Environmental Resources Management

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6 March 2014

Dennis Harwood/David Allen
555 Cordova Street
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Subject: Garden Soil Sampling (NTP 18-8036-02-002E)

Dear Mr. Harwood and Mr. Allen:

The purpose of this report is to transmit the results of garden soil sampling performed on 30 August and 4 September 2013. The sampling was performed in North Pole, Alaska, approximately 13 miles southeast of Fairbanks, Alaska, within the Fairbanks North Star Borough.

Alaska Department of Environmental Conservation (ADEC) tasked ERM Alaska, Inc. (ERM) to collect samples to assess whether there is any evidence of sulfolane contamination of garden or lawn soil as a result of watering with sulfolane-impacted irrigation water. There are many residences with gardens located within and near the sulfolane groundwater plume to the north, northeast, and northwest of the North Pole Refinery (NPR) (Figure 1). ERM collected surface soil samples from six residential lawns or gardens that are watered with sulfolane-laden water from residential wells. The samples were analyzed for sulfolane, total organic carbon (TOC), and grain-size to evaluate the potential for sulfolane accumulation in the garden soil.

In addition ERM collected surface water samples from three locations in the Tanana River to support ongoing stable isotope work by the University of Alaska, Fairbanks (UAF). Sample locations are presented in Attachment A but results are not discussed in this report.

BACKGROUND

The NPR is an active petroleum refinery that receives crude oil feedstock from the Trans-Alaska Pipeline. The site was developed in the mid-1970s and operations began in 1977. The NPR contains crude oil processing units, tank farms, truck loading racks, wastewater treatment lagoons, storage areas, and two flooded gravel pits. Since 1985, the NPR has used a proprietary chemical, sulfolane, in the refining process to extract aromatics from the feedstock. Over the years, there were documented releases of sulfolane at the NPR, and there were very high concentrations of sulfolane historically

detected in the wastewater lagoons. In 2009, sulfolane was first detected in groundwater samples from offsite monitoring wells.

In 2012, the state of Alaska established an alternative cleanup level (ACL) of 14 micrograms per liter (µg/L) for sulfolane in water (ADEC 2012) and a screening level of 38 micrograms per kilogram (µg/Kg) for sulfolane in soil). Extensive characterization work has shown the sulfolane groundwater plume above the ACL to extend approximately 3.5 miles downgradient (north) of the NPR. Sulfolane has been detected in shallow monitoring wells screened across the water table, deeper monitoring wells, and also in private wells completed subpermafrost at depths up to approximately 300 feet below ground surface. The extent of sulfolane in groundwater exceeding the 14 µg/L ACL in the 10 to 55 feet below water table interval, as of the 3rd quarter of 2013 (Arcadis, 2013), is shown on Figure 1.

Prior to the current study, there has been one other garden soil sampling event. In October 2011, four soil samples were collected from two properties located within the sulfolane plume. Sulfolane was not detected in any of the samples; however, the garden areas sampled were reported to have not been watered with sulfolane-laden water during the 2011 growing season (Barr 2012).

The purpose of the current garden sampling is to evaluate potential ecological and human health risk from the application of sulfolane-laden water to garden and lawn soil. Sulfolane has a low organic carbon partitioning coefficient; therefore, it has been assumed that it does not adhere to soil particles. The samples in the current effort represent areas that are reported to have been watered with impacted water for several years. To better understand the possible retention of sulfolane in garden soil, samples from each property were also analyzed for grain size and TOC.

SOIL SAMPLE LOCATIONS

Garden or lawn surface soil samples were collected from six properties. ADEC identified candidate properties for surface sampling by reviewing responses to a June 2013 ADEC sulfolane survey of North Pole residents and by recommendations offered by Flint Hills. In selecting candidates for garden sampling, ADEC identified properties where untreated water was reportedly used to water gardens or lawns and where recent sampling indicated elevated sulfolane concentrations in the untreated water. ADEC was able to obtain access to sample garden soil at properties with a range of untreated sulfolane concentrations, as shown in Table 1. The garden sampling locations are shown in Figure 1.

