

Soil Health 101: Evaluating and Managing Your Soil for Healthier Plants

Megan Weldon & Jay Mirro
Resource Planner & Senior Resource Planner



King Conservation District

Outline

- Who is the King Conservation District?
- A Brief History of Soil Conservation
- Soil Basics
- KCD Soil Testing Program & How to Collect a Soil Sample
- Understanding Soil Tests
- Ways to Improve Soil Health



Promoting sustainable uses of natural resources through responsible stewardship.



King Conservation District

Mission:

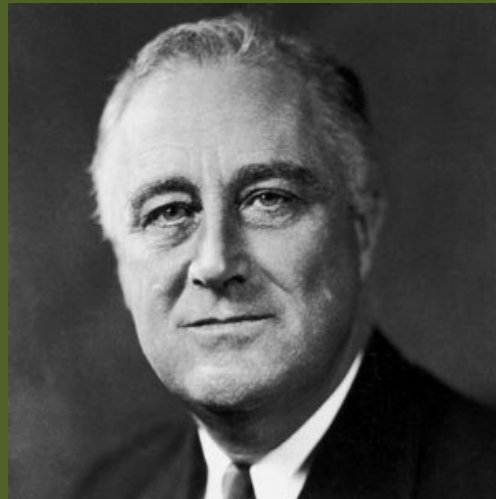
**Promote the sustainable use of natural resources
through responsible stewardship for both city
dwellers and rural residents alike.**

www.kingcd.org

Soil Conservation History



**“The nation that destroys its soil destroys
itself.” — Franklin D. Roosevelt**





KCD Programs

- Shoreline & Riparian Habitat Enhancement
- Forest Health Management
- Educational Programs
- Regional Food Systems Grant Program
- Community Agriculture
- Agricultural Drainage Programs
- Native Plant Sale
- Conservation Reserve Enhancement Program
- Equipment Rental
- Farm Management Services



A close-up photograph of two hands cupped together, holding a large amount of dark brown, crumbly soil. The hands are positioned in the center of the frame, with the fingers slightly curled. The background is a dense field of tall, green grass, which is slightly out of focus. The overall lighting is natural, suggesting an outdoor setting. A semi-transparent dark green rectangular box is overlaid on the center of the image, containing the text "Soils 101" in a white, serif font.

Soils 101

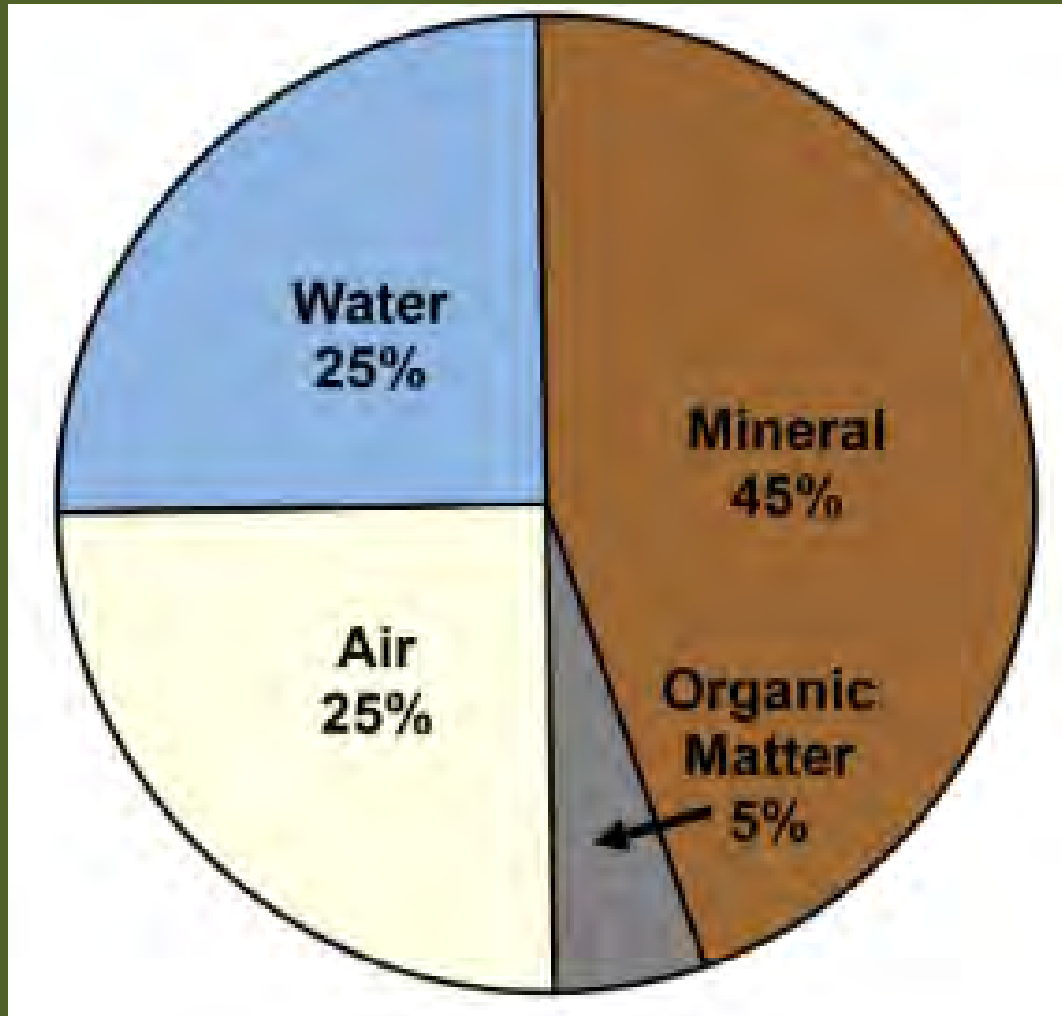
Soil Basics

Soil health is the capacity of soil to function as a living ecosystem that sustains plants, animals, and humans (USDA-NRCS, 2012).

- Retain and cycle nutrients
- Support plant growth
- Sequester carbon
- Allow infiltration and filtration of water
- Suppress pest, disease and weeds
- Detoxify chemicals
- Support food, fiber and fuel
- Provide habitat



Soil Composition



Soil Texture

3 Basic Soil Sizes:

- Sand
 - Largest particle size
 - Least holding capacity of water or nutrients per volume of soil
 - Large pore space
- Silt
 - Medium size particles
- Clay
 - Particles are small and closely spaced
 - Less pore space for air

