## Pfeiffer, Jane K - DNR

**From:** Sameer Neve <sneve@ksinghengineering.com>
**Sent:** Thursday, August 24, 2023 11:08 AM
**To:** Pfeiffer, Jane K - DNR
**Cc:** Shane LaFave; Que El-Amin; Pratap Singh; Robert Reineke; Angy Singh
**Subject:** Biochar Investigation Report - CWC East Block
**Attachments:** 20230823 - CWC EB Biochar Investigation.pdf

**Follow Up Flag:** Follow up
**Flag Status:** Completed



Jane,

Please find attached the Biochar Investigation Report for supplemental remediation at the East Block of Community Within The Corridor (CWC). Your expedited review and approval would be much appreciated. Please let me know if you have any questions or need anything else.

Thank you,

**Sameer Neve, Ph.D., ENV SP**

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August 23, 2023

Ms. Jennifer Meyer
Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
1027 West St. Paul Avenue
Milwaukee, WI 53233

**Project # 40441B**

**Subject**: **Biochar Investigation Report**
**Community Within the Corridor – East Block**
**2748 N. 32nd Street, Milwaukee, WI 53210**
**BRRTS #: 02-41-263675, FID #: 241025400**

Dear Ms. Meyer:

On behalf of the Community Within the Corridor Limited Partnership (CWC), K. Singh & Associates, Inc. (KSingh) is pleased to submit a Biochar Investigation Report for WDNR's review.

The purpose of this memorandum is to summarize the findings of a pilot scale study to assess the effectiveness of using biochar in mitigating Trichloroethylene (TCE) vapors at the Community Within the Corridor (CWC) site. Also, a study was conducted to prepare a biochar-alginate mix which could be used to mitigate the migration of TCE vapors through the wooden columns in the living space.

**Experimental Setup**

To confirm the test results from the previous pilot testing, the biochar-soil interaction and the biochar-alginate sealing mix test was repeated in a 3-day experiment that was performed between August 5 – 8, 2023 in a more controlled environment. In addition to this, a biochar swelling test was conducted over a one-month period to determine if the biochar absorbs water and swells up disturbing the layer of fill above it. The main objectives of these tests were:

1. To optimize the biochar mix with soil for adsorption
2. To optimize the biochar-alginate mix for sealing application
3. To observe any swelling of the biochar due to wet conditions

**Biochar – Soil Interaction**

The objective of this study was to optimize the biochar loading on the contaminated soil to have efficient adsorption of TCE on biochar. This setup included 5 plastic Ziploc bags with varying concentrations of biochar - 0% (Control), 5%, 10%, 15%, 20% w/w to make up 500 gms of sample. The contents of each sample are given in Table 1. The test was conducted in a closed kitchen cabinet in an unoccupied unit on the third floor (Unit 3021), which had a historically low value of TCE, to minimize the interference of ambient TCE levels and in darkness to eliminate the possibility of photodegradation. The tip of the sampling syringe was inserted in the small opening of the Ziploc bag to ensure there was no significant exchange of air to and from the bag. Samples were taken on Day 0 and Day 3 and analyzed using the portable Gas Chromatograph (GC) to determine the % removal.

Table 1 – Experimental Design for Soil – Interaction study

| Sample No. | Dosage (% w/w) | Soil Weight (gm) | Biochar Weight (gm) |
|---|---|---|---|
| 1 | 0 | 500 | 0 |
| 2 | 5 | 475 | 25 |
| 3 | 10 | 450 | 50 |
| 4 | 15 | 425 | 75 |
| 5 | 20 | 400 | 100 |

Picture 1 – Coarse Biochar for Soil Interaction Study

**Biochar – Alginate Mix**

In order to mitigate the migration of TCE vapors into living spaces through the wooden columns, a biochar-alginate mix was tested as a sealant. This mix was prepared using 30 gm of Sodium Alginate in 1L of Deionized (DI) water, forming the base of the gel. About 150 gms of ground biochar, prepared by grinding the coarse biochar, was added to the gel. In order to solidify the gel, a 6% (w/v) solution of Calcium Chloride was sprayed over the surface of the gel. Similar to the soil-interaction study, concentrated TCE from the scotty canister (industrial gas cylinder) was stored in air-tight Ziploc bags with enough ambient air to allow partial dilution of the TCE. The tip of the sampling syringe was inserted in the small opening to ensure there was no significant exchange of air to and from the bag. An initial sample was taken to establish a background concentration on Day 0. 50 mL of biochar gel was added to the Ziploc bag to allow adsorption and the bag was sealed. Samples were then collected on Day 3 and analyzed using the portable GC.

