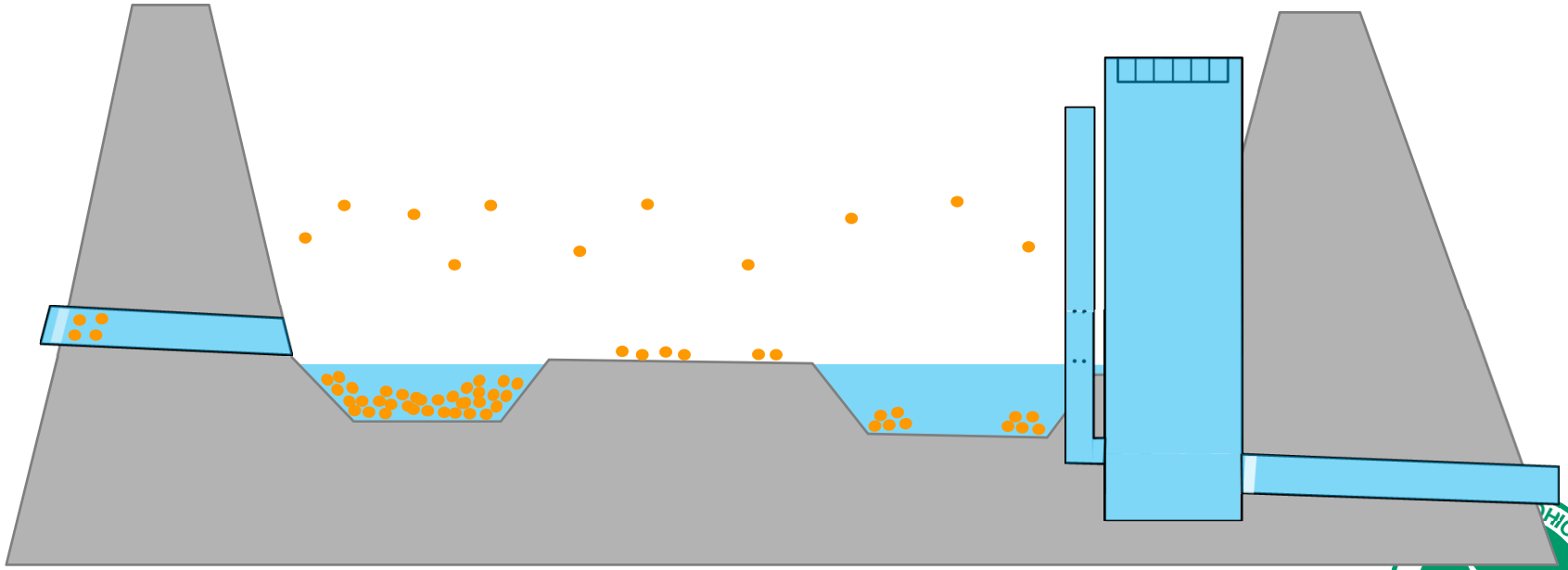
Extended Detention Basin Design

Extended Detention

Extended Detention Basin

- L&D Vol. 2 Section 1117.3
- Provides quality and quantity treatment

Extended Detention Basin Treatment Processes



Design Process

- Treatment Goals
- Preliminary Det. Basin Sizing
- Siting Analysis
- Det. Basin Shape and Detailed Sizing
- Water Quality Outlet
- Primary Outlet
- Overflow Weir
- Other Considerations

Siting Analysis - Considerations

- Space
- Enough R/W treatment
- Tributary area too large?
- Safety
- Environmental impacts
- Floodplain cut/fill
- R/W acquisition
- Vehicle access

Siting Analysis

- It can be difficult to find space.
- Intersections
- Interchanges
- R/W acquisition
- Underground detention

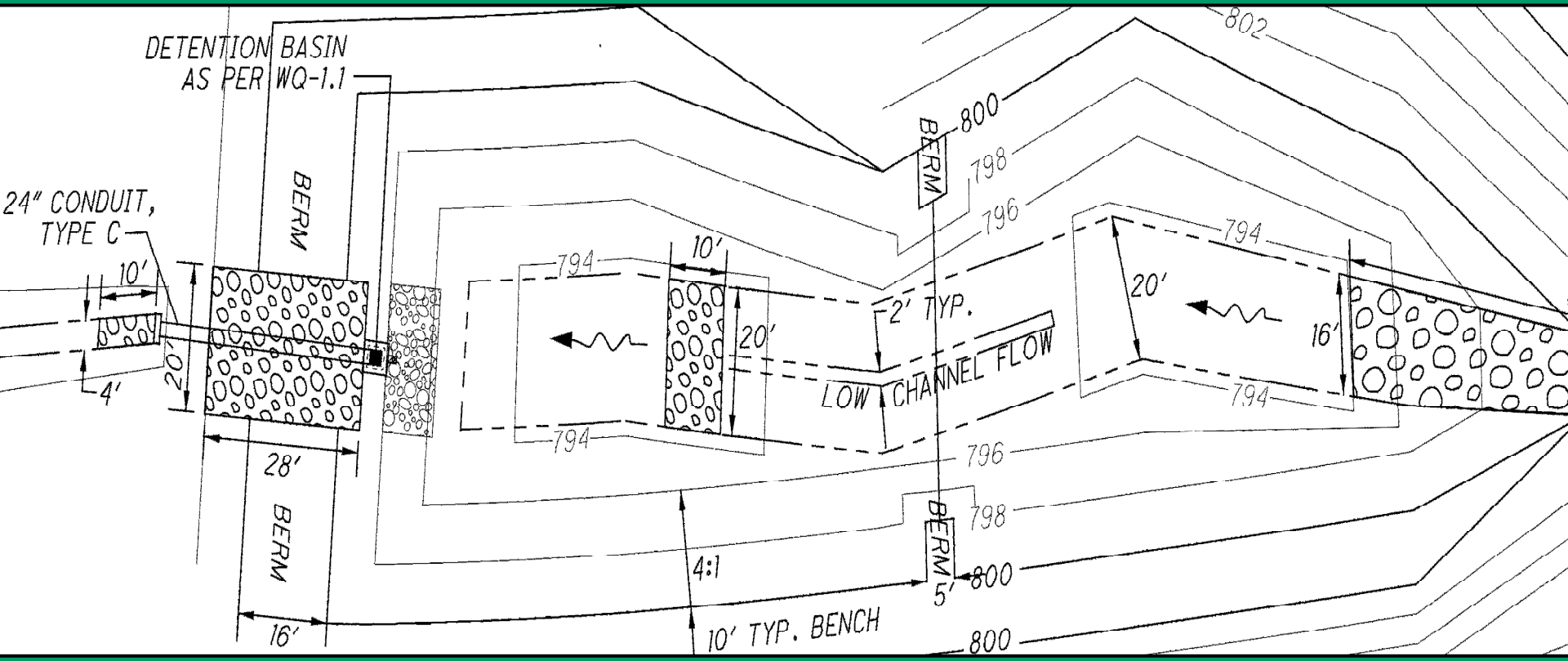
Design Process

- Treatment Goals
- Preliminary Det. Basin Sizing
- Siting Analysis
- Det. Basin Shape and Detailed Sizing
- Water Quality Outlet
- Primary Outlet
- Overflow Weir
- Other Considerations

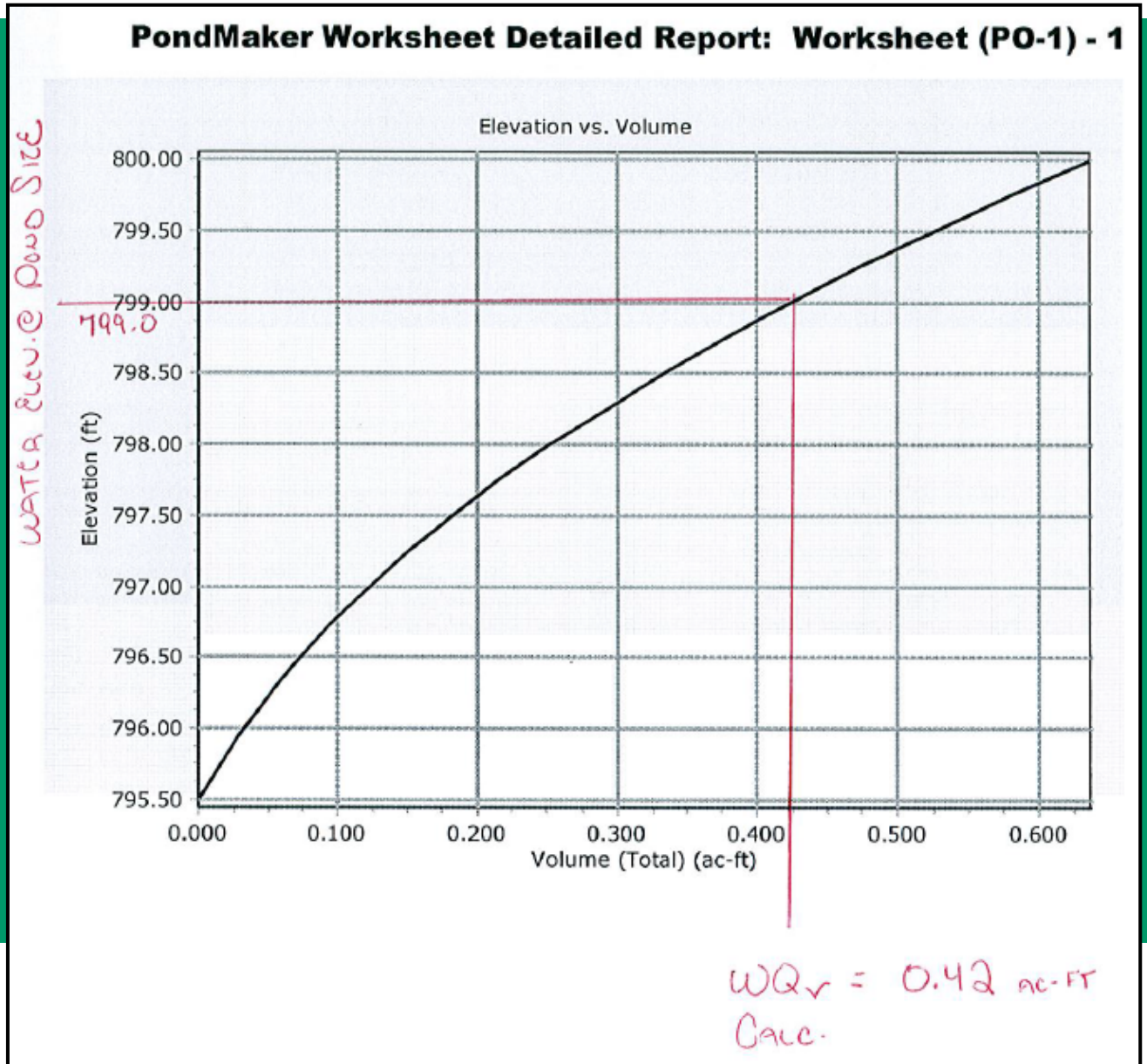
Detention Basin Sizing

- Calculate WQ_V based on tributary area
- WQ_V must be between lowest outlet primary outlet (10-yr)
- 10% WQ_V additional for forebay
  - Dead storage
- 10% WQ_V additional for micropool
  - Dead storage

