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OFFICE OF
ENVIRONMENTAL
CLEANUP

SEP 18 2012

MEMORANDUM

SUBJECT: Responses to National Remedy Review Board Recommendations for the 100-K, 200-UP-1, and 300 Areas of the Hanford Superfund Site

FROM: Daniel D. Opalski, Director

TO: Amy R. Legare, Chair
National Remedy Review Board

Attached please find EPA Region 10's responses to the Remedy Review Board recommendations for the cleanup for Hanford's 200-UP-1 OU, 100-K Area and 300 Area.

If you have any questions, please contact the following individuals:

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Attachment

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National Remedy Review Board Advisory Recommendations

Recommendations Common to All Three Areas:

Human Health Risk

The Board package indicates that potential risks from groundwater were estimated using a 90th percentile value to represent the exposure point concentration (EPC). EPA guidance exists on how to calculate EPCs when calculating risk (OSWER Directive No. 9285.6-10, December 2002, *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*), which recommends the use of an upper-bound estimate of the mean; or, if this upper-bound cannot be calculated due to data paucity or limitations, the guidance defaults to the maximum detected concentration. It is this statistical representation of the data set that should be used as the EPC when estimating cancer risks and non-cancer hazards at a site. EPA's risk assessment guidance recommends that the reasonable maximum exposure estimates the maximum exposure reasonably anticipated at a site. This estimation involves using upper-bound values for the exposure parameters (such as contact rate, frequency and duration) with an estimate of the average concentration that is not likely to underestimate the average concentration. For these areas, the Region identified EPCs using a 90th percentile concentration, which does not follow either recommendation for an EPC nor does it follow the guidance by using an upper-bound estimate of the concentration. The Board recommends that the decision documents fully explain how the cleanup approach at these areas (including those where contamination is above MCLs) is consistent with EPA guidance (e.g., achieving groundwater cleanup levels throughout the plume [as measured in each well]; see OSWER Directive 9283.1-33, June 2009, *Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration*), and, if it is not consistent, what the reason for deviating from EPA guidance is and how the approach would still result in a remedial action that is protective of human health and the environment. In addition, the decision documents also should include an uncertainty discussion explaining why the approach being taken at these areas does not result in an overestimate or underestimate of the likely true risk.

Response: We agree that the decision documents should summarize how the cleanup approach at these areas differs from EPA guidance and explain the reasons for the deviation. However, the full detailed description and justification for the deviation will be provided in the Remedial Investigation and Feasibility Study (RI/FS) reports. The RI/FS reports will explain how the cleanup approach would still result in a remedial action that is protective of human health and the environment and any associated uncertainties in determining risk.

We acknowledge that EPA Superfund guidance recommends using the 95 percent upper confidence limit (95 % UCL) on the mean concentration for estimating EPCs. The 95% UCL on the mean represents a value that when calculated for a random data set equals or exceeds the true mean 95% of the time. Experience at the Hanford Site indicates that averages and UCLs can sometimes be unreliable for groundwater data sets. This is in part due to Hanford groundwater data being usually collected from areas with known contamination, which results in data sets containing higher contaminant concentrations and frequencies of detection. The 90th percentile, which represents a value that is greater than 90% of the values in a data set, was identified as a potential value to use for EPCs. Risk assessments were included in the three project documents provided to the Board. All three included groundwater risk assessment in which the 95% UCL and the 90th percentile values were calculated for the K-Area, the 300 Area, and the 200-UP-1 OU data sets.

For the 200-UP-1 OU, the 90th percentile (with few exceptions) is a higher concentration than the 95% UCL. The comparison shows that the 90th percentile concentration values are more conservative than the 95% UCL values. For those few instances where the 90th percentile value was lower than the 95% UCL, both values were used to determine potential risks and it was determined that these contaminants would have been eliminated during the COPC selection process, regardless of which value was used. Since the 90th percentile values are more conservative than the 95% UCL values, the 90th percentile was used to determine EPCs for the 200-UP-1 OU risk assessment.

For the K-Area and 300 Area, the risk assessments used the more conservative of the two values, which was determined to provide a better representation of the groundwater conditions.

Applicable or Relevant and Appropriate Requirements

The Board did not have sufficient information to evaluate the role of the Washington Model Toxics Control Act (MTCA) for these areas and whether MTCA Method B is an applicable or relevant and appropriate requirement (ARAR) for these areas. However, it may be appropriate to use it as a "to-be-considered" guidance in developing soil cleanup levels. To the extent MTCA might be considered as an ARAR, the Board notes that the stringent cleanup levels identified by the State of Washington may not be achievable with current technology. The Board recommends that the Region, DOE, and the State work together in evaluating the appropriate role of MTCA in designing a remedial action that will protect human health and the environment. In addition, the Board recommends that the proposed plan and decision documents explain how the cleanup adequately meets the National Historic Preservation Act consultation process, including, for example, the specific and concrete steps for how cleanup in the cultural areas will proceed in a manner that prevents disturbances (e.g., specific soil sampling designs to protect artifacts), including associated costs.

Response: We will continue to work with DOE and the State to evaluate the appropriate role of MTCA in CERCLA remedial actions.

The National Historic Preservation Act is an ARAR for these actions. However, we do not agree that the proposed plan or decision documents are the appropriate documents to explain details of the National Historic Preservation Act consultation process. This effort is a part of an ongoing discussion between the Tri-Party agencies and the tribes. The goal of these discussions is to produce a guiding document for preservation practices that will be used in remedial design/remedial action work plans to ensure culturally sensitive areas are preserved accordingly.

