GRAVEL UPFLOW ROUGHING FILTERS AS PRE-TREATMENT FOR SLOW SAND FILTRATION

AWWA PNWS Annual Conference

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By

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Gray & Osborne, Inc.

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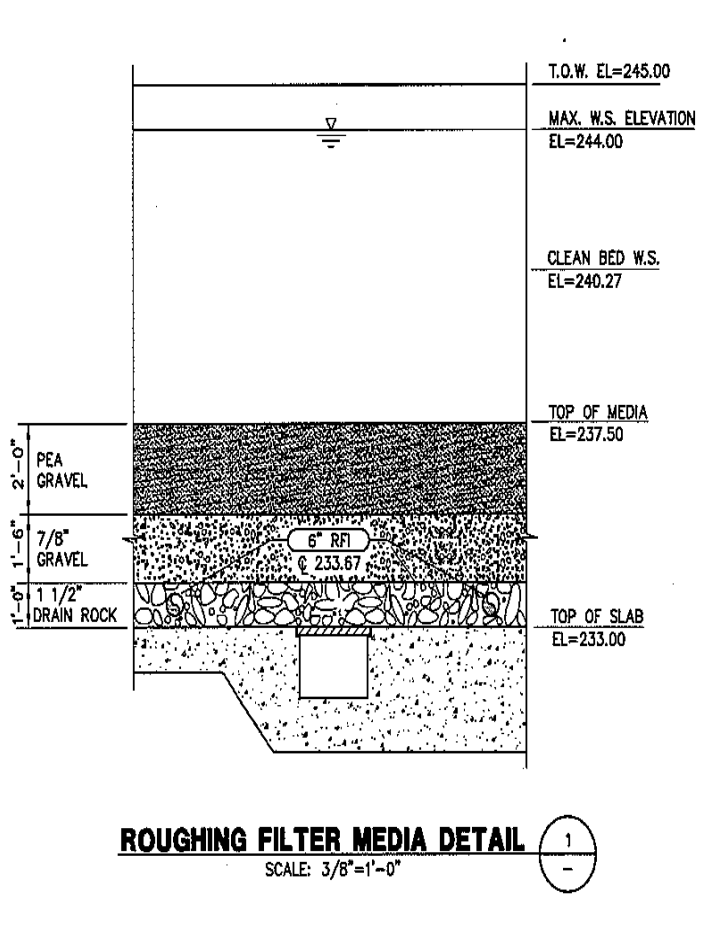
Slow Sand Filters

- Physical / Biological Treatment Process
- Filter Surface is Scraped Periodically to Restore Filtration Capacity
  - Typical Scraping Interval = 1 – 12 months
- Filter Scraping
  - Labor Intensive
  - Removes Filters from Production
    - 1-2 Days to Scrape
    - Several Days to Weeks to Ripen
- Typically Limited to High Quality Source Water
  - <5-10 NTU

Roughing Filters

- Upflow
- Graded Washed Gravels
  - Pea Gravel
  - 7/8” Drain Rock
  - 1 ½” Drain Rock
- Loading Rate
  - 1 gpm/sf
  - 10 x loading rate of Slow Sand Filter
- Piping
  - Distribution Manifold to Evenly Distribute Raw Water
  - Collection Header to Evenly Collect Treated Water
  - Drain Trough to Allow Rapid Flushing



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Roughing Filter Operations

- Periodically Backflush to Remove Accumulated Material
  - Typically Flush Every 1-3 Months
- Rapidly Open Drain Valve to Flush
- Flush Until Clear Water Observed
  - Typically 5 – 20 Minutes

Roughing Filter Advantages

- Reduce Turbidity Loading to Slow Sand Filters
- Increase Interval Between Slow Sand Filter Scraping
- Allow Slow Sand Filters to be Used On Higher Turbidity Source Waters
- Benefits Can be Source/Site Specific

Roughing Filter Case Studies

- Pilot Studies
  - Spring Point HOA
- Pilot Studies with Full Scale Treatment Plants Constructed
  - City of Roslyn
  - Town of Coulee Dam
  - Town of Pe Ell
  - Naselle Water Company

Spring Point HOA

- Orcas Island, WA
- Water Sources
  - Jay's Pond
  - Clyde's Pond
- Raw Water Quality
  - Shallow Ponds
  - High Organic
    - TOC = 6 – 13 mg/L
  - Raw Water Turbidity
    - Average = 8.0 NTU
    - Range = 1.1 – 120 NTU

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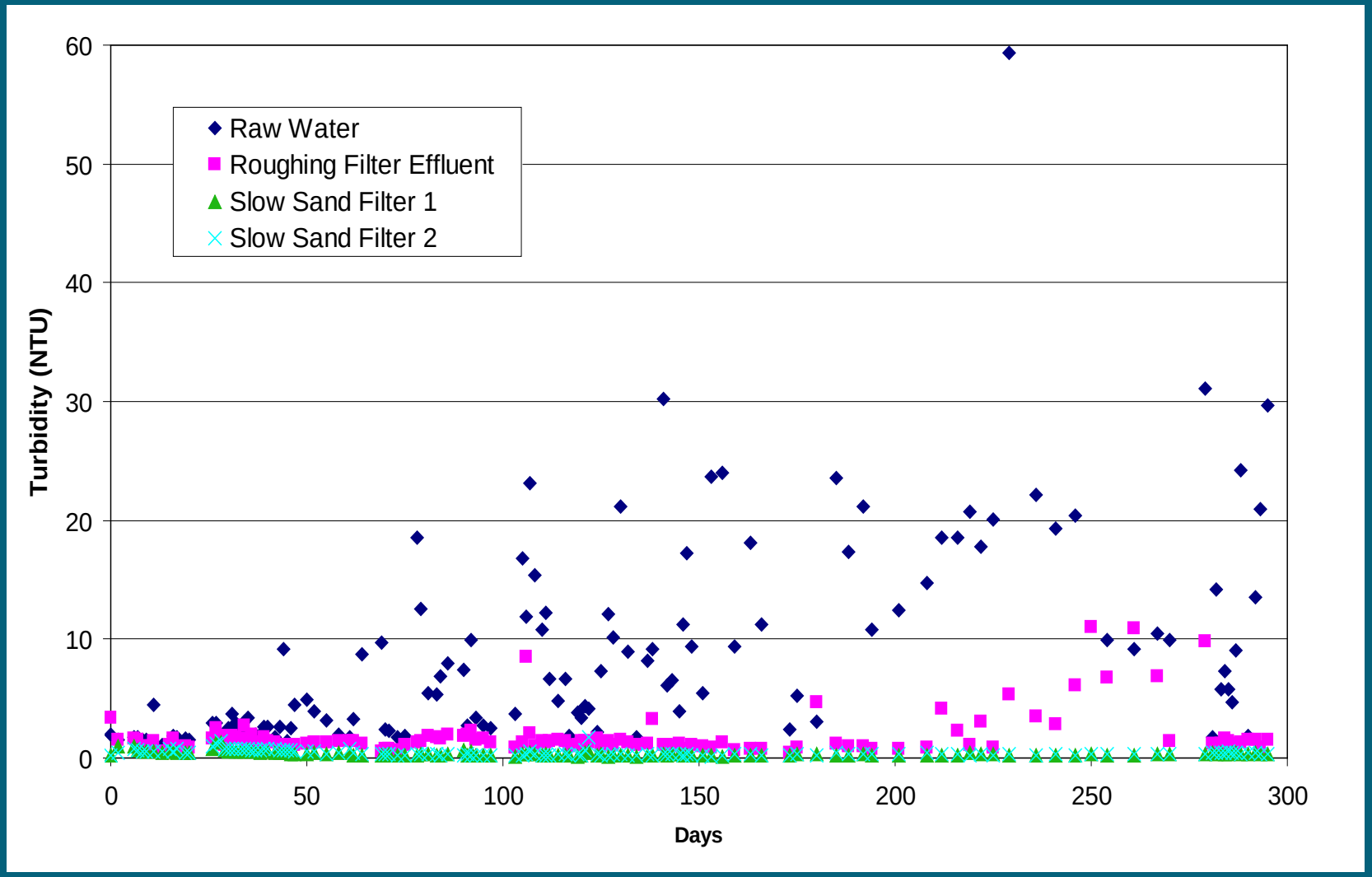
Spring Point HOA Pilot Study Data



