Tertiary Wastewater Filtration Facility

Ukiah Wastewater Treatment Plant

Environmental Consultants at Cal

28 April 2015

544 Davis Hall

UC Berkeley, CA

Environmental Consultants at Cal

Environmental Consultants at Cal

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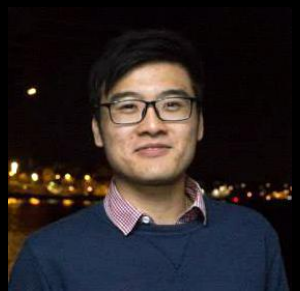
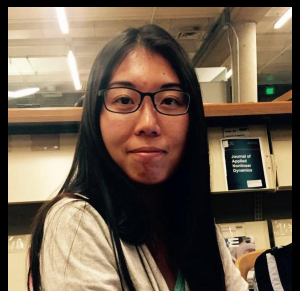
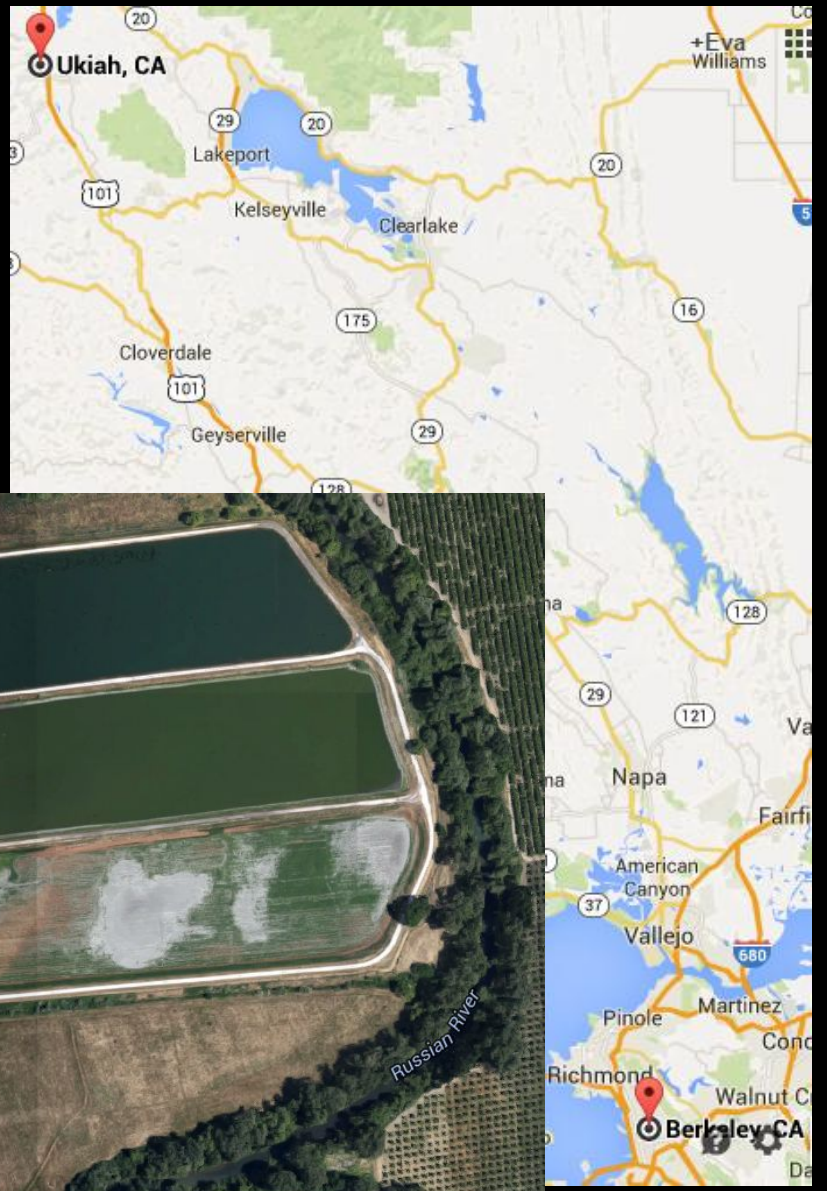



Location

Ukiah, CA

- Mendocino County
- 115 miles North of Berkeley



Location

Ukiah, CA

- Mendocino County
- 115 miles North of Berkele

Advanced Wastewater Treatment

Goals

- Augment to 14 mgd
- Dual media filtration

Outline

- Layout, pipes, valves, pumps
- Additional units
- Operability and constructability
- Life Cycle Assessment (LCA)
- Cost in January 2017