Cost

In the package presented to the Board, no detailed costs were provided for any of the alternatives; therefore, the Board could not determine if EPA guidance was followed when determining the costs. The lack of detailed cost information also prevented the Board from evaluating cost effectiveness during its review. Also, since there is a 20-year history of remedial/removal actions at the Hanford facility, there should be unit costs that are easily available from actual expenditures for similar completed actions. The Board recommends that detailed unit costs be provided for all the alternatives in the decision documents, using OSWER Directive No. 9355.0-75, July 2000, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study.*

Response: Cost information was presented in accordance with the 2006 "National Remedy Review Board Questions and Answers for Superfund Site Managers" guidance. Appendix A, which is a

recommended outline for the site information package, states that packages should include capital costs, annual operations and maintenance costs, and the net present value of capital and O&M costs. If the Board would like more detailed information in packages, we suggest the guidance be updated to reflect these expectations.

Detailed cost information is included in the FS report. Detailed cost information will also be included as part of the decision documents as outlined in OSWER Directive No. 9200.1-23P, A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents.

Terminology

In the documents and presentation to the Board there was inconsistent use of terminology in reference to "chromium:" in some instances, the term appeared to apply to both hexavalent and trivalent chromium but in other instances, only to hexavalent chromium. Clear terminology is especially critical when discussing risks associated with trivalent chromium, which is an essential dietary nutrient, and hexavalent chromium (a chemical EPA has recently identified with oral carcinogenic potential acting through a mutagenic mode of action). The Board recommends that the decision documents clearly define the terms "chromium" and "hexavalent chromium" for remedy selection purposes at these areas and use them consistently.

Response: We agree that chromium should be clearly defined in decision documents to differentiate between chromium and hexavalent chromium. Typically, chromium measurements in groundwater at the Hanford Site are assumed to represent hexavalent chromium levels because it is the soluble form of chromium.

Policy and Guidance

The Board notes that CERCLA Section 120(a)(2) of CERCLA states that "No department, agency, or instrumentality of the United States may adopt or utilize any such guidelines, rules, regulations, or criteria which are inconsistent with the guidelines, rules, regulations, and criteria established by the Administrator under this Act." Future decision documents should fully explain any such use of non-EPA guidance (e.g., RESRAD, lack of lines of evidence to support monitored natural attenuation, use of something other than 90-99 percent reduction in toxicity per the NCP), why it is appropriate for these areas, and how it will ensure protectiveness of human health and the environment consistent with CERCLA and the NCP.

Response: Decision documents for the Hanford site will continue to meet all legal requirements, including identifying remedies that are protective of human health and the environment. Region 10 considers any applicable EPA guidance when developing supporting documents and decision documents. When appropriate, the Region may choose to use non-EPA guidance tools, such as RESRAD. The rationale for using these types of tools is provided in the supporting technical documents.

100-K Area Recommendations:

Institutional Controls

The package presented to the Board indicated that ICs will play an important role for the 100-K Area. The Board recommends that the proposed plan and other decision documents clearly explain in sufficient detail which specific ICs would be needed to ensure protectiveness of human health, upon what authority they would be based and how they would be enforced over the long-term.

Response: The Region agrees with this recommendation. Each type of institutional control is defined and discussed in greater detail in Chapter 8 of the RI/FS. The Proposed Plan includes a new table identifying institutional controls proposed for implementation at waste sites post remediation.

Human Health Risk

The Region indicated that a quantitative baseline human health risk (BHHRA) had been completed in the early 1990s. Since that time, several interim actions and removal actions have been implemented to remediate specific areas of contamination. The Board recommends that the Region update or develop an addendum to the BHHRA to confirm current 100-K Area conditions are associated with unacceptable risks. This update should also address significant changes in toxicity values, or exposure pathways or scenarios that may have changed since the time of the original BHHRA. Additionally, the Board recommends that risk from specific exposure scenarios, such as exposures unique to culturally or archaeologically sensitive areas, be characterized in this revision or addendum.

The Board notes that in some areas of the package, the soil cleanup levels are at times based on residential land use at 1×10^{-4} and at other times, on rural residential land use at 1×10^{-4}. "Rural residential land use" is not defined by EPA in CERCLA risk assessment guidance. Rather, EPA used this term used during a draft proposed rulemaking under the Atomic Energy Act. A similar risk assessment scenario in EPA's preliminary remediation goal (PRO) for radionuclides calculator (OSWER Directive No. 9355.01-83A, February 2002, *Radionuclide Preliminary Remediation Goals for Superfund*) used to be called "Agricultural," but now it is referred to as "Farmer." The soil- based cleanup numbers used in the BHHRA seem to differ from the PRO residential or farmer scenarios. The Board recommends that the Region provide documentation of the risk assessment performed per EPA guidance; otherwise, justify the reason for deviating from EPA guidance.

Response: In the 100 Areas of the Hanford Site, an assumption of "unrestricted use" was used to select a cleanup remedy and establish cleanup goals, such that future use of the land would not be precluded by contamination left from past Hanford Site operations. Unrestricted surface use is represented by a rural-residential scenario in which an individual in a rural-residential setting, living in the remediated areas, is conservatively assumed to consume crops raised in a backyard garden, meat and milk from locally raised livestock, and meat from game animals and fish. The following exposure pathways are used to consider estimated dose from radionuclides in soil: inhalation; soil ingestion; ingestion of crops, meat, fish, drinking water, and milk; and external gamma exposure. Unrestricted land-use cleanup levels for chemicals or nonradionuclides are based on Washington Administrative Code (WAC) 173-340-740(3). The exposure pathway for residual nonradiological contamination is from ingestion of contaminated soil.

Ecological Risk

The Board notes that within the presented package, it was stated that there was an ecological risk from both hexavalent chromium and carbon-14. Through communication with the Region, it is clear that the preferred alternative remedy addresses these ecological risks. Since there is a substantial interest in the ecological risks at the 100-K Area, the Board commends the Region for highlighting the ecological risks from hexavalent chromium and carbon-14. The Board recommends that the Region clearly communicate in the decision document how the preferred alternative remediates these risks.

Response: The Region agrees with this Recommendation.

