General

Los Alamos Study Group

July 29, 1993

Bruce Swanton, HRMB Chief
New Mexico Environment Department
Harold Runnels Building
1190 St. Francis Dr.
P.O. Box 26110
Santa Fe, NM 87502

Dear Bruce--

Since you had a question about how much of the work enclosed with my July 19 letter was mine, I am enclosing copies of some of the work which preceded the omnibus comments of November 1991 on the Livermore cleanup. The oral comments I made in November will show you which topics in the omnibus comments originated with me, and from the other documents included you can see their chronological development. As you will note, as time went on my comments became less technically-oriented and more policy-oriented, as it became clear that technical analysis was proceeding in a different direction than policy decisions.

You may find the July 1991 comments interesting in their own regard, as some of issues--e.g. use of statistical analysis in site investigation--are at least to some degree common with LANL.

I was musing the other day about the phrase "technical qualifications" in the context of environmental remediation. The phrase can mean not only technical background and knowledge, but also a willingness to limit one's attention to technical matters. This is the dark side of being a "professional;" one may became willing to not ask too many questions about the policy decisions and assumptions which inform the technical questions that are posed. Of course, as any attorney knows, if you ask the right questions, you can often get the "right" answers. I included one letter here which predicted that the maximum ambient air pollution concentrations from air stripping at LLNL would be benign, a letter which questioned a central position previously taken by my client.

Hope all is well with you.

Sincerely,

Greg Mello

RECEIVED
AUG 0 2 1993

12416

433MDZ

240 Griffin Street, Santa Fe, New Mexico 87501; telephone 505-~~982-8515~~ XXXXXX 820-7822

File

July 20, 1991; hand-delivered

Marylia Kelley
Tri-Valley CAREs
5720 East Ave. #116
Livermore, CA 94550

Re: **Preliminary questions and issues in the RI/FS and PRAP reports related to groundwater contamination and remediation at the LLNL Superfund site**

Dear Marylia:

The referenced reports summarize a great deal of competent work done by many dedicated people over the last decade. Generally the work appears to be very thorough and thoughtful. Almost nothing in these reports appeared patently mistaken to this reader.

Nevertheless, I do have some questions and comments on the analysis given in these reports. These questions must be considered very preliminary at this stage, since I haven't yet had a chance to see some of background documents referenced in them. The purpose of these comments is not to hold back the cleanup efforts being planned for the site by raising old issues about old reports, but to attempt to understand the site better so that the remediation being planned for it will be as thorough, cost-effective, reasonably prompt, and supported by the community as is possible.

I've tried to avoid repeating the comments and questions of MHB Technical Associates--and of state and federal reviewers, which I have just received here yesterday--and have tried to stick, more-or-less, to questions and issues specifically relating to the groundwater and vadose zone at the site. As you will see, some of the questions have to do with the scope of the RI/FS and the policy decisions which guide the RI/FS, rather than its technical content. It is often the case that good technical capabilities are compromised by a scope which is too narrow--in effect compromised by failing to ask some of the important questions.

Here is a summary list of this reader's questions; following this summary there is are a number of more detailed questions and comments, organized by RI/FS page number.

Integrative Points of Concern

1. Investigation of Sources

The RI/FS does not give the reader confidence that all the possible significant sources of ground-water contamination in the

vadose zone, together with vadose zone contamination zones in general, have been discovered and mapped. It is possible that the emphasis on groundwater contamination has been, to some extent, at the expense of emphasis on vadose zone contamination. I cannot yet be confident that all sources of VOCs in the vadose zone have been found, and I still less confident that all inorganic contaminants in the vadose zone have been found and characterized.

The radiochemical characterization of the site (including tritium) is treated very summarily indeed in the RI/FS, almost dismissively. The reader cannot be at all confident with respect to these contaminants. Perhaps the authors of the RI/FS were aware of previous work which made it unnecessary to conduct a thorough radiological survey in the present context.

It may have been true that "all known sources" have been thoroughly investigated, as the RI indicates, but the continuing discovery of new metallic and radiochemical contaminant occurrences and locations belies this conclusion. In the end, it is not the <u>known</u> sources that are the problem; it is the as-yet-<u>unknown</u> sources that are of concern.

Given the shocking discoveries of entire landfills that were not a matter of record, the long history of industrial and military use, much of which occurred in an atmosphere of cold-war urgency, and the intensiveness of activity at the site, it is appropriate to consider <u>the entire site</u> as a potential source until proven otherwise. While a large number of soil borings, wells, and soil vapor survey points have been sampled, the average density of these sampling points over the entire site is really quite low, and it is very possible--and current history suggests this--that new areas of significant contamination are yet to be found.

2. <u>Investigation of Recharge and Leaching Potential</u>

The RI/FS presents contradictory conclusions on the possible presence of aqueous advection downward in the vadose zone at LLNL, saying in some places that such leaching cannot occur and implying in other places (e.g. FS: 3-40) that it does occur.

Note:

a) Run-on from paved areas and buildings can be a potent cause for rainfall concentration and deep infiltration;

b) Recent research[1] has confirmed that percolation is

---

[1]. The thesis work of John Selker at Cornell, now of Oregon State University, summarizes some of this work (oral communication, John Selker).

often concentrated in just a few places (rather than being spread evenly), raising the effective flux and hydraulic conductivity in those places;

c) The presence of chromate anion in several distinct places at LLNL suggests that aqueous advective transport has occurred in those places in the past;

d) The presence of tritium in a number of locations in the groundwater at LLNL suggests that tritiated water reaches, or at least has reached, the water table from the surface at LLNL by some combination of liquid- and gas-phase transport; it would be interesting to compute a range of fluxes based on a range of possible source strengths;

e) The presence of vertical groundwater gradients throughout much of the area, despite generally rising water tables, indicates downward flux in the saturated zone; one possible explanation of this is that areal recharge is occurring (another being leakage downward into a transmissive and heavily-pumped aquifer);

f) The literature on recharge in semiarid climates indicates that the Livermore climate, with its winter precipitation, is actually fairly conducive to recharge, especially in areas without deep-rooted plants;

g) The irrigation (100,000-200,000 gallons per day) practiced at LLNL assures that soil moisture in many areas is plentiful, if not in fact assuring leaching;

h) The presence of perched water (see RI: 3-100) is consistent with recharge in some areas;

i) Regional water studies (Zone 7) have estimated areal recharge to be quite respectable--some 40% of total recharge;

j) The presence of areas of low total dissolved solids (TDS; see RI: 4-266) is consistent with the hypothesis that relatively fresh meteoric water is diluting regional high-TDS water in some areas.

For these reasons, I don't believe that localized infiltration, percolation, and recharge, capable of transporting contaminants downward over time in selected areas, can be easily ruled out at LLNL.

3. Analysis of Pumping Tests and Choice of Aquifer Parameters

Generally, the analysis of pumping tests relies on inappropriate conceptual and mathematical models; this is often the best that can be done. The work done in the RI/FS is competent by

generally-accepted professional standards but cannot avoid this criticism. In particular, the actual saturated hydraulic conductivity K of the permeable paleochannels will be significantly higher (perhaps about twice as high) than the "K" estimated in the RI/FS, which is estimated by assuming that these narrow paleochannels have no lateral boundaries.

Data obtained from the use of diverse aquifer models, none of which really describe the actual situation, are combined in the RI/FS to generate statistics on "K," as if these "K"s came from a single population. The estimation of transmissivities by the Thiem method, calculated using radii of the pumping wells, is very error-prone.

Some of the biases in the determination of K are removed by the selection, by stochastic methods, of a "K" for modelling that is 3.76 times the geometric mean "K" in the "best estimate" case, and 7.36 times the geometric mean "K" in the "health-conservative" case. Yet contaminated water will actually travel fastest in narrow channels that <u>could</u>, and in many cases <u>do</u>, have a K significantly higher than either of these numbers. Of the 166 hydraulic tests selected for presentation on p. 5-84 in the RI, 10% of them gave "K"s greater than 10 times the geometric mean; the very highest "K"s were 40 and 60 times that mean. And remember, these "K"s are, due to an inappropriate conceptual and mathematical model, too small to begin with.

Note that the mean "K" from the southwest/offsite portion of the study area was some 66% higher than the overall mean "K;" see p. 3-125. This is the area of greatest concern in capture-zone and plume migration modelling.

If one were preparing a "health conservative" analysis of the possibility of contaminating particular near-field observation or pumping wells--which might be located in longitudinally-extensive paleochannels--it would be appropriate to use a significantly larger K than is done in the RI/FS, and hence a proportionally greater velocity.

Much of this criticism does not apply, however, to far-field predictions, where a hypothetical homogenous aquifer is being contaminated <u>as a whole</u> by groundwater advection. In this case, the inappropriate estimate of K may be, as it were, canceled by the (symmetrically inappropriate) application of that K to the aquifer as a whole.

To put it another way, the heterogeneity of the site can be approximated by an equivalent homogenous aquifer when large-scale flow phenomena are under consideration, as has been done--but the scale of the near-field flow is <u>less</u> than the observed range of scale for the heterogeneity, as examination of the pumping tests and examination of the large-scale heterogeneities mapped by LLNL

shows.

The use of laboratory porosity data for effective porosity in the field is highly questionable; the former are greater than the latter by a significant margin. The use of a more correct, and lower, effective porosity will result in a proportionally higher groundwater velocity prediction.

4. Plume Capture Analysis

The analysis given does not appear to include the effects of recharge to the upper aquifer by treated water discharges. Neither is the question of the stability of the gradient over time or over space treated or discussed. With significantly rising water tables, will the gradient increase? What is the expected future of the gradient, with and without pumping, in various parts of the plume? The analysis does not appear to include options for upgradient recharge of treated water, and is in general vague on the subject of well designs, screen locations, pumping rates, and so on. While I can understand and agree with the need for flexibility, strict performance standards, and means to measure compliance, should be offered for regulatory and citizen approval.

5. Vadose Zone Transport in General

Despite the good work done for the RI/FS in this area, some important questions remain. Why do the cleanup time estimates assume that flux of VOCs to the groundwater will immediately cease, when the transport modelling presented assumes that 50%, or even 100%, more VOC burden will eventually be added to the groundwater? Why was the boundary condition for VOC concentration at the ground surface set at zero in the FS Appendix G models, when much or even most of the ground surface at LLNL is paved or under a building? Why was barometric pumping not discussed in that Appendix?

The treatment of environmental attenuation factors (EAFs) is far too general, but despite this, application of an EAF of 100, suggested by the RI/FS, would require vadose zone cleanup in some areas of metallic contamination. Application of the California LUFT (leaking underground fuel tank) manual cleanup standards for benzene--which are self-described as very rough guidelines--would suggest that VOC cleanup in the vadose zone is appropriate for VOC concentrations in excess of about 300 ug/kg for those VOCs with MCLs comparable to benzene.

In short, the question of vadose zone transport is far from being a closed one at the site, and may need to be re-evaluated before cleanup decisions are made.

6. The Tritium Question

The continuing discovery of ^3H at LLNL is unnerving, as is the abbreviated treatment of this issue in the RI/FS/PRAP. Given the very real local concern about tritium in groundwater, soils, and biota, it is appropriate to examine how to prevent tritium from leaving the LLNL site and from entering the biosphere. This should be a major goal of the cleanup plan, one that can, I believe, be easily attained by relatively minor modifications to the PRAP.

7. Duration of Cleanup

The cleanup times estimated in the FS represent a concatenation of a number of guesses--guesses, which, overall, appear reasonable to this reader--and so are completely uncertain. Actually, over a projected 53-year project life, a great many things are uncertain: the retention of institutional memory; a favorable regulatory climate; permanence of wells, piping, and treatment works; groundwater conditions; and, perhaps most of all, adequate funding. It is not clear that administrative agreements have a longer half-life than contaminants, particularly at a time when LLNL may lose much of what has been its primary mission. As the FS/PRAP points out, costs for remediation activity are likely to increase faster than inflation generally.

For these reasons and others, it is appropriate to examine more aggressive cleanup strategies. Specifically, it is appropriate to examine vadose zone remediation in selected areas and more aggressive pump-and-treat scenarios. Criteria for vadose zone remediation should not be simply whether the contaminant masses in place are competent to contaminate groundwater above health-based standards--which they are in some places--but also how much the contaminants which will be added to the groundwater from the vadose zone will increase the overall project duration and cost. What is the marginal cleanup cost of 1 lb of TCE left in the soil at various known source areas, and how does it compare with extraction and treatment costs for that 1 lb via soil venting?

8. Statistical Obfuscation

The LLNL site is large, and it is difficult to summarize the reams of data now available for the site as a whole. Some summarization is helpful, but I would respectfully suggest that the Ground Water Project attempt fewer such summaries. Some of these summaries are (I believe) epistemologically flawed; some of them serve to obscure the uniqueness of the data from particular areas by mixing them with a large number of irrelevant data points.

In one case (RI: 5-12) the calculated upper-bound concentrations (chosen as the "the 99th cumulative percentile on the lognormal distribution," p. 5-9) for all but four compounds in well waters

were actually lower than the maximum measured values, in many cases very significantly lower. It is my understanding that the reverse should be true, as it is extremely unlikely that a suite of samples from a group of wells has found the maximum concentration that could be found, were more wells drilled and more samples taken.

As I see it, there is simply no reason to believe that all these well water concentrations--or hydraulic conductivities, or soil concentrations of contaminants--are part of the same sample universe, and many reasons to believe they are not. To lump them all together makes the higher values found appear less significant--statistically and otherwise--than in fact they are.

This submergence of the primary data in summary statistics appears in a different form on p. 5-37 and p. 5-40ff of the RI, where the number of soil samples with contaminants measured below the detection limit is used to decrease the apparent importance of the relatively few with high levels of contaminants. This "averaging," as it were, over the site, is useful and correct for establishing site-wide exposure factors, but less useful for establishing remediation policy at particular locations. The scale of the overall site should not bias the scale of the investigation, and the number of clean wells and soil samples located a quarter- or a half-mile away is irrelevant in the decision of what to do about the contamination found here. All contamination is localized--i.e. has properties, including statistical properties, which are not constant over space--and cleanup decisions should be based on the careful study of one contaminated area at a time.

9. Detail, Commitment, and Formality

The Draft Final PRAP only very generally outlines the preferred alternatives. The PRAP does not yet commit LLNL to specific actions and standards of performance; that is, it is unenforceable as written. And this is appropriate at this stage, when community and regulatory input has not yet been fully received and integrated in a final remediation strategy and record of decision.

While it is certainly understandable that LLNL will want to retain as much flexibility of means as possible, there should soon be installation and start-up schedules, objective standards of success and of compliance, and formal agreement on milestones of cleanup progress incorporated into the final Remedial Action Plan, together with commitments to contingency actions when necessary to bring the cleanup back "on track" when it falls behind.

It is my experience that the success of cleanups is greatly enhanced when the common interests of all parties in

environmental remediation are formalized in a binding agreement that can outlast the changes in context and personnel that will inevitably occur over the life of a project such as this one.

Specific Concerns and Questions

A. The Remedial Investigations (RI) Report

1-8 "The principal compounds addressed in the Ground Water Project are VOCs and...fuel hydrocarbons." This emphasis is apparently based on frequency of occurrence in groundwater and potential to migrate beyond the facility boundaries. It may be out of place, however, to limit the scope of the investigation at the very outset, as the experience with chromium, and subsequently with tritium, indicates.

1-10 The omission of the southern boundary area--i.e. SNL and vicinity--as a second offsite area appears significant. See p. 3-3 for a better map, which suggests that the area potentially affected by SNL activities is quite large. The southernmost LLNL well is about 1500 ft S. of East Ave (see 3-74); in general the wells are sparse in the SNL area. This is particularly significant since SNL is the site of an important recharge basin, already in use. Neither are the downgradient water users/wells as well-described as those downgradient from LLNL. Is there an independent investigation and characterization program extant for SNL?

1-13 The discussion of "source" in the SW Area appears oversimplified; probably "sources" is better. This appears to be a general trend in the text: reduction of a large number of possible sources to a few sources which are deemed significant, apparently prior to investigation. See p. 2-1.

1-17 The use of contaminant "signatures" is fraught with a number of difficulties (e.g. differential transport and degradation) and cannot, in general, be reliably used for conclusions as to responsible parties. This situation <u>may</u> have unusual clarity, but it appears from the RI that LLNL does not know what and where contaminants have been disposed of and spilled.

1-19 The discussion of the AEC years at LLNL is far too brief. Perhaps the Dreicer report goes over this territory in detail. It is clear, however, that industrial-scale demonstration projects have always been a feature of the LLNL landscape, with industrial-scale use of hazardous and radioactive materials under cold-war urgencies. It is important for outside reviewers to correlate lists of SWMUs and other identified sites with borings and soil vapor survey points on a site-by-site basis. There should be a summary database of potential sources and SWMUs with bibliographic information and short summaries of work performed

to date at each site, indexed by contaminant, site number, etc.

1-20 The conclusion of Stone et. al. (1982) as cited here in regard to infiltration not proceeding beyond 40' is highly questionable, on its face. What processes will bring the water back up from such a depth? What about rainfall concentration via impervious surfaces? What about preferred pathways? (But see p. 2-16.)

1-21 The 28-acre-ft drainage basin spoken of as "a significant source of ground water recharge" should be remembered in capture zone and transport modelling, if it is still active. What about the other unpaved areas? Are they significant? The arroyo channels? Are there other closed drainage basins onsite, even small ones? If so, what is their relationship to source areas? Have vadose zone investigations mapped zones of possible leaching, perhaps given in other reports?

1-24 Concerning sealing of wells: It can be difficult to grout an existing well such that the possibility of vertical migration (in this case, between QTl and Tpl aquifers) is removed, if the wellscreen spans the aquitard. How was this sealing accomplished?

1-30 ARARs re vadose zone cleanup: "attenuation factor" approach needs close scrutiny.

2-1 a) The criteria used here for ranking potential sources are highly based on <u>existing</u> groundwater contamination, and on the proximity to the facility boundary. These seem too narrow, in the first case, and inappropriate (at least for long-lived contaminants) in the second.

b) Only those sites with the highest ranking were investigated for this RI. Unless the others have been or are being (promptly) investigated, this could be a mistake. Out of 356 sites, 130 were investigated. Out of 862 SWMUs--some of which are in the list of 356--only nine were added to this investigation, making a total of only 139.

There clearly needs to be a comprehensive list of possible sources with a <u>comprehensive</u> investigation and cleanup plan, fully cross-referenced, and given some legal status so that investigation (and cleanup, where appropriate) of <u>all</u> areas occurs. This RI is clearly not such a comprehensive effort.

2-3 "The investigation is principally concerned with volatile organic compounds (VOCs); however, other types of hazardous materials...are included if they are suspected or encountered..." Apparently, if other hazardous materials are not already suspected at a site or inadvertently found somehow, they will not be discovered. Some of this is inevitable, but I would be less

uncomfortable with this statement if the investigation of possible sources were presented, as mentioned above, in a comprehensive way.

2-7 It might, in retrospect, have been better to screen for tritium more routinely. Why only start monitoring for tritium at 50'? The "2 times background" approach seems rather suspect; isn't it the case that many toxic radionuclides (e.g. plutonium) should not be present in soil concentrations which would even approach this emission rate?

2-16 The work of Stone et. al. (1982) and Rogers (1982) is here cited as saying that tritium tracer studies show that infiltration to the water table may have occurred in places at LLNL. This is a much different spin than was placed on their work on p. 1-20.

2-27 This laboratory determination of porosity is fine, but is later used directly in modelling without considering the difference between total porosity and effective porosity. This is incorrect.

If an aquifer is made of sand, silt, gravel, and clay, that portion of the porosity surrounding the clays and silts--the small pores, in other words--is unimportant in advective transport. This is the reason that the effective porosity n_e is often substantially less than the porosity n, the latter being measured using lab measurements of bulk density vs. particle density as described here in the RI. The water passes, in effect, through a smaller cross-sectional area--and goes faster--to create a given flux than if the aquifer were a perfectly-sorted porous medium. On a slightly larger scale, the more finely heterogeneous the porous medium, the greater the discrepancy between n_e and bulk n.

Bear (p. 203) suggests that

$$n - n_e = \text{field capacity.}$$ [2]

For a homogenous isotropic soil and very deep water table, he goes on to say (p. 204) that field capacity = specific retention = 1 - specific yield, where n = specific yield + specific retention. In other words, for homogenous isotropic soils,

$$n_e = \text{specific yield, more or less.}$$

McWhorter and Sunada, citing earlier compilations, report these

---

[2]. Bear and Verruijt, 1987, Modelling Groundwater Flow and Pollution, Reidel, Dordrecht, Netherlands.

average values:[3]

Aquifer Material	Porosity	Specific Yield
sand (fine)	0.43	0.33
sand (medium)		0.32
sand (coarse)	0.39	0.30
gravel (fine)	0.34	0.28
gravel (coarse)	0.28	0.21
silt	0.46	0.20
clay	0.42	0.06

The K reported at LLNL is more-or-less equivalent to the K of a uniform silty sand (Freeze and Cherry, p. 29).[4] One would expect, in such a case, for n_e to be very roughly two-thirds of n.

