Unlocking Conservation Innovation Grant Insights:

Evaluating Manure Management Technologies
Let’s Get Our Hands Dirty

May 12, 2026

OBJECTIVES

- Project Overview: Conservation Innovation Grant (CIG)
- Manure Management Technologies & Systems Evaluated
- Performance Results: Environmental Outcomes, Economic Considerations & Implementation Factors
- Key Takeaways

NEWTRIENT
INNOVATIVE SOLUTIONS IN RESOURCE RECOVERY

REPRESENTING NEARLY ALL U.S. DAIRY FARMERS

NEWTRIENT'S MISSION

To reduce the environmental footprint of U.S. dairy and make it economically viable to do so

May 12, 2026

PROJECT OVERVIEW

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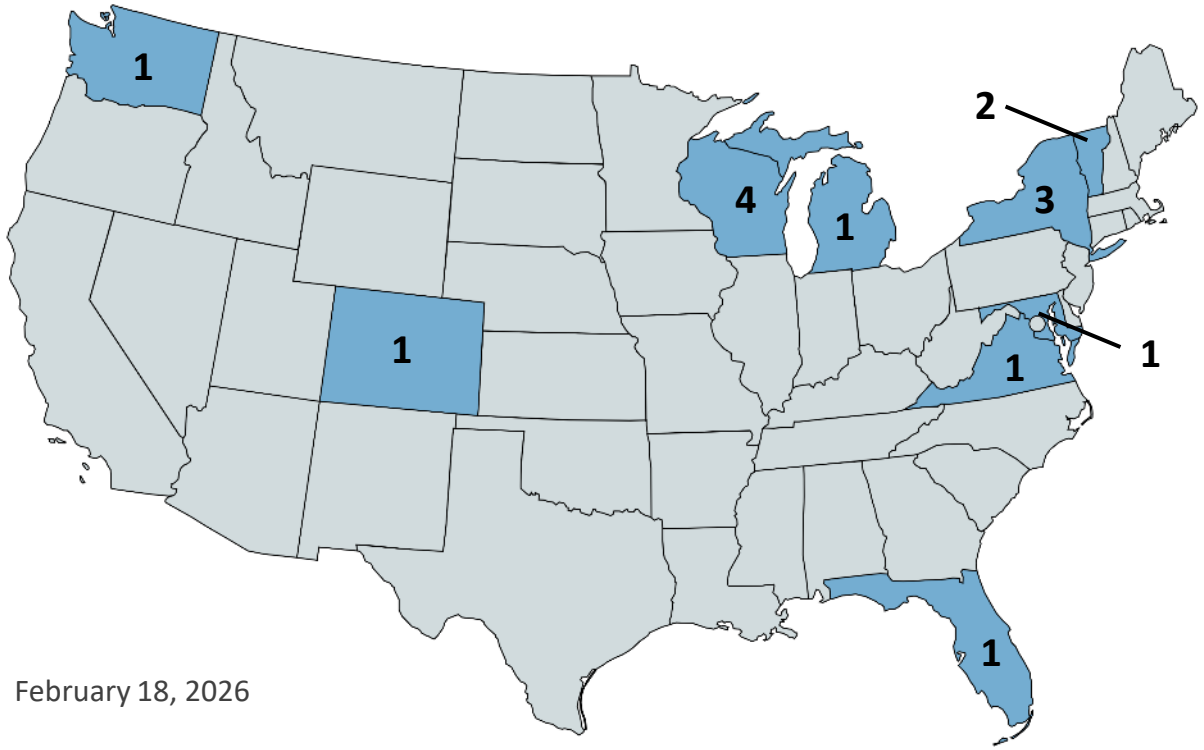
2020 CONSERVATION INNOVATION GRANT

Evaluating Environmental/Economic Benefits of Dairy Manure Technologies for Improving Water Quality

Project Timeline: 2020-2025

A **$966K NRCS grant-funded project** supported by Newtrient match and partner contributions.

15 TECHNOLOGIES EVALUATED



51 OUTREACH DELIVERABLES

13 Vendor Snapshots	**15** Evaluation Summaries	**15** Comprehensive Reports
5 Webinars	**3** Informative Videos	**7** Conference Presentations

Visit Newtrient.com for all resources

February 18, 2026

STUDY DESIGN OVERVIEW

Objective

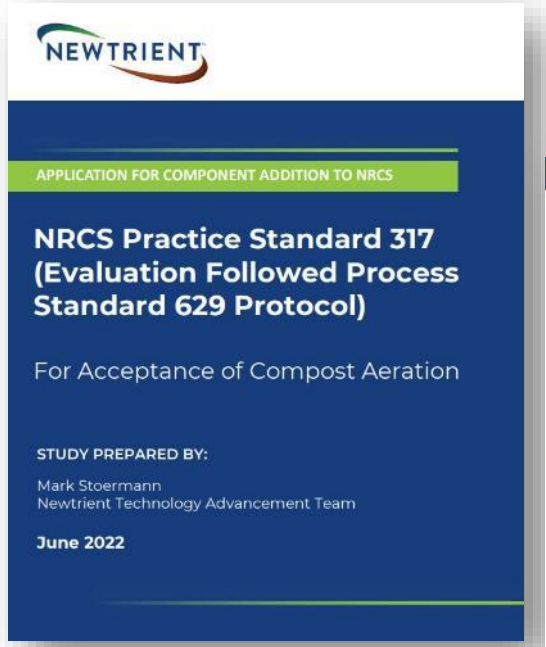
- Evaluate 15 dairy manure management technologies
- Focus: environmental performance → water quality

Key Metrics

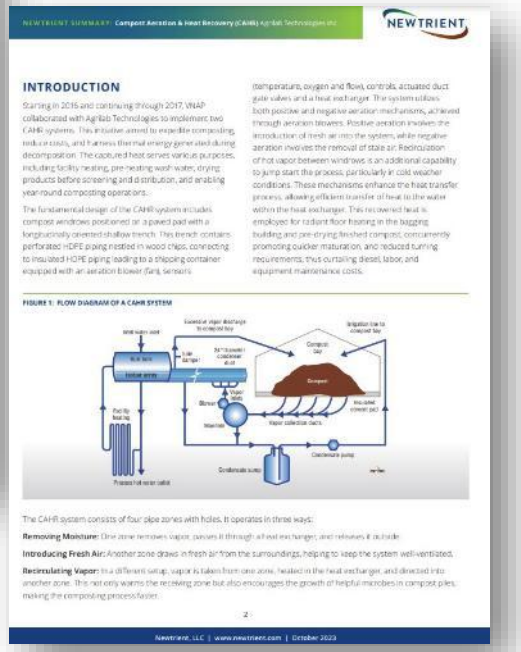
- Nutrient impacts across waste streams:
  - **Nitrogen (N)**
  - **Phosphorus (P)**