Site layout

➔ **Design flow:**

6.8 mgd

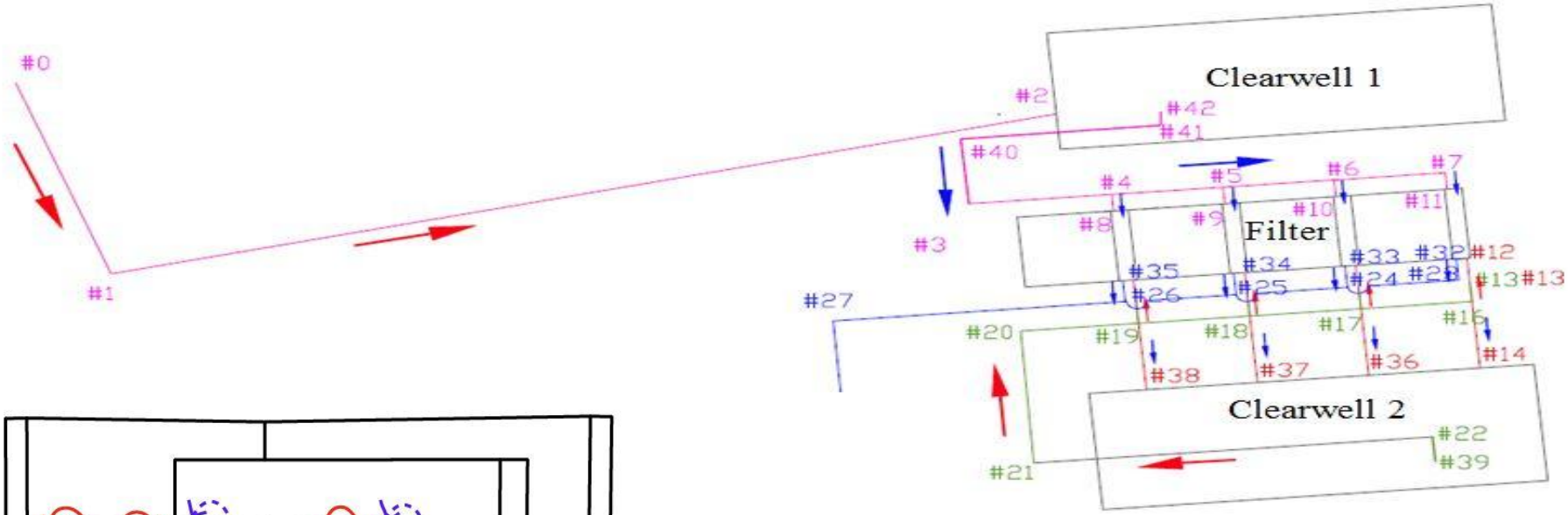
➔ **Filtration rate:**

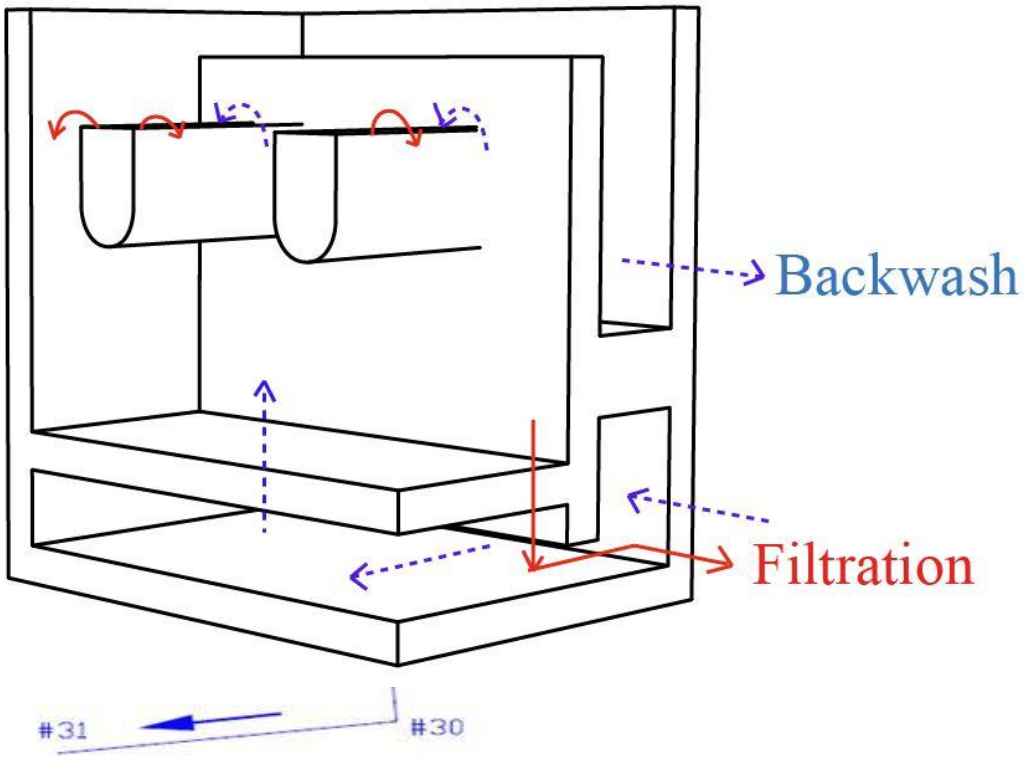
5 gpm/ft^2

➔ **filters #:**

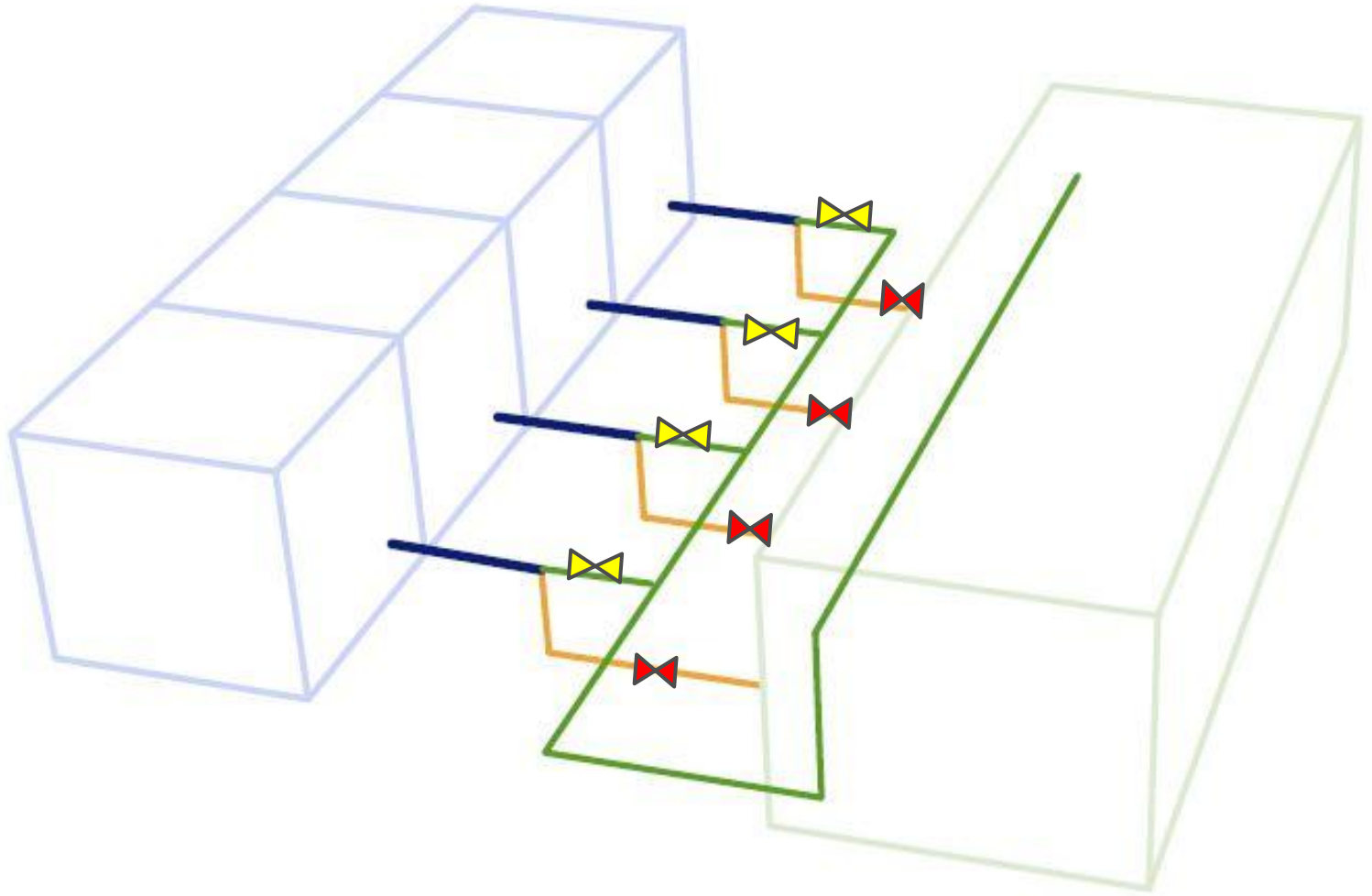
4

Flow illustration

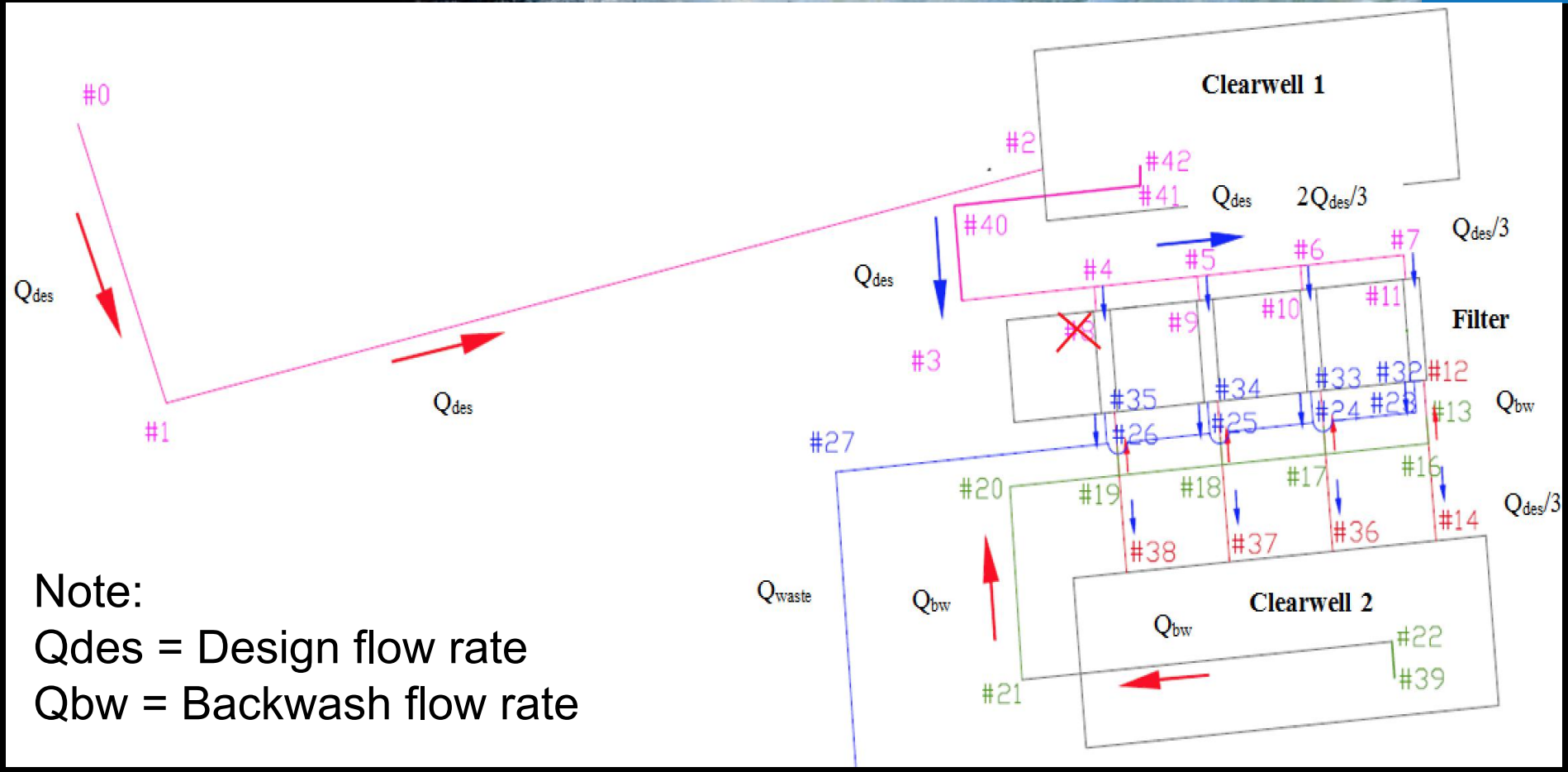




Flow illustration



Pipe headloss assumption



Note:
Qdes = Design flow rate
Qbw = Backwash flow rate

To get the largest headloss in pipes, assume:

Filter inlet #8 was closed due to backwash

- affect flow rates across the filter inflow pipes

Piping design

Pipe diameter (16 in, 20 in & 22 in)

- common manufacturing size
  - save $$

- flow velocity > 3 fps
  - prevent deposition of solids

Headloss

(i) Secondary clarifiers to clearwell 1 (h = 2.23 ft)

- friction & components

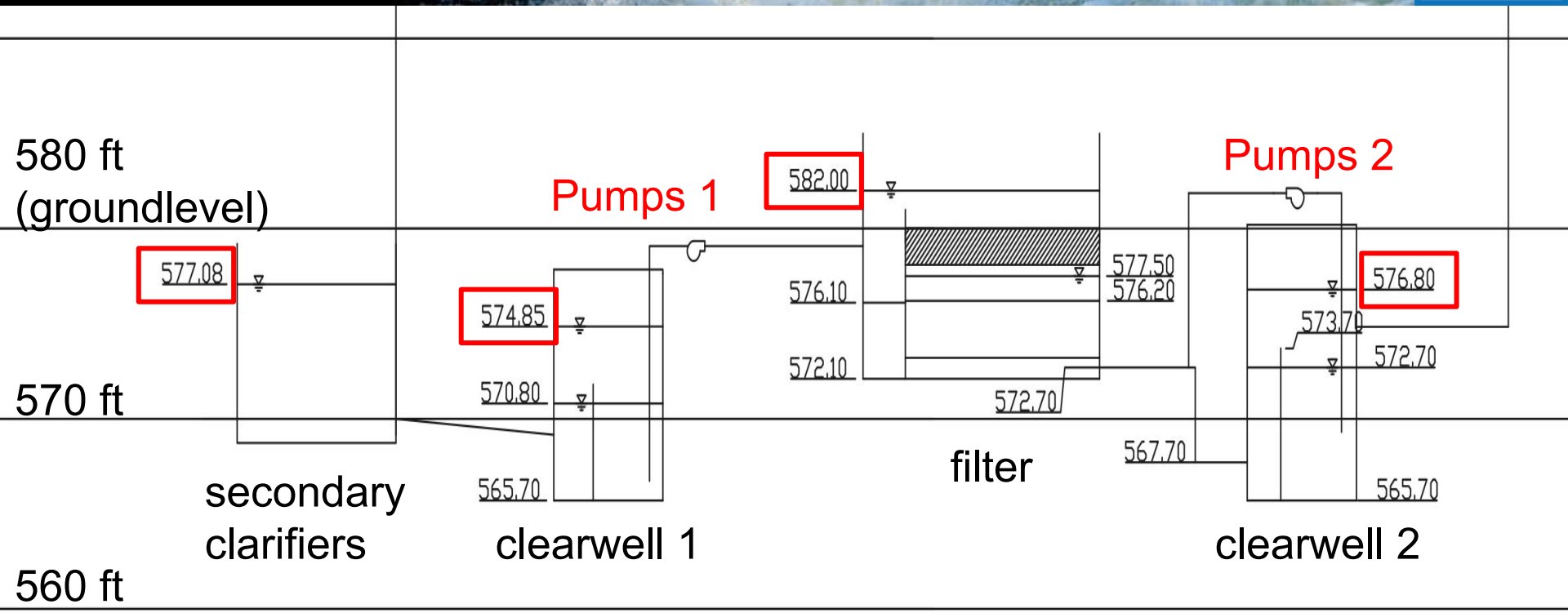
(ii) Clearwell 1 to filter (h = -7.15 ft)

- friction & components
- head (energy) gained from pump

(iii) Filter to clearwell 2 (h = 5.2 ft)

