Treating Runoff

Biological Treatment of Nursery Runoff

to Remove Pathogens, Nutrients, and Pesticides

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Challenges & Concerns

- Quality
  - Contaminants
    - nutrients
    - pesticides
    - pathogens
- Quantity
  - Limited potable supply
  - Alternative water sources
  - Recycling

Pathogen contaminants

- Waterborne pathogens
  - perennial problem
  - billions in crop losses
- Treatment
  - effective (chlorine, pasteurization, UV, etc.)
  - drawbacks
    - expense
    - worker safety

Biological filters

- Soils provide habitat for microbes
- Microbes process
  - nutrients
  - organic contaminants
- Vegetation slows water
- Plant uptake/absorption
  - nutrients
  - trace metals
  - other compounds

Constructed biofiltration systems

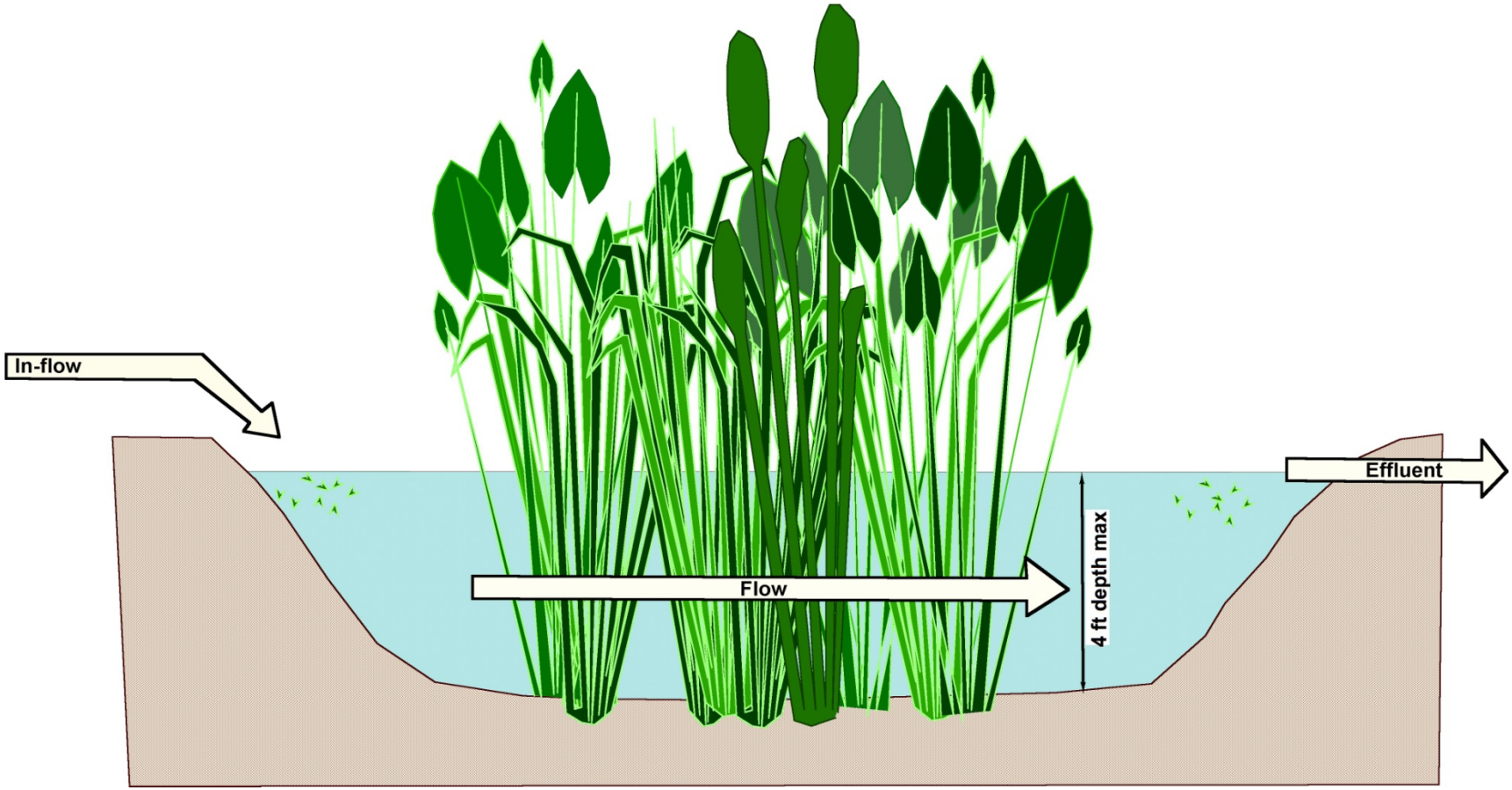
- Water management tool
  - Site-specific design
    - Contaminants
    - Loading rates
    - Runoff volumes
  - Low maintenance
  - For both recycling and release

Ecological treatment alternatives

- Large-scale treatment systems
  - Constructed wetlands
    - free water surface (surface flow)
    - subsurface
- Small-scale treatment systems
  - slow sand filtration
  - mobile/portable constructed wetlands

