



134 - 68A - GET - 00001  
United States Department of the Interior

U.S. GEOLOGICAL SURVEY

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MAY 05 1997

SUPERVISOR

SL-1186

May 1, 1997

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Mr. Dan Wall  
U.S. Environmental Protection Agency  
Kansas City, Kansas

Dear Mr. Wall:

I have reviewed the "Remedial Investigation Report for the St. Louis Site, St. Louis, Missouri, January, 1994," prepared for the U.S. Department of Energy, Oak Ridge Operations Office under contract No. DE-AC05-91OR21949 by Bechtel National, Inc. focusing on the St. Louis Airport Site (SLAPS). This review was done concurrently with my review of the water-quality data in preparation for the joint DGLS-USGS-DOE meeting on data gaps that was held in Rolla, Missouri, on April 29. I spent most of my time reviewing the water-quality data and determining if the water-quality data presented are consistent with the hydrogeology of the site. I did not review the SLDS work in detail; therefore, the following discussion focuses on the SLAPS, HISS, and vicinity.

In general, the document is very fragmented and contains little specific data to verify the stated conclusions. After reading the RI and several supporting documents, it is my opinion that insufficient data have been collected to characterize the extent of ground-water contamination or assess the environmental fate of the contaminants (predominately uranium) in the ground water. This does not mean that the number of data points (monitoring well and surface-water sampling sites) is inadequate, but that the sampling program has been erratic and inconsistent over the years to such a degree that a clear picture of the extent and magnitude of ground-water contamination cannot be seen. In addition, a number of indicator constituents have not been analyzed for, or, if they have, the detection limits have been too large. Coupled with the inadequate data collection over the years is a cursory and incomplete review of the data and discussion in the RI.

Most of the water-quality analyses lack basic field parameters and major constituents, such as dissolved oxygen, alkalinity, chloride, fluoride, and nutrients (nitrate, nitrite, ammonia, and phosphorus). A small amount of these data exist (a few HISS wells have one or two rounds of field parameters and major constituents according to the 1995 HISS yearly monitoring report). The RI states that a few VOCs (volatile organic compounds) were detected in ground water at SLAPS, but that their distribution was erratic and probably not related to DOE activities. A major concern is that the detection limits for the VOCs were large [10 ug/L (micrograms per liter) or larger], and it appears that not all wells were sampled. The relatively large detection limits present a problem because the MCLs for many VOCs such as TCE (trichloroethene), PCE (tetrachloroethene), and VC (vinyl chloride) are less than 5 ug/L. The infrequent and constantly changing analyte list and large detection levels for VOCs and other organic compounds may mask the true extent of contamination and any spatial or temporal trends in the data.

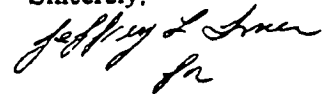
In addition to lacking sufficient data to characterize the extent and magnitude of contamination in the ground water, data in the RI are relatively old (pre-1994). David Miller of SAIC has indicated that there has been additional quarterly sampling of monitoring wells at SLAPS and HISS in the last several years. Although these subsequent data collection activities are not comprehensive either, they represent

additional information that should be included in the RI. A summary of these data was to have been provided to me by April 21, 1997; however, I have not received it.

Perhaps the history of ground-water sampling at the Weldon Spring site could provide some "lessons learned" for the SLAPS. For example, in the early 1980s and before, only radionuclides were analyzed in ground-water samples. Only small concentrations of these compounds were detected, leading to the erroneous conclusion that the raffinate pits were, in general, not leaking. Ground-water samples collected in the mid-1980s and later, however, showed this not be true because large concentrations (hundreds to thousands of milligrams per liter) of calcium, sodium, nitrate, sulfate, and increased concentrations of trace elements (primarily lithium and strontium) were detected substantial distances from the raffinate pits. Recently (1996), TCE has been discovered at the site.