Picture 2 – Ground Biochar for Column-Sealing Study

**Biochar – Water Interaction**

About 2 inches of biochar was covered with about 1 foot of pea gravel in a 3.5-Gal plastic bucket to mimic the application to soil. Distilled water was added and maintained to simulate flooding conditions at all times. The displacement (if any) of the biochar was observed over a 4-week period and pictures were taken to indicate the level.

**Results from Biochar – Soil Interaction**

The test results shown in Table 2 indicate that biochar mixed with soil conclusively sequesters TCE. A 15% (w/w) was the most efficient loading rate. The control sample also had a reduction of about 22%, thus implying an effective removal of about 50% by biochar. It can thus be concluded that the optimum loading of biochar at 15% w/w to the contaminated soil can result in significant adsorption of TCE. Since it is impractical to mix the biochar in the entire contaminated soil mass, it is recommended to mix the biochar with 6-inches of the soil after excavation in the quantity required to handle the residual TCE in the soil. To capture the excess volatilized TCE, a layer of biochar about 1 – 2 inches thick can be used as an adsorbent barrier. If any VOCs escape this, they will be removed by the existing Vapor Mitigation System. The cross-sectional layout with all the components can be seen in Figure 2 (attached).

Table 2 – TCE removal at various biochar loading rates

| | TCE Concentrations (µg/m$^3$) | | | | | |
|---|---|---|---|---|---|---|
| Time (day) | BC - C | BC - 5% | BC - 10% | BC - 15% | BC - 20% | Alginate Mix |
| 0 | 498.2 | 441.5 | 404.3 | 299.9 | 286 | 519.6 |
| 3 | 387.1 | 184.2 | 146.7 | 83.8 | 78.4 | 108.2 |
| % Removal | 22.30 | 58.28 | 63.72 | 72.06 | 72.59 | 79.18 |

**Results from Biochar – Alginate Mix**

The biochar – alginate mix used to seal the cracks demonstrated about 80% removal at high concentrations of TCE. The efficiency may reduce at ambient concentrations, however the reduction is effective. Shrinking of the biochar-alginate mixture was also observed that suggested additional reinforcement to the composition of the gel may be required to ensure long-term effectiveness of the product. Alternatively, the ground biochar may also be added to different caulking mixtures to evaluate the effectiveness of biochar alone.

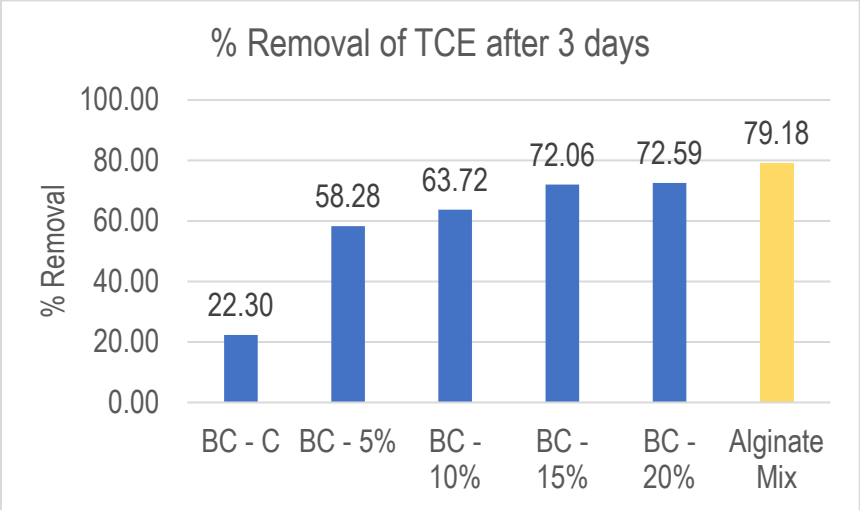
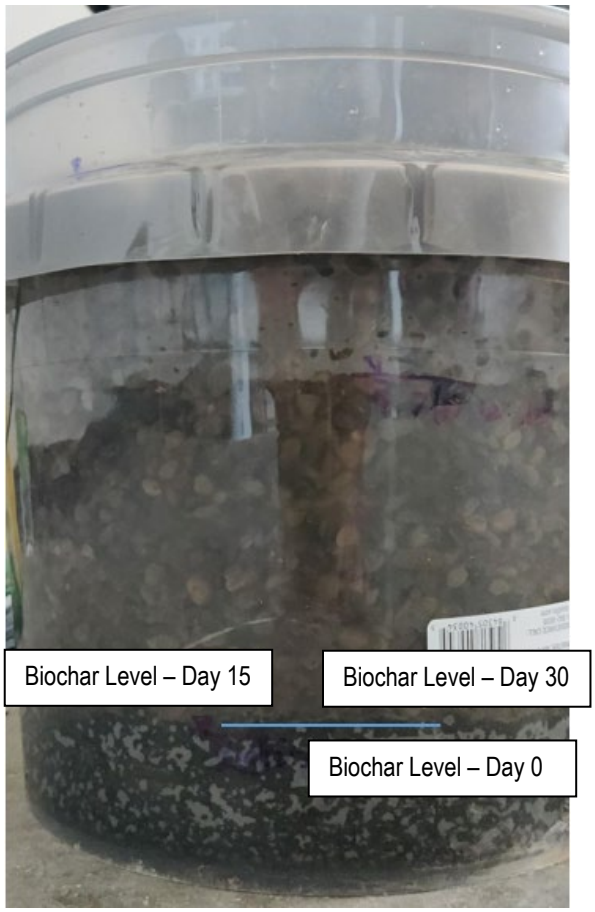