Soil sample information is summarized in Table 2. The number of samples collected from each property was based on the recent groundwater sulfolane concentrations. Three samples were collected from the properties with highest groundwater sulfolane concentrations, while one soil sample was collected from the properties with lower groundwater sulfolane concentrations (note that there were two properties with similar sulfolane concentrations of approximately 120 µg/L; three samples were taken from one

of these properties and one from the other). One TOC and one soil particle size sample were also collected from each of the six properties to help interpret the distribution of any sulfolane detections. Table 2 also indicates if the samples came from a garden or lawn and any associated notes.

TABLE 1: GARDEN SOIL SAMPLE PROPERTIES WITH CURRENT SULFOLANE GROUNDWATER CONCENTRATIONS

Map ID	PW-ID	Sulfolane concentration in groundwater (µg/L)	Well Depth (feet below ground surface)	Date of Recent Sample
1	PW-1363	132	40	7/11/2013
2	PW-0625	32.5 J	Unknown	12/14/2012
3	PW-1452	181	Unknown	6/18/2013
4	PW-1451	288	34	6/10/2013
5	PW-1354	122	60	1/11/09
6	PW-0597	123 J	Unknown	12/7/2012
		88.3 J		6/6/2013
		96.5 J		6/27/2013
		70.7 J		8/6/2013

Notes:

PW-ID – Flint Hills Resource assigned private well identification number
J – Estimated concentration
µg/L – micrograms per liter

TABLE 2: PROPERTY INFORMATION AND SAMPLE LOCATION

Map ID	PAN	# Sulfolane Samples	# TOC Samples	# Particle Size Samples	Sample Location Type	Location Details and Well Water Usage
1	565831	3	1	1	Flowerbed	Samples collected from flowerbed primarily containing annual petunias and watered throughout summer with well water.
2	328430	1	1	1	Flowerbed	Samples collected from flowerbed with perennial flowers (peonies and delphinium). Watered periodically through summer with well water, but outdoor city water spigot was installed prior to sampling event.
3	627057	3	1	1	Greenhouse Vegetable Pot	Sample collected from cucumber planter box inside greenhouse that was presumably watered with well water. This location was protected from rainwater.
4	299774	3	1	1	Lawn	Approximately 4 inches of topsoil were imported and area was hydro-seeded in Spring 2013. Lawn was watered with well water extensively throughout the summer months to promote new growth.
5	565652	3	1	1	Lawn	Sample collected beneath well-established sod layer. Lawn was watered with well water throughout summer
6	327948	1	1	1	Lawn	Sample collected beneath well-established sod layer. Lawn was watered with well water throughout summer

Notes:

PAN – Fairbanks parcel account number

FIELD WORK AND SAMPLING PROCEDURES

Soil property map locations 1, 2, and 3 were sampled on 30 August 2013 and locations 4, 5, and 6 were sampled on 4 September 2013 by ERM staff. Field notes are provided in Attachment B. Weather during both sampling events was rainy with air temperatures ranging from 50˚ to 60˚ Fahrenheit (F). The North Pole area experienced a relatively warm summer with below average rainfall for the months of June, July, and August. Therefore, gardens and lawns would have been expected to receive above average rates of irrigation during the summer of 2013. However, during and for a short time prior to both sampling events conditions were rainy. Attachment C presents North Pole daily precipitation events and precipitation accumulation since 1 June 2013. Significant rain events (greater than 0.1 in) occurred within seven days of the first event and three days prior to the second sampling event.

The field team coordinated with analytical laboratory SGS North America, Inc. (SGS) in Fairbanks for transfer of sample containers. For the UAF stable isotope sampling, ERM coordinated with Michelle Barnes of UAF.

