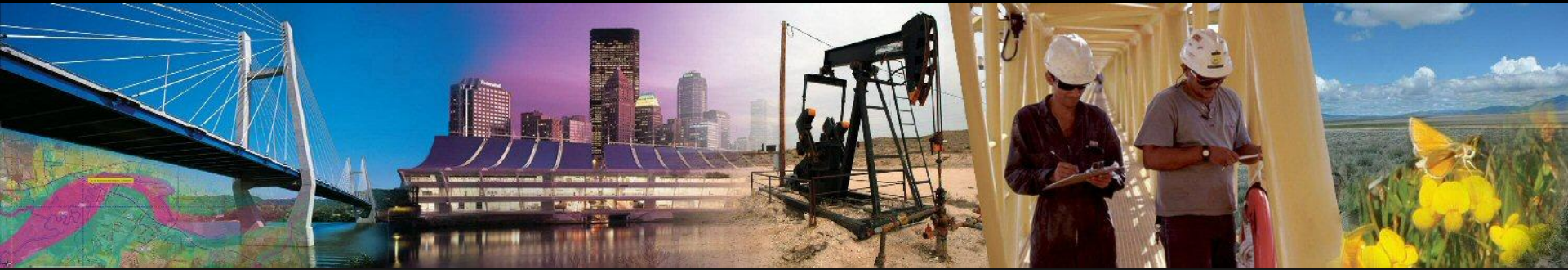


MICHAEL BAKER CORPORATION



Updated Regional Regression Equations for Estimating Peak Discharges for Maryland Streams

Wilbert O. Thomas, Jr.

Maryland Association of Floodplain and Stormwater
Managers

October 21, 2010

Linthicum, Maryland

Outline of the Presentation

- **The objectives of the presentation are to describe:**
 - The purpose of the Maryland Hydrology Panel
 - Previous accomplishments and reports of the Panel
 - Recommended hydrologic procedures for Maryland
 - Introduce the Third Edition of the Panel report
 - New regional regression equations for Maryland
 - Summary comments

Maryland Hydrology Panel

- **Hydrology Panel convened in June 1996 by Maryland State Highway Administration (SHA) and Maryland Department of Environment (MDE)**
- **Mission of the Panel was**
 - Review Maryland hydrologic practices and make recommendations concerning peak flood estimating procedures that will best serve to satisfy agency needs, Maryland laws and regulations.

Maryland Hydrology Panel

- **The Hydrology Panel was to**
 - explore the development of improved procedures that would ensure an optimal balance between preserving the environmental quality of Maryland streams and the hydraulic performance of highway drainage structures.
- **MDE had selected the NRCS TR-20 model for computing flood flows in Maryland; SHA wanted to make greater use of regional regression equations based on USGS streamgaging records**

The Maryland Hydrology Panel

- **The current Hydrology Panel consists of:**
 - Richard Berich, Private Consultant
 - Donald Woodward, retired Natural Resources Conservation Service
 - Glenn Moglen, Virginia Tech
 - William Merkel, Natural Resources Conservation Service
 - Michael Casey, George Mason University
 - Wilbert Thomas, Michael Baker, Jr.

