San Jacinto River Waste Pits Superfund Site

Comments
of
International Paper Company
and
McGinnes Industrial Maintenance Corporation
on
Environmental Protection Agency Region 6
Proposed Remedial Action Plan

Appendix A

Review of Proposed Remedial Action Plan
for
San Jacinto Waste Pits Superfund Site
by
Michael R. Palermo, PhD, PE

January 12, 2017

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Contents

1 Introduction

1.1 Background

I have been asked to provide comments on the Proposed Remedial Action Plan (PRAP) for the San Jacinto Waste Pits Superfund Site (Site). This report provides my comments on both the PRAP and the Final Interim Feasibility Study (Final Interim FS) for the Site, focusing primarily on a comparison of the technical aspects of potential capping/ containment and excavation/ dredging remedy approaches for the Site.

1.2 Qualifications

I am a consulting engineer with experience in Dredged Material Management and Contaminated Sediment Remediation since 1974, serving both private sector and government clients. I was employed as a civilian with the U.S. Army Corps of Engineers (USACE) from 1967 to 2003. While with the USACE, I served as a Civil Engineer with the Vicksburg District and as a Research Civil Engineer and Director of the Center for Contaminated Sediments at the Engineer Research and Development Center (ERDC) at the Waterways Experiment Station (WES), where I managed and conducted both research and applied studies for the USACE, the United States Environmental Protection Agency (EPA), Department of Justice, National Oceanic and Atmospheric Administration, U.S. Navy, and others. Since entering private practice in 2003, I have provided design services, technical review and oversight for clients, both in the U.S. and abroad, on a wide range of sediment remediation and navigation projects to include major Superfund sites such as the Hudson River, Housatonic River, Fox River, Portland Harbor, Onondaga Lake, and Gowanus Canal sites.

I received Bachelor of Science (BS) and Master of Science (MS) degrees in Civil Engineering from Mississippi State University and a PhD degree in Environmental and Water Resources Engineering from Vanderbilt University. I am a Registered Professional Engineer (Mississippi and North Carolina) and a member of the Western Dredging Association (WEDA) and the American Society of Civil Engineers (ASCE). I have served on the adjunct faculty at Texas A&M University and Mississippi State University. I also serve as Associate Editor for the Journal of Dredging Engineering, a peer-review publication of WEDA.

I have authored or co-authored well over 200 publications in the area of dredging and dredged material disposal technology and remediation of contaminated sediments. These include the 2005 EPA *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, commonly known as the "Superfund Sediment Guidance", the 1998 EPA *Guidance for In-Situ Subaqueous Capping of Contaminated Sediment*, the 2008 USACE/EPA *Technical Guidelines for Environmental Dredging of Contaminated Sediments*, and *Sediment Dredging, Treatment, and Disposal* in the 2014 SERDP and ESTCP Remediation Technology Monograph *Processes, Assessment, and Remediation of Contaminated Sediments*. My experience base regarding environmental dredging, subaqueous capping, sediment management, and sediment remediation spans four decades.

My full CV is included as Appendix A to this report.

1.3 Summary of Site Conditions and Waste Characteristics

The Site consists of impoundments built in the mid-1960s for the disposal of solid and liquid pulp and paper mill wastes and the surrounding areas containing sediments and soils impacted by the waste materials disposed in the impoundments. The Site investigation has included (1) a northern set of impoundments (Northern Impoundments) approximately 14 acres in size, located on the San Jacinto River, north of the Interstate-10 (I-10) Bridge and (2) the southern impoundment (Southern Impoundment) less than 20 acres in size and located on a small peninsula that extends south of I-10. In 2011, the Northern Impoundments were the subject of a Time Critical Removal Action (TCRA) involving the construction of a cap over the Northern Impoundments. The wastes are contaminated with polychlorinated dibenzo-p-dioxins (dioxins) and polychlorinated dibenzofurans (furans). The armored cap of the Northern Impoundments has been the focus of a series of field investigations and subsequent repairs of small portions of the armor stone.

1.4 Development of the PRAP, Final Interim FS and USACE Report

The Respondents had initially prepared a draft Feasibility Study (FS) for the Site under oversight of the EPA, and had submitted a revised FS based on EPA review and comment (Anchor QEA 2014 referred to as “Respondents’ draft FS”). The Respondents’ draft FS contained an evaluation of both containment-focused and removal-focused alternatives, and included modeling of extreme flow events. EPA elected to revise and complete the FS for the Site, and issued the Final Interim FS concurrently with the PRAP. In support of that effort, EPA entered into an agreement with the USACE’s ERDC to provide specific technical information and modeling analysis. The scope of the USACE’s work was defined in a list of specific tasks, with a main focus on technical evaluations and modeling for containment and removal alternatives. The resulting report issued by the USACE (Hayter *et al* 2016 referred to as “USACE Report”) was completed in August 2016 and is included as Appendix A to the Final Interim FS (USEPA 2016a).

EPA subsequently completed its Final Interim FS in September 2016, citing some of the findings in the USACE Report in developing its Final Interim FS. The PRAP for the Site is also dated September 2016 (USEPA 2016b). Based on the contents of the Final Interim FS and PRAP, their publication dates, and a review of the Administrative Record for the PRAP, it appears that EPA did not rely on any significant technical evaluations other than those in the Respondents’ draft FS and the USACE Report.

Evaluation of the PRAP from a technical standpoint must necessarily include an evaluation of the Final Interim FS and USACE Report, since the remedy alternatives considered in the PRAP were defined and evaluated in those reports. Similarly, EPA commissioned the USACE to prepare its report focusing on the containment and removal remedy approaches, and EPA partially based the Final Interim FS and PRAP on portions of the USACE Report. Therefore, a technical evaluation of the PRAP must also necessarily include a technical evaluation of the findings of the USACE Report and how those findings were used by EPA in developing its Final Interim FS and later in developing the PRAP.

The PRAP and Final Interim FS consider a number of alternatives. All the active alternatives have components for both the Northern Impoundments and South Impoundment, but my discussion of technical details focuses only on the Northern Impoundment alternatives. The short title of the alternatives included in the PRAP for the Northern Impoundments are:

- Alternative 1N – Temporary Armored Cap (TCRA cap with No Further Action)
- Alternative 2N – Armored Cap (TCRA cap)
- Alternative 3N – Upgraded Cap (median stone sizes ranging 3 to 12 inches)
- Alternative 3aN – Enhanced Cap (median stone size 15 inches), Protective Pilings
- Alternative 4N – Partial Solidification/Stabilization, Upgraded Cap
- Alternative 5N – Partial Removal, Upgraded Cap
- Alternative 5aN – Partial Removal of Materials, Upgraded Cap
- Alternative 6N – Full Removal of Waste Materials

With the exception of Alternative 1N, all the other alternatives include additional components such as Institutional Controls, Ground Water Monitoring, and Monitored Natural Recovery. When evaluating the alternatives included in an FS, it is important to consider an appropriate range of intensity, complexity and intrusiveness of the alternatives as well as the range of potential costs. In this case, I believe the Final Interim FS and PRAP consider an appropriate range of alternatives for this Site, including several levels of complexity and intensity of effort for both containment and removal remedy approaches.

Alternatives 1N, 2N and 3N are not sufficiently effective for containment for the very extreme flow events USACE was asked by EPA to model for the USACE Report. Alternatives 4N and 5N are partial removal/containment alternatives; from my viewpoint they are useful to fill out the range of options in the Final Interim FS, but from a remedy selection viewpoint they still have all the downside, discussed below, associated with dismantling the existing armored cap and reconstruction of a new cap. Alternative 3aN is robust containment and Alternative 6N is a combined remedy of full removal with capping of deep inventory and generated residuals.

