

DRAMATICALLY INCREASE THE HEALTH  
& SURVIVAL OF TRANSPLANTED TREES



ALL YOU NEED  
TO KNOW ABOUT  
COMMUNITY  
GRAVEL BEDS

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## COMMONLY ASKED QUESTIONS



*Kentucky coffeetree from gravel bed*  
Photo courtesy: Jacob Ryg

### ***What is a gravel bed and why would I build one?***

A gravel bed is an irrigated bed or pile of gravel to place and safely hold bare root or washed containerized stock for (a.k.a. “heeling in”) up to 3-6 months. Doing this dramatically increases fibrous root volume, decreasing transplant shock and increasing survivability of the plant. Since bare root stock is typically only available during spring, this also allows for staged plantings throughout the year.

### ***Will this require a large upfront investment?***

No, the price is up to you. You can use a pile of gravel you already have, or build a bed that is a centerpiece for your community.

### ***Will using a gravel bed save my community money?***

Assuming you currently plant containerized or balled and burlapped stock, YES. Bare root stock is on average 1/4 the price of balled and burlapped, and 1/2 the price of a containerized tree. This along with the reduced planting cost and higher survival rates for trees planted in the autumn will add up to a significant savings.

### ***Are there other communities in Minnesota currently using gravel beds?***

Yes, over 20 communities are currently using a gravel bed system with great success.

### ***The gravel bed uses bare root stock. Aren't they tough to handle? Won't they dry out?***

Bare root stock can dry out if not handled properly, but this can be easily prevented with proper covering while out of the ground. One of the advantages of using bare root stock is that it is much easier to transport and plant than alternative stock types. One person can plant with a shovel vs. using multiple people and machinery.

### ***Would I be GROWING trees in the gravel bed?***

The above ground portion of the tree will not grow any faster than normal. The purpose is to increase the fibrous root system, recover poor root systems, and prepare for planting at a later date.

### ***What if I buy bare root stock and don't get them planted before winter?***

We do not recommend intentionally storing trees in a gravel bed over the winter, but as long as you protect the stems from critter damage, they typically do fine.

### ***Can I put more than trees in a gravel bed and are there species that don't do well?***

Yes, shrubs as well as most conifer and deciduous trees do great. The only species we know that struggle in a gravel bed are American linden and bur oak.

### ***Is it difficult to find bare root stock of desired species?***

No, typically there are many more species available in bare root stock than balled and burlapped or containerized. See Appendix C for bare root suppliers.

### ***Why not just plant bare root stock in the spring?***

Most unfavorable weather for a transplanted tree occurs in spring and summer. By planting in the fall, roots have time to establish in more favorable conditions, allowing for a higher survival rate through the stressful times of the following spring and summer.



*Swamp white oak from gravel bed*  
Photo courtesy: Jacob Ryg

## COMMUNITY GRAVEL BEDS A-Z

A Community Gravel Bed (GB) is a system that has been in use at commercial nurseries, municipalities, and universities for over 20 years. Building one for your community can provide many advantages over planting traditional bare root, balled and burlapped, and containerized stock. The system is far from complex. All you are doing is placing bare root stock in an irrigated pile of gravel, which will increase the quality of the root system and prepare them for later planting.

There are many communities in Minnesota that have built and are currently using the GB system with great success. Some of these community contacts are listed at the end of this document (Appendix C.) and you are encouraged to contact them about their experiences.

### Benefits of building a Community Gravel Bed

**Saving \$** – The GB system uses bare root stock, which is on average  $\frac{1}{4}$  the price of a balled and burlapped tree and  $\frac{1}{2}$  the price of a containerized tree. Ease of installation also increases savings because there are less people, time, and machinery required in planting bare root stock than alternative stock types.

**Plant health and survival** – An increased fibrous root system allows for an increased uptake of water and nutrients. Transplanting is a stressful time for any plant due to a high portion of its root system being lost when it is removed from the ground. The majority of the energy the plant produces is put into restoring lost roots and sustaining life. This reduces its available energy to fight off pests, diseases, and other health threats. The more water and nutrients the plant is able to absorb, the more energy it is able to produce for root restoration and defense.

**Planting times** – In Minnesota, most of the unfavorable conditions for a newly transplanted tree occur in the spring and summer (wind desiccation, flooding, drought, etc). This contributes to the difficulty of getting healthy trees established in an urban environment. By planting in fall, roots have time to establish in more favorable conditions, giving the tree a higher probability of survival through the more stressful times in the following spring and summer. Healing bare root trees and shrubs in a GB allows stock that is usually only available in spring to take advantage of these more favorable fall planting times.

“Transplanting in early fall confers earlier post-transplant root growth and therefore is the best time of year to transplant most cold-hardy deciduous landscape trees.” (Harris, 2002).

**Community involvement** – Bare root trees provide excellent planting opportunities for volunteers due to their ease of handling and planting. A bare root tree can be planted by one person and a shovel. Plantings can be done quickly and efficiently by auguring holes with a machine and having a volunteer group follow behind planting and mulching. Using volunteers for tree planting is a good way to spark interest from community members to become stewards of your urban forest.

**Better species availability** – Typically there are more species available in bare root stock than in balled and burlapped or containerized stock. This allows for more diversity in your urban forest, reducing your vulnerability to pest and insect threats.

### BEFORE

*bare root stock*



Balsam Poplar



Red Maple

### AFTER

*14 weeks*



Balsam Poplar



Red Maple



*Volunteer Planting in Rochester, MN*

*Photo courtesy: Jacob Ryg*

**Volume discounts** – When buying bare root stock for the GB, you are typically buying trees in high quantities. Often, this offers an opportunity to receive a discounted price.

