

Treatment of Nitrate on the Edge of Vegetable Farms

UC Cooperative Extension Field Day
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Spreckles, California

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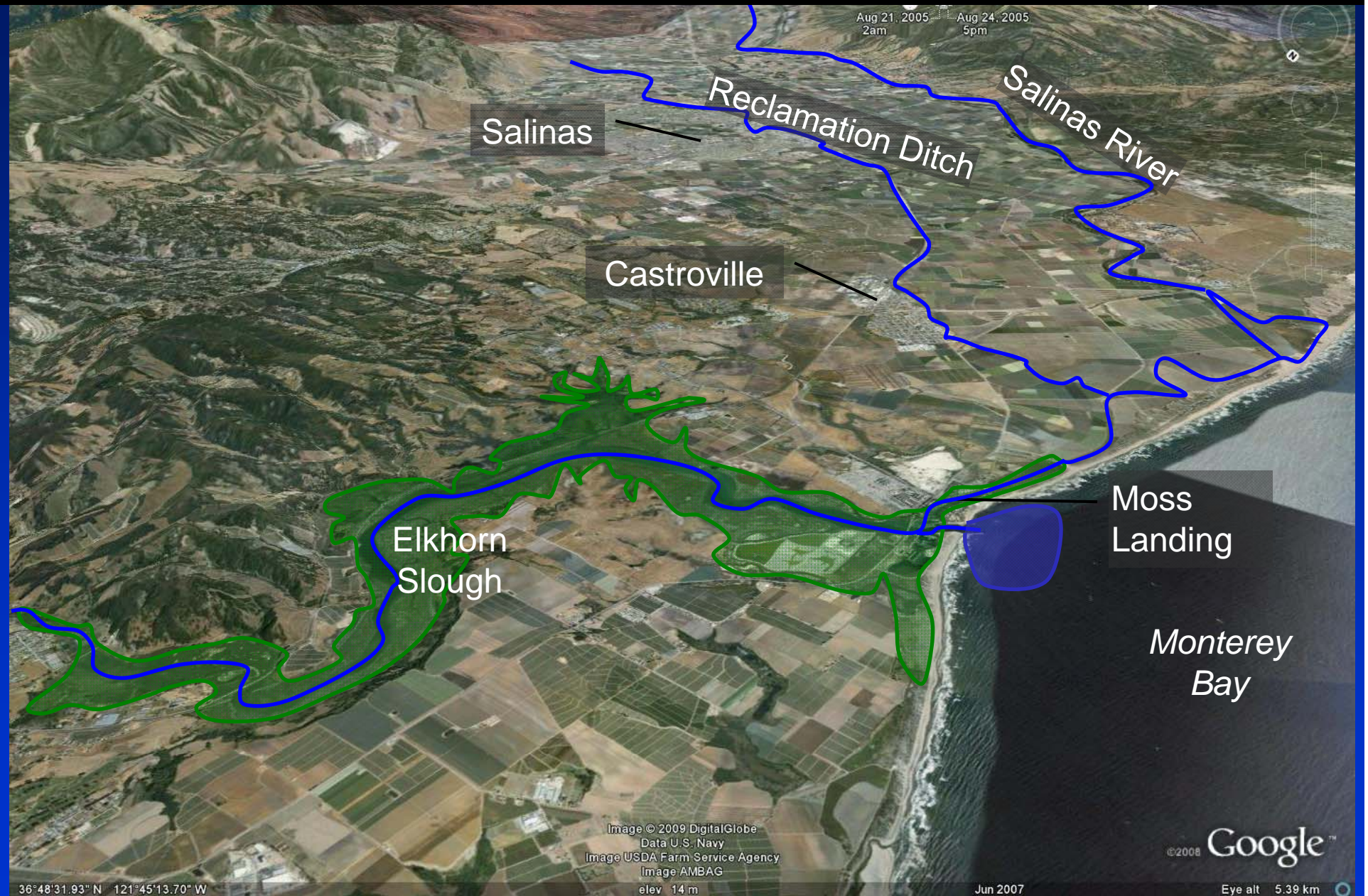
University of California at Davis

Civil and Environmental Engineering

Outline

- Regional context
- Objective: remove nitrate from drainage water
- Design alternatives

