START 9613105.0030 0043002 027571

124
R

State of Washington Water Research Center

Address correspondence to:
State of Washington
Water Research Center
Washington State University
Pullman, WA 99164-3002
509-335-5531

MAR 1996 RECEIVED EDMC

16, February 1996

Robert K. Stewart
U.S. Department of Energy
Richland Operations Office
3350 George Washington Way Rm 2D41
Richland, Washington

RE: Submission of Technical Peer Review comment compilation for the draft, *Identification of Contaminants of Concern,* Contract DE-AC06-96RL-13395.

Dear Bob:

40140

The compilation document, "Compiled Technical Peer Review Comments for the draft, *Identification of Contaminants of Concern*" has been electronically transferred this morning to Amoret Bunn, Sandra Cannon, and yourself via e-mail. Enclosed are hardcopies of that document as well as the individual comment sets from the ten participating reviewers (all Technical Peer Review names have been removed from these documents). An individual set of comments is being forwarded to Sandra Cannon.

We are pleased with how smoothly the management and compilation of these reviews has progressed and look forward to our future involvement with the CRCIA project.

Sincerely,

Rene Forman Derewetzky

Rene Forman Derewetzky
Research Associate

William H. Funk
Director

RECEIVED
FEB 20 1996
DOE-RL / DCC

cc Amoret Bunn
encl.

Compiled Technical Peer Review Comments for

Draft Identification of Contaminants of Concern[1]

STATE OF WASHINGTON WATER RESEARCH CENTER
Washington State University
Pullman, Washington 99164-3002

for the

COLUMBIA RIVER COMPREHENSIVE IMPACT ASSESSMENT PROJECT[2]

FEBRUARY 16, 1996

---

[1]Napier, B.A., N.C. Batishko, D.A. Heise-Craff, M.F. Jarvis, and S.F. Snyder. January 1995. *Draft Identification of Contaminants of Concern.* PNL-10400 UC-630 Draft.

[2]Prepared for the U.S. Department of Energy under Contract DE-AC06-96RL13395

Page, Paragraph	Comment	Resolutions
general	Approach The identification of contaminants of concern is a critical first step in any comprehensive environmental impact assessment of this type. The general approach was (1) to conduct a comprehensive review of recent work that involved the measurement of contaminants in Columbia River water, adjacent groundwater, soils and sediments; (2) to select maximum obseved concentrations of contaminants in the media sampled; and (3) to use conservative screening assumptions and calculations to estimate upper limit annual health risks to people and risks to biota living in the river. Based on this analysis, a list of over 600 possible radionuclides and chemicals was reduced to 20 contaminants for which the calculations indicated annual health risks above 10^{-6} or non-carcinogenic hazard rankings greater than 0.1.	

general	Reviewer's Assumptions and Caveats In order to evaluate a report such as this, I assumed that the data are accurate and comprehensive, and that the computations were done correctly. Furthermore, I would have to assume that any reliable monitoring data which might have changed the final list of contaminants were not overlooked. One could question such assumptions, but time and resource constraints precluded any formal challenge of the basic data and the mechanics of the computations. Based on my familiarity with the authors of the report, and my long-term awareness of the environmental research conducted at the Hanford Site, I have no *a-priori* reason to doubt the validity and completeness of the data or accuracy of the calculations. Another point I must make is that although sampling can establish the presence and concentration of a contaminant at the time and place of sampling, no reasonable amount of sampling can prove conclusively that a foreign substance at a particular concentration has never existed in the environment, particularly a system as large as the Columbia River.	
general	Credibility of the Report With regard to the basic data reviewed to perform the calculations, I am very impressed with the number of reports cited, and the many thousands of samples taken and analyses completed. The screening approach used seems reasonable and appropriate for the intended purpose of this document. I can believe that if toxic or or otherwise biologically-significant levels of contaminants have existed in the Columbia River during the past several years, that one or more of the sampling programs would have identified a problem. I see no reason why knowledge of any such problem, especially since the end of the cold war, might have been suppressed. It would seem that the present "cleanup" mission of the Hanford operation could only benefit from open dissemination of all environmental monitoring data. Based on the radionuclides that might be expected at a facility such as Hanford, I am not surprised about those that appear on the final list (Table 9.1). I am not expert in the chemical arena, so I cannot judge the reasonableness of the chemicals that may or may not be on the final list.	

general	<u>Conservatisms in the Screening Calculations</u> The screening approach used is highly simplistic, but I believe it to be very conservative. It is possibly so conservative that actual human health and ecological risks may be over-estimated by several orders of magnitude. Screening is a prudent and necessary approach to narrow the scope of further evaluations to something of a managable size. I reviewed the structure of the screening equations and found them to be logical and reasonable. Some of the conservatisms evident in the screening calculations are: 1. The risk criterion of 10^{-6}/year contrasts with the normal EPA criterion of 10^{-6}/lifetime for carcinogens (including radionuclides). Assuming a 70 year lifespan, this approach has a 70-fold conservatism built in. Even the 10^{-6} lifetime risk seems ultra-conservative to me, considering the fact that the normal lifetime cancer incidence is $>10^{-1}$. 2. Assuming a sediment/water K_d of 10^5 for all contaminants in the sediment pathway seems very conservative, since for the vast majority I would expect K_ds of one to several orders of magnitude less. Furthermore, the sediment pathways may not be very important for the gravel-bottom areas in the flowing sections of the river. Even in the quiet water areas behind the dams, I would expect the most-contaminated sediments from historic releases to be covered with less-contaminated deposits of more recent origin. The finest textured sediments, which typically contain the highest contaminant concentrations, tend to deposit in the deepest regions of the impoundments, which further isolates most of the material from important transport pathways to biota or humans.	

general	Conservatisms in the Screening Calculations (cont.) 3. The assumption in the contaminated soil pathway calculation that the groundwater concentration is equal to the soil concentration also seems ultra-conservative for nearly all the contaminants. Nearly all the radionuclides and metals, for example, would be expected to have K_d values from one to several orders of magnitude greater than the assumed value of 1.0. I would also expect most contaminated soils at Hanford to be in the vadose zone and seldom subject to the leaching effects of flowing groundwater. If this is actually true, then this provides another major conservatism. 4. The estimates of human consumption rates of water, fish, and sediments seem quite conservative for the majority of the population using the river for recreation. However, I'm not familiar with actual consumption patterns of Native American Tribal Members that use the Columbia River. If there are such data, they should be incorporated into the screening calculations. 5. For the ecological risk assessment, I could believe that there may be small, local areas along the Hanford shoreline where biota could be subject to potential contaminant impacts. However, the large size and volume of the river has enormous dilution potential, as well as a very large adjacent area that is apparently not impacted by contaminants from Hanford operations. Furthermore, animals such as fish and waterfowl move over large areas of the river and would not be expected to reside for any significant length of time in small, local areas with measureable contamination. Any local impacts on biota, irrespective of whether mortality, reproduction, or genetic damage was involved, would, in my opinion, be overwhelmed and selected out of the population over time by the large reservoir of unimpacted individuals. 6. The use of 1 % of the LC_{50} toxicity values for aquatic biota should provide yet another conservatism to account for any sublethal impacts, although use of this particular value could be better-justified. 7. Finally, the use of maximum observed concentrations would have a strong tendency to bias the calculations in the conservative direction.	

general	Concerns One area that is not covered in this document is the future potential, however remote, of large, accidental releases from waste storage tanks or from decontamination/decomissioning of buildings. Another is the ecological and human health impacts of the actual cleanup of contaminated sites. Such events and activities have the potential to release contaminants to the environment, resulting in levels much higher than those currently measured. Also, such releases could include contaminants that may not be on the final list of twenty substances targeted for further evaluations. While these topics may be outside the scope of this particular document, they would constitute my primary concern for the potential impacts of Hanford on the future integrity and quality of the Columbia River system. Another concern that might be raised is that this document does not discuss the next step in the evaluation of contaminants on the final list of 20 to receive futher work. Clearly, I would expect a lack of site-specific data on K_ds, bioconcentration factors, etc. for certain contaminants. Such data would be crucial to the credibility of more rigorous evaluations. A more detailed and realistic evaluation should include an uncertainty analysis, yet the uncertainties are likely to be quite large if the proper site-specific data are lacking. One purpose of the present report could be the identification of such data needs.	
general	Throughout the document, the screening levels are referred to as tools to evaluate potential risk to humans and other biota. Yet the techniques used to derive an estimate of radiation risk are based solely on human consumption of, or external exposure to, radioactive and chemical constituents. Other than the use of a bioconcentration factor for fish, no attempt was made to estimate dose rates to aquatic or terrestrial species. Are the authors assuming that if the risk to humans is less than 10^{-6}, the risk to other biota is negligible? If this is the case, they should provide references to that effect (for example, IAEA, 1992, Effects of Ionizing Radiation on Plants and Animals at Levels Implied by current Radiation Protection Standards, Technical Report Series No. 332, Vienna, Austria; or NCRP Report 109, Effects of Ionizing Radiation on Aquatic Organisms, 1991.)	
general	The inhalation pathway was apparently ignored in this screening assessment, although the discussion in section 5 makes this statement a bit uncertain. It would be appropriate to consider inhalation of resuspended silt or clay sized particles which tend to have higher concentrations of contaminants.	

general	The screening level equations which dilute the groundwater seeps into the greater volume of the Columbia river ignore the potential impacts on biota living in the immediate (undiluted) vicinity of the seeps.	
general	The screening level equations are dimensionally correct, but are not conceptually explained as to why they should be accepted. Also, for screening levels one would, presumably choose parameter values that maximize the dose or risk estimate - for example the 2 L/d consumption of drinking water is a standard value used in radiological assessments - why not pick an upper bound value, since this approach is meant to be an extremely conservative method for identifying potential contaminants of concern?	
general	The screening level approach ignores the fact that consumption of foodstuffs grown in contaminated soils/sediments/waters may account for >99% of potential dose in some scenarios. If a contaminant yields a screening level risk of 10^{-6} based solely on water or soil ingestion (and therefore subject to elimination from consideration), its potential risk from other exposure routes could be at the 10^{-4} level, far above the trigger point.	
general	Basing all the screening on estimated water concentrations ignores pathways to shore dwelling biota such as external irradiation from contaminated sediments.	
general	Using an arbitrary K_d of 100,000 to predict water concentrations from soils or sediments is not necessarily conservative for many elements such as Am, Co, I, U, etc. (Source, Till and Meyer, Radiological Assessment, NUREG/CR-3332).	
general	The document does not clearly state the intended uses of the resulting list of contaminants of concern. If one of the purposes of this list of 20 contaminants is to determine the constituents analyzed in future monitoring efforts, then the list excludes many potential contaminants of concern for which data are lacking or where concentrations of these potential contaminants may increase with time.	
general	The exposure scenarios should be expanded to include exposure pathways that are typical of Native Americans. A table is attached showing potential routes of exposure that are consistent with the traditional Native American lifestyle.	
general	The current methodology does not evaluate the synergistic or additive risks from the complex chemical mixtures present at the Hanford site. Nor does it evaluate teratogenic, mutagenic, immunologic, developmental, or multigenerational effects. How will the CRCIA project incorporate these added risks in the evaluation process?	

general	Washington regulations under MTCA do not allow dilution of groundwater with surface water to achieve cleanup standards. Given the paucity of information regarding water quality in the river bottom gravels where salmon eggs are laid, and the numerous instances of groundwater concentrations exceeding fresh water chronic criteria in nearshore point of compliance wells, a more conservative approach is warranted.	
general	The CRCIA project must keep in mind that many of the previous studies on which this document is based screened out potential contaminants of concern in groundwater that were above ARARs if they occurred in unfiltered samples and not in filtered samples. These studies typically do not justify their exclusion of the unfiltered concentrations. That is, they do not demonstrate that the contaminants are not bioavailable for particle sizes greater than the filter size that was used. Thus, the raw data used as the basis for this effort should be closely scrutinized and include unfiltered concentrations of contaminants. This is particularly important because a primary exposure scenario is the ingestion of unfiltered river water. Where unfiltered data do not exist, the risk assessment should identify those areas as data gaps and include with future monitoring programs.	
general	This report should remain within the negotiated scope. If the scope of the CRCIA is to evaluate the risks associated with contamination of the *river and 500 ft. shoreline*, discussion of potential contamination from sources further inland should be omitted. If the scope of the CRCIA is to evaluate the *present* risks, then discussion of the potential for future contamination and associated risk should not be included. This comment will be resolved by reviewing the statement of work and, if appropriate, editing the document such that it is consistent with the stated scope.	
general	It is unclear as to whether all the background levels of radionuclide contaminates that are currently available have been subtracted during the screening. The Hanford Site Background Concentrations for most of the non-radionuclides are cited from the 1994 background document. It is appropriate to incorporate the Hanford Site-specific radiological data too. The Westinghouse Hanford (Scott Peterson?) report may be most comprehensive in this regard. This comment will be resolved by confirming that each of the contaminates were screened against the most recent determinations of background concentrations.	

general	A comprehensive assessment is desired by all. However, the degree of sophistication achievable is limited by the scientific uncertainties inherent in each component of this risk evaluation. In this regard it should be noted the toxicity assessment does not incorporate scientific advances made over the last decade. For example, the process by which the slope factors were derived does not consider biological defense mechanisms such as DNA repair or the normal processes of cellular turnover. In light of more recent scientific information, it is now a general consensus among toxicologist that the margin of safety that is incorporated into toxicity factors is large. The appropriateness of this large margin of safety is increasingly controversial. It is the opinion of this reviewer that the margin of safety, in just the toxicity assessment component, is at least one order of magnitude for the radionuclides and at least two orders of magnitude for the non-radioactive carcinogens. It is likely the margins are larger. The margins of safety are sufficiently large to adequately protect human health even though a limited number of pathways are considered. Additional assumptions made by the assessor in the face of scientific uncertainty in assessing additional pathways blur the distinction between what is of concern and what is not. This limits the usefulness of the screening exercise. I suggest that the protection gained by considering additional pathways does not balance with the reduced reliability of the screening. For this reason this reviewer suggest that biota ingestion pathways not be incorporated in the screening process.*	
general	What is the process for dealing with contaminates for which there is no toxicity factor? What is the source of the oral slope factors for Benzo(b) and Benzo(k) Fluoranthene?	
general (note)	I developed the comments and opinions described below by reading the "Identification of Contaminants of Concern" report without considering comments that had been written earlier by others. After reading the report and writing my comments, I reviewed comments that that been previously submitted by the Washington Department of Ecology, the US EPA, the Washington Department of Health, and the Nez Perce Tribe. Although some of the issues described below were also identified in these earlier comments, I decided to keep my comments as originally written and to let these redundancies reflect similar opinions.	

general	The purpose of this project, as described in the preface of the report, is "to determine if enough contamination exists in the Columbia River to warrant cleanup actions under applicable environmental regulations." I would like to suggest that a better objective might be to use the risk calculations to prioritize cleanup actions at the site. Using risk analysis to determine if cleanup should be undertaken requires that the risk calculations have some meaning in an absolute sense. I would argue, or at least hope, that few people actually believe that the risk numbers that we derive have much meaning in absolute terms. However, in relative terms, these numbers can tell us which sites or contaminants pose the greatest risk, given the assumptions on which the risk calculations are based. Adopting the objective of prioritizing sites rather than a binary "yes or no" decision on whether a cleanup action should be included in the risk evaluation would seem to take some of the pressure off the risk calculations. This objective would require that more constituents and more sites be included in the study, but I think, in the long run, it would be more efficient than spending time and efforts arguing whether a particular risk number is "significant" or "insignificant." An additional advantage of using the risk calculations to prioritize sites rather than to eliminate them is that the prioritization would allow comparisons to be made across DOE facilities. What might be considered a small risk at Hanford could be a relatively substantial risk at some other DOE site. If budget allocations are ultimately made based on these risk calculations, Hanford could be short-changed if sme of its sites are dropped from the risk analysis at this point in time because they fall below some arbitrary risk level.	

general	I had expected the tone of the report to be more neutral. I recognize that science is somewhat subjective, but I found the report to use a language of advocacy that I found annoying. I have listed below several examples of instances in which I found the report to use language and wording that is less objective than it might be. These examples may seem trivial and inconsequential, but I do believe that a tone is set in the report that will be aggravating to some readers. The effect of this on my review was that I became more defensive and perhaps less objective as a result of the tone. I suspect this tone would have a similar impact on others. I recommend that each report be reviewed by an editor whose sole task is to ensure that the language and writing is as objective and value-free as possible. p. 3.1 "Many of the analytes found are naturally occurring....." What does "many" mean in this sentence? Could one also state that "Many of the analytes found are directly a result of activities at the Hanford site?" If so, why not include the latter sentence as well? p. 4.1 "sediment ingestion rate of 10 milligrams/day (almost 4 grams/year)." This could also be written as "sediment ingestion rate of 10 milligrams/day (less than 4 grams/year)." Why not write it the second way instead of the first? Or better yet, try to make it more neutral with "approximately 4 grams/year." p. 7.1 "Those contaminants contained in Hanford tank farms or burial grounds may not pose a future hazard." I would suspect that the following would be at least as valid: "Those contaminants contained in Hanford tank farms or burial grounds may pose a future hazard." p. 10.1, paragraph 3 "all contaminants to be quite low in Columbia River sediment." What is meant by "quite low?" Low relative to what?	

general	I was a bit troubled by the scope of a "comprehensive impact assessement" that does not consider "the potential impact of contaminants that are not presently in the groundwater but which may be in soils or facilities away from the Columbia River." A compelling argument could be made that the greatest risk to the Columbia could be from some short-term catastrophic event such as a tank explosion, rather than the more slow and continuous risk posed by existing subsurface contamination. Futhermore, the biggest risk reduction, in terms of dollars spent, might be derived from treating contaminants at their source (e.g. soils or tanks) rather than after they have reached the Columbia River.	
general	This may be related to my Comment #3 (directly above). The fact sheet dated January 11, 1996 that accompanied the report indicates that "the work essential to an acceptable comprehensive assessment will be defined by the project management team while the scoping level impact assessment is being performed." It is not clear to me what is meant by a "scoping level impact assessment." Does it make sense to continue with the impact assessment if the work is going to be re-done? Should the tasks in the ongoing work be redefined to maximize the likelihood that it will be useful for the subsequent "truly comprehensive assessment?" I would think that the work product for the current study would be somewhat different if it is known that a subsequent study will be conducted. Has the scope of work for the ongoing assessment been redefined to reflect the fact that a follow-up study will be conducted?	
general	My comments are limited to the ecological risk assessment (ERA). The principal problem with this screening ERA is it has no problem formulation. Much of the confusion that led to the comments from the regulators and Nez Perce (some of which are repeated here) have to do with issues that should have been laid out at the beginning of the assessment but were not.	
general	Some of the issues that are treated as technical comments by the regulators are actually risk management (i.e., policy) issues that should have been settled by the FFA parties ahead of time. When policy issues are settled they should not be reopened as if they were technical issues. For example, the issue of screening out undetected chemicals when EPA-approved methods or equivalent are used has been standard practice in many EPA regions and the DOE's contention that that policy is in place at Hanford seems probable given my experience. However, the EPA objects to the practice in this case without acknowledging the policy agreement. The DOE needs to make it clear in the text when they are invoking such policy judgements and cite their source so as to clearly differentiate them from technical judgements..	

general	The inclusion of potentially higher future exposures is another policy issue that should be resolved among the FFA parties and clearly enunciated in the assessment. Currently the DOE's position is unclear.	
general	The report succeeds in bringing together enormous amounts of information into a manageable document. Most of the information on assumptions, parameters used, etc. could be found in the report appendices.	
general	Much of the critically important information is deep in the report (specific examples are given below). Suggestion: Bring some items forward into the Abstract and earlier parts of the report.	
general	The report shows an enormous amount of effort and provides a wealth of information. Some areas can use improvement. Suggestion: Focus on correcting the weaknesses.	
general	Because this document includes a good deal of monitoring data, the quality assurance (QA) program under which it was done is of interest and is, indeed, critical to a review. Are the data assured to NQA-1? NQA-3? It would be wise to append the QA Project Plan, or at least to refer to it. Appending a QA plan would also head off future arguments about data quality.	
general	The purpose of the Columbia River Comprehensive Impact Assessment (CRCIA) is to assess the impact of operations at Hanford on the Columbia River. In that context, a map showing monitoring sites both upriver and downriver from the Hanford operations is needed. The map should also show the locations of springs and seeps, because these are referred to in the text and in some of the comments on the document. Moreover, tabulated monitoring data should include data from sites upriver and downriver from Hanford. If tables refer to contaminant concentrations at particular locations (e.g. the references in Table 3.2 to concentrations at the 100, 300, and 1100 areas) the concentrations at those specific sited should be given.	
general	Tables should include reference concentrations (e.g EPA RfD values) using the same units as the monitoring data.	

general	Because the purpose of this impact assessment is to assess the impact of Hanford operations on the Columbia River, and not to assess the water quality of all of the Columbia downstream from Pasco and Kennewick, the document should concentrate on those contaminants that enter the river along the Hanford Reach or other locations where the source could be traced to Hanford runoff. Many contaminants enter the Columbia River from agricultural runoff, highway runoff, and urban and suburban stormwater runoff. There may also be industrial runoff downstream (and upstream) from Hanford. It is important, therefore, to compare assays of downstream water with assays at those points where contamination traceable to Hanford operations enter the river. The latter assays are only to identify contaminants, and it is probably better if they are done on entering water that is not yet diluted by river water. the important thing is to separate the contamination for which the Hanford operations may be responsible from other contamination.	
general	A serious deficiency in the report (particularly in Sections 8, 9, and 10) is a comparison of substances entering the river at Hanford and *upstream* contaminants and sources of contamination. This EA should determine the contaminants that Hanford operations add to the Columbia (or potentially add to the river) beyond those added by upstream sources, not just what is found at Hanford and downstream. There is considerable acreage in agricultural production upstream from the Vernita Bridge; how, for example, does nitrate runoff compare with nitrate contamination from Hanford? Without this type of comparison, the CRCIA is potentially much less useful than it could be.	
general	In my opinion, the appropriate contaminants have been identified. However, substantiation of their selection should be stronger. The screening approach is acceptable, but there are remaining questions about the screening method (see specific comments below).	
general	A glossary of all acronyms used should be included.	

general	All Hanford-released contaminants at the Hanford site are of concern, because of our lack of knowledge of all the ways these contaminants may damage living organisms (see twenty potential sources of underestimation of damage in the comment regarding page 10.1, below). This damage may be caused by single contaminants and/or contaminants in combination with other contaminants and vulnerabilities of the organisms and their inter-species relationships. Therefore, this report should be called "A Selected List of Contaminants of Concern." This list has been selected on the basis of a specific set of assumptions and is therefore not actually "identification" of contaminants of concern, as if some contaminants have been identified factually as of concern, while others have been identified factually as not of concern. In other words, under different sets of assumptions (e.g., different assumptions regarding the significance of absence of chronic effects data or the significance of cumulative impacts), and even different data (e.g., inclusion of suggestive field data on Hanford-area species as well as related species or organisms), different lists of "contaminants of concern" would be generated. This list, then, is just a list of some contaminants of concern according to certain selected assumptions. Nothing more can be claimed for it.	
general	2.This report needs to indicate when screening results for individual analytes have been based on available field and experimental data versus when they are bsed on default assumptions in the screening formulas.	
general	This report needs to be written in a manner that is meaningful to the public, e.g., showing visually which areas and which media (e.g., underground water plumes, soils, sediments) in the study site are assumed to contain which contaminants of concern. This would give some sense of which areas contain multiple contaminants of concern.	

general	Department of Energy responses to many (not all) of the comments made by the Nez Perce Tribe, Department of Ecology, Department of Health, and U.S. EPA are terse, undocumented assertions. An example of this is the Department of Energy response to a U.S. Environmental Protection Agency concern regarding failure to consider any interactive effects of contaminants. The response is: "Not Accepted. The limits [what are these?] on the conservative [according to whom?] screens are set very low [what does this mean?] for each contaminant. If interactions do occur, they are not expected [according to whom?] to increase the risk by even an order of magnitude; thus the eliminated [?] contaminants are not expected [by whom?] to contribute significantly to risk." This is not an appropriate response. If I receive an undocumented, uninformative response like that to any of my comments, I will pursue that response until I get adequate information and documentation from the Department of Energy for their response.	

