

# Multi-functional Managed Wetlands:

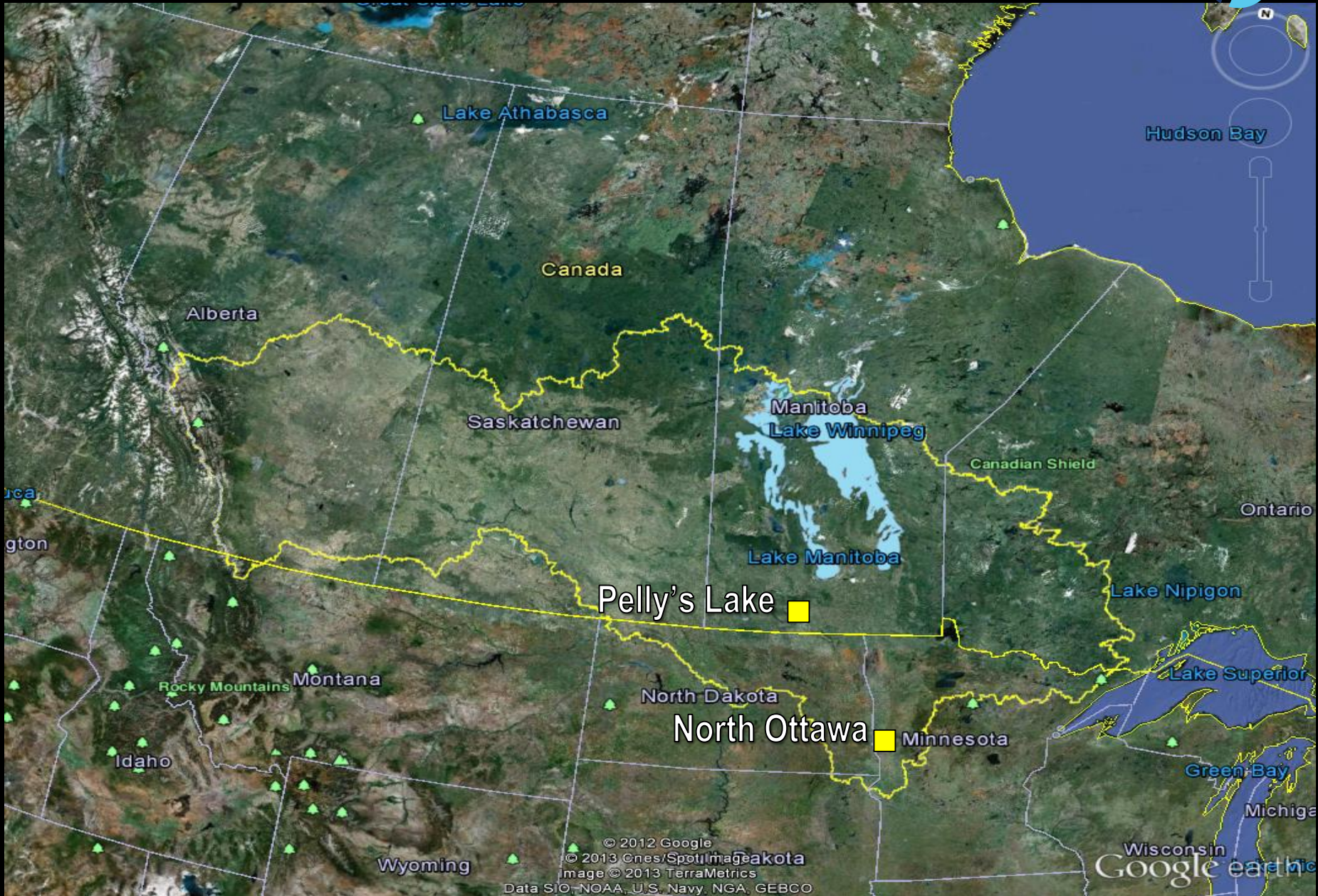
*Water Retention, Phosphorus Recovery,  
and Sustainable Bioenergy*