Large-scale treatment systems

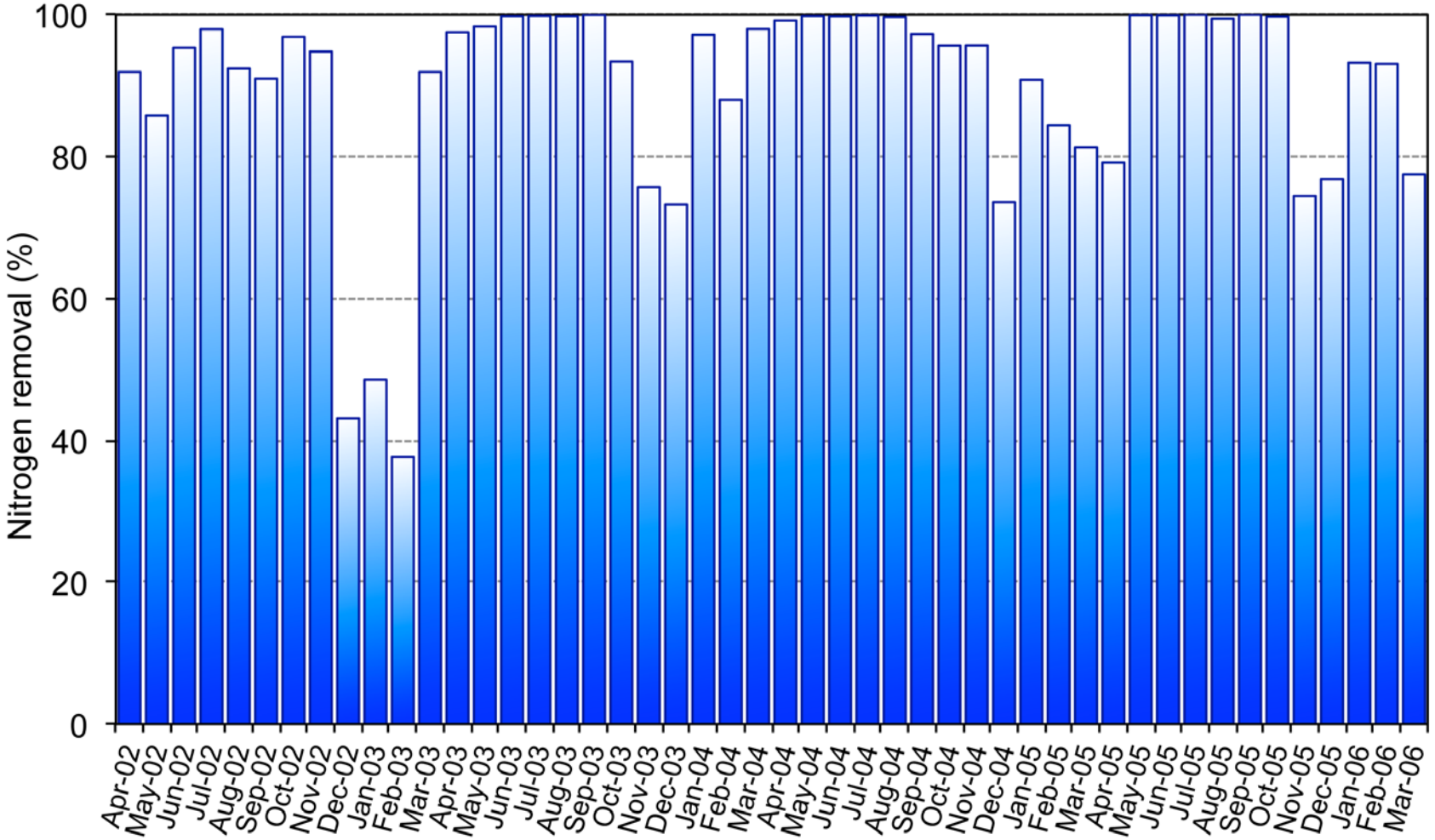
Free water surface constructed wetland



Nursery case study

- 9.31acre
- Runoff from 120 acres of production

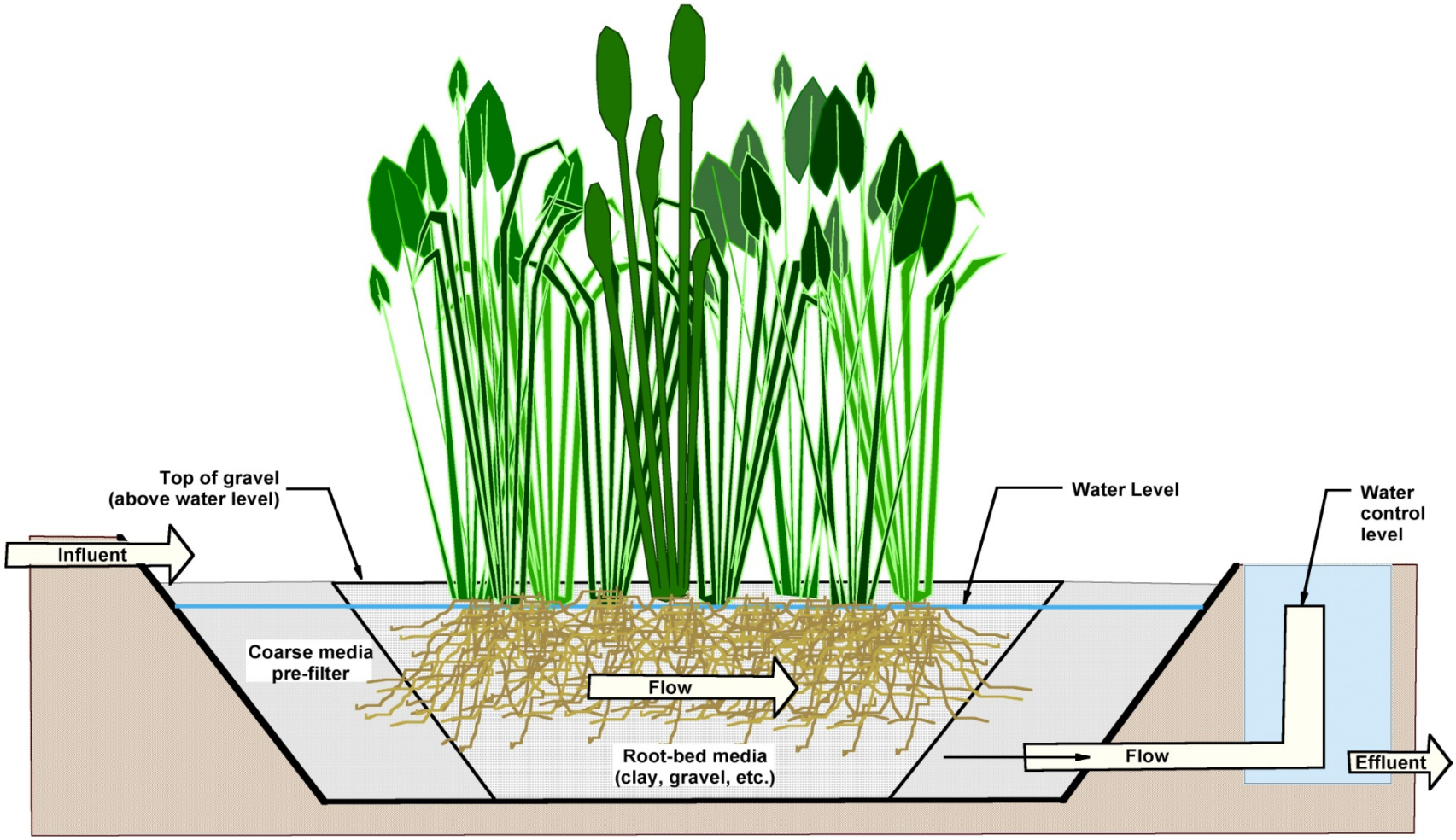
Nitrogen removal efficiency



Surface flow constructed wetlands

- Most efficient with high to moderate runoff volumes
- Efficient nitrogen removal
- Phosphorus not consistently treated
- Pesticide removal 50-98%

Subsurface flow constructed wetlands



Subsurface flow constructed wetlands

Image: Ayala Water | Kibutz Lotan – Dairy & residential sewage treatment in an extremely arid zone

Phosphorus removal

- Subsurface flow CWs treatment enhanced phosphorus removal
- Vegetated subsurface flow wetlands increased longevity of phosphorus removal
- Monitor for phosphorus saturation of clay

Subsurface flow constructed wetlands

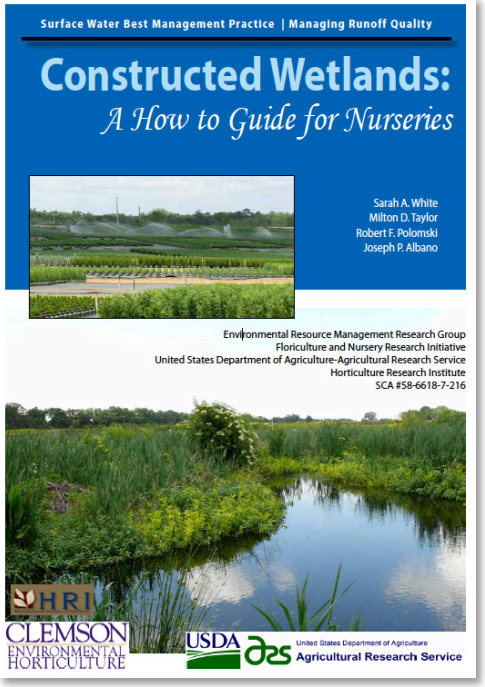
- Reduce ammoniacal N emissions
- Efficient nitrogen & phosphorus removal
- Pesticide removal depends upon pesticide class

Large-scale treatment systems

- Free water surface constructed wetlands
  - large land area
  - effective N remediation
- Subsurface flow constructed wetlands
  - smaller land "footprint"
  - effective N & P remediation
- Pesticide removal depends upon pesticide chemistry

Constructed Wetlands: *A How to Guide for Nurseries*

http://tinyurl.com/sustainable-nursery



Slow Sand Filtration

- What is slow sand filtration?
- System design and operation
- How they work

What is Slow Sand Filtration?

Sand Filters

- Rapid sand filtration
- Slow sand filtration

What is Slow Sand Filtration?

Water Treatment Methods

- Rapid sand filtration
  - Coarse sand (>1mm)
  - Removes larger particles only
  - Does not remove pathogens
  - Does not remove pollutants
  - 2-20 gpm/ft^2
  - Low maintenance

What is Slow Sand Filtration?

