MinnFARM

Minnesota Feedlot Annualized Runoff Model

David Schmidt

Department of Bioproducts and Biosystems

University of Minnesota

Presented by Steven Schmidt Minnesota Pollution Control Agency

Adapted for Presentation October, 2013

MinnFARM

- www.manure.umn.edu "Open Lots'
  - Current EXCEL Spreadsheet Model 2.3
  - Users guide
- Uses site specific feedlot data to estimate annual pollutant loading to nearby waters
- Results are used to
  - Help determine if a feedlot is out of regulatory compliance
  - Prioritize state and federal cost share assistance for feedlot fixes

What are the Critical Factors Impacting the Pollution Risk from a Feedlot?

- **Amount and type of Pollutants Generated**
- **Transport of Pollutants off Lot**
- **Treatment in Buffer**

Amount and Type of Pollutants

Pollutant Generation

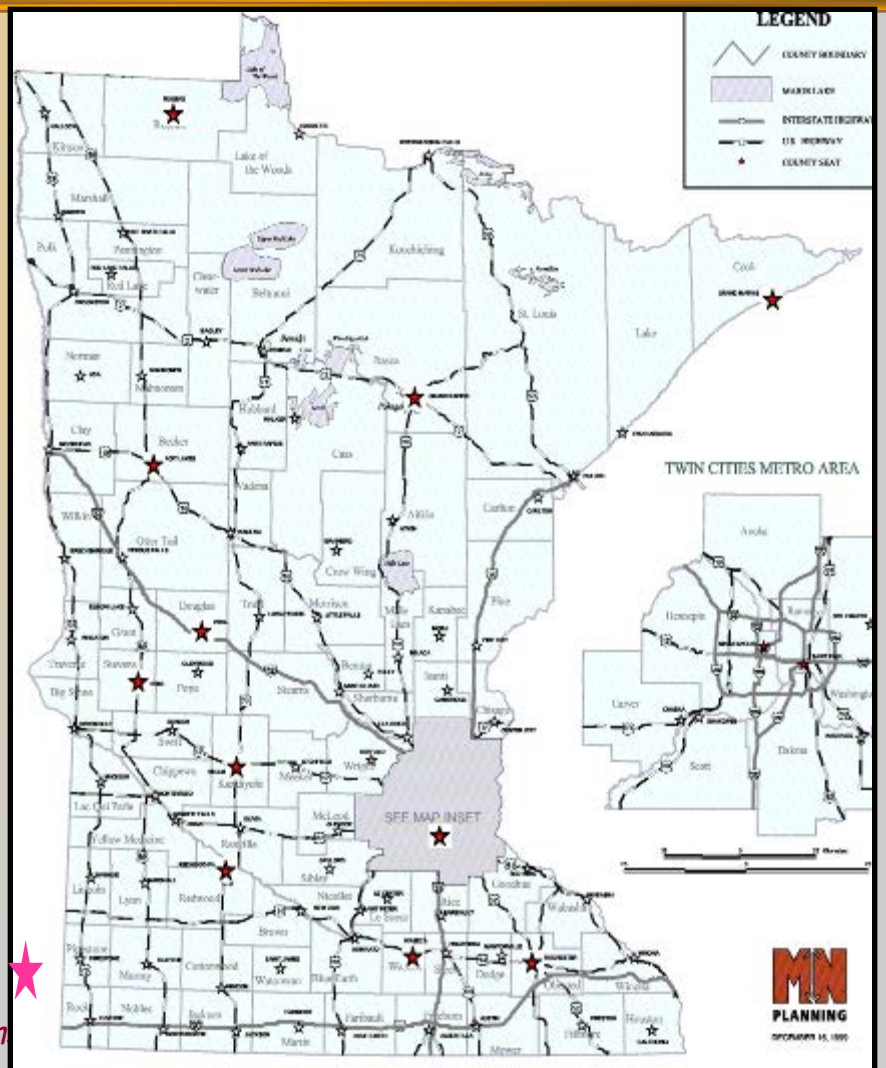
- Size of Lot
- Type and size of animals
- Hours on lot
- Lot cleaning
- Seasonal adjustments to animal numbers and weights are allowed
  - Spring (April - May)
  - Summer (June – August)
  - Fall (Sept – Oct)
  - Winter (Nov – Mar)

Factors Affecting Transport

- Size of Rainfall Events
- Number of Events
- Surface Characteristics of Lot

Historical Rainfall Data

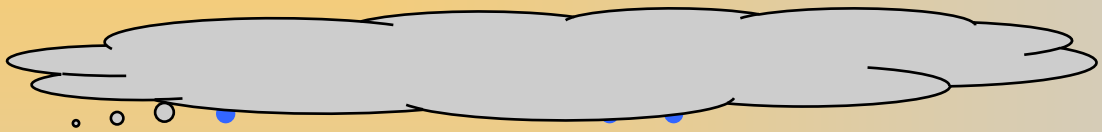
- Alexandria
- Detroit Lakes
- Grand Marais
- Grand Rapids
- Twin Cities
- Morris
- Redwood Falls
- Rochester
- Roseau
- Waseca
- Willmar
- Sioux Falls



Snowmelt Runoff

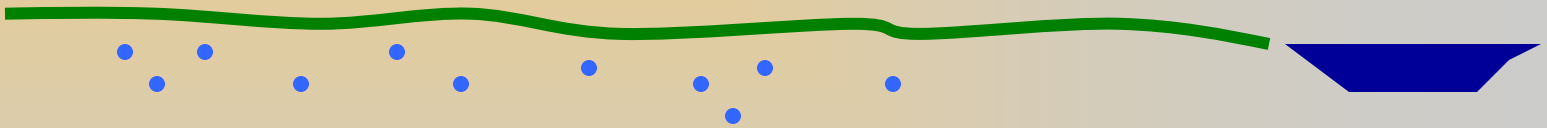
- Long term Snow Water Equivalent (SWE) data from 3 locations in MN
  - Marshall
  - St. Cloud
  - Rushford

