5395-6.6-198

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C-49-7-7-160

6.6-7/22/97-1401

July 22, 1997

Brown & Root Environmental Project Number 5395

Mr. Lance Laughmiller
Atlantic Division
Naval Facilities Engineering Command
Code 1823
6500 Hampton Boulevard
Norfolk, Virginia 23508

Reference: CLEAN Contract No. N62472-90-D-1298
Contract Task Order No. 211

Subject: Feasibility Study - Operable Unit 2
Marine Corps Air Station
Cherry Point, North Carolina

Dear Mr. Laughmiller:

Enclosed please find two (2) copies of the final Feasibility Study (Revision 2) for OU2, MCAS Cherry Point, North Carolina. I have also sent six (6) copies to John Myers (two [2] of which are for the Air Station and Havelock libraries), one (1) copy to Jay Bassett, two (2) copies to Linda Raynor, one (1) copy to Cindy Tschaepe, one (1) copy to each of the regulatory/government RAB members, and one (1) copy to Patricia McClellan-Green. One (1) copy of the FS Executive Summary has been sent to each of the other community RAB members.

As agreed to by the Partnering Team, only those portions of the FS that have been revised since the April 1997 version are included in this submission. There were no revisions needed for Appendix A or Appendix D (plates); therefore, these appendices are not included.

If I can be of any assistance or if you have any questions, please do not hesitate to call me at (412) 921-8945.

Very truly yours,

Kim C. Turnbull

Kim C. Turnbull
Project Manager

Approved By,

John Trepanowski, P.E.
Program Manager

KCT:lcj

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C-49-7-7-160

Mr. Lance Laughmiller
Atlantic Division
Naval Facilities Engineering Command
July 22, 1997 - Page 2

Enclosure

cc: Mr. Roger Boucher, NORTHDIV (w/o enclosure)
Mr. John Myers, MCAS Cherry Point (w/enclosure)
Mr. Jay Bassett, USEPA (w/enclosure)
Ms. Linda Raynor, NCDEHNR (w/enclosure)
Ms. Cynthia Tschaepe, OHM (w/enclosure)
Mr. Tom Augspurger, USFW (w/enclosure)
Mr. Alex Cardinell, USGS (w/enclosure)
Ms. Lauren Hillman, USFS (w/enclosure)
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Ms. Beth Hartzell, NCDEHNR (w/o enclosure)
Mr. Richard Powers, NCDEHNR (w/enclosure)
Ms. Grace Evans (RAB) (w/Executive Summary)
Ms. Patricia McClellan-Green, RAB (w/enclosure)
Mr. Lewis Mitchell, RAB (w/Executive Summary)
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Mr. Greg Zimmerman, B&R Environmental (w/o enclosure)
File (w/enclosure)

Feasibility Study

for

Operable Unit 2

Marine Corps Air Station

Cherry Point, North Carolina

Atlantic Division

Naval Facilities Engineering Command

Contract Number N62472-90-D-1298

Contract Task Order 0211

July 1997

Brown & Root Environmental

A Division of Halliburton NUS Corporation

FINAL RESPONSE TO COMMENTS
JULY 23, 1997
OU2 2nd DRAFT (REVISION 1) FEASIBILITY STUDY
MCAS CHERRY POINT, NORTH CAROLINA

COMMENTS FROM JAY BASSETT, EPA REGION IV - May 29, 1997

1. Page ES-6: As discussed in PRAP comments, look at combining Groundwater Alternatives 3 and 4.

Response:

Agree. Groundwater Alternatives 3 and 4, with discharge to Slocum Creek and the Sewage Treatment Plant, respectively, were combined as Groundwater Alternative 3. Groundwater Alternative 5 (AS/SVE) became Groundwater Alternative 4. These changes were also made in Section 4.4 (Description of Groundwater Alternatives), Section 5.3 (Description and Analysis of Alternatives for Groundwater Remediation), Section 6.2 (Comparison of Groundwater Remediation Alternatives by Category), Section 6.3 (Summary of Comparative Analysis of Groundwater Remedial Alternatives), Appendix B (Conceptual Design Calculations), and Appendix C (Cost Estimates).

2. Page ES-7, Evaluation of Remedial Alternatives: The paragraph is not correct. The criteria are divided into three categories - Primary, Balancing, and Modifying. Any remedy selected and those compared with the balancing criteria must meet primary criteria of Overall Protection of Human Health and the Environment and Compliance with ARARs. Those alternatives that meet the primary criteria are then compared to the balancing criteria of which alternative that best matches these criteria (long-term effectiveness; reduction in toxicity, mobility, or volume; short-term effectiveness; implementability; and cost) is proposed to the public and the state as the remedy. The last two criteria (public input and state concurrence are modifying criteria that may modify the proposed remedy based upon comments. (ENSURE THIS APPROACH IS USED THROUGHOUT DOCUMENT)

Response:

Agree, except the categories specified in RI/FS guidance are Threshold Criteria, Primary Balancing Criteria, and Modifying Criteria. The first sentence of this section was revised as follows: "Remedial alternatives are evaluated against nine criteria specified in CERCLA regulations." The following was added to the second sentence: "(8) State and USEPA acceptance; and (9) community acceptance." The last sentence was deleted and replaced with the following: "The first two criteria are threshold criteria in that each alternative must meet them. The next five criteria are primary balancing criteria. The alternative(s) that best matches these criteria are proposed to the USEPA, state, and community as the preferred remedy. The last two criteria are modifying criteria that may modify the proposed remedy following comments on the FS and the proposed plan."

The following subheadings were added to the nine criteria listed in Section 5.2: "Threshold Criteria" above item 1, "Primary Balancing Criteria" above item 3, and "Modifying Criteria" above item 8.

Revisions were also made in Section 6, Comparative Analysis of Alternatives because Groundwater Alternative 1 and Soil Alternative 1 are not protective of human health and the environment, and Soil Alternative 2 will not attain ARARs (and a waiver is not justified). These alternatives were not evaluated against the Primary Balancing Criteria, and references to them were deleted in the appropriate sections. The first bullet in Section 6.2.1 (Overall Protection) was revised as follows: "Groundwater Alternative 1 does not reduce potential risks to human health and the environment and is not evaluated further." The first bullet in Section 6.4.1 (Overall Protection) was revised as follows: "Soil Alternative 1 does not reduce potential risks to human health or the environment and is not evaluated further." The first bullet in Section 6.4.2 (Compliance with ARARs) was revised as follows: "Soil Alternative 2 would not comply with chemical-specific ARARs and TBCs and is not evaluated further."

3. Page 2-20, RCRA Subtitle C: RCRA Subtitle C may be applicable at this site due to the fact the facility if currently managed under a RCRA permit. Modify relevant and appropriate to applicable.

Response:

Agree; however, the requested change is in a general discussion of RCRA requirements. To clarify this section, the following paragraph was added after the bullet items on Page 2-20: "RCRA Subtitle C may be applicable at OU2 because the facility is currently managed under a RCRA permit."

4. Page 2-25, Section 2.4.1: There is no discussion of MCLs and groundwater standards or ARARs in this section or Tables 2-3 and 2-4. Include this comparison in the text as well as adding a column on referenced tables to include these potential RGOs.

Response:

Agree. Columns showing MCLs and state Class GA Groundwater Standards were added to Tables 2-3 and 2-4 only for the compounds listed in these tables. A new table (Table 2-5) was added that presents the MCLs and state standards for all of the chemicals that exceed these potential RGOs. The following was added to Section 2.4.1 (Groundwater Remedial Goal Options): "Table 2-5 presents the RGOs based on exceedance of MCLs and/or state groundwater standards."

The following was added to Section 2.5.1 (Groundwater COCs) following the discussion of contaminants that exceed state groundwater standards: "Based on 1994 and 1996 results for the surficial aquifer, benzene, chlorobenzene, cis-1,2-dichloroethene, tetrachloroethene, trichloroethene, vinyl chloride, bis(2-ethylhexyl)phthalate, arsenic, and cadmium exceeded MCLs and are retained as COCs."

COMMENTS FROM LANCE LAUGHMILLER, LANTDIV - June 2, 1997

1. Page ES-3, last paragraph, 6th sentence: Revise to read "The contaminant concentrations in the Yorktown aquifer are <u>much</u> lower than those found in the surficial aquifer."

Response:

Agree. Sentence was revised as indicated.

2. Page ES-4, last bullet: Split to discuss terrestrial receptors and aquatic receptors separately. Indicate some risk from metals in Turkey Gut, but risks is not significant due to other factors. Slocum Creek will be evaluated as OU15.

Response:

Agree. This item was revised as follows: First bullet - "Potential risks to terrestrial receptors do not appear to be a significant concern at OU2 and do not warrant remediation based on potential ecological risks alone. Potential risks were due to scattered detections of chemicals. Potential risks generated from food-chain models were mainly driven by uncertainty in toxicity data, rather than actual risk." Second bullet - "Elevated detections of compounds of concern in Turkey Gut were limited to single locations or the exceedances occurred at locations upstream of OU2. Therefore, these detections are considered to be isolated occurrences and are not believed to be a significant concern. Elevated detections of compounds of concern in Slocum Creek, including the possibility of an upgradient source, will be evaluated under Operable Unit 15."

3. Page ES-6, Remedial Action Objectives: Add a bullet for "Protection of the environment."

Response:

Agree. This was added at the end of the list of objectives.

4. Page ES-7, Evaluation of Alternatives: What about state/USEPA and community acceptance. To be done in PRAP?

Response:

See response to J. Bassett Comment 2. State/USEPA acceptance was evaluated and discussed in the final FS, based on comments on the draft FS. Community acceptance will be evaluated in the ROD after the public comment period.

5. Pages ES-7 and ES-8, list of bullets: Restructure under separate headings for the preferred soil remedy and preferred groundwater remedy.

Response:

Agree. There was some duplication because certain components (e.g., Base Master Plan Records) apply to both groundwater and soil.

6. Page ES-8, last paragraph: This sentence is not true, based on unacceptable risks to future residents.

Response:

Agree. The unacceptable risk to future residents was included at the end of the sentence. In order to clarify the point, the sentence was revised as follows: "The only unacceptable risks are for the future hypothetical residential exposure. All other potential risks under the remaining current and future exposure scenarios are within the USEPA "acceptable" risk range."

7. Page 2-1, Section 2.2 - Remedial Action Objectives: See comment on Page ES-6.

Response:

Agree. A bullet "Protection of the environment" was added to the list of objectives.

8. Page 2-2, last bullet, line 3: Change "not applicable" to "not necessarily applicable."

Response:

Agree. Text was revised as indicated in the comment.

9. Page 2-45: Delete the first sentence "The complete extent of contamination must be accurately defined during the remedial design" because it only confuses the issue (i.e., discussion of volume of contaminated media).

Response:

Agree. The sentence in question was deleted.

10. Page 3-20, *Section 3.5.3: Containment should not be retained* because maintaining the integrity of vertical barriers is difficult over the long term.

Response:

Agree. The Conclusion was revised as follows: "Eliminate vertical barriers from further consideration because of implementability concerns." The following sentence was deleted from the second paragraph of Section 3.7.1: "Hydraulic barriers are chosen to be the representative process option for groundwater containment because of better effectiveness in controlling contaminant migration in coarse, sandy soils than vertical controls."

11. Page 3-20, Section 3.5.4, first sentence: Change "subsurface" to "aquifer."

Response:

Agree. The text was revised as follows: "Remediation of groundwater may be achieved by removal of contaminated groundwater from the aquifer."

12. Page 3-23, Section 3.5.5: Need to include natural attenuation as a treatment technology.

Response:

Agree. A discussion of natural attenuation was added as Section 3.5.5.2. The existing discussion of AS/SVE is now Section 3.5.5.1. This change was also made through the FS, as summarized below:

Page 3-7, Table 3-1: Natural attenuation was added as a technology under the in-situ treatment general response action. The following description was added: "Use of natural processes that affect the rate of migration and the concentration of contaminants in groundwater." The following screening comment was added: "Retain to treat contaminated groundwater."

Page 3-17, Natural attenuation was added as a remedial technology and process option under the in-situ treatment general response action.

Page 3-23, Section 3.5.5: The first sentence was revised as follows: "In-situ treatment process options retained from the initial screening are air sparging/soil vapor extraction (AS/SVE) and natural attenuation, which are evaluated below.

New Section 3.5.5.2 - Natural Attenuation. The following description was added: "Natural attenuation (or intrinsic remediation) refers to inherent processes that affect the rate of migration and the concentration of contaminants in groundwater. The most important processes are biodegradation, advection, hydrodynamic dispersion, dilution from recharge, sorption, and volatilization." The following effectiveness evaluation was added: "Natural attenuation is effective if the rate of biodegradation, aided by sorption, is rapid enough to prevent significant contaminant migration by advection and dispersion. The strategy for documenting the occurrence of natural attenuation is based on documented loss of contaminants and one or more pieces of evidence showing that biodegradation reactions are actually occurring in the field. Monitoring is a key component in confirming effectiveness." The following implementability evaluation was added: "Natural attenuation would be readily implementable. A monitoring program can be conducted without any major implementability concerns." The following cost evaluation was added: "Capital and O&M costs for natural attenuation are low." The following conclusion was added: "Retain natural attenuation with confirmation monitoring for further consideration."

Page 3-55, Table 3-3 - Summary of Retained Technologies and Process Options - Groundwater: Natural attenuation was added as a technology and process option under the in-situ treatment general response action.

Page 4-3, Section 4.2.1 - Technologies and Process Options: Natural attenuation was added as a process option under the in-situ treatment general response action.

13. Page 4-3, Section 4.2.1: Add natural attenuation as a process option.

Response:

Agree. See response to L. Laughmiller Comment 12.

14. Page 4-7, list of groundwater alternatives: Need to develop the viability of natural attenuation.

Response:

Agree. See response to L. Laughmiller Comment 12.

15. Page 5-7, Figure 5-1, Groundwater Alternative 2 - Conceptual Block Flow Diagram: Is this figure really necessary?

Response:

As discussed with the Partnering Team, this figure was retained because it had already been prepared. However, the figure was moved to Appendix B (Conceptual Design Calculations).

16. Pages 5-14, Section 5.3.3.1, Component 2: The description is too detailed for an FS, please simplify. This is design work, not FS.

Response:

As discussed with the Partnering Team, the information presented is the conceptual design that forms the basis for the cost estimate. However, the details on pages 5-14 (last three paragraphs), 5-15, 5-16, and 5-17 (first two paragraphs) were moved to Appendix B (Conceptual Design Calculations).

17. Page 5-18, Figure 5-2 - Groundwater Alternative 3 Site Layout: This is good.

Response:

No response required.

18. Page 5-19, Figure 5-3 - Groundwater Treatment System for Groundwater Alternative 3: This is on the upper end and is heading toward design.

Response:

As discussed with the Partnering Team, this figure was moved to Appendix B (Conceptual Design Calculations). See response to L. Laughmiller Comment 16.

19. Page 5-28, Figure 5-5 - Groundwater Alternative 4 Site Layout: Reference Figure 5-2.

Response:

Agree. See response to Jay Bassett Comment 1 (combine groundwater alternatives 3 and 4). The site layout for the new combined groundwater alternative shows the extraction wells and both discharge options (i.e., Slocum Creek and Sewage Treatment Plant).

20. Page 5-29, Figure 5-6: Refer to Figure 5-3 for comment.

Response:

As discussed with the Partnering Team, this figure was moved to Appendix B (Conceptual Design Calculations). See responses to L. Laughmiller Comments 16 and 18.

21. Page 5-32, Reduction of Toxicity, Mobility, and Volume Through Treatment (Groundwater Alternative 4): If the analysis is the same as for Groundwater Alternative 3, state so and refer back.

Response:

The analysis was not the same as for Groundwater Alternative 3, except for the volume of water to be treated. As stated previously, Groundwater Alternatives 3 and 4 were combined. Common elements and evaluations were not repeated.

22. Page 5-46, third paragraph, first sentence: Change "conceptual SVE systems have been designed" to "conceptual SVE systems will be designed." Check the tense of "future" design globally.

Response:

Do not agree. The wording is correct. All alternatives contain conceptual designs that are used as the basis for the cost estimate. As discussed with the Partnering Team, however, design details were moved to Appendix B (Conceptual Design Calculations). This includes the second and third paragraphs on page 5-46.

23. Page 5-60, Section 5.4.5, Component 2 (Onsite Treatment/Fixation and Disposal of Soil): This is a little verbose, but okay.

Response:

As discussed with the Partnering Team, details were moved to Appendix B (Conceptual Design Calculations). This includes the second, third, and fourth paragraph on page 5-60 and the third and fourth paragraph on page 5-61.

24. Page 6-14, Section 6.6: Underline the recommended alternative.

Response:

Agree: The following text was underlined: "Groundwater Alternative 2 - Natural Attenuation, Institutional Controls, and Monitoring and Soil Alternative 3 - Soil Vapor Extraction and Institutional Controls." This revision was also be made on Page ES-7 under the Preferred Alternative.

25. Page 6-19, Sixth bullet: Delete "as per state and Federal requirements" and replace with "to determine the effectiveness of natural attenuation and monitor for other potential releases."

Response:

Agree; however, the suggest language was paraphrased in response to EPA concerns on this language in the FS and PRAP. The bullet was revised as follows: "Monitoring of groundwater under OU2 and surface water and sediment in Slocum Creek and Turkey Gut to confirm the effectiveness of natural attenuation and to confirm that contaminant migration from the site to the environment is not occurring. The monitoring program will be developed as part of the Remedial Design, with USEPA and state concurrence."

COMMENTS FROM JOHN MYERS, MCAS CHERRY POINT - June 3, 1997

1. Page ES-5, Development of Remediation Levels and Contaminants of Concern: Groundwater is listed as an exposure pathway for Adult resident (6-year exposure), Child/Adult resident (30-year exposure), and Child resident in this section. The Air Station has a public water supply (although this site will never be used as a residential area). What is the exposure pathway for this presumed residence? How will the presumed residence be exposed if the aquifer is not used as a potable water supply? Why are we considering residential standards for an old landfill which will never be utilized for such an activity?

Response:

The human health risk assessment was conducted in accordance with USEPA guidance (headquarters and Region IV). Future residents were identified as potential receptors because no land use restrictions are in effect at this site. In addition, in the unlikely event that the property is no longer owned by the government, the Air Station could no longer control the use of the site.

COMMENTS FROM LINDA RAYNOR, NCDEHNR SUPERFUND SECTION - June 3, 1997

General Comments:

1. Please be sure that the duplicated information from the Remedial Investigation (RI) Report that is presented in the text and tables of this Feasibility Study coincide with the most recent version of the RI Report for OU-2. All comments/changes that have been made to the RI Report should also have been incorporated, where necessary, in this Feasibility Study.

Response:

The most recent version of the RI (Revision 2 - April 1997) was used as the source of RI summary information presented in Revision 1 of the FS.

2. The "hot spot" soil treatment areas need to be overlain on Figures 2-1 and 2-2 to show the areas of soil contamination that will be encompassed by the soil vapor extraction systems.

Response:

Agree. Hot spot Areas 1, 2, 3A, 3B, and 4 were added to Figures 2-1 and 2-2.

3. Please include a relative ranking summary table that rates the alternatives according to the nine evaluation criteria.

Response:

As discussed with the Partnering Team, this table was included in the PRAP but not in the FS. Only the primary balancing criteria were presented, because alternatives that are not protective of human health and the environment or do not attain ARARs (and a waiver is not justified) cannot be selected as the preferred remedy. Also, community acceptance cannot be evaluated until after the public comment period (and after the final PRAP has been completed).

Specific Comments:

1. Page ES-8, last bullet - Need to indicate that additional hot spots may be detected during the data gap investigation to be performed during the design phase. Also, add information regarding the confirmation sampling of air emissions and soils that will need to be performed to evaluate the effectiveness of the in-situ soil treatment.

Response:

Agree. The last bullet on this page was revised as follows: "In-situ treatment using soil vapor extraction at four major "hot spots" (secondary source areas) that are contaminated with volatile organics and any other such hot spots identified during the Remedial Design. This includes monitoring of air emissions and soil to evaluate the effectiveness of treatment." The same revisions were made on Page 6-19.

2. Section 2 Tables - Need to recheck tables to ensure correctness and consistency with previous documents and listed standards/criteria. (Some discrepancies were noted below; others may exist.)

Table 2-1 - The NC groundwater standard for chloroethane should be 2.8 mg/L.

Response:

Agree. The revision was made as noted.

<u>Table 2-5</u> - The RGOs for target cancer risks for chromium differ from previous version of RI; the first version of the RI had 0.84, 8.4, and 84 for chromium, the second version had "NA" for all three entries. Please verify which is correct.

Response:

The RGOs in Table 2-5 of the FS (Revision 1) and Table 6-15 of the RI (Revision 2) are correct. There are no Cancer Slope Factors for chromium based on ingestion or dermal exposure (see page 6-53, Table 6-9 in Revision 2 of the RI).

<u>Table 2-7</u> - Recheck the entries for beryllium - shouldn't 1E-4 be "18" rather than "180" for the target cancer risk? Also, for the target hazard quotients, are "140, 1,400, and 14,000" correct? (Previous tables from the RI (Rev. 1) had 930, 9,300, and 93,000).

Response:

In Table 2-7, the RGO for beryllium for a 1E-4 target cancer risk was changed from 180 to 18. The RGOs for Target Hazard Quotients in this table are correct.

<u>Table 2-8</u> - Please recheck the input data for toluene, bis(2-ethylhexyl)phthalate, naphthalene (groundwater input data appears to be an error), heptachlor, and chromium. (The S-3 target concentrations listed are significantly higher that the State's calculated S-3 values.) Also, shouldn't diazinon be included in this table? Check also the maximum concentration and the prefix for BHC (see Table 4-26 of RI, sample 10B03-0810 @ 4.6 ug/kg; should "beta" be "delta"). Are any soil RGOs affected or new "hot spots" identified?

Response:

The values for toluene, bis(2-ethylhexyl)phthalate, heptachlor, and chromium are correct (the source document for the partition coefficient and Henry's Law constant for these chemicals was Appendix C of EPAs "Soil Screening Guidance: User's Guide).

The groundwater input concentration used for naphthalene was 0.21 mg/L instead of 0.021 mg/L (state groundwater standard). The S-3 concentration for naphthalene was revised from 9,247 µg/kg to 925 µg/kg based on this. The following new locations now exceed the S-3 target concentration for naphthalene: 10B01-1012 (5,500 µg/kg), 10SISB1-1012 (2,600 µg/kg), 10SISB3-1618 (8,700 µg/kg), and 10SISB4-1214 (830 µg/kg). All of these locations are within the previously identified hot spot Area 1 (former sludge impoundment area). These results were also added to Figure 2-1 (Organic Constituents in Soil Exceeding RGOs).

Diazinon was not included in Table 2-8 because none of the soil samples collected at OU2 were analyzed for this chemical. Diazinon analysis was only conducted by USGS for groundwater samples collected in 1987 and 1988. It is not on the TCL list for organics.

The information presented for beta-BHC is correct. The S-3 target concentrations were calculated for any chemical that ever exceeded a state groundwater standard based on all historical data. Delta-BHC was not detected in any groundwater sample. Beta-BHC was the compound detected in groundwater above a state standard (see RI Table 4-7 - one detection in 1985).

<u>Table 2-9</u> - Should the entry for beryllium under full-time employee be "18" rather than "180"? (See also Table 6-19 in RI Rev. 2).

Response:

Agree. The table was revised in accordance with the comment.

3. Page 2-25 - Section 2.4.1, Re: Groundwater Remedial Goal Options - The RGOs for contaminants in groundwater should be the NC Groundwater Standards.

Response:

Agree; however, these are RGOs for protection of human health in accordance with EPA Region IV risk assessment protocols. NC groundwater standards were added to Tables 2-3 and 2-4, along with MCLs. In addition, a new table was added (as Table 2-5) that shows all chemicals that exceed state groundwater standards and/or MCLs. See response to J. Bassett Comment 3.

4. Page 2-31, 1st para., 4th line - "not" should be "no" numerical standard ...

Response:

Agree. The text was revised in accordance with the comment.

5. Page 2-38 - 1st para. - Delete "In addition, even though there were a few exceedances of state surface water standards, there are no indications that adverse ecological effects are occurring." What "indications" are being referenced here? The upcoming investigation of Slocum Creek should help determine the validity of this statement. Until further investigation is done, this statement (and the one that follows) should be deleted.

Response:

Agree. The second and third sentences of this paragraph were deleted.

6. Page 4-4, 4th para., - "While under the control of the Air Station, land use will continue as it is; however, the Site 46 ponds may be used for stormwater management or removed." Need to add the following statement: "Concurrence will be obtained from the USEPA and NCDEHNR prior to any changes to the current use of these inactive ponds."

Response:

Agree. The statement was added as indicated in the comment.

7. Section 4.4 - Need to maintain consistency between discussion of alternatives - For example, for groundwater alternative 2, institutional controls and monitoring are listed as two separate components, while the other groundwater alternatives list them as one component, listing both. For soils alternative 2, institutional controls and monitoring are listed as one component and are both listed in the heading for alternative 2, while soil alternative 3 lists institutional controls in the heading, but groups monitoring with institutional controls in the discussion. Please check all alternatives (headings and text) and adjust as necessary to clarify and provide consistency.

Also, soil alternative 3 should include confirmation sampling if air emissions and soil samples to evaluate the effectiveness of the soil vapor extraction system.

For soil alternative 4, what are the plans for backfilling or resurfacing areas from which soils were removed and transferred to the consolidation area.

Response:

Item 1: Because monitoring is a technology under the institutional controls general response action (See Tables 3-1 and 3-2) the word "monitoring" was deleted, where appropriate. This was done for all alternatives, as appropriate, in the Executive Summary, Section 4, Section 5, and Section 6. This revision was made at the following locations:

- Pages ES-6 and ES-7 - Remedial Alternative Development
- Page ES-7 - Preferred Alternative
- Page 4-7 - bullet items
- Page 4-8 - heading and first paragraph of Section 4.4.2
- Page 4-9 - first paragraph of Sections 4.4.3 and 4.4.4
- Page 4-10 - first paragraph of Section 4.4.5; heading and first paragraph of Section 4.5.2
- Page 4-11 - first paragraph of Sections 4.5.3
- Page 5-5 - heading of Section 5.3.2; first paragraph of Section 5.3.2.1
- Section 5.3.2 - The separate discussions of institutional controls and monitoring were be combined under the institutional controls component
- Page 5-41 - heading of Section 5.4.2; first paragraph of Section 5.4.2.1
- Page 6-1 - second bullet of Section 6.2
- Page 6-6 - second bullet of Section 6.4
- Table 6-1 - column heading for Groundwater Alternative 2
- Page 6-14 - first paragraph of Section 6.6
- Table 6-2 - column heading for Soil Alternative 2
- Conforming changes were also made to the Proposed Plan

Item 2: Agree. The following was added to the last paragraph of Section 4.5.3 (Soil Alternative 3): "In addition, monitoring of air emissions and confirmation soil sampling would be conducted to determine the effectiveness of treatment." This addition was also included in Component 2 of Section 5.4.3.1.

Item 3: Agree. The following was added to Section 4.5.4 (Soil Alternative 4): "Clean fill would be placed and compacted in the excavated areas. Topsoil would be placed on top of the compacted fill, and the areas would be revegetated."

8. <u>Page 5-6</u>, 1st para. - "The government will maintain the institutional controls ..." Need to be more specific regarding the government." (See also page 5-41, 3rd paragraph.)

Response:

Agree. These statement were revised as follows: "The Navy and MCAS Cherry Point will maintain the institutional controls until RAOs have been achieved."

9. <u>Page 5-8</u>, 2nd para. - "Monitoring of groundwater, surface water and <u>sediments</u> ..." (Add underlined text.)

Response:

Agree. The text was revised in accordance with the comment.

10. <u>Page 5-9</u>, 4th para. - "Although migration ... annual monitoring of groundwater ..." Delete "annual". Note: Check the document for other references to specific frequencies or sampling and analysis and delete (except when referencing basis of cost estimates); the frequency will be specified at a later date. (See also page 5-17, last paragraph, page 5-20, 4th paragraph, and page 5-31, 1st paragraph - delete "annual.")

Response:

All conceptual design information, including monitoring frequencies, is used as the basis for cost estimates. However, as discussed with the Partnering Team, conceptual design details were moved to Appendix B (Conceptual Design Calculations), and the word "annual" was deleted from the main text of the FS.

11. Page 5-41, last sentence - "Any future construction activity at OU2 must be conducted ... contaminants." Need to add: "The State and USEPA will be properly notified of proposed construction plans at OU2 prior to commencement of any construction activities."

Response:

Agree. The statement was added as indicated in the comment.

12. Page 6-9, 1st para. - "Exceedances of RGOs based on protection of future residents and full-time employees only occurred at three sample locations." What are these sample locations, and are they within areas to be addressed by the soil vapor extraction systems?

Response:

As stated in the second paragraph of Section 2.7 - "As shown on Table 2-9, none of the concentrations exceeded RGOs based the full-time employee scenario. RGOs for protection of future residents were only exceeded for iron and thallium. Based on a review of the analytical data, the RGO for iron was exceeded at locations OU2SS07 (54,700 mg/kg) and OU2LS05 (40,500 mg/kg). The RGO for thallium was exceeded at location 44ASO03 (6.7 mg/kg)."

None of these locations are within any of the proposed SVE systems. No revisions were made in response to this comment.

13. Page 6-11, 2nd bulleted item - Need to include the monitoring of sediments in Slocum Creek and Turkey Gut.

Response:

Agree. Text was revised as indicated in the comment.

14. Page 6-16, Table 6-2 - Modifying Criteria for Soil Alternative 1: "No" should be "Not."

Response:

Agree. Text was revised as indicated in the comment.

15. Page 6-19, 3rd bulleted item - Replace restricting the use of groundwater beneath OU2 such that all aquifers shall be restricted from any use as a water source and no wells will be installed (except for monitoring wells).

Response:

Agree. This bullet was revised as follows: "Restricting the use of groundwater from all aquifers beneath OU2 as a water source with provisions for no installation of wells (except monitoring wells)."

109502/P

FEASIBILITY STUDY
FOR
OPERABLE UNIT 2

MARINE CORPS AIR STATION
CHERRY POINT, NORTH CAROLINA

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Atlantic Division
Environmental Restoration Branch, Code 1823
Naval Facilities Engineering Command
1510 Gilbert Street
Norfolk, Virginia 23511-2699

Submitted by:
Brown & Root Environmental
993 Old Eagle School Road, Suite 415
Wayne, Pennsylvania 19087-1710

CONTRACT NUMBER N62472-90-D-1298
CONTRACT TASK ORDER 0211

JULY 1997

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LIST OF ACRONYMS AND ABBREVIATIONS

AEC	Area of Environmental Concern
ARAR	Applicable or Relevant and Appropriate Requirements
AS	Air Sparging
atm	Atmosphere
AWQC	Ambient Water Quality Criteria
BDAT	Best Demonstrated Available Technology
BDT	Best Demonstrated Technology
BGS	Below Ground Surface
B&R	Brown & Root
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
C	Celsius
CAA	Clean Air Act
CAMA	Coastal Area Management Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmentla Action Navy
cm	Centimeter
CNO	Chief of Naval Operations
COC	Contaminant of Concern
COPC	Contaminant of Potential Concern
CO_2	Carbon Dioxide
CSF	Cancer Slope Factor
CTO	Contract Task Order
cu	Cubic
CWA	Clean Water Act
DCA	Dichloroethanes
DCE	Dichloroethenes
DEHNR	Department of Environment, Health and Natural Resources
DL	Detection Limit
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
DWEL	Drinking Water Equivalent Level
EO	Executive Order
EPA	Environmental Protection Agency
F	Farenheit
FMF	Fleet Marine Force
FR	Federal Register
FS	Feasibility Study
FSSG	Force Service Support Group
ft	Feet
GAC	Granular Activated Carbon
gpm	Gallons Per Minute
GRA	General Response Action
HCl	Hydrochloric Acid
HDPE	High Density Polyethylene
HI	Hazard Index
HpCDD	Heptachlorodibenzo-p-dioxin
HpCDF	Heptachlorodibenzo-p-furan
HQ	Hazard Quotient
IAS	Initial Assessment of Site

ICR	Incremental Cancer Risk
IWTP	Industrial Wastewater Treatment Plant
kg	Kilogram
L	Liter
lb	Pound
LDR	Land Disposal Restrictions
LOAEL	Lowest-Observed-Adverse-Effect Level
MAW	Marine Aircraft Wing
MCAS	Marine Corps Air Station
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
m	Meter
μg	Microgram
mg	Milligram
ml	Milliliter
mm	Millimeter
MGD	Million Gallons Per Day
MSL	Mean Sea Level
NA	Not Applicable or Not Analyzed
NAAQS	National Ambient Air Quality Standards
NADEP	Naval Aviation Depot
NAVFACENGCOM	Naval Facilities Engineering Command
NCAC	North Carolina Administration Code
NCDAQ	North Carolina Department of Air Quality
NCDEHNR	North Carolina Department of Environment, Health and Natural Resource
NCNHP	North Carolina Natural Heritage Program
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NOAEL	No-Observed-Adverse-Effect Level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NS	No Standard
NSPS	New Source Performance Standards
O&M	Operation and Maintenance
OCDD	Octachlorodibenzo-p-dioxin
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PAH	Polynuclear Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
POL	Petroleum, Oil, and Lubricant
PRAP	Proposed Remedial Action Plan
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RAO	Remedial Action Objective
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RGO	Remedial Goal Option
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SDWA	Safe Drinking Water Act

sec	Second
SIP	State Implementation Plan
sq	Square
SOC	Soluble Organic Carbon
SSL	Soil Screening Level
STP	Sewage Treatment Plant
SVE	Soil Vapor Extraction
TAL	Target Analyte List
TBC	To Be Considered (Criteria)
TCA	Trichloroethane
TCE	Trichloroethene
TCDD	Tetrachlorodibenzo-p-dioxin
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total Dissolved Solids
THQ	Target Hazard Quotient
TR	Target Risk
TSDF	Treatment, Storage, and Disposal Facility
UCL	Upper (95%) Confidence Limit
UF	Uncertainty Factor
USC	United States Code
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	Underground Storage Tank
UV	Ultraviolet
VOC	Volatile Organic Compound
WQS	Water Quality Standard
yd	Yard

EXECUTIVE SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The objective of the Remedial Investigation/Feasibility Study (RI/FS) process is to gather and evaluate information sufficient to select the most appropriate remedy for a given site based on an informed risk management decision making process. This FS is the second of two documents that provides the basis for selecting a remedial alternative for Operable Unit (OU) 2 at Marine Corps Air Station (MCAS) Cherry Point, North Carolina. The objective of the FS was to develop and evaluate potential remedial alternatives that address unacceptable risks to human health and the environment that were identified in the RI report. The objective of the RI was to collect adequate chemical analytical data to determine the contaminants present at OU2 and to determine whether those contaminants present an unacceptable risk to human health and the environment. An evaluation of the analytical data and the risk assessment revealed no unacceptable risks to human health under current land uses. However, exposure to contaminated groundwater and contaminated soil presents unacceptable risks to adult and child receptors only under a hypothetical future residential scenario. In addition, groundwater contaminant concentrations exceed state groundwater quality standards, and soil contaminant concentrations exceed levels protective of groundwater. Remedial action is required at OU2 to address these potential threats to human health and the environment. The FS focuses on evaluating cleanup alternatives for soil and groundwater contamination. The alternatives were developed by combining remedial technologies that address the potential threats to human health and the environment that may result from soil and groundwater contamination.

SITE OVERVIEW

OU2 is located in the west-central portion of MCAS Cherry Point, on the east bank of Slocum Creek, which flows to the north (Figure 1-2). OU2 consists of Site 10 - Old Sanitary Landfill, Site 44A - Former Sludge Application Area, Site 46 - Polishing Ponds No. 1 and No. 2, and Site 76 - Vehicle Maintenance Area (Hobby Shop) (Figure 1-3 and Plate 1 in Appendix D).

- Site 10 is a 40-acre sanitary landfill that served as the primary disposal site at the Air Station from 1955 until the early- to late-1980s. Site 10 is divided by Turkey Gut (a small stream), which flows westward into Slocum Creek. Former sludge impoundments that were used for management of Resource Conservation and Recovery Act (RCRA) hazardous wastes until closed in the mid-1980s are also located in the north-central portion of Site 10. This former sludge application area is included as a hazardous waste management unit in the Air Station's RCRA

Part B permit. A fenced, gravel area formerly used to store drums of petroleum products is also located at Site 10.

- Site 44A consists of an area in the north-central portion of Site 10 where sludge from the sewage treatment plant was applied.

- Site 46 consists of two inactive unlined ponds, approximately 12 feet deep, that were used as aeration basins for wastewater from the sewage treatment plant. The ponds are located north of Site 10.

- Site 76 is located south of Site 10 and consists of a building and parking lot where personal vehicles are repaired. In the past, Site 76 was part of a motor pool and equipment storage area.

Investigations were conducted at OU2 from 1981 through 1996. Activities included reviewing aerial photographs; conducting a soil-gas survey and magnetometer and terrain conductivity studies; drilling soil borings; excavating test pits; installing permanent and temporary monitoring wells; measuring groundwater levels; and sampling and analyzing surface and subsurface soil, groundwater, surface water, sediment, and leachate seeps. The results from the magnetometer and terrain-conductivity studies were used to identify locations for some of the test pits and soil borings.

PHYSICAL FEATURES

The ground surface elevation varies from approximately 30 feet mean sea level (MSL) in the central portions of the landfill areas to approximately 1.5 feet MSL at Slocum Creek. The ground surface is relatively flat in these central areas with smaller areas of uneven terrain. The ground surface adjacent to Slocum Creek and Turkey Gut generally has moderate to steep slopes. The berms of the Site 46 polishing ponds have an elevation of approximately 22 feet MSL. The ground surface west of the ponds slopes steeply downward to approximately 5 feet MSL, then becomes flat and heavily vegetated near Slocum Creek. The ground surface south of the ponds slopes moderately towards the Site 10 landfill area. The areas east and northeast of the ponds are relatively flat. Sites 10, 44A, and 46 are inactive. The only site activities occur at Site 76, where Air Station personnel can work on their private vehicles.

The surface of the landfill at OU2 consists of fill material (sand, silt, and clay mixed with refuse including domestic trash, wood, plastic, rubber, asphalt, concrete, and metal fragments) and natural materials. As much as 26 feet of fill was noted at Site 10. The fill is generally thickest at the central landfill areas. The majority of the ground surface at OU2 is vegetated. After the Site 10 landfill was closed, a layer of cover material was placed over the existing fill material. The landfill areas are vegetated with pine trees (southwest portion) and fields with grasses and trees. Wetlands vegetated with trees and shrubs are located adjacent to Slocum Creek and Turkey Gut. There is a hardwood forest on the land between the wetlands and landfill areas.

GEOLOGY/HYDROGEOLOGY

Based on the site investigations, a variety of subsurface characteristics were identified at OU2. The geologic and hydrogeologic units are listed from shallowest to deepest:

- Fill material
- Undifferentiated surficial formation and surficial aquifer
- Yorktown confining unit
- Yorktown aquifer
- Pungo River confining unit
- Pungo River aquifer
- Upper Castle Hayne confining unit
- Upper Castle Hayne aquifer
- Lower Castle Hayne confining unit
- Lower Castle Hayne aquifer

The fill material consists of waste materials that were buried. Underlying the fill material are alternating layers that consist of aquifers and confining units. In general, aquifers are permeable materials (sands) that contain groundwater that could be available for use. The confining layers are less permeable materials (silts and clays) that do not contain significant amounts of groundwater. Confining units tend to retard the vertical flow of groundwater from one aquifer to the next.

Although the drinking water at the Air Station is not obtained from the surficial aquifer, it is the primary unit of concern at OU2 because monitoring wells installed in the surficial aquifer indicate that this groundwater is adversely affected by OU2. Groundwater in the surficial aquifer was encountered at depths of 7 to 22 feet below the ground. Groundwater in the surficial aquifer flows toward, and discharges to, Turkey Gut and Slocum Creek. Underlying the surficial formation and surficial aquifer is the Yorktown confining unit, which separates the surficial aquifer from the Yorktown aquifer. Monitoring wells installed in the Yorktown aquifer indicate that only a few contaminants were detected. The contaminant concentrations in the Yorktown aquifer are much lower than those found in the surficial aquifer. Groundwater in the Yorktown aquifer flows toward, and discharges to, Slocum Creek. None of the deeper aquifers beneath OU2 were investigated.

The Castle Hayne aquifers, which begin at a depth of approximately 195 feet below OU2, serve as a source of drinking water at the Air Station, so protecting this water is important. The Castle Hayne aquifers are separated from the surficial and Yorktown aquifers by the Pungo River and Upper Castle Hayne confining units.

MEDIA OF CONCERN

Based upon an evaluation of the nature and extent of contamination, contaminant fate and transport, and toxicity and risk assessment, the media of concern at OU2 were determined to be groundwater and soil. Soil also includes waste materials buried in the landfill. The media of concern addressed in this FS are based on the following conclusions from the RI investigations and report:

- Contaminant concentrations in groundwater exceed state groundwater standards.
- Unacceptable risks to human health were identified for adults and children only under a hypothetical future residential scenario. The majority of these risks are from ingesting groundwater from the surficial aquifer. The risks are driven by volatile organic compounds and metals.
- The data do not indicate an unacceptable risk to human health from exposure to soil contaminants except under the future hypothetical residential use exposure scenario.
- There are soil "hot spot" areas where concentrations exceed levels based on protection of groundwater.
- Municipal waste, industrial waste, and construction debris were encountered during test pit excavation activities.
- Although groundwater discharges to Turkey Gut and Slocum Creek, there were only limited exceedances of state surface water standards in these streams.
- Potential ecological risks do not appear to be a significant concern at OU2 and do not warrant remediation based on potential ecological risks alone. Potential risks were due to scattered detections of chemicals. Potential risks generated from food-chain models were mainly driven by uncertainty in toxicity data, rather than actual risk.

- Elevated detections of compounds of concern in Turkey Gut were limited to single locations or the exceedances occurred at locations upstream of OU2. Therefore, these detections are considered to be isolated occurrences and are not believed to be a significant concern. Elevated detections of compounds of concern in Slocum Creek, including the possibility of an upgradient source, will be evaluated under Operable Unit 15.

DEVELOPMENT OF REMEDIATION LEVELS AND CONTAMINANTS OF CONCERN

During the RI, a human health risk assessment was conducted to develop remediation (cleanup) levels and identify contaminants of concern. The following receptors and exposure pathways were evaluated as part of the baseline human health risk assessment under current and future potential land use scenarios:

- Maintenance worker - direct contact with surface soil.
- Construction worker - direct contact with soil and groundwater (surficial aquifer) and inhalation of fugitive dust; direct contact with polishing pond sediment.
- Adolescent trespasser - direct contact with surface soil and leachate seeps; direct contact with Slocum Creek water and sediment; direct contact with Turkey Gut water and sediment.
- Adult recreational user - direct contact with Slocum Creek water and sediment and ingestion of fish.
- Full-time employee - direct contact with surface soil.
- Adult resident (6-year exposure) - direct contact with groundwater (surficial aquifer) and surface soil; direct contact with groundwater (Yorktown aquifer) and surface soil.
- Child/adult resident (30-year exposure) - direct contact with groundwater (surficial aquifer) and surface soil; direct contact with groundwater (Yorktown aquifer) and surface soil.
- Child resident - direct contact with groundwater (surficial aquifer) and surface soil; direct contact with groundwater (Yorktown aquifer) and surface soil.

Except for future residents, risks for all other receptors and exposure pathways are within the U.S. Environmental Protection Agency (USEPA) "acceptable" risk range (cancer risk of 1E-6 to 1E-4 and Hazard

Index [HI] below 1.0). However, USEPA Region IV requires an evaluation of Remedial Goal Options (RGOs) for three risk range levels for any receptor for which an individual chemical has a cancer risk greater than 1E-6 or a HI greater than 1.0. RGOs were developed for groundwater and soil for the full-time employee, 6-year resident (adult or child), and 30-year resident. RGOs were also developed for soil based on the protection of groundwater from the leaching of soil contaminants.

Contaminants of concern (COCs) and estimated volumes of contaminated material were determined based on comparisons of OU2 site contaminants to these RGOs. Compliance with regulatory standards and criteria was also considered in compiling the COCs.

REMEDIAL ACTION OBJECTIVES

Based on the media of concern and the potential receptors/pathways of exposure, the remedial action objectives (RAOs) for OU2 are as follows:

- Protection of human receptors from adverse health effects that may result from dermal contact and incidental ingestion of contaminated surface soils.
- Protection of human receptors from adverse health effects that may result from incidental ingestion of waste/fill material and contaminated subsurface soils.
- Protection of human receptors from adverse health effects that may result from dermal contact, ingestion, and inhalation of contaminants in the groundwater in the surficial aquifer beneath OU2.
- Mitigation of contaminant migration from OU2 into the environment.
- Protection of the environment.

REMEDIAL ALTERNATIVE DEVELOPMENT

The following remedial alternatives for groundwater were developed to meet the remedial action objectives:

- Alternative 1 - No Action
- Alternative 2 - Natural Attenuation and Institutional Controls

- Alternative 3 - Groundwater Extraction; Treatment and Discharge to Slocum Creek or Pretreatment and Discharge to Sewage Treatment Plant (STP); Institutional Controls.

- Alternative 4 - Air Sparging/Soil Vapor Extraction; Institutional Controls

Alternative 1 is required under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Alternative 2 was developed to evaluate the minimum actions needed to meet the remedial action objectives. Alternatives 3 and 4 were developed to evaluate active groundwater remediation.

The following remedial alternatives for soil were developed to meet the remedial action objectives:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls
- Alternative 3 - Soil Vapor Extraction; Institutional Controls
- Alternative 4 - Excavation, Consolidation, and Containment; Institutional Controls
- Alternative 5 - Excavation, Treatment, and Onsite Disposal; Institutional Controls
- Alternative 6 - Excavation and Offsite Disposal; Institutional Controls

Alternative 1 is required under CERCLA. Alternative 2 was developed to evaluate the minimum actions needed to meet the remedial action objectives. Alternatives 3, 4, 5, and 6 were developed to evaluate active soil remediation.

EVALUATION OF REMEDIAL ALTERNATIVES

Remedial alternatives were evaluated against nine criteria specified in CERCLA regulations. These criteria are: (1) overall protection of human health and the environment; (2) compliance with applicable or relevant and appropriate requirements (ARARs); (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume through treatment; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state and USEPA acceptance; and (9) community acceptance. The first two criteria are threshold criteria in that each alternative must meet them. The next five criteria are primary balancing criteria. The alternative(s) that best matches these criteria are proposed to the USEPA, state, and community as the preferred remedy. The last two criteria are modifying criteria that may modify the proposed remedy following comments on the FS and the Proposed Plan.

PREFERRED ALTERNATIVE

Based on available information and the current understanding of conditions at OU2, the preferred site-wide alternative combines Groundwater Alternative 2 - Natural Attenuation and Institutional Controls, and Soil Alternative 3 - Soil Vapor Extraction; Institutional Controls. These alternatives are the most cost-effective method for satisfying applicable ARARs and providing short- and long-term protection of human health and the environment for current and most reasonable future land use scenarios.

The preferred alternative for groundwater consists of the following:

- Maintaining records of the contamination at OU2 in the MCAS Cherry Point Base Master Plan.
- Restricting the use of groundwater beneath OU2 with provisions for no installation of wells (except monitoring wells).
- Monitoring of groundwater under OU2 and surface water and sediment in Slocum Creek and Turkey Gut.

The preferred alternative for soil consists of the following:

- Maintaining records of the contamination at OU2 in the MCAS Cherry Point Base Master Plan.
- Restricting land use at OU2 to non-residential uses with provisions for no intrusive activities (no excavation of surface soil or subsurface soil).
- Installing a fence around the polishing ponds, and repair and replacement of existing fencing.
- Placing warning signs along the fence, Slocum Creek, and Turkey Gut.
- Monitoring of groundwater under OU2 and surface water and sediment in Slocum Creek and Turkey Gut.
- In-situ treatment using soil vapor extraction at four major soil "hot spots" (secondary source areas) that are contaminated with volatile organics and any other such hot spots identified during the Remedial Design. This includes monitoring of air emissions and soil to evaluate the effectiveness of treatment.

The preferred alternative addresses the principal threats associated with exposure to soil, buried wastes, and groundwater within the surficial aquifer at OU2. The preferred alternative meets all of the remedial action objectives and the satisfies the statutory requirements of CERCLA Section 121 which include (1) be protective of human health and the environment, (2) comply with applicable or relevant and appropriate requirements (ARARs), unless a waiver is justified, (3) be cost-effective, (4) utilize permanent solutions and alternate treatment technologies to the maximum extent practical, and (5) satisfy the preference for treatment that reduces toxicity, mobility, or volume as a principal element.

The only unacceptable risks are for the hypothetical residential scenario. All other risks under the remaining current and future exposure scenarios are within the USEPA "acceptable" risk range. The majority of the risks are due to ingestion of surficial aquifer groundwater and ingestion of surface soil. The future residential exposure pathway for groundwater is extremely unlikely because the surficial aquifer is not used as a source of drinking water, and the Air Station has a separate potable water supply system.

1.0 INTRODUCTION

This Feasibility Study (FS) has been prepared by Brown & Root (B&R) Environmental (formerly known as Halliburton NUS Corporation and NUS Corporation) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract No. N62472-90-D-1298, Contract Task Order (CTO) 211. This Feasibility Study has been prepared to provide remedial action alternatives for Operable Unit 2 (OU2) at the Marine Corps Air Station (MCAS) Cherry Point, North Carolina. OU2 consists of four sites (Sites 10, 44A, 46, and 76) that were identified in the Initial Assessment of Sites (IAS) performed by a Navy contractor and listed in a multi-task Resource Conservation and Recovery Act (RCRA) Section 3008(h) Administrative Order on Consent signed by the Navy and the U.S. Environmental Protection Agency (USEPA) in December 1989. MCAS Cherry Point was placed on the National Priorities List (NPL) in December 1994. The sites included in this report are now managed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The RCRA Section 3008h Administrative Order on Consent is still in effect as an ARAR.

1.1 PURPOSE OF THE REPORT

This report summarizes the information presented in the Remedial Investigation (RI) (B&R Environmental, 1996) and discusses the basis for any remedial action that may be required at OU2. The scope of this report is limited to the environmental media present at OU2 and those media that may be affected by the contamination at these sites. Remedial technologies and process options will be evaluated and screened in this report to select those which are most viable for the site conditions and contaminants. The remaining technologies and process options will be combined to form remedial alternatives that will address site contamination. The remedial alternatives will be evaluated to distinguish positive and negative aspects of each alternative.

1.2 BACKGROUND INFORMATION

This section presents the location and a description of OU2. This section also presents the available historic background of the OU2 sites. The historical background provides an indication of the sources that might have been the cause of contamination at OU2.

1.2.1 Location

MCAS Cherry Point is part of a military installation located in southeastern Craven County, North Carolina, just north of the town of Havelock. The Air Station covers approximately 11,485 acres. Its boundaries are the Neuse River to the north, Hancock Creek to the east, North Carolina Highway 101 to the south, and an irregular boundary line approximately three-fourths of a mile west of Slocum Creek. The entire Air Station is situated on a peninsula north of Core and Bogue Sounds and south of the Neuse River. The general location of the Air Station is shown on Figure 1-1.

OU2 is located in the west/central portion of the Air Station, as shown on Figure 1-2. OU2 is bounded by the Sewage Treatment Plant (STP) to the north, Roosevelt Boulevard to the east, a residential area to the south, and Slocum Creek to the west. OU2 consists primarily of the Site 10 landfill. It also includes the polishing ponds (Site 46) north of the landfill, a former sludge application area (Site 44A formerly Site 45) located in the north-central portion of OU2, and the vehicle maintenance area (Hobby Shop) (Site 76) located southwest of the landfill.

1.2.2 Air Station History and Description

The MCAS Cherry Point mission is to maintain and support facilities, services, and materiel of a Marine Aircraft Wing, or units thereof, and other activities and units as designated by the Commandant of the Marine Corps in coordination with the Chief of Naval Operations (CNO). Occupants at the Air Station include the Second Marine Aircraft Wing (2nd MAW), the Naval Aviation Depot (NADEP), the combat Service Support Detachment 21 of the Second Force Service Support Group (2nd FSSG), the Naval Hospital, the Dental Clinic, the Naval Air Maintenance Training Group Detachment, and the Defense Reutilization and Marketing Office (DRMO). The Air Station has facilities for training and support of the Fleet Marine Force (FMF) Atlantic aviation units and is also designated as a primary aviation supply point.

The Air Station was commissioned in 1942. Continuing construction in 1943 added a massive aircraft assembly and repair shop, which later became the NADEP. During the 1950s and 1960s, the size of the Air Station increased from 7,582 acres to more than 11,000 acres (not including outlying facilities) as a result of land acquisitions. During the 1970s, commercial and residential development of the surrounding area grew substantially. In 1980, the City of Havelock annexed MCAS Cherry Point.

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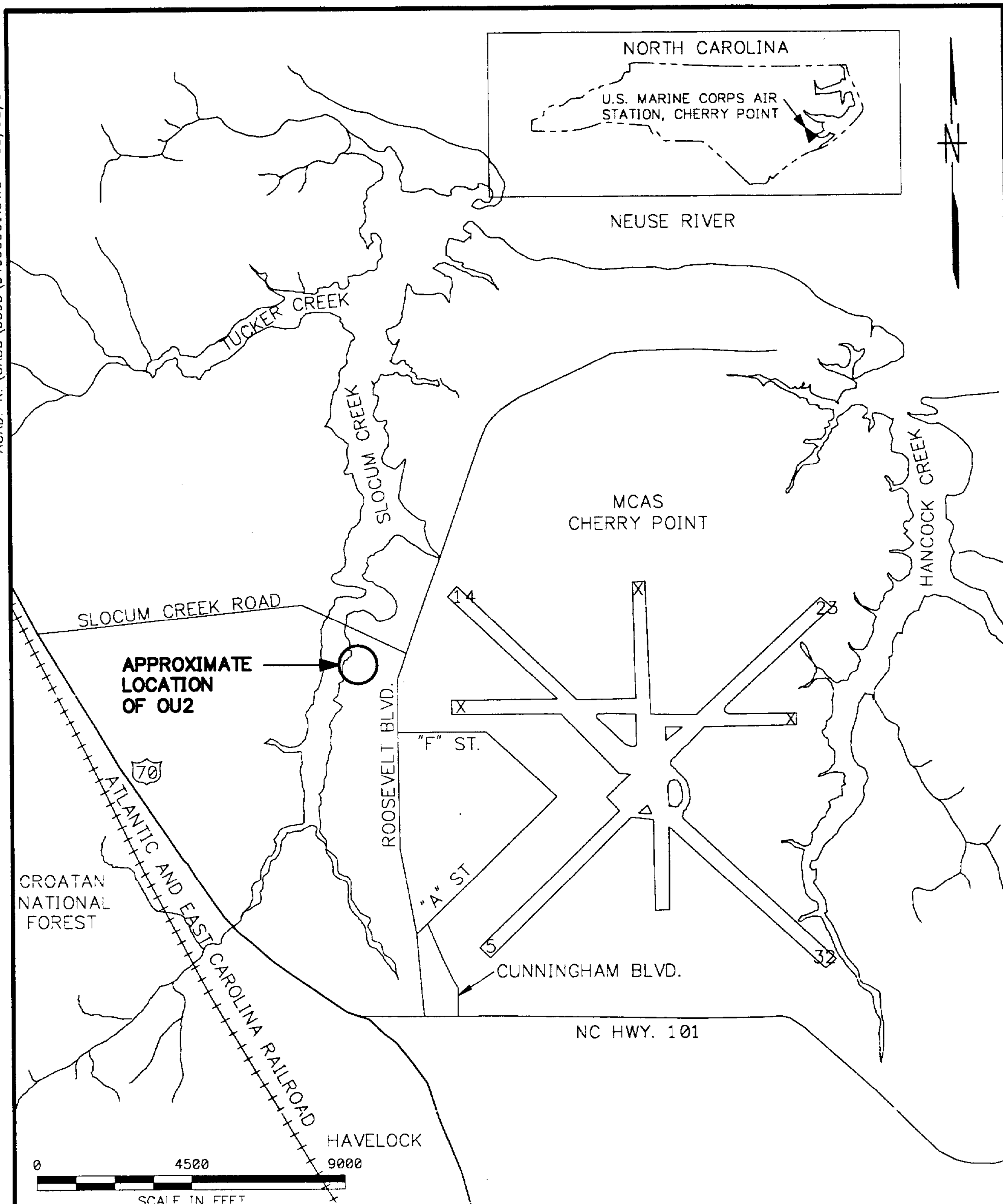

DRAWN BY HJP / DATE 4/9/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY / DATE	**LOCATION MAP** **MCAS CHERRY POINT, NORTH CAROLINA**	APPROVED BY / DATE	
COST/SCHED-AREA		APPROVED BY / DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 1-1	REV. 0

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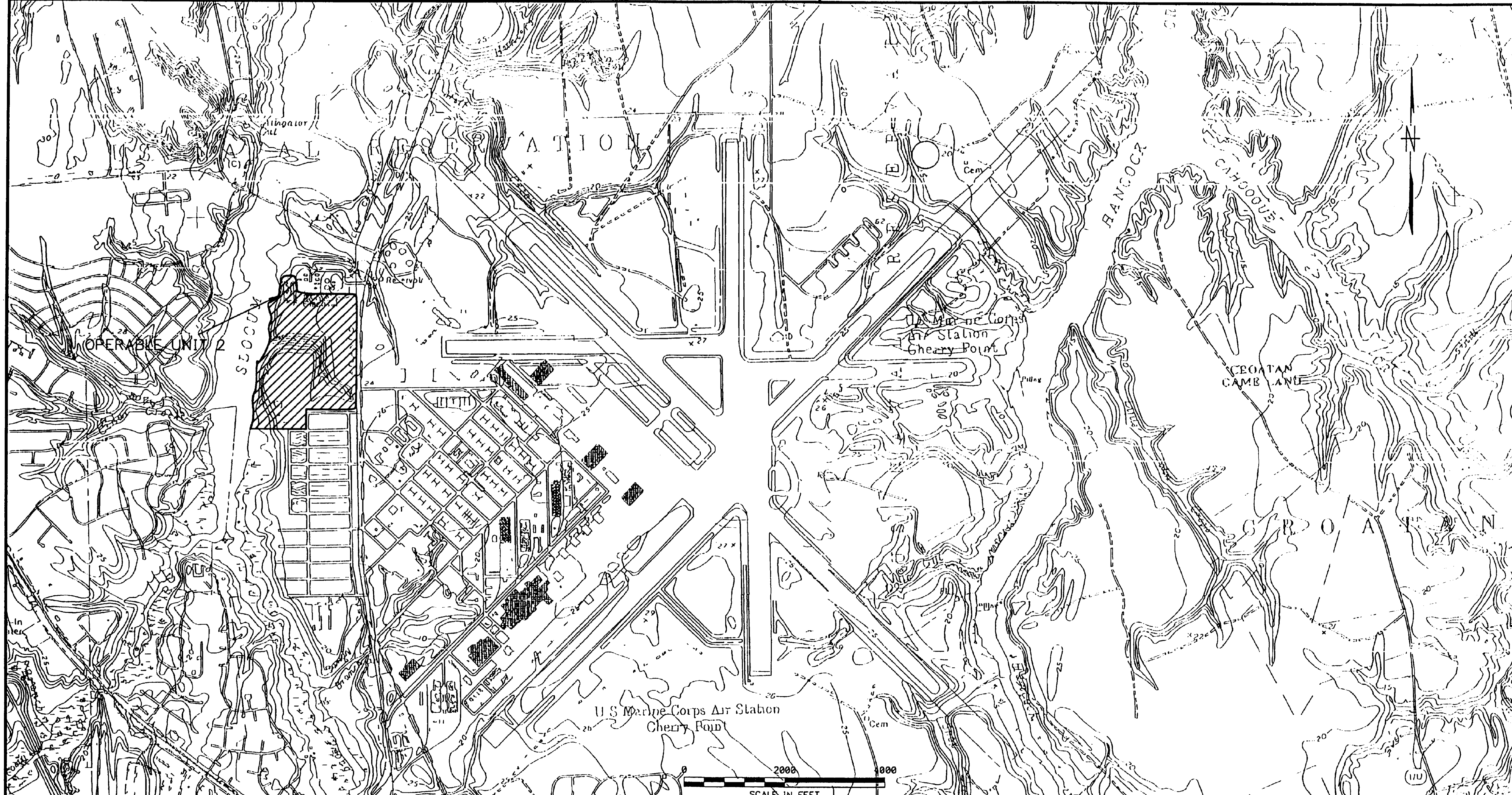

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 4/16/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY DATE		APPROVED BY	DATE
COST/SCHED-AREA	OPERABLE UNIT 2 GENERAL AIR STATION MAP MCAS CHERRY POINT, NORTH CAROLINA	APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 1-2	REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

1.2.3 Description of Operable Unit 2

OU2 consists of four sites located in proximity to the Site 10 - Old Sanitary Landfill. These sites have been grouped into one operable unit because of their proximity to each other (i.e., Site 44A - the Former Sludge Application Area overlies portions of the Site 10 landfill, and Site 46 - Polishing Ponds No. 1 and 2, and Site 76 - Vehicle Maintenance Area (Hobby Shop) are located adjacent to the landfill). In addition, Site 44A and Site 46 both contain the same types of suggested contamination derived from sewage treatment. Figure 1-3 provides a layout of the OU2 area. A full-size drawing of this figure is also provided in Appendix D as Plate 1.

Site 10 - Old Sanitary Landfill

Site 10 is located west of Roosevelt Boulevard and south of Site 43 - Sewage Treatment Plant, on the east side of Slocum Creek. The site consists of a sanitary landfill approximately 40 acres in size that served as the primary disposal site at MCAS Cherry Point from 1955 until the early- to mid-1980s. Contaminated material and petroleum, oil, and lubricants (POLs) were spread on the land, burned, stored in unlined pits, and buried at the landfill. Former sludge impoundments that were closed in the mid-1980s are also located at this site. The impoundments were used to dispose of metal filings, plating sludges, paints, organic solvents, oil and grease, and miscellaneous chemicals. The sludge impoundment area is included as a hazardous waste management unit in the Air Station's RCRA Part B permit. During closure, the impoundments were excavated to approximately 9.5 feet below the existing ground surface. They were backfilled with soil and covered with 2 feet of clay and 2 feet of topsoil. A fenced, paved area formerly used for storage of drums of petroleum products is located at Site 10. This area is no longer used for drum storage. Investigative activities have been ongoing at this site since the mid-1980s and have included monitoring well installations; soil borings; geophysical studies; test pit excavations; and soil, surface water, sediment, and groundwater sampling.

Site 44A - Former Sludge Application Area

Site 44 consists of two areas in which sludge from the STP was applied. Liquid sludge was removed from the digesters for land application every 30 days. Sludge removed between September and November 1987 was applied at Sites 10 and 21. Site 44A is located on Site 10 (OU2), and Site 44B is located on Site 21 (OU13). Site 44B is not discussed further in this report, as it is not an OU2 site. The sludge contained organic material and other constituents that would not be digested during the sewage treatment process.

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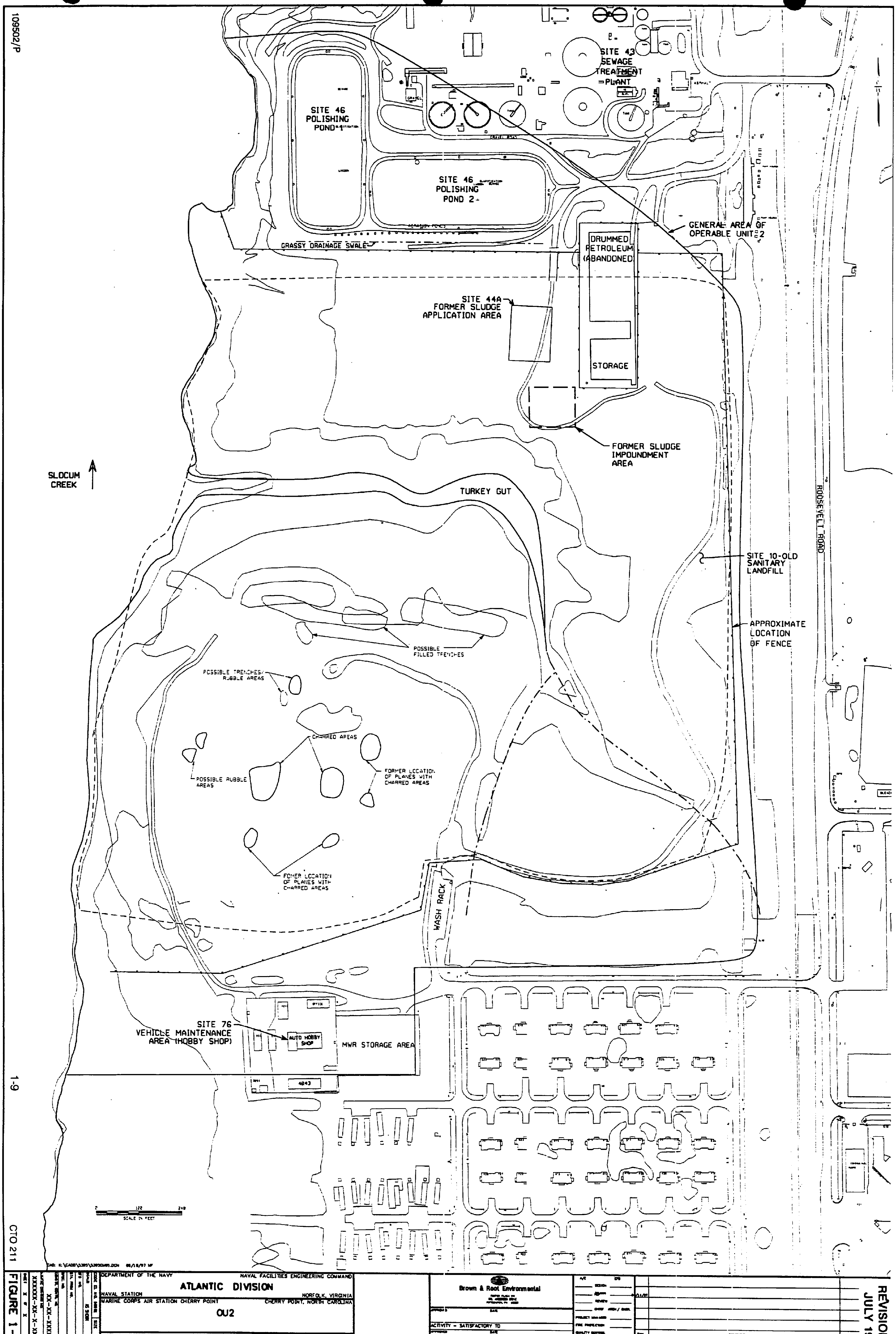

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DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA

MARINE CORPS AIR STATION CHERRY POINT — CHERRY POINT, NORTH CAROLINA

OU2

GENERAL SITE LOCATION MAP

Brown & Root Environmental

ACTIVITY – SATISFACTORY TO

REVISIONS

REVISION 2
JULY 1997

FIGURE 1-3

Site 46 - Polishing Ponds 1 and 2

This site consists of two inactive unlined ponds that served as aeration basins for wastewater from the STP. The ponds are approximately 12 feet deep. The STP was recently upgraded and does not require the use of the ponds for aeration. The ponds may be used for future stormwater management. The Air Station submitted a Closure Plan for this site to the state in December 1988. USEPA Region IV is amenable to waiving the closure requirements and allowing the ponds to be addressed under the NCDEHNR solid waste management unit (SWMU) authority.

Site 76 - Vehicle Maintenance Area (Hobby Shop)

Site 76 consists of a building and parking lot where personal vehicles are repaired. General auto maintenance and auto body repair are typical work activities conducted at this facility. In the past, Site 76 was part of a motor pool and equipment storage area.

1.3 PHYSICAL CHARACTERISTICS

This section summarizes the pertinent information for surface features, geology, hydrogeology, surface water, and ecology.

1.3.1 Surface Features

MCAS Cherry Point is located within the Coastal Plain Physiographic Province. The province is characterized as an elevated sea-bottom environment with low topographic relief and is generally below 100 feet mean sea level (MSL) in elevation.

The ground surface elevation varies from approximately 30 feet MSL in the central portions of the landfill areas to approximately 1.5 feet MSL at Slocum Creek. The ground surface is relatively flat in these central areas with relatively smaller areas of uneven terrain. The ground surface at the perimeter of the landfill areas adjacent to the floodplains of Slocum Creek and Turkey Gut generally form moderate to steep slopes.

The polishing ponds (Site 46) are formed by earthen berms with elevations of approximately 22 feet MSL. The ground surface west of the ponds slopes steeply from 22 feet to approximately 5 feet MSL, giving way to a flat and heavily vegetated area adjacent to Slocum Creek. The ground surface south of the ponds slopes moderately towards the old sanitary landfill giving way to a grass swale where standing water is common. The areas east and northeast of the ponds are relatively flat where the STP is located.

1.3.2 Geology

The Air Station is underlain by about 3,000 feet of interbedded, unconsolidated to partially consolidated sedimentary deposits of sand, silt, clay, shell, and limestone that range in age from Cretaceous to Holocene. These deposits are part of the Coastal Plain sediments of North Carolina that, in aggregate, form a wedge-shape mass that thickens from a feather edge at the Fall Line to as much as 10,000 feet at Cape Hatteras. The Coastal Plain deposits are underlain by igneous and metamorphic basement rocks.

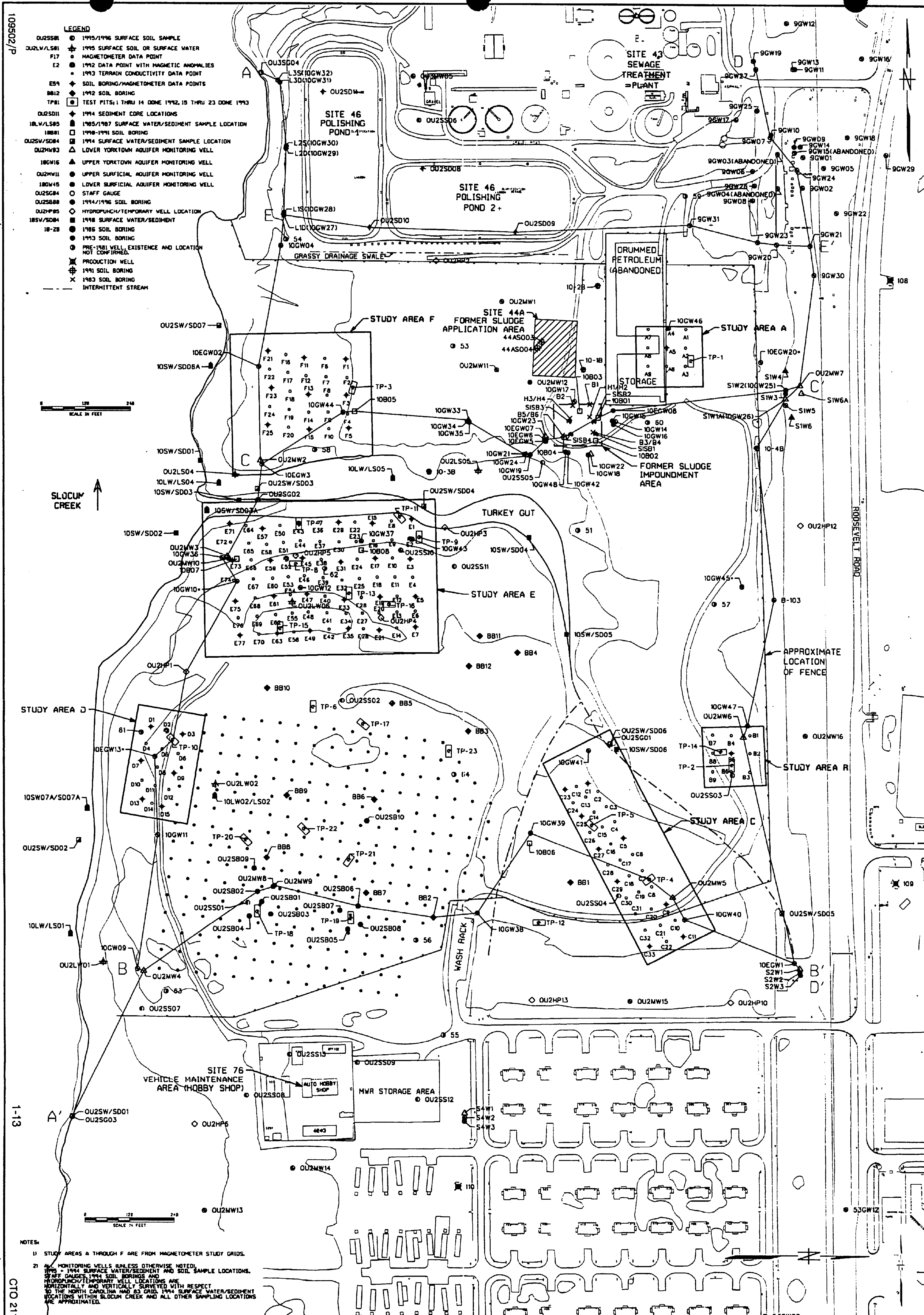
Four types of lithologic materials were encountered during the subsurface investigation at the OU2 area. These were identified as fill material, the undifferentiated surficial formation, the Yorktown Formation, and the upper portion of the Pungo River Formation.

Figure 1-4 identifies the location of typical cross-sections, which are provided in Figures 1-5, 1-6, and 1-7. Some of the information provided on Figure 1-4 may be difficult to read because of the size of the drawing; therefore, a full-size drawing of Figure 1-4 is provided in Appendix D as Plate 2.

1.3.2.1 Fill Material

The fill material consists of sand, silt, and clay mixed with refuse consisting of domestic trash, industrial waste, construction debris, wood, plastic, rubber, glass, asphalt, concrete, and metal fragments.

Generally, the fill material is at its maximum thickness in the center of the landfill area and thins gradually to the west and abruptly to the east. Refuse was encountered in seven of the soil borings and ranged in thickness from 10 to 26 feet. Refuse extended below the water table at one of these locations. Refuse was encountered above the water table in test pit excavations and ranged from 0 to 10 feet thick. In approximately 50 percent of the test pits, the waste material extended below the bottom of the test pit (generally 10 to 12 feet deep). Although groundwater was not encountered, the relationship between the waste and groundwater could not be determined for these test pits.



NOTES:
1) STUDY AREAS A THROUGH F ARE FROM MAGNETOMETER STUDY GRIDS.
2) ALL MONITORING WELLS (UNLESS OTHERWISE NOTED), 1995 + 1994 SURFACE WATER/SEDIMENT AND SOIL SAMPLE LOCATIONS, STAFF GAUGES, 1994 SOIL BORINGS AND HYDROPUNCH/TEMPORARY WELL LOCATIONS ARE HORIZONTALLY AND VERTICALLY SURVEYED WITH RESPECT TO THE NORTH CAROLINA NAD 83 GRID. 1994 SURFACE WATER/SEDIMENT LOCATIONS WITHIN SLOCUM CREEK AND ALL OTHER SAMPLING LOCATIONS ARE APPROXIMATED.

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA

MARINE CORPS AIR STATION CHERRY POINT — CHERRY POINT, NORTH CAROLINA

OU2

SAMPLE LOCATIONS AND CROSS SECTION MAP

Brown & Root Environmental

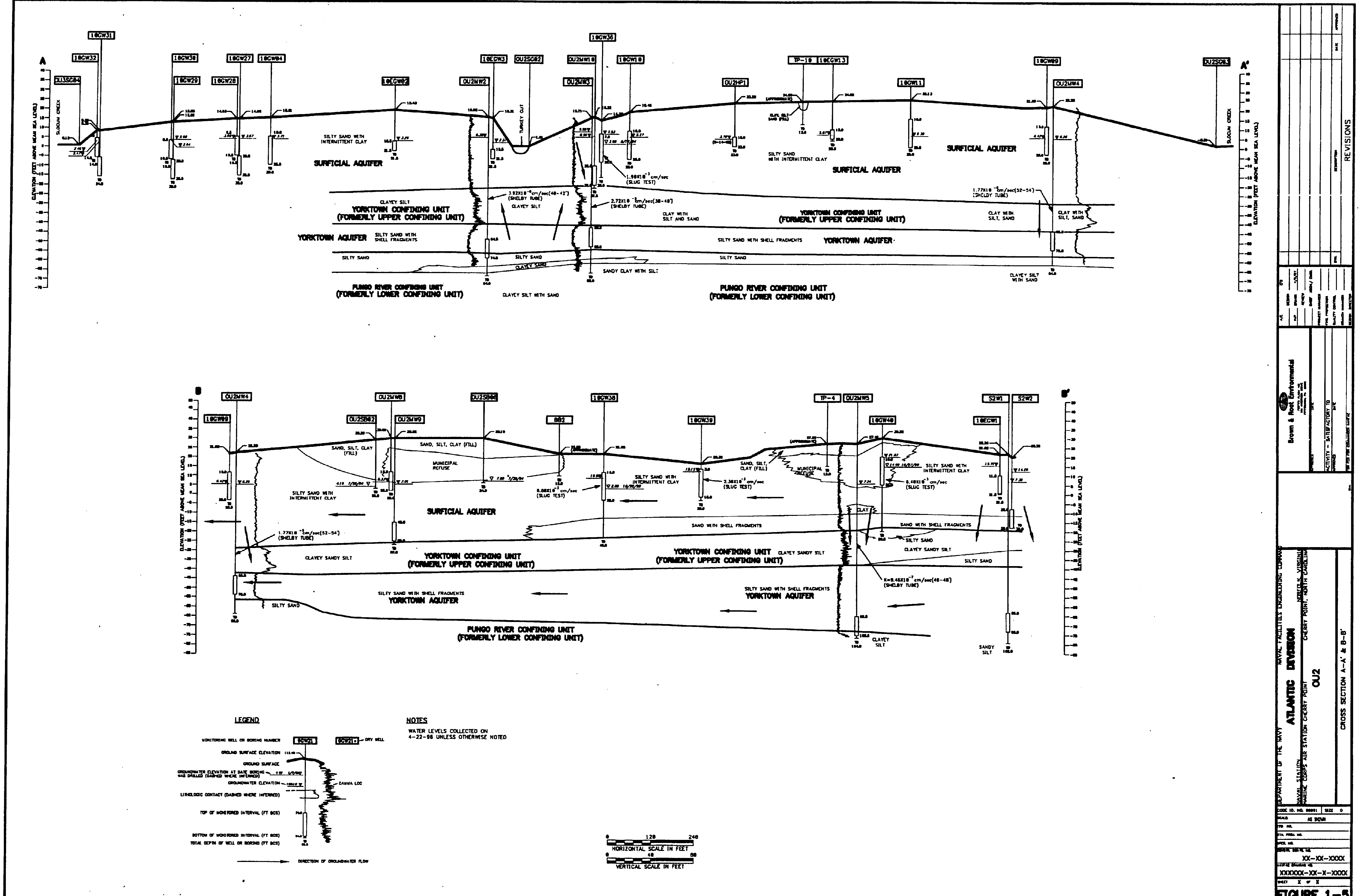
REVISIONS

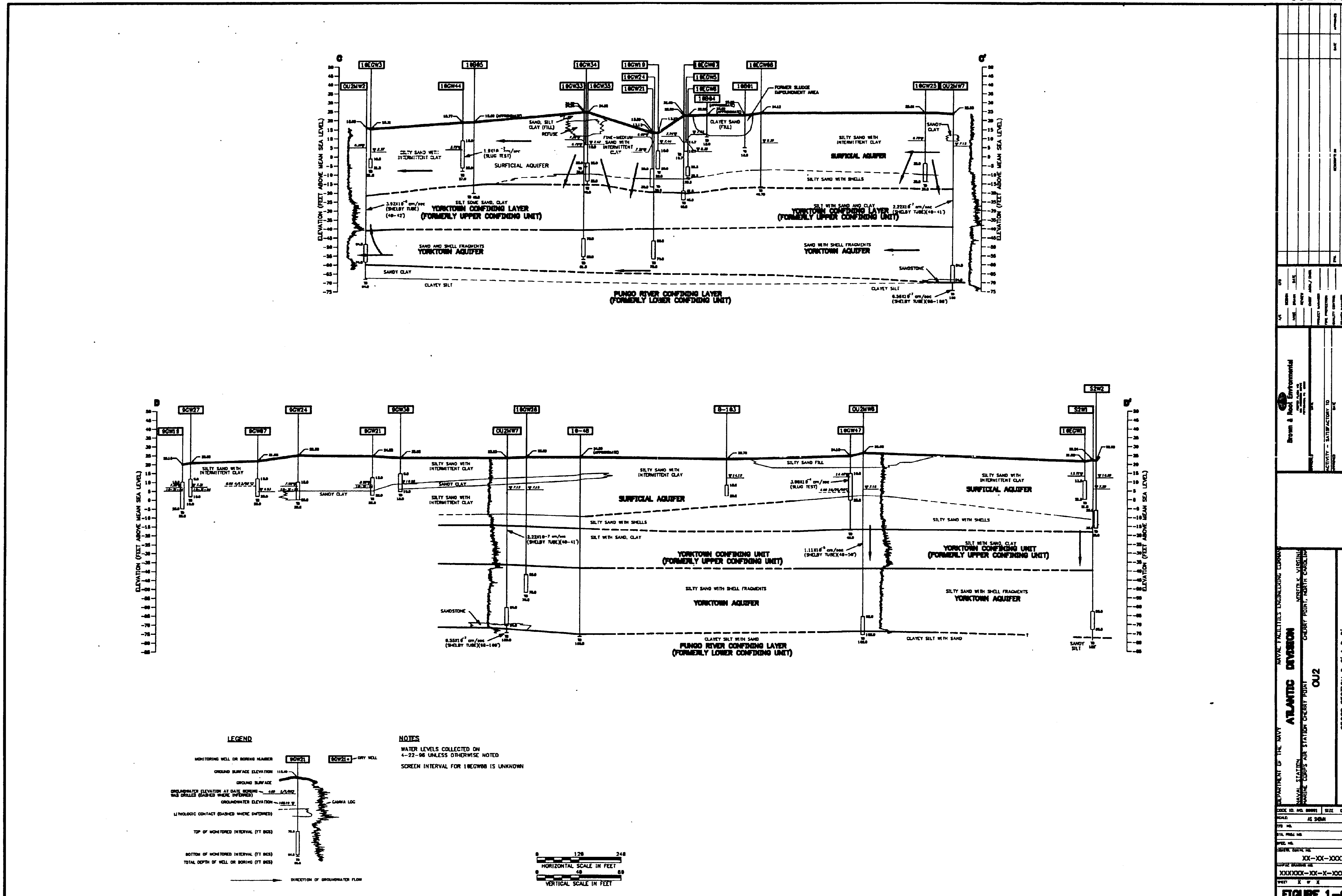
1-13

CTO 211

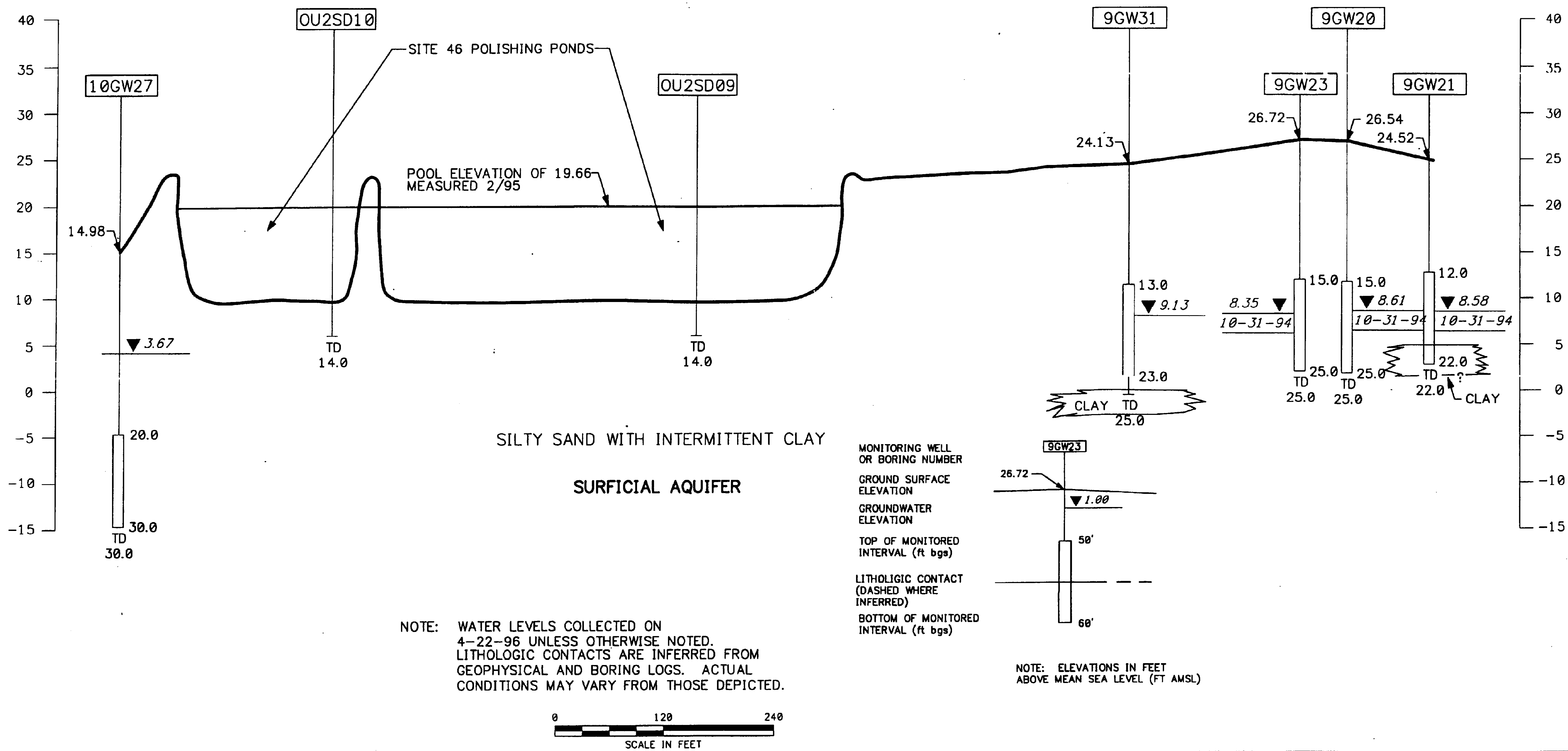
FIGURE 1-4

REVISION 2
JULY 1997


A
A'
B
B'
SURFICIAL AQUIFER
YORKTOWN CONFINING UNIT
(FORMERLY UPPER CONFINING UNIT)
YORKTOWN AQUIFER
PUNGO RIVER CONFINING UNIT
(FORMERLY LOWER CONFINING UNIT)
SILTY SAND WITH INTERMITTENT CLAY
CLAYEY SILT
SILTY SAND WITH SHELL FRAGMENTS
SILTY SAND
CLAYEY SANDY SILT
MUNICIPAL REFUSE
SAND, SILT, CLAY (FILL)
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
LEGEND
MONITORING WELL OR BORING NUMBER
GROUND SURFACE ELEVATION
GROUND SURFACE
GROUNDWATER ELEVATION
LITHOLOGIC CONTACT (DASHED WHERE INFERRED)
TOP OF MONITORED INTERVAL (FT BGS)
BOTTOM OF MONITORED INTERVAL (FT BGS)
TOTAL DEPTH OF WELL OR BORING (FT BGS)
DIRECTION OF GROUNDWATER FLOW
GAMMA LOG
DRY WELL
NOTES
WATER LEVELS COLLECTED ON 4-22-98 UNLESS OTHERWISE NOTED
HORIZONTAL SCALE IN FEET
VERTICAL SCALE IN FEET
REVISIONS
Brown & Root Environmental
NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NORFOLK, VIRGINIA
MARINE CORPS AIR STATION CHERRY POINT
CHERRY POINT, NORTH CAROLINA
OU2
CROSS SECTION A-A' & B-B'
AS SHOWN
XX-XX-XXXX
XXXXXX-XX-X-XXXX
FIGURE 1-5


YORKTOWN CONFINING LAYER (FORMERLY UPPER CONFINING UNIT)
YORKTOWN AQUIFER
SURFICIAL AQUIFER
FUNGO RIVER CONFINING LAYER (FORMERLY LOWER CONFINING UNIT)
YORKTOWN CONFINING UNIT (FORMERLY UPPER CONFINING UNIT)
ELEVATION (FEET ABOVE MEAN SEA LEVEL)
LEGEND
NOTES
WATER LEVELS COLLECTED ON 4-22-96 UNLESS OTHERWISE NOTED
SCREEN INTERVAL FOR 18EGW08 IS UNKNOWN
HORIZONTAL SCALE IN FEET
VERTICAL SCALE IN FEET
REVISIONS
Brown & Root Environmental
NAVAL FACILITIES ENGINEERING COMMAND
ATLANTIC DIVISION
NORFOLK, VIRGINIA
MARINE CORPS AIR STATION CHERRY POINT
CHERRY POINT, NORTH CAROLINA
OU2
CROSS SECTION C-C' & D-D'
FIGURE 1-6

ACAD: K:\CADD\5395\5395BX03.DWG 04/09/97 HJP



NOTE: WATER LEVELS COLLECTED ON 4-22-96 UNLESS OTHERWISE NOTED. LITHOLOGIC CONTACTS ARE INFERRED FROM GEOPHYSICAL AND BORING LOGS. ACTUAL CONDITIONS MAY VARY FROM THOSE DEPICTED.

NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 4/9/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY DATE	GENERALIZED GEOLOGIC CROSS SECTION E-E' OPERABLE UNIT 2 MCAS, CHERRY POINT	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 1-7	REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

1.3.2.2 The Undifferentiated Surficial Formation

The shallowest natural materials beneath Site 10 consisted of orange, yellow, and brown silty sand with trace to some amounts of clay present in localized areas. This material is present at the ground surface where fill is nonexistent or underlies the fill. This material extends to a maximum depth of 52 feet below the ground surface in the southwest portion of OU2 and thins slightly to the north and northeast to approximately 38 and 40 feet respectively. It is at least 25 to 30 feet thick at the Site 46 polishing ponds. These materials correlate with the Undifferentiated Surficial Formation as described by the U.S. Geological Survey (USGS).

1.3.2.3 The Yorktown Formation

Underlying the Undifferentiated Surficial Formation is an olive green to grayish green, dense, fine sand with varying amounts of bivalve shell fragments, clay, and silt. It is believed that this layer correlates with the hydrogeologic Yorktown confining unit (formerly named the upper confining unit) that makes up the upper portion of the Yorktown Formation. It has an average thickness of 19 feet.

Seven Shelby tube samples were collected from the upper portion of the Yorktown Formation. The grain-size distribution curves indicate poorly sorted sands with little fines but with an average effective grain size of 0.029 mm diameter (silt).

Underlying the upper portion of the Yorktown Formation is a grey silty sand with varying amounts of bivalve shell fragments and correlates with the hydrogeologic unit named the Yorktown aquifer. The lower portion of the Yorktown Formation has an average thickness of approximately 35 feet in the eastern portion of the site and approximately 14 feet in the western portion of the site.

1.3.2.4 The Pungo River Formation

A dark green, clayey silt and clayey sand was encountered in six of the OU2 Lower Yorktown wells at depths below ground surface varying from 69 to 100 feet. These materials are inferred to be the upper portion of the Pungo River Formation and correlate to the hydrogeologic unit named the Pungo River confining unit (formerly the lower confining unit). The top surface of the Pungo River Formation dips to the east at approximately 0.01 percent grade. The thickness of the Pungo River confining unit was not determined because the unit was not penetrated during the drilling activities.

One Shelby tube sample was collected from the upper portion of the Pungo River Formation. The grain-size distribution curve indicates poorly sorted sand with an effective grain size of 0.019 millimeter (mm) diameter (silt).

1.3.3 Hydrogeology

MCAS Cherry Point is underlain by five non-saline aquifers and four confining units to a depth of approximately 500 feet. These aquifers and confining units, in order or increasing depth, are the surficial aquifer, the Yorktown confining unit (formerly named upper confining unit), the Yorktown aquifer, the Pungo River confining unit (formerly named lower confining unit), the Pungo River aquifer, the Upper Castle Hayne confining unit, the Upper Castle Hayne aquifer, the Lower Castle Hayne confining unit, and the Lower Castle Hayne aquifer. These units are described below.

- Surficial Aquifer - The surficial aquifer is the uppermost aquifer of the study area and is exposed at the ground surface and in streambeds throughout the Air Station. This aquifer consists of unconsolidated and interfingering beds of fine sand, silt, clay, shell, and peat beds, as well as scattered deposits of coarser grained material as part of relic beach ridges and alluvium (USGS, 1994).

- Yorktown Aquifer and Confining Unit - The Yorktown confining unit overlies the Yorktown aquifer and is composed of clay and sandy clay with locally discontinuous, thin beds of fine sand or shells. The Yorktown confining unit is not present in the southern portion of the Air Station (USGS, 1994).

  The Yorktown aquifer consists of consolidated and unconsolidated fine sand, silty and clayey sand, and clay. Shells and shell beds also occur in the unit and indicate a marine depositional environment.

- Pungo River Aquifer and Confining Unit - The Pungo River aquifer and confining unit underlie the Yorktown aquifer throughout the area of the Air Station.

  The Pungo River confining unit overlies the Pungo River aquifer and is composed mostly of clay and possibly some clay-containing phosphatic sand. The unit is inferred to be missing in the southern portion of the Air Station (USGS, 1994). The Pungo River aquifer consists of fine- to medium-grained sand with some local beds of silt, clay, and phosphatic sand. A few beds of coarse sand also occur in the unit.

- Upper Castle Hayne Aquifer and Confining Unit - The Upper Castle Hayne aquifer and confining unit underlie the Pungo River aquifer everywhere beneath the Air Station. The Upper Castle Hayne confining unit overlies the Upper Castle Hayne aquifer and is composed of clay and sandy clay at the Air Station. Thin beds of sand have been documented to exist in this confining unit (USGS, 1994).

  The Upper Castle Hayne aquifer is composed primarily of porous limestone, sandy limestone, and medium to fine sand. Thin, discontinuous beds of clay can also be present in the aquifer.

- Lower Castle Hayne Aquifer and Confining Unit - The Lower Castle Hayne aquifer and confining unit underlie the Upper Castle Hayne aquifer and are believed to be continuous beneath the Air Station. The Lower Castle Hayne confining unit overlies the Lower Castle Hayne aquifer and is composed of clay, sandy clay, and sand. The observed thickness of the confining unit ranges from about 15 to 50 feet. The confining unit is slightly thicker in the northern part of the Air Station (USGS, 1994).

  The Lower Castle Hayne aquifer is composed of limestone, sandy limestone, calcareous sand, and clay beds. Thin, discontinuous stringers of consolidated limestone also are present. The aquifer grades to progressively finer grained sediments with depth; fine sand mixed with silt and clay dominate the lower two-thirds of the unit.

The Castle Hayne aquifers are the principal water-supply for many domestic,municipal, and industrial users in eastern North Carolina, including the Air Station and the nearby town of Havelock.

The USGS has identified paleochannels and suspected stratigraphic breaks beneath and in the vicinity of the Air Station. Paleochannels filled with permeable material could act as conduits for groundwater flow or movement of contaminants between the surficial and Castle Hayne aquifers (USGS, 1996).

1.3.3.1 OU2 Hydrogeology

Four hydrogeologic units were encountered during the subsurface investigation at OU2. They are presented in the order at which they were encountered from top to bottom. The units are the surficial aquifer, the

Yorktown confining unit (formerly the upper confining unit), the Yorktown aquifer, and the upper portion of the Pungo River confining unit (formerly the lower confining unit).

The Surficial Aquifer

Groundwater beneath the site was encountered in the surficial aquifer at approximately 7 to 22 feet below ground surface (BGS), and water-level elevations ranged from approximately 2.6 to 22 feet mean sea level (MSL).

The groundwater in the surficial aquifer flows toward and discharges into either Slocum Creek or Turkey Gut. Polishing Ponds No. 1 and No. 2 (Site 46), which are unlined, act as a recharge zone for the surficial aquifer. There are two distinct areas of water table mounding based on April 1996 water level measurements. A large mounding effect in the southeast is due to a topographic high. A small mounding in the central area is due to wells that are located near trenches that act as recharge zones.

The saturated thickness of the surficial aquifer tends to increase toward the southern portion of the site. The average saturated thickness is 29 feet as measured at 9 well clusters across the site, ranging from approximately 22 feet at well cluster 10GW34 in the north to approximately 37 feet at well cluster 10GW40 in the south.

Because of the varying hydraulic gradients throughout the operable unit, the seepage velocity (groundwater flow velocity) was calculated for three areas within the site: the sanitary landfill area, the central landfill area south of Turkey Gut, and the landfill area in the southeast corner of the site.

At the northern landfill area, the hydraulic gradient was estimated to be 1.1E-2 ft/ft by graphic interpretation from the potentiometric surface map. Slug tests were performed in this area in 1990 at monitoring wells 10GW42 and 10GW44 with a resulting average permeability value of 69 ft/day. The effective porosity was estimated to be 0.3 for sand. These values result in a seepage velocity of 2.6 ft/day (9.1E-4 cm/sec).

At the central landfill area, the hydraulic gradient was estimated to be 5.1E-2 ft/ft by graphic interpretation from the potentiometric surface map in the area of monitoring well 10GW36 in the northwestern direction. Slug tests were performed in the central landfill in 1990 at monitoring wells 10GW36, 10GW37, and 10GW43 with a resulting average permeability value of 8.6 ft/day. The effective porosity was estimated to be 0.3 for sand. These values result in a seepage velocity of 1.5 ft/day (5.2E-4 cm/sec).

At the landfill area in the southeast corner of the site the hydraulic gradient was estimated to be 0.018 ft/ft by using graphic interpretation from the potentiometric surface map between monitoring wells 10GW40 and 10GW39. Slug tests were performed in this area in 1990 at monitoring wells 10GW40 and 10GW39 with a resulting average permeability value of 11 ft/day. The effective porosity was estimated to be 0.3 for sand. These values result in a seepage velocity of 0.66 ft/day (2.3E-4 cm/sec).

The Yorktown Confining Unit and Aquifer

The Yorktown confining unit has an average thickness of approximately 19 feet as measured at six Lower Yorktown wells. The thickness ranges from approximately 12 feet at OU2MW2 in the south to approximately 22 feet at OU2MW06 located in the southeast. The Yorktown confining unit is continuous throughout OU2. Seven Shelby tube samples were collected in 1994 from the upper portion of the Yorktown confining unit for geotechnical parameters. The results indicated a geometric average permeability of 1.8E-06 cm/sec (0.005 ft/day). This permeability is likely to be a conservative value because the boring logs and the natural gamma logs indicate that the clay content increases downward within the confining unit.

The groundwater within the Yorktown aquifer beneath the site flows westward and discharges into Slocum Creek. The potentiometric surface elevation (April 1996) of the Yorktown aquifer ranges from approximately 6 to 9.5 feet (MSL). The 8.3-foot potentiometric surface elevation at OU2MW3 is believed to be due to an unexplained localized increase in the potentiometric surface. The average elevation of the Yorktown aquifer potentiometric surface is 6.9 feet MSL. This is consistent with the USGS simulated potentiometric surface of the Yorktown aquifer (USGS, 1994).

The thickness of the aquifer increases towards the southern portion of the site. The average thickness of the Yorktown aquifer is 29 feet as measured at 9 well clusters across the site. Thickness ranges from approximately 22 feet at well cluster 10GW34 in the north to approximately 37 feet at well cluster 10GW40 in the south.

The hydraulic conductivity value of 15 ft/day was obtained from the 1994 USGS report. The hydraulic gradient was estimated to be 5.3E-4 ft/ft by graphic interpretation from the potentiometric surface map. The effective porosity was estimated to be 0.3 for sand. These values result in a seepage velocity of 0.027 ft/day (9.3E-6 cm/sec).

Generally, the vertical hydraulic gradients between the surficial and Yorktown aquifers are upward in areas near Slocum Creek and downward in the central and eastern portion of the site. Upward gradients occur in well clusters OU2MW3 and OU2MW2. This is an area where the groundwater in the surficial aquifer is recharged by the underlying Yorktown aquifer through the Yorktown confining unit. Because of the proximity of Slocum Creek, the groundwater from the Yorktown aquifer is discharging to the creek through the surficial aquifer.

Based on the most recent water-level measurements, a small (head differential of 0.16 feet), downward gradient was observed at well cluster OU2MW4. Larger (average head differential of 8.2 feet) downward gradients were observed in clusters OU2MW5, 10EGW01, OU2MW6, and OU2MW7, located on the eastern side of the site. At well cluster OU2MW7, water-level measurements were not taken at the surficial well because of inaccessibility; however, water levels were obtained from the lower surficial well 10GW25 (S1W2). Moderate downward gradients occur in the central portion of the site at well clusters 10GW19 and 10GW33.

Pungo River Confining Unit

The Pungo River confining unit was believed to be encountered in all of the six lower Yorktown Wells. One Shelby tube sample was collected from the upper portion of the Pungo River confining unit at OU2MW7. The hydraulic conductivity was measured to be 6.6E-7 cm/sec.

1.3.3.2 Groundwater Use and Classification

Groundwater from the Castle Hayne aquifers is the major source of drinking water at the Air Station and in the City of Havelock. Groundwater use within the area includes domestic, light industrial, and industrial. The Air Station uses between 2.5 and 4.5 million gallons of water per day (USGS, 1988). This supply is derived from about 20 wells that range in depth from 195 to 330 feet. The number of wells in use at any one time varies with need. The City of Havelock obtains its water from two wells that are 144 to 150 feet deep. There are no drinking water wells located at OU2.

The groundwater in the vicinity of MCAS Cherry Point is classified by the state of North Carolina Department of Environmental Health and Natural Resources (NCDEHNR) as Class GA. Class GA groundwaters are considered to be existing or potential sources of drinking water.

1.3.4 Surface Water Hydrology and Classification

OU2 is bounded on the west by Slocum Creek, which flows north past the site. Turkey Gut is a perennial stream that flows northwestward through the central portion of OU2 and discharges to Slocum Creek. There is a surface drainage swale between the polishing ponds and the Old Sanitary Landfill where standing water is common during wet periods. The swale drains west, discharging to Slocum Creek.

Slocum Creek is shallow, warm, and brackish. It is approximately 800 feet wide at the confluence of Turkey Gut. During the 1994 sampling event, depths ranged from 2.4 to 4 feet approximately 25 feet from shore. It serves as a recreational resource (e.g., boating) for military personnel and local residents. NCDEHNR has classified Slocum Creek as a Class SC tidal salt water. The SC classification is defined as suitable for fish and wildlife propagation, secondary recreation (i.e., recreational activities not involving whole-body contact), and other uses applicable for waters of lower quality (15A NCAC 2B.0212).

Turkey Gut is a small channelized freshwater tributary to Slocum Creek that drains a portion of MCAS Cherry Point south of the STP. The stream is approximately 10 feet wide and varies in depth from 2 inches to 2 feet based on estimates made during the ecological assessment. The width increases to approximately 50 feet where it enters Slocum Creek. Turkey Gut is classified as a Class C fresh surface water. The C classification is defined as suitable for aquatic life propagation and maintenance of biological integrity, wildlife, secondary recreation, agriculture, and any other usage except for primary recreation or as a source of water supply for drinking, culinary, or food processing purposes (15A NCAC 2B.0211). The classification of surface water is described under Section 2.3 of this FS, which describes Applicable or Relevant and Appropriate Requirements (ARARs).

1.3.5 Climate and Meteorology

Proximity to the Atlantic Ocean significantly influences the climate of MCAS Cherry Point. The climate is warm and humid, with short, mild winters and long, hot summers. Winter temperatures average 46°F, and summer temperatures average 77°F (NAVFACENGCOM, 1980). The average annual temperature is approximately 64°F. Periods of continuous freezing temperatures seldom last more than a few days. Precipitation is unevenly distributed, with the greatest monthly precipitation occurring during July, August, and September (6 to 8 inches per month). In the other months, rainfall averages 3 to 4 inches per month. Average annual precipitation in Craven County is approximately 55 inches (Floyd, 1969). During extreme dry years, precipitation may be as low as 35 inches, whereas rainfall may increase to 80 inches during very wet years. Tropical hurricanes pass offshore twice in an average year but infrequently strike the coast with full force. Average annual evapotranspiration is 36.8 inches (Floyd, 1969).

1.3.6 Ecology

MCAS Cherry Point comprises 11,485 acres, 6,336 acres (55 percent) of which are forested. The remainder is in military use for operations, training, maintenance, construction, supply, housing, support facilities, and utilities. The majority of military use facilities are located in the central and south-central portions of the Air Station. The majority of forested lands are located in the northwest, north-central, and southeast portions of the Air Station. Much of the forested land is used for training purposes.

The Air Station has an active fish and wildlife management program, with on-staff foresters, wildlife biologists, and game wardens. The objectives of the management program are to protect all native wildlife species and their habitat, make fish and wildlife resources available on a continuing basis, enhance fish and wildlife resources, and participate in the multiple uses of Marine Corps property. A copy of the Fish and Wildlife Management Plan is included in Appendix K of the RI (B&R Environmental, April 1997).

Most of the game species native to eastern North Carolina are present at MCAS Cherry Point. These include large game (white-tailed deer, black bear, and wild turkey), small game (grey squirrel, mourning dove, rabbits, bobwhite quail, and waterfowl), and furbearers (raccoon, grey fox, river otter, opossum, muskrat, beaver, nutria, and bobcat), as well as a variety of nongame species (amphibians, reptiles, birds, and mammals). Some of the management programs are active in maintaining population and habitat (e.g., rabbits and squirrels). Some areas of the Air Station are planted in grains to provide additional forage (e.g., doves), and some species are managed primarily by restricting hunting and providing protection from poaching (e.g., bears). Only one waterfowl species (the wood duck) actively breeds in the area, and nesting boxes are provided.

In addition, the Air Station carries out management programs for endangered and threatened species, and all actions are evaluated for the potential effects on these resources. A few endangered and threatened species are known to exist or pass through the area, as follows:

- Bald eagle - A few birds use Slocum Creek or the Neuse River during their migrations. No nests are known.

- American alligator - It is estimated that four to six alligators reside in local creeks and marshes. Young have occasionally been seen in the Jack's Branch area of Hancock Creek.

- Red-cockaded woodpecker - No active colonies have been found in the area, although the birds did exist historically. Monitoring continues, but there have been no confirmed sightings.

- Loggerhead turtle - Found in sounds and rivers adjacent to MCAS Cherry Point.

A rare species and special-interest natural areas inventory of MCAS Cherry Point was conducted by the North Carolina Natural Heritage Program (NCNHP) during 1992 and 1993. The animal and plant inventory was designed to gather data on the population and habitat characteristics of each documented rare species, to map their locations, to assess the quality and integrity of habitat, and to make management recommendations regarding species and habitat.

NCNHP has divided MCAS Cherry Point into 15 critical areas, which are considered to be essential to the conservation and management of rare species. Of these 15 critical areas only one is partially associated with OU2 (all of Slocum Creek and its tributaries). This area contains tidal freshwater marshes, coastal small stream swamps,a nd cypress-gum swamps.

MCAS Cherry Point forested uplands are dominated by the Wet Pine Flatwoods community, most of which has been managed for timber production. The Tidal Freshwater Marsh community forms a fringe along the tidal creeks, and the Coastal Fringe Evergreen Forest community occupies low upland terraces along the tidal creeks. Tidal creek tributaries support the Coastal Plain Small Stream Swamp (Blackwater Subtype) community, and the Mesic Mixed Hardwood Forest community occupies the slopes adjacent to these inland streams.

Pine is the dominant canopy tree, with loblolly pine (*Pinus taeda*) covering about 4,000 acres. Mixed pine and hardwoods cover about 1,200 acres. Some forested lands are managed for natural and scenic values. These include major road corridors; riparian, beach, and bluff areas along the major river and creek systems, including their tributaries; areas containing federally designated endangered, threatened, or rare species; and forests adjacent to some residential areas and the Air Station golf course. Other forested lands are managed for even-age timber production and to enhance wildlife populations, such as by maintaining wildlife food plots. Although there is a recent history of prescribed winter burning in MCAS Cherry Point forests, shrub dominance of the ground layer and the near absence of wiregrass (*Aristida stricta*) indicate a long historical period without fire. It is also possible that land uses, such as agriculture, prior to the establishment of the Air Station contributed to loss of wiregrass.

The game warden staff assists Federal and state authorities in enforcement of the Endangered Species Act. The Air Station also runs an active fisheries management program to provide recreational fishing for military personnel and their dependents, civilian employees, and public guests. The program consists of intensive management of four freshwater ponds, as well as regulation and enforcement on adjacent waters. The ponds are stocked with catfish, largemouth bass, bluegill, and redear sunfish.

1.3.7 Current Site Utilization

MCAS Cherry Point is located within the limits of the City of Havelock, North Carolina. The area surrounding the Air Station consists of commercial and residential developments, waterways, and public lands (Croatan National Forest). It is isolated from relatively large population centers. The largest cities in the vicinity are the City of New Bern (approximately 19 miles northwest of the Air Station) and Morehead City (approximately 19 miles southeast of the Air Station). There are 8,267 active military personnel and 5,946 civilian personnel living and/or working at the Air Station. In addition 27,586 dependents live on or off the station.

Enlisted military personnel assigned to the Air Station typically remain for two tours of duty (a total of approximately 3 years). Officers may remain longer.

As noted in Section 1.3.6, MCAS Cherry Point comprises 11,485 acres. The primary military land uses at the Air Station include military operations, training, maintenance and production, supply, medical administration, troop and family housing, community support, and utilities. The most concentrated area of development occurs in an area bounded by "A" Street, Sixth Avenue, and Roosevelt Boulevard. This area is southeast of OU2 on the opposite side of Roosevelt Boulevard. Most of the assigned personnel, both civilian and military, work in this area, and most of the enlisted men's quarters are located there.

The area between the East Prong of Slocum Creek and Roosevelt Boulevard, and south of Runway 14 is generally devoted to a Community Services complex. Most housing is located within the Community Services Complex in the southwest corner of the Air Station along Roosevelt Boulevard (southeast of OU2). The northwest corner and the area west of Slocum Creek are devoted to Ordnance and Survival Training areas. These areas are also northwest and west of OU2. None of the above areas have been impacted by past activities at OU2.

The surficial and Yorktown aquifers at OU2 or anywhere at the Air Station are not currently used as a drinking water source. There are no plans to make use of the surficial or Yorktown aquifers. The Air Station obtains its potable water from the Castle Hayne aquifers, approximately 190 feet below ground surface. The only area at OU2 which is currently in use is the vehicle maintenance area.

1.4 NATURE AND EXTENT OF CONTAMINATION

Soil, groundwater, surface water, sediment, leachate seep, and polishing pond sediment samples were collected and analyzed for a variety of parameters to determine the nature and extent of contamination. This section summarizes the data and discussion presented in the RI Report (B&R Environmental, April 1997). The sampling locations are provided in Figure 1-4 and Plate 2 (in Appendix D).

The complete database for all sampling results is contained in Appendix H of the RI Report.

1.4.1 Soil

1.4.1.1 Surface Soil

Until 1995, only five soil samples had been collected at OU2 from depths of less than 2 feet. Three of these samples were analyzed for Target Compound List (TCL) volatile and semivolatile organics and Target Analyte List (TAL) metals. Two of the samples were only analyzed for RCRA List 2 metals. In 1995, thirteen additional surface soil and dry leachate seep soil samples were collected and analyzed for the full TCL/TAL, including cyanide. In 1996, two surface soil samples were collected and analyzed for the full TCL/TAL including cyanide, and two surface soil samples were collected and analyzed for dioxins. Table 1-1 summarizes the surface soil sampling results.

Only a few volatile organic compounds were detected. These include single detections of 1,2-dichloroethane (20 micrograms per kilogram [μg/kg]), methylene chloride (12 μg/kg), and chloroform (9 μg/kg). Xylenes were detected in seven samples at concentrations of 1 to 11 μg/kg, and toluene was found in three samples at concentrations of 11 to 42 μg/kg.

One surface soil sample contained several polynuclear aromatic hydrocarbons (PAHs) at concentrations ranging from 140 μg/kg for indeno(1,2,3-cd)pyrene to 360 μg/kg for pyrene. This sample also contained the highest concentrations of the DDT isomers (maximums of 35 to 69 μg/kg). Several other pesticides

TABLE 1-1

SUMMARY OF ANALYTICAL RESULTS - SURFACE SOIL AND DRY LEACHATE SEEP SOIL (0 TO 2 FEET) - OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection
Volatile Organics (μg/kg)				
Toluene	3/18	21.7	11 - 42	OU2LS05-0001
Xylenes	7/18	3.7	1 - 11	OU2LS05-00001
1,2-Dichloroethene (total)	1/18	20	20	10TP15-0002
Methylene chloride	1/18	12	12	10TP15-0002
Chloroform	1/18	9	9	OU2LS05-0001
Semivolatile Organics (μg/kg)				
2,4-Dinitrophenol	1/15	850	850	OU2LS04-0001
4-Nitrophenol	1/15	850	850	OU2LS04-0001
Di-n-octylphthalate	2/15	128.5	67-190	OU2SS13-0001
Benzo(a)anthracene	1/15	160	160	OU2SS04-0001
Benzo(b)fluoranthene	1/15	170	170	OU2SS04-0001
Benzo(k)fluoranthene	1/15	160	160	OU2SS04-0001
Benzo(g,h,i)perylene	1/15	250	250	OU2SS04-0001
Benzo(a)pyrene	1/15	240	240	OU2SS04-0001
Chrysene	1/15	220	220	OU2SS04-0001
Fluoranthene	1/15	270	270	OU2SS04-0001
Indeno(1,2,3-cd)pyrene	1/15	140	140	OU2SS04-0001
Pyrene	1/15	360	360	OU2SS04-0001
Pesticides/PCBs/Dioxins/Furans (μg/kg)				
alpha-Chlordane	7/15	8.9	1.9 - 27	OU2SS06-0001
gamma-Chlordane	2/15	20.5	12 - 29	OU2SS06-0001
4,4'-DDD	2/15	23.4	3.8 - 43	OU2SS04-0001
4,4'-DDE	6/15	22.9	4.2 - 69	OU2LS05-0001
4,4'-DDT	7/15	14.4	4.7 - 35	OU2SS04-0001
Dieldrin	4/14	10.7	3.8 - 20	OU2LS05-0001
Endosulfan I	2/15	4.7	1.8 - 7.6	OU2LS05-0001
Endrin aldehyde	6/14	10.7	3.0 - 27	OU2SS02-0001
Heptachlor	1/15	2.0	2.0	OU2SS06-0001

TABLE 1-1 (Continued)
SUMMARY OF ANALYTICAL RESULTS - SURFACE SOIL AND DRY LEACHATE SEEP SOIL (0 TO 2 FEET) - OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection
Aroclor-1254	2/15	29.5	28-31	OU2SS12-0001
Aroclor-1260	1/15	630	630	OU2SS01-0001
OCDD	2/2	0.58	0.141-1.012	OU2SB10-0001
Total HpCDD	1/2	0.026	0.026	OU2SB10-0001
Inorganics (mg/kg)				
Aluminum	18/18	4,541	1190 - 13,000	10TP15-0002
Antimony	4/18	2.3	1.1 - 3.6	OU2LS05-0001
Arsenic	20/20	2.4	0.68 - 17.1	OU2LS05-0001
Barium	20/20	24.7	3.3 - 103	OU2LS05-0001
Beryllium	1/20	0.28	0.28	OU2SS03-0001
Cadmium	8/20	2.0	0.29 - 6.4	10TP15-0002
Calcium	17/18	20,416	210 - 209,000	OU2SS03-0001
Chromium	20/20	14.0	2.2 - 51.2	OU2SS08-0001
Cobalt	13/20	0.73	0.22 - 1.6	OU2SS07-001
Copper	18/20	11.0	1.1 - 50.8	OU2SS02-0001
Iron	18/18	8,552	1,520 - 54,700	OU2SS07-0001
Lead	17/20	29.3	3.8 - 76.5	OU2LS05-0001
Magnesium	14/18	678	236 - 2,180	OU2SS03-0001
Manganese	18/18	37.3	3.7 - 211	OU2SS07-0001
Mercury	10/18	0.30	0.06 - 1.0	OU2LS05-0001
Nickel	15/20	2.2	0.35 - 5.4	10TP16-0002
Potassium	12/18	578	189 - 1140	OU2SS03-0001
Selenium	6/20	0.98	0.30 - 3.1	OU2LS05-0001
Silver	2/20	2.1	0.43 - 3.7	44ASO03-0000
Sodium	8/18	124	40.3 - 424	OU2LS05-0001
Thallium	3/20	2.6	0.47 - 6.7	44ASO03-0000
Vanadium	19/20	9.7	3.2 - 24.2	10TP15-0002
Zinc	19/20	43.1	4.8 - 209	10TP23-0102

were also detected in surface soils, including chlordanes (1.9 to 29 μg/kg), dieldrin (3.8 to 20 μg/kg), endrin aldehyde (3.0 to 27 μg/kg), and heptachlor (2 μg/kg). The maximum concentrations of pesticides were found in various samples throughout the site. Polychlorinated biphenyls (PCBs) were only detected in two surface soil samples at concentrations ranging from 28 μg/kg (Aroclor-1254) to 630 μg/kg (Aroclor-1260).

Dioxins were detected in two surface soil samples. The congeners detected include octachlorodibenzo-p-dioxin (OCDD) and total heptachlorodibenzo-p-dioxin (HpCDD). These are the least toxic of the dioxins. Dioxins are evaluated using Toxicity Equivalence Factors (TEF) relative to the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). TCDD equivalent concentrations ranged from 0.0001 to 0.001 μg/kg.

Metals of interest in the surface soil samples were cadmium, chromium, manganese, and thallium, which were detected at maximum concentrations of 6.4 milligrams per kilogram (mg/kg), 51.2 mg/kg, 211 mg/kg, and 6.7 mg/kg, respectively. No single sample location contained an overwhelming majority of the detected maximums. The maximum values were detected at a number of sample locations. Table 1-1 summarizes the surface soil sample results.

1.4.1.2 Subsurface Soil

The subsurface soil sampling program concentrated on areas that had a higher potential for contamination based on past experience and knowledge. Figure 1-4 and Plate 2 (Appendix D) identify the major study areas. Past soil sampling programs were based on soil-gas and geophysical surveys, aerial photographs, and knowledge of existing groundwater contamination. When anomalous areas or areas of groundwater contamination were identified, soil borings and test pits were installed to collect subsurface soil samples. The 1994 and 1996 field activities were conducted to fill known data gaps from previous investigations. The subsurface soil sampling results are summarized in Table 1-2.

The analytical results for subsurface soil show that volatile organic compounds were not detected frequently, but were detected at notable concentrations in a limited number of samples. In addition, only a limited number of samples were analyzed for semivolatile organic compounds and pesticides/PCBs. Fuel-type constituents, including benzene, toluene, ethylbenzene, and xylenes (BTEX), were identified in a number of subsurface soil samples. The vast majority of samples analyzed for BTEX did not contain these compounds at detectable levels. The primary detections were scattered throughout the site, with the highest concentrations reported in the areas used for fire training exercises in the southern portion of the landfill. The highest concentrations of BTEX (primarily, toluene, ethylbenzene, and xylenes, with lower concentrations

TABLE 1-2

SUBSURFACE SOIL ANALYTICAL RESULTS (> 2 FEET)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Concentration Range	Frequency of Detection	Location of Maximum Detection
Volatile Organics (µg/kg)			
Acetone	4 - 5,300	24/111	OU2SB5-2224
2-Butanone	11 - 16,000	15/111	10TP02-0405
4-Methyl-2-pentanone	10 - 1,000	5/111	10TP15-0810
2-Hexanone	7 - 510	7/111	10TP01-0709
Benzene	4 - 280	7/115	OU2SB8-2224
Toluene	5 - 67,000	20/115	OU2SB7-2224
Ethylbenzene	7 - 140,000	19/115	10TP18-0910
Xylenes (total)	5 - 450,000	32/111	10TP18-0910
Chlorobenzene	14 - 520	7/115	10TP04-1012
Styrene	5	1/111	10SB-E31-0406
1,1,1-Trichloroethane	3 - 2,500	15/115	10B02-0608
1,1-Dichloroethane	9 - 69	4/115	OU2SB8-2224
1,2-Dichloroethane	13	1/115	10TP15-0810
Chloroethane	14	1/115	10TP17-0910
Tetrachloroethene	38 - 4,800	2/111	10SISB3-1618
Trichloroethene	5 - 880	7/115	10B04-1012
1,2-Dichloroethene (total)	5 - 4,700	6/111	10SB-E63-0204
Vinyl chloride	13 - 490	2/115	10SB-E63-0204
Chloroform	470 - 2,590	4/115	B1-14
Methylene chloride	4 - 190,000	16/115	10TP18-0910
Trichlorofluoromethane	4.9 - 24	4/4	B1-14
trans-1,3-Dichloropropene	98	1/115	10TP02-0405
Carbon disulfide	6 - 44	7/111	10SB-C33-1921
Semivolatile Organics (µg/kg)			
Phenol	43 - 12,000	4/20	10B03-0810
2,4-Dimethylphenol	52 - 4,100	5/20	10B03-0810

TABLE 1-2 (Continued)
SUBSURFACE SOIL ANALYTICAL RESULTS (> 2 FEET)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Concentration Range	Frequency of Detection	Location of Maximum Detection
4-Methylphenol	590 - 27,000	2/16	10B03-0810
1,2-Dichlorobenzene	430 - 2,000	2/20	10SISB3-1618
Bis(2-ethylhexyl)phthalate	49 - 11,000	9/20	OU2SB8-2224
Di-n-butylphthalate	110 - 360	5/20	OU2SB2-2426
Diethylphthalate	55 - 160	2/20	OU2SB4-2224
Butylbenzylphthalate	140 - 2,300	2/20	OU2SB8-2224
Anthracene	1,000	1/20	10SISB3-1618
Fluoranthene	1,100	1/20	10B01-1012
Fluorene	420 - 20,000	4/20	OU2SB8-2224
2-Methylnaphthalene	140 - 230,000	8/16	OU2SB8-2224
Naphthalene	100 - 39,000	9/20	OU2SB8-2224
Phenanthrene	200 - 90,000	6/20	OU2SB8-2224
Pyrene	190	1/20	10SISB2-1618
Dibenzofuran	4,300 - 11,000	2/16	OU2SB8-2224
Pesticides/PCBs (μg/kg)			
Aldrin	3.6	1/14	OU2SB4-2224
delta-BHC	4.6	1/14	10B03-0810
alpha-Chlordane	3.9 - 630	3/9	OU2SB8-2224
gamma-Chlordane	1.2 - 2.8	3/10	OU2SB5-2224
4,4'-DDD	1.4 - 3.5	4/11	OU2SB3-2022
4,4'-DDE	2.5 - 30	2/13	10B01-1012
4,4'-DDT	120 - 130	2/13	10B03-0810
Dieldrin	7.2 - 53	4/14	10B03-0810
Endosulfan I	2.2	1/14	10B01-1012
Endosulfan II	32 - 47	2/12	10B03-0810
Endosulfan sulfate	36 - 67	2/14	10B03-0810
Endrin	15 - 21	2/14	10B03-0810

TABLE 1-2 (Continued)
SUBSURFACE SOIL ANALYTICAL RESULTS (> 2 FEET)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Concentration Range	Frequency of Detection	Location of Maximum Detection
Heptachlor epoxide	7.7 - 18	2/12	10B03-0810
1,2,3,4,6,7,8-HpCDD	0.0404	1/2	OU2SB10-0406
1,2,3,4,6,7,8-HpCDF	0.0061	1/2	OU2SB09-0810
OCDD	0.210-0.651	2/2	OU2SB10-0406
Total HpCDD	0.0404	1/2	OU2SB10-0406
Total HpCDF	0.0075	1/2	OU2SB09-0810
Inorganics (mg/kg)			
Aluminum	467 - 18,500	32/32	10TP23-0910
Antimony	3.9 - 66.3	15/111	10SB-E19-1012
Arsenic	0.12 - 13.7	113/118	10TP17-0910
Barium	1.0 - 705	38/40	10TP23-0910
Beryllium	0.02 - 3.7	38/117	10SB-E19-1012
Cadmium	0.14 - 119.5	26/127	10TP17-0910
Calcium	49.7 - 105,000	32/32	10SISB4-1214
Chromium	1.1 - 122	120/127	H3/H4-C (10-14.5)
Cobalt	0.50 - 16.7	14/34	10TP23-0910
Copper	0.24 - 2,370	76/127	10SB-E19-1012
Iron	717 - 62,600	32/32	OU2SB4-2224
Lead	0.82 - 1,650	118/127	10TP23-0910
Magnesium	25.3 - 3,440	32/32	10TP23-0910
Manganese	2.7 - 1,170	32/32	10TP23-0910
Mercury	0.04 - 4.1	12/115	10TP17-0910
Nickel	1.0 - 176	54/127	10SB-E35-0810
Potassium	54.6 - 2,040	22/32	10TP23-0910
Selenium	0.02 - 1.5	38/117	10TP23-0910
Silver	0.09 - 90.0	11/125	10TP15-0810
Sodium	30.6 - 2,250	19/32	10TP23-0910
Thallium	0.12 - 7.4	6/117	44ASO03-0203
Vanadium	4.0- 27.2	27/34	10TP17-0910
Zinc	0.58 - 2,650	113/127	10TP23-0910

of benzene) ranged from 155,280 to 617,000 μg/kg. The sample with the lower concentration was collected at the water table. All other sample intervals were above the water table.

Other areas with BTEX contamination were in the area of the former sludge impoundments (1,900 to 7,500 μg/kg); one boring in Study Area E, which is south of Turkey Gut (4,830 μg/kg); and in Study Area B, which is in the east-central portion of the site (2,174 to 10,993 μg/kg). All of the samples in these areas were collected from above the water table. The presence of these constituents in soil suggests potential source area(s) for BTEX in groundwater.

Another group of compounds potentially relating to observed groundwater contamination includes chlorinated solvents such as tetrachloroethene (PCE), trichloroethene (TCE), dichloroethenes (DCE), vinyl chloride, and 1,1,1-trichloroethane (TCA). While not widespread, their presence also appears to correlate with observed areas of these compounds in the surficial aquifer. There are a few areas with chlorinated solvents in the soil, such as in Study Area E (DCE at 6 to 4,700 μg/kg and vinyl chloride at 490 μg/kg), the area of the former sludge impoundments (PCE at 4,800 μg/kg, TCE at 800 to 880 μg/kg, and TCA at 2,500 μg/kg), and Study Area B (PCE at 38 μg/kg). All samples in these areas were collected above the water table.

Semivolatile compounds of note in the subsurface soil include several phenols found in the area of the former sludge impoundments. These compounds and the maximum concentrations included phenol (12,000 μg/kg), 2,4-dimethylphenol (4,100 μg/kg), and 4-methylphenol (27,000 μg/kg). All samples in this area were collected above the water table. In addition, several of the more soluble polycyclic aromatic hydrocarbons (PAHs) were detected in the area formerly used for fire-training exercises in the southern portion of the landfill. The highest concentrations were reported for fluorene (20,000 μg/kg), phenanthrene (90,000 μg/kg), naphthalene (39,000 μg/kg), and 2-methylnaphthalene (230,000 μg/kg). The depth interval was at the water table.

Pesticides were not frequently analyzed nor were they frequently detected. Dieldrin was one of the most commonly detected pesticides and was found at a maximum concentration of 53 μg/kg in the former sludge impoundment area. Other pesticides of note were chlordanes (630 μg/kg maximum) and 4,4'-DDD (3.5 μg/kg maximum). The maximum concentrations of these pesticides were detected in the southern portion of the landfill near Test Pits TP-18 and TP-19 at the water table depth interval. Many of the maximum concentrations of these and other pesticides were found at depths greater than 10 feet. This may indicate soil mixing or application of pesticides for insect control when various areas were receiving waste material.

Dioxins and furans were detected in two subsurface soil samples. Congeners detected include OCDD, HpCDD, and heptachlorodibenzo-p-furan (HpCDF). These are the least toxic of the dioxins and furans. TCDD equivalent concentrations ranged from 0.0003 to 0.0011 μg/kg.

Ketones were detected in several soil samples. Acetone was detected at concentrations up to 5,300 μg/kg near TP-19, and 2-butanone was detected up to 16,000 μg/kg in Study Area B.

A number of metals were detected in the subsurface soil samples. Many metals were detected in 90 percent or more of the samples, with the following metals detected less frequently: antimony (14 percent), mercury (10 percent), beryllium (32 percent), cadmium (20 percent), cobalt (41 percent), copper (60 percent), nickel (43 percent), selenium (32 percent), silver (9 percent), thallium (5 percent), and vanadium (79 percent). Metals that were detected in at least 90 percent of the samples include aluminum, arsenic, barium, calcium, chromium, iron, lead, magnesium, manganese, potassium, sodium, and zinc. Several metals, including arsenic, vanadium, and zinc, were detected at concentrations that are not significantly different from the background concentration range. The metals whose maximum detected concentrations exceed the background results were antimony, barium, cadmium, copper, lead, manganese, and silver. Metals were not widespread or common contaminants in subsurface soil at OU2, although there are a limited number of locations with high concentrations (i.e., hot spots). Copper, lead, and zinc were those metals which were detected frequently at concentrations greater than background and which appeared to be the most widespread.

1.4.2 Groundwater

1.4.2.1 Surficial Aquifer

The most commonly detected contaminants in the surficial aquifer were monocyclic aromatic fuel constituents (BTEX), halogenated aliphatics (chlorinated solvents and breakdown products such as PCE, TCE, DCE, vinyl chloride, TCA, dichloroethanes (DCA), and chloroethane), and chlorinated monocyclic aromatics (chlorobenzene and dichlorobenzenes). Several items are of note in discussing the nature and extent of contamination in the surficial aquifer. First, there is widespread contamination of groundwater with organic chemicals. Those listed above are the most prevalent based on past and recent data. Second, the maximum detected concentrations of many compounds have declined over the years. Third, while no distinct plumes are visible based on the most recent sampling event, several areas of overall contamination can be outlined as general areas of concern. These areas of concern are where certain contaminants exceed state and/or federal groundwater or drinking water standards. Table 1-3 summarizes the most recent (1994 and 1996) analytical results from the surficial aquifer.

Benzene, vinyl chloride, and trichloroethene were the compounds that exceeded the state groundwater quality standards most often. Chlorobenzene, chloroethane, 1,1-dichloroethane, and cis-1,2-dichloroethene were also detected frequently. The concentration of benzene over almost the entire area exceeds the state standard of 1 microgram per liter (μg/L). Within this area of general benzene contamination, three areas of solvent contamination were identified. One area is located west (downgradient) of the former sludge impoundment area and extends to the south side of Turkey Gut (Study Area E). Another area is centered on Study Area B on the eastern edge of the landfill, and a third area is located in the southwest portion of OU2. This area may be associated with the fire training areas and potential use of solvents there or in the adjacent vehicle maintenance area (Site 76).

Several areas have chlorobenzene concentrations exceeding the state standard of 50 μg/L. These areas are as follows: (1) coincident with the solvent contamination area south of Turkey Gut (Study Area E), (2) an area in the upstream area of Turkey Gut (Study Area C), and (3) the areas surrounding OU2HP1, which is located southwest of Study Area E.

Metals are not significant groundwater contaminants at OU2. Only two toxic metals (arsenic and cadmium) were found during the most recent sampling event that exceeded state standards (50 μg/L and 5 μg/L, respectively). Iron and manganese concentrations exceeded the state standards of 300 μg/L and 50 μg/l, respectively) in most of the wells during the most recent sampling event. The standards for iron and manganese are based on aesthetics (e.g., taste, odor, staining of plumbing) rather than toxicity. Cobalt and vanadium were detected in several wells; however, they were not detected in background samples. Many detections of calcium, magnesium, potassium, and sodium also exceeded background concentrations.

There is no significant difference in the analytical results for wells screened in the upper and lower portions of the surficial aquifer. This indicates there is little potential for nonaqueous-phase liquids at this site.

1.4.2.2 Yorktown Aquifer

The analytical results for the Yorktown aquifer indicate that metals are not significant contaminants except for iron and manganese. Iron exceeded the state groundwater standard in most wells, and manganese

TABLE 1-3

SUMMARY OF ANALYTICAL RESULTS - SURFICIAL AQUIFER (1994 AND 1996) OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection	NC Class GA Standard[4]
Volatile Organics (µg/L)					
Acetone	3/9	19.0	7 - 32	OU2MW11	700
2-Butanone	2/17	76.0	69 - 83	OU2MW11	170
2-Hexanone*[5]	1/46	1	1	OU2MW10	> DL[6]
4-Methyl-2-pentanone*	5/46	17.0	3 - 64	OU2MW1	> DL
Benzene*	21/46	19.6	2 - 230	10GW09	1
Toluene	7/46	41.6	2 - 110	10GW47	1,000
Ethylbenzene*	7/46	13.0	1 - 38	OU2HP2	29
Xylenes	11/46	49.9	2 - 180	OU2HP3	530
Chlorobenzene*	22/46	42.3	1 - 180	10GW40	50
1,2-Dichlorobenzene[1]	15/76	8.5	0.75 - 28	OU2HP1	620
1,3-Dichlorobenzene[1]	2/79	2	2	OU2HP1	620
1,4-Dichlorobenzene[1]	26/79	10.7	2.5 - 40	OU2HP1	75
1,1,1-Trichloroethane	2/46	4	3 - 5	10EGW5	200
1,1-Dichloroethane	18/46	27.6	1 - 79	OU2MW11	700
1,2-Dichloroethane*	3/46	3.7	2 - 5	OU2MW10	0.38
Chloroethane	12/46	27.3	1 - 90	10EGW02	2,800
Tetrachloroethene*	6/46	7.4	1 - 21	OU2HP6	0.7
Trichloroethene*	11/46	11.3	1 - 40	OU2MW11	2.8
1,1-Dichloroethene	1/46	2	2	OU2MW11	7
cis-1,2-Dichloroethene*	16/46	29.2	1 - 140	10EGW5	70
trans-1,2-Dichloroethene	6/46	1.8	0.75 - 3	OU2HP2	70
Vinyl chloride*	16/46	8.3	1 - 26	10EGW02	0.015
Methylene chloride	3/45	1.5	1 - 2	OU2MW16	5
1,2-Dichloropropane*	5/46	1.2	1 - 2	OU2MW11	0.56
Chloroform*	2/46	2	1 - 3	OU2MW14	0.19
Semivolatile Organics (µg/L)					
Phenol	4/33	8.3	3 - 16	10EGW5	300
2-Methylphenol*	2/33	8.5	6 - 11	10EGW5	> DL
4-Methylphenol*	5/33	32.7	3 - 65	10EGW5	> DL
2,4-Dimethylphenol*	4/33	77.3	4 - 280	OU2HP3	> DL
Bis(2-ethylhexyl)phthalate*	3/33	33.0	4 - 66	10GW34	3
Diethylphthalate	9/33	18.2	4 - 53	OU2HP1	5,000
2-Methylnaphthalene*	4/33	8.3	4 - 18	10EGW5	> DL
Naphthalene*	8/33	14.6	3 - 41	10GW47	21
Nitrobenzene*	1/33	5	5	10GW34	> DL
Bis(2-chloroethyl)ether*	1/33	3	3	OU2HP3	> DL

TABLE 1-3 (Continued)
SUMMARY OF ANALYTICAL RESULTS - SURFICIAL AQUIFER (1994 AND 1996)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection	NC Class GA Standard
Pesticides/PCBs (µg/L)					
Aldrin*	1/32	0.0034	0.0034	10GW35	> DL
alpha-BHC*	2/30	0.0094	0.0089 - 0.0098	10GW43	> DL
gamma-BHC (Lindane)	2/28	0.024	0.0089 - 0.041	OU2HP1/HP3	0.2
alpha-Chlordane	5/30	0.0009	0.0054 - 0.014	OU2HP3	0.027
gamma-Chlordane	1/31	0.0085	0.0085	OU2HP1	0.027
4,4'-DDE*	1/30	0.0092	0.0092	OU2HP1	> DL
4,4'-DDT*	1/31	0.017	0.017	S4W2	> DL
Endosulfan I*	1/32	0.0090	0.0090	OU2HP3	> DL
Endosulfan II*	3/26	0.021	0.0033 - 0.056	OU2HP1	> DL
Endrin	3/32	0.013	0.00071 - 0.020	OU2HP3	2
Endrin aldehyde*	5/29	0.22	0.01 - 0.97	OU2MW11	> DL
Heptachlor	1/31	0.0055	0.0055	10GW43	0.008
Heptachlor epoxide*	2/30	0.012	0.0033 - 0.024	OU2HP2	0.004
Inorganics (µg/L)					
Aluminum	29/46	347	15.0 - 4,840	OU2MW15	NS[7]
Arsenic*	27/46	42.6	3.9 - 126	10EGW3	50
Barium	44/46	78.5	16.0 - 306	10GW41	2,000
Cadmium*	2/46	5.6	5.2 - 6.0	OU2HP1	5
Calcium	45/45	32,502	1,170 - 93,850	10GW39	NS
Cobalt	10/46	32.5	8.6 - 81.0	10GW27	NS
Copper	2/46	6.2	1.7 - 10.6	9GW31	1,000
Iron*	43/46	34,774	69.9 - 100,500	OU2MW11	300
Lead	9/46	2.8	0.75 - 7.3	10GW40	15
Magnesium	46/46	8,116	1,080 - 34,900	OU2HP2	NS
Manganese*	46/46	400	5.4 - 3,270	10GW31	50
Nickel	2/46	18.6	15.3 - 22.0	10GW36	100
Potassium	46/46	7,526	923 - 36,900	10GW40	NS
Sodium	46/46	27,452	1,070 - 95,900	10GW12	NS
Vanadium	4/46	6.0	1.8 - 9.0	OU2HP1	NS
Zinc	14/46	22.8	6.0 - 90.5	OU2HP4	2,100
Cyanide	1/46	28.0	28.0	10GW34	154
pH (units)*	37/37	5.95[2]	3.22 - 7.28	NA[3]	6.5 - 8.5

1 Measured in both volatile and semivolatile fraction.
2 Geometric average.
3 NA - Not applicable.
4 15A NCAC 2L.0200.
5 Asterisk next to analyte indicates exceedance of state standard.
6 > DL - Greater than detection limit. Any detection is considered an exceedance of the standard.
7 NS - No standard.

exceeded the standard in more than 50 percent of the wells. Organic compounds were detected in low concentrations during the most recent (1994) sampling round. These include chloroform (1 and 2 μg/L) methylene chloride (3 μg/l), and bis(2-ethylhexyl)phthalate (25 μg/l), which are common laboratory contaminants. However, none of these compounds were found in QA/QC blanks at levels that would affect the data. Chloroform and bis(2-ethylhexyl)phthalate exceeded the state standards.

The concentrations of all metals found in the Yorktown aquifer during the most recent sampling event were below drinking water standards or state groundwater standards, except for iron and manganese. The standards for iron and manganese are based on aesthetic concerns. The most recent analytical results (1994) for the Yorktown aquifer are summarized in Table 1-4.

1.4.3 Surface Water

The most recent analytical results for samples collected from Turkey Gut and Slocum Creek in 1994 are summarized in Table 1-5 and Table 1-6, respectively, along with state surface water standards. The suite of analytes detected in Turkey Gut is similar to the types and classes of compounds detected in onsite groundwater. However, the surface water concentrations were generally much lower than those detected in groundwater. In Turkey Gut, a sample that was located just upstream of an identifiable leachate seep (in 1985) contained benzene, chlorobenzene, 1,4-dichlorobenzene, 1,1-dichloroethane, chloroethane, cis-1,2-dichloroethene, and vinyl chloride. Most detections were 1 to 3 μg/L. Chlorobenzene was detected at a concentration of 10 μg/L in this sample. This was the only Turkey Gut sample that contained detectable concentrations of volatile organic compounds. In Slocum Creek, chloroform was consistently detected at a concentration of 1 μg/l in 1994. Chloroform was not detected in samples collected from the surficial aquifer in 1994. Another compound, cis-1,2-dichloroethene, that was consistently found at OU2 was also detected in Slocum Creek. Therefore, it can be assumed that contaminated groundwater is discharging to Slocum Creek. The sample in which cis-1,2-dichloroethene was detected is at the downgradient end of a contaminant plume emanating from the former sludge impoundment.

Pesticides were detected in several surface water samples, although their presence may be related to suspended sediment material in the samples rather than dissolved concentrations in the surface waters. Pesticides were detected at low concentrations in a number of groundwater samples, although no plume or significant soil source area could be identified that could result in the presence of these pesticides in Turkey Gut or Slocum Creek. The source of these pesticides is most likely the prior or current application of these materials throughout the watershed, followed by runoff.

TABLE 1-4

SUMMARY OF ANALYTICAL RESULTS - YORKTOWN AQUIFER (1994)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	NC Groundwater Standard[1]	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection
Volatile Organics (μg/L)					
Chloroform*[2]	0.19	2/10	1.5	1 - 2	OU2MW6
Methylene chloride	5	1/10	3	3	OU2MW6
Semivolatile Organics (μg/L)					
Bis(2-ethylhexyl)phthalate*	3	1/8	25	25	10GW24
Inorganics (μg/L)					
Aluminum	NS[3]	6/10	198	25.0 - 936	OU2MW3
Barium	2,000	10/10	18.1	2.0 - 44.0	OU2MW7
Calcium	NS	10/10	61,930	49,500 - 68,600	OU2MW2
Iron*	300	9/10	827	279 - 2,010	10GW22
Lead	15	2/10	1.2	1.2	10GW24/ OU2MW3
Magnesium	NS	10/10	1,700	783 - 2,380	OU2MW5
Manganese*	50	10/10	50.9	12.0 - 90.0	OU2MW5
Potassium	NS	10/10	2,238	858 - 7,510	OU2MW7
Sodium	NS	10/10	10,409	1,280 - 32,000	OU2MW3
Zinc	2,100	1/10	10.0	10.0	OU2MW3
pH (units)*	6.5 - 8.5	10/10	7.42[4]	6.99 - 8.59	NA[5]

1 15A NCAC 2L.0200.
2 Asterisk indicates exceedance of state standard.
3 NS - No standard.
4 Geometric average.
5 NA - Not applicable.

TABLE 1-5

SUMMARY OF ANALYTICAL RESULTS - TURKEY GUT SURFACE WATER (1994)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection	NC Class C Standard/ Criteria[4]
Volatile Organics (μg/L)					
Benzene	1/4	1	1	OU2SW4	71.4
Chlorobenzene	1/4	10	10	OU2SW4	21,000
1,4-Dichlorobenzene[1]	1/8	2	2	OU2SW4	2,600
1,1-Dichloroethane	1/4	2	2	OU2SW4	19.8
Chloroethane	1/4	3	3	OU2SW4	860
cis-1,2-Dichloroethene	1/4	1	1	OU2SW4	7.0
Vinyl chloride	1/4	1	1	OU2SW4	525
Semivolatile Organics (μg/L)					
Bis(2-ethylhexyl)phthalate*	2/4	5	4 - 6	OU2SW6	5.9
Pesticides/PCBs (μg/L)					
gamma-BHC (Lindane)	2/4	0.0049	0.0016 - 0.0081	OU2SW4	0.01
4,4'-DDD*	1/4	0.028	0.028	OU2SW3	0.00084
Heptachlor epoxide*	1/4	0.0019	0.0019	OU2SW4	0.00011
Inorganics (μg/L)					
Aluminum	3/4	380	29.0 - 1,010	OU2SW5	NS[5]
Arsenic	1/4	2.95	2.95	OU2SW6	50
Barium	4/4	57.1	40.5 - 90.0	OU2SW5	NS
Calcium	4/4	63,750	21,400 - 135,000	OU2SW3	NS
Iron*	4/4	4,391	1,435 - 11,600	OU2SW4	1,000
Lead	1/4	7.5	7.5	OU2SW5	25
Magnesium	4/4	102,719	3,125 - 393,000	OU2SW3	NS
Manganese	4/4	268	80.5 - 458	OU2SW4	NS
Potassium	4/4	33,176	1,840 - 123,000	OU2SW3	NS
Sodium	4/4	766,645	3,170 - 3,030,000	OU2SW3	NS
Zinc	1/4	17.0	17.0	OU2SW5	50
pH (units)	4/4	6.52[2]	6.01 - 6.95	NA[3]	6 - 9

TABLE 1-5 (Continued)
SUMMARY OF ANALYTICAL RESULTS - TURKEY GUT SURFACE WATER (1994)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection	NC Class C Standard/ Criteria[4]
Inorganics - Filtered (μg/L)					
Antimony	1/4	11.5	11.5	OU2SW3	4,300
Barium	4/4	54.5	39.0 - 86.0	OU2SW5	NS
Calcium	4/4	64,550	22,100 - 139,000	OU2SW3	NS
Copper*	2/4	16.1	7.25 - 25.0	OU2SW3	7
Iron*	3/4	2,526	727 - 5,580	OU2SW4	1,000
Magnesium	4/4	101,246	3,115 - 387,000	OU2SW3	NS
Manganese	4/4	232	71.5 - 447	OU2SW4	NS
Potassium	4/4	31,430	1,890 - 116,000	OU2SW3	NS
Sodium	4/4	796,685	3,200 - 3,150,000	OU2SW3	NS
Zinc	1/4	12.0	12.0	OU2SW5	50

1 Measured in both volatile and semivolatile fractions.
2 Geometric average.
3 NA - Not applicable.
4 Reid, 1996. Asterisk next to analyte indicates exceedance of standard.
5 NS - No standard.

TABLE 1-6

SUMMARY OF ANALYTICAL RESULTS - SLOCUM CREEK SURFACE WATER (1994)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection	NC Class SC Standards/ Criteria[3]
Volatile Organics (µg/L)					
Acetone	1/1	3	3	OU2SW7	NS[4]
cis-1,2-Dichloroethene	2/3	1.5	1 - 2	OU2SW1	NS
Chloroform	3/3	1	1	OU2SW1/2 /7	470
Pesticides/PCBs (µg/L)					
4,4'-DDD*	3/3	0.033	0.027 - 0.039	OU2SW1	0.00084
Inorganics (µg/L)					
Barium	3/3	51.0	37.0 - 60.0	OU2SW2	NS
Calcium	3/3	134,000	132,000 - 135,000	OU2SW2/7	NS
Copper*	1/3	28.0	28.0	OU2SW7	3
Iron	2/3	132	106 - 158	OU2SW7	NS
Magnesium	3/3	396,000	379,000 - 407,000	OU2SW2	NS
Manganese	3/3	383	350 - 432	OU2SW1	NS
Potassium	3/3	120,333	116,000 - 123,000	OU2SW7	NS
Sodium	3/3	3,073,333	2,950-000 - 3,150,000	OU2SW2	NS
pH (units)	3/3	7.47[1]	7.55 - 7.87	NA[2]	6 - 9
Inorganics - Filtered (µg/L)					
Antimony	1/3	7.4	7.4	OU2SW7	4,300
Barium	3/3	32.0	28.0 - 37.0	OU2SW7	NS
Calcium	3/3	140,333	138,000 - 144,000	OU2SW7	NS
Copper*	3/3	27.7	23.0 - 37.0	OU2SW7	3
Magnesium	3/3	401,667	395,000 - 414,000	OU2SW7	NS
Manganese	2/3	6.0	6.0	OU2SW1/7	NS

TABLE 1-6 (Continued)
SUMMARY OF ANALYTICAL RESULTS - SLOCUM CREEK SURFACE WATER (1994)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection	NC Class SC Standards/ Criteria(3)
Potassium	3/3	119,000	116,000 - 124,000	OU2SW7	NS
Sodium	3/3	3,140,000	3,090,000 - 3,210,000	OU2SW7	NS
Zinc	1/3	7.0	7.0	OU2SW1	86

1 Geometric average.
2 NA - Not applicable.
3 Reid, 1996. Asterisk next to analyte indicates exceedance of standard.
4 NS - No standard.

Manganese was a prevalent groundwater contaminant at concentrations that exceeded state groundwater standards. It is notable that manganese was also found in Turkey Gut at similar concentrations. Manganese was also detected in Slocum Creek.

There were a few exceedances of state surface water quality standards in Turkey Gut and Slocum Creek. Bis(2-ethylhexyl)phthalate slightly exceeded the state standard in one sample from Turkey Gut. There were also single exceedances for 4,4'-DDD and heptachlor epoxide in Turkey Gut. The standard for copper was exceeded in two Turkey Gut samples. The standard for iron was exceeded in all Turkey Gut samples, including the most upstream location. The standards for 4,4'-DDD and copper were exceeded in all three samples from Slocum Creek, including the sample location upstream of OU2. Therefore, OU2 may not be the source (or only source) of 4,4'-DDD and copper in Slocum Creek.

There is no general pattern or trend in contaminant distribution in either Turkey Gut or Slocum Creek.

1.4.4 Sediment

The analytical results for all samples collected from Turkey Gut and Slocum Creek are summarized in Tables 1-7 and 1-8, respectively.

In Turkey Gut, six volatile organic compounds and one semivolatile organic compound were detected. The maximum concentrations of volatile and semivolatile organic compounds were detected at either 10SD04 or 10SD05, which are located downgradient of Study Areas B, C, and E. Carbon disulfide, choroethane, 1,1-dichloroethane, and ethylbenzene were only detected once. 2-Butanone, xylenes, and di-n-butyl phthalate were the only volatile/semivolatile organics detected in more than one sample. Volatile organics were not detected in any of the samples collected during the 1994 sampling event. Eleven pesticides were detected at four locations sampled in 1994. Four of the pesticides (4,4'-DDT, endosulfan II, endrin aldehyde, and heptachlor) were detected at concentrations below 1 μg/kg. Alpha-chlordane, gamma-chlordane, 4,4'-DDD, 4,4'-DDE, and dieldrin were detected most frequently. The maximum concentrations of several pesticides (4,4'-DDE, 4,4'-DDT, endosulfan II, endrin aldehyde, and endrin ketone) were reported at the most upstream sampling location (OU2SD5). This suggests that the detection of pesticides may be a result of past widespread use of pesticides and is not strictly related to study area activities. No major source area of pesticides was found at OU2.

TABLE 1-7

SUMMARY OF ANALYTICAL RESULTS - TURKEY GUT SEDIMENT
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection/Date
Volatile Organics (µg/kg)				
2-Butanone	3/10	191	9.25 - 540	10SD04/1990
Ethylbenzene	1/10	11	11	10SD05/1990
Xylenes (total)	2/10	24	5 - 43	10SD04/1990
1,1-Dichloroethane	1/10	19	19	10SD04/1990
Chloroethane	1/10	75	75	10SD04/1990
Carbon disulfide	1/8	20	20	10SD04/1990
Semivolatile Organics (µg/kg)				
Di-n-butylphthalate	4/6	494	350 - 640	OU2SD5/1994
Pesticides/PCBs (µg/kg)				
alpha-Chlordane	4/4	6.67	0.36 - 25	OU2SD3/1994
gamma-Chlordane	4/4	3.1	0.34 - 8.8	OU2SD3/1994
4,4'-DDD	3/5	1.48	0.45 - 3.4	OU2SD4/1994
4,4'-DDE	3/5	0.87	0.42 - 1.4	OU2SD5/1994
4,4'-DDT	1/6	0.20	0.20	OU2SD5/1994
Dieldrin	3/6	7.9	0.52 - 22	OU2SD3/1994
Endosulfan II	1/6	0.24	0.24	OU2SD5/1994
Endrin aldehyde	1/6	0.40	0.40	OU2SD5/1994
Endrin ketone	1/4	1.2	1.2	OU2SD5/1994
Heptachlor	2/6	0.14	0.13 - 0.15	OU2SD6/1994
Heptachlor epoxide	1/6	16	16	OU2SD3/1994
Inorganics (mg/kg)				
Aluminum	8/8	7230	1,630 - 11,100	OU2SD3/1994
Antimony	2/9	15.0	10.0 - 20.0	10SD03A/1985
Arsenic	7/9	3.3	1.2 - 7.2	10SD05/1990
Barium	8/8	30.7	12.6 - 92.1	10SD04/1990
Beryllium	1/9	0.20	0.20	10SD03A/1985
Cadmium	2/9	2.5	1.4 - 3.6	10SD05/1990
Calcium	8/8	4208	348 - 12,000	10SD06/1990
Chromium	9/9	11.1	2.0 - 24.6	10SD05/1990
Cobalt	1/7	2.3	2.3	10SD05/1990

TABLE 1-7 (Continued)
SUMMARY OF ANALYTICAL RESULTS - TURKEY GUT SEDIMENT
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection/Date
Copper	6/9	4.0	2.0 - 6.6	10SD05/1990
Iron	8/8	8480	1,930 - 18,200	OU2SD3/1994
Lead	8/10	22.5	6.55 - 52.5	10SD05/1990
Magnesium	8/8	494	155 - 930	OU2SD3/1994
Manganese	8/8	45.1	6.4 - 182	10SD04/1990
Mercury	2/9	0.14	0.10 - 0.17	OU2SD5/1994
Nickel	2/10	9.5	4.3 - 14.7	10SD04/1990
Potassium	7/7	400	123 - 679	OU2SD6/1994
Selenium	1/9	0.70	0.70	OU2SD5/1994
Sodium	6/8	304	40.7 - 1,090	OU2SD3/1994
Vanadium	8/8	15.9	4.8 - 26.7	OU2SD6/1994
Zinc	10/10	23.5	2.0 - 73.1	10SD04/1990

TABLE 1-8

SUMMARY OF ANALYTICAL RESULTS - SLOCUM CREEK SEDIMENT
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection/Date
Volatile Organics (μg/kg)				
2-Butanone	1/7	13	13	OU2SD1/1994
Chlorobenzene	1/7	61	61	10SD02/1990
Chloromethane	1/7	16	16	10SD06/1987
Semivolatile Organics (μg/kg)				
Bis(2-ethylhexyl)phthalate	1/5	430	430	OU2SD7/1994
Di-n-butylphthalate	3/5	430	190 - 800	OU2SD1/1994
Pesticides/PCBs (μg/kg)				
alpha-Chlordane	1/3	1.5	1.5	OU2SD7/1994
4,4'-DDD	1/4	2.7	2.7	OU2SD1/1994
4,4'-DDE	1/5	2.8	2.8	OU2SD7/1994
Inorganics (mg/kg)				
Aluminum	5/5	2,289	382 - 8,760	OU2SD7/1994
Antimony	1/7	10.6	10.6	10SD01/1990
Arsenic	5/7	8.1	0.30 - 32.7	10SD01/1990
Barium	5/5	10.6	1.1 - 35.8	OU2SD7/1994
Calcium	5/5	1,732	136 - 6,540	OU2SD7/1994
Chromium	3/7	21.7	1.7 - 57.5	OU2SD7/1994
Cobalt	1/5	3.4	3.4	OU2SD1/1994
Copper	2/7	10.9	3.9 - 17.9	OU2SD7/1994
Iron	5/5	11,122	932 - 32,600	10SD01/1990
Lead	4/7	13.5	1.2 - 37.7	OU2SD7/1994
Magnesium	4/5	1,036	93.7 - 2,650	OU2SD7/1994
Manganese	5/5	111	3.3 - 394	OU2SD7/1994
Mercury	1/7	0.60	0.60	OU2SD7/1994
Nickel	1/7	3.0	3.0	10SD06A/1987
Potassium	3/5	444	93.6 - 956	OU2SD7/1994
Selenium	1/7	0.89	0.89	OU2SD7/1994
Sodium	5/5	3,006	155 - 8,250	OU2SD7/1994
Vanadium	2/5	3.5	1.7 - 5.2	10SD01/1990
Zinc	6/7	26.1	1.0 - 113	OU2SD7/1994

In Turkey Gut, the maximum concentrations of several of the heavy/toxic metals detected (arsenic, cadmium, chromium, cobalt, copper, and lead) were detected at location 10SD05 (1990 sample). This location is downstream of Study Areas B and C. However, maximum detections of mercury and selenium were detected at location OU2SD5, which is the most upstream sampling location. Several metals (antimony, barium, copper, lead, manganese, nickel, vanadium, and zinc) were detected at maximum concentrations that were two or more times the soil background levels. Overall, however, the concentrations of most metals in Turkey Gut sediment did not indicate a major contamination problem.

In Slocum Creek, three volatile organic compounds (2-butanone, chlorobenzene, and chloromethane), two semivolatile organic compounds (bis[2-ethylhexyl]phthalate and di-n-butyl phthalate), and three pesticides (alpha-chlordane, 4,4'-DDD, and 4,4'-DDE) were detected in sediment samples. Only di-n-butyl phthalate was detected in more than one sample. The maximum concentrations of 2-butanone, di-n-butylphthalate, and 4,4'-DDD were detected at the most upstream location (OU2SD1). The maximum concentrations of bis(2-ethylhexyl)phthalate, alpha-chlordane, and 4,4'-DDE were detected at the most downstream location (OU2SD7).

The maximum concentrations of most of the heavy or toxic metals (arsenic, lead, cadmium, mercury, nickel, and chromium) were detected from locations in the vicinity of or downstream of the confluence with Turkey Gut. The concentrations of metals at the most upstream location were generally lower than at downstream locations. The maximum concentrations of any metals (antimony, arsenic, barium, chromium, cobalt, copper, lead, manganese, mercury, and zinc) were two or more times higher than background soil levels. Since metals were not significant surface soil contaminants, the source may not be related to activities at OU2.

1.4.5 Leachate Seeps

The earliest leachate seep water and sediment samples were collected and analyzed in 1985 and 1987. Additional leachate seep samples were collected in 1995. Samples were collected of water (if present) or sediment (if no water present) from near the four locations sampled between 1985 and 1987, along with a water sample from a new location. One of the water samples was from a leachate seep/spring at the toe of the landfill, and two were from areas of ponded water.

Based on the 1995 results, the actual leachate seep (OU2LW01) contained several volatile organic compounds (2 μg/L of benzene, 5 μg/L of chloroethane, and 3 μg/L of vinyl chloride) that were also detected in the surficial aquifer, although at much higher concentrations. One of the areas of ponded water contained the only other detections of organic chemicals (xylenes at 2 μg/L and several pesticides ranging from 0.0625 μg/L to 0.17 μg/L).

Based on the 1995 results, the leachate seep (OU2LW01) contained the highest concentrations of many metals (except thallium). In several cases, the concentrations of metals in this sample exceeded the maximum detections in the surficial aquifer. These metals included antimony, cadmium, chromium, copper, lead, nickel, selenium, and zinc. For all other metals, the concentrations in groundwater exceed the leachate water concentrations. Many of the metals (cadmium, iron, and manganese) were present at concentrations that exceeded state groundwater standards and/or federal drinking water standards. The most recent (1995) leachate seep water samples analytical results are summarized in Table 1-9.

The sediment samples collected in 1995 from the vicinity of previously identified (but dry at the time of sampling) leachate seep locations were similar in concentration to surface soil samples. The results from leachate seep sediment are included in Table 1-1 with the surface soil results. Only a few organic compounds were detected (monocyclic aromatics, a trihalomethane, a phthalate ester, and pesticides) at low concentrations. The organic compounds detected at the highest concentrations were 4,4'-DDE (69 μg/kg), di-n-octylphthalate (67 μg/kg), and toluene (42 μg/kg). The concentrations of all other organics ranged from 7.6 μg/kg (endosulfan I) to 25 μg/kg (alpha-chlordane).

The concentrations of metals in these two leachate seep sediment samples were also similar to those reported for surface soil. However, some metals were found at higher concentrations, whereas others were found at lower concentrations. Some of the more notable metals detections include arsenic (17.1 mg/kg), lead (76.5 mg/kg), and zinc (80.8 mg/kg).

1.4.6 Polishing Pond Sediment

Eight sediment and soil samples were collected from four locations in the polishing ponds in 1994. The uppermost sample was collected from the pond sediment, and the deeper sample was collected from the underlying natural soil material. The results are summarized in Table 1-10. The data indicate that the sediments in the ponds contain a number of organic chemicals, whereas the underlying soils are fairly free of organic contamination. For example, pond sediment contain ketones, monocyclic aromatics, phthalate esters, PAHs, and pesticides at concentrations ranging from 0.063 μg/kg (gamma-BHC) to 13,000 μg/kg [bis(2-ethylhexyl)phthalate]. The underlying material contains chloroform (4 μg/kg), bis(2-ethylhexyl)phthalate (130 μg/kg), di-n-butylphthalate (up to 290 μg/kg), alpha-chlordane (0.1 μg/kg),

TABLE 1-9

SUMMARY OF ANALYTICAL RESULTS - LEACHATE SEEP WATER (1995)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection
Volatile Organics (μg/L)				
Benzene	1/3	2	2	OU2LW01
Xylenes	1/3	2	2	OU2LW02
Chloroethane	1/3	5	5	OU2LW01
Vinyl chloride	1/3	3	3	OU2LW01
Semivolatile Organics (μg/L)				
Butylbenzylphthalate	1/3	10	10	OU2LW01
Pesticides/PCBs (μg/L)				
Aldrin	1/3	0.0625	0.0625	OU2LW02
gamma-BHC	1/3	0.0725	0.0725	OU2LW02
4,4'-DDT	1/3	0.17	0.17	OU2LW02
Dieldrin	1/3	0.155	0.155	OU2LW02
Endrin	1/3	0.165	0.165	OU2LW02
Heptachlor	1/3	0.0775	0.0775	OU2LW02
Inorganics (μg/L)				
Aluminum	3/3	721.8	360.5 - 1,310	OU2LW01
Antimony	1/3	9.4	9.4	OU2LW01
Arsenic	3/3	2.8	2.2 - 3.9	OU2LW01
Barium	3/3	31.2	5.2 - 76.8	OU2LW01
Cadmium	3/3	9.4	0.8 - 24.2	OU2LW01
Calcium	3/3	16,185	3,705 - 36,500	OU2LW01
Chromium	3/3	3.8	0.85 - 5.6	OU2LW01
Cobalt	1/3	6.5	6.5	OU2LW01
Copper	2/3	36.0	9.3 - 62.6	OU2LW01
Iron	3/3	13,991	558 - 40,400	OU2LW01

TABLE 1-9 (Continued)
SUMMARY OF ANALYTICAL RESULTS - LEACHATE SEEP WATER (1995)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Frequency of Detection	Average of Positive Detections	Range of Positive Detections	Location of Maximum Detection
Lead	1/3	24.1	24.1	OU2LW01
Magnesium	3/3	1,401.7	681 - 2,580	OU2LW01
Manganese	3/3	212.3	62.5 - 494	OU2LW01
Nickel	3/3	33.3	0.85 - 97.9	OU2LW01
Potassium	3/3	3,033.3	1,860 - 4,470	OU2LW01
Selenium	2/3	2.45	2.3 - 2.6	OU2LW01
Sodium	3/3	2,926.7	1,240 - 5,640	OU2LW01
Thallium	1/3	1.95	1.95	OU2LW02
Vanadium	3/3	3.5	2.15 - 6.0	OU2LW01
Zinc	3/3	299.2	26.3 - 813	OU2LW01
pH	3/3	6.11 (1)	6.09 - 6.15	NA (2)

1 Geometric average.
2 NA - Not applicable.

TABLE 1-10

SUMMARY OF ANALYTICAL RESULTS - POLISHING POND SEDIMENT/SOIL
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Sediments[1]			Soil[2]		
	Concentration Range	Average of Positive Detections	Frequency of Detection	Concentration Range	Average of Positive Detections	Frequency of Detection
Volatile Organics (µg/kg)						
Acetone	1,300	1,300	1/4	ND[3]	--	--
2-Butanone	11 - 80	34.3	3/4	ND	--	--
Toluene	26	26	1/4	ND	--	--
Ethylbenzene	42	42	1/4	ND	--	--
Xylenes	44	44	1/4	ND	--	--
Chloroform	ND	--	--	4	4	1/4
Carbon disulfide	31	31	1/4	ND	--	--
Semivolatile Organics (µg/kg)						
Bis(2-ethylhexyl)phthalate	120 - 13,000	3,590	4/4	130	130	1/4
Di-n-butylphthalate	180 - 350	250	4/4	200 - 290	255	4/4
Phenol	260	260	1/4	ND	--	--
Fluoranthene	250	250	1/4	ND	--	--
2-Methylnaphthalene	130	130	1/4	ND	--	--

TABLE 1-10 (Continued)
SUMMARY OF ANALYTICAL RESULTS - POLISHING POND SEDIMENT/SOIL
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Sediments[1]			Soil[2]		
	Concentration Range	Average of Positive Detections	Frequency of Detection	Concentration Range	Average of Positive Detections	Frequency of Detection
Pesticides/PCBs (μg/kg)						
Aldrin	0.28 - 3.8	2.0	2/4	ND	--	--
gamma-BHC (Lindane)	0.063 - 1.2	0.63	2/4	ND	--	--
alpha-Chlordane	0.66 - 15	7.8	2/4	0.10	0.10	1/4
gamma-Chlordane	2.6	2.6	1/3	ND	--	--
4,4'-DDD	13	13	1/2	ND	--	--
4,4'-DDE	0.19 - 16	5.5	3/3	ND	--	--
Dieldrin	0.53 - 9.4	5.0	2/4	ND	--	--
Endosulfan I	5.1	5.1	1/4	ND	--	--
Heptachlor	0.11	0.11	1/3	0.068 - 0.14	0.099	3/3
Methoxychlor	0.44	0.44	1/3	ND	--	--
Inorganics (mg/kg)						
Aluminum	5,330 - 9.810	8,040	4/4	2,920 - 4/410	3,580	4/4
Arsenic	2.3 - 3.3	2.8	2/4	1.3 - 2.3	1.9	4/4
Barium	10.2 - 25.6	15.8	4/4	5.0 - 7.2	5.75	4/4
Beryllium	0.34	0.34	1/4	ND	--	--

TABLE 1-10 (Continued)
SUMMARY OF ANALYTICAL RESULTS - POLISHING POND SEDIMENT/SOIL
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Sediments(1)			Soil(2)		
	Concentration Range	Average of Positive Detections	Frequency of Detection	Concentration Range	Average of Positive Detections	Frequency of Detection
Cadmium	1.7 - 41.	2.9	2/4	ND	--	--
Calcium	319 - 1,180	636	4/4	73.3 - 295	185	4/4
Chromium	14.0 - 78.5	32.4	4/4	3.8 - 11.7	7.55	4/4
Copper	2.3 - 17.4	6.7	4/4	1.2 - 1.6	1.47	3/4
Iron	3,340 - 14,500	8,312	4/4	2,690 - 6,720	4,368	4/4
Lead	3.2 - 7.1	5.0	4/4	1.9 - 3.7	2.4	4/4
Magnesium	264 - 514	417.4	4/4	148 - 220	184	4/4
Manganese	9.5 - 20.4	14.2	4/4	4.3 - 10.2	6.5	4/4
Mercury	0.12 - 0.85	0.485	2/4	ND	--	--
Nickel	10.3	10.3	1/4	ND	--	--
Potassium	328 - 616	453	4/4	244 - 262	235.5	4/4
Selenium	0.18 - 0.26	0.22	2/4	ND	--	--
Silver	0.97 - 4.1	2.54	2/4	ND	--	--
Vanadium	14.8 - 36.8	23.3	4/4	8.5 - 13.0	9.9	4/4

TABLE 1-10 (Continued)
SUMMARY OF ANALYTICAL RESULTS - POLISHING POND SEDIMENT/SOIL
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	Sediments[1]			Soil[2]		
	Concentration Range	Average of Positive Detections	Frequency of Detection	Concentration Range	Average of Positive Detections	Frequency of Detection
Zinc	7.08 - 55.3	27.9	3/4	ND	--	--
Cyanide	1.8	1.8	1/4	ND	--	--

1 Includes sample OU2SD08-1012, OU2SD09-1012, OU2SD10-1012, OU2SD10-1012-D, and OU2SD11-1012. Duplicate sample results are averaged and counted as one sample.
2 Includes samples OU2SD08-1214, OU2SD09-1214, OU2SD10-1214, and OU2SD11-1214.
3 ND - Not Detected.

and heptachlor (up to 0.14 μg/kg). In general, the pond sediments contain higher concentrations of metals than the underlying soils. These data probably reflect the nature of the wastewaters treated in the polishing ponds.

1.5 CONTAMINANT FATE AND TRANSPORT

The primary contaminants at OU2 are volatile organic compounds in soil and shallow groundwater (surficial aquifer). Volatile organic chemicals are typically considered to be fairly mobile and have a low capacity for retention to soil organic carbon. Therefore, they are the organic compounds most likely to be detected in groundwater. These types of chemicals may migrate through the soil column to groundwater as infiltrating precipitation solubilizes them. Some portion of these chemicals is retained by the unsaturated soil, but most will continue migrating downward until they reach the water table. At that time, migration is primarily laterally with the hydraulic gradient at a rate determined by the aquifer seepage velocity and chemical retardation. Again, some portion of the chemical may be retained by the saturated soil.

Several of these compounds have specific gravities less than that of water (e.g., benzene, xylenes). These compounds are typically found in fuels, and if a large enough spill occurs (including open burning and using gasoline, etc. as a fuel), these compounds may move through the soil column as a bulk liquid until they reach the water table. There, instead of going into solution, the majority of the release may remain as a discrete fuel layer on the water table surface, with some of the material being dissolved at the water/fuel interface. No floating fuel product was observed in any of the monitoring wells at OU2. The water table over much of the study area is less than 15 feet deep.

Pesticides were widely used at the Air Station. Many of the compounds detected are no longer licensed for general sale and use in the United States. Therefore, it is assumed that much of what was detected in the soil and sediments are representative of past application for insect control. Pesticides as a class of compounds are not considered to be very mobile in the environment. These chemicals, upon application or disposal, tend to remain affixed to soil particles. Migration of pesticides occurs primarily by wind or water erosion. Concentrations of pesticides are generally below 50 μg/kg, with a few exceptions, such as detections of DDT and DDD in subsurface soils.

1.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section provides a discussion of the main features of the baseline human health risk assessment for OU2. The exposure scenarios, frequencies, and durations are discussed in detail in the RI Report (B&R Environmental, April 1997).

1.6.1 Risk Estimation Methods

Quantitative estimates of risk are calculated according to risk assessment methods outlined in current USEPA risk assessment guidance (USEPA, December 1989) and Region IV supplements (USEPA Region IV, November 1995). Lifetime cancer risks are expressed in the form of dimensionless probabilities based on Cancer Slope Factors (CSFs). Noncarcinogenic risk estimates are presented in the form of Hazard Quotients (or Hazard Indices) that are determined through a comparison of intakes with published Reference Doses (RfDs).

An Incremental Cancer Risk (ICR) of 1E-6 indicates that the exposed receptor has a one-in-one-million chance of developing cancer under the defined exposure scenario. Alternatively, such a risk may be interpreted as representing one additional case of cancer in an exposed population of one million persons.

The USEPA has defined the range of 1E-6 to 1E-4 as the "target range" for most hazardous waste facilities addressed under CERCLA. Typically, individual or cumulative ICRs greater than 1E-4 are not considered to be protective of human health, whereas ICRs below 1E-6 are.

Noncarcinogenic risks are assessed using the concept of Hazard Quotients (HQs) and Hazard Indices (HIs). An HI is generated by summing the HQs for the individual chemicals. If the value of the HI exceeds unity (1.0), there is a potential noncarcinogenic health risk associated with exposure to that particular chemical mixture (USEPA, September 24, 1986). At that time, particular attention should be paid to the target organs associated with exposure to each chemical, as not all noncarcinogenic health effects are considered to be additive. The HI is not a mathematical prediction of the severity of toxic effects and, therefore, is not a true "risk." It is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

1.6.2 Calculated Risks

A summary of the carcinogenic and noncarcinogenic risks for potential receptors at OU2 is provided in Tables 1-11 and 1-12. Risks are presented for individual exposure routes; a cumulative risk for noncarcinogens and carcinogens across all applicable exposure routes is also calculated for each receptor.

1.6.2.1 Carcinogenic Risks

Carcinogenic risks for each current and future potential receptor are discussed in this section. Receptors considered under current land use conditions are maintenance workers, adolescent trespassers, and adult recreational users. Under future land use conditions, adolescent trespassers, construction workers, hypothetical full-time employees, and adult/child residents are also considered.

Maintenance Workers

Under current conditions, the total incremental cancer risk for maintenance workers exposed only to surface soil is 1.0E-6. This risk is within the risk range goal of 1E-6 to 1E-4 for cancer risks; therefore, adverse health effects would be minimal for maintenance workers at this site.

Adolescent Trespassers

Under current and future land use conditions, adolescent trespassers could be exposed to surface soil (ingestion and dermal contact) and leachate seep water (ingestion and dermal contact) while actually on site. In addition, these receptors may also be exposed to surface water and sediment in both Slocum Creek and Turkey Gut. Both ingestion and dermal contact are considered for these media as well.

Risks for adolescent trespassers on site are an ICR of 3.9E-7. This value is below the USEPA risk range goal of 1E-6 to 1E-4.

In Turkey Gut and Slocum Creek, the risks for the adolescent trespasser are below 1E-6. Therefore, the infrequent exposures of this receptor (12 days/year in each water body) are not expected to result in any adverse health effects.

TABLE 1-11

CUMULATIVE RISKS - GROUNDWATER AND SOIL
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Exposure Route	Maintenance Worker	Adolescent Trespasser	Construction Worker	Onsite Adult Resident (6-Yr)	Onsite Child Resident (6-Yr)	Full-Time Employee	Onsite Child/ Adult Resident (30-Yr)[3]
Incremental Cancer Risk							
Inhalation of Fugitive Dust	NA[1]	NA	8.7E-9	NA	NA	NA	NA
Dermal Contact with Soil	6.0E-8	5.4E-8	2.0E-9	7.0E-7	2.4E-6	1.3E-6	5.2E-6
Incidental Ingestion of Soil	9.7E-7	3.0E-7	2.1E-7	3.4E-6	3.2E-5	5.1E-6	4.6E-5
Dermal Contact with Leachate	NA	2.4E-8	NA	NA	NA	NA	NA
Incidental Ingestion of Leachate	NA	8.6E-9	NA	NA	NA	NA	NA
Dermal Contact with Groundwater (surficial aquifer)	NA	NA	5.4E-7	1.4E-6	2.5E-6	NA	8.2E-6
Ingestion of Groundwater (surficial aquifer)	NA	NA	NA	3.7E-4	8.7E-4	NA	2.4E-3
Inhalation of Volatiles in Groundwater (surficial aquifer)	NA	NA	NA	1.8E-6	8.2E-6	NA	1.5E-5
Total:	**1.0E-6**	**3.9E-7**	**7.6E-7[2]**	**3.8E-4**	**9.2E-4**	**6.4E-6**	**2.5E-3**
Hazard Index							
Inhalation of Fugitive Dust	NA	NA	0.00051	NA	NA	NA	NA
Dermal Contact with Soil	0.0016	0.0036	0.003	0.078	0.27	0.034	0.27/0.078
Incidental Ingestion of Soil	0.014	0.011	0.042	0.2	1.9	0.071	1.9/0.2
Dermal Contact with Leachate	NA	0.0039	NA	NA	NA	NA	NA
Incidental Ingestion of Leachate	NA	0.0013	NA	NA	NA	NA	NA
Dermal Contact with Groundwater (surficial aquifer)	NA	NA	0.56	0.22	0.38	NA	0.38/0.22
Ingestion of Groundwater (surficial aquifer)	NA	NA	NA	21	48	NA	48/21
Inhalation of Volatiles in Groundwater (surficial aquifer)	NA	NA	NA	0.16	0.77	NA	0.77/0.16
Total:	**0.016**	**0.020**	**0.61[2]**	**22**	**51**	**0.10**	**51/22**

1 NA - Not applicable. Exposure route not evaluated for this receptor.
2 No additional risks associated with exposure to polishing pond sediments (no contaminants of potential concern [COPCs]).
3 Includes 6 years as child and 24 years as adult. The 30-yr child/adult ICR was obtained by adding the 6-yr child ICR and the 24-yr adult ICR. HIs are not additive. The first HI value is for a 6-yr child, and the second value is for a 24-yr adult.

