



Research Annual Report

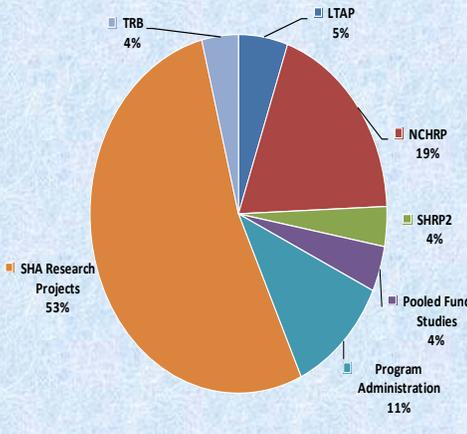
STATE PLANNING & RESEARCH PART II PROGRAM

2014 At-A-Glance

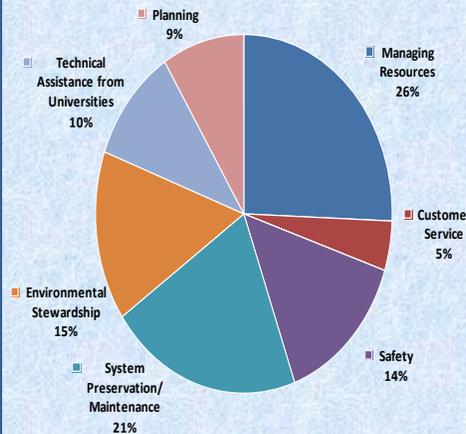
JANUARY 1, 2014 – DECEMBER 31, 2014

This report presents a summary of the Maryland State Highway Administration’s State Planning & Research (SPR) Part II Program. The funding statistics are provided for the FY 2014 Research Work Program in the following charts. The tables on pages 2 through 5 list all SHA-funded research projects by subject area that were active or completed during 2014. Two completed projects during the year are highlighted in the third section.

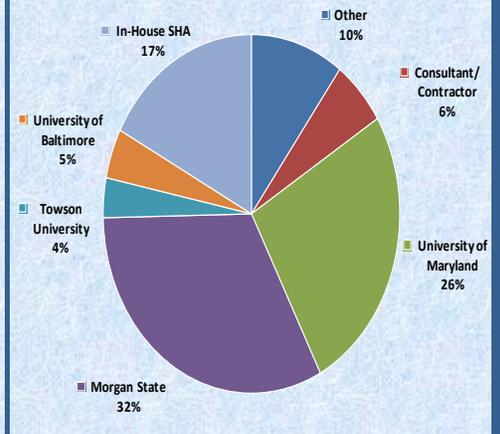
FY 2014 Funding by Project Type



FY 2014 Projects by Subject Area



FY 2014 Projects by Performing Org.



LTAP	\$ 170,000
NCHRP	\$ 600,783
SHRP2	\$ 113,785
Pooled Fund Studies	\$ 130,000
Program Administration	\$ 350,000
SHA Research Projects	\$ 1,677,000
TRB	\$ 125,870
TOTAL	\$ 3,167,438

Managing Resources	\$ 430,000
Customer Service	\$ 75,000
Safety	\$ 240,000
System Preservation/ Maintenance	\$ 350,000
Environmental Stewardship	\$ 257,000
Technical Assistance from Universities	\$ 175,000
Planning	\$ 150,000
Total	\$ 1,677,000

Other	\$ 170,000
Consultant/ Contractor	\$ 100,000
University of Maryland	\$ 440,000
Morgan State	\$ 542,000
Towson University	\$ 60,000
University of Baltimore	\$ 75,000
In-House SHA	\$ 290,000
Total	\$ 1,677,000

In addition to administering the annual Research Work Program, in 2014 the Research Division focused on providing access to SHA research reports and implemented a new request for proposals process to ensure an open and competitive process for selecting principal investigators. All SHA research reports since Year 2000 can be accessed online: <http://www.roads.maryland.gov/pages/oprreports.aspx?pageid=367>. Subscribe to [OPR's RSS feeds](#) to get notified as soon as a new report is posted on the site.