Considering the nature of the Site and the issues of potential extreme events, the real decision for this Site comes down to Alternative 3aN Enhanced Containment vs. Alternative 6N Full Removal. I have focused my review of these documents on those sections dealing with the EPA rationale in selecting Alternative 6N as the preferred alternative, the EPA rationale in rejecting Alternative 3aN, and the EPA interpretation of the USACE Report in selecting the preferred alternative and developing the PRAP.

1.5 Summary of Comments

A summary of my comments on the Final Interim FS and PRAP follows:

- The range of alternatives considered in the Final Interim FS and PRAP cover an appropriate range with respect to complexity, intensity of actions, and cost.
- This PRAP is typical of many that I have seen for sediment sites in that the critical decision on a preferred remedy alternative is influenced by an EPA preference for physical removal (in this case excavation and dredging). EPA has based its selection of Alternative 6N as the preferred alternative citing excessive concerns over containment approaches, while accepting the full removal alternative with hand waving to dismiss the downside of removal approaches.
- The Final Interim FS and PRAP reflect a clear bias in Region 6 against containment as an effective remedy approach. Alternative 3aN was not selected as the preferred alternative based on EPA concerns over an ultra-extreme flow condition, based on a 500 year reliability benchmark. The use of a 500 year event is extreme and is inconsistent with EPA technical guidance for capping.
- EPA dismisses the fact that a containment remedy approach can be designed and implemented at this Site to provide secure and permanent isolation of the waste.
- The selection of a preferred alternative for the Northern Impoundments principally hinges on the evaluation of physical stability of an armored cap over the waste impoundments. EPA has rejected the robust containment approach and proposes the full removal approach mainly based on doubts that the containment cap can be designed to reliably contain the waste in the long term. This evaluation in turn hinges on the selection of a design event for flow conditions and a modeling-based determination of the required armor stone size to resist the flow event.
- Alternative 3aN contains provisions that would ensure stability against very extreme events. This Alternative was essentially dismissed by EPA for the same reasons they rejected Alternative 3N, even though 3aN is a significantly more robust containment alternative.
- It is puzzling that EPA did not fully evaluate Alternative 3aN. Once the higher bar for stability against an ultra-extreme event was set, Alternatives 1N, 2N, and 3N were essentially non-starters.
- The PRAP indicates that the preferred remedy was selected based on the Final Interim FS as supported by the USACE Report. But, the details on long term effectiveness and implementability for the alternatives in both the Final Interim FS and PRAP were selectively cited from the USACE Report to support a removal alternative. In plain language, the PRAP cherry picked statements from the USACE Report to support removal, while largely ignoring considerations in the USACE Report that clearly supported a containment alternative.
- There is no precedent for a remedy similar to Alternative 6N that involves de-construction of a secure containment and subsequent removal and transport of hazardous waste under these site conditions. The existing TCRA cap has soundly contained the waste since its construction. Repairs made to the existing cap have been minor and appear to be consistent with either flaws during the construction of the cap or a barge strike. There have been no documented releases of dioxin from the containment now in place.

- Alternative 6N is acknowledged by EPA to result in short term releases of dioxin during implementation. Further, Alternative 6N exposes the waste to a potential extreme flow event during the period of implementation.
- The USACE raised issues related to implementability of Alternative 6N that were dismissed by EPA by a hand wave mention of Best Management Practices (BMPs).
- The comparison of Alternatives 3aN and 6N was developed on an inequitable basis. EPA's comparison of alternatives was pre-disposed toward removal as a remedy approach and so inequitably exaggerated the disadvantages of a containment approach and dismissed the disadvantages of the removal approach.
- In general, Alternative 6N is a very inefficient remedy. It has a much higher cost, much higher short term risk, significant implementation issues, and longer construction time.
- Alternative 3aN holds significant advantages over Alternative 6N since it has no short term impacts, a lower risk of a catastrophic release of dioxin, and no implementability issues.
- I recommend that EPA select Alternative 3aN for this Site. The Remedial Design for Alternative 3aN should include the appropriate evaluations and modeling to determine the cap armor design and containment features necessary to ensure long term effectiveness and reliability to resist ultra-extreme flow events and forces associated with potential channel migration processes that may impact the Site.

The detailed basis of these comments is provided in the following sections of this report.

2 Alternative 3aN – Enhanced Cap

Alternative 3aN Enhanced Cap is the containment alternative with features designed to resist the most extreme event. In addition, protections would be added to guard against barge groundings. The armored cap for this alternative would be composed of median stone size of 15 inches placed in a layer thickness of at least 24 inches over the entire surface of the cap.

2.1 Long Term Effectiveness – Alternative 3aN

EPA rejected the containment remedy approach in favor of the removal approach based on perceived issues of long-term effectiveness.

Specifically, EPA did not select Alternative 3aN based on these considerations:

- Characterization of the waste as Principal Threat Waste (PTW) due to the perception that the waste is now and would be "highly mobile" even with construction of an enhanced containment.
- The perception that the armored cap for a containment remedy would be subject to erosion during an ultra-extreme 500 year flow event.
- The perception that a containment remedy would be subject to catastrophic failure due to possible migration of the San Jacinto River channel during extreme events.

In my opinion, these perceptions are not adequately supported from a technical standpoint. The USACE Report clearly supports the position that a containment cap can in fact be designed to provide physical stability even against the ultra-extreme event proposed by EPA. The potential for channel migration is a potential concern and should be further evaluated. However, EPA has not technically evaluated the potential for such events to compromise a well-designed and constructed containment. Therefore, the position that the waste is "highly mobile" even in an enhanced containment (such as Alternative 3aN) is unfounded.

In my opinion, the Enhanced Cap as described for Alternative 3aN can be designed and constructed to meet the criterion of long term effectiveness and permanence.

2.1.1 Principal Threat Waste

EPA in the PRAP characterizes the waste at the Site as a PTW. The benchmarks for PTW include high concentrations of contaminants and the potential as a source if the material cannot be reliably contained.

In the Final Interim FS, EPA states:

> "With the regular occurrence of severe storms and flooding in the area, there is high level of uncertainty that the waste material can be reliably contained over the long term (Appendix A). Therefore, the dioxin/furan waste at the San Jacinto River Waste Pits Superfund Site is considered a Principal threat waste based on high toxicity or potential mobility." (Final Interim FS, p. ES-4)

The EPA characterization of PTW hinges on the perception that the waste cannot be reliably contained over the long term. The reference to Appendix A in the quote above is to Appendix A of the Final Interim FS, the USACE Report. This in an inequitable argument, since Alternative 3N evaluated in the USACE Report is not the enhanced cap described by USACE, rather it is the cap evaluated in the Respondents' draft FS, designed to resist a lesser event than the ultra-extreme event proposed by EPA. While EPA's focus on that ultra-extreme event is inappropriate for the reasons discussed below, Alternative 3aN is the design conceived by the USACE to address EPA's concerns about an ultra-extreme event and ensure long-term effectiveness and permanence in connection with that ultra-extreme event.

The PTW argument used by EPA against Alternative 3aN is really an argument surrounding the selection of an ultra-extreme event for design of the cap armor layer. Extreme events and cap armor modeling are discussed below.