TABLE 1-12

CUMULATIVE RISKS - SURFACE WATER AND SEDIMENT EXPOSURES
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Exposure Route	Slocum Creek		Turkey Gut
	Adult Recreational User	Adolescent Trespasser	Adolescent Trespasser
Incremental Cancer Risk			
Dermal Contact with Sediment	2.0E-7	2.3E-8	4.2E-8
Incidental Ingestion of Sediment	1.8E-6	2.6E-7	6.1E-8
Dermal Contact with Surface Water	4.0E-8	1.3E-9	4.9E-9
Incidental Ingestion of Surface Water	3.5E-10	4.9E-11	2.4E-8
Ingestion of Fish	3.8E-5	NA(1)	NA
Total:	**4.0E-5**	**2.8E-7**	**1.3E-7**
Hazard Index			
Dermal Contact with Sediment	0.019	0.0063	0.002
Incidental Ingestion of Sediment	0.025	0.010	0.0056
Dermal Contact with Surface Water	(2)	(2)	0.00011
Incidental Ingestion of Surface Water	(2)	(2)	0.00038
Ingestion of Fish	(2)	NA	NA
Total:	**0.044**	**0.016**	**0.0081**

1 NA - Not applicable. Exposure route not evaluated for this receptor.
2 No dose-response parameters available for COPCs.

Construction Worker

The estimated incremental cancer risk for the construction worker exposed to soil and groundwater is 7.6E-7, which is below the USEPA risk range goal. There were no COPCs, and therefore no risk, for exposure to polishing pond sediment. Therefore, adverse health effects would be minimal for a construction worker.

Future Full-Time Employee

This receptor is based on the supposition that some facility could be built on site to house full-time personnel. These persons are assumed to be exposed to surface soil only (via ingestion and dermal contact). The risks for this receptor are 6.4E-6, which is within the USEPA risk range goal of 1E-6 to 1E-4. This risk is almost exclusively due to the evaluation of arsenic (88 percent of total risk) at its maximum detected concentration of 17.1 mg/kg.

Future Onsite Residents

The most likely residential exposure scenario, as long as the Air Station remains active, is a 6-year exposure duration. The carcinogenic risks for both adult and child receptors exceed 1E-4. The risks are more than 95 percent attributable to potential ingestion of groundwater. More than 90 percent of the ingestion risk is attributable to the presence of arsenic (evaluated at a concentration of 96.7 μg/L, versus an overall average of positive detections of 42.6 μg/L which is below the MCL and state groundwater standard) while 6 percent is attributable to vinyl chloride.

If groundwater use is not considered (i.e., future residents use the Air Station's potable water supply), the cancer risks are within the USEPA risk range goal. Under this scenario, arsenic, which was evaluated at its maximum concentration, and beryllium contribute approximately 88 percent of the total soil risks.

An alternate residential exposure scenario was also evaluated, incorporating the USEPA default exposure duration of 6 years as a child and 24 years as an adult (USEPA, March 25, 1991). The total risks under this scenario are 2.5E-3, which is an order of magnitude higher than for the 6-year adult exposure. Arsenic and vinyl chloride again are the major risk drivers for groundwater, and arsenic and beryllium drive the soil risks.

Adult Recreational Users

Adult recreational users exposed orally and dermally to water and sediment in Slocum Creek, as well as via fish ingestion, would experience an incremental cancer risk of 4.0E-5, which is within the USEPA risk range goal. Therefore, these exposures could be considered to result in minimal adverse health effects.

1.6.2.2 Noncarcinogenic Hazards

Noncarcinogenic hazards are presented in this section for each of the defined receptor groups. The USEPA considers Hazard Indices over 1.0 for any target organ to be indicative of the potential for onset of adverse health effects.

Maintenance Workers

The Hazard Index for maintenance workers was estimated to be 0.016. Because this value is below 1.0, adverse health effects would not be expected in this receptor population.

Adolescent Trespassers

HIs for all adolescent trespasser scenarios (soil/leachate exposures, Turkey Gut exposures, and Slocum Creek exposures) are all below 1.0, ranging from 0.0081 to 0.020. Therefore, toxic effects would not be expected to occur.

Construction Worker

The total HI for construction workers is estimated at 0.61. Because this value is below 1.0, adverse health effects would not be expected.

Future Full-Time Employee

A full-time employee exposed to surface soil at this site would have an HI of 0.10. Therefore, no adverse toxic effects are anticipated for this receptor.

Future Onsite Residents

The HIs for both adult and child residents exceed 1.0 (22 and 51, respectively). These hazards are due almost solely (more than 85 percent) to ingestion of groundwater containing iron (44 percent) and arsenic (42 percent). Individually, these metals have HIs greater than 1.0. These HIs make the potential domestic use of water in the surficial aquifer unacceptable.

Adult Recreational User

The estimated HI for the adult recreational user of Slocum Creek is 0.044. Therefore, no adverse, noncarcinogenic health effects would be expected.

1.6.3 Summary

Quantitative carcinogenic and noncarcinogenic risks for the Reasonable Maximum Exposure (RME) were estimated for maintenance workers, adolescent trespassers, construction workers, full-time employees, future residents (adult and child), and adult recreational users for exposure to media at OU2. With the exception of future potential exposure to groundwater in a residential setting, all carcinogenic risks for all receptors were within the USEPA target risk range. The maximum risk is reported as 2.5E-3 for the future 30-year resident exposed to arsenic and vinyl chloride in shallow groundwater and arsenic and beryllium in soil. The risks for all future residents (children and adults) exceed 1E-4, which is the upper end of the USEPA target risk range.

For future residents (using the 6-year residence period typical of military installations), several analytes have individual cancer risks greater than 1E-6, making them contaminants of concern (COCs) for groundwater. The following analytes were determined to be COCs:

- 1,1-Dichloroethene
- 1,4-Dichlorobenzene
- Benzene
- Vinyl chloride
- Bis(2-chloroethyl)ether
- Heptachlor epoxide
- Arsenic

In addition, there were several noncarcinogenic analytes in the surficial aquifer with HIs greater than 0.1, which also makes them COCs. These analytes are as follows:

- Chlorobenzene
- 4-Methylphenol
- Nitrobenzene
- Heptachlor epoxide
- Arsenic
- Cadmium
- Iron
- Manganese

In addition to the future potential exposure to the surficial aquifer, potential potable use of the Yorktown aquifer was also considered. These risks were not included in the risk summary tables, as the use of the surficial aquifer and the Yorktown would be mutually exclusive. However, they are provided below:

Receptor	Incremental Cancer Risk	Hazard Index
Adult residents - 6 yr	8.2E-7	0.27
Adult/child residents - 30 yr	5.4E-6	0.27 (adult) / 0.63 (child)
Child residents	2.1E-6	0.63

The risks associated with use of the Yorktown aquifer fall within the USEPA target risk range.

Exposure to soil at OU2 results in unacceptable risks (HIs) only for future child residents. All other soil exposures result in ICRs below 1E-4 or HIs below 1. There are, however, several COPCs that contributed individual ICRs greater than 1E-6 for residential or full-time employee exposures, as follows:

- Benzo(a)pyrene
- Arsenic
- Beryllium

Several COCs are identified for soil where they contribute HIs greater than 0.1 for one or more receptor and/or exposure route, as follows:

- Antimony
- Arsenic
- Chromium
- Iron
- Thallium

No other COCs were identified in soil. In addition, no individual compounds in either the surface waters or sediments would be considered as COCs based on protection of human health.

In addition to COCs based on risk (i.e., protection of human health), many groundwater and a few surface water analytes exceed state standards, also making them COCs. Some soil analytes exceed concentrations based on protection of groundwater. This is discussed further in Sections 2.4 and 2.5.

1.7 ECOLOGICAL ASSESSMENT

The ecology of the site consists of wetlands and the adjacent surface water bodies. As part of the ecological assessment performed at OU2, areas of wetlands were delineated. The wetlands are adjacent to Slocum Creek and Turkey Gut and are classified as Coastal Plain Small Stream Swamp areas. These areas, which cover an area of approximately 6 acres, are the only wetlands that have been identified at OU2. The landfill supports Old Field vegetation and Second Growth Loblolly Pine stands. The native soils adjacent to Turkey Gut generally support Mesic Mixed Hardwood Forest on the slopes and Coastal Plain Small Stream Swamp in the wetlands. The developed portion near OU2 is characterized by buildings, roads, gravel parking lots, and mowed grass lawns.

A preliminary ecological assessment was performed using surface water and sediment data in Slocum Creek and Turkey Gut and soil data. Groundwater sampling data obtained in 1994 and 1996 were used qualitatively. The maximum exposure point concentrations and estimated dose received by receptors were compared to benchmark values and doses that are protective of ecological receptors. Contaminants whose concentrations exceeded these values were regarded as ecological COPCs, and their toxicological properties were summarized. The relative potential risks that each of these COPCs might pose to ecological receptors inhabiting the area near OU2 were then evaluated in the form of Hazard Quotients and Hazard Indices.

The results of the ecological assessment indicate that some contaminants are present in OU2 surface water, sediment, and surface soil at concentration that exceed screening benchmarks. However, risks implied by most of these exceedances are mitigated by several factors.

In Turkey Gut water, only a few COPCs (three organics and two metals) were identified in the surface water samples. The organic COPCs were only detected at single sampling locations. The concentrations of two of the organics were below the state water quality standard. The detections of organics are considered to be isolated occurrences and are not believed to be a significant concern. The metal COPCs were detected in all samples; however, the concentrations in the farthest upstream sample also exceeded the benchmark values. Consequently, OU2 may not be the source (or only source) of these metals. In Turkey Gut sediment, several pesticides and two metals were identified as COPCs. Most of the pesticides were only detected once, and the detections of these compounds appear to be isolated occurrences. Since few compounds were identified as COPCs, widespread contamination and significant potential risks are considered to be absent in Turkey Gut.

Some COPCs were identified in Slocum Creek water and sediment samples. For the most part, the COPCs identified in surface water are not believed to be related (or solely related) to OU2, as evidenced by the presence of elevated concentrations in the upgradient samples. The concentrations of most sediment COPCs only exceeded the benchmarks at one location, and the exceedances are considered to be an isolated occurrence. Slocum Creek has been designated as a separate Operable Unit and will be evaluated further at a later date.

In surface soils, potential risks were assessed using two approaches. To begin with, maximum contaminant concentrations in surface soils were compared to conservative screening levels that were mainly based on human health risks. Using this methodology, concentrations that exceeded the screening values were only detected at five widely spaced locations. To reduce uncertainties and generate a risk range, mean contaminant concentrations were then compared to more realistic but generally less conservative ecologically-based benchmarks. Most of the COPCs from the conservative first screening were not retained as COPCs using the mean concentrations and ecologically-based benchmarks. Only one chemical (Aroclor-1260) had a slightly elevated HQ value. This chemical was only detected in one surface soil sample.

For the second approach, terrestrial foodchain modeling using representative terrestrial receptors was performed to investigate potential ecological risks from surface soil contaminants. Using the maximum contaminant concentrations and several conservative assumptions, HI values for all receptors were high. To reduce uncertainties and generate a risk range, mean contaminant concentrations were then used. HI values were reduced by approximately one-half for all contaminants for all receptors, but were still relatively high. However, the majority of the remaining HI values were a result of conservative assumptions in the models. In addition, the COPCs from the foodchain model were primarily metals, and potential risks from these contaminants were heavily mitigated by the factors discussed above.

For these reasons, potential risks to ecological receptors from contaminants related to OU2 do not appear to be significant. As a result, additional study or remediation based on ecological concerns at OU2 is not warranted.

2.0 REMEDIAL ACTION OBJECTIVES AND GOALS

2.1 INTRODUCTION

This section presents the objectives for remedial action and the driving factors used in the development of remedial actions. These are the Remedial Goal Options (RGOs) which propose cleanup levels for remediation and the regulatory requirements and guidances (Applicable or Relevant and Appropriate Requirements, or ARARs) that may potentially govern remedial activities. In addition, this section presents the contaminants of concern (COC) and the conceptual pathways through which these contaminants may affect human health and the environment. The environmental media of concern are derived from this information. Finally, this section presents the volumes of contaminated media that may need to be remediated.

2.2 REMEDIAL ACTION OBJECTIVES

Based on the contaminated media of concern, the potential pathways and receptors of concern, and current and potential future land use scenarios, the remedial action objectives (RAOs) for OU2 are as follows:

- Protection of human receptors from adverse health effects that may result from dermal contact and incidental ingestion of contaminated surface soils at OU2.
- Protection of human receptors from adverse health effects that may result from incidental ingestion of waste/fill material and contaminated subsurface soils at OU2.
- Protection of human receptors from adverse health effects that may result from dermal contact, ingestion, and inhalation of contaminants in the surficial aquifer beneath OU2.
- Mitigation of contaminant migration from OU2 into the environment.
- Protection of the environment.

These RAOs have been developed following guidance provided by the USEPA entitled "Land Use in the CERCLA Remedy Selection Process" (USEPA, 1995). According to this guidance, "remedial action objectives developed during the RI/FS should reflect the reasonably anticipated future land use or uses."

2.3 COMPLIANCE WITH ARARs AND TBC CRITERIA

ARARs consist of the following:

- Any standard, requirement, criterion, or limitation under Federal environmental law.

- Any promulgated standard, requirement, criteria, or limitation under a state environmental or facility-siting law that is more stringent than the associated Federal standard, requirement, criterion, or limitation.

To be considered (TBC) criteria are nonpromulgated, nonenforceable guidelines or criteria that may be useful for developing a remedial action or are necessary for determining what is protective of human health and/or the environment. Examples of TBC criteria include EPA Drinking Water Health Advisories, Reference Doses, and Cancer Slope Factors.

One of the primary concerns during the development of remedial action alternatives for hazardous waste sites under CERCLA or "Superfund" is the degree of human health and environmental protection offered by a given remedy. Section 121 of CERCLA requires that primary consideration be given to remedial alternatives that attain or exceed ARARs. The purpose of this requirement is to make CERCLA response actions consistent with other pertinent Federal and state environmental requirements.

Definitions of the two types of ARARs are given below:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and Appropriate Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or state law, which while not necessarily "applicable", address problems or situations sufficiently similar (relevant) to those encountered at the CERCLA site, that their use is well suited (appropriate) to the particular site. Requirements must be relevant and appropriate to be an ARAR.

Section 121(d)(4) of CERCLA allows the selection of a remedial alternative that will not attain all ARARs if any of six conditions for a waiver of ARARs exist. These conditions are as follows: (1) the remedial action is an interim measure whereby the final remedy will attain the ARAR upon completion; (2) compliance will result in greater risk to human health and the environment than other options; (3) compliance is technically impracticable; (4) an alternative remedial action will attain the equivalent of the ARAR; (5) for state requirements, the state has not consistently applied the requirement in similar circumstances; or (6) compliance with the ARAR will not provide a balance between protecting public health and the environment at the facility with the availability of fund money for response at other facilities (fund-balancing). The last condition only applies to Superfund-financed actions.

ARARs fall into three categories, based on the manner in which they are applied. The characterization of these categories is not perfect, as many requirements are combinations of the three types of ARARs. These categories are as follows:

- Contaminant-Specific: Health/risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of contaminant-specific ARARs include Maximum Contaminant Levels (MCLs) and Clean Water Act (CWA) Ambient Water Quality Criteria.

- Location-Specific: Restrictions based on the concentration of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of a site. Examples of location-specific ARARs include wetland regulations.

- Action Specific: These are regulations and guidelines that must be followed depending on the activity performed on site.

2.3.1 Contaminant-Specific ARARs and TBC Criteria

This section presents a summary of Federal and state contaminant-specific ARARs and TBC criteria. All of these ARARs and TBC criteria provide some medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

The Safe Drinking Water Act (SDWA) promulgated National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs) (40 CFR Part 141). MCLs are enforceable standards for contaminants in a public drinking water supply system. They consider not only health factors but also the economic and technical feasibility of removing a contaminant from a water supply system. EPA has also proposed Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are nonenforceable guidelines that do not consider the technical feasibility of contaminant removal. Secondary MCLs (40 CFR Part 143) are not enforceable but are intended as guidelines for contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems. SDWA requirements may be applicable or relevant and appropriate to remedial actions involving groundwater. Table 2-1 contains available Federal SDWA standards for the contaminants of potential concern at the site.

EPA Health Advisories are nonenforceable guidelines (TBCs) developed by the EPA Office of Drinking Water for chemicals that may be intermittently encountered in public water supply systems. Health advisories are available for short-term, longer-term, and lifetime exposures for a 10-kg child and/or a 70-kg adult. Health advisories may be pertinent for remedial actions involving groundwater, especially for contaminants that are not regulated under the SDWA. Table 2-1 contains available EPA health advisories for the contaminants of potential concern at the site.

EPA Ambient Water Quality Criteria (AWQC) are nonenforceable guidelines (TBCs) that were developed for pollutants in surface waters pursuant to Section 304(a)(l) of the Clean Water Act. Although AWQC are not legally enforceable, they have been used by many states to develop enforceable water quality standards. These guidelines should be considered as potential ARARs, as specified by CERCLA. AWQC are available for the protection of human health from exposure to contaminants in drinking water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQC may be considered for actions that involve groundwater treatment and/or discharges to Slocum Creek or Turkey Gut, which are the streams nearest to the site. Table 2-1 contains AWQC for the contaminants of potential concern at the site.

TABLE 2-1

CONTAMINANT-SPECIFIC ARARs AND TBCs FOR COPCs (mg/L) - WATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	Federal Standards					North Carolina Standards		
	MCL[1]	MCLG[1]	Health Advisories[1]	AWQC[2]	Tap Water RBC[3]	Class GA Groundwater[4]	Class SC Tidal Saltwater[5]	Class C Freshwater[5]
Volatiles								
1,1-Dichloroethene	0.007	0.007	1-Day Child: 2 10-Day Child: 1 Longer-term Child: 1 Longer-term Adult: 4 Lifetime: 0.007 DWEL[6] 0.4	0.000057	0.000044	0.007	0.0032	0.0032
1,2-Dichloroethane	0.005	0	1-Day Child: 0.7 10-Day Child: 0.7 Longer-term Child: 0.7 Longer-term Adult: 2.6	0.00038	0.00012	0.00038	0.099	0.099
1,2-Dichloropropane	0.005	0	10-Day Child: 0.09	0.00052	0.00016	0.00056	0.039	0.039
Benzene	0.005	0	1-Day Child: 0.2 10-Day Child: 0.2	0.0012	0.00036	0.001	0.0714	0.0714
2-Butanone	NA	NA	NA	NA	1.9	0.17	NA	NA
2-Hexanone	NA	NA	NA	NA	NA	>DL	NA	NA
4-Methyl-2-pentanone	NA	NA	NA	NA	2.9	>DL	NA	NA
Chlorobenzene	0.1	0.1	1-Day Child: 2 10-Day Child: 2 Longer-term Child: 2 Longer-term Adult: 7 Lifetime: 0.1 DWEL: 0.7	0.68	0.039	0.05	21	21
Chloroethane	NA	NA	NA	NA	8.6	2.8	0.86	0.86
Chloroform	0.1[8,9]	0	1-Day Child: 4 10-Day Child: 4 Longer-term Child: 0.1 Longer-term Adult: 0.4 DWEL: 0.4	0.0057	0.00015	0.00019	0.47	0.47

TABLE 2-1 (Continued)
CONTAMINANT-SPECIFIC ARARs AND TBCs FOR COPCs (mg/L) - WATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	Federal Standards					North Carolina Standards		
	MCL[1]	MCLG[1]	Health Advisories[1]	AWQC[2]	Tap Water RBC[3]	Class GA Groundwater[4]	Class SC Tidal Saltwater[5]	Class C Freshwater[5]
cis-1,2-Dichloroethene	0.07	0.07	1-Day Child: 4 10-Day Child: 3 Longer-term Child: 3 Longer-term Adult: 11 Lifetime: 0.07 DWEL: 0.4	0.7[10]	0.061	0.07	NA	0.007
Ethylbenzene	0.7	0.7	1-Day Child: 30 10-Day Child: 3 Longer-term Child: 1 Longer-term Adult: 3 Lifetime: 0.7 DWEL: 3	3.1	1.3	0.029	0.325	0.325
Tetrachloroethene	0.005	0	1-Day Child: 2 10-Day Child: 2 Longer-term Child: 1 Longer-term Adult: 5 DWEL: 0.5	0.0008	0.0011	0.0007	0.0085	0.0085
Toluene	1	1	1-Day Child: 20 10-Day Child: 2 Longer-term Child: 2 Longer-term Adult: 7 Lifetime: 1 DWEL: 7	6.8	0.750	1.0	NA	0.011
Trichloroethene	0.005	0	DWEL: 0.3	0.0027	0.0016	0.0028	0.081	0.081
Vinyl chloride	0.002	0	1-Day Child: 3 10-Day Child: 3 Longer-term Child: 0.01 Longer-term Adult: 0.05	0.002	0.000019	0.000015	0.525	0.525
Semivolatiles								
1,2-Dichlorobenzene	0.6	0.6	1-Day Child: 9 10-Day Child: 9 Longer-term Child: 9 Longer-term Adult: 30 Lifetime: 0.6 DWEL: 3	2.7	0.270	0.62	17	17

TABLE 2-1 (Continued)
CONTAMINANT-SPECIFIC ARARs AND TBCs FOR COPCs (mg/L) - WATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	Federal Standards					North Carolina Standards		
	MCL(1)	MCLG(1)	Health Advisories(1)	AWQC(2)	Tap Water RBC(3)	Class GA Groundwater(4)	Class SC Tidal Saltwater(5)	Class C Freshwater(5)
1,4-Dichlorbenzene	0.075	0.765	1-Day Child: 10 10-Day Child: 10 Longer-term Child: 10 Longer-term Adult: 40 Lifetime: 0.075 DWEL: 4	0.4	0.00044	0.075	2.6	2.6
2,4-Dimethylphenol	NA	NA	NA	0.54	0.73	>DL(13)	2.3	2.3
2-Methylnaphthalene	NA	NA	NA	NA	NA	>DL	3.11E-5	3.11E-5
2-Methylphenol	NA	NA	NA	NA	1.8	>DL	NA	NA
4-Methylphenol	NA	NA	NA	NA	0.18	>DL	NA	NA
Bis(2-chloroethyl)ether	NA	NA	NA	0.000031	9.2E-6	>DL	0.0014	0.0014
Bis(2-ethylhexyl)phthalate	0.006	0	DWEL: 0.7	0.0018	0.0048	0.003	0.0059	0.0059
Naphthalene	NA	NA	1-Day Child: 0.5 10-Day Child: 0.5 Longer-Term Child: 0.4 Longer-Term Adult: 1 Lifetime: 0.02 DWEL: 0.1	NA	1.5	0.021	3.11E-5	3.11E-5
Nitrobenzene	NA	NA	NA	0.017	0.0034	>DL	1.9	1.9
Pesticides/PCBs								
4,4'-DDE	NA	NA	NA	5.9E-7	0.0002	>DL	5.9E-7	5.9E-7
4,4'-DDD	NA	NA	NA	8.3E-7	0.00028	>DL	8.4E-7	8.4E-7
4,4'-DDT	NA	NA	NA	5.9E-7	0.0002	>DL	5.9E-7	5.9E-7
Aldrin	NA	NA	1-Day Child: 0.0003 10-Day Child: 0.0003 Longer-Term Child: 0.0003 Longer-Term Adult: 0.0003 DWEL: 0.001	1.3E-7	4E-6	>DL	1.36E-7	1.36E-7
alpha-BHC	NA	NA	NA	3.9E-6	1.1E-5	>DL	1.3E-5	1.3E-5

TABLE 2-1 (Continued)
CONTAMINANT-SPECIFIC ARARs AND TBCs FOR COPCs (mg/L) - WATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	Federal Standards					North Carolina Standards		
	MCL[1]	MCLG[1]	Health Advisories[1]	AWQC[2]	Tap Water RBC[3]	Class GA Groundwater[4]	Class SC Tidal Saltwater[5]	Class C Freshwater[5]
gamma-BHC (lindane)	0.0002	0.0002	1-Day Child: 1 10-Day Child: 1 Longer-Term Child: 0.03 Longer-Term Adult: 0.1 Lifetime: 0.0002 DWEL: 0.01	1.9E-5	5.2E-5	0.0002	4E-6	1E-5
Dieldrin	NA	NA	1-Day Child: 0.0005 10-Day Child: 0.0005 Longer-Term Child: 0.0005 Longer-Term Adult: 0.002 DWEL: 0.002	1.4E-7	4.2E-6	>DL	1.44E-7	1.44E-7
Endosulfan I	NA	NA	NA	0.00093	0.22	>DL	9E-6	5E-5
Endosulfan II	NA	NA	NA	0.00093	0.22	>DL	9E-6	5E-5
Endrin aldehyde	NA	NA	NA	0.00076	NA	>DL	8.1E-4	8.1E-4
Heptachlor	0.0004	0	1-Day Child: 0.01 10-Day Child: 0.01 Longer-term Child: 0.005 Longer-term Adult: 0.005 DWEL: 0.02	2.1E-7	2.3E-6	8E-6	2.14E-7	2.14E-7
Heptachlor epoxide	0.0002	0	1-Day Child: 0.01 Longer-term Child: 0.0001 Longer-term Adult: 0.0001 DWEL: 0.02	1.0E-7	1.2E-6	4E-6	1.1E-7	1.1E-7
Inorganics								
Aluminum	NA	NA	NA	NA	37	NA	NA	NA
Antimony	0.006	0.006	1-Day Child: 0.01 10-Day Child: 0.01 Longer-Term Child: 0.01 Longer-Term Adult: 0.015 Lifetime: 0.003 DWEL: 0.01	0.014	0.015	NA	4.3	4.3
Arsenic	0.05[11]	NA	NA	0.000018	4.5E-5	0.05	0.05	0.05

TABLE 2-1 (Continued)
CONTAMINANT-SPECIFIC ARARs AND TBCs FOR COPCs (mg/L) - WATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	Federal Standards					North Carolina Standards		
	MCL[1]	MCLG[1]	Health Advisories[1]	AWQC[2]	Tap Water RBC[3]	Class GA Groundwater[4]	Class SC Tidal Saltwater[5]	Class C Freshwater[5]
Barium	2	2	Lifetime: 2 DWEL: 2	NA	2.6	2.0	NA	NA
Cadmium	0.005	0.005	1-Day Child: 0.04 10-Day Child: 0.04 Longer-Term Child: 0.005 Longer-Term Adult: 0.02 Lifetime: 0.005 DWEL: 0.02	0.016	0.018	0.005	0.005	0.002
Copper	1.3[12]	1.3	NA	1.3	1.5	1.0	0.003	0.007
Iron	0.3[15]	NA	NA	NA	11	0.3	NA	1.0
Lead	0.015[12]	0	NA	0.05	NA	0.015	0.025	0.025
Manganese	0.05[15]	NA	NA	NA	0.84	0.05	NA	NA
Nickel	0.1	0.1	1-Day Child: 1 10-Day Child: 1 Longer-Term Child: 0.5 Longer-Term Adult: 1.7 Lifetime: 0.1 DWEL: 0.6	0.61	0.73	0.1	0.0083	0.088

TABLE 2-1 (Continued)
CONTAMINANT-SPECIFIC ARARs AND TBCs FOR COPCs (mg/L) - WATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	Federal Standards					North Carolina Standards		
	MCL[1]	MCLG[1]	Health Advisories[1]	AWQC[2]	Tap Water RBC[3]	Class GA Groundwater[4]	Class SC Tidal Saltwater[5]	Class C Freshwater[5]
Thallium	0.002	0.0005	1-Day Child: 0.007 10-Day Child: 0.007 Longer-Term Child: 0.007 Longer-Term Adult: 0.02 Lifetime: 0.0004 DWEL: 0.002	0.0017	0.0026[14]	NA	0.0063	0.0063

1 USEPA, February 1996.
2 USEPA, June 14, 1991. Values for ingestion of water and organisms are presented.
3 USEPA Region III, May 10, 1996.
4 NCAC, October 25, 1994.
5 NCAC, June 1, 1994; Reid, 1996; or federal AWQC for ingestion of organisms or protection of aquatic life, whichever is lower (for chemicals not detected in surface water)
6 Drinking Water Equivalent Level.
7 NA - Not available (no standard).
8 Total trihalomethanes.
9 1994 proposed rule. Total THM cannot exceed 0.08.
10 Value for trans-1,2-dichloroethene.
11 MCL under review.
12 SDWA action level.
13 >DL - Greater than detection limit.
14 Thallic oxide.
15 Secondary MCL.

Reference Doses (RfDs) are estimates (with uncertainty spanning perhaps an order of magnitude) of the amount of chemical to which the human population (including sensitive subgroups) can be subjected on a daily exposure basis without an appreciable risk of deleterious effects during a lifetime. RfDs are developed for chronic and/or subchronic human exposure to hazardous chemicals and are based on the assumption that thresholds exist for certain toxic effects. The RfD is usually expressed as an acceptable dose (mg) per unit body weight (kg) per unit time (day). The RfD is derived by dividing the no-observed-adverse-effect level (NOAEL) or the lowest-observed-adverse effect level (LOAEL) by an uncertainty factor (UF). RfDs are TBCs for the site.

Risk Based Concentration (RBCs), USEPA Region III, May 10, 1996, are presumptive levels that are calculated using certain exposure assumptions for ingestion of contaminated soil. These concentrations are calculated for a Target Hazard Quotient (THQ) of 1.0 for noncarcinogenic effects and a Target Risk (TR) of 1E-6 for carcinogenic effects. Table 2-2 presents RBCs for an industrial exposure scenario and a residential exposure scenarios for the contaminants of potential concern at OU2. These are TBCs for use at OU2.

Draft Soil Screening Levels (SSLs), USEPA, December 1994, are risk-based concentrations in soil that, if exceeded through three possible exposure pathways, may be of potential concern. The Draft SSLs consider the following three exposure pathways: direct ingestion of soil, inhalation of volatiles and fugitive dust, and migration to groundwater. SSLs are based on residential exposure assumptions and, therefore, are conservative TBCs for use at OU2. These SSLs are presented for the contaminants of potential concern in Table 2-2.

Cancer Slope Factors (CSFs) are used for estimating the lifetime probability (assumed 70-year lifespan) of human receptors developing cancer as a result of exposure to known or suspected carcinogens. These factors are generally reported in units of kg-day/mg and are derived through an assumed low dosage linear relationship and an extrapolation from high to low dose responses determined from human or animal studies. Cancer risk and CSFs are most commonly estimated through the use of a linearized, multistage, mathematical extrapolation model applied to animal bioassay results. The value used in reporting the slope factor is the upper 95 percent confidence limit (UCL).

The Clean Air Act (CAA) consists of three programs or requirements that may be ARARs: National Ambient Air Quality Standards (NAAQS) (40 CFR Part 50), National Emissions Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61), and New Source Performance Standards (NSPS) (40 CFR Part 60).

TABLE 2-2

CONTAMINANT-SPECIFIC ARARs AND TBCs FOR COPCs (mg/kg) - SOIL AND SEDIMENT
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	Industrial RBC(1)	Residential RBC(1)	Draft Soil Screening Levels (SSLs)	
			Inhalation	Groundwater Migration
Benzo(a)anthracene	7.8	0.88	27	0.7
Benzo(a)pyrene	0.78	0.088	11	4.0
Benzo(b)fluoranthene	7.8	0.88	23	4.0
Benzo(k)fluoranthene	78	8.8	NA(2)	4.0
Chrysene	780	88	3.6	1.0
Indeno(1,2,3-cd)pyrene	7.8	0.88	280	35
Aroclors (PCBs)	0.74	0.083	NA	NA
Aluminum	1,000,000	78,000	NA	NA
Antimony	820	31	NA	NA
Arsenic	3.8	0.43	380	15
Beryllium	1.3	0.15	690	180
Cadmium	1,000	39	920	6.0
Chromium (VI)	10,000	390	140	19
Iron	610,000	23,000	NA	NA
Lead	2,000(3)	400(3)	NA	NA
Manganese	47,000	1,800	NA	NA
Thallium	140(4)	5.5(4)	NA	0.4

1 USEPA Region III, May 10, 1996.
2 NA - Not Available.
3 USEPA, July 14, 1994.
4 Thallic oxide.

EPA requires the attainment and maintenance of primary and secondary NAAQS to protect public health and public welfare, respectively. NAAQS are available for six criteria pollutants (carbon monoxide, lead, nitrogen oxides, ozone, sulfur dioxide, and airborne particulates). These standards are not source specific but rather are national limitations on ambient air quality. The sources of the contaminant and the routes of exposure were considered. However, the standards do not consider costs for achievement or feasibility. States are responsible for assuring compliance with the NAAQS. Requirements in an EPA-approved State Implementation Plan (SIP) for the implementation, maintenance, and enforcement of NAAQS are potential ARARS. NAAQS might be relevant and appropriate for emissions of particulates from remedial activity related to contaminated soils at the site.

NESHAPs are emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants and include significant sources of beryllium, vinyl chloride, benzene, asbestos, wet dust particulates, and other hazardous substances. NESHAPs might be relevant and appropriate for particulate emissions from remedial activity on contaminated soils at the site.

NSPS are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. Standards are based upon the best demonstrated technology (BDT). NSPS may be relevant and appropriate if the pollutant(s) emitted (e.g., from an air stripping tower) and the technology employed during the cleanup action are sufficiently similar to the pollutant and source category regulated by an NSPS and are well suited to the circumstances at the site.

North Carolina Air Pollution Control Requirements (North Carolina Administrative Code [NCAC], Title 15A, Chapter 2). Subchapter 2D consists of five programs or requirements that may be ARARs: Ambient Air Quality Standards (Part 0400), Emission Control Standards (Part 0500), Volatile Organic Compounds (Part 0900), Control of Toxic Air Pollutants (Part 1100), and Control of Emissions from Incinerators (Part 1200).

Ambient air quality standards have been established for sulfur oxides, total suspended particulates, carbon monoxide, ozone, nitrogen dioxide, lead, and particulate matter. These standards establish maximum limits on parameters of air quality that should provide for the protection of the public health, plant and animal life, and property. No facility or source of air pollution shall cause any ambient air quality standard to be exceeded. The standards do not apply directly to source-specific emission limitations.

Emission control standards apply to all air pollution sources, both combustion and noncombustion. Many of the regulations apply to source-specific requirements that are not generally considered applicable to site cleanups. However, a standard may be applicable if the facility at the site is a new source (e.g., incinerator) or may be relevant and appropriate if circumstances are similar to those regulated. Sections of the emissions control standards that may be ARARs for remedial actions may include, but not be limited to, particulates from miscellaneous industrial processes, sulfur dioxide emissions from combustion sources, miscellaneous volatile organic compound emissions, control of nitrogen oxides emissions, prohibition of open burning, control of visible or odorous emissions, new source performance standards, emissions standards for hazardous air pollutants, and control of mercury emissions.

Volatile organic compounds (VOCs) generally does not apply to sources whose emissions of VOCs are not more than 15 pounds per day. Most of these regulations apply to sources of VOCs from manufacturing operations that would not be applicable or relevant and appropriate to remedial actions. Rules .0950 (Interim Standards for Certain Categories) and .0951 (Miscellaneous) may be ARARs for remedial actions.

The toxic air pollutant rules apply to all facilities that emit a toxic air pollutant and that are required to have a permit under 15A NCAC 2H (Permit Requirements for Toxic Air Pollutants). This section contains lists of toxic air pollutants and associated air pollutant guidelines. The regulations state that a facility shall not emit toxic air pollutants in such quantities that may cause or contribute to any significant ambient air concentration that may adversely affect human health beyond the facility premises. The regulations provide lists of air pollutants and associated acceptable ambient levels that are provided as guidance in determining significant ambient air concentrations. Guidelines are available for the following averaging periods: annual (carcinogens), 24-hour (chronic toxicants), 1-hour (acute systemic toxicants), and 15-minute (acute irritants). Guidelines are available for more than 90 chemicals.

Rules for the control of the emissions from incinerators do not apply to afterburners, flares, fume incinerators, and other similar devices used to reduce the emissions of air pollutants from processes, whose emissions are regulated as process emissions. They also do not apply to any boilers or industrial furnaces that burn waste as fuel. The regulations contain requirements for reporting and recordkeeping and emission standards for particulate matter, sulfur dioxide, visible emissions, odorous emissions, hydrogen chloride, mercury, arsenic, beryllium, cadmium, and chromium. The regulations also contain operational standards such as temperature and retention time requirements.

Subchapter 2Q of 15A NCAC states when a permit for construction and operation of an air pollution source is needed. Facilities that emit regulated pollutants require permits, although certain categories of facilities may be exempted from permitting requirements. If a facility is subject to any of the following rules (which may be potential ARARs for remedial action), the facility is not exempted from permit requirements, and exemptions do not apply: new source performance standards (15A NCAC 2D .0524), emission standards for hazardous air pollutants (15A NCAC 2D .0525), and sources of toxic air pollutants (15A NCAC 2D .1100). Certain exemptions may apply because of the category of the source or because of the size or production rate of the source. A facility that is required to have a permit may request an exemption if there are no pollution control devices, if there is no source at the facility to violate any applicable emissions control standard when operating at maximum design or rate, and if modeling shows that the ambient impact will not exceed the levels specified in 15A NCAC 2D .0532 when all sources at the facility are operating at maximum design or rate.

The North Carolina Department of Air Quality (NCDAQ) has informed MCAS Cherry Point that no construction permit is required to construct air strippers or vapor extraction systems as there are no applicable standards. In addition, no modeling for air toxics from such systems is required (Curlin, 1996).

<u>North Carolina Surface Water Classifications and Quality Standards</u> (NCAC, Title 15A, Chapter 2) Subchapter 2B provides classifications and surface water standards that regulate the quality of water that may be discharged to surface waters. Slocum Creek, which borders the site, is classified as a Class SC tidal salt water. Turkey Gut, a tributary of Slocum Creek, is classified as a Class C freshwater. Both of these classifications allow for the following uses: fish and wildlife propogation, secondary recreation (i.e., not involving whole-body contact), and other uses for water of lower quality. In addition, Class C waters may be used for agriculture. Neither class of water is meant for ingestion by humans. The State of North Carolina has specific numerical standards for the protection of both aquatic life and human health. The lower value applies. These standards may be potentially applicable to OU2. Table 2-1 presents the potentially applicable standards for the surface waters at OU2.

<u>North Carolina Groundwater Quality Standards</u> (NCAC, Title 15A, Chapter 2). Subchapter 2L provides classification of groundwaters in various river basins in the State of North Carolina. According to these standards, the State of North Carolina has classified the groundwater at MCAS Cherry Point as Class GA, which is an existing or potential source of drinking water for humans. The contaminant-specific concentration limits for the COPCs detected in the groundwater at OU2 are provided in Table 2-1. If there is no numerical standard, any detection of a non-naturally occurring substance is considered to be an exceedance of standards. Corrective action requirements are also presented in this regulation. Where groundwater quality has been degraded, the goal of any required corrective action shall be restoration to the level of the standards, or as close as is economically and technically feasible.

North Carolina Water Quality Standards (NCAC, Title 15A, Chapter 18). Subchapter 18C regulations include maximum contaminant levels (MCLs) for organic and inorganic chemicals in public drinking water supplies, which may be appropriate and relevant for groundwater contamination. The state regulations incorporate the Federal MCLs by reference. Rule .1510 (MCLs for inorganic chemicals) incorporates the provisions of 40 CFR 141.11 and 141.62 by reference. Rules .1517 and .1518 (MCLs for organic chemicals) incorporate the provisions of 40 CFR 141.12 and 141.61, respectively. MCLs for chemicals of potential concern are presented in Table 2-1.

North Carolina Oil Pollution and Hazardous Substances Control Act (General Statues of North Carolina, Chapter 143, State Department, Institution and Commission, Article 21A: Oil Pollution and Hazardous Substances Control) promotes the health, safety, and welfare of the citizens of the State of North Carolina by protecting the land and the waters over which the state has jurisdiction from pollution by oil, oil products, oil byproducts, and other hazardous substances.

North Carolina DEHNR Groundwater Section Guidelines for the Investigation and Remediation of Soils and Groundwater. This document provides instructions for investigation and remediation activities for soil and groundwater contaminated with nonhazardous waste. These guidelines include information on the statutes and rules governing groundwater investigations, along with the actual step-by-step process required to comply with requirements for the remediation of contaminated soil and groundwater. Alternative methods of remediation will be considered if it can be demonstrated that the proposed methods achieve comparable results. The guidelines also include methods for collecting soil and groundwater samples; determining the source, degree, and extent of contamination; and implementing remediation. This document contains information on underground storage tank (UST) investigations, petroleum contaminated soil and/or groundwater cleanups, above-ground leaks and spills, and other potential sources of contamination that could affect groundwater quality.

(Draft) North Carolina Risk Analysis Framework (November 1996). This document provides methods for determining target concentrations (cleanup levels) in soil and groundwater. It also describes procedures for assessing the risk of harm to human health, the environment, and public welfare. This framework presents a streamlined tiered approach (Methods I, II, or III) for evaluating risk. Each successive tier (or method) uses more site-specific information to determine the target concentrations for soil and groundwater.

2.3.2 Location-Specific ARARs and TBC Criteria

Federal Protection of Wetlands Executive Order (E.O. 11990) provides for consideration of wetlands during remedial actions. This Executive Order is to be considered as implemented by EPA's August 6, 1985, Policy on Flood Plains and Wetlands Assessments for CERCLA Actions (CERCLA Compliance Policy). E.O. 11990 requires Federal agencies, in carrying out their responsibilities, to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands. Wetlands are present at OU2 along the banks of Slocum Creek and Turkey Gut.

The Endangered Species Act of 1978 (16 USC 1531 / 40 CFR Part 502) provides for consideration of the impacts on endangered and threatened species and their critical habitats. This act requires Federal agencies, in consultation with the Secretary of the Interior, to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or adversely affect its critical habitat. A review of the available information indicates that the forests surrounding MCAS Cherry Point, provide extensive wildlife habitat and a variety of game. The creeks, bays, swamps, and marshes provide habitat for many types of birds, reptiles, and freshwater fish. The vegetation is mainly mixed pine and hardwoods. Endangered bird species that are known to pass through the region are the red-cockaded woodpecker (*Picoides borealis*) and the bald eagle (*Haliaeetus leucocephalus*). However, neither of these endangered birds is known to nest at OU2. The young of the American Alligator have been occasionally sighted in the Jack's Branch area of Hancock Creek and Slocum Creek. The Loggerhead Turtle has been found in sounds and rivers adjacent to MCAS Cherry Point. However, none of the endangered or threatened species are known to exist at OU2.

The Fish and Wildlife Coordination Act (16 USC 661) provides for consideration of the impacts on wetlands and protected habitats. The act requires that Federal agencies, before issuing a permit or undertaking Federal action for the modification of any body of water, consult with the appropriate state agency exercising jurisdiction over wildlife resources, to conserve those resources. Consultation with the U.S. Fish and Wildlife Service is also required. The game warden staff at MCAS Cherry Point assists in the enforcement of the Endangered Species Act. MCAS Cherry Point also has an active wildlife and fishing management program.

The Fish and Wildlife Improvement Act of 1978 (16 USC 742a) and The Fish and Wildlife Conservation Act of 1980 (16 USC 2901) provide for consideration of the impacts on wetlands and protected habitats. The only wetlands that have been identified at OU2 are coastal small stream swamps on the banks of Slocum Creek and Turkey Gut.

EPA's Groundwater Protection Strategy (USEPA, 1984). This policy is to protect groundwater for its highest present or potential beneficial use. This policy (TBC) will be incorporated into future regulatory amendments. The strategy designates three categories of groundwater:

- Class 1: Special Groundwaters - Waters that are highly vulnerable to contamination and are either irreplaceable or ecologically vital sources of drinking water.

- Class 2: Current and Potential Sources of Drinking Water and Waters Having Other Beneficial Uses - Waters that are currently used or that are potentially available.

- Class 3: Groundwater Not a Potential Source of Drinking Water and/or Limited Beneficial Use. Class 3 groundwater units are further subdivided into two subclasses.

  - Subclass 3A includes groundwater units that are highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class 2 groundwaters, depending upon the potential for producing adverse effects on the quality of adjacent waters.

  - Subclass 3B is restricted to groundwater characterized by a low degree of interconnection to adjacent surface waters or other groundwater units of a higher class within the Classification Review Area. These groundwaters are naturally isolated from sources of drinking waters in such a way that there is limited potential for producing adverse effects on quality . They have low resource values outside of mining or waste disposal.

The groundwater in the shallow surficial aquifer at OU2 is neither an ecologically vital source of drinking water, nor is it currently being used as a source of drinking water. Currently, only the deeper Castle Hayne aquifers are being used as a drinking water source. The Castle Hayne aquifers are separated from the shallow surficial aquifer by both the Yorktown aquifer and associated confining unit, as well as the Pungo River aquifer and confining unit.

North Carolina's Coastal Area Management Act (NCAC, Title 15A, Chapter 7). Subchapter 7H provides guidelines for areas of environmental concern. Coastal wetlands, such as those that might be present at the site at MCAS Cherry Point, are required to be maintained according to the management objective stated in Section 0.0205. The management objective for coastal wetlands is to give highest priority to safeguard and perpetuate their biological, social, economic, and aesthetic values and to coordinate and utilize them as a natural resource essential to the functioning of the entire estuarine system.

Subchapter 7H guidelines were developed for categories of areas of environmental concern (AECs) that are separated into four broad groupings (estuarine system, ocean hazard areas, public water supplies, and natural and cultural resource areas). The guidelines were developed to support a permit program capable of controlling inappropriate or damaging development activity within the AECs. "Minor development" activities within an AEC receive permits from a local permit officer, whereas "major development" activities receive permits from the Coastal Resources Commission. A major development is any development that requires permission, licensing, approval, certification, or authorization from a state or Federal agency; occupies an area or more than 20 acres; contemplates drilling for or excavating natural resources; or occupies, on a single parcel, a structure or structures in excess of a ground area of 60,000 square feet. Any other development is a minor development.

AECs within the estuarine system include coastal wetlands, estuarine waters, public trust areas, and estuarine shorelines. Uses that are not water dependent will not be permitted in coastal wetlands, estuarine waters, and public trust areas. AECs within ocean hazard areas include the ocean erodible area, high hazard flood area, inlet hazard area, and unvegetated beach area. AECs within public water supplies include small surface water supply watersheds and public water supply well fields. AECs within natural and cultural resource areas include coastal areas that sustain remnant (threatened and endangered) species, coastal complex natural area, unique coastal geologic formations, significant coastal archaeological resources, and significant coastal historic architectural resources. General and specific use standards are provided for development within these AECs.

Subchapter 7J contains procedures for handling major development permits, variance requests, and appeals from minor development permit decisions. The general permit procedure is also included.

Subchapter 7K includes activities in AECs that do not require a Coastal Area Management Act (CAMA) permit. Included are activities that are not considered development and classes of minor maintenance and improvements that are exempted from the CAMA major development permit requirements. Subchapter 7M contains general policy guidelines for the coastal area.

2.3.3 Action-Specific ARARs and TBC Criteria

Action-specific ARARs and TBCs are technology- or activity-based regulatory requirements or guidances that would control or restrict remedial action. The following ARARs and TBCs might relate to remedial action at OU2.

Resource Conservation and Recovery Act (RCRA) Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if the following apply:

- The waste is a listed or characteristic waste under RCRA; and
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration; or
- The activity at a CERCLA site constitutes current treatment, storage, or disposal as defined by RCRA.

RCRA Subtitle C requirements may be relevant and appropriate when the waste is sufficiently similar to a hazardous waste and/or the onsite remedial action constitutes treatment, storage, or disposal of such wastes. In addition, the particular RCRA requirement must be well suited to the circumstances of the contaminant release and site. RCRA Subtitle C requirements would be applicable when the remedial action constitutes generation of a hazardous waste. Onsite activities, mandated by a Federally ordered Superfund cleanup, must comply with the substantive requirements of RCRA Subtitle C but not with the administrative requirements (i.e., permits). All RCRA Subtitle C requirements must be met if the cleanup is not under Federal order and/or when the hazardous waste is transported off site.

The fill material/contaminated soils at OU2 are not listed hazardous wastes and are not expected to be characteristic hazardous wastes. However, the following requirements included in the RCRA Subtitle C regulations may be potentially applicable to treatment residues produced at the site:

- Hazardous waste generator requirements (40 CFR Part 262).
- Transportation requirements (40 CFR Part 263).

- Standards for owners and operators of hazardous waste treatment, storage, and disposal facilities (40 CFR Part 264).

- Interim status standards for owners and operators of hazardous waste treatment, storage, and disposal facilities (40 CFR Part 265).

RCRA Subtitle C may be applicable to OU2 because the facility is currently managed under a RCRA permit.

A generator who treats, stores, or disposes of hazardous waste on site must comply with RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262). These standards include manifest requirements, pre-transport requirements (i.e., packaging, labeling, placarding), recordkeeping, and reporting. The standards are potentially applicable to actions taken at the site if they constitute generation of a hazardous waste (such as movement of hazardous waste, if any, out of the area of contamination).

Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263) are potentially applicable to offsite transportation of hazardous waste, if any such wastes are generated at OU2. These regulations include requirements for compliance with the manifest and recordkeeping systems and requirements for immediate action and cleanup of hazardous waste discharges (spills) during transportation. Transporters must also have a North Carolina transporter permit.

Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (TSDFs) (40 CFR Part 264) are potentially applicable to remedial actions involving hazardous wastes, if any, that may be taken at the site and to offsite facilities receiving such wastes from the site for treatment and/or disposal. Standards for TSDFs include requirements for preparedness and prevention, releases from solid waste management units (i.e., corrective action requirements), closure and post-closure care, use and management of containers, and design and operating standards for tank systems, surface impoundments, waste piles, landfills, and incinerators. Onsite facilities must also have a RCRA Part B permit if the site is not a Federally ordered CERCLA cleanup.

RCRA Subtitle D establishes design and operating criteria for solid waste (nonhazardous) landfills. In general, RCRA Subtitle D establishes minimum design and operating criteria for all solid waste landfills that:

- Receive municipal solid waste as defined in 40 CFR Part 258,
- Codispose sewage sludge with municipal solid waste,

- Receive nonhazardous municipal solid waste combustion ash, or
- Are not regulated under Subtitle C of RCRA.

The closure and post-closure care requirements under RCRA Subtitle D may be relevant and appropriate to the contaminated waste fill and soils at the site. These requirements are intended to minimize the infiltration of water into the landfill and maintain the integrity of the cover during the post-closure period by minimizing cover erosion. They include closure and post-closure plans (post-closure plans must include a description of monitoring and maintenance activities as well as a description of any uses of the property during the post-closure period) and minimum requirements for a final landfill cover. In states with EPA-approved programs, the director of the program may approve alternative cover designs. Post-closure care must be conducted for 30 years except in states with EPA-approved programs where the director of the program has the authority to lengthen or shorten the post-closure period.

Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171-179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are potentially applicable to wastes shipped offsite for laboratory analysis, treatment, or disposal.

The Clean Water Act (CWA), as amended, governs point-source discharges through the National Pollutant Discharge Elimination System (NPDES), discharge of dredged or fill material, and oil and hazardous waste spills to U.S. waters. NPDES requirements (40 CFR Part 122) are potentially applicable if the direct discharge of pollutants into surface waters is part of the remedial action.

Occupational Safety and Health Administration (OSHA) (29 CFR Parts 1910, 1926, and 1904) regulates occupational safety and health requirements for workers engaged in remedial activities on site.

RCRA Land Disposal Restrictions (LDR) (40 CFR Part 268) restrict certain hazardous wastes from being placed or disposed of on land unless they meet specific the Best Demonstrated Available Technology (BDAT) treatment standard. The treatment standard is expressed as total concentrations in the waste, concentrations in the Toxicity Characteristic Leaching Procedure (TCLP) extract, or a specified treatment technology. LDR standards are potentially applicable to hazardous wastes generated on the site which must subsequently be disposed of at a landfill off site.

Based on the available contaminant concentrations at OU2 and available TCLP results, the soils are not expected to be hazardous. Also, the contamination is not the result of disposal of a listed hazardous waste. Therefore, the RCRA regulations stated above are not likely to be applicable to remedial actions for the contaminated soil at OU2. However, the final determination must be made by TCLP analysis of samples at the time of remedial design.

National Environmental Policy Act (NEPA) (42 USC 4321) (40 CFR Part 6) requires Federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement. Specifically, NEPA requires federal agencies to consider five issues during the planning of major actions: (1) the environmental impact of the proposed action; (2) any adverse impacts which cannot be avoided with the proposed implementation; (3) alternatives to the proposed action; (4) the relationship between short-term and long-term effects; and (5) any irreversible and irretrievable commitments of resources which would be involved in a proposed action. All of the listed items are addressed in the detailed evaluation of this FS report.

Federal Protection of Wetlands Executive Order (E.O. 11990) and North Carolina Coastal Area Management Act (NCAC, Title 15A, Subchapter 7H) would be applicable to actions that affect wetlands. Approximately 6 acres of coastal small stream swamp have been identified along Slocum Creek and Turkey Gut. Mitigation of adverse effects to these wetlands must be implemented if they will be disturbed by remedial activities.

North Carolina Hazardous Waste Management Regulations (NCAC, Title 10, Chapter 10). Subchapter 10F establishes minimum state regulations for hazardous waste management applicable to generators, transporters, owners, and operators of facilities that treat, store, incinerate, or dispose of hazardous wastes.

State of North Carolina Hazardous Waste and Solid Waste Management Regulations (NCAC, Title 15A, Chapter 13). Subchapter 13A, Hazardous Waste Management, includes Federal requirements which are incorporated by reference, with a few exceptions. These exceptions include a minor revision pertaining to inspection records of generators, revisions pertaining to financial requirements, location standards, and community participation in the siting process for TSDFs, revisions pertaining to additional information requirements, operating record, justification and need for the facility, a revision involving requirements for offsite recycling facilities in the hazardous waste permit program, and a revision pertaining to annual reporting requirements in the standards for the management of used oil.

Subchapter 13B governs the solid waste management regulations. It provides for cover requirements for sanitary landfills. According to this regulation, at least 2 feet of compacted earth is required after final termination of disposal operations at a site. This cover requirement may be relevant and appropriate to the wastes and contaminated soils at the site.

Subchapter 13C requires notification of certain site information and a remedial action plan at inactive hazardous substances and waste disposal sites. This requirement would be applicable to OU2 because of the solid waste disposal that occurred there. Subchapter 13C contains notification requirements where each owner, operator, or responsible party shall submit relevant site data known and readily available for each inactive hazardous substance or waste disposal site (Section .0100). Section .0200 contains the site prioritization system. The DEHNR shall review and evaluate relevant site data and prioritize the sites using the priority system established in the regulations.

North Carolina Water Pollution Control Regulations (NCAC, Title 15A, Chapter 2). Subchapter 2B regulates wastewaters discharged to surface waters. The regulations contain requirements and procedures for application and issuance of state NPDES permits for a discharge from an outlet, point source, or disposal system, to the surface waters or a disposal system, which, in turn, may discharge into surface waters of the state. The regulation also provides monitoring requirements including discharge flow measurements, sampling frequency and locations, biological and toxicity monitoring, and testing and analysis.

Subchapter 2H contains requirements and procedures for application and issuance of state NPDES permits for discharges to surface water and for the construction and operation of treatment facilities. The rules also contain requirements for stormwater discharges and general permits. After an NPDES permit has been issued, construction cannot begin until an Authorization to Construct Permit has been issued. These regulations are potentially applicable to the discharge of treated groundwater to surface water at OU2. These regulations are also potentially applicable for indirect discharges of treated groundwater to surface water through a wastewater treatment facility that has a permitted NPDES outfall. At OU2, the use of the MCAS Cherry Point STP for discharge of contaminated groundwater would require meeting the pretreatment requirements of the STP.

North Carolina Stormwater Runoff Disposal (NCAC, Title 15A, Chapter 2). Subchapter 2H regulates pollutants associated with stormwater runoff and apply to development of land for residential, commercial, industrial, or institutional use. The rules contain requirements for coastal stormwater disposal (Rule .1003), including stormwater disposal options, design criteria for development draining to Outstanding Resource Waters, design criteria for development draining directly to Class SA Waters, design criteria for development not draining to Class SA waters, infiltration system requirements, detention pond requirements, vegetative filter requirements, operation and maintenance, and system design.

North Carolina Erosion and Sedimentation Control (NCAC, Title 15A, Chapter 4). Subchapter 4B states that all reasonable measures shall be taken to protect all public and private property from damage caused by land-disturbing activities. An erosion and sedimentation control plan is required for a land-disturbing activity that covers one or more acres. The regulations contain requirements for the design storm standard (10-year storm that produces the maximum peak rate of runoff); storm water outlet protection, including maximum permissible velocity of discharges; operations in natural watercourses; ground cover; design standards for sensitive watersheds; and buffer zones. Control measures would be included during remedial designs for construction activities at OU2.

North Carolina Well Construction Standards (NCAC, Title 15A, Chapter 2). Subchapter 2C, Section .0100, sets criteria and standards governing the location, construction, repair, and abandonment of wells used for water supply, monitoring, recovery of contaminants, exploration, or injection. It also governs the installation and repair of pumps and pumping equipment. Permits are required for monitoring wells, recovery wells, and recharge or injection wells. Section .0200 contains criteria and standards applicable to injection wells, including classes of wells, and requirements and procedures for permitting, construction, operation, monitoring, reporting, and abandonment of approved types of injection wells. These rules are potentially applicable to monitoring wells, extraction wells, and injection wells used for the disposal of treated groundwater.

2.4 REMEDIAL GOAL OPTIONS

The USEPA Region IV requires, as part of the risk assessment, an estimation of Remedial Goal Options (RGOs) for three risk range levels for any receptor for which any individual contaminant has a cancer risk greater than 1E-6 or a Hazard Index greater than 0.1. RGOs are presented in the RI for future residents (30-year and 6-year) and full-time employees. The following two sections outline the RGOs for groundwater and soil, respectively.

2.4.1 Groundwater Remedial Goal Options

Although OU2 will most likely never be used as a residential area, RGOs for groundwater at OU2 have been developed for the residential scenario as a conservative approach to meet the RAOs. Tables 2-3 and 2-4 present the RGOs for protection from ingestion and other residential use of groundwater. Compounds that exceeded the 1E-6 criteria for total cancer risk include benzene, 1,1-dichloroethene, vinyl chloride, bis(2-chloroethyl)ether, 1-4 dichlorobenzene, heptachlor epoxide, and arsenic. Compounds that exceeded the 0.1 criteria for HIs include benzene, chlorobenzene, 1,4-dichlorobenzene, 4-methylphenol, nitrobenzene, heptachlor epoxide, arsenic, cadmium, iron, and manganese. Table 2-5 presents the RGOs based on exceedance of MCLs and/or state groundwater standards.

TABLE 2-3

REMEDIAL GOAL OPTIONS FOR GROUNDWATER - FUTURE RESIDENT (6-YEAR)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	RGOs for Target Cancer Risk (μg/L)			RGOs for Target Hazard Quotient (μg/L)			NC Class GA Standard (μg/L)	Federal MCL (μg/L)
	1E-6	1E-5	1E-4	0.1	1	10		
Benzene	3.8	38	380	4.4	44	440	1.0	5.0
Chlorobenzene	NA[1]	NA	NA	26	260	2,600	50	100
1,1-Dichloroethene	0.25	2.5	25	-[2]	-	-	7.0	7.0
Vinyl chloride	0.086	0.86	8.6	NA	NA	NA	0.015	2.0
Bis(2-chloroethyl)ether	0.16	1.6	16	NA	NA	NA	DL[3]	NS[4]
1,4-Dichlorobenzene	6.9	69	690	3,400	34,000	340,000	75	75
4-Methylphenol	NA	NA	NA	7.6	76	760	DL	NS
Nitrobenzene	NA	NA	NA	0.77	7.7	77	DL	NS
Heptachlor epoxide	0.019	0.19	1.9	-	-	-	0.004	0.2
Arsenic	0.1	1.0	10	0.47	4.7	47	50	50
Cadmium	NA	NA	NA	0.74	7.4	74	5.0	5.0
Iron	NA	NA	NA	460	4,600	46,000	300	300[5]
Manganese	NA	NA	NA	7.8	78	780	50	50[5]

1 NA - Not applicable. No cancer slope factor or Reference Dose for this chemical.
2 Concentration of contaminant at site results in a Hazard Index less than 0.1.
3 DL - Detection limit. Any detection is considered an exceedance of the state standard.
4 NS - No standard.
5 Secondary MCL.

TABLE 2-4

REMEDIAL GOAL OPTIONS FOR GROUNDWATER - FUTURE RESIDENT (30-YEAR)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	RGOs for Target Cancer Risk (μg/L)			RGOs for Target Hazard Quotient (μg/L)			NC Class GA Standard (μg/L)	Federal MCL (μg/L)
	1E-6	1E-5	1E-4	0.1	1	10		
Benzene	1.6	16	160	3.6	36	360	1.0	5.0
Chlorobenzene	NA[1]	NA	NA	18	180	1,800	50	50
1,1-Dichloroethene	0.097	0.97	9.7	-[2]	-	-	7.0	7.0
Vinyl chloride	0.032	0.32	3.2	NA	NA	NA	0.015	2.0
Bis(2-chloroethyl)ether	0.059	0.59	5.9	NA	NA	NA	DL[3]	NS[4]
1,4-Dichloroebenzene	2.5	25	250	610	6,100	61,000	75	75
4-Methylphenol	NA	NA	NA	5.3	53	530	DL	NS
Nitrobenzene	NA	NA	NA	0.54	5.4	54	DL	NS
Heptachlor epoxide	0.0069	0.069	0.69	0.014	0.14	1.4	0.004	0.2
Arsenic	0.038	0.38	3.8	0.33	3.3	33	50	50
Cadmium	NA	NA	NA	0.52	5.2	52	5.0	5.0
Iron	NA	NA	NA	330	3,300	33,000	300	300[5]
Manganese	NA	NA	NA	5.4	54	540	50	50[5]

1 NA - Not applicable. No cancer slope factor or Reference Dose for this chemical.
2 Concentration of contaminant at site results in a Hazard Index less than 0.1.
3 DL - Detection limit. Any detection is considered an exceedance of the state standard.
4 NS - No standard.
5 Secondary MCL.

TABLE 2-5

GROUNDWATER COCs THAT EXCEED MCLs OR STATE GROUNDWATER STANDARDS
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical of Concern	NC Class GA Standard (μg/L)	Federal MCL (μg/L)
Benzene	1	5
Chlorobenzene	50	100
Chloroform	0.19	100
1,2-Dichloroethane	0.38	5
cis-1,2-Dichloroethene	70	70
1,2-Dichloropropane	0.56	5
Ethylbenzene	29	700
2-Hexanone	DL[(1)]	NS[(2)]
4-Methyl-2-pentanone	DL	NS
Tetrachloroethene	0.7	5
Trichloroethene	2.8	5
Vinyl chloride	0.015	2
Bis(2-chloroethyl)ether	DL	NS
Bis(2-ethylhexyl)phthalate	3	6
2,4-Dimethylphenol	DL	NS
2-Methylnaphthalene	DL	NS
2-Methylphenol	DL	NS
4-Methylphenol	DL	NS
Naphthalene	21	NS
Nitrobenzene	DL	NS
Aldrin	DL	NS
alpha-BHC	DL	NS
4,4'-DDE	DL	NS
4,4'-DDT	DL	NS
Endosulfan I	DL	NS
Endosulfan II	DL	NS

TABLE 2-5 (Continued)
GROUNDWATER COCs THAT EXCEED MCLs OR STATE GROUNDWATER STANDARDS
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical of Concern	NC Class GA Standard (μg/L)	Federal MCL (μg/L)
Endrin aldehyde	DL	NS
Heptachlor epoxide	0.004	0.2
Arsenic	50	50
Cadmium	5	5
Iron	300	300[(3)]
Manganese	50	50[(3)]

(1) DL - Detection limit. Any detection is considered an exceedance of state standard.
(2) NS - No standard.
(3) Secondary MCL.

2.4.2 Soil Remedial Goal Options

2.4.2.1 Risk-Based Remedial Goal Options

RGOs for remediation of waste/fill material and contaminated soil at OU2 have been developed for the residential exposure scenario and the full-time employee exposure scenario as a conservative approach to meet the RAOs. Although OU2 will most likely never be used as a residential area, RGOs were developed for the residential exposure scenario as a conservative estimate of volumes requiring remediation. Although carcinogenic risks under the full-time employee scenario were within the USEPA acceptable risk range, individual cancer risks were greater than 1E-6. In addition, noncarcinogenic risks for a few contaminants were greater than 0.1. The main contaminants of concern are metals and benzo(a)pyrene. Tables 2-6 and 2-7 present the RGOs for a 6-year residential exposure scenario and a 30-year residential scenario, respectively. Table 2-8 presents the RGOs for a full-time employee scenario. These RGOs are the allowable concentrations of various contaminants in the soil corresponding to an acceptable risk for carcinogens (i.e., and incremental cancer risk of 1E-6 to 1E-4) and/or noncarcinogens (i.e., a hazard index of 0.1 to 10).

2.4.2.2 Remedial Goal Options for the Protection of Groundwater

RGOs based on potential movement of contaminants from soil to groundwater were developed as part of the RI. NCDEHNR has grouped contaminated soil in North Carolina into three soil categories. Current or potential migration of soil contaminants to groundwater was evaluated according to Method II Category S-3 (NCDEHNR, November 1996). Method II uses a transport model to calculate soil contaminant target concentrations that would not likely exceed the groundwater target concentrations. The groundwater target concentrations were either Class GA groundwater quality standards or risk-based concentrations (for chemicals where no numerical standard was available). The transport model and input parameters are provided in Appendix M (Volume IV) of the RI Report (B&R Environmental, April 1997).

Soil RGOs based on protection of groundwater were developed for any chemical ever detected in groundwater that exceeded the Class GA groundwater standard. In addition, "mother and daughter products" from potential chemical transformations were included. Table 2-9 provides the Category S-3 soil RGOs along with the maximum soil concentrations detected for each chemical. Chemicals where the maximum concentrations exceeds the RGO are indicated with an asterisk.

TABLE 2-6

REMEDIAL GOAL OPTIONS FOR SOIL - FUTURE RESIDENT (6-YEAR)
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	RGOs for Target Cancer Risk (mg/kg)			RGOs for Target Hazard Quotient (kg/kg)		
	1E-6	1E-5	1E-4	0.1	1	10
Benzo(a)pyrene	0.12	1.2	12	NA[1]	NA	NA
Antimony	NA	NA	NA	2.9	29	290
Arsenic	0.51	5.1	51	2.3	23	230
Beryllium	0.072	0.72	7.2	13.3	133	1,330
Chromium (VI)	NA	NA	NA	13.3	133	1,330
Iron	NA	NA	NA	2,140	21,400	214,000
Thallium	NA	NA	NA	0.5	5.0	50

1 NA - Not applicable. No cancer slope factor or Reference Dose for this chemical.

TABLE 2-7

REMEDIAL GOAL OPTIONS FOR SOIL - FUTURE RESIDENT (30-YEAR) OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA

Analyte	RGOs for Target Cancer Risk (mg/kg)			RGOs for Target Hazard Quotient (mg/kg)		
	1E-6	1E-5	1E-4	0.1	1	10
Benzo(a)pyrene	0.088	0.88	8.8	NA(1)	NA	NA
Antimony	NA	NA	NA	2.5	25	250
Arsenic	0.35	3.5	35	2.1	21	210
Beryllium	0.038	0.38	3.8	11	110	1,100
Chromium (VI)	NA	NA	NA	12	120	1,200
Iron	NA	NA	NA	1,900	19,000	190,000
Thallium	NA	NA	NA	0.45	4.5	45

1 NA - Not applicable. No cancer slope factor or Reference Dose for this chemical.

TABLE 2-8

REMEDIAL GOAL OPTIONS FOR SOIL - FUTURE FULL-TIME EMPLOYEE
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Analyte	RGOs for Target Cancer Risk (mg/kg)			RGOs for Target Hazard Quotient (mg/kg)		
	1E-6	1E-5	1E-4	0.1	1	10
Benzo(a)pyrene	-[1]	-	-	NA[2]	NA	NA
Antimony	NA	NA	NA	-	-	-
Arsenic	1.2	12	120	-	-	-
Beryllium	0.18	1.8	18	140	1,400	14,000
Chromium (VI)	NA	NA	NA	140	1,400	14,000
Iron	NA	NA	NA	46,600	466,000	4,660,000
Thallium	NA	NA	NA	-	-	-

1 Concentration of contaminant at site results in a cancer risk less than 1E-6 or Hazard Index less than 0.1.

2 NA - Not applicable. No cancer slope factor or Reference Dose for this chemical.

TABLE 2-9

REMEDIAL GOAL OPTIONS FOR SOIL - PROTECTION OF GROUNDWATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	S-3 Target Concentration	Maximum Soil Concentration
Volatiles (μg/kg)		
Benzene*[1]	5.6	280
Bromodichloromethane	2.9	ND[2]
2-Butanone*	687	16,000
Carbon tetrachloride	2.9	ND
Chlorobenzene*	432	520
Chloroethane	13,848	14
Chloroform*	0.96	2,590
Chloromethane	6.7	ND
Dibromochloromethane	0.69	ND
1,1-Dichloroethane	3,521	69
1,2-Dichloroethane*	1.7	13
1,1-Dichloroethene	49.2	ND
cis-1,2-Dichloroethene*	350	4,700 (total)[3]
trans-1,2-Dichloroethene*	400	4,700 (total)[3]
1,2-Dichloropropane	2.8	ND
cis-1,3-Dichloropropene	1.2	ND
trans-1,3-Dichloropropene*	1.2	98
Ethylbenzene*	343	140,000
2-Hexanone	760	510
Methylene chloride*	21.9	190,000
4-Methyl-2-pentanone	2,500	1,000
1,1,2,2-Tetrachloroethane	0.31	ND
Tetrachloroethene*	5.9	4,800
Toluene*	8,111	67,000
1,1,1-Trichloroethane*	1,484	2,500
1,1,2-Trichloroethane	0.96	ND

TABLE 2-9 (Continued)
REMEDIAL GOAL OPTIONS FOR SOIL - PROTECTION OF GROUNDWATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	S-3 Target Concentration	Maximum Soil Concentration
Trichloroethene*	20.7	880
Vinyl chloride*	0.09	490
Semivolatiles (µg/kg)		
Bis(2-chloroethyl)ether	0.04	ND
Bis(2-ethylhexyl)phthalate	906,000	11,000
2,4-Dimethylphenol*	1,194	4,100
2-Methylnaphthalene*	3,235	230,000
2-Methylphenol	2,097	ND
4-Methylphenol*	205	27,000
Naphthalene*	925	39,000
Nitrobenzene	3.6	ND
2-Nitrophenol	2,346	ND
Pesticides (µg/kg)		
Aldrin	203	3.6
alpha-BHC	0.31	ND
beta-BHC	1.1	ND
4,4'-DDD	5,601	43
4,4'-DDE	17,881	69
4,4'-DDT	10,521	130
Dieldrin*	1.8	53
Endosulfan I	2,059	7.6
Endosulfan II	2,059	47
Endrin aldehyde	348	27
Heptachlor	226	2.0
Heptachlor epoxide*	6.7	18

TABLE 2-9 (Continued)
REMEDIAL GOAL OPTIONS FOR SOIL - PROTECTION OF GROUNDWATER
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Chemical	S-3 Target Concentration	Maximum Soil Concentration
Metals (mg/kg)		
Arsenic	26.2	17.1
Cadmium*	2.7	119.5
Chromium	21,000	122
Iron*	151	62,600
Lead*	270	1,650
Manganese*	65.2	1,170
Nickel*	56.4	176
Silver*	0.22	90

1 Asterisk indicates exceedance of target concentration.
2 Not detected.
3 Samples were analyzed for total 1,2-dichloroethene.

2.5 CONTAMINANTS OF CONCERN

The OU2 baseline risk assessment, discussed in Section 1.0, evaluated contaminants of potential concern (COPCs) and exposure pathways to determine present and potential future impacts on human health. Not all COPCs identified in the baseline risk assessment pose significant health risks, and many need not be considered in future remedial activities. Contaminants of concern (COCs) are those constituents that remain a concern following analysis in the baseline risk assessment process or that exceed a state groundwater or surface water quality standard. Only those contaminants identified as posing a concern at the site need be considered in the development of the FS. Restricting the number of COCs in the FS allows for focusing on those contaminants which require the implementation of remedial actions to ensure the protection of human health and the environment.

2.5.1 Groundwater

Groundwater from the surficial aquifer beneath OU2 exceeds several RGOs for the future resident receptors (both 6-year and 30-year scenarios). Risk based COCs are as follows:

- Benzene
- Chlorobenzene
- 1,1-Dichloroethene
- Vinyl chloride
- 1,4-Dichlorobenzene
- 4-Methylphenol
- Nitrobenzene
- Heptachlor epoxide
- Arsenic
- Cadmium
- Iron
- Manganese

Benzene, 1,1-dichloroethene, vinyl chloride, bis(2-chloroethyl)ether, 1,4-dichlorobenzene, heptachlor epoxide, and arsenic were selected as COCs because their total risks exceeded 1E-6. The remaining chemicals were selected as COCs because their cumulative HIs exceeded 0.1.

The following contaminants in the surficial aquifer exceed the State of North Carolina numerical quality standards for Class GA groundwaters based on 1994 and 1996 results and are retained as COCs:

- Benzene
- Chlorobenzene
- Chloroform
- 1,2-Dichloroethane
- Vinyl chloride
- Bis(2-ethylhexyl)phthalate
- Naphthalene
- Heptachlor epoxide

- cis-1,2-Dichloroethene
- 1,2-Dichlororpropane
- Ethylbenzene
- Tetrachloroethene
- Trichloroethene
- Arsenic
- Cadmium
- Iron
- Manganese

In addition, the following contaminants in the surficial aquifer exceeded the state narrative groundwater quality standards (any detection considered to be an exceedance) and are retained as COCs:

- 2-Hexanone
- 4-Methyl-2-pentanone
- Bis(2-chloroethyl)ether
- 2,4-Dimethylphenol
- 2-Methylnaphthalene
- 2-Methylphenol
- 4-Methylphenol
- Nitrobenzene
- Aldrin
- alpha-BHC
- 4,4'-DDE
- 4,4'-DDT
- Endosulfan I
- Endosulfan II
- Endrin aldehyde

Based on 1994 and 1996 results for the surficial aquifer, benzene, chlorobenzene, cis-1,2-dichloroethene, tetrachloroethene, trichloroethene, vinyl chloride, bis(2-ethylhexyl)phthalate, arsenic, and cadmium exceeded MCLs and are retained as COCs.

Based on 1994 results for the Yorktown aquifer, bis(2-ethylhexyl)phthalate, chloroform, iron, and manganese exceeded State of North Carolina quality standards for Class GA groundwaters. Only bis(2-ethylhexyl)phthalate exceeded an MCL (at one location). No individual compounds in the Yorktown aquifer would be considered as COCs, based upon incremental cancer risk, hazard indices, or the one exceedance of an MCL.

2.5.2 Soil

Soil (0 to 2 feet in depth) at OU2 exceeds several RGOs for the future resident (6-year and 30-year) and future full-time employee scenarios. The cumulative list of identified risk-based COCs is as follows:

- Benzo(a)pyrene
- Antimony
- Arsenic
- Beryllium
- Chromium
- Iron
- Thallium

Of these chemicals, benzo(a)pyrene, arsenic, and beryllium were selected based on their individual percent contributions to the cumulative carcinogenic risks. The remaining analytes were selected as COCs because they contribute significantly to cumulative noncarcinogenic hazards.

In addition to those contaminants in the 0- to 2-foot deep soils that exceed risk-based RGOs, modeling studies indicated that many contaminants present in soils of all depths beneath OU2 would exceed RGOs for the protection of groundwater. These COCs include the following:

- Benzene
- 2-Butanone
- Chlorobenzene
- Chloroform
- 1,2-Dichloroethane
- cis-1,2-Dichloroethene
- trans-1,2-Dichloroethene
- trans-1,3-Dichloropropene
- Ethylbenzene
- Methylene chloride
- Tetrachloroethene
- Toluene
- 1,1,1-Trichloroethane
- Trichloroethene
- Vinyl chloride
- 2,4-Dimethylphenol
- 2-Methylnaphthalene
- 4-Methylphenol
- Naphthalene
- Dieldrin
- Heptachlor epoxide
- Cadmium
- Iron
- Lead
- Manganese
- Nickel
- Silver

2.5.3 Surface Water

Based on the most recent analytical data (1994), no individual compounds in either Slocum Creek or Turkey Gut would be considered as COCs based upon cancer slope factors or hazard indices. However, several contaminants in these streams exceed North Carolina Water Quality Standards and were retained as COCs. There were exceedances of state standards for bis(2-ethylhexyl)phthalate, 4,4'-DDD, heptachlor epoxide, copper, and iron in Turkey Gut and 4,4'-DDD and copper in Slocum Creek.

2.6 MEDIA OF CONCERN

The contaminated media at OU2 are soil and groundwater. The potential receptors and the pathways of concern that may pose a human health risk due to exposure to the contaminated media were discussed in Section 1.0 and are summarized as follows:

- Future full-time employees: Dermal contact with and incidental ingestion of contaminated surface soil.

- Future adult residents: Incidental ingestion of contaminated surface soil; dermal contact with, ingestion of, and inhalation of volatiles in surficial aquifer groundwater.

- Future child residents: Dermal contact with and incidental ingestion of contaminated surface soil; dermal contact with, ingestion of, and inhalation of volatiles in surficial aquifer groundwater.

Therefore, the media of concern based on protection of human health include surface soil and surficial aquifer groundwater.

Several contaminants were detected in groundwater from the Yorktown aquifer at concentrations that exceed state standards. However, there is no unacceptable potential risk to human health from exposure to this groundwater. The Yorktown aquifer groundwater at OU2 is not currently used as a source of drinking water, and it is anticipated that the groundwater in the Yorktown aquifer will never be used for drinking water. In addition, the extent and magnitude of contamination in this aquifer is minimal. Therefore, groundwater in the Yorktown aquifer is not considered a medium of concern.

The surface waters and sediments in Slocum Creek and Turkey Gut are not expected to pose unacceptable health risks to humans. It should be noted that Slocum Creek has been designated as a separate operable unit that will be addressed in the future.

The concentrations of many soil contaminants exceed RGOs based on protection of groundwater. Therefore, soil (and buried waste/fill materials) are media of concern based on the potential migration of contaminants to the surficial aquifer.

2.7 VOLUMES OF CONTAMINATED MEDIA

Volumes of contaminated soil were estimated based on sample locations that contained contaminant concentrations that exceeded RGOs. This was done for protection of human health (i.e., future residents and future full-time employees) and protection of groundwater.

For protection of human health, the RGO was assumed to be exceeded if the concentrations of contaminants yielded a cumulative hazard index greater than 1.0 or the incremental cancer risk exceeded 1E-4. Table 2-10 provides these RGOs for future residents (30-year and 6-year) and future full-time employees along with the concentrations detected at OU2. As shown on Table 2-10, none of the concentrations exceeded RGOs based on the full-time employee scenario. RGOs for protection of future residents were only exceeded for iron and thallium. Based on a review of the analytical data, the RGO for iron was exceeded at locations OU2SS07 (54,700 mg/kg) and OU2LS05 (40,500 mg/kg). The RGO for thallium was exceeded at location 44ASO03 (6.7 mg/kg). The complete analytical data base is presented in Appendix H of the RI Report (B&R Environmental, April 1997). The volume of contaminated soil that exceeds residential RGOs was not calculated because the RGOs were only exceeded at three locations, and future residential use of OU2 is extremely unlikely.

For protection of groundwater, contaminant concentrations exceeded the RGOs at many more locations than for protection of human health. Figures 2-1 and 2-2 present the sample locations and concentrations of organic and inorganic contaminants, respectively, that exceed RGOs based on protection of groundwater. For silver, the RGO was less than background levels; therefore, only those locations where silver exceeds background (and the RGO) are shown on Figure 2-2.

Currently, based on the assumed extent of contamination (i.e., exceedance of RGOs for protection of groundwater), the following are the estimated volumes of contaminated soil: organics - 8,700 cubic yards; inorganics - 2,700 cubic yards). Details of the volume estimates are presented in Appendix C.

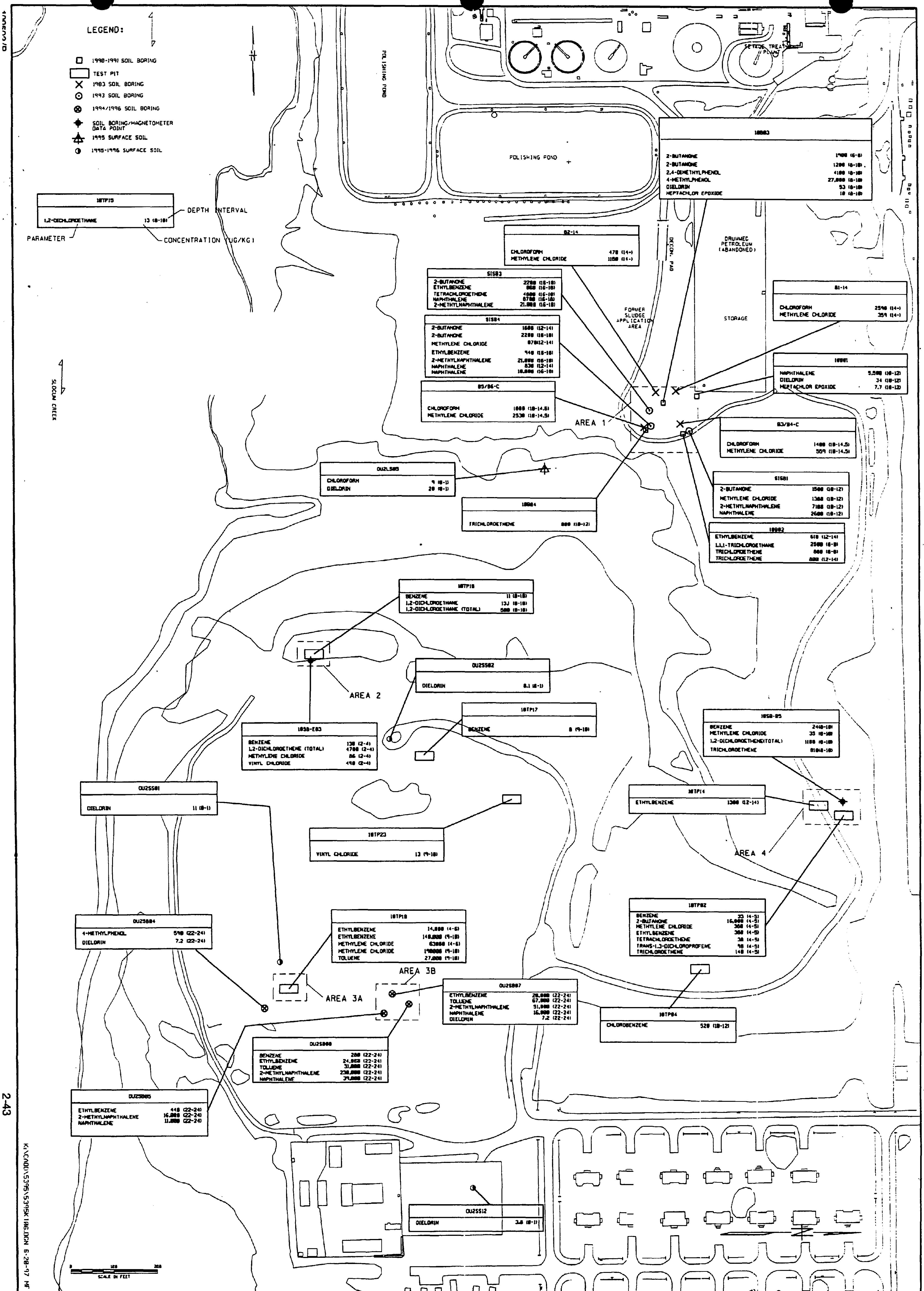
Figure 2-3 presents the sample locations and contaminant concentrations in the surficial aquifer groundwater that exceed state groundwater standards. Benzene is the most widespread organic contaminant in the surficial aquifer, and the size of the benzene plume is essentially the entire area of OU2 (approximately 3.25

TABLE 2-10

SOIL RGOs FOR PROTECTION OF HUMAN HEALTH[1]
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Contaminant of Concern	30-Year Resident	6-Year Resident	Full-time Employee	Range of Positive Detections
Organics (μg/kg)				
Benzo(a)pyrene	8,800	12,000	NA[2]	240
Metals (mg/kg)				
Antimony	25	29	NA	1.1 - 3.6
Arsenic	21	23	120	0.68 - 17.1
Beryllium	3.8	7.2	18	0.28
Chromium	120	133	1,400	2.2 - 51.2
Iron	19,000	21,400	466,000	1,520 - 54,700
Thallium	4.5	5.0	NA	0.47 - 6.7

1 ICR of 1E-4 or HI of 1.0, whichever is lower.
2 NA - Not applicable; not a COC for this receptor.



DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION — NORFOLK, VIRGINIA

NAVAL STATION — MARINE CORPS AIR STATION CHERRY POINT — CHERRY POINT, NORTH CAROLINA

OU2

ORGANIC CONSTITUENTS IN SOIL EXCEEDING RGOs

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FIGURE 2-1

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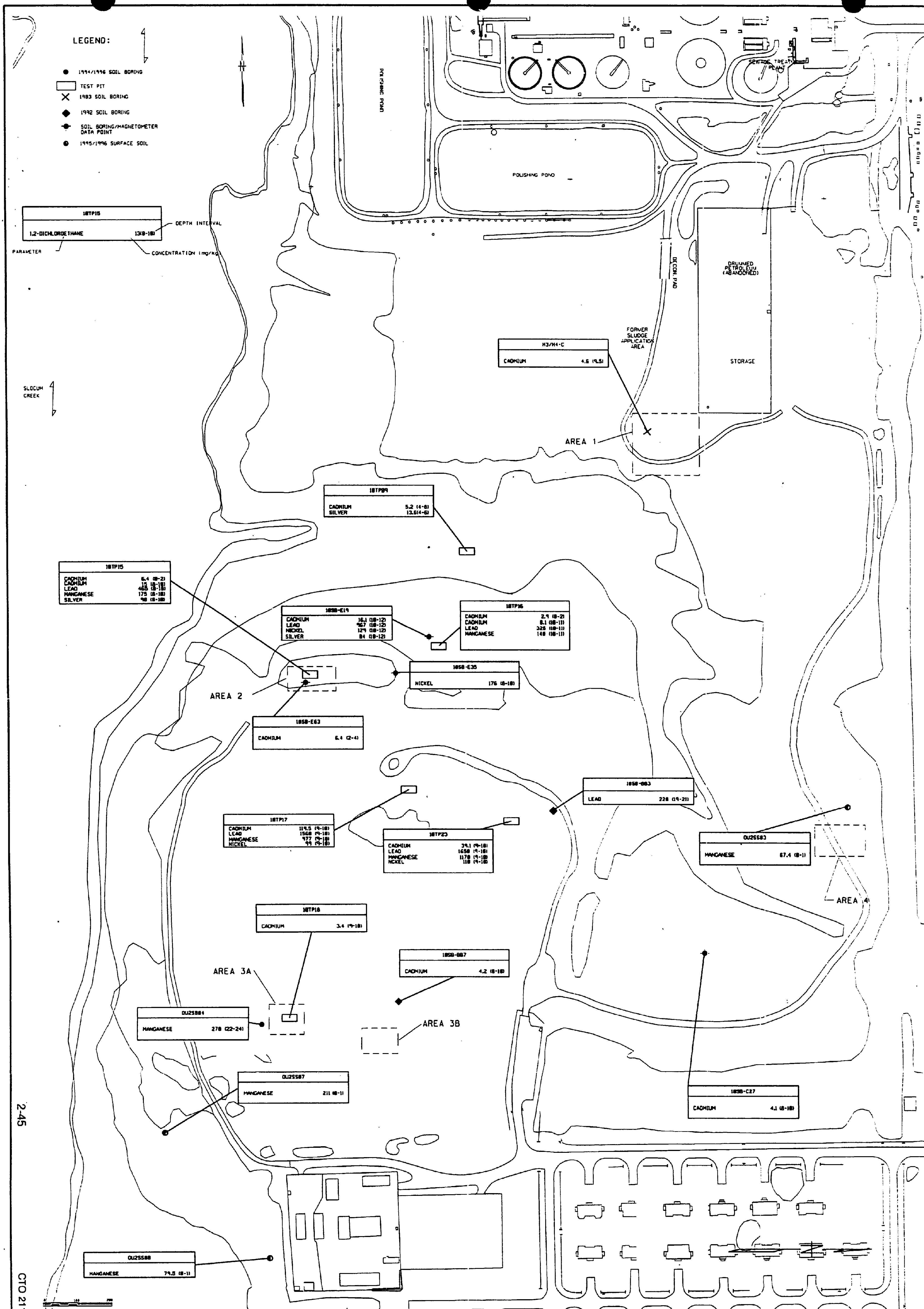

2-45

CTO 211

FIGURE 2-2

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NAVAL STATION — NORFOLK, VIRGINIA

MARINE CORPS AIR STATION CHERRY POINT — CHERRY POINT, NORTH CAROLINA

OU2

INORGANIC CONSTITUENTS IN SOIL EXCEEDING RGOs

AS NOTED

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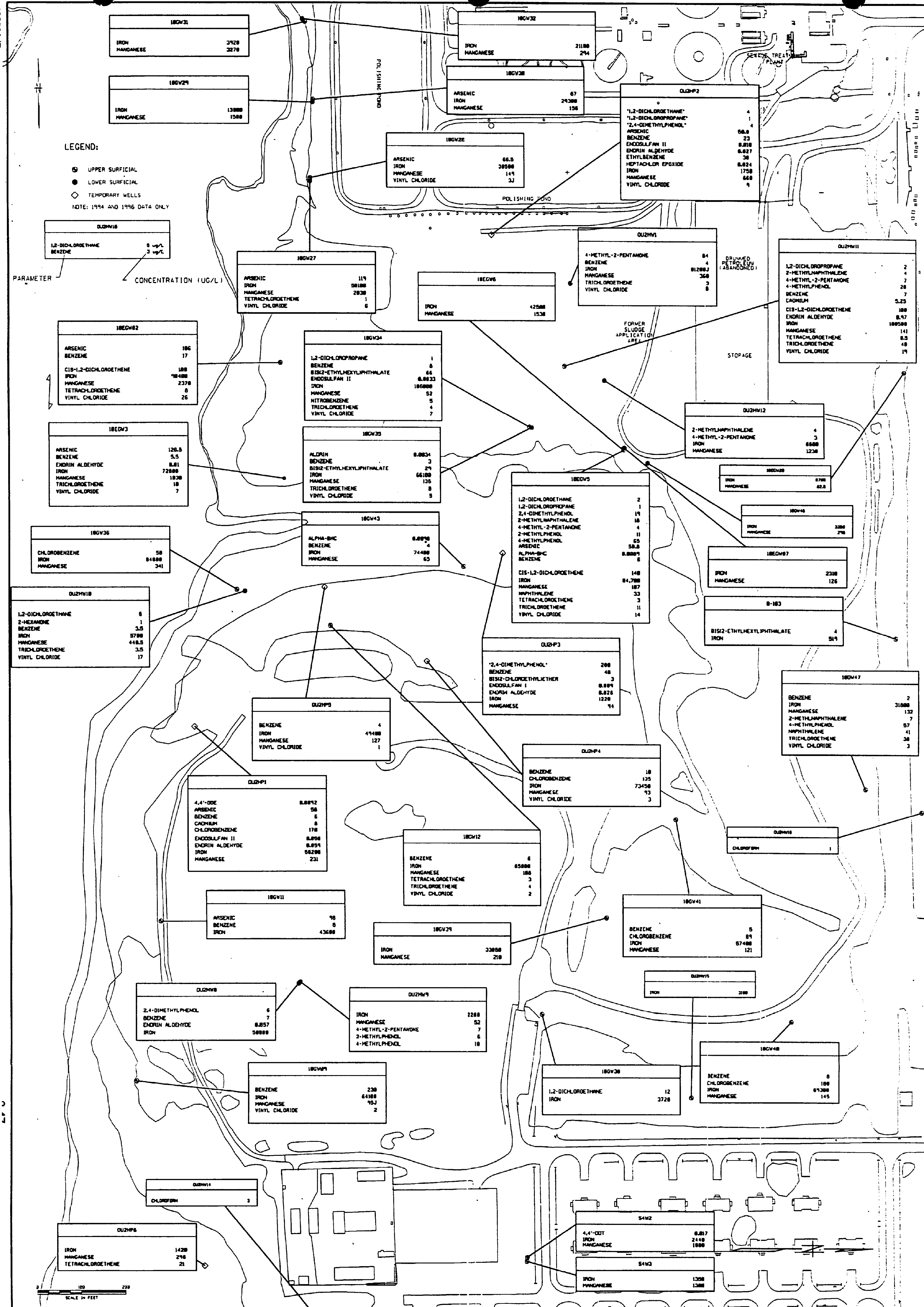

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DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION — NORFOLK, VIRGINIA

NAVAL STATION MARINE CORPS AIR STATION CHERRY POINT — CHERRY POINT, NORTH CAROLINA

OU2

CONTAMINANTS IN SURFICIAL AQUIFER EXCEEDING STATE STANDARDS

FIGURE 2-3

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million square feet). Using an estimated average surficial aquifer depth of 30 feet and an average porosity of 0.3, the volume of contaminated groundwater is approximately 220 million gallons.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

3.1 INTRODUCTION

Identification, screening, and evaluation of potentially applicable technologies and process options are key steps in the FS process. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options that will be formulated into preliminary remedial alternatives in the following section.

