TETRA TECH

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Reference: CLEAN Contract No. N62467-04-D-0055
Contract Task Order No. 405

Subject: Transmittal of Revised Response to Comments and Report Revisions
Draft Study Area Screening Evaluation Report
Former Melville Water Tower Site, Portsmouth, Rhode Island

Dear Ms Lombardo, Mr. Kulpa:

Enclosed you will find responses to comments to the Draft SASE report for the site referenced above. The response includes the following attachments:

Attachment A provides responses to comments from USEPA dated January 15, 2009. Attachment B provides responses to comments from RIDEM dated January 22, 2005. Attachment C provides a draft revision of the text of Appendix G, which clarifies the background assessment of soil, and additional figures and support documentation requested. Attachment D provides revised text and tables that will be included in the revised document based on the responses to comments.

If you have any questions regarding this material, please do not hesitate to contact me.

Very truly yours,

Stephen S. Parker, LSP
Project Manager

SSP/lh

Encl.

c: T. Finlayson, Gannett Fleming (1 - w/encl.)
W. Johnson, NAVFAC (1 - w/encl.)
C. Mueller, NAVSTA (2 - w/encl.)
G. Glenn, TtNUS (w/o encl.)
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ATTACHMENT A
Response to U.S. EPA Comments,
Draft Study Area Screening Evaluation
Former Melville Water Tower Site
NAVSTA, Newport, Rhode Island
Comments Dated 1/15/09

Comment on Arsenic Human Health Risk Evaluation:

Appendix G, Evaluation of Arsenic and Background Soil, concludes that arsenic levels in soils from Areas A, B, and C may be considered to be elevated relative to the levels found in some of the local background soil types. Then, Section 5.3 summarizes the Navy's evaluation of arsenic in soil. The first bullet here indicates that arsenic concentrations suggest no pattern associated with the water tower. Please provide the data or a reference to the data that supports this statement. The second bullet indicates that arsenic was not a "primary" ingredient of the paint and that "arsenic is not associated with the paint." This is misleading. Arsenic was detected in paint samples, as shown in Table 2-1, so arsenic was associated with the paint. The third bullet indicates that soil concentrations are within the ranges of arsenic concentrations in background soils. However, this is misleading, as the conclusion of the statistical comparison presented in Appendix G indicated that the arsenic in areas A, B, and C may be considered to be elevated compared to background. Section 5.3 then concludes that the elevated arsenic concentrations in soil do not need further consideration. EPA does not agree that the Draft SASE Report makes the case that arsenic levels in soil require no further action. The Navy must provide further support for a no further action decision related to arsenic in soil.

EPA suggests the use of ProUCL version 4.0 (http://www.epa.gov/nerlesd1/tsc/software.htm) to calculate the 95% Upper Confidence Limit (95%UCL) Exposure Point Concentration (EPC) followed by calculation of cancer and non-cancer risk of arsenic to residential receptors. Since the entire area is less than an acre, EPA suggests that all of the data from the post-excavation confirmatory sampling can be used to calculate one EPC for the area. Identify the Exposure Point Concentration (EPC) as the lower of the maximum concentration or 95% UCL. Arsenic has both carcinogenic and non-carcinogenic risks. EPA also suggests use of the regional screening levels (http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/index.htm) developed for a residential soil scenario for screening arsenic. Note that EPA Regions 3, 6, and 9 have replaced their screening levels with the EPA regional screening levels.

For carcinogenic risk, the EPA regional screening level for residential soil arsenic of 0.39 mg/kg as presented from the above weblink is associated with a risk of 1E-06 for all exposure pathways. EPA suggests adjusting this screening level to 39 mg/kg to be used as a site-specific screening level for arsenic. Note that this adjusted screening level is associated with a risk of 1E-04 for all exposure pathways.

For non-carcinogenic risk, the EPA regional screening level for residential soil arsenic of 22 mg/kg as presented from the above weblink is associated with a hazard quotient of 1. This level is associated with a carcinogenic risk of 5.6E-05. Since the screening level for carcinogenic risk of 39 mg/kg is not as conservative as the screening level for non-carcinogenic risk, the level of 22 mg/kg based on non-carcinogenic risk would be used as the screening level for arsenic at the site. Compare the calculated EPC to this screening level. If the EPC is less than 22 mg/kg, than the Screening Hazard Quotient (SHQ) is less than 1 or the associated screening carcinogenic risk (SCR) is less than 5.6E-05. In that situation, the Navy can conclude that no further action is needed.

If the EPC is greater than 22 mg/kg (associated with the SCR greater than 5.6E-05 or the SHQ greater than 1), the Navy should re-calculate the EPC taking into account the clean fill material

that was used to fill the removal action excavations at the site. The goal of this calculation would be to estimate the concentration in a hypothetical mixture of surface and subsurface soil (0-10 ft.) that would occur after basement excavation, stockpiling, and re-grading of excavated soil during home building. For this calculation, the Navy could calculate the mass of arsenic in the 6 inch layer of added topsoil, the mass of arsenic in the fill material, and the mass of arsenic in the layer below the confirmatory samples to the maximum depth of 10 feet, and then calculate the concentration in the whole volume. In other words, the Navy could determine the % of the soil volume that is represented by the fill material and incorporate the arsenic data for the fill into the ProUCL evaluation and attempt to calculate an EPC representative of the post-removal action soil conditions. Then, follow the same steps as discussed above to evaluate a SCR and SHQ. If the SCR is less than 5.6E-05 or if the SHQ is less than 1, the Navy can conclude that no further action is needed.

If SCR is still greater than 5.6E-05, but less than 1E-4, or SHQ is still greater than 1, the Navy should utilize the baseline background data set to calculate the risk associated with background and determine whether site-related risks in comparison with background warrant action under CERCLA. If SCR is greater than 1E-4, the Navy will need to consider further action under CERCLA. Also, please note that ProUCL has a background analysis and comparison tool, and the Navy may want to consider repeating the background evaluation with the ProUCL software.

Navy should provide a technical memorandum that shows these calculations, as well as the input concentrations for the ProUCL calculations of EPCs and the ProUCL printout of the selected EPC and its statistical distribution.

Response: The Navy is concerned with setting precedence for evaluating risk associated with arsenic in soil if that arsenic is not a result of the releases at the site. It is the Navy's belief that the arsenic concentrations found in soil in the post excavation samples at the water tower site are not a result of releases of hazardous materials at the site, but instead are a result of background conditions.

However, in the interest of moving this site toward closure, the Navy has calculated an exposure point concentration (EPC) in accordance with the guidelines stated above. The EPC is calculated at 6.7 mg/kg, which, given EPA's interpretation above, indicates that the Screening Hazard Quotient (SHQ) is less than 1 and the screening carcinogenic risk (SCR) is less than 5.6E-05. Therefore, the Navy concludes that no further action is needed.

In addition, the Navy concurs that the conclusions in the report require revision. In accordance with our conversation on January 21, 2009, and a subsequent conversation March 18, 2009, the Navy has prepared a draft revision to Appendix G of the SASE. New portions of the Appendix G, including revised text, added figures, and new tables are provided in Attachment C of this response summary. Revised and additional text to be included in various sections of the SASE report is provided in Attachment D of this response summary.

At this time, the Navy proposes to revise the SASE report with this information, and reissue as a final document.

Comments on Ecological Risk Assessment Evaluation

The Draft SASE Report should be revised to provide further support related to ecological risk related to lead in soil, particularly in the East Area. Rather than making the general statement that the Eco SSL for lead is "low", it would be more productive for the Navy to examine the

exposure assumptions used in the development of the Eco SSL and describe any conditions assumed in the Eco SSL development that are not met in this situation. A more robust case must be made for the position that no further action is needed. Does the Eco SSL assume a home range factor of 1 (i.e. a bird would spend 100% of time in the site area)? Are there habitat characteristics that make all or part of the area unsuitable for bird life, or unable to support a population or sub-population of small mammals? Section 5.4 indicates that "other SSLs for other receptors may be more appropriate for this site." What other SSLs and what data supports this position? Short of doing a full ecological risk assessment, the Navy could provide a habitat description, map and/or aerial photograph or other site photo, and a description of the type of wildlife receptors that might inhabit this portion of the site.

In addition, it would be helpful for the Navy to provide some information on the EPC used in the ecological evaluation. The tables describe the data points as average of all soil depths. The ecological evaluation should use only surficial soil data such as 0-1' or 0-2'. Are the averages skewed by any particular hot spots or uniquely high values that might be considered outliers? The Eco SSLs are designed to be conservative and exceeding the Eco SSL does not indicate a need for remedial action. However, a well-reasoned risk-based argument must be made for setting a higher threshold based on site-specific considerations.

Response: A revised section 4.3 has been prepared and provided in Attachment D of this response summary. The revised text presents a discussion of SSLs available, habitat present and low possibility of risk to ecological receptors.

ATTACHMENT B
Responses to RIDEM Comments,
Draft Study Area Screening Evaluation Report
Former Melville Water Tower Site

1. ***Section 2.0, Previous Studies***
   Page 2-2,

This section of the report summarizes the results of the previous investigations conducted at the site. The report does not include a discussion of the collection of soil samples west of the tower by the United States Navy, which was the first investigation conducted at the site. Please include a discussion of this investigation in this section of the report.

Response: On October 18, 2005, the Navy conducted sampling of the ground surface west of the tower for lead. Twelve samples were collected, and analyzed for lead. The reported concentrations were between 4.6 mg/kg and 12 mg/kg. A summary of this effort and the data collected will be included in the revised report.

2. ***Section 2.3.2, Paint Chip Sampling***
   Page 2-5, 2nd Paragraph

The report states that the concentration of PCBs found in the sample from the drum was due to incidental presence of PCBs and not due to its presence in paint. As this is a public document please expound on the incidental presence of PCBs, (that is whether the observed concentration represents what is typically found in soil, is a contaminant that was in the drum from another location, represents PCBs from a non paint source at the water tower, etc). If the source of the PCBs is not known this should be clearly stated in the report.

Response: The source of the PCBs in the drum is unknown, this will be clarified.

3. ***Section 2.3.2, Paint Chip Sampling***
   Page 2-5, 4 th Paragraph

This section of the report includes a discussion of the lead and arsenic results found in the paint and in the soil. Please add the following to this section of the report:

Elevated levels of arsenic were found in paint chips samples collected at the site. In addition, one soil sample collected immediately adjacent to the tower had an arsenic concentration of 1311 ppm. This is the highest concentration of arsenic observed in a soil sample collected from any site located in the State of Rhode Island. The distribution of arsenic at the site was similar to lead with the highest concentrations being found in the immediate vicinity of the tower.

Response: The comment is noted. It is also noted that the sample analysis that provided the result of 1311 ppm of arsenic was conducted through XRF analysis by RIDEM. XRF analysis for arsenic in soil is not reliable. Paint chip samples contained ND to a maximum of 73 mg/kg arsenic, analyzed by fixed lab methods.

The distribution of arsenic in the surface soils is acknowledged to be similar to that for the lead results. However, this could be attributed to the fill that was placed under the tower during its construction in the 1940s. A large quantity of blast stone and rock was removed from this area during the removal action, which was clearly used as fill to level this area for the water tower. Bedrock in the Newport area is known to contain elemental arsenic (up to 78 mg/kg) and this could have provided the elevated concentrations in soil under the tower but not in

other areas which was not filled. Additionally, the surrounding area surface soils are covered with loam, and this soil is not comparable with the exposed compacted fill and stone directly under the tower. The revised report will clarify these points.

4. ***Section 2.3.3, Soil Sampling***
   Page 2-7, 3 rd Paragraph

Th report notes that paint chips were not evident in the soil samples indicating that that potential source of contamination may have been associated with sand blasting. Please be advised that the investigations and actions conducted at this site were prompted when a child brought home a paint chip containing lead. The Navy subsequently engaged in a daily activity of removing paint chips from the grassed and gravel areas surrounding the tower. This daily activity was deemed necessary as paint chips continued to peel off the tower and land in the surrounding play areas. Despite this effort paint chips still were found scattered throughout the site during the investigation conducted by RIDEM. The Office of Waste Management agrees that sand blasting operations may have been a source of the lead found in the area. Another clear source (which is known to the public) would have been peeling paint. Therefore, the report must note that the known source of lead observed at the site is peeling paint and a potential source is sand blasting operations.

Response: The text will be revised to state: "Sources of lead may include peeling paint and former sand-blasting operations."

5. ***Section 2.3.3, Soil Sampling***
   Page 2-8, 3 rd Paragraph

The report notes that the elevated levels of lead found adjacent to the fence is more likely a result of traffic from the adjacent road. Please be advised that prior to the removal action blue paint chips were found in this area. Further, elevated levels of lead were typically not found in soil sample collected elsewhere adjacent to the road. Therefore, please remove this statement and simply note that as paint chips were found in this area and the elevated levels of lead may have come from the tower.

Response: The comment is noted, however, the text is correct as stated.

6. ***Section 2.4.1, Valve Chamber Excavation***
   Page 2-10, Whole Section

Please include a figure demarcating the location of the investigation and confirmatory samples taken at this location, as well as, the approximate location where elevated levels of lead contaminated soils were left in place.

Response: This information is provided on Figure 2-6.

7. ***Section 2.4.1, Valve Chamber Excavation***
   Page 2-9, 6 th Paragraph

"It was recognized that a removal action goal for the site had not been determined..."

Please be advised that at the time of the construction of the valve chamber the remedial action goal had been established at 150 ppm. The Navy was actively removing all soils which exceeded this standard. Therefore, please remove the above statement from this section of the report.

Response: The statement will be struck.

8. ***Section 2.4.1, Valve Chamber Excavation***
Page 2-9, 6 th Paragraph

This section of the report indicates that per RIDEM requests soils was placed south of the valve building in order to facilitate its removal in the future. Please be advised that prior to the construction of the valve building sampling results revealed that soils exceeded RIDEM standards. Unfortunately, the roll off which the Navy was placing contaminated soils in had already been taken off site. Accordingly, the Navy, without consulting RIDEM, elected to place the contaminated soils south of the valve building (RIDEM was informed of the Navy's action after the Navy had placed the soils in the aforementioned location). Subsequent to the Navy's action RIDEM allowed these soils to remain in place with the understanding that they would be addressed by a RIDEM approved remedial action at a later date, such as removal, cap, etc. Please modify the report accordingly.

