



Designing for Success: Optimizing Denitrification BMP Performance

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WIDELY USED, NOT STANDARDIZED

- **Used in Brevard County**
- **Recognized in Florida**
- **Limited Design Guidance**



**PERFORMANCE
VARIABILITY**



UNCERTAINTY

BUILT ON FLORIDA PRACTICE

- **Long History of Stormwater BMP Innovation**
- **Early Denitrification Research**
- **Applied Across System Types**

The background of the bottom half of the slide is a grayscale photograph of a stormwater treatment facility. It shows several large, rectangular concrete structures, likely part of a denitrification system, situated in an open field. A large blue arrow points from the left side of the image towards the right side.

**STRONG
FOUNDATION**

**VARIABLE
PERFORMANCE**

STUDY OBJECTIVES

**Characterize
Performance**

Evaluate Media

**Identify Key
Drivers**

**Define Design
Expectations**

STUDY SCOPE & APPROACH

LITERATURE REVIEW

- Lab to Field Systems
- Screened 114 Studies
 - ↳ Outreach & Design (12)
 - ↳ Data Extraction (55)

Experimental
Design Type

Lab, Pilot, or
Field

Substrate
Type

Environmental
Conditions

Temperature

Hydraulic
Retention
Time

NO₃⁻-N
Influent
Concentration

Performance
Metrics

Removal
Efficiency /
Rate

Limitations

Phosphorus
Consideration

Salinity
Consideration

STUDY SCOPE & APPROACH

INTERVIEWS

- **Experts**
 - Researchers
 - Industry
 - Public Sector
- **Contacted 65 Experts**
 - ↳ 18 Responded
 - ↳ 13 Interviewed