Regional Context: Monterey Bay



Local impacts

1 ton of nitrate enters Moss Landing Harbor every day

Elkhorn Slough receives 125 lbs of N/acre/year

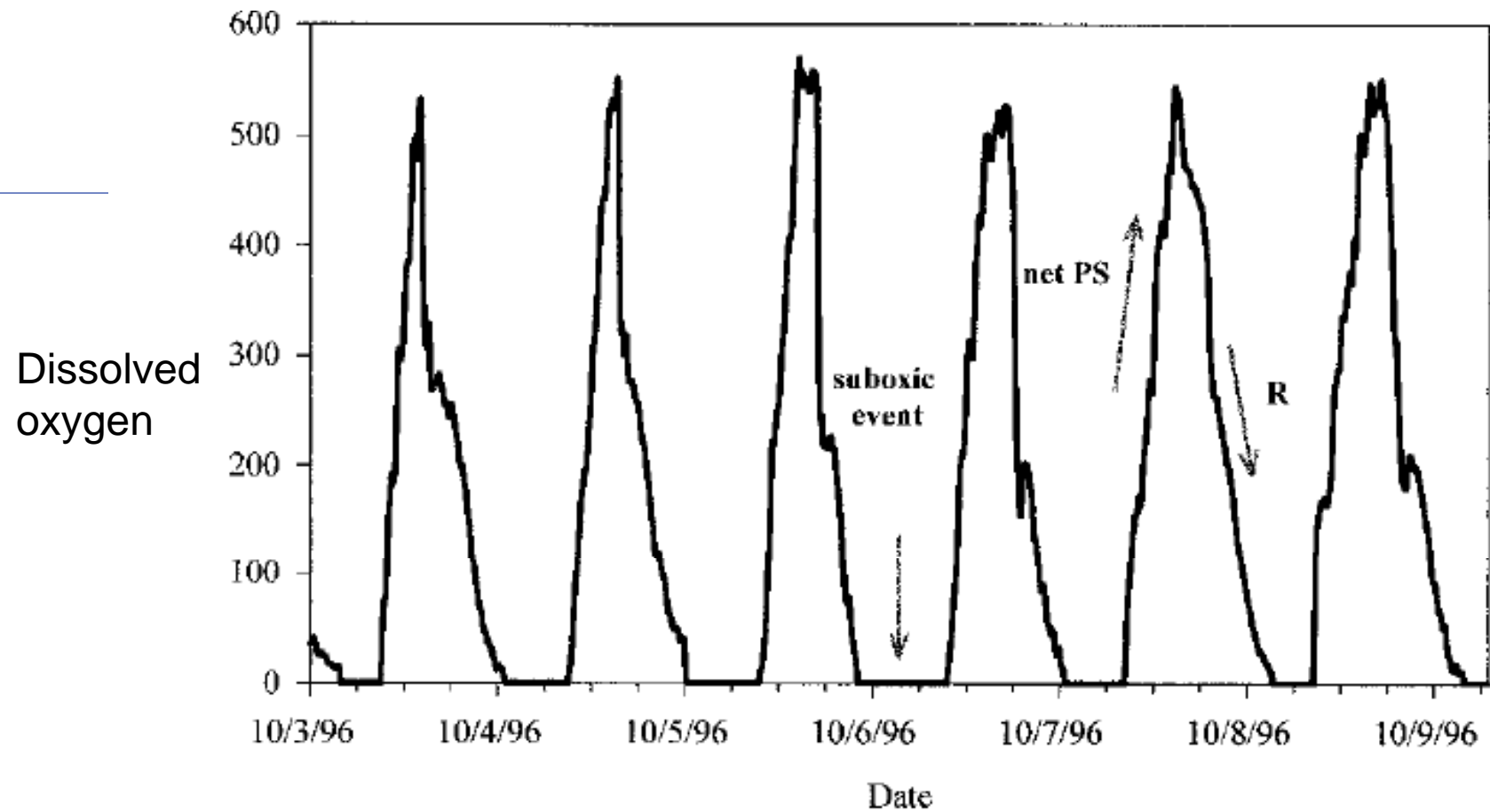
- algal blooms
- low dissolved oxygen

Parts of Elkhorn Slough run out of oxygen every night.

