North Pole Refinery Technical Project Team
October 23, 2013
Alaska Department of Environmental Conservation, Fairbanks Office
Fairbanks, Alaska

In Attendance

Rebecca Andresen	Arcadis
Brian Angerman	Barr Engineering
Dave Barnes	University of Alaska Fairbanks
Cody Black	ERM (telecon)
Stephanie Buss	SPB Consulting
Tamara Cardona	DEC, Contaminated Sites, Project Manager
Dave Dahlstrom	Barr Engineering
Andy Davis	Geomega
Loren Garner	FHRA Project Manager
JoAnn Grady	Grady and Associates
Patrick Haas	PE Haas and Associates
Steven Humphrey	Geomega
Brad Koons	Arcadis
Dave Lipson	Arcadis
Mark Lockwood	Shannon and Wilson
Gordon McCurry	Geomega
Andrew Ohrt	Arcadis
Jane Paris	ERM
Britt Phillips	Geomega
Gary Remple	Barr Engineering
Max Schwenne	ERM
David Smith	Koch Remediation Services, Project Manager
Eric Zentner	Boreal Communications

ACTION ITEMS FROM THE PREVIOUS MEETING

- The team discussed the status of the action items from the previous meeting.
    - Dr. Barnes said that he will determine whether his budget will allow him to conduct age dating on the water being collected for his isotope project.
    - Mr. Garner said that he would send to Ms. Cardona a list of outstanding permits, such as the building permits, that are required for the approval of the expansion of the pump and treat system.
    - The team determined that all other action items had been completed.

THE CONCEPTUAL SITE MODEL

Items Discussed

- Mr. Ohrt gave an overview on the development of the Conceptual Site Model (CSM). Mr. Ohrt noted that although the document is in the preliminary stages of its development, he wanted to

explain the philosophical approach that the FHRA team used while developing the document as well as a brief overview of its current contents. Mr. Ohrt said that the CSM was written under the guidance of two reference documents: a guidance document on the development of CSMs from the American Society for Testing Materials (ASTM) and a guidance document from the Alaska Department of Environmental Conservation (ADEC). Mr. Ohrt commented that the FHRA team intends to write the document such that it will provide a broad, high-level overview of the site that can be understood by readers without a technical background. Ms. Cardona replied that ADEC expects that the document will be highly detailed and technical since it will be used by experts to make decisions.

Mr. Ohrt described how the CSM will account for the information that is currently available on the historical source areas of sulfolane and the fate and transport of sulfolane impacted water. He commented that the CSM does not emphasize a specific contaminant release, but considers a number of historical releases that occurred at different times, in different areas of the refinery, and at varying concentrations. Mr. Ohrt briefly described a number of major sources areas that are considered in the CSM, including the Crude Unit # 1 Wash Area, the Crude Unit #2/Extraction Unit Area, Lagoon B, and the Southwest Area Former Wash area. Mr. Ohrt presented a series of slides showing the depths and locations of soil borings and monitoring wells, the location of discontinuous permafrost, and trends in the concentration of sulfolane at certain monitoring points throughout the site. He presented a series of slides that demonstrated the efficacy of the groundwater recovery system by showing the decreases in the concentration of sulfolane across significant portions of the plume that have occurred since it has been in operation.

Mr. Ohrt briefly described how the CSM accounts for the various geological and hydrological factors that have been found to influence the fate and transport of sulfolane at the site. He explained how the document accounts for the effects of discontinuous permafrost, seasonal variation in the rate of surface water infiltration, groundwater recharge, and the direction of groundwater flow; as well as variation in the hydraulic conductivity and the storage capacity of the soils, and the permeability of the surface materials about the refinery. Mr. Ohrt said that the CSM will explain the extent to which the transport of sulfolane throughout the site can be attributed, within the context of the aforementioned factors, to the fundamental transport mechanisms of advection and dispersion.