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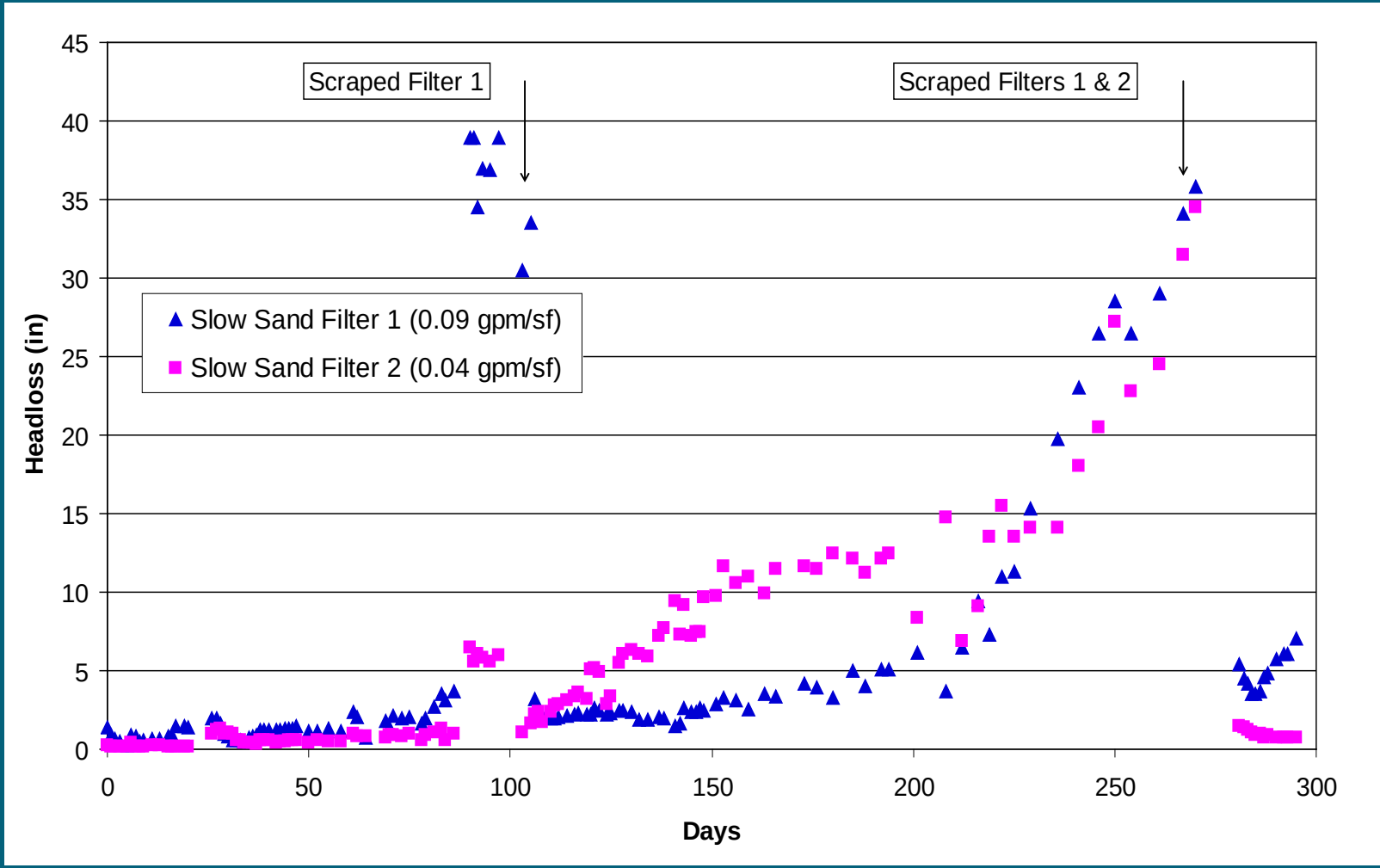
Spring Point HOA Pilot Study Data



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City of Roslyn, WA

- 1.0 MGD Slow Sand Filter with Gravel Upflow Roughing Filters
- Two Filter Trains
- On-Line Since 1998
- Water Source
  - Domerie Creek
- Turbidity
  - Raw Water
    - Avg. = 1.3 NTU
    - Range = 0.25 – 10.2 NTU
- Filter Runs
  - 9 Years

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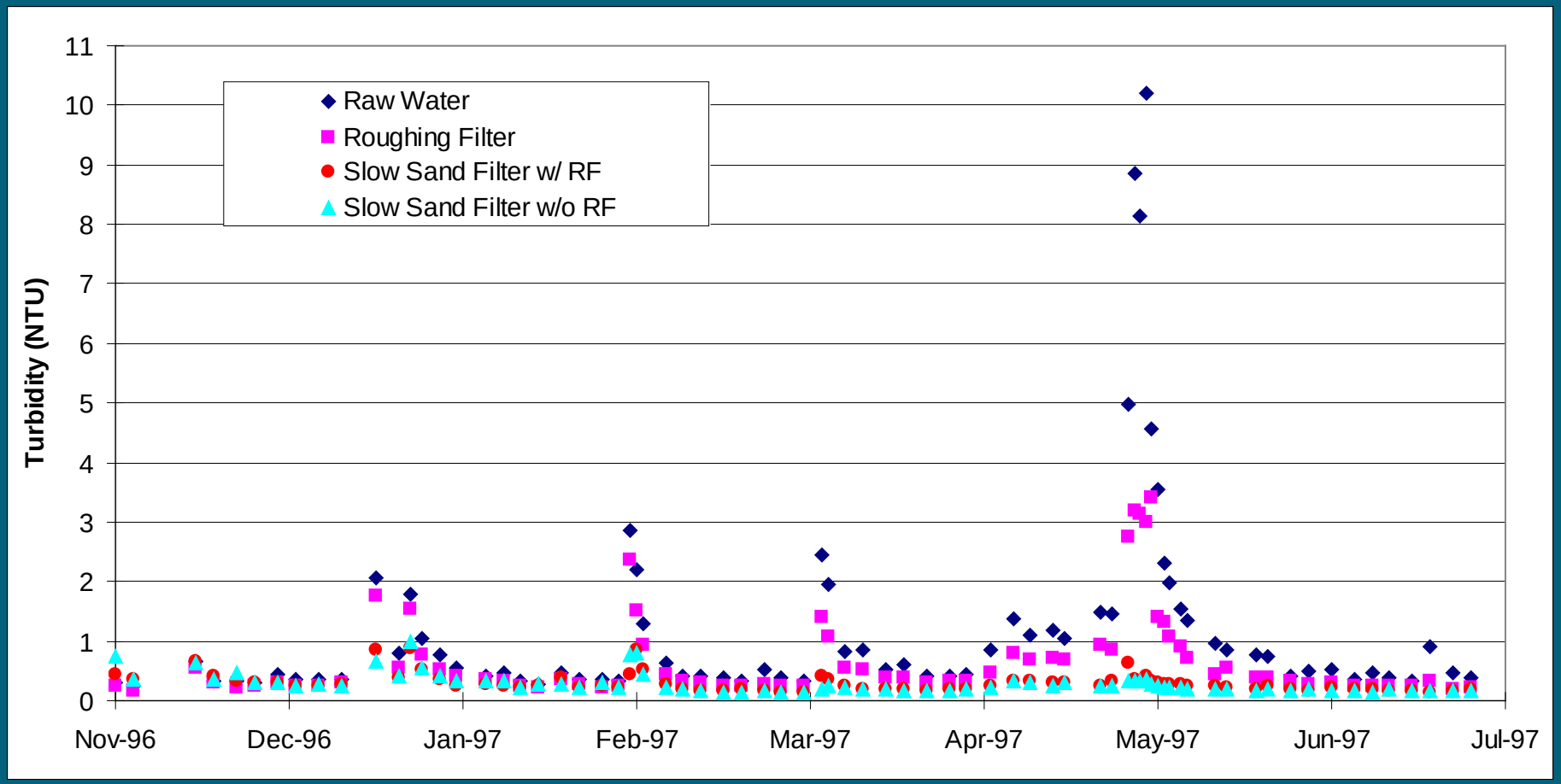
Roslyn Pilot Study Data



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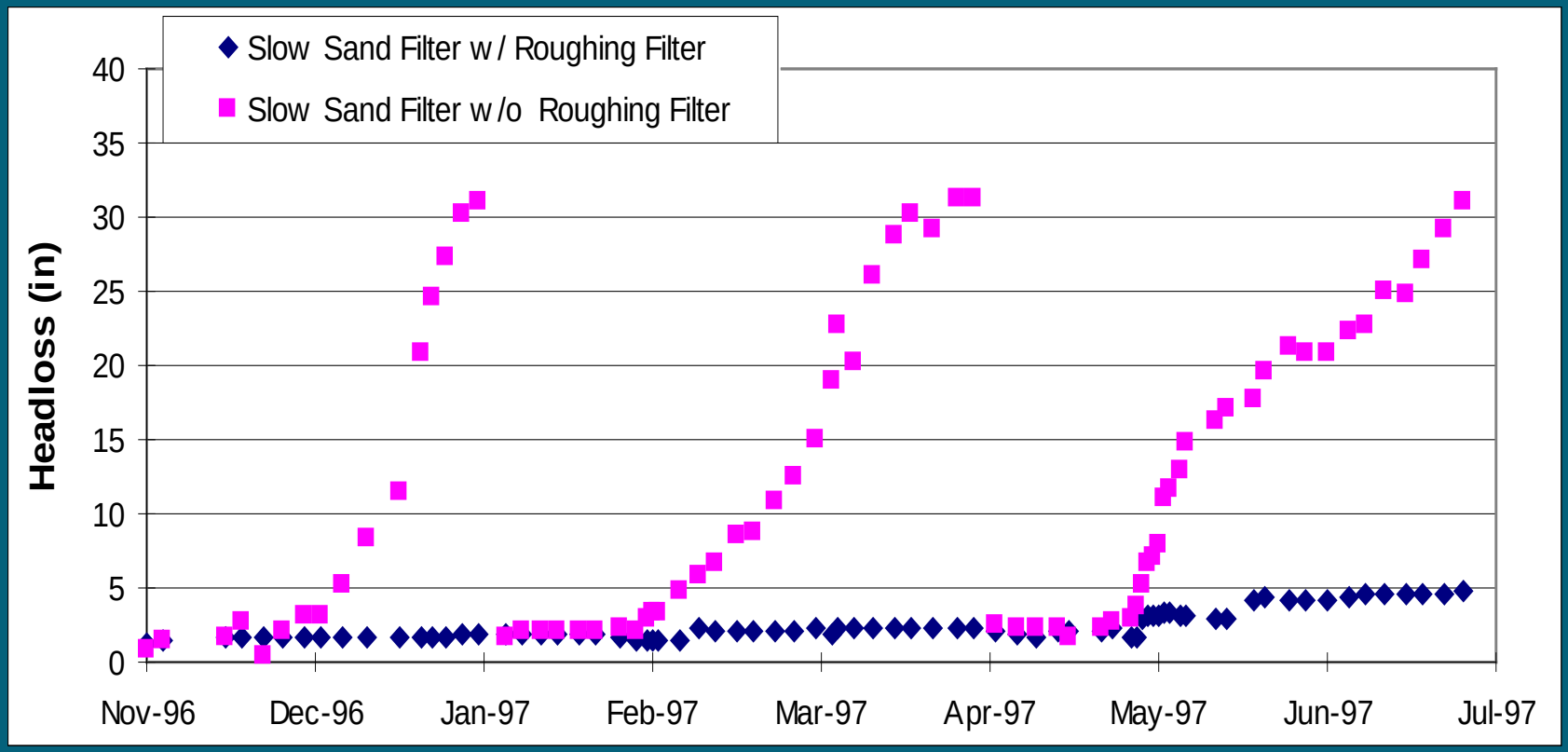
Roslyn Pilot Study Data



