AECOM

Remedial Action Plan

EXETER SPORTSMAN'S CLUB
WATER WORKS POND ROAD
EXETER, NEW HAMPSHIRE

Prepared for:

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1.0 INTRODUCTION

On behalf of the Exeter Sportsman's Club Inc. (ESC), AECOM Technical Services, Inc. [formerly URS Corporation (URS)] has completed this Remedial Action Plan (RAP) for the Exeter Sportsman's Club property, located at 111 Portsmouth Avenue in Exeter, New Hampshire. The Site, as defined herein, is limited to the lead shot fall zone of the properties owned by the Town of Exeter (the Town) and the Blanchard family that has been impacted by the historic use of the trap range at the ESC. This RAP documents the results of Site investigation activities, presents a summary of potential remedial alternatives which are protective of human health and the environment to varying degrees, and provides a discussion of the selected remedial alternatives to address the constituents identified in surficial soil at the Site. This report presents a summary of the Site investigation activities followed by a discussion of the remedial alternatives proposed for this Site.

The Site investigative and remediation work performed by AECOM to date includes the following:

- Field screening of soil samples for lead using an X-Ray Florescence Analyzer (XRF);
- Soil, groundwater, and sediment sampling for analytical laboratory analyses;
- Collection of depth to groundwater measurements;
- Remediation of the northern tributary to the reservoir; and
- Remediation of the open portion of the former trap range.

1.1 Site Location and Description

The Site consists of the former trap range of the ESC and is located at the southeast end of an unimproved dirt road, identified by Google Earth, Inc. as Water Works Pond Road, in Exeter, New Hampshire. The Site is abutted to the north, east, and south by approximately 117 acres of undeveloped land. New Hampshire State Route 88 is located between 1,000 and 1,700 feet north and east of the range. Additional undeveloped land and State Highway 101 are located further north of Route 88. The Exeter Reservoir abuts the Site to the south and west. Commercial and industrial zoned properties are located further to the north and west along Portsmouth Avenue. Residential developments are located south of the Exeter Reservoir. A *Site Location Map* is provided as **Figure 1.**

Following remediation of the tributary in 2007, AECOM developed a phased approach to the remediation of the lead-impacted soils. Area 1 was defined as the open portion of the trap range; Area 2 was defined as the forested portion of the shot fall zone that is owned by the Town; and Area 3 is the forested portion of the shot fall zone that is owned by the Blanchard Family. **Figure 2** provides a 2015 aerial photograph which depicts Areas 1 through 3.

1.2 Site History

In 1956, the Town permitted ESC to relocate their trap and small bore ranges to the northern shore of the Exeter Reservoir. Since that time, ESC has operated a small bore range. The trap range reportedly operated until the range was closed in 1986 (CDM 2003). The small bore range is currently in use. Lead shot associated with the trap range has been distributed throughout the forested land to the north and east of the trap range. Various soil and sediment sampling activities were conducted by CDM in 2002 and AECOM in 2006 to evaluate potential impacts from the lead shot. Results of these investigations revealed that sediments present at the confluence of the northern tributary/intermittent stream and the Exeter Reservoir exhibit concentrations of lead which exceed ecological risk standards. In addition, soils in forested portion of the shot fall zone contained concentrations of lead ranging from less than 400 milligrams per kilogram (mg/kg) or parts per million (ppm) to 330,000 ppm. **Figure 3** presents the results of the lead sampling that has been conducted at the Site.

In 2007, AECOM conducted remedial response actions to remediate the impacted sediments from the northern tributary. Lead-impacted sediments were excavated from the tributary and were reused as core material for a safety berm along the southern side of the small bore range. Soils from the open portion of the trap range were excavated in 2014 and were also reused to raise and widen the backstop of the small bore range. **Figure 2** depicts the results of the lead sampling on an aerial photograph which shows the current range configuration.

2.0 SUMMARY OF CURRENT SOIL AND GROUNDWATER CONDITIONS

2.1 Soil Conditions

<u>Area 2 – Forested Area Adjacent to Former Trap Range (Town owned property)</u>

CDM conducted Site characterization work that included the collection of 423 soil samples from 142 locations that were laid out on a 25-foot by 25-foot grid in the forested area adjacent to the former trap range, between grid line 2 and grid line 10. As stated above, this portion of the Site is owned by the Town and is referred to as Area 2. Samples were collected at depths ranging from 0 to 3 inches, 3 to 9 inches, and 9 to 15 inches below the ground surface and were submitted for laboratory analysis of lead. An additional 230 samples were collected by CDM from 115 selected locations that were laid out in a 50-foot by 50-foot grid in the forested area north and west of grid line 10. These samples were collected from depth intervals of 0 to 6 inches and 6 to 12 inches below the ground surface and were also submitted to an analytical laboratory for lead analysis. In general, the CDM report identified lead impacts in Area 2 at concentrations ranging from 420 ppm to 330,000 ppm. CDM summarized their results in Tables 2-1 through 2-7 which are included in this report as **Appendix A**. **Figure 3** depicts the CDM grids and sample locations.

On March 7, 2013, the New Hampshire Department of Environmental Services (NHDES) directed the Town to collect data from the area located east of the tributary from grid line C to grid line U and south of grid line 2. AECOM collected soil samples from 10 locations laid out on a 25-foot by 25-foot grid, between grid line C and grid line A, and between grid line 1 and grid line 1.5. Samples were collected at depths ranging from 0 to 3 inches, 3 to 9 inches, and 9 to 15 inches from each location and were submitted for laboratory analysis of total lead. If the surficial sample results were less than 400 ppm, then the deeper samples were not analyzed. Results of this sampling round indicated all 10 samples contained concentrations of lead below 120 ppm.

<u>Area 3 – Forested Area East of the Former Trap Range (Privately owned property)</u>

In 2006, AECOM conducted Site characterization work that included the collection of 150 samples from 57 locations that were laid out on a 50-foot by 50-foot grid in the forested area east of grid line A. This property is reportedly owned by the Blanchard family and is referred to as Area 3. Samples were collected and screened in the field with and X-Ray Fluorescence Analyzer (XRF) at depths ranging from 0 to 27 inches below the ground surface. Twenty-six of the samples screened with the XRF reported concentrations greater than 400 ppm. Of the 26 samples collected, seven were submitted for laboratory analysis. Due to the grain size of the impacted soils, it was not possible to sieve or remove the lead shot from the soil matrix before the laboratory analyzed the samples for lead. Concentrations of lead in soil were reported by the laboratory to range from 66 ppm to 15,000 ppm. As such, it appears that the lead shot present in the soil samples has significantly biased the analytical results.

As previously stated, NHDES has identified the area from grid line C to grid line U, and south of grid line 2, as an area of concern based on the lack of prior data from this location. The portion of this area that is located on the Blanchard property is limited by the shore line to the areas between grid lines O, P and R, and along grid lines 1 and 2. AECOM collected soil samples from three locations designated O1, P1 and R2. Samples were collected at depths of 0 to 6 inches and 6 inches to 12 inches from each location and were submitted for laboratory analysis of lead in soil. If the surficial sample results were less than 400 ppm, then the lower samples were not analyzed. The results of the sample analyses indicated concentrations of lead up to 52 ppm. The sample results are plotted on **Figure 3**.

The results of the studies conducted by AECOM and CDM, as described above, indicate that approximately 130,000 square feet (~3 acres) of surficial soils located on the forested portion of the Site are impacted by lead concentrations exceeding 400 ppm. Of the three acres, approximately one acre is located on the Town-owned portion of the Site (Area 2), and approximately two acres are located within Area 3 (the Blanchard property). These two areas serve as the focus of this RAP.

2.2 Groundwater Conditions

Groundwater sampling has been conducted on five separate occasions dating back to 2005. Groundwater sampling was conducted in April 2005, August 2005, June 2010, July 2011, and December 2012 for analysis of antimony, arsenic, lead, and poly aromatic hydrocarbons (PAHs). Samples were collected from four monitoring wells designated as MW-2, MW-3, MW-4, and MW-5, which are generally located at the four corners of the trap range. The results of the groundwater sampling are presented in **Table 1,** and indicate that dissolved concentrations of antimony and arsenic have not been detected above NHDES AGQS since 2011, and lead has not been detected above NHDES AGQS since April 2005. PAHs have not been detected above the detection limits in all sampling events. Based on these data and the trap range ceasing operation in 1986, groundwater is not considered a media of concern at the Site.

Refer to Figure 3 for the approximate locations of onsite groundwater monitoring wells.

3.0 ACTIVITIES COMPLETED PRIOR TO THE RAP

3.1 Sediment Removal

Based on the results of investigations conducted by AECOM in the northern tributary in 2006, an area of approximately 6,000 square feet of impacted sediment was estimated for removal. Previous sampling investigations in this area determined the vertical extent of lead-impacted sediments to be approximately 12 to 15 inches in depth below the bottom of the stream bed and sediment surface.

After lowering the surface water elevation in the reservoir approximately 10 feet, AECOM was able to access the impacted sediments using a track-mounted excavator. Sediments were excavated to a depth of approximately 18 inches to 24 inches below the streambed and sediment surface to meet the vertical limits of the lead-impacted sediments. Sediments were excavated from the approximate high water line along the edge of the stream bank throughout the entire confluence area. Excavated sediments were loaded into a track-mounted dump truck and relocated for use as berm material along the southeastern side of the small bore range. The excavated sediments included organic matter (leaf litter, twigs, aquatic vegetation) in the upper four inches, which was underlain by a tan/brown sandy silt (4 inches to 20 inches below the streambed and sediment surface), which was underlain by a grey clay. In general, sediments were excavated to the depth at which the grey clay was encountered. Excavation of the sediments proceeded in an upstream direction along an intermittent stream, towards the Town property line. Sediments present in the intermittent stream were excavated to a depth of approximately 12 inches below the streambed, primarily to remove remaining lead shot pellets present throughout the streambed.

Upon completion of the sediment excavation, a sediment trap and check dam were constructed near the property line between Area 2 and Area 3. The sediment trap was installed as a collection system for lead shot remaining in the un-remediated portion of the intermittent stream, which extends onto the adjacent Blanchard property.

Following the excavation of the lead-impacted sediments, confirmatory sampling was conducted to verify that the horizontal and vertical extent of contamination had been removed. A total of nine post-excavation sediment samples were collected; eight sediment samples (SED-1C through SED-8C) were collected within the excavation and one sediment sample (SED-Background) was collected outside of the excavation, as a representation of the Site background conditions. The confirmatory soil samples were analyzed for total lead, total arsenic, and pH.