Mr. Ohrt listed the following as the takeaway points for the CSM overview:

- There are a number of processes to explain the residual sulfolane concentrations.
- Permafrost is bifurcating the sulfolane plume vertically and widening it horizontally.
- Concentration trends in the distal portions of the sulfolane plume are increasing while sulfolane trends in wells near the North Pole Refinery (including the VPT) are decreasing.
- Sulfolane concentrations in the sub-permafrost portion of the aquifer appear to be similar to those in the supra-permafrost portion of the aquifer.
- Light Non-aqueous Phase Liquid (LNAPL) contamination is neither a source nor sink of sulfolane.

- The potential receptors of sulfolane-impacted water have been identified and they are being protected.
- The CSM will also discuss other contaminants of concern (COCs).

- Mr. Ohrt presented a brief animation that was created by Geomega to demonstrate what they believe to be the primary explanation for the continued presence of sulfolane in the aquifer long after the sources of the sulfolane contamination from the refinery had been cut off. The animation illustrated their theory that once sulfolane was released from the refinery, it dissolved into groundwater and traveled downgradient through preferential pathways by advection while gradually diffusing into immobile pore spaces in the soils adjacent to the pathways. The diffusion process into the adjacent soils continued until the movement of sulfolane between the soils and pathways reached a point of equilibrium. Once the sulfolane concentrations in the groundwater began to decrease, the sulfolane stored in the immobile porespaces began to diffuse back into the relatively cleaner water advectively flowing through the pathways.
  - The team discussed Mr. Ohrt's presentation. Dr. Barnes asked what was driving the sulfolane down as it was being bifurcated vertically around the permafrost wedges. Mr. McCurry explained that the FHRA team believes it is being driven down by a combination of head pressure being created by the gravel pits and high stage in the Tanana River, and by the shape of the preferential flow paths in the aquifer. Dr. Barnes asked whether preferential flow was possible in alluvial deposits such as the ones that characterize the project site. Mr. McCurry assured him that it is possible, and, particularly so in heterogeneous systems such as the one at the site wherein channels that were formed at different times are interconnected.
  - Dr. Barnes agreed with the process of diffusion into and out of dead-end pore spaces and asked whether this analysis of the concentration of sulfolane matches the groundwater model. Mr. McCurry replied that the model's values for anisotropy, combined with its dispersion values, are adequate to account for the concentrations of sulfolane that were found at depth in the aquifer.

Outstanding Questions

- Dr. Barnes commented that he feels that the concentrations that are being observed in the down-gradient wells are somewhat higher, given the differences in the rates of advection and diffusion, than what he would expect to see if diffusion from the pore space in the impacted soils really is the primary source of those concentrations. Mr. Lipson indicated that what is being observed in the monitoring wells is a combination of a variety of processes: the process of advection, diffusion, the historical aspect of the release, and seasonal changes in the groundwater elevation.

THE AIRBORNE ELECTROMAGNETIC SURVEY

Items Discussed

- Mr. Humphrey provided an overview of the preliminary results of the Airborne Electromagnetic (AEM) survey that was conducted over the plume area. He said that data was collected at 128,000 positions over a number of transects that covered a total of 227 miles within the project area. Mr. Humphrey briefly explained that the AEM survey provides data on the resistivity of soil to

electromagnetic energy. The resistivity of the soil is determined at different depths by varying the frequency of the energy. The resistivity data is then interpreted to give clues as to the nature of the soil and whether or not it is frozen as permafrost. Mr. Humphrey emphasized that a number of factors must be taken into account while interpreting the data since interference is created by highly conductive surface features such as roads, railroads, and water bodies, as well as from power lines and radio towers. He added that there is additional ambiguity in the results since different kinds of soils can have similar levels of resistivity to each other depending on whether the soils are frozen or thawed.