- friction & components
- cleanbed: sand & antracite
- clogging
- underdrain

AWT cross section



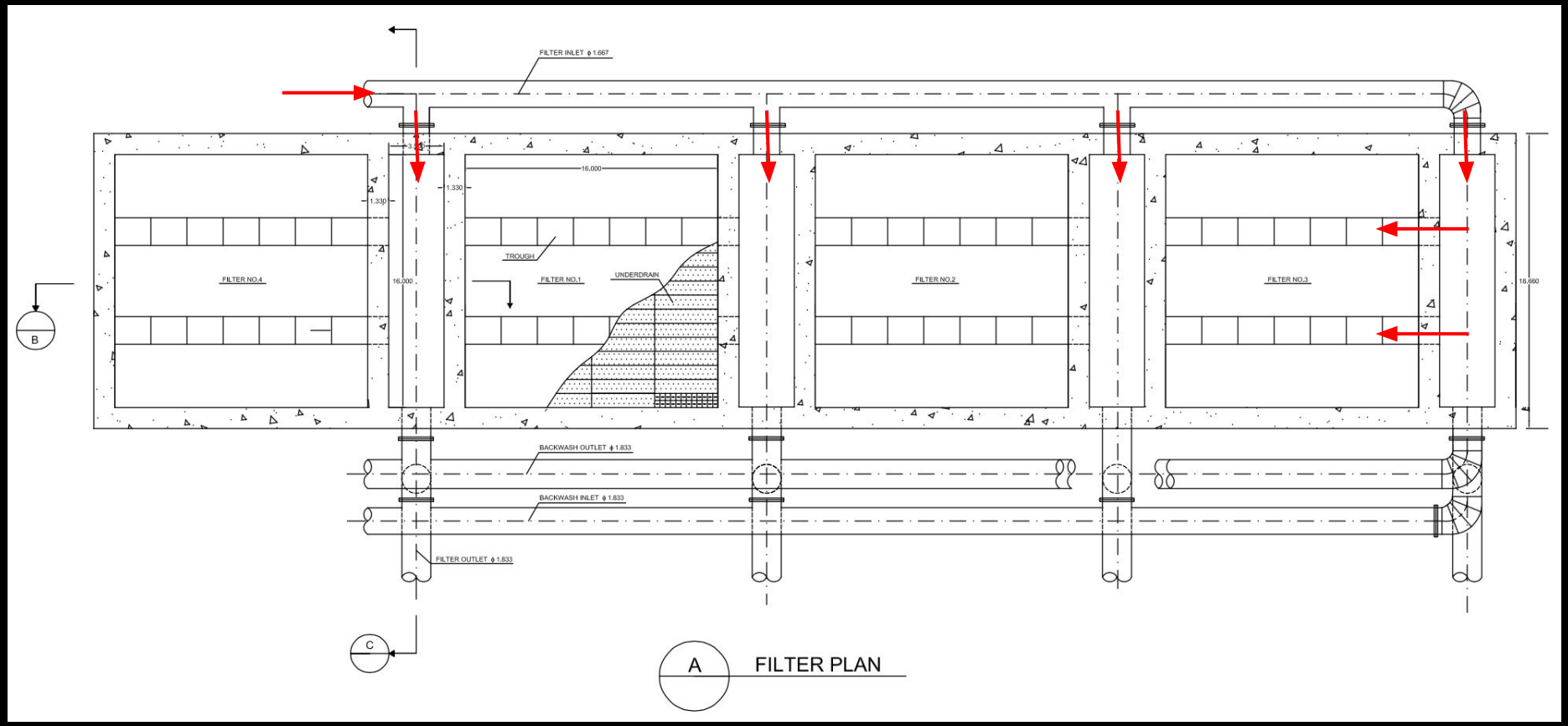
Note:

(i) Use of pumps in clearwell 1 & 2

(ii) Pumps 1: **Prevent deep excavation** for filter ($$)

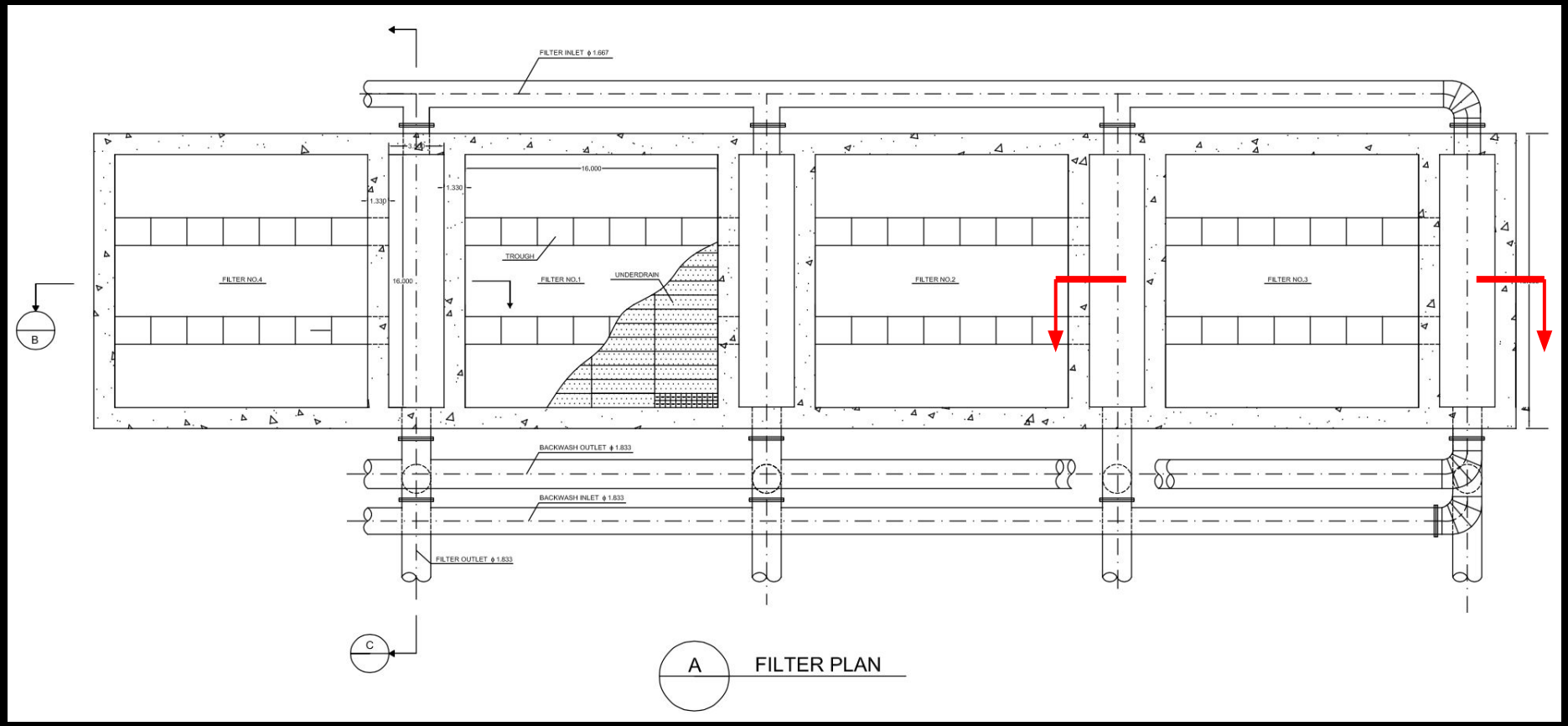
Pumps 2: Backwash

Filter Design



- Design flow rate: Q_{design} = 6.8 mgd
- Filtration rate: q_h = 5 gpm/ft^2
- Dimensions: 16 ft ×16 ft

Filter Design



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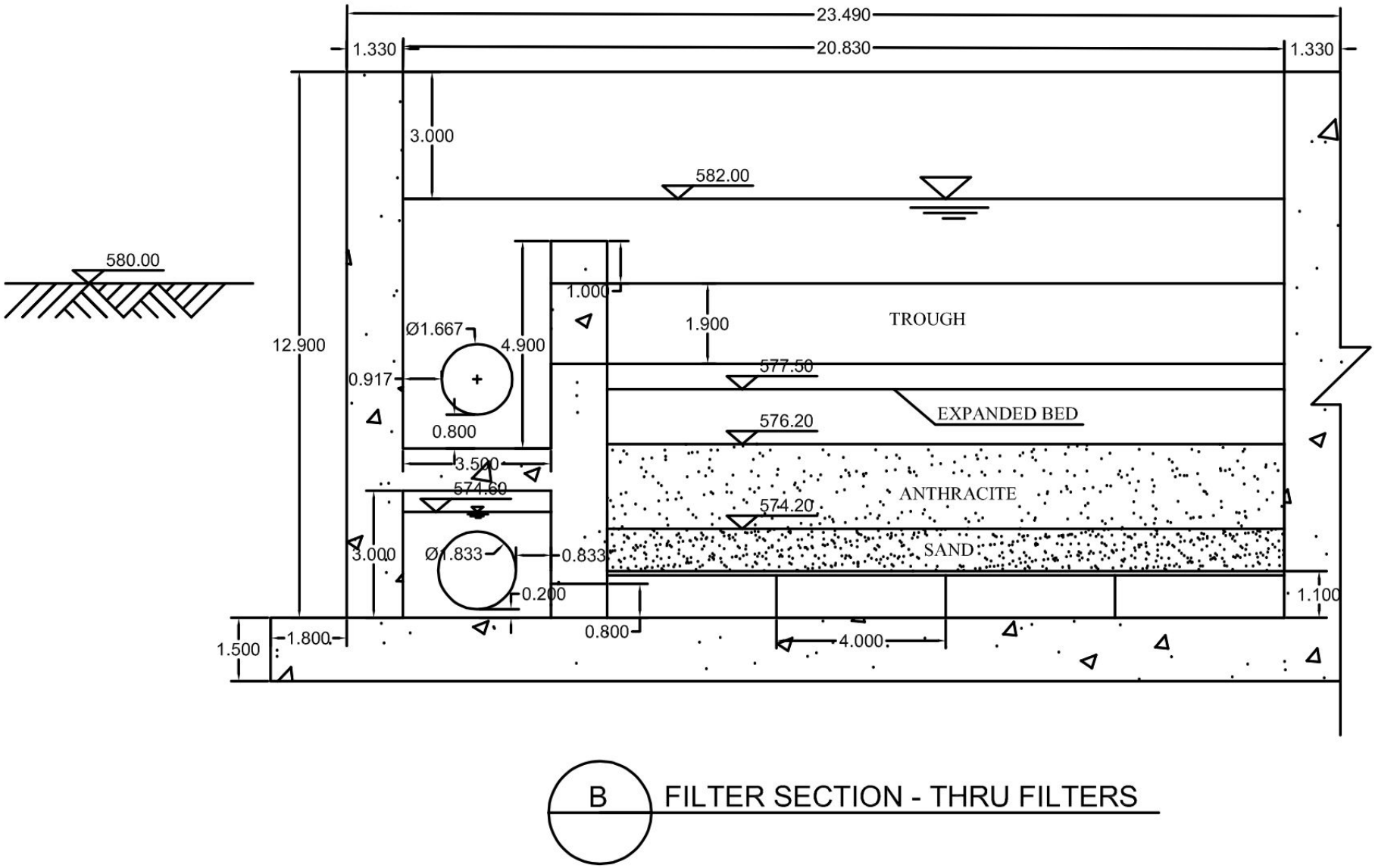

