

IMPACT OF OIL PRODUCTION RELEASES ON SOME SOIL CHEMICAL PROPERTIES AT THE O.S.P.E.R. FIELD SITE

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ABSTRACT

Surface and soil core samples were collected at two field sites in an old oil production area near Skiatook Lake in Oklahoma. The soil samples were analyzed for nitrates, organic matter, total petroleum hydrocarbons, conductivity, chlorides and dehydrogenase activity. Low level nitrates and organic matter were fairly consistent for most of the samples. Variations were apparent in TPH, chlorides and conductivity. Viable biomass was measured by a dehydrogenase activity test. The study was done as a site characterization assessment to develop guidelines for stabilizing or restoring such degraded areas.

INTRODUCTION

Hydrocarbon and produced water releases occur in oilfield operations as a result of equipment failures and other accidents. These releases, the disposal of water produced with oil and gas, and restoration of effected areas are national issues that concern watershed managers as well as regulators, surface landowners and local residents. Most of the releases were related to past acceptable oilfield practices. Studies are now needed to evaluate and restore the ecosystems in cost-effective techniques.

The two field sites have a long history of petroleum production with the highest activity occurring in the 1930's. Crude oil and brine water have impacted the landscape surface, subsurface and plant ecosystem. The information attained will be helpful for developing an effective restoration program.

EXPERIMENTAL METHODS

Surface soil samples to a depth of six inches were collected at locations shown in Figures 1A and 1B. Three core samples were collected to a depth of four feet using a hydraulic-driven probe. Dehydrogenase activity determination was done on freshly collected soil material. The procedure is described in Stevenson (1) and reported as triphenylformazan per gram of moist soil. The remaining soil was air dried and passed through a 10-mesh sieve. Soil nitrates were measured on a dilute acid extract of the soil using a cadmium reduction method. Percent organic matter of the air-dried soil samples was determined using a Model ST-OR 5020 LaMotte Company kit. Total petroleum hydrocarbons, TPH, was determined by an EPA-Approved protocol by Petro FLAG identified in EPA-SW 846. Conductivity was determined in a 1:1 soil-water slurry using a conductivity probe meter. Soluble chlorides were determined on a filtrate from 3 parts water to 1 part dry soil sample. The analytical protocol used was an ion chromatography method.

RESULTS

Table 1 lists the analyses for the six parameters. Values reported are means of duplicate sample analyses for nitrates, TPH and DHA. Conductivity, chlorides and organic matter were not duplicated.

DISCUSSION

Reported measurements of soluble salts as applied to a soil water extract were first done in 1897 by Whitney and Means (2). The choice of our method was not to correlate soluble salt levels with plant growth, but to measure relative differences between the soil and core samples. A dehydrogenation process usually occurs during the biological oxidation of organic compounds in soil. The process usually involves a soil organic compound as a hydrogen donor and another ingredient that seems as a hydrogen acceptor. These dehydrogenases systems are an integral part of viable microbial populations. In this study, DHA was used as an index of viable biomass. The protocol most widely used for determination of DHA was reported in 1959 by Stevenson (1). Changes in soil microbial biomass has been used since 1995 as a sensitive indicator of

the toxicity of pollutants by Horwath and Paul (3).

Nitrates, except for two of the 20 samples, were in a low 0.1 to 0.2 ppm range. Animal activity could have contributed to the two higher nitrate levels. Although nitrates were low, the concentrations would be sufficient to support native vegetation growth. Organic matter was in a 1.2 to 5.6 percent typical range. Conductivity and chlorides were used to detect the presence of brine wastes. Conductivity and chlorides ranged from 4 to 1766 uS/cm and 12 to 15540 ppm, respectively. Assuming that DHA was an indicator of viable biomass, the surface soils from locations DKA3, DKB6, and DKB8 were the most biologically active and therefore most capable of supporting plant growth.

The vertical profile core samples at Site A showed that TPH, conductivity and chlorides increased while DHA decreased with depth. The trend at Site B for DKB4 generally was opposite. The DKB6 profile had the highest brine/oil wastes and lowest DHA at about two feet below the surface. Low DHA in the vertical profiles appeared related to high TPH and conductivity for most, but not all, samples.

Interactions appeared operative between TPH, conductivity and chlorides to influence DHA. For instance, high TPH and water-extractable chlorides did not cause low DHA in many of the samples. High TPH may have reduced conductivity by combining with the brine salts to reduce solubility while permitting the vigorous water extraction for chlorides to increase this component.

Most useful data obtained from the study were the site characterization measurements to determine low level nitrates, TPH from crude oil contamination, and chlorides for the presence of brine waste. The results obtained will be helpful information for the selection of restoration activities at the two sites.

QA/QC STATEMENT

All soil and core analyses were done by standardized published protocols. DHA values reported in Table 1 are means of duplicated samples. Linear regression calculations between any two parameters did not give a correlation coefficient to indicate a close relationship. Best fit was $r=0.60$ between organic matter and TPH.