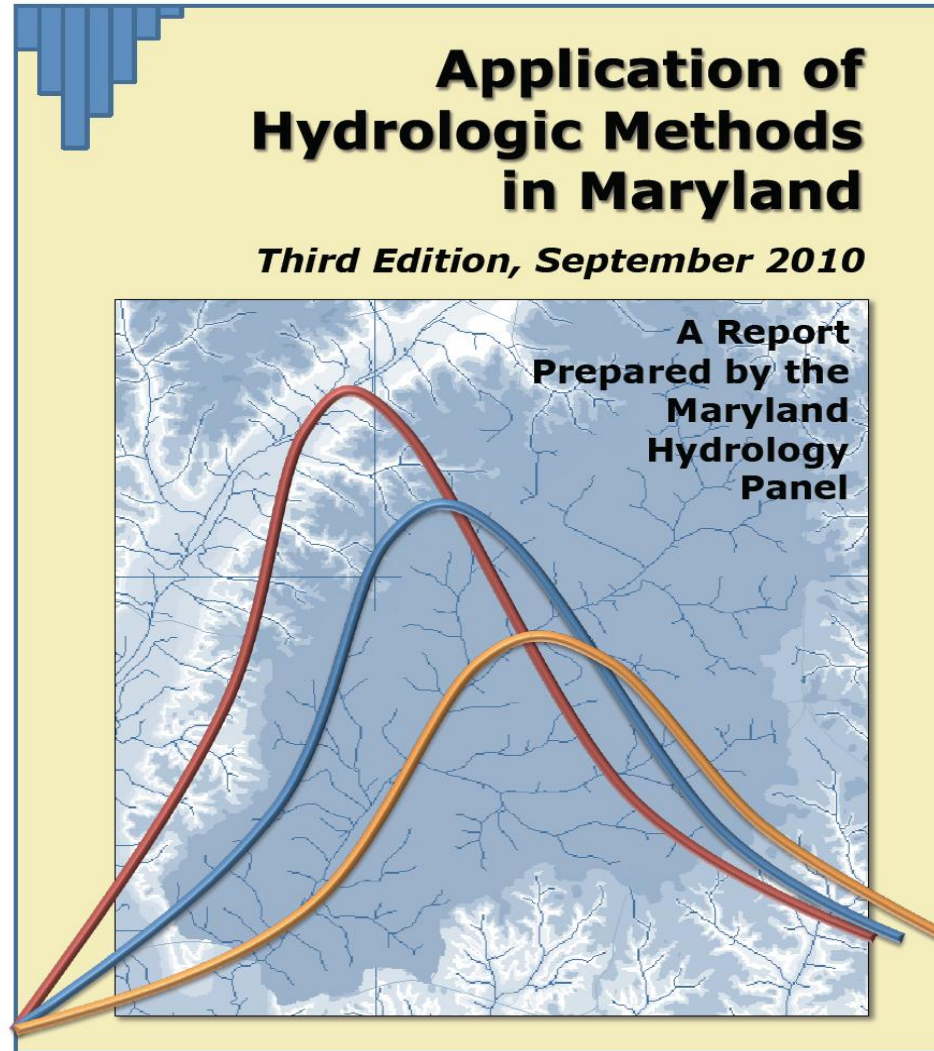
SHA represented by Andy Kosicki and Len Podell

MDE represented by Dave Guignet and others

Hydrology Panel Reports

- The Hydrology Panel previously published the following versions of the report:
Application of Hydrologic Methods in Maryland
 - *February 2001*
 - *August 2006*
- The Third Edition will be completed by the end of October 2010 and posted at:
 - <http://www.gishydro.umd.edu/panel.htm>