In Dunne and Leopold (p. 200-201), data from independent sources is cited which confirms these general relationships between specific yield and porosity for various aquifer materials.[5]

The effective porosity must be determined from field tests, or, with great caution, from laboratory flow tests.

2-28 "In general, coarser grained sediments...are not shown to be continuous over distances greater than about 200 ft". This is apparently a sampling bias. One cannot know this without many closely-spaced monitoring wells. During deposition, all paleochannels are by their nature fairly continuous, over relatively long distances. The groundwater gradient is now subparallel to the original direction of deposition, that is, the groundwater is now more-or-less flowing along the axes of the former stream channels. The question is only to what degree intervening erosional events removed parts of the channels. In general, shouldn't one assume continuity of these channels until proven otherwise, rather than the reverse as is done here?

Page 3-92 shows one interpretation of permeable zones that are continuous, at least to some degree, over a scale of more than a mile. The response of pumping tests likewise shows large-scale interconnection in many cases. Note the discussion on p. 3-100.

---

[3]. McWhorter and Sunada, 1977, Ground-Water Hydrology and Hydraulics, Water Resources Pub., Littleton, CO

[4]. Freeze and Cherry, 1979, Groundwater, Prentice-Hall, Englewood Cliffs, NJ.

[5]. Dunne and Leopold, 1978, Water in Environmental Planning, Freeman and Co., San Francisco.

Again, the use of chemical signatures is tricky because of chromatographic fractionation in the ground and differing degradation rates.

2-30 My concerns about the analysis of the pumping test data are summarized on pages 3-4 above. In addition, the use of one-hour pumping tests is not always a good idea, because aquifer boundaries are often intercepted in later time that materially effect the analysis and interpretation of the data. The measure used to check whether the water level had "stabilized" strikes me as rather loose, and so the applicability of the method of Hantush and Jacob for leaky steady-state flow is actually fairly uncertain.

As noted on pages 3-4, the linearity of the aquifer strings trangresses the assumptions of <u>all</u> these analyses. A narrow aquifer zone bounded on either side by significantly less permeable boundaries will, using these methods, have an apparent K which is much less than the actual K in the narrow zone. In the ideal case of a narrow zone with impermeable sides, the width of which is small, image well theory suggests that the effective pumping rate Q used to calculate T should be almost three times the rate at which the pumping well is pumped, corresponding to the original pumping well and two nearby image wells pumping at the same rate.

This inappropriate modelling leads to an apparent lateral scale-dependence of T (and hence of K) which is acknowledged to some extent on p. 3-84.

How were the wells developed? Was all the mud out? The subsequent attribution of chloroform in many samples to drilling mud made with tap water raises some questions in this regard.

The homology between measured data and a particular type curve is necessary, but not sufficient, to show that the assumptions used to derive that type curve apply to the aquifer. In other words, the inverse problem--finding aquifer parameters by measuring aquifer response--has solutions which are not unique.

Some of the tests presumably displayed delayed yield, rather than leakage. ("...the uppermost saturated, permeable sediments are largely unconfined"; p. 3-101) Was this considered in analysis? How were well losses treated?

2-35 In retrospect, more wells should have been sampled for tritium and radioparameters. There is no assurance in the RI/FS that this process has been complete.

2-55 "Trends were discarded as insignificant if the entire suite of analyses showed only concentrations below appropriate action levels." This is needlessly narrow, and makes the trend analyses

much less useful than they would otherwise be. Given this rule, an increase of a contaminant would be "discarded" if it was approaching, but had not yet exceeded, an action level.

3-8 The inadvertent discovery of two old landfills containing radioactive waste is shocking, and casts doubt upon the Ground Water Project's technique of investigating known areas of contamination.

3-10 Note that the storm drainage system in the oldest part of LLNL has been piped since at least 1965, suggesting that infiltration from unlined ditches in that portion of the site has not changed drastically since that time.

3-19 A cursory comparison of this page with p. 2-2 does not reveal a complete correspondence between areas identified by Dreicer and areas investigated for this report.

3-49 The reader of this report cannot conclude that the recharge pond at SNL will not adversely affect plume management because nothing at all is said about the presence or absence of contamination at SNL. Certainly Albuquerque SNL has much affected its site with mixed waste, metals, and VOCs.

3-58 The data supporting the presence of a confining layer between the QTl (Upper Livermore) and the permeable parts of the Tpl (Lower Livermore), i.e. in the uppermost Tpl are generally convincing. Which wells are completed in the Tpl?

3-73 Isn't it certain, rather than "possible," that some permeable layers are continuous out of a given plane?

3-90 The determination of depositional gradient by maximizing slice lithology correlation sounds great, if the detail of the lithologic data will support this approach. It is interesting that these QTl deposits are apparently indistinguishable (as a group) from Holocene deposition over the site, despite the alternation of pluvial and dry climates which has occurred since the beginning of Qtl time. Doesn't this suggest either 1) that the slopes involved are not much different from the current topography in any important way, or 2) that our ability to discriminate these fan deposits is low?

3-94 The conclusion that rainfall penetrates to the saturated zone only along infiltration channels and beneath the drainage basin is not what this paragraph is saying; "[had] penetrated" is the verb, and I suspect that "tritiated water" is the noun, based on previous citations to Stone et. al.'s work. The statement "That is, except where rainfall penetrates to the water table, there is no significant aqueous transport to the ground water" is a tautology. See p. 3-111.

Have chloride mass-balance studies of recharge been made at LLNL?

3-98 Note that vertical gradients are widespread, and are not just confined to areas of significant pumping from the lower aquifer. A small downward vertical gradient exists within both QT1 and the Recent alluvium, despite the general absence of pumping from these units--especially the latter--over most of the study area. All these facts are consistent with areal recharge.

Have isotopic age determinations been made of groundwaters in the LLNL vicinity?

3-100 Perched water can apparently be found in the SE part of LLNL and about one mile W of LLNL. What is the presumed source of this perched water? What is its apparent age?

Note that some 2-day tests show response over thousands of feet. If the monitoring well network were very dense, this might be more frequently true.

3-101 Groundwater is rising fast. This is extremely significant. Groundwater has risen 36 ft. in MW-17 between 1985 and 1989. Where does this water come from? How does this affect the gradient over the lifetime of the project, in both direction and magnitude? Will increasing discharge in Arroyo Las Positas swing the LLNL gradient more toward the north? Will discharge in that arroyo begin to flow closer to LLNL? When will the water table rise stop? Will it intercept significant vadose zone contamination? How will the diminishing vadose zone thickness affect the transport of contaminants to the water table? Prior to agricultural withdrawals, what was the depth to water beneath the site? The hydrographs which follow do not show older data.

3-103 It is quite possible that additional groundwater withdrawals may develop in the future in the Livermore Valley.

3-111 LLNL does not question the recharge sources given here from Zone 7 and CDWR sources, which include 40% of total recharge from direct areal infiltration, exclusive of infiltration in channels.

3-112 "...the significant vertical gradient in many parts of the map area..." This is discussed in more detail on p. 3-119 and in the following figures. What, if not downward infiltration, is causing these vertical gradients on the west side of the site?

3-119 Why is the geometric mean K given as 32.5 gpd/ft^2 here and only "approximately 30" gpd/ft^2 on p. 5-83, when modelling inputs are being prepared?

The discussion of specific storage is astute.

3-125 Note that the mean K for the modelling region of greatest interest ("Southwest and adjacent offsite") is higher than the overall mean K by some 66%. Using an overall site mean for modelling is not a conservative approach, therefore. This higher K may reflect the better sorting which is commonly found in medial (as opposed to proximal) fan deposits.

3-149 The estimates of ground water velocity are flawed because they are, at best, averages, i.e. Darcian fluxes divided by the effective porosity (erroneously, in this case, the total porosity was used). Subsequent estimates of groundwater velocity, in section 5 of this report, are greater, though not great enough, as noted elsewhere in this letter.

4-1 "...none of the many areas investigated appear to be current sources of contaminants to the ground water" (emphasis added). This statement summarizes the mood of the RI, as it raises some questions. What about the areas not investigated? Can we be sure that we have investigated all possible source areas? And are we sure that none of the areas are current sources of contaminants to ground water? After all, in both the "best-estimate" and "health-conservative" cases examined later, it is assumed that significant fluxes of VOCs are entering and will enter the groundwater in the future, a view supported, for the Bldg. 518 area at least, by the modelling of Appendix G in the FS.

Look at 4.1.1. Four out of 15 sites show "no physical or historical evidence of hazardous material releases." Were they sampled? Why this language "considered to be the most likely potential sources?" Potential source #9 was "associated" with "a minor release" of what? All this appears very hedged, and makes me, despite the generally very good quality of the RI, distrust the completeness of this work.

4-6 Note that "historical information suggests a hazardous material release" from the mercury reclaimer in former Building 212. Yet on p. 4-8, we find that "possible releases of hazardous materials by the mercury reclaimer (site #3) have not been evaluated...since mercury has not been detected in LLNL groundwater." This is somewhat shocking. The same is done for PCBs, as 4-8 goes on to say. While not reviewing the correspondence between the named sites and the work done on them in detail for this letter, it is clear that a careful independent review of possible sources would be a very good idea. It is likely that some of this work has been done already and is available in other reports (e.g. the RCRA RFA?).

4-39 Is the Livermore Water Reclamation Plant at LLNL?

4-43 It is difficult to investigate soil vapors beneath buildings. On this page, several possible sources are shown

within the building footprint, but there are no soil vapor survey monitoring stations within that footprint. Soil vapor contours are shown hachured (declining) toward the building, when actually what is under the building is not that well-known, and could be a soil vapor concentration peak rather than a valley. Many of these buildings are fairly large, and will tend to retain VOC concentrations more than the open areas because they are less permeable to diffusion.

4-72 Note that the detection of tritium at low levels at depth suggests to the authors of the RI "more than average recharge is occurring in the Bldg. 212 area or a tritium release may have occurred." The same explanations are noted for elevated tritium at depth in the Bldg. 321 area on p. 4-76, and in the West Traffic Circle area on p. 4-81. Elevated tritium was found at 50 and at 71 ft depths in two borings at the East Traffic Circle (p. 4-91), and at the East Taxi Strip at 21 and 81 ft. in one well; in the latter case pond leakage could have provided a ready means of downward transport. Tritium was also found at Bldg. 514 in three of five borings at depth.

4-123 Note the presence of perched water in a portion of the Bldg. 518 area.

The suggestion, here and on previous pages, that the practices at the Fire Training Area can be well-known through institutional records, is suspect unless the documentation is very thorough.

4-126 The omission of the higher contours for BTEX in this and the following figure reduces the clarity of the diagrams.

4-128 There were 170 soil borings, 270 monitoring wells, and 598 SVS stations, in about 89,533,709 sq ft of study area, or one boring or well for each 203,486 sq ft--a square 451 ft on a side. If SVS are included, we have 86,256 sq ft/station or one every 294 ft. This is not a fine grid, even though they were well-placed.

The low VOC concentrations found are consistent with fairly rapid mobility in the vadose zone and significant expiration from the surface of the soil, as discussed in Appendix G of the FS. Yet a cursory review of the cross-sections shows that there are significant downward concentration gradients in some cases, indicative of downward VOC diffusion and either indicating possible current addition of VOCs to the groundwater (in a few cases: Gasoline Spill area; Bldg. 518 area; East Taxi Strip area; possibly others) or threatening to add VOCs in the future in other cases. VOCs will exhibit net diffusion <u>upward</u> over contaminated groundwater plumes non-source areas, and some of the VOCs found in the soil may reflect this.

The conclusions shown on this page tend to minimize the

uncertainties about vadose zone transport: while it is true that most of the source areas are "old" and "no longer active," some are clearly not and others may or may not be a source of future groundwater contamination.

4-132 Despite the large number of wells, the control on the total VOC plume maps is relatively weak along the southern boundary and in the western offsite area. In particular, there is a large white patch (i.e. no wells) north of Arroyo Seco, with only MW-571 to find possible off-site contamination. There appears to be no justification for contouring the westernmost VOC concentrations as an "island" rather than a "peninsula."

4-152 The presence of 1,2 DCE only in the deeper intervals in the southeast portion of LLNL does suggest that degradation of more chlorinated species is occurring or has occurred, as the RI indicates.

4-170 Note that low levels of chloroform in groundwater samples are though to possibly originate in drilling mud. This is certainly possible and suggests that mud removal may not have been complete, possibly biasing other sampling parameters slightly and conceivably affecting short-term hydraulic tests.

4-178 Well MW-19 shows slight VOC contamination at the inferred lower limit of the Tpl-g confining layer; this is the only such contamination in or near the Tpl aquifer that I can find. Is there any noted elsewhere?

4-210 It is not yet clear to me why it is categorically asserted that the NW corner plume is not a LLNL plume; there may be other information which are not included here.

4-212 The trend analysis is based on extremely stringent criteria for a significant change, such that wells below the MCL were excluded. Was this necessary? For total VOCs, 24 wells increased, and 20 wells decreased. For TCE, 26 wells increased and 7 decreased. These numbers are too small to infer a great deal--and if wells are divided into shallower and deeper classes the numbers become even smaller--but the generally rising TCE concentrations are consistent, as the RI says, with fresher sources, or in other words with continuing transport to the groundwater during the study period. Carbon tetrachloride concentrations are also generally rising (14 rising vs. 4 falling wells).

4-245 The finding that VOCs are primarily in the coarser-grained sediments is helpful to pump-and-treat options. The time to diffuse out of the finer-grained sediments will in general be comparable to the time taken to diffuse in, if that is indeed the mechanism by which they got there.

4-251/2 EDB is very high near the leaded gasoline spill, up to 580 ppb, vs. an MCL of 0.02 ppb (29,000 times the MCL). This is somewhat glossed over in subsequent pages of the RI and FS. It does not biodegrade easily and could persist after the benzene present in the plume is gone.

4-258 The widespread presence of elevated Cr^{+6} in groundwater beneath LLNL offers a demonstration that entirely liquid-phase transport to the groundwater has occurred not just in one but in several locations around LLNL. It would be useful to compare the size of the estimated discharges with locations of storm sewers and unlined storm channels and with subsequent groundwater contamination.

4-261 The discussion of radiological parameters appears rather brief. Clearly the tritium analyses have been supplemented by new findings. Bldg. 281 is a decommissioned nuclear reactor. This wasn't mentioned in the previous list of potential sources. Has there been a soil investigation in its vicinity?

Alpha activity should be reported when it is above (say: twice) background, not just when it is above the MCL. There is detectable beta activity in 74 wells so far; what is the local background for this?

4-264 The list of potentially radioactive sites is quite short and looks very innocuous compared to corresponding lists at Los Alamos National Laboratory. Has LLNL really been that careful all through the years?

The plutonium garden area is a point of concern.

4-266 The very low TDS of MW-148 in the S-central portion of the site (117 ppm) may indicate percolating fresh (rain-?) water. Look how the water entering the LLNL site from the east (p. 4-267) has very high TDS, whereas at least three declining bullseyes of low TDS occur on the site (these should be hachured). There is one beneath the drainage basin, or maybe two there.

5-1 I agree <u>a priori</u> that groundwater is the only important migration pathway. There is nagging concern about evapotranspiration of tritium, but VOCs, metals, etc. are not an exposure problem in the vadose zone.

Now for long-lived radionuclides, e.g. Pu, judgement must be withheld. That garden experiment--where is the Pu now? How much of it was there? The question of contamination by radionuclides is only sketchily handled in the RI.

5-9ff Comments about this procedure can be found on pp. 6-7

of this letter.

5-12/13 Tritium is absent from this table.

5-19 Basically the RI appears to be saying that dilution will take care of everything except Cr+6, and it's not important to find out what caused the other metallic pollutants to appear in the groundwater analyses. This approach would be more convincing if it was coupled with a careful analysis of sources.

5-25 It is certainly not conservative to dismiss the carcinogenicity of 1,1 DCE because the data are equivocal.

5-26 The most toxic compound at the gasoline spill is not benzene, but EDB. It is fairly persistent as well, but is for some reason dismissed in the discussion on this page. Note that special problems exist in the analysis for EDB, as the MCL is 0.02 ug/l. which is lower than the limit of detection in many samples.

5-27 The RI speaks here of "gradual leaching [and vapor-phase transport, presumably] of tritium from the vadose zone." What about the possibility of leaching of other compounds?

On what basis were wells selected for radiological analyses?

5-31 The number of surface soil sampling sites appears tiny compared to the size of LLNL and the number and diversity of industrial activities that have taken place there.

5-37 Why is it helpful to base vadose zone clean up questions on statistical analyses--analyses which are in any case, by their nature, suspect? What if someone digs at the one spot where there is a nasty contaminant, which has been declared statistically insignificant compared to the site as a whole? The larger the site, and the more non-detects can be generated, the less important any given locus of contamination then appears to be.

5-40 It is discomforting not to see the spatial distribution of soil data. Where is the mercury (in "almost half of 57 samples")? The beryllium ("nearly three-quarters of 57 samples")? Are there explanations for the elevated levels of certain metals that were found?

5-45 Sample sites SSD-008, 009, and SSS-009 were excavated, thus lowering the maximum As levels found? This reader--and he may be typical--would like to systematically know what was found where and what was done about it.

5-46 This table contains some fairly large numbers for soil concentrations of some metals, mostly in a few areas. How

comprehensively was the site examined for these and other metals? How do these and other soils rate under the RCRA TCLP?

5-47 Administrative controls are not a very good long-term answer.

The RI essentially says here that it is not known whether the ^{137}Cs and ^{3}H onsite and the gross beta activity in an arroyo offsite are attributable to a source on-site (isn't this logically necessary?), or whether this source requires remediation. The radiological characterization of the site appears to be not over. Decisions regarding remediation of sources should be a formal part of the RI/FS process and should not be made without public and regulatory input.

5-48 The tritium information given here is now dated.

5-49 These estimates of VOCs in groundwater do not include VOCs sorbed on solids below the water table, as subsequent tables do. Note that in addition to these VOCs, the FS estimates some 289 kg of VOCs in the vadose zone (p. 3-23).

5-52 The discussion on this page all appears very reasonable, although I'm not sure that the "highest" permeabilities were used, as noted above on p. 3-4 of this letter.

5-53 It is not certain that the site will be non-commercial. And there is a little circularity in the logic of saying that no one will drill a new well in a contaminated area because it is contaminated. With this logic, we could write off large areas as having no potential health impacts, contaminated or not! And we would be strictly correct. Clearly the relevant values here include more than strictly public health concerns.

5-57 As discussed above on pp. 3-4, it is more reasonable to use a higher K and hence higher velocity for the near-field zone than for the farther impact points.

5-58 Missing in my copy.

5-66 Note that increasing the velocity used in modelling (as I believe should be done for the near-field wells) has the effect of increasing peak concentrations and overall exposures because the peaks arrive sooner at the points in question.

5-69ff The analysis on these pages is crucial and a bit sketchy. A typical rule of thumb with a history of regulatory use in this geographical region is apparently that the soil concentrations should not exceed 100x the MCL in groundwater. At a typical 5 ppb VOC MCL, that gives 0.5 ppm, or 500 ppb, in soil as a threshold value. Application of the screening method given

in an older edition of the California LUFT manual[6] suggests that cleanup should occur for all sediments holding greater than 300 ppb benzene (or other VOC of roughly-equivalent toxicity and mobility, in this case).

Unfortunately, the EAF approach does not take into account the mass of contaminant in the vadose zone and the mass-weighted distance of this contaminant body above the water table.

In any case, the EAF approach is not of the rigor that it needs to be as a basis for this analysis of contaminant fate and transport. It is basically an assumption at this point, not a real analysis. Is it possible to compute the actual historic EAFs for various source masses at the site? Certainly site-specific modelling and analysis is to be preferred over rules-of-thumb.

To this end, note that the range of vadose zone properties given here is rather broad, with the exception of K_z, which is given the low value of 10^{-7} cm/sec. I am surprised to see it given that low, and with no other explanation. I would have expected something closer to 10^{-4} or 10^{-5} cm/sec.

Note that even very slight differences in lithology--undetectable in tests--lead to concentration and channeling of percolating water, both in saturated and in unsaturated flow. It is not through the lowest K_z values, but the highest, that flow occurs.

"...extremely limited amount of recharge..." There may be an amplification of recharge due to paving, etc. as noted above.

"Practices which led to this condition [migration through the vadose zone] are no longer operative at LLNL..." What are these? Overirrigation? Even though vadose zone migration to the water table occurred in the past it has now definitively stopped?