Semi-Structured Interviews

System Performance

Design Considerations

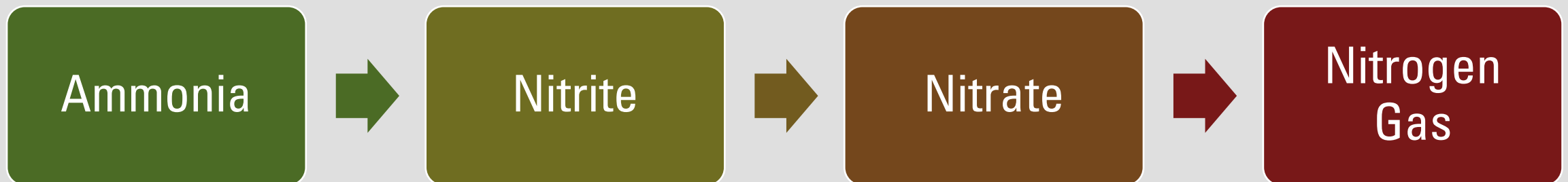
Environmental Conditions

Operations and
Maintenance

Implementation
Challenges

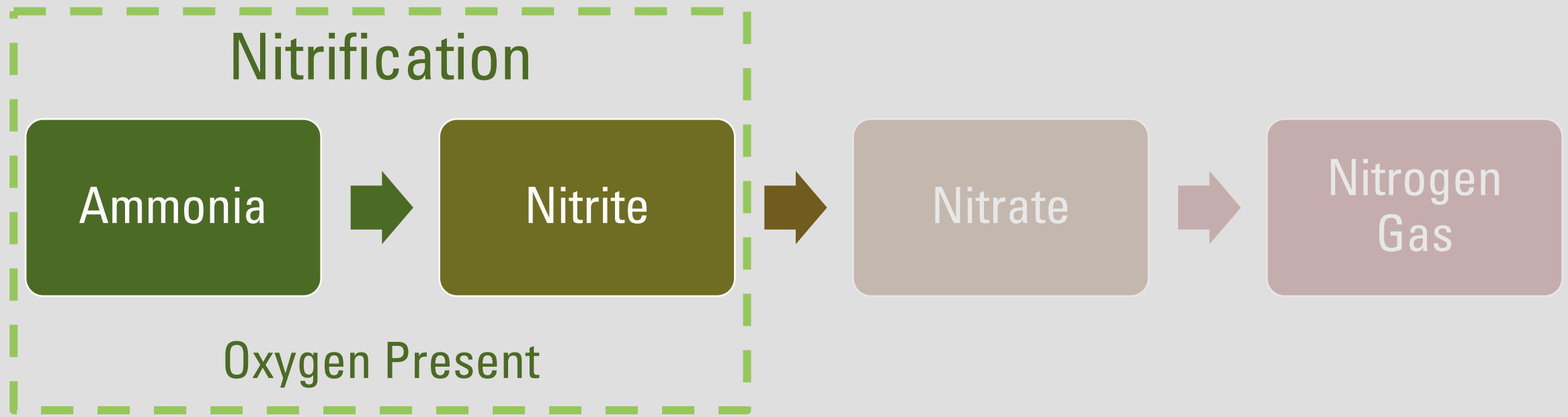
STORMWATER DENITRIFICATION

HOW DO THESE SYSTEMS WORK?



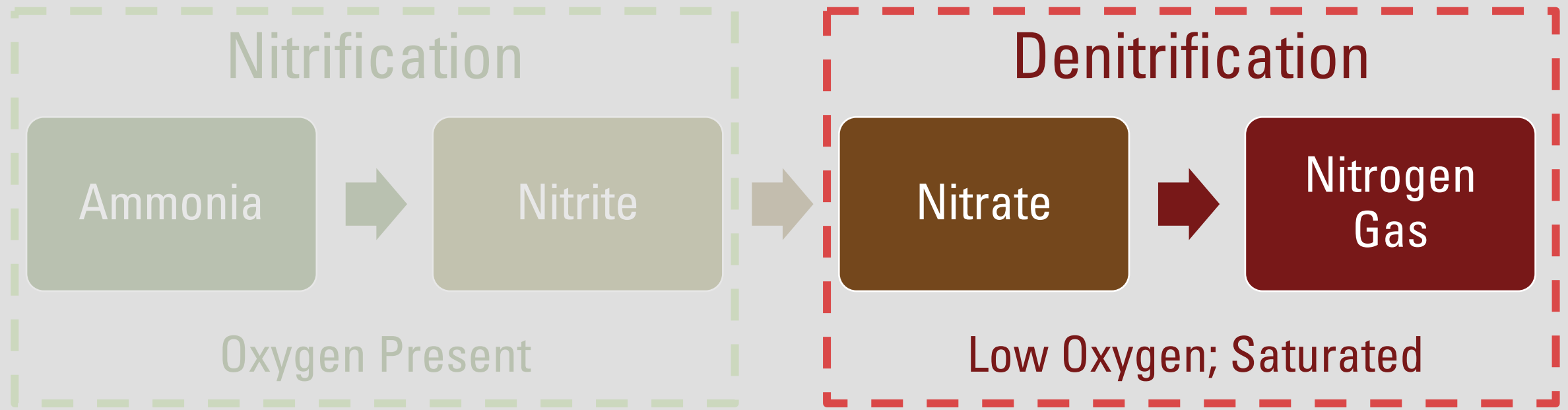
STORMWATER DENITRIFICATION

HOW DO THESE SYSTEMS WORK?

