

**AN INVESTIGATION OF RAIN GARDEN PLANTING MIXTURES
AND THE IMPLICATIONS FOR DESIGN**

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- 1) Technical assistance and guidance materials on rain garden engineering design (storm water flow and soil mix options), prepared by Donald Carpenter, Ph.D.
- 2) Two-page fact sheet, “storm water flows and soil mixes for rain garden design” in Southeast Oakland County, prepared by Donald Carpenter, Ph.D.
- 3) Presentations at three rain garden workshops to be organized by SOCWA in cooperation with municipal and private sector partners.

This report satisfies the first deliverable listed above. Lawrence Technological University graduate students Laura Hallam, Prethi Kaluvakolanu, and Gregory Mausolf assisted Dr. Carpenter in data collection, analysis, and reviewing existing literature.

CHAPTER 1

INTRODUCTION

Municipalities in the Rouge River watershed are interested in utilizing rain gardens as a “best management practice” (BMP) for storm water management. In addition to providing storm water storage (water quantity), they also remove nutrients and filter pollutants, thereby improving water quality. As such, the Southeastern Oakland County Water Authority (SOCWA) is encouraging their implementation in Michigan. However, there exists a need for technical reference materials and a deeper understanding of the implications of planting mix design. A laboratory investigation conducted by Lawrence Tech on behalf of SOCWA in 2005 (Carpenter, 2005) considered the effects of compost and sand on field capacity and permeability, but that investigation left several items unresolved. This current investigation was initiated to address several of the unanswered questions from the 2005 investigation and assist municipalities and homeowners in properly designing rain gardens. This report includes a summary of national rain garden design criteria (Appendix A), a literature review of rain garden research (Appendix B), and a laboratory and field investigation of rain garden planting mixtures.

A review of state stormwater standards indicates the growing use of rain gardens as a stormwater management feature. A complete review of recommended design parameters is included in Appendix A with a summary of those design recommendations provided as part of a printed PowerPoint presentation in the companion report, “Rain Garden Design Guidance and Public Education Outreach – A Final Report” by Donald Carpenter (2007). Of specific interest for this investigation are the recommended planting mixtures, which vary by region and recommending body.

Several municipalities and state regulatory authorities require planting mixture testing to verify the placed mix is classified as a sandy loam or loamy sand based on the soil classification triangle (Figure 1). Others recommend a mixture of compost, sand, and topsoil with ranges of 20 to 35% for the compost, 35 to 60% for the sand, and 20 to 30% for the topsoil. Within those ranges, there can be additional clarifications for clay content, pH, and granular sizes. Perhaps the most varied recommendation has to do with the clay content (as a component of the topsoil) found in the planting mixture. A review of the standards indicates the recommended clay

content ranges from between 1.5% and 3%, to less than 10%, to between 10 to 25%. The reason for the wide range of recommended clay content probably stems from the role clay plays in the bioretention process. Clay will greatly reduce the infiltration rate and also will assist in filtering and absorbing pollutants. The relative importance of these two processes will dictate the recommended amount of clay for a state or municipality. However, the state of Michigan does not currently have a specified mix design for bioretention and SOCWA has had good results using a mixture of compost and sharp sand, especially in native clay soil environments where the infiltration of underlying soils is very poor. One goal of this investigation was to evaluate a range of planting mix designs to determine their performance both in the field and in the laboratory. Overall, nine different mix designs were evaluated in the laboratory and an additional twelve tests of field infiltration were performed. Finally, soil samples were taken at the twelve field locations and evaluated in the laboratory for grain size distribution and permeability.



Figure 1: Soil Classification Triangle (Reprinted with permission from the Idaho Association of Soil Conservation Districts)

CHAPTER 2

RAIN GARDEN DESIGN PARAMETERS

There were multiple soil parameters investigated in this study, including field capacity (water volume retention), permeability, infiltration, organic content, dry bulk density, porosity, and sediment grain size distribution. The first parameter, field capacity, is a measure of the mixture's overall ability to retain water, or, simply put, water that is captured and held by the mixture. The second parameter, permeability, is a laboratory measurement of water flow through a porous medium, also known as hydraulic conductivity. Permeability is the velocity of water through a porous medium when the medium is completely saturated and under a constant or falling head of water. Permeability is similar to infiltration, which would be the rate at which rainfall infiltrates the surface, but permeability and infiltration are not synonymous. The coefficient of permeability is measured in the laboratory and infiltration is measured in the field. However, if a rain garden was completely saturated and ponding was occurring on the surface, then the water would flow through the compost planting mixture at approximately the rate of permeability for the soil. In addition to laboratory measurements of permeability, field infiltration rates of existing rain gardens under saturated conditions were measured and compared to laboratory measurements of permeability for the same soil. Organic content is a measurement of what percentage of the material is organic. Dry bulk density represents how dense the material is under a dry condition. In other words, it is the density of the material when water is removed through oven drying. Porosity is a measurement of void space of the soil. Porosity is an indication of how much air (or water) can be found with the soil structure. Finally, sediment samples were sieved to determine the sediment grain size distribution.

