Bid Waiver Form

Revised 01/2024

Short Description of Goods/Services	PFAS Remediation for Darwin Training Area Locations	**Total Cost**	$1,500,000

Vendor Name	ORIN Technologies LLC	**MUNIS #**	30472	**Req #**	TBD

Purchasing Officer	Pete Patten	**Date**	10/3/2024
Department	Airport	**Email**	kirchner@msnairport.com
Name	Michael Kirchner	**Phone**	608-246-3393

A VENDOR QUOTE MUST BE ATTACHED TO THE WAIVER FOR APPROVAL

Provide a detailed description of the goods/services intended to be purchased:

After the completion of the environmental investigation by ORIN Technologies, in coordination with The Dane County Regional Airport, a remediation plan was drafted. The remediation plan will use multifaceted approach to treat the source area and contain the PFAS plume from continued leaching into the waterways.

Remediation will be broken up into two parts, soil blending the source area contaminated soils and a Sonic injection with electrochemical oxidation treating the groundwater at the Darwin Training Area site. Soil blending will involve blending approximately 1,759 cubic yards of contaminated PFAS soils with a combination of BAM-X and organoclay. The soil mixing will treat the contamination in the soils and prevent further leaching of PFAS compounds by stabilizing the soil on the site. Sonic injection will cover approximately 28,280 square feet, and inject BAM Ultra and Calcium peroxide in combination with a PFAS degrading bacteria to treat the groundwater as it flows through the site. An electrochemical oxidation system will be installed in the area of the sonic chemical injection and used to help maintain an optimal environment for the PFAS degrading bacteria to thrive while breaking down PFAS compounds moving through the groundwater.

Send to a Purchasing Officer Once Completed

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Procurement Exception List
☐ Emergency Procurement
☒ Unique and specific technical qualifications are required
☒ A special adaptation for a special purpose is required
☐ A unique or opportune buying condition exists
☒ Only one vendor possesses the unique and singularly available ability to meet the Department's requirements

Provide a detailed explanation as to why the competitive bidding (RFB/RFP) process cannot be used. Also provide a detailed justification in relation to the Procurement Exception(s) chosen:

The Dane County Regional Airport partnered with the Wisconsin Air National Guard to conduct a pilot study done by ORIN Technologies in an attempt to significantly reduce the levels of PFAS in the pilot area at the airport. This was done in coordination with the Wisconsin Department of Natural Resources. This pilot study was successful in reducing levels of contamination and the airport is now looking to implement this practice on a much larger scale.

ORIN Technologies has pioneered a groundbreaking remediation process, making it the only company in the United States currently utilizing this advanced technology. This innovative approach is set to be deployed at the site, promising unparalleled efficiency and effectiveness in addressing contamination issues.

With the completion of the delineation of the PFAS source area, the next critical step is to implement the remediation plan. Given ORIN Technologies' unique expertise and proprietary technology, it is essential to engage them for the services. Their involvement will ensure the remediation plan is meticulously executed, leveraging their cutting-edge solutions to achieve optimal results.

The Dane County Regional Airport will also be seeking funding from other sources to help pay for this remediation work

This bid waiver requests the authorization of additional environmental remediation services from ORIN Technologies for the Darwin Training Area site, if necessary.

Bid Waiver Approval (For Purchasing Use Only)	
☐ Under $44,000 (Controller)	
☐ $44,000+ (Personnel & Finance Committee)	Date Approved:

Send to a Purchasing Officer Once Completed

DRAFT

Draft Work Plan – Source Area Interim Response Measure and Performance Monitoring, Darwin Burn Pit (DBP)
Dane County Regional Airport (DCRA)
Madison, Wisconsin

Prepared for:
Dane County Regional Airport (DCRA)

ORIN Technologies, LLC. (ORIN)

Larry Kinsman, Geologist
Principal
ORIN Technologies, LLC

September 19, 2024

Mike Kirchner
Dane County Regional Airport (DCRA)
4000 International Lane
Madison, WI 53704

Cc: Steve Ales
Wisconsin DNR

Subject: **Draft Work Plan – Source Area Interim Response Measure and Performance Monitoring, Darwin Burn Pit (DBP), BRRTS # 02-13-583366 Dane County Regional Airport (DCRA), Madison, Wisconsin.**

Dear Mr. Kirchner:

ORIN is pleased to submit this draft work plan to perform a source area interim response measure (IRM) to address perfluoroalkyl substances (PFAS) in the center of the source area at the former Darwin Burn Pit (DBP) at the Dane County Regional Airport (DCRA). This IRM is intended to stabilize PFAS impacts in soil and shallow groundwater below the former DBP to reduce the flux of PFAS in groundwater away from the primary source area.

It is ORIN's understanding that the DBP was used as a firefighting training area (FFTA) between 1953 and 1987. Two former FFTAs exist, one located under the existing parking area and the second, which is the focus of this IRM. The former FFTA under the parking area was located to the north of the DBP and appears to have been in use in the 1950s (Shannon and Wilson, Inc. [SWI], 2023). In 1963, the United States NAVY developed an aqueous film forming foam (AFFF) that contained PFAS. AFFF was developed to quickly smother fires associated with plane/ helicopter crashes in an effort to save lives. PFAS-containing AFFF began to be used more broadly at commercial airports in the late 1970s. The "recipe" or types of PFAS used in AFFF has changed overtime. In the late 1970's and 1980's AFFF typically included perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA) and/or perflouorohexanesulfonic acid (PFHxS). Based on the timing of AFFF development and use, the DBP discussed in this work plan is the likely source of PFAS detected in site soil and groundwater. Understanding of the nature and extent of PFAS impacts in soil and groundwater are based primarily on two previous PFAS remedial investigations:

- Former Firefighting Training Areas Soil and Groundwater Sampling Summary prepared by LimnoTech, dated December 9, 2020 (LimnoTech, 2020)
- Dane County Fire Training Areas – Darwin Road SI, prepared by SWI, dated December 2023 (SWI, 2023)

Background

The DBP is an approximately 3.5-acre field located off Darwin Road on the west side of the DCRA property (**Figure 1**). It is bordered by an airport parking lot to the north, a commercial building to the west, Darwin Road and vacant land to the south, and the airport runway/taxiway to the east. A ditch connecting to Starkweather Creek is located between the DBP and the airport runway to the east.