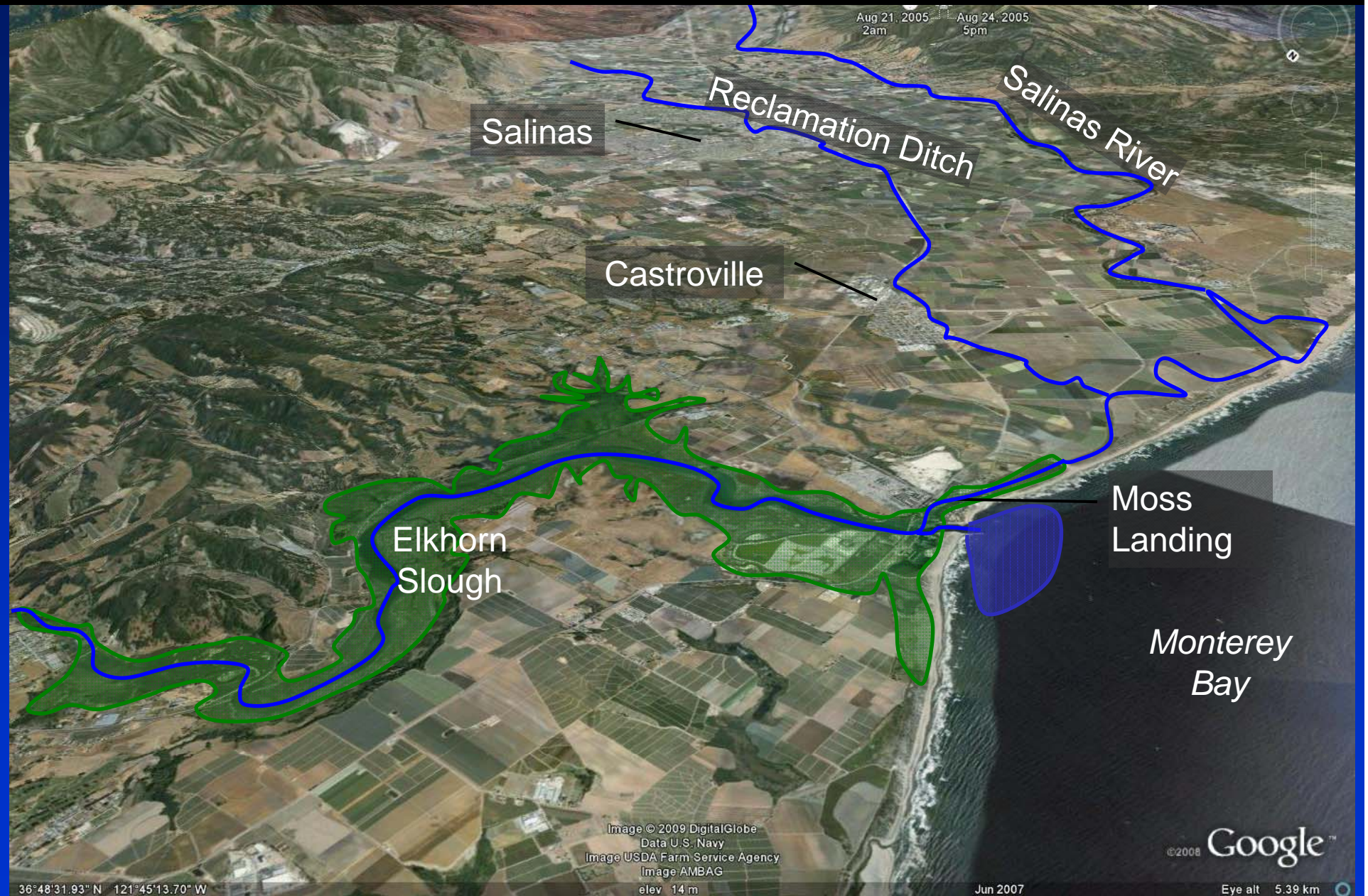


Local impacts:

Low dissolved oxygen in Elkhorn Slough



Many Sources of Nitrogen



Healthy food, community, environment

- **Vegetables and fruits**
- **\$4 Billion in produce**
- **Long time residents**
- **History of partnership**



Nitrate management options

- More precise nutrient management
 - Slim margin for error
- Denitrification
- a fuel is consumed using nitrate instead of oxygen
 - Farm edge treatment
 - Regional treatment

Nitrate treatment options

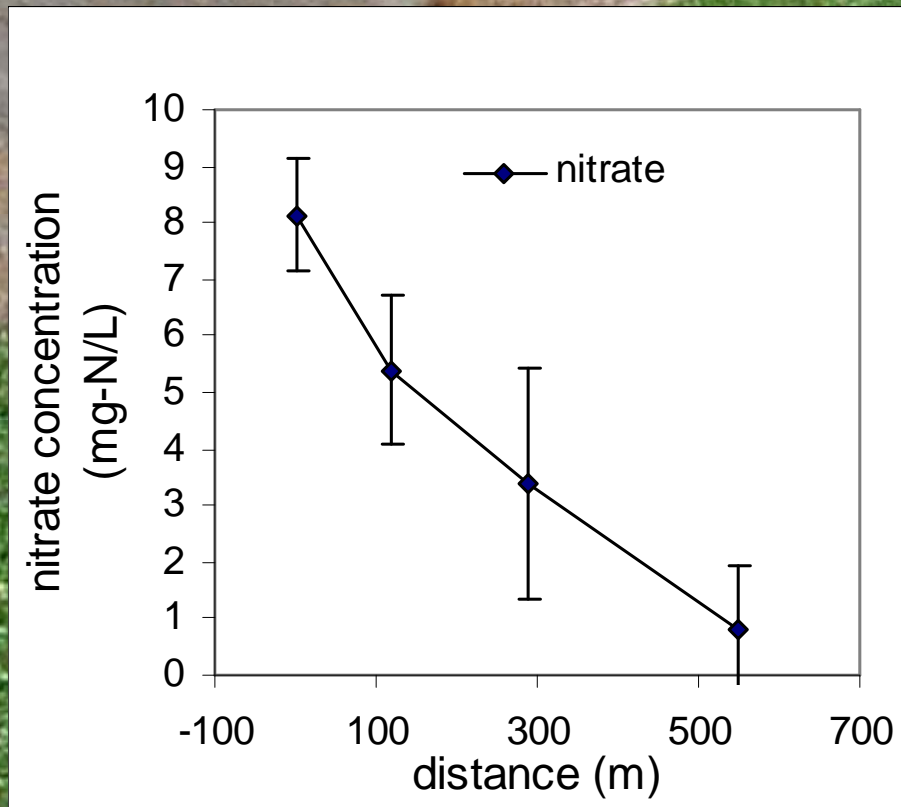
■ Denitrification

- Constructed wetland – ditch with plants
- Reactor – container with media, chemical feed
- Reactor - wood chips, buried or at-grade

