Raised Bed Gardening

How to Build a Raised Garden Bed - Plans & Examples Using Wood, Stone, Block & Other Materials

Taylor Birch

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Chapter I: Introduction

Section 1: What is a Raised Bed?

The simplest definition of a raised bed could be soil that is piled up above the ground level, but that level above the ground could be only about a foot. With an angle of repose of 30° - 45°, dry soil can be piled up 1.2 - 2.0 feet high in the center of a four foot wide bed, but there would be no additional soil depth at the edge of the bed. Figure 1 shows dry soil piled on top of the ground at a 30° angle without containment.

When the soil is wet, it will slump down and spread outside of the bed area. So, to add more than a few inches of compost or soil above the surrounding ground level, it must be contained to keep it from spreading out.

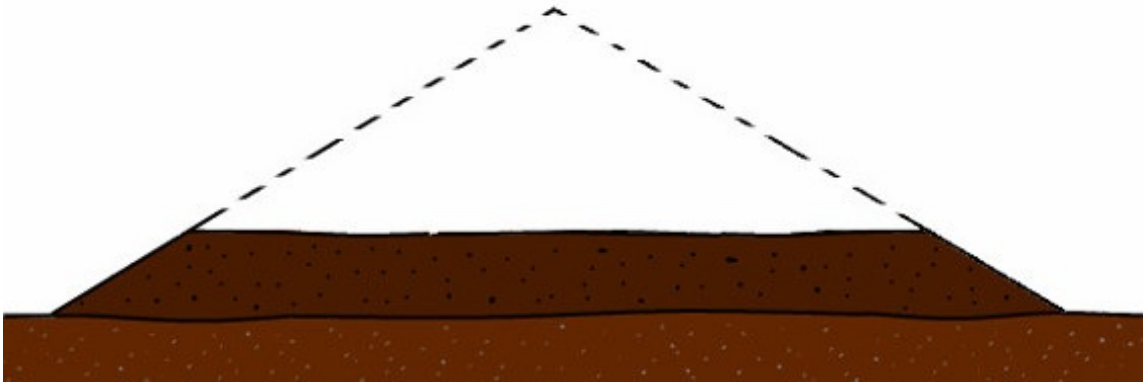

Figure 1. Example of Soil Piled up at 30° Angle on top of the Ground.

Gardens have been grown for years without raised beds, so why go to all the trouble? Because there are many advantages of raised beds over traditional gardening.

Section 2: Advantages of Raised Bed Gardening

There are several real advantages of gardening in raised beds. Part of the appeal is to create an ordered look to the garden. Part of the advantages are creating ideal conditions for plants so they can be intensively managed to produce high yields in relatively small areas. The most appealing part to me is that it makes gardening easier. Raised beds also offer the ability to grow food or flowers in areas that would otherwise be unsuitable.

1. **Improves Conditions For Plants**

- Increases Soil Depth
- Improves Soil Aeration
- Improves Soil Quality
- Prevents Soil from Compacting
- Longer Growing Season
- Higher Yields
- Bed Frames Support Trellises, Cold Frames, Covers and Irrigation

- **Less Work and Easier Access for the Gardener**
  - Reduces Maintenance
  - Can Work in Garden without Getting Dirty
  - Access for Physically Impaired
  - Bunnies Can't Jump

- **Ability to Garden on Unsuitable Sites**
  - Can Grow on Sites without Soil
  - Can Grow on Sites that are too Steep
  - Can Grow where Concerned about Soil Contamination

- **Saves Water**
  - Water only the Beds, Not the Pathways
  - Deep, Compost Soil Holds Moisture

Improves Conditions For Plants

There are many different environmental factors that determine how well plants grow, but we can have the most positive effects on plants by improving the soil and controlling moisture. The construction of a raised bed automatically allows for deeper soils and for better drainage of wet soils. Soil aeration is improved as wet soils are drained. In Spring, the soil in a raised bed will warm faster than soil at or below ground level, so the growing season is slightly longer.

But just because soil is deeper and better drained does not automatically improve soil quality or improve yields. For this, we need to take the next step.

My Grandfather used to say "don't plant a $5 plant in a 50 cent hole". What he meant, was why spend $5 on a plant and then just stick it in the ground with little or now preparation for the plant's success. Same is true with raised bed gardening. Just because we build a raised bed doesn't automatically mean that we will have more vegetables than we know what do with.

To really improve the soil, we really need to use the Double Dig Method (see Soil Preparation). That means to dig down the depth of two shovels, or about two feet and mix peat moss and/or compost into the native soil. This will create light and well aerated soils with lots of natural nutrients.

Increases Soil Depth - Deep fertile soil that is not compacted is partially achieved by building a frame or wall to raise the soil above ground level. This is further achieved by digging down to improve the soil at least two feet deep.

Drains Soil - As long as the raised beds are not water tight, excess water will drain away, at least down to the ground level.

I'm sure you have heard the phrase "Plant as soon as soil is workable", but what does it mean? This is about the condition of the soil and not about a date on the calendar. The soil is beginning to warm and is not too wet. It is easy to turn over with a trowel or shovel and does not form clumps.

To test the soil, grab a handful of soil and squeeze it. If it crumbles, it's ready to work. If it sticks together in a ball, it is too wet and/or you have too much clay. Sandy soil and soil with lots of compost will always be ready to work before clay soils.

Allowing the soil to drain in the Spring allows the soil to be worked earlier. Adding compost, peat moss or even sand to clay soils also helps the soil to be worked earlier.

Note: Draining Soil is a double-edged sword. If a raised bed helps dry the soil in the Spring, it will also dry the soil during the Summer when you don't need it to

be so dry. In climates that gets plenty of rain, this will not be a big problem. Where I live, we get only 13-15 inches of rainfall per year, so it is a problem. I have to irrigate everything if I want to grow anything besides sagebrush. I like the idea of building raised beds two feet deep, so soil can be kept deep and aerated without having to dig so far down into the ground, but it would take too much water to keep the beds watered during July and August. So my raised beds are at most, 12 inches above ground which seems to be a good balance for my climate.

Improves Soil Quality - The soil is improved because the raised bed creates vertical space to add compost and other organic matter to the garden soil. Decomposition can occur most quickly in soils that are both moist and aerated.

Prevents Soil from Compacting - Part of soil quality is maintaining the light, deep aerated soils. So walking in the raised bed is a no no. Keeping beds to 4 foot or less will allow reaching to any place in the bed without stepping into it.

I have some beds that are wider than 4 feet. I either have a walkway down the center (8x10 bed) or I place stepping stones or boards so we never have to step directly onto the soil.

Walking on compacted soil is not a big deal because the soil is already compacted. If you walk on freshly dug soil that is two feet deep with lots of organic matter, your footprint may sink 4 or 5 inches. If you stepped beside a plant that was growing in that soil, a 4 or 5 inch indention may break all the roots off one side of that plant.

Longer Growing Season - Beds allow soil to be worked earlier in the season and the soil starts warming earlier in the raised bed than the soil at ground level.

Higher Yields because of better, deeper soil provides plants with loose, deep, well drained, well aerated soil - Higher yields per square foot is also because we can intensively manage small raised beds.

A farmer that plants a crop in a 500 acre field plows it to disrupt weeds and to create light aerated soil, but he plows it with a 10 ton tractor which also compacts the soil. When the crop is growing, he can only check a small sample of the crop to check for moisture, proper growth, insects or ripeness.

In small raised beds, deep aerated soils are easier to maintain. Nearly every plant can be checked at least on a weekly basis for moisture, proper growth, insects or ripeness. Any problems can be quickly spotted and corrected. The entire bed can easily be watered or just one or two plants that need water. A single pest can be smashed or a single leaf with aphids can be dipped in soapy water before the infestation has a chance to spread. If you determine that a pesticide needs to be

used, you decide how much is used and which plants need it.

Bed Frames Support Trellises, Cold frames, Covers and Irrigation - A wooden bed frame makes a ready foundation to attach trellises, supports or covers over the raised bed. I also like to attach drip line in straight rows on the inside of the bed frames with staples.

- Trellis
- Tomato Supports
- Support Bird netting
- Support for Fabric or Plastic Sheeting
- Irrigation Drip Line

Less Work and Easier Access for the Gardener

Reduces Maintenance - The physical border of the raised bed prevents weed and grass roots from creeping into the bed. The deep, loose soil makes pulling weeds simple and does not usually require digging tools. If the beds are narrow, planting, weeding and harvesting can be done within reach of the path.

Pulling weeds from light, aerated soil is not comparable to pulling weeds from compacted soil. In hard soil, chances are you will have to dig the weed up or you risk breaking the plant off, leaving the root behind to grow again. In light soil, the entire weed can simply be pulled out of the ground. Since it is not a chore, you will find that you are pulling a few small weeds when you find them instead of making plans to pull weeds or hoe the rows for several hours on your next day off. In fact, I don't even own a hoe.

Can Work in Garden without Getting Dirty - With most traditional row gardens, when you go out to plant, weed or harvest, you change clothes, especially your shoes, because you know you are going to get dirty. Now don't get me wrong, you can get dirty when turning over the soil in a raised bed. But for the most part, you can stand outside the raised bed to perform most gardening tasks without stepping onto the soil.

Remember, part of the purpose of the raised bed is to keep you from stepping on the soil. If you must step into the bed, place a board or stepping stone, so you step in the same place every time. This will keep the soil from compacting longer.

Access for Physically Impaired raised beds can reduce stooping and bending and can be built to match the comfortable height for someone in a wheel chair or someone that uses a walker.

Bunnies Can't Jump - I had to add this one. I read an online discussion about raised bed gardening. One person, new to gardening, did not have much success the previous season because rabbits kept eating her plants. Someone suggested they build a raised bed high enough to put it out of reach of the rabbits. They built a bed that appeared to be about 2 feet above ground level (Figure 12) and claimed the raised bed solved all the problems caused by rabbits, because "bunnies can't actually jump".

Rabbits can jump. I have seen them do it, so I call that pure nonsense, but perhaps rabbits don't like to jump up into a raised bed where they can't see the landing spot.

It seems to me that fencing or small cages would be a cheaper solution to stopping rabbits in a small garden bed, but I don't have rabbits where I live now, so I can't test either method. I would like to hear from anyone else that has successfully eliminated rabbit problems with raised beds instead of fencing.

Ability to Garden on Unsuitable Sites

Can Grow on Sites without Soil - In cities, raised beds can be used used on concrete, asphalt, extremely compacted areas or even roof tops. Raised beds can also be placed on extremely rocky or sandy areas that otherwise would be impossible to plant a garden.

Can Grow on Sites that are too Steep - Steep slopes are not suitable for traditional row gardening, but raised beds built like terraces can create suitable areas to plant.

Concerns about Soil Contamination - Just as raised beds can be used on concrete areas or roof tops in cities, anyone that is concerned about soil contamination can still use the area to grow vegetables. Raised beds can be used to hold clean soil and a pond liner could be used to make sure the plant roots don't penetrate down into the contaminated soil or prevent the contamination from mixing with the clean soil.

Section 3: Raised Bed Building Materials

Once we decide to build a raised bed, the next step is to decide what material to use.

Considerations for Raised Bed Building Materials

- **Functional and/or Visually Appealing**
- **Cost of Materials**
- **Life Span of Material**
- **Hold soil only and/or provide place to sit or walk**
- **Organic Requirements**
- **Does the material leach chemicals or change the pH?**

Functional and/or Visually Appealing - I think my simple wooden and stacked stone raised beds look nice, but the beds are primarily built to be inexpensive and functional. The planting areas are confined by the frames or stones and the pathways are lined with landscape fabric and crushed stone to keep unwanted weeds and grass out and to provide wide walkways that are clean, relatively level and dry.

We have all seen amazing stone landscaping and raised beds designed not only to look very nice, but also to be functional and that will last for many years.

Cost of Materials - Few of us grow tomatoes at home to save money. We can not compete with the ag-industry for price per pound. We do it because the ag-industry can not provide the same fresh home-grown taste and quality. I joke with friends and family about spending hundreds of dollars per pound just to have home-grown tomatoes, but that is a huge exaggeration. Truth is, it makes more sense to me to spend a little money, time and effort on something I can eat instead of mowing grass.

If time, space and money were no object, most of us would have skilled stone masons build beautiful stone "seat-walled" raised beds. But most of us are not likely to spend thousands of dollars for a stone raised bed when an untreated lumber raised bed can be built for less than $50.

If we think of the cost of building raised beds in terms of the square foot cost of building a wall, the square foot cost of common building materials shows that untreated dimensional lumber is least expensive (Table 1). The cost to build a wall with concrete block is almost twice as much. Railroad ties cost more than concrete block, especially if the seven inch side is used as the wall instead of the

nine inch side. The cost of pressure treated lumber is twice as much as untreated lumber. Garden block is a nice looking option, but cost about three times as much as untreated lumber.

