START

0022261 9203158

RECEIVED
JUL 10 1992
T.B. VENEZIANO

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Mail Stop PV-11 • Olympia, Washington 98504-8711 • (206) 459-6000

July 1, 1992

JUL 1992
RECEIVED
EDMC

Mr. Steven H. Wisness
Tri-Party Agreement Manager
Department of Energy
Richland Operations Office
P.O. Box 550
Richland, WA 99352

Dear Mr. Wisness:

Re: Review of Hanford Site Ground Water Background Report

The Washington State Department of Ecology (Ecology) and its contractors have completed the review of the Hanford Site Ground Water Background, DOE/RL-92-23, report. Enclosed are our comments on the technical and regulatory content of this report.

The report is not complete enough to allow any thorough review. Appendix D and critical tables and figures are missing. There is not sufficient information presented to derive threshold values for ground-water background.

Because of the various ground-water recharge regimes present at the Hanford Site, it is possible that multiple background threshold values for a single analyte would be required. One value would be required for those areas where recharge and bank storage are affected by the Columbia River; whereas, another value may be needed for those areas in the central part of the site where natural recharge is from Cold Creek or the highlands to the west. This possibility was not sufficiently discussed in this document.

As in the soil background document, there is no discussion of trace element chemistry. The trace elements are of major interest from a regulatory standpoint, since most of the compounds considered potential hazards to human health or the environment (and naturally occurring) are trace elements.

Milestone M-28-04 will be considered complete when the background thresholds for the contaminants of concern and the missing tables, figures and appendices have been incorporated into the ground-water background document.

The report focuses on site geochemistry and very little information on the statistical development of background threshold values is presented. Ecology is presently drafting a statistical guidance document to supplement the regulations in the WAC 173-340 Model Toxics Control Act (MTCA). This document should be available by the end of August 1992. The application of these guidelines to the ground water will need to be discussed during the resolution of comments.

If you have any questions or concerns regarding these comments, please contact me at (206) 438-7556.

Sincerely,

Chuck Cline
Hydrogeologist
Nuclear & Mixed Waste Management

CC:kw
Enclosure

cc: L.G. Goldstein, Ecology
L.E. Gadbois, EPA-Richland
D.R. Jensen, Ecology
D.C. Nylander, Ecology
K.M. Thompson, DOE
T.B. Veneziano, WHC

9 3 1 2 7 . 9 7 3 3 4

1. General Comment;

Portions of this document need a great deal of editing. There are many instances of unclear and imprecise language.

2. General Comment;

Appendix D is referenced in Section 4 and repeatedly in Section 5. This appendix is not present in this document and cannot be evaluated. Therefore any statements or conclusions based on information contained in Appendix D cannot be fully evaluated at this time.

3. General Comment;

The primary focus of this report is major element chemistry with virtually no discussion of trace element chemistry. The trace elements are of primary interest from a regulatory standpoint, since most of the compounds considered potential hazards to human health or the environment (and naturally occurring) are trace elements. Sections should be added discussing trace element chemistry to the level of detail that major elements are discussed.

4. General Comment;

A continuing disagreement in the determination of groundwater quality is whether monitoring samples should be filtered or unfiltered water samples, particularly in the case of major elements and trace metals. In this case, agency guidance is required. Both Ecology and EPA require groundwater monitoring standards collected to show compliance with cleanup standards to be unfiltered. The data used in this study are all from filtered samples. Unfiltered samples measure both the dissolved and the particulate phases of a groundwater sample. These samples are considered, by some to be more representative of what would be collected by a private well for drinking water use, since drinking water systems typically do not have filtering systems. Conversely, it can be argued that, although most drinking water systems do not have filtering apparatus, they also do not typically draw water directly to the tap. Most domestic drinking water systems utilize some sort of storage tank where many reactions can occur (such as degassing of water) that can change the nature of the water and allow time for solids to settle; making filtered water the best representation of groundwater quality. Unfiltered samples are not suitable for determining the dissolved phase chemistry or the geochemical evolution of groundwater. Filtered samples measure only the dissolved phase of a groundwater sample, and when properly collected, are indicative of the actual groundwater chemistry. Filtered

samples are also most representative of what chemicals are mobile in groundwater, since most of the particulate phase will not move with the groundwater, except possibly in coarser geologic materials. Filtered samples will also provide lower background limits than unfiltered samples. If the goal of this study is to include anything that may be ingested in the groundwater analyses, then unfiltered sample data should be used. If the goal is to determine what is actually dissolved in the groundwater, then filtered sample data should be used. For purposes of background determination, it would be best to use the same type of sample as will be required for cleanup. To be safe, filtered and unfiltered samples should be taken.