CHAPTER 3

INVESTIGATION

3.1 Procedures and Approaches

This investigation included both laboratory and field tests to quantify parameters relative to rain garden design and construction. The two most relative laboratory experiments conducted as part of this investigation were a field capacity test and a permeability analysis. In addition, American Society for Testing and Materials (ASTM) standard soil analysis tests were conducted to determine the organic content, dry bulk density, porosity, and sediment grain size. Overall, nine different planting mixtures were evaluated with various amounts of compost, sand, and topsoil. In addition, the 100% compost planting mix was evaluated under two different levels of compaction. Laboratory tests were also performed on twelve soil samples from actual rain gardens located in southeast Michigan. Finally, field infiltration rates were measured using a double ring infiltrometer.

3.1.1 Field Capacity

Field capacity is a measurement of how much water soil can retain when the force of gravity balances surface tension and gravity drainage ceases. The field capacity test was conducted on two or three samples from each mixture. This determined the average water carrying capacity for each mixture and provided an indication of the effect of mixture ratios as well as variability. To conduct field capacity tests, a laboratory experiment was devised and equipment constructed. Figure 2 is a photograph of the equipment.

The upper cylindrical vessel is filled with the planting mixture to be testing. It is added in three layers with gentle compaction between each layer. This was meant to simulate field conditions where planting mixtures would be lightly compacted by foot traffic as they are constructed. The vessel is then filled to the rim with water. The total amount of water added is measured by weight. The outlet at the bottom of the vessel is plastic tubing. Water flowing out of the vessel is then captured in the lower vessel (milk container) and measured on the scale. This information was used to calculate the total volume of water retained (field capacity) after allowing the water to drain via gravity for six hours. The six-hour timeframe was determined

based on the 2005 laboratory investigation where it was determined surface tension and gravity typically balanced in less than six hours for typical rain garden planting mixtures.



Figure 2: Photograph of Field Capacity Experimental Apparatus

3.1.2 Permeability

The permeability analysis experiment was conducted using a falling head permeability test. The basic equipment to conduct this test was already available at Lawrence Tech. This test was conducted on three samples from each laboratory mixture and one sample from each field location. This experiment was run in accordance with ASTM 2434-68 Standard Test Method for Permeability of Granular Soils. Figure 3 has two photographs of the permeability experimental apparatus: a close up of the sample vessel and a test being conducted.



Figure 3: Photographs of the Permeability Apparatus

3.1.3 Additional Laboratory Experiments

ASTM standard laboratory tests were conducted to determine the organic content, dry bulk density, porosity, and sediment grain size distribution. The organic content was calculated utilizing the ASTM 2974-87 Moisture, Ash, and Organic Matter of Peat and Other Organic Soils procedure which calls for burning a sample in an oven at 440 °C for 24 hours. Equation (1) is the equation used to calculate the organic content, where O is the organic content, and D is the ash content in percent.

$$O = 100 - D \quad (1)$$

The material left represents the portion of the material that is mineral. The dry bulk density was conducted and calculated in accordance with ASTM C29/C29M-97 Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate and is the mass of the material per a volumetric container (kg/m^3) after the material was dried in the oven at 105°C for 24 hours. This will evaporate off all water while leaving the sample intact. The porosity is measured by determining the total volume of voids over the total volume of the sample (voids and solids

combined). Finally, sediment grain size distribution was determined by performing ASTM Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates C136-96a and Standard Test Method for Particle-Size Analysis of Soils D422-63. This was used to determine the sediment size diameter for which 10% of the materials is smaller in size (D_{10}). D_{10} is a key parameter for the empirical determination of hydraulic conductivity.

3.1.4 Infiltration

The infiltration rate is the rate at which water moves through an in-situ soil. After reviewing available literature, it was determined that the ASTM D3385 Test Method for Infiltration Rate of Soils using Double Ring Infiltrimeters would be the most applicable for this project. Therefore, a double ring infiltrimeter was purchased from Rickly Hydrological Company to measure infiltration rates of existing rain gardens identified by SOCWA based on their soil characteristics and location. Figure 4 is a picture of the Double Ring Infiltrimeter similar to the one used in this investigation and a photograph of the equipment in use can be found in Appendix B.

