EA Engineering, Science, and Technology, Inc.

12011 Bellevue-Redmond Road, Suite 200
Bellevue, WA 98005
Telephone: 425-451-7400
Fax: 425-451-7800
www.eaest.com

19 April 2004
13890.20

Mr. Dennis Boles
USDA Forest Service
1242 Lynnewood
Klamath Falls, Oregon 97601

SUBJECT: Index Sportsmen's Club – Final Field Investigation Report
Mt. Baker-Snoqualmie National Forest

EA Engineering, Science and Technology, Inc. (EA) is pleased to present this letter report on the findings of our field investigation at the Index Sportsmen's Club in Index, Washington. Following are brief discussions of the project objectives, site history and characteristics, field activities, analytical results, significance of the results, and conclusions and recommendations. A brief discussion of the applicability of Best Management Practices (BMPs) at shooting ranges is also provided. Site photographs are included in Attachment A. A list of references used is provided in Attachment B.

OVERVIEW

Soil sampling was performed at the Index Sportsmen's Club located in Index, Washington, within the Mount Baker-Snoqualmie National Forest. The site is leased to the club by the U.S. Department of Agriculture, Forest Service (Forest Service), and is used as a trap shooting range. Shallow soils in portions of the site appear to be impacted by lead from shot. Lead concentrations detected in soil samples collected from 5 locations in a wooded area at the north end of the site exceeded the U.S. Environmental Protection Agency (EPA) Preliminary Remediation Goal (PRG) criterion, as well as the state criterion, for soil in industrial areas. Arsenic was detected at elevated concentrations in soil throughout the site area, including background locations. The elevated arsenic concentrations are likely primarily due to natural processes. However, comparatively higher concentrations of arsenic were detected in two of the locations with the highest lead concentrations; elevated arsenic concentrations in these locations may be due to the presence of shot. Groundwater occurs within a few feet of the land surface in portions of the northern site area.

BACKGROUUND AND OBJECTIVES

The investigation was performed to assess whether or not lead and arsenic from shot accumulation at the trap shooting range have impacted soil at the site. Although lead is the principal component of ammunition used at shooting ranges, arsenic can occur with the lead and, in some cases, is added to the shot during manufacturing to increase the surface tension of the metal and allow a more spherical shape (Cohen 2000). Arsenic typically comprises less than 1 percent of the metal in lead shot. Typical lead shot composition includes lead (97%), antimony (2%), arsenic (0.5%), and sometimes nickel (0.5%) (EPA 2003a).

Clay targets used at shooting ranges typically are composed of approximately 67% dolomitic limestone, 32% petroleum pitch, and 1% fluorescent aqueous paint (painted targets only) (Baer, et.al. 1995). An evaluation of the potential toxicity of clay targets indicated that the target materials are not toxic, as determined by an EPA toxicity test (Baer, et.al. 1995). The targets do contain substantial amounts of polycyclic aromatic hydrocarbons (PAHs), but the PAHs are tightly bound in the petroleum pitch and lime matrix and are unlikely to be readily available in the environment. In laboratory tests, leachate from clay target fragments was not toxic to tested organisms (Baer, et.al. 1995).

Although lead in its pure metallic or alloy form is not mobile in the environment, once it oxidizes it becomes more mobile and bioavailable. The oxidation of lead in the environment is largely controlled by the chemistry of the local environment. Factors to be considered include soil pH, organic matter, clay content, and phosphorus content. The weathering rate for lead may also be affected by the amount of precipitation, pH of rain, and slope of the ground (amount of contact time with runoff). Finer soils are more likely to bind metals. Lead is also bound more tightly when the clay and phosphorus contents are higher. Lead is more mobile in soil when the pH is below 6 (Cohen 2000) or 6.5 (EPA 2001). The ideal pH for shooting ranges is 6.5 to 8.5 (EPA 2001). Arsenic mobility does not have such a simple correlation to pH (Cohen 2000).

The major factors controlling lead mobility include (Peddicord 1996):

- Acidity – the more acid the conditions, the greater the mobility of lead.

- Precipitating agents – carbonates, phosphates, and sulfates, which form lead compounds that are only very slightly soluble in water.

- Sorbents – iron and manganese oxides and hydroxides, clays, and organic matter, that do not form chemical compounds with lead, but provide a surface to which lead adheres very tightly.

Lead concentrations tend to decline with increasing depth in soil (Cohen, 2000). The highest concentrations of lead are typically found in the top 6-8 in. of soil at shooting ranges; however, elevated concentrations of lead have been detected at 24 in. below grade in skeet and trap range shotfall zones (EPA 2003). Most lead and arsenic contamination stays near the surface, although arsenic is more mobile (Cohen 2000; AWSCTF 2003). Arsenic and lead are both considered persistent contaminants; they bind strongly to soil and usually remain in the environment without breaking down or losing their toxicity (AWSCTF 2003). Lead may form immobile compounds with phosphate or sulfide. Arsenic is readily sorbed to iron compounds. Arsenic is more likely to migrate downward in heavily leached sandy-to medium-textured soils with very uniform soil profile characteristics (AWSCTF 2003).

At low velocity ranges, such as those used for trap shooting, shotfall can cover a fairly large area between the shooter and the farthest traveling shot. The travel distance depends on both the type of shot and the angle of shooting (Baldwin 1994). Smaller shot travels a shorter distance. Shot also travels a shorter distance with horizontal shooting, and further when shot at an upward angle. Shot sizes used for skeet and trap shooting are typically very small, including no. 7.5 to 9 shot (0.095 to 0.08 in.) (EPA 2003). According to a representative of the Index Sportsmen's Club, typical shot sizes used on site include no. 7.5 and 8 (0.095 to 0.09 in.). According to the National Shooting Sports Foundation (NSSF 1997), typical lead trap loads travel about 375 to 600 feet from the shooter, with a maximum distance of about 770 feet. Shot falls in a fan shape, spreading outward from the shooting position. Where multiple trap houses and shooting pads are positioned side-by-side, the shotfall zones overlap, creating a higher concentration of shot in the overlapping area.

There is little fragmentation of shot at low velocity ranges. Shot is typically found within the first few inches of the soil surface (ITRC 2003).