■ Extraction

- Ion exchange – recovers nitrate
- Reverse osmosis

Keys to performance: Reference sites





Treatment Wetlands: floating pennywort watercress



Trial Site:

VTS Site 4, Dual Ponds, Row Crops

Footprint 0.4 acres

Volume 0.5 acre-feet



Nitrate and Field Ditch Wetlands

How did they work?

Only worked well at very low flow rates

Too small:

not enough carbon

too much nitrate

Other issues

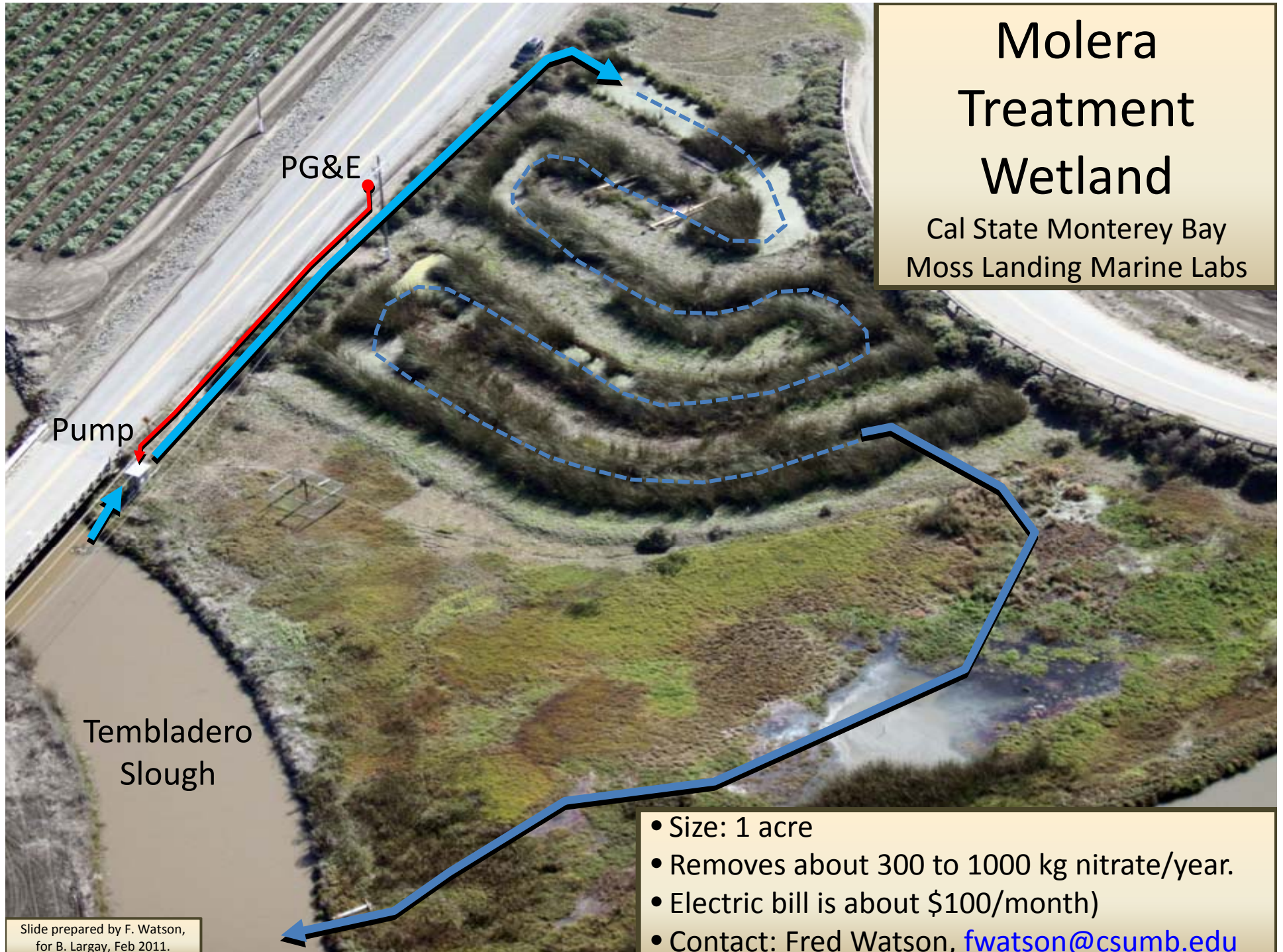
Food safety concerns

Regional treatment wetlands

- Use low value wet ground
- Would require 300+ acres in the Rec Ditch watershed
- Cooperative agreements among upstream operators
- Economic impacts of lost production

