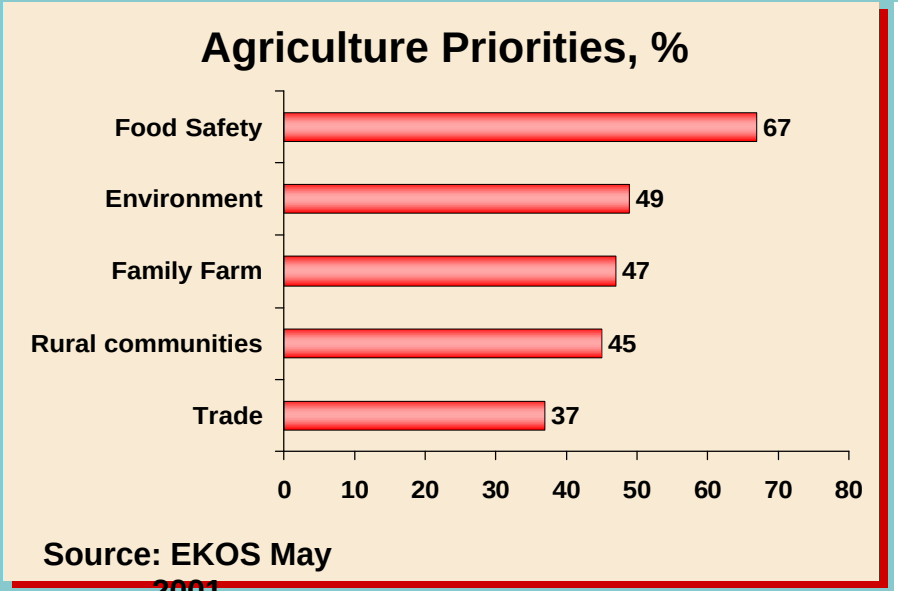
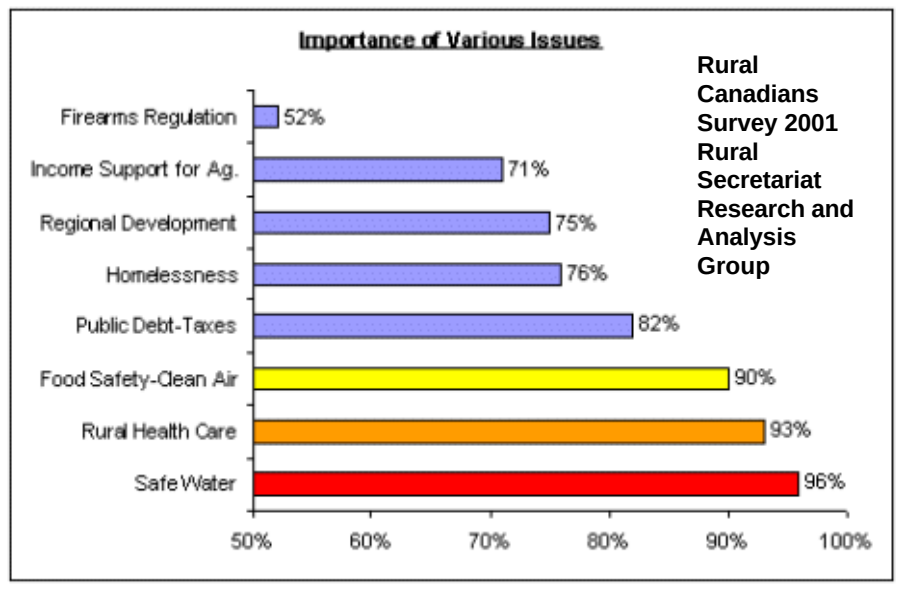
Tile Water Quality and Nitrogen Management

Michelle Harland
Senior Soil Resource Specialist
Agriculture Canada/PFRA
harlandm@agr.gc.ca

Should Nitrogen Management be a Consideration in Tile Drainage Design?





Producer perspective

- protection of water quality
- liability with respect to environmental impact
- unintended costs
  - livestock health, water treatment systems

Should Nitrogen Management be a Consideration in Tile Drainage Design?

The Trade-Off

- decreased surface runoff resulting in decreased soil erosion and P loss

BUT …

- improved infiltration and internal drainage resulting in elevated nitrates in effluent

Should Nitrogen Management be a Consideration in Tile Drainage Design?