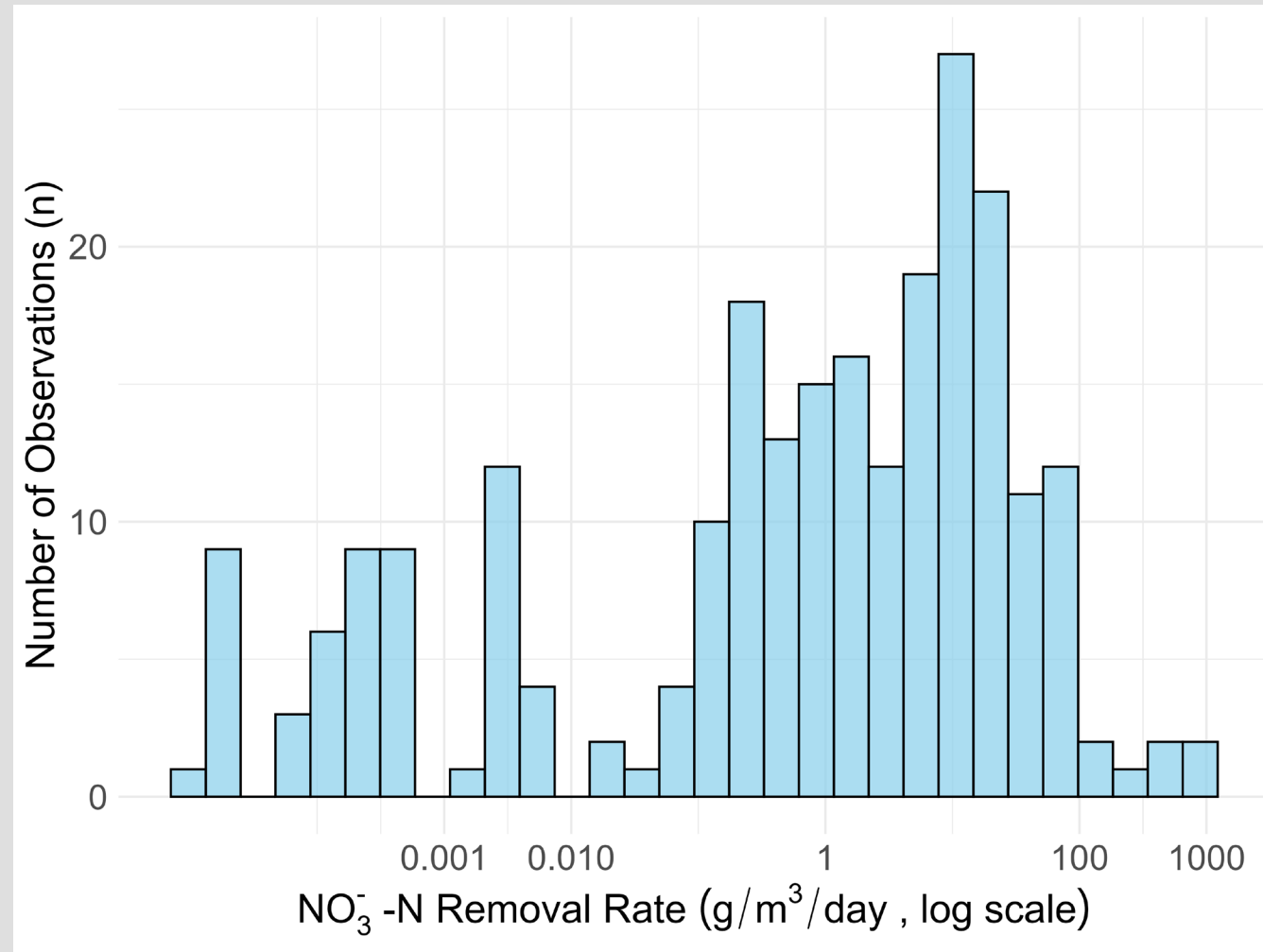


STORMWATER DENITRIFICATION

HOW DO THESE SYSTEMS WORK?