Infiltration rates were calculated utilizing Eqn. (2) where V is the inner ring incremental infiltration velocity in inches per hour, ΔV equals the volume of liquid used during the time interval to maintain constant head in the inner ring in cubic inches, A is the internal area of the inner ring in inches squared, and ΔT is the change in time, in hours.

$$V = \frac{\Delta V}{A \times \Delta T} \quad (2)$$

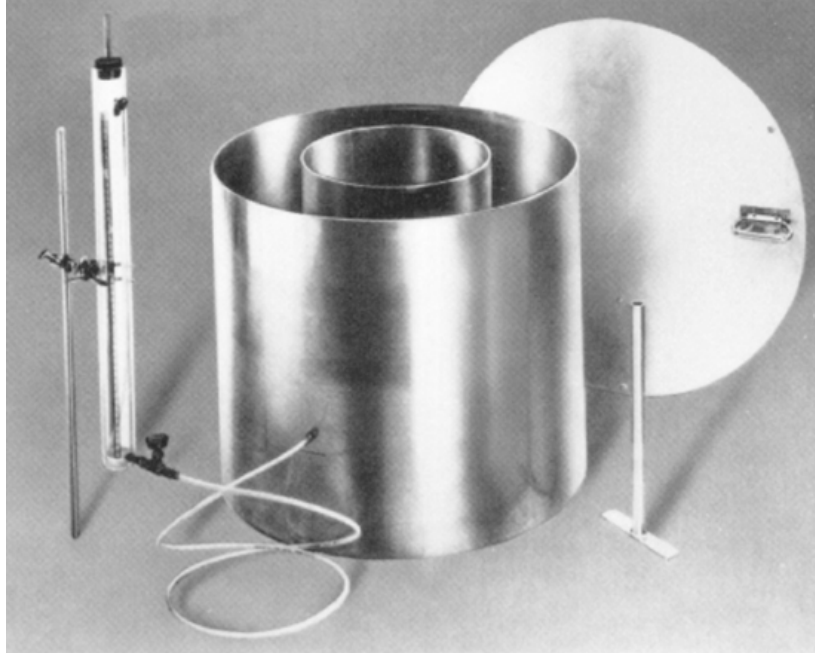


Figure 4: Double Ring Infiltrometer (Coutesy of Rickly Hydrological Company)

3.2 Results

3.2.1 Laboratory Results

Table 1 lists the mean permeability, field capacity, and porosity for each of the nine samples tested in the laboratory. Permeability measures the rate at which water moved through the sample. Eqn. 3 (Bedient and Huber 2002) exhibits the parameters necessary to calculate permeability. Where K is the hydraulic conductivity, A is the cross sectional area, Δh is the change in head between two points that are very close together, and ΔL is the small distance between these two points. Field capacity measures the ultimate water carrying capacity of each sample when surface tension and gravity balance. Porosity is the ratio of the volume of voids (V_v) over total volume (V), Eqn. 4 (Bedient and Huber, 2002), which indicates the pore space that can be filled with water. Where n is the porosity, ρ_g is the grain density, and ρ_b is the bulk density.

$$K = \frac{-Q}{A(\Delta h / \Delta L)} \quad (3)$$

$$n = \frac{V_v}{V} = 1 - \frac{\rho_b}{\rho_g} \quad (4)$$

The mixture label indicates the percent by volume of each component of compost, sand, and topsoil in the planting mixture such that “35 c / 65 s / 0 t” indicates 35% compost, 65% sand, and 0% topsoil. In addition, two of the mix designs have the label “field” or “lab”. This designation was used because two of the laboratory mix designs were also created in the field using a front-end loader as part of a full-scale rain garden implementation project simultaneously being conducted at Lawrence Technological University. As part of the implementation project, two rain gardens were constructed using different mix designs – 80 c / 20 s / 0 t and 20 c / 50 s / 30 t. This provided the opportunity to evaluate the impact of “gross mixing” in the field compared to precision mixing in the laboratory. From the table, there are several important observations that were made. First, the results for the 80% compost and 20% sand mix compared well between field and laboratory samples. The results for the other mix design created in the field and laboratory (20 c / 50 s / 30 t) were not as comparable.