Response: The comment is noted. The text is correct as written.

9. ***Section 2.4.1, Valve Chamber Excavation***
Page 2-10, 1 st Paragraph

The report notes that the elevated levels of lead observed next to the fence are from road run off. Please remove this statement and any other similar statements from this section and other sections of the report.

Response: The report states that the pattern indicates that the lead in these locations is likely to be a result of traffic along the road. This is a correct statement, based on the data available.

10. ***Section 2.4.2, Demolition of Water Tower***
Page 2-10, 2 nd Paragraph

"Demolition of Tower was conducted in August of 2006."

Please change 2006 to 2007.

Response: The tower was actually demolished in August 2006. The soil removal was conducted in July and completed in August 2007. The text is correct as stated.

11. ***Section 2.4.3, Soil Excavation***
Page 2-10, Whole Section

Soils at and in the vicinity of the present day valve building was removed as part of this effort. Please include a discussion of this removal and the approximate yards taken off site.

Response: This information is not pertinent to the SASE. Dimensions as known to the Navy are provided on Figure 2-6.

12. ***Section 4.1, Evaluation of Lead Concentrations and Human Health,***
Page 4-1.

Please be advised that all of the locations where elevated levels of lead were observed, including those taken adjacent to the fence and those collected by RIDEM must be included in this assessment. Please revise accordingly.

Response: The text is correct as stated. The East Area is evaluated as one of the five separate areas within Section 4 of the report.

13. ***Section 4.1, Evaluation of Lead Concentrations and Human Health, Page 4-1.***

Please include a figure demarcating the sampling locations which were used in the lead evaluation.

Response: Figure 4-1 presents this information. The text in Section 4-1 will be revised to reference this figure.

14. ***Section 4.2, Evaluation of Arsenic Page 4-5.***

The report proposes using soil types SE and NE in the assessment. Please be advised that in order to use these soils types the following information must be included in the report: A US Soil Survey map depicting the soil types in the immediate vicinity of the water tower. A map depicting the location of the soil types which were used in comparison.

Response: This information will be provided in Appendix G. Please refer to Attachment C of this response summary.

15. ***Section 5.2, Presence of Arsenic Page 5-3.***

"The distribution of samples at the site with elevated arsenic concentrations suggest no pattern associated with the water tower as does the lead concentrations."

The arsenic distribution was similar to the lead distribution with the highest concentrations being found in and adjacent to the water tower. Therefore please modify the above as follows:

The distribution of samples at the site with elevated arsenic concentrations suggest a pattern associated with the water tower similar to the lead concentrations.

Response: The comment is actually referring to Section 5.3. This test has been revised as presented in Attachment D of this response summary.

16. ***Section 5.2, Presence of Arsenic Page 5-3.***

Please include a statement noting that prior to the removal action one soil sample had a arsenic concentration of 1311 ppm.

Response: This information is best suited for the background section (Section 2 of the report) where that data is discussed. This information will be included in Section 2, and as described in the response to comment no. 3.

17. ***Section 5.2, Presence of Arsenic Page 5-3.***

"Analysis of the paint chip samples shows that arsenic was not a primary ingredient of the paint on the tower suggesting that arsenic was not associated with the paint."

Arsenic was typically used in paint as a pigment, anti fouling agent, fungicide, etc. Elevated levels of arsenic was found in two paint chips samples. Therefore, please remove this statement from the report.

Response: The comment is actually referring to Section 5.3. This test has been revised as presented in Attachment D of this response summary.

18. ***Section 5.2, Presence of Arsenic***
Page 5-3.

"Overall soil concentrations are within the range of background concentrations'"

A report states in Appendix G that the following areas A, B and C are elevated with respect to background; Areas D is not elevated with respect to background. Therefore, please removed the quoted statement and simply state that Areas A, B and C are elevated with respect to background and Area D is not.

Response: This section will be revised. Please refer to Attachment C.

19. ***Section 5.2, Presence of Arsenic***
Page 5-3.

The report does not recommend any further action with respect to arsenic. The site has been used by the school as a playground. Evidence of a release of arsenic was found during the initial investigations. The current concentrations observed at the site are elevated with respect to regulatory limits. A review of the background study reveals that, at a minimum, site samples in Areas A, B and C are elevated with respect to background. In light of the above the report should recommend further action under CERCLA.

Response: The preponderance of evidence indicates that the arsenic present at the site is not a result of the releases associated with paint from the tower. This section will be revised as presented in Attachment D of this response summary.

20. ***Appendix G,***
Page 1.

Please include a figure depicting current arsenic distribution at the site.

Response: Arsenic evaluations have been revised as presented in Attachments C and D of this response summary. Plot maps of arsenic are nto required due to the scope of these revisions.

21. ***Appendix G,***
Page 1.

Background studies are site specific. As such they must contain all of the information associated with the background sampling stations including a map depicting the locations of the stations, a table listing the concentrations observed in the background stations and descriptive statistics for the background stations. As this is a stand alone document this information must be included in the Appendix (a reference to a previous study is not sufficient).

Response: The background study is specific to soil types, as recommended by EPA guidance and in accordance with previous versions of RIDEM regulations. Site-specific studies are not used at Newport because of the scarcity of non-altered soils. The descriptive statistics for the applicable soil types used in the evaluation will be included in Appendix G. Please refer to Attachment C of this response summary.

22. ***Appendix G, Section 4-1, Exploratory Data Evaluation Page 3.***

The report notes that outliers were present in the SeSS data set. As noted in previous correspondence these points cannot be used in a background evaluation. Therefore, please conduct the assessment without the use of these outliers.

Response: Candidate outliers were identified and considered, but allowed to remain, as stated in the document. The document is correct as stated and will not be revised.

23. ***Appendix G, Section 4-1, Exploratory Data Evaluation Page 3, Paragraph 3.***

Distribution analysis was conducted to ascertain the distribution of the site data set. Please include the results of the same distribution test for the background data sets.

Response: This information is provided in Table 2 of Appendix G of the Draft SASE report.

24. ***Appendix G, Section 4-2, Statistical Methods Page 3.***

Please include descriptive statistics, (range, average, medium, mode, kutortosis, etc) and list data in ascending concentrations for both the site and background samples.

Response: Appendix G will be revised to include the information requested, please refer to Attachment C of this response summary.

25. ***Appendix G, Section 4-2, Statistical Methods Page 3.***

The report list a series of test, Student t test, Mann Whittney test, etc. As this is a public document the report should indicate which tests are parametric and which test are non parametric.

Response: The requested information is provided in the revised Appendix G, presented as Attachment C of this response summary.

26. ***Appendix G, Section 4-2, Statistical Methods Page 3.***

Please provide additional information concerning the upper ranks test, including but not limited to a literature citation for the test employed, the equations used in the test and an example calculation

Response: The requested information is provided in the revised Appendix G, presented as Attachment C of this response summary.

ATTACHMENT C

DRAFT REVISION: APPENDIX G TO THE SASE REPORT
ASSESSMENT OF ARSENIC CONCENTRATIONS IN SOIL
POST REMOVAL SAMPLE EVALUATIONS
FORMER NAVY WATER TOWER SITE
PORTSMOUTH RHODE ISLAND

1.0 INTRODUCTION

This assessment has been prepared by Tetra Tech NUS (TtNUS) under Contract Task Order CTO 405 issued by the Naval Facilities Engineering Command under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract number N62472-03-D-0057.

The assessment evaluates remaining soil arsenic concentrations, relative to background levels, after the remedial action that was conducted at the Former Melville Water Tower Site on Naval Station Newport (NAVSTA), Newport, Rhode Island. The background soils data used for this comparison were obtained from the results of the base-wide background study of NAVSTA Newport soils[1] . At NAVSTA Newport, studies of background soil have shown that elevated arsenic levels are associated with certain soil types and bedrock geology in the areas surrounding the base. The assessment was conducted in accordance with the Guidance for Environmental Background Analysis, NFEC, 2002[2]

2.0 FIELD AND SAMPLING ACTIVITIES

2.1 Soil Investigation

During the timeframe of July 25, 2007 to August 7, 2007, soil samples were collected at the Water Tower Site to verify the adequacy of excavation and removal actions. As shown in Figure 1, all removal verification samples were located along a rectangular sampling grid established across the remediation area. Concentrations of arsenic, cadmium, chromium, and lead were investigated by sampling within the post-removal areas, including excavation sidewalls and floor samples. The analytical data from these areas, combined with results from unexcavated areas within the grid zone, together comprise a total of 355 locations. Seventeen (17) field duplicate samples were included in this data set.

All samples were collected using new disposable plastic trowels at each sampling point to avoid cross contamination between samples. Following sample collection, samples were packaged

and shipped to an offsite laboratory for analysis for arsenic, cadmium, chromium, and lead by EPA method SW-846 6010B.

3.0 DATA EVALUATION

3.1 Post-Excavation Sample Data Set

The post-remediation analytical data were divided into four groups, Areas A through D, for statistical evaluation. Data from Areas A and B represent soil left behind after excavation conducted to a depth of up to 2 feet. Area C data represent soil left behind after excavation was conducted to a depth of 3 feet. Area D data represent soil left after removal of the surface six inches of soil was performed, west of Areas A, B, and C. Laboratory analyses were performed for arsenic, lead, cadmium, and chromium at the request of EPA. The complete set of analytical results for post-excavation soil sampling is presented in Table 1.

3.2 Background Soil Data Set

The Base-Wide Background Study Report (TtNUS, 2008) identified seven US Department of Agriculture (USDA) soil types that are found at or near NAVSTA Newport sites. The two soil types evaluated in this comparison are Stissing silt-loam (Se) and Newport silt-loam (Ne) [(3)]. Both soil types were compared with the site data for the following reasons:

1. Soil at the water tower location is identified as "udorthents" (UD) by USGS. UD soils are soils that are altered and reworked during construction of local features. UD is characterized differently from "urban fill" (UR) because UD soil contains mostly original material that has been cut and filled, whereas UR soil contains mostly fill.
2. Se soils abut the site to the west, and Ne soils abut the site to east and south. Se soil to the west also abuts a small reservoir constructed by the Navy at the same time as the water tower. Based on this observation, it appears that the soil excavated to construct this reservoir may have well been Se soils, and those soils may have been used to level the area of the Melville School and the water tower site.

Based on the soil types present around the site, it is presumed that the UD soils under the water tower are likely to be made up of either one or a mixture of both of Se and Ne soil types, along with observed fractured phyllite/schist, leveled and compacted to form a stable ground surface.

Since the original soil types present in this area before disturbance occurred were not categorized, it was decided that the most appropriate comparison would be to the background soil types cited above which are found in areas adjacent to the Former Water Tower. Background data sets for these soil types were subdivided into surface soil (SS) and subsurface soil (SB). Thus the background data sets have been designated with the abbreviations, NeSS, SeSS, NeSB, and SeSB.

4.0 STATISTICAL DATA EVALUATION

4.1 Exploratory Data Evaluation

As part of the Base-Wide Background Study report (TtNUS, 2008), an exploratory data analysis was performed on the background data to evaluate the distributional shape, check for outliers, and compare descriptive statistics. The Base-wide background study evaluated found both qualitative and quantitative differences in arsenic concentrations between various soil types, and differences in the shape of the population distributions (normal, lognormal, or nonparametric). It was noted that candidate outliers were found in the SeSS background data set, but after a careful assessment, no scientific or judgmental reasons could be identified to justify eliminating two data points that may actually represent the upper range of observed natural variation in background soil.

The arsenic soil concentrations in Areas A through D were plotted side-by-side for a qualitative comparison with background data for soil types NeSS, NeSB, SeSS, and SeSB. Figure 2 presents a univariate box plot of arsenic concentrations for each site and background data set. The descriptive statistics illustrated on this plot include the interquartile range (IQR), maximum, minimum, and median. Examination of the plot reveals obvious differences in these properties between individual site data sets and background data sets. Surface soils from Area D exhibit an IQR that is generally less than the IQR displayed by the background surface soil types NeSS and SeSS. Subsurface soils from Area C exhibit an IQR that is intermediate between the IQRs displayed by the two background subsurface soil types – greater than the IQR of NeSB but less than the IQR of SeSB. Arsenic concentrations from Area A display a median similar to that of the background soil type SeSS, but exhibit an IQR that spans a wider range than any of the background IQRs for surface soils. Area B soil concentrations exhibit an IQR that is very similar to the IQR for background soil type NeSS, but somewhat less than the IQR for the background soil type SeSS.

Distributional analysis tests were also performed on the four background data sets and the four site data sets in order to establish whether any of these data sets match a normal or lognormal shape. Results of the background data distributional analysis are presented in Table 2, and the site data distributional analysis in Table 3.

4.2 Statistical Methods

The Base-Wide Background Study identified two types of statistical methods that may be utilized in accordance with Navy guidance (Navy, 2002) to evaluate whether site data are above background, either a two sample hypothesis test or a geochemical prediction method. At the Former Melville Water Tower Site, analytical results are not available for the mineral components that would be used to evaluate the geochemical correlation with arsenic in site-related samples. Therefore, site data were compared to background data using two sample hypothesis tests which start with an assumption (null hypothesis) that site concentrations are indistinguishable from background (belong to the same population distribution as background). These tests determine if the null hypothesis can be rejected, which would indicate that site concentrations are greater than background. Since the site data is being compared to multiple background soil data groups, the null hypothesis would have to be rejected for all comparisons to arrive at a conclusive determination that the site condition is above background.

Multiple tests were performed, including the t-test (parametric), which looks for differences in the means of site and background data; the Mann Whitney test (non-parametric), which looks for which looks for differences between the site and background rank sums; and the upper ranks or quantile test (parametric), which looks at the rank sums that constitute only the highest range of concentrations found in site and background data sets.

A detailed description of the upper ranks test is provided in Attachment B of this Appendix.

So that any type of statistically elevated concentrations among the site data would not be overlooked, a conservative decision scheme was employed that would designate site concentrations to be greater than the background soil being compared to if any one of the three tests found a significant difference for that soil data set.