Does this analysis result in a TDL for Pb and Cr that is orders of magnitude less than the actual levels still in the soil (see 5-46)? How do these TDLs relate conceptually and, if applicable, in a regulatory fashion to the STLCs (Soluble Threshold Limit Concentrations)?

5-80 These guesstimates of total additional VOCs to be added to the groundwater are consistent with other estimates in the RI. Are they consistent with integrating known concentrations over the total soil volume above the plume? What is the total VOC mass in that integrated volume?

---

[6]. "Leaking Underground Fuel Tank Manual," December 1987 version, California State Water Resources Control Board.

To the extent that the groundwater is equilibrated with the VOC concentrations in overlying sediments, groundwater cleanup will drive additional VOCs into the groundwater.

With much of the site now paved, a large portion of the vadose zone contamination may eventually appear in the groundwater, if it does not degrade.[7]

The porosity used is too large; see discussion on p. 10-11 above.

The thickness of aquifer used in the model is arbitrary, but not so if this thickness is used to calculate contaminant mass, as has apparently been done. Five meters of contaminated thickness seems much to small; perhaps I do not understand the procedure the RI has followed.

Note that the concentrations of TCE and CCl_4 are generally rising at the site. Have the source half-life estimates taken this into account?

5-83 As noted here and above, there is some uncertainty as to what the best value of hydraulic conductivity K is for this simulation. Without reading the Tompson analysis, I would suggest that the values chosen are too low for the near-field, health conservative case, although they may be appropriate for the far-field cases.

5-91 The long time period of these estimates leads the authors of the RI to suggest that the hydraulic gradient may not be constant over the period of simulation. I think it may be more likely to rise than to fall, as noted previously.

The result that the 70-yr average concentration at a near-field well would be fairly small because of a localized "hot spot" quickly passing the observation point assumes 1) that the observation point has no cone of depression, and 2) that the rate of addition from the vadose zone is small.

5-96 The analysis of the benzene from the gasoline spill is very reasonable. The conclusions in the RI generally agree with my experience here. But what about the EDB? What is its half-life?

7-2 The assessment given here of in-situ biodegradation appears appropriate: very difficult with chlorinated VOCs in an aerobic environment. However, what about experimenting with enhanced biodegradation <u>within the context of a pump-and-treat system</u>? A ten- or twenty-year time savings would be very worthwhile, if it

---

[7]. See Baehr, "Selective Transport of Hydrocarbons in the Unsaturated Zone Due to Aqueous and Vapor Phase Partitioning" Water Resources Research 23:10, pp. 1926-1938.

could be accomplished with a modest investment of money. Is there a way to prudently attempt this?

Note that under Alt. 2, we find this statement:

> "...further detailed search would be conducted to locate and remediate all contaminants in the vadose zone that could reach the ground water...Ongoing development of the site since the U.S. Navy tenancy ended in 1950 may have obscured some of the locations of past releases, thereby precluding their further identification and complete remediation."

Like this reader, the authors of the RI are not completely happy with the quantity of work done thus far on this subject.

7-3 Why is excavation for removal of VOCs the technique of choice, when they move readily by vapor transport? Are there other co-contaminants involved?

The LLNL UST program would be well-advised to be absolutely (not "we believe") sure no leaks occur at this point in the history of this site, i.e. while a site remediation program is about to get underway. LLNL might wish to apply a significantly higher standard than the Federal one, perhaps one equivalent in stringency to the German program for fuels, or to RCRA for storage of non-fuel solvents and wastes.

7-5 The trouble with delayed action is that LLNL, like any other institution in this situation, may not be around to take that action.

Appendix C

Note that a fair number of the long-term tests in the SW area have quite large estimated hydraulic conductivities (Ks), significantly over the geometric mean of 32.5 gpd/ft^2. Migration in one of these channels will occur, as noted above, faster than predicted by the RI, and capture will likewise be more difficult both to achieve--and, because of the low number of wells in some areas, to know that one has achieved.

The Thiem formula is unlikely to be accurate because the pumping well radius is used as an observation point, and so the ratio of transmissivities between the pumping well and observation wells has a low confidence attached to it. But the confidence between these ratios for different observation wells should be more accurate.

Appendix P

It appears that there is soil contamination by a number (at least

16) of metallic species at LLNL, in scattered locations. Very little is said about this in the text--or here, for that matter. A careful reading of Appendices N and U, which apparently contain the raw data for these statistical comparisons, is in order.

B. The Feasibility Study (FS)

1-4 LLNL stormwater discharge may be no more hazardous than ordinary stormwater discharge, but in the present regulatory and cleanup-oriented environment, LLNL may not be able to afford to allow even low levels of contaminants to percolate from its drainage basin. Why is Cr present in these waters above the MCL? Why isn't LLNL responsible for the Cr present offsite to the northwest?

1-5 It is important to identify the areas of VOCs in sediment which can or could contaminate groundwater. We will see later (in the PRAP) how inexpensive, in terms of total cleanup costs, venting of these locations can be.

1-7 The discussion of tritium does not engender confidence that all the ^3H has yet been found. Why was the tritium-containing tank not double-walled? The cleanups and investigations of this leak should ideally not be reported as part of another program, but in a coordinated and comprehensive site-, media-, source-, and contaminant-wide program.

The potential for this tritium to leach/diffuse downward should be discussed here; these concentrations are up to 10,000 times the MCL and so fail the previously-suggested EAF-of-100 approach.

Seven more wells with concentrations greater than the MCL for Cr were found after the RI and before this report; was or is the site characterization incomplete, or are Cr concentrations in the groundwater apparently rising?

1-8 What are STLCs (State Soluble Threshold Limit Concentrations), exactly? I am unfamiliar with this term.

2-4 The predicted and observed capture zones match quite well, but the number of control points are too sparse to know whether the actual capture zone boundary is smooth or dentate. That is, an assumption of aquifer homogeneity has entered into the interpretations of the field data.

2-11 The points about future well design are well-taken, but the advantages of discretely-zoned multiple wells must be weighed against the data collection and interpretation scenarios that such wells involve. What is the marginal savings from a particular piece of detailed knowledge--say, the pumping rate in x stratum, vs. the pumping rate in y stratum a few feet up or

down? The cost of the cleanup is very heavily influenced by staff time, a theme that should begin to be heard more and more often in deliberations at this point. It may be better to put in an over-designed system--i.e. more wells--than to have to fine-tune a well system in three dimensions, constantly taking data and interpreting it.

2-1 Is SNL property subject to the same FFA that will keep it in government hands indefinitely?

3-4 A subset of the 9th criterion, local community acceptance, may turn out to be something like this: Tritium and other contaminants will not be spread beyond site boundaries at any concentrations. LLNL needs to understand that meeting MCLs may not be sufficient to win community approval.

3-9 In the third paragraph, it is clear that LLNL has not yet decided which volumes in the vadose zone require remediation. This should, it seems to me, have been determined by this stage in the process, and the specific areas outlined for the reader. As it is, Appendix G is good but not yet sufficient to determine which areas require cleanup (see preliminary comments to follow). Neither has it been proven that VOCs are the only contaminants in the vadose zone requiring cleanup; in fact the RI suggests the opposite.

3-15 The question is not whether sources in the vadose zone are likely to cause groundwater to "exceed their present value," or the ARARs, but whether those sources will cause the present high concentrations to continue longer under various remediation scenarios than they would if the sources were removed.

Have there been soil excavations since the RI? That seems to be implied here, for "a few unoccupied portions of the site."

What are the radionuclide concentrations in the vadose zone that "do not present a health hazard?"

3-22ff Comments on Appendix G follow below. Note that Fig. 3-6 shows VOCs exceeding 10 ppb in the investigation study areas. The reader is left wondering whether there are other areas of VOC contamination, since the areas studied comprise roughly 10% of LLNL.

3-31 The question of where to dispose of the treated water is a very important one. Why not infiltrate some of the water in basins or trenches along the east side of LLNL? This will recirculate the ^{3}H beneath LLNL until it substantially decays.

3-37 The relationship between the water yield of MW-206 and the size of the contaminated zone it intercepts is fallacious, is it not?

3-38 The assumptions here are interesting. There is a slight internal contradiction. If there is equilibrium between vadose zone and groundwater (assumption #3), and the concentrations in the groundwater are decreased, then (contra assumption #2) contamination will move from soil to groundwater. Is this important? This reader is not sure.

3-40 The paragraphs at the top of this page represent what appears to be a radical about-face in the treatment of vadose zone contamination, and apparently contradict the statements of previous pages. These statements are all very good, in my opinion, and appropriate in this context. Note: this page considers local infiltration. But why excavate if one can vent VOCs?

3-49 The discussion of shallow recharge wells along the eastern boundary in 3.4.4.3 is a good idea, as noted earlier. Recharge wells (they do not mention this) are a maintenance problem of serious proportions. It may be better to use an infiltration gallery at the surface. It is also possible that a recharge basin or gallery--or irrigated land--with the vadose zone beneath it, could be engineered to accomplish some polishing of effluent.

4-2ff Groundwater alternative #2 simply takes too long to be at all realistic. It also suffers from not being as robust as the #1 concept, i.e. if some well screens clog in a scenario like #1, containment is not as likely to be breached.

It may well be worth while to consider faster cleanup scenarios, as noted previously.

Appendix B

The use of a uniform velocity field, hydraulic conductivity, effective porosity, aquifer thickness, etc. is fine, as far as it goes, subject to the comments made previously. But isn't more known about the system? It might be possible to progressively tune a more detailed leaky 2-D model as pumping begins, and this <u>might</u> (I am unsure) be worth the modest investment.

Appendix C

Clearly the site is not a well-mixed tank, and significant vadose zone gradients exist at some locations. The simplifying assumption at the tope of C-2, that no more VOC transport to the vadose zone will occur, is somewhat at variance with the results of Appendix G.

Appendix G

Appendix G is elegant.

Note that gaseous advection, e.g. by barometric pumping, was not considered. Couldn't this materially affect the rate of movement if the dominant mode of transport is gaseous diffusion?

The aqueous advection discussion does not include "fingering" phenomena, or localized run-on, and depends heavily on Stone et. al. (1982), which I haven't yet seen. It is not settled that "an almost constant flux exists down to the water table."

The partitioning calculated on p. G-15 depends on measured K_d values from the site which I do not have. Are laboratory values likely to be accurate?

To set the surface boundary condition at zero concentration is the least conservative way to frame this problem, and inaccurate for many LLNL areas. This is a big problem.

Note that the bottom boundary condition was set at no-flow, also the least conservative choice. This was done due to the ease of which the author found that concentrations could move across the transition zone and into the groundwater in the one-dimensional diffusive flux model used. But what if "fresh" groundwater were flowing into the system; wouldn't this raise the flux across the transition zone and require a boundary condition of the form of equation (G-50)? Although groundwater movement was considered in this appendix, it was considered only <u>after</u> establishing VOC fluxes without groundwater flow.

C. Proposed Remedial Action Plan (PRAP: June 24, 1991: "Draft Final")

3 Vertical thickness of VOC plume is given as 30-100ft, not 5 m as in the model in the RI and FS. Are the contaminant masses correct there?

"It is possible that an additional site (Trailer 5475...) will be added to this list [of vadose zone contamination] when soil investigations are complete." Why aren't they complete?

Nowhere in the RI/FS/PRAP has convincing data been presented that the plume off the northwest corner of LLNL is not in fact LLNL's responsibility. With both VOCs and chromium present, this reader will have to be convinced that it these did not originate in LLNL discharges to Arroyo Las Positas. Perhaps this matter can be cleared up by a review of Iovenitti et. al. (1991). As other commenters have pointed out, discharge of treated LLNL waters in this area may impede investigation and remediation of the contamination. Have tritium investigations been conducted here?

8 This 1.3 ppm of EDB is apparently new data and more than twice the previous high; see RI:4-252. The potential for

migration of EDB offsite has not been evaluated.

There is a question about the propriety of allowing tritium-contaminated storm-water runoff to leave the LLNL property. Has sampling for tritium been done in the appropriate storm-water outfall areas? Apparently so, because tritium has been found "immediately adjacent to" LLNL and SNL. x [in rain

11 "LLNL will use the MCL for tritium as the discharge limit." This is unlikely to be acceptable by citizens' groups.

12 A future commercial-use or partial-tenancy commercial scenario is realistically possible and should have been considered.

13 EDB is not mentioned among the fuel hydrocarbons here; it is arguably the most important contaminant in the long run at that site.

Is it possible that, if groundwater levels continue to rise, the discharge point in Arroyo Las Positas could migrate to near the LLNL boundary?

17 The discharge options are too vague to evaluate.

If tritium-containing waters are discharged to points on the upgradient side of LLNL, concern about spreading tritium beyond the site boundaries would be alleviated.

Has LLNL considered reduction of the chromate ion in the pumped waters, rather than ion exchange?

In the FS, phased and pulsed pumping is mentioned. Overall cleanup time will probably be decreased by such an approach; it may be advisable to have a set of "containment" wells, the pumping of which is relatively constant, and another set of "source remediation" wells, if this is not in fact what is planned. This is the reason that a numerical model capable of handling transient conditions may be cost-effective.

18 Note the dominance of program costs over capital costs in the overall budget for all alternatives. This suggests that additional wells and treatment facilities may be warranted. Nowhere in the PRAP is it established that a shorter cleanup will not in fact be a less-costly one.

20 "...all extraction and treatment facilities would be operational by 1993, depending on congressional funding." LLNL should commit to definite dates for cleanup and make up funding shortfalls as needed, using institutional discretionary funds as necessary.

21 Bioremediation may yet play a role at the site, as is implied.

22 Plan #1: 350 gpm = 1.54 af/day. Won't the configuration of the piezometric surface change so much under this pumping stress that the simple RESSQ-based analysis, which relies on an a uniform steady-state velocity field, be inappropriate? In fact, the initial velocity field is not uniform now. It would have been simple, I think, to modify the code used to enter velocity as a matrix variable. Does this figure and analysis include the proposed recharge basin and other recharge locations? I don't think so.

27 The conclusions about VOC remediation are not yet firm for this reader.

It is theoretically possible to strip tritium from vented soil moisture by exchanging it with water obtained from a treatment plant that is en route to a recharge location on the LLNL site.

In summary, the PRAP, though generally a fine document, has four major weaknesses:

1. The sources of contamination appear to not have been fully defined, nor their potential to contaminate groundwater fully known;

2. While the proposed remedial actions are very appropriate, there are no real commitments in the plan other than to goals;

3. The preferred alternative was not compared against the costs of more expeditious strategies for cleanup;

4. The plan as presented appears likely to spread tritium off-site.

Please consider these comments preliminary until I am able to review further documents from the site and discuss some of the issues involved with MHB Associates, with LLNL and Weiss Associates personnel, with regulatory officials I hope to meet this coming week, and with Tri-Valley CAREs. It may easily be that I have misunderstood portions of the work done so far and therefore unjustly criticized it in places. And, despite these questions and comments, the work done is generally very impressive. It is much easier to critique, than to do, work like this.

I do not yet know all the people who would normally receive carbon copies of these preliminary comments (e.g. EPA, and California State and regional, officials); please advise me in

this regard and feel free to distribute this to them.

Sincerely,

greg mello

Greg Mello
204 Alto Lane
Santa Fe, NM 87501
505-982-8315

cc: Peter Strauss, MHB Associates
Karen Anderson, for LLNL and Weiss Associates personnel

November 30, 1991: BY FAX

Marylia Kelley
Tri-Valley CAREs
5720 East Ave. #116
Livermore, CA 94550

Re: **Suggestions for five-year milestones in the Record of Decision (ROD) for the Lawrence Livermore National Laboratory (LLNL) Superfund site**

Dear Marylia:

A number of possible milestones can be suggested; our conversations to date have frequently returned to two kinds: mass removal milestones, and water quality (or contaminant concentration) milestones. Some other types of milestones and commitments are very briefly considered.

I. Mass Removal Milestones

Mass removal milestones have the advantage of integrating progress at the site as a whole, without tying the hands of Ground Water Project (GWP) staff to specific progress at any particular place, or restricting remediation to any particular technology. And, in the long run, the remaining contaminant mass is probably the single best predictor of impacts on distant wellfields, such as the Livermore town wells. The disadvantages of mass milestones are, first, that remaining contaminant mass is an estimated quantity, subject to disagreement, and second, that our understanding of mass removal rates from a given technology is very imperfect.

CERCLA requires that LLNL estimate and compare the time involved in its cleanup proposals, and LLNL has done this. Mass removal milestones merely restate explicitly what LLNL already has stated implicitly. If LLNL has no confidence in its own projections, LLNL should retract them and offer new ones. If LLNL cannot offer milestones in which it has confidence, then certainly the regulatory agencies and the public can likewise have no confidence in the remedies proposed and the entire CERCLA process is reduced to an empty exercise.

a. LLNL's mass removal milestones: a 50-year cleanup

Appendix C of the Feasibility Study (FS) gives the method used by LLNL to provide estimates of cleanup duration. There, a 50-year half-life for the natural degradation of volatile organic hydrocarbons (VOCs) is assumed, and the site is modelled as a single well-mixed tank. A volume of 184 million gallons of groundwater is assumed to be contaminated at an average concentration of 81 ug/l total VOCs. A total pumping rate of 350 gallons per minute (gpm) is assumed.

These assumptions are used to calculate a mass half-life for the

site of 13.3 years; the (mean) concentration of contaminants at the site follows an exponential decline with a rate constant of 0.0521 yrs^{-1}.

Using these assumptions, it is easily calculated that, in the preferred alternative, LLNL is proposing to remove 22.9% of the contaminant mass in the first 5 years of the project, and to reach an (average) contaminant concentration of 5 ug/l over the entire plume in 53.5 years, at which point the cleanup will conclude. Further mass removal milestones implicit in LLNL's analysis are presented in Table 1 below in the "350 gpm" column.

The well-mixed tank assumption is, as an examination of LLNL's preliminary pumping strategy shown in the Proposed Remedial Action Plan (PRAP) will reveal, highly optimistic. Not only are many areas of contamination far from any wellhead on a geographic scale (see, for example, the case of the East Traffic Circle area), but, on a meso- and micro-scale, contaminants have, and for some time will continue to, migrate into lower permeability strata, lenses, weathered zones, etc. For these reasons and others, it is the norm for pump-and-treat systems of the type proposed by LLNL to fail to remediate the aquifer on the schedule that a simple analysis of the type presented in Appendix C would predict. Therefore, if we retain the other assumptions of Appendix C, it follows that for a cleanup to be completed within 50 years, LLNL must propose a more aggressive cleanup than that shown in the PRAP.

In other words, any pump-and-treat system capable of remediating the aquifer within 50 years will need to remove more mass than Appendix C suggests is necessary in the early years. It is especially important to establish, as soon as possible, favorable diffusion gradients in the more highly-contaminated portions of the plume--that is, to bring down the concentrations of VOCs in the source areas as soon as possible. Until this happens, VOCs will continue to migrate into, rather than out of, the less-permeable aquifer materials.

Therefore I suggest, if a 50-year cleanup is to be the goal, that something in the ballpark of 30% of the total VOC mass be removed within the first 5 years.

b. A 30-year cleanup

In my September 7 comments I urged that the proposed alternative be compared against other more aggressive remediation options. On July 25, LLNL and Weiss Associates staff told me that their calculations showed that doubling the investment in pumping would be rewarded by roughly halving the estimated cleanup time.

Following this approach, and using a pumping rate of 700 gpm to calculate decreases in contaminant mass using the method and assumptions of Appendix C, a rate factor of 0.0939 yrs^{-1} and a mass

half-life of 7.38 years is obtained. Under this alternative, 37.5% of the total contaminant mass is removed in the first five years of pumping, and cleanup is achieved in 29.7 years. Using the same reasoning as before, I suggest that if a 30-year cleanup is desired, roughly 45% of the contaminant mass should be targeted for removal in the first five years.

The mass removal curves for the 350 gpm and 700 gpm scenarios, calculated from Appendix C, are shown in the Table 1 below for reference.

Table 1: Percent of VOCs Removed by Pumping Using Appendix C

Time in years	LLNL: 350 gpm	At 700 gpm
5	22.9%	37.5%
10	40.6	60.9
15	54.2	75.6
20	64.7	84.7
25	72.8	90.4
30	79.1	94.0 (complete)
35	83.9	
40	87.6	
45	90.4	
50	92.6	
55	94.3 (complete)	

II. Water Quality Milestones

These have the advantage of being directly measurable in the field, and of directly portraying the environmental and public-health parameters of interest. Their disadvantages are, first, that they are more specific and hence limiting of design than mass-removal milestones, and second, that it is very hard to predict when contaminant levels will decline to a given threshold.

LLNL's Appendix C calculations, made explicit above in Table 1, suggest that average contaminant concentrations will decline exponentially. The percentages shown in Table 1 apply equally to mass or to (average) total VOC concentration.

