

Rao, R., D. Dewing, Q.M. Ketterings, and H. Krol (2007). Delaware Soil Sample Survey (2002-2006). CSS Extension Bulletin E07-19. 35 pages.

# Soil Sample Survey

# Delaware County

Samples analyzed by CNAL (2002-2006)

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Delaware County (photo credit: Dale Dewing, CCE of Delaware County).

**Summary compiled by**  
**Renuka Rao, Dale Dewing, Quirine M. Ketterings, and Hettie Krol**



Cornell Nutrient Analysis Laboratory  
<http://www.css.cornell.edu/soiltest/newindex.asp>

&

Nutrient Management Spear Program  
<http://nmisp.css.cornell.edu/>



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Summary compiled by

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**October 25, 2007**

Correct Citation:

Rao, R., D. Dewing, Q.M. Ketterings, and H. Krol (2007). Soil sample survey of Delaware County. Samples analyzed by the Cornell Nutrient Analysis Laboratory (2002-2006). CSS Extension Bulletin E07-19. 35 pages.

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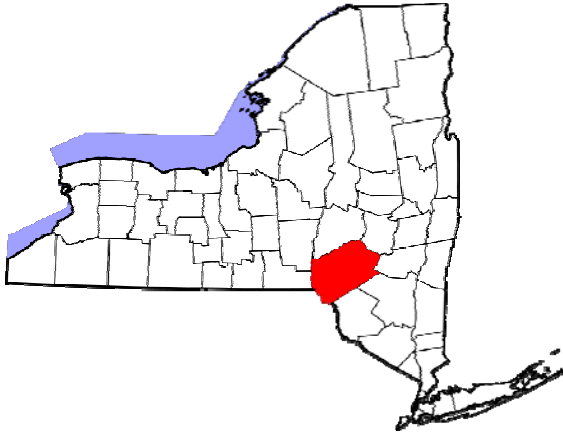
Delaware County (photo credit: Dale Dewing, CCE of Delaware County).





# 1. County Introduction

Delaware County is a geographically large county, covering 1468 square miles (about 939,900 acres) located in the Southern Tier of New York State bordering Broome,



Chenango, Otsego, Schoharie, Greene, Ulster, and Sullivan Counties. The county includes the eastern edge of the Catskill Mountains, the terrain rising from 1000 feet above sea level in the Delaware River Valley to the 3,520-foot summit of Bearpen Mountain along the Greene County line. Both branches of the Delaware River arise in the northeast corner of the county and traverse the County before joining forces in

Hancock where it becomes the border with the State of Pennsylvania. The Susquehanna River flows along the northwest edge of the county.

Farming in Delaware County is dominated by small and mid-sized farms; primarily dairies intermixed with livestock farms. The crops grown are used on the farm as livestock feed. Because of steep slopes and high elevation, many of the areas of the county are best suited for permanently vegetated forage crops like grass hay and pasture, and these crops occupy the majority of acreage. Corn – alfalfa rotations are grown on alluvial valley soils where the land has low soil erosion potential resulting in outstanding yield.

Non-point source water quality concerns are significant in the county. Much of Delaware County drains to the reservoirs supplying drinking water to nine million consumers in and around New York City. The Watershed Agricultural Council (WAC) administers voluntary water quality protection programs in farming and forestry with a goal of balancing economic viability, and water quality protection. WAC's programs focus on Whole Farm Planning, adoption of best management practices, the promotion of good forest stewardship by landowners and forestry professionals, and the purchase of development rights on farms through conservation easements. These programs are carried out through partnerships with the New York City Department of Environmental Protection, Cornell Cooperative Extension, USDA-NRCS, Soil and Water Conservation

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Districts, USDA Forest Service and others. The areas of the county draining to the Susquehanna River, part of the Chesapeake Bay Watershed, are targeted for nitrogen and phosphorus reductions. Many of the farms in this watershed participate in conservation planning efforts spearheaded by The Delaware Soil and Water Conservation District, USDA NRCS, and Cornell Cooperative Extension.

Nutrient management is an essential Best Management Practice (BMP) in all conservation plans developed in Delaware County. A Nutrient Management Plan (NMP) is designed to manage the application of nutrients from fertilizer and manure to assure optimum crop growth. A NMP minimizes the risk of pollution of surface water from excess nutrients while improving or maintaining the condition of the soil. To support its nutrient management planning efforts WAC maintains up to date soil fertility information on participating farms by soil sampling participating farms every three years. Many of the samples represented in this summary were collected as part of the WAC and Susquehanna basin nutrient management planning efforts.

