Summary – Stream Information Exchange
Fine Sediment and the Chesapeake Bay Watershed Workshop

<u>Introduction to the Workshop</u>

Maryland's Department of Natural Resources recognized that the public is losing faith in the Bay Program and our ability to meet our Chesapeake Bay restoration goals. We have a last opportunity to garner the support and confidence of the public. Maryland is working to show and prove actual measurable progress, using a statistics tracking program similar to one used in Baltimore.

The goal is to focus limited funds on what has been identified as the most useful strategies to control sediment, but it has been very difficult to achieve consensus in the scientific community. The charge of this workshop is to come to consensus on the best advice that will be useful now to make improvements.

The workshop organizers put forth a charge to the workshop attendees, to report on what are the key knowledge gaps in watershed sediment modeling, monitoring and assessment. Attendees were asked what are the most effective BMPs for reducing fine sediment loads to the Bay, and asked if we knew enough to promote large investments in particular BMPs. This was a meeting of applied science, to look at what we know and don't know about soil erosion, transport, and fate. We know that history matters (i.e. historical treatment of the land), location matters (is the erosion happening in the mountains or coastal plain?), and timing matters (large storms and debris flows). The challenge is how do we incorporate these? There is a "restoration industry" that is blossoming now, and a real clamor to fix problems now. Are we as a scientific and policy community able to answer these applied science questions? Do we really know what will work yet? Have we worked enough to learn from our past actions – is science really up to this?

Interestingly, the Rivanna River Basin Commission Task Force recently asked itself the same questions as it considered the best methods for tackling sedimentation in the Rivanna River watershed. So, decision makers at the local level are asking the same questions as the leaders in NPS science and policy development are asking about the Bay's watershed, showing that we're on par with leaders in the profession. It's energizing that we are asking the same questions, but at the same time disconcerting that the best and brightest minds are still unsure about how to meet the goals we've set for ourselves.

<u>Speaker – Lewis Linker – Chesapeake Bay Program Modeling Coordinator</u>

Made it clear that now working on the TMDL for the Bay, which is simply interesting because our language has now shifted from Tributary Strategies to TMDL given the fact that we have missed our goals. Indicated that estimates are that we need 185,000 acres of SAV restored, but the Tributary Strategies (which were aggressive) would only yield about 135,000 acres. Shows that there is a gap between numbers of BMPs that were in the Trib Strategies and what may come out of the TMDL.

<u>Speaker – David Montgomery, author of Dirt: The Erosion of Civilizations.</u>

A rich mix of history, archaeology and geology, Dirt traces the role of soil use and abuse in the history of Mesopotamia, Ancient Greece, the Roman Empire, China, European colonialism, Central America, and the American push westward. We see how soil has shaped us and we have shaped soil—as society after society has risen, prospered, and plowed through a natural endowment of fertile dirt. David R. Montgomery sees in the recent rise of organic and no-till farming the hope for a new agricultural revolution that might help us avoid the fate of previous civilizations.

Montgomery stresses the fact in restoration work, context is the most important factor. His premise is that the natural system was a balance between soil production and soil erosion. Many folks attribute widespread deforestation to the demise of our soil structure, but it is plow, not the axe that brought down civilizations by farming in a way that was unsustainable.

<u>Speakers Dorothy Merritts – Franklin and Marshall College; Dr. Richard Vogel – Tufts University</u>
Merritts spoke on dam breaching and resulting sediment movement, and Vogel spoke on understanding the ability of a river system to carry sediment and implications for restoration projects. These speakers illuminated how unpredictable sediment transport and modeling can be – sediment sources and sinks within the stream systems vary spatially and temporally. Sediment loads are always more variable than streamflow, and don't have a linear relationship.

<u>Speaker Jonathan Phillips – University of Kentucky</u>
Challenged the steady state equilibrium sediment flux concept – that sediment yield balances sediment production within a watershed. This concept is often considered the state that streams are either in naturally or that try to revert to when hydrology has been altered. Job of the river is to simply redistribute water by moving it from higher elevations to lower elevations. The transport of sediment is merely a secondary result of this primary job. So, if we try to assume a steady state equilibrium in our models then we are making this secondary result the actual driver of our river design. Erosion is a natural process and places like the Grand Canyon are proof that not everything operates in that steady state. Phillips stresses that stability and instability will always exist at some time – there will always be transition from aggrading to degrading, and the steady state is not the norm.

<u>Speaker Andrew Miller – University of MD – Baltimore</u>
Was the first speaker, but not the last, to indicate that erosion from headwater streams in the Bay watershed may not often be a sediment load that reaches the Bay. There is now a question about the cost effectiveness of promoting stream restoration further up in the watershed as a BMP for sediment reduction in the Bay. We don't understand enough yet about the role of floodplain storage and retention as sediment sinks or sediment sources.

<u>Speakers John Brakebill – USGS; Gary Shenk – Chesapeake Bay Program</u>
Brakebill summarized the USGS SPARROW model, which stands for Spatially Referenced Regressions on Watershed Attributes. The model is a tool to try to achieve a comprehensive understanding of the long term steady state of sediment supply and transport in the Bay watershed. It predicts sediment origin and fate, and is based on a river reach network with associated watersheds at a 1:500 scale. Inputs include mean

annual flows and velocities, mean annual flux and water quality. It can spatially assign sediment generation; and it attempts to tell how much sediment is generated from land sources and how much is really reaching the Bay. Results have shown that the highest sediment yields are from urban development and that in-stream sources of sediment are significant for stream above the fall line. The shortcoming of the model is that it is not as useful on a smaller scale – would need more precise spatial and temporal data to provide the variability to be useful on that smaller scale.