Principal Threat Waste

The package states there are no principal threat wastes (PTW) as part of the 100-K Area action, but also states that a majority of the 165 individual waste sites have not been characterized. The importance of PTW identification was recently the subject of the Region 4 Regional Administrator's decision in the Department of Energy (DOE) Paducah dispute. The identification and treatment of PTW at the Hanford Site (e.g., for Cr(VI) in soils found at concentrations several orders of magnitude above the cleanup level of2 mg/kg) should be consistent with CERCLA, the NCP and EPA guidance (i.e., OSWER Directive No. 9380.3-06FS, November 1991, *A Guide to Principal Threat and Low Level Threat Wastes*). The Board recommends that the Region thoroughly investigate the individual waste sites and address PTW if discovered.

Response: The only known remaining principal threat waste in 100-K includes the two reactor cores and the 105-KW FSB. The reactor cores will be addressed in a separate action following the interim safe storage period. An interim remedy for the 105-KW FSB was selected in the K Basins Interim Remedial Action ROD We acknowledge that the chromium levels are elevated in many of the K Area wastes but we do not think the chromium contamination is high enough to be classified as principal threat waste.

Remedial Action Objectives

The remedial action objective (RAO) 2 included in the package states: "RAO 2. Prevent unacceptable risk to human health and ecological exposure to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds." The Board recognizes the importance of the Columbia River as a resource and agrees that ongoing monitoring of river impacts from the Hanford Site should be performed, either as a part of this remedy or other actions at the Site. However, the package did not provide clear enough information indicating that the 100-K Area impacts surface water to the extent that an RAO is called for and a subsequent remedial action is needed to mitigate these impacts. The Board recommends that the decision documents explain more clearly how the 100-K Area contaminants are in fact impacting surface water in the Columbia River in a manner that results in unacceptable human health or ecological risks and how the preferred alternative will address these risks.

Response: The Region will provide additional information in the ROD in regard to Columbia River impacts. Data was collected at 100 K to address the level of contamination entering the Columbia River via upwelling, including the contaminant transport mechanisms. Pore water, surface water, and sediment sampling in the Columbia River was conducted in 2009 and 2010. Measurement of specific conductance or conductivity in pore water can be used as an indicator of the presence of groundwater, since surface water conductivity in the Columbia River is typically lower (130 to 145 µS/cm) than

groundwater (400 to 600 µS/cm). In a similar manner, pore water temperatures can be used as an indication of groundwater by comparing them to surface water temperatures. In this region of the Columbia River, surface water temperatures typically range from approximately 0.5°C (33°F) in the winter months to more than 27°C (80°F) during the late summer months, whereas groundwater typically stays between 7°C (45°F) and 15°C (60°F).

The maximum Cr(VI) detection in pore water was 56 µg/L, which exceeds the ambient water quality criteria. Modifications to the pump and treat well extraction network are proposed in the RI/FS to address protection of the Columbia River. Other detections include tritium which is addressed through the RI/FS and Proposed Plan. No other contaminants were detected in pore water sampling.

Remedy Performance

The Board notes that under Alternative #3, temporary surface barriers are proposed for those contaminated areas that will not be addressed until the reactors are removed sometime within the next 75 years. The Washington State Department of Ecology raised concerns regarding the scope and timing of the final action for the reactor and adjacent contaminated materials. The Board recommends that the upcoming decision documents present a detailed schedule for completion of the reactor removals, and in the event removal does not occur, a contingency to address the remaining contamination.

Response: The environmental impacts associated with the ultimate disposition of the reactors were evaluated in an Environmental Impact Statement ROD ("Record of Decision: Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington," 1992 [58 FR 48509]), which documented DOE's selection of interim safe storage (ISS) for the reactors. Subsequent to the issuance of this ROD, DOE conducted a Supplemental Analysis that evaluated the feasibility of dismantlement. DOE is currently planning to implement ISS activities for both 100-K reactors. The two reactors are anticipated to be removed through separate action following the ISS period. DOE plans to collect additional data to insure that the cap will be protective in the interim. If information indicates that the cap will not be protective, the Agencies will consider early removal of the reactor.

As explained in the package, the groundwater conditions are alternating between high flow rates through the 100-K Area toward the river and into the river at low flow river stage, and frequent pulsed reversed groundwater gradients at high river stage that flush from the vadose zone inland and up into the shallow groundwater. Due to the high yield porous aquifer and river interaction with the groundwater, conventional pump-and-treat may be impractical (i.e., not cost-effective) to control groundwater contaminant migration. The Board recommends that the Region request that the Department of Energy (DOE) evaluate the practicality and cost-effectiveness of physical containment (e.g., installing a slurry wall and/or grout curtain) around the chromium source areas to enhance the effectiveness of the groundwater pumping containment action so as to make it practical/cost-effective.

Response: Conventional pump-and-treat is a proven technology at the Hanford Site and has been effective in removing Cr(VI) from the aquifer as well as preventing significant concentrations from entering the river. The preferred alternative expands the existing interim action pump-and-treat system operations by adding approximately 70 new wells and adjusting the system treatment capacity based on plume concentrations and locations.

Monitored Natural Attenuation

Based on the information provided in the package, the mechanism for the groundwater COCs to reach drinking water standards was not fully explained. The Board recommends that future decision documents provide additional supporting evidence for monitored natural attenuation (MNA) consistent with Agency guidance. (OSWER Directive No. 9200.4-l?P, April 1999, *Use Of Monitored Natural Attenuation At Superfund, RCRA Corrective Action, And Underground Storage Tank Sites*; EPA/600/R-07/139, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume I- Technical Basis for Assessments*; EPA/600/R-07/140, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 2- Assessment for Non-Radionuclides*; EPA/600/R-10/093, September 2010, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 3 - Assessment for Radionuclides*.) The decision documents should identify mechanisms of natural attenuation for all contaminants for which MNA is being selected (nitrates, tritium and carbon tetrachloride). These mechanisms, which may be different under different conditions, should be identified for the range of hydrologic and geochemical settings encountered in the 100-K Area. This information includes determining the organic transformation products, radionuclide isotopes and daughters; and identifying the immobilization processes and rates that may be present or become present in both the vadose zone and groundwater environments.