Analytical results indicate that concentrations of lead detected in the samples did not exceed the three applicable National Oceanic and Atmospheric Administration (NOAA) standards (i.e., Threshold Effects Concentration (TEC), Probable Effects Concentration (PEC), and Upper Effects Threshold (UET). The analytical results for total arsenic indicate that concentrations of arsenic detected in the samples exceeded one or more of the NOAA standards. Samples SED-1C, SED-4C, SED-6C, and SED-7C exceeded the TEC standard of 5.9 mg/kg for arsenic. Sample SED-Background exceeded all three of the NOAA standards. It should be noted that sample SED-Background was collected from a "background" location at the Site. Based on these results, it appears that arsenic is naturally occurring in the Site sediments, and is not attributed to the historical use of the Site by the ESC. The results of the pH analyses indicated a pH range of approximately 6.4 to 7.2, which is within a normal range for this area of New Hampshire.

Upon review of the confirmatory analytical data, Site restoration activities were initiated. An erosion control blanket (ECB) was placed on the surface of the sediments throughout the entire span of the excavated area, including the confluence area and the intermittent stream (up to the Town property line). The ECB was installed to limit the potential for erosion of the newly exposed sediments and protected the reservoir from silt intrusion due to storm events.

The information provided above was documented in a letter report that was transmitted to NHDES on March 5, 2013.

3.2 Trap Range Remediation

On May 9, 2014, trap range remediation was initiated under the direction of Mr. Joseph Kenick of ESC. The objective of the work was to remove lead-impacted soils and recycle them as core material in a new safety berm to be constructed along the southern side of the small bore range. With the exception of a limited area in the center of the trap range where CDM had excavated a shallow test pit, the depth of the excavation was limited to the top 15 inches of soil. In the area where CDM had excavated the test pit, the depth of the excavation was increased to 24 inches.

Work began in the northern and western portions of the former trap range where tree clearing was required. This area was clear cut and partially grubbed. Stumps located in the proposed berm alignment remained in place while stumps outside the area were stockpiled and burned to reduce their size. Imported fill that had previously been stored on the trap range was relocated to cover the stumps that were left in place along the southern edge of the small bore range. Trees along the eastern end of the trap range were also cut and grubbed to provide access to a 100 foot long pile of clay target. Approximately 240 cubic yards of clay targets and soil were removed and disposed of at the Raymond Transfer Station in Raymond, New Hampshire.

On June 20, 2014, excavation began with K.G. Blood and Sons Excavating removing the top15 inches of soil along the back of the range where the clay target pile was located. The excavation then moved to the former test pit area where the top 24 inches of soil was removed and relocated to the small bore range berm. Upon completion of these excavations, a total of five samples were collected and submitted to Eastern Analytical Incorporated (EAI) of Concord, New Hampshire for PAH analysis using USEPA method 8270. The first three samples, designated PAH-1, PAH-2, and PAH-3, were collected from the former clay target pile while the remaining two soil samples, designated PAH-4 and PAH-5, were collected from the 24 inch deep excavation. Results of these analyses indicated that PAHs were not detected above the laboratory detection limits which were set below the NHDES Risk Characterization and Management Policy (RCMP) Method 1 Soil Standards.

Soil excavation continued in the remaining open portion of the trap range where the top 15 inches of soil was removed and placed in the small bore range's eastern berm. Prior to excavation of this area, ground surface elevations were surveyed. Excavation was conducted in quadrants. The bottom elevation of each quadrant was surveyed to confirm a minimum of 15 inches of soil had been removed. Upon completion of the soil removal, a total of eight soil samples were collected and submitted to EAI for total lead analysis. Results of the analyses indicated that concentrations of residual lead in soil ranged from 2.6 to 110 ppm, which is significantly below the NHDES RCMP S-1 Soil Standard of 400 ppm.

Sometime between the end of August 2014 and the beginning of September 2014, the areas where excavation had occurred were backfilled with clean fill to re-establish the base grade. Approximately three inches of loam was spread over the areas and the areas were seeded. In addition, the newly constructed southern berm of the small bore range was loamed and seeded to establish a vegetative support layer and to limit the potential for erosion of the berm.

The information provided above was documented in a completion report which was transmitted to the NHDES on October 1, 2014.

4.0 REMEDIAL ACTION ALTERNATIE DEVELOPMENT

AECOM evaluated available remedial technologies and developed remedial alternatives that were potentially applicable to the Site given Site-specific conditions and the current nature and extent of impacts. The remedial technologies are described in conceptual detail. Once the alternative is determined to be applicable, the following five criteria are used to evaluate the alternative:

a) Effectiveness and reliability,
b) Feasibility and ease of implementation,
c) Risk reduction and associated benefits,
d) Cost, and
e) Timeliness.

Using these criteria, each alternative is compared head to head with the others to identify a preferred remedial alternative. A discussion justifying the preferred alternative is provided which addresses the means by which the alternative will achieve a level of no significant risk at the Site.

5.0 REMEDIAL ACTION ALTERNATIVES EVALUATION

An initial screening was conducted to identify remedial action technologies that are reasonably feasible to be implemented at the Site, based on the presence of elevated concentrations of lead in Site soils. A remedial response alternative is deemed feasible if it is reasonably likely to meet the no further action criteria of Env-Or 609.02, and if the individuals with the expertise needed to effectively implement a solution are available. Remedial technologies are then evaluated either as a standalone alternative or can be combined with other remedial technologies to form a remedial alternative.

The following remedial action alternatives evaluation conforms to the requirements of Chapter Env-Or 606.10 Remedial Action Plan, as contained in Chapter Env-Or 600 Contaminated Site Management (NHDES, 2015). The selected remedial alternative for the Site is planned to be implemented (upon NHDES approval) in 2016.

5.1 Remedial Objectives

The remedial objectives for this Site are protection of human health and the environment, are discussed below. The following provides a summary of remedial objectives based on environmental medium.

5.1.1 Soil

Under the current conditions and foreseeable future plans for this Site as a passive recreational area, measures should be taken to reduce the potential risk of exposure to soils containing elevated levels of lead.

Lead was identified in the Site soil above NHDES S-1 soil standards. The remedial objectives for surficial soils are to limit exposure to future users of ESC from direct contact, ingestion, or inhalation of surface soils containing elevated concentrations of lead. The NHDES RCMP has established a clean-up level of 400 ppm for unrestricted uses. The RCMP also establishes an Upper Concentration Limit (UCL) for lead in soil of 4,000 ppm.

5.1.2 Groundwater

Based upon the results of the Site investigations conducted by AECOM and others, groundwater at the Site has not been significantly impacted by ESC operations. More specifically, with the exception of groundwater samples collected in 2005, concentrations of lead in groundwater samples collected from four monitoring wells installed across the Site, were not detected above the NHDES AGQS. Therefore, setting remedial objectives for groundwater is not warranted.

5.1.3 Sediment

This portion of the Site was assessed and remediated in 2006 and 2007, and the check dams constructed in the tributary have limited subsequent lead shot migration downstream. As such, setting remedial objectives for sediment is not warranted.

5.2 Identification and Initial Screening of Remedial Technologies

Six remedial alternatives were considered based on existing Site data, AECOM's experience at similar sites, and the technology's likelihood of achieving the no further action criteria of Env-Or 609.02. These technologies include the following: the no action alternative; in-situ soil stabilization; soil excavation and off-site disposal; Monitored Natural Attenuation (MNA), capping, and restricting access. A general description of each technology, along with its advantages and disadvantages, is presented in the following subsections. A summary of the technologies retained for detailed evaluations are presented in Section 5.3. A head to head comparison of each of the retained technologies is presented in Section 5.4.

5.2.1 Option #1 – No Action

The No Action alternative assumes no additional efforts are undertaken to eliminate potential future exposures to surface and subsurface soil impacts at the Site. This is not an effective alternative for limiting lead exposure to current and future Site receptors, and as such, would not meet the no further action criteria of Env-Or 609.02. Therefore, a No Action remedial alternative will not be retained for consideration.

5.2.2 Option #2 - In-situ Stabilization

In-situ stabilization is a remedial alternative that involves the "in-place" treatment of soils which contain highly leachable organic or inorganic compounds and that are not a direct contact risk. This alternative can be completed through a variety of thermal, biological, or chemical processes, and is designed to neutralize, encapsulate or limit leaching of the chemical constituents to groundwater.

In-situ thermal stabilization and chemical oxidation are two alternatives that are typically used to address soil impacts from organic chemicals. These forms of treatment would not adequately benefit the Site since the constituents of concern are inorganic and their effectiveness is limited. As such, these alternatives will not be retained for consideration. In-situ chemical stabilization is a technology that involves mixing chemical additives with the constituents of concern to limit the leaching of lead from impacted soils. Stabilization through the use of phosphates, iron, manganese and specialized chemical blends such as Enviroblend® have been successfully used at other lead contaminated sites. As such, in-situ chemical stabilization is considered a technically-feasible and a practical remedial alternative at this Site and will be further evaluated.

5.2.3 Option #3 – Soil Excavation and Off-Site Disposal

Soil excavation and off-site disposal is a risk reduction measure that involves relocation of the constituents of concern from the Site to an approved disposal facility. Excavation and off-Site disposal is a proven and commonly used method that addresses all chemicals and is generally easily implemented. This alternative often targets small volumes of soil due to the costs associated with excavation, transportation, and disposal. In addition, the process of excavating the impacted soils would require complete destruction of the forested portion of the shot fall zone.

Impacted soil could be mechanically excavated by readily available excavation equipment or may be remove through the use of a vacuum box which can be filled and transported to the disposal facility. Treatment/stabilization of excavated soil may be required where elevated concentrations fail to meet the Toxic Characteristics Leaching Procedure (TCLP) criteria and render the excavated soil a hazardous waste. Stabilization may be performed in-situ, at an on-site stockpile or staging area, or at the receiving facility.

Removal and off-site disposal are common methods of site remediation. Given the proven performance of excavation as a site remedy at similar sites, this technology will be retained for further evaluation.

5.2.4 Option #4 - Monitored Natural Attenuation

Monitored natural attenuation (MNA) is typically a remedial option that is used to address contaminated groundwater and soil associated with petroleum or chlorinated solvents that readily degrade under naturally occurring conditions. Inorganic contaminants such as lead are persistent and do not readily degrade. For this reason and since groundwater is not an impacted media, this alternative is not considered a viable remedial alternative.