Based on visual observation of the field mixing process and the results of these laboratory tests, it is believed the three-component mix (20 c / 50 s / 30 t) was not as well mixed by the front-end loader as the 80 c / 20 s / 0 t mix design. This led to several conclusions. First, it is important to ensure proper mixing of materials in the field if specific values of permeability, field capacity, and porosity are necessary. Second, the impact topsoil has on mix performance is evident. Mixes that included topsoil have significantly less permeability and field capacity than mixes without topsoil. Third, the impact of sand has on the porosity of the mix designs is evident. The 100% compost mix has a porosity of 0.594 and a field capacity of 115.3%, which means compost retains approximately 115% of its weight in water. Conversely, the sand will only retain about 14% of its weight in water and has a porosity of 0.351, which means less void space for water to reside. In practical terms, this means compost acts as a sponge and will retain more water for longer periods of time. Finally, the addition of topsoil or sand to the compost significantly affects its field capacity. Mixing only 20% of sand and/or topsoil to the compost reduces the field capacity by approximately half. Figure 5 visually demonstrates the impact of reducing the amount of compost with the planting mixtures being ordered from left to right in decreasing percent of compost present in the sample. This figure also includes two mix designs

tested in 2005 (60 c / 40 s / 0 t and 35 c / 35 s / 30 t) that were not considered in this investigation to further demonstrate the impact.

Table 1: Hydrologically significant soil parameters for mixes.

Mixture Label	Mean Permeability (in/hr)	Mean Field Capacity @ 6 hours (%)	Porosity
100 c / 0 s / 0 t	7.42	115.3	0.594
0 c / 100 s / 0 t	10.23	13.8	0.351
0 c / 0 s / 100 t	0.66	24.7	0.486
80 c / 20 s / 0 t Field	18.35	53.5	0.529
80 c / 20 s / 0 t Lab	17.95	63.9	0.459
20 c / 50 s / 30 t Field	0.80	28.3	0.540
20 c / 50 s / 30 t Lab	1.84	16.5	0.429
50 c / 50 s / 0 t	2.18	20.8	0.476
35 c / 65 s / 0 t	2.77	24.2	0.497

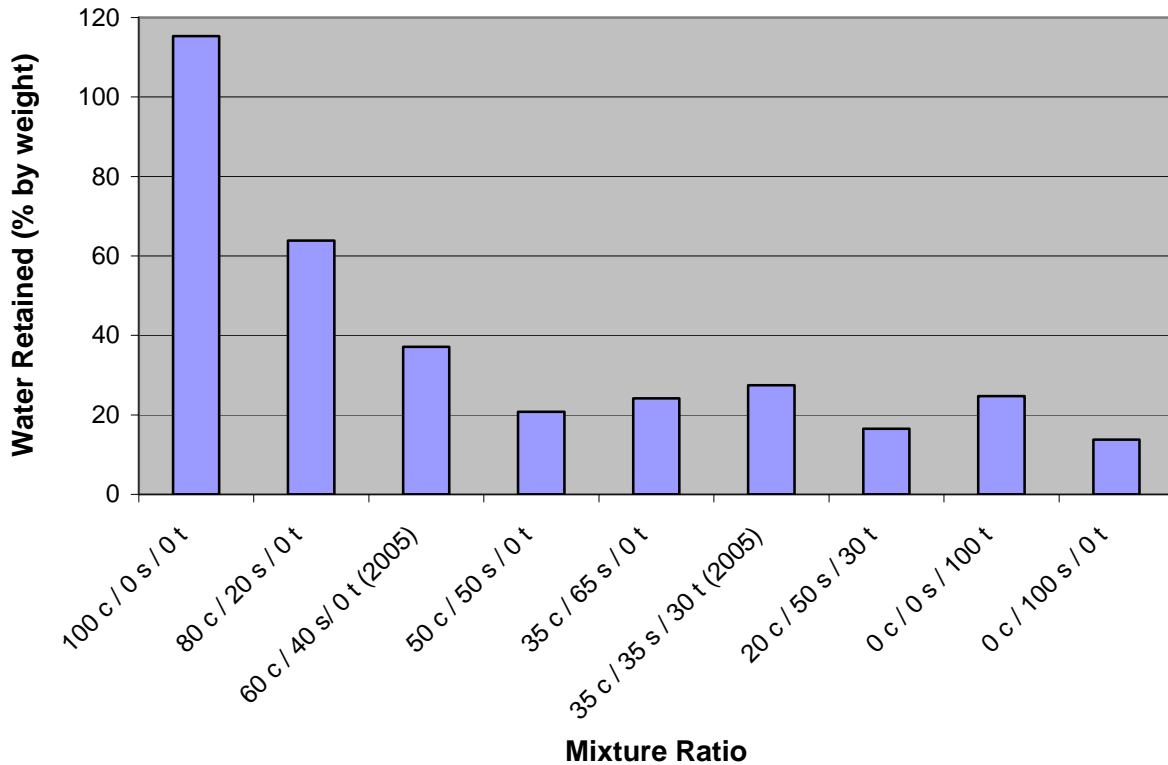


Figure 5: Results of Field Capacity Experiments.