5. General Comment;

Deficiency: In many places in this document, reference is made to a statistical approach for determining a threshold concentration described in WAC 173-340-708(11)(d). During the development of a statistical guidance document, Ecology determined that this is not the best approach to use for identifying a threshold concentration. An approach that more carefully balances the risk of identifying a contaminated area as clean and the risk of identifying a clean area as contaminated is being prepared. This approach uses a lower percentile, in certain conditions, than the one currently in the regulations. In addition, the new guidance recognizes that a log-normal distribution better estimates the distribution of environmental monitoring data. It is recommended in the new guidance that data sets be examined first for lognormality and then secondly for normal and nonparametric distributions.

Recommendation: The approach should be revised to match Ecology's proposed guidance, particularly since the approach adopted at the Hanford site will be a model for other sites in the country.

6. General Comment;

Deficiency: It is not clear how the groundwater background threshold values were derived. The report focuses upon site geochemistry and very little information on the statistical development of background threshold values is presented. Specific questions about derivation of the background threshold values include:

- Which data were used as the sample populations for statistical analysis? Section 5.4, page 5-25, paragraph 3 states that the Basalt Waste Isolation Project Hydrochemistry (BWIP) unconfined aquifer data and the Hanford Groundwater Database were used as the "provisional" data set. However, only the BWIP data is included in Appendix A. There is no discussion of how individual samples were treated (e.g., averaging replicate values from the same day; potentially averaging data across quarters when the assumption of serial correlation cannot be rejected).

9 3 1 2 7 9 1 0 3 6

- What assumptions were made in selecting the sample populations, and how were the assumptions justified?

- How was the removal of outliers from the data set justified?

- How were data that were recorded as below the detection limit incorporated into the data set?

- How and why were the various statistical procedures applied to the data set for each analyte?

Recommendation: Additional text explaining the procedures used to calculate background threshold values should be presented. This text should provide enough detail (methods and data) that the background threshold value calculations can be reproduced from information provided in the report. Data presented in the report should be clearly labeled to easily identify which data sets were analyzed for each of the different components of the statistical analysis. A discussion of how individual samples were treated should be provided. Information about site geochemistry should be limited to that which has significance for development and/or interpretation of the background threshold values.

7. General Comment;

Deficiency: It is not clear how the provisional groundwater background values presented in the report should be applied for the identification of contamination. Specific issues include:

- Selection of a groundwater background threshold value when multiple values have been calculated for a single analyte.

- Application of a groundwater background threshold value when confidence in the value is low because of small sample population size.

Recommendation: Application of the provisional groundwater background threshold values for identification of contamination should be discussed in the report. This discussion should include an assessment of accuracy of the background threshold value for each analyte. Additional data necessary for increasing the accuracy of the background threshold values should also be identified.

8. Definition of Terms, Page ix, sixth paragraph

Deficiency: See general comment 5.

Recommendation: See general comment 5.

9. Section 2.0 (entire section);

Deficiency: The stated purpose of this study is to characterize the levels of naturally occurring inorganic chemicals within the unconfined aquifer at the Hanford site. Such chemicals include trace constituents that are often regulated at very low levels. The data quality objectives outlined in this section do not include any identification of applicable or relevant and appropriate requirements (ARARs) in order to determine groundwater constituents that are regulated, and the level at which they are regulated.

Recommendation: This section should list chemicals that are considered groundwater contaminants, as indicated by the ARARs, that are likely to be naturally present in the groundwater. The objectives for data use should include the comparison of groundwater analyses to regulatory limits, the determination of naturally occurring compounds that may be near or above regulatory limits, and, possibly, the determination of natural sources of the compounds near or above regulatory limits. Compounds that are well below regulatory limits in the background waters are not of concern for this study, since regulatory limits can be used as the cleanup criteria.

10. Section 2.1.6, Page 2-3, second and third paragraphs

Deficiency: The list of general DQO criteria are not criteria, but rather, data needs. However, two general data quality objective (DQO) "criteria" (lateral and vertical coverage, and the numbers and types of samples appropriate for evaluating the various natural process impacts) are not addressed by the "specific criteria" or rather, data limitations, presented for evaluating and screening the site data. Failure to consider these two criteria may result in inadequate characterization of background groundwater concentrations.

Recommendation: Specific criteria should be developed that address the two general DQO criteria not presently addressed (lateral and vertical coverage, and the numbers and types of samples appropriate for evaluating the various natural process impacts). The data screening should then be repeated using the complete set of specific criteria. If results of data screening change as a result of using the newly developed screening criteria, the statistical analyses should be repeated for the new data set.

11. Section 2.1.6, Page 2-4, second bullet;

Deficiency: It is not clear why a submersible pump is necessarily the most reliable sampling method and, therefore, a good screening criterion. Other sampling techniques have been shown to be quite reliable and certain types of submersible pumps are not acceptable for groundwater quality sampling.

