SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

July 13, 2018

Ms. Janet DiMaggio
Wisconsin Department of Natural Resources
South Central Region
3911 Fish Hatchery Road
Fitchburg, Wisconsin 53711

RE: Work Plan to Prepare a Corrective Measures Study Addendum
Hacco, 110 Hopkins Drive, Randolph, Wisconsin
BRRTS #02-14-000900

Dear Ms. DiMaggio:

Shannon & Wilson has prepared this Corrective Measures Study (CMS) Addendum Work Plan for the Haaco facility in Randolph, Wisconsin. Its purpose is to evaluate remedy options for persistent pesticides along with other contaminants in soil (e.g. herbicides, VOCs and SVOCs) that are an ongoing source of groundwater contamination at the site. This plan has been prepared in response to a formal Wisconsin Department of Natural Resources (WDNR) June 29, 2017 letter request, along with subsequent correspondence and discussions between the Agency and Hacco.

1.0 BACKGROUND

WDNR's June 29, 2017 letter summarized the results of a meeting held among the Agency and Hacco the previous day (June 28th). The meeting was convened to discuss recommendations in Haaco's 2016 Annual Groundwater Report that described augmenting the existing pump and treatment system currently operating at the facility. Though the Agency confirmed the system was containing the plume, it requested further source control. Accordingly, WDNR stated in its letter that additional work was needed for case closure, concluding the following:

> …an updated Corrective Measures Study (CMS) is necessary to identify a viable pathway forward to achieve adequate source control in both the unsaturated zone soils and the aquifer in the vicinity of Area 2, and possibly other areas of the site. Remediation technology has improved significantly since the last CMS was completed and we are hopeful that a practicable cleanup method can be identified through this process.

Potential remedial alternatives were previously evaluated in a September 2006 CMS Report and a September 2008 CMS Addendum. However, these options were limited because of available technologies at that time. One technically viable option described included soil excavation and off-site disposal. This action along with the associated costs were discussed with WDNR in a meeting held on September 18, 2009. Costs for building demolition, site restoration, lost production and sales from these activities were also presented. Because many of the

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contaminants (i.e. pesticides) will likely cause a hazardous waste listing classification at the time of excavation, off-site hazardous waste disposal would likely be unavoidable and therefore was considered financially prohibitive.

2.0 TECHNICAL APPROACH

Since the time of the previous CMS Report and Addendum, newer remedial technologies utilizing on-site ex-situ and in-situ thermal and chemical treatment have become more common. Though these technologies have had limited use on pesticides, the application and success at comparable contaminated sites merit their consideration. However, bench scale treatability tests and a potential subsequent pilot test will likely be needed for all constituents of concern (COCs) before a comprehensive remedial action could be implemented.[1] Further, because soil contaminated with these COCs will be a listed hazardous waste or characteristic hazardous waste following excavation, permitting and Agency approval will be required for any ex-situ treatment. Comparatively in-situ technologies have no restrictions regarding hazardous waste classification and include both thermal and chemical treatment. In-situ method applications will also avoid lost productivity costs.

In-situ thermal treatment utilizes either indirect or direct electrical heating of the soil mass to volatilize contaminants where they are in turn captured via a soil-vapor extraction (SVE) system. Indirect heating includes electrical resistance heating (ERH), and direct heating includes thermal conductive heating (TCH). ERH is generated by an electric field passed through the targeted soil volume between subsurface electrode elements. The resistance to the electrical current in the soil causes heating until the boiling point of water is reached. Further energy input causes a phase change, forming steam and mobilizing the volatile contaminants where they are captured by the SVE system. TCH differs in that the electrodes are placed in an array across the field mass, directly heating the soil around each electrode above the boiling point. Both methods are highly effective for VOCs and are designed to reach a total contaminant mass removal up to 99% in a few months. However, historical applications using thermal technologies at pesticide sites are limited.[2]

In-situ chemical treatment was previously evaluated in the September 2006 CMS. As described in that report, a bench scale test for potassium permanganate and Fenton's Reagent (hydrogen peroxide) was performed in September 2002. In an August 2003 letter Hacco reported that

[1] Please note that because of the installation effort for the in-situ thermal infrastructure, no pilot tests are performed.