The following procedures were followed for surface soil sample collection. ADEC or Flint Hills coordinated with property owners to obtain approval for sample collection. If available, property owners were asked a series of questions by ADEC about garden or lawn watering habits at the property. ERM staff scheduled the sampling event with each the property owners. If possible, ERM staff discussed watering history with the property owner prior to sampling in order to determine the most appropriate location to sample, based on exposed soil and amount of well water received. However, of the six properties sampled, only two property owners were home at the time of sampling.

Individual soil sample location preference was given to areas of bare soil. If bare garden soil was not available, a section of lawn was selected for sampling. Care was taken not to damage flowers or vegetation. In areas of bare soil, a disposable sample spoon was used to remove the upper half inch of material from the sample site and to collect the sample. Soil samples from areas of bare soil were collected from approximately one half inch below the ground surface. In areas where there was no exposed soil and only lawn, the sod layer was either cut with a knife or shovel blade to expose bare soil. Jars were filled to minimize head space, and any soil particles adhering to the lip of the jar were wiped clean with a paper towel prior to capping the jar. If a shovel or knife was used to cut sod, all soil particles remaining on the tools were removed with a brush, and then the tools were wiped clean with a deionized water- wetted paper towel. New gloves and sampling gear were used at each sample location. Disposable sampling gear was the only investigation derived waste generated and was disposed of at the Fairbanks landfill.

Photographs documenting the sampling effort are provided in Attachment D.

Work Plan Deviations

- The work plan stated eight properties would be sampled. However, six properties were sampled because ADEC was able to obtain consent from six property owners.
- The work plan called for asking the property owner a series of questions regarding specific well water use and obtaining help from the property owner in selecting the sample location. However, sampling was scheduled with the property owners via phone, and in most cases (four of the six properties) the property owner was not present during sampling to provide additional details.

QUALITY ASSURANCE AND QUALITY CONTROL

Laboratory reports are presented in Attachment. A detailed Data Quality Assurance Review (QAR) and ADEC laboratory checklist are presented in Attachment F. Organic material in the soil samples had a high molecular weight, resulting in the laboratory's need to add a cleanup process to the sample preparation. Because of the cleanup process, the standard 14-day holding time was exceeded for all of the samples. However, all but two of the samples were re-extracted within twice the standard holding time and were therefore flagged as estimated due to exceeded holding time. The non-detected results for sulfolane were rejected in two samples (13-NPR-01-SS-03 and 13-NPR-03-SS-01) due to grossly exceeded holding times. The data quality objective for completeness was met. With the exception of the two rejected sulfolane sample results, data quality was determined as acceptable or estimated. Acceptable data are associated with quality control (QC) data that meet all QC criteria or with QC samples that did not meet QC criteria but data quality objectives were not affected. The rejected results are only usable for screening purposes.

FINDINGS

Soil sample results are presented in Table 3. The project resulted in the following findings:

- Sulfolane was not detected in any of the lawn or garden locations sampled.
- The TOC and grain size data did not provide any insight into sulfolane retention in soil, because there were no sulfolane detections in soil.
- Detection limits were below ADEC soil screening levels.
- Data were considered useable to assess sulfolane concentrations at the time and locations of the sample event.