LLNL, however, makes no predictions or commitments regarding exact contaminant trajectories at any given point--something a person

could actually measure. As predictions, any such trajectories would be highly speculative.

As commitments, however, reasonable concentration milestones are design parameters, not predictions, and the remediation can be designed, insofar as is possible, to achieve those milestones. After all, CERCLA requires that LLNL bring concentrations throughout the plume from their present level down to drinking water standards as quickly as is feasible. Therefore, given the current concentrations and an overall duration of cleanup, the concentration curves around which design must proceed are constrained both at their beginning and at their endpoints.

We also know, both from theory and experience, that these curves, generally speaking, will fall most steeply in the beginning of the cleanup. And we know that concentrations often rise at any cessation of pumping, so that cleanup progress cannot be easily gauged during active pumping.

With this background, here are some possible water quality milestones. Here the term "plume area" refers to the area where total VOC concentrations exceed 5 ug/l; these milestones approach a proposed 30-year cleanup:

Immediately:	There will be no increases in plume area.
After five years:	a. The area of the offsite Arroyo Seco plume will have declined by 50%; and b. No areas in excess of 1000 ug/l total VOCs will remain.
After ten years:	a. The area of the offsite Arroyo Seco plume will have declined by 75%; and b. No areas in excess of 100 ug/l total VOCs will remain.
After 15 years:	The area of the offsite Arroyo Seco plume will have declined by 90%.

These proposals place emphasis on retraction of the plume to property managed by DOE or its successor agencies and on ameliorating the worst areas of contamination, where the greatest contaminant mass resides. They seem reasonable to me, given the 30-year cleanup goal, but are highly subjective. LLNL may be able to offer alternatives, based on the design work they have been doing.

III. Vadose Zone Milestones

The degree to which vadose zone cleanup is appropriate for this site is a matter of dispute at this time. I believe that LLNL will find it cost-effective to conduct vadose zone cleanups early on the remediation process, and so avoid as much as possible the continuing contamination of the groundwater it is trying to clean up. Since the cost of vadose zone cleanup of VOCs is so much less than aquifer cleanup, a reasonable decision analysis will suggest that, where there is uncertainty about the competence of the vadose zone contaminants to contaminate ground water, they should be removed down to a non-contaminating threshold.

In short, I think the vadose zone remediation of VOCs should be completed within the first five years of the project.

IV. Pumping Design Criteria

Both mass removal milestones and the concentration milestones, whatever the final numbers that are chosen may be, suggest that the placement of extraction wells and recharge facilities be done in such a way that all the highly contaminated ground water at the site enters an extraction well as soon as possible. Something like the following design criteria then seem appropriate:

a. All zones of groundwater containing more than 1000 ug/l total VOCs shall lie within the (2.5- or) 3-year capture volume of an extraction well.[1]

b. All zones of groundwater containing between 100 and 1000 ug/l of total VOCs shall lie within the (5- or) 7-year capture volume of an extraction well.

V. Other Milestones

I believe other milestones are appropriate as well, and these have been briefly mentioned in my August 8 letter to you. In addition, many of the comments made previously by MHB Associates and myself appear as candidates for 5-year milestones, dealing with such concerns as continuing investigations, non-VOC cleanup of soil and groundwater, reporting requirements, and monitoring.
Five-year milestones are not the only kind that could be incorporated into the ROD, of course; the CERCLA-mandated review does make that time of special interest, however.

I hope these are helpful to you.

---

1. If extraction wells are modelled as injection wells, and vice-versa, and if the natural gradient is reversed, won't the endpoints of streamlines emerging from each so-called "injection well," after "injection" for some time t, correspond to the boundary of the capture zone of that well after the same time t?

Sincerely,

gregory mello

Greg Mello
204 Alto Lane
Santa Fe, NM 87501
505-982-8315

cc: Peter Strauss, MHB Associates

SUMMARY OF CONCERNS AND ISSUES
in regard to the LLNL Proposed Remediation Action Plan

July 30, 1991
by
Greg Mello, groundwater consultant to Tri-Valley CARES

Summary

A great deal of good technical work has been and is being done at the LLNL Superfund site. Whether this will be translated into effective cleanup actions remains to be seen, and whether these actions can be sustained for the several decades that will be needed to remediate the site is still more unknown. Despite its capabilities, LLNL has made few or no formal commitments to clean up the site, and this places the cleanup in jeopardy. A number of technical issues also remain unresolved; these could be more easily resolved in a committed institutional context.

Concerns and Issues

1. The Proposed Remedial Action Plan (PRAP) contains few or no concrete commitments of any kind. Health-based maximum contaminant levels (MCLs) are adopted as goals, and all proposed actions--which are only described in vague and general terms--are placed in the subjunctive voice, such as this: "Under this plan, extraction wells would be strategically placed..." (p. 20, emphasis added). The PRAP does not propose a single strategy for cleanup; it merely sketches alternatives. This PRAP is primarily a summary of the Feasibility Study (FS), shortened and simplified for a wide audience, rather than a proposed plan of action. In the final analysis, this fundamental problem makes the PRAP almost useless as a formal document. Instead of turning the PRAP into a public outreach document, it would have been--and still would be--better to make a separate, accurate, summary of a much more substantive PRAP.

It is argued by LLNL that flexibility is needed to design remediation activities that incorporate the latest site data and the latest cleanup techniques. While this is true, the PRAP does not fully utilize existing LLNL research, experience, and currently-known cleanup techniques. At the same time, it does not commit the Lab to meeting any general installation or performance deadlines, which can be written without unduly constraining LLNL to existing techniques.

To pick one example, the Lab does not commit in writing to hydraulic containment of the groundwater plume, which is spreading further offsite as research continues. (Since the study of groundwater contamination at LLNL began, the contamination has spread hundreds of feet further offsite.)

Neither does the PRAP offer any specific means to verify the progress of plume containment and cleanup. The public is being asked their opinion on a course of action which is not only indeterminate, but which does not include any explicit internal measures of performance or success. There are no contingency plans presented.

The deadlines given in the Federal Facilities Agreement (FFA) that was drawn up for this site are merely deadlines for document submission, not for the implementation of remedial action. And, under this FFA, the regulatory agencies cannot sue DOE or LLNL for failure to clean up. Yet another aspect of the FFA is that DOE's failure to fund a cleanup, should this occur, will be considered an adequate excuse ("force majeure") from its responsibilities. It is therefore doubly important to incorporate specific commitments in the Record of Decision (ROD), which will guide future actions at this site.

2. The preferred alternative--which involves a "guesstimated" 50-year cleanup duration--was not compared against other, faster, cleanup alternatives. Since about three-quarters of the currently-projected cleanup cost is comprised of staff and consultant time over a projected 50-year period, and less than 10% of the total is earmarked for actual equipment, wells, etc. to be used for cleaning up the aquifer and site, LLNL should carefully examine the total cost of cleanup alternatives which are show promise for more rapid cleanup. These alternatives should be presented to the public and the regulatory agencies in the public hearing that is part of the ROD process.

3. The technical basis of the PRAP is optimistic in many ways. For example:

a. The estimated groundwater velocity chosen to predict plume movement in the uncontrolled case is, for nearby points of interest, lower than may actually be the case. The predicted capability of a single extraction well to capture the entire leading edge of the migrating offsite contamination is correspondingly rather high.

b. The model used to predict gaseous diffusion of VOCs above the water table, which suggests that only two source areas need cleanup above the water table, used what I think are highly optimistic assumptions about the ability of pollutants to escape from the surface of the ground instead of going down to groundwater--in effect assuming that the surface of the ground is completely uncovered at LLNL.

c. The water table will be significantly drawn down by the proposed 18 extraction wells, unless LLNL installs on-site recharge facilities. Yet the simplified modelling of plume capture that is the basis of the PRAP takes neither of these possibilities into account.

d. The possibility of contaminants (VOCs, metals, tritium and other radionuclides) leaching from the unsaturated zone into the ground water in the long run is optimistically, and without adequate data, dismissed.

e. The monitoring well network in the downgradient (western) offsite area is very sparse--too sparse to detect any "rogue" VOC contaminants that may have bypassed the wells on Vasco Road and too sparse to define either the northern portion of the Arroyo Seco plume or the southern portion of the northwest offsite plume (which LLNL believes is not its responsibility).

f. The cleanup time calculations presented utilize the highly inappropriate assumption that the entire site can be treated as "well-mixed tank." More realistic estimates of site cleanup may be significantly longer than 50 years, perhaps longer than a century.

g. In the Superfund-related reports at this site, there is a tendency to bury possible concerns about small areas of contamination within statistical analyses taken from the site as a whole, analyses which show that these small areas are not important in "the big picture." This may be true, but these areas may be still require further investigation and cleanup. The size of the site and the number of "non-detects" which can be generated using samples taken from over the whole site should not affect cleanup decisions for particular local areas.

LLNL should adequately address these and other technical issues in writing prior to the ROD.

4. <u>The PRAP as written has the potential to spread low-level tritium contamination off-site.</u> Many members of the public are concerned about tritium discharges from LLNL, in groundwater, surface water, and in the air. Yet although LLNL has voluntarily committed to VOC concentrations in its discharge water that are, in some cases, more stringent than the applicable MCLs, LLNL has refused to agree to any limit on tritium concentration in discharge water that is less than the MCL. The recent discoveries of additional tritium contamination--after the investigations that are the basis for the PRAP--as well as a recent tritiated water spill, suggest that the extent of tritium contamination at the Lab is not yet fully known. While separating tritium from water is highly impractical, and destruction of tritium is virtually impossible, it <u>is</u> possible and inexpensive to prevent tritium that is inadvertently pumped into the groundwater remediation system from being spread off-site.

5. Even after a decade of research, investigations into possible sources of groundwater contamination, as well as contamination in the vadose zone, are on-going. <u>There is no means of reporting this work to the public and to the regulatory agencies short of reading and analyzing the raw data.</u>

6. It is clear from a review of documents in the Ground Water Project (GWP) repository, and even more so from the responses of GWP personnel to my technical questions, that the summary documents prepared for readers outside the laboratory--the PRAP and supporting documents, for example--report on only a portion of the work being done, and on only a portion of the concerns being actively addressed by GWP staff. This selection is done with many goals in mind, one of which clearly is public relations: the reassurance of the general public. This interferes with candid scientific exchange and, if continued long enough, with clear thinking.

GWP staff, to their credit, are bringing in outside experts for peer review of their work, and this will help assure that technical errors are avoided. But it is not primarily in the narrowly technical domain that objectivity is most threatened, and outside technical experts will not be able to effectively question the overall policy directions involved--directions which will bear crucially on the ability of LLNL to transform its outstanding technical capabilities into actual cleanup. Other than in the narrow technical fields, it is difficult to buy objectivity.

The staff of the GWP need to be given the right questions in order to come up with the right answers. It is up to the PRAP and the Record of Decision to help frame a policy environment in which those questions will be consistently asked, and in which adequate funding will be available to answer them--both in the domain of knowledge and in the domain of actual cleanup, now and in the long run.

August 27, 1991

Marylia Kelley
Tri-Valley CAREs
5720 East Ave. #116
Livermore, CA 94550

Re: <u>Comments on the Draft Final Proposed Remedial Action Plan (Draft Final PRAP) for the Lawrence Livermore National Laboratory (LLNL) Superfund site</u>

Dear Marylia:

Here are comments on the Draft Final PRAP for your use. LLNL should respond in detail to them, if possible prior to the final PRAP. All in all, despite the fine work that has gone into the RI/FS/PRAP, I advise you to seek for its substantial revision and expansion prior to citizen approval of a final PRAP and prior to the Record of Decision (ROD).

A few of these comments will be perceived by LLNL as asking LLNL to go beyond the scope of the CERCLA process as they understand it. If the concerns I have noted are being addressed by some other LLNL program, so much the better. In that case the work being done can simply be referenced in the CERCLA documents.

As noted below, a letter outlining some proposed commitments by LLNL is being sent under separate cover. It complements the present letter in many ways.

1. These comments are on the entire RI/FS/PRAP.

It is clear from the National Contingency Plan (NCP)--the regulation that guides CERCLA cleanups--that the Proposed Remedial Action Plan (PRAP) is meant to "supplement the RI/FS [i.e. the Remedial Investigation/Feasibility Study]" and, "<u>at a minimum</u>" (emphasis added), to be a "summary" of the work done to date in selecting an alternative.[1] In other words, the PRAP is not meant to be a stand-alone document. Therefore it is appropriate to include comments on the entire RI/FS/PRAP sequence where those comments are germane to the selection of the remedy proposed. This is done here. Generally speaking, the issues raised here have not been, in this reviewer's opinion, adequately addressed to date in the entire RI/FS/PRAP sequence.

---

[1]. See Fed. Reg., Vol. 55, No. 46 (3/8/90), p. 8851, section 300.430(f)(2). (Subsequent references to the NCP will be by section only.)

2. Please refer to my previous comments on the RI/FS/PRAP.

On July 25, representatives of Tri-Valley CAREs, including myself, met with LLNL, Weiss Associates, and Department of Energy (DOE) staff and discussed many of the preliminary issues pertaining to the RI/FS/PRAP that were previously identified in a letter from me to Marylia Kelley, dated July 20, 1991. That letter had been furnished to LLNL staff on July 22. I would like at this time to thank those who met with us that day for the very cordial reception we received from everyone and for the time that was allocated for answering our questions.

Reading over those earlier comments, I see that almost all of them are still germane in some way. While many (though not all) of my technical questions were indeed "answered" in that meeting, in the sense that LLNL Ground Water Project (GWP) staff orally pointed to work that has been or is being done that addresses the issues raised, little of this work has been published by the Lab in the Administrative Record, and none of it has yet been incorporated into the primary documents, specifically into the PRAP. (See also issue No. 3 to follow.)

Therefore I believe that those earlier comments, as well as the present ones, should be addressed in the final PRAP (or in a letter referenced in the final PRAP) and in the final remedy selection of the ROD.[2]

3. Technical capabilities and good will are not enough.

It was clear from the July 25 meeting that, while uncertainties remain, LLNL and Weiss Associates staff were conscientiously and competently working to clear up these inevitable uncertainties. Particularly praiseworthy was the decision to bring in outside peer reviewers--the individuals mentioned to me by Mr. Ziagos were all leaders in their particular specialties--to provide needed perspective. I left with a very good impression of the technical capabilities and intentions of the Ground Water Project (GWP) staff.

Yet having strong technical capabilities and good intentions is far from enough to assure a successful cleanup. Much of the good work being done is not part of (and has not sufficiently informed) the formal CERCLA process, is sometimes guided by basic research priorities rather than site cleanup priorities, is not published and is therefore inaccessible to the public and regulatory community, and may never actually be applied to the

---

[2]. Cf. NCP section 300.430(f)(4), which calls for the lead agency to "factor in [to the final remedy selection] any new information or points of view expressed...during the public comment period."

site--even when technically applicable--because of policy decisions made by LLNL or DOE managers. For these reasons, even the best research--which may have tremendous merit in itself--cannot really resolve some of my concerns until this research is published, incorporated in the public record and ROD, and actually used in the Remedial Design (RD) and in the field.

The dark side of LLNL's continuing study is this: after some eight or nine years of investigation, the LLNL Ground Water Project (GWP) is still not sure where to best pump to contain the plume, where to best recharge the water, and which areas in the vadose zone need remediation. These are very basic questions. It is disturbing that LLNL has not answered them better--and that LLNL has not acted more substantively and decisively on its answers.

4. The PRAP should be more explicit and detailed.

The PRAP outlines an approach to remediation at LLNL which is, in its broad outlines, generally reasonable. Yet the PRAP is vague, and defers many details of remediation decisions until some future time. Note that the "at a minimum" language cited above does not rule out a clearer, more complete, and more explicit PRAP and subsequent Record of Decision (ROD). Why is this desirable?

First, the record shows that CERCLA has resulted in many more investigations than actual cleanups. In the entire history of Superfund, cleanup had begun (by 1989) at only 204 sites (17% of the National Priority List at that time) and had actually been "completed" at only 3% of the NPL sites by that date.[3] It is difficult to know, of course, what "completed" actually means; the NCP currently defines a cleanup as "administratively complete" after the passage of ten years, or when cleanup measures aren't being effective, regardless of the environmental status of the site.[4] Where aquifers, as opposed to surficial sediments, have been contaminated, it can be difficult to find

---

[3]. The New Mexican, June 16, 1989.

[4]. See NCP, section 300.435(f)(3)(ii and iii). This section, strictly speaking, applies to EPA-financed cleanups. Yet even if this sunset date does not strictly apply to the LLNL site, it is likely that the administrative procedures this section establishes within the EPA will influence the administration of all sites, and that the EPA, and regulatory agencies in general, will lose interest in the present site over the passage of years and with the advent of new crises and priorities.

examples of successful remediation.[5]

With this record as background, and with the technical difficulties and scale of the LLNL site in mind, it is clear that simply meeting EPA minimum guidance on a proposed remedial action is far from being a guarantee that the cleanup will actually be successful. Apparently the reverse is more likely to be true, at least to date.

Second, a review of the NCP reveals that there are no formal opportunities for public comment at a CERCLA site after the ROD, unless the ROD requires amendment or unless the Community Relations Plan provides for such opportunities. Regulatory agencies will recognize that public scrutiny gives the regulatory community greater leverage in pressing for clear commitments and consummated remedial actions. Since the PRAP is the formal basis for public comment, the quality of that comment will be dependent upon the quality of the PRAP. A vague PRAP evokes vague comments.

A related factor is the ability of citizens' groups such as Tri-Valley CAREs to sustain long-term technical involvement, once the ROD passes. While it is not the stated intent of CERCLA to circumvent public participation, postponing all the details--including the scheduling--of the proposed cleanup plan until after the ROD can have that effect.

Third, once entered, the ROD is the primary point of reference for resolution of future disputes about cleanup at the site. For this reason the ROD should be as detailed as possible and embody clear commitments. These details and commitments should be proposed to the public, and the only vehicle for this is the PRAP.

Fourth, the Federal Facilities Agreement (FFA) for this site is particularly weak. Under this agreement, the regulatory agencies cannot sue DOE or LLNL for failure to remediate. Likewise under this agreement, failure of DOE to fund the cleanup is considered <u>force majeure</u>, a sufficient excuse from the obligations of the agreement. The FFA contains no deadlines for remedial action. Nor does it contain any measures of remedial success. Therefore it is in the interest of the regulatory agencies as well as the public to be sure that the ROD, which is based on the RI/FS/PRAP,

---

[5]. See C. C. Travis and C. Doty, "Can Contaminated Aquifers at Superfund Sites be Remediated?" <u>Environ. Sci. and Technol.</u> V. 24, No. 10, 1990, pp. 1464-1466. The authors failed to find, despite extensive searching, a single aquifer that had been remediated by pump-and-treat technology. The present comments will return to discuss the issues these authors raise later in the text.

contains explicit and detailed commitments.

This is particularly true because, under CERCLA and the NCP, the lead agency for releases of hazardous materials on DOE sites is the DOE.[6] This means, among other things, that the DOE and its contractors will "make the final remedy selection and document that decision in the ROD."[7] That is, LLNL will draft the ROD. All other parties have subsidiary roles, roles which decrease in influence with the passage of each administrative step in the CERCLA process. It is important, therefore, to call for clarity and explicit descriptions in the PRAP, using what little leverage the FFA provides, before the administrative requirements of the FFA have all been met.

Fifth, the cleanup at LLNL will take a long time. It is difficult to sustain funding for projects lasting decades, let alone the institutional memory in either the responsible party or the regulatory agencies. Interest in cleaning up the contamination at LLNL is unlikely ever again to be as high as it is now. It is therefore important to all parties--not least to LLNL--to codify this interest in the PRAP and ROD in as much detail as possible.

Sixth, the PRAP represents the last opportunity to incorporate new information and evolving perspectives into the primary CERCLA documents prior to the ROD. As the GWP staff made clear to me on July 25, neither the investigation of new sources nor the evaluation of new remediation technologies are over at this site. For this reason, the PRAP, if limited to a summary of the RI/FS, will inevitably not reflect LLNL's most current thinking. On July 25, I was told that much of the information in the RI/FS/PRAP was about two years old. The new information that has been developed should be, at a minimum, published elsewhere and summarized in relevant detail in the PRAP.

Seventh, and perhaps most important, the vagueness of the present PRAP masks a great deal of uncertainty--uncertainty about the technical feasibility of the cleanup alternative preferred, uncertainty in the estimated time to cleanup and how various possible remedial designs will affect this, uncertainty in the ability of the wells shown to give the cleanup time estimates given, uncertainties in the vadose zone cleanup decision process, and uncertainty in the exact means of plume capture and whether this is actually still possible (involving, as it does, the cooperation of private landowners or the condemnation of required easements, etc.). These issues have not just been left out of the PRAP, <u>they have not yet been addressed at all by LLNL in the</u>

---

[6]. NCP section 300.5.