2.1.2 Extreme Events

A significant issue associated with EPA's concerns about containment is the appropriate event or events that should be evaluated to address physical stability of the containment. The event modeled in Respondents' draft FS for the Alternative 3N Upgraded Cap was a 100-year storm, such as the October 1994 flood. The 2005 Superfund Sediment Guidance calls for using a 100-year return interval event as a basis of cap armor design as a general benchmark, but allows for consideration of more extreme events. This 100-year event was modeled for the Alternative 3N Upgraded Cap under oversight and approval of EPA during the Respondents' FS effort, and this same Alternative 3N Upgraded Cap was modeled by USACE as described in the USACE Report.

As part of EPA's decision to revise and complete the FS, a much more severe event was used for the modelling performed by the USACE, a hypothetical synoptic occurrence of Hurricane Ike and the October 1994 flood. This USACE modeling effort was focused on the Alternative 3N cap (with a range of median stone sizes from 3 to 10 inches), and was designed to simulate the 1994 flood event. But EPA essentially raised the bar with respect to an extreme event as part of its decision to revise and complete the FS.

EPA tasked the USACE to use a 500-year reliability in its modeling of cap stability. The USACE Task 7 Statement reads:

> "Assess the long-term reliability (500 years) of the cap under the potential conditions within the San Jacinto River, including severe storms, hurricanes, storm surge, subsidence, etc. Include in the assessment an evaluation of the potential for cap failure that may result from waves, propwash, toe scour and cap undermining, rock particle erosion, substrate material erosion, stream instability, and other potential failure mechanisms. Reliability will be based on the ability of the cap to prevent any release of contaminated material from the Site. Also discuss any uncertainty regarding the long-term reliability and effectiveness of the existing cap." (USACE Report, p. 52)

In addition, EPA states the following in the PRAP:

> "However, the uncertainty inherent in any quantitative analysis technique used to estimate the long-term (500 years or more) reliability of the cap is very high." (PRAP at p. 8)

EPA mentions a target of "reliability" over a time period of 500 years. EPA's use of a 500-year benchmark for reliability is, in my view, extreme. EPA's rationale for selection of such an extreme benchmark is presumably tied to the length of time dioxin may remain toxic.

It is not made clear in the Final Interim FS or PRAP whether the target is stability against an event with a 500-year return interval or against multiple events that might occur during that period. The energy or intensity with respect to river stage or flow does not increase linearly with higher return interval events. For example a 500-year return interval event is not 5 times more intense than a 100-year event. And, since these events are characterized based on records of past events, our ability to characterize long return intervals is limited. A 500-year return interval event cannot be characterized with certainty, so, results of any modeling for a 500-year event would have the same issue of uncertainty. The hypothetical synoptic occurrence of Hurricane

Ike and the October 1994 flood was selected for the USACE modeling for 500-year “reliability”, but it is unclear how this event would relate to a 500-year return interval.

In my opinion, the EPA Region 6 rejection of Alternative 3aN based on uncertainty surrounding a 500-year “reliability” is setting a terrible precedent. Most structures, even those designed for protection of life and property, such as dams and levees, are not designed to withstand a 500-year event. A 500-year event would essentially destroy a large piece of Houston and would result in a number of releases and environmental issues from multiple sources. Such events, were they to occur, would carry with them extreme levels of loss of life, widespread property damage, and environmental insult. Also, 500 years from now, Federal and State governments as we know them may not exist, so any landfill (including the one to which EPA is proposing that the waste from this Site be hauled) could be subject to disturbance and exposures of whatever civilization might succeed us. We cannot and do not design projects such as flood control levees or dams or coastal protection features against such events; therefore, selecting a remedy approach or designing a remedy for CERCLA on such a basis is inequitable and technically inappropriate in my view.

Further, the benchmark to “prevent any release of contaminated material from the Site” is not consistent with EPA’s evaluation of the Alternative 6N Full Removal in which a significant mass release during implementation will without any question occur and has been deemed to be acceptable by Region 6 in the Final Interim FS. (Final Interim FS, p. ES-12).

EPA also states that:

> “The possibility that a more severe storm will occur are increased given the hundreds of years that the dioxin waste will remain hazardous. Therefore, there is a high degree of uncertainty regarding the long term permanence of the cap, even with the improvements suggested by the USACE.” (Final Interim FS p 58).

I would agree that our ability to characterize an extremely long return interval event is uncertain. The EPA Superfund Sediment Guidance (USEPA 2005 p. 7-3) encourages project managers to consider a range of scenarios reflecting both best case and worst case. For this Site, EPA Region 6 has focused on the ultra-worst case only, in its attempt to reduce uncertainty. Even so, in my opinion, there is a high degree of certainty that a robust armored cap can be designed and constructed such that the waste can be reliably contained in the face of any extreme event that can be reasonably considered.

The USACE Report stated that a stone size of 12 inches or greater over the entire capped area should be used for an enhanced cap design. The Alternative 3aN Enhanced Cap now calls for a 15 inch median stone size across the entire cap area which provides a huge factor of safety above the most severe event modeled. Further, the stone size could be enhanced with minimal cost increase, resulting in an even larger degree of certainty that the containment armor will be stable. To the extent there are issues related to the weight of such a thick armor layer, these issues could be addressed during remedial design considering features such as an additional rock toe berm and flattened slopes, as recommended in the Respondents’ draft FS.

2.1.3 USACE Modeling for Cap Stability

The evaluation of long term stability for Alternatives 3N or 3aN is a key consideration for assessing the long term effectiveness of a containment remedy approach. Such evaluations must necessarily be based on modeling, considering the site conditions, extreme events, and the designs of the caps being evaluated (to include armor stone size and armor layer thickness).

There were two types of modeling conducted by USACE and cited by EPA in developing the Final Interim FS and PRAP. First, hydrodynamic modeling was conducted of flood flow events, wind driven waves, prop wash from vessels, and storm surge and flows due to hurricanes.

The second type of modeling conducted by USACE is aimed at prediction of potential erosion of an impoundment cap during an extreme flow event. Such predictions are made for a given armor material and stone size. USACE used their LTFATE model for this purpose. The LTFATE model was developed for evaluations of the stability of submerged dredged material mounds under various flow conditions. The armored caps for the impoundments would have the same characteristics as a submerged dredged material mound under extreme storm conditions with the water surface over the entire capped impoundments. Therefore, the use of LTFATE is an appropriate approach to determine erosion of the cap and thereby determine a design for stability under extreme conditions.

As described above, the flow events selected for cap modeling are an important consideration. The USACE modeled different events, but the key event was the higher intensity event, a hypothetical synoptic occurrence of Hurricane Ike and the October 1994 flood.

The results of the USACE modeling for this hypothetical event are best summarized directly from the USACE Report:

> "The most severe event simulated as a component of this task was the hypothetical synoptic occurrence of Hurricane Ike and the October 1994 flood, with a peak discharge of approximately 11,000 cms (390,000 cfs) occurring at the time of the peak storm surge height at the Site. The maximum scour depth in any grid cell within the cap boundary during this hypothetical extreme event was 2.4 ft (0.73 m). The results during the peak of the storm surge at the Site showed that the sections using Cap Armor A (D_{50} = 3 inches) were completely eroded, while the sections using Cap Armor D (D_{50} = 10 inches) were only eroded more than 12 inches in about 25 percent of those sections. The sections using Cap Armor B/C and C (D_{50} = 6 inches) incurred a maximum erosion of more than 9 inches in about 85 percent of those areas. Thus, approximately 80 percent (12.5 acres) of the 15.7 acre impoundment was simulated to incur severe erosion, and an estimated 170 g of 2,3,7,8-TCDF (which was the only dioxin/furan congener modeled) would be resuspended. Replacement of all the Cap Armor materials with a median size of at least D_{50} = 12 inches would be needed to greatly reduce the amount of scour that occurs during such an extreme event." (Appendix A, Final Interim FS, p. 57, pdf p. 290)

A casual reading of the Final Interim FS and PRAP can be confusing, in that it is not clearly stated what alternative or cap design was modeled and found to have an 80% erosion under the hypothetical ultra-extreme event, the existing TCRA cap or the Alternative 3N Upgraded Cap, or the Alternative 3aN Enhanced Cap. It must be emphasized that this modeling result of 80% erosion is for the Alternative 3N Upgraded Cap (with a range of median stone sizes of 3 to 10 inches), not the 3aN Enhanced Cap (with a median stone size of 15 inches across the entire cap).