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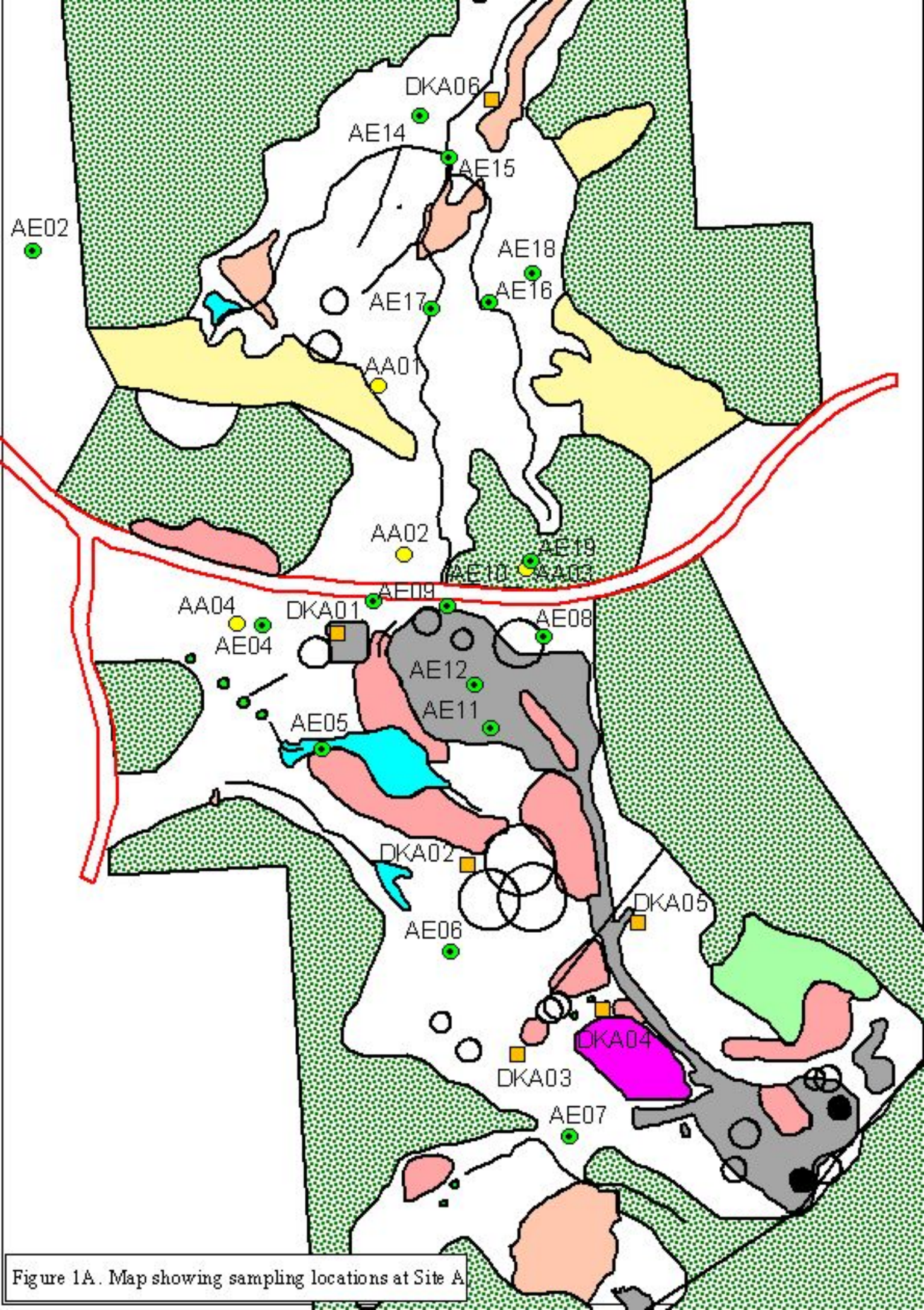


Figure 1A. Map showing sampling locations at Site A.