Outputs

- Individual technology evaluation reports
- Comparative insights across systems



Comprehensive Reports



Evaluation Summaries

SAMPLING & DATA COLLECTION

Protocol Development

- Developed by Newtrient + Washington State University
- Standardized testing and sampling protocol
- Meets third-party review requirements for NRCS Waste Treatment (629) Conservation Practice Standard
- Documents technology performance during the evaluation period

SAMPLING & DATA COLLECTION

Protocol Application

- Advanced phosphorus recovery and recycling
- Modified dissolved air flotation (DAF) system
- Samples collected three times/week for 15 weeks

SAMPLING & DATA COLLECTION

CIG sampling approach followed Newtrient/Washington State Protocol

Sampling Design

- Two validated approaches:
  - **3 samples/week for 15 weeks**
  - **1 sample/week for 52 weeks**
- Captures both short-term variability and annual trends

Laboratory Analysis

- Certified labs:
  - **A&L Laboratories** (Fort Wayne, IN)
  - **Agrolab** (Harrington, DE)

DATA QUALITY & EVALUATION FRAMEWORK

Independent Data Collection

- 3rd-party, unbiased sampling
- Conducted by colleges & universities
- Ensures credibility and consistency

Data & Reporting

- Standardized data collection reports per technology
- Enables cross-technology comparison

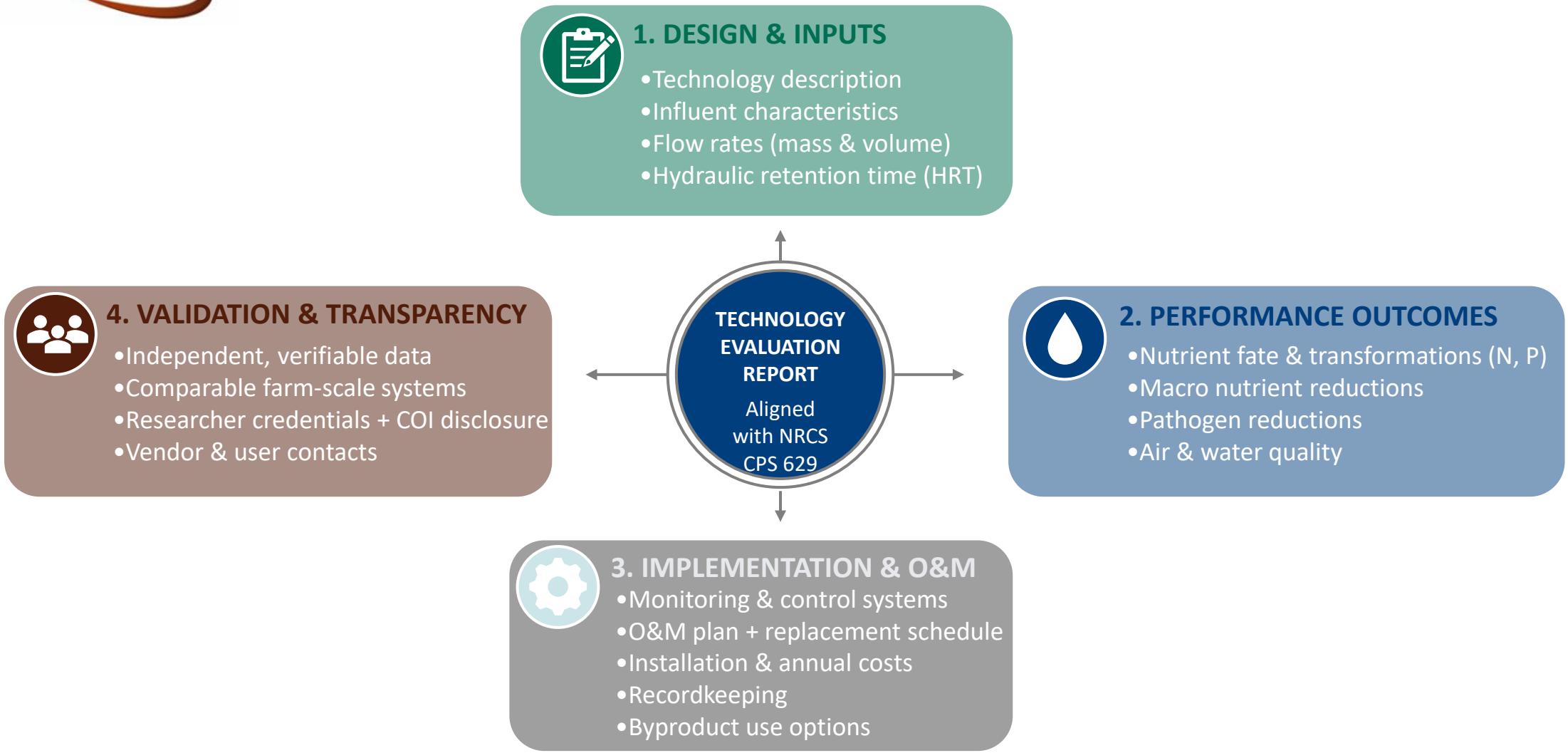
Evaluation Framework

- Aligned with NRCS Waste Treatment Standard (CPS 629)
- Assessment based on 15 evaluation elements

Output

- Technology reviews structured for NRCS consideration and potential practice standard inclusion

TECHNOLOGY EVALUATION REPORT FRAMEWORK



MANURE MANAGEMENT TECHNOLOGIES & SYSTEMS EVALUATED

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EVALUATED TECHNOLOGIES	
Windrow Composting (Traditional)	Ultrafiltration/Reverse Osmosis
Windrow Composting (Aeration and Heat Recovery)	Nitrogen Interception
Drum Composting (Bedding Recovery Unit)	Biomass Pyrolysis - Biochar
Pond Aeration	Mechanical Sand Separation
Biofiltration	Polymer-Assisted Separation/Reverse Osmosis
Centrifuge Separation	Adaptive Irrigation System
Vibratory Screen Separation	Large Animal Mortality Composting
Nitrogen Enrichment	Coarse Solid Separation (white paper)