general	The undocumented, oft-repeated assertion in both this report and Department of Energy responses to commenters to the effect that this screening is "conservative" is both a non-verifiable assertion, and arrogant. For instance, the Department of Energy asserts that "Conservatism will be retained in this screening report. We expect to use realistic values in the final assessment" (Response to the U.S. Environmental Protection Agency Comments of February 28, 1995, on "Identification of Contaminants of Concern", response to comment #27). This presupposes that the Department of Energy knows what is "conservative" and what is "realistic." Unless the report authors admit that they could be potentially underestimating damage and risk (see comment relating to p. 10.1, below) just as they claim they are potentially over-estimating damages, then any statement about "conservatism" has no credibility. The above-stated plan to "use realistic values in the final assessment" is an ominous statement. Unfortunately, "realistic values" probably does not refer to additional ecological, field, experimental, and observational data about the effects of the analytes in the real-world environment, but rather to using probabilistic assumptions. Contaminants of concern are of concern in part because in reality we know very little about their overall potential to harm and to contribute to degradation caused by other compounds. Any move toward "realistic" assumptions will need to consider the twenty factors potentially leading to drastic underestimation of impacts, as noted below in the comment on page 10.1. Those factors constitute realism.	
general	Ultimately, the list of "contaminants of concern" that the Department of Energy is generating using the particular assumptions that PNL has chosen to use, must not be used as a weapon against concerns raised about these and other contaminants on the Hanford site based on evidence not considered in this exercise. In other words, field or experimental evidence of endocrine disruption may be found at some point with some of the contaminants. This information has likely not been considered in developing any of the EPA Water Quality Criteria used in screening contaminants by PNL. Or a field study by a graduate student somewhere regarding one of the analytes might be turned up in coming months. Such information must be considered, on an ongoing basis, as actions are chosen for contaminants on the Hanford Site. In other words, it is not scientific, realistic, appropriate, or acceptable to decide, at any point, that "THIS list is our list of contaminants of concern, and other contaminants are not of concern."	

general	I read the reports with two questions in mind: • If I were a citizen reading this report, would reading it increase or decrease my confidence that human health and the environment were being protected? • Would it increase my understanding of the central issues? After reading the documents, I can answer those questions with a rousing: "It depends!" The key issue is who is the intended audience. If the audience is intended to be only technically qualified reviewers, then the documents are well-written. Having read numerous technical reports, I would say these show signs of having been polished by a good technical writer. The language is clear and concise. If the audience is intended to be an interested and intelligent citizen, without qualifications in biology or chemistry, then quite a bit needs to be done to make the documents more accessible. As (I will indicate below), all of these suggestions assume that you want a document that a general reader can deal with. If you want a technical report only, the present report is generally clear and well-written. Whether it's technically adequate I will have to leave to the other reviewers.	
general	For the general reader to get anything from the report, the report must tell a story about what's being studied and why. The impression I had reading this report was that the story the general reader needed to hear was always assumed to be understood by the reader. It's always just out of reach for those without technical training. If you want to reach the average reader I suggest the report have sprinkled throughout a series of boxes that provide a running commentary that tells the reader what is happening and why the next section matters. For example: (see Chapter examples below)	

general	CHAPTER 1 We know that in the past chemicals and radioactive materials ("radionuclides") from the Hanford Site reached the Columbia River, and some continue to enter the river today through water in the soils ("groundwater") that moves slowly towards the river from the old production sites. What we're trying to do in this study is to figure out whether these chemicals or radionuclides -- the contaminants -- pose any risk now. The first step is to determine exactly what chemicals and materials are in the river, and whether they are "of concern." A contaminant is "of concern" if it could harm either human health or there is ecological risk. The purpose of this study is to get agreement on a list of those contaminants that are in the river (or in river sediments) that have known radiological, carcinogenic or toxic effects to humans or to the environment. Future documents will deal with other questions such as: Which of these contaminants should be of the greatest concern? What actions, if any, need to be taken to protect human health or the environment?	
general	CHAPTER 1 (cont.) The question we're addressing is what contaminants are there right now, so we relied on the most recent monitoring rather than going back to look at contaminants that may have reached the river in the past. We concentrated on water, sediment, or soil in or within 500 feet of the Columbia River. That's because those areas are the closest to the source, so they will have the highest contamination. Contamination further away from the source will be lower, usually considerably lower, than the figures shown in these studies. We also looked at the potential for future pollution from contaminants we know are in the groundwater under the Hanford site. We didn't consider contaminants that are in the soil under the Hanford site if they are not in the groundwater, since it won't reach the river unless it gets into the groundwater. Other studies are looking at ways to clean up such contamination before it gets into the groundwater. CHAPTER 2 This chapter lists all the studies and other documents we relied on in preparing this report. It's important to list these so that other scientists can go back and verify the information we used.	

general	CHAPTER 3 The first step was simply to compile a list of all the chemicals and radionuclides that have been tested for at any time, whether or not they were ever detected. These are shown in Tables 3-1 to 3-3. For those chemicals or radionuclides that were detected, we identified the highest detected amounts any time during the period from 1980-1994. Using the highest figure was a way of being cautious.	
general	CHAPTER 4 We then created a series of theoretical "screens" through which we could pass all the contaminants that had been detected, retaining only those contaminants that were "of concern." There are a limited number of ways that humans could be exposed to these contaminants, and all of them require that the individual vists the shores of the river frequently. A human being could be exposed by drinking untreated river water, by eating freshwater fish from the river, or by somehow swallowing sediment. Our assumption was that the amount of exposure was equal to someone who drank 2 liters or untreated river water every day, consumes about .25 kilograms of fish every day (or 100 kilograms a year), and ingests about 10 milligrams of sediment each day (or 4 grams/year). That's a lot. We believe that very few, if any, people ever receive this much exposure. But we're trying to be safe. When it came to the environment, we relied on criteria developed by the U.S. Environmental Protection Agency, called Ambient Water Quality Criteria, and we also considered what concentrations of a contaminant could kill fish, and set a level that was only a fraction of that amount. We looked at actual sample of Columbia River water, and, based on our screens, we identified the contaminants shown in Table 4.1. Then we looked at groundwater samples taken within 1 km of the river. The contaminants from those samples are shown in Table 4.2 We also looked at sediments taken from the river, identifying the contaminants shown in Table 4.3. Finally, we looked at samples of soil taken from near the river. The contaminants in these soils are shown in Table 4.4.	

general	CHAPTER 4 (cont.) One of the problems, of course, is that we were looking at reports that summarized literally thousands of samples. It's inevitable, with that many samples, that people are bound to make a mistake every now and then. We don't want to list a chemical as a problem just because someone made a mistake. So we looked at whether any result was significantly different from other samples, or just didn't make sense from what we lnow about the river. For example, two chemicals were detected in only one sample. But when we looked at the study closely, we found that during the same sampling process these chemicals showed up in another sample taken upstream of Hanford. Since these chemicals are contained in laboratory or industrial solvents, it's likely that the sample itself was contaminated during the laboratory work. In any event, because the chemicals were also detected upstream, these chemicals didn't come from Hanford. Although there were several cases like this, we didn't drop any of these suspected mistakes from the report. But we did put a footnote by them showing our concern about how valid they are. These examples illustrate the kind of commentary that could be inserted in boxes to be helpful to the general reader. Technical people could skip over them if they preferred.	
general	To tell "the story" it would also be helpful if you had a diagram that showed what questions this report answered, and what questions will be addressed in future reports. For example: • What contaminants can be detected in the river? • What's the maximum amount ever detected since 1980? • Could this amount be a health or environmental risk? etc. This will reassure readers that even if their concerns aren't being addressed yet, they will be.	
general	There are several points at which graphics would be helpful, especially: • Pathways by which human health could be affected • A figure showing the "exposure" levels for humans. Ideally, if the information is available, this would even compare the "exposure" levels with normal human exposure for Tri-Cities people.	

iii	The word "contaminants" is vague, and may be interpreted by some readers as including all "pollutants" occurring on the Hanford sites, or at least within 150 meters of the river. To other readers, "contaminants" may exclude those materials in storage. In the case of unlined ponds or landfills, this may be a judgement call. Does this report include or exclude materials in waste management units? Do any of waste management units occur in the area under consideration? These are listed as including spills, cribs, ditches, ponds, tanks, trenches, landfills, burial grounds, pits, French drains, and other ...". Is this material considered as being contaminants in this report, or as being in storage and reported elsewhere? Are any pollutants unaccounted for that reside between soil and groundwater. (Does soil = surface soil, or everything above the ground water?) For example, in Section 4, it is stated that analytes in tanks were not included in this study. For example, in section 7, it is made clear that there are many stored materials that can contribute to future ground water problems, and that chemicals now stored in tanks, landfills, decommissioned reactors, including submarine reactors, nuclear fuel storage units, etc. are not included in this report, but other reports are referenced. Suggestion: State the limitations on this report more clearly in the Scope Section (1.3) and Screening Section (4.0), and mention earlier in summary, etc. Cross reference to Section 7 for other reports.	
iii	Preface: This is well written.	
v	Abstract: Very little information is provided in the Abstract. If the Abstract is to be the portion available via computerized literature searches, this abstract provides very little information. Suggestion: The chemicals of concern (all three columns) should be listed in the abstract, along with the purpose and limitation of the study.	
v	Abstract & Summary: Is there a good reason to have both an abstract and a summary?	

vii, para 4	The word "contaminants" is vague, and may be interpreted by some readers as including all "pollutants" occurring on the Hanford sites, or at least within 150 meters of the river. To other readers, "contaminants" may exclude those materials in storage. In the case of unlined ponds or landfills, this may be a judgement call. Does this report include or exclude materials in waste management units? Do any of waste management units occur in the area under consideration? These are listed as including spills, cribs, ditches, ponds, tanks, trenches, landfills, burial grounds, pits, French drains, and other ...". Is this material considered as being contaminants in this report, or as being in storage and reported elsewhere? Are any pollutants unaccounted for that reside between soil and groundwater. (Does soil = surface soil, or everything above the ground water?) For example, in Section 4, it is stated that analytes in tanks were not included in this study. For example, in section 7, it is made clear that there are many stored materials that can contribute to future ground water problems, and that chemicals now stored in tanks, landfills, decommissioned reactors, including submarine reactors, nuclear fuel storage units, etc. are not included in this report, but other reports are referenced. Suggestion: State the limitations on this report more clearly in the Scope Section (1.3) and Screening Section (4.0), and mention earlier in summary, etc. Cross reference to Section 7 for other reports.	
xiii	"Carcinogenic chemicals". I would suggest, "....contracting cancer at some point after exposure." The phrase "later in life" is misleading; childhood cancer can occur a relatively short time after exposure to certain carcinogens.	
viii	The descriptions of carcinogenic and toxic chemical screening are confusing as written. For example, while there is no carcinogenic external exposure risk in many cases, carcinogens may well pose other risks on external exposure. Adverse effects from external exposure certainly occur from many non-carcinogens: acids are an almost trivial example. I believe it is just the statement that is confusing. What is clearly meant is that the maximum measured concentrations are not sufficient to pose any risk from external exposure for either carcinogens or non-carcinogenic hazardous chemical compounds. Moreover, in my opinion, the term "hazardous" is to be preferred to "toxic."	

viii	It should be noted that the radionuclide screening is based on exposure of humans to the contaminants of concern.	
viii	The text states that the initial screening eliminated contaminants that showed no detectable levels of activity or concentration. It would be appropriate to add a sentence noting the time interval encompassed by the data.	
viii, para1	Something should be said here to give the reader some feel as to how hard people have looked for contaminants in the river environment.	
viii, para1	Screening of contaminants based on non-detectable concentrations is not appropriate if the detection limits are above ARARs. I disagree with your response to the EPA comment stating "The detection limits typically used in data collection at Hanford over the last 15 years meet or exceed those established by the EPA". At sites other than Hanford, detection limits are typically set at a level at or below the most stringent ARARs. In our reviews of other Hanford documents we have found many cases where detection limits were well above the cleanup standards and were not attributable to interference or method limitations. This is not just a situation that occurred in the distant past. For a recent example, the 300-FF-5 RI/FS document (DOE/RL-94-85 - not listed in Section 2.0: Data Sources, but it should be included) revealed several heavy metals and organics where detection limits were above standards. To illustrate, the 300-FF-5 RI/FS risk assessment screened out vinyl chloride based on non-detectable concentrations. However, for approximately 74% of the analyses a detection limit of 10 ug/l was used which is 50 times the MTCA groundwater standard of 0.2 ug/l. In the case of vinyl chloride this is particularly concerning given that TCE above MCLs is present in the 300 Area groundwater, and the fact that vinyl chloride is a highly toxic degradation product of TCE. Thus, lower detection limits for vinyl chloride and other TCE degradation products should be consistently used. In addition to vinyl chloride, metals including cadmium and lead were analyzed in many samples using detection limits above MCLs or chronic fresh water criteria.	
viii, para 2	Risk assessment methodologies based only on the risk of cancer to an individual organism will not account for mutagenic, teratogenic, or developmental effects in the organism or its descendants. In addition, it only evaluates the risk to those organs in which cancer develops.	

viii, para 3	External risks from carcinogenic chemicals include dermal contact with contaminated plants, fish (and other game), sediment, soils, and water. Inhalation of contaminated dust and smoke from burning plants (used for Native American rituals and in food preparation) are other exposure scenarios to incorporate. Inclusion of crop ingestion as a pathway is also important as indicated in Ecology's comments.	
viii, para 6	I might expect crayfish or insects to be less susceptable to many toxins than fish. Where this is true, these organisms would not seem to be a conservative surrogate for fish.	
viii, para 7	It could be mentioned in this paragraph how the background was determined for the various substances.	
ix	The section on river sediment assumes (without justifying the assumption) that contaminant concentration in the sediments is 100,000 times higher than in Columbia River waters. I wonder why the distribution coefficient (K_d) was not simply measured, or why there have been no measurements of K_d for Columbia River sediments published. The proposed value cannot just be accepted at face value, although it appears to be in the appropriate range for river sediments. The next paragraph contains the assumption that 1%of the Hanford soil is contaminated to the maximum concentration. No evidence or background is given for this 1% figure, and there is no indication whether it is high or low. The number of 1% needs some evidentiary support.	

ix, para 2 and 4.5, para 1	This is a general comment concerning the approach used in the report to estimate surrogate river concentrations from groundwater concentrations. The specific issue is described on Page ix, paragraph 2 "For conservatism, ...the value of 100 cfs was adopted for the screening. In effect, this implies that the entire groundwater that flows from beneath Hanford to the Columbia River is contaminated to the maximum level measured." Page 4.5, paragraph 1. "For conservatism (i.e, to provide an overestimate of the resulting concentration in the river) the upper value of 100 cfs was adopted for the screening. In effect, this implies that the entire volume of groundwater that flows from beneath Hanford to the Columbia River is contaminated to the maximum level measured." The report argues that the methodology used to estimate river concentrations from groundwater measurements is conservative because of the assumptions described above. However, there are other assumptions, some implicit and some explicit, that tend to make this methodology non-conservative. For example, it is implicitly assumed that monitoring wells are placed in locations where the groundwater is most contaminated. It is explicitly asssumed that complete mixing occurs in the river with an average flow rate of 100,000 cfs. With the proposed approach, the ratio of the measured groundwater concentration to the calculated river concentration is 1,000. (The maximum observed groundwater concentration is divided by 1,000 to get the assumed river concentration.) Table B.1 shows several examples where this approach is non-conservative: Copper: 516 in groundwater/22 in river water = 23 Magnesium: 55,000 in groundwater/9,860 in river water = 5.6. Mangenese: 400 in groundwater/22.8 in river water = 17.5 Sodium: 200,000 in groundwater/13,800 in river water = 14.5 Tritium: 1,900,000 in groundwater/4,430 in river water = 438 Toluene: 2.9 in groundwater/4.7 in river water = 0.6 A "dilution factor" of 1,000 seems to be non-conservative in many instances. I suggest that one might use the actual data as described above to come up with some reasonable dilution factor.	

ix	In the section on **River Sediment** an equilibrium ratio of 1:100,000 is assumed for contaminants. This is extremely conservative for many elements (the sediments are sucking the contamination out of the water). This statement appears at odds with the one which appears in the next section (**Near-River Soil**) where it is assumed that all contaminants are environmentally mobile and potentially dissolvable in groundwater. A statement acknowledging the apparent inconsistency, and the rationale behind it, would be appropriate.	
ix, para 1	I was surprised that actual data on fish were not used. Instead, fish concentrations were estimated from the product of water concentrations and bioconcentration factors. Why is this the case? Were there any actual data on fish? If so, why not use such data directly in the dose calculations.	
ix, para 2	How firm (and conservative) is the maximum groundwater flow estimate of 100 cfs into the Hanford reach?	
xi	The penultimate paragraph has some syntax errors. What is meant by "essentially associated with soil near the river"?	
xiii	(a) Definitions of the 100, 200, etc. areas should include reference to the map of Figure 1.1. (b) The appropriate definition of "bioconcentration factor" is "ratio *of* (not "on") the radionuclide concentration in biota *to* (not "and") the water in which the biota live and feed, *or the ratio of radionuclide concentration in any step of a food chain to that of the next lower step*." (c) Add "(sometimes called "Superfund")" to the definition of CERCLA. (d) The definition of "concentration" is wrong. Concentration is the amount of dissolved substance (solute) in a given quantity of total solution (e.g. grams of salt per liter of salt solution) or in a given quantity of solvent (e.g. grams of salt per kg of water). (e) A conceptual model is a conceptual representation of a process. (f) Definitions of alpha, beta, and gamma radiation should be included.	
xiii	The definition of **bioconcentration factor** should include a statement as to whether or not the ratio is a fresh or dry weight value.	
xiii	In the definition of **Ci**, note that the term is fully defined in the text below.	

xiv	(a) "Half-life" is the time required for ... to be reduced to half ... by *radioactive decay* (not "radiological transformation"). (b) The definition of hazardous chemicals is meaningless, unless you also define "toxic" and that starts to get silly. Why not define "chemically hazardous" as distinct from "radiologically hazardous" and just say in the text when you mean carcinogenic and when you mean non-carcinogenic? (c) "Irradiation" is exposure to any radiation, not just ionizing radiation.	
xiv	In the definition of **isotope** - give an example, such as tritium as an isotope of hydrogen	
xv	(a) Natural uranium includes the daughter elements. (b) What is the NPL the National Priorities List of? (c) A picocurie is 10^{-12} Ci; "millionth of a millionth" does not, contrary to current thinking, make this more understandable. People who don't understand exponents won't understand the rest of the document either. Perhaps the glossary should include definitions of milli-, micro-, nano-, pico-, femto-, etc. in terms of powers of ten. (d) Delete the word "definitive" from the definition of "plume." (e) "Production reactor" is NOT synonymous with "reactor." The word "reactor" is used in place of "production reactor" in this document, which is not the same thing as a synonym.	
xv	In the definition of **radioactivity**: to be more accurate, it should state "by some <u>nuclides</u> as they transform into other <u>nuclides</u>"; of course, now you need to define the term <u>nuclide</u>.	
xv	In the definition of **reference dose**: on page viii you define the EPA chronic oral reference dose for noncarcinogens as the "safe dose level EPA established for specific chemicals"; here you define the reference dose as "the smallest daily intake of a hazardous material that first leads to deleterious health effects"; this seems a bit of a contradiction. Also the text in Section 4 refers to the **RfD**; it should be included in the glossary with the reference dose.	
xvi	In the definition of **surrogate** you state that it is an "estimated substitute measurement used". This is a bit is unwieldy. How about defining a surrogate as "an estimated value used when the actual measurement is unavailable"?	
1.1, Section1.1, para 2	The Hanford site is **currently** 1,4560 square kilometers. It used to be bigger. Do you wish to acknowledge this change?	

1.3, Section 1.1, para 3	You note that contaminated groundwater has moved out of the 200 Areas into adjoining areas. Hasn't contaminated groundwater moved from the 200 Areas to the Columbia River as well? Note that in your statement on the 600 Areas in the last paragraph of this section you acknowledge that groundwater from the 600 areas has moved to the Columbia River.	
1.3, Section 1.1, para 2	In describing the contamination of the 3000 area, you state that it is "minor". What is the basis for this statement? Is the contamination minor relative to the other operating areas, or minor relative to some gas station's leaking underground fuel tank? A simple clarification would suffice.	
1.4 , Section 1.3	The word "contaminants" is vague, and may be interpreted by some readers as including all "pollutants" occurring on the Hanford sites, or at least within 150 meters of the river. To other readers, "contaminants" may exclude those materials in storage. In the case of unlined ponds or landfills, this may be a judgement call. Does this report include or exclude materials in waste management units? Do any of waste management units occur in the area under consideration? These are listed as including spills, cribs, ditches, ponds, tanks, trenches, landfills, burial grounds, pits, French drains, and other ...". Is this material considered as being contaminants in this report, or as being in storage and reported elsewhere? Are any pollutants unaccounted for that reside between soil and groundwater. (Does soil = surface soil, or everything above the ground water?) For example, in Section 4, it is stated that analytes in tanks were not included in this study. For example, in section 7, it is made clear that there are many stored materials that can contribute to future ground water problems, and that chemicals now stored in tanks, landfills, decommissioned reactors, including submarine reactors, nuclear fuel storage units, etc. are not included in this report, but other reports are referenced. Suggestion: State the limitations on this report more clearly in the Scope Section (1.3) and Screening Section (4.0), and mention earlier in summary, etc. Cross reference to Section 7 for other reports.	
1.4, Section 1.3	<u>Scope of Work:</u> The stated scope may not be consistent with statements within the document.	

1.4, Section1.3	It is not clear if only the portions of sites 100, 300 and 1100 that are within 150 meters of Columbia River are included, or if all of these sites are included. This may be an artifact of Fig. 1.1, but the sites appear to extend much further than 150 meters from the river. Suggestion: Clarify if 150 meters includes all of the sites, or if the study only considers those portions of the sites that are within 150 meters.	
2.1	How were the documents in Section 2.1 peer reviewed, by whom, and under what conditions? If PNL has an internal review system, it should be described somewhere. Under what QA program was their quality assured? The appropriate QA documents should be included in this list.	
2.1 para 3	The use of most recent sampling data to provide the source term for risk calculations is completely appropriate.	
2.1 para 4	The word "contaminants" is vague, and may be interpreted by some readers as including all "pollutants" occurring on the Hanford sites, or at least within 150 meters of the river. To other readers, "contaminants" may exclude those materials in storage. In the case of unlined ponds or landfills, this may be a judgement call. Does this report include or exclude materials in waste management units? Do any of waste management units occur in the area under consideration? These are listed as including spills, cribs, ditches, ponds, tanks, trenches, landfills, burial grounds, pits, French drains, and other ...". Is this material considered as being contaminants in this report, or as being in storage and reported elsewhere? Are any pollutants unaccounted for that reside between soil and groundwater. (Does soil = surface soil, or everything above the ground water?) For example, in Section 4, it is stated that analytes in tanks were not included in this study. For example, in section 7, it is made clear that there are many stored materials that can contribute to future ground water problems, and that chemicals now stored in tanks, landfills, decommissioned reactors, including submarine reactors, nuclear fuel storage units, etc. are not included in this report, but other reports are referenced. <u>Suggestion:</u> State the limitations on this report more clearly in the Scope Section (1.3) and Screening Section (4.0), and mention earlier in summary, etc. Cross reference to Section 7 for other reports.	

2.2	Dirkes, Patton and Tiller reference: Which VOCs, metals and anions were sampled? An actual list would be very helpful.	
2.2	DOE 1992b: More specificity in this sort of summary would improve its usefulness; e.g., how much lower were concentrations in surface water than in springs, etc.? Perhaps where such a document contained a summary table, that table could be reproduced in this summary chapter. This comment applies in general to this type of document.	
2.4	Fowler reference: Is there a final version of this document? Even if the document cited represents only the first step in developing risk-based standards, a draft is not a good or reliable citation. If this document can be finalized, it should be. If not, the extent of internal review should be noted in the citation.	
2.5	Wells reference: What is "artificial radioactivity?" Do you mean anthropogenically produced radionuclides? Fission products? Products of alpha or neutron bombardment? Transuranic elements? Or all radionuclides produced at Hanford? Po-210, for instance, is the same isotope whether it is a uranium daughter or part of a transuranic decay chain. I believe you mean radionuclides produced at Hanford, regardless of whether or not they have naturally-occurring counterparts. However, this should be clearly stated.	
2.5	Notes on Weiss: The annotation notes "the sand-sized and smaller sediment samples were analyzed for metals and radionuclides from the near-shore and shoreline". Do you mean to say that sand-sized and smaller sediment samples collected from the near-shore and shoreline were analyzed for metals and radionuclides?	
2.5	Same notes as above. The paragraph states "sediment was collected at depths of ...below the surface"; does the term surface refer to the water or sediment surface?	
2.8, para1	A Qualitative Risk Assessment is available for NR-1. Shouldn't this document be included on the list? Are data from all the operable units included in the Tables A?	
2.10	Notes on EG&G: The terms **anthropomorphic** and **isopleth** are used, but are not defined in the glossary.	