Rainfall, Runoff and Infiltration



V=Volume or “Precipitation” on land surface

Z=Runoff



F= Infiltration = V - Z

Runoff Volume

- Use NRCS Curve Number method
- Predicts runoff from an area based on
  - P = 24-hour rainfall amount
  - CN or Curve Number – a standard value that considers surface cover and underlying soil type
  - I_a Initial abstraction or initial surface storage

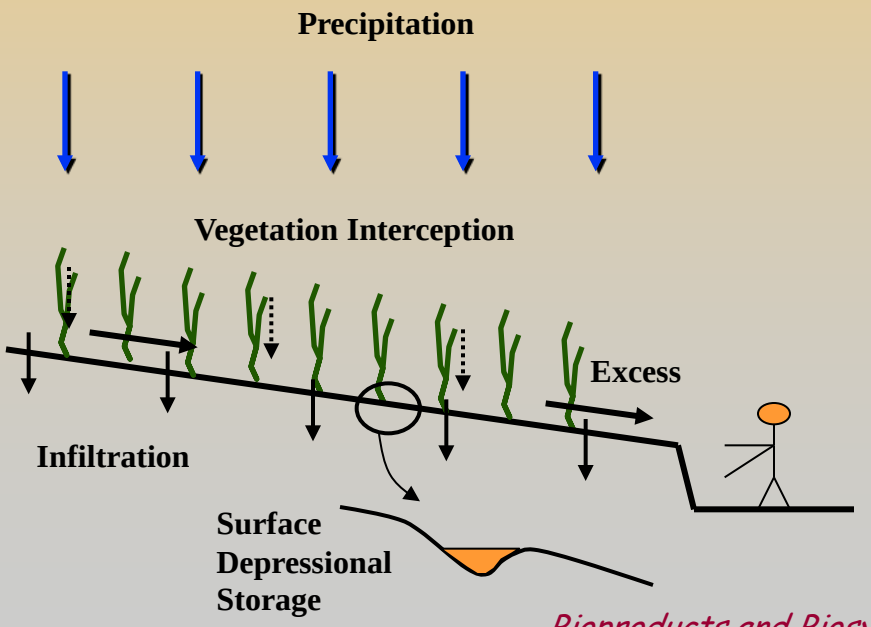
Runoff Calculation using CN

Summer		Soil Complex Number (CN)			
Cover Type	Surface Constant	Group A	Group B	Group C	Group D
Row Crop-Contour	0.29	44	56	66	72
Row Crop-Straight	0.05	46	60	70	77
Small Grain Contour	0.29	40	53	64	69
				67	74
				60	67
				75	79
Pasture/Grassland-Poor	0.05	47	61	72	77
Pasture/Grassland-Fair	0.15	29	48	61	69
Pasture/Grassland-Good	0.22	21	40	54	63
Permanent Meadow	0.59	15	37	51	60
Lawn	0.22	21	40	54	63
Driveway/Road	0.02	57	70	77	81
Farmstead mix	0.05	38	54	66	72
Woods	0.29	19	39	53	61
Roof	0.01	100	100	100	100

MinnFARM uses
Dirt Feedlot CN=91 Paved Lot CN = 94

CN and Initial Abstraction

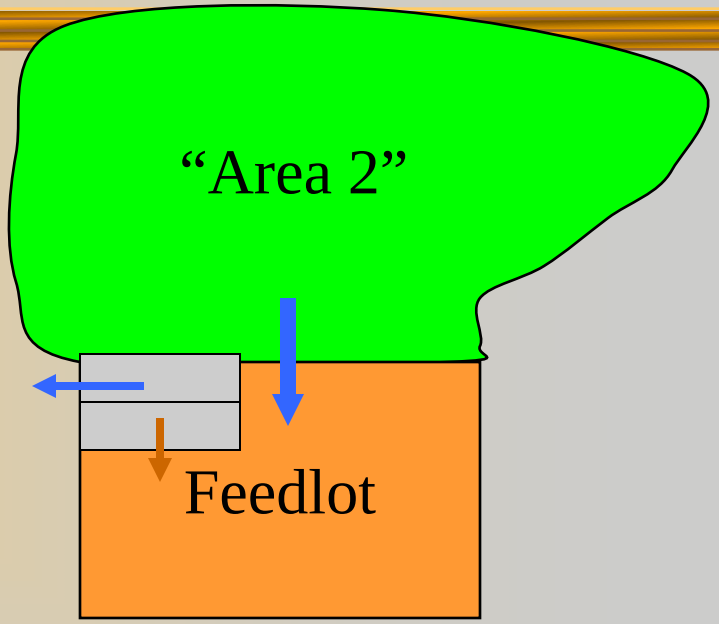
- Nebraska study CN measurement . . .
- Initial abstraction a function of roughness, slope, and moisture content



Load at Feedlot Edge

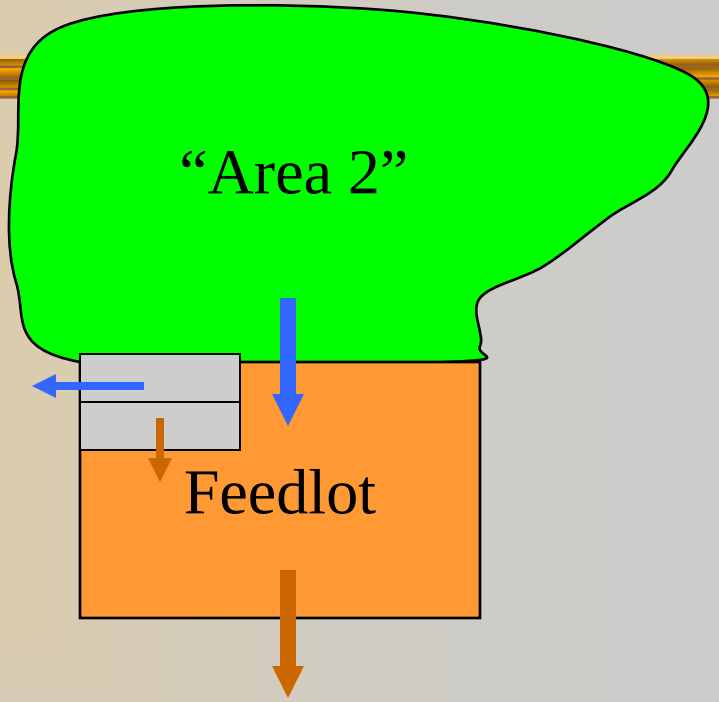
- Load for a single rainfall event
  - ***Concentration*** at “feedlot edge” times the ***runoff volume***
- Annual load
  - Sum of all events
  - Load per each size of event X the probability of the event