This trend is more visually evident when considering the effect of adding sand to a mix design. Figure 6 includes all 24 field capacity tests run in both the 2005 and 2007 laboratory investigations (not including field mixed samples or the compacted compost tests) along with a best-fit polynomial trend line. As the percent of sand content increases, the field capacity sharply decreases.

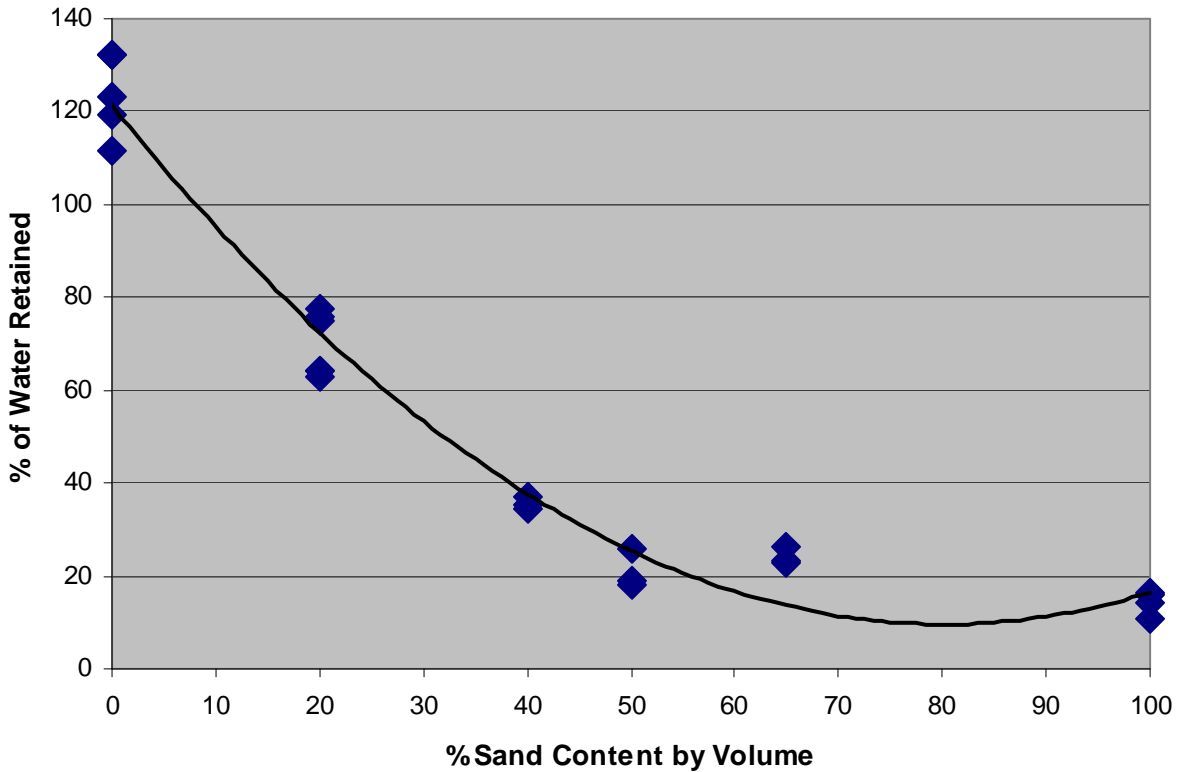


Figure 6: Effect of Sand on Field Capacity

Another function evaluated in the laboratory was the impact of compaction on mix design performance. Literature indicates infiltration is greatly reduced by compaction (Pitt et. Al., 1999). Compaction will also reduce porosity, which limits the amount of water that can reside in the soil. In an attempt to simulate compaction in the laboratory, the amount of compost that would normally reside in the 12” tall cylinder (Figure 1) for the field capacity test was compacted by 2” and 4” respectively. In other words, the same volume of compost was tested for field capacity under its normal condition, under a condition where the sample was 10” tall (2” of compaction – a 16.7% initial volume reduction), and under a condition where the sample was

8” tall (4” of compaction – a 33.3% initial volume reduction). To conduct a fair comparison, the volume of water added to the vessel was equal such that the 8” tall sample was saturated to a level of 8” of water and not to a level of 12”, which would have had 4” of ponded water on top of the sample.

