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April 15, 2020

Mr. Prathap Kodial
Crowley Fuels, LLC
201 Arctic Slope Ave.
Anchorage, AK 99518

**Subject: Remedial Options Assessment; Former Nenana Fuel Terminal, Nenana, Alaska; ADEC File Nos. 110.38.01 & 110.38.011**

Dear Mr. Kodial:

Crowley Fuels, LLC (Crowley) committed to the Alaska Department of Environmental Conservation (ADEC) and the City of Nenana that it would investigate the implementation of a bio-reactive barrier at the former Nenana Fuel Terminal to address the possible impacts to the Tanana River posed by the former Nenana Fuel Terminal site. Additionally, Crowley desires to understand other in-situ or ex-situ remediation technologies that may be used to address known contamination at the site.

This letter presents six remedial options, including the use of bio-reactive barrier technology, along with a rough order of magnitude (ROM) cost estimate for each option.

## CONCEPTUAL SITE MODEL SUMMARY

Previously prepared human health Conceptual Site Models have identified the ingestion of contaminated groundwater and surface water and the inhalation of outdoor air as the primary human health exposure pathways at this site (OASIS 2011). Although groundwater and surface water are not currently used for ingestion in the vicinity of the site, they are protected resources. Other completed pathways include incidental soil ingestion and dermal adsorption of contaminants in soil. Bioaccumulate compounds are not a concern at the site and therefore the ingestion of wild or farmed foods are not currently considered a competed exposure pathway. Subsurface soils at the site are contaminated with gasoline-range organics (GRO), diesel-range organics DRO), benzene, toluene, ethylbenzene, total xylenes (BTEX), naphthalene, and methylnaphthalenes at concentrations greater than the ADEC Method Two, Table B1 and B2, Migration to Groundwater Soil Cleanup Levels (SCLs, OASIS 2011). Impact in subsurface soil ranges in depth from 2 to 15 feet below ground surface (bgs), with the majority of impact between 4 and 10 feet bgs.

Dissolved-phase hydrocarbon plumes are present at the site for the following contaminates as compared ADEC Table C Groundwater Cleanup Levels (GCLs): GRO, DRO, benzene, naphthalene, and 1-methylnaphthalene. Separate-phase hydrocarbons are present at two monitoring wells (DNA 2020). The leading edge of each plume appears to end at the Tanana River. Groundwater flow direction, as found during previous monitoring events, is interpreted to be to the north with a possible westerly component; the Tanana appears as a gaining river at this site.

A preliminary ecoscoping evaluation did identify an aquatic exposure route if groundwater discharges to the Nenana or Tanana Rivers (Weston 2018). Although no sheening of surface water has been reported, and the evaluation of surface water by the collection of samples from either the Nenana or Tana Rivers have not occurred, several groundwater monitoring wells are located adjacent to the Tanana river in what is expected to be a hydrologically connected hyporheic zone. Evaluation of surface water by review of these near shore wells against established Alaska Water Quality Standards indicate violations at wells near the Header Area (DNA 2020).

## PROJECT SCOPE AND OBJECTIVE

The objective of this assessment was to evaluate technologies that would mitigate or eliminated impact to surface water due to the leaching of contaminated soil into groundwater and the flow of contaminated groundwater to surface water.

As part of this evaluation, the following activities were completed:

- Identification of remedial alternatives
- Evaluation of remedial alternatives
- Development of a rough order of magnitude ROM cost estimate
- Comparison of remedial alternatives

## SITE BACKGROUND

The former Marine Header Area has been used for decades for transferring fuel between docked barges along the Tanana River and the former Middle Tank Farm. The exact date of installation of the fuel distribution and storage system is currently unknown. Crowley commenced operation at the site in approximately 2006. The site was previously operated by Yutana Barge Lines and Yukon Fuel Company. The fuel header system was allegedly comprised of one 6-inch, one 4-inch, and four 3-inch fuel pipelines with storage capacity of 22,400 barrels. The former Rail Line area is the location where rail cars with fuel were allegedly on or off loaded, transferring fuel to or from the Middle Tank Farm. This fuel transfer operation at the Rail Line area has not been performed since Crowley began operations in approximately 2006 (Oasis 2011). The majority of the fuel transfer and storage infrastructure has been permanently closed and/or removed from the site.