SITE HISTORY AND CHARACTERISTICS

The Index Sportsmen's Club maintains a trap-shooting range on land managed by the Forest Service within the Mt. Baker-Snoqualmie National Forest. The site is located on Old Goldbar-Index Road, roughly ½ mi west of the town of Index (Figure 1). It occurs within the NE ¼ of Section 19, Township 27 North, Range 10 East, at an elevation of approximately 500 ft. The site is located in the foothills of the Cascade Mountains. Annual precipitation generally ranges from approximately 80 to 90 in. per year, with some of this falling as snow. Photographs of the site are provided in Attachment A. Information regarding the site was obtained during an initial site visit (13 October 2003) and during the field investigation, as well as from interviews with long-time club members. The site characteristics are as follows:

- The shooting range has been in use since about 1940, and has remained in the same general configuration.
- All shooting at the site is done using shotguns and clay targets.
- Two trap houses are present at the site, and contain machines to launch the targets. The trap house on the west side is used more often. There are 5 shooting stations (pads) on the left side and 5 on the right side of the south end of the range. Shot is fired to the north.
- Surface debris (pieces of clay targets and shells) appears to be heaviest on the west side of the site, within the cleared range area.
- Clay targets and shells have been vacuumed or scraped from the surface of the shooting range periodically and left as waste piles on the west side of the site. Several 55-gallon drums (one labeled motor oil), tires, and an old refrigerator were also observed in this area.
- The cleared range area is generally flat; it was leveled when the range was originally established. No major regrading has taken place since then. Adjacent land slopes upward to the east and downward to the west.
- Minor leveling was done at the northeast end of the cleared area around 1985 when a baseball field was created.
- A portion of the range area is covered with maintained grass. Surrounding areas are wooded, with large trees and fairly heavy undergrowth.
- Railroad tracks are located roughly 600 ft north of the shooting positions. The tracks are elevated on a berm, approximately 15 ft high. The tracks are used frequently; several trains (both passenger and freight) passed by during each site visit.
- The wooded area to the north includes several depressions and low spots that tend to pond water. A discontinuous drainage runs along the toe of the railroad berm, flowing generally east to west and ending in ponded areas with no apparent outlet.

- The cleared shooting range area of the site occupies a little over 2 acres. A clubhouse, caretaker's residence (trailer), small children's play area, driveway, and parking area occupy additional land to the south of the range.

- The site occasionally has been roto-tilled or raked to improve conditions, primarily in the baseball field area.

- Near the northeast corner of the range (east of the ball field area) are a fire ring, small shelter, bench seats, a water faucet, and an outhouse.

- The site also is used for other club activities, including camp outs, baseball games, and barbeques.

- The North Fork Skykomish River is located roughly 500 ft south of the shooting range.

- The site is served by city water.

No record of well installation at the site was found based on a search of the Washington Department of Ecology (Ecology) on-line well log database. However, several logs were found for nearby wells. All 6 records found appear to be for wells installed south of the river from the site. Five of the wells were completed to depths less than 100 ft, and range from 36 to 60 ft deep. However, all of the well logs indicate the presence of a clay layer above the water-bearing zone tapped. The clay layer was reported to be more than 20 ft thick in all but one well, where the thickness was reported as only 6 ft. Based on the location and construction of the wells, they are unlikely to be impacted by the site.

FIELD ACTIVITIES

Limited soil sampling programs were performed on 12 November 2003 and 12 February 2004. Initial soil samples were collected from 10 locations, including 8 locations on or adjacent to the cleared range area and 2 background or reference locations (designated as BK) away from range activities. Additional samples were collected from 5 locations in the wooded area north of the cleared range area. A soil sample log is provided as Table 1; this table includes a brief description of each sample location. Sample locations are indicated on Figure 2. Impacted area samples (non-background or test area [TA] samples) were collected from areas of greatest apparent or potential impact, including areas with high accumulations of shot, areas with high accumulations of visual surface debris (shells and clay targets), and depressions where surface water runoff appeared to accumulate. In addition, in some cases, sample locations were adjusted to allow collection of finer grained soil. For example, soils in the northwest corner of the site typically consisted of coarse-grained sand with little fines; samples planned in this area were moved further north or south.

Surface soil samples (designated as SSS) were collected from all 15 locations, at depths just below the root mat (typically about 3 to 6 in.). In several locations within the cleared range area (TA-04, TA-05, and TA-06), shallow buried debris was found. At these locations, samples were collected below the debris. Subsurface soil samples (typically from a depth of approximately 24 to 27 in. and designated as SUS) were collected from 6 of the locations, including 1 reference location. Sample depths are provided in Table 1. Samples were collected and handled according to the site Sampling and Analysis Plan (EA 2003a), using disposable equipment, except that 5 surface soil samples (TA-SSS-12 through TA-SSS-16) were sieved on site to remove shot. A number 10 sieve (0.08 in.) was used; it was decontaminated between sample locations by washing with laboratory grade detergent and water, and rinsing with distilled water. On-site work was performed in accordance with the health and safety guidelines provided in the Emergency Contingency Plan (EA 2003b) prepared for the site.

All samples were analyzed for arsenic, lead, and pH. Of the samples collected on 12 November 2003, four surface soil samples selected to be representative of on-site soil were also analyzed for grain size, total organic carbon (TOC by the Walkley-Black method), total and soluble phosphorus, and cation exchange capacity (CEC). In addition, the four surface soil samples exhibiting the highest concentrations of total arsenic and/or lead were analyzed by the Synthetic Precipitation Leaching Procedure (SPLP) for arsenic and lead. The SPLP extraction simulates metals solution due to acid rain. Of the samples collected on 12 February 2004, one surface soil sample was analyzed for total phosphorus and one sample was analyzed for SPLP arsenic and lead.

Soil samples were submitted to North Creek Analytical, Inc., in Bothell, Washington, for analyses. A site survey was performed by INCA Engineers, Inc., and included mapping of general site features and of the 10 locations sampled on 12 November 2003. Locations sampled on 12 February 2004 (in the wooded area) were measured by EA.

Soils in the site area appear to be largely derived from the river floodplain. They tend to consist of coarse sand with rounded gravel and cobbles at depth. In the wooded areas, these coarse soils are overlain by fine-grained organic-rich soils and detritus. Most of the soils sampled within the cleared range area were sandy and contained little organic material. Surface soil in one on-site location (TA-10), and in most of the locations in the wooded areas, was comprised of silt.

Most of the lead shot observed on or near the land surface was in the wooded area between the cleared range area and the railroad tracks, at a distance of about 330 to 500 ft from the shooting pads. No shot was observed in the railroad berm (roughly 580 ft or more from the shooting pads); shot likely falls out sooner due to the dense tree cover.

