



Civil & Environmental
Consultants, Inc.

Managed Release Concept Strategy

Presented By:

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Background – Pennsylvania Stormwater Regulations

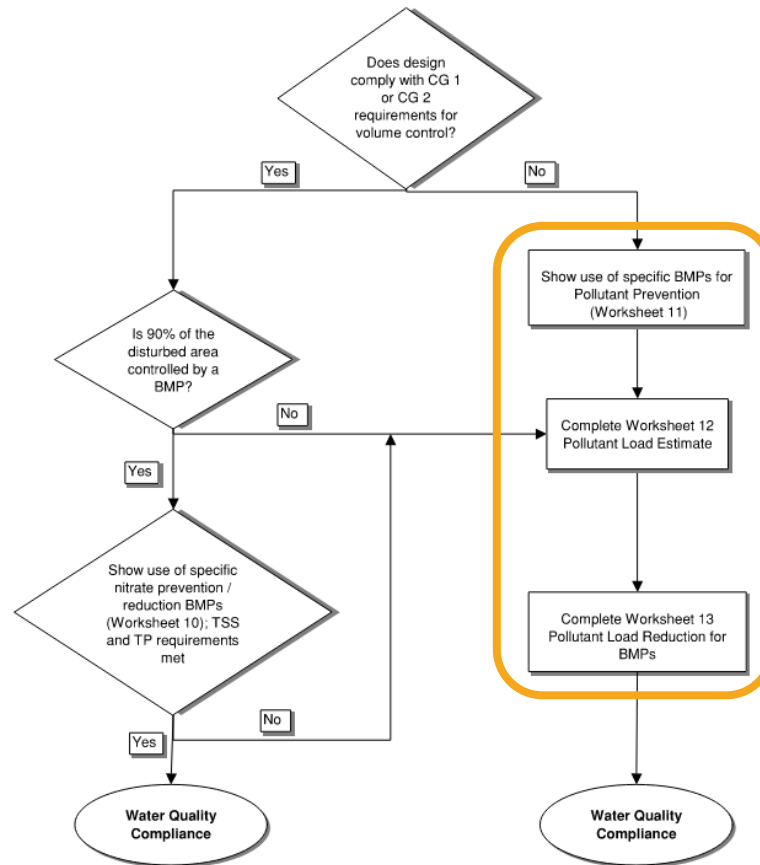
- Projects must meet **volume reduction** and **water quality requirements** specified in an applicable Department approved and/or current Act 167 Stormwater Management Plan; **or manage the net change** for storms up to and including the 2-year 24/hour storm event when compared to preconstruction runoff volume and water quality.

Background – Pennsylvania Stormwater Regulations

- Volume Control Guideline 1 (CG-1): *Very commonly used*
 - Do not increase the post-development runoff volume (2-year/24-hour event)
 - Existing non-forested pervious areas considered meadow in good condition
 - 20% of existing impervious area considered meadow in good condition (pre-development)
- Volume Control Guideline 2 (CG-2): *Not commonly used*
 - Not applicable for regulated activities with earth disturbances > 1 acre
 - Stormwater facilities sized to capture at least the first 2” of runoff from all contributing impervious surfaces
 - At least the first 1” of runoff from new impervious surfaces shall be permanently removed

Infiltration Not Feasible – Previous Process

Flow Chart D
Water Quality Process

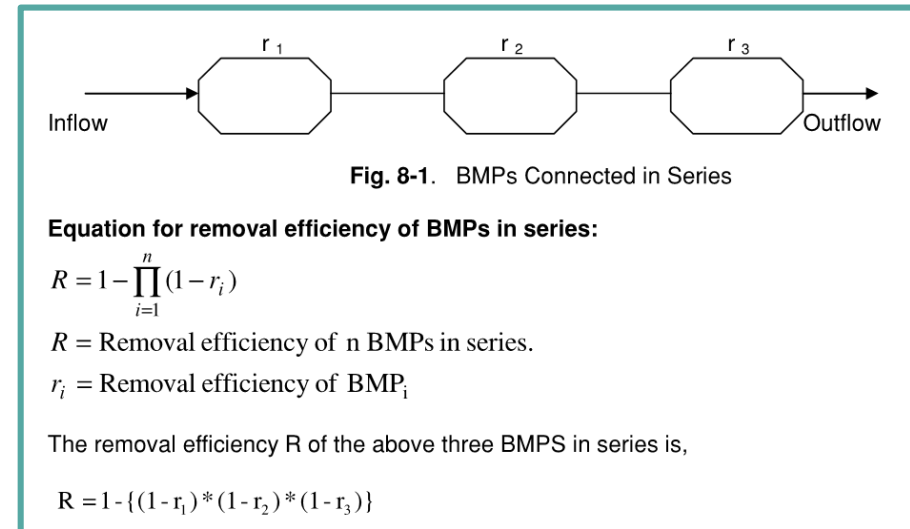


“Management” of 2-year/24-hour storm event volume increase per 25 PA Code 102.8.(g).(2)