Figure 1 – TCE removal at various biochar loading rates

**Results from Biochar Swelling Study**

As seen in Picture 3, no change in the level of biochar or gravel was observed despite maintaining the water level. This indicates that there is no evidence of swelling of the biochar due to wet conditions.




Picture 3 – Biochar Swelling Study

**Results from Biochar Investigation Study**

Based on the test results, the proposed application of biochar can prove to be an effective medium for remediation of the soils contaminated with VOCs. To supplement the source removal being done at the site, the residual contamination in the soil can be remediated using biochar. The average concentration of TCE in soil is 3.41 mg/Kg based on the site investigation reports, the remedial action report and the soil boring report. Please see below for the proposed biochar application design and application summary in Table 3:

Table 3 – Biochar Application Summary

| | | |
|---|---|---|
| **Excavation Area** | $ft^2$ | **2500.72** |
| Depth of contamination (after excavation) | ft | 4.00 |
| Total Soil Volume | $ft^3$ | 10002.88 |
| Soil Density | $lbs/ft^3$ | 130.00 |
| **Soil Mass** | lbs | 1300374.40 |
| | kg | **589839.42** |
| TCE in soil | mg/kg | 3.41 |
| **Total TCE mass** | g | **2011.35** |
| Biochar adsorption capacity | mg/g | 20.00 |
| Biochar needed | g | 100567.62 |
| | kg | 100.57 |

| | | |
|---|---|---|
| Effective Adsorption efficiency | % | 50.00 |
| **Total biochar needed for soil mixing** | kg | **201.14** |
| **Biochar needed for 1" layer** | kg | **2035.86** |
| **Biochar needed for sealing** | kg | **30** |
| **Total Biochar Needed** | **kg** | **2267** |

**Conclusions**

The following conclusions were drawn based on the results of this study:

- Biochar application with a 15% by weight offers an opportunity to adsorb TCE vapors in the soil thereby minimizing the transport of TCE to reach the Vapor mitigation system.
- Biochar-Alginate mix is effective in sealing the cracks in the wooden columns which will also adsorb TCE vapors and prevent it from reaching living space.
- Because of the black color of the mix, the columns may not look aesthetically pleasing. Wrapping around the columns would help alleviate this condition.

**Closing**

We request WDNR's review and approval of the Biochar Investigation Report and use of biochar as a component of our Remedial Action at CWC East Block. Please note that Robert Fedorchak with Patriot Engineering and Environmental, Inc., an NRPP-Certified Radon Mitigation Specialist, has provided plan input and feedback. We appreciate WDNR's assistance with this project. Please contact us if you have any questions.