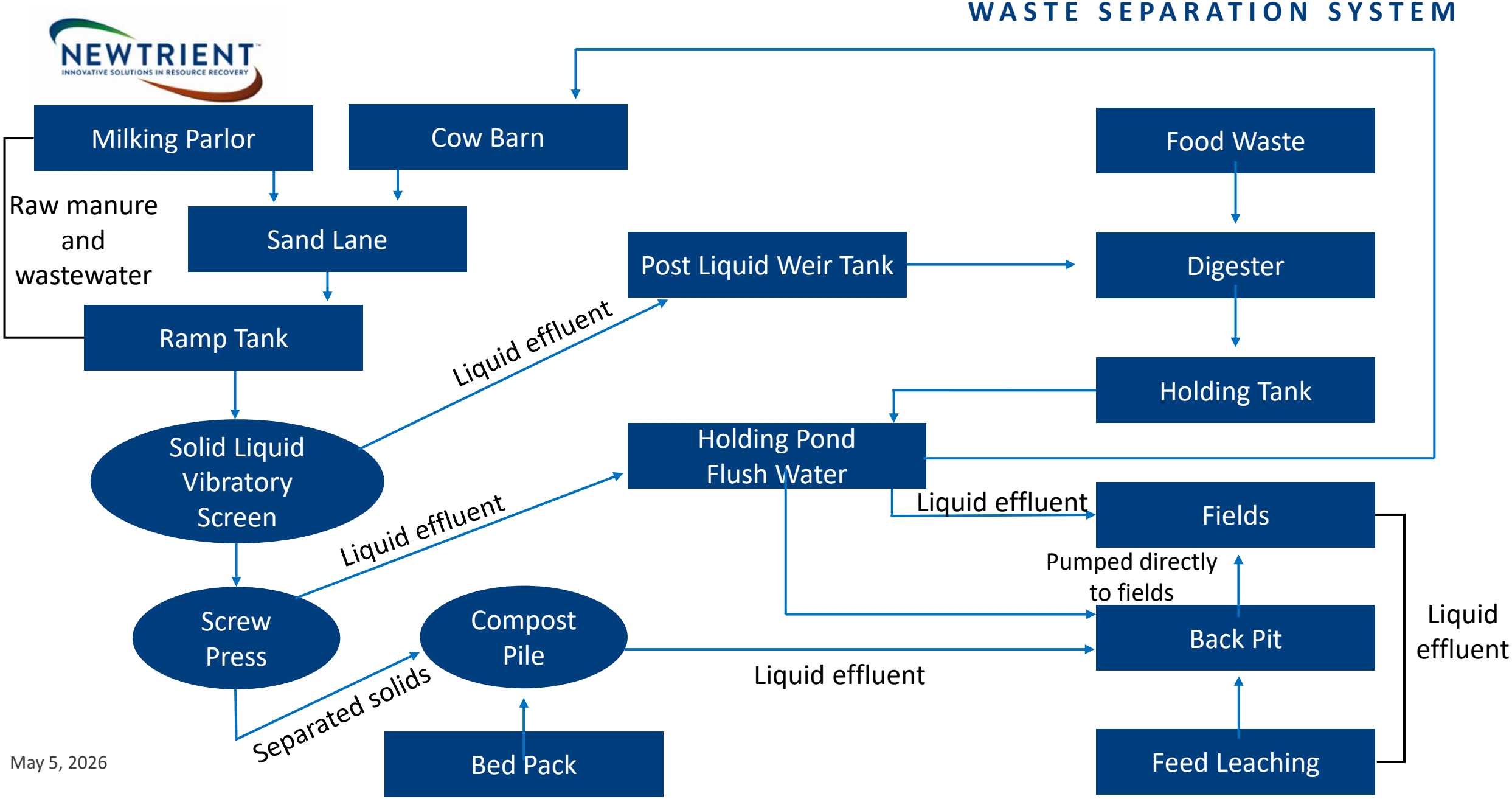
WHAT IS AN INTEGRATED MANURE MANAGEMENT SYSTEM?





An assembly of manure handling and treatment processes, arranged in a strategic fashion, to accomplish identified farm, water quality, and/or air quality goals and objectives.

WASTE SEPARATION SYSTEM



May 5, 2026

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Image from Google Maps

May 12, 2026

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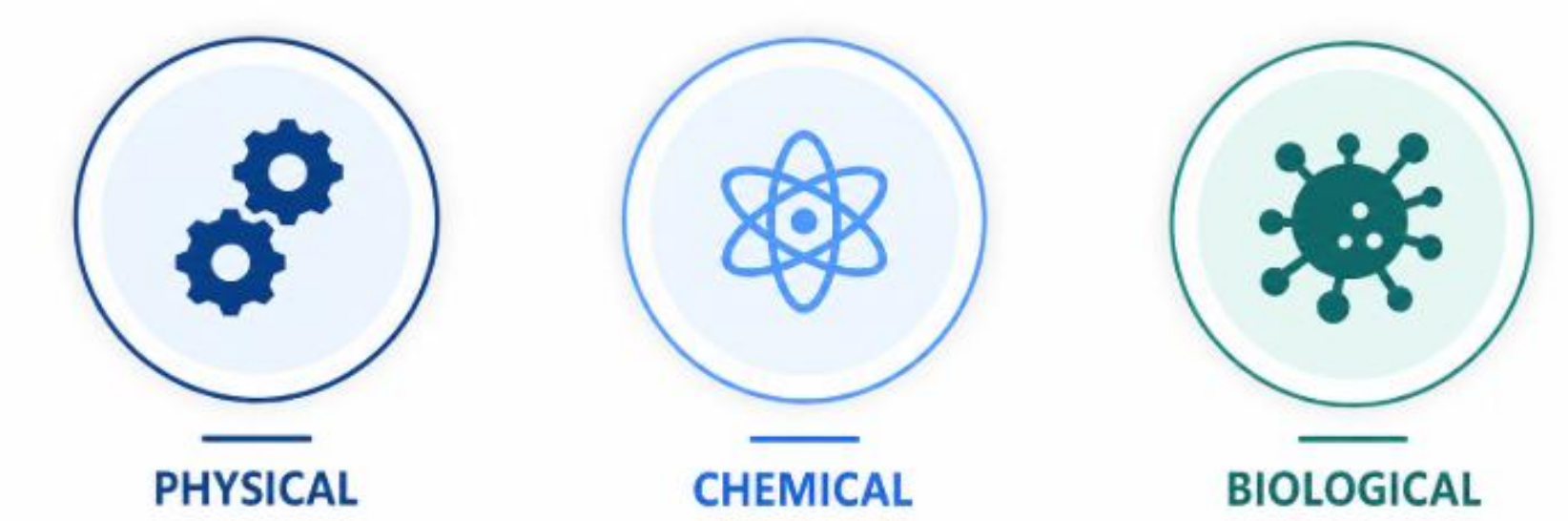
UNIT PROCESSES

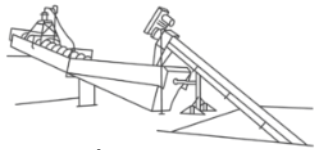


SYSTEM APPROACH – BRINGING IT ALL TOGETHER

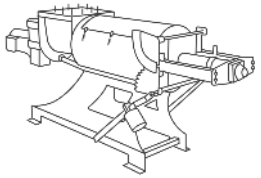
- Landowner's goals and objectives
- Addressing appropriate resource concern(s)
- Dealing with excess nutrients
  - Nitrogen
  - Phosphorus
- Nutrient imbalance – manure vs. crop
- Available and required land application area
- Waste streams