Third Edition of Hydrology Panel Report



Neil J. Pedersen
Administrator



Martin O'Malley, Governor

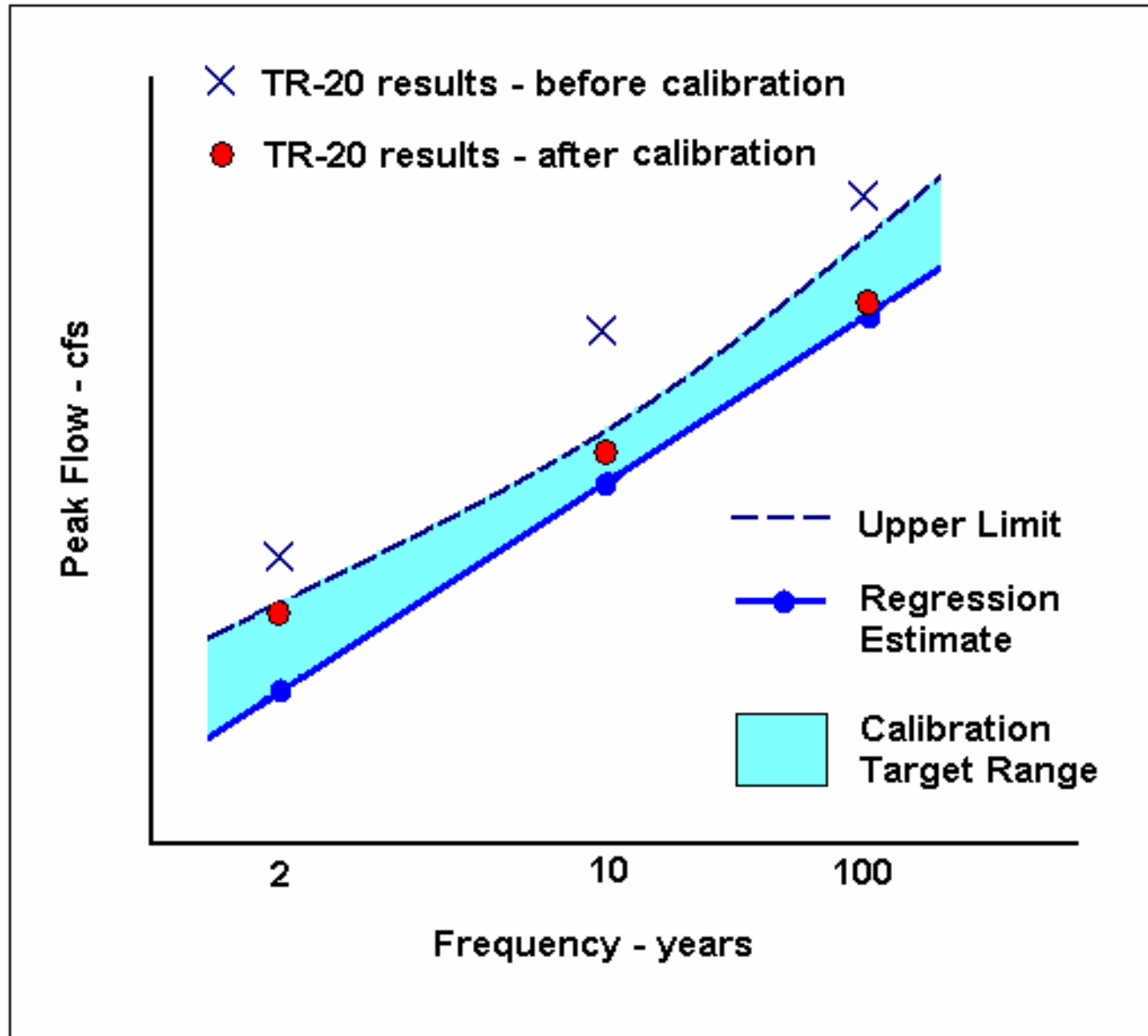


Jay G. Sakai
Director, Water Management
Administration

Hydrologic Procedures

- **In all versions of the Panel report, the recommended hydrologic procedures included:**
 - TR-20 model developed by NRCS to serve as the base method
 - Design discharges based on ultimate development
 - TR-20 “calibrated” to flood discharges estimated at USGS gaging stations or from regional regression equations