Infiltration Not Feasible – Previous Process

- Previously accepted approaches:
 - Underdrains
 - Controlled dewatering (between 24 and 72 hours)
 - Shutoff valve for underdrain that would only be open for the purpose of maintenance activities.
 - Wet Ponds (in certain instances)
 - Worksheets 12/13 – Water Quality (BMPs in series)

| | Removal Efficiency | | |
|---|--------------------|--------------|-----------------|
| | TSS | TP | NO ₃ |
| 6.4.2 Infiltration Basin | 85% | 85% | 30% |
| 6.6.4 Water Quality Filters & Hydrodynamic Devices | 60% | 50% | 20% |
| 6.4.8 Vegetated Swale | 50% | 50% | 20% |
| Combined Removal Efficiency for BMPs in Series (R) | 97.0% | 96.3% | 55.2% |



Infiltration Not Feasible – MRC Approach

- Managed Release Concept (MRC) was introduced by the PADEP to establish guidance for project areas or subareas where infiltration is considered infeasible to meet regulatory requirements under §102.8(g)(2)
- Intention of MRC is to replicate the stormwater volume reduction and water quality benefits of conventional infiltration BMPs and to protect and improve geomorphologic processes within downstream receiving waters.

MRC – White Paper

- The MRC white paper provides design guidance and background information.
- General objectives of the MRC:
 - Manage the 2-year volume increase;
 - Provide WQ treatment (via media and/or pre-treatment); and
 - Provide means for infiltration (when conditions permit).
- Refer to the [MRC white paper](#) for more information

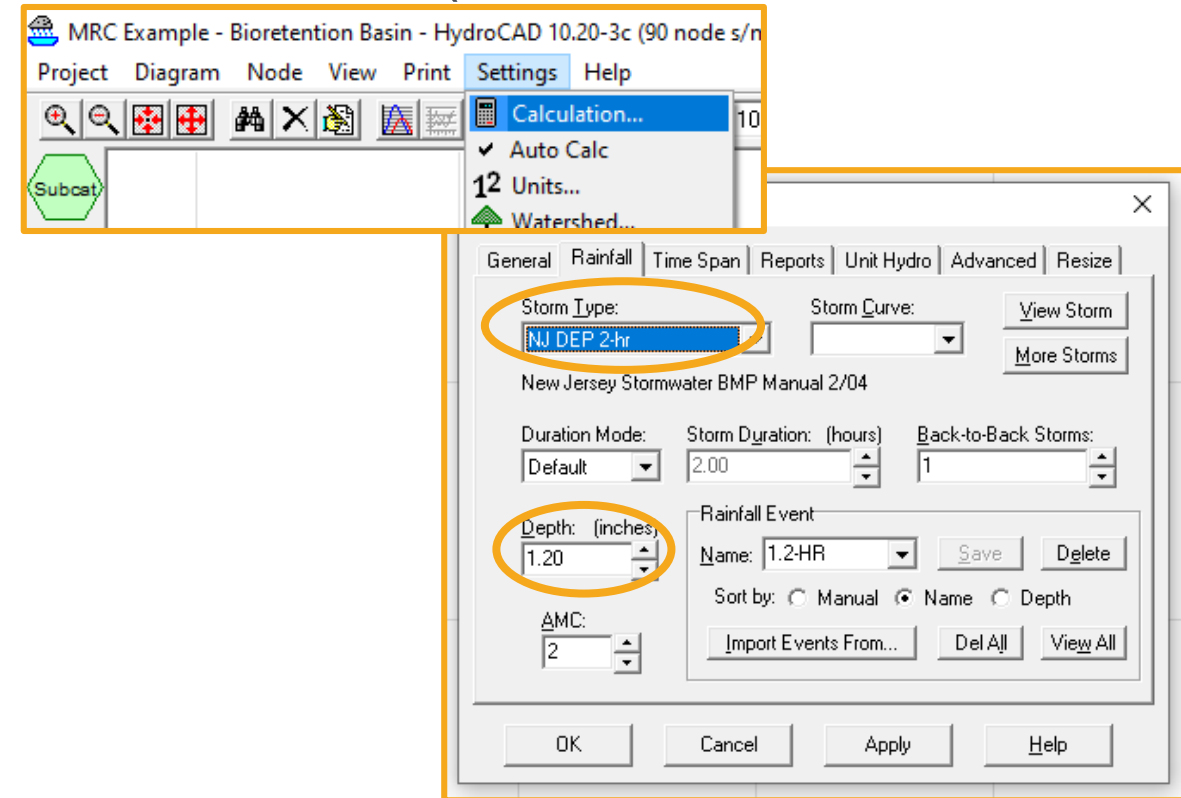
MRC Design Standards

- 1.2"/2-hour storm event
- Release Rate
- Internal Water Storage (IWS)
- Equivalent Impervious Area
- Geomorphologic Peak Flow Management
- Infiltration Testing
- Separation Distance
- Ponding Depth/Dewatering Time
- Underdrain Design