5.2.5 Option #5 –Limited Capping

The current and foreseeable use of the Site is anticipated to be used as a sportsman's club. The club is private and is secured with a gate to limit vehicle access. The ESC currently conducts hunter safety classes on the Site and fishermen use the walking paths to gain access to the water for fishing. The frequency of the hunter safety classes is approximately 4 to 6 times per year for an instructor. Students will attend the class once in a lifetime. Use of the walking paths is likely also limited to a few times per year. With the exception of a short segment of the walking path, the majority of the path is located outside of the shot fall zone. Given the exposure to lead shot is defined by low intensity and low frequency of use, the use of the RCMP UCL is appropriate for the Site. As stated earlier, the Site is not easily accessed by the general public.

Implementation of this alternative will result in the lateral extent of the area requiring remediation being significantly reduced. The forested area requiring remediation may be able to be capped using a soil cap to limit exposure to lead shot. If capping is considered, an inventory of the types of trees will be required. Typically the roots of shallow rooted trees such as hemlock and pine may become smothered and increase tree mortality. Deep rooted tress such as oak tree would be less likely to be impacted. Lead shot located in the walking paths may be able to be either vacuumed up or capped with a geotextile and wood chips. This combination of remedial technologies will be retained for further consideration.

5.2.6 Option #6 - Access Restriction/Institutional Controls

Access restriction such as fencing can be used to eliminate the direct exposure pathway. Remedial alternatives that restrict access or limit exposure while the technology remains in place will require an institutional control to maintain a condition of No Significant Risk. Institutional controls establish administrative restrictions on the use of a site that would otherwise result in exposure to existing Site contaminants. This would require the filing of a deed restriction in the form of an Activity and Use Restriction (AUR), as outlined in Env-Or 608. An institutional control in the form of an AUR is not appropriate if the remediation objective is to achieve unrestricted future use of this Site. However, an AUR may be used in conjunction with other technologies such as fencing to achieve or maintain protection of human health and the environment. The current and foreseeable future use of the Site is a recreational sportsman's club, and as such certain Site use restrictions could be established. Therefore institutional controls have been retained for consideration in the development of a comprehensive remedial scenario at the Site.

5.3 Detailed Evaluation of Remedial Alternatives

AECOM conducted an initial screening of the technologies presented above to determine which have the greatest potential to limit immediate risks to human health and the environment. The following potentially applicable technologies were selected for further evaluation:

- **In-Situ Stabilization –** This alternative includes distribution of stabilization agents on the ground surface and rototilling them into the top 6 to 15 inches of soil depending on the location. This alternative relies on the implementation of institutional controls such as an AUR to limit future exposure to constituents of concern.

- **Soil Excavation and Off-Site Disposal** – This alternative includes excavation of contaminated soils with concentrations greater than 400 ppm across the Site. A portion of the soil will be required to be stabilized on Site before it can be transported to a Subtitle D landfill.

- **Capping** – This alternative is based on capping the portion of the shot fall zone where concentrations of lead in soil exceed the NHDES upper concentration limit (UCL) of 4,000 ppm for lead. Areas exceeding the UCL will be capped with topsoil to support a vegetative cover that will limit exposure to lead shot. This alternative relies on the implementation of institutional controls such as an AUR to limit future lead exposure.

- **Access Restriction**– This alternative would include the installation of a fence to limit access to the lead impacted soil and relies on implementation of an AUR to limit future human exposure to constituents of concern.

Each of the four remedial alternatives listed above was identified as having potential to achieve no further action criteria of Env-Or 609.02. A description of each alternative and the results of the comparative analysis are presented in the following subsections.

5.3.1 *Remedial Alternative #1: In-Situ Stabilization*

Prior to conducting stabilization at the Site, bench and pilot scale treatability study will have to be conducted to determine the optimum mix design for the stabilization reagents. Once determined, the delivery mechanism will have to be evaluated (rotary head mixer, rototiller, disk harrow, pug mill, mechanical mixer, etc.) based on the delivery mechanism's ability to work around trees. More than likely removal of brush, small and dead trees and low lying branches will be required. It is anticipated that approximately 3.5 acres of the shot fall zone contain lead at concentrations greater than 400 ppm. Stabilization of this area will result in the need to treat approximately 3,500 cubic yards or about 4,500 tons of soil. Although two of the alternatives discussed below have a cleanup objective of 4,000 ppm, AECOM believes that in order to access the 4,000 ppm areas, a substantial portion of the 400 ppm area will need to be cleared to gain access. As such, the cleanup objective for this technology was set at 400 ppm.

Advantages of this alternative include:

1. Leaching of lead to groundwater is less likely to occur than the current condition; and
2. Encapsulation of the lead shot will slightly reduce the exposure potential.

Disadvantages of this method include:

1. The need to conduct bench and pilot tests are expensive and delay the implementation;
2. The need to remove small and dead trees which provide habitat for small animals;

3. Stabilization (encapsulation) does not address dermal contact as efficiently as other technologies such as capping or removal;
4. Although stabilization limits the leaching potential, the groundwater has not been, nor is it expected, to be impacted;
5. The success of the stabilization technology is heavily dependent on the ability to mix the soil so that the reagents come in contact with the lead. The presence of shallow tree roots will significantly limit this technology's ability to distribute the reagents. Further, the mixing process will likely have a detrimental effect on the tree roots and cause a significant increase in tree mortality;
6. The potential impacts from the application of the chemistry to trees and future vegetation are unknown; and,
7. Stormwater runoff could have detrimental impact to aquatic life in the reservoir.

The estimated cost for implementing Remedial Alternative #1 is approximately $343,000 rounded to the nearest $1,000. According to the USEPA feasibility study guidance, estimated costs at this level of detail can range from minus 30% to plus 50%. As such, the cost for this alternative could range from $240,000 to $514,000. This estimate includes costs for: mix design studies; Site preparation including establishing erosion controls, minimal tree clearing, brush removal, tree pruning; remedial additives, soil mixing, and site restoration including application of 3 acres of loam and hydro seeding. AECOM assumes $28,000 in developing remediation work plans, specifications and bid documents, $30,000 in construction oversight, and $10,000 for confirmatory sampling and analysis.

5.3.2 *Remedial Alternative #2: Soil Excavation and Off-Site Disposal*

Remedial Alternative #2 consists of removing lead-impacted soils at the Site through excavating and disposing the material at a licensed Subtitle D landfill. Based on the sampling conducted to date, it is anticipated that approximately 3,500 cubic yards or approximately 4,550 tons of soil will require off-site disposal at a Subtitle D landfill. Given the elevated concentrations of lead up to 330,000 ppm, it is highly likely that a portion of the impacted soil would not pass the TCLP requirement of 5 mg/l. As such, approximately 2210 tons of soil will be required to be stabilized on site before it can be shipped to the landfill as a non-Hazardous material. This alternative will require tree clearing, stump removal, excavation, stabilization and site restoration, which will likely include loaming and seeding with some tree plantings. Like the stabilization alternative, AECOM believes that in order to access the 4,000 ppm areas, a substantial portion of the 400 ppm area will need to be cleared to gain access. As such, the cleanup objective for this technology was set at 400 ppm.

Advantages of this method include:

1 The short-term duration;
2 Timely implementation to achieve no further action criteria (permanent solution);
3. The equipment and technology are readily available (excavator, vacuum, air knife, hand tools, etc.);
4. Buildings, pavement or other structures are not present on the Site; and,
5. The Site would not require an AUR to meet the no further action criteria.

Disadvantages of this method include:

1. The need to clear cut and grub 3 acres;
2. The need to excavate soil on the abutting property;

3. The need to stabilize hazardous soils to render them non-hazardous;
4. The cost of waste soil transportation and disposal;
5. Potential for erosion and sediment loading to the adjacent reservoir; and,
6. The time required to reestablish trees and vegetation.

The estimated cost for implementing Remedial Alternative #2 is $916,000. Using the feasibility study costing range, the cost for this alternative could range from $641,000 to $1,374,000. This estimate includes costs for tree clearing, stump removal, excavation, stabilization, transportation and disposal of 4550 tons of soil at a Subtitle D landfill, confirmatory sampling, application of 3.5 acres of loam, hydro seeding, and planting of up to 250 tree saplings. AECOM assumes $77,000 in developing remediation work plans, specifications and bid documents, $60,000 in construction oversight, and $10,000 for confirmatory sampling and analysis.

5.3.3 *Remedial Alternative #3: Limited Capping*

Remedial Alternative #3 consists of using the RCMP UCL for lead of 4,000 ppm as the cleanup objective. Areas with concentrations of lead below the UCL would be left untreated while areas with concentrations of lead greater than the UCL would be capped. These areas would be either forested ground or walking paths. The forested areas would be capped with a maximum of 6 inches of topsoil. As previously mentioned, applying 6 inches of topsoil could smother the shallow rooted trees. The tree mortality would be dependent on the type of tree (deep or shallow rooted), the age of the tree, and the ability to limit the cap at the base of the tree. In some locations it may be possible to remove the soil at the base of the trees and replace it with topsoil. The material removed from the base of the tree would be spread in open areas within the forest and would be capped. This alternative will require detailed design studies to be conducted by a certified arborist.

Advantages of this alternative include:

1. The UCL is based on the RCMP and will still be considered to be conservative given the assumptions used to develop the UCL and actual site conditions;
2. Exposure to higher than UCL concentrations of lead shot is eliminated;
3. A smaller area will require remediation;
4. Less disturbance to the existing ground cover vegetation;
5. Minimizes tree cutting; and,
6. Walking paths can be reworked to be more easily traveled.

Disadvantages of this method include:

1 Tree mortality rate is unknown and all trees in the capped area may die over time;
2 Concentrations of lead are not reduced in the environment;
3 This alternative will require the use of an AUR; and
4 This alternative will require some tree clearing to gain access to the greater than 4,000 ppm of lead areas.

The estimated cost for implementing Remedial Alternative #3 is $174,000 and could range from $122,000 to $261,000. The area requiring capping is estimated to be approximately 70,000 square feet of forest and 425 feet of walking path. Approximately 1,300 cubic yards of soil will be required for capping and 150 square yards of geotextiles will be required to cover the walking paths. We assume that brush and small trees can be gathered and chipped to provide cover over the geotextile. AECOM assumes $10,000 in developing remediation work plans and $60,000 in construction oversight.