Response: The Region agrees that supporting evidence for MNA consistent with EPA guidance should be provided; however, we do not agree that this level of detail should be provided in a ROD. The full detailed description and justification for MNA will be provided in the (RI/FS) reports. For the 100-K Area, this evidence is provided in Chapter 8 of the RI/FS document. MNA relies on natural processes within the aquifer to achieve reductions in the toxicity, mobility, volume, concentration, and/or bioavailability of the COCs. These natural processes include physical, chemical, and biological transformations that occur without human intervention. MNA is a viable component for strontium-90 (radioactive decay and sorption to aquifer materials), carbon-14 (sorption to aquifer materials), and tritium (radioactive decay); specifically for tritium because of its short radioactive half-life (12.3 years) and because there is no groundwater treatment technology for this constituent.

Cost

The Board notes there are available technologies for treating groundwater with Cr(VI) in addition to pump-and-treat (e.g., in-situ chemical reduction using calcium polysulfide, ferrous iron or zero valent iron). The Board recommends that the Region evaluate cost estimates for different treatment technologies that are based on unit volume or mass of soil and groundwater to be treated. The Board also recommends that the Region include in the decision documents a better justification as to why pump-and-treat is the best approach to be taken to treat Cr(VI) in the 100-K Area.

Response: The alternatives analysis in the RI/FS document evaluated several technologies including in-situ treatment, but the technologies were not retained (Chapter 8, specifically Table 8-6) because 15 years of using the pump-and-treat technology has shown that it is highly effective in removing chromium.

Stakeholders

During the presentation to the Board, a number of issues related to tribal consultation, exposure scenarios in the risk assessment process and cleanup levels were discussed. Resolution of some of these issues appears to involve federal trustee responsibilities and treaty rights, as well as environmental

justice considerations. The Board recommends that the Region continue to work with the Tribes and DOE to ensure that the cultural areas are appropriately addressed consistent with legal requirements and EPA guidance and policy positions (*EPA Policy on Consultation and Coordination with Indian Tribes*, May 4, 2011). For example, the Board recommends that the proposed plan and other decision documents provide a clear description of "protocols (e.g., tribal archeology) and procedures" regarding cleanup in the cultural areas, and how capping and ICs would be used (if at all) to help ensure protection of human health. If protocols and procedures have not been agreed to by the time a proposed plan is published, the Board recommends that the Region consider addressing the cultural areas as a separate operable unit.

Response: The Region agrees with the Recommendation and is continuing to work with the Tribes and DOE on protocols and procedures regarding cleanup in culturally sensitive areas. The Agencies do not believe a separate OU is needed for this type of site.

200-UP-1 Area Recommendations:

Human Health Risk

The summary of the baseline risk assessment presented in Section 6.1 of the Board package appears to be a residual risk assessment, rather than a true baseline risk assessment. For example, Table 6-2 presents risks/hazards that appear to be simple ratios of exposure point concentrations to state standards and criteria, instead of estimating exposure point concentrations and running those concentrations through risk scenarios to estimate the potential risks now and in the future if no remedial action is implemented. The Board recommends the Region conduct a BHHRA consistent with EPA CERCLA guidance (i.e., EPA/54011-89/002, December 1989, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual*) that identifies risk-driving chemicals, and exposure pathways and media of concern. This information will be helpful to identify and support remedial action objectives for this area.

Response: The Region agrees and DOE has conducted risk estimates based on a reasonable maximum exposure scenario assuming no remedial action is implemented. This was included in the risk assessment section of the 200-UP-1 OU RI/FS document.

Remedy Performance

The package provided to the Board presented three active groundwater pump-and-treat alternatives with three estimated remediation time periods. The different time periods were related to the degree that contaminants would be addressed with both chromium and nitrate lengthening the remediation periods. The Region described the action as a final remedy for the groundwater except for iodine for which no effective treatment technology exists. The proposed action would hydraulically contain iodine contamination and be considered an interim remedy. The Board notes that the remediation timeframes for all alternatives assume that the contaminant source is eliminated. However, vadose zone contamination still exists. The issue is further complicated by the fact that the State agency is responsible for the vadose zone remediation and that there has not been a cleanup schedule identified. Since the contaminant source is not being addressed and will continue to migrate into the groundwater, the Board believes that the entire groundwater action should be an interim remedy. The Board recommends that the Region reconsider its designation of the proposed groundwater action as final and also include more discussion of the iodine technology development issue, along with associated costs, in the proposed plan and other decision documents. In addition, the Board encourages the State and DOE

to work quickly to identify remedies for the vadose zone in order to ensure that groundwater cleanup goals can be achieved throughout the plume.

Response: The Region agrees that the decision should be an interim remedial action and we have changed the scope of the remedial alternatives to reflect an interim decision. The decision document will have more discussion of the iodine technology development issue.

Based on information presented to the Board, it appears that the primary risk driver in the groundwater cleanup action is carbon tetrachloride (CCl4) and, therefore, effective source control to reduce groundwater loadings will save cost and time in the groundwater cleanup action. The existing CC14 soil vapor extraction system was installed in 1992. The Board recommends that the Region consider re-evaluating and potentially optimizing the system to maximize CCl4 removal (e.g., more vapor extraction wells, use of inlet air wells, rebound cycling, weatherization and preheating for year-round operation and other engineering solutions).

Response: The soil vapor extraction system installed in 1992 is part of the remedy identified in the record of decision for the 200-PW-1 OU and is not part of the 200-UP-1 OU remedial alternatives. The Region will consider optimizing the system under the 200-PW-1 OU ROD (formally known as the 200-CW-5, 200-PW-1/3/6 ROD) and will continue to do so in the future.