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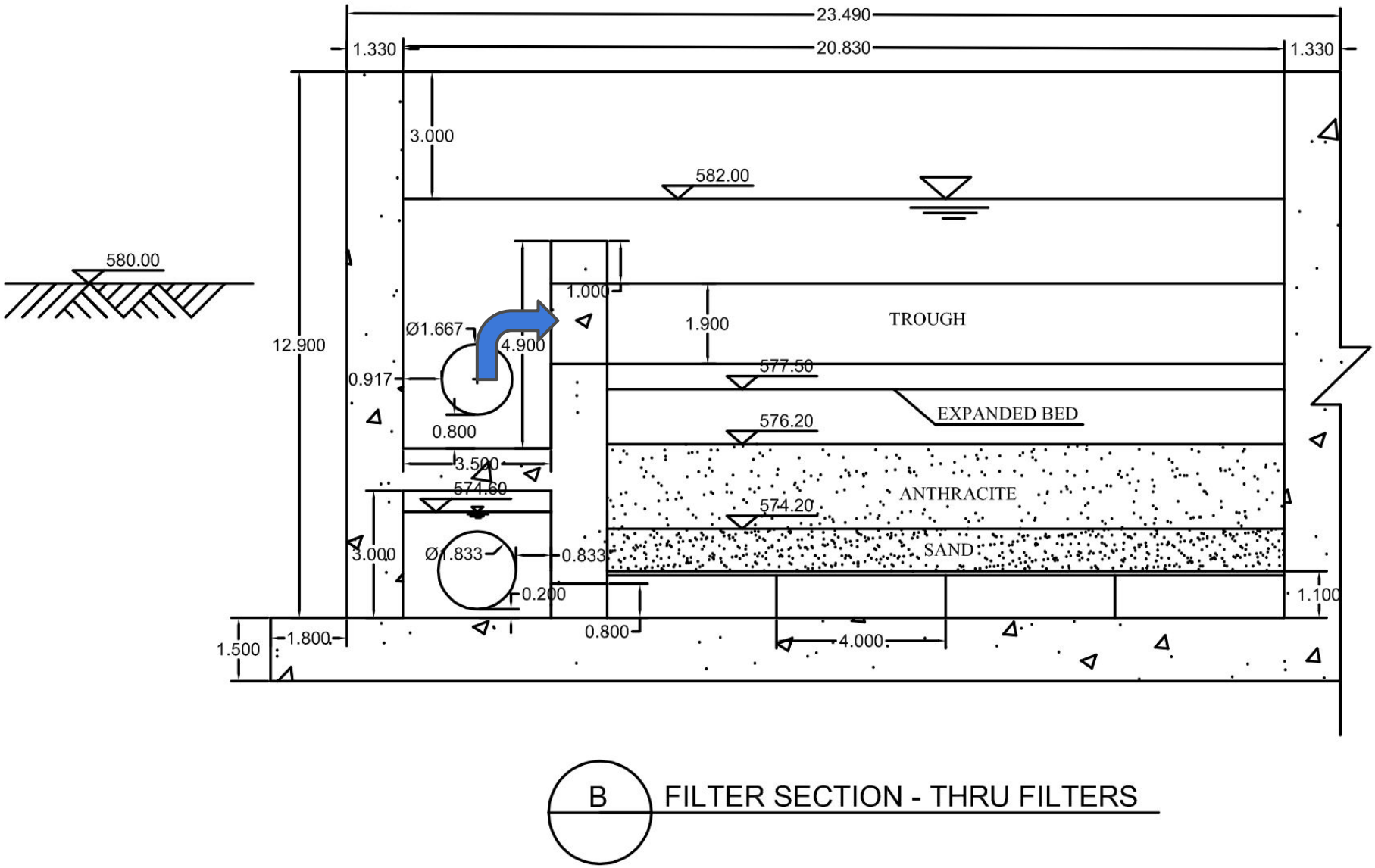

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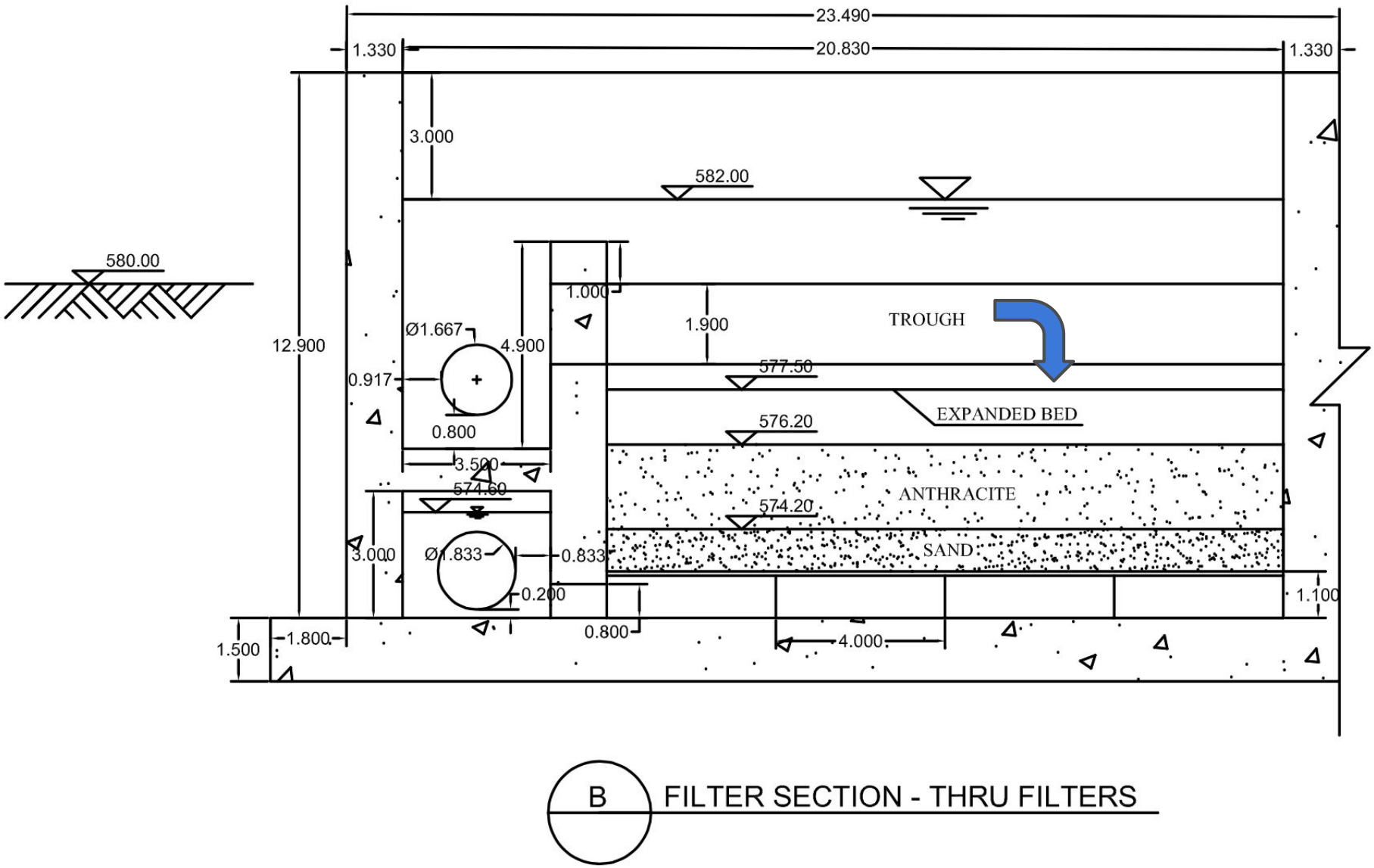

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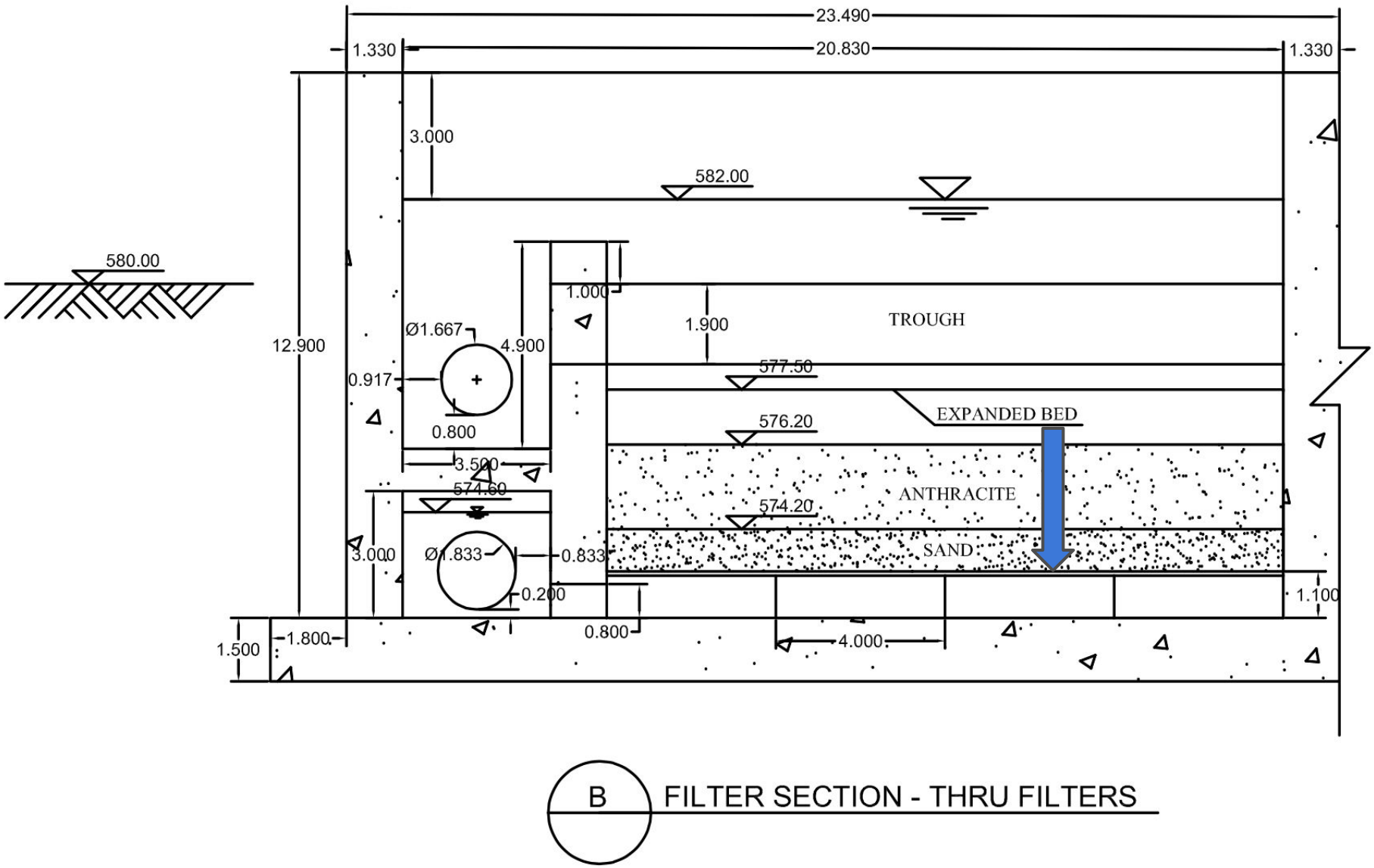