**Recover pot-bound trees** – A GB can be used to recover trees with pot-bound or substandard root systems. Trees with these issues can often be bought at a reduced price. The root system can then be recovered in the GB and planted out in better condition.

**The rooting structure is visible** – Stem girdling roots are proving to be a significant problem with transplanted balled and burlapped and containerized trees. This is due to the difficulty and time needed to inspect the root systems for encircling roots on these stock types. Planting bare root stock allows you to easily examine the root system before installation, as well as identify the first main lateral root, assuring correct planting depth.

### Sizing your Gravel Bed

How many trees will you plant per year? What stem caliper of trees will you plant? After answering those questions, you can use the table to the right (Table 1.) to determine what size GB will meet your needs. Example: to plant 50 trees that will average 1.5”-2” in stem caliper, a bed measuring at least 10’x20’ will be needed.

		Stem Diameter				
		0.5”-1”	1”-1.5”	1.5”-2”	2”-2.5”	2.5”-3”
Gravel Bed Size	Number of Trees					
	10’x20’	56	36	25	16	11
	10’x30’	113	72	50	32	22
	10x40’	169	108	75	48	33
	10x50’	226	144	100	64	44
	10x60’	282	181	125	80	56
Stem to Stem Spacing		16”	20”	24”	30”	36”

Table 1. Sizing of gravel bed.

### Picking a site to build a Gravel Bed

**Accessibility** – Irrigation is an essential component of the GB. Easy and continuous access to water is a priority when deciding where to place the bed. Ability to drive close to the bed with a machine or vehicle should also be taken into account.

**Drainage** – Do not choose a low lying area or a site that regularly has standing water after rainfall. Root growth will be inhibited by insufficient drainage. Keep in mind, the majority of the drainage does not take place vertically (through the soil), it takes place horizontally out of the bed. Knowing this, it does not matter if it is placed on an impervious surface, as long as water does not pool and it can drain out of the bed.

**Light and wind exposure** – Light exposure is not crucial to the success of the GB. Shady sites have been used with no problems. Placing the bed on a site with high wind exposure can lead to uprooted trees in the GB. Sites with high wind and sun exposure will require more watering than sites with less exposure.

**Vandalism** – If vandalism is a problem in your community, consider building it inside a fenced property or placing a fence around the GB.

**Alternative uses for area** – It is not recommended to place a GB on a piece of land that might have another better use. Consider what the land could be used for in the future. This may dictate what style of gravel bed you build.

**Visibility** – Placing the GB on a site that is highly visible to your community can be a good opportunity to educate community members and spark interest in volunteer efforts.

### Types of gravel

A gravel depth of at least 15” is needed throughout the bed. It is recommend to use 3/8” washed river gravel or 3/8” washed river gravel with 10% sand, some communities in Minnesota have used other media with great results. These mediums consist of:

- 3/8”washed river gravel
- Peastone and 10% fine sand
- Peastone and 10-30% TurfaceR
- “B” stone (3/4” washed gravel) with 20% fine sand

Adding sand or Turface<sup>R</sup> will increase moisture holding capacity and reduce the amount of watering needed, but may not be best for all species of nursery stock.

### Building materials

Required materials depend on the style of GB you plan on building. Do whatever is the most cost effective and works best for your community. If you desire a strictly utilitarian or temporary GB, consider just using a pile of gravel contained by some sort of barrier (such as “Jersey” barriers found in road construction Figure 2.). If you want to display the GB to your community, you might want to build it out of treated lumber and construct a sign stating its value to the community. Consider asking for donations of lumber or gravel from local businesses. Be creative. A GB can be constructed on a very modest budget.

### Styles of Gravel Bed

#### Building a traditional gravel bed with treated lumber

(Figure 1.) This is a GB with all sides built of treated lumber and 4”x4” posts buried in the ground. Below is a materials list for this style (Table 2.).



Figure 1. This community gravel bed is 32’x16’ is located in Hendricks, MN. It was constructed in 2010 at a community park. It is made of treated lumber and is irrigated with a soaker hose.

Gravel Bed Size	2’x10’ Pressure Treated Quantity-Length	4”x4” Pressure Treated Quantity-Length	3” Galvanized Lag Screws	Geotextile Fabric	Pea Stone (cubic yard)
10’x10’	8-10’	2-10’ 1-8’	48	210sf 70’ of 3’roll	5cy
10’x20’	12-10’	4-10’	72	360sf 120’ of 3’roll	9cy
10’x30’	16-10’	5-10’ 1-8’	96	510sf 170’ of 3’roll	14cy
10’x40’	20-10’	6-10’ 1-8’	120	660sf 220’ of 3’roll	19cy
10’x50’	24-10’	8-10’	144	810sf 270’ of 3’roll	23cy

Table 2. Materials list for traditional gravel bed with treated lumber.

**Building a gravel bed with portable barriers (Figure 2.&3.)** If you have a site you might want to repurpose in the future or want a strictly utilitarian GB, this may be a good choice for you.

Figure 2 (right). This is a 70'x 50' community gravel bed located in Rochester, MN. It is built on asphalt located at the Olmsted Country Fair Grounds. It has gravel about 30" deep contained by "Jersey barriers" and is irrigated with spray heads mounted on tripods. The gravel bed has been in use since 2010.



Figure 3 (left). This community gravel bed is located in Bemidji, MN. It was made of concrete blocks in 2011 and has one open side for machine access.

Figure 4 (below). This is a 20'x50' community gravel bed located in Fargo, ND. It was constructed in 2006 out of concrete and slopes to a 4" drain on one side. As you can see, it is easily accessed with a front end loader.

**Building a permanent gravel bed out of concrete (Figure 4.)** This is one of the most expensive options, but offers a good opportunity to recycle water that drains through the gravel as well as protection from damage by machinery while installing/harvesting plants from the bed. It is essential to have adequate drainage with this system, if the bed holds water it can be fatal to trees and shrubs.