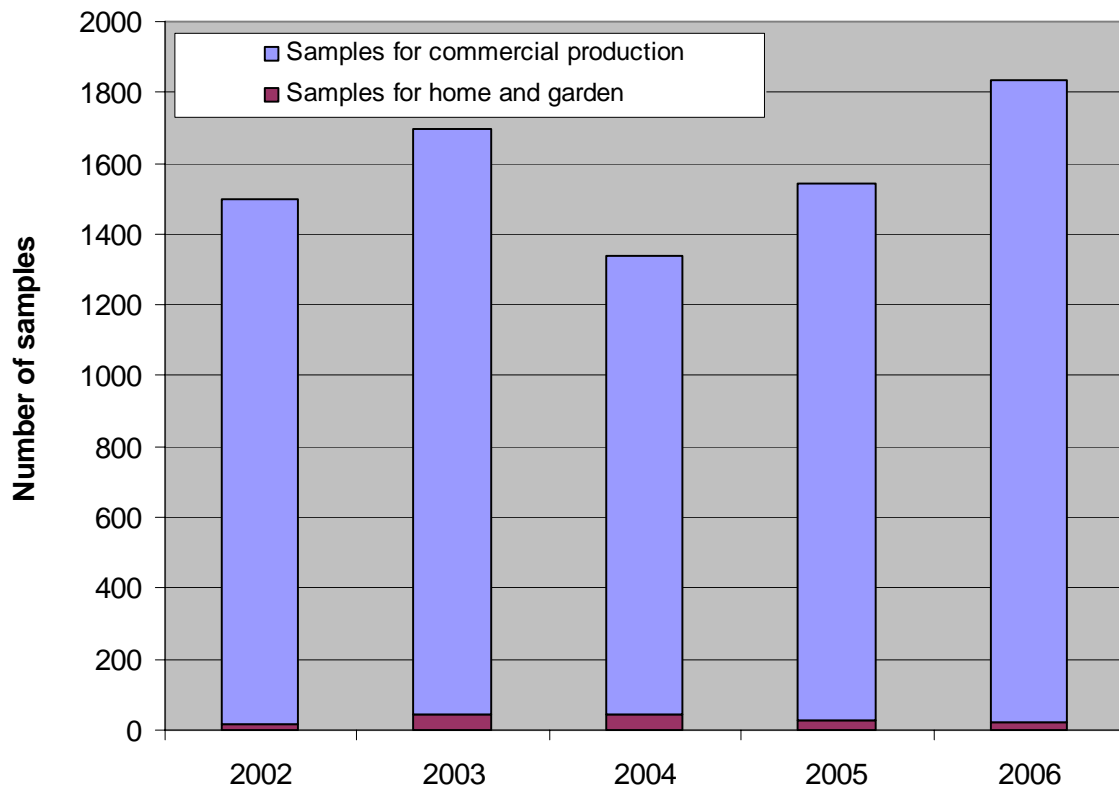
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Delaware County (photo credit: Dale Dewing, CCE of Delaware County).

## 2. General Survey Summary

This survey summarizes the soil test results from grower (identified as “commercial samples”) and homeowner samples from Delaware County submitted to the Cornell Nutrient Analysis Laboratory (CNAL) from 2002 to 2006. The total number of samples analyzed in these years amounted to 7910. Of these, 7759 samples (98%) were submitted by commercial growers while 151 samples (2%) were submitted by homeowners.



Homeowners		Commercial		Total
2002	17	2002	1481	1498
2003	44	2003	1652	1696
2004	43	2004	1298	1341
2005	27	2005	1513	1540
<u>2006</u>	<u>20</u>	<u>2006</u>	<u>1815</u>	<u>1835</u>
Total	151	Total	7759	7910

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Homeowners submitted soil samples to the Cornell Nutrient Analysis Laboratory during 2002-2006 primarily to request fertilizer recommendations for home garden vegetable production (41%), herb gardens (12%) and lawns (11%). Commercial growers submitted samples for hay production (41%), alfalfa or alfalfa/grass mixes (27%), pasture (13%) and corn silage or grain (11%), while a few growers were planning to grow other crops.

Soils tested for home and garden in Delaware County were classified as belonging to soil management group 2 (20%), group 3 (15%), group 4 (60%), or group 5 (5%). A description of the different management groups is given below.

#### Soil Management Groups for New York

1	Fine-textured soils developed from clayey lake sediments and medium- to fine-textured soils developed from lake sediments.
2	Medium- to fine-textured soils developed from calcareous glacial till and medium-textured to moderately fine-textured soils developed from slightly calcareous glacial till mixed with shale and medium-textured soils developed in recent alluvium.
3	Moderately coarse textured soil developed from glacial outwash and recent alluvium and medium-textured acid soil developed on glacial till.
4	Coarse- to medium-textured soils formed from glacial till or glacial outwash.
5	Coarse- to very coarse-textured soils formed from gravelly or sandy glacial outwash or glacial lake beach ridges or deltas.
6	Organic or muck soils with more than 80% organic matter.

Of the samples submitted by commercial growers, the majority (94%) belonged to soil management group 3. There were no group 1 samples. Four percent belonged to group 2. Group 4 was represented by a little over 1% of the samples while two samples were classified as organic soils (group 6). Willoweoc was the most common soil series (22% of all samples), followed by Lewbeach (13%), Tunkhannock (8%), Wellsboro (8%) and Barbour (7).

Organic matter levels, as measured by loss-on-ignition, ranged from less than 1% to greater than 40%. For homeowners 34% had between 2 and 5% organic matter, 11% testing between 5 and 6% organic matter and 38% were classified as soils with more than



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6.9% organic matter. Of the samples submitted by commercial growers, 82% contained more than 4% organic matter.

Soil pH in water (1:1 soil:water extraction ratio) varied from less than 3.8 to 8.5 for home and garden samples with 46% testing between 6.0 and 7.4 for pH. For the commercial samples, the highest pH was 7.9, 67% tested between pH 5.5 and 6.5, and 52% were pH 5.9 or lower where lime applications would be recommended for optimum production of most common field crops.

Extractable nutrients such as phosphorus (P), potassium (K), magnesium (Mg), calcium (Ca), iron (Fe), manganese (Mn), and zinc (Zn) were measured using the Morgan method (Morgan, 1941). This solution contains sodium acetate buffered at pH of 4.8.

Soil test P levels of <1 lb P/acre are classified as very low. Between 1-3 lbs P/acre is low. Medium is between 4-8 lbs P/acre. High testing soils have P levels between 9 and 39 lbs P/acre and anything higher is classified as very high. For homeowners, 17% of the soils tested low for P, 15% tested medium, 27% tested high and 41% tested very high. This meant that 68% tested high or very high in P. For commercial growers, 11% tested very high. In total 26% were low or very low in P, 25% tested medium for P while 38% of the submitted samples were classified as high in soil test P. This means that 49% tested high or very high in P.

Classifications for K depend on soil management group. The fine textured soils (soil management group 1) have a greater K supplying capacity than the coarse textured sandy soils (soil management group 5). Classification for each of the management groups in the above table represent very low, low, medium, high and very high. So for example for soil management group 5 and 6, <60 lbs K/acre means the soil is very low in K, between 60 and 114 lbs K/acre is medium, 115-164 lbs K/acre is medium, 165-269 lbs K/acre is high and >269 lbs K/acre is classified as very high (see Table on page 6).