Recommendation: A more detailed explanation of what sampling methods were judged acceptable, and why, should be provided.

12. Section 2.2, Page 2-4, first bullet;

Deficiency: Why should this be "scientifically unjustified"? It may be that there will be several background levels for individual constituents, because the natural groundwater regime varies throughout the Hanford Site. If areas of concern are adjacent to the Columbia River, then recharge and mixing may create a different "natural condition" than for an area located in the middle of the Hanford Site. The ground water beneath the Site is not one system, but rather a number of systems.

Recommendation: A more detailed explanation or revision of this paragraph should be provided.

13. Section 2.2, Page 2-6, second paragraph

Deficiency: An additional, and equally important, benefit of establishing site-wide background concentrations is the prevention of misidentification of contaminated groundwater as clean or within background concentrations. This misidentification could occur using a waste management unit (WMU) approach to identifying background concentrations if an upgradient well is contaminated by upgradient activities.

Recommendation: This benefit should be identified in the text.

14. Section 3.1, Page 3-1, 5th paragraph;

Comments: 1) Other aquifers are not a type of surface water. Springs, which could originate in another aquifer, are already listed.

2) It appears that one of the parentheses has been placed incorrectly.

15. Section 3.1, Page 3-2, 4th paragraph;

Deficiency: The term "hydraulic conductivity" is *not* synonymous with flow rate. Hydraulic conductivity is a property of the porous medium and the fluid flowing through it (Freeze and Cherry 1979). The flow rate, in the sense of the average linear velocity of groundwater, is determined by the hydraulic conductivity, hydraulic gradient, and porosity. The flow rate, in the sense of Darcy velocity (flux), is determined by the hydraulic conductivity and hydraulic gradient.

Recommendation: The language in the second sentence of this paragraph is incorrect and must be corrected.

16. Section 3.1, Page 3-2, 4th paragraph;

Comment: There is no indication of a closed groundwater system on the Hanford site. The term closed system means that there is nothing entering or leaving the system. The fact that groundwater is flowing through all of the systems described in this document indicates that the systems are open. Certain groundwater samples may have chemical characteristics similar to closed system laboratory experiments. This similarity probably indicates that the groundwater system is at or near equilibrium (at least for kinetically "fast" reactions), and that the system behaves similarly to the closed system experiments. It does *not* indicate that the system is closed.

17. Section 3.2.3, Page 3-4, 3rd paragraph;

Comment: The discussion of what constitutes a reducing environment is misleading. The following comments apply to the discussion of reduction-oxidation:

1) As measured with a platinum electrode, oxygen disappearance can occur as high as 600 mV (Bohn et al 1979), rather than 100 mV as stated in this report. Was there some reason 100 mV, specifically, was chosen to represent reducing environments?

2) Oxidation and reduction are generally discussed in terms of redox potential (Eh or pE, where pE=Eh/0.0592), rather than as an electrode reading.

3) There is no mention of the fact that, when considering mineral solubilities, one must consider the Eh and pH together. The use of Eh-pH diagrams would illustrate this point.

4) Redox potentials for specific redox couples often differ greatly from measured electrode potentials. The potential of the platinum electrode is a

poorly defined average of the potentials of all of the redox couples measured. The contribution of each couple to the average potential is an unknown function of its concentration and irreversibility (Hem 1985).

18. Section 3.3, Page 3-6, 4th paragraph;

Comment: The second sentence should read "... the effects of *residence* time...." Time itself does not have any effect on groundwater composition.

19. Section 3.4.1, Page 3-7 (entire section);

Deficiency: This discussion is difficult to follow without figures.

Recommendation: The discussion of regional geology should be accompanied by a figure, or figures, showing the features being discussed.

20. Section 3.4.2.2, Page 3-8, 2nd paragraph;

Deficiency: "Pedified" is not a standard geologic term.

Recommendation: Define this term in the glossary.

21. Section 3.4.3.1, Page 3-9, 7th paragraph;

Deficiency: This discussion is difficult to follow without a figure.

Recommendation: This section should be accompanied by a figure showing the surface hydrology, including springs.

22. Section 3.4.3.3, Page 3-11, 5th paragraph;

Deficiency: This section includes a reference to Figure 3-8, a cross section through the Pasco Basin showing vertical contours of chloride concentrations. This figure is not present in the document.

Recommendation: Include the figure.

23. Section 3.4.3.3, Page 3-12, 1st paragraph;

Deficiency: This section includes a reference of Figure 3-9, a generalized water table map for the Pasco Basin and adjacent portions of the Columbia Plateau. This figure is not present in the document.

Recommendation: Include the figure.

24. Section 3.4.3.3, Page 3-12, 1st and 2nd paragraphs;

Deficiency: The last sentences of these paragraphs refer to the effect of the water table being located in different formations. However, there is no way for the reader to correlate groundwater gradients or contaminant plumes with the formations through which the groundwater is flowing.