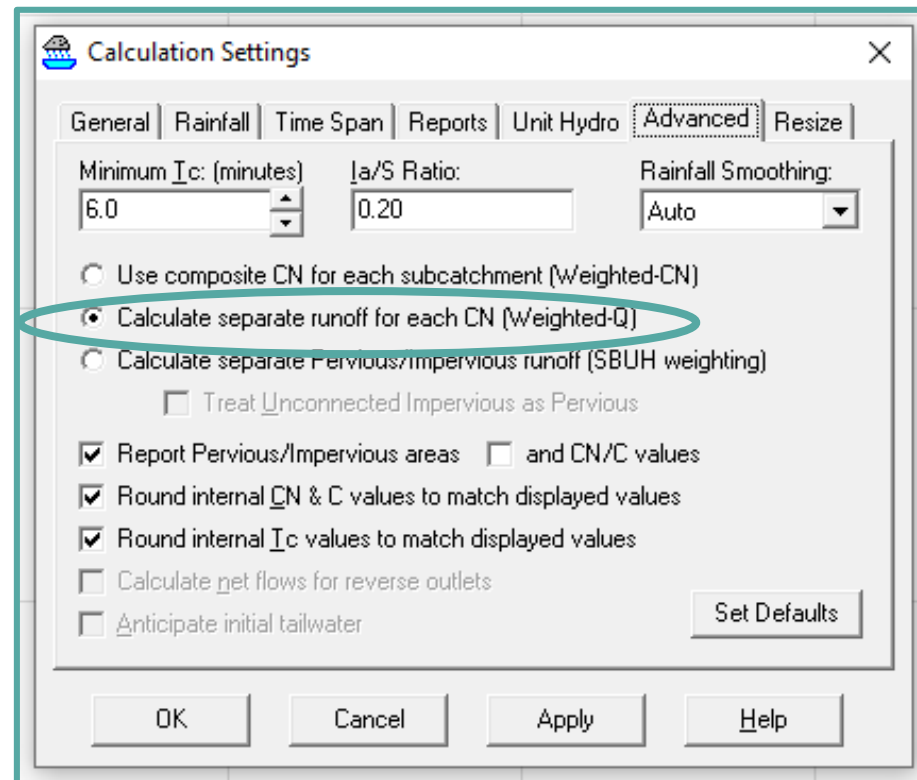
1.2"/2-Hour Storm

- Runoff from the 1.2"/2-hour storm from the *contributing watershed* should be treated by the MRC without overflow (i.e. it must flow through only the underdrain)
 - *1.2 inches of rainfall is equivalent to 1.0 inches of runoff from impervious surfaces using the NRCS curve number method.*
 - *The 2-hour distribution is a common practice used to develop a short duration rainfall pattern for analysis.*



1.2"/2-Hour Storm

- The 1.2"/2-hour volume and rate must be analyzed via the *Weighted Q method*



Weighted Q vs. Weighted CN

- **Weighted Q:** Runoff is calculated for *each individual* CN
- **Weighted CN:** Runoff is calculated for the *average* CN

Edit Subcat DA-4A - MRC Example - Bioretention Basin

General Area Tc Notes

| Line | Area (acres) | CN | Description |
|------|--------------|----|---------------------------|
| 1 | 0.930 | 78 | Meadow, non-grazed, HSG D |
| 2 | 2.940 | 98 | Paved parking, HSG D |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |

Total Area: [3.870] acres Weighted CN: [93]

Large areas Import areas automatically

Weighted Q:

| Cover Type | Soil Type | Area (sf) | Area (ac) | CN | S | la (0.2*S) | Q Runoff ¹ (in) | Runoff Volume ² (ft ³) |
|---------------|-----------|-----------|-----------|----|------|------------|----------------------------|---|
| Meadow | D | 40510.8 | 0.93 | 78 | 2.82 | 0.56 | 0.12 | 395 |
| Impervious | D | 128066.4 | 2.94 | 98 | 0.20 | 0.04 | 0.99 | 10,519 |
| TOTAL: | | 168577.2 | 3.87 | | | | | 10,914 |

Weighted CN:

| Cover Type | Soil Type | Area (sf) | Area (ac) | CN | S | la (0.2*S) | Q Runoff ¹ (in) | Runoff Volume ² (ft ³) |
|---------------|-----------|-----------|-----------|----|------|------------|----------------------------|---|
| N/A | | 168,577 | 3.87 | 93 | 0.75 | 0.15 | 0.61 | 8,585 |
| TOTAL: | | 168,577 | 3.87 | | | | | 8,585 |

1. Runoff (in) = $Q = (P - 0.2S) / (P + 0.8S)$ where
 $P = 2\text{-Year Rainfall (in)}$
 $S = (1000/CN) - 10$

2. Runoff Volume (CF) = $Q \times \text{Area} \times 43,560 \times 1/12$
 $Q = \text{Runoff (in)}$
 $\text{Area} = \text{Cover Type Area (ac.)}$

Release Rate

- The 1.2"/2-hour storm release rate *from* the MRC should not exceed 0.01 CFS per acre of **equivalent impervious area**.
- This release rate is approximately the expected rate of interflow (lateral movement of stormwater to a stream) after a 2-year/24-hour storm event.
- Releasing at this rate will produce a condition where baseflow contributions will be similar to that of an undeveloped area during and after storm events.