Potassium classifications for Delaware County soils varied from very low (4% of the homeowner soils and 2% of the commercial growers' soils) to very high (58% of the homeowner soils and 45% of the commercial growers' soils). For homeowners, 7% tested low in K, 11% tested medium, and 19% tested high for potassium. For commercial growers' soils, 9% tested low, 16% tested medium and 28% tested high in K.

Soil Management Group	Potassium Soil Test Value (Morgan extraction in lbs K/acre)				
	Very low	Low	Medium	High	Very High
1	<35	35-64	65-94	95-149	>149
2	<40	40-69	70-99	100-164	>164
3	<45	45-79	80-119	120-199	>199
4	<55	55-99	100-149	150-239	>239
5 and 6	<60	60-114	115-164	165-269	>269

Soils test very low for Mg if Morgan extractable Mg is less than 20 lbs Mg/acre. Low testing soils have 20-65 lbs Morgan Mg per acre. Soils with 66-100 lbs Mg/acre test medium for Mg. High testing soils have 101-199 lbs Mg/acre while soils with more than 200 lbs Mg/acre in the Morgan extraction are classified as very high in Mg. Magnesium levels ranged from 9 to slightly more than 8000 lbs Mg/acre. There was only one soil sample that tested very low for Mg (homeowner sample). Most soils tested high or very high for Mg (88% of the homeowner soils and 95% of the soils of the commercial growers). In total 12% of the homeowner soils and 5% of the commercial growers' soil tested low or medium in Mg.

Soils with more than 50 lbs Morgan extractable Fe per acre test excessive for Fe. Anything lower than 50 lbs Fe/acre is considered normal. Iron levels ranged from 79-86% in the normal range with 21% of the homeowner soils and 14% of the commercial grower soils testing excessive for Fe. Similarly, most soils (81-93%) tested normal for manganese. Soils with more than 100 lbs Morgan extractable Mn per acre are classified as excessive in Mn. Anything less than 100 lbs Mn per acre is classified as normal. Soils with less than 0.5 lb Zn per acre in the Morgan extraction are classified as low in Zn. Medium testing soils have between 0.5 and 1 lb of Morgan extractable Zn per acre. If more than 1 lb of Zn/acre is extracted with the Morgan solution, the soil tests high in Zn. For the homeowner soils, 97% tested high for Zn while 2% tested medium. Of the commercial growers' samples, 3% tested low, 13% tested medium while 84% were high in Zn.

In the following sections, the summary tables for each of the soil fertility indicators described above are given. The appendix contains the crop codes used in section 3.

### 3. Cropping Systems

#### 3.1 Homeowner Samples

Crops for which recommendations were requested by homeowners:

	2002	2003	2004	2005	2006	Total	%
APR	0	0	0	0	1	1	1
ATF	0	1	0	0	2	3	2
BLU	0	0	5	0	0	5	3
FLA	3	1	1	0	1	6	4
GRA	1	0	0	0	2	3	2
HRB	0	10	0	8	0	18	12
LAW	1	4	7	2	2	16	11
MIX	0	0	1	0	0	1	1
MVG	8	14	16	15	9	62	41
OTH	3	3	3	1	0	10	7
PER	0	5	1	1	1	8	5
PRK	0	1	0	0	0	1	1
PTO	0	0	0	0	1	1	1
RSP	0	0	0	0	1	1	1
SAG	1	2	5	0	0	8	5
TRF	0	3	4	0	0	7	5
Total	17	44	43	27	20	151	100

Note: See Appendix for Cornell crop codes.

### 3.2 Commercial Samples

Crops for which recommendations were requested in commercial samples:

Current year crop	2002	2003	2004	2005	2006	Total	%
ABE/ABT	6	0	0	0	1	7	0
AGE/AGT	154	262	183	394	848	1841	24
ALE/ALT	31	80	26	23	36	196	3
APP	0	1	2	0	0	3	0
ASP	0	0	1	0	0	1	0
BCE/BCT	16	1	0	1	0	18	0
BGE/BGT	7	1	3	0	0	11	0
BKB	0	0	1	0	0	1	0
BLB	0	0	1	0	1	2	0
BSP	1	4	0	0	2	7	0
BTT	1	0	0	0	0	1	0
BUK	0	0	2	0	0	2	0
BWI	1	0	0	0	0	1	0
CBP	0	2	0	0	0	2	0
CBS	0	0	1	0	0	1	0
CGE/CGT	35	6	9	12	24	86	1
CLE/CLT	2	3	5	2	8	20	0
COG/COS	171	170	138	157	191	827	11
CUR	0	0	2	0	0	2	0
ELD	0	0	2	0	0	2	0
GIE/GIT	34	175	25	6	1	241	3
GRE/GRT	806	670	615	683	413	3187	41
IDL	7	7	5	8	28	55	1
MIX	5	19	5	2	3	34	0
OAS	3	2	2	1	0	8	0
OAT	9	1	1	2	13	26	0
OTH	12	4	2	2	2	22	0
PCH	0	0	2	0	0	2	0
PEP	0	0	1	0	0	1	0
PGE/PGT	5	3	4	0	19	31	0
PIE/PIT	8	59	33	96	0	196	3
PLE/PLT	0	5	2	2	2	11	0
PNT	154	143	202	105	188	792	10
POT	4	2	1	1	2	10	0
PUM	1	2	4	0	5	12	0
RSF	0	0	1	0	0	1	0

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Current year crop	2002	2003	2004	2005	2006	Total	%
RSS	0	0	1	1	0	2	0
RYC	0	2	2	2	4	10	0
RYS	0	0	0	0	6	6	0
SOY	0	0	2	4	1	7	0
SSH	3	4	3	1	7	18	0
STE	0	0	0	1	0	1	0
SUN	0	0	0	0	2	2	0
SWC	0	3	6	0	1	10	0
TOM	2	0	1	0	0	3	0
TRE	1	1	0	2	0	4	0
TRT	0	0	2	2	0	4	0
WHT	0	0	0	2	1	3	0
Unknown	2	20	0	1	6	29	0
Total	1481	1652	1298	1513	1815	7759	100

Note: See Appendix for Cornell crop codes.