What Next?
Area 2



Area 2 runoff discharges into the feedlot

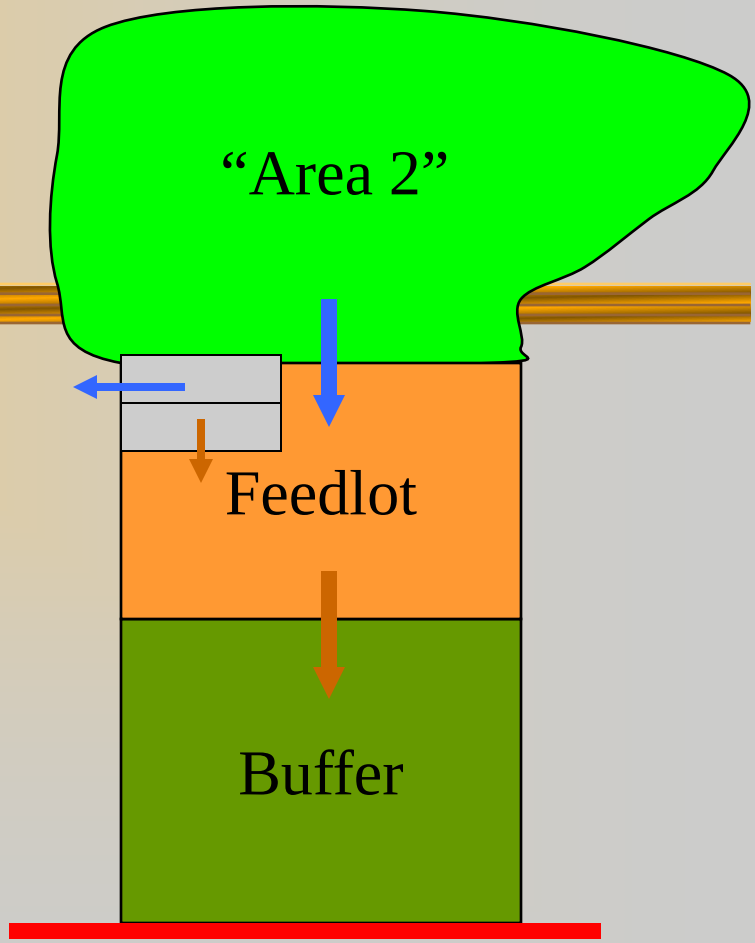
Area 2 Concentration



- Uses calculated "feedlot edge" concentration for 1st 30 acre-inches then background concentrations of
  - COD = 60 mg/l
  - P = 2 mg/l
  - N = 12 mg/l
  - Pathogens = 0 cfu/ 100 ml
- Area 2 contribution has a significant impact on model results.

What Next?

Buffer Reductions



Buffer Treatment

- **Infiltration** of water and pollutants in soil profile to be later used by vegetation
- **Filtration** is the removal of heavier particles as they settle out and are captured by vegetation

Estimating Buffer Infiltration

- Use CN method (cover type and Hydro group)
- Precipitation is the runoff from feedlot entering the buffer divided by buffer area to get inches of precipitation.
- Volume of runoff from feedlot minus runoff volume from the buffer is considered infiltrated into the buffer
- Pollutants infiltrate into the buffer along with the feedlot runoff (e.g 50% volume reduction through infiltration is a 50% reduction in pollutant loading leaving the buffer)
- Requires calculation of buffer area (length and width)

Buffer Filtration

- Settleable nutrients only
- Function of travel time in buffer or T_c
  - Buffer Length
  - Velocity of runoff
    - Slope
    - Surface Condition Constant (S_c)
    - Higher S_c means longer time in buffer and therefore more settling

Surface Condition Constants (Sc)