Monitored Natural Attenuation

Based on the information provided in the package, the Board believes that MNA has not been evaluated to the degree necessary to consider it an appropriate remedy for the 200-UP-1 Area. The Board recommends that future decision documents provide supporting evidence for MNA consistent with Agency guidance. (OSWER Directive No. 9200.4-17P, April 1999; EPA/600/R-07/139, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 1- Technical Basis for Assessments*; EPA/600/R-07/140, October 2007, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 2- Assessment for Non-Radionuclides*; EPA/600/R-10/093, September 2010, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water Volume 3- Assessment for Radionuclides*.) The decision documents should identify mechanisms of natural attenuation for all contaminants for which MNA is being selected (nitrates, tritium and carbon tetrachloride). These mechanisms, which may be different under different conditions, should be identified for the range of hydrologic and geochemical settings encountered at the Site. This information includes determining the organic transformation products, radionuclide isotopes and daughters, identifying the immobilization processes and rates that may be present or become present in both the vadose zone and groundwater environments.

Furthermore, contaminated plumes that are unstable or expanding are not candidates for MNA (OSWER Directive No. 9200.4-17P, April 1999). The Board recommends that the decision documents include a discussion of plume stability and biotic and abiotic degradation rates for the plumes for which MNA is being proposed. The degradation rates can be compared to values in the literature. Because the sediments in this area contain low organic matter and groundwater is mostly oxic, natural attenuation via biological degradation for both nitrate and CCl4 may be limited.

In addition, the package (page 83 and table 8-1) provides information on the preferred alternative with a given MNA timeline for tritium remediation of 25 years. Also, the package (page 60) indicates that initial concentrations for tritium are in the range of 200,000 to 2,000,000 picoCurie per liter. The time to reach tritium remediation goals using decay alone would be in the neighborhood of 41 to 82 years

using this initial concentration range. The Board recommends the Region clarify the role of radioactive decay and any additional attenuation mechanisms to meet the remediation goal of 25 years for the tritium groundwater plume per the 200-UP-1 Area package.

Response: The Region agrees that supporting evidence for MNA consistent with EPA guidance should be provided; however, we do not agree that this level of detail should be provided in a ROD. The full detailed description and justification for MNA will be provided in the (RI/FS) reports. For the 200-UP-1 OU, this evidence is provided in Chapter 7 of the RI/FS document.

The timeframe for remediation of tritium considers diffusion of the tritium plume in addition to contaminant mass. When groundwater transport and diffusion are considered, the timeframe for reaching the DWS of 20,000 piC/L is different than calculations based on radiological decay alone. The 25 year remediation goal for tritium is based on fate and transport modeling, which is presented in Chapter 6 of the 200-UP-1 RI/FS report. There are no new sources of tritium to groundwater to consider.

Cost

Alternatives 2, 3, and 4 appear to be all the same pump-and-treat remedies with minor variations. Also, based on the estimated time to meet the RAO to return the groundwater to a beneficial use, all three alternatives will require 125 years. Alternative 2 appears to be the most cost-effective remedy based on the nine criteria presented in the package to the Board. However, Alternative 3 is the Region's preference. Therefore, the Board recommends that the Region better explain their preference for Alternative 3 in the decision documents.

In the presentation to the Board, the Region indicated that the cost estimates provided in the package may not include some major maintenance efforts that will be required at the end of the design life of some equipment, and that some economy of scale will be lost when the 200-ZP-1 pump-and-treat remedy is completed. The Board recommends that the Region revisit the cost estimates for the three alternatives and ensure the cost estimates are complete per OSWER Directive No. 9355.0-75, July 2000, *A Guide to Developing and Documenting Cost Estimate During the Feasibility Study.*

Response: The Region agrees and will clarify the justification for choosing Alternative 3 in the decision document, if alternative 3 is chosen. The cost estimates for the alternatives have been done to meet EPA guidance and are provided in the 200-UP-1 RI/FS report.

300 Area Recommendations:

Remedial Action Objectives

The RAO 2 included in the package states: "RAO 2. Prevent unacceptable risk to human health and ecological exposure to surface water containing contaminant concentrations above federal and state standards and risk-based thresholds." The Board recognizes the importance of the Columbia River as a resource and agrees that ongoing monitoring of river impacts from the Hanford Site should be performed, either as a part of this remedy or other actions at the Site. However, the package did not provide clear information indicating that the Site impacts surface water to the extent that an RAO is called for and a subsequent remedial action is needed to mitigate these impacts. The Board recommends that the decision documents explain how Site contaminants are in fact impacting surface water in the Columbia River in a manner that results in unacceptable human health or ecological risks. The

administrative record should contain data and information showing that the RAO is appropriate and can be measured to ensure the remedial action and clean-up goals have been achieved. If there is insufficient information to demonstrate an unacceptable current or future impact on surface water, the Board recommends that this RAO should be modified or dropped, and the vadose zone cleanup levels should not be based on protection of surface water.

The review package states that groundwater was evaluated as a potential drinking water source. Proposed cleanup levels for groundwater were provided yet there was no RAO for restoring groundwater. To the extent the groundwater is found to be a potential drinking water aquifer, the Board recommends that the decision documents clearly state that the groundwater RAO in the Hanford and Ringold Formations is to restore the aquifer to drinking water standards. If the Ringold Formation is not considered a drinking water aquifer (see recommendation below), then the RAO and performance standards should not be included in future decision documents.

Response: The Region believes that the RAO to be protective of the Columbia River that the Region presented to the Board is appropriate. While there are currently no exceedances of standards or risk limits within the river water, it is important to the Region that future conditions do not degrade. In addition, alternatives 2-5 all include active steps to protect groundwater and to restore groundwater uranium contamination to drinking water standards.