The cap designs modeled to date consider different armor stone sizes for different areas of the Northern Impoundments, designated as Cap Armor A, B, C, and D, with D being the largest. The Armor D median stone sizes (D_{50}) for the various caps are: 8 inches for the TCRA cap, 10 inches for the Alternative 3N Upgraded Cap, and 15 inches for the Alternative 3aN Enhanced Cap. It is clear that the USACE modeling result of 80% erosion refers to the Alternative 3N cap (with a range of median stone sizes of 3 to 10 inches), not the 3aN Enhanced Cap (with a median stone size of 15 inches across the entire cap). A cap with 15 inch stone across the whole capped area would be very robust and would reliably resist ultra-extreme events, as compared to a cap with a range of 3 to 10 inch stone.

The USACE Report does not include mention of any modeling done for the Alternative 3aN Enhanced Cap. EPA states in the PRAP:

> "Alternative 3aN is an enhanced capping alternative with armor cap improvements (larger 15" armor stone, 24" of additional cap thickness on top of the Alternative 3N cap) recommended by the Corps of Engineers to address the deficiencies of Alternative 3N. Alternative 3aN would be better able to withstand a future severe storm, although the Corps of Engineers did not model this." (PRAP at p. 33)

This statement implies the USACE chose not to model the 3aN cap with 15 inch stone, but the scope of the USACE Report was defined by EPA. Since the real decision on the preferred remedy is Alternative 3aN versus Alternative 6N, it is very puzzling that EPA did not choose to model the Enhanced Cap for Alternative 3aN.

EPA repeatedly states in the PRAP that the USACE modeling of the Alternative 3N cap results in significant erosion, and further, EPA uses the erosion of the Alternative 3N cap (3 to 10 inch stone) as a main reason to question the long term stability of the 3aN cap (15 inch stone). This is misleading and inappropriate. Further, the decision by EPA to not model the performance for the 3aN Enhanced Cap has resulted in a critical gap in the Final Interim FS and PRAP, and results in an inequitable comparison of the alternatives.

2.1.4 Potential Channel Migration

EPA raised concern in both the Final Interim FS and PRAP over possible geomorphic changes resulting from highly extreme flow events in the San Jacinto River. EPA states:

> "The Site is located in the estuarine portion of the lower San Jacinto River where the river begins to transition from a river system to a delta. River conditions have

> significantly changed with respect to the location of the waste impoundments (Figures 2-4.1 through 2- 4.4). These photos clearly show that the river channel has changed over time. These river changes will continue and could cause a catastrophic release of the highly toxic waste materials from the impoundments, if the waste materials remain in place." (Final Interim FS, p. 9)

Visually, these photos in the Final Interim FS do not directly show a channel migration; rather they show inundated areas.

The issue of channel migration was not addressed in the USACE modeling effort. EPA states in the PRAP:

> "The Corps report did not consider changing river conditions. New channels eroding during flooding as well as changes in channel cross section due to bank erosion, shoreline breaches, etc. during a high flow event caused by a major flood or hurricane is beyond the ability of existing sediment transport models to simulate." (PRAP, p. 8)

EPA acknowledges that USACE did not consider changing river conditions. But it offers no explanation as to why it did not perform a technical evaluation of such an event as part of its Final Interim FS. Yet, Region 6 uses the possibility of such an event as an argument to reject any containment approach.

In my opinion, any potential channel migration that might be demonstrated as likely to occur at or near the Northern Impoundments can be mitigated by design of the remedy under Alternative 3aN Enhanced Cap. Any potential channel migration occurs as the flow seeks a lesser resistance, so a channel cut directly through the capped area, i.e., the containment area with Enhanced Cap, would be resisted by the armored side slopes and the cap itself. The principle concern related to a potential channel migration is undermining of the containment dike. This potential occurrence could be considered in the remedial design by appropriate flattening of the outer armored slopes and possibly incorporating a rock toe berm in the design if necessary. These enhancements were recommended in the Respondents' draft FS and would be incorporated in the design for the Alternative 3aN Enhanced Cap.

The USACE Report provides some support for the above possibility of control of channel migration:

> "Impact of Toe Erosion and Cap Undermining - The possibility of wave- and current-induced toe erosion that might lead to undermining of a portion of the cap would be greatly reduced if the recommended reductions in some of the cap side slopes are implemented. Enhancement of the armor rocks around the toe of the submerged cap would also lessen the possibility of toe erosion and undermining." (USACE Report, p. 55)

2.1.5 Stability and Permanence of 3aN Enhanced Cap

The USACE Report states:

> "These issues related to cap permanence can be addressed by additional modifications to Alternative 3N, including upgrading the blended filter in the Northwestern Area to control sediment migration into the cap, upgrading the armor stone size in vulnerable areas by doubling its D_{50} to prevent movement during very severe hydrologic and hydrodynamic events, thickening of the armor cap to at least 24 to 30 inches across the site to minimize the potential for disturbance by anthropogenic activities or gas entrapment in submerged areas where a geotextile filter was used, and installing pilings to protect the cap from barge strikes." (USACE Report, pgs. 2-3)

The additional modifications referred to by USACE are included in the Alternative 3aN Enhanced Cap or can be included in the Alternative 3aN cap during the Remedial Design.

2.2 Short-Term Effectiveness – Alternative 3aN

I am in full agreement with the PRAP with respect to the Short-Term Effectiveness of Alternative 3aN Enhanced Cap as described on page 34 of the PRAP.

EPA states in the PRAP:

> "Alternative 3N would not result in any significant short term dioxin impact during construction because the existing cap is not removed." (PRAP, p. 32).

The USACE Report describes Alternative 3N (that is, Alternative 3aN in the PRAP) from the standpoint of release potential as follows:

> "Some localized disturbances of the cap may occur from bearing capacity failures of the soft sediment, gas entrapment by the geomembrane or geotextiles, or barge strikes, requiring maintenance or repair. The expected releases from these localized disturbances would be expected to be very small, more than a thousand times smaller than releases from removal of the contaminated sediment as predicted for dredging Alternative 6N or a new Alternative 6N* with enhanced resuspension BMPs, even if these disturbances are not quickly repaired." (USACE Report, p. 2)

The USACE Report clearly supports the finding that Alternative 3N/3aN has no issues with respect to short-term effectiveness, i.e., no significant releases. This is consistent with the nature of Alternative 3aN in that no removal of existing cap is required, therefore no potential for short term releases to the river.

Alternative 3aN can also be designed with control measures such as a toe berm and reinforced and flattened side slopes to protect the cap from barge strikes, and such control features could be incorporated or combined with needed features to protect against undermining from potential channel migration. Bearing capacity of the containment will also be increased by flattening the side slopes, an included feature of Alternative 3aN.