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Town of Coulee Dam, WA

- 2.0 MGD Slow Sand Filter with Gravel Upflow Roughing Filter
- Two Filter Trains (Four SSF)
- On-Line Since 2003
- Water Source
  - Lake Roosevelt
- Turbidity
  - Raw Water
    - Avg. = 0.80 NTU
    - Range = 0.3 – 3.6 NTU
- Filter Runs
  - Average = 2.3 years
  - Range = 1.5 years – 3.2 years

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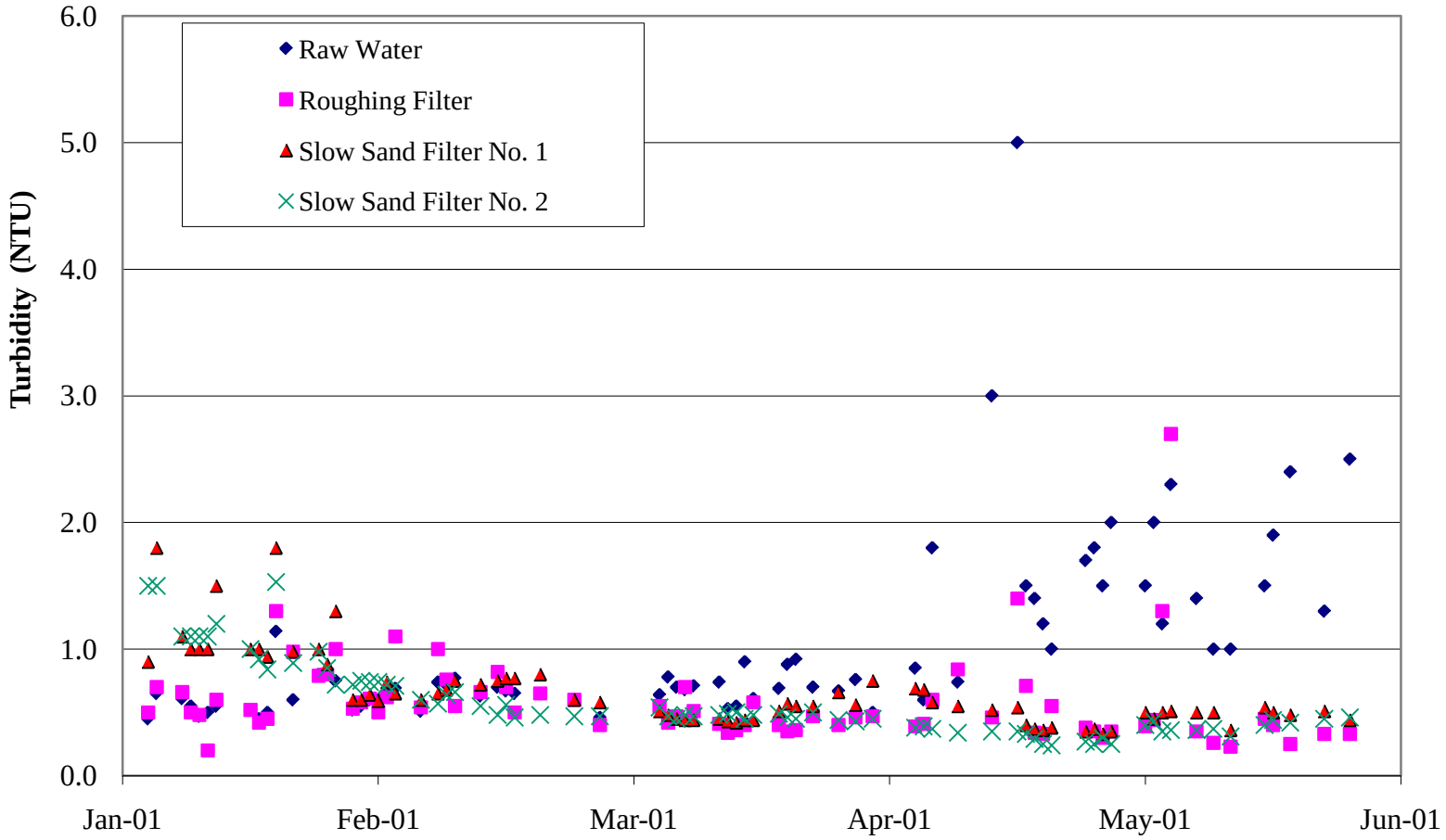
Coulee Dam Pilot Study Data



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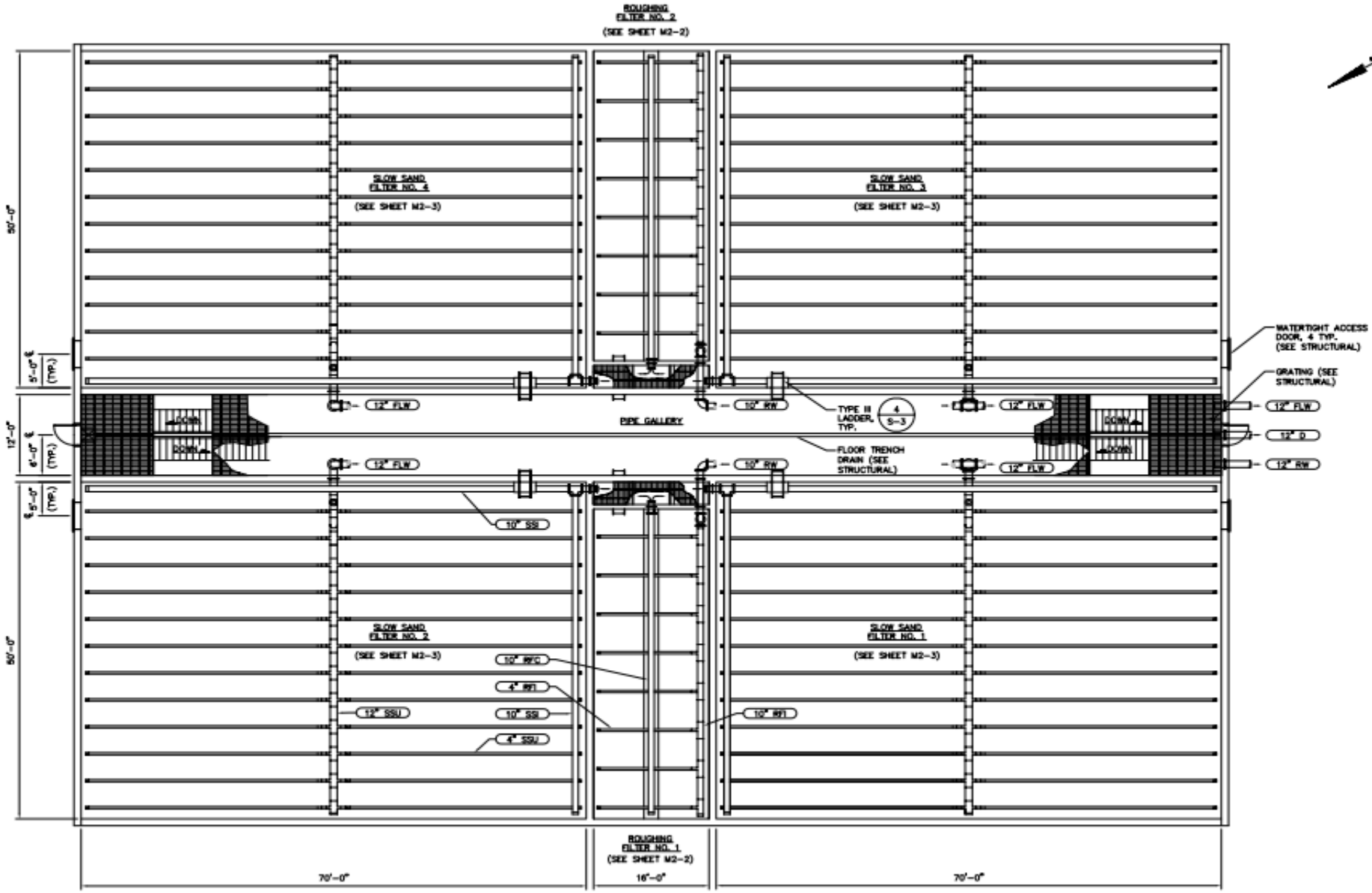