ANALYTICAL RESULTS

A summary of the laboratory analytical results is provided in Table 2. The pH in background soils ranged from 5.01 to 5.94. In on-site soils, the pH ranged from 5.58 to 7.44. Of the on-site surface soil samples collected in the cleared range area, 4 locations had a pH less than 6.5 (typically more lead mobility) and 4 had a pH greater than 6.5 (typically less lead mobility). The surface soil samples collected from the wooded areas (with high organic content) had a pH less than 6.5.

Arsenic and lead concentrations were compared to the following criteria (see Table 2):

- EPA Industrial Preliminary Remediation Goals (PRGs) (EPA 2003b)
- Washington State Department of Ecology (Ecology) natural background soil metals concentrations in Washington State (Ecology 1994)
- Model Toxics Control Act (MTCA) Method A cleanup standards (Ecology 2003).

The Ecology natural background level for lead in soils in Washington State (17 mg/kg) was exceeded in 1 background and most on-site soil samples. Lead concentrations in background surface soil samples were 12.1 mg/kg (BK-SSS-01) and 61.1 mg/kg (BK-SSS-02); the surface soil sample from location BK-SSS-02 appears to have an unusually high concentration of lead. On-site surface soil samples contained lead at concentrations ranging from 8.24 to 58,100 mg/kg. Lead was detected at concentrations exceeding the lowest comparison criteria (250 mg/kg for MTCA Method A, unrestricted use) in 5 surface soil samples collected from the wooded area north of the cleared range. Lead concentrations in all 5 of these samples also exceeded the highest comparison criteria (1,000 mg/kg for MTCA Method A, industrial use). The highest concentration of lead was detected in sample TA-SSS-14, collected from shallow soil in a depression that collects surface water runoff from the site area. Lead concentrations in the deeper soil samples were relatively low (6.23 to 44.3 mg/kg), and in all cases were lower than in the overlying soil.

Arsenic was detected in all samples collected (including background) at concentrations exceeding Ecology's Washington state natural background level (7 mg/kg) and the EPA Industrial PRG (1.6 mg/kg). Except for 1 background (deeper soil) and 3 on-site (shallow and deep samples from TA-SSS-04 and deep sample from TA-SS-13), samples also exceeded the MTCA Method A cleanup criteria of 20 mg/kg. Arsenic concentrations in background surface soil samples were 24.9 mg/kg (BK-SSS-01) and 44.8 mg/kg (BK-SSS-02). On-site surface soil samples contained arsenic at concentrations ranging from 13.3 to 319 mg/kg. In locations where shallow and deeper soil samples were collected, arsenic concentrations decreased with depth in 3 samples, and increased with depth in 3 samples. The highest arsenic concentration was detected in sample TA-SSS-14, the same sample in which the highest concentration of lead was detected.

Five surface soil samples (BK-SSS-02, TA-SSS-05, TA-SSS-08, TA-SSS-10, and TA-SSS-13) were analyzed for arsenic and lead following SPLP extraction. Arsenic concentrations in the extract ranged from <0.00100 to 0.0778 mg/L. Lead concentrations ranged from 0.00336 to 1.15 mg/L. The highest SPLP results (both arsenic and lead) were detected in sample TA-SSS-13; this sample also had elevated total arsenic and lead concentrations.

Total phosphorus concentrations ranged from 354 to 691 mg/kg in the 5 samples analyzed. The soluble phosphorus concentrations (2.10 to 3.3 mg/kg) were negligible. TOC concentrations ranged from 0.74 to 1.46 %. CEC measurements ranged from 2.0 to 6.1 milliequivalents per 100 grams of soil (meq/100g).

Four samples were analyzed for grain size. Two of the samples (TA-SSS-03 and TA-SSS-08) were composed primarily of fine sand and silt/clay. The other two samples (TA-SSS-04 and TA-SSS-09) were composed primarily of sand and gravel. The results confirmed the field identification of soil types.

SIGNIFICANCE OF RESULTS

Within the cleared range area, lead concentrations detected did not exceed the comparison criteria. Arsenic concentrations in shallow soil in this area exceeded some of the comparison criteria; however, the concentrations detected in this area appear to be largely due to natural processes, such as weathering of high-arsenic bedrock. Because the lead concentrations in this area were so low and because arsenic typically comprises less than 1% of shot content, the elevated arsenic is unlikely to be connected to the presence or use of shot. Metals detected in this area were somewhat higher in the fine-grained soils with higher organic content.

Surface soil samples from the wooded area, north of the cleared range area, were collected from locations with large amounts of visible shot. The shot was sieved out of the samples. Surface soil samples collected from this area contained elevated concentrations of lead (exceeding all of the comparison criteria). A couple of these samples also contained elevated concentrations of arsenic. The highest concentrations of lead and arsenic were detected in a surface soil sample collected from a depression which collects stormwater runoff from the site area (location TA-14; see Figure 2 and Photo 18). A large amount of shot was observed in soil throughout much of this depression. Shot observed on and near the land surface in this location was noticeably weathered. An attempt was made to collect a deeper sample at this location; however, groundwater was encountered only a few inches below the ground surface. An SPLP sample was not collected from this location due to difficulty in sieving the organic-rich, wet soil and in obtaining sufficient sample volume.

While not specifically applicable to this site, Ecology currently views arsenic concentrations up to 200 mg/kg and lead concentrations up to 1,000 mg/kg in soil as within the range of low to moderate contamination for “area-wide” soil contamination at properties such as parks (AWSCTF 2003). One arsenic and 5 lead concentrations (in samples from the wooded area) exceeded these levels. While the Area-Wide Soil Contamination Task Force (AWSCTF) reports that they have not seen evidence of groundwater contamination associated with area-wide arsenic and lead soil contamination at low to moderate levels in Washington (AWSCTF 2003), based on the elevated concentrations detected in the northern portion of the site, and on the shallow depth to groundwater in this area, potential impacts to groundwater should be considered.

Surface water tends to pond in the wooded area north of the cleared range area. This is also the area where the vast majority of the shot accumulates. The high organic content of the soils in this area tends to cause a low soil pH. This, in turn, tends to cause accelerated degradation of the shot, with dissolved lead released to the environment. In addition, lead shot and dissolved lead can be moved by surface water runoff, causing it to concentrate in low, ponded areas. Although surface water was observed to flow from east to west in a discontinuous drainage along the railroad berm, the water ponded in several areas with no apparent outlet.