Table 1. Common Building Materials; Square Foot Cost to Build a Wall

Material	Description	Cost per Sq Foot
Untreated Lumber	2x8 x 8 ft	$1.48
	2x10 x 10 ft	$1.48
	2x10 x 12 ft	$1.49
	2x12 x 8 ft	$1.63
	2x12 x 10 ft	$1.66
	2x12 x 12 ft	$1.67
Concrete Block	8x8x16	$2.22
	8x4x16	$2.32
	8x6x16	$2.45
Rail Road Ties	9 inch	$2.50
	7 inch	$3.21
Treated Lumber	2x10 x 10 ft	$3.02
	2x12 x 12 ft	$3.11
Garden Block	4x12	$4.92
	6x16	$5.66

Life Span of Material - Untreated wood will probably last 10 years in my cold dry climate, but may not last but a few years in warm and wet climates like found in the Southern U.S. Pressure Treated Wood is supposed to last for 20 years. Used railroad ties have already been discarded but will last for many more years. Concrete blocks should last for a long time, but some are brittle and will easily break if they are not filled with soil or mortared in place. I have also seen some landscape or garden blocks that have totally deteriorated from freezing and thawing in about 10 years.

Hold soil only and/or provide place to sit or walk - A new trend in landscaping is the Seat Wall. Why not build a raised bed that looks and sits like a seat wall? A typical 2x12 board does a good job of holding soil inside the raised bed, but on edge, a single board makes a poor seat. Additional lumber could be attached to the tops of the raised bed to create a better seat. Most true seat walls are made of stone, concrete or garden blocks.

Organic Requirements - Many people that start raised bed gardening do so with the idea of growing some of their own food that has little or no pesticides. If the garden is sprayed, they know what kind, how much spray was used and when it was last used. They may or may not buy into the whole "Organic" idea.

I am not going to get into all the details here, but I know it is possible to have Arsenic treated wood in contact with soil, food or animals and still be Certified Organic by the Federal Government. I like the idea of knowing where my food comes from and that it has not been poisoned and does not have additives I don't want. But since the Federal Government is in charge of the Organic Program, it works like everything else the Federal Government touches. I am not convinced we are getting what we pay for or have been led to believe.

If you are interested in following the Organic Program, you need to be aware that some building materials that could be used for raised beds may leach chemicals into the soil or water. For more information see USDA Organic Certification Program.

Does the Material Leach chemicals or affect soil pH? - Read my take on using pressure treated wood in the garden here: Chapter IV; Section 1.

- The pressure treated wood available at most building supply stores will leach copper into the soil. Copper is not a big deal in soil and not a big problem to people, but it is a big problem in aquatic systems.
- Wood treated with Arsenic is still available for agricultural purposes leaches arsenic into the soil.

- Soil in contact with concrete will have elevated pH because of the lime in the concrete. This is good for some plants, but is not good for plants that prefer low pH.
- Metal materials can leach metals into the soil especially at pH 5.5 or lower - fortunately, most plants prefer pH above 5.5.

Raised Bed Building Materials

I have seen a variety of materials used to create raised beds. The following list includes those materials.

- Lumber - treated or untreated - some untreated wood like cedar and redwood are naturally rot resistant
- Landscape timbers
- Railroad ties (creosote)
- Rock or Stone; mortared or loose stacked
- Concrete blocks; mortared or stacked
- Bricks; mortared or stacked
- Formed concrete
- Corrugated metal and culverts
- Corrugated fiberglass
- Old tires
- Other Repurposed Materials

Section 4: Wood; Raised Bed Examples and Ideas

The following sections are photos or drawings of Wood, Stone, Brick, Concrete Block and other materials used to build raised beds. Figure 2 and Figure 3 are pictures of some of our raised beds built from untreated lumber.

The beds are level even though the land has a fair amount of slope. The untreated lumber of the raised beds are starting to show a little weathering, but they are still square and very sturdy. The wood had been exposed to the weather for four full years when these pictures were taken. The have changed little in the two years since then, so I expect they will last at least at least 10 years in my climate. Notice our A-frame PVC Greenhouse has been assembled in one of the raised beds.

Figure 2. Three of our 5x10 foot Raised Beds built from 2x12 Untreated Lumber.

Figure 3. Ground-level Photo of Same Raised Beds.

The peppers were transplant and then plastic sheeting was attached to the PVC frame with homemade PVC clamps.

Figure 4 is another of our raised beds under construction. The lower bed is 8x8 feet and the new upper bed is 4x8 feet with room for another 4x8 feet bed farther up the hill.

Also notice the railroad ties that are stabilizing the slope for the pathway above and to the right of the raised beds. Railroad ties can also be used for raised beds, but they are heavy for one person to move by themselves.

Figure 4. Stepped Raised Bed under construction (8x4 feet).

Figure 5 is an example of how to fasten double stacked beds together. Raised bed that are built using more than one layer of lumber, should use 4x4 corner posts. The corner posts provides extra wood to fasten the corners of the box, so the corners are stronger and it holds the stacked frames in place.

Figure 5. Double stacked Raised Bed Frame.

Figure 6. Raised Beds Built From Sawmill Slabs.

Slabs are the outside leftover cut from trees as a round tree is turned into lumber. Slabs are square on the inside and rounded on the bark side. Depending upon the type of wood, the bark may say on for years or it may fall off. Sometimes these slabs can be picked up at little or no charge from small scale saw mills.

Figure 7. Deep Custom Built Wood Raised Beds.

The frames appear to be built from thick (2-3 inch) lumber that is 12-18 inches above ground and are supported by what looks to be 6x6 posts. The pathway is wide enough for wheelbarrows and garden carts.

Figure 8. Example of Raised Bed Assembled from a Kit.

These kits are made of long lasting cedar boards and are connected by sliding mortises through slots that are held in place by pins. The stacked stones used in the landscaping in the background, could also be used for raised beds. These beds don't appear to be very level.

Figure 9. Nice Example of a Simple Double Layer Frame with a Decorative Edge on Top.

Edges can be put on box frames so they are more comfortable to sit on, but if you add this element, make sure the edge is sturdy enough to withstand a person's weight from walking or sitting.

Figure 10. An Example of Rough wood and Stakes to Build Raised Beds.

The soil in this bed does not appear to be very deep, but I suspect these beds have been in place a long time. The lettuce looks good, but the soil could probably benefit from being loosened by digging and the addition of new compost.

Figure 11. Long, Narrow Wooden Frame Raised Bed.

This bed is stacked 4 or 5 boards in height. Notice the posts (probably 4x4s) to support the corners and sides. In a very tall raised bed like this, it might be necessary to add cross pieces to prevent the weight of the soil from pushing out on the sides of the box, especially in the center.

Figure 12. Another Nice Little Raised Bed.

This bed looks to be about two feet deep. This was the raised bed that the person claimed kept rabbits from eating the plants. Notice the "pipes" in the corners. It looks like 4 inch PVC pipe has been used as corner supports and is attached to the wood with bolts.

Figure 13. An Example of an Elevated Planter.

Elevated planters could be used by people that can walk, but can not sit or stand back up easily. Elevated planters built for people in wheel chairs would need to have leg room so they could get up close to the planter.

Figure 14. The British Prime Minister's Raised Bed.

This raised bed is at 10 Downing Street in London. It is constructed of very thick lumber and appears to have some kind of plastic or rubber lip around the top. Notice the bed has been placed on concrete.

Figure 15. An Example of a Bed Frame with a Hot Box Attached.
Wood frames make good foundations for attaching trellises, supports and covers.

Figure 16. Wood Raised Bed with Decorative Posts and Caps.

These decorative post and caps are normally used on decks and fences, but is an example of how raised beds can be dressed up if that is your thing. This raised bed also has a top rail so it would be comfortable to sit on the edge.

Figure 17. An Example of a Raised Bed Built from Landscape Timbers.

Landscape timbers are usually 6-8 feet long and are only about 3inches thick. Landscape fabric would be good to keep soil from washing out between the cracks. These timbers are much smaller than old railroad ties, but they do not contain creosote, which is harmful to plants. Old railroad ties can be used, but make sure they are well weathered and are not "dripping" creosote. Be aware, that landscape timbers sometimes have a tendency to warp.

Section 5: Stone and Block; Raised Bed Examples and Ideas Our lot had so many stones we create raised beds with them, just to get them out of the way. Figure 18 is an example of a raised bed built from loosely stacked stone. The bed is on a steep slope with the upper side of the bed at ground level and the lower end of the bed has stones stacked up to about 20 inches to level the bed. The mass of stones provides enough weight to hold the soil and the soil is kept from washing between the stones with landscape fabric.

Figure 18. Stacked Stone Raised Bed.

Figure 19. A Simple Example of Loose Stones Stacked up to form a Raised Bed.

I have also seen broken concrete salvaged from a driveway that was replaced used in this manner. It stacked well because one side was flat and the other side was nearly flat. It is a good idea to use landscape fabric to prevent the soil from washing out between loose stacked the rocks.

Figure 20 is a simple, but nice looking example of loose stacked landscape block (or garden wall block) to build a nice little flower bed. These Blocks are about 12 inches wide and 4 inches thick and can easily be stacked up to build raised beds. If they are not mortared or stacked very close together, then landscape fabric would be helpful to keep the soil from washing though the cracks between the blocks.

Any time mortar is used to secure any type of block or brick, a good level foundation is necessary. It's no big deal if un-mortared block shifts or settles, but if if a poor foundation shifts, mortar will crack and it will be difficult to fix.

Figure 20. A Very Nice Little Raised Flower Bed.

Figure 21. A Very Nice Landscape Feature.

This landscape feature was created to provide a flat place on a sloping site, but it is a very nice example of how a raised bed could be built with landscaping blocks.

Figure 22. Very Nice Brick Work in a Formal Garden in Chelsey, England. If money is no object, the sky is the limit. Notice the drainage hole.

Figure 23. Brick or Landscape Blocks Border.

This is more of a border than a raised bed. Compost has been added, but the soil can not be piled up more than a few inches deep. I wonder how long this nice looking border would last if I stepped on or tripped over the brick.

Figure 24 and Figure 25 are examples raised beds built from stacked concrete blocks. The blocks in Figure 24 are typically 16 inches long, 4 inches thick and 8 inches wide and the diagram in Figure 25 is an example of 8x8x16 inch blocks.

Concrete blocks are heavy, so can hold our weight if we sit or step on the blocks without causing them to move. The bottom row needs to be level or the next row will not stack properly. The larger 16x8x8 inch blocks typically have large holes (not shown in diagram) which can be filled with soil to provide more weight, but these holes can also be planted.

When stacking or mortaring blocks, make sure to overlap the gaps between the blocks on the bottom row with the next row.

Figure 24. Example of Concrete Blocks used to Build a Raised Bed.

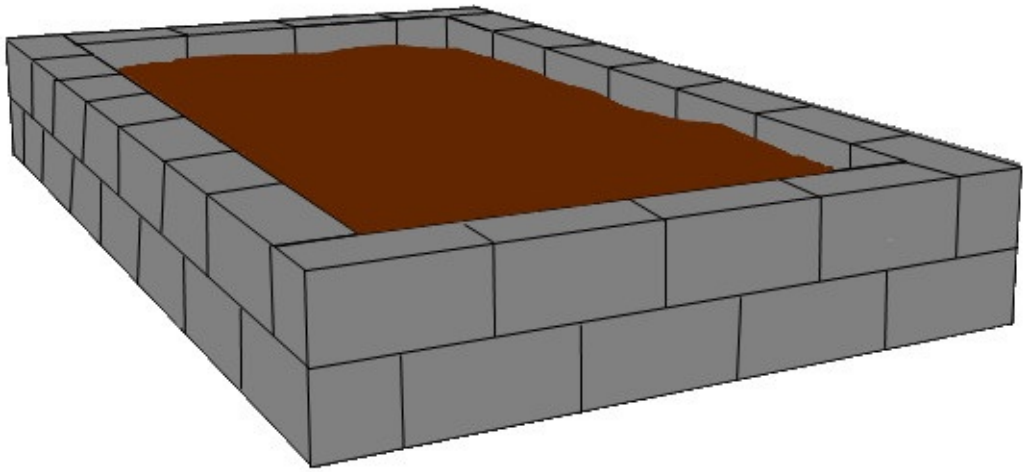

Figure 25. Another example of Concrete Block Pattern used to Build a Raised Bed.

Figure 26. A Unique Example of using Concrete Pavers for a Raised Bed.

Here is a guy that cares more about function than looks. These are 24 inch concrete pavers held together with 2x4s. I'm sure this raised bed will work very well, and it will look much better when the bed is full of healthy plants.

Section 6: Other Materials; Raised Bed Examples and Ideas

Figure 27. An Example of a Culvert Used as a Large Planter or Small Raised Bed.

The above photo appears to be a culvert used as an large planter. The edge of the container looks too sharp to be safely used in a playground.

Figure 28. A Salvaged Water Tank to be used to Create Raised Beds.

The soil depth from these rings would be good, but the beds will be very wide, so it would be impossible to work without stepping on the soil. Edges may also be sharp.