TABLE 3: GARDEN SURFACE SOIL SAMPLING RESULTS
FLINT HILLS RESOURCES, NORTH POLE REFINERY
NORTH POLE, ALASKA

Client Sample Id:	Location	Analysis	SM21 2540G		Sulfolane-SW8270D M w/IsoDl Sl		SW9060A-Mod		Beckman-Coulter LS Particle Size Analyzer				
		Analyte	Total Solids		Sulfolane		Total Organic Carbon		Particle Size				
		Matrix:	Date Sampled:	%	ERM Qualifier	mg/Kg	ERM Qualifier	%	ERM Qualifier	d10 (µm)	d50 (µm)	d90 (µm)	% > 2000 µm	Comments
13-NPR-01-SS-01	01-SS-01	Soil	8/30/13	62.0	--	U (<0.01)	UJ-H	--	--					
13-NPR-01-SS-02	01-SS-02	Soil	8/30/13	70.9	--	U (<0.00872)	UJ-H	3.60	--	9	64	413	20%	Organics, Grass, Roots
13-NPR-01-SS-03	01-SS-03	Soil	8/30/13	68.5	--	U (<0.009)	UR-H	--	--					
13-NPR-02-SS-01	02-SS-01	Soil	8/30/13	62.1	--	U (<0.00998)	UJ-H	17.9	--	28	216	770	30%	Organics, Grass, Roots
13-NPR-03-SS-01	03-SS-01	Soil	8/30/13	64.2	--	U (<0.00964)	UR-H	--	--	12	79	461	12%	Organics, Grass, Roots
13-NPR-03-SS-02	03-SS-02	Soil	8/30/13	61.0	--	U (<0.01016)	UJ-H	--	--					
13-NPR-03-FD-03	03-SS-03	Soil	8/30/13	75.9	--	U (<0.00816)	UJ-H	1.17	J-D					
13-NPR-03-SS-03	03-SS-03	Soil	8/30/13	77.4	--	U (<0.00796)	UJ-H	3.41	J-D					
13-NPR-04-FD-01	04-SS-01	Soil	9/4/13	60.8	--	U (<0.01014)	UJ-H	13.3	--	13	100	536	14%	Big rocks, organics
13-NPR-04-SS-01	04-SS-01	Soil	9/4/13	60.2	--	U (<0.01026)	UJ-H	12.6	--					
13-NPR-04-SS-02	04-SS-02	Soil	9/4/13	59.0	--	U (<0.01048)	UJ-H	--	--					
13-NPR-04-SS-03	04-SS-03	Soil	9/4/13	61.8	--	U (<0.01004)	UJ-H	--	--					
13-NPR-05-SS-01	05-SS-01	Soil	9/4/13	74.7	--	U (<0.00824)	UJ-H	5.46	--	9	65	453	3%	Organics
13-NPR-05-SS-02	05-SS-02	Soil	9/4/13	75.5	--	U (<0.00818)	UJ-H	--	--					
13-NPR-05-SS-03	05-SS-03	Soil	9/4/13	76.6	--	U (<0.00808)	UJ-H	--	--					
13-NPR-06-SS-01	06-SS-01	Soil	9/4/13	80.5	--	U (<0.0374)	UJ-H	1.34	--	10	61	236	6%	Organics, rocks

- The cleanup procedure was needed for the current garden soil samples but not the 2011 garden soil samples. The range of TOC values was similar between the two sets of samples (i.e., 1.8 to 23.1% in 2011 and 1.17 to 17.9% in 2013), so TOC differences do not explain the need to use the cleanup procedure in 2013. If garden soil sampling is performed in the future, the potential need to use the cleanup procedure should be discussed with the lab ahead of time to decrease the probability of needing to reanalyze samples and incur possible holding time exceedences.
- The data quality in the non-rejected results is considered adequate to show that there is no evidence of sulfolane retention at detectable concentrations in soil watered with sulfolane-laden water.
- Property owners were notified of the sampling results for their property through a letter from ADEC.

Sincerely,

Jane Paris
Project Manager

Max Schwenne
Managing Partner

cc:

Tamara Cardona, ADEC (via e-mail)

Tables:

1. Garden Soil Sample Properties with Current Sulfolane Groundwater Concentrations
2. Property Information and Sample Location
3. Garden Surface Soil Sampling Results

Figures:

1. Garden Sampling Property Locations

Attachments:

A. UAF Tanana River Isotope Sample Location Information
B. Field Notes and Field Data Sheets
C. North Pole Cumulative Precipitation
D. Photo Log
E. Laboratory Reports
F. Quality Assurance Review and ADEC Checklist

REFERENCES

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Arcadis. 2013. Third Quarter 2013 Groundwater Monitoring Report. North Pole Refinery, North Pole, Alaska. October 31, 2013.

Barr Engineering Company. 2012. Site Characterization Report – Through 2011. North Pole Refinery, North Pole, Alaska. December 2012.