The CEC of a soil indicates the capacity of the soil to hold cations, including soil nutrients and elemental lead. The CEC is controlled by the amount of clay and humus present in the soil. Clayey soils with high levels of organic matter have a much higher CEC than clean sandy soils. Since organic matter also holds cations, an increased TOC increases the CEC of soil. The higher the CEC, the more cations the soil can hold. A typical CEC for sandy soil is about 2.0 meq/100g, and for a silt/clay mixture it is on the order of 5.0 meq/100g or higher. The CEC results reported for soil within the cleared range area of the site (2.0 to 6.1 meq/100g) reflect this typical variation. The CEC of soils within the wooded area of the site is expected to be on the high end.

Since most of the onsite soil within the cleared range area consists of medium to coarse-grained sand with little clay, the ability of the soil to retain cations is somewhat limited. However, based on the lead concentrations detected, the thickness of the soil column, and the CEC, soils in the cleared range area appear to be sufficient to prevent vertical migration of lead more than a foot or two below the surface, assuming that best management practices are followed. The CEC of soils in the northern, wooded area of the site would be expected to be sufficient to tie up lead in a properly constructed and operated range area. However, based on the accumulation of lead shot, the weathered condition of much of the shot, and the shallow depth to groundwater (a few inches) in parts of the northern site area, lead may migrate to groundwater in this area.

Several patches of stressed grass growth were observed within the cleared range area. However, these areas of thin grass growth appear to be due to the large grain size of the underlying soil and to the lack of organic material or nutrients.

BEST MANAGEMENT PRACTICES

The discharge of firearms does not constitute waste management for the purpose of RCRA; however, spent munitions left in the environment may at some point be considered RCRA solid wastes (Meyer 2000). The EPA includes spent bullets and shot within the broad definition of solid waste, as defined by RCRA statutes (EPA 2001). However, lead shot is excluded from RCRA regulation, under what is known as the scrap metal exemption, provided it is recycled (Meyer 2000). Lead shot recovered using BMP separation techniques does not have to be handled and shipped according to RCRA requirements.

The 4 steps that form the BMPs include (EPA 2001):

1. Control and containment (stormwater management and vegetation management to control erosion and migration).

2. Prevention of migration (soil amendment to chemically fix/stabilize lead and arsenic).

3. Removal and recycling of spent munitions.

4. Documentation and record keeping (shot use and removal/recycling activities).

A flat, open field is best for all of the shotfall area for lead collection. However, at the subject site, the majority of the shotfall occurs within the wooded area. Recovery equipment can work around large trees, but shot is difficult to recover in areas of small trees and brush, such as the subject site. Large trees can keep shot from traveling farther into forested areas; however, shot was found inside of the forested area at the site, at least 500 ft from the shooting stations.

Soil amendments can include lime and phosphate. Agricultural lime can be used to reduce acidity and therefore the potential for lead dissolution. A pH of about 7.0 is recommended for the deposition area on trap or skeet ranges (Petrucelli 1996). Lime must be replenished periodically to maintain the pH. Phosphate can be used to form insoluble compounds with lead; this is most effective under acid conditions (Peddicord 1996). Lime and phosphate addition can be especially important in wooded areas where access to remove shot is limited (EPA, 2001).

CONCLUSIONS AND RECOMMENDATIONS:

Although lead concentrations were not found to be a concern within the cleared range area of the site, the wooded area north of the cleared range (where the majority of the shotfall occurs) has been impacted by lead shot. Lead concentrations in soil samples collected from the site exceeded the EPA PRG criterion for industrial soils, as well as the MTCA Method A cleanup criteria for both unrestricted and industrial use. Lead concentrations decreased with depth; however, groundwater was encountered only a few inches below the land surface in the location with the highest concentration of lead in surface soil. Surface water also tends to pond in much of the northern site area. Water may stay in contact with lead shot for extended periods of time in this area.

Elevated concentrations of arsenic were detected in soil both onsite and in a background location. Arsenic tends to be a very small component of shot. Based on the relative concentrations of lead and arsenic, much of the arsenic detected in onsite soils is likely due to natural conditions (such as high-arsenic bedrock) in the site area. However, significant concentrations of arsenic were detected in a couple of the soil samples with the highest lead concentrations; these elevated concentrations appear to be related to the presence of shot.

Lead and arsenic levels in soils at the site may present a risk to human health. The site also presents a potential threat to groundwater and surface water in the area. Groundwater is not used for potable water at the site; however, contaminated groundwater could migrate to nearby surface water bodies.

The following steps are recommended to limit on-site exposure to arsenic and lead in soil, and to minimize lead contamination problems:

- Discourage other uses of the shooting range area from which people may come in contact with the soil (baseball, camping, social activities, etc.).

- Use caution to avoid inhaling or accidentally ingesting dust or soil on site, especially during site maintenance activities. Although special personal protective equipment does not appear to be warranted, site workers should wash their hands and face before eating or drinking, and clean contaminated clothing and shoes prior to reuse.

- Add lime to soil periodically to maintain a pH of approximately 7. Lime spreading is particularly important in heavily wooded areas where soil removal is difficult and where surface detritus tends to increase soil acidity.

- Add phosphate to soil to tie up lead. Phosphate addition is especially important in locations where there is a high potential for migration of lead to groundwater (i.e., low soil pH and shallow groundwater).

It should be noted that lime and phosphate spreading are not permanent solutions. Routine lead removal/recycling activities will be very difficult at this site since the majority of the shot is located in heavily wooded areas with dense brush. Even hand raking or vacuuming would be difficult in these areas.

The following activities are recommended to further investigate potential environmental impacts from the site:

- Collect shallow groundwater samples and analyze for lead and arsenic.
- Evaluate groundwater flow patterns and potential impacts to nearby surface water bodies.

Please contact me at 425-451-7400 with any questions about the enclosed information.

