



Comparison of Raised Bed Methods, Materials, and Costs

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Introduction

Raised garden beds are a common feature of the home garden landscape and come in a wide variety of shapes, sizes, and materials. From the most basic mound of soil to the most elaborate brick planter, there are many benefits and challenges to each type of raised bed. Which type of raised bed you choose to build will depend on your needs, such as your goals, budget, maintenance needs, and available space.

This publication will review raised bed necessity and types including bed construction materials and cost analysis.

Are Raised Beds Necessary?

One of the main reasons for installing a raised bed is to avoid poor water drainage issues. In poorly drained soil, plant nutrient uptake and productivity are reduced (Fausey 1987). In addition, roots in flooded soils cannot produce energy from photosynthates and toxic substances are produced and accumulated (Drew 1983). Raised beds help with drainage by adding a layer of soil above the poorly drained area. The greater force of gravity due to the extra bed height allows for increased drainage. However, if the soil is well drained, plants will grow successfully on flat ground. The degree to which plants tolerate flooded soils is dependent on species and temperature, with plants tolerating flooding longer during cool temperatures (Kramer 1954). Plants are also more susceptible to flooding injury at young growth stages (Rao 2003). To determine if your soil is well drained you can do a simple percolation test. Dig a hole 6" - 10" deep and fill the hole several times with water to saturate the soil. Once the soil is saturated, fill the hole again and

time how long it takes to fully drain. While vegetables vary in their susceptibility to flooding, if it takes longer than 10 hours to drain, then a raised bed is probably necessary to improve drainage.

Another reason for raised bed construction is avoidance of soil contaminated with lead. Urban areas are widely contaminated with lead from historically used lead-based paints, fuels and industrial processes (Laidlaw 2017). The primary pathways for lead exposure are the ingestion of contaminated soil via hand to mouth and dust inhalation (Clark 2008). Ingestion of soils accounted for 82% of children's daily exposure (Clark 2008). Consumption of homegrown produce only accounted for 3% of children's daily exposure (Clark 2008). Research shows that placing soil on top of contaminated soil with a permeable layer of landscape plastic separating the soil types did not reduce lead in vegetables in comparison to no barrier (Richard 2020). Use of a neoprene barrier under a raised bed actually increased lead content in vegetables from lead contained in the neoprene material (Richard 2020). Additional research showed that raised beds were recontaminated with lead after 4 years presumably from wind borne lead-based paint (Clark 2008). Another potential avenue for recontamination not mentioned in the research is bioturbation or the mixing of soils by earthworms and soil organisms. Soil removal and replacement or just covering all contaminated soil on a neighborhood scale helps lower lead blood levels more than just preventing lead uptake in vegetables (Laidlaw 2017). Additions of compost and high iron biosolids compost reduces the accessibility of lead by plants (Laidlaw 2017). If raised beds are used to prevent lead in vegetables, complete isolation from underlying soil is recommended using a lead-free impermeable barrier with drainage holes. Alternatively, adding generous amounts of compost

and organic matter to the raised bed media will make the lead less accessible to plants.

In terms of working convenience, raised beds increase the height of plants making access easier. While a bed 6” tall does not provide a lot of relief, walls of a bed 2’ tall provide a nice seat and limit bending over. However, constructed raised beds increase the management required to control weeds growing under and along the edge of the raised beds. This means you will have to bend over more often to pull weeds or string trim along the outer edge of the bed. Tools like collinear and stirrup hoes allow weeding without bending over but do not work well along the edges of constructed raised beds. Overall, raised beds require more work to build and maintain so using them will add considerable time and expense to gardening (to be discussed) and you may find yourself bending over more often to manage weeds along the edge. Carefully consider the need for a raised bed and the associated costs to determine if a raised bed is warranted.

Raised Bed Types

Mounded Earth Raised Bed

The simplest form of raised bed is a Mounded Earth model, where soil is shoveled, raked, or tilled into raised mounds with the tops raked flat. Soil is pulled from the pathways or furrows and piled onto the raised bed areas thereby avoiding the need to purchase soil to make the raised beds. On a farm scale, a machine called a bed shaper is pulled behind a tractor to make a mound of soil on well tilled ground. On a medium scale, a walk-behind tractor with a rotary plow is used to throw soil into raised beds. On a small scale a shovel, hoe and rake are used to move soil from pathways to bed tops.

Mounded earth raised beds come with some challenges. Beds will shrink over time as soil washes down the edges requiring rebuilding to maintain height. In addition, if soil to make the beds comes from the adjacent pathways, excavated areas will be lower than the existing grade. In poorly drained soil, water may pool in these areas unless a ditch or drain is provided.