SYSTEM APPROACH – BRINGING IT ALL TOGETHER

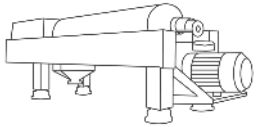
EXAMPLE: MANURE MANAGEMENT SYSTEM SCENARIO



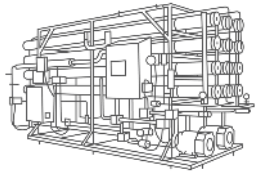
Sand Separation
1



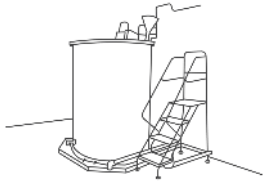
Coarse Solids Separation
2



Fine Solids Separation
3



Ultrafiltration with Reverse Osmosis



Polymer-Assisted & Dissolved Solids
4

Adaptive Irrigation
5

SOLID-LIQUID SEPARATION: THE FOUNDATION

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PROTECTING WATER QUALITY THROUGH SOLID-LIQUID SEPARATION (SLS)

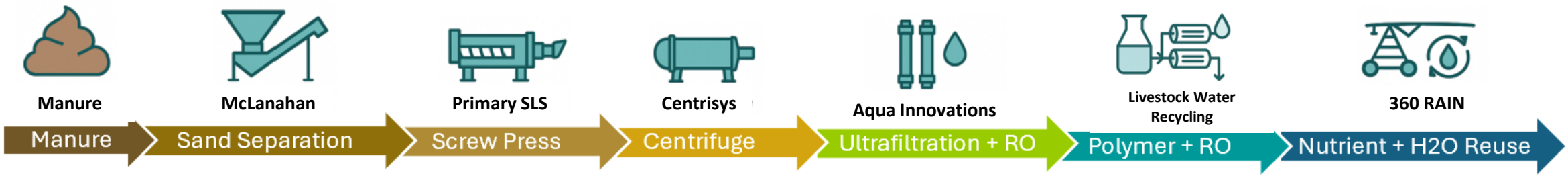
THE CHALLENGE

- Nutrient-rich effluent contributing to surface water contamination (N, P, pathogens)
- Increased GHG emissions from overloaded storage
- Higher organic loading → lagoon imbalance, crusting, odor
- Pump, pipe, and membrane fouling from suspended solids

WHY SLS IS ESSENTIAL

- Captures nutrients early in the process
- Produces clarified liquid that protects downstream systems
- Reduces solids loading in storage and improves storage performance
- Forms the foundation for all subsequent treatment systems (membranes, nutrient recovery, water reuse)

THE ROLE OF SLS IN SYSTEM PERFORMANCE



Core Process	Mechanical sand separation/ coarse solids	Mechanical solid-liquid separation	Fine solids separation	Ultrafiltration + reverse osmosis integrated membrane system	Polymer assisted separation + reverse osmosis	Nutrient and water reuse
Function	Front end grit and sand removal	Removes large fiber & solids	Clarifies effluent; concentrates fine solids/ nutrients	Produces clean “tea water” and final reusable/ dischargeable water	Nutrient concentration and clean water recovery	Field-level integration, closes the loop

STEP 1: SAND REMOVAL

McLanahan Sand Separator

- **Function**
  - Separates sand from manure for bedding reuse
  - Removes heavy particles early
  - Reduces sand buildup in storage and digesters
  - Minimizes abrasion and downstream wear and tear on equipment
- **Performance**
  - Multiple sizes for different herd and system configurations
  - 300-50,000 cow capacity
  - Up to 100 tons/hour sand removal

STEP 2: COARSE SOLIDS SEPARATION

✓ **Captures large fibers, producing stackable solids**

✓ **Reduces solids loading for fine separation and membranes**

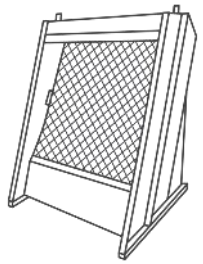
Slope Screen

Function

- Removes coarse solids from diluted raw manure using a sloped wedge-wire screen
- Often followed by a press or roller to reduce moisture
- About 20% of nutrients stay within solids

Performance (GEA)

- 120-35,000 cow capacity
- 1,200 cows/screen (east/Midwest)
- 2,000+ cows (west)



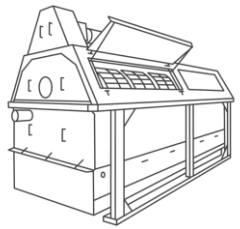
Rotary Drum Screen

Function

- Rotating drum of wedge-wire or screen removes liquid and coarse solids
- Typically followed by a screw press or roller to increase dryness
- About 20% of nutrients stay within the solids

Performance (McLanahan)

- 200-15,000 cow capacity



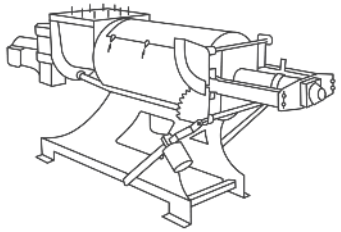
Screw Press

Function

- Auger pushes manure through a wedge-wire cylinder
- Backpressure squeezes out liquid
- About 10-30% of nutrients stay within solids

Performance (FAN)

- 50-10,000+ cow capacity



STEP 3: FINE SOLIDS SEPARATION

Centrisys Centrifuge

Function

- Removes fine particles and colloids after mechanical separation
- Applies 3,000× g (2,000-4,000 rpm)
- Forces solids to bowl perimeter; liquids to the center
- Produces a nutrient-rich (especially P) into a thicker solids stream
- Operates continuously with high reliability
- Delivers clarified liquid ideal for UF/RO

Performance

- 1,000-10,000 cow capacity
- Up to 700 gpm slurry throughput
- 0.2-0.4 kW/gpm energy use
- Configurable to farm-specific layouts and needs

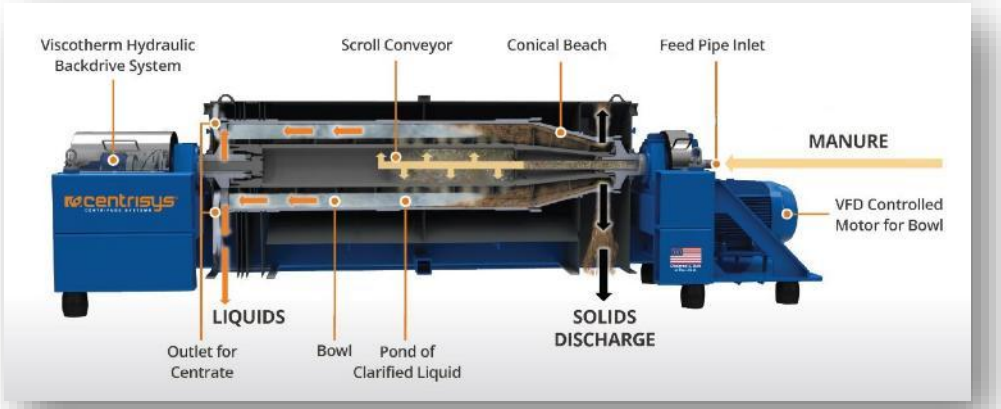


Image from Centrisys website

BUILDING THE BASE

TIERED SEPARATION

Sand

Coarse

Fine

Each step improves liquid clarity and nutrient concentration and sets the stage for high-efficiency membrane or polymer enhanced treatment.