Section 3.0 discusses the identification, development, and screening of applicable technologies and process options that will be used to assemble the remedial action alternatives for OU2. The basis for technology identification and screening actually began in Section 2.0 with a series of discussions that included the following:

- Identification of ARARs
- Development of remedial action objectives (RAOs)
- Identification of volumes or areas of media of concern

Technology screening is completed and technology evaluation is performed in this section with the completion of the following analytical steps:

- Identification of general response actions (GRAs)
- Identification and screening of remedial technologies and process options
- Evaluation and selection of representative process options

3.2 GENERAL RESPONSE ACTIONS

GRAs describe categories of actions that could be implemented to satisfy or address a component of a RAO for the site. Typically, the formation of remedial action alternatives represents the coupling of GRAs to fully address RAOs. When implemented, the coupled GRAs are capable of achieving the RAOs which have been generated for each contaminated medium at the site. For OU2, the contaminated media of concern include the following:

- Groundwater from the surficial aquifer.
- Contaminated soil and waste/fill material located beneath OU2 to any depth.

The following are GRAs to be considered for OU2:

- No Action
- Institutional Controls
- Containment
- Removal
- Treatment
- Disposal

3.2.1 No Action

The no-action response is retained throughout the FS process as required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) [40 CFR 300.430(e)(6)]. The no-action response provides a comparative baseline against which other alternatives can be evaluated. Under this response, no remedial action will be taken. In the no-action alternative, the contaminated media are considered to be left "as is," without the implementation of any institutional controls, containment, removal, treatment, or other mitigating actions. The no-action alternative does not provide for the monitoring of groundwater or for the implementation of access controls to reduce the potential for exposure (e.g., alternative water supply, physical barriers, deed restrictions).

3.2.2 Institutional Controls

Institutional controls involve the application of various site access controls and/or land use restrictions to reduce or eliminate direct contact pathways of exposure to hazardous substances at the site. These controls could involve the use of groundwater monitoring networks, groundwater use restrictions, and access controls. The volume, mobility, and toxicity of the contaminants is not reduced through the singular application of institutional controls.

3.2.3 Containment

Another method of reducing risk to the public and the environment is through containment, which involves the application of physical measures to reduce the potential for exposure to contaminants and contaminant migration. To reduce the migration of contaminants, the contaminated media must be isolated from the primary transport mechanisms, such as wind, erosion, surface water, and groundwater. Contaminated media may be isolated by installing surface and subsurface barriers that either block or divert any transport media (i.e., groundwater, wind, etc.) or exposure pathway from the contaminants. Pumping wells used for gradient control can provide a type of barrier to contain the migration of contaminated groundwater plumes.

3.2.4 Removal

Technologies under the removal response action category are used to move contaminated media from its present location to be treated and/or disposed of elsewhere. Removal process options are combined with treatment and/or disposal process options to develop alternatives and could involve the installation of extraction wells or collection trenches to remove contaminated groundwater.

3.2.5 Treatment

The treatment response action includes both in-situ and ex-situ treatment process options and could include physical, chemical, biological, solidification and/or thermal measures designed to reduce the toxicity, mobility, and/or volume of the contaminants present. Ex-situ treatment process options are used with removal and disposal process options to develop alternatives.

3.2.6 Disposal

Disposal technologies include placement of removed or treated materials in an onsite or an offsite permanent disposal facility. The disposal process options are used with removal options and possibly treatment options to develop alternatives. The toxicity, mobility, or volume of the contaminants is not reduced through the singular application of disposal. This response action will reduce or eliminate exposure pathways related to direct human contact with contaminated material and also includes discharge/release of untreated or treated groundwaters.

3.3 IDENTIFICATION AND PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

In this subsection a variety of technologies and process options are identified under each GRA (discussed in Section 3.2) and screened. The selection of technologies and process options for initial screening is based on the document "Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites" (U.S. EPA, 1991). The screening is first conducted at a preliminary level to focus on relevant technologies and process options. Then the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the technologies that have passed the detailed evaluation and screening.

In this subsection technologies and process options are identified and screened at a preliminary stage based on implementation with respect to site conditions and contaminants of concern. Section 3.3.1.1 provides preliminary screening of technologies and process options for groundwater while Section 3.3.1.2 provides preliminary screening of soil technologies and process options.

3.3.1. Preliminary Screening of Technologies and Process Options for Groundwater

Table 3-1 summarizes the preliminary screening of technologies and process options applicable to groundwater. It lists the general response actions, identifies the technologies and process options, and provides a brief description of each process option followed by the screening comments. All technologies and process options that are not eliminated will be evaluated in greater detail in Section 3.5.

3.3.2 Preliminary Screening of Technologies and Process Options for Soils

Table 3-2 summarizes the preliminary screening of technologies and process options applicable to soil and waste/fill material. It presents the general response actions, identifies the technologies and process options, and provides a brief description of each process option followed by the screening comments. All technologies and process options that are not eliminated will be evaluated in greater detail in Section 3.6.

3.4 EVALUATION CRITERIA

The evaluation criteria for detailed screening of technologies and process options that have been retained after the preliminary screening in Section 3.3 are effectiveness, implementability, and cost. The following are descriptions of the evaluation criteria:

- Effectiveness
  - Protection of human health and environment; reduction in toxicity, mobility, and volume; and permanence of solution.
  - Ability of the technology to address the estimated areas or volumes of contaminated medium.
  - Ability of the technology to meet the remediation goals identified in the remedial action objectives.

TABLE 3-1

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
GROUNDWATER REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Process Options	Description	Screening Comment
No Action	None	Not Applicable	No activities conducted at site to address contamination.	Required by NCP. Retain for baseline comparison to other technologies.
Institutional Controls	Monitoring	Monitoring	Periodic sampling and analysis of groundwater and other media to track the spread of contamination.	Retain to assess migration of contaminants from site and evaluate remedial actions.
	Access/Use Restrictions	Active Restrictions: Physical Barriers/ Security Guards	Fencing, markers, and warning signs to restrict site access.	Retain to limit human exposure to contaminated groundwater.
		Passive Restrictions: Deed and Land Use Restrictions	Administrative action used to restrict future site activities and use.	Retain to limit human exposure to contaminated groundwater.
Containment	Vertical Barriers	Slurry Wall	Low-permeability wall formed in a perimeter trench to restrict horizontal migration of groundwater.	Retain to reduce lateral movement of contaminated groundwater.
		Grout Curtain	Pressure injection of grout to form a low-permeability perimeter wall to restrict horizontal migration of groundwater.	Retain to reduce lateral movement of contaminated groundwater.

TABLE 3-1 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
GROUNDWATER REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Process Options	Description	Screening Comment
Containment (Continued)	Vertical Barriers (Continued)	Sheet Piling	Metal sheet piling driven into the ground to restrict horizontal migration of groundwater.	Retain to reduce lateral movement of contaminated groundwater.
		Hydraulic Barrier	Use of extraction wells and/or collection trenches to restrict horizontal migration of groundwater.	Retain to reduce lateral movement of contaminated groundwater.
	Horizontal Barriers	Physical Barrier	Injection of bottom sealing slurry beneath the landfill to minimize vertical migration of groundwater.	Eliminate because of effectiveness and implementability concerns in a landfill environment.
Removal	Groundwater Extraction	Extraction Wells	Series of conventional pumping wells used to remove contaminated groundwater.	Retain to remove contaminated groundwater.
		Collection Trench	A permeable trench used to intercept and collect groundwater.	Retain to remove contaminated groundwater.

TABLE 3-1 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
GROUNDWATER REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Process Options	Description	Screening Comment
In-situ Treatment	Biological	Aerobic	Enhancement of biodegradation of organics by addition of nutrients and control of the oxygen concentration.	Not applicable. Unproven effectiveness in the treatment of metals, monocyclic aromatics, and halogenated aliphatics which are the primary COCs found in site groundwater.
		Anaerobic	Enhancement of biodegradation of organics in an anaerobic (oxygen-deficient) environment.	Not Applicable. Unproven effectiveness in the treatment of metals, monocyclic aromatics, and halogenated aliphatics which are the primary COCs found in site groundwater.
	Physical/Biological	Air Sparging/ Soil Vapor Extraction	Volatilization and enhancement of biodegradation of organics by supply of air and extraction of volatile gases.	Retain for treatment of volatile organics.
	Natural Attenuation	Natural Attenuation	Use of natural processes that affect the rate of migration and the concentration of contaminants in groundwater.	Retain to treat contaminated groundwater.
Ex-situ Treatment	Physical	Solids Dewatering	Mechanical removal of free water from wastes using equipment such as a filter press or vacuum filter.	Retain for dewatering treatment plant sludges.
		Filtration	Separation of suspended solids from water via entrapment in a bed of granular media or membrane.	Retain for aiding in inorganics removal.

TABLE 3-1 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
GROUNDWATER REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Process Options	Description	Screening Comment
Ex-situ Treatment (Continued)	Physical (Continued)	Reverse Osmosis	Use of high pressure and membranes to separate dissolved materials from water.	Retain for removal of dissolved inorganics as a polishing stage treatment.
		Air Stripping	Contact of water with air to remove volatile organics.	Retain for removal of volatile organics.
		Adsorption	Separation of dissolved contaminants from water via adsorption onto activated carbon, resins, or activated alumina.	Retain for removal of a wide range of organics.
		Extraction	Separation of contaminants from a solution by contact with an immiscible liquid with a higher affinity for the contaminants of concern.	Eliminate extraction because it is not applicable at low concentrations of contaminants.
		Distillation	Vaporization of a liquid following by condensation of the vapors to concentrate various constituents.	Eliminate distillation because it is not applicable at low concentrations of contaminants.
		Sedimentation	Separation of solids from water via gravity settling.	Retain process for aiding in inorganics removal.
	Chemical	Ion Exchange	Process in which ions, held by electrostatic forces to charged functional groups on the resin surface, are exchanged for ions of similar charge in a water stream.	Retain process for removal of dissolved inorganics as a polishing stage treatment.

TABLE 3-1 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
GROUNDWATER REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Process Options	Description	Screening Comment
Ex-situ Treatment (Continued)	Chemical (Continued)	Oxidation	Use of oxidizers such as air, ozone, peroxide, chlorine, or permanganate, or use of high pressure/temperature to chemically increase the oxidation state of organic and inorganic compounds.	Retain process for removal of organic and inorganic contaminants.
		Reduction	Use of reducers such as sulfur dioxide, sulfite compounds, or ferrous iron compounds to decrease the oxidation state of organic and inorganic compounds.	Eliminate reduction because it is not applicable to contaminants of concern.
		Chemical Precipitation	Use of reagents to convert soluble constituents into insoluble constituents.	Retain process for removal of inorganics.
		Coagulation/ Flocculation	Use of chemicals to neutralize surface charges and promote attraction of colloidal particles to facilitate settling.	Retain process for removal of suspended solids and inorganics.
		Neutralization/pH Adjustment	Use of acids or bases to counteract excess pHs.	Retain process for possible pretreatment step or a final processing step.
	Biological	Aerobic	Natural degradation of organic contaminants via microorganisms in an aerobic (oxygen) environment.	Not applicable. Unproven effectiveness in the treatment of halogenated organics.
		Anaerobic	Natural degradation of organic contaminants via microorganisms in an anaerobic (oxygen-deficient) environment.	Not applicable. Unproven effectiveness in the treatment of halogenated organics.

TABLE 3-1 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
GROUNDWATER REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Process Options	Description	Screening Comment
Discharge/ Disposal	Surface Discharge	Direct Discharge (NPDES)	Discharge of collected/treated water to Slocum Creek.	Retain for discharge of treated groundwater.
		Indirect Discharge (IWTP/STP)	Discharge of collected/treated water to Industrial Waste Treatment Plant (IWTP) or Sewage Treatment Plant (STP).	Retain for discharge of treated groundwater.
		Offsite Treatment Facility	Treatment and disposal of water at a privately owned treatment works.	Eliminate because expected volumes of water are too large for offsite transport/ treatment.
	Subsurface Discharge	Reinjection	Use of injection wells, spray irrigation, or infiltration to discharge collected/treated groundwater underground.	Eliminate reinjection because groundwater is too shallow for effective discharge.

TABLE 3-2

PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
WASTES/FILL/CONTAMINATED SOIL REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
No Action	None	Not applicable	No activities conducted at the site to address contamination.	Required by NCP. Retain for baseline comparison to other technologies.
Institutional Controls	Access/Use Restrictions/ OSHA Requirements	Active Restrictions: Physical Barriers/ Security Guards	Fencing, markers, warning signs, and monitoring to restrict site access.	Retain to preclude direct human exposure to contaminated media.
		Passive Restrictions: Deed or Land Use Restrictions	Administrative action using property deeds or other land use prohibitions to restrict future site activities.	Retain to preclude direct human exposure to contaminated media.
	Monitoring	Groundwater/surface water/sediment sampling	Sampling and analysis of groundwater, surface water, sediment, etc., to study the migration of contaminants in the environment.	Retain monitoring to assess migration of contaminants from site.
Containment	Capping	Soil/multimedia	Use of semipermeable or impermeable barriers to minimize horizontal/vertical migration of contaminants.	Retain. Barriers may be used to minimize access to contaminated material, and vegetative cover may be maintained/enhanced to minimize disruptive effects of remediation.
	Erosion control	Rip-rap cover/vegetation	Use of gravel/cobbles or dense plant growth to minimize migration of wastes/contaminated soils.	

TABLE 3-2 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
WASTES/FILL/CONTAMINATED SOIL REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
Removal	Bulk excavation	Excavation	Means for removal of wastes/contaminated soils/ buried material/ contaminated sediments, etc.	Retain excavation as a potentially effective technology for removal of contaminated soils/wastes.
In-situ Treatment	Thermal	Vitrification/ Radiofrequency Heating	Use of high-temperature melting to fuse inorganic contaminants into a glass matrix within vadose zone or the use of moderate temperature heating to volatilize contaminants and remove them from the vadose zone.	Eliminate thermal technologies because of the ineffectiveness and implementability concerns in the vadose zone under shallow groundwater conditions. Not proven effective with heterogeneous subsurface material (e.g., garbage).
	Physical/Chemical	Soil Flushing	Use of water/solvents to remove contaminants from the vadose zone by flushing and collecting the contaminated wastewater in the saturated zone followed by above-ground pump/treat.	Eliminate soil flushing because its applicability under heterogeneous site material conditions is questionable.
		Soil Vapor Extraction	Use of vacuum and possibly air sparging to volatilize contaminants.	Retain for use in treating soil "hot spot" areas that contain mainly volatile organic contaminants.

TABLE 3-2 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
WASTES/FILL/CONTAMINATED SOIL REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
In-Situ Treatment (Continued)	Physical/Chemical (Continued)	Chemical Fixation/ Solidification	Mixing of pozzolanic agents in the vadose zone to chemically fix inorganics and solidify the matrix.	Eliminate because of heterogeneous nature of landfill contents. Effectiveness may also be questionable for soil "hot spots".
Ex-situ Treatment	Physical/Chemical	Soil Washing/Solvent Extraction	Use of solubilization and chemical (oxidation/ reduction/neutralization) processes to remove contaminants from the solid phase and convert them into more concentrated forms or less toxic forms in liquid phase.	Retain for treating "hot spots" with exclusively inorganic or organic contaminants.
		Chemical Fixation/ Solidification	Use of chemicals and pozzolans (cementitious solidifying agents) to reduce the mobility of contaminants and create solid, impenetrable blocks from wastes/contaminated soil.	Retain as a potentially effective technology to make the wastes/ contaminated soils less likely to enter the human exposure pathways.
		Microencapsulation/ Macroencapsulation	Use of thermoplastic polymers to entrap contaminated particles or envelop entire waste forms.	Eliminate. Typically applicable to highly contaminated, very mobile wastes that are not amenable to chemical fixation/solidification.

TABLE 3-2 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
WASTES/FILL/CONTAMINATED SOIL REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
Ex-Situ Treatment (Continued)	Biological	Landfarming	Tilling of contaminated soils and wastes in layers of surface soil to aerate and biodegrade organic contaminants.	Eliminate biological treatment because it is not applicable to metals and chlorinated alkanes and alkenes, which are the primary contaminants of concern found in soil at the site.
		Bioslurry Treatment	Treatment of soils in a slurry reactor under controlled conditions using natural or cultured microorganisms to biodegrade organic contaminants.	Eliminate for the same reason as above.
	Thermal	Incineration	Use of high temperatures to pyrolize or oxidize organic contaminants into less toxic gases.	Retain to treat "hot spots" containing mainly organics. Additional treatment may be required for metals.
		Low-Temperature Thermal Description	Use of low to moderate temperatures to volatilize contaminants and remove them from the solid phase into the gaseous phase.	

TABLE 3-2 (Continued)
PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
WASTES/FILL/CONTAMINATED SOIL REMEDIATION
OPERABLE UNIT 2
MCAS, CHERRY POINT, NORTH CAROLINA

General Response Action	Remedial Technology	Process Option	Description	Screening Comment
Ex-Situ Treatment (Continued)	Solids Processing	Crushing/Grinding	Size reduction of wastes as a preliminary process to aid in downstream treatment.	Retain solids processing because contaminated material is heterogeneous and preliminary treatment might be required prior to treatment for removal of contaminants of concern.
		Screening	Removal/segregation of material based on size as a preliminary process to aid in downstream treatment.	
		Magnetic Separation	Removal of ferromagnetic material to aid in downstream treatment.	
Disposal	Landfill (onsite/offsite)	Hazardous/ nonhazardous waste landfill	Disposal of excavated wastes and treatment residuals in a permitted TSDF.	Retain offsite landfilling as a potentially effective option for contaminated soil. Not practical for large volume of buried wastes. Eliminate onsite landfilling because of unavailability of appropriate land.
		Consolidation	Excavation and deposition in one location to minimize space and closure requirements.	Retain for contaminated soil.

- Technical reliability (innovative versus well-proven) with respect to contaminants and site conditions.

- Implementability
  - Overall technical feasibility at the site.
  - Availability of vendors, mobile units, storage and disposal services, etc.
  - Administrative feasibility.
  - Special long-term maintenance and operation requirements.

- Cost (Qualitative)
  - Capital cost.
  - Operation and maintenance (O&M) costs.

All of the items listed above may not apply directly to each technology and, therefore, will be addressed only as appropriate. Screening evaluations at this stage generally focus on effectiveness and implementability, with less emphasis on cost evaluations. Technologies whose use would be precluded by waste characteristics and inapplicability under the given site conditions are screened and eliminated from further consideration. At this stage, no technologies will be eliminated based on cost. A process option within a technology category, however, may not be carried through if an equally effective process option under that technology is available at a lower cost. Each technology presented in this section is not necessarily intended to be implemented alone, as it may be combined with other technologies into remedial action alternatives.

3.5 FINAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

The final screening of technologies and process options is based on the evaluation criteria described in Section 3.4. The following are the groundwater technologies and process options remaining for final screening:

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls	Monitoring	Groundwater/Surface Water/Sediment Sampling
	Access/Use Restrictions	Active: Physical Barriers/Security Guards
		Passive: Deed or Land Use Restrictions
Containment	Vertical Barriers	Slurry Wall
		Grout Curtain
		Sheet Piling
		Hydraulic Barrier
Removal	Groundwater Extraction	Extraction Wells
		Collection Trench
In-Situ Treatment	Physical/Biological	Air Sparging/Soil Vapor Extraction
	Natural Attenuation	Natural Attenuation
Ex-Situ Treatment	Physical	Sedimentation
		Filtration
		Reverse Osmosis
		Air Stripping
		Adsorption
		Solids Dewatering
	Chemical	Ion Exchange
		Neutralization/pH Adjustment
		Coagulation/Flocculation
		Chemical Precipitation
		Oxidation
Disposal	Discharge	Direct Discharge (NPDES)
		Indirect Discharge (IWTP/STP)

3.5.1 No Action

No action consists of no remedial action at the site and is typically considered in an FS to serve as a baseline comparison or to address sites that do not require any active remediation to meet remedial action objectives.

Effectiveness

No action would not achieve RAOs for groundwater; however, the degree of contamination would continue to decrease through natural attenuation. No action would not reduce the migration of groundwater contaminants into the surrounding environment.

Implementability

No action would be readily implementable. Since no action would be implemented, potential constraints, such as the need for permits, TSDF availability, and equipment and resources availability, are not concerns. There would be no additional risks to human health and the environment.

Cost

There are no costs associated with no action.

Conclusion

The no action option will be retained throughout the screening process as required by the NCP to provide a baseline comparison.

3.5.2 Institutional Controls

Institutional controls consist of activities designed to minimize potential risks to human health by prohibiting or controlling access to contaminated groundwater and monitoring to assess migration of contaminants. Institutional controls include controls already in place at MCAS Cherry Point via the Air Station's Base Master Plan to restrict surficial aquifer groundwater usage at the Air Station. Groundwater monitoring is used to identify contaminant migration and identify the need for future action, if necessary. Monitoring consists of periodic sampling and analysis of groundwater, surface water, and sediment to evaluate the spread and changes in contaminant concentration.

Effectiveness

As there is no removal or treatment of contaminated groundwater associated with this action, institutional controls would not meet all RAOs. Institutional controls would not be effective in preventing the spread of contaminants into uncontaminated or less contaminated areas; however, access/use restrictions could eliminate potential human health risks associated with ingestion of contaminated groundwater. Monitoring would not provide any additional protection of the environment, since contaminants could spread into uncontaminated or lesser contaminated areas. However, monitoring could identify a trend in contaminant levels at a site and determine whether contaminants are migrating off site. Periodic monitoring could also be used to assess the effectiveness of remedial action and natural attenuation processes.

Implementability

Access/use restrictions may be implementable because the Air Station can restrict land uses and access to groundwater at OU2 while MCAS Cherry Point is an active facility. A monitoring program can be conducted without any major implementability concerns.

Cost

Capital and O&M costs for both access/use restrictions and monitoring are low.

Conclusion

Retain the use of institutional controls to enforce access/use controls and implement monitoring as necessary.

3.5.3 Containment

Containment of groundwater can be performed using hydraulic controls, such as extraction wells and collection trenches, or passive controls, such as vertical barriers. Extraction wells, collection trenches, and vertical barriers can be used to contain a contaminant plume by restricting lateral migration of the groundwater. Passive barriers are evaluated in this section, whereas hydraulic barrier technologies are discussed in Section 3.5.4.

Vertical barriers consist of sheet piles, slurry walls, grout curtains, etc., that are used to minimize the horizontal migration of contaminants especially within the saturated zone. These barriers are placed around the wastes or contaminated areas vertically into the subsurface extending from the level of the top of the wastes to at least the bottom depth of the wastes and, very commonly, to the confining layer of the aquifer. The selection of the type of barrier depends on site-specific conditions, including compatibility of the barrier with the subsurface contaminants.

Effectiveness

The use of vertical barriers may be considered if horizontal migration of contaminants from groundwater into the adjoining surface waters is expected to be of concern. Slurry walls may be more effective in controlling contaminant migration in coarse, sandy soils than sheet piling and grout curtains and are more commonly used (U.S. EPA, 1985).

Implementability

The use of vertical subsurface barriers must take into consideration the control of the water-table levels within the contained area wherein accumulation of rainfall would occur. Moreover, the maintenance of the integrity of vertical subsurface barriers is difficult over the long term.

Cost

Costs of vertical barriers are moderate for slurry walls and sheet pilings but high for grout curtains.

Conclusion

Eliminate vertical barriers from further consideration because of implementability concerns.

3.5.4 Removal

Remediation of groundwater may be achieved by removal of contaminated groundwater from the aquifer. The two removal technologies evaluated in this section are extraction wells and collection trenches.

3.5.4.1 Extraction Wells

Groundwater pumping techniques involve the active manipulation and management of groundwater to contain or remove a plume or to adjust groundwater levels to prevent formation of a plume. The selection of the appropriate well system depends upon the depth of contamination and the hydrologic and geologic characteristics of the aquifer. Well systems are very versatile and can be used to contain, remove, divert, or prevent development of plumes under a variety of site conditions. Extraction of the groundwater can also be used as a technique to lower the water-table level so that contaminated, saturated soil may be excavated.

Effectiveness

Groundwater pumping systems are the most versatile and flexible of the groundwater control technologies. They can be used to contain, remove, or divert the groundwater under a wide variety of geologic and hydrogeologic conditions. Pumping, by itself, does not reduce the toxicity of contaminants. Extraction of contaminated groundwater through appropriately located wells would reduce the concentration of contaminants in the subsurface. Extracted groundwater would then require treatment and/or disposal.

Implementability

Installation of a groundwater pumping system is feasible. Contractors qualified to drill and install wells are readily available. Pumps, casing, and screens must be maintained to ensure a constant, reliable flow of water from the well. Proper well maintenance is especially important in plume management because the loss of a well could result in contaminant escape. The causes of well yield loss and failure are typically encrustation, corrosion, and pump failure, the latter of which is typically caused by sand intrusion, wear on mechanical parts, or electrical failure.

Cost

Costs of well systems for plume management can vary greatly from site to site, depending on site geology, characteristics of the groundwater and contaminants, extent of contamination, and periods and duration of pumping. Typically, capital and O&M costs are moderate.

Conclusion

Extraction wells will be retained for further evaluation.

3.5.4.2 Collection Trench

Collection trenches are used to convey and collect aqueous discharges by gravity flow. They essentially function like a continuous line of extraction wells. Collection trenches create a continuous zone of influence in which groundwater within this zone flows toward the collection points. However, trenches cannot create as steep a hydraulic gradient as do extraction wells, and consequently, are less effective at depressing the water table. Since collection trenches function like a line of extraction wells, they can perform many of the same functions as wells. They can be used to contain or remove the groundwater or to prevent contact of water with the waste material. They offer the advantage of collection of contaminated water in situations where the groundwater recharge rate is insufficient to sustain extraction well pumping. Further, they can also be used in circumferential configurations where the infiltration from upgradient groundwater is captured while the enclosed saturated zone is simultaneously dewatered.

A collection trench is formed by excavating a ditch a few feet wide. A backhoe or clam shell is common equipment used for the excavation. The ditch is excavated to a depth where an impermeable base is encountered. This excavated trench is then backfilled with permeable material, such as gravel or crushed rock. Collection pipes and pumps are then placed in the trench to allow for water removal.

Effectiveness

The use of collection trenches is limited by depth considerations. Collection trenches are used for relatively shallow aquifers. They are most effective for aquifers that have low hydraulic conductivities and shallow gradients, such as the surficial aquifer at OU2. Limitations include the presence of viscous or reactive chemicals that could clog drains and envelope material. Conditions which favor the formation of iron, manganese, or calcium carbonate deposits may also limit the use of trenches. Although these limitations are also applicable to extraction wells, the adverse effects are more pronounced for collection trenches.

Implementability

Collection trenches are readily implementable for shallow groundwater, and equipment and resources are readily available. Collection trenches would be difficult to implement at OU2 because of the proximity of both Slocum Creek and Turkey Gut and the presence of a shallow water table.

Cost

Costs depend primarily on the depth of excavation, stability of soils, and groundwater flow rates. Capital costs are generally high and O&M costs low.

Conclusion

Collection trench will be removed from further consideration. The presence of a shallow water table at OU2, the high iron concentrations in the groundwater, and the fact that the surficial aquifer has sufficient groundwater recharge rate to sustain a series of extraction wells makes extraction wells the more attractive process option.

3.5.5 In-situ Treatment

In-situ treatment process options retained from the initial screening are air sparging/soil vapor extraction (AS/SVE) and natural attenuation, which are evaluated below.

3.5.5.1 Air Sparging/Soil Vapor Extraction

Air sparging consists of volatilization of VOCs in the groundwater by injecting clean air. Vapor extraction consists of the removal of the volatilized contaminants from the vadose zone. This technology uses wells screened within or below the contaminant plume to inject air from above-ground blowers. It also uses wells screened within the vadose zone to capture and extract the VOCs using above-ground vacuum pumps. The VOCs in the vapor are treated in above-ground off-gas treatment units. Typically, this technology is used for the remediation of petroleum-contaminated soil and groundwater where the air sparging serves the dual purpose of volatilizing the VOCs and supplying adequate oxygen for biodegradation of other organics. At site where chlorinated alkanes and alkenes are present, the remediation is almost entirely dependent on volatilization and vapor extraction.

Effectiveness

AS/SVE is a relatively novel technology in the remediation field. However, its effectiveness in rapidly removing VOCs has been demonstrated at a number of sites. Since it is an in-situ process, a good understanding of the geological and hydrogeological nature of the site is essential. One of the main factors is the permeability of the subsurface to air flow, which must be determined by pilot-scale tests. The results of the pilot-scale study would help determine the number, location, spacing, depths and sizes of screens, air flow rates, and pressures for the full-scale system. Normally, if biodegradation of semivolatile organics is expected to be a significant process, additional studies would be required to determine whether the indigenous microorganisms are viable. AS/SVE is generally not effective for non-volatile or non-biodegradable organics or for metals.

Implementability

AS/SVE would be readily implementable. Equipment and resources are readily available. If an adsorption media (e.g., activated carbon) is used for off-gas treatment, onsite or offsite regeneration or disposal of the used media must be provided.

Cost

The capital and O&M costs for AS/SVE are low to medium.

Conclusion

AS/SVE will be retained for removal of volatile and other potentially biodegradable organic compounds.

3.5.5.2 Natural Attenuation

Natural attenuation (or intrinsic remediation) refers to inherent processes that affect the rate of migration and the concentration of contaminants in groundwater. The most important processes are biodegradation, advection, hydrodynamic dispersion, dilution from recharge, sorption, and volatilization.

Effectiveness

Natural attenuation is effective if the rate of biodegradation, aided by sorption, is rapid enough to prevent significant contaminant migration by advection and dispersion. The strategy for documenting the occurrence of natural attenuation is based on documented loss of contaminants and one or more pieces of evidence showing that biodegradation reactions are actually occurring in the field. Monitoring is a key component in confirming effectiveness.

Implementability

Natural attenuation would be readily implementable. A monitoring program can be conducted without any major implementability concerns.

Cost

Capital and O&M costs for natural attenuation are low.

Conclusion

Retain natural attenuation with confirmation monitoring for further consideration.

3.5.6 Ex-Situ Treatment

The following ex-situ treatment technologies and process options for contaminated groundwater are evaluated in this section.

- Sedimentation
- Filtration
- Air Stripping
- Adsorption
- Dewatering
- Ion Exchange
- Chemical Precipitation
- Enhanced Oxidation

3.5.6.1 Sedimentation

Sedimentation is a method by which suspended solids are removed from an aqueous waste stream by gravity settling. Water containing suspended solids is retained temporarily under quiescent conditions in a specially designed tank (e.g., clarifier or separator) to allow the solids to settle to the bottom while relatively clear water is allowed to overflow out of the tank to the next treatment process.

Sedimentation provides a reliable means of removing suspended matter that is heavier than water provided the suspended matter is settleable and the treatment process (including the use of flocculants/coagulants) has been appropriately designed from laboratory settling tests.

Sedimentation is commonly applied to aqueous wastes with high suspended solids loadings and is often required as a pretreatment step for many chemical processes, including carbon adsorption, ion exchange, air stripping, reverse osmosis, and filtration. Sedimentation is also required as a post-treatment step after such processes as chemical precipitation and chemical oxidation. The process can be applied to almost any liquid waste stream containing suspended solids. Sedimentation is used at the IWTP and STP at the Air Station.

Effectiveness

Sedimentation is effective for the treatment of water with high suspended solids content that would otherwise interfere with subsequent treatment operations. Sedimentation would not in itself achieve RAOs, since it typically does not reduce concentrations of contaminants dissolved in the water. Sedimentation is a proven technology for preliminary treatment and is typically required for removal of insoluble inorganic contaminants.

Implementability

Sedimentation is readily implementable. Equipment and resources are readily available, and the process can be easily integrated into more complex treatment systems. Generated sludge must be disposed. The use of sedimentation at the IWTP or STP would be readily implementable provided that the hydraulic capacity is not exceeded.

Cost

Capital and O&M costs of sedimentation are moderate.

Conclusion

Sedimentation will be retained for further consideration as part of groundwater treatment alternatives for the removal of suspended contaminants.

3.5.6.2 Filtration

Filtration is used to separate suspended solids from water by passing it through a filter bed composed of granular material (e.g., sand, gravel, anthracite coal) or through a semipermeable membrane. Typical filtration equipment consists of deep-bed pressure sand filters/multi-media filters, which are applicable to the removal of suspended solids of varying particle sizes. Other types of equipment include bag/cartridge filters that are applicable to low flow/low solids streams containing a narrow range of particle sizes. The removal of solids depends upon the porosity or permeability of the filter media, the filtration rate, and the physical/chemical characteristics of the influent.

Filtration is commonly applied to aqueous wastes with significant suspended solids loadings (no more than 100 mg/L) and is often required as a pretreatment step for many chemical treatment processes, including carbon adsorption, ion exchange, and air stripping. The process can be applied to almost any liquid waste stream containing suspended solids.

During the filtration cycle, solid material accumulates within the void spaces of the filter media. When the holding capacity of the filter media is approached, indicated by either a "breakthrough" of turbidity or suspended solids, or by an excessive back pressure or head loss rise, the unit is backwashed where the filtration cycle is reversed. Backwashing consists of pumping clean water through the filter at a relatively high rate in the reverse direction from the filtering mode to physically agitate the media and dislodge the accumulated solids. The effluent from the backwash operation is recycled or discharged to an additional treatment device for solids removal. The separated solids (sludge) must subsequently be disposed of. The IWTP at MCAS Cherry Point uses a deep-bed pressure filter. The STP at the Air Station uses a rapid sand filter.

Effectiveness

Filtration is a well-proven, reliable technology. Depending upon the nature of the influent, sand filtration can typically result in an effluent suspended solids concentration of about 1 to 10 mg/L, and ultrafiltration typically provides effluents with less than 1 mg/L suspended solids. This process would not in itself achieve RAOs since it typically does not reduce concentrations of dissolved contaminants in the groundwater. Sand filtration and/or ultrafiltration would remove suspended metals and organic contaminants that are bound to suspended solid materials but would not remove dissolved contaminants. Filtration could be used as a pretreatment step for suspended solids control.

Implementability

Filtration can be readily implemented. Equipment and resources are readily available, and the sand filtration process can be easily integrated into more complex treatment systems. High suspended solids concentrations in the backwash water must be further concentrated prior to final disposal.

Cost

Capital costs for filtration are moderate, and O&M costs are low.

Conclusion

Filtration will be retained for further consideration in the development of groundwater treatment alternatives for the removal of suspended contaminants and as a pretreatment step for certain primary treatment processes.

3.5.6.3 Reverse Osmosis

Osmosis is the spontaneous flow of solvent (e.g., water) from a dilute solution through a semipermeable membrane to a more concentrated solution containing impurities or solute, which permeate at a much slower rate. Reverse osmosis is the application of sufficient pressure to the concentrated solution to overcome the osmotic pressure and force the net flow of water through the membrane toward the dilute phase. This allows the concentration of solute (impurities) to be built up in a circulating system on one side of the membrane, while relatively pure water is transported through the membrane.

The basic components of a reverse osmosis unit are the membrane, a membrane support structure, a containing vessel, and a high-pressure pump. The membrane and membrane support structure are the most critical elements.

Effectiveness

Reverse osmosis is an effective treatment technology for removal of dissolved solids. Appropriate pretreatment would need to be performed for removal of suspended solids, oxidizers, oil, and grease. Adjustment of pH may also be needed.

For the treatment of contaminated groundwater, use of reverse osmosis is primarily limited to polishing (i.e., further reducing contaminant concentration as in a tertiary treatment) of relatively low-flow streams containing highly toxic contaminants. In general, good removal can be expected for high molecular weight organics and ionized constituents, such as dissolved metallic salts. Multi-valent ions are treated more effectively than uni-valent ions. Reverse osmosis is more effective for the general removal of dissolved solids typically contained in groundwater (e.g., calcium and sodium bicarbonates and other salts) than for the selective removal of low concentrations of specific contaminants. It is generally uses to produce high purity water.

Implementability

Reverse osmosis membranes are subject to chemical attack, fouling, and plugging. Pretreatment requirements can be extensive. Contaminated water must be pretreated to remove oxidizing materials, such as chlorine, to remove fouling agents, such as iron and manganese salts, to filter out suspended particulates, and adjust the pH to a range of 4.0 to 7.5. The growth of slime/biomass on the membrane surface or the presence of organic macromolecules may also foul the membrane. This organic fouling can be minimized by prechlorination followed by dechlorination, addition of biocides, and/or pretreatment with activated carbon.

The volume of the reject, which contains the removed contaminants, generated by reverse osmosis is approximately 10 to 25 percent of the feed volume. Provisions must be made to treat or dispose of this waste.

Cost

Capital and operating costs are high.

Conclusion

Eliminate reverse osmosis from further consideration. Other technologies, such as precipitation and suspended solids removal, can meet adequate discharge standards if necessary, at lower costs.

3.5.6.4 Air Stripping/Volatilization

Air stripping is a mass transfer process in which volatile contaminants in water are transferred to a gas (e.g., the atmosphere). It is commonly used to remove volatile organics from aqueous waste streams. Contaminants with Henry's law constants of greater than 3×10^{-3} atm-m^3 per mole can be effectively removed by air stripping. These include such contaminants as benzene, chlorobenzene, vinyl chloride, DCE, TCE, and other volatile compounds. The feed stream must be low in suspended solids. pH adjustment may be required to reduce the solubility and enhance the transfer to the gas phase of such compounds as hydrogen sulfide, phenol, ammonia, and other organic acids or bases. The off-gas stream generated during treatment may require collection and subsequent treatment.

Air stripping can be accomplished in a counter current or cross-flow packed tower, a coke tray aerator, or by diffused aeration. Most air stripping packed towers operate on the principle of countercurrent flow. The water stream flows down through the packing while the air flows upward and is exhausted through the top. Volatile components have an affinity for the gas phase and tend to transfer from the aqueous stream and into the gas phase. In a cross-flow packed tower, water flows down through the packing, as in the countercurrent packed column, but the air is pulled across the water flow path by a fan. The coke tray aerator is a simple, low-maintenance process requiring no blower. The water is allowed to trickle through several layers of trays. This produces a large surface area for gas transfer. Diffused aeration stripping and induced draft stripping use aeration basins similar to standard wastewater treatment aeration basins. Water flows through the basin from top to bottom or from one side to another while air is dispersed through diffusers at the bottom of the basin. The air-to-water ratio is significantly lower than in either the packed column or the cross-flow tower.

Air stripping issued at the MCAS Cherry Point IWTP and STP. The IWTP uses a packed tower air stripper. The STP achieves air stripping indirectly through aeration during biological treatment.

Effectiveness

Air stripping is a well-proven, reliable technology for the removal of volatile organics. Air stripping would be effective for removing the primary organic contaminants at OU2 from groundwater. Theoretically, removal efficiencies greater than 99 percent could be achieved for vinyl chloride, DCE, and TCE. Air stripping would not be effective in removing any semivolatile, pesticide, or metal contaminants. Since air stripping only removes the contaminants from the water and transfers them to an off-gas, the off-gas may have to be subsequently treated by other means depending on contaminant concentrations, air flow rates, and applicable discharge standards. Types of off-gas treatment include thermal oxidation, catalytic oxidation, non-regenerable carbon adsorption, steam regenerable carbon adsorption, and a combination of carbon adsorption and thermal oxidation. The choice of the type of off-gas treatment is primarily a matter of economics and is dependent on the air volume as well as type and concentration of contaminants.

Implementability

Air stripping would be readily implementable at the site. A sufficient number of vendors provide air stripping technology. If an activated carbon technology is chosen for off-gas treatment, offsite disposal/regeneration or onsite regeneration must be provided. One maintenance consideration for air stripping is channeling of the flow resulting from clogging of the packing material. Common causes of clogging include suspended solids, oxidized manganese, and oxidized iron. Pretreatment is typically required for metal removal and suspended solids control.

Cost

Capital costs for air stripping are moderate, and O&M costs are low to moderate, depending on the need for off-gas treatment.

Conclusion

Air stripping will be retained for further consideration in groundwater treatment alternatives for the removal of volatile organic contaminants.

3.5.6.5 Adsorption

The most common adsorption process for groundwater treatment is activated carbon adsorption. Activated carbon adsorption is the process by which a waste stream flows through one or more activated carbon, packed bed reactors. Selected contaminants are attracted to the internal pores of the activated carbon and adsorbed. This process is effective for removing many organic compounds to some extent, but it is most effective for the less soluble and more polar compounds.

Regeneration of spent carbon must be performed for each reactor at the conclusion of its bed-life. The regeneration is intended to restore the activated carbon to nearly its original capacity for reuse. If the carbon cannot be regenerated, it must be disposed of. The IWTP at MCAS Cherry Point uses activated carbon adsorption.

Effectiveness

Liquid-phase activated carbon adsorption is a well-proven, reliable technology that would be effective for removing many organic contaminants. However, this technology would not remove several chlorinated VOCs, in particular, vinyl chloride. This technology also has limited effectiveness for BTEX and would not remove metals, at least not effectively and dependably. It would be effective for removing semivolatile and pesticide contaminants, in addition to most of the primary volatile organic contaminants from the groundwater at OU2. Removal efficiencies greater than 99 percent could be achieved for some of the contaminants. The low organic contaminant concentrations in the groundwater at OU2 provide an ideal application for carbon adsorption and result in a relatively low carbon consumption. Since activated carbon only concentrates the contaminants, the spent carbon would have to be subsequently disposed of in a hazardous waste facility (landfill or incinerator) or regenerated.

Implementability

Liquid-phase carbon adsorption would be readily implementable. There are a sufficient number of vendors that provide carbon adsorption technology. Implementation factors include planning for disposal or regeneration (onsite or offsite) of the exhausted carbon. Thermal treatment is the most common type of regeneration technology. Steam and solvent injections can be used but are not very common. Pretreatment (i.e., filtration) would be required prior to the adsorption process to prevent clogging and high pressure drops in the adsorbers.

Cost

Capital costs for activated carbon adsorption are moderate. Because of relatively low organic contaminant concentrations in the groundwater at OU2, it is anticipated that O&M costs will also be moderate.

Conclusion

Carbon adsorption will be retained for further consideration in the development of groundwater treatment alternatives for the removal of organic contaminants.

3.5.6.6 Solids Dewatering

Solids dewatering is considered as a secondary component of a groundwater treatment alternative. Some pretreatment and treatment technologies may generate a sludge or residue, which would require dewatering prior to disposal. Dewatering is typically required to reduce the volume of waste solids to facilitate handling, transportation, and disposal. Further, dewatering would be required to remove free liquids prior to offsite disposal of waste sludges or residues. Typically plate-and-frame filter presses, belt filter presses, etc., may be used to dewater sludges.

Effectiveness

Solids dewatering is a reliable and widely used technology to reduce the moisture content of soils, sediments, sludges, and residues. Dewatering by itself would not achieve the RAOs but is considered for inclusion as a component of any groundwater remedial alternative where sludge is generated. The use of filter presses or belt filter presses is proven to be effective for dewatering sludges.

Implementability

Solids dewatering is readily implementable. Equipment and resources are readily available from a wide variety of vendors. If dewatering is conducted on site, no permits are required, and TSD availability is typically not a concern. Dewatering is not expected to adversely affect human health or the environment. Water removed during dewatering would need to be treated and/or disposed.

Cost

Both capital and O&M costs for dewatering are moderate.

Conclusion

Dewatering will be retained for further consideration as a secondary treatment step in the formulation of groundwater treatment alternatives.

3.5.6.7 Ion Exchange

Ion exchange is a process whereby the contaminant ions are removed from the groundwater by exchange with relatively harmless ions [generally hydrogen (H^+), hydroxyl (OH^-), sodium (Na^+), or chloride (Cl^-)] held by the ion exchange material. Ion exchange resins are synthetic organic, bead-like materials containing ionic functional groups to which exchangeable ions are attached. These synthetic resins are structurally stable (i.e., can tolerate a wide range of temperature and pH conditions), exhibit a high exchange capacity, and can be tailored to show selectivity toward specific ions. Ion exchangers with negatively charged sites are named cation exchangers because they take up positively charged ions. Anion exchangers have positively charged sites, and consequently, take up negatively charge ions. The exchange reaction is reversible and concentration dependent, and the resin can be regenerated for multiple reuse.

Effectiveness

Ion exchange is a well-established technology for removal of heavy metals and other anionic contaminants from dilute solutions. However, the effective operation of ion exchange is markedly affected by the presence of suspended solids, organics, and oxidants. Suspended solids should be less than 25 mg/L to prevent plugging of the resin bed, and waste streams must be free of strong oxidants, such as chlorine, that may chemically degrade the resin matrix. Additionally, organic concentrations should be relatively low to avoid irreversible blockage of the active sites within the resins. High concentrations of total dissolved solids (TDS) would reduce the effectiveness of this technology because of the nonselective nature of the removal of metal ions by normal ion exchange resins. Typically, ion exchange is most effective for removal of one or two metals to achieve low concentrations in the dissolved state.

Implementability

Ion exchange systems are commercially available from a number of vendors. The spent regenerant solution may have to be disposed of as a hazardous waste. Monitoring of the effluent is important to detect contaminant breakthrough when the bed is exhausted.

Cost

Capital costs of ion exchange, including the initial resin, are high. O&M costs can be high to very high.

Conclusion

Eliminate ion exchange from further consideration because other technologies, such as chemical precipitation and suspended solids removal, can meet adequate discharge standards at a lower cost.

3.5.6.8 Coagulation/Flocculation

Coagulation/flocculation is the process by which small, unsettleable particles suspended in a liquid medium are made to agglomerate into larger, more settleable particles. The mechanisms by which coagulation/flocculation occur involve surface chemistry and particle charge phenomena.

Coagulation/flocculation is applicable to any aqueous waste stream where fine suspended solid particles must be agglomerated into larger, more settleable particles prior to sedimentation or other types of treatment. The type and quantity of reagent to be added for coagulation/flocculation is best determined using laboratory tests and must be adjusted for compositional changes of the water being treated, or poor performance will result. Coagulation/flocculation is used at the Air Station IWTP through the addition of chemical agents. Coagulation/flocculation at the Air Station STP is achieved as part of the biological sludge formation in the activated sludge nitrification process that follows the trickling filter process.

Effectiveness

Coagulation/flocculation is an effective means of enhancing removal of suspended particles from groundwater prior to sedimentation or other types of treatment. When combined with solids removal, it can used to prevent clogging or scaling of downstream process equipment.

Implementability

Coagulation/flocculation is a well-established technology, and the operating parameters are well defined. Equipment is readily available and easy to operate. While the chemicals typically employed as coagulation/flocculation agents, such as alum, polyelectrolyte, etc., are often skin irritants, they can be easily handled in a safe manner as long as appropriate precautions are taken.

Cost

Capital costs of coagulation/flocculation are low, and O&M costs are moderate.

Conclusion

Coagulation/flocculation will be retained for further consideration as part of groundwater treatment.

3.5.6.9 Chemical Precipitation

Precipitation is a physical/chemical process where some or all of a substance in solution is transformed to an insoluble form. It is based on alteration of the chemical equilibrium relationships affecting the solubility of inorganic species. The insoluble particles are separated from the liquid phase by sedimentation and/or other physical processes, such as filtration.

Precipitation is useful for treatment of most aqueous waste streams. However, limitations may be imposed by certain physical or chemical characteristics. In some cases, organic compounds may form organometallic complexes with metals, which could inhibit precipitation. Cyanide and other ions in the wastewater may also complex with metals, making treatment by precipitation less efficient.

Precipitation is useful for the removal of most metals from wastewater. Also, certain anionic species, such as phosphate, sulfate, and fluoride can be removed by precipitation. Precipitation is not completely selective in that some compounds other than those targeted may be removed.

Addition of the appropriate type and quantity of reagent for chemical precipitation must be determined using laboratory tests and must be adjusted for compositional changes of the waste being treated to ensure optimum performance. The IWTP at MCAS Cherry Point uses chemical precipitation for the removal of heavy metals. The Air Station STP can also achieve some removal of dissolved metals through bisorption and removal of particulate metals through suspended solids removal.

Effectiveness

Chemical precipitation is a well-proven, reliable technology that is applicable to the removal of most metals (including arsenic, iron, and manganese) which are found in the groundwater at the site. Sedimentation and/or filtration is required following precipitation to remove the suspended solid particles generated by this process.

Implementability

Precipitation is readily implementable requiring equipment that is readily available and easy to operate. Disposal of the generated sludge is required.

Cost

Capital costs for chemical precipitation are low, and O&M costs are moderate.

Conclusion

Precipitation will be retained for further consideration.

3.5.6.10 Enhanced Oxidation

Enhanced oxidation processes use a controlled combination of ozone or hydrogen peroxide and ultraviolet (UV) light to induce photochemical oxidation of organic compounds. Ozone has been used extensively in Europe for purification, disinfection, and odor control of drinking water. Ozone alone has the ability to break down some organic compounds, but its effectiveness is vastly enhanced with the use of UV light.

UV radiation is electromagnetic energy whose wavelengths fall between those of visible light and x-ray radiation on the electromagnetic spectrum. UV energy is capable of breaking down or rearranging a molecular structure, depending on the dissociation energies of the chemical bonds within the structure. The combination of UV radiation with ozone or hydrogen peroxide treatment results in the oxidation of organic contaminants at a rate many times faster than that obtained from applying UV light or hydrogen peroxide and ozone alone.

A typical continuous-flow ozone/hydrogen peroxide/UV system consists of an oxygen or air source, an ozone generator or hydrogen peroxide feed system, a UV/oxidation reactor, and an ozone decomposer.

Flow patterns and configurations are designed to maximize exposure of the ozone-bearing wastewater to the UV radiation, which is supplied by an arrangement of UV lamps. Typical reactor designs range from mechanically agitated reactors to spray, packed, and tray-type towers. Reactor gases are passed through a catalytic decomposer, which converts remaining ozone to oxygen and destroys any volatile organic compounds, and are then discharged or recycled.

Effectiveness

Enhanced oxidation is considered an innovative technology for the destruction of most volatile organics and some semivolatile organics in groundwater. Destruction efficiencies in excess of 99 percent may be expected for benzene and various alkenes, such as dichloroethenes and trichloroethene. However, alkanes such as dichloroethanes are more difficult to remove through enhanced oxidation. Overall, the process is relatively selective with respect to the removal of organic contaminants.

Implementability

Enhanced oxidation technology should be implementable. Some vendors currently offer this technology; however, specialized labor would be required. Enhanced oxidation has no effect in the reduction of metals, and its effect on reduction of semivolatile organics and pesticides is not yet proven. With ozone/hydrogen peroxide/UV treatment, no toxics are emitted to the atmosphere or adsorbed onto media that require further treatment or disposal. Bench- and possibly pilot-scale treatability studies would be needed to determine the actual effectiveness and cost of applying an enhanced oxidation process to the contaminants in the groundwater. Pretreatment using clarification and/or filtration would typically be required for turbidity control to ensure the proper operation of the UV lamps used in this process.

Cost

Capital costs for enhanced oxidation are high, and O&M costs are moderate to high.

Conclusion

Enhanced oxidation is eliminated from further consideration. Other effective technologies for the removal of organic contaminants are more readily available and are less expensive.

3.5.7 Disposal (Discharge)

Extracted groundwater must be disposed or discharged. Two possible disposal options for extracted groundwater are direct discharge to Slocum Creek and indirect discharge to either the MCAS Cherry Point Sewage Treatment Plant (STP) or Industrial Waste Treatment Plant (IWTP).

3.5.7.1 Direct Discharge

Direct discharge would involve discharging extracted and/or treated groundwater to Slocum Creek. Prior to discharge, groundwater may need to be treated to meet NPDES discharge standards.

Effectiveness

Discharge to Slocum Creek is effective, provided that groundwater is treated to the necessary levels required for discharge. Compliance with discharge limits would meet the RAOs.

Implementability

Discharge to Slocum Creek is readily implementable and can be accessed adjacent to the site. An NPDES permit would need to be obtained for groundwater to be discharged to Slocum Creek. Implementing this option would cause no adverse impact to human health or the environment.

Cost

Capital and O&M costs are low for direct discharge to Slocum Creek. However, additional costs would be necessary if treatment is necessary to meet discharge limits.

Conclusion

Discharge to Slocum Creek is retained for further consideration in the development of remedial alternatives.

3.5.7.2 Indirect Discharge

Indirect discharge would involve discharge of groundwater to the IWTP or STP. Indirect discharge to either plant would involve constructing a pipeline from the groundwater collection system to that facility.

The IWTP has a design average flow rate of 0.627 million gallons per day (MGD) and currently treats approximately 0.25 MGD. The IWTP is used as a pretreatment facility for the STP with effluent from the IWTP being piped to the STP. The unit treatment processes in the IWTP include primary clarification, aeration, cyanide destruction, hexavalent chromium reduction, secondary clarification (including coagulation), pressure filtration, air stripping, and activated carbon adsorption. As a conservative measure, the sludge generated from the IWTP is disposed of at a hazardous waste landfill.

The STP has a design average flow rate of 3.2 MGD and a design maximum flow rate of 7.5 MGD. Currently, approximately 2.2 MGD of wastewater is being treated at the STP. The unit treatment processes in the STP include primary clarification, primary biological (trickling filter), secondary biological (activated sludge), secondary clarification, rapid sand filtration, and chlorination/ dechlorination. The sludge generated by the STP is disposed of by land application.

Effectiveness

Both the IWTP and the STP have the hydraulic capacity to handle pretreated groundwater from the shallow aquifer beneath OU2 during remediation efforts at the site. Prior to discharge to the STP, pretreatment standards for total suspended solids would have to be met. Because the oxidation of ferrous (+2) iron to ferric (+3) iron will likely take place in the pipeline transporting OU2 groundwater to the STP, it is a possibility that suspended solids pretreatment standards could be exceeded. Therefore, pretreatment of the groundwater may be required prior to transporting the groundwater to the STP. Although the IWTP could accommodate untreated groundwater from OU2, the transport pipeline could be subject to clogging caused by the iron oxidation. Therefore, once again it would be beneficial to pretreat the groundwater, a measure which would negate the possible advantage of sending untreated groundwater directly to the IWTP. OU2 groundwater contaminant concentrations are relatively low and are not anticipated to exceed the pretreatment standards for the STP. However, status with regard to pretreatment requirements cannot be determined until specific extraction systems are developed that will allow influent concentrations to be estimated. Actual pretreatment requirements will be determined later in the FS process.

Implementability

Discharge to the IWTP is implementable providing the concentrations of contaminants do not significantly impact the normal influent concentrations. However, discharge to the STP is more easily implemented because it has more available hydraulic capacity than the IWTP. Moreover, the STP is located closer to the site. Therefore, it is the preferable discharge option, assuming that pretreatment standards can be met. Both options should be implementable.

Cost

Capital costs are moderate, and O&M costs are low. However, additional costs to meet pretreatment standards may be applicable.

Conclusion

Discharge to either the STP or the IWTP is retained for further consideration.

3.6 FINAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOILS

The final screening of technologies and process options is based on the evaluation criteria described in Section 3.4. The following are the soils technologies and process options for final screening:

General Response Action	Remedial Technology	Process Options
No Action	None	Not applicable
Institutional Controls	Monitoring	Groundwater/Surface Water/Sediment Sampling
	Access/Use Restrictions	Active: Physical Barriers/Security Guards
		Passive: Deed and Land Use Restrictions
Containment	Capping	Soil/Multimedia Cap
	Erosion Control	Revegetation/Rip-rap
Removal	Bulk Excavation	Excavation
In-situ Treatment	Physical/Chemical	Soil/Vapor Extraction
Ex-situ Treatment	Physical/Chemical	Chemical Fixation/Solidification
		Soil Washing/Solvent Extraction
	Thermal	Low Temperature Thermal Desorption
		Incineration
	Solids Processing	Crushing/Grinding/Screening
Disposal	On Site	Consolidation/Engineered Disposal
	Off Site	Hazardous/Nonhazardous Waste Landfill

3.6.1 No Action

No action consists of maintaining status quo at the site. No action is retained as a baseline for comparison purposes.

Effectiveness

No action would not achieve RAOs for OU2. Potential exposure to contaminated soil and buried wastes could pose an unacceptable level of health hazard to current and future receptors. Migration of contaminants in the environment would continue.

Implementability

There are no implementability concerns associated with the no action GRA.

Cost

There are no costs associated with no action.

Conclusion

No action is retained as required by the NCP to provide a baseline comparison.

3.6.2 Institutional Controls

Institutional controls consisting of access and deed or land use restrictions, requiring compliance with OSHA requirements, and monitoring are being considered. Access restrictions use fences, barriers, etc., to prevent human contact with contaminants. Records in the MCAS Cherry Point Base Master Plan (or deed restrictions) can be used to prevent future land uses from posing a risk to human health or the environment. OSHA provides rules and guidance for maintaining safety and preserving the health of workers exposed to health hazards in a work environment. Such rules include prohibition of eating, drinking, and smoking in contaminated areas, the use of personal protective equipment to minimize the potential for contaminants to enter the human body, minimization of the duration of exposure to contaminants, decontamination procedures, etc. Monitoring may consist of collection of environmental samples, such as groundwater, soil, surface water, and sediment, followed by analysis for target contaminants.

Effectiveness

Access and land use restrictions can be effective, depending on the administration of the controls. The compliance with OSHA standards can be effective in minimizing the potential for incidental ingestion, inhalation, and dermal contact with contaminants in soil and buried waste. Sampling and analysis of environmental media are by themselves ineffective in minimizing the migration of contaminants in the environment, but they can determine the nature of future remedial action. Sampling and analysis of environmental samples would also be required to assess the progress and ensure completion of remedial actions.

Implementability

Compliance with the access and land use restrictions, OSHA requirements, and monitoring are readily implementable, assuming that the site will continue to be a Federal facility.

Cost

Costs of access and use restrictions are low. Costs associated with the purchase of personal protective equipment are low to moderate. Costs associated with sampling and analysis are also low to moderate.

Conclusion

Retain the use of institutional controls to enforce access and use restrictions in the MCAS Cherry Point Base Master Plan, OSHA regulations, and monitoring.

3.6.3 Containment

The technologies being considered under containment are capping and erosion controls. These technologies serve different purposes in containment and are not mutually exclusive.

Multimedia caps consist of layers of soil, clay, synthetic materials, or composites compacted or placed over the wastes. The purpose of the cap is to minimize the potential for human contact with the wastes and also to reduce the migration of the contaminated material in the wastes due to surface water infiltration, runoff, or wind erosion. Synthetic material, clay, or composite materials may be used to construct the cap when contaminant migration into the groundwater due to infiltration must be minimized.

Erosion controls consist of vegetative cover and/or rip-rap (i.e., rocks, stones, etc.) placed on the wastes or a topsoil cover to minimize the entrainment of contaminated material or clean soil (cap material) in surface water runoff. Usually, vegetation is seeded in a topsoil covering the wastes, and rip-rap material is used on the surface of the soil.

Effectiveness

Multimedia caps can be effective in minimizing human exposure to the waste materials beneath the cap. The choice of the material depends on the concern for migration of contaminants into the subsurface due to infiltration through the vadose zone. Compacted soil with a topsoil layer, including a vegetative cover, would be effective as a barrier to minimize human exposure. The use of synthetic, low permeability material such as high density polyethylene (HDPE), polyvinyl chloride (PVC), or composite materials would be effective to minimize rainfall infiltration into the wastes beneath the cover. Erosion controls would be effective in the collection of rainfall, diversion of surface water flow, and control of runoff.

Implementability

The main concern with the implementation of caps and erosion controls is the maintenance of the integrity of the cap under the influence of natural and human interferences. However, since the site is expected to be under Federal control, human interferences can be minimized.

Cost

Costs of caps are moderate to high, depending on the materials and labor involved in placement. O&M costs for caps can also be moderate to high. Costs of erosion controls are low.

Conclusion

Retain the use of multimedia caps for hot-spot consolidation and erosion controls as an effective means of minimizing exposure to human receptors and reducing the migration of contaminated material into the environment.

3.6.4 Removal

The technology being considered under removal is excavation. Excavation can be performed by a variety of equipment, such as tractor shovels (front-end loaders), backhoes, grade-alls, clamshells, draglines, etc. The type of equipment selected must take into consideration several factors, such as type of material, load-supporting ability of the soil, rate of excavation required, depth of excavation, etc. Usually, power shovels, draglines, clamshells, or backhoes are used for deep excavations or when the required excavation rates are high. This equipment is mounted on mobile units and operated hydraulically.

The logistics of excavation must take into account the available space for operating the equipment, loading/unloading to transport the removed material, location of the site, etc. The excavated location is filled and graded with clean fill material or treated soils.

Effectiveness

Excavation can be effective in removing contaminated material from the site. Fill material and contaminated sandy/silty soils such as those present at OU2 are amenable to removal by excavation. Confirmatory sampling is required to indicate the completion of the removal action. Soil samples must be taken from the exposed faces of the pit and analyzed for the contaminants of concern to ensure that the residual material is not contaminated at unacceptable levels.

Implementability

The availability of excavation equipment is not of concern. The technology is well proven and established in the construction and remediation industries. During excavation, OSHA requirements must be imposed to ensure that the exposure of the workers to the contaminants is minimized. Any excavation below the water table may require dewatering (or removal of water) to depress the water table below the bottom of the estimated depth of contamination. The water would need to be treated and disposed of appropriately.

Cost

Excavation costs are directly proportional to the extent of excavation required but are typically considered to be low.

Conclusion

Retain excavation for further consideration in the development of remedial alternatives.

3.6.5 In-situ Treatment

Soil/Vapor Extraction

Soil vapor extraction (SVE) consists of the removal of volatile organic contaminants from the vadose zone using suction or vacuum. SVE may be enhanced by the injection or aspiration of clean air into the soil or water table (i.e., air sparging). This technology uses wells screened within the vadose zone to capture and extract the VOCs using above-ground vacuum extraction pumps. The VOCs in the vapor phase are treated in above-ground, off-gas treatment units.

Typically, this technology is used for the remediation of VOCs and fuel-related compounds. The main contaminants of concern at OU2 hot spots are volatile organics. The Henry's law constants for most of these compounds are greater than 0.01 (2.4E-4 atm-m^3 per mole), which is a threshold for determining ease of volatilization. Therefore, these contaminants are expected to be readily removed by volatilization.

Effectiveness

Soil/vapor extraction is a relatively novel technology in the remediation field. However, recently, its effectiveness in rapidly removing VOCs from the soil has been demonstrated at a number of sites. The technology is not applicable for the removal of inorganics or lesser volatile organics. Since it is an in-situ technology, a good understanding of the geological nature of the site is essential. One of the main factors that would affect the effectiveness of this technology is the permeability of the subsurface to air flow, which must be determined by pilot-scale tests. The results of the pilot-scale study would help determine the number, location, spacing, depths and sizes of screens, air flow rates and pressures for the design of the full-scale system. At the OU2 hot spots, volatilization is expected to be the major removal process for the primary COCs. Typically, in sandy soils, permeability of air and vapor-laden gas is high, and therefore, the technology is effective. However, when mixed with debris and other materials that might not allow air to flow through, there might be preferential flow paths, and pockets of VOCs may not be influenced. Therefore, pilot-scale studies are very important at OU2 to determine the effectiveness of soil vapor extraction.

Implementability

This technology is relatively easy to install and operate. The equipment consist of wells, piping, and vacuum pumps, which are readily available. Well installation and plumbing services are offered by numerous vendors. The system can operate free of supervision and only requires occasional checks on flow rates and pressures. Maintenance requirements for vacuum pumps are minor. The need for offsite disposal/regeneration facilities would depend on the type of off-gas treatment that is required, which in turn depends upon the type and quantities of contaminants found in the soil. Operating and maintenance requirements for off-gas treatment equipment vary, depending on whether vapor-phase activated carbon, catalytic oxidation, or incineration is chosen.

Cost

The capital and O&M costs are low to moderate compared to other in situ technologies.

Conclusion

Retain soil vapor extraction as a potentially effective method for treatment of "hot spot" areas contaminated with volatile organics.

3.6.6 Ex Situ Treatment

The following ex situ treatment technologies and process options for contaminated site soils are evaluated in this section.

- Chemical Fixation/Solidification
- Soil Washing/Chemical Extraction
- Thermal Desorption
- Incineration

3.6.6.1 Chemical Fixation/Solidification

Cement/pozzolan-based solidification is effective in treating soil that is contaminated with heavy metals and relatively immobile organics, such as pesticides and PAHs. The mobility of the contaminants is reduced by binding the chemical into a solid matrix that is resistant to leaching. Typically, solidification occurs at high pHs where most metals become less soluble. Organic contaminants can be bound in the solid matrix using various additives, such as organophilic compounds. A typical solidification system includes an untreated waste staging area, reagent feed systems, one or more mixing vessels, and a treated waste curing area. The solidified material can be formed into monolithic blocks or can be made into a material with a consistency of soil-cement. The process results in an increase in the total weight and volume of material.

This technology reduces mobility through the binding of hazardous constituents into a solid mass with low permeability that resists leaching or by chemically binding them to the solidification reagents and thereby resisting leaching. Solidification agents typically include pozzolanic-based materials such as portland cement, cement kiln dust, and fly ash. Additives, such as lime or proprietary reagents, are often added to the solidification formula to increase the effectiveness of the treatment. Specifically, lime can be added to reduce the solubility of metals and neutralize acidity, which would otherwise destroy the cementitious matrix and release the metals into the environment.

The performance of a solidification system is highly waste specific; therefore, the process must be designed to accommodate the specific waste. A thorough physical and chemical characterization of the waste and treatability testing are essential in determining the most suitable solidification reagents and mixing ratios, as well as any special pretreatment or material handling methods that may be required.

After the waste is mixed with the solidifying agents, the material is allowed to cure for a specified time period. The duration of curing is dependent on the strength required before handling or disposal.

Effectiveness

Cement/pozzolan based solidification is a viable option for the contaminated soils and waste fill materials located at OU2 and should be effective in solidifying the soil matrix and immobilizing the numerous metal contaminants. Iron-based methods using ferric sulfate have proven to be effective in immobilizing arsenic and are potentially applicable. Cement/lime-based fixation, on the other hand, has shown to be effective in the immobilization of most other metals.

Solidification will minimize migration of these contaminants; however, the solidified mass will require some type of cover as a barrier to human access. The solidification process would be effective in minimizing the leaching of contaminants in the soil to other environmental media. Long-term stability and leachability, however, are potential concerns because the contaminants are not destroyed but remain within the solidified mass. This type of solidification also results in a volume increase. This technology should be capable of handling the volume of contaminated soil and waste fill material at OU2. Implementation should not cause any adverse effects on human health and the environment.

Implementability

Ex-situ fixation/solidification is implementable. Monitoring for physical integrity of the treated material and the effectiveness of the process is typically required. The equipment and resources necessary to solidify the soil and waste/fill material on site are readily available, with many vendors capable of performing this work. The equipment necessary for this process is similar to that used for cement mixing and handling. It includes a feed system, mixing vessel, and a curing area, plus a bulk storage area for the solidification agents.

Cost

Capital and O&M costs are moderate for cement/pozzolan-based solidification.

Conclusion

Retain ex-situ cement/pozzolan-based solidification as an effective means to reduce the migration of inorganic contaminants from the soil.

3.6.6.2 Soil Washing/Chemical Extraction

Soil washing uses physical processes such as high-pressure water, screening, attrition scrubbing, froth flotation, electromagnetic separation, mechanical separation, hydrogravimetric separation (including hydrocyclones, mineral jigs, and spiral classifiers), and multigravity separation. Such physical separation processes achieve waste minimization through a volume reduction process by separating out a size fraction of the soil containing little or no contamination (such as coarse-grained soils and large-sized material) from the more contaminated, finer-grained material.

Chemical extraction is based on the use of water or other solvents to extract or desorb the contaminants from the soil and dissolve them into the liquid phase. Often, chemical extraction requires a preliminary treatment using physical separation to reduce the volume of material to be treated.

The performance of a soil washing system is highly waste specific. A thorough physical and chemical characterization of the waste and treatability testing is essential in determining the most suitable and efficient means of separating the contaminants from the clean soil. When different classes of contaminants are present (such as metals, VOCs, PAHs, etc.) a series of extraction operations using different solvents, pH adjustment, etc.) may be required.

Effectiveness

A combination of physical separation and various chemical extraction techniques might be used to remove the inorganic and organic contaminants from various hot spots at OU2. Physical separation of the wastes (debris, municipal refuse, etc.) from the soils may be required at certain hot spots for efficient treatment of the soils. Nontoxic organic solvents may be used for the removal of organic contaminants. Acidic solutions may be required for leaching of metals from the soils. The extraction process would yield clean soils that would require rinsing with clean water several times to remove the residual extractant. By-products from the process would consist of spent solvent streams (containing the removed contaminants) that require further treatment/disposal and recovery/recycle of the extractants. The effectiveness of the soil washing/chemical extraction process is questionable at hot spot locations that contain high fractions of clays because the physical separation and desorption processes are more difficult to perform on these types of particles.

Implementability

A soil washing/chemical extraction process is implementable. A full-scale soil washing/chemical extraction system would be extensive, consisting of physical separation operations and chemical extraction processes. Physical separation would consist of several operations depending on the type of debris, sizes, densities of materials, etc. Chemical extraction would definitely require treatability studies to demonstrate its effectiveness. Typically, waste streams produced from chemical extraction are more contaminated and greater in volume than waste streams from other processes. Unless efficient recovery/recycle of the extractant is achievable, there would be significant implementability concerns for further treatment/disposal of the waste streams.

Cost

Capital and O&M costs for the soil washing/chemical extraction process are moderate to high. Additional costs for disposal of residues may be moderate to high.

Conclusion

Soil washing/chemical extraction poses certain effectiveness and implementability concerns, and therefore, it is eliminated from further consideration.

3.6.6.3 Thermal Desorption

Thermal desorption uses direct or indirect heating to thermally desorb or volatilize organic contaminants. The temperatures used are contaminant- and matrix-specific, with a range of approximately 150°F to 800°F. Typically, wastes are processed through an externally fired pug mill or rotary drum system equipped with heat transfer surfaces that are heated by circulating hot oil. An induced air flow conveys the desorbed organics through a secondary treatment system, such as a carbon adsorption unit, combustion afterburner, or a condenser unit. The air stream is then discharged through a stack. Thermal desorption processes are generally more applicable to the removal of volatile organic compounds and are well demonstrated for industrial sludge and product drying applications. Thermal desorption units can borrow technology from other applications, such as sludge or asphalt dryers.

Effectiveness

Thermal desorption should be effective at volatilizing the VOCs of concern. However, particle-size-based screening requirements are more stringent for thermal desorption units than for incineration units. Therefore, any oversized materials containing VOC contamination would require a deagglomeration or shredding step prior to treatment.

Implementability

Thermal desorption should be implementable. Mobile units are available. Off-gas treatment for the removed organics may be required. Treatment options include condensation, activated carbon, incineration, catalytic oxidation, and flaring. Offsite thermal desorption is not implementable because of the absence of available units.

Cost

The relative capital and O&M costs of thermal desorption compared to incineration is low to moderate.

Conclusion

Thermal desorption is effective and implementable; therefore, it will be retained for further consideration.

3.6.6.4 Incineration

Incineration is a thermal oxidation process that converts organic solids, liquids, and gases to inorganic substances at high temperatures in the presence of oxygen. The technology uses controlled flame combustion in an enclosed reactor to decompose organics. Carbon and hydrogen waste components are converted to carbon dioxide (CO_2) and water, respectively. Chlorine, if present, is mostly converted to hydrochloric acid (HCl). Other combustion products are also present in smaller quantities. These may include carbon monoxide, nitrogen oxides, chlorine, fluorine, and trace metals. Incineration produces a solid stream from the incombustible portion of the original material, which is removed as a bottom fly ash, detoxified soil, and/or other solid treatment residuals. If a wet scrubber air pollution control system is used, a liquid waste stream could also be generated. Screening of the contaminated material would be required to remove the noncombustible waste/debris from the soils. The noncombustible waste/debris must be treated or disposed of by other means, depending upon the level of contamination associated with it. Common, available incineration systems are described below.

Rotary Kiln Incineration. Rotary kilns are one of the most widely-used incinerators for wastes in the form of solids, sludges, liquids, and gases. An integrated system for incineration by rotary kiln includes a solid feed system; a rotary kiln and secondary combustion chamber; air pollution control units for particulate and acid gas removal; and an exhaust stack. Such a system employs a refractory-lined rotary kiln operating at high temperatures (800°C to 1,600°C) to combust wastes in the presence of oxygen. Wastes with a high salt or heavy metal content and explosive wastes require special evaluation. A typical throughput for a transportable rotary kiln is 75 to 200 tons per day. For wastes which have high heat content, the throughput may be limited by the capacity of the unit to control the heat generation rate. Fixed-based units, such as cement kilns that may be permitted to accept contaminated soils, are also available.

Infrared Incineration. An integrated system for infrared incineration consists of silicon resistance heating elements, a refractory-lined reactor chamber, a traveling-belt-type waste conveyor, and air pollution control units. Infrared energy, supplied from an electric power source, destroys organic waste components at high temperatures (540°C to 1,260°C). Off-gases from the primary reactor are exhausted to a secondary chamber to ensure complete combustion. Infrared incineration has been used primarily to treat solids and sludges, but incinerator modifications would allow liquid and gas treatment. Mobile units have a maximum processing capability of approximately 5 to 7 tons per hour of contaminated soil.

Fluidized Bed Incineration. Fluidized beds are vertical, refractory-lined chambers that contain an inert material, usually sand. Air is forced through a supporting distribution plate at the bottom of the bed at a rate sufficient to fluidize the inert material. Waste materials are introduced just above or directly into the fluidized bed. The passage of air through the bed causes agitation and promotes rapid and uniform mixing of the waste material, air, and bed particles. Heat is transferred from the bed particles to the waste material, which burns rapidly and transfers heat back to the bed. This bed is preheated (to start-up temperatures) using either preheated air or an impinging burner (located above the bed). Auxiliary fuel is usually added through nozzles within the bed. As the waste materials burn, the larger, inert particles remain in the bed, and the smaller particles are separated from the exhaust gases in a freeboard area above the bed. The fluidized bed must be regenerated as the inert material within the bed increases. Renovation of the bed can be performed as a batch process or continuously. As the bed material is removed from the incinerator, the inert particles are separated, and the material can then be reused. Normal operating temperatures vary from 850°F to 2,100°F, and residence times vary with bed depth. Fluidized beds are available as mobile units.

Circulating Fluidized Bed Incineration. The circulating bed incinerator is similar to the fluidized bed incinerator, except that the system operates with high combustion air velocities and finer bed material. The higher velocities create greater turbulence within the reactor, which allows for efficient destruction of all types of hydrocarbons. The high turbulence entrains the solids and allows combustion to take place along the entire height of the unit. This allows uniform temperatures to be achieved in the unit. An integral cyclone is used to separate the fluidized solids from the off-gases. These solids are returned to the combustion zone. Secondary air is injected into the upper portion of the unit. Burning the waste material in the presence of dry limestone controls the formation of acidic gases. Normal operating temperatures are 850°F. Circulating beds are also available as mobile units.

Effectiveness

Incineration should be very effective for destroying the organic contaminants of concern in the soil. Incineration typically achieves in excess of 99.99 percent destruction of organics with the resulting formation of inert carbon dioxide and water. Residual ash results from the inorganics in the soil. Metals present in the soil may render the ash from incineration a hazardous waste subject to RCRA hazardous waste regulations and land disposal restrictions.

Implementability

Incineration is implementable, with several vendors capable of performing this work. Offsite incineration is typically more easily implemented than onsite incineration, since waste approvals are only required at existing facilities. Onsite incineration would require trial burns, which are difficult and time consuming procedures. Also, local citizen groups can significantly delay the approval process. Other considerations include air discharges and water discharges.

Cost

The relative cost of incineration is high to very high compared to other ex-situ treatment technologies.

Conclusion

Both onsite and offsite incineration are effective and implementable for the organic "hot spots" at OU2. As a result, both are retained for further consideration.

3.6.7 Disposal

The technologies being considered under disposal are onsite consolidation and offsite disposal in a hazardous waste or nonhazardous waste landfill.

3.6.7.1 Onsite Consolidation

Onsite disposal of contaminated material would involve excavation of various contaminated areas (i.e., hot spots) followed by consolidation at one location with a cover. The cover may be a layer of compacted soil or clay with erosion controls (in accordance with North Carolina solid waste disposal requirements) or may have additional impermeable synthetic layers to minimize infiltration. Monitoring of groundwater would be required to detect any migration of contaminants. Gas emissions control may be needed because potentially putrescible wastes may have been deposited at the site.

Effectiveness

Onsite consolidation techniques can be effective for the contaminated materials present at OU2. This technology is especially effective if the wastes are nonhazardous and excavation and disposal does not trigger Land Disposal Restrictions (40 CFR Part 268). The adequacy of a multilayer cap or cover would depend on the estimated impact on the environment. If the contaminants are highly mobile, then a simple cover might not be sufficient because of potential groundwater impacts.

Implementability

Onsite consolidation and placement of a cover or multilayer cap can be implemented at OU2. Excavation and deposition activities may expose the workers to the contaminants present in the wastes and soils, but adequate personal protective equipment and observance of OSHA requirements can address potential health concerns.

Cost

Capital and O&M costs of onsite consolidation with a cover would be low to moderate.

Conclusion

Retain consolidation (with placement of a cover or multilayer cap) for further consideration in the development of remedial alternatives.

3.6.7.2 Offsite Landfill Disposal

Offsite disposal is applicable to excavated soil "hot spots", but not the entire contents of the landfill at Site 10. Landfills differ mainly in the types of wastes that they are permitted to accept. Nonhazardous waste landfills are permitted to accept municipal solid wastes, construction debris, contaminated soil, and other waste which must be proven to have nonhazardous characteristics. Hazardous waste landfills can accept listed and characteristic RCRA hazardous wastes.

Nonhazardous waste landfills are regulated by the siting, operating, and maintenance requirements of the state or local agencies. Hazardous waste landfills are regulated by the requirements set forth by RCRA (40 CFR 264), the state, and local laws. Among the requirements for landfills are foundation, liner, leak detection, leachate collection and treatment, closure and post-closure care, inspections, monitoring, etc. The requirements are more stringent for hazardous waste landfills than those for nonhazardous waste landfills.

Effectiveness

Landfilling can be an effective method of disposal of wastes and contaminated soil. However, because of the long-term liability associated with disposal at an offsite location and the preference for treatment under CERCLA, the suitability of landfilling is always questionable. At this site, the contaminated media would consist mainly of contaminated soil that may be mixed with lesser quantities of buried waste.

Implementability

There are no major implementability concerns with offsite landfilling. The contaminated soil is expected to be a nonhazardous waste based on the testing conducting during the RI. Sanitary or municipal solid waste landfills are available to accept the contaminated material. Hazardous waste landfills are also available to accept any hazardous wastes that may be encountered during soil excavation and for any hazardous residues that may be generated from soil or groundwater treatment processes.

Costs

Costs of disposal in nonhazardous waste landfills are low to moderate. Costs of disposal at hazardous waste landfills are high to very high.

Conclusion

Retain nonhazardous waste landfilling for the contaminated soil "hot spots" present at the site. Retain hazardous waste landfilling for any hazardous waste that may be encountered during excavation of soil and for any residues that may be produced during onsite treatment.

3.7 SUMMARY OF SCREENING AND SELECTION OF REPRESENTATIVE PROCESS OPTIONS

All of the technologies and process options that were evaluated and retained for both soil and groundwater are summarized in this section. Representative process options for groundwater are discussed in Section 3.7.1, and representative process options for soil are discussed in Section 3.7.2.

3.7.1 Selection of Representative Process Options for Groundwater

Table 3-3 summarizes the retained technologies and representative process options for groundwater.

Representative process options are chosen from each technology to assemble an adequate variety of alternatives and evaluate the alternatives in sufficient detail to aid in the final selection process. The specific process option selected for the remedial action will be determined during the remedial design or during the bid evaluation and selection of the remedial contractor. Carbon adsorption is chosen to be the representative process option for the removal of organics from the groundwater, since it is capable of handling several nonvolatile organic contaminants of concern in addition to the volatile organic contaminants. Finally, indirect discharge of extracted groundwater to the MCAS Cherry Point STP has been chosen as the representative process option for indirect discharge, since the STP has greater excess capacity than the IWTP and all other factors, such as required pretreatment, are equal.

All of the other process options retained from screening are being selected as representative process options under their respective technologies.

TABLE 3-3

SUMMARY OF RETAINED TECHNOLOGIES AND REPRESENTATIVE PROCESS OPTIONS - GROUNDWATER OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Representative Process Option
No Action	None	Not applicable
Institutional Controls	Monitoring	Groundwater/surface water/sediment sampling
	Land Use Restrictions	Active: Physical Barriers Passive: Land Use Restrictions
Containment	Vertical Barriers	Hydraulic Barrier
Removal	Groundwater Extraction	Extraction Wells
In-Situ Treatment	Physical/Biological	Air Sparging/Soil Vapor Extraction
	Natural Attenuation	Natural Attenuation
Ex-Situ Treatment	Physical	Sedimentation
		Filtration
		Adsorption
		Solids Dewatering
	Chemical	Neutralization/pH Adjustment
		Coagulation/Flocculation
		Chemical Precipitation
Disposal	Surface Discharge	Direct Discharge to Slocum Creek
		Indirect Discharge to STP

3.7.2 Selection of Representative Process Options for Soil

Table 3-4 summarizes the retained technologies and representative process option for soil.

Representative process options are chosen from each technology to assemble an adequate variety of alternatives and evaluate the alternatives in sufficient detail to aid in the final selection process. The specific process option selected for the remedial action will be determined during remedial design or during bid evaluation and selection of the remedial contractor.

With regard to treatment of soil "hot spots," the specific process option selected will be based on the type of contamination present. It is anticipated that process options will be required for both inorganic and organic contaminants. Low temperature thermal desorption has been selected as the representative process for thermal treatment in-lieu of incineration. Thermal desorption is considered more applicable for the organic hot spots, which are the primary risk at the site (i.e., VOCs). Chemical fixation/solidification will be used to remediate inorganic contamination. The multilayer cap is chosen as the representative process option for a cap because it is expected to be effective in providing a barrier for human contact and is required by state and Federal solid waste regulations. All of the other process options retained from screening are selected as representative process options under their respective technologies. Solids processing options for preliminary treatment of contaminated soil will be retained as appropriate for the ex-situ treatment options.