3.1 et seq and Appendix A	Any judgment about Table 3.1 is difficult to make in the absence of any comparable standard. What are the MCLs for the listed substances? Are there water and soil standards for these in the draft of 40 CFR 264.512 (Subpart S)? Moreover, neither Table 3.1 nor the tables in Appendix A state which Hanford Area the cited maxima were measured in. Tables 3.1 and A.3 cite the number of plumes assayed but there is no indication of which or how many plumes exhibited the maximum concentration for each contaminant. A map of isopleths would be more informative and would speak directly to the question of contaminants of concern.	
3.3-4; Table 3.1	In this table, the radionuclides are mixed with the chemicals. Suggestion: Be consistent with Table 3.2	
General, with specific examples: **page 3.4, T3.1** and A10	Explain more fully why chemicals have been eliminated. For example tritium which is shown in this report at very high radiation levels, relative to other chemicals, is screened out. The equation on p. 4.2 for screening radiation, shows that the concentration is multiplied by SS and SI as well as other coefficients. For Carcinogenic Chemical Screening, only internal exposure is considered. Upon examination of page B.3 (Table B.1 item 66) the Ingestion Slope factor is 5.40 E-14. and the External Slope Factor is 0. No parameters are shown for Cancer Potency; was 0 assumed? Any number, no matter how large can be eliminated by multiplying by 0. And very large numbers are negated by multiplying by E10-14. For the ecological risk factors, none were considered. Given that tritium is a beta emitter, some explanation needs to be provided as to why these levels of tritium are screened out. Suggestion: Provide explanations for selected chemicals of public concern, such as Tritium. Distinguish between chemical eliminated by the screening by knowing they are safe from those eliminated because no toxicity data are available.	
General, with specific examples: **page 3.4, T3.1** and A10	How would these risk factors compare with occupational safety levels? (Occupational safety usually considers 8 hr./day exposure; a person residing at that site would have greater exposure. Suggestion: Compare the levels here to Occupational Safety.	
3.4, Table 3.1	Plutonium 239 is listed as an analyte. Presumably this is really Pu-239&240? See footnote b to table 3.2 for comparison.	
3.5-6, Table 3.2	In this table, the radionuclides are listed separately. Be consistent with Table 3.1.	
3.5, Table 3.2	Is it Antimony 124 or 125?	
3.7, Table 3.3	The units (ppb) are not in the same style as the other tables that use ug/kg. Be consistent with other tables.	

3.7, Table 3.3	For the 600 Area, the concentration of contaminants in ground water leaves unclear if there is a quantity of contaminants that have "escaped" from storage areas but is not yet measurable in the ground water. Suggestion: Clarify if this is reported elsewhere, or is included here.	
4.1-11	The Screening approach is difficult to follow, although much time seems to have expended on trying to make it clear. Specific examples follow because it is the critical process for identifying chemicals of concern.	
4.1	What are the assessment endpoints? The document implies that it is some property of fish. On what basis were other aquatic biota eliminated? On what basis were piscivorous and insectivorous wildlife (e.g., herons and bats) excluded?	
4.1	Where is the environmental description? We do not need a lot of species lists and other descriptive ecology, but an appropriate environmental description would have made it clear that the near-field concentrations were intended to conservatively represent the entire river and may explain why some endpoint groups were not included (e.g., few herons or other piscivorous wildlife).	
4.1	The screening approach does not consider uncertainty or confidence intervals.	
4.1, para 2	This is much too conservative an ingestion scenario. Two liters of water a day is about a half gallon, which is more than the maximum amount of liquid most people consume daily. Doesn't this individual ever drink a Coke? Does he or she haul water from the river to make tea or coffee rather than getting it from the tap? Does this individual live right by the river without running water in his or her abode? Does his or her protein intake consist exclusively of more than half a pound of fish a day? The scenario used by the Hanford Environmental Dose Reconstruction (HEDR) project uses a scenario that includes consumption of about 41 kg fish per year with a 95% confidence limit of 82 kg/year (not 100 kg/year). The HEDR project is a PNL project. Certainly PNL should make use of all available resources, particularly those available at the same laboratory.	

4.1, para 2 Tables C.1, C.2, and C.3	Given the understanding that value judgments are a necessary part of any risk assessment, it is important to avoid any perception that values held by the risk assessor are unilaterally incorporated into risk evaluations. While MEPAS may be a very appropriate methodology for screening, this can not be ascertained from the documentation presented. The importance of a more in-depth review is highlighted, from a toxicological view point, by the inconsistencies between the toxicity factors used in *Identification of Contaminates of Concern* and *Toxicology Profiles of Chemical and Radiological Contaminants at Hanford* (see comment below). So many of the contaminates are listed in the tables as screened by MEPAS that this may become a critical issue. An outstanding question this reviewer has is, what is the process by which an M or I is attached to each contaminate in Tables C? Does not MEPAS incorporate IRIS toxicity values? One way this comment might be resolved is to negotiate the assumptions used in MEPAS through a formal review process.	
4.1, Section 4.0, para 2	The incidental ingestion rate of 10 mg/d sediment seems low for a "dedicated river user" and especially in comparison to the median **soil** ingestion rate for children of about 16 mg/d (about 6 gm/y); is there a basis for the 10 mg/d value?	
4.1, para 3	An ecological conceptual model should define the sources, routes of exposure, and receptors that will be assessed. Water quality criteria do not constitute a conceptual model.	

4.1, para 3	Limiting the ecosystem risk calculations to EPA Ambient Water Quality Criteria (EPA 1992) and fish lethality is inadequate. It seems from Appendix C that most of the items eliminated by the screening process had no risk data other than carcinogenic risk. In fact, most of the items listed as "Continued Public Interest" are of obvious concern, but may have been screened out by lack of data rather than assurance of safety. There seems to be an attempt here to use EPA Ambient Water Quality Criteria to assure the public that the screening process is using generally accepted values that have been extensively reviewed and stood the test of time and numerous challenges. However, many of the chemicals considered here are not commonly encountered chemicals and not included in EPA AWQC documents. The report does not indicate how widely the literature was searched for toxicity data. Suggestion: Search more extensively for data. Use AQUIRE (EPA (US Dept. of the Interior, 1986, Resource Pub. 160) to identify concentrations of concern for biota. Various DOE laboratories including Hanford and ORNL have spend years studying the toxicity of many of these items, e.g. Friant and Brandt (1984) References at end.	

4.1, para 4	The word "contaminants" is vague, and may be interpreted by some readers as including all "pollutants" occurring on the Hanford sites, or at least within 150 meters of the river. To other readers, "contaminants" may exclude those materials in storage. In the case of unlined ponds or landfills, this may be a judgement call. Does this report include or exclude materials in waste management units? Do any of waste management units occur in the area under consideration? These are listed as including spills, cribs, ditches, ponds, tanks, trenches, landfills, burial grounds, pits, French drains, and other ...". Is this material considered as being contaminants in this report, or as being in storage and reported elsewhere? Are any pollutants unaccounted for that reside between soil and groundwater. (Does soil = surface soil, or everything above the ground water?) For example, in Section 4, it is stated that analytes in tanks were not included in this study. For example, in section 7, it is made clear that there are many stored materials that can contribute to future ground water problems, and that chemicals now stored in tanks, landfills, decommissioned reactors, including submarine reactors, nuclear fuel storage units, etc. are not included in this report, but other reports are referenced. Suggestion: State the limitations on this report more clearly in the Scope Section (1.3) and Screening Section (4.0), and mention earlier in summary, etc. Cross reference to Section 7 for other reports.	
4.1, para 6, Section 4.1.1	The radionuclide screening handles each radionuclide as a separate and independent item. It would seem useful to calculate the total radiation absorbed (Gy) by Columbia River biota. Laws (1993, p. 473-474) provides a discussion of Oak Ridge (White Oak Creek) fish receiving 3.6 mGy/day and Chironomid larvae receiving 6m Gy/d as worse case scenarios. Friant and Brant 1994 offer a risk assessment for the Columbia River than might be useful to discuss. Suggestion: Supplement the report with data of an ecological nature in situations of similar exposure.	

4.1, 7	The assessment of external exposure seems to make a very significant assumption. It appears to this reviewer that it is assumed that the radio isotope contaminant is found in an infinite slab geometry. This assumption weights heavily the risk associated with external exposure pathways relative to the other pathways. The result of this assumption may be that contaminates associated with external exposure pathways are consistently assessed as contributing the largest risk. This is not because of the inherent toxicity of these contaminates, rather it is because the conservatism incorporated into assessment of the external exposure pathway. The potential consequence might be that, in risk-based decision-making, external exposure may inappropriately become the focus of efforts aimed at reducing risk. In this regard, the infinite slab assumption may be a hidden value judgment that expropriates the basic science. I suggest that the infinite slab assumption be reviewed by the CRCIA management team in the context of the many risk assessment that have incorporated it. If necessary the geometry assumption should be formally replaced by one or more probability statements to provide a more realist assessment. This comment will be resolved by a formal request for TPA management review of the infinite slab assumption.	
4.1, 7	It appears to this reviewer that the 100,000 water/sediment ratio may have a very large potential to impact the risk assessment out-come. For sediment considerations, the ratio is used to estimate the concentration of the radionuclide in an infinite slab geometry. The potential to over-estimate risk is magnified by this layering of conservative assumptions. There are several outstanding question concerning the derivation of this ratio. Why is one ratio used to represent several of the contaminates? Why hasn't actual analytical data been used? It may be that this comment can only be resolve through more than one review cycle.	
4.1, last para	What is the evidence for presuming a Kd = 100,000? Was the Kd measured? If not, why not?	

4.1, last para	The assumption is made of a 1:100,000 water:sediment ratio for radionuclides. Have field data ever shown a larger proportion for any of the radionuclides in water relative to sediment? If so, are field data substituted rather than the 1:100,000 assumption, when field data are used? If so, the reader needs to know when a screening conclusion is based on field measurements rather than assumptions for the water:sediment ratio. If field data have shown a larger proportion for any of the radionuclides in water relative to sediment, either a larger ratio needs to be employed, or a statement needs to be made that for some radionuclides, this ratio may underestimate the presence of the radionuclides in water.	
4.1, last para, and 4.2	Since sediment data is presented (Table 3.2) for most chemicals, it isn't clear why a sediment concentration of 100,000 x the water concentration needs to be calculated. Was this factor used to estimate sediment concentration only if data did not exist , or was it used to provide a more realistic estimate than the maximum detected concentration? Spot checking Appendix B.2, the maximum Detected Conc. are listed as being used as parameters. Clarify. (If the estimated sediment concentration was only used in the Radionuclide and Carcinogenic Screening, the point may be unimportant, because the values of SS, IS, and chemical cancer potency are so low that few chemicals and no radionuclides passed the screen. See the comments below on tritium: any number multiplied by 0 is zero, and the risks per pCi were so low that even orders of magnitude difference in sediments wouldn't have affected the ultimate risk. If no number is shown for cancer potency factor, is it assumed to be 0?) Clarify; is it correct that the risk factors for radionuclides were all very low that only As and Chromium were carcinogenicity risks?	
4.1-4.3: formulas 4.1.1, 4.1.2, 4.1.3	The mathematical aspects of these formulas are correct. However, it is the opinion of this reviewer that inclusion of fish and sediment ingestion pathways evaluation is misleading in that it implies a level of precision not achievable due to uncertainties inherent in the toxicity parameters.	
4.2, 1 & 2	sediment/water ratio; should this not be water/sediment ratio? The units must match.	
4.2, first full para	In the screening equation (1) a risk estimate is derived for external exposure. Is this the risk from immersion in contaminated water or sitting on contaminated shoreline? It is not clear how this part of the equation was arrived at, and what exposure duration was assumed.	

4.2, first full para	It would be easier to follow the equation (1) if the dimensions of all the variables were consistently reported; for example the water consumption rate of 730 is reported as "2 L/d for 1 year" - when actually the value 730 has dimensions of L/yr. Similarly, the sediment consumption rate is discussed in g/yr but the value as shown in the equation is kg/y.	
4.2, para 3	"Values from this screening which approach or are greater than 10^{-6} imply radionuclides of potential concern." It is not clear why this particular risk value (10^{-6}) was chosen to identify contaminants of concern. What is the justification of this number, in an absolute sense?	
4.2, both eq.	What is the source of the values used for BCF? Were they the same for all species?	
4.2, Section 4.1.2, eq. 2	It would be easier to follow the equation (1) if the dimensions of all the variables were consistently reported. The same comments as above apply, for example in explaining the value of 1×10^{-5} as "consumption of 10 mg/d of sediment, kg". It would be clearer to note that 1×10^{-5} is "The consumption of 10 mg/d of sediment, expressed in kg".	
4.2, para 5	"Values from this screening which approach or are greater than 10^{-6} imply chemicals of potential concern." Again, the justification for this particular risk value is not clear. It also seems that there is an inconsistency here. For the radionuclide calculation, the number is risk per year. For the chemical screening, the number is risk, with no time unit involved.	
4.2, last sentence	The Department of Energy response to the Department of Ecology suggestion (p. 6 of comments, sent under a March 29, 1995 cover letter) that 10E-7 be used to provide some recognition that additive, synergistic, or multiplicative effects are almost certainly operating, is not adequate. The Department of Energy has simply responded, "In general, the HSRAM methodology is not appropriate for this assessment" (response to concern #25 of Department of Ecology) That does not speak to the issue that contaminants could be eliminated as contaminants of concern simply on the basis that they are being considered as if they were single actors in an otherwise pristine world. This is a terribly non-conservative assumption.	
4.3	<u>Toxic Chemical Screening</u>: Toxic Chemical Screening should be called "Human Toxicity Chemical Screening."	

4.3	Aquatic Biota Toxicity Screening: The aquatic biota toxicity screening fails to include biomagnification. A chemical is of concern if it biomagnifies at the top of a food chain, even if it does not reach some threshold of known toxicity in organisms lower in t he food chain. If later ecological risk assessments will be performed only on "contaminants of concern," then it is inappropriate to fail to calculate biomagnification. Therefore, an additional screen needs to be added for persistent, bioaccumulative, toxic compounds. Field data regarding biomagnification of such compounds should be figured heavily into any list of contaminants of concern. Likewise, any contaminant that bioaccumulates more than 100 times (as expressed by the bioconcentration factor or the octanol-water partition coeficient) and has a half-life in any medium (air, water, soil, sediment, or biota) of eight weeks should be tagged as a contaminant of concern. As the U.S.-Canadian, federally-appointed International Joint Commission on Great Lakes Water Quality notes, "We conclude that persistent toxic substances are too dangerous to the biosphere and to humans to permit their release in any quantity" (emphasis in original: International Joint Commission; 1992; *Sixth Biennial Report on Great Lakes Water Quality*).	
4.3	Aquatic Biota Toxicity Screening: Aquatic biota include crustaceans, insects, other invertebrates, amphibians, and fish. When you have had experimental data on two taxa, only one of which is fish, have you always selected the lower? The reader needs to know when a screening conclusion is based on experimental data rather than the assumption of one percent of the LC50.	
4.3, 1	sediment/water ratio; should this not be water/sediment ratio? The units must match.	
4.3, Section 4.1.3, eq. (3)	It would be easier to follow the equation (1) if the dimensions of all the variables were consistently reported. The same comments as above apply, for example in explaining the value of 1×10^{-5} as "consumption of 10 mg/d of sediment, kg". It would be clearer to note that 1×10^{-5} is "The consumption of 10 mg/d of sediment, expressed in kg".	
4.3, Section 4.1.3	Page 4.1 claims to use a scenario involving consumption of 0.25 kg fish daily, while this section uses 0.27 kg fish daily. Which was actually used?	
4.3, eq. 4	Page 4.3, equation 4. Concentration units should be mg/L.	
4.3, Sections 4.1.4 and 4.1.5	The units of Equations (4) and (5) are given as picocuries per microgram. How can this apply to non-radioactive substances?	

4.4	The use of LC50/100 as the ecotoxicological screening benchmark is conservative, but it is not clear why it is used rather than alternative benchmarks that are based on chronic toxicity data or that have better technical justification such as the secondary chronic values (see the ORNL benchmarks data base which was distributed to Hanford). [I assume that "LD50" is a typo.]	
4.4	Definition of the measurement endpoint should have included a definition of TLM. Is it a NOEC or CV or something else (e.g., a human health criterion)? Also explain why equation 5 indicates that LC50 is preferred to it.	
4.4	All fish chronic tests include eggs and larvae. Also, I agree with the EPA that in general larvae are more sensitive than eggs and they occur in spawning gravels. Therefore, the comment about the unavailability of data to address the issue of exposure of salmon early life stages is incorrect.	
4.4, 1	Have field or experimental data indicated chronic or other adverse effects at less than one percent of LC50 for any of the analytes? If so, this needs to be noted, and the one percent of LC50 assumption will need to be altered. Recent literature on endocrine disruption in fish (e.g., increase in vitellogenin) needs to be considered in relation to this assumption, as well.	
4.4, 1	It is implied that sublethal effects are less significant than lethal effects. In many cases, reproduction, for example, can be impaired at sublethal doses, but in the context of populations, this can be just as significant, in due course, as mortality.	
4.4, eq. 5	Page 4.4, equation 5. Concentration units should be mg/L.	
4.4, 3.	As Department of Ecology has noted, literature <u>is</u> available on the impact of some chemical and radionuclide contaminants on fish eggs. Please indicate the literature search methods that were used that failed to note fish egg toxicity literature. this may be a problem in choosing one percent of LC50 for chronic effects, as well. Did PNL do any search of field and experimental literature? Existing field and experimental literature will require a modification of the one percent of LC50 default assumption, if any of the literature indicates sensitivity at lower levels, for any life stage.	
4.4, para 2 and Appendix B.1	The use of TLM = threshold limit for fresh water is confusing. Laws (1993, p. 191) defines TLm as the median tolerance limit, which can be equivalent to LC50. The text of this report suggests that TLM is being used in the sense of the Incipient Lethal Level, a hypothetical concentration of the toxicant corresponding to an infinite median survival time (p. 189). I do not have the CD referred to as EPA 1985, but a number of similar terms have been used by various authors to express acute and No observable or threshold concentrations. <u>Suggestion:</u> Clarify the definition of TLM.	

4.4, 3	The problem raised with groundwater possibly affecting fish eggs seems to be rather casually dismissed. I suspect additional effort here could lead to a more useful treatment of fish eggs, one of the most sensitive stages of the life cycle of fishes.	
4.4-6.	The conversions of data units and assumptions here seem unnecessary if measured values were used; it is not clear why and when calculated values were used instead of measured values were used. Clarify. Examples follow:	
4.5	Using the conversion equation of surrogate river water concentration equals the measured groundwater concentration divided by 1000, is effectively dismissing the impact of groundwater in near-shore wells with concentrations up to 1000 times the ambient water quality criteria, 1000 times the TLM, or 10 times the LD50. I do not know of any other site in the State of Washington where such high concentrations of contaminants in groundwater are not, at a minimum, considered contaminants of concern.	
general ix, para. 2, and **4.5, para 1**	This is a general comment concerning the approach used in the report to estimate surrogate river concentrations from groundwater concentrations. The specific issue is described on Page ix, paragraph 2 "For conservatism, ...the value of 100 cfs was adopted for the screening. In effect, this implies that the entire groundwater that flows from beneath Hanford to the Columbia River is contaminated to the maximum level measured." Page 4.5, paragraph 1. "For conservatism (i.e, to provide an overestimate of the resulting concentration in the river) the upper value of 100 cfs was adopted for the screening. In effect, this implies that the entire volume of groundwater that flows from beneath Hanford to the Columbia River is contaminated to the maximum level measured." The report argues that the methodology used to estimate river concentrations from groundwater measurements is conservative because of the assumptions described above. However, there are other assumptions, some implicit and some explicit, that tend to make this methodology non-conservative. For example, it is implicitly assumed that monitoring wells are placed in locations where the groundwater is most contaminated. It is explicitly asssumed that complete mixing occurs in the river with an average flow rate of 100,000 cfs. (continued below)	

general ix, para. 2, and **4.5, para 1**	(continued from above) With the proposed approach, the ratio of the measured groundwater concentration to the calculated river concentration is 1,000. (The maximum observed groundwater concentration is divided by 1,000 to get the assumed river concentration.) Table B.1 shows several examples where this approach is non-conservative: Copper: 516 in groundwater/22 in river water = 23 Magnesium: 55,000 in groundwater/9,860 in river water = 5.6. Mangenese: 400 in groundwater/22.8 in river water = 17.5 Sodium: 200,000 in groundwater/13,800 in river water = 14.5 Tritium: 1,900,000 in groundwater/4,430 in river water = 438 Toluene: 2.9 in groundwater/4.7 in river water = 0.6 A "dilution factor" of 1,000 seems to be non-conservative in many instances. I suggest that one might use the actual data as described above to come up with some reasonable dilution factor.	
4.5, para 1	As above (see reference for Page 4.1 last Para, and P 4.2), it isn't clear why surrogate river water is calculated when river water concentration is measured. Is this to calculate how much additional material would be added to the river when distant subsurface flow might reach the river and be diluted? Is this a worse case scenario? Clarify.	
4.5,para 3	In equation (7), it seems that C_{sed} should be the quantity to be estimated, based on C^{o}_{w}. Shouldn't C_{sed} be on the left side of the equation?	
4.5, eq. 6	An average flow of 100,000 cfs is used. For a conservative model shouldn't a more restrictive value be used?	
4.5, eq. 6	What is the source of the 100 cfs estimated discharge of groundwater to the Hanford Reach? Is this a peak value or an average?	
4.5, eq. 6, (Section 4.2.1.1, eq. 6)	This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	

4.5, Section 4.2.1.2, eq. 7	If you are using sediment concentrations to predict water concentrations in a conservative screening model, you should use distribution coefficients that maximize the predicted water concentrations. Literature values of K_ds for radionuclides range from 0 for ^3H to 1,000 for ^{60}Co to 10^6 for Th. Is there a Hanford-specific basis for using a K_d of 100,000 for all nuclides?	
4.5, para 5 (Section 4.2.1.3)	Everywhere else, pCi/kg or pCi/L are used; why does this section use pCi/g? The question is the same as before; why is this calculated instead of using measured values? Clarify	
4.5 & 4.6	I agree with the prior reviewers that the use of fully mixed concentrations is not appropriate for a screening assessment. Given the concern about upwelling groundwater inspawning gravels, no dilution is appropriate.	
4.5 & 4.6	The authors need to provide a better justification of their selection of a Kd of 100,000 for sediments and 1 for soils. In both cases they are estimating aqueous exposure levels from particulate concentrations, so conservatism would be achieved by using a low Kd. However, they claim conservatism for both values.	
4.5 & 4.6	It is not clear what the authors are trying to estimate with equations 7 and 10. Are they trying to estimate exposure of benthic organisms to pore water or exposure to the surface water from which the particles settled?	
4.5 & 4.6	In place of apparently arbitrary Kd values, the authors should have used Kd values from the literature for metals and the conventional equilibrium partitioning model for neutral organics.	
4.6, para 1	The assumption that only one percent of the total Hanford Site is contaminated must be re-examined. First, it would seem that only the area that is being analyzed for contaminants should be considered as the area within which a fraction of contaminated area is estimated. Second, the methodology of arriving at a contaminated area fraction should be spelled out. The Department of Energy response to this same concern raised by the Department of Ecology is <u>not</u> adequate.	
4.6, top of page	What is the supporting evidence for claiming that 1% of the Hanford soil is contaminated to the maximum concentration? Since the area of which this is 1% is not clearly defines, it is not even clear what "1%" means. Would it not be preferable to take soil samples in quadrats along the river shore where the maximum contamination is suspected or known to be, measure the soil concentrations, and statistically estimate the mean and the distribution?	
P 4.6, Section 4.2.1.3, eq.8	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	

4.6, Section 4.2.2.1, eq. 9	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
4.6, Section 4.2.2.2, eq.10	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
4.7, Near-River soil equation	The Department of Energy response to the Department of Ecology concern that hexavalent chromium prefers to concentrate in the groundwater rather than being equally concentrated in soil and groundwater is not adequate. When field data or experimental data are available regarding soil/groundwater distribution, are they used in preference to the <u>assumption</u> of soil/groundwater concentration equivalency? If so, the reader needs to be informed when a screening result has been based on data, and when on a default assumption. If not, then this needds to be done: Field and experimental data must be used in preference to a modeling assumption of soil/groundwater concentration equivalency.	
4.7, Section 4.2.2.3, eq. 11	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
4.7, para. 4	"A screening level was used to account for over 1) 95 percent of the carcinogenic risk for each result, above a cutoff of 10^{-6}..." It is not clear to me what this means.	
4.7 para 4	Potential Na toxicity should be examined; many organisms are sensitive to salinity (NaCl). <u>Suggestion:</u> Calculate if Na could contribute significantly to the salinity of the River.	
4.7, Section 4.3	In discussing the screening results, reference is made to the identification of a few chemicals and radionuclides of potential interest that were not carried forward because the measurements were "within naturally occurring background levels". It would be useful to provide a table listing the naturally occurring range of concentrations of these contaminants in environmental media (i.e., soil, sediment, groundwater and river water).	
4.7, 5	The term "hazard ranking" should be defined, either here or in the glossary, or in both places.	