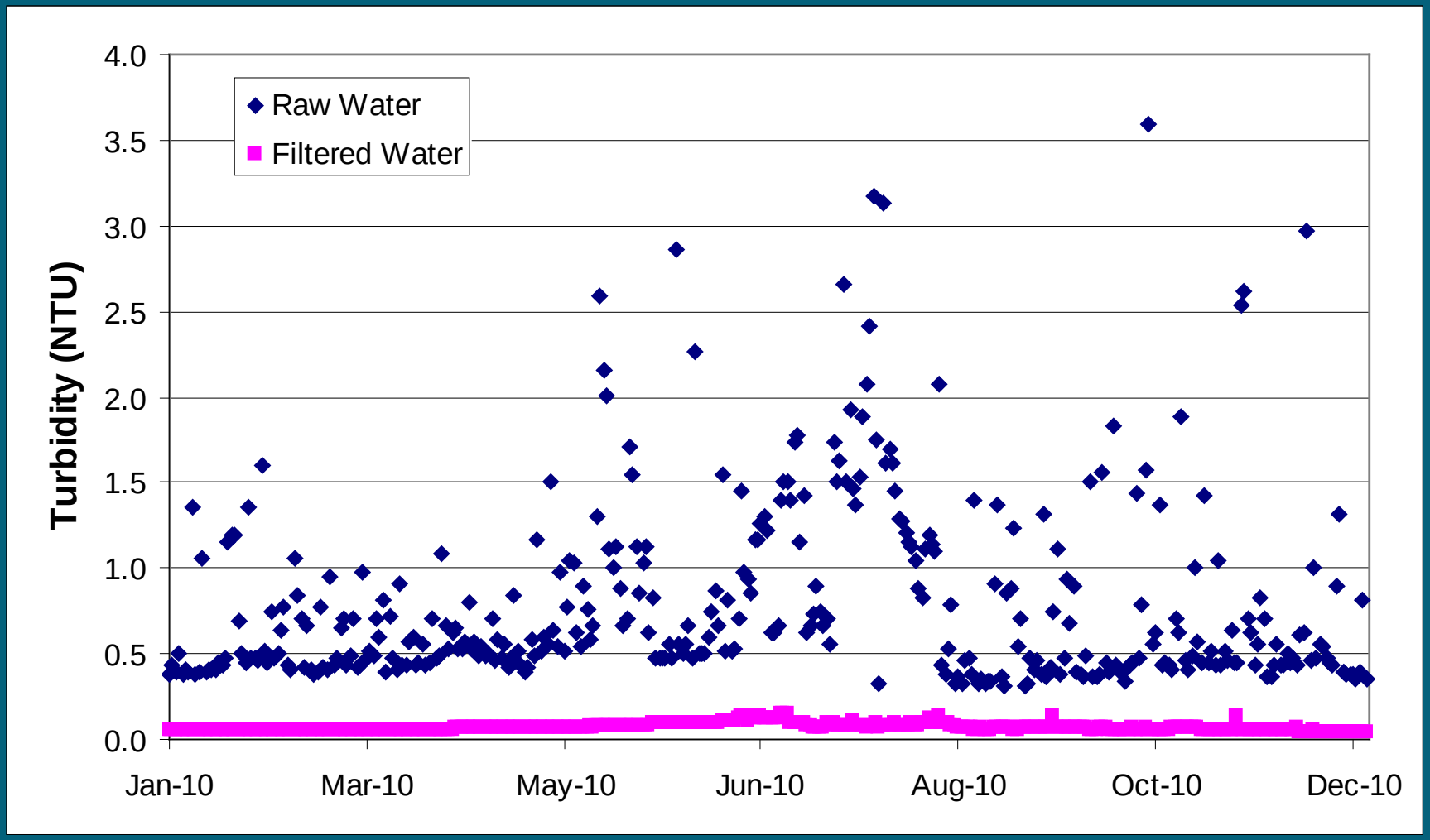
NOTES:

1. FILTER ROOF A
2. NOT ALL PIPIN FOR PIPE GALL

FILTER PLAN

SCALE: 1/8"=1'-0"

Coulee Dam Full Scale Data



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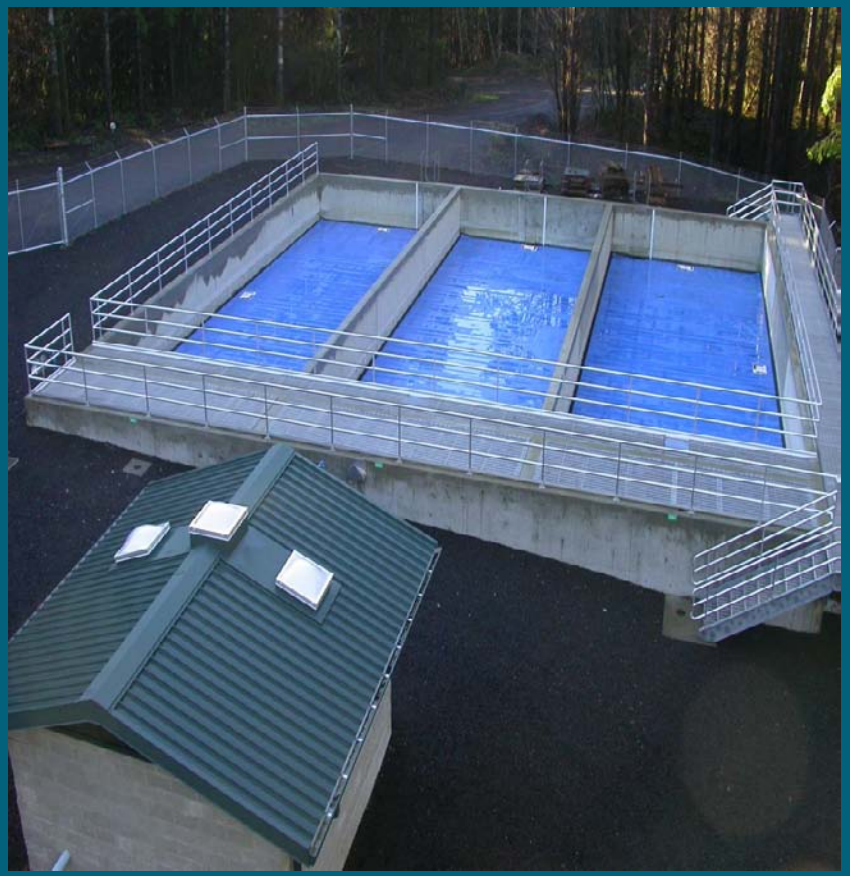
Town of Pe Ell, WA

- 0.5 MGD Slow Sand Filter with Gravel Upflow Roughing Filter
- Three Filter Trains
- On-Line Since 2003
- Water Sources
  - Lester Creek
  - Chehalis River
- Turbidity
  - Raw Water
    - Avg. = 0.80 NTU
    - Range = 0.3 – 20 NTU
- Filter Runs
  - Average = 12 months
  - Range = 4 months – 29 months



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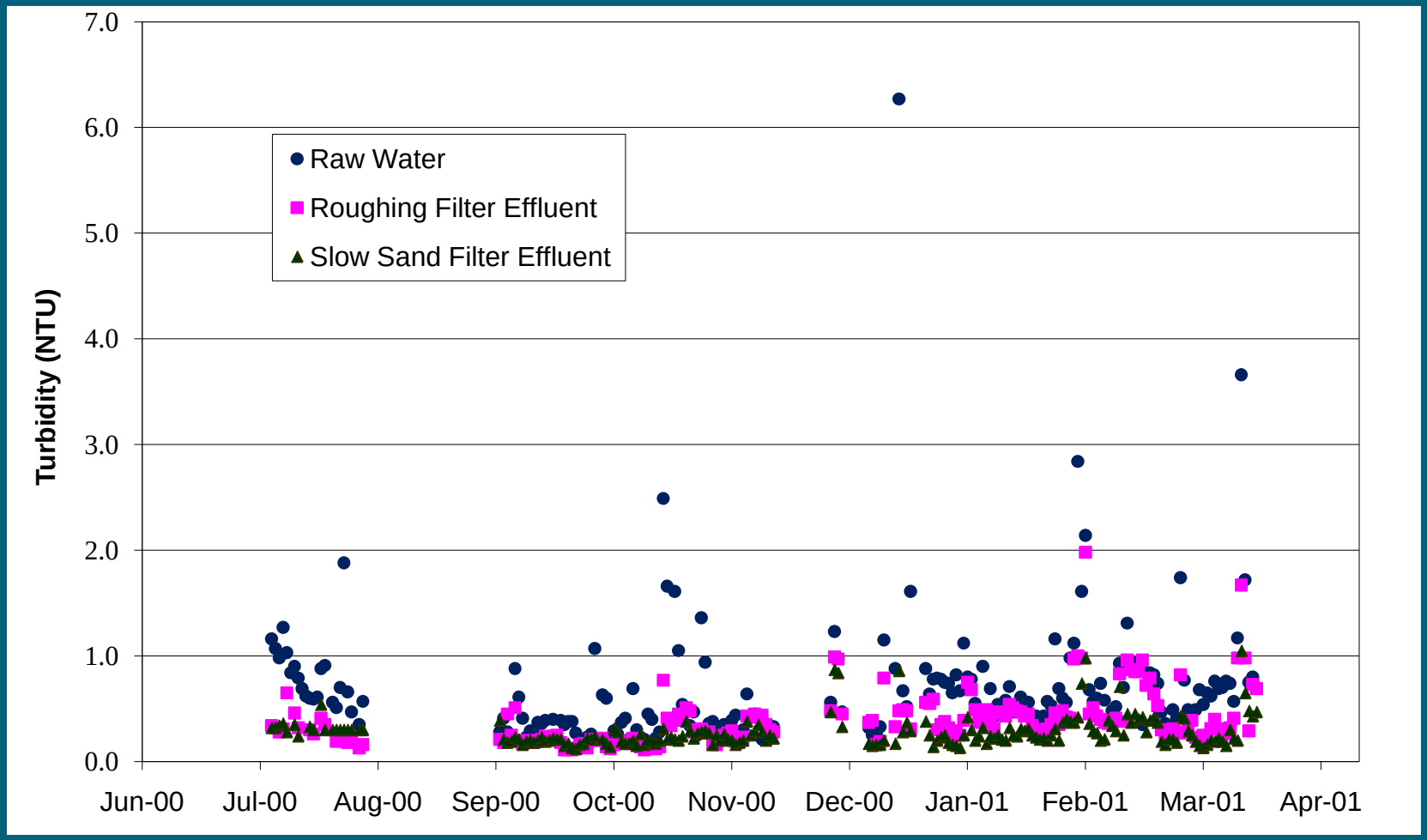
Pe Ell Pilot Study Data