5.3.4 *Remedial Alternative #4: Access Restriction/Institutional Controls*

Remedial Alternative #4 consists of restricting access through installation of fencing around the portion of the Site where concentrations of lead are greater than 4,000 ppm. Under foreseeable Site uses (future use), restricting access is not considered an appropriate permanent solution due to remaining risks and hazards associated with potentially accessible soils. Therefore, the implementation of an AUR must be used in conjunction with fencing to notify perspective buyers of the property that they must continue to eliminate risks to human health and the environment by maintaining the fence. The fence can only be removed if another equally protective remedy is implemented. This would require the filing of a deed restriction in the form of an AUR, as outlined in Env-Or 608.01.

Advantages of this alternative include:

1 Exposure to highest concentrations of lead shot is eliminated;
2 Trees and vegetation are minimally impacted; and
3 This alternative Is the least expensive alternative;

Disadvantages of this method include:

1 Access to the fenced area is restricted and this portion of the forest cannot be used;
2 This alternative will require the use of an AUR;
3 This alternative will restrict wild life movement; and
4 This alternative cannot be implemented on property not owned by the Town without the land owner's approval.

The estimated cost for implementing Remedial Alternative #4 is $104,000 and could range from $72,000 to $155,000. This estimate includes $66,000 for the installation of 2,200 linear feet of 6 foot high fencing, $5,000 for a land survey in support of the AUR, $10,000 for the writing and filing the AUR at the Rockingham County registry of deeds, and $14,000 for construction oversight.

5.4 Comparison to Comparative Evaluation Criteria

In accordance with Env-Or 606.12(c), these remaining remedial alternatives were subjected to a relative comparative analysis for the following criteria:

a) Effectiveness and reliability;

b) Feasibility and ease of implementation;

c) Risk reduction and associated benefits;

d) Cost effectiveness; and

e) Timeliness.

As part of this evaluation, each remedial alternative was assigned a relative ranking (1 through 4, with 4 being the most desirable and 1 being the least desirable) for each category. A *Comparative Evaluation of Alternatives Matrix* is provided as **Table 2**, and a *Remedial Alternatives Ranking Summary* is provided as **Table 3**. The following subsections briefly discuss the rationale used to assign the ranking selected for each alternative in each of the five evaluation categories.

5.4.1 Effectiveness and Reliability

The *Effectiveness and Reliability* criterion takes into account the remedial alternative's ability to achieve no further action criteria established under Env-Or 609.02, while considering the degree of certainty that the technology will be successful. All four alternatives will be effective in protecting human health and the environment. The most effective alternative was excavation and off-site disposal of impacted soils where the concentration of lead exceeded 400 PPM. This alternative effectively removes the contaminated soil and replaces it with clean backfill. Access restriction coupled with a land use restriction was judged to be the second most effective alternative since it restricts access to lead impacted soils thereby eliminating the exposure. Since lead shot has existed in the environment for almost 30 years and monitoring wells located around the range have seen negligible impacts, the impacts from residual lead shot in the remaining shot fall zone are not believed to pose a significant threat to groundwater. Capping would eliminate the exposure pathways in the near future; however, depending on the final cap grades and storm events, portions of the Site may be susceptible to erosion which could re-expose the lead shot. Soil stabilization was judged to be the least effective alternative since this technology does not really address the dermal contact and ingestion exposure pathways.

5.4.2 Feasibility and Ease of Implementation

The Feasibility and Ease of Implementation criterion takes into account the complexity of the remedial alternative, the availability of necessary resources, expertise or receiving facilities, and physical limitations or regulatory restraints to activation. Access restriction was judged to be the most easily implementable alternative mostly due to its limited disruption of the wooded area. Installation of a 6 foot high chain link fence is common in wooded areas and requires no specialized equipment. All three of the other alternatives require varying degrees of brush clearing and or tree removal. Excavation and off-site disposal of impacted soils would be the most complicated since it involve clear cutting the forest, uses heavy equipment to excavate the soil, will require stabilization of some of the high lead soils, and will require reforestation. Soil stabilization would be less complicated however mixing the chemical admixtures into the soil would be problematic in areas with shallow tree roots. In addition, the ground surface would have to be restored through the application of loam which will be difficult to distribute in the wooded areas. Likewise, the capping alternative would be complicated in that the capping soils would have to be brought in from off-site and be distributed, graded, compacted and seeded in tight areas if the trees were to remain.

5.4.3 Risk Reduction and Associated Benefits

The Risk Reduction and Associated Benefits criterion evaluates short-term and long-term, on-site and off-site risks to public health, safety, and the environment during and following the implementation of the remediation alternative. The criterion also evaluates the possible benefits of restoring natural resources, reuse of the Site, and the avoided costs associated with relocation of residences or potential lost value of a site. Excavation and off-site disposal of lead impacted soils was judged to provide the most long term risk reduction. In the short term, there will be moderate risks associated with operation of large construction equipment; however, that risk can be mitigated by using a well-qualified contractor and strict adherence to a health and safety plan. This is the only alternative that will result in unrestricted use of the Site after implementation. The greatest disadvantage of this alternative is the number of years it will take to restore the forest to its current condition. Access restriction using a 6 foot high fence was judged to be the second most effective risk reduction alternative since it eliminates the exposure pathways. The fence will need to remain in place and maintained, and an AUR will need to be recorded in the deed until such time as the impacted soils are removed, presumably during future development of the property or when/if another equally protective alternative is implemented. The two remaining alternatives would have adequate short term risk reduction; however, there is some question regarding how long the stabilization will remain effective as the lead shot continues to degrade. In addition, there is concern that erosion of capped soils may expose lead shot and re-create an exposure pathway.

5.4.4 Cost Effectiveness

The cost effectiveness criterion evaluates costs associated with the remediation alternative, including implementation, restoration costs and impacts on limited energy resources. The cost estimates for each technology included in **Table 4** were used as the basis for assigning the cost ranking. The cost estimates provided herein are based on contractor's quotes, published information and industry experience. They reflect order-of-magnitude costs and have been prepared solely for the relative comparison of the identified alternatives. As such, these cost data are not to be used as design-level estimates. The USEPA suggest that costing at the feasibility study level be given in ranges of minus 30 percent to plus fifty percent of the estimated cost. Table 4 calculates the low and high range costs for each alternative. As previously discussed in section 5.3, the most cost effective alternative was determined to be Access Restriction ($72,000 to $155,000) followed by Capping ($121,000 to $261,000), followed by In-situ Stabilization ($240,000 to $514,000). Soil excavation and off-site disposal had the highest cost ($641,000 to $1,374,000).

5.4.5 Timeliness

The timeliness criterion evaluates the estimated period of time required to achieve the no further action criteria pursuant to the requirements of Env-Or 609.02. With the exception of soil excavation and off-site disposal, the remaining three alternatives will need to rely on an AUR to maintain a condition of no significant risk. None of these three alternatives results in a reduction of contaminant mass or volume. As such, future use of the property will be restricted until such time as development occurs that removes the residual contamination or until an equally protective alternative is implemented. The excavation and off-site disposal alternative will achieve a condition of No Significant Risk as soon as the soil has been removed; however, it will take 10s of years to restore the forest to its current condition. Similarly, soil stabilization and capping are expected to have a significant impact on tree mortality and will also take decades for the forest to return to its current condition. Access restriction will have the least impact of all four alternatives on the health of the forest.

6.0 RANKING OF REMEDIATION OPTIONS EVALUATED

The criteria evaluated in Table 2 have been summarized in Table 3 and indicate following scores: Access Restriction with Institutional Controls (15 points); Soil Excavation and Off-site Disposal (14 points); Capping with Institutional Controls (13 points); and, In-Situ Stabilization (8 points). As such, Access Restriction with Institutional Controls is the preferred alternative.

The Access Restriction with Institutional Controls will need to be further evaluated during the design process. This alternative relies on fencing all portions of the shot fall zone where concentrations of lead are above 4,000 ppm. The current data set identifies concentrations of lead in soil in Areas 2 and 3 ranging from less than 400 ppm to 330,000 ppm. The wide range in reported lead concentrations is likely due to the procedures used in the analytical analysis of the soil samples. More specifically, CDM and AECOM provided representative samples of soil collected at numerous locations throughout the Site. The samples were provided to the laboratory in glass containers and a small aliquot of the sample was removed and analyzed by the laboratory staff. Since the diameter of a single lead shot is equivalent to that of a sand particle, it is reasonable to assume that for the higher reported concentrations of lead in soil, lead shot was actually included in the soil sample and was analyzed by the laboratory instrumentation. As such, the concentrations of lead in soil have to be considered as highly variable.

The future use of the property is likely to remain a Sportsmans club. The activities that are conducted in the impact areas (hunter safety courses, possible action archery, hunting, etc.) are infrequent and the likelihood of extended exposure to lead is highly unlikely given that a significant portion of the impacted area is located directly behind an active small bore shooting range. Further, signs have been posted warning passersby of the active range. Lastly, due to the range's location in approximately 100 plus acres of woods, access to the impacted portion of the property is greatly limited. Passersby are not likely to wander into the area and become exposed for any significant portion of time.

Based on the exposure scenarios previously described, using the RCMP UCL as the cleanup objective for lead containing soils can be protective of human health and the environment. Soils with concentrations below this limit would not need to be restricted with a fence due to the likely short duration of an exposure. An AUR would be put on the portion of the Site where concentrations of lead in soil are known to exceed the UCL. This approach limits the amount of fencing required, while providing restrictions on future use of the area with soil concentrations above the UCL. In addition, it notifies future purchasers of the land of the environmental restrictions and obligations that come with ownership.

7.0 REFERENCES

ASTM, 2010, *Standard Guide for Risk Based Corrective Action* (ASTM E 2081-00),

CDM, 2003. Appendix B of the *Phase 2 Water Treatment Plant Preliminary Design Report*.

NHDES, 2001. *Field Sampling Procedures Guidance Manual*, October 2001.

NHDES, 2015. *Chapter Env-Or 600 Contaminated Site Management*, Effective June 1, 2015.

