N00129.AR.000926
NSB NEW LONDON
5090.3a

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 1
1 CONGRESS STREET, SUITE 1100
BOSTON, MASSACHUSETTS 02114-2023

April 3, 2002

Mark Evans, Remedial Project Manager
U.S. Department of the Navy
Naval Facilities Engineering Command
Northern Division
10 Industrial Highway
Code 1823, Mail Stop 82
Lester, PA 19113-2090

Re: Draft Year 2 Annual Groundwater Monitoring Report for the Area A Landfill at the Naval Submarine Base - New London

Dear Mr. Evans:

EPA reviewed the *Draft Year 2 Annual Groundwater Monitoring Report for Area A Landfill*, dated March 2002 in light of the Groundwater Monitoring Plan [1], completeness of the execution and presentation, consistency of the interpretations with the available data, and appropriateness of the recommendations. The report briefly reviews the site history and documents results from four quarterly rounds of groundwater sampling and analyses performed between December 2000 and September 2001. The report also offers analyses and interpretation of the data, as well as recommendations for the monitoring program. Detailed comments are provided in Attachment A.

The field and analytical activities summarized in the Groundwater Monitoring Report (GMR) generally follow the Groundwater Monitoring Plan [1]. Deviations include omission of sampling from monitoring wells destroyed by remedial activities in the Area A Downstream area (wells 3MW12S,D), omission of sampling of surface water owing to lack of water, and omission of complete analyses for one sample from monitoring well 2WMW38DS because of small volume recovery. These deviations were inevitable.

Qualitative review of the data raises no significant concerns with respect to site contaminants that may have impacted groundwater. There are no detections of VOCs, pesticides, or PCBs. PAHs were detected above primary monitoring criteria in several samples. Arsenic and zinc (total) were detected in exceedance of primary monitoring criteria; chromium, copper, and lead were detected above secondary criteria in groundwater. Arsenic and zinc were found above the primary criteria; copper and lead were found above the secondary criteria in surface water. Arsenic in groundwater continues to be the most persistent and widespread contaminant of concern in exceedance of monitoring criteria. No temporal trends in arsenic concentrations are evident.

I look forward to working with you and the Connecticut Department of Environmental Protection to ensure that the Area A Landfill remedy remains protective. Please do not hesitate to contact me at (617) 918-1385 should you have any questions.

Sincerely,

Kymberlee Keckler, Remedial Project Manager
Federal Facilities Superfund Section

Attachment

cc: Mark Lewis, CTDEP, Hartford, CT
Dick Conant, NSBNL, Groton, CT
Jennifer Stump, Gannett Fleming, Harrisburg, PA

ATTACHMENT A

Page	Comment
p. 2-11, §2.3.6	The text notes that the Groundwater/Leaching Modeling Study predicted long-term changes in the groundwater elevations beneath the landfill cover, ranging from 0.1 feet along the Area A Wetland boundary to 0.5 feet at the eastern end of the landfill. Has this prediction been tested against water-level data collected before and after the cap installation? Such a test would add confidence to the model predictions.
p. 4-2, §4.2.1	It is interesting to note that chloride is very high (*e.g.*, 19,000 mg/L in 2WMW43DS in Round 8; *e.g.*, Table 4-2) in dredged material wells, and sodium, where data are reported, is also high (*e.g.*, 8,400 mg/L in 2WMW43DS in Round 8; *e.g.*, Appendix A of Appendix F), and correlated strongly with chloride. In addition, salinity was measured in the dredged material samples as high as 33 ppt (2WMW46DS; Table D-1). Thus, the dredged material pore water appears to retain a strong signal of the seawater that presumably once saturated it when in the Thames estuary. While high chloride is sometimes associated with landfill leachate, it is noted that 2WMW21S, which is not downgradient of the landfill, shows chloride comparable to other dredged material wells (*e.g.*, 17 ppt in Round 8; >21 ppt in rounds 2 and 3). Note that the high-chloride wells also show high calcium, magnesium, potassium, and alkalinity (*e.g.*, 2WMW43DS in Round 8: 202 mg/L; 668 mg/L; 371 mg/L; and 2100 mg/L, respectively), with levels also approaching those of seawater. As a conceptual model emerges for transport processes that influence inorganics concentrations, these observations should be incorporated. For example, how have these indicators of seawater persisted since the time of emplacement of the dredged material?
p. 4-2, §4.2.1	Reference is made in the first paragraph on this page to well 2WMW21DS, rather than 2WMW21S. Please check nomenclature for consistency.
p. 4-4, §4.2.1	It is interesting to note that pH and ORP appear to be inversely correlated (see, *e.g.*, Table D-1). This may reflect the residence time of groundwater, or equivalently, the distance traveled from recharge/infiltration. Low-pH (acid rain), high-ORP water recharges groundwater (*e.g.*, near 4MW1S), and is buffered along its path, while simultaneously being depleted of oxygen by interaction with organic carbon in the aquifer and/or the landfill.
p. 4-20, §4.5	Following previous review comments suggesting that elevated arsenic in groundwater in the dredged material might be because of reductive dissolution of iron oxyhydroxides and consequent mobilization of sorbed arsenic, the report shows plots of total arsenic versus total iron (Fig. 4-14) and dissolved arsenic