Calibration of TR-20 Model



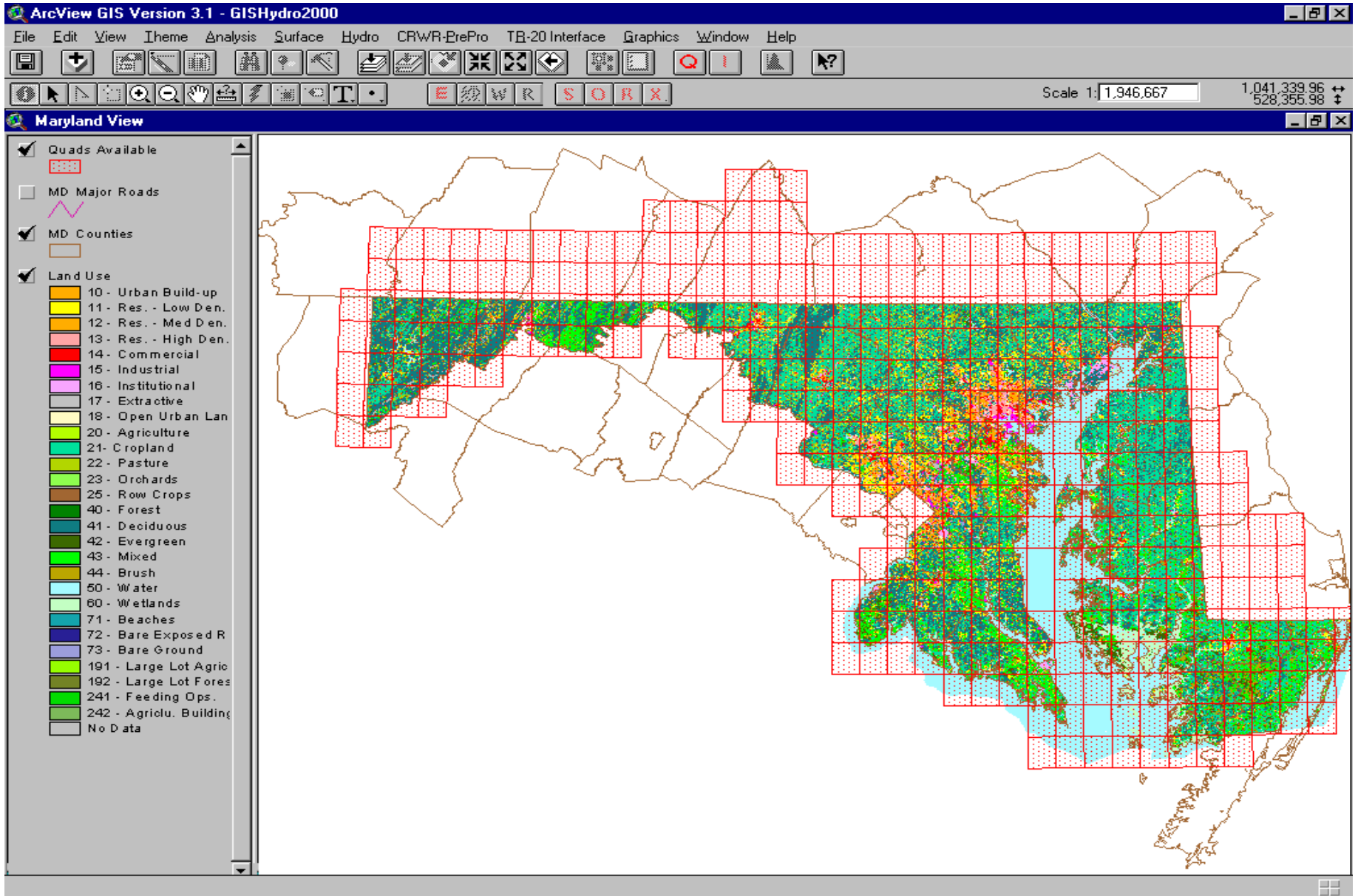
Regional Regression Equations

- **The regional regression equations used to “calibrate” TR-20 have changed over time:**
 - February 2001 report: USGS regression equations described by Dillow (1996)
<http://md.water.usgs.gov/publications/wrir-95-4154/>
 - August 2006 report: Fixed Region regression equations described by Moglen and others (2006) – a UMD Research Report
http://www.gishydro.umd.edu/documents/mdsha_reports/peakflowsfinalreport.pdf
 - September 2010 report: Fixed Region regression equations to be described in this presentation

Implementation of Hydrologic Procedures

- **TR-20 and regional regression procedures implemented within GISHydro2000 – software package developed by the University of Maryland with funding from SHA**
 - GIS software based on ArcView Version 3 that includes statewide land use, soils and topographic data
 - New version GISHydroNXT being developed based on ArcGIS 9.3.1 as ArcView version will be phased out in the future
- <http://www.gishydro.umd.edu/news/news.htm>

