



Introduction

- Granular activated carbon (GAC) (**Figure 1, Figure 2**) is used in water and wastewater treatment plants because of its adsorption properties.
- GAC reduces undesirable taste, odor, and color in drinking water and removes organic contaminants, heavy metals, pesticides, along with other contaminants.
- Spent GAC can either be regenerated and reused or sent to a landfill.



Figure 1. Dry Granular Activated Carbon (GAC)



Figure 2. Saturated Granular Activated Carbon (GAC)

Objectives

- To measure the hydraulic conductivity and matric potential of exhausted GAC from Upper Valley Water Treatment Plant (UV-WTP).
- To improve our understanding of exhausted GAC from UV-WTP and its potential to be used as a soil amendment for growing riparian vegetation.

Methodology

- Air dried ten samples of GAC and labeled as GAC-1 through GAC-10

Hydraulic conductivity

- Followed ASTM standards for the constant head method (**Figure 3**)
- Used a measured head of about 101.5 cm
- Collected water out of spigot for 5 seconds (**Figure 4**)
- Measured volume of water in graduated cylinder
- Repeated three trials for each sample of GAC
- Corrected for viscosity of water at 20°C

Matric Potential—Water Content Relationship

- Measured volumetric water content (VWC) (m^3/m^3) using a reflectometer model CS655 by Campbell Scientific Inc. (**Figure 5**)
- Measured matric potential (MPa) of GAC at specific VWC using WP4C Dewpoint PotentiaMeter by Meter Environment (**Figure 6**)
- Repeated measurements for predetermined VWCs



Figure 3. Assembly of Constant Head Hydraulic Conductivity Test



Figure 4. Collection of Water from Permeameter for Hydraulic Conductivity Measurements



Figure 5. Volumetric Water Content Measurements of Granular Activated Carbon (GAC) Using Reflectometer



Figure 6. Matric Potential Measurements of Granular Activated Carbon (GAC)

Results

Saturated Hydraulic Conductivity (Ks)

- Average: 0.019 cm/s; Standard deviation: 0.004 cm/s (n=10 samples). See **Table 1**.
- Comparable to that of fine sand (0.001 – 0.1 cm/s).

Matric Potential-Water Content Relationship

- Moisture characteristic curve (**Figure 7**) indicates how much water is potentially available to plants and at what VWCs.
- The amount of available water for plants is determined based on a soils' permanent wilting point (PWP) and field capacity (FC).
- For the UV-WTP GAC, PWP occurs at a VWC of about 15%, while FC ranged from about 25% to 40% (**Figure 7**).

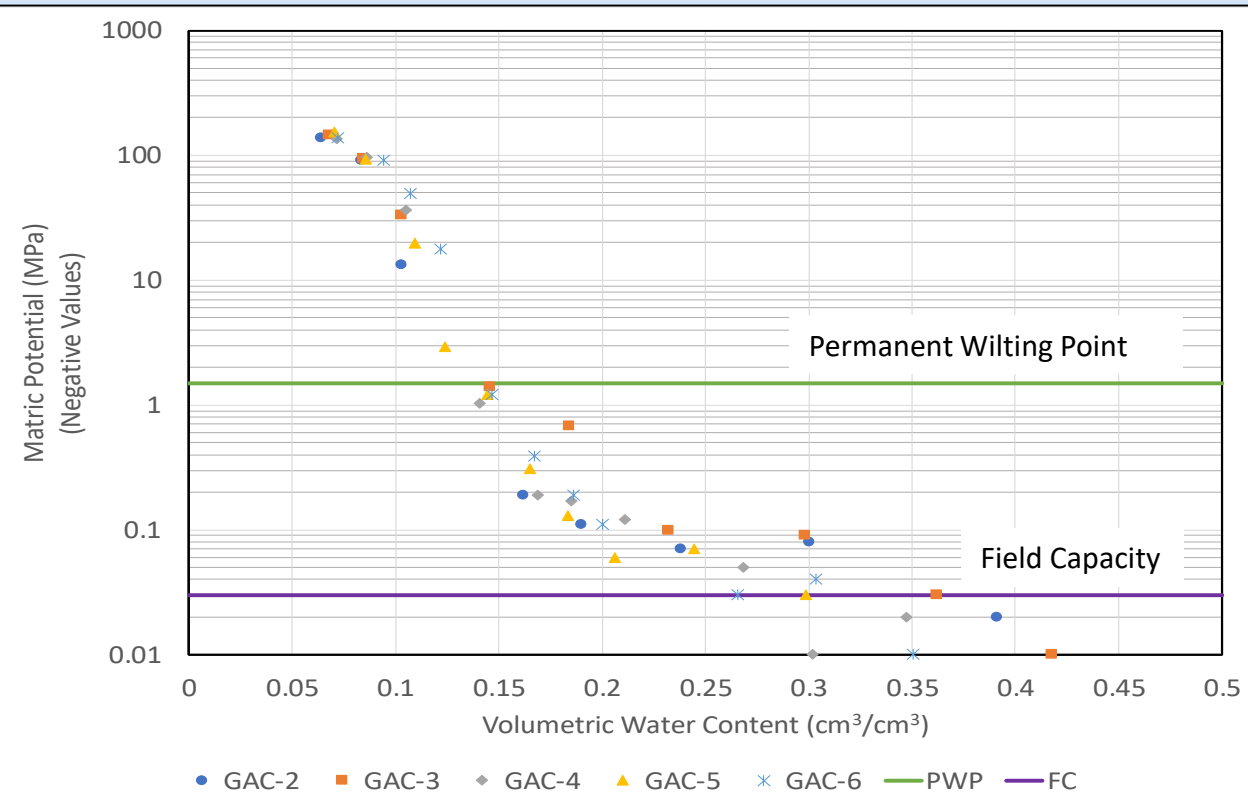


Figure 7. Moisture Characteristic Curve for Granular Activated Carbon (GAC)

Conclusions

- The Ks values of exhausted GAC from UV-WTP are comparable to that of fine, graded, sand
- A GAC moisture characteristic curve was developed:
 - demonstrated low matric potentials at VWCs ranging from 20% to 40% which are suitable for plant growth
- These hydraulic properties indicate:
 - good soil drainage

Table 1. Measured Hydraulic Conductivity of Granular Activated Carbon (GAC)

Sample No.	Hydraulic Conductivity (cm/s)
GAC-1	0.016
GAC-2	0.023
GAC-3	0.019
GAC-4	0.016
GAC-5	0.015
GAC-6	0.014
GAC-7	0.018
GAC-8	0.025
GAC-9	0.021
GAC-10	0.024
Mean	0.019
Stdev.	0.004

Future Work

- Measuring capillarity of GAC to evaluate its use as a wicking material
- Chemical testing to better understand the macro and micronutrients adsorbed to the GAC
- Chemical testing to better understand harmful substances adsorbed to the GAC
- Ensuring the safe use of GAC as a soil amendment