**A gravel bed without containment (Figure 5.)** If a lot of space and a machine to move the gravel is available, this can be the easiest way to start a gravel bed.

Figure 5 (left). This gravel bed is located at Jim Whiting's Nursery in Rochester, MN. It is 32,000sf and regularly holds 1,500 trees. They use a stationary spray head (SenningerR Mini-WobblerR) for irrigation. This gravel bed was built on soil and has been in operation since 1997.



## **Irrigation of Gravel Bed**

There are many options for GB irrigation. Make a decision based on what you already have and what is most user friendly for your situation.

**Irrigation timers (Figure 6.)** Setting your irrigation system on a timer is the easiest and most reliable way to assure your GB is being watered regularly. A home grade irrigation timer works well.

**Soaker hose (Figure 7.)** These offer easy installation and removal along with a lowered water usage due to minimal evaporation. Instances of rodent damage to soaker hoses have been reported in dryer months.

**Drip tape** While practical for nursery “row” style plantings, this option is generally not recommended for gravel bed use. This is due to its labor intensive setup, short service time, and high vulnerability to animal damage.

**Stationary spray heads (Figure 8.&9.)** These require less water pressure than a soaker hose, but use more water due to higher evaporation. Placing the spray heads closer to the ground decreases water use compared to heads higher above the ground.

**Irrigation time** A good starting point for irrigation time is around 100 minutes of irrigation per day. Most home grade irrigation timers have 4-6 timing intervals you can set. This means you could do 4 intervals at 25 minutes, 5 intervals at 20 minute, and so on. It is recommended one interval during the night, one right before sun-up and the rest spread out through the daylight hours. These times are dependant on the flow rate of your system, along with the exposure of your gravel bed. Do not take these recommendations as law! Check the moisture of your bed and adjust accordingly.



Figure 6. Irrigation timers.



Figure 7. Wrap soaker hose through rows of trees, placing it close to tree stems.



Figure 8. Stationary spray head.



Figure 9. Stationary spray head.

## Monitoring moisture level

**Checking gravel moisture** The easiest and cheapest way to monitor gravel moisture is to check the gravel moisture level with your fingers. Typically if you stick your hand into the gravel up to your extended thumb and feel moisture (about 4" deep), the bed is being adequately watered.

**Indicator species** Certain species of plants can be used to help monitor the moisture level of the GB. Typically species that wilt and recover quickly make good indicator species. Species we have found work well are Catalpa and Potentilla. When these plants wilt, water the bed as soon as you can.

## Post options

**4"x4" pressure treated posts** For these posts auger a hole to bury each post in the ground. For stability half of the length of the post should be below ground. When backfilling make sure to tamp or compact the fill as you go, not only at ground level. Using 'Class 5' will make the post more stable. Spacing for 4"x4" posts are typically every 5'-6' with the splice (where the end of the 2"x10s" meet) of the 2"x10" walls falling on the center of the post.

**Heavy duty fence posts (Figure 10.)** Buy a post that has holes for lag bolts to go through for attachment to green treated 2"x10" walls. Simply drive the posts into the ground with a hand held post pounder, sledge hammer, or pneumatic post pounder. Spacing for fence posts are typically every 5'-6', with one post being in the middle and one on each end of the 2"x10" (3 posts per board length).

**Street sign posts** Your community may have old street sign posts available. Drive these into the ground and fasten them to the green treated 2"x10" with 2 hole conduit straps (4 per post). A pneumatic post pounder is needed for driving the posts into the ground. Spacing for sign posts are typically every 5'-6', with one post being in the middle and one on each end of the 2"x10" (3 posts per board length).

All post options should be buried at least 20" in the ground.

## Laying out and leveling

The first step in building a gravel bed is laying out where each post is going. Small flags or construction paint are useful for this. Measure out where each corner post will be and mark with a flag. See Appendix B. for instructions on squaring the bed. After the corners are laid out, mark or flag where each post will be located. You can get a general idea of how level the ground is by driving two stakes in the ground in two corners of the bed and running a tight construction line (string) from one stake to the other. Either attach a line level or hold a hand level up to the construction line and adjust the line on one stake until it is level. You can now measure from the line to the ground to get an idea if cutting or filling is needed.

**Geotextile fabric/weed barrier** The purpose of lining the GB with this is for ease of clean up in the future. It keeps the gravel from being compacted into the soil. Line the bottom and sides of the bed with the barrier if desired. Never use plastic as a substitute. It will not allow for proper drainage and can encourage rot of the structure.



Figure 10. This GB in Morris, MN uses fence posts, lag screws, and angle irons in the corners.

## Selecting bare root trees and shrubs

Before deciding what species, sizes, and quantities to order from the nursery, ask yourself the following 9 questions:

**1. What are the recommended trees and shrubs for my area of the state?**

Refer to-“Recommended trees: an ecosystem approach” [www.extension.umn.edu/distribution/naturalresources/M1277.html](http://www.extension.umn.edu/distribution/naturalresources/M1277.html) and “Tough Trees and Shrubs for Tough Sites” [www.extension.umn.edu/distribution/naturalresources/dd7502.html](http://www.extension.umn.edu/distribution/naturalresources/dd7502.html)

Also located in “All You need To Know About Community Gravel Beds: Appendices” PDF available at [trees.umn.edu/products](http://trees.umn.edu/products)

**2. What trees and shrubs do well in the gravel bed?**

We have composed a list of species performance in the gravel bed. See Appendix A.

**3. How many trees does my gravel bed hold?**

Refer to Table 1.

**4. How many newly planted trees and shrubs can I maintain at once?**

Dependant on available employees or volunteers during the summer months to water trees.