GISHydro2000



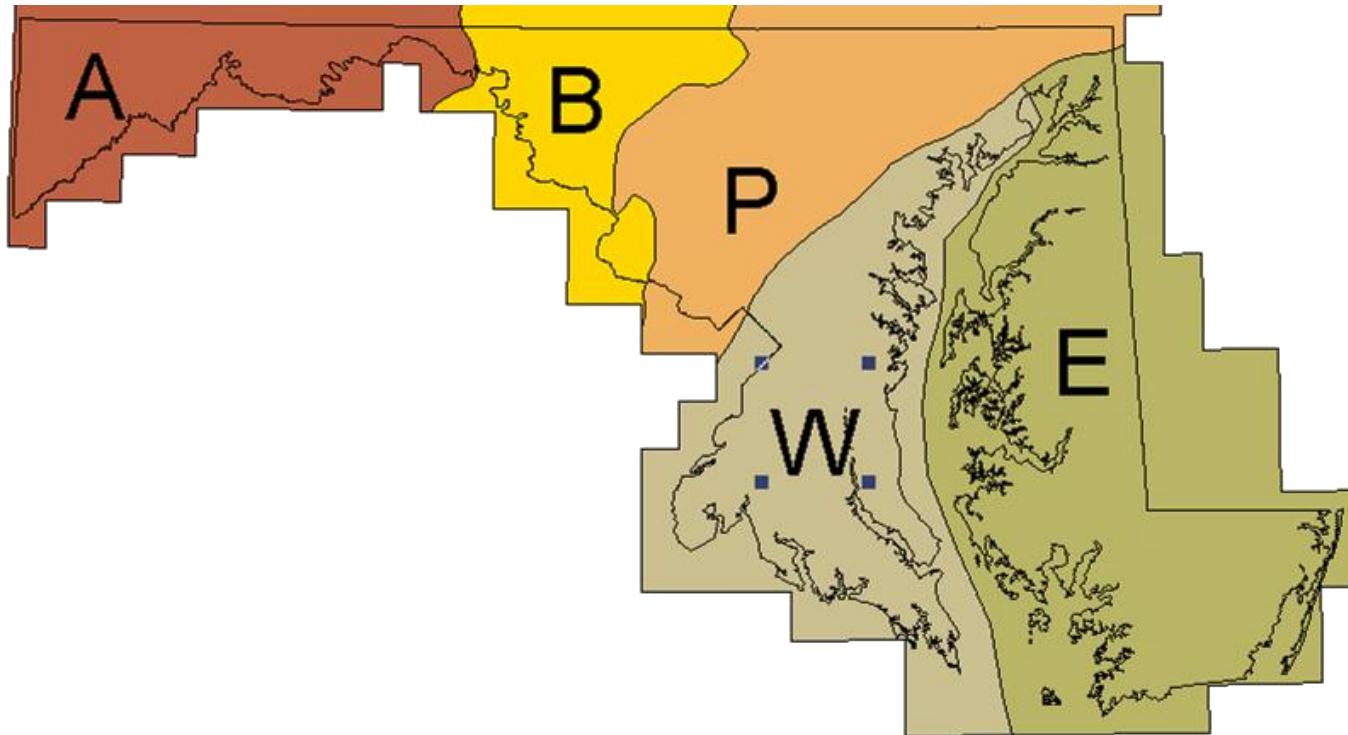
GISHydro2000

- **GISHydro2000 is available at no cost at**
 - <http://www.gishydro.umd.edu>
- **A web-based version of the software is available at**
 - <http://www.gishydro.umd.edu/web.htm>
- **Software is also available at SHA headquarters for firms performing work on state or county-funded projects by contacting Andy Kosicki at SHA**

Regional Regression Equations

- **Dillow (1996) defined five hydrologic regions (USGS WRIR 95-4154)**
- **Moglen and others (2006) evaluated the five regions and decided to use the same regions**
 - Evaluated Region of Influence, L-Moment procedures and Fixed Regions equations
 - Determined the Fixed Regions approach to be most accurate
- **Recently developed (2010) Fixed Region regression equations have combined the Piedmont and Blue Ridge Regions for rural watersheds**

Maryland's Physiographic Provinces



A = Appalachian Plateaus and Allegheny Ridges

B = Blue Ridge and Great Valley

P = Piedmont

W = Western Coastal Plain

E = Eastern Coastal Plain

Regional Regression Equations (2010)

- **Motivation for updating the Moglen and others (2006) equations for the Coastal Plain Regions was the release of SSURGO soils data by NRCS**
- **Motivation for updating the Moglen and others (2006) equations for rural watersheds in the Piedmont and Blue Ridge Regions was the development of a new limestone/carbonate rock map**

Eastern Coastal Plain Analysis

- **Regression equations updated in September 2007 after release of SSURGO soils data (2006 equations based on STATSGO soils data)**
- **Equations based on 28 stations in MD and DE with annual peak data through 2006**
- **Revised SSURGO data became available in early 2010 and used in final equations – peak flow data were not updated**

Eastern Coastal Plain (ECP) Analysis

- **The 2010 equations for ECP based on**
 - Drainage area (DA) in square miles
 - A soils (S_A) in percent of drainage area – SSURGO data
 - Land slope (LSLOPE) in ft/ft (perpendicular to channel)
- **An example of the revised equations**
 - $Q_{100} = 4433 DA^{0.812} (S_A+1)^{-0.230} LSLOPE^{0.557}$

Western Coastal Plain Analysis

- **Regression equations updated in June 2009 after release of SSURGO soils data (2006 equations based on STATSGO soils data)**
- **Equations based on 24 stations in MD with annual peak data through 2008**
- **Revised SSURGO data became available in early 2010 and used in final equations – peak flow data were not updated**

