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# Sediment transport and particulate-sorbed contaminant redistribution pathways in alluvial rivers and streams

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## Summary

Contaminants that enter alluvial rivers and streams can have severe consequences to water quality and ecosystem health. Historical and present-day contaminants can enter the riverine environment through various mechanisms and can be subsequently transported downstream in the dissolved or particulate-sorbed phase (i.e., sorbed to stream sediments). The transport of particulate-sorbed contaminants is dependent upon numerous interactions between stream hydraulics, sediment transport and the morphology of the river system. Their ability to be transported downstream, eroded from stream bed and banks, and deposited in the riverine environment results in immense complexity in predicting their movement and location. Understanding these processes and their interactions is particularly important for contaminated site characterization and implementation of effective and appropriate remediation measures.

## Background and theory

As illustrated in Figure 1, contaminants can enter rivers and streams through various mechanisms, including: 1) groundwater surface-water interactions in the hyporheic zone; 2) overland transport from runoff processes in the watershed; and 3) erosion of the stream bed and banks. After entering the river, contaminants in the particulate-sorbed phase can be readily transported downstream. In addition, particulate-sorbed sediments can also be transported from the stream to the floodplain areas during periods of higher discharge (e.g., flood events). Once in the riverine system, transport of sediment-sorbed contaminants is influenced by sediment transport processes and the morphological conditions in the stream.

Sediment transport and morphological adjustments in alluvial rivers and streams are affected by numerous processes. These include hydraulic factors that influence velocity distribution and shear stresses and hydrologic factors in the watershed that affect the rainfall-runoff response and flow regimes. Geologic factors and substrate conditions are also known to affect sediment transport and morphological adjustments through the planform morphology of the stream and the grain size distribution of the stream sediment, respectively. Sediment transport processes result in consideration erosion and deposition in the stream, which includes expansion and migration of planform morphology of the stream (e.g., changes in the meandering pattern) and development and migration of bed forms (e.g., dunes and ripples).

Assessing the interaction between hydraulics and sediment transport processes is required in order to predict morphological responses, assess stream stability, estimate erosion rates in the river, and understand and predict the transport and behavior of particulate-sorbed contaminants. While various model equations exist to assess sediment transport and stream morphological adjustments, site-specific factors (namely, unsteady and non-uniform hydraulic conditions, complex planform morphology and non-uniform stream beds) add considerable complexity to these processes and limit their application in real-world applications.

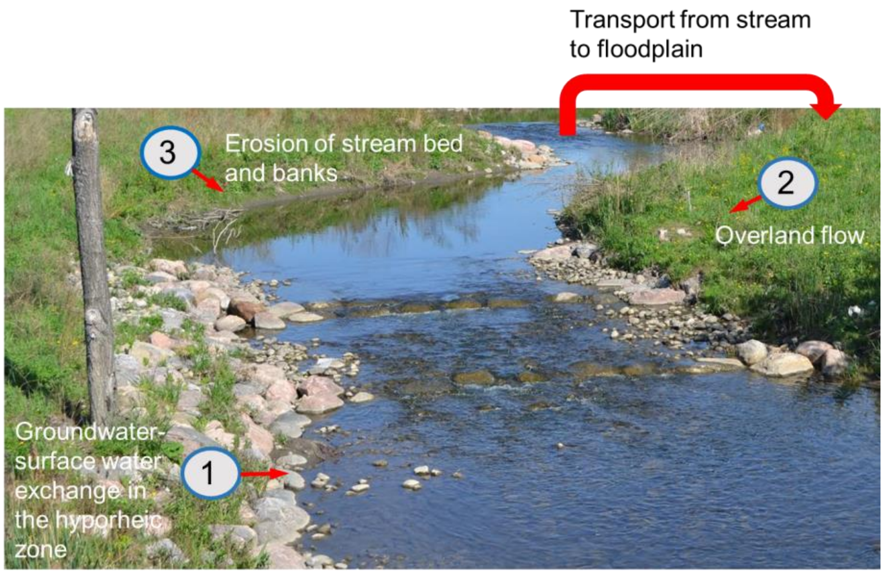


**Figure 1:** Mechanisms and pathways for contaminants to enter the riverine environment

## Results

For site characterization and implementation of effective remediation measures it is necessary to understand the full complexity of these factors that occur in nature. Recent laboratory and field research has sought to further the understanding of how sediment (and thus, particulate-sorbed contaminants) is transported under complex hydraulic, hydrologic and morphologic conditions (see, e.g., Binns and da Silva 2009, 2011, 2015; Elkurdy and Binns 2018). Considering this, this work seeks to characterize and quantify the influence of these factors on sediment transport and particulate-sorbed contaminant redistribution pathways in riverine environments. From this knowledge, conceptual models of particulate-sorbed contaminant migration in rivers and streams can be developed that will lead to better short-and long-term particle tracking capabilities, a greater understanding of the morphological processes in rivers and streams, and improved management and remediation of contaminated riverine environments.

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