4.3 Statistical Tests To Compare Within Background Soil Types

Background data sets representing the soil types NeSS and SeSS were tested twice – once to

see if arsenic concentrations in NeSS were significantly greater than those in SeSS, and again to see if concentrations in SeSS were greater than those in NeSS. The level of significance was set to 0.025, so that the overall chance of finding differences of either variety would be 0.025 + 0.025 = 0.05. In addition, background data from all depths for soil type Ne were compared to background data from all depths for soil type Se. Table 4 presents the outcome of these tests, which show that significant differences in Arsenic concentrations exist when data are compared between background soil types or between soil depth categories. Therefore, it was concluded that statistical comparisons to site data should be performed separately for each background soil type, since the site data cannot be assumed to be an equal mixture of background soil types.

4.4 Statistical Tests Comparing Water Tower Arsenic Data to Background

The Former Melville Water Tower arsenic data were compared to background using statistical tests with a level of significance set to 0.05. This means that random samples collected from the site data population subjected to a statistical background comparison would not be expected to yield a conclusion that site is greater than background data more than 5 percent of the time if in fact both data sets actually belonged to the same identical underlying population distribution.

Table 5 presents the outcome of statistical comparisons for Area A soils versus background. As stated earlier, since soils at the Water Tower site are classified as Udorthents (soil disturbed by cutting and filling), Area A soil could be comprised of a combination of soil types Ne and Se. Therefore, statistical tests were performed against each individual background soil type that might be present. The results presented in Table 5 indicate that arsenic concentrations in Area A soil are greater than those found in background soil types NeSS and NeSB. However, arsenic concentrations in Area A soil are not greater than arsenic concentrations in background soil type Se.

Table 6 presents the outcome of statistical comparisons for Area B soils versus background. Again, Area B soil could be comprised of a combination of soil types Ne and Se. Therefore, statistical tests were performed against each individual background soil type that might be present. The test results in Table 6 indicate that arsenic concentrations in Area B soil are greater than those found in background soil type NeSB, but they are not greater than arsenic concentrations in background soil types NeSS, SeSS and SeSB.

Since all samples from Area C represent subsurface soil, statistical tests were performed using only background subsurface soils (SeSB, and NeSB). The test results in Table 7 indicate that arsenic concentrations in Area C soil are greater than those found in background soil type NeSB,

but they are not greater than arsenic concentrations in background soil type SeSB .

Since all samples of Area D represent surface soil, statistical tests were performed using only background surface soils. The test results in Table 8 indicate that Area D soils are not considered to be elevated relative to either background soil type (NeSS or SeSS).

5.0 SUMMARY AND CONCLUSIONS

Soil samples were collected after removal actions from Areas A, B, C, and D at the Former Melville Water Tower Site. Two soil types, Ne and Se, represent the predominant soil types occurring in the vicinity of the site. However, the exact composition of Water Tower site soils is not known because soils have been disturbed by past cutting and filling.

Recent removal actions at the site excavated soils containing concentrations of several metals that are of regulatory concern. Since the regulatory levels of concern for arsenic in soil are in some cases very close to or below naturally occurring background concentrations of some soil near the site, a statistical comparison of the post-excavation sample analytical data was performed to determine if the concentrations of arsenic remaining in soils at the site exceed background levels. Several comparison were performed against each of the site soil data sets in order to determine whether residual concentrations are greater than those of any of the possible soil types naturally present – NeSS, NeSB, SeSS, or SeSB.

The statistical testing shows that a) arsenic concentrations in all the post excavation site soils (Areas A, B, C, and D) are not greater than those in the Se background soil data set, but are similar to the concentrations that would be expected in surface and subsurface soils of this type; and b), the post excavation site soils in Areas A, B and C do have arsenic concentrations greater than the Ne background data set. To simplify, the site arsenic concentrations are within expected ranges of the Se background soil, but they are higher than the Ne background soil.

Given that arsenic in the background Se soil is higher than the background Ne soil, it has to be accepted that if there are appreciable amounts of Se soils present at the site, the site soil would have to have arsenic concentrations greater than those in the Ne background soil. Unless there are no Se soils present at the site, the arsenic concentrations in the site data set could not be as low as that measured in the Ne background data set.

To conclude, metals content of the post excavation samples collected are a result of both soil types likely present at the site, and arsenic concentrations greater than RIDEM criteria are likely a

result of the presence of the Se soil type, in which similarly elevated arsenic concentrations have been measured.

6.0 REFERENCES

[1] Tetra Tech NUS, Inc. (TtNUS), 2008. Basewide Background Study Report for Naval Station Newport, Newport, Rhode Island. Contract No. N62467-04-D-0055. Contract Task Order 402. July.

[2] Naval Facilities Engineering Command (NFEC). 2002. Guidance for Environmental Background Analysis. Volume I: Soil. Washington, D.C. NFESC UG-2049-ENV. April.

(3) Soil survey of Rhode Island. US Department of Agriculture, Soil Conservation Service. July 1981.

APPENDIX G, ATTACHMENT B
Summary of the Upper Ranks Test

The Quantile test

The quantile test or upper ranks test (EPA, 1992, 2006, NFEC, 2002) is a type of hot spot test. This test combines two subgroups of data (for example site and background) into one set and determines whether an upper rank subset displays an unusually large proportion of data points belonging to one subgroup rather than a mixture of samples from the two groups in the expected proportion equal to the ratio of number of samples between the parent data groups. In this procedure, the probability is calculated that k or more samples from the largest r data points in the combined data set belong to one subgroup, with the null hypothesis that the two subgroups come from the same population. If calculations show there is less than a five percent chance that k or more samples could be observed among a randomly selected subset of the r largest upper ranks of the data, then the test concludes that the k largest ranked samples from one subgroup exhibit statistically elevated concentrations, which might indicate one or more hot spots.

Procedure for conducting the Quantile test

To conduct the quantile test, the site and background data sets (with n and m samples, respectively), are first combined together and arranged in the order of decreasing concentrations. The quantile test can be performed in one of two ways. One way is to refer to look-up tables (NFEC, 2002) of critical values for r and k that result in a probability very close to the level of significance desired for the test (for example, an alpha of 0.05 for comparing site versus background). Alternatively, the quantile test can be performed with an exact computation of the probability that k or more samples out of the largest r data points in the combined data set of m + n background and site samples belong to the site data group. Combinatorial probabilities are determined using the hypergeometric distribution as follows:

$$\alpha = \frac{\sum_{i=k}^{r} \binom{m+n-r}{n-i}\binom{r}{i}}{\binom{m+n}{n}}$$

The choice of what size subset of the data set is selected to examine the upper ranks of the data is somewhat arbitrary, since the probability of a particular observed outcome can be calculated for any given size subgroup that contains the r largest data points of the combined data set of m + n background plus site samples. For example, the test could be set up to only look at the top 10 percent of concentrations, or the top 20 percent, etc. Since computer programs can perform multiple simulations rapidly, a sequence of test analyses can be performed that looks all possible

ranked subsets of the combined data set. The sequence starts by examining only the 2 largest data points in the combined data set and calculates the probability, α_2, of an outcome where the actual number of site samples, k_2, that occur among this subset is equal to k_2 or greater. The procedure is then repeated for the next larger subset of the combined data set which contains only the 3 largest ranked samples, and again for the subset consisting of the 4 largest ranked samples, etc. The sequence is halted when the first non-detected result is encountered, since it is not known whether the true environmental concentration of any non-detected result is associated with a rank smaller or larger than that of other non-detects or other positive values less than the largest non-detect in the data set. Practically speaking, the upper ranks fraction of the combined data set does not need to approach 100 percent, since in that situation the Mann-Whitney rank sum test of the entire data set would be more easily performed.

When all simulations are complete, the figure of merit most useful to the project investigation is reported in a table, which may be either the data subset size having the most significant (smallest) alpha or the largest subset (the greatest number of upper ranked site samples) that still generates an alpha less than the desired level of significance (such as 0.05). The former situation identifies the most unusual site data subset that has the lowest probability of belonging to the same population as background, while the latter corresponds to the largest number of site samples that can be considered to be unlikely to all belong to the same underlying population distribution as background.

Example calculations for the quantile test using look-up tables can be found in the cited references (EPA, 2002, 2006 and NFEC, 2002). An example of the method of calculation using the exact computation of probabilities is given below.

In Table 5 of the Newport Water Tower Site background comparison letter report, the arsenic sample results from Area A (28 samples) were compared to background subsurface soil samples associated with the soil type Stissing Silt Loam (15 samples). The reported results of the quantile test for this example were as follows:

When the combined data set consisting of 28 Water Tower Site samples plus 15 background samples was examined, the 21 largest ranked sample concentrations included 12 Water Tower Site samples within this subset of data. The probability of finding at least 12 site samples among the 21 largest samples selected from the combined data set was calculated to be 0.9184. Therefore, the null hypothesis was not rejected and it cannot be concluded that the right tail of the site data distribution contains higher ranked concentrations than would be expected based on the background data set.

The Newport Water Tower Site arsenic data demonstrate the following ordered sample concentrations compared to background Stissing Silt Loam subsurface soil data:

Background Concentrations	Site Rank (k)	Site Concentrations	Overall Rank (r)
32.2			1
25			2
24.6			3
	1	24	4
23.6			5
23.3			6
	2	23	7
22.65			8
	3	22	9
	4	21	10
20.9			11
20.5			12
	5	20	13
	6	19	14
	7	18	15
	8	16	16
15.4			17
	9	13	18
	10	12.5	19
	11	12	20
	12	12	**21**
10.4			
10.1			
		10	
		9.7	
9.5			
		9.2	
		7.9	
		7.3	
		7.3	
		7.1	
		6.7	
		5.7	
5.2			
		5.1	
		4.8	
4.5		4.5	
4.4			
		3.9	
		3.9	
		3.7	
		3.6	

If the Water Tower Site arsenic data belong to the same underlying population as background, then the probability, alpha, that 12 or more site samples would occur amongst the largest 21 samples selected from the combined data set of 28 site samples and 15 background samples can be calculated as follows:

$$\alpha = \frac{\sum_{i=12}^{21} \binom{15+28-21}{28-i}\binom{21}{i}}{\binom{15+28}{28}} = \frac{\sum_{i=12}^{21} \binom{22}{28-i}\binom{21}{i}}{\binom{43}{28}}$$

$$= \frac{\sum_{i=12}^{21} \left(\frac{22!}{(28-i)!\,(i-6)!}\right)\left(\frac{21!}{(i!)(21-i)!}\right)}{\left(\frac{43!}{(28!)(15)!}\right)} = 0.9184$$

The computation of factorials in this instance was performed by computer programs. However, the same conclusion (the upper ranks of site concentrations are not greater than the upper ranks of background) can be achieved by looking at the following table, with m = 15, n = 28, and noting that 7 site samples would have to be observed out of the largest 7 samples in the combined data set in order to reject the null hypothesis. Since only 2 Water Tower Site samples were found within the subset defined as the 7 largest ranked samples from the combined data set, the probability of finding this many site samples or more among the 7 largest samples is greater than 0.05.

TABLE C-6. Values of *r*, *k*, and α for the Quantile test when α is approximately equal to 0.05