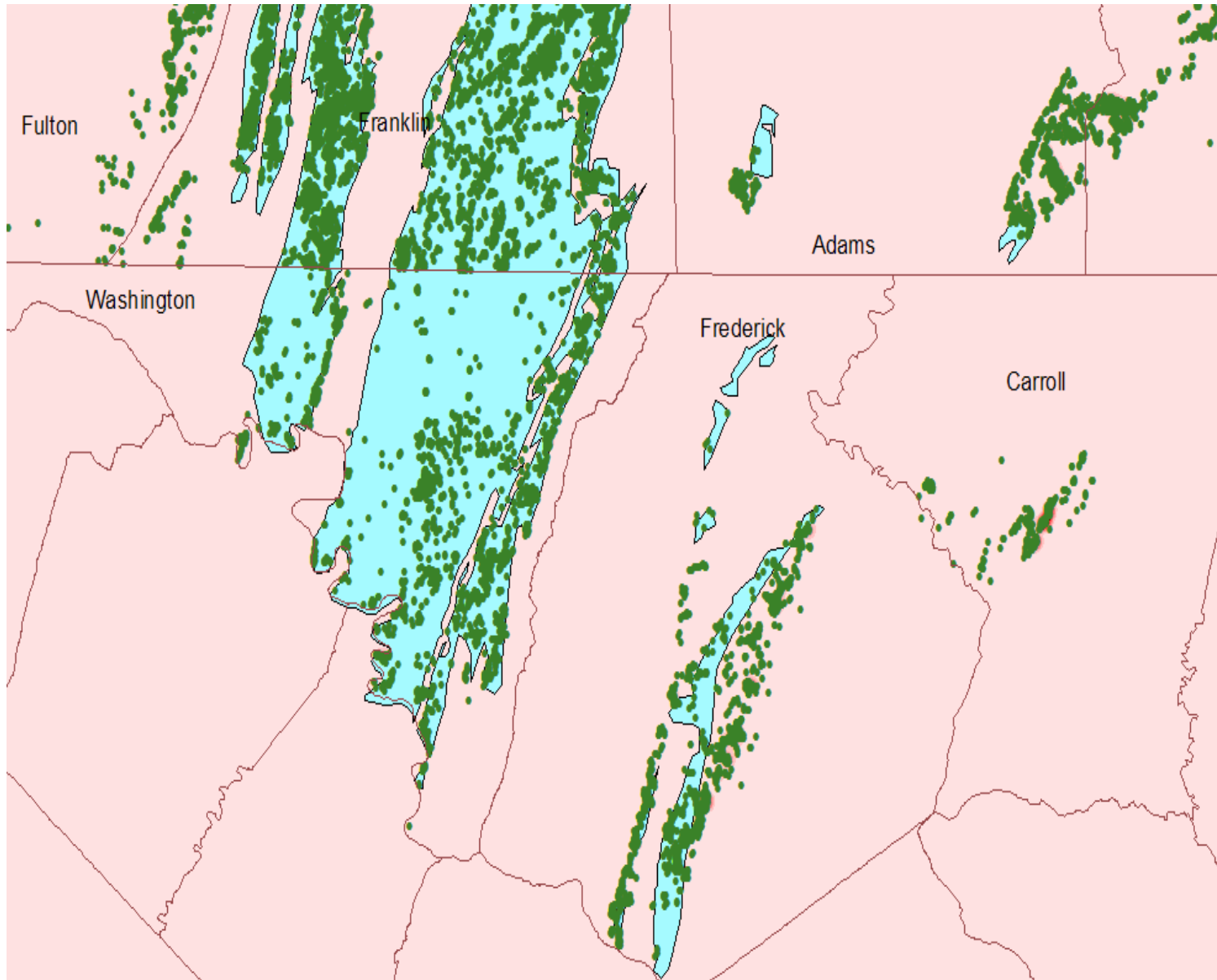
- **The 2010 equations for WCP based on**
 - Drainage area (DA) in square miles
 - Sum of C and D soils (S_{CD}) in percent of drainage area – SSURGO data
 - Impervious area (IA) in percent of drainage area

- **An example of the revised equations**
 - $Q_{100} = 25.6 DA^{0.608} (IA+1)^{0.262} (S_{CD}+1)^{0.781}$

Piedmont and Blue Ridge Analysis

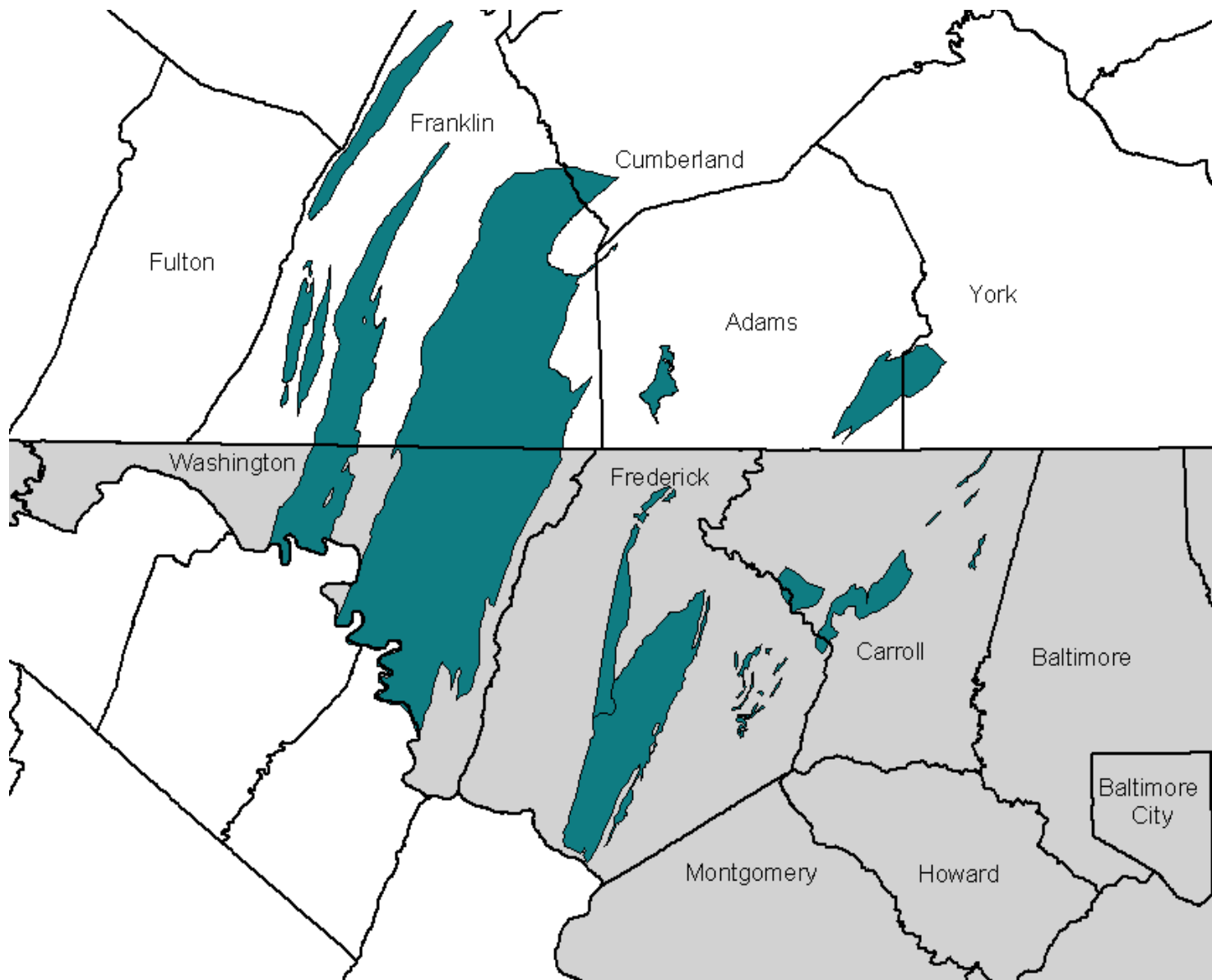
- **In an effort to improve the estimation of flood discharges in karst areas, the Hydrology Panel determined the number of sinkholes per square kilometer**
- **Data were compiled from**
 - PA Dept of Conservation and Natural Resources
 - Tom DeVillbis with Carroll County Planning Dept
 - Dave Brezinski with MD Geological Survey provided data for Frederick and Hagerstown Valley
 - Maryland Geological Survey RI 73