**5. Is there an opportunity to plant new trees and shrubs (new construction sites, parks, boulevards, etc.) and what species will work well on those sites?**

Take into consideration site conditions like height restrictions (utility lines), soil (wet or droughty), salt exposure...etc. “Recommended trees: an ecosystem approach” as well as “Tough Trees and Shrubs for Tough Sites” (see above for access) can help with making species choices for certain sites.

**6. What size of stock should I order?**

We recommend bare root tree stock from 1”-2” in diameter, but a variety of sizes have been used with great success. Buy the size you want to plant out in fall as they will grow minimally above ground during the time in the GB.

**7. Would residents of my community be interested in a tree sale?**

Community tree sales are a good way to draw attention to your GB as well as giving you some control over species planted on private property.

**8. When should I install bare root stock in the gravel bed?**

After the ground thaws and when buds are supple, but before leaf-out. Bare root stock should typically be ordered from a nursery in late fall to early winter. Ordering early allows time for the order to be processed and delivered to the nursery by the following spring.

**9. What species would increase the diversity of my community’s urban forest?**

Stay away from species that are overplanted in your community. Plant trees that make-up a low percentage of your urban forest, or consider introducing new species. If you do not have a tree inventory for your community, in 2010 the Minn. Department of Natural Resources completed a Rapid Assessment Tree Inventory of most communities in Minnesota. This can give you an idea of the top species in your urban forest.

For access to this inventory contact the DNR Information Center at [info.dnr@state.mn.us](mailto:info.dnr@state.mn.us) to request a chart and table. Their number is 651-296-6157 or toll-free at 888-646-6367.



*A young community member doing her part.  
Photo courtesy: Jacob Ryg*

## *Importance of species diversity in an urban forest*

A high level of species diversity in your urban forest protects you from catastrophic tree loss after introduction of a new insect or disease. A general rule is the 10-20-30 rule. This means one species should make up no more than 10%, one genus should make up no more than 20%, and one family should make up no more than 30% of your total tree population. This rule is a recommended minimum, strive for higher diversity if possible.

## *ANSI Standards for bare root stock*

The performance of the bare root stock in the GB greatly depends on the quality of stock received. There are minimum standards all nurseries in America are required to meet when supplying nursery stock. These can be found in the American Standard for Nursery Stock (ANSI Z60.1-2004). Contracts with nurseries can be written with standards that exceed ANSI standards, such as Minn. Department of Agriculture has written in “INSPECTION AND CONTRACT ADMINISTRATION MANUAL FOR MnDOT LANDSCAPE PROJECTS, 2013 EDITION.” This manual can be found at [goo.gl/fbfxb](http://goo.gl/fbfxb) or [www.dot.state.mn.us/roadsides/vegetation/pdf/landscapeinspectionmanual.pdf](http://www.dot.state.mn.us/roadsides/vegetation/pdf/landscapeinspectionmanual.pdf)

### **1.5 Bare root specifications**

#### **1.5.1 Nursery grown – spread of roots**

**Definition:** Trees grown in the ground in the nursery without artificial root restriction devices, such as containers or fabric bags, under favorable growing conditions and which have received the proper cultural treatment to develop a well-branched root system. After harvest, the soil is removed from the roots.

**Table 5 – Caliper/height/root spread relationship – nursery grown bare root trees**

All bare root trees shall have a well-branched root system characteristic of the species. The following table represents the approved minimum root spread for nursery grown shade trees.

<b>Caliper</b>	<b>Average height range</b>	<b>Minimum root spread</b>
½ in.	5 to 6 ft.	12 in.
¾ in.	6 to 8 ft.	16 in.
1 in.	8 to 10 ft.	18 in.
1 ¼ in.	8 to 10 ft.	20 in.
1 ½ in.	10 to 12 ft.	22 in.
1 ¾ in.	10 to 12 ft.	24 in.
2 in.	12 to 14 ft.	28 in.
2 ½ in.	12 to 14 ft.	32 in.
3 in.	14 to 16 ft.	38 in.

The bare root specifications at right are taken directly from ANSI Z60.1-2004. There are many more standards bare root nursery stock are required to meet besides what is shown here. It is highly recommended that you look through these standards before accepting nursery stock. As a buyer you have the right to decline stock that does not meet standards outlined in ANSI Z60.1-2004 or standards specified in your contract with the nursery.

Source: American Standard for Nursery Stock (ANSI Z60.1-2004) Page 13.  
[www.anla.org/docs/About%20ANLA/Industry%20Resources/ANLAStandard2004.pdf](http://www.anla.org/docs/About%20ANLA/Industry%20Resources/ANLAStandard2004.pdf)

## Installing bare root stock in the Gravel Bed

Plan to install the bare root stock in the GB the same day it is delivered or picked up. If not, you can leave them overnight in a stock tank full of water, or in a dark cool place with wet straw or untreated burlap over the roots.

### There are two options for installing stock into the GB:

**1. With a shovel (Figure 11.)** With the bed full of gravel, dig a trench down to ground level. Hold the trees in place and backfill the gravel on the root system and around the stem. Mound the gravel around the stems to hold them in place. Make sure to thoroughly water the stock in the gravel bed after installation and assure the irrigation system is working properly. Roots need to be covered with about 4 inches of gravel for stable moisture content.



Figure 11 (above). Installing trees in gravel bed with shovel.



Rows of installed trees, Rochester, MN

Photo courtesy: Jacob Ryg

**2. With a machine (Figure 12)** If you have a machine with a bucket, start with a layer of gravel 2"-4" on the ground and the rest removed. Hold a row of trees upright and dump a bucket of gravel on the root systems. Dump enough gravel to hold the trees in place and move on to the next row. Make sure to thoroughly water the stock in the gravel bed after installation and assure the irrigation system is working properly. Roots need to be covered with about 4 inches of gravel for stable moisture content.

