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C-49-11-5-103

November 17, 1995

Project Number 5082

Mr. Mark Evans
Northern Division (Code 1823)
Naval Facilities Engineering Command
Mail Stop 82, 10 Industrial Highway
Lester, PA 19113-2090

Reference: CLEAN Contract N62472-90-D-1298
Contract Task Order No. 203

Subject: Responses To USEPA's Comments On Letter Work Plan and Work Plan Addendum
Groundwater/Leachate Modeling Study
Area A Landfill Design
Naval Submarine Base New London, Groton, Connecticut

Dear Mr. Evans:

Please find attached one (1) copy of the responses prepared by Brown & Root Environmental (B&R Environmental), a division of Halliburton NUS Corporation, for the comments submitted to the Navy by U.S. EPA Region I (USEPA) in their letter dated October 24, 1995 regarding the Letter Work Plan and Work Plan Addendum for the Groundwater/Leachate Modeling Study being performed as part of the Area A Landfill remedial design.

Copy of the attached responses is being sent today via express mail to Kymberlee Keckler at USEPA and to Dale Weiss at TRC Environmental Corporation (TRC). Copies are also being sent via regular mail to Mark Lewis at the Connecticut Department of Environmental Protection (CTDEP), Jim Briggs at NORTHDIV Civil Design, and Andy Stackpole at NSB NLON Environmental Department.

Very truly yours,

Jean-Luc Glorieux, P.E.
Project Manager

JLG/jlg
Attachment

cc: Mr. Roger Boucher, NORTHDIV (letter only)
Mr. Jim Briggs, NORTHDIV (1 copy)
Mr. Andrew Stackpole, Environmental Department, NSB NLON (1 copy)
Mr. John Trepanowski, B&R Environmental, Wayne (1 copy)
Mr. Daryl Hutson, B&R Environmental, Pittsburgh (letter only)
File 5082

RESPONSES TO U.S. EPA'S OCTOBER 16, 1995 LETTER OF COMMENTS ON LETTER WORK PLAN AND LETTER WORK PLAN ADDENDUM FOR GROUNDWATER/LEACHATE MODELING STUDY AREA A LANDFILL REMEDIAL DESIGN NAVAL SUBMARINE BASE - NEW LONDON, GROTON, CONNECTICUT (November 17, 1995 Cover Letter)

GENERAL COMMENTS

1. Groundwater Level Measurements

Comment

Since the investigations at the Area A Landfill have been principally focused on source control, there is an incomplete database of groundwater level measurements and interpretation. Bedrock groundwater flow directions and the movement of groundwater at the Area A Landfill is not understood well enough to use a 3-D groundwater model (*see also* letter dated April 7, 1995). In fact, some contours are up to 30 feet apart.

In order to determine the success of a groundwater modeling effort, the model result should be compared to the known conditions. Since there are insufficient piezometric data to conceptualize the current groundwater head distribution at the Area A Landfill, there are not enough data to construct a 3-D MODFLOW groundwater flow model for the Area A Landfill. U.S. EPA believes that the proposed wells should be relocated as several locations within the assumed model boundary require piezometric data and other areas are already sufficiently covered.

Response

The Navy believes that the proposed field effort, which will include the completion of numerous fill, dredge spoil, and bedrock wells; drive point piezometers; staff gauges; and a comprehensive round of water level measurements in all newly completed and existing wells at the Area A Landfill, will provide a sufficient amount of information to satisfy the project objectives and to determine the appropriateness of a 3-D groundwater modeling effort. Data collected in the field will be interpreted along with existing data to update the conceptual model of hydrogeologic conditions for the site. Once the newly collected data is interpreted, a decision will be made as to the most appropriate approach to modeling the site so that key questions can be answered regarding the cap and trench design. The Navy reserves the right to conduct a supplemental field investigation to collect additional data if the results of the current field effort do not sufficiently answer questions about the hydrogeologic conditions at the site.

As discussed in the Draft Letter Work Plan (September 5, 1995) and the Letter Work Plan Addendum (October 5, 1995) a comprehensive round of water level measurements will be collected from all newly installed wells and existing wells at the Area A Landfill. The newly

collected data will be used during the calibration of the proposed model. In addition, the Second Letter Work Plan Addendum (October 25, 1995) discusses the relocation of several wells and the addition of two temporary drive point piezometers in the fill, one dredge spoil well, and one bedrock well to provide better areal and vertical coverage of the Area A Landfill for estimating the potentiometric surface in the various geologic units. These revisions were made to address concerns of U.S. EPA and its contractor (TRC). Therefore, the comprehensive round of water level measurements to be collected at the site will provide sufficient information to define the potentiometric surfaces in the fill, dredge spoil, and bedrock.