- **Numerous applied research and monitoring studies**
  - **Lake Winnipeg**
  - **ADA**
  - **Field monitoring – irrigation programs**
  - **Deep nitrate soil testing - high input crops**

Manitoba Nitrate Monitoring Data Examples

Canadian Water Quality Guideline for NO_3-N is 10 ppm

- in-field groundwater - 46 ppm
- R.M. well water quality project (93 wells)
  - 43 over 10 ppm; 3 over 100 ppm
- ADA study up to >120 ppm
- soil testing to 12 feet
  - 3852 lbs highest, 423 lbs second highest

Soil Sample Results

Date Sampled - October 9, 2001

Soil Sample	Depth (feet)	Nitrate (#/ac)
N1	0-1	20
N1	1-2	26
N1	2-3	34
N1	3-4	54
N1	4-5	48
N1	5-6	32
N1	6-7	24
N1	7-8	22
N1	8-9	30
N1	9-10	56

346 #/ac N = $140/ac

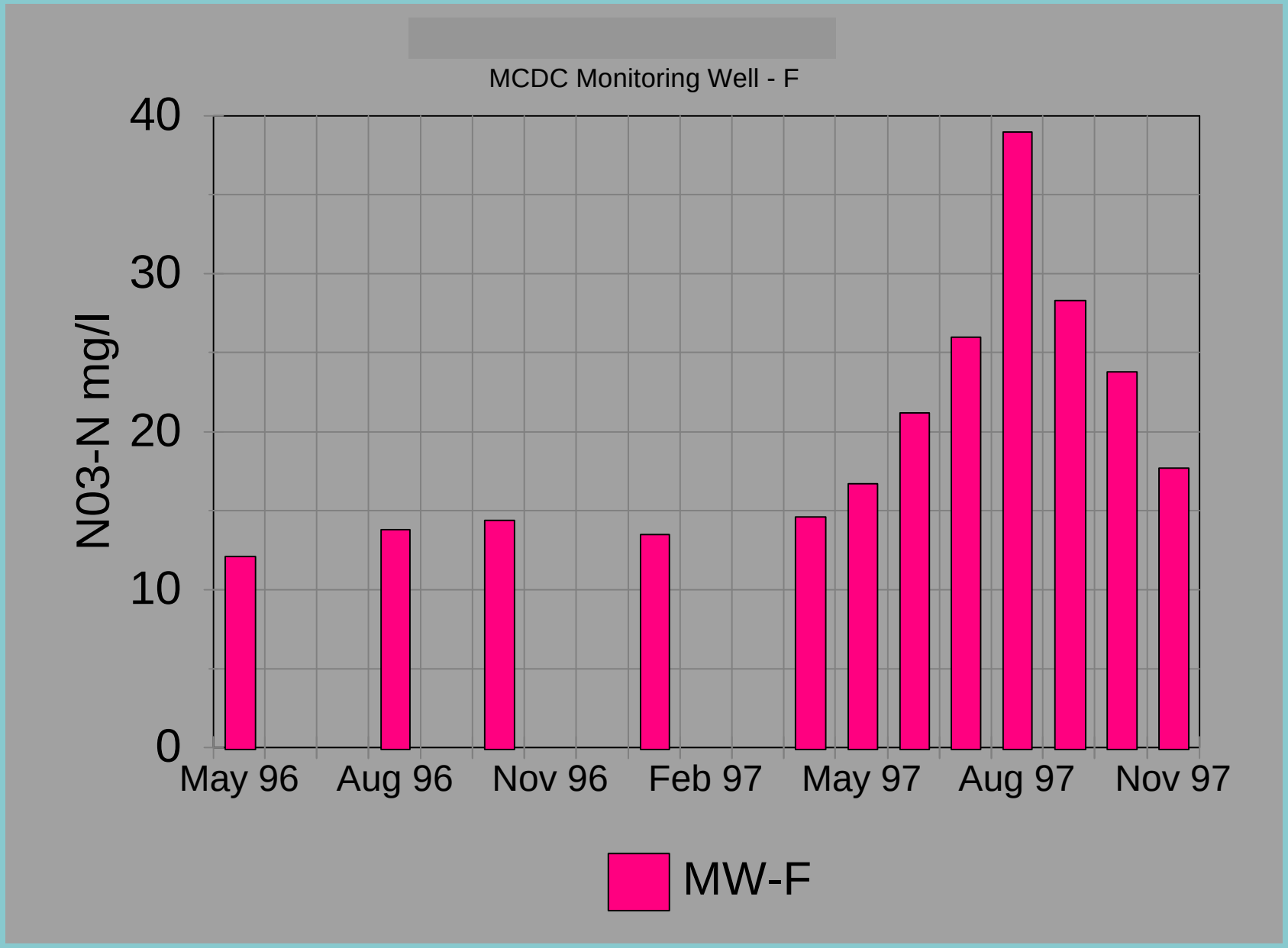
Water - Conventional Parameters

Site Number	N1
Date Sampled	9-Oct-01
EC (uS/cm)	670
pH (pH units)	7.21
Hardness	1290
Total Dissolved Solids	535
Total Alkalinity	190
Bicarbonate Alkalinity	232
Carbonate Alkalinity	<0.5
Hydroxide Alkalinity	<0.5
fluoride	<0.5
Chloride	16.40
NO_3+NO_2-N (mg/L)	38.3
Nitrate	38.3
Nitrite	0.007
Sulphate	28.9
Ammonia Nitrogen	0.06
Total Phosphorus (mg/L as P)	0.518