Sincerely,

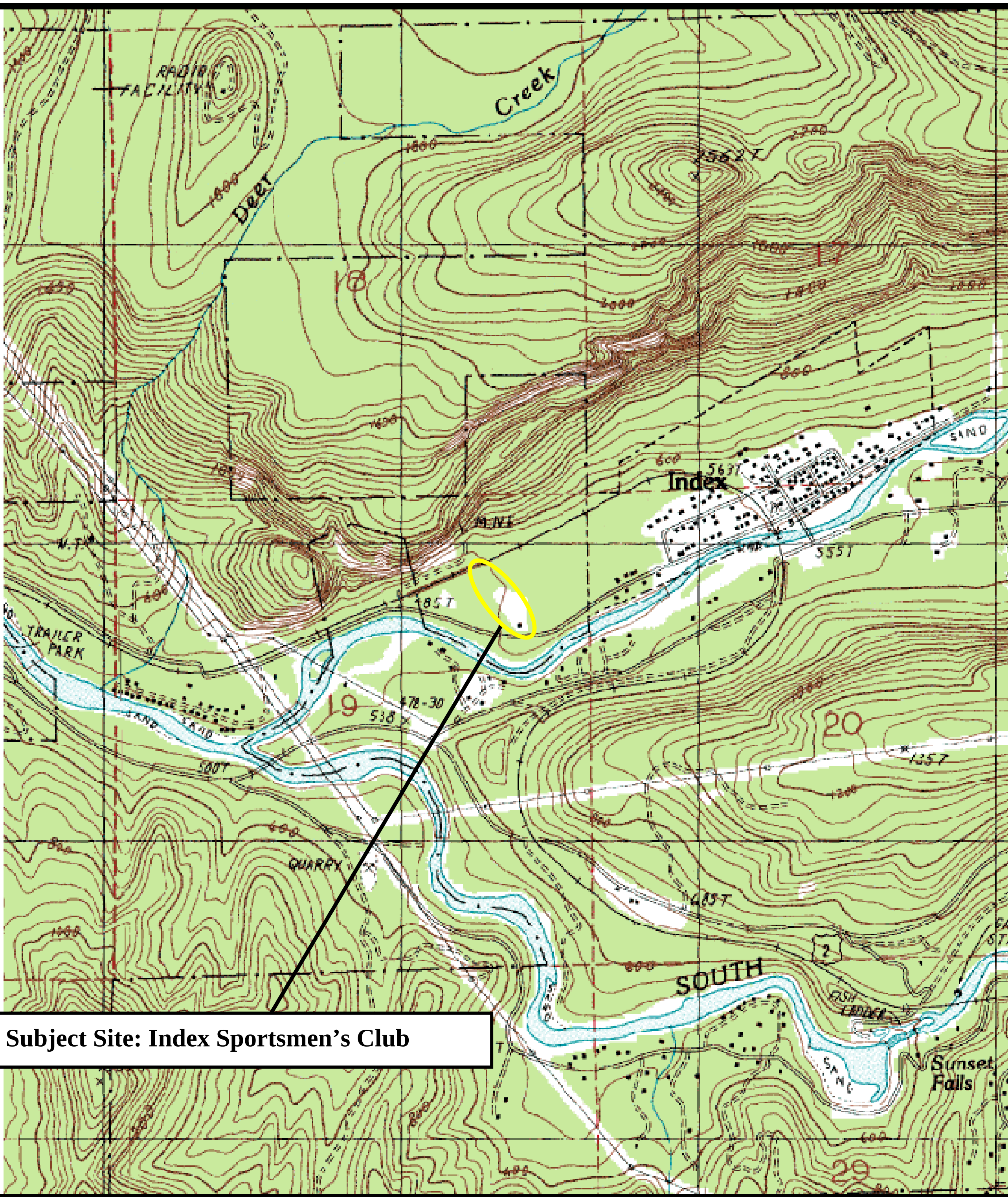
EA ENGINEERING, SCIENCE,
AND TECHNOLOGY, INC.

Catherine M. Böhlke

Catherine Böhlke, L.G., L.H.G.
Project Manager

Attachments

FIGURES



Reference: USGS Topographic Quadrangle Map, Index, Washington, 1989
Courtesy of TopoZone.com and Maps a la carte, Inc.