2.3 Implementability – Alternative 3aN

I am in full agreement with the PRAP with respect to the implementability of Alternative 3aN Enhanced Cap.

The USACE Report clearly supports the finding that Alternative 3N/3aN has no issues with respect to implementability. The present cap would remain in place, with no exposure of the waste during implementation and therefore no risk of significant releases during implementation. This is a significant advantage of Alternative 3aN as compared to Alternative 6N which requires exposure of the waste as the existing cap is removed.

Construction of an Enhanced Cap over the existing TCRA cap can be accomplished using conventional construction approaches. The existing cap provides a stable base for operation of equipment. No unusual or unproven construction steps would be required.

Overall, implementation of Alternative 3aN is straightforward and holds the advantage of a shorter construction time as compared to Alternative 6N.

3 Alternative 6N – Full Removal

3.1 Long-Term Effectiveness – Alternative 6N

Alternative 6N is a full removal alternative. A variation of this alternative in the Final Interim FS is Alternative 6N* that includes BMPs for implementation. EPA states in the PRAP that this alternative best meets the criteria for long-term effectiveness because: 1) the waste material would be permanently removed from the river; 2) there is no potential for future releases; and, 3) there are no concerns on long term viability and effectiveness of a maintenance program. (PRAP, p. 33).

I agree that a full removal of the waste, with appropriate Solidification/Stabilization treatment and placement in an approved landfill will meet the criterion for long term effectiveness. And, the advantages of full removal stated by EPA may apply in varying degrees to the Northern Impoundments, but I disagree that these advantages hold across the board.

First, there will be residual sediments left in the lower horizons below the impoundments, even following waste removal. Alternative 6N calls for a capping remedy component for these residuals, and similar issues hold for this cap as for any of the containment alternatives. It therefore will not be the case that the waste material will be "permanently removed from the river" or that there is "no potential" for future releases. (PRAP, p. 33).

Further, considering that EPA holds a containment alternative to reliably containing the waste for a 500 year timeframe, the same should be applied regarding potential releases from any off-site landfill where excavated material is placed. For this timeframe there will be potential for releases and there will be issues for the effectiveness of a monitoring program for any off-site landfill. EPA completely ignores these issues in the Final Interim FS and PRAP.

Alternative 6N does remove a mass of waste from the aquatic environment, but there will be significant residual waste and associated contaminants, so essentially for Alternative 6N we would be left with two containments for the same waste, a cap over deep inventory and residuals and an off-site landfill.

3.2 Short-Term Effectiveness – Alternative 6N

EPA acknowledges issues with short-term effectiveness for Alternative 6N, but essentially dismisses the impact of these issues. In my opinion, Alternative 6N has significant disadvantages with respect to short-term effectiveness due to both (1) acknowledged releases of the waste during excavation or dredging operations, and (2) the potential for a flood event eroding exposed waste during implementation, presenting a risk of a significant release of dioxins.

3.2.1 Releases during Construction

The USACE Report comments on specific aspects of remedy implementation that would result in releases. The USACE Report states removal of rock riprap will result in negligible resuspension of material, but the removal of the geotextile will result in considerable resuspension. (USACE Report, pgs. 90, and 118). I agree that geotextile removal will result in releases, but the resuspension due to rock riprap removal may not be negligible. Debris in the waste and/or sediment and the rock riprap will result in incomplete bucket closure during dredging and subsequently high loss of material from the buckets and high resuspension rates.

EPA states:

> "Alternative 6N best realizes the Threshold Criteria of overall protectiveness because the waste material would be removed and therefore not subject to a potential future release of a significant amount of Principal Threat Waste into the San Jacinto River, although there will be some short term releases of dioxin (estimated by the USACE as between 0.2% and 0.34% of the waste material with Best Management Practices or BMPs) as a result of implementing the full removal alternative." (Final Interim FS, p. ES-11).

A mass release of 0.34% of the waste for Alternative 6N stands in stark contrast with no releases from implementing Alternative 3aN. And this mass release estimate assumes BMPs will be effective. This contrasts with the negligible release potential for Alternative 3aN, which the USACE Report describes as "more than a thousand times smaller than releases from removal of the contaminated sediment as predicted for dredging Alternative 6N or a new Alternative 6N* with enhanced resuspension BMPs". I believe that if any of the containment options held the potential for a 0.34% release of the dioxin mass during implementation, EPA would consider that as a significant factor against selection of that alternative.

EPA criticizes the USACE Report for focusing on risks of implementing a removal action. In reference to the USACE Report, EPA states:

> "In addition, the report's evaluation of excavation and removal often focuses on risks which will be reduced and/or eliminated through use of best management practices." (PRAP, p. 8).

Also, the statements in the USACE Report regarding releases during removal are significantly downplayed in the Final Interim FS main text and especially in the PRAP. This is especially true of statements regarding the likely impacts of releases on fish tissue concentrations.

USACE states:

> "Tasks 11 and 12 predicted and compared the short-term releases of solids and contaminants for the various removal alternatives. The releases represent a significant increase in exposure (more than two orders of magnitude greater than pre-remediation exposures) during the period of active removal operations or period of exposed residuals. Existing releases throughout the site are estimated to be up to 5 mg/year of dioxin-related contaminants without an erosion event, while the original full removal Alternative 6N and the new full removal Alternative 6N* are predicted to release about 20,000 mg and 2,000 mg, respectively, during remediation activities covering a period of up to two years. Fish tissue contaminant concentrations are directly related to the releases to the water column, but are also related to the entirety of their food sources which are largely impacted by the water column concentrations and releases. Consequently, depending on the BMPs employed and the feeding range of the fish species, fish tissue contaminant concentrations would be expected to be dozens times (for the new full removal Alternative 6N*) and perhaps hundreds times (for the original full removal Alternative 6N) greater than existing tissue concentrations for several years before returning to near existing values. Upon comparison with Task 16 long-term post remediation predictions, the short-term releases during remediation predicted in Tasks 11 and 12 are comparable to the expected long-term releases across the entire site over the 500 years following remediation, and more than 100 times the predicted releases from an intact cap over the 500 years following placement. Similarly, the short-term releases for the new full removal Alternative 6N* is about 400,000 times greater than the releases from the intact cap for the same period and area and about 2500 times more than the releases from stable sediment of the same area at the PCL Tasks 14 and 16 showed that the short-term releases will be completely dispersed throughout the site or transported downstream, and areas immediately adjacent to the site would largely recover to the PCL from the releases of Alternative 6N using a silt curtain in a decade in areas of higher deposition. However, the releases could be redistributed in time over a larger area by future erosion events and impact long-term recovery rates. Additionally, use of other BMPs with Alternative 6N such as sheet pile containment enclosures to reduce releases would achieve the PCL in

> these adjacent areas in a few years. The new Alternative 6N* would be expected to have only limited areas exceeding the PCL." (USACE Report, p. 6).

EPA was critical of the USACE Report in the Final Interim FS and PRAP with respect to the findings of release and associated fish tissue concentrations. EPA states:

> "Several of the USACE's comparisons between containment and removal alternatives use the earlier version of Alternative 6N for the comparison, without BMPs, and therefore higher expected releases of hazardous substances during implementation. The expected releases from the Respondents' original version of Alternative 6N, not using BMPs, were estimated at 3.3% of the total waste to be removed during removal operations; the expected releases from the new Alternative 6N (Alternative 6N* in the Alternatives Evaluation report) are between 0.2% and 0.34% of the waste, depending on whether sheet pile walls can be effectively used in the Northwest Cell." (Final Interim FS, p. 5):

However it is apparent from the above direct quote from USACE, that the USACE Report clearly distinguished the release and resulting impacts for Alternative 6N versus Alternative 6N* (which is the 6N alternative in the PRAP).