Number of Site Measurements, n

Number of Reference (Background) Measurements, m	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
5	r, k α		8,8 0.051	10,10 0.057	13,13 0.043	15,15 0.048	17,17 0.051	19,19 0.054	21,21 0.056											
10		4,4 0.043	5,5 0.057	14,12 0.045	8,8 0.046	9,9 0.052	10,10 0.058	12,12 0.046	13,13 0.050	14,14 0.054	15,15 0.057	17,17 0.049	18,18 0.052	19,19 0.055	20,20 0.057	21,21 0.059	23,23 0.053			
15	2,2 0.053	3,3 0.052	4,4 0.050	5,5 0.048	6,6 0.046	7,7 0.045	8,8 0.044	9,9 0.043	9,9 0.060	10,10 0.057	11,11 0.055	12,12 0.054	13,13 0.052	14,14 0.051	15,15 0.050	16,16 0.049	16,16 0.058	17,17 0.057	18,18 0.056	19,19 0.055
20	9,4 0.040	8,5 0.056	6,5 0.040	4,4 0.053	5,5 0.043	9,8 0.052	6,6 0.056	7,7 0.048	8,8 0.043	8,8 0.057	9,9 0.051	10,10 0.046	10,10 0.057	11,11 0.052	12,12 0.048	12,12 0.057	13,13 0.053	14,14 0.049	14,14 0.057	15,15 0.054
25	6,3 0.041	6,4 0.043	3,3 0.046	6,5 0.052	4,4 0.055	5,5 0.041	5,5 0.059	6,6 0.046	11,10 0.042	7,7 0.050	8,8 0.042	8,8 0.053	9,9 0.045	9,9 0.055	10,10 0.048	11,11 0.042	11,11 0.050	11,11 0.058	12,12 0.052	12,12 0.060
30	3,2 0.047	2,2 0.058	10,6 0.052	3,3 0.058	11,8 0.045	4,4 0.056	8,7 0.045	5,5 0.054	6,6 0.040	6,6 0.053	7,7 0.041	7,7 0.052	8,8 0.042	8,8 0.051	9,9 0.042	9,9 0.050	9,9 0.059	10,10 0.049	10,10 0.057	11,11 0.049
35	8,3 0.046	2,2 0.045	6,4 0.058	3,3 0.043	6,5 0.041	4,4 0.040	4,4 0.057	8,7 0.043	5,5 0.051	9,8 0.052	6,6 0.047	6,6 0.058	7,7 0.043	7,7 0.053	8,8 0.041	8,8 0.049	8,8 0.057	9,9 0.046	9,9 0.053	10,10 0.044
40	4,2 0.055	5,3 0.048	4,3 0.057	10,6 0.059	3,3 0.053	6,5 0.048	4,4 0.043	4,4 0.058	8,7 0.042	5,5 0.048	9,8 0.047	6,6 0.042	6,6 0.051	11,10 0.042	7,7 0.045	7,7 0.053	8,8 0.041	8,8 0.048	8,8 0.055	9,9 0.043
45	4,2 0.045	9,4 0.047	2,2 0.059	8,5 0.052	3,3 0.042	8,6 0.041	6,5 0.054	4,4 0.045	4,4 0.058	8,7 0.041	5,5 0.046	5,5 0.057	9,8 0.056	6,6 0.047	6,6 0.055	11,10 0.046	7,7 0.047	7,7 0.054	8,8 0.041	8,8 0.047
50		6,3 0.052	2,2 0.050	6,4 0.051	12,7 0.050	3,3 0.049	8,6 0.049	6,5 0.059	4,4 0.047	4,4 0.059	8,7 0.041	5,5 0.045	5,5 0.054	9,8 0.051	6,6 0.043	6,6 0.050	6,6 0.058	7,7 0.042	7,7 0.048	7,7 0.054
55		3,2 0.059	2,2 0.043	4,3 0.056	8,5 0.058	3,3 0.041	5,4 0.041	6,5 0.046	9,7 0.042	4,4 0.048	4,4 0.059	8,7 0.040	5,5 0.043	5,5 0.052	9,8 0.048	6,6 0.040	6,6 0.047	6,6 0.054	11,10 0.043	7,7 0.043
60		3,2 0.052	5,3 0.052	4,3 0.046	6,4 0.059	3,3 0.035	3,3 0.047	8,6 0.043	6,5 0.051	9,7 0.046	4,4 0.049	4,4 0.059	13,10 0.052	5,5 0.042	5,5 0.050	5,5 0.058	9,8 0.054	6,6 0.044	6,6 0.050	6,6 0.056
65		3,2 0.045	5,3 0.043	2,2 0.053	6,4 0.048	10,6 0.050	3,3 0.040	3,3 0.053	6,5 0.041	6,5 0.055	4,4 0.042	4,4 0.050	4,4 0.060	13,10 0.052	5,5 0.041	5,5 0.048	5,5 0.055	9,8 0.051	6,6 0.041	6,6 0.047
70		8,3 0.057	9,4 0.048	2,2 0.047	4,3 0.055	8,5 0.050	5,4 0.041	3,3 0.046	3,3 0.057	6,5 0.045	6,5 0.058	4,4 0.043	4,4 0.051	4,4 0.060	13,10 0.051	5,5 0.041	5,5 0.047	5,5 0.054	9,8 0.048	9,8 0.057
75		8,3 0.049	6,3 0.056	2,2 0.043	4,3 0.047	6,4 0.054	10,6 0.053	3,3 0.040	3,3 0.051	8,6 0.044	6,5 0.049	9,7 0.041	4,4 0.044	4,4 0.052	5,5 0.060	13,10 0.051	8,7 0.047	5,5 0.046	5,5 0.052	5,5 0.058
80		4,2 0.059	6,3 0.048	5,3 0.053	2,2 0.055	6,4 0.046	8,5 0.055	5,4 0.042	3,3 0.045	3,3 0.055	6,5 0.041	6,5 0.052	9,7 0.043	4,4 0.045	4,4 0.053	7,6 0.058	13,10 0.051	8,7 0.046	5,5 0.045	5,5 0.051
85		4,2 0.054	3,2 0.058	5,3 0.047	2,2 0.050	4,3 0.054	4,3 0.048	10,6 0.056	5,4 0.049	3,3 0.049	3,3 0.059	6,5 0.044	6,5 0.055	9,7 0.046	4,4 0.046	4,4 0.053	7,6 0.059	10,8 0.060	8,7 0.045	5,5 0.044
90			3,2 0.053	5,3 0.041	2,2 0.046	6,4 0.059	6,4 0.051	8,5 0.058	5,4 0.042	3,3 0.044	3,3 0.053	8,6 0.045	6,5 0.047	6,5 0.058	4,4 0.041	4,4 0.047	4,4 0.054	7,6 0.059	10,8 0.060	8,7 0.045
95			3,2 0.048	9,4 0.048	2,2 0.042	2,2 0.056	4,3 0.059	8,5 0.050	10,6 0.058	5,4 0.048	3,3 0.048	3,3 0.056	6,5 0.041	6,5 0.050	9,7 0.040	4,4 0.042	4,4 0.048	4,4 0.054	7,6 0.059	10,8 0.059
100			3,2 0.044	6,3 0.057	5,3 0.054	2,2 0.052	4,3 0.053	6,4 0.056	10,6 0.049	5,4 0.043	3,3 0.043	3,3 0.051	3,3 0.059	6,5 0.044	6,5 0.053	9,7 0.042	4,4 0.043	4,4 0.049	4,4 0.055	7,6 0.059

TABLE C-5. Values of *r*, *k*, and α for the Quantile test when α is approximately equal to 0.025

Number of Site Measurements, n

Number of Reference (Background) Measurements, m	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
5	r, k α		9,9 0.030	12,12 0.024	15,15 0.021	17,17 0.026	20,20 0.024	22,22 0.028	25,25 0.025											
10		7,6 0.029	6,6 0.028	8,8 0.022	9,9 0.029	11,11 0.024	12,12 0.029	14,14 0.025	15,15 0.029	17,17 0.025	18,18 0.029	20,20 0.026	21,21 0.029	23,23 0.026	24,24 0.029	26,26 0.026	27,27 0.029			
15	11,5 0.030	6,5 0.023	5,5 0.021	6,6 0.024	7,7 0.026	8,8 0.027	9,9 0.028	10,10 0.029	11,11 0.030	13,13 0.022	14,14 0.023	15,15 0.023	16,16 0.024	17,17 0.025	18,18 0.025	19,19 0.026	21,21 0.021	21,21 0.027	22,22 0.027	23,23 0.027
20	8,4 0.023	3,3 0.030	4,4 0.026	5,5 0.024	6,6 0.022	7,7 0.020	12,11 0.021	13,12 0.024	9,9 0.028	10,10 0.026	11,11 0.024	12,12 0.023	13,13 0.022	13,13 0.029	14,14 0.027	15,15 0.026	16,16 0.025	17,17 0.024	17,17 0.029	18,18 0.028
25	2,2 0.023	8,5 0.027	6,5 0.021	7,6 0.023	5,5 0.025	6,6 0.020	10,9 0.026	7,7 0.027	8,8 0.023	13,12 0.027	9,9 0.027	10,10 0.024	11,11 0.022	11,11 0.028	12,12 0.025	13,13 0.023	13,13 0.028	14,14 0.025	15,15 0.023	15,15 0.028
30	6,3 0.026	6,4 0.026	9,6 0.026	4,4 0.021	7,6 0.029	5,5 0.026	9,8 0.024	6,6 0.029	7,7 0.023	12,11 0.021	8,8 0.025	9,9 0.021	9,9 0.027	10,10 0.023	10,10 0.029	11,11 0.025	11,11 0.030	12,12 0.026	13,13 0.023	13,13 0.027
35	7,3 0.030	4,3 0.030	3,3 0.023	6,5 0.020	4,4 0.026	10,8 0.022	5,5 0.027	9,8 0.024	6,6 0.027	7,7 0.020	7,7 0.027	8,8 0.021	8,8 0.027	9,9 0.022	9,9 0.027	10,10 0.022	10,10 0.027	11,11 0.022	11,11 0.027	12,12 0.023
40	3,2 0.029	4,3 0.022	8,5 0.028	11,7 0.025	6,5 0.028	4,4 0.030	10,8 0.026	5,5 0.027	9,8 0.023	6,6 0.026	10,9 0.028	7,7 0.024	12,11 0.020	8,8 0.023	8,8 0.029	9,9 0.022	9,9 0.027	10,10 0.021	10,10 0.026	11,11 0.021
45	3,2 0.023	8,4 0.029	6,4 0.030	3,3 0.026	8,6 0.021	4,4 0.023	7,6 0.025	5,5 0.020	5,5 0.028	9,8 0.023	6,6 0.024	10,9 0.026	7,7 0.022	7,7 0.027	8,8 0.020	8,8 0.025	8,8 0.030	9,9 0.023	9,9 0.027	10,10 0.021
50		2,2 0.025	6,4 0.022	3,3 0.021	11,7 0.027	6,5 0.026	4,4 0.026	7,6 0.028	5,5 0.021	5,5 0.028	9,8 0.022	6,6 0.023	6,6 0.029	7,7 0.020	7,7 0.025	12,11 0.020	8,8 0.022	8,8 0.026	13,12 0.027	9,9 0.023
55		2,2 0.022	4,3 0.029	8,5 0.028	3,3 0.028	8,6 0.021	4,4 0.020	4,4 0.029	10,8 0.021	5,5 0.022	5,5 0.028	9,8 0.022	6,6 0.023	6,6 0.028	10,9 0.029	7,7 0.023	7,7 0.027	12,11 0.023	8,8 0.023	8,8 0.027
60		14,5 0.022	4,3 0.024	8,5 0.021	3,3 0.023	11,7 0.029	6,5 0.024	4,4 0.023	7,6 0.023	10,8 0.024	5,5 0.023	5,5 0.029	9,8 0.022	6,6 0.022	6,6 0.027	10,9 0.027	7,7 0.021	7,7 0.025	7,7 0.030	8,8 0.021
65		6,3 0.028	7,4 0.021	6,4 0.025	10,6 0.025	3,3 0.029	8,6 0.021	6,5 0.029	4,4 0.026	7,6 0.026	10,8 0.026	5,5 0.023	5,5 0.029	9,8 0.022	6,6 0.021	6,6 0.026	10,9 0.026	7,7 0.020	7,7 0.024	7,7 0.028
70		6,3 0.024	2,2 0.029	6,4 0.021	8,5 0.028	3,3 0.025	13,8 0.026	6,5 0.023	4,4 0.022	4,4 0.028	7,6 0.028	10,8 0.027	5,5 0.024	5,5 0.029	9,8 0.022	6,6 0.021	6,6 0.025	6,6 0.029	10,9 0.030	7,7 0.022
75		11,4 0.022	2,2 0.026	4,3 0.028	8,5 0.022	3,3 0.022	9,6 0.028	8,6 0.021	6,5 0.027	4,4 0.024	7,6 0.023	7,6 0.030	10,8 0.029	5,5 0.024	5,5 0.029	9,8 0.021	6,6 0.021	6,6 0.024	6,6 0.028	10,9 0.028
80		7,3 0.028	2,2 0.024	4,3 0.024	6,4 0.028	10,6 0.024	3,3 0.027	13,8 0.027	6,5 0.023	4,4 0.020	4,4 0.026	7,6 0.024	10,8 0.023	5,5 0.020	5,5 0.025	5,5 0.029	9,8 0.021	6,6 0.020	6,6 0.024	6,6 0.027
85		3,2 0.029	2,2 0.021	4,3 0.021	6,4 0.023	8,5 0.028	3,3 0.023	9,6 0.030	8,6 0.020	6,5 0.026	4,4 0.022	4,4 0.028	7,6 0.026	10,8 0.024	5,5 0.021	5,5 0.025	5,5 0.029	9,8 0.021	6,6 0.020	6,6 0.023
90			5,3 0.020	11,5 0.027	9,5 0.023	8,5 0.023	3,3 0.021	3,3 0.028	13,8 0.028	6,5 0.022	6,5 0.029	4,4 0.024	4,4 0.029	7,6 0.028	10,8 0.026	5,5 0.022	5,5 0.025	5,5 0.030	9,8 0.021	9,8 0.025
95			10,4 0.029	2,2 0.029	4,3 0.028	6,4 0.029	10,6 0.023	3,3 0.025	11,7 0.026	8,6 0.020	6,5 0.025	4,4 0.021	4,4 0.026	7,6 0.024	7,6 0.029	10,8 0.027	5,5 0.022	5,5 0.026	5,5 0.030	9,8 0.021
100			6,3 0.029	2,2 0.027	4,3 0.025	6,4 0.025	8,5 0.028	3,3 0.022	3,3 0.029	13,8 0.028	6,5 0.022	6,5 0.028	4,4 0.023	4,4 0.027	7,6 0.025	10,8 0.022	10,8 0.028	5,5 0.022	5,5 0.026	5,5 0.030