Surface condition constants change with season automatically

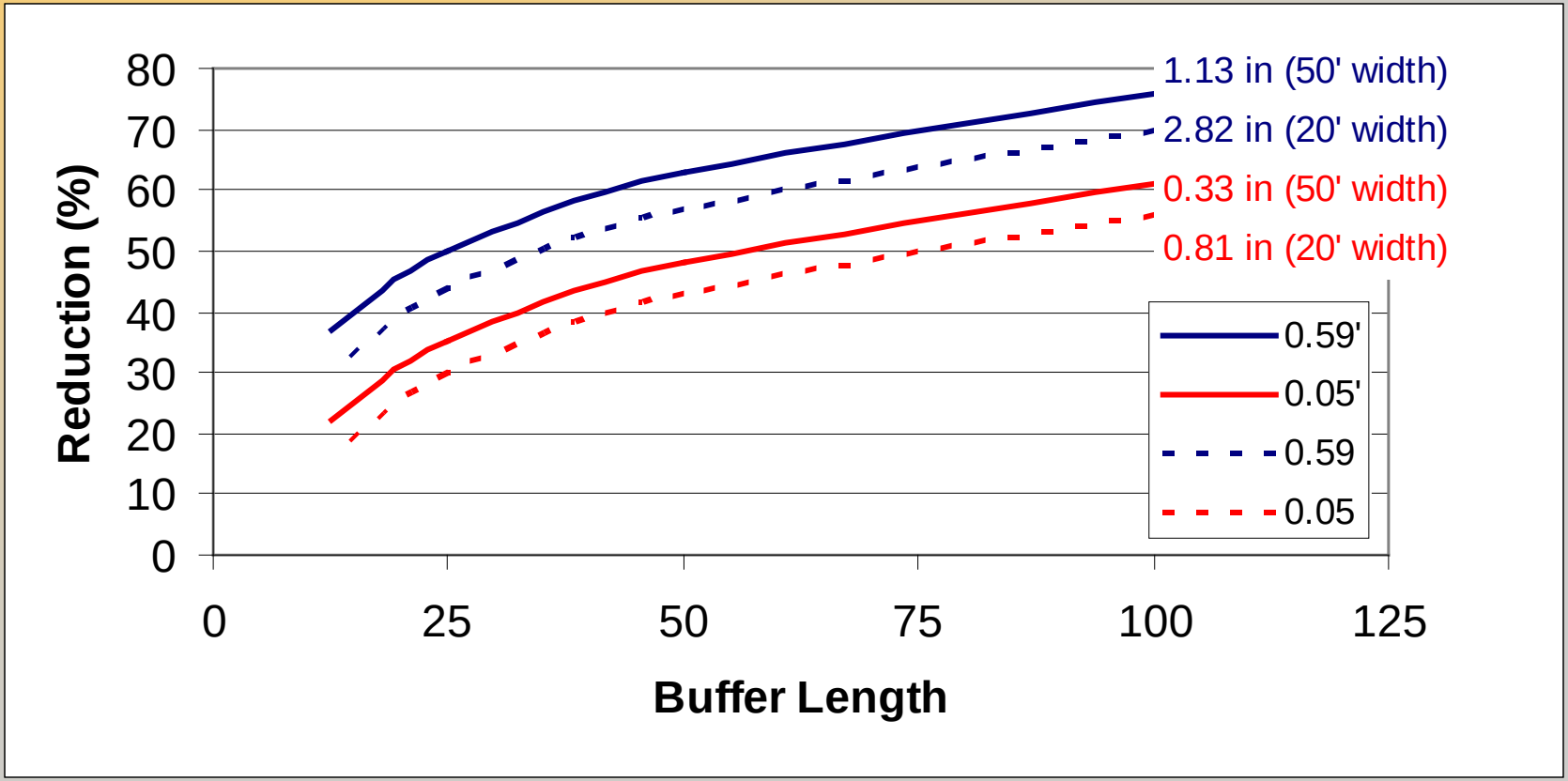
Summer

Cover Typ	
Row Crop-Contou	
Row Crop-Straight	
Small Grain Contour	
Small Grain Straight	0.29
Alfalfa Rotation	0.29
Fallow	0.22
Pasture/Grassland-Poor	0.05
Pasture/Grassland-Fair	0.15
Pasture/Grassland-Good	0.22
Permanent Meadow	0.59
Lawn	0.22
Driveway/Road	0.02
Farmstead mix	0.05
Woods	0.29
Roof	0.01

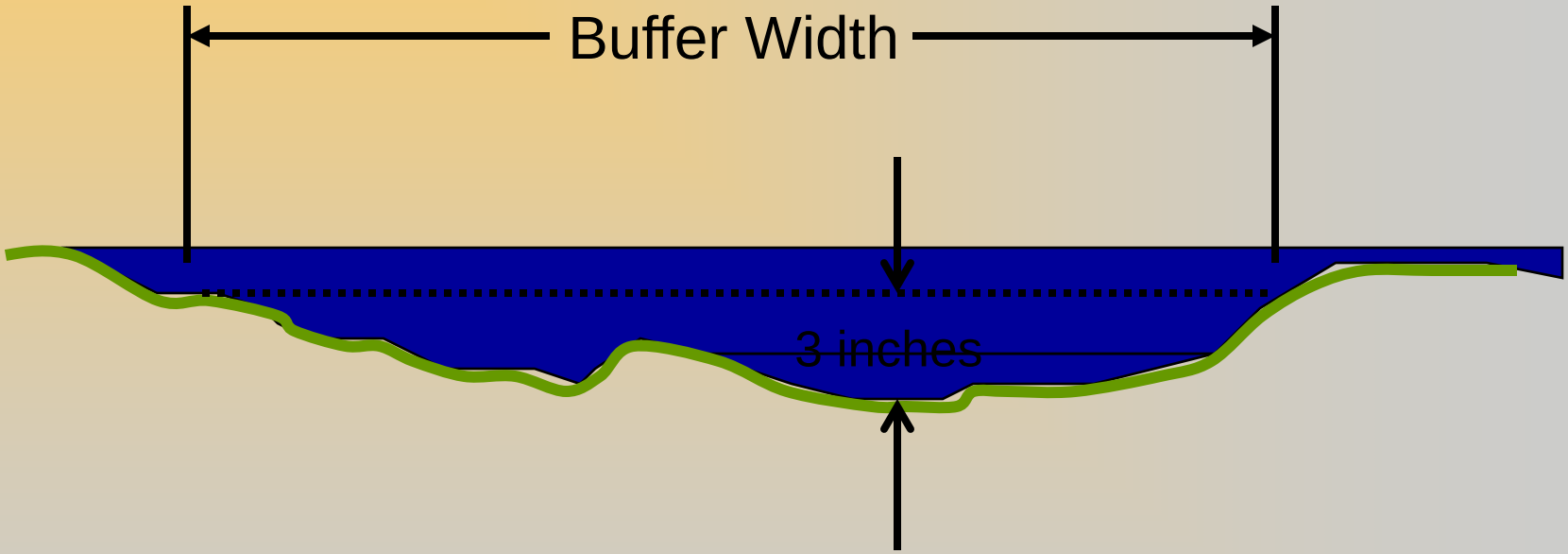
Buffer Vegetation

- Pasture (Poor, Fair Good) (NRCS guidance for CN)
  - Poor < 50% ground cover or heavily grazed with no mulch
  - Fair 50-75% ground cover and not heavily grazed
  - Good >75% groundcover and lightly or occasionally grazed