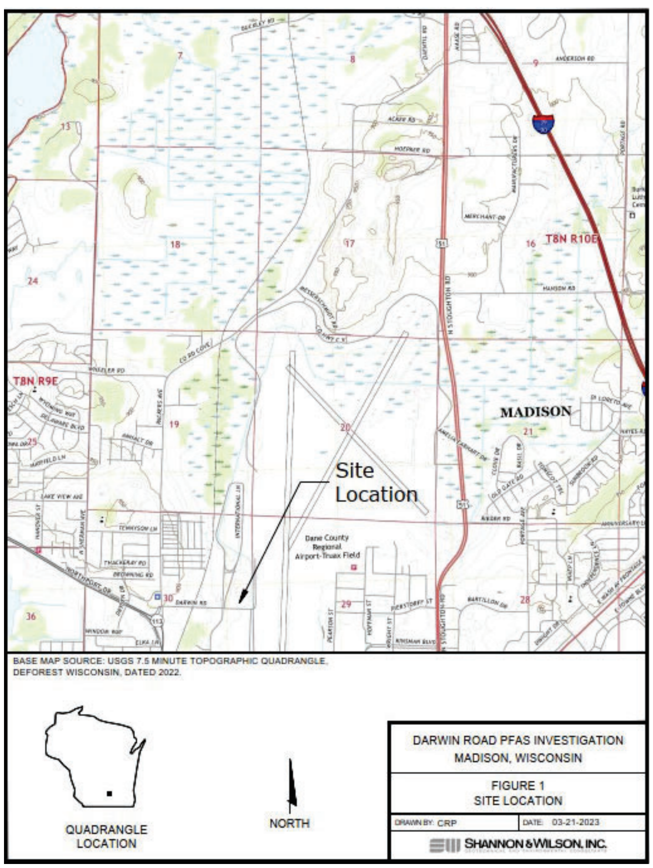


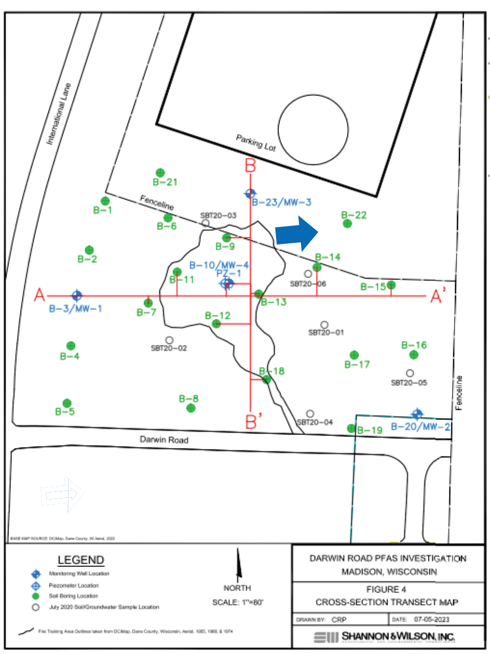
Figure 1 Site Location Map (SWI, 2023)

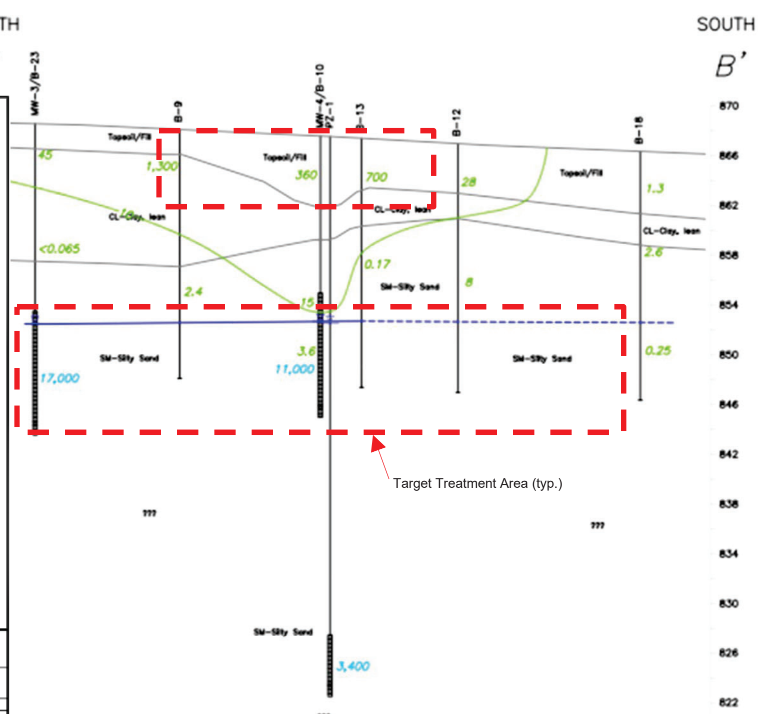
Hydrogeology

The hydrogeology in the area of the DBP has been characterized by soil descriptions, slug testing and groundwater elevation determinations obtained from the existing monitoring well network (e.g., **Figures 2** and **3**, modified from SWI, 2023). The geologic layering at the site consists primarily of three key layers (**Figure 3**):