Table 1. Materials and cost analysis of mounded earth raised beds.

Material	Cost	Total
	TOTAL	\$0

Tools Required

- Shovel or hoe
- Garden rake

Mounded Earth Raised Bed with Woven Polypropylene Ground Cover

Covering mounded earth raised beds with a long-lasting light blocking ground cover provides many benefits. Plastic ground covers come in many different grades, qualities and colors. Some plastic mulches are water permeable and some are not. The ground cover prevents weeds from growing between the plants eliminating the task of weeding. Plastic mulch also reduces evaporation conserving soil moisture and reduces leaching of nutrients (Lament, 1993). Plastic mulch also prevents soil splashing, keeping vegetables cleaner and preventing plant disease (Lament 1993, Jambhulkar 2012). Black plastic mulch heats the soil, speeding up plant maturity and increasing yield (Jenni 1986). The extra heat from black plastic is beneficial during the spring but stresses fall transplants planted in the heat of summer. White plastic mulch is available for fall gardening or black plastic mulch painted with white latex paint will reflect sunlight keeping plants and soil cooler. White mulch reduces soil temperatures in relation to dark colored plastic mulch but does not keep the soil as cool as bare soil (Luis 2008). Black plastic can also be turned white organically using kaolin clay (Surround) sprayed on the black plastic with a pump sprayer. Paint and clay may clog porous plastic reducing permeability.

Typically, single use or biodegradable white or black plastic film is used on a farm scale and comes in lengths of 4000 feet. Home gardeners and market farmers can use a permeable woven polypropylene ground cover sometimes called geotextile fabric. Woven fabric lasts for 3-7 years or longer depending on grade and exposure to sunlight. Woven ground covers have enough shear strength to resist tearing when secured using sod staples along the edges. The edge of the bed is also easy to maintain with a lawn

mower as the wheels drive over the plastic allowing the mower to trim the edges without the need of a string trimmer. Make sure the plastic lays flat against the ground and sod staples used to secure edges are placed ½” from the edge to prevent mower blades from hitting the edge flap. Non-woven ground covers have little shear strength and all edges should be buried to secure.

Woven ground covers will unravel if cut with a knife. To prevent the fabric from unraveling, cut with a propane, butane or mapp gas torch using a piece of wood to guide the flame and prevent curling or use a hot knife. Burn small holes just large enough to slip transplants through to prevent weeds from growing in the holes.

To qualify for organic status, plastic on the beds must be removed annually. This ensures the soil is improved by additions of amendments or cover cropping.

Plastic mulch comes with its challenges. Applying and removing the mulch takes time and planting through the plastic is more difficult. In addition, adding fertilizer after the soil is covered with plastic poses problems. Compensate by adding all nutrients pre-plant or adding water soluble nutrients through a drip system or watering can after planting. Solid plastic necessitates drip irrigation under the plastic to water crops. Permeable plastic allows some water through but drip irrigation over or under the plastic is still recommended. Woven poly ground covers may not be locally available requiring shipping.

Table 2. Materials and cost analysis of mounded earth raised bed with woven polypropylene ground cover.

Material	Cost ^a	Total
Woven Polypropylene Ground Cover	\$0.74 /lf ^b	\$5.90
Stakes/Pins/sod staples	\$0.18 /unit	\$1.80
	TOTAL	\$7.70

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

^bLinear feet

Tools Required

- Shovel or hoe
- Garden rake
- Propane torch or hot knife
- Hammer for sod staples



Photo 1. Woven poly raised beds left and composite raised beds right. (Shawn Jadrnicek, Virginia Cooperative Extension)

