

Irrigating Agricultural Crops with Treated Municipal Wastewater: *Review of a Three Year Study and New Regulations in Delaware*

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UD

Acknowledgement:
Marline Baust
DNREC



Town of Middletown:

- Treatment = ~1 Million Gallons/day
- Lagoon Storage = 180 Million Gallons

- In 2009, DE Code Title 3, Chapter 23, Sec. § 2301 enacted.
- “Any agricultural lands which are actively being farmed shall have the right to receive and recycle to such land reclaimed water through irrigation systems.”

DELAWARE
DEPARTMENT OF NATURAL RESOURCES AND ENVIRONMENTAL CONTROL
DIVISION OF WATER
GROUNDWATER DISCHARGES SECTION
Statutory Authority
7 Delaware Code Chapter 60

**REGULATIONS GOVERNING THE DESIGN, INSTALLATION AND OPERATION OF
ON-SITE WASTEWATER TREATMENT AND DISPOSAL SYSTEMS**

ADOPTED: January 4, 1985

EFFECTIVE: January 4, 1985 Sections 1.00000, 2.00000, 3.00000, 7.00000, 9.00000 and Exhibits
May 1, 1985 Section 4.00000
July 10, 1985 Sections 5.00000, 6.00000, 8.00000 and 10.00000

AMENDED: July 10, 1985
August 15, 1986
September 30, 1989
January 31, 1995
March 11, 2002
April 11, 2005
January 11, 2013

6.11.7.1.1.3 Decennial - Results of soils sampling and the calculated remaining site life on a constituent by constituent basis for phosphorus, cadmium, copper, lead, nickel and zinc.

6.11.7.1.2 Recipients of treated wastewater:

6.11.7.1.2.1 Weekly - The quantity of treated wastewater provided to each recipient on a weekly basis.

6.11.7.1.2.2 Monthly - Copies of all effluent monitoring results.

6.11.7.1.2.3 Annual - A copy of the Annual Summary Report.

6.11.8 Agricultural Use of Distributed Treated Wastewater

Agricultural use of distributed treated wastewater is the distribution of treated wastewater to farmers for irrigation of agricultural crops in accordance with 3 Del.C. §2301. Sites using treated wastewater in accordance with 3 Del.C. §2301 which have incorporated the use of treated wastewater in a Delaware Department of Agriculture approved Nutrient Management Plan are exempt from the requirements of Sections 6.0 through Section 6.10, and Section 6.12 of these Regulations unless specifically referenced within this Section 6.11. Wastewater treatment facilities proposing to distribute treated wastewater for agricultural use must comply with all requirements set forth in Section 6.11 and must adhere to the requirements of this Section 6.11.8.

6.11.8.1 General Requirements

6.11.8.1.1 Wastewater treatment facilities permitted to distribute treated wastewater to farmers will not receive an increase in the permitted disposal capacity for the volume distributed.

6.11.8.1.2 Providing treated wastewater to farmers to utilize in accordance with 3 Del.C. §2301 must not cause the quality of Delaware's groundwater resources to be in violation of applicable Federal or State Drinking Water Standards on an average annual basis and must not cause violation of State Water Quality Standards for streams.

6.11.8.1.3 In addition to the limits found in Section 6.3.2.3.3.2, the treated wastewater to be distributed must not exceed a chloride concentration of 250 mg/L on an annual average basis.

6.11.8.1.4 The total volume of treated wastewater that may be distributed to each farmer must not exceed agronomic rates as determined and reported in a Delaware Department of Agriculture approved Nutrient Management Plan; and an irrigation plan developed to NRCS standards.

6.11.8.1.5 The total volume of treated and filtered wastewater distributed must be recorded/calculated over a weekly period for each user. The volume must be reported in accordance with Section 6.11.8.3.

6.11.8.2 Application Requirements

6.11.8.2.1 One application shall be coordinated, completed and submitted to both DDA and DNREC. The application submitted to DNREC shall omit the Nutrient Management Plan.

6.11.8.2.2 The application must include:

6.11.8.2.2.1 All applicable items iterated in Section 6.11.4.

6.11.8.2.2.2 The wastewater treatment facility must execute an Agricultural Spray Agreement with each farmer receiving treated wastewater. The agreement must include a point of contact and mailing address for the farmer, and Land Zoning/Ownership verification of the farmers' properties. If the farmer

Regulatory Requirements

- Department of Natural Resources and Environmental Control (DNREC)
 - Regulates treatment facility and distribution up to the farmer's property line.
 - Issues permit to the Town of Middletown to operate facility and provide spraywater to farmers.
 - Spraywater must meet unlimited public assess standards.
- Department of Agriculture and the Nutrient Management Commission (DDA)
 - Regulates N and P application including treated spraywater.
 - Amends nutrient management planning requirements to reflect nutrient contributions from spraywater.
 - For this Pilot Project, grower letters to Middletown state that several BMP's will be implemented.

Unlimited Public Access Wastewater

- All wastewater used for irrigation on unlimited access sites must be biologically treated, filtered and disinfected.
- Specific limits on:
 - BOD
 - TSS
 - Fecal Coliforms
 - Limits also exist for other water quality parameters.

Status of As-Needed Spray Irrigation in Middletown

- Dennis Clay and Larry Jester have written letters to Middletown requesting spraywater.
- Middletown has agreed to supply spraywater to:
 - Jester (440 acres)
 - Clay (389 acres)
 - Permit to Middletown approved
- Underground distribution lines installed from Middletown's lagoons to the grower's property line.
- Operating Conditions:
 - "As-Needed Irrigation"
 - Growers control the timing and depth of spraywater application