### *Site Setting*

The former Nenana Fuel Terminal is located at approximately 64.564688 degrees (°) north latitude and -149.100866° west longitude on the south shore of the Tanana River. Nenana is located approximately 55 road miles south of Fairbanks, Alaska (Weston 2019).

Soil at the site is mostly non-native backfill, approximately 75 percent (%) medium grained brown sand and 25% coarse gravel, to 2 feet bgs and below 2 feet bgs is sand, silty sand, and/or silt (OASIS 2010). Subsurface soils typically remain frozen from October through May in most years (Weston 2019, USDA 2007). The groundwater gradient at the Rail Line and Header Areas appear to be from south/southeast to north/northwest with a slight east to west gradient (Weston 2013 and 2018). During the October 2019 groundwater sampling event, the gradient was reported south to north and the gradient flow direction has varied in direction throughout the monitored history but is predominantly towards the north and the Tanana River (DNA 2020).

In the spring the average depth to groundwater is 8 feet bgs and in the fall the average depth to groundwater is 9 to 11 feet bgs. Groundwater elevation is sometimes slightly lower than the Tanana River's elevation. Previous comparisons between the Tanana River and selected monitoring wells at the site indicate alternate gaining and losing scenarios depending on season and rainfall/precipitation events. Oxygen reduction potential indicates a reducing environment and dissolved oxygen indicates groundwater is slightly oxygen deficient.

## *Previous and Current Environmental Status*

Initial site characterization work began at the Header Area in May 2010 after the discovery of potentially contaminated soil during excavation work conducted to inspect the fuel header lines. Integrity testing of the header pipelines was conducted to determine the source of the potentially contaminated soil. Hydrostatic integrity testing indicated no deficiencies or leaks in the pipelines. The fuel-contaminated soils are believed to be related to historical site activities dating back to the early 1900s. The May 2010 characterization work included collection of soil samples from the open excavation area, and further delineation activities were conducted in October 2010.

Similar excavation activity along an inactive rail line in September 2010, west of the Header Area, resulted in the discovery of fuel-contaminated soil. This Rail Line Area along the abandoned tracks is believed to be related to historical operations, including the off-loading of fuel from rail cars during previous site operations. Concurrent with delineation work at the Header Area, additional characterization activities were also conducted at the Rail Line Area in October 2010.

Since 2010, various site assessment and groundwater monitoring activities have been conducted at the facility. These activities included advancing soil borings, installation of groundwater monitoring wells (MW1 through MW-16), initiation of passive product recovery at MW-13, and collection of soil and groundwater samples for laboratory analysis. Groundwater sampling events of different frequencies have been performed at the facility since 2011. Results of the subsurface soil assessments and groundwater sampling events have been used to estimate the extent of soil contamination and the extent of groundwater plumes located within the facility.

### Soil

Soil sample analytical results indicate that the following contaminants of concern (COCs) are consistently present across the site at concentrations greater than the SCLs: GRO, DRO, BTEX, naphthalene, 1-methylnaphthalene, and 2methylnaphthalene (Weston 2017).

### Groundwater

Groundwater sample analytical results indicate that the following COCs are present at concentrations greater than the ADEC Table C Groundwater cleanup levels: GRO, DRO, benzene, naphthalene, and 1-methylnaphthalene (Weston 2019 and DNA 2020).

**Surface Water**

Tanana's River velocity and depth fluctuation make it difficult to collect porewater samples (Weston, 2017). Porewater samples were collected in 2013 and samples exceeded 18 Alaska Administrative Code (AAC) 70, Alaska Water Quality Standards (AWQS) for total aromatic hydrocarbon (TAH) and total aqueous hydrocarbon (TAqH) constituents (Weston 2013). A review of 2019 well data for wells located in the hyporheic zone (wells MW-01, MW-03, MW-04, MW-14, and MW-15) indicate that the wells at the Header Area (MW-01, MW-03, MW-04) exceed AWQS criteria. The wells located further to the west, west and north of the Rail Line area (MW14, and MW-15) do not exceed AWQS criteria.