The migration of radionuclides, especially uranium, can be complex because uranium tends to readily sorb to iron oxides and organic matter. However, depending on the concentration of other constituents in solution, such as carbonate, uranium may or may not sorb to the aquifer material and may be transported at nearly the velocity of water. The geochemistry of the shallow and deep unconsolidated sediments must be described and a thorough characterization of water quality made before conclusions can be made regarding the migration of uranium and other contaminants of concern (COCs) in the ground water. As written, the RI does not present sufficient information to characterize the geochemistry of the shallow and deep unconsolidated sediments. Apparently, a few ground-water samples have been analyzed for nitrate, and concentrations as large as 985 mg/L (milligrams per liter) have been detected. These large concentrations of nitrate have a dramatic effect on the ground-water quality and geochemistry, yet no mention is made of them in the RI. The RI makes general statements like "ground water at the SLAPS and HISS is of poor quality." These generalizations are based on "indicator" parameters, such as specific conductance. In my review of the sparse data available, the background quality of ground water in the shallow and deep unconsolidated sediments does not look of "poor" quality. It is the huge concentrations of excess salts that are leaching from the SLAPS and HISS that have generated the large specific conductance and hardness values. In this respect, insufficient detail discussing the ground-water quality is presented not only in the RI but in the RI addendum and annual monitoring reports.

Sincerely,



John G. Schumacher  
Hydrologist

The following are more specific comments relating to the RI and supporting RI addendum document.

Table 1:

| S1 P. 1-1 p 2  | It is stated that the RI was conducted to determine the extent of radioactive and chemical contamination. The RI does not accomplish its main objective as stated here. A relatively good job of characterizing the extent of radioactive contamination in the soils at SLAPS and vicinity properties and sediments in Coldwater Creek has been done. The inconsistent ground-water sampling and undocumented sampling procedures make conclusions regarding the extent of radiologic contamination in ground water somewhat equivocal. The extent of chemical contamination is known with even less certainty. In addition, the lack of flow-based surface-water sampling also makes conclusions regarding the effect of SLAPS on surface-water quality equivocal. |
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| S2 P. 1-17 p 2 | Last sentence states that 10,000 tons of Colorado raffinate and 8,700 tons of BaSO <sub>4</sub> were transferred to Cannon City in 1970. Where did the raffinate come from? The first sentence in the paragraph states 13 tons of uranium and 32,500 tons of leached BaSO <sub>4</sub> were transferred to HISS.  |
| S3 P. 3-2 p 3  | Background concentrations of metals, VOCs, and BNAs, and general parameters, such as clay content, organic carbon content, soil pH, etc. in soils should be obtained prior to completion of the RI. This information is necessary to identify the extent of chemical contamination. In addition, these data will help assess the potential for migration of COCs from the SLAPS and HISS sites.   |
| S4 P. 3-2 p 4  | Apparently, only background concentrations of total U have been determined. It is highly likely that very large concentrations of many other constituents are detected in the waste, and many of these can be more mobile than U, Ra, or Th. Later in the report, large concentrations of several metals are mentioned as being present within the waste. How can an assessment of the extent of contamination be made if background concentrations have not been established? The lack of analytical data on constituents other than radionuclides is a serious omission.  |
| S5 P. 3-4 p 1  | TOX analysis (total organic halides) is not an appropriate or valid indicator of VOC contamination. The TOX is a very generalized test that has many problems. A look at the large number of TOX "hits" suggests that the high TOC in many ground-water samples may be interfering with the TOX analysis. I have collected TOX and actual VOC samples from the same monitoring wells and have seen no relation between the TOX values and actual VOC concentrations [VOCs in the 0.1 to 50 parts per billion (ppb) concentrations].   |
| S6 P. 3-4 p 3  | The generalization that U behaves like other metals in the environment is not correct. In fact, in an environment with large quantities of decomposing organic matter, U can behave exactly opposite of what is described here. Uranium migration is not a simple function of pH; in fact, the concentration of complexing ligands and ions such as SO <sub>4</sub> , PO <sub>4</sub> , and CO <sub>3</sub> is more important.  |

Table 1:

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| S7 P. 3-39 p 2  | Again, TOX scans probably are not suitable for looking for specific VOC contamination. A description of the Mallinckrodt procedure used for U metal production (Harrington and Ruehle, 1959) specifically mentions that TCE is used to clean the U metals casts. This probably explains why TCE has recently been discovered at Weldon Spring and why some of the sparse VOC sampling at SLAPS and vicinity show TCE.  |
| S8 P. 3-39 p 2  | Comparing metals data to Appendix B values is not adequate because Appendix B values may not represent background conditions at SLAPS. The geologic origin of the material greatly affects the chemical makeup of the soil. In lieu of actual background values near SLAPS, I'd suggest looking at values from the Weldon Spring site as a first cut. There are more than 100 analysis of soil chemistry from the WSTA and WSCP in two USGS documents (Schumacher, 1991; Schumacher and others, 1993). In some cases, values from the loess and glacial till differ from those listed in Appendix B.       |
| S9 P. 3-9 p 2   | It is known that other metals were present in the ore and wastes from U operations, such as Li and Sr. Lithium does not occur in large concentrations in soils and rocks in the area and would be a sensitive indicator of chemical soil contamination from SLAPS activities.  |
| S10 P. 3-9 p 3  | Large concentrations of Mg also are present in carbonate minerals comprising rocks in the region. Also, large Mg concentrations could be detected from pieces of gravel. Naturally occurring sources of many of the metals detected should be discussed.   |
| S11 P. 3-40 p 2 | States that 37 of 90 soil samples contained VOCs with concentrations ranging from 1.3 to 1,200 ppb (most in the tens of parts per billion). The discussion on p 3-39 suggests that TOX was determined in previous samples. TOX detection levels are in the parts per million range, whereas VOCs analysis detection levels are in the parts per billion range. Thus earlier sampling could have missed much, if not all, of the VOCs detected in the 1988 sampling. Also how many samples were collected in 1986 and 1988 and from how many boreholes? Figure 2-11 only shows the 1988 sampling locations. |
| S12 P. 3-40 p 2 | What were the BNAs detected? Why isn't a summary table or previous report referenced. Insufficient information is given here. Are these compounds thought to be associated with the wastes or were they used in the U operations? Documentation exists that mentions kerosene and other compounds were used. I could not find this data or I do not have the appropriate reports.  |

Table 1:

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| S13 P. 3-41 p 4 | Analysis of pH, specific conductance, TOC, and TOX are not adequate to detect possible changes in the inorganic and organic composition of ground water. Specific conductance is only a general indicator of the dissolved solids concentration. Ion exchange reactions such as Na (coming from the waste) for Ca (clays, for example.) will not be detected by specific conductance. It's only useful for gross changes in dissolved solids concentration. Also why are the specific conductance values not discussed further in the report? A few specific conductance values I found in the 1995 HISS report suggest that very large concentrations of major ions and nutrients (hundreds of milligrams per liter of Na, SO <sub>4</sub> , NO <sub>3</sub> and probably others) are coming from HISS wastes. Certainly, these constituents also are present at SLAPS and potentially would be good tracers for contaminant migration from SLAPS.  |
| S14 P. 3-41 p 4 | States that ground water at SLAPS is of poor quality with larger than normal dissolved solids concentrations. What are the "normal" concentrations? Also, does this mean SLAPS has increased the dissolved solids concentration of the water? If so, then why wasn't a chemical characterization done to determine the source of the increased specific conductance?   |
| S15 P. 3-41 p 4 | ..."many of the metals detected in soil samples also were detected in ground water." What does this statement mean? I assume samples were not filtered (although the report doesn't say), thus why wouldn't we expect to see the same metals in ground water that we do in soils?  |
| S16 P. 3-41 p 2 | States that several shallow wells have elevated radionuclide concentrations because the wells are located in areas of known subsurface contamination. Are the wells actually open to contaminated subsurface materials? At the technical meeting at the Missouri Division of Geology and Land Survey (DGLS) on April 27, 1997, we could not establish the completion interval of several wells, such as M11-9, nor wells A-F. Geologic logs for the M11-9 borehole suggest that the well is screened beneath contaminated materials, indicating that radionuclides have migrated out of the fill. This is an important point that should be clarified. A thorough discussion of where the monitoring wells are screened is needed (especially in relation to the wastes). Recent data (1995) from well B5312S (north of McDonnell Blvd) indicate above background concentrations of U. Also well B53W18S across Coldwater Creek may have elevated radionuclides. These wells are outside the fence and their locations cast doubt on the assumption that radionuclides have not migrated, as is made here. |
| S17 P. 3-41 p 1 | A table listing the concentrations of constituents and radionuclides in the background wells should be listed.   |
| S18 P. 3-42 p 1 | Apparently a thorough review of the history of U processing was not done because TCE is specifically mentioned along with several other VOCs. (Harrington and Ruehle, 1959)  |
| S19 P. 3-42 p 2 | The detection of cis 1,2-DCE is interesting because it was not used in the process although TCE apparently was. Under anaerobic conditions TCE can degrade to DCE, which is what may be occurring.   |