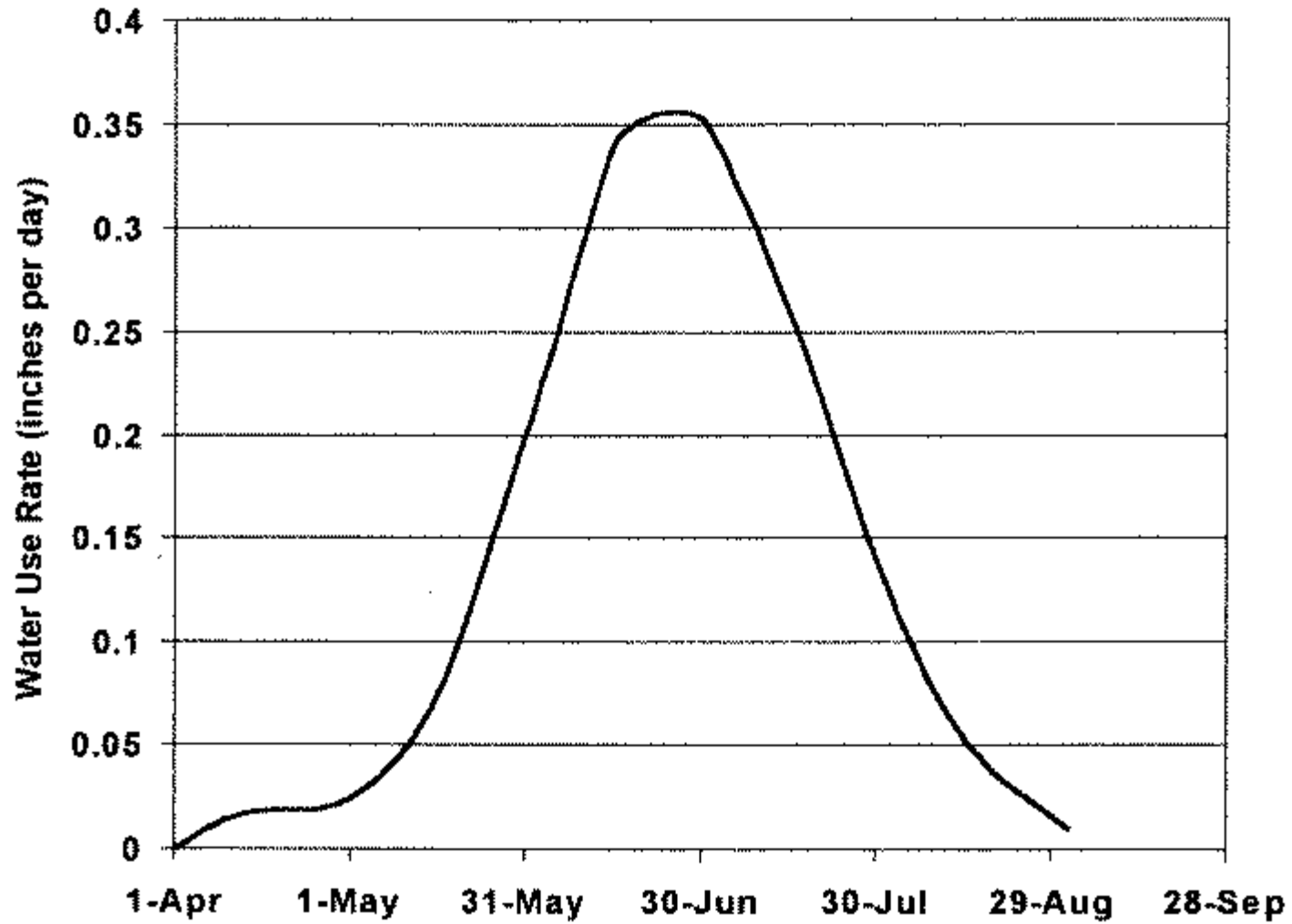
Topics to Address

- Crop Water Demand
- Potential Nutrient Loading on Cropland
- Cost Implications for Growers
- Metals Accumulation in the Soil
- Recommendations