[2] WDNR previously met with Dune Technologies (Dune), representatives for McMillan McGee (holding one of the few U.S. ERH patents) to discuss the Hacco site. Dune reported that a preliminary cost estimate from $4M - $5M to implement ERH was submitted to WDNR. However, Dune indicated additional information (i.e. geology, depth to water, contaminant distribution and treatability) would be needed to fully evaluate the site.

bench scale studies yielded limited COC destruction, but increased the levels for other constituents. No additional evaluation was performed because the results confirmed that treatment may cause further contaminant migration. The 2006 CMS report concluded that another bench scale test or pilot test was needed to determine a more suitable chemical reagent. Additionally, in-situ chemical treatment was recommended for only the east side of the facility where contaminated groundwater is contained by the extraction wells.[3]

Though previous CMS evaluations indicated that several source area remedial actions were either technically limited or cost-prohibitive, review of emerging technologies for persistent organic pollutants (POPs) should be evaluated. Accordingly, Haaco recommends evaluation of the following potential corrective measures for the source areas:

- Soil excavation and off-site disposal;
- Soil excavation, ex-situ thermal treatment, and replacement;
- Soil excavation, ex-situ chemical treatment/stabilization, and replacement;
- In-situ thermal treatment, and
- In-situ chemical treatment.

Each of these response actions assume continued operation of the existing pump and treatment system.

3.0 SCOPE OF SERVICES

Task 1 – Soil Sample Collection and Treatability Study

Though the previous evaluation for in-situ chemical treatment indicated shortcomings, subsequent advances with this technology confirms that an evaluation of different reagents is appropriate. Accordingly, an updated bench-scale treatability test will be performed to confirm its current viability. The purpose of the treatability study will be to determine the applicable chemistry and required loading rates for source area remediation.

In preparation of this work plan Shannon & Wilson discussed site conditions and historic sample results with ORIN Remediation Technologies (ORIN). Because the previous treatability study used a combination potassium permanganate and Fenton's Reagent, and potential migration of contaminants to the saturated zone was identified, ORIN recommended that chemical treatment should consider other processes to reduce contaminant mobility. The proposed treatability study

[3] The estimated costs for in-situ chemical treatment evaluated in the 2006 CMS Report exceeded $1M; because multiple applications may be needed to achieve the desired reduction in contaminant mass, toxicity, and mobility, a pilot test was recommended to determine full scale application rates and remediation costs.

will include evaluation of several reagents, catalysts, Zero Valent Iron (ZVI), and Bioavailable Absorbent Media (BAM). A copy of the ORIN's treatability study proposal included as Attachment A.

Shannon & Wilson will collect a minimum of three soil samples from soil borings advanced at each of the three solid waste management areas subject to the ongoing groundwater extraction system (Areas 2, 3, and 12). Soil samples will be collected from borings advanced with a direct push drill rig. Additionally, one groundwater sample will be collected from MW-3AR to evaluate treatment within the saturated zone. All samples will be collected and transported in accordance to procedures recommended by ORIN. Upon receipt of soil samples, ORIN will perform baseline testing to determine pre-treatment concentrations. Baseline testing will include analyses for organo-chlorine pesticides and other chlorinated mixtures by Method 8081, organo-phosphorus pesticides, triazine herbicides, and organo-nitrogen herbicides by Method 8270, chlorinated acid herbicides by Method 8151A, and urea-carbamates by Method 8321 – HPLC. Samples will also be analyzed for arsenic by Method 6010B, and VOCs by Method 8260, and SVOCs by Method 8270. Organic constituents included with each analytical method are summarized on Table B1 included as Attachment B.

Treatability testing will be performed on multiple soil samples with various proven treatment chemistries. ORIN will test several reagents, catalysts, Zero Valent Iron (ZVI) and Bioavailable Absorbent Media (BAM). ORIN will then provide a report with the oxidant demand observed, contaminant reductions, and recommendations for the preferred treatment chemistry and loading.

Task 2 – Corrective Measures Study Addendum Report

The CMS Addendum report will include an evaluation of the above five potential corrective measures at the three subject areas. The discussion on in-situ chemical treatment will include a detailed evaluation for the feasibility of this remedial action if treatability study results are favorable, depending on the recommendations in ORIN's report. [4] Each subject corrective measure will include a description and evaluation of the technical feasibility and economic feasibility based on criteria outlined in Wisconsin Admin. Code chapter NR 722. These will include weighting the technical feasibility criteria for long-term and short-term effectiveness, implementability, and restoration time frame, along with the economic feasibility for each corrective measure. Economic feasibility will be further evaluated be providing detailed estimates for engineering design costs, construction oversight, disposal costs, and long-term monitoring costs. For comparison purposes, the proprietary Remedial Action Cost Engineering and Requirements (RACER®) database platform may be utilized as part of these cost estimates.