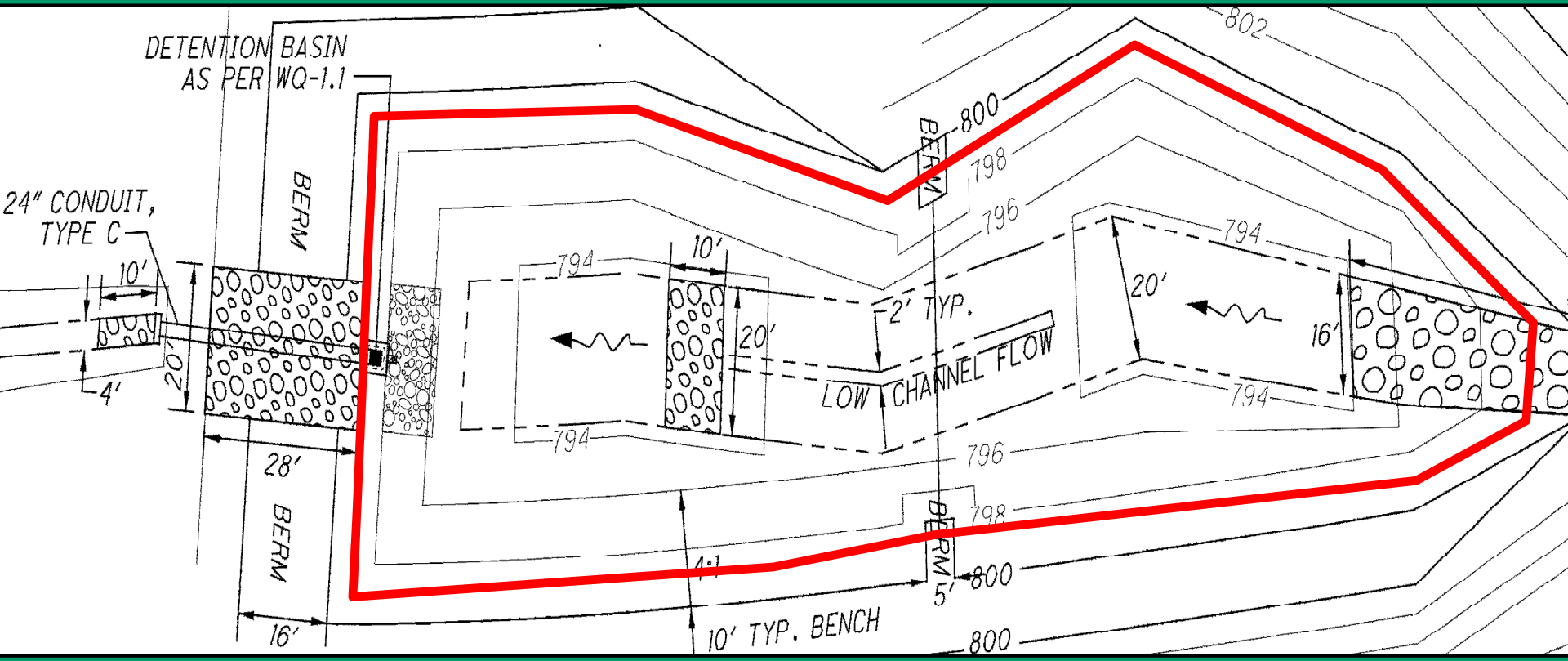
Project Example - WQ_V



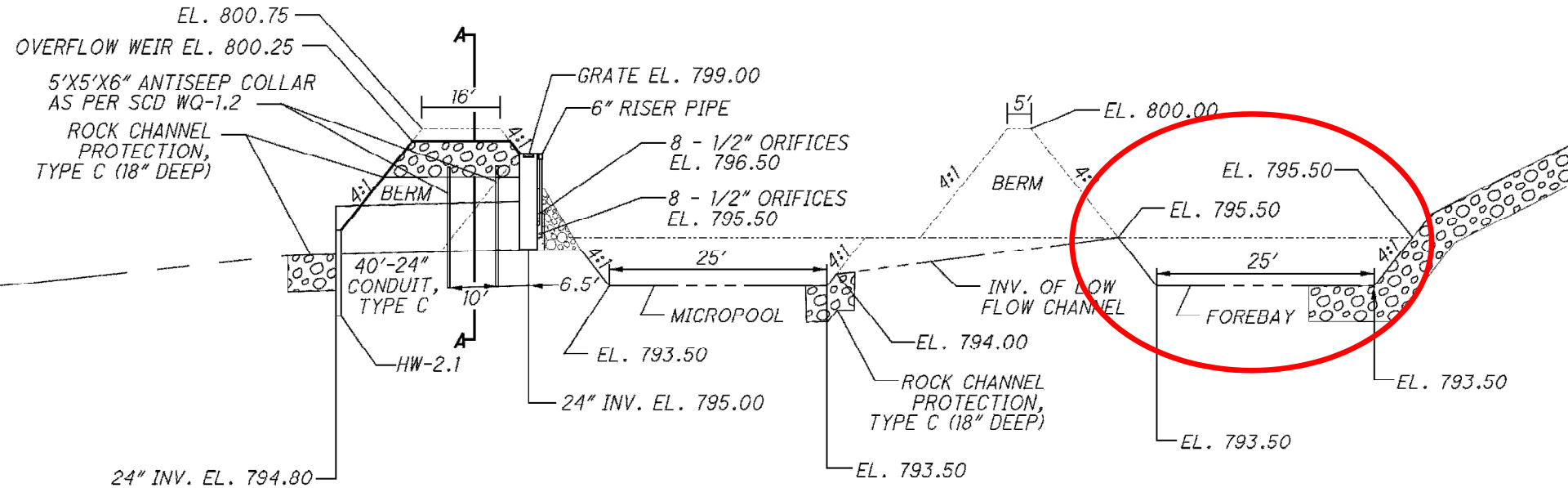
Stage / Storage Curve



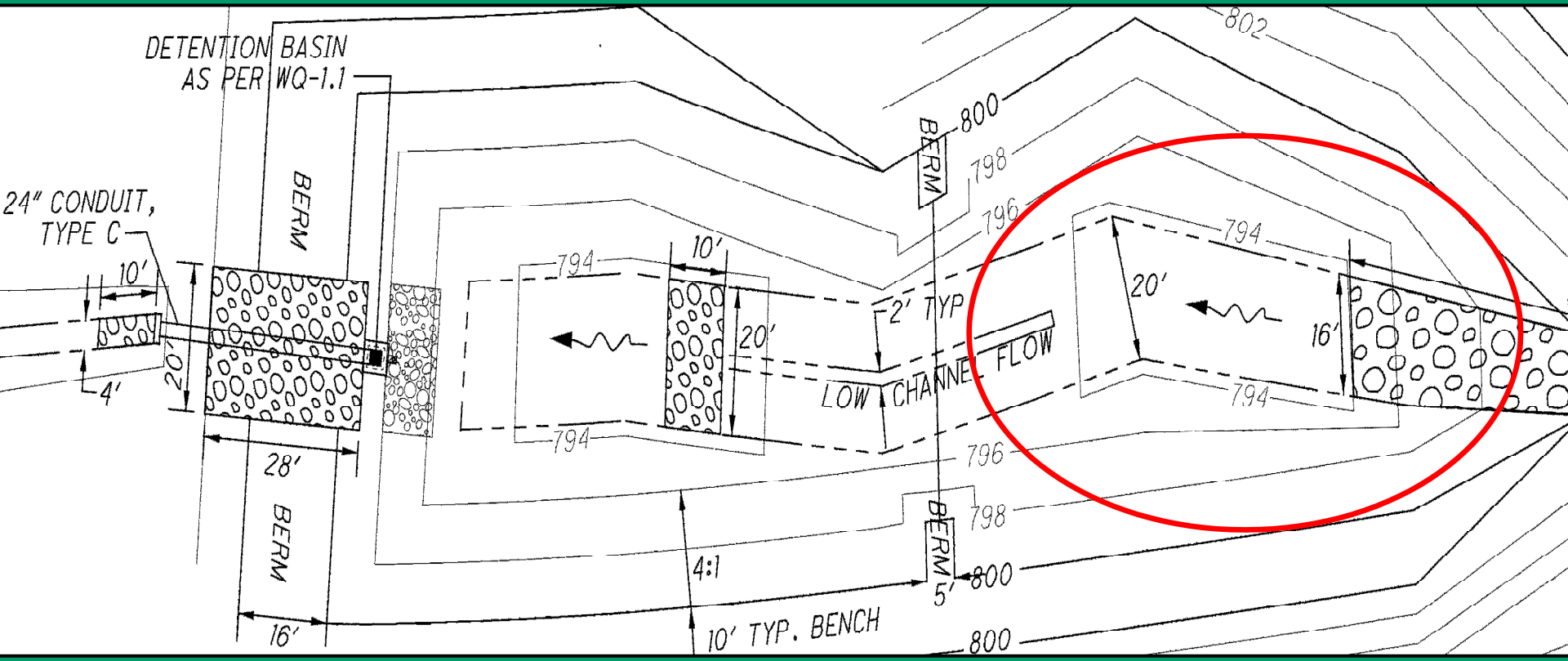
Project Example - WQ_V



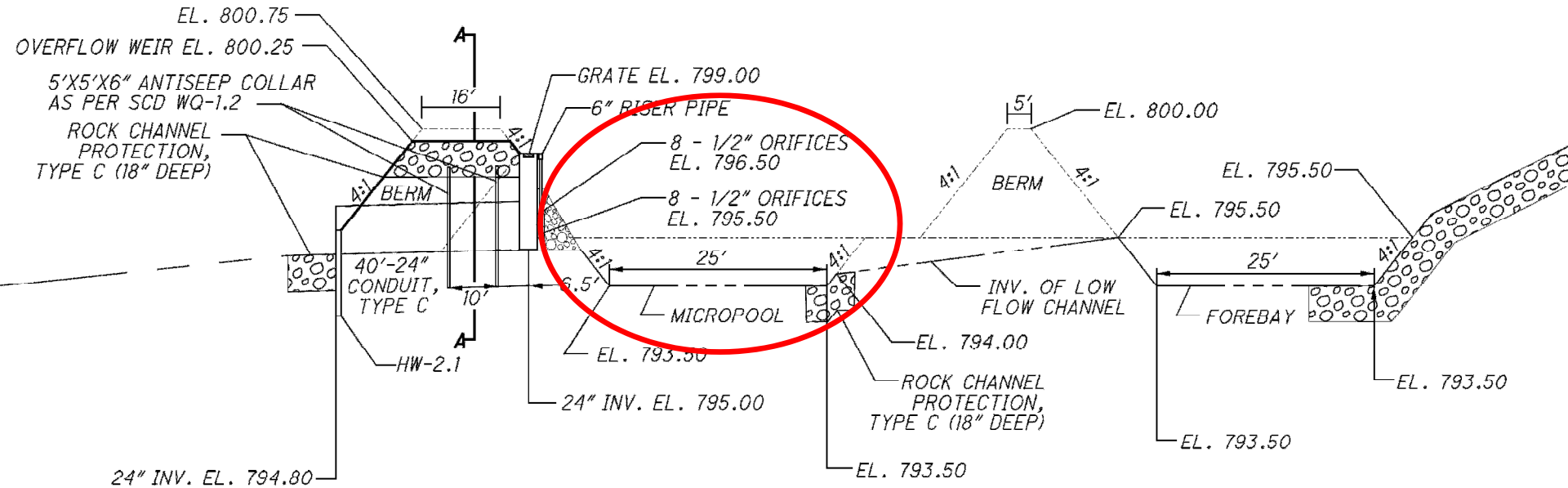
Project Example - Forebay



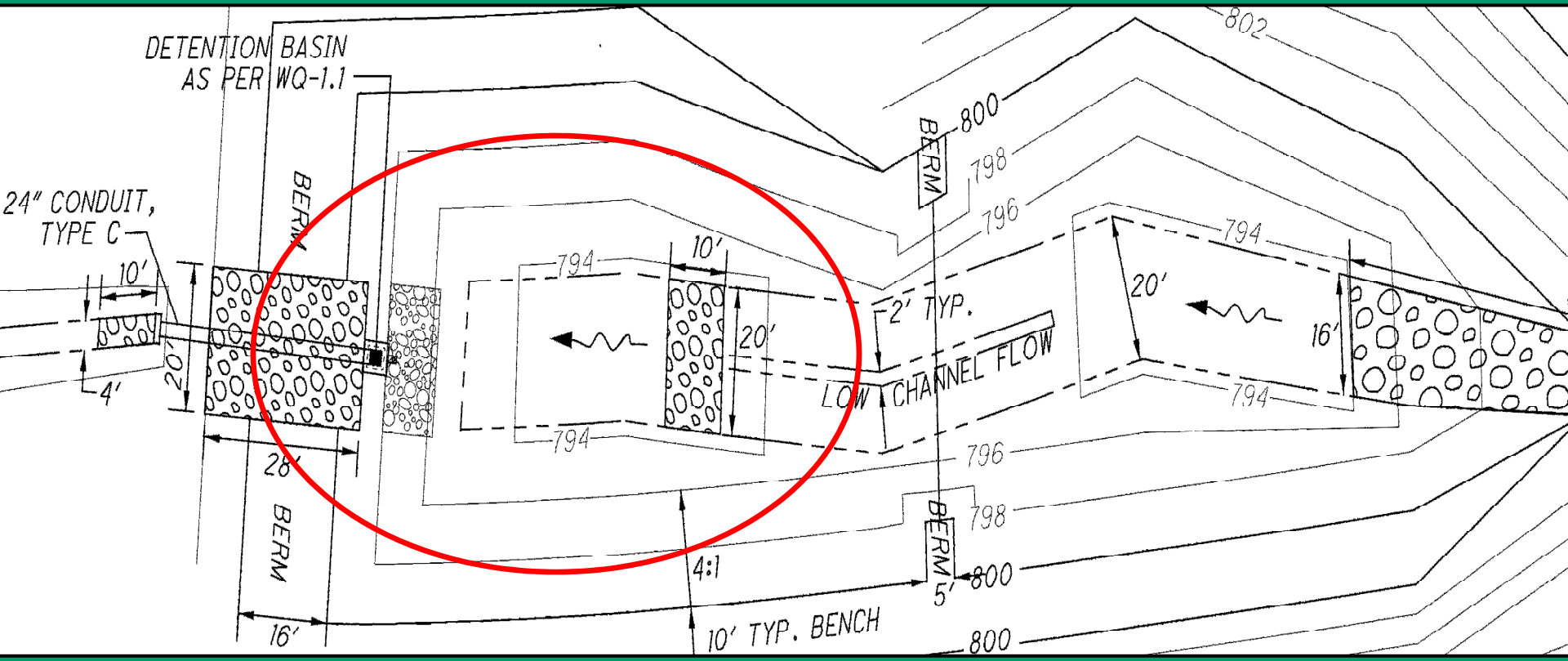
Project Example - Forebay



Project Example - Micropool



Project Example - Micropool



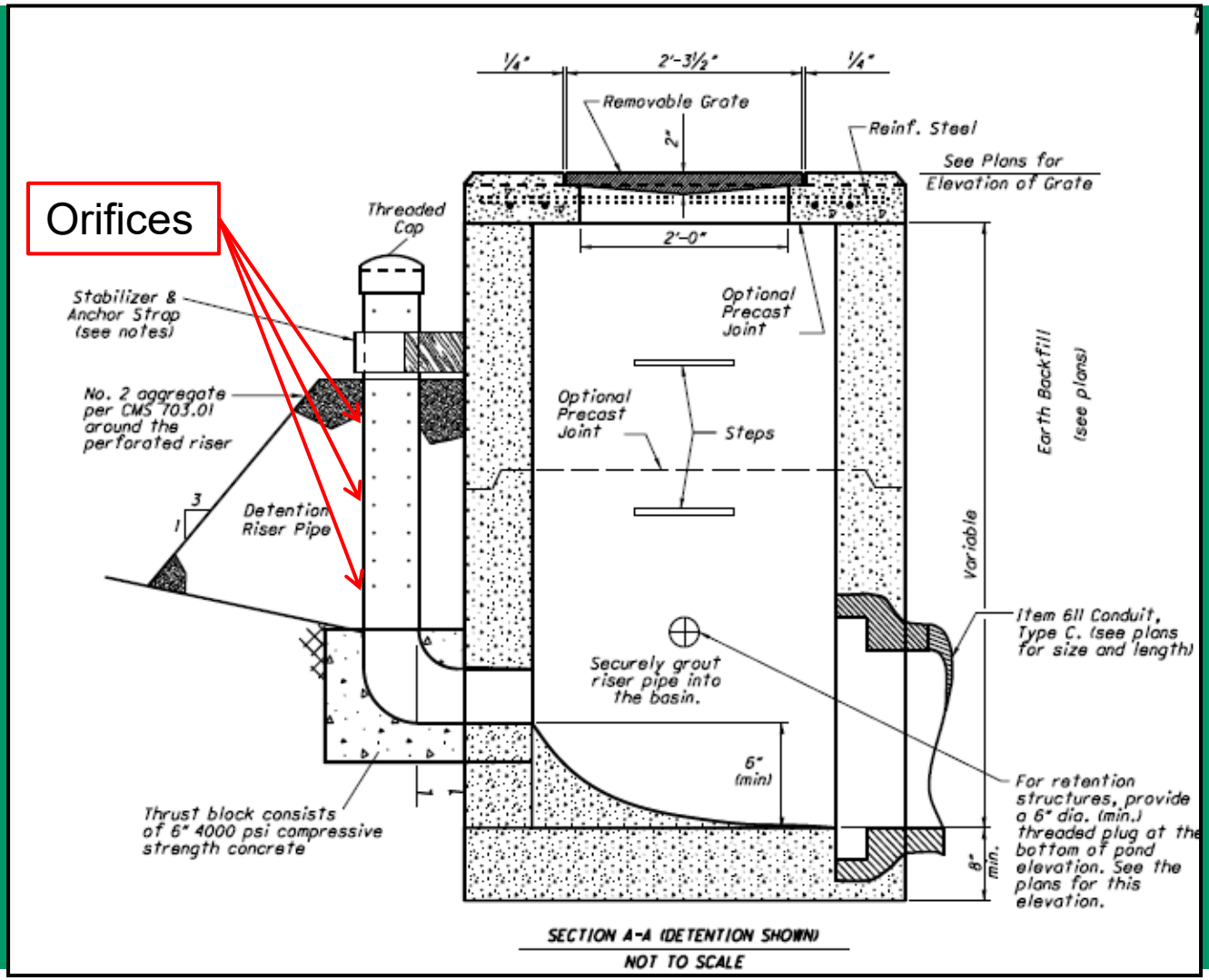
Design Process

- Treatment Goals
- Preliminary Det. Basin Sizing
- Siting Analysis
- Det. Basin Shape and Detailed Sizing
- **Water Quality Outlet**
- Primary Outlet
- Overflow Weir
- Other Considerations

Water Quality Outlet Design

- **Drain WQ_V in 48 hours or more**
- **50% of WQ_V or less drained in 1/3rd of the drain time**
  - 0.422 ac-ft * 50% = 0.211 ac-ft
  - 48 hrs * 1/3 = 16 hrs
- **Provide time for <u>sedimentation</u>**