EPA also exaggerates the benefits of BMPs and downplays the impact of releases on fish tissue with respect to the time required for recovery even to existing levels. EPA states (, Final Interim FS, p.ES-16):

> "However, using robust BMPs, including sheet piles in the Northwestern Area, would reduce the release by 40% and therefore reduce the estimated fish tissue increases by 40% as well (Appendix A, Table 12-19)."

The above optimistic statement by EPA on fish tissue is contradicted by the following statement in the USACE Report:

> "Fish tissue contaminant concentrations are directly related to the releases to the water column, but are also related to the entirety of their food sources which are largely impacted by the water column concentrations and releases. Consequently, depending on the BMPs employed and the feeding range of the fish species, fish tissue contaminant concentrations would be expected to be dozens times (for the new full removal Alternative 6N*) and perhaps hundreds times (for the original full removal Alternative 6N) greater than existing tissue concentrations for several years before returning to near existing values." (USACE Report, p. 6).

3.2.2 Releases Due to Flood Event

Of equal concern with respect to short-term effectiveness is the potential for a significant release from the exposed waste during a storm or flood event. EPA proposes berms or sheet pile walls for flood protection during implementation of the waste removal under Alternative 6N.

EPA describes the degree of protection proposed:

> "Releases from flood flows over the containment structure regardless of the removal alternative will be dependent on the height of the containment structure and the flood stage. A sheet pile wall built in and supported by an armored waste pit berm and along the southern shoreline to an elevation of about +10 ft would protect the waste pit excavation from releases from more common floods (e.g., the 25-yr or 50-yr flood stage, Appendix A)." (Final Interim FS, p. ES-15).

EPA later states in the PRAP:

> "To control the sediment re-suspension during construction, the containment structures would consist of berms and sheet pile walls or caissons to an elevation of about +10 NAVD88 (protection from 25-year or 50-year flood stage). If performing excavation of the waste materials in the dry, the top of the berms would preferably be no lower than +5 NAVD88 (protection from 5-year or 10-year flood stage)." (PRAP, p. 35).

The proposed sheet pile wall would offer protection from flooding for "more common floods" (Final Interim FS, p. 121). But, for the proposed dry excavation protection, a flood overtopping event could occur once in 5 to 10 years. Considering a likely timeline for implementation of two or more years, the chances of overtopping and flooding of the exposed waste is significant. Such an overtopping event could result in a release much higher than the 0.34% release estimated for the construction activities themselves. Further, the likelihood of an overtopping event, which could occur with a 10 year return interval flow event, is much higher than the likelihood of cap failure, with the cap designed to meet a 500-year reliability goal. This clearly shows a double standard exercised by EPA in evaluating containment versus removal.

Another aspect of releases from the Site is an issue of odor from the exposed waste during the removal operations. There is no mention of this issue in either the Final Interim FS or PRAP. This could be a major issue with ramifications for community support if the community is not properly informed. There are no nearby residences immediately adjacent to the Site, but residences are numerous across the river from the Site. Also, I-10 runs right by the Site. The chemistry data does not reflect an issue with releases of VOCs, so emissions are not an issue from the human health standpoint, but odor issues have presented significant problems for environmental dredging remedies at other sites. The odor issue could be classified as an implementability issue, but I mention it here under short term effectiveness since it could be considered as a form of release during implementation.

3.3 Implementability - Alternative 6N

EPA acknowledges implementability issues for Alternative 6N due to the larger scope and scale of the full removal remedy and the need for staging areas, and an off-site area to manage the material. (Final Interim FS, p. 109 and PRAP, p. 35). But EPA dismisses or ignores significant issues related to the excavation and/or dredging process, the need for dewatering, and difficulty in management of the waste during excavation and transport and disposal. This is essentially a hand wave over truly significant implementability issues for a removal remedy at this Site.

First of all, I am not aware of any precedent for such a large scale removal, with dioxin-laden material being dredged or excavated from an existing armored containment, mostly submerged in a riverine site that has been shown to be effectively containing the waste. Such an endeavor may hold implementability issues that are completely unforeseen. But, there are multiple implementability issues that are apparent.

3.3.1 Dewatering

In my view, there will be significant implementability issues with removal of the TCRA cap and excavation of the waste either in the dry or in the wet; the fact that the excavated material is contaminated with dioxins will present even more practical problems with all the required operations.

The waste in the Northern Impoundment is physically similar to dredged material that is disposed of in Confined Disposal Facilities (CDFs). I have worked with numerous CDFs from the standpoint of dewatering and reclamation of the material for dike construction or beneficial use, and all such operations in these sites are difficult and fraught with problems. Equipment becomes clogged with sediment, equipment becomes immobilized and sometimes sinks through soft layers of the material, and equipment can track contaminated material and recontaminate clean areas. The fact that the material to be excavated is a waste material contaminated with dioxin exacerbates all such problems.

Removal of the existing cap and geotextile is a process that will contribute to releases of material, but these operations also present implementation issues. The USACE Report states:

> "It is difficult to understand how the armor cap material could be readily removed without snagging and disturbing the geotextile and sediment, particularly if performed underwater." (USACE Report, p. 118).

I certainly agree. This excavation operation would be sloppy and subject to slow progress, depending largely on how much of the work can be accomplished in the dry and how effectively the material can dry out as work progresses.

Dewatering will be an implementation issue. Core data reflect the waste characteristics vary from clay-like material to high water content material. EPA states that the goal is dry excavation to the extent possible, with dredging as required. But dewatering will be difficult since the excavation will extend approximately 5 to 10 feet below the water table. This is not an upland site, and gravity drainage of rainwater and seep water from the enclosure area into a sump for pumpout will be a constant requirement. Drying an exposed surface of fine grained material takes months at best, and then the drying does not extend to depth. So, in areas with high water content, the excavation will be a slow and sloppy operation even if done "in the dry."

3.3.2 Incremental Excavation

The PRAP proposes that protection against flooding is required to avoid releases of the exposed waste during a flood event. The Final Interim FS and PRAP also propose that the excavation and dredging for removal of the waste be done incrementally to avoid exposing the entire impoundment surface, reducing the risk of release if flooding does overtop the protective barrier. This need for incremental removal of armor and cap presents significant issues with respect to timing, transition between open areas being excavated and other capped areas, slope stability during excavation, and related safety of workers.

But this approach of incremental removal and capping is in conflict with USACE recommendations. The USACE Report states:

> "The entire cap within the sheet pile enclosure should be removed prior to solidification, excavation or dredging to limit contamination of the TCRA armor cap material." (USACE Report, p. 118).

The point made by USACE with this statement relates to the difficulty in excavating a portion of the waste material without tracking over clean capped areas to transport the excavated material out of the work area. Also, the incremental excavation of sub-areas requires excavation to depth and placement of the residuals cap while still maintaining the surrounding areas without slumping and deeper slope failures.

Another concern with incremental excavation is the possibility of an overtopping event during a flood. If this occurs with a portion of the waste exposed, the entire surface of the work area will become recontaminated. All the completed portions with completed cap would then require removal and reconstruction.

If these problems with incremental excavation result in a shift to total excavation of the entire area, the risk of release during a flood overtopping event would involve a much greater loss of dioxin contaminated waste material.