Sincerely,

K. SINGH & ASSOCIATES, INC.

Sameer Neve, Ph.D., ENV SP
Staff Engineer

Robert T. Reineke, PE
Senior Engineer

Pratap N. Singh, Ph.D., PE
Principal Engineer

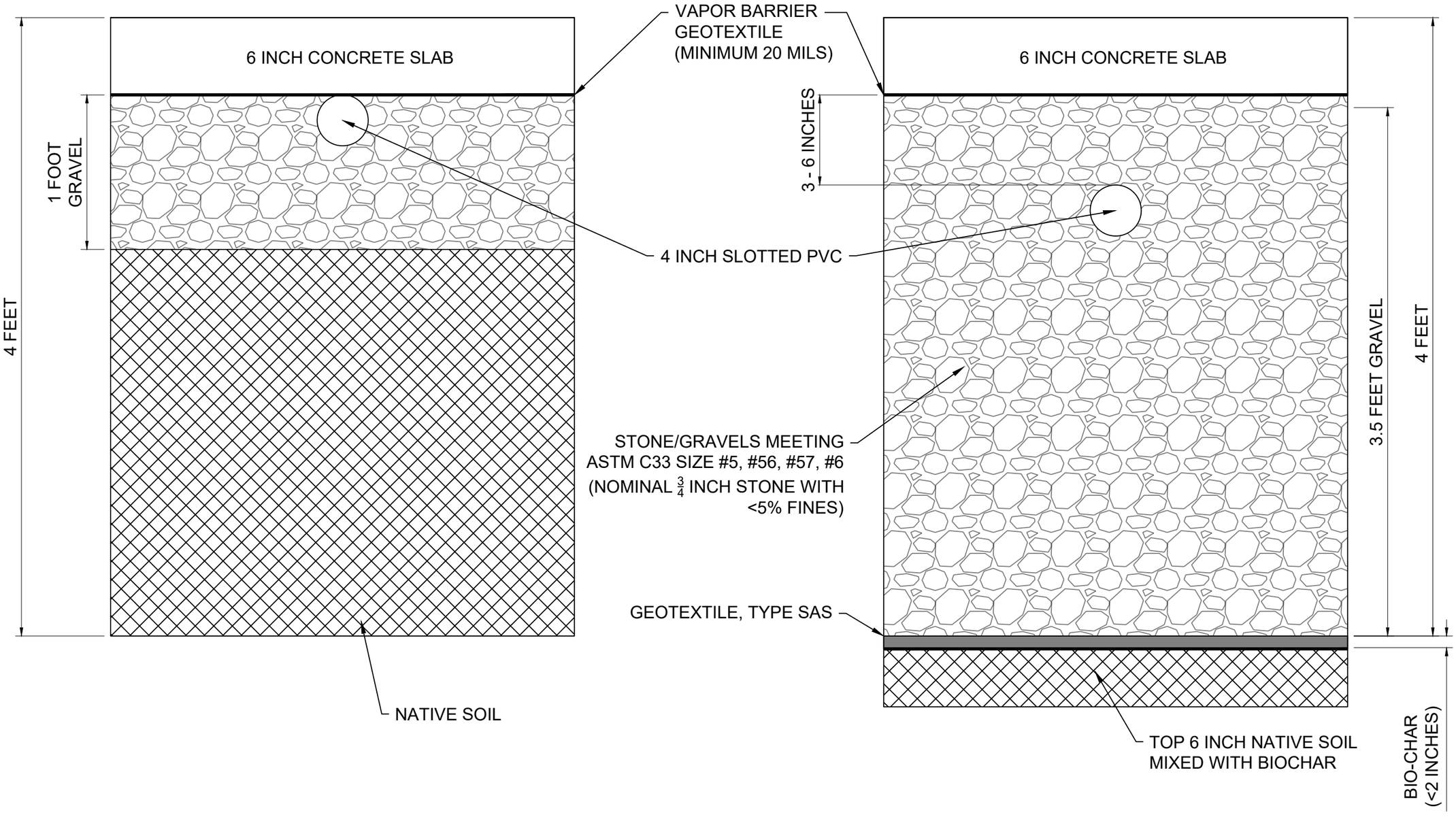
cc: Shane LaFave / Roers Companies
Que El-Amin / Scott Crawford, Inc.
Robert Fedorchak, PE / Patriot Engineering and Environmental, Inc.

Figures

Figure 2. Cross Section of Excavation and Restoration

EXCAVATION CROSS SECTION

RESTORATION CROSS SECTION

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PROJECT TITLE: COMMUNITY WITHIN THE CORRIDOR
2748 N 32ND STREET
MILWAUKEE, WI 53210
PROJECT NUMBER: 40441

CLIENT: COMMUNITY WITHIN THE CORRIDOR LIMITED PARTNERSHIP

| REVISIONS | DATE | DESCRIPTION |
|---|---|---|
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| DRAWN BY | DATE 4/7/2023 |
| CHECKED BY | DATE 4/7/2023 |

SHEET TITLE

CROSS SECTIONS OF EXCAVATION AND RESTORATION

# FIGURE 2



FILE NAME :C:\USERS\RHARRYANKARLO\ONEDRIVE - K. SINGH & ASSOCIATES, INC\DOCUMENTS\PROJECTS\40441B CWC ER\ENV\CADD\RADR CROSS SECTION FIGURE.DWG PLOT DATE :7/20/2023 9:48 AM PLOT BY :RAVEN HARRY-ANKARLO