Water Treatment Methods

- Slow sand filtration
  - Removes pathogens
  - Removes many pollutants
  - Low maintenance
  - Slow flow rates
    - **0.06-0.2 gpm/ft^2**
    - 12’ dia tank can treat 10,000 gpd

Mechanism

- Very little mechanical removal
- “Schmutzdecke” Where most treatment occurs
  - A community of microorganisms
  - Bed surface to 6 inches below
- Organisms that have been identified:
  - algae, bacteria, diatoms, and zooplankton
- Mechanisms for removal are not fully understood

Capabilities

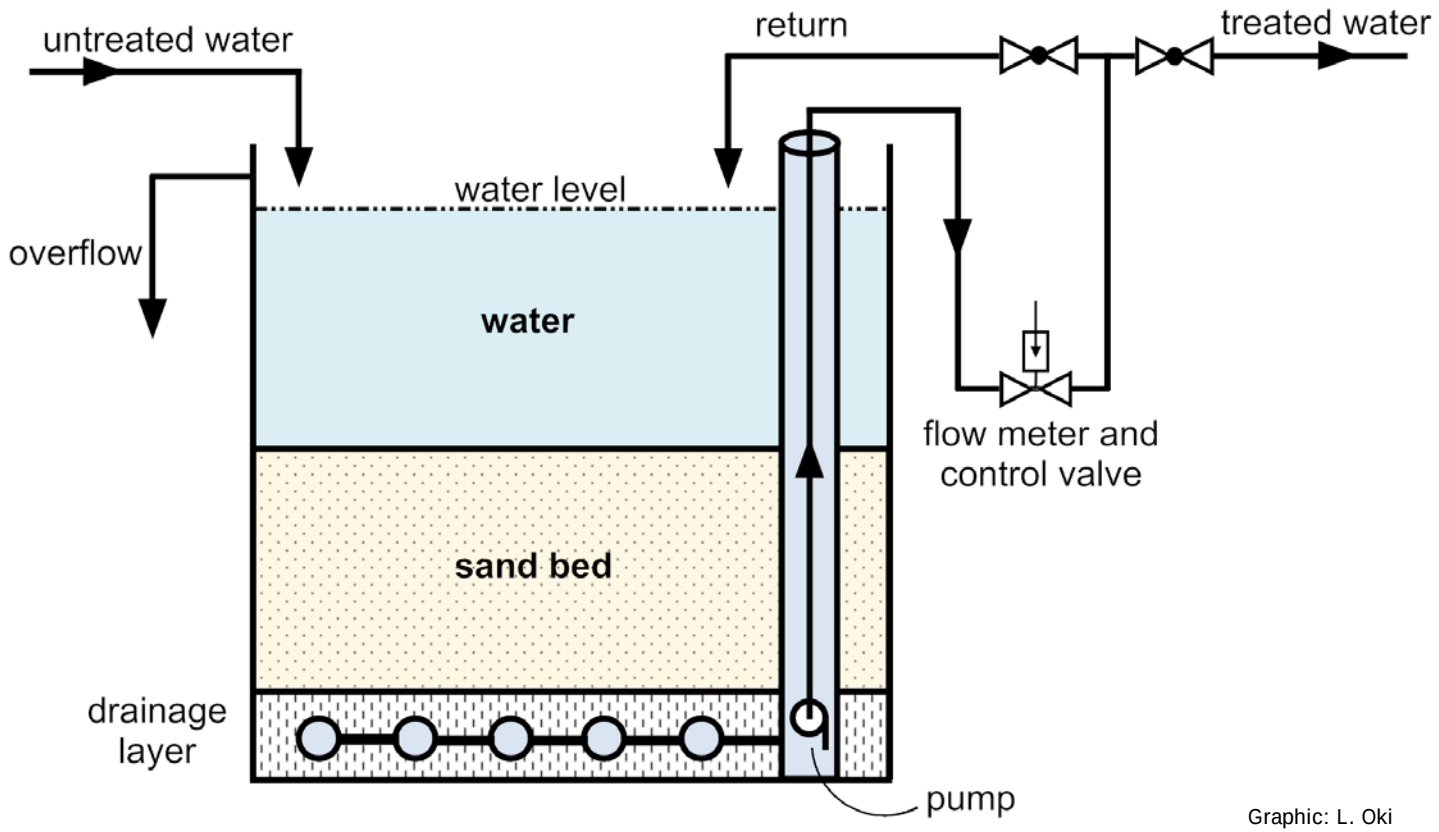