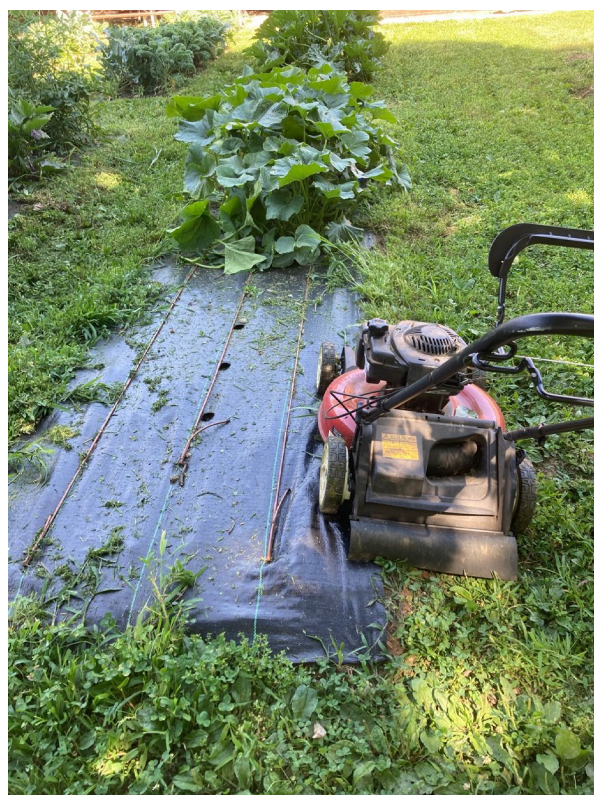


Photo 2. Mowing the edge of a woven poly secured with sod staples. (Shawn Jadrnicek, Virginia Cooperative Extension)

Wood Raised Bed

A wooden raised bed is one of the most common forms of raised beds. Durability of wood varies by species, climate and treatment. Warm and wet climates facilitate faster decay. Untreated southern pine (*Pinus* sp.) is not resistant to decay and may only last a few years before rotting while Eastern Redcedar (*Juniperus virginiana*) heartwood is resistant to decay and lasts longer than other woods (Scheffer 1998).

Arsenic compounds are banned from newer wood treatments making the wood treatments safe to use in garden beds. However, chemicals in treated wood leach into the adjacent soil and vegetables grown in treated wood beds are not organic approved (NOP 5036). Vegetables should not come in contact with treated wood which may be difficult to do in a small raised bed. Tests on the durability of several new wood treatments showed the average percent strength of the treated wood ranged from 46% to 72% thirty months after ground contact depending on the treatment (Freeman 2008). After its useful life, treated wood should not be burned or chipped but disposed of at a landfill (personal communication DEQ 6/8/22).

Wooden raised beds require purchasing or acquiring soil to fill the raised beds adding to the expense and difficulty of making the beds. Moving soil may also require a wheelbarrow and truck. Be sure to measure the volume of the raised bed and purchase enough soil to fill that volume.

The wood around the edge of the raised beds complicates maintenance. The steep edge requires lifting of mowers or tillers onto the beds and hoeing weeds along the edges is difficult. Perennial weeds like bermudagrass (wiregrass) may establish themselves under the wood structure. Once established, they continually invade the beds requiring constant hand weeding or application of herbicides. Hand weeding alone is not likely to kill perennial weeds. Covering the beds with light blocking black plastic or ground cover or solarizing with clear plastic will kill weeds organically. Corners of the beds should be padded to prevent sharp edges from ripping the plastic and allowing light through. The plastic should also extend several feet or more beyond the wood structure.

If grass or vegetation is grown in the pathways between the raised beds, the plants should be mown

before mature seeds fall into the beds and become weeds. Wheels on mowers prevent them from cutting the vegetation all the way to the wood edge. String trimmers or hand trimmers can then be used to cut the strip missed by the mower. Alternatively, vegetation between raised beds can be killed with herbicides, tillage, light blocking tarps, wood chips, or mulch placed between the beds to keep them weed free. As the wood chips decompose, the rich soil is added to the beds and fresh wood chips added to the paths.

Avoid adding wood chips or mulch on top of weed blocking fabric or ground cover. The mulch will decompose into soil and weeds will eventually grow on top of the weed barrier negating the purpose and making the plastic difficult to remove later.

Table 3. Materials and cost analysis of untreated wood raised bed.

Material	Cost ^a	Total
Lumber 2x12x8	\$3.12/lf ^b	\$74.92
Lumber 4x4x8	\$2.20/lf ^b	\$17.62
Fasteners	\$0.21 /unit	\$6.83
Fill Soil	\$2.77/cu ft	\$88.72
	TOTAL	\$188.09

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

^bLinear feet

Table 4. Materials and cost analysis of treated wood raised bed.

Material	Cost ^a	Total
Lumber 2x12x8	\$4.48/lf ^b	\$107.63
Lumber 4x4x8	\$1.28/lf ^b	\$10.25
Fasteners	\$0.21 /unit	\$6.83
Fill Soil	\$2.77/cu ft	\$88.72
	TOTAL	\$213.43

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

^bLinear feet

Tools Required

- Shovel or garden rake
- Wheelbarrow
- Electric Drill/Screwdriver
- Circular or hand saw
- Measuring tape
- Pencil
- Square



Photo 3. A wooden raised bed with Bermudagrass (wiregrass) creeping in from under the wood. (Shawn Jadrnicek, Virginia Cooperative Extension)