Scale:	EA Project
1 in. = 1,600 ft	**No. 13890.20**

Figure 1
Site Location Map
Index Sportsmen's Club
Index, Washington

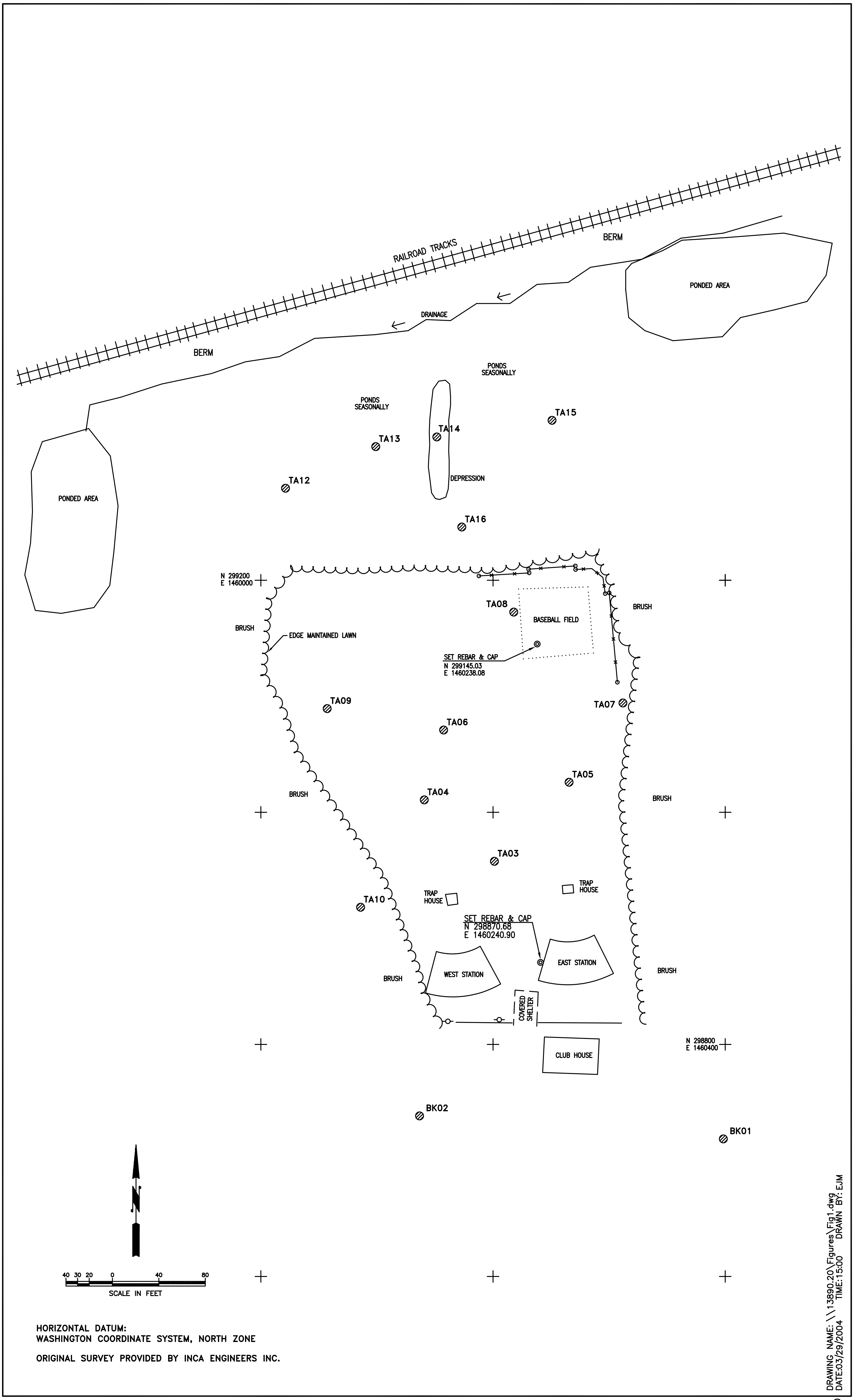


Figure 2. Index Sportsmans Club soil sample locations.

TABLES

TABLE 1 - SOIL SAMPLE LOG, INDEX SPORTSMEN'S CLUB

Location	Sample No.	Sample Depth (in.)	Date Collected	Time Collected	Location Description	Soil Description
Background						
BK-01	BK-SSS-01	3 - 6	11/12/2003	1040	SE of firing range in wooded area.	Silty SAND; brown to dk brown, moist, med dense, with roots.
BK-02	BK-SSS-02	3 - 6	11/12/2003	1055	SW of firing range in wooded area.	Sl sandy to sandy SILT; dk brown, moist, loose to med dense, with roots.
BK-02	BK-SUS-02	24 - 27	11/12/2003	1107	As above.	Sl silty, gravelly SAND (coarse) with cobbles (rounded); gray-brown, moist, dense.
On-Site						
TA-03	TA-SSS-03	3 - 6	11/12/2003	1130	Near shooting pads and traphouses in cleared range area.	Silty SAND (fine); brown to dk brown, moist, dense.
TA-04	TA-SSS-04	8 - 10	11/12/2003	1200	In area of heavy surface debris (clay pigeons and shells) in cleared range area.	Gravelly SAND (med to coarse), tr silt and cobbles (rounded); brown to dk brown, moist, med dense. Encountered a former surface horizon at about 3" (dk brown w/ small pieces of debris); about 3" deep. Sampled a few inches below.
TA-04	TA-SUS-04	24 - 27	11/12/2003	1215	As above.	Gravelly (rounded) SAND, tr silt; brown to gray/orange brown, moist, med dense to dense.
TA-05	TA-SSS-05	6 - 8	11/12/2003	1238	In debris area (clay pigeons and shells) in cleared range area.	Silty SAND (fine); brown to dk brown, moist, med dense. Debris intermixed with soil to a few in deep. (Some charcoal at ~6".)
TA-06	TA-SSS-06	5 - 8	11/12/2003	1258	In area of heavy surface debris (clay pigeons and shells) in cleared range area.	Silty SAND (fine); brown to gray brown, moist, med dense to dense, trace roots. Debris here extends ~3-4" deep. Grading to coarse sand at about 8-9".
TA-06	TA-SUS-06	24 - 27	11/12/2003	1308	As above.	Med to coarse SAND w/ gravel (rounded); brown, moist, med dense.
TA-07	TA-SSS-07	3 - 6	11/12/2003	1330	Slight depression and area of debris; near fire circle and seating area.	Fine to med SAND; lt to med brown, moist, loose. Cobbles (round) at ~8".
TA-07	TA-SUS-07	24 - 27	11/12/2003	1342	As above.	Sl silty SAND; brown, moist, med dense to dense.
TA-08	TA-SSS-08	3 - 6	11/12/2003	1405	In depression at NE corner of cleared range area (baseball field) where stormwater collects.	Silty SAND (fine); brown, moist, dense.
TA-08	TA-SUS-08	24 - 27	11/12/2003	1411	As above.	Sl silty fine SAND; brown, moist, med dense.
TA-09	TA-SSS-09	2 - 4	11/12/2003	1440	Near NW corner of cleared area - location adjusted to avoid collection of coarse sand.	Gravelly, fine to coarse SAND, tr silt; brown, moist, med dense to dense. Sand became coarser with depth.
TA-10	TA-SSS-10	3 - 6	11/12/2003	1505	Adjacent to wastepile (clay targets and shell debris).	Sandy (fine) SILT; dk brown, moist, med dense.

TABLE 1 - SOIL SAMPLE LOG, INDEX SPORTSMEN'S CLUB

Location	Sample No.	Sample Depth (in.)	Date Collected	Time Collected	Location Description	Soil Description
TA-12	TA-SSS-12	2 - 4	2/12/2004	1255	N of NW corner of cleared area (~425' from firing stations) in woods. Heavy shot accumulation.	Sl sandy SILT, trace clay; dk brown, moist, loose. Roots and numerous organics in first 1-2 in. Much shot sieved out.
TA-13	TA-SSS-13	2 - 4	2/12/2004	1320	N of cleared area (~450' from firing stations) in woods. Heavy shot accumulation.	SILT, trace fine sand; dk brown, moist, loose. Roots and numerous organics in first 2 in. Much shot sieved out.
TA-13	TA-SUS-13	16 - 22	2/12/2004	1550	As above.	Gravelly SAND (coarse), trace silt; med brown, moist, w/ cobbles. Roots and cobbles prevented sampling deeper.
TA-14	TA-SSS-14	2 - 4	2/12/2004	1418	In large depression N of cleared area, in woods. Very heavy shot accumulation.	SILT, tr sand and clay; dk brown, moist to wet, loose to med dense. Water at approx. 6 in. V large amount of shot sieved out.
TA-15	TA-SSS-15	2 - 4	2/12/2004	1450	N of cleared area, in woods (~450' from shooting pads). Heavy shot accumulation.	SILT, tr fine sand; med to dk brown, moist, loose to med dense. Thick organic debris cover. Much shot sieved out.
TA-16	TA-SSS-16	2 - 4	2/12/2004	1520	Just N of cleared area in woods. Some shot. Collected adjacent to Forest Service flags labeled ISC-06 and ISC-07.	Sl sandy (fine) SILT; med to dk brown, moist, med dense.