versus dissolved iron (Fig. 4-15). No correlation is apparent in these plots, as noted in the text. The lack of such an association is somewhat surprising, particularly given the strong correlation between arsenic and iron found in solid phases (see, *e.g.*, Fig. 4-13), along with the very low ORP found in groundwater in the dredged material. In view of the importance of understanding the processes controlling arsenic concentrations in groundwater at the site, and their implications for long-term monitoring, it is worthwhile to re-examine the existing data. In particular, it may be fruitful to seek factors that may mask a correlation between arsenic and iron in groundwater. First, the treatment of non-detects (NDs) may obscure a pattern. In the present case, it appears that Figures 4-14 and 4-15 are constructed by plotting As at half its detection limit when As is undetected. Detection limits for the arsenic analyses appear to be somewhat variable, ranging, for example, from 4 to 13.1 μg/L in Round 8 analyses on filtered samples. Analytical results for iron are not reported in Table 4-3; therefore, no assessment of iron detection limits and their possible influence on the plots can be made. In any event, perhaps the correlation should be sought only using analyses for which both As and Fe were quantified. Second, the text notes (p. 4-20, §4.5) that turbidity levels were high (visually), despite the low-flow sampling procedure. Although the correlation between As and Fe is not apparent even for the filtered samples, it is possible that the presence of very fine (<0.45 μm) particulates introduces another variable. Finally, it is sometimes found that careful separation of individual wells or groups of wells reveals a correlation, possibly owing to spatial variation in the ratio of arsenic to iron in solid phases. For future documentation of analytical results from the monitoring program, please report iron in the summary tables. (I note that iron analyses are reported in the QA tables provided in Appendix A (Qualified Analytical Results) of Appendix F (Round 8 Data Validation...), but only for samples that are qualified.) Given the potentially important role of iron in the transport of iron, these data should be documented.

In the absence of complete reporting of iron analyses, correlations between various metals were sought as a secondary indicator of reductive dissolution. It is expected that iron oxyhydroxides, if present, would sorb other metals in addition to arsenic. If these metals are present in groundwater in fixed ratios to iron, then they will also appear in fixed ratios to each other. Examination of data from Round 8 (Table 4-1) shows a correlation of copper and zinc for samples for which both elements were above detection limits. This test is limited, of course, by the small number of samples. However, it is suggestive of a role for reductive dissolution, even though a correlation of arsenic and iron is not apparent in the data presented in Figures 4-14 and 4-15.

p. 4-20, §4.5 I note in Table D-1 that DO is measurable at a few mg/L in many samples where ORP is very low (<-300 mV). For example, in 2WMW40DS in Round 8, DO is 3.36 mg/L, while ORP is -372 mV. Similarly, 2WMW43DS in Round 8 shows DO at 4.13 mg/L and ORP at -390 mV. While disparity between DO and ORP measurements is not uncommon because of limitations on field instrumentation or disequilibrium among the redox couples, these data raise questions about the redox conditions. The sulfate data, too, seem inconsistent with the reported ORPs. Sulfate reported for 2WMW43DS in Round 8 (see, *e.g.*, Appendix A of Appendix F) is 530 mg/L. How can this high sulfate be reconciled with the low ORP observed at this well? Is it possible that sulfide formation and oxidation plays a role in controlling iron concentrations in solution, and, by association, arsenic?

p. 4-20, §4.5 The "threshold" effect found in the plots of As versus TDS (Figs. 4-10 and 4-11) is intriguing; elevated As appears to be associated with samples with TDS greater than about 2000 mg/L. Is there a proposed mechanism to explain this phenomenon? Is it possible that the dredged material wells tend to be high in TDS from the seawater characteristics discussed in a previous comment, and that, somewhat independently (*e.g.*, because the dredged material is high in organic carbon and groundwater velocities are small), the dredged material wells also sample a highly reducing environment?