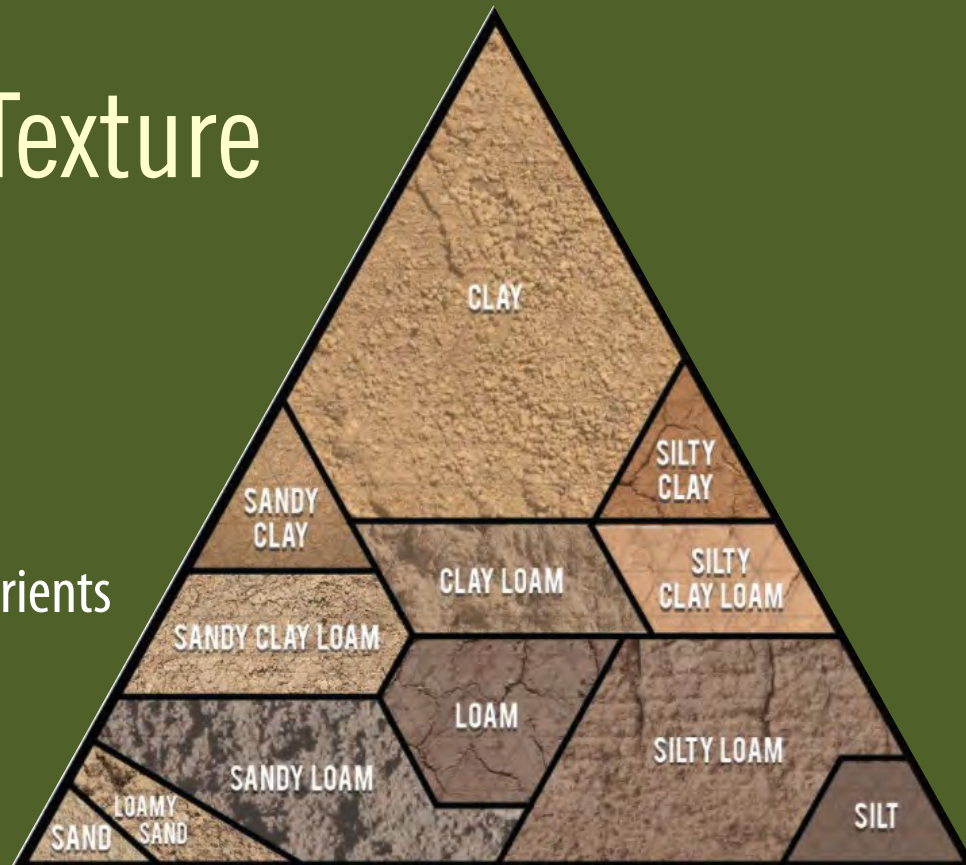
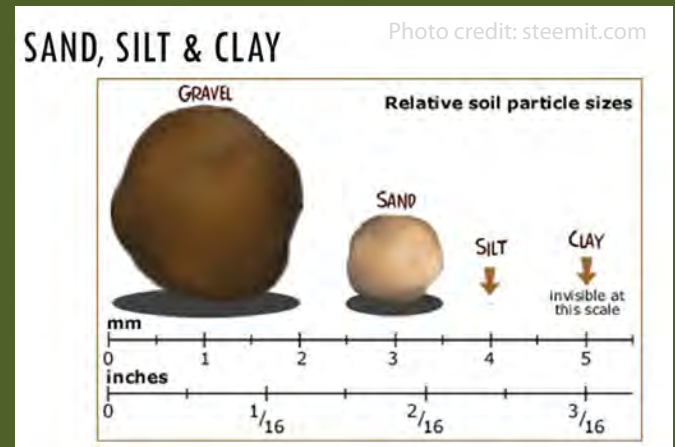
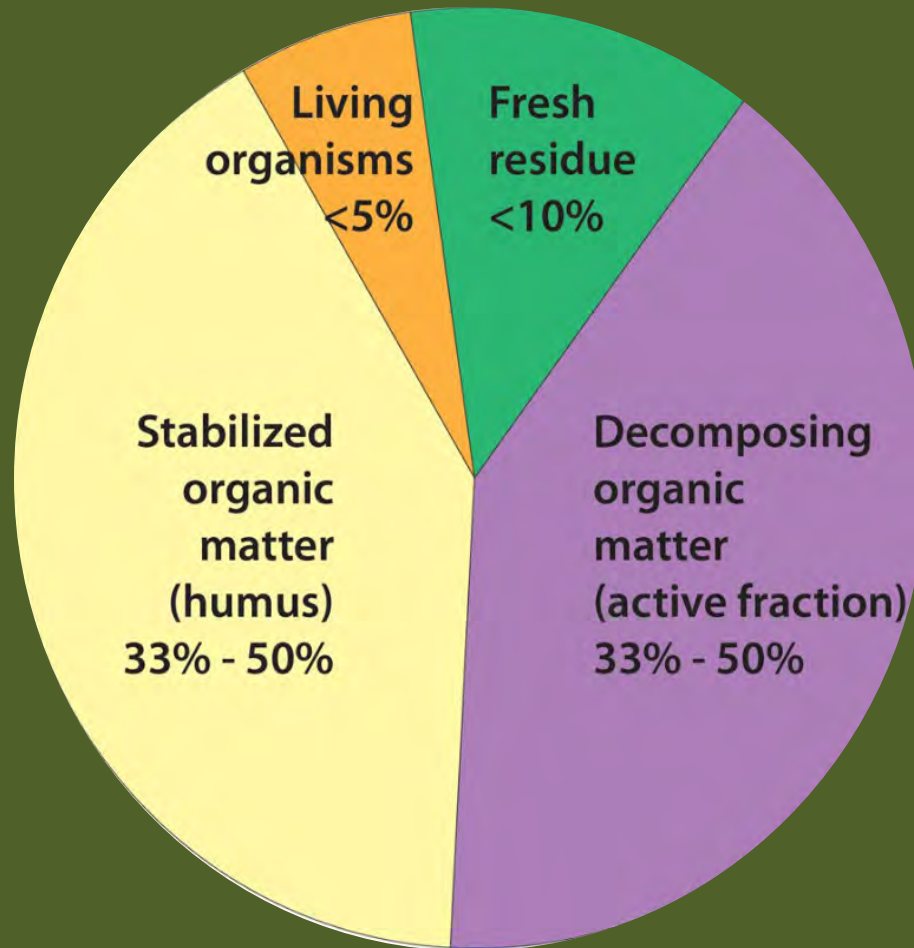


Photo credit: <http://www.grabco.co.uk/soil-guide/>



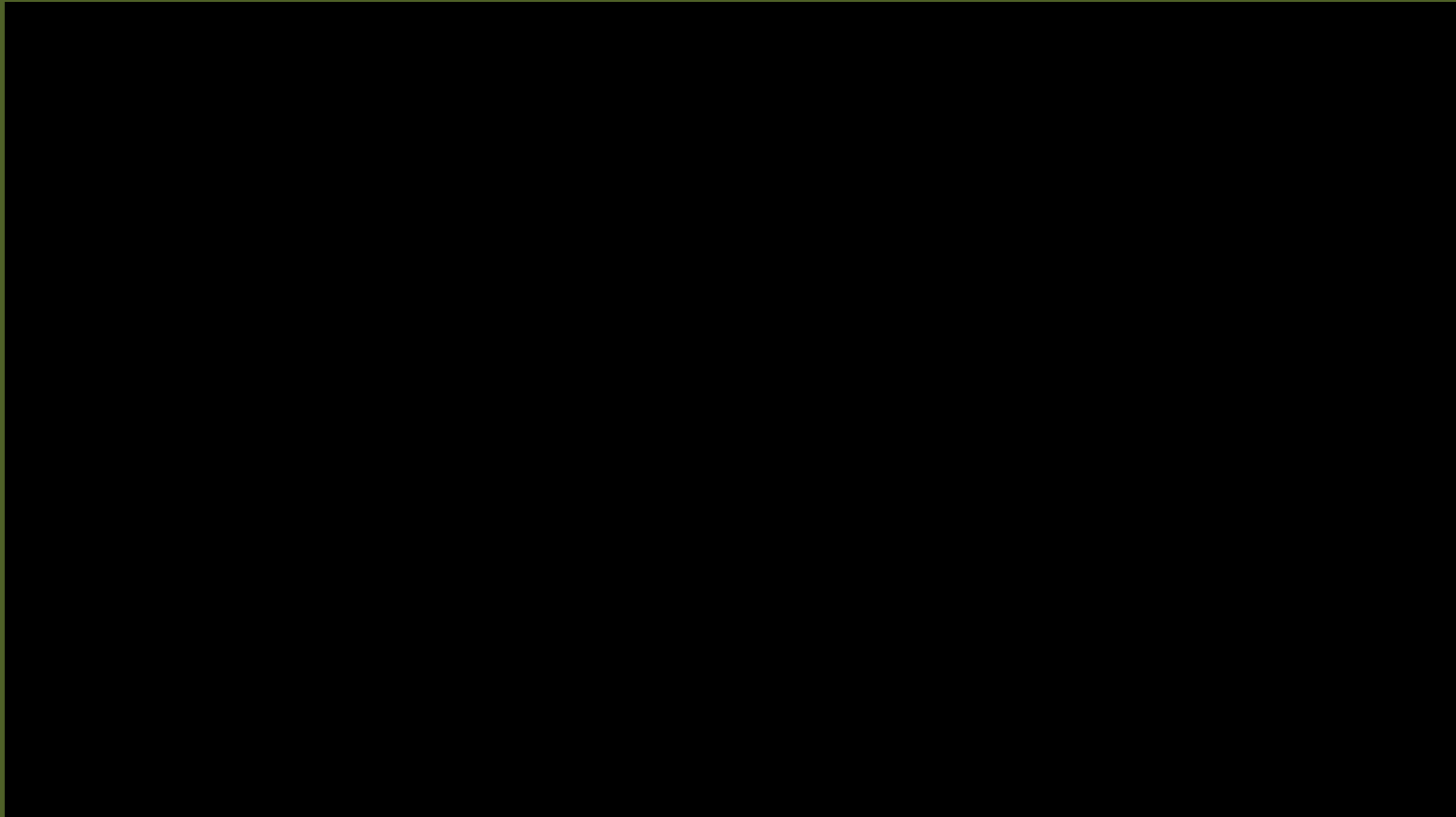
Soil Organic Matter



Organic Matter

Nutrients available for plant uptake (manure, plant residue)

<https://www.youtube.com/watch?v=Mxp1nnrUG0Q>



A photograph of a person's legs in red rubber boots. The person is stepping on the handle of a shovel that is stuck in the ground. The shovel's blade is visible, and it is covered in dark soil. The boot being stepped on also has soil on its sole. The background is a blurred garden with green plants and some red flowers.

King Conservation District Soil Testing Program



SOIL TESTING PROGRAM

Why Test Soil?

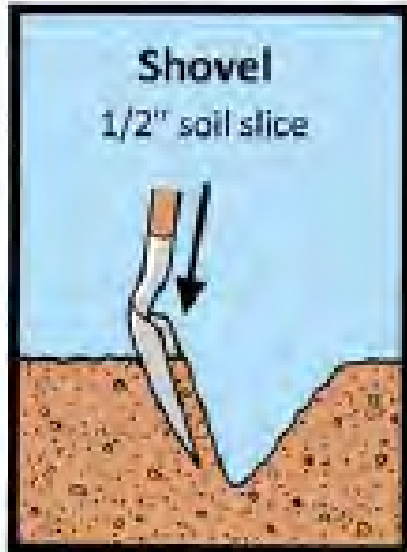
Whether growing forage for livestock, growing a vegetable garden, or maintaining an orchard or landscape, soil testing will help you to:

- ◆ Apply the correct amount of fertilizer for the plants you are growing.
- ◆ Prevent surface and groundwater from becoming contaminated by excess fertilizers.
- ◆ Ensure that soil nutrients and other conditions (such as soil pH) affecting plant growth are present in the right amounts.