Mr. Humphrey said the data from the AEM survey will be compared to geophysical data taken from existing well logs, ground-based electromagnetic data, and other sources of information to better identify the types of soil and shapes of permafrost bodies in the project area. Mr. Humphrey emphasized that the AEM investigation is still in its preliminary phase and that he expects his team's confidence in their interpretations to grow as it is able to compare the data from the survey to other project data. He noted that, at this point, his team currently has confidence in the shape of the bottom of the permafrost in areas where background interference is minimal. He said that they are gaining confidence in their understanding of the kinds of discontinuities that may be present in the project area. Mr. Humphrey remarked that his group still has some uncertainty in their interpretations of the data from the shallow zone intervals where the aforementioned interference is most pronounced.

Mr. Humphrey said that the data from the survey supports the current Conceptual Site Model (CSM) since it substantiates the hypothesis that a large mass of continuous permafrost exists in the project area and that the sulfolane plume is spreading around it vertically and horizontally. He added that the data from the survey should provide an element of support for the groundwater model by providing a means of corroborating its predictions of groundwater flow.

OVERVIEW OF RECENT SOIL GAS TESTING

Items discussed

- Mr. Koons presented an overview of the results of recent soil gas testing that was conducted at the site. He said that nested soil gas points were installed in the vadose zone and screened approximately near the groundwater table at the LNAPL contamination and at the midpoint between surface and groundwater table. He said that the soil was initially screened with a Photoionization Detector (PID) to detect contamination. Mr. Koons said that the soil gas samples were analyzed for their levels of oxygen, carbon dioxide, and methane and for their concentrations of volatile petroleum and other hydrocarbons. Mr. Koons related the results of the testing and noted the following observations:
    - Soil gas levels were near atmospheric concentrations in samples taken from monitoring points where LNAPL was not present.
    - Depressed oxygen levels were found across the board at monitoring points where contamination was present. In these samples increasing oxygen concentrations and decreasing carbon dioxide concentrations were correlated with decreasing soil depths.
    - The results revealed high levels of methane at depth in some locations. This was attributed to the presence of methanogenic bacteria and other factors.

- The results of the soil gas testing enabled the team to calculate the natural source zone depletion rates per the Interstate Technology and Regulatory Council's (ITRC) method. These rates will be used to update the assumptions that were made about soil gas in previous reports.

- Mr. Koons reviewed the proposal to perform preliminary testing to determine the viability of using bioventing/Soil Vapor Extraction (SVE) technology as a remediation tool to be used at the site. He briefly described the methodology and objectives of the test and the criteria that his team used to determine the proposed locations for its monitoring points.
    - The team discussed whether additional soil sampling should be used to confirm the concentration and thickness of contamination in areas where the only source of assessment was photoionization detection (PID). Mr. Haas noted this sampling would help the team define the lower extent of the contamination in the proposed testing areas and thus improve its understanding of the potential efficacy of Bioventing/SVE as a remediation technology.

Agreement/Action Item

- Ms. Cardona requested that the team perform soil sampling to validate the locations that were selected for the Bioventing/SVE study on the basis of data provided by PID. She clarified that the team need not delay other project work to wait for the results of the soil sampling.
- Per Mr. Smith's request, Ms. Cardona agreed to send her approval for the installation of the proposed Bioventing/SVE study wells provided that the aforementioned soil sampling is conducted.

CAMERA ASSESSMENT

Items Discussed

- Mr. Garner updated the team on the status of the ongoing camera assessment. He said that a resident living south of Christine Loop near the north-central portion of the deep residential well network is scheduled to have a camera assessment conducted on his well. He added that another resident living on Poppy Street has also agreed to a camera assessment, but the resident has not had time to schedule a specific appointment. Mr. Garner said that his group is waiting for the lab results from a 300 foot well that was sampled in the Tanana Drive area. He added that although the Ground Water office has been unable to identify any additional candidates for sampling on Tanana Drive, they are continuing to look for more opportunities to conduct camera assessments in that area.

WELL INSTALLATION UPDATE

Items Discussed

- Mr. Lockwood updated the team on the status of the installation of on-site and off-site project wells. He said that most of the monitoring wells that were proposed to be installed this season have been installed, with the exception of the upgradient wells, some in-fill wells, and wells in Location 8-A through 8-F, which will be installed after the construction of roads and pads that are

associated with them. Mr. Lockwood noted that installation of one well in Location 8-U was cancelled due to permitting issues that were associated with crossing the rail road tracks in the area. Mr. Lockwood related the following information about status of the well installations.