The results from these experiments are in Table 2. Somewhat surprisingly, the field capacities for all three tests were approximately the same. This could be explained by the compost “expanding” as the water was added to the sample as was observed during the test. This might also be explained by the fact that when 100% compost with no initial compaction is drained, it compacts itself almost 2” during the draining process. The compost with 2” of initial compaction compacts itself an additional 1.5” during the draining process, and the compost sample with 4” of initial compaction compacts itself an additional 0.5” during the draining process. In other words, an initially 12” tall sample of compost becomes 10” tall as part of the draining process, an initially 10” tall sample of compost becomes 8.5” tall, and an 8” tall sample become 7.5” tall. Therefore, initial compaction had less impact on the final volumes because of the nature of this test. Because of the observations of the field capacity tests on 100% compost, it was decided to forgo additional compaction testing.

A similar analysis was conducted on permeability (also listed in Table 2) and the permeability rate was reduced by half under the 16.7% volume reduction, which is consistent with observations reported in the literature. Given the small sample test size in the permeability test (Figure 3), it was impossible to compress the amount of compost necessary into the apparatus to simulate a 33.3% volume compaction. Finally, as anticipated, the porosity of the compost sample decreases with compaction.

The other soil parameters that were tested in the laboratory during this investigation were percent organic matter and dry bulk density. Table 3 provides those two parameters along with the porosity for each of the mix designs investigated. Finally, Table 4 and Table 5 provided typical values of permeability and porosity, which indicate the values of permeability and porosity reported in this investigation are comparable with previously published values.

Table 2: Effect of compaction on hydrologically significant soil parameters for mixes.

Mixture Label	Mean Permeability (in/hr)	Mean Field Capacity @ 6 hours (%)	Porosity
100% compost – no compaction	7.42	115.3	0.594
100% compost – 16.7% volume compaction	3.76	113.0	0.521
100% compost – 33.3% volume compaction	NA	112.2	0.438

Table 3: Soil parameters for mixes.

Mixture Label	% Organic Matter	Dry Bulk Density (kg/m ³)	Porosity
100 c / 0 s / 0 t	28.37	442.6	0.594
0 c / 100 s / 0 t	0.22	1648.3	0.351
0 c / 0 s / 100 t	2.04	1284.2	0.486
80 c / 20 s / 0 t Field	13.98	650.3	0.529
80 c / 20 s / 0 t Lab	12.92	746.0	0.459
20 c / 50 s / 30 t Field	2.69	1029.5	0.540
20 c / 50 s / 30 t Lab	2.65	1502.2	0.429
50 c / 50 s / 0 t	5.09	950.1	0.476
35 c / 65 s / 0 t	5.02	1021.4	0.497

Table 4: Typical values of permeability for unconsolidated sediments (Bedient and Huber, 2002)

Sediment Type	Permeability (in/hr)
Well Sorted Gravel	1000 to 15
Well Sorted Sand or Glacial Outwash	15 to 1.5
Silty Sands	1.5 to 0.015
Silt, Sandy Clay, or Till	0.015 to 0.00015
Clay	0.00015 to 0.0000015

Table 5: Typical values of porosity for unconsolidated sediments (Fetter, 2001)

Sediment Type	Porosity
Well Sorted Sand or Gravel	0.25 to 0.50
Well Mixed Sand or Gravel	0.20 to 0.35
Glacial Outwash	0.10 to 0.20
Silt	0.35 to 0.50
Clay	0.33 to 0.60

3.2.2 Field Results

Table 6 is a summary of the field infiltration rates from the twelve rain gardens investigated as part of this project. At one location, the Costick Center in Farmington Hills, two independent tests were conducted in different rain garden “cells”. In addition, two rain gardens located on San Rosa Avila in Lathrup Village had underdrains beneath the rain garden, which caused infiltration rates in excess of 20 inches per hour. This infiltration rate exceeded the infiltrometer’s water supply capacity. Analyzing the results from Table 6, it is apparent that the infiltration rates of the twelve raingardens vary considerably. However, homeowner rain gardens or community rain gardens maintained by local gardeners (shaded gray in Table 6) tended to perform better than municipal rain gardens. In addition, with the exception of a single homeowner rain garden location (Eldorado), all of the measured rates of infiltration were greater than 7.4 inches per hour. Interviews conducted with the homeowners indicate all of these sites drain well after a storm event with no appreciable ponding. This is consistent with the measured rates of infiltration. Finally, in the case of the one homeowner site (Eldorado) that had a lower rate of infiltration, the owner reported that the garden had clay “pockets” which she planned to remove and, overall, their rain garden drained well. It is hypothesized that the field infiltration test happened to be conducted in one of those pockets of clay. Appendix C provides a brief description of each location along with photographs of the sites.