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IISD



# The Lake Winnipeg Watershed





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- Ongoing issues in Manitoba = **Flooding + Nutrient Loading** (phosphorus)
- Runoff water carries phosphorus and contaminants downstream to Lake Winnipeg
- Eutrophication - *too much phosphorus* - causes algae blooms in rivers and lakes
- Immediate need to **reduce phosphorus loading + increase water retention** in basin
- **Climate change** is increasing risk from flood and drought

**FLOODING**



**ALGAE BLOOMS**

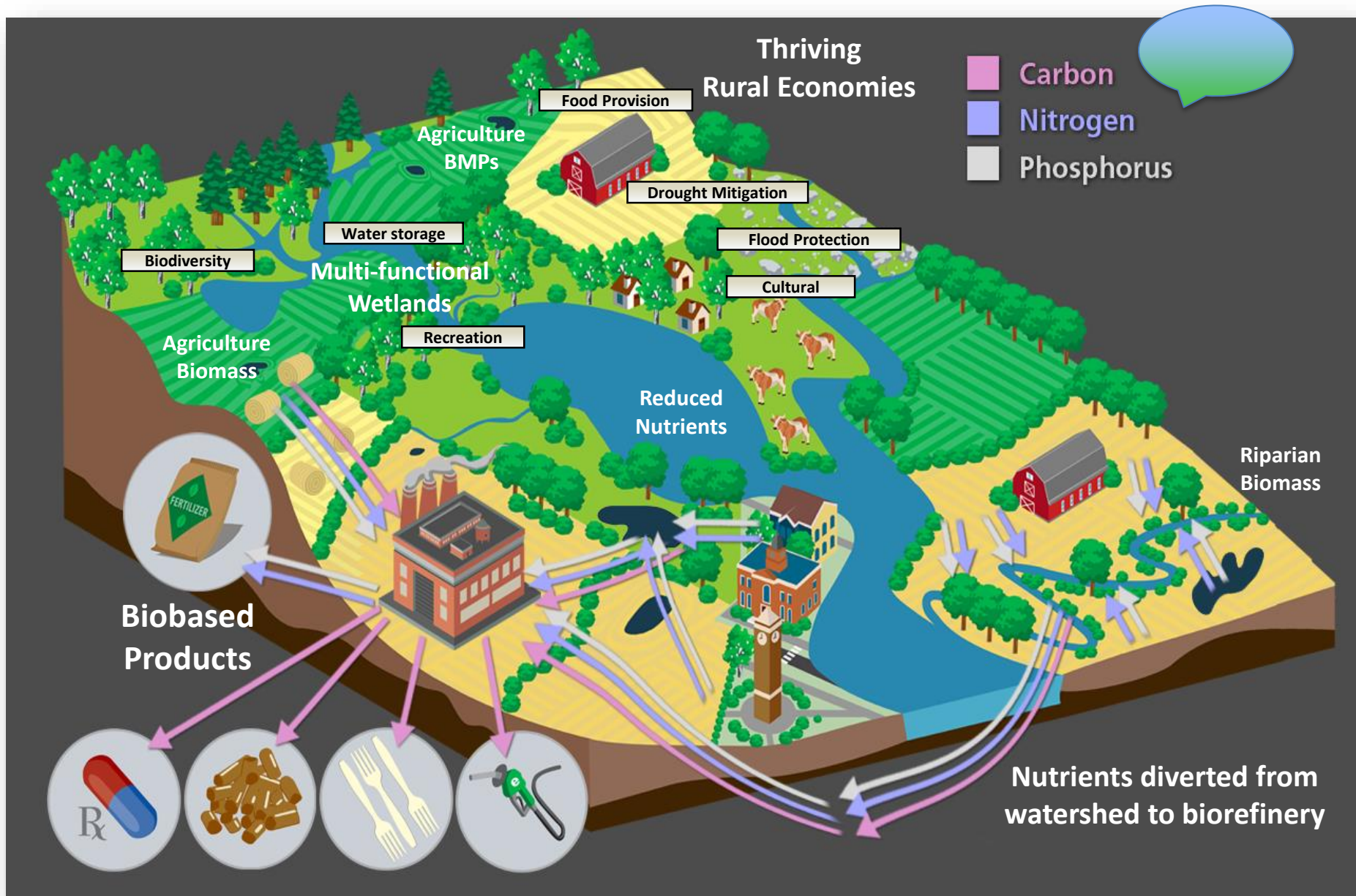