Metals in Water

	Total	Dissolved
Site Number	N1	N1
Date Sampled	9-Oct-01	9-Oct-01
Calcium	392	343
Iron	47.5	3.43
Magnesium	137	114
Manganese	6.28	3.29
Potassium	6.1	2.97
Silicon		23.3
Sodium		3.28

Results expressed as Milligrams per Litre (mg/L) unless otherwise stated


MCDC Monitoring Well - F
N03-N mg/l
40
30
20
10
0
May 96
Aug 96
Nov 96
Feb 97
May 97
Aug 97
Nov 97
MW-F

Should Nitrogen Management be a Consideration in Tile Drainage Design?

- **Tile drainage essentially transforms a non-point source situation to point source**

Pilot Project Sites
Manitoba Tile Drainage Study

Site	Acres	Soil Type	Design	Spacing Between Tile (m)	Depth to Drain Invert (m)	Outlet Type	$/ac
A	27	sand over clay	random	30 to 40	0.9 to 1.3	gravity	510
B	21	sand	systematic	40	0.8 to 1.5	pumped	387
C	81	clay loam or sandy loam over clay	systematic	30	0.9 to 1.2	gravity	542
E	45	sandy loam over silty clay	systematic	30	1.2 to 1.4	gravity	461

Manitoba Tile Drainage Study Effluent Water Quality