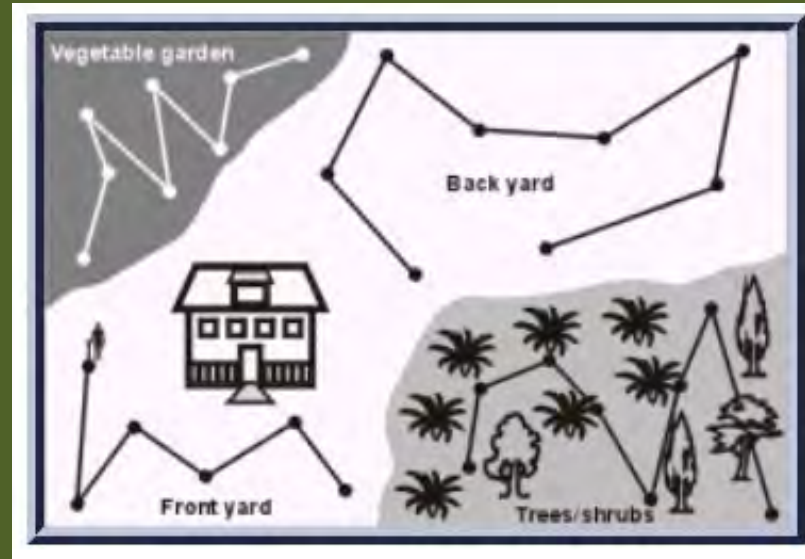
Each resident in the King Conservation District service area is eligible for up to five free soil tests, lifetime per address. Additional tests are \$20 each.



How to collect a soil sample



Take thin slices of soil approximately 1/2 inch. It is easiest to take a slice if you first remove a v-shaped hole, as shown above.



Guidelines for Sampling Depth

	Type of Crop	Sampling Depth
For samples taken in September and October	All samples	12"
	Established lawn & pasture	4"
	New lawn & pasture	6"
	Gardens	6"
	Trees & shrubs	8"
For samples taken any other time of year	Commercial crops	8"

Submitting Soil Samples to KCD



Soil Sample Information Sheet

LAB USE ONLY

LANDOWNER CONTACT INFORMATION

Name			
Home Address			
Site Address Where Sampled (if different than above)			
City	State	WA	Zip
Phone	E-mail Address		

Please print clearly and complete entire form! Results will be e-mailed in about 3 weeks. ☐ Please check this box if you do not want to be added to KCD's e-mail list.

KCD USE ONLY Submitted to A&L on / /

King Conservation District
1107 SW Grady Way, Suite 130
Renton
425-282-1900

WA 98057
soiltests@kingcd.org

Office Hours: Monday-Friday 8:30am to 5:00pm

Each resident in the King Conservation District service area is eligible for up to five free soil tests, **lifetime per parcel number**. Additional tests are \$20 each. Deliver or mail soil samples to our office (address above). **If you need to submit more than 5 soil samples, please use an additional form.** Please see our website or contact our office to determine your eligibility. www.kingcd.org

Please label each sample with your last name and up to five characters. Each sample must be **2 CUPS**. More than 3 cups may cause problems with handling, less than 2 cups may cause problems getting an accurate analysis.

☒ Graphics Report ☒ Email Report soiltests@kingcd.org

☒ Recommendations required

☐ LBS PER ACRE

☐ LBS PER 1,000 SQ FEET

SAMPLE ID (up to 5 characters)	TEST PACKAGE (office use only)	Vegetable, perennials, pasture, raised bed, etc.	DETAILED DESCRIPTION (more detailed information about what you are growing)	Please check one		Sample Depth
				Established	Pre-Plant	
<input type="text"/>				<input type="checkbox"/>	<input type="checkbox"/>	0-6"
<input type="text"/>				<input type="checkbox"/>	<input type="checkbox"/>	0-6"
<input type="text"/>				<input type="checkbox"/>	<input type="checkbox"/>	0-6"
<input type="text"/>				<input type="checkbox"/>	<input type="checkbox"/>	0-6"
<input type="text"/>				<input type="checkbox"/>	<input type="checkbox"/>	0-6"

Please let us know you found out about KCD's Soil Testing Program:

Understanding Soil Test Results



A Typical Test Results Page

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10220 SW NIMBUS AVE Bldg K-9 | PORTLAND OREGON 97223 | (503) 968-9225 | FAX (503) 598-7702



REPORT NUMBER: 15-014-077

CLIENT NO: 4793

SEND TO: KING CONSERVATION DISTRICT
1107 SW GRADY WAY STE 130
RENTON, WA 98057

GROWER: MELISSA LANG

SUBMITTED BY: JAY MIRRO

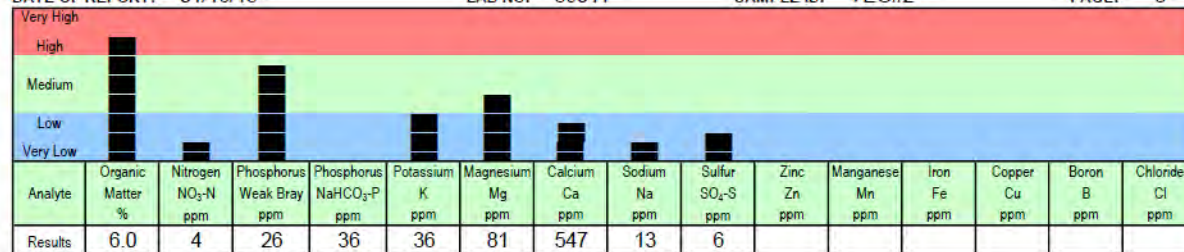
Graphical Soil Analysis Report

DATE OF REPORT: 01/16/15

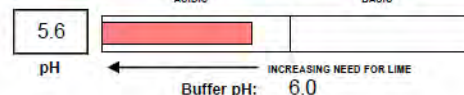
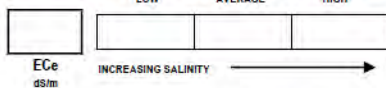
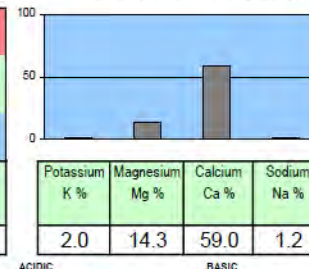
LAB NO: 59041

SAMPLE ID: VEG#2

PAGE: 3



Percent Cation Saturation (computed)



NaHCO₃-P unreliable at this soil pH

Soil Fertility Guidelines

CROP: VEGETABLES

RATE: lb/1000 sq ft

NOTES:

Dolomite 100 score	Lime 100 score	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
210				3.1	2.0	6.0		0.6					

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Organic Matter

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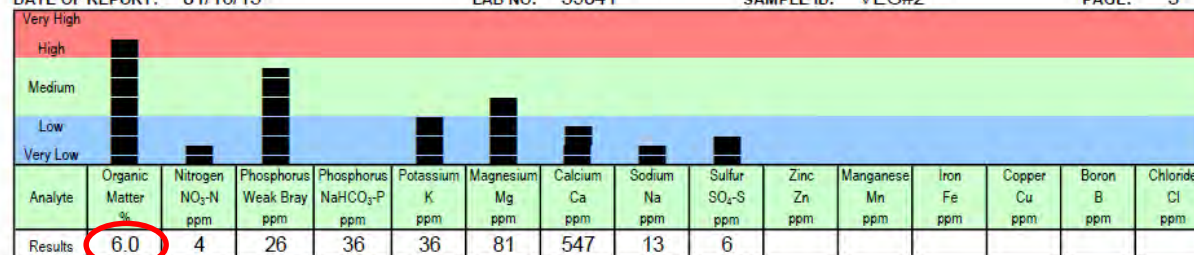
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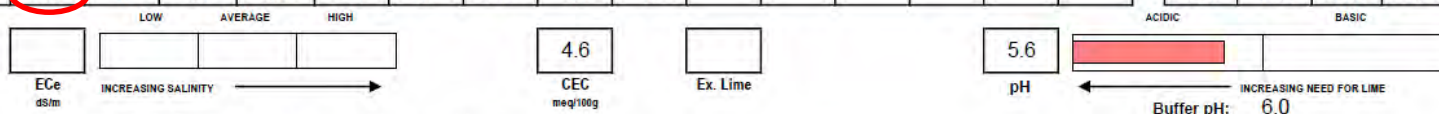
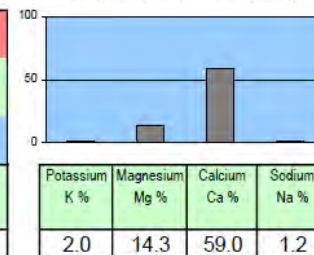
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Organic Matter

Organic Matter Reading	C.E.C. Reading	Action to Take
Less than 2	Any	Add organic matter
Below 5 but above 2	Under 20	Add high quality organic matter
Below 5 but above 2	Over 20	Maintain organic matter
Above 5	Under 20	Promote biological activity
Above 5	Over 20	Don't add

If you have high organic matter levels:

- No additional organic matter is needed
- Encourage decomposition of existing organic material
- Ensure microbial populations are present in soil (to break up OM)
 - Add small amounts of compost (15-25lbs per 100sq. ft.)
 - Apply soil inoculant (beneficial bacteria)
 - Monitor nitrogen levels