# Wetlands and water retention = reduced flooding & nutrient loading



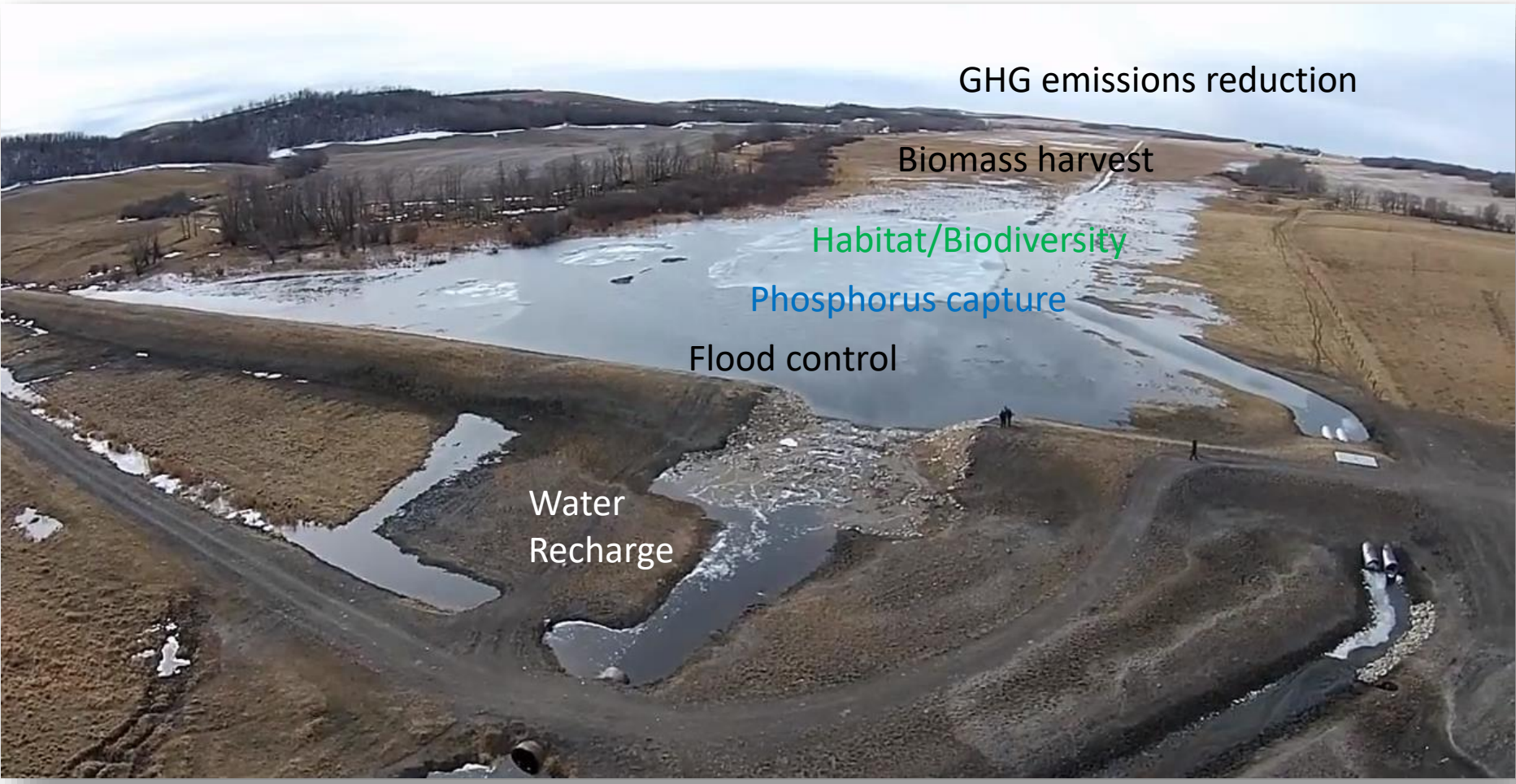
- Wetlands are a critical part of a healthy watershed - *“Nature’s Kidneys”*
- Store runoff water = reduces downstream flooding + Holding water on the land also captures nutrients and toxins from the water before reaching downstream lakes
- **Multi-functional Wetlands** – Managed not only for flood protection:
  - clean the water through nutrient and contaminant capture
  - provide critical wildlife habitat
  - improve air quality and sequester carbon, and
  - *provide a biomass crop*

# Resilient Watersheds – The Circular Economy



# Stacked Benefits of Surface Water Retention: *Not just for flood management*

Pelly's Lake Wetlands- near Holland, Manitoba



GHG emissions reduction

Biomass harvest

Habitat/Biodiversity

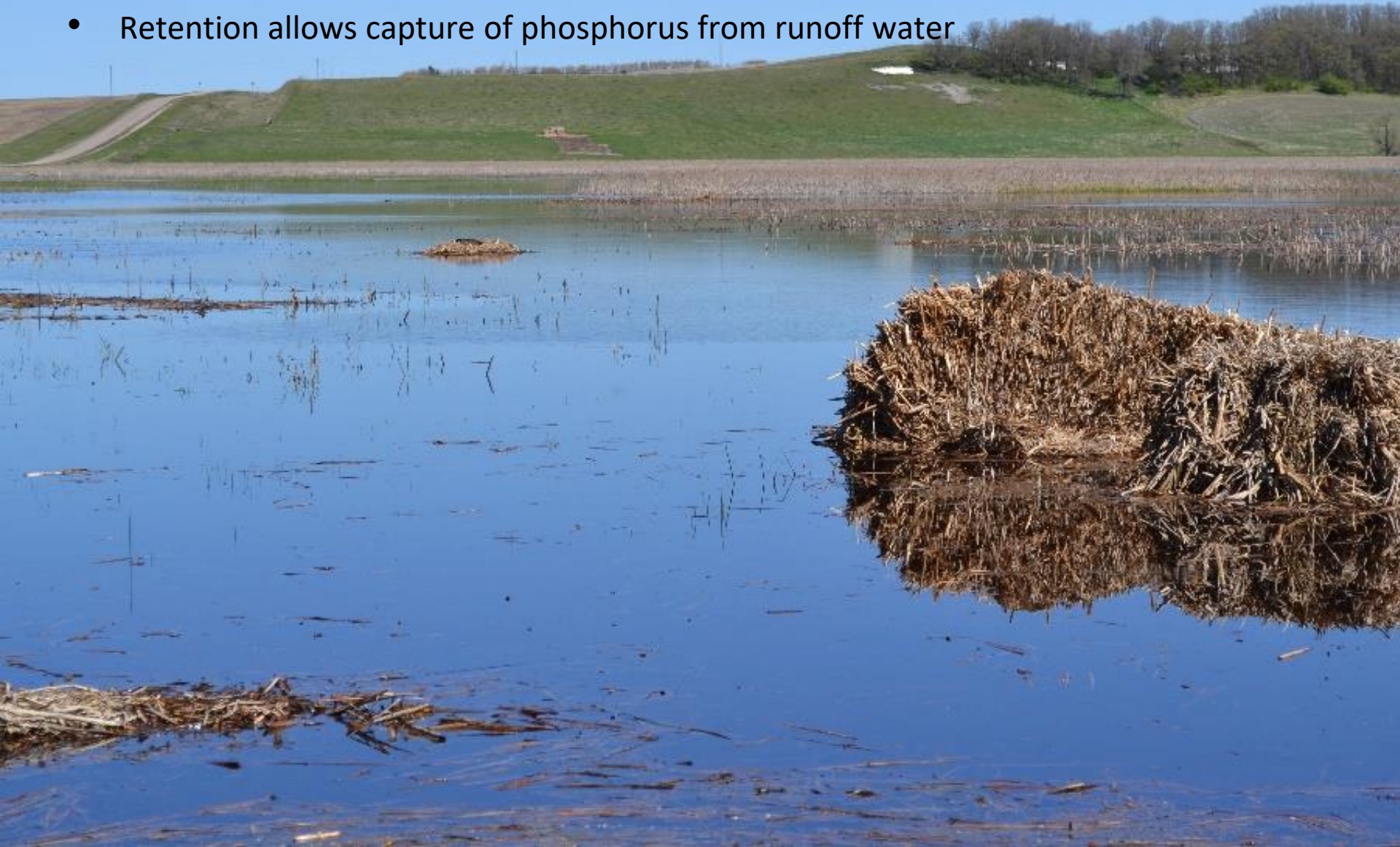
Phosphorus capture

Flood control

Water  
Recharge

# Water Retention and Phosphorus Capture

- 1,200 acre feet of gated controlled water storage on 800 acres
- Protects flooding of surrounding farmland, provides water recharge
- Retention allows capture of phosphorus from runoff water



# Summer water level control

- Provides excellent conditions for cattail and other emergent plants (biomass)
- Provides wildlife habitat for nesting birds
- Phosphorus, nitrogen, contaminants taken up by cattails





# Fall cattail harvesting = management and biomass

- Dries up in the fall
- Suitable for harvesting with conventional agriculture equipment
- Harvesting the biomass = REMOVES CAPTURED PHOSPHORUS

*1 Hectare = 10 Tonnes of biomass + 10 kg of P + 40 kg of N*



# Wetland Habitat Restoration

- Prior to management, site was a dense field of dead cattail debris
- Over 200 hectares of wetland habitat has been restored – flood and harvest
- Increase in number and diversity of waterfowl and marsh birds



# Biomass Harvest + carbon + phosphorus +

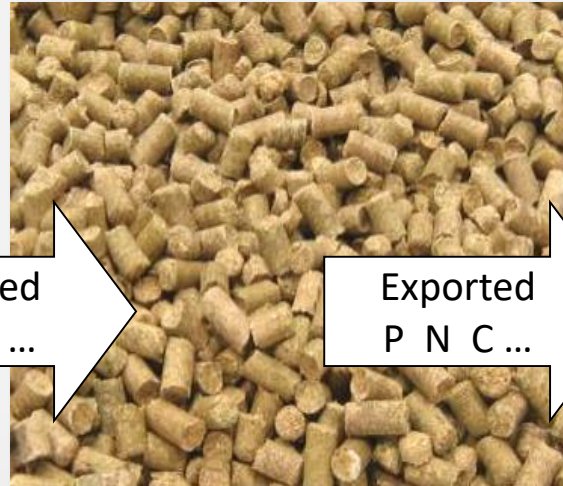
*turning a problem into a sustainable input for the Bioeconomy*

Lower GHG emissions

Cattail Biomass



Pellets for fuel



Captured  
P N C ...

Exported  
P N C ...

Low C Bioenergy - Heat



CO<sub>2</sub>  
N

P

ASH Recovery

Phosphorus  
Recovery

- Harvesting cattail **captures stored P and N** – recovery of Phosphorus (P)
- **Sustainable renewable biomass** feedstock for bioenergy (displace fossil)
- **Carbon offset credits** - production of “low carbon” bioenergy
- Restoring wetland wildlife habitat = biodiversity
- + **Water quality/phosphorus offsets** – *payments for value (\$/kg)*
- + **Higher value bioproducts** – *biogas, fibres, composites, methanol*

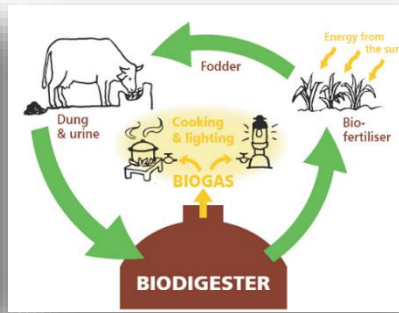
# Manitoba markets for Biomass:



- ✓ Proved integration with water retention for management, biomass and STACKED BENEFITS
- ✓ Critical incentives are END USES and MARKETS
- In Manitoba = Ban on use coal for heating (2014 – 2017)
  - Replace coal/fossil fuels with biomass
  - created rapid growth in biomass industry
  - increased demand for rough (wood chips, sawdust, demo waste) and processed fuel (fuel pellets)



## ❑ What are the MARKETS? HIGH VALUE END USES?



# Higher Value End Use - *Biogas*



- Transportation fuel and building heating = biggest sources of GHG emissions in Manitoba
- Vehicle fuel or injected into the grid = “green” natural gas
- Digestion - can harvest biomass green, collect with a forage chopper - **RECOVER PHOSPHORUS FOR REUSE**
- **Great Lakes coastal wetlands** - Harvest to control invasive phragmites and cattail for habitat and marsh restoration
- **Biogas** - Loyola University and Quasar Energy, converted harvested reeds into a green natural gas
- HIGH value + HIGH volume USE OF BIOMASS



# Investments in GHG Offsets = *added embedded benefits*



## COST

- **\$80,000 COST** to Harvest **1250 T Cattail biomass** for management
- **1250 T biomass** = 2500 T CO<sub>2</sub> offsets (*displacing Estevan, SK Lignite Coal*)
- **Cost to produce** (\$/T CO<sub>2</sub>) :  $\$80,000/2500 = \mathbf{\$32 \text{ cost/T CO}_2}$

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## CREDIT

- **GHG offset CREDIT payment = \$25 GHG credit / T of CO2**
- Embedded benefits within each T of CO2 offset:
  - Each T of CO2 offset = 500 kg of biomass + **0.5 kg of P**
  - = **0.5 kg P @ \$50/kg P WQ Credit**
  - = **\$25 WQ CREDIT / T CO2**

# Investments in GHG Offsets = *added embedded benefits*

## COST

- **\$80,000 COST** to Harvest 1250 T Cattail biomass for management
- 1250 T biomass = 2500 T CO<sub>2</sub> offsets (*displacing Estevan, SK Lignite Coal*)
- Cost to produce (\$/T CO<sub>2</sub>) :  $\$80,000/2500 = \mathbf{\$32 \text{ cost/T CO}_2}$

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## INVESTMENT

- GHG offset investment =  
 $\$25 \text{ Biomass} + \$25 \text{ GHG offset} + \$25 \text{ WQ credit} - \$32 \text{ Cost} = \mathbf{\$43 \text{ PROFIT}}$ 
  - + \$\$ biodiversity credit + \$\$ flood damage reduction + \$\$ drought resilience +



# Water retention and wildlife habitat

Minnesota and North Dakota, USA



## Case Study 2 - North Ottawa water retention project near Fargo, ND

- 16,000 acre feet of gated controlled water storage on 1,920 acres
- Protects flooding of 25 to 40 square km of farmland

Pre-project: The Problem



# Habitat Management and Nutrient Capture



- DNR counted 10,000 ducks and 4,000 geese along with other waterfowl
- **Nutrient Capture in Impoundment (% of annual load):**
  - 47% ↓ of sediment
  - 68% ↓ in Total Nitrogen
  - 54% ↓ in Total Phosphorus
- **Biomass Harvest:** P removal to over 100% of annual load
- Land application as “Green Manure”

October 2016

C1 - Water

B1 - Soy  
B2 - Millet

B3 - Corn

B4 - Shallow Wetland

A1 - Corn

A2 - Water

A3 - Flooded Wheat

A4 - Water/Cattails





# Harvesting in Germany, Estonia, Netherlands

- University of Greifswald, Michael Succow Foundation, Wageningen University
- Harvest for biodiversity and habitat - use for roof thatching, compost, and bioenergy
- IISD co-authored publications, book chapters on Paludiculture, collaborative research



# Stacked EGS benefits:

## High value Environmental and Economic benefits build Agroecosystem Resilience

- + **Surface Water Management** – *hold water to reduce flood*
- + **Cattail “ecological” biomass harvest** – *biomass supply*
- + **Phosphorus capture** – *in flood water + harvested biomass*
- + **Biodiversity and habitat management** – *improved*
- + **Carbon offsets** – *payments for offsetting carbon emissions* –
- + **Water quality/phosphorus offsets** – *payments for value (\$/kg)*
- + **Higher value bioproducts** – *biogas, fibres, composites, methanol*

*Investments in C offsets (biomass energy) and Green Infrastructure (water retention) builds Agroecosystem Resilience (P reduction, habitat, biodiversity...)*



# From research to watershed application

## Success built on support of funders

- Funders have allowed us to apply these practices in the watershed
- Influence management practices locally, nationally and internationally
- Have changed government policies at all levels
- Without our funders, this program area would not exist at IISD



Environment  
Canada

Environnement  
Canada