## REMEDIAL OPTIONS EVALUATION

The following potential remedial alternatives were identified and evaluated for the former Nenana Fuel Terminal:

- Remedial Option No. 1 – No Action
- Remedial Option No. 2 – Oleophilic Biobarrier (OBB)
- Remedial Option No. 3 – Permeable Reactive Barrier (PRB)
- Remedial Option No. 4 – Smoldering
- Remedial Option No. 5 – Source Removal

Each of the remedial options were evaluated to determine effectiveness, implementability, and cost. Effectiveness is determined by the ability of the option to minimize potential impacts for human health and the environment. Implementability is the feasibility of conducting the proposed remedial option both technically and administratively. The cost evaluation includes direct costs, indirect costs, and costs for operation and maintenance (O&M) for implementation and three years of effectiveness monitoring (groundwater sampling annually).

Except for the implementation of the no-action alternative, all options include three years of annual groundwater monitoring. Annual groundwater monitoring would be conducted to determine if COC concentrations are decreasing over time after implementation of the remedial alternative.

For each option, permits may be required from the Alaska Railroad because the site is leased by the City of Nenana from the Alaska Railroad and the work area is located within 100 feet of an active rail line. An Alaska Railroad Flagger may also be required because a portion of the work is within 100 feet of an active rail line. Some options may also require the withdrawal of water from the Tanana River. An estimated cost for anticipated permitting is included in each ROM cost estimate.

For each option, prior to implementation of subsurface activities, utility locates will be completed for the proposed work locations. An estimated cost for this utility locating work is included in each ROM cost estimate.

The option assessment did not evaluate remediation by oxidation (chemical destruction; i.e. use of ORC® or similar product) because it was found on initial investigation to be impracticable financially due to the large mass of contamination and site conditions that would necessitate multiple treatments. Preliminary cost for source treatment by oxidation would be in the tens of millions of dollars for this site. Additionally, oxidation would lead to desorption of contaminants and a large release of COCs into the groundwater/surface water system. The analysis therefore focused on adsorptive bio-reactive enhancement as a more feasible active remediation option.

The following subsections provide descriptions of each remedial alternative, an evaluation of the alternative, and associated ROM costs. Attachment 1, Figures 1 and 2, show the proposed locations for the Remedial Options. Attachment 2, Table 1 presents a comparison of the proposed alternatives. All options, with the exception of complete removal, assume land use controls may be required.

### *Remedial Option No. 1 – No Action*

No action is a baseline alternative by which alternatives can be compared. No action involves not taking any further actions to manage environmental concerns at the site.

The following summarizes the effectiveness, Implementability and cost for Option 1:

- **Effectiveness**. Impacts to the groundwater and soil would not be abated and potential impacts to the surface water would not be abated. Reduction of petroleum constituent concentrations would only occur through natural source-zone depletion (NSZD, a.k.a natural attenuation).
- **Implementability**. The no action alternative is feasible to implement.
- **Cost**. There are no costs associated with the Remedial Alternative No. 1.

### *Remedial Option No. 2 – Oleophilic Biobarrier (OBB)*

Remedial Option No. 2 addresses the area located downriver of the metal pilings along the Tanana River, and assumes the metal piling provides a barrier to migration of contaminants into the Tanana River and instead directs contaminates downstream and west to the proposed stretch of shoreline for OBB implementation. The OBB would be installed between MW-15 on the west end, and the end of the metal piling west of MW-7R (see Attachment 1, Figure 1).

The use of OBB is indicated at sites with petroleum sheens on surface water that are generated due to NAPL seepage from sediment. At many sites, NAPL seepage occurs as a non-steady and, even, ephemeral process; at Nenana, there is no evidence of NAPL seepage, but site conditions, including current velocity and water level fluctuations may hinder observation of NAPL release. OBB is used to intercept NAPL seepage and prevent sheens while the naturally occurring, petroleum-degrading microorganisms that colonize it destroy the NAPL retained by the OBB. Utilizing the oleophilic geocomposite material to retain seeping NAPL provides a buffer between sporadic NAPL releases and the steadier degradation process as petroleum NAPL adheres to the OBB material and microorganisms colonized the OBB and degraded the retained NAPL. Through these processes, the OBB provides a long-term remedy for preventing sheen formation on the surface water. Again, the key aspect of this technology is that the ability of the OBB to intercept and retain NAPL seepage is regenerated in between NAPL seepage episodes as the hydrocarbons naturally degrade.