2. Model Development Details

Comment

The Work Plan and addendum do not provide enough information to assess the modeling proposal and the proposed data collection program. In particular, the Work Plan should clearly state the following details regarding the groundwater flow model: dimensions of model (2-D or 3-D); size of model grid; location of model grid; number of layers to be modeled; dimensions of grid cells; cell types (active, river, constant head, constant flux, etc.); number and location of calibration points and calibration threshold; contaminants of concern to be modeled; decay parameters; and the software to be used for transport modeling. Additionally, U.S. EPA requested copies of the geoprobe logs at the September 27, 1995 meeting that still need to be provided.

Response

Once the proposed field effort is completed and the newly collected and existing data has been interpreted, the appropriate modeling approach will be defined. Details of the modeling effort requested in the comment such as: dimensions of model (2-D or 3-D); size of model grid; location of model boundaries; number of layers to be modeled; cell types (active, river, constant head, constant flux, etc.); number and location of calibration points and calibration threshold; contaminants of concern to be modeled; decay parameters; and the software to be used for transport modeling will be defined using the data collected. The Navy will prepare a supplemental document which summarizes the information requested by U.S. EPA and will be submitted for their review and comment before finalizing the modeling approach.

The Navy will submit a copy of the geoprobe logs to U.S. EPA. The purpose of the geoprobes was to determine the depth of bedrock and they will not provide U.S. EPA with significant information other than the depth to bedrock.

3. Standard Operating Procedures

Comment

Most of the SOPs appear to be incomplete. For example, SOP GH-2.5 begins with Section 5.0 on page 3 of 10. Additionally, this SOP does not include any information on contour mapping.

Response

It is the general practice of the Navy's contractor to provide only those portions of an SOP that are applicable to the project of concern. In some instances only several sections are applicable and only those sections are provided. This manner of providing only applicable SOPs eliminates confusion and reduces the volume of the work plan.

The SOPs provided in the work plan are only for field activities. Section 5.3 of SOP GH-2.5 provides information regarding potentiometric surface mapping. This information, along with other SOPs applicable to modeling activities, will be provided to U.S. EPA for review in a supplemental document which will outline the details of the modeling effort.

SPECIFIC COMMENTS (ATTACHMENT A)

4. Page 1, Paragraph 4

Comment:

Add "determining how to dewater the saturated waste material" as an objective.

Response:

A toe drain system will be evaluated as part of the modeling effort and this is discussed in the Work Plan on page 3, paragraph 4. It is assumed that the toe drain is an effective tool for dewatering the saturated waste material. The only question to be answered is how deep of a toe drain is necessary to dewater the waste material. Other methods of dewatering the saturated waste will not be evaluated as part of this task.

5. Page 4

Comment:

Indicate that a model sensitivity analysis will be performed before the model simulations.

Response:

The Navy does not understand the logic of performing a model sensitivity analysis before the model simulations. The general sensitivity of model performance to each parameter will be understood during the model development and calibration process. A final sensitivity analysis should be used to determine the uncertainty in the model results. Therefore, the model should be calibrated, validated, and then the model simulations should be performed to give a baseline set of results. After which, a sensitivity analysis is performed to bracket or give the range of model results to quantify the uncertainty in the results due to uncertainty in model parameters.

This methodology for sensitivity analysis is typical for modeling projects and has been accepted in various U.S. EPA regions. Therefore, the Navy does not feel that it is appropriate to agree to performing sensitivity analysis before the model simulations. The Navy will conduct sensitivity/uncertainty analysis after the model simulations.

6. Page 6, Paragraph 3

Comment:

Demonstrate that the data needs were developed after consideration of existing data and data gaps. The resulting data collection effort is not adequate to support a 3-D groundwater flow model.

It is not clear why 2LMW31F is proposed, given that two monitoring wells screened in the fill are located within 80 feet (2LMW8S and 1MW2S). Similarly, it is unclear why there is a proposed monitoring well at location 2LMW29F, since the pump test well (2LPW1S), screened in the fill is located less than 50 feet away. The monitoring well proposed at location 2LMW28F is located within 100 feet of four wells screened in the fill (2LOW1S, 2LOW2S, 2LOW3S, and 2LPW1S). The monitoring well at location 2LMW33F is located within 100 feet of well 2LMW20S, also screened in the fill layer. Lastly, the need for the two upgradient bedrock wells is not clear, and it appears that bedrock wells located within the model boundary would provide more relevant information for the groundwater flow model construction and calibration.

As a result, the 3-D distribution of piezometric data points for the hydrostratigraphic layers to be modeled should be reassessed. Additional wells or piezometers should be installed where there is not sufficient data to interpret the current water level elevations. U.S. EPA suggests the following locations for additional monitoring points: approximately four monitoring points should be installed in the fill at locations between transects B-B' and C-C'; and additional bedrock water level monitoring points should be added near 2LTB27, 2LMW30 (proposed location), 2LPZ30S (proposed location), GP22, and GP3.

Although the Work Plan did not specify how many layers will be modeled, we discussed that the dredged material would be included as a model layer. If the dredged material is modeled as a separate layer (rather than treating the dredged material using leakance between the fill and bedrock), then a significant amount of piezometric information is needed. Currently, there

are no wells screened solely in the dredged material, yet only four wells are proposed. The Work Plan does not include a map showing the extent and thickness of the dredged material. The boring logs and cross sections indicate that the dredged material is extensive and it is not possible to determine the fluid potential without a more extensive spatial distribution of piezometric data.