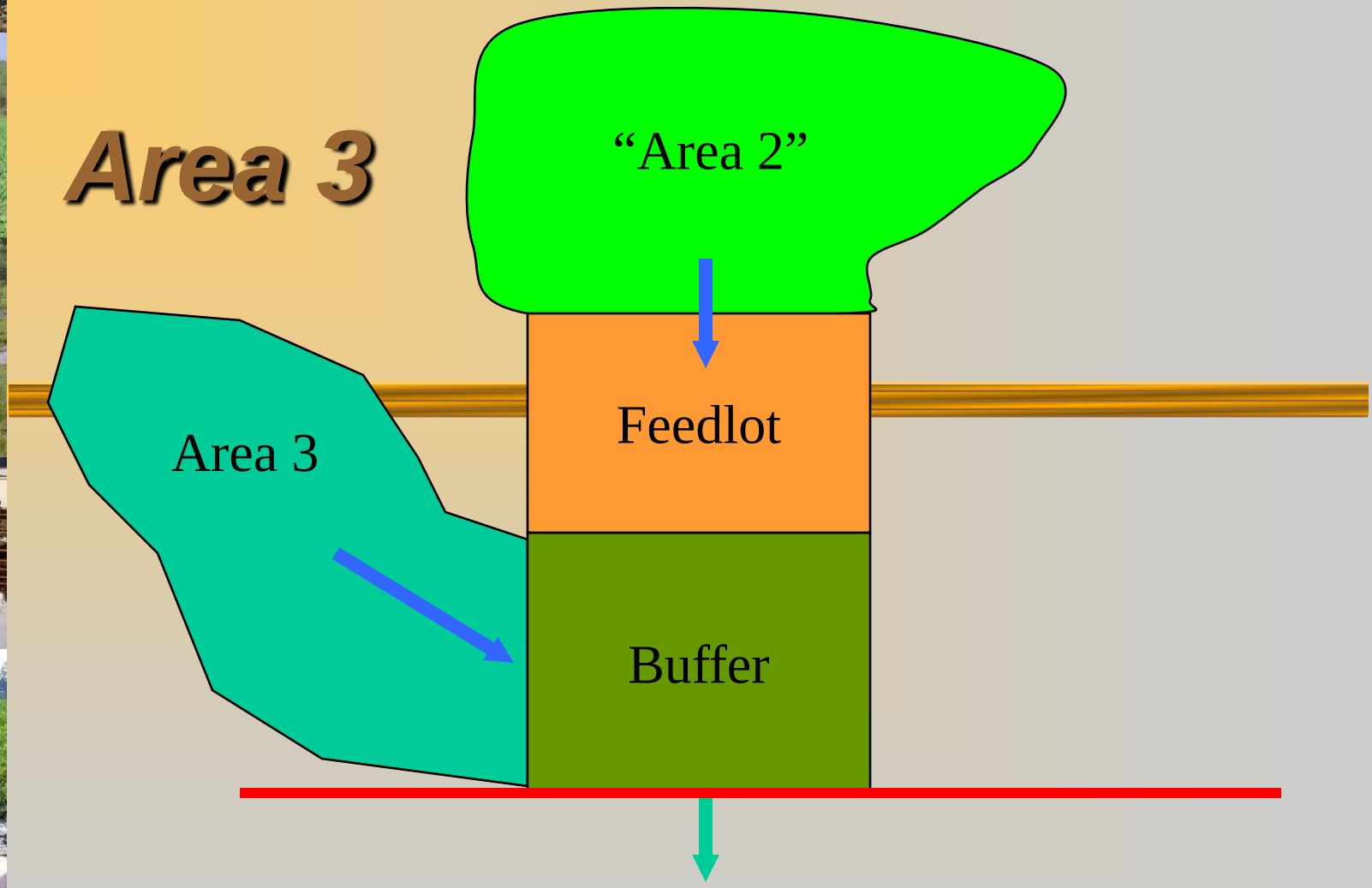
Reduction with Buffer Length



Buffer Width



Area 3



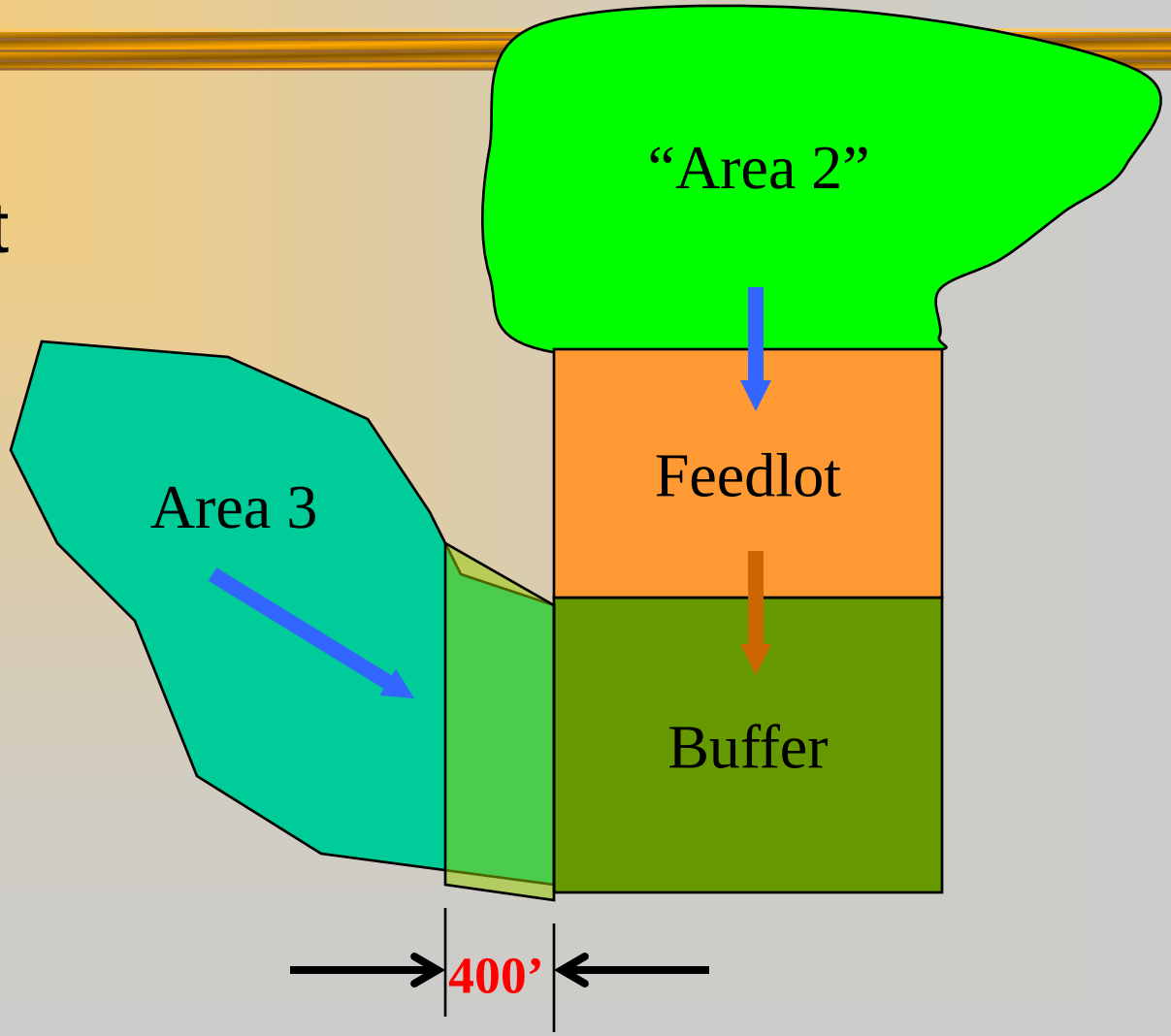
Area 3 runoff discharges onto buffer area