Table 1:

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| S20 P. 3-46 p 1         | ...states that the 3M unit is thought to have a major role in ground-water flow and solute transport. Laboratory permeability values are questionable because the samples are disturbed. Data in other references and in table 3-10 (p. 3-56) indicate that the permeability of the various units (2, 3T, 3M, 3B, and 4) overlap and really are similar (within the error of these types of measurements). It is possible that the effectiveness of the 3M as a "hydraulic barrier" to flow may be over emphasized. Upward gradients north of SLAPS could be a function of the shallow units being drained by Coldwater Creek (next paragraph suggests this), and the reason deep wells don't show an effect from the creek may be because there simply is too much material between them and the creek regardless of whether it is 3M or not. The 1989 SLAPS monitoring report indicates that the deep unconsolidated deposits are hydraulically connected to the underlying Mississippian bedrock aquifer. Does the Mississippian aquifer have a higher hydraulic head, thus contributing to some of the higher hydraulic heads in the deep unconsolidated deposits? Discussions with field personnel indicate that deep wells typically produce less water than shallow wells, suggesting that the deep units (3B and 4) may be "lighter" than units overlying the 3M. Piezometers screened at discrete, narrow intervals, above, within, and beneath the 3M at several areas across the site and ball fields would help address this uncertainty. |
| S20a fig. 3-17 and 3-18 | The hydrograph of well M10-25D (fig. 3-18) looks similar to those of shallow wells in fig. 3-17. Well M10-25D is located in an area where the 3M is absent. This may suggest that the 3M is a vertical barrier because the hydrograph from well 15D (beneath 3M) is flat. However, the hydrograph from well 11D is also relatively flat, and this well is located in an area containing no 3M. There is some sort of complicating factor here that goes beyond the simple presence or absence of the 3M. The 1989 annual monitoring report indicates that the screen in well 25D (39.3-44.3 feet) is much shallower than the screen in well 15D (80.0-85.0 feet), suggesting that the apparently small hydraulic interaction between the well openings may be caused by their large vertical separation, as much as by the hydraulic properties of 3M.  |
| S21 P. 3-52 p 3         | The statement is made that a downward gradient exists at the southeast part of the SLAPS between the shallow and deep unconsolidated systems. A review of the 1989 SLAPS monitoring report indicates a slight UPWARD gradient between wells 25S and 25D. This suggests the flow system is more complicated than originally thought.   |
| S21 P. 3-55 p 2         | The slower ground-water velocities calculated for the 3B and 4 units compared to the shallow units reflect the lower gradient because the conductivity values are similar for all the units.  |
| S22 P. 3-5 p 2          | Uncertainties regarding the calculations of vertical flow rates between M10-15S and M10-15D should be included in the discussion here.  |

Table 1:

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| S23 P. 3-56     | <p>The estimated retardation values seem reasonable; however, why is the <math>K_d</math> for the 3M so much lower than that for the overlying units? Understanding why they are different is important. Is this an artifact of how the tests were conducted? Also, it appears synthetic solutions were used (U and <math>\text{NO}_3</math>). What about the effect of the other ions that may be in the solutions in very large concentrations? What were the geochemical properties of the solid samples used in the lab experiments? Were they similar to the units in the field? Our work at Weldon Spring shows that U sorption was controlled by iron oxides and not sorption by clay minerals. Alkalinity (carbonate concentrations) had dramatic impacts on how well U sorbed. The discussion here and in Appendix D is not adequate.</p>   |
| S24 P. 3-56     | <p>It seems that only downward vertical migration of contaminants is considered, why? The most likely exposure point for contaminants migrating from the SLAPS is lateral migration to Coldwater Creek. Indeed, lateral conductivities are orders of magnitude larger than vertical values. It seems that transport laterally was not considered. This should be addressed in a similar manner using values from table 3-10. The average flow rate from the northern part of SLAPS to well B53W08S is 4 to 7 feet per year. At this rate it would take water 80 to 90 years to reach well B53W08S. Based on the fact that SLAPS has been in existence for nearly 50 years, water from SLAPS should have migrated north of McDonnell Bvd and traversed about one-half of the distance to B53W08S. Constituents not attenuated like <math>\text{SO}_4</math>, <math>\text{NO}_3</math>, or Li (among others) potentially have migrated into the bail fields area, whereas U would only now be reaching the vicinity of wells B53W13S and B53W12S. The recent (1995) data from SLAPS suggest that U in well B53W12S is now above background concentrations, which could be the result of migration from SLAPS. Data on major and other trace constituents are needed to establish if a plume of contaminants is in fact migrating. We should expect to see constituents like <math>\text{NO}_3</math>, <math>\text{SO}_4</math>, Li, and maybe elevated Na or Ca concentrations to show up first, followed by constituents such as U. A few sorption experiments could be done at low cost (less than \$5,000) to determine retardation rates of U and other indicator constituents in this system. These would not need to be done before the ROD, but should be done to develop any long-term monitoring strategy. Redox will be very important in this system.</p> |
| S25 P. 3-59 p 1 | <p>This paragraph references figure 3-21 for a summary of the lateral and vertical distribution of radioactive contamination in the ditches. The text and figures do not show any contamination in the ditch that crosses McDonnell Bvd and goes west along the north side of the street to Coldwater Creek. View graphs presented at the meeting on April 27, 1997, clearly showed substantial radioactive contamination along the entire length of this ditch. This seems like a significant omission since this ditch appears to drain more than 50 percent of the SLAPS site. More recent view graphs list this as drainage No. 3.</p>   |

Table 1:

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| S26 P. 3-59 p 3 | Section 3.5.3 indicates that Th activities in 1986 samples from SLAPS to HISS were less than 110 pCi/g. This seems to contradict the next paragraph on p 3-64 that states that 1987 data showed 230Th at 0.8 to 5,100 pCi/g in sediments between SLAPS and Pershall Rd. Were the large activities between SLAPS and HISS or downstream of HISS? This should be clarified.  |
| S27 fig. 3-23   | The lines give the impression that these are continuous data; however, they are not continuous. Also the lines make reading the figure nearly impossible. A bar chart would be more understandable.  |
| S28 table 3-11  | It would be helpful to include the background values upstream of SLAPS in the column headings.   |
| S29 P. 3-68 p 2 | Second sentence states "given the use of the property, the VOCs detected in soil at the ball fields are likely to have originated from landfilling activities." What VOCs? Are these the VOCs mentioned in the last paragraph (toluene, and 1,1,1-TCA)? Needs clarification. Note, however, that toluene was detected in soils at SLAPS also.  |
| S30 P. 3-70 p 2 | Were pesticides and PCBs also looked for in soil samples from SLAPS?   |
| S31 P. 3-90 p 3 | Why was 230Th only analyzed in samples that had no gamma emitting radionuclides? Was this a screening activity, and were subsequent analysis done? Since these were soil samples, is the 232Th an exposure hazard to workers at HISS or neighbors? The same can be said for the FUTURA?  |
| S32 P. 3-93 p 3 | The last sentence states that metals contamination was limited to the surface or near the surface as was observed at SLAPS. Discussion on p 3-40, however, suggests that chemical contamination in soil at SLAPS extends up to 18 feet. The discussion on p 3-93 is misleading and may be inconsistent with that on p 3-40. Also, the comparison to background may not be valid because no actual background data exist. |
| S33 P. 3-96 p 2 | The last sentence needs clarification. What do background metals concentrations in soil have to with ground-water samples at HISS exceeding background ground-water concentrations of Al, B, Cr, and Se? The relation here is not clear.   |
| S34 P. 3-98 p 1 | This appears to be the first mention of 210Pb in the text. Was 210Pb analyzed at SLAPS? If not, why?   |