Nitrate-N

- **1.8 to 73.6 ppm**

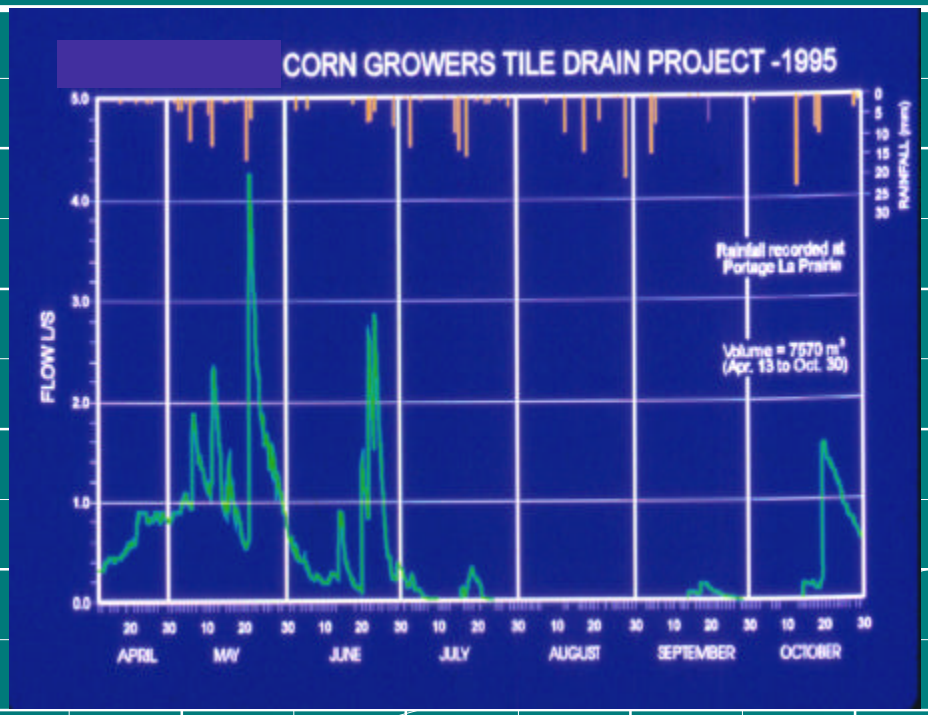
Conductivity

- 303 to 5070 uS/cm

Pesticides

- 1 detect
  - Atrazine 0.0002 ppm (CWQG 0.005 ppm)
  - all other below D.L.'s

Site A Tile Effluent
1995 Nitrate-N Concentrations

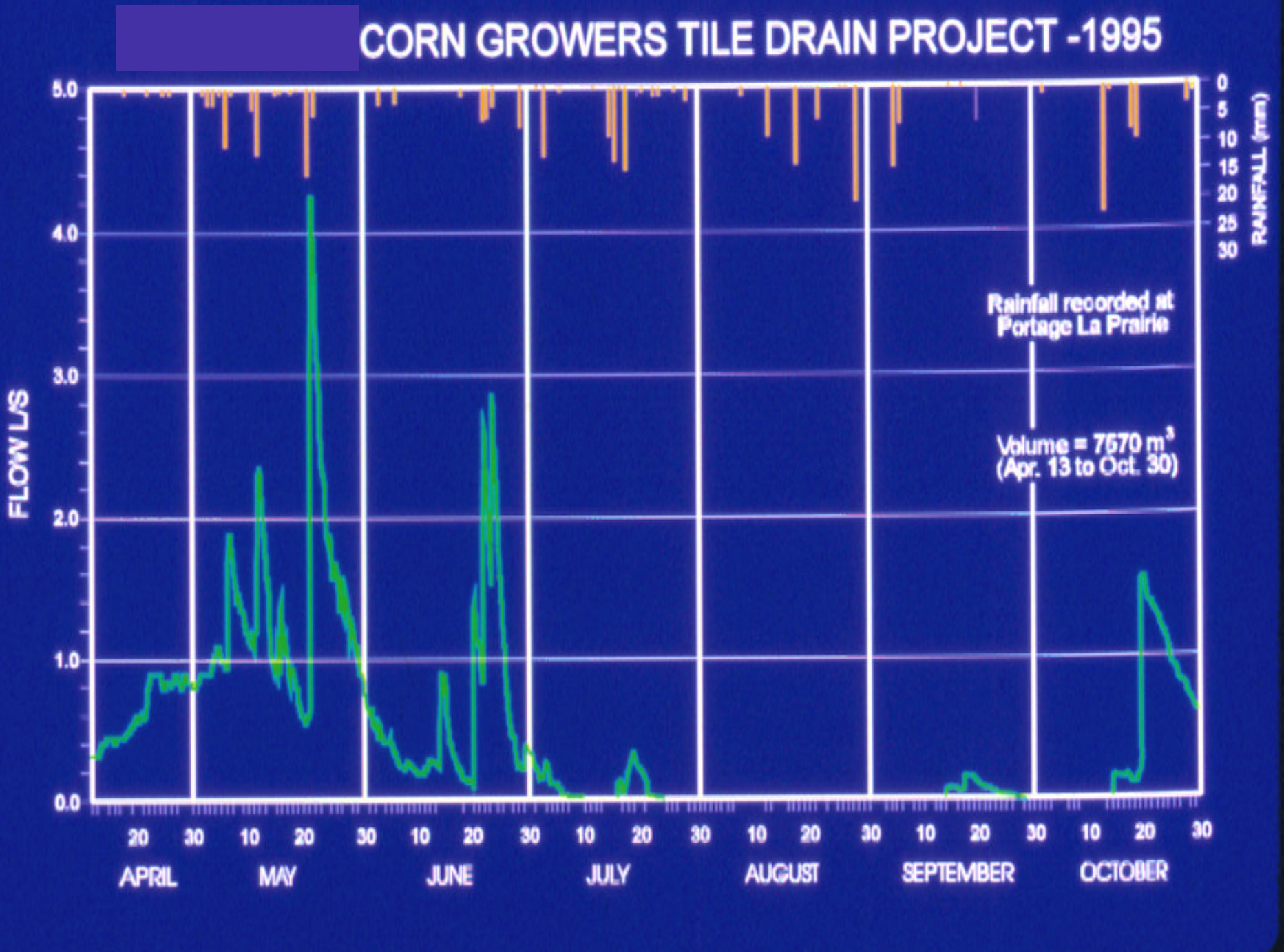


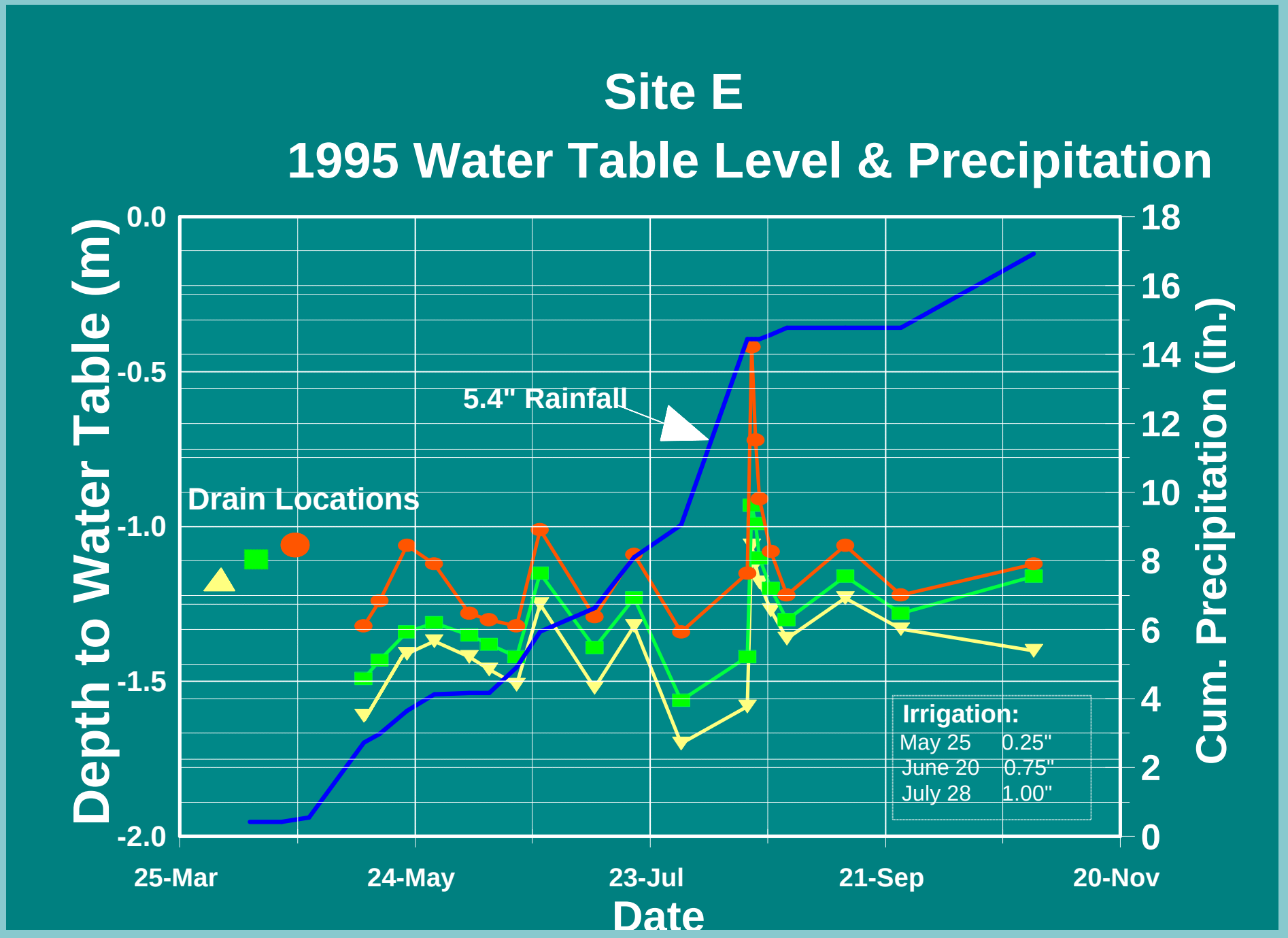
Nitrate-N (ppm)

60
55
50
45
40
35
30

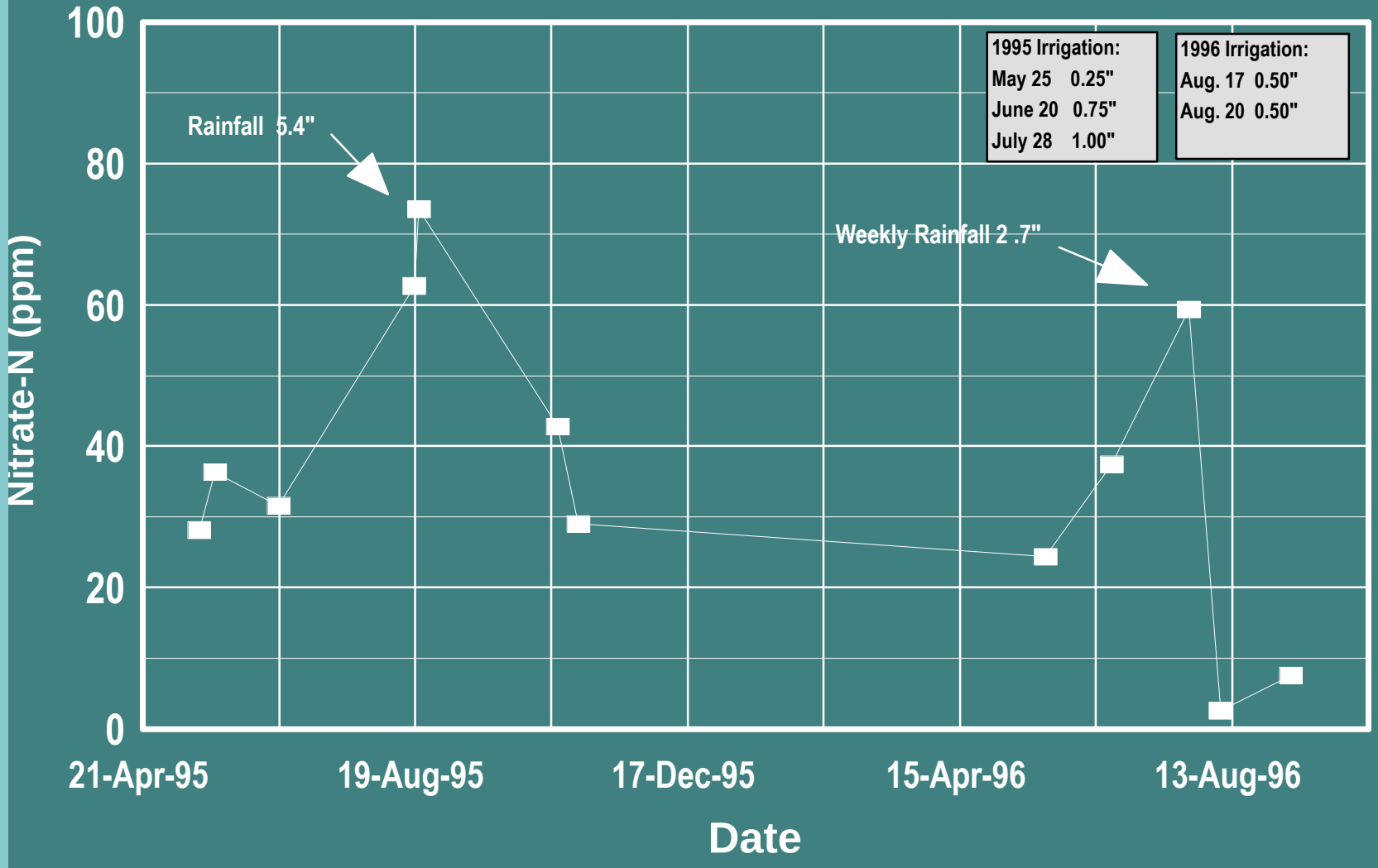
11-Apr-95
11-May-95
10-Jun-95
10-Jul-95
09-Aug-95
08-Sep-95
08-Oct-95
07-Nov-95