Water Quality Outlet Design



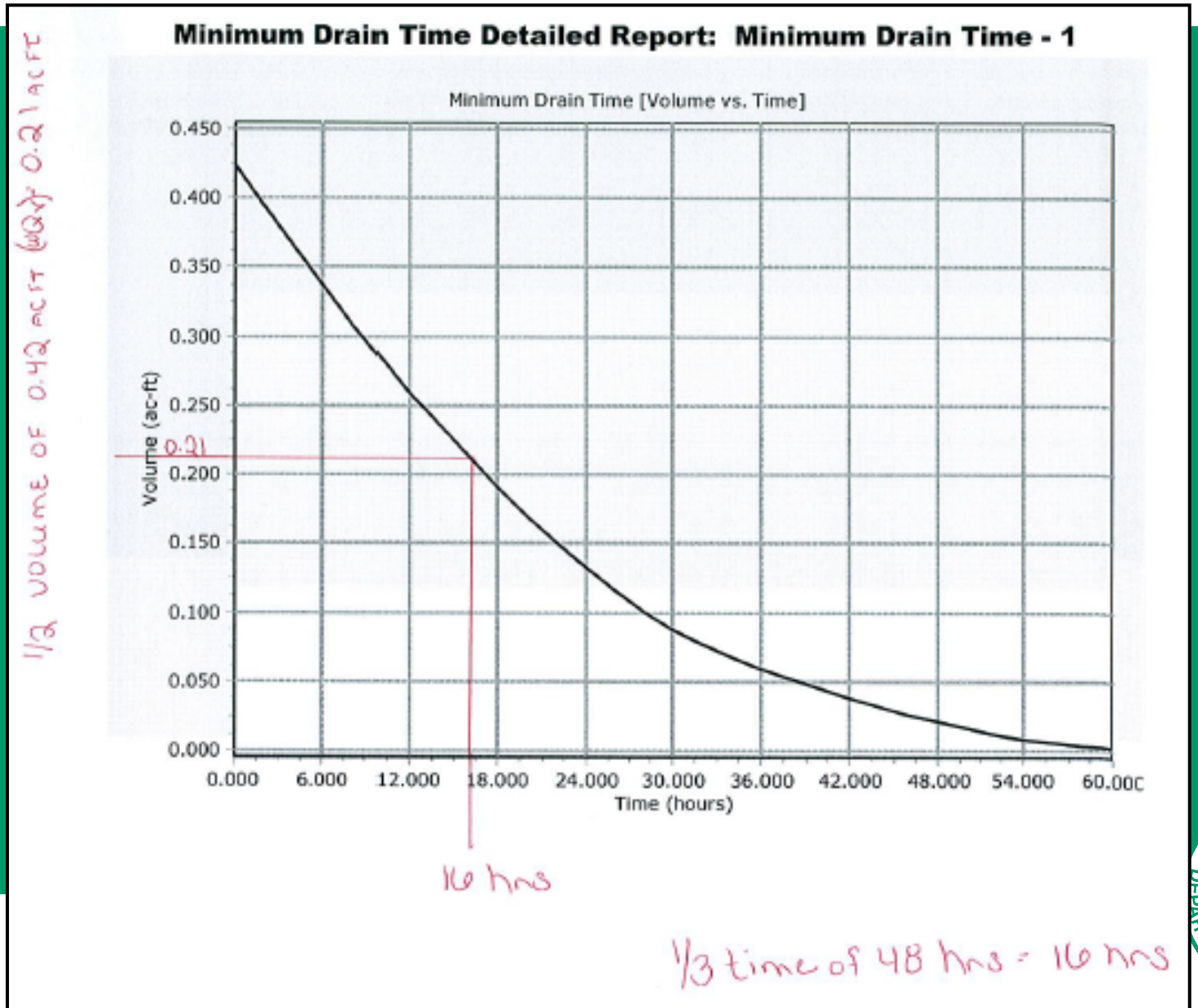
Water Quality Outlet Design

- A Hydrograph drawdown curve is necessary
- Calculate a stage / discharge curve

Or

- Use Pond Pack or HydroCAD
  - Pond Pack is part of Bentley Hydraulics Suite

Project Example – WQ Outlet



Design Process

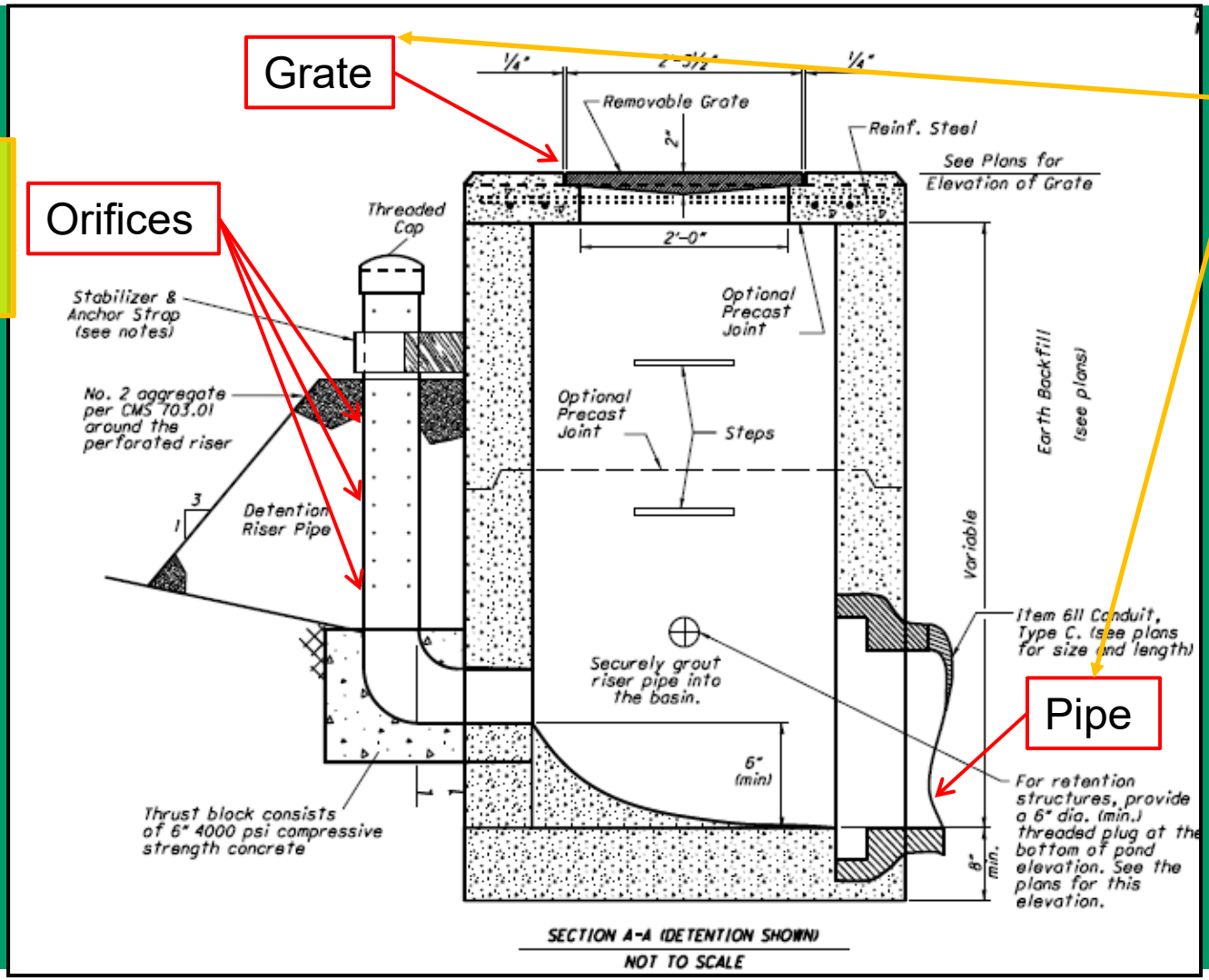
- Treatment Goals
- Preliminary Det. Basin Sizing
- Siting Analysis
- Det. Basin Shape and Detailed Sizing
- Water Quality Outlet
- Primary Outlet
- Overflow Weir
- Other Considerations

Outlet Structure

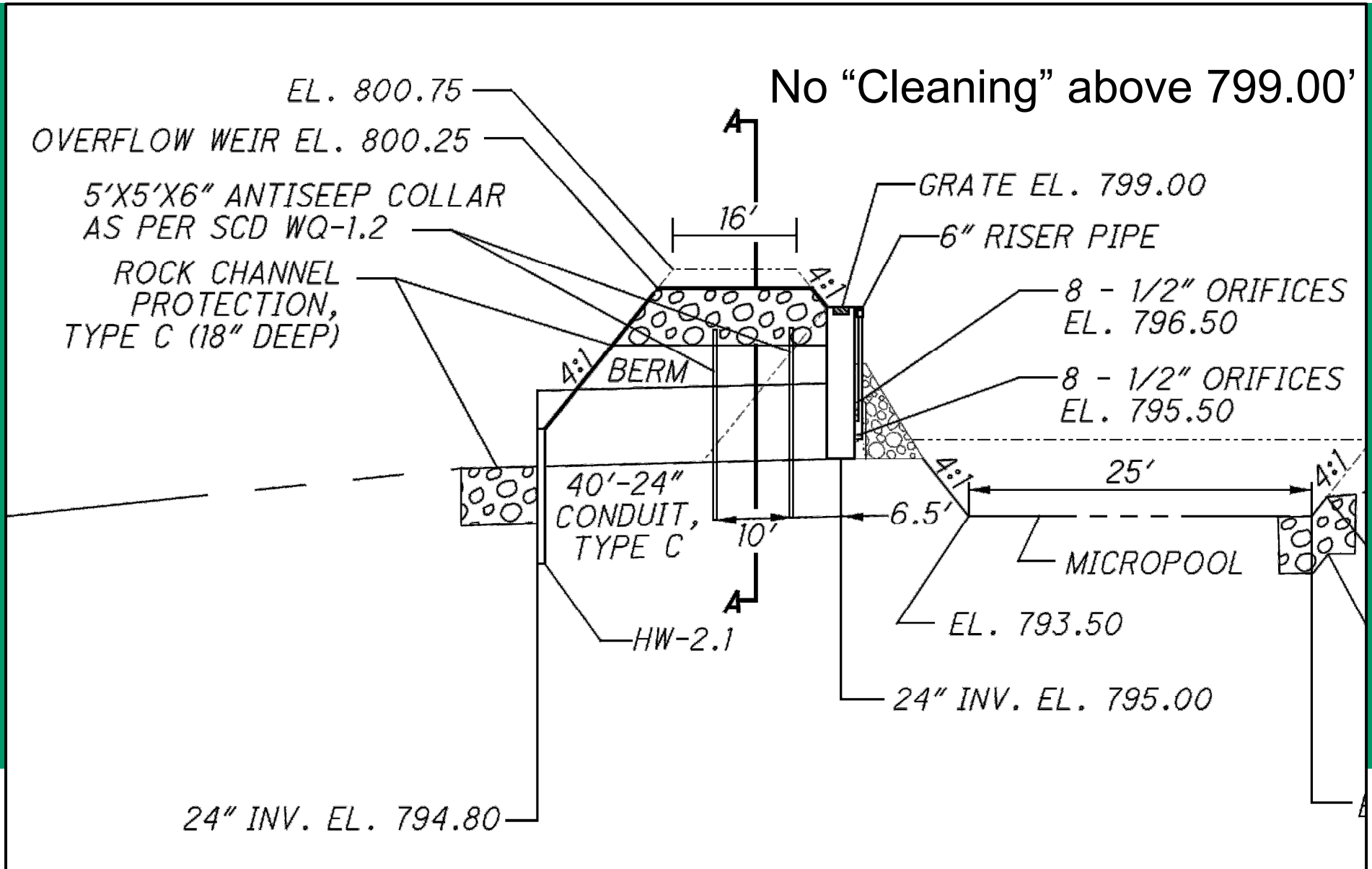
- **3 parts of detention basin outlet**
  - Water quality outlet(s)
    - Slowly draw down the WQ_V
  - Primary outlet(s)
    - Convey the 10-yr design storm (L&D Vol. 2, 1117.3.3
  - Overflow weir
    - Convey the 25-yr design storm (L&D Vol. 2, 1104.2.2

ODOT SCD WQ-1.1

Water Quality Outlets



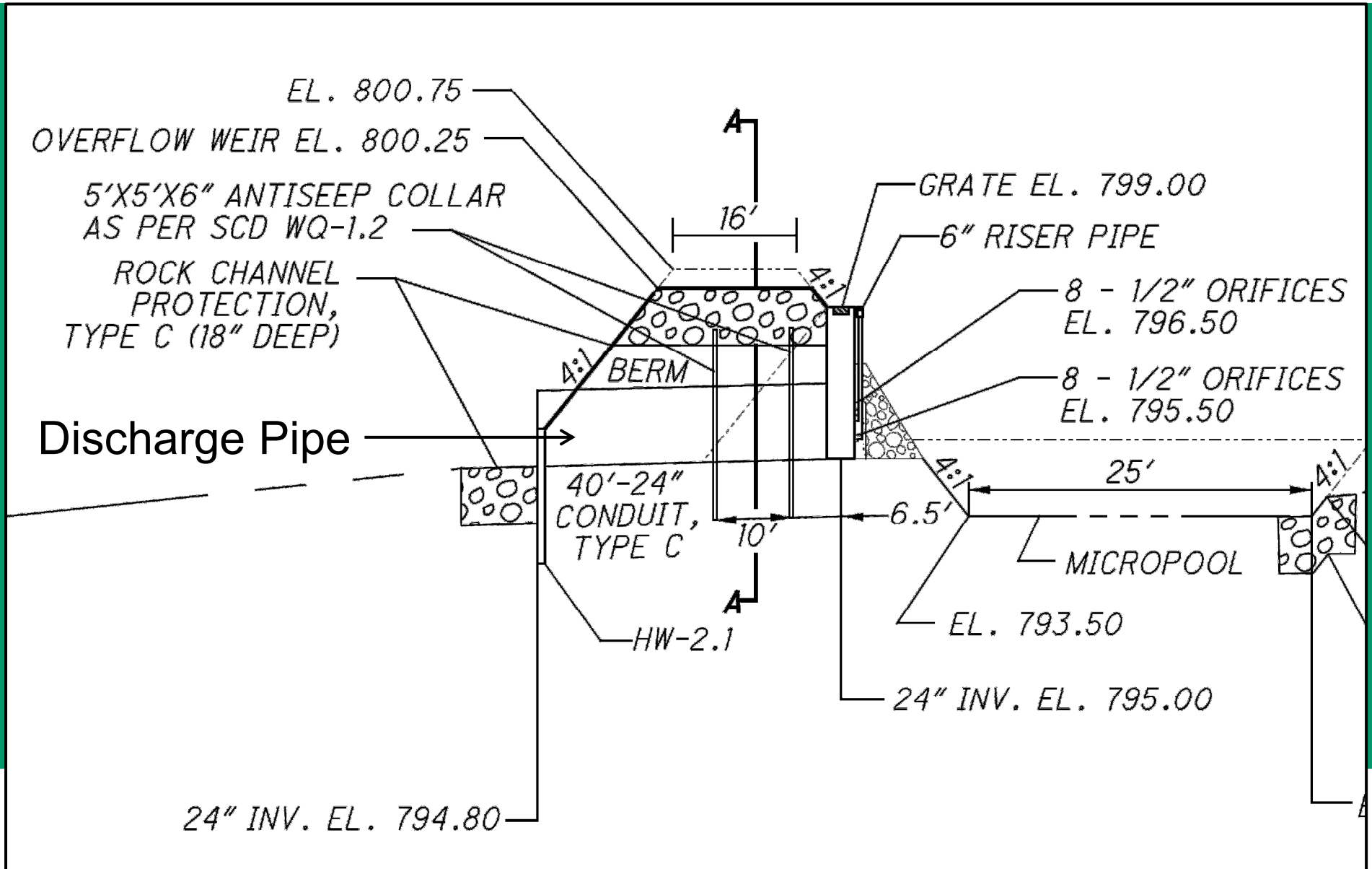
Project Example – WQ Outlet



Primary Outlet Design

- Size pipe discharging from catch basin for the 10-yr storm
- Set the catch basin grate elevation
- Confirm that the grate has the capacity to pass the 10-yr storm