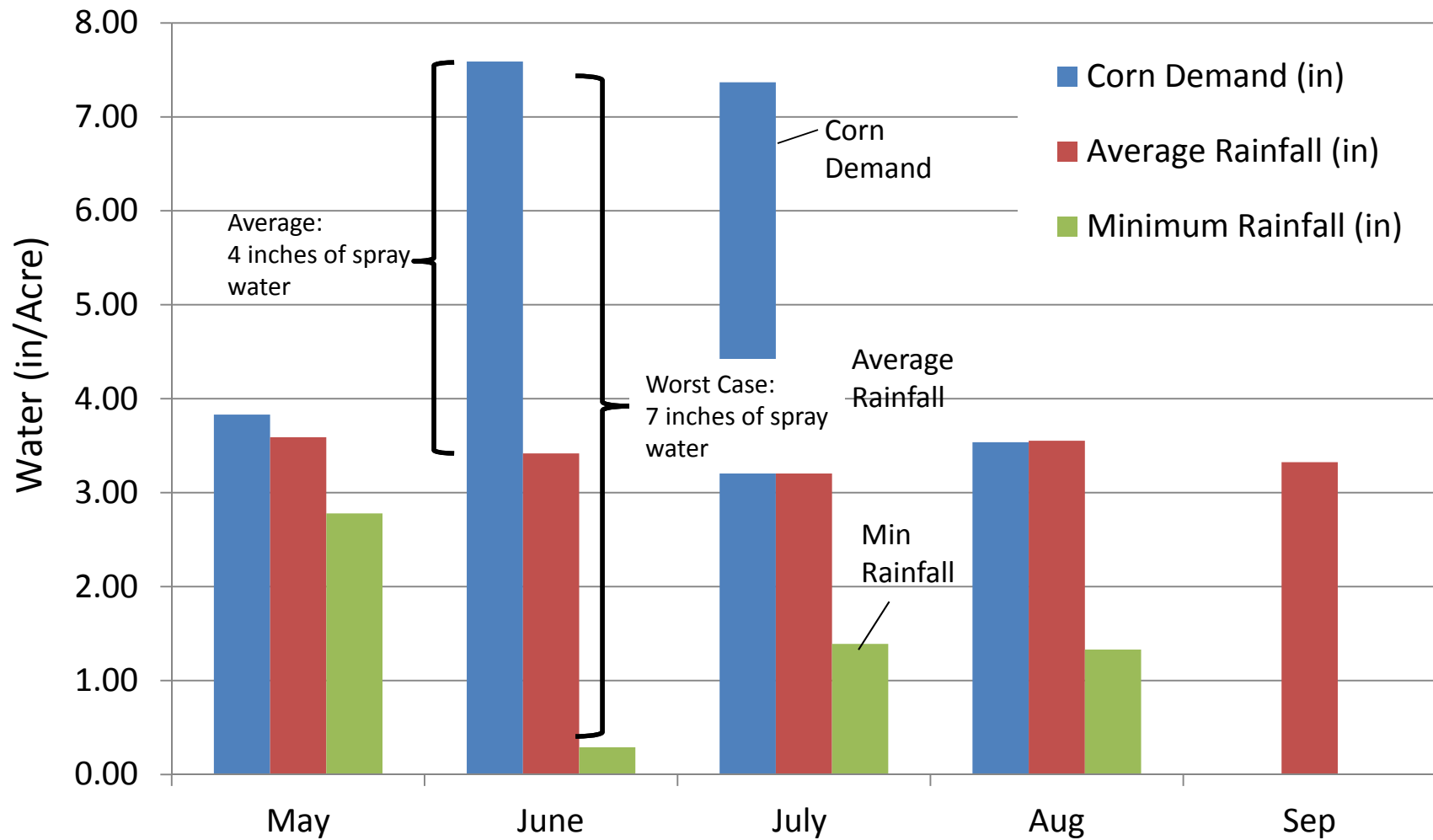
Crop Water Demand

Based on a 35 Year Weather
History of Middletown

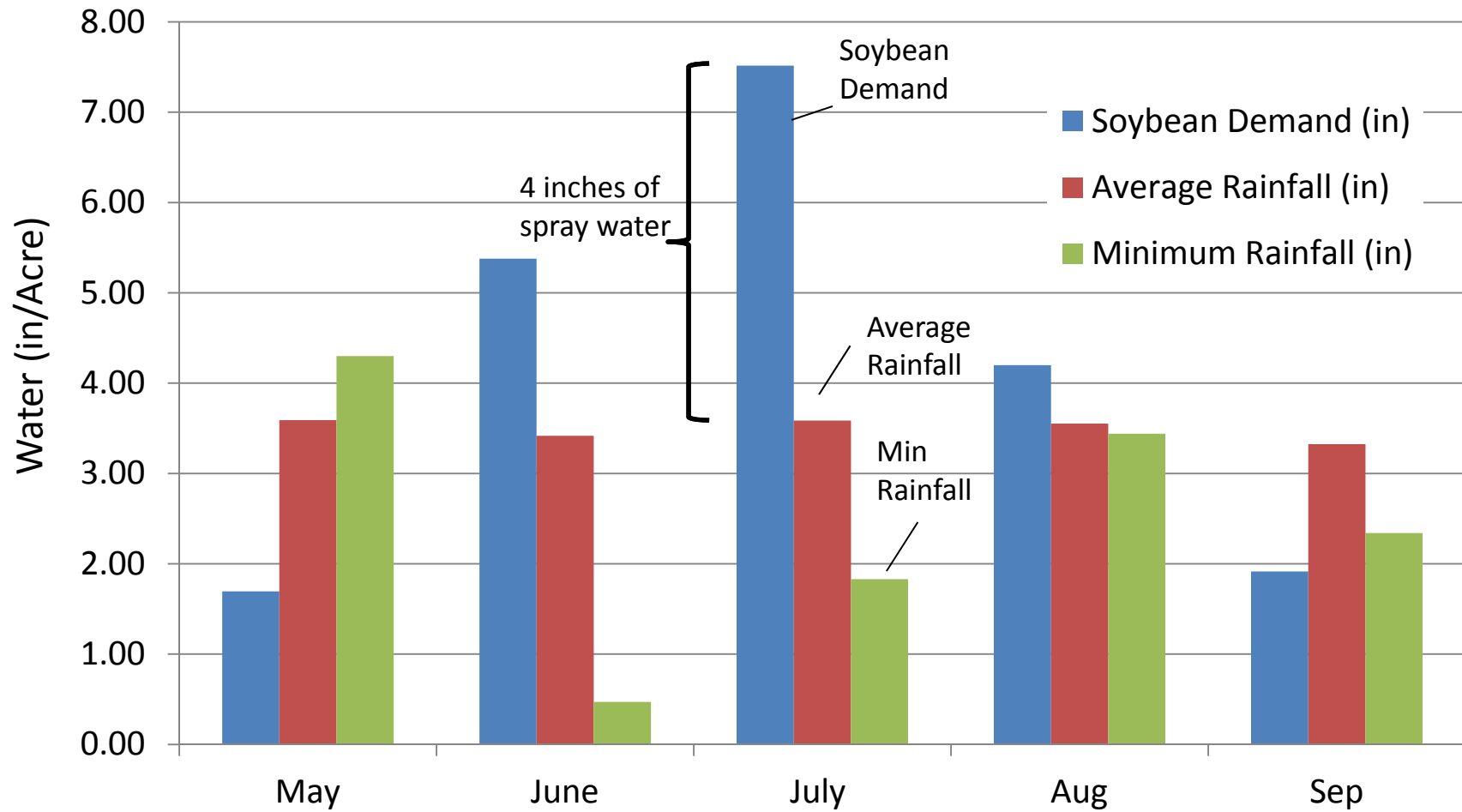
Typical Corn Water Use Per Day



Corn Water Demand in Middletown (35 Year Weather History)