Date


CORN GROWERS TILE DRAIN PROJECT -1995
FLOW L/S
5.0
4.0
3.0
2.0
1.0
0.0
RAINFALL (mm)
0
5
10
15
20
25
30
Rainfall recorded at Portage La Prairie
Volume = 7670 m³
(Apr. 13 to Oct. 30)
20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER

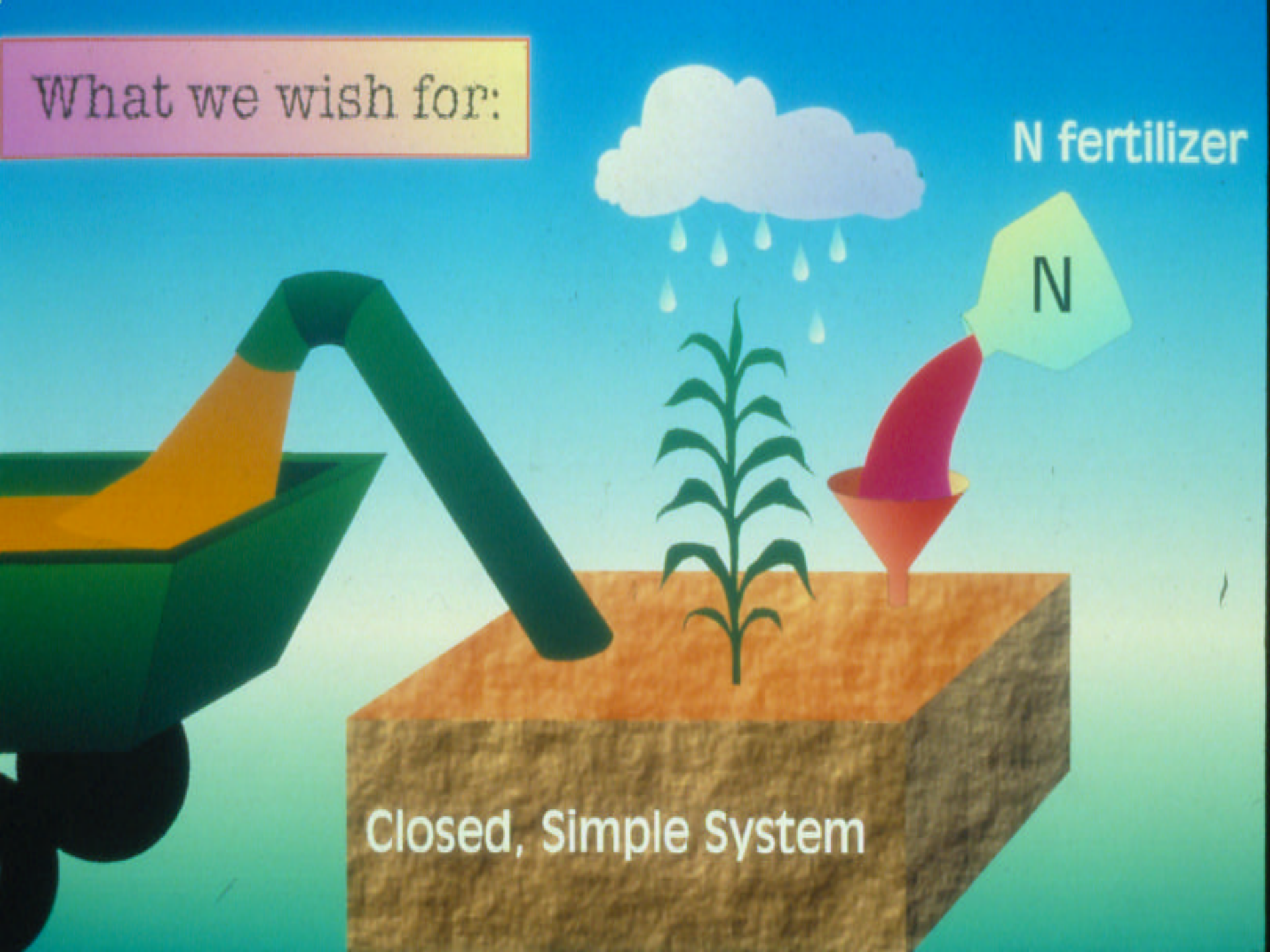

Site E
1995 Water Table Level & Precipitation