4.7, Section 4.3.1	The meaning of the second sentence which begins "a screening level was used to account for over 1) 95% of the carcinogenic risk for each result, above a cutoff of 10^{-6}..."is unclear.	
4.8, paragraph below Table 4.1	It ought to be possible to measure quite accurately the fraction of Cs-137 and Cs-134 that are due to worldwide fallout by comparing the Hanford soil concentrations to soil concentrations in similar locations that are not influenced by Hanford. The claim that these contaminants are "largely derived" from non-Hanford sources is not accurate enough and need to be supported quantitatively.	
4.8-9	Given the assumptions and calculations of surrogate groundwater, sediment, and river water, it is not clear if the Screening results represent that calculated from measured maximum concentration, or from the surrogate values. Clarify.	
4.9, Section 4.3.4	The first sentence discusses contaminants measured in soil near the Columbia River as not being an immediate hazard as they are not subject to mass transport to the river. Are these soils located at a specific distance from the river such that flooding or overland runoff is not likely to move them? If so, specify how far they are from the river and why they are unlikely to move.	
4.10, Table 4.4	In the appendix, table C.2, the carcinogenic risk ranking for ^{241}Am in soil was 2.3 E-06, yet it didn't get put on the contaminants of concern list, Table 4.4. Why? A similar question is asked for ^{239}Pu.	
4.10, last paragraph	As well as noting that six contaminants had six single, questionable, measured results, the reader should be informed of which analytes in Table A.1 had only single measured results, which might indicate that greater existing contamination has been missed.	
4.11, para 1 and 3	How many times were toluene, xylene, benzo(a)pyrene and indeno (1,2,3-CD) pyrene sampled in the areas?	
4.20, Section 4.4	Please include a direct citation to the quality assurance (QA) plan under which these data were collected. Was it consistent with NQA-1? Is it available to reviewers? The QA procedures generally include a quantitative procedure for estimating acceptable sampling error or sampling deviation. Except for lack of an appropriate QA reference, this discussion of deviant samples is acceptable.	
5.1	Previous evaluations of risk from the discrete particles of the cobalt-60 alloy appear to be based on human health and not ecological risk. How did the current study evaluate biotic exposure and secondary human risk?	

5.1	This text discusses the presence of discrete radioactive particles, but doesn't explicitly state that they will be evaluated as a contaminant of concern. It is inferred from the text that they will be and Table 9.1 appears to confirm this assumption. However, and explicit statement to that effect should be included.	
5.1, Section 5.0	The size of the recently found particles is not mentioned, nor does there appear to be any particle size distribution. A particle 0.1 mm (100 microns) in diameter is about ten times the size of what is usually considered respirable (capable of entering the lung alveoli). Such a particle, if inhaled, would not be expected to pass through the upper respiratory tract and even less likely to be passed through the bronchi. The estimated dose given in this section is quite conservative.	
5.1, para 6	It would seem that the dose from a particle lodged in the nasal passage would be quite localized and not very comparable to the limit for occupational exposure. This should be clarified in the text.	
6.1	Relate the information concerning direct radiation exposure to human and ecological risks and incorporate the results in the risk assessment.	
6.1	This text discusses the direct irradiation from Hanford facilities and provides estimates of exposure rates in micro roentgens per hour, but no discussion is given as to where these measurements are made (at the ground surface, at 1 m from the surface, etc). Assuming the source of contamination is represented by an "infinite plane", the exposure rates are not going to change dramatically as one gets nearer to the surface, but some discussion should be made as to what the exposure rates are likely to be for nonhuman biota residing in the vicinity.	
6.1	A map of the area with this area enlarged would be helpful. Isopleths of direct irradiation could be shown.	
6.1, Section 6.0	These surveys seem to have been appropriately done, and their results are not surprising. Some comparison (e.g. to average background, cosmic ray exposure, etc.) might be helpful.	
6.1, 1	It should be stated that this discussion pertains to the Hanford shoreline.	
6.1, 2	It would be helpful to indicate the amount of acreage with elevated exposure rate readings.	

Section 7	The word "contaminants" is vague, and may be interpreted by some readers as including all "pollutants" occurring on the Hanford sites, or at least within 150 meters of the river. To other readers, "contaminants" may exclude those materials in storage. In the case of unlined ponds or landfills, this may be a judgement call. Does this report include or exclude materials in waste management units? Do any of waste management units occur in the area under consideration? These are listed as including spills, cribs, ditches, ponds, tanks, trenches, landfills, burial grounds, pits, French drains, and other ...". Is this material considered as being contaminants in this report, or as being in storage and reported elsewhere? Are any pollutants unaccounted for that reside between soil and groundwater. (Does soil = surface soil, or everything above the ground water?) For example, in Section 4, it is stated that analytes in tanks were not included in this study. For example, in section 7, it is made clear that there are many stored materials that can contribute to future ground water problems, and that chemicals now stored in tanks, landfills, decommissioned reactors, including submarine reactors, nuclear fuel storage units, etc. are not included in this report, but other reports are referenced. <u>Suggestion:</u> State the limitations on this report more clearly in the Scope Section (1.3) and Screening Section (4.0), and mention earlier in summary, etc. Cross reference to Section 7 for other reports.	
Page 7.1	Figures presented in the Hanford site Groundwater Protection Management Plan, DOE/RL 89-12, 1994, show the present location of the radioactive and non-radioactive contamination plumes for the 200 West sites which indicate that the migration pattern differs for these two categories of contaminants. The non-radioactive plume (nitrate and chlorinated hydrocarbons) appears to be moving north toward Cable Gap as stated in the GPMP report. However, the plume of radioactive materials (tritium, strontium-90, uranium, iodine-129, technetium-99, cesium-137 and plutonium) appears to be moving to the south-southeast, where it will soon come in contact with the highly transmissive zones present at the 200 East area. The flow path to the river will then be to the southeast, and will have an arrival time closer to 10 to 20 years, rather than the 80 to 300 years referenced in Freshley and Graham (1988). Accordingly, ignoring the risks of radionuclides with half-lives of less than 35 years is not appropriate in light of the insufficient understanding of the Hanford site geology and hydrology and the complexities of the contaminant flow paths.	

7.1 et seq	Please append maps of all 105 plumes; it is very difficult to review this section or statements like " ... plumes ... do not yet constitute a source of contaminants in the river." It would be even more helpful to include at least some older maps of plumes, so that a qualitative judgment of travel times could be made by the reviewer. The description given here, even when combined with the information in Table B-1, is not enough to judge whether any of the contaminant plumes will pose a health hazard or exceed any MCLs. I have attached a table (Table 1) and two graphs (Figures 1 and 2) plotting the decay of Sr-90, Co-60, and Cs-137 from the initial concentrations for the 200 East Area that are given in Table B-1. The 20-year concentrations certainly strike me as rather high. In order to know if they pose a health threat we should know the rate (e.g., liter/sec, liter/year) at which groundwater reaches the river, to what extent and how rapidly it is diluted in the river, and the comparative rate of uptake by fish. This sort of precision would also enable a better discussion of future groundwater contamination (Section 7.2). In addition, while the reference to the two EIS documents (p. 7.4, two penultimate paragraphs) is very helpful, a brief summary of their conclusions would be even more helpful.	
7.1, para 4	Exposure Assumptions. Assuming all chemicals to be at maximum concentration at 1% of the site (given that only 6% of the Hanford Reservation has been developed, seems very broad brush for the detailed monitoring that the public has been told is or has occurred. By using the same multiplying factors, the Maximum Detected Concentrations (Table 3.1) drives the whole risk calculation. There is no ability to distinguish between a bucket full of highly contaminated material, and a huge area of moderate contamination. Given that chemicals were injected directly into the ground water (Area 200, p. 7.1, 4th paragraph), this use of a single factor seems unwise. It seems to be offered as a way of overestimating and providing a conservative estimate. But, it could also obscure some problems. Suggestion: Provide more detailed information where appropriate. At least give some indication of areal extant of specific pollutants of concern.	
7.2, and other	Eutrophication must be considered as well as toxicity, when these high concentrations of inorganic N and P are encountered. Suggestion: Estimate and report on the eutrophication risk of N and P	
7.2, Figure 7.1	This graphic is difficult to interpret; i.e., contour lines for >1000 mg/L nitrate are given in the legend, but don't appear to be presented anywhere in the map.	

7.2, Figure 7.1	Figure 7.1 notes a drinking water standard of 45 mg/L. This is not correct. EPA has set a guidance level for nitrate in drinking water at 10 mg/L; a guidance level for nitrite in drinking water at 1 mg/L, and a guidance level for the combination of nitrate and nitrite in drinking water of 10 mg/L. Infants are susceptible to methemoglobinemia at nitrate levels in excess of 10 mg/L (EPA undated Health Advisory Summary: Nitrate/Nitrite). Washington State Board of Health drinking water regulations (revised September, 1989) provide for an MCL of 10.0 mg/L for nitrate.	
7.2, Figure 7.1	Figure 7.1 is unintelligible. Most people are totally thrown by contour lines. Use shading to shown intensity and configuration of the plume.	
7.3, Section 7.2	This section appears to be a justification of the temporal limitations to the scope of this document. There is an implication that because of the extensive remediation efforts anticipated, future impacts to the Columbia River will only decrease with time. However, all remediation efforts have unanticipated side effects, some of which could increase environmental or human health risks. Future operable unit risk assessment efforts should not rely on the results of this study but should evaluate risks based on up-to-date information.	

Page 8, Section 8	The arguments here seem contorted. The section may suffer from trying to state too much in too limited a space, but it makes several statements that are unsupported in this document. I found no calculation or discussion that 100 tons of uranium form natural sources pass the Hanford site from natural causes, and it seems irrelevant to the issue. The section raises other issues not addressed in text. For example, given that radiation units have been in pCi, it seems odd to state that no more than 1.7 curies of plutonium resulted from the 6.3 million curies of neptunium-239. If you are going to equate atoms of neptunium to atoms of plutonium, you have to state the radiation equivalents. Presumably, much of the released neptunium-239 has been diluted and washed out to sea? This section seems to be saying that even if a major nuclear facility had never been at this site, the radiation levels for uranium and plutonium 239/240 and other chemicals would be the same; it seems unlikely. On other concerns, the section implies that topics have been discussed, that were covered only by omission. For example, tritium was shown in A.1, A.2, and A.3 to have been measured in concentrations very much higher than background; (>6,000 to 1,900,000, or 6,193,000 pCi/L) as compared to background (40 pCi/L) (Tables A.1, 3.3).. Only by examining the parameters used in B.1 did it become obvious that tritium did not pass the screen because the Ingestion Slope Factor was 5.4E-14, the External Slope Factor was 0, there is no Cancer Potency Factor (assumed to be 0?), and no toxicity data were listed. There may be very valid reasons not to worry about these concentrations of tritium, but it was not discussed in this report. The Trojan Nuclear Plant Environmental Report has a 2 page discussion on why tritium concentrations may be discounted; such a discussion may be useful here. Many of the other chemicals of concern were also not discussed, but only listed as concentrations detected and parameters used to calculate risk. This section seems to raise more problems than it solves. <u>Suggestion:</u> Improve this section so that it seems reasonable, or just list chemicals of continued interest.	
8.1, para 2	Radiation attributable to fallout from nuclear weapons testing should not be considered "background." It may be called fallout radiation, but it should be distinguished from naturally occurring radionuclides.	
8.1, para 2	Is it also possible that some Pu was released to the river that was not generated from the decay of Np released to the river? Are we missing something here?	

8.2, last para	The nature of the public concern regarding each of the eight substances noted, should be briefly, but comprehensively, described. If valid evidence or reasons for concern have been brought up, but do not happen to fit in the precise set of assumptions used by PNL/DOE, then these contaminants should be added to Table 9.1 as identified contaminants of concern.	
9.1, first para	The following statement is meaningless, because different compounds may have quite different environmental fates and toxicity characteristics: "The results were consistent in that the same compounds were identified numerous times by the various screenings." In actuality, if a compound were only identified in ONE screening, that would not imply any "inconsistency" at all, because the compound might be hazardous because of its fate in one particular medium, or its toxic effects on one organism. Therefore, the appearance in "various screenings" cannot be labeled a sign of "consistency."	
9.1, para 4	Arochlor 1248 is currently used in equipment on the Hanford site?	

9.2, Table 9.1	As I read Table C.1 (Appendix C, Complete Numerical Results [for Screening]), the following substances have exceeded screening criteria and therefore need to be listed as "Identified Contaminants of Concern" in Table 9.1: <u>A. Add to column 1 of Table 9.1:</u> benzoanthracene benzoapyrene benzo(b)fluoranthene benzo(k)fluoranthene beryllium bis(2-ethylhexyl)phthalate cadmium chrysene methylene chloride nickel ruthenium 106 thorium 228 zirconium 95 <u>B. Label the following contaminants with a superscript (d),</u> because they also appear as contaminants of concern in groundwater plumes away from the Columbia River: arsenic cesium-137 cobalt-60 particles strontium-90 <u>Add to column 2 (i.e., groundwater away from the Columbia River) of Table 9.1:</u> chloroform	

10.1	From a "normal person's" perspective, Chapter 10.0 is the most important chapter, because it addresses the question of "Am I safe?" Much more attention needs to be spent making sure the significance of what's being said her is understood. It might be some variation on: The question everybody is bound to ask is: Should I be concerned about the impacts upon human health or the environment from contaminants in the Columbia River? Here are some things to consider: • Recent studies show that concentrations of contaminants in sediments downstream of Hanford are very low. • The concentrations downstream were well within safe-drinking water standards. • These concentrations were about the same as in other rivers not affected by Hanford. The greatest area of concern, of course, is in those areas immediately adjacent to the Hanford Shoreline. We'll be looking at those areas, and areas throughout the Hanford Reach, in subsequent studies.	

10.1, para 1	The statement is made, "The screening and selection process described in this report is a conservative (cautious) process." This is incorrect, because there may be some conservative assumptions, but there are many potential underestimates of concern. Both supposedly conservative assumptions and the following sources of potential underestimation of toxicity must be listed for the reader: 1. The screenings fail to account in any way for synergism, additivity, or cumulative effects which may occur when the analyte is in the presence of other chemicals, radionuclides, metals, or conditions (e.g., thinned ozone layer). 2. Many endpoints of toxicity have not been tested for in most or all analytes: e.g., endocrine disruption, immune suppression, neurotoxicity, subtle but significant functional development or behavior modifications. 3. Most of the analytes have not even been tested for the "standard" toxicity endpoints such as chronic toxicity in aquatic organisms and wildlife, cancer, or chronic toxicity in laboratory animals (for use in extrapolation to humans). 4. Sampling for the analytes on the Hanford site is often sparse, and could therefore have missed certain concentrations. 5. The analyte could be toxic below detection limits used (e.g., 2,3,7,8-TCDD). 6. The screening analysts do not know or acknowledge the most sensitive aquatic or riparian species. (list continues below)	

10.1, para 1	(list continued from above) 7. The screenings for the vast majority of the analytes are not based on knowledge of the most sensitive life stages of Hanford Site and Hanford Reach species, e.g., eggs, or a particular day of development if exposed to an endocrine disrupter. 8. The screeing analysts do not account for biomagnification (e.g., birds of prey). 9. The screening analysts do not consider individual sensitivities, vulnerabilities, or life histories of human individuals. 10. The screening analysts do not know or account for the food webs, life histories of individual species, and inter-species interactions and dependencies. 11. The screenings are not taking into account effects on the food base (primary producers) in the Hanford Site and Hanford Reach area. 12. Chronic effects could be lower than one percent of LC50. 13. The ratio of a radionuclide might be higher in water than the 1:100,000 water:sediment assumption. 14. Inter-species and gender differences in toxicity aren't known. 15. Certain pockets of contamination can be much higher than those estimated for the Hanford Reach (e.g., in seeps, shoreline indentations). (list continues below)	

10.1, para 1	(list continued from above) 16. Acidity or alkalinity may mobilize some metals (e.g., aluminum) or increase toxicity of certain chemicals. Temperature may increase toxicity, BOD. 17. Just as single, questionably high measured results may be suspect as being too high, single or few measured low amounts may be equally questionable. 18. Existing body burdens of contaminants (e.g., 2,3,7,8-TCDD and other dioxin-like compounds, which affect the immune system) have not been considered when estimating the toxicity of Hanford contaminants. Instead, the screenings assume the exposed individual is pristine; that the individual has not been exposed to other contaminants, which exposure might affect the effect of the contaminant being examined. 19. Averages (e.g., of groundwater discharge, uses of the site area) hide extremes in exposure, sensitivity, vulnerability, etc. 20. The screenings do not consider the cumulative impacts of these contaminants downstream from the Hanford Reach.	
10.1	Unless the Pinza report is a landmark document in the context of the Data Compendium, these paragraphs may inappropriately highlight it. Perhaps the discussion leads the reader too much toward validation of *the Identification of Contaminates of Concern*. These paragraphs might be taken as promotion of the risk assessor's values. Omitting paragraphs 2-4 of the perspective will resolve this comment.	
10.1, para 4	It seems from this last paragraph, that the authors have already reached their conclusion of the impact assessment. I do not see the value of continuing this study if the final conclusions have already been reached. It seems to me that the authors view this study as simply jumping through hoops to reach what they feel is a self-evident conclusion.	
Appendices (all)	Blank spaces imply that no information is available?	

Table A.1	This table has many blank cells. Some cells are labeled "ND" for non-detect. As I understand from communications with Rene Derewetsky [sic], some of the blank cells signify that the analyte has <u>never</u> been sampled on the Hanford Site in a given study, while others of the cells signify that it was sampled, but was a <u>non-detect</u>, at some unstated level of detection. This is not adequate. This table needs to be re-done, indicating which cells are "ND" and which signify lack of sampling. It is not clear, for instance, whether any of the media have been analyzed for 2,3,7,8-TCDD, and at what level of detection (see page A.9). All cells are blank for that analyte. It certainly cannot be eliminated as a contaminant of concern if it has not been adequately sampled on the Hanford Site. Following this correction to the table, analytes which have been inadequately sampled, but which could be considered potential contaminants of concern, cannot be eliminated from the contaminants of concern.	
Table A.1	Why is 2,3,7,8-TCDD the only dioxin-like compound considered as an analyte that should be sampled on the Hanford Site? The appropriate analyte would be toxic equivalencies of dioxins and furans that are dioxin-like in toxicity, since dioxins and furans of lesser, but like, potency than 2,3,7,8-TCDD could be present in much higher concentrations than 2,3,7,8-TCDD.	
General, with specific examples: 3.4, T3.1 **and A10**	Explain more fully why chemicals have been eliminated. For example tritium which is shown in this report at very high radiation levels, relative to other chemicals, is screened out. The equation on p. 4.2 for screening radiation, shows that the concentration is multiplied by SS and SI as well as other coefficients. For Carcinogenic Chemical Screening, only internal exposure is considered. Upon examination of page B.3 (Table B.1 item 66) the Ingestion Slope factor is 5.40 E-14. and the External Slope Factor is 0. No parameters are shown for Cancer Potency; was 0 assumed? Any number, no matter how large can be eliminated by multiplying by 0. And very large numbers are negated by multiplying by E10-14. For the ecological risk factors, none were considered. Given that tritium is a beta emitter, some explanation needs to be provided as to why these levels of tritium are screened out. <u>Suggestion:</u> Provide explanations for selected chemicals of public concern, such as Tritium. Distinguish between chemical eliminated by the screening by knowing they are safe from those eliminated because no toxicity data are available.	

General, with specific examples: page 3.4, T3.1 **and A10**	How would these risk factors compare with occupational safety levels? (Occupational safety usually considers 8 hr./day exposure; a person residing at that site would have greater exposure. Suggestion: Compare the levels here to Occupational Safety.	
Table B.1	The "notes on fish toxicity" are unexplained.	
4.4, para 2 and **Appendix B.1**	The use of TLM = threshold limit for fresh water is confusing. Laws (1993, p. 191) defines TLm as the median tolerance limit, which can be equivalent to LC50. The text of this report suggests that TLM is being used in the sense of the Incipient Lethal Level, a hypothetical concentration of the toxicant corresponding to an infinite median survival time (p. 189). I do not have the CD referred to as EPA 1985, but a number of similar terms have been used by various authors to express acute and No observable or threshold concentrations. Suggestion: Clarify the definition of TLM.	
B.2-B.4: Table B.1 & B.2	The ingestion and external slope factors used to screen the water sources, soil and sediment are not consistent with the parameters cited in *Toxicological Profiles of Chemical and Radiological Contaminates at Hanford* by B.L. Harper, D.L. Strenge, R.D. Stenner , A.D. Maughan and M.K. Jarvis. The document number is PNL-10601. For example the discrepancy for Radium 226 external exposure slope factor: 1.20 E-08 compared to 6.74 E-06. It is suggest that these parameters be reviewed and if the difference between parameters is greater than a factor of 5, then re-screening is recommended.	
Appendix B, Table B.1	The bioconcentration factors used for fish appear reasonable, but they ignore the fact that other organisms may have substantially higher values; for example for Pu, a BCF of 250 is used, but aquatic plants such as algae have values of 10^4 and crayfish have values of 10^3. If you are truly doing a screening for contaminants of potential ecological significance, shouldn't you consider radionuclide uptake by organisms a bit further down the food chain?	
Appendix B, Table B.1	The use of TLM = threshold limit for fresh water is confusing. Laws (1993, p. 191) defines TLm as the median tolerance limit, which can be equivalent to LC50. The text of this report suggests that TLM is being used in the sense of the Incipient Lethal Level, a hypothetical concentration of the toxicant corresponding to an infinite median survival time (p. 189). I do not have the CD referred to as EPA 1985, but a number of similar terms have been used by various authors to express acute and No observable or threshold concentrations. Suggestion: Clarify the definition of TLM.	

B.3, line 66, 4th coln, and B.10	typo? Tritium should be 1,900,000 as shown on page 3.4, table 3.1 and A.10 (not 900,000 as shown on page B.3)? Suggestion: Correct the one that is in error.	
Appendix C	Background designation for samples. It would be useful to provide some sort of reference for the constituents that were eliminated on the basis of "background levels." I suggest that these references include the sample locations and dates for the data that were used to determine background levels. Where these background levels subjected to any sort of statistical evaluation, or could a "background outlier" eliminate a potentially important contaminant from further consideration?	
Table C.1	Each analyte's name should be followed by the number of positive samples and total samples upon which the screening results are being based. For instance 2/3 would mean two positive samples were found; it was sampled three times.	
4.1, para 2 **Tables C.1, C.2, and C.3**	Given the understanding that value judgments are a necessary part of any risk assessment, it is important to avoid any perception that values held by the risk assessor are unilaterally incorporated into risk evaluations. While MEPAS may be a very appropriate methodology for screening, this can not be ascertained from the documentation presented. The importance of a more in-depth review is highlighted, from a toxicological view point, by the inconsistencies between the toxicity factors used in *Identification of Contaminates of Concern* and *Toxicology Profiles of Chemical and Radiological Contaminants at Hanford* (see comment below). So many of the contaminates are listed in the tables as screened by MEPAS that this may become a critical issue. An outstanding question this reviewer has is, what is the process by which an M or I is attached to each contaminate in Tables C? Does not MEPAS incorporate IRIS toxicity values? One way this comment might be resolved is to negotiate the assumptions used in MEPAS through a formal review process.	
Response to comments	The authors are probably correct in stating in their response to prior comments that there are no significant risks from radiation to aquatic biota, but they need to justify that in the SERA.	
Response to comments	The authors are correct that concentrations within background levels are not indicative of risks due to the Hanford site, only if the chemical is not released in a form that is more toxic than the form occurring at background sites. For example, the authors say that Hanford released silver as the nitrate salt which is more toxic than the forms of silver that would be expected in background samples.	

9613405.0090

*Specific References:

Science and Judgment in Risk Assessment, National Research Council, National Academy Press, Washington, DC, 1994

Casarett & Doull's Toxicology -The Basic Science of Poisons, Fourth Edition

Other References

EPA. (Interactive Data Base) AQUIRE (Aquatic Informational Retrieval Toxicity Data Base).

Friant, S.L., and C.A. Brandt. 1994. Ecological Risk Assessment Case Study: Effects of Radionuclides in the Columbia River System--a Historical Assessment. in EPA A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective. EPA/630/R-94/003.

Laws, Edward A. 1993. Aquatic Pollution. Wiley-Interscience.

Trojan Nuclear Plant, Environmental Report. Vol. 1. 1971. (Tritium discussion, Section 5.2, pages 9-10.)

US Dept. of the Interior, 1986. Manual of Acute Toxicity: Interpretation and Data Base for 420 Chemicals and 66 Species of Freshwater animals (Resource Publication 160)

I read the reports with two questions in mind:

- If I were a citizen reading this report, would reading it increase or decrease my confidence that human health and the environment were being protected?
- Would it increase my understanding of the central issues?

After reading the documents, I can answer those questions with a rousing: "It depends!" The key issue is who is the intended audience.

If the audience is intended to be only technically qualified reviewers, then the documents are well-written. Having read numerous technical reports, I would say these show signs of having been polished by a good technical writer. The language is clear and concise.