Can remove

- Pathogens
- Nutrients
- Chemical pollutants

Specifications

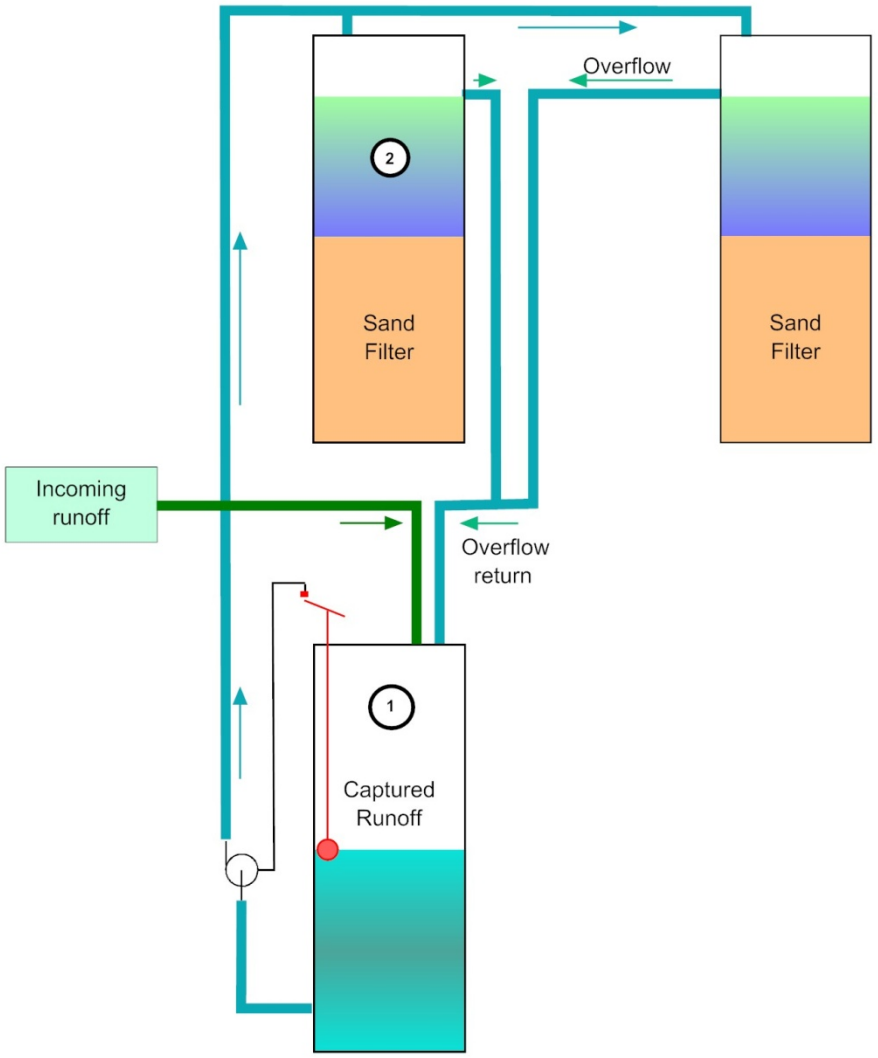
- Uniform particle size
  - 60 mesh (0.3mm)
  - Uniformity Coefficient (UC)<3
- 1m water head over sand
- Sand must stay submerged
- Sand surface must not be disturbed
- Flow control
- Recommend 1m sand depth
- Recommend at least two filters

System Design



Graphic: L. Oki

System Design



Graphic: L. Oki

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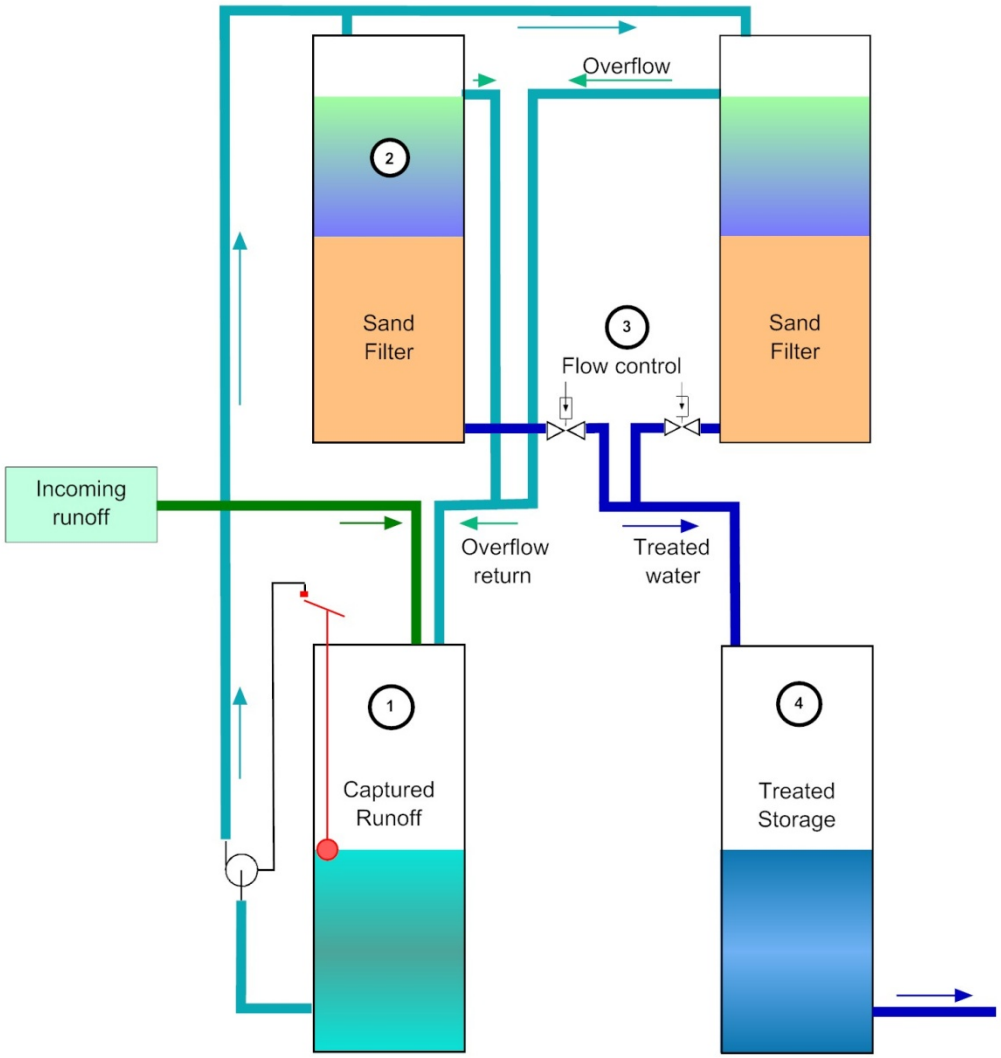