Equivalent Impervious Area

- **Equivalent Impervious Area** is equal to the *total volume of runoff (acre-feet)* reaching the MRC generated during the 1.2"/2-hour storm divided by 0.08333 feet

Calculating Equivalent Impervious Area & Release Rate

Rainfall:

1.20 in

Proposed Conditions:

| Cover Type | Soil Type | Area (sf) | Area (ac) | CN | S | Ia (0.2*S) | Q Runoff ¹ (in) | Runoff Volume ² (ft ³) |
|---------------|-----------|-----------|-----------|----|------|------------|----------------------------|---|
| Meadow | D | 40,511 | 0.93 | 78 | 2.82 | 0.56 | 0.12 | 395 |
| Impervious | D | 128,066 | 2.94 | 98 | 0.20 | 0.04 | 0.99 | 10,519 |
| TOTAL: | | 168,577 | 3.87 | | | | | 10,914 |

0.251 Ac-ft

- Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where
 $P = \text{Rainfall (in)}$
 $S = (1000/CN) - 10$
- Runoff Volume (CF) = $Q \times \text{Area} \times 43,560 \times 1/12$
 $Q = \text{Runoff (in)}$
 $\text{Area} = \text{Cover Type Area (ac.)}$

Calculating Equivalent Impervious Area & Release Rate

MRC Equivalent Impervious Area (Acres)

$$\begin{aligned} 0.251 \text{ Ac-ft} &= \text{Total Volume of runoff generated during the 1.2-inch/2-hour storm} \\ 0.0833 \text{ ft} &= \text{Conversion factor} \\ &= 0.251 \text{ Ac-ft} / 0.0833 \text{ ft} \end{aligned}$$

3.007 acres

$$= \text{Total Volume (Ac-ft)} * 12 * 0.01$$

MRC 1.2IN/2HR Storm Event Rate

$$= 3.007 \text{ acres} * 0.01 \text{ cfs/acre}$$

0.03 cfs

$$= \text{MRC Equivalent Impervious Area (Ac.)} * 0.01 \text{ (cfs/Ac.)}$$

Remember – the 1.2"/2-hour rate leaving the MRC must be less than or equal to this rate.

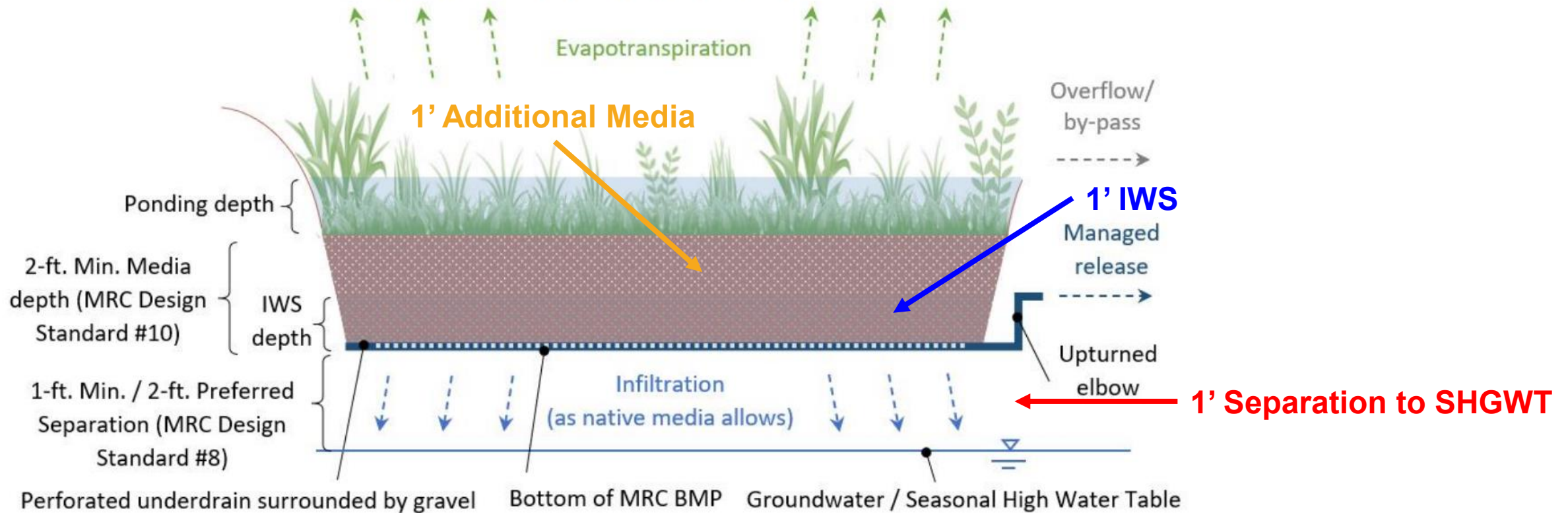


Internal Water Storage (IWS)