Response:

The proposed field effort to collect additional hydrogeologic data for the modeling effort was developed considering the existing data and data gaps. For example, little or no information was available for unit-specific hydraulic conductivity values, therefore the Navy proposed to install unit specific wells and perform slug tests in them. In addition, little information was known about the potential confining effect of the dredge spoil layer and its effect on the potentiometric surface in the fill, dredge spoil and the bedrock. Therefore, monitoring well clusters were proposed to be installed to understand the potentiometric surface in the fill, dredge spoil, and bedrock at various locations across the landfill. The Navy believes that until the proposed field effort is completed and the results are interpreted, it is premature to state that the proposed data collection effort is inadequate to support a 3-D groundwater flow model.

Monitoring wells 2LMW8S (fill/alluvium) and 1MW2S (fill/dredge) are screened in multiple units. These wells are not suitable for estimating hydraulic conductivities for a specific unit by slug testing. In addition, a better estimate of the potentiometric surface in a unit can be estimated by taking water level measurements from a well screened in a specific unit. Therefore, a fill monitoring well (2LMW31F) is necessary in this area because there are no other wells in the area to determine fill-specific hydraulic conductivities or to measure fill-specific water levels.

Pump test well 2LPW1S (fill/dredge) is screened in multiple layers. Therefore, for the same reasons as discussed above a new fill monitoring well (2LMW29F) is necessary in this area.

Monitoring wells 2LOW1S (fill/dredge), 2LOW2S (fill/dredge), 2LOW3S (fill/dredge) and pump test well 2LPW1S (fill/dredge) are screened in multiple layers. Therefore, for the same reasons as discussed above a new fill monitoring well (2LMW28F) is necessary in this area.

Monitoring well 2LMW20S (fill/alluvium) is screened in multiple layers. Therefore, for the same reasons as discussed above a new monitoring well (2LMW33F) is necessary in this area.

The two upgradient bedrock wells (2LMW35B and 2LMW36B) will be used for two purposes; to answer questions about groundwater flow directions for the draft final Phase II RI and to provide potentiometric information for determining boundary conditions for the Area A Landfill modeling effort. This cost effective approach does result in less specific information for determining the boundary conditions for the model (i.e., no data collected directly along the boundary), but it is felt that the wells will provide adequate information for the estimation of boundary conditions.

As a results of the conference call held on October 20, 1995 between the Navy, U.S. EPA and their contractors, it was agreed that many of the proposed wells would be acceptable with

minor modifications to their locations and only two extra wells (2LMW34DS and 2LMW32B) and two extra fill drive point piezometers (2LPZ1F and 2LPZ2F) were necessary. This information is summarized in a second Letter Work Plan Addendum dated October 25, 1995. The field investigation modifications were reflected on a revised Figure 3-1 which was attached to the second addendum. It was also agreed upon that if the results of this field effort were not conclusive, the Navy would consider a second field effort to answer any remaining critical questions.

Seven wells are proposed to be screened in the dredge spoil layer. However, there is a possibility that two or three of these proposed wells (2LMW29DS, 2LMW31DS/A, and 2LMW33DS) may ultimately be screened in alluvium depending on what is found during the field effort. The reason for this uncertainty is due to the discontinuous nature of the dredge spoil along the southern side of the landfill. Therefore, there will be at least four wells screened specifically in the dredge spoil layer, each of these wells will be slug tested, and water levels will be measured in each of the wells. If only four dredge spoil wells are installed, these wells (2LMW28DS, 2LMW30DS, 2LMW34DS, and 2LMW32DS) will still be areally distributed across the Area A Landfill from east to west and should provide relevant information regarding the confining nature and the potentiometric head in the dredge spoil across the landfill. The proposed field effort will better define the extent of the dredge spoil and a map of the extent and thickness of dredge spoil will be prepared once the results of the field effort are available.

7. Page 8, Paragraph 4

Comment:

The Work Plan needs to include the following details regarding the groundwater flow model: dimensions of model (2-D or 3-D); size of model grid; location of model grid; number of layers to be modeled; dimensions of grid cells; cell types (active, river, constant head, constant flux, *etc.*); number and location of calibration points and calibration threshold; and target groundwater elevation maps for each layer used for calibration.

The model should be oriented northwest-southeast and should extend at least 300 to 500 feet south of the landfill boundary. Cell dimensions should be no larger than 20 feet in the area of the landfill because the landfill is only 200 feet wide, and water levels vary more than ten feet over the landfill width. Larger cells may be used in the buffer areas at the edge of the model. Constant head nodes should not be used in the model since there are no water bodies (such as a lake or large river) which would serve as an infinite supply of water. Use constant flux cells where possible. If flow from the seep is significant, use a drain node to simulate the seep. The model discretization should be fine enough to allow simulation of the interception trench and the toe drain.