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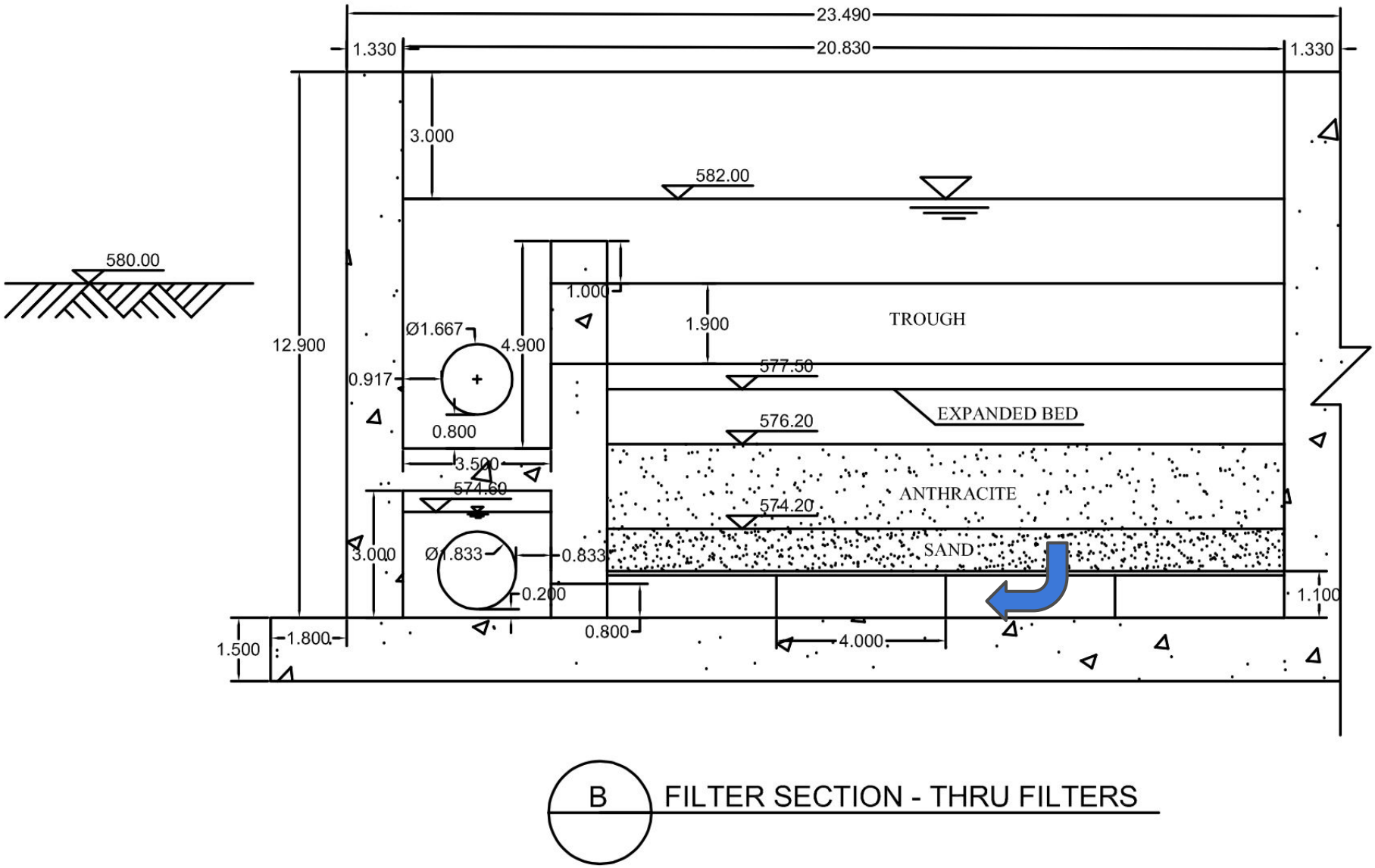

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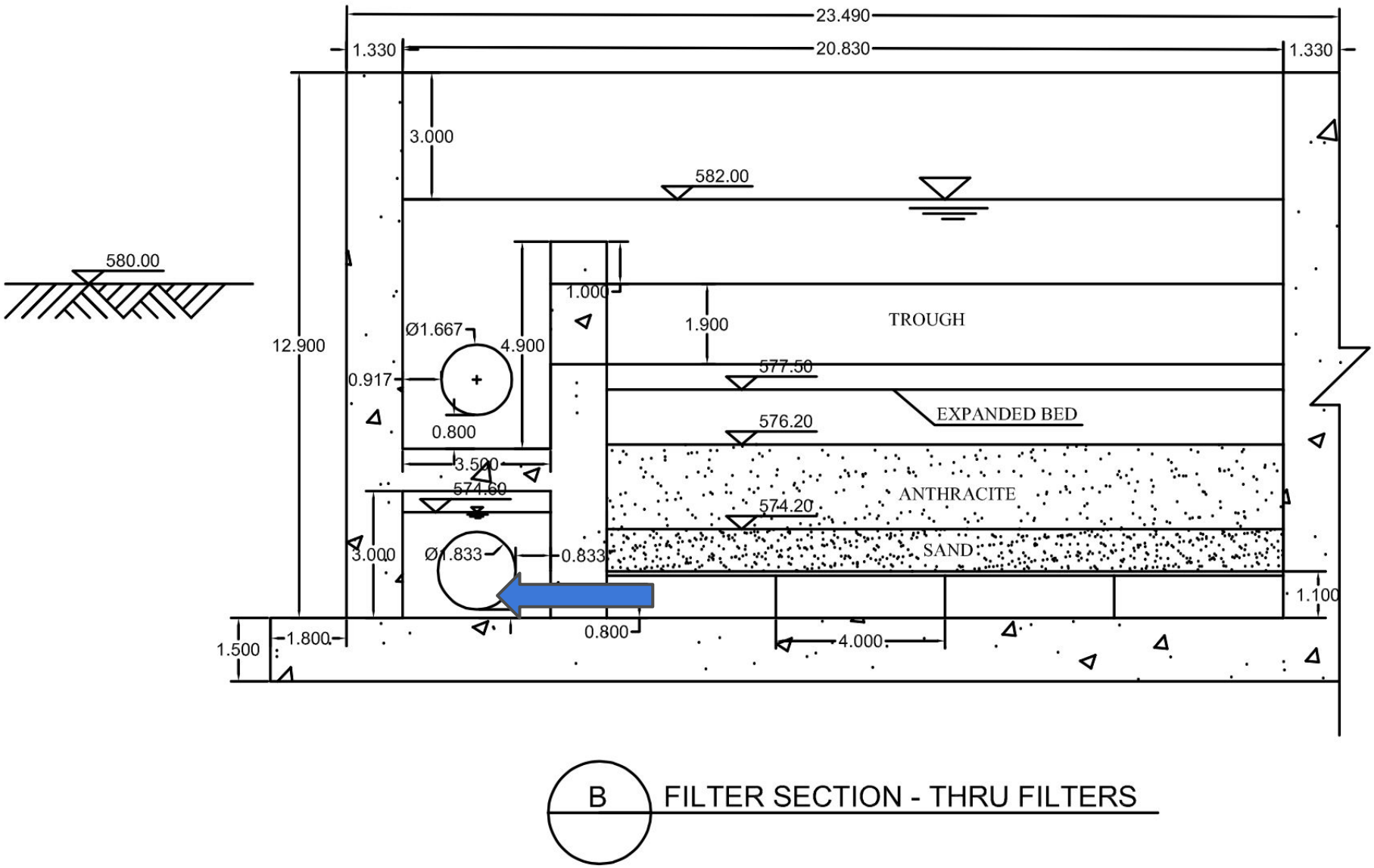


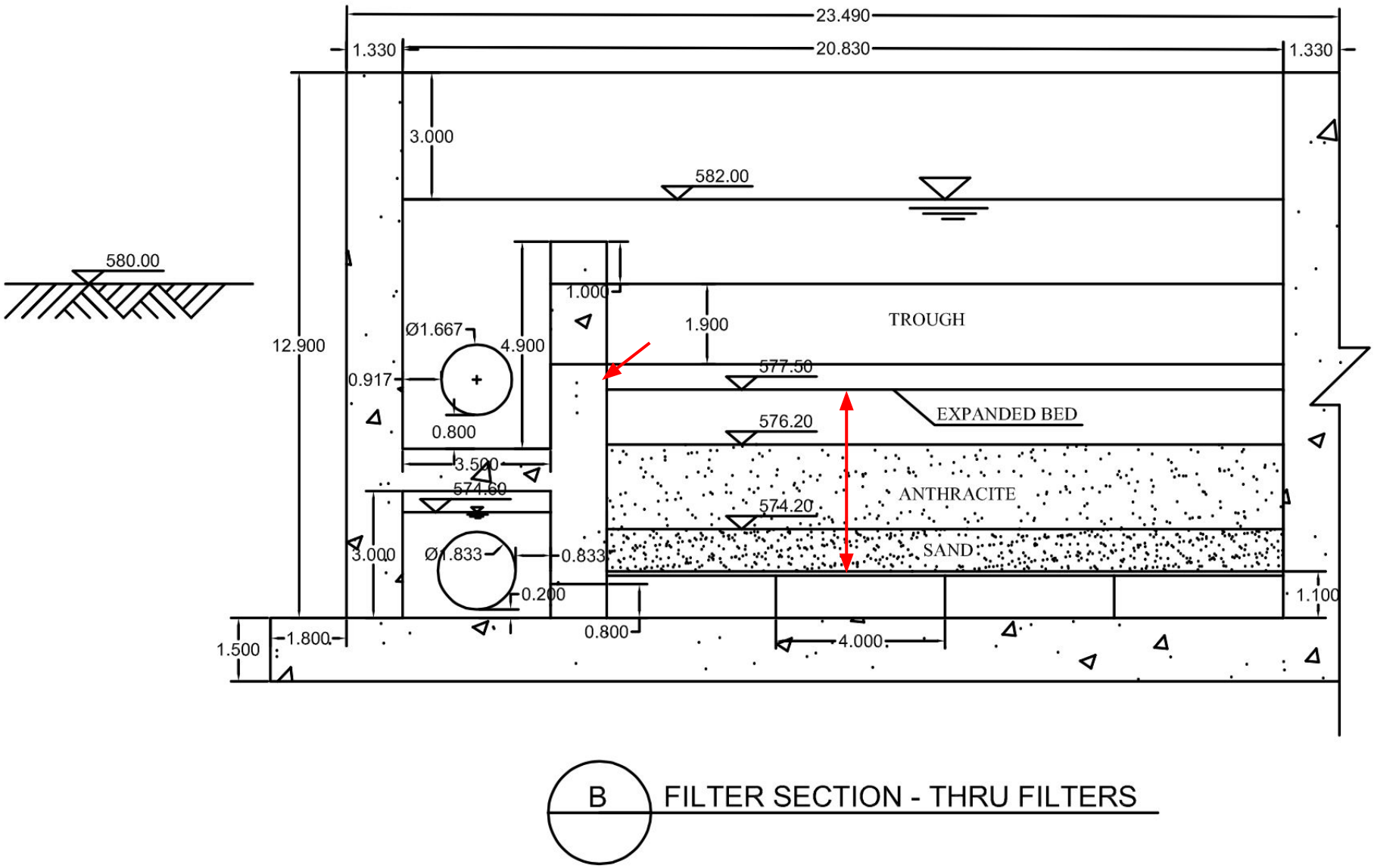
Filter Design

Filtration bed

- Dual Media

Parameter	Sand	Anthracite
d_{10} (mm)	0.5	1.1
UC	1.3	1.3
Density (g/cm^3)	2.6	1.5
Porosity	0.4	0.4
Spherical factor	0.95	0.7
Depth (in)	**12**	**24**
Expanded depth (in) (winter condition)	**16.9**	**34.1**