Figure 29 is another example of repurposing an item to be used as a large planter or a raised bed.

I have seen livestock water troughs used as large containers or raised beds before. They are a bit expensive, but look like they should work nicely.

Many people recommend that holes be drilled in the bottom so water can escape, but I think that would be a mistake in dry climates. Once holes are drilled, they can not be easily un-done. These troughs have drainage holes. I am sure with a little thought, we could come up with a better way to drain excess water and still have a reservoir of water in the bottom as with most indoor planters.

Note: If the soil pH is lower than 5.5, there may be some leaching of metals into the soil. Fortunately, most plants need soil pH above 5.5.

Figure 29. Livestock Watering Trough used as Planter or Small Raised Bed.

Figure 30. Another Example of Water Tank used for Raised Beds.

These raised beds are at a primary school in North Melbourne Australia. These tanks are used for both collecting water and for the raised beds. They look very nice, but I wonder about how sharp the edges are.

Figure 31 is another example of a re-purposed material to build a raised bed. I can't tell if the corrugated material is metal or fiberglass, but it appears to be connected with electrical ties (zip ties) to metal fence posts. If these are zip ties, they will not last long under this type of pressure. The material could be bolted or wired to the posts, but other than that, this raised bed should work well. This bed appears to be longer on the opposite side indicating the builder was making use of salvaged materials. You can already see foot prints in the bed since it is so wide, which defeats the purpose of a raised bed. Not the best looking raised bed, but it will look better when plants are growing in it.

Figure 31. An Example of a Corrugated Material (Metal or Fiberglass) used to form a Raised Bed.

Figure 32. Potatoes Sprouting from an Old Tire.

The tire is not visually appealing and it is not a raised bed, but a stack of tires could hold soil between them as well as hold soil inside the tires. If someone had access to a lot of tires, it is an idea. The trick would be making it look nice.

Chapter II: Raised Bed Construction

Section 1: Materials List for Raised Beds made with Dimensional Lumber

We moved into our house in the Spring of 2005. As typical for our area, there was no landscaping of any kind, just a graded lot with clay, large boulders and chunks of concrete from other construction projects. The yard was pure mud after the snow melted, then quickly turned into adobe brick and dust in our dry climate.

We started building raised beds in 2006 and now have 11 different raised beds made from un-treated dimensional lumber that totals about 650 square feet of garden space. We have an additional 12 raised beds made from stacked stones pulled from our lot which hold fruit trees, strawberries, vegetables and a variety of flower beds.

Table 2 and Table 3 below list the lumber needed to build rectangular raised beds of various sizes with minimal waste (left over).

Table 2. Lumber Needed for 2 and 3 foot Wide Raised Beds.

Bed Width (feet)	Bed Length (feet)	Total Square Feet	Number of Boards			Left Over (ft)
			8 ft	10 ft	12 ft	
2	2	4	1			0
2	4	8	2			4
2	6	12	1	1		2
2	8	16	3			4
2	10	20	1	2		4
2	12	24	1		2	4
3	3	9	2			4
3	4	12	2			2
3	5	15		2		4
3	6	18	1	1		0
3	8	24	3			2
3	10	30	2	1		0
3	12	36	1		2	2

Table 3. Lumber Needed for 4 - 12 foot Wide Raised Beds.

Bed Width (feet)	Bed Length (feet)	Total Square Feet	Number of Boards			Left Over (ft)
			8 ft	10 ft	12 ft	
4	4	16	2			0
4	6	24		1	1	2
4	8	32	3			0
4	10	40	1	2		0
4	12	48	1		2	0
5	5	25		2		0
5	10	50		3		0
6	6	36			2	0
6	8	48	4			4
6	10	60		2	1	0
6	12	72			3	0
8	8	64	4			0
8	10	80	2	2		0
8	12	96	2		2	0
10	10	100		4		0
10	12	120		2	2	0
12	12	144			4	0

The lumber represents the majority of the expense if building raised beds with lumber. the only other materials needed is screws or nails, but screws hold better and longer. For building bed frame with 2x lumber, I recommend using #10 exterior screws that are 3½ inches long.

Section 2: Raised Beds and Slope of Garden Site

The slope of your garden site is very important and determines the size, cost or effort required to build raised beds.

If the site is flat or if it slopes very little, you can build raised beds almost any length and width as long as you have room. If the slope is very steep, you will be limited to building small frames unless you move lots of dirt or build stair-stepped beds.

To measure slope over a short distance, you can use a carpenters level and a straight 8 or 10 foot board. A simple string and line level will measure slope over larger distances without having to buy or borrow a survey level.

Figure 33 shows an example of a raised bed built on a flat to mild slope. Mild being defined as the width of the lumber you plan to use is sufficient to level the bed.

If the rise (or drop) in the example is only 8 inches over a 10 foot length, 2 x 10 boards would be wide enough to create a level raised bed. If the rise of the site is only 6 inches over the 10 foot length, 2 x 8 boards would be wide enough to create a level bed, but if the rise is greater than the width of a 2 x 12 (11.25 inches), you will have to move some dirt, or build shorter raised beds (Figure 34 and Figure 35).

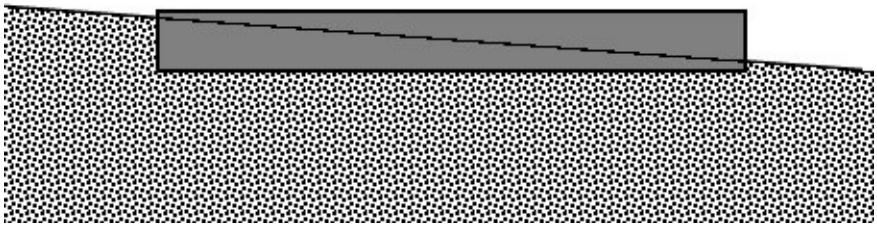

Figure 33. Diagram of a Site with a Mild Slope for a Raised Garden Bed.

The slope is not more than width of board over the length of the board. Flat sites are suitable to build raised bed with minimal effort. Sites with a mild slope requires more effort.

Figure 34 and Figure 35 show two ways to build raised beds on steeper slopes. Figure 33 is an example of stair-stepping beds on a slope and Figure 4 is an example of excavating an area to create a flat building area. Obviously, it will be simpler and less costly to to build stepped beds.

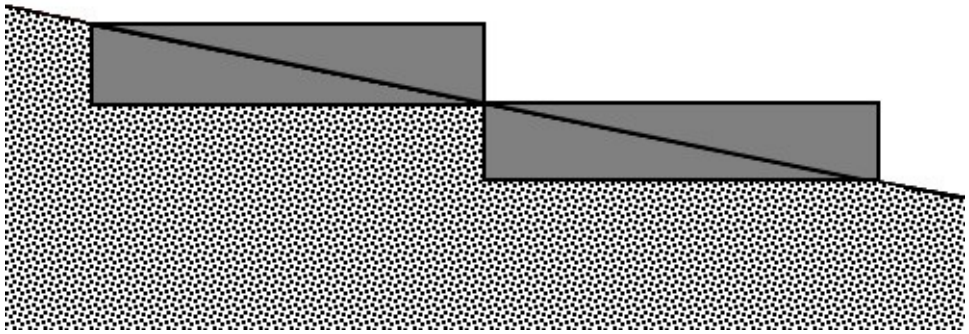

Figure 34. Example of a Site with a Steep Slope for Raised Garden Beds.

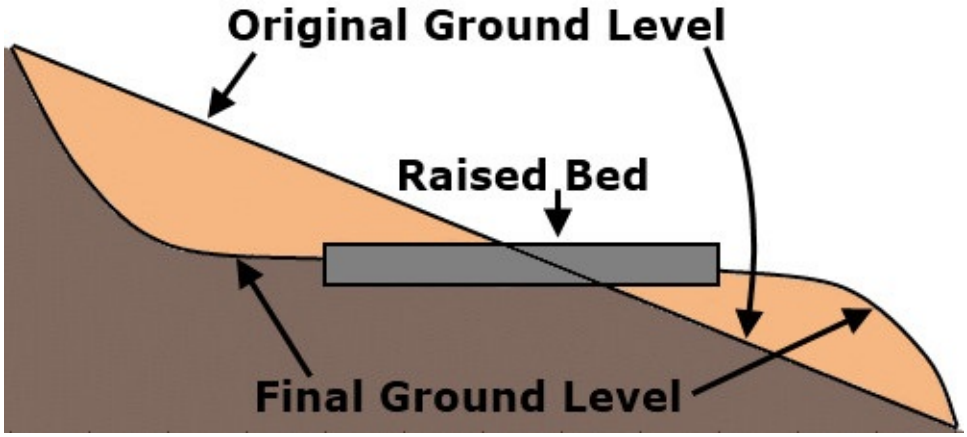

Figure 35. Example of Site with Steep Slope.

Soil has to be excavated from up slope and deposited down slope to create a level site for the raised garden bed. In addition to the excavation, both the uphill cut and the downhill fill would have to be stabilized with rocks or walls. This kind of site is much better suited for building stair-stepped beds.

Special Case: The building site for my 8x10 foot raised bed was moderately sloped, but had a severe drop off on the downhill side. Figure 36 shows a diagram of the raised bed in relation to the slope. I could have created two stepped beds instead of one, but I had planned to build a greenhouse over this bed, so needed it to be one level.

You can see the down hill side needed to be supported. Figure 37 shows how the downhill side was supported with large stones. I also supported the overhanging frame by driving stakes into the ground and screwing the stakes to the frame.

I used landscape fabric to prevent soil from washing out between the stones. I planned to mix a few bags of concrete to pour in among the stones, but they are well set into the soil and are extremely sturdy, so I have not yet used the concrete.

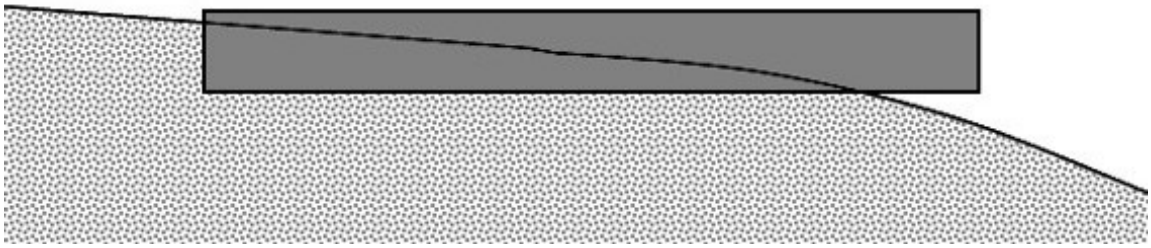

Figure 36. Example of Slope of My 8 x 10 foot raised bed.

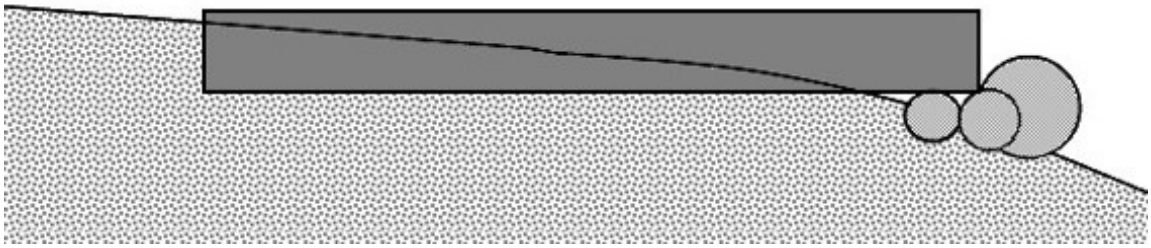

Figure 37. Example of Slope of My 8 x 10 foot raised bed.

I used large stones to support the downhill end of the bed frame. Additional large stones were stacked against that end of the greenhouse for additional support and landscape fabric was attached to the inside of the bed to hold the soil. Look ahead to Figure 49 and Figure 50 to see photos of the actual raised bed.

Section 3: Lumber Raised Bed Frame Construction

Steps to Build a Raised Bed Frame:

1. Measure and Cut Lumber
2. Decide Frame Orientation
3. Mark and Drill Pilot Holes
4. Attach Frame with Screws
5. Attach angles or Corner Brackets for Additional Strength (Optional)

Step 1: Measure and Cut Lumber

Depending upon the size of your raised bed and the size lumber you buy, you may not need to make any cuts, but in most cases, lumber will need to be cut. Some building supply stores will make these cuts for you.

I have three 5x10 foot raised beds built from 2x12 lumber. I bought the lumber in 10 foot lengths, so three boards were needed for each frame. Only one 10 foot board was cut in half for each bed.

Step 2: Decide Frame Orientation.

Now decide which way the frame will fit together. There are three different ways (Figure 38) to construct a simple frame with four sides. Figure 2 is an example using two, five foot boards and two 10 foot boards. Decide if you want the bed to be slightly longer (example A - Drive screws through the 5 foot end boards into the the ends of the 10 foot side boards), slightly wider (example B - Drive screws through the 10 foot side boards into the the ends of the 5 foot end boards), or split the difference (example C - start at one corner and lap each board over the end of the next board). If you care about such things, Example A has a "cleaner" look when viewed toward the short ends. Example B has a cleaner look when viewing the long sides.