MEMBRANE AND POLYMER ASSIST RECOVERY SYSTEMS

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STEP 4: MEMBRANE-BASED UF + RO

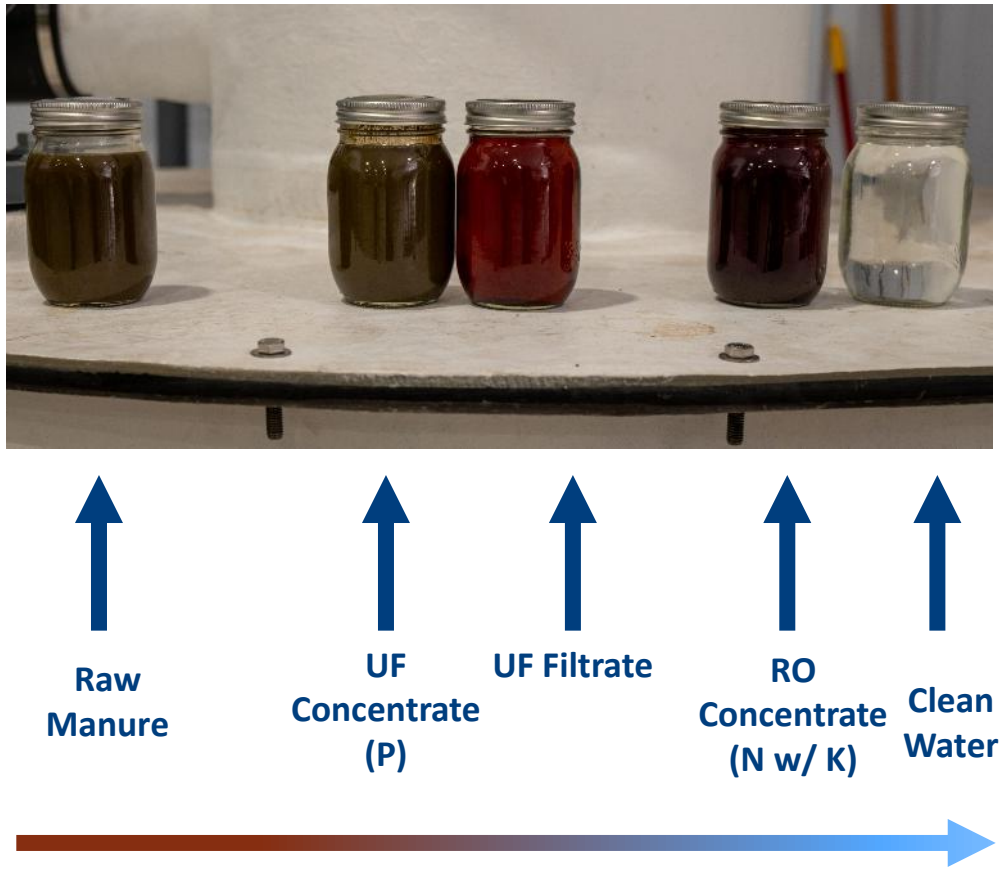
Aqua Innovations

Function

- Requires upstream SLS (membranes are sensitive to solids)
- UF removes fine solids, pathogens, and P
- RO removes remaining dissolved nutrients (N, K, salts) → produces dischargeable water
- Produces low-TSS, clarified water
- Creates “tea water” or fully clean water depending on configuration – clean water suitable for discharge or livestock drinking water
- UF can run independently for partial treatment

Performance

- 50 gpm
- Combined maximum capacity of 115,000 gpd = 42 million gallons annually at 80% runtime



STEP 5: POLYMER-ASSISTED & DISSOLVED SOLIDS SYSTEM

Livestock Water Recycling (LWR)

Function

- Two-part treatment:
  1. Polymer-assisted fine solids separation (CIG evaluation) → dough-like nutrient-rich solids + clarified liquid
  2. Dissolved solids removal/conditioning → concentrated nutrient liquid + partially clarified water
- Handles high solids or flush water streams efficiently

Performance

- Polymer-assisted fine solids separation
  - 100-10,000 cow capacity
  - 15,000-264,000 gpd
- Dissolved solids removal
  - 600-7,200 cow capacity
  - 100,000 gpd for 1,000 cows

Images from LWR website

COMPARING POLYMER-BASED AND MEMBRANE-BASED TREATMENT SYSTEMS

Feature/Step	Polymer-Assisted & Dissolved Solids	Membrane-Based UF & RO
Core Process	Flocculation → filtration → dissolved solids separation	UF → RO
Front-end Requirement	Coarse solids removal upstream	Low solids feed from SLS
Primary Output	Nutrient-rich solids + concentrated ammonium/potassium liquid + reusable water	High-quality clean water suitable for drinking or discharge + concentrate
Best Use Case	Flush water, high-solids effluent, nutrient recovery	Drinkable, irrigation, or dischargeable water
Strength	Handles high solids loads; maximizes nutrient recovery	Produces very clean water; modular UF for partial treatment