Filter Design



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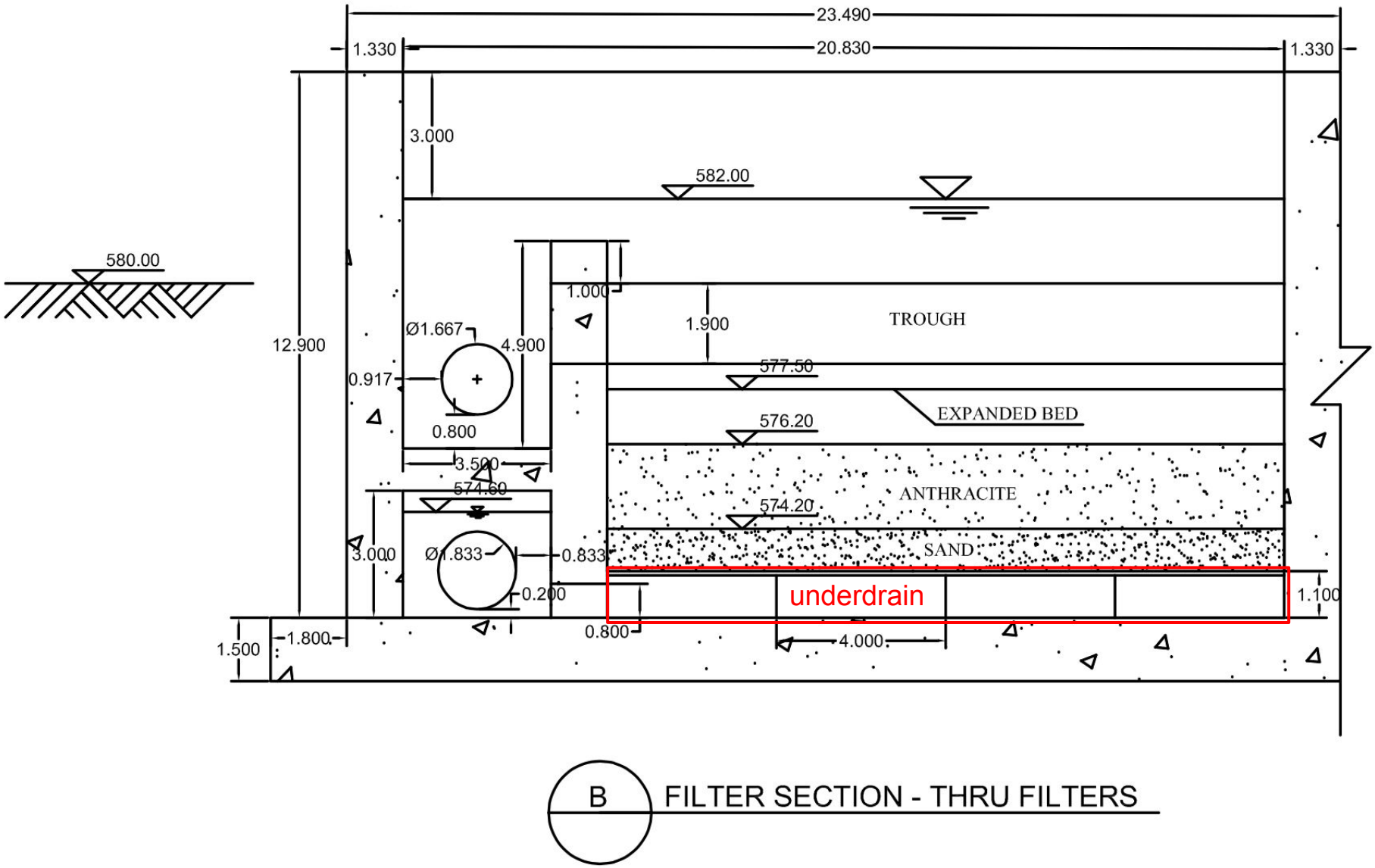
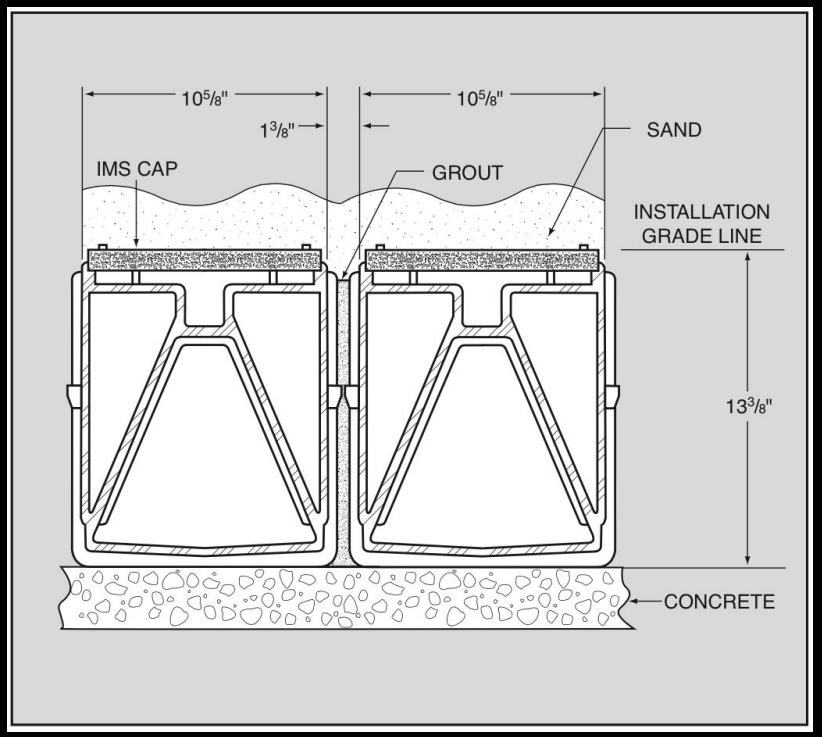


Filter Design

Underdrain

- Leopold type S drain
  - Number of units per filter cell: 72



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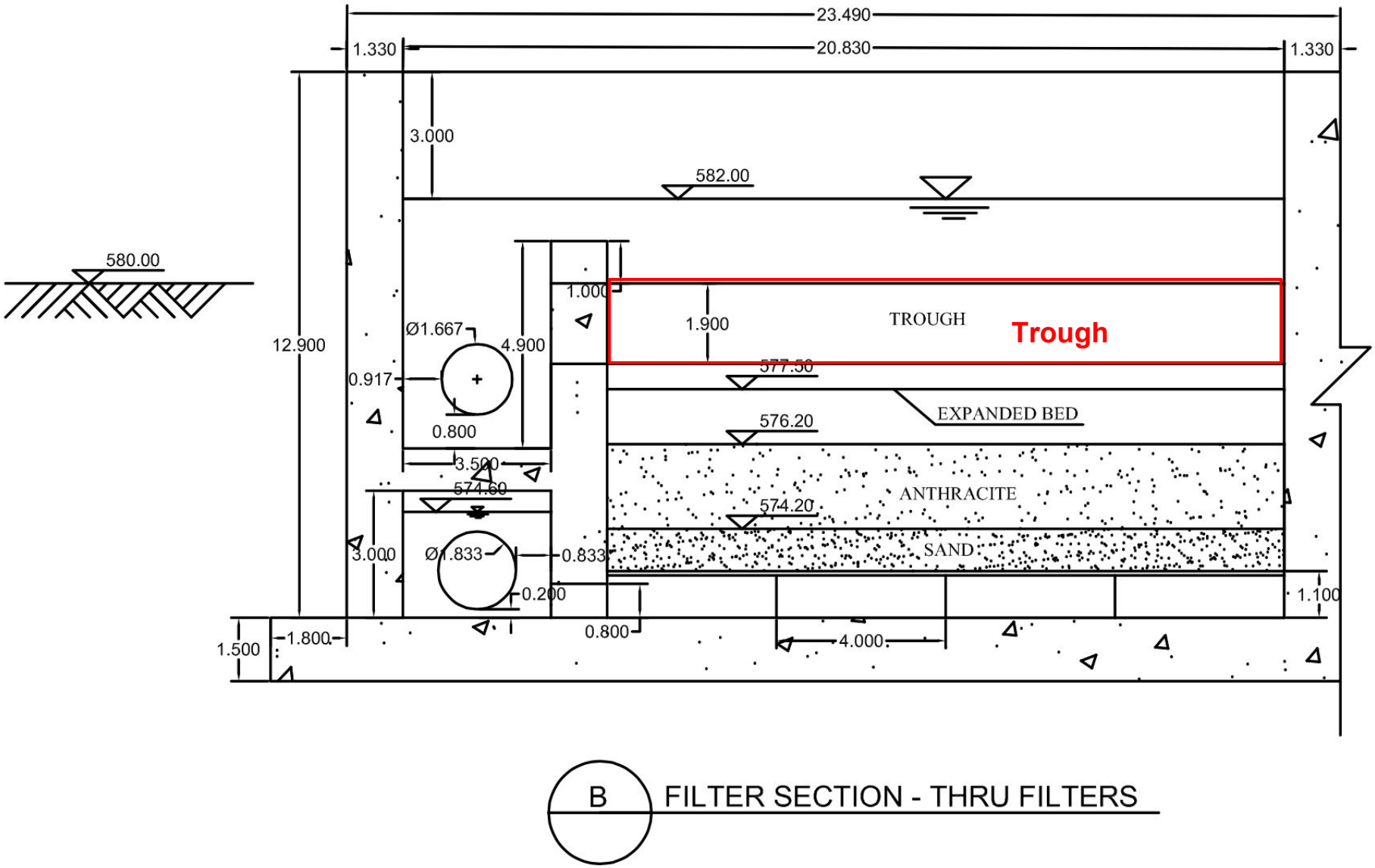
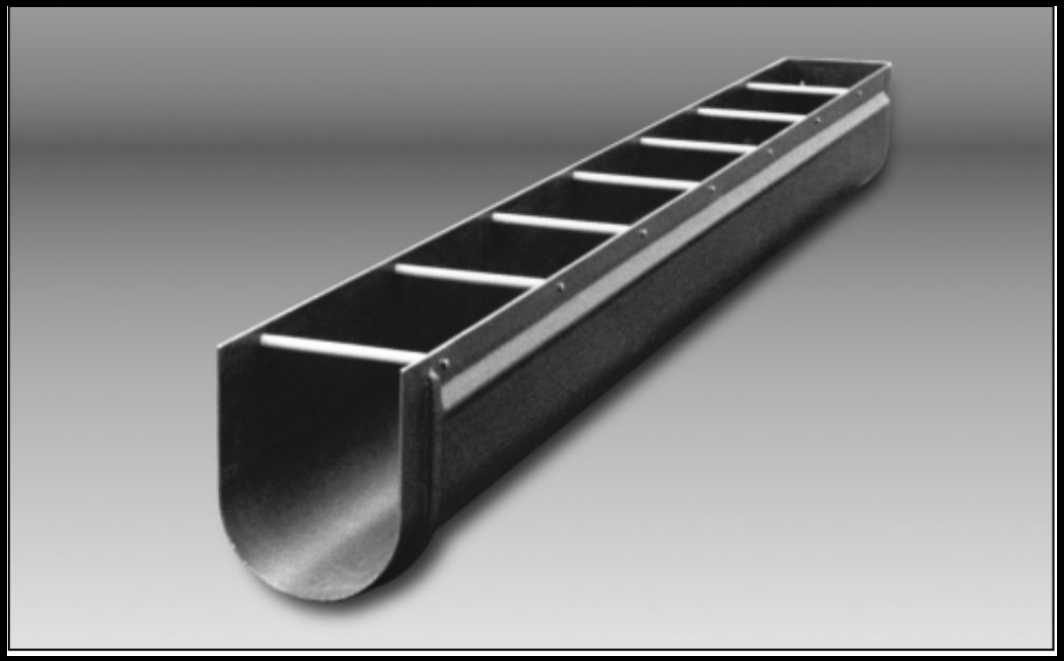


