State of the Art in the USA

Sediment Remediation: U.S. Focus on Capping and Monitored Natural Recovery

Fourth International Battelle Conference on Remediation of Contaminated Sediments

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Abstract

The Battelle Conferences series represent the state-of-the-art of emerging technologies, science and management issues for contaminated sediment remediation. In the 2007 Conference held in Savannah, GA, two in situ technologies for cleanup sites were at the centre of interest: Sediment capping, a form of in situ containment, which involves the placement of a subaqueous covering of clean sediment and/or other materials to isolate contaminated sediments, and monitored natural recovery (MNR), where natural processes are used to mitigate the transfer of particle-bound contaminants into the water phase and/or biota. A third priority technology in the Superfund program, recommended by the U.S. Environmental Protection Agency (EPA), is environmental dredging, i.e., removing the sediments from the aquatic environment.

About 30 platform or poster presentations dealt with in situ capping as a technology, reflecting the rapid developments in this field, both in assessments and enhancements of ‘classic’ passive caps and the development and demonstration of active capping technologies. Issues relevant to monitored natural recovery were spread throughout many sessions; e.g., contaminant source identification, control, remediation strategies; innovative characterization and assessment, chemical/toxicological/biological measurements and characterization, bioavailability of contaminants, contaminant fate and transport and remediation effectiveness: defining, monitoring, and demonstrating success.

Presentations addressing the role of science and stakeholder input were complemented by discussions on the importance of data quality considerations, uncertainty analysis, and careful selection of reference sites highlighted the complex nature of these multidisciplinary assessments. Case studies, in which site-specific information was linked to regional management objectives, various approaches to watershed-scale assessment and management, and the role of ecosystem considerations, were all discussed in these sessions, as well as in a complementary panel discussion.

One compelling feature of the Savannah Conference 2007 (relative to the first couple of meetings) is that there were a much larger number of presentations that provided the tools, models, case studies, etc to fill in the lines of evidence that allow a fair comparison between removal and in situ management when appropriate, and evidence of a growing acceptance that the residuals and impacts of removal approaches can at times offset perceived benefits, so that in situ management can be considered if exposure risk can be properly assessed.

Keywords: Environmental dredging; monitored natural recovery (MNR); sediment capping; sediment remediation; USA

Introduction

The 310 platform and poster presentations of the 4th Conference on Remediation of Contaminated Sediments, held in Savannah, Georgia, January 22–25, 2007 represented the state-of-the-art of emerging technologies, science and management issues for contaminated sediment remediation. Extensive involvement of representatives of the US EPA, and the US Department of Defence ensured that current and emerging US policy and guidance on the subject was highlighted as well. Although the majority of presenters were from the United States, sediment experts in government, academia and industry throughout the world provided an international flavour, and allowed for some comparison of different approaches in different regions.

1 Treatment of Dredged Material vs. Remediation of Contaminated Sediments

While there are exceptions to every rule, the field of contaminated sediment management can be divided into two general categories, largely defined by the purpose for which they are being examined. The first, construction or navigational dredging, generally involves the assessment and removal of large volumes of sediment. Assessment is carried out to address the risks of resuspension through dredging, disposal, beneficial uses and/or treatment options. The second type of sediment management, hotspot or environmental cleanup of contaminated sediments, generally addresses smaller volumes of sediment, though there are notable exceptions such as industrial megasites. These sediments become the target of investigation when a spill, survey, toxic effect or historical record flags them as potentially posing a risk to human health, fisheries or the environment. Site conditions are important in determining which remediation techniques (and combinations thereof) are appropriate (National Research Council 2007). Assessment of such sediments can focus on absolute and relative risk, as well as risks of in-place vs. removal options (Apitz and Power 2002).

2 Developments in Contaminated Sediment Management

Internationally, sediment management issues are highly politicized and often newsworthy. Not surprisingly, given the complex environmental issues and the enormous potential costs, in some cases, the decision process can be very adversarial. In the early 1990’s, regulators (and most site owners) thought that removal and treatment of contami-
minated sediments would be the remedy of choice, most sedi-
ment-related research and development (R&D), in North
America and Europe pursued technologies to support such
an approach. However, based upon potential volumes and
projected treatment costs, estimated potential costs of the
indiscriminate use of such an approach are prohibitive. An
increasing use of comparative risk assessments (CRA) that
consider all risks of a remedial option, including those of
removal, residuals, treatment, transport and disposal, pro-
vides a body of evidence which suggests that sediment re-
moval can at times result in more human health risk and
ecological damage (Wenning et al.), or, after great expense,
not show measurable ecological improvement (Thibodeaux
et al. 1999). Thus, there is growing acceptance that large
volumes of contaminated sediments will be managed in place.
There continue, however, to be gaps in our knowledge of
the fate of contaminants in place, and the effects of in place
and ex situ remedial strategies, which must be filled if man-
agement strategies are to be compared and chosen wisely
(Apitz et al. 2005a).