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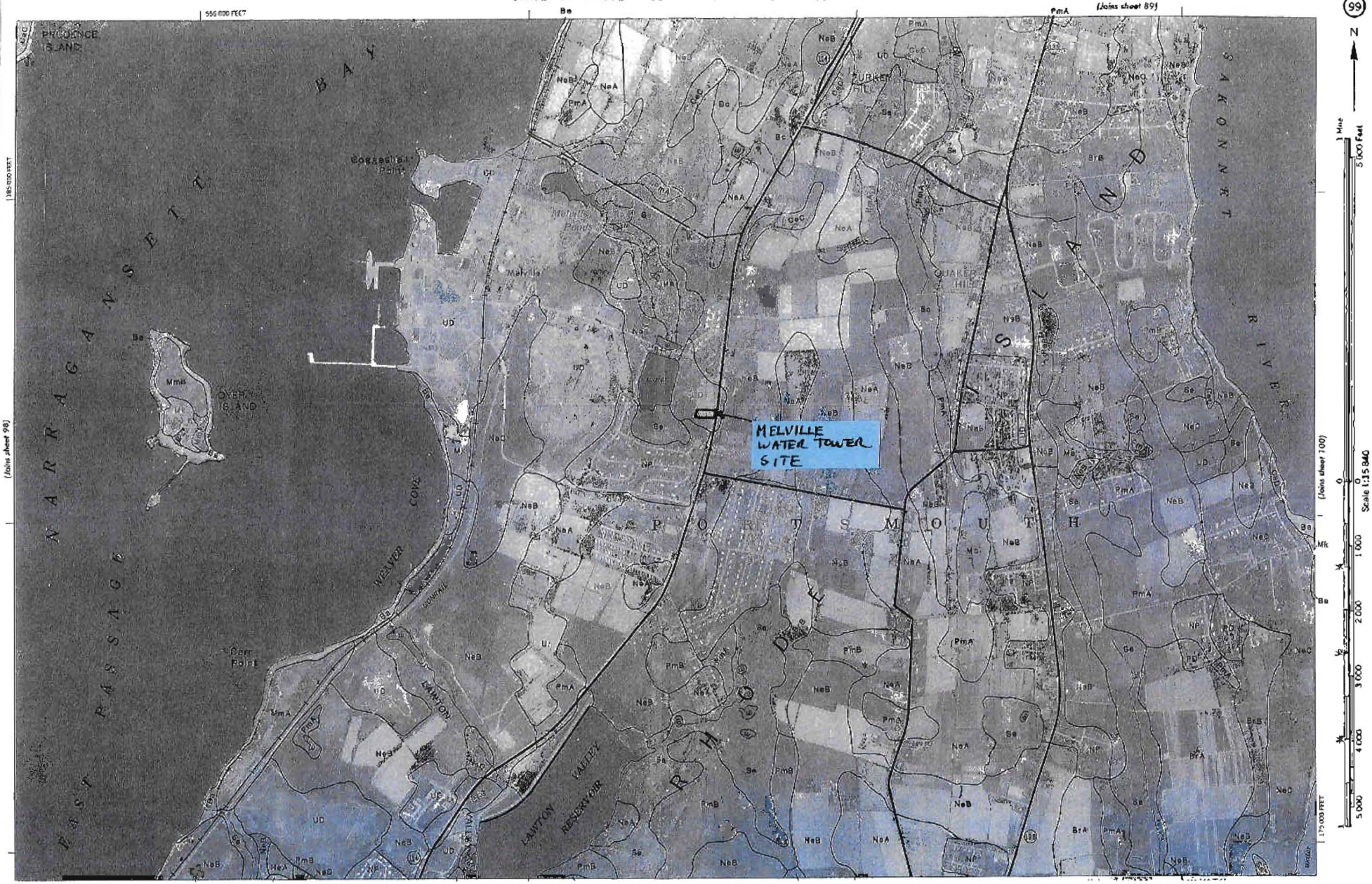
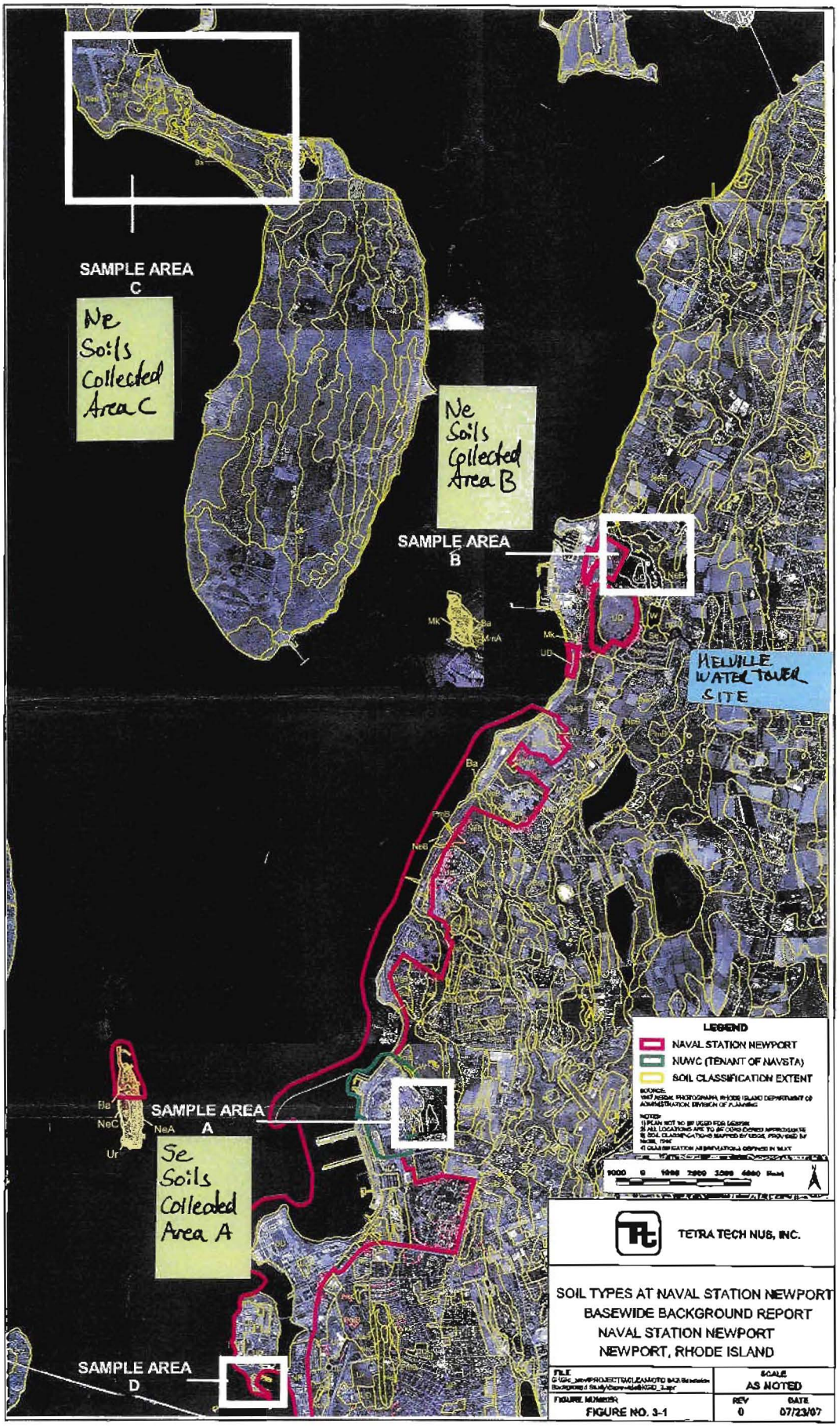
STATE OF RHODE ISLAND — SHEET NUMBER 99




SAMPLE AREA C
Ne Soils Collected Area C
Ne Soils Collected Area B
SAMPLE AREA B
MELVILLE WATER TOWER SITE
SAMPLE AREA A
Se Soils Collected Area A
SAMPLE AREA D
LEGEND
NAVAL STATION NEWPORT
NUWC (TENANT OF NAVSTA)
SOIL CLASSIFICATION EXTENT
TETRA TECH NUS, INC.
SOIL TYPES AT NAVAL STATION NEWPORT
BASEWIDE BACKGROUND REPORT
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND
SCALE
AS NOTED
FIGURE NUMBER
FIGURE NO. 3-1
REV
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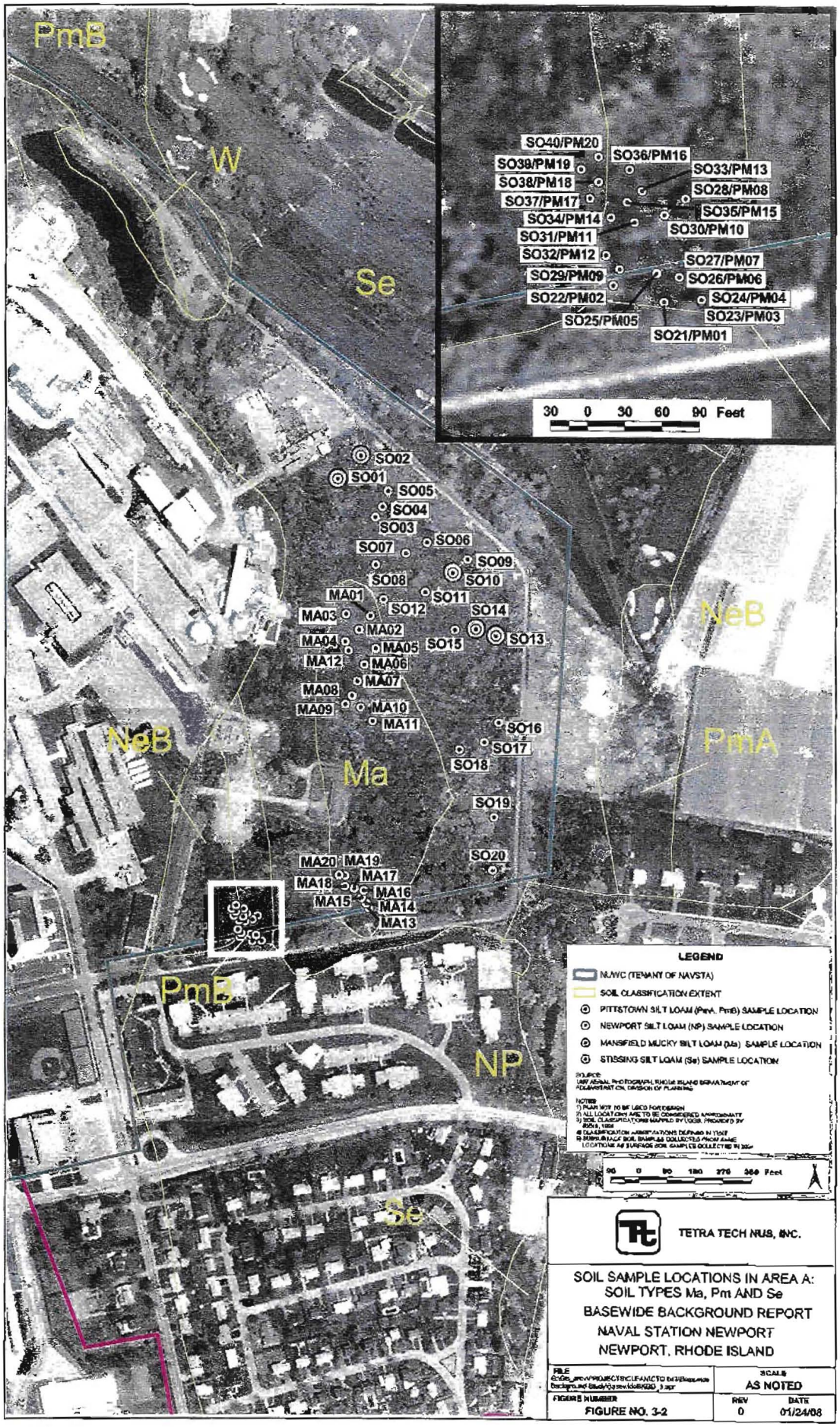
DATE
07/23/07