## 4. Soil Types

### 4.1 Homeowner Samples

Soil types (soil management groups) for homeowner samples:

	2002	2003	2004	2005	2006	Total	%
SMG 1 (clayey)	0	0	0	0	0	0	0
SMG 2 (silty)	1	4	14	6	5	30	20
SMG 3 (silt loam)	0	11	8	4	0	23	15
SMG 4 (sandy loam)	15	24	21	16	15	91	60
SMG 5 (sandy)	1	5	0	1	0	7	5
SMG 6 (mucky)	0	0	0	0	0	0	0
Total	17	44	43	27	20	151	100

## 4.2 Commercial Samples

Soil series for commercial samples:

Name	SMG	2002	2003	2004	2005	2006	Total	%
Appleton	2	0	0	2	0	0	2	0
Arnot	3	1	0	1	4	1	7	0
Barbour	3	112	95	85	129	101	522	7
Basher	3	52	37	31	35	74	229	3
Bath	3	11	5	0	34	10	60	1
Braceville	4	1	0	0	0	0	1	0
Canadaigua	3	0	0	0	0	1	1	0
Carlisle	6	0	0	0	0	1	1	0
Castile	4	2	0	0	0	0	2	0
Chenango	3	6	9	25	7	12	59	1
Collamer	3	0	1	5	1	8	15	0
Deposit	3	3	8	3	2	11	27	0
Elka	4	17	7	13	20	10	67	1
Halcott	2	14	14	24	11	24	87	1
Hamlin	2	0	0	11	0	0	11	0
Hilton	2	0	1	1	0	0	2	0
Lackawanna	3	67	132	84	94	90	467	6
Lewbath	3	9	26	1	31	25	92	1
Lewbeach	3	190	192	159	172	328	1041	13
Lordstown	3	2	7	5	9	8	31	0
Maplecrest	2	71	30	31	59	40	231	3
Mardin	3	27	42	12	67	30	178	2
Middlebrook	3	8	0	9	1	3	21	0
Middelbury	3	5	0	0	3	0	8	0
Mongaup	3	15	33	10	15	5	78	1
Morris	3	22	22	17	22	50	133	2
Norchip	3	1	3	1	1	3	9	0
Norwich	3	0	4	0	0	0	4	0
Onteora	3	30	55	39	28	80	232	3
Ontusia	3	4	9	0	11	0	24	0
Oquaga	3	9	26	8	8	9	60	1
Papakating	2	0	0	0	0	1	1	0
Philo	3	0	2	4	2	0	8	0
Raypol	3	4	0	0	2	6	12	0
Red Hook	4	0	4	0	1	4	9	0
Rigdgebury	4	2	0	0	0	0	2	0

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Name	SMG	2002	2003	2004	2005	2006	Total	%
Riverhead	4	1	6	4	4	1	16	0
Scio	3	0	0	1	0	0	1	0
Teel	2	0	0	6	0	0	6	0
Torull	3	0	1	1	0	1	3	0
Trestle	3	45	78	47	59	69	298	4
Tuller	3	1	0	0	0	0	1	0
Tunkhannock	3	142	111	96	159	144	652	8
Unadilla	3	5	2	23	2	6	38	0
Valois	3	5	10	8	10	6	39	1
Venango	3	0	13	0	2	6	21	0
Vly	3	79	83	71	62	115	410	5
Volusia	3	7	3	1	10	4	25	0
Wayland	2	0	0	0	0	2	2	0
Wellsboro	3	112	154	127	121	85	599	8
Wenonah	4	0	7	7	1	1	16	0
Willdin	3	43	61	6	52	4	166	2
Willette	6	1	0	0	0	0	1	0
Willowemoc	3	353	345	317	262	434	1711	22
Unknown	-	2	14	2	0	2	20	0
Total	-	1481	1652	1298	1513	1815	7759	100

## 5. Organic Matter

### 5.1 Homeowner Samples

Organic matter (loss-on-ignition method) in homeowner samples (number):

	<1	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	>6.9	Total
2002	0	0	2	2	1	2	2	8	17
2003	2	1	1	8	5	7	4	16	44
2004	0	3	8	5	2	3	4	18	43
2005	1	3	1	3	6	4	1	8	27
2006	0	3	6	2	0	1	1	7	20
Total	3	10	18	20	14	17	12	57	151

	2002	2003	2004	2005	2006
Lowest:	2.1	0.4	1.1	0.7	1.0
Highest:	20.0	33.2	41.1	11.4	20.0
Mean:	8.1	8.0	6.7	5.4	5.7
Median:	6.2	5.6	6.1	4.9	3.1

Organic matter in homeowner samples (% of total number of samples):

	<1	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	>6.9	Total
2002	0	0	12	12	6	12	12	47	100
2003	5	2	2	18	11	16	9	36	100
2004	0	7	19	12	5	7	9	42	100
2005	4	11	4	11	22	15	4	30	100
2006	0	15	30	10	0	5	5	35	100
Total	2	7	12	13	9	11	8	38	100

## 5.2 Commercial Samples

Organic matter (loss-on-ignition method) in commercial samples (number):

	<1	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	>6.9	Total
2002	0	20	91	132	229	397	316	296	1481
2003	0	31	112	199	367	405	293	245	1652
2004	0	28	109	164	250	294	236	217	1298
2005	0	26	66	106	179	337	330	469	1513
2006	2	22	99	183	349	491	393	276	1815
Total	2	127	477	784	1374	1924	1568	1503	7759