Interpreting Test Results for Nitrogen

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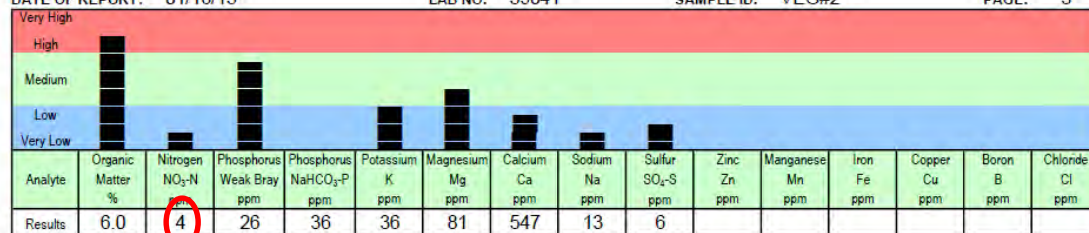
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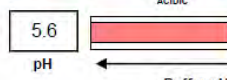
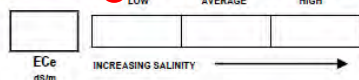
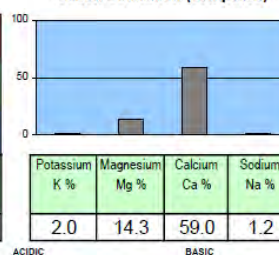
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Percent Cation Saturation (computed)



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Soil Fertility Guidelines

CROP: VEGETABLES

RATE: lb/1000 sq ft

Dolomite 100 score	Lime 100 score	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B
210				3.1	2.0	6.0		0.6					

NOTES:

Nitrogen Level

Under 10
Very Low

10-20
Low

20-30
Medium

30-40
High

Above 40
Very High

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Interpreting Test Results for Phosphorus

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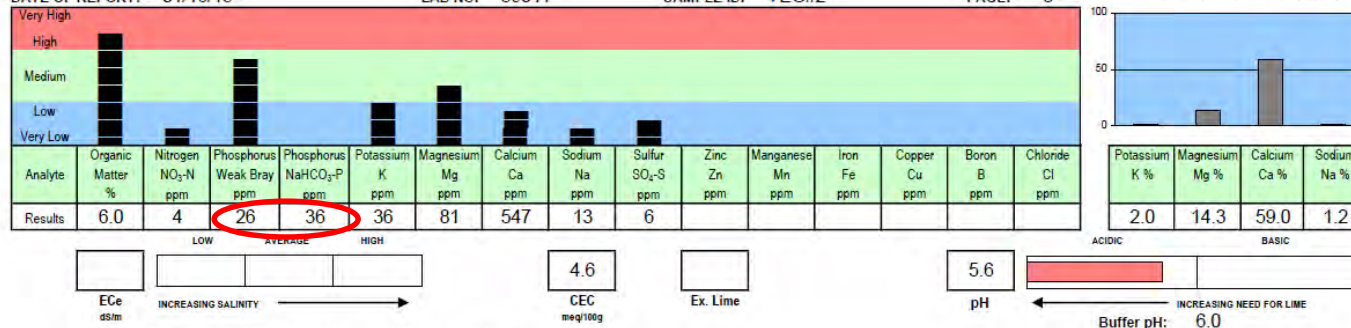
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Soil Fertility Guidelines

CROP: VEGETABLES

RATE: lb/1000 sq ft

NOTES:

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Phosphorus Level

Under 10 Very Low, Low

10-20 Medium

20-30 High

Over 30 Very High

Interpreting Test Results for Potassium

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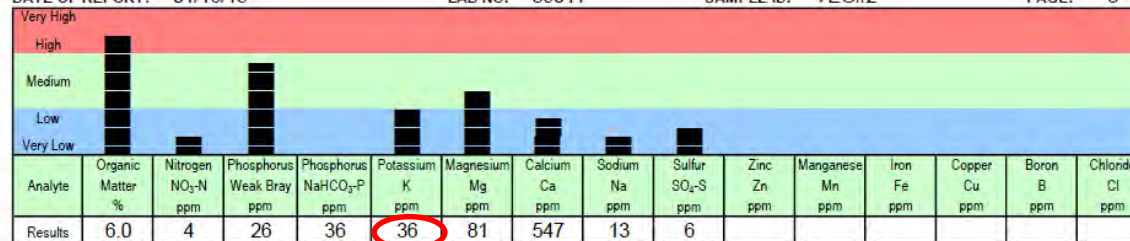
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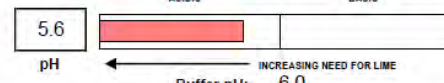
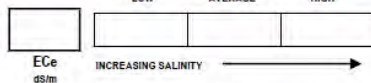
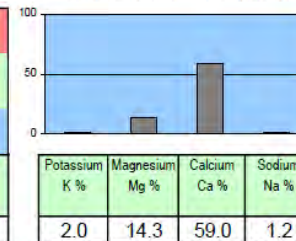
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Percent Cation Saturation (computed)



NaHCO₃-P unreliable at this soil pH

Soil Fertility Guidelines

CROP: VEGETABLES

RATE: lb/1000 sq ft

NOTES:

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Potassium Level

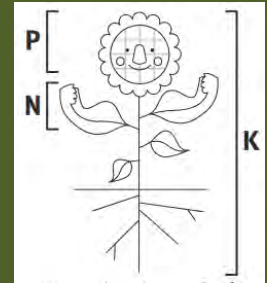
100 or less
Very Low

100 to 150
Low

150 to 250
Medium

300 or higher
High, Very High

Macronutrients



Nitrogen (N)

Phosphorus (P)

Potassium (K)

Critical for plant growth

Plays vital role in plant reproduction

Plays key role in vast array of physiological process

Legumes can fix atmospheric nitrogen

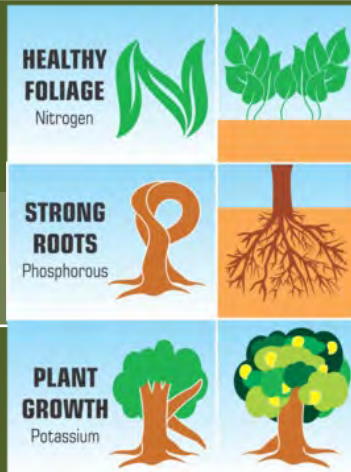
Essential for seed & fruit production

Organic matter holds and releases potassium in soil

Nitrate can leach soil and ammonium nitrogen can be lost to the atmosphere

Least mobile macronutrient (generally doesn't leach)

Also called Potash



Becomes unavailable in very acidic or alkaline conditions

Generally not considered a pollution problem

Loss through soil erosion

Calcium, Magnesium, & Sulfur

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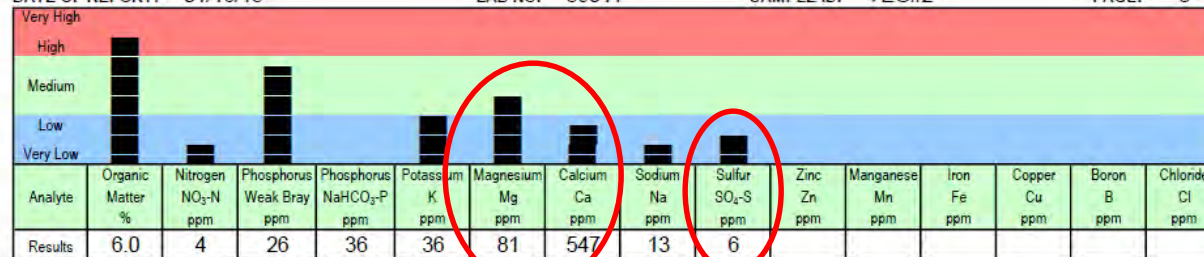
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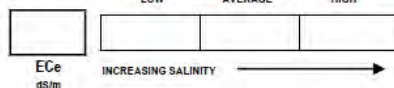
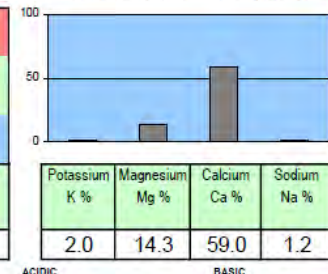
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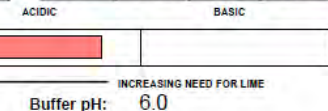
Percent Cation Saturation (computed)



4.6
CEC meq/100g

Ex. Lime

5.6
pH



NaHCO₃-P unreliable at this soil pH

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Secondary Nutrients: Calcium, Magnesium, Sulfur



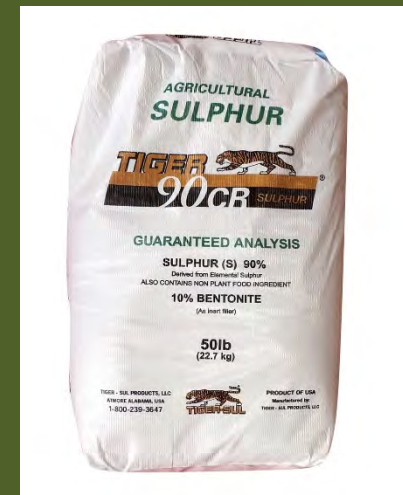
Calcium plays a key role in plant cell walls