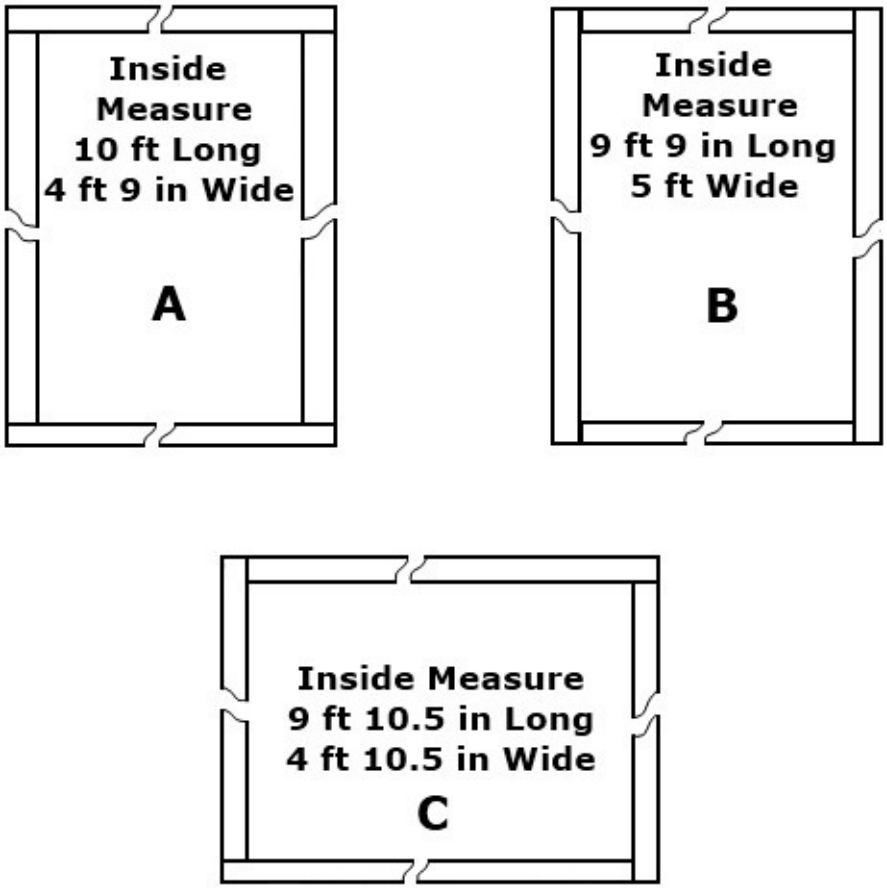

Figure 38. Diagram of Three Different Methods to Attach a Lumber Frame for a Raised Garden Bed. **(A)** To maximize length, **(B)** To maximize width and **(C)** To split the difference. The measurements are for a 5x10 foot bed.

Step 3: Mark and Drill Pilot Holes

Most lumber framing is done simply with hammer and nails, but screws with pre-drilled pilot holes are used instead, the frame will fit tighter, last longer, warp less and will help prevent the boards from splitting. Start by marking the width of your board on each end that is to be drilled (Figure 39), so you can drill holes close to the center of the board. Use a drill bit that is slightly narrower than the screws you plan to use. A 1/8th inch drill bit is recommended for #10 screws in softwood.

Drill the pilot hole through both the face of one board and through the end of the other board (Figure 40).

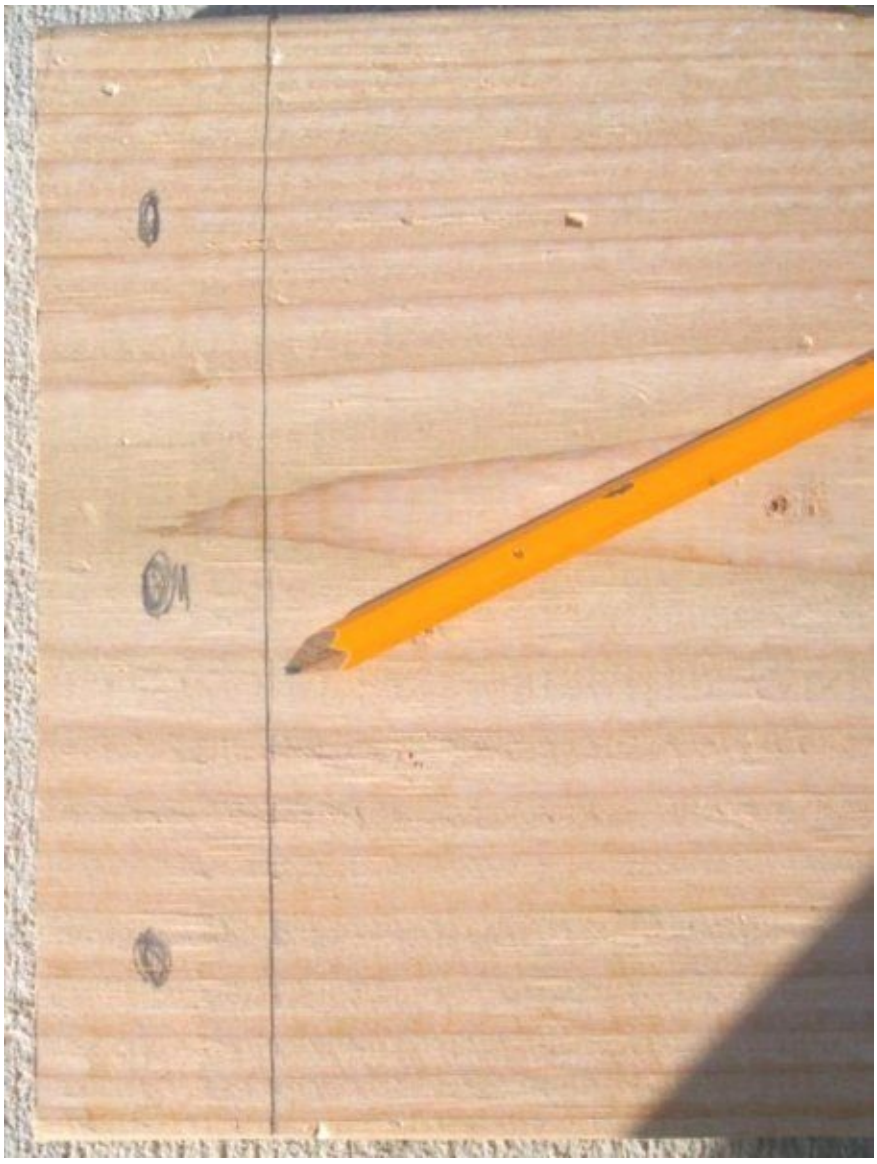

Figure 39. Mark holes to be pre-drilled.

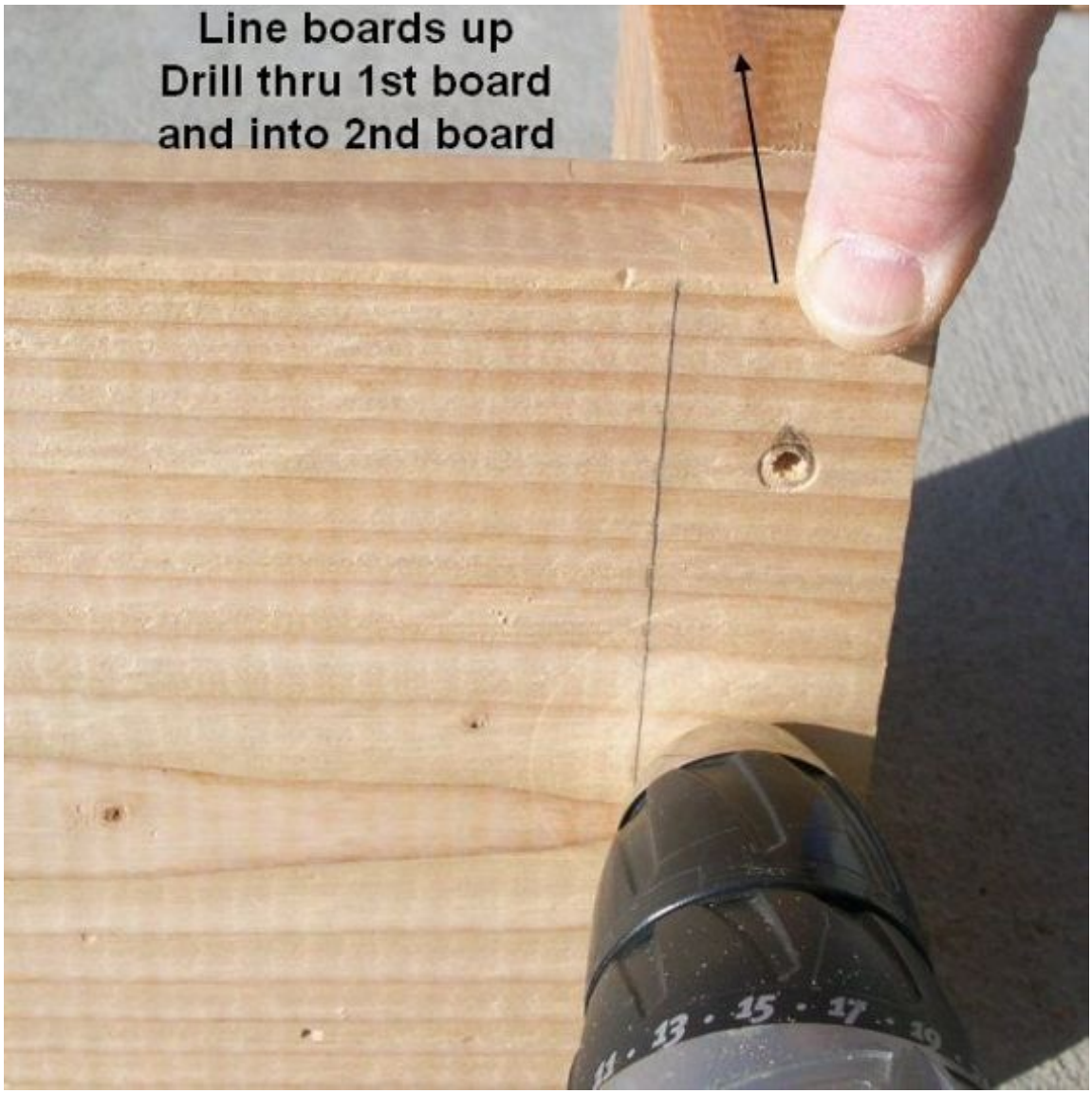

Figure 40. Drill Pilot Holes.

In this case drill through both the face of one board & through the end of the other board.

Step 4: Attach Frame with Screws

Make sure to use screws that are long enough to hold the boards together for many years. A 2 inch screw might hold a 2x4 board for a very short time, but the screw (Figure 41), is #10 screw that is 3.5 inches long and should hold for many years.

After drilling the pilot holes, start the screws and let them extend about quarter inch out of each hole on the other side of the board so you will be able to feel when the screws fit into the holes on the other board (Figure 42).

Hold the two boards tightly together and while each screw is tightened (Figure 43).

Figure 41. Use screws long enough for a strong hold. This is a #10 exterior screw, 3.5 inches long.