Response:

The Navy feels that to meet the overall objectives of the project that a 3-D groundwater flow model should be used to evaluate the hydrogeologic conditions at the Area A Landfill. It is hopeful that when the proposed field effort is completed and the data has been interpreted,

the 3-D modeling approach will be confirmed. Existing data as well as newly collected data will be used to make the decision. If the results of the evaluation of existing and proposed data do not confirm a 3-D modeling approach, the Navy will either conduct an additional field sampling event or reconsider their proposed modeling approach.

Details of the modeling effort requested in the comment such as: dimensions of the model; size of model grid; location of model; number of layers to be modeled; cell types (active, river, constant head, constant flux, *etc.*); number and location of calibration points and calibration threshold; and target groundwater elevation maps for each layer used for calibration will be defined using the newly collected and existing data. The Navy will prepare a supplemental document which summarizes the information requested by U.S. EPA and it will be submitted for their review and comment before finalizing the modeling approach.

The Navy will keep in mind the information discussed in the second paragraph of the above comment when developing the model. This information will be used as a guide and if any of the guidelines can not be followed then the reasons and the rationale used for taking a different approach will be documented in the supplemental document to be provided to U.S. EPA.

8. Page 9, Paragraph 1

Comment:

The plan should also acknowledge that the sensitivity analysis will determine how sensitive the model is to an inaccurate selection of key parameters (*e.g.*, recharge, vertical and horizontal hydraulic conductivity, *etc.*).

Response:

The Navy generally agrees with U.S. EPA's understanding of sensitivity analysis as discussed in the comment. However, the use of the statement "...inaccurate selection of key parameters..." in the comment may not be the most appropriate terminology to describe a sensitivity analysis. Field tests (i.e., slug tests, infiltration tests, etc.) are performed to estimate model parameters. There are inherent errors related to field tests and to compound those errors, simplified equations are used to determine the parameters from the field test results. The resulting information is therefore only a best estimate of natural conditions. With this information in mind, the Navy feels that it is not the inaccurate selection of key parameters which is of importance, rather the inaccuracy of the key parameters themselves that should be evaluated by the sensitivity analysis. A statement such as "Sensitivity analysis helps to determine the potential for errors in model results that may be caused by a lack of accuracy in the various input parameters (e.g., recharge, vertical and horizontal hydraulic conductivity, etc.)." will be included in the report which will be prepared to document this modeling effort.

9. Page 10, Paragraph 3

Comment:

The Work Plan suggests that the fate and transport model will attempt to simulate the *natural decay of contaminants*. However, if biodegradation or some other *natural process* is modeled, then information regarding the decay rates and other fate parameters must be provided and referenced.

The plan for modeling contaminant transport is not clearly discussed. The Work Plan mentions using both MT3D (page 9) and performing a simpler estimation using mass-flux equations (Section 5.1.2).

Response:

All decay rates and fate and transport parameters to be used will be documented in the report, which will be prepared to document the modeling effort.

The mention of MT3D on page 9 of the Work Plan was only to summarize other modular programs that can use MODFLOW results. There is no mention of using this program for the modeling effort anywhere in the Work Plan. A simple mass-flux approach is proposed to be used for this project and it is discussed in detail in the Work Plan in Section 4.7 and Section 5.1.2.

10. Page 10, Paragraph 5

Comment:

Since the objective of this modeling study is to "predict the impact upon the flow rate and quality of the groundwater/leachate discharge (page 1)," the Work Plan should develop a conceptual model for contaminant transport to identify data gaps.

Response:

A more detailed conceptual model for contaminant transport, including a verbal description and pictorial representation, will be identified in the supplemental document to summarize detailed modeling information. This document will be supplied to U.S. EPA for their review and comment prior to finalizing the modeling approach.

11. Page 10, Paragraph 7

Comment:

The calibration plan is not adequate. The Work Plan proposes to calibrate to within the range of observed water levels, that have historically varied as much as 7 feet. The model should select a target calibration data set (*e.g.*, April 1994), and calibrate the model to match the

target groundwater elevations within one foot. The calibration error should be less than one foot everywhere, and should not be compared to an average error. In addition, the gradient should be calibrated if possible to an acceptable value (*e.g.*, ±20%).

The model should be calibrated to a conservatively high water level scenario, as typically occurs in the spring.

Response:

The Navy will attempt to achieve the calibration criteria discussed in the above comment when developing the model. The Navy will also calibrate the model to a conservatively high water level scenario, as typically occurs in the spring. The Navy has committed to contact U.S. EPA throughout the modeling process to apprise them of their progress. If, during the calibration procedure, there is any difficulty in meeting U.S. EPA's criteria, U.S. EPA will be contacted and a mutual agreement will be reached on the proper approach to finalize the calibration of the model. The consequences of not achieving these criteria will also be determined by the sensitivity /uncertainty analysis.

12. Page 11, Paragraph 6

Comment:

The Work Plan should indicate which contaminants of concern will be used in the transport model. Contaminants selection should be based on toxicity, mobility, and type of contaminant. Clarify what is meant by most significant Contaminants of Concern.