- IWS is the material between native soil and the lowest structural outlet (i.e. the outlet for the underdrain)
 - Media Types: Soil or Gravel
- 1' minimum / 2' maximum depth
- 4' maximum “total media” depth (IWS + additional media)
- If the MRC is vegetated, the IWS should be modeled as 50% of the chosen media typical void space
 - Soil media typically modeled as 30% voids. For vegetated MRC, the IWS would be modeled as 15% voids, and additional media outside of the minimum 1' IWS would be modeled as 30% voids
- If the MRC is non-vegetated, the IWS is modeled at 0%

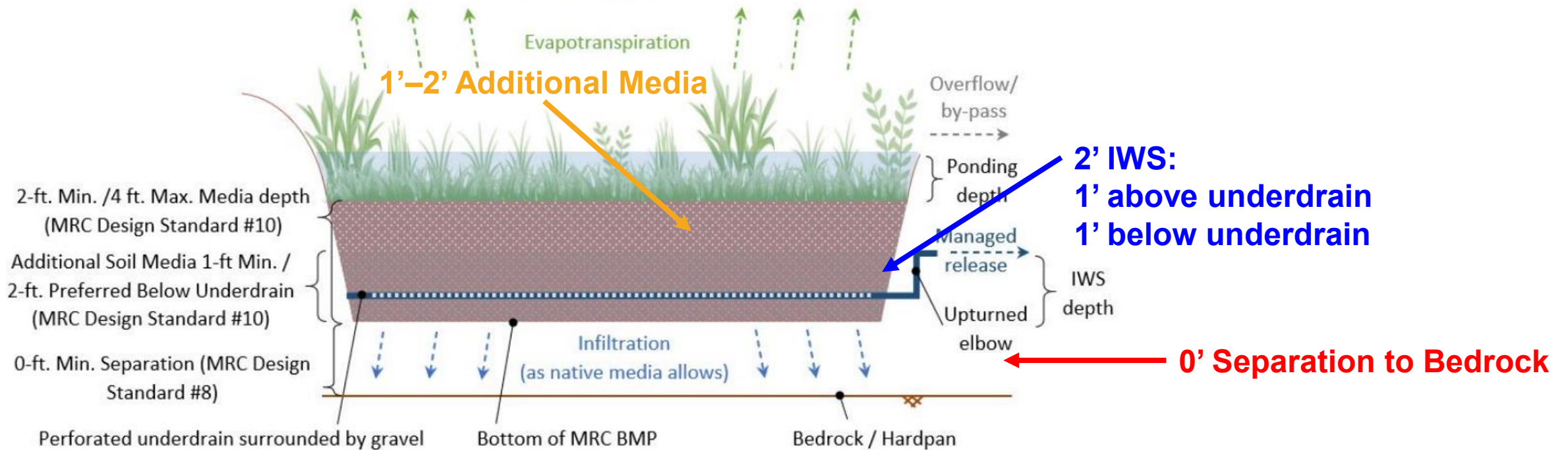
Internal Water Storage (IWS)

Figure 3: Managed Release Concept Where In-Situ Soils are Suitable in Relation to Groundwater/Seasonal High Water Table



Internal Water Storage (IWS)

Figure 6: Managed Release Concept Where In-Situ Soils are not Suitable in Relation to Bedrock/Hardpan