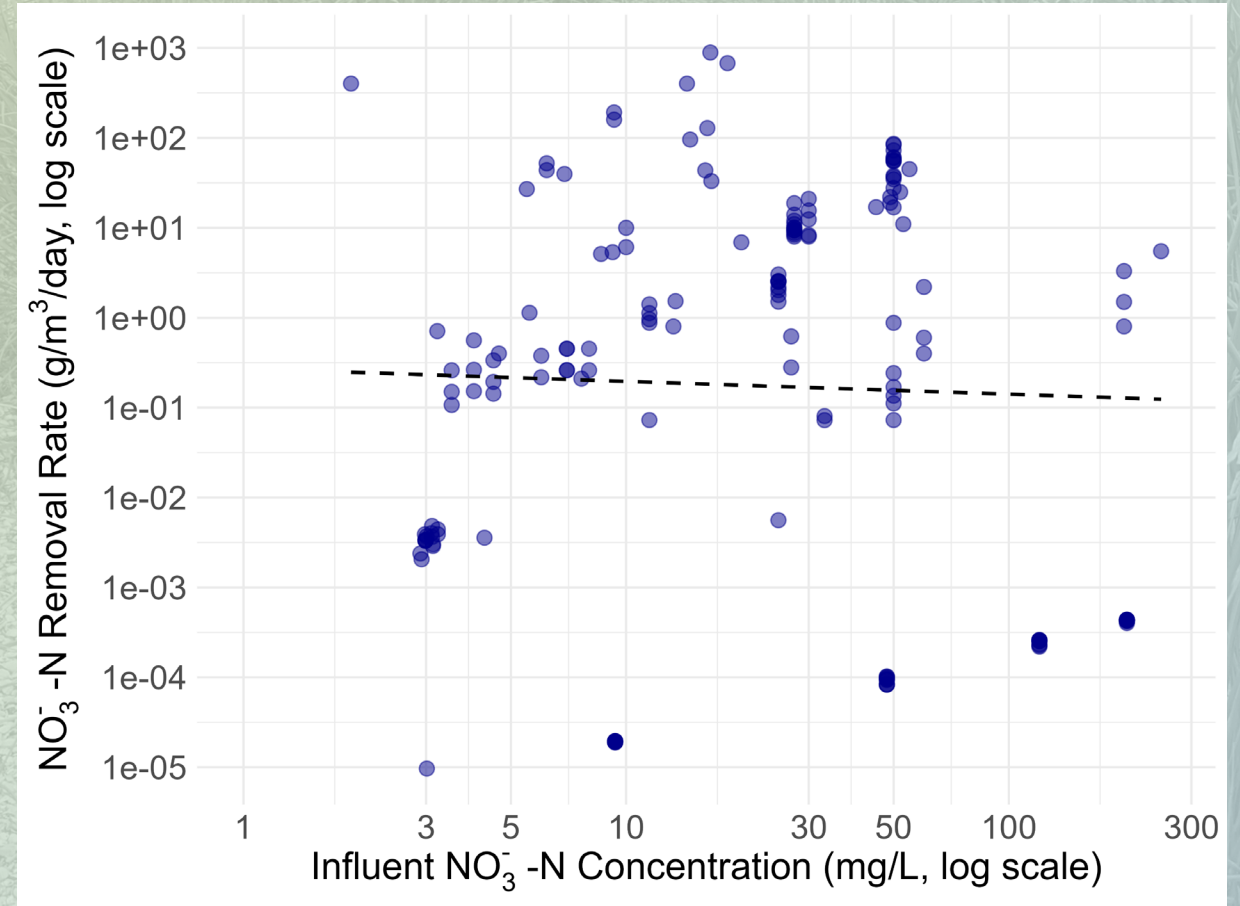


PERFORMANCE IS HIGHLY VARIABLE