Molera Treatment Wetland

Cal State Monterey Bay
Moss Landing Marine Labs



- Size: 1 acre
- Removes about 300 to 1000 kg nitrate/year.
- Electric bill is about \$100/month)
- Contact: Fred Watson, fwatson@csumb.edu

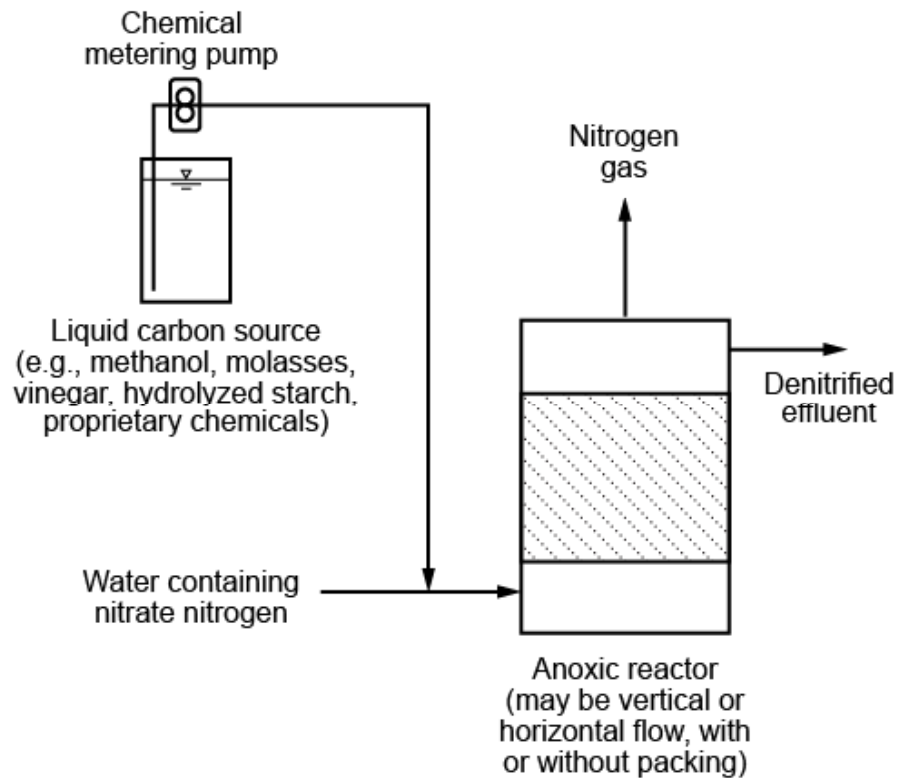
Efficient, individual field-edge treatment

Denitrification of tile-drain effluent:

Technology Summary

**Proven and experimental technologies for
full-scale, on-field applications.**

Prepared by: Harold Leverenz, PhD, PE and
Aaron King, EIT



ANOXIC REACTOR WITH CHEMICAL FEED

1. Flow from collector pipe pumped into reactor.
2. Mixed with chemical Carbon source (methanol, etc).

Startup Cost: ~ \$15,000 for 100 acre field

Decreased per acre cost with larger acreage

Requires:

1. Chemical inputs, tank and pump
2. Reactor (s)
3. ~ monthly operation/maintenance inputs

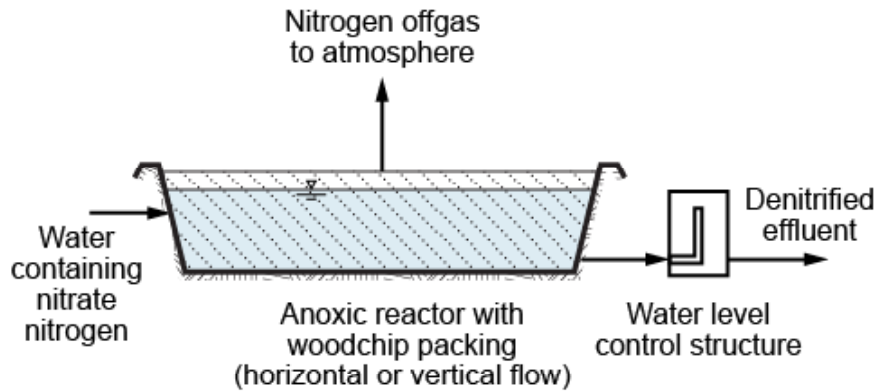
Pre-engineered systems available

Proven technology



www.aquapoint.com

ANOXIC WOODCHIP REACTOR AT-GRADE or BELOW-GRADE



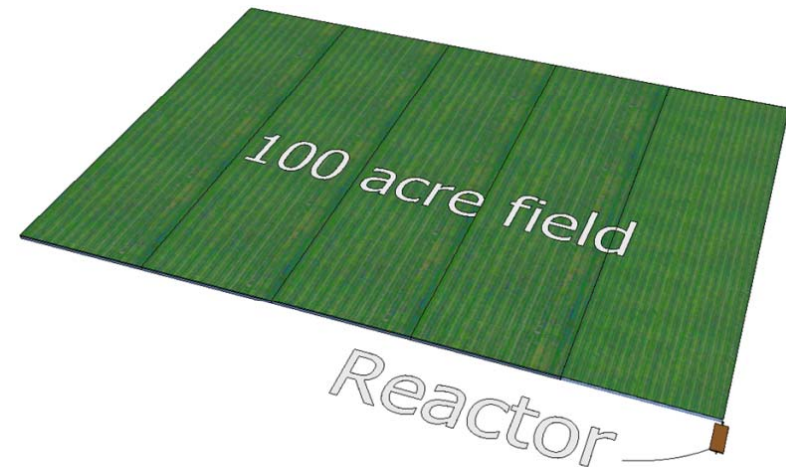
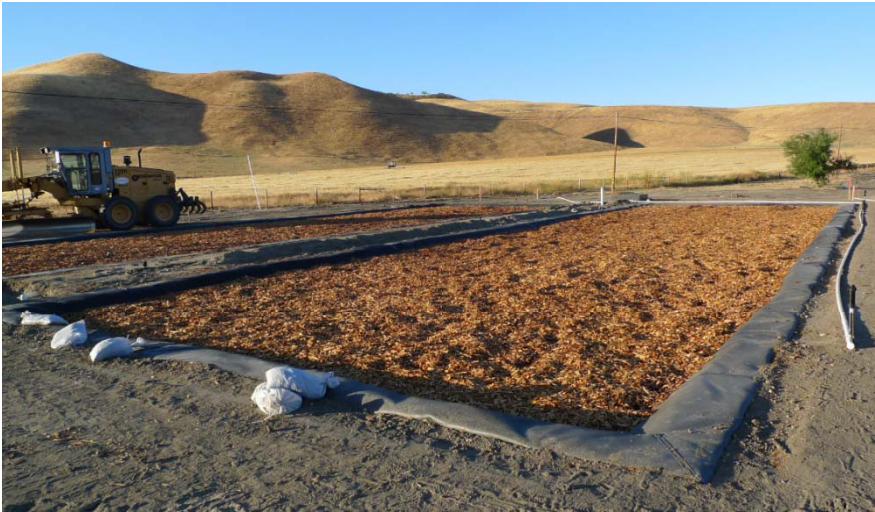
1. Passive system
2. Flow from collector pipe pumped into reactor
3. Wood chips as Carbon source

Startup Cost: ~ \$20,000 for 100 acre field

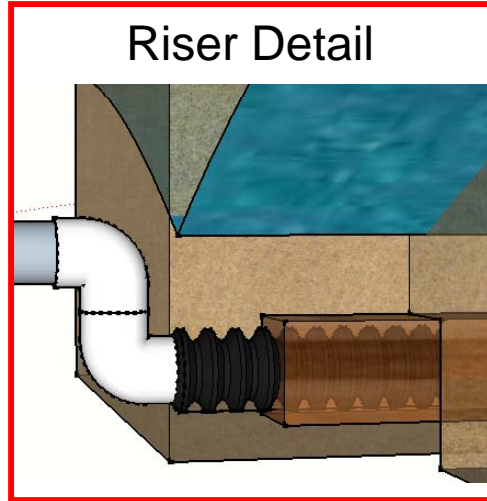
Decreased per acre cost with larger acreage

Requires:

1. Reactor basin
2. Woodchips
3. Minimal operation and maintenance



***In-situ* treatment option for tile drains**

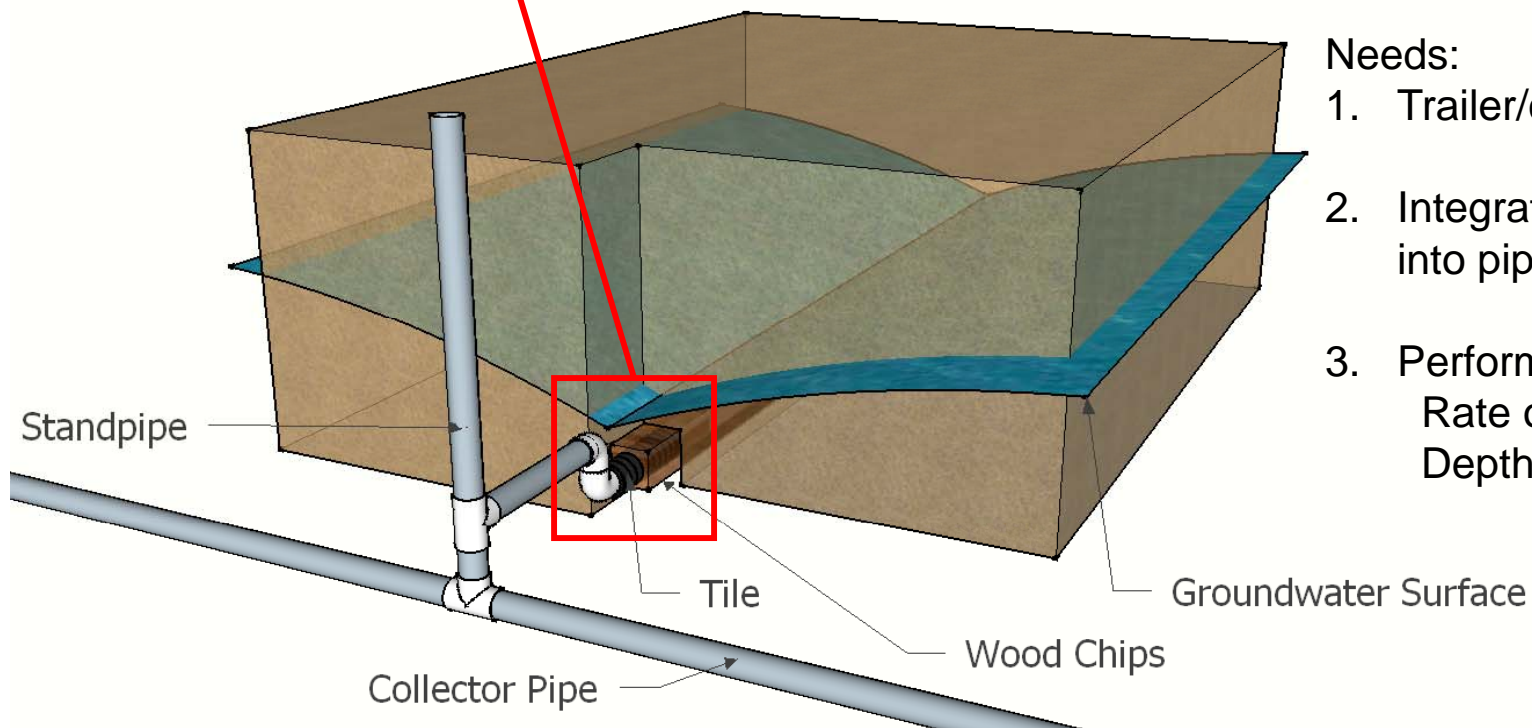


1. Place woodchips in with tile drain
2. Passive denitrification in tile drain ditch

Startup Cost: 20% to 50% increase over normal tile drain installation

Requires:

1. Modification of tile installation equipment
2. Wood-chip trailer/dispenser
3. ~240 feet of ditch per cubic yard of chips



Needs:

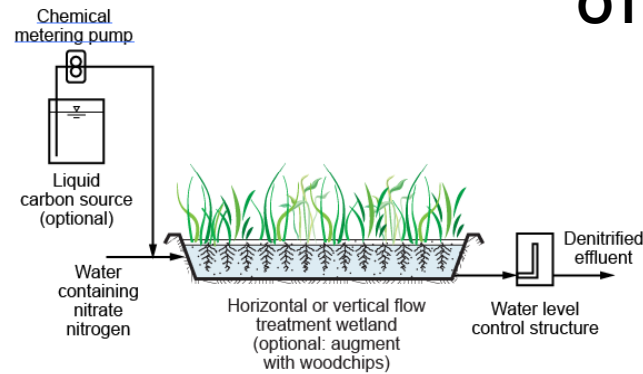
1. Trailer/chute design
2. Integration of chip delivery into pipe laying
3. Performance testing on:
Rate of chip application
Depth of water

OTHER SYSTEM TYPES

Hybrid Constructed Wetland

plants uptake nutrients

- space inefficient without chemical feed

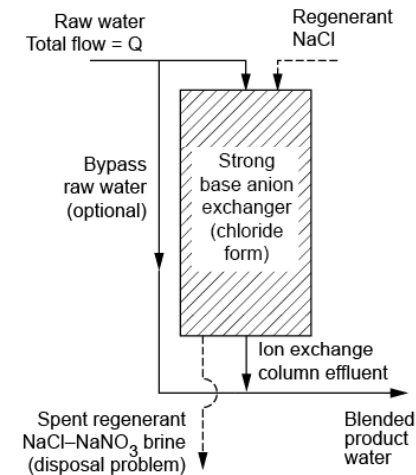


Ion Exchange

similar to a water softener

+ recoverable N

- very expensive
- high maintenance
- must remove regenerant salts from brine to use the recoverable N