Table 1:

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| S35 P. 3-98    | The discussion here indicates that ground-water studies at HISS have focused on shallow ground water. The presence of a ground-water mound near the pile suggests that an increased downward vertical gradient may be present. Because wells around the pile show contaminants, it follows that the vertical extent of contamination has not been defined. More recent data (1994-1995 HISS annual reports) indicate that very large (hundreds to 1,000 mg/L) concentrations of major constituents (Na, SO <sub>4</sub> , NO <sub>3</sub> ) are present in ground water at HISS. These constituents may be more mobile than radionuclides and may be good tracers and precursors of radionuclide transport. Insufficient data are presented in the RI to characterize the extent of ground-water contamination at HISS. Also, recent data indicate that a number of HISS wells have or have had larger than background (4 pCi/L) concentrations of U (HISS wells 02, 03, 04, 06, and 16). In addition, data from the 1995 reports indicate that elevated concentrations of NO <sub>3</sub> are present in wells 13 and 17 (only 13, 15, and 17 sampled). Thus, even more recent data fail to completely characterize the extent of contamination. |
| S36 P. 5-2 p 2 | Paragraph gives the impression metals contamination is limited to the near surface, which contrasts statements in section 3 that indicate contamination extends to 18 feet in places.   |
| S37 P. 5-2 p 2 | The phrase "poor quality" of ground water at SLAPS needs to be explained. If large specific conductance values have been detected, why haven't samples been collected to determine what is causing the excessive specific conductance? Could these constituents also have health risks? They certainly could be more mobile and indicate that contaminants have migrated offsite.   |
|                | <b>SPECIFIC COMMENTS ON THE RI ADDENDUM</b>   |
| s1 p 2-10      | Paragraph 2 states that additional samples were collected to define the lateral extent of radionuclide contamination at SLAPS and vicinity properties. Were constituents other than radionuclides looked for in soils? These constituents also may have associated risks (rare earths, trace elements, for example).  |
| s2 p 2-10      | Paragraph 3 states that background values for chemical constituents in soil are listed in table 3-38. Were previous data in the RI re-evaluated to compare against these new numbers?   |
| s3 p 2-14      | Paragraph 2. Were the Se values indeed normally distributed? Because there were only 21 samples collected at SLAPS, could Se be in fact a more widespread concern?  |
| s4 p 2-16      | Why were samples collected from only 23 wells and not all of the wells  |
| s5 table 3-48  | This table only lists values that were detected. What were the constituents that were not detected?   |

## References Cited

- Harrington, C.D., and Ruehle, A.E., eds., 1959, Uranium production technology: Princeton, N.J., D. Van Nostrand Co., Inc., 579 p.
- Schumacher, J.G., 1990, Geochemical data for the Weldon Spring chemical plant site and vicinity property, St. Charles County, Missouri—1989-90: U.S. Geological Survey Open-File Report 90-351, revised in 1991, 47 p.
- Schumacher, J.G., Sutley, S.J., and Cathcart, J.D., 1993, Geochemical data for the Weldon Spring training area and vicinity property, St. Charles County, Missouri—1990-92: U.S. Geological Survey Open-File Report 93-153, 84 p.

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for the St. Louis Site, Missouri

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