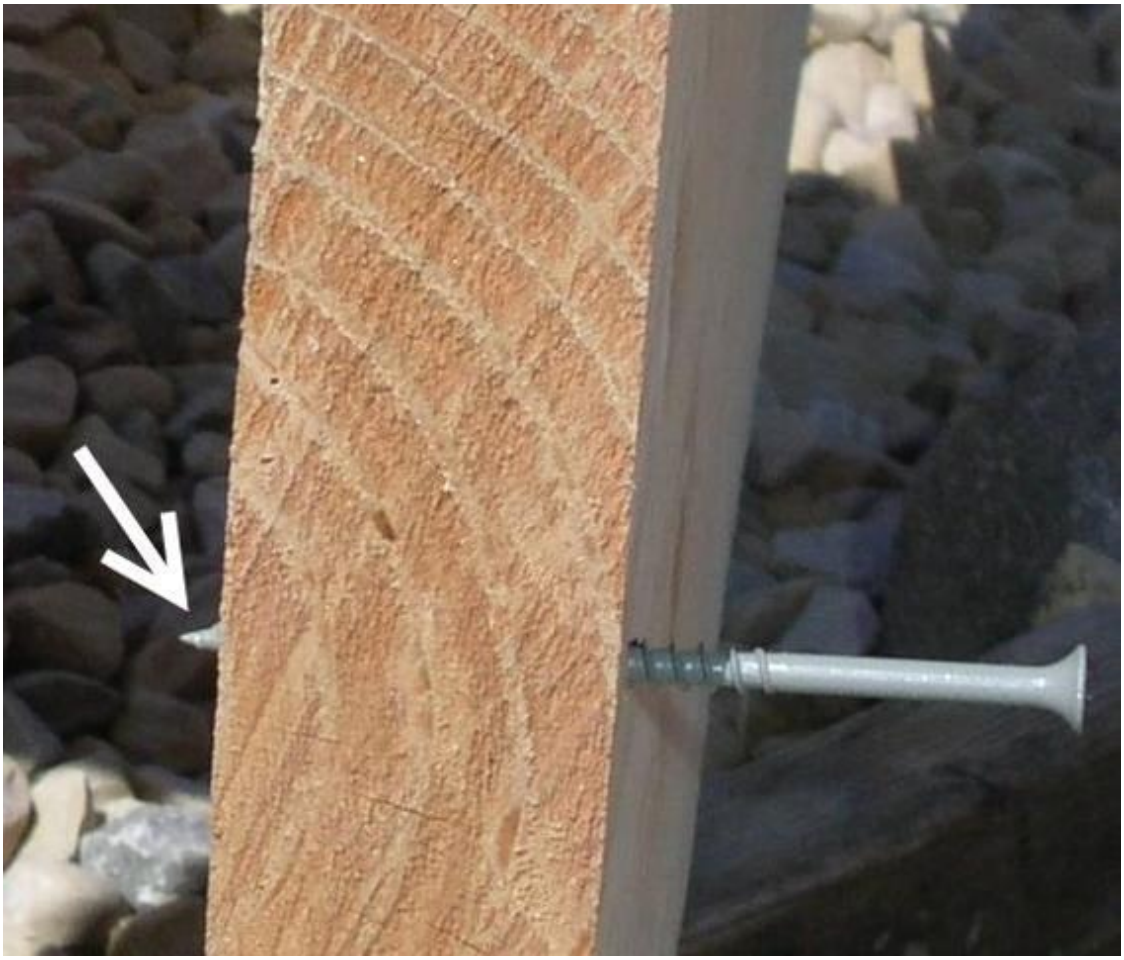

Figure 42. Start Screws. Let them extend about quarter inch so you can feel them fit into the holes on the other board.

Figure 43. Hold Frame Firmly while Driving Screws.

The example in the photo has only one screws started. Sometimes it is faster to start all 3 screws at once, line them up in the 3 holes and then screw them all the way down, one at a time.

Step 5: (Optional) - Attach angles or corner brackets for additional strength

There are many types of angles and corner brackets ranging from about 50 cents to $15 that will add strength to the corners. Some are so strong, they would hold the bed frame together without additional screws, but the better ones are expensive and require bolts to hold the angles to the frame. If you built the frame properly, with good exterior screws, the frame will last for many years without additional support.

Section 4: Directions for Leveling and Squaring a Raised Bed

As with any construction project, it is important that the foundation be as level and as square as possible. If you take a little extra time and care to make sure the raised bed frame is level and square, the bed will function better and will also look better and the soil will not wash out on the downhill side.

Figure 44. Example of Un-level Raised Garden Beds. Notice soil washed to the downhill side of the bed.

Steps to Level and Square the Raised Bed Frame

1. Place Raised Bed Frame Close to the Final Location
2. Square the Bed Frame
3. Use Level to Determine High and Low Areas
4. Dig High Areas Down and Fill Low Areas
5. Final Check Frame for Square and Level
6. Back-fill around Bed Frame with Soil or Gravel

Step 1: Place Raised Bed Frame Close to the Final Location

Figure 45 shows the finished raised bed frame moved into position to be squared, leveled and then partially buried into the ground. This will be your last chance to make sure the frame is properly spaced from other raised beds or structures. Originally, I had covered the area with landscape fabric and gravel. Before I could start leveling and squaring the frame, I had to rake the gravel out of the way and move the stakes.

Figure 45. Finished Raised Bed Frame.

The frame has been placed close to where I intend to level it.

Step 2: Square the Bed Frame

I will start with squaring the frame, but both leveling and squaring have to go together. You can have the frame perfectly level, but be out of square and vice versa. Any adjustment to one will effect the other. Depending upon how much of a perfectionist you are determines how close to square and level you make your frame.

If the frame is square, it helps everything fit together properly, but it doesn't have to be perfect. This is rough framing not fine cabinetry work. The best way to square a rectangular frame, no matter what size, is to make sure the measurement across the outside diagonals are the same. For example, the outside diagonal measurements of an 8 ft by 10 ft frame (Figure 46) should be just a hair over 156 inches long. If they are within a quarter of an inch, bump it one time and measure again. That's probably close enough for a raised bed frame.

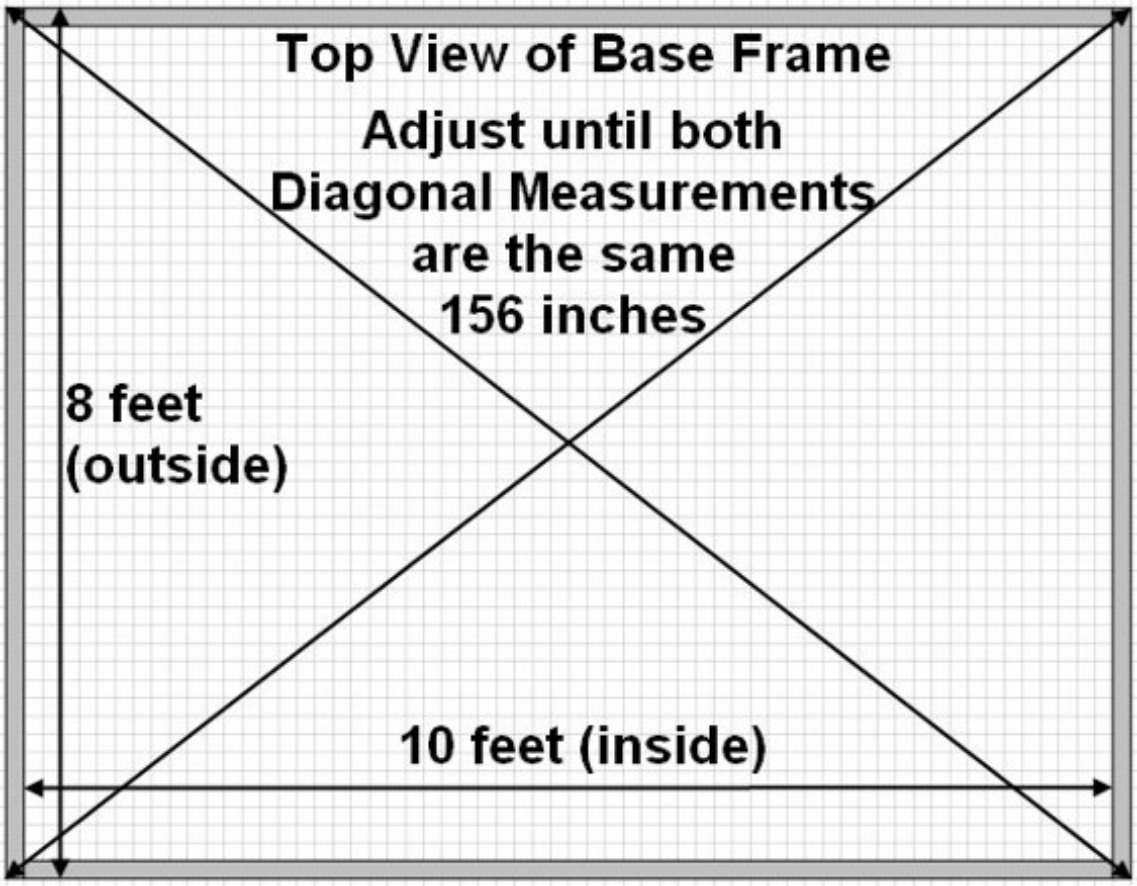

Figure 46. Scale Drawing of 8 ft X 10 ft Bed Frame.

The actual outside measure is 10 ft 3 inches x 8 feet and the actual inside measure is 10 ft x 7 feet 9 inches. The diagram shows where to measure diagonals to square the frame.

Step 3: Use a Level to Determine High and Low Areas

To level the frame, use a carpenters level. Even if you have a perfectly level site, you may still want to dig a trench so the bed frame sits down into the ground at least two - three inches to increase the frame's strength and to keep soil from washing out under the bed frame. For a sloping site, you will dig down on the uphill side until it is level with the low side.

Step 4: Dig High Areas Down and Fill Low Areas

To remove the soil from the high areas, you will have to prop up the bed frame with a board, rock or concrete block until there is room for a shovel, pry bar or pick axe. After all the high places are identified and dug out, check the level again. Then identify and remove the new high spots. Repeat the process until the frame is level. This is a back and forth process as the frame "see-saws" it's way down into the ground.

Then, when satisfied the frame is at the pre-planned depth and is level, fill any low areas with soil or gravel and tamp it with a board or pry bar.

Figure 47 & Figure 48 show various stages of the leveling process and Figure 49 shows the final position of the bed frame. Notice in Figure 50, the large rock on top of the frame to hold the frame in position. The frame had not yet been back-filled with soil.

Figure 47. Leveling the Bed Frame.

Notice rock holding frame up so soil could be removed from under the frame. I used rebar to hold back the landscape fabric, soil and gravel and also to hold the frame in place during leveling.

Figure 48. Leveling the Bed Frame II. Almost complete.

Figure 49. The Bed Frame is Level.

Measure one more time to make sure frame is also square. Notice the large rock holding frame in position on the front (left side) until the frame is backfilled.

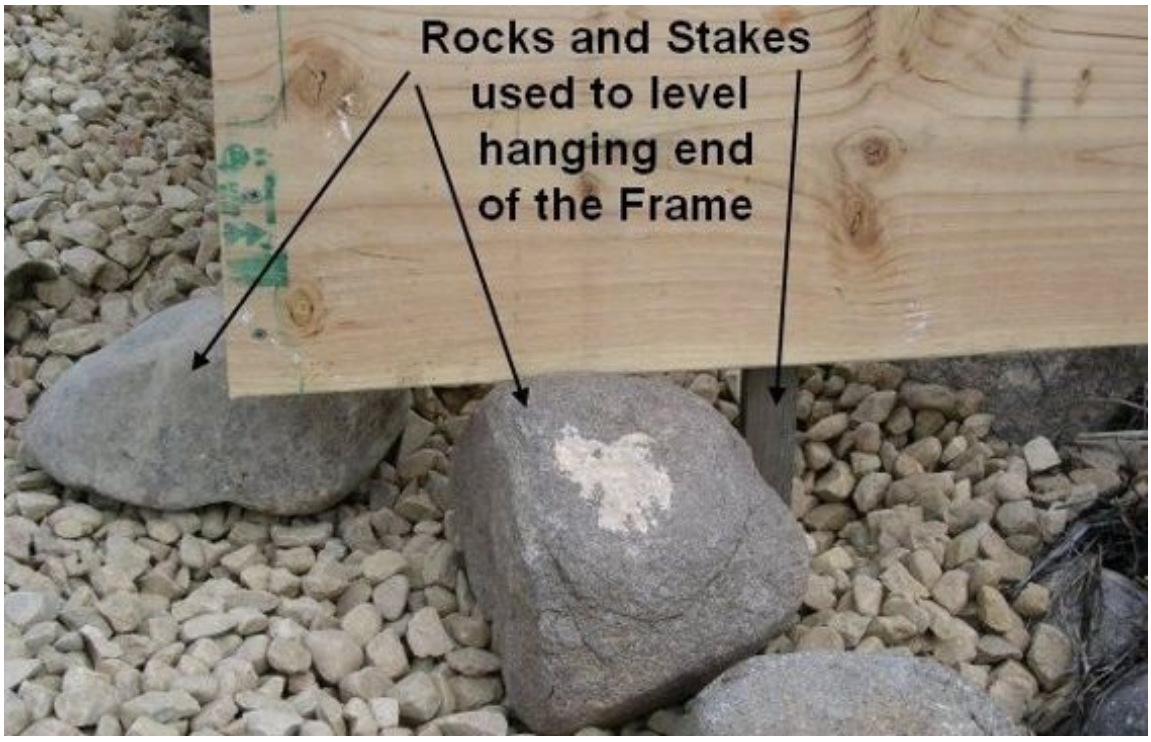

Figure 50. Large Rocks Used to Support the Hanging End of the Bed Frame.

Additional rocks were added for support on the downhill side and stakes were driven into the ground and screwed to the bed frame. Landscape fabric was used to prevent the soil from washing between the stones. Concrete could be poured to support the stones if needed.

Step 5: Final Check Frame for Square and Level

Make sure the bed frame is still level on all four sides and across all four corners and keep checking the diagonal measurements to keep the frame square.

Step 6: Back-fill around Bed Frame with Soil or Gravel Fill all areas around the bed frame with soil or gravel to help hold it in place.

If the frame is not solid, tamp the soil down around the bed frame and check again. If it is still not sturdy, drive several stakes into the ground next to the frame and screw the stakes into the bed frame.