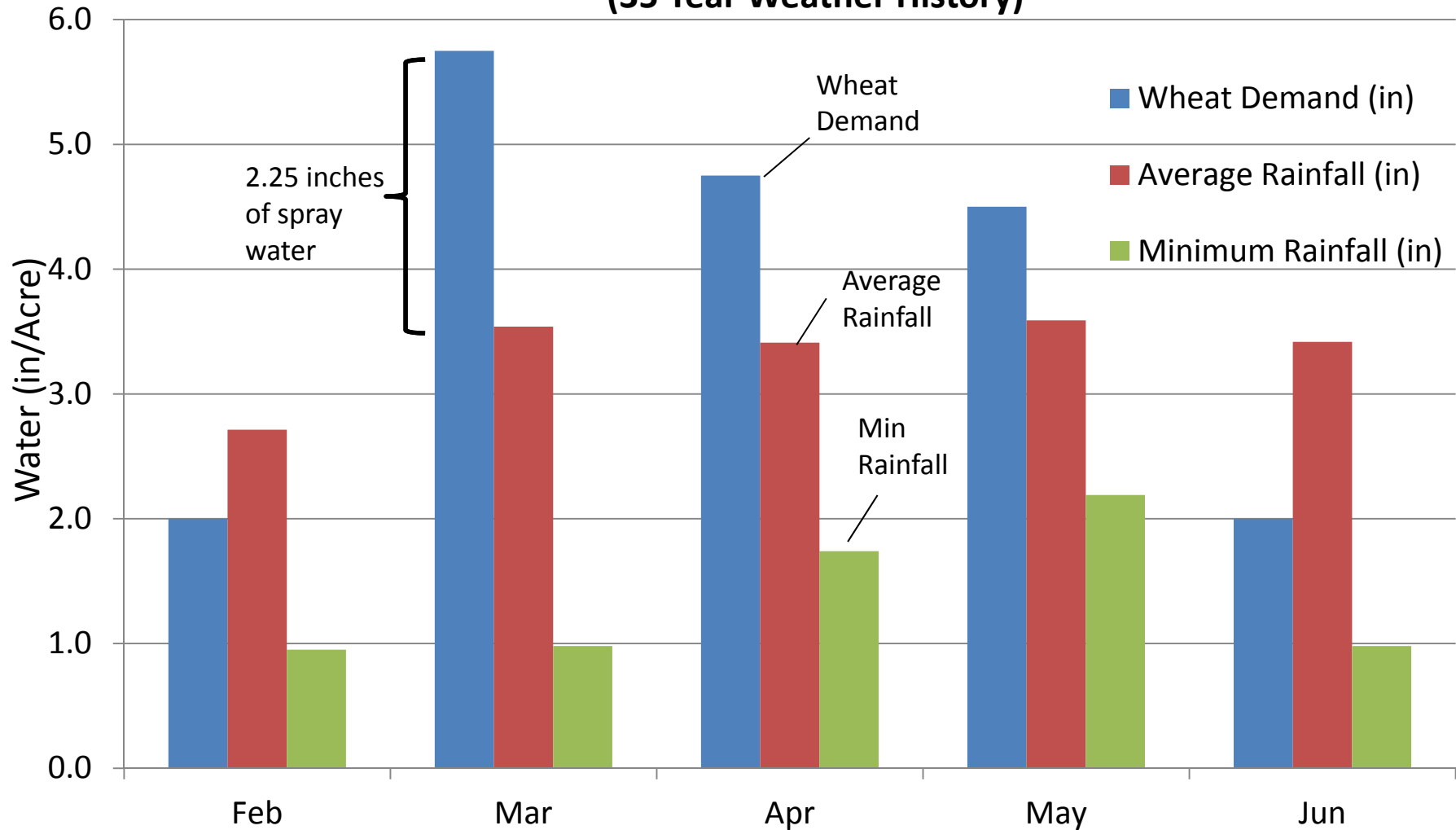
Soybean Water Demand in Middletown (35 Year Weather History)



Summary:

- Average July Irrigation: 4 inches/Acre (108,000 Gallons/Acre)
- Maximum July Irrigation: 5.75 inches/Acre (156,000 Gallons/Acre)

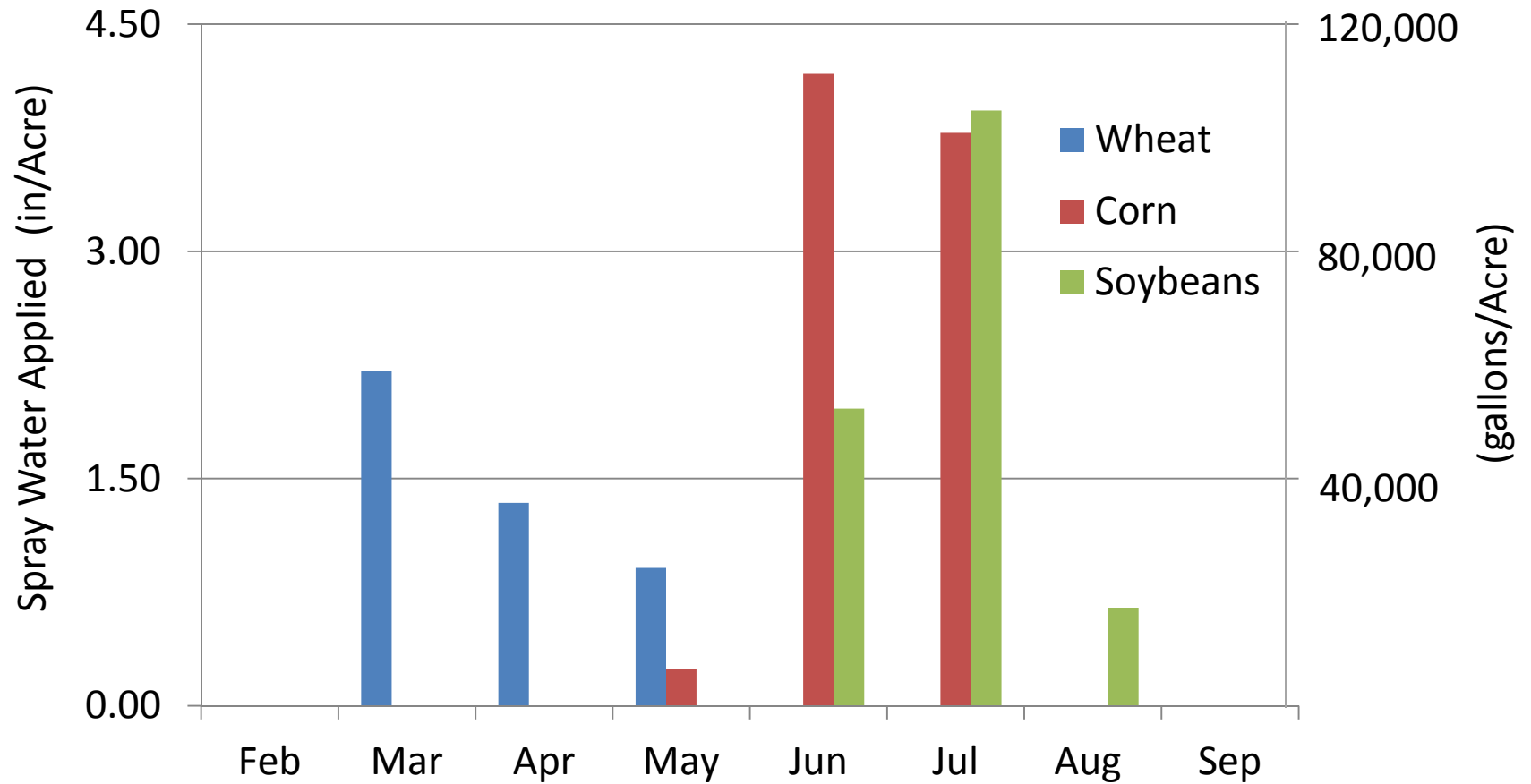
Wheat Water Demand in Middletown (35 Year Weather History)