The OBB consists of a combination of sand, structural geocomposite liner, and geotextile fabric. It is typically placed along a fuel contaminated shoreline, absorbing hydrocarbons, and providing a medium to support biodegradation before the fuel constituents are released to surface water. Previous case studies for OBB systems installed within Alaska waterways indicate that there was minimal damage to the OBB after winter breakup (OBB Application Assessment Summary, Operable Unit 5, US Army Garrison, Fairbanks Environmental Services, 2019). The OBB is constructed using the following steps:

- Removal of the top 2 to 3 inches of sediment;
- Addition of a layer of sand (10/20 or bedding sand);
- Placement and securing a geocomposite liner on top of the sand;
- Placement and securing geotextile fabric on top of the geocomposite liner for protection;
- Placement of metal fencing on top of the geotextile fabric as a structural cover;
- Securing the metal fencing with river rock; and then
- Securing everything in place with cinder blocks and duckbill anchors.

It is proposed that the OBB be placed along the Tanana River on the northwest portion of the site, as shown on Figure 1. The proposed length of the OBB is approximately 240 linear feet trending east to west and a proposed width of approximately 4 feet. The OBB would require annual inspections during groundwater monitoring activities and if damage is observed, maintenance would occur to repair the system to full functionality.

The following summarizes the effectiveness, Implementability and cost for Option No. 2:

- **Effectiveness**. Previous projects where OBB was implemented, overall results indicated that OBB are effective at sorbing organic compounds but at concentrations less than the total capacity of the material. Sorption is likely due to direct contact and mostly provides a protective layer minimizing disturbance and release of COCs to the adjacent surface water. The OBB will not decrease dissolved-phase COC concentrations overtime within the source area, instead this approach relies on the natural depletion of petroleum NAPLs (a.k.a. natural source-zone depletion or NSZD; a well-documented in situ process) that can destroy thousands of gallons of petroleum NAPL per acre per year and is a steady to seasonally varying process. The limits of the OBB use to the east, near MW-7R will be limited by active erosion in this area, therefore additional action would be required to mitigate erosion or an secondary option considered to treat the presence of separate-phase hydrocarbons at MW-7R.
- **Implementability**. The OBB installation is feasible and easy to implement. No data gaps appear relevant for this application and no additional work is required at the site. The site is located along the road system and is accessible using motor vehicle. Proper placement of the OBB along the Tanana riverbank may be difficult due to the Tanana River velocity and depth fluctuation and we estimate up to 30 days will be needed to install the OBB. Operation and maintenance are feasible due to the sites location along the road system, seasonal breakup would likely result in some degree of O&M. However, the presence of the metal piling along the Tanana River precludes the use of this alternative near the Header Area. Although OBB was effective in the Chena River on a shorter stretch, the effectiveness in the higher volume Tanana, along a steeper bank, may make implementation difficult. Because this approach relies on NSZD, groundwater monitoring and removal of measurable NAPL that accumulates in project monitoring wells would be on-going for many years.
- **Cost.** The estimated costs for this alternative include planning, coordination, permitting, work plans, and one annual report per year for three years. Costs associated with the OBB include installation, operation, and maintenance of the OBB. A previous case study along the Chena River indicated that after breakup the only observed damage was to the cinderblocks, but it is anticipated that some degree

of more intense O&M may be required for this site. The estimated cost to implement Remedial Option No. 2 is between $450,000 and $550,000.

### *Remedial Option No. 3 – Permeable Reactive Barrier (PRB)*

To mitigate impact to surface water, a PRB can be constructed between the surface water and the contaminant source area, treating groundwater as it flows through the PRB. For this site, PetroFix™, manufactured by Regenesis®, would serve as the PRB. PetroFix is a highly concentrated water-based suspension consisting of micron-scale activated carbon and bio-stimulating electron acceptors designed to remediate petroleum hydrocarbons. PetroFix can be injected in-situ under low pressure, distributing the treatment solution in the subsurface without fracturing over or underlying bedding deposits and avoiding the need to excavate. It has a dual function: removing hydrocarbons from the dissolved phase by absorbing them onto the activated carbon particles, and also added electron acceptors to stimulate hydrocarbon biodegradation in-place.

PetroFix will be mixed on-site utilizing water from the Tanana River as authorized under an approved use permit issued by the Alaska Department of Natural Resources (ADNR). The estimated volume of water needed is 110,000 gallons over a 30-day period.