3.3.3 Transport Off-Site

An ancillary issue related to implementation of a full removal remedy is the transport of excavated waste off-site. The PRAP states:

> "Approximately 13,300 truck trips may be required to transport the waste material to the off-site approved permitted facility; however, capacity of roads to handle the loads will impact the truck size that can be used. The method of transportation and number of trips will be determined during the Remedial Design, as well as other transportation alternatives, including rail transport. The material will require dewatering by removal and/or treatment so that there are no free liquids." (PRAP, p. 29).

EPA has indicated that barging of materials from the site is a possibility (see Final Interim FS, p. 50). But even with barging to an off-site management area, the stabilized material will still require truck transport to a landfill for disposal. Truck transport of dioxin contaminated material with 13,300 truck trips through the City of Houston is not a trivial implementation issue.

3.3.4 Construction Duration

EPA states in the PRAP that the estimated construction time for Alternative 6N is 19 months. (PRAP, p. 29). The expectation that implementation of Alternative 6N to include dewatering, excavation, and capping can be accomplished in an efficient manner and completed within 19 months is, in my opinion, unrealistic.

4 Comparison of Alternatives 3aN and 6N

4.1 EPA Bias for Removal Over Containment

When EPA compared the alternatives in the PRAP, it arrived at the conclusion that Alternative 3aN Enhanced Cap did not provide adequate long term effectiveness and permanence and selected Alternative 6N Full Removal as the preferred alternative. In my opinion, EPA's comparison of alternatives was pre-disposed toward removal as a remedy approach and so inequitably exaggerated the disadvantages of a containment approach and dismissed the disadvantages of the removal approach. Some examples of this are taken directly from the Final Interim FS, USACE Report, and PRAP:

- EPA refers to the erosion modeled for Alternative 3N Upgraded Cap for the duel extreme event in the Final Interim FS and PRAP and associates this result with the Alternative 3aN Enhanced Cap. This is an unequitable comparison. EPA does this repeatedly, referring to the 80% erosion finding for Alternative 3N a total of 13 times in the Final Interim FS and PRAP (PRAP, p. 2, p. 22, p. 23, p. 32, and in the Final Interim FS, p. ES-7, ES-12, ES-15, p. 3, p. 51, p. 58, p. 60, p. 86, p.118). Such repetitive mention of one modeling result is essentially a scare tactic to justify the full removal option over an enhanced cap option that would not experience any such erosion. The most egregious example of this tactic is the Text Box on p. 8 of the PRAP (the one thing most readers would see). This text box mentions the 80% erosion finding, but conveniently does not state this finding was for the Alternative 3N Upgraded Cap and not the Alternative 3aN Enhanced Cap. The real decision on remedy approach comes down to Alternative 6N Full Removal as compared to Alternative 3aN Enhanced Cap.
- EPA uses a double standard regarding dioxin releases when comparing Alternative 3aN and Alternative 6N. EPA tasked the USACE to "Assess the long-term reliability (500 years) of the cap…..reliability will be based on the ability of the cap to prevent any release of contaminated material from the Site." (USACE Report, p. 11). In contrast, EPA is willing to accept a mass release of 0.34 % of the dioxin mass from the Site during implementation of a full removal under Alternative 6N with BMPs to control releases.

No allowable release for containment and 0.34% mass release for removal is an inequitable comparison.

- EPA did not provide an accurate description of stability of jetties and breakwaters in the context of evaluations of Alternative 3aN cap armor. EPA presents a partial quote from the USACE Report in the PRAP: "There appears to be no documented cases of any armored cap or armored confined disposal facility breaches. However, there have been many occurrences of breaches and slope failures of armored dikes, jetties, and breakwaters, with some of those structures confining dredged material." (PRAP, p. 8, quoting USACE Report, p. 82). However, EPA conveniently fails to provide the second part of the same statement from the USACE Report which states: "None of the listed cases completely breached or failed and were discovered by routine inspections. Repairs and rehabilitation measures, when documented, were easily made." (USACE Report, p. 82). This is a classic example of taking a statement out of context, to skew the message. This tactic of presenting partial information in an unbalanced fashion is clearly an example of inequitable comparison of alternatives.

EPA policy calls for a level playing field and fair comparison and consideration of remedy approaches. The 2002 EPA Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites, OSWER Directive 9285.6-08, states:

> "EPA's policy has been and continues to be that there is no presumptive remedy for any contaminated sediment site, regardless of the contaminant or level of risk. This is consistent with the NRC report's statement (p. 243) that 'There is no presumption of a preferred or default risk management option that is applicable to all PCB-contaminated-sediment sites.' At Superfund sites, for example, the most appropriate remedy should be chosen after considering site-specific data and the NCP's nine remedy selection criteria. All remedies that may potentially meet the removal or remedial action objectives (e.g., dredging or excavation, in-situ capping, in-situ treatment, monitored natural recovery) should be evaluated prior to selecting the remedy. This evaluation should be conducted on a comparable basis, considering all components of the remedies, the temporal and spatial aspects of the sites, and the overall risk reduction potentially achieved under each option."

The Site material involves a waste material but also involves contaminated sediment. All the issues associated with the waste pits are identical to those of the wide range of sediment sites nationwide, as are the potential remedy approaches of capping and excavation and dredging. The above EPA principles therefore apply.

4.2 Comparison of Reduction of Toxicity, Mobility and Volume

Removal of toxicity, mobility, and volume of waste through treatment is a CERCLA primary balancing criterion. EPA has frequently used this criterion as a basis for selecting dredging/excavation-focused remedies over containment remedies.

EPA states in the PRAP that Alternative 3aN Enhanced Cap does not include additional measures to reduce toxicity, mobility, or volume. (PRAP, p. 34). But, by definition, a containment remedy does in fact reduce mobility of the waste. Alternative 3aN significantly reduces mobility through a robust cap design. Further, Alternative 3aN will reduce the volume of the waste as a result of consolidation under the additional load of an enhanced cap.

By comparison, EPA tries to take credit for reduction in volume under Alternative 6N simply due to the removal of the material. But, Alternative 6N Full Removal does not reduce volume, it simply moves volume from one place to another. In fact there would be an increase in volume under Alternative 6N due to the stabilization treatment prior to transport and disposal in the landfill.

4.3 Cost Comparisons

EPA also commented in the Final Interim FS on the cost-effectiveness of Alternative 6N with respect to releases, but this comment is a clear example of overreach in an attempt to justify a removal remedy. EPA states:

> "The cost of Alternative 6N ($87 million) is about 21 times more than the cost of the upgraded capping Alternative 3N ($4.1 million), but is about 3.5 times more than the cost of enhanced capping Alternative 3aN ($24.8 million). However, the potential future dioxin release for the temporary cap with the upgrades described for the Upgraded Cap (Alternative 3N) during a future severe storm results in a release of approximately 29% of the dioxin in the waste pits." (Final Interim FS, p. ES-17).

Use of such wording in the PRAP is very frustrating. It is disingenuous of EPA to cite the release for Alternative 3N Upgraded Cap instead of the zero release for a properly enhanced and effective Alternative 3aN Enhanced Cap, and equally if not more disingenuous to tie that to a comparison of the cost of Alternative 3aN to Alternative 6N, and so implying that for 3.5 times the cost we avoid a potential 29% release.

In my opinion, the comparison of the alternatives in the PRAP, exemplified by the use of the tactics in the above examples, was inequitable and inconsistent with EPA policy as described in the EPA principles.