Monitor trees-The most important thing to monitor after tree installation is sufficient gravel moisture. Check the gravel bed regularly after installation and make adjustments to irrigation system as needed. As long as there is proper drainage in the bed, it is better to overwater than underwater.



Figure 12. Installing trees with a machine in Rochester, MN

Photo courtesy: Jacob Ryg



Keeping roots from drying out before installing in GB.

Photo courtesy: Jacob Ryg

## Removing bare root stock from gravel bed and planting

**When to harvest gravel bed stock** We recommend the trees spend 3-6 months (2-3 months at least) in the GB before transplanting into the soil to gain the maximum benefits of the GB. Depending on local temperatures and weather, September to early November is a good time to harvest and plant out GB stock.

**Handling bare root stock out of the gravel bed** Keeping the roots of the bare root stock from drying out is essential to tree survival. A stock tank full of water can be useful when removing the plants from the bed, otherwise spray them down with a hose when needed. Keep them out of the sun and wind as much as possible. Before transporting, cover the roots with straw, untreated burlap, or place them in a plastic bag and spray down with water. This provides a reasonable amount of time to get them in the ground.

## Planting bare root stock

Prune out dead or broken branches as well as encircling or broken roots.

Dig hole to proper depth (measure from 1st main lateral root to bottom of root system) and 2-3 times as wide as the root system. (Figure 13.)

Place tree in the hole and backfill the soil assuring soil is no more than 1" above 1st main lateral root.

Place a 2"-4" layer of mulch around tree keeping mulch from touching the tree's trunk. Think mulch donut, not volcano.

Staking of gravel bed trees is typically not needed.

Water with 5 gallons immediately after planting.

Continue to water tree as needed for next 2-3 years after transplant.

We highly recommend looking through a free USFS publication called "Tree Owner's Manual" which is a very concise manual for tree planting and maintenance. It is available online at [www.treeownersmanual.info](http://www.treeownersmanual.info) or in "All You Need To Know About Community Gravel Beds: Appendices" PDF Available at [trees.umn.edu/products](http://trees.umn.edu/products).



Volunteer tree planting in Rochester, MN

Photo courtesy: Jacob Ryg

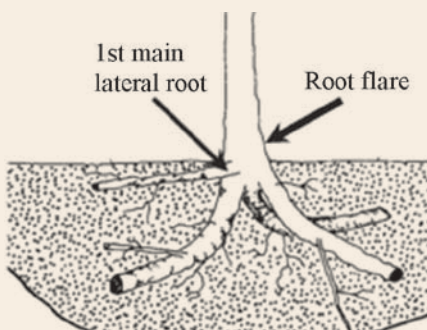
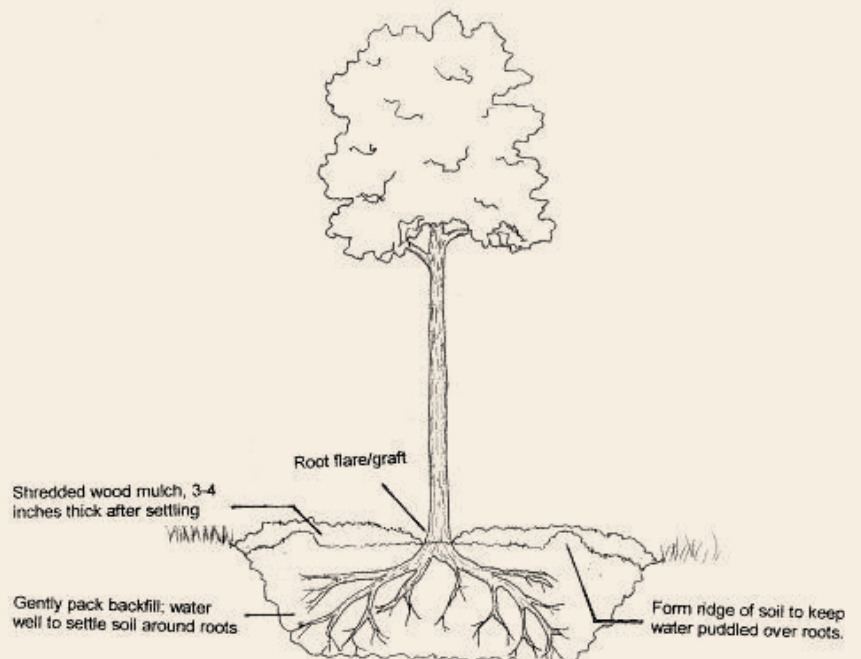


Image Credit: <http://hort.ufl.edu>

Figure 13. Image of a properly planted bare root tree.



## PERSONAL EXPERIENCES WITH COMMUNITY GRAVEL BEDS AROUND MINNESOTA

“The City of Duluth uses a gravel bed and it has really allowed us to get more trees for our money, since bare root trees are significantly cheaper. We have found that sometimes the weather conditions really do a number on the way the trees look (particularly their leaves...they almost look like they're half dead), but when you pull them out of the gravel bed in the fall, their roots look beautiful and all doubts about their condition are relieved. They do great in the ground after being planted, and the leaves look great the next season. Species that have worked for us are crabapples, Japanese tree lilacs, swamp white oak (but not other oaks), and some maple hybrids. We haven't tried anything else yet, but plan to try some elm hybrids, hackberry, and honeylocust this year.”

- Shawna MullenEardley, Urban Forestry GreenCorps Member, Duluth, MN.

“Our gravel bed has been an exciting addition to our city reforestation program. Every good city forester knows that planting bare root trees is vital to a cost effective way to get a sizeable number of trees planted within a city. Gravel beds are a way to make a very perishable (bare root) tree into something that can be planted with very little water and care – any time during the growing season. Labor is our most expensive budget time and when we can avoid many injuries associated with using heavy tree packaging methods – we come out ahead. Trees that come out of a gravel bed have excellent root systems that often give a small tree a more successful start on the landscape.”