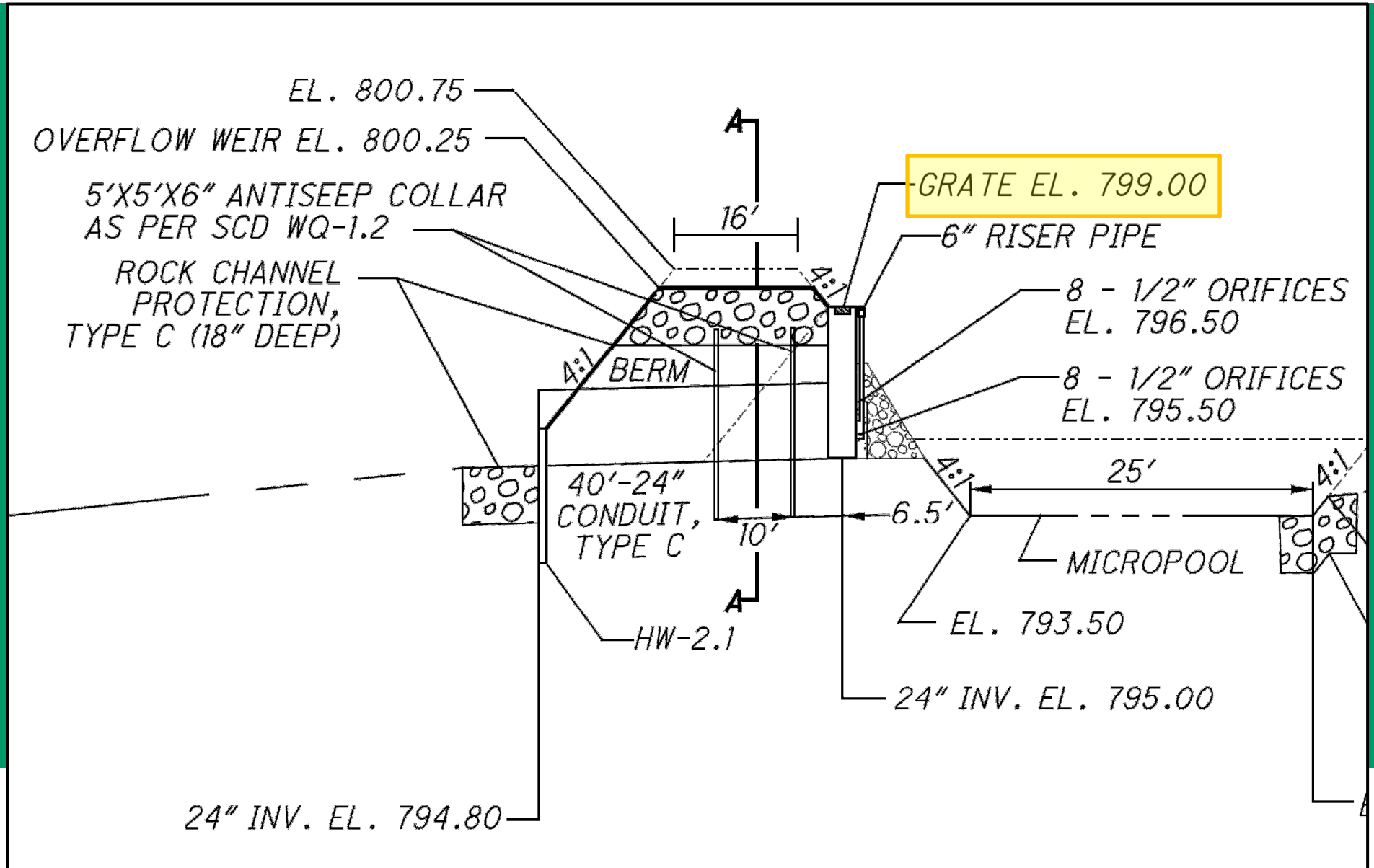
Project Example – WQ Outlet



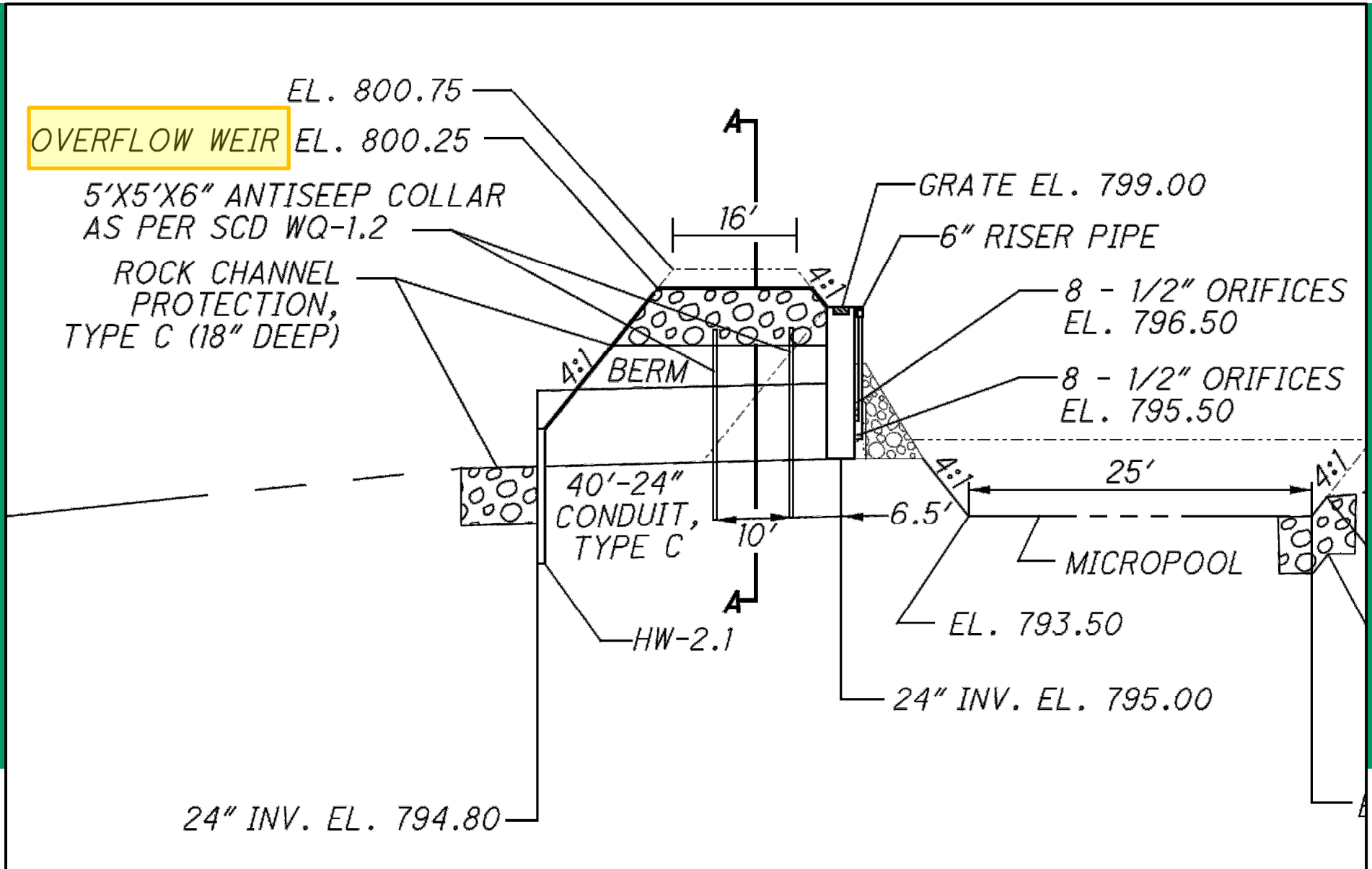
Primary Outlet Design

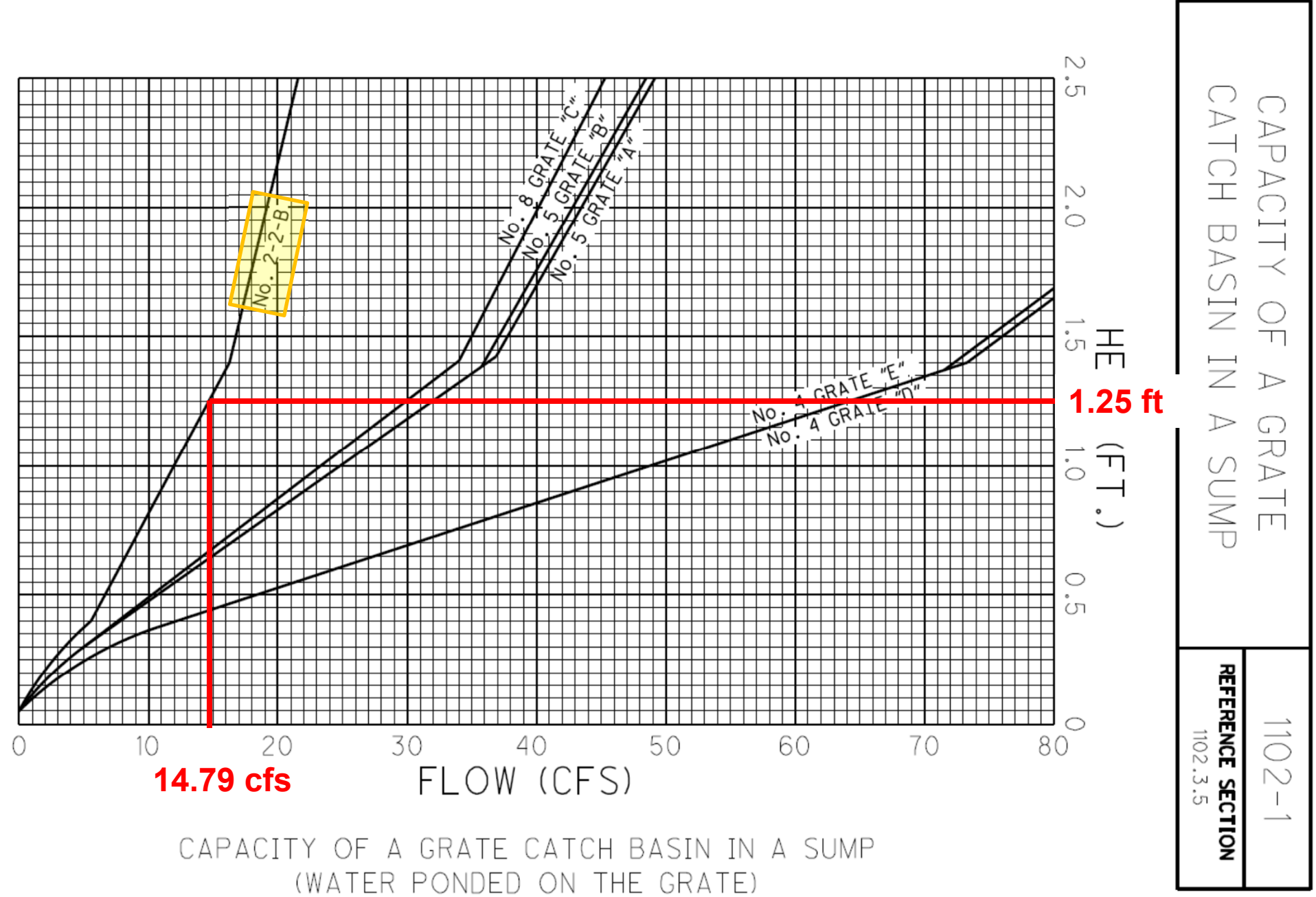
- Size pipe discharging from catch basin for the 10-yr storm
- Set the catch basin grate elevation
- Confirm that the grade has the capacity to pass the 10-yr storm

Project Example – Grate Elevation



Project Example – Grate Elevation





CAPACITY OF A GRATE CATCH BASIN IN A SUMP
(WATER PONDED ON THE GRATE)