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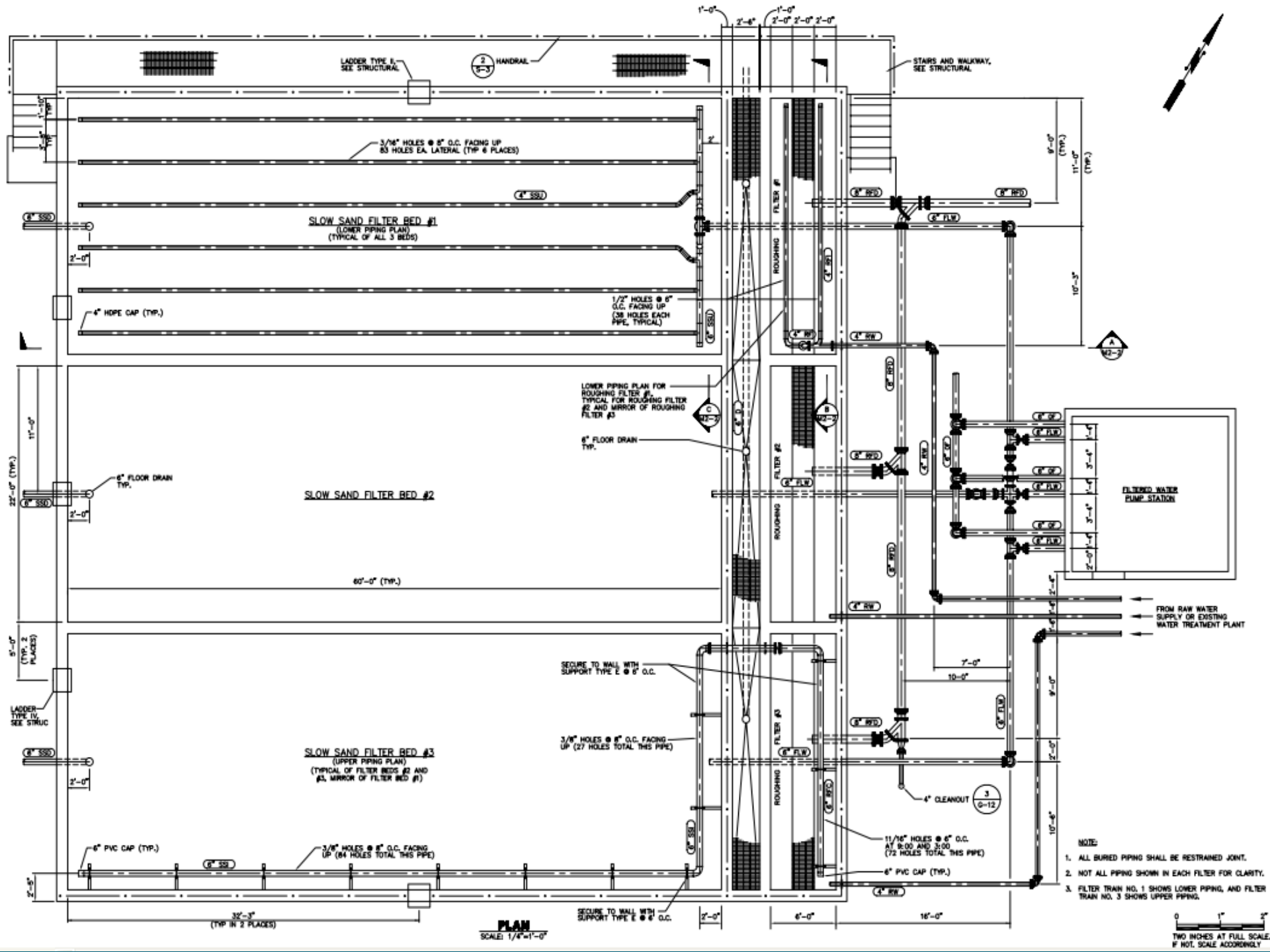
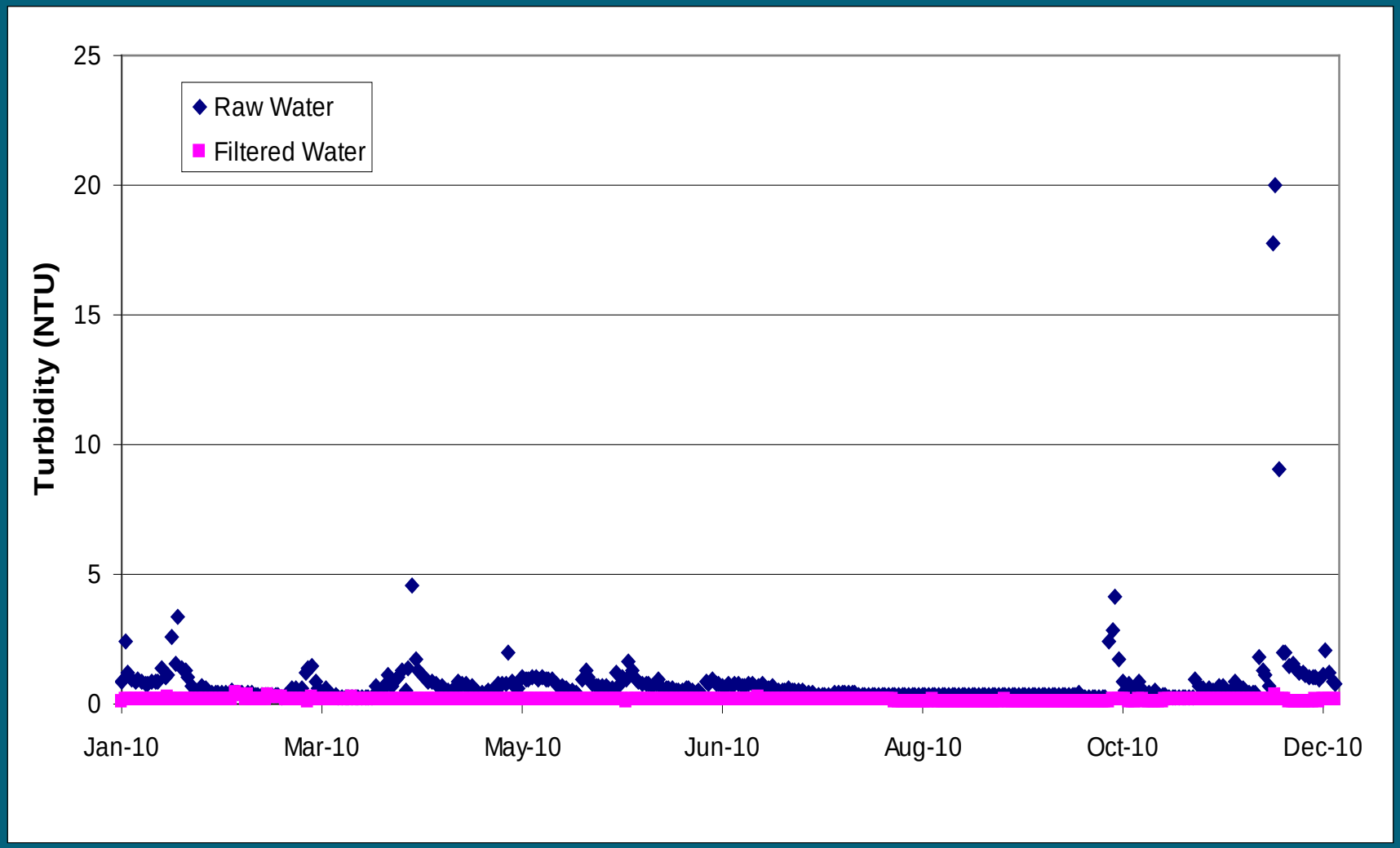

LADDER TYPE II, SEE STRUCTURAL
HANDRAIL
STAIRS AND WALKWAY, SEE STRUCTURAL
3/16" HOLES @ 8" O.C. FACING UP 83 HOLES EA. LATERAL (TYP 6 PLACES)
SLOW SAND FILTER BED #1
(LOWER PIPING PLAN)
(TYPICAL OF ALL 3 BEDS)
4" HDPE CAP (TYP.)
1/2" HOLES @ 6" O.C. FACING UP (38 HOLES EACH PIPE, TYPICAL)
LOWER PIPING PLAN FOR ROUGHING FILTER #1, TYPICAL FOR ROUGHING FILTER #2 AND MIRROR OF ROUGHING FILTER #3
6" FLOOR DRAIN TYP.
SLOW SAND FILTER BED #2
60'-0" (TYP.)
FILTERED WATER PUMP STATION
FROM RAW WATER SUPPLY OR EXISTING WATER TREATMENT PLANT
SECURE TO WALL WITH SUPPORT TYPE E @ 6' O.C.
3/8" HOLES @ 8" O.C. FACING UP (27 HOLES TOTAL THIS PIPE)
SLOW SAND FILTER BED #3
(UPPER PIPING PLAN)
(TYPICAL OF FILTER BEDS #2 AND #3, MIRROR OF FILTER BED #1)
LADDER TYPE IV, SEE STRUC
6" PVC CAP (TYP.)
3/8" HOLES @ 8" O.C. FACING UP (84 HOLES TOTAL THIS PIPE)
4" CLEANOUT
11/16" HOLES @ 6" O.C. AT 9:00 AND 3:00 (72 HOLES TOTAL THIS PIPE)
6" PVC CAP (TYP.)
32'-3" (TYP IN 2 PLACES)
ROUGHING FILTER #1
ROUGHING FILTER #2
ROUGHING FILTER #3
8" RFD
6" FLW
4" RW
6" GF
8" SSD
4" SSD
PLAN
SCALE: 1/4"=1'-0"
NOTE:
1. ALL BURIED PIPING SHALL BE RESTRAINED JOINT.
2. NOT ALL PIPING SHOWN IN EACH FILTER FOR CLARITY.
3. FILTER TRAIN NO. 1 SHOWS LOWER PIPING, AND FILTER TRAIN NO. 3 SHOWS UPPER PIPING.
TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

Pe Ell Full Scale Data



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Naselle Water Company

- 480 gpm Slow Sand Filter
- Three Filter Trains
- On-Line Since 1996
- Roughing Filter Added in 2011
- Water Sources
  - Lane Creek
  - O'Connor Creek
- Turbidity
  - Raw Water
    - Avg. = 1 NTU
    - Range = 0.3 - 15 NTU
- Filter Runs w/o Roughing Filter
  - Average = 3-4 months
- Anticipated Filter Runs w/ Roughing Filter
  - 6-12 months