[7]. NCP section 300.430(f)(4).

CERCLA process.[8] To allow a vague PRAP to stand is, at this point, to allow the difficult questions that are, or ought to be, at the heart of the ROD to remain unanswered until after that ROD is entered.

For all these reasons, I suggest that the PRAP be detailed and specific wherever possible, and correct where appropriate the deficiencies of the FS in this regard.

More generally, the administrative record should reflect not only good, detailed technical work but also an unusually clear commitment to actually clean up the site, and the cleanup plans presented need to be not just technically sound but both robust and aggressive in design. The administrative record does not yet do this. I have seen many remedial systems fail because they were designed around optimistic assumptions (see No. 7 below) or with an "if-all-goes-well" attitude.

Mr. Fred Hoffman of LLNL said on July 25 that any actions LLNL might take to contain and remediate the plume must be delayed until after the ROD, and therefore any delays in the ROD caused by citizen group comments on the PRAP could jeopardize the cleanup.

Actually, however, LLNL need not wait until the ROD to initiate containment or cleanup actions, and in fact LLNL has not done so. Based on the comments on the PRAP received by LLNL, there appears to be a durable consensus among all parties, including LLNL, that it is important to prevent the further migration of contaminated groundwater. And there is really only one practical technical solution to this problem: capture wells. Therefore I cannot give the weight that Mr. Hoffman does to the argument that requesting further commitments and details in the PRAP might hurt the project. Rather, it is my view that containment of the moving plume is the highest priority at the site, and one that can and should be implemented while design and discussion of the other aspects of the remedial actions continue.[9] The philosophy

---

[8]. The exception in this list is the uncertainty about plume capture, which was discussed most recently in Dresen, et.al. (1987), Remedial Alternatives for VOCs in Ground Water West of LLNL, UCAR-10202 (draft).

[9]. There is a broad consensus, both technical and legal, supporting the appropriateness of early containment actions necessary to prevent the migration of contaminants. The "operable units" philosophy of the NCP, given in section 300.430(a)(ii)(A), the hierarchy of groundwater remediation goals expressed in subsection (F) there, as well as LLNL's intent in the draft final PRAP, all support such early action.

The preamble to the NCP is very explicit about this:

expressed by Mr. Hoffman is damaging, not just to the credibility of the Laboratory, but potentially also to the success of the cleanup program.

Since it is important to have a simplified document for wide dissemination to the public, an executive summary PRAP can be easily prepared, as is or already has been done. The need for wide public participation need not interfere with technical design or managerial commitment.

5. The PRAP should contain clear commitments.

At the July 25 meeting, the issue of commitments (or codification of commitments) was raised. LLNL staff pointed out that it would be inadvisable to make rigid commitments in advance of operations--commitments that very well could, as they were quickly rendered obsolete by additional information coming from the field or from new technological developments, hinder cleanup. So I volunteered to draft a set of commitments that would have the character of "performance standards," rather than specific detailed actions. These are now in draft form and being reviewed by Tri-Valley CAREs and MHB. They are being forwarded in a separate letter.

Should the preferred alternatives be adopted, the draft final PRAP now offers the following basic commitments (see p. 40):

1. "Immediately" (i.e. by 1993) pump from 18 initial wells that will contain all portions of the plume above maximum contaminant levels (MCLs) and, it is implied (though not actually stated), eventually capture all groundwater where VOCs or fuel

---

> "EPA expects to take early action at sites where appropriate, and to remediate sites in phases using operable units as early actions to eliminate, reduce or control the hazards posed by a site or to expedite the completion of total site cleanup...EPA promotes the responsiveness and efficiency of the Superfund program by encouraging action prior to or concurrent with conduct of an RI/FS as information is sufficient to support remedy selection." (p. 8704, emphasis added).
>
> "Operable units...may include interim actions (e.g. pumping and treating of ground water to retard plume migration) that must be followed by subsequent actions which fully address the scope of the problem..." (p. 8705).

Clearly, delays can, in this as in many situations, markedly increase containment costs and jeopardize the feasibility of containment.

hydrocarbon (FHC) concentrations exceed 100 ppb;

2. Treat the pumped water to contaminant levels stipulated in Table 1 or lower; and

3. Probably install vadose zone venting systems at two locations, and possibly at a third, with the final decisions about vadose zone venting being reserved for later.

This last doesn't really count as a commitment.

I am concerned that even the first basic commitment above is vitiated by its conditional nature: should the preferred alternative not be adopted, all bets are apparently off. And what are the alternatives LLNL presents to the preferred plan? Alternatives which, to put the matter as simply as possible, do not remediate the site.[10]

The entire PRAP is, in fact, written in a conditional mood. All the actions proposed there--which are only described in vague and general terms--are placed in the subjunctive voice, such as this: "Under this plan, extraction wells would be strategically placed..." (p. 20, emphasis added).

Please understand that this criticism is partly directed at the

---

[10]. Two of the alternatives (the "no action" alternative and the "deferred action" alternative) do not meet the requirements of CERCLA or the NCP. CERCLA states, at section 121(b), that

> "Remedial actions in which treatment which permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants is a principal element, are to be preferred over remedial actions not involving such treatment. The offsite transport...of hazardous substances or contaminated materials should be the least favored alternative..."

Section 300.430(e)(9)(D) of the NCP calls for the selected remedy(ies) to reduce toxicity, mobility, or volume through treatment, and section 300.430(a)(1)(ii)(F) calls for restoration of groundwater wherever practicable. Section 300.435(f)(4) says that measures initiated for the primary purpose of providing a drinking water supply and not for restoring ground water (such as LLNL's deferred action alternative) do not constitute treatment or ground-water restoration.

Alternative #2 takes so long to remediate the site, even under LLNL's optimistic assumptions, that in reality it is just a containment, and not a remediation, option.

CERCLA process as well as at LLNL, since the National Contingency Plan (NCP) apparently does not require more commitments than LLNL has presented at this stage of the process.[11]

In case the conditional nature of the commitments of the PRAP were not clear enough, on p. 20 the PRAP explicitly links a deadline for installation of equipment to congressional funding. It is instructive, in this context, to compare the level of planned remediation expense to the overall LLNL budget: at an average annual cost of about $5.1 million, the cleanup comprises 0.5% of a typical $1 billion annual Lab budget. Surely LLNL and DOE can commit to this level of effort. Their explicit caveat on p. 20, despite Secretary Watkins' statement that environmental, safety, and health concerns will henceforth rank first in DOE priorities, is worrisome. The recent transfer of some $118 million from environmental cleanups at defense installations to nuclear weapons design and testing in the proposed budget suggests that the funding limitations on p. 20 of the PRAP are a very real concern.

The fact that the PRAP does not propose or summarize even a single fully thought-out strategy for cleanup, that it merely sketches alternatives vaguely, is a serious problem in that an ROD based on this PRAP must share many of these same weaknesses. In the final analysis, this fundamental problem makes the PRAP almost useless as a formal document. Instead of turning the PRAP into a public outreach document--as is, frankly, encouraged by the NCP--it would have been, and still would be, better to make a separate, accurate, summary of a much more substantive PRAP, acting decisively in the meantime to arrest further plume migration.

As noted above, it is argued by LLNL that flexibility is needed to design remediation activities that incorporate the latest site data and the latest cleanup techniques. While this is true, the PRAP does not fully utilize existing LLNL research, experience, and currently-known cleanup techniques, even within the realm of pump-and-treat design. At the same time, it does not commit the Lab to meeting any general installation or performance deadlines,

---

[11]. See NCP, section 300.430(f)(2). The approach given in the NCP would work, however, if the Feasibility Study were sufficiently detailed to allow comparison between sufficiently-thought-out alternatives. It is not. The argument given by some LLNL personnel--that the PRAP is not meant to carry the detail that Tri-Valley CAREs would prefer--is narrowly correct but begs the response that since the FS did not provide sufficient detail, the PRAP--or some other formal addition to the record which is subject to public comment--must do so. And the problem remains that LLNL has proposed only one alternative that actually makes a serious attempt at cleaning up the site.

which can be written without unduly constraining LLNL to existing techniques.

The public and regulatory agencies are, in effect, being asked their opinion on a course of action which is not only indeterminate, but which does not include any explicit internal measures of performance or success.[12] There are no contingency plans presented.[13]

6. The preferred alternative was not compared against other, faster, cleanup alternatives.

Since about three-quarters of the currently-projected cleanup cost is comprised of staff and consultant time over a projected 50-year period, and less than 10% of the total is earmarked for actual equipment, wells, etc. to be used for cleaning up the aquifer and site, LLNL should carefully examine the total cost of cleanup alternatives which show promise for more rapid cleanup. These alternatives should be presented to the public and the regulatory agencies in the public hearing that is part of the ROD process.

Despite concerns about the length and complexity of the PRAP by the EPA, LLNL has retained discussions of alternatives (the "no action" alternative and the "deferred action" alternative) for which, as noted previously, it is a priori clear that neither the requirements of the NCP, nor the requirements of CERCLA, nor applicable or relevant and appropriate requirements (ARARs) are adequately met. It would have been better to evaluate and present only those alternatives which meet those requirements, and which have some likelihood of acceptance by the community.

---

[12]. Such internal measures can include mass removal targets. These are proposed in the draft commitments being separately prepared, and can be based, as indicated there, on mass removal curves developed by a realistic model of the pump-and-treat system. LLNL has not to date presented such a realistic model.

Such interim mass-reduction goals make very good sense from a technical point of view, since the long-term risk of down-gradient groundwater contamination at a site such as this one is, simplistically speaking, a function of the mass of contaminants left in the saturated zone or capable of arriving there from the vadose zone. See the article in footnote 4 above.

[13]. The EPA encourages the use of contingency plans in the context of ground-water pump-and-treat systems, due to the "significant uncertainty involved in predicting the ultimate effectiveness" of such systems: "In many cases, this uncertainty warrants inclusion of contingencies in remedy selection decisions for contaminated ground water" (NCP preamble, p. 8734).

Since LLNL is prepared to make, and has made, assumptions about cleanup time, why not a) refine those assumptions, as discussed elsewhere in these comments, and b) present cleanup alternatives which are estimated to take 50 years, 30 years, and 20 years (if this last is feasible), with their respective costs, mass-removal curves, uncertainties, and so on? Alternatively, the expected mass removed in the first 10 or 20 years of each alternative can be presented to identify alternatives. In contrast, the current FS/PRAP does very little to highlight the actual issues, technical and otherwise, related to remediation speed and likelihood of success.[14]

At the July 25 meeting, it was clear that GWP staff had been looking at the costs of more aggressive cleanups, and they told me then that a larger investments in capital equipment--e.g. wells--appeared to give proportionally quicker cleanup time estimates. This work should be published in the FS or PRAP, not kept, like so much of the work being done, within the oral tradition of the GWP project.

---

[14]. The preamble to the NCP (Federal Register, 3/8/1990) makes clear EPA's intent to encourage aggressive remedies: "Today's rule promotes the aggressive use of treatment technologies to achieve reliable remedies while acknowledging the practical limitations on the use of treatment" (p. 8700, emphasis added). And again, more explicitly,

> "Reasonable restoration time periods may range from very rapid (one to five years) to relatively extended (perhaps several decades). EPA's preference is for rapid restoration, when practicable...
>
> "The Superfund program will usually consider several different alternative restoration time periods and methodologies to achieve the preliminary remediation goal and select the most appropriate option (including the final remediation goal) by balancing tradeoffs..." (p. 8732, emphasis added).

CERCLA itself requires Federal facilities to choose aggressive cleanup strategies:

> "Remedial actions at facilities subject to interagency agreements under this section shall be completed as expeditiously as practicable. Each agency shall include in its annual budget submissions to the Congress a review of alternative agency funding which could be used to provide for the costs of remedial action." (CERCLA section 120(e)(3), emphasis added).

The PRAP submitted by LLNL does not meet these requirements.

Using the (inadequate) FS Appendix C "bathtub" model of the site cleanup, and using cost figures provided in the PRAP, it is possible to heuristically generate alternative cleanup scenarios based on doubling and quadrupling the proposed 350 gpm overall pumping rate, called "Alternative #3" (700 gpm) and "Alternative #4" (1400 gpm) below. These concepts of "doubling" and "quadrupling" must be considered to be very generally descriptive of systems of pumping wells and recharge facilities which move 2 and 4 times the water per unit time as does the base case (PRAP Alternative #1), and which do so in such a way that the aquifer is not dewatered. At least "Alternative #3" has apparently already been studied by the GWP, though it was not presented in the PRAP.

Assuming that capital costs are proportional to overall pumping rate, that annual operating and maintenance costs are also proportional to pumping rate, and that program costs are insensitive to pumping rate, the following table can be easily generated using the method of Appendix C. Dollar figures are in millions; these figures are for ground water cleanup costs only and do not include the costs of vadose zone remediation.

		Discounted Costs				Undiscounted Costs			
Alt.	Yrs	Cap.	O&M	Prog	Tot.	O&M	Prog	Ann.	Tot.
#1	54	9	21	73	103	1.1	3.9	5.0	279
#3	30	18	34.6	61.3	114	2.2	3.9	6.1	251 210
#4	16	36	49.3	43.7	129	4.4	3.9	8.3	169

Note that the overall discounted costs of the three alternatives do not vary by more than 25% from one to another. The undiscounted costs--which LLNL has said, and I agree, may more accurately compare the costs of the alternatives--are significantly lower for the more aggressive cleanup options.

To the extent that diffusive processes dominate VOC movement to wells, and to the extent that VOCs have entered low-permeability facies and lenses at the site, simple advective models, let alone the "bathtub" model of Appendix C, cannot accurately predict cleanup time. Yet LLNL has found (see p. 4-236ff of the RI), that VOCs are primarily confined to the coarser-grained sediments in downgradient areas, consistent with a transport mechanism dominated by advection.

This has two important implications for pump-and-treat alternatives at LLNL. First, it means that advective capture by pumping can remove the bulk of the contaminant mass in the downgradient areas, with more aggressive capture schedules being rewarded by proportionally more aggressive mass removal curves

for those areas. As noted above, this is the conclusion of LLNL modelling to date, and it supports the qualitative conclusions of the table above.

Second, it means that the area (or volume) of contaminated groundwater exceeding MCLs can be aggressively diminished using aggressive capture scenarios. While it may take a longer time to remediate the aquifer in the source areas, the bulk of the plume may be cleaned up much sooner than this, with corresponding lower risk, with lower costs for operating and maintenance and especially for monitoring, and with correspondingly higher payoffs for novel remediation technologies which can then be applied on a relatively localized scale. As it is, high costs (energy and otherwise) and the risk of failure preclude the application of novel remediation technologies to the LLNL plumes.

According to LLNL, then, an existing technology--groundwater extraction, treatment, and reinjection--can remediate most if not all of the contaminated groundwater more quickly than LLNL is proposing. Why not, then, use existing technology where it is effective to cut down the size of the problem to a scale where novel physical or biological processes, if needed, can be applied?

As I keep repeating, cleanups which are planned to be extremely slow may never be concluded at all. For this reason, I do not consider Alternative #2 a remediation alternative; it is a containment alternative. And as noted below, even Alternative #1 fails to capture many highly-contaminated volumes for long periods of time, perhaps for decades, thus allowing further time for diffusion to carry contaminants deeper into the low permeability zones and decreasing the a priori probability of a successful cleanup.

7. The technical basis of the PRAP is optimistic.

The reasons for this are summarized under this heading and discussed in more detail elsewhere in this and the previous letter. In brief, they are:

a. The estimated groundwater velocity chosen to predict plume movement in the uncontrolled case is, for nearby points of interest, lower than may actually be the case. The predicted capability of a single extraction well to capture the entire leading edge of the migrating offsite contamination is correspondingly rather high.

b. The model used to predict gaseous diffusion of VOCs above the water table, which suggests that only two source areas need cleanup above the water table, used what I think are optimistic assumptions about the ability of pollutants to escape from the surface of the ground instead of going down to

groundwater--in effect assuming that the surface of the ground is completely uncovered at LLNL.

c. The water table will be significantly drawn down by the proposed 18 extraction wells, unless LLNL installs on-site recharge facilities. Yet the simplified modelling of plume capture that is the basis of the PRAP takes neither of these possibilities into account.

d. The possibility of contaminants (VOCs, metals, tritium and other radionuclides) leaching from the unsaturated zone into the ground water in the long run is optimistically, and without adequate data, dismissed.

e. The monitoring well network in the downgradient (western) offsite area is very sparse--too sparse to detect any "rogue" VOC contaminants that may have bypassed the screened intervals in the wells on Vasco Road and too sparse to define either the northern portion of the Arroyo Seco plume or the southern portion of the northwest offsite plume (which LLNL believes is not its responsibility).[15]

f. The cleanup time calculations presented utilize the highly inappropriate assumption that the entire site can be treated as "well-mixed tank." More realistic estimates of site cleanup may be significantly longer than 50 years, perhaps longer than a century under the preferred alternative.

g. In the Superfund-related reports at this site, there is a tendency to bury possible concerns about small areas of contamination within statistical analyses taken from the site as a whole, analyses which show that these small areas are not important in "the big picture." This may be true, but these areas may be still require further investigation and cleanup. The size of the site and the number of "non-detects" which can be generated using samples taken from over the whole site should not affect cleanup decisions for particular local areas.

h. The extraction well network presented is not

---

[15]. According to GWP staff, it has been difficult to obtain permission to drill monitoring wells in the area west of Vasco Road. This difficulty was noted in the October-November 1988 monthly report of the GWP, which noted: "Negotiations are underway with Signature Properties, the developers of the now-vacant land west of Vasco Road and north of Arroyo Seco, for access to drill monitoring wells on that tract. Full detailed definition of the off-site plumes will require such drilling" (p. 7). Since that time, a few wells have been drilled, but GWP project personnel will I believe concur that the well density is still low in this area.

sufficiently dense to adequately extract and treat all the contaminated groundwater at the site.[16]

8. The preferred alternative has the potential to spread low-level tritium contamination off-site.

Many members of the public are concerned about tritium discharges from LLNL in groundwater, surface water, and in the air. Yet although LLNL has voluntarily committed to VOC concentrations in its discharge water that are, in some cases, more stringent than the applicable MCLs, LLNL has refused to agree to any limit on tritium concentration in discharge water that is less than the MCL. The recent discoveries of additional tritium contamination--after the investigations that are the basis for the PRAP--as well as a recent tritiated water spill, suggest that the extent of tritium contamination at the Lab is not yet fully known, and possibly could be impacted by ongoing Lab operations. I believe it is possible and inexpensive to prevent tritium that is inadvertently pumped into the groundwater remediation system from being spread off-site, and LLNL should commit to this.

9. There are no suggested means of public and regulatory involvement in ongoing decisions about the site.

Even after a decade of research, investigations into possible sources of groundwater contamination, as well as contamination in the vadose zone, are on-going. There are no explicit means of reporting this work to the public and to the regulatory agencies short of reading and analyzing the raw data in monthly reports.

Even if informed, no one outside LLNL has any formal means of providing input into ongoing decisions about remediation at the site, other than the EPA, whose formal input is confined to one review in five years.[17]

---

[16]. In case it is not a priori clear, the EPA's NCP preamble, on p. 8713, expresses EPA's desire for remedial actions to meet remediation levels--MCLs--"throughout the contaminated plume."

[17]. See NCP section 300.430(f)(4)(iii)(C), as well as CERCLA section 121(c).

Section 300.435(c)(1) of the NCP is also germane here: "Prior to the initiation of the RD, the lead agency [DOE] shall review the CRP [Community Relations Plan] to determine whether it should be revised to describe further public involvement activities during RD/RA that are not already addressed or provided for in the CRP." The draft commitments being offered under separate cover offer such "further public involvement activities."

10. <u>There are no suggested criteria for modifying the remedial actions to include new information</u>.

There are as well no formal procedures given for modifying the remedial actions to incorporate new discoveries at the site. This is particularly important since this site has not been fully investigated--i.e. the RI is not actually complete--and it is likely that additional new areas of contamination will be found.

11. <u>The primary documents are written to be reassuring and because of this the objectivity of technical investigations is at risk.</u>

It is clear from a review of the primary documents, the documents in the GWP repository, and even more so from the genuinely helpful and sincere responses of GWP personnel to my technical questions, that the summary documents prepared for readers outside the laboratory--the PRAP and supporting documents, for example--report on only a portion of the work being done, and on only a portion of the concerns being actively addressed by GWP staff. This selection is done with many goals in mind, one of which clearly is public relations: the reassurance of the general public. This can interfere with candid scientific exchange and, if continued long enough, with clear thinking.