Magnesium plays a critical role in photosynthesis



Sulfur is common component in protein development



Soil pH

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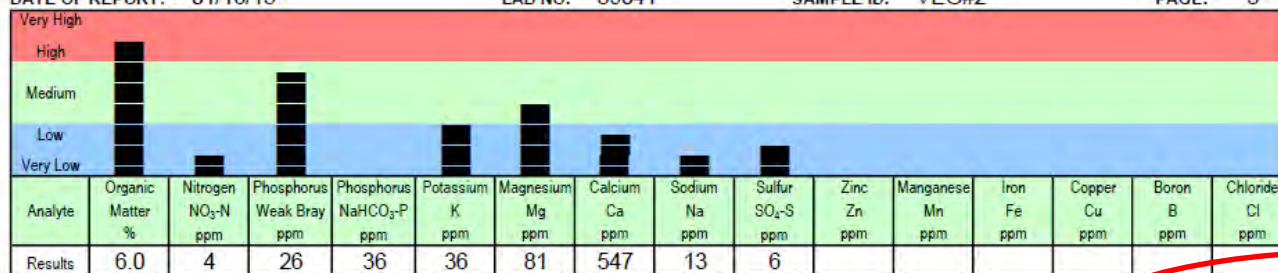
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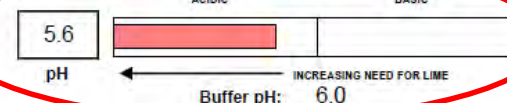
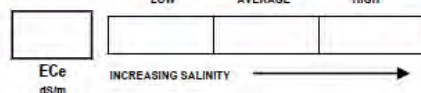
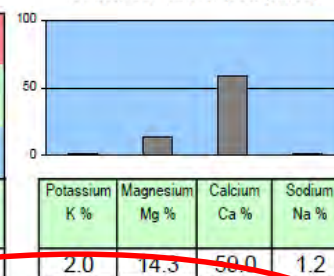
LAB NO: 59041

SAMPLE ID: VEG#2

PAGE: 3



Percent Cation Saturation (computed)



NaHCO₃-P unreliable at this soil pH

Soil Fertility Guidelines

CROP: VEGETABLES

RATE: lb/1000 sq ft

NOTES:

Dolomite 100 score	Lime 100 score	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
210				3.1	2.0	6.0		0.6						

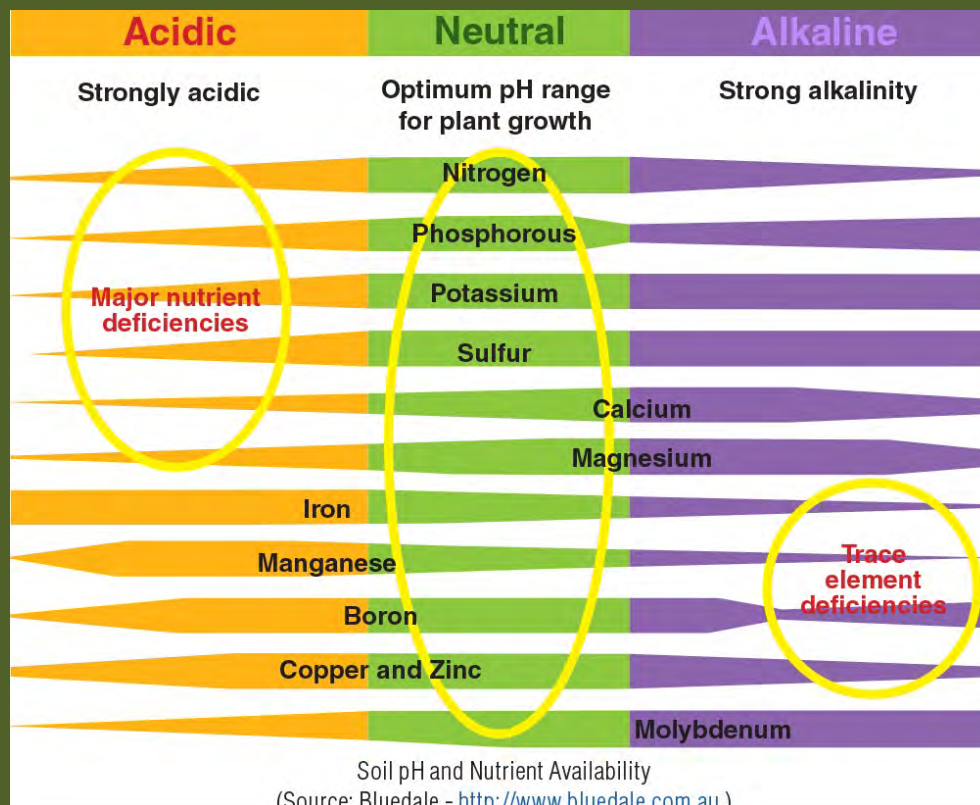
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Darcy L. Peebles, CCA
A & L WESTERN LABORATORIES, INC

Soil Chemistry: pH

Important for: Nutrient Availability, Nitrogen Fixation by legumes, Organic Matter Decomposition by Soil Organisms, Plant Root Function



Soil pH	Plant Growth
> 8.3	Too alkaline for most plants
7.5	Iron availability becomes a problem on alkaline soils
7.2	6.8 to 7.2 – near neutral 6.0 to 7.5 – acceptable for most plants
7.0	
6.8	
6.0	
5.5	Reduced soil microbial activity
< 4.6	Too acid for most plants

(Source: Colorado State University – CMG Garden Notes #222)

Micronutrients (Trace Elements)

(Iron, Manganese, Boron, Chloride, Zinc, Copper)

- Not needed in large quantities
- Crucial in facilitating a wide range of processes important for plant growth
- Plant tissue analysis is more reliable than soil testing for identifying micronutrient problems.
- Soils that receive regular additions of organic residues such as manure rarely show micronutrient deficiencies.
- Organic matter (like composted manure, cover crops) can be a good source of micronutrients

*Micronutrient analysis is not included in basic soil analysis package



Cation Exchange Capacity

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10220 SW NIMBUS AVE Bldg K-9 | PORTLAND OREGON 97223 | (503) 968-9225 | FAX (503) 598-7702



REPORT NUMBER: 15-014-077

CLIENT NO: 4793

SEND TO: KING CONSERVATION DISTRICT
1107 SW GRADY WAY STE 130
RENTON, WA 98057

GROWER: MELISSA LANG

SUBMITTED BY: JAY MIRRO

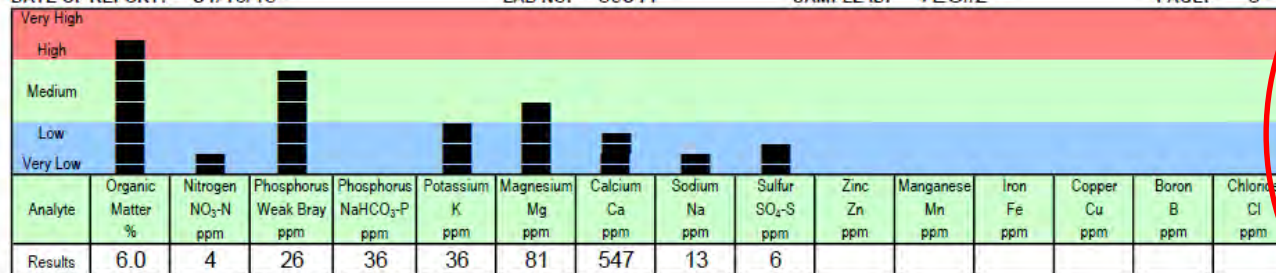
Graphical Soil Analysis Report

DATE OF REPORT: 01/16/15

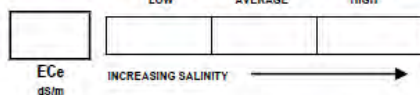
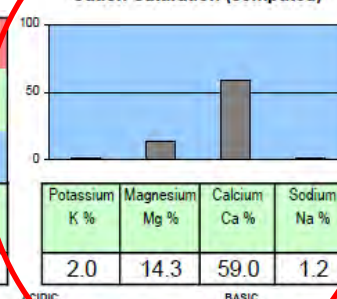
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SAMPLE ID: VEG#2

PAGE: 3

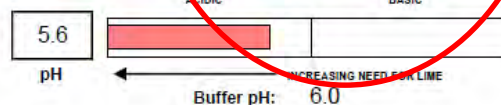


Percent Cation Saturation (computed)



4.6

CEC meq/100g



NaHCO₃-P unreliable at this soil pH

Soil Fertility Guidelines

CROP: VEGETABLES

RATE: lb/1000 sq ft

NOTES:

Dolomite 100 score	Lime 100 score	Gypsum	Elemental Sulfur	Nitrogen N	Phosphate P ₂ O ₅	Potash K ₂ O	Magnesium Mg	Sulfur SO ₄ -S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	
210				3.1	2.0	6.0		0.6						