- Jacob Ryg, City Forester, Rochester, MN

“The root development on bare root trees in the first season is amazing. They can end up getting as thick as a mop head. We have found roots as long as 3 feet long in a single growing season.”

- Jeff Haberman, Park Forester, Fargo, ND

“I think having the gravel bed has been great. Two main aspects...WOW do the roots grow. From when we place trees in the GB in the spring until we take them out, their roots have really grown to the point it is tough sometimes to get them out. Secondly, it has been a great talking point. Everybody asks what we are doing with the gravel bed and it really gets the conversation going about trees and plantings, etc...”

- David Blees, City Administrator, Hendricks, MN

“Utilizing the gravel bed system in our community has been a successful endeavor. We are now able to plant bare root trees throughout the growing season. This has resulted in reduced costs in materials and labor versus using all containerized trees.”

- Mike Bahe, Natural Resource Specialist, Hutchinson, MN.

“My experience with GBs has been all positive. The benefits for the trees is the greatest benefit, and it also plays into our hands in that it so inexpensive to build and offers such great flexibility in planting out the stock. I'm very impressed with how many roots they will grow in a short time. Gravelbed Nurseries just may be the answer to male-patterned baldness as well.”

- Daryl Brekke, Engineering Technician/Tree Inspector, City of Hibbing, MN

### **Bibliography**

Harris, J.R. (2002). *Transplant timing affects early root system regeneration of sugar maple and northern red oak. HortScience* , 37.6, 984-987.

# APPENDIX A.

## Minnesota Gravel Bed Recommendations

Urban Forestry & Horticulture Research Institute – University of Minnesota

Botanical Name	Common Name	Gravel Bed Suitability*	Transplant Success**	Best Transplant: Time of Year
<i>Acer platanoides</i> and varieties	Norway Maple	Good	Good	Summer; Autumn
<i>Acer rubrum</i>	Red Maple	Poor	Fair	Summer; Autumn
<i>Acer saccharinum</i>	Silver Maple	Good	Good	Summer; Autumn
<i>Acer saccharum</i>	Sugar Maple	Fair	Good	Summer; Autumn
<i>Aesculus glabra</i>	Ohio Buckeye	Fair	Fair	Summer; Autumn
<i>Alnus glutinosa</i>	European Alder	Excellent	Excellent	Summer; Autumn
<i>Alnus hirsuta</i> 'Harbin'	Prairie Horizon Alder	Excellent	Excellent	Summer; Autumn
<i>Amelanchier canadensis</i>	Juneberry	Fair	Good	Summer; Autumn
<i>Aronia melanocarpa</i>	Black Chokeberry	Excellent	Excellent	Summer; Autumn
<i>Betula nigra</i>	River Birch	Fair	Fair	Summer; Autumn
<i>Betula papyrifera</i>	Paper Birch	Good	Good	Summer; Autumn
<i>Betula papyrifera</i> 'Varen'	Prairie Dream Paper Birch	Good	Good	Summer; Autumn
<i>Betula platyphylla</i> 'VerDale'	Prairie Vision Asian White Birch	Good	Good	Summer; Autumn
<i>Betula populifolia</i> 'Whitespire'	Whitespire Birch	Good	Good	Summer; Autumn
<i>Celtis occidentalis</i>	Hackberry	Fair	Good	Summer; Autumn
<i>Cornus amomum</i>	Silky Dogwood	Excellent	Excellent	Summer; Autumn
<i>Cornus racemosa</i>	Grey Dogwood	Excellent	Excellent	Summer; Autumn
<i>Cornus racemosa</i> 'Jade'	Snow Mantle Grey Dogwood	Excellent	Excellent	Summer; Autumn
<i>Cornus sericea</i>	Redosier Dogwood	Excellent	Excellent	Summer; Autumn
<i>Corylus americana</i>	American Hazel	Excellent	Excellent	Summer; Autumn
<i>Crataegus mollis</i>	Downy Hawthorn	Poor	Poor	neither
<i>Crataegus phaenopyrum</i>	Washington Hawthorn	Poor	Poor	neither
<i>Gymnocladus dioicus</i>	Kentucky Coffeetree	Good	Good	Summer; Autumn
<i>Gymnocladus dioicus</i> 'Bravo'	Bravo Kentucky Coffeetree (male)	Good	Good	Summer; Autumn
<i>Juglans nigra</i>	Black Walnut	Good	Good	Summer; Autumn
<i>Larix laricina</i>	Tamarack	Excellent	Excellent	Summer; Autumn
<i>Maackia amurensis</i>	Amur Maackia	Good	Good	Summer; Autumn
<i>Maackia amurensis</i> 'Starburst'	Starburst Amur Maackia	Good	Good	Summer; Autumn
<i>Malus</i> spp.	Crabapple	Excellent	Excellent	Summer; Autumn
Botanical Name	Common Name	Gravel Bed Suitability*	Transplant Success**	Best Transplant: Time of Year
<i>Phellodendron amurense</i> 'His Majesty'	His Majesty Male Corktree	Fair	Fair	Summer; Autumn
<i>Phellodendron amurense</i> 'Macho'	Macho Male Corktree	Fair	Fair	Summer; Autumn
<i>Physocarpus opulifolius</i>	Common Ninebark	Excellent	Excellent	Summer; Autumn
<i>Picea abies</i>	Norway Spruce	Fair	Good	Summer; Autumn
<i>Picea glauca</i> var. <i>densata</i>	Black Hills Spruce	Good	Good	Summer; Autumn
<i>Pinus ponderosa</i>	Ponderosa Pine	Good	Good	Summer; Autumn
<i>Populus deltoides</i>	Cottonwood (male clone)	Good	Good	Summer; Autumn
<i>Prunus americana</i>	American Plum	Good	Good	Summer; Autumn
<i>Prunus maackii</i>	Amur Chokecherry	Excellent	Excellent	Summer; Autumn
<i>Prunus serotina</i>	Black Cherry	Good	Good	Summer; Autumn
<i>Pyrus ussuriensis</i>	Ussurian Pear	Good	Excellent	Summer; Autumn
<i>Quercus alba</i>	White Oak	Poor	Poor	Neither