Choosing the Right Solution for Your Water Quality Goals

EFFLUENT UTILIZATION

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STEP 6: ADAPTIVE IRRIGATION

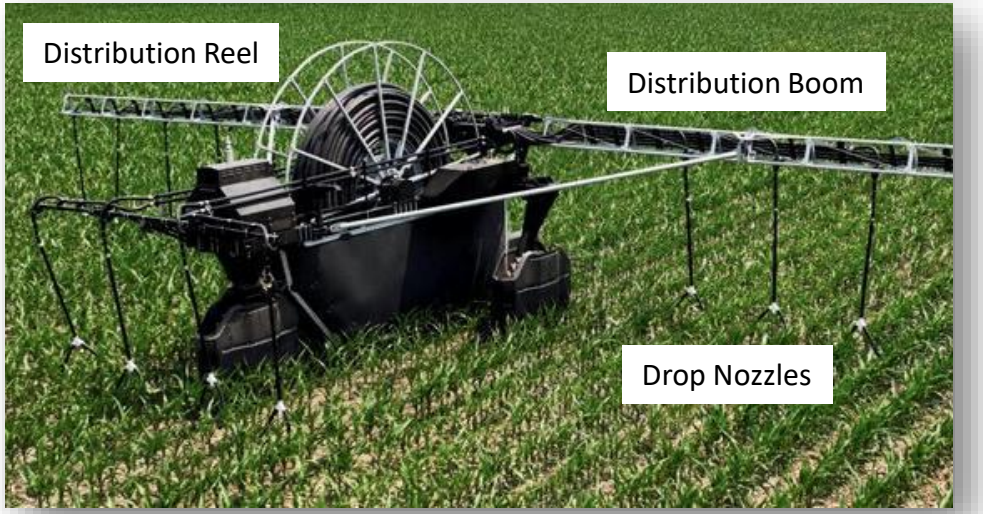
360 RAIN

Function

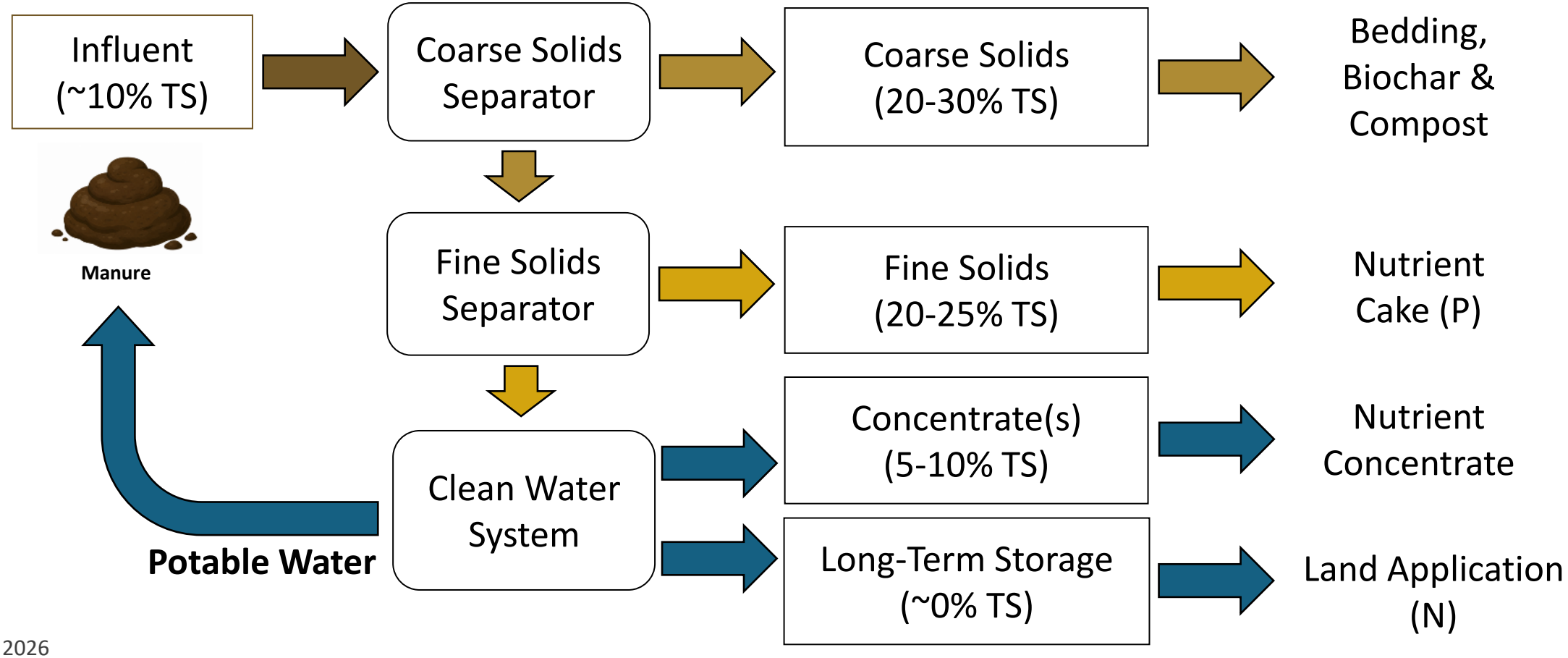
- Works in a variety of field configurations
- Applies a variety of liquid sources up to 10% solids (wastewater, digestate, fertigation)
- Cellular and real-time kinematic positioning for accurate navigation
- Delivers nutrients + water directly to the root zone
  - Integrates with polymer-assisted or UF/RO
  - Enables full circular reuse: manure → treatment → field

Performance

- 200-250 gpm @ 115 PSI
- 3,000 ft of 3” hose (up to 200 acres)
- 60 ft and 80 ft boom options
- Banded or flat fan drop nozzle options
- 300-50,000+ cow capacity
- Diesel-electric: ~½ gallon/hr (2 – 150-gallon diesel tanks)



COARSE SEPARATION → FINE SEPARATION → CLEAN WATER → LAND APPLICATION



CLEAN WATER PATHWAY SUMMARY

- SLS is the foundation for all downstream water recovery
- Polymer-assisted and dissolved solids systems
  - Robust flush water
- Membrane-based UF and RO systems
  - High-quality water suitable for livestock drinking water or discharge for irrigation, flush water, cleaning, or cooling livestock
- On-farm water reuse conserves freshwater sources and supports improved water management