In such an environment, staff can easily think: "What is the point of examining issues which cannot be presented to the public, or which are not considered germane by [more public-relations-oriented] Laboratory managers, and which will therefore not even be published?" In this way the answers to scientific inquiry and engineering design questions can be molded by controlling the questions that are asked and the environment in which they are asked.

As noted above, GWP staff are bringing in outside experts for peer review of their work, and this will help assure that technical errors are avoided. But it is not primarily in the narrow technical domain that objectivity is most threatened, and outside technical experts will not be able to effectively question the overall program directions involved--directions which will bear crucially on the ability of LLNL to transform its outstanding technical capabilities into actual cleanup. Other than in the narrow technical fields, it is by definition difficult to buy objectivity.

The staff of the GWP need to be given the right questions in order to come up with the best answers. It is up to the PRAP and the Record of Decision to help frame a policy environment in which those questions will be consistently asked, and in which adequate funding will be available to answer them. In the end, the most important answers to the contamination at LLNL will be found, not in words or reports, but in a successful cleanup.

12. The PRAP is based on an incomplete investigation of sources.

This subject was covered in some detail in the July 20 comments, both in summary form under the heading Investigations of Sources and in comments on the following pages of the RI: 1-8, 1-10, 1-13, 1-19, 2-1, 2-3, 2-35, 3-8, 3-19, 4-1, 4-6, 4-26, 4-128, 4-261, and 4-132.

During the July 25 meeting, LLNL staff acknowledged that the investigation was incomplete, and we discussed at some length the Lab's ongoing efforts to search for and characterize vadose zone contamination.[18]

This defect is in itself not a fatal one, especially if coupled with the improvements listed in No.'s 9 and 10 above and discussed in the forthcoming "proposed commitments" letter. In that letter it is proposed that LLNL publish a complete source database, cross-referenced with the Dreicer report, with RCRA investigations, with DOE audits, and with all other investigations of contamination at LLNL, and including both an annotated bibliography of investigations to date and a database on diskette for ready use by outside agencies and interested citizens.

According to the LLNL GWP 1988 Annual Report, the Regional Water Quality Control Board (RWQCB) Site Cleanup Order No. 88-103, dated June 23, 1988, "set compliance tasks and dates for reports that will characterize the distribution of hazardous materials in soil and groundwater at the site and evaluate, select, and implement remedial actions." Even though this order has been superseded by the FFA, it is clear that reporting on "the distribution of hazardous materials in soil" is incomplete. The RI investigation, as noted previously, basically was oriented around ground-water contamination. There is relatively very little information given there about inorganic or radiochemical contaminants in the soil.

It is important to note that the Lab's possible lack of candor in its formal reports (No. 11 above) makes it essential to formalize reporting of its source investigations. Source investigations are probably at least as likely as any other portion of the project to be subject to possible internal censorship.

Included in any final report on soil contamination and sources of groundwater contamination at LLNL should be a discussion of the

---

[18]. One of the points made in my earlier comments was that sources may now be covered by buildings, etc. Dresen, et. al. (1987) concur with this point on p. v. Indeed, the highest tritium concentration in the East Taxi Strip area has been found beneath a building.

possible impact of on-going operations. A recent tritium leak to soil and groundwater from a disused laboratory (Bldg. 292) points to the importance of this. Such a discussion should include disused facilities like Bldgs. 292 and 281 (the latter a former nuclear reactor, described by Dreicer as "still highly contaminated"), and should ideally include LLNL's proposed schedule for removing these potential sources of soil and groundwater contamination. The final remedial investigation report should reference other reports (e.g. for the RCRA and UST programs) which can assist in providing an overview of activities which pose risks of contamination at LLNL.

As noted previously, the short shrift given to radiological contaminants in the RI/FS is a matter of concern. The density of reported radiological samples over the LLNL site is extremely low, and there is no indication that this sampling even attempted to be comprehensive. The relevant question is: "Are there areas of radiological contamination at LLNL, either in buildings, on the surface of the ground, or beneath the ground surface, and if so what are the extent and character of these areas?" This question, in its generality, is not answered by the RI.

There needs to be deadlines for completing the site investigation and for publication of the comprehensive report described above. I would suggest two years as appropriate.

13. The potential for recharge and leaching of contaminants is dismissed too quickly in the RI/FS/PRAP.

This problem, mentioned in No. 7d above and discussed in the July 20 comments in some detail under the heading Investigation of Recharge and Leaching Potential, remains. Further discussion of this topic can be found in that previous letter in comments on pages 1-20, 1-21, 3-94, 3-98, 3-100, 3-111, 3-112, 5-27, and 5-69ff of the RI, and in comments on page 3-40 and Appendix G of the FS.

Note that Dr. Zakikhani of the EPA's laboratory in Athens, Georgia, in his cursory review of Appendix G of the FS, also questioned the dismissal of aqueous advection without "more field data" in that analysis.

It is apparent from a reading of Stone, et. al. (1982), which is used in the RI as the primary data source on this subject, that the RI and subsequent FS do not accurately portray all the conclusions of this document.[19] For example:

---

[19]. Stone, R., et. al., (1982), Potential for Saturated Ground-Water System Contamination at the Lawrence Livermore national Laboratory, UCRL-53426.

--The authors note on p. 25 that "Ground-water recharge apparently occurs at the LLNL and local vicinity because hydraulic gradients are...downward."

--MWs 4, 5, 8 and TB20 all show Class III water (water containing tritium at levels corresponding to LLNL rainfall) to the water table. At least the first three of these are located remotely from the recharge basin; although MWs 5 and 8 are near unlined surface drainage channels, MW 4 is not.

--The authors note (p. 76) that "...[drum] racks at LLNL drain to fields, lawn areas, and open ditches. This creates the potential for infiltration of contaminated water at LLNL."

--"The apparent deep infiltration to the water table at Bldg. 331 (without an obvious mechanism of infiltration enhancement) is not fully understood" (p.88). Note that the RI does not even discuss infiltration enhancement as a possibility.

--"If this interpretation [non-piston flow] is correct, it infers that Laboratory effects on ground water may continue long after atmospheric releases [or soil contamination] have ceased" (p. 92). The RI does not even discuss the possibility of non-piston flow.

In any case, the conclusions of Stone et. al. (1982) on pp. 94-95 in regard to the low potential for contamination of groundwater have not been borne out by later data, e.g. by what has been found at the East Taxi Strip area.

Data in Stone and Ruggieri (1983) show recent infiltration to ground water at TB11 (not located by me).[20]

Clearly, the time scale of tritiated water movement examined by Stone et. al. (1982), namely about 30 years at most, is short compared to the longevity of some hazards at LLNL. The tritium in the soil moisture at Bldg. 292, for example, will require decay for about 163 years to reach the drinking water standard for tritium, as it is now about 10,000 times that standard. The mixed fission products and transuranic wastes mentioned by Stone et. al. (1982) as possible ground-water contaminants are of concern in the long run, where present at sufficient levels. Also of concern are any metallic contaminants, including but not limited to Cr^{+6}, in the vadose zone.

---

[20]. Stone, R., and M.R. Ruggieri (1983), Ground-Water Quality and Movement at Lawrence Livermore National Laboratory, UCRL-53474.

Note that tritium has been able to enter the saturated ground-water system in what appear to be several places without an apparent unusual driving head. One example is in the East Taxi Strip Area, where ^{3}H at 10^{5} pCi/L is found in the ground water.

14. The analysis of pumping tests and choice of aquifer parameters which underlies the PRAP appears optimistic and at variance with previous work.

This topic was discussed at length in the July 20 comments, both in the summary and in comments on pages 2-27, 2-28, 2-30, 3-90, 3-119, 3-125, 3-149, 5-57, 5-66, 5-80, 5-83, and 5-91 of the RI.

What is interesting is that LLNL understanding of some aquifer parameters appears to have decreased over the life of the GWP. For example, the concept of effective porosity appears in Stone et. al. (1982); it appears in Stone and Ruggieri (1983), where laboratory studies were used to estimate effective porosity for LLNL samples (albeit using a very large gradient); it appears in the Annual Report of the GWP for 1985 (p. 74), where a value of 0.20 was chosen for this parameter[21]; and in Dresen et. al. (1987), where a value of 0.25 was chosen. By the time the RI was published in May 1990, the concept of effective porosity has disappeared, and a (total) porosity of 0.30 was used to create a velocity input for the PLUME model and elsewhere.[22]

Another very important issue that apparently is treated rather differently in non-primary project documents than in the primary RI/FS/PRAP sequence is the subject of the continuity and conductivity of the paleochannels which constitute the preferred pathways for contaminant migration at LLNL. Whereas in the RI, the discontinuities of these deposits are stressed, both in text and in the many hydrogeologic cross-sections that are speculatively drawn in the RI, in previous documents it is the continuity of these deposits that is of interest and concern.

Page 2-28 of the RI states: "In general, coarser grained sediments...are not shown to be continuous over distances greater than about 200 ft," a statement flatly contradicted by the pump test data presented in that report. In contrast, the authors of the executive summary of the 1985 Annual Report write: "In the area west of LLNL, NW-trending buried stream channel deposits

---

[21]. Weiss Associates (1985), Annual Report for Fiscal Year 1985, Ground Water Investigation at Lawrence Livermore National Laboratory, Livermore, California, UCRL-15835.

[22]. In the calculation of the retardation coefficient the use of total porosity is appropriate, which LLNL did in its "best-estimate" case. The health-conservative case assumed no retardation.

located near Arroyo Seco apparently comprise a preferred path for migration of ground water and VOCs." This conclusion is repeated on p. 1 of Dresen and Hoffman (1986).[23] In Dresen et. al. (1987), the authors prefer (see p. 42) an estimated hydraulic conductivity (K) of about 500 gpd/ft^2, the high end of their range in estimated K, which is about 4-5 times the K of the "best estimate" in the FS and about twice the "health-conservative" estimate given in the FS. As a result, the authors of the 1987 report are not as sanguine about the ability of a single capture well to capture all the contamination in the offsite Arroyo Seco area as are the authors of the PRAP.

LLNL staff told me that the Tompson statistical analysis of K is not yet published, despite the fact that it was the basis of the remedial design presented in the PRAP and was referenced in the December 1990 FS with a document number (Tompson, A.F.B., 1990, Flow and Transport With the Saturated Zone Beneath Lawrence Livermore National Laboratory: Modeling Considerations for Heterogeneous Media, UCID-21828). This document should be a part of the public record.

15. The analysis of plume capture given in the PRAP is inadequate.

This point was also made in the July 20 comments and discussed on July 25. LLNL staff recognized that the analytical velocity field model they used, which relies on a uniform gradient, a uniform velocity (and hence uniform hydraulic conductivity), an aquifer of constant saturated thickness which does not change over time,[24] and which did not include either the effects of LLNL's as-yet undesigned recharge system or the effects of pumping the Wente Winery well, located close to the Arroyo Seco plume, was inadequate.

In this regard, it is important to note recent reports that Mr. Wente may increase the pumping rate from his East Avenue well.

---

[23]. Dresen, M.D., and Hoffman, F., (1986), Volatile Organic Compounds in Ground Water West of LLNL, UCRL-53740. Interestingly, the distal portion of the Arroyo Seco plume is shown in this report as continuous with the portion closer to LLNL, rather than as discontinuous as shown in the FS/PRAP (see, for example, the PRAP, p. 5). It is the earlier version which is correct, since channel flow at the surface was shown to not be the mechanism of rapid VOC transport in this area.

[24]. GWP staff have recognized the possibility of dewatering portions of the southeast corner of LLNL during ground water extractions related to cleanup, if recharge is not provided. See Dresen, M.D., et. al. (1991), Ground Water Recharge in the Southeast Corner of LLNL, UCRL-AR-106894.

His well (14C3) can produce, according to newspaper accounts (The Independent, August 7, 1991), between 900 and 1000 gpm. I cannot seem to find in what intervals his well is screened, but it stands to reason that this well, located less than 1/4 mile from the plume, could interfere with plume capture during the irrigation season.

LLNL staff told me that they are now tuning up a powerful transient three-dimensional model (CFEST) of the site to overcome these deficiencies, one which will run on a Cray supercomputer. Yet the 1988 Annual Report of the project tells that CFEST modelling was begun some three years ago. My intuition, for what it's worth, is that a 2-D transient model would be adequate for planning the remediation, particularly since the data needs of a 3-D transient model may be difficult and/or very expensive to provide with sufficient accuracy to justify the time and cost involved. Such a 2-D model could be set up and calibrated in weeks, rather than years, and would result in a far more trustworthy remedial design than that presented in the PRAP. In any case, the modelling used as a basis for the alternatives in the PRAP is simply inadequate.

The 1987 work of Dresen et. al., cited earlier, strikes me as a more thoughtful use of a simple flow model than was presented in the FS three years later, and is indispensable reading for a review of the FS and PRAP.

It is important to note that the large times necessary for contaminants to travel to extraction wells, even under aggressive scenarios, militate against the use of a "well-mixed tank" model of the site for predicting cleanup times. The work of Dresen et. al. in 1987, using the same CAPTURE model used in the FS/PRAP, showed successive particle positions on the streamlines and used these to estimate the rate of pore washing in the plume. This analysis is absent in the FS/PRAP.

A cursory look at the preferred ground water treatment alternative--e.g. p. 3-30 in the FS--will reveal that many areas of total VOC concentration in excess of 100 ppb, and a few areas of total VOC concentration in excess of 1000 ppb, do not lie close (either in space or in travel time) to any extraction well. Some of these areas could take decades for even a single pore volume exchange with clean water, let alone the longer times necessary for diffusive flow out of low-permeability lenses. LLNL staff told me that the extraction well design and recharge locations were being optimized in a number of independent efforts, and this is good news. Such optimization will be most useful if it is not constrained by an arbitrarily fixed number of wells, recharge locations, or overall flow rates. In the meantime, though, how can the public or the regulatory agencies comment intelligently about LLNL's design, since, even in broad outline, we don't know exactly what it is?

The radial pattern of the streamlines shown in the preferred alternative make it clear that the combined influence of all the wells was used to compute velocity vectors at any given point. Yet, if water is recharged at the site, this radial inflow will be replaced by some other pattern--which will diminish the capture that can be expected in the offsite areas. The single capture well located in the Arroyo Seco area is shown in the FS and PRAP to have a far greater downstream stagnation radius than the on-site wells, a radius that may be unrealistic (see below).

If Q is the pumping rate, b the thickness of the aquifer, K the hydraulic conductivity, i the slope of the water table, v the ground-water velocity, and n_e the effective porosity, the distance r_s from a single pumping well to the downstream stagnation point resulting from that well in uniform flow is given by the expression

$$r_s = Q/2\pi Kib = Q/2\pi bvn_e \text{ , where } v = Ki/n_e \text{ .}$$

Other factors being equal, the larger the ground-water velocity, the smaller the capture zone becomes.

Previous estimates by GWP staff of ground water velocity are somewhat higher than those presented in the RI/FS. For example, the 1985 Annual Report suggests, in its summary, that ground water velocities at the site may range from 17 to 370 ft/yr. Estimates of aquifer parameters in Dresen et. al. (1987) give ground water velocities ranging from 19.5 to 195 ft/yr, with the best-guess values being closer to the higher numbers (see p. 47).

In contrast, the velocities shown on p. 3-150 of the RI range between 3.9 and 35 ft/yr; they are based on geometric mean Ks, which is inappropriate if the most permeable sediments are continuous over the scale of concern, and on a porosity of 0.30, which is too high. Both of these factors were understood by Dresen et. al. in 1987.

In the FS, these biases were corrected to some extent; velocity inputs to PLUME on p. 5-81 ranged from 72 ft/yr (best estimate) to 144 ft/yr (health-conservative). The velocity that was used for the CAPTURE modeling in Appendix B of the FS was 70 ft/yr for what is now the preferred alternative. It was based on a hydraulic conductivity of 14.4 ft/d, a gradient of 0.004, and a porosity of 0.3. This seems reasonable to me but not conservative.

Here is an estimate of what I think to be a reasonable upper bound on velocity in the crucial southwest and offsite area:

> The 90th percentile of the 166 hydraulic conductivities shown on p. 5-84 of the RI is about 40 ft/d, almost three times the value used in the FS. Note also that

the mean K from the southwest and offsite portion of the site is some 66% higher than the overall mean K (see the RI, p. 3-150). Therefore I'd pick a K for this estimate of about 66 ft/d.

I would estimate the effective porosity as being between 0.20 and 0.25, given LLNL's previous measurements and estimates of this parameter, and given the lithology present. 0.20 is the conservative value.

Reducing the gradient to 0.003 for this area (the FS used 0.004 for the overall site) and using the other numbers given here, I would suggest that groundwater velocity could be as great as 364 ft/yr in some parts of the southwest area, as a reasonable upper bound. I have not adjusted this velocity upward to account for the interception of patchy aquifer boundaries in pumping tests, so it is possible that an upper bound on ground water velocity should be selected that is even higher than this. This number is consistent with the upper bound on velocity suggested in the earlier LLNL reports.

Here is what I think is a reasonable best estimate for velocity in the southwest and offsite area:

The analysis of Tompson, cited on p. 5-83 of the FS, suggests that an appropriate K for modelling purposes is approximately 3.6 times the geometric mean K. Applying this factor to the mean K reported for the southwest and offsite area on p. 3-150 of the RI (3.6 x 5.6 ft/d gives 20 ft/d), with an estimated effective porosity of 0.22 and a gradient of 0.003 gives an estimated velocity of 100 ft/yr. This is somewhat, but not a great deal, higher than the value used in the FS.

In the CAPTURE analysis, the FS used an aquifer thickness b of 40 ft. The actual thickness of saturated sediments above the Tpl is greater than this; presumably the FS had in mind the total thickness of the <u>permeable</u> strata. It is unfortunate that the FS does not describe the aquifer parameters which were used to match the observed and predicted capture zones in the experimental capture wells.

In the words of Dresen <u>et. al.</u> (1987) (p. 40): "The parameters i, b, and Q are all known or can be estimated to within a factor of about two. The major uncertainty in predicting capture areas in alluvial deposits at LLNL is the variability in K." The ability of capture wells to reach out in the downgradient direction and bring back contaminants is thus seen to dependent upon a number of variables, and the aggregate uncertainty is actually fairly great. LLNL's capture design should, but does

not yet, account for this uncertainty.

Using K = 20 ft/d, i = 0.002 (appropriate for the distal portion of the Arroyo Seco plume), b = 40 ft, and Q = 20 gpm, the downstream capture radius is 383 ft, far less than that shown in the PRAP. Using the worst-case figures given above, the downstream capture radius could be as small as 100 ft. In short, LLNL's capture analysis looks to me like it is more optimistic than its own best-estimate aquifer parameters would suggest, and a high-conductivity scenario is not addressed at all, even as a contingency.

Partially-screened capture wells and piezometers screened similarly to them may describe capture in one conductive stratum while contaminated groundwater is escaping above or below the pumped interval. LLNL therefore should verify capture in all contaminated strata.

It is possible that LLNL does not actually intend to capture the offsite plume, given the optimistic capture modelling in the FS/PRAP, the order and locations in which LLNL has chosen to make its investments in the site so far and in capture wells in particular, and the difficulty in obtaining well and piping easements on private property. During the eight or so years that LLNL has known about its ground water contamination, this contamination has probably moved a few hundred feet further downgradient. On p. 63, Dresen et. al. (1987) suggest that complete contaminant capture may not actually be necessary.

16. The analysis of vadose zone transport in the RI/FS/PRAP is inadequate.

This problem was discussed in the July 20 comments, in the summary and in comments on page 1-30, 4-128, 5-1, 5-27, 5-69ff, 5-80, and 7-3 of the RI, as well as comments on pages 1-5, 1-8, 3-9, 3-15, 3-22ff, 3-38, 3-40, and Appendix G of the FS, and comments on pages 3 and 27 of the PRAP.

As noted before, the analysis of aqueous advection in Appendix G has been superseded by new data regarding transport of tritium to groundwater in the East Taxi Strip area (and possibly in other areas, not yet published, that have been discovered in LLNL's ^{3}H monitoring program), and relies upon the very questionable assumption that a spatially- and temporally-constant flux exists down to the water table.

When I was at the Bldg. 518 area, LLNL staff responded to my questions about perched water by mentioning that a shallow perched zone does indeed develop in this area in response to rainfall, and agreed that this water--being too deep for much if any transpiration--eventually goes to the water table. The area of highest VOC concentration is located at the bottom of a

landscaping slope and just off the edge of a paved parking lot--both sufficient causes for enhanced percolation. All this is clearly in contradiction to the idealizations of Appendix G.