PmB
W
Se
SO40/PM20
SO39/PM19
SO38/PM18
SO37/PM17
SO34/PM14
SO31/PM11
SO32/PM12
SO29/PM09
SO22/PM02
SO25/PM05
SO36/PM16
SO33/PM13
SO28/PM08
SO35/PM15
SO30/PM10
SO27/PM07
SO26/PM06
SO24/PM04
SO23/PM03
SO21/PM01
30 0 30 60 90 Feet
SO02
SO01
SO05
SO04
SO03
SO06
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SO11
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MA03
MA02
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MA17
MA18
MA16
MA15
MA14
MA13
NeB
NeB
PmA
PmB
NP
Se
LEGEND
NUWC (TENANT OF NAVSTA)
SOIL CLASSIFICATION EXTENT
PITTSTOWN SILT LOAM (PmA, PmB) SAMPLE LOCATION
NEWPORT SILT LOAM (NP) SAMPLE LOCATION
MANSFIELD MUCKY SILT LOAM (Ma) SAMPLE LOCATION
STISSING SILT LOAM (Se) SAMPLE LOCATION
TETRA TECH NUS, INC.
SOIL SAMPLE LOCATIONS IN AREA A:
SOIL TYPES Ma, Pm AND Se
BASEWIDE BACKGROUND REPORT
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND
SCALE
AS NOTED
FIGURE NUMBER
FIGURE NO. 3-2
REV
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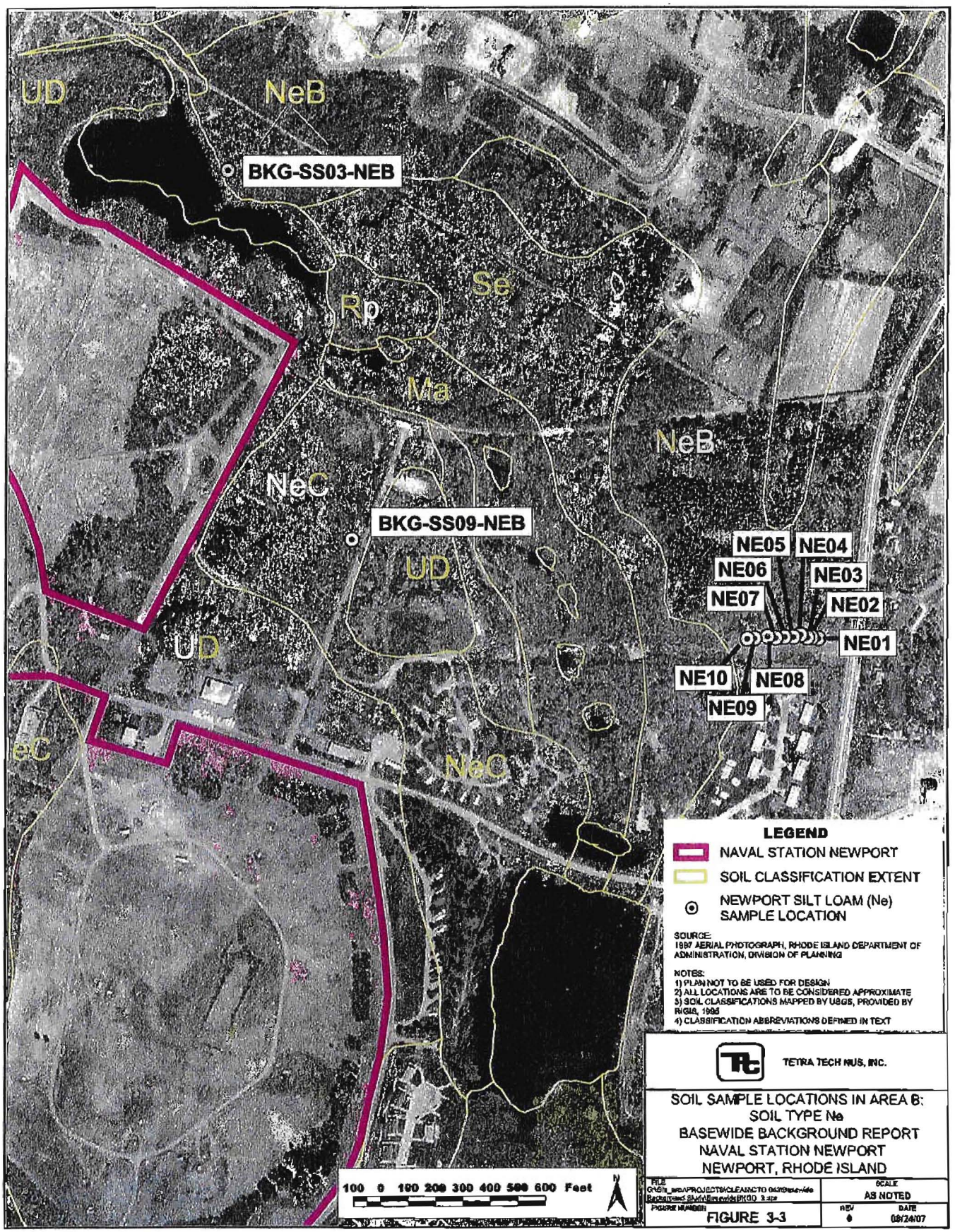
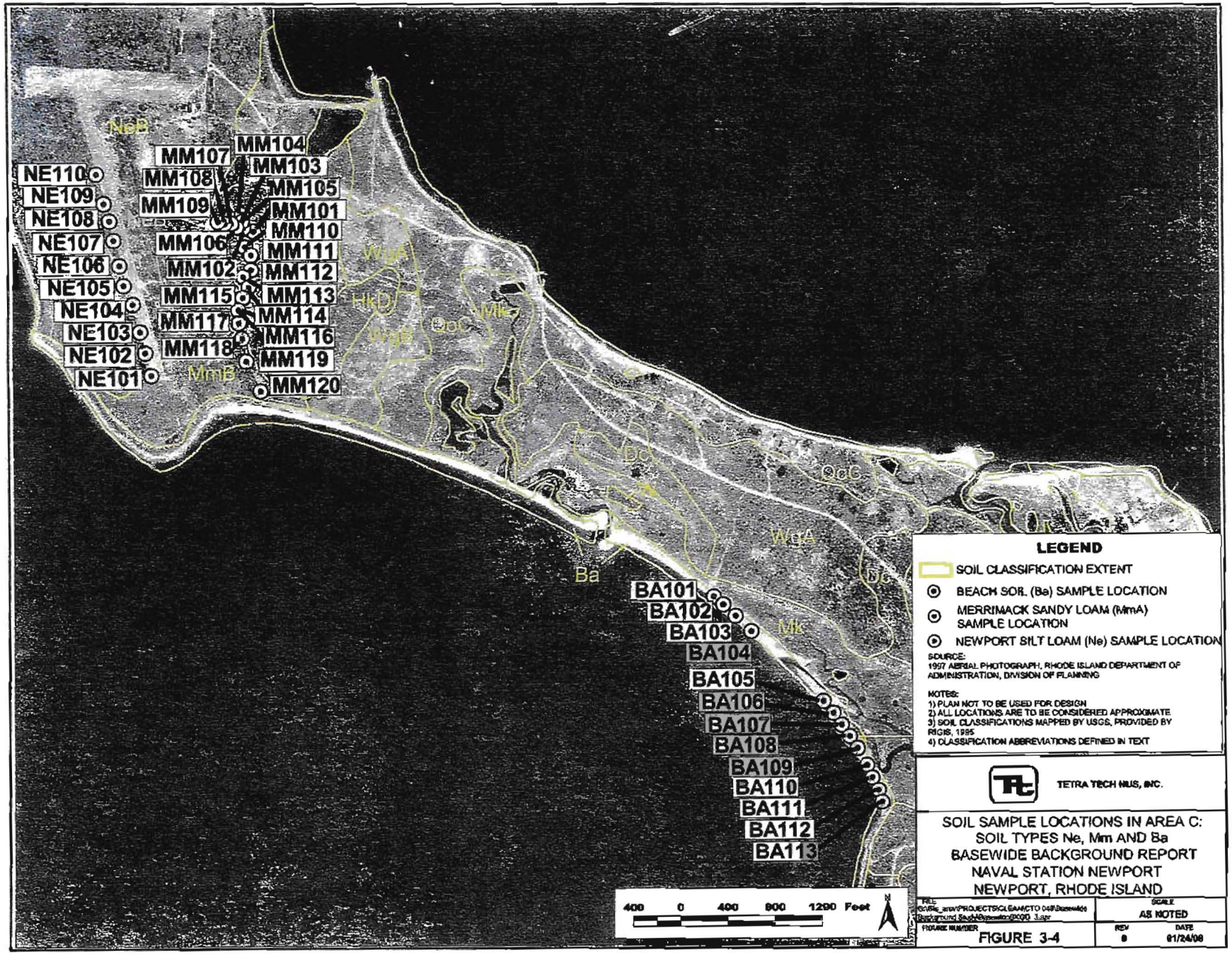
DATE
01/24/08


UD
NeB
BKG-SS03-NEB
Se
Rp
Ma
NeB
NeC
BKG-SS09-NEB
UD
UD
eC
NeC
NE05
NE04
NE06
NE03
NE07
NE02
NE01
NE10
NE08
NE09
LEGEND
NAVAL STATION NEWPORT
SOIL CLASSIFICATION EXTENT
NEWPORT SILT LOAM (Ne) SAMPLE LOCATION
SOURCE:
1997 AERIAL PHOTOGRAPH, RHODE ISLAND DEPARTMENT OF ADMINISTRATION, DIVISION OF PLANNING
NOTES:
1) PLAN NOT TO BE USED FOR DESIGN
2) ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE
3) SOIL CLASSIFICATIONS MAPPED BY USGS, PROVIDED BY RIGIS, 1995
4) CLASSIFICATION ABBREVIATIONS DEFINED IN TEXT
TETRA TECH NUS, INC.
SOIL SAMPLE LOCATIONS IN AREA B:
SOIL TYPE Ne
BASEWIDE BACKGROUND REPORT
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND
100 0 100 200 300 400 500 600 Feet
N
FILE
SCALE
AS NOTED
FIGURE NUMBER
FIGURE 3-3
REV
DATE
08/24/07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NE105
NE104
NE103
NE102
NE101
MM107
MM108
MM109
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MM102
MM115
MM117
MM118
MmB
MM104
MM103
MM105
MM101
MM110
MM111
MM112
MM113
MM114
MM116
MM119
MM120
WgA
HkD
WgB
QcC
Mk
Dc
Ba
BA101
BA102
BA103
BA104
BA105
BA106
BA107
BA108
BA109
BA110
BA111
BA112
BA113
400 0 400 800 1200 Feet
N
LEGEND
SOIL CLASSIFICATION EXTENT
BEACH SOIL (Ba) SAMPLE LOCATION
MERRIMACK SANDY LOAM (MmA) SAMPLE LOCATION
NEWPORT SILT LOAM (Ne) SAMPLE LOCATION
SOURCE:
1997 AERIAL PHOTOGRAPH, RHODE ISLAND DEPARTMENT OF ADMINISTRATION, DIVISION OF PLANNING
NOTES:
1) PLAN NOT TO BE USED FOR DESIGN
2) ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE
3) SOIL CLASSIFICATIONS MAPPED BY USGS, PROVIDED BY RIGIS, 1995
4) CLASSIFICATION ABBREVIATIONS DEFINED IN TEXT
TETRA TECH NUS, INC.
SOIL SAMPLE LOCATIONS IN AREA C:
SOIL TYPES Ne, Mm AND Ba
BASEWIDE BACKGROUND REPORT
NAVAL STATION NEWPORT
NEWPORT, RHODE ISLAND
SCALE
AS NOTED
FIGURE NUMBER
FIGURE 3-4
REV
0
DATE
01/24/08

APPENDIX E, TABLE E1-11
DESCRIPTIVE STATISTICS FOR SUBSURFACE SOIL CLASSIFICATION: STISSING SILT LOAM (SESB)
BASEWIDE BACKGROUND STUDY
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Substance	Freq. of Detection	Range of Positive Detection Min.		Max.		Mean of All Data	Location of Maximum	Interquartile Range (Detects)	Standard Deviation	Variance	Skewness	Kurtosis	Geometric Mean
Aluminum	15/15	9060	-	14000		11100	BWBK-SB-SO03-0108	3300	1720	2770000	0.334	-1.288	10930
Arsenic	15/15	4.4	-	37.1		16.8	BWBK-SB-SO06-0108-D	14.1	8.86	73.3	-0.089	-1.251	14.1
Barium	15/15	19.3 J	-	30.2	J	25.2	BWBK-SB-SO09-0106	5.9	3.14	9.2	0.138	-1.044	25.0
Beryllium	15/15	0.44	-	0.62		0.524	BWBK-SB-SO06-0108	0.08	0.0536	0.00269	0.250	-0.963	0.522
Cadmium	11/15	0.084 J	-	0.28		0.135	BWBK-SB-SO08-0108	0.12	0.0724	0.00489	0.252	-1.032	0.114
Calcium	15/15	703 J	-	1540	J	1170	BWBK-SB-SO08-0107	338	255	60500	-0.686	-0.426	1138
Chromium	15/15	12.6	-	17.3		14.8	BWBK-SB-SO08-0107	2.5	1.51	2.14	0.208	-1.242	14.7
Cobalt	15/15	9	-	17.7		13.7	BWBK-SB-SO03-0108	6.1	3.13	9.15	-0.040	-1.631	13.3
Copper	15/15	11.1	-	30.5		19.6	BWBK-SB-SO03-0108	10.6	6.07	34.4	-0.024	-1.027	18.7
Iron	15/15	15000	-	48600		29600	BWBK-SB-SO06-0108	12200	8740	71300000	-0.258	-0.868	28197
Lead	15/15	7.1	-	15.4		10.3	BWBK-SB-SO08-0108	4.9	2.23	4.62	0.118	-1.282	10.0
Magnesium	15/15	2380	-	3850		2970	BWBK-SB-SO03-0108	1050	495	229000	0.509	-1.059	2928
Manganese	15/15	191	-	1330		461	BWBK-SB-SO11-0106	277	320	95500	1.972	3.594	391
Nickel	15/15	15.1	-	37.1		24.2	BWBK-SB-SO03-0108	11.3	6.42	38.4	0.220	-0.553	23.4
Potassium	15/15	376 J	-	677	J	548	BWBK-SB-SO08-0107	124	79.2	5850	-0.156	-0.506	542
Selenium	1/15	0.5 J	-	0.5	J	0.155	BWBK-SB-SO06-0108-D	0.167	0.0663	0.00411	1.207	2.627	0.143
Sodium	3/15	58.8 J	-	60.8	J	35.2	BWBK-SB-SO19-0104	2	13.1	160	1.562	0.657	33.4
Vanadium	15/15	15.5	-	21.2		18.7	BWBK-SB-SO06-0108-D	2.3	1.68	2.63	-0.119	-0.475	18.6
Zinc	15/15	34.1	-	74.5		55.4	BWBK-SB-SO03-0108	21.5	12.8	152	-0.242	-1.082	53.9

Notes:

Units are mg/kg.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are considered as one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.
Skewness = (n*SUM(x-xbar)3)/((n-1)(n-2)s3) = a measure of asymmetry of a distribution. 0 indicates perfect symmetry. Positive or negative values indicate asymmetry.
Kurtosis = ((n+1)*n*SUM(x-xbar)4)/((n-1)*(n-2)*(n-3)*s4) - (3*(n-1)2)/((n-2)(n-3)) = measures sharpness of the peak of a distribution (+ or -) relative to normal distribution.

APPENDIX E, TABLE E1-10
DESCRIPTIVE STATISTICS FOR SURFACE SOIL CLASSIFICATION: STISSING SILT LOAM (SESS)
BASEWIDE BACKGROUND STUDY
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Substance	Freq. of Detection	Range of Positive Detection Min.		Max.	Mean of All Data	Location of Maximum	Interquartile Range (Detects)	Standard Deviation	Variance	Skewness	Kurtosis	Geometric Mean
Aluminum	20/20	7580	-	16700	12100	DABK-S-SO04-0001	3000	2230	4740000	0.122	-0.329	11857
Arsenic	20/20	3.3 J	-	71.7 J	13	DABK-S-SO06-0001	5.77	14.6	201	3.790	15.614	9.86
Barium	20/20	15.1 J	-	60.6	35	DABK-S-SO02-0001	19.9	11.7	130	0.375	-0.526	33.1
Beryllium	1/20	0.37 J	-	0.37 J	0.35	DABK-S-SO06-0001	0.185	0.0318	0.000963	0.046	-0.229	0.349
Chromium	20/20	7.6	-	28.2	12.7	DABK-S-SO02-0001	3.8	4.27	17.3	2.638	9.283	12.2
Cobalt	20/20	3.3 J	-	11.9	5.52	DABK-S-SO06-0001	1.83	2.33	5.17	2.027	3.608	5.18
Iron	20/20	8290	-	53900	19600	DABK-S-SO06-0001	7300	9130	79200000	2.893	11.138	18225
Lead	20/20	13.4	-	38	23.2	DABK-S-SO19-0001	8.2	6.59	41.3	0.604	0.036	22.3
Magnesium	15/20	1570	-	2930	1660	DABK-S-SO20-0001	710	742	522000	-0.199	-0.744	1460
Manganese	20/20	46.6	-	373	130	DABK-S-SO06-0001	108.8	88.4	7430	1.581	1.903	110
Mercury	2/20	0.1 J	-	0.12 J	0.0559	DABK-S-SO20-0001	0.045	0.0293	0.000816	1.189	0.190	0.050
Nickel	20/20	5.3 J	-	19.1	11	DABK-S-SO02-0001	4.95	3.39	10.9	0.387	0.305	10.5
Vanadium	20/20	14	-	34.2	25.1	DABK-S-SO03-0001	7.9	5.41	27.8	0.008	-0.457	24.5
Zinc	20/20	21.4	-	81.7	43.3	DABK-S-SO02-0001	17.9	14.2	193	0.801	1.473	41.1

Notes:

Units are mg/kg.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are considered as one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.
Skewness = (n*SUM(x-xbar)3)/((n-1)(n-2)s3) = a measure of asymmetry of a distribution. 0 indicates perfect symmetry. Positive or negative values indicate asymmetry.
Kurtosis = ((n+1)*n*SUM(x-xbar)4)/((n-1)*(n-2)*(n-3)*s4) - (3*(n-1)2)/((n-2)(n-3)) = measures sharpness of the peak of a distribution (+ or -) relative to normal distribution.