Remedy Performance

The package provided to the Board for the 300 Area presented three active remedial action alternatives that varied only in the manner in which deeper uranium contamination is addressed. The remedy preferred by the Region (Alternative 3) includes in-situ uranium sequestration (phosphate precipitation) in the vadose zone and at depths below 15 feet in all areas with vadose zone uranium that could impact groundwater above maximum contaminant levels (MCLs). Under the preferred alternative, the in-situ phosphate treatment would be implemented in a phased manner and its effectiveness would be evaluated during implementation. The Board notes that the effectiveness of this technology has not been demonstrated on a pilot or full scale at this or other sites. As described in the package, treatment success is defined as a 50 percent reduction in leaching; the incremental cost of this treatment would be $113 million. Alternative 4 would physically remove the deep uranium contamination to the top of the water table at low river stage; this may be up to a depth of up to 45 feet (depending on the river stage). The incremental cost of doing this would be $255 million. Based on their comments, the states of Oregon and Washington prefer the RTD approach because of concerns about the effectiveness of the in-situ uranium sequestration process.

Given the uncertainties about the *in-situ* treatment process, the Board recommends that: 1) additional information be developed to sufficiently support selection of this vadose zone treatment approach, especially considering the hydraulic conditions in this area of the Hanford facility, and 2) the decision documents establish clear benchmarks for defining success (including timeframes) if Alternative 3 is selected. This approach would help ensure that all stakeholders have a common understanding of what is expected and would help avoid the potential for disputes and delays in remedy implementation. The Board also recommends consideration of a contingency remedy (e.g., Alternative 4), which could be included in the decision documents in case initial treatment efforts (pilot or full scale) prove to be ineffective. Including a contingency remedy at this time could avoid the need to amend the ROD in the future. The Board recognizes the importance of a timelier cleanup of the area given its close proximity to the river.

With regard to Alternative 3's treatment success being defined as a 50 percent reduction in leaching, the Board notes that CERCLA contains a preference for treatment to the maximum extent practicable, and that the NCP preamble provides a guideline for effective treatment as a 90 to 99 percent reduction in concentration. The Board recommends that the decision documents explain how a 50 percent success rate is consistent with the statutory and NCP provisions regarding treatment.

The information presented to the Board for the preferred alternative indicated that soil physical characterization would take place in the subsurface before the preferred alternative uranium sequestration (phosphate precipitation) takes place. However, it would be important to determine how the preferred alternative affects the subsurface soil particles after uranium sequestration. Given the 300 Area's river flux velocity of 50 feet/day, phosphate treated uranium particles may be mobilized for enhanced transport in flux water to the river. The Board recommends that physical and chemical analyses be performed to determine if enhanced transport of phosphate treated uranium particles (colloids) may reduce the effectiveness of the proposed remedy.

As explained in the package, the groundwater conditions are alternating high flow rates through the Site area toward the river and into the river at low flow river stage, and frequent pulsed reversed groundwater gradients at high river stage that flush from the vadose zone inland and up into the shallow groundwater. Due to the high yield porous aquifer and river interaction with the groundwater, conventional pump-and-treat may be impractical (i.e., not cost-effective) to control groundwater contaminant migration. The Board recommends that the Region request DOE to evaluate the practicality and cost-effectiveness of physical containment (e.g., installing a slurry wall and/or grout curtain) around the 300 Area industrial complex to enhance the effectiveness of the groundwater pumping containment action so as to make it practical/cost-effective.

Based on the package presented to the Board, groundwater trichloroethene (TCE) and cis- 1,2-dichloroethene concentrations, along with uranium, are above MCLs in the upper Ringold Formation, yet their treatment is not addressed and there is no proposed remedy for these contaminants in this formation. In addition, it is asserted that the Ringold Formation is not a drinking water aquifer as discussed in EPA guidance (OSWER Directive No. 9283.1-33, June 2009, *Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration*, EPA/440/6-86-007, November 1986, *Guidelines for Ground-Water Classification Under the [1984] EPA Ground-water Protection Strategy, Final Draft*). The Board recommends that the decision documents explain the basis for the groundwater classification in this Area and how the remedy selection approach for TCE contamination daylighting in the river above MCLs in the finer grained interval is consistent with CERCLA, as well as the NCP (e.g., expectations) and Agency guidance on restoration of groundwater to its beneficial use.

Response: The most controversial aspect of the cleanup for Hanford's 300 Area is uranium contamination in the deep vadose zone that continues to migrate into groundwater and sustain a uranium plume. The preferred alternative, #3, uses in-situ treatment to immobilize uranium so that it does not leach into the groundwater above drinking water standards. Alternative #4 uses excavation (remove-treat-dispose) for a small portion of the uranium-contaminated soil and in-situ treatment for the remaining areas. Alternative #5 uses excavation only without in-situ treatment. In accordance with EPA's ROD Guidance (EPA 540-R-98-031), alternative #3 uses phased implementation stages of the remedy that will be used to optimize the remedy for site conditions and increase cost-effectiveness. The Board recommended that additional information be developed to sufficiently support selection of this vadose zone treatment approach. The Region proposes using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of