- Permafrost was encountered at 110 feet while attempting to install additional monitoring wells at MW-148.
- A few of the wells that were proposed to evaluate the 2014 proposed western expansion of the hydraulic capture zone have yet to be installed.
- MW-106 may need to be replaced depending on whether the alignment of the nearby fencing can be maintained; normal operations will be maintained throughout the winter and the decision of whether to replace the well will be made in the early spring.
- The results of preliminary testing indicate that the wells that were proposed to be installed near MW-138 will be sufficient for vertical delineation of the sulfolane plume in this area.

- Mr. Lockwood said that his group is waiting for the lab results from a series of soil borings, hydro-punch samples, and water samples taken in the southern portion of the project area between Lagoon B and the southern gravel pit.
- Mr. Garner said that FHRA will soon be able to inform Dr. Barnes of whether they will be able to provide a sample of spent Granular Activated Carbon (GAC) from the groundwater extraction system.
- Mr. Garner said while the sampling of wells for the Stable Isotope Study is proceeding according to schedule, the sampling of the wells in the far northern and northwestern portion of the plume has been reprioritized to occur after the sampling of the more accessible wells that are located closer to the refinery.

Action Items

- Mr. Lockwood will provide ADEC additional information on the private wells around Tanana Drive (well depths, results, etc.) to attempt to resolve apparent differences between ADEC's GIS dataset and SWI's dataset.
- Ms. Buss will send Ms. Andresen ADEC's information on the input parameters for the screening levels for PFOS and PFOA.
- Ms. Barnes will discuss with Dr. Barnes whether it will be possible to reschedule the installation of the well thermistors for the First Quarter of 2014.

THE CAPILLARY FRINGE INVESTIGATION

Items discussed

- Mr. Koons gave a presentation on the results of recent soil sampling that was conducted as part of an investigation on the fate and transport of sulfolane within the capillary fringe layer. Mr. Koons briefly reviewed the methodology that was used in the investigation and he listed some of the challenges that were encountered while the samples were being collected and analyzed. He said the samples were collected to determine if there is a correlation between the grain size, density, permeability, Total Organic Carbon (TOC) content, and the concentration of sulfolane

that was found in the soil. Mr. Koons said that the FHRA team is particularly interested in being able to determine the levels of pore water saturation in the soil since that will allow them to determine the sulfolane concentration in the pore water.

Mr. Koons presented a series of slides showing the levels of sulfolane, pore saturation, and TOC that was measured in the vadose, saturated, and capillary fringe zones from a column of soil samples that was taken from CF13-1(A-E) in the southwest area. He noted that the peak concentration of sulfolane in the column corresponded with the peak levels of TOC and soil moisture. Mr. Koons pointed out the range of the groundwater flux across the column and identified the locations where samples were taken from the fine-grained material and in areas just above the water table. Mr. Koons commented that the samples were taken from an area with highly compacted soil that was located beneath a gravel road. He said that his team hypothesizes that the low infiltration of water along the roads and other developed areas is allowing the sulfolane to be retained in the low-density layers associated with high TOC and high moisture. He added that they also believe that it is retained in areas between the fine-grained and coarse-grained soils.

The team discussed the significance of this hypothesis within the context of its analysis of the source areas at the site. Mr. Davis reiterated that there were a variety of potential historical sulfolane release mechanisms such as a release of sulfolane to groundwater from a failed sump, infiltration of impacted water from Lagoon B, and the release of sulfolane-impacted wastewater to the surface from the wash areas. Mr. Davis said that the hypothesis concerning low surface infiltration is applicable to areas contaminated by the release of sulfolane –impacted wastewater to the surface and it may provide a useful explanation of why sulfolane has been lingering in some developed areas long after it has been washed out of others. Mr. Smith said that his team is still waiting for the project lab to send the data from most of the samples that were taken as part of this analysis. He added that they will have a much better understanding of this mechanism once this data has been analyzed.