APPENDIX E, TABLE E1-7
DESCRIPTIVE STATISTICS FOR SUBSURFACE SOIL CLASSIFICATION: NEWPORT SILT LOAM (NESB)
BASEWIDE BACKGROUND STUDY
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Substance	Freq. of Detection	Range of Positive Detection Min.	Max.	Mean of All Data	Location of Maximum	Interquartile Range (Detects)	Standard Deviation	Variance	Skewness	Kurtosis	Geometric Mean
Aluminum	20/20	8090	12300	10600	BWBK-SB-NE01-0108	1000	1110	1160000	-0.790	1.014	10539
Arsenic	20/20	1.9	5.8	3.71	BWBK-SB-NE02-0109	2.55	1.32	1.67	0.062	-1.630	3.47
Barium	20/20	16.4	39.6	26.5	BWBK-SB-NE102-0110	15.7	8.19	63.8	0.274	-1.482	25.3
Beryllium	20/20	0.3	0.51	0.394	BWBK-SB-NE10-0107	0.077	0.0558	0.00296	0.212	-0.344	0.39
Cadmium	2/20	0.067 J	0.075 J	0.0322	BWBK-SB-NE01-0108	0.0247	0.0134	0.000172	2.860	7.179	0.031
Calcium	20/20	314	815	540	BWBK-SB-NE09-0110	258	143	19400	0.245	-1.235	522
Chromium	20/20	7.6 J	14.9	11.3	BWBK-SB-NE01-0108	3.35	2.13	4.3	-0.119	-0.758	11.1
Cobalt	20/20	4.8	9.6	7.07	BWBK-SB-NE01-0108	2.82	1.62	2.49	0.111	-1.520	6.89
Copper	20/20	8.5	16.8	12.9	BWBK-SB-NE05-0108	3.5	2.3	5.03	-0.068	-0.913	12.71
Iron	20/20	11800	23700	18000	BWBK-SB-NE01-0108	7100	3770	13500000	0.049	-1.376	17623
Lead	20/20	5.5	7.8	6.77	BWBK-SB-NE07-0107	0.97	0.648	0.399	-0.347	-0.721	6.73
Magnesium	20/20	2050	3890	2940	BWBK-SB-NE01-0108	620	455	197000	0.223	-0.113	2907
Manganese	20/20	176	834	285	BWBK-SB-NE02-0109	106	99.3	9370	2.375	7.804	272
Mercury	2/20	0.013	0.017	0.0077	BWBK-SB-NE07-0107	0.00725	0.00268	0.0000068	2.822	8.156	0.0074
Nickel	20/20	8.8	19	13.5	BWBK-SB-NE01-0108	6.5	3.47	11.4	0.197	-1.485	13.1
Potassium	20/20	434	2040 J	1030	BWBK-SB-NE105-0110	1082	583	323000	0.226	-1.766	863
Sodium	1/20	54.9 J	54.9 J	29.3	BWBK-SB-NE105-0110	27.4	6.23	36.9	4.034	17.097	28.9
Vanadium	20/20	11.7	18.5	14	BWBK-SB-NE10-0107	1.8	1.7	2.75	1.025	1.150	13.9
Zinc	20/20	22.1 J	41.9	32	BWBK-SB-NE01-0108	10.3	6.31	37.8	0.180	-1.255	31.4

Notes:

Units are mg/kg.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are considered as one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.
Skewness = (n*SUM(x-xbar)3)/((n-1)(n-2)s3) = a measure of asymmetry of a distribution. 0 indicates perfect symmetry. Positive or negative values indicate asymmetry.
Kurtosis = ((n+1)*n*SUM(x-xbar)4)/((n-1)*(n-2)*(n-3)*s4) - (3*(n-1)2)/((n-2)(n-3)) = measures sharpness of the peak of a distribution (+ or -) relative to normal distribution.

APPENDIX E, TABLE E1-6
DESCRIPTIVE STATISTICS FOR SURFACE SOIL CLASSIFICATION: NEWPORT SILT LOAM (NESS)
BASEWIDE BACKGROUND STUDY
NAVSTA NEWPORT, NEWPORT, RHODE ISLAND

Substance	Freq. of Detection	Range of Positive Detection Min.		Max.	Mean of All Data	Location of Maximum	Interquartile Range (Detects)	Standard Deviation	Variance	Skewness	Kurtosis	Geometric Mean
Aluminum	22/22	9260	-	17900	13100	BWBK-SS-NE09-0001	4900	2810	7520000	-0.037	-1.492	12856
Arsenic	22/22	1.7	-	17.1	6.28	BWBK-SS-NE02-0001	6.4	4.39	18.4	0.963	0.259	4.94
Barium	22/22	18.2	-	36.3	25.2	BWBK-SS-NE09-0001	6.7	5.03	24.2	0.631	-0.229	24.8
Beryllium	22/22	0.28 J	-	0.79	0.485	BWBK-SS-NE09-0001	0.225	0.133	0.017	0.235	-0.422	0.47
Cadmium	6/22	0.068 J	-	0.53	0.0748	BKG-SS03-NEB-0016	0.1677	0.11	0.0116	3.695	14.983	0.048
Calcium	22/22	231 J	-	559 J	370	BWBK-SS-NE01-0001	169	103	10100	0.365	-1.221	356.5
Chromium	22/22	6.3	-	17.1	11.3	BWBK-SS-NE01-0001	7.6	3.95	14.9	0.047	-1.651	10.7
Cobalt	22/22	1.5 J	-	7.4	3.83	BWBK-SS-NE04-0001	3.12	1.93	3.54	0.356	-1.134	3.35
Copper	22/22	3.3	-	20.3	10.1	BWBK-SS-NE10-0001	9.4	5.82	32.3	0.483	-1.124	8.49
Iron	22/22	9020	-	23000	15100	BWBK-SS-NE01-0001	9100	4870	22600000	0.091	-1.594	14314
Lead	22/22	8.2	-	44 J	16.6	BKG-SS03-NEB-0016	8.8	8.15	63.4	1.930	5.138	15.1
Magnesium	22/22	932 J	-	2780 J	1740	BWBK-SS-NE02-0001	940	602	346000	0.242	-1.189	1637
Manganese	22/22	85.5	-	290	171	BWBK-SS-NE01-0001	76	50.8	2470	0.431	-0.051	163.8
Mercury	22/22	0.021 J	-	0.24	0.0844	BWBK-SS-NE01-0001	0.0947	0.0606	0.00351	0.926	0.323	0.065
Nickel	22/22	4.6	-	16.5	9.44	BWBK-SS-NE02-0001	6.75	3.84	14.1	0.188	-1.416	8.67
Potassium	22/22	308	-	666	402	BWBK-SS-NE101-0001	49	69.4	4600	2.679	10.230	397
Selenium	16/22	0.2 J	-	0.89	0.295	BKG-SS03-NEB-0016	0.145	0.192	0.0353	1.399	3.215	0.24
Vanadium	22/22	12.5	-	23.1	18.1	BKG-SS03-NEB-0016	5.5	3.28	10.3	-0.123	-1.016	17.8
Zinc	22/22	15.6	-	67.4	29.9	BWBK-SS-NE02-0001	19.9	13.7	179	1.170	1.354	27.3

Notes:

Units are mg/kg.
Number of sample results excludes rejected data or blank-qualified data. Duplicates are considered as one result.
Mean of all data includes positive detections and non-detected results. Detection limits are divided by two.
Frequency of detection refers to number of times compound was detected among all samples versus total number of samples.
Number of samples may vary based on the number of usable results.
Skewness = (n*SUM(x-xbar)3)/((n-1)(n-2)s3) = a measure of asymmetry of a distribution. 0 indicates perfect symmetry. Positive or negative values indicate asymmetry.
Kurtosis = ((n+1)*n*SUM(x-xbar)4)/((n-1)*(n-2)*(n-3)*s4) - (3*(n-1)2)/((n-2)(n-3)) = measures sharpness of the peak of a distribution (+ or -) relative to normal distribution.

ATTACHMENT D
Text Revisions for The SASE Report
Former Melville Water Tower Site

The text provided in this Attachment has been prepared to clarify the sections of the SASE report dated November 2008 related to arsenic in soil at the Former Melville Water Tower Site, 1485 West Main Road, Portsmouth Rhode Island.

Added Text: New Last Paragraph for Section 2.3.1:

As noted above, this initial testing was conducted using an Innov-X Model XT-440 X-Ray fluorescence detector (XRF). The XRF technology was originally developed to identify heavy metals in dry materials. Since its development, XRF technology has gone through improvements to become accepted as an adequate screening device to provide relative concentrations of some metals in dry soil samples. However, the XRF has a tendency to provide higher concentrations of arsenic in soil than the fixed laboratory methods, which is what the regulatory criteria are based on. In addition, the moisture content and lead content of the soil can interfere with XRF results for arsenic[1]. The RIDEM report states that the ground surface was "semi-frozen", and although the moisture content is not reported, the report does state "moisture content may have an effect on the accuracy of the results"[2]. This calls into question the concentrations reported.

Added Text: Text to be Incorporated to Section 2.3.2:

To verify RIDEMs findings, the U.S.EPA collected surface soil samples and paint chip samples from the site in May 2006. EPA had samples analyzed with a fixed-laboratory XRF spectrometer at the EPA New England Regional Laboratory in Chelmsford MA. Arsenic was not found at a detection limit of 10 mg/kg in any of the 7 surface soil samples collected at that time, even those that were collected directly under the tower and those in which blue paint chips were observed[3]. Similarly, arsenic was not detected in the paint chip samples analyzed by the US EPA laboratory. While EPA's analysis found lead concentrations in soil similar to that measured by RIDEM (>1000 mg/kg) and found lead in paint chip samples up to 25,000 mg/kg, they did not substantiate RIDEMs findings of arsenic in paint or soil.

Tetra Tech NUS Inc., acting as a representative to the U.S. Navy, split the samples of paint chips analyzed by USEPA in May. The paint chips were analyzed by a fixed commercial laboratory through total digestion analysis for both lead and arsenic. This analysis provided concentrations of arsenic in four of six paint chip samples from 2.4 mg/kg to 74 mg/kg, and non detected in two samples. Lead

concentrations in these paint chip samples were in the 28,000-50,000 mg/kg range [4]. This data confirmed the presence of lead in paint, but did not indicate a problem with arsenic.

Based on the findings of the initial sampling conducted on soils and paint prior to tower demolition, it was determined by the Navy that the concentrations of arsenic measured by RIDEM in semi-frozen soil with unknown moisture content through XRF field screening could not be substantiated. The total digestion analysis of paint conducted by Tetra Tech suggested that paint from the tower that contained 74 mg/kg arsenic would have to be added to soil at a significant rate to affect soil arsenic concentrations, and such a contribution could not provide an arsenic concentration in soil greater than the concentration measured in the paint. Thus it was determined that the XRF soil analysis conducted by RIDEM was impacted by some interference, and was not reliable.

Added Text: Text to be incorporated into Section 2.4.3.

Soils excavated during the removal action at the former water tower were noted to be fill, along with fractured rock and stone similar to the Rhode Island formation (sedimentary phyllite/schist) that is common elsewhere on the eastern edge of Aquidneck Island[7].

Added Text: New First Two Paragraphs of Section 4.2

Arsenic is a natural component of soil and bedrock, and thus part of what is considered "background" soil. However, concentrations measured in environmental samples collected by the Navy and other groups in the Newport area have identified concentrations of arsenic in soil and bedrock that are above Rhode Island regulatory criteria of 7 mg/kg, although they are generally within the range of concentrations observed by USGS for the Eastern United States (up to 73 mg/kg) [5]. The Navy and other organizations have also noted that concentrations of arsenic increase with depth into the soil[6] and have found concentrations of arsenic in bedrock of up to 79 mg/kg [7]. RIDEM views concentrations greater than 7 mg/kg as actionable under their environmental rules, though they have occasionally allowed consideration of the local background conditions when evaluating metals data. The Navy has conducted a study of background metals concentrations for the six soil types mapped by the USGS within property owned by the Navy on Aquidneck Island, and this assessment found different ranges of arsenic concentrations measured in each of those soil types[7].

Contribution of arsenic to site soil is also possible from the rock types. The presence of the fractured bedrock in the fill that was excavated indicated that the rock makes up a large portion of the soil within the excavation. Additionally, Site Area A and Site Area C excavations encountered native bedrock under the

site. If the fractured rock within the fill at the site or the native bedrock under the site have arsenic concentrations similar to the background bedrock, these materials could have provided a significant contribution of arsenic to the site soil. However, because soil data cannot be statistically compared with bedrock data, a background comparison was not made between site soil and bedrock.

New last Paragraph of Section 4.2

Prior to comparing the site soil to the two background soil types, the background Se soil was compared with the background Ne soil. This comparison showed that the two background data sets have arsenic concentrations that are quite different: Arsenic concentrations range in the Se soil between 2.73 mg/kg and 71.7 mg/kg (average 13.0 mg/kg for surface soil and (16.8 mg/kg for subsurface soil) and in the Ne soil between 1.7 mg/kg and 17.1 mg/kg (average 6.28 mg/kg for surface and 3.71 mg/kg for subsurface soil)[7]. Therefore, Se soil contains a higher background concentration of arsenic than the Ne soil.

New Text: Replacement Section 4.2.2:

The Basewide Background Study identified two types of statistical methods that may be utilized in accordance with Navy guidance (Navy, 2002) to evaluate whether site data are above background, either a two sample hypothesis test or a geochemical prediction method. At the Former Melville Water Tower Site, analytical results are not available for the mineral components that would be used to evaluate the geochemical correlation with arsenic in site-related samples. Therefore, site data were compared to background data using two sample hypothesis tests to compare site data to the data from background soils surrounding the site.

Based on the soil types present around the site, it is presumed that the UD soils under the water tower are likely to be made up of either one or a mixture of both of the Se and Ne soil types, along with fractured phyllite/schist found in the excavation, leveled and compacted to form a stable ground surface.