Recommendation: Construct a figure or figures to illustrate this point.

25. Figure 3-1, Page F3-1;

Comment: Arrows should be placed on the figure showing sidebank recharge/discharge.

26. Figure 3-2, Page F3-2;

Comment: This figure is incomplete. It only shows redox changes with depth. Other processes are mentioned in the text and should be included in the figure. These processes include, but are not limited to: mineral dissolution/precipitation, ion exchange and adsorption, use/generation of dissolved gases.

27. Section 4.1 (entire section);

Comment: This section should be accompanied by a figure, or figures, showing the locations of the wells from each data set that was used for this study. The figure referenced in this section is not clear.

9 3 1 2 7 9 0 0 2

28. Section 4.1.1.1, Page 4-3, third paragraph

Deficiency: The location of wells with reference to known or potential sources of contamination and contaminant plumes is not discussed as a selection criterion.

Recommendation: A discussion of whether this information was used in selecting data for inclusion in the background data set, or if not, why not, should be provided.

29. Section 4.1.1.3, Page 4-3, fifth paragraph

Deficiency: The text does not identify how the background concentration of tritium was determined. Without the results of the background study, it is premature to screen for the presence of contamination using tritium, particularly given the confounding anthropogenic sources described in this and the following paragraph.

Recommendation: The text should provide more explanation of how the background concentration was determined, or a more appropriate screening method for contamination should be used.

30. Section 4.1.1.4, Page 4-4, first paragraph;

Deficiency: This paragraph states that the selection criterion for charge balances was set at 5 percent.

Recommendation: Explain the rational for selecting 5 percent as the selection criterion for charge balances.

31. Section 4.1.1.5, Page 4-4, 2nd paragraph;

Deficiency: The monitoring well physical descriptions on the referenced tables (4-3 and 4-4) indicate that standard submersible pumps used for water supply well were used for sampling. This type of pump is generally not acceptable for certain groundwater quality sampling because the sample may be altered by the pump.

Recommendation: This section should include a discussion and evaluation of potential problems with the data due to the method of sample collection.

32. Section 4.1.2.1, Page 4-5, third paragraph;

Deficiency: This paragraph states that the selection criterion for tritium from the Hanford Groundwater Database data was set at 500 picocuries per liter. However, the selection criterion for tritium from the Basalt Waste Isolation Project Hydrochemistry Database data was set at 3.23 picocuries per liter. True, the 500 picocuries criterion is the detection limit for the Hanford Groundwater Database data. However, since this value is much higher than that of the Basalt Waste Isolation Project Hydrochemistry Database data, Tritium may not be a feasible criterion for the Hanford Groundwater Database data.

Recommendation: Explain the rational used in selecting the tritium selection criterion for both data sources.

33. Section 4.1.2.2, Page 4-5, first paragraph in this section

Deficiency: Both B Pond and U Pond are also responsible for contributing contamination to the ground water, especially tritium. It may not be correct to state that Columbia River water disposed to the ponds has resulted "in a significant dilution of existing Hanford Site groundwater." The Columbia River water may have been run through PUREX, or U and Z-Plants first.

Recommendation: This general statement should be clarified and elaborated upon.

34. Section 4.1.2.2, Page 4-6, first paragraph

Deficiency: The locations of the wells that meet the selection criteria are not shown on Figure 3-7; all the monitoring wells are shown on that figure, including those within tritium plumes.

Recommendation: In general, maps and explanations that show step-by-step documentation of how wells were eliminated and which ones were retained should be included.

35. Section 4.4.2, Page 4-9, 1st paragraph;

Deficiency: Insufficient description of well construction.

Recommendation: Explain how these wells deviate from RCRA or WAC 173-160 standards or provide a general description of well construction if all the wells, or groups of wells, have been constructed in a similar fashion.

9 3 1 2 7 5 9 0 0 9 4

36. Tables 4-2, 4-3, 4-4, Pages T4-2.1 to T4-4;

Deficiency: There is no way to correlate well completions with well locations.

Recommendation: Provide a figure showing the locations of the wells, with legible well numbers.

37. Section 5 (entire section);

Comment: Many of the figure and table references are wrong and need to be corrected.

38. Section 5.0, Page 5-1, 2nd paragraph;

Comment: There is a word missing in the first sentence.

39. Section 5.0, Page 5-1, second paragraph

Deficiency: This paragraph states that the emphasis of the evaluation is on major and minor constituents of groundwater rather than on trace elements. However, trace elements may make up the majority of the contaminants of concern at the site.