- Upper Fill/Topsoil – this unit generally consists of silty sand with varying amounts of organics and has locally been interpreted as fill material (SWI, 2023). It extends from the ground surface to depths of 1 to 7 feet below ground surface (ft bgs).
- Clay – A lean clay has been encountered across the DBP. The clay occurs in the vadose zone and varies in thickness from 2 to 8 feet thick. Thin (typically less than 6-inches thick), sandy lenses or occasional gravel are sometimes reported in the thicker accumulations of the clay.
- Silty Sand – this layer comprises primarily fine-grained sand with some silt. This layer includes gravel as well as discrete silt and clay-rich lenses interbedded with the silty sand (LimnoTech, 2020). This layer has been shown to extend from the vadose zone (i.e., below the clay layer) to depths of more than 45 ft bgs (e.g., PZ-1 location; SWI, 2023).

Figure 2 Site Features Map (SWI, 2023; left).
Figure 3 North-South Cross Section (SWI, 2023; right).





Hydraulic results at the DBP include the following:

- Groundwater is generally encountered at an average depth of 12 ft bgs but has been encountered between 10 and 15 ft bgs.
- Groundwater flow below the DBP is generally directed to the east, varying between an east-northeast and east-southeast direction (e.g., **Figure 2**).
- The lateral hydraulic gradient is relatively flat (0.001 to 0.002 feet/day) and may explain some of the variation noted by others in the groundwater flow direction.
- Vertical hydraulic gradients have been shown to be downward directed in the spring (April and May) and upward directed in the summer (August).
- Hydraulic conductivity has been shown to range from 8.47×10^{-4} centimeters per second (cm/s) or 2.4 feet per day (ft/d) at the water table to 1.9×10^{-4} cm/s or 0.54 ft/d at depth (SWI, 2023).
- The groundwater seepage velocity at the DBP was determined to range between 1 to approximately 9 feet per year, assuming an effective porosity of 20%.

PFAS Contamination

ORIN understands that there are soil and groundwater PFAS impacts that have been previously identified at the DBP site. SWI advanced 23 boring locations and installed four water table monitoring wells (MW-1 through MW-4) and one deep monitoring well (PZ-1) as part of the 2023 PFAS site investigation.

Previous investigations by LimnoTech and SWI detected PFAS in soil and groundwater at levels that exceed one or more Wisconsin Department of Natural Resources (DNR) Residual Contaminant Levels (RCLs). PFOA has been detected in soil at one location at a level that exceeds the non-industrial direct contact RSL of 1,260 micrograms per kilogram (µg/kg) but were below the industrial direct contact RSL in soil (1,300 µg/kg in soil boring B-9 at 3 ft bgs; **Figure 3**).

PFOA, PFOS, PFHxS as well as Perfluorononanoic acid (PFNA) have all been detected in one or more groundwater sample collected from the DBP at levels that exceed the recommended Enforcement Standard (ES) published by the Wisconsin Department of Health Services (DHS) and/or the Maximum Contaminant Levels (MCLs) established by the United States Environmental Protection Agency (EPA) in April 2024. Detected concentrations of PFOA and PFOS in groundwater are depicted on **Figures 4 and 5**, respectively. The highest PFOA concentrations have been detected in samples collected from well MW-3 at concentrations 17,000 nanograms per liter (ng/L) in May 2023 and 16,000 ng/L in August 2023 (**Figure 4**). The highest detected PFOS concentrations at the water table (2,400 ng/L in May

2023 and 3,000 ng/L in August 2023) occurred at well MW-4. Higher concentration of PFOS was detected in the deep well PZ-1. Water table well MW-4 and the deeper PZ-1 well are believed to be installed at the center of the old burn pit (**Figures 3-5**). The extent of PFAS groundwater impacts is not fully delineated to the north and east of the DBP (**Figures 4-5**). The delineation of the PFAS impacts in groundwater is outside of the scope of this work plan.

Figure 4 – PFOA in Groundwater (SWI, 2023)