Section 5: Stepped Raised Bed Construction on a Steep Slope

I recently added a new raised bed to the south side of our house. The area was about 14 feet long and 3 feet wide and sloped very steeply downhill with a total drop of about 32 inches (Figure 51). The area has never been planted but was covered with landscape fabric and bark to keep weeds from growing.

Figure 51. Future Site of Stepped Raised Beds. The total drop is 32 inches over the 14 foot distance.

Steps to Build Stepped Raised Beds on a Slope

1. Determine the Total Amount of Rise or Drop on the Slope
2. Determine Size of Lumber Number of Steps to Negotiate the Slope
3. Build Open Ended Bed Frame Sections
4. Place Bed Frames in Position One at a Time
5. Level and Square Bed Frames
6. Fasten Bed Frames Together
7. Back-fill around Outside of Bed Frame with Soil or Gravel
8. Double Dig Soil
9. Add Soil Amendments
10. Connect Drip Irrigation

Step 1: Determine the Total Amount of Rise or Drop on the Slope - It was a simple task to measure the slope, because the site of the new raised beds was next to the house and the amount of drop was easily measured by referencing the the siding. I have a 6 foot level and also took measurements every two feet to see how consistent the slope was. I measured the drop next to the house and also 3 feet away from the house. In this case, the total drop was about 32 inches from the upper end of the proposed bed to the lower end.

Step 2: Determine Size of Lumber and Number of Steps to Negotiate the Slope - If I had 32 inch wide boards, I could build one 14 foot frame to level the area. But that would mean the upper end of that frame would have to be dug nearly 32 inches down into the ground and the downhill side would have 32 inches of frame exposed to the Sun, which would have to be watered constantly in the Summer. A slope is the perfect place to build stair-stepped raised beds.

Table 4 shows the nominal and actual dimensions of common dimensional lumber. The Maximum Slope that lumber of each size can level is the actual width of that lumber. 2x4 lumber can only level a slope of 3½ inches and 2x12 lumber can level a slope 11¼ inches. 2x4s would really be more of a border than a raised bed, but you get the idea. Also, consider that two 2x12s stacked on top of each other could level an area that had a slope up to 22½ inches.

Table 4. Nominal and Actual Dimensions of Lumber and Maximum Rise for Construction of Level Raised Beds.

Lumber Nominal Dimension	Actual Dimension	Maximum Rise of Slope for Raised Bed
2 x 4	1½ x 3½	3½
2 x 6	1½ x 5½	5½
2 x 8	1½ x 7¼	7¼
2 x 10	1½ x 9¼	9¼
2 x 12	1½ x 11¼	11¼

To negotiate the 32 inch slope over a 14 foot span. 2x12 lumber is 11¼ inches wide (high), so 3 steps at 11.25 inches = 33.75 inches, so 3 steps would work using the 2x12 lumber. If the slope had been over 33.75 inches, I would have had to add a step, shorten each bed or keep three steps but have to shorten the span.

Table 5 shows the number of steps required to negotiate various rises or drops across a slope. You can see that I had other options such as six steps using 2x6 lumber, five steps using 2x8 lumber or 2x10 lumber with four steps.

Table 5. Number of Steps Required for Rise or Drop of Slopes using Dimensional Lumber.

Lumber Nominal Dimension	Number of Steps	Rise or Drop of Slope	
		Minimum (inches)	Maximum (inches)
2 x 6	1	0.00	5.50
2 x 6	2	5.50	11.00
2 x 6	3	11.00	16.50
2 x 6	4	16.50	22.00
2 x 6	5	22.00	27.50
2 x 6	6	27.50	33.00
2 x 6	7	33.00	38.50
2 x 6	8	38.50	44.00
2 x 6	9	44.00	49.50
2 x 6	10	49.50	55.00
2 x 8	1	0.00	7.25
2 x 8	2	7.25	14.50
2 x 8	3	14.50	21.75
2 x 8	4	21.75	29.00
2 x 8	5	29.00	36.25
2 x 8	6	36.25	43.50
2 x 8	7	43.50	50.75
2 x 10	1	0.00	9.25
2 x 10	2	9.25	18.50
2 x 10	3	18.50	27.75
2 x 10	4	27.75	37.00
2 x 10	5	37.00	46.25
2 x 10	6	46.25	55.50
2 x 12	1	0.00	11.25
2 x 12	2	11.25	22.50
2 x 12	3	22.50	33.75
2 x 12	4	33.75	45.00
2 x 12	5	45.00	56.25

Note: The stepped beds could also be built using concrete blocks. The 32 inches of drop would require a minimum of four rows of eight inch blocks or eight rows of four inch blocks. Four steps could be made from one row of eight inch blocks or four steps could be made from two rows of four inch blocks. Figure 52 shows two different solutions to building raised beds with blocks on a slope. The top example requires fewer blocks, but will be less stable than the lower example because the different steps are not tied together and there is less mass to hold the soil in place and resist movement from walking and sitting.

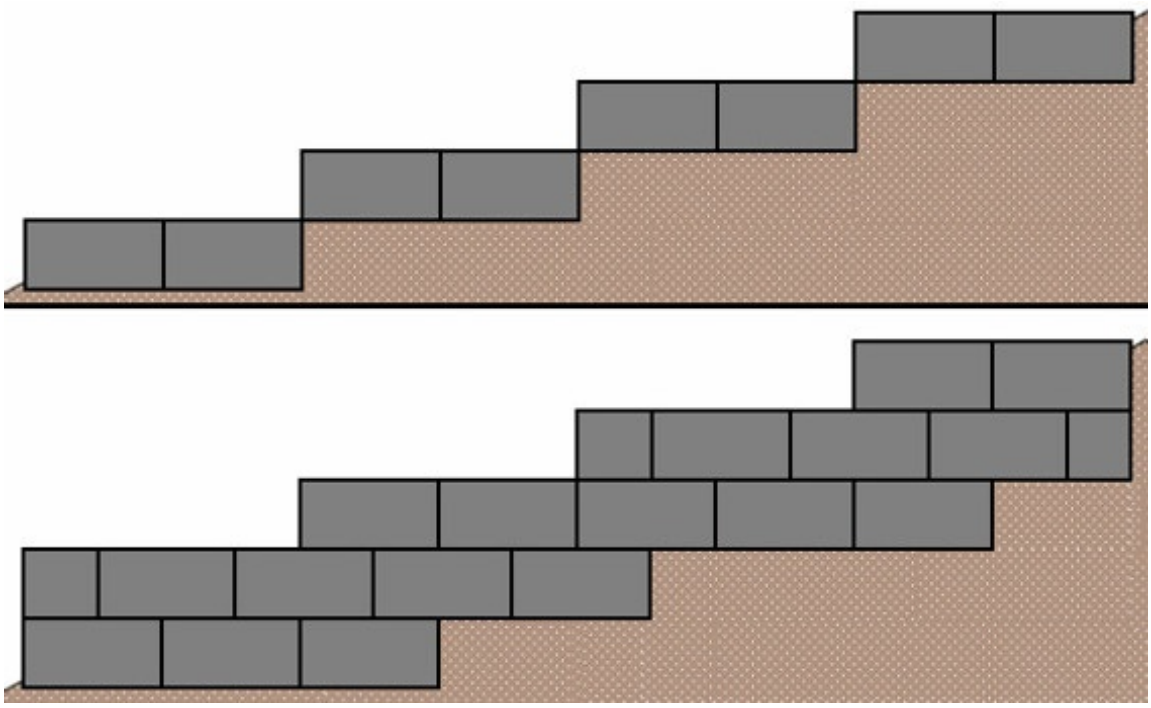

Figure 52. Two Options for Building Stepped Raised Beds with Concrete Blocks on a Slope.

Step 3: Build Open Ended Bed Frame Sections - I decided to build the stepped raised beds with lumber instead of concrete block. I planned for three stepped beds about 3 feet wide and 14 feet long using 2x12 lumber. I left a four inch space between the house and the raised bed to keep the side of the house dry. I also didn't want the bed to extend past the basement window wells, so the 36 inch original plan shrunk by four inches to 32 inches. I built the frames with the outside width at 32 inches (example B in Figure 38), making the inside bed frame cuts at 29 inches.

I built two frame sections four feet long and one section at 62 inches long. I chose this length just to make the best use of my existing 10 foot lumber (62+29+29 = 120). So the final length of the stepped bed was 13 feet 2 inches.

The bed frame sections are built the same way as was shown back in Section 3, except one end of the bed frame is left open (Figure 53). The top step can be completed with a smaller board or it can be added after leveling.

Figure 53. Two of Three Bed Frame Sections.

Step 4: Place Bed Frames in Position One at a Time - Place the first raised bed frame section into place at the top of the slope to mark where the soil needs to be removed to level the frame section (Figure 54).

Figure 54. First Bed Frame Section in Place Before Leveling.

Step 5: Level and Square Frames - Set the frame section aside and begin removing soil. This step is similar to Steps 3 and 4 in Section 4, but since there is a definite uphill side, it is easy to determine high and low areas. The soil on the uphill side is broken up and the soil is pulled out leaving trenches for the raised bed section to fit into (Figure 55, Figure 56 and Figure 57).

If the uphill end of the bed frame section is left open, take care to keep the box square. I temporarily attached a furring strip to hold the box square and eventually replaced it and closed the end of the box with a section of 2x4.

After both sides of the frame section is level and the frame is also level from side to side, add the next frame section and continue.

Figure 55. Frame Section Nearly Level.

Figure 56. First Bed Frame Section is Level, Second Section in place.

Figure 57. First Two Bed Frame Sections are leveled and attached with Angles. The third frame section is in place and nearly leveled.

Step 6: Fasten Frames Together - After the bed frames are backfilled with soil on the outside of the frame and filled with compost on the inside of the frame, the frames should be very sturdy, but until then, the bed frames a just sitting level in the soil. To add strength to all the bed frame sections, use angles and attach the frame sections together. The angles can be seen in Figure 57 and Figure 58.

Figure 58. Stepped Raised Bed Frames Complete. Notice many large stones have been removed.

Step 7: Back-fill around Outside of Bed Frame with Soil or Gravel - To increase the stability of the entire stepped raise bed, back fill the outside of the frame with soil or gravel and tamp it down firmly. Notice in Figure 58 the drip line has been threaded from the supply source under the raised bed before tamping down the soil.

Step 8: Double Dig Soil & Step 9: Add Soil Amendments - The beds were double dug (at least 2½ feet) and then refilled and mixed with soil amendments (Figure 58 and Figure 59). See Chapter III: Soil Preparation for an explanation and photos of the double dig method.

Figure 59. Side View of Completed Stepped Raise Bed Frame. Also notice 2x4 attached to close off and strengthen upper end of top bed.

Step 10: Connect Drip Irrigation - Many of you will not have to regularly depend upon irrigation like I do. I like to use drip irrigation and staple it in straight rows to the bed frame Figure 60. The drip line was passed from the supply underneath the raised bed and then threaded between the stepped beds underneath the landscape fabric that helps to hold the soil between the beds. The total length of drip line in these three beds (two four ft. beds and one six ft.) is about 65 feet.

Figure 60. Raised Bed with Drip Irrigation Line. Drip irrigation line is threaded under the bed frame and stapled to the wood frame.

Section 6: S, U, E and W-Design Raised Beds

The S, U, E and W-shaped raised bed designs are good examples of beds that maximize garden bed space, but still allow access to all areas of the raised beds without stepping into the beds. The extra pathways make it possible to reach all parts of the raised bed without stepping onto the soil.

While looking at the S, E and W designs, notice that no area within the bed is wider than four feet. These designs can take advantage or relatively large areas, but add access points in the form of short pathways or alcoves that allow the gardener to reach all points of the bed without stepping into it. Also, the "fingers" of each of these designs can be extended, just remember to keep all widths to four feet.

"S" Design - I present two designs for the "S" shaped raised bed; one for concrete block and one for lumber (Figure 61).

The Concrete Block Version of the S Design covers 9 feet 4 inch x 21 feet 4 inch area (198 sq ft) with 114.7 sq ft of bed area. That means 57.9% of the area is inside the bed. The concrete blocks take up 49.8 square feet which is 25% of the total area. The block make nice wide and heavy supports for the raised bed, but unless you add soil and plant in the holes of the concrete block, much space is wasted when compared to lumber.

Remember that one row of block can level only 4-8 inches of drop.

Concrete Block S Design materials list:

- 56 8x8x16 inch blocks per row - each row 8 inches high
- 56 4x8x16 inch blocks per row - each row 4 inches high

The simple S-Design could also be easily modified to a U-Design for a smaller areas or expanded to a "W" (Figure 64) or a double-S for longer areas.