Recommendation: To determine which major, minor, and trace elements might be appropriate to address, the contaminants expected to be of concern at the site should be listed along with screening-level, risk-based concentrations. The risk-based concentrations could be compared on an order-of-magnitude basis with background concentrations expected for these elements in groundwater to determine which elements may be important to address (i.e., those whose background concentrations might exceed screening-level, risk-based concentrations). This evaluation would help focus collection of future data on only those contaminants for which background concentrations are expected to be relevant to setting cleanup standards.

40. Section 5.1.2, Page 5-3, third paragraph

Deficiency: The text states that water quality data from 10 Hanford Groundwater Database wells were selected for analysis during the groundwater background study that was conducted for the unconfined (suprabasalt) aquifer. However, information presented in Table 4-2 and Section A-1 of Appendix A indicates that only seven wells from the BWIP database were used in the analysis.

9 3 1 2 7 5 9 0 0 9 5

Recommendation: Information presented in the text should be consistent with the referenced supporting information in tables and appendices.

41. Section 5.1.2.1, Page 5-3, 5th paragraph;

Comment: This section references figure 4-1. There is no figure 4-1 in this document.

42. Section 5.1.2.2, Page 5-3, sixth paragraph

Deficiency: This paragraph concludes that no seasonal variation occurs in groundwater concentrations for the BWIP wells, based on a comparison of standard deviations presented in Figure 5-1. An evaluation of the adequacy of this approach cannot be made as Figure 5-1 has not been completed. However, statistical tests are available for trend analysis and should be considered because of the increased statistical power that these tests provide.

Recommendation: The text should include a discussion of alternative statistical tests for detecting trends, such as regression of concentrations against time, or the seasonal Kendall test for trends (most appropriate for data that are skewed, cyclic, and serially correlated [Gilbert 1987]). Issues surrounding seasonality and the detection of trends are also discussed by Montgomery et al. (1987).

43. Section 5.1.2.2, Page 5-4, 1st paragraph;

Comment: There is no Figure 5-1.

44. Section 5.1.2.3, Page 5-4, second paragraph

Deficiency: The conclusions presented about serial correlation are based on Figure 5-1, which has not been completed. An evaluation of the adequacy of this approach cannot be made without this figure. However, available statistical tests designed for testing serial or autocorrelation should be considered because of the increased statistical power that these tests provide. Rejecting the hypothesis of serial correlation is necessary for establishing a data set based on independent samples.

Recommendation: The text should include a discussion of alternative statistical tests such as the rank von Neumann test for serial correlation (Bartels 1982, Gilbert 1987). The issue of independence of groundwater data is also addressed by Montgomery et al. (1987).

9 3 1 2 7 1 9 0 0 9 6

45. Section 5.1.2.4, Page 5-4, 5th paragraph;

Deficiency: There is no discussion of the significance of the variation diagram.

Recommendation: Given that this document is intended for a mixed audience, there should be a discussion of how to read the variation diagrams (Figures 5-1 and 5-3), either here or later in this section.

46. Section 5.1.2.4, Page 5-5, 5th paragraph;

Comment: There is no Figure 5-1.

47. Section 5.1.2.6, Page 5-6, 1st paragraph;

Comments: 1) There appear to be approximately the same number of samples that exhibit low concentrations as exhibit high concentrations at low redox potential (< 100 mV, based on Figure 5-5). What is the explanation for this pattern?

2) The redox potential should be expressed as Eh or pE.

3) How do the concentrations compare to the pH of the water? The pH can also affect the solubilities of Fe, Mn, Ca, and other compounds. Correlations of pH and redox conditions should be addressed

48. Section 5.1.2.7, Page 5-6, 4th paragraph;

Comment: 50 feet does not equal 915.2 meters.

49. Section 5.1.2.8, Page 5-7, 1st paragraph;

Comment: Discuss the studies that have been done at other locations within the Hanford Site comparing water level fluctuations in the wells adjacent to the rivers and river level fluctuations.

50. Section 5.1.3.1, Page 5-7, 3rd paragraph;

Deficiency: There is no data for the reader to compare river alkalinities with groundwater alkalinities.

Recommendation: Alkalinity should be added to Table 5-1 for comparison to groundwater values.

51. Section 5.1.3.1, Page 5-7, 5th paragraph;

Comment: There does appear to be some increase in alkalinity on the eastern side of the site, as indicated by the values of about 130 mg/L near the 100 mg/L contour (Figure 5-6). However, this figure is barely legible.

52. Section 5.1.3.2, Page 5-8, 3rd paragraph;

Deficiency: This section consists of a statement with no discussion and cannot be evaluated.

Recommendation: This section should be expanded.

53. Section 5.1.6, Page 5-12, 3rd paragraph;

Comment: Specify what type of geochemical modeling was performed. Was a specific model used (eg. PHREEQE, MINTEQ)?

54. Section 5.2, Page 5-14, 5th paragraph;

Deficiency: This section does not make sense.