Botanical Name	Common Name	Gravel Bed Suitability*	Transplant Success**	Best Transplant: Time of Year
<i>Quercus macrocarpa</i>	Bur Oak	Poor	Poor	Neither
<i>Quercus rubra</i>	Red Oak	Poor	Poor	Neither
<i>Rhus typhina</i>	Staghorn Sumac	Excellent	Poor/Excellent	Summer; Autumn
<i>Salix amygdaloides</i>	Peach-Leaf Willow	Good	Good	Summer; Autumn
<i>Sorbus spp.</i>	Mountain Ash	Good	Good	Summer; Autumn
<i>Syringa pekinensis</i> 'SunDak'	Copper Curly Tree Lilac	Good	Excellent	summer; Autumn
<i>Syringa reticulata</i>	Japanese Tree Lilac	Excellent	Excellent	Summer; Autumn
<i>Syringa vulgaris</i>	Common Lilac	Excellent	Excellent	Summer; Autumn
<i>Thuja occidentalis</i>	Northern White Cedar	Excellent	Excellent	Summer; Autumn
<i>Tilia americana</i> ('Boulevard,' 'Redmond')	American Linden	Good	Good	Summer; Autumn
<i>Tilia cordata</i>	Littleleaf Linden	Fair	Fair	Summer; Autumn
<i>Ulmus americana</i> 'American Liberty'	American Liberty American Elm	Good	Good	Summer; Autumn
<i>Ulmus americana</i> 'New Horizon'	New Horizon American Elm	Excellent	Excellent	Summer; Autumn
<i>Ulmus americana</i> 'St. Croix'	St. Croix American Elm	Good	Good	Summer; Autumn
Botanical Name	Common Name	Gravel Bed Suitability*	Transplant Success**	Best Transplant: Time of Year
<i>Ulmus americana</i> 'Prairie Expedition'	Prairie Expedition American Elm	Excellent	Excellent	Summer; Autumn
<i>Ulmus americana</i> 'Princeton'	Princeton American Elm	Excellent	Excellent	Summer; Autumn
<i>Ulmus americana</i> 'Valley Forge'	Valley Forge American Elm	Good	Good	Summer; Autumn
<i>Ulmus davidiana</i> var. <i>japonica</i> 'Discovery'	Discovery Elm	Excellent	Excellent	Summer; Autumn
<i>Viburnum dentatum</i>	Arrowwood Viburnum	Excellent	Excellent	Summer; Autumn
<i>Viburnum lentago</i>	Nannyberry	Excellent	Excellent	Summer; Autumn
<i>Viburnum trilobum</i>	American Cranberrybush Viburnum	Excellent	Excellent	Summer; Autumn

\*Definition of Gravel Bed Suitability: High survival rate in GB, develops more fibrous root system, and has a greater survival rate when transplanted.

\*\*Definition of Transplant Success: Has higher survival rate due to more fibrous roots system and the ability to plant later in the growing season

Excellent=Shows excellent improvement over typical stock types

Good=Shows good improvement over typical stock types

Fair=Shows little improvement over typical stock types

Poor=Condition declines in GB

This list of species performance is based on research done by the Forest Resources-Urban Forestry Department at the University of Minnesota. If a species is not on this list, it does not mean it will not perform well in the Community Gravel Bed. 82% of species we have studied in the GB have resulted in having either a Good or Excellent Transplant Success, with only 8% of studied species having a Poor Transplant Success.

If you try species not on this list, we recommend buying only a few the first year to test their suitability. We would be very interested to hear your results with new species, as well as species on this list. If you have results you want to share please send them to Gary Johnson [johns054@umn.edu](mailto:johns054@umn.edu) at the University of Minnesota.