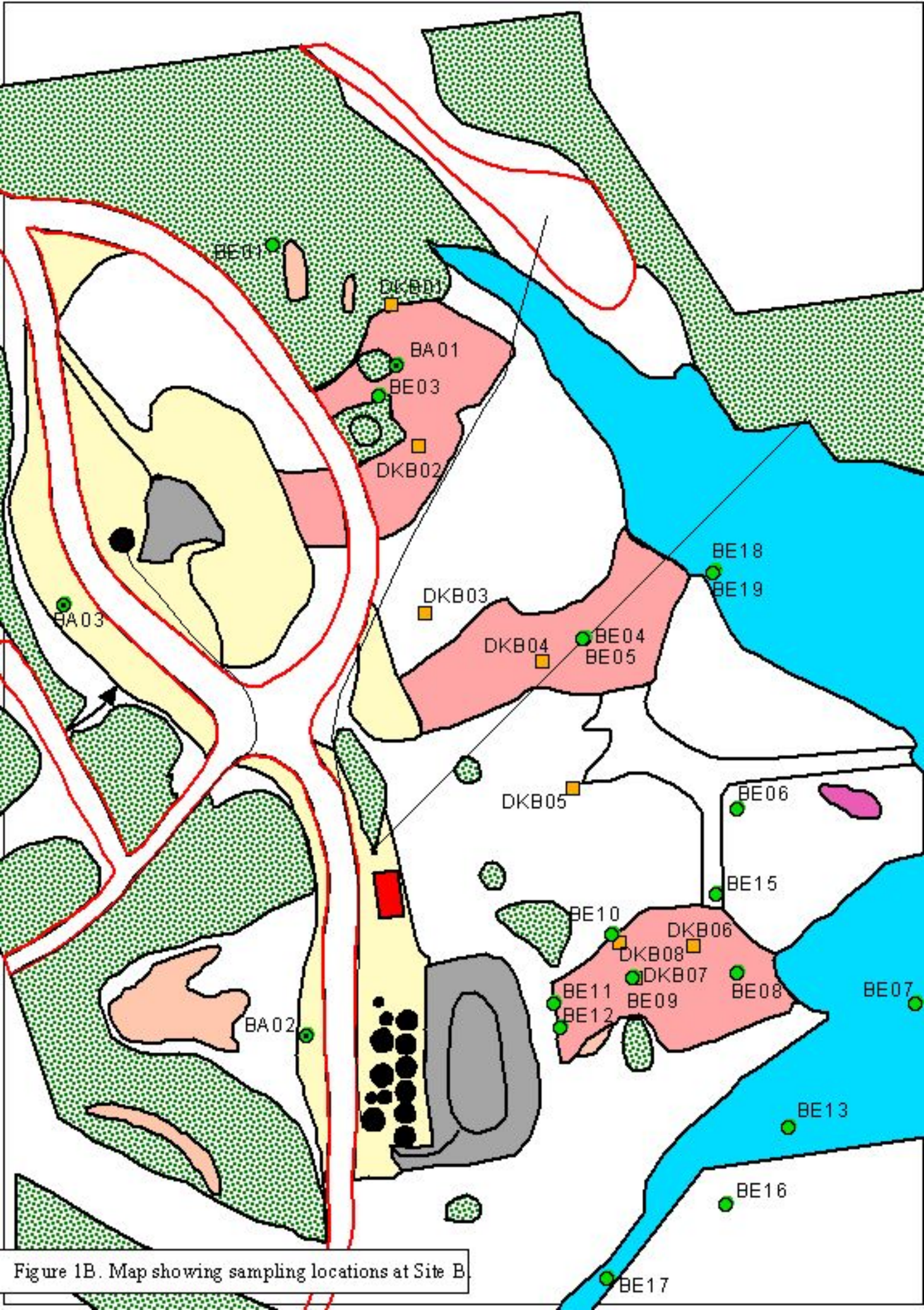


Figure 1B. Map showing sampling locations at Site B.

TABLE 1. Soil and Core Analyses from OSPER Sites A and B.

Sample	Nitrates (ppm)	O.M. (%)	TPH (ppm)	Conductivity (uS/cm)	Chlorides (ppm)	DHA (mg/g)
DKA1, 0-1« ¹	0.15	3.3	1580	90	12	2.7
DKA1, 1«-2« ¹	0.12	3.3	6320	418	93	2.3
DKA1, 2«-4 ¹	0.15	3.8	608	571	158	0.72
DKA2, 0-6 ¹¹	0.06	1.8	262	86	12	3.6
DKA3, 0-6 ¹¹	0.18	2.7	122	125	12	33.2
DKA4, 0-6 ¹¹	0.21	5.0	1695	122	14	2.3
DKA5, 0-6 ¹¹	0.12	4.2	2336	64	12	5.4
DKA6, 0-6 ¹¹	0.12	1.2	89	572	441	4.4
DKB1, 0-6 ¹¹	0.12	1.8	365	184	32	3.3
DKB2, 0-6 ¹¹	0.12	1.5	31	4.5	3930	9.9
DKB3, 0-6 ¹¹	14.4	2.4	166	25.2	15540	5.8
DKB4, 0-1« ¹	0.18	1.5	257	3.6	1929	-0-
DKB4, 1«-2« ¹	0.18	1.2	42	1766	1857	-0-
DKB4, 2«-4 ¹	0.12	1.5	-0-	743	2313	23.4
DKB5, 0-6 ¹¹	0.15	1.8	374	1470	3990	37.9
DKB6, 0-1« ¹	0.15	2.7	2052	3.8	2235	15.1
DKB6, 1«-2« ¹	0.15	2.7	2900	1156	1548	-0-
DKB6, 2«-4 ¹	0.18	1.5	90	391	981	17.8
DKB7	0.15	2.4	1985	6.7	3810	11.5
DKB8	1.2	5.6	2584	4.3	4380	43.8

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