NOTES:
- SSS = surface soil sample (typically collected from about the 3 to 6 in. depth interval).
- SUS = subsurface soil sample (typically collected from about the 24 to 27 in. depth interval).
- Samples TA-SSS-11 and TA-SUS-14 are duplicates of TA-SSS-06 and TA-SUS-13, respectively.
- Samples TA-SSS-12 through TA-SSS-16; samples sieved with #10 sieve to remove shot.

TABLE 2 - SOIL ANALYTICAL RESULTS, INDEX SPORTSMEN'S CLUB

											Grain Size					
Sample No.	**Depth, inches**	**pH, std. units**	**Arsenic, mg/kg**	**Lead, mg/kg**	**Total Phosphorus, mg/kg**	**Soluble Phosphorus, mg/kg**	**Total Organic Carbon, %**	**Cation Exchange Capacity, meq/100g**	**SPLP Arsenic, mg/L**	**SPLP Lead, mg/L**	**Gravel (fine), %**	**Sand (coarse), %**	**Sand (medium), %**	**Sand (fine), %**	**Silt, %**	**Clay, %**
Background																
BK-SSS-01	3 - 6	5.01	24.9	12.1												
BK-SSS-02	3 - 6	5.65	44.8	61.1					0.00471	0.00407						
BK-SUS-02	24 - 27	5.94	14.6	7.98												
On Site																
TA-SSS-03	3 - 6	5.97	**53.6**	18.8	691	2.10	1.38	6.1			0	0	6.2	57.4	29.5	6.8
TA-SSS-04	8 - 10	7.44	13.3	19.7	449	2.22	0.94	2.1			32.3	17.4	39.2	8.9	2.2	--
TA-SSS-05	6 - 8	7.22	**57.6**	37.1					0.00681	0.00336						
TA-SSS-06	5 - 8	7.39	**40.3**	17.2												
TA-SSS-11**	5 - 8	7.42	**37.4**	16.1												
TA-SSS-07	3 - 6	6.89	26.5	8.24												
TA-SSS-08	3 - 6	5.72	**56.8**	93.5	354	3.30	1.46	5.8	0.00779	0.00346	0	0.3	6.7	52.4	29.6	11.0
TA-SSS-09	2 - 4	6.46	**30.9**	18.0	493	2.43	0.74	2.0			20.1	16.0	35.5	24.1	4.3	--
TA-SSS-10	3 - 6	5.80	**77.9**	53.1					<0.00100	0.0127						
TA-SSS-12	2 - 4	5.58	22.4	**2,440**												
TA-SSS-13	2 - 4	6.01	**60.2**	**7,140**	507				0.0778	1.15						
TA-SSS-14	2 - 4	6.26	**319**	**58,100**												
TA-SSS-15	2 - 4	5.72	**111**	**10,200**												
TA-SSS-16	2 - 4	5.93	**33.2**	**1,130**												
TA-SUS-04	24 - 27	7.38	18.1	6.29												
TA-SUS-06	24 - 27	7.31	20.8	6.23												
TA-SUS-07	24 - 27	6.24	**33.4**	7.61												
TA-SUS-08	24 - 27	5.68	**65.7**	14.9												
TA-SUS-13	16 - 22	5.70	13.4	44.3												
TA-SUS-14**	16 - 22	5.79	11.5	62.1												
Comparison Criteria																
Ecology - Background			7	17												
Average Site Background			28.1	27.1												
Ecology - MTCA A			20[a]	250[b]												
Ecology - MTCA A - Industrial			20	1000												
EPA PRGs - Industrial			1.6 - 260[c]	750												

TABLE 2 - SOIL ANALYTICAL RESULTS, INDEX SPORTSMEN'S CLUB

NOTES:

Arsenic and lead concentrations exceeding both the average site background and MTCA Method A (unrestricted use) concentrations are shown in bold.

- meq/100g = milliequivalents per 100 grams
- mg/kg = milligrams per kilogram
- mg/L = milligrams per liter

Blank spaces indicate that the sample was not analyzed for that constituent.

Comparison Criteria Sources:

Ecology background levels are the 90th percentile for both Statewide and Puget Sound Regions (Ecology 1994).

The average site background numbers were obtained by taking an average of the three background results obtained in the site area.

MTCA Method A is for "routine cleanup actions" (Ecology 2003).

[a] Cleanup level based on direct contact using Equation 740-2 and protection of ground water for drinking water use using the procedures in WAC 173-340-747(4), adjusted for natural background for soil (Ecology 2003).

[b] Cleanup level based on preventing unacceptable blood lead levels (Ecology 2003).

[c] EPA Industrial PRGs for arsenic are 1.6 mg/kg for cancer endpoint, and 260 mg/kg for non-cancer endpoint (EPA 2003b).

** TA-SSS-11 is a duplicate of sample TA-SSS-06.
TA-SUS-14 is a duplicate of sample TA-SUS-13.

ATTACHMENT A

Photo 1 Date: 10/13/03 Time: 1250 Looking north from south end of the site, across the parking lot and club building.

Photo 2 Date: 10/13/03 Time: 1301 Looking northwest across the cleared range area from the club house area.

Photo 3 Date: 10/13/03 Time: 1255 Looking generally northwest across the site from the club house and covered shelter area.

Photo 4 Date: 10/13/03 Time: 1300 Looking north across the site and through the covered shelter, from the club house area.

Photo 5 Date: 10/13/03 Time: 1310 Looking south-southwest from the northeast corner of the site.

Photo 6 Date: 10/13/03 Time: 1330 Looking generally southeast across the site from the northwest corner. Baseball field is to the right, fire ring and water tap on the left.

Photo 7 Date: 11/12/03 Time: 1043 Background sampling location BK-01, looking generally north-northwest toward the site. Sample hole is just right of center below the fens.

Photo 8 Date: 11/12/03 Time: 1108 Background sampling location BK-02, looking generally northeast towards the site. Hole is at the yellow flag just below and right of center.