## A Breakdown of the GB Species Performance List

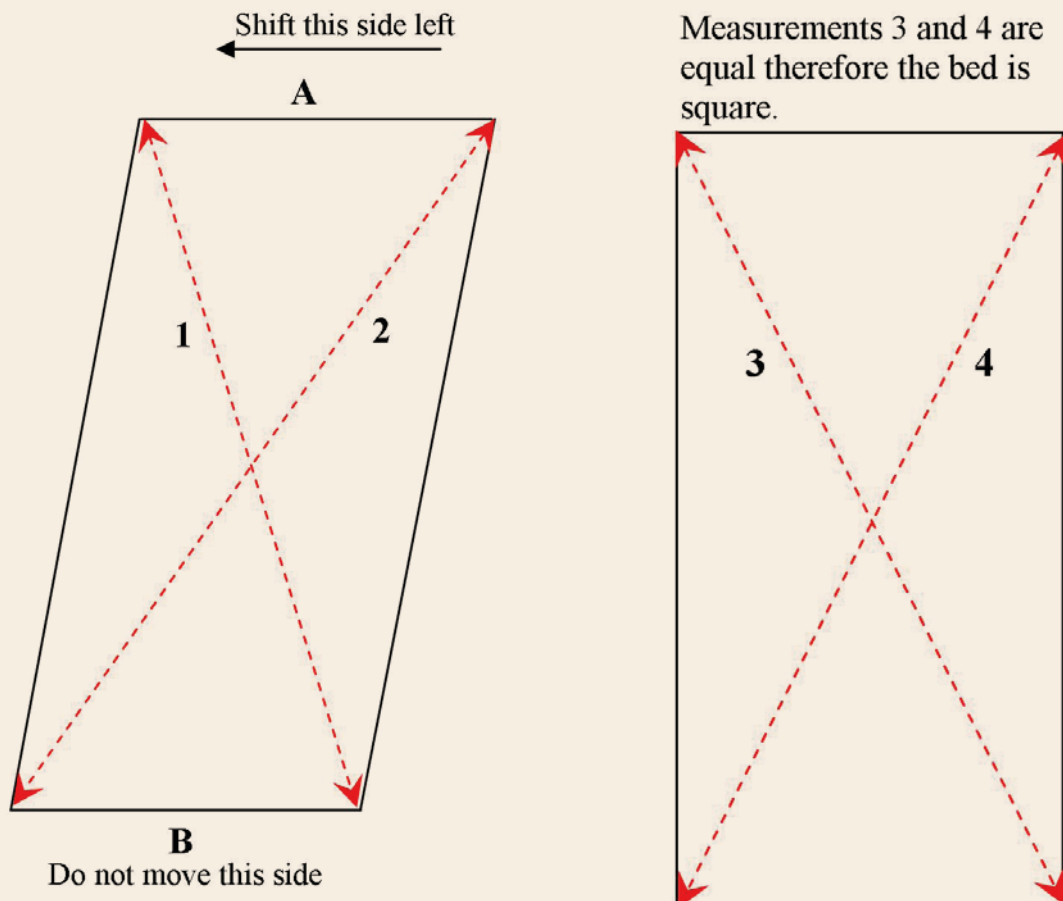
	GB Suitability (#species/rating)	Transplant Success (#species/rating)	GB Suitability (%/rating)	Transplant Success (%/rating)
Excellent	23	25	37%	40%
Good	24	26	3%	42%
Fair	9	6	15%	10%
Poor	6	5	10%	8%
<b>Total</b>	<b>62</b>	<b>62</b>	<b>100%</b>	<b>100%</b>

The table above is based on the provided list “Minnesota Gravel Bed Recommendations.”

## APPENDIX B.

### Squaring the Gravel Bed

After your corner flags are set in approximate locations, take a measurement from each corner of one side to the opposite corners of the other side (as shown below). If these measurements are the same, your bed is square. If they are not, adjust one side (A) by moving it parallel to the opposite side (B). In the case below, measurement 2 is longer than measurement 1. By shifting side A left and leaving side B in place, measurement 2 decreases in length and measurement 1 increases in length. Adjust one side (A) until the measurements are the same.



## APPENDIX C.

### Community Contacts

The contacts listed below are professionals who have first hand experience with the Community Gravel Bed and have agreed to share their experience:

Name	Title	Email	Phone
Daryl Brekke	Engineering Technician II City of Hibbing, MN	daryl@ci.hibbing.mn.us	218-262-3486, ext. 723
Jacob Ryg	City Forester City of Rochester, MN	jryg@rochestermn.gov	507-328-2515
Paige Scarborough	MN GreenCorps Urban Forestry	scarb015@morris.umn.edu	320-766-6295
Sam Kezar	Owner, Aspen Arboriculture Solutions, LLC	sam@aspenarbo.com	218-289-4862
Mike Babe	Natural Resource Specialist City of Hutchinson, MN	mbabe@ci.hutchinson.mn.us	320-234-4475
Shawna MullenEardley	Urban Forestry GreenCorps Member		218-730-4311
Jeff Haberman	Forester City of Fargo	jhaberman@fargoparks.com	

### Minnesota Nurseries That Supply Bare Root Stock:

The list below displays some of the bare root stock suppliers in Minnesota (based on an internet search of “bare root nursery MN”). This is not a complete list of suppliers in Minnesota, nor do we endorse any of the suppliers listed below. This is simply an aid to find and compare bare root suppliers in your area.

Name	Address	Phone	Email	Website
B&J Evergreen	12946 47th Street Clear Lake, MN 55319	320-743-2255	trent@bjevergreen.com	www.bjevergreen.com/
Bailey Nurseries	1325 Bailey Road St. Paul, MN 55119	800-829-8898	plants@baileynurseries.com	www.baileynurseries.com/
Branch Landscape Nursery	7185 372nd St. North Branch, MN 55056	651-674-7698	eric@branchland.com	www.branchland.com/
Cross Nurseries Inc.	22953 Highview Ave Lakeville, MN 55044	952-469-2414	crossnurseries@frontier-net.net	www.crossnurseries.com/
Jim Whiting Nursery and Garden Center	3430 19th St NW Roch- ester, MN 55906	507-289-3741	chris@jimwhitingnurs- ery.com	www.cheapbareroot.com/
Kahnke Brothers Tree Farm	10603 Boone Road Plato, MN 55370	320-238-2572	conniek@kahnkefarm.com	www.kahnkefarm.com/
Nelson Nursery Inc. Garden Center	25834 Main Street Zim- merman, MN 55398	763-856-2441	garden@nelsonnursery.com	www.nelsonnursery.com/
Prairie Moon Nursery	32115 Prairie Lane Winona, MN 55987	507-452-1362	info@prairiemoon.com	www.prairiemoon.com/
Schumachers Nursery and Berry Farm Inc.	37806 910th St. Heron Lake, MN 56137	507-793-2288	berry01@centurytel.net	www.schumachersnursery.com/
Stockmen's Greenhouse and Landscaping	60973 US Highway 12 Litchfield, MN 55355	320-693-7787	stockmen@hutchtel.net	stockmensgreenhouse.com/

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# ALL YOU NEED TO KNOW ABOUT COMMUNITY GRAVEL BEDS



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*University of Minnesota, Department of Forest Resources, 2013*