Filter Design

Troughs

- Leopold Fiberglass Wash - Water troughs
  - Number of units: 2 per filter cell
  - Dimension: 1.75 ft × 1.87 ft × 16 ft



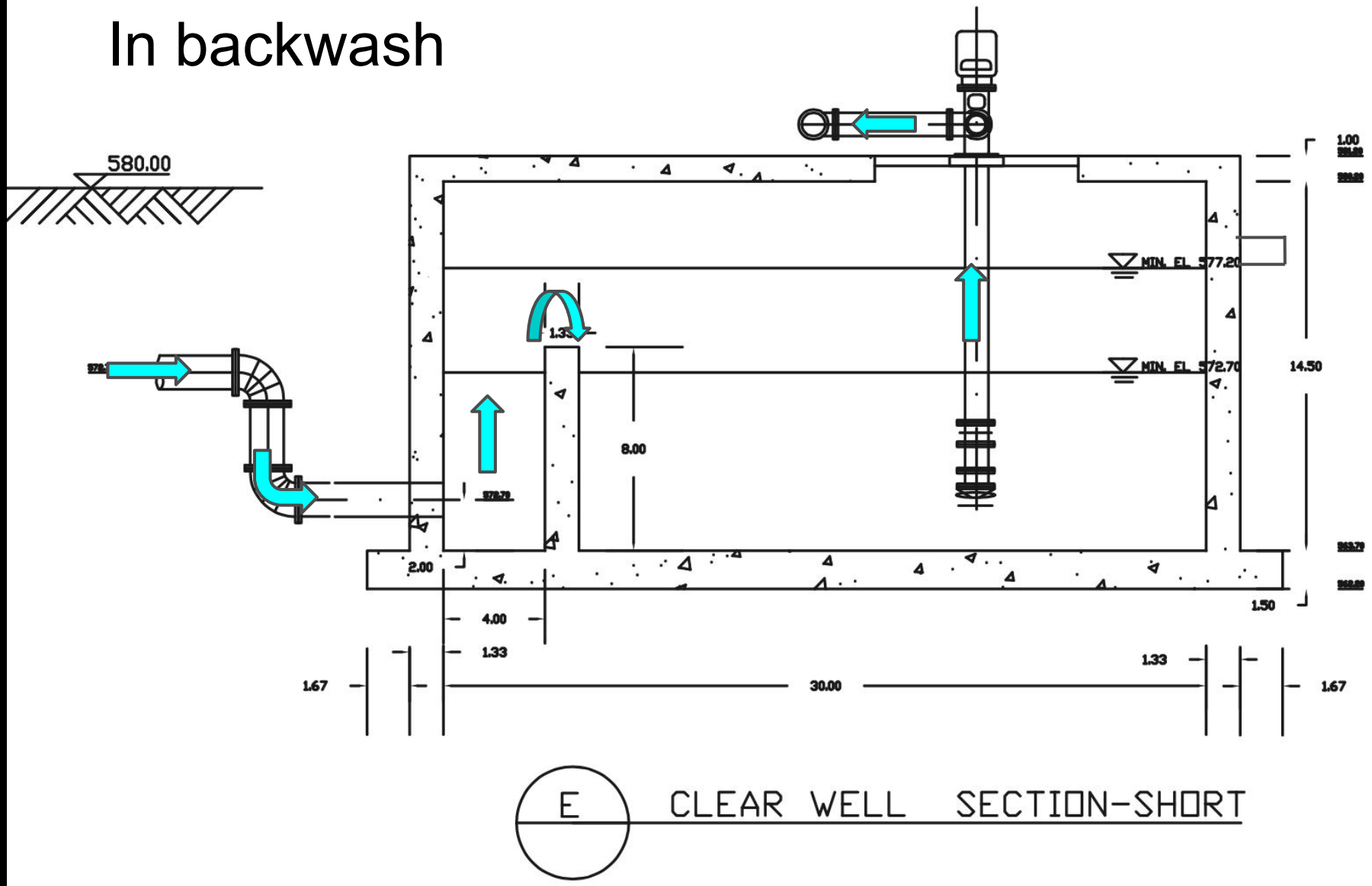
Clear Well

- First clear well
  - Between secondary clarifier and filter
  - Lifting pumps

- Second clear well
  - After filter
  - backwash pumps

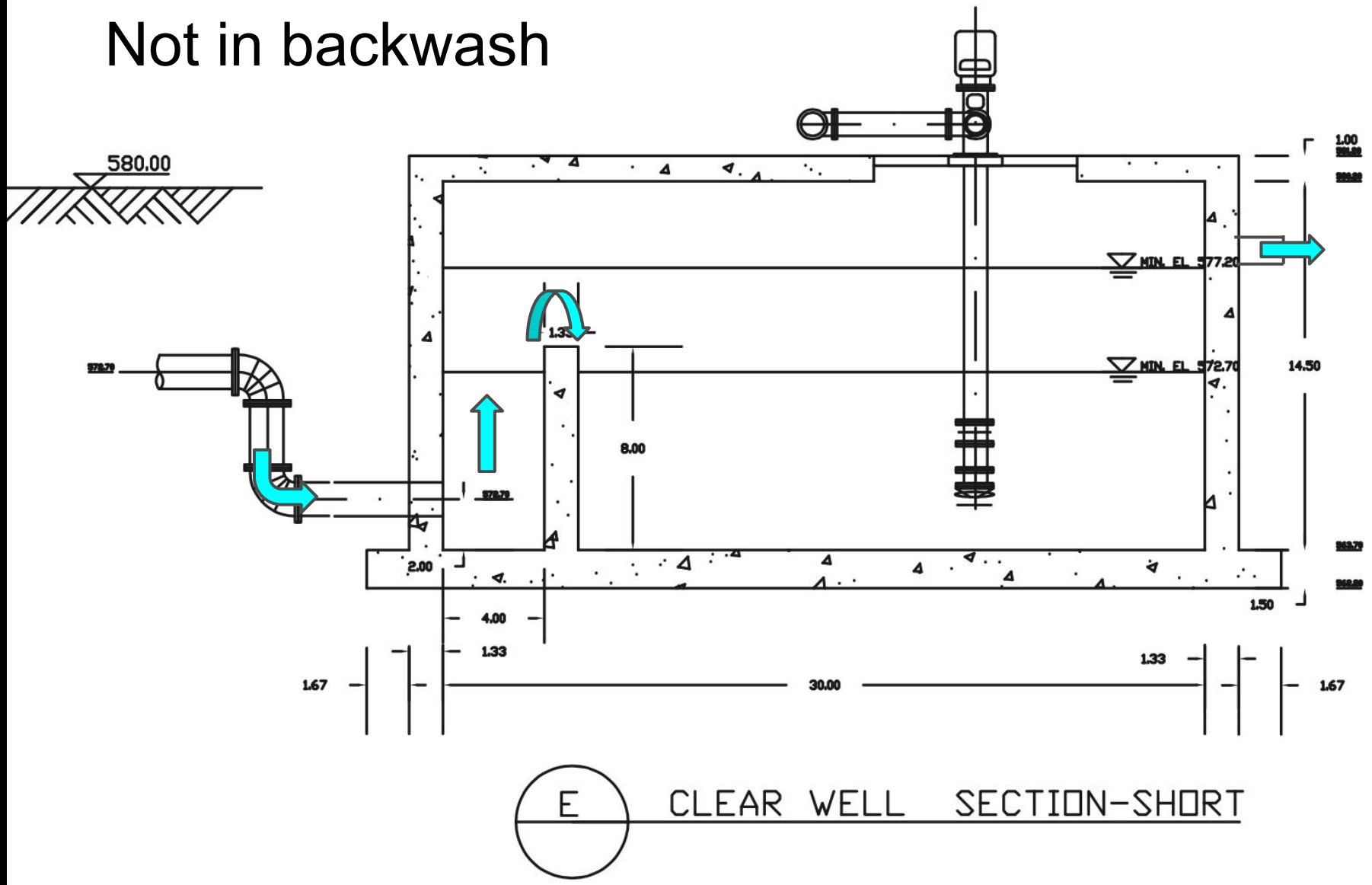
Clear Well

In backwash

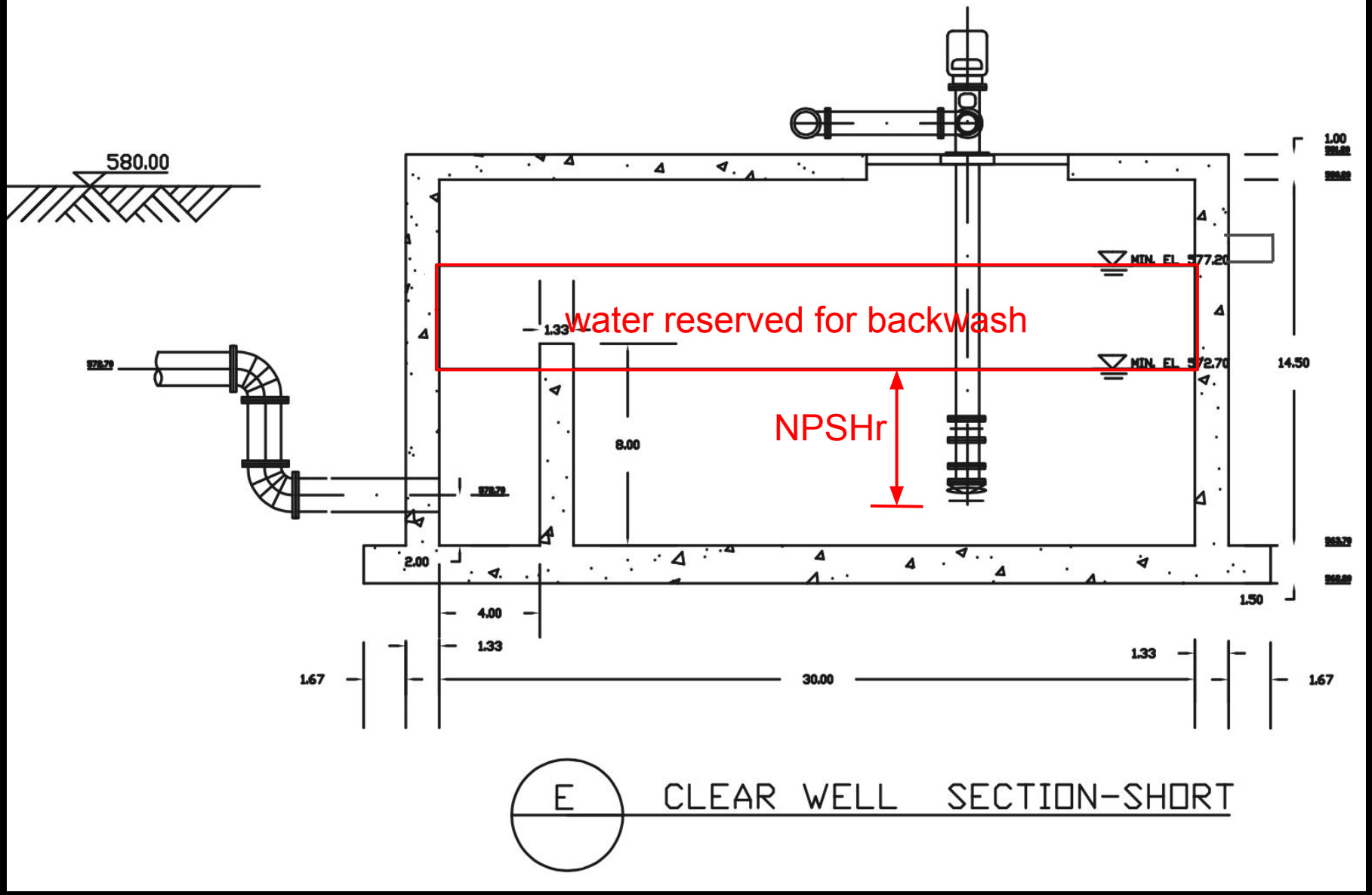


Clear Well

Not in backwash



Clear Well


580.00
water reserved for backwash
MIN. EL. 577.20
MIN. EL. 572.70
NPSHr
14.50
8.00
1.33
2.00
4.00
1.33
1.67
30.00
1.33
1.67
1.50
1.00
E
CLEAR WELL SECTION-SHORT

Pump Selection

Backwash Pumps

Number of pumps	5
Total flow rate (gpm)	5632
Total head (ft)	20.54

Lifting Pumps

Number of pumps	5
Total flow rate (gpm)	4722
Total head (ft)	12.07

- 5430-SOLIDS HANDLING SUBMERSIBLE PUMP
- Manufacturer: PENTAIR-FAIRBANKS NIJHUIS

Operability and Constructability

FILTER

CLEAR WELL

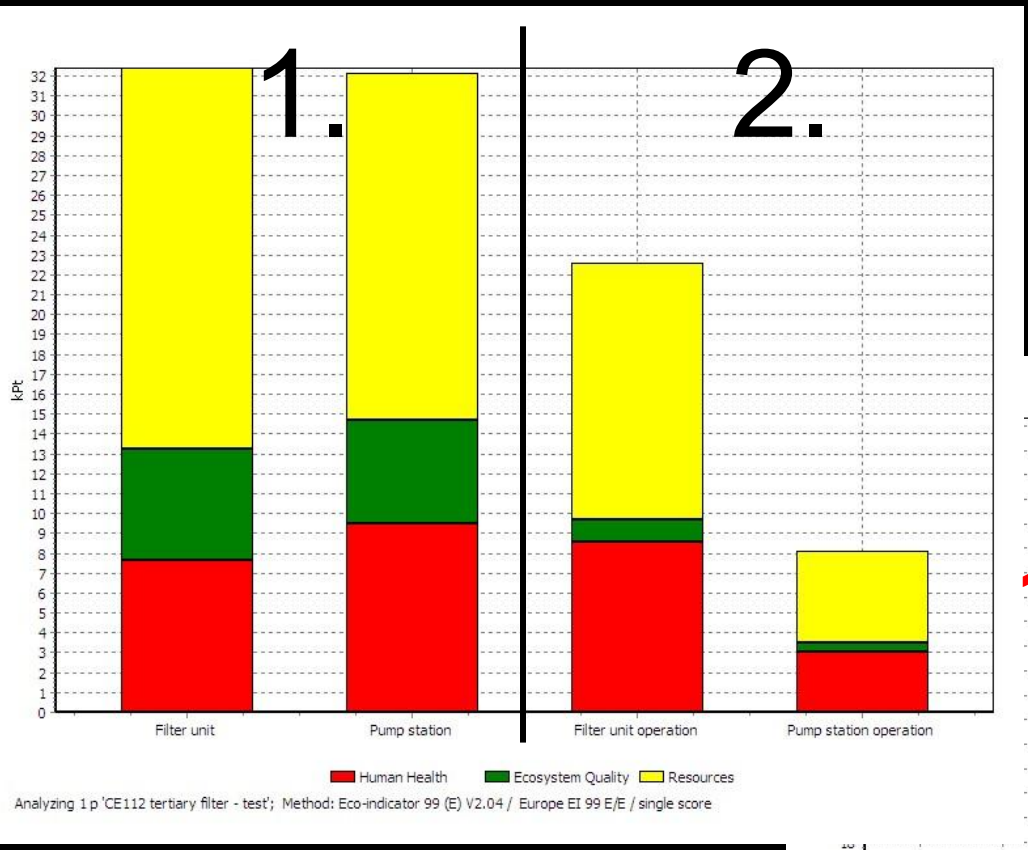
PUMP

Life Cycle Assessment

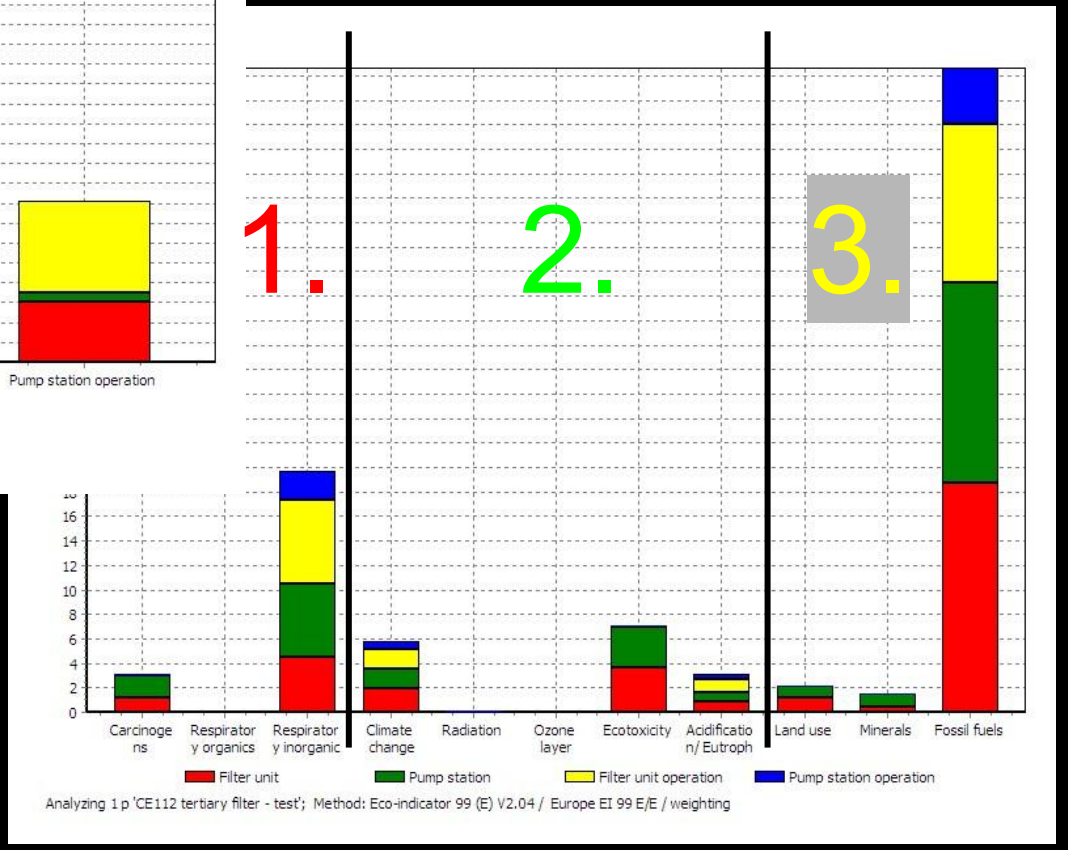
EarthShift SimaPro Software

- Software from 1990
  - 1,000+ users, 80 countries
- Impacts
  - Resource depletion
  - Human health
  - Ecological quality

Life Cycle Assessment



1. Construction
2. Operation



1. Human Health
2. Ecosystem Quality
3. Resource Depletion

Cost Estimates

ENR Construction Cost Index