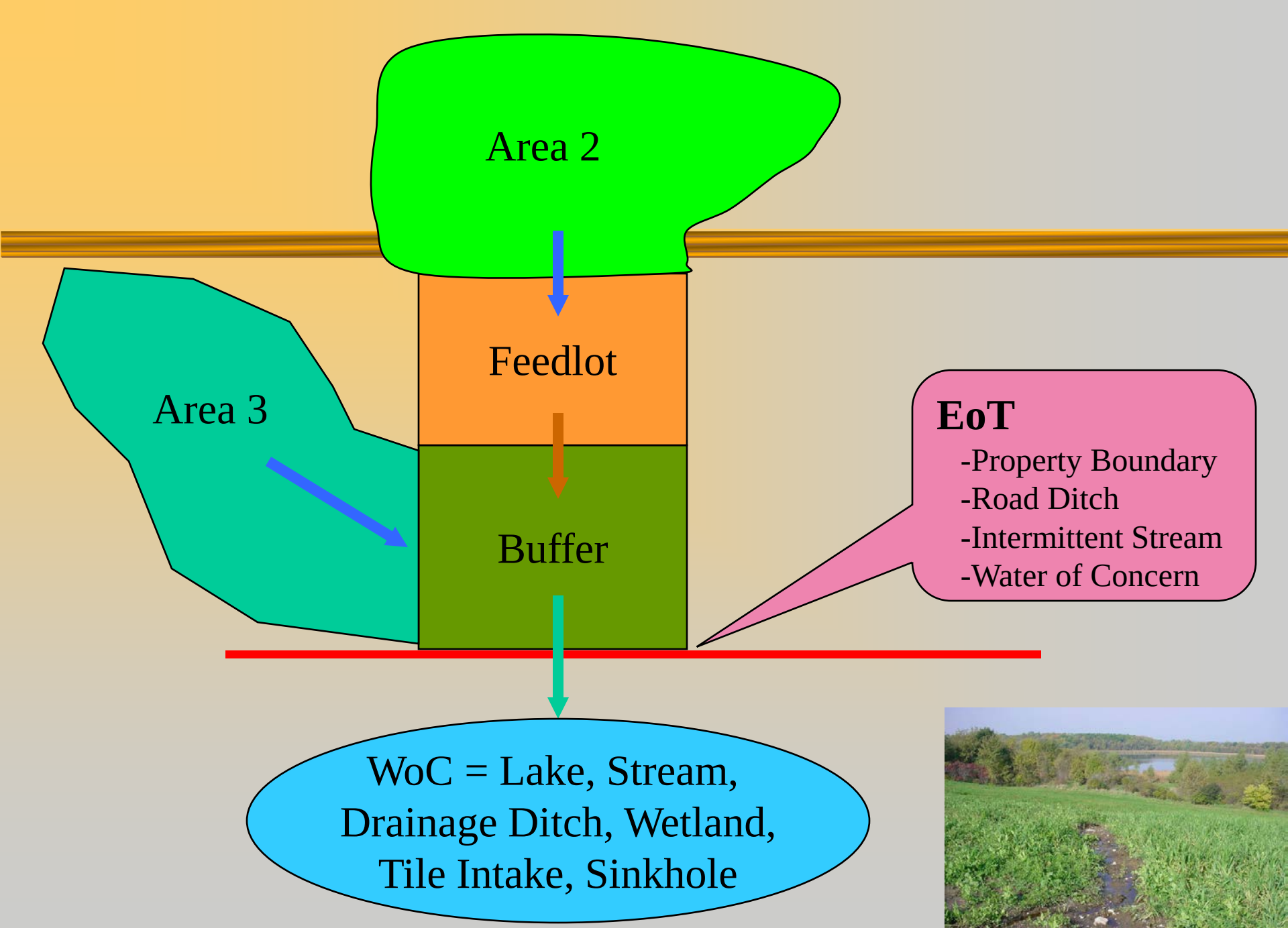
Area 3

- Runoff calculated with CN method
- Dilutes runoff in buffer making the runoff depth higher, decreasing filter efficiency
- Infiltrates into buffer making the buffer less effective
- Model recommends only using a limited amount of Area 3 due to timing of runoff with feedlot runoff

