Table 1. Desirable range of soil properties for healthy plants in urban landscapes (based on CSU Soil Testing Lab Methods) *

pH *(Influences availability of nutrients for plant uptake)*	pH less than 6 is considered too acidic for most plants. Addition of lime is recommended to raise pH to 6.0. pH 6.0 to 7.2 is the preferred pH range for growth of most plants. pH 7.3 to 7.9: plants native to the Colorado Front Range are generally well adapted, but most garden and landscape plants will tolerate this pH range with few problems if supplemental nutrients and irrigation are added when needed. pH = 8.0 to 8.4: it may be difficult to obtain optimal growth for plants not adapted to high pH soils. Deficiencies of iron, zinc, manganese, and phosphorus may occur. pH greater than 8.5 indicates that the soil probably contains excess sodium. An SAR test and gypsum application are recommended.
E.C. or SALTS *(Electrical Conductivity)*	When E.C. is less than 2.0, salinity is not a problem for most plants. E.C. = 2 to 4 is slightly saline; many landscape plants are negatively affected. E.C. = 4.1 to 8 is moderately saline; most landscape plants are negatively affected. Xeriscape plants tend to be more tolerant of this level of salinity. E.C. > 8 is strongly saline. Most plants do not survive this level of salinity. **See CSU GardenNotes 224 *Saline Soils* or CSU Fact Sheet 0.503 *Managing Saline Soils* at www.cmg.colostate.edu for information on removing excess salts from soils.**
Lime Estimate *(Keeps the soil pH high)*	"Low" indicates less than 1% $CaCO_3$ (free lime) "Medium" indicates 1-2% $CaCO_3$ (free lime) "High" indicates 2-5% $CaCO_3$ (free lime) "Very high" indicates greater than 5% $CaCO_3$ (free lime) If the lime content of the soil is medium-to-high, soil pH cannot effectively be lowered by the addition of acidifying amendments. Any decrease in soil pH is temporary because the lime in the soil neutralizes all acidity added. If soil lime is <1%, it is possible to achieve a temporary decrease in soil pH by adding an acidifier e.g., peat moss or sulfur, but repeated applications are necessary. **See CSU GardenNote 222 *Soil pH* at www.cmg.colostate.edu for more information.**
Texture Estimate *(Influences water movement and retention, and nutrient retention, in the soil)*	Clayey soils drain at slow rates, about 0.25 to 0.33 inches per hour. They have high water- and nutrient-holding capacities but can be poorly aerated, especially if compacted. Loamy soils drain at moderate rates, about 0.5 inches per hour. Sandy soils drain at fast rates, about 0.7 inches per hour. They have low water- and nutrient-holding capacities, which usually can be increased by the addition of organic matter.
SAR ***(Sodium Adsorption Ratio)***	SAR is the amount of sodium in the soil relative to the amounts of calcium and magnesium. If SAR is less than 13, sodium is not a problem in the soil. If SAR>13, the soil is sodic, and addition of gypsum will be recommended.
%O.M. *(Organic Matter)* *Annual beds: Maximum annual application: 1" of manure or manure compost, or 2" of plant-based compost, tilled into the top 6-8" of soil.* *Perennial beds: organic mulch on the soil surface decomposes and slowly adds organic matter to the soil.*	Less than 3% O.M. is Low. Adding compost to the soil would be beneficial for most plants. 3 to 4% O.M. is Moderate. Moderate soil OM is adequate for good plant growth of most landscape plants. 4.1 to 6 %OM is High. Application of compost is not needed if %OM is ≥ 5%. Over-amending with compost may add excess salts to the soil, which can harm plant growth. Focus instead on protecting and replenishing the soil OM content by using an organic mulch. ***See CSU GardenNotes 245 Mulching with Wood/Bark Chips, Grass Clippings and Rock* at www.cmg.colostate.edu for more information.** Greater than 6 %OM is Very High. Do not add more compost. Very high levels of soil OM resulting from over-amending the soil with compost can disrupt healthy nutrient ratios in the soil and can add excessive levels of salinity to the soil.