Graphic: L. Oki

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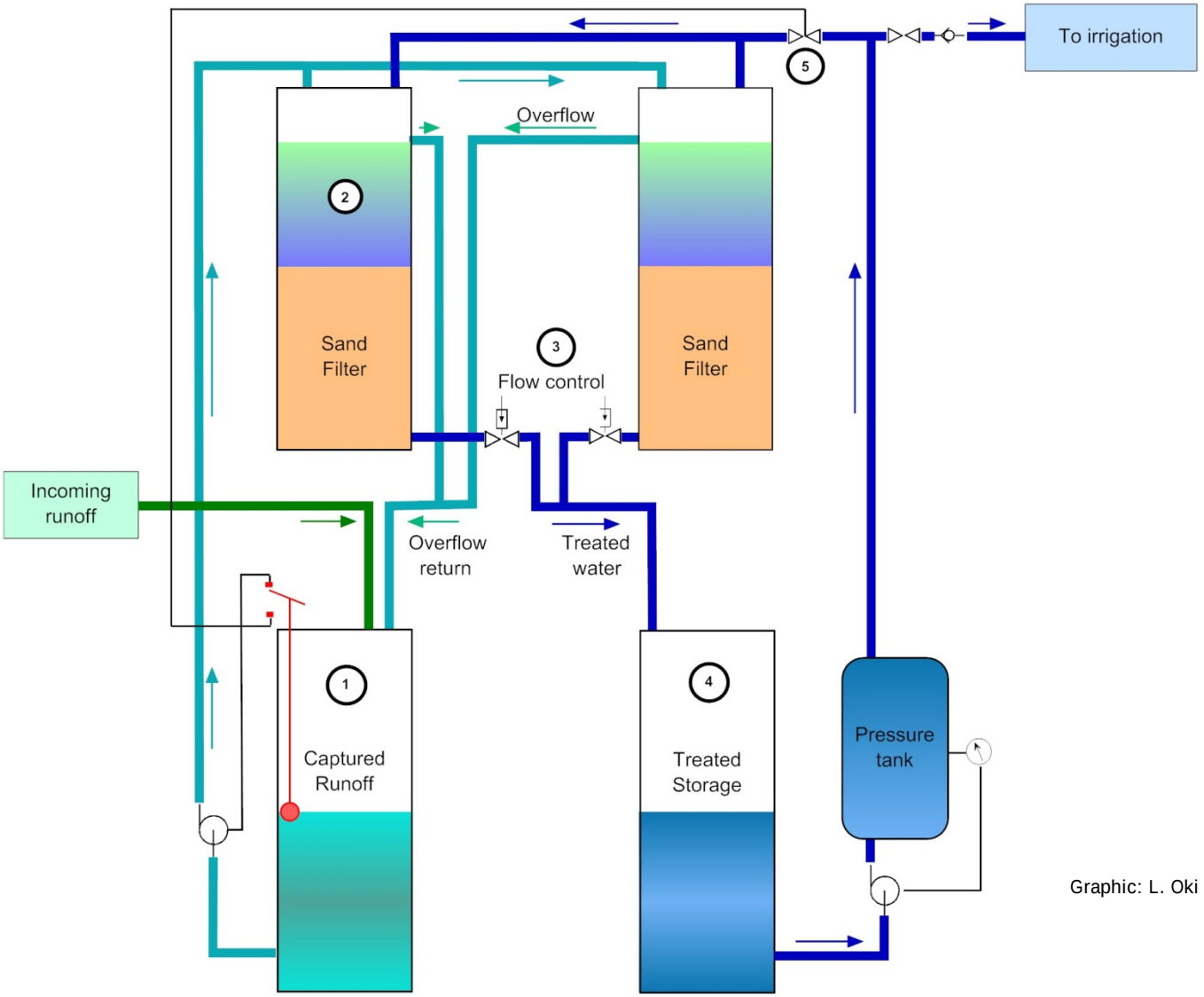
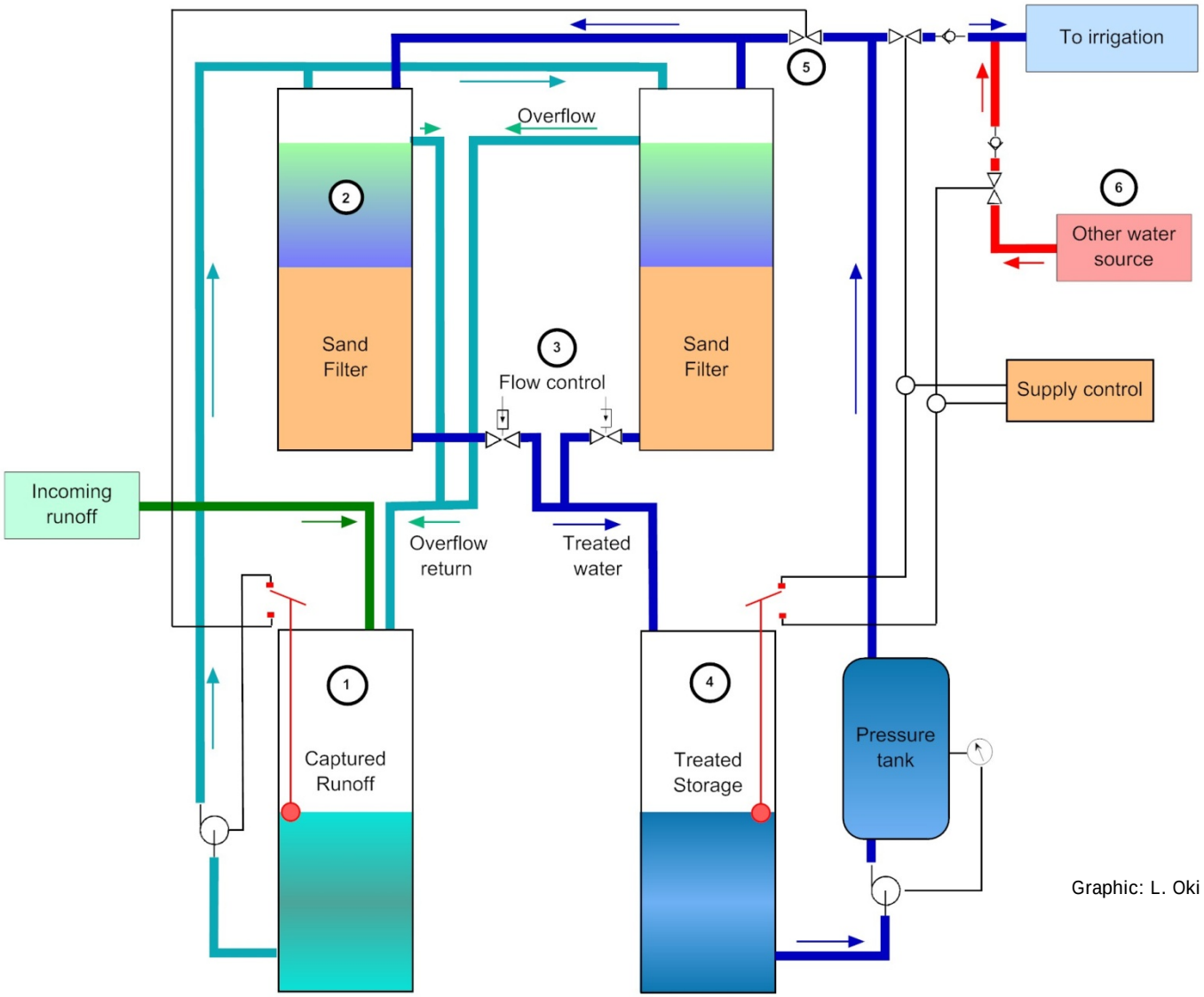