TABLES

TABLE 1
GROUNDWATER ANALYTICAL SUMMARY
Antimony, Arsenic, Lead and PAHs

	NHDES AGQS	Year	MW-2	MW-3	MW-4	MW-5
Antimony	0.006 mg/l	June 27, 2010	<0.001mg/l	<0.001 mg/l	**0.008 mg/l**	<0.001 mg/l
		July 28, 2011	<0.001mg/l	<0.001 mg/l	**0.008 mg/l**	<0.001 mg/l
		December 13, 2012	<0.001mg/l	<0.001 mg/l	0.003 mg/l	<0.001 mg/l
Arsenic	0.010 mg/l	April 28, 2005	<0.005	0.011	0.006	<0.005
		August 2, 2005 **	<0.3	<0.3	<0.3	<0.3
		June 27, 2010	0.001 mg/l	**0.035 mg/l**	0.002 mg/l	0.003 mg/l
		July 28, 2011	0.004 mg/l	**0.015 mg/l**	<0.001 mg/l	<0.001 mg/l
		December 13, 2012	<0.001mg/l	0.004 mg/l	<0.001 mg/l	<0.001 mg/l
Lead	0.015 mg/l	April 28, 2005	**0.017**	0.014	<0.005	<0.005
		August 2, 2005	0.0076*	0.0058*	<0.003	<0.003
		June 27, 2010	<0.001 mg/l	<0.001 mg/l	0.004 mg/l	0.013 mg/l
		July 28, 2011	<0.001 mg/l	<0.001 mg/l	<0.001 mg/l	<0.001 mg/l
		December 13, 2012	<0.001 mg/l	<0.001 mg/l	<0.001 mg/l	<0.001 mg/l
All PAHs (8270D)		June 27, 2010	Not sampled	<0.1 ug/l	<0.1 ug/l	Not sampled
		July 28, 2011	Not sampled	<0.1 ug/l	<0.1 ug/l	Not sampled
		December 13, 2012	Not sampled	<0.1 ug/l	<0.1 ug/l	Not sampled

Notes:
* indicates compound detected in lab blank
** August 2005 detection limits greater than NHDES AGQS for Arsenic
Concentrations in bold exeed NHDES AGQS

TABLE 2:
COMPARATIVE EVALUATION OF ALTERNATIVES MATRIX
EXETER SPORTSMAN'S CLUB
EXETER, NEW HAMPSHIRE

		REMEDIATION ALTERNATIVE			
EVALUATION CRITERIA		**In-Situ Stabilization**	**Soil Excavation and Off-Site Disposal**	**Capping and Institutional Controls**	**Access Restriction and Institutional Controls**
1. Effectiveness and Reliability - Env-Or 606.12(c)(1)					
a)	Achieving no further action criteria established under Env-Or 609.02	Will require an AUR to achieve no further action criteria since the lead will remain on site.	Will achieve no further action criteria.	Will require an AUR to achieve no further action criteria since the lead will remain on site.	Will require an AUR to achieve no further action criteria since the lead will remain on site.
b)	Degree of certainty that the alternative will be successful	Will limit the potential for leaching lead to groundwater; however, stabilization/encapsulation is less protective in terms of dermal contact.	Soil removal coupled with confirmatory sampling provides the highest degree of certainty between the four alternatives.	This alternative will be effective in limiting access to lead impacted soils so long as the integrity of the cap is maintained. Maintenance will need to focus on the elimination of erosion potential	This alternative will be effective in limiting access to lead impacted soils so long as the integrity of the fence is maintained.
Ranking		**1**	**4**	**2**	**3**
2. Feasibility and Ease of Implementation - Env-Or 606.12(c)(2)					
a)	Technical complexity of the alternative	Moderate to high technical complexity.	Moderate technical complexity.	Moderate technical complexity.	Low technical complexity.
b)	Integration of the alternative with existing facility operations and other current or potential remedial actions	The site is routinely occupied by club members and students. During construction activities, which are estimated to be 30 day,s the range will need to be closed.	The site is routinely occupied by club members and students. During construction activities, which are estimated to be 60 days, the range will need to be closed.	The site is routinely occupied by club members and students. During construction activities, which are estimated to be 60 days, the range will need to be closed.	The site is routinely occupied by club members and students. During construction activities, which are estimated to be 14 days, the range will need to be closed. This is the least disruptive alternative.
c)	Monitoring, operations, maintenance or site access requirements or limitations	Long term operation, maintenance and monitoring will be minimal	Long term operation, maintenance and monitoring will be minimal	Annual inspections of the cap will be required. In addition there is a potential for above average tree mortality. As the trees die off they can become susceptible to overturning and can potentially expose lead impacted soils. Site is readily accessible.	Annual inspections of the fence will be required. Since the site is in a remote location and few persons use the area, inspections should be quick and straight forward.
d)	Availability of necessary services, materials, equipment, or specialists	Difficulties are not anticipated with obtaining the required services, materials, or equipment.	Difficulties are not anticipated with obtaining the required services, materials, or equipment.	Difficulties are not anticipated with obtaining the required services, materials, or equipment.	Difficulties are not anticipated with obtaining the required services, materials, or equipment.
e)	Availability, capacity, and location of necessary off-site treatment, storage and disposal facilities	None required.	Potential difficulties expected due to the large volume of material requiring off site disposal.	None required.	None anticipated.
f)	Whether the alternative meets regulatory requirements for any likely approvals, permits or licenses required by NHDES or other state, federal, or local agencies	Alteration of terrain permit may be required	Alteration of terrain permit will likely be required. Permitting of waste hauling trucks and acceptance of the soil at the disposal facility will be required	Alteration of terrain permit may be required	None required.
Ranking		**2**	**1**	**3**	**4**
3. Risk Reduction and Associated Benefits - Env-Or 606.12(c)(3)					
a)	Short-term on-site and off-site risks posed during implementation of the alternative associated with any excavation, transport, disposal, containment, construction, operation or maintenance activities, or discharges to the environment from remedial systems	Highest short-term risk associated with soil mixing and wind blown emissions.	Moderate short-term risk associated with excavating and trenching. Procedures are well established. Transportation and Disposal will need to be done by licensed carriers.	Moderate short-term risk due to the need for brush cutting, chipping, clean soil hauling and placement.	Slight short-term risk associated with excavating and trenching.
b)	On-site and off-site risks posed over the period of time required for the alternative to attain applicable remedial standards, including risks associated with ongoing transport, disposal, containment, operation or maintenance activities, or discharges from remedial systems	Potential long term risk associated with degradation of the chemicals used to encapsulate the lead shot. In addition, lead shot will breakdown with time rendering the stabilization reagents less effective.	Little to no long-term risk.	Moderate long-term risk associated with maintaining the cap.	Little to no long-term risk.
c)	Potential risk of harm to health, safety, public welfare or the environment posed to human or environmental receptors by any OHM remaining at the disposal site after the completion of the remedial action	Treatment will stabilize the hazardous characteristic of the lead shot but will not significantly address the direct contact exposure pathway. In addition, there may be unintended consequences to groundwater and	Lead shot will have bee removed to below 400 PPM. Therefore a condition of no significant risk will have been achieved.	Remaining lead shot will capped and will eliminate the exposure pathway. Therefore a condition of no significant risk to dermal exposure, ingestion or inhalation will have been achieved.	Restricting access to remaining to lead shot will eliminate the exposure pathway and represent a condition of no significant risk. Remaining OHM is not believed to be an issue relative to groundwater based on the range closure in 1986 and recent groundwater sampling results.

TABLE 2:
COMPARATIVE EVALUATION OF ALTERNATIVES MATRIX
EXETER SPORTSMAN'S CLUB
EXETER, NEW HAMPSHIRE

		REMEDIATION ALTERNATIVE			
EVALUATION CRITERIA		**In-Situ Stabilization**	**Soil Excavation and Off-Site Disposal**	**Capping and Institutional Controls**	**Access Restriction and Institutional Controls**
d)	Benefit of restoring natural resources	The natural resources may be impacted by the stabilization chemistry	Natural resources will be restored over a long period of time as the forest re-establishes itself.	Natural resources will be restored in a shorter period of time as the forest and wildlife get acclimated to the cap.	Natural resources will be maintained.
e)	Providing for the productive reuse of the site	Future site use will likely be unrestricted.	Future site use will be unrestricted.	Future site use will be restricted.	Future site use will be restricted.
f)	Avoided costs of relocating people, businesses, or providing alternative water supplies	Relocating people, businesses, or providing alternative water supplies is not applicable under the current site conditions.	Relocating people, businesses, or providing alternative water supplies is not applicable under the current site conditions.	Relocating people, businesses, or providing alternative water supplies is not applicable under the current site conditions.	Relocating people, businesses, or providing alternative water supplies is not applicable under the current site conditions.
g)	Avoided lost value of the site	Future site use may be unrestricted and the club can continue to operate.	Future site use will be unrestricted.	Future site use will be restricted until such time as the lead impacted soils are removed.	Future site use will be restricted until such time as the lead impacted soils are removed.
Ranking		**1**	**4**	**2**	**3**
4. Cost Effectiveness - Env-Or 606.12(c)(4)					
a)	Costs of implementing the alternative, including without limitation: design, construction, equipment, site preparation, labor, permits, disposal, operation, maintenance, and monitoring costs.	Second highest ($240,000 to $514,000)	Highest ($641,000 to $1,374,000)	Second Lowest ($122,000 to 261,000)	Lowest ($72,000 to $155,000)
b)	Costs of environmental restoration, potential damages to natural resources, including consideration of impacts to surface waters, wetlands, wildlife, fish and shellfish habitat.	Included in above estimated cost calculations. Note that there could be impacts to groundwater and vegetation that could require further investigation and mitigation.	Included in above estimated cost calculations.	Included in above estimated cost calculations. Note that there could be a potential mortality issue with capping and smothering tree roots, which may require further evaluation and mitigation in the form of needing to provide plantings.	Included in above estimated cost calculations.
c)	Relative consumption of energy resources in the operation of the alternatives, and externalities associated with the use of those resources.	Included in above estimated cost calculations. Note that energy consumption will be required only during construction	Included in above estimated cost calculations. Note that there could be impacts to groundwater and vegetation that could require further investigation and mitigation.	Included in above estimated cost calculations. Note that there could be impacts to groundwater and vegetation that could require further investigation and mitigation.	Included in above estimated cost calculations. Note that there could be impacts to groundwater and vegetation that could require further investigation and mitigation.
Ranking		**2**	**1**	**3**	**4**
5. Estimated Time to Reach No Further Action Criteria - Env-Or 606.12(c)(5)					
a)	Estimated duration to achieve no further action criteria	This alternative will not achieve a condition of no significant risk in the absence of an AUR. As such, the period of time required to meet the no further action criteris is unknown.	3-4 months	This alternative will not achieve a condition of no significant risk in the absence of an AUR. As such, the period of time required to meet the no further action criteris is unknown.	This alternative will not achieve a condition of no significant risk in the absence of an AUR. As such, the period of time required to meet the no further action criteris is unknown.
Ranking		**2**	**4**	**3**	**1**

Notes:
Rankings are comparative with the greatest number possible (4) being the most favorable and the lowest number possible (1) being the least favorable

TABLE 3
REMEDIAL ALTERNATIVES RANKING SUMMARY TABLE
EXETER SPORTSMAN'S CLUB
EXETER, NEW HAMPSHIRE

Remedial Alternative No.	Description	Effectiveness and Reliability	Feasibility and Ease of Implementation	Risk Reduction and Associated Benefits	Cost Effectiveness	Timeliness	Score	Overall Ranking
1	In-Situ Stabilization	1	2	1	2	2	8	4
2	Soil Excavation and Off-Site Disposal	4	1	4	1	4	14	2
3	Capping with Institutional Controls	2	3	2	3	3	13	3
4	Access Restriction with Institutional Controls	3	4	3	4	1	15	1

Notes: Rankings are based on a comparison to each other. The greatest number possible (4) represents the most favorable approach while the least favorable approach is scored with the lowest possible number (1).