	2002	2003	2004	2005	2006
Lowest:	1.1	1.0	1.0	1.3	0.9
Highest:	33.7	11.8	18.1	14.3	29.8
Mean:	5.6	5.2	5.3	6.1	5.5
Median:	5.6	5.3	5.3	6.1	5.4

Organic matter in commercial samples (% of total number of samples):

	<1	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	>6.9	Total
2002	0	1	6	9	15	27	21	20	100
2003	0	2	7	12	22	25	25	15	100
2004	0	2	8	13	19	23	23	17	100
2005	0	2	4	7	12	22	22	31	100
2006	0	1	5	10	19	27	27	15	100
Total	0	2	6	10	18	25	25	19	100



## 6. pH

### 6.1 Homeowner Samples

pH of homeowner samples (numbers):

	<4.5	4.5-4.9	5.0-5.4	5.5-5.9	6.0-6.4	6.5-6.9	7.0-7.4	7.5-7.9	8.0-8.4	>8.4	?	Total
2002	0	1	2	3	2	4	4	0	0	1	0	17
2003	6	5	8	5	7	7	4	2	0	0	0	44
2004	0	2	5	14	8	1	7	1	0	0	5	43
2005	0	0	4	3	3	5	7	5	0	0	0	27
2006	0	1	2	4	4	3	4	2	0	0	0	20
Total	6	9	21	29	24	20	26	10	0	1	5	151

	2002	2003	2004	2005	2006
Lowest:	4.7	3.8	4.9	5.0	4.9
Highest:	8.5	7.6	7.6	7.8	7.5
Mean:	-	-	-	-	-
Median:	6.5	5.7	5.9	6.7	6.3

pH of homeowner of samples (% of total number of samples):

	<4.5	4.5-4.9	5.0-5.4	5.5-5.9	6.0-6.4	6.5-6.9	7.0-7.4	7.5-7.9	8.0-8.4	>8.4	?	Total
2002	0	6	12	18	12	24	24	0	0	6	0	100
2003	14	11	18	11	16	16	9	5	0	0	0	100
2004	0	5	12	33	19	2	16	2	0	0	12	100
2005	0	0	15	11	11	19	26	19	0	0	0	100
2006	0	5	10	20	20	15	20	10	0	0	0	100
Total	4	6	14	19	16	13	17	7	0	1	3	100

## 6.2 Commercial Samples

pH of commercial samples (number):

	<4.5	4.5-4.9	5.0-5.4	5.5-5.9	6.0-6.4	6.5-6.9	7.0-7.4	7.5-7.9	8.0-8.4	>8.4	Total
2002	3	18	185	511	425	275	57	7	0	0	1481
2003	0	31	229	519	578	262	31	2	0	0	1652
2004	0	17	218	516	377	154	16	0	0	0	1298
2005	2	28	272	567	445	166	31	2	0	0	1513
2006	2	39	218	700	607	209	35	5	0	0	1815
Total	7	133	1122	2813	2432	1066	170	16	0	0	7759

	2002	2003	2004	2005	2006
Lowest:	3.8	4.5	4.6	4.2	4.2
Highest:	7.9	7.5	7.4	7.6	7.8
Mean:	-	-	-	-	-
Median:	6.0	6.0	5.8	5.8	5.9

pH of commercial samples (% of total number of samples):

	<4.5	4.5-4.9	5.0-5.4	5.5-5.9	6.0-6.4	6.5-6.9	7.0-7.4	7.5-7.9	8.0-8.4	>8.4	Total
2002	0	1	12	35	29	19	4	0	0	0	100
2003	0	2	14	31	35	16	2	0	0	0	100
2004	0	1	17	40	29	12	1	0	0	0	100
2005	0	2	18	37	29	11	2	0	0	0	100
2006	0	2	12	39	33	12	2	0	0	0	100
Total	0	2	14	36	31	14	2	0	0	0	100

## 7. Phosphorus

### 7.1 Homeowner Samples

Phosphorus (lbs/acre Morgan P) in homeowner samples (numbers):

	<1	1-3	4-8	9-39	40-60	61-80	81-100	101-150	151-200	>200	Total
	VL	L	M	H	VH	VH	VH	VH	VH	VH	
2002	0	4	1	1	2	2	1	1	2	3	17
2003	0	8	11	11	3	2	4	2	2	1	44
2004	0	6	9	18	1	0	1	2	1	5	43
2005	0	4	2	5	2	1	1	2	2	8	27
2006	0	4	0	5	3	3	0	1	0	4	20
Total	0	26	23	40	11	8	7	8	7	21	151

VL = very low, L = low, M = medium, H = high, VH = very high.

	2002	2003	2004	2005	2006
Lowest:	1	1	1	1	1
Highest:	678	426	962	668	816
Mean:	119	43	74	127	138
Median:	61	11	14	66	47

Phosphorus in homeowner samples (% of total number of samples):

	<1	1-3	4-8	9-39	40-60	61-80	81-100	101-150	151-200	>200	Total
	VL	L	M	H	VH	VH	VH	VH	VH	VH	
2002	0	24	6	6	12	12	6	6	12	18	100
2003	0	18	25	25	7	5	9	5	5	2	100
2004	0	14	21	42	2	0	2	5	2	12	100
2005	0	15	7	19	7	4	4	7	7	30	100
2006	0	20	0	25	15	15	0	5	0	20	100
Total	0	17	15	27	7	5	5	5	5	14	100

VL = very low, L = low, M = medium, H = high, VH = very high.