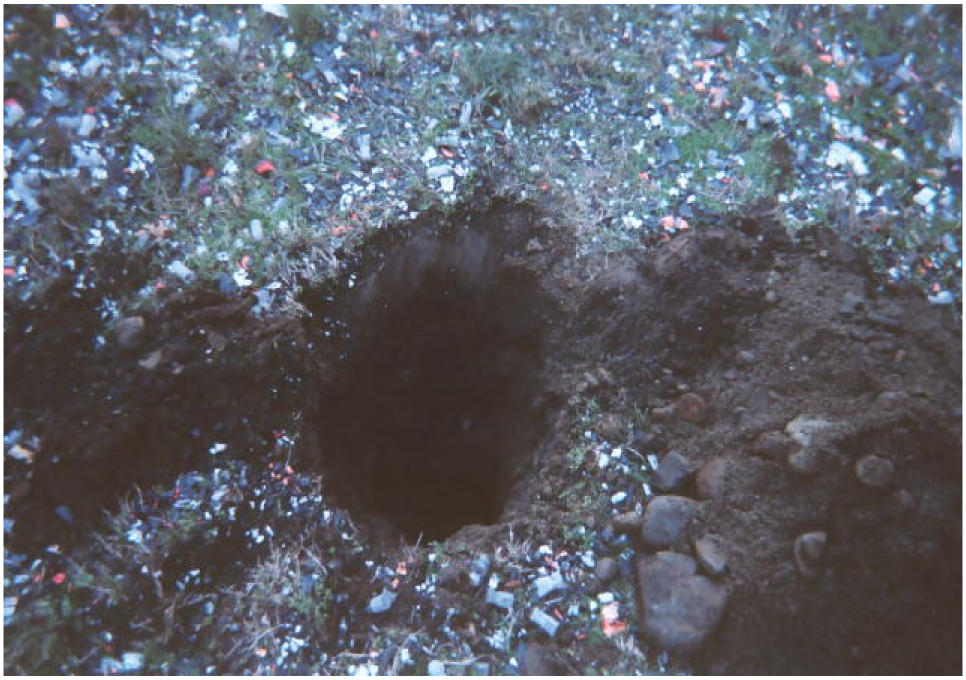


Photo 9 Date: 11/12/03 Time: 1219 Sampling location TA-04, close-up of hole. Former soil horizon with debris at about three inches depth. Note debris on surface.

Photo 10 Date: 11/12/03 Time: 1220 Looking generally southeast across sampling location TA-04. Note dense debris cover.

Photo 11 Date: 11/12/03 Time: 1245 Looking generally northeast across sampling location TA-05 (dirt pile).

Photo 12 Date: 11/12/03 Time: 1315 Looking south across the site and sampling location TA-06 (dirt pile). Note surface debris.

Photo 13 Date: 11/12/03 Time: 1345 Looking north across sampling location TA-07 (dirt pile). Note debris on land surface.

Photo 14 Date: 11/12/03 Time: 1416 Looking north across sampling location TA-08, in the ballfield area. This is a low spot where site runoff collects.

Photo 15 Date: 10/13/03 Time: 1340 Debris scrapings piled on the west side of site, at the edge of the cleared range area.

Photo 16 Date: 02/12/04 Time: 1149 Looking east at drainage north of site along the railroad berm.

Photo 17 Date: 02/12/04 Time: 1217 Ponded water in depression north of the site.

Photo 18 Date: 02/12/04 Time: 1220 Abundant shot in soil just beneath the moss cover (cover is peeled back). Located in the depression north of about mid-site, near sampling location TA-14.

Photo 19 Date: 02/12/04 Time: 1503 Looking across sampling location TA-12, toward the range (south).

Photo 20 Date: 02/12/04 Time: 1509 Looking across sampling location TA-14, toward the range (south). Note very dense vegetation.

Photo 21 Date: 02/12/04 Time: 1535 Sampling location TA-16, looking south towards the clubhouse.

Photo 22 Date: 02/12/04 Time: 1626 Sampling location TA-15, looking southward. Note very dense vegetation.

ATTACHMENT B

REFERENCES

AWSCTF. 2003. Area-Wide Soil Contamination Task Force Report. Prepared by the Area-Wide Soil Contamination Task Force. Submitted to WA State Departments of Agriculture, Ecology, Health, and Community, Trade and Economic Development. June 30.

Baer, K.N., D.G. Hutton, R.L. Boer, T.J. Ward, and R.G. Stahl. 1995. Toxicity evaluation of trap and skeet shooting targets to aquatic test species. Ecotoxicology 4, 385-392. Also available at http://www.rangeinfo.org/resource_library/facility_mngmnt/environment/toxicity.htm.

Baldwin, D. 1994. How Far Will a Shotgun Shoot? Reprinted from the Gun Club Advisor; Spring. http://www.rangeinfo.org/resource_library/facility_mngmnt/design/how_far_will.htm

Cohen, S.Z. 2000. Testing Your Outdoor Range – Using the Right Tools. Presented at the Fourth National Shooting Range Symposium. Policy Track: Environmental Issues. http://www.rangeinfo.org/NSRS/4%20Policy%20Track/TestingRange.pdf

Ecology. 1994. Natural Background Soil Metals Concentrations in Washington State. Washington Department of Ecology; Toxics Cleanup Program. Publication no. 94-115. October.

Ecology. 2003. Model Toxics Control Act Cleanup Regulation, Chapter 173-340 WAC. Publication no. 94-06. Amended February 12, 2001; revised January 2003.

EPA. 2001. Best Management Practices for Lead at Outdoor Shooting Ranges. U.S. Environmental Protection Agency, Region 2. EPA-902-B-01-001. January. http://www.epa.gov/region2/waste/leadshot.

EPA. 2003a. TRW Recommendations for Performing Human Health Risk Analysis on Small Arms Shooting Ranges. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response. March. http://www.epa.gov/superfund/programs/lead/products/firing.pdf

EPA. 2003b. Preliminary Remediation Goals. U.S. Environmental Protection Agency, Region 9, Superfund. Including February 2003, Notice of Slight Revision to 2002 PRGs. http://www.epa.gov/Region9/waste/sfund/prg/index.htm

ITRC. 2003. Characterization and Remediation of Soils at Closed Small Arms Firing Ranges. Technical/Regulatory Guidelines. Interstate Technology and Regulatory Council, Small Arms Firing Range Team. January.

Meyer, G. 2000. Best Management Practices for Lead at Outdoor Shooting Ranges. Presented at the Fourth National Shooting Range Symposium. Policy Track: Environmental Issues.

Peddicord, R.K. 1996. Lead Mobility in Soils. Reprinted from the Third National Shooting Range Symposium with permission from the International Association of Fish and Wildlife Agencies, Wildlife Management Institute and U.S. Fish and Wildlife Service. http://www.rangeinfo.org/resource_library/facility_mngmnt/environment/lead_mobility.htm.

Petrucelli, S.T. 1996. Best Management Practices for Ranges. Reprinted from the Third National Shooting Range Symposium, with permission from the International Association of Fish and Wildlife Agencies, Wildlife Management Institute and U.S. Fish and Wildlife Service. http://www.rangeinfo.org/resource_library/facility_mngmnt/environment/best_management.htm.