[4] In addition to the results of the treatability study, the discussion on in-situ chemical treatment will evaluate sorption/ enhanced bioremediation.

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The report will include a recommendation for a selected corrective measure. This will be based on the above criteria weighting.

4.0 SCHEDULE

Soil sample collection described in Task 1 will be completed within three weeks following work plan approval. Orin confirmed in its proposal (Attachment A) that it will require an additional six weeks to perform the bench tests and prepare its report. Shannon & Wilson will require an additional six weeks for the CMS report and internal review prior to submittal to the WDNR.

Please call me at (608) 442-5223, extension 8156 with any questions.

Sincerely,

SHANNON & WILSON, INC.

David P. Trainor

David P. Trainor, P.E., P.G.
Vice President

Enc:

Attachment A - ORIN Treatability Study Proposal
Attachment B - Analyte List Tables

David
P.
Trainor

ATTACHMENT A

ORIN REMEDIATION TECHNOLOGY TREATABILITY STUDY PROPOSAL

June 26, 2018

David Trainor
Shannon & Wilson, Inc.
6506 Schroeder Road, Suite 201
Madison, WI 53711

Subject: **Proposal for Total Oxidant Demand (TOD) and Treatability Testing of Soils and Groundwater for the Hacco Facility Located in Randolph, Wisconsin**

Dear David,

ORIN Technologies, LLC. (ORIN) is pleased to present this proposal to Shannon & Wilson, Inc. for Total Oxidant Demand (TOD) and Treatability Testing at the Hacco Facility located in Randolph, WI (site).

Approach

The Contaminants of Concern (COC) are Organochlorine Pesticides, Organo-Phosphorus Pesticides, Urea Carbamates, Volatile Organic Compounds (VOC), and Semi-Volatile Organic Compounds (SVOC). The tests will be used to determine the most cost-effective treatment chemistry and dosage rate for treatment of the COCs. The TOD test and treatability study will be conducted at ORIN's laboratory in conjunction with a commercial analytical laboratory. After the study ORIN will provide recommendations for the chemistry that is the most suitable for the site and provide a cost for implementation upon request.

Total oxidant demand (TOD) testing reveals the amount of chemical needed to fully oxidize both the contaminant, and naturally occurring organic matter in the soil matrix. Estimating oxidant demand can lead to overestimating the amount of chemical needed (leading to higher chemical cost), or underestimating the amount of chemical needed (leading to inadequate contaminant degradation). TOD Testing involves dosing soils with a known amount or concentration of oxidant and then measuring the residual concentration over a period of several days. The ratio of the amount of oxidant consumed to the amount of soil it was in contact with provides the total oxidant demand, often given in units of g/kg.

A treatability study will be used to determine the most effective treatment chemistry for the site by testing several treatment chemistries on site soils and measuring performance. After dosing a slurry of the soil and allowing the treated soils to react, they will be analyzed and compared to a control sample. ORIN will test several oxidants, catalysts, Zero Valent Iron (ZVI) and Bioavailable Absorbent Media (BAM). Water will also be collected and tested utilizing several oxidants, catalysts, ZVI and BAM. After the study, ORIN will provide a report with the oxidant demand observed, COC reductions, and recommendations for the preferred treatment chemistry and loading. Analytical testing will be performed on both the groundwater and soil fractions.

Sample Requirements

- Samples shall be collected in a manner to minimize volatilization.
- ORIN recommends that samples be collected in an acetate sleeve, macro core liner, or wide mouth glass amber jars with minimal headspace.
- ORIN requests that three macro cores or equivalent soil in jars from each of the three areas (2, 3, & 12) be filled with site soil with no headspace from each sample location. The samples should be taken from the most contaminated area and be non-preserved.
- ORIN recommends that 10 liters of water from the most contaminated well be collected in 1-liter amber jars.
- Samples shall be properly capped, labeled on both ends with the appropriate depths, contain the appropriate boring location information, and proper well designations.
- Samples shall be placed in a cooler chilled with ice.
- **Samples and ice should be placed in separate heavy-duty plastic bags (e.g. garbage bags) to prevent dilution and cross contamination.**
- Samples shall be shipped overnight under proper chain of custody protocol.

Scope of Services

TOD Testing

- ORIN will perform a sodium persulfate TOD test.
- The persulfate will be activated by using alkaline activation for the TOD test.

- Data obtained in the TOD tests will be used for setting the oxidant dosing rates in the treatability study.
- ORIN will prepare a report to accompany the treatability testing, outlining the findings of the TOD tests.