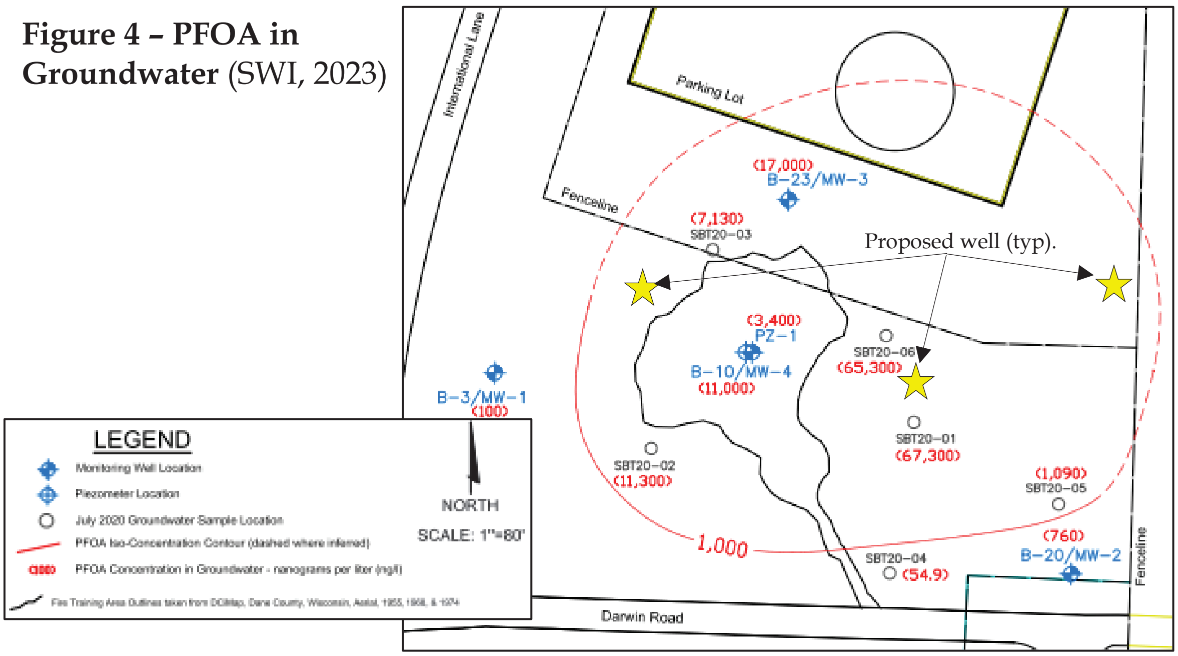
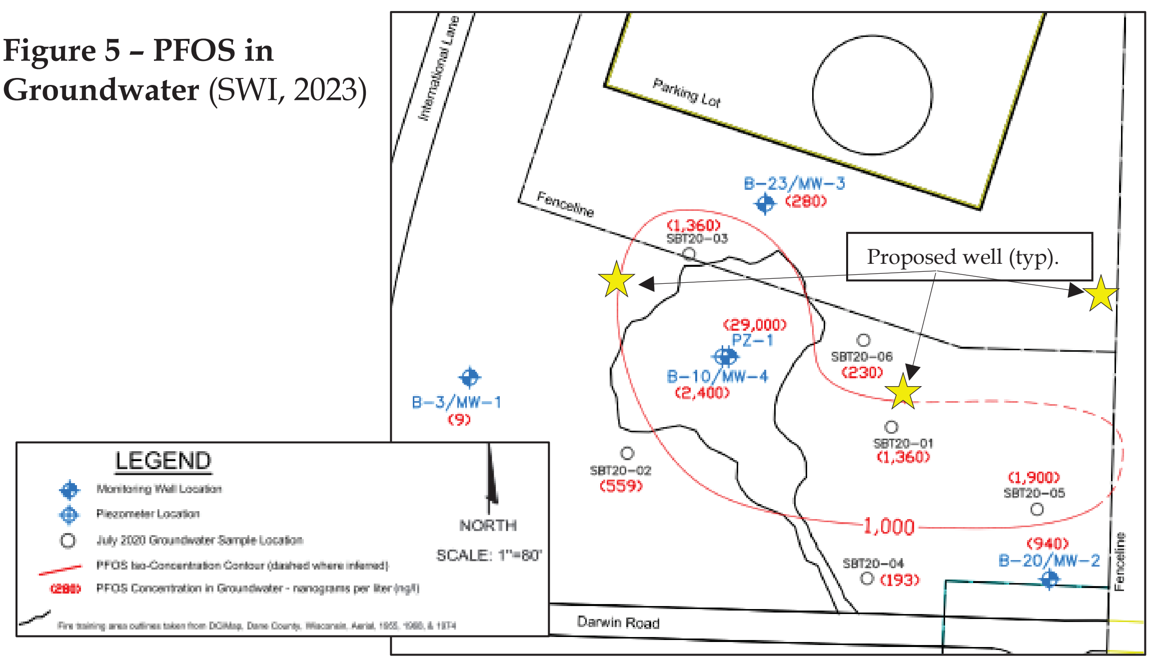


Figure 5 – PFOS in Groundwater (SWI, 2023)



Remedial Action Approach
ORIN proposes an IRM approach to address the primary source of PFAS at the DBP that includes the following:

1) Soil blending of Bioavailable Absorbent Media™ (BAM) and organoclay; to stabilize and reduce leaching of elevated levels of PFOA detected at levels above the non-industrial direct contact RSL in Fill (i.e., above the top of clay on the vadose zone); and
2) Injection of BAM to retain PFAS in groundwater near the water table below the former DBP. The BAM treatment will be augmented with microbes and electrochemical oxidation to enhance destruction of some PFAS.

As a source area treatment, this IRM is intended to reduce the flux of PFAS in groundwater migrating toward the ditch located to the east of the DBP. Back diffusion of residual PFAS present in the aquifer/adsorbed onto the aquifer matrix, into the treated groundwater will likely occur following the source area treatment. Description of the primary treatment media (BAM) and details related to the implementation of the IRM are presented in the following sections.

<u>BAM Treatment Media</u>
BAM is a sustainable, pyrolyzed, recycled cellulosic bio-mass product (>80% fixed carbon) derived from a proprietary blend of recycled organic materials with a high cation exchange. BAM has diverse pore sizes with a minimum total surface area of up to 1,133 square meters per gram.

BAM's absorption ability or sponge-like effect comes from its unique and diverse honeycomb- structure. The shape creates pores or openings within the structure that allows for contaminants and microbes to be drawn in and retained within the pores. This unique ability prevents exterior surface microfilm buildup that allows BAM to continually absorb contaminants.

BAM has numerous synergistic qualities and is relatively affordable in large quantities for remediation purposes. BAM has ample usable surface area for maximizing microbial colonization. Due to its unique 'honeycomb' structure, BAM has the ability to provide increased pore space for the different strains of microbes. BAM's affinity for organic and inorganic compounds supports contact with microbes to promote contaminant degradation.

The unique absorption capability of BAM prevents exterior surface microfilm buildup providing long term remediation capabilities. This allows BAM to absorb contaminants for more productive bio-attenuation of contaminants over a longer period of time. Granular Activated Carbon (GAC) primarily adsorbs contamination to the surface of the media, which then is subject to bio-film development, preventing further adsorption.