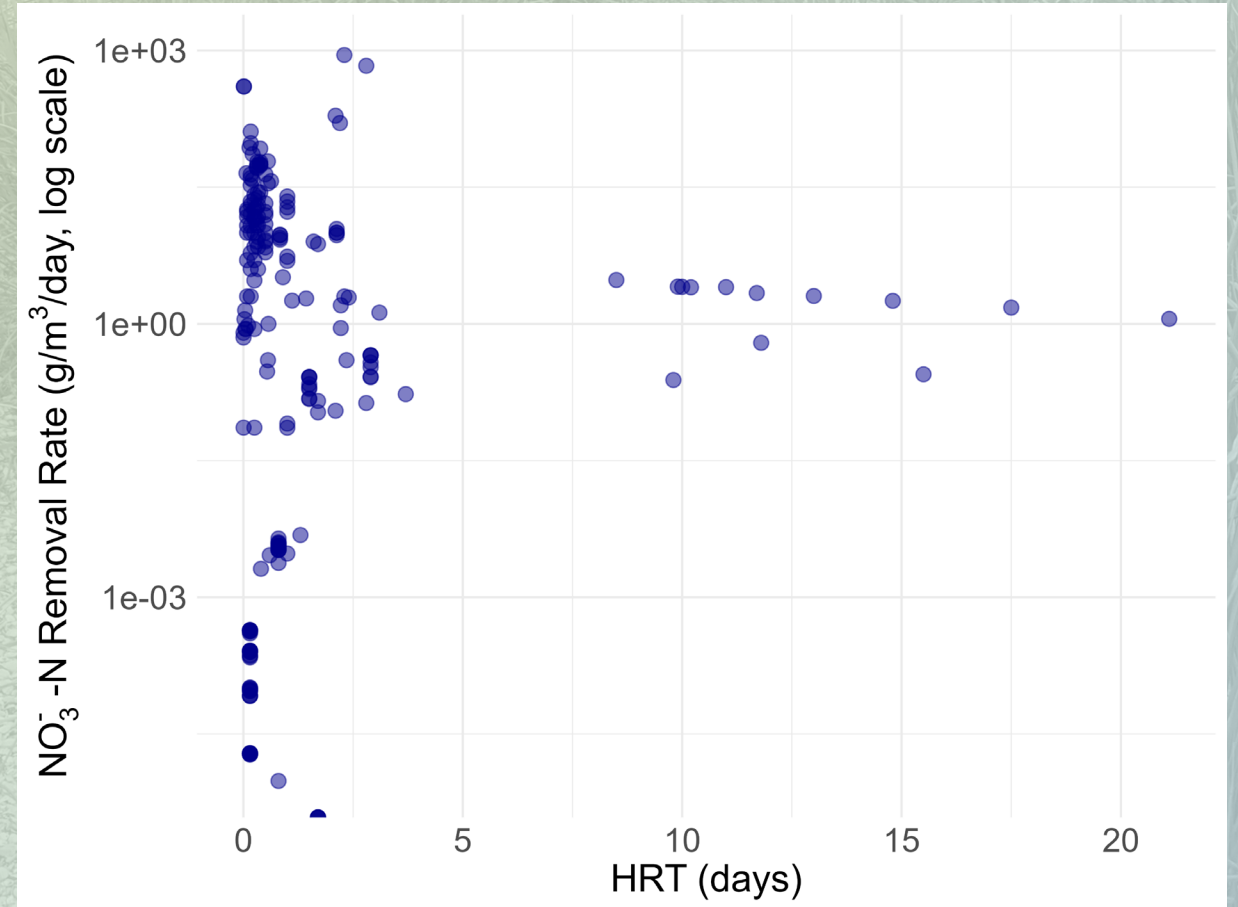
WHAT DRIVES THE VARIABLE PERFORMANCE?