If the audience is intended to be an interested and intelligent citizen, without qualifications in biology or chemistry, then quite a bit needs to be done to make the documents more accessible. Here are my suggestions related to the document titled "Identification of Contaminants of Concern":

1) For the general reader to get anything from the report, the report must tell a story about what's being studied and why. The impression I had reading this report was that the story the general reader needed to hear was always assumed to be understood by the reader. It's always just out of reach for those without technical training.

If you want to reach the average reader I suggest the report have sprinkled throughout a series of boxes that provide a running commentary that tells the reader what is happening and why the next section matters. For example:

CHAPTER 1

We know that in the past chemicals and radioactive materials ("radionuclides") from the Hanford Site reached the Columbia River, and some continue to enter the river today through water in the soils ("groundwater") that moves slowly towards the river from the old production sites. What we're trying to do in this study is to figure out whether these chemicals or radionuclides -- the contaminants -- pose any risk now.

The first step is to determine exactly what chemicals and materials are in the river, and whether they are "of concern." A contaminant is "of concern" if it could harm either human health or there is ecological risk. The purpose of this study is to get agreement on a list of those contaminants that are in the river (or in river sediments) that have known radiological, carcinogenic or toxic effects to humans or to the environment.

Future documents will deal with other questions such as: Which of these contaminants should be of the greatest concern? What actions, if any, need to be taken to protect human health or the environment?

The question we're addressing is what contaminants are there right now, so we relied on the most recent monitoring rather than going back to look at contaminants that may have reached the river in the past. We concentrated on water, sediment, or soil in or within 500 feet of the Columbia River. That's because those areas are the closest to the source, so they will have the highest contamination. Contamination further away from the source will be lower, usually considerably lower, than the figures shown in these studies. We also looked at the potential for future pollution from contaminants we know are in the groundwater under the Hanford site. We didn't consider contaminants that are in the soil under the Hanford site if they are not in the groundwater, since it won't reach the river unless it gets into the

groundwater. Other studies are looking at ways to clean up such contamination before it gets into the groundwater.

Chapter 2

This chapter lists all the studies and other documents we relied on in preparing this report. It's important to list these so that other scientists can go back and verify the information we used.

Chapter 3

The first step was simply to compile a list of all the chemicals and radionuclides that have been tested for at any time, whether or not they were ever detected. These are shown in Tables 3-1 to 3-3. For those chemicals or radionuclides that were detected, we identified the highest detected amounts any time during the period from 1980-1994. Using the highest figure was a way of being cautious.

Chapter 4

We then created a series of theoretical "screens" through which we could pass all the contaminants that had been detected, retaining only those contaminants that were "of concern."

There are a limited number of ways that humans could be exposed to these contaminants, and all of them require that the individual vists the shores of the river frequently. A human being could be exposed by drinking untreated river water, by eating freshwater fish from the river, or by somehow swallowing sediment. Our assumption was that the amount of exposure was equal to someone who drank 2 liters or untreated river water every day, consumes about .25 kilograms of fish every day (or 100 kilograms a year), and ingests about 10 milligrams of sediment each day (or 4 grams/year). That's a lot. We believe that very few, if any, people ever receive this much exposure. But we're trying to be safe.

When it came to the environment, we relied on criteria developed by the U.S. Environmental Protection Agency, called Ambient Water Quality Criteria, and we also considered what concentrations of a contaminant could kill fish, and set a level that was only a fraction of that amount.

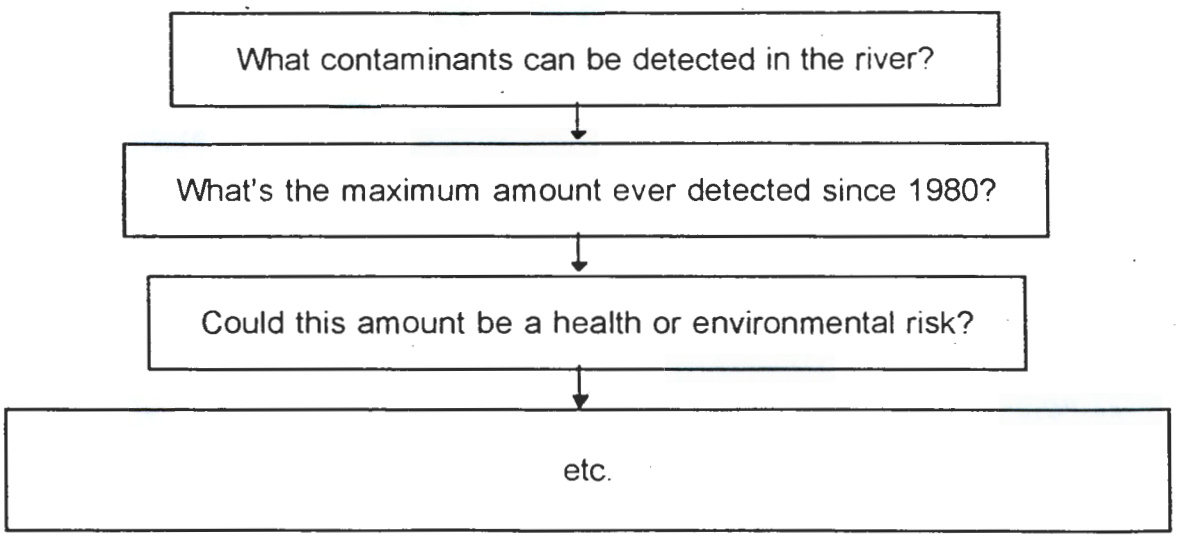
We looked at actual sample of Columbia River water, and, based on our screens, we identified the contaminants shown in Table 4.1. Then we looked at groundwater samples taken within 1 km of the river. The contaminants from those samples are shown in Table 4.2 We also

looked at sediments taken from the river, identifying the contaminants shown in Table 4.3. Finally, we looked at samples of soil taken from near the river. The contaminants in these soils are shown in Table 4.4.

One of the problems, of course, is that we were looking at reports that summarized literally thousands of samples. It's inevitable, with that many samples, that people are bound to make a mistake every now and then. We don't want to list a chemical as a problem just because someone made a mistake. So we looked at whether any result was significantly different from other samples, or just didn't make sense from what we lnow about the river. For example, two chemicals were detected in only one sample. But when we looked at the study closely, we found that during the same sampling process these chemicals showed up in another sample taken upstream of Hanford. Since these chemicals are contained in laboratory or industrial solvents, it's likely that the sample itself was contaminated during the laboratory work. In any event, because the chemicals were also detected upstream, these chemicals didn't come from Hanford. Although there were several cases like this, we didn't drop any of these suspected mistakes from the report. But we did put a footnote by them showing our concern about how valid they are.

These examples illustrate the kind of commentary that could be inserted in boxes to be helpful to the general reader. Technical people could skip over them if they preferred.

2) To tell "the story" it would also be helpful if you had a diagram that showed what questions this report answered, and what questions will be addressed in future reports. For example:



This will reassure readers that even if their concerns aren't being addressed yet, they will be.

3) There are several points at which graphics would be helpful, especially:

   - Pathways by which human health could be affected

   - A figure showing the "exposure" levels for humans. Ideally, if the information is available, this would even compare the "exposure" levels with normal human exposure for Tri-Cities people.

4) Figure 7.1 is unintelligible. Most people are totally thrown by contour lines. Use shading to shown intensity and configuration of the plume.

5) From a "normal person's" perspective, Chapter 10.0 is the most important chapter, because it addresses the question of "Am I safe?"
   Much more attention needs to be spent making sure the significance of what's being said her is understood. It might be some variation on:

   The question everybody is bound to ask is: Should I be concerned about the impacts upon human health or the environment from contaminants in the Columbia River? Here are some things to consider:

   - Recent studies show that concentrations of contaminants in sediments downstream of Hanford are very low.

   - The concentrations downstream were well within safe-drinking water standards.

   - These concentrations were about the same as in other rivers not affected by Hanford.

   The greatest area of concern, of course, is in those areas immediately adjacent to the Hanford Shoreline. We'll be looking at those areas, and areas throughout the Hanford Reach, in subsequent studies.

9613405.0096

Review Comments
Columbia River Comprehensive Impact Assessment

Name:

Page, Paragraph	Comment	Resolutions
General	The report succeeds in bringing together enormous amounts of information into a manageable document. Most of the information on assumptions, parameters used, etc. could be found in the report appendices.	
General	Much of the critically important information is deep in the report (specific examples are given below).	Bring some items forward into the Abstract and earlier parts of the report.
v. Abstract	Very little information is provided in the Abstract. If the Abstract is to be the portion available via computerized literature searches, this abstract provides very little information.	The chemicals of concern (all three columns) should be listed in the abstract, along with the purpose and limitation of the study.
Page 1.4 (Section 1.3)	It is not clear if only the portions of sites 100, 300 and 1100 that are within 150 meters of Columbia River are included, or if all of these sites are included. This may be an artifact of Fig. 1.1, but the sites appear to extend much further than 150 meters from the river.	Clarify if 150 meters includes all of the sites, or if the study only considers those portions of the sites that are within 150 meters.

iii, vii para 4, p 1.4 (Sect. 1.3) Page 2.1 para 4 Page 4.1, para 4 Section 7	The word "contaminants" is vague, and may be interpreted by some readers as including all "pollutants" occurring on the Hanford sites, or at least within 150 meters of the river. To other readers, "contaminants" may exclude those materials in storage. In the case of unlined ponds or landfills, this may be a judgement call. Does this report include or exclude materials in waste management units? Do any of waste management units occur in the area under consideration? These are listed as including spills, cribs, ditches, ponds, tanks, trenches, landfills, burial grounds, pits, French drains, and other ...". Is this material considered as being contaminants in this report, or as being in storage and reported elsewhere? Are any pollutants unaccounted for that reside between soil and groundwater. (Does soil = surface soil, or everything above the ground water?) For example, in Section 4, it is stated that analytes in tanks were not included in this study. For example, in section 7, it is made clear that there are many stored materials that can contribute to future ground water problems, and that chemicals now stored in tanks, landfills, decommissioned reactors, including submarine reactors, nuclear fuel storage units, etc. are not included in this report, but other reports are referenced.	State the limitations on this report more clearly in the Scope Section (1.3) and Screening Section (4.0), and mention earlier in summary, etc. Cross reference to Section 7 for other reports.
Page 3.3-4; Table 3.1	In this table, the radionuclides are mixed with the chemicals	Be consistent with Table 3.2
Page 3.5-6 Table 3.2	In this table, the radionuclides are listed separately	Be consistent with Table 3.1
Page 3.7 Table 3.3	The units (ppb) are not in the same style as the other tables that use ug/kg.	Be consistent with other tables.
Page 3.7 Table 3.3	For the 600 Area, the concentration of contaminants in ground water leaves unclear if there is a quantity of contaminants that have "escaped" from storage areas but is not yet measurable in the ground water.	Clarify if this is reported elsewhere, or is included here.
Pages 4.1-11	The Screening approach is difficult to follow, although much time seems to have expended on trying to make it clear. Specific examples follow because it is the critical process for identifying chemicals of concern.	
Pages 4.4-6.	The conversions of data units and assumptions here seem unnecessary if measured values were used; it is not clear why and when calculated values were used instead of measured values were used. Examples follow:	Clarify
Appendices (all)	Blank spaces imply that no information is available?	

Page 4.1 (last Para, and P 4.2	Since sediment data is presented (Table 3.2) for most chemicals, it isn't clear why a sediment concentration of 100,000 x the water concentration needs to be calculated. Was this factor used to estimate sediment concentration only if data did not exist , or was it used to provide a more realistic estimate than the maximum detected concentration? Spot checking Appendix B.2, the maximum Detected Conc. are listed as being used as parameters. (If the estimated sediment concentration was only used in the Radionuclide and Carcinogenic Screening, the point may be unimportant, because the values of SS, IS, and chemical cancer potency are so low that few chemicals and no radionuclides passed the screen. See the comments below on tritium: any number multiplied by 0 is zero, and the risks per pCi were so low that even orders of magnitude difference in sediments wouldn't have affected the ultimate risk. If no number is shown for cancer potency factor, is it assumed to be 0?)	Clarify. Clarify; is it correct that the risk factors for radionuclides were all very low that only As and Chromium were carcinogenicity risks?
Page 4.5, para 1	As above, it isn't clear why surrogate river water is calculated when river water concentration is measured. Is this to calculate how much additional material would be added to the river when distant subsurface flow might reach the river and be diluted? Is this a worse case scenario?	Clarify
Page 4.5, para 5 (Section 4.2.1.3)	Everywhere else, pCi/kg or pCi/L are used; why does this section use pCi/g? The question is the same as before; why is this calculated instead of using measured values?	Clarify
page 4.4, para 2 Appendix B.1	The use of TLM = threshold limit for fresh water is confusing. Laws (1993, p. 191) defines TLm as the median tolerance limit, which can be equivalent to LC50. The text of this report suggests that TLM is being used in the sense of the Incipient Lethal Level, a hypothetical concentration of the toxicant corresponding to an infinite median survival time (p. 189). I do not have the CD referred to as EPA 1985, but a number of similar terms have been used by various authors to express acute and No observable or threshold concentrations.	Clarify the definition of TLM.
Page 4.8-9	Given the assumptions and calculations of surrogate groundwater, sediment, and river water, it is not clear if the Screening results represent that calculated from measured maximum concentration, or from the surrogate values.	Clarify
Page 6.1	A map of the area with this area enlarged would be helpful. Isopleths of direct irradiation could be shown.	Provide a map.

Page 4.1, para 3	Limiting the ecosystem risk calculations to EPA Ambient Water Quality Criteria (EPA 1992) and fish lethality is inadequate. It seems from Appendix C that most of the items eliminated by the screening process had no risk data other than carcinogenic risk. In fact, most of the items listed as "Continued Public Interest" are of obvious concern, but may have been screened out by lack of data rather than assurance of safety. There seems to be an attempt here to use EPA Ambient Water Quality Criteria to assure the public that the screening process is using generally accepted values that have been extensively reviewed and stood the test of time and numerous challenges. However, many of the chemicals considered here are not commonly encountered chemicals and not included in EPA AWQC documents. The report does not indicate how widely the literature was searched for toxicity data.	Search more extensively for data. Use AQUIRE (EPA (US Dept. of the Interior, 1986, Resource Pub. 160) to identify concentrations of concern for biota. Various DOE laboratories including Hanford and ORNL have spend years studying the toxicity of many of these items, e.g. Friant and Brandt (1984) References at end.
p. 7.2, and other	Eutrophication must be considered as well as toxicity, when these high concentrations of inorganic N and P are encountered	Estimate and report on the eutrophication risk of N and P
p. 4.7 para 4	Potential Na toxicity should be examined; many organisms are sensitive to salinity (NaCl).	Calculate if Na could contribute significantly to the salinity of the River.
Page B.3, line 66, 4th coln, and B.10	typo? Tritium should be 1,900,000 as shown on page 3.4, table 3.1 and A.10 (not 900,000 as shown on page B.3)?	Correct the one that is in error

General, with specific examples: page 3.4, T3.1 and A10	Explain more fully why chemicals have been eliminated. For example tritium which is shown in this report at very high radiation levels, relative to other chemicals, is screened out. The equation on p. 4.2 for screening radiation, shows that the concentration is multiplied by SS and SI as well as other coefficients. For Carcinogenic Chemical Screening, only internal exposure is considered. Upon examination of page B.3 (Table B.1 item 66) the Ingestion Slope factor is 5.40 E-14. and the External Slope Factor is 0. No parameters are shown for Cancer Potency; was 0 assumed? Any number, no matter how large can be eliminated by multiplying by 0. And very large numbers are negated by multiplying by E10-14. For the ecological risk factors, none were considered. Given that tritium is a beta emitter, some explanation needs to be provided as to why these levels of tritium are screened out.	Provide explanations for selected chemicals of public concern, such as Tritium. Distinguish between chemical eliminated by the screening by knowing they are safe from those eliminated because no toxicity data are available.
As above	How would these risk factors compare with occupational safety levels? (Occupational safety usually considers 8 hr./day exposure; a person residing at that site would have greater exposure.	Compare the levels here to Occupational Safety.
Exposure Assumptions, p. 7.1, 4th para	Assuming all chemicals to be at maximum concentration at 1% of the site (given that only 6% of the Hanford Reservation has been developed, seems very broad brush for the detailed monitoring that the public has been told is or has occurred. By using the same multiplying factors, the Maximum Detected Concentrations (Table 3.1) drives the whole risk calculation. There is no ability to distinguish between a bucket full of highly contaminated material, and a huge area of moderate contamination. Given that chemicals were injected directly into the ground water (Area 200, p. 7.1, 4th paragraph), this use of a single factor seems unwise. It seems to be offered as a way of overestimating and providing a conservative estimate. But, it could also obscure some problems.	Provide more detailed information where appropriate. At least give some indication of areal extant of specific pollutants of concern.
Page 4.1, para 6, Section 4.1.1	The radionuclide screening handles each radionuclide as a separate and independent item. It would seem useful to calculate the total radiation absorbed (Gy) by Columbia River biota. Laws (1993, p. 473-474) provides a discussion of Oak Ridge (White Oak Creek) fish receiving 3.6 mGy/day and Chironomid larvae receiving 6m Gy/d as worse case scenarios. Friant and Brant 1994 offer a risk assessment for the Columbia River than might be useful to discuss.	Supplement the report with data of an ecological nature in situations of similar exposure.

Page 8 (Section 8)	The arguments here seem contorted. The section may suffer from trying to state too much in too limited a space, but it makes several statements that are unsupported in this document. I found no calculation or discussion that 100 tons of uranium form natural sources pass the Hanford site from natural causes, and it seems irrelevant to the issue. The section raises other issues not addressed in text. For example, given that radiation units have been in pCi, it seems odd to state that no more than 1.7 curies of plutonium resulted from the 6.3 million curies of neptunium-239. If you are going to equate atoms of neptunium to atoms of plutonium, you have to state the radiation equivalents. Presumably, much of the released neptunium-239 has been diluted and washed out to sea? This section seems to be saying that even if a major nuclear facility had never been at this site, the radiation levels for uranium and plutonium 239/240 and other chemicals would be the same; it seems unlikely. On other concerns, the section implies that topics have been discussed, that were covered only by omission. For example, tritium was shown in A.1, A.2, and A.3 to have been measured in concentrations very much higher than background; (>6,000 to 1,900,000, or 6,193,000 pCi/L) as compared to background (40 pCi/L) (Tables A.1, 3.3).. Only by examining the parameters used in B.1 did it become obvious that tritium did not pass the screen because the Ingestion Slope Factor was 5.4E-14, the External Slope Factor was 0, there is no Cancer Potency Factor (assumed to be 0?), and no toxicity data were listed. There may be very valid reasons not to worry about these concentrations of tritium, but it was not discussed in this report. The Trojan Nuclear Plant Environmental Report has a 2 page discussion on why tritium concentrations may be discounted; such a discussion may be useful here. Many of the other chemicals of concern were also not discussed, but only listed as concentrations detected and parameters used to calculate risk. This section seems to raise more problems than it solves.	Improve this section so that it seems reasonable, or just list chemicals of continued interest.
General	The report shows an enormous amount of effort and provides a wealth of information. Some areas can use improvement.	Focus on correcting the weaknesses.

References:

EPA. (Interactive Data Base) AQUIRE (Aquatic Informational Retrieval Toxicity Data Base).

Friant, S.L., and C.A. Brandt. 1994. Ecological Risk Assessment Case Study: Effects of Radionuclides in the Columbia River System--a Historical Assessment. in EPA A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective. EPA/630/R-94/003.

Laws, Edward A. 1993. Aquatic Pollution. Wiley-Interscience.

9613405.0102

Trojan Nuclear Plant, Environmental Report. Vol. 1. 1971. (Tritium discussion, Section 5.2, pages 9-10.)

US Dept. of the Interior, 1986. Manual of Acute Toxicity: Interpretation and Data Base for 420 Chemicals and 66 Species of Freshwater animals (Resource Publication 160)

END

Columbia River Comprehensive Impact Assessment

Page, Paragraph	Comment	Resolutions
Comments related to specific sections of the text		
viii	The text states that the initial screening eliminated contaminants that showed no detectable levels of activity or concentration. It would be appropriate to add a sentence noting the time interval encompassed by the data.	
viii	It should be noted that the radionuclide screening is based on exposure of humans to the contaminants of concern.	
ix	In the section on **River Sediment** an equilibrium ratio of 1:100,000 is assumed for contaminants. This is extremely conservative for many elements (the sediments are sucking the contamination out of the water). This statement appears at odds with the one which appears in the next section (**Near-River Soil**) where it is assumed that all contaminants are environmentally mobile and potentially dissolvable in groundwater. A statement acknowledging the apparent inconsistency, and the rationale behind it, would be appropriate.	
xiii	The definition of **bioconcentration factor** should include a statement as to whether or not the ratio is a fresh or dry weight value.	
xiii	In the definition of **Ci**, note that the term is fully defined in the text below.	
xiv	In the definition of **isotope** - give an example, such as tritium as an isotope of hydrogen	
xv	In the definition of **radioactivity**: to be more accurate, it should state "by some nuclides as they transform into other nuclides"; of course, now you need to define the term nuclide.	
xv	In the definition of **reference dose**: on page viii you define the EPA chronic oral reference dose for noncarcinogens as the "safe dose level EPA established for specific chemicals"; here you define the reference dose as "the smallest daily intake of a hazardous material that first leads to deleterious health effects"; this seems a bit of a contradiction. Also the text in Section 4 refers to the **RfD**; it should be included in the glossary with the reference dose.	
xvi	In the definition of **surrogate** you state that it is an "estimated substitute measurement used". This is a bit is unwieldy. How about defining a surrogate as "an estimated value used when the actual measurement is unavailable"?	
P 1.1, section 1.1, 2nd paragraph	The Hanford site is **currently** 1,4560 square kilometers. It used to be bigger. Do you wish to acknowledge this change?	

P. 1.3, section 1.1, 3rd paragraph from the top	You note that contaminated groundwater has moved out of the 200 Areas into adjoining areas. Hasn't contaminated groundwater moved from the 200 Areas to the Columbia River as well? Note that in your statement on the 600 Areas in the last paragraph of this section you acknowledge that groundwater from the 600 areas has moved to the Columbia River.	
P. 1.3, section 1.1, 2nd to last paragraph	In describing the contamination of the 3000 area, you state that it is "minor". What is the basis for this statement? Is the contamination minor relative to the other operating areas, or minor relative to some gas station's leaking underground fuel tank? A simple clarification would suffice.	
P 2.5, notes on Weiss	The annotation notes "the sand-sized and smaller sediment samples were analyzed for metals and radionuclides from the near-shore and shoreline". Do you mean to say that sand-sized and smaller sediment samples collected from the near-shore and shoreline were analyzed for metals and radionuclides?	
P 2.5, same notes as above	The paragraph states "sediment was collected at depths of ...below the surface"; does the term <u>surface</u> refer to the water or sediment surface?	
P 2.10, notes on EG&G	The terms **anthropomorphic** and **isopleth** are used, but are not defined in the glossary.	
P 3.4, Table 3.1	Plutonium 239 is listed as an analyte. Presumably this is really Pu-239&240? See footnote b to table 3.2 for comparison.	
p 4.1, Section 4.0, 2nd paragraph	The incidental ingestion rate of 10 mg/d sediment seems low for a "dedicated river user" and especially in comparison to the median **soil** ingestion rate for children of about 16 mg/d (about 6 gm/y); is there a basis for the 10 mg/d value?	
P 4.2, first full paragraph	In the screening equation (1) a risk estimate is derived for external exposure. Is this the risk from immersion in contaminated water or sitting on contaminated shoreline? It is not clear how this part of the equation was arrived at, and what exposure duration was assumed.	
P 4.2, first full paragraph	It would be easier to follow the equation (1) if the dimensions of all the variables were consistently reported; for example the water consumption rate of 730 is reported as "2 L/d for 1 year" - when actually the value 730 has dimensions of L/yr. Similarly, the sediment consumption rate is discussed in g/yr but the value as shown in the equation is kg/y.	
P 4.2, Section 4.1.2, equation (2)	It would be easier to follow the equation (1) if the dimensions of all the variables were consistently reported. The same comments as above apply, for example in explaining the value of 1×10^{-5} as "consumption of 10 mg/d of sediment, kg". It would be clearer to note that 1×10^{-5} is "The consumption of 10 mg/d of sediment, expressed in kg".	