TABLE 3-4

SUMMARY OF RETAINED TECHNOLOGIES AND REPRESENTATIVE PROCESS OPTIONS - SOIL OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA

General Response Action	Technology	Representative Process Option
No Action	None	Not Applicable
Institutional Controls	Monitoring	Groundwater/Surface Water/Sediment Sampling
	Access/Use Restrictions	Active: Physical Barriers Passive: Land Use Restrictions
Containment	Capping	Multilayer Cap
	Erosion Control	Revegetation/Rip-Rap
Removal	Bulk Excavation	Excavation
In-Situ Treatment	Physical/Chemical	Soil Vapor Extraction
Ex-Situ Treatment	Physical/Chemical	Chemical Fixation/Solidification
	Thermal	Low Temperature Thermal Desorption
	Solids Processing	Crushing/Grinding/Screening
Disposal	On Site	Consolidation
	Off Site	Hazardous/Nonhazardous Waste Landfill

4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

4.1 INTRODUCTION

This section presents the rationale for and the development of the remedial alternatives that are evaluated in the OU2 Feasibility Study. These alternatives are developed from combinations of the technologies and process options evaluated in Section 3.0. A range of remedial alternatives for groundwater and soil, based on the GRAs discussed in Section 3.3, was developed for OU2. The groundwater and soil alternatives are developed and described in Sections 4.3 and 4.4, respectively.

4.1.1 National Oil and Hazardous Substance Pollution Contingency Plan Focus

The purpose of the FS and the overall remedy selection process is to identify remedial actions that eliminate, reduce, or control risks to human health and the environment (40 CFR 300). The national program goal for the FS process, as defined in the NCP, is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. The criteria for identifying potentially applicable technologies to achieve these goals are provided in EPA guidance (U.S. EPA, 1988) and in the NCP. The NCP provides a strong statutory preference for remedies that will result in a permanent and significant decrease in toxicity, mobility, or volume; provide long-term protection of human health and the environment; and comply with ARARs. Primary balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; implementability; and cost.

In addition to the above objectives, the NCP defines certain expectations in developing and screening remedial action alternatives.

- The expectation to use treatment to address the principal threats posed by a site, wherever practical. Principal threats are considered to be liquids, areas contaminated with high concentrations of toxic compounds, and highly mobile materials.

- The expectation to use engineering controls, such as containment, for waste that poses a relatively low, long-term threat and for which treatment is impractical.

- The expectation to use a combination of methods, as appropriate, to achieve protection of human health and the environment. In appropriate site situations, treatment of principal threats will be combined with engineering controls (such as containment) and institutional actions for treatment residuals and untreated waste.

- The expectation to use institutional actions, such as deed restrictions and water controls, to supplement engineering controls for short- and long-term management to prevent or limit exposures to hazardous substances, pollutants, or contaminants.

- The expectation to consider using innovative technology when such technology offers the potential for comparable or superior treatment performance or implementability, fewer or lesser adverse impacts than other available approaches, or lower costs for similar levels of performance than previously demonstrated technologies.

- The expectation to return environmental media such as groundwater to their beneficial uses, wherever practical, within a time frame that is reasonable, given the particular circumstances of the site. When restoration of groundwater to beneficial uses is not practical, USEPA expects to prevent further migration of the contaminant plume, prevent exposures to contaminated groundwater, and evaluate further risk reduction.

These expectations have been applied in the development of the OU2 remedial alternatives.

4.2 RATIONALE FOR ALTERNATIVE DEVELOPMENT

The purpose of the FS is to evaluate the information provided in the RI, which assesses site conditions, and develop an appropriate range of alternatives to allow remedy selection. The development of alternatives should reflect the scope and complexity of the site problems that are being addressed. The number and types of alternatives should also be based on the site characteristics and complexity of the site concerns. Development of alternatives for OU2 is based on the following:

- Technologies and process options remaining after the screening evaluations from Section 3.0
- Land use scenarios for OU2
- Exposure scenarios
- RGOs for each COC
- ARARs

4.2.1 Technologies and Process Options

GRAs and representative process options have been developed for the groundwater at OU2. Those GRAs and process options that have been retained for assembly into alternatives are as follows:

General Response Action	Process Option
No Action	None
Institutional Controls	Records in the MCAS Cherry Point Base Master Plan (access and land use/deed restrictions) Fencing and warning signs Groundwater, surface water, and sediment sampling
Containment	Hydraulic barrier
Removal	Extraction wells
In-situ Treatment	Air sparging/soil vapor extraction Natural Attenuation
Ex-situ Treatment	Neutralization/pH adjustment Chemical precipitation Coagulation/flocculation Sedimentation Filtration Activated carbon adsorption Solids dewatering
Disposal	Direct discharge to Slocum Creek Indirect discharge to STP

GRAs and representative process options have been developed for the contaminated soil and waste/fill material at OU2. Those GRAs and process options that have been retained for assembly into alternatives are as follows:

General Response Action	Process Option
No Action	None
Institutional Controls	Records in the MCAS Cherry Point Base Master Plan (access and land use restrictions) Groundwater, surface water, and sediment sampling
Containment	Multilayer cap Revegetation/rip-rap cover
Removal	Excavation

General Response Action	Process Option
In-situ Treatment	Soil vapor extraction
Ex-situ Treatment	Chemical fixation/solidification Low temperature thermal desorption Crushing, grinding, and screening
Disposal	Onsite consolidation Offsite hazardous waste and nonhazardous waste landfills

These process options will be used individually or combined with each other, as appropriate, to form remedial alternatives.

4.2.2 Land Use Scenarios

Potential exposure of the environmental media are evaluated in the context of two land use scenarios: (1) current land use and (2) future land use. These land use designations reflect the current framework for assessing risk at OU2.

Under current land use, Sites 10 and 44A are not used, but would remain as former waste disposal areas. The Site 46 polishing ponds are currently inactive. Site 76 is the only active site at OU2 and is used for repair of personal vehicles.

Under the future land use, the OU2 area could be released to the public or remain under the control of the Air Station. Currently, it is anticipated that the OU2 area will remain under control of the Air Station. While under the control of the Air Station, land use will continue as it is; however, the Site 46 ponds may be used for stormwater management or removed. Concurrence will be obtained from the USEPA and NCDEHNR prior to any changes to the current use of these inactive ponds.

4.2.3 Exposure Scenarios

Assumptions for the land use scenarios and receptors used for alternative development are consistent with the OU2 risk assessment.

Under the current land use scenario, OU2 is assumed to remain as it currently exists. Existing current land use at and in the vicinity of OU2 indicates that receptors most likely to be exposed to contaminants on and migrating from the site include maintenance workers, adult recreational users, and adolescent trespassers. No adverse health effects are expected in any of the three current receptor populations.

Under the future land use scenario, OU2 could be developed into a residential or industrial community. Additional receptors under future land use include onsite residents, full-time employees, and construction workers. No adverse health effects are expected for full-time employees or construction workers. Potential future receptors for which possible adverse health effects could be expected include the following:

- Onsite Resident (30 years) - This exposure scenario assumes that a resident resides at OU2 for a period of 30 years. Exposure routes include:
  - Dermal contact with groundwater
  - Ingestion of groundwater
  - Inhalation of volatiles from groundwater
  - Incidental ingestion of soil
  - Dermal contact with soil

- Onsite Resident (6 years) - This exposure scenario assumes that a resident at OU2 serves two complete tours of duty at MCAS Cherry Point. Exposure routes include:
  - Dermal contact with groundwater
  - Ingestion of groundwater
  - Inhalation of volatiles from groundwater
  - Incidental ingestion of soil
  - Dermal contact with soil

4.2.4 Accommodation of RGOs and ARARs

In general, it is desirable to develop remedial alternatives that achieve compliance with all ARARs and RGOs. However, in certain cases, technical limitations and cost prevent developing alternatives that comply with all ARARs and RGOs. For example, waste areas that pose relatively low levels of risk over long time frames are considered appropriate for containment technologies (i.e., capping) combined with institutional controls. Municipal landfills are identified in the preamble to the NCP as a type of site where treatment may be impractical because of the size and heterogeneity of the contents (U.S. EPA, 1990). Because treatment is usually considered impracticable for large municipal landfills, containment is often considered to be an appropriate response action or the "presumptive remedy" (U.S. EPA, September 1993).

Because OU2 includes a 40-acre landfill (Site 10), it falls into the category of being impracticable to treat all of the landfill contents. As a result, no alternatives will be developed that consider excavation and disposal (on site or off site) of the entire landfill contents. Alternatives will be developed that considered treatment of identified soil hot spots, which is consistent with EPA guidance (EPA, September 1993).

As a result of following the Presumptive Remedy for CERCLA Municipal Landfill Sites, it is implied that the OU2 will remain a former landfill and may not be suitable for residential use. Review of the risk assessment presented in the Remedial Investigation (B&R Environmental, April 1997) indicates that the driving force resulting in the unacceptable risks is use of the surficial aquifer as a potable water source. Contact with soils does not present a carcinogenic risk that is considered to be unacceptable for either the 6-year or 30-year resident, although the HI for incidental ingestion of soil is greater than 1.0 for the child resident.

Based on current site knowledge (nature and extent of contamination), it is feasible that upon remediation of the groundwater in the surficial aquifer, the OU2 site could be suitable for residential land uses. However, it is not common practice to develop landfill areas for residential use.

4.3 DEVELOPMENT OF ALTERNATIVES FOR OU2

This section develops the remedial alternatives for OU2 considering the information provided in Section 4.2. Additional site-specific information and assumptions are provided in this section to further explain the alternative development process. All alternatives will be briefly explained in the following sections. More detailed descriptions are provided in Section 5.0.

OU2 consists of medium textured soils with moderate permeability. Areas of fill material (debris, refuse, and garbage) are present from 0 to 23 feet below the surface. The surficial aquifer ranges from approximately 15 to 20 feet below the surface to a depth of approximately 52 feet below the surface. The surficial aquifer is separated from the Yorktown aquifer by a low-permeability confining layer.

The OU2 area is contaminated with various volatile and semivolatile organics, pesticides, PCBs, and metals. Areas of soil contamination are dispersed throughout the site and have relatively low concentrations, with the exception of several small areas that have high concentrations of volatile organics. The surficial aquifer is contaminated with low levels of mainly volatile organics and metals. Several of the organic contaminant concentrations have been observed to be decreasing over time.

Currently, there are no human receptors for the surficial aquifer. The aquifer discharges into Turkey Gut and Slocum Creek. Minimal levels of contamination have been detected in Slocum Creek and Turkey Gut that may or may not be attributable to OU2. The surficial aquifer has contaminant concentrations that exceed state groundwater standards and state and Federal drinking water standards. Potable use of the aquifer would result in incremental carcinogenic risks and a health Hazard Index that would be considered unacceptable for future residents.

Development of remedial alternatives will focus on groundwater remediation as a result of exceedances of state groundwater quality standards and potential unacceptable risks to future residents for potable groundwater use. Alternatives will be developed which evaluate groundwater remediation and those that address identified hot spots within the soil that exceed RGOs based on protection of groundwater.

The following alternatives have been developed for groundwater at OU2:

- Alternative 1 - No Action.

- Alternative 2 - Natural Attenuation and Institutional Controls

- Alternative 3 - Groundwater Extraction; Treatment and Discharge to Slocum Creek or Pretreatment and Discharge to Sewage Treatment Plan (STP); Institutional Controls.

- Alternative 4 - Air Sparging/Soil Vapor Extraction; Institutional Controls.

A brief description of each groundwater alternative is provided in Section 4.4. Each alterative is composed of various components (e.g., component 1 - institutional controls) (U.S. EPA, February 1991).

The following alternatives have been developed for soil hot spots areas at OU2:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls
- Alternative 3 - Soil Vapor Extraction; Institutional Controls
- Alternative 4 - Excavation, Consolidation, and Containment; Institutional Controls
- Alternative 5 - Excavation, Treatment, and Onsite Disposal; Institutional Controls
- Alternative 6 - Excavation and Offsite Disposal; Institutional Controls

A brief description of each soil alternative is provided in Section 4.5. As with the groundwater alternatives, each alternative is composed of various components.

4.4 DESCRIPTION OF GROUNDWATER ALTERNATIVES

4.4.1 Groundwater Alternative 1: No Action

No action is required for Groundwater Alternative 1. This alternative is required by the NCP and is used as a baseline comparison with other alternatives. The only activity that would occur under the no action alternative is 5-year periodic reviews of the site.

4.4.2 Groundwater Alternative 2: Natural Attenuation and Institutional Controls

Groundwater Alternative 2 consists of two components: (1) institutional controls and (2) natural attenuation.

Institutional controls for groundwater consist of maintaining records of the groundwater contamination at OU2 in the MCAS Cherry Point Base Master Plan and designating the area as a restricted or limited use area. The area would be given a designation in the Base Master Plan that would prohibit groundwater use and the installation of wells (except monitoring wells). The Base Master Plan would ensure that the Air Station would be able to take adequate measures to minimize adverse human health and environmental effects at the time of any future land development.

Natural attenuation (or intrinsic remediation) refers to inherent processes that affect the rate of migration and the concentration of contaminants in groundwater. The most important processes are biodegradation, advection, hydrodynamic dispersion, dilution from recharge, sorption, and volatilization.

Monitoring would include sampling and analysis of groundwater beneath OU2 and surface waters and sediments in Slocum Creek and Turkey Gut. The objectives of monitoring would be to determine the effectiveness of the remedy and confirm that contaminants are not migrating offsite into the environment.

At least every 5 years, a site review would be conducted to evaluate the site status and provide direction for further action, if deemed necessary at that time. The site review is required because this alternative allows contaminants to remain at levels that exceed RGOs. If the property is sold for private use, a deed restriction must be placed on the site to ensure the continuation of institutional controls and monitoring.

4.4.3 Groundwater Alternative 3: Groundwater Extraction; Treatment and Discharge to Slocum Creek or Pretreatment and Discharge to STP; Institutional Controls

Groundwater Alternative 3 consists of three major components: (1) groundwater extraction, (2) onsite groundwater treatment and discharge to Slocum Creek or the STP, and (3) institutional controls.

A groundwater extraction and treatment system would be installed to contain the contaminants in the surficial aquifer by restricting lateral and vertical migration of the groundwater. Contaminated groundwater migrating within and from the OU2 landfill would be captured prior to its discharge into Slocum Creek and/or Turkey Gut. The extraction system would consists of 19 wells, pumping at an aggregate rate of 123 gallons per minute (gpm), located along the boundaries of Slocum Creek and Turkey Gut. Extracted groundwater would be pumped to a newly constructed, centrally located treatment building. For discharge to Slocum Creek, the treatment train would consist of the following treatment processes; equalization, pH adjustment/chemical precipitation, clarification, sand filtration, and carbon adsorption. Treated groundwater would then be discharged directly to Slocum Creek from the treatment plant. For discharge to the STP, the pretreatment train would consist of the following: equalization/aeration for iron oxidation, and pH adjustment. Pretreated groundwater would then be transferred to the STP for final treatment and discharge.

This alternative would also include all of the institutional controls and monitoring requirements detailed in Groundwater Alternative 2. The five year site review outlined in Groundwater Alternative 2 would be required because this alternative still allows contaminants to remain on the site at levels that exceed RGOs.

4.4.4 Groundwater Alternative 4: Air Sparging/Soil Vapor Extraction; Institutional Controls

Groundwater Alternative 4 is made up of two major components: (1) air sparging/soil vapor extraction (AS/SVE) and (2) institutional controls.

Groundwater contaminated with VOCs would be treated in-situ using AS/SVE technologies. The AS/SVE system would consist of a series of wells screened near the bottom of the surficial aquifer to inject air into the contaminated groundwater. The injection wells would be alternately spaced between horizontal extraction wells constructed in trenches approximately three feet deep. Extracted air, which would contain the VOCs removed from the groundwater, would be treated in an above ground, off-gas treatment system. The in-situ groundwater treatment system would consist of a series of 9 subsystems located along the boundaries of Slocum Creek and Turkey Gut. Each subsystem would consist of 9 to 11 air injection wells, 8 to 10 horizontal extraction wells, and a separate control building.

This alternative would also include all the institutional controls and monitoring requirements detailed in Groundwater Alternative 2. The five year site review outlined in Groundwater Alternative 2 would be required because this alternative allows contaminants to remain on the site at levels that exceed RGOs.

4.5 DESCRIPTION OF SOIL ALTERNATIVES

4.5.1 Soil Alternative 1: No Action

No action is required for Soil Alternative 1. This alternative is required by the NCP and is used as a baseline comparison with other alternatives. The only activity that would occur under the no action alternative is 5-year periodic reviews of the site.

4.5.2 Soil Alternative 2: Institutional Controls

Soil Alternative 2 consists of one major component (i.e., institutional controls).

Institutional controls include maintaining records of the soil contamination and buried waste at OU2 in the MCAS Cherry Point Base Master Plan and designating the area as a restricted or limited use area. The area would be given a designation in the Base Master Plan that would prohibit residential or intrusive (e.g., excavation) activities. The Base Master Plan would ensure that the Air Station would be able to take adequate measures to minimize adverse human health and environmental effects at the time of any future land development.

Fencing and warning signs would be replaced and repaired as necessary to physically limit access to the site and indicate to potential trespassers that a health threat is present. Warning signs would also be placed along Slocum Creek and Turkey Gut.

Monitoring would include sampling and analysis of groundwater beneath OU2 and surface waters and sediments in Slocum Creek and Turkey Gut. The objectives of monitoring would be to confirm that migration of contaminants from the site into the environment is not occurring and to determine the effectiveness of the remedy.

At least every 5 years, a site review would be conducted to evaluate the site status and provide direction for further action, if deemed necessary at that time. The site review is required because this alternative allows contaminants to remain at levels that exceed RGOs. If the property is sold for private use, a deed restriction must be placed on the site to ensure the continuation of institutional controls and monitoring.

4.5.3 Soil Alternative 3: Soil Vapor Extraction; Institutional Controls

Soil Alternative 3 consists of two major components: (1) in-situ soil "hot spot" treatment and (2) institutional controls.

Soil containing VOCs at significant concentrations would be treated in-situ using air soil vapor extraction (SVE) to eliminate the four major "hot spots". The SVE systems would use wells screened in the vadose zone for capture and extraction of VOCs sorbed to the soil. Extracted air, contaminated with VOCs, would be treated using an aboveground, off-gas treatment system.

This alternative would also include all of the institutional controls and monitoring requirements detailed in Soil Alternative 2. The five-year site review outlined in Soil Alternative 2 would be required because this alternative allows contaminants to remain on the site at levels that exceed RGOs. In addition, monitoring of air emissions and confirmation soil sampling would be conducted to determine the effectiveness of treatment.

4.5.4 Soil Alternative 4: Excavation, Consolidation, and Containment; Institutional Controls

This alternative is made up of three major components: (1) excavation and consolidation of contaminated soil, (2) capping of consolidation area, and (3) institutional controls.

Identified areas of soil contaminated at concentrations exceeding RGOs for groundwater protection would be excavated, consolidated, and capped. Clean fill would be placed and compacted in the excavated areas. Topsoil would be placed on top of the compacted fill, and the areas would be revegetated.

A multilayer cap would be installed over the consolidation area to minimize the potential for human contact and to reduce the migration of the contaminated material due to infiltration, surface water runoff, and/or wind. To minimize excavation and transportation requirements, the consolidation area will be the largest single area that exceeds RGOs. The multilayer cap would consist of 24 inches of soil and vegetative cover underlain by the following: a non-woven geotextile (filter fabric), a 12-inch drainage layer with permeability greater than 10^{-3} centimeters per second (cm/sec), a 30-mil flexible membrane liner, and a 24-inch clay layer with permeability less than 10^{-7} cm/sec.

This alternative would also include all of the institutional controls and monitoring requirements detailed in Soil Alternative 2. The five-year site review outlined in Soil Alternative 2 would be required because this alternative allows contaminants to remain on site at levels that exceed RGOs.

4.5.5 Soil Alternative 5: Excavation, Treatment, and Onsite Disposal; Institutional Controls

This alternative is made up of three major components: (1) excavation of contaminated soil, (2) onsite treatment/fixation and disposal of treated/fixated soil, and (3) institutional controls.

Identified areas of contaminated soil in excess of the RGOs for groundwater protection would be excavated and treated, based on the contaminants of concern, to immobilize and/or remove contaminants in the soil phase. Metals contamination in the soil would be immobilized using chemical fixation/solidification technologies that bind the chemical into a solid matrix that is resistant to leaching. Solidified material would be consolidated and covered using the capping system described for Soil Alternative 4. Thermal desorption technologies would be used to treat volatile organic contaminated soil. Thermal desorption uses indirect or direct heating of the soil to thermally desorb or volatilize organic contaminants. The clean soil would be used as general backfill. Off-gas from the thermal desorption process would be treated through a secondary treatment system.

This alternative would also include all of the institutional controls and monitoring requirements detailed in Soil Alternative 2. The five-year site review outlined in Soil Alternative 2 would be required because this alternative allows contaminants to remain on site at levels that exceed RGOs.

4.5.6 Soil Alternative 6: Excavation and Offsite Disposal; Institutional Controls

Soil Alternative 6 is made up of three major components: (1) excavation of contaminated soil, (2) offsite landfill disposal, and (3) institutional controls.

Identified areas of contaminated soil in excess of the RGOs for groundwater protection would be excavated and hauled to an offsite landfill. Based on previous testing, the contaminated soil would be classified as a nonhazardous waste. Clean fill would be placed and compacted in the excavated areas. Topsoil would be placed on top of the compacted fill, and the areas would be revegetated.

This alternative would also include all of the institutional controls and monitoring requirements detailed in Soil Alternative 2. The five-year site review outlined in Soil Alternative 2 would be required because this alternative allows contaminants to remain on site at levels that exceed RGOs.

4.6 SCREENING OF ALTERNATIVES

The screening of alternatives is used to decrease the number of alternatives that are carried forward for detailed analysis. This step in the FS process is conducted, when appropriate, to eliminate alternatives that do not achieve protection of human health or the environment. Alternatives which are significantly less effective than other more promising alternatives, which are not technically or administratively implementable, or which have significantly higher costs should also be eliminated.

The groundwater and soil alternatives developed and described for OU2 are considered to represent an appropriate range of alternatives. All alternatives are considered effective and implementable. Therefore, all of the groundwater and soil alternatives developed for OU2 will be carried forward for detailed analysis.

5.0 DETAILED DESCRIPTION AND ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

In this section each remedial alternative developed in Section 4.0 for OU2 is described and analyzed in detail in accordance with the "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA,1988) and the NCP (40 CFR 300). The detailed analysis of remedial alternatives provides information needed for the comparison of alternatives as well as for the final selection of alternative(s) which is included in Section 6.0.

5.2 CRITERIA FOR DETAILED ANALYSIS

The following nine criteria will be used for the detailed analysis for each remedial alternative:

Threshold Criteria

1. Overall Protection of Human Health and the Environment
2. Compliance With ARARs and TBCs

Primary Balancing Criteria

3. Long-term Effectiveness and Permanence
4. Reduction of Toxicity, Mobility, and Volume through Treatment
5. Short-term Effectiveness
6. Implementability
7. Cost

Modifying Criteria

8. State and USEPA Acceptance
9. Community Acceptance

The first two criteria are threshold criteria in that each alternative must meet them. The next five criteria are primary balancing criteria. The alternative(s) that best matches these criteria are proposed to the USEPA, state, and community as the preferred remedy. The last two criteria are modifying criteria that may modify the proposed remedy following comments on the FS and the Proposed Plan. Community acceptance will be addressed in the Record of Decision that will be finalized after the public comment period for the FS and Proposed Remedial Action Plan (PRAP). State, USEPA, and community acceptance must be considered during remedy selection. The following is a description of each of the nine evaluation criteria:

1. Overall Protection of Human Health and the Environment. The primary requirement for CERCLA remedial actions are that they are protective of human health and the environment. A remedy is protective if it adequately eliminates, reduces, or controls all current and potential risks. All pathways of exposure must be considered when evaluating the remedial alternative. After the remedy is implemented, if hazardous substances remain without engineering or institutional controls, then the evaluation must consider unrestricted use and unlimited exposure for human and environmental receptors. For those sites where hazardous substances remain and unrestricted use and unlimited exposure are not allowable, engineering controls, institutional controls, or some combination of the two must be implemented to control exposure and thereby ensure reliable protection over time. In addition, implementation of a remedy cannot result in unacceptable short-term risks to, or cross-media impacts on, human health and the environment.

2. Compliance with ARARs and TBCs. Compliance with ARARs and TBCs is one of the statutory requirements for remedy selection. Alternatives are developed and refined throughout the FS process to ensure that they will meet all of their respective ARARs or that there is good rationale for waiving an ARAR. During the detailed analysis, information on Federal and state action-specific ARARs will be assembled along with previously identified chemical-specific and location-specific ARARs. Alternatives will be refined to ensure compliance with these requirements.

3. Long-term Effectiveness and Permanence. This criterion reflects CERCLA's emphasis on implementing remedies that will ensure protection of human health and the environment in the future, as well as in the near term. In evaluating alternatives for their long-term effectiveness and the degree of permanence they afford, the analysis should focus on the residual risks that will remain at the site after the completion of the remedial action. This analysis should include consideration of the following:

   - Degree of threat posed by the hazardous substances remaining at the site.

   - Adequacy of any controls (e.g., engineering and institutional controls) used to manage the hazardous substances remaining at the site.

- Reliability of those controls.

- Potential impacts on human health and the environment, should the remedy fail, based on assumptions included in the reasonable maximum exposure scenario.

4. Reduction of Toxicity, Mobility and Volume through Treatment. This criterion addresses the statutory preference for remedies that employ treatment as a principal element by ensuring that the relative performance of the various treatment alternatives in reducing toxicity, mobility, or volume will be assessed. Specifically, the analysis should examine the magnitude, significance, and irreversibility of reductions.

5. Short-term Effectiveness. This criterion examines the short-term impacts of the alternatives (i.e., impacts of the implementation) on the neighboring community, the workers, or the surrounding environment, including the potential threat to human health and the environment associated with excavation, treatment, and transportation of hazardous substances. The potential cross-media impacts of the remedy and the time to achieve protection of human health and the environment should also be analyzed.

6. Implementability. Implementability considerations include the technical and administrative feasibility of the alternatives, as well as the availability of the goods and services (e.g., treatment, storage, or disposal capacity) on which the viability of the alternative depends. Implementability considerations often affect the timing of various remedial alternatives (e.g., limitations on the season in which the remedy can be implemented, the number and complexity of materials-handling steps that must be followed, the need to obtain permits for offsite activities, and the need to secure technical services (such as well drilling and excavation).

7. Cost. Cost encompasses all capital costs and operation and maintenance (O&M) costs incurred over the life of the project. The focus during the detailed analysis is on the net present value of these costs. Costs were used to select the least expensive (or most cost-effective) alternative that will achieve the remedial action objectives. For purposes of calculating the present worth for the annual operating and maintenance costs, a 30-year maintenance life and a 5 percent annual discount factor are used.

8. State and USEPA Acceptance. This criterion, which is an ongoing concern throughout the remediation process, reflects the statutory requirement to provide for substantial and meaningful state and USEPA involvement.

9. Community Acceptance. This criterion refers to the community's comments on the remedial alternatives under consideration, where "community" is broadly defined to include all interested parties. These comments are taken into account throughout the FS process. However, only preliminary assessment of community acceptance can be conducted during the development of the FS, since formal public comment will not be received until after the public comment period for the preferred alternative is held.

5.3 DESCRIPTION AND ANALYSIS OF ALTERNATIVES FOR GROUNDWATER REMEDIATION

This section describes and analyzes in detail each of the groundwater alternatives that were assembled in Section 4.0. These alternatives are analyzed using the criteria described in Section 5.2.

5.3.1 Groundwater Alternative 1: No Action

5.3.1.1 Detailed Description

This alternative is a "walk-away" alternative that is required under CERCLA to establish a basis for comparison with other alternatives. In this alternative, any existing remedial activities, monitoring programs, and institutional controls would be discontinued, and the property could be released for unrestricted use. The only activity that would occur under the no-action alternative is 5-year periodic reviews of the site.

5.3.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Groundwater Alternative 1 would not be protective of human health and the environment. The major contaminants in the surficial aquifer will remain until dispersion, dilution, and other natural attenuating factors eventually reduce their concentrations. This process may take several hundred years for the slower migrating, heavy metal contaminants. Additionally, contaminant migration into the nearby surface streams and deeper aquifers is also possible. There would be no controls to prevent human exposure to contaminated groundwater. There would be no monitoring to assess contaminant migration or natural attenuation processes.

Compliance with ARARs and TBCs

Groundwater Alternative 1 will not comply with ARARs and TBCs, including state groundwater quality standards, Federal and state drinking water standards, and risk-based concentrations.

Long-term Effectiveness and Permanence

Contaminants remaining in the groundwater will continue to remain until dispersion, dilution, and other natural attenuating factors eventually reduce their concentrations. This process may take several hundred years for the slower migrating heavy metal contaminants. In the meantime, contaminant migration into the nearby surface streams and deeper aquifers is possible. Since the no-action alternative considers unrestricted use of the site, private ownership is possible, and private drinking water supply wells could be installed in the surficial aquifer. Use of the contaminated groundwater as a drinking water source would result in an unacceptable risk.

Under this alternative, there are no long-term management controls for the site. Therefore, the adequacy and reliability of controls would not be applicable. Also, there would be no long-term monitoring programs to assess the migration of contaminants from the site or natural attenuation processes. A 5-year periodic review of the site would be required as long as contaminants at OU2 would remain at levels that exceed RGOs.

Reduction of Toxicity, Mobility, and Volume through Treatment

Groundwater Alternative 1 does not include treatment to reduce toxicity, mobility, or volume of the hazardous substances at the site. There are no treatment processes employed; therefore, no materials are treated or destroyed.

Short-term Effectiveness

Since no actions would occur, Groundwater Alternative 1 would not pose any risks to the local community or onsite workers during implementation. There would be no environmental impacts from implementation. None of the remedial action objectives would be achieved.

Implementability

Since no actions would occur, Groundwater Alternative 1 is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost

There are no costs associated with the no-action alternative.

USEPA/State Acceptance

Groundwater Alternative 1 is not acceptable to USEPA or NCDEHNR.

5.3.2 Groundwater Alternative 2: Natural Attenuation and Institutional Controls

5.3.2.1 Detailed Description

Groundwater Alternative 2 consists of two components: (1) institutional controls and (2) natural attenuation. This alternative relies upon aquifer use restrictions to eliminate or reduce exposure pathways. Groundwater contamination would be allowed to naturally attenuate over time. Monitoring would be performed to confirm that contaminant migration from the site into the environment is not occurring and the effectiveness of natural attenuation. The Navy and MCAS Cherry Point will maintain the institutional controls until RAOs have been achieved.

Component 1: Institutional Controls

Institutional controls for groundwater consist of maintaining records of the groundwater contamination at OU2 in the MCAS Cherry Point Base Master Plan and designating the area as a restricted or limited use area. The Base Master Plan would ensure that the Air Station would be able to take adequate measures to minimize adverse human health and environmental effects at the time of future land development. The area would be given a designation in the Base Master Plan that would prohibit groundwater use and the installation of wells (except monitoring wells). Residential development or any intrusive activities would be prohibited.

Monitoring of groundwater, surface water, and sediment to support institutional controls would be conducted to confirm that migration of contaminants is not occurring and to determine the need for future actions. Monitoring would consist of sampling and analysis of surficial aquifer and Yorktown aquifer monitoring wells near Slocum Creek and Turkey Gut and surface water and sediment in Slocum Creek and Turkey Gut. The objective of monitoring is to allow an evaluation of contaminant migration and potential adverse effects on surface water bodies caused by the discharge of contaminated groundwater. A long-term monitoring plan must be implemented to confirm the ongoing effectiveness of natural attenuation and to detect unexpected contaminant migration away from the site. This may include upgradient wells, wells in the contaminated area, and wells near the receptor locations (i.e., Slocum Creek and Turkey Gut). Monitoring of the groundwater in the surficial aquifer would be used to confirm the effectiveness of natural attenuation and, possibly, whether biodegradation is occurring. Direct measurement of natural attenuation would involve analyzing for contaminant concentrations periodically and comparing these results to historic values. For cost estimating purposes, it is assumed that samples will be collected annually and analyzed for TCL organics, TAL metals, and cyanide. The details of the monitoring plan to be implemented will need to be developed during the Remedial Design with concurrence from USEPA and NCDEHNR.

Parameters that are indicators of biodegradation could also be measured. An observed loss of electron acceptors or an accumulation of metabolic byproducts in the contaminated area provides evidence that biodegradation is occurring. In aerobic respiration, dissolved oxygen serves as the electron receptor and is transformed to water. Dissolved oxygen will decrease during aerobic respiration. During anaerobic degradation, nitrate, ferric (III) iron, sulfate, and carbon dioxide can serve as electron receptors and are reduced to such byproducts as nitrite, ferrous (II) iron, hydrogen sulfide, and methane, respectively. Nitrate will decrease to concentrations below upgradient levels during denitrification. Ferrous (II) iron will increase to concentrations above upgradient levels during reduction of ferric (III) iron. Sulfate will decrease to concentrations below upgradient levels during sulfate reduction, and sulfide concentrations will increase to concentrations above upgradient levels. Methane will increase to concentrations above upgradient levels during methanogenesis. Alkalinity will increase to concentrations above upgradient levels during aerobic respiration, denitrification, iron (III) reduction, and sulfate reduction. Chloride will increase to concentrations above upgradient levels if chlorinated solvents are being biodegraded.

The analytical results from groundwater monitoring could be input into the groundwater model that is being developed for OU2. These results can be used to help calibrate the model to reflect actual field conditions. Depending on the analytical results, the model may possibly be used to predict future contaminant concentrations and the progress of natural attenuation.

<u>Component 2: Natural Attenuation</u>

Natural attenuation (or intrinsic remediation) refers to inherent processes that affect the rate of migration and the concentration of contaminants in groundwater. The most important processes are biodegradation, advection, hydrodynamic dispersion, dilution from recharge, sorption, and volatilization.

Advection and dispersion are the dominant mechanisms responsible for transporting contaminants in groundwater. These processes cause contaminants to spread and thus mix with uncontaminated groundwater to become diluted with increased travel distance. Dilution from recharge occurs as upgradient groundwater flows into and mixes with contaminated groundwater, causing a reduction in contaminant concentrations. Sorption slows the migration of contaminants relative to the rate of groundwater movement. Volatilization results in the transfer of contaminants to the soil gas in the unsaturated zone above the aquifer and, in some cases, the atmosphere.

Biodegradation is the only mechanism that can transform some contaminants into innocuous byproducts. It has been most effective for petroleum-related contaminants (e.g., BTEX compounds) and chlorinated solvents. It may be effective for other organics; however, it is not effective for metals. Biodegradation occurs when indigenous microorganisms reduce the total mass of contamination without the addition of nutrients. In most subsurface environments, both aerobic and anaerobic degradation can occur. These processes include aerobic respiration and the anaerobic processes of denitrification, iron (III) reduction, sulfate reduction, and methanogenesis.

Natural attenuation is effective if the rate of biodegradation, aided by sorption, is rapid enough to prevent significant contaminant migration by advection and dispersion. The strategy for documenting the occurrence of natural attenuation is based on documented loss of contaminants from the site and one or more pieces of evidence showing that biodegradation reactions are actually occurring in the field.

At least every 5 years, as site review would be conducted to evaluate the site status and determine whether further action is necessary. The site review is required because this alternative allows contaminants to remain at levels that exceed RGOs.

5.3.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Groundwater Alternative 2 would be protective of human health by preventing groundwater use with land and aquifer use restrictions. Protection of the environment would not be achieved if contaminants migrate from OU2 to nearby surface waters and result in concentrations that could adversely affect aquatic life.

The contaminants in the surficial aquifer will remain until biodegradation, dispersion, dilution, and other natural attenuating factors eventually reduce their concentrations. This process could take several hundred years for the heavy metal contaminants. Future contaminant migration into the nearby surface streams and the Yorktown aquifer is possible. Although potential migration of contaminants into the environment will not be reduced, except through the natural reduction of contaminant concentration, monitoring of groundwater in the surficial and Yorktown aquifers and surface water and sediment in Slocum Creek and Turkey Gut will determine whether further action is required.

Compliance with ARARs and TBCs

Groundwater Alternative 2 will eventually comply with chemical-specific ARARs and TBCs, including state groundwater standards, Federal and state drinking water standards, and risk-based concentrations.

Otherwise, a waiver of state groundwater standards is needed, or the groundwater can be reclassified. Alternative 2 does not propose active treatment of contaminated groundwater; therefore, this alternative must comply with the corrective action requirements of 15A NCAC 2L. 0106, demonstrating that groundwater restoration using best available technology is not required to provide protection of human health and the environment.

Long-term Effectiveness and Permanence

Although no removal would occur in Groundwater Alternative 2, the risks to human health and the environment would be reduced. Contaminants in the groundwater would remain until biodegradation, dispersion, dilution, and other natural attenuating factors eventually reduce their concentrations. This process could take several hundred years for the heavy metal contaminants. In the meantime, migration into the nearby surface streams and the Yorktown aquifer is also possible. This alternative can use institutional controls such as the MCAS Cherry Point Base Master Plan to restrict use of any Air Station property. Therefore, use of the groundwater beneath the site would be restricted until cleanup levels are achieved through natural attenuation. This would be determined by a long-term monitoring program to confirm that migration of contaminants from the site into the environment is not occurring and to compare the current and future concentrations of contamination at the site.

Institutional controls would be effective in the long term. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

Reduction of Toxicity, Mobility and Volume through Treatment

Groundwater Alternative 2 does not include treatment to reduce toxicity, mobility, or volume of the hazardous substances at the site. There are no treatment processes employed; therefore, no materials are treated or destroyed.

Short-term Effectiveness

Groundwater Alternative 2 would have minimal short-term effectiveness concerns. Any exposure of workers to the contaminated environmental media during monitoring can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. There would be no risks to the community or environmental impacts upon implementation of institutional controls. Based on modeling conducted to evaluate groundwater remediation, it is estimated that RGOs for organics will be achieved in less than 12 years. It may take 60 years to achieve RGOs for some metals (e.g., arsenic) and 1,000 years to attain RGOs for other metals (e.g., manganese).

Implementability

Implementability concerns associated with Groundwater Alternative 2 are expected to be minimal, since the site is located within a military facility, where land uses can be strictly enforced. Additional monitoring wells, if needed, are both easily constructed and commonly used, with equipment and resources readily available to perform the work.

Cost

The estimated costs for this alternative are:

- Estimated capital costs: $0
- Estimated annual costs: $43,800
- Estimated 30-year present worth: $729,000

The present-worth cost estimate of this alternative is based on a 30-year operation period for the monitoring (groundwater, surface water, and sediment sampling) costs. The details of the cost estimation are provided in Appendix C.

USEPA/State Acceptance

Groundwater Alternative 2 is acceptable to USEPA and NCDEHNR.

5.3.3 Groundwater Alternative 3: Groundwater Extraction; Treatment and Discharge to Slocum Creek or Pretreatment and Discharge to Sewage Treatment Plant (STP); Institutional Controls

5.3.3.1 Detailed Description

Groundwater Alternative 3 focuses on the removal and treatment of the contaminated groundwater beneath OU2. This alternative is made up of three major components: (1) groundwater extraction, (2) onsite groundwater treatment and discharge to Slocum Creek or the STP, and (3) institutional controls.

Component 1: Groundwater Extraction

The groundwater extraction system is designed to capture contaminated groundwater migrating from within the landfill, prior to its discharge into Slocum Creek and/or Turkey Gut. It is a containment-type remedy which assumes that the groundwater beneath the entire OU2 landfill area has been adversely affected and requires remediation. The design process for the extraction system was based upon a two-dimensional numerical modeling approach using the FLOWPATH groundwater flow and particle tracking model. The model addressed the surficial aquifer only, using the top of the confining layer separating the surficial aquifer from the Yorktown aquifer as the base of the model. Appendix B contains the conceptual design information for the groundwater extraction system.

The extraction system consists of 19 wells pumping at an aggregate rate of 123 gpm. Individual well pumping rates vary from 4 to 8 gpm. Well locations are shown in Appendix B, along with particle tracks indicating groundwater flow directions under pumping conditions. The wells are placed far enough from Slocum Creek or Turkey Gut to minimize induced infiltration of water from these streams.

The individual extraction well design for the OU2 groundwater extraction system includes stainless-steel casing and screen, for long-term durability, and a 6-inch well diameter to allow for adequate annular space between the submersible pump and well casing. Well borings will be 10 inches in diameter to allow sufficient space for proper well and gravel pack installation. The wells will extend vertically from ground surface to the top of the Yorktown confining unit, approximately 45 feet below ground surface on average. Screened intervals for the wells will be from the water table to the bottom of each well, an average distance of about 30 feet.

Groundwater extraction would continue until the RGOs for each of the contaminants of concern in the surficial aquifer groundwater are achieved. Modeling studies (Appendix A) have indicated that this process would take approximately 60 years for the majority of the contaminants. It may take much longer to achieve RGOs for manganese and iron.

Component 2A: Onsite Groundwater Treatment and Discharge to Slocum Creek

Groundwater treatment is designed to reduce concentrations of contaminants present in extracted surficial aquifer groundwater to levels, which upon discharge to Slocum Creek, would meet State of North Carolina surface water quality standards. Slocum Creek is classified as a Class SC tidal salt water for water quality purposes.

Table 5-1 indicates the estimated discharge limitations that would apply if extracted surficial aquifer groundwater were discharged directly into Slocum Creek. The discharge limitations are based upon no dilution in Slocum Creek and assume the maximum flow discharged from the groundwater treatment facility will be the design capacity of 150 gpm. Maximum contaminant concentrations in the extracted groundwater were estimated to be 1.5 times the average concentrations, which were calculated based upon analytical data and estimated pumping rates for the 19 wells.

Table 5-1 indicates that, based upon average expected groundwater contaminant concentrations, only pH, naphthalene (a polynuclear aromatic hydrocarbon), and alpha-chlordane would not meet the assumed discharge limitations based on State of North Carolina Water Quality Standards for surface water discharge. However, other contaminants must be removed from the groundwater to meet site-specific requirements of the National Pollutant Discharge Elimination System (NPDES) established under the Clean Water Act as well as the requirements of the state waste discharge programs. Typically, NPDES permits limit the amount of suspended solids discharged to a surface stream, such as Slocum Creek, to 30 mg/L. Since high concentrations of dissolved ferrous (II) iron in the surficial aquifer groundwater at OU2 have a strong tendency to oxidize to the less soluble ferric (III) state when brought to the surface (at pH $\geq$ 4.5), it is anticipated that treatment for suspended solids would also be required prior to discharge to Slocum Creek.

Onsite groundwater treatment would consist of the following unit operations/processes: equalization, pH adjustment/chemical precipitation, clarification, sand filtration, and carbon adsorption. Appendix B contains a detailed description of these processes and the conceptual design calculations for the groundwater treatment system.

Component 2B: Onsite Groundwater Pretreatment and Discharge to Sewage Treatment Plant

Groundwater pretreatment is designed to reduce concentrations of contaminants present in extracted surficial aquifer groundwater to levels that would be accepted by the MCAS STP.

Table 5-2 shows the estimated pretreatment standards expected to be enforced for any wastewaters, groundwaters, or stormwaters received by the STP. The pretreatment standards are based upon the STP NPDES discharge permit, State of North Carolina surface water quality standards for Slocum Creek, RCRA hazardous waste identification standards, and the current treatment capabilities of the STP. The sewage treatment facility has sufficient capacity to handle extracted groundwaters from the surficial aquifer beneath OU2. Currently, approximately 2.20 MGD of wastewater is being treated by the STP while its design capacity (average flow rate) is 3.20 MGD. Anticipated loading from extracted shallow groundwater at OU2 is not expected to contribute more than 0.216 MGD of flow to the facility.

TABLE 5-1

TREATMENT REQUIREMENTS FOR DISCHARGE TO SLOCUM CREEK
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Contaminant	Avg Groundwater Treatment Plant Influent(1)	Class SC Water Quality Standard	Maximum Concentration in Slocum Creek	Max Groundwater Treatment Plant Influent	Estimated Discharge Limitation	Method Detection Limit(2)
Volatile Organics (μg/L)						
Benzene	10.6	71.4	ND(3)	15.9	71.4	1
Trichloroethene	6.6	81	ND	9.9	81	1
Vinyl chloride	3.3	525	ND	5.0	525	1
Semivolatile Organics (μg/L)						
Naphthalene	4.5	0.0311(4)	ND	6.8	0.0311	7
Pesticides/PCBs (μg/L)						
Aldrin	0.00013	0.000136	ND	0.00019	0.00014	0.002
gamma-BHC (Lindane)	0.0023	0.0040	ND	0.0035	0.0040	0.006
alpha-Chlordane	0.0020	0.000588	ND	0.0030	0.00059	0.009
4,4'-DDT	0.0004	0.000591	ND	0.0006	0.00059	0.005
Endosulfan	0.0030	0.0090	ND	0.0045	0.0090	0.003
Endrin	0.0011	0.0020	ND	0.0016	0.0020	0.006
Heptachlor	0.0002	0.000214	ND	0.0003	0.00021	0.003
Inorganics (μg/L)						
Arsenic	33.7	50	ND	50.5	50	2
Beryllium	0.025	0.117	ND	0.037	0.117	1
Cadmium	1.1	5.0	ND	1.6	5.0	5
Copper	0.042	3.0	37	0.063	3.0	2
Lead	0.435	25	ND	0.652	25	1
Nickel	0.63	8.3	ND	0.94	8.3	20
Zinc	5.9	86	7.0	8.8	86	6
Cyanide	0.70	1.0	ND	1.0	1.0	10
Conventional (mg/L)						
pH (Standard Units)	5.9	6.8 - 8.5	6.7 - 7.0	5.9	6.8 - 8.5	NA
Iron	62.5	NS(5)	0.158	93.7	NS	0.02
Manganese	0.30	NS	0.43	0.45	NS	0.002
Turbidity (NTUs)	8.2	25	---	12.3	25	---
Total Suspended Solids (est. based on iron conc.)	120	---	---	180	30	---

(1) Calculated value based upon expected pumping rates and contaminant concentrations for the 19 extraction wells.
(2) Method or instrument detection limit used during the most recent sampling event.
(3) ND - Not detected.
(4) Standard for polynuclear aromatic hydrocarbons.
(5) NS - No standard.

TABLE 5-2

PRETREATMENT STANDARDS FOR DISCHARGE TO MCAS SEWAGE TREATMENT PLANT OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA

Contaminant	Average Groundwater Treatment Plant Influent	Maximum Groundwater Treatment Plant Influent	STP Pretreatment Standard
Volatile Organics (µg/L)			
Benzene	10.6	15.9	500
Chlorobenzene	69.7	104.5	100,000
1,4-Dichlorobenzene	12.2	18.3	7,500
1,2-Dichloroethane	0.14	0.21	500
1,1-Dichloroethene	0.08	0.12	700
2-Butanone (MEK)	8.9	13.3	200,000
Tetrachloroethene	0.67	1.0	700
Trichloroethene	6.6	9.9	500
Vinyl chloride	3.3	5.0	200
Semivolatile Organics (µg/L)			
Nitrobenzene	0.07	0.10	2,000
Pesticides/PCBs (µg/L)			
gamma-BHC (Lindane)	0.0023	0.0034	0.050
alpha-Chlordane	0.0020	0.0030	0.040
Endrin	0.0011	0.0016	0.047
Heptachlor	0.0002	0.0003	0.050
Organics (µg/L)			
Total Toxic Organics	165	248	2,100
Inorganics (µg/L)			
Arsenic	33.7	50.5	500
Barium	137	205	100,000
Cadmium	1.1	1.6	50
Copper	0.042	0.063	210
Lead	0.435	0.652	250
Nickel	0.63	0.94	500
Zinc	5.9	8.8	4,000
Cyanide	0.70	1.0	50
Conventional (mg/L)			
pH (Standard Units)	5.9	5.9	6.0 - 9.0
Iron	62.5	93.8	NA
Total Suspended Solids (est. based on iron conc.)	120	180	450

The STP consists of the following sequential treatment steps: primary settling, primary biological treatment (trickling filter), secondary biological treatment (activated sludge), secondary clarification, rapid sand filtration, and chlorination/dechlorination. The sludge generated by this facility is disposed of by permitted land application. Maximum contaminant concentrations in the extracted groundwater were estimated to be 1.5 times the average concentrations, which were calculated based upon analytical data and estimated pumping rates for the 19 wells.

Table 5-2 indicates that only pH may not meet estimated pretreatment standards applicable for discharge of extracted surficial aquifer groundwater to the STP. Although high concentrations of dissolved ferrous (II) iron in the extracted groundwater at OU2 have a strong tendency to oxidize to the less soluble ferric (III) state when brought to the surface (at pH $\geq$ 4.5), it is anticipated that the STP pretreatment standard of 450 mg/L for suspended solids will not be exceeded. Therefore, pretreatment of the extracted groundwater will only require equalization/aeration followed by pH adjustment, with the resultant ferric hydroxide laden groundwater stream being discharged to the primary settling chamber of the STP. Appendix B contains a detailed description of the processes and the conceptual design calculations for the groundwater pretreatment system.

It is proposed that the groundwater treatment or pretreatment facility be placed in a newly constructed treatment building located to the south of the unlined ponds between the existing fence and the former sludge application area. A site layout map for this alternative is shown in Figure 5-1.

Component 3: Institutional Controls

Institutional controls would consist of maintaining records of the groundwater contamination at OU2 in the MCAS Cherry Point Base Master Plan and designating the area as a restricted or limited use area. Also monitoring of groundwater, surface water, and sediment to confirm that migration of contaminants into the environment is not occurring and to determine the need for future actions would be conducted.

The Base Master Plan records on the presence of contamination at the site would ensure that at the time of future land development, the Air Station would be able to take adequate measures to minimize adverse human health and environmental effects. The area would be given a designation in the Base Master Plan that would prohibit residential use and installation of wells, except monitoring wells. In addition, the Base Master Plan would restrict the uses of the groundwater at the site until groundwater cleanup levels are achieved.

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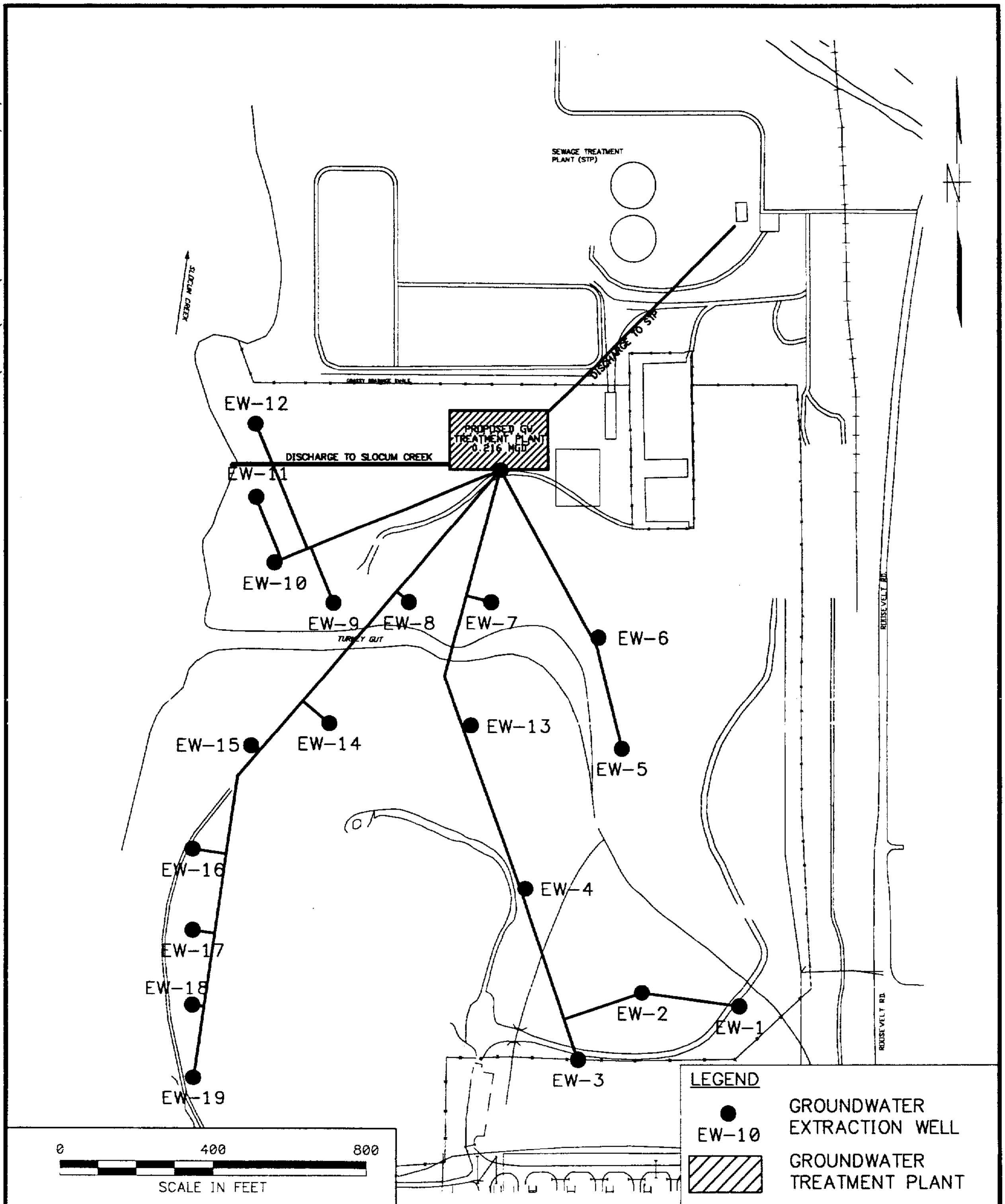

DRAWN BY HJP DATE 04/14/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
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COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 5-1	REV. 0

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Monitoring would consist of sampling and analysis of surficial and Yorktown aquifer monitoring wells and surface waters and sediments in Slocum Creek and Turkey Gut to confirm aquifer restoration and confirm that migration of contaminants from OU2 into the environment is not occurring. Monitoring would continue until COC concentrations decrease to or approach cleanup goals.

Every 5 years, a site review would be conducted to evaluate the site status and determine whether further action is necessary. The site review is required because this alternative allows contaminants to remain at levels that exceed RGOs.

5.3.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Groundwater Alternative 3 would be protective of human health and the environment. By implementing the groundwater extraction and treatment system, the major contaminants in the surficial aquifer will be contained from migrating off the OU2 site. Migration into the nearby surface streams would be prevented, and the potential for contaminant migration into the Yorktown aquifer would be minimized as the surficial aquifer contaminant concentrations are reduced. In addition, monitoring of groundwater in the surficial and Yorktown aquifers, as well as surface water and sediment in Slocum Creek and Turkey Gut, will help in confirming the effectiveness of this remedial action and whether additional modifications are required.

Compliance with ARARs and TBCs

The contaminated groundwater in the surficial aquifer currently exceeds North Carolina Class GA groundwater standards or Federal drinking water MCLs. This alternative would be capable of complying with these standards with the exception of manganese, which modeling indicates could not be removed to less than 50 $\mu g/L$ within 1,000 years. A waiver for technical impracticability would be warranted for manganese. Iron would be similar to manganese and may require a long duration to achieve compliance with state standards. Considerations undertaken during implementation of this alternative will comply with action- and location-specific ARARs.

Long-Term Effectiveness and Permanence

Contamination in the groundwater would be removed from the surficial aquifer and treated prior to discharge to Slocum Creek or the MCAS Cherry Point STP.

Manganese and iron are expected to remain as contaminants in the surficial aquifer at the completion of remediation. The balance of the inorganic contaminants would be reduced to concentrations less than RGOs within a period of approximately 60 years. It should be noted that organic contaminants in this system will be reduced to concentrations below RGOs within approximately 11 years, and the carbon adsorption portion of the treatment system (for discharge to Slocum Creek) may be discontinued at that time. This remedial action alternative would use institutional controls such as the MCAS Cherry Point Base Master Plan to restrict use of any Air Station property. Therefore, use of the groundwater beneath the site could be restricted until cleanup levels are achieved. This would be determined by long-term monitoring programs that confirm the effectiveness of the remedial action. Additionally, monitoring of the Yorktown aquifer would be conducted to determine whether future remedial actions are warranted. It is anticipated that as the surficial aquifer contaminant concentrations decrease, the potential for adversely affecting the Yorktown aquifer also decreases. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

The treatment system for discharge to Slocum Creek uses aeration, pH adjustment, chemical precipitation, clarification, filtration, and granular activated carbon (GAC) adsorption to enable the extracted groundwater to achieve surface stream standards prior to discharge to Slocum Creek. The pretreatment system for discharge to the STP uses aeration and pH adjustment to enable the extracted groundwater to achieve STP pretreatment standards. These are well-proven technologies that should provide adequate performance over the entire period of remediation. Sufficient equalization capacity has been provided to eliminate large slugs of contaminants that could reduce treatment efficiency. The O&M requirements for the extraction/treatment system would consist of routine checks and servicing of wells, pumps, blowers, mixers, valves, electrical components, etc.; offsite regeneration of the spent GAC (for discharge to Slocum Creek); and disposal of nonhazardous dewatered sludge (for discharge to Slocum Creek). Pumps, blowers, mixers, and other mechanical equipment will typically require replacement every 30 years. Caustic for pH control would have to be replaced monthly, and GAC (for discharge to Slocum Creek) would require replacement on a quarterly basis. Safety controls could be included in the design so that in the event of equipment failure, the extraction system would be shut down to ensure that untreated groundwater was not released to Slocum Creek or the STP.

Reduction of Toxicity, Mobility, and Volume through Treatment

The groundwater extraction system is designed to remove 65 million gallons of contaminated surficial aquifer groundwater per year for 60 years for a total of 3.9 billion gallons. The extracted groundwater is then treated to meet North Carolina surface water quality standards prior to being discharged to Slocum Creek or STP pretreatment standards prior to being discharged to that facility. Although the major contaminants in the surficial aquifer do not meet North Carolina groundwater standards, they are sufficiently low in concentration to meet state surface water standards and STP pretreatment standards and, therefore, do not require treatment.

For discharge to Slocum Creek, however, trace amounts of naphthalene and alpha-chlordane require treatment by GAC to meet stream standards. In addition, pH adjustment and treatment of iron to meet projected NPDES suspended solids limits are also necessary. During the aeration step to oxidize the iron, a certain percentage of the VOCs in the extracted groundwater will escape to the atmosphere because of transfer to the vapor phase. Assuming that 90 percent volatilization takes place, the three largest losses of VOC contaminants to the atmosphere would be chlorobenzene at 33.8 pounds per year (lb/yr), benzene at 5.1 lb/yr, and TCE at 3.2 lb/yr. The VOCs that are not discharged to the atmosphere during aeration will be removed by GAC along with naphthalene, aldrin, heptachlor, and other incidental organics present in the groundwater. It is estimated that 21 tons per year of spent liquid-phase GAC would be thermally destroyed (100 percent irreversibly) during the regeneration of the spent carbon. The chemical precipitation, clarification, filtration, and sludge dewatering processes in the groundwater treatment operation will generate approximately 130 tons per year of ferric hydroxide filter cake, which would be disposed of at an offsite, nonhazardous waste landfill.

For discharge to the STP, only pH adjustment is necessary to meet pretreatment standards; therefore, only equalization/aeration and pH adjustment are employed. During the equalization/aeration step, VOCs will escape to the atmosphere, as discussed above for discharge to Slocum Creek. The VOCs that are not discharged to the atmosphere will be removed irreversibly at the STP by adsorption into the microorganisms of the biological treatment process. Sludge generated by the STP is disposed of by permitted land application.

Short-Term Effectiveness

In Groundwater Alternative 3, exposure of workers to the contaminated environmental media during monitoring, installation of the groundwater extraction wells, or construction of the groundwater treatment system can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. The remedial activities are not expected to have an adverse impact on either the community or the environment. Once the groundwater treatment plant becomes operational, all activities will occur within the fenced-in confines of OU2 except for the delivery of treatment chemicals (caustic), the offsite disposal/treatment of dewatered sludges and spent carbon, and the placement of the discharge pipe to the STP. Any risks of exposure to the community during transportation of the spent GAC (approximately 5 tons every 90 days) would be adequately controlled. With adequate safety precautions, offsite transportation of contaminated material should not pose significant concerns. Adequate alarms and controls would be installed to minimize the release of contaminated groundwater into the environment. Volatile organics may be released to the environment during the equalization/aeration process in the groundwater treatment facility; however, the amounts are expected to be very small and well within emissions limits. The groundwater extraction and treatment operations are estimated to be completed in approximately 60 years.

Implementability

Groundwater Alternative 3 is readily implementable. Groundwater monitoring and extraction wells are both easily constructed and commonly used, with equipment and resources readily available to perform the work. Chemical precipitation, clarification, and carbon adsorption are commonly used and reliable processes in groundwater remediation for treatment of various organic and inorganic contaminants. Equipment and services necessary to construct these groundwater treatment processes and a building to house them are offered by numerous commercial vendors. Local and construction permits or approvals may be required to build the groundwater treatment facility, and an NPDES permit may be required to discharge the treated groundwater to Slocum Creek. An outfall must be established for discharge to Slocum Creek in coordination with the appropriate state agencies. The spent activated carbon is typically regenerated off site by the supplier, who would replace it with fresh or regenerated carbon on a contractual basis. The dewatered sludge from the treatment process is anticipated to be nonhazardous and, therefore, will not require disposal at a hazardous waste disposal site. It is expected that permitted, nonhazardous waste landfills are available with adequate capacity to accept the dewatered sludge from the groundwater treatment facility. Both monitoring to confirm the effectiveness of this alternative and NPDES or STP discharge monitoring would be readily implemented.

Cost

The estimated costs for this alternative for discharge to Slocum Creek are:

- Estimated capital costs: $4,340,000
- Estimated annual costs: $395,000
- Estimated 30-year present worth: $10,466,000

The estimated costs for this alternative for discharge to the STP are:

- Estimated capital costs: $2,181,000
- Estimated annual costs: $198,000
- Estimated 30-year present worth: $5,278,000

The present-worth cost estimates of this alternative are based on a 30-year operation period for the groundwater extraction and treatment system and for monitoring (groundwater, surface water, and sediment sampling) costs. The details of the cost estimations are provided in Appendix C.

USEPA/State Acceptance

Groundwater Alternative 3 is acceptable to USEPA and NCDEHNR.

5.3.4 Groundwater Alternative 4: Air Sparging/Soil Vapor Extraction; Institutional Controls

5.3.4.1 Detailed Description

Groundwater Alternative 4 focuses on the in-situ treatment of volatile organics in the groundwater beneath OU2. This alternative is made up of two major components: (1) air sparging (AS) and soil vapor extraction (SVE) and (2) institutional controls.

Component 1: Air Sparging and Soil Vapor Extraction

The in-situ groundwater treatment system is designed to intercept contaminated groundwater migrating from within the landfill, prior to its discharge into Slocum Creek and/or Turkey Gut. Volatile organic compounds, and possibly some biodegradable semivolatile organics, would be removed. Appendix B contains the conceptual design information for the in-situ AS/SVE system.

The AS/SVE system would consist of a series of wells screened near the bottom of the surficial aquifer to inject air into the contaminated groundwater. The average well depths range from 35 to 50 feet. The injection wells would be alternately spaced between horizontal extraction wells constructed in trenches approximately 3 feet deep. Extracted air, which would contain the VOCs removed from the groundwater, would be treated using an above ground, off-gas treatment system. The in-situ groundwater treatment system would consist of a series of 9 sub-systems along the boundaries of Slocum Creek and Turkey Gut. Each sub-system would contain 9 to 11 air injection wells, 8 to 10 horizontal extraction wells, and a separate control building and off-gas treatment system.

Each AS/SVE system was limited to 600 feet in length (300 feet on each side of the control building) to avoid significant friction losses. A control building would be required for each AS/SVE sub-system. Each horizontal extraction well would be 60 feet in length and located equidistant between two air injection wells and perpendicular to the line connecting two adjacent injection wells.

In-situ groundwater treatment would continue until RGOs for the VOCs in the surficial aquifer are achieved. Modeling studies have indicated that this process would take approximately 11 years. The intent of the system is not to remove semivolatile organics, pesticides, or metals; however, there may be some incidental removal. A site layout map and a conceptual diagram of the AS/SVE system component of this alternative is shown in Figure 5-2.

Component 2: Institutional Controls

This component is identical to the institutional controls component as described in Section 5.3.3.1 for Groundwater Alternative 2.

5.3.4.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Groundwater Alternative 4 would be protective of human health and the environment. By implementing the in-situ groundwater treatment system, the volatile organic contaminants in the surficial aquifer will be contained from migrating off the OU2 site. Migration of volatile organics into nearby streams would be prevented, and the potential for migration into the Yorktown aquifer would be minimized as the surficial aquifer contaminant concentrations are reduced. In addition, monitoring of groundwater in the surficial and Yorktown aquifers, as well as surface water and sediment in Slocum Creek and Turkey Gut, will help in confirming the effectiveness of this remedial action and whether additional modifications are required.

Compliance with ARARs and TBCs

The contaminated groundwater in the surficial aquifer currently exceeds North Carolina Class GA groundwater standards and Federal drinking water MCLs. This alternative would only be capable of complying with these standards for volatile organics. In-situ treatment would not be capable of complying with these standards for other organics or metals, which would eventually be reduced by natural attenuation processes. Modeling indicates that it would take approximately 11 years to attain ARARs for other organics and 60 years for most metals through natural attenuation. Modeling also indicates that standards for manganese could not be attained within 1,000 years. A waiver for technical impracticability would be warranted for manganese. Iron would be similar to manganese and may require a long duration to achieve compliance with state standards. Considerations taken during implementation of this alternative will comply with action- and location-specific ARARs.

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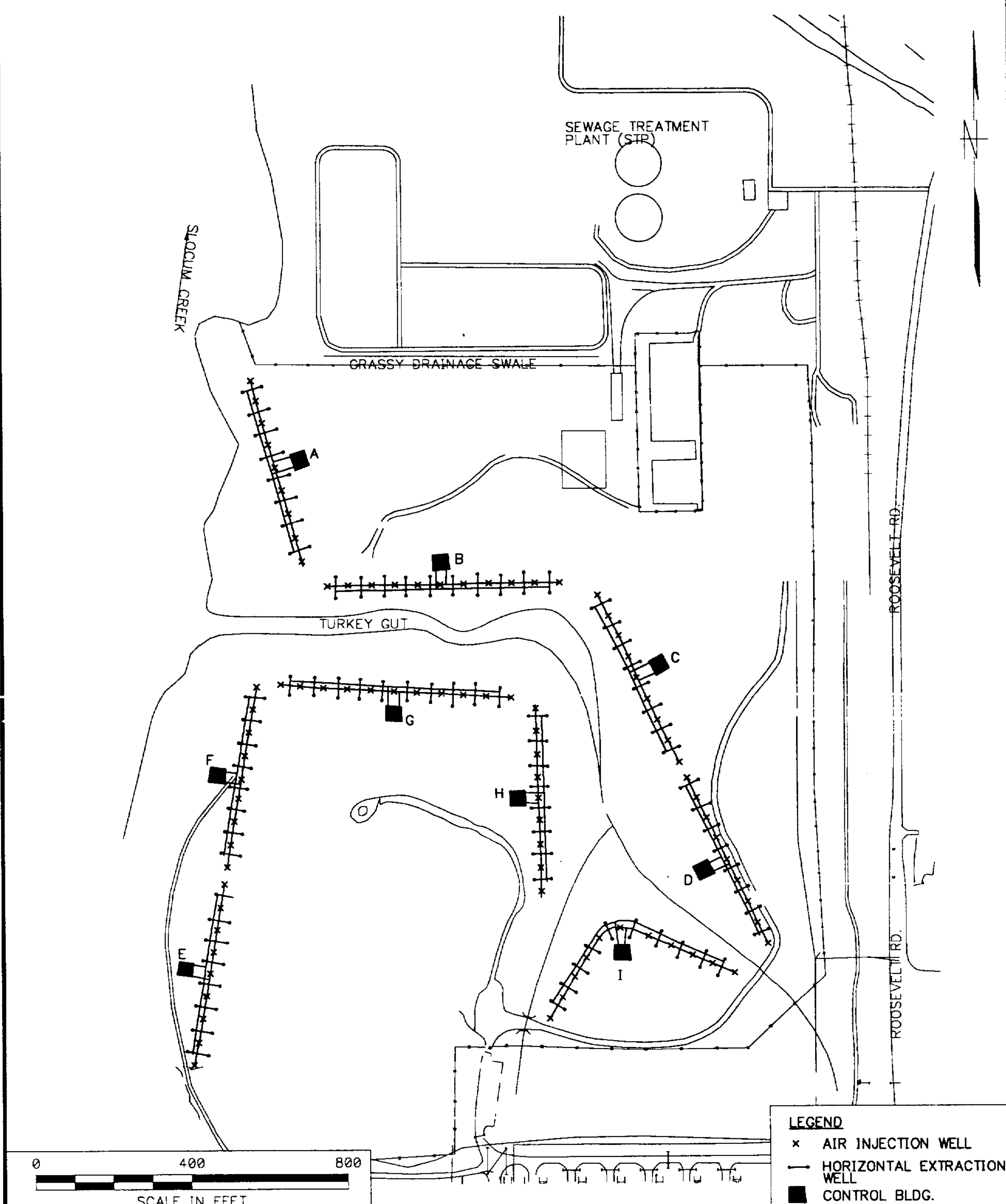

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SCALE AS NOTED			DRAWING NO. FIGURE 5-2	REV. 0

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Long-Term Effectiveness and Permanence

Although this alternative only targets the removal of volatile organics, the risks to human health and the environment would be reduced. Groundwater contaminants other than volatiles would remain until biodegradation, dispersion, dilution, and other natural attenuating factors eventually reduce their concentrations. This process could take several hundred years for some of the heavy metal contaminants. In the meantime, migration into the nearby surface streams and the Yorktown aquifer is also possible; however, these other organics and metals are generally less mobile in the environment that the VOCs targeted for removal. This alternative can use institutional controls such as the MCAS Cherry Point Base Master Plan to restrict the use of any Air Station property. Therefore, use of the surficial aquifer groundwater would be restricted until cleanup levels are achieved through natural attenuation. This would be determined by a long-term monitoring program.

Institutional controls would be effective in the long term. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

Reduction in Toxicity, Mobility, and Volume through Treatment

Groundwater Alternative 4 uses in-situ AS/SVE to remove volatile organics from the surficial aquifer groundwater. It would not remove most other organics or metals. Volatile organics in the off-gas would be removed by GAC prior to discharge to the atmosphere. It is estimated that 5,200 pounds per year of spent vapor phase GAC would be generated.

Short-Term Effectiveness

In Groundwater Alternative 4, exposure of workers to the contaminated environmental media during monitoring and installation of the AS/SVE systems can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. The remedial activities are not expected to have an adverse impact on either the community or the environment. Once the AS/SVE systems become operational, all activities will occur within the fenced-in confines of OU2 except for the offsite disposal/treatment of spent carbon. Any risks of exposure to the community during transportation of spent GAC would be adequately controlled. With adequate safety precautions, offsite transportation of contaminated material should not pose significant concerns. The in-situ groundwater treatment operations are estimated to be completed in approximately 11 years.

Implementability

Groundwater Alternative 4 is readily implementable. Air injection and extraction wells and groundwater monitoring wells are easily constructed, with equipment and resources readily available to perform the work. Vapor-phase carbon adsorption is a commonly used and reliable process for removal of organics from off-gas emissions. Equipment and services necessary to construct the in-situ groundwater treatment systems and control buildings are offered by numerous commercial vendors. Local and construction permits or approvals may be required to build the treatment systems. The spent activated carbon is typically regenerated off site by the supplier, who would replace it with fresh or regenerated carbon on a contractual basis. Monitoring to confirm the effectiveness of this alternative would be readily implementable.

Cost

The estimated costs for this alternative are:

- Estimated capital costs: $2,089,000
- Estimated annual costs: $248,000
- Estimated 30-year present worth: $4,514,000

The present-worth cost estimate of this alternative is based on an 11-year operational period for the in-situ groundwater treatment system and 30 years for monitoring (groundwater, surface water, and sediment sampling). The details of the cost estimate are provided in Appendix C.

USEPA/State Acceptance

Groundwater Alternative 4 is acceptable to USEPA and NCDEHNR.

5.4 DESCRIPTION AND ANALYSIS OF ALTERNATIVES FOR SOIL REMEDIATION

This section describes and analyzes in detail each of the soil alternatives that were assembled in Section 4.0. These alternatives were analyzed using the criteria described in Section 5.2.

5.4.1 Soil Alternative 1: No Action

5.4.1.1 Detailed Description

This alternative is a "walk-away" alternative that is required under CERCLA to establish a basis for comparison with other alternatives. In this alternative, any existing remedial activities, monitoring programs, and institutional controls would be discontinued, and the property could be released for unrestricted use. The only activity that would occur under the no-action alternative is 5-year periodic reviews of the site.

5.4.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Soil Alternative 1 would not be protective of human health and the environment. The future potential for contaminants in the surface soil to enter the human exposure pathway through incidental ingestion and dermal contact would continue to exist. In addition, contaminants in the soil could continue to migrate into the surficial aquifer and could eventually enter the nearby surface streams of Slocum Creek and Turkey Gut.

Compliance with ARARs and TBCs

Soil Alternative 1 will not comply with ARARs and TBCs, including state soil target concentrations for protection of groundwater and risk-based concentrations.

Long-Term Effectiveness and Permanence

The current and future threats to human health and the environment would remain. Surface soil contaminants would continue to pose a threat from dermal contact and incidental ingestion. Other soil contaminants could also migrate into the surficial aquifer, Slocum Creek, and Turkey Gut.

Under this alternative, there are no long-term management controls for the site. Therefore, the adequacy and reliability of controls would not be applicable. Also, there would be no long-term monitoring program to confirm that migration of soil contaminants from the site to the environment is not occurring. A 5-year periodic review of the site would be required as long as contaminants at OU2 would remain at levels that exceed RGOs.

Reduction of Toxicity, Mobility, and Volume through Treatment

Soil Alternative 1 does not include treatment to reduce the toxicity, mobility, or volume of the hazardous substances at the site. There are no treatment processes employed; therefore, no materials are treated or destroyed.

Short-Term Effectiveness

Since no actions would occur, Soil Alternative 1 would not pose any risks to the local community or onsite workers during implementation. There would be no environmental impacts from implementation. None of the remedial action objectives would be achieved.

Implementability

Since no actions would occur, Soil Alternative 1 is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Costs

There are no costs associated with the no-action alternative.

USEPA/State Acceptance

Soil Alternative 1 is not acceptable to USEPA and NCDEHNR.

5.4.2 Soil Alternative 2: Institutional Controls

5.4.2.1 Detailed Description

Soil Alternative 2 consists of only one component, institutional controls. This alternative relies on land use restrictions, limited site access, and monitoring to eliminate or reduce exposure pathways. Monitoring would be performed to confirm that contaminant migration from the site into the environment is not occurring. The Navy and MCAS Cherry Point will maintain the institutional controls until RAOs have been achieved.

Institutional controls would consist of maintaining records of the contamination at OU2 in the MCAS Cherry Point Base Master Plan and designating the site as a restricted or limited use area. Residential development or any intrusive activities would not be permitted. Also, monitoring of groundwater, Slocum Creek, and

Turkey Gut would be conducted to confirm that migration of contaminants into the environment is not occurring and to determine the need to future actions. This alternative also includes reinforcement and repair of fencing and warning signs around the site to minimize human exposure to contaminated media and buried wastes.

The Base Master Plan records on the presence of contamination at OU2 would ensure that at the time of any future land development, the Air Station would be able to take adequate measures to minimize adverse human health and environmental effects. The area would be given a designation in the Base Master Plan that would prohibit residential use, invasive construction activities, and installation of wells (except monitoring wells).

Monitoring would consist of sampling and analysis of surficial aquifer and Yorktown aquifer monitoring wells and surface water and sediment in Slocum Creek and Turkey Gut to confirm that migration of contaminants from OU2 into the environment is not occurring. Any future construction activity at OU2 must be conducted in compliance with health and safety requirements that would minimize the potential for exposure to contaminants. The state and USEPA would be properly notified of proposed construction plans at OU2 prior to commencement of any construction activities.

Fencing and warning signs would be replaced and repaired as necessary to physically limit access to the site and indicate to potential trespassers that a potential health threat is present. Signs are typically posted at equal intervals along the perimeter of a site and along roads leading to a site. Warning signs would also be posted along Slocum Creek and Turkey Gut. A chain-link fence approximately 8 feet high currently surrounds most of the site (except along Slocum Creek) to limit access. The two unlined ponds at the north end of OU2, which until recently served as aeration basins for the STP, would also be enclosed by fencing. Locked gates would be maintained at the entrance of each roadway to the site. It is estimated that approximately 1,400 feet of chain-link fence would be required for the perimeter of the ponds.

At least every 5 years, a site review would be conducted to evaluate the site status and determine whether further action is necessary. The site review would be required because this alternative allows contaminants to remain at levels that exceed RGOs.

5.4.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Soil Alternative 2 would be protective of human health by limiting site access with land use restrictions. Protection of the environment would not be achieved if contaminants migrate to groundwater or nearby surface waters and result in concentrations that could adversely affect aquatic life. The potential for contaminants in the surface soil to enter the human exposure pathway through incidental ingestion and dermal contact would be reduced by securing the fencing and access to the site. Soil contaminants could continue to migrate to the surficial aquifer and eventually enter the nearby streams of Slocum Creek and Turkey Gut.

Although migration of contaminants into the environment would not be reduced, monitoring of groundwater in the surficial and Yorktown aquifers and surface water and sediment in Slocum Creek and Turkey Gut will determine whether further action is required.

Compliance with ARARs and TBCs

Soil Alternative 2 will not comply with the state S-3 target concentrations for protection of groundwater. The primary (i.e., buried waste) and secondary (i.e., contaminated soil) sources of groundwater contamination would remain, which is not in compliance with the groundwater corrective action requirements of 15A NCAC 2L .0106.

Long-Term Effectiveness and Permanence

Although, no removal would occur in Soil Alternative 2, the risks to human health and the environment would be reduced. Buried wastes would remain at the site. Contaminants would remain in the surface soil; however, secure perimeter fencing and controlled site access would reduce the potential health hazard. Soil contaminants that may migrate to groundwater would remain and could migrate to nearby surface streams; however, monitoring would be conducted to confirm this is not occurring.

Institutional controls would be effective in the long term. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

Reduction of Toxicity, Mobility, and Volume through Treatment

Soil Alternative 2 does not include treatment to reduce toxicity, mobility, or volume of hazardous substances at the site. Since no treatment processes are employed, no materials are treated or destroyed.

Short-Term Effectiveness

Soil Alternative 2 would have minimal short-term effectiveness concerns. Any exposure of workers to the contaminated environmental media during monitoring or repairing or replacement of fencing can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. There would be no risks to the community or environmental impacts upon implementation of institutional controls. The fencing and warning signs could be implemented in less than one year.

Implementability

Implementability concerns associated with Soil Alternative 2 are expected to be minimal, since the site is located within a military facility, where land uses can be strictly enforced. Security fencing, warning signs, and additional monitoring wells, if needed, are easily constructed and commonly used, with equipment and resources readily available to perform the work.

Costs

The estimated costs for this alternative are:

- Estimated capital costs: $70,800
- Estimated annual costs: $43,800
- Estimated 30-year present worth: $800,000

The present-worth cost estimate of this alternative is based on a 30-year operational period for the monitoring (groundwater, surface water, and sediment sampling) costs. The details of the cost estimation are provided in Appendix C.

USEPA/State Acceptance

Soil Alternative 2 is not acceptable to USEPA and NCDEHNR.

5.4.3 Soil Alternative 3: Soil Vapor Extraction; Institutional Controls

5.4.3.1 Detailed Description

Soil Alternative 3 addresses major areas of VOC contamination that exceed RGOs based on protection of groundwater. This alternative does not address buried waste materials (primary source), but addresses major secondary sources of groundwater contamination. This alternative is made up of two major components: (1) soil vapor extraction (SVE) and (2) institutional controls.

Component 1: Soil Vapor Extraction (SVE)

In-situ treatment is designed to address the four previously identified major VOC "hot spots" (secondary source areas) in the vadose or unsaturated zone above the surficial aquifer. Each of these concentrated areas of volatile organic contamination would be remediated using SVE. Vapor extraction in the vadose zone removes the VOCs from the contaminated soils in the unsaturated zone.

For each area or "hot spot" where an SVE system is applicable, a network of vapor extraction wells with perforated well screens will be installed. The wells are packed with gravel and sealed at the top with bentonite to prevent short circuiting. The extraction wells are connected to the suction side of a vacuum extraction unit through a surface collection manifold. The vacuum extraction unit induces a flow of air through the subsurface and into the extraction wells. The vacuum not only draws vapors from the vadose zone but also decreases the pressure in soil voids and thus causes the release of additional VOCs. The extracted gas flows through the surface collection manifold, where it is then treated further by carbon adsorption prior to being vented to the atmosphere.

In the design of each SVE treatment system, horizontal spacing between the extraction wells must be close enough to ensure that no contaminated areas are left untreated. However, they must be spaced far enough apart to prevent overlapping influence zones of individual wells. Care must be taken to prevent the vapor extraction process from being shortcircuited by debris and noncontinuous lifts. This may require that more extraction wells be placed closer together to ensure sufficient treatment. In addition, the vapor extraction well depths must be close enough to the water table to maximize the removal of vapors, yet sufficiently removed to prevent groundwater extraction due to water table fluctuations.

It is estimated that 16 vapor extraction wells would be installed in Area 1, 4 extraction wells would be installed in Area 2, 4 extraction wells would be installed in Area 3A, 6 extraction wells would be installed in Area 3B, and 6 extraction wells would be installed in Area 4. In each system, the extracted vapors are then treated by activated carbon adsorption for removal of residual organic contaminants prior to being vented to the atmosphere.

The extraction wells would be connected to a vacuum pump that would be designed to extract approximately 2.5 cfm of vapor-laden air per well at a vacuum of 6 psia. It is estimated that 2 years of time will be required to construct the in-situ SVE process and successfully treat the volatile "hot spots" at OU2.

Component 2: Institutional Controls

This component is identical to the institutional controls component as described in Section 5.4.2.1 for Soil Alternative 2. In addition, monitoring of air emissions and confirmation soil sampling would be conducted to determine the effectiveness of treatment.

Figure 5-3 shows the site layout map for this alternative.

5.4.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Soil Alternative 3 would be protective of human health and the environment by limiting site access with land use restrictions and treating the major secondary sources of groundwater contamination using SVE. Protection of the environment would not be achieved if contaminants in the buried wastes (primary source) or at minor secondary source areas migrate to groundwater or nearby surface waters and result in concentrations that could adversely affect aquatic life. The potential for contaminants in the surface soil to enter the human exposure pathway through incidental ingestion and dermal contact would be reduced by securing the fencing and access to the site.

Migration of volatile organic contaminants to the environment would be reduced, but all potential sources of groundwater contamination would not be addressed. Monitoring of groundwater in the surficial and Yorktown aquifers and surface water and sediment in Slocum Creek and Turkey Gut will confirm that other contaminants are not migrating into the environment and whether further action is required.

Compliance with ARARs and TBCs

The SVE systems will reduce the volatile organic concentrations in the major hot spot areas to state S-3 target concentrations for protection of groundwater. Soil Alternative 3 will not comply with the state S-3 target concentrations for minor source areas of organic or inorganic contamination. The primary (i.e., buried waste) and minor secondary sources (isolated hot spots) of groundwater contamination would not be controlled, which is not in compliance with the groundwater corrective action requirements of 15A NCAC 2L .0106. It would not be feasible to treat the entire contents of the landfill at OU2. In addition, it would not be feasible to cap the landfill because of the trees that have grown after the landfill was covered with a layer of soil at closure. Considerations taken during implementation of this alternative will comply with action- and location-specific ARARs.

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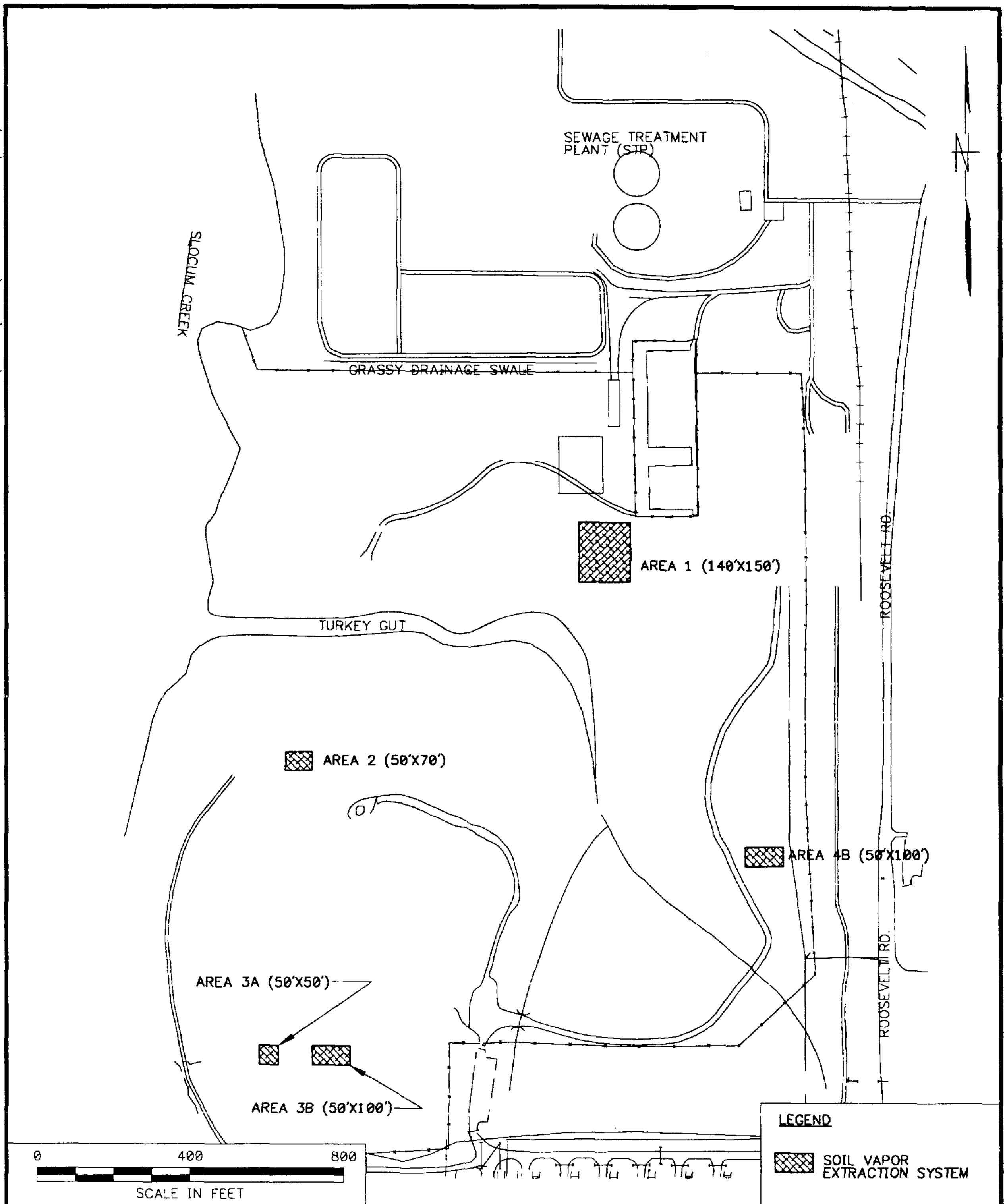

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SCALE AS NOTED		DRAWING NO. FIGURE 5-3	REV. 0

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Long-Term Effectiveness and Permanence

In Soil Alternative 3, major VOC "hot spots" would be treated in-situ using SVE. Contaminants would remain in the surface soil; however, secure perimeter fencing and control of site access could reduce the health hazard of these chemicals by limiting human exposure. Other organics and metals would remain in the subsurface soil and could continue to migrate into the surficial aquifer; however, monitoring would be conducted to confirm this is not occurring.

The in-situ treatment systems use SVE to remove high concentrations of volatile organics from the subsurface. These contaminants would be collected using GAC filters, then disposed of or treated off site. This is a well-proven technology that should provide adequate performance over the 2-year time period that would be required to remove volatile contaminants from the "hot spots". The O&M requirements for the in-situ treatment system would consist of routine checks and servicing of wells, pumps, blowers, valves, electrical components, etc., and offsite disposal of the spent GAC. GAC would require replacement on a quarterly basis.