INFLUENT CONCENTRATION?



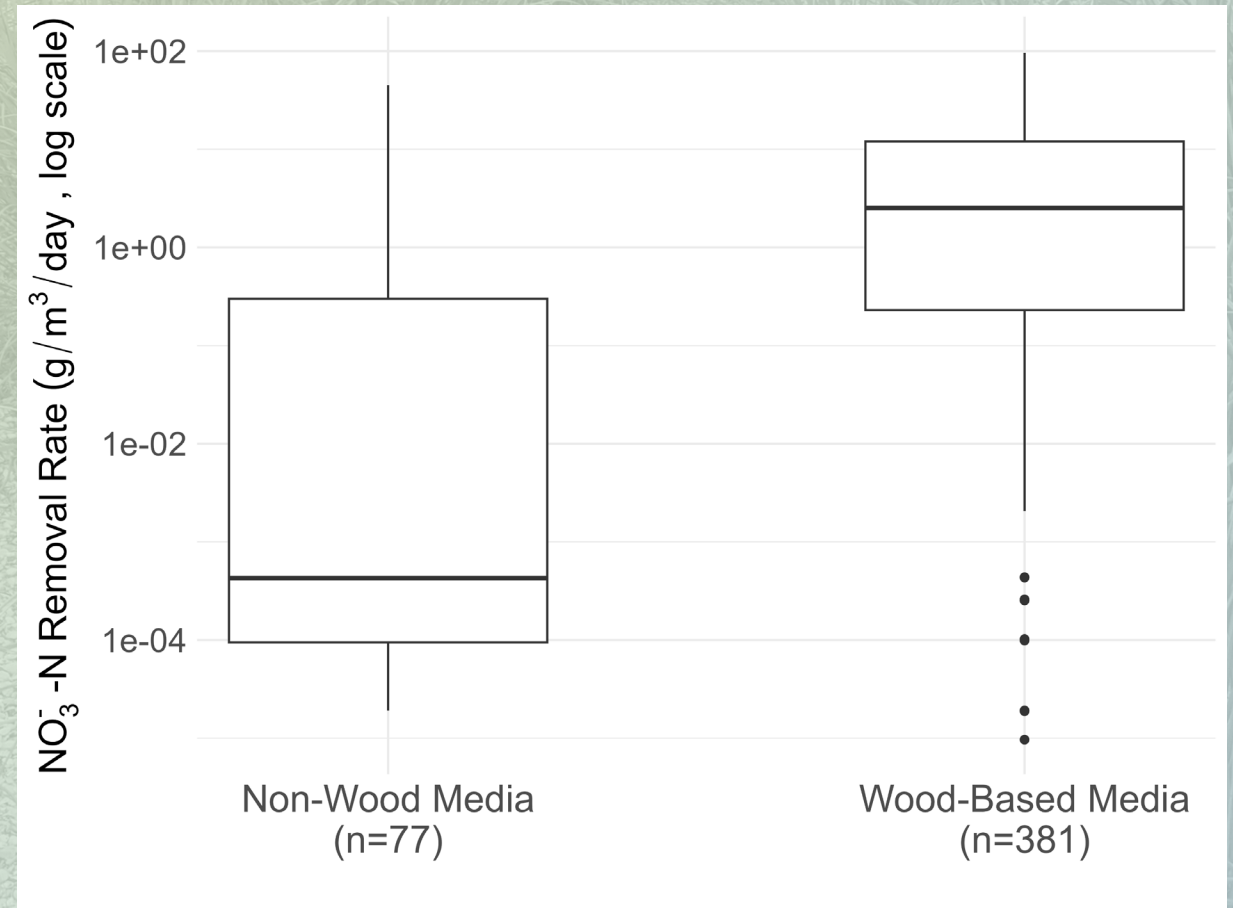
WHAT DRIVES THE VARIABLE PERFORMANCE?