Score = Summation of the ranking entered for the five evaluation criteria

Overall Ranking identifies the preferred approach in terms of 1st, 2nd, 3rd and 4th preferred alternatives.

TABLE 4
ESTIMATED REMEDIAL ALTERNATIVE COSTS

Remedial Alternative 1 - In-Situ Stabilization of Soil Greater than 400 PPM

Task	Quantity	Units	Unit cost	Total Task	Cost Basis
Bench Scale Testing	1	L.S.	7,000	$ 7,000	Past Experience
Pilot Scale Testing	1	L.S.	25,000	$ 25,000	Past Experience
Mobilization	1	L.S.	10,000	$ 10,000	Contractor's Estimate
Erosion Control	2800	L.F.	2.43	$ 6,804	Past Experience
Brush Clearing	3.5	Acres	5,500	$ 19,250	Contractor's Estimate
Soil Stabilization	3.5	Acres	40,000	$ 140,000	Contractor's Estimate
Loam & Seed	3.5	Acres	19,200	$ 67,200	Contractor's Estimate
Subtotal Construction Costs				$ 275,254	
Permitting & Engineering	1	L.S.	27,525	$ 27,525	10% of total
Construction Oversight	30	Days	1,000	$ 30,000	
Confirmatory Sampling	1	LS	10,000	$ 10,000	
			Total Estimate	**$ 342,779**	
			High Range	$ 514,169	
			Low Range	$ 239,946	

Remedial Alternative 2 - Excavation and Offsite Disposal of Soil Greater than 400 PPM

Task	Quantity	Units	Unit cost	Total Task	
Mobilization	1	L.S.	10,000	$ 10,000	Contractor's Estimate
Erosion Control	2800	L.F.	2.43	$ 6,804	Past Experience
Tree Clearing	3.5	Acres	7,860	$ 27,510	Contractor's Estimate
Stump Grinding	3.5	Acres	3,000	$ 10,500	Contractor's Estimate
Soil Excavation	4550	Tons	25	$ 113,750	Contractor's Estimate
Hazardous soils stabilization	2210	Tons	50	$ 110,500	Contractor's Estimate
Soil Transportation - Non-Hazardous	4550	Tons*	25	$ 113,750	Contractor's Estimate
Soil Disposal - Non-Hazardous	4550	Tons	67	$ 304,850	Contractor's Estimate
Loam & Seed	3.5	Acres	19,200	$ 67,200	Contractor's Estimate
Tree Plantings	250	Each	18	$ 4,500	Contractor's Estimate
Subtotal Construction Costs				$ 769,364	
Permitting & Engineering	1	L.S.	76,936	$ 76,936	10% of total
Construction Oversight	60	Days	1,000	$ 60,000	
Confirmatory Sampling	1	LS	10,000	$ 10,000	
			Total Estimate	**$ 916,300**	
			High Range	$ 1,374,451	
			Low Range	$ 641,410	

Remedial Alternative 3 - Capping Soil Greater than 4,000 PPM

Task	Quantity	Units	Unit cost	Total Task	
Tree Mortality Assessment	1	Each	20,000	$ 20,000	
Mobilization	1	L.S.	10,000	$ 10,000	Contractors Estimate
Erosion Control	2800	L.F.	2.43	$ 6,804	Past Experience
Brush Clearing & Chipping	2	Acres	10,500	$ 21,000	Contractors Estimate
Geotextile	150	S.Y.	1.63	$ 245	Manufactures Estimate
Loam & Seed	1.6	Acres	19,200	$ 30,720	Contractors Estimate
Land Survey	1	Each	5,000	$ 5,000	Surveyors Estimate
Land Use Restriction	1	Each	10,000	$ 10,000	Past Experience
Subtotal Construction Costs				$ 103,769	
Permitting & Engineering	1	L.S.	10,377	$ 10,377	10% of total
Construction Oversight	60	Days	1,000	$ 60,000	
			Total Estimate	**$ 174,145**	
			High Range	$ 261,218	
			Low Range	$ 121,902	

Remedial Alternative 4 - Restricted Use of Soils Greater than 4,000 PPM

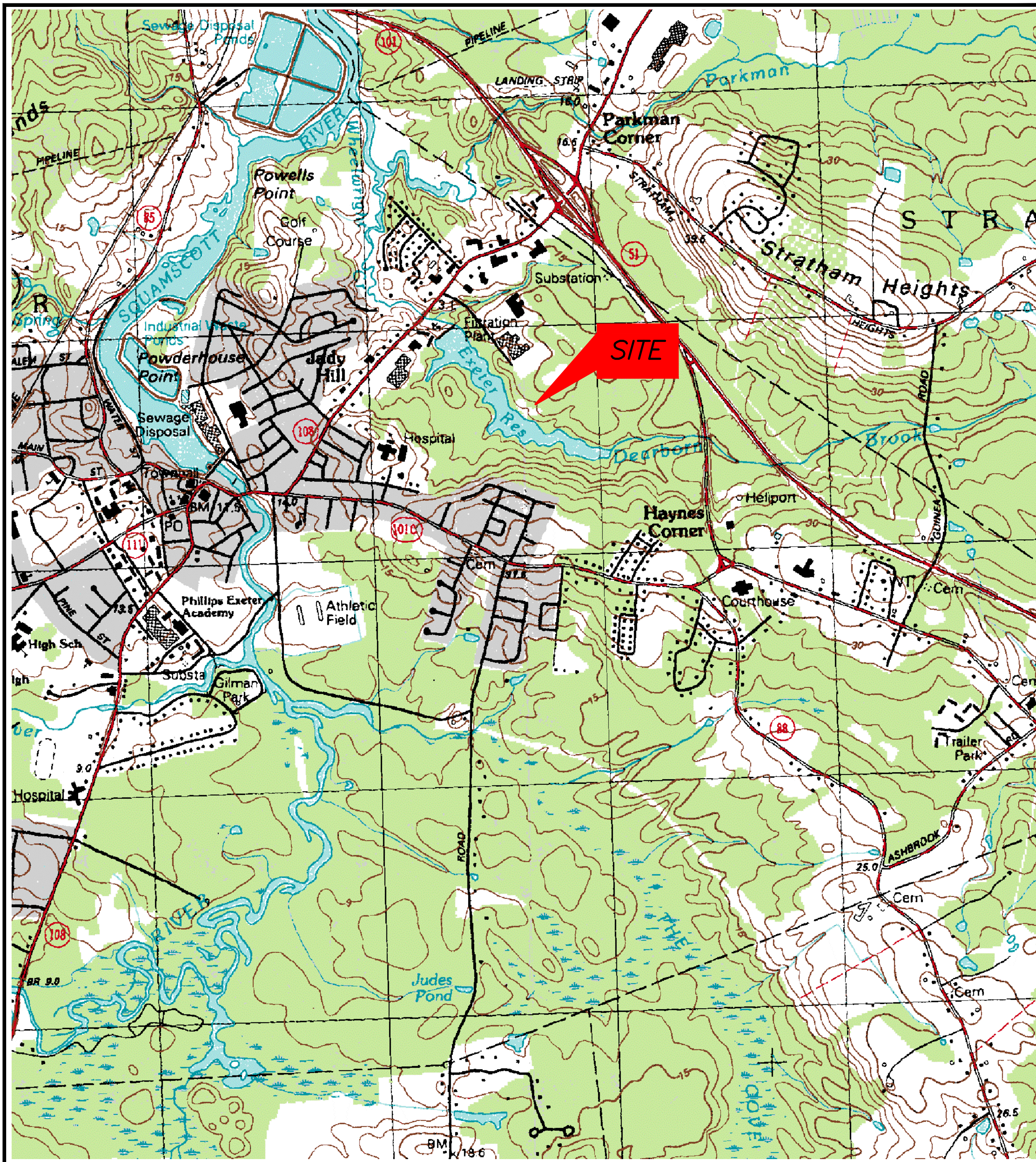
Task	Quantity	Units	Unit cost	Total Task	
Fence Installation	2,200	L.F	30	$ 66,396	Contractors Estimate
Land Survey	1	Each	5,000	$ 5,000	Surveyors Quote
Land Use Restriction	1	Each	10,000	$ 10,000	Past Experience
Subtotal Construction Costs				$ 81,396	
Permitting & Engineering	1	L.S.	8,140	$ 8,140	10% of total
Construction Oversight	14	Days	1,000	$ 14,000	
			Total Estimate	**$ 103,536**	
			High Range	$ 155,303	
			Low Range	$ 72,475	

Cost range based on -30% to +50 %

* Conversion from cubic yards to tons of soil is 1.3 tons/ cubic yard due to the organic nature of the soil being removed.