performance than demonstrated technologies. The Region's preferred alternative includes extensive testing before and after the first phase to both optimize the remedy (in accord with the phased approach in EPA guidance) and ensure it will be effective at restoration of the aquifer to drinking water standards for uranium. The Region's preferred alternative presented to the Board included the provision that if at the end of phase I the remedy is not deemed successful, then a proposed plan and FS for an alternative remedy will be developed and presented to the public for comment. The Department of Energy's letter to the Board explained that $12 million has been spent defining the conceptual model for uranium and evaluating remedial alternatives. The Region's preferred alternative is the best alternative available relative to the CERCLA criteria. The Region does not agree with the Board's recommendation to develop additional information to support remedy selection, which costs more money and delays restoration of the aquifer. The Region believes that remedial actions are to be implemented as soon as site data and information make it possible to do so. The Board recommended the decision documents establish clear benchmarks for defining success (including timeframes) if Alternative 3 is selected. The information provided to the Board included a clear benchmark to define success, i.e. 50% reduction in mobile uranium, but a timeframe was not included. The Region supports the recommendation to add a timeframe for success. The information provided to the Board stated that alternative 3 would attain the uranium drinking water standard in 18 years. Updated modeling indicates it would be attained in 16 years. This restoration time is about half the time it would take under the no action alternative. The Board also recommended consideration of a contingency remedy (e.g. Alternative 4) in case initial treatment proved to be ineffective. The Region did consider a contingency remedy although not Alternative 4. Alternative 4 uses the same in-situ treatment of uranium for most of the contaminated area so if Phase I of Alternative 3 showed in-situ treatment is not effective, the Region would not want that to also be the main part of the contingency remedy. The Region considered the other alternatives but they performed poorly in the CERCLA nine criteria evaluation so the Region does not believe it is appropriate to include any as a proposed contingent remedy. The Board noted that the NCP preamble provides a guideline for effective treatment as 90 to 99 percent reduction in concentration, and the Board recommended that the decision documents explain how a 50 percent success rate is consistent with the statutory and NCP provisions regarding treatment. The Region has worked with DOE to change the preferred alternative #3 to no longer use 50% treatment as the basis for determining success. Rather, under this alternative after treatment, implementation of Phase II will be determined by comparing the number of cycles of saturation of the PRZ required to limit the release of mobile uranium from the PRZ to achieve the remediation goal of aquifer restoration within 50 years as well as the demonstrated efficacy of the ability to deliver and treat the source of the uranium in the deep vadose zone and PRZ from Phase I. The Board recommends that physical and chemical analyses be performed to determine if enhanced transport of phosphate treated uranium particles (colloids) may reduce the effectiveness of the proposed remedy. One of the treatment tests that was performed at the 300 Area injected the phosphate treatment chemical directly into the groundwater. The phosphate did react with the uranium to create autunite which dropped out of solution and groundwater uranium concentration dropped below the MCL. That prior treatability test was done during the time of year when groundwater velocity was high. The Region's data at this site has not shown enhanced transport via colloids. The uranium release tests proposed as part of alternative #3 will measure all the uranium released, regardless of whether or not it is colloid form. So the remedy effectiveness determination will not be affected by formation of colloids. The Board recommended that the Region request DOE evaluate the practicality and cost-effectiveness of physical containment (e.g., installing a slurry wall and/or grout curtain) around the 300 Area industrial complex to enhance the effectiveness of the groundwater pumping containment action so as to make it practical/cost-effective. The Region notes that these technologies were initially considered during development of likely response scenarios, however the technologies were not included in an alternative for reasons including practicality and cost-effectiveness identified by the Board.

Tritium is in groundwater in a small plume downgradient of the 618-11 burial ground. This plume is immediately adjacent to and beneath an operating commercial nuclear power reactor. The Region does not believe it is reasonable for this groundwater to be used for drinking water during the decades this nuclear reactor is operating and the tritium plume decays to the drinking water standard. Alternatives #2-5 all include restoration of the aquifer to tritium drinking water standards after that period. This portion of the Hanford aquifer is relatively stagnant. Since there is no technology to remove tritium from the groundwater, there are no active groundwater technologies the Region could present in the alternatives. The Region believes source removal plus MNA of the groundwater tritium that does not and will not impact any receptors is appropriate for the alternatives. This hydraulically stagnant part of the Hanford aquifer that is miles from the Columbia River and next to and below an operating reactor is a good location for the plume while it decays to drinking water standards.

Regarding groundwater contamination due to organics, alternatives 2-5 have been revised since presentation to the Board. The alternatives now include MNA to drinking water standards.

Monitored Natural Attenuation

In the package presented to the Board, the preferred remedy for the tritium plume would be an MNA approach. During the presentation, the Region clarified that the tritium plume is actually expanding yet the tritium is undergoing decay. The package indicates (page 6) that the tritium MCL (20,000 pCi/L) will be achieved in 17 years with MNA. The tritium concentration in the plume is reported to be 50 times the MCL (1,000,000 pCi/L) in the package (page 5). However, the time to achieve the tritium MCL via radioactive decay (primary attenuation mechanism) is approximately 69 years when calculated from the initial concentration given in the package. The Board recommends that the Region clarify the role of radioactive decay and any additional attenuation mechanisms to meet the RAO goal of 17 years for the tritium ground water plume as per the package. The Board notes that existing EPA guidance on MNA states that a plume should be stable and that all mechanisms be clearly identified to be appropriately considered as an MNA remedy. The Board recommends that the proposed plan and other decision documents provide lines of evidence explaining how the proposed approach would be effective and consistent with OSWER Directive No. 9200.4-17P, April 1999 and the ORD technical background document, *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume III-Tritium*, EPA/600/R-10/093) September 2010.

The Board Chair received a March 26, 2012, letter from DOE in which the Department provided its perspective on the cleanup options for the 300 Area. DOE expressed a belief that natural attenuation continues to be a viable approach to address the uranium plume in the 300 Area. The letter advocates identification of natural attenuation as a contingent remedy to be implemented if a performance benchmark (50 percent reduction in labile uranium) for the uranium treatment is not achieved. Neither the package, the March 26th letter, nor the presentation to the Board, gave any indication DOE has demonstrated the existence of lines of evidence, as discussed in the above referenced EPA guidance, to justify an MNA remedy. The Board does not support selection of MNA as a remedy or contingent remedy unless such lines of evidence exist. The Board further notes that no basis for the suggested 50% reduction performance benchmark is given, and that the relationship between percent reduction in labile uranium and achievement of numeric cleanup goals in soil and groundwater is unclear. The Board recommends that the decision documents clearly reflect EPA's approach which uses achievement of numeric cleanup levels to judge the ultimate success of remediation.