Response:

The contaminants of concern (COCs) that will be modeled will be identified in the supplemental document to be supplied to U.S. EPA for review and comment. The screening procedure for identifying COCs will be included in that document as well.

Paragraph 2 of Section 5.1.2 of the Work Plan clarifies the meaning of "most significant Contaminants of Concern." The third sentence in the paragraph is as follows: "COCs that contribute significantly to the risk of the site, are the most prevalent, and are most mobile will be the focus of the calculations." Therefore, the Navy was planning to use a COC selection process which accounted for toxicity, frequency of detection, and mobility.

U.S. EPA's request for using "type of contaminant" for the screening process is not thoroughly understood by the Navy. It is assumed for this response that this statement refers to contaminant categories such as inorganics and organics. An evaluation of contaminant type will be made to screen out contaminants (i.e., inorganics) that may be attributable to background conditions.

13. Page 19, Paragraph 1

Comment:

The report for this study needs to include the following: elevation maps for all hydrostratigraphic units modeled, including posted data points; target piezometric maps for each layer; calibrated piezometric maps for each layer; input parameter maps for hydraulic conductivity, cell type, recharge, *etc.*; difference maps for modeled minus target heads for each layer; predicted piezometric maps for all layers; difference maps for predicted minus modeled (or target) heads for each layer; and particle tracking, if performed.

Response:

The Navy will provide figures in the Area A Landfill Groundwater/Leachate Modeling Study report that detail the information requested by U.S. EPA in the above comment. Supplemental information will be presented in tabular format. The information requested is typical of what would be included in a report for a modeling study.

14. Page 19, Paragraph 4

Comment:

As discussed on September 27, 1995, the two to three proposed meetings held during the modeling process at critical decision points (*e.g.*, after model conceptualization; after model calibration and sensitivity analysis; after selection of contaminants of concern/prior to transport modeling) may be conference calls as long as they are supplemented with a hard copy of the current modeling results.

Response:

The Navy is committed to keeping U.S. EPA informed on the progress of the modeling project throughout the task. The Navy concurs with U.S. EPA's approach of conference calls with supplemental data for keeping everyone informed. The Navy feels that this is an efficient and cost-effective approach to resolving problems.

15. Page A-4, Paragraph 4

Comment:

Field Sampling and Analysis Plan: Obtain bedrock cores at several locations to evaluate the groundwater flow network in bedrock. Bedrock cores will help determine the extent of fracturing and the degree of anisotropy.

Response:

Several bedrock cores can provide a qualitative assessment of bedrock fracturing, but they

will not provide sufficient quantitative information for input to a groundwater model. The modeling code (MODFLOW) that is proposed for this project is capable of simulating flow in porous media, but it does not have the capability of simulating flow in fractured media. Therefore, the Navy does not understand U.S. EPA's request for information regarding the extent of fracturing and the degree of anisotropy since the information would have little bearing on the development of the proposed model. The field geologist will identify and record the depths and approximate yields of water bearing zones encountered during air rotary drilling operations.

16. Page A-6, Paragraph 2

Comment:

The bedrock hydraulic conductivity testing should be determined using packer tests or pumping tests, because the data analysis method for slug tests does not account for the non-homogenous conditions in the bedrock aquifer.

Response:

Contrary to the statement in the above comment, packer test analysis methods do not fully account for non-homogeneous conditions. Only pumping tests can be used to identify large scale non-homogeneities in a formation, however this requires a detailed, long-term test with numerous observation wells. Based on a cost-benefit basis, the Navy does not feel a test of this magnitude is warranted. Slug testing a cased-off bedrock well will provide similar estimates of hydraulic conductivity as a packer test in the same well if done properly. Slug test analysis and measured hydraulic potentials in existing and new bedrock wells will provide a means to delineate potential zones of preferential flow in the bedrock. Consideration of non-water yielding zones encountered in bedrock will be built into the slug test evaluation process to provide more accurate estimates of the bulk hydraulic conductivity of the bedrock. The slug testing results will provide reasonable estimates of bulk hydraulic conductivity which will be used as input to the model. During calibration of the model it is possible that hydraulic conductivity values will be corrected to fit measured flow conditions. Therefore, the reasonable estimates of hydraulic conductivities estimated from the slug tests will be refined during model calibration.

17. Addendum, Page 2, Paragraph 3

Comment:

Although U.S. EPA agrees that the resolution needed to accomplish the stated objectives is not as high as that needed to evaluate pumping scenarios, minimum amount of information describing the current groundwater flow system is necessary to attempt a model simulation. If there are not enough data to develop a confident interpretation of piezometric elevations and hydrostratigraphy, then it will not be possible to determine if the model is an accurate representation of the real system. Currently, it is not clear what is meant by low resolution, so it is not possible to determine whether a sufficiently detailed approach is

proposed. However, a series of well planned 2-D cross-sectional models may be more useful and reliable. As discussed above, additional model specifics are needed to evaluate the current proposal.