Appendix G focusses in part upon the potential for VOCs in this Bldg. 518 area to (continue to) contaminate groundwater. Appendix G assumes that the ground surface is completely open, which is certainly neither the case in the Bldg. 518 area (where it is half-open), nor is it the case throughout most of the southern portion of LLNL. Surely the mathematically-competent author(s) of Appendix G knew of the sensitivity of the model's results to the upper boundary condition, a sensitivity which is discussed in one paper cited in Appendix G,[25] and in other readily-available literature.[26]

The results of the Appendix G modelling appear to conflict with known facts. The predictions of Appendix G are, basically, that a peak concentration of 15-20 ppb of TCE will develop beneath the vadose zone contamination in the Bldg. 518 area after approximately 60 years. It follows from this that the vadose zone concentrations of TCE at Bldg. 518 are not currently a source of ground water contamination, even though TCE concentrations in ground water there are now about 100 ppb. The idea that steadily decreasing vadose zone contamination caused ground water contamination in the past, and will, without further additions to the vadose zone, cause ground water contamination again in the future, yet do not do so at the present time, defies logic. For this to be true, the concentration vs.time curves for ground water contamination would have to show a valley, which Appendix G (as well as common sense) say they do not.

It was observed by Iovenitti et. al. (1991) that even after 40 or 50 years after releases of TCE to the subsurface by the Navy, the highest ground water concentrations continue to linger close to the points of origin.[27] Two possible explanations for this are 1) a high effective retardation factor (either conventionally

---

[25]. Mendoza, C.A., and McAlary, T.A., 1990, Modeling of Ground-Water Contamination Caused by Organic Solvent Vapors, Ground Water, Vol. 28, No. 2, pp.199-206.

[26]. For example, see Baehr, A.L., 1987, Selective Transport of Hydrocarbons in the Unsaturated Zone Due to Aqueous and Vapor Phase Partitioning, Water Resources Research, Vol. 23, No. 10, pp. 1926-1938. Baehr's simulations show, as he puts it, that "the groundwater contaminating potential is quite sensitive to the ground surface boundary characterization."

[27]. Iovenitti, J.L., et. al. (1991), Possible Sources of VOCs in the Vasco Road-Patterson Pass Road Area, Livermore, California, UCRL-AR-106898.

conceived or as a result of heterogeneity in the aquifer), and 2) continued flux from sources in the vadose zone.

In many ways Appendix G is a paradigm for what is wrong with the entire RI/FS/PRAP. Outstanding technical capabilities were applied there in an analytical tour de force, yet without a close correspondence to reality, and with the errors apparently being on the side of minimizing the predicted ground water contamination potential. It is as if the simplifications necessary to solve the equations were more important than an accurate understanding of what is actually going on, an understanding which will necessarily be quite vague because the physical reality is so complex.

Looking from the outside, I am tempted to find the same lack of proportion in the choice of a very complex model for the site hydrology, a choice which apparently necessitated, after two years of work, falling back to an extremely oversimplified modelling effort to satisfy the requirements of the FS and PRAP. All of this leads me to the conclusion, expressed below in issue No. 18, that much of the fine technical work being done at LLNL--and it is fine work; be clear about this--may be actually rather decoupled from site remediation.

The vast bulk of the attention in the RI/FS/PRAP devoted to vadose zone transport concerns VOCs. As noted in my previous comments, inorganic contaminants and radionuclides were apparently not considered much of a vadose zone transport issue if they were not yet found in the ground water. There is no analysis of tritium transport in the vadose zone, which is important in the case of Bldg. 292, if not also at other locations.

As noted in the previous letter, the interrelationship between vadose zone cleanup and groundwater cleanup times and costs was not addressed. This is an important area of inquiry that can affect the remedial actions selected.

17. The RI/FS/PRAP obscures some information by the use of statistical summaries.

This is discussed in some detail in the July 20 letter, in summary form (item 8 there) and in specific comments on pages 4-212, 5-37, 5-40, and Appendix P of the RI.

I am particularly concerned about the exclusion of concentration data less than the MCL from trend analyses of contaminant concentrations in monitoring wells. It would be difficult to find a better way to make it impossible to tell, with concentration data, where the groundwater plume is expanding.

18. LLNL must be aware of the distinction between research and

cleanup.

There is a tendency for the LLNL GWP to blur the distinction between research and environmental cleanup. These activities are certainly mutually reinforcing, but they are also mutually competitive for attention and for funding. The proper balance between the two will be easier to achieve if the applicability of each project to the LLNL cleanup is explicitly stated. LLNL would do well to make itself very accountable, as congressional critics are already beginning to realize that the environmental remediation of defense installations is in many ways an unexamined fiscal black hole, possibly an immense boondoggle. And should LLNL be forced by funding cutbacks to conduct less than an aggressive and successful cleanup, there will be, rightly or wrongly, many critics of the way in which LLNL spent the money it had. It is in the interest of both LLNL and Tri-Valley CAREs to be sure that adequate funding is available for actual environmental cleanup.

It should noted that the projected average annual cost of the cleanup--$5.1 million/yr--is a little less than 25% of the FY92 program costs ($23 million, which includes activities at Site 300) mentioned by Mr. Hoffman in our July 25 meeting. With 60 full-time equivalent staff and another 60 individuals coordinating with them, I for one would expect to see an aggressive, competent cleanup implemented at the site. I do not believe that there is currently any shortage of resources for an aggressive and effective LLNL cleanup.

The LLNL ground water plume and associated vadose zone contamination can be cleaned up with existing technology. LLNL research, to be applicable to its own site, must therefore, if successful, pass tests of cost-effectiveness before it is applied to the site. Occasionally boundaries can be placed on cost-effectiveness even before the research is conducted.

To pick an example: at the underground storage tank leak site, LLNL is planning an experiment in steam stripping. As I understand it, steam will be introduced to the vadose zone, where it will flow radially to a central well, greatly expediting the removal of fuel hydrocarbons.

If steam is to travel through the soil, the soil must be heated to the boiling point of water, a process which will involve energy costs. For a soil with 10% moisture content, with an overall 75% thermal efficiency for the steam generation and transport, and with an energy cost of $0.08/kw-hr, this cost is about $4.24/m^3 of soil. For a perfectly insulated cylinder of soil 15 meters in radius and 25 meters deep, energy costs alone would be about $75,000.

The physical set-up required would be more complicated than that

required for a standard vacuum venting system, a system which could clean up the vadose zone perfectly well, and fairly quickly too (i.e. in approximately one to, at most, three years). Apparently the steam stripping process also involves an initial pilot, or control, study in a clean area at Sandia National Laboratory (SNL), which is an additional expense.

This cleanup technique is not needed at the UST site, nor is it cost-effective there. Neither is it easily applicable to the LLNL site as a whole. The energy cost of raising a large volume of sediment to relatively high temperatures is large: $(10^7\ m^3)$ X (0.66 kw-hr/m^3°C) X (80 °C) X ($0.08/kw-hr) = $4.2 X 10^7. Should LLNL attempt to raise the temperatures of <u>saturated</u> sediments, the energy penalties are even greater, since the specific heat of water is roughly three times that of dry earth. In addition, attempts to heat the vadose zone with steam will add a substantial amount of condensed water to the vadose zone (about 60 L/m^3 or so) which will then percolate to groundwater carrying dissolved pollutant species. The costs of the physical plant to conduct this heating will be very great, probably much greater than the energy costs.

This is not to say that it is inappropriate to look at steam stripping technology. It may find a place in the remediation of some kinds of sites--but probably not this site. This is not to say that <u>some</u> heating--by steam or electrical resistance or other means--<u>in selected areas</u> can be <u>a priori</u> dismissed. But the point is that the cost of this research should not compete with the cost of actual cleanup.

<u>19. The information presented in the PRAP is dated.</u>

This critique, already mentioned above, was offered by GWP staff during our July 25 meeting in response to questions. It is, of course, difficult to keep documents up to date when as much data is being generated as is the case in the project. It would be well, however, to work from <u>recent</u> maps of total VOCs, TCE, PCE, and Cr, and I am not aware of <u>any</u> comprehensive geographic presentation of ^3H concentrations. Of particular interest would be an analysis of contaminant trends in the "leading edge" area--say in wells 517, 571, 516, 150, 481, 149, and wells in the Arroyo Seco area.

<u>20. The relationship of the CERCLA process to other environmental programs at LLNL is unclear.</u>

It is currently LLNL's intention to address some of the vadose zone contamination under other programs. Quoting from the response of LLNL to a question by the California Department of Health Services, LLNL said that any other vadose zone remediations besides the Bldg. 518 area and the gasoline spill area "can be conducted outside of the scope of the CERCLA process

via separate reporting and approval processes." This seems less than satisfactory to me. As long-time regulators know, it is possible for many concerns to fall in the cracks between programs. Even if it is not possible to conduct and report all of LLNL's investigation and cleanup activities in one coordinated effort, the CERCLA effort publications should contain summaries and complete bibliographies of the work going on in coordinating programs.

21. Table 1 in the PRAP needs revision.

First, it is suggested that LLNL negotiate with Tri-Valley CAREs to find mutually-acceptable discharge limits for tritium. As I implied before, I would suggest making a distinction in allowable concentration between on-site and off-site discharges for tritium--and for any other situations where discharge limits are desired by some parties that are below ARARs.

For example, if the discharge limit for tritium on-site is the MCL (20,000 pCi/L) or even higher, it will allow for the re-injection of tritiated water on-site so that the tritiated water will have a chance to decay before possibly leaving the site. This, in my mind, would be the next-best course of action to leaving the tritium in the ground. There will be some tritium in any water that is discharged off-site, and so a discharge limit of, say, 10% of the MCL in this water could be selected. Such a limit would reassure citizen groups and at the same time be easily achievable by the Lab, since highly-tritiated ground water is the exception rather than the rule at LLNL.

Second, it is apparent that the discharge limits shown for ethylene dibromide (EDB), carbon tetrachloride, and 1,2 dichloroethane are significantly greater than the California MCL. In the case of EDB, the discharge limit is 100 times the Federal MCL and 250 times the CA MCL. Is this an error? Section 121(d) of CERCLA, which deals with cleanup standards, calls for cleanup to levels which assure protection of human health and the environment; it is not clear without further analysis of the specific quantity and locations of discharge that the discharge limits of Table 1 accomplish that. The selection of ARARs for off-site discharge which are 10, 100, and 250 times the applicable drinking water standards is highly questionable on its face.[28]

Third, it appears that some of the entries in the last column of this table may involve typographical omissions, in that the word "total" may be meant to appear on some of the entries.

---

[28]. For further discussion of ARARs see the preamble to the National Contingency Plan, 3/8/90 Federal Register, p. 8694ff.

Freon seems to be missing from this table.

In sum, I would suggest using the MCL for drinking water as a discharge standard over and above whatever standard is called for in LLNL's NPDES/RWQCB permit(s), except, as noted above, for highly controversial discharge components, such as tritium, that can practically be kept to lower limits. For these compounds, off-site discharge limits can be set lower than MCLs.

These conclude my comments at this time. I hope to send to you the promised letter with draft commitments in the next few days.

Sincerely,

greg mello

Greg Mello
204 Alto Lane
Santa Fe, NM 87501
505-982-8315

cc: Peter Strauss, MHB Associates

August 27, 1991

Marylia Kelley
Tri-Valley CAREs
5720 East Ave. #116
Livermore, CA 94550

Re: **The ground-water treatment technologies chosen may not be cost-effective from a public health point of view, and apparently reflect concern for community acceptance.**

Dear Marylia:

1. Air quality impacts of air stripping towers under PRAP Alternative #1

The current total volatile organic compound (VOC) treatment rate of treatment facility B (TFB) is 3.4 grams/day, or roughly 2.3 ml/day of pure contaminants at 1.5 grams/ml. At TFA, approximately 10 times that flux is currently experienced (37.3 grams/day, or about 25 ml/day).[1]

Appendix C of the FS can be used to calculate the maximum expected VOC removal rate of the preferred alternative under optimum ("well-mixed tank:" the maximum removal rate) conditions. The maximum (i.e. the initial) rate of concentration decline there can be computed to be -4.22 ug/L per year. Multiplying this by the total volume of the groundwater containing VOCs (1.1 X 10^{10} L) gives an initial mass removal rate of 127 grams/day, or 0.012 lbs/hr. The current mass removal rate (3.4 + 37.3 grams/day) is 32% of that proposed in the preferred alternative. The compounds present are primarily trichloroethylene (TCE) and perchloroethylene (PCE).

This proposed mass removal rate, if added directly to the atmosphere, is roughly equivalent in air emissions to somebody cleaning one automobile engine per day, and is no doubt greatly dwarfed by the other emissions of VOCs from routine LLNL operations.

In New Mexico, the air quality permitting thresholds for TCE and PCE are 18 and 22.3 lbs/hr, respectively.[2] These are the emissions allowed from a point source less than 3 meters tall without a full modelling and permitting effort, and were computed by the State by comparing worst-case plume dispersion analyses with ambient thresholds of 1% of the occupational exposure limit

---

[1]. LLNL Ground Water Project, 1990 Annual Report, p. ix.

[2]. New Mexico Air Quality Regulation 702, Appendix A.

(OEL) for each compound.[3] If the projected emissions were entirely composed of TCE (the more toxic of the two compounds mentioned), and if the FS (Appendix C)-projected emissions were released from a single stack, the emission rate of that stack would be 0.06% of the New Mexico permitting threshold, resulting in a projected maximum ambient concentration of 0.0006% (6×10^{-6}) of the OEL.

I ran a quick analytical air dispersion model (SCREEN, from Trinity Consultants, Inc., Austin, TX) to estimate worst-case ambient concentrations from a single stack emitting an air pollutant at a rate of 0.012 lbs/hr. At 100 meters, the ambient concentration under the most unfavorable stability class (5) and wind speed (1 m/s) was 2.0 ug/m^3. This is 7.4×10^{-6} of the OEL if that pollutant is TCE. At 1000 meters, the ambient concentration was 0.1 ug/m^3, or 20 times less than at 100 meters. The SCREEN printout is attached to these comments.

SCREEN typically overestimates ambient concentrations. The effect of multiple stacks in widely separated locations and the effect of buildings, which increase dispersion, must also be taken into account. The mass removal rate chosen above was the maximum expected by Appendix C to occur over the lifetime of the cleanup. All in all, the concentration of VOCs which is expected to be created, <u>even from uncontrolled air stripping towers under worst-case conditions</u>, is extremely small, roughly on the order of one ten-millionth (10^{-7}) of the OEL at a kilometer from a stack at near-calm conditions.

This analysis, which is very rough-and-ready, and which omits any analysis of risk, suggests that the use of direct solar UV degradation of VOCs, <u>in the biosphere</u>, may be practical at this site, and warrant more detailed attention. Even if not initially applicable, such less-expensive treatment technologies need to be considered for the "out years" of the project, especially given the high energy costs of the artificial UV oxidation machines--machines which will, by means of the energy they use, cause pollution of the environment elsewhere.

2. <u>Public health concerns are not, however, the only factor.</u>

The application of risk analysis based on strictly public health concerns is clearly not the only relevant factor in the selection of remedial actions at this or any site. CERCLA mandates the protection of <u>both</u> public health "and the environment;" it is therefore not the intent of CERCLA to collapse all environmental concern into strictly matters of public health. In addition, CERCLA calls upon the responsible party to consider the comments

---

[3]. The OELs of TCE and PCE are 270 and 335 mg/m^3, respectively.

of interested citizens in the selection of a remedy, without stipulating that these comments be entirely confined to recognized public health issues. These principles are already recognized throughout, and are a fundamental basis of, LLNL's proposed actions.

For example, the protection of groundwater as a resource has guided the selection of the preferred alternative, a concern which is over and above concerns strictly about public health, which could have been addressed by LLNL's delayed action alternative.

Likewise, the willingness of LLNL to add expensive granular activated carbon (GAC) treatment to its current and proposed treatment systems, in order to prevent <u>any</u> VOCs from being emitted, is an example of a remedial action which is apparently motivated as much by community relations concerns as it is by risk-analysis-based public health concerns. <u>And this may be entirely appropriate</u>.

From this it follows that LLNL would not be inconsistent with its approach up to now if it were to commit to controlling tritium emissions to levels below the applicable public health standards, in order to gain public acceptance of its cleanup plans. The cost of accommodating public concerns on the tritium issue is, I believe, far less than the corresponding accommodation in the case of VOC emissions from air stripping towers, which LLNL has presented without comment.

3. <u>LLNL's commitment to zero VOC air emissions suggests that funds for cleanup are not limiting.</u>

LLNL's investigation and cleanup effort is not, as this example and many others which could be mentioned show, proceeding on a shoestring budget. If the community and regulatory officials wish a more aggressive cleanup than LLNL has offered in the PRAP, it appears that funds are available to accomplish this.

I hope these comments are helpful to you.

Sincerely,

greg mello

Greg Mello
204 Alto Lane
Santa Fe, NM 87501
505-982-8315

cc: Peter Strauss, MHB Associates

IBM-PC VERSION (1.04)

(C) COPYRIGHT 1989, TRINITY CONSULTANTS, INC.

LLNL Worst-Case Air Stripper 1

SIMPLE TERRAIN INPUTS:

SOURCE TYPE	=	POINT
EMISSION RATE (G/S)	=	.1500E-02
STACK HEIGHT (M)	=	8.00
STK INSIDE DIAM (M)	=	.50
STK EXIT VELOCITY (M/S)	=	2.00
STK GAS EXIT TEMP (K)	=	293.00
AMBIENT AIR TEMP (K)	=	293.00
RECEPTOR HEIGHT (M)	=	.00
IDPT (1=URB,2=RUR)	=	1
BUILDING HEIGHT (M)	=	.00
MIN HORIZ BLDG DIM (M)	=	.00
MAX HORIZ BLDG DIM (M)	=	.00

BUOY. FLUX = .00 M**4/S**3; MOM. FLUX = .25 M**4/S**2.

** FULL METEOROLOGY ***

****

** SCREEN AUTOMATED DISTANCES ***

****

** TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	UOM (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
1.	.0000	0	.0	.0	.0	.0	.0	.0	
100.	2.010	5	1.0	1.0	5000.0	11.0	10.8	7.5	NO
200.	1.180	5	1.0	1.0	5000.0	11.0	21.2	14.1	NO
300.	.6591	5	1.0	1.0	5000.0	11.0	31.2	19.9	NO
400.	.4200	5	1.0	1.0	5000.0	11.0	40.9	25.3	NO
500.	.2942	5	1.0	1.0	5000.0	11.0	50.2	30.2	NO
600.	.2200	5	1.0	1.0	5000.0	11.0	59.3	34.8	NO
700.	.1724	5	1.0	1.0	5000.0	11.0	68.1	39.1	NO
800.	.1398	5	1.0	1.0	5000.0	11.0	76.6	43.2	NO
900.	.1165	5	1.0	1.0	5000.0	11.0	84.9	47.0	NO
1000.	.9912E-01	5	1.0	1.0	5000.0	11.0	93.0	50.6	NO

X JM 1-HR CONCENTRATION AT OR BEYOND 1. M:

102.	2.012	5	1.0	1.0	5000.0	11.0	11.1	7.7	NO

WASH= MEANS NO CALC MADE (CONC = 0.0)

WASH=NO MEANS NO BUILDING DOWNWASH USED

WASH=HS MEANS HUBER-SNYDER DOWNWASH USED

WASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED

WASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

****

* SCREEN DISCRETE DISTANCES ***

****

* TERRAIN HEIGHT OF 0. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH

1.	.0000	0	.0	.0	.0	.0	.0	.0	
10.	.9919E-01	2	5.0	5.0	1600.0	7.5	3.2	2.4	NO
20.	1.386	1	2.0	2.0	640.0	9.0	6.4	4.9	NO
30.	2.294	3	1.0	1.0	320.0	11.0	6.6	6.1	NO
40.	2.657	3	1.0	1.0	320.0	11.0	8.8	8.0	NO
50.	2.491	4	1.0	1.0	320.0	11.0	8.0	7.0	NO
60.	2.525	4	1.0	1.0	320.0	11.0	9.5	8.4	NO
70.	2.338	4	1.0	1.0	320.0	11.0	11.1	9.7	NO
80.	2.084	4	1.0	1.0	320.0	11.0	12.6	11.1	NO
90.	1.949	5	1.0	1.0	5000.0	11.0	9.8	6.8	NO

DWASH= MEANS NO CALC MADE (CONC = 0.0)

DWASH=NO MEANS NO BUILDING DOWNWASH USED

DWASH=HS MEANS HUBER-SNYDER DOWNWASH USED

DWASH=SS MEANS SCHULMAN-SCIRE DOWNWASH USED

DWASH=NA MEANS DOWNWASH NOT APPLICABLE, X<3*LB

```
****************************************
*** SUMMARY OF SCREEN MODEL RESULTS ***
****************************************
```

CALCULATION PROCEDURE	MAX CONC (UG/M**3)	DIST TO MAX (M)	TERRAIN HT (M)
IMPLE TERRAIN	2.657	40.	0.

```
*****************************************************
* REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
*****************************************************
```

November 6, 1991

John Ziagos
Acting Ground Water Project Leader
Environmental Restoration Division
LLNL (L-528) P.O. Box 808
Livermore, California 94551

Oral comments on the Proposed Remedial Action Plan (PRAP) for the Lawrence Livermore National Laboratory (LLNL) Superfund site from Greg Mello

My name is Greg Mello. I am a hydrologist in private practice based in Santa Fe, New Mexico. My professional experience has been primarily in the investigation and remediation of ground-water contamination. I am a technical consultant to Tri-Valley CAREs.