Maryland SHA 2014 Research

TABLES ARE ORGANIZED BY SUBJECT AREAS:

ABBREVIATIONS:

SHA Maryland State Highway Administration
 FHWA Federal Highway Administration
 MSU Morgan State University
 TU Towson University
 UB University of Baltimore
 UMBC University of Maryland, Baltimore County
 UMCP University of Maryland, College Park

 Cancelled research projects
 Research projects that are still active
 Completed research projects

Safety

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP409B4K	Validation and Guideline Development of Dilemma Zone Protection Systems	UMCP	Hua	FY 2014	\$140,000	25%	\$ -	
SP409B4N	Development of Local Calibration Factors for Implementing the Highway Safety Manual Phase II - study for Freeway and Ramp Applications	MSU	Hua	FY 2014	\$100,000	30%	\$ -	

Mobility/Congestion Relief

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP209B4R	Understanding CHART's Overall Effectiveness and Identification of Areas for Growth	UMCP	Hua	FY 2012	\$100,000	100%	\$ 41,444.04	
SP309B4C	Work Zone Performance Monitoring and Assessment through RITIS	UMCP	Hua	FY 2013	\$100,000	10%	\$ 70,988.16	
SP309B4F	Validation and Augmentation of INRIX Arterial Travel Time Data Using Independent Sources	UMCP	Hua	FY 2013	\$100,000	100%	\$ 87,715.75	

Planning

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP209B4P	Measuring Economic Contribution of Freight Industry to the MD Economy	MSU	Allison	FY 2012	\$100,000	100%	\$ 15,344.58	
SP309B4H	MOSAIC Phase 3: Comprehensive Model Calibration/Validation and Additional Model Enhancement	UMCP	Hua	FY 2013	\$100,000	100%	\$ 78,466.04	
SP409B4M	Estimating the Economic Impacts of Multimodal Transportation Improvements	UMCP	Hua	FY 2014	\$150,000	70%	\$ 15,140.13	

Administrative

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP409B42	Research Program Administration (with overhead)	In-House SHA	Allison	FY 2014	\$350,000	100%	\$236,442.15	

System Preservation/Maintenance

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP009B4M	Determining Sinkhole Susceptibility for the Hagerstown Valley: Phase II	Other	Allison	FY 2010	\$136,924	100%	\$ 43,840.00	X
SP209B4H	Geotechnical and Environmental Impacts of Steel and Blast Furnace Slag Use in Highway Construction	UMCP	Hua	FY 2012	\$95,000	100%	\$ 34,986.34	
SP309B4E	Durability Assessment of Prefabricated Bridge Elements and Systems	MSU	Sharon	FY 2013	\$100,000	90%	\$ 73,290.88	
SP309B4R	Effective Implementation of Ground Penetrating Radar (GPR) for Condition Assessment & Monitoring of Critical Infrastructure Components	UMCP	Hua	FY 2013	\$100,000	100%	\$ 83,057.36	X
SP409B45	LTPP Maryland Performance Data Collection/Monitoring	In-House SHA	Allison	FY 2014	\$30,000	100%	\$ 21,280.77	
SP409B4F	Validation of Source approval of HMA Surface Mix Aggregates using	MSU	Sharon	FY 2014	\$110,000	20%	\$ 419.47	
SP409B4G	Stormwater Infiltration Potential (SIP)/Site Characterization using NASA Public Domain Imagery	MSU	Sharon	FY 2014	\$110,000	30%	\$ -	
SP409B4J	Precision monitoring of bridge deck curvature change during replacement	UMCP	Sharon	FY 2014	\$100,000	60%	\$ 31,968.44	

Customer Service

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP309B4K	Survey on the Public's Perception of Freight Movement in Maryland by all Transportation Modes	UB	Allison	FY 2013	\$75,000	100%	\$ -	
SP409B4C	External Customer Survey	UB	Allison	FY 2014	\$75,000	100%	\$ -	