P 4.3, Section 4.1.3, equation (3)	It would be easier to follow the equation (1) if the dimensions of all the variables were consistently reported. The same comments as above apply, for example in explaining the value of 1×10^{-5} as "consumption of 10 mg/d of sediment, kg". It would be clearer to note that 1×10^{-5} is "The consumption of 10 mg/d of sediment, expressed in kg".	
P 4.5, equation 6	An average flow of 100,000 cfs is used. For a conservative model shouldn't a more restrictive value be used?	
P 4.5, equation 6	What is the source of the 100 cfs estimated discharge of groundwater to the Hanford Reach? Is this a peak value or an average?	
P 4.5, equation 6 Section 4.2.1.1, equation 6	This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
P 4.5, Section 4.2.1.2, equation 7	If you are using sediment concentrations to predict water concentrations in a conservative screening model, you should use distribution coefficients that maximize the predicted water concentrations. Literature values of K_ds for radionuclides range from 0 for ^{3}H to 1,000 for ^{60}Co to 10^{6} for Th. Is there a Hanford-specific basis for using a K_d of 100,000 for all nuclides?	
P 4.6, Section 4.2.1.3, equation 8	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
P 4.6, Section 4.2.2.1, equation 9	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
P 4.6, Section 4.2.2.2, equation 10	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
P 4.7, Section 4.2.2.3, equation 11	(Same comment as for equation 6). This equation dilutes the impact of the groundwater by a factor of 1000, ignoring the fact that the "plume" may be undiluted for some distance downstream. For screening purposes it might be more appropriate to simply use the groundwater concentration at the point of discharge into the river.	
P 4.7, Section 4.3	In discussing the screening results, reference is made to the identification of a few chemicals and radionuclides of potential interest that were not carried forward because the measurements were "within naturally occurring background levels". It would be useful to provide a table listing the naturally occurring range of concentrations of these contaminants in environmental media (i.e., soil, sediment, groundwater and river water).	

P 4.7, Section 4.3.1	The meaning of the second sentence which begins "a screening level was used to account for over 1) 95% of the carcinogenic risk for each result, above a cutoff of 10^{-6}..."is unclear.	
P 4.9, Section 4.3.4	The first sentence discusses contaminants measured in soil near the Columbia River as not being an immediate hazard as they are not subject to mass transport to the river. Are these soils located at a specific distance from the river such that flooding or overland runoff is not likely to move them? If so, specify how far they are from the river and why they are unlikely to move.	
P 4.10, Table 4.4	In the appendix, table C.2, the carcinogenic risk ranking for ^{241}Am in soil was 2.3 E-06, yet it didn't get put on the contaminants of concern list, Table 4.4. Why? A similar question is asked for ^{239}Pu.	
P 5.1	This text discusses the presence of discrete radioactive particles, but doesn't explicitly state that they will be evaluated as a contaminant of concern. It is inferred from the text that they will be and Table 9.1 appears to confirm this assumption. However, and explicit statement to that effect should be included.	
P 6.1	This text discusses the direct irradiation from Hanford facilities and provides estimates of exposure rates in micro roentgens per hour, but no discussion is given as to where these measurements are made (at the ground surface, at 1 m from the surface, etc). Assuming the source of contamination is represented by an "infinite plane", the exposure rates are not going to change dramatically as one gets nearer to the surface, but some discussion should be made as to what the exposure rates are likely to be for nonhuman biota residing in the vicinity.	
P 7.2, Figure 7.1	This graphic is difficult to interpret; i.e., contour lines for >1000 mg/L nitrate are given in the legend, but don't appear to be presented anywhere in the map.	
Appendix B, Table B.1	The bioconcentration factors used for fish appear reasonable, but they ignore the fact that other organisms may have substantially higher values; for example for Pu, a BCF of 250 is used, but aquatic plants such as algae have values of 10^4 and crayfish have values of 10^3. If you are truly doing a screening for contaminants of potential ecological significance, shouldn't you consider radionuclide uptake by organisms a bit further down the food chain?	
General comments on technical approach used in the document		

	Throughout the document, the screening levels are referred to as tools to evaluate potential risk to humans and other biota. Yet the techniques used to derive an estimate of radiation risk are based solely on human consumption of, or external exposure to, radioactive and chemical constituents. Other than the use of a bioconcentration factor for fish, no attempt was made to estimate dose rates to aquatic or terrestrial species. Are the authors assuming that if the risk to humans is less than 10^{-6}, the risk to other biota is negligible? If this is the case, they should provide references to that effect (for example, IAEA, 1992, Effects of Ionizing Radiation on Plants and Animals at Levels Implied by current Radiation Protection Standards, Technical Report Series No. 332, Vienna, Austria; or NCRP Report 109, Effects of Ionizing Radiation on Aquatic Organisms, 1991.)	
	The inhalation pathway was apparently ignored in this screening assessment, although the discussion in section 5 makes this statement a bit uncertain. It would be appropriate to consider inhalation of resuspended silt or clay sized particles which tend to have higher concentrations of contaminants.	
	The screening level equations which dilute the groundwater seeps into the greater volume of the Columbia river ignore the potential impacts on biota living in the immediate (undiluted) vicinity of the seeps.	
	The screening level equations are dimensionally correct, but are not conceptually explained as to why they should be accepted. Also, for screening levels one would, presumably choose parameter values that maximize the dose or risk estimate - for example the 2 L/d consumption of drinking water is a standard value used in radiological assessments - why not pick an upper bound value, since this approach is meant to be an extremely conservative method for identifying potential contaminants of concern?	
	The screening level approach ignores the fact that consumption of foodstuffs grown in contaminated soils/sediments/waters may account for >99% of potential dose in some scenarios. If a contaminant yields a screening level risk of 10^{-6} based solely on water or soil ingestion (and therefore subject to elimination from consideration), its potential risk from other exposure routes could be at the 10^{-4} level, far above the trigger point.	
	Basing all the screening on estimated water concentrations ignores pathways to shore dwelling biota such as external irradiation from contaminated sediments.	
	Using an arbitrary K_d of 100,000 to predict water concentrations from soils or sediments is not necessarily conservative for many elements such as Am, Co, I, U, etc. (Source, Till and Meyer, Radiological Assessment, NUREG/CR-3332).	

Review Comments
Columbia River Comprehensive Impact Assessment

Page, Paragraph	Comment	Resolutions
Preface	This is well written.	
Abstract & Summary	Is there a good reason to have both an abstract and a summary?	
Scope of Work	The stated scope may not be consistent with statements within the document. See comment below.	
2.8, 1	A Qualitative Risk Assessment is available for NR-1. Shouldn't this document be included on the list? Are data from all the operable units included in the Tables A?	
4.2, 1 & 2 4.3, 1	sediment/water ratio; should this not be water/sediment ratio? The units must match.	
4.1, 2 Tables C.1, C.2, and C.3	Given the understanding that value judgments are a necessary part of any risk assessment, it is important to avoid any perception that values held by the risk assessor are unilaterally incorporated into risk evaluations. While MEPAS may be a very appropriate methodology for screening, this can not be ascertained from the documentation presented. The importance of a more in-depth review is highlighted, from a toxicological view point, by the inconsistencies between the toxicity factors used in *Identification of Contaminates of Concern* and *Toxicology Profiles of Chemical and Radiological Contaminants at Hanford* (see comment below). So many of the contaminates are listed in the tables as screened by MEPAS that this may become a critical issue. An outstanding question this reviewer has is, what is the process by which an M or I is attached to each contaminate in Tables C? Does not MEPAS incorporate IRIS toxicity values? One way this comment might be resolved is to negotiate the assumptions used in MEPAS through a formal review process.	

4.1, 7	The assessment of external exposure seems to make a very significant assumption. It appears to this reviewer that it is assumed that the radio isotope contaminant is found in an infinite slab geometry. This assumption weights heavily the risk associated with external exposure pathways relative to the other pathways. The result of this assumption may be that contaminates associated with external exposure pathways are consistently assessed as contributing the largest risk. This is not because of the inherent toxicity of these contaminates, rather it is because the conservatism incorporated into assessment of the external exposure pathway. The potential consequence might be that, in risk-based decision-making, external exposure may inappropriately become the focus of efforts aimed at reducing risk. In this regard, the infinite slab assumption may be a hidden value judgment that expropriates the basic science. I suggest that the infinite slab assumption be reviewed by the CRCIA management team in the context of the many risk assessment that have incorporated it. If necessary the geometry assumption should be formally replaced by one or more probability statements to provide a more realist assessment. This comment will be resolved by a formal request for TPA management review of the infinite slab assumption.	
4.1, 7	It appears to this reviewer that the 100,000 water/sediment ratio may have a very large potential to impact the risk assessment out-come. For sediment considerations, the ratio is used to estimate the concentration of the radionuclide in an infinite slab geometry. The potential to over-estimate risk is magnified by this layering of conservative assumptions. There are several outstanding question concerning the derivation of this ratio. Why is one ratio used to represent several of the contaminates? Why hasn't actual analytical data been used? It may be that this comment can only be resolve through more than one review cycle.	
10.1	Unless the Pinza report is a landmark document in the context of the Data Compendium, these paragraphs may inappropriately highlight it. Perhaps the discussion leads the reader too much toward validation of *the Identification of Contaminates of Concern*. These paragraphs might be taken as promotion of the risk assessor's values. Omitting paragraphs 2-4 of the perspective will resolve this comment.	

General Comment	This report should remain within the negotiated scope. If the scope of the CRCIA is to evaluate the risks associated with contamination of the *river and 500 ft. shoreline*, discussion of potential contamination from sources further inland should be omitted. If the scope of the CRCIA is to evaluate the *present* risks, then discussion of the potential for future contamination and associated risk should not be included. This comment will be resolved by reviewing the statement of work and, if appropriate, editing the document such that it is consistent with the stated scope.	
General Comment	It is unclear as to whether all the background levels of radionuclide contaminates that are currently available have been subtracted during the screening. The Hanford Site Background Concentrations for most of the non-radionuclides are cited from the 1994 background document. It is appropriate to incorporate the Hanford Site-specific radiological data too. The Westinghouse Hanford (Scott Peterson?) report may be most comprehensive in this regard. This comment will be resolved by confirming that each of the contaminates were screened against the most recent determinations of background concentrations.	
4.3	The rate of soil ingestion used is 10 mg/kg. This is somewhat of a concern. It is the opinion of this reviewer that although this is a realistic approximation, it might be appropriate in attach some margin of safety. It is suggested that the rate might be increased to 50 mg/kg.	

General Comment	A comprehensive assessment is desired by all. However, the degree of sophistication achievable is limited by the scientific uncertainties inherent in each component of this risk evaluation. In this regard it should be noted the toxicity assessment does not incorporate scientific advances made over the last decade. For example, the process by which the slope factors were derived does not consider biological defense mechanisms such as DNA repair or the normal processes of cellular turnover. In light of more recent scientific information, it is now a general consensus among toxicologist that the margin of safety that is incorporated into toxicity factors is large. The appropriateness of this large margin of safety is increasingly controversial. It is the opinion of this reviewer that the margin of safety, in just the toxicity assessment component, is at least one order of magnitude for the radionuclides and at least two orders of magnitude for the non-radioactive carcinogens. It is likely the margins are larger. The margins of safety are sufficiently large to adequately protect human health even though a limited number of pathways are considered. Additional assumptions made by the assessor in the face of scientific uncertainty in assessing additional pathways blur the distinction between what is of concern and what is not. This limits the usefulness of the screening exercise. I suggest that the protection gained by considering additional pathways does not balance with the reduced reliability of the screening. For this reason this reviewer suggest that biota ingestion pathways not be incorporated in the screening process.*	
Table B.1 & B.2	The ingestion and external slope factors used to screen the water sources, soil and sediment are not consistent with the parameters cited in *Toxicological Profiles of Chemical and Radiological Contaminates at Hanford* by B.L. Harper, D.L. Strenge, R.D. Stenner , A.D. Maughan and M.K. Jarvis. The document number is PNL-10601. For example the discrepancy for Radium 226 external exposure slope factor: 1.20 E-08 compared to 6.74 E-06. It is suggest that these parameters be reviewed and if the difference between parameters is greater than a factor of 5, then re-screening is recommended.	
Formulas 4.1.1, 4.1.2, 4.1.3	The mathematical aspects of these formulas are correct. However, it is the opinion of this reviewer that inclusion of fish and sediment ingestion pathways evaluation is misleading in that it implies a level of precision not achievable due to uncertainties inherent in the toxicity parameters.	
3.5, Table 3.2	Is it Antimony 124 or 125?	

General Comment	What is the process for dealing with contaminates for which there is no toxicity factor? What is the source of the oral slope factors for Benzo(b) and Benzo(k) Fluoranthene?	

* References: Science and Judgment in Risk Assessment, National Research Council, National Academy Press, Washington, DC, 1994
Casarett & Doull's Toxicology -The Basic Science of Poisons, Fourth Edition

General Comments	1. All Hanford-released contaminants at the Hanford site are of concern, because of our lack of knowledge of all the ways these contaminants may damage living organisms (see twenty potential sources of underestimation of damage in the comment regarding page 10.1, below). This damage may be caused by single contaminants and/or contaminants in combination with other contaminants and vulnerabilities of the organisms and their inter-species relationships. Therefore, this report should be called "A Selected List of Contaminants of Concern." This list has been selected on the basis of a specific set of assumptions and is therefore not actually "identification" of contaminants of concern, as if some contaminants have been identified factually as of concern, while others have been identified factually as not of concern. In other words, under different sets of assumptions (e.g., different assumptions regarding the significance of absence of chronic effects data or the significance of cumulative impacts), and even different data (e.g., inclusion of suggestive field data on Hanford-area species as well as related species or organisms), different lists of "contaminants of concern" would be generated. This list, then, is just a list of some contaminants of concern according to certain selected assumptions. Nothing more can be claimed for it. 2. This report needs to indicate when screening results for individual analytes have been based on available field and experimental data versus when they are bsed on default assumptions in the screening formulas. 3. This report needs to be written in a manner that is meaningful to the public, e.g., showing visually which areas and which media (e.g., underground water plumes, soils, sediments) in the study site are assumed to contain which contaminants of concern. This would give some sense of which areas contain multiple contaminants of concern. 4. Department of Energy responses to many (not all) of the comments made by the Nez Perce Tribe, Department of Ecology, Department of Health, and U.S. EPA are terse, undocumented assertions.

An example of this is the Department of Energy response to a U.S. Environmental Protection Agency concern regarding failure to consider any interactive effects of contaminants. The response is: "Not Accepted. The limits [what are these?] on the conservative [according to whom?] screens are set very low [what does this mean?] for each contaminant. If interactions do occur, they are not expected [according to whom?] to increase the risk by even an order of magnitude; thus the eliminated [?] contaminants are not expected [by whom?] to contribute significantly to risk." This is not an appropriate response. If I receive an undocumented, uninformative response like that to any of my comments, I will pursue that response until I get adequate information and documentation from the Department of Energy for their response.

5. The undocumented, oft-repeated assertion in both this report and Department of Energy responses to commenters to the effect that this screening is "conservative" is both a non-verifiable assertion, and arrogant. For instance, the Department of Energy asserts that "Conservatism will be retained in this screening report. We expect to use realistic values in the final assessment" (Response to the U.S. Environmental Protection Agency Comments of February 28, 1995, on "Identification of Contaminants of Concern", response to comment #27). This presupposes that the Department of Energy <u>knows</u> what is "conservative" and what is "realistic." Unless the report authors admit that they could be potentially <u>underestimating</u> damage and risk (see comment relating to p. 10.1, below) just as they claim they are potentially <u>over-estimating</u> damages, then any statement about "conservatism" has no credibility.

The above-stated plan to "use realistic values in the final assessment" is an ominous statement. Unfortunately, "realistic values" probably does not refer to additional ecological, field, experimental, and observational data about the effects of the analytes in the real-world environment, but rather to using probabilistic assumptions. Contaminants of concern are of concern in part because in reality we know very little about their overall potential to harm and to contribute to degradation caused by other compounds. Any move toward "realistic" assumptions will need to consider the twenty factors potentially leading to drastic <u>underestimation</u> of impacts, as noted below in the comment on page 10.1. <u>Those factors</u> constitute realism.

	6. Ultimately, the list of "contaminants of concern" that the Department of Energy is generating using the particular assumptions that PNL has chosen to use, must not be used as a weapon against concerns raised about these and other contaminants on the Hanford site based on evidence not considered in this exercise. In other words, field or experimental evidence of endocrine disruption may be found at some point with some of the contaminants. This information has likely not been considered in developing any of the EPA Water Quality Criteria used in screening contaminants by PNL. Or a field study by a graduate student somewhere regarding one of the analytes might be turned up in coming months. Such information must be considered, on an ongoing basis, as actions are chosen for contaminants on the Hanford Site. In other words, it is not scientific, realistic, appropriate, or acceptable to decide, at any point, that "THIS list is our list of contaminants of concern, and other contaminants are not of concern."
xiii, "Carcinogenic chemicals"	I would suggest, "....contracting cancer at some point after exposure." The phrase "later in life" is misleading; childhood cancer can occur a relatively short time after exposure to certain carcinogens.
4.1, last parag.	The assumption is made of a 1:100,000 water:sediment ratio for radionuclides. Have field data ever shown a larger proportion for any of the radionuclides in water relative to sediment? If so, are field data substituted rather than the 1:100,000 assumption, when field data are used? If so, the reader needs to know when a screening conclusion is based on field measurements rather than assumptions for the water:sediment ratio. If field data have shown a larger proportion for any of the radionuclides in water relative to sediment, either a larger ratio needs to be employed, or a statement needs to be made that for some radionuclides, this ratio may underestimate the presence of the radionuclides in water.
4.2, last sentence	The Department of Energy response to the Department of Ecology suggestion (p. 6 of comments, sent under a March 29, 1995 cover letter) that 10E-7 be used to provide some recognition that additive, synergistic, or multiplicative effects are almost certainly operating, is not adequate. The Department of Energy has simply responded, "In general, the HSRAM methodology is not appropriate for this assessment" (response to concern #25 of Department of Ecology) That does not speak to the issue that contaminants could be eliminated as contaminants of concern simply on the basis that they are being considered as if they were single actors in an otherwise pristine world. This is a terribly non-conservative assumption.
4.3 Toxic Chemical Screening	Toxic Chemical Screening should be called "Human Toxicity Chemical Screening."

4.3, Aquatic Biota Toxicity Screening	The aquatic biota toxicity screening fails to include biomagnification. A chemical is of concern if it biomagnifies at the top of a food chain, even if it does not reach some threshold of known toxicity in organisms lower in t he food chain. If later ecological risk assessments will be performed only on "contaminants of concern," then it is inappropriate to fail to calculate biomagnification. Therefore, an additional screen needs to be added for persistent, bioaccumulative, toxic compounds. Field data regarding biomagnification of such compounds should be figured heavily into any list of contaminants of concern. Likewise, any contaminant that bioaccumulates more than 100 times (as expressed by the bioconcentration factor or the octanol-water partition coeficient) and has a half-life in any medium (air, water, soil, sediment, or biota) of eight weeks should be tagged as a contaminant of concern. As the U.S.-Canadian, federally-appointed International Joint Commission on Great Lakes Water Quality notes, "We conclude that persistent toxic substances are too dangerous to the biosphere and to humans to permit their release in <u>any</u> quantity" (emphasis in original: International Joint Commission; 1992; *Sixth Biennial Report on Great Lakes Water Quality*).
4.3, Aquatic Biota Toxicity Screening	Aquatic biota include crustaceans, insects, other invertebrates, amphibians, and fish. When you have had experimental data on two taxa, only one of which is fish, have you always selected the lower? The reader needs to know when a screening conclusion is based on experimental data rather than the assumption of one percent of the LC50.
4.4, first parag.	Have field or experimental data indicated chronic or other adverse effects at less than one percent of LC50 for any of the analytes? If so, this needs to be noted, and the one percent of LC50 assumption will need to be altered. Recent literature on endocrine disruption in fish (e.g., increase in vitellogenin) needs to be considered in relation to this assumption, as well.
4.4, third parag.	As Department of Ecology has noted, literature <u>is</u> available on the impact of some chemical and radionuclide contaminants on fish eggs. Please indicate the literature search methods that were used that failed to note fish egg toxicity literature. this may be a problem in choosing one percent of LC50 for chronic effects, as well. Did PNL do any search of field and experimental literature? Existing field and experimental literature will require a modification of the one percent of LC50 default assumption, if any of the literature indicates sensitivity at lower levels, for any life stage.
4.6, first parag.	The assumption that only one percent of the total Hanford Site is contaminated must be re-examined. First, it would seem that only the area that is being analyzed for contaminants should be considered as the area within which a fraction of contaminated area is estimated. Second, the methodology of arriving at a contaminated area fraction should be spelled out. The Department of Energy response to this same concern raised by the Department of Ecology is <u>not</u> adequate.

4.7, Near-River soil equation	The Department of Energy response to the Department of Ecology concern that hexavalent chromium prefers to concentrate in the groundwater rather than being equally concentrated in soil and groundwater is not adequate. When field data or experimental data are available regarding soil/groundwater distribution, are they used in preference to the assumption of soil/groundwater concentration equivalency? If so, the reader needs to be informed when a screening result has been based on data, and when on a default assumption. If not, then this needds to be done: Field and experimental data must be used in preference to a modeling assumption of soil/groundwater concentration equivalency.
4.10, last paragraph	As well as noting that six contaminants had six single, questionable, measured results, the reader should be informed of which analytes in Table A.1 had only single measured results, which might indicate that greater existing contamination has been missed.
4.11, first and third paragraphs	How many times were toluene, xylene, benzo(a)pyrene and indeno (1,2,3-CD) pyrene sampled in the areas?
7.2, Figure 7.1	Figure 7.1 notes a drinking water standard of 45 mg/L. This is not correct. EPA has set a guidance level for nitrate in drinking water at 10 mg/L; a guidance level for nitrite in drinking water at 1 mg/L, and a guidance level for the combination of nitrate and nitrite in drinking water of 10 mg/L. Infants are susceptible to methemoglobinemia at nitrate levels in excess of 10 mg/L (EPA undated Health Advisory Summary: Nitrate/Nitrite). Washington State Board of Health drinking water regulations (revised September, 1989) provide for an MCL of 10.0 mg/L for nitrate.
8.1, second parag.	Radiation attributable to fallout from nuclear weapons testing should not be considered "background." It may be called fallout radiation, but it should be distinguished from naturally occurring radionuclides.
8.2, last parag.	The nature of the public concern regarding each of the eight substances noted, should be briefly, but comprehensively, described. If valid evidence or reasons for concern have been brought up, but do not happen to fit in the precise set of assumptions used by PNL/DOE, then these contaminants should be added to Table 9.1 as identified contaminants of concern.
9.1, first parag.	The following statement is meaningless, because different compounds may have quite different environmental fates and toxicity characteristics: "The results were consistent in that the same compounds were identified numerous times by the various screenings." In actuality, if a compound were only identified in ONE screening, that would not imply any "inconsistency" at all, because the compound might be hazardous because of its fate in one particular medium, or its toxic effects on one organism. Therefore, the appearance in "various screenings" cannot be labeled a sign of "consistency."
9.1, fourth parag.	Arochlor 1248 is currently used in equipment on the Hanford site?

9.2, Table 9.1	As I read Table C.1 (Appendix C, Complete Numerical Results [for Screening]), the following substances have exceeded screening criteria and therefore need to be listed as "Identified Contaminants of Concern" in Table 9.1: <u>A. Add to column 1 of Table 9.1:</u> benzoanthracene benzoapyrene benzo(b)fluoranthene benzo(k)fluoranthene beryllium bis(2-ethylhexyl)phthalate cadmium chrysene methylene chloride nickel ruthenium 106 thorium 228 zirconium 95 <u>B. Label the following contaminants with a superscript (d),</u> because they also appear as contaminants of concern in groundwater plumes away from the Columbia River: arsenic cesium-137 cobalt-60 particles strontium-90 <u>Add to column 2 (i.e., groundwater away from the Columbia River) of Table 9.1:</u> chloroform

10.1, first parag.	The statement is made, "The screening and selection process described in this report is a conservative (cautious) process." This is incorrect, because there may be some conservative assumptions, but there are many potential underestimates of concern. Both supposedly conservative assumptions and the following sources of potential underestimation of toxicity must be listed for the reader: 1. The screenings fail to account in any way for synergism, additivity, or cumulative effects which may occur when the analyte is in the presence of other chemicals, radionuclides, metals, or conditions (e.g., thinned ozone layer). 2. Many endpoints of toxicity have not been tested for in most or all analytes: e.g., endocrine disruption, immune suppression, neurotoxicity, subtle but significant functional development or behavior modifications. 3. Most of the analytes have not even been tested for the "standard" toxicity endpoints such as chronic toxicity in aquatic organisms and wildlife, cancer, or chronic toxicity in laboratory animals (for use in extrapolation to humans). 4. Sampling for the analytes on the Hanford site is often sparse, and could therefore have missed certain concentrations. 5. The analyte could be toxic below detection limits used (e.g., 2,3,7,8-TCDD). 6. The screening analysts do not know or acknowledge the most sensitive aquatic or riparian species. 7. The screenings for the vast majority of the analytes are not based on knowledge of the most sensitive life stages of Hanford Site and Hanford Reach species, e.g., eggs, or a particular day of development if exposed to an endocrine disrupter. 8. The screeing analysts do not account for biomagnification (e.g., birds of prey). 9. The screening analysts do not consider individual sensitivities, vulnerabilities, or life histories of human individuals. 10. The screening analysts do not know or account for the food webs, life histories of individual species, and inter-species interactions and dependencies.