Photo 4. Mowers miss weeds on the edge of a wooden raised bed requiring string trimming. (Shawn Jadrnicek, Virginia Cooperative Extension)

Cinder Block Raised Bed

Cinder blocks also known as concrete masonry units come in different shapes and sizes and make long-lasting raised beds. Blocks are either dry stacked without mortar between joints or secured together with mortar or construction adhesive. Dry stacked blocks are not as stable or secure as mortared blocks or blocks secured with construction adhesive. Soil or concrete placed inside the blocks give more structural strength as well. Solid blocks placed on top will give a finished look to the raised bed or an entire bed can be made with solid blocks. Solid blocks or blocks filled with soil act as extra thermal mass absorbing heat during the day and releasing the heat at night, possibly improving the microclimate. Cinder blocks won't degrade over time and can last over 100 years (Subasic 2013).

Depending on the soil type, cinder blocks may sink over time leading to a deformed looking raised bed. Placing the blocks over 4-6" of compacted gravel provides a solid foundation and prevents blocks from sinking. Either way, leveling the blocks adds considerable time and effort to bed construction. Each block weighs around 30 pounds and moving blocks into place and leveling will require several lifts per block.

Similar to raised wooden beds, perennial weeds may establish themselves under, inside and around the cinder blocks increasing bed maintenance and getting power equipment onto the bed surface requires lifting. Mowing the edge of the bed with a string trimmer will also be necessary if vegetation is grown between the beds and beds will need the addition of soil to fill them.

The width of cinder blocks also takes up space adding to the total dimensions of the raised bed or reduces the growing area. For example, a cinder block bed with outside dimensions of 4' x 8' has an interior area of 18ft² versus a wooden bed with the same outside dimensions has internal dimensions of 30ft² or a 40% increase in growing space.

Cinder blocks containing fly ash may contaminate soil and plants with heavy metals. However, conclusive research is unavailable on cinder block leaching and toxicity.

Table 5. Materials and cost analysis of cinder block raised bed.

Material	Cost ^a	Total
Concrete block 8 x 8 x 16	\$3.12/lf ^b	\$41.40
Solid block 4 x 8 x 16	\$2.20/lf ^b	\$32.16
Construction adhesive	\$0.12/lf ^b	\$17.05
Fill Soil	\$2.77/cu ft	\$64.19
	TOTAL	\$154.80

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

^bLinear feet

Tools Required

- Shovel or garden rake
- Wheelbarrow
- Level
- Tamper
- Measuring tape
- String line and stakes

Retaining Wall Block Raised Bed

Low retaining walls made from concrete retaining wall blocks make long lasting raised beds. Some blocks are designed to look like natural stone, thereby improving the appearance. Blocks may have a lip on the rear bottom edge creating a key effect locking the upper blocks into the lower blocks when dry stacked adding to the strength. Securing landscape blocks with construction adhesive or mortar is also an option.

Depending on the soil type, retaining wall blocks may sink over time leading to a deformed looking raised bed. Placing the blocks over 4-6" of compacted gravel provides a solid foundation and prevents blocks from sinking. Each block weighs 24-53 pounds and will require several lifts and considerable effort to put into place.

Similar to cinder block beds, perennial weeds may establish themselves under and around the blocks increasing bed maintenance and getting power

equipment onto the bed surface requires lifting. Mowing the edge of the bed with a string trimmer will also be necessary if vegetation is grown between the beds and beds will need the addition of soil to fill them. The width of landscape blocks also takes up space adding to the total dimensions of the raised bed.

Table 6. Materials and cost analysis of retaining wall block raised bed.

Material	Cost ^a	Total
Landscape block 12 x 4 x 8	\$6.54/lf ^b	\$156.96
Construction adhesive	\$0.12/lf ^b	\$17.05
Fill Soil	\$2.77/cu ft	\$62.94
	TOTAL	\$236.95

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

^bLinear feet

Tools Required

- Shovel or garden rake
- Wheelbarrow
- Level
- Tamper
- Measuring tape
- String line and stakes

HDPE (Plastic) Lumber

High-Density Polyethylene (HDPE) is a thermoplastic polymer made from petroleum. HDPE lumber, also called plastic lumber, is usually made from recycled HDPE products represented by the "2" number on the recycling symbol like milk jugs and plastic bags. HDPE lumber is resistant to degradation and could last over 1000 years making it a durable material for raised bed construction (Ali 2020).

Similar to raised wooden beds, perennial weeds may establish themselves under and around the HDPE lumber edges increasing the beds maintenance. Mowing the edge of the bed with a string trimmer will also be necessary if vegetation is grown between the beds. Beds will also need the addition of soil to fill them.