5 Conclusions and Recommendations

The selection of Alternative 6N Full Removal in the PRAP is largely based on assumed ultra-extreme flow events or possible channel migration processes, perceived uncertainty surrounding such ultra-extreme events, and perceived uncertainty in the ability to design Alternative 3aN Enhanced Cap to resist such events. In reality, Alternative 3aN Enhanced Cap can be designed as a robust containment remedy which will provide long term effectiveness and permanence in the face of such ultra-extreme events and processes.

Alternative 6N Full Removal has significant short term effects, with a significant loss of contaminants during implementation. Alternative 6N also has significant implementation issues associated with the removal of an existing containment cap and removal of the waste for off-site disposal. The need to remove the existing cap also exposes the waste to potentially significant losses in the event of a flood event during implementation. Alternative 3aN Enhanced Cap has essentially no short term impacts, and a straightforward implementation without exposure of the waste.

Based on these considerations, I recommend that Alternative 3aN Enhanced Cap be selected as the remedy for the Northern Impoundments. I further recommend that the Remedial Design include the appropriate evaluations and modeling to determine the cap armor design and containment features necessary to ensure that Alternative 3aN provides long term effectiveness and reliability to resist ultra-extreme flow events and forces associated with potential channel migration processes that may impact the Site.

6 References

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Appendix A: Curriculum Vitae

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Education:

- BS Civil Engineering, Mississippi State University, 1971
- MS Civil Engineering, Mississippi State University, 1977
- PhD Environmental and Water Resources Engineering, Vanderbilt University, 1984

Professional Positions:

- Consulting Engineer and President, Mike Palermo Consulting, Inc., 2003-Present
- Director, Center for Contaminated Sediments, U.S. Army Corps of Engineers (USACE) Waterways Experiment Station, 1998-2003
- Research Civil Engineer, Special Projects Group, Environmental Engineering Division, USACE Waterways Experiment Station, 1988-1998
- Supervisory Research Civil Engineer, Chief, Water Resources Engineering Branch, USACE Waterways Experiment Station, 1980-1988
- Research Civil Engineer, Water Resources Engineering Branch, USACE Waterways Experiment Station, 1974-1980
- Civil Engineer, Geotechnical Branch, USACE Vicksburg District, 1971-1974
- Student Trainee, USACE Vicksburg District, 1967-1971

Professional Registration:

- Registered Professional Engineer, Mississippi and North Carolina

Memberships:

- International Navigation Association (PIANC)
- Western Dredging Association (WEDA)
- American Society of Civil Engineers (ASCE)

Editorships:

- Associate Editor, Western Dredging Association *Journal of Dredging Engineering*

Academic Teaching and Activities:

- Mississippi State University, Adjunct Professor
    - CE 8913, Dredging and Dredged Material Disposal, 1987
    - CE 8803, Intro to Environmental Engineering I, 1991
- Texas A&M University, Visiting Assistant Professor
    - OCEN 688, Marine Dredging, 1990, 1993, 1995, 2002
    - Graduate committees for MS and PhD students

Instructor for Shortcourses:

- Managing the 5Rs of Environmental Dredging, Battelle 8th International Conference on Remediation of Contaminated Sediments, New Orleans, LA, 2015
- Managing the 4Rs of Environmental Dredging, PIANC/COPRI Dredging 2012, San Deigo, CA, 2012
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- Technical Guidelines for Environmental Dredging of Contaminated Sediments, Battelle 5th International Conference on Remediation of Contaminated Sediments, Jacksonville, FL, 2009
- Sediment Management Work Group Sediment Remediation Seminars, 2007
- USEPA Sediment Remedies Internet Seminars, 2006
- USEPA Environmental Dredging and Capping Sediment Remedies Shortcourses, 2005
- International Program for Port Planning and Management, University of New Orleans, 1990-2005
- Dredging Engineering Shortcourse, Texas A&M University, 1980-present
- USACE Dredged Material Management Shortcourse, 1984-2003
- Understanding Harbor and River Sediment: Remediation, University of Wisconsin, 2000

Committees, panels, workgroups:

- Peer Review Panel, EPA National Risk Reduction Laboratory, Land Remediation and Pollution Control Division, 2006
- Value Engineering Study Team, Waukegan Outer Harbor, 2006
- Steering Committee, USACE-USEPA 4Rs Workshop for Resuspension, Release, Residual, and Risk of Environmental Dredging, 2006
- International Advisory Committee, ASTM 3rd International Symposium on Contaminated Sediments, Shizuoka, Japan, 2005-2006
- Chair, Joint Federal Working Group, Interagency Framework for Assessing and Managing Contaminated Sediment Sites, 2002-2003
- Cooperative Research and Development Agreement with FUNDESPA, Sao Paulo, Brazil, 2003.
- Hudson River Superfund, USACE Performance Standards Quality Review Team, 2002-2003
- Fox River Superfund, State of Wisconsin Technical Review Team, 2002

- Keynote Speaker, 1st Battelle International Conference on Remediation of Contaminated Sediments, Venice, Italy, 2001
- St. Louis River Interlake Duluth Tar Superfund, Peer Review Team, 1999 to 2003
- EPA Forum on Managing Contaminated Sediments at Hazardous Waste Sites, 2001
- U.S. Delegate, PIANC Working Group PEC5, Guidelines for Confined Dredged Material Disposal, 1999-2002.
- EPA Remediation Technologies Development Forum, 1998 to 2003
- Housatonic Superfund, Technical Advisory Board, Region 1 EPA, 1998 to 2003
- Ross Island Site, Interagency Technical Advisory Committee, State of Oregon, 1998 to 2003
- U.S. Delegate, PIANC Working Group PEC1, Guidelines for Open Water Dredged Material Placement, 1997-1998.
- EPA Superfund Sediment Guidance Workgroup , 1997 to 2003
- Cooperative Research and Development Agreement with ERM Hong Kong Inc. 1996
- USACE Committee on Tidal Hydraulics, 1995 to 2003
- Manistique Harbor, Superfund Site Interagency Review Team, 1994
- Flemish Government Contaminated Sediments Workshop, Gent Belgium, 1994
- Coordinator for National Wetlands Engineering Workshop, St. Louis MO, 1993
- EPA/USACE Workgroup, Dredged Material Inland Testing Manual, 1991-1993
- Chair, USACE/USEPA Workgroup on Technical Framework for Dredged Material Disposal Alternatives, 1991-1992
- EPA/USACE Workgroup, Dredged Material Ocean Testing Manual, 1991-1993
- Value Engineering Study Team, Bayou Bonfouca Superfund Project, 1990
- Value Engineering Study Team, Marathon Battery Superfund Project, 1988
- USACE-EPA Oakland Harbor Review Panel, 1988
- USACE-EPA Technical Working Group on RCRA and Dredged Material, 1985
- Review Committee for the USACE National Waterways Study, 1980-1981
- Chairman for USACE Confined Dredged Material Disposal Workshop, 1981

Special recognition or awards:

- De Fleury Medal, Army Engineer Association, 2003
- Dept of the Army Meritorious Civilian Service Award, 2003
- USACE Project Delivery Team Excellence Award, 2001
- Director's Award, EPA Office of Emergency and Remedial Response, 1996
- WES Commander and Director's Research and Development Achievement Award, 1990
- USACE Special Commendation for Exemplary Performance, Flood Fighting Operations, 1973
- Chi Epsilon (Honorary Civil Engineering Fraternity), Mississippi State University, 1971

Professional Publications for Dr. Michael R. Palermo

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