L.S. = Lump Sum, S.Y.=Square Yards, L.F.=Linear Feet

FIGURES



SOURCES:
USGS EXETER, NH QUADRANGLES
7.5 MINUTE SERIES TOPOGRAPHIC MAPS
DATED 1985

0 1000 2000 4000

APPROXIMATE SCALE (FEET)

N

SITE LOCATION MAP

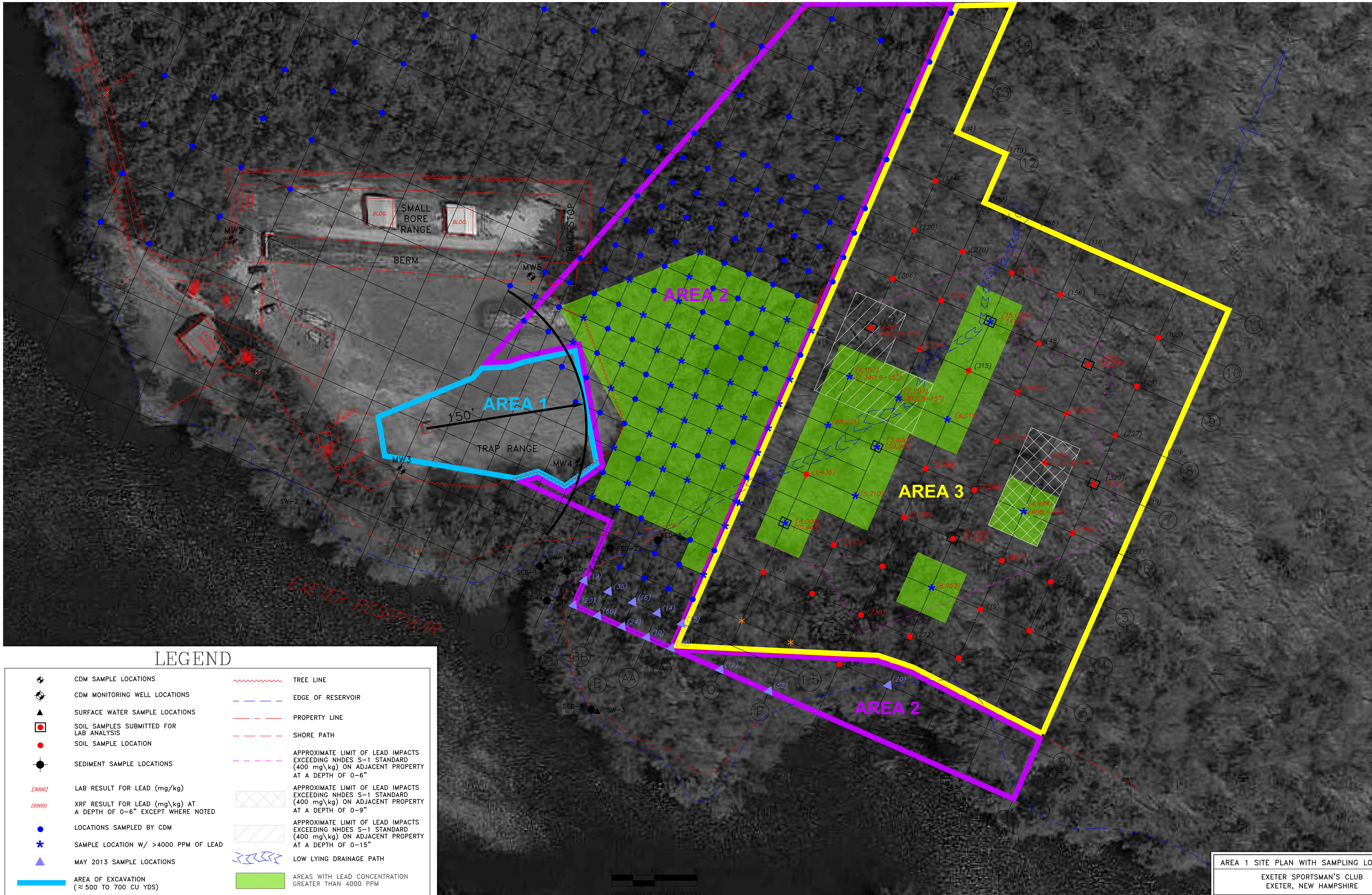
EXETER SPORTSMAN'S CLUB
PORTSMOUTH AVENUE
EXETER, NEW HAMPSHIRE

CLIENT *TOWN OF EXETER*

AECOM

AECOM; Inc.
1155 Elm Street; Suite 401
Manchester, New Hampshire 03101
Tel: 603.606.4800
Fax: 603.606.4801
www.aecom.com

SCALE	NTS	DRAWN BY	BCL	JOB NO.	60441637
DATE	10/15	APPR. BY	ALP	FIG. NO.	1



T:\ACAD-PROJECT\39743921-EXETER_SPORTSMAN_CLUB\CADD\SAMPLE RESULTS PLAN OCTOBER 2015.DWG [FIGURE 2] 10/18/15 1049PM

AREA 1 SITE PLAN WITH SAMPLING LOCATIONS

EXETER SPORTSMAN'S CLUB
EXETER, NEW HAMPSHIRE

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Manchester, New Hampshire 03101
Tel: 603.606.4800
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DRAWN BY: HAB	PROJECT NO.: 60441637	FIGURE NO.: 2
DESIGN BY: TM	SCALE: 1" = 40'	
APPROVED BY: GMG	DATE: 10/15	

LEGEND

Symbol	Description
	CDM SAMPLE LOCATIONS
	CDM MONITORING WELL LOCATIONS
	SURFACE WATER SAMPLE LOCATIONS
	SOIL SAMPLES SUBMITTED FOR LAB ANALYSIS
	SOIL SAMPLE LOCATION
	SEDIMENT SAMPLE LOCATIONS
[3000]	LAB RESULT FOR LEAD (mg/kg)
(2000)	XRF RESULT FOR LEAD (mg\kg) AT A DEPTH OF 0-6" EXCEPT WHERE NOTED
	LOCATIONS SAMPLED BY CDM
*	SAMPLE LOCATION W/ >4000 PPM OF LEAD
	MAY 2013 SAMPLE LOCATIONS
	AREA OF EXCAVATION (≈ 500 TO 700 CU YDS)
	TREE LINE
	EDGE OF RESERVOIR
	PROPERTY LINE
	SHORE PATH
	APPROXIMATE LIMIT OF LEAD IMPACTS EXCEEDING NHDES S-1 STANDARD (400 mg\kg) ON ADJACENT PROPERTY AT A DEPTH OF 0-6"
	APPROXIMATE LIMIT OF LEAD IMPACTS EXCEEDING NHDES S-1 STANDARD (400 mg\kg) ON ADJACENT PROPERTY AT A DEPTH OF 0-9"
	APPROXIMATE LIMIT OF LEAD IMPACTS EXCEEDING NHDES S-1 STANDARD (400 mg\kg) ON ADJACENT PROPERTY AT A DEPTH OF 0-15"
	LOW LYING DRAINAGE PATH

PLAN OF LEAD SAMPLE RESULTS PLAN

EXETER SPORTSMAN'S CLUB
EXETER, NEW HAMPSHIRE

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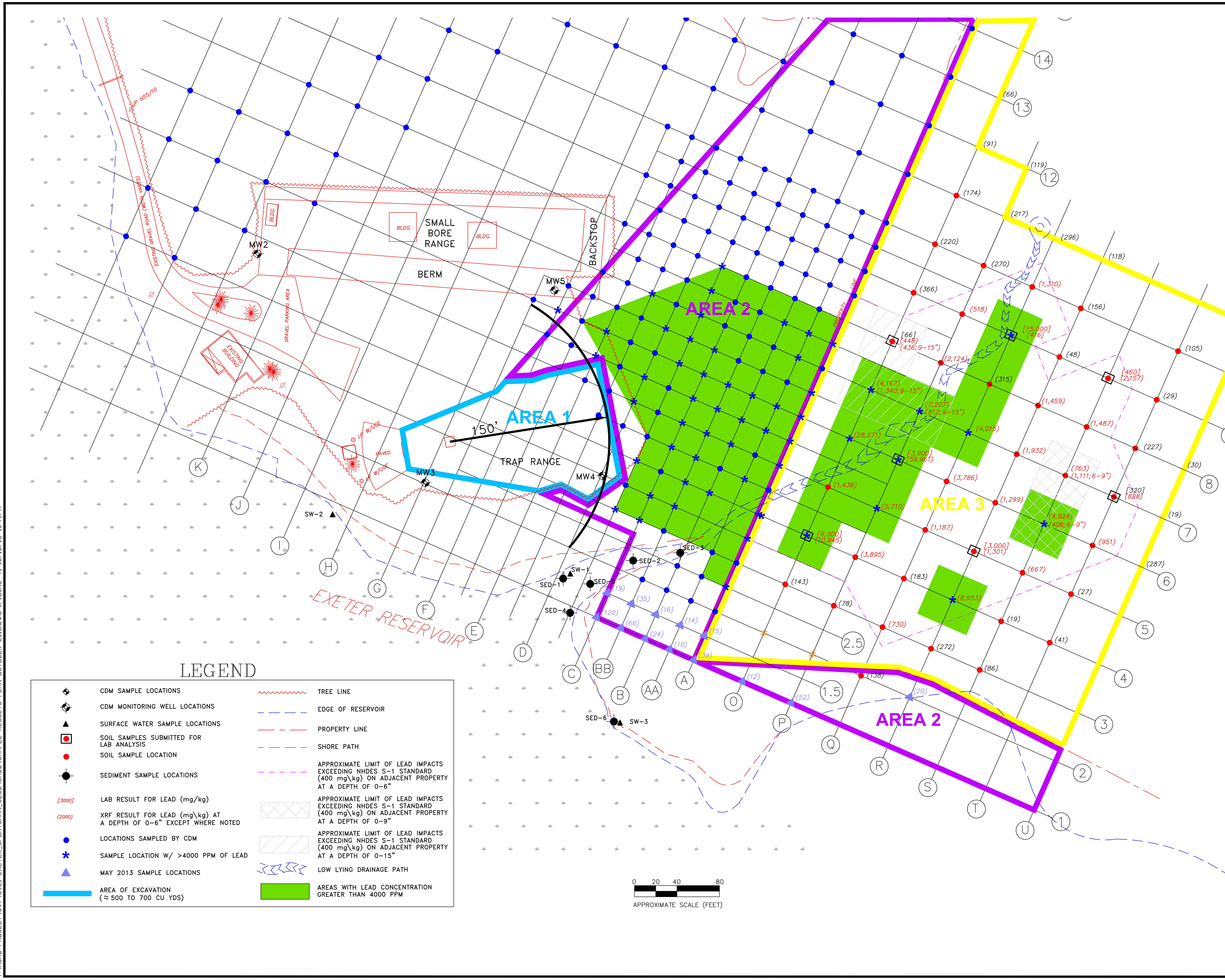
1155 Elm Street; Suite 401
Manchester, New Hampshire 03101
Tel: 603.606.4800
Fax: 603.606.4801
www.aecom.com