## 7.2 Commercial Samples

Phosphorus (lbs P/acre Morgan extraction) for commercial samples (number):

	<1	1-3	4-8	9-39	40-60	61-80	81-100	101-150	151-200	>200	Total
	VL	L	M	H	VH	VH	VH	VH	VH	VH	
2002	0	445	303	548	101	37	18	15	5	9	1481
2003	0	549	444	517	63	30	18	14	13	4	1652
2004	0	409	337	410	68	34	19	14	3	4	1298
2005	0	249	393	696	104	30	11	18	8	4	1513
2006	0	337	493	757	139	40	22	19	5	3	1815
Total	0	1989	1970	2928	475	171	88	80	34	24	7759

VL = very low, L = low, M = medium, H = high, VH = very high.

	2002	2003	2004	2005	2006
Lowest:	1	1	1	1	1
Highest:	938	346	385	534	362
Mean:	19	15	16	19	19
Median:	8	6	7	11	10

Phosphorus in commercial samples (% of total number of samples):

	<1	1-3	4-8	9-39	40-60	61-80	81-100	101-150	151-200	>200	Total
	VL	L	M	H	VH	VH	VH	VH	VH	VH	
2002	0	30	20	37	7	2	1	1	0	1	100
2003	0	33	27	31	4	2	1	1	1	0	100
2004	0	32	26	32	5	3	1	1	0	0	100
2005	0	16	26	46	7	2	1	1	1	0	100
2006	0	19	27	42	8	2	1	1	0	0	100
Total	0	26	25	38	6	2	1	1	0	0	100

VL = very low, L = low, M = medium, H = high, VH = very high.

## 8. Potassium

### 8.1 Homeowner Samples

Potassium (lbs K/acre Morgan extraction) in homeowner samples (number):

Soil Management Group 1						
	<35	35-64	65-94	95-149	>149	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
Total (#)	0	0	0	0	0	0
Total (%)	-	-	-	-	-	-
Soil Management Group 2						
	<40	40-69	70-99	100-164	>164	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	0	0	1	1
2003	0	0	0	2	2	4
2004	0	0	1	5	8	14
2005	0	0	0	2	4	6
2006	0	0	1	0	4	5
Total (#)	0	0	2	9	19	30
Total (%)	0	0	7	30	63	100
Soil Management Group 3						
	<45	45-79	80-119	120-199	>199	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	0	0	0	0
2003	1	2	3	2	3	11
2004	1	2	1	0	4	8
2005	0	0	1	0	3	4
2006	0	0	0	0	0	0
Total (#)	2	4	5	2	10	23
Total (%)	9	17	22	9	43	100



Soil Management Group 4						
	<55	55-99	100-149	150-239	>239	Total
	Very Low	Low	Medium	High	Very High	
2002	0	1	3	4	7	15
2003	2	1	3	2	16	24
2004	0	1	2	2	16	21
2005	0	0	0	4	12	16
2006	1	2	1	4	7	15
Total (#)	3	5	9	16	58	91
Total (%)	3	5	10	18	64	100
Soil Management Group 5						
	<60	60-114	115-164	165-269	>269	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	1	0	0	1
2003	1	2	0	1	1	5
2004	0	0	0	0	0	0
2005	0	0	0	1	0	1
2006	0	0	0	0	0	0
Total (#)	1	2	1	2	1	7
Total (%)	14	29	14	29	14	100
Soil Management Group 6						
	<60	60-114	115-164	165-269	>269	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
Total (#)	0	0	0	0	0	0
Total (%)	-	-	-	-	-	-

Potassium classification summary for homeowners:

Summary (#)	Very Low	Low	Medium	High	Very High	Total
2002	0	1	4	4	8	17
2003	4	5	6	7	22	44
2004	1	3	4	7	28	43
2005	0	0	1	7	19	27
2006	1	2	2	4	11	20
Grand Total	6	11	17	29	88	151

Summary (%)	Very Low	Low	Medium	High	Very High	Total
2002	0	6	24	24	47	100
2003	9	11	14	16	50	100
2004	2	7	9	16	65	100
2005	0	0	4	26	70	100
2006	5	10	10	20	55	100
Grand Total	4	7	11	19	58	100

	2002	2003	2004	2005	2006
Lowest:	89	30	17	81	46
Highest:	1820	1652	16731	2380	2241
Mean:	356	309	738	570	491
Median:	228	215	279	333	272

## 8.2 Commercial Samples

Potassium (lbs K/acre Morgan extraction) in commercial samples (number):

Soil Management Group 1						
	<35	35-64	65-94	95-149	>149	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
Total (#)	0	0	0	0	0	0
Total (%)	-	-	-	-	-	-
Soil Management Group 2						
	<40	40-69	70-99	100-164	>164	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	5	21	59	85
2003	1	5	7	14	18	45
2004	1	5	6	14	49	75
2005	0	0	7	20	43	70
2006	0	2	5	16	44	67
Total (#)	2	12	30	85	213	342
Total (%)	1	4	9	25	62	100
Soil Management Group 3						
	<45	45-79	80-119	120-199	>199	Total
	Very Low	Low	Medium	High	Very High	
2002	11	117	213	377	652	1370
2003	67	252	308	384	558	1569
2004	49	175	224	331	418	1197
2005	20	47	130	415	805	1417
2006	11	86	283	514	835	1729
Total (#)	158	677	1158	2021	3268	7282
Total (%)	2	9	16	28	45	100

Soil Management Group 4						
	<55	55-99	100-149	150-239	>239	Total
	Very Low	Low	Medium	High	Very High	
2002	0	4	4	4	11	23
2003	2	4	5	7	6	24
2004	2	5	3	10	4	24
2005	0	4	10	5	7	26
2006	0	4	0	6	6	16
Total (#)	4	21	22	32	34	113
Total (%)	4	19	19	28	30	100
Soil Management Group 5						
	<60	60-114	115-164	165-269	>269	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	0	0	0	0
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	0	0	0
Total (#)	0	0	0	0	0	0
Total (%)	-	-	-	-	-	-
0 Soil Management Group 6						
	<60	60-114	115-164	165-269	>269	Total
	Very Low	Low	Medium	High	Very High	
2002	0	0	1	0	0	1
2003	0	0	0	0	0	0
2004	0	0	0	0	0	0
2005	0	0	0	0	0	0
2006	0	0	0	1	0	1
Total (#)	0	0	1	0	1	2
Total (%)	0	0	50	0	50	100

Potassium classification summary for commercial samples.