Bench Scale Treatability Test

- Use the data collected from the TOD tests to determine oxidant loading in the treatability test.
- Several combinations of oxidants, catalysts, ZVI and BAM will be tested.
- All samples will be analyzed for EPA 8260 VOCs, EPA 8321 Urea Carbamates, EPA 8081A Organochlorine Pesticides, EPA 8270 GCMS Pesticides, HPLC Acid Herbicides, EPA 8270 SVOCs, and Arsenic.
- If any COCs that are important to this site are not specifically listed above, Shannon & Wilson should contact ORIN before the start of the treatability study to ensure they are included in the analyte list.
- Analytical testing will be performed on a standard turn-around time by a commercial laboratory.
- ORIN will provide a treatability study report with recommendations.
-

Standard Turnaround time from receipt of sample to final report is 6 weeks

ORIN appreciates the opportunity to provide you these services. If you have any questions or comments, please contact me at 608-838-6699 or on my cell at 608-445-8584.

Sincerely,

Keith Becker
Project Manager
ORIN Technologies, LLC.

Disclaimer
Unauthorized duplication of any section or design concept contained within this report without the express written or verbal consent of ORIN is strictly prohibited.

ATTACHMENT B

ANALYTE LIST TABLE

Table B1 – Analyte List

Method 8081A - GC/EC
Organochlorine Pesticides
Other Chlorinated Mixtures

-- 2,4'-DDD
-- 2,4'-DDE
-- 4,4'-DDD
-- 4,4'-DDE
-- 4,4'-DDT
-- Aldrin
-- alpha-BHC
-- alpha-Chlordane
-- beta-BHC
-- cis-nonachlor
-- delta-BHC
-- Dieldrin
-- Endosulfan I
-- Endosulfan II
-- Endosulfan Sulfate
-- Endrin
-- Endrin Aldehyde
-- Endrin Ketone
-- alpha- BHC (Lindane)
-- gamma-Chlordane
-- HCB
-- Heptachlor
-- Heptachlor Epoxide
-- Methoxychlor
-- Mirex
-- PCNB
-- Toxaphene
-- trans-nonachlor
-- Pentachloronitrobenzene

Method 8270 - GCMS
Organo-Phosphorus Pesticides
Triazine Herbicides
Organo-Nitrogen Herbicides

-- EPTC
-- Butylate
-- Trifluralin
-- DEA
-- DIA
-- Prometon
-- Propazine
-- Atrazine
-- Simazine
-- Acetochlor
-- Dimethenamid
-- Alachlor
-- Metribuzin
-- Metolachlor
-- Chlorpyrifos
-- Pendimethalin
-- Cyanazine
-- Dichlorovos
-- Ethafluralin
-- Benfluralin
-- Propachlor
-- Phorate
-- Terbufos
-- Triallate
-- Fonofos
-- Dimethoate
-- Ametryn
-- Prometryn
-- Parathion
-- Isofenphos
-- Profenofos
-- Hexazinone
-- Ethoprop
-- Diazinon
-- Command
-- Disulfoton
-- Chlorothalonil
-- Terbacil
-- Methyl Parathion
-- Malathion
-- Bromacil
-- Napropamide
-- Ethion
-- Phosmet
-- Carbaryl
-- Carbofuran

Table B1 – Analyte List

Method 8151A - GC/EC Chlorinated Acid Herbicides	Method 8321 - HPLC Urea Carbamates
-- Dalapon	-- Fenuron
-- Dicamba	-- Tebuthiuron
-- Dichlorprop	-- Bromacil
-- Pentachlorophenol	-- Monuron
-- 2,4-D	-- Fluometuron
-- 2,4,5-TP	-- Diuron
-- 2,4,5-T	-- Propham
-- Dinoseb	-- Siduron
-- 2,4-DB	-- Linuron
-- Picloram	-- Chlorpropham
-- Bentazon	-- Neburon
-- Dacthal	
-- Triclopyr	
-- Bromoxynil	
-- Acifluorfen	
-- MCPA	
-- MCPP	