Response:

The Navy intends on using a 3-D groundwater flow model to evaluate the hydrogeologic conditions at the Area A Landfill. It is hopeful that when the proposed field effort is completed and the data has been interpreted, the 3-D modeling approach will be confirmed. Existing data as well as newly collected data will be used to make the decision. If the results of the evaluation of existing and proposed data do not confirm a 3-D modeling approach, the Navy will either conduct an additional field sampling event or reconsider their proposed modeling approach. The Navy will prepare a supplemental document that summarizes the details of the model, and it will be submitted to U.S. EPA for their review and comment.

18. Addendum, Page 3, Paragraph 2

Comment:

Simply measuring the head difference between two wells will not demonstrate that there is flow between the two units. Two-dimensional flow diagrams or a 3-D model must be used to evaluate such behavior.

Response:

Measuring the potentiometric head in specific units allows one to determine the potential for flow between separate units. However, as discussed in the comment it does not demonstrate that there is flow between the units. The proposed field effort targets specific units for installation of monitoring wells and water level measurements to try to understand the potential for flow between separate units. The field data will be used for creating and calibrating a groundwater flow model for the site. Prior to numerical modeling, 2-D flow diagrams will be created and utilized during the conceptual model development process. If an adequate 3-D model can be developed and calibrated with the existing and additional data that is to be collected, then the flow between units can be further evaluated using the 3-D model.

19. Addendum, Page 3, Paragraph 3

Comment:

The Work Plan also indicates that the bedrock hydraulic conductivity will be measured.

Response:

A discussion of the measurement of bedrock hydraulic conductivity is not included in this paragraph because it is not related to the topic of discussion. It is understood that the hydraulic conductivity of the bedrock is an important piece of information that is needed for

determining the modeling approach. However, the dredge spoil layer is the "buffer layer" between the bedrock and the fill and flow through this dredge spoil layer is most critical for estimating the flow to the fill from the bedrock. Therefore, this paragraph does not discuss the bedrock hydraulic conductivity values or their method for estimation.

20. Addendum, Page 3, Paragraph 4

Comment:

The addendum indicates that "several overburden and bedrock well clusters . . .currently exist along the upgradient portion of the landfill," but there appear to be only two clusters (2LMW8, 2LMW20).

Response:

The Navy disagrees with U.S. EPA's estimate of upgradient well clusters. There are four monitoring well clusters which currently exist along the upgradient (southern) portion of the landfill. They are the following: 4MW4S/4D, 2LMW8S/8D, 2LMW20S/20D, and 2WMW3S/3D. Well cluster 4MW4S/4D may not be considered a true overburden/bedrock well cluster because 4MW4S is completed in the till and bedrock units. Therefore, even if this well cluster is disregarded, there are still at least three overburden/bedrock well clusters that currently exist along the upgradient (southern) portion of the landfill.

21. Addendum, Page 4, Paragraph 1

Comment:

It is not clear that water levels in the wetland will be unchanged by landfill capping. Presumably, the leachate outflow will be eliminated, possibly resulting in lower water levels in the wetland near the landfill.

Response:

The statement is made in this paragraph that " the hydraulic head is not expected to change from the existing condition once the landfill cap is installed." This statement was made using the following logic. Surface water runoff is most likely the largest contributor to the surface water levels in the wetland and groundwater would generally contribute to "base" surface water levels in the wetland. The surficial groundwater levels in the wetland (i.e., in the dredge spoil layer) are likely controlled by the surface water body and lateral recharge from overburden layers. The groundwater levels in the bedrock under the wetland are likely controlled by the recharge areas upgradient of the wetland. Based on the current design of the cap for the Area A Landfill, runoff from the cap, upgradient runoff collected by the interception trench, and infiltration intercepted by the drainage layer of the cap will be diverted around the landfill to the Area A Wetland. It is unlikely that the surface water levels in the wetland will be lowered because the total flow rate into the wetland due to runoff will be approximately the same as the leachate flow rate. In addition, the landfill cap will positively

impact the flow into the wetland because previously contaminated leachate will now be diverted around the landfill and will be uncontaminated. Therefore, the Navy feels that making the assumption that the water levels in the wetland will remain unchanged after construction activities is appropriate.

22. Addendum, Page 4, Paragraph 2

There are not sufficient piezometric data to understand the current groundwater flow system, and therefore there are not sufficient data to calibrate a 3-D flow model. There are only three wells that are screened solely in the fill layer, and seven wells that are screened more than 50 percent in the fill. It is not clear how the wells that are not screened solely in the fill can be used to measure the piezometric surface in the fill unit. Even if all ten wells can be used they are not distributed evenly across the landfill. Five of these wells are clustered around the pumping test well. There are no wells screened solely in the dredged material, so there is no piezometric data for this layer. There are 12 wells that are open in bedrock, and these are well distributed across the landfill, although the opened intervals range greatly in depth. There are a few areas where additional bedrock piezometric data are needed, but the data needs for the fill and dredged material are more critical.