As a result, BAM has been proven to supply long term maintenance free remedial abilities over GAC. Laboratory tests have also shown that BAM has a significantly higher absorptive capacity than commercially available GAC products. Advantages include:

- Rapid absorption of contaminants.
- The unique pores provide extremely high surface area per gram of material creating a high cation exchange capacity.
- Promotes microbial colonization's that biodegrade contaminants.

BAM Soil Blending Approach

ORIN and its subcontractors will treat shallow vadose zone soils (i.e., above the clay) by blending BAM-X and a stabilizing organoclay into the impacted soil. ORIN's blending process will blend BAM from 0 to 5-ft bgs (or to the top of clay, see **Figure 3**) until the target depth is reached using mechanical mixing methods. The shallow soil will be treated by a combination of continuously mixing the impacted soil while applying the preferred treatment chemistry in the area depicted on **Figure 6**. Due to the coarse nature of BAM-X, the BAM-X and organoclay mixture is visually observable during application. ORIN will visually inspect the mixing of treatment chemistry into the soil until a homogenous appearance and distribution is achieved across the treatment area. Potable water will be applied during blending to assist the blending process and to hydrate the organoclay. The amount of water required will vary and will be determined based on field observations at the time of mixing. The consistency of the soil is intended to never exceed the saturation limits of the soil and only be used to promote its homogenization.

The combination of BAM and organoclay to treat vadose zone soil is intended to address and treat PFOA detected in soil at levels approaching potential direct contact concerns and to stabilize these areas of elevated PFAS that are detected above the partially confining clay layer in the vadose zone (**Figure 3**). Based on the 2024 treatability test completed by ORIN, the BAM-X dosing rate in the shallow soil will be 2.5% (i.e., weight of BAM to soil [wt/wt]) will be used. This dosing rate produced an 83% reduction in the leaching concentration of PFOA and a 90% PFOS reduction in the leaching concentration by synthetic precipitation leaching procedure (SPLP). During the benchtop testing organoclay also produced additional PFOA and PFOS reduction, as measured by SPLP and the organoclay dose will be 0.34% wt/wt.

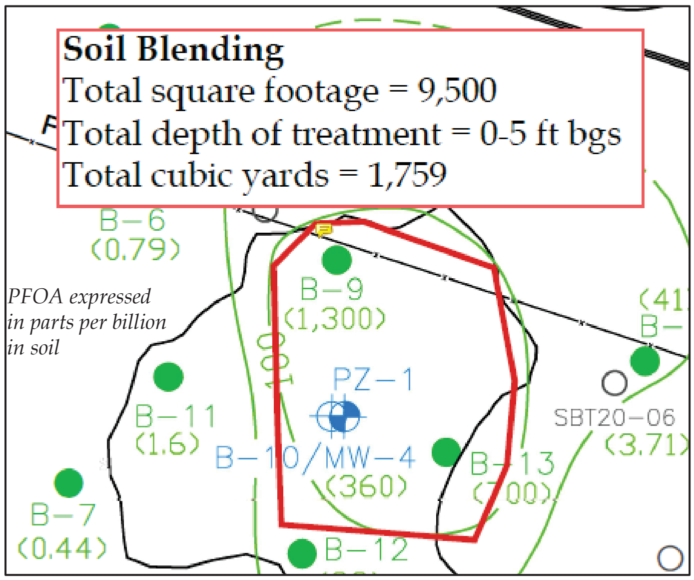


Figure 6 – Soil Blending Area with Respect to PFOA Detected in Shallow Soil.

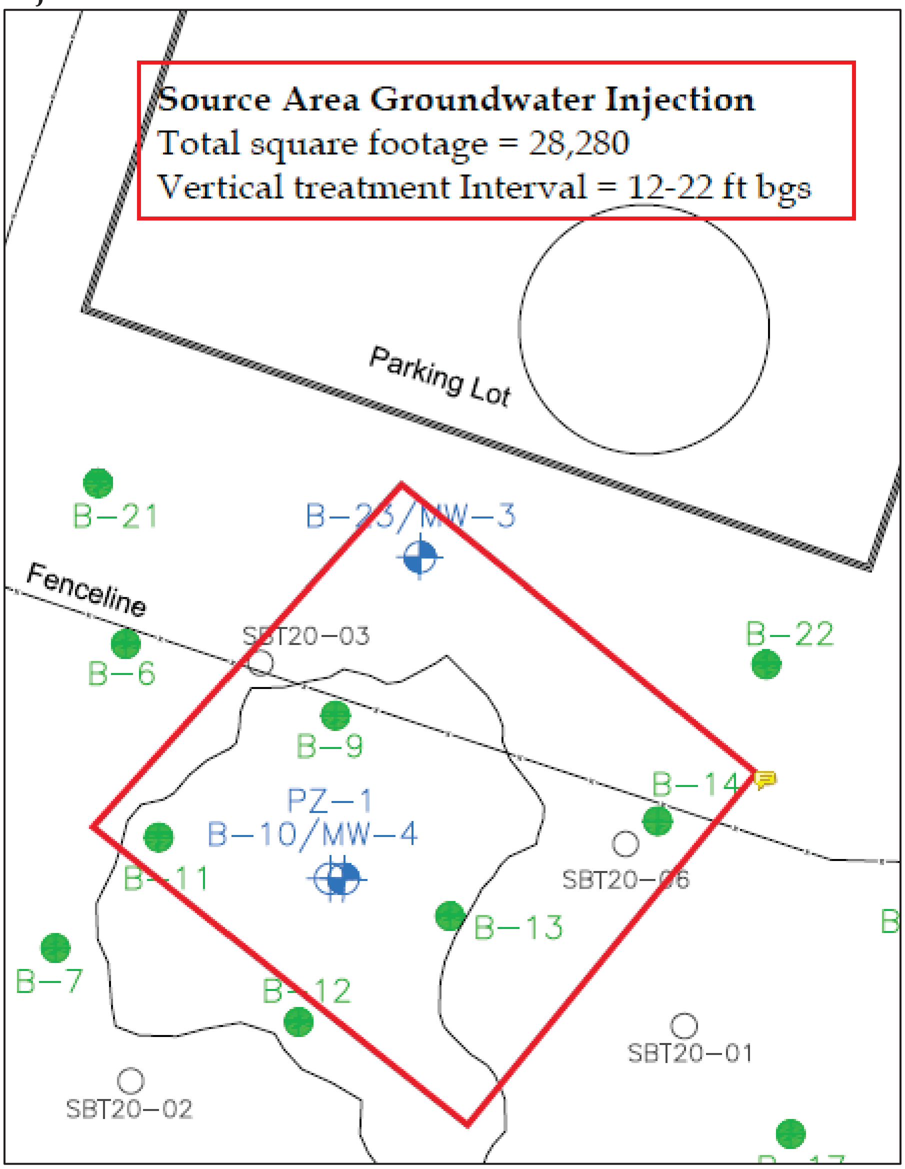
<u>Injection of BAM to Treat Shallow Groundwater</u>