Table B1 – Analyte List

Method 8260

VOCs

--	1,1,1,2-Tetrachloroethane	--	Methyl-tert-butyl-ether
--	1,1,1-Trichloroethane	--	MIBK
--	1,1,2,2-Tetrachloroethane	--	MEK
--	1,1,2-Trichloroethane	--	Naphthalene
--	1,1-Dichloroethane	--	N-Butylbenzene
--	1,1-Dichloroethene	--	n-Propylbenzene
--	1,2-Dichloroethane	--	Xylene, o
--	1,1-Dichloropropene	--	p-Isopropyltoluene
--	1,2,3-Trichlorobenzene	--	sec-Butylbenzene
--	1,2,3-Trimethylbenzene	--	Styrene
--	1,2,4-Trichlorobenzene	--	trans-1,2-Dichloroethene
--	1,2,4-Trimethylbenzene	--	trans-1,3-Dichloropropene
--	1,2-Dibromo-3-chloropropane	--	tert-Butylbenzene
--	1,2-Dibromoethane	--	Trichloroethene
--	1,2-Dichlorobenzene	--	Tetrachloroethene
--	1,2-Dichloroethane	--	Toluene
--	1,2-Dichloropropane	--	Vinyl chloride
--	1,3,5-Trimethylbenzene	--	
--	1,3-Dichlorobenzene	--	
--	1,3-Dichloropropane	--	
--	1,4-Dichlorobenzene	--	
--	2,2-Dichloropropane	--	
--	2-Chlorotoluene	--	
--	4-Chlorotoluene	--	
--	Acetone	--	
--	Benzene	--	
--	Bromochloromethane	--	
--	Bromodichloromethane	--	
--	Bromobenzene	--	
--	Bromoform	--	
--	Bromomethane	--	
--	Carbon Disulfide	--	
--	Carbon tetrachloride	--	
--	Chlorodibromomethane	--	
--	Chlorobenzene	--	
--	Chloroethane	--	
--	Chloroform	--	
--	Chloromethane	--	
--	cis-1,2-Dichloroethene	--	
--	cis-1,3-Dichloropropene	--	
--	Dichlorodifluoromethane	--	
--	Dibromomethane	--	
--	Diisopropyl ether	--	
--	Ethylbenzene	--	
--	Fluorotrichloromethane	--	
--	Hexachlorobutadiene	--	
--	Isopropylbenzene	--	
--	Methylene chloride	--	
--	Xylenes, m + p	--	

Table B1 – Analyte List

Method 8270

SVOCs

--	1,2,4-Trichlorobenzene	--	Dibenz(a,h)anthracene
--	1,2-Dichlorobenzene	--	Diethylphthalate
--	1,3-Dichlorobenzene	--	Dibenzofuran
--	1,4-Dichlorobenzene	--	Dimethylphthalate
--	2,2'-oxybis(1-Chloropropane)	--	di-n-Butylphthalate
--	2,4,5-Trichlorophenol	--	di-n-Octylphthalate
--	2,4,6-Trichlorophenol	--	Fluoranthene
--	2,4-Dichlorophenol	--	Fluorene
--	2,4-Dimethylphenol	--	Hexachlorobutadiene
--	2,4-Dinitrophenol	--	Hexachlorobenzene
--	2,4-Dinitrotoluene	--	Hexachlorocyclopentadiene
--	2,6-Dinitrotoluene	--	Hexachloroethane
--	2-Chloronaphthalene	--	Indeno(1,2,3-cd)pyrene
--	2-Chlorophenol	--	Isophorone
--	1-Methylnaphthalene	--	Naphthalene
--	2-Methylnaphthalene	--	Nitrobenzene
--	2-Methylphenol	--	N-Nitrosodi-n-propylamine
--	2-Nitroaniline	--	N-Nitrosodiphenylamine
--	2-Nitrophenol	--	Pentachlorophenol
--	3,3-Dichlorobenzidine	--	Phenanthrene
--	3 & 4-Methylphenol	--	Phenol
--	3-Nitroaniline	--	Pyrene
--	4,6-Dinitro-2-methylphenol	--	
--	4-Bromophenyl phenyl ether	--	
--	4-Chloro-3-methylphenol	--	
--	4-Chloroaniline	--	
--	4-Chlorophenyl phenyl ether	--	
--	4-Nitroaniline	--	
--	4-Nitrophenol	--	
--	Acenaphthene	--	
--	Acenaphthylene	--	
--	Anthracene	--	
--	bis(2-Chloroethyl)ether	--	
--	bis(2-Chloroethoxy)methane	--	
--	bis(2-Ethylhexyl)phthalate	--	
--	Benzoic Acid	--	
--	Benzo(a)anthracene	--	
--	Benzo(a)pyrene	--	
--	Benzo(b)fluoranthene	--	
--	Benzo(ghi)perylene	--	
--	Benzo(k)fluoranthene	--	
--	Butylbenzylphthalate	--	
--	Carbazole	--	
--	Chrysene	--	
--	o-Cresol	--	
--	p-Cresol	--	