CAPACITY OF A GRATE
CATCH BASIN IN A SUMP

1102-1

REFERENCE SECTION
1102.3.5

Overflow Weir Elevation

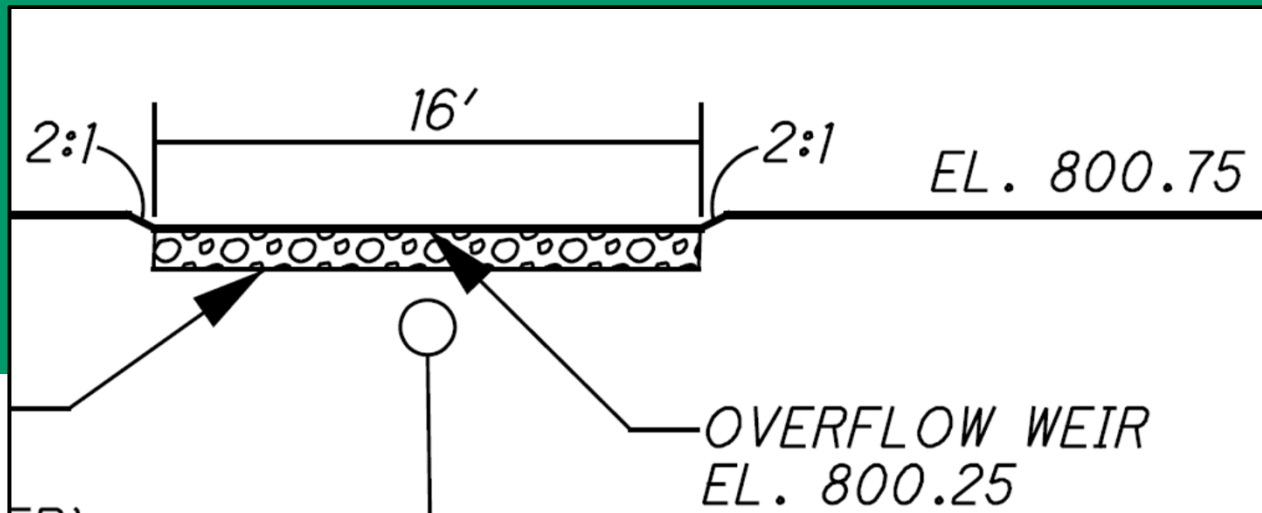
- **Grate elevation = 799.0 ft**
- **Head needed to pass 14.79 cfs = 1.25 ft**
- **Overflow weir elevation:**
  - 799.0 ft + 1.25 ft = 800.25 ft

Project Example – Overflow Weir

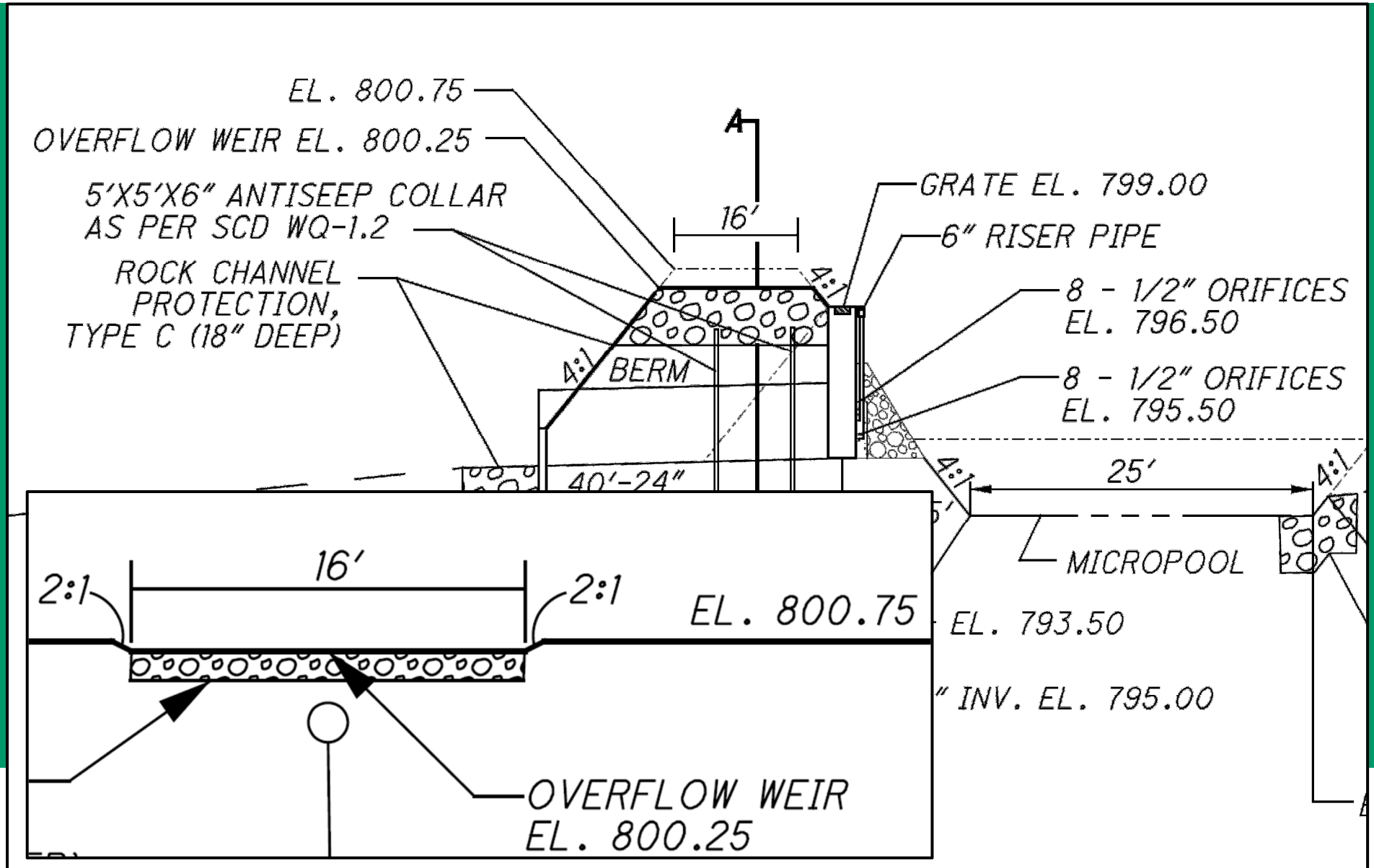
- 25-yr peak flow = 16.53 cfs
- Assume top of basin is 0.5 ft higher than overflow weir
- Weir elevation = 800.25 ft
- Top of basin = 800.25 ft + 0.5 ft = 800.75 ft

Project Example – Overflow Weir

- **$Q = CLH^{1.5}$**
  - Q = 16.53 cfs
  - C = 3 (L&D Vol. 2, 1102.3.4)
  - H = 800.75 ft – 800.25 ft = 0.5 ft
- **$16.53 \text{ cfs} = 3 * L * 0.5^{1.5}$**
- **L = 15.6 ft**



Project Example – Overflow Weir



Overflow Weir

- Flow rates over the 25-yr storm may overtop the detention basin uncontrolled.
- Consider erosion / scour protection
- Consider catastrophic failure

Design Process

- Treatment Goals
- Preliminary Det. Basin Sizing
- Siting Analysis
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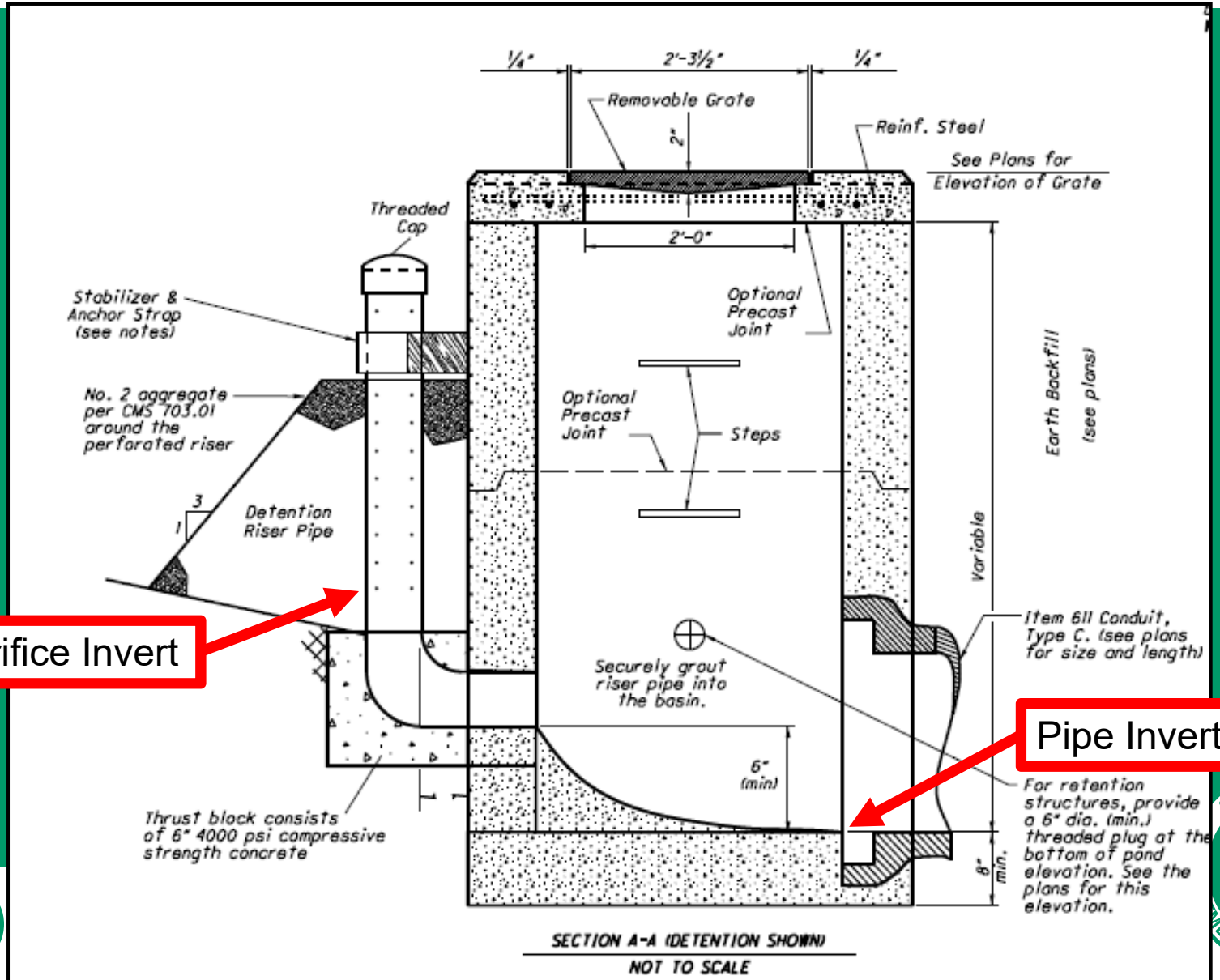
- Water Quality Outlet
- Primary Outlet
- Overflow Weir
- Other Considerations