Recommendation: This section appears to be two sentences accidentally combined into one. Revise the section.

55. Section 5.2.1, Page 5-15 (entire section);

Comment: This section would be better illustrated by a series of trilinear plots, Stiff diagrams, or some other graphical method that shows individual sample values. Conclusions that can be drawn from maxima and mean concentrations are very limited.

61. Section 5.3.2, Page 5-23, 5th paragraph;

Deficiency: There are no figures illustrating the relationship between reducing conditions and elevated levels of iron and manganese.

Recommendation: Add relevant figures.

62. Section 5.3.3.1, Page 5-24, 3rd paragraph;

Deficiency: This discussion neglects the effects of waste water discharge on trace element concentrations. While discharge waters may have more dilute major element concentrations, some are more heavily loaded with contaminants than natural waters.

Recommendation: Discuss the effect of waste water discharge on trace element concentrations, particularly those considered hazards to human health or the environment.

63. Section 5.4, Page 5-25, fourth paragraph

Deficiency: The use of tritium as a screening criterion implies that elevated concentrations of tritium are expected to be present in all waste streams at Hanford, including those that do not include waste or radioactive waste. If all groundwater plumes at the site contain tritium, a detailed explanation and background information should be provided. If some wastes did not contain tritium, data derived from samples of contaminated groundwater may be included in the background data set. Application of groundwater background threshold values developed from such a data set may result in failure to identify some contaminated areas of the site.

Recommendation: The use of tritium concentrations as the sole screening criterion for contamination should be discussed in more detail, as described above. Information on the tritium content of wastes discharged at the site should be provided or referenced.

64. Section 5.4, Page 5-25, fourth paragraph

Deficiency: Neither the data nor the assumptions used to construct the statistical sample populations for each analyte are clearly presented. Without this information, validity of the analyses performed cannot be evaluated.

Recommendation: A clear presentation of the data and assumptions used to construct the statistical sample populations for each analyte should be provided. This

presentation should include results of analyses performed and a discussion of whether grouping of the spatially and temporally distributed data produced populations that were truly independent. The text should address the issue of autocorrelation between the quarterly samples and present statistical results. The replicate samples reported in Table A-1 should be averaged prior to analysis, as these are not independent samples.

65. Section 5.4, Page 5-25, fourth paragraph

Deficiency: As indicated in the text and on Figure 5-18, the statistical population was constructed from data collected near the western edge of the suprabasalt aquifer. Given that systematic variation occurs during sediment deposition, it is probable that sediments present at the aquifer edge differ from those located in the center of the aquifer, and natural groundwater quality may differ along with the sediment type. No discussion of the effects of data location upon the statistical data distribution and the calculated groundwater background threshold values is presented.

Recommendation: An assessment of the effect of sample location upon background threshold value calculation should be provided. This assessment should address any anticipated effects of sample location upon the ability to discern groundwater contamination. The results of the assessment should be used to identify additional data necessary for increasing the accuracy of the background study results.

66. Section 5.4, Page 5-25, fifth paragraph

Deficiency: Figure 5-19 is referenced, but little presentation of the statistical methods indicated on the figure appears in the text.

Recommendation: The statistical methods indicated on Figure 5-19 should be further discussed in the text. Specifically, the statistical criteria used to determine whether use of the lognormal or normal distribution is reasonable should be identified. Also, how the data were treated when separate concentration groups for an analyte are suspected should be clarified.

67. Section 5.4, Page 5-26, first paragraph

Deficiency: The text states that for each analyte, concentration data were separated into two or more populations where distinct concentration groups were apparent and that background threshold values were calculated for each new group. As a result, multiple background threshold values exist for some analytes (e.g., iron on Table 5-9). However, no method for applying multiple background threshold values to detect onsite contamination is presented.

9 3 1 2 7 5 9 0 1 0 0

Recommendation: The text should discuss how multiple background threshold values for a single analyte will be used to evaluate onsite contamination.

68. Section 5.4, Page 5-26, second paragraph

Deficiency: The identification of two groups of background concentrations for some elements suggests that additional interpretation of these data is needed.

Recommendation: It should be determined, through a spatial analysis of the grouped data, whether the two groups correspond to differing geologic formations. If so, it may be appropriate to develop separate background thresholds for groundwater in these formations.

69. Section 5.4, Page 5-26, 2nd paragraph;

Deficiency: Iron and manganese data are not discussed in most sections nor plotted in most figures. Their use as a basis for determining groupings cannot be evaluated.

Recommendation: Provide figures and discussion on this topic.

70. Section 5.4, Page 5-26, 5th, 6th and 7th paragraphs;

Deficiency: There is no basis in the previous text for the discussion of trace element results. This is the first place trace elements are discussed!

Recommendation: The previous sections should be expanded to include trace elements.