Environmental Stewardship

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP209B4S	Sustainable Landscaping Practices for Enhancing Vegetation	UMBC	Sharon	FY 2012	\$100,000	40%	\$ 5,630.05	
SP309B4J	Evaluation of Reclaimed (Recycle) Concrete Aggregate (RCA) Road Materials for Use in Oyster Aquaculture: Phase 2 - Field Testing	MSU	Hua	FY 2013	\$98,000	100%	\$ 30,310.30	
SP309B4N	Informing Nest Site Restoration for the Endangered Northern Map Turtle	TU	Sharon	FY 2013	\$56,000	90%	\$ 13,558.20	
SP309B4S	Evaluating Channel Degradation of Maryland Streams (Phase III)	Consultant/Contractor	Hua	FY 2013	\$100,000	100%	\$ 47,978.59	
SP309B4T	Bog Turtle Population Assessment - Added to Program on 04/18/13	TU	Sharon	FY 2013	\$15,000	100%	\$ -	
SP409B4D	Are outbreaks of emerging pathogens correlated with construction of wetlands?	TU	Sharon	FY 2014	\$60,000	90%	\$ 24,678.02	
SP409B4E	Evaluation of Waste Concrete Road Materials For Use In Oyster Aquaculture Phase III: Restoration Scale Applications	MSU	Hua	FY 2014	\$97,000	5%	\$ -	
SP409B4H	Evaluating Channel Degradation of Maryland Streams (Phase III- Part 2)	Consultant/Contractor	Hua	FY 2014	\$100,000	10%	\$ -	

Managing Resources

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP309B4D	Updated Regression Equations for Piedmont and Western Maryland	Consultant/Contractor	Hua	FY 2013	\$100,000	100%	\$ 53,756.37	
SP309B4G	Stainless Steel Prestressing Strands and Reinforcing bars for Use in Concrete Structural Elements	MSU	Sharon	FY 2013	\$60,000	90%	\$ 31,937.55	
SP309B4M	Serviceability-related Issues for Bridge Live Load Deflection and Construction Closure Pours	UMCP	Hua	FY 2013	\$99,080	85%	\$ 33,666.74	
SP409B44	Evaluation of Experimental Features	In-House SHA	Allison	FY 2014	\$80,000	100%	\$ 40,461.76	
SP409B46	Technology Transfer Program	Other	Allison	FY 2014	\$50,000	80%	\$ 45,707.50	
SP409B47	New Products Evaluation	In-House SHA	Allison	FY 2014	\$80,000	100%	\$ 65,801.51	
SP409B48	Implementation of Research Findings	In-House SHA	Allison	FY 2014	\$100,000	80%	\$ -	

Technical Assistance from Universities

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP309B48	University of Maryland Technical Assistance	UMCP	Allison	FY 2013	\$75,000	100%	\$ -	
SP309B49	Morgan State Technical Assistance	MSU	Allison	FY 2013	\$75,000	100%	\$ 41,534.91	
SP309B4A	Support For UTC Research	UMCP, MSU	Allison	FY 2013	\$100,000	100%	\$ -	
SP409B49	Morgan State Summer Internship Program	MSU	Sharon	FY 2014	\$75,000	100%	\$ -	
SP409B4A	Support For UTC Research	UMCP, MSU	Allison	FY 2014	\$100,000	50%	\$ 1,340.23	

National Initiatives

Project Number	Project Title	Performing Organization	Research Manager	Work Program	Funding	% Complete as of 12/31/2014	FY 2014 Expenditures	Spotlight
SP409B41	Local Technical Assistance Program (LTAP)	UMCP	Allison	FY 2014	\$170,000	100%	\$171,340.23	
SP409B43	TRB Technical Activities Service	Other	Allison	FY 2014	\$125,870	100%	\$118,725.00	
NCHRP	National Cooperative Highway Research Program	Other	Allison	FY 2014	\$600,783	100%	\$603,000.88	
SHRP2	SHRP2 Implementation	Other	Allison	FY 2014	\$113,785	100%	\$426,180.00	
SP409B4B	AASHTO Technical Services Programs	Other	Allison	FY 2014	\$120,000	100%	\$ 94,200.00	

Transportation Pooled Fund Studies

Project Number	Project Title	Lead Agency	Research Manager	Work Program	Funding	Transfer Completed?	FY 2014 Expenditures	Spotlight
TPF-5(054)	MDSS	SD	Sharon	FY 2014	\$25,000	Y	\$25,000	
TPF-5(065)	Traffic Control Device (participation revisited on annual basis)	FHWA	Sharon	FY 2014	\$10,000	Y	\$10,000	
TPF-5(099)	Evaluation of Low Cost Safety Improvements (participation revisited on	FHWA	Sharon	FY 2014	\$30,000	Y	\$30,000	
TPF-5(198)	Urban Mobility Study	TX	Sharon	FY 2014	\$25,000	Y	\$25,000	
TPF-5(279)	High Performance Computational Fluid Dynamics (CFD) Modeling Services for Highway Hydraulics (1st year of a 3-year commitment)	FHWA	Sharon	FY 2014	\$15,000	Y	\$15,000	
TPF-5(285)	Standardizing the Lightweight Deflectometer (LWD) equipment for measuring the Modulus/Stiffness of Unbounded Soils and Aggregate tool as Compaction Quality Assurance Measures (QA) (2nd year of a 2 year commitment)	MD	Sharon	FY 2014	\$25,000	Y	\$25,000	