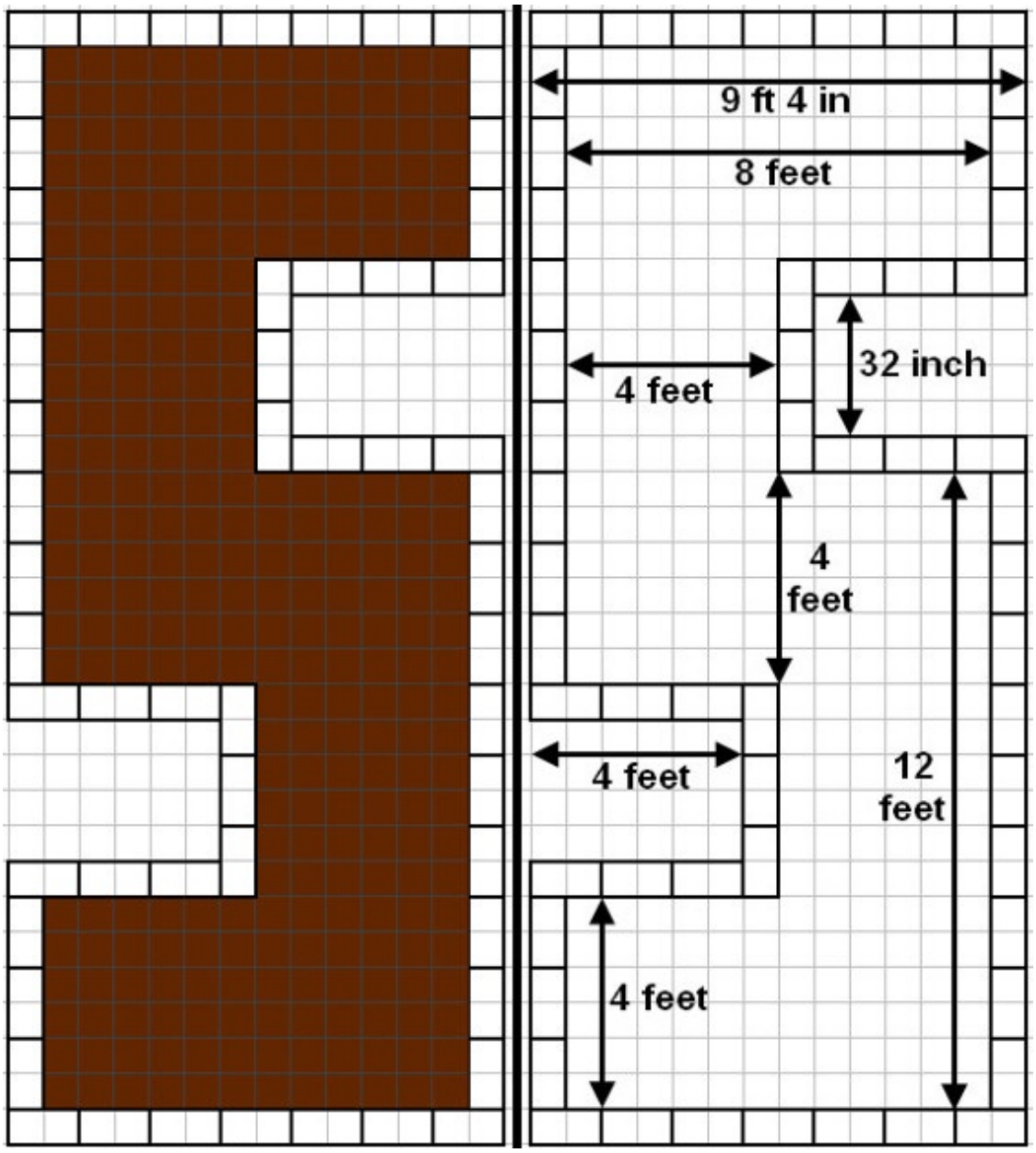

Figure 61. Concrete Block "S" Design.

The Lumber Version - Figure 62 shows the Lumber Version of the S Design with four foot paths that covers a 10x20 ft area (200 sq ft). There is 152 sq ft of area within the raised bed (76% of total area). The 84 linear feet of 1½ inch lumber only takes up 10.5 square feet, so more area is available for planting and less area devoted to structure and pathway. In addition, a frame made from 2x12s can level an area with 11¼ inches of total drop (see Table 2).

In alternate plan using 3 foot wide paths covers an smaller area that is 10x18 foot (180 sq ft) and the area within the bed is 144 sq ft (80%). The 80 linear feet of 1½ inch lumber only takes up 10 square feet of space.

Lumber S Design materials list:

- 2 boards 12 feet
- 6 boards 10 feet

Cut List for 3 foot path:

- 2 boards 12 feet - cut to 11 feet
- 2 boards 10 feet - uncut
- 2 boards 10 feet - cut 2 pieces; 6 feet and 3 feet
- 2 boards 10 feet - cut 2 pieces; 6 feet and 4 feet

Cut List for 4 foot path:

- 2 boards 12 feet - uncut
- 2 boards 10 feet - uncut
- 4 boards 10 feet - cut 2 pieces; 6 feet and 4 feet

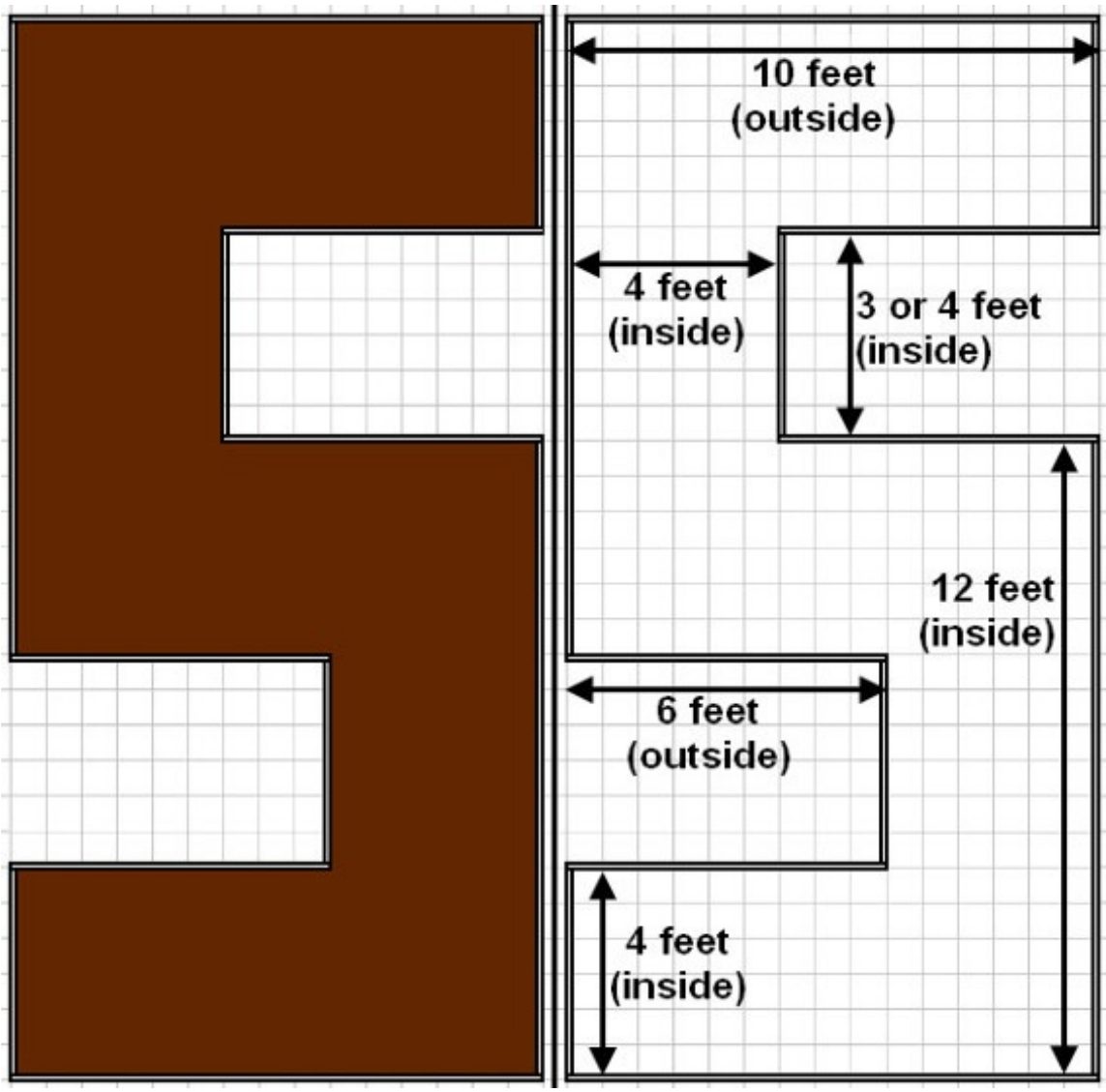

Figure 62. Lumber "S" Design.

"E" Design - Each of the E designs shown in Figure 63 covers a 12x18 ft area (216 sq ft). There is 168 sq ft of area within the raised bed (77.8% of total area). The 92 linear feet of 1½ inch lumber only takes up 11.5 square feet. The examples shows two opposing "E's" that could be left with an open pathway or could be joined.

Lumber E Design materials list:

- 3 boards 12 feet
- 1 board 10 feet
- 6 boards 8 feet

Cut List for E Design:

- 2 boards 12 feet - uncut
- 1 board 12 feet - cut 3 pieces 4 feet
- 1 board 10 feet - uncut
- 5 boards 8 feet - uncut
- 1 board 8 feet - cut 2 pieces 3 feet

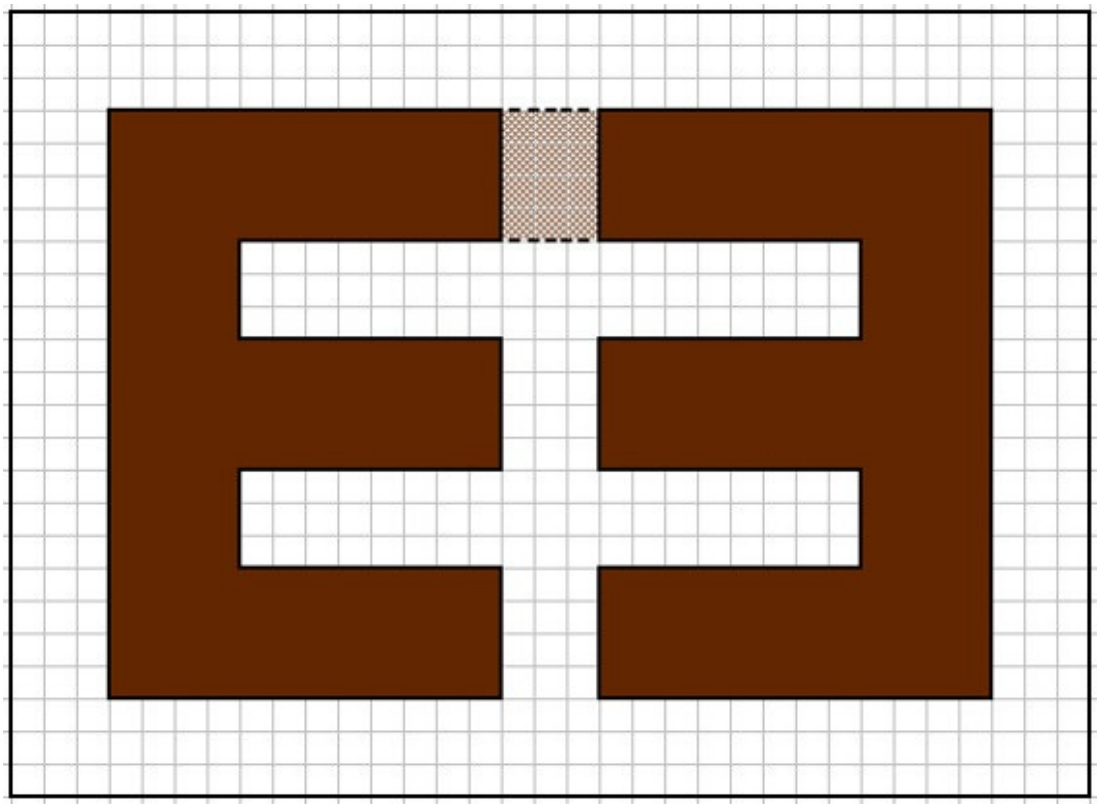

Figure 63. "E" and Double "E" Design. All bed widths are 4 feet and pathways are 3 feet.

"W" Design - The W design shown in Figure 64 covers a 8x25 ft area (200 sq ft). Think of the W design as an extended "S". There is 164 sq ft of area within the raised bed (82% of total area). The 90 linear feet of 1½ inch lumber only takes up 11.25 square feet.