Shenk described the new Phase 5.0 Bay Program watershed model, which will be used (in conjunction with the other Bay models) to develop the Bay's TMDL, and will ultimately provide jurisdictional load allocations for nutrients and sediment. Past work has used the Phase 4.3 model. This model predicts changes in flow to derive sediments yield – same basic concept as SPARROW. SPARROW is used in conjunction with the Bay model to allocate loads. An important component of the model is its land use classifications which determine source load. The Phase 5 model will have 25 land use classifications (4.3 only had 9) to refine the data. The model only looks at land sources, not instream sources, because that's what Bay Program could put BMPs on and model reductions. But, Shenk did indicate that perhaps 15-20% of sediment reaching the Bay could come from in-stream sources. The basic model structure is an edge of field delivery, to which is added a BMP factor. The Phase 5 is improved in that it does take into account now the loss of BMP efficiency over time and in large storms. Those attributes are applied to the land use type and acreage, a delivery factor, then edge of stream and in-stream delivery. My own thought is that it is safe to assume that the more accurate the Bay model becomes, the more reductions will need to be achieved throughout the watershed.

<u>Speakers Cliff Hupp- USGS; Gregory Noe - USGS</u>
Hupp discussed the role of floodplain trapping and storage of sediment. In understanding overall load to the Bay, floodplain trapping and releasing of sediment certainly plays a role. However, the retention time and remobilization of trapped sediment is still poorly understood, so we're still unable to really predict this sediment budget. Trapping in the floodplain usually exceeds predicted yield, so it can be a sink and protects downstream reaches. But, the degree of the sink, whether it eventually becomes a significant source is still unknown and needs to be further researched.

Noe addressed sediment and nutrient retention in floodplains, specifically looking at cycling rates and % of retention. While retention of nutrients in one study points to 25% nitrogen and 60% phosphorus, the study also showed 120% retention of the stream loading of sediment, suggesting the floodplain can be a large sink.

<u>Speakers Scott Eaton – James Madison University; Paul Bierman – University of Vermont; Milan Pavich - USGS</u>
Eaton spoke on large debris flows and mass movements in relation to sediment loading downstream. Example of large scale debris flows are from Camille in Nelson County and a 1995 storm in Madison County. His research is trying to determine if debris flows are significant factor in the process of moving sediment, how frequent they are, how

much sediment is moved, and how fast uplands are really eroding. His research has concluded there is evidence of previous mass movements over geologic time, and that the frequency of these large movements is every 2500 to 3500 years, and that the overall landscape is lowered 2-5 cm in each event. Like other speakers, Eaton explained that they do not yet understand sediment residence time in floodplains, and how much is really making it to the Coastal Plain.

Bierman addressed his research on what the background amount of sediment is that has been fluxing through the system to the Bay. Background erosion is highest in the mountainous area, but is less in the Piedmont and Coastal Plain. Background erosion can be 10-20 meters per million years overall, and background sediment generation (loading) can be 30-40 tons per square kilometer per year. By comparison, construction projects can generate 250-400 tons per square kilometer per year, which can be reduced to 150 tons with best management practices.

Pavich discussed the concept of yo-yo tectonics as a sediment source – glacioisostatic cycles are a major driver of landscape change. Rivers are actually minor sources of sediment whereas marine sources due to subsidence of a "forebulge" and resulting rise sea level could be major source.

Speaker Jim Pizzuto – University of Delaware

Pizzuto reported that we really need an improved conceptual model for East Coast river systems to be able to predict geomorphic changes. Stressed that need gaging stations for sediment to be able to measure actual flux throughout the system. His research on the South River in the Shenandoah Valley shows that while the river cannot be described as in an equilibrium state, it reflects little geomorphic change over time. This particular system is a sediment transport system; where the sediment is not changing morphology. This points to the lack of consensus/understanding about sediment movement through our streams. Many speakers have challenged the notion that streams in the uplands are merely transportation systems for sediment to the Coastal Plain, while this presentation seems to uphold that notion. However, this research is in the Valley, and the system is bedrock with an alluvial cover, and not in the Piedmont.

Speaker Lee Currey – MD Department of the Environment; Tom Schueler – Chesapeake Stormwater Network

Currey discussed Maryland's approach to benthic stream impairments caused by sediment. Since there isn't a water quality standard for sediment, it is difficult to know how to determine the maximum load. It is very difficult to estimate sources, and the real relationship between sediment quantity and the viability of a benthic community is unknown. In an attempt to establish a target, a reference reach approach was used – streams with healthy benthic communities were found, but the TSS/SS rates were not very different from the impaired reaches so that comparison did not work. The revised approach attempts to quantify how much of the reference reach watershed is forested and utilize that in developing the TMDL. This is similar to the Rivanna River Basin Commission's focus on altered hydrology as the cause of sediment – how can the watershed replicate a forest function, rather than focusing on specific overland sources of sediment.

Schueler's discussion also support this, as he indicates that in Maryland most sediment is coming from channel enlargement in streams due to altered hydrology and the stream's reaction to that. Therefore the solution should be more focused on low impact development ideas where infiltration and replicating forest function are an integral part of land management.

<u>Conclusions</u>
The discussions revealed that much progress has been made in understanding the origins, transport, and fate of sediment, but consensus for immediate tools to make quantifiable progress towards improving Bay goals is not yet formed. For our local situation, the research and conclusions presented generally support our hypotheses and strategies for understanding and addressing our local sediment issues in the Rivanna watershed. However, we could, as can the whole Bay watershed, benefit greatly from the empirical data derived in subwatersheds through application and monitoring of specific BMPs in defined situations.