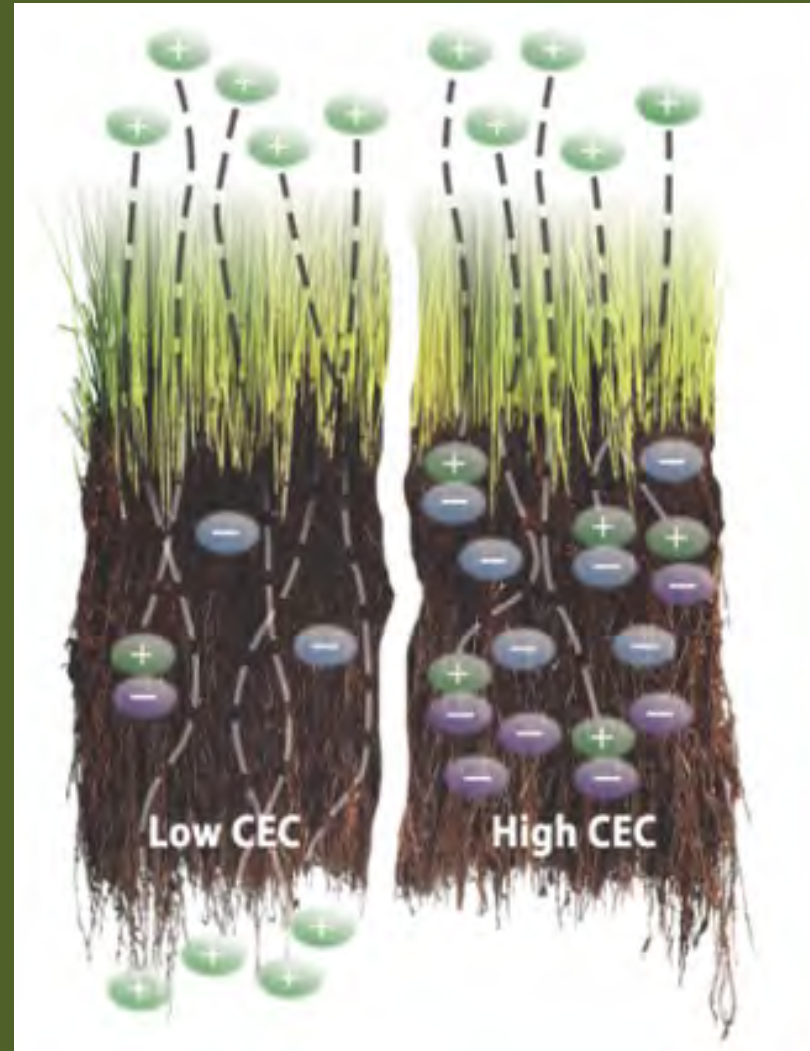
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Cation Exchange Capacity (CEC)/Cation Saturation

- Cations are + charged ions that are attracted to negatively charged sites on soil particles and organic matter
- # of “parking spots” available for cars to park
- CEC= Soil’s ability to hold cations (0-100 scale)
- K, Mg, Ca, Na dominate most cation volume
- More organic matter = higher CEC



A photograph of a garden scene. In the foreground, a wooden raised garden bed contains various green leafy plants. To the left, a wire mesh tunnel structure is set up over a row of plants. In the background, a light-colored house with a covered porch is visible, surrounded by lush greenery and red flowers. A semi-transparent green banner with white text is overlaid in the center.

Improving Soil Fertility using a Soil Test

How to Use Fertility Guidelines

A & L WESTERN AGRICULTURAL LABORATORIES

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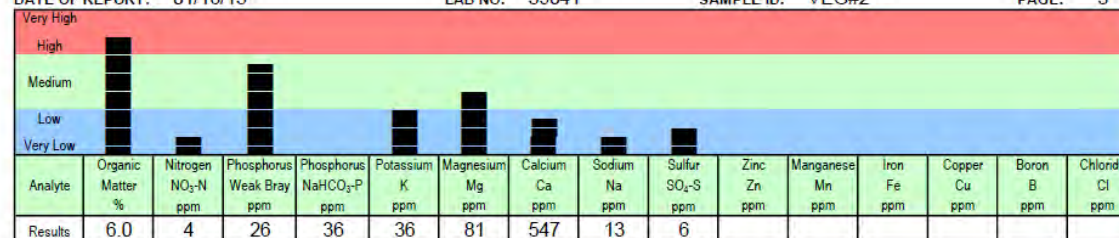
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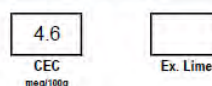
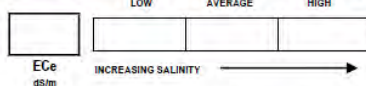
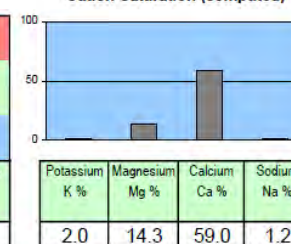
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210				3.1	2.0	6.0		0.6					

COMMENTS



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You are at the store, now what?

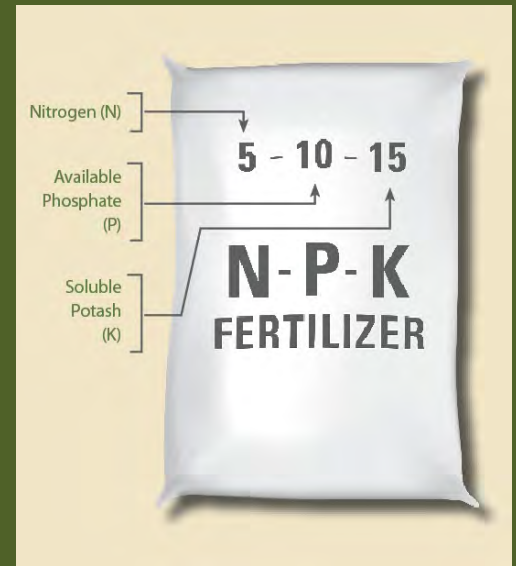
How to read a fertilizer label

Most fertilizers have 3 numbers on front label separated by dashes

10-10-10

50 lb bag (10% of each = 0.10 of total weight)

5 lbs nitrogen, phosphate and potash



18-18-18

50 lb bag of fertilizer (0.18 x 50)

How much N, P, K is in the bag?



How to determine how much you need:

Nitrogen recommendation: 3.1 lbs per 1000sq. ft.

Now what?

Step 1: How big is your garden area?

example: 100sq. ft.= 0.31lbs of N

Step 2: Pick your supplement

example: blood meal= 14-0-0

Step 3: Do a proportion

example:

1	=	?
0.14		0.31

We now know that we need **2.21lbs** of blood meal per 100sq. ft.

Additional Help for Figuring Out Correct Applications

- Great websites available for help:
 - Example: <http://newsomseed.com/usefulinformation.html>
- Call or visit your local conservation district or garden center



Newsom Seed Warehouse
Phone: 800-553-2719
Fax: 240-554-0366
11788 Scaggsville Road
Fulton, MD 20759

**Satellite Warehouse at the
Airpark in Gaithersburg**
Phone: 301-355-6366
Fax: 301-355-7446
7620-A Rickenbacker Drive
Gaithersburg, MD 20879

Home Grass Seed Products Resource Tools Ice Melt Partners
Meet The Team Credit Application Contact Us Blog

Useful Information

Below is a lot of information about fertilizers, compost, lime requirements and more.

Slow-Release Nitrogen Sources

If you are confused by all the different slow-release nitrogen sources that are available, you aren't alone. Below I have provided some information on 5 common sources of slow-release nitrogen.

MESA
Meth-Ex & IBDU
Urea-Formaldehyde (UF)
Sulfur-Coated Urea (SCU)

Useful Information

Probably the most frequent question I get is about the application rates. A customer will call and tell me they need to apply 1 lb. of nitrogen per 1000 sf. Because they don't do it often enough, they forget how to figure it out. Below are some examples that will hopefully help. However, you are always free to call and ask.

Fertilizer Conversion Table		
Fertilizer Analysis	Pounds of Product	
	Per 1,000 sf (1)	per acre (2)
10-6-4	10.00	435
14-1-11	7.15	311
16-4-8	6.25	272
18-24-12 w/SCU	5.55	242
19-0-19 w/MESA	5.25	230
20-0-5 w/MESA	5.00	218
21-0-0	4.80	208
24-4-6 w/MESA	4.20	182
26-4-18 w/SCU	3.85	168
29-3-5 w/ SCU	3.45	150
32-0-6 w/Meth-X	3.15	136
34-3-11 w/SCU	2.95	128
39-0-0 (SCU)	2.60	112
46-0-0 (urea)	2.20	95

(1) Amount of product needed to apply 1 pound of nitrogen per thousand square feet.

(2) Amount of product needed to apply 43.5 pounds of nitrogen per acre. To determine the amount of product needed to deliver 1 pound of nitrogen per thousand square feet, divide 100 by the first number in the fertilizer ratio. For example, for 16-4-8 fertilizer, divide 100 by 16. The result is 6.25 pounds of product per thousand square feet.