Institutional controls would be effective over the long term. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

Reduction of Toxicity, Mobility, and Volume through Treatment

Soil Alternative 3 employs "hot spot" treatment of volatile organics in the vadose zone using soil vapor extraction. Separate vapor extraction systems are installed beneath four soil areas at OU2 that are heavily contaminated with volatile organics. Volatilized organic contaminants will be extracted and adsorbed onto vapor-phase granular activated carbon (GAC). Assuming that greater than 95 percent volatilization takes place, it is anticipated that the total soil contaminants recovered by adsorption onto GAC from all SVE systems combined will be as follows: methylene chloride - 91 lb., ethylbenzene - 71 lb., toluene - 42 lb., 2-butanone - 17 lb., chloroform - 7.1 lb., trichloroethene - 3.1 lb., 1,2-dichloroethene - 2.1 lb., and others - less than 1 lb. It is estimated that 520 pounds per year of spent vapor phase GAC would be generated.

Short-Term Effectiveness

Exposure of workers to the contaminated environmental media during monitoring, repairing and replacement of fencing, or construction of the SVE systems can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. The remedial activities are not expected to have an adverse impact on either the community or the environment. All activities will occur within the fenced-in confines of the operable unit except for the offsite disposal/treatment of spent carbon. Any risks of exposure to the community during transportation of the spent GAC (approximately 520 pounds per year) would be adequately controlled. With adequate safety precautions, offsite transportation of contaminated material should not pose significant concerns. The SVE systems are expected to operate for 2 years.

Implementability

Soil Alternative 3 is readily implementable. Security fencing is easily constructed and commonly used, with equipment and resources readily available to perform the work. In-situ soil vapor extraction is an innovative technology, although it has been selected and implemented at several remediation sites. Equipment and services necessary to construct these systems are offered by a few commercial vendors. Vapor extraction wells necessary for this procedure are both easily constructed and commonly used, with equipment and resources readily available to perform the work. A small pilot study should be performed prior to the final design of the SVE systems to verify the local soil and groundwater conditions for each specific area. Transportation permits would be required to haul spent GAC at an offsite TSD facility or for regeneration.

Cost

The estimated costs for this alternative are:

- Estimated capital costs: $720,000
- Estimated annual costs: $91,400
- Estimated 30-year present worth: $1,538,000

The present-worth cost estimate of this alternative is based on a 2-year operation period for the SVE systems and on 30 years of monitoring (groundwater, surface water, and sediment sampling) costs. The details of the cost estimates are provided in Appendix C.

USEPA/State Acceptance

Soil Alternative 3 is acceptable to USEPA and NCDEHNR.

5.4.4 Soil Alternative 4: Excavation, Consolidation, and Containment; Institutional Controls

5.4.4.1 Detailed Description

Soil Alternative 4 focuses on containment of areas of soil contamination that exceed RGOs based on protection of groundwater (secondary sources of groundwater contamination). This alternative does not address buried waste materials (primary source). This alternative consists of three major components: (1) excavation/consolidation of contaminated soil, (2) capping of consolidation area, and (3) institutional controls.

Component 1: Excavation/Consolidation of Contaminated Soil

For this alternative, containment of the contaminated secondary source material first requires that the materials be excavated and then transported to a single consolidation area over which a multiple-layer cap will be placed. Consolidation, which allows for contaminated source material or "hot spots" to be combined in a given location, is a component for a capping-type alternative. Since consolidation within the area of contamination is not considered management of the material, Land Disposal Restrictions requirements typically do not apply; therefore, material can be consolidated without being treated first. To minimize the excavation and transportation requirements, the consolidation area chosen was the largest single area of contaminated secondary source material at the OU2 site. This 21,000 ft^2 area, which is contaminated with 2-butanone, chloroform, ethylbenzene, methylene chloride, 1,1,1-trichloroethane, and trichloroethene is located approximately 150 feet south of the former sludge application area. At one time, this area was the site of sludge impoundments.

For this component, all identified areas of organic and inorganic contaminated soil that exceed RGOs based on protection of groundwater would be excavated using conventional construction equipment. Typically, mechanical equipment such as backhoes, bulldozers, and front-end loaders are used for excavation. Any excavations must be performed in accordance with OSHA requirements. Excavated material would be loaded into trucks and transported to the designated consolidation area, where it would then be placed over the area of existing contaminated soil. A temporary, clean soil cover would be placed over the transported soil at the end of each day to reduce the migration of contaminants to the environment due to wind and erosion. After each "hot spot" had been completely excavated, it would be backfilled with clean fill material from off site, regraded to achieve desired drainage patterns, and revegetated.

It is estimated that 1,300 cubic yards of soil that exceeds RGOs for various organic contaminants will require excavation and placement within the consolidation area. It is estimated that 2,700 cubic yards of soil that exceeds RGOs for various inorganic contaminants will also require excavation and placement within the consolidation area.

The final size of the consolidation area should be larger than the 21,000 ft^2 of contaminated area beneath it and be sufficiently large to limit the height of the soil being placed to 3 feet or less. Based upon the contaminated soil volumes calculated in this study, it is anticipated that the size of the consolidation area will be approximately 36,100 ft^2 (190 feet by 190 feet). Contaminated soil volumes should be verified prior to the final design of the consolidation area.

Component 2: Capping of Consolidation Area

Capping of the consolidation area is a containment action that addresses areas of both organic and inorganic contamination. The purpose of capping is to reduce the rate of surface water infiltration, reduce erosion, and improve aesthetics. Capping also provides a stable outside surface that prevents direct contact with wastes.

RCRA Subtitle D and North Carolina Subchapter 13B closure requirements were deemed relative and appropriate for the consolidation cap at OU2. However, because of the presence of small pockets of highly concentrated organic and heavy metal contaminants throughout the site, the cap design was upgraded to include an additional impermeable layer (barrier). This additional barrier allows for the placement of higher concentration wastes while still being protective of the groundwater. The minimum thicknesses for the layers in this multiple barrier cap are as follows:

- Vegetative and protective layer - 24 inches of native soil
- Drainage layer - 12 inches of sand (permeability $\geq 1 \times 10^{-2}$ cm/sec) or geonet (transmissivity $\geq 3 \times 10^{-5}$ m^2/sec)
- First barrier layer component - flexible membrane liner (20 mil minimum)
- Second barrier layer component - 24 inches of clay (permeability – $\leq 1 \times 10^{-7}$ cm/sec)
- Bedding layer (optional) - 12 inches of native soil or sand subgrade

The vegetative and protective layer provides stability and erosion control and protects the synthetic liner and drainage layer. The drainage layer provides drainage of infiltration water to maintain a hydraulic head of no more than 1 foot on top of the synthetic liner barrier. The synthetic and clay liner barriers provide maximum infiltration protection.

Component 3: Institutional Controls

This component is identical to the institutional controls component as described in Section 5.4.2.1 for Soil Alternative 2.

Figure 5-4 shows the site location map for this alternative.

5.4.4.2 Detailed Analysis

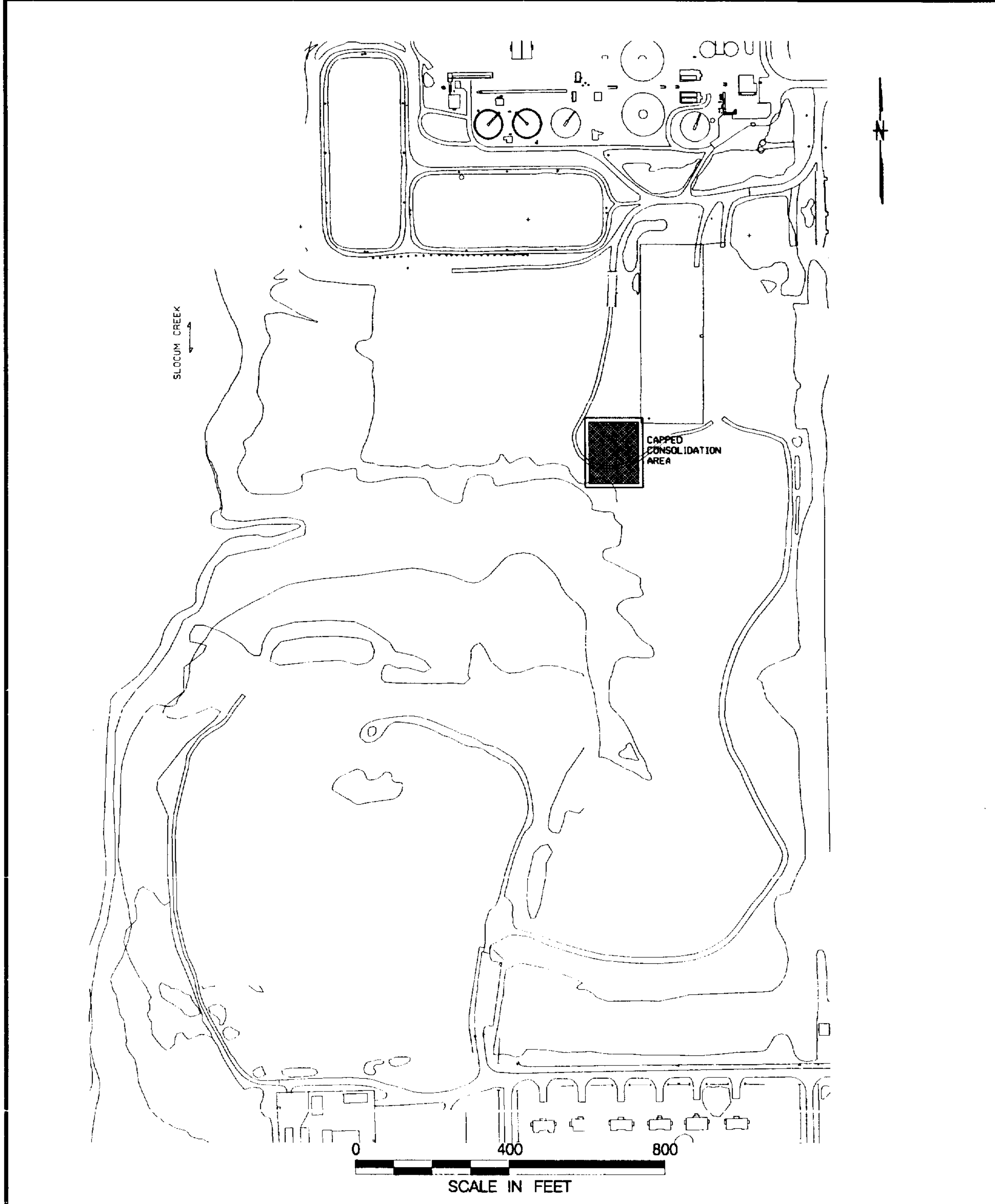
Overall Protection of Human Health and the Environment

Soil Alternative 4 would be protective of human health and the environment by limiting site access with land use restrictions and containing all secondary sources of groundwater contamination beneath a cap. Protection of the environment would not be achieved if contaminants in the buried waste (primary source) migrate to groundwater and nearby surface waters and result in concentrations that could adversely affect aquatic life. The potential for contaminants in the surface soil to enter the human exposure pathway through incidental ingestion and dermal contact would be reduced by securing the fence and access to the site. Migration of contaminants from secondary sources would be greatly reduced, but the primary source of groundwater contamination (buried waste) would not be addressed.

Monitoring of groundwater in the surficial and Yorktown aquifers and surface water and sediment in Slocum Creek and Turkey Gut will help in confirming the effectiveness of this remedial action and whether additional modifications are required.

Compliance with ARARs and TBCs

All identified soil areas where contaminants exceed RGOs based on protection of groundwater (S-3 target concentrations) will be consolidated and capped. The primary source of groundwater contamination (i.e., buried waste) would not be controlled, which is not in compliance with the groundwater corrective action requirements of 15A NCAC 2L .0106. It would not be feasible to construct an engineered cap over the landfill, because it is vegetated with trees. The landfill, however, was covered with soil upon closure. Considerations undertaken during implementation of this alternative will comply with action- and location-specific ARARs.



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SCALE AS NOTED		DRAWING NO. FIGURE 5-4	REV. 0

Long-Term Effectiveness and Permanence

In Soil Alternative 4, "hot spot" contamination in the soils would be contained. The contaminants would remain in the soil; however, all of the "hot spots" based on groundwater protection would be excavated, consolidated, and capped. Institutional controls and fencing would be employed to limit the land usage and restrict access. In this alternative, the rate of migration of inorganic and organic contaminants from secondary sources into the surficial aquifer would be reduced. The primary sources (buried waste) would remain as a potential source of groundwater contamination; however, monitoring would be conducted to confirm that contaminant migration is not occurring

Institutional controls would be protective over the long term. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

Reduction of Toxicity, Mobility, and Volume through Treatment

Soil Alternative 4 does not include treatment to reduce the toxicity, mobility, or volume of hazardous substances at the site. Since no treatment processes are employed, no materials are treated or destroyed.

Short-Term Effectiveness

Exposure of workers to the contaminated environmental media during monitoring and repairing and replacement of fencing, can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. In addition, during the excavation, transportation, and placement of contaminated soils in the consolidation area and placement of the multilayer cap, dust and erosion control measures and worker safety practices must be utilized and air monitoring should be conducted. The remedial activities are not expected to have an adverse impact on either the community or the environment; however, during excavation, transportation, and consolidation of contaminated soils care must be taken that spillage does not occur, especially since transportation of contaminated soils from certain "hot spots" to the consolidation area may require some travel outside the OU2 site.

Operations involving excavation and placement of soil "hot spots" beneath a consolidated cap are expected to be completed in approximately 1 year.

Implementability

Soil Alternative 4 is readily implementable. Security fencing is easily constructed and commonly used, with equipment and resources readily available to perform the work. Multiple barrier capping is a proven and reliable containment technology. Equipment and services necessary to construct multilayer caps are readily available. Contaminated soil volumes should be verified prior to the final design of the cap and consolidation area.

Cost

The estimated costs for this alternative are:

- Estimated capital costs: $1,214,000
- Estimated annual costs: $43,800
- Estimated 30-year present worth: $1,943,000

The present-worth cost estimate of this alternative is based on a 30-year operation period for the monitoring (groundwater, surface water, and sediment sampling) costs. The details of the cost estimates are provided in Appendix C.

USEPA/State Acceptance

Soil Alternative 4 is acceptable to USEPA and NCDEHNR.

5.4.5 Soil Alternative 5: Excavation, Treatment, and Onsite Disposal; Institutional Controls

5.4.5.1 Detailed Description

Soil Alternative 5 focuses on the removal and treatment of areas of soil contamination that exceed RGOs based on protection of groundwater (secondary sources of contamination). This alternative does not address buried waste materials (primary source). This alternative is made up of three major components: (1) excavation of contaminated soil, (2) onsite treatment/fixation and disposal of treated/fixated soil, and (3) institutional controls.

Component 1: Excavation of Contaminated Soil

For this alternative, treatment or solidification of the contaminated secondary source material requires excavation of the materials and then transport to one of two staging areas, depending on whether the excavated material contains volatile organic contamination or heavy metal and nonvolatile organic contamination. So that transportation requirements can be minimized, the staging area chosen for soils containing volatile organic contaminants will be located to the east and adjacent to the largest single area of organically contaminated secondary source material at the OU2 site (the former sludge impoundment area), and directly to the south of the fenced in former drum storage area. Similarly, the staging area for soils containing metals and nonvolatile organic contamination will be located approximately 900 feet south of Turkey Gut, closer to the general areas of inorganic contamination. This staging area is expected to be approximately 250 feet north of the south access gate to the site along the roadway leading to the center of the old landfill.

For this component, contaminated soil not meeting RGOs for protection of groundwater would be excavated using conventional construction equipment. Typically, mechanical equipment such as backhoes, bulldozers, and front-end loaders are used for excavation. Any excavations must be performed in accordance with OSHA requirements. The excavated contaminated material will be loaded into trucks and transported to the appropriate staging area, where it would await treatment or solidification. In cases where contaminated material is located beneath clean material, the clean material would be excavated, placed to the side, then immediately backfilled into the excavated area once the contaminated material has been removed and transported. After treatment, the excavation would be backfilled with either treated material or clean fill from off site, regraded to achieve desired drainage patterns, and revegetated.

It is estimated that 8,700 cubic yards of soil that exceeds RGOs for various volatile organic contaminants will require excavation and placement within the staging area for treatment. It is estimated that 2,700 cubic yards of soil that exceeds RGOs for various inorganic and nonvolatile organic contaminants will also require excavation and placement within the staging area for solidification. Soil that contains volatile organics and metals (or nonvolatile organics) may need to be treated using both processes.

The final size of each staging area should be approximately 150 feet by 150 feet. Contaminated soil volumes should be verified prior to the final design of the staging areas.

Component 2: Onsite Treatment/Fixation and Disposal of Treated/Fixated Soil

The onsite treatment/fixation systems are both designed to reduce or immobilize the contaminants present in excavated soil. Onsite treatment is designed to address "hot spots" of soil that do not meet RGOs because of high concentrations of volatile organics. An ex-situ treatment process using thermal desorption has been chosen for this application. Onsite fixation is designed to address "hot spots" of soil that cannot meet RGOs because of high concentrations of nonvolatile organics or heavy metals. An ex-situ fixation process using cement pozzolan-based solidification can be used to stabilize the materials containing the lower mobility contaminants, such as metals and polyaromatic hydrocarbons.

Soil contaminated with volatile organics will be treated using low-temperature thermal desorption to remove contaminants from the soil matrix by volatilization. Thermal treatment is designed to reduce contaminant concentrations present in soil to levels, which upon use as general backfill, would meet RGOs for groundwater protection. Onsite thermal treatment of soil consists of the following operations/processes: classification, thermal processing, conditioning, off-gas treatment, and condensate collection/separation. Excavations would be backfilled with the treated soil and revegetated.

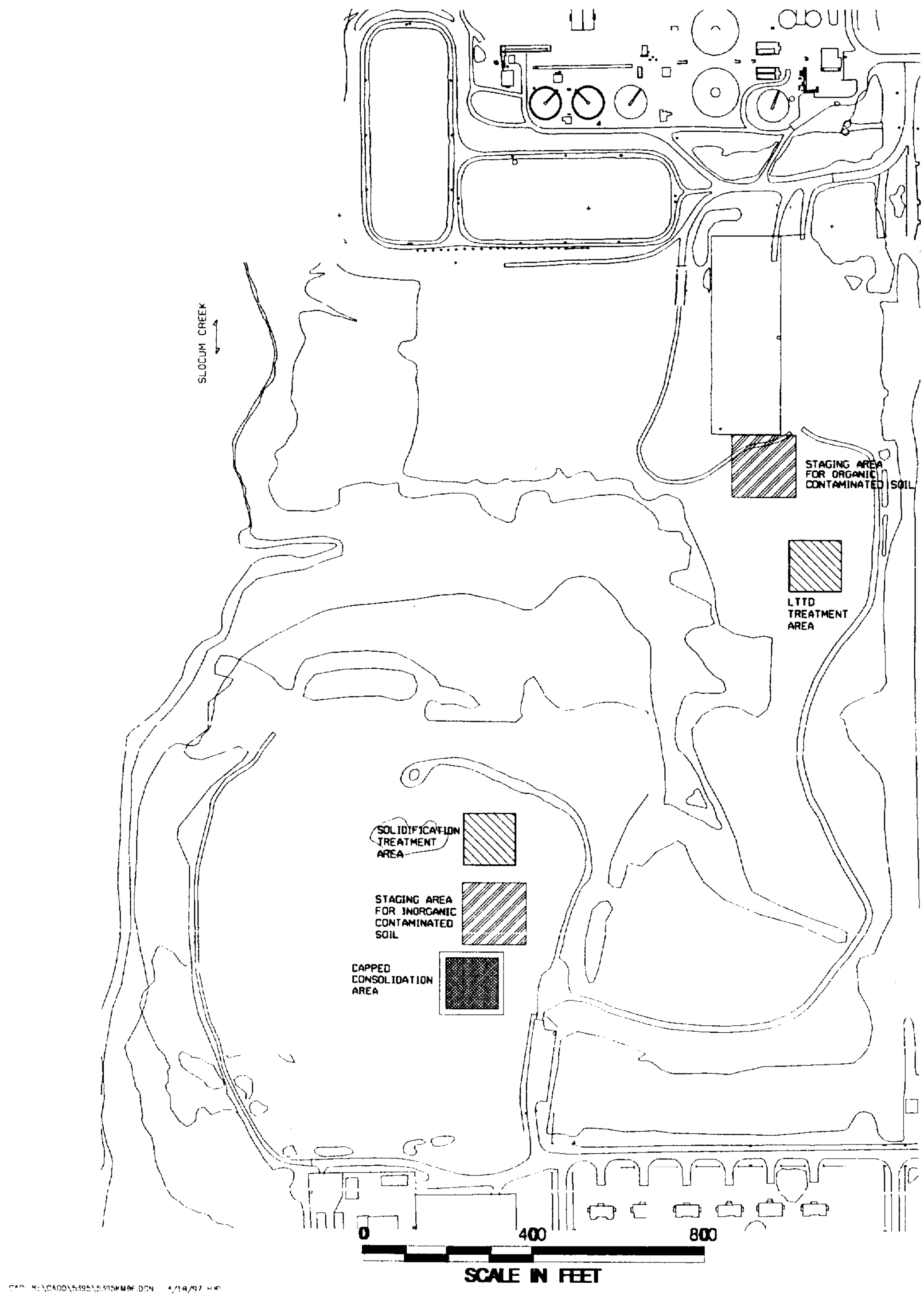
Soil contaminated with metals and nonvolatile organics will be treated using cement pozzolan-based solidification to immobilize contaminants within the soil matrix. This is accomplished by adding treatment reagents to form both highly insoluble compounds and a solid mass with low permeability that is resistant to leaching. Solidification is designed to reduce contaminant mobility in soil to sufficiently low levels that contaminant migration to the environment approaches zero.

Ex-situ fixation of soil consists of the following operations/processes: classification, chemical addition, chemical/soil mixing, and curing. Since the process can vary significantly for types of waste material and specific remedial goals, a detailed description of specific equipment and chemicals cannot be formulated without significant bench and possibly pilot treatability studies. The solidified soil would be placed in a consolidation area and covered with a multi-layer cap. The multi-layer cap would be of the same design as for Soil Alternative 4.

Component 3: Institutional Controls

This component is identical to the institutional controls component as described in Section 5.4.2.1 for Soil Alternative 2.

Figure 5-5 shows the site layout map for this alternative.



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COST/SCHED-AREA		APPROVED BY DATE	
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5.4.5.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Soil Alternative 5 would be protective of human health and the environment by limiting site access with land use restrictions and treating all secondary sources of groundwater contamination. Protection of the environment would not be achieved if contaminants in the buried waste (primary source) migrate to groundwater and nearby surface waters and result in concentrations that could adversely affect aquatic life. The potential for contaminants in the surface soil to enter the human exposure pathway through incidental ingestion and dermal contact would be reduced by securing the fence and access to the site. Migration of contaminants from secondary sources would be greatly reduced, but the primary source of groundwater contamination (buried waste) would not be addressed.

Monitoring of groundwater in the surficial and Yorktown aquifers and surface water and sediment in Slocum Creek and Turkey Gut will help in confirming the effectiveness of this remedial action and whether additional modifications are required.

Compliance with ARARs and TBCs

All identified soil areas where contaminants exceed RGOs based on protection of groundwater (S-3 target concentrations) will be treated to remove volatile organics or solidified. S-3 target concentrations will be attained for volatiles. S-3 target concentrations for other contaminants will not be attained; however, the material will be solidified and capped to significantly reduce leachability. The primary sources of groundwater contamination (i.e., buried wastes) would not be controlled, which is not in compliance with the groundwater corrective action requirements of 15A NCAC 2L .0106. It would not be feasible to treat all of the waste in the landfill. In addition, it would not be feasible to cap the landfill because of the trees that have grown after the landfill was covered with a layer of soil at closure. Considerations undertaken during implementation of this alternative will comply with action- and location-specific ARARs.

Long-Term Effectiveness and Permanence

In Soil Alternative 5, "hot spot" contamination would be removed and treated. All contaminants other than volatile organics would remain in the soil; however, soil in these areas would be excavated, solidified, placed into a consolidation area, and capped. Institutional controls and fencing would be employed to limit the land usage and restrict access. In this alternative, migration of inorganic and non-volatile organic contaminants from secondary sources into the surficial aquifer would be greatly reduced. All identified VOC "hot spots" will be excavated and removed by thermal treatment. The primary source (buried waste) would remain as a potential source of groundwater contamination; however, monitoring would be conducted to confirm that contaminant migration from the site to the environment is not occurring.

The treatment system uses a mobile thermal desorption unit remove volatile organics in excavated soil "hot spots". These contaminants would be collected and separated using liquid and vapor phase GAC filters, then disposed off site with the spent carbon. This is a reliable technology that should provide adequate performance over the projected 100 day operating period that would be required to remove volatile contaminants from these "hot spots". Due to the relatively short time of operation, the only O&M requirements for the mobile treatment unit would consist of special skilled labor to mobilize, operate, and demobilize the treatment unit and offsite disposal of the spent GAC at the conclusion of treatment.

The fixation system for inorganics and nonvolatile organics uses a conventional mobile solidification unit to immobilize high concentrations of contaminants in excavated soil "hot spots". This is a reliable technology that should provide adequate performance over the projected two to four week operating period that would be required to bind contaminants in the soil "hot spots" into a solidified matrix. Due to the short time of operation for this system, the only O&M requirements for the mobile solidification unit would consist of special skilled labor to mobilize, operate, and demobilize the unit.

Institutional controls would be protective over the long term. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

Reduction of Toxicity, Mobility, and Volume through Treatment

Soil Alternative 5 employs ex-situ soil "hot spot" treatment/fixation using low-temperature thermal desorption for volatile organics and pozzolan-based solidification in conjunction with consolidation and capping for nonvolatile organics and inorganics. Soil areas at OU2, which are contaminated with volatile organics and total approximately 8,700 cubic yards, will be excavated for treatment using low-temperature thermal desorption. In this process, volatilized organic contaminants will be recovered from the off-gas or from a condensing unit with each being sent to respective liquid- and vapor-phase granular activated carbon (GAC) for final capture. Assuming that greater than 95 percent volatilization takes place, it is anticipated that the major soil contaminants recovered by adsorption onto both vapor-phase and liquid-phase GAC will be as follows: methylene chloride - 91 lb., ethylbenzene - 71 lb., toluene - 42 lb., 2-butanone - 17 lb., chloroform 7.1 lb., trichloroethene - 3.1 lb., 1,1,1-trichlorethane - 2.9 lb., and 1,2-dichloroethene - 2.1 lb. It is estimated that a total of 2,000 pounds of spent liquid-phase and vapor-phase GAC would be disposed off site at a permitted hazardous waste TSD facility at the conclusion of the 100 day soil processing period.

Soil "hot spots" at OU2, which are contaminated with metals and nonvolatile organics and total approximately 2,700 cubic yards, will be excavated for fixation using pozzolan-based solidification. Fixation/solidification can reduce the potential for contaminants to enter the human exposure pathway and also reduce the mobility of contaminants in the soils. There will be no reduction in the total quantities of contaminated material at the site. The volume may increase approximately 30 percent from the addition of solidification reagents. The solidified matrix, however, will be less amenable to ingestion than the untreated soil, and the contaminants will also be less mobile and, thereby, less likely to migrate into the environment. Additional protection is afforded by placement of a multiple barrier cap over the solidified materials after consolidation.

Short-Term Effectiveness

Exposure of workers to the contaminated environmental media during monitoring and repairing and replacement of fencing can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. In addition, during the excavation, transportation and staging of contaminated soils for treatment or fixation, dust and erosion control measures and worker safety practices must be utilized, and air monitoring should be conducted. Also, because the thermal desorption system involves high temperatures and high electrical power requirements, adequate precautions must be taken. The remedial activities are not expected to have an adverse impact on either the community or the environment; however, during excavation, transportation, and treatment/fixation of contaminated soils care must be taken that spillage does not occur, especially since transportation of contaminated soils from certain "hot spots" to the treatment/fixation staging areas may require some travel outside the OU2 site.

All activities will occur within the fenced-in confines of the operable unit except for the delivery of treatment and fixation chemicals (caustic, lime, etc.) and the offsite disposal/treatment of spent carbon. Any risks of exposure to the community during transportation of the spent GAC (approximately one ton at the conclusion of the 100 day thermal desorption process) would be adequately controlled. With adequate safety precautions, offsite transportation of contaminated or fixated materials should not pose significant concerns.

Implementability

Soil Alternative 5 is readily implementable. Security fencing is both easily constructed and commonly used, with equipment and resources readily available to perform the work. Ex-situ thermal desorption is an innovative technology which has been implemented as a mobile operation at several remediation sites. Equipment and skilled labor necessary to construct and operate these mobile units are offered by a few commercial vendors. Permits would not be required for onsite operation; however, the substantive permitting requirements for air emissions and the registration requirement with the State of North Carolina may have to be met. In addition, transportation permits may be required to haul spent vapor-phase GAC to an offsite facility at the conclusion of the 100-day cleanup operation. Ex-situ solidification is a proven and reliable technology which has been implemented as a mobile operation at many remediation sites. However, treatability studies must be performed on specific site soils to confirm that adequate levels of fixation/solidification can be achieved. Equipment and skilled labor necessary to construct and operate these mobile units are offered by a many commercial vendors.

Cost

The estimated costs for this alternative are:

- Estimated capital costs: $4,713,000
- Estimated annual costs: $43,800
- Estimated 30-year present worth: $5,442,000

The present-worth cost estimate of this alternative is based on a 30-year operation period for the monitoring (groundwater, surface water, and sediment sampling) costs. The details of the cost estimates are provided in Appendix C.

USEPA/State Acceptance

Soil Alternative 5 is acceptable to USEPA and NCDEHNR.

5.4.6 Soil Alternative 6: Excavation and Offsite Disposal; Institutional Controls

5.4.6.1 Detailed Description

Soil Alternative 6 is similar to Soil Alternative 5, except that excavated soil would be transported to an offsite landfill instead of being treated and disposed of on site. Soil Alternative 6 focuses on the removal and offsite disposal of areas of soil contamination that exceed RGOs based on protection of groundwater (secondary sources of contamination). This alternative does not address buried waste materials (primary source). This alternative is made up of three major components: (1) excavation of contaminated soil, (2) offsite disposal, and (3) institutional controls.

Component 1: Excavation of Contaminated Soil

This component is similar to the excavation component as described in Section 5.4.5.1 for Soil Alternative 5. One difference is that contaminated soil would be loaded into trucks or roll-off containers for transport to the offsite disposal facility instead of being hauled to an onsite staging area. In addition, all excavated areas would be backfilled with clean soil rather than treated soil.

Component 2: Offsite Disposal

Approximately 11,400 cubic yards of soil contaminated with organics and inorganics would be loaded into trucks or roll-off containers and hauled to the nearest nonhazardous waste disposal facility that has the capacity to accept the soil. Based on testing conducted to date, none of the contaminated soil would be classified as a RCRA hazardous waste. However, some testing would be required to determine if any of the excavated material was hazardous and to determine compliance with the disposal facility waste acceptance criteria.

Component 3: Institutional Controls

This component is identical to the institutional controls component as described in Section 5.4.2.1 for Soil Alternative 2.

5.4.6.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Soil Alternative 6 would be protective of human health and the environment by limiting site access with land use restrictions and hauling all secondary sources of groundwater contamination to an offsite disposal facility. Protection of the environment would not be achieved if contaminants in the buried waste (primary source) migrate to groundwater and nearby surface streams and result in concentrations that could adversely affect aquatic life. The potential for contaminants in the surface soil to enter the human exposure pathway through incidental ingestion and dermal contact would be reduced by securing the fence and access to the site. Migration of contaminants from secondary sources would be eliminated, but the primary source of groundwater contamination (buried waste) would not be addressed. Monitoring of groundwater in the surficial and Yorktown aquifers and surface water and sediment in Slocum Creek and Turkey Gut will help in confirming the effectiveness of this remedial action and whether additional modifications are required.

Compliance with ARARs and TBCs

All identified soil areas where contaminants exceed RGOs based on protection of groundwater (S-3 target concentrations) will be removed from the site. The primary source of groundwater contamination (i.e., buried wastes) would not be controlled, which is not in compliance with the groundwater corrective action requirements of 15A NCAC 2L .0106. It would not be feasible to remove the entire contents of the landfill. In addition, it would not be feasible to cap the landfill because of the trees that have grown after the landfill was covered with a layer of soil at closure. Considerations taken during implementation would comply with action- and location-specific ARARs.

Long-Term Effectiveness and Permanence

In Soil Alternative 6, "hot spot" contamination would be removed to an offsite disposal facility. Institutional controls and fencing would be employed to limit land usage and restrict site access. In this alternative, migration of organic and inorganic contaminants from secondary sources into the surficial aquifer would be eliminated. The primary sources (buried waste) would remain as a potential source of groundwater contamination; however, monitoring would be conducted to confirm that contaminant migration into the environment is not occurring.

Institutional controls would be effective over the long term. A 5-year periodic review of the site would be required as long as contaminants at OU2 remain at levels that exceed RGOs. Any private ownership of the land in the future would need to be controlled under a deed restriction.

Reduction of Toxicity, Mobility, or Volume through Treatment

Soil Alternative 6 does not include treatment to reduce the toxicity, mobility, or volume of hazardous substances at the site. Since no treatment processes are employed, no materials are treated or destroyed.

Short-Term Effectiveness

Exposure of workers to the contaminated environmental media during monitoring and repairing and replacement of fencing can be minimized by the use of personal protective equipment, engineering controls, and compliance with OSHA regulations. In addition, during the excavation of contaminated soils, dust and erosion control measures and worker safety practices must be utilized, and air monitoring should be conducted. The remedial activities are not expected to have an adverse impact on either the community or the environment; however, during excavation and transportation of contaminated soil, care must be taken that spillage does not occur, especially since transportation will required travel outside the OU2 site.

All activities will occur within the fenced-in confines of the operable unit except for the hauling and offsite disposal of excavated soil. With adequate safety precautions, offsite transportation of contaminated materials should not pose significant concerns.

Operations involving excavation and offsite disposal of contaminated soil are expected to be completed within one year.

Implementability

Soil Alternative 6 is readily implementable. Security fencing is both easily constructed and commonly used, with equipment and resources readily available to perform the work. Equipment and resources are also available for excavation, hauling, and offsite disposal. Transportation permits or licenses may be required to haul soil to the offsite facility.

Cost

The estimated costs for this alternative are:

- Estimated capital costs: $2,808,000
- Estimated annual costs: $43,800
- Estimated 30-year present worth: $3,537,000

The present-worth cost estimate of this alternative is based on a 30-year operation period for the monitoring (groundwater, surface water, and sediment sampling) costs. The details for the cost estimates are provided in Appendix C.

USEPA/State Acceptance

Soil Alternative 6 is acceptable to USEPA and NCDEHNR.

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

6.1 INTRODUCTION

This section compares the analyses that were presented for each of the remedial alternatives in Section 5.0 of this FS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

6.2 COMPARISON OF GROUNDWATER REMEDIATION ALTERNATIVES BY CATEGORY

The following groundwater remedial alternatives are being compared in this section:

- Groundwater Alternative 1 - No Action.
- Groundwater Alternative 2 - Natural Attenuation and Institutional Controls.
- Groundwater Alternative 3 - Groundwater Extraction; Treatment and Discharge to Slocum Creek or Pretreatment and Discharge to STP; Institutional Controls.
- Groundwater Alternative 4 - Air Sparging/Soil Vapor Extraction; Institutional Controls

6.2.1 Overall Protection of Human Health and the Environment

The two main concerns addressed are the protection of human health from potential risks due to contaminants in the surficial aquifer groundwater and protection of the environment (surface water and deeper aquifers) from potential risks due to discharge and migration of contaminated groundwater.

- Groundwater Alternative 1 does not reduce potential risks to human health or the environment and is not evaluated further.
- Groundwater Alternatives 2, 3, and 4 would employ institutional controls and monitoring to reduce risks to human health. For these alternatives,the sampling and analysis program would confirm the effectiveness of the remedy while institutional controls would limit site access and

prohibit residential use, invasive construction activities, and installation of wells (except monitoring wells) within the area of OU2.

- Groundwater Alternative 2 relies on natural attenuation processes to reduce contaminant concentration. Monitoring would be used to confirm the progress of natural attenuation and whether further actions are required.

- Groundwater Alternatives 3 and 4 involve active groundwater remediation systems which provide additional protection of the environment by preventing migration of contaminated groundwater to nearby surface waters. Groundwater Alternative 3 would remove organics and inorganics. Groundwater Alternative 4 would remove mainly volatile organics.

For all alternatives, the waste buried in the landfill would remain at OU2. The waste buried in the landfill may act as a continuing source of contamination that could not feasibly be removed.

6.2.2 Compliance with ARARs and TBCs

The major concerns addressed are compliance with chemical-specific, location-specific, and action-specific ARARs and TBCs. The main ARAR used for the comparison is state groundwater standards (15A NCAC 2L), including groundwater corrective action requirements.

- Groundwater Alternative 2 will eventually comply with chemical-specific ARARs and TBCs through natural attenuation, otherwise a waiver of the state groundwater standards is needed, or the surficial aquifer could be reclassified from drinking water (GA) to either restricted designation (RS) or water supplies for purposes other than drinking (GC). Since Alternative 2 does not propose active treatment of the surficial aquifer, this alternative must comply with the Corrective Action requirements of Chapter 2L of the North Carolina Administrative Code demonstrating that groundwater restoration using best available technology is not required to provide protection of human health and the environment. No location-specific or action-specified ARARs apply to Groundwater Alternative 2.

- Groundwater Alternatives 3 and 4 involve active groundwater remediation systems which will comply with chemical-specific ARARs and TBCs, except for manganese and possibly iron, in approximately 60 years. Groundwater Alternative 3 would actively remove organic and inorganic contaminants. Groundwater Alternative 4 would actively remove mainly volatile organics; other contaminants would be removed by natural attenuation processes.

- Although Groundwater Alternatives 3 and 4 provide active remediation of groundwater, waste buried in the landfill would continue to be a potential source of groundwater contamination. The volume of buried waste is substantially greater than the volume of "hot spot" soil that would be addressed under one of the remedial alternatives for soil.

- Alternatives 3 and 4 can be designed to meet all of the location-specific and action-specific ARARs that apply to them.

6.2.3 Long-term Effectiveness and Permanence

The main concerns in this category would be the reliability of controls over the residual risks associated with untreated contaminants at the site and the permanence of the effectiveness of each alternative.

- Since Groundwater Alternatives 2, 3, and 4 involve some form of active or passive remediation, they are all expected to be effective at decreasing groundwater contaminant levels over the long-term. It is expected that each alternative will offer permanent results.

- Groundwater Alternatives 2, 3, and 4 provide continued groundwater and surface water monitoring, aquifer use restrictions, and land use restrictions which are all adequate and reliable controls.

- Groundwater Alternatives 2, 3, and 4 can mitigate the potential for human exposure through the use of institutional controls. Any private ownership of the land in the future would need to be controlled under a deed restriction. In addition, because of the monitoring programs included in Groundwater Alternatives 2, 3, and 4, a confirmation of their effectiveness can be made.

Landfill waste will remain at the site indefinitely under all alternatives. This will be considered in the review of long-term monitoring results. Until such time that no residual risk remains at the site, all alternatives will require 5-year reviews to ensure that adequate protection of human health and the environment is maintained.

6.2.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The major concerns addressed are reduction in toxicity, reduction in mobility, and reduction in volume of contaminants provided through treatment processes.

- Groundwater Alternative 2 does not involve active groundwater treatment processes to reduce toxicity, mobility, or volume.

- Groundwater Alternatives 3 and 4, which provide for groundwater extraction and treatment and in-situ treatment, respectively, will reduce the toxicity, mobility or volume of contaminated groundwater through active remediation.

- Groundwater Alternatives 3 and 4 satisfy the statutory preference for treatment; however, the groundwater treatment processes will create residuals that will require proper disposal. There are no treatment residuals associated with Groundwater Alternative 2.

6.2.5 Short-term Effectiveness

The main concern would be potential effects to the workers, community, and environment during remedial action.

- No risks to the community or environment are anticipated for any of the groundwater alternatives.

- Groundwater Alternatives 2, 3, and 4 have minimal risks to workers associated with groundwater and surface water monitoring.

- Groundwater Alternatives 3 and 4 will create some risks to workers during implementation. Risks will be increased during the installation of the groundwater extraction wells and the construction of the groundwater treatment plant (Alternative 3) and installation of the in-situ AS/SVE system (Alternative 4).

All potential risks to workers can be adequately controlled.

An additional concern would be the time for each of the alternatives to achieve the remedial action objectives.

- The time in which the groundwater alternatives will achieve the remedial action objectives for surficial aquifer groundwater is estimated to be 11 years for organics and 60 years for metals (except for manganese and possibly iron). The times are the same even though Groundwater Alternatives 3 and 4 provide active remediation. This is because the active remediation systems were designed to remove or treat water at the same rate as the groundwater flows under natural conditions.

- The time to remediate the surficial aquifer groundwater cannot be accurately estimated because the contribution from the primary source of contamination (buried wastes) is unknown. Evaluation of future monitoring results may allow for an estimate of the effect of landfilled wastes on groundwater remediation times.

6.2.6 Implementability

The major concerns in this category would consist of the ease of implementation, including availability of equipment and services, the technical complexity of the processes, and the ease of obtaining permits or approvals. All of the other groundwater alternatives are implementable. Depending upon the final alternative selected, treatability studies may be required.

- Groundwater Alternatives 2, 3, and 4 use conventional, well-demonstrated, and commercially available technologies to the extent that these alternatives are proven to be reliable and readily implementable.

- Groundwater Alternative 3 with discharge to Slocum Creek presents certain additional implementability concerns over Groundwater Alternative 3 with discharge to the STP because permits to discharge to Slocum Creek would be more difficult to obtain than meeting pretreatment standards to discharge into the STP. In addition, the complexity of the groundwater treatment facility for discharge to Slocum Creek would be much greater than for the pretreatment facility for discharge to the STP.

6.2.7 Cost

The capital, annual operating and maintenance (O&M), and 30-year net present-worth (NPW) costs of the groundwater alternatives are presented in the following table.

Groundwater Alternative	Capital ($)	O&M ($/yr)	NPW ($)
1	0	0	0
2	0	43,800	729,000
3 (Slocum Creek)	4,340,000	395,000	10,466,000
3 (STP)	2,181,000	198,000	5,278,000
4	2,089,000	248,000	4,514,000

6.2.8 USEPA and State Acceptance

Groundwater Alternatives 2, 3, and 4 are acceptable to USEPA and NCDEHNR.

6.2.9 Community Acceptance

This criterion will be evaluated after the public comment period.

6.3 SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES

Table 6-1 summarizes the comparative analysis of the 4 groundwater remedial alternatives.

6.4 COMPARISON OF SOIL REMEDIATION ALTERNATIVES BY CATEGORY

The following soil remedial alternatives are being compared in this section:

- Soil Alternative 1 - No Action
- Soil Alternative 2 - Institutional Controls
- Soil Alternative 3 - Soil Vapor Extraction; Institutional Controls
- Soil Alternative 4 - Excavation, Consolidation, and Containment; Institutional Controls
- Soil Alternative 5 - Excavation, Treatment, and Onsite Disposal; Institutional Controls
- Soil Alternative 6 - Excavation and Offsite Disposal; Institutional Controls

TABLE 6-1

SUMMARY OF EVALUATION OF GROUNDWATER ALTERNATIVES
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Evaluation Criteria	Groundwater Alternative 1: No Action	Groundwater Alternative 2: Natural Attenuation and Institutional Controls
Threshold Criteria		
Overall Protection of Human Health and Environment	No reduction in potential risks except through natural attenuation of the groundwater.	Natural attenuation, institutional controls, and monitoring will reduce potential risks to human health and the environment under realistic exposure scenarios.
Compliance with ARARs Chemical-Specific ARARs	No active effort to reduce contaminant levels to below federal or state ARARs.	Can meet state groundwater standards following natural attenuation except for manganese and iron or if shallow aquifers can be reclassified from drinking water.
Location-Specific ARARs	Not applicable.	Not applicable.
Action-Specific ARARs	Not applicable.	Not applicable.
Primary Balancing Criteria		
Long-Term Effectiveness and Permanence	Allows risk to remain uncontrolled.	Monitoring and use restrictions provide adequate and reliable controls.
Reduction of Toxicity, Mobility, or Volume through Treatment	No treatment.	No treatment.
Short-Term Effectiveness	Not applicable, no short term impacts/concerns at site.	Minor risks to workers involved in monitoring of groundwater, surface water, and sediment. No impacts to community upon implementation of institutional controls.
Implementability	Nothing to implement. No monitoring to show effectiveness.	Enforcement of institutional controls at military site is proven to be effective and reliable. Monitoring will confirm effectiveness.
Costs: Capital O&M NPW	 $0 $0 $0	 $0 $43,800 $729,000
Modifying Criteria		
USEPA/State Acceptance	Not acceptable to USEPA and NCDEHNR.	Acceptable to USEPA and NCDEHNR.

TABLE 6-1

SUMMARY OF EVALUATION OF GROUNDWATER ALTERNATIVES
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Evaluation Criteria	Groundwater Alternative 3: Groundwater Extraction;, Treatment and Discharge to Slocum Creek or Pretreatment and Discharge to STP; Institutional Controls		Groundwater Alternative 4: Air Sparging/Soil Vapor Extraction; Institutional Controls
Threshold Criteria			
Overall Protection of Human Health and Environment	Institutional controls and monitoring provide some protection of human health and the environment. Groundwater containment using extraction wells provides some additional protection.		Institutional controls and monitoring provide some protection to human health and the environment. Groundwater treatment using AS/SVE provides some additional protection.
Compliance with ARARs Chemical-Specific ARARs Location-Specific ARARs Action-Specific ARARs	Would comply with state groundwater standards except for manganese and iron. Can be designed to attain ARARs that apply. Can be designed to attain ARARs that apply.		Would only comply with state groundwater standards for volatile organics. Can be designed to attain ARARs that apply. Can be designed to attain ARARs that apply.
Primary Balancing Criteria			
Long-term Effectiveness and Permanence	Removal of contaminated groundwater will reduce site hazards to potential land users. Institutional controls will further limit risks.		In-situ treatment of contaminated groundwater will reduce site hazards to potential land users. Institutional controls will further limit risks.
Reduction of Toxicity, Mobility, or Volume through Treatment	The volume and toxicity of contaminated groundwater would be reduced through active remediation. Residuals created that require disposal.		Active remediation will reduce the volume and toxicity of contaminated groundwater. Residuals generated that require disposal.
Short-term Effectiveness	Proper system management will limit short term hazards associated with contaminated media treatment. Groundwater RGOs achieved in about 60 years. One to two years to implement.		Proper system management will limit short term hazards associated with contaminated media treatment and potential exposure to workers during alternative implementation. Groundwater RGOs achieved in about 60 years except for manganese and iron. Two to three years to implement.
Implementability	Alternative consists of common treatment practices, which are readily available/implementable. Monitoring will confirm effectiveness.		Alternative consists of common treatment practices, which are readily available/implementable. Monitoring will demonstrate effectiveness.
Costs	Slocum Creek	STP	
Capital	$4,340,000	$2,181,000	$2,089,000
O&M	$395,000	$198,000	$248,000
NPW	$10,466,000	$5,278,000	$4,514,000
Modifying Criteria			
USEPA/State Acceptance	Acceptable to USEPA and NCDEHNR.		Acceptable to USEPA and NCDEHNR.

6.4.1 Overall Protection of Human Health and the Environment

The main concern addressed is the protection of groundwater from potential risks due to migration of soil contaminants that exceed RGOs for groundwater protection. These areas are considered secondary sources of groundwater contamination. A minor consideration is the protection of human health from future potential risks due to contaminants in the surface soil. Exceedances of RGOs based on protection of future residents and full-time employees only occurred at three sample locations. There may also be potential risks to human health and the environment from exposure to and migration of contaminants from buried waste (primary source of groundwater contamination).

- Soil Alternative 1 does not reduce potential risks to human health or the environment and is not evaluated further.

- Soil Alternatives 2, 3, 4, 5, and 6 would employ institutional controls and monitoring to reduce risks to human health. For these alternatives, the sampling and analysis program would confirm that migration of soil and waste contaminants to groundwater and surface water is not occurring. Institutional controls would limit site access and prohibit residential use, invasive construction activities, and installation of wells (except monitoring wells) within the area of OU2.

- Soil Alternatives 3 and 5 involve soil treatment which provides additional protection of the environment by removing soil contaminants that could migrate to groundwater and surface water.

- Soil Alternatives 4 and 5 involve containment of untreated or solidified contaminated which provides additional protection of the environment by reducing the potential for migration of soil contaminants to groundwater and surface water.

- Soil Alternative 6 involves removal and offsite disposal of soil which provides additional protection of the environment by eliminating the potential for migration to groundwater and surface water.

For all of the alternatives, the waste buried in the landfill would remain at OU2. The waste buried in the landfill may act as a continuing source of contamination that could not feasibly be removed.

6.4.2 Compliance with ARARs and TBCs

The major concerns addressed are compliance with chemical-specific, location-specific, and action-specific ARARs and TBCs. The main ARAR used for the comparison is the state S-3 target concentrations for protection of groundwater and corrective action requirements for groundwater.

- Soil Alternative 2 would not comply with chemical-specific ARARs and TBCs and is not evaluated further.
- Soil Alternative 3 would only comply with chemical-specific ARARs (S-3 target concentrations) for volatile organics.
- Soil Alternative 4 would comply with chemical-specific ARARs by consolidating all soil areas that exceed S-3 target concentrations and capping the consolidation area.
- Soil Alternative 5 would comply with all chemical-specific ARARs by removing volatile organics and by solidification of soil that exceeds S-3 target concentrations for non-volatile organics and metals.
- Soil Alternative 6 would comply with all chemical-specific ARARs by removing all areas of soil that exceed S-3 target concentrations.
- Soil Alternatives 3, 4, 5, and 6 can be designed to meet all of the location-specific and action-specific ARARs that apply to them.

For all soil alternatives, the primary source of groundwater contamination (buried wastes) would not be controlled or removed, which is not in compliance with the groundwater corrective action requirements of 15A NCAC 2L .0106. It would not be feasible to control or remove the entire contents of the landfill. A soil cover was placed over the landfill at closure.

6.4.3 Long-Term Effectiveness and Permanence

The main concerns in the category would be the reliability of controls over the residual risks associated with untreated contaminants at the site and the permanence of the effectiveness of each alternative.

- Soil Alternatives 3, 4, 5, and 6 provide continued groundwater, surface water, and sediment monitoring; fencing; and land use restrictions which are all adequate and reliable controls.

- Soil Alternatives 3, 4, 5, and 6 can mitigate the potential for human exposure through the use of institutional controls. Any private ownership of the land in the future would need to be controlled under a deed restriction. In addition, because of the monitoring programs included in Soil Alternatives 3, 4, 5, and 6, a confirmation of their effectiveness can be made.

- The containment, treatment, and removal components of Soil Alternatives 3, 4, 5, and 6 are well-proven technologies that should provide adequate performance.

Landfill waste will remain at the site indefinitely under all soil alternatives. This will be considered in the review of long-term monitoring results. Until such time that no residual risk remains at the site, all alternatives will require 5-year reviews to ensure that adequate protection of human health and the environment is maintained.

6.4.4 Reduction of Toxicity, Mobility, and Volume Through Treatment

The major concerns addressed are reduction in toxicity, reduction in mobility, and reduction in volume provided through treatment processes.

- Soil Alternatives 4 and 6 do not involve active soil treatment processes.

- Soil Alternative 3 uses soil vapor extraction to remove volatile organics, thereby reducing toxicity.

- Soil Alternative 5 uses low-temperature thermal desorption to remove volatile organics, thereby reducing toxicity. This alternative also uses solidification to reduce the mobility of non-volatile organics and metals; however, the volume would increase by approximately 30 percent.

- Soil Alternatives 3 and 5 satisfy the statutory preference for treatment; however, the soil treatment processes will create residuals that will require proper disposal. There are no treatment residuals associated with Soil Alternatives 4 and 6.

6.4.5 Short-Term Effectiveness

The main concern would be potential effects to the workers, community, and environment during remedial action.

- No risks to the community or environment are anticipated with any of the soil alternatives.

- Soil Alternatives 3, 4, 5, and 6 have minimal risks to workers associated with groundwater and surface water monitoring.

- Soil Alternatives 3, 4, 5, and 6 will create some risks to workers during implementation. These activities include the excavation, handling, consolidation, and treatment of contaminated soils at the site.

All potential risks to workers can be adequately controlled.

An additional concern would be the time for each of the alternatives to achieve the remedial action objectives.

- The fencing and warning signs for Soil Alternatives 3, 4, 5, and 6 could be implemented in less than 1 year.

- The SVE systems for Soil Alternative 3 are expected to operate for 1 to 2 years.

- For Soil Alternative 4, 5, and 6, the excavation, consolidation, capping, treatment, and offsite disposal activities are all expected to be implemented in less than 1 year.

6.4.6 Implementability

The major concerns in this category would consist of the ease of implementation, including availability of equipment and services, the technical complexity of the processes, and the ease of obtaining permits or approvals. All of the other soil alternatives are implementable. Depending on the final alternative selected, treatability studies may be required.

- Soil Alternatives 3, 4, 5, and 6 use conventional, well-demonstrated, and commercially available technologies to the extent that these alternatives are proven to be reliable and readily implementable.
- Soil Alternatives 3 and 5 present certain additional implementability concerns because treatability studies will probably be required.
- Soil Alternatives 3, 4, 5, and 6 will require verification of soil contamination volumes.

6.4.7 Cost

The capital, annual operating and maintenance (O&M), and 30-year net present worth (NPW) costs of the soil alternatives are presented in the following table.

Soil Alternative	Capital ($)	O&M ($/yr)	NPW ($)
1	0	0	0
2	70,900	43,800	800,000
3	720,000	91,400	1,538,000
4	1,214,000	43,800	1,943,000
5	4,713,000	43,800	5,442,000
6	2,808,000	43,800	3,537,000

Note that the O&M cost in each alternative includes costs for long-term monitoring.

6.4.8 USEPA and State Acceptance

Soil Alternatives 3, 4, 5, and 6 are acceptable to USEPA and NCDEHNR.

6.4.9 Community Acceptance

This criterion will be evaluated after the public comment period.

6.5 SUMMARY OF COMPARATIVE ANALYSIS OF SOIL REMEDIAL ALTERNATIVES

Table 6-2 summarizes the comparative analysis of the 6 soil remedial alternatives.

6.6 RECOMMENDED ALTERNATIVES

Based on consideration of the requirements of CERCLA, the detailed analysis of potential alternatives using the evaluation criteria, and current and proposed exposure scenarios, the preferred remedial alternatives for OU2 are Groundwater Alternative 2 - Natural Attenuation and Institutional Controls, and Soil Alternative 3 - Soil Vapor Extraction and Institutional Controls. These alternatives appear to provide the best balance with respect to the seven CERCLA evaluation criteria described in previous sections of this report. The preferred alternative is cost effective and is anticipated to meet the following objectives:

- Prevent potential exposure to contaminated soil and buried waste.
- Restrict current and future use of OU2.
- Prevent exposure to contaminated groundwater at OU2.
- Prevent future potential use of the groundwater at OU2.
- Allow for natural attenuation of the groundwater at OU2.
- Mitigate migration of contaminants from the soil (major secondary sources) to the environment.

Based on current potential exposure scenarios and future exposure scenarios, all risks are within the USEPA "acceptable" risk range except for the future hypothetical residential exposure. The majority of the risks are due to ingestion of surficial aquifer groundwater and ingestion of surface soil. The future residential exposure pathway for groundwater is extremely unlikely because the surficial aquifer is not used as a source of drinking water, and the Air Station has a separate potable water supply system.

TABLE 6-2

SUMMARY OF EVALUATION OF SOIL ALTERNATIVES
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Evaluation Criteria	Soil Alternative 1: No Action	Soil Alternative 2: Institutional Controls	Soil Alternative 3: Soil Vapor Extraction; Institutional Controls
Threshold Criteria			
Overall Protection of Human Health and the Environment	No reduction in potential risks.	Institutional controls and monitoring will reduce potential risks to human health and the environment.	Institutional controls and monitoring will reduce potential risks to human health and the environment. Treatment of major secondary source areas will provide additional protection of groundwater and surface water.
Compliance with ARARs Chemical-Specific ARARs	No active effort to reduce contaminant levels to attain ARARs.	No active effort to reduce contaminant levels to attain ARARs.	Would only comply with S-3 target concentrations for volatile organics.
Location-Specific ARARs	Not applicable.	Not applicable.	Can be designed to attain ARARs that apply.
Action-Specific ARARs	Not applicable.	Not applicable.	Can be designed to attain ARARs that apply.
Primary Balancing Criteria			
Long-Term Effectiveness and Permanence	Allows risks to remain uncontrolled.	Monitoring and use restrictions provide adequate and reliable controls.	Removal of volatile organics from secondary source areas will reduce risks to the environment. Monitoring and use restrictions provide adequate and reliable controls.
Reduction of Toxicity, Mobility, and Volume Through Treatment	No treatment.	No treatment.	Toxicity reduced by removal of volatile organics from major secondary sources areas. No reduction of mobility or volume. Residuals created that require disposal.

TABLE 6-2 (Continued)
SUMMARY OF EVALUATION OF SOIL ALTERNATIVES
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Evaluation Criteria	Soil Alternative 1: No Action	Soil Alternative 2: Institutional Controls	Soil Alternative 3: Soil Vapor Extraction; Institutional Controls
Short-Term Effectiveness	Not applicable. No short-term impacts or concerns.	Minor risks to workers involved in installation of fencing and warning signs and monitoring of groundwater, surface water, and sediment. No impacts to community or environment. Less than one year to implement.	Proper system management will limit short-term hazards associated with contaminated media treatment. Minor risks to workers involved in installation of fencing and warning signs and monitoring of groundwater, surface water, and sediment. No impacts to community or environment. SVE systems are expected to operate for one to two years.
Implementability	Nothing to implement. No monitoring to show effectiveness.	Enforcement of institutional controls at military site is proven to be effective and reliable. Monitoring will demonstrate effectiveness.	Alternative consists of common treatment practices, which are readily available and implementable. Treatability study may be necessary. Enforcement of institutional controls at military site is proven to be effective and reliable. Monitoring will demonstrate effectiveness.
Cost Capital O&M NPW	 $0 $0 $0	 $70,900 $43,800 $800,000	 $720,000 $91,400 $1,538,000

Modifying Criteria

USEPA/State Acceptance	Not acceptable to USEPA or NCDEHNR.	Not acceptable to USEPA or NCDEHNR.	Acceptable to USEPA and NCDEHNR

TABLE 6-2 (Continued)
SUMMARY OF EVALUATION OF SOIL ALTERNATIVES
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Evaluation Criteria	Soil Alternative 4: Excavation, Consolidation, and Containment; Institutional Controls	Soil Alternative 5: Excavation, Treatment, and Onsite Disposal; Institutional Controls	Soil Alternative 6: Excavation and Offsite Disposal; Institutional Controls
Threshold Criteria			
Overall Protection of Human Health and the Environment	Institutional controls and monitoring will reduce potential risks to human health and the environment. Consolidation and containment of all secondary source areas will provide additional protection of groundwater and surface water.	Institutional controls and monitoring will reduce potential risks to human health and the environment. Removal of volatile organics from and stabilization and capping of all secondary source areas will provide additional protection of groundwater and surface water.	Institutional controls and monitoring will reduce potential risks to human health and the environment. Removal of all secondary source areas will provide additional protection of groundwater and surface water.
Compliance with ARARs Chemical-Specific ARARs Location-Specific ARARs Action-Specific ARARs	Would comply with S-3 target concentrations for volatile organics and metals. Can be designed to attain ARARs that apply. Can be designed to attain ARARs that apply.	Would comply with S-3 target concentrations for volatile organics and metals. Can be designed to attain ARARs that apply. Can be designed to attain ARARs that apply.	Would comply with S-3 target concentrations for volatile organics and metals. Can be designed to attain ARARs that apply. Can be designed to attain ARARs that apply.
Primary Balancing Criteria			
Long-Term Effectiveness and Permanence	Containment of contaminants from all secondary source areas will reduce risks to the environment. Monitoring and use restrictions provide adequate and reliable controls.	Treatment of contaminants from all secondary source areas will reduce risks to the environment. Monitoring and use restrictions provide adequate and reliable controls.	Removal of all secondary source areas will reduce risks to the environment. Monitoring and use restrictions provide adequate and reliable controls.
Reduction of Toxicity, Mobility, and Volume Through Treatment	Mobility reduced by containment of all contaminants from secondary source areas beneath a cap. No reduction of toxicity or volume.	Toxicity reduced by removal of volatile organics from all secondary source areas. Residuals created that require disposal. Mobility reduced by solidification of secondary source areas contaminated with non-volatile organics and metals. Volume would increase.	No treatment.

TABLE 6-2 (Continued)
SUMMARY OF EVALUATION OF SOIL ALTERNATIVES
OPERABLE UNIT 2
MCAS CHERRY POINT, NORTH CAROLINA

Evaluation Criteria	Soil Alternative 4: Excavation, Consolidation, and Containment; Institutional Controls	Soil Alternative 5: Excavation, Treatment, and Onsite Disposal; Institutional Controls	Soil Alternative 6: Excavation and Offsite Disposal; Institutional Controls
Short-Term Effectiveness	Proper system management will limit short-term hazards associated with containment of contaminated media. Minor risks to workers involved in installation of fence and warning signs and monitoring of groundwater, surface water, and sediment. No impacts to community or environment. Less than one year to implement.	Proper system management will limit short-term hazards associated with contaminated media treatment. Minor risks to workers involved in installation of fence and warning signs and monitoring of groundwater, surface water, and sediment. No impacts to community or environment. Less than one year to implement.	Proper system management will limit short-term hazards associated with handling of contaminated media. Minor risks to workers involved in installation of fence and warning signs and monitoring of groundwater, surface water, and sediment. No impacts to community or environment. Less than one year to implement.
Implementability	Alternative consists of common remediation practices, which are readily available and implementable. Enforcement of institutional controls at military site is proven to be effective and reliable. Monitoring will confirm effectiveness.	Alternative consists of common treatment and remediation practices, which are readily available and implementable. Treatability study may be required. Enforcement of institutional controls at military site is proven to be effective and reliable. Monitoring will confirm effectiveness.	Alternative consists of remediation practices, which are readily available and implementable. Enforcement of institutional controls at military site is proven to be effective and reliable. Monitoring will confirm effectiveness.
Costs: Capital O&M NPW	 $1,214,000 $43,800 $1,943,000	 $4,713,000 $43,800 $5,442,000	 $2,808,000 $43,800 $3,537,000
Modifying Criteria			
USEPA/State Acceptance	Acceptable to USEPA and NCDEHNR.	Acceptable to USEPA and NCDEHNR.	Acceptable to USEPA and NCDEHNR.

Under the preferred alternatives, the following institutional controls and treatment processes would be implemented to eliminate or reduce pathways of exposure:

- Maintaining records of the contamination at OU2 in the MCAS Cherry Point Base Master Plan.

- Restricting land use at OU2 to non-residential uses with provisions for no intrusive activities (no excavation of surface soil or subsurface soil).

- Restricting the use of groundwater from all aquifers beneath OU2 as a water source with provisions for no installation of wells (except monitoring wells).

- Installing a fence around the polishing ponds, and repair and replacement of existing fencing.

- Placing warning signs along the fence, Slocum Creek, and Turkey Gut.

- Monitoring of groundwater under OU2 and surface water and sediment in Slocum Creek and Turkey Gut to confirm the effectiveness of natural attenuation and to confirm that contaminant migration from the site to the environment is not occurring. The monitoring program will be developed as part of the Remedial Design, with USEPA and state concurrence.

- In-situ treatment using SVE at four major soil "hot spots" (secondary source areas) that are contaminated with volatile organics and any other such hot spots identified during the Remedial Design. This includes monitoring of air emissions and soil to evaluate the effectiveness of treatment.

The records on the presence of contamination at OU2 and the specific restrictions for site use listed above (including land use and groundwater use restrictions) will be recorded in the MCAS Cherry Point Base Master Plan. This will ensure that at the time of any future land development, the Air Station will be able to take adequate measures to minimize adverse human health and environmental effects.

The fencing and warning signs will be installed, replaced, and repaired, as necessary, to restrict access to OU2, thereby minimizing human exposure to contaminated media and landfilled wastes. The warning signs will be installed along the fence and along the banks of Slocum Creek and Turkey Gut.

Monitoring will consist of the sampling of groundwater in the surficial and Yorktown aquifers and surface water and sediment in Slocum Creek and Turkey Gut. Monitoring will confirm the progress of natural attenuation processes and that migration of contaminants from OU2 into the environment is not occurring. A monitoring plan will be developed during the Remedial Design, with USEPA and state concurrence. Based on the results of the monitoring, additional sampling and analysis and/or additional remedial actions may be required.

Every 5 years, a site review would be conducted to evaluate the site status and determine whether further action is necessary. The site review is required because this alternative allows contaminants to remain on site at levels that exceed RGOs.

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APPENDIX A

CONTAMINANT FATE AND TRANSPORT GROUNDWATER MODELING

APPENDIX A
CONTAMINANT FATE AND TRANSPORT GROUNDWATER MODELING TO SUPPORT OPERABLE UNIT 2 FEASIBILITY STUDY

This appendix describes the groundwater contaminant fate and transport modeling conducted to support the Feasibility Study for Operable Unit 2 (OU2) at the Marine Corps Air Station, Cherry Point. All of the modeling was completed using simplistic models of the site in order to screen remedial alternatives. The modeling results should be viewed as conceptual in nature and only used to compare various alternatives. The following sections describe the estimates of aquifer remediation times. The aquifer remediation time estimates are the estimated lengths of time from the beginning of the proposed passive groundwater extraction until the contaminant concentrations in the aquifer reach an acceptable level.

A.1.0 OBJECTIVES

The objective of groundwater contaminant fate and transport modeling is to estimate aquifer remediation times based on the proposed pump and treat remedial alternatives.

The objective of the aquifer remediation time estimate is to determine the time until the aquifer reaches an acceptable concentration (exposure criteria) for each of the prevalent contaminants detected in the groundwater (i.e, chemicals detected often in the groundwater and which would be expected to bound the aquifer remediation time [quickest and longest]) under the proposed groundwater extraction strategy. The aquifer remediation time estimates are based on the existing levels of contamination in the aquifer and the existing concentrations in the soil.

A.2.0 TECHNICAL APPROACH

The technical approach used to achieve the above described objectives is broken into the following three categories to facilitate its description: modeling tools, conceptual model, and modeling procedures. Each of these categories is discussed in the following subsections.

A.2.1 Modeling Tools

The groundwater contaminant fate and transport groundwater modeling task was completed using an analytical computer model. This model is implemented on the spreadsheet software Excel 4.0 and Crystal Ball 3.0 and is called ECTran (which stands for Excel-Crystal Ball Transport). The ECTran model (Chiou

1993) is based on straightforward mass-balances and advection/dispersion analytical equations, but can be used to simulate a variety of complex conditions. ECTran is a multi-layer one dimensional model in the unsaturated zone which can then simulate down gradient lateral transport in the saturated zone. It provides a conservative estimate of the contaminant concentration at a receptor location or discharge area downgradient of the source area under different source-loading conditions. To date, ECTran and its predecessors have been employed at hazardous waste sites in U.S. EPA Regions III, V, VI, and X to evaluate soil cleanup goals, cleanup time estimations, and to support baseline risk assessments. It has been used at DOD, DOE, and industrial sites for both RCRA and CERCLA applications.

A.2.2 Conceptual Model

The conceptual model of the contaminant transport represents a simplified interpretation of the complex natural aquifer system and the movement of contaminants within it. The following subsection describes the aquifer system beneath OU2 and the simplified representation of it used in the model.

A.2.2.1 General Pattern of Contaminant Transport

The groundwater beneath the OU2 consists of several distinct layers. The uppermost aquifer is referred to as the surficial aquifer. Beneath the surficial aquifer is the Yorktown confining layer (a layer of lower hydraulic conductivity). Beneath the Yorktown confining layer is the Yorktown aquifer followed by the Pungo River confining layer. There are two additional aquifers underlying the Pungo River Formation: the Upper and Lower Castle Hayne Aquifers. Rainwater which falls on the site reaches the groundwater by directly infiltrating into the soils. As the water infiltrates through the contaminated soil and buried wastes, contaminants leach out of the soil and are transported with the water through the unsaturated zone to the surficial aquifer below. The contaminants can then be transported laterally in the surficial aquifer, and the contaminants could also migrate vertically to deeper aquifers.

The aquifer remediation times are based on the proposed pump and treat system developed for the Surficial aquifer. The concentration of contaminant at any specific point in the groundwater will change with time. The concentration will increase as contaminants continue to leach from the source into the groundwater. As the source becomes depleted (depleting source term) and releases contaminant at a decreased rate, the groundwater concentration will begin to decrease with time.

A.2.2.2 Conceptual Model of Used for Aquifer Remediation Time Estimates

The conceptual model for aquifer remediation times consists of an unsaturated zone and a saturated zone (Figure A-1). Source areas were delineated based on the location and concentration of contaminants in the groundwater as well as the location of the proposed extraction well locations (Figures 5-2 and 5-5). The ECTran model is used to simulate plumes of contamination in the groundwater and the different capture zones in the proposed pump and treat system (See Appendix B). The existing initial groundwater concentration in the saturated zone is input into the model. The existing soil concentrations in the unsaturated zone are also input into the model. The aquifer remediation time is the time until the concentration in the aquifer reaches the exposure criteria. The saturated and unsaturated layers are assigned the layer-specific average concentrations. The source areas developed for the estimation of remediation times cover the entire area of contamination in the groundwater (Figure A-2). The selection of source areas is discussed further in Section A.4 The source areas either border Slocum Creek, Turkey Gut, or a line of extraction wells so that there is no downgradient transport from any of these source areas before the contaminants would reach the exposure point. The simulated average concentration in the saturated zone under the source is used for comparison to determine when the exposure criteria has been met.

A.2.3 Modeling Procedures

Conceptually, determining the aquifer remediation times involves entering the existing soil concentrations and the existing aquifer concentrations and running the model until the contaminant concentration in the aquifer reaches the exposure criteria. Various remediation alternatives are incorporated by removing the soil source term from the model simulation when the remediation is expected to be completed (e.g., if a certain remedial alternative is expected to clean the soil in two years, the contaminant concentration in the soil is assumed to be zero after the second year of the simulation).

A.3.0 INPUT DATA

ECTran model inputs include site specific hydrogeologic/physical and chemical information. Necessary physical input data includes the areal dimensions of the source areas, detailed description of the underlying geology, the source area orientation with respect to groundwater flow, and its travel distance from the selected exposure point. Chemical input data includes soil/water partitioning coefficients (K_ds), chemical/biological degradation rates (half-life), and the acceptable groundwater concentration (exposure criteria).

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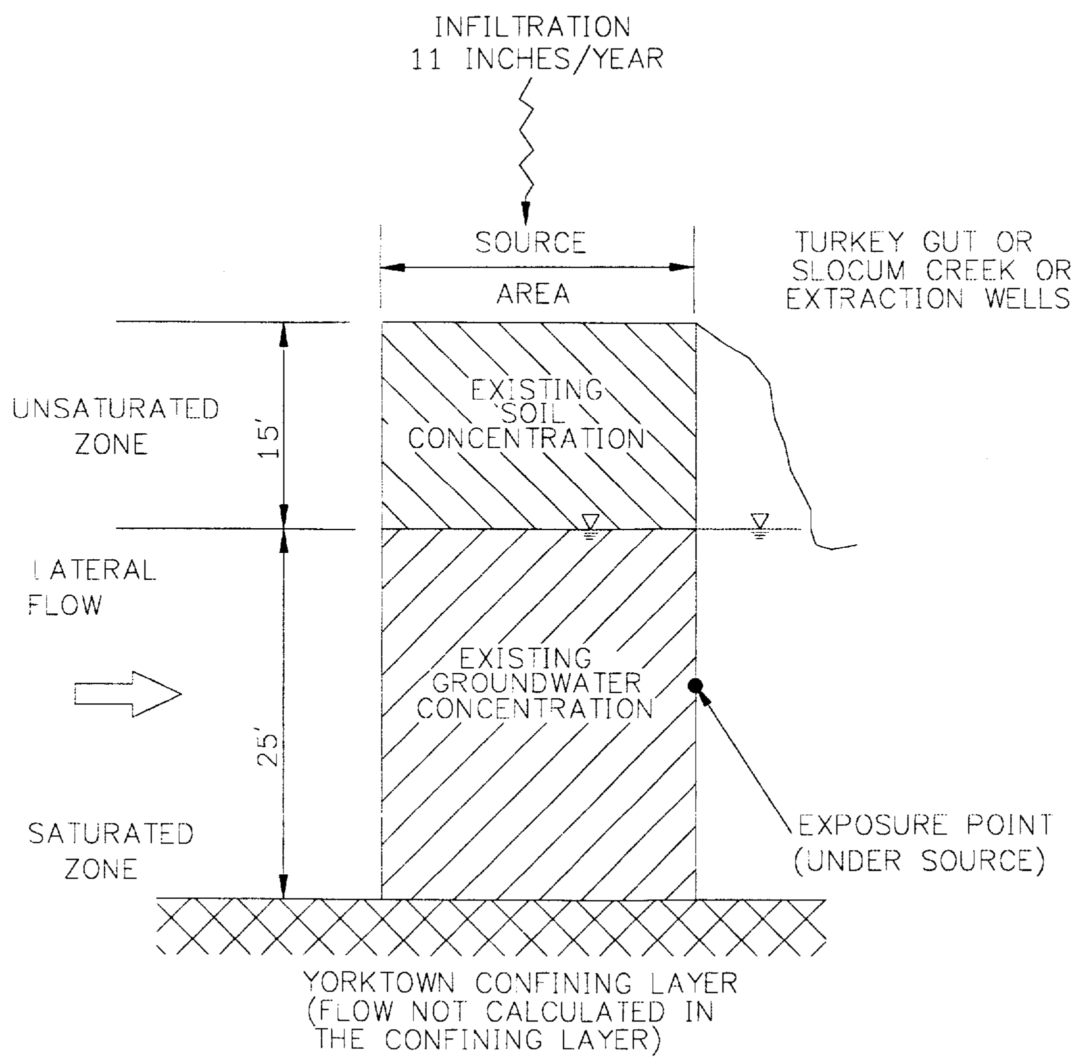
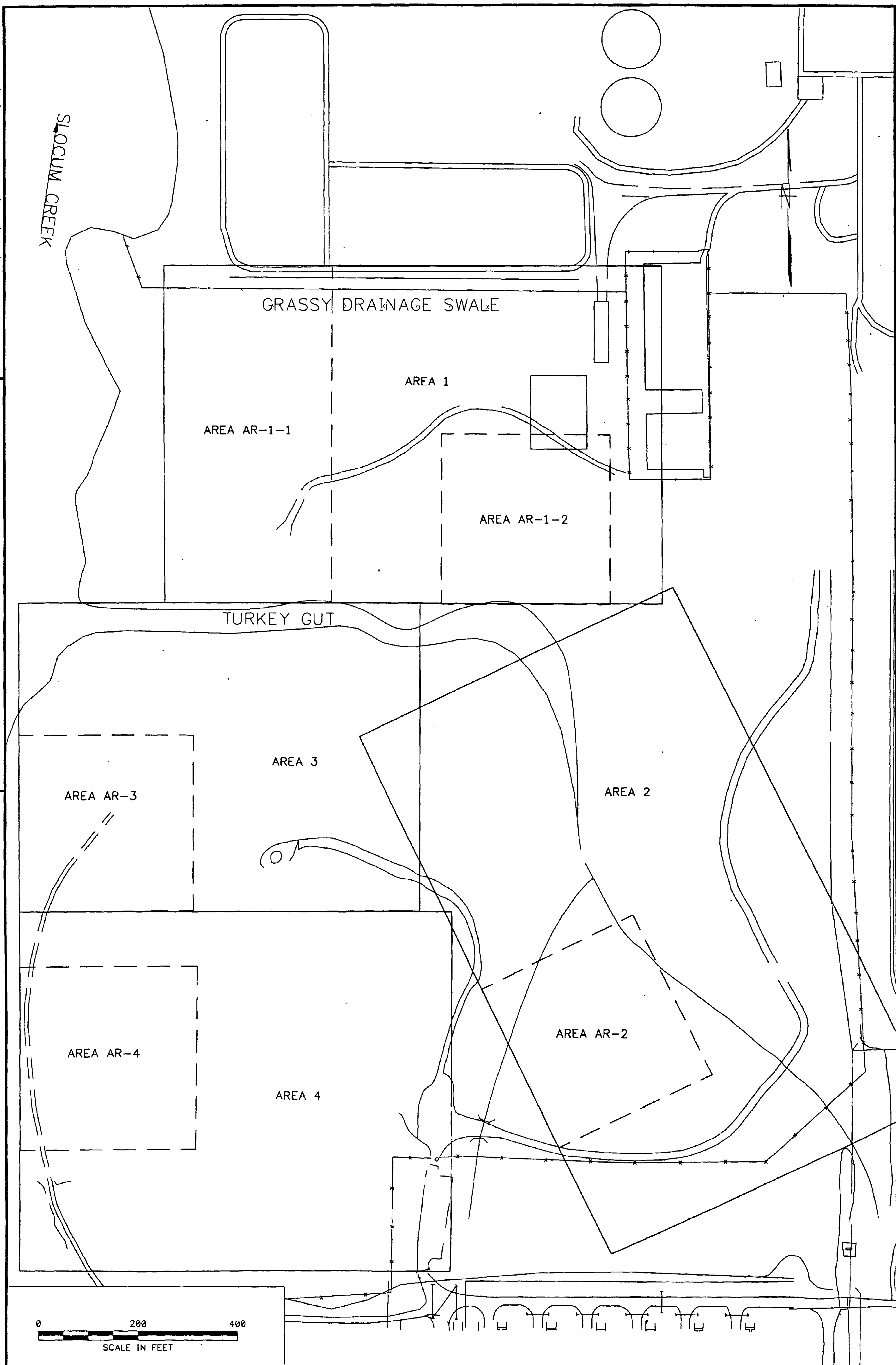


CONCEPTUAL MODEL USED FOR AQUIFER REMEDIATION TIME ESTIMATES

DRAWN BY HJP / DATE 04/15/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY / DATE	CONCEPTUAL MODEL OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA	APPROVED BY / DATE	
COST/SCHED-AREA		APPROVED BY / DATE	
SCALE AS NOTED		DRAWING NO. FIGURE A-1	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97



DRAWN BY HJP	DATE 4/16/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY	DATE	SOURCE AREAS FOR AQUIFER REMEDIATION TIMES OPERABLE UNIT 2 MCAS CHERRY POINT, NORTH CAROLINA	APPROVED BY	DATE
COST/SCHED-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE A-2	REV. 0

FORM CADD NO. SDUTH_B.DWG - REV 0 - 04/16/97

A.3.1 Hydrogeologic/Physical Data

As described in the Conceptual Model section (Section A.2.2), the ECTran model uses layers to simulate the groundwater flow system. The thicknesses of the layers in the source areas are shown in Table A-1. All source areas are simplified as rectangles. The size of each source area and travel distance between source area and exposure point are presented in Table A-2. The width is defined as the side of the rectangle perpendicular to the groundwater flow direction and length is defined as the side parallel to the groundwater flow direction. Figure A-2 presents the model source areas.

Hydrogeologic information such as groundwater velocity, soil saturation rate, infiltration rate, soil density, and dispersion coefficients are all necessary model inputs. The groundwater flow velocities are calculated based on groundwater gradients, hydraulic conductivities, and porosity. These input parameters are presented in Tables A-1 and A-2. The groundwater gradients used for the aquifer remediation time estimates are based on the groundwater contours predicted with the pump and treat system in operation (See Appendix B). The hydraulic conductivity used for the modeling at OU2 in the surficial aquifer is 10 feet/day. The porosity used in the modeling (i.e., 0.3) was based on the values reported in the RI report.

The infiltration of rain and surface water for the area was assumed to be approximately one-fourth of the annual rainfall. The infiltration through the uncapped site was estimated as 11 inches per year.

A.3.2 Chemical Data

The typical chemical information for model input varies depending on the type of chemical to be modeled (i.e., organic or inorganic.) The typical input includes K_d and half-life. Also discussed in this section is the chemical concentration data for the soil and groundwater that was used as inputs for the aquifer remediation time estimates.

A.3.2.1 Soil/Water Partitioning Coefficient (K_d)

The soil/water partitioning coefficient is used to estimate each chemical's mobility in the groundwater. The K_d value is the chemical's ratio of its concentration in soil to its concentration in groundwater when the two concentrations are in equilibrium. A high K_d value would be representative of a chemical which has a tendency to bind to the soil and is therefor less mobile in the groundwater. The K_d values used for the modeling of contaminants for OU2 were based on conservative (low) literature values. Depending on the chemical form of a certain contaminant (specifically for inorganics) the K_d values can vary substantially. In general, low K_d values (corresponding to a mobile form of contaminant) were used in the modeling. For the

TABLE A-1

INPUT PARAMETERS USED IN THE ECTRAN MODEL

Parameter	Aquifer Remediation
Unsaturated Zone Thickness (ft)	15
Saturated Zone Thickness (ft)	25
Soil Density (g/cm^3)	1.7
Porosity[1]	0.3
Hydraulic Conductivity[1] (ft/day)	10
Infiltration Rate (inches/yr)	11

1 Values taken from RI Report (B&R Environmental, April 1997).

TABLE A-2

SOURCE AREA SIZES (FT)

Aquifer Remediation Source Areas	Length (ft)	Width (ft)	Gradient (ft/ft)
Area 1	1150	700	0.0058
Area 2	1020	700	0.0061
Area 3	840	620	0.0071
Area 4	920	750	0.0071
AR-1-1(1)	360	700	0.0058
AR-1-2(1)	360	360	0.0058
AR-2(1)	360	360	0.0061
AR-3(1)	360	360	0.0071
AR-4(1)	360	360	0.0071

1 Areas used for arsenic only, see Section A.4.1.

aquifer remediation times, if a soil concentration was very close to the background concentration in the soil, a higher K_d value was used. Background levels of a chemical in soil generally do not change with time which implies that the chemical is immobile. This would correspond to a higher K_d value. For the aquifer remediation times, lower K_d values were still used for the saturated zone since the chemicals that are presently in the groundwater are more likely to be a mobile form of the contaminants. The K_d values used for the groundwater fate and transport modeling are presented in Table A-3.

A.3.2.2 Half-life Decay Constants

The inorganic COCs are assumed to not decay during migration in the groundwater. Decay of organic contaminants occur by biological and non-biological mechanisms The half-lives of the organic COCs were taken from literature values and are listed in Table A-3.

A.3.2.3 Exposure Criteria

The acceptable groundwater concentration (or exposure criteria) at the exposure point is based on North Carolina State Groundwater Quality Standards (15A NCAC 2L) for Class GA classified groundwater class. GA groundwater is suitable to be used as a drinking water source. The exposure criteria are presented in Table A-3.

A.3.2.4 Soil and Groundwater Concentration Data

Existing soil concentrations were needed for the aquifer remediation time estimates. The average of the positive detections were calculated for soil samples taken from zero to fifteen feet for the source areas shown on Figure A-2.

The initial concentration in the groundwater was calculated using the most recent (1994 and 1996) groundwater data. The concentration of contaminants in wells screened in the surficial aquifer were averaged to determine the initial concentration in the source areas shown on Figure A-2. The average soil and groundwater concentration by source area are shown in Table A-4.

TABLE A-3
CHEMICAL INPUT PARAMETERS

COC	KOW	Background Kd (L/kg)	Kd (L/kg)	Half Life (yr)	Risk Criteria (ug/L)
ORGANICS					
1,1,1-Trichloroethane	295.12 (1)	9.30E-01	9.30E-01 (3)	3.01E+00 (2)	200 (7)
1,2-Dichloroethane	28.18 (1)	8.88E-02	8.88E-02 (3)	2.00E+00 (2)	0.38 (7)
1,2-Dichloroethene(total)	30.20 (1)	9.51E-02	9.51E-02 (3)	2.00E+00 (2)	70 (7)
2,4-Dimethylphenol	2.63E+02 (1)	8.29E-01	8.29E-01 (3)	7.66E-02 92)	730 (7)
Benzene	134.90 (1)	4.25E-01	4.25E-01 (3)	2.00E+00 (2)	1 (7)
Chlorobenzene	691.83 (1)	2.18E+00	2.18E+00 (3)	1.64E+00 (2)	50 (7)
Chloroform	9.33E+01 (1)	2.94E-01	2.94E-01 (3)	5.01E-01 (2)	0.19 (7)
Dieldrin	1.23E+04 (1)	3.88E+01	3.88E+01 (3)	7.00E+00 (2)	0.0042 (7)
Ethylbenzene	1412.54 (1)	4.45E+00	4.45E+00 (3)	6.25E-01 (2)	29 (7)
Methylene Chloride	17.78 (1)	5.60E-02	5.60E-02 (3)	1.54E-01 (2)	5 (7)
Naphthalene	2.34E+03 (1)	7.38E+00	7.38E+00 (3)	7.06E-01 (2)	21 (7)
Tetrachloroethene	3.39+02 (1)	1.07E+00	1.07E+00 (3)	4.52E+00 (2)	0.7 (7)
Toluene	489.78 (1)	1.54E+00	1.54E+00 (3)	5.75E-01 (2)	1000 (7)
Trichloroethene	338.84 (1)	1.07E+00	1.07E+00 (3)	4.52E+00 (2)	2.8 (7)
Vinyl Chloride	3.98 (1)	1.25E-02	1.25E-02 (3)	7.92E+00 (2)	0.015 (7)
Xylenes (total)	1100.00 (1)	3.47E+00	3.47E+00 (3)	1.00E+00 (2)	530 (7)
INORGANICS					
Arsenic	--	2.00E+02	3.30E+00 (4)	NA(9)	50 (7)
Barium	--	2.00E+01	2.00E+01 (8)	NA	2000 (7)
Cadmium	--	8.00E+01	1.20E+01 (4),(5)	NA	5 (7)
Chromium	--	7.00E+01	7.00E+01 (4)	NA	50 (7)
Manganese	==	2.00E+01	2.00E+01 (4)	NA	50 (7)
Mercury	--	5.00E+01	1.00E+01 (6)	NA	1.1 (7)
Nickel	==	4.00E+02	4.00E+02 (4)	NA	100 (7)
Selenium	--	1.50E+02	1.50E+02 (4)	NA	50 (7)
Thallium	--	1.50E+03	1.50E+03 (6)	NA	2 (7)

(1) U.S. EPA Risk Reduction Engineering Laboratory (RREL) Cincinnati, Ohio, Treatability Database
(2) Handbook of Environmental Degradation Rates, Howard, Philip H., Lewis Publishers, Inc. 1991
(3) Kd = KOCxFOC, FOC = 0.005, KOC = 0.63KOW (Maidment, 1990)
(4) Thibault et al. 1990
(5) Raj and Zachara 1984
(6) Baes et al 1984
(7) North Carolina Groundwater Quality Standards
(8) Sheppard et al. 1984
(9) Inorganics are assumed to not decay.

TABLE A-4

INITIAL SOIL AND GROUNDWATER CONCENTRATIONS

COC	Area	Soil Conc. (mg/kg)	Background Soil Conc. (mg/kg)[2]	Background Soil Conc. Used in the Model (mg/kg)	Saturated Layer Initial Conc. (ug/L)
AQUIFER REMEDIATION					
Arsenic	Area AR-1-1	2.47	4.5	2.47[1]	117.5
Arsenic	Area AR-1-2	2.47	4.5	2.47[1]	50.8
Manganese	Area 1	8.31	14.06	8.31[1]	722
Benzene	Area 1	0	0	0	8.33
Chlorobenzene	Area 1	0	0	0	1.64
Arsenic	Area AR-2	2.53	4.5	2.53[1]	6.1
Manganese	Area 2	45.8	14.06	14.06	152
Benzene	Area 2	0.028	0	0	3.75
Chlorobenzene	Area 2	0.152	0	0	67.8
Arsenic	Area AR-3	2.75	4.5	2.75[1]	56
Manganese	Area 3	62.3	14.06	14.06	188
Benzene	Area 3	0.070	0	0	10.3
Chlorobenzene	Area 3	0.024	0	0	70
Arsenic	Area AR-4	2.81	4.5	2.81[1]	98
Manganese	Area 4	194	14.06	14.06	54.3
Benzene	Area 4	0.006	0	0	60.5
Chlorobenzene	Area 4	0.034	0	0	15.8

1 If the average soil concentration was less than the background concentration, the average soil concentration was used in the model for remediated soil concentrations.
2 Table 4-2, RI Report (B&R Environmental, April 1997).