	11. The screenings are not taking into account effects on the food base (primary producers) in the Hanford Site and Hanford Reach area. 12. Chronic effects could be lower than one percent of LC50. 13. The ratio of a radionuclide might be higher in water than the 1:100,000 water:sediment assumption. 14. Inter-species and gender differences in toxicity aren't known. 15. Certain pockets of contamination can be much higher than those estimated for the Hanford Reach (e.g., in seeps, shoreline indentations). 16. Acidity or alkalinity may mobilize some metals (e.g., aluminum) or increase toxicity of certain chemicals. Temperature may increase toxicity, BOD. 17. Just as single, questionably high measured results may be suspect as being too high, single or few measured low amounts may be equally questionable. 18. Existing body burdens of contaminants (e.g., 2,3,7,8-TCDD and other dioxin-like compounds, which affect the immune system) have not been considered when estimating the toxicity of Hanford contaminants. Instead, the screenings assume the exposed individual is pristine; that the individual has not been exposed to other contaminants, which exposure might affect the effect of the contaminant being examined. 19. Averages (e.g., of groundwater discharge, uses of the site area) hide extremes in exposure, sensitivity, vulnerability, etc. 20. The screenings do not consider the cumulative impacts of these contaminants downstream from the Hanford Reach.
Table A.1	This table has many blank cells. Some cells are labeled "ND" for non-detect. As I understand from communications with Rene Derewetsky, some of the blank cells signify that the analyte has <u>never</u> been sampled on the Hanford Site in a given study, while others of the cells signify that it was sampled, but was a <u>non-detect</u>, at some unstated level of detection. This is not adequate. This table needs to be re-done, indicating which cells are "ND" and which signify lack of sampling. It is not clear, for instance, whether any of the media have been analyzed for 2,3,7,8-TCDD, and at what level of detection (see page A.9). All cells are blank for that analyte. It certainly cannot be eliminated as a contaminant of concern if it has not been adequately sampled on the Hanford Site. Following this correction to the table, analytes which have been inadequately sampled, but which could be considered potential contaminants of concern, cannot be eliminated from the contaminants of concern.
Table A.1	Why is 2,3,7,8-TCDD the only dioxin-like compound considered as an analyte that should be sampled on the Hanford Site? The appropriate analyte would be toxic equivalencies of dioxins and furans that are dioxin-like in toxicity, since dioxins and furans of lesser, but like, potency than 2,3,7,8-TCDD could be present in much higher concentrations than 2,3,7,8-TCDD.

Table C.1	Each analyte's name should be followed by the number of positive samples and total samples upon which the screening results are being based. For instance 2/3 would mean two positive samples were found; it was sampled three times.

9513405.0122

027571

REVIEW OF "IDENTIFICATION OF CONTAMINANTS OF CONCERN/COLUMBIA RIVER COMPREHENSIVE IMPACT ASSESSMENT", PNL-10400/UC-630--DRAFT--DATED JANUARY 1995

GENERAL COMMENTS

Approach

The identification of contaminants of concern is a critical first step in any comprehensive environmental impact assessment of this type. The general approach was (1) to conduct a comprehensive review of recent work that involved the measurement of contaminants in Columbia River water, adjacent groundwater, soils and sediments; (2) to select maximum obseved concentrations of contaminants in the media sampled; and (3) to use conservative screening assumptions and calculations to estimate upper limit annual health risks to people and risks to biota living in the river. Based on this analysis, a list of over 600 possible radionuclides and chemicals was reduced to 20 contaminants for which the calculations indicated annual health risks above 10^{-6} or non-carcinogenic hazard rankings greater than 0.1.

Reviewer's Assumptions and Caveats

In order to evaluate a report such as this, I assumed that the data are accurate and comprehensive, and that the computations were done correctly. Furthermore, I would have to assume that any reliable monitoring data which might have changed the final list of contaminants were not overlooked. One could question such assumptions, but time and resource constraints precluded any formal challenge of the basic data and the mechanics of the computations. Based on my familiarity with the authors of the report, and my long-term awareness of the environmental research conducted at the Hanford Site, I have no *a-priori* reason to doubt the validity and completeness of the data or accuracy of the calculations. Another point I must make is that although sampling can establish the presence and concentration of a contaminant at the time and place of sampling, no reasonable amount of sampling can prove conclusively that a foreign substance at a particular concentration has never existed in the environment, particularly a system as large as the Columbia River.

Credibility of the Report

With regard to the basic data reviewed to perform the calculations, I am very impressed with the number of reports cited, and the many thousands of samples taken and analyses completed. The screening approach used seems reasonable and appropriate for the intended purpose of this document. I can believe that if toxic or or otherwise biologically-significant levels of

contaminants have existed in the Columbia River during the past several years, that one or more of the sampling programs would have identified a problem. I see no reason why knowledge of any such problem, especially since the end of the cold war, might have been suppressed. It would seem that the present "cleanup" mission of the Hanford operation could only benefit from open dissemination of all environmental monitoring data. Based on the radionuclides that might be expected at a facility such as Hanford, I am not surprised about those that appear on the final list (Table 9.1). I am not expert in the chemical arena, so I cannot judge the reasonableness of the chemicals that may or may not be on the final list.

Conservatisms in the Screening Calculations

The screening approach used is highly simplistic, but I believe it to be very conservative. It is possibly so conservative that actual human health and ecological risks may be over-estimated by several orders of magnitude. Screening is a prudent and necessary approach to narrow the scope of further evaluations to something of a managable size. I reviewed the structure of the screening equations and found them to be logical and reasonable. Some of the conservatisms evident in the screening calculations are:

1. The risk criterion of 10^{-6}/year contrasts with the normal EPA criterion of 10^{-6}/lifetime for carcinogens (including radionuclides). Assuming a 70 year lifespan, this approach has a 70-fold conservatism built in. Even the

10^{-6} lifetime risk seems ultra-conservative to me, considering the fact that the normal lifetime cancer incidence is $>10^{-1}$.

2. Assuming a sediment/water K_d of 10^5 for all contaminants in the sediment pathway seems very conservative, since for the vast majority I would expect K_ds of one to several orders of magnitude less. Furthermore, the sediment pathways may not be very important for the gravel-bottom areas in the flowing sections of the river. Even in the quiet water areas behind the dams, I would expect the most-contaminated sediments from historic releases to be covered with less-contaminated deposits of more recent origin. The finest textured sediments, which typically contain the highest contaminant concentrations, tend to deposit in the deepest regions of the impoundments, which further isolates most of the material from important transport pathways to biota or humans.

3. The assumption in the contaminated soil pathway calculation that the groundwater concentration is equal to the soil concentration also seems ultra-conservative for nearly all the contaminants. Nearly all the radionuclides and metals, for example, would be expected to have K_d values from one to several orders of magnitude greater than the assumed value of 1.0. I would also expect most contaminated soils at Hanford to be in the vadose zone and seldom subject to the leaching effects of flowing groundwater. If this is actually true, then this provides another major conservatism.

4. The estimates of human consumption rates of water, fish, and

sediments seem quite conservative for the majority of the population using the river for recreation. However, I'm not familiar with actual consumption patterns of Native American Tribal Members that use the Columbia River. If there are such data, they should be incorporated into the screening calculations.

5. For the ecological risk assessment, I could believe that there may be small, local areas along the Hanford shoreline where biota could be subject to potential contaminant impacts. However, the large size and volume of the river has enormous dilution potential, as well as a very large adjacent area that is apparently not impacted by contaminants from Hanford operations. Furthermore, animals such as fish and waterfowl move over large areas of the river and would not be expected to reside for any significant length of time in small, local areas with measureable contamination. Any local impacts on biota, irrespective of whether mortality, reproduction, or genetic damage was involved, would, in my opinion, be overwhelmed and selected out of the population over time by the large reservoir of unimpacted individuals.

6. The use of 1 % of the LC_{50} toxicity values for aquatic biota should provide yet another conservatism to account for any sublethal impacts, although use of this particular value could be better-justified.

7. Finally, the use of maximum observed concentrations would have a strong tendency to bias the calculations in the conservative direction.

Concerns

One area that is not covered in this document is the future potential, however remote, of large, accidental releases from waste storage tanks or from decontamination/decomissioning of buildings. Another is the ecological and human health impacts of the actual cleanup of contaminated sites. Such events and activities have the potential to release contaminants to the environment, resulting in levels much higher than those currently measured. Also, such releases could include contaminants that may not be on the final list of twenty substances targeted for further evaluations. While these topics may be outside the scope of this particular document, they would constitute my primary concern for the potential impacts of Hanford on the future integrity and quality of the Columbia River system.

Another concern that might be raised is that this document does not discuss the next step in the evaluation of contaminants on the final list of 20 to receive futher work. Clearly, I would expect a lack of site-specific data on K_ds, bioconcentration factors, etc. for certain contaminants. Such data would be crucial to the credibility of more rigorous evaluations. A more detailed and realistic evaluation should include an uncertainty analysis, yet the uncertainties are likely to be quite large if the proper site-specific data are lacking. One purpose of the present report could be the identification of such data needs.

SPECIFIC COMMENTS

Page	Paragraph	Comment
vii	2	Can it be stated that the spatial restrictions will not lead to the omission of sites that might contribute contaminants to the river?
viii	1	Something should be said here to give the reader some feel as to how hard people have looked for contaminants in the river environment.
viii	6	I might expect crayfish or insects to be less susceptable to many toxins than fish. Where this is true, these organisms would not seem to be a conservative surrogate for fish.
viii	7	It could be mentioned in this paragraph how the background was determined for the various substances.
ix	1	I was surprised that actual data on fish were not used. Instead, fish concentrations were estimated from the product of water concentrations and bioconcentration factors. Why is this the case? Were there any actual data on fish? If so, why not use such data directly in the dose calculations.
ix	2	How firm (and conservative) is the maximum groundwater flow estimate of 100 cfs into the Hanford reach?

4.1	3	It should be mentioned here which sublethal damage endpoints might be of concern, and cite some relevant literature to back up the value of 1 % of the concentration causing 50 % mortality.
4.4	1	It is implied that sublethal effects are less significant than lethal effects. In many cases, reproduction, for example, can be impaired at sublethal doses, but in the context of populations, this can be just as significant, in due course, as mortality.
4.4	3	The problem raised with groundwater possibly affecting fish eggs seems to be rather casually dismissed. I suspect additional effort here could lead to a more useful treatment of fish eggs, one of the most sensitive stages of the life cycle of fishes.
4.5	3	In equation (7), it seems that C_{sed} should be the quantity to be estimated, based on C^{o}_{w}. Shouldn't C_{sed} be on the left side of the equation?
4.7	5	The term "hazard ranking" should be defined, either here or in the glossary, or in both places.
5.1	6	It would seem that the dose from a particle lodged in the nasal passage would be quite localized and not very comparable to the limit for occupational exposure. This

should be clarified in the text.

6.1	1	It should be stated that this discussion pertains to the Hanford shoreline.
6.1	2	It would be helpful to indicate the amount of acreage with elevated exposure rate readings.
8.1	2	Is it also possible that some Pu was released to the river that was not generated from the decay of Np released to the river? Are we missing something here?

Review Comments
Columbia River Comprehensive Impact Assessment

Name:

Instructions: This electronic form is to facilitate compilation, responding to, and incorporation of your comments. Your name will be removed from this form by OSU/WSU prior to receipt of it by the author of the report. The form was created using the table editor feature (alt-F7 on Word Perfect 5.1 for DOS or select "table" from the menu on Macintosh and Windows software). To write a comment, place the cursor first in the "page, paragraph" column and identify where in the text of the report the comment applies. [If the comment is a general comment concerning the entire document, write "general" in the "page, paragraph" column.] Then place the cursor in the "comment" column, to write your comments. The cell will expand as you write. Use a new cell for each separate comment. Rows may be added as necessary by going into the table editor feature of your software and selecting "insert."

Page, Paragraph	Comment	Resolutions
Note	I developed the comments and opinions described below by reading the "Identification of Contaminants of Concern" report without considering comments that had been written earlier by others. After reading the report and writing my comments, I reviewed comments that that been previously submitted by the Washington Department of Ecology, the US EPA, the Washington Department of Health, and the Nez Perce Tribe. Although some of the issues described below were also identified in these earlier comments, I decided to keep my comments as originally written and to let these redundancies reflect similar opinions.	

General #1	The purpose of this project, as described in the preface of the report, is "to determine if enough contamination exists in the Columbia River to warrant cleanup actions under applicable environmental regulations." I would like to suggest that a better objective might be to use the risk calculations to prioritize cleanup actions at the site. Using risk analysis to determine if cleanup should be undertaken requires that the risk calculations have some meaning in an absolute sense. I would argue, or at least hope, that few people actually believe that the risk numbers that we derive have much meaning in absolute terms. However, in relative terms, these numbers can tell us which sites or contaminants pose the greatest risk, given the assumptions on which the risk calculations are based. Adopting the objective of prioritizing sites rather than a binary "yes or no" decision on whether a cleanup action should be included in the risk evaluation would seem to take some of the pressure off the risk calculations. This objective would require that more constituents and more sites be included in the study, but I think, in the long run, it would be more efficient than spending time and efforts arguing whether a particular risk number is "significant" or "insignificant." An additional advantage of using the risk calculations to prioritize sites rather than to eliminate them is that the prioritization would allow comparisons to be made across DOE facilities. What might be considered a small risk at Hanford could be a relatively substantial risk at some other DOE site. If budget allocations are ultimately made based on these risk calculations, Hanford could be short-changed if sme of its sites are dropped from the risk analysis at this point in time because they fall below some arbitrary risk level.	

General #2	I had expected the tone of the report to be more neutral. I recognize that science is somewhat subjective, but I found the report to use a language of advocacy that I found annoying. I have listed below several examples of instances in which I found the report to use language and wording that is less objective than it might be. These examples may seem trivial and inconsequential, but I do believe that a tone is set in the report that will be aggravating to some readers. The effect of this on my review was that I became more defensive and perhaps less objective as a result of the tone. I suspect this tone would have a similar impact on others. I recommend that each report be reviewed by an editor whose sole task is to ensure that the language and writing is as objective and value-free as possible. p. 3.1 "Many of the analytes found are naturally occurring....." What does "many" mean in this sentence? Could one also state that "Many of the analytes found are directly a result of activities at the Hanford site?" If so, why not include the latter sentence as well? p. 4.1 "sediment ingestion rate of 10 milligrams/day (almost 4 grams/year)." This could also be written as "sediment ingestion rate of 10 milligrams/day (less than 4 grams/year)." Why not write it the second way instead of the first? Or better yet, try to make it more neutral with "approximately 4 grams/year." p. 7.1 "Those contaminants contained in Hanford tank farms or burial grounds may not pose a future hazard." I would suspect that the following would be at least as valid: "Those contaminants contained in Hanford tank farms or burial grounds may pose a future hazard." p. 10.1, paragraph 3 "all contaminants to be quite low in Columbia River sediment." What is meant by "quite low?" Low relative to what?	

General #3	I was a bit troubled by the scope of a "comprehensive impact assessement" that does not consider "the potential impact of contaminants that are not presently in the groundwater but which may be in soils or facilities away from the Columbia River." A compelling argument could be made that the greatest risk to the Columbia could be from some short-term catastrophic event such as a tank explosion, rather than the more slow and continuous risk posed by existing subsurface contamination. Futhermore, the biggest risk reduction, in terms of dollars spent, might be derived from treating contaminants at their source (e.g. soils or tanks) rather than after they have reached the Columbia River.	
General #4	This may be related to my Comment #3. The fact sheet dated January 11, 1996 that accompanied the report indicates that "the work essential to an acceptable comprehensive assessment will be defined by the project management team while the scoping level impact assessment is being performed." It is not clear to me what is meant by a "scoping level impact assessment." Does it make sense to continue with the impact assessment if the work is going to be re-done? Should the tasks in the ongoing work be redefined to maximize the likelihood that it will be useful for the subsequent "truly comprehensive assessment?" I would think that the work product for the current study would be somewhat different if it is known that a subsequent study will be conducted. Has the scope of work for the ongoing assessment been redefined to reflect the fact that a follow-up study will be conducted?	
General #5 (Page ix, para. 2, and Page 4.5, para. 1)	This is a general comment concerning the approach used in the report to estimate surrogate river concentrations from groundwater concentrations. The specific issue is described on Page ix, paragraph 2 "For conservatism, ...the value of 100 cfs was adopted for the screening. In effect, this implies that the entire groundwater that flows from beneath Hanford to the Columbia River is contaminated to the maximum level measured." Page 4.5, paragraph 1. "For conservatism (i.e, to provide an overestimate of the resulting concentration in the river) the upper value of 100 cfs was adopted for the screening. In effect, this implies that the entire volume of groundwater that flows from beneath Hanford to the Columbia River is contaminated to the maximum level measured." The report argues that the methodology used to estimate river concentrations from groundwater measurements is conservative because of the assumptions described above. However, there are other assumptions, some implicit and	

Page 4.2, para. 3	"Values from this screening which approach or are greater than 10^{-6} imply radionuclides of potential concern." It is not clear why this particular risk value (10^{-6}) was chosen to identify contaminants of concern. What is the justification of this number, in an absolute sense?	
Page 4.2, para. 5	"Values from this screening which approach or are greater than 10^{-6} imply chemicals of potential concern." Again, the justification for this particular risk value is not clear. It also seems that there is an inconsistency here. For the radionuclide calculation, the number is risk per year. For the chemical screening, the number is risk, with no time unit involved.	
Page 4.3, eq. 4 Page 4.4, eq. 5	Page 4.3, equation 4. Concentration units should be mg/L. Page 4.4, equation 5. Concentration units should be mg/L.	
Pag 4.7, para. 4	"A screening level was used to account for over 1) 95 percent of the carcinogenic risk for each result, above a cutoff of 10^{-6}..." It is not clear to me what this means.	
Page 10.1, para. 4	It seems from this last paragraph, that the authors have already reached their conclusion of the impact assessment. I do not see the value of continuing this study if the final conclusions have already been reached. It seems to me that the authors view this study as simply jumping through hoops to reach what they feel is a self-evident conclusion.	

Appendix C	Background designation for samples. It would be useful to provide some sort of reference for the constituents that were eliminated on the basis of "background levels." I suggest that these references include the sample locations and dates for the data that were used to determine background levels. Where these background levels subjected to any sort of statistical evaluation, or could a "background outlier" eliminate a potentially important contaminant from further consideration?	

Review Comments
Columbia River Comprehensive Impact Assessment

Name:

Page, Paragraph	Comment	Resolutions
General	My comments are limited to the ecological risk assessment (ERA). The principal problem with this screening ERA is it has no problem formulation. Much of the confusion that led to the comments from the regulators and Nez Perce (some of which are repeated here) have to do with issues that should have been laid out at the beginning of the assessment but were not.	
General	Some of the issues that are treated as technical comments by the regulators are actually risk management (i.e., policy) issues that should have been settled by the FFA parties ahead of time. When policy issues are settled they should not be reopened as if they were technical issues. For example, the issue of screening out undetected chemicals when EPA-approved methods or equivalent are used has been standard practice in many EPA regions and the DOE's contention that that policy is in place at Hanford seems probable given my experience. However, the EPA objects to the practice in this case without acknowledging the policy agreement. The DOE needs to make it clear in the text when they are invoking such policy judgements and cite their source so as to clearly differentiate them from technical judgements..	
General	The inclusion of potentially higher future exposures is another policy issue that should be resolved among the FFA parties and clearly enunciated in the assessment. Currently the DOE's position is unclear.	
P. 4.1, 3rd paragraph	An ecological conceptual model should define the sources, routes of exposure, and receptors that will be assessed. Water quality criteria do not constitute a conceptual model.	
P. 4.1	What are the assessment endpoints? The document implies that it is some property of fish. On what basis were other aquatic biota eliminated? On what basis were piscivorous and insectivorous wildlife (e.g., herons and bats) excluded?	
P. 4.1	Where is the environmental description? We do not need a lot of species lists and other descriptive ecology, but an appropriate environmental description would have made it clear that the near-field concentrations were intended to conservatively represent the entire river and may explain why some endpoint groups were not included (e.g., few herons or other piscivorous wildlife).	
P. 4.4	The use of LC50/100 as the ecotoxicological screening benchmark is conservative, but it is not clear why it is used rather than alternative benchmarks that are based on chronic toxicity data or that have better technical justification such as the secondary chronic values (see the ORNL benchmarks data base which was distributed to Hanford). [I assume that "LD50" is a typo.]	
P. 4.4	Definition of the measurement endpoint should have included a definition of TLM. Is it a NOEC or CV or something else (e.g., a human health criterion)? Also explain why equation 5 indicates that LC50 is preferred to it.	

P. 4.4	All fish chronic tests include eggs and larvae. Also, I agree with the EPA that in general larvae are more sensitive than eggs and they occur in spawning gravels. Therefore, the comment about the unavailability of data to address the issue of exposure of salmon early life stages is incorrect.	
p. 4.5 & 4.6	I agree with the prior reviewers that the use of fully mixed concentrations is not appropriate for a screening assessment. Given the concern about upwelling groundwater inspawning gravels, no dilution is appropriate.	
p. 4.5 & 4.6	The authors need to provide a better justification of their selection of a Kd of 100,000 for sediments and 1 for soils. In both cases they are estimating aqueous exposure levels from particulate concentrations, so conservatism would be achieved by using a low Kd. However, they claim conservatism for both values.	
p. 4.5 & 4.6	It is not clear what the authors are trying to estimate with equations 7 and 10. Are they trying to estimate exposure of benthic organisms to pore water or exposure to the surface water from which the particles settled?	
p. 4.5 & 4.6	In place of apparently arbitrary Kd values, the authors should have used Kd values from the literature for metals and the conventional equilibrium partitioning model for neutral organics.	
Table B.1	The "notes on fish toxicity" are unexplained.	
Respons e to commen ts	The authors are probably correct in stating in their response to prior comments that there are no significant risks from radiation to aquatic biota, but they need to justify that in the SERA.	
Respons e to commen ts	The authors are correct that concentrations within background levels are not indicative of risks due to the Hanford site, <u>only if</u> the chemical is not released in a form that is more toxic than the form occurring at background sites. For example, the authors say that Hanford released silver as the nitrate salt which is more toxic than the forms of silver that would be expected in background samples.	

9613405.0139

027571

Review Comments
Identification of Contaminants of Concern
Columbia River Comprehensive Impact Assessment
PNL-10400, UC-630
January 1995

General

The document does not clearly state the intended uses of the resulting list of contaminants of concern. If one of the purposes of this list of 20 contaminants is to determine the constituents analyzed in future monitoring efforts, then the list excludes many potential contaminants of concern for which data are lacking or where concentrations of these potential contaminants may increase with time.

General

The exposure scenarios should be expanded to include exposure pathways that are typical of Native Americans. A table is attached showing potential routes of exposure that are consistent with the traditional Native American lifestyle.

General

The current methodology does not evaluate the synergistic or additive risks from the complex chemical mixtures present at the Hanford site. Nor does it evaluate teratogenic, mutagenic, immunologic, developmental, or multigenerational effects. How will the CRCIA project incorporate these added risks in the evaluation process?

General

Washington regulations under MTCA do not allow dilution of groundwater with surface water to achieve cleanup standards. Given the paucity of information regarding water quality in the river bottom gravels where salmon eggs are laid, and the numerous instances of groundwater concentrations exceeding fresh water chronic criteria in nearshore point of compliance wells, a more conservative approach is warranted.