Summary (#)	Very Low	Low	Medium	High	Very High	Un-known	Total
2002	11	121	223	402	722	2	1481
2003	70	261	320	405	582	14	1652
2004	52	185	233	355	471	2	1298
2005	20	51	147	440	855	0	1513
2006	11	92	288	537	885	2	1815
Grand Total	164	710	1211	2139	3515	20	7759

Summary (%)	Very Low	Low	Medium	High	Very High	Un-known	Total
2002	1	8	15	27	49	0	100
2003	4	16	19	25	35	1	100
2004	4	14	18	27	36	0	100
2005	1	3	10	29	57	0	100
2006	1	5	16	30	49	0	100
Grand Total	2	9	16	28	45	0	100

	2002	2003	2004	2005	2006
Lowest:	28	12	11	6	31
Highest:	3240	1901	1590	3753	1676
Mean:	285	209	222	281	265
Median:	192	145	150	221	196

## 9. Magnesium

### 9.1 Homeowner Samples

Magnesium (lbs Mg/acre Morgan extraction) in homeowner samples (numbers):

	<20	20-65	66-100	101-199	>199	Total
	Very Low	Low	Medium	High	Very High	
2002	0	1	2	1	13	17
2003	0	4	3	11	26	44
2004	0	2	1	8	32	43
2005	0	1	1	6	19	27
2006	1	2	0	4	13	20
Total	1	10	7	30	103	151

	2002	2003	2004	2005	2006
Lowest:	48	31	28	61	9
Highest:	2697	1273	8006	1423	1827
Mean:	582	296	596	476	503
Median:	424	270	284	481	240

Magnesium in homeowner samples (% of total number of samples):

	<20	20-65	66-100	101-199	>199	Total
	Very Low	Low	Medium	High	Very High	
2002	0	6	12	6	76	100
2003	0	9	7	25	59	100
2004	0	5	2	19	74	100
2005	0	4	4	22	70	100
2006	5	10	0	20	65	100
Total	1	7	5	20	68	100

## 9.2 Commercial Samples

Magnesium (lbs Mg/acre Morgan extraction) in commercial samples (number):

	<20	20-65	66-100	101-199	>199	Total
	Very Low	Low	Medium	High	Very High	
2002	0	15	39	237	1190	1481
2003	0	29	65	294	1264	1652
2004	0	31	72	263	932	1298
2005	0	5	38	239	1231	1513
2006	0	26	69	313	1407	1815
Total	0	106	283	1346	6024	7759

	2002	2003	2004	2005	2006
Lowest:	32	29	20	43	37
Highest:	1923	1234	1288	1741	1142
Mean:	385	351	324	411	345
Median:	338	313	288	363	316

Magnesium in commercial samples (% of total number of samples):

	<20	20-65	66-100	101-199	>199	Total
	Very Low	Low	Medium	High	Very High	
2002	0	1	3	16	80	100
2003	0	2	4	18	77	100
2004	0	2	6	20	72	100
2005	0	0	3	16	81	100
2006	0	1	4	17	78	100
Total	0	1	4	17	78	100

## 10. Iron

### 10.1 Homeowner Samples

Iron (lbs Fe/acre Morgan extraction) in homeowner samples:

Total number of samples:

	0-49	>49	Total
	Normal	Excessive	
2002	17	0	17
2003	29	15	44
2004	36	7	43
2005	21	6	27
2006	16	4	20
Total	119	32	151

Percentages:

	0-49	>49	Total
	Normal	Excessive	
	100	0	100
	66	34	100
	84	16	100
	78	22	100
	80	20	100
	79	21	100

	2002	2003	2004	2005	2006
Lowest:	2	5	3	2	5
Highest:	35	683	305	207	191
Mean:	10	70	32	29	33
Median:	5	23	15	8	14



## 10.2 Commercial Samples

Iron (lbs Fe/acre Morgan extraction) in commercial samples:

Total number of samples:

	0-49	>49	Total
	Normal	Excessive	
2002	1387	94	1481
2003	1401	251	1652
2004	1039	259	1298
2005	1320	193	1513
2006	1561	254	1815
Total	6708	1051	7759

Percentages:

	0-49	>49	Total
	Normal	Excessive	
	94	6	100
	85	15	100
	80	20	100
	87	13	100
	86	14	100
	86	14	100

	2002	2003	2004	2005	2006
Lowest:	1	1	2	1	1
Highest:	438	273	534	377	513
Mean:	17	27	33	26	27
Median:	9	17	22	16	16

## 11. Manganese

### 11.1 Homeowner Samples

Manganese (lbs Mn/acre Morgan extraction) in homeowner samples:

Total number of samples:				Percentages:		
	0-99	>99	Total	0-99	>99	Total
	Normal	Excessive		Normal	Excessive	
2002	14	3	17	82	18	100
2003	31	13	44	70	30	100
2004	40	3	43	93	7	100
2005	22	5	27	81	19	100
2006	16	4	20	80	20	100
Total	123	28	151	81	19	100

	2002	2003	2004	2005	2006
Lowest:	12	9	16	15	5
Highest:	183	910	303	155	286
Mean:	59	124	60	70	58
Median:	38	63	45	63	37

## 11.2 Commercial Samples

Manganese (lbs Mn/acre Morgan extraction) in commercial samples:

Total number of samples:				Percentages:		
	0-99	>99	Total	0-99	>99	Total
	Normal	Excessive		Normal	Excessive	
2002	1393	88	1481	94	6	100
2003	1561	91	1652	94	6	100
2004	1205	93	1298	93	7	100
2005	1372	141	1513	91	9	100
2006	1669	146	1815	92	8	100
Total	7200	559	7759	93	7	100

	2002	2003	2004	2005	2006
Lowest:	6	6	6	9	8
Highest:	630	362	536	769	887
Mean:	45	47	48	56	50
Median:	34	41	37	45	35

## 12. Zinc

### 12.1 Homeowner Samples

Zinc (lbs Zn/acre Morgan extraction) in homeowner samples:

Total number of samples:

	<0.5	0.5-1.0	>1	Total
	Low	Medium	High	
2002	0	0	17	17
2003	0	1	43	44
2004	0	0	43	43
2005	0	0	27	27
2006	1	2	17	20
Total	1	3	147	151

Percentages:

<0.5	0.5-1.0	>1	Total
Low	Medium	High	
0	0	100	100
0	2	98	100
0	0	100	100
0	0	100	100
5	10	85	100
1	2	97	100

	2002	2003	2004	2005	2006
Lowest:	1.4	0.8	1.1	1.4	0.1
Highest:	62.1	165.8	45.5	31.2	29.3
Mean:	16.0	13.2	7.4	7.4	7.9
Median:	8.1	6.2	3.9	6.2	5.6

## 12.2 Commercial Samples

Zinc (lbs Zn/acre Morgan extraction) in commercial samples:

Total number of samples:

	<0.5	0.5-1.0	>1	Total
	Low	Medium	High	
2002	11	126	1344	1481
2003	29	279	1344	1652
2004	40	270	988	1298
2005	38	104	1371	1513
2006	81	240	1494	1815
Total	199	1019	6541	7759

Percentages:

	<0.5	0.5-1.0	>1	Total
	Low	Medium	High	
1	1	9	91	100
2	2	17	81	100
3	3	21	76	100
3	3	7	91	100
4	4	13	82	100
3	3	13	84	100

	2002	2003	2004	2005	2006
Lowest:	0.1	0.1	0.1	0.1	0.1
Highest:	102.5	37.7	49.0	128.5	42.0
Mean:	3.2	2.6	2.5	3.3	2.6
Median:	2.3	2.0	1.8	2.7	2.0

## Appendix: Cornell Crop Codes

Crop codes used in the Cornell Nutrient Analysis Laboratory.

Crop Code	Crop Description
<b>Alfalfa</b>	
ABE	Alfalfa trefoil grass, Establishment
ABT	Alfalfa trefoil grass, Established
AGE	Alfalfa grass, Establishment
AGT	Alfalfa grass, Established
ALE	Alfalfa, Establishment
ALT	Alfalfa, Established
<b>Birdsfoot</b>	
BCE	Birdsfoot trefoil clover, Establishment
BCT	Birdsfoot trefoil clover, Established
BGE	Birdsfoot trefoil grass, Establishment
BGT	Birdsfoot trefoil grass, Established
BSE	Birdsfoot trefoil seed, Establishment
BST	Birdsfoot trefoil seed, Established
BTE	Birdsfoot trefoil, Establishment
BTT	Birdsfoot trefoil, Established
<b>Barley</b>	
BSP	Spring barley
BSS	Spring barley with legumes
BUK	Buckwheat
BWI	Winter barley
BWS	Winter barley with legumes
<b>Clover</b>	
CGE	Clover grass, Establishment
CGT	Clover grass, Established
CLE	Clover, Establishment
CLT	Clover, Established
CSE	Clover seed production, Establishment
CST	Clover seed production, Established

Crop Code	Crop Description
	Corn
COG	Corn grain
COS	Corn silage
	Grasses, pastures, covercrops
CVE	Crownvetch, Establishment
CVT	Crownvetch, Established
GIE	Grasses intensively managed, Establishment
GIT	Grasses intensively managed, Established
GRE	Grasses, Establishment
GRT	Grasses, Established
PGE	Pasture, Establishment
PGT	Pasture improved grasses, Established
PIE	Pasture intensively grazed, Establishment
PIT	Pasture intensively grazed, Established
PLE	Pasture with legumes, Establishment
PLT	Pasture with legumes, Established
PNT	Pasture native grasses
RYC	Rye cover crop
RYS	Rye seed production
TRP	Triticale peas
	Small grains
MIL	Millet
OAS	Oats seeded with legume
OAT	Oats
SOF	Sorghum forage
SOG	Sorghum grain
SOY	Soybeans
SSH	Sorghum sudan hybrid
SUD	Sudangrass
WHS	Wheat with legume
WHT	Wheat
	Others
ALG	Azalea
APP	Apples
ATF	Athletic field

Crop Code	Crop Description
BDR/DND	Beans-dry
BLU	Blueberries
CEM	Cemetery
FAR	Fairway
FLA	Flowering annuals
GRA	Grapes
GEN	Green
HRB	Herbs
IDL	Idle land
LAW	Lawn
MIX/MVG	Mixed vegetables
PER	Perennials
PRK	Park
POT/PTO	Potatoes
PUM	Pumpkins
ROD	Roadside
ROS	Roses
RSF	Raspberries, Fall
RSP	Raspberries (homeowners)
RSS	Raspberries, Summer
SAG	Ornamentals adapted to pH 6.0 to 7.5
SQW	Squash, Winter
STE	Strawberries, Ever
STR	Strawberries (homeowners)
STS	Strawberries, Spring
SUN	Sunflowers
SWC	Sweet corn
TOM	Tomatoes
TRE	Christmas trees, Establishment
TRF	Turf
TRT	Christmas trees, Topdressing



Rao, R., D. Dewing, Q.M. Ketterings, and H. Krol (2007). Delaware Soil Sample Survey (2002-2006). CSS Extension Bulletin E07-19. 35 pages.



Delaware County (photo credit: Dale Dewing, CCE of Delaware County).