Consider Catch Basin Invert

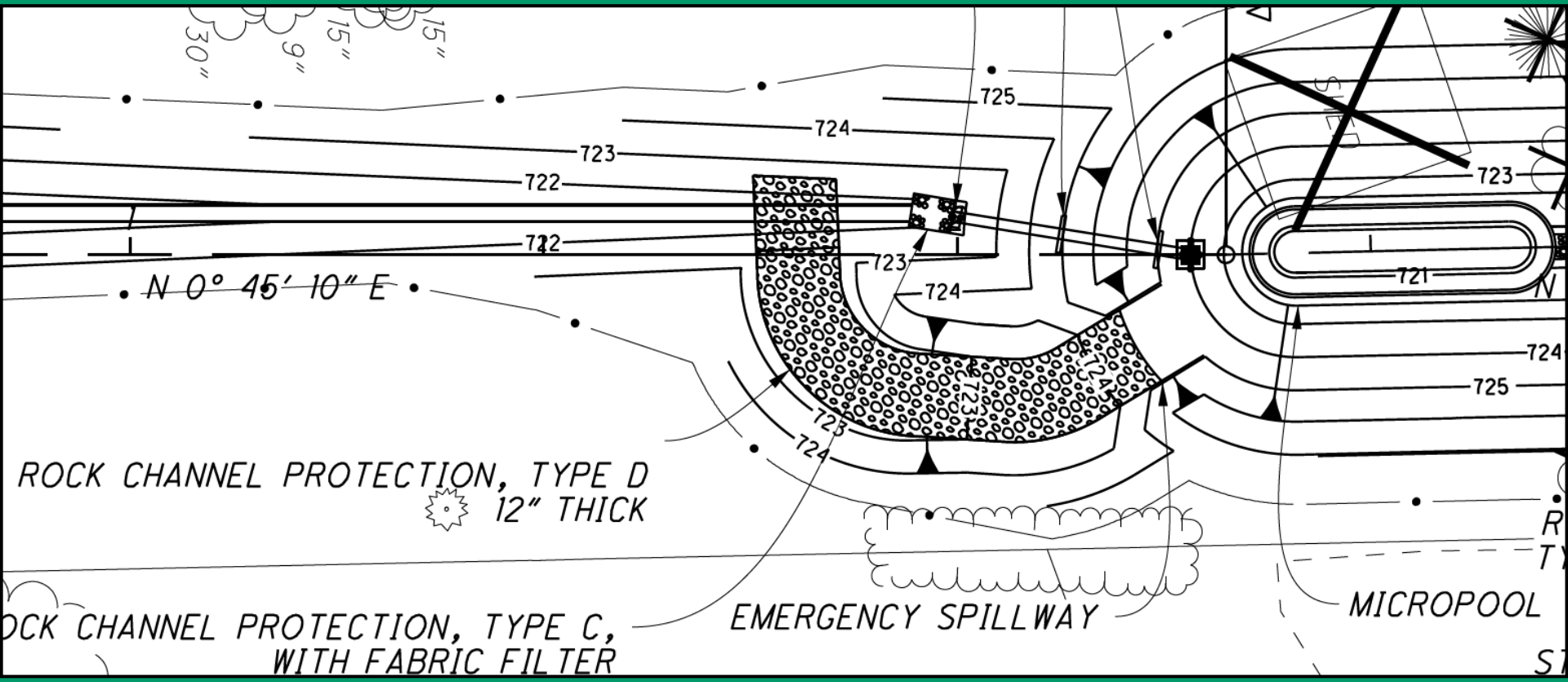


Call Out Catch Basin Invert

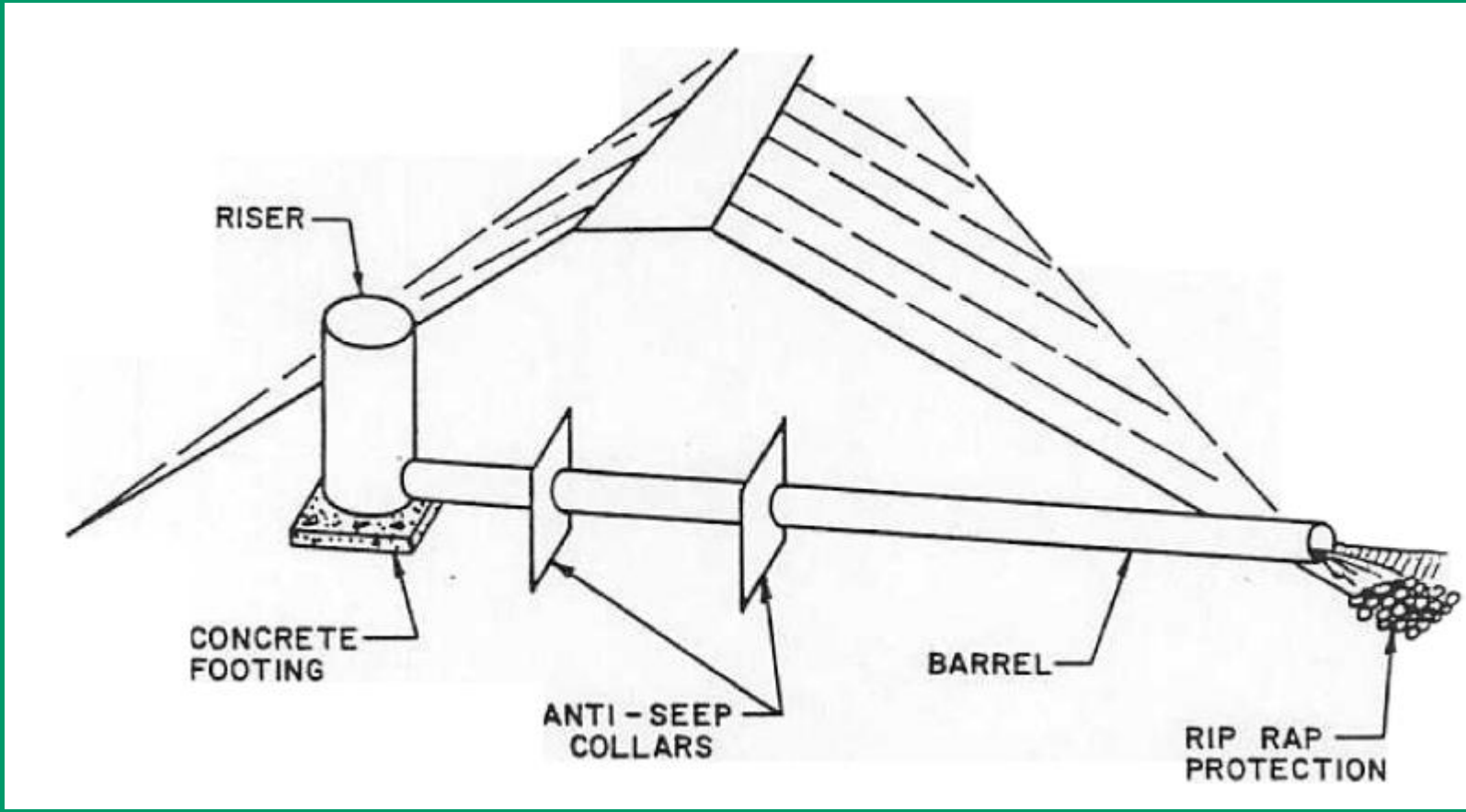
Other Det. Basin Considerations

- Velocity / Scour
- Anti-Seep Collars
- Safety
- Slope Stability and Item 670
- Maintenance Access
- FEMA Floodplain
- ODNR Dam Permit?

Velocity / Scour

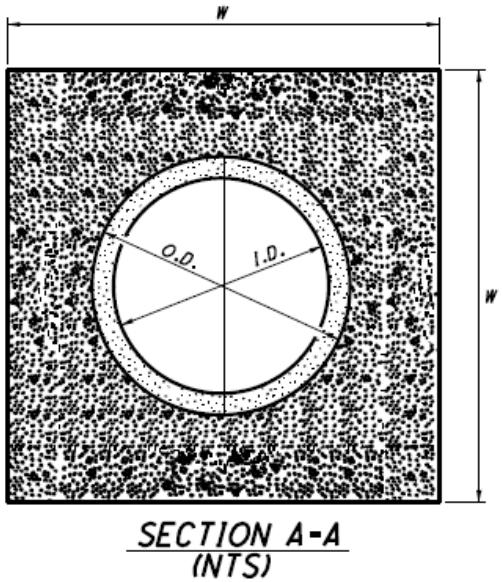


Anti-Seep Collars

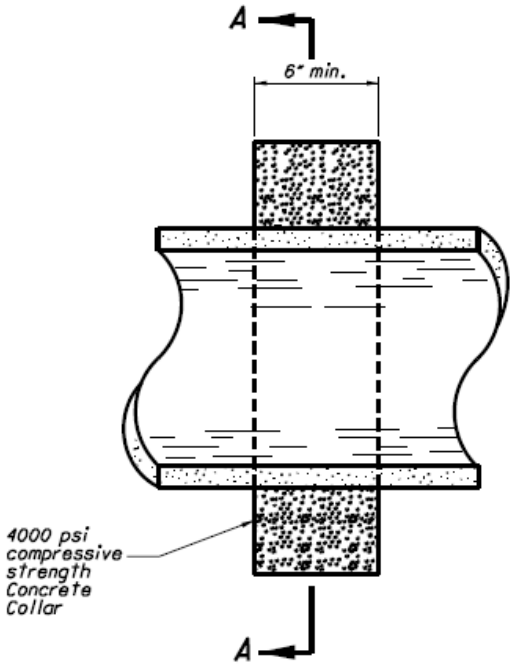


Reference: Dept. of Interior, 1982

Anti-Seep Collars



SECTION A-A
(NTS)

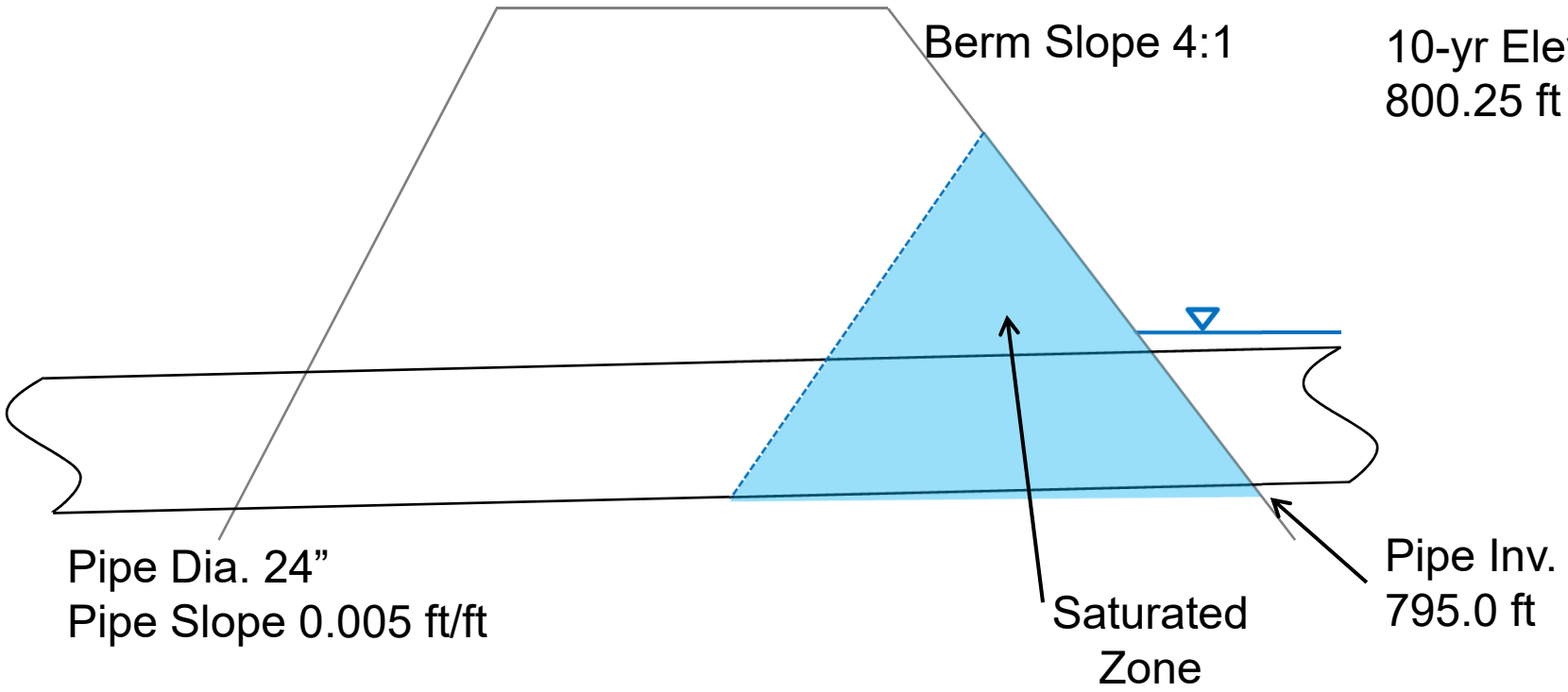


ANTI-SEEP COLLAR
(NTS)