The Tanana River is a salmon bearing stream so an Alaska Department of Fish and Game (ADF&G) water withdrawal permit (or consultation) is required along with requirements to use specific best management practices (BMPs) for water withdrawal to minimize disturbance. If possible, work would be conducted at a timeframe that does not coincide with the seasonal salmon run or spawning events.

Performance monitoring of groundwater is recommended once a year for three years to help measure the effectiveness of this remedial alternative. Additionally, evaluation of nitrate and sulfate levels on a more frequent basis or as part of pre-planning may be needed to ensure favorable conditions for biodegradation processes are present or can be produced.

**Approach 1**

To address both the Rail Line Area and the Header Area, Approach 1, proposes to place, by injection using a direct-push drill rig, an absorptive barrier comprised of about 72,000 pounds of PetroFix along a 700-foot long line from the western area of the site near MW-15 to the eastern area of the site near MW-1 (see Attachment 1, Figure 1). The PBR would be installed in the path of the flow of the contaminated groundwater. PetroFix would be injected at 216 locations at a treatment depth interval located between 4 to 19 feet bgs. The injection locations will be located 6 feet on center in two rows, with 5 feet between the rows. By using two rows, some source treatment effect can be realized especially at the Header Area.

**Approach 2**

Approach 2 is similar to Approach 1 except it assumes that there is a sufficient westerly component to the groundwater flow direction at the site as to capture contaminants flowing from the Header Area. It is further assumed that the metal piling along the Tanana River serve as a barrier to migration, and instead water flows west to the end of the pilings.

This alternative reduces the length of the PetroFix application from 700 feet to 385 feet, reduces the treatment to one row of injection points, but increases the density of injection points. This reduces source treatment but increases the effectiveness of the PetroFix as a permeable reactive barrier.

Approach 2 proposes that PetroFix solution be applied perpendicular to the groundwater migration pathway in two injection lines (see Figure 1). The first injection line (Line 1) will be oriented in a north to south direction and would be approximately 110 feet long. The second injection line (Line 2) would be installed in an east to west orientation that would be approximately 275 feet long.

PetroFix will be injected along each line every 2 feet and the treatment interval at each boring location will extend between 4 and 19 feet bgs. Line 1 will require 56 injection borings and Line 2 will require 139 injection borings. Approximately 333 pounds of PetroFix is required for each injection point requiring a total of approximately 65,000 pounds of PetroFix. PetroFix will be mixed onsite utilizing water from the Tanana River.

The following summarizes the effectiveness, Implementability and cost for Option No. 3:

- **Effectiveness**. The quantity of PetroFix proposed will provide at least 25 years of treatment as well as stimulate biodegradation before breakthrough of COCs could happen; a product like PetroFix acts like a filter. Groundwater monitoring in near-river wells will measure the effectiveness of the remedial alternative. Remedial Alternative No. 3 will minimize potential release of contaminants to the surface water by treating the northern edge of the dissolved-phase hydrocarbon plume. Like alternative Nos. 1 and 2, this alterative relies on NSZD for source treatment while mitigating impact to surface water; groundwater monitoring and removal of measurable NAPL that accumulates in project monitoring wells would be on-going for many years. Effectiveness of treatment along the leading edge of the plume should be measurable within one to six months. Effectiveness could be enhanced by conducting a high-resolution site characterization (HRSC) that fully identifies all sources at the site and the depth of impact on a tight grid. By conduit a HRSC, the zone of treatment (both horizontally and vertically) and volume of PetroFix could be adjusted and optimized.
- **Implementability.** Administrative filings will be moderate in effort due to permits required by the Alaska Railroad, ADNR, and ADF&G prior to implementation. Alaska Railroad permits take an average of 6 weeks for approval. The site is located on the road system and is easily accessible without requiring off-road vehicles. The injection of PetroFix is recommended to occur during high groundwater, generally found earlier in the year, but the treatment interval may be better understood after completion of a HRSC. The injection of the PetroFix as a permeable reactive barrier is implementable under the current site conditions.
- **Cost**. Overall costs for this alternative include planning, coordination, permits, work plans, and preparation of one annual report a year for three years. Costs also include PetroFix shipping and transport of materials, private utility locates, subcontractors to inject PetroFix, and three years of annual performance monitoring. The estimated cost for implementation of Remedial Option No. 3 being between $800,000 to $950,000.