In addition, laboratory permeability tests were performed on a soil sample collected at each location (Table 7). The soil samples were collected from the same general location of the infiltration test. The purpose of running permeability tests was to identify a possible correlation between laboratory measurements of permeability and field infiltration rates. However, after comparing results in Tables 6 & 7, there is no statistical correlation between infiltration and permeability for these twelve sites.

Table 6: Field infiltration rates.

Location	Infiltration Rate, (in/hr)
Beach Park	4.1
City of Wayne	0*
Avilla #2	> 20.0
Costick A	0.8
Costick B	0*
Eisenhower	0*
Eldorado	0.1
Inkster	4.1
E. California	7.4
Lathrup Village	19.7
Avilla #1	> 20.0
Newburgh Point	2.9
Lathrup Blvd.	20.0

*below detectable limit

Table 7: Laboratory measurements of permeability on field samples.

Location	Hydraulic conductivity k in/hr
Beach Park	42.22
City of Wayne	29.93
Avilla #2	137.08
Costick	173.97
Eisenhower	94.96
Eldorado	15.16
Inkster	43.82
E. California	60.02
Lathrup Village	72.76
Avilla #1	130.20
Newburgh Point	27.06
Lathrup Blvd.	12.11

To investigate the laboratory results further, a standard ASTM C136 Sieve Analysis was performed on the samples and the gradation curves can be found in Appendix D. The purpose of conducting a sieve analysis is to determine the D_{10} value for each sample. The D_{10} represent the sediment diameter for which ten percent of the soil is finer than this diameter and ninety percent is coarser. The D_{10} values for each site can be found in Table 8.

There is a known relationship between D_{10} and the permeability of a granular material with finer grained soils having smaller rates of permeability (Fetter, 2001). In addition, the permeability of the soil is dependent upon the gradation of the soil. The more uniform the soil, the higher the rate of permeability. The rate of permeability (K) is proportional to the D_{10}^2 , where C is a coefficient that factors in the sorting characteristics of the sediment and D_{10} is Hazen's effective grain size in mm, relative to which 10% of the sample is finer.

$$K = C \times D_{10}^2 \quad (5)$$

A plot of the data in Table 8 is found in Figure 6. From Figure 6, it can be seen that there is a fairly strong relationship between sediment grain size and permeability for these locations. However, there was no statistical relationship between D_{10} and field measurements of infiltration. As such, the difference between permeability rates measured in the laboratory and field infiltration rates cannot be explained solely by planting mixture sediment size composition. There are probably two primary reasons for this: 1) during the sampling process the soil is significantly disturbed and loosened which would yield higher permeability rates in the laboratory and 2) field infiltration is a function of more than just soil composition. In the field, clogging of the rain garden surface or excess compaction of the rain gardens can impact infiltration. Conversely, mature plants have root structures that can promote infiltration. None of those physical properties are captured by permeability tests in the laboratory.

Table 8: Laboratory measurements of permeability and D_{10} on field samples.

Location	Permeability (in/hr)	D_{10} (mm)
Beach Park	42.22	0.15
City of Wayne	29.93	0.129
Avilla #2	137.08	0.231
Costick	173.97	0.322
Eisenhower	94.96	0.275
Eldorado	15.16	0.05
Inkster	43.82	0.075
E. California	60.02	0.158
Lathrup Village	72.76	0.05
Avilla #1	130.20	0.25
Newburgh Point	27.06	0.138
Lathrup Blvd.	12.11	0.075