Graphic: L. Oki

System Design



Graphic: L. Oki

Installations

Estimated treatment capacity
Surface area ≈ 50 sq.ft. (5'x10')
@ 0.5 gpm/yd^2 → 4,400 gpd

Berylwood Tree Farm, Somis

Installations

Supernatant water

Filter surface (sand)

Underdrain system (lowest level)

From: Sabine Werres, Federal Biological Research Center for Agriculture and Forestry, Braunschweig, Germany

Installations

- 80 m^2 surface
  - 861 sq.ft.
  - ~33’ dia.
- ~74,000 gal/day
- Untreated storage
  - 1,717,118 gal
  - 5.2 acre-ft
- Treated storage
  - 132,000 gal

Classic SSF system setup, Roundstone Nurseries

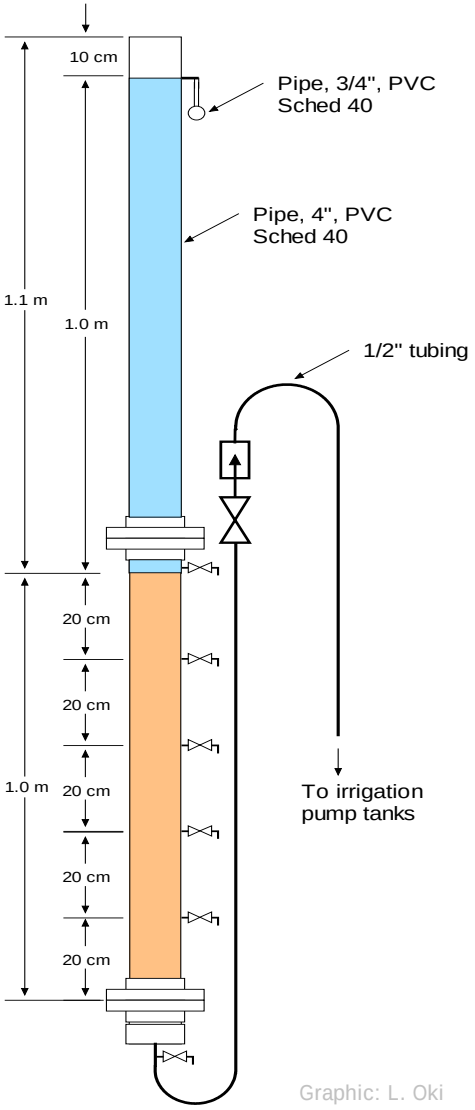
Horticultural Development Council, 2005

Slow Sand Filtration

Experimental design

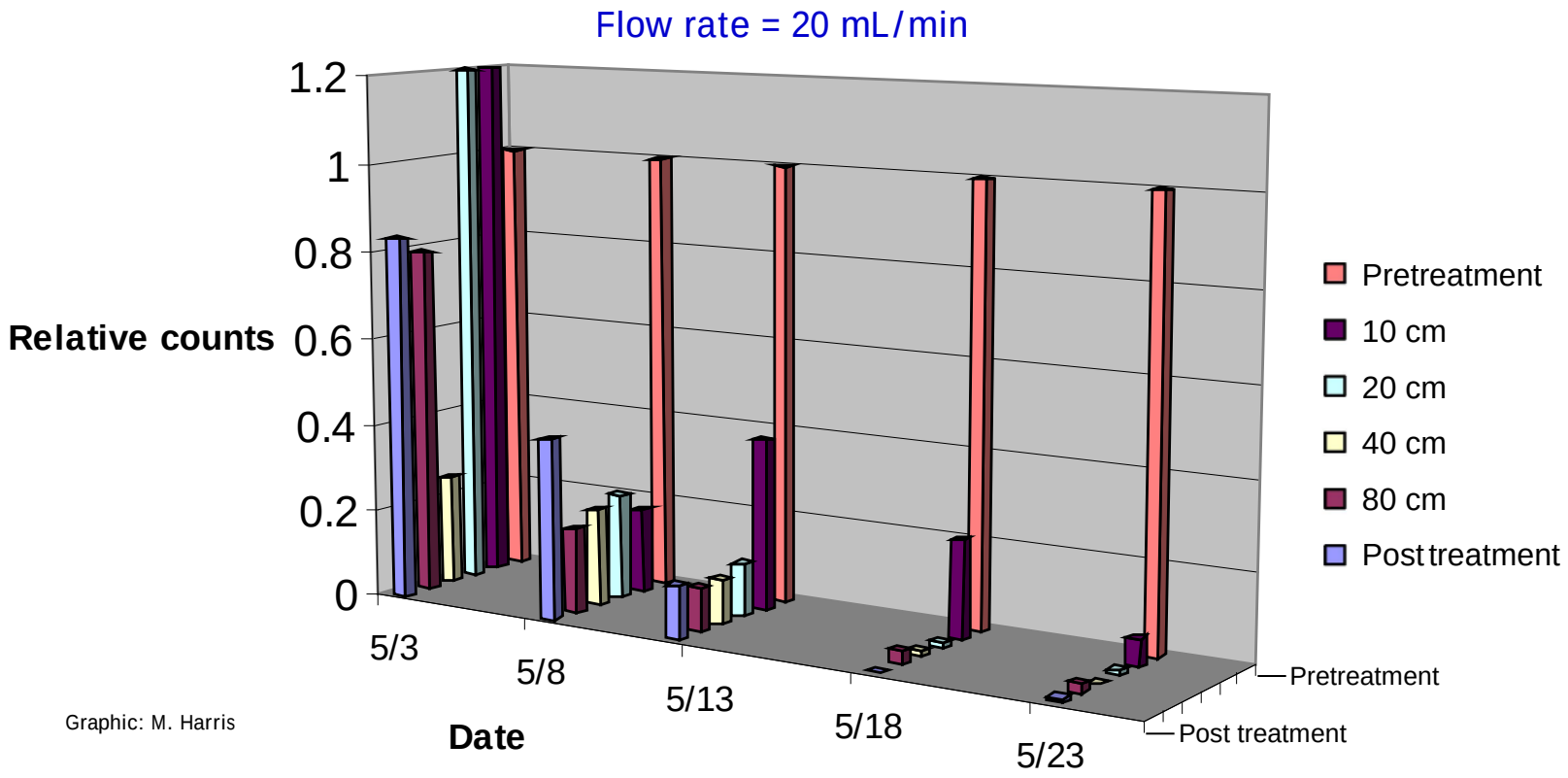
- Generate and capture irrigation runoff
- Inoculate treatment water
  - *Phytophthora capsici*
- Collect water samples
  - Pretreatment
  - From within sand bed
  - Post treatment
- Analyze for *P. capsici*

Slow Sand Filtration



Graphic: L. Oki

Relative colony counts



Graphic: M. Harris

Current and future work

- Examine treatment mechanisms
  - Identify microorganisms present
- Coupled systems
  - Vegetated filters
- Removal of viruses & nematodes

Mobile Environmental Solutions Inc.
Tustin, CA

Current and future work

Conclusions

Biological treatment systems:

- Require little or no inputs
  - Contrast with energy (UV irradiation) or chemical-based (chlorination) methods
- Can remove nutrients, chemical pollutants, and pathogens
- Low flow rates means space is required to hold large volumes of water

Conclusions

- Both vegetated and slow sand systems require long residence times
- Subsurface flow and slow sand filters can clog if water contains particulates
- Efficient water treatment systems may consist of combinations of treatment methods
  - Vegetated or slow sand systems alone can provide adequate treatment
  - Paired systems may be able to provide greater flow rates


Thank you
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