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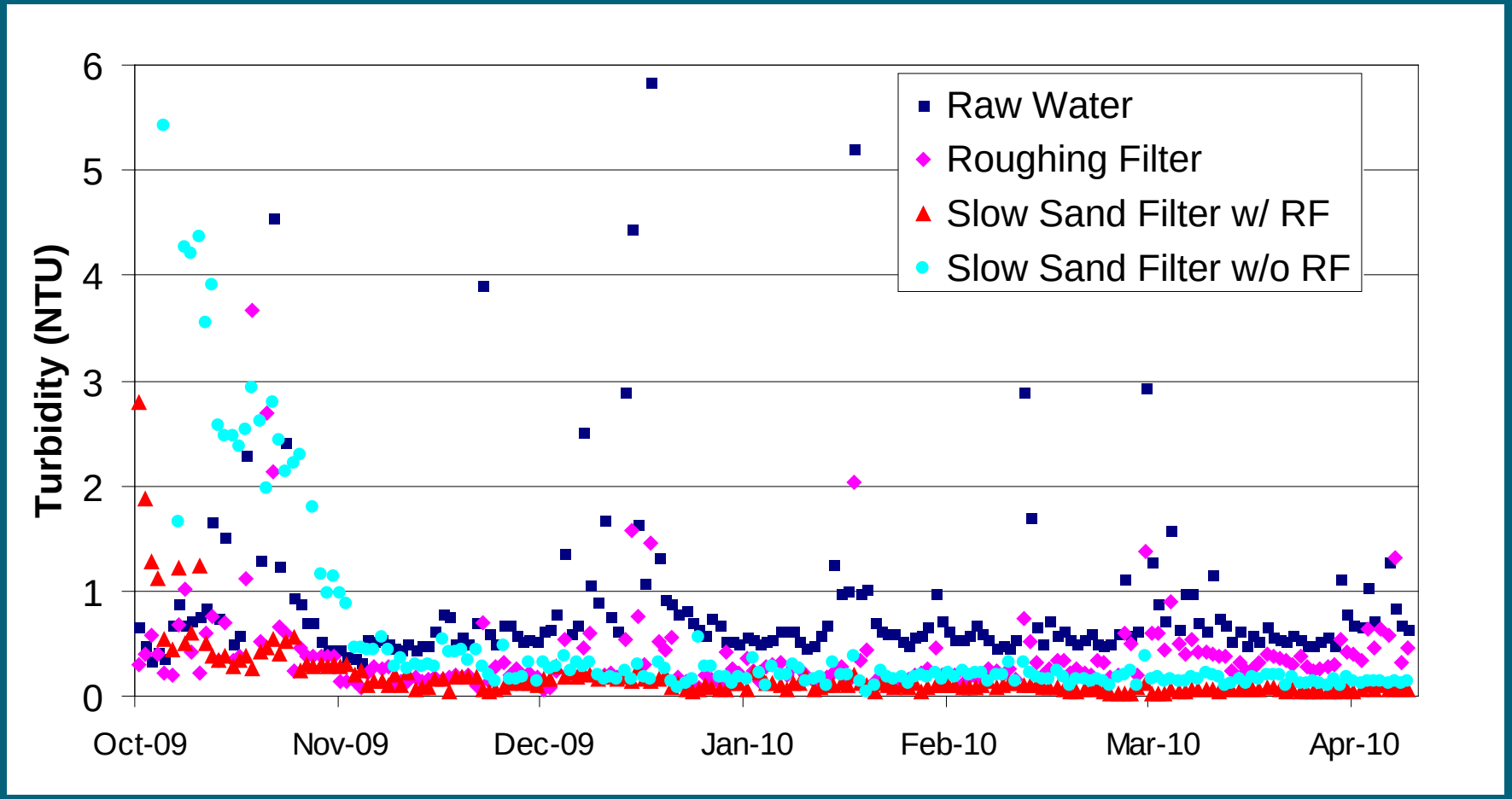
Naselle Pilot Study Data



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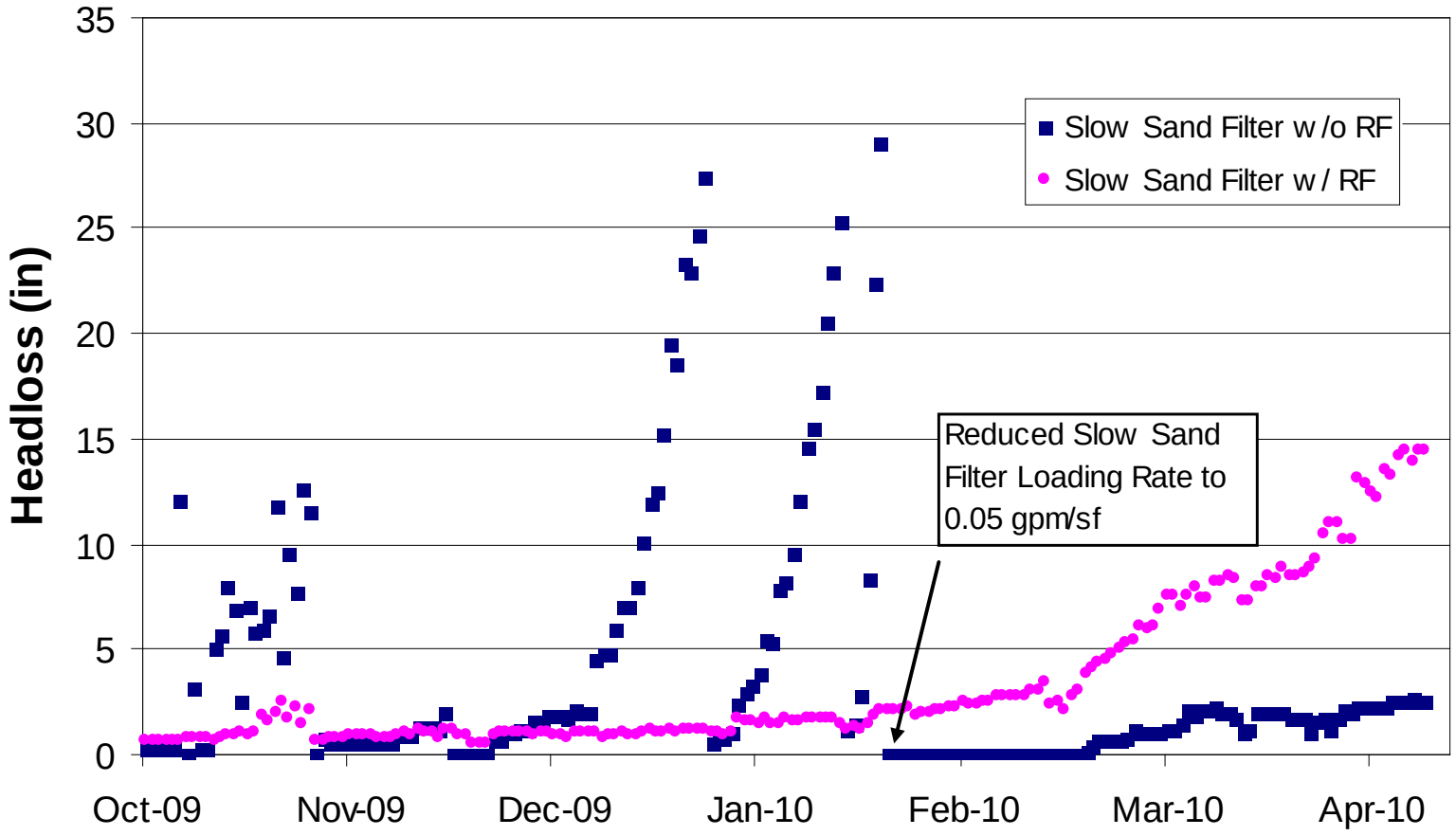

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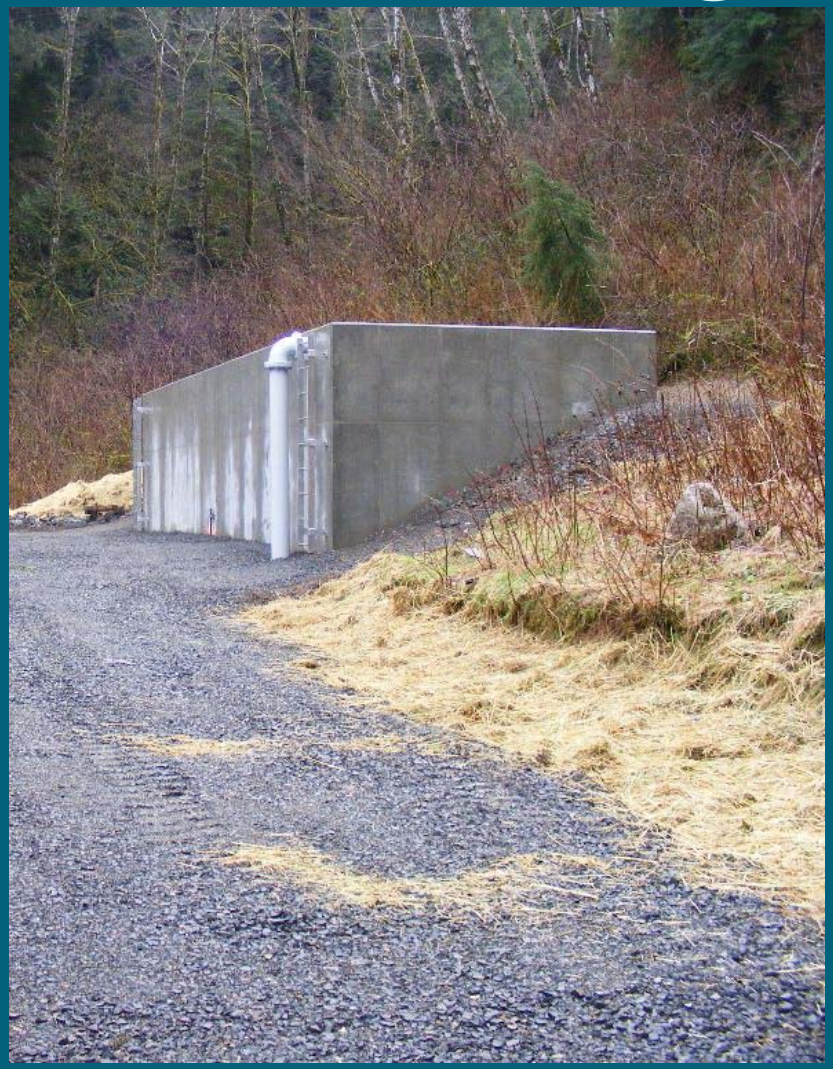
Naselle Roughing Filter