2014 Research Highlights

SP309B4R – EFFECTIVE IMPLEMENTATION OF GROUND PENETRATING RADAR (GPR) FOR CONDITION ASSESSMENT & MONITORING OF CRITICAL INFRASTRUCTURE COMPONENTS OF BRIDGES AND HIGHWAYS

In 2013 the Maryland State Highway Administration (SHA) started to explore use of Ground Penetrating Radar (GPR) technology to provide quantitative information for improved decision making and reduced operating costs. To take full advantage of the GPR capabilities, improved analysis techniques need to be developed and implemented.

The objective of this study was to assist SHA engineers, technicians, and decision makers with exploring the use of GPR in the condition assessment of critical infrastructure components and identifying potential improvements in GPR data analysis. The research team closely interacted with representatives from selected divisions of the Office of Materials Technology (OMT) to identify potential GPR applications using existing equipment accessible to SHA, targeting critical high priority areas for analysis and improvement. The project team (i) identified applications for the GPR equipment currently accessible to SHA, (ii) identified a broader set of GPR applications for monitoring the spatial and functional conditions of infrastructure components, and provided recommendations of alternative equipment, when needed, (iii) developed improved analysis methods for GPR data collected for bridge decks, pavements and precast concrete elements, (iv) developed testing protocols, to be incorporated into the Maryland Standard Method of Test (MSMT) Manual, and (v) training modules.

In regards to pavement structures, a new methodology was suggested to improve the accuracy of GPR data analysis. The initial analysis and results indicated that Multi-scale Pavement GPR data Analysis (MPGA) has significant potential to add value and accuracy to pavement thickness data used in pavement management and rehabilitation analysis. The MPGA results indicate that pavement thickness data trends can be identified based on either automated or semi-automated procedures based on target variability levels of thickness uniformity, and thus can be used to efficiently evaluate pavement material layers.

Similarly, for bridge deck analysis, techniques such as migration imaging (for concrete cover depth measurement applications among others) and Fourier analysis of GPR waveforms (for qualitative bridge deck moisture analysis) were used in addition to emerging techniques such as Short Time Fourier Transform analysis (for anticipated quantitative moisture analysis) for improving GPR data interpretation. Migration and Fourier techniques were illustrated corresponding to GPR data collected using a GPR array on selected bridge decks in the Salisbury, MD area (See Figures 1 and 2). When applied appropriately, such techniques can provide more reliable analysis of bridge deck inspection than conventional means.

In terms of precast concrete, this study has shown how GPR can be used to address several of the inspections needed in precast concrete production, including an evaluation of concrete cover depth, reinforcement location, and section thicknesses. The testing and demonstration showed significant potential for quality control using GPR.