A.4.0 AQUIFER REMEDIATION TIME RESULTS

The aquifer remediation times were calculated for four chemicals; arsenic, manganese, benzene, and chlorobenzene. These chemicals are widespread in the groundwater and should provide a range of the estimated remediation times.

Groundwater Alternatives 3 and 4 involve the extraction of groundwater. Source areas were delineated based on the current location of groundwater contamination in the Surficial aquifer (See Figure 2-3). Because the contamination in the aquifer is widespread across the site, large source areas were chosen. Four source areas were chosen for manganese, benzene, and chlorobenzene. These are Areas 1, 2, 3, and 4 as shown on Figure A-2. The concentration of arsenic in the groundwater was not as widespread as the other contaminants so smaller source areas were chosen for these area. These correspond to source areas AR-1-1, AR-1-2, AR-2, AR-3, and AR-4. The average source concentration in the groundwater was calculated for these areas and is presented in Table A-4. The soil concentration for each of these source areas was also calculated and was presented in Table A-4. The large source areas required to cover the large plume areas results in the soil concentrations being average over large areas. This has a tendency to lessen the effect of "Hot Spots" in the soil. The results of the model will yield a general remediation time for the entire plume in the source area.

The calculated average concentration for arsenic in the soil for all of the arsenic source areas was below the background concentration of 4.5 mg/kg (Table 4-2, RI Report, [B&R Environmental, April 1997]). To account for this, a higher K_d value (200 L/kg) was used for the unsaturated zone in the model. A K_d value of 3.3 L/kg was used for the saturated zone. The other chemicals modeled for the aquifer remediation times used the same K_d values for the unsaturated and the saturated zones.

The maximum remediation time of any of the source areas for each contaminant is reported as the aquifer remediation time presented in Table A-5. All of the aquifer remediation times are measured from the beginning of the operation of the pumping system. Manganese is very prevalent in the groundwater and soils at OU2. The manganese concentration did not reach the exposure criteria at the end of the modeling time frame (1,000 years). Arsenic had the next longest cleanup time of 60 years in area AR-1-1.

The pumping system was designed to capture groundwater at the rate that it flows under natural conditons. Therefore, the aquifer remediation time estimates are also applicable to other groundwater remedial alternatives.

TABLE A-5

AQUIFER REMEDIATION TIME ESTIMATE RESULTS

Chemical	Area	Remediation Time (Yr)
Arsenic	AR-1-1	60
Benzene	Area 4	10.4
Chlorobenzene	Area 3	0.8
Manganese	Area 1	>1000

A.7.0 REFERENCES

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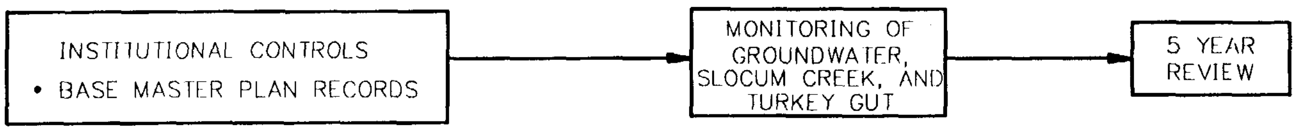
APPENDIX B

CONCEPTUAL DESIGN CALCULATIONS

GROUNDWATER ALTERNATIVE 2

NATURAL ATTENUATION AND INSTITUTIONAL CONTROLS

ACAD: K:\CADD\5395\5395PF03.DWG 06/30/97 HP



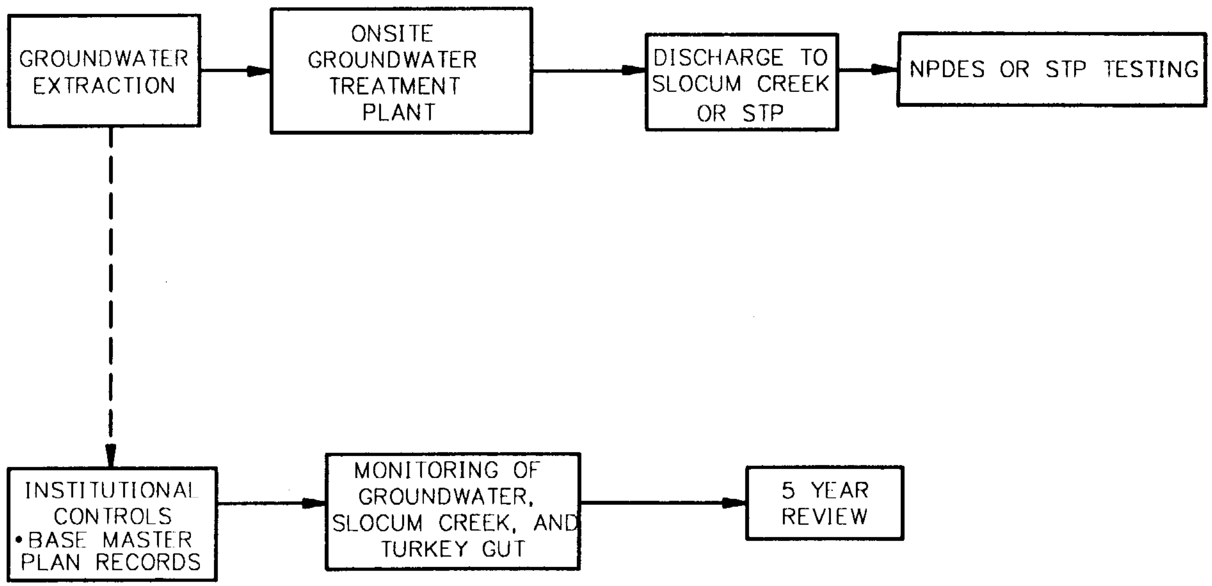
DRAWN BY HJP	DATE 4-11-97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY	DATE	GROUNDWATER ALTERNATIVE 2 CONCEPTUAL BLOCK FLOW DIAGRAM OPERABLE UNIT 2 MCAS CHERRY POINT, NC	APPROVED BY	DATE
COST/SCHED-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE B-1	REV. 0

FORM CADD NO SOUTH_AV.DWG - REV 0 - 02/07/97

GROUNDWATER ALTERNATIVE 3

GROUNDWATER EXTRACTION; TREATMENT AND DISCHARGE TO SLOCUM CREEK OR PRETREATMENT AND DISCHARGE TO STP; INSTITUTIONAL CONTROLS

ACAD: K:\CADD\5395\5395PF13.DWG 06/30/97 HP



DRAWN BY HJP	DATE 4-11-97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY	DATE	GROUNDWATER ALTERNATIVE 3 CONCEPTUAL BLOCK FLOW DIAGRAM OPERABLE UNIT 2 MCAS CHERRY POINT, NC	APPROVED BY	DATE
COST/SCHED-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE B-2	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

Groundwater Extraction System Design

The technical approach for the groundwater extraction system design for OU-2 (Site 10 landfill) was to design an extraction system to capture contaminated groundwater migrating within/from the Site 10 landfill, prior to it's discharge into Slocum Creek and/or Turkey Gut. As such, the design developed is a containment-type remedy. For design purposes, it was assumed that groundwater throughout the Site 10 landfill area has been impacted and requires remediation.

Based on observed site conditions and groundwater flow patterns in the area, it was felt that a design developed from analytical calculations would not adequately factor in the hydrogeologic variables present, such as the northern recharge basin, the two streams in the area, and two areas of groundwater mounding in the southern portion of the landfill. A two-dimensional numerical modeling approach was selected for the design process, using the FLOWPATH groundwater flow and particle tracking model.

Geologic cross sections, groundwater flow maps, and aquifer testing results were evaluated to provide the basic framework for the model. For modeling purposes, 100 feet was added to each measurement to facilitate model development while keeping the scale of the model consistent with actual conditions. For example, if the bottom of the aquifer was at an elevation of -20 ft msl and the water level elevation was 15 feet above msl, a base of aquifer elevation of 80 feet was input along with a water level elevation of 115 feet - in both cases resulting in an aquifer thickness of 35 feet. The model addressed the surficial aquifer only, using the top of the confining layer separating the surficial aquifer from the Yorktown aquifer as the base of the model.

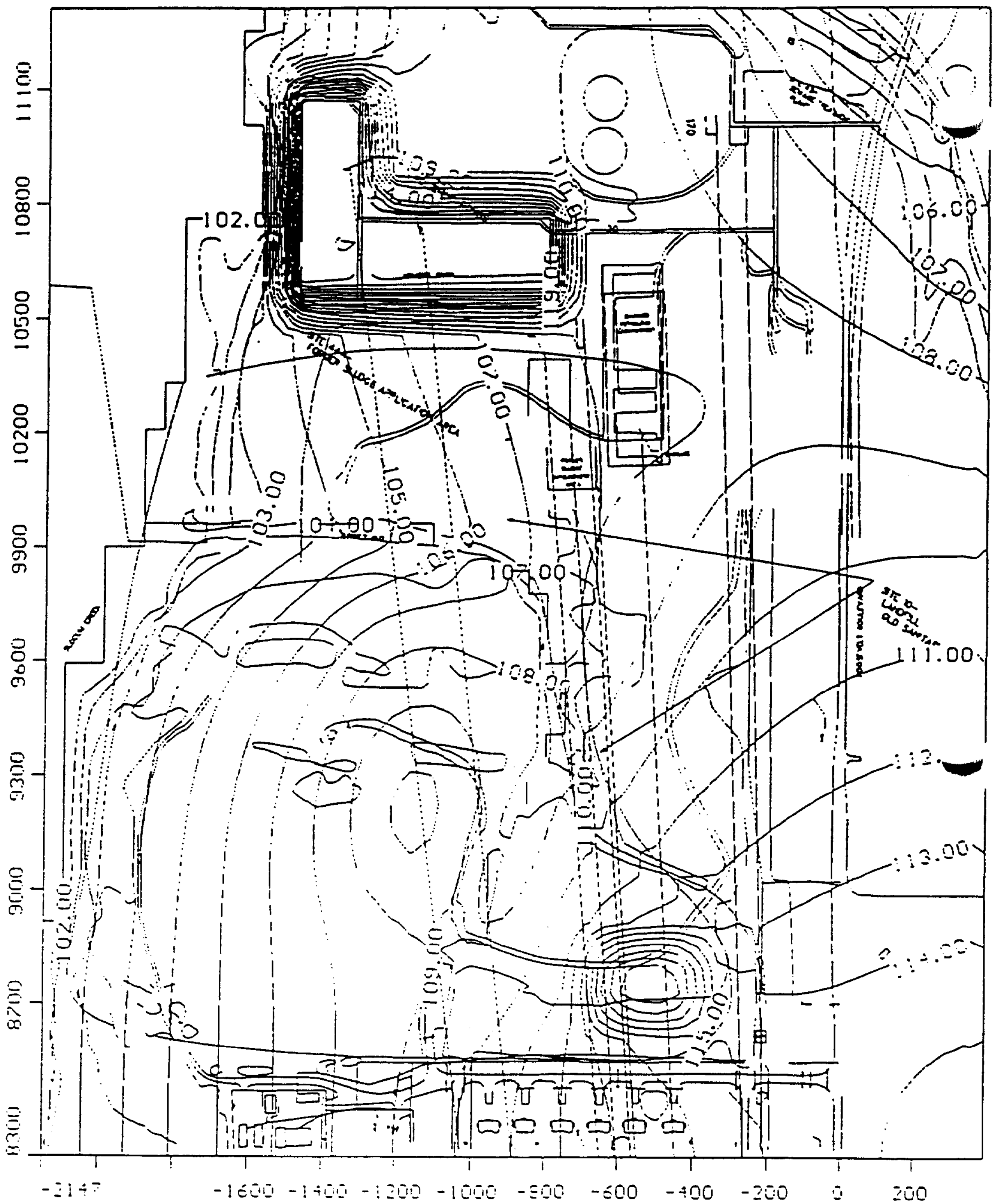
A uniform hydraulic conductivity (K) of 20 ft/day (based on slug test and pumping test results) was input for the model area, with 2 minor exceptions. Beneath the northern recharge basin, the K was reduced to 0.2 ft/day. This was necessary to match the modeled hydraulic head dropoff around the pond to actual conditions, and is consistent with the presence of low-permeability sludges in the bottom of the basin. The other area of differing hydraulic conductivity is in the southeastern corner of the landfill, where a K decrease to 2 ft/day was used along with a higher infiltration rate to recreate the mounding seen. A uniform effective porosity of 0.1 was applied across the entire model.

The bottom of the aquifer elevation varied from 80 feet, along the eastern landfill boundary, to 75 feet along Slocum Creek. Both Slocum Creek and Turkey Gut were modeled as constant head boundaries, with constant head nodes corellating to field-measured surface water elevations inserted along their reaches. Similarly, constant head nodes were placed along the eastern edge of the model, representing the hydraulic head field data for this area. Finally, constant head nodes were used to represent the water level in the northern recharge basin.

The two areas of groundwater mounding within the southern portion of the landfill were simulated by increasing the recharge rate from the assigned background recharge rate of 0.002 ft/day applied elsewhere within the modeled area. The higher mound in the southeastern corner of the landfill was simulated using a recharge rate of 0.08 ft/day. The other area of mounding, in the south-central portion of the model, was simulated using recharge rates of 0.06 and 0.03 ft/day.

The groundwater flow pattern simulated by the model was compared against the groundwater flow maps prepared for the area, using field data. As described previously, model input parameters were adjusted as necessary to address significant variances between initial modeled and field-observed flow patterns. The final modeled and field-derived groundwater flow patterns matched up well with each other, thus the model was assumed to be adequately calibrated for FS design purposes.

The groundwater extraction system was developed by adding extraction wells to the final flow model. Particle tracking was used to determine extraction well capture zones and to adjust well locations and extraction rates as necessary to provide complete capture of groundwater passing through the landfill. The particles were placed in upgradient areas and in areas of mounding, then tracked across the flow field to the extraction wells. The final extraction system developed consists of 19 wells, pumping at an aggregate rate of 123 gpm. Individual well pumping rates vary from 4 to 8 gpm. Well locations are shown on Figure 2, along with particle tracks indicating groundwater flow directions under pumping conditions. The wells were placed far enough from Slocum Creek or Turkey Gut to minimize induced infiltration of water from these streams.



Background Groundwater Flow Pattern
Non-Pumping Conditions FIG 1

3/10

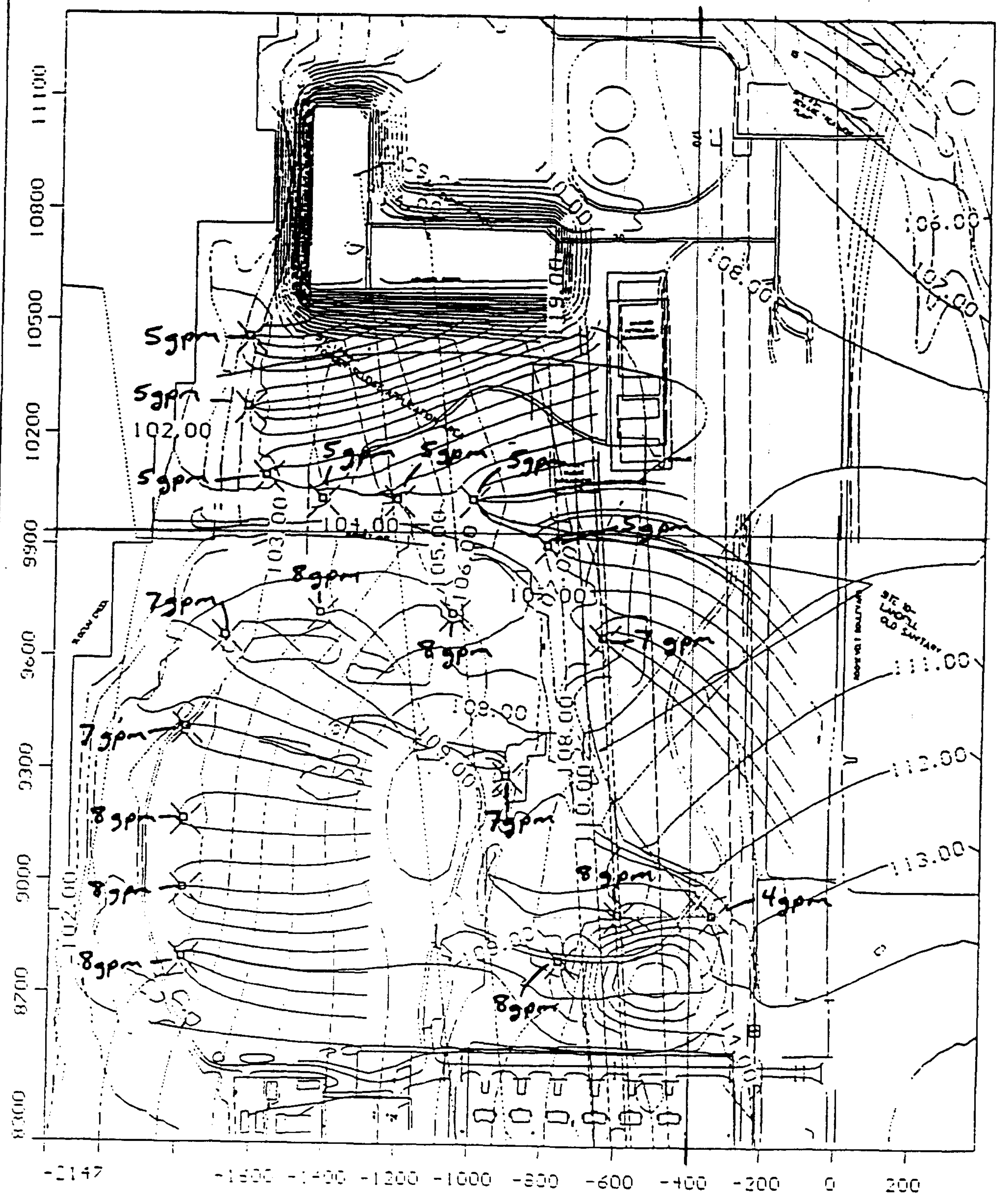


FIG 2

Extraction Well Locations
Particle Tracks
Equipotential Lines (Pumping Conditions)

4/10

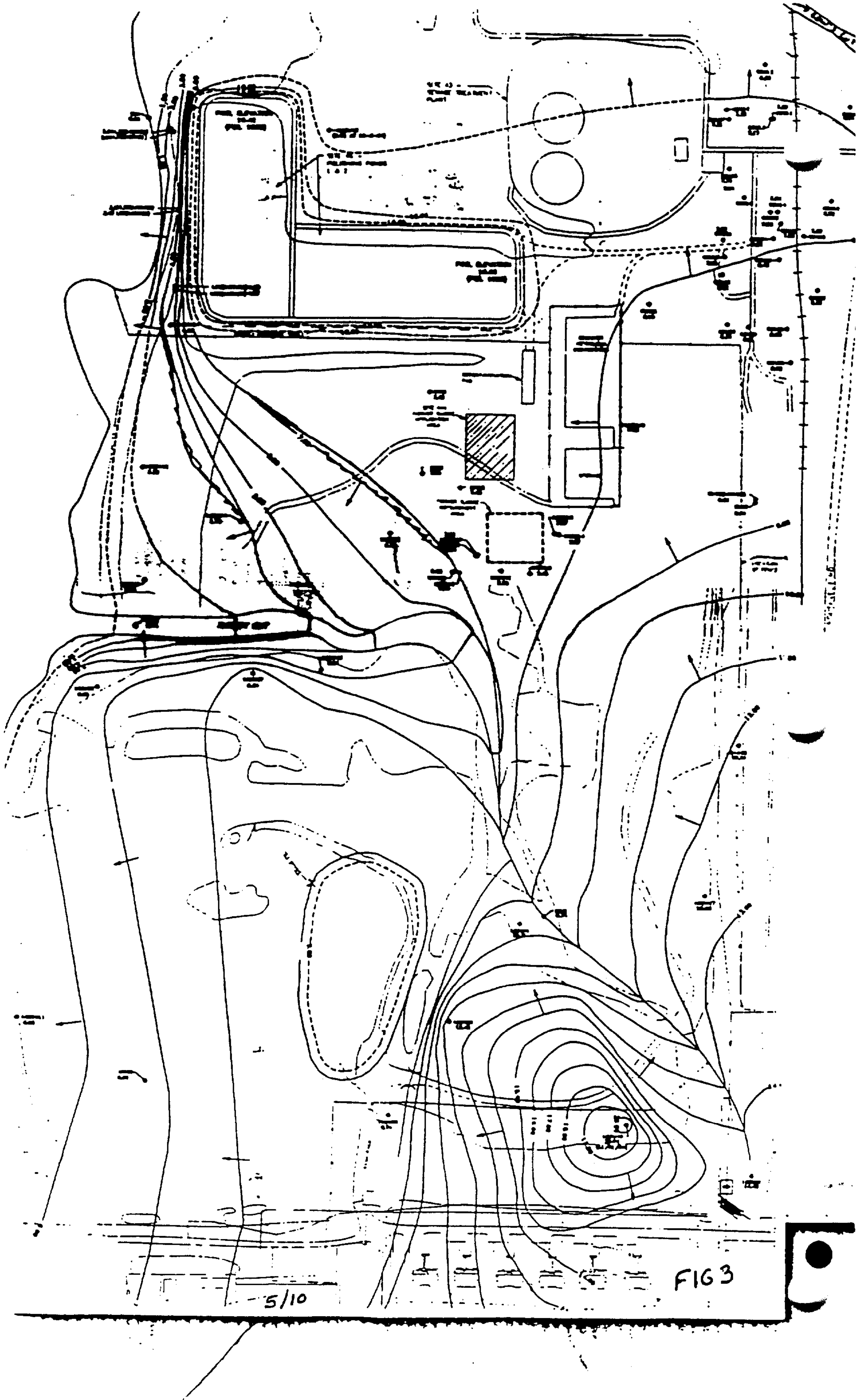


FIG 3

5/10

The extraction well design for the OU-2 groundwater extraction system includes stainless steel casing and screen, for long term durability, and a 6-inch well diameter, to allow for adequate annular space between the submersible pump and well casing. Well borings will be 10 inches in diameter, to allow sufficient space for proper well and gravel pack installation. The wells will extend vertically from ground surface to the top of the Yorktown confining unit, approximately 45 feet below ground surface on average. Screened intervals for the wells will be from the water table to the bottom of each well, an average distance of about 30 feet.

Contaminant	EW-1	EW-2	EW-3	EW-4	EW-5	EW-6	EW-7	EW-8	EW-9	EW-10
1,1-Dichloroethene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
1,2-Dichlorobenzene	0.0	0.0	0.0	0.0	22.0	22.0	1.3	4.0	0.0	0.0
1,2-Dichloroethane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1,2-Dichloropropane	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	2.0	0.0
1,4-Dichlorobenzene	16.0	16.0	16.0	13.0	4.0	4.0	0.0	1.3	3.0	3.0
Benzene	8.0	8.0	8.0	5.0	2.0	2.0	2.0	3.7	8.0	6.0
Chlorobenzene	180.0	180.0	180.0	89.0	2.0	2.0	0.0	0.7	4.0	0.0
Chloroform	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
cis-1,2-Dichloroethene	0.0	0.0	0.0	0.0	13.0	13.0	50.3	13.0	110.0	16.0
trans-1,2-Dichloroethene	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	1.0	2.0
Tetrachloroethene	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	9.0	0.0
Toluene	0.0	0.0	0.0	0.0	110.0	110.0	22.7	1.0	20.0	0.0
Trichloroethene	0.0	0.0	0.0	0.0	38.0	38.0	3.7	4.0	46.0	11.0
Vinyl chloride	0.0	0.0	0.0	0.0	3.0	3.0	4.7	4.0	22.0	8.0
Methylene chloride	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	2.0	0.0
1,1,1-Trichloroethane	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	22.0	22.0	1.3	0.0	3.0	0.0
Xylenes (total)	170.0	170.0	170.0	0.0	47.0	47.0	8.3	1.0	13.0	0.0
2,4-Dimethylphenol	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0
4-Methylphenol	0.0	0.0	0.0	0.0	57.0	57.0	21.7	0.0	21.0	0.0
Bis(2-chloroethyl)ether	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bis(2-ethylhexyl)phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.7	0.0	0.0
Nitrobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Heptachlor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Heptachlor epoxide	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0056
Arsenic	0.0	0.0	0.0	15.0	13.0	13.0	31.7	11.7	19.0	129.0
Cadmium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0
pH	6.2	6.2	6.2	6.2	6.1	6.1	6.4	6.5	6.2	6.1
Nickel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Turbidity	8.0	8.0	8.0	9.0	4.0	4.0	7.0	9.0	22.0	4.0
Barium	277	277	277	306	74	74	42	70	50	135
Manganese	145	145	145	121	132	132	644	472	142	1,050
Calcium	117,000	117,000	117,000	74,800	53,800	53,800	36,537	28,233	10,000	14,600
Magnesium	27,800	27,800	27,800	19,500	5,450	5,450	4,117	8,113	7,670	10,000
Hardness	408,426	408,426	408,426	268,315	157,227	157,227	108,508	104,416	56,984	78,200
Iron	69,300	69,300	69,300	57,400	31,800	31,800	43,483	59,587	101,000	73,200
Sodium	65,400	65,400	65,400	43,900	9,130	9,130	8,700	26,800	30,200	68,900

Contaminant	EW-11	EW-12	EW-13	EW-14	EW-15	EW-16	EW-17	EW-18	EW-19	WTP Influent Equal Flows	WTP Influent Varying Flows
1,1-Dichloroethene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.11	0.08
1,2-Dichlorobenzene	0.0	0.0	3.5	6.0	2.5	28.0	28.0	0.0	1.0	6.2	6.6
1,2-Dichloroethane	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.14	0.14
1,2-Dichloropropane	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.16	0.12
1,4-Dichlorobenzene	7.5	1.7	5.5	6.5	8.5	40.0	40.0	18.0	8.0	11.2	12.2
Benzene	10.5	7.7	26.0	7.0	3.0	6.0	6.0	5.0	60.3	9.7	10.6
Chlorobenzene	3.0	2.0	38.0	93.5	50.0	170.0	170.0	25.0	16.3	63.4	69.7
Chloroform	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0000	0.0000
cis-1,2-Dichloroethene	61.5	5.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3	15.0	11.8
trans-1,2-Dichloroethene	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.29	0.23
Tetrachloroethene	4.0	0.3	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.83	0.67
Toluene	12.0	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5	15.8	14.0
Trichloroethene	1.5	0.7	0.0	0.0	2.0	0.0	0.0	0.0	1.0	7.7	6.6
Vinyl chloride	17.0	6.0	0.0	2.0	1.0	0.0	0.0	0.0	5.5	4.0	3.3
Methylene chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.24	0.21
1,1,1-Trichloroethane	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.14	0.11
Ethylbenzene	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	6.0	3.5	3.2
Xylenes (total)	2.0	28.0	90.0	0.0	0.0	0.0	0.0	0.0	6.5	39.6	40.6
2,4-Dimethylphenol	0.0	1.3	140.0	0.0	0.0	0.0	0.0	0.0	1.5	7.9	9.5
4-Methylphenol	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0	8.8	7.9
Bis(2-chloroethyl)ether	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.08	0.10
Bis(2-ethylhexyl)phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.3
Nitrobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.09	0.07
Heptachlor	0.0000	0.0000	0.0028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0002
Heptachlor epoxide	0.0075	0.0080	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0009
Arsenic	67.0	79.0	2.0	21.5	33.0	56.0	56.0	98.0	19.3	35.0	33.7
Cadmium	0.0	0.0	0.0	0.0	0.0	6.0	6.0	0.0	0.0	1.1	1.1
pH	6.2	6.5	6.4	6.7	6.4	3.2	3.2	6.3	6.2	5.9692	5.9204
Nickel	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0	0.58	0.63
Turbidity	3.5	7.0	10.0	10.0	12.0	4.0	4.0	10.0	10.3	8.0921	8.1260
Barium	83	123	57	164	85	165	165	51	63	134	137
Manganese	1,369	946	80	111	225	231	231	30	157	343	297
Calcium	29,750	54,567	7,835	41,000	41,050	78,000	78,000	39,600	32,350	53,943	[illegible]
Magnesium	12,000	15,430	8,525	12,175	13,700	29,000	29,000	17,100	6,800	15,128	[illegible]
Hardness	124,415	200,760	55,137	153,270	159,754	315,930	315,930	170,307	109,231	197,941	[illegible]
Iron	85,800	87,867	98,200	61,550	74,900	58,200	58,200	43,600	30,715	63,432	62,552
Sodium	46,150	42,133	30,150	51,600	81,000	107,000	107,000	39,700	23,675	48,493	50,181

Contaminant	EW-1	EW-2	EW-3	EW-4	EW-5	EW-6	EW-7	EW-8	EW-9	EW-10
1,1-Dichloroethene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
1,2-Dichlorobenzene	0.0	0.0	0.0	0.0	22.0	22.0	1.3	4.0	0.0	0.0
1,2-Dichloroethane	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1,2-Dichloropropane	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	2.0	0.0
1,4-Dichlorobenzene	16.0	16.0	16.0	13.0	4.0	4.0	0.0	1.3	3.0	3.0
Benzene	8.0	8.0	8.0	5.0	2.0	2.0	2.0	3.7	8.0	6.0
Chlorobenzene	180.0	180.0	180.0	89.0	2.0	2.0	0.0	0.7	4.0	0.0
Chloroform	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
cis-1,2-Dichloroethene	0.0	0.0	0.0	0.0	13.0	13.0	50.3	13.0	110.0	16.0
trans-1,2-Dichloroethene	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	1.0	2.0
Tetrachloroethene	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	9.0	0.0
Toluene	0.0	0.0	0.0	0.0	110.0	110.0	22.7	1.0	20.0	0.0
Trichloroethene	0.0	0.0	0.0	0.0	38.0	38.0	3.7	4.0	46.0	11.0
Vinyl chloride	0.0	0.0	0.0	0.0	3.0	3.0	4.7	4.0	22.0	8.0
Methylene chloride	0.0	0.0	0.0	0.0	1.0	1.0	0.0	0.0	2.0	0.0
1,1,1-Trichloroethane	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0
Ethylbenzene	0.0	0.0	0.0	0.0	22.0	22.0	1.3	0.0	3.0	0.0
Xylenes (total)	170.0	170.0	170.0	0.0	47.0	47.0	8.3	1.0	13.0	0.0
2,4-Dimethylphenol	0.0	0.0	0.0	0.0	0.0	0.0	6.3	0.0	0.0	0.0
4-Methylphenol	0.0	0.0	0.0	0.0	57.0	57.0	21.7	0.0	21.0	0.0
Bis(2-chloroethyl)ether	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bis(2-ethylhexyl)phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.7	0.0	0.0
Nitrobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Heptachlor	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Heptachlor epoxide	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000	0.0056
Arsenic	0.0	0.0	0.0	15.0	13.0	13.0	31.7	11.7	19.0	129.0
Cadmium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.0	0.0
Chromium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nickel	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Thallium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Barium	277	277	277	306	74	74	42	70	50	135
Manganese	145	145	145	121	132	132	644	472	142	1,050
Calcium	117,000	117,000	117,000	74,800	53,800	53,800	36,537	28,233	10,000	14,600
Magnesium	27,800	27,800	27,800	19,500	5,450	5,450	4,117	8,113	7,670	10,000
Hardness	408,426	408,426	408,426	268,315	157,227	157,227	108,508	104,416	56,984	78,200
Iron	69,300	69,300	69,300	57,400	31,800	31,800	43,483	59,587	101,000	73,200
Sodium	65,400	65,400	65,400	43,900	9,130	9,130	8,700	26,800	30,200	68,900

Contaminant	EW-11	EW-12	EW-13	EW-14	EW-15	EW-16	EW-17	EW-18	EW-19		WTP Influent
1,1-Dichloroethene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.11**
1,2-Dichlorobenzene	0.0	0.0	3.5	6.0	2.5	28.0	28.0	0.0	1.0		**6.2**
1,2-Dichloroethane	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3		**0.14**
1,2-Dichloropropane	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.16**
1,4-Dichlorobenzene	7.5	1.7	5.5	6.5	8.5	40.0	40.0	18.0	8.0		**11.2**
Benzene	10.5	7.7	26.0	7.0	3.0	6.0	6.0	5.0	60.3		**9.7**
Chlorobenzene	3.0	2.0	38.0	93.5	50.0	170.0	170.0	25.0	16.3		**63.4**
Chloroform	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0000**
cis-1,2-Dichloroethene	61.5	5.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3		**15.0**
trans-1,2-Dichloroethene	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		**0.29**
Tetrachloroethene	4.0	0.3	0.0	0.0	1.5	0.0	0.0	0.0	0.0		**0.83**
Toluene	12.0	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.5		**15.8**
Trichloroethene	1.5	0.7	0.0	0.0	2.0	0.0	0.0	0.0	1.0		**7.7**
Vinyl chloride	17.0	6.0	0.0	2.0	1.0	0.0	0.0	0.0	5.5		**4.0**
Methylene chloride	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5		**0.24**
1,1,1-Trichloroethane	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.14**
Ethylbenzene	0.0	12.7	0.0	0.0	0.0	0.0	0.0	0.0	6.0		**3.5**
Xylenes (total)	2.0	28.0	90.0	0.0	0.0	0.0	0.0	0.0	6.5		**39.6**
2,4-Dimethylphenol	0.0	1.3	140.0	0.0	0.0	0.0	0.0	0.0	1.5		**7.9**
4-Methylphenol	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.0		**8.8**
Bis(2-chloroethyl)ether	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0		**0.08**
Bis(2-ethylhexyl)phthalate	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**1.7**
Nitrobenzene	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.09**
Heptachlor	0.0000	0.0000	0.0028	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		**0.0001**
Heptachlor epoxide	0.0075	0.0080	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000		**0.0012**
Arsenic	67.0	79.0	2.0	21.5	33.0	56.0	56.0	98.0	19.3		**35.0**
Cadmium	0.0	0.0	0.0	0.0	0.0	6.0	6.0	0.0	0.0		**1.1**
Chromium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0000**
Nickel	0.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0		**0.58**
Thallium	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		**0.0000**
Barium	83	123	57	164	85	165	165	51	63		**134**
Manganese	1,369	946	80	111	225	231	231	30	157		**343**
Calcium	29,750	54,567	7,835	41,000	41,050	78,000	78,000	39,600	32,350		**53,943**
Magnesium	12,000	15,430	8,525	12,175	13,700	29,000	29,000	17,100	6,800		**15,128**
Hardness	124,415	200,760	55,137	153,270	159,754	315,930	315,930	170,307	109,231		**197,941**
Iron	85,800	87,867	98,200	61,550	74,900	58,200	58,200	43,600	30,715		**63,432**
Sodium	46,150	42,133	30,150	51,600	81,000	107,000	107,000	39,700	23,675		**48,493**

Contaminant	10GW02	10GW03	10GW05	10GW06	10GW09	10GW11	10GW12	10GW27	10GW28	10GW34	10GW35	10GW36	10GW40	10GW41
1,1-Dichloroethene														
1,2-Dichlorobenzene			4				5			9	3			
1,2-Dichloroethane														
1,2-Dichloropropane			1							1				
1,4-Dichlorobenzene	15	3			17	18	8			4		9	16	13
Benzene	17	6	6		230	5	6			8	3		8	5
Chlorobenzene	5				27	25	42			2		58	180	89
Chloroform														
cis-1,2-Dichloroethene	100	16	140	11	1			13		14	24			
trans-1,2-Dichloroethene		2	2		1					2				
Tetrachloroethene	8		3				3	1						
Toluene			68		2									
Trichloroethene		11	11				4	2		4	8			
Vinyl chloride	26	8	14		3		2	6	3	7	5			
Methylene chloride					2									
1,1,1-Trichloroethane			5											
Ethylbenzene			4		10									
Xylenes (total)			25		14								170	
2,4-Dimethylphenol			19											
4-Methylphenol			65											
Bis(2-chloroethyl)ether														
Bis(2-ethylhexyl)phthalate										66	29			
Nitrobenzene										5				
Heptachlor														
Heptachlor epoxide	0.015	0.0056								0.0033				
Arsenic	106	129	51	44	44	98	39	119	67	30	5	27		15
Cadmium														
Chromium														
Nickel												22		
Thallium														
Barium	112	135	21	79	64	51	70	152	45	103	47	100	277	306
Manganese	2370	1050	107	1530	95	30	108	2030	149	52	135	341	145	121
Calcium	20100	14600	12600	7210	53700	39600	35500	44200	31300	11700	10400	46600	117000	74800
Magnesium	13300	10000	7000	2220	9470	17100	11600	7850	3540	12900	8350	15800	27800	19500
Hardness	105711	78200	60690	27282	173740	170307	137122	143235	93012	83043	60820	182386	408426	268315
Iron	90400	73200	84700	42500	64100	43600	65000	50100	38500	106000	66100	84800	69300	57400
Sodium	67200	68900	11700	7160	13200	39700	95900	41100	42600	39500	14400	66100	65400	43900

Contaminant	10GW43	10GW47	10GW48	MW01	MW08	MW09	MW10	MW11	MW12	HP01	HP02	HP03	HP04	HP05
1,1-Dichloroethene								2						
1,2-Dichlorobenzene	5	22			3		1			28		2	1	11
1,2-Dichloroethane							5				4			
1,2-Dichloropropane								2			1			
1,4-Dichlorobenzene	11	4			11		4	3		40	5		5	8
Benzene	4	2		4	7		4	8		6	23	48	10	4
Chlorobenzene	45	2		1	11		27	4		170	6	31	140	47
Chloroform														
cis-1,2-Dichloroethene		13		23			8	110	1		2			
trans-1,2-Dichloroethene								1			3			
Tetrachloroethene								9						
Toluene		110		24				20	3		70			
Trichloroethene		38		3			4	46						
Vinyl chloride		3		8			19	22			9		3	1
Methylene chloride		1						2						
1,1,1-Trichloroethane											3			
Ethylbenzene		22			14			3			38			
Xylenes (total)		47		4	10	2		13	3		84	180		
2,4-Dimethylphenol					6						4	280		
4-Methylphenol		57		3	18	18		21						
Bis(2-chloroethyl)ether												3		
Bis(2-ethylhexyl)phthalate														
Nitrobenzene														
Heptachlor	0.0055													
Heptachlor epoxide											0.024			
Arsenic	4	13		28	33			19		56	51		13	30
Cadmium								8		6				
Chromium														
Nickel														
Thallium														
Barium	63	74	25	54	41	62	85	50	61	165	172	51	226	101
Manganese	65	132	296	368	40	52	442	142	1230	231	660	94	94	127
Calcium	5960	53800	89800	39400	31400	24800	19500	10000	62600	78000	88200	9710	47400	34600
Magnesium	9280	5450	3130	10700	9050	1640	7040	7670	3090	29000	34900	7770	9250	15100
Hardness	53597.6	157227	237552	143119	116239	68839	78107	56984	169385	315930	366033	56676	157073	149467
Iron	74400	31800	3250	81200	50800	2200	5760	101000	6660	58200	175000	122000	73700	49400
Sodium	21100	9130	7240	25100	21800	17000	42700	30200	26500	107000	42700	39200	27300	75900

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EXTRACTION WELL		FLOW (GPM)		BASIS FOR QUALITY			
				Upper Surficial		Lower Surficial	
EW -1	C3	4		10GW40			
EW -2	D3	8		10GW40			
EW -3	E3	8		10GW40			
EW -4	F3	7		10GW41			
EW -5	G3	7		10GW47			
EW -6	H3	5		10GW47			
EW -7	I3	5		10GW05		10GW06	10GW48
EW -8	J3	5		10GW34		10GW35	MW12
EW -9	K3	5		MW11			
EW-10	L3	5		10GW03			
EW-11	C44	5		10GW02	MW01		
EW-12	D44	5		10GW28	HP02	10GW27	
EW-13	E44	8		10GW43	HP03		
EW-14	F44	8		HP04	HP05		
EW-15	G44	7		10GW36		10GW12	
EW-16	H44	7		HP01			
EW-17	I44	8		HP01			
EW-18	J44	8		10GW11			
EW-19	K44	8		10GW09	MW08	MW09	MW10

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GROUNDWATER ALTERNATIVE 3 - TREATMENT SYSTEM FOR DISCHARGE TO SLOCUM CREEK

Extracted groundwater from 19 wells is pumped first to an equalization/aeration tank, where contaminant surges are dampened and ferrous iron is oxidized to the less soluble ferric form. The equalization/aeration tank is sized for 27,000 gallons based on a 3-hour retention time at a design flow rate of 150 gpm. This tank will have a closed top and be vented to the atmosphere. No treatment of vapors from this tank is anticipated because of the minimal concentrations of volatile organics present in the extracted surficial aquifer groundwater. The equalization/aeration tank will be equipped with an automated level control system and two blowers to supply thorough mixing and sufficient air to oxidize ferrous iron to the less soluble ferric state.

The effluent from the equalization/aeration tank is pumped to a flash mix tank, where 50 percent caustic soda (sodium hydroxide) is added to adjust the pH to meet discharge requirements and supply hydroxide ion for the formation of less soluble ferric hydroxide. The flash mix tank is sized for 1,500 gallons based on a 20-minute retention time at the design flow rate and will be equipped with a top-mounted, turbine-type mixer for blending and an automated pH control system.

Fifty percent caustic will be used to maintain a pH between 7.0 and 7.5. This will ensure that sufficient hydroxide ion is supplied to precipitate all available ferric iron as less soluble ferric hydroxide and that stream discharge requirements for pH (6.8 to 8.5) are met. It is estimated that approximately 80 gallons per day (200 mL per minute) of 50 percent caustic will be required to maintain the pH between 7.0 and 7.5. The sodium hydroxide will be fed directly from the 2,500-gallon caustic storage tank, which is sized to hold a 30-day supply of the chemical.

The discharge from the flash mix tank is then pumped to a clarifier or inclined plate separator to settle out the heavier ferric hydroxide floc and other suspended solids. The required diameter of a conventional circular type gravity clarifier would be 25 feet based on a typical overflow rate of 0.3 gpm per ft^2 at the design flow rate of 150 gpm. The corresponding straight shell height of the clarifier would be 20 feet. The clarifier features a center feedwell, a bridge, a peripheral effluent collection launder, a bottom sludge removal outlet, and a bridge-suspended bottom rake mechanism. Inside the clarifier the suspended solids particles, mostly ferric hydroxide, settle as a sludge to the bottom of the unit while the clarified groundwater overflows into the peripheral collection launder, where it then proceeds by gravity to an overflow transfer tank. An inclined plate separator such as a Lamella, Graver, or comparable brand can be substituted for the conventional clarifier, provided that the inclined plate model is equivalent to a 25-foot diameter conventional model.

Overflow from the clarifier or inclined plate separator, which should contain about 30 mg/L of total suspended solids, flows by gravity to a 1,500-gallon transfer tank, sized for a 10-minute detention time at the design flow rate, prior to being pumped to a pressure sand filtration system for removal of lighter and/or smaller suspended solids. The transfer tank will be equipped with a level control system.

The sand filtration system will consist of two units operating in parallel, with one unit being switched into operation as the other is being taken off line for backwashing. Each of the two sand filters, sized to accommodate a minimum loading rate of 5 gpm per ft^2, is a vertical cylindrical pressure vessel 6.5 feet in diameter with a straight shell height of 6 feet. During remedial design, adequate depth and appropriate size and type of media must be selected to achieve a suspended solids concentration in the filtrate of 10 mg/L or less. This represents the solids concentration that will not interfere with the operation of the downstream carbon adsorption units. Frequency of backwashing is determined by the solids loading on the filters. Typically, about 1.5 lb per ft^2 is the maximum solids loading that can be achieved between backwash cycles; therefore, it is anticipated that one backwash cycle per day will be required. A centrifugal backwash pump and a blower will be required for each pressure filter to perform the backwashing sequence. Approximately 4,300 gallons of "dirty" backwash water containing 1,500 mg/L of suspended solids should be produced during each daily backwash cycle.

The effluent from the sand filter is discharged under pressure to a granular activated carbon adsorption system for removal of naphthalene and other incidental organic contaminants prior to discharge to Slocum Creek. Filtered groundwater would flow through a series of two activated carbon, packed bed adsorbers connected in series. Each of the two adsorbers, sized to accommodate a loading rate of 3 to 5 gpm per ft^2, is a vertical cylindrical pressure vessel 8 feet in diameter with a carbon holding capacity of 10,000 pounds.

Manifolding and valving is provided so that each of the two adsorber vessels can be operated in either the lead or lag position. The carbon bed of the lead adsorber removes most of the organic contaminants, while the carbon in the lag adsorber then removes any residual contaminant and prevents contaminant breakthrough out of the system upon exhaustion of the carbon in the lead adsorber. When an analysis of the lead adsorber effluent detects significant contaminant breakthrough, that vessel is taken out of service and replaced by a fresh vessel. This replacement is typically performed on a contractual basis by a supplier bringing in an adsorber full of regenerated carbon and taking away the spent carbon vessel for offsite regeneration of its contents. When replacement of the lead adsorber is required, the adsorber previously in the lag position is then valved to the lead position while the new vessel is valved to the lag position as the system is placed back into operation.

The carbon usage rate is estimated to be 115 lbs per day during the first year, with progressively reducing usage rates in subsequent years. This usage is based on the conservative assumption that 10 pounds of carbon will be expended for every pound of soluble organic carbon (SOC) in the shallow aquifer groundwater. At 115 lbs per day consumption, an adsorber vessel will have to be replaced about four times per year. These carbon usage rates must be recalculated during the remedial design process.

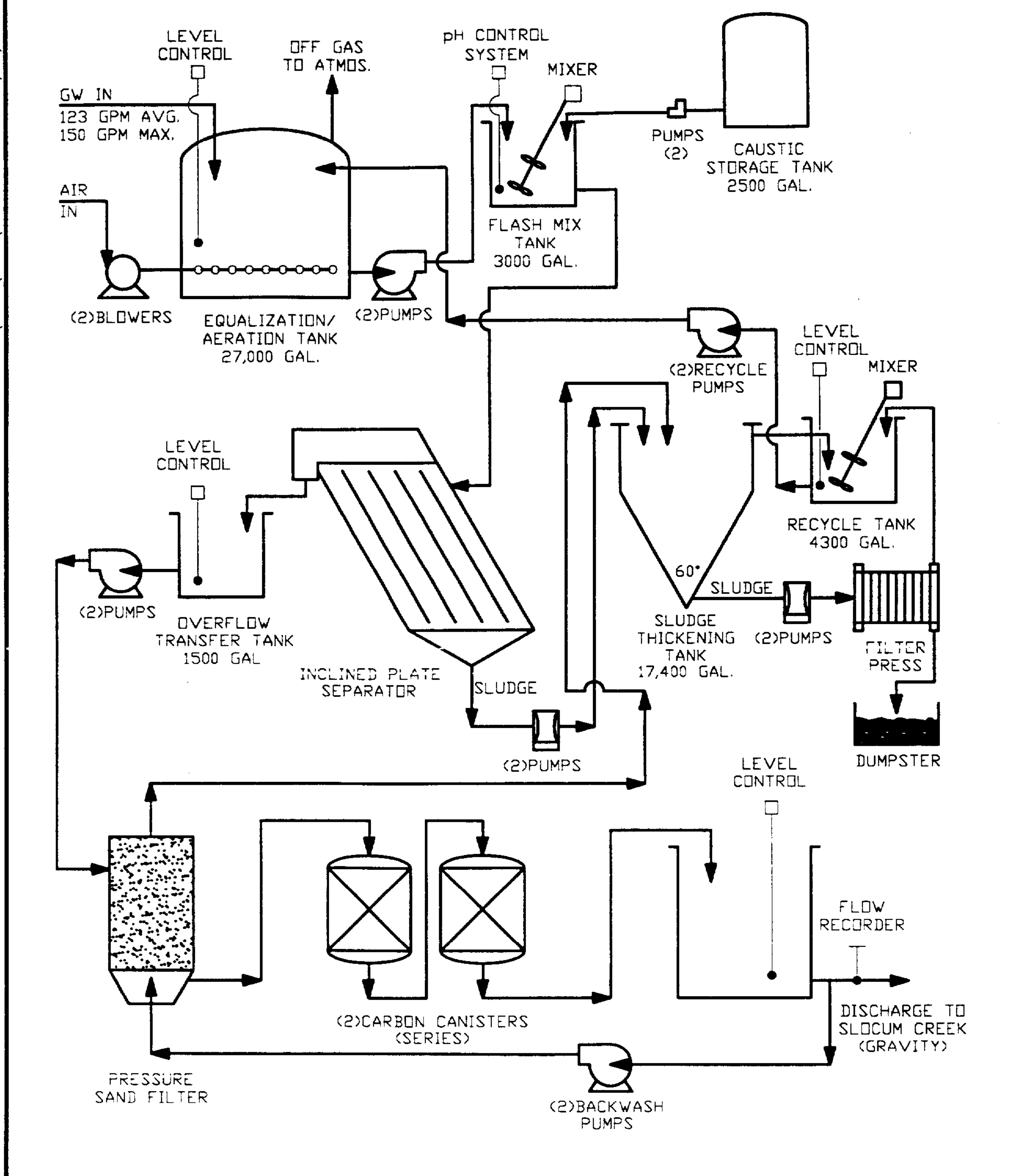
Prior to discharge, the effluent from the activated carbon adsorption system will proceed to a 9,000-gallon, cylindrical, effluent tank sized for a 1-hour retention time at the design flow rate. Since water from this effluent tank can be used to backwash the carbon filter beds as necessary, the same backwash pumps can be used to discharge the contents of the effluent tank to Slocum Creek, or the contents can be discharged by gravity. The effluent tank will be equipped with an automated level control system and flow recording system for effluent monitoring purposes. The final groundwater treatment plant effluent will meet anticipated NPDES limits for discharge to Slocum Creek including pH, total suspended solids, and naphthalene. In addition, the high iron concentrations in the extracted groundwater will be substantially reduced.

Underflow from the clarifier or inclined plate separator, daily backwash from the sand filters, and periodic carbon adsorber backwashes (if required) are sent to a sludge thickening tank and ultimately to a filter press for dewatering. Total sludge produced from the clarifier underflow is expected to be 1,500 gallons per day at 1.5 percent solids, while filter backwash water is expected to contribute 4,300 gallons per day at an average of 0.15 percent solids (1,500 mg/L). Underflow from the sludge thickening tank is estimated to be approximately 1,000 gallons per day at 3 percent solids. The volume of filter cake produced by the dewatering operation is expected to be about 12.2 cubic feet per day at 25 percent solids. This material will be disposed of off site as a nonhazardous waste.

Design of the sludge thickening tank is based on the daily loading rate of 1.5 lb/ft^2-day solids (dry weight basis) as well as the daily volume of sludge anticipated from both the filter backwash water and underflow from the clarifier. Since the dewatering process will not be operated on weekends, this tank must also be of sufficient capacity to handle at least a 3 day quantity or 17,400 gallons of unthickened sludge and have a 60° conical bottom to promote settling/thickening. This results in a cylindrical tank with a diameter of 15 feet, a straight shell height of 6 feet, and a cone bottom. Thickened sludge will be transported by two air diaphragm sludge pumps to a plate-and-frame type filter press where the sludge will be dewatered. The filter press will operate at two cycles per day and 5 days per week.

Both the overflow from the sludge thickening tank, which flows by gravity, and the filtrate from the filter press, which is pumped, enter a recycle tank prior to being returned to the equalization/aeration tank. The recycle tank is sized to handle the largest flow received from the sludge thickening tank over a 20-minute period, which corresponds to the volume produced by the 20-minute backwash cycle for the pressure sand filtration system. Therefore, the recycle tank will be a 4,300-gallon, cylindrical tank, equipped with a top-mounted, turbine-type mixer and an automated level control system. Two centrifugal recycle pumps will operate intermittently to recycle the contents of this tank back to the 27,000-gallon equalization/aeration tank.

ACAD: K:\CADD\5395\GWTSYS01.DWG 06/30/97 HP



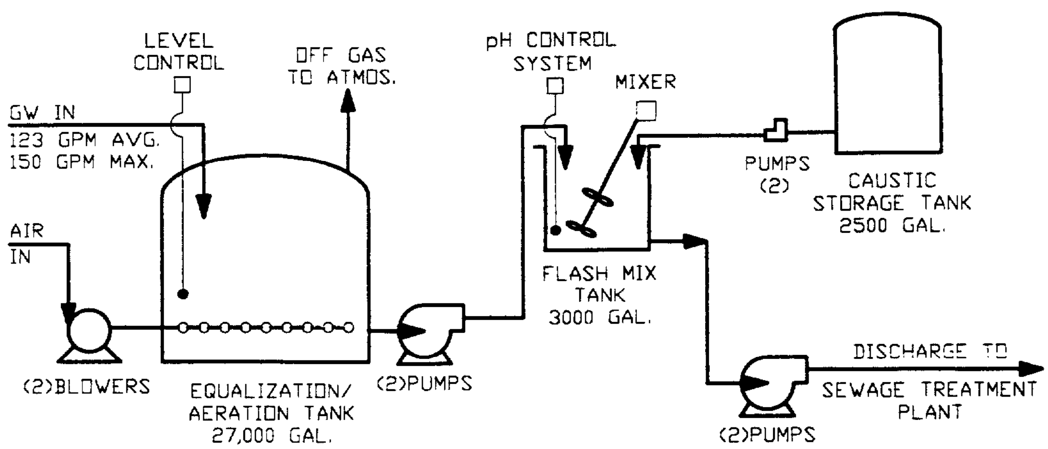
DRAWN BY HJP / DATE 04/14/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY / DATE	**GROUNDWATER TREATMENT SYSTEM GROUNDWATER ALTERNATIVE 3 DISCHARGE TO SLOCUM CREEK OPERABLE UNIT 2 MCAS CHERRY POINT, NC**	APPROVED BY / DATE	
COST/SCHED-AREA		APPROVED BY / DATE	
SCALE AS NOTED		DRAWING NO. FIGURE B-3	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

PRETREATMENT SYSTEM - DISCHARGE TO SEWAGE TREATMENT PLANT

A sufficient quantity of excavated soil and waste/fill material is stockpiled in a staging area prior to starting the pozzolan-based solidification system to ensure continuous operation of the system. The average production rate for a mobile solidification system is approximately 300 tons/day. Excavated soil is typically classified using a vibrating screen, crusher, or shredder and transported to a batch plant by conveyor. The classified soil is then mixed with appropriate solidifying agents. After the waste is mixed with the solidifying agents, it is sent to a curing area, where it is allowed to form a hardened block or a friable soil prior to being placed into a consolidation area and covered with a multi-layer cap. The multi-layer cap will be of the same design as that referenced in Soil Alternative 4. The consolidation area will be located adjacent to the staging area for the solidification process and must be sufficiently large to account for a volume increase of up to 30 percent higher than the original contaminated soil and waste/fill material. Based on the final solidified volume of 3,500 cubic yards, it is anticipated that the consolidation area required will be approximately 32,400 ft^2 (180 feet by 180 feet).

The mobile solidification unit will require approximately 100 feet by 100 feet of space for equipment setup and will require at least two weeks to mobilize. The space requirement does not include the staging area for soil stockpiling both prior to treatment or curing area. At a processing rate of 300 tons per day, it would take approximately 12 days, not including curing time, to solidify all of the identified nonvolatile organic and metal contaminated soil at the OU2 site.



DRAWN BY HJP / DATE 4/9/97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY / DATE	GROUNDWATER PRETREATMENT SYSTEM GROUNDWATER ALTERNATIVE 3 DISCHARGE TO STP OPERABLE UNIT 2 MCAS CHERRY POINT, NC	APPROVED BY / DATE	
COST/SCHED-AREA		APPROVED BY / DATE	
SCALE AS NOTED		DRAWING NO. FIGURE B-4	REV. 0

CLIENT NAVY - CHERRY POINT, NC		JOB NUMBER 5395	
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN			
BASED ON DISCHARGE TO SLOCUM CREEK		DRAWING NUMBER	
BY GND	CHECKED BY	APPROVED BY	DATE 10/23/95

1.0 DESIGN PARAMETERS

1.1 FLOW (Shallow Aquifer)

- Average groundwater extraction flow - 123 GPM (19 wells)
- Design groundwater treatment system throughput - 150 GPM (0.216 MGD)

1.2 CONTAMINANTS (ug/l)

	AVG	MAX
- Semi Volatiles		
Naphthalene	4.5	9.0
- Metals		
Iron	62,500	125,000
- Conventional		
pH (Units)	5.8 - 6.0	5.8 - 6.0
Suspended Solids (est)	120,000	240,000
SOC	6,400	12,800

2.0 TREATMENT SCHEME

The groundwater treatment system shall consist of the following processes/unit operations

- Equalization / Aeration
  For blending groundwater from 19 extraction wells and oxidizing iron from ferrous to ferric state

- pH Adjustment / Chemical Precipitation
  To meet pH discharge requirements and to form insoluble ferric hydroxide for iron removal

- Clarification / Sand Filtration
  To remove suspended solids (including iron hydroxide) and provide pretreatment for downstream carbon treatment

- Granular Activated Carbon Adsorption
  To remove naphthalene and other incidental organic contaminants

- Sludge Thickening / Dewatering
  To minimize the volume of treatment residues to be disposed

CLIENT NAVY - CHERRY POINT, NC		JOB NUMBER 5395	
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN			
BASED ON DISCHARGE TO SLOCUM CREEK		DRAWING NUMBER	
BY GND	CHECKED BY	APPROVED BY	DATE 10/23/95

3.0 EQUALIZATION / AERATION

The equalization tank is sized for 3 hours detention time at the design flow rate

- Tank Volume: 150 gal/min x 180 min = 27,000 gal

- Tank Dimensions: 15 ft Dia x 20 ft SSH (Cylindrical)

- Other Considerations:
  1 - Air blowers to supply good mixing and oxidize the iron
  2 - Automatic level control system
  3 - Two variable speed centrifugal feed pumps to send groundwater to the flash mix tank

4.0 pH ADJUSTMENT / CHEMICAL PRECIPITATION

4.1 FLASH MIX TANK

pH adjustment is performed in a flash mix tank sized for 20 minutes retention time at the design flow rate

- Tank Volume: 150 gal/min x 20 min = 3,000 gal

- Tank Dimensions: 7 ft Dia x 10 ft SSH (Cylindrical)

- Other Considerations:
  1 - Top mounted turbine type mixer for blending
  2 - Automatic pH control system
  3 - Use of 50 % caustic (NaOH) to adjust pH from 5.9 to 7.5

4.2 pH ADJUSTMENT / CHEMICAL PRECIPITATION

- Raise pH from 5.9 to 7.5 using 50 % NaOH
  Initial [H+] = 1.26E-6 >>> Initial [OH-] = 7.94E-9
  Final [H+] = 3.16E-8 >>> Final [OH-] = 3.16E-7
  [OH-] added = 3.08E-7 moles/l
  = 3.08E-7 moles/l x 3.785 l/gal x 150 gal/min x 1440 min/day x 40 g/mole x lb/454 g x 1/.5
  = 0.044 lb/day of 50 % NaOH

CALCULATION WORKSHEET

CLIENT NAVY - CHERRY POINT, NC	JOB NUMBER 5395
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN	
BASED ON DISCHARGE TO SLOCUM CREEK	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
GND			10/23/95

4.2 pH ADJUSTMENT / CHEMICAL PRECIPITATION (Cont)

- Precipitate iron

NaOH <-----> [Na+] + [OH-]

[Fe+++] + 3[OH-] <-----> Fe(OH)3

[OH-] added = 3.08E-7 moles/l

Need 3 equivalents of NaOH per equivalent of Fe(OH)3

Fe = 62.5 mg/l x 1.0 g/1000 mg x 1.0 mole/55.85 g = 1.12E-3 moles/l

Fe = 1.12E-3 moles/l

NaOH = 3(1.12E-3) moles/l

NaOH = 3.36E-3 moles/l

50 % NaOH added:

= 3.36E-3 moles/l x 3.785 l/gal x 150 gal/min x 1440 min/day x 40 g/mole x 1.0 lb/454 g x 1/.5

= 484 lb/day of 50 % NaOH

Total NaOH required:

= 484 lb/day + 0.044 lb/day = 484 lb/day

= 484 lb/day x 1.0 gal/6.0 lb

= 80.7 gal/day of 50 % NaOH

4.3 SODIUM HYDROXIDE STORAGE TANK

Closed tank sized for 30 days storage

- Tank Volume: 80.7 gal/day x 30 days = 2,421 gal ----> 2,500 gal

- Tank Dimensions: 7.5 ft Dia x 8 ft SSH (Cylindrical)

4.4 OTHER CONSIDERATIONS

1 - Use 2 diaphragm pumps to feed 50 % NaOH solution

2 - Average chemical feed flow required

= 80.7 gal/day x 1.0 day/1440 min x 3785 ml/gal

= 200 ml/min of 50 % NaOH solution

CLIENT NAVY - CHERRY POINT, NC	JOB NUMBER 5395
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN	
BASED ON DISCHARGE TO SLOCUM CREEK	DRAWING NUMBER

BY GND	CHECKED BY	APPROVED BY	DATE 10/24/95

5.0 CLARIFICATION

5.1 CLARIFIER / INCLINED PLATE SEPARATOR

A. For conventional type circular gravity clarifier, size at an overflow rate of 0.3 gpm/sq ft at the design flow rate

- Minimum Clarifier Surface: 150 gpm/ 0.3 gpm/sq ft = 450 sq ft > 500 sq ft

- Clarifier Dimensions: 25 ft Dia x 20 ft SSH

B. For inclined plate separator, size at an overflow rate of 0.25 gpm/sq ft at the design flow rate

- Minimum Plate Separator Surface: 150 gpm/ 0.25 gpm/sq ft = 600 sq ft

- Separator Dimensions: Use separator equivalent to a 28 ft dia clarifier

- Other Considerations:
  1 - Use 2 air driven clarifier underflow pumps to send sludge to the to the thickening tank
  2 - Gravity flow to the clarifier overflow transfer tank
  3 - Overflow transfer tank sized for 10 minutes retention at the design flow rate
    - Tank Volume: 150 gal/min x 10 min = 1,500 gal
    - Tank Dimensions: 6 ft Dia x 7 ft SSH (Cylindrical)
  4 - Use 2 horizontal centrifugal filter feed pumps to transfer water from the clarifier overflow transfer tank to the next stage

5.2 SLUDGE BLOWDOWN FROM CLARIFIER / SEPARATOR

Assume the following:

- Calcium in the water is essentially 100 % soluble at pH = 7.5
- Clarifier overflow contains 30 mg/l suspended solids
- Sludge consists of iron hydroxide precipitate plus an additional 10 % for all other materials precipitated
  $Fe(OH)_3$ = 62.5 mg Fe/l x (107 mg $Fe(OH)_3$ / 56 mg Fe)
  $Fe(OH)_3$ = 120 mg/l
  Total precipitated solids = 132 mg/l
  = (132-30) mg/l x 3.785 l/gal x 150 gal/min x 1440 min/day x 1.0 g/1000 mg x 1.0 lb/454
  Total Sludge Produced = 184 lb/day (dry wt basis)
- @ 1.5 % solids the volume of the sludge produced is as follows:
  Sludge Volume = 184 lb/day x 1.0 gal/8.34 lb x (1.0/.015) = 1,500 gal/day

CLIENT NAVY - CHERRY POINT, NC		JOB NUMBER 5395	
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN			
BASED ON DISCHARGE TO SLOCUM CREEK		DRAWING NUMBER	
BY GND	CHECKED BY	APPROVED BY	DATE 10/24/95

6.0 SAND FILTRATION

6.1 REMOVAL OPERATION

Sand filtration will involve the use of 2 filters operating in parallel with one unit being used while the other is backwashed

- Influent Flow Rate = (150 - 1) gpm = 149 gpm
- Influent Solids Concentration = 30 mg/l
- Effluent Solids Concentration = 5 mg/l
- Minimum loading rate is 5.0 gpm/sq ft

- Unit Size: 149 gpm / 5.0 gpm/sq ft = 30 sq ft ----> Use 33 sq ft

- Unit Dimensions: 6.5 ft Dia x 6.0 ft SSH (33 sq ft units)

- Removal Rate:
  = (30-5) mg/l x 3.785 l/gal x 149 gal/min x 1440 min/day x 1.0 g/1000 mg x 1.0 lb/454 g
  = 45 lb/day of solids (dry weight basis)

6.2 BACKWASH OPERATION

- Run for 15 minutes @ 6.0 gpm / sq ft
  = 6.0 gal/min-sq ft x 33 sq ft x 15 min = 2,970 gal ----> 3,000 gal
- Run for 5 minutes @ 8.0 gpm / sq ft
  = 8.0 gal/min-sq ft x 33 sq ft x 5 min = 1,320 gal ----> 1,300 gal
- Assume solids loading of 1.0 - 1.5 lb/sq ft between backwash cycles
  = (45 lb/day) / 33 sq ft = 1.36 lb/sq ft loading rate
- Therefore can operate at 1 backwash cycle per day with the total amount of backwash water generated being 4,300 gallons per cycle
- Assuming 100% backwash efficiency, the concentration of solids in the backwash water would be:
  = (45 lb/4,300) gal x 454 g/lb x 1000 mg/g x 1.0 gal/ 3.785 l = 1,255 mg/l

- Other Considerations:
  1 - Use 2 centrifugal backwash pumps
  2 - Use 2 blowers for the first backwash cycle
  3 - Send all backwash water to the sludge thickening tank

CALCULATION WORKSHEET

CLIENT NAVY - CHERRY POINT, NC		JOB NUMBER 5395	
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN			
BASED ON DISCHARGE TO SLOCUM CREEK		DRAWING NUMBER	
BY GND	CHECKED BY	APPROVED BY	DATE 10/24/95

7.0 GRANULAR ACTIVATED CARBON (GAC)

7.1 ADSORPTION OPERATION

This will involve 2 units operating in series, each designed at an empty bed contact time of 12 minutes and a surface loading rate 3-5 gpm/sq ft at the design flow rate

- Unit Model: Calgon Model 8 (Replaces old Model 7.5) - 2 Units

- Dimensions of each Unit: 8 ft Dia - Holds 10,000 lb carbon

7.2 CARBON USAGE

Will use Filtrasorb 300 type carbon

- Assume 10 lb of carbon used per 1.0 lb SOC in the groundwater
- SOC concentration in the groundwater is estimated at 6.4 mg/l
- Therefore carbon usage is:
  = 6.4 mg SOC/l x 3.785 l/gal x 1.0 g/1000 mg x 150 gal/min x 1440 min/day x 1.0 lb/454 g
  = 11.5 lb SOC / day x 10 lb carbon / lb SOC = 115 lb / day of activated carbon required

- Time between carbon changes:
  = 10,000 lb / 115 lb/day = 87 days ----> approx 90 days

8.0 DISCHARGE SYSTEM

8.1 EFFLUENT TANK

The effluent tank sized for 60 minutes retention time at the design flow rate

- Tank Volume: 150 gal/min x 60 min = 9,000 gal

- Tank Dimensions: 10 ft Dia x 15 ft SSH (Cylindrical)

- Other Considerations:
  1 - Carbon backwash pumps can also be used for discharge
  2 - Automatic flow control and flow recording system

CLIENT NAVY - CHERRY POINT, NC	JOB NUMBER 5395
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN	
BASED ON DISCHARGE TO SLOCUM CREEK	DRAWING NUMBER

BY GND	CHECKED BY	APPROVED BY	DATE 10/24/95

9.0 SLUDGE THICKENING

Use a loading rate of 1.5 lb (dry) / sq ft / day for the sludge thickening tank

- Solids received from the clarifier underflow - 184 lb/day
- Solids received from sand filter backwash - 45 lb/day

- Total daily solids loading - 229 lb/day

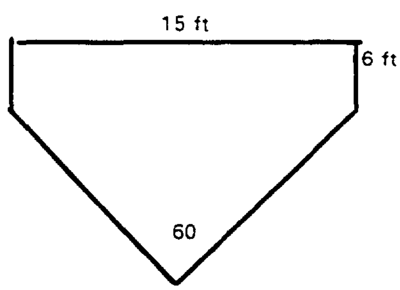
9.1 THICKENING TANK

- Surface Area Required: (229 lb/day) / 2.0 lb/sq ft-day = 115 sq ft
  Multiply by 2 to account for intermittent flow from backwashes = 230 sq ft

- Size for 3 days retention time since no sludge dewatering will occur on weekends

- Tank Volume: 1500 gal + 4300 gal = 5,800 gal x 3 days = 17,400 gal

- Tank Dimensions: 15 ft Dia x 6 ft SSH (Cylindrical w/ Conical Bottom)



- Other Considerations:
  1 - Use 2 sludge underflow pumps to transfer thickened sludge to dewatering equipment
  2 - Overflow from this tank proceeds by gravity to the thickener recycle tank

9.2 THICKENER RECYCLE TANK

- Size for 20 minutes retention time at the average sand filter backwash flow rate; ie., one backwash cycle volume or 4,300 gallons (575 cu ft)

- Tank Dimensions: 9 ft Dia x 9 ft SSH (Cylindrical)

- Other Considerations:
  1 - Use 2 centrifugal pumps to intermittently pump contents of recycle tank back to equalization/aeration tank
  2 - Automatic level control system required

CLIENT NAVY - CHERRY POINT, NC		JOB NUMBER 5395	
SUBJECT OU-2 GROUNDWATER TREATMENT DESIGN			
BASED ON DISCHARGE TO SLOCUM CREEK		DRAWING NUMBER	
BY GND	CHECKED BY	APPROVED BY	DATE 10/24/95

9.3 THICKENING TANK UNDERFLOW

- Assume that 95% of all solids are recovered in the thickener underflow

- Therefore: 229 lb/day x 0.95 = 218 lb/day recovered in underflow

- Estimate thickener underflow at 3% solids - this proceeds to filter press
  = 218 lb/day x (1.0/0.03) x (1.0 gal/ 8.34 lb) = 870 gal/day

- Other Considerations:
  1 - Use 2 air diaphragm thickener underflow pumps
  2 - There is no weekend operation of dewatering equipment, therefore pumps are sized to fill the filter press in 2 cycles/day, 5 days/week
  = 870 gal/day x (7.0/5.0) x (1.0 day/ 2.0 cycles) = 610 gal/cycle
  At approximately 30 minutes per pumping cycle, pumps should be sized at 25 gpm

10.0 SLUDGE DEWATERING

10.1 FILTER PRESS

- Assume that 99% of all solids are recovered in the filter press

- Estimate the final filter cake @ 25% solids (SpGr = 1.25)

- Loading from the thickener underflow at 3% solids is 870 gal/day or 218 lb/day on a dry weight basis

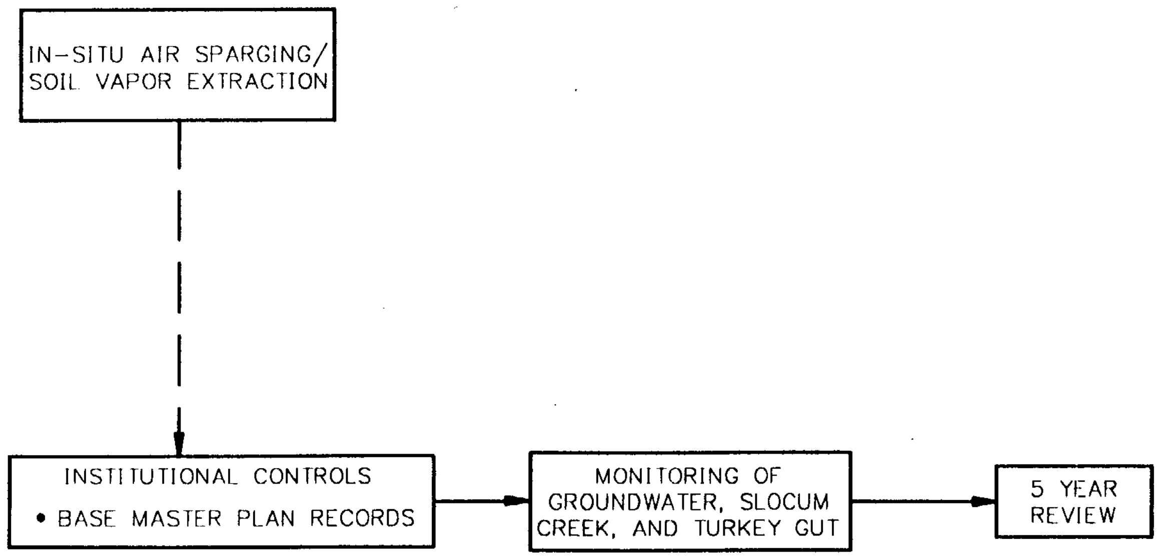
- Volume of Filter Cake:
  = 218 lb/day x 0.99 x (1.0 cu ft / (62.4x1.25) lb) x (1.0 / 0.25)
  = 11.0 cu ft / day or 5.5 cu ft / cycle

- Filtrate Flow to Recycle Tank: 870 gal/day - (11.0 cu ft/day x 7.48 gal/cu ft)
  = 870 gal/day - 82 gal/day
  = 788 gal/day or 394 gal/cycle

  Size filtrate pumps at 20 gpm to pump intermittently for approximately 20 minuteseach cycle

GROUNDWATER ALTERNATIVE 4

AIR SPARGING/SOIL VAPOR EXTRACTION; INSTITUTIONAL CONTROLS



DRAWN BY HJP DATE 4-11-97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY DATE	**GROUNDWATER ALTERNATIVE 4** **CONCEPTUAL BLOCK FLOW DIAGRAM** **OPERABLE UNIT 2** **MCAS CHERRY POINT, NC**	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE B-5	REV. 0

CALCULATION WORKSHEET

Order No. 19116 (01-91)

CLIENT	JOB NUMBER
SUBJECT ASVE SYSTEM FOR GROUNDWATER (9 SUB-SECTIONS)	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
CAD			8/7/96

* – ALL PIPE SCHEDULE 40 PVC (HEADERS – 4" / BRANCHES – 2")
* – ONE INJECTION POINT BOX PER INJECTION WELL
* – ONE EXTRACTION NEST PER HORIZONTAL EXTRACTION WELL
* – ONE CONTROL BUILDING PER LETTERED SECTION (9 TOTAL)
* – ASSUME ONE COMPLETE EQUIPMENT SWITCHOVER FOR LIFE OF SYSTEM

Section

A. INJECTION WELLS – 9 Avg Depth 40'
HORIZONTAL EXTRACTION WELLS – 8 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER – 90 CFM
VACUUM BLOWER – 120 CFM
INJECTION HEADER – 500'
EXTRACTION HEADER – 440'

B. INJECTION WELLS – 11 Avg. Depth 35'
HORIZONTAL EXTRACTION WELLS – 10 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER – 110 CFM
VACUUM BLOWER – 150 CFM
INJECTION HEADER – 620'
EXTRACTION HEADER – 560'

C. INJECTION WELLS – 9 Avg. Depth 40'
HORIZONTAL EXTRACTION WELLS – 8 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER – 90 CFM
VACUUM BLOWER – 120 CFM
INJECTION HEADER – 500'
EXTRACTION HEADER – 440'

D. INJECTION WELLS – 9 Avg. Depth 40'
HORIZONTAL EXTRACTION WELLS – 8 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER – 90 CFM
VACUUM BLOWER – 120 CFM
INJECTION HEADER – 500'
EXTRACTION HEADER – 440'

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
SUBJECT ASVE SYSTEMS FOR GROUNDWATER	
BASED ON	DRAWING NUMBER
BY GMD / CHECKED BY	APPROVED BY / DATE 8/7/96

E. INJECTION WELLS - 9 Avg. Depth 50'
HORIZONTAL EXTRACTION WELLS - 8 Avg Length 60' (in 3' deep trench)
INJECTION BLOWER - 90 CFM
VACUUM BLOWER - 120 CFM
INJECTION HEADER - 500'
EXTRACTION HEADER - 440'

F. INJECTION WELLS - 9 Avg. Depth 45'
HORIZONTAL EXTRACTION WELLS - 8 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER - 90 CFM
VACUUM BLOWER - 120 CFM
INJECTION HEADER - 500'
EXTRACTION HEADER - 440'

G. INJECTION WELLS - 11 Avg. Depth 40'
HORIZONTAL EXTRACTION WELLS - 10 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER - 110 CFM
VACUUM BLOWER - 150 CFM
INJECTION HEADER - 620'
EXTRACTION HEADER - 560'

H. INJECTION WELLS - 9 Avg Depth 45' (est)
HORIZONTAL EXTRACTION WELLS - 8 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER - 90 CFM
VACUUM BLOWER - 120 CFM
INJECTION HEADER - 500'
EXTRACTION HEADER - 440'

I. INJECTION WELLS - 11 Avg. Depth 45'
HORIZONTAL EXTRACTION WELLS - 10 Avg. Length 60' (in 3' deep trench)
INJECTION BLOWER - 110 CFM
VACUUM BLOWER - 150 CFM
INJECTION HEADER - 620'
EXTRACTION HEADER - 560'

CLIENT	JOB NUMBER		
SUBJECT Average Concentrations in Groundwater for Volatiles			
BASED ON	DRAWING NUMBER		
BY GND	CHECKED BY	APPROVED BY	DATE 8/7/96

Organic Concentrations in Groundwater (Volatiles)

1,2 Dichlorobenzene	6.2 μg/l	=	11.4 LB
1,4 Dichlorobenzene	11.2 μg/l	=	20.5 LB
Benzene	9.7 μg/l	=	17.8 LB
Chlorobenzene	63.4 μg/l	=	116 LB
1,2 Dichloroethene (Cis.)	15.0 μg/l	=	27.5 LB
Tetrachloroethene	0.8 μg/l	=	1.5 LB
Toluene	15.8 μg/l	=	29.0 LB
Trichloroethene	7.7 μg/l	=	14.1 LB
Vinyl Chloride	4.0 μg/l	=	7.3 LB
Ethylbenzene	3.5 μg/l	=	6.4 LB
Xylenes	39.6 μg/l	=	72.6 LB
			324 LB Organics (V

Groundwater Volume 220,000,000 gal.

Per. 1.0 μg/l

$$1.0 \frac{\mu g}{l} \times \frac{3.785\, l}{gal} \times 220,000,000\, gal \times \frac{g}{1000000\, \mu g} \times \frac{LB}{454\, g}$$

$$1.0 \frac{\mu g}{l} = 1.834\, LB \text{ Contaminant}$$

SOIL VOLUME CALCULATIONS

LOCATIONS EXCEEDING RGOs FOR GROUNDWATER PROTECTION

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
MCAS CHERRY POINT OU2 FS	CTO211 5395

SUBJECT: SOIL VOLUME – EXCEEDING RGOs FOR GROUNDWATER PROTECTION

BASED ON	DRAWING NUMBER
RI	FS FIG 2-1 & 2-2

BY	CHECKED BY	APPROVED BY	DATE
KCT			4/1/97

ORGANICS

HOT SPOT 1

LOCATION	DEPTH INTERVAL
B1-14	14-16
10B01	10-12
B3/B4-C	10-14.5
1051SB1	10-12
10B02	6-8; 12-14 ⇒ 8 FT
10B04	10-12
B5/B6-C	10-14.5
1051SB4	12-14; 16-18
1051SB3	16-18
B2-14	14-16
10B03	6-8; 8-10

AREA = 140' × 150' = 21,000 FT²

ASSUME DEPTH = 8 FT (10B02)

VOLUME = 6,222 CY

HOT SPOT 2

LOCATION	DEPTH INTERVAL
10TP15	8-10
10SB-EG3	2-4

AREA = 70' × 50' = 3500 FT²

DEPTH = 2 FT

VOLUME = 259 CY

HOT SPOT 3

LOCATION	DEPTH INTERVAL
10TP18	4-6; 9-10
OU2SB05	22-24
OU2SB07	22-24
OU2SB08	22-24

10TP18: AREA = 50' × 50' = 2500 FT²

DEPTH = 6 FT

VOLUME = 556 CY

OTHER: AREA = 50' × 100' = 5000 FT²

DEPTH = 2 FT

VOLUME = 370 CY

CLIENT	JOB NUMBER
SUBJECT Soil Volume	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE

ORGANICS (CONT)

HOT SPOT 4

LOCATION	DEPTH INTERVAL
10TP14	12 - 14
10SB-B5	8 - 10
10TP02	4 - 5

AREA = 50' x 100' = 5000 FT²
DEPTH = 2 FT
VOLUME = 370 CY

OTHERS

LOCATION	DEPTH INTERVAL	AREA	VOLUME
OU2SS05	0 - 1	50' x 50'	93 CY
OU2SS02	0 - 1	↓	93 CY
10TP17	9 - 10	↓	93 CY
10TP23	9 - 10	↓	93 CY
OU2SS01	0 - 1	↓	93 CY
OU2SB04	22 - 24	↓	185 CY
10TP04	10 - 12	↓	185 CY
OU2SS12	0 - 1	50' x 50'	93 CY
		20,000 FT²	928 CY

SUMMARY

HOT SPOT 1		6,222 CY	21,000 FT²
HOT SPOT 2		259 CY	3500 FT²
HOT SPOT 3	10TP18	556 CY	2500 FT²
	OTHER	370 CY	5000 FT²
HOT SPOT 4		370 CY	5000 FT²
OTHERS		928 CY	20,000 FT²
		8,705 CY	57,000 FT²

CLIENT		JOB NUMBER	
SUBJECT Soil Volumes			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE

INORGANICS

LOCATION	DEPTH INTERVAL	AREA	VOLUME (CY)
H3/H4-C	9.5-11.5	50' x 50'	185
10TP09	4-6	↓	185
10TP15	0-2 ; 8-10		370
10SB-E19	10-12		185
10SB-E35	8-10		185
10TP16	10-11		93
10SB-E63	2-4		185
10TP17	9-10		93
10TP23	9-10		93
10SB-B63	19-21		185
OU2SS03	0-1		93
10TP18	9-10		93
10SB-B67	8-10		185
10SB-C27	8-10		185
OU2SS07	0-1		93
OU2SS08	0-1		93
OU2SB04	22-24	50' x 50'	185
		42,500 FT²	2,686 CY

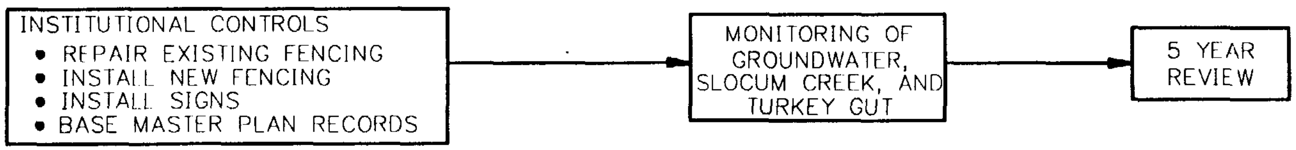
SUMMARY

ORGANICS	8705 CY	57,000 FT²
INORGANICS	2686 CY	42,500 FT²
	11,391 CY	99,500 FT²

SOIL ALTERNATIVE 2

INSTITUTIONAL CONTROLS

ACAD: K:\CADD\5395\5395PF06.DWG 06/30/97 HP



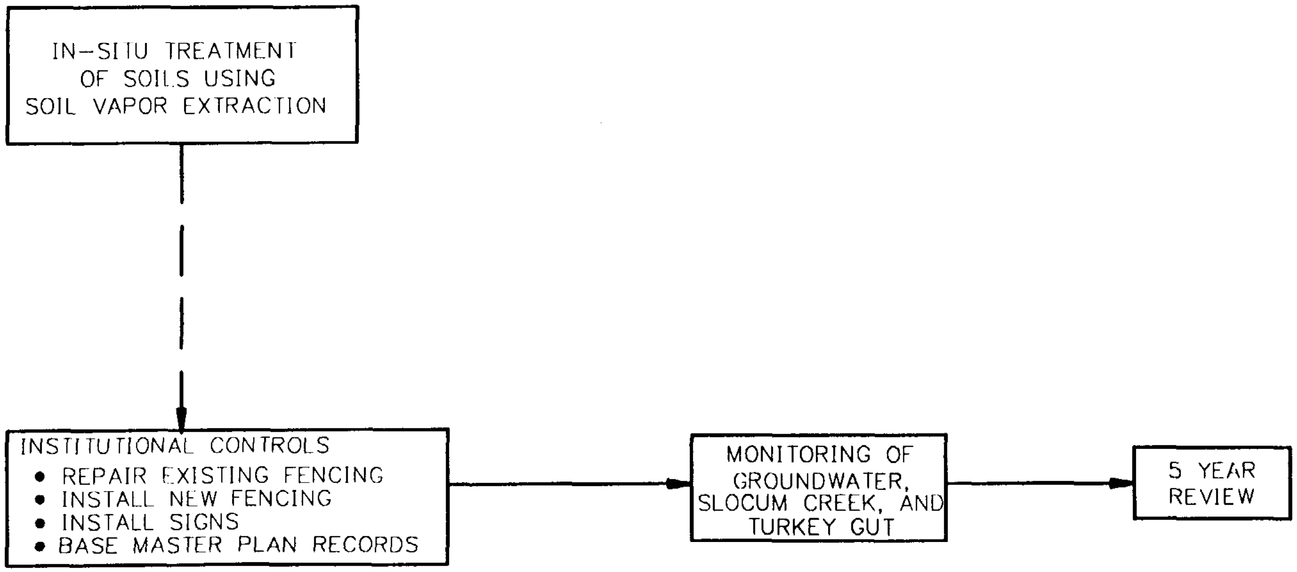
DRAWN BY HJP	DATE 4-11-97	Brown & Root Environmental	CONTRACT NO. 5395 / OWNER NO. 0211
CHECKED BY	DATE	**SOIL ALTERNATIVE 2** **CONCEPTUAL BLOCK FLOW DIAGRAM** **OPERABLE UNIT 2** **MCAS CHERRY POINT, NC**	APPROVED BY / DATE
COST/SCHED-AREA			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE B-6 / REV. 0

FORM CADD NO SOUTH_AV.DWG - REV 0 - 02/07/97

SOIL ALTERNATIVE 3

SOIL VAPOR EXTRACTION; INSTITUTIONAL CONTROLS

ACAD: K:\CADD\5395\5395PF07.DWG 06/30/97 HP



DRAWN BY HJP DATE 4-11-97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY DATE	**SOIL ALTERNATIVE 3** **CONCEPTUAL BLOCK FLOW DIAGRAM** **OPERABLE UNIT 2** **MCAS CHERRY POINT, NC**	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE B-7	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

SOIL VAPOR EXTRACTION

Based on the nature and extent of contamination at OU2, it is anticipated that four SVE systems will be required. Area 1 covers approximately 21,000 square feet (150 feet by 140 feet), the center of which is located approximately 150 feet south of the former sludge application area at the location of the former sludge impoundments. This area contains concentrations of 2-butanone, chloroform, ethylbenzene, methylene chloride, tetrachloroethene, 1,1,1-trichloroethane, and trichloroethene that exceed RGOs. Area 2 covers approximately 3,500 square feet (70 feet by 50 feet) located approximately 400 feet southeast of the point where Turkey Gut flows into Slocum Creek (Study Area A). This area contains concentrations of benzene, 1,2-dichloroethane, 1,2-dichloroethene, methylene chloride, and vinyl chloride that exceed RGOs. Area 3A covers approximately 2,500 square feet (50 feet by 50 feet) and Area 3B an area of approximately 5,000 square feet (50 feet by 100 feet) that are contaminated with benzene, ethylbenzene, methylene chloride, and toluene. These areas may be combined in the future pending results of a planned treatability study. These areas are located to the south of the second system at a distance of approximately 750 feet. Area 4 covers approximately 5,000 square feet (50 feet by 100 feet) that is contaminated with benzene, 2-butanone, 1,2-dichloroethene, 1,3-dichloropropene, ethylbenzene, methylene chloride, tetrachloroethene, and trichloroethene. This area is located in the southeast portion of OU2 (Study Area B).

Based on site soil conditions, conceptual SVE systems have been designed for the four areas. It is recommended that a small pilot study be performed prior to the final design of the SVE systems to verify the local soil and groundwater conditions for each specific area. Each of the systems includes vapor extraction wells placed in a network with a spacing of approximately 40 feet. Extraction wells would be placed with screens in the soils sufficiently below the surface to stay above the water table.