Groundwater treatment will consist primarily of BAM injected into the shallow portion of the aquifer and capillary fringe using rotosonic methods. At sites with similar soils, ORIN has achieved an injection radius of influence of up to 10-feet using the rotosonic approach. The injection area is shown on **Figure 7** and details of the injection are summarized as follows:

- The remedial design footprint is approximately 28,280 ft^2.
- The treatment media will be injected at each location from approximately 12 to 22-ft bgs.
- An average of 7.5 feet radius of influence is conservatively expected. Therefore, injections will be advanced at spacing of approximately 15 feet.
- Approximately 160 DPT injection points will be advanced in this area.
- An average of 200 gallons of 20% BAM Ultra (<30 microns in diameter), PFAS Degrading Bacteria, and 0.5% calcium peroxide treatment chemistry will be injected into each of the 160 injection points.

The borings would be advanced to the appropriate depth using Sonic Technology. The treatment chemistry will be injected into the rods to create minimal positive pressure before commencing injection into the surrounding formation. The rods will then be raised through the vertical treatment zone while simultaneously injecting the treatment chemistry into the formation.

Figure 7 Injection Treatment Area to Address PFAS in Shallow Groundwater



The remedial treatment chemistry will be prepared using ORINs specialized treatment and application equipment. The treatment chemistry will be mixed and temporarily staged prior to application, in up to four 200-gallon tanks located inside ORINs enclosed remediation trailer. The tank will first be filled with the proper amount of water to achieve the appropriate treatment chemistry solution concentration. Multiple tanks will be mixed and used during the application, which enables work to proceed steadily and efficiently. The treatment chemistry will be pumped onto the targeted matrix using ORINs air-driven, chemical and spark resistant pumps. Shut-off valves are present at numerous locations throughout the delivery system for health and safety purposes. To further mitigate accidental spills and/or leaks, ORIN uses a variety of catch basins and sorbent pads/socks. Emergency eye washes are readily available throughout the trailer.

ORIN will use approximately two to three-foot lift intervals throughout the targeted zone and inject the appropriate amount of treatment chemistry into each interval. The proper amount of treatment chemistry will be administered according to the subsurface and known contamination characteristics in each injection area. The total volume and pressure of treatment chemistry injected will be monitored by ORIN and amended according to field conditions to ensure maximum injection effectiveness.

Immediately after the completion of each injection point, the borehole will be backfilled and hydrated using bentonite crumbles or chips to prevent subsequent treatment chemistry short circuiting.

<u>Additional Treatment – Microbial Enhancement and Electrooxidation System</u>
As indicated previously, bioaugmentation will be performed as part of the BAM injections. The microbial approach includes direct injection of a concentrated microbial consortium identified previously at the DCRA (i.e., endemic to the area) that have been shown to be both viable on a PFAS-substrate (i.e., where PFAS are the only available carbon substrate) and to produce free fluorine (evidence of PFAS carbon-fluorine bond cleavage). The goal of bioaugmentation is to breakdown PFAS sorbed onto the BAM and by doing so, free up sorption sites on the BAM to extend its lifecycle.

The microbes that were previously isolated from the DCRA soil and groundwater and shown to reduce PFAS concentrations in the laboratory, did so under aerobic conditions. Thus, this remedy will include the injection of a dilute oxidant (calcium peroxide) and installation of an in-situ electrooxidation system that produces dissolved oxygen via hydrolysis. Bioaugmentation is applied within the BAM treatment zone so that if PFAS precursor breakdown occurs under the produced aerobic conditions, any additional PFOS or PFOA generated that is not rapidly degraded, would then become trapped on the BAM.

PFAS Degrading Bacteria

The carbon-fluorine (C-F) bond is one of the strongest single covalent bonds known. The presence of numerous C-F bonds in any given PFAS molecule makes these compounds very difficult to degrade. As a result of their resilience, PFAS compounds have commonly become known as “forever chemicals” due to their persistence in the environment. PFAS compounds are generally considered to be resistant to biodegradation due to their chemical stability, although some limited biotransformation of PFAS is known in wastewater systems that typically lead to the formation of PFOS from other fluorinated compounds. ORIN/Fixed Earth Innovations has developed a method to obtain microbes that are capable of degrading PFAS substances in a timely manner that are native to the impacted site. Specific microbes are aerobic, which utilize low levels of oxygen for survival and their metabolic process.