71. Section 5, figures

Deficiency: These figures are not readable or useful. The use of hand-drawn graphics and very small print is inappropriate and renders the figures somewhat confusing. In addition, concentration units are missing from many figures.

Figures that are illegible: 5-5, 5-6, 5-7, 5-18, 5-20, 5-21, 5-22

Figures lacking concentration units: 5-2a, 5-2b, 5-2c, 5-2d, 5-2e, 5-2f, 5-2g, 5-3, 5-9, 5-12a, 5-13, 5-15.

Recommendation: These graphics should be finalized. Units should be added to the axes of all figures.

72. Figure 5-5, Page F5-5;

Comment: This figure needs to be formalized. Redox potential should be reported as Eh or pE.

73. Figure 5-8, Pages F5-8.1 to F5-8.5;

Comment: The symbols for each aquifer type and redox state should be consistent between graphs.

74. Figure 5-14, Page F5-14;

Comment: There should be a location map showing where this area is in relation to the rest of the site. Calling out specific operable units is not sufficient.

75. Figure 5-18, Page F5-18

Deficiency: This figure is especially confusing. Are all the wells on the map background wells or just those indicated with stars? If all the wells were included, what are the starred wells and why are some of the other wells located within WMUs? What does the striped area represent? None of the well names are easily readable, making it hard to correlate the data with well locations.

Recommendation: The figure legend should be clarified and the graphics improved.

76. Figure 5-19, Page F5-19

Deficiency: This figure specifies that any "potential outliers" which are outside the "95/95" range should be omitted from the data set and the calculation of the threshold value rerun excluding these values. Data points should not be excluded from a background data set unless they are determined to be in error (e.g., analytical error, sampling error).

Recommendations: This figure and any supporting text should be revised regarding exclusion of outliers. The 95 percent confidence limit of the 95th percentile should be calculated using all data not shown to be in error.

77. Figure 5-22, Page F5-22

Deficiency: This figure seems to show that a single probability distribution function was used for what clearly appear to be two separate distributions.

Recommendation: Some discussion of the appropriateness of such a representation should be included, along with some indication of how many and which contaminants exhibited this type of distribution. It appears that this one figure is used to illustrate similarity to a normal distribution and the identification of multiple groupings of the data. It would be better to include a second figure, one which illustrates a better fit to the lognormal or normal distribution based on a single grouping of the data.

78. Tables 5-2, 5-3, 5-6, 5-7, 5-10, Pages T5-2, T5-3, T5-6.1 & T5-6.2, T5-7, T5-10.1 & T5;

Deficiency: The above listed tables do not note the units being used.

79. Table 5-9, Page T5-9.1

Deficiency: Several threshold values are listed on this table as being below a detection limit. However, some of these detection limits are inappropriately high for determining background concentrations, because the detection limits exceed maximum contaminant levels (MCLs) (cadmium), water quality criteria (cadmium, copper, lead, mercury, silver), or risk-based screening levels that may be applicable as cleanup standard for groundwater at the site.

Recommendation: The need for collection of additional data with reasonable detection limits should be identified as a data gap for future groundwater monitoring efforts. The evaluation of detection limits against applicable or relevant and appropriate requirements (ARARs) and potential risk-based standards should be a standard part of DQOs for groundwater sampling.

80. Section 6.1, Page 6-1, 2nd paragraph;

Comment: This section references Table 6-1. There is no Table 6-1.

81. Section 6.1.2, Page 6-2, 5th paragraph;

Comment: While discharge of waste waters may result in more dilute major element concentrations, the effect on trace element concentrations has not been addressed.

9 3 1 2 7 0 9 1 0 3

The effects of waste water discharge on contaminant concentrations in the groundwater should be considered.

82. Section 6.3.1, Pages 6-3 and 6-4

Deficiency: Data needs for the uppermost confined aquifer are not specified. Data limitations for this hydrostratigraphic unit (identified in Section 5.4, Page 5-25, third paragraph) precluded statistical development of background threshold concentrations, and no alternative approach for assessing background concentrations has been posed. As a result, no plans for determining remediation levels for the upper confined aquifer are stated.

Recommendation: Clarification of plans for determining remediation levels for the uppermost confined aquifer should be presented.

83. Appendix A, Tables A-1, A-2, A-3, A-4;

Deficiency: These sections do not note where the reader can find the units and definitions needed to use and understand the data tables.

Recommendation: Within these sections, refer the reader to the first part of Appendix A for units and definitions for the data tables.

84. Appendix B, Page 1-2, first paragraph

Deficiency: See general comment 5.

Recommendation: See general comment 5.

85. Appendix B, Page 1-3, third paragraph

Deficiency: Washington water quality standards for groundwater are not applicable to sites undergoing cleanup under either CERCLA or MTCA (see WAC 173-200-010(3)(c)). Therefore, these provisions are not relevant. However, the provisions of MTCA for Method B cleanup standards state that the natural background concentration may be used as a cleanup standard if the background-based standard is higher than a risk-based concentration or ARAR.