### *Remedial Option No. 4 – Smoldering*

Self-sustaining Treatment for Active Remediation (STAR) is an in-situ thermal technology based on smoldering combustion, where the contaminants are the fuel that supports this remedial approach. The process is sustained by the addition of air injected through a well that is placed within the target treatment zone and is initiated through a short duration, low energy "ignition event." Once the process is initiated (ignited), the energy of the reacting contaminants is used to pre-heat and initiate combustion of contaminants in adjacent areas, propagating a combustion front through the contaminated zone in a self-sustaining manner (i.e., no external energy or added fuel input following ignition) provided a sufficient flux of air is supplied.

STAR technology works best on long carbon chain contaminants like coal tar; the contaminates at Nenana are shorter hydrocarbons in the DRO and GRO range. Site contaminants are likely too volatile and therefore unable to maintain the smolder necessary for thorough treatment without the injection of massive amounts a surrogate fuel (emulsified vegetable oil ([EVO]) to support the combustion.

The following summarizes the effectiveness, Implementability and cost for Option No. 4:

- **Effectiveness.** Remedial Option No. 4 is not anticipated to be an effective remedial alternative for the site due to the depth of the COCs (between 4 and 19 feet bgs) and because the COCs are LNAPL.
- **Implementability**. Remedial Alternative No. 4 is not feasible to implement because of the large number of EVO injections and additional labor required to maintain the smolder for the LNAPL petroleum constituents.
- **Cost**. Cost estimating for Remedial Alternative No. 4 were not completed the technology is not appropriate for this site.

### *Remedial Option No. 5 – Source Removal*

Remedial Option No. 5 proposes the removal of contaminated soil via excavation. This Remedial Option removes the source material out of the groundwater system quickly and also proposes to treat remaining contaminants with PetroFix to reduce residual contaminant concentrations.

Two areas are identified for focused removal work and are presented on Figure 1, Attachment 1:

- Excavation Area 1 is located at the Header Area and is approximately 4,930 square feet. The total volume for excavation, assuming a maximum excavation depth of 10 feet bgs, is 1,825 bank cubic yards (BCY), of which the top three feet (~547 BCY) may be uncontaminated. This excavation extends beneath the bridge and within the right of way for the Parks Highway. There is an abandoned rail line within the area that will require removal as well possibly buried fuel lines.
- Excavation Area 2 is located along the Rail Line Area is approximately 15,395 square feet. The total volume for excavation, again assuming a maximum excavation depth of 10 feet bgs, is 5,701 BCY, of which the top three feet (~1,700 BCY) may be uncontaminated. There are two abandoned rail lines within the area that would require removal as well as remaining tank farm infrastructure and buried fuel lines. The ROM cost estimate is based on loose CY with a conversion factor of 1.15. Based on the size of the mixing zone and concentration of contaminants it is estimated that 18,000 to 24,000 pounds of PetroFix and 900 to 1,200 pounds of nitrate and sulfate be mixed with the soil between 10 and 13 feet bgs.

The excavations would extend from the ground surface to the top of groundwater and remove the vadose zone soil that is impacted. Removal of some smear zone soil would also be achieved. Once excavated, soil in the saturated zone would be treated with PetroFix by mixing PetroFix into the floor of the excavation, up to a depth of three or four feet. With groundwater expected between 8 and 10 feet bgs, the vertical depth of remediation would be between 12 and 14 feet bgs. Alternatively, PetroFix could be injected into the excavation floor after the excavation is backfilled using direct-push technology and targeting the injection between the floor of the excavation and the maximum depth of contamination, which is usually 14 feet bgs.

The soil will be excavated and stockpiled to a lined onsite staging area or direct-loaded onto trucks for transport to an approved disposal/thermal treatment facility (OIT in Fairbanks). Once the excavation is complete, confirmation field screening and soil samples will be collected following ADEC Field Sampling Guidance at the required frequencies.

After collection of the confirmation soil samples, PetroFix will be mixed with the soil of the excavation floor in a four-foot treatment zone and sprayed on the side walls of the excavation. It is assumed that the excavation efforts will be conducted in the late fall when water levels are at their lowest but when the ground is unfrozen. This method would require sloping of excavation side walls to prevent slumping or cave-in. This estimate does not include the implementation of engineering shoring or sheet piling for side wall stabilization, nor does it include dewatering and treatment of excavation seep water. The excavation would not proceed deeper than the water table.