The performance of the PFAS degrading microbes has been previously validated in multiple laboratory studies and in an in-situ field demonstration. The available data from these studies suggests that cleavage of the C-F bond occurs, resulting in complete mineralization of PFAS.

Calcium Peroxide

Calcium peroxide releases oxygen over an extended time period to enhance the biodegradation of petroleum hydrocarbons and other biodegradable contaminants in soil and groundwater.

It is well documented that the release of oxygen in the subsurface environment enhances the biodegradation of contaminants. Based on extensive laboratory studies, the release of oxygen can provide a useful and cost-effective mechanism for enhancing aerobic bioremediation.

Successful bioremediation of contamination via aerobic microbial respiration depends on a number of factors including the presence of appropriate microbes, nutrients, electron donors and terminal electron acceptors. In the aerobic metabolism of contaminants, oxygen acts as a terminal electron acceptor and contaminants act as electron donors, which are oxidized. Often, the limiting factor in aerobic bioremediation of contaminants is oxygen. Calcium peroxide provides oxygen by reacting with water. The reaction is:

$$CaO_2 + 2H_2O \rightarrow Ca(OH)_2 + H_2O_2$$

$$2H_2O_2 \rightarrow O_2 + 2H_2O$$

Electrooxidation System
An electrooxidation system utilizes subsurface electrodes to induce electrochemical reactions to enhance the bioremediation and break down of the contaminant compounds in groundwater. The reactions increase the dissolved oxygen content of the groundwater to supplement the oxygen demand of the selected aerobic microbes.

Electrooxidation remediation is an advanced in-situ remediation technology. The approach enhances natural processes and supports complementary remediation methods. This method utilizes electrochemical phenomena to generate chemical radicals on soil particle surfaces and electrokinetic and electro osmotic phenomena to increase availability of organic contaminants for bioremediation, chemical degradation, or mechanical removal. The system utilizes the capacitive nature of the soil matrix. Reactions will occur at the surface of each soil particle and everywhere between the electrodes – not just at the installed electrodes. The effect can be quickly seen in the form of reduced pollutant concentrations in the soil and groundwater as well as stabilized ORP and dissolved oxygen levels.

The electrooxidation system involves installation of electrodes into the subsurface in a grid pattern offset on 14-foot centers. Steel screw pilings are used as electrodes, and they will be advanced to a depth not to exceed 25 ft bgs immediately following injection. Two electrodes are then hooked together to act as one "current" set. The electrode array is wired back to a control box using heavy gauge cable and the control box is plugged into a standard outlet for power. A low amperage direct current is then applied to the electrode pairs with frequent polarity shifts that prevent precipitation build up. A technician can interface with the system to observe the electrical response of the soil and optimize the pulsing (voltages, timing, etc.) to maximize oxygen production in situ.

An electrooxidation system will generate oxygen through low voltage currents that are transferred between conductive rods within the treatment area. The oxygen will be used by PFAS degrading bacteria in their metabolic process.

Site Restoration and Erosion Control
ORIN will implement erosion controls during the soil blending portion of the work by installing a silt fence on the tarmac side of the work area. In addition to the silt fence, ORIN will have a temporary fence installed in the work area that

overlaps the existing fence. Any permits required for the installation of silt fencing will be the responsibility of the DCRA. Once the work has been completed, ORIN will restore the work area by adding shredded topsoil and reseeding the area as necessary.

Decontamination and Waste Management

Prior to mobilization from the shop, all of ORIN's equipment including pumps, tanks, hoses, application heads and rig will be properly decontaminated using specialized chemical treatments and procedures.

All waste will be properly disposed of according to standard regulatory protocol. ORIN will properly dispose of all empty chemical containers and spent personal protective equipment (PPE). Any soil or groundwater waste material generated will be properly disposed of by DCRA.

Performance Monitoring

The treatment approach consists of treatment to stabilize PFAS in vadose zone soil and the treatment of shallow groundwater. ORIN will assess both soil and groundwater for a period of one year to assess the performance of the remedy.

Soil Performance Monitoring

Following the completion of soil blending ORIN, or ORIN's subcontractor, will collect confirmation soil samples to assess the ability of the treatment to address PFAS levels and leachability. Confirmation soil samples will be collected by ORIN during two sampling events – 30 days post mixing and 1-year post mixing. Each confirmation event will consist of two hand auger borings advanced to the top of clay. ORIN will collect soil samples from each boring from the upper foot of treated soil overlying the clay for analysis of PFAS by modified method 537 and SPLP. The two distinct sampling events are intended to provide an understanding of the performance of the treatment approach overtime.

Groundwater Performance Monitoring

As shown on Figure 2 there are four monitoring wells (MW-1 through MW-4) installed in or near the former DBP in the shallow portion of the water table. The source area remedy is focused on the treatment of shallow groundwater. Well PZ-1 is a deep well that is installed within deeper portions of the unconfined aquifer.

To support IRM implementation and performance monitoring, ORIN and its subcontractors propose to install three additional water table monitoring wells at the site (**Figures 4 and 5**). One monitoring well will be installed adjacent to the groundwater treatment area and will be used both to assess the radius of influence during injections as well as to understand the fate of PFAS following treatment. The other monitoring wells will be installed to the east of the treatment area to better constrain the groundwater flow direction and the downgradient extent of PFAS-related impacts. Monitoring wells will be installed with a 10-foot long well screen to ensure that the wells PFAS levels in groundwater in the existing and the expanded monitoring well network will be monitored over time, to assess the effectiveness of the IRM on groundwater quality and to assess for potential back diffusion of PFAS from the formation following treatment. Based on previously calculated groundwater flow velocities, the effect of the aquifer treatment may not significantly influence PFAS levels in downgradient receptors during the performance monitoring time period. Ongoing monitoring will provide a framework for assessing whether additional treatment to address potential downgradient receptors may be advisable.