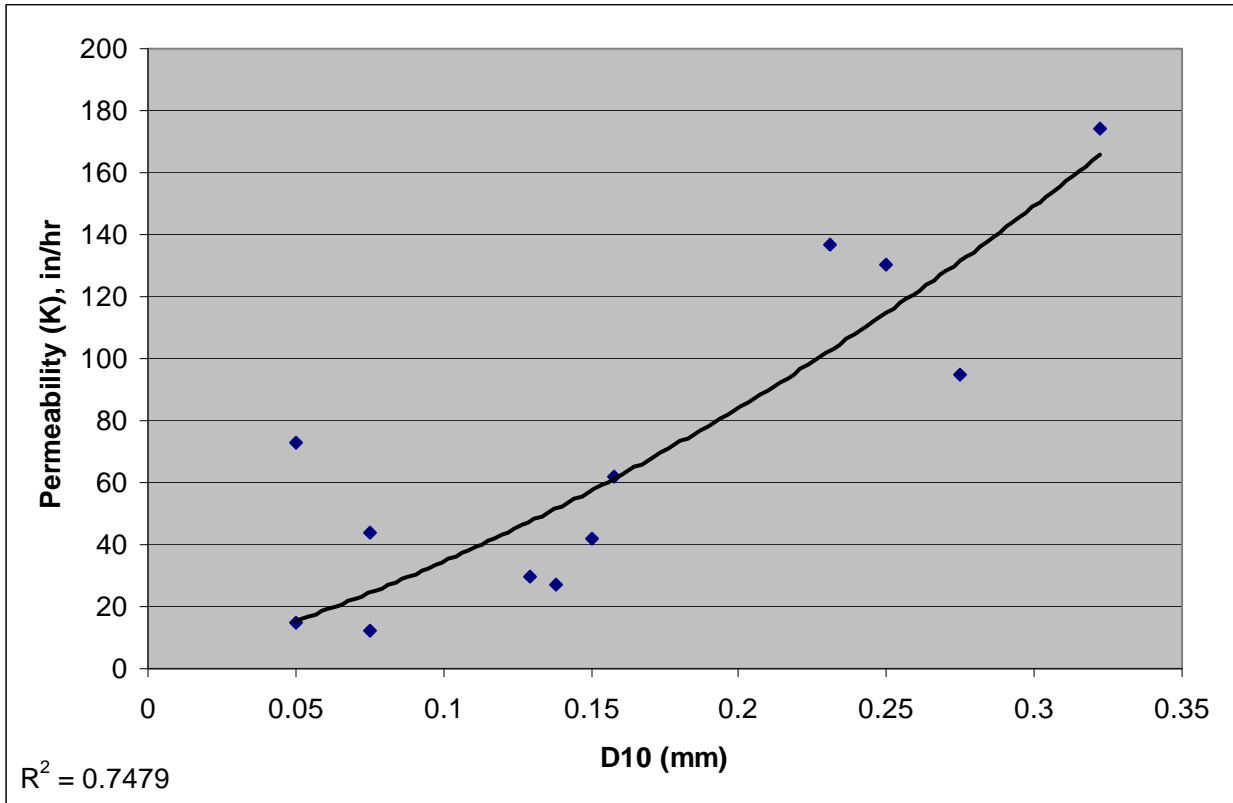


Figure 7: D₁₀ vs. permeability for field soil samples.

CHAPTER 4

IMPLICATIONS FOR RAIN GARDEN DESIGN

The purpose of this investigation was to determine the impact of various rain garden planting mixtures on rain garden design and performance. The study included both a laboratory and a field investigation and evaluated numerous design parameters including field capacity (water volume retention), permeability, infiltration, organic content, dry bulk density, porosity, sediment grain size distribution, and field infiltration rate. Based on the results from this investigation, several observations can be made that have implications for rain garden design:

- The rain garden planting mixture (i.e. the amount of compost, sand, and topsoil) is going to dictate permeability and water carry capacity of the rain garden.
- A planting mixture consisting of 100% compost has a field capacity of greater than 115% and a porosity (void space) of approximately 60%. Conversely, 100% sand has a field capacity of approximately 14% and a porosity of approximately 35%. Therefore, compost can retain significantly more water in its void space for longer periods of time when drained via gravity.
- If the goal of the rain garden design is to maximize water retention, than the amount of sand or topsoil should be limited since 100% compost will hold more than its weight in water. A planting mixture consisting of 80% to 100% compost (with the remaining amounts consisting of sand) will work well, especially in clay soil sites.
- If the goal of the rain garden design is to promote infiltration (for example into an underdrain or into permeable layers of natural soil below), then additional sand should be added to the planting mixture. A planting mixture of 40% sand and 60% compost will work for gardens whose goal is to promote infiltration.
- The inclusion of topsoil causes a reduction of both field capacity and permeability and, from a hydrological point of view, should be avoided. However, topsoil (with a small percentage of clay content – less than 10%) should be included if hydrocarbons or heavy metals in the inflow are a concern since those pollutant will be absorbed by the clay.

- Field infiltration rates of rain gardens cannot be predicted solely by soil characteristics of the planting mixture. Variables such as compaction, root growth and density, and surface clogging by fine particulates can greatly impact field infiltration rates.
- Well-maintained homeowner or community rain gardens had measured field infiltration rates between 7 in/hr and 20 in/hr whereas municipal rain gardens tended to have infiltration rates less than 4 in/hr. As such, for well-maintained rain gardens, the limited factor for infiltration and drainage will be the native soils below the rain garden, which will almost always have infiltration rates lower than those of the planting mixture. For example, if the native soil is primarily clay, as is prevalent in the Rouge River watershed, the infiltration rate of the soil below the rain garden will be less than 0.2 inches/hour. Therefore, the water can easily drain through the rain garden planting mixture but won't be able to drain through underlying soils.

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