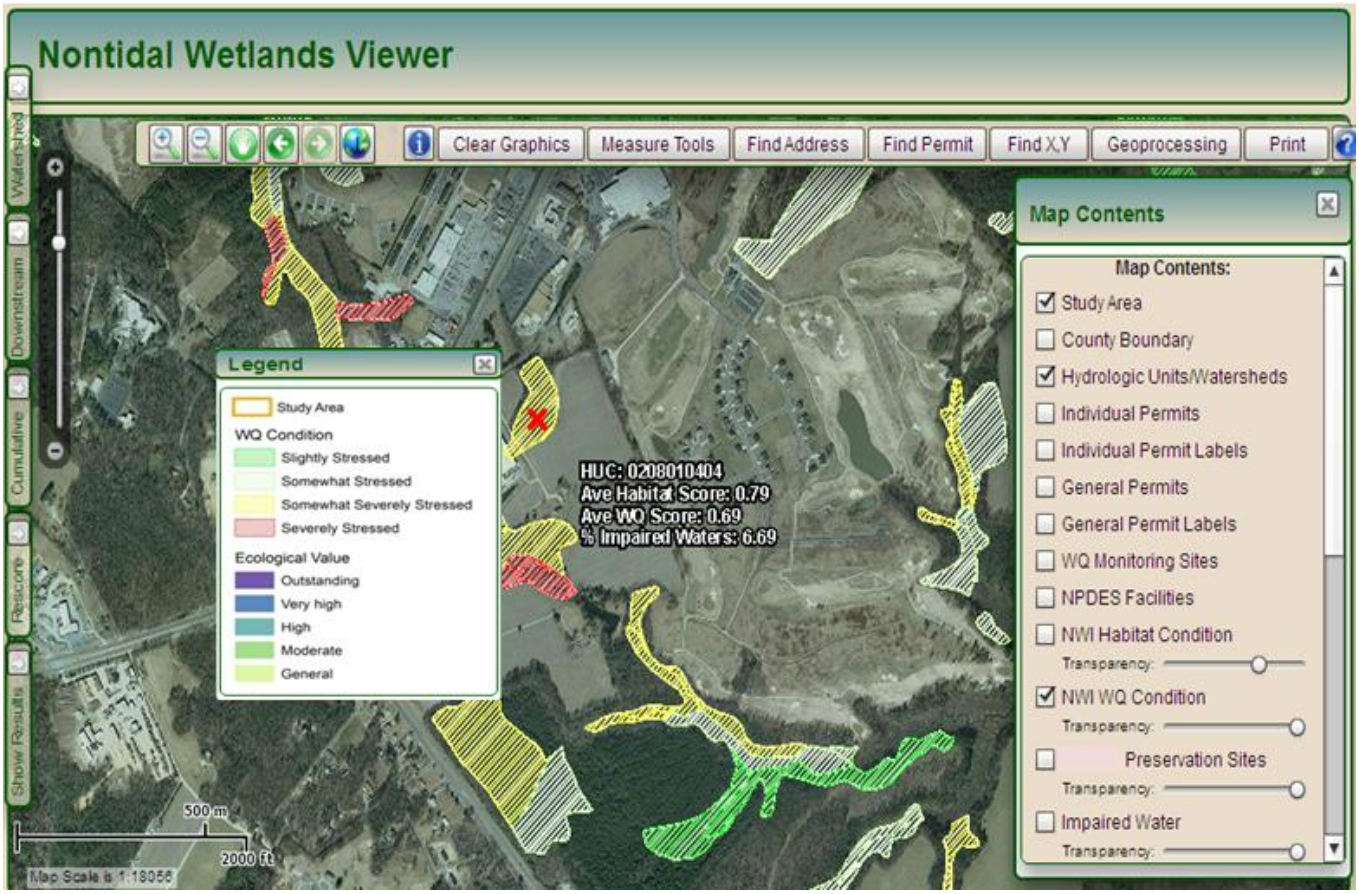


Figure III.C.6-6. Non-tidal Wetland Data Viewer



serve as a surrogate for multiple indicators on the checklist. The final report on the FQIA was completed and submitted to EPA in July 2005 (See "Determining Coefficient of Conservatism Values" [III-C-6-7a.pdf] and the accompanying Appendix A- "Virginia Wetland Plants C-Value List" [III-C-6-7b.pdf]).

(3) Quality Assurance

A Quality Management Plan (QMP) [IV-d.pdf]) and Quality Assurance Project Plan [III-C-6c.pdf] (QAPP) have been developed for the wetland assessment protocol and approved by EPA Region III. These Plans are in accordance with EPA QA/R-2 EPA requirements for Quality Management Plans and EPA QA/5 EPA Requirements for Quality Assurance Project Plans to ensure the validity of data collected.

(4) Estimated timelines

A summary of the milestones already achieved, and estimated timelines for completion of the scope of work of the EPA grants for Wetland Monitoring and Assessment Strategies is provided in the linked table titled "Wetlands Strategy Project Milestones" [III-C-6b.doc]. The "Final Wetland Monitoring and Assessment Strategy" [III-C-6d.pdf] document was submitted to EPA on December 16, 2005. Virginia's wetland monitoring and assessment program is being implemented through a cooperative agreement between DEQ's OWSP and the Center for Coastal Resources Management (CCRM) at the Virginia Institute of Marine Science using funds awarded through EPA's Wetland Program Development Grants to

continue these efforts. DEQ has received seven grant awards from EPA over the past eight years for this initiative, and Virginia is recognized as one of five states leading this initiative nationally.

For additional information related to the Wetlands Monitoring Program, consult the DEQ Wetlands WebPages [http://www.deq.virginia.gov/Programs/Water/WetlandsStreams.aspx] or contact:

David L. Davis, CPWD, PWS
Director, Office of Wetlands & Stream Protection
VA Department of Environmental Quality
629 East Main Street
PO Box 1105
Richmond, VA 23218
(804) 698-4105
Dave.davis@deq.virginia.gov

Michelle Henicheck, PWS
Senior Wetland Ecologist
VA Department of Environmental Quality
Office of Wetlands & Stream Protection
629 East Main Street
PO Box 1105
Richmond, VA 23218
(804) 698-4007
Michelle.henicheck@deq.virginia.gov