Response: One of the recommendations from the Board pertained to organic contamination in groundwater. Beneath the upper aquifer is an area of fine grained sediment that contains trichloroethane (TCE) and its degradation product, cis- 1,2-dichloroethene (DCE). It is difficult to obtain a water sample from this zone due to the extremely low yield. Sediment cores using well drilling equipment have been collected and interstitial water from the core samples has been extracted which shows both TCE and DCE. Degradation of TCE to DCE and DCE to carbon dioxide consumes oxygen and accordingly measurements in this zone show a depleted oxygen environment. Sampling over time has documented a large drop of TCE concentration as it has degraded. The DCE concentration has not dropped dramatically yet because DCE degradation to carbon dioxide has been offset by additional DCE due to TCE degradation. The Region believes this is an appropriate natural process to allow to run to completion, in particular because there is no current or reasonably anticipated future risk from the contamination while degradation is allowed to complete. The layer of fine-grained sediment below the aquifer is intersected by the adjacent Columbia River. These organics are not measured in the river or river bottom. One potential degradation product of TCE is vinyl chloride which is more toxic than TCE or DCE. Fortunately vinyl chloride does not occur in the groundwater. The Region does not want to propose any alternatives that change the environment in this zone which could induce production of vinyl chloride.

The Region considered three options to address the organics: (1) Removal of the organics would require removal of this sediment layer and is technically impracticable. The sediment layer is partly below land and partly below the Columbia River. There is also the saturated aquifer above the tight layer with organics. It would be technically impracticable to dam off that part of the river, hydraulically isolate the aquifer from adjacent aquifer, dewater the aquifer, exhume the vadose zone and aquifer sediment, and finally exhume the fine grained material contained the organics that are degrading. (2) Monitored Natural Attenuation to allow the organics to complete their natural degradation. (3) No Action, based on no current or reasonably anticipated future risk, and the fact that this groundwater does not qualify as a drinking water aquifer due to the low hydraulic conductivity and therefore MCLs don't apply. The Region presented the third hydraulic conductivity option to the Board. Since then the Region has changed the preferred alternative to be based on monitored natural attenuation for the organics to reach drinking water standards. The Board recommended the decision documents explain the basis for the groundwater classification in this Area and how the remedy selection approach for TCE contamination daylighting in the river above MCLs in the finer grained interval is consistent with CERCLA, the NCP, and Agency guidance on restoration of groundwater to its beneficial use. Since the presentation to the Board, the Region has decided to present an MNA-based remedy for the organics in the proposed plan alternatives. The Region does note to the Board that organics are not detected in the river above the MCLs.

There is a small localized tritium (radioactive hydrogen) groundwater plume beneath the 618-11 solid waste burial ground several miles from the Columbia River. The interim action for 300-FF-2 selected removal of this burial ground, which has not yet been performed. One of the radioactive wastes in the burial ground is tritium gas. This has diffused through the vadose zone and dissolved into the groundwater which is very stagnant in this location. Tritium has a 12-year half life. All the alternatives include removal of the burial ground and MNA of tritium in the groundwater. There is no technology available for removal of tritium from groundwater so a TI wavier could be a viable alternative. The Region chose to include MNA in the alternatives. The Board recommended that the proposed plan and other decision documents provide lines of evidence explaining how the proposed approach would be effective and consistent with OSWER Directive No. 9200.4-17P and the ORD technical background document "Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume III-Tritium" EPA/600/R-10/093. The Region agrees with that recommendation.

The DOE provided the Board a letter which expressed DOE's belief that natural attenuation continues to be a viable approach for the uranium groundwater plume. The Board recommends that the decision documents clearly reflect EPA's approach which uses achievement of numeric cleanup levels to judge the ultimate success of remediation. The Region agrees with this recommendation.

Stakeholders

During the presentation to the Board, a number of issues related to tribal consultation, exposure scenarios in the risk assessment process, and cleanup levels were discussed. Resolution of some of these issues appears to involve federal trustee responsibilities and treaty rights, as well as environmental justice considerations. The Board recommends that the Region continue to work with the Tribes and DOE to ensure that the cultural areas are appropriately addressed consistent with legal requirements and EPA guidance and policy positions (e.g., *EPA Policy on Consultation and Coordination with Indian Tribes,* May 4, 2011). For example, the Board recommends that the proposed plan and other decision documents provide a clear description of "protocols (e.g., tribal archeology) and procedures" regarding cleanup in the cultural areas, and how capping and ICs would be used (if at all) to help ensure protection of human health. If "protocols and procedures" have not been agreed to by the time a proposed plan is published, the Board recommends that the Region consider addressing the cultural areas as a separate operable unit.

Response: The Region has and will continue to work with the Tribes and DOE on these issues. The Region has tried to honor the Tribes' requests and expectations to honor the sensitive nature of Tribal archeology and cultural areas by not providing clear descriptions of protocols and procedures, particularly in the proposed plan, as these are implementation matters that will be resolved as part of remedial design and remedial action planning.

Off-Site Plume

In the presentation to the Board, it was stated that the nitrate groundwater contamination in and around the 300 Area is not associated with activities from the 300 Area. The Board notes that the Region also indicated that up-gradient nitrate groundwater contamination is coming from the west (i.e., the 200 Area) and southwest (i.e., the irrigated agriculture fields and some industry). This would suggest that the agriculture-related nitrate is not site related but may affect the groundwater restoration objective for the 300 Area. The Board recommends that the Region further evaluate whether CERCLA authority should be used to address this plume as part of the remedial action to be selected, and if so, which alternatives (including engineering controls, ICs and/or other response actions) might be needed to address the off-site agriculture nitrate groundwater contamination that could affect the 300 Area cleanup.

Response: 300 Area groundwater is impacted by a nitrate plume that originates off site and flows through the 300 Area. All the action alternatives included groundwater consumption ICs to be protective of potential future groundwater use. The Board recommended that the Region further evaluate whether CERCLA authority should be used to address this plume as part of the remedial action to be selected, and if so, which alternatives (including engineering controls, ICs and/or other response actions) might be needed to address the off-site agriculture nitrate groundwater contamination that could affect the 300 Area cleanup. The Region had extensively evaluated this issue and concluded that the 300 Area CERCLA remedy would not pass the threshold criteria for protectiveness and ARAR compliance if the nitrate MCL violations were ignored in this CERCLA decision. Alternatives 2-5

include institutional controls of groundwater with nitrate above standards to protect human health from consumption of the contaminated water.