Groundwater performance monitoring will include gauging of existing wells to assess vertical and lateral hydraulic gradients/flow and the collection of groundwater samples using low-flow methods. Low flow sampling techniques will include the use of dedicated high-density polyethylene (HPDE) tubing, and an inline water quality meter connected to a peristaltic pump. The pump will be operated at a flow rate of 100 to 500 milliliters per minute and low flow water quality parameters as well as the depth to water (i.e., drawdown) will be monitored at 3- to 5-minutes intervals until the water quality parameters stabilize over three successive monitoring intervals.

PFAS levels in groundwater will be assessed on high and low frequency time frames:

- High frequency sampling will be performed within treatment zone wells (MW-3, MW-4 and one of the proposed, new monitoring wells) and the upgradient well (MW-1) over time to assess changes in PFAS levels resulting both from the applied treatment and potential natural flushing of PFAS generally in the source (e.g., MW-1). In order to capture subtle changes in PFAS concentrations that may result due to microbial degradation, groundwater samples will be collected for PFAS (Modified Method 537). At these locations PFAS levels in groundwater will be assessed prior to initiation of treatment (but within one month of the start of treatment) and approximately 1-week, 2-weeks, 30 days, 3-months, 6-months and 1-year post injection.
- Assessment of PFAS on a semi-annual basis (including pre-treatment baseline sampling) at wells MW-1, MW-2, PZ-1 and the proposed,

easternmost monitoring well. Due to the relatively slow groundwater velocity at the DBP, it is unlikely that the effect of PFAS immobilization in the treatment area will be realized in downgradient wells within the first year of treatment.

In addition to PFAS sampling, ORIN will:

- Collect low flow water quality stabilization parameters (i.e., pH, dissolved oxygen, oxidation reduction potential [ORP], etc.) obtained during purging and prior to sample collection at each well included in the performance monitoring event.
- Collect additional groundwater samples for fluorine analysis (Method 9214) from monitoring wells MW-1, MW-3 and MW-4 prior to injection and at 2-weeks, 1-, 3-, 6- and 12-months post injection. Fluorine is an expected byproduct of PFAS mineralization. However, it has been ORIN's experience that due to fluorine's reactivity in the subsurface and the relatively elevated method detection limits (relative to PFAS concentrations), fluorine analyses may not be sufficient to prove or disprove that PFAS degradation is occurring.
- Collect additional groundwater sample for microbial analysis (qPCR at the genus level) from monitoring wells MW-1, MW-3 and MW-4 prior to injection, 2-weeks post injection and 3-months post injection to directly assess microbial diversity and bacterial counts in the treated and untreated areas. This will include comparison to the microbial consortium injected with the BAM.

Cost Estimates

Soil Blending	$262,741
Sonic Injection	$877,407
Electrode Installation	$209,852

Costs for site restoration & performance monitoring are not included in the above price estimates.

Missing additional well install, sample collection, site restoration, consultant oversight/report writing. Silt fencing is not included, vendor has not responded to request. Estimate could be $150,000.

Total Estimates $1,500,000

Assumptions

- Information supplied to ORIN is accurate and representative regarding the site contaminants and concentrations, area, and volume of materials to treat, and the geology of the site.
- DCRA is responsible for providing water used for remedial activities described within this proposal. The water will be available from onsite fire hydrants or another source capable of providing 15 gpm designated and provided by DCRA.
- Treatment chemical, injection equipment, blending equipment, electrooxidation equipment, subcontractors, and ORIN personnel are included in the cost estimates.
- Performance monitoring costs are not included in the cost estimates. Additional monitoring well installation & development is not included in the cost estimates.
- ORIN will prepare and implement a site-specific health and safety plan upon award of this project. Preparation costs are included.
- ORIN will maintain site cleanliness by properly disposing refuse, including used PPE.
- DCRA is responsible for providing a power source for the electrooxidation system.
- DCRA is responsible for marking all public and private utility lines in or near the area of concern.
- DCRA is responsible for traffic control, if necessary.
- ORIN will not be responsible for any treatment chemistry infiltration into nearby utility trenches, sewer systems, basements, catch basins, etc.
- The site is accessible to ORIN and ORIN's subcontractor's equipment.

Health and Safety

To ORIN, health and safety is not just a priority, it's a value. By being proactive instead of reactive, ORIN has learned to identify and listen to health and safety triggers, such as fatigue, emotion and rushing. ORIN reports near misses and lessons learned to help facilitate open discussions with clients and vendors alike about health and safety on our projects.

ORIN Technologies

ORIN is ISN certified. ISN is a certification that ensures all members are up to date and compliant with safety standards and training in some of the most safety conscious industries. We pursued ISN certification to show our commitment to health and safety, and to ensure we meet even the most stringent requirements for companies we work with.

ORIN subscribes to Occupational Safety and Health Administration (OSHA)- and United States Environmental Protection Agency (USEPA)-mandated Health and Safety standards for protection of hazardous waste workers. Because of the wide range of potential exposure for our employees, ORIN must make conservative judgments as to potential health risks. The services outlined in this proposal are offered on the basis of providing Level D health and safety protection (Tyvek®, steel-toed boots, hard hats, nitrile gloves, hearing protection, eye protection, and air-purifying respirators). ORIN personnel will abide by the applicable OSHA guidelines for personal safety outlined in 29 CFR 1910.

Prior to daily commencement of injection activities, ORIN will conduct health and safety tailgate meetings with all applicable onsite personnel. The meetings will include but will not be limited to discussion of the work planned for the day and any potential hazards, changes in work assignment, any problems encountered during past operations, and any other pertinent health and safety issues.