Area 3

- Model has suggested limit of 400 feet on either side of the buffer




Area 2
Feedlot
Area 3
Buffer
EoT
-Property Boundary
-Road Ditch
-Intermittent Stream
-Water of Concern
WoC = Lake, Stream, Drainage Ditch, Wetland, Tile Intake, Sinkhole

End of Treatment (EoT)

- Road Ditches: Can’t use public lands to treat waste
- Property Lines: Can’t use neighbors property to treat waste
- Intermittent Streams/Waterways: Streams make for poor treatment (timing is important)
- Surface Water

Water of Concern (WoC)

- WoCs are the final receiving water for the feedlot runoff.
  - Lakes (25 acres of open water)
  - Perennial Stream w/wo lake
  - Drainage Ditch w/wo lake
  - Tile intake w/wo lake
  - Public wetland
  - Non-public wetland
  - Critical sinkhole or other direct conduits to Groundwater
- MinnFARM developers prioritized the value of these waters for INDEX system

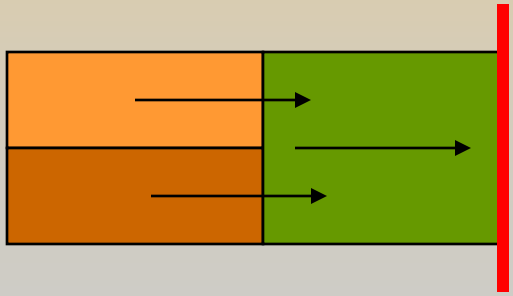
Prioritizing Waters

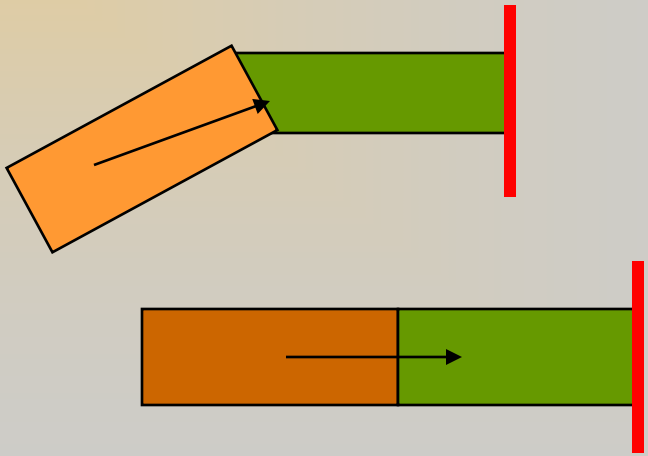
- Type of Water
- Distance to Water

Where is EoT and WoC?

One more thing . . .

- Feedlot
  - Goes to single EoT
- Sublot(s)
  - Defined by management, typically fenced areas within whole feedlot





MinnFARM Outputs

-MPCA estimated compliance with state standards

-INDEX to guide in prioritizing cost share

MPCA Compliance Criteria

- Loading limits related to the state BOD and P concentration standard
- **If WoC is a lake:** Annual P load at EoT of 2 lbs plus allowance for 0.01 additional pounds per 1000 lbs of animal weight
- **In all other cases:** Annual BOD load at EoT of 50 lbs plus allowance for 0.25 additional pounds per 1000 lbs of animal weight