Sinkholes and Limestone Map from Dillow (1996)



- **Regression analyses were performed using the density of sinkholes and the percent carbonate rock**
- **The percent carbonate rock was shown to provide slightly better results**
- **The percent carbonate rock was developed from the following map developed by the Hydrology Panel**

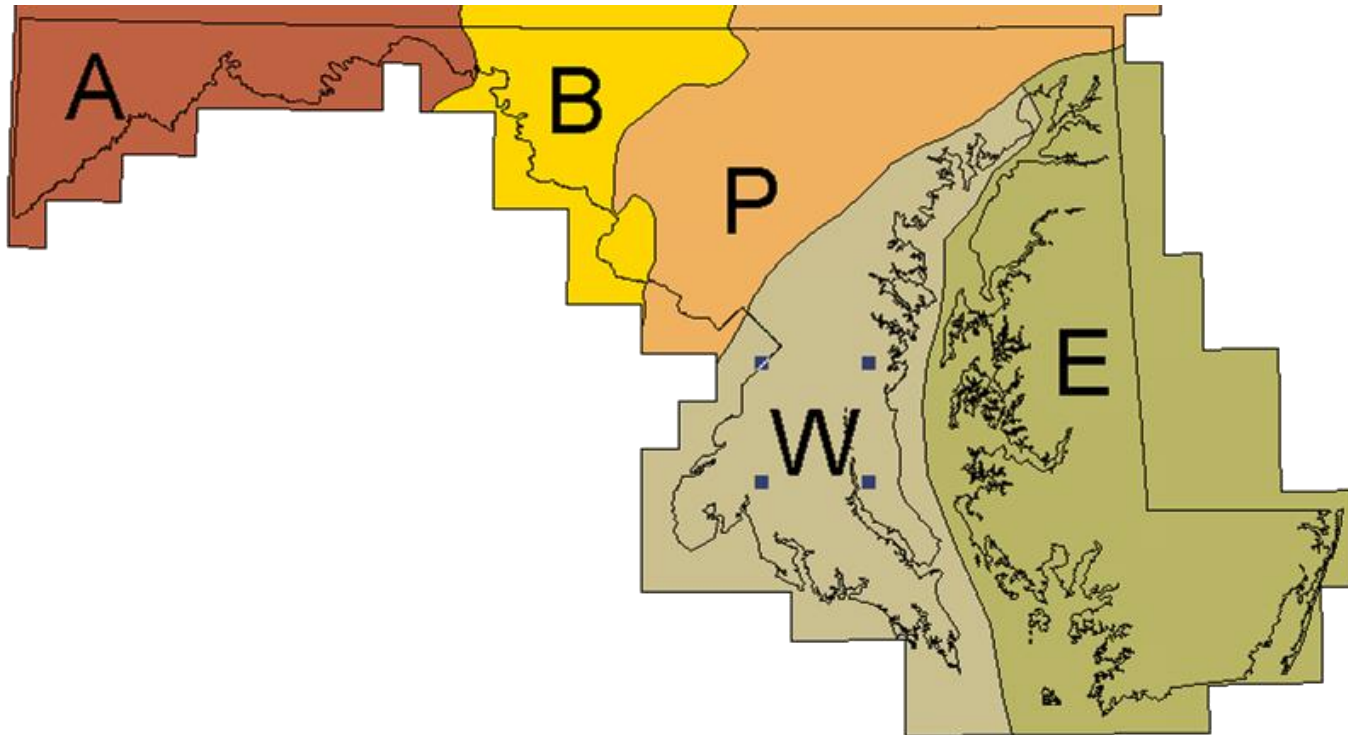
Revised Limestone/Carbonate Map (2010)