Table 7. Materials and cost analysis of HDPE plastic lumber raised bed.

Material	Cost ^a	Total
Lumber 2x6x8	\$13.12/lf ^b	\$314.90
Lumber 4x4x8	\$7.71/lf ^b	\$61.68
Fasteners	\$0.21 /unit	\$6.83
Fill Soil	\$2.77/cu ft	\$88.72
	TOTAL	\$472.13

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

^bLinear feet

Tools Required

- Shovel or rake
- Wheelbarrow
- Electric Drill/Screwdriver
- Circular Saw
- Pencil
- Measuring tape
- Square

Composite Lumber

Composite lumber is made from a combination of wood fiber, plastic and a binding agent. The amount of each component varies by manufacturer and may determine longevity of the product. The wood component in composite lumber is subject to fungal decay. Zinc borate is commonly used to prevent decay of the wood and may leach into the soil (Pendleton 2002). Composite lumber lacks the lateral strength of wood and will bend easily causing deformation when used in raised beds. Adding more vertical supports will help prevent the wood from bending or pushing out with the weight of the soil. Wire cross ties will also provide more support. However, use of composite lumber for raised beds has not been researched and soil contact with composite lumber is not recommended by manufacturers (personal communication Trex lumber 6/1/2022). Composite 4" x 4" lumber for the corners is not available due to composite woods' limitations with ground contact. Use of wood, plastic wood or metal bracket is required to secure edges.

Similar to raised wooden beds, perennial weeds may establish themselves under, inside and around the composite lumber edges increasing the beds maintenance. Mowing the edge of the bed with a string trimmer will also be necessary if vegetation is grown between the beds. Beds will also need the addition of soil to fill them.

Table 8. Materials and cost analysis of composite lumber raised bed.

Material	Cost ^a	Total
Composite Deck boards 1x6x8	\$4.78/lf ^b	\$114.68
Treated wood 4x4x8	\$1.28/lf ^b	\$10.25
Fasteners	\$0.21 /unit	\$6.83
Fill Soil	\$2.77/cu ft	\$88.72
	TOTAL	\$220.48

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

^bLinear feet

Tools Required

- Shovel or rake
- Wheelbarrow
- Electric Drill/Screwdriver
- Circular Saw
- Pencil
- Measuring tape
- Square

Wooden Logs

Wooden logs make a cost-effective raised bed material. Durability depends on the species. Sapwood also degrades before heartwood leading to uneven decomposition of the raised bed structure. To prevent the logs from rolling away, drill holes through the logs and insert rebar through the holes in the logs and into the ground. Alternatively, logs placed in a shallow trench will prevent rolling. Once the logs decompose, the untreated wood is safe to use as a mulch in the raised bed or landscape.

Mushrooms grown on the logs will add another component of food production to the beds. Be sure to harvest the logs when trees are dormant and

inoculate logs with the appropriate mushroom species for the wood type. To avoid weed fungi from taking hold, allow the mushroom species in logs to fully colonize before placing in contact with the ground. Logs will fruit when the right combination of moisture, temperature and light are achieved. Since vegetables require full sunlight and mushrooms require shade, achieving the correct light requirements for mushrooms may be difficult.

Table 9. Materials and cost analysis of wood log raised bed.

Material	Cost ^a	Total
Wooden logs	\$0	\$0
Rebar (optional)	\$4.03/2'	\$32.20
Fill Soil	\$2.77/cu ft	\$62.94
	TOTAL	\$95.14

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

Tools Required

- Shovel or rake
- Wheelbarrow
- Chainsaw
- Measuring tape
- Hammer
- Drill

Metal

Metal raised beds come in many different shapes and sizes. Metal beds are generally lighter than wood or concrete beds making movement of materials easier. Kits can be purchased online and shipped to your front door. Thinner metals contain ridges adding strength to the material. In addition, cross members keep the sides from pushing out. Durability of the metal depends on the thickness and corrosion treatment as well as pH of the soil and moisture content. Typically, beds are constructed of galvanized steel with a 20-24-gauge thickness. Research shows that galvanized steel at a 14-gauge thickness could last 35 - 50 years or longer before first perforation (Bednar 1989).

Table 10. Materials and cost analysis galvanized metal raised bed.

Material	Cost ^a	Total
Metal bed Kit	\$87.99	\$87.99
Fill Soil	\$2.77/cu ft	\$88.72
	TOTAL	\$176.71

^aBased on average of three searches 2022 using a standard 4'x8'x12" bed

Tools Required

- Shovel or rake
- Wheelbarrow
- Screwdriver

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