Using compost as a fertilizer:

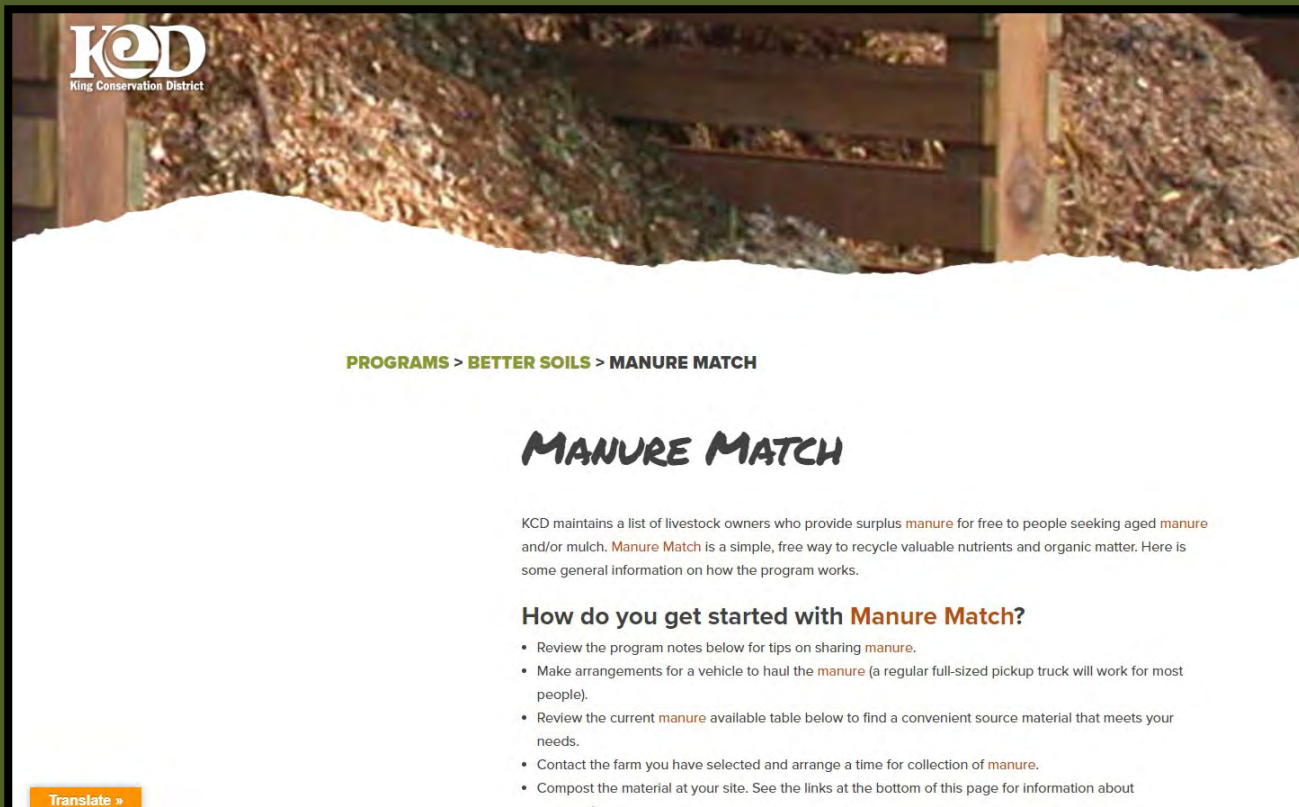
- Caution- Not all compost is created equal
- Store-bought compost can have varying levels of N, P and K
- N, P, & K are all present in manure compost
- For home-made compost, proper compost management is important in preserving N
- Composted manure should be applied as close as possible to the time crops need them
- Do not apply before rain events



KCD Manure Match Program

<https://kingcd.org/programs/better-soils/manure-match>

- List of livestock owners who provide surplus manure for free (includes manure type, bedding ratio, address, contact info)
- List of landowners looking for bedding and preferences



Dolomite & Lime (increasing pH levels)

KCD has a Broadcast Spreader Loan Program. To make a reservation, visit the information page on our web site to be added to the waiting list.

- Increase soil pH and supplement for Magnesium and Calcium

Two Common Types of Liming Agents:

- Dolomite
 - Apply if soil is low in both magnesium and calcium
- Lime (agricultural lime)
 - Apply to supplement for calcium



Unsifted lime powder fresh from the kiln



Lime being spread with the KCD Broadcast Spreader

Cover Crops

Grasses, legumes, and forbs planted for seasonal cover

- Reduces erosion from wind and water
- Increases soil organic matter
- Captures & recycles nutrients in soil profile
- Promotes nitrogen fixation
- Increases biodiversity
- Suppresses weeds
- Manages soil moisture
- Minimizes and reduces soil compaction



Take Home Thoughts

- Organic matter
- Nitrogen
- pH
- Don't feel like you have to fix everything at once!


A close-up photograph of a soil profile. The top of the image shows green grass and a small white flower. Below the surface is a thick layer of dark brown, moist soil. The soil has a crumbly texture with some small roots and organic matter visible. The text "Thank you" is overlaid in white on the soil.

Thank you

Questions?

USDA Web Soil Survey

<https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm>

The banner features a wooden ruler at the top with the USDA logo and text: "United States Department of Agriculture" and "Natural Resources Conservation Service". Below the ruler are several soil color and texture samples. On the right, a hand holds a small green seedling in soil. The text "Web Soil Survey" is written in large, bold, yellow letters across the middle of the banner.

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You are here: Web Soil Survey Home

The simple yet powerful way to access and use soil data.

START WSS

Welcome to Web Soil Survey (WSS)

Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information.

Search

Enter Keyword

All NRCS Sites ▼

Browse by Subject

- Soils Home
- National Cooperative Soil Survey (NCSS)
- Archived Soil Surveys
- Status Maps
- Official Soil Series Descriptions (OSD)
- Soil Series
- Extent Mapping Tool
- Geospatial Data Gateway
- eFOTG
- National Soil Characterization Data

Want To...

- **Start Web Soil Survey (WSS)**
- **Know Web Soil Survey Requirements**
- **Know Web Soil Survey operation hours**
- **Find what areas of the U.S. have soil data**
- **Find information by topic**
- **Know how to hyperlink from other documents to Web Soil Survey**
- **Know the SSURGO data structure**

Navigating Web Soil Survey Website

SDA United States Department of Agriculture
Natural Resources Conservation Service

Web Soil Survey

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Area of Interest

Import AOI

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Address

Show location marker ☒

View

State and County

Soil Survey Area

Latitude and Longitude or Current Location

PLSS (Section, Township, Range)

Bureau of Land Management

Department of Defense

Forest Service

National Park Service

Hydrologic Unit

Area of Interest Interactive Map

View Extent: Contiguous U.S. Scale: (not to scale)

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A A A

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Search

[Clear](#) [Search](#)

Basic Search

Enter keywords

Advanced Search

[Clear](#) [Search](#)

Area of Interest

[Open All](#) [Close All](#)

AOI Properties

[Clear AOI](#)

AOI Information

Name

Map Unit Symbols

- ☒ Use Soil Survey Area Map Unit Symbols
☐ Use National Map Unit Symbols

Area (acres) 3,319

Soil Data Available from Web Soil Survey

King County Area, Washington (WA633)

Data Availability Tabular and Spatial, complete

Tabular Data Version 12, Sep 7, 2017

Spatial Data Version 3, Dec 10, 2013

[Clear AOI](#)

Import AOI

Export AOI

Quick Navigation

Address

[View](#)

Address

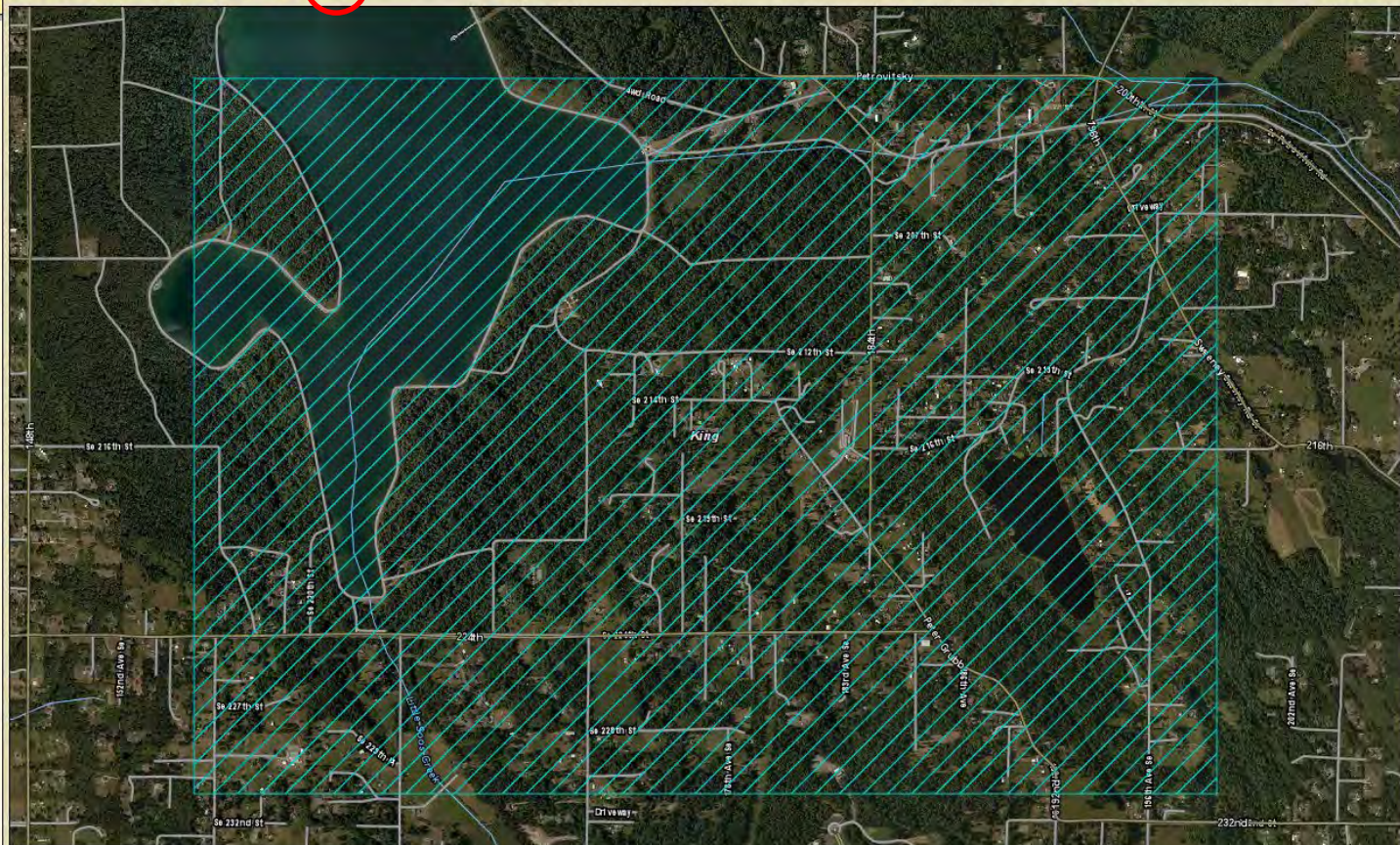
Area of Interest Interactive Map

[View Extent](#)