MRC Components – Liners

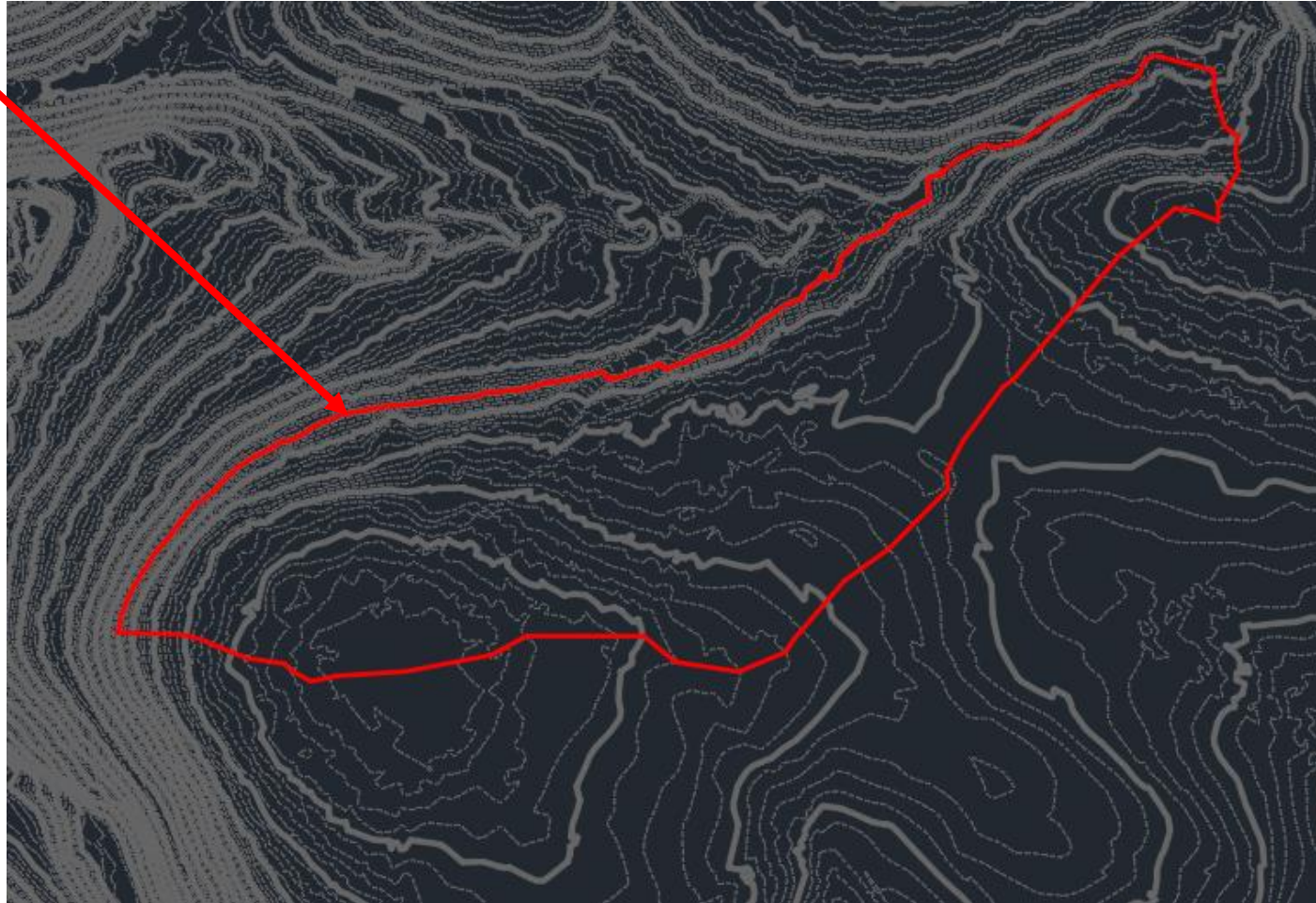
- *An MRC should not have an impervious liner installed unless environmental or geological conditions necessitate use of a liner, or if an existing structure would be damaged as a result of not lining the facility.*
 - *Examples include BMPs located adjacent to a constructed fill slope, BMPs located within contaminated soils, BMPs located in an area of known karst soil conditions.*
- If a system is lined – IWS starting elevations as follows:
 - Lined – start at upturned elbow (0% IWS storage)
 - Unlined & aboveground/vegetated – start at bottom
 - Unlined & belowground/non-vegetated – start at upturned elbow

Geomorphologic Peak Flow

- The peak flow from the post-construction 2-year/24-hour storm event should be managed to be less than or equal to the pre-construction 1-year/24-hour storm event
- *Typically* this is taken at the POI/POA – but there can be room for other approaches
 - Post-Development MRC DA analyzed with Pre-Development land covers
 - Post-Development MRC DA overlayed on and adjusted to follow Pre-Development DA (see following snips)