Outstanding Questions

- Dr. Barnes commented that while this explanation for the lingering sulfolane in areas of low infiltration seems valid, he was not totally convinced that the aforementioned transport mechanisms could account for the concentrations that have been found in those areas, especially since the rates of infiltration are so low. Mr. McCurry remarked it may be worthwhile to consider the possibility that the contamination in these areas may have been transported by episodic infiltration events such as periods of high rainfall.

THE RESULTS OF RECENT TRACER TESTING

Items discussed

- Mr. Ohrt updated the team on the results of the tracer testing that was conducted over the previous weeks. He reviewed the methodology for the test and added that the objectives of the test were to validate the dual porosity model and to determine the well-specific injection flow rates and other conditions in the testing areas. The recent testing was conducted in two locations

which were chosen based on data that was obtained from boring logs and from air sparge and tracer testing that was previously conducted at the site. The two testing locations, Area One and Area Two, were chosen as areas representing fine-grained and coarse-grained soils respectively. He added that the researchers hoped to validate the dual porosity model by comparing the differences in the response curves for conductivity that were observed in the monitoring wells of the two test areas.

Mr. Ohrt described the results of the testing that had been received to date. He concluded that this data shows that the specific conductivity measured in the wells associated with Area Two exhibited a rapid increase followed by a symmetrical decrease back to near their baseline levels, indicating rapid transport of the tracer in this area. The specific conductivity measured in the wells associated with Area One behaved much differently in that it did not increase nearly as quickly and, in cases where the wells began to show a decrease in conductivity, they did not exhibit the same symmetrical pattern of decreasing conductivity as was observed in the wells associated with Area Two. He said that his team believes that the sustained conductivity that was exhibited in Area One wells appears to be consistent with the dual porosity model since it seems to indicate that some of the tracer is being stored in the fine-grained sands and then slowly bleeding out into the coarse-grained sands that are adjacent to them.

The team discussed whether the slow rise in conductivity and asymmetric tail in the response curves from the Area One wells is due primarily to diffusion or whether it is primarily due to very slow advective flow through the fine-grained soils. Dr. Barnes commented that while the team has not observed the wells for a sufficient amount of time to determine whether the asymmetric response curves are predominantly the result of diffusion or slow advection, the current data demonstrates the differences in the mass flux between the different soil types. Several team members expressed their hopes that such questions about the nature of the transport mechanisms will be answered as more data becomes available from the study.

OVERVIEW OF ADEC'S EXPECTATIONS FOR THE FEASIBILITY STUDY

Items Discussed

Ms. Cardona presented an overview of ADEC's expectations for the Feasibility Study (FS) that will be conducted on the project site. Ms. Cardona said that ADEC expects that the FS will be written in accordance with the guidelines set forth under the United States Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Ms. Cardona briefly reviewed the steps of the CERCLA process as they pertain to the development of a FS, particularly with regard to how the range of remedial alternatives is expected to be established within the document. The team discussed how existing uncertainties and data gaps could be addressed in the FS given the timeframe that has been allotted for its development. Mr. Smith commented that ADEC should not approve the Site Characterization Report (SCR) and move ahead with the FS if the uncertainties at the site are so great that the team cannot have sufficient confidence in its evaluation of the proposed remedial alternatives. Ms. Cardona commented that it is important that FHRA clearly identify each and every data gap that exists and how it will be addressed so that the team can clearly decide whether the uncertainties are acceptable. Mr. Smith

replied that FHRA will need to have certain assurances and written approval of FHRA's Site Characterization Reports before it could proceed with the Feasibility Studies. Ms. Cardona indicated that the Site Characterization process will continue and, even if the reports are approved, the process continues as more information is learned. The team agreed to further discuss the matter at the end of November, after it has had a chance to review the data from that month.

NEXT MEETING AND OPEN HOUSE

The team agreed to hold a Community Open House on January 14, followed by the next team meeting on January 15th.