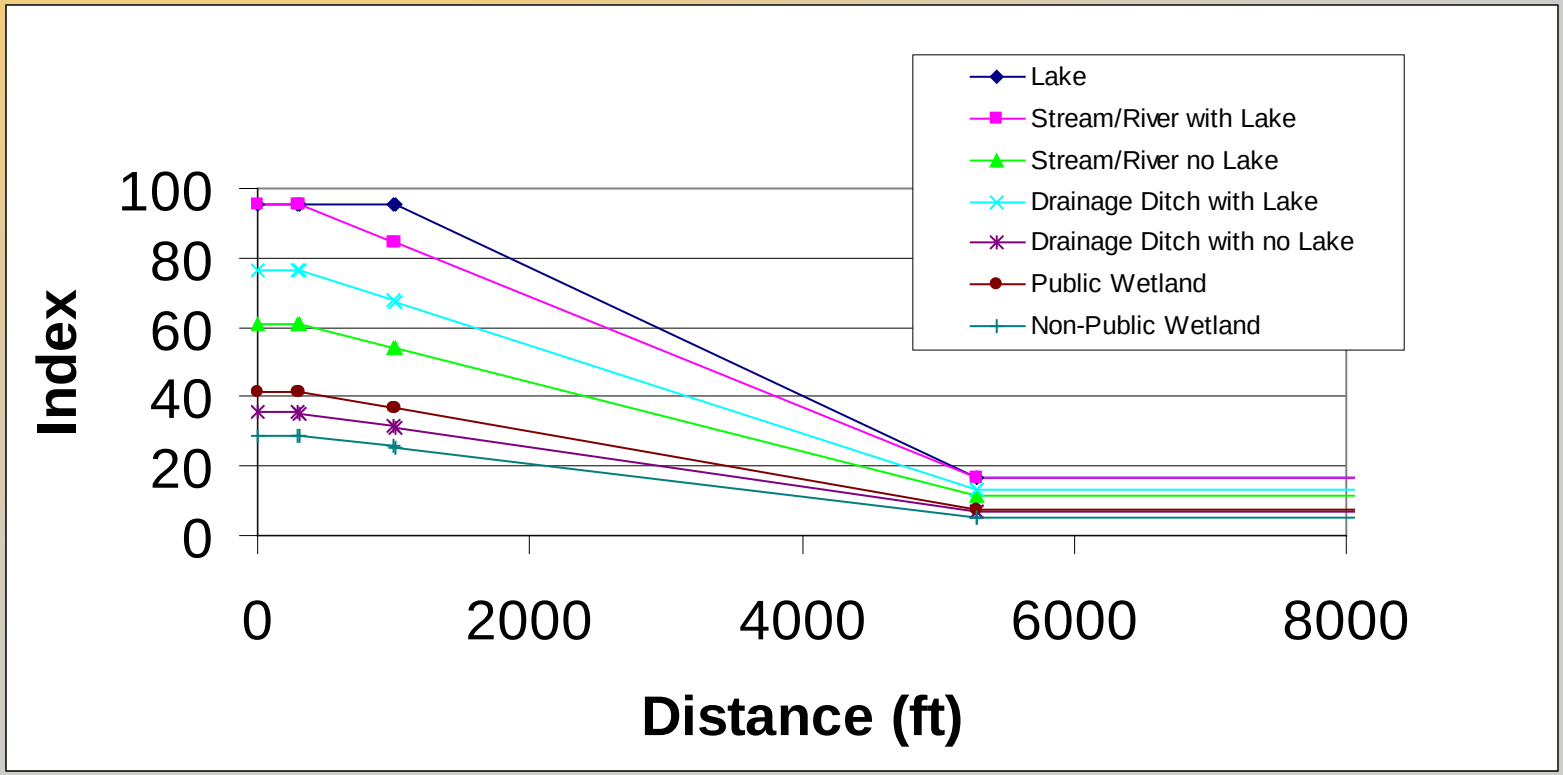
MPCA Compliance Indicator

- Evaluated at EoT
- Yes or No answer but is only an "indicator of compliance"
- Best Professional Judgment is still required
- It helps if MinnFARM results concur with BPJ

MinnFARM INDEX

- Point Rating System from 1 - 100
  - Annual BOD and P load at EoT
  - BOD Concentration (Lakes and Streams)
  - Type of WoC
  - Distance from EoT to WoC

Example INDEX



1 acre lot with 100 AUD, no buffer

Model Outputs

MPCA Compliance Indicator

MinnFARM Version 2.3 UMN BBE

3/18/2010

MODEL RESULTS FOR: John Doe 1/0/00

Site Summary

Total Feedlot Area =	**1.00**	acres
Roof Area =	**0.09**	acres
Total Area 2 =	**0.19**	acres
Total Buffer Area =	**0.23**	acres
Total Area 3 =	**0.00**	acres
Ratio of Buffer to Feedlot Area (includes Area 2)=	**0.19**	

Site Evaluation Results

Does Evaluation Indicate Regulatory Compliance?	***NO***
Prioritization INDEX =	41

Receiving Water Summary

The Feedlot is **NOT in a TMDL area**
The Feedlot is **NOT in a Riparian Area as defined by BWSR**
The End of Treatment is a **Water of Concern**
The Water of Concern is a **Stream/River no Lake**
The name of the WoC is **was not provided**
The distance from the EoT to the WoC is **0** **ft**

INDEX - Used for prioritizing

Seasonal Runoff Summary

Average Seasonal and Annual Runoff Volume

Location (units)	Spring	Summer	Fall	Winter	Annual
Feedlot Edge (acre-in)	0.73	2.45	0.96	0.66	**4.79**
Buffer Edge (acre-in)	0.47	0.93	0.50	0.60	**2.50**

Average Annual Loading from Feedlot

Parameter (units)	Spring	Summer	Fall	Winter	Annual	*Compliance Indicator*
COD (lbs)	288	626	324	343	**1530**	
Phosphorus (lbs)	5	12	6	6	**30**	*3.0*
Nitrogen (lbs)	16	35	18	19	**88**	
Fecal Coliform (cfu)	1.4E+14	3.2E+14	1.6E+14	1.7E+14	**8.0E+14**	
BOD 5 (lbs)	64	139	72	76	**351**	*75.0*

<=Using BOD Based limit

Load limits - Used for reference only

Comments

Tools for MinnFarm On-site Inspection

- Aerial Photo – GIS/Google Earth

3
3
3
3
10th St SW

Terra McCree Holsteins
Terra McCree Holsteins
3
10th St SW
3
Connelly
Connelly
3
Cascade Creek
Cascade Creek

WQ Feedlot Detail Report

Terra McCree Holsteins

Feedlot Location Address:
835 County Road 3 SW
Byron, MN 55920

Owning Organization Address:
Terra McCree Holsteins
835 County Road 3 SW
Byron, MN 55920

Latest Feedlot Registration

Registration Status: Complete
Registration Date: 9/30/2013
Registration Source: Registration Form
Holding Area Distance: 150 feet
Storage Area Distance: 150 feet

- [x] A) Open Lots designation?
- [x] B) Animal Confinement Buildings?
- [x] C) Animals on Pasture?
- [x] D) Liquid Manure Storage Basin?
- [ ] E) Manure Stockpile?
- [ ] F) Surface waters within 1000 feet?
  - [ ] Lake?
  - [ ] River / Stream?
  - [ ] Wetland?
  - [ ] Drainage Ditch?
  - [ ] Tile Intake?
  - [ ] Other Waters?
  - [ ] Shoreland 300 ft?

Open Lot Agreement? No
Agreement Receipt:
Agreement Completion:

Permit Information

Registration #: 109-78894
Feedlot County ID: 109-584
Former Permit Number: MPCA-I 1984 (A)

Registration Animals

Dairy Cattle - Calf: 40
Dairy Cattle - Heifer: 40
Dairy Cattle - Mature (1000 lb or over): 120
Total Animal Units: 204.000

Geographical Information

Region: Rochester (Southeast)
County 1: Olmsted
Congressional District: 1
Legislative District(s): 26B
Basin: Upper Mississippi River, Lower Portion
Major Watershed: Zumbro River
Minor Watershed: Cascade Cr
HUC Code: 07040004
Latitude / Longitude: +44 00 32.9 / -092 36 38.9 -- Address Matching House Number (18-MAR-10)
PLS Location: SE Qtr of SW Qtr of Sec 3, T106N, R15W

Contacts

Permittee - Activity Owner: Kevin Connelly -- (507)775-6701
Permittee - Activity Owner: Terra McCree Holsteins

Permit Components and Animals

Total Animal Units:

Tools for MinnFarm On-site Inspection

- Map marking pen – silver sharpie/colored pen
- Range finder
- Planimeter
- Bio-security measures
- Aerial with Lydar
- Camera
- Inspection Checklist – performing compliance inspection

Questions?