General	The CRCIA project must keep in mind that many of the previous studies on which this document is based screened out potential contaminants of concern in groundwater that were above ARARs if they occurred in unfiltered samples and not in filtered samples. These studies typically do not justify their exclusion of the unfiltered concentrations. That is, they do not demonstrate that the contaminants are not bioavailable for particle sizes greater than the filter size that was used. Thus, the raw data used as the basis for this effort should be closely scrutinized and include unfiltered concentrations of contaminants. This is particularly important because a primary exposure scenario is the ingestion of unfiltered river water. Where unfiltered data do not exist, the risk assessment should identify those areas as data gaps and include with future monitoring programs.
viii, Para 1	Screening of contaminants based on non-detectable concentrations is not appropriate if the detection limits are above ARARs. I disagree with your response to the EPA comment stating "The detection limits typically used in data collection at Hanford over the last 15 years meet or exceed those established by the EPA". At sites other than Hanford, detection limits are typically set at a level at or below the most stringent ARARs. In our reviews of other Hanford documents we have found many cases where detection limits were well above the cleanup standards and were not attributable to interference or method limitations. This is not just a situation that occurred in the distant past. For a recent example, the 300-FF-5 RI/FS document (DOE/RL-94-85 - not listed in Section 2.0: Data Sources, but it should be included) revealed several heavy metals and organics where detection limits were above standards. To illustrate, the 300-FF-5 RI/FS risk assessment screened out vinyl chloride based on non-detectable concentrations. However, for approximately 74% of the analyses a detection limit of 10 ug/l was used which is 50 times the MTCA groundwater standard of 0.2 ug/l. In the case of vinyl chloride this is particularly concerning given that TCE above MCLs is present in the 300 Area groundwater, and the fact that vinyl chloride is a highly toxic degradation product of TCE. Thus, lower detection limits for vinyl chloride and other TCE degradation products should be consistently used. In addition to vinyl chloride, metals including cadmium and lead were analyzed in many samples using detection limits above MCLs or chronic fresh water criteria.

viii, Para 2

Risk assessment methodologies based only on the risk of cancer to an individual organism will not account for mutagenic, teratogenic, or developmental effects in the organism or its descendants. In addition, it only evaluates the risk to those organs in which cancer develops.

viii, Para 3

External risks from carcinogenic chemicals include dermal contact with contaminated plants, fish (and other game), sediment, soils, and water. Inhalation of contaminated dust and smoke from burning plants (used for Native American rituals and in food preparation) are other exposure scenarios to incorporate. Inclusion of crop ingestion as a pathway is also important as indicated in Ecology's comments.

Page 4.5

Using the conversion equation of surrogate river water concentration equals the measured groundwater concentration divided by 1000, is effectively dismissing the impact of groundwater in near-shore wells with concentrations up to 1000 times the ambient water quality criteria, 1000 times the TLM, or 10 times the LD50. I do not know of any other site in the State of Washington where such high concentrations of contaminants in groundwater are not, at a minimum, considered contaminants of concern.

Page 5.1

Previous evaluations of risk from the discrete particles of the cobalt-60 alloy appear to be based on human health and not ecological risk. How did the current study evaluate biotic exposure and secondary human risk?

Page 6.1

Relate the information concerning direct radiation exposure to human and ecological risks and incorporate the results in the risk assessment.

Page 7.1

Figures presented in the Hanford site Groundwater Protection Management Plan, DOE/RL 89-12, 1994, show the present location of the radioactive and non-radioactive contamination plumes for the 200 West sites which indicate that the migration pattern differs for these two categories of contaminants. The non-radioactive plume (nitrate and chlorinated hydrocarbons) appears to be moving north toward Cable Gap as stated in the GPMP report. However, the plume of radioactive materials (tritium, strontium-90, uranium, iodine-129, technetium-99, cesium-137 and plutonium) appears to be moving to the south-southeast, where it will soon come in contact with the highly transmissive zones present at the 200 East area. The flow path to the river will then be to the southeast, and will have an arrival time closer to 10 to 20 years, rather than the 80 to 300 years referenced in Freshley and Graham (1988). Accordingly, ignoring the risks of radionuclides with half-lives of less than 35 years is not appropriate in light of the insufficient understanding of the Hanford site geology and hydrology and the complexities of the contaminant flow paths.

Sec 7.2

This section appears to be a justification of the temporal limitations to the scope of this document. There is an implication that because of the extensive remediation efforts anticipated, future impacts to the Columbia River will only decrease with time. However, all remediation efforts have unanticipated side effects, some of which could increase environmental or human health risks. Future operable unit risk assessment efforts should not rely on the results of this study but should evaluate risks based on up-to-date information.

Review Comments
Identification of Contaminants of Concern
Columbia River Comprehensive Impact Assessment
PNL-10400, UC-630
January 1995

General Comments:

1.) The document does not clearly state the intended uses of the resulting list of contaminants of concern. If one of the purposes of this list of 20 contaminants is to determine the constituents analyzed in future monitoring efforts, then the list excludes many potential contaminants of concern for which data are lacking or where concentrations of these potential contaminants may increase with time.

2.) The exposure scenarios should be expanded to include exposure pathways that are typical of Native Americans. A table is attached showing potential routes of exposure that are consistent with the traditional Native American lifestyle.

3.) The current methodology does not evaluate the synergistic or additive risks from the complex chemical mixtures present at the Hanford site. Nor does it evaluate teratogenic, mutagenic, immunologic, developmental, or multigenerational effects. How will the CRCIA project incorporate these added risks in the evaluation process?

4.) Washington regulations under MTCA do not allow dilution of groundwater with surface water to achieve cleanup standards. Given the paucity of information regarding water quality in the river bottom gravels where salmon eggs are laid, and the numerous instances of groundwater concentrations exceeding fresh water chronic criteria in nearshore point of compliance wells, a more conservative approach is warranted.

5.) The CRCIA project must keep in mind that many of the previous studies on which this document is based screened out potential contaminants of concern in groundwater that were above ARARs if they occurred in unfiltered samples and not in filtered samples. These studies typically do not justify their exclusion of the unfiltered concentrations. That is, they do not demonstrate that the contaminants are not bioavailable for particle sizes greater than the filter size that was used. Thus, the raw data used as the basis for this effort should be closely scrutinized and include unfiltered concentrations of contaminants. This is particularly important because a primary exposure scenario is the ingestion of unfiltered river water. Where unfiltered data do not exist, the risk assessment should identify those areas as data gaps and include with future monitoring programs.

Specific Comments:

Page viii, Para 1
Screening of contaminants based on non-detectable concentrations is not appropriate if the detection limits are above ARARs. I disagree with your response to the EPA comment stating "The detection limits typically used in data collection at Hanford over the last 15 years meet or exceed those established by the EPA". At sites other than Hanford, detection limits are typically set at a level at or below the most stringent ARARs. In our reviews of other Hanford documents we have found many cases where detection limits were well above the cleanup standards and were not attributable to interference or method limitations.

This is not just a situation that occurred in the distant past. For a recent example, the 300-FF-5 RI/FS document (DOE/RL-94-85 - not listed in Section 2.0: Data Sources, but it should be included) revealed several heavy metals and organics where detection limits were above standards. To illustrate, the 300-FF-5 RI/FS risk assessment screened out vinyl chloride based on non-detectable concentrations. However, for approximately 74% of the analyses a detection limit of 10 ug/l was used which is 50 times the MTCA groundwater standard of 0.2 ug/l. In the case of vinyl chloride this is particularly concerning given that TCE above MCLs is present in the 300 Area groundwater, and the fact that vinyl chloride is a highly toxic degradation product of TCE. Thus, lower detection limits for vinyl chloride and other TCE degradation products should be consistently used. In addition to vinyl chloride, metals including cadmium and lead were analyzed in many samples using detection limits above MCLs or chronic fresh water criteria.

Page viii, Para 2
Risk assessment methodologies based only on the risk of cancer to an individual organism will not account for mutagenic, teratogenic, or developmental effects in the organism or its descendants. In addition, it only evaluates the risk to those organs in which cancer develops.

Page viii, Para 3
External risks from carcinogenic chemicals include dermal contact with contaminated plants, fish (and other game), sediment, soils, and water. Inhalation of contaminated dust and smoke from burning plants (used for Native American rituals and in food preparation) are other exposure scenarios to incorporate. Inclusion of crop ingestion as a pathway is also important as indicated in Ecology's comments.

Page 4.5
Using the conversion equation of surrogate river water concentration equals the measured groundwater concentration divided by 1000, is effectively dismissing the impact of groundwater in near-shore wells with concentrations up to 1000 times the ambient water quality criteria, 1000 times the TLM, or 10 times the LD50. I do not know of any other site in the State of Washington where such high concentrations of contaminants in groundwater are not, at a minimum, considered contaminants of concern.

Page 5.1
Previous evaluations of risk from the discrete particles of the cobalt-60 alloy appear to be based on human health and not ecological risk. How did the current study evaluate biotic exposure and secondary human risk?

Page 6.1
Relate the information concerning direct radiation exposure to human and ecological risks and incorporate the results in the risk assessment.

Page 7.1
Figures presented in the Hanford site Groundwater Protection Management Plan, DOE/RL 89-12, 1994, show the present location of the radioactive and non-radioactive contamination plumes for the 200 West sites which indicate that the migration pattern differs for these two categories of contaminants. The non-radioactive plume (nitrate and chlorinated hydrocarbons) appears to be moving north toward Cable Gap as stated in the GPMP report. However, the plume of radioactive materials (tritium, strontium-90, uranium, iodine-129, technetium-99, cesium-137 and plutonium) appears to be moving to the south-southeast, where it will soon come in contact with the highly transmissive zones present at the 200 East area. The flow path to the river will then be to the southeast, and will have an arrival time closer to 10 to 20 years, rather than the 80 to 300 years referenced

in Freshley and Graham (1988). Accordingly, ignoring the risks of radionuclides with half-lives of less than 35 years is not appropriate in light of the insufficient understanding of the Hanford site geology and hydrology and the complexities of the contaminant flow paths.

Sec. 7.2
This section appears to be a justification of the temporal limitations to the scope of this document. There is an implication that because of the extensive remediation efforts anticipated, future impacts to the Columbia River will only decrease with time. However, all remediation efforts have unanticipated side effects, some of which could increase environmental or human health risks. Future operable unit risk assessment efforts should not rely on the results of this study but should evaluate risks based on up-to-date information.

Table 1. Yakama Nation Cultural Activities and Potential Routes of Exposure to Human Health

DRAFT

General Cultural Activities	Specific Activities	Exposure Media	Most Significant Exposure Routes Associated with Cultural Activity
1) Hunting/Consuming Game	Hunting/Stalking	Air	Inhalation of contaminated dust in arid areas
		Soil	Dermal contact with contaminated soils
	Food Preparation	Biota	Dermal contact with contaminated game
	Consumption	Biota	Ingestion of contaminated game
2) Fishing/Consuming Salmon	Fishing/Collection	Surface Water	Dermal contact with contaminated waters
		Sediments	Dermal contact with contaminated river sediments
	Fish Preparation	Biota	Dermal contact with contaminated fish
	Consumption	Biota	Ingestion of contaminated fish
3) Collecting/Using/ Consuming Plants	Digging/Gathering	Air	Inhalation of contaminated dust in arid areas or volatile contaminants
		Soil/Sediments	Dermal contact with contaminated soil/sediments
		Soil/Sediments	Ingestion of soils during gathering activities (dust/particulates)
		Surface Water	Dermal contact with contaminated waters in riparian collection areas
		Biota	Dermal contact with contaminated plants
	Plant/Herb Preparation	Biota	Dermal contact with contaminated plants
	Crafts	Biota	Dermal contact with contaminated plants
		Biota	Inhalation (indoor) of dust from reed mats and other crafts
	Consumption/Use	Biota	Ingestion of contaminated plants/herbs
		Air	Inhalation of smoke from plant/herb burning
4) Livestock Tending	Herding/Grazing	Air	Inhalation of contaminated dust in arid areas or volatile contaminants
	Milking/Sheering	Air	Inhalation of contaminated dust when handling livestock
	Food Preparation	Biota	Dermal contact with contaminated livestock/products
	Consumption	Biota	Ingestion of contaminated livestock/products

9410405.0146

DRAFT

Table 1. Yakama Nation Cultural Activities and Potential Routes of Exposure to Human Health

General Cultural Activities	Specific Activities	Exposure Media	Most Significant Exposure Routes
5) Fish Aquaculture	Managing Aquaculture	Surface Water	Dermal contact with contaminated surface waters used in holding pens
		Groundwater	Dermal contact with contaminated groundwater used in holding pens
	Consumption	Biota	Ingestion of contaminated fish
6) Religious/Spiritual Ceremonies	Gathering Plants/Stones	Air	Inhalation of contaminated dust in arid areas or volatile contaminants
		Soil/Sediments	Dermal contact with contaminated soils/sediment/stones
		Soil/Sediments	Ingestion of soils during gathering activities (dust/particulates)
		Surface Water	Dermal contact with contaminated waters in riparian collection areas
		Biota	Dermal contact with contaminated plants
	Burials	Air	Inhalation of smoke from plant/herb burning
		Soil/Sediments	Dermal contact with contaminated soils/sediment
		Biota	Dermal contact with contaminated plants
		Biota	Ingestion of contaminated plants
	Sweat Lodges	Air	Inhalation of smoke from plant/herb burning
		Air	Inhalation of steam from contaminated water
		Soil/Sediments	Dermal contact w/contaminated soil/sediments during lodge construction
		Biota	Dermal contact with contaminated plants during lodge construction
	Vision Quest	Air	Inhalation of contaminated dust in arid areas
		Soil/Sediments	Dermal contact with contaminated soils/sediment
7) Home-Life	Breast-Feeding	Biota	Ingestion of mother's milk by infants
	Drinking Water	Water	Ingestion of contaminated drinking water with meals
	Dairy Products	Biota	Ingestion of dairy products

9613405.0147

Review Comments
Columbia River Comprehensive Impact Assessment

Document Reviewed: *Identification of Contaminants of Concern: Columbia River Comprehensive Impact Assessment* (PNL-10400)
Instructions: This electronic form is to facilitate compilation, responding to, and incorporation of your comments. Your name will be removed from this form by OSU/WSU prior to receipt of it by the author of the report. The form was created using the table editor feature (alt-F7 on Word Perfect 5.1 for DOS or select "table" from the menu on Macintosh and Windows software). To write a comment, place the cursor first in the "page, paragraph" column and identify where in the text of the report the comment applies. [If the comment is a general comment concerning the entire document, write "general" in the "page, paragraph" column.] Then place the cursor in the "comment" column, to write your comments. The cell will expand as you write. Use a new cell for each separate comment. Rows may be added as necessary by going into the table editor feature of your software and selecting "insert."

Page, Paragraph	Comment	Resolutions
General Comment	Because this document includes a good deal of monitoring data, the quality assurance (QA) program under which it was done is of interest and is, indeed, critical to a review. Are the data assured to NQA-1? NQA-3? It would be wise to append the QA Project Plan, or at least to refer to it. Appending a QA plan would also head off future arguments about data quality.	
General Comment	The purpose of the Columbia River Comprehensive Impact Assessment (CRCIA) is to assess the impact of operations at Hanford on the Columbia River. In that context, a map showing monitoring sites both upriver and downriver from the Hanford operations is needed. The map should also show the locations of springs and seeps, because these are referred to in the text and in some of the comments on the document. Moreover, tabulated monitoring data should include data from sites upriver and downriver from Hanford. If tables refer to contaminant concentrations at particular locations (e.g. the references in Table 3.2 to concentrations at the 100, 300, and 1100 areas) the concentrations at those specific sited should be given.	
General Comment	Tables should include reference concentrations (e.g EPA RfD values) using the same units as the monitoring data.	

General Comment	Because the purpose of this impact assessment is to assess the impact of Hanford operations on the Columbia River, and <u>not</u> to assess the water quality of all of the Columbia downstream from Pasco and Kennewick, the document should concentrate on those contaminants that enter the river along the Hanford Reach or other locations where the source could be traced to Hanford runoff. Many contaminants enter the Columbia River from agricultural runoff, highway runoff, and urban and suburban stormwater runoff. There may also be industrial runoff downstream (and upstream) from Hanford. It is important, therefore, to compare assays of downstream water with assays at those points where contamination traceable to Hanford operations enter the river. The latter assays are only to identify contaminants, and it is probably better if they are done on entering water that is not yet diluted by river water. the important thing is to separate the contamination for which the Hanford operations may be responsible from other contamination.	
General Comment	A serious deficiency in the report (particularly in Sections 8, 9, and 10) is a comparison of substances entering the river at Hanford and *upstream* contaminants and sources of contamination. This EA should determine the contaminants that Hanford operations add to the Columbia (or potentially add to the river) beyond those added by upstream sources, not just what is found at Hanford and downstream. There is considerable acreage in agricultural production upstream from the Vernita Bridge; how, for example, does nitrate runoff compare with nitrate contamination from Hanford? Without this type of comparison, the CRCIA is potentially much less useful than it could be.	
General Comment	In my opinion, the appropriate contaminants have been identified. However, substantiation of their selection should be stronger. The screening approach is acceptable, but there are remaining questions about the screening method (see specific comments below).	
General Comment	A glossary of all acronyms used should be included.	

p. viii	The descriptions of carcinogenic and toxic chemical screening are confusing as written. For example, while there is no carcinogenic external exposure risk in many cases, carcinogens may well pose other risks on external exposure. Adverse effects from external exposure certainly occur from many non-carcinogens: acids are an almost trivial example. I believe it is just the statement that is confusing. What is clearly meant is that the maximum measured concentrations are not sufficient to pose any risk from external exposure for either carcinogens or non-carcinogenic hazardous chemical compounds. Moreover, in my opinion, the term "hazardous" is to be preferred to "toxic."	
p. ix	The section on river sediment assumes (without justifying the assumption) that contaminant concentration in the sediments is 100,000 times higher than in Columbia River waters. I wonder why the distribution coefficient (K_d) was not simply measured, or why there have been no measurements of K_d for Columbia River sediments published. The proposed value cannot just be accepted at face value, although it appears to be in the appropriate range for river sediments. The next paragraph contains the assumption that 1%of the Hanford soil is contaminated to the maximum concentration. No evidence or background is given for this 1% figure, and there is no indication whether it is high or low. The number of 1% needs some evidentiary support.	
p. xi	The penultimate paragraph has some syntax errors. What is meant by "essentially associated with soil near the river"?	
p. xiii	(a) Definitions of the 100, 200, etc. areas should include reference to the map of Figure 1.1. (b) The appropriate definition of "bioconcentration factor" is "ratio *of* (not "on") the radionuclide concentration in biota *to* (not "and") the water in which the biota live and feed, *or the ratio of radionuclide concentration in any step of a food chain to that of the next lower step*." (c) Add "(sometimes called "Superfund")" to the definition of CERCLA. (d) The definition of "concentration" is wrong. Concentration is the amount of dissolved substance (solute) in a given quantity of total solution (e.g. grams of salt per liter of salt solution) or in a given quantity of solvent (e.g. grams of salt per kg of water). (e) A conceptual model is a conceptual representation of a process. (f) Definitions of alpha, beta, and gamma radiation should be included.	

p. xiv	(a) "Half-life" is the time required for ... to be reduced to half ... by *radioactive decay* (not "radiological transformation"). (b) The definition of hazardous chemicals is meaningless, unless you also define "toxic" and that starts to get silly. Why not define "chemically hazardous" as distinct from "radiologically hazardous" and just say in the text when you mean carcinogenic and when you mean non-carcinogenic? (c) "Irradiation" is exposure to any radiation, not just ionizing radiation.	
p.xv	(a) Natural uranium includes the daughter elements. (b) What is the NPL the National Priorities List of? (c) A picocurie is 10^{-12} Ci; "millionth of a millionth" does not, contrary to current thinking, make this more understandable. People who don't understand exponents won't understand the rest of the document either. Perhaps the glossary should include definitions of milli-, micro-, nano-, pico-, femto-, etc. in terms of powers of ten. (d) Delete the word "definitive" from the definition of "plume." (e) "Production reactor" is NOT synonymous with "reactor." The word "reactor" is used in place of "production reactor" in this document, which is not the same thing as a synonym.	
p. 2.1	How were the documents in Section 2.1 peer reviewed, by whom, and under what conditions? If PNL has an internal review system, it should be described somewhere. Under what QA program was their quality assured? The appropriate QA documents should be included in this list.	
p. 2.1 par. 3	The use of most recent sampling data to provide the source term for risk calculations is completely appropriate.	
p. 2.2, Dirkes, Patton and Tiller reference	Which VOCs, metals and anions were sampled? An actual list would be very helpful.	
p. 2.2, DOE 1992b	More specificity in this sort of summary would improve its usefulness; e.g., how much lower were concentrations in surface water than in springs, etc.? Perhaps where such a document contained a summary table, that table could be reproduced in this summary chapter. This comment applies in general to this type of document.	
p. 2.4, Fowler reference	Is there a final version of this document? Even if the document cited represents only the first step in developing risk-based standards, a draft is not a good or reliable citation. If this document can be finalized, it should be. If not, the extent of internal review should be noted in the citation.	

p. 2.5, Wells reference	What is "artificial radioactivity?" Do you mean anthropogenically produced radionuclides? Fission products? Products of alpha or neutron bombardment? Transuranic elements? Or all radionuclides produced at Hanford? Po-210, for instance, is the same isotope whether it is a uranium daughter or part of a transuranic decay chain. I believe you mean radionuclides produced at Hanford, regardless of whether or not they have naturally-occurring counterparts. However, this should be clearly stated.	
p. 3.1 et seq and Appendix A	Any judgment about Table 3.1 is difficult to make in the absence of any comparable standard. What are the MCLs for the listed substances? Are there water and soil standards for these in the draft of 40 CFR 264.512 (Subpart S)? Moreover, neither Table 3.1 nor the tables in Appendix A state which Hanford Area the cited maxima were measured in. Tables 3.1 and A.3 cite the number of plumes assayed but there is no indication of which or how many plumes exhibited the maximum concentration for each contaminant. A map of isopleths would be more informative and would speak directly to the question of contaminants of concern.	
p. 4.1 second paragraph	This is much too conservative an ingestion scenario. Two liters of water a day is about a half gallon, which is more than the maximum amount of liquid most people consume daily. Doesn't this individual ever drink a Coke? Does he or she haul water from the river to make tea or coffee rather than getting it from the tap? Does this individual live right by the river without running water in his or her abode? Does his or her protein intake consist exclusively of more than half a pound of fish a day? The scenario used by the Hanford Environmental Dose Reconstruction (HEDR) project uses a scenario that includes consumption of about 41 kg fish per year with a 95% confidence limit of 82 kg/year (not 100 kg/year). The HEDR project is a PNL project. Certainly PNL should make use of all available resources, particularly those available at the same laboratory.	
p. 4.1 last paragraph	What is the evidence for presuming a Kd = 100,000? Was the Kd measured? If not, why not?	
p. 4.1	The screening approach does not consider uncertainty or confidence intervals.	
p. 4.2 both equations	What is the source of the values used for BCF? Were they the same for all species?	
p. 4.3 section 4.1.3	Page 4.1 claims to use a scenario involving consumption of 0.25 kg fish daily, while this section uses 0.27 kg fish daily. Which was actually used?	

p. 4.3 sections 4.1.4 and 4.1.5	The units of Equations (4) and (5) are given as picocuries per microgram. How can this apply to non-radioactive substances?	
p. 4.6 top of page	What is the supporting evidence for claiming that 1% of the Hanford soil is contaminated to the maximum concentration? Since the area of which this is 1% is not clearly defines, it is not even clear what "1%" means. Would it not be preferable to take soil samples in quadrats along the river shore where the maximum contamination is suspected or known to be, measure the soil concentrations, and statistically estimate the mean and the distribution?	
p. 4.8 paragraph below Table 4.1	It ought to be possible to measure quite accurately the fraction of Cs-137 and Cs-134 that are due to worldwide fallout by comparing the Hanford soil concentrations to soil concentrations in similar locations that are not influenced by Hanford. The claim that these contaminants are "largely derived" from non-Hanford sources is not accurate enough and need to be supported quantitatively.	
p. 4.20 section 4.4	Please include a direct citation to the quality assurance (QA) plan under which these data were collected. Was it consistent with NQA-1? Is it available to reviewers? The QA procedures generally include a quantitative procedure for estimating acceptable sampling error or sampling deviation. Except for lack of an appropriate QA reference, this discussion of deviant samples is acceptable.	
p. 5.1 section 5.0	The size of the recently found particles is not mentioned, nor does there appear to be any particle size distribution. A particle 0.1 mm (100 microns) in diameter is about ten times the size of what is usually considered respirable (capable of entering the lung alveoli). Such a particle, if inhaled, would not be expected to pass through the upper respiratory tract and even less likely to be passed through the bronchi. The estimated dose given in this section is quite conservative.	
p. 6.1 Section 6.0	These surveys seem to have been appropriately done, and their results are not surprising. Some comparison (e.g. to average background, cosmic ray exposure, etc.) might be helpful.	

p. 7.1 et seq	Please append maps of all 105 plumes; it is very difficult to review this section or statements like " ... plumes ... do not yet constitute a source of contaminants in the river." It would be even more helpful to include at least some older maps of plumes, so that a qualitative judgment of travel times could be made by the reviewer. The description given here, even when combined with the information in Table B-1, is not enough to judge whether any of the contaminant plumes will pose a health hazard or exceed any MCLs. I have attached a table (Table 1) and two graphs (Figures 1 and 2) plotting the decay of Sr-90, Co-60, and Cs-137 from the initial concentrations for the 200 East Area that are given in Table B-1. The 20-year concentrations certainly strike me as rather high. In order to know if they pose a health threat we should know the rate (e.g., liter/sec, liter/year) at which groundwater reaches the river, to what extent and how rapidly it is diluted in the river, and the comparative rate of uptake by fish. This sort of precision would also enable a better discussion of future groundwater contamination (Section 7.2). In addition, while the reference to the two EIS documents (p. 7.4, two penultimate paragraphs) is very helpful, a brief summary of their conclusions would be even more helpful.	