Summary:

- Average March Irrigation: 2.25 inches/Acre (61,000 Gallons/Acre)
- Maximum March Irrigation: 4.75 inches/Acre (129,000 Gallons/Acre)

Average Annual Spray Water Demand (Based on Average Rainfall)



Implications:

- For 100 Acres, Peak June Demand = 11,000,000 gallons

Nutrient Balance

Crop Parameters

	Irrigated Yield	Nutrients Removed (lbs/Acre)		
		N	P	K
Soybeans	60 bu/Acre	50	26.4	75
Corn	250 bu/Acre	250	44	62
Wheat Grain	90 bu/Acre	120	19.8	22
Wheat Straw	3 tons/Acre	33	10	46

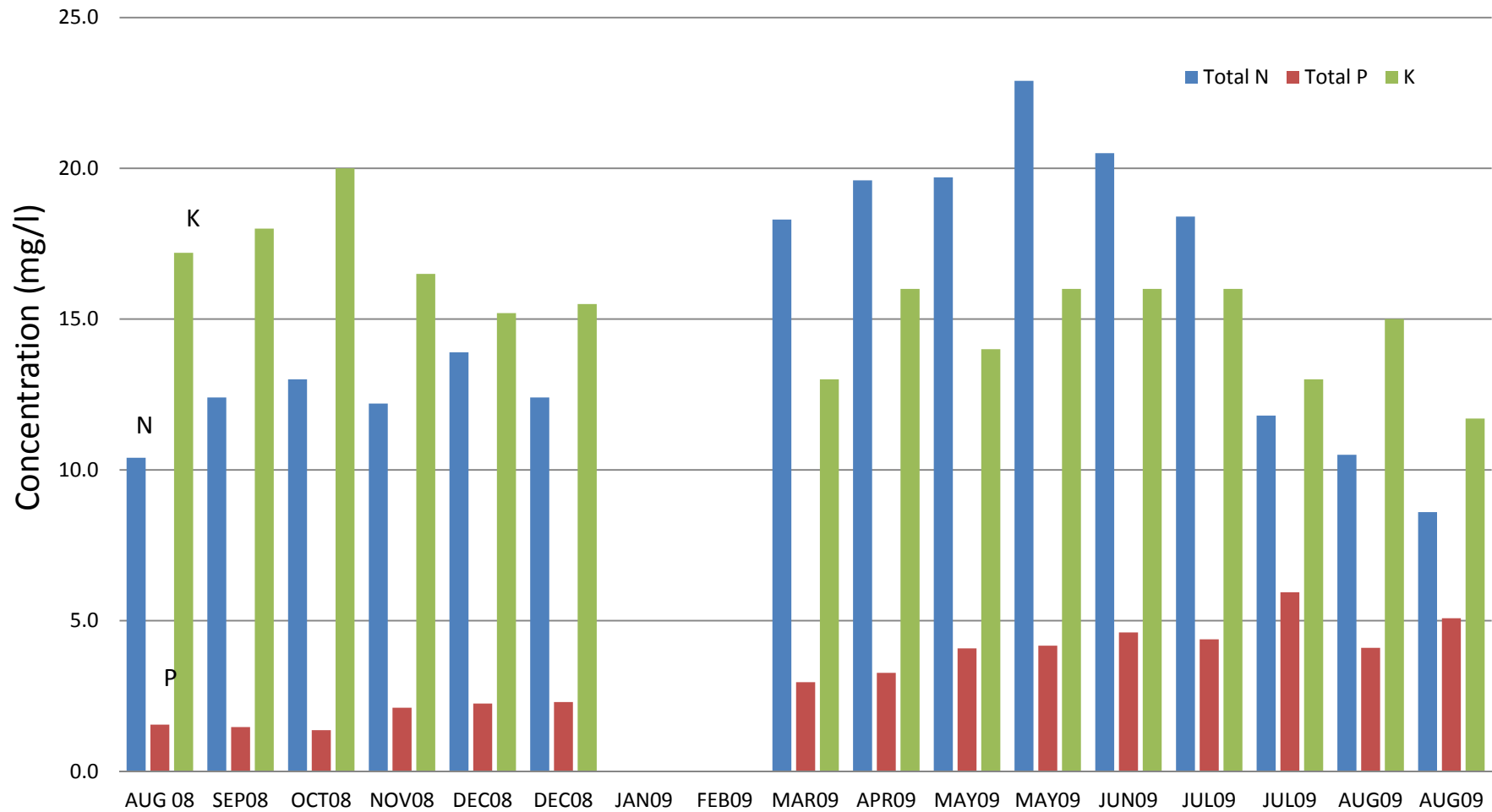
Agricultural Nutrient Management

The Delaware Nutrient Management Law states:

The amount of Nitrogen (N) and Phosphorous (P) applied as fertilizers and wastes cannot exceed the amount of N and P removed at harvest.