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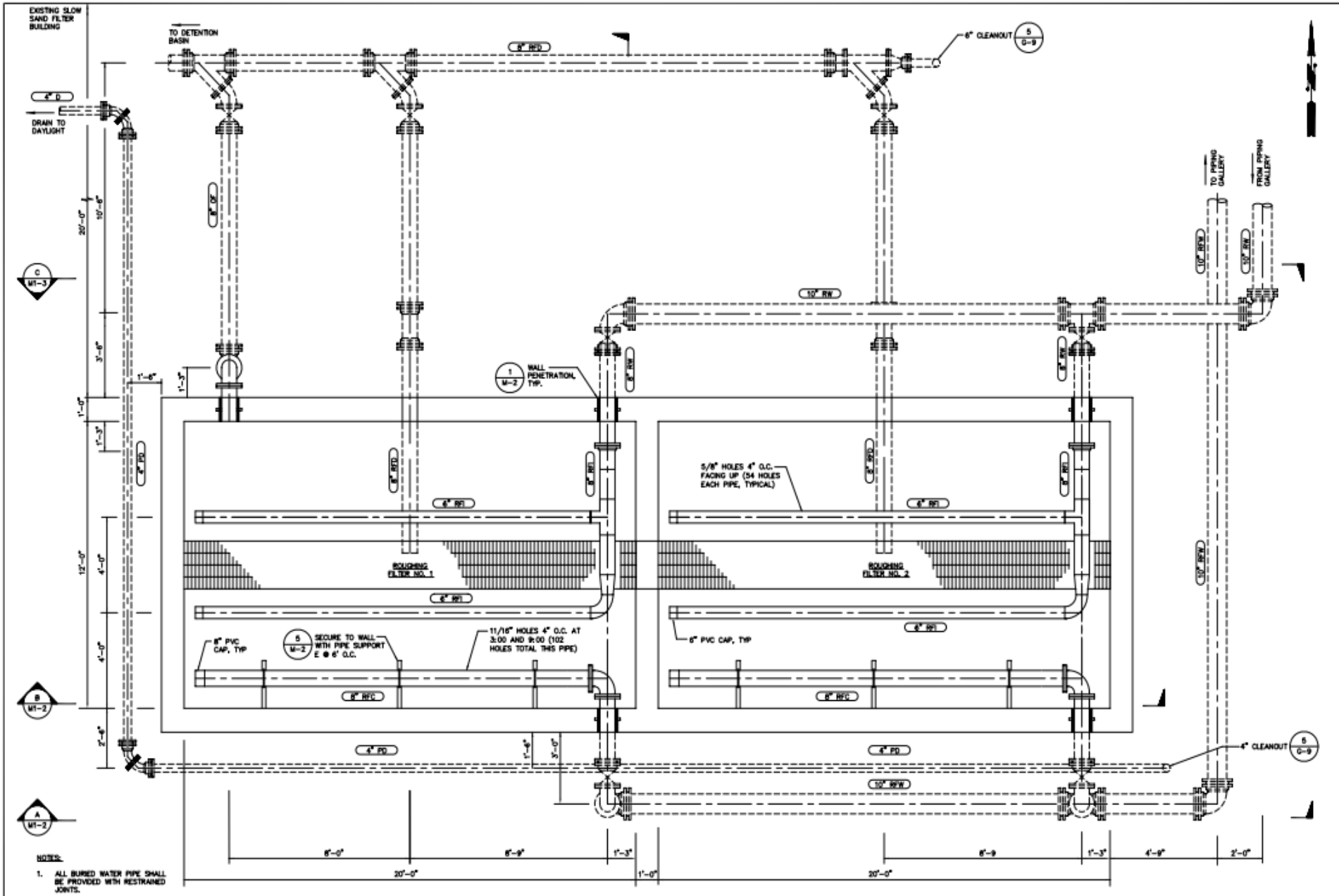


NOTES:

1. ALL BURIED WATER PIPE SHALL BE PROVIDED WITH RESTRAINED JOINTS.

D M1-3

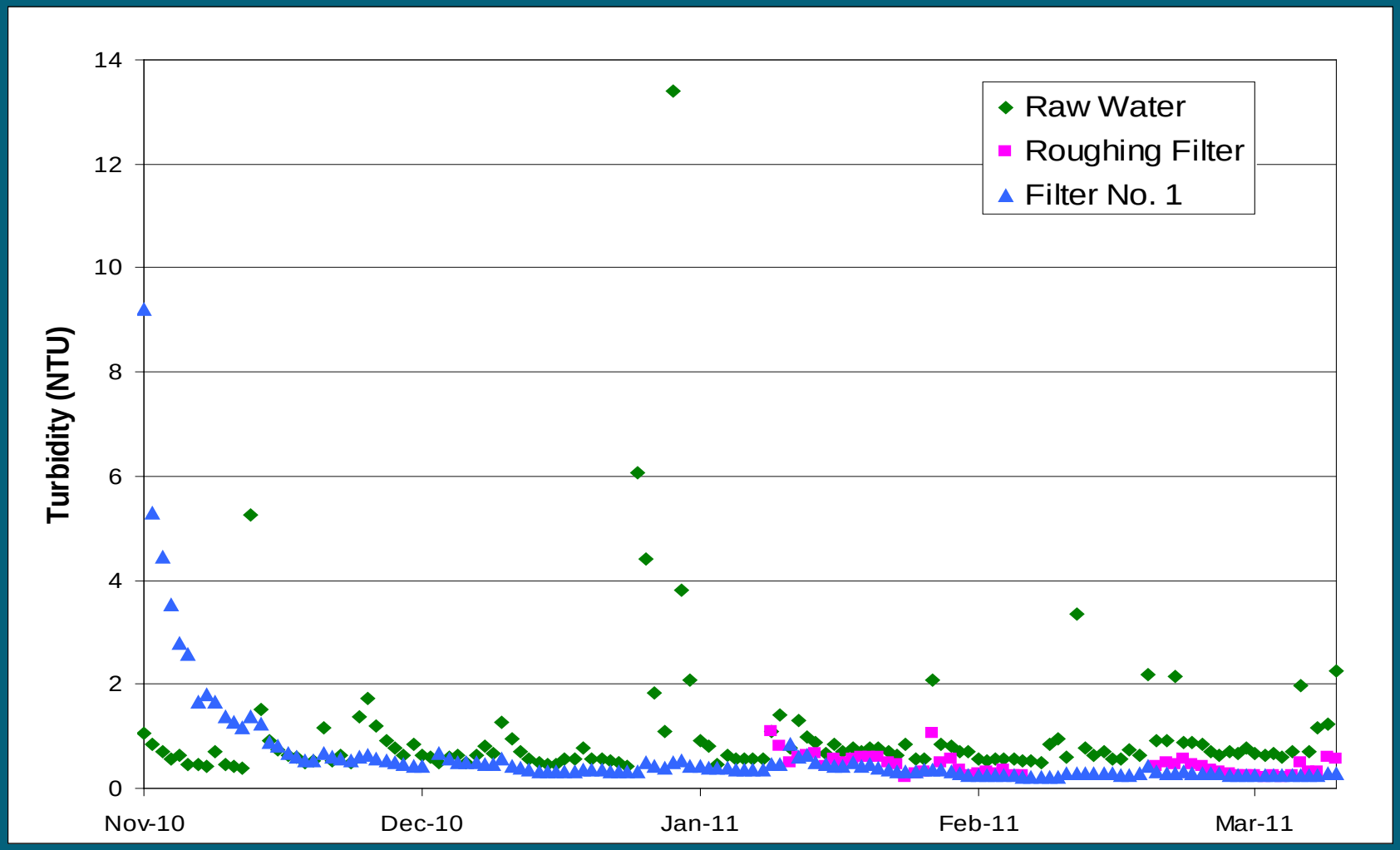
ROUGHING FILTER PLAN

SCALE: 1/2"=1'-0"

0 1" 2"

TWO INCHES AT FULL SCALE. IF NOT, SCALE ACCORDINGLY

Naselle Full Scale Data



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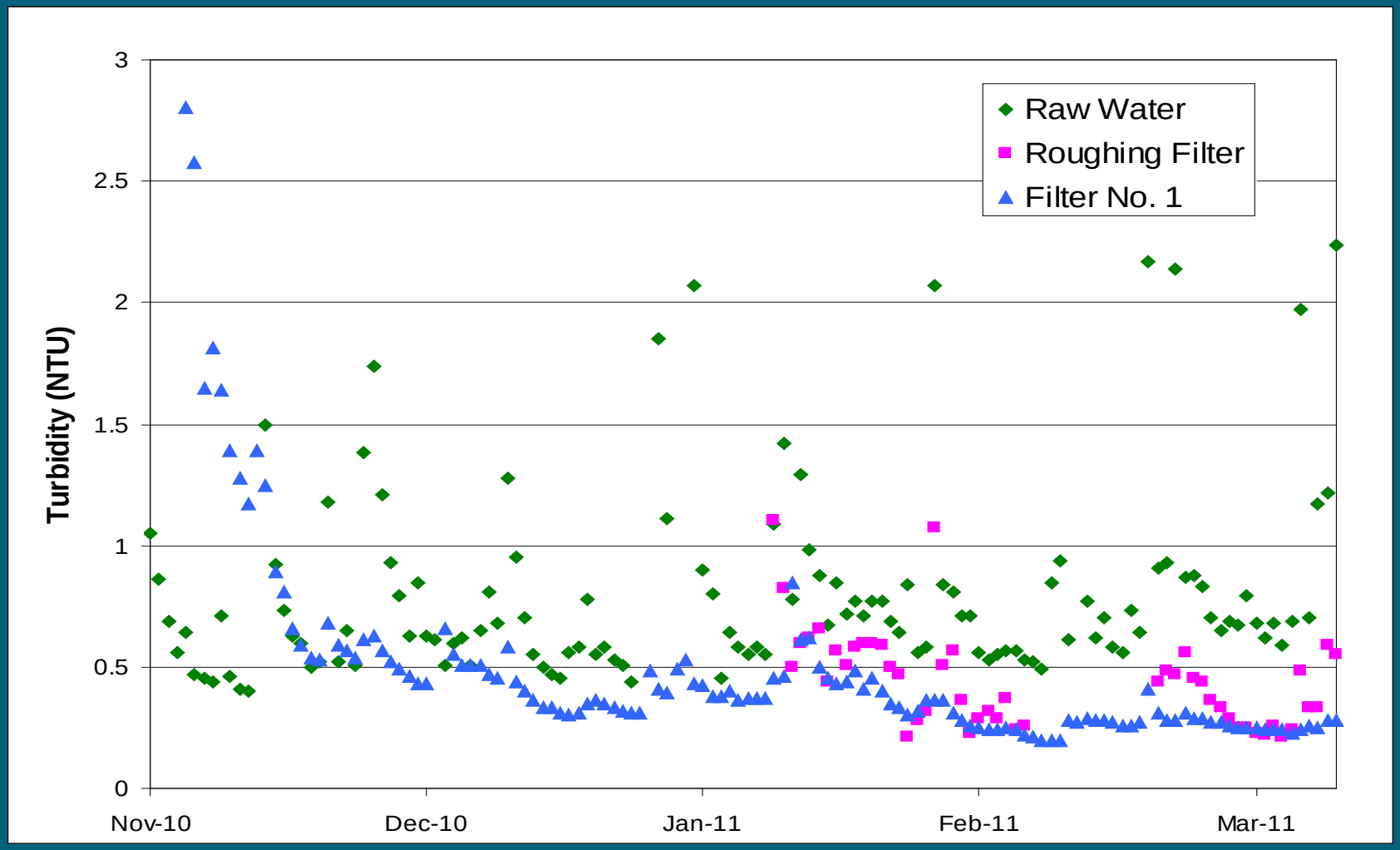