Depth to Water Table (m)
0.0
-0.5
-1.0
-1.5
-2.0
Cum. Precipitation (in.)
18
16
14
12
10
8
6
4
2
0
5.4" Rainfall
Drain Locations
Irrigation:
May 25 0.25"
June 20 0.75"
July 28 1.00"
25-Mar
24-May
23-Jul
21-Sep
20-Nov
Date

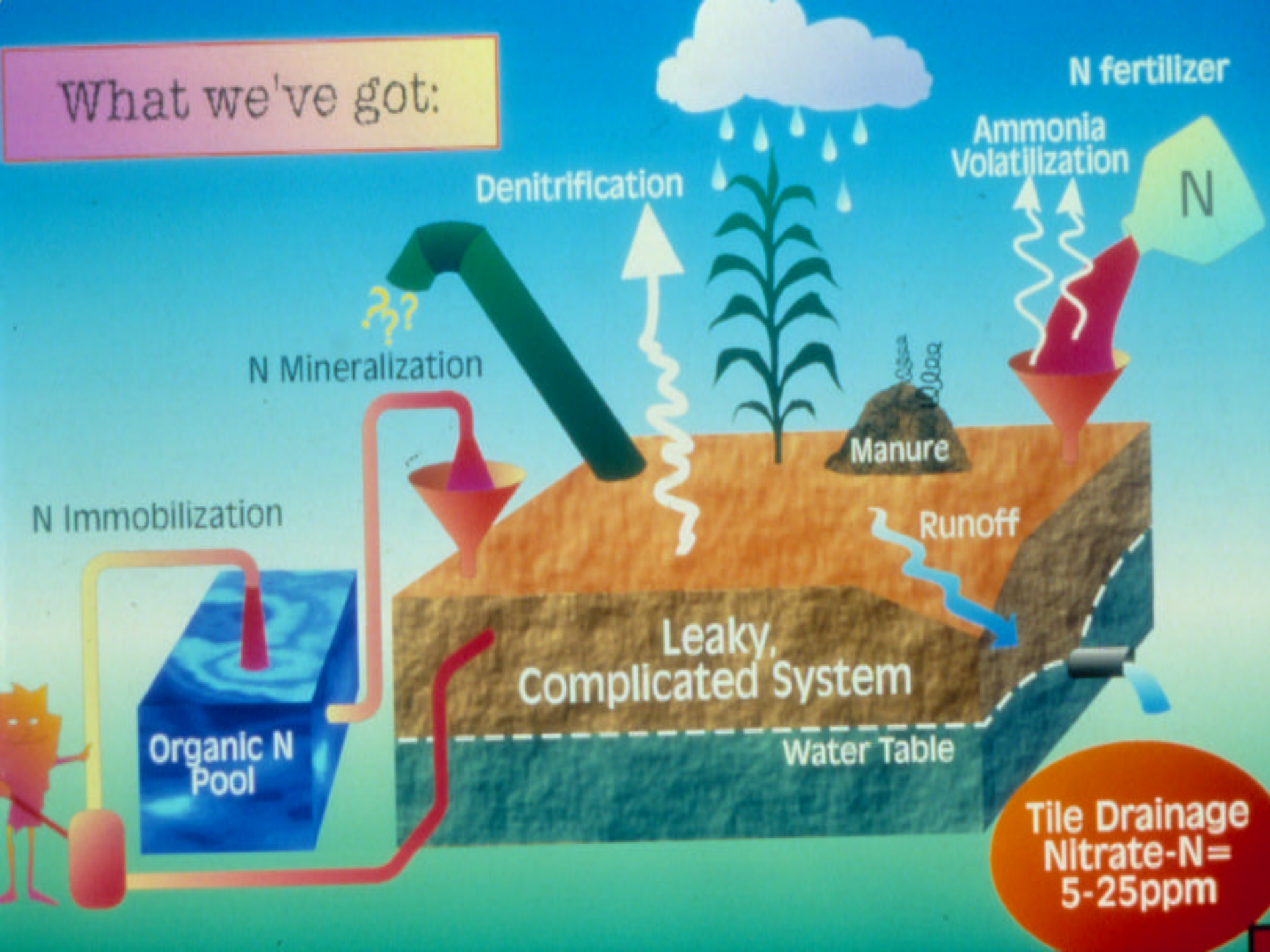
Site E Tile Effluent
1995 and 1996 Nitrate-N Concentrations