CALCULATION WORKSHEET Order No. 19116 (01-81)

CLIENT	JOB NUMBER
MCAS CHERRY POINT OU2 FS	CTO 211 5395

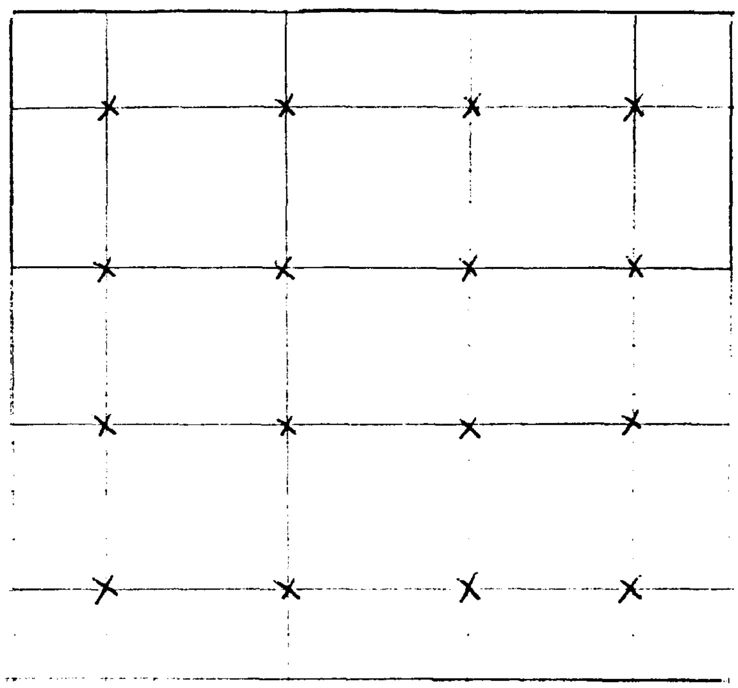
SUBJECT
SOIL ALTERNATIVE 3 - INSITU SOIL VAPOR EXTRACTION

BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
KCT			4/3/97

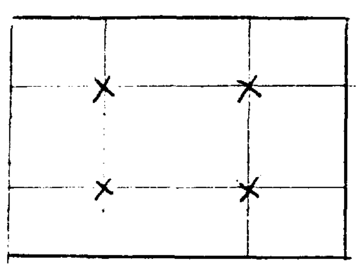
HOT SPOT 1 150 x 140

WELL SPACING @ ~40 FT (MAX)



16 WELLS @ 15' DEPTH

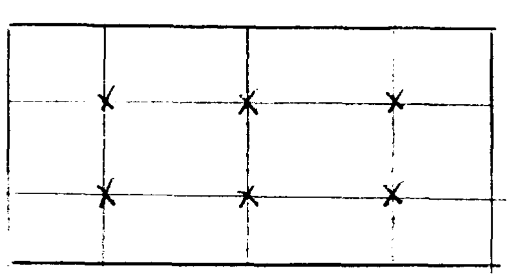
HOT SPOT 2 70 x 50



4 WELLS @ 10' DEPTH

HOT SPOT 3A 50 x 50 ⇒ 4 WELLS @ 10' DEPTH

HOT SPOTS 3B & 4 50 x 100



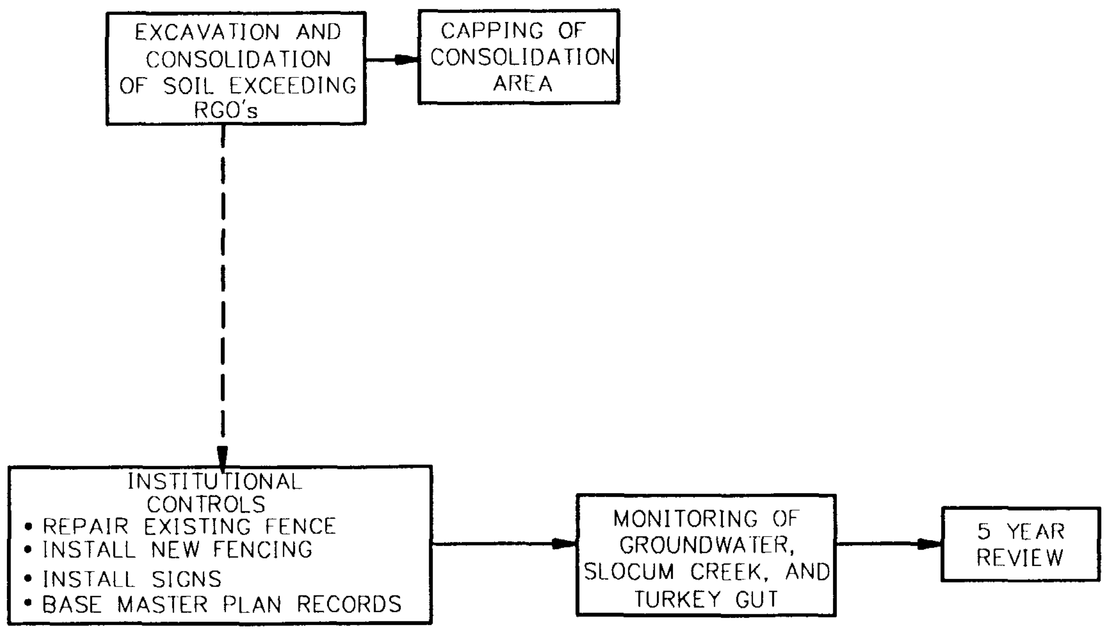
3B 6 WELLS @ 10' DEPTH

4 6 WELLS @ 12' DEPTH

SOIL ALTERNATIVE 4

EXCAVATION, CONSOLIDATION, AND CONTAINMENT; INSTITUTIONAL CONTROLS

ACAD: K:\CADD\5395\5395PF01.DWG 04/21/97 MF



DRAWN BY HJP / DATE 4-11-97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY / DATE	**SOIL ALTERNATIVE 4 CONCEPTUAL BLOCK FLOW DIAGRAM OPERABLE UNIT 2 MCAS CHERRY POINT, NC**	APPROVED BY / DATE	
COST/SCHED-AREA		APPROVED BY / DATE	
SCALE AS NOTED		DRAWING NO. FIGURE B-8	REV. 0

FORM CADD NO SOUTH_AV.DWG - REV 0 - 02/07/97

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER
MCAS CHERRY POINT OU2 FS	CTO 211 5395
SUBJECT: SOIL ALTERNATIVE 4 - CONSOLIDATE AND CAP	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
KCT			4/2/97

EXCAVATE ORGANIC AND INORGANIC HOT SPOTS (EXCEPT HOT SPOT 1)
CONSOLIDATE AND CAP AT HOT SPOT 1 AREA

EXCAVATION ORGANICS 1298 CY
INORGANICS 2686 CY
3984 CY

PLACE AT HOT SPOT 1 (140 FT x 150 FT) = 21,000 FT^2
~ HEIGHT = (3,984 CY x 27 FT^3/CY) ÷ 21,000 FT^2 = 5.1 FT
LIMIT HEIGHT TO ~ 3 FT ⇒ AREA REQUIRED = 35,856 FT^2
~ (190 FT x 190 FT)

CLAY LAYER (24") V = (190 FT x 190 FT x 2 FT) ÷ 27 = 2,674 CY

PVC MEMBRANE A = 190 FT x 190 FT = 36,100 FT^2

SAND LAYER (12") V = (190 x 190 x 1) ÷ 27 = 1,337 CY

GEOTEXTILE A = (190 FT x 190 FT) ÷ 9 = 4,011 SY

SOIL LAYER (18") A = (190 x 190 x 1.5) ÷ 27 = 2,006 CY

TOPSOIL (6") A = (190 x 190 x 0.5) ÷ 27 = 669 CY

REVEGETATION A = 36,100 FT^2

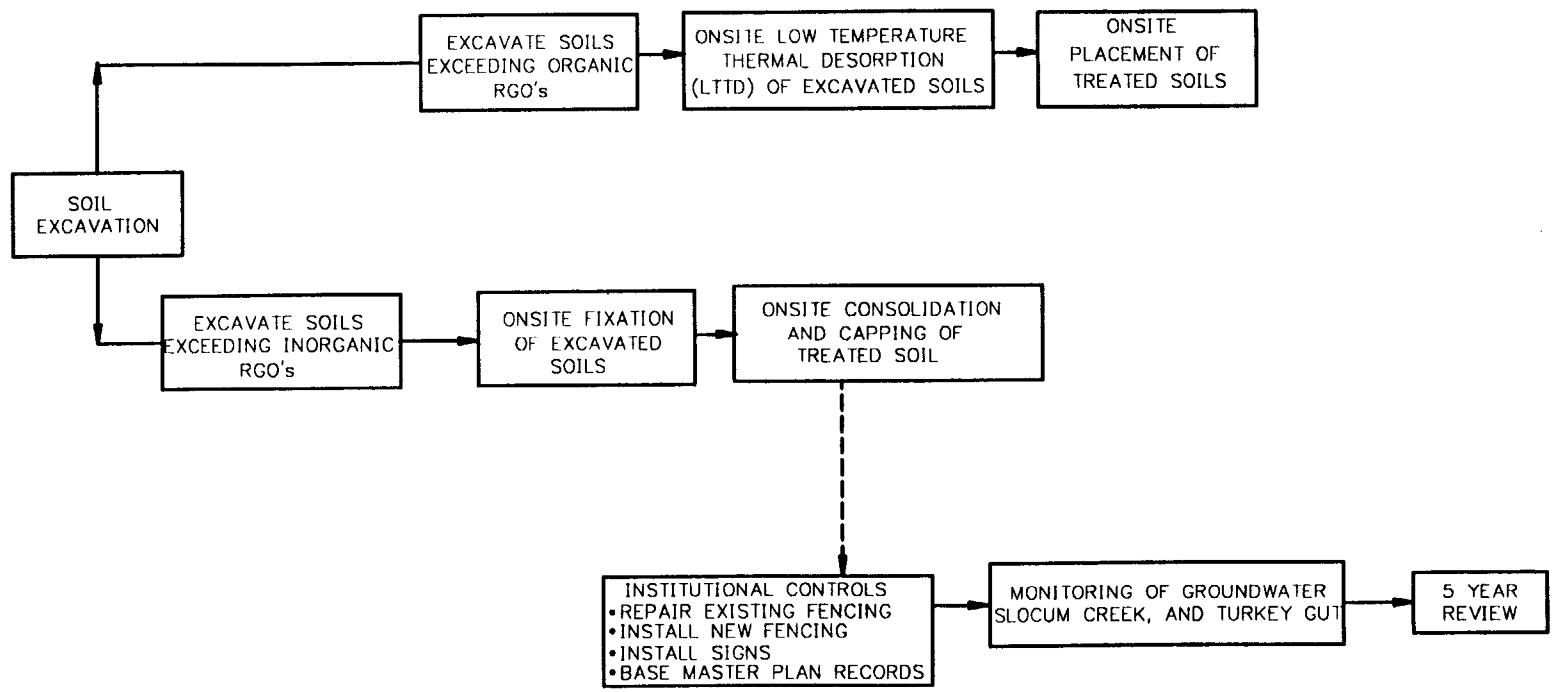
BACKFILL EXCAVATED AREAS 3,984 CY

REVEGETATE EXCAVATED AREAS 36,000 FT^2 (ORGANIC) + 42,500 FT^2 (INORGANIC)
⇒ 78,500 FT^2

SOIL ALTERNATIVE 5

EXCAVATION, TREATMENT, AND ONSITE DISPOSAL; INSTITUTIONAL CONTROLS

ACAD: K:\CADD\5395\5395PF02.DWG 04/21/97 MF



DRAWN BY HJP, DATE 4-11-97	Brown & Root Environmental	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY / DATE	**SOIL ALTERNATIVE 5 CONCEPTUAL BLOCK FLOW DIAGRAM OPERABLE UNIT 2 MCAS CHERRY POINT, NC**	APPROVED BY / DATE	
COST/SCHED-AREA		APPROVED BY / DATE	
SCALE AS NOTED		DRAWING NO. FIGURE B-9	REV. 0

FORM CADD NO. SOUTH_AV.DWG - REV 0 - 02/07/97

LOW TEMPERATURE THERMAL DESORPTION

A sufficient quantity of excavated soil is stockpiled in a staging area prior to initiating thermal desorption treatment to ensure continuous operation of the system. Typically, thermal desorption units are designed to operate continuously, 24 hours per day, because of the energy input required to achieve operating conditions. The average production rate for the thermal treatment system is approximately 5 to 10 tons/hr.

Excavated soil is classified (reduced in size to less than 2 inches) using a vibrating screen or shredder and transported into the feed hopper by conveyor. The classified soil is then treated in the thermal processing unit. This unit consists of two jacketed thermal processors, the second of which is gravity fed from the first. Each processor houses several hollow screw conveyors that convey the soil through the processing system and heat the soil to the required temperature. Heated oil at temperatures up to 650°F circulates through the shaft, flights, and outer jackets of the screw conveyors in a countercurrent flow. Soils are indirectly heated by the thermal fluid to temperatures up to 580°F, depending on the moisture content of the feed soil. The action of the multiple-screw system enhances mixing and improves the transfer of heat from the fluid to the soil. Low-oxygen gases are introduced into the processors to facilitate removal of the organic/moisture mixture and are subsequently drawn out of the thermal processing units by a fan. The off-gas is directed through a baghouse and two condenser units prior to being treated by activated carbon. The collected condensate consists of water and condensed organics. The organic condensate is separated in an oil/water separator and stored in 55-gallon drums for offsite disposal. Separated water is treated with activated carbon, stored, and tested prior to use in post-treatment soil conditioning. The conditioned soil is transferred via conveyor system to a stockpile area for use as backfill in the previously excavated areas.

The thermal treatment unit will require approximately 100 feet by 100 feet of space for equipment setup and will require 1 to 2 weeks to mobilize. The space requirement does not include the staging area for soil stockpiling either prior to and after treatment. At a conservative processing rate of 5 tons per hour, it would take approximately 100 days to process all of the identified volatile organic contaminated soil at the OU2 site.

SOLIDIFICATION

A sufficient quantity of excavated soil and waste/fill material is stockpiled in a staging area prior to starting the pozzolan-based solidification system to ensure continuous operation of the system. The average production rate for a mobile solidification system is approximately 300 tons/day. Excavated soil is typically classified using a vibrating screen, crusher, or shredder and transported to a batch plant by conveyor. The classified soil is then mixed with appropriate solidifying agents. After the waste is mixed with the solidifying agents, it is sent to a curing area, where it is allowed to form a hardened block or a friable soil prior to being placed into a consolidation area and covered with a multi-layer cap. The multi-layer cap will be of the same design as that referenced in Soil Alternative 4. The consolidation area will be located adjacent to the staging area for the solidification process and must be sufficiently large to account for a volume increase of up to 30 percent higher than the original contaminated soil and waste/fill material. Based on the final solidified volume of 3,500 cubic yards, it is anticipated that the consolidation area required will be approximately 32,400 ft^2 (180 feet by 180 feet).

The mobile solidification unit will require approximately 100 feet by 100 feet of space for equipment setup and will require at least two weeks to mobilize. The space requirement does not include the staging area for soil stockpiling both prior to treatment or curing area. At a processing rate of 300 tons per day, it would take approximately 12 days, not including curing time, to solidify all of the identified nonvolatile organic and metal contaminated soil at the OU2 site.

CLIENT	JOB NUMBER
MCAS CHERRY POINT OU2 FS	CTO 211 5395
SUBJECT: SOIL ALTERNATIVE 5 - ONSITE TREATMENT & DISPOSAL	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
KCT			4/2/97

SOLIDIFICATION - INORGANIC HOT SPOTS

EXCAVATION 2,686 CY
SOIL BACKFILL 2,686 CY
SOLIDIFICATION 2,686 CY
BACKFILL TREATED SOIL 3,492 CY (~30% VOLUME INCREASE)

LIMIT HEIGHT TO APPROX 3 FT
AREA TO BE CAPPED (SOLIDIFIED SOIL) = (3,492 CY × 27 CF/CY) ÷ 3 FT = 31,428 FT²
=> APPROX 180 FT × 180 FT

CLAY (24") V = (180 FT × 180 FT × 2 FT) ÷ 27 = 2,400 CY

PVC MEMBRANE A = 180 × 180 = 32,400 FT²

SAND (12") V = (180 × 180 × 1) ÷ 27 = 1,200 CY

GEOTEXTILE A = (180 × 180) ÷ 9 = 3,600 SY

SOIL (18") A = (180 × 180 × 1.5) ÷ 27 = 1,800 CY

TOPSOIL (6") A = (180 × 180 × 0.5) ÷ 27 = 600 CY

REVEGETATION A = 32,400 FT²

PROCESSING RATE 300 TONS/DAY

(2,686 CY)(1.35 TON/CY) = 12 DAYS (NOT INCL. CURING TIME)

REVEGATE EXCAVATED AREAS 42,500 FT²

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT		JOB NUMBER	
SUBJECT: SOIL ALTERNATIVE 5			
BASED ON		DRAWING NUMBER	
BY	CHECKED BY	APPROVED BY	DATE

THERMAL DESORPTION - ORGANIC HOT SPOTS

EXCAVATION 8,705 CY
TREATMENT 8,705 CY
BACKFILL CLEAN SOIL 8,705 CY

PROCESSING RATE 5 TO 10 TONS/HR

(8705 CY)(1.35 TON/CY) = 11,752 TONS   2350 HR = 98 DAYS (5 TPH)

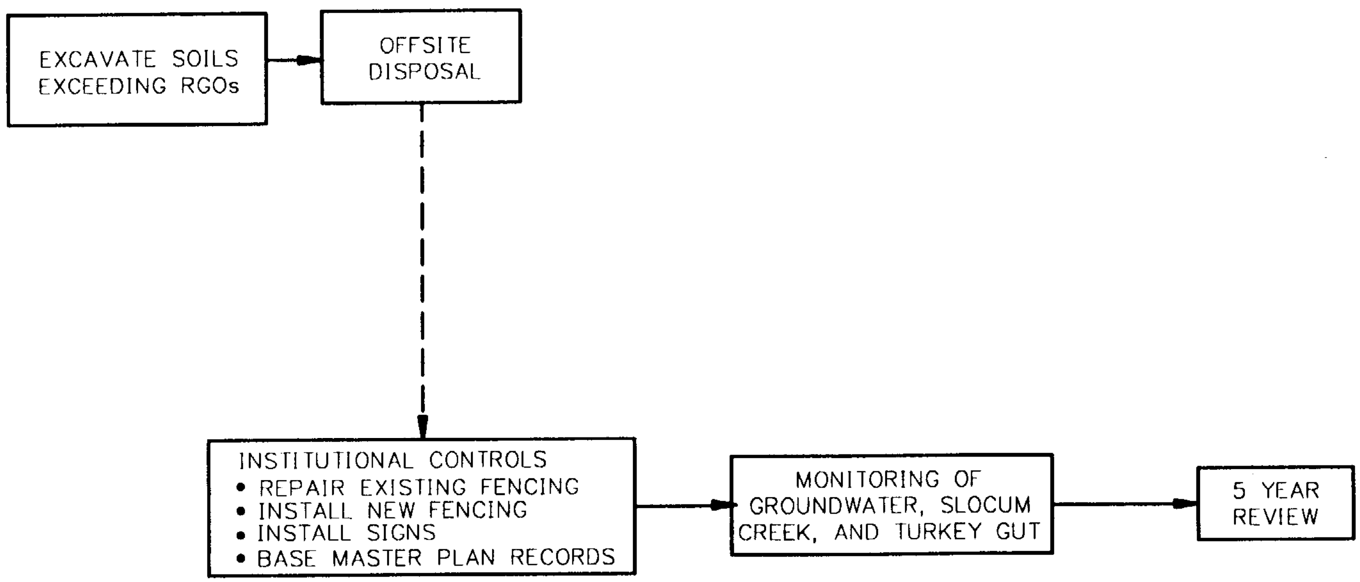
⇒ 49 TO 98 DAYS

REVEGETATE BACKFILLED AREAS 57,000 FT²

SOIL ALTERNATIVE 6

EXCAVATION AND OFFSITE DISPOSAL; INSTITUTIONAL CONTROLS

ACAD: K:\CADD\5395\5395PF08.DWG 04/21/97 MF



DRAWN BY HJP DATE 4-11-97	**Brown & Root Environmental**	CONTRACT NO. 5395	OWNER NO. 0211
CHECKED BY DATE	**SOIL ALTERNATIVE 6** **CONCEPTUAL BLOCK FLOW DIAGRAM** **OPERABLE UNIT 2** **MCAS CHERRY POINT, NC**	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE B-10	REV. 0

FORM CADD NO SOUTH_AV.DWG - REV 0 - 02/07/97

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT MCAS CHERRY POINT OU2 FS	JOB NUMBER CTO 211 5395
SUBJECT SOIL ALTERNATIVE 6 - EXCAVATION & OFFSITE DISPOSAL	
BASED ON	DRAWING NUMBER

BY	CHECKED BY	APPROVED BY	DATE
KCT			4/2/97

EXCAVATION	11,391 CY	
BACKFILL	11,391 CY	
REVEGETATION	99,500 FT^2	
HAULING/DISPOSAL	15,378 TONS	(1.35 TON/CY)

APPENDIX C

COST ESTIMATES

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Natural Attenuation, Institutional Controls,
Monitoring
Annual Monitoring
Groundwater Alternative No. 2
(OMPOG22) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Natural Attenuation, Institutional Controls,
Monitoring
Groundwater Alternative No. 2
(PWAPOG22) 4/11/97
729

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	0											
2. O & M COSTS		43.8										
3. ANNUAL COSTS	0	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	0	42	40	38	36	50	33	31	30	28	39	26

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	24	23	22	31	20	19	18	17	24	16	15	14

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	43.8	63.8	43.8	43.8	43.8	43.8	63.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	14	19	12	12	11	11	15	729

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To Slocum Creek
Groundwater Alternative No. 3A

(MCPOG23S)
4/11/97

SUMMARY

Item	Sub.	Mat.	Labor	Equip.	
1) SITE WIDE SITE PREPARATION	0	0	50000	50000	100000
2) TREATMENT PLANT SITE PREPARATION	8000	0	9549	15088	32637
3) EQUIPMENT	296000	629300	80300	51500	1057100
4) PIPING & INSTRUMENTATION	0	127326	115271	20318	262915
5) FOUNDATION & STRUCTURAL	104400	33600	62250	3150	203400
6) ELECTRICAL	10000	202080	169065	0	381145
	418400	992306	486435	140056	2037197
Burden @ 30% of Labor Cost			145931		145931
Labor @ 10% of Labor Cost			48644		48644
Material @ 10% of Material Cost		99231			99231
Subcontract @ 10% of Sub. Cost	41840				41840
Total Direct Cost	460240	1091537	681009	140056	2372842
Indirects @ 75% of Total Direct Labor Cost			510757		510757
Profit @ 10% Total Direct Cost					237284
					3120883
Health & Safety Monitoring @ 3%					93626
Total Field Cost					3214509
Contingency @ 20% of Total Field Cost					642902
Engineering @ 15% of Total Field Cost					482176
Total Cost This Page					4339587

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To Slocum Creek
Groundwater Alternative No. 3A

(MCPOG23)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
SITE WIDE SITE PREPARATION												
1) Surface Water Run-off Control		LS			30000.00	30000.00			30000	30000	60000	
2) Construction Debris Removal		LS			20000.00	20000.00			20000	20000	40000	
							0	0	50000	50000	100000	
TREATMENT PLANT SITE PREPARATION												
1) Mobilization		LS			4000.00	6000.00			4000	6000	10000	
2) Site Survey		LS	8000.00				8000				8000	
3) Clearing & Grubbing	1	AC			1165.00	1840.00			1165	1840	3005	
4) Earthwork Grading	1600	CY			.24	.78			384	1248	1632	
5) Demobilization		LS			4000.00	6000.00			4000	6000	10000	
							8000	0	9549	15088	32637	
EQUIPMENT												
1) Groundwater Extraction Well	855	LF	200.00				171000				171000	19 @ 45'
2) Extraction Well Pumps	19			1500.00	400.00			28500	7600		36100	5 - 8 gpm
3) Equalization Tank	1		50000.00				50000				50000	27000 gallon
4) Equalization Tank Blower	2			6000.00	800.00			12000	1600		13600	
5) Mix Tank Supply Pump	2			4000.00	600.00			8000	1200		9200	150 gpm
6) Mix Tank	1			4500.00	600.00			4500	600		5100	3000 gallon
7) Mix Tank Mixer	1			6000.00	400.00			6000	400		6400	
8) Inclined Plate Separator	1			92500.00	12500.00	12500.00		92500	12500	12500	117500	
9) Inclined Plate Separator Transfer Tank	1			2300.00	400.00			2300	400		2700	1500 gallon
10) Inclined Plate Separator Underflow Pump	2			1500.00	400.00			3000	800		3800	
11) Filter Supply Pump	2			6000.00	600.00			12000	1200		13200	150 gpm
12) Sand Filter	2			70000.00	7000.00	7000.00		140000	14000	14000	168000	6.5' dia.
13) Filter Backwash Blower	2			6000.00	800.00			12000	1600		13600	
14) Filter Backwash Pump	2			7000.00	600.00			14000	1200		15200	
15) Effluent Tank	1			14000.00	1000.00			14000	1000		15000	9000 gallon
16) Carbon Adsorption Filter	2			60000.00	6000.00	6000.00		120000	12000	12000	144000	8' dia.
17) Carbon Backwash Pump	2			7000.00	600.00			14000	1200		15200	
18) Thickener	1			74000.00	10000.00	10000.00		74000	10000	10000	94000	61200 gallon
19) Filter Press Feed Pump	2			2500.00	600.00			5000	1200		6200	
20) Filter Press	1			30000.00	6000.00	3000.00		30000	6000	3000	39000	6 c.f.
21) Supernatant Recycle Tank	1			7500.00	800.00			7500	800		8300	5000 gallon
22) Supernatant Recycle Tank Mixer	1			8000.00	600.00			8000	600		8600	
23) Supernatant Recycle Pump	2			2500.00	400.00			5000	800		5800	
24) Caustic Feed System	1			8000.00	2000.00			8000	2000		10000	
25) Air Compressor	1			6000.00	800.00			6000	800		6800	
26) Sump Pump	2			1500.00	400.00			3000	800		3800	
27) Equipment/Piping Painting		LS	75000.00				75000				75000	
							296000	629300	80300	51500	1057100	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To Slocum Creek
Groundwater Alternative No. 3A

(MCPOG23)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
PIPING & INSTRUMENTATION												
1) Extraction Wells To Equalization Tank												
a) Well Piping - 1-1/2"	855	LF		1.00	5.25			855	4489		5344	
b) Collection Piping - 1-1/2"	3100	LF		1.00	1.90			3100	5890		8990	
c) Collection Piping - 4"	4250	LF		2.50	4.00			10625	17000		27625	
d) Collection Piping - 6"	800	LF		4.00	6.00			3200	4800		8000	
e) Excavation,Backfill,Compaction	8150	LF			3.80	2.13			30970	17360	48330	
f) Pipe Bedding	8150	LF		.54	.80			4401	6520		10921	
g) Revegetation	82	MSF		50.00	11.00	9.00		4100	902	738	5740	
2) System Interconnection Piping												
a) 1"	200	LF		6.50	3.50			1300	700		2000	
b) 2"	400	LF		13.00	7.00			5200	2800		8000	
c) 3"	500	LF		19.50	10.50			9750	5250		15000	
d) 4"	200	LF		27.00	13.00			5400	2600		8000	
e) 6"	100	LF		27.00	13.00			2700	1300		4000	
3) Air Piping												
a) 1-1/2"	200	LF		9.75	5.25			1950	1050		3000	
4) Effluent To Slocum Creek Piping												
a) Effluent Piping - 4"	1000	LF		8.00	4.00			8000	4000		12000	
b) Excavation,Backfill,Compaction	1000	LF			3.80	2.13			3800	2130	5930	
c) Pipe Bedding	1000	LF		.54	.80			540	800		1340	
d) Revegetation	10	MSF		50.00	11.00	9.00		500	110	90	700	
4) Valves												
a) 1/2"	50			65.00	15.00			3250	750		4000	
b) 1"	42			130.00	35.00			5460	1470		6930	
c) 2"	16			220.00	60.00			3520	960		4480	
d) 3"	22			300.00	90.00			6600	1980		8580	
e) 4"	8			450.00	110.00			3600	880		4480	
5) Pressure Gauges	45			175.00	50.00			7875	2250		10125	
6) PH Control System	2			5000.00	1000.00			10000	2000		12000	
7) Flow Recording System	1			3000.00	800.00			3000	800		3800	
8) Level Control System	28			800.00	400.00			22400	11200		33600	
							0	127326	115271	20318	262914	
FOUNDATION & STRUCTURAL												
1) Treatment Building	3200	SF	30.00				96000				96000	40' x 80'
2) Building Foundation	150	CY		170.00	315.00	15.00		25500	47250	2250	75000	
3) Equipment Foundation	60	CY		135.00	250.00	15.00		8100	15000	900	24000	
4) Loading/Unloading Area	6000	SF	1.00				6000				6000	
5) Parking Area	800	SF	3.00				2400				2400	
							104400	33600	62250	3150	203400	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To Slocum Creek
Groundwater Alternative No. 3A

(MCPOG23)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
ELECTRICAL												
1) Power Supply		LS	10000.00				10000				10000	
2) Well Pump Feeder Cable	8200	LF		3.00	4.50			24600	36900		61500	
3) Starter												
a) # 1	40			1350.00	550.00			54000	22000		76000	
b) # 2	1			1500.00	720.00			1500	720		2220	
4) Disconnect Switch	41			150.00	50.00			6150	2050		8200	
5) Conduit, Cable, Control												
a) #1	40			655.00	735.00			26200	29400		55600	
b) #2	1			930.00	795.00			930	795		1725	
6) Main Control Panel incl. PLC	1			40000.00	25000.00			40000	25000		65000	
7) Instrument Loop	30			500.00	700.00			15000	21000		36000	
8) Grounding		LS		8200.00	8200.00			8200	8200		16400	
9) Miscellaneous Wiring		LS		20500.00	20500.00			20500	20500		41000	
10) Outdoor Lighting		LS		5000.00	2500.00			5000	2500		7500	
							10000	202080	169065	0	381145	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To Slocum Creek
Annual Monitoring
Groundwater Alternative No. 3A
(OMPOG23) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To Slocum Creek
Groundwater Alternative No. 3A
(OMPOG23a) 4/11/97

Annual Costs - (24 hr/day - 365 days/year)

ITEM	QTY	UNIT	UNIT$	ITEM $	NOTES
1. Energy					
a. Electric	587910	Kw-hr	.085	$49972	Treatment Plant
2. Maintenance				$71200	3% of Capital Co
3. Operator	1	EA.	40000.00	$40000	1 Operator/Day 5 Days/Week
4. Chemical					
a. Caustic Soda	189	TON	500.00	$94500	
5. Activated Carbon					
a. Liquid	41975	LB	2.00	$83950	
6. Sludge Disposal					
a. Hauling	10	LD	200.00	$2000	
b. Disposal	190	TON	50.00	$9500	
TOTAL ANNUAL COSTS				$351122	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To Slocum Creek
Groundwater Alternative No. 3A
(PWAPOG23) 4/11/97
10466

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	4339.6											
2. O & M COSTS		394.9										
3. ANNUAL COSTS	4339.6	394.9	394.9	394.9	394.9	414.9	394.9	394.9	394.9	394.9	414.9	394.9
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	4340	376	358	341	325	325	295	281	267	255	255	231

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	394.9	394.9	394.9	414.9	394.9	394.9	394.9	394.9	414.9	394.9	394.9	394.9
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	220	209	199	200	181	172	164	156	156	142	135	129

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	394.9	414.9	394.9	394.9	394.9	394.9	414.9	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	122	122	111	106	101	96	96	10466

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To WWTP
Groundwater Alternative No. 3B

(MCPOG24S)
4/11/97

SUMMARY

Item	Sub.	Mat.	Labor	Equip.	
1) SITE WIDE SITE PREPARATION	0	0	50000	50000	100000
2) TREATMENT PLANT SITE PREPARATION	6000	0	5549	9088	20637
3) EQUIPMENT	226000	70000	14200	0	310200
4) PIPING & INSTRUMENTATION	0	74621	94306	20318	189245
5) FOUNDATION & STRUCTURAL	28200	8825	16350	825	54200
6) ELECTRICAL	5000	150750	125150	0	280900
	265200	304196	305555	80231	955182
Burden @ 30% of Labor Cost			91667		91667
Labor @ 10% of Labor Cost			30556		30556
Material @ 10% of Material Cost		30420			30420
Subcontract @ 10% of Sub. Cost	26520				26520
Total Direct Cost	291720	334616	427777	80231	1134344
Indirects @ 75% of Total Direct Labor Cost			320833		320833
Profit @ 10% Total Direct Cost					113434
					1568611
Health & Safety Monitoring @ 3%					47058
Total Field Cost					1615669
Contingency @ 20% of Total Field Cost					323134
Engineering @ 15% of Total Field Cost					242350
Total Cost This Page					2181153

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To WWTP
Groundwater Alternative No. 3B

(MCPOG24)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
SITE WIDE SITE PREPARATION												
1) Surface Water Run-off Control		LS			30000.00	30000.00			30000	30000	60000	
2) Construction Debris Removal		LS			20000.00	20000.00			20000	20000	40000	
							0	0	50000	50000	100000	
TREATMENT PLANT SITE PREPARATION												
1) Mobilization		LS			2000.00	3000.00			2000	3000	5000	
2) Site Survey		LS	6000.00				6000				6000	
3) Clearing & Grubbing	1	AC			1165.00	1840.00			1165	1840	3005	
4) Earthwork Grading	1600	CY			.24	.78			384	1248	1632	
5) Demobilization		LS			2000.00	3000.00			2000	3000	5000	
							6000	0	5549	9088	20637	
EQUIPMENT												
1) Groundwater Extraction Well	855	LF	200.00				171000				171000	19 @ 45'
2) Extraction Well Pumps	19			1500.00	400.00			28500	7600		36100	5 - 8 gpm
3) Equalization Tank	1		50000.00				50000				50000	27000 gallon
4) Equalization Tank Blower	2			6000.00	800.00			12000	1600		13600	
5) Mix Tank Supply Pump	2			4000.00	600.00			8000	1200		9200	150 gpm
6) Mix Tank	1			4500.00	600.00			4500	600		5100	3000 gallon
7) Mix Tank Mixer	1			6000.00	400.00			6000	400		6400	
8) Caustic Feed System	1			8000.00	2000.00			8000	2000		10000	
9) Effluent Pump	2			5000.00	600.00			10000	1200		11200	150 gpm
10) Sump Pump	2			1500.00	400.00			3000	800		3800	
11) Equipment/Piping Painting		LS	5000.00				5000				5000	
							226000	80000	15400	0	321400	
PIPING & INSTRUMENTATION												
1) Extraction Wells To Equalization Tank												
a) Well Piping - 1-1/2"	855	LF		1.00	5.25			855	4489		5344	
b) Collection Piping - 1-1/2"	3100	LF		1.00	1.90			3100	5890		8990	
c) Collection Piping - 4"	4250	LF		2.50	4.00			10625	17000		27625	
d) Collection Piping - 6"	800	LF		4.00	6.00			3200	4800		8000	
e) Excavation,Backfill,Compaction	8150	LF			3.80	2.13			30970	17360	48330	
f) Pipe Bedding	8150	LF		.54	.80			4401	6520		10921	
g) Revegetation	82	MSF		50.00	11.00	9.00		4100	902	738	5740	
2) System Interconnection Piping												
a) 1"	50	LF		6.50	3.50			325	175		500	
b) 2"	50	LF		13.00	7.00			650	350		1000	
c) 3"	100	LF		19.50	10.50			1950	1050		3000	
d) 4"	50	LF		27.00	13.00			1350	650		2000	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To WWTP
Groundwater Alternative No. 3B

(MCPOG24)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
3) Effluent To WWTP Piping												
a) Effluent Piping - 4"	1000	LF		8.00	4.00			8000	4000		12000	
b) Excavation,Backfill,Compaction	1000	LF			3.80	2.13			3800	2130	5930	
c) Pipe Bedding	1000	LF		.54	.80			540	800		1340	
d) Revegetation	10	MSF		50.00	11.00	9.00		500	110	90	700	
4) Valves												
a) 1/2"	28			65.00	15.00			1820	420		2240	
b) 1"	38			130.00	35.00			4940	1330		6270	
c) 2"	12			220.00	60.00			2640	720		3360	
d) 3"	2			300.00	90.00			600	180		780	
5) Pressure Gauges	23			175.00	50.00			4025	1150		5175	
6) PH Control System	1			5000.00	1000.00			5000	1000		6000	
7) Level Control System	20			800.00	400.00			16000	8000		24000	
							0	74621	94306	20318	189244	
FOUNDATION & STRUCTURAL												
1) Treatment Building	800	SF	30.00				24000				24000	20' x 40'
2) Building Foundation	40	CY		170.00	315.00	15.00		6800	12600	600	20000	
3) Equipment Foundation	15	CY		135.00	250.00	15.00		2025	3750	225	6000	
4) Loading/Unloading Area	3000	SF	1.00				3000				3000	
5) Parking Area	400	SF	3.00				1200				1200	
							28200	8825	16350	825	54200	
ELECTRICAL												
1) Power Supply		LS	5000.00				5000				5000	
2) Well Pump Feeder Cable	8200	LF		3.00	4.50			24600	36900		61500	
3) Starter												
a) # 1	30			1350.00	550.00			40500	16500		57000	
4) Disconnect Switch	30			150.00	50.00			4500	1500		6000	
5) Conduit, Cable, Control												
a) #1	30			655.00	735.00			19650	22050		41700	
6) Main Control Panel incl. PLC	1			25000.00	10000.00			25000	10000		35000	
7) Instrument Loop	21			500.00	700.00			10500	14700		25200	
8) Grounding		LS		6000.00	6000.00			6000	6000		12000	
9) Miscellaneous Wiring		LS		15000.00	15000.00			15000	15000		30000	
10) Outdoor Lighting		LS		5000.00	2500.00			5000	2500		7500	
							5000	150750	125150	0	280900	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To WWTP
Annual Monitoring
Groundwater Alternative No. 3B
(OMPOG24) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To WWTP
Groundwater Alternative No. 3B
(OMPOG24a) 4/11/97

Annual Costs - (24 hr/day - 365 days/year)

ITEM	QTY	UNIT	UNIT$	ITEM $	NOTES
1. Energy					
a. Electric	202502	Kw-hr	.085	$17213	Treatment Plant
2. Maintenance				$34000	3% of Capital Co:
3. Operator	416	HR	20.00	$8320	1 Operator 1 Day/Week
4. Chemical					
a. Caustic Soda	189	TON	500.00	$94500	
TOTAL ANNUAL COSTS				$154033	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls, Groundwater Extraction,
Groundwater Treatment, Discharge To WWTP
Groundwater Alternative No. 3B
(PWAPOG24) 4/11/97
5278

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	2181.2											
2. O & M COSTS		197.8										
3. ANNUAL COSTS	2181.2	197.8	197.8	197.8	197.8	217.8	197.8	197.8	197.8	197.8	217.8	197.8
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	2181	188	179	171	163	171	148	141	134	128	134	116

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	197.8	197.8	197.8	217.8	197.8	197.8	197.8	197.8	217.8	197.8	197.8	197.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	110	105	100	105	91	86	82	78	82	71	68	64

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	197.8	217.8	197.8	197.8	197.8	197.8	217.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	61	64	56	53	50	48	50	5278

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4
Page 1 of 6
(MCPOG25S)
4/11/97

SUMMARY

Item	Sub.	Mat.	Labor	Equip.	
1) SITE WIDE SITE PREPARATION	0	0	50000	50000	100000
2) IN-SITU TREATMENT (AS/SVE) - AREA A	26500	29299	20917	8104	84820
3) IN-SITU TREATMENT (AS/SVE) - AREA B	27750	32500	23431	8517	92198
4) IN-SITU TREATMENT (AS/SVE) - AREA C	26500	29249	20906	8095	84750
5) IN-SITU TREATMENT (AS/SVE) - AREA D	26500	29249	20906	8095	84750
6) IN-SITU TREATMENT (AS/SVE) - AREA E	31000	29339	21160	8095	89594
7) IN-SITU TREATMENT (AS/SVE) - AREA F	28750	29294	21033	8095	87172
8) IN-SITU TREATMENT (AS/SVE) - AREA G	30500	32555	23586	8517	95158
9) IN-SITU TREATMENT (AS/SVE) - AREA H	28750	26794	21033	8095	84672
10) IN-SITU TREATMENT (AS/SVE) - AREA I	33250	34610	24141	8517	100518
	259500	272889	247113	124130	903632
Burden @ 30% of Labor Cost			74134		74134
Labor @ 10% of Labor Cost			24711		24711
Material @ 10% of Material Cost		27289			27289
Subcontract @ 10% of Sub. Cost	25950				25950
Total Direct Cost	285450	300178	345958	124130	1055716
Indirects @ 75% of Total Direct Labor Cost			259469		259469
Profit @ 10% Total Direct Cost					105572
					1420756
Health & Safety Monitoring @ 5%					71038
Total Field Cost					1491794
Contingency @ 20% of Total Field Cost					298359
Air Sparging/Vapor Extraction Pilot Study					75000
Engineering @ 15% of Total Field Cost					223769
Total Cost This Page					2088922

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4

(MCPOG25)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
SITE WIDE SITE PREPARATION												
1) Surface Runoff Control		LS			30000.00	30000.00			30000	30000	60000	
2) Construction Debris Control		LS			20000.00	20000.00			20000	20000	40000	
							0	0	50000	50000	100000	
IN-SITU TREATMENT (AS/SVE) - AREA A												
1) Injection Well	360	LF	50.00				18000				18000	9 @ 40'
2) Extraction Well Piping - 2"	480	LF		1.00	2.82			480	1354		1834	
3) Extraction Well Collection Piping - 4"	440	LF		2.50	4.51			1100	1984		3084	
a) Excavation,Backfill,Compaction	920	LF			1.76	1.07			1619	984	2604	
b) Pipe Bedding	920	LF		.57	.85			524	782		1306	
c) Revegetation	10	MSF		50.00	11.00	9.00		500	110	90	700	
4) Injection Well Piping - 2"	360	LF		1.00	2.82			360	1015		1375	
5) Injection Well Collection Piping - 4"	500	LF		2.50	4.51			1250	2255		3505	
a) Excavation,Backfill,Compaction	500	LF			1.76	1.07			880	535	1415	
b) Pipe Bedding	500	LF		.57	.85			285	425		710	
c) Revegetation	5	MSF		50.00	11.00	9.00		250	55	45	350	
6) Valves	11			50.00	25.00			550	275		825	
7) Extraction Vacuum Pump	1			5000.00	600.00			5000	600		5600	
8) Injection Blower	1			5000.00	600.00			5000	600		5600	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							26500	29299	20917	8104	84821	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4

(MCPOG25)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
IN-SITU TREATMENT (AS/SVE) - AREA B												
1) Injection Well	385	LF	50.00				19250				19250	11 @ 35'
2) Extraction Well Piping - 2"	600	LF		1.00	2.82			600	1692		2292	
3) Extraction Well Collection Piping - 4"	560	LF		2.50	4.51			1400	2526		3926	
a) Excavation,Backfill,Compaction	1160	LF			1.76	1.07			2042	1241	3283	
b) Pipe Bedding	1160	LF		.57	.85			661	986		1647	
c) Revegetation	12	MSF		50.00	11.00	9.00		600	132	108	840	
4) Injection Well Piping - 2"	385	LF		1.00	2.82			385	1086		1471	
5) Injection Well Collection Piping - 4"	620	LF		2.50	4.51			1550	2796		4346	
a) Excavation,Backfill,Compaction	620	LF			1.76	1.07			1091	663	1755	
b) Pipe Bedding	620	LF		.57	.85			353	527		880	
c) Revegetation	6	MSF		50.00	11.00	9.00		300	66	54	420	
6) Valves	13			50.00	25.00			650	325		975	
7) Extraction Vacuum Pump	1			6000.00	600.00			6000	600		6600	
8) Injection Blower	1			6000.00	600.00			6000	600		6600	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							27750	32500	23431	8517	92197	

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
IN-SITU TREATMENT (AS/SVE) - AREA C												
1) Injection Well	360	LF	50.00				18000				18000	9 @ 40'
2) Extraction Well Piping - 2"	480	LF		1.00	2.82			480	1354		1834	
3) Extraction Well Collection Piping - 4"	440	LF		2.50	4.51			1100	1984		3084	
a) Excavation,Backfill,Compaction	920	LF			1.76	1.07			1619	984	2604	
b) Pipe Bedding	920	LF		.57	.85			524	782		1306	
c) Revegetation	9	MSF		50.00	11.00	9.00		450	99	81	630	
4) Injection Well Piping - 2"	360	LF		1.00	2.82			360	1015		1375	
5) Injection Well Collection Piping - 4"	500	LF		2.50	4.51			1250	2255		3505	
a) Excavation,Backfill,Compaction	500	LF			1.76	1.07			880	535	1415	
b) Pipe Bedding	500	LF		.57	.85			285	425		710	
c) Revegetation	5	MSF		50.00	11.00	9.00		250	55	45	350	
6) Valves	11			50.00	25.00			550	275		825	
7) Extraction Vacuum Pump	1			5000.00	600.00			5000	600		5600	
8) Injection Blower	1			5000.00	600.00			5000	600		5600	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							26500	29249	20906	8095	84751	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4

(MCPOG25)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
IN-SITU TREATMENT (AS/SVE) - AREA D												
1) Injection Well	360	LF	50.00				18000				18000	9 @ 40'
2) Extraction Well Piping - 2"	480	LF		1.00	2.82			480	1354		1834	
3) Extraction Well Collection Piping - 4"	440	LF		2.50	4.51			1100	1984		3084	
a) Excavation,Backfill,Compaction	920	LF			1.76	1.07			1619	984	2604	
b) Pipe Bedding	920	LF		.57	.85			524	782		1306	
c) Revegetation	9	MSF		50.00	11.00	9.00		450	99	81	630	
4) Injection Well Piping - 2"	360	LF		1.00	2.82			360	1015		1375	
5) Injection Well Collection Piping - 4"	500	LF		2.50	4.51			1250	2255		3505	
a) Excavation,Backfill,Compaction	500	LF			1.76	1.07			880	535	1415	
b) Pipe Bedding	500	LF		.57	.85			285	425		710	
c) Revegetation	5	MSF		50.00	11.00	9.00		250	55	45	350	
6) Valves	11			50.00	25.00			550	275		825	
7) Extraction Vacuum Pump	1			5000.00	600.00			5000	600		5600	
8) Injection Blower	1			5000.00	600.00			5000	600		5600	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							26500	29249	20906	8095	84751	
IN-SITU TREATMENT (AS/SVE) - AREA E												
1) Injection Well	450	LF	50.00				22500				22500	9 @ 50'
2) Extraction Well Piping - 2"	480	LF		1.00	2.82			480	1354		1834	
3) Extraction Well Collection Piping - 4"	440	LF		2.50	4.51			1100	1984		3084	
a) Excavation,Backfill,Compaction	920	LF			1.76	1.07			1619	984	2604	
b) Pipe Bedding	920	LF		.57	.85			524	782		1306	
c) Revegetation	9	MSF		50.00	11.00	9.00		450	99	81	630	
4) Injection Well Piping - 2"	450	LF		1.00	2.82			450	1269		1719	
5) Injection Well Collection Piping - 4"	500	LF		2.50	4.51			1250	2255		3505	
a) Excavation,Backfill,Compaction	500	LF			1.76	1.07			880	535	1415	
b) Pipe Bedding	500	LF		.57	.85			285	425		710	
c) Revegetation	5	MSF		50.00	11.00	9.00		250	55	45	350	
6) Valves	11			50.00	25.00			550	275		825	
7) Extraction Vacuum Pump	1			5000.00	600.00			5000	600		5600	
8) Injection Blower	1			5000.00	600.00			5000	600		5600	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							31000	29339	21160	8095	89595	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4

(MCPOG25)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
IN-SITU TREATMENT (AS/SVE) - AREA F												
1) Injection Well	405	LF	50.00				20250				20250	9 @ 45'
2) Extraction Well Piping - 2"	480	LF		1.00	2.82			480	1354		1834	
3) Extraction Well Collection Piping - 4"	440	LF		2.50	4.51			1100	1984		3084	
a) Excavation,Backfill,Compaction	920	LF			1.76	1.07			1619	984	2604	
b) Pipe Bedding	920	LF		.57	.85			524	782		1306	
c) Revegetation	9	MSF		50.00	11.00	9.00		450	99	81	630	
4) Injection Well Piping - 2"	405	LF		1.00	2.82			405	1142		1547	
5) Injection Well Collection Piping - 4"	500	LF		2.50	4.51			1250	2255		3505	
a) Excavation,Backfill,Compaction	500	LF			1.76	1.07			880	535	1415	
b) Pipe Bedding	500	LF		.57	.85			285	425		710	
c) Revegetation	5	MSF		50.00	11.00	9.00		250	55	45	350	
6) Valves	11			50.00	25.00			550	275		825	
7) Extraction Vacuum Pump	1			5000.00	600.00			5000	600		5600	
8) Injection Blower	1			5000.00	600.00			5000	600		5600	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							28750	29294	21033	8095	87173	
IN-SITU TREATMENT (AS/SVE) - AREA G												
1) Injection Well	440	LF	50.00				22000				22000	11 @ 40'
2) Extraction Well Piping - 2"	600	LF		1.00	2.82			600	1692		2292	
3) Extraction Well Collection Piping - 4"	560	LF		2.50	4.51			1400	2526		3926	
a) Excavation,Backfill,Compaction	1160	LF			1.76	1.07			2042	1241	3283	
b) Pipe Bedding	1160	LF		.57	.85			661	986		1647	
c) Revegetation	12	MSF		50.00	11.00	9.00		600	132	108	840	
4) Injection Well Piping - 2"	440	LF		1.00	2.82			440	1241		1681	
5) Injection Well Collection Piping - 4"	620	LF		2.50	4.51			1550	2796		4346	
a) Excavation,Backfill,Compaction	620	LF			1.76	1.07			1091	663	1755	
b) Pipe Bedding	620	LF		.57	.85			353	527		880	
c) Revegetation	6	MSF		50.00	11.00	9.00		300	66	54	420	
6) Valves	13			50.00	25.00			650	325		975	
7) Extraction Vacuum Pump	1			6000.00	600.00			6000	600		6600	
8) Injection Blower	1			6000.00	600.00			6000	600		6600	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							30500	32555	23586	8517	95157	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4

(MCPOG25)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
IN-SITU TREATMENT (AS/SVE) - AREA H												
1) Injection Well	405	LF	50.00				20250				20250	9 @ 45'
2) Extraction Well Piping - 2"	480	LF		1.00	2.82			480	1354		1834	
3) Extraction Well Collection Piping - 4"	440	LF		2.50	4.51			1100	1984		3084	
a) Excavation,Backfill,Compaction	920	LF			1.76	1.07			1619	984	2604	
b) Pipe Bedding	920	LF		.57	.85			524	782		1306	
c) Revegetation	9	MSF		50.00	11.00	9.00		450	99	81	630	
4) Injection Well Piping - 2"	405	LF		1.00	2.82			405	1142		1547	
5) Injection Well Collection Piping - 4"	500	LF		2.50	4.51			1250	2255		3505	
a) Excavation,Backfill,Compaction	500	LF			1.76	1.07			880	535	1415	
b) Pipe Bedding	500	LF		.57	.85			285	425		710	
c) Revegetation	5	MSF		50.00	11.00	9.00		250	55	45	350	
6) Valves	11			50.00	25.00			550	275		825	
7) Extraction Vacuum Pump	1			5000.00	600.00			5000	600		5600	
8) Injection Blower	1			2500.00	600.00			2500	600		3100	
9) Granulated Carbon Adsorber	2			1000.00	200.00			2000	400		2400	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							28750	26794	21033	8095	84673	
IN-SITU TREATMENT (AS/SVE) - AREA I												
1) Injection Well	495	LF	50.00				24750				24750	11 @ 45'
2) Extraction Well Piping - 2"	600	LF		1.00	2.82			600	1692		2292	
3) Extraction Well Collection Piping - 4"	560	LF		2.50	4.51			1400	2526		3926	
a) Excavation,Backfill,Compaction	1160	LF			1.76	1.07			2042	1241	3283	
b) Pipe Bedding	1160	LF		.57	.85			661	986		1647	
c) Revegetation	12	MSF		50.00	11.00	9.00		600	132	108	840	
4) Injection Well Piping - 2"	495	LF		1.00	2.82			495	1396		1891	
5) Injection Well Collection Piping - 4"	620	LF		2.50	4.51			1550	2796		4346	
a) Excavation,Backfill,Compaction	620	LF			1.76	1.07			1091	663	1755	
b) Pipe Bedding	620	LF		.57	.85			353	527		880	
c) Revegetation	6	MSF		50.00	11.00	9.00		300	66	54	420	
6) Valves	13			50.00	25.00			650	325		975	
7) Extraction Vacuum Pump	1			6000.00	600.00			6000	600		6600	
8) Injection Blower	1			6000.00	600.00			6000	600		6600	
9) Granulated Carbon Adsorber	2			2000.00	400.00			4000	800		4800	
10) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
11) Instrumentation		LS		6000.00	2500.00			6000	2500		8500	
12) Electrical Panel/Starters	1			6000.00	2500.00			6000	2500		8500	
13) Electrical Power Supply		LS	1000.00				1000				1000	
14) Clear & Grub	1.5	AC			2375.00	4300.00			3563	6450	10013	
							33250	34610	24141	8517	100517	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Grounwater Treatment (AS/SVE)
Annual Monitoring
Groundwater Alternative No. 4
(OMPOG25) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4
(OMPOG25a) 4/11/97

Annual Costs - (24 hr/day - 365 days/year)

ITEM	QTY	UNIT	UNIT$	YR 1-11 ITEM $	NOTES
1. Energy					
a. Electric	1763730	Kw-hr	.085	149917	AS/SVE Systems
2. Maintenance				31700	3% of Capital Cost
3. Operator	480	HR	20.00	9600	40 Hrs/Month
4. Activated Carbon					
a. Vapor	5200	LB	2.50	13000	Area A,B,C,D,E,F, G,H,I
TOTAL ANNUAL COSTS				204217	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ Groundwater Treatment (AS/SVE)
Groundwater Alternative No. 4
(PWAPOG25) 4/11/97
4514

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	2088.9											
2. O & M COSTS		248										
3. ANNUAL COSTS	2088.9	248	248	248	248	268	248	248	248	248	268	248
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	2089	236	225	214	204	210	185	176	168	160	165	145

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	24	23	22	31	20	19	18	17	24	16	15	14

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	43.8	63.8	43.8	43.8	43.8	43.8	63.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	14	19	12	12	11	11	15	4514

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls
Soil Alternative No. 2
(MCPOS22)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
1) Chain Link Fence - 8'	800	LF	12.00				9600				9600	Repair/Replace
2) Chain Link Fence - 8'	1400	LF	20.00				28000				28000	New
3) Signs	33			75.00	25.00			2475	825		3300	
							37600	2475	825	0	40900	
Burden @ 30% of Labor Cost									248		248	
Labor @ 10% of Labor Cost									83		83	
Material @ 10% of Material Cost								248			248	
SubContract @ 10% of Sub. Cost							3760				3760	
Total Direct Cost							41360	2723	1155	0	45238	
Indirects @ 75% of Total Direct Labor Cost									866		866	
Profit @ 10% of Total Direct Cost											4524	
Total Field Cost											50628	
Contingency @ 20% of Total Field Cost											10126	
Engineering @ 20% of Total Field Cost											10126	
TOTAL COST THIS PAGE											70879	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls
Annual Monitoring
Soil Alternative No. 2
(OMPOS22) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Institutional Controls
Soil Alternative No. 2
(PWAPOS22) 4/11/97
800

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	70.9											
2. O & M COSTS		43.8										
3. ANNUAL COSTS	70.9	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	71	42	40	38	36	50	33	31	30	28	39	26

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	24	23	22	31	20	19	18	17	24	16	15	14

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	43.8	63.8	43.8	43.8	43.8	43.8	63.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	14	19	12	12	11	11	15	800

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ (Hot Spot) Soil Treatment (SVE)
Soil Alternative No. 3

(MCPOS23S)
4/11/97

SUMMARY

Item	Sub.	Mat.	Labor	Equip.	
1) SURFACE WATER RUN-OFF PREPARATION	0	0	50000	50000	100000
2) HOT SPOT TREATMENT (SVE) - AREA 1	20250	36589	12043	812	69694
3) HOT SPOT TREATMENT (SVE) - AREA 2	8375	19513	4046	127	32061
4) HOT SPOT TREATMENT (SVE) - AREA 3A	6500	10958	3856	89	21403
5) HOT SPOT TREATMENT (SVE) - AREA 3B	9375	17855	4761	253	32244
6) HOT SPOT TREATMENT (SVE) - AREA 4	9975	19867	4795	253	34890
	54475	104782	79501	51534	290292
Burden @ 30% of Labor Cost			23850		23850
Labor @ 10% of Labor Cost			7950		7950
Material @ 10% of Material Cost		10478			10478
Subcontract @ 10% of Sub. Cost	5448				5448
Total Direct Cost	59923	115260	111301	51534	338018
Indirects @ 75% of Total Direct Labor Cost			83476		83476
Profit @ 10% Total Direct Cost					33802
					455296
Health & Safety Monitoring @ 5%					22765
Total Field Cost					478061
Contingency @ 20% of Total Field Cost					95612
Air Sparging/Vapor Extraction Pilot Study					75000
Engineering @ 15% of Total Field Cost					71709
Total Cost This Page					720382

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ (Hot Spot) Soil Treatment (SVE)
Soil Alternative No. 3

(MCPOS23)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
SITE WIDE SITE PREPARATION												
1) Surface Water Run-off Control		LS			30000.00	30000.00			30000	30000	60000	
2) Construction Debris Removal		LS			20000.00	20000.00			20000	20000	40000	
							0	0	50000	50000	100000	
HOT SPOT TREATMENT (SVE) - AREA 1												
1) Extraction Well	240	LF	50.00				12000				12000	16 @ 15'
2) Extraction Well Piping - 2"	240	LF		1.00	2.82			240	677		917	
3) Extraction Well Collection Piping - 4"	700	LF		2.50	4.91			1750	3437		5187	
a) Excavation,Backfill,Compaction	700	LF			1.76	1.07			1232	749	1981	
b) Pipe Bedding	700	LF		.57	.85			399	595		994	
c) Revegetation	7	MSF		50.00	11.00	9.00		350	77	63	490	
4) Valves	17			50.00	25.00			850	425		1275	
5) Extraction Vacuum Pump	1			7000.00	600.00			7000	600		7600	
6) Granulated Carbon Adsorber	2			10000.00	1000.00			20000	2000		22000	
7) Equipment Building	300	SF	25.00				7500				7500	15' x 20'
8) Instrumentation		LS		3000.00	1500.00			3000	1500		4500	
9) Electrical Panel/Starters	1			3000.00	1500.00			3000	1500		4500	
10) Electrical Power Supply		LS	750.00				750				750	
							20250	36589	12043	812	69694	
HOT SPOT TREATMENT (SVE) - AREA 2												
1) Extraction Well	40	LF	50.00				2000				2000	4 @ 10'
2) Extraction Well Piping - 2"	40	LF		1.00	2.82			40	113		153	
3) Extraction Well Collection Piping - 2"	110	LF		1.00	2.82			110	310		420	
a) Excavation,Backfill,Compaction	110	LF			1.76	1.07			194	118	311	
b) Pipe Bedding	110	LF		.57	.85			63	94		156	
c) Revegetation	1	MSF		50.00	11.00	9.00		50	11	9	70	
4) Valves	5			50.00	25.00			250	125		375	
5) Extraction Vacuum Pump	1			4000.00	400.00			4000	400		4400	
6) Granulated Carbon Adsorber	2			5000.00	400.00			10000	800		10800	
7) Equipment Building	225	SF	25.00				5625				5625	15' x 15'
8) Instrumentation		LS		2500.00	1000.00			2500	1000		3500	
9) Electrical Panel/Starters	1			2500.00	1000.00			2500	1000		3500	
10) Electrical Power Supply		LS	750.00				750				750	
							8375	19513	4046	127	32061	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ (Hot Spot) Soil Treatment (SVE)
Soil Alternative No. 3

(MCPOS23)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
HOT SPOT TREATMENT (SVE) - AREA 3A												
1) Extraction Well	40	LF	50.00				2000				2000	4 @ 10'
2) Extraction Well Piping - 2"	40	LF		1.00	2.82			40	113		153	
3) Extraction Well Collection Piping - 2"	75	LF		1.00	2.82			75	212		287	
a) Excavation,Backfill,Compaction	75	LF			1.76	1.07			132	80	212	
b) Pipe Bedding	75	LF		.57	.85			43	64		107	
c) Revegetation	1	MSF		50.00	11.00	9.00		50	11	9	70	
4) Valves	5			50.00	25.00			250	125		375	
5) Extraction Vacuum Pump	1			2500.00	400.00			2500	400		2900	
6) Granulated Carbon Adsorber	2			2000.00	400.00			4000	800		4800	
7) Equipment Building	150	SF	25.00				3750				3750	10' x 15'
8) Instrumentation		LS		2000.00	1000.00			2000	1000		3000	
9) Electrical Panel/Starters	1			2000.00	1000.00			2000	1000		3000	
10) Electrical Power Supply		LS	750.00				750				750	
							6500	10958	3856	89	21403	
HOT SPOT TREATMENT (SVE) - AREA 3B												
1) Extraction Well	60	LF	50.00				3000				3000	6 @ 10'
2) Extraction Well Piping - 2"	60	LF		1.00	2.82			60	169		229	
3) Extraction Well Collection Piping - 2"	220	LF		1.00	2.82			220	620		840	
a) Excavation,Backfill,Compaction	220	LF			1.76	1.07			387	235	623	
b) Pipe Bedding	220	LF		.57	.85			125	187		312	
c) Revegetation	2	MSF		50.00	11.00	9.00		100	22	18	140	
4) Valves	7			50.00	25.00			350	175		525	
5) Extraction Vacuum Pump	1			4000.00	400.00			4000	400		4400	
6) Granulated Carbon Adsorber	2			4000.00	400.00			8000	800		8800	
7) Equipment Building	225	SF	25.00				5625				5625	15' x 15'
8) Instrumentation		LS		2500.00	1000.00			2500	1000		3500	
9) Electrical Panel/Starters	1			2500.00	1000.00			2500	1000		3500	
10) Electrical Power Supply		LS	750.00				750				750	
							9375	17855	4761	253	32245	
HOT SPOT TREATMENT (SVE) - AREA 4												
1) Extraction Well	72	LF	50.00				3600				3600	6 @ 12'
2) Extraction Well Piping - 2"	72	LF		1.00	2.82			72	203		275	
3) Extraction Well Collection Piping - 2"	220	LF		1.00	2.82			220	620		840	
a) Excavation,Backfill,Compaction	220	LF			1.76	1.07			387	235	623	
b) Pipe Bedding	220	LF		.57	.85			125	187		312	
c) Revegetation	2	MSF		50.00	11.00	9.00		100	22	18	140	
4) Valves	7			50.00	25.00			350	175		525	
5) Extraction Vacuum Pump	1			4000.00	400.00			4000	400		4400	
6) Granulated Carbon Adsorber	2			5000.00	400.00			10000	800		10800	
7) Equipment Building	225	SF	25.00				5625				5625	15' x 15'
8) Instrumentation		LS		2500.00	1000.00			2500	1000		3500	
9) Electrical Panel/Starters	1			2500.00	1000.00			2500	1000		3500	
10) Electrical Power Supply		LS	750.00				750				750	
							9975	19867	4795	253	34890	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ (Hot Spot) Soil Treatment (SVE)
Annual Monitoring
Soil Alternative No. 3
(OMPOS23) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ (Hot Spot) Soil Treatment (SVE)
Soil Alternative No. 3
(OMPOS23a) 4/11/97

Annual Costs - (24 hr/day - 365 days/year)

ITEM	QTY	UNIT	UNIT$	YR 1-2 ITEM $	NOTES
1. Energy					
a. Electric	424602	Kw-hr	.085	36091	SVE Systems
2. Maintenance				6400	3% of Capital Cost
3. Operator	192	HR	20.00	3840	16 Hrs/Month
4. Activated Carbon					
a. Vapor	520	LB	2.50	1300	Area 1,2,3,4
TOTAL ANNUAL COSTS				47631	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
In-Situ (Hot Spot) Soil Treatment (SVE)
Soil Alternative No. 3
(PWAPOS23) 4/11/97
1538

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	720.4											
2. O & M COSTS		91.4										
3. ANNUAL COSTS	720.4	91.4	91.4	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	720	87	83	38	36	50	33	31	30	28	39	26

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	24	23	22	31	20	19	18	17	24	16	15	14

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	43.8	63.8	43.8	43.8	43.8	43.8	63.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	14	19	12	12	11	11	15	1538

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Consolidation, Containment
Soil Alternative No. 4
Page 1 of 3
(MCPOS24S)
4/11//97

SUMMARY

Item	Sub.	Mat.	Labor	Equip.	
1) MOBILIZATION/DEMOBILIZATION	88000	0	0	0	88000
2) DECONTAMINATION FACILITIES AND SERVICES	43560	13818	7319	666	65363
3) INSTITUTIONAL CONTROLS	37600	2475	825	0	40900
4) SITE WIDE SITE PREPARATION	0	0	50000	50000	100000
5) BARRIER CAP	23264	64748	46256	130979	265247
	192424	81041	104400	181645	559510
Burden @ 30% of Labor Cost			31320		31320
Labor @ 10% of Labor Cost			10440		10440
Material @ 10% of Material Cost		8104			8104
Subcontract @ 10% of Sub. Cost	19242				19242
Total Direct Cost	211666	89145	146160	181645	628617
Indirects @ 75% of Total Direct Labor Cost			109620		109620
Profit @ 10% Total Direct Cost					62862
					801098
Health & Safety Monitoring @ 3%					24033
Total Field Cost					825131
Contingency @ 20% of Total Field Cost					165026
Predesign Sampling					100000
Engineering @ 15% of Total Field Cost					123770
Total Cost This Page					1213927

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Consolidation, Containment
Soil Alternative No. 4

(MCPOS24)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1)	9	MO	500.00				4500				4500	
2) Storage Trailer (1)	9	MO	500.00				4500				4500	
3) Construction Survey		LS	10000.00				10000				10000	
4) Portable Communication Equipment	3	SETS	1500.00				4500				4500	
5) Equipment Mobilization/Demobilization		LS	15000.00				15000				15000	
6) Site Utilities	9	MO	4000.00				36000				36000	
7) Decontamination Trailer	9	MO	1500.00				13500				13500	
							88000	0	0	0	88000	
DECONTAMINATION FACILITIES AND SERVICES												
1) Laundry Service	36	WK	250.00				9000				9000	
2) Truck Decon Pad												
a) Concrete Pad - 8"	40	CY		70.00	125.00	5.00		2800	5000	200	8000	
b) Gravel Base - 6"	30	CY		7.50	3.33	8.00		225	100	240	565	
c) Curb	120	LF		3.07	1.99	.05		368	239	6	613	
d) Collection Sump	1			1450.00	500.00	220.00		1450	500	220	2170	
e) Splash Guard	780	SF		1.25	1.00			975	780		1755	
3) Decontamination Service	9	MO	1200.00				10800				10800	
4) Decon Water	118800	GAL	.20				23760				23760	
5) Clean Water Storage Tank	1			3000.00	300.00			3000	300		3300	
6) Spent Water Tank	1			5000.00	400.00			5000	400		5400	
							43560	13818	7319	666	65363	
INSTITUTIONAL CONTROLS												
1) Chain Link Fence - 8'	800	LF	12.00				9600				9600	Repair/Replace
2) Chain Link Fence - 8'	1400	LF	20.00				28000				28000	New
3) Signs	33			75.00	25.00			2475	825		3300	
							37600	2475	825	0	40900	
SITE WIDE SITE PREPARATION												
1) Surface Water Run-off Control		LS			30000.00	30000.00			30000	30000	60000	
2) Construction Debris Removal		LS			20000.00	20000.00			20000	20000	40000	
							0	0	50000	50000	100000	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Consolidation, Containment
Soil Alternative No. 4

(MCPOS24)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
BARRIER CAP												
1) Excavation Hot Spots	3984	CY			1.00	3.04			3984	12111	16095	
a) Place, Spread & Compact	3984	CY			.84	2.67			3347	10637	13984	
2) Soil Backfill (Hot Spot Area)	3984	CY		4.50	2.70	7.43		17928	10757	29601	58286	
a) Place, Spread & Compact	3984	CY			.84	2.67			3347	10637	13984	
3) Revegetation	78.5	MSF		24.60	8.40	6.68		1931	659	524	3115	
4) Clay Layer - 24"	2764	CY		6.00	2.70	7.43		16584	7463	20537	44583	
a) Place, Spread & Compact	2764	CY			.84	2.67			2322	7380	9702	
5) PVC Synthetic Membrane - 30 Mil	36100	SF	.50				18050				18050	
6) Sand Layer - 12"	1337	CY		7.50	2.70	7.43		10028	3610	9934	23571	
a) Place, Spread & Compact	1337	CY			.84	2.67			1123	3570	4693	
7) Geotextile	4011	SY	1.30				5214				5214	
8) Soil Layer - 18"	2006	CY		4.50	2.70	7.43		9027	5416	14905	29348	
a) Place, Spread & Compact	2006	CY			.84	2.67			1685	5356	7041	
9) Topsoil Layer - 6"	669	CY		12.50	2.70	7.43		8363	1806	4971	15139	
a) Place & Spread	669	CY			.65	.86			435	575	1010	
10) Revegetation	36.1	MSF		24.60	8.40	6.68		888	303	241	1432	
							23264	64748	46256	130979	265248	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Consolidation, Containment
Annual Monitoring
Soil Alternative No. 4
(OMPOS24) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Consolidation, Containment
Soil Alternative No. 4
(PWAPOS24) 4/11/97
1943

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	1213.9											
2. O & M COSTS		43.8										
3. ANNUAL COSTS	1213.9	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	1214	42	40	38	36	50	33	31	30	28	39	26

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	24	23	22	31	20	19	18	17	24	16	15	14

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	43.8	63.8	43.8	43.8	43.8	43.8	63.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	14	19	12	12	11	11	15	1943

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Treatment, Onsite Disposal
Soil Alternative No. 5

(MCPOS25S)
4/11//97

SUMMARY

Item	Sub.	Mat.	Labor	Equip.	
1) MOBILIZATION/DEMOBILIZATION	112500	0	0	0	112500
2) DECONTAMINATION FACILITIES AND SERVICES	58080	13818	7319	666	79883
3) INSTITUTIONAL CONTROLS	37600	2475	825	0	40900
4) SITE WIDE SITE PREPARATION	0	0	50000	50000	100000
5) SOLIDIFICATION - INORGANIC HOT SPOT	179300	13133	15485	44902	252820
6) BARRIER CAP	20880	39797	21398	59730	141805
7) THERMAL ADSORPTION - ORGANIC HOT SPOT	1690280	39970	39793	114600	1884643
	2098640	109193	134820	269898	2612551
Burden @ 30% of Labor Cost			40446		40446
Labor @ 10% of Labor Cost			13482		13482
Material @ 10% of Material Cost		10919			10919
Subcontract @ 10% of Sub. Cost	209864				209864
Total Direct Cost	2308504	120112	188748	269898	2887262
Indirects @ 75% of Total Direct Labor Cost			141561		141561
Profit @ 10% Total Direct Cost					288726
					3317550
Health & Safety Monitoring @ 3%					99526
Total Field Cost					3417076
Contingency @ 20% of Total Field Cost					683415
Predesign Sampling					100000
Engineering @ 15% of Total Field Cost					512561
Total Cost This Page					4713053

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Treatment, Onsite Disposal
Soil Alternative No. 5

(MCPOS25)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1)	12	MO	500.00				6000				6000	
2) Storage Trailer (1)	12	MO	500.00				6000				6000	
3) Construction Survey		LS	15000.00				15000				15000	
4) Portable Communication Equipment	3	SETS	1500.00				4500				4500	
5) Equipment Mobilization/Demobilization		LS	15000.00				15000				15000	
6) Site Utilities	12	MO	4000.00				48000				48000	
7) Decontamination Trailer	12	MO	1500.00				18000				18000	
							112500	0	0	0	112500	
DECONTAMINATION FACILITIES AND SERVICES												
1) Laundry Service	48	WK	250.00				12000				12000	
2) Truck Decon Pad												
a) Concrete Pad - 8"	40	CY		70.00	125.00	5.00		2800	5000	200	8000	
b) Gravel Base - 6"	30	CY		7.50	3.33	8.00		225	100	240	565	
c) Curb	120	LF		3.07	1.99	.05		368	239	6	613	
d) Collection Sump	1			1450.00	500.00	220.00		1450	500	220	2170	
e) Splash Guard	780	SF		1.25	1.00			975	780		1755	
3) Decontamination Service	12	MO	1200.00				14400				14400	
4) Decon Water	158400	GAL	.20				31680				31680	
5) Clean Water Storage Tank	1			3000.00	300.00			3000	300		3300	
6) Spent Water Tank	1			5000.00	400.00			5000	400		5400	
							58080	13818	7319	666	79883	
INSTITUTIONAL CONTROLS												
1) Chain Link Fence - 8'	800	LF	12.00				9600				9600	Repair/Replace
2) Chain Link Fence - 8'	1400	LF	20.00				28000				28000	New
3) Signs	33			75.00	25.00			2475	825		3300	
							37600	2475	825	0	40900	
SITE WIDE SITE PREPARATION												
1) Surface Water Run-off Control		LS			30000.00	30000.00			30000	30000	60000	
2) Construction Debris Removal		LS			20000.00	20000.00			20000	20000	40000	
							0	0	50000	50000	100000	
SOLIDIFICATION - INORGANIC HOT SPOT												
1) Staging Area - Asphalt	22500	SF	2.00				45000				45000	
2) Excavation Hot Spots	2686	CY			1.00	3.04			2686	8165	10851	
3) Soil Backfill (Hot Spot Area)	2686	CY		4.50	2.70	7.43		12087	7252	19957	39296	
a) Place, Spread & Compact	2686	CY			.84	2.67			2256	7172	9428	
4) Revegetation	42.5	MSF		24.60	8.40	6.68		1046	357	284	1686	
5) Solidification	2686	CY	50.00				134300				134300	
a) Place, Spread & Compact	3492	CY			.84	2.67			2933	9324	12257	
							179300	13133	15485	44902	252819	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Treatment, Onsite Disposal
Soil Alternative No. 5

(MCPOS25)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
BARRIER CAP												
1) Clay Layer - 24"	2400	CY		6.00	2.70	7.43		14400	6480	17832	38712	
a) Place, Spread & Compact	2400	CY			.84	2.67			2016	6408	8424	
2) PVC Synthetic Membrane - 30 Mil	32400	SF	.50				16200				16200	
3) Sand Layer - 12"	1200	CY		7.50	2.70	7.43		9000	3240	8916	21156	
a) Place, Spread & Compact	1200	CY			.84	2.67			1008	3204	4212	
4) Geotextile	3600	SY	1.30				4680				4680	
5) Soil Layer - 18"	1800	CY		4.50	2.70	7.43		8100	4860	13374	26334	
a) Place, Spread & Compact	1800	CY			.84	2.67			1512	4806	6318	
6) Topsoil Layer - 6"	600	CY		12.50	2.70	7.43		7500	1620	4458	13578	
a) Place & Spread	600	CY			.65	.86			390	516	906	
7) Revegetation	32.4	MSF		24.60	8.40	6.68		797	272	216	1286	
							20880	39797	21398	59730	141806	
THERMAL ADSORPTION - ORGANIC HOT SPOT												
1) Staging Area - Asphalt	22500	SF	2.00				45000				45000	
2) Excavation Hot Spots	8705	CY			1.00	3.04			8705	26463	35168	
3) Soil Backfill (Hot Spot Area)	8705	CY		4.50	2.70	7.43		39173	23504	64678	127354	
a) Place, Spread & Compact	8705	CY			.84	2.67			7312	23242	30555	
4) Revegetation	32.4	MSF		24.60	8.40	6.68		797	272	216	1286	
5) Thermal Adsorption Treatment	11752	TON	140.00				1645280				1645280	
							1690280	39970	39793	114600	1884643	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Treatment, Onsite Disposal
Annual Monitoring
Soil Alternative No. 5
(OMPOS25) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
1. Sampling	6500.00		8 groundwater samples, Surficial Aquifer 3 groundwater samples, Yorktown Aquifer 4 surface water samples, 4 sediment samples per sampling period, annually plus travel, living & shipping costs.
2. Analysis	35300.00		9 groundwater samples, Surficial Aquifer 4 groundwater samples, Yorktown Aquifer 5 surface water samples, 5 sediment samples per sampling period.(incl. blank & duplicate for each medium) TAL Metals, TCL VOCs, SVOCs, Pesticides/PCBs
3. Reporting	2000.00		20 manhours per report plus other direct costs
4. Site Review		20000.00	Analysis Review performed for years 5,10,15,20,25,30
TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Treatment, Onsite Disposal
Soil Alternative No. 5
(PWAPOS25) 4/11/97
5442

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	4713.1											
2. O & M COSTS		43.8										
3. ANNUAL COSTS	4713.1	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	4713	42	40	38	36	50	33	31	30	28	39	26

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	24	23	22	31	20	19	18	17	24	16	15	14

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	43.8	63.8	43.8	43.8	43.8	43.8	63.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	14	19	12	12	11	11	15	5442

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Offsite Disposal
Soil Alternative No. 6
Page 1 of 2
(MCPOS26S)
4/11/97

SUMMARY

Item	Sub.	Mat.	Labor	Equip.	
1) MOBILIZATION/DEMOBILIZATION	112500	0	0	0	112500
2) DECONTAMINATION FACILITIES AND SERVICES	58080	13818	7319	666	79883
3) INSTITUTIONAL CONTROLS	37600	2475	825	0	40900
4) SITE WIDE SITE PREPARATION	0	0	50000	50000	100000
5) OFFSITE DISPOSAL	911400	53720	52555	150346	1168021
	1119580	70013	110699	201012	1501304
Burden @ 30% of Labor Cost			33210		33210
Labor @ 10% of Labor Cost			11070		11070
Material @ 10% of Material Cost		7001			7001
Subcontract @ 10% of Sub. Cost	111958				111958
Total Direct Cost	1231538	77014	154979	201012	1664543
Indirects @ 75% of Total Direct Labor Cost			116234		116234
Profit @ 10% Total Direct Cost					166454
					1947231
Health & Safety Monitoring @ 3%					58417
Total Field Cost					2005648
Contingency @ 20% of Total Field Cost					401130
Predesign Sampling					100000
Engineering @ 15% of Total Field Cost					300847
Total Cost This Page					2807625

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Offsite Disposal
Soil Alternative No. 6
Page 2 of 2
(MCPOS26)
4/11/97

Item	Qty	Unit	Unit Cost Sub.	Unit Cost Mat.	Unit Cost Labor	Unit Cost Equip.	Total Cost Sub.	Total Cost Mat.	Total Cost Labor	Total Cost Equip.	Total Direct Cost	Comments
MOBILIZATION/DEMOBILIZATION												
1) Office Trailer (1)	12	MO	500.00				6000				6000	
2) Storage Trailer (1)	12	MO	500.00				6000				6000	
3) Construction Survey		LS	15000.00				15000				15000	
4) Portable Communication Equipment	3	SETS	1500.00				4500				4500	
5) Equipment Mobilization/Demobilization		LS	15000.00				15000				15000	
6) Site Utilities	12	MO	4000.00				48000				48000	
7) Decontamination Trailer	12	MO	1500.00				18000				18000	
							112500	0	0	0	112500	
DECONTAMINATION FACILITIES AND SERVICES												
1) Laundry Service	48	WK	250.00				12000				12000	
2) Truck Decon Pad												
a) Concrete Pad - 8"	40	CY		70.00	125.00	5.00		2800	5000	200	8000	
b) Gravel Base - 6"	30	CY		7.50	3.33	8.00		225	100	240	565	
c) Curb	120	LF		3.07	1.99	.05		368	239	6	613	
d) Collection Sump	1			1450.00	500.00	220.00		1450	500	220	2170	
e) Splash Guard	780	SF		1.25	1.00			975	780		1755	
3) Decontamination Service	12	MO	1200.00				14400				14400	
4) Decon Water	158400	GAL	.20				31680				31680	
5) Clean Water Storage Tank	1			3000.00	300.00			3000	300		3300	
6) Spent Water Tank	1			5000.00	400.00			5000	400		5400	
							58080	13818	7319	666	79883	
INSTITUTIONAL CONTROLS												
1) Chain Link Fence - 8'	800	LF	12.00				9600				9600	Repair/Replace
2) Chain Link Fence - 8'	1400	LF	20.00				28000				28000	New
3) Signs	33			75.00	25.00			2475	825		3300	
							37600	2475	825	0	40900	
SITE WIDE SITE PREPARATION												
1) Surface Water Run-off Control		LS			30000.00	30000.00			30000	30000	60000	
2) Construction Debris Removal		LS			20000.00	20000.00			20000	20000	40000	
							0	0	50000	50000	100000	
OFFSITE DISPOSAL												
1) Excavation Hot Spots	11391	CY			1.00	3.04			11391	34629	46020	
2) Backfill Soil (Hot Spot Area)	11391	CY		4.50	2.70	7.43		51260	30756	84635	166650	
a) Place, Spread & Compact	11391	CY			.84	2.67			9568	30414	39982	
3) Revegetation	100	MSF		24.60	8.40	6.68		2460	840	668	3968	
4) Waste Hauling	28500	MI	5.00				142500				142500	570 Tr @ 50 Mi.
5) Waste Disposal	15378	TON	50.00				768900				768900	
							911400	53720	52555	150346	1168020	

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Offsite Disposal
Annual Monitoring
Soil Alternative No. 6
(OMPOS26) 4/11/97

Annual Costs

ITEM	ITEM $ ANNUALLY SAMPLING	ITEM $ COST PER 5 YEARS	NOTES
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TOTAL ANNUAL COST	43800.00	20000.00	Monitoring will be performed annually for years 1 thru 30

U.S. MARINE CORPS AIR STATION
Cherry Point, North Carolina
Operable Unit 2
Excavation, Offsite Disposal
Soil Alternative No. 6
(PWAPOS26) 4/11/97
3537

PRESENT WORTH ANALYSIS

COST/YEAR COST OCCURS ($000'S)

COST COMPONENT	0	1	2	3	4	5	6	7	8	9	10	11
1. CAPITAL COST	2807.6											
2. O & M COSTS		43.8										
3. ANNUAL COSTS	2807.6	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8
4. ANNUAL DISCOUNT RATE=5%	1	.952	.907	.864	.823	.784	.746	.711	.677	.645	.614	.585
PRESENT WORTH =	2808	42	40	38	36	50	33	31	30	28	39	26

	12	13	14	15	16	17	18	19	20	21	22	23
O & M COSTS	43.8	43.8	43.8	63.8	43.8	43.8	43.8	43.8	63.8	43.8	43.8	43.8
ANNUAL DISCOUNT RATE=5%	.557	.53	.505	.481	.458	.436	.416	.396	.377	.359	.342	.326
PRESENT WORTH =	24	23	22	31	20	19	18	17	24	16	15	14

	24	25	26	27	28	29	30	TOTAL PRESENT WORTH (000'S)
O & M COSTS	43.8	63.8	43.8	43.8	43.8	43.8	63.8	
ANNUAL DISCOUNT RATE=5%	.31	.295	.281	.268	.255	.243	.231	
PRESENT WORTH =	14	19	12	12	11	11	15	3537

APPENDIX D

FULL-SIZED DRAWINGS

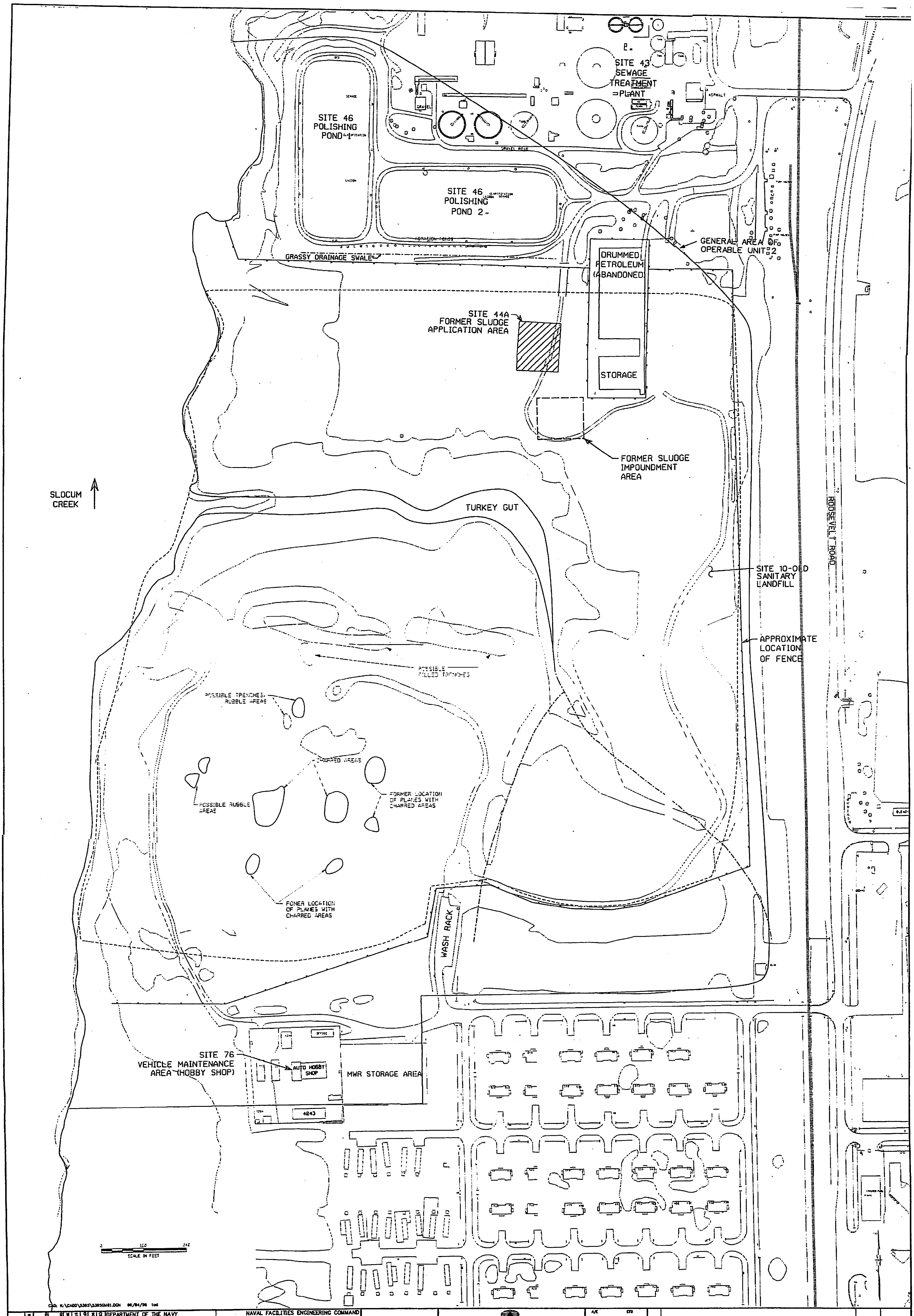

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PLATE 1

SHEET X of X

XXXXXX-XX-X-XXXX

XX-XX-XXXX

SCALE: AS SHOWN

SIZE: D

DEPARTMENT OF THE NAVY — NAVAL FACILITIES ENGINEERING COMMAND

ATLANTIC DIVISION

NORFOLK, VIRGINIA

NAVAL STATION

MARINE CORPS AIR STATION CHERRY POINT — CHERRY POINT, NORTH CAROLINA

OU2

GENERAL SITE LOCATION MAP

Brown & Root Environmental

ACTIVITY - SATISFACTORY TO

REVISIONS