Geomorphology Group Briefing Paper

South River Science Team Expert Meeting, October 18-19, 2005

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During the last year, the work of the Geomorphology Group has focused on the following two hypotheses:

1. Bank erosion represents a significant source of Hg to the river channel.
2. Hg associated with silt and clay, after being introduced into the channel, will be stored for "significant" periods of time at "characterisic locations" within the wetted perimeter of the stream.

We also surmise that storage of Hg associated with fine-grained sediments within the wetted perimeter of the stream channel provides opportunities for methylation that lead to increased levels of Hg in fish, although we are not working on evaluating this hypothesis directly.

Our results to date lead us to the following provisional conclusions:

1. Although bank erosion rates on South River are low compared to many rivers of similar size and geomorphic setting, bank erosion is pervasive, and eroding bank sediments often have high Hg concentrations.
2. Preliminary estimates suggest that bank erosion is a quantitatively significant source of fine-grained sediment to the stream, possibly accounting for around 5-10% of the annual suspended load.
3. Significant deposits of fine-grained sediment occur within the wetted perimeter along the channel margins. These "channel margin mud deposits" are nearly all associated with accumulations of "large woody debris".
4. At least one fine-grained deposit has *very* high Hg concentrations, with values up to 600 ppm.

Our approach to date has focused on quantifying components of an annual sediment budget for the reach from the plant at Waynesboro to Crimora (Figure 1). This approach allows us to assess the relative significance of all sources of silt and clay to the stream and its alluvial valley. It also provides two other important ingredients: a historical perspective (because sediment inputs must be evaluated over time) and an appreciation of processes and mechanics of erosion, deposition, and transport. Understanding the processes that create sediment budget components is important, because it leads to the ability to forecast future trends in fine-grained sediment transport and associated Hg concentrations under natural or engineered conditions along the river.

During the final 8 months of our project, we propose two primary tasks, each of which involves several inter-related components:

1. Finalize fine-grained sediment budget estimates for a typical year for the reach from the plant at Waynesboro to Crimora (termed the "upstream" reach).
2. Selectively sample the reach from Crimora to Port Republic (the "downstream reach") to determine if the fine-grained sediment budget in this reach differs significantly from that of the reach upstream.

Detailed work plans for each of these two tasks will be presented at the Expert Meeting. To finalize the fine-grained sediment budget for the upstream reach, we propose 1) very selective sampling of floodplain deposits, 2) continued historical analysis of bank erosion and channel migration using aerial photographs, 3) sampling of fine-grained sediment stored in the gravel bed of the stream, and 4) a detailed geochronological study of sediment cores obtained from fine-grained channel margin deposits. The coring program will require analyses of Pb-210, Cs-137, Hg, grain size, and organic content from selected cores, as well as related analyses of suspended sediments of the stream. Parallel analyses will also be needed in selected upland sites unaffected by erosion or deposition, so that atmospheric deposition rates of nuclides can be determined. If the geochronological studies proceed as planned, they will provide information on the ages of the fine-grained channel margin deposits as well as the frequency and extent of reworking by storm flows.

We would also like to propose additional studies that would extend beyond June 30, 2005. These studies are designed 1) to increase our understanding of the ***processes*** controlling the production, movement and storage of fine-grained sediment, and 2) to lead to methods that allow ***forecasting*** and ***prediction*** of the timing and spatial patterns of fine-grained sediment transport, erosion, and deposition in the study reach, under natural or "engineered" conditions that may arise in the future. Specifically, we propose studies to:

1. Determine the processes and variables that control the rates and patterns of bank erosion from Waynesboro to Port Republic, leading to the ability to quantify and predict bank erosion under a variety of scenarios;
2. Quantify rates of deposition and erosion of fine-grained sediment within the wetted perimeter of the stream channel, since these processes partly control the residence time of Hg supplied by bank erosion to the stream channel.

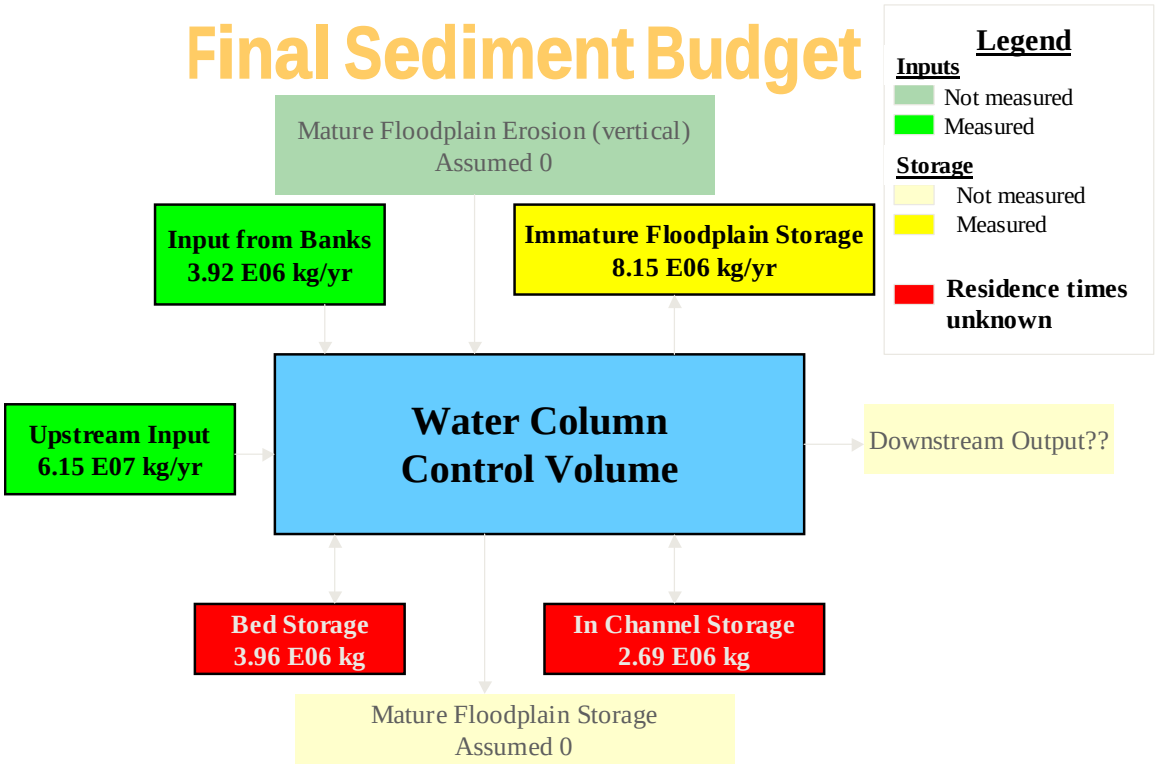

Figure 1. Provisional annual fine-grained (silt and clay) sediment budget for the South River between Waynesboro and Crimora. Note that upstream inputs and bank erosion are expressed as rates, whereas bed and channel storage are expressed as volumes.