Middletown Spray Effluent Summary

Aug 08 to Aug 09



Annual Summary (mg/l)

	N	P	K
Average	15.0	3.31	15.5
Low	8.6	1.37	11.7
High	22.9	5.94	20.0

May-Aug Summary (mg/l)

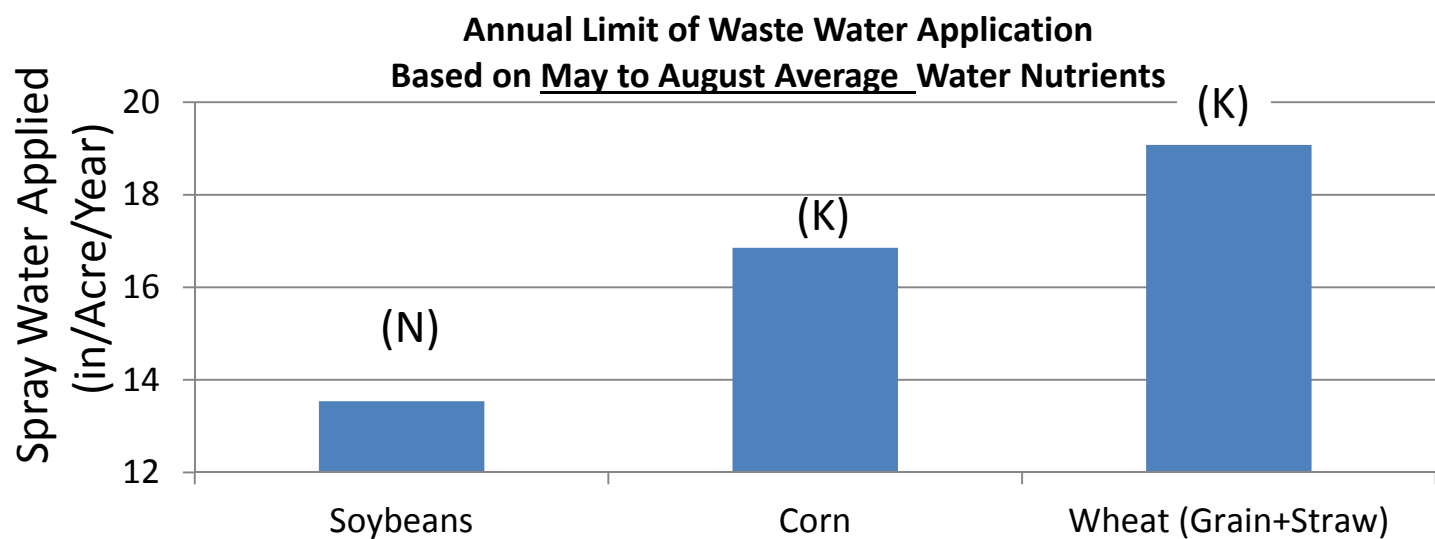
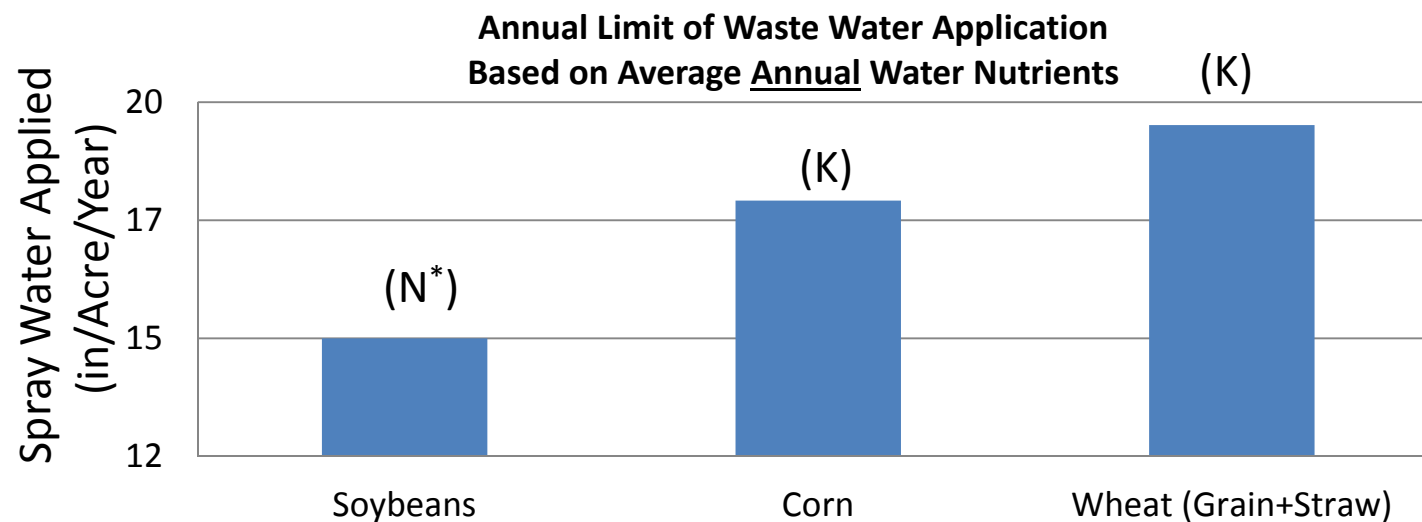
	N	P	K
Average	16.1	4.6	14.5
Low	8.6	4.1	11.7
High	22.9	5.9	16.0

Spray Water Nutrient Summary

(based on May through Aug Average)