Lumber W Design materials list:

- 3 boards 12 feet
- 1 board 10 feet
- 6 boards 8 feet

Cut List for W Design:

- 3 boards 12 feet - cut 11 feet
- 1 board 10 feet - cut 3 pieces 3 feet
- 2 board 8 feet - uncut
- 4 boards 8 feet - cut 2 pieces 4 feet

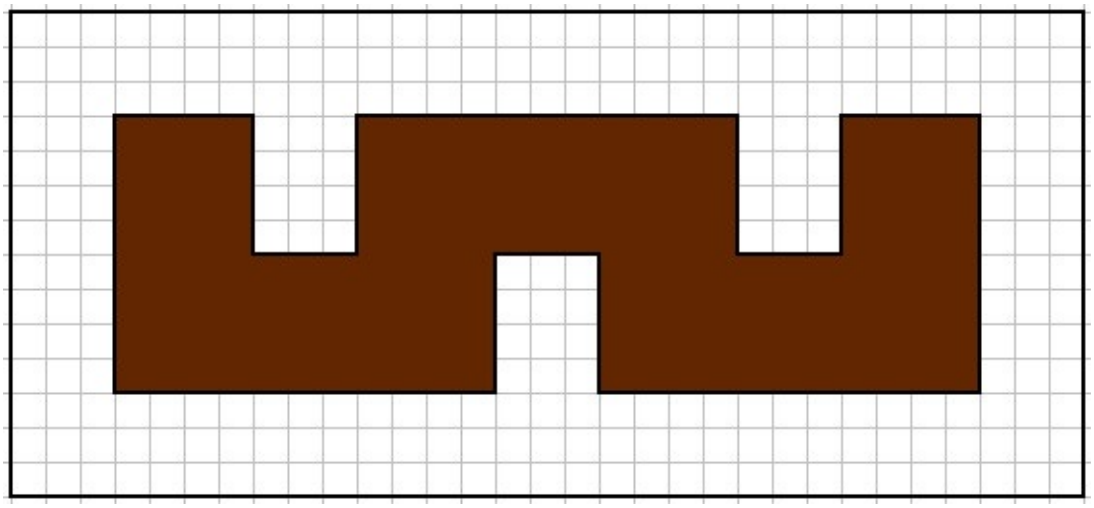

Figure 64. "W" Design. All bed widths are 4 feet and pathways are 3 ft.

Chapter III Soil Preparation

Soil is a very complex subject. There are degrees in Soil Science and NASA devotes an entire section to soil on their website. We don't need have a soil science degree to grow tomatoes, but if we understand what makes better soil, we can grow more and better vegetables or flowers.

Soil Preparation - Double Dig Method - Dig two shovel-lengths down. This requires the top layer of soil be placed to the side so you can reach the next layer down. If you want to keep the area clean, place the soil on a tarp (Figure 65 and Figure 66), landscape fabric or large pieces of cardboard. Then dig the second level of soil, which can stay in place or be removed (Figure 67) to make it easier to mix. Either way, the soil needs to be turned, broken up and mixed well with compost and/or sphagnum moss (Figure 68). I also added top soil in my beds because it contains sand, which is in addition to compost, also helps break up the clay soil.

Start adding the original soil back into the bed and mix more compost as you go. Depending upon how serious you get, this will mix, aerated and add fresh compost into soil from 1-2 feet deep. The more time and effort you can afford, the better.

Since my underlying soil has so many clods and rocks, I build a frame and attached ½ inch welded wire with furring strips and screws. (Figure 69). The screen removes all rocks, clods and sticks larger than ½ inch. A little pounding on the the larger clods breaks them into smaller pieces and allows them to pass through the screen.

You can add compost until the soil mix is at or very close to the top of the raised beds. Over time, the soil level will settle again.

Since the soil line on my raised bed was about four inches from the top before I started digging, I estimate the bed could hold about 16.5 cubic feet (CF) of new compost and other soil amendments. In the process of double digging, I removed another 2 or 3 CF of large stones. During the mixing process, I added about 20 CF of compost, sphagnum moss and top soil into the bed, but when I finished adding, mixing and putting all the removed topsoil back in the bed (Figure 70), the soil is rounded off above the level of the raised bed. I estimate the mixing process added about 15 CF of air space into the soil. So plan accordingly, just removing and replacing the same soil will add about 4 inches to a 50 square foot bed.

Figure 65. Use Tarp to Hold Soil and Keep Pathways Clean.

The tarp was anchored to the raised bed with nails and folded so there were four layers. I have added much compost to this bed over the past 4 years, but the bed has never been dug down to the full two feet. The top layer had very rich soil with plenty of worms, but the next layer was packed clay and rocks.

Figure 66. Top Layer of Good Soil and Compost Removed.

The clay soil has been exposed and removed from the north side of the bed and piled up on the south side.

Figure 67. Removing Clay Soil.

I added amendments and mixed it with the clay soils back on the north side of the bed, but ran out of room to work, so I put down some landscape fabric so I could remove the clay soil. It gives more room to work and makes it easier to mix if the clay is completely removed.

Figure 68. Common Soil Amendments.

I used peat moss and top soil to loosen up my clay soils. The moss is a good source of water absorbing organic material and the topsoil contains lots of sand. I also added the steer manure and additional compost from our compost piles.

Figure 69. Screening Soil.

The screen removes all stones, clods and sticks larger than ½ inch. The photo shows three shovels of soil before and after sifting.

Figure 70. Top Soil Returned to the Raised Bed.

The Soil was piled up higher than the edges of the raised bed. I removed several cubic feet of stones and added about 20 cubic feet of compost and peat moss. I estimate about 15 cubic feet of air was mixed into the soil.

Chapter IV Additional Information, Results, FAQs, Resources

Section 1: Is Pressure Treated Wood Safe to Use in Your Garden?

There have been many concerns and much has been written about chemicals used to treat wood getting into vegetables.

Prior to 2003, lumber was treated with chromated copper arsenate (CCA), which is toxic and the EPA issued warnings about even touching arsenate treated wood.

There has been an erroneous belief that the EPA banned the sale of lumber treated with chromated copper arsenate (CCA) in 2003 (12/31/2003). Not true. CCA treated lumber is no longer approved for residential construction, but it is still approved for sale for industrial, commercial and agricultural uses.

Chances are any treated lumber you buy today at your local building supply store is one of the new EPA approved alternatives to CCA:

- Alkaline Copper Quaternary (ACQ)
- Copper Azole (CA)
- Micronized Copper Quaternary (MCQ)

But you should make sure before buying it.

I read in some of the gardening forums that the new treated wood products are perfectly safe to use for raised garden bed frames, but I needed to do the research for myself.

Alkaline Copper Quaternary (ACQ) - the Copper is the primary active ingredient and is described as being similar to chemicals used to keep swimming pools clean and primarily prevents fungal growth. The Quat formulation is similar to other bio-degradable cleaners and preservatives and is a back up for Copper resistant fungi and termites.

There are no EPA listed carcinogens in ACQ. Research has not identified any direct threats to humans, but the products do leach copper, which is very toxic in aquatic systems. Brand Names include YellaWood, Preserve® and NatureWood®.

Copper Azole (CA) - as with ACQ, the Copper is the primary ingredient (98%) and the tebuconazole fungicide is the backup (<1%). Brand names are

Wolmanized, Tanalith®, or Tanalised® and Residential Outdoor®.

Micronized Copper Quaternary (MCQ) - is the same chemical formula as ACQ, but it is first ground into tiny particles (micron sized) then are injected into the cellular structure of the wood under high pressure. This process releases 90-99% less copper into the environment, which is good news for aquatic environments.

MicroPro® claims that the small amount of Copper that is released, binds quickly to organic compounds in the soil, making it biologically inactive. The MCQ treated wood does not show as much color change as the other treatment processes. It is also not as corrosive to fasteners as ACQ or CA treated wood, but you would still need to use approved fasteners. because less corrosive does not mean non-corrosive. Brand names for MCQ treated wood include Yellawood MCQ, MicroPro® and SmartSense®.

Copper Corrodes Hardware

Since the new wood preservatives use Copper, treated wood is more likely to react and corrode standard nails, screws and other fasteners. Building codes have begun to require stainless steel, ceramic coated or hot dipped galvanized fasteners to prevent failures due to corrosion when using the ACQ, CA or MCQ treated wood products.

Treated Wood May be Wet

Another consideration with treated wood is the fact that the treatment process also pumps water back into the dry wood as it applies the chemical treatment. Since the wood may still have a high moisture content it may shrink, warp and split as it dries out.

Safety Precautions

We are always cautioned to wear gloves, dust masks and eye protection when handling and cutting both treated and untreated wood. We are also advised to wash our hands after handling the new types of treated lumber, to wash clothes separately and are warned not to burn treated lumber or use it as mulch.

Another consideration with treated wood is the fact that the treatment process also pumps water back into the dry wood as it applies the chemical treatment. Since the wood may still have a high moisture content it may shrink, warp and split as it dries out.

Using Untreated Wood

Am I convinced that it is safe to use the new copper treated wood products for raised garden beds? Yes, it is safe for people, but it is not safe for aquatic systems. The new Micronized process is better and leaches 90% less copper

back into the environment than the CA or ACQ methods.

At the time of this writing, my untreated wood frames have been in the soil for between 4 - 6 years. Yes, they have weathered and there are a few signs of decay to the wood that is underground, but they are still very sound and solid and I expect to get another 4 or 5 years before I have to pull them up and replace them.

The same cold, dry climate that make it hard for me to grow vegetables also slows the decomposition rate of untreated wood. Untreated wood may not last as long in your climate.

For me, 10+ years of use from the less expensive, untreated wood is good deal. I also like the look of the untreated wood better, though the new micronized process looks more natural. If I had to choose, I would use the Micronized Copper Quaternary (MCQ) treated wood. While leaching Copper into the soil may not be all bad, leaching 90% less would be better.

Organic Farming

I read recently that organic farmers could not declared their produce "Organic" if they had treated lumber that contacted their soils or animals. I did a little research and found the statues (see § 205.206 & § 205.602 below*) that regulate the use of treated wood under the Organic Food Production Act. The actual language in § 205.206 refers only to arsenate materials in new and replacement installations, not to existing installations. After further research, it appears that existing installations that use even arsenic based pressure treated wood are "grandfathered". So it is still possible for certified Organic Vegetables to be produced in raised beds constructed from arsenate treated wood if they received their certification prior to December 31, 2003.

Also, since CCA treated wood is still approved for sale for agricultural uses, the possibility exists that the animals or plants we eat can come in contact with new sources of Arsenic. Don't think so? Who is responsible to make sure it doesn't?

Another reason we should all know the people that produce and deliver our food. Who does it make more sense to trust? The local farmer who knows their livelihood depends on their ability to satisfy us as consumers? Or the USDA, FDA and EPA, who are apparently responsible to no one and not accountable for anything?

***§ 205.206:** Crop pest, weed, and disease management practice standard. (f) The producer must not use lumber treated with arsenate or other prohibited materials for new installations or replacement purposes in contact with soil or livestock.

***§ 205.602:** Nonsynthetic substances prohibited for use in organic crop production. The following nonsynthetic substances may not be used in organic

crop production: (b) Arsenic.

Section 2: Resources:

Click on links for additional information.

USDA Plant Hardiness Zone Map - Determine which plants are most likely to thrive at a location

NOAA Regional Climate Centers - For frostfree dates by region: Western, High Plains, Southern, Midwestern, Northeast & Southeast.

NOAA Freeze/Frost Maps - Spring & Fall Freeze Occurrence Maps (10% Probability), Freeze Free Period Map (90% Probability)

Soil Information - Soil Science Society of America

Soil Information - NASA Website

Soil Information - USDA NRCS Website

Soil Information - Victoria Australia Agriculture Website

Wheelchair Access Raised Bed Kits

Greenhouse Tips - Additional information and tips about building raised beds, greenhouses and gardening from the author's blog, HomemadeHints.com.

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Happy Gardening & May Your Fresh Fruits & Vegetables be Plenty!

I hope you enjoyed this book and that these raised bed plans and ideas help you on your gardening journey.

I value reader feedback. If you have comments, questions or see errors in this book, please feel free to contact me at my blog, . Unfortunately, every reading device displays a little differently so it is difficult to make everything perfect for every device.

I use a Kindle, but personally will also read my books on my computer through the Kindle Cloud Reader or with Kindle for PC which makes it a little easier when viewing links to web pages or videos. Here is a link to all of the free Kindle Reading Apps if you don't already know about them:

http://www.amazon.com/gp/feature.html?ie=UTF8&docId=1000493771

You can also Find Us on Facebook. Feel free to post any of your questions on our wall.

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Thanks again you for your support!

Taylor Birch

http://www.HomemadeHints.com/

Stop by our site above and tell us about your gardening experiences!

"Gardens are not made by sitting in the shade." -Rudyard Kipling

Other Books by the Author

We enjoy gardening, but wanted to extend the growing season by planting earlier in the spring and letting vegetables and fruits ripen further into the fall. So we decided to build 2 greenhouses; one small, simple and portable and the other as a larger walk-in greenhouse. If you want to build either, you can view them by following the links below.

How to Build a Small, Portable A-Frame Greenhouse:

http://www.amazon.com/dp/B007VG91H4/

DIY Greenhouse: How to Build a Walk-In, Ventilated Greenhouse:
http://www.amazon.com/dp/B00CD94WLO/

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