Introduction

Historical mercury (Hg) releases occurred at a textile manufacturing facility on the South River, Virginia, resulting in increased Hg concentrations in biotic and abiotic media, which have not declined over the past thirty years, as originally expected. Effective remediation of the Hg contamination requires a clear understanding of migration, and complete exposure pathways. This model is further complicated by the unique nature of the biogeochemical fate of Hg in the environment, along with the relationships of discrete linkages among abiotic and biotic elements. Any remedy must also include a robust monitoring program, informed by data collected along these pathways. As such, good quality empirical data are essential to document whether or not remedial objectives are met.

Approach

- Over the past decade, numerous scientific studies have collected comprehensive empirical data on Hg pathways of the aquatic food web of the South River (Table 1)
- These data were used to develop a conceptual site model (CSM) for the South River food web (Figure 1)
- Remedial alternatives were selected to address the key sources of Hg loading (i.e. eroding bank soils) to reduce Hg exposure in aquatic and terrestrial receptors
- Short-term Monitoring (STM) i.e., (0-10 years) and Long-term Monitoring (LTM), i.e., (10+ years) programs have been established to evaluate remedy efficacy and system response to remediation in an adaptive management framework (Figure 2)

Historical Studies

- Tissue burden and uptake studies characterized Hg concentrations in biotic and abiotic media (Table 1, Figure 3)
- Diet, stable isotope, and Hg bioaccumulation studies identified Hg transport pathways in the aquatic food web (Table 1, Figure 4, Figure 5)

Table 1: Historical Studies

<table>
<thead>
<tr>
<th>Type of Study</th>
<th>Sample</th>
<th>Size Range (mm)</th>
<th>Date</th>
<th>Location</th>
<th>Hg Concentration (μg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tissue Burden Study</td>
<td>Fish</td>
<td>80-109</td>
<td>2014</td>
<td>South River</td>
<td>121-140</td>
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<tr>
<td>Uptake Study</td>
<td>Periphyton</td>
<td>171-190</td>
<td>2015</td>
<td>South River</td>
<td>141-170</td>
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<tr>
<td>Stable Isotope Studies</td>
<td>Earthworms</td>
<td>180-244</td>
<td>2016</td>
<td>South River</td>
<td>161-180</td>
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<tr>
<td>Bioaccumulation Studies</td>
<td>Fish</td>
<td>221-245</td>
<td>2017</td>
<td>South River</td>
<td>241-265</td>
</tr>
</tbody>
</table>

Figure 3: Historical Sample Collection A) Fish Tissue

Figure 4: Smallmouth Bass Stomach Contents

Figure 5: Smallmouth Bass Food Model

Long-term Monitoring Results and Discussion

- Baseline LTM data is consistent with historical datasets, which formed the basis of the CSM and remediation strategy (Figure 6 and 7)
- Robust monitoring program designed to detect reductions in Hg loading across different spatial and temporal scales
- Adaptive management framework used to inform remedial decision-making and future monitoring

Figure 6: Historical / Baseline LTM Data – Aquatic Receptors

Figure 7: Historical / Baseline LTM Data – Human Exposure