The following summarizes the effectiveness, Implementability and cost for Option No. 5:

- **Effectiveness.** Remedial Option No. 5 would remove the majority of the source, and the remaining residual contaminants could be treated by the application of PetroFix. Performance monitoring would be completed once a year to measure the effectiveness of the remedial alternative. Additionally, this method would remove the areas where separate-phase hydrocarbons have accumulated by excavating through MW-7R and MW-13.
- **Implementability**. Administrative filings will be moderate in effort due to permits required by the Alaska Railroad and possible the Alaska Department of Transportation and Public Faculty (ADOT&PF). This alternative is technically feasible with the following difficulties: the excavations are deep and will require benching; Excavation Area 1 is located under and adjacent to an ADOT&PF, which will require working with ADOT&PF; Excavation Area 1 is located alone the Tanana River Sheet piling and would likely necessitate an excavation plan overseen by a civil engineer; both excavations are located adjacent to an active rail line and will likely require an Alaska Railroad Flagger during all excavation activities; abandoned rail lines at both the Header Area and Rail Line Area will need to be properly removed (cost for this rail line removal is not included and is assumed to be the responsibility of the Alaska Railroad Corporation); the amount of contaminated soil being removed and the amount of required backfill will require space for staging, space may be limited. Similar to Option No. 3, this option should not be considered until a HRSC has been conducted, including the characterization of soil below the former Middle Tank Farm, in order to best plan the excavation area and avoid missing mass or excavating in a dig-and-chase method. Source Soil Removal is feasible to implement.
- **Cost**. The cost for this alternative includes coordination, permits, work plan preparation, and preparation of one annual groundwater monitoring report a year for three years to measure effectiveness. The cost also includes PetroFix, shipping and transport of materials, private utility locates, excavation of contaminated soil, analytical laboratory for analysis of groundwater and soil samples, subcontractors conduct the soil excavation and to inject PetroFix. The ROM cost estimate is based on loose CY and an expansion factor of 15%. The ROM also assumes up to 34,000 pounds of

PetroFix and 420 pounds of nitrate and sulfate would be mixed with the soil between 10 and 13 feet bgs while the excavation is open. The estimated cost implementation of Remedial Option No. 5 ranges from approximately $1,600,000 to $1,900,000. A smaller excavation area, or just excavating at one area would cost less.

## CONCLUSIONS

The remedial options presented here may not represent all available options, and a combination of the above options may best fit this site. Overall, each option would be better implemented after conducting a HRSC to ensure the location of the contaminant mass is fully understood and delineated. The lack of soil data from below the former Middle Tank Farm, and the slow accumulation of NAPL at MW-7R indicates a possible source east of the Rail Line Area. The erosion occurring near MW-7R, and the relatively short distance between MW-7R and the area of erosion is a concern that may require action soon.

## RECOMMENDATIONS

DNA recommends the implementation of a PRB, as outlined in Option 3, along with some source removal work in the areas of MW-13 and MW-7R. This work should be informed by the implementation of a HRSC. The HRSC would include the use of a combination of historical soil data and a field screening tool such as the Geoprobe® Optical Image Profiler (OIP) on a grid pattern across the site. The OIP would provide continues details on contaminant depth and relative concentration that are more accurate than achieved using just soil coring and other non-continuous field screening methods. The HRSC would also identify any, as yet unknown, source areas. If source removal is considered, DNA recommends Crowley work with the landowners and managers and the ADEC to develop site-specific soil cleanup levels and a long-term closure plan. Before conducing any remedial effort, DNA recommends an evaluation of seasonal groundwater data, for all seasons and years that data is available, to evaluate for flow direction trends not found when evaluating for one season.

With regard to the erosion near MW-7R. DNA recommends taking action at this location by contracting specialists to determine the steps needed to protect this area. DNA has worked with DOWL on similar projects, and recommends Crowley consider contracting DOWL to investigate the site to establish the extent of scour, the configuration of bank erosion, and establish the river flow regime.