Piedmont and Blue Ridge Analysis

- **Rural stations in the Piedmont and Blue Ridge Regions were combined into a single analysis since limestone/carbonate rock is prevalent in both regions**
- **Previous analyses, Dillow (1996) and Moglen and others (2006), only used limestone data in the Blue Ridge Region**
- **53 rural stations with peak flow data through 1999 were used in 2010 analysis**

Maryland's Physiographic Provinces



A = Appalachian Plateaus and Allegheny Ridges

B = Blue Ridge and Great Valley

P = Piedmont

W = Western Coastal Plain

E = Eastern Coastal Plain

Piedmont and Blue Ridge (P&BR) Analysis

- **The 2010 rural equations for P&BR based on**
 - Drainage area (DA) in square miles
 - Limestone/carbonate rock (LIME) in percent of drainage area
 - Forest cover (FOR) in percent of drainage area
- **An example of the revised equations**
 - $Q_{100} = 1471 DA^{0.617} (LIME+1)^{-0.154} (FOR+1)^{-0.045}$

Regression Equations Not Revised

- **The urban equations for the Piedmont Region were not updated (DA and IA)**
- **The equations for the Appalachian Plateau Region were not updated (DA and LSLOPE)**
- **These equations are the same as developed by Moglen and others (2006) and given in Appendix 3 of the August 2006 Panel report**

USGS StreamStats Program

- **USGS is developing the StreamStats Program for Maryland for MDE**
- **USGS will use the regression equations developed by the Hydrology Panel in StreamStats - cite the Third Edition of the Panel report for documentation**
- **StreamStats, like GISHydro2000, is a GIS web-based application for applying regression equations**

USGS StreamStats Program

The screenshot shows the USGS StreamStats web application running in Microsoft Internet Explorer. The browser title is "USGS StreamStats - Microsoft Internet Explorer". The page header includes the USGS logo and "Idaho StreamStats Prototype".

The main map area displays a topographic map of the Pacific Northwest, with a blue polygon highlighting a specific watershed area. The map includes labels for "Seattle" and "Portland".

The toolbar above the map contains the following tools: Zoom In, Zoom Out, Pan, Get Info, Full Extent, Last Extent, Watershed Delineation, Get Statistics, Clear Polygon, and Download. On the right side of the toolbar, there are links for "NWIS Info", "Print", and "Help".

Below the toolbar, there is a "Scale" section with a scale bar and a "Zoom To:" dropdown menu set to "a water feature". Below that is an input field for "Enter Water Resource Name".

The "Map Layers" panel on the right is open, showing the following layers:

- BASE LAYERS**
 - Shaded_Relief
 - 24K QUAD Boundaries
 - Major Highways
 - Interstate
 - State Highway
 - US Highway
- WATER**
 - Water Bodies
 - Rivers
 - HUCs
 - Unavailable Area
 - Undefined Area
 - Watershed Delineation
 - Stream Gages

Buttons for "Refresh Map" and "Reset Layers" are located at the bottom of the panel.

The footer of the page includes the text: "U.S. Department of the Interior, U.S. Geological Survey", "Contact: Streamstats Help", "Accessibility | Disclaimer | Privacy", "Metadata", and "StreamStats Disclaimer".

New (2010) Regression Equations

- **New regression equations provide following improvements:**
 - Based on SSURGO soils data in the Eastern and Western Coastal Plain Regions
 - Updated flood data for the Eastern and Western Coastal Plain Regions
 - Combined regression equations for rural watersheds in Piedmont and Blue Ridge Regions provides estimates for karst watersheds in the Piedmont Region

Final Comments

- **Third edition of Panel report will be posted at <http://www.gishydro.umd.edu/panel.htm> by end of October 2010**
- **USGS will include new regression equations in their StreamStats Program**
- **New regression equations will be available in GISHydro2000 and in a standalone program (<http://www.gishydro.umd.edu/document.htm>)**