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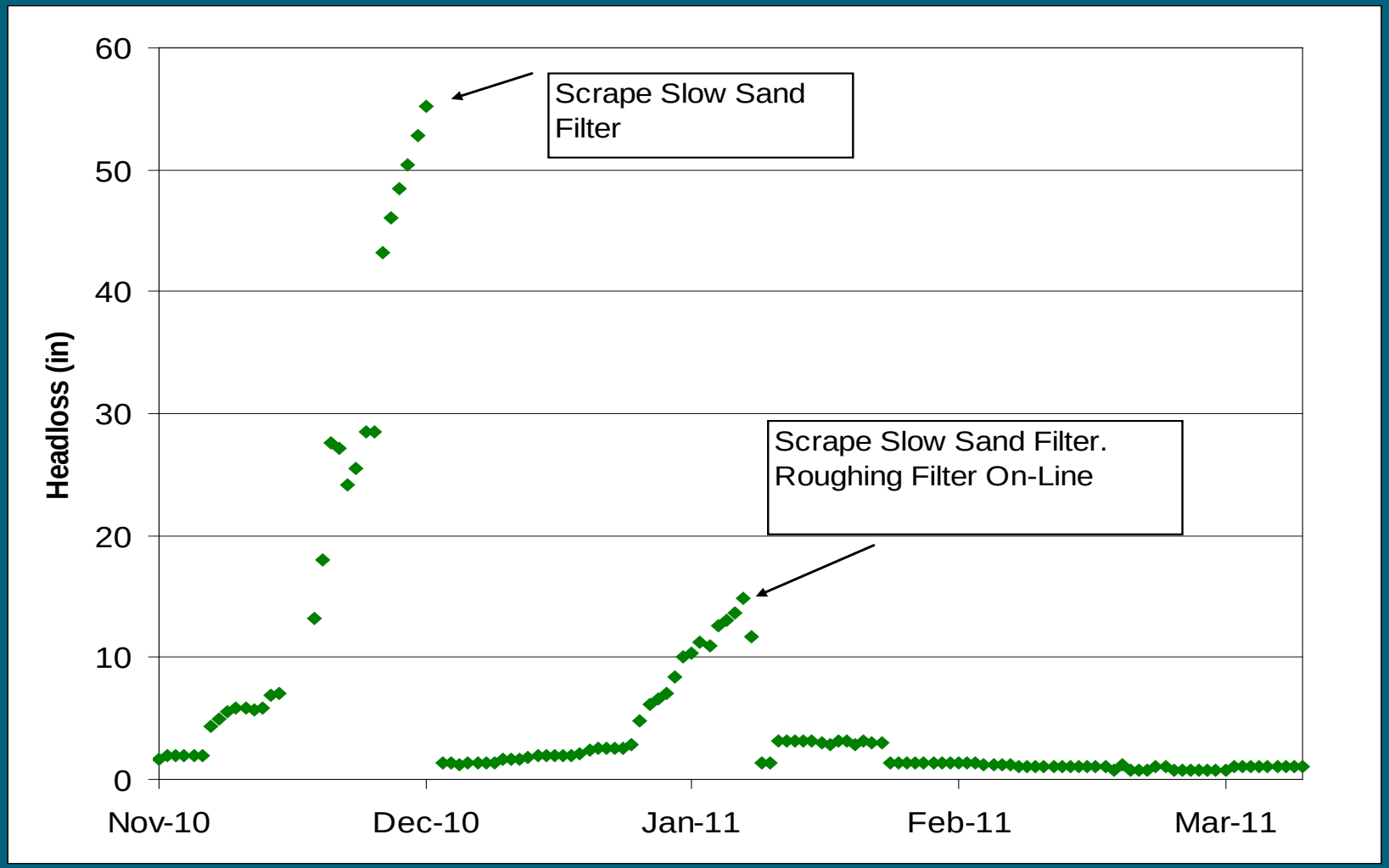

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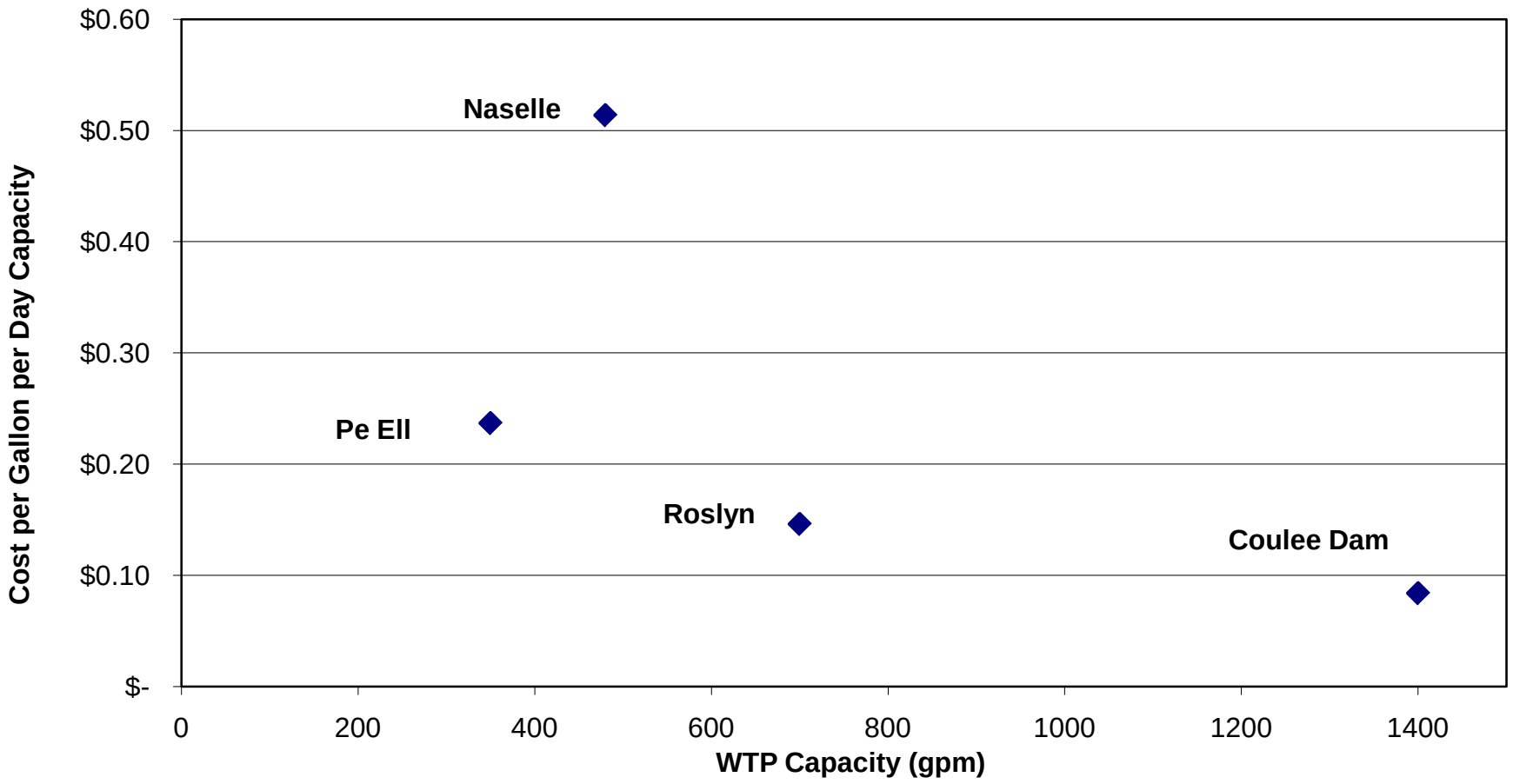
Cost Data



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Conclusions

- Gravel Upflow Roughing Filters
  - Are a Simple, Cost-Effective Technology that are Appropriate Pre-Treatment for Slow Sand Filters
  - Increase the Range of Water Quality that can be Treated by Slow Sand Filters
  - Improve the Performance of Slow Sand Filters
    - Reduce Turbidity Loading to Slow Sand Filters
    - Reduce Rate of Accumulation of Headloss
    - Increase Filter Scraping Interval

Acknowledgements

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Janet Cherry, Gray & Osborne
Pat Gill, Gray & Osborne

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