PERFORMANCE RESULTS: ENVIRONMENTAL OUTCOMES, ECONOMIC CONSIDERATIONS & IMPLEMENTATION FACTORS

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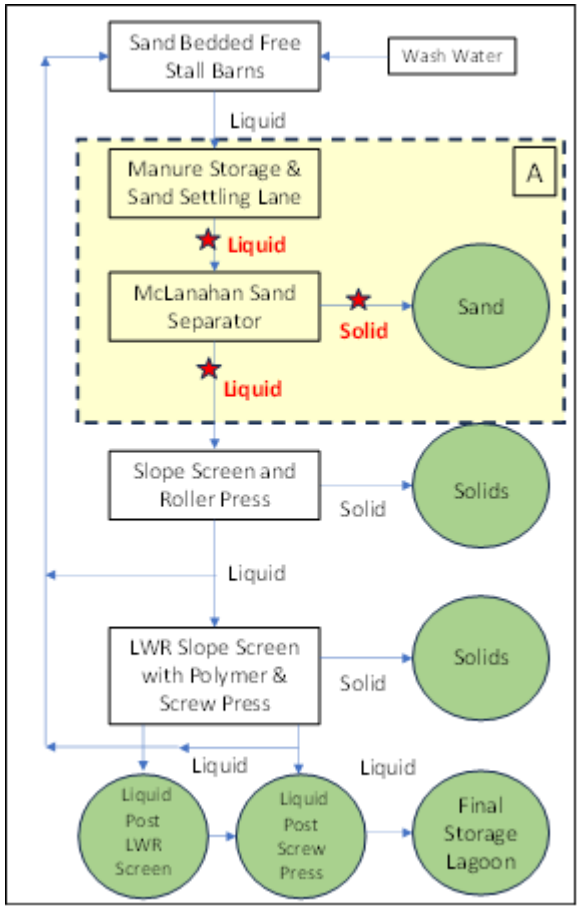
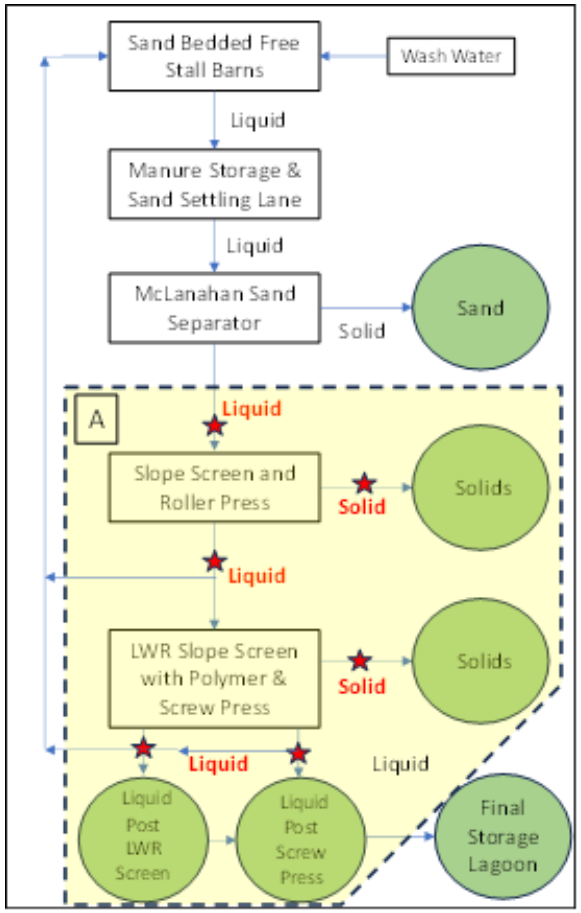
DAIRY CASE STUDY (UW-MADISON)





- Integrated manure management systems approach
  - Sand Separation
  - Coarse Solids Separation
  - Polymer-Assisted Fine Solids Separation
  - Reverse Osmosis*
- Clean water produced on-site
- Reduced nutrient losses and hauling volumes

**The farm includes an RO system downstream of LWR; however, RO was not operated during the CIG evaluation. CIG results focused on solids separation and effluent handling.*

ENVIRONMENTAL BENEFITS

- **Reduced Ammonia & Nitrate Losses**
  – Lower volatilization from storage and field application
  – Reduced groundwater nitrate leaching
- **Concentrated, Targeted Nutrient Delivery**
  – Solids and liquids separated for precision placement
  – Enables in-season application aligned with crop demand (UF/RO + 360 RAIN)
- **Improved Water Quality Protection**
  – Lower phosphorus runoff risk
  – Clarified and dischargeable water streams from membrane systems
- **Reduced Hauling & Land Application Footprint**
  – Volume reduction through SLS + centrifuge + membranes
  – Decreases heavy equipment use and field compaction
- **Enhanced Storage & Lagoon Management**
  – Reduced solids accumulation
  – Increased operational life of storage structures
- **Support for Circular Resource Recovery**
  – Reuse-quality water for flushing or irrigation
  – Nutrient-rich concentrates suitable for export or targeted fields
- **Lower Odor & Pathogen Loads**
  – Fine solids removal + UF/RO improve microbial reduction
  – Cleaner water streams reduce odor during handling

CAPITAL, OPERATIONS, AND MAINTENANCE COSTS

Technology	Capital Investment	Operations & Maintenance
Sand Separation (mechanical)	$936,855 – flush-compatible for 1,500 cows, excluding freight or shipping, electrical, plumbing, installation, building, concrete, and startup	$5,000 - $10,000 annually for the first 5 years Years 4 and 5 will be on the higher end of the scale
Slope Screen	$28,000-$74,000	Operation costs typically considered on a 24/7 runtime $2,700/year – maintenance
Rotary Drum Screen	$39,000-$105,000	Primarily electric costs for running 1-3 HP motor
Screw Press	$21,000 – ≤ 400 cows $110,000 – 1,200 cows	$13,000 maintenance/year – operating 10 hrs./day for 1,000 cows
Centrifuge	$400,000 – 1,000 cows $750,000 – 10,000 cows	$10,000 electricity and $40,000 maintenance – 10,000 cows

**Note: Estimated costs are accurate as of 2024/2025 and may vary due to project specifics, farm size, capacity, market conditions, and additional features.*

CAPITAL, OPERATIONS, AND MAINTENANCE COSTS

Technology	Capital Investment	Operations & Maintenance
Membrane-Based UF + RO	$750,000 – One UF unit, 3,000 cows $1.6 million – Two UF units, 5,000 cows $2.5 million – UF + RO, 5,000 cows	$0.006/gal of power over three months
Polymer-Assisted & Dissolved Solids	$3,567/month – 100 cows, polymer-assisted only $14,916/month – 6,500 cows, polymer-assisted only Dissolved solids technology pricing available upon request	$0.003/gal – polymer-assisted $0.01/gal – dissolved solids Maintenance costs are estimated at 3-5% of system capital cost annually
Adaptive Irrigation	$280,000-$300,000	$82/day or $3.25/acre/pass – operations $1,200/year – maintenance

**Note: Costs are accurate as of 2024/2025 and may vary due to project specifics, farm size, capacity, market conditions, and additional features.*

ECONOMIC & OPERATIONAL BENEFITS

- **Lower Hauling & Storage Costs**
  - Reduced hauling frequency due to solids concentration
  - Smaller storage volumes and slower fill rates
  - Less dredging and long-term sludge management
- **Lower Equipment Wear & Maintenance**
  - Cleaner liquids reduce pump, pipe, and nozzle abrasion
  - Fewer clogs and less downtime
  - Improved lifespan of irrigation or fertigation equipment
  - Reduced maintenance on flush systems
- **Improved Labor Efficiency**
  - Automated separation, membranes, and field application reduce manual handling
  - Centralized control of nutrient, water, and solids logistics
- **Water Reuse Reduces Freshwater Demand**
  - Clean water from UF/RO replaces potable or well water for:
    - Irrigation
    - Flushing
    - Cooling or parlor use (if appropriate)
- **Energy Optimization Across the System**
  - Efficient centrifuges, polymer systems, and pumps
  - Reduced transportation energy compared to hauling raw manure
- **Enhanced Field Performance**
  - Nutrients delivered directly to the root zone reduce fertilizer purchases
  - Precision application improves crop uptake and reduces field passes

KEY TAKEAWAYS

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KEY TAKEAWAYS & LESSONS FROM THE FIELD

- SLS is the prerequisite for clean water, nutrient recovery, and effective downstream treatment.
- Sequence matters: Systems perform best when separation, membrane, and nutrient recovery steps are properly ordered.
- Front-end separation is critical: Sand and grit removal protects membranes and reduces operational issues.
- Integrated systems maximize benefits: Environmental gains, nutrient management, operational efficiency, and return on investment (ROI) all improve when systems are designed as a connected flow.