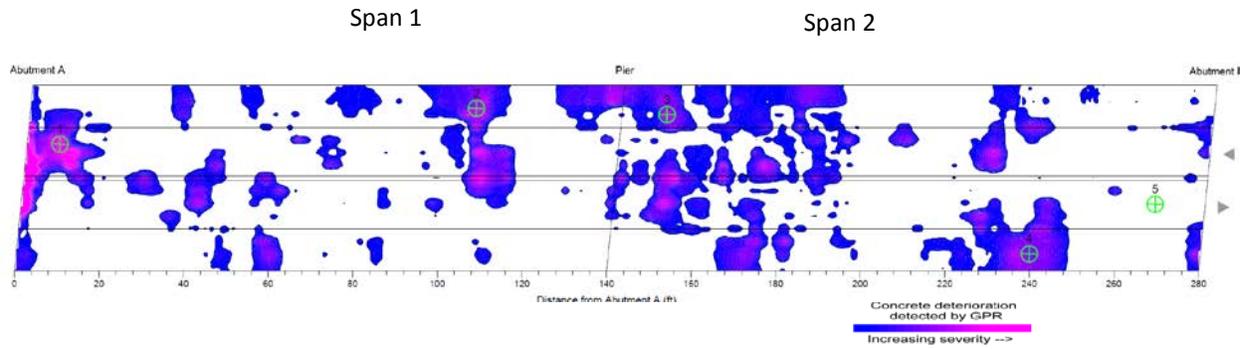


Figure 1: Structure Rebar Surface Level Results

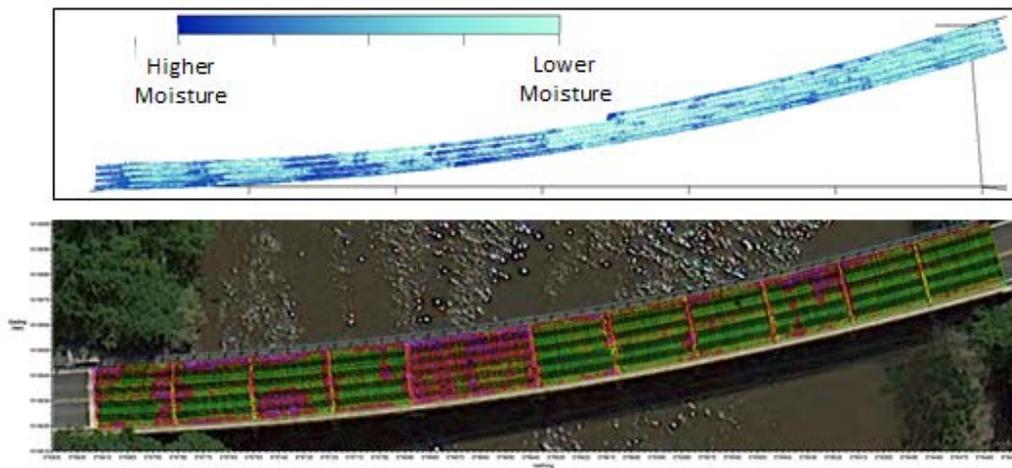


Figure 2: Route 290 Over Chester River Migration Results - Moisture

The expected benefits of the GPR based condition assessment techniques include: i) higher precision and accuracy of the condition assessment of key infrastructure components and materials; ii) higher speed of condition assessment and reduced monitoring time and cost; iii) increased accuracy in locating material failures; iv) improving overall condition assessment methods and more accurate performance and life cycle predictions; v) facilitating a method of non-destructive testing for Quality Assurance testing and forensic investigations.

Link to the final report: http://www.roads.maryland.gov/OPR_Research/MD-15-SHA-UM-3-11_GPR-Phase1_Report.pdf

SP009B4M – GEOLOGY AND SINKHOLE DEVELOPMENT OF THE HAGERSTOWN VALLEY: PHASE II

Areas underlain by carbonate rocks such as limestone, marble, and dolomite are prone to sinkholes because ground-water can cause them to dissolve over time. This dissolution of bedrock produces distinctive topographic features that characterize what is known as karst terrane. While karst terranes are present to some degree in all areas underlain by all carbonate rocks, they develop at varying levels based on changes in the chemical makeup and geologic structure of the bedrock. It is therefore impossible to characterize or predict the distribution, type, abundance, or size of karst features in any particular terrane without first assembling data and evaluating the distribution of mapped bedrock units, their intrinsic geologic structure, and proximity to major hydrologic features such as streams or rivers. In addition to geologic factors, the activities of humans, such as road construction and housing development can have a significant impact on the development of karst features. Unlined drainage and stormwater runoff ponds are key human factors that affect sinkhole development. Because these factors are commonly employed in highway projects and the Hagerstown Valley is susceptible to sinkhole development, the State Highway Administration (SHA) was interested in developing a better understanding of the geological and topographic factors in the region.

The objective of this study was to map the western half of the Hagerstown Valley to determine the distribution of karst features relative to bedrock geologic units using a global positioning system (GPS). Four types of karst features were identified: depressions, active sinkholes, karst springs, and caves. The figure below illustrates these features.