Geomorphologic Peak Flow

Pre-Development DA



Geomorphologic Peak Flow

Post-Development
DA to MRC Basin

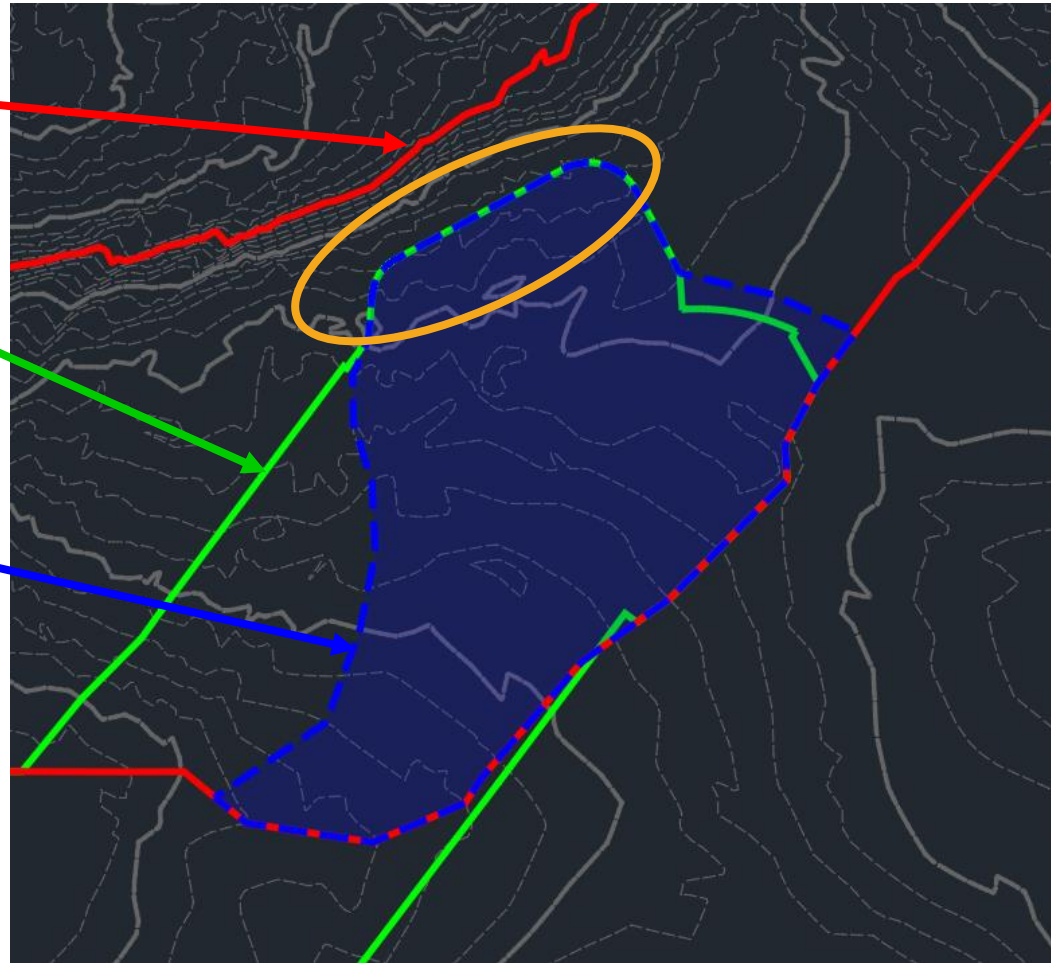


Geomorphologic Peak Flow

Pre-Development DA

Post-Development
DA to MRC Basin

1-YR Pre-Development DA
follows **fill slope limits** of
MRC and then follows
pre-development contours



Infiltration Testing

- *“At a minimum, one infiltration test for every 40,000 square feet (0.92 acres) of disturbed acreage should be performed with a minimum of four tests, equally distributed across the site.”*
- The minimum number of tests can be reduced if it can be demonstrated that the subsurface conditions are uniform; however, this is considered a deviation from MRC Design Standards, requiring an individual permit.
- Tests should be performed at the bottom elevation of the BMP (i.e. the bottom of the IWS)
- Test should be performed near the location of the BMP, preferably within the footprint of the BMP

Separation Distance

- 1' minimum separation between the bottom of IWS/soil media and evidence of a Seasonal High Groundwater Table (SHGWT) (2' preferred). This is determined during infiltration testing (i.e. mottling and/or redoximorphic features).
 - If 1' separation cannot be provided, consider MRC with constructed wetland.
- No minimum separation between the bottom of IWS/soil media and bedrock/hardpan
- The White Paper does not specify a separation to coal/carbonaceous material, but as with other BMPs in the PCSM manual, but we typically maintain a minimum of 2'.

Ponding Depth/Dewatering Time

- Maximum ponding depth (above media) for the 2-year/24-hour storm is 2' (1' preferred)
- Maximum ponding depth (above media) for any event greater than the 2-year/24-hour storm is 4'
- Dewatering time is dependent on MRC type
 - Surface MRC = 72 hours (maximum)
 - Subsurface MRC = 7 days (maximum)
 - No minimum dewatering time

Underdrain Design

Vegetated

- Depending on in-situ soil infiltration capabilities, the underdrain can be located at the bottom of the IWS *or* within the IWS
- “If on-site undisturbed soils are unsuitable for the purpose of providing IWS, an additional one to two feet of suitable soil media should be provided below the underdrain.”