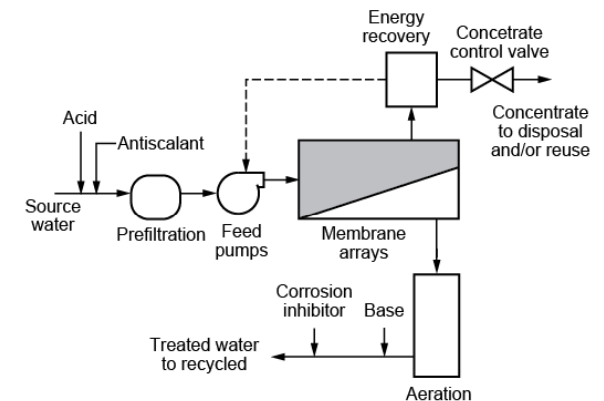
Reverse Osmosis

like bulk water dispensers or under-sink units

+ smallest footprint

+ recoverable N

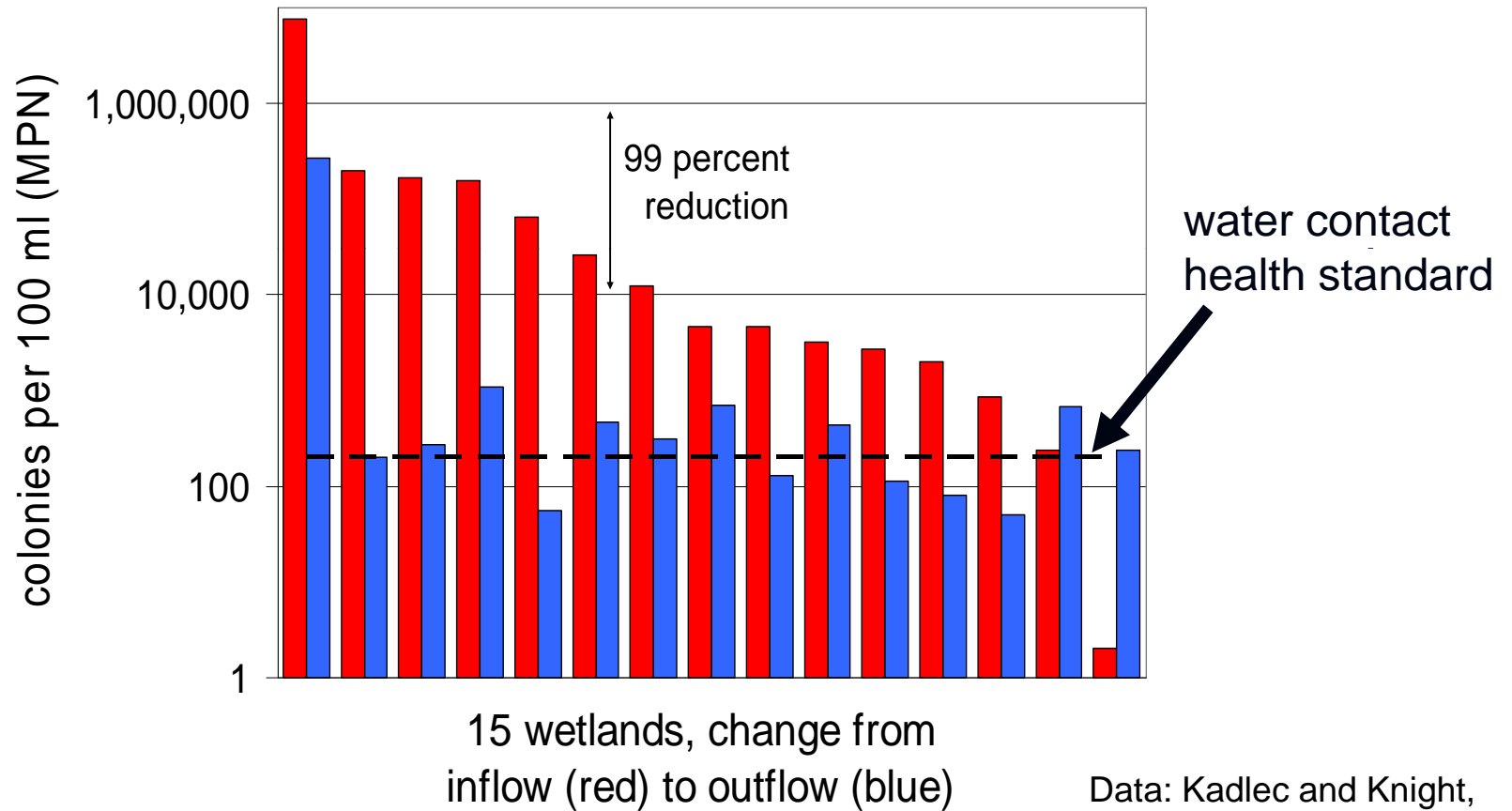
- other constituents come along with N
- very expensive
- high maintenance



Questions

Barrier: Bacteria and food safety

Wetlands treat wastewater



Data: Kadlec and Knight, 1996. Treatment Wetlands