Recommendation: The discussion and citation should be revised.

86. Appendix B, Table 1, Page T-1.1

Deficiency: The "guideline limit" listed in this table is not defined. If this row is intended to show potential ARARs or cleanup levels for groundwater, it is not clear why detection limits were selected that are higher than the guidance limits (e.g., for aluminum).

Recommendation: Footnotes with references should be provided for these values. If the values are based on MCLs, some of them are out of date (e.g., the new MCL for chromium is 100 μg/L). Water quality criteria should also be listed for groundwater that discharges to surface water. Detection limits should be lower than all applicable criteria and standards.

87. Appendix B, Table 1, Page T-1.1

Deficiency: For many of the analytes, relatively few of the data are above the detection limit. No method for analyzing data sets in which a portion of the data are below detection limits is presented in the text.

Recommendation: A method for analyzing data sets that contain data that are below detection limits (BDL) should be presented. MTCA requires that all concentrations below the detection limit be assigned a value equal to one-half the detection limit of the method being used (WAC 173-340-708(11)(e)). However, alternate statistical procedures for handling censored (BDL) data may be approved by Ecology. Helsel (1990) presents a recent review of this subject and several alternative approaches for BDL data.

88. Appendix B, Table 1, Page T-1.1

Deficiency: For many of the analytes, the reported sample size is smaller than that calculated in the document (Appendix B, page 1-2, fifth paragraph) to attain a 95 percent tolerance limit for the 95th percentile (59 samples). No indication of the actual confidence associated with the reported sample size is presented.

Recommendation: The confidence level corresponding to the sample size for each analyte should be presented.

89. Appendix B, Table 1, Page T-1.1

Deficiency: The text does not state how the analytes were selected for calculation of background threshold values.

Recommendation: The reasons for selecting the analytes for statistical analysis should be presented.

90. Appendix B, Figure 1, Page F-1

Deficiency: The text does not discuss the statistical methods indicated on Figure 1 for evaluating onsite contamination based on a comparison to background.

Recommendation: Application of the statistical methods indicated on Figure 1 should be discussed in the text. A justification or reference should be included for the criteria used to determine the statistical method selection (e.g., proportion of BDL data greater than or equal to 50 percent resulting in the use of a test of proportions for comparison to background).

9 3 1 2 7 : 9 0 1 0 6

REFERENCES

Bartels, R. 1982. "The Rank Version of Von Neumann's Ratio Test for Randomness". Journal of the American Statistical Association. 77:40-46.

Bohn, Hinrich L., Brian L. McNeal, George A. O'Conner. 1979. Soil Chemistry. John Wiley and Sons, New York.

Freeze, R. Allan, and John Cherry. 1979. Groundwater. Prentice-Hall, Englewood Cliffs, N.J.

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Company, New York, NY.

Helsel, D.R. 1990. "Less than Obvious: Statistical Treatment of Data Below the Detection Limit". Environ. Sci. Technol. 24(12):1766-1774.

Hem, John D. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. 3rd ed. U.S. Geological Survey Water Supply Paper 2254.

Montgomery, R.H., J.C. Loftis, and J. Harris. 1987. "Statistical Characteristics of Ground-Water Quality Variables. Ground Water 25(2):176 et seq.

U.S. EPA. 1988. Regional quality assurance position regarding field filtration of aqueous samples. (Memorandum from R.R. Jones, dated February 10, 1988). U.S. Environmental Protection Agency Region 10, Seattle, WA.

9 3 1 2 7 0 9 1 0 7

CORRESPONDENCE DISTRIBUTION COVERSHEET

Author	Addressee	Correspondence No.
C. Cline, Ecology	S. H. Wisness, RL	Incoming 9203158

Subject: REVIEW OF HANFORD SITE GROUND WATER BACKGROUND REPORT

INTERNAL DISTRIBUTION

Approval	Date	Name	Location	w/att
		Correspondence Control	A3-01	X
		President's Office	B3-01	
		M. R. Adams	H4-55	X
		G. D. Carpenter	B2-16	
		C. K. DiSibio	B3-03	
		C. J. Geier	B2-19	
		J. D. Hoover	H4-57	X
		R. E. Lerch	B2-35	X
		P. J. Mackey	B3-15	X
		H. E. McGuire	B3-63	
		P. D. Mix	L4-92	X
		S. M. Price	H4-57	
		A. L. Prignano	H4-57	X
		F. A. Ruck III	H4-57	X
		T. B. Veneziano	B2-35	
		T. M. Wintczak	L4-92	X
		R. D. Wojtasek	L4-92	
		EDMC	H4-22	X

9312710108