3 U.S. EPA Priority Technologies for Remediation of
Contaminated Sediments

The majority of contributions to this conference series re-
lated to sediment remediation technologies from U.S. com-
panies and institutions reflect the development under the
Environmental Protection Agency since 1991 (e.g., USEPA
'Contaminated Sediment Remediation Guidance for Haz-
ardous Waste Sites' (USEPA 2005), the currently mature and
available management strategies for contaminated sediments
(not dredged material) are dredging, capping, and monitored
natural recovery (MNR). In 2004, the US EPA decided to
take action to clean up contaminated sediment at approxi-
mately 140 sites, including federal facilities, under the Com-
prehensive Environmental Response, Compensation, and
Liability Act (CERCLA, commonly known as Superfund)
and additional sites under the Resource and Recovery Act
(RCRA). Many other sites are being cleaned up under state
authorities, other federal authorities, or as voluntary actions
(USEPA 2005). Capping, either alone or in combination with
removal and/or MNR, is planned or has been implemented
at about 40 sediment remediation projects in the United
States, whereas MNR as a primary remedy, or in combina-
tion, is a component of about 28 projects in the United States.
In spite of the above, however, both capping and MNR con-
tinue to be ‘a harder sell’ as the remedy of choice for regula-
tory agencies and the public because the contaminants are
left in place (Zeller et al. 2005, Zeller & Cushing 2006;
Table 1). As a result, greater emphasis is placed on demon-
strating effectiveness than is typically done at a removal site,
even if many of these actions may just move contaminants
and their associated risks to other sites and systems.

This overview of the main meeting themes follows the order
of major themes in the 2007 Proceedings (editors: Eric A.
Foote and Gregory S. Durell, Battelle, Columbus/OH; ISBN
978-1-57477-159-6, compact disc format): A – Character-
ization, Assessment, and Monitoring; B – Sediment Proces-
ses and Modelling; C – Management and Policy; D – Reme-
diation, Restoration, and Treatment; E – Regional Studies.
In the following text, author names of the 2007 conference
papers are in italics and are marked with * in the selected
references.

A. Characterization, Assessment and Monitoring

The use of ecological risk assessment (ERA) to determine
whether sites present a risk that requires remedial action is
now well-established, in North America, and is increasingly
used in Europe. A number of authors presented case studies
on the evaluation of human and ecological risk assessment

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Monitored Natural Recovery</th>
<th>In situ Capping</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Site Characteristics</td>
<td>• Anticipated land uses or new structures are not incompatible with natural recovery</td>
<td>• Suitable types and quantities of cap material are available</td>
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<td></td>
<td>• Natural recovery processes have a reasonable degree of certainty to continue at rates that will contain, destroy, or reduce the bioavailability or toxicity of contaminants with an acceptable time frame</td>
<td>• Anticipated infrastructure needs (e.g., piers, pilings, buried cables) are compatible with cap</td>
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<td>• Water depth is adequate to accommodate cap with anticipated uses (e.g., navigation, flood control)</td>
<td>• Expected human exposure is low and/or reasonably controlled by institutional controls (ICs)</td>
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<tr>
<td>Human and Ecological Environment</td>
<td>• Expected human exposure is low and/or reasonably controlled by institutional controls (ICs)</td>
<td>• Expected human exposure is substantial and not well-controlled by ICs</td>
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<td></td>
<td>• Site includes sensitive, unique environments that could be irreversibly damaged by capping or dredging</td>
<td>• Long-term risk reduction outweighs habitat disruption, and/or habitat improvements are provided by the cap</td>
</tr>
<tr>
<td>Hydrodynamic Conditions</td>
<td>• Deposition of sediment is occurring in the areas of contamination</td>
<td>• Hydrodynamic conditions are not likely to compromise cap or can be accommodated in design</td>
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<td></td>
<td>• Hydrodynamic conditions (e.g., floods, ice scour) are not likely to compromise natural recovery</td>
<td>• Rates of ground water flow in cap area are low and not likely to increase unacceptable contaminant releases</td>
</tr>
<tr>
<td>Sediment Characteristics</td>
<td>• Sediment is resistant to resuspension (e.g., cohesive or well-armoured sediment)</td>
<td>• Sediment has sufficient strength to support cap (e.g. has high density/low water content)</td>
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<tr>
<td>Contaminant Characteristics</td>
<td>• Contaminants readily biodegrade or transform to lower toxicity forms</td>
<td>• Contaminants have low rates of flux through cap</td>
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<td></td>
<td>• Contaminant concentrations are low and cover diffuse areas</td>
<td>• Contamination covers contiguous areas (e.g., to simplify capping)</td>
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