The comparisons of site soil to background soil are based on the null hypothesis that the site concentrations are indistinguishable from each of the background data sets. If the null hypothesis is rejected by the test, the site concentrations are considered greater than background. If it is not rejected, the site concentrations are not greater than background. Thus there is no test to determine if the site is below background.

New Text: Replacement Section 4.2.3:

The arsenic concentrations from four areas of the site after excavation were compared to Se and Ne surface and subsurface soils, individually, creating a total of 12 comparisons. The result of the comparisons are best summarized below:

Arsenic data set from:	Greater than Se Surface soil?	Greater that Se Subsurface Soil?	Greater than Ne Surface Soil?	Greater than Ne Subsurface Soil?
Site Area A	No	No	Yes	Yes
Site Area B	No	No	No	Yes
Site Area C*	---	No	---	Yes
Site Area D*	No	---	No	---

* - Site Area C soils are subsurface soil only, and Site Area D soils are surface soil only.

The matrix above clearly shows two things: First, arsenic concentrations in the post excavation site soils are not greater than those in the Se background soil data set, but are similar to the concentrations that would be expected in background Se soil. Second, the post excavation site soils do have arsenic concentrations greater than the Ne background data set. Put together, the site arsenic concentrations are the same as the Se background soil, but they are higher than the Ne background soil.

Given that the Se soil is also higher than the Ne soil, it has to be accepted that if there are any Se soils present at the site, the site soil would have to have arsenic concentrations greater than those in the Ne background soil. Unless there are no Se soils present, the arsenic in the site data set could not be as low as that in the Ne background data set.

New Section 4.2.4

4.2.4 Human Exposure to Arsenic

At the request of the USEPA, the remaining concentration of arsenic to which persons using the site would be exposed was estimated. One exposure point concentration (EPC) for arsenic was calculated for the entire Melville Water Tower Site using all available post-excavation site data (Table 3-1). Field duplicate pair samples, consisting of original and field duplicate samples (taken at the same coordinates and depths), were averaged together (arithmetic mean) before further calculations were conducted to avoid overemphasizing any particular sample location. The calculated average concentrations were used to replace the original and duplicate samples in the EPC calculation. Additionally, non-detected arsenic results, marked with a "<" in Table 3-1, were qualified as non-detected (U) for input to the EPC program. For non-detected arsenic concentrations, ½ of the reported concentration was used as a proxy concentration for the EPC calculation. The imported backfill soil was not factored into this calculation. The samples and concentrations input to the EPC program are listed in Appendix H, Table H-4.2.

The EPC concentration for arsenic was calculated using a program based on the EPA's Pro UCL software. The 95% upper confidence limit (UCL) value recommended by EPA's Pro UCL was chosen as the site EPC for arsenic (see output file). The 95% UCL was used because the dataset contained more than 10 samples and the 95% UCL did not exceed the maximum concentration. Descriptive statistics and the site EPC calculated for arsenic are included in Table 4-2.

The calculated EPC is 6.7, which would correspond to a contaminant specific cancer risk value of well below 1E-4, and a hazard index well below 1.0.

New Text, Replacement Section 4.3:

4.3 COMPARISON TO ECOLOGICAL CRITERIA

As an indication of the possibility of risk to ecological receptors, site data was compared to selected ecological benchmarks that are published by the U.S. Environmental Protection Agency[10]. These benchmarks are known as Ecological Soil Screening Levels (Eco SSLs). The State of Rhode Island does not publish or enforce ecological based soil benchmark concentrations. Eco SSLs are screening values That are protective of ecological receptors that commonly come into contact with and/or consume biotia that live in or on soil.

The comparison is presented as Table 4-3. To make this comparison, only data from the remaining soil (post excavation) in the 0-2 foot intervals were used, because the ecological receptors are presumed to be exposed only to these shallower soils. Data used to provide this average concentration is preesented in Appendix H-4.3. New fill was excluded from the comparison as this material is accepted to be free of contaminants from the release at the site. Similarly, the east area of the site is excluded because the contaminants in this area are expected to be a result of traffic from the state highway adjacent to this area, given the proximity (distance less than 30 feet) to the four-lane State Route 114. These limitations restricted the comparsion to post excavation samples from Areas A, B and D as shown on Figure 2-6.

The comparsion was made by selecting the lowest available Eco SSL for each of the metals that were analzyed for in the post excavation samples. Rather than comparing each sample to the Eco SSL, an average concentration for the site was developed and used for comparison. This approach is appropriate for the purposes of this comparison because of the size of the exposure area represented (0.5 acre) and the number of samples (over 200) representing the exposure area.

Table 4-3 shows that none of the ecological criteria were exceeeded with the exception of lead. The criteria for cadmium is met but not exceeded when non-detected values are used as whole values. If one-half the non-detected values were used to caluclate the average concentration, the average concentration would be well below the SSL of 0.36 mg/kg. The mean concentrations for chromium and arsenic are below the SSLs.

The mean lead concentration for site soil that was used for comparison is 38.08 mg/kg. For ecological exposures to lead, there are four primary SSLs that are published for soil: these represent exposures to

plants, soil invertebrates, mammals, and birds. These primary SSLs are the lowest of a series of SSLs for different receptor species groups. The SSLs are developed by taking applicable toxicity studies on specific contaminants published in scientific literature, and using the the data from those studies to develop toxicity reference values, in turn used to calculate a No Observed Adverse Effects Level (NOAEL). The NOAEL is then used as the SSL.

Receptor	SSL based on NOAEL
Shrew – insectivorous mammal	56 mg/kg
Vole – herbivorous mammal	1200 mg/kg
Weasel – carnivorous mammal	460 mg/kg
Dove – herbivorous bird	46 mg/kg
Woodcock – insectivorous bird	11 mg/kg
Hawk – carnivorous bird	510 mg/kg
Invertebrates - general	1200 mg/kg
plants	120 mg/kg

Only the lowest SSL, that for the woodcock, is exceeeded by the mean site soil concentration. The other SSLs are above site average concentration. The woodcock can be expected to be the most affected by contaminants in soil because it feeds on the ground looking for insects by stirring up and turning over leaf litter and other detritus. However, this species is slightly unusual in that they nest in depressions on the ground, and this behavior provides additional exposure to soil contaminants. It is likely for this species to ingest contaminated soil through preening and nest construction, as well as incidental ingestion during foraging and feeding. However, the woodcocks preferred habitat is woodland, with dense overstory and open understory, and not open fields, as is present at this site. Woodcock could not nest in open mown grass such as is present at the site. Similarly, they are solitary shy animals who would not forrage on open grass lands that offer no cover.

The other SSLs for the other avian receptors that may be more appropriate for use are for doves and hawks, both of which have been observed to be present at the site or in the site vicinity.

The fact that the lead SSL for woodcock (11 mg/kg) is exceeded by the site surface soil average lead concentration (38 mg/kg) should not be considered of significant concern due to the unfavorable habitat present to this one receptor and fact that this SSL is actually a calculated NOAEL which is a highly conservative value. The average site surface soil concentrations are below the other SSLs published for receptors who may actually be present at the site. Using this single value out of context with the other SSLs published by USEPA to conclude that the site may pose an unacceptable risk to ecological receptors would be erroneous.

New Text: Replaces Fifth Paragraph of Section 5.3:

The following points summarize the evaluation of arsenic in soil at the site:

1. High concentrations of arsenic measured in soil by RIDEM via XRF could not be reproduced by Navy or EPA analytical methods, and RIDEM's samples may have been compromised by the lead content and / or the moisture content in the samples, invalidating their initial assessment that arsenic in paint contributed to arsenic in soil.
2. Arsenic in paint was measured by EPA and Tetra Tech at concentrations ranging from non-detect to 74 mg/kg. At these concentrations, there would have to be a significant contribution of paint to provide a concentration of 11 mg/kg arsenic in soil (Site Area A average post-excavation concentration).
3. Arsenic concentrations measured in post excavation soil samples under the water tower were similar to one of the two background soil types (Se) which are likely to make up the soil at the site, while these concentrations were above the other background soil type (Ne).
4. Concentrations of arsenic in Se background soil are higher than those in Ne soil, concentrations of arsenic at the site could not be as low as the Ne soil if any of the Se soil is mixed within.
5. Arsenic is present in background bedrock at concentrations well above those measured in the confirmation soil samples. The presence of similar rock within the fill at the site and underlying the site could both be contributing arsenic to site soil[7].
6. A site-wide exposure point concentration for arsenic remaining in soil was calculated to be 6.7mg/kg, which would correspond to a contaminant specific cancer risk value of well below 1E-4, and a hazard index well below 1.0.

There are multiple uncertainties in the comparison to background, including location and impacts of agriculture on background and site soils, as well as construction disturbance of soils and selection of soils for comparison. However, considering all of these findings in conjunction, one could conclude that arsenic levels in some subsets of the soil data reported may exceed background, but all actually lie within the

range of background soil concentrations, and overall do not appear to be significantly elevated from what could be expected to be present at the site. Based on these findings, no further action to address arsenic is needed.

Additional References:

1) Monitoring Arsenic in The Environment, A review of Science and Technologies for Field Measurements and Sensors. Melamed, Daniel. Office of Superfund Remediation and Technology Innovation. Office solid Waste and Emergency Response, USEPA Washington DC. April 2004

2) Semi-Quantitative Metals Analysis, Melville Elementary School, Portsmouth RI. Rhode Island Department of Environmental Management, Office of Waste management. March 29, 2006.

3) Memorandum, Naval Station Newport –Melville Water Tower, Portsmouth(Melville) Rhode Island. Memorandum from Lisa Thuot, EIA team, to Kymberlee Keckler, HBT. June 20, 2006.

4) Results from Paint Chip Sampling, Melville Water Tower, Portsmouth Rhode Island. Letter from Stephen S. Parker Tetra Tech NUS Inc. To James Colter, US Navy, NAVFAC. June 2, 2006.

5) Background Levels of Priority Pollutant Metals in Rhode Island Soils. Timothy O'Connor, PE, Rhode Island Department Of Environmental Mangement, Division of Site Remediation (no date given).

6) Arsenic in Rhode Island Soil. Timothy O'Connor, Vanasse Hangen Brustlin, Inc. Presentation to the Restoration Advisory Board, NAVSTA Newport, Newport RI (no date given).

7) Basewide Background Study Report for Naval Station Newport, Newport Rhode Island. Tetra Tech NUS, Inc. July 2008.

8) Soil Survey of Rhode Island. US Department of Agriculture, Soil Conservation Service. July 1981.

9) Proposed Addition of a new Study Area, Naval Station Newport, Rhode Island. Letter from James Colter, NAVFAC To Kymberlee Keckler (USEPA) and Paul Kulpa (RIDEM) January 11, 2007.

10) Ecological Site Screening Levels for Lead, Interim Final. USEPA Office of Solid Waste and Emergency Response. Washington DC. March 2005.

Revised

TABLE 2-1
SUMMARY OF PAINT CHIP ANALYSIS
FORMER MELVILLE WATER TOWER SITE
1451 WEST MAIN ROAD, PORTSMOUTH RI

Samples Collected by Tetra Tech NUS, Inc. May 25, 2006

Sample No.	Description	Total Lead (mg/kg)	Total Arsenic (mg/kg)	Total PCBs (ug/kg)	Split with EPA?
PT01	Old paint from diagonal brace southwest - blue, red orange layers.	49,500 mg/kg	ND	ND	No
PT02	"Freeze Box" - paint peeling from wooden structure, south side, blue paint and white primer underneath.	83.2 mg/kg	ND	ND	Yes
PT03	Sweepings, dirt and chips collected by contractor and stored in drum.	28,800 mg/kg	7.6 mg/kg	4.4 ug/kg	No
DUP1	Duplicate of PT03, collected for quality control.	39,300 mg/kg	7.4 mg/kg	3.8 ug/kg	No
PT04	North east steel plates on footing - blue, red orange layers.	57,600 mg/kg	2.4 mg/kg	ND	Yes
PT05	Southeast diagonal and concrete footing. New and old paint mix.	39,300 mg/kg	74 mg/kg	ND	Yes
RB1	Field blank on clean sampling tools for quality control.	ND	ND	ND	No

NOTES:

RIDEM method 1 Residential Direct Exposure Criteria (RIDEC - R) for lead in soil is 150 mg/kg.
RIDEM method 1 industrial / commercial Direct Exposure Criteria (RIDEC - IC) for lead in soil is 500 mg/kg.
RIDEM method 1 RIDEC – R and RIDEC – IC is 7 mg/kg.
ND – Not Detected

NEW

TABLE 4-2
DESCRIPTIVE STATISTICS AND EPC FOR ARSENIC
FORMER MELVILLE WATER TOWER
PORTSMOUTH, RHODE ISLAND

Area	Minimum Detection[1]	Maximum Detection[1]	Units	Arithmetic Mean	Probability Distribution	95% UCL	EPC[2]
Site	1	30	mg/kg	5.6	Non-parametric	6.7	6.7

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.

1 - Original and duplicate sample results were considered in determining the maximum and minimum detection.
2 - The 95% UCL is used as the EPC unless the sample set contains less than 10 samples or the 95% UCL is greater than the maximum concentration; in these cases, the maximum concentration is used as the EPC.

NEW

TABLE 4-3
COMPARISON OF AVERAGE METALS CONCENTRATIONS TO ECOLOGICAL CRITERIA AND BACKGROUND
FORMER MELVILLE WATER TOWER SITE
PORTSMOUTH RI

	Lowest Ecological Criteria	Background Average Concentration SeSS	Background Average Concentration NeSS	Site Average Surface Soil
Lead (plants)	120	23.2	16.6	38.08
Lead (invertebrates)	1200	23.2	16.6	38.08
Lead (birds)	11	23.2	16.6	38.08
Lead (mammals)	56	23.2	16.6	38.08
Arsenic	18	13	6.28	5.29
Cadmium	0.36	ND	0.7	0.36
Chromium	26	12.7	11.3	10.28

Average concentrations do not include backfill material
Average Concentrations for Areas A, B and D (0-2 foot interval only) taken from Table 4-2b
Shaded values exceed ecological benchmark
Background average concentrations from Basewide Background Report TTNUS, July 2008

SeSS - Stissing Soil, background surface soil samples
NeSS - Newport Soil, background surface soil samples