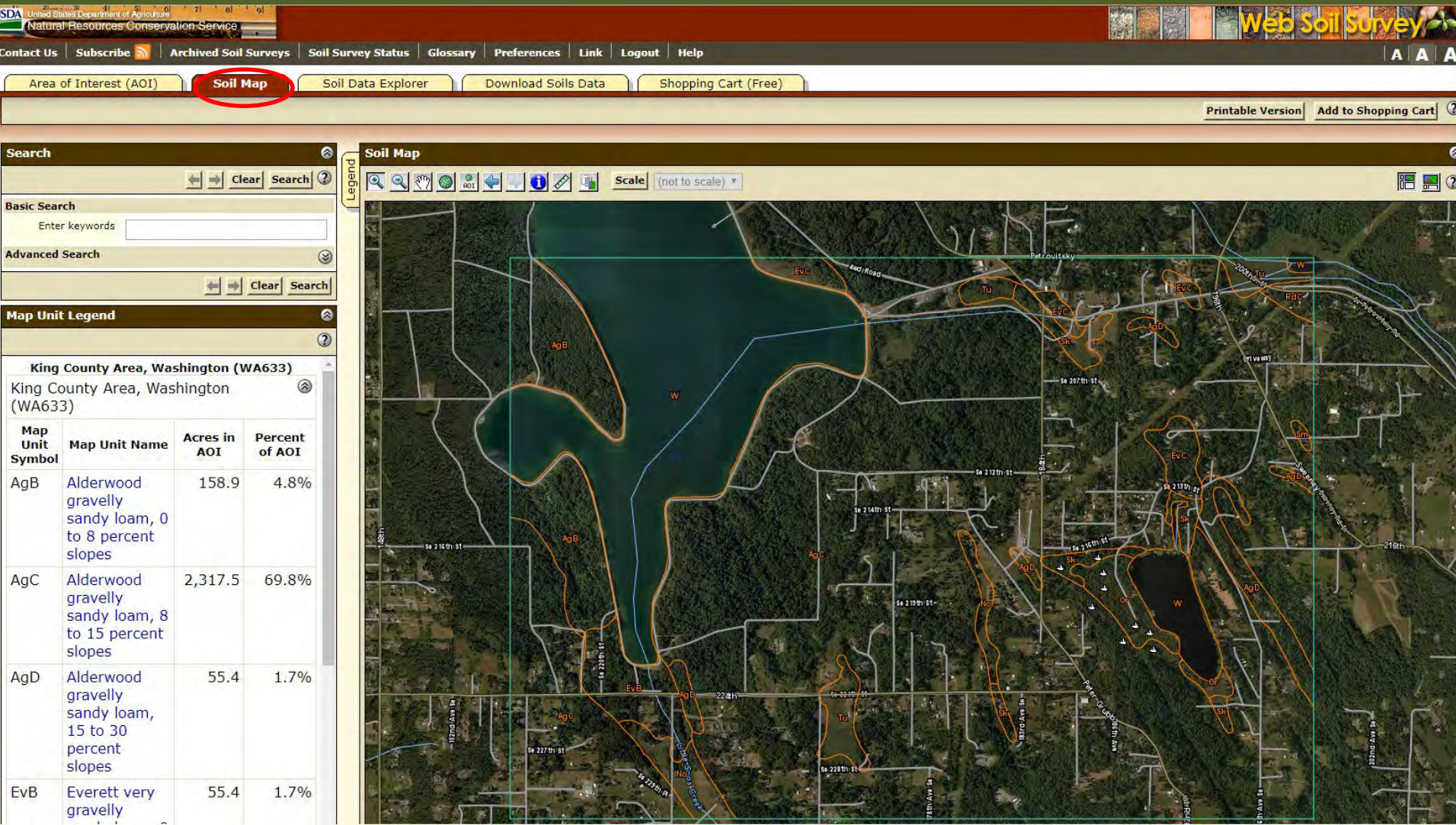
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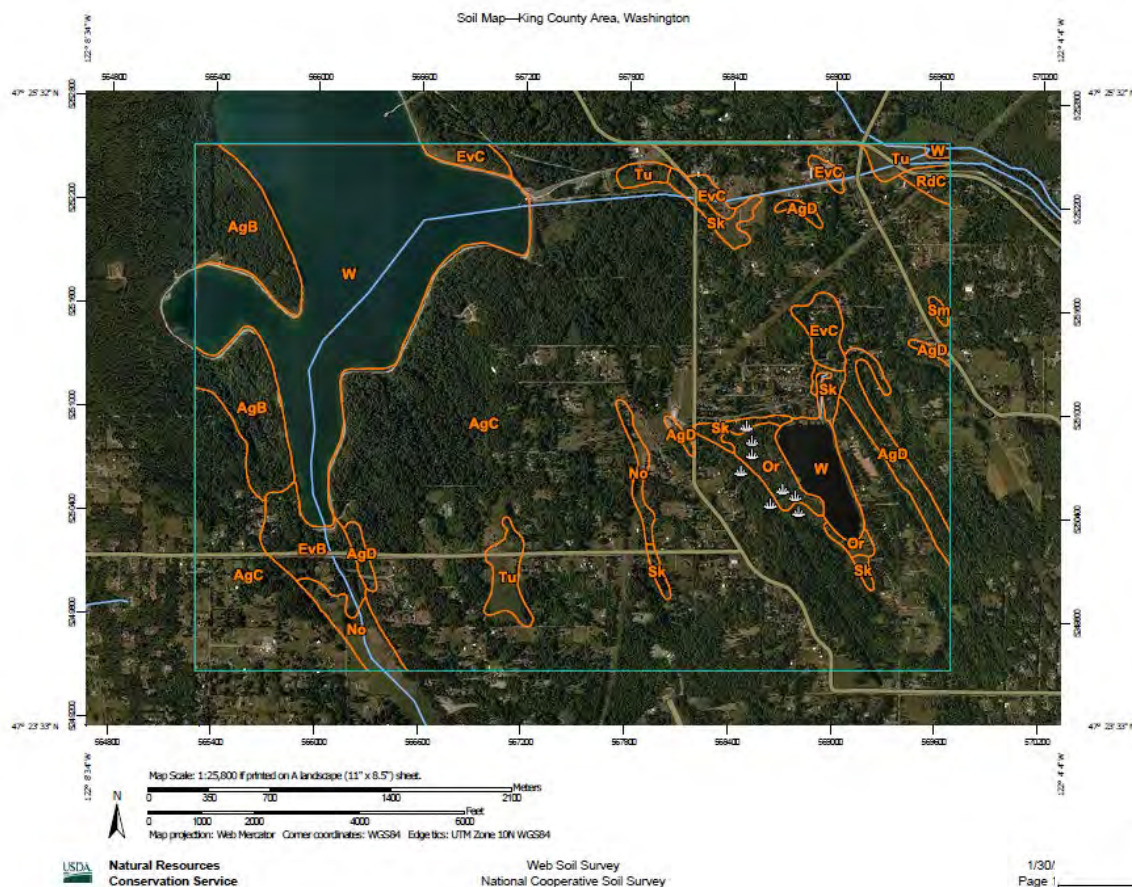
Scale

(not to scale)



Soil Type





Create a Soil Map

Alderwood soil

Developed on glacial till. Coarse texture and glacial consolidation render it relatively resistant to erosion, but the presence of a shallow impervious layer at depth often leads to erosion problems related to standing g water and poor drainage.

Map Unit Legend

1/30/
Page 1

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AgB	Alderwood gravelly sandy loam, 0 to 8 percent slopes	158.9	4.8%
AgC	Alderwood gravelly sandy loam, 8 to 15 percent slopes	2,317.5	69.8%
AgD	Alderwood gravelly sandy loam, 15 to 30 percent slopes	55.4	1.7%
EvB	Everett very gravelly sandy loam, 0 to 8 percent slopes	55.4	1.7%
EvC	Everett very gravelly sandy loam, 8 to 15 percent slopes	47.5	1.4%
No	Norma sandy loam	41.4	1.2%
Or	Orcas peat	35.1	1.1%
RdC	Ragnar-Indianola association, sloping	10.2	0.3%
Sk	Seattle muck	42.6	1.3%
Sm	Shalcar muck	2.4	0.1%
Tu	Tukwila muck	47.5	1.4%
W	Water	505.5	15.2%
Totals for Area of Interest		3,319.3	100.0%

Soil Data Explorer

SDA United States Department of Agriculture
Natural Resources Conservation Service

Web Soil Survey

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Properties and Qualities Ratings

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- Soil Chemical Properties
- Soil Erosion Factors
- Soil Health Properties
- Soil Physical Properties
- Soil Qualities and Features
- Water Features

Soil Map

Legend

Scale (not to scale)