§5.2 A number of recommendations are made in §5.2, and are addressed in this comment.

Monitoring frequency: Reduction from quarterly to bi-annual sampling is appropriate at this time. Sufficient quarterly data are in hand to evaluate short-term variability, including potential seasonal effects. There are no indications of rapid changes in COCs that would require high-frequency monitoring in order to resolve trends.

Analytes: I agree that analyses for VOCs, pesticides, and PCBs can be eliminated without loss of significant data. These compounds have been ND for two years. Dissolved metals analyses, as well as the miscellaneous parameters (*e.g.*, alkalinity, COD, chloride, hardness, sulfate, TDS, TOC), are important to developing a defensible conceptual model for the transport of arsenic in this environment, and should not be dropped at this time.

Arsenic monitoring criteria: I agree that the appropriate criterion for arsenic should be discussed. It is not apparent that arsenic concentrations in groundwater downgradient of the landfill can be expected to change in the foreseeable future. A sound conceptual model for the source(s) and controls on transport of arsenic in this setting, consistent with available site data, is essential to guide the discussion.

Please evaluate all available data to support the development of a conceptual model for arsenic in this system. It is possible that the arsenic in the wetland wells (including those along the toe of the landfill) may be present in the dredged material, and mobilized by the reducing conditions that prevail. It is possible that the landfill has little influence on this picture. In particular, note that soil samples taken throughout the wetland correlate arsenic and iron, so the arsenic appears to be ubiquitous. Also, the wetland well 2WMW21S, which is a "reference" well - *i.e.*, not downgradient of the landfill --- seems to look chemically similar to the wells at the toe of the landfill. All of these are screened in the dredged material, all see highly reducing conditions, elevated As, high salinity, *etc.*

Another tool for getting at the hydrochemical facies is to look at major-element compositions of subdomains of the groundwater (and possibly the surface water). One way to do this is with Piper diagrams. For example, Piper diagrams could be used to see if the major-element chemistry of 2WMW21S fits with the other wetland wells downgradient of the landfill, which would suggest a minor role for the landfill in determining at least the major-element chemistry. In order to do this, the major element analytes on their PAL (Fe, Ca, Mg, Na, K, sulfate, chloride, and alkalinity) need to continue to be analyzed. This reviewer tried this with the few wells for which these results were reported (in the QA appendix). The wetland wells group tightly on the Piper diagram, so this is promising. However, the reviewer didn't have data for 21S. Surface waters grouped, too, but plotted in a different domain from the wetland groundwaters - not surprising, but verifying that the method can discriminate among waters.

Staff gauges and surface water sampling: The locations noted should be eliminated from the program, as surface water is not reliably present. Data from these locations will be sporadic, if any at all is collected, and their interpretation will be ambiguous, at best.

Downgradient well 3MW12S: The loss of downgradient monitoring well 3MW12S has been discussed in previous exchanges, and a convincing case has been made by Navy that the loss of these wells does not compromise the Area A Landfill monitoring program. In view of a historical lack of detections of constituents clearly associated with the landfill or the Area A wetlands, the stability of other monitoring points in the program, and the availability of another shallow downgradient well (3MW37S), the loss of the shallow downgradient well does not appear to result in a loss of critical data or monitoring coverage.

Downgradient well 3MW12D: I agree that the loss of 3MW12D leaves a significant gap in the coverage of the long-term monitoring program. Bedrock groundwater downgradient of the dike should be monitored in order to verify that contaminants are not transported from the Area A Landfill/Wetlands area and

discharged upward to overburden groundwater and/or surface water in the remediated Area A Downstream area.

REFERENCE

[1] Tetra Tech NUS, Inc., "Groundwater Monitoring Plan for Area A Landfill, Naval Submarine Base, New London, Groton, Connecticut," January 1999.