A great deal of fine work has been done by the Ground Water Project (GWP) in this CERCLA [Superfund] process. I don't want to minimize these accomplishments in any way. My comments will center, however, not on these accomplishments but rather on what remains to be done, and on ways in which I believe the current work could be improved.

Having strong technical capabilities and good intentions--and even adequate funding--is not enough to assure a successful cleanup. These capabilities and intentions need to be matched by committed and pragmatic actions. The PRAP, as these comments will say, does not yet describe such a program. LLNL is still not sure where to best pump water to contain the groundwater plume, where to best recharge the water, and which areas in the vadose zone need remediation. These are very basic questions, and they are not answered in the PRAP and its supporting documents.

Before beginning, it's important to say that, to date, there has been no written response to any of Tri-Valley CAREs comments on the PRAP. The new October PRAP differs little from the June version and incorporates none of the comments offered throughout 1991 by Tri-Valley CAREs and its advisors.

So, for the reasons presented previously and which follow, I advise against accepting the PRAP. The Ground Water Project staff should go back to the drawing board, and offer a substantially improved action plan.

1. The PRAP should be more explicit and detailed. This is desirable for a number of reasons.

First, the record shows that CERCLA has resulted in many more investigations than actual cleanups. Only the most well thought-out cleanup plans are likely to succeed.

Second, a review of the National Contingency Plan (NCP) reveals that there are no formal opportunities for public comment at a CERCLA site after the PRAP is approved.

Third, once entered, the Record of Decision (ROD) is the primary point of reference for resolution of future disputes about cleanup at the site.

Fourth, the Federal Facilities Agreement (FFA) for this site is particularly weak. From a regulatory point of view, it is worse than useless. Under this agreement, the regulatory agencies cannot sue DOE or LLNL for failure to remediate. Likewise under this agreement, failure of DOE to fund the cleanup is considered a sufficient excuse from the obligations of the agreement. The FFA contains no deadlines for remedial action. Nor does it contain any measures of remedial success.

Fifth, the cleanup at LLNL will take a long time. It is difficult to sustain funding for projects lasting decades. It is therefore important to all parties--not least to LLNL--to codify this interest in the PRAP and ROD in as much detail as possible.

Sixth, the PRAP represents the last opportunity to incorporate new information and evolving perspectives into the primary CERCLA documents prior to the ROD.

Seventh, and perhaps most important, the vagueness of the present PRAP masks a great deal of uncertainty--uncertainty about the technical feasibility of the cleanup alternative preferred, uncertainty in the estimated time to cleanup and how various possible remedial designs will affect this, uncertainty in the ability of the wells shown to give the cleanup time estimates given, uncertainties in the vadose zone cleanup decision process, and uncertainty in the exact means of plume capture. These issues have not just been left out of the PRAP--<u>they have not yet been addressed at all by LLNL in the formal CERCLA process</u>. To allow a vague PRAP to stand is to allow the difficult questions that are, or ought to be, at the heart of the ROD to remain unanswered.

2. Delays in acceptance of the PRAP and in the ROD need not delay containment and cleanup; this fact is not recognized in the PRAP. Containment of the moving plume is the highest priority at the site, and one that can and should be implemented while design and discussion of the other aspects of the remedial actions continue.

3. The PRAP should contain clear commitments. These can be of at least three kinds:

a. installation deadlines,
b. performance standards, and
c. progress milestones.

Such commitments can reserve ample technical flexibility while still assuring that cleanup will proceed in a timely manner.

At present, the PRAP contains only vague commitments, and these are vitiated by funding uncertainties. The authors of CERCLA foresaw this and required Federal facilities in LLNL's situation to present alternative funding plans. No such plan is presented in the PRAP.

In sum, the public and regulatory agencies are, in effect, being asked their opinion on a course of action which is not only indeterminate, but which does not include any explicit internal measures of performance or of success. There are no contingency plans presented.

Internal performance milestones can include mass removal or plume-area reduction targets. The former can be based on mass removal curves developed by a geographic model of the pump-and-treat system. Yet LLNL has not to date presented a model of the cleanup process that incorporates distance, let alone acknowledges that the contamination occurs in a porous medium, and still less that the site lithology is inhomogeneous. Neither does the LLNL model account for any additions of contaminants to the aquifer from the vadose zone.

Interim mass-reduction goals make good sense from a policy point of view, since the long-term risk of down-gradient groundwater contamination at a site like this one is, simplistically speaking, a function of the mass of contaminants left in the saturated zone or capable of arriving there from the vadose zone. They can most easily be keyed to the five-year performance reviews required in Section 121 of CERCLA.

I've prepared some possible performance milestones for LLNL review and these are attached to my written comments.

I want to call your attention to the fact that the pumping scheme of the preferred alternative, as analyzed in Appendix C of the Feasibility Study (FS), contains an exponential mass-reduction curve for the plume as a whole, expressed in a mass half-life of 13.3 years. LLNL could choose, if it has confidence in this analysis, to make this mass-reduction schedule a formal part of the PRAP. We believe, however, that the analysis of Appendix C is optimistic, and therefore meeting a 50-year cleanup goal will, unless natural degradation has been underestimated, require removing more contaminant mass in early time than the Appendix C analysis would suggest.

4. The preferred alternative was not compared against more complete or faster cleanup alternatives. Actually the PRAP presents only one actual cleanup option. Alternative #2 in the PRAP is really just a containment strategy, not a cleanup plan. The "no action" and "delayed action" strategies do not, by LLNL's

admission, meet legal requirements and so it is not clear why LLNL has presented them.

Because it presents only one alternative, the current PRAP does very little to highlight the actual issues, technical and otherwise, related to remediation speed and likelihood of success.

The preferred alternative earmarks less than 10% of its total cost to actual equipment, and over 90% for staff and consultant time. If current dollars instead of discounted dollars are used, over 95% of the budget is for staff time and less than 5% for wells and other equipment. It is likely, therefore, that more aggressive cleanups involving greater capital expenses with fewer decades of staff and consultant time will be at least as cost-effective as the alternative proposed. Ground Water Project staff have done calculations which support this idea, but these alternatives do not appear in the PRAP and supporting documents.

Cleanups which are based on optimistic assumptions, as this one is, yet are planned to be extremely slow, may never be concluded at all. Even Alternative #1 fails to capture many highly-contaminated ground-water volumes for long periods of time, perhaps for decades, thus allowing further time for diffusion to carry contaminants deeper into the low permeability zones and decreasing the probability of a successful cleanup.

5. The relationship of the CERCLA process to other LLNL environmental programs and laws is unclear at best and apparently, at odds with FFA and CERCLA. First, there is no legally-required program which could be, as LLNL put it, "outside the scope of the CERCLA process"--all such requirements appear as ARARs in the CERCLA process.

Second, according the FFA, RCRA [hazardous waste] requirements are an ARAR (applicable relevant and appropriate requirement) under CERCLA at this site. Section 3016 of RCRA is entitled "Inventory of Federal Agency Hazardous Waste Facilities" and requires, every two years, submission of a highly-detailed inventory of each site at which hazardous waste is stored, treated, or disposed of <u>or has been disposed of at any time.</u> This ARAR does not appear in the PRAP.

6. There are no suggested means of public and regulatory involvement in ongoing decisions about the site.

7. There are no suggested criteria for modifying the remedial actions to include new information or technology.

8. The primary documents are written to be reassuring; because of this the objectivity of technical investigations is at risk--and the public is shut out of effective participation.

9. The PRAP is based on an incomplete investigation of sources. The emphasis on groundwater contamination at LLNL has been, to some extent, at the expense of emphasis on vadose zone contamination. The radiochemical characterization of the site (including tritium) is treated very summarily indeed in the Remedial Investigation (RI), almost dismissively. We do not have a complete picture of radiological contaminants at the LLNL site, let alone of their potential to contaminate ground water.

To overcome these deficiencies, LLNL should publish, every two years (as required by RCRA Section 3016), an ever-more-complete source database, cross-referenced with the Dreicer report, with RCRA investigations, with DOE audits, and with <u>all</u> other investigations of contamination at LLNL, and including both an annotated bibliography of investigations to date and a database on diskette for ready use by outside agencies and interested citizens. The work could be completed by the first five-year EPA audit of the CERCLA cleanup. These activities should be guaranteed by the ROD.

10. The geographic area of the investigation appears abridged. The omission of the southern boundary area--i.e. Sandia National Laboratory (SNL) and vicinity--as a second offsite area could potentially be significant.

11. The potential impact of continuing LLNL operations on the CERCLA-mandated cleanup has not been discussed. A recent tritium leak to soil and groundwater from a disused laboratory (Bldg. 292) points to the importance of concern in this regard. Ongoing leaks from site sewer systems have also been identified by Federal inspectors as a concern. Such a discussion should include disused facilities like Bldgs. 292 and 281 (the latter a former nuclear reactor, described by Dreicer as "still highly contaminated"), and should include LLNL's proposed schedule for removing these potential sources of soil and groundwater contamination.

12. The precision with which LLNL has estimated the total contaminant mass in the compartments of the site is uncertain. This information is crucial to evaluating the likelihood of cleanup success and should be estimated and presented in the PRAP.

13. The analysis of pumping tests and choice of aquifer parameters which underlies the PRAP appears optimistic and at variance with previous LLNL work.

14. The analysis of plume capture given in the PRAP is inadequate. The analytical velocity-field model used, which relies on a uniform gradient, a uniform velocity (and hence uniform hydraulic conductivity), an aquifer of constant saturated thickness which does not change over time, and which did not include either the effects of LLNL's as-yet undesigned recharge system or the effects of pumping the Wente Winery well, located close to the Arroyo Seco plume, is inadequate.

The large times necessary for contaminants to travel to extraction wells, even under aggressive scenarios, militate against the use of a "well-mixed tank" model of the site for predicting cleanup times, as was done in the PRAP. Many areas of total VOC concentration in excess of 100 ppb, and a few areas of total VOC concentration in excess of 1000 ppb, do not lie close to any extraction well. Some of these areas could take decades for even a single pore volume exchange with clean water, let alone the longer times necessary for diffusive flow out of low-permeability lenses.

GWP staff are working to design a better system. In the meantime, though, how can the public or the regulatory agencies comment intelligently about LLNL's design, since, even in broad outline, we don't know what it is?

The offsite capture well proposed for the Arroyo Seco area is shown in the FS and PRAP to have a far greater downstream stagnation radius than is likely, once project recharge is taken into account.

GWP staff should promptly prepare, as part of a revised PRAP, a detailed containment plan, including a detailed analysis of lithology, aquifer parameters, recent trends in water quality in the off-site area, the effect of non-LLNL pumping, hydraulic capture design, and the verification of hydraulic capture. This work was substantially done by 1987 but has not sufficiently informed the PRAP.

15. The analysis of vadose zone transport in the RI/FS/PRAP is inadequate. This analysis appears to be contradicted by new data regarding transport of tritium to groundwater in the East Taxi Strip area (and possibly in other areas, not yet published); it relies upon the very questionable assumption that a spatially- and temporally-constant flux exists down to the water table; it is contradicted by the transient presence of perched water zones; it assumes that the surface of the ground has no buildings or paved areas, which is not the case; and its conclusion that ground water contamination will not occur for many decades appears to contradict current reality.

The potential for leaching of contaminants is dismissed too quickly in the RI/FS/PRAP.

Inorganic contaminants and radionuclides were apparently not considered a vadose zone transport issue if they were not yet found in the ground water. There is no analysis of tritium transport in the vadose zone.

Possible benefits to the ground-water cleanup resulting from vadose zone cleanup were not addressed.

16. The RI/FS/PRAP obscures the import of local contamination by the use of site-wide statistical summaries.

17. The information presented in the PRAP is about two years old. Of particular interest would be an up-to-date analysis of contaminant trends in the "leading edge" area--say in wells 517, 571, 516, 150, 481, 149, and wells in the Arroyo Seco area.

18. There aren't enough monitoring wells to the west of the LLNL site.

19. The cleanup time calculations presented in the FS are unrealistic. More realistic estimates of site cleanup may be significantly longer than 50 years, perhaps longer than a century under the preferred alternative. It is not clear why LLNL did not use an advective model such as PLUME (which it used elsewhere in the FS) to calculate a better estimate of cleanup time, or far better still, a model with both advection and diffusion from less permeable sediments.

20. The effluent limitations in the PRAP are not all clearly protective of health and the environment. Specifically, the discharge limits shown for ethylene dibromide (EDB), carbon tetrachloride, and 1,2 dichloroethane are 10, 100, and 250 times the applicable drinking water standards, respectively.

21. The preferred alternative has the potential to spread low-level tritium contamination off-site. It is possible and inexpensive to prevent tritium that is inadvertently pumped into the groundwater remediation system from being spread off-site, and LLNL should commit to this. More fundamentally, LLNL should provide a map showing all known occurences of tritium at LLNL.

22. Section 120 of CERCLA requires LLNL to begin "substantial continuous physical onsite remedial action" by 15 months after completion of the RI/FS, or by March, 1992. The "1993 to 1994 timeframe" proposed in the PRAP does not meet this requirement.

23. LLNL should prepare and present a map with accompanying report describing all known occurences of tritium in soil and groundwater, tritium transport in and between those media and the air, as well as the possible impact of tritium on groundwater remediation.

24. LLNL should commit to a public hearing and public comment period on its remedial design.

These conclude my comments at this time.

Greg Mello
204 Alto Lane
Santa Fe, NM 87501
505-982-8315

fk

November 13. 1991

John Chestnutt. Environmental Engineer
U.S. Environmental Protection Agency
Office of Superfund Programs
75 Hawthorne St.
San Francisco. CA 94105

Re: A. The Proposed Remedial Action Plan (PRAP) for the Lawrence Livermore National Laboratory (LLNL) Superfund site does not meet CERCLA standards.

B. There is a history of deadline slippage in this project.

Dear John:

A. CERCLA standards

The PRAP presented by LLNL is not only not acceptable to Tri-Valley CAREs. but also does not. we believe. meet minimum CERCLA and National Contingency Plan (NCP) standards. The bases for this belief can be found in our comments. and they are also summarized here.

1. The construction schedule does not meet requirements for CERCLA cleanups at Federal facilities.

CERCLA section 120(e)(2) requires that "Substantial continuous physical onsite remedial action shall be commenced at each facility not later than 15 months after completion of the [remedial] investigation and [feasibility] study." This date is March 31. 1991. The proposed "1993-1994 timeframe" for construction and 1996 date for containment of the plume appears to be in violation of this section. unless the pilot studies now underway can be considered "substantial."

We believe that these studies are not "substantial," for two reasons. First, these pilot studies comprise, together, only about one-sixth of the proposed pumping rate for the site as a whole. Using the optimistic "well-mixed tank" analysis of the Feasibility Study, such a pumping rate would result in a cleanup time of 169 years if natural degradation occurs as predicted, or 387 years if natural degradation does not occur. These schedules do not, we believe. constitute "substantial" cleanup.

Second. the pilot projects do not contain the plume. Containment is recognized in most cases as the first substantive benchmark of success in dealing with a moving contaminant plume.

There is no technical reason why LLNL cannot act decisively to contain the moving plume by the statutory deadline.

2. Only one remediation alternative was presented.

This is discussed on pp. 11ff of our comments. In effect, the choice presented to the public was one of being in favor of the plan presented--or against cleanup.

3. The actions in the PRAP are not effective in the short term.

Short-term effectiveness is one of the EPA's nine criteria; a plan which defers containment of a moving plume for five years cannot be considered to be effective in the short term.

4. The discharge quality commitments do not necessarily protect public health.

This is discussed in on pp.32ff in our comments.

5. The PRAP contains language which undercuts any alternative agency funding plan or commitment.

This was mentioned in our oral comments but does not appear in our omnibus comments. CERCLA, at section 120(e)(3), requires Federal facilities to submit "alternative agency funding" for cleanups with their budget requests so that Federal facility cleanups will not be held hostage to other intra-agency priorities. The authors of CERCLA recognized that Federal facilities would be often be hard-pressed to provide funding for cleanups if that funding required an additional congressional appropriation. On its face, it appears that CERCLA section 120(e)(3) requires funding for the cleanup of DOE Superfund sites, like this one, to be of higher priority than other DOE budget line items. We would be interested in EPA's interpretation of this section.

No such commitment to alternative funding appears in this PRAP, and in fact the reverse occurs: the authors of the PRAP make all cleanup contingent upon "DOE and congressional funding." In the handouts presented by LLNL on November 6, the phrase "contingent upon DOE funding" appears on the top of the sheet labelled "Planned Goals for the Cleanup."[1]

6. The actions proposed are not expeditious.

This CERCLA and NCP requirement is discussed in footnote 15 on p.12 of our comments. Those comments were written before we heard about the 1996 containment proposal, which was mentioned by LLNL for the first time on the evening of November 6. This proposal apparently represents a slackening of the schedule proposed in the June 1991 PRAP by some three years.

---

[1]. Note that these are "planned goals," not commitments of any kind.

7. The plan does not involve an "operable units" approach.

This is discussed in detail in footnote 10 on p. 7 of our comments. The NCP, at 300.430(a)(1)(ii), "under the heading Program Management Principles," calls for operable units to be used "when...necessary or appropriate given the size or complexity of the site," as is the case here.

8. The PRAP does not include contingency plans.

As noted in footnote 14 on p. 10 of our comments, the EPA encourages the use of contingency plans in ground-water pump-and-treat systems. This is not, however, a strict requirement.

9. The technical basis of the PRAP is inadequate.

This is discussed at several places in our comments; of particular concern are the estimates of cleanup duration.

10. The requirements of RCRA have not been included as ARARs.

First, the remedial investigation did not encompass all RCRA solid waste management units (SWMUs). Second, there is no reference to the requirements of RCRA section 3016 in the PRAP. These are of particular concern because language in the FFA (Part VII, pp. 16-17 there) says that these RCRA requirements will be deemed satisfied by the CERCLA work on which we now comment.

11. a) The PRAP is not acceptable to the community, and b) LLNL has not been responsive to community concerns.

Community acceptance is one of the nine criteria set by the EPA with which it will choose among competing plans.[2]

At the meeting on November 6, no one spoke in favor of the proposed plan. As you know, the PRAP is not acceptable to Tri-Valley CAREs. The Community Work Group likewise has found serious omissions in the plan.

In Tri-Valley CAREs' November 6 comments, it was noted that the comments of Tri-Valley CAREs were ignored in the preparation of the final PRAP.[3] These concerns were communicated with LLNL far

---

[2]. These criteria appear in the NCP at section 300.430(e)(9).

[3]. The NCP calls, at section 300.430(f)(4), for the lead agency to "factor in [to the final remedy selection] any new information or points of view expressed...during the public comment period." So far this has not occurred.

Also, at 300.430(c)(2)(ii)(A), the NCP calls upon LLNL to

in advance of the November 6 meeting. I have received no telephone calls or written communication from any Ground Water Project personnel since our meeting on July 25. The concerns of the Community Work Group have likewise not yet been addressed by LLNL.

B. Deadline slippage

On another subject, we note that the formal deadlines in the FFA have been extended two times (in October 1989, and again in January 1991). The last deadline shown there for the PRAP is February 1, 1991, to be followed by a remedial design (RD) on January 1, 1992. Is this the formal schedule that we are now supposed to be following? On November 6, it was said that the RD is to be prepared by "early 1993."

In the June PRAP, installation of 18 wells was to have been complete in 1993. By October, the PRAP said that installation would be complete in "the 1993 to 1994 timeframe." On November 6, we heard that containment was to be achieved by 1996, but this is only a "planned goal."

These frequent slippages underscore the need for milestones and deadlines in the cleanup plan, milestones which are in addition to those in the FFA.

Please call if you have any questions or comments about these concerns.

Sincerely,

greg mello

Greg Mello
204 Alto Lane
Santa Fe, NM 87501
505-982-8315

cc: Peter Strauss, MHB Associates
Marylia Kelley, Tri-Valley CAREs
Michelle Rembaum, Cal EPA
Walter Bahm, Cal EPA
John Ziagos, LLNL
Rico Duazo, RWQCB
Mike Brown, DOE

"Ensure the public appropriate opportunities for involvement in a wide variety of site-related decisions, including site analysis and characterization, alternatives analysis, and selection of remedy" (emphasis added).