HYDRAULIC RETENTION TIME?



WHAT DRIVES THE VARIABLE PERFORMANCE?

MEDIA TYPE?
CARBON SOURCE?



WHAT DRIVES THE VARIABLE PERFORMANCE?



PRACTITIONER INSIGHTS

Performance
Varies
Across
Systems

Hydraulics
and
Saturation
are Critical

Carbon
Availability
Limits
Performance

Maintenance
Affects
Reliability

Field
Conditions
Drive
Outcomes

IMPLICATIONS OF VARIABLE PERFORMANCE

Design Controls	Not One-Size-Fits-All	Field Conditions Matter	Variability is Expected
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DESIGN DECISIONS ARE IMPORTANT

DESIGN IMPLICATIONS

MAKE BIOLOGY WORK FOR US

1

Ensure
Adequate
Residence Time

2

Provide a
Reliable Carbon
Source

3

Maintain
Saturated
Conditions

4

Control Flow
Paths

WHAT THIS LOOKS LIKE IN PRACTICE

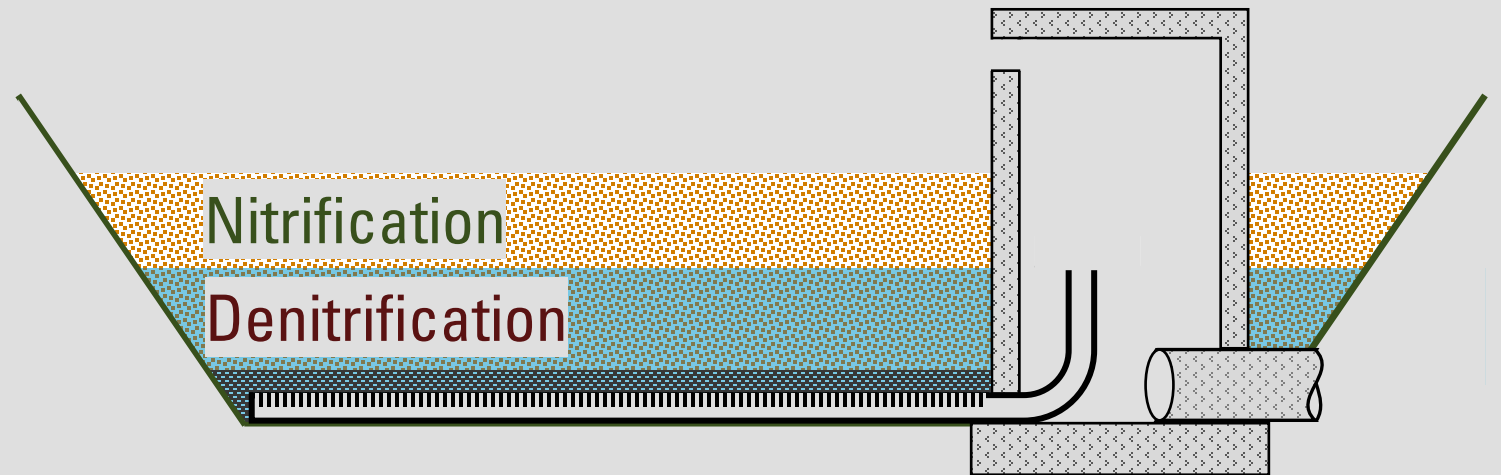
BIORETENTION DESIGN

1 Residence Time

2 Carbon Source

3 Saturated Conditions

4 Control Flow Paths



WHAT THIS LOOKS LIKE IN PRACTICE

BIOREACTORS

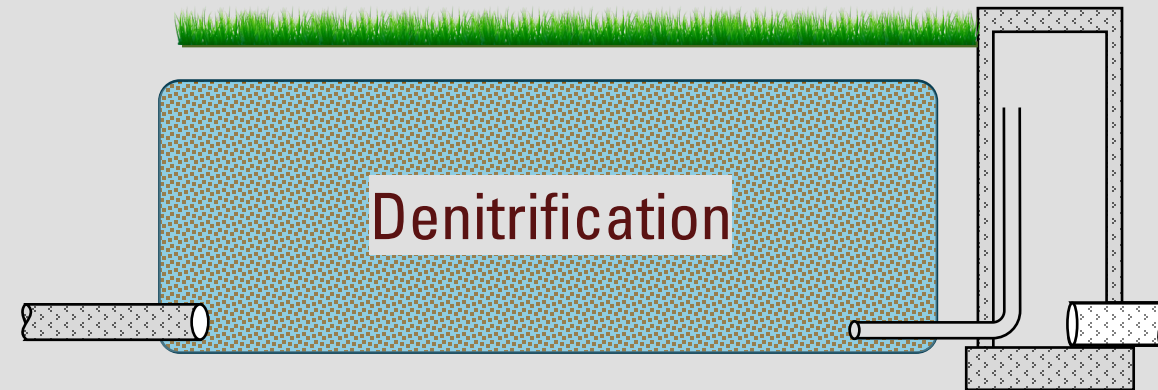
- 1 Residence Time
- 2 Carbon Source
- 3 Saturated Conditions
- 4 Control Flow Paths



USDA
United States Department of Agriculture

605-CPS-1

Natural Resources Conservation Service
CONSERVATION PRACTICE STANDARD
DENITRIFYING BIOREACTOR
CODE 605



WHAT THIS LOOKS LIKE IN PRACTICE

A HANDBOOK OF CONSTRUCTED WETLANDS



a guide to creating wetlands for:
AGRICULTURAL WASTEWATER
DOMESTIC WASTEWATER
COAL MINE DRAINAGE
STORMWATER