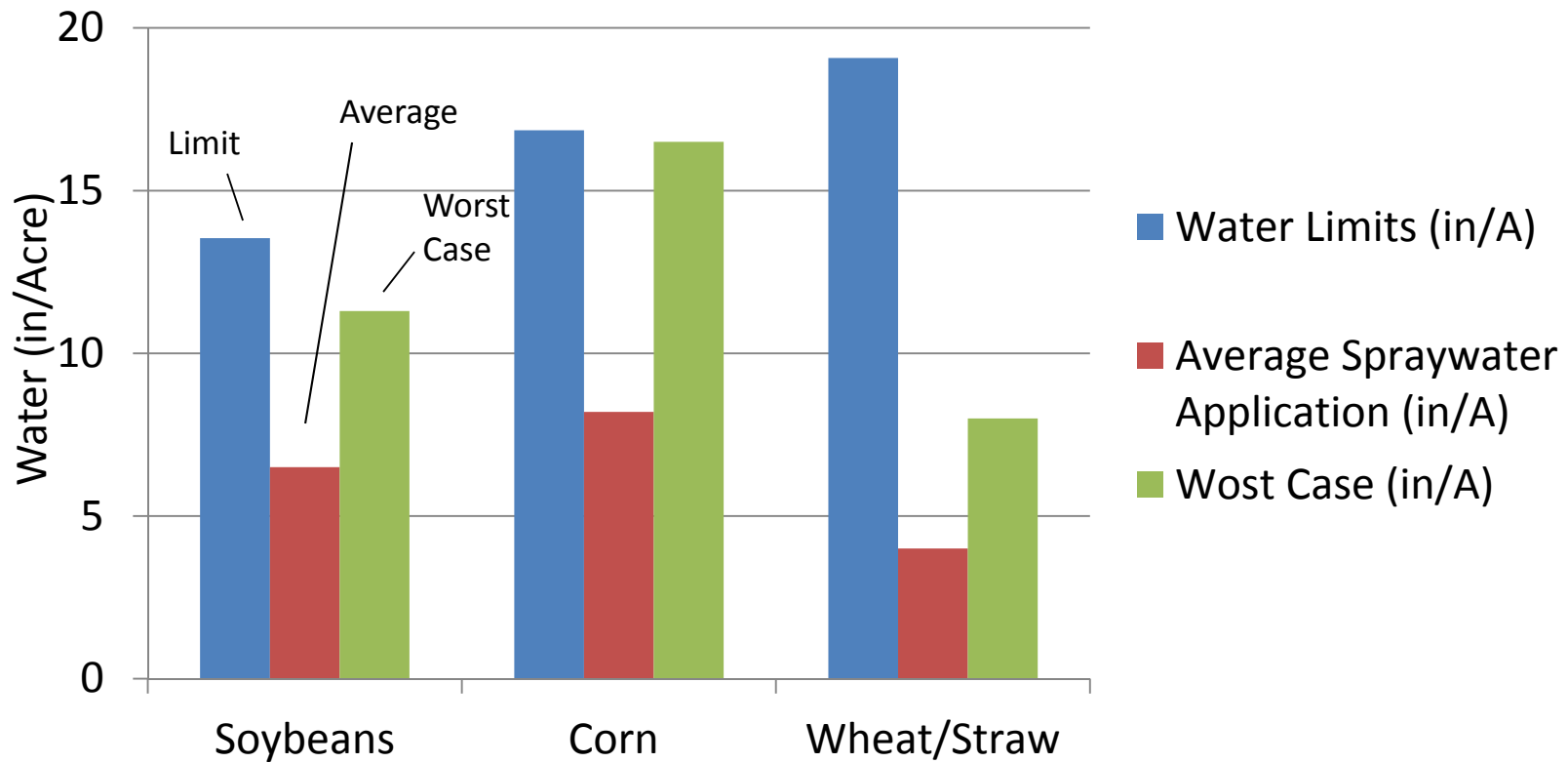
	(mg/l)	(lbs/ million gallons)	(lbs/inch of water)
N	16.1	136	3.7
P	4.6	39	1.1
K	14.5	123	3.3

Annual Spray Water Application Limits Based on Nutrient Loading



* Limiting
Nutrient

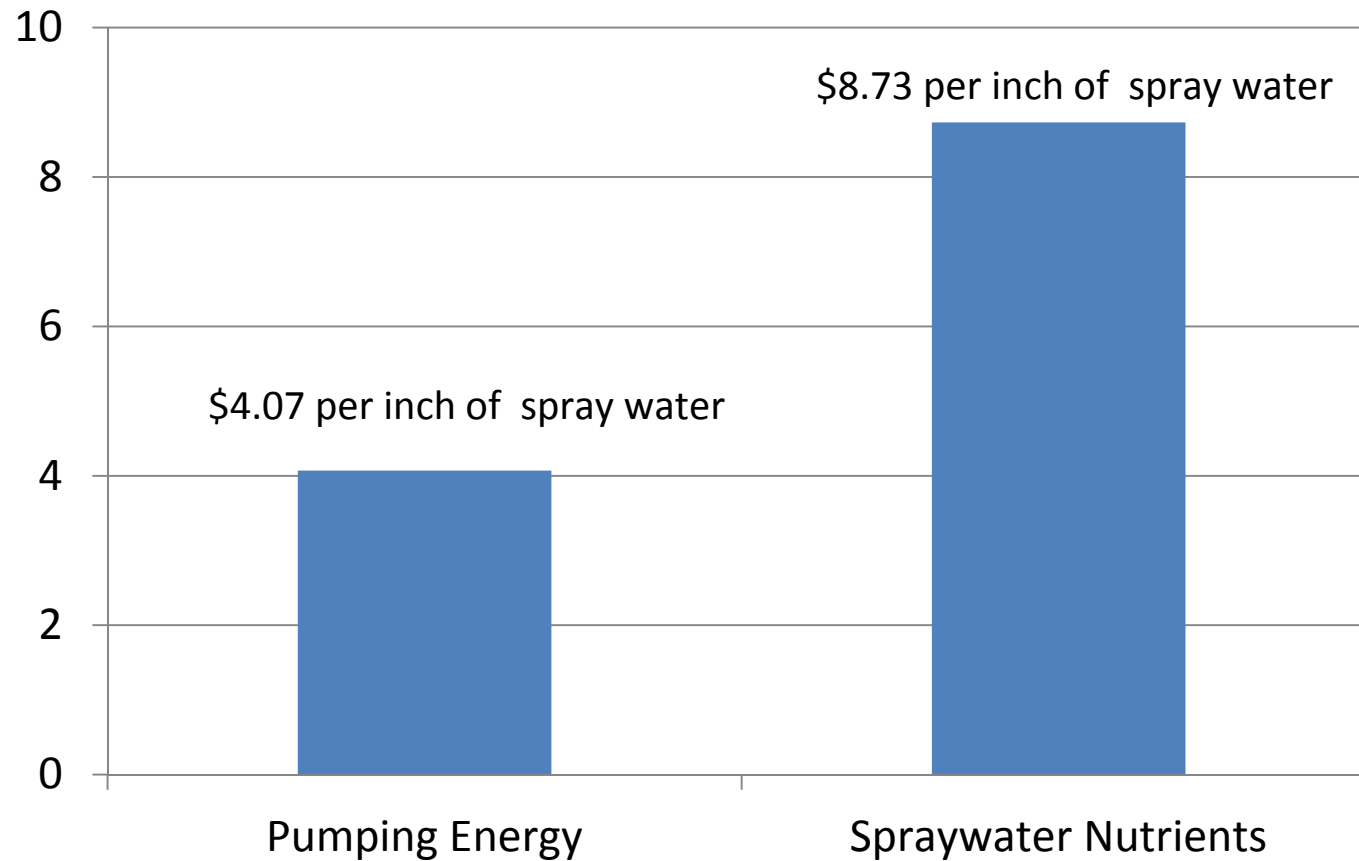
Crop Irrigation Demand vs. Spray water Limits