Underdrain Design

Non-Vegetated

- Underdrains should be located at the bottom of the IWS to promote movement of water from previous storms (i.e. to flush the water out)

PCSM SPREADSHEET EXAMPLE

Structural BMP Volume Credits:

No. Structural BMPs:

Start BMP Numbering at:

| DP No. | BMP No. | BMP Name | MRC? | Discharge | Incremental BMP DA (acres) | Volume Routed to BMP (CF) | Infiltration / Vegetated Area (SF) | Infiltration Rate (in/hr) | Infiltration Period (hrs) | Vegetated? | Media Depth (ft) | Storage Volume (CF) | Infiltration Credit (CF) | ET Credit (CF) |
|--------|---------|----------------------------|------|-----------|----------------------------|---------------------------|------------------------------------|---------------------------|---------------------------|------------|------------------|---------------------|--------------------------|----------------|
| 005 | 3 | Rain Garden / Bioretention | Y | Off-Site | 3.87 | 25,744 | 11,900 | 0.00 | 24 | Yes | 2.0 | 10,854 | 0 | 6,259 |
| 006 | 4 | Rain Garden / Bioretention | Y | Off-Site | 5.84 | 37,392 | 12,025 | 0.00 | 24 | Yes | 2.5 | 14,673 | 0 | 7,756 |

Totals: **14,016**

INFILTRATION & ET CREDITS (CF):

MANAGED RELEASE CREDIT (CF):

NET CHANGE IN VOLUME TO MANAGE (CF):

TOTAL CREDITS (CF):

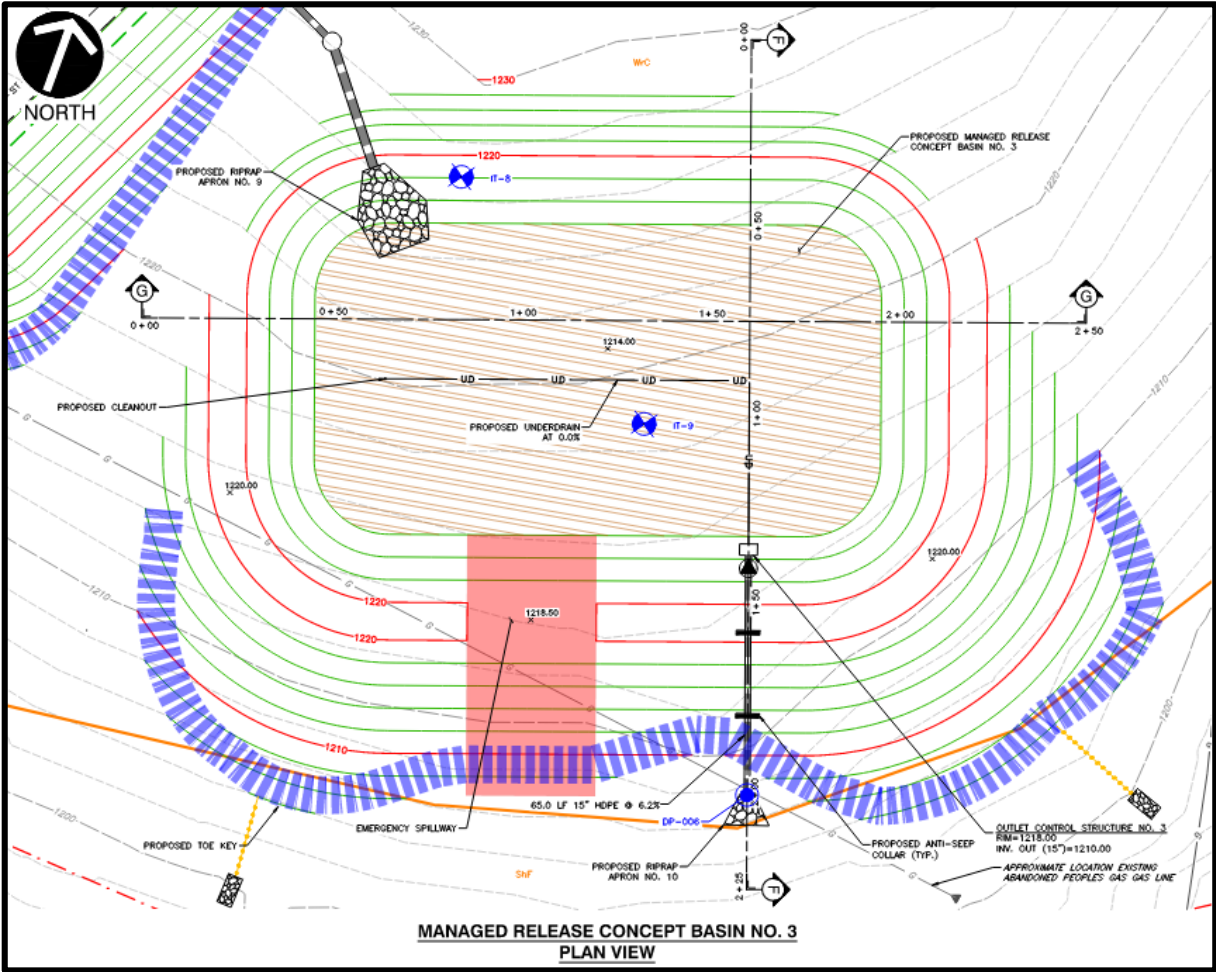
VOLUME REQUIREMENT SATISFIED