%O.M. *(Organic Matter)* **Cont.**	**See CSU GardenNotes #241 *Organic Soil Amendments* and #243 *Using Compost* at www.cmg.colostate.edu for information on compost selection and application rates.** **Native/xeric/adapted plants:** Many, but not all, of these plants prefer soils with a low soil OM content (<3%) and may not thrive in a high OM soil. See information on specific plant preferences at www.cmg.colostate.edu, or www.plantselect.org . **Vegetables, fruits and annual flower beds**: A moderate level of soil OM (3 to 4%) is adequate for good plant growth, but these plants generally prefer high soil OM (4.1 to 6%). If raising the level of soil OM is desired, gradually increase soil OM content by the annual addition of 1" of compost incorporated into the top 6-8" of the soil until at least a moderate level of soil OM is achieved. Do not add more compost than the recommended annual amount. Stop routine annual additions of compost when about 5% soil OM is achieved, to avoid salinity and nutrient balance problems associated with over-amending with compost. Once a high level of soil OM is achieved, protect and replenish soil OM content by using organic mulch **(see CSU GardenNotes 245 *Mulching with Wood/Bark Chips, Grass Clippings and Rock***), and planting cover crops as a green **manure (See CSU GardenNotes #244 *Cover Crops and Green Manures*** at www.cmg.colostate.edu). Every few years reanalyze the soil to determine if %OM has decreased to a level where adding compost is recommended again. **Trees and shrubs**: A moderate level of soil OM is adequate for good growth. Incorporating compost into the soil to increase soil OM content of established perennial beds is difficult because of potential damage to perennial roots. However, a 3-4" depth of wood/bark mulch will gradually increase surface soil OM content as the mulch decomposes. Xeric trees and shrubs that prefer low fertility soil may not thrive with an organic mulch and may grow better with a rock mulch. **(see CSU GardenNotes 245 *Mulching with Wood/Bark Chips, Grass Clippings and Rock*** *at www.cmg.colostate.edu).* ***Planting a tree or shrub***: Amending the backfill soil OM content (1-part compost to 20 parts backfill soil) is standard procedure in garden soil amendment. Do not add more compost than the recommended amount. Use well-aged, high-quality compost and thoroughly mix the compost into the backfill soil. See CSU GardenNotes #633 *The Science of Planting Trees* at www.cmg.colostate.edu for full directions on how to properly plant a tree. If the tree or shrub is a native or xeric variety that prefers low-OM soil, do not add compost to the backfill soil. **Perennial ornamental beds**: Moderate soil OM is adequate for good plant growth, although many non-native plants prefer high soil OM (4.1 to 6% soil OM content). Incorporating compost into the soil to increase soil OM is difficult in established perennial beds because of potential damage to perennial roots. However, a 3-4" depth of wood/bark mulch will gradually increase surface soil OM content as the mulch decomposes. **(see CSU GardenNotes 245 *Mulching with Wood/Bark Chips, Grass Clippings and Rock* at www.cmg.colostate.edu for more information**) ***Planting ornamental perennials***: If the plant variety prefers high-OM soil, add a well-aged, high-quality compost to the backfill soil at a rate of 1-part compost to 20 parts backfill soil and mix together thoroughly. Do not add more compost than the recommended rate. **Turf/Lawn**: Moderate soil OM (3 to 4%) is adequate for good plant growth. Adding compost to established turf is difficult since the compost cannot be tilled into the soil. However, with proper irrigation and fertilization, established lawns will accumulate soil OM over time from root turnover. Returning clippings to the lawn provides a source of recycled nutrients and organic matter. **Establishing a new lawn**: Incorporate 3 cu. Yd. of high-quality, well-decomposed compost into the top 6-8" of the soil, along with any fertilizers specified by the soil test results. See CSU Plantalk 1516 (seeding a Lawn) or CSU Plantalk 1517 (Sodding a Lawn) at www.cmg.colostate.edu for full directions.

NO_3-N
(Nitrate-nitrogen)

NOTE: Plant-available nitrogen is the sum of ammonium-N and nitrate-N in the soil. Normally in urban landscapes, very little of the plant-available N is in the ammonium form in soils. Since most of the plant-available N in soil is in the nitrate form, often only nitrate-N is analyzed for a standard soil test.

For each pound of N needed per 1000 sq. ft., apply 2.5 lb. urea, 5 lb. ammonium sulfate, 7.5 lb. bloodmeal, 10 lb. corn gluten meal, or 50 lb. alfalfa meal pellets. Per 100 sq. ft. apply 0.25 lb. urea, 0.5 lb. ammonium sulfate, 0.75 lb. blood meal, 1 lb. corn gluten meal, or 5 lb. alfalfa meal pellets.

See CSU Garden*Notes* #232 *Understanding Fertilizers,* #233 *Calculating Fertilizer Rates,* and #234 *Organic Fertilizers* at www.cmg.colostate.edu for more information.

Xeriscapes: If NO_3-N is less than 20 ppm, add 1 lb. N per 1000 sq. ft. Adequate moisture is needed when fertilizers are applied. If NO_3-N is 20 ppm or higher, no fertilizer N is needed.

Trees and shrubs (irrigated):

If NO_3-N is 20 ppm or higher, no fertilizer N is needed.
If NO_3-N is 13 to 19 ppm, add 1 lb. N per 1000 sq. ft.
If NO_3-N is 0 to 12 ppm, add 2 lb. N per 1000 sq. ft.

If trees or shrubs are not irrigated, cut the recommended fertilizer application rate in half. Response to added fertilizer depends on adequate soil moisture in non-irrigated conditions.

Fertilizing in August or later tends to delay hardening of woody plants, which can result in winter kill. Avoid adding fertilizers to new plantings; let them adapt and grow some before fertilizing.

Vegetables, fruits and non-xeriscape ornamentals:

	% Organic Matter				
NO_3-N	0 - 1%	1.1 - 2%	2.1 - 3%	3 - 4.9%	>5 %
ppm	*Pounds of N to add per 1000 sq. ft. area*				
0 to 9	3	3	3	2	1
10 to 19	3	3	2	1	0
20 to 29	3	2	1	0	0
30 to 39	2	1	0	0	0
40 to 49	1	0	0	0	0
>50	0	0	0	0	0

Both the amount of N needed, and the timing of fertilizer N application, vary for different types of vegetables. **See CSU GardenNote 711 *Vegetable Gardens: Soil Management and Fertilization*** for information on specific crop preferences. (www.cmg.colostate.edu). If using rapid-release inorganic fertilizer, avoid adding more than 1 lb. N per 1000 sq. ft. at any one fertilizer application.

Established Turf: If NO_3-N = 20 ppm or higher, no fertilizer is needed. Fertilize when NO_3-N is less than 20 ppm. **(See CSU Fact Sheet 7.202 *Lawn Care*, by T. Koski and V. Skinner)**

High maintenance bluegrass/ryegrass: 1 lb. N/1000 sq. ft. in each of 4 applications:
(1) Mid-April, (2) May-to-mid-June, (3) mid-Aug to mid-Sept, (4) early Oct to early Nov.
Low maintenance bluegrass, tall fescue, fine fescue: cut above rates in half, omit July/Aug
Buffalograss, blue grama, bermudagrass: ½ lb. N/1000 sq.ft. in May/June, and July/Aug.

P
(Plant-available phosphorus)

Most Colorado soils are not deficient in plant-available P.

Xeriscapes, Trees, Shrubs: P= 15 ppm or higher is adequate for good plant growth. If P = 0 to 14 ppm, add 1 lb. P_2O_5 per 1000 sq. ft. Adequate moisture is needed for plant response to added fertilizer.

	Vegetables and non-xeriscape ornamentals: P = 15 ppm or higher is adequate for good plant growth; no fertilizer P is needed P = 12 to 14 ppm is slightly low; add 1 lb. P_2O_5 per 1000 sq. ft. P = 8 to 11 ppm is medium-low; add 2 lb. P_2O_5 per 1000 sq. ft. P = 0 to 7 ppm is low; add 3 lb. P_2O_5 per 1000 sq. ft. **Turf:** P = 20 ppm or higher is adequate, no fertilizer P is needed P = 10 to 19 ppm; add 1 lb. P_2O_5 per 1000 sq. ft. P = 0 to 9 ppm; add 2 lb. P_2O_5 per 1000 sq. ft. ***P that is applied to the soil in excess of plant needs can interfere with the plant's ability to take up iron and zinc. Excess P also can be found in runoff waters, which can result in eutrophication (algal blooms) of ponds and lakes.***
K *(Plant-available potassium)*	**Most Colorado soils are not deficient in plant-available K.** **Xeriscapes**: K = 120 ppm is or higher adequate for good plant growth; if K is less than 120 ppm, add 1 lb. K_20 per 1000 sq. ft. Adequate moisture is needed for plant response to added fertilizer. **Turf**: K = 150 ppm or higher is adequate for good plant growth; if K is less than 150 ppm, add 1 lb. K_2O per 1000 sq. ft. **Trees, shrubs**: K = 150 ppm or higher is adequate for good growth; if K = 50 to 149 ppm, add 1 lb. K_2O per 1000 sq. ft. If K is less than 50 ppm, add 2 lb. K_2O per 1000 sq. ft. **Vegetables, non-xeric ornamentals**: K = 180 ppm or higher is adequate for good plant growth; no fertilizer K is needed K = 121 to 179 ppm is medium-low; add 1 lb. K_2O per 1000 sq. ft. K = 61 to 120 ppm is low; add 2 lb. K_2O per 1000 sq. ft. K = 0 to 60 ppm is very low; add 3 lb. K_2O per 1000 sq. ft. ***Natural soils typically contain 250 to 350 ppm plant-available K. Available K levels greater than 500 ppm are high, and levels greater than 800 ppm are very high, suggesting an over-application of manure-based compost. High levels of available K can interfere with plant uptake of other nutrients e.g., calcium and magnesium.***
Zn *(Plant-available zinc)*	1.5 to 15 ppm plant-available zinc is adequate for good plant growth. 16 to 99 ppm is high; avoid adding manure-based compost or fertilizers containing zinc. Levels greater than about 100 ppm are very high and may inhibit plant growth.
Fe *(Plant-available iron)*	10 ppm plant-available iron is adequate for good plant growth. Some plants tolerate 5-10 ppm. Over-application of iron can interfere with plant uptake of other micronutrients e.g. zinc
Mn *(Plant-available manganese)*	0.5 to 5 ppm plant-available manganese is adequate for good plant growth. 6 to 39 ppm is high; avoid adding manure-based compost or fertilizers containing manganese Levels greater than 40-50 ppm are very high and may inhibit plant growth.
Cu *(Plant-available copper)*	0.2 to 10 ppm plant-available copper is adequate for good plant growth. 11 to 19 ppm is high; avoid adding manure-based compost, or fertilizers containing copper Levels greater than 20-30 ppm are very high and may inhibit plant growth.
B *(Plant-available boron)*	0.5 to 1.5 ppm plant-available boron is adequate for good plant growth. Levels greater than 4 ppm may inhibit plant growth.

**** Values presented are based on the laboratory methodology used by the Colorado State University Soil, Water and Plant Testing Laboratory, Fort Collins CO, as of December, 2020. Table values may not be applicable to soil data from other labs using different methods.***

***** When a nutrient content of the soil is at the adequacy level, as indicated above, no supplemental fertilizer is needed.***

CSU GardenNotes and Fact Sheets can be found at www.cmg.colostate.edu