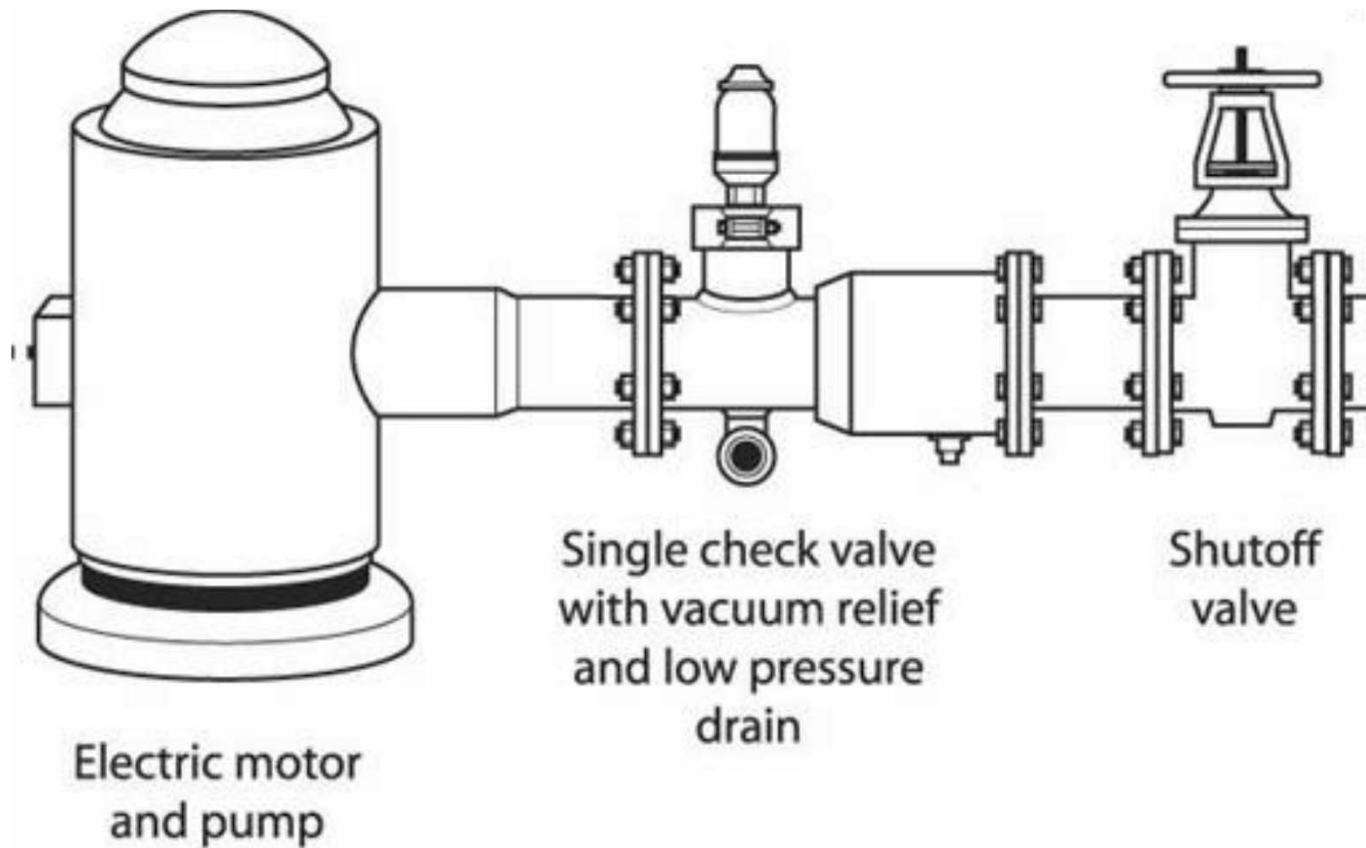
Implications:

- Nutrient loading from spray water irrigation will never exceed crop removal rates

Cost Savings For Farmers (per Acre)



Backflow Prevention



Metals Loading

(Based on Lab Detection Limits)

	DNREC Limit (lbs/A)	Highest Possible Annual Loading (lbs/A)	Minimum Lifespan (years)
Cadmium	4.46	0.0156	285
Copper	140	0.0196	7,161
Lead	560	0.0391	14,322
Nickel	140	0.0196	7,161
Zinc	280	0.0196	14,322

Recommendations

- Based on current N, P, and K spray water concentrations, annual spraywater irrigation limits are:
 - Corn 18 inches per year
 - Soybeans 13 ½ inches per year
 - Wheat & Straw 18 ½ inches per year
- Anticipated spray water irrigation demand will be:
 - Average Year 6 to 8 inches per acre per year
 - Worst Year 12 inches per acre year for soybeans
..... 16 ½ inches per acre per year for corn
- Growers in Middletown will not use more than 40 million gallons of spray water annually per 100 acres.

Recommendations . . .

- The accumulation of metals in the soil is not a concern.
- Feasibility studies must be performed as a first step in considering spray on demand with treated wastewater.
- Overall Recommendation:
Growers can irrigate with treated wastewater in a manner that is compliant with current Delaware nutrient management laws and planning guidelines.

Recommendations . . .

- Annually, growers in Middletown will use about 22 million gallons of spray water per 100 acres.
- Growers in Middletown will not use more than 40 million gallons of spray water annually per 100 acres.
- The accumulation of metals in the soil is not a concern, and is lower than loading rates on existing spray fields.
- Overall Recommendation:
Growers can irrigate with treated wastewater in a manner that is compliant with current Delaware nutrient management laws and planning guidelines.

Current Status

- Middletown
 - To date, growers have recycled about 200 million gallons of spraywater
 - The town is providing about all the water it can
- One jurisdiction was not eligible to provide spray water based on water quality.
- Several jurisdictions have completed technical feasibility studies.
- In general, costs to upgrade wastewater treatment capabilities are the limiting factor.

Questions?
Comments?