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FIGURES

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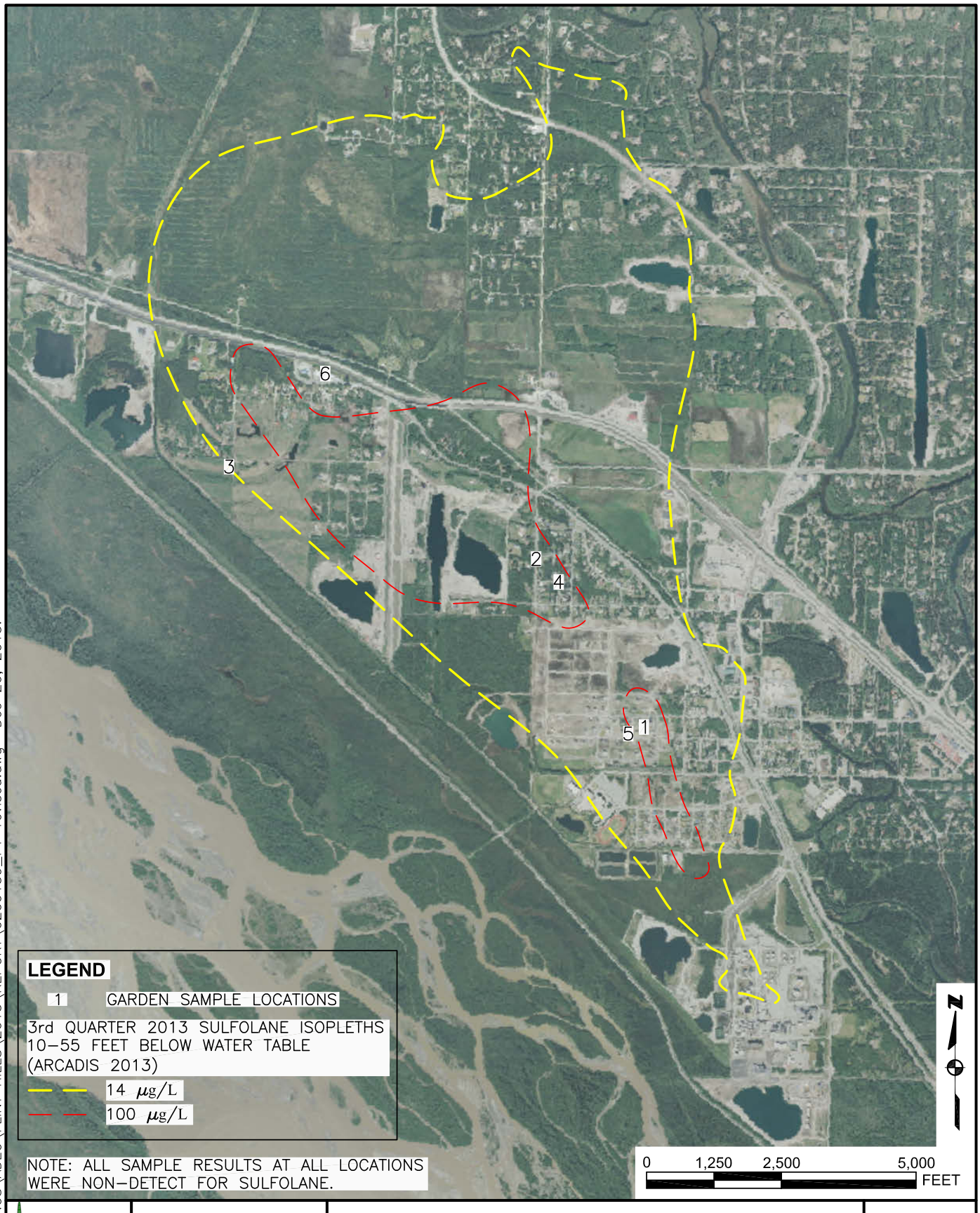

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GARDEN SAMPLING LOCATIONS

NORTH POLE REFINERY AREA
GARDEN SAMPLING REPORT
North Pole, Alaska

FIGURE
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