1 Residence Time

2 Carbon Source

3 Saturated Conditions

4 Control Flow Paths

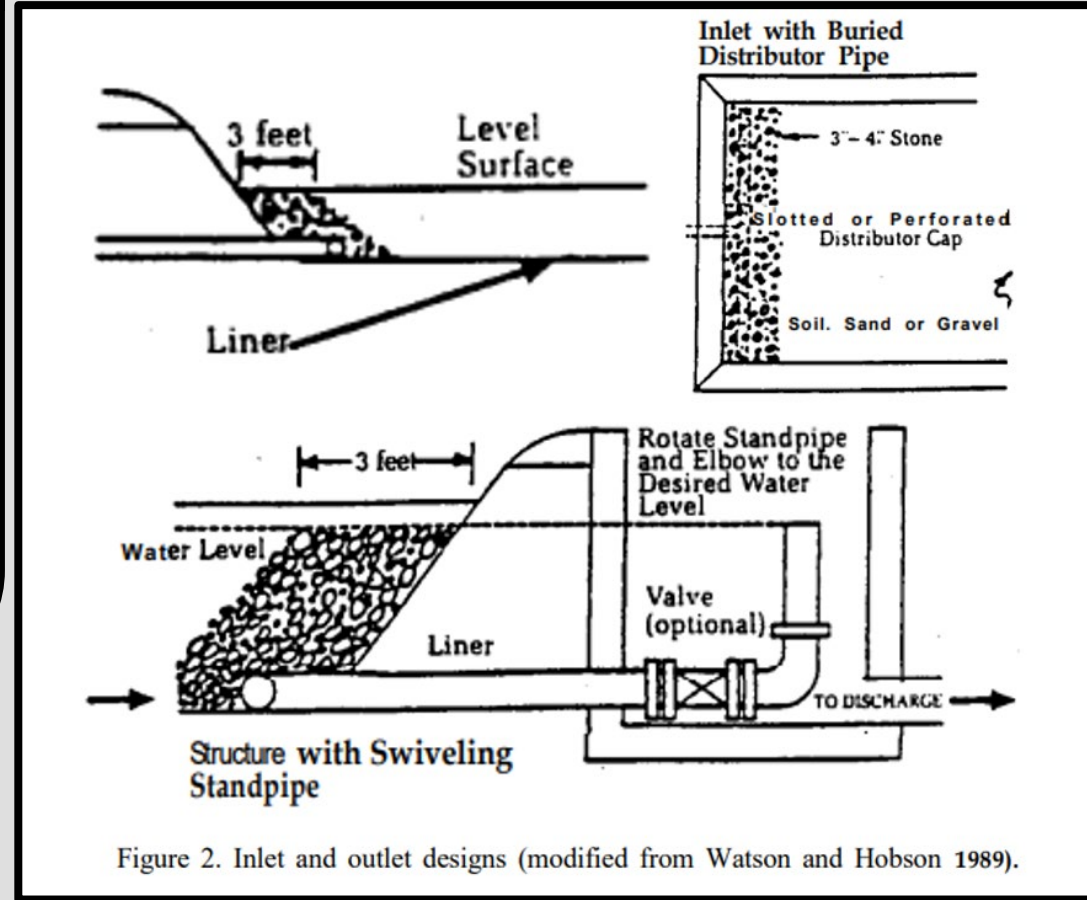


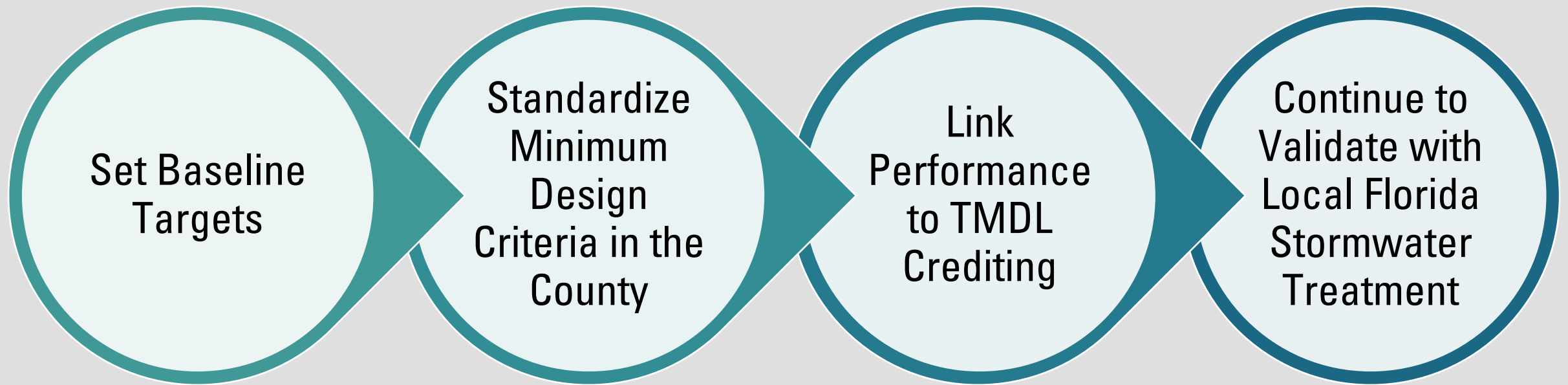
Figure 2. Inlet and outlet designs (modified from Watson and Hobson 1989).

KEY TAKEAWAYS

- Variable Performance
- No Single Controlling Factor
- Nitrate Removal Can Be Predictable
 1. Design
 2. Maintenance



PATH FORWARD





THANK YOU!

Questions?