Response:

The Navy has made modifications to the work plan to address U.S. EPA's concerns about the number and locations of proposed monitoring wells. The modifications are presented in the second Letter Work Plan Addendum dated October 25, 1995. These modifications were made based on discussions between the Navy, U.S. EPA and their contractors on October 20, 1995 during a teleconference.

The following table (Table 1) summarizes the monitoring wells in the vicinity of the Area A Landfill which could be considered as fill monitoring wells. Only nine wells are included in the table in comparison to the ten indicated in U.S. EPA's comment above. The reason for the discrepancy is not known because the monitoring well numbers considered by U.S. EPA are not provided. Information summarized in the table includes the ground elevation at the well, the screened elevation, water level measurements, and thickness and percentage of fill or other unit screened.

As can be seen in the table, all wells except 2WMW3S are completed in a majority of fill or alluvium. The alluvium should not be a semi-confining layer and the potentiometric head in the fill and alluvium should be similar. Therefore, it seems appropriate to use water levels from these wells to represent the water table in the fill material. Monitoring well 2WMW3S it is a borderline well because it is completed approximately 50% in fill and 50% in dredge spoil. The two water level measurements taken at this well and shown in the table are relatively constant over time. This occurrence would indicate that the water level in this well may be under pressure and is affected by potentiometric head of the dredge spoil layer. Therefore, this well should probably not be used to define the water table in the fill material. With the exclusion of 2WMW3S, there are 8 existing monitoring wells which can be used to define the potentiometric surface in the fill material. These wells are areally distributed from east to west across the site, but do not completely cover the site in the south to north

direction. However, the proposed fill monitoring wells and piezometers will complement the existing wells and will provide the areal coverage needed to provide a sufficient fill potentiometric surface for modeling purposes. A summary of the proposed field effort is presented in the paragraph below.

Table 1

Monitoring Well	Ground Elevation (ft msl)	Elevation Screened (ft msl)	Measured Groundwater Elevations (ft msl)[1]		Amount of Screen Interval in Fill (ft) and Percent (%)	Amount of Screen Interval in Other Material[2] and Percent (%)
			March '94	August '94		
2LMW8S	86.40	80.9-70.9	87.32	80.45	4 (40%)	6 (60%A)
2LMW13S	86.90	80.4-70.4	75.57	72.40	10 (100%)	0 (0%)
2LMW18S	77.94	72.2-62.2	72.65	71.23	10 (100%)	0 (0%)
2LMW20S	87.35	78.4-68.4	72.98	71.28	1 (10%)	9 (90%A)
2LPW1S	86.25	82.3-72.3	78.55	77.10	7 (70%)	3 (30%DS)
2LOW1S	86.26	82.3-72.3	78.61	77.13	8 (80%)	2 (20%DS)
2LOW2S	86.69	82.7-72.7	78.64	77.67	7 (70%)	3 (30%DS)
2LOW3S	85.50	82.5-72.5	78.09	75.57	7 (70%)	3 (30%DS)
2WMW3S	82.80	75.0-60.0	74.47	74.21	7 (47%)	8 (53%DS)

(1) Water level measurements were taken from the Draft Phase II RI Report.
(2) Other Material refers to the following material: A = Alluvium; DS = Dredge Spoil.

The following information is contained in the second Addendum to the Letter Work Plan (revised Table A-2) and summarizes the Navy's current approach to the proposed field effort. Six fill monitoring wells; seven dredge spoil monitoring wells; three bedrock monitoring wells; six dredge spoil drive point piezometers; two fill drive point piezometers; and eight staff gauges are proposed to be installed to collect data for the modeling project. Water levels will be measured in each of the proposed unit-specific wells and each will be slug tested to determine estimates of hydraulic conductivity. Water levels will also be measured in each piezometer and at each of the existing monitoring wells. The wells, piezometers, and staff gauges are distributed across the landfill to provide sufficient coverage of the site for developing a model. Locations of the proposed wells and drive points are shown on revised Figure 3-1, which is attached to the second Addendum to the Letter Work Plan (October 25, 1995).

23. Addendum, Page 4, Paragraph 3

Use of water levels from the fall of 1995 will result in a less conservative estimate of leachate flow since water levels are considerably higher in the spring (also, the summer of 1995 was considerably dry). Propose an approach to develop a more conservative calibration target.

The potentiometric maps presented in the Phase II RI are not adequate for this modeling task. Potentiometric maps were not prepared for the fill and bedrock separately, and the existing maps do not provide sufficient detail to allow calibration to within one foot. The existing potentiometric maps use contours ranging from 10 feet to 30 feet. Although the Navy has committed to revising these maps, U.S. EPA has not yet reviewed these maps.

Response:

A considerable amount of rainfall has occurred during the fall of 1995. It is possible that the rainfall and subsequent infiltration has returned water levels to normal or high conditions. Therefore, until the comprehensive round of water level measurements is taken, it is premature to make any judgement on the acceptability of using the data for calibration. Once the water levels are collected and evaluated, the Navy will determine their acceptability and will develop an alternate approach for using the data if necessary. In either case, the data and approach will be discussed with U.S. EPA to get their approval.