- 2008 Values = $2,120,000
- Projections
  - 2008 Cost Index = 8094.28

1913 = 100	INDEX VALUE	MONTH	YEAR
CONSTRUCTION	9992.34	+0.2	+2.5
COMMON LABOR	21336.45	+0.3%	+2.5%
WAGE $/HR.	40.45	+0.3%	+2.5%

  - Today's Value = $2,620,000
  - 1 year + 9 months
    - January 2017 Value = $2,740,000

Cost Estimates

Operation and Maintenance

- Operation (Electricity costs)
  - 4 backwash pumps
  - 4 lifting pumps
- Maintenance
  - 5% mechanical equipment cost
- $24,200 / year
- $6,020,000 Present Value (PV)
  - N = 20 years
  - *i* = 5%

$$PV(1+i)^N + PYMT\frac{(1+i)^N - 1}{i} = 0$$

Cost Estimates

Time Value of Money

- Project Lifetime and Interest
  - N = 20 years
  - *i* = 5%
- Calculate Annual Payments
  - Total January 2017 Cost = $8,760,000
  - -$703,000 annual payments

$$PV(1+i)^N + PYMT\frac{(1+i)^N - 1}{i} = 0$$

Summary

AWT Expansion

- Augment AWT facility to 14 mgd
- Construction of
  - 2 clear wells
  - 1 dual media filtration unit (sand and anthracite coal)
- 20 year lifetime
- Provide cleaner effluent to surroundings of Ukiah

Thank You.

Sources Cited

Images:

ECAC Logo: Jorge Carreño

Title Page / Banner: http://www.earthyreport.com/site/reusing-wastewater/

LCA page: http://www.earthshift.com/sites/all/themes/acquia_prosper/logo.png

Cost Estimate Page: http://enr.construction.com/economics/current_costs/

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Questions?