

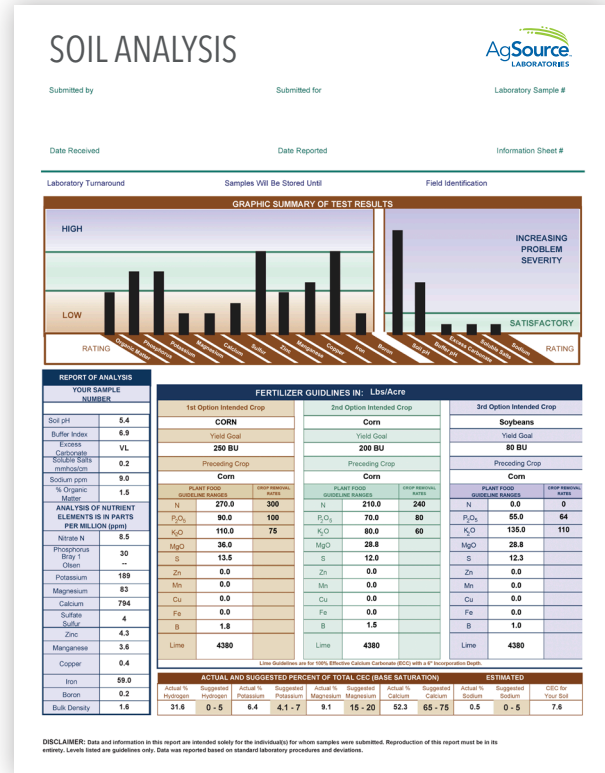
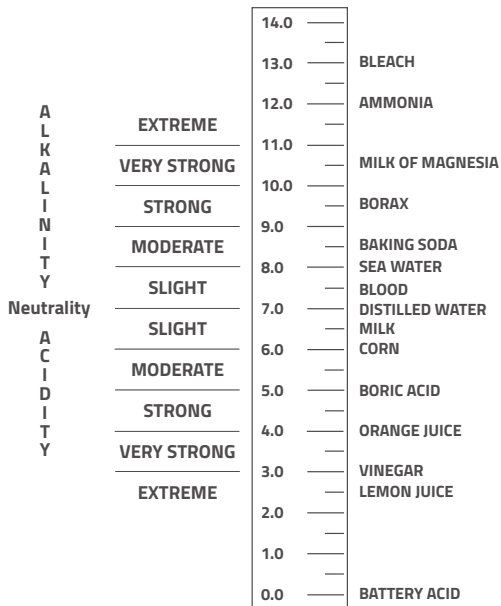
Understanding a Soil Report

1. Soil pH

Soil pH is a measure of the acidity in the soil. An acidic soil has a greater amount of hydrogen (H+) ions and a pH below 7.0. Values above 7.0 indicate a basic soil. The pH values of most soils range from 5.0 to 8.5; however, slightly acidic conditions are usually the most productive (6.4 to 6.9). Manage soil pH by adding either lime to raise it, or an acid forming material to lower it.

Because soil pH measures only the active hydrogen, it is quite variable from one season to the next. This variability makes it difficult to predict the amount of lime necessary to neutralize all the acidity.

Figure 1. Alkalinity Chart



2. Buffer Index

Buffer Index is also referred to as Buffer pH or Buffer Code. This pH value measures the response of the soil to a known amount of lime. Lime is added to soil to neutralize soil acidity and raise pH. As the Buffer pH values range downward from 7.5, this measurement indicates increasing amounts of lime required to raise soil pH. The lower the value is below 7.5, the greater the amount of lime required.

If the difference between the Soil pH and the Buffer Index measurements is large and the Buffer Index is 7.2 or higher, it means that the soil pH is easily changed, and a low rate of lime will be sufficient. If the Buffer Index is not much higher than the Soil pH it means that it is difficult to change the pH of the soil and a larger lime addition is needed to reach the desired pH level. Buffer Index is often measured and reported on every sample but only used to calculate the lime requirement when the soil pH is below 6.5.