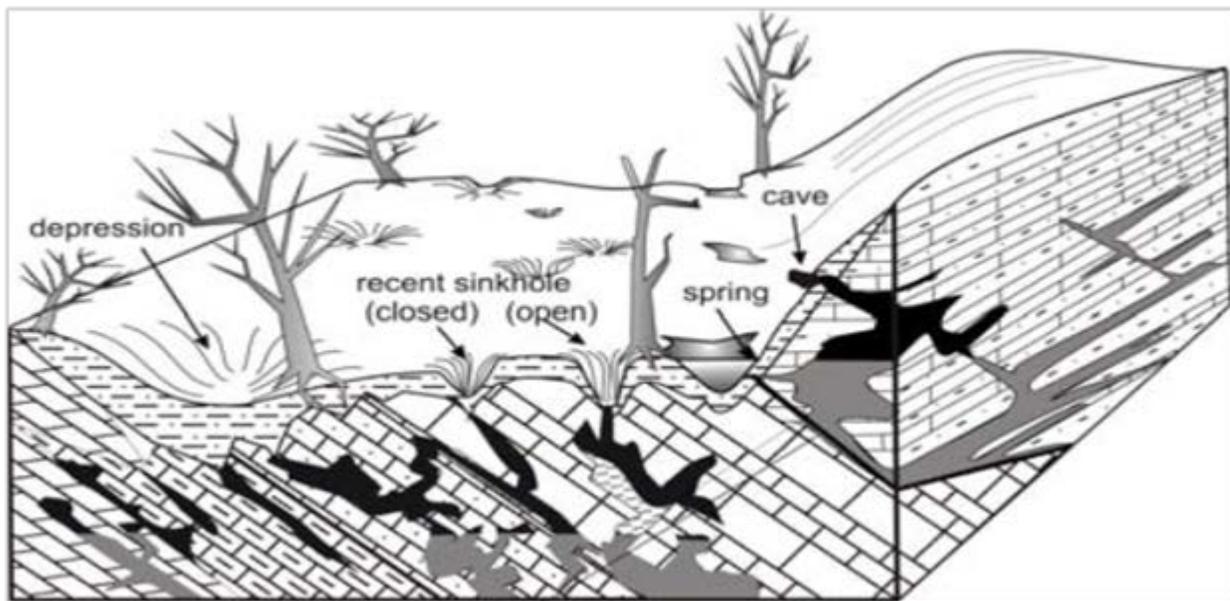


Figure 3: Four types of karst features: depressions, active sinkholes, karst springs, and caves

More than 2,100 karst features were identified and located during the geologic mapping of the Hagerstown, Mason-Dixon, Shepherdstown, Clear Spring, and Hedgesville quadrangles. These geographic areas were canvassed during geologic field mapping, and definable karst features were precisely located and identified utilizing a GPS receiver. In some circumstances features that could not be entered because of property permission constraints, were located by calculating the azimuth (i.e. the angle formed between a reference direction, typically north, and a line from the observer to the point of interest), and then the distance was delineated using a laser range finder. In addition to the geographic coordinates, data acquired at each location included the karst feature type, bedrock unit identification, presence or absence of Quaternary deposits that

might cover the feature, and other possibly significant characteristics, such as location in a drainage lowland, drainage ditch, or stormwater management reservoir.

The following observations were made in this study: (1) there is a generally identifiable relationship between the type of karst feature and the bedrock units; (2) in addition to bedrock composition, joints and faults appear to have played important roles in the development of the karst systems in the area; (3) preliminary findings suggest the impact of human activity on karst development is less pronounced than in the Frederick Valley; and (4) unlined drainage appear to be just as frequent culprits in sinkhole activity as they are in the Frederick Valley. Likewise, areas surrounding quarries and stormwater runoff ponds are common sites of sinkhole development.

SHA's Office of Materials Technology (OMT) will refer to the maps developed in this study when conducting construction and access permits reviews. The reviews will help determine the following:

- If the access permit site is on a carbonate rock and whether stormwater facilities will require impermeable lining systems;
- If construction projects are in carbonate rock areas and the relative density of karst activity;
- The potential need to include sinkhole remediation and/or subsurface grouting in contract document provisions; and
- The potential need for on-site geophysical surveys for karst conditions.

OMT will also refer to the maps to reference geologic karst activity prior to site visits. The GPS locations for new sinkholes will be provided to the Maryland Geological Survey as they are identified.

Link to the final report: http://www.roads.maryland.gov/OPR_Research/MD-14-SP009B4M_Geology-and-Sinkhole-Mapping-Of-The-Hagerstown-Valley-Phase-II_Final-Report.pdf

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To access SHA research reports: <http://www.roads.maryland.gov/pages/oprreports.aspx?pageid=367>

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