The potentiometric surface map (Drawing 4) presented in the draft Phase II RI was developed to show general groundwater elevations and flow patterns for the site. New maps have been developed, taking into account shallow overburden and bedrock, and will be submitted as part of the draft final Phase II RI. The new maps are still not at a scale which presents extensive detail for each site. The paragraph in which the use of these maps is discussed states that the "...potentiometric maps from the Draft Phase II RI report will be used for preliminary conceptualization...". The Navy feels that U.S. EPA may have misunderstood the intended use of the figures, as the Navy only plans to use them for conceptualization. The maps will not be used as a calibration target for the modeling task. Instead, a more detailed figure will be developed for the modeling task at the Area A Landfill using newly collected data, if it is applicable (see paragraph above), or a combination of new and existing water level data.

24. Addendum, Page 5, Paragraph 1

Comment:

It is unclear what is meant by "triangulated data" in this sentence. Contour maps need to be prepared by hand in order to properly interpret geologic influence on groundwater flow and on unit thicknesses. Computer contoured maps of model output will be acceptable since they will be prepared from a grid of data points.

Response:

The word "triangulation" was not used correctly in this sentence. A database of existing and proposed topographic elevation information for the Area A Landfill was developed during the

design of the cap. The existing Area A Landfill surface contours were developed using aerial photogrammetry and the contours were developed at a 1-foot contour interval. The proposed cap surface was developed using an advanced site design software (TERRA model) to "layout" the surface to meet design requirements. A triangulation method is used by this model to generate contours. The method of triangulation uses groups of three data points (a triangle) to develop contours. This method is used extensively and is typically acceptable. The bedrock surface map was developed by a qualified geologist using existing bedrock elevation information from test pits, borings, and geoprobes. Triangulation and judgement were used for developing the bedrock surface map.

The Navy will follow U.S. EPA's suggestions for contouring existing data and computer generated data. Groundwater contours will be generated by hand from measured groundwater elevations by a qualified geologist using the method of triangulation and knowledge of the site. Model output will be contoured by a computer program and the resulting contours will be checked by hand for accuracy.

25. Addendum, Page 5, Paragraph 3

Comment:

It is unclear how the hydraulic conductivity test results from the dredged material Shelby tube samples will be used. These results should be used to estimate vertical hydraulic conductivity in the dredged material, or leakance between the fill and bedrock.

Response:

The Navy believes that the dredge spoil is a critical layer which must be understood to develop a representative model. This layer is the "buffer" layer between the bedrock and fill. The layer will likely control the flow of water between the two units. As proposed in the Work Plan, the values can be used as the vertical hydraulic conductivity of the dredge spoil in the 3-D model that is to be developed. The values can also be used in a 2-D cross-sectional model, however the Navy has not committed to using a 2-D model. The final design of the model has not been determined due to data gaps. Once the field effort is completed, the data will be interpreted and the most appropriate model design will be developed.

26. Addendum, Page 5, Paragraph 4

Comment:

The approach presented in this paragraph is unclear. The Work Plan proposes to construct a 3-D model to calculate QS, QD, QI, and QF; yet this paragraph discusses estimation of these values using the field data. Since a 3-D model is planned, it is unclear why estimation of these values is necessary.

Response:

A 3-D model is proposed to be used to estimate Q_S, Q_D, Q_I, and Q_F. The discussion provided in paragraph 4 on page 5 was intended to discuss the data that is available for the model. The paragraph may have been misleading. Hand calculations will be performed with some of the data to do a check on the model results. However, this was not the intention of this paragraph.

27. Addendum, Page 6, Paragraph 1

Comment:

As indicated above, a 3-D model needs to be based on a sufficiently complete 3-D database of hydrologic and geologic data. The proposal to collect data along three 2-D cross sections, in some cases duplicating existing well locations, is not consistent with the data needed to develop a 3-D model. The data collection plan should be reevaluated in light of the data needed to complete the proposed 3-D model.

Response:

The Navy has made modifications to the work plan and first addendum to address U.S. EPA's concerns about the number and locations of proposed monitoring wells. The modifications are presented in the Second Letter Work Plan Addendum dated October 25, 1995. These modifications were made based on discussions between the Navy, U.S. EPA and their contractors on October 20, 1995 during a teleconference.

The Navy intends on using a 3-D groundwater flow model to evaluate the hydrogeologic conditions at the Area A Landfill and they feel that this type of model is the best for understanding the 3-D hydrogeologic conditions which are important to the project objectives. It is hopeful that when the proposed field effort is completed and the data has been interpreted, the 3-D modeling approach will be confirmed. Existing data as well as newly collected data will be used to make the decision. If the results of the evaluation of existing and proposed data do not confirm a 3-D modeling approach, the Navy will either conduct an additional field sampling event or reconsider their proposed modeling approach. The Navy will provide all information regarding the model to U.S. EPA for their review and comment when it is available.