Sincerely,
**DNA Environmental Consultants, LLC**

Daniel Frank
Principal

Attachments

1. Figure 1

## REFERENCES

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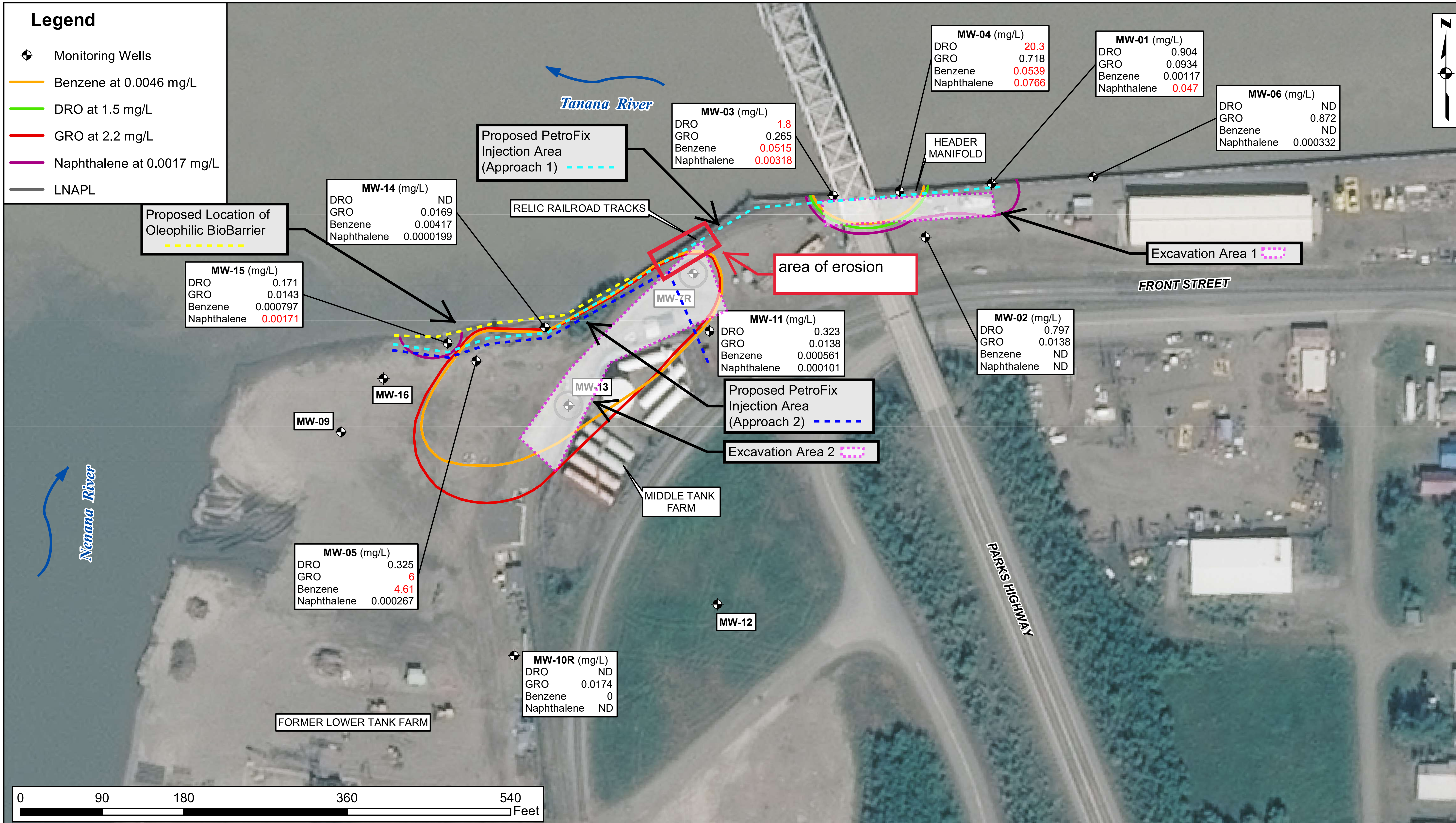
# ATTACHMENT 1

## Figures




October 2019 Groundawater Monitoring Event
Nenana Header and Rail Line Areas
Nenana, Alaska

**Remedial Options**

Figure 1

dna ENVIRONMENTAL

1 inch equals 0.02 miles

03/xx/2020 | 19.CMS.10.1

DRAWN: CDH | CHKD: DJF

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