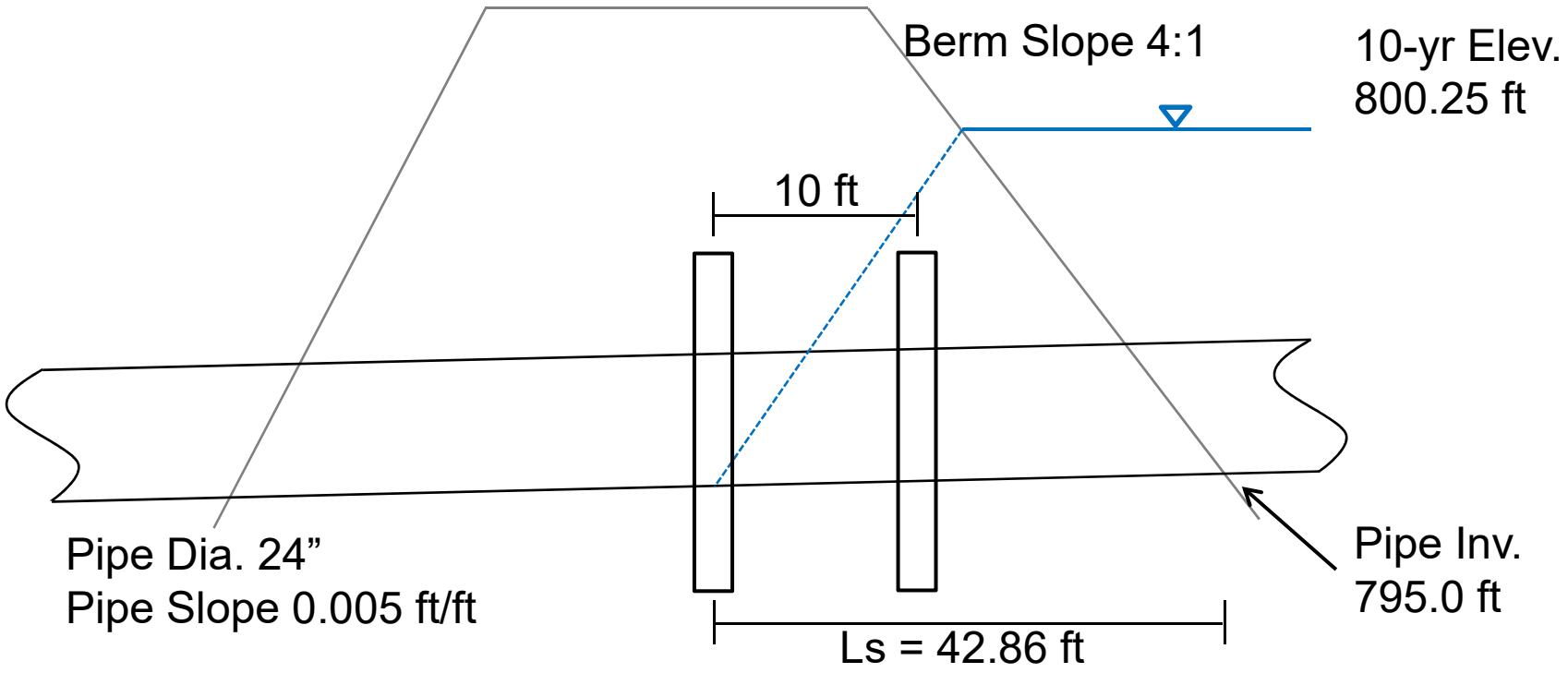
DIAMETER (I.D.) (FT.)	CONCRETE (C.Y.) DIMENSION OF COLLAR W X W (FT.)		
	3X3	4X4	5X5
1	0.15	0.28	0.45
2	N/A	0.24	0.40
3	N/A	N/A	0.33

ODOT Standard Drawing WQ-1.2

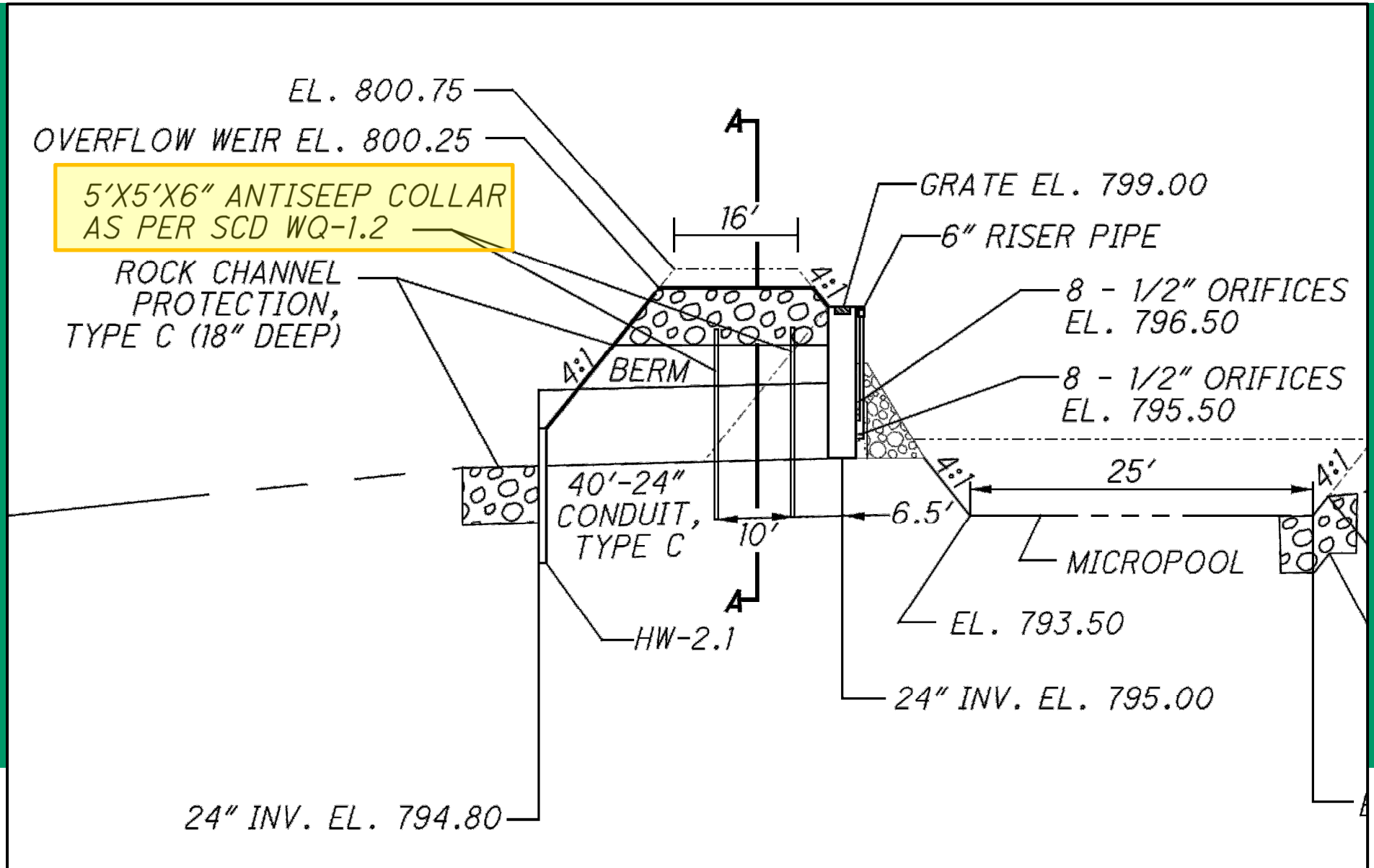
Project Example – Collar Design



Project Example – Collar Design



Project Example – Collar Design



Safety

- Detention basins are safety risks
- Clear zone: grading and 12” ponding
- Drowning hazard
- Local requirements?
- Fencing, trash rack, aquatic bench
- Impacts to upstream or downstream flooding

Slope Stability

- Do not locate on uncompacted fill or steep slopes (2:1 or more).
- Vegetate sides of basin
- Item 670, Slope Erosion Protection
- Don’t plant grass under water
  - Forebay
  - Micropool

Maintenance Access

- Regular maintenance necessary
- Flat bench wide enough for a truck
- Grass needs to be mowed
- Woody vegetation cut from berm
- Regular unclogging of WQ outlet
  - Every 6 months

Maintenance Access

FEMA Floodplain

- **No BMPs in FEMA Floodplain**
  - Floodplains have open space for a reason
- **No fill in FEMA Floodplain**
  - Unless compensatory cut/fill analysis
- **Confirm limits of det. basin berms outside floodplain**

ODNR Dam Permit

- **Only for big detention basins**
- **No permit needed if:**
  - <10’ Berm and <50 ac-ft storage; or
  - < 15 ac-ft storage; or
  - < 6’ Berm

Re-Run the Numbers!

- Many iterations
- After values are set, re-run the analyses and check

Ohio Department of Transportation - Office of Hydraulic Engineering

Post-Construction BMP Calculation Spreadsheet

Extended Detention Basin / Retention Basin

Drainage Area #	Total Tributary Area (acres)	Tributary Area in ODOT R/W (acres)	WQ_V (ac-ft)
Det. #1	7.50	7.20	0.422

Yellow: Requires Input (See instructions tab)

Total Treatment Credit from Extended Detention (within R/W):[1]

7.20	acres

(Treatment is for quality and quantity)

	Extended Detention #1	
	Values	Notes / Checks
WQ_V (ac-ft)	0.422	Calculation
Detention or Retention	Detention	Drop Down List
Minimum ED_V (ac-ft)[2]	0.422	Calculation
Design ED_V (ac-ft)[3]	0.422	GOOD
Min. Time to Drain EDV (hrs)[4]	48	By Rule
Design Time to Drain Edv	60	GOOD
50% EDV (ac-ft)	0.211	Calculation
Min. Time to Drain 50% EDV (hrs)[5]	16	Calculation
Design Time to Drain 50% EDV	16	GOOD
Min. Forebay and Micropool Vol. (ac-ft)[6]	0.042	Calculation
Design Forebay Volume (ac-ft)	0.042	GOOD
Design Micropool Volume (ac-ft)	0.045	GOOD
Minimum Permanent Pond Vol. (ac-ft)[7]	0.000	Calculation
Design Permanent Pond Vol. (ac-ft)		Not required

Sample Plan Note W106

W106 **EXTENDED DETENTION BASIN**

THIS PLAN UTILIZES EXTENDED DETENTION BASIN(S) FOR POST CONSTRUCTION STORM WATER TREATMENT. DETENTION BASINS MAY BE USED AS SEDIMENT CONTROL DEVICES DURING CONSTRUCTION. FOLLOWING STABILIZATION OF THE TRIBUTARY AREA, FINAL GRADING OF THE DETENTION BASIN MUST MATCH THE PLANS. THE DETENTION BASIN OUTLET STRUCTURE FOR CONSTRUCTION SEDIMENT CONTROL MUST BE REMOVED AND THE OUTLET STRUCTURE MUST BE MADE TO MATCH THE DESIGN SHOWN IN THE PLANS.

Designer Note: This plan note shall be used on all projects that have extended detention basins identified in the plan. This note may be modified for retention basins or constructed wetlands, if those are included in the plans.

Questions ?

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