Should Nitrogen Management be a Consideration in Tile Drainage Design?

- **YES**
- **water volume drained is significant (3”to 5”/ac)**
- **nitrate concentration of tile effluent is a problem**
- **can identify higher risk scenarios and apply beneficial management practices to minimize this risk**
- **level of management intensity of BMPs must be chosen to match level of risk**


What we wish for:
N fertilizer
N
Closed, Simple System


What we've got:
N fertilizer
Ammonia Volatilization
N
Denitrification
N Mineralization
N Immobilization
Manure
Runoff
Leaky, Complicated System
Organic N Pool
Water Table
Tile Drainage Nitrate-N= 5-25ppm

Nutrient Management BMPs

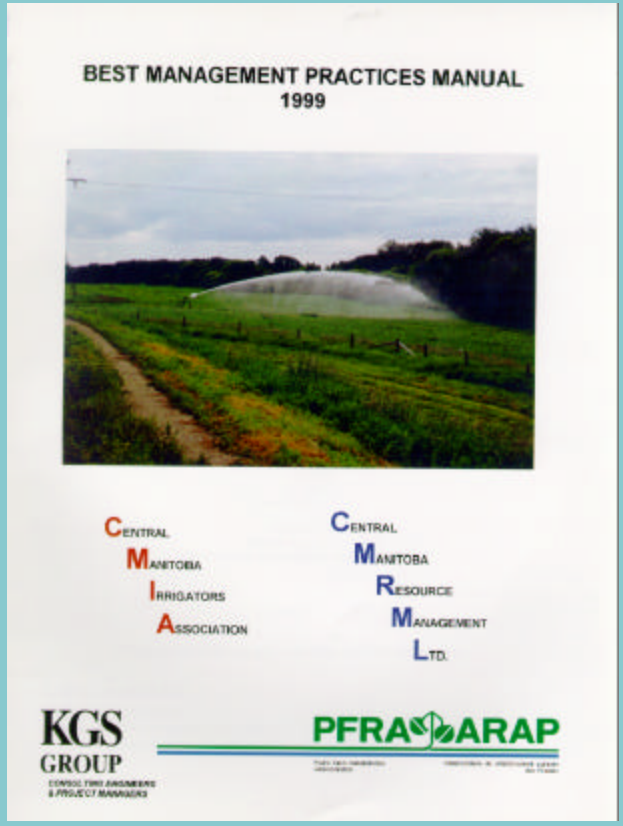
- practical, affordable approach to protecting soil and water resources without sacrificing productivity
- reflect current knowledge/technology
- change with advances
- will not solve all problems
- minimizing rather than eliminating or preventing
- NOT zero tolerance

Nutrient Management BMPs

- **Options depend on operational components of your farm management system**
- **C/B of “on-farm” BMPs will be favorable compared to “design added” BMPs**

Nitrogen Management BMPs

- alternatives to fall application
- lower rates at planting
- split applications
- petiole testing, tissue analysis
- soil testing to 4 feet
- crop rotations
- irrigation scheduling
- realistic target yields relative to natural soil productivity



Canada Manitoba Farm Stewardship Program

- Nutrient Management Planning
  - consultative services to develop nutrient management plans, planning and decision support tools
- Irrigation Management and Irrigation Management Planning

Nutrient Management BMPs

N Rating	N Fertilizer (lb/ac)	Relative Irrigation Amount	Irrigation Amount (inches)	N Leaching Loss (lb/ac)	Final Grain Yield (bu/ac)
Low	83	Low	7.6	17.6	200
Low	83	High	10	30.2	195
High	127	Low	7.6	19.7	215
High	127	High	10	30.1	215

North Dakota State University
3 year plot study - Montgomery, 1990

Future Considerations

- **Suitability assessment and classification standards for soil and landscape factors for irrigation and tile drainage**
- **Coordinated approach by producers, industry, government**
- **Proactive environmental assessment, management and monitoring**
- **Continued efforts in studying effectiveness of BMPs, developing recommendations, awareness and technology transfer**