DRAWN BY:	HAB	PROJECT NO.:	60441637	FIGURE NO.:
DESIGN BY:	TM	SCALE:	1" = 40'	3
APPROVED BY:	GMG	DATE:	10/15	

T:\ACAD-PROJECT\39743921-EXETER_SPORTSMAN_CLUB\CADD\SAMPLE RESULTS PLAN OCTOBER 2015.DWG [FIGURE 3] 10/18/15 10:49PM

PLAN DEPICTING AREAS OF LEAD GREATER THAN 4,000 PPM



T:\ACAD-PROJECT\39743921-EXETER_SPORTSMAN_CLUB\CADD\SAMPLE RESULTS PLAN OCTOBER 2015.DWG [FIGURE 4] 10/18/15 10:49PM

PLAN DEPICTING AREAS OF LEAD GREATER THAN 4,000 PPM

EXETER SPORTSMAN'S CLUB
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Manchester, New Hampshire 03101
Tel: 603.606.4800
Fax: 603.606.4801
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DRAWN BY:	HAB	PROJECT NO.:	60441637	FIGURE NO.:
DESIGN BY:	TM	SCALE:	1" = 40'	4
APPROVED BY:	GMG	DATE:	10/15	

APPENDIX A

CDM Tables 2-1 to 2-7

Table 2-1
Summary of Soil Samples in Water Treatment Plant (Low) Area Exceeding Background Concentrations

Sample Identification	*Sample Depth*	*Lead Concentration mg/kg*
Background Concentration		51 mg/kg
RCMP Method 1 Standard		400 mg/kg
WTP-A12-0	0-6"	230
WTP-A11-0	0-6"	230
WTP-A17-0	0-6"	130
WTP-H12-0	0-6"	95
WTP-F9-0	0-6"	75
WTP-M6-0	0-6"	66
WTP-F10-0	0-6"	65
WTP-B11-0	0-6"	62
WTP-H11-0	0-6"	61
WTP-A20-0	0-6"	57

Table 2-2
Summary of Soil Samples from Water Treatment Plant (High) Exceeding Method 1 Standards

Sample Identification	*Sample Depth*	*Lead Concentration mg/kg*
Background Concentration		51 mg/kg
RCMP Method 1 Standard		400 mg/kg
Method 3 Upper Concentration Limit		4,000 mg/kg
TR-A7.5-0	0-3"	160,000
TR-AA7.5-0	0-3"	140,000
TR-CC7-0	0-3"	9,900
TR-CC8-0	0-3"	8,100
TR-CC7.5-0	0-3"	6,400
TR-B7.5-0	0-3"	6,100
TR-A8-0	0-3"	6,000
TR-DD7-0	0-3"	4,100
TR-A9.5-0	0-3"	3,100
TR-C8-0	0-3"	2,400
TR-BB8-0	0-3"	2,300
TR-E7-0	0-3"	2,000
TR-D8-0	0-3"	1,400
TR-C7.5-0	0-3"	1,400
TR-DD8-0	0-3"	1,300
TR-B9-0	0-3"	1,300
TR-B8-0	0-3"	1,300
TR-A9-0	0-3"	1,200
TR-AA8-0	0-3"	1,100
TR-B8.5-0	0-3"	1,000
TR-AA10-0	0-3"	1,000
TR-C8.5-0	0-3"	880
TR-BB7.5-0	0-3"	840
TR-C7-0	0-3"	830
TR-B9.5-0	0-3"	820
TR-DD8.5-0	0-3"	770
TR-A8.5-0	0-3"	760
TR-E8-0	0-3"	640
TR-BB9.5-0	0-3"	590
TR-D7-0	0-3"	540
TR-AA8.5-0	0-3"	520
TR-BB8.5-0	0-3"	490
TR-C9.5-0	0-3"	450
TR-A7.5-3	3-9"	1,000
TR-A8-3	3-9"	520
TR-AA7.5-3	3-9"	490
TR-BB8-3	3-9"	440
TR-A7.5-9	9-15"	1,000
TR-A8-9	9-15"	550

Table 2-3
Summary of Samples in Water Treatment Plant (High) Area Exceeding 100 mg/kg

Sample Identification	*Lead Concentration mg/kg*
Background Concentration RCMP Method 1 Standard Method 3 Upper Concentration Limit	51 mg/kg 400 mg/kg 4,000 mg/kg
TR-CC9-0	400
TR-DD7.5-0	330
TR-BB10-0	330
TR-EE8.5-0	310
TR-C10-0	290
TR-CC7-9	270
TR-A9.5-3	250
TR-AA9.5-0	250
TR-BB9-0	250
TR-DD8-3	210
TR-B8-3	210
TR-C7.5-3	200
TR-AA8.5-9	190
TR-CC8.5-0	190
TR-E8.5-0	180
TR-CC8-3	180
TR-B7.5-3	170
TR-D8.5-0	160
TR-DD9.5-0	150
TR-C8.5-3	140
TR-D8-9	140
TR-A9-9	140
TR-A10-0	130
TR-A9.5-9	130
TR-CC7-3	120
TR-D7.5-0	120
TR-AA9-0	120
TR-D9-0	120
TR-D7.5-3	110
TR-D8-3	110
TR-A8.5-3	100
TR-BB7.5-3	100
TR-BB8-9	100

Table 2-4
Summary of Soil Samples from Rifle Range Berm

Sample Identification	*Sample Depth*	*Lead Concentration mg/kg*
Background Concentration		51 mg/kg
RCMP Method 1 Standard		400 mg/kg
Method 3 Upper Concentration Limit		4,000 mg/kg
TR-E7.5-0	0-3"	470
TR-E7.5-3	3-9"	63
TR-E7.5-9	9-15"	14
TR-EE-7-0	0-3"	780
TR-EE-7-3	3-9"	120
TR-EE-7-9	9-15"	230
TR-F-7-0	0-3"	68
TR-F-7-3	3-9"	120
TR-F-7-9	9-15"	ND
TR-EE7.5-0	0-3"	2,200
TR-EE7.5-3	3-9"	190
TR-EE7.5-9	9-15"	320
TR-EE8-0	0-3"	770
TR-EE8-3	3-9"	310
TR-EE8-9	9-15"	48
WTP-F8-0	0-6"	20
WTP-F8-6	6-12"	5

Table 2-5
Summary of 0 to 3 Inch Interval Trap Range Soil Samples Exceeding RCMP Method 1 Standards

Sample Identification	*Lead Concentration mg/kg*
Background Concentration RCMP Method 1 Standard Method 3 Upper Concentration Limit	51 mg/kg 400 mg/kg 4,000 mg/kg
TR-B6-0	330,000
TR-E5.5-0	270,000
TR-C6-0	210,000
TR-C4.5-0	170,000
TR-BB5.5-0	170,000
TR-AA7-0	160,000
TR-A6-0	140,000
TR-BB4.5-0	140,000
TR-CC6.5-0	110,000
TR-AA6-0	88,000
TR-C5-0	83,000
TR-B5-0	75,000
TR-A6.5-0	67,000
TR-A5-0	49,000
TR-D5-0	24,000
TR-C6.5-0	22,000
TR-D6.5-0	20,000
TR-BB4-0	20,000
TR-C3-0	19,000
TR-A5.5-0	16,000
TR-C5.5-0	14,000
TR-BB6-0	13,000
TR-B4-0	11,000
TR-AA4.5-0	9,600
TR-CC6-0	8,400
TR-AA5.5-0	8,200
TR-F6-0	7,400
TR-A3-0	7,300
TR-CC4-0	7,200
TR-C3.5-0	6,700
TR-E6-0	6,400
TR-B5.5-0	5,700
TR-D5.5-0	5,700
TR-BB3.5-0	5,200
TR-BB5-0	5,000
TR-AA3-0	5,000
TR-A4.5-0	4,900
TR-A4-0	4,900

Table 2-5 (cont.)

Summary of 0 to 3 Inch Interval Trap Range Soil Samples Exceeding RCMP Method 1 Standards

Sample Identification	*Lead Concentration mg/kg*
Background Concentration RCMP Method 1 Standard Method 3 Upper Concentration Limit	51 mg/kg 400 mg/kg 4,000 mg/kg
TR-CC3-0	4,200
TR-B7-0	3,200
TR-AA5-0	2,900
TR-DD5.5-0	2,800
TR-DD6.5-0	2,700
TR-CC5.5-0	2,300
TR-CC4.5-0	2,200
TR-BB2-0	2,000
TR-C4-0	1,700
TR-A7-0	1,300
TR-DD5-0	1,300
TR-D6-0	1,300
TR-A3.5-0	1,000
TR-BB7-0	990
TR-CC5-0	980
TR-B4.5-0	940
TR-CC3.5-0	750
TR-AA2.5-0	730
TR-B6.5-0	730
TR-E6.5-0	650
TR-FF6.5-0	620
TR-B2.5-0	560
TR-AA6.5-0	520
TR-EE5.5-0	500

Table 2-6
Summary of 3 to 9 Inch Interval Trap Range Soil Samples Exceeding RCMP Method 1 Standards

Sample Identification	*Lead Concentration mg/kg*
Background Concentration RCMP Method 1 Standard Method 3 Upper Concentration Limit	51 mg/kg 400 mg/kg 4,000 mg/kg
TR-C6-3	200,000
TR-A6.5-3	9,400
TR-A4.5-3	2,400
TR-C5-3	2,300
TR-AA5.5-3	2,000
TR-A5-3	1,800
TR-A4-3	1,500
TR-CC3-3	1,400
TR-A5.5-3	1,400
TR-C6.5-3	1,100
TR-C5.5-3	1,100
TR-AA6-3	1,100
TR-B6-3	1,100
TR-D6.5-3	990
TR-AA5-3	910
TR-BB6-3	740
TR-C3.5-3	740
TR-C4.5-3	650
TR-A6-3	570
TR-E6-3	540
TR-CC6.5-3	530
TR-BB5.5-3	520
TR-AA3-3	510
TR-C3-3	440
TR-D6-3	430

Table 2-7
Summary of 9 to 15 Inch Interval Trap Range Soil Samples Exceeding RCMP Method 1 Standards

Sample Identification	*Lead Concentration mg/kg*
Background Concentration	51 mg/kg
RCMP Method 1 Standard	400 mg/kg
Method 3 Upper Concentration Limit	4,000 mg/kg
TR-BB5-9	150,000
TR-B4-9	100,000
TR-D5.5-9	1,800
TR-B6-9	1,300
TR-C6-9	1,200
TR-A4.5-9	1,100
TR-EE6-9	940
TR-EE5.5-9	810
TR-A6.5-9	760
TR-C6.5-9	720
TR-AA6-9	670
TR-A5-9	530
TR-C5.5-9	500
TR-D4.5-9	460
TR-BB4-9	450
TR-C4.5-9	420