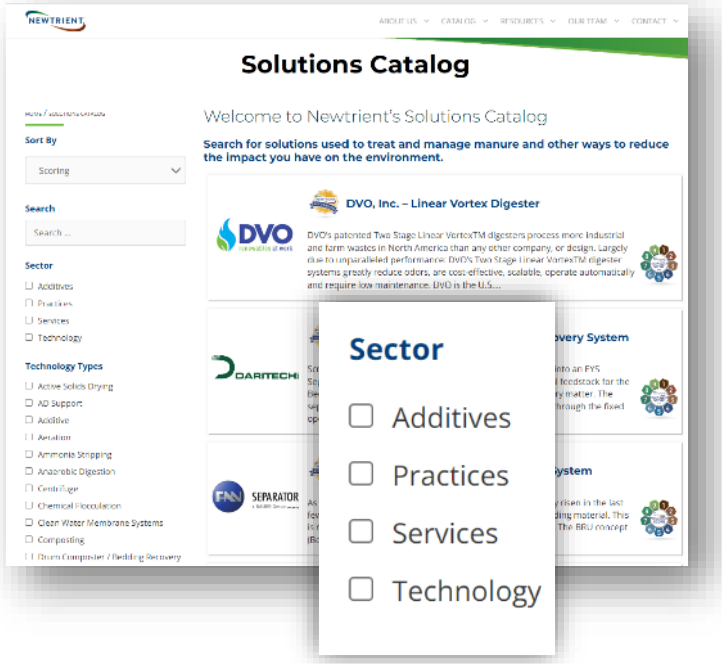
POTENTIAL NRCS ACTIONS

- Use third-party evaluations to stay current on manure management innovations
- Partner with external organizations (e.g., Newtrient) to accelerate technology review and adoption and to update standards, specifications, and technical references more rapidly
- Explore payment schedules to support emerging technologies
- Establish a clear process to help producers incorporate new technologies into conservation plans

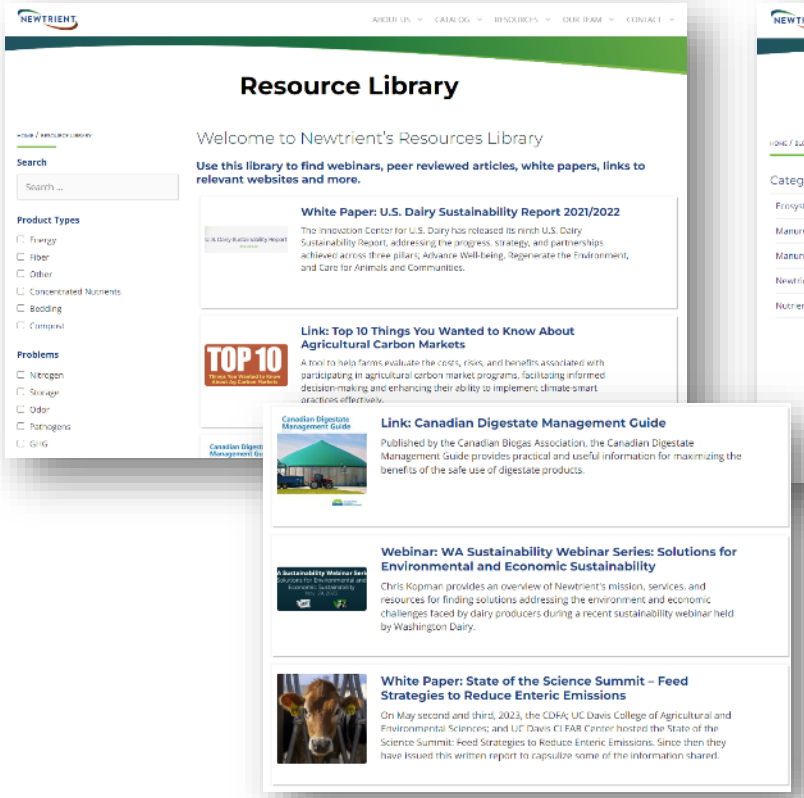
NEWTRIENT RESOURCES

NEWTRIENT RESOURCES

SOLUTIONS CATALOG



RESOURCE LIBRARY



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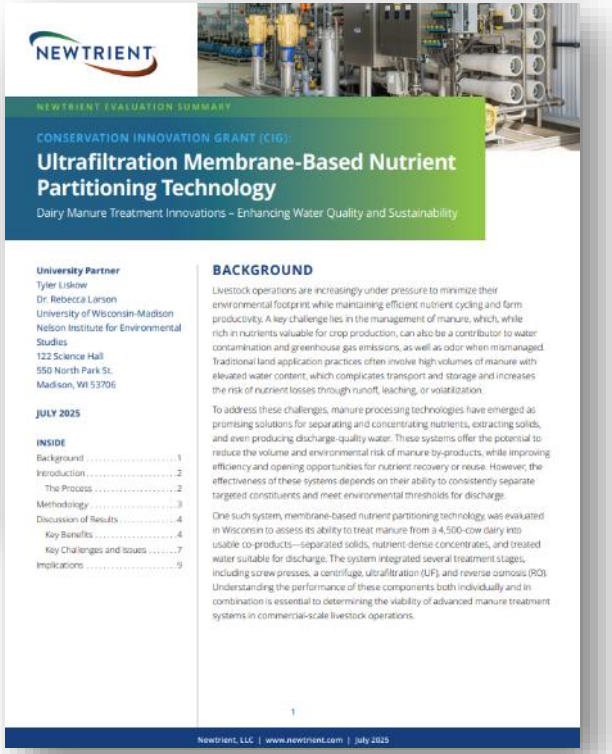
CURIOUS ABOUT NEWTRIENT'S OTHER CIG EVALUATIONS?

EXPLORE NEWTRIENT'S CIG PROJECT

- **Learn more about our 2020 Conservation Innovation Grant (CIG) project and access key resources:**
  - Vendor Snapshots
  - Evaluation Summaries
  - Comprehensive Reports
  - Webinars & Videos



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