SOIL ANALYSIS



Submitted by **(A)**

Submitted for

Laboratory Sample #

Date Received

(B)

Date Reported

(C)

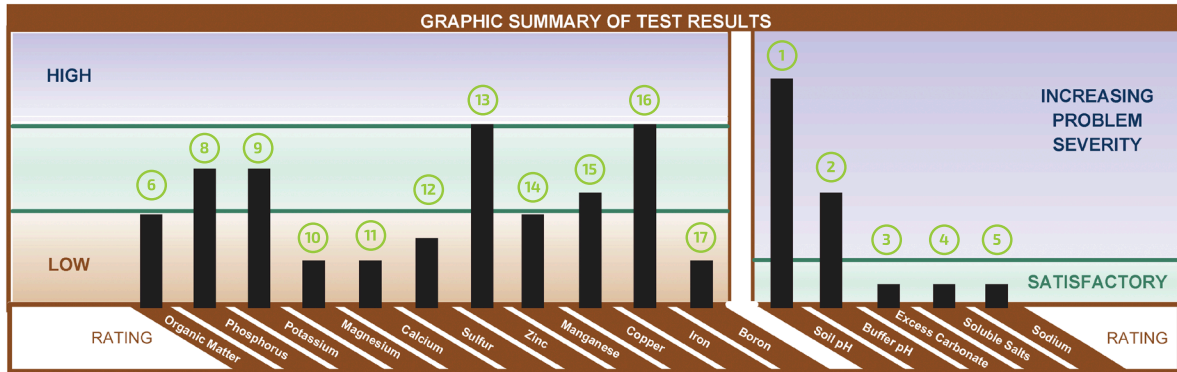
Information Sheet #

(D)

Laboratory Turnaround

Samples Will Be Stored Until

Field Identification **(G)**



REPORT OF ANALYSIS

YOUR SAMPLE NUMBER

(F)

Soil pH	5.4
Buffer Index	6.9
Excess Carbonate	VL
Soluble Salts mmhos/cm	0.2
Sodium ppm	9.0
% Organic Matter	1.5
ANALYSIS OF NUTRIENT ELEMENTS IS IN PARTS PER MILLION (ppm)	
Nitrate N	8.5
Phosphorus Bray 1 Olsen	30
Potassium	189
Magnesium	83
Calcium	794
Sulfate Sulfur	4
Zinc	4.3
Manganese	3.6
Copper	0.4
Iron	59.0
Boron	0.2
Bulk Density	1.6

FERTILIZER GUIDELINES IN: Lbs/Acre

1st Option Intended Crop	2nd Option Intended Crop	3rd Option Intended Crop
CORN	Corn	Soybeans
Yield Goal	Yield Goal	Yield Goal
250 BU	200 BU	80 BU
Preceding Crop	Preceding Crop	Preceding Crop
Corn	Corn	Corn
PLANT FOOD GUIDELINE RANGES	PLANT FOOD GUIDELINE RANGES	PLANT FOOD GUIDELINE RANGES
CROP REMOVAL RATES	CROP REMOVAL RATES	CROP REMOVAL RATES
N 270.0 300	N 210.0 240	N 0.0 0
P ₂ O ₅ 90.0 100	P ₂ O ₅ 70.0 80	P ₂ O ₅ 55.0 64
K ₂ O 110.0 75	K ₂ O 80.0 60	K ₂ O 135.0 110
MgO 36.0	MgO 28.8	MgO 28.8
S 13.5	S 12.0	S 12.3
Zn 0.0	Zn 0.0	Zn 0.0
Mn 0.0	Mn 0.0	Mn 0.0
Cu 0.0	Cu 0.0	Cu 0.0
Fe 0.0	Fe 0.0	Fe 0.0
B 1.8	B 1.5	B 1.0
Lime 4380	Lime 4380	Lime 4380

Lime Guidelines are for 100% Effective Calcium Carbonate (ECC) with a 6" Incorporation Depth.

ACTUAL AND SUGGESTED PERCENT OF TOTAL CEC (BASE SATURATION)

ACTUAL AND SUGGESTED PERCENT OF TOTAL CEC (BASE SATURATION)						ESTIMATED				
Actual % Hydrogen	Suggested Hydrogen	Actual % Potassium	Suggested Potassium	Actual % Magnesium	Suggested Magnesium	Actual % Calcium	Suggested Calcium	Actual % Sodium	Suggested Sodium	CEC for Your Soil
31.6	0 - 5	6.4	4.1 - 7	9.1	15 - 20	52.3	65 - 75	0.5	0 - 5	7.6 (18)

DISCLAIMER: Data and information in this report are intended solely for the individual(s) for whom samples were submitted. Reproduction of this report must be in its entirety. Levels listed are guidelines only. Data was reported based on standard laboratory procedures and deviations.

3. Excess Carbonate

Excess Carbonate measures the amount of free limestone in the soil. Ratings increase from Very Low to Very High indicating increasing amounts of un-reacted lime present in the soil. Associated with high pH, and originating from sources that are native to the soil, it is very difficult to reduce the amount of free carbonate in a soil. However, knowing the excess carbonate content in the soil can be important in herbicide selection and in choosing fertilizer application techniques.

4. Soluble Salt

Soluble Salt (EC) is a measure of the electrical conductivity of soil solution, expressed as mmhos/cm. This measures the concentration of dissolved salts in the soil solution. High values are associated with higher salt concentrations and reduced plant growth. For salt-sensitive plants the critical value is between 1.0 and 1.5 mmhos/cm. If the soil is sandy the lower value in the range applies.

Generally, high salt levels are associated with soils that have poor drainage conditions. The salts accumulate at the soil surface rather than leaching throughout the profile. If irrigation water contains a medium or high amount of salt, the accumulation process increases.

5. Exchangeable Sodium (Na)

Sodium (Na) is not considered to be a required nutrient for most plants but it has both beneficial and detrimental effects on plants and in soil. High sodium content in the soil reduces water infiltration and limits root growth. Sodium also competes with potassium for plant uptake. Reducing high sodium levels involves replacing the element with another beneficial element, usually calcium, and leaching the soil.

6. Organic Matter (OM)

Organic Matter (OM) refers to the stable byproducts of decomposition that occur in the soil. The organic matter content, expressed as a percent, reflects the ability of the soil to supply nutrients, moisture and other physical benefits to growing plants. Productive soils can range from 0.5% up to 10% organic matter depending on soil texture, local geographic and prevailing climatic conditions.

Organic matter acts as a storehouse for plant nutrients and improves physical structure of the soil. It has a very high capacity for holding cations as well as soil water. Because of its active holding sites, mining organic matter also impacts the choice of herbicide and adjustments of application rates.

MAJOR NUTRIENTS

7. Nitrate (NO₃)

Nitrate (NO₃) is the most common measure of available nitrogen in the soil. As a required component in all proteins, nitrogen is an essential plant nutrient. Nitrogen is usually applied to the soil as fertilizer but it is also available from biological sources such as manure, decomposing plant residues, or through nitrogen fixation in legumes. Nitrate is a form of nitrogen that is easily absorbed by plants and utilized by soil microorganisms, yet it can rapidly leach out of the soil as well. Because of this mobility the nitrate value indicates the available nitrogen at the time the sample was collected, but not what will be available later in the season.

This nitrate nitrogen measurement is reported as ppm of nitrogen in the nitrate form (NO₃-N) and can be easily converted to pounds per acre (lbs/acre) of NO₃-N. To convert ppm into pounds/acre, use the following formula:

$$\text{Sampling depth (in inches)} \times 0.333 = \text{conversion factor (CF)}$$
$$\text{CF} \times \text{NO}_3\text{-N ppm} = \text{NO}_3\text{-N pounds/acre}$$

Example:

Soil test = 7 ppm NO₃-N
Sample collection depth = 0 to 8 inches

$$8 \times 0.333 = 2.66$$
$$2.66 \times 7 \text{ ppm} = 19 \text{ pounds/acre Nitrate Nitrogen (NO}_3\text{-N)}$$

8. Phosphorus

Phosphorus (P) is an essential plant nutrient that is often low in soil and must be added as fertilizer. Phosphorus is a key nutrient for seedling growth because it contributes significantly to healthy seed formation and to initial root development after germination. Phosphorus is also directly related to energy transfers in cells that are vital to all growth processes.

The availability of phosphorus in soil is influenced by pH and mineralogy. Different analysis methods are used to give an index of availability in these various soil conditions. Bray is suited for neutral and low pH soil and Olsen is used on high pH samples. Mehlich 3 is used on most types of soil and across the pH range typically found in cultivated soils. Soil test ranges are similar for Bray and Mehlich 3 and lower for Olsen extractions. The following table defines the interpretation for two methods.

Rating	Bray or Mehlich 3 Phosphorus PPM	Olsen Phosphorus PPM
Low	1-14	1-9
Low to adequate	15-25	10-15
Adequate	26-40	16-24
High	>40	>24

9. Potassium (K)

Potassium (K) is another essential plant nutrient that is used in large amounts by plants and is typically added as fertilizer for maximized crop growth. Potassium is involved in controlling the flow of water through plants in transpiration and is also generally associated with winter hardiness and disease resistance. The soil test evaluates the readily available, or exchangeable, potassium content of a dried and ground soil sample. Soil potassium levels can be increased by adding more K to the soil than is required by plant uptake. Levels can also decline in most soils if the crops are under-fertilized.

The following table provides a generalized interpretation for potassium. Soil textures have a great influence on its availability. With sand textures, high levels of K may be difficult to obtain because of its ability to leach.

Rating	Potassium PPM
Low	1-120
Low to adequate	121-190
Adequate	191-300
High	>400

SECONDARY NUTRIENTS

10. Magnesium (Mg)

Magnesium (Mg) is an essential plant nutrient that is typically abundant in soils, especially when soil pH is 6.5 and above. Magnesium is an integral part of the chlorophyll molecule, which means it is essential for photosynthesis. Magnesium is also associated with phosphorus uptake and utilization within the plant. As was noted above, if the soil requires lime to raise the pH, then ground limestone is added as the liming material. If magnesium is low it can be increased in the soil with a dolomitic liming material.

11. Calcium (Ca)

Calcium (Ca) is an important constituent of plant cell walls, thereby giving overall strength to the plant. Calcium is also essential for good root development and may serve to neutralize some toxic compounds present in the plant. Calcium is abundant in mineral soils with pH above 6.0. Because calcium is the major component of limestone added to raise soil pH, it is adequately supplied to plants in the management of acidic soils as well.

12. Sulfur

Sulfur (S) is available to plants through root uptake. Sulfur is an integral part of certain amino acids and, therefore it is necessary in the formation of proteins. Measurements of sulfur in the soil are based on an extraction of sulfate, the soluble, most readily available form. This form is subject to leaching and therefore a soil analysis indicates the available S at sampling time. The ability of the soil to supply sulfur to a crop is influenced by soil organic matter content, recent manure additions and sulfur from air pollution that is deposited through rainfall. These sources may not be enough to meet crop requirements and additional S can be applied to the soil as fertilizer. See Boron on the table in the Micronutrients section for interpretation ranges.

MICRONUTRIENTS

Below is a table which gives a general interpretation for these micronutrients.

Rating	Zinc PPM	Manganese PPM	Copper PPM	Iron PPM	Sulfur PPM	Boron PPM
Low	0.1-0.8	0.1-2.5	0.1-0.4	0.1-4.5	1-4	0.1-0.5
Low to adequate	0.9-1.2	2.6-4.0	0.5-0.9	4.6-7.0	5-9	0.6-0.9
Adequate	1.3-3.0	4.1-12.0	1.0-2.0	7.1-20.0	10-25	1.0-1.5
High	>5.0	>50	>2.0	>70	>25	>2.0

13. Zinc (Zn)

Zinc (Zn) regulates energy use and chlorophyll production in plant cells. Soil tests for Zn are able to accurately predict if a crop will respond to additions of zinc fertilizer. Levels typically found in the soil are 5 ppm and lower, with response to fertilizer being less likely if the value is above 2 ppm.

14. Manganese (Mn)

Manganese (Mn) activates enzymes that are involved in photosynthesis. Manganese availability in the soil is influenced by soil pH and organic matter content. Low pH increases manganese availability in soil as does increasing organic matter at higher pH ranges. However, soils that formed from organic material, such as muck soils, may have very low levels of plant available manganese. Deficiencies are more likely when the values extracted from the soil are below 4 ppm.

15. Copper (Cu)

Copper (Cu), like iron, is an important part of chlorophyll production and is essential to many enzymes as well. Deficiencies of copper are found in very acidic soils with naturally high levels of organic matter (such as peat or muck soils) and when the extracted levels are below 0.5 ppm.

16. Iron (Fe)

Iron (Fe) is a common element in many soils. As a plant nutrient iron is required as an integral part in chlorophyll production and is also a part of many enzymes. But iron availability is controlled by soil factors such as pH and oxygen supply around plant roots. Testing the soil for extractable iron helps to indicate the probability that iron deficiency may occur. Soils with values testing below 5 ppm are the most likely to exhibit limited plant growth.

17. Boron

Boron (B) is required in carbohydrate metabolism and sugar movement within the plant. The availability of this micronutrient is most limited on sandy soils with low organic matter. Extractable boron and values of 0.7 ppm and below are considered low while values above 5.0 ppm may actually be toxic for crops.

OTHER TESTS

18. Cation Exchange Capacity (CEC)

Cation Exchange Capacity (CEC) refers to the ability of the soil to attract and retain cations (elements with positive charges such as potassium, calcium, magnesium, sodium and hydrogen) on exchange sites present on the clay and organic matter particles in the soil. A higher value indicates that the soil has a greater capacity to supply these elements to plants as they are removed by crop uptake. Increases in soil organic matter and high clay content are associated with improved soil fertility by increasing the CEC.

This CEC value can be used as a way to estimate soil texture.

CEC	Soil Texture
0-8	Sand
8-12	Loamy Sand
13-20	Sandy/Silt Loam
21-28	Loam
29-40	Clay Loam
>40	Clay

The above table holds true about 90% of the time; however, free calcium carbonate in the soil can cause the CEC value to be inflated. If the excess carbonate values are high or very high, the soil texture should be determined with a particle size analysis.

Base Saturation

Base Saturation is the measure of the relative quantity of the basic elements (potassium, calcium, magnesium and sodium) present on the cation exchange sites in the soil and is reported in the same table as the CEC. Soils that have a pH in the neutral to basic range (6.5 – 8.0) have a higher base saturation. Hydrogen (H+) is an acidic cation and is the source of acidity in the soil. A soil with a low pH (acidic) will have a high H+ content and display a lower base saturation. Understanding base saturation is important to understanding the influence of pH on soil as well as the availability of K, Ca, and Mg as plant nutrients.

These basic cations, expressed here as percentages of CEC, typically dominate the soil's cation exchange capacity and can be managed with additions of fertilizer or lime, or by using a non-liming material, such as gypsum as a calcium source. Soil test ranges are generally quite wide for calcium and magnesium but excess calcium can induce magnesium deficiency in some cases. Excess magnesium can interfere with potassium availability in soil. And excess sodium disperses soil particles, breaking down soil structure, and it can interfere with potassium uptake as well.

The suggested cation percentages listed on each report are:

Hydrogen	Potassium	Magnesium	Calcium	Sodium
0 - 5%	3 - 7%	15 - 20%	65 - 75%	0 - 5%

Bulk Density

Bulk Density is a measure of the weight of the soil in a specific volume. The value represented here is grams of dry soil per cubic centimeter (g/cm³). Values for bulk density range from 1.0 to 1.75 g/cm³ with lower values being associated with more organic matter and higher values associated with sandy soil. High values in loamy and clay soils are often associated with soil compaction and restricted root growth.

UNITS OF MEASUREMENT

Parts per million (ppm)

Parts per million (ppm) is used for most elements in soil testing. This unit covers the very low test levels of micronutrients, often between 0.1 and 1.0 ppm, and the high test levels of potassium and calcium in the range of 200 to 5,000 ppm. This unit of measure is equivalent to the metric form, indicated as mg/kg or mg/L.

Pounds per acre (lbs/ac)

Pounds per acre (lbs/ac) is used as a way to express levels of nutrients available in the soil. This value is twice the ppm value for samples collected to a depth of 6 inches. One acre of soil to the depth of 6 inches is estimated to weigh 2 million pounds. Therefore 1 part per million is equivalent to 2 pounds per acre (2 million pounds of soil).

Percent (%)

Percent (%) is used to express the organic matter content of soil as well as the ratios of elements within the soil's cation exchange capacity.

Milli-equivalents per 100 grams (meq/100g)

Milli-equivalents per 100 grams (meq/100g) is the unit of measure for the cation exchange capacity (CEC) of the soil. The value is related to the number of positive (+) charged ions held by the clay and organic matter particles.

Millimhos per centimeter (mmhos/cm)

Millimhos per centimeter (mmhos/cm) is a measure of the electrical conductivity of a solution and is related to the salt content of that solution. Soil solution contains dissolved salts and can be measured in this way. Pure water has a very low conductivity.

Additional Information

- A. Account information and the address of the client that submitted the sample. Submitted for indicates the name and address of the client for whom the sample was collected if it is different from the Submitted by information.
- B. Date Received is the date that the sample was received by the laboratory.
- C. Date Reported is the date that the sample report was created and released by the laboratory.
- D. Information Sheet Number is an identification number created by the laboratory to help track groups of samples.
- E. Laboratory Sample Number is the individual sample number or range of numbers assigned to the sample(s) by the laboratory.
- F. Your Sample Number is the client's sample identification number provided on the submittal form with the samples.
- G. Field Identification is the client's field information as provided on the submittal form.
- H. Fertilizer Guidelines can be provided for up to three different intended crops with recommended rates given in pounds per acre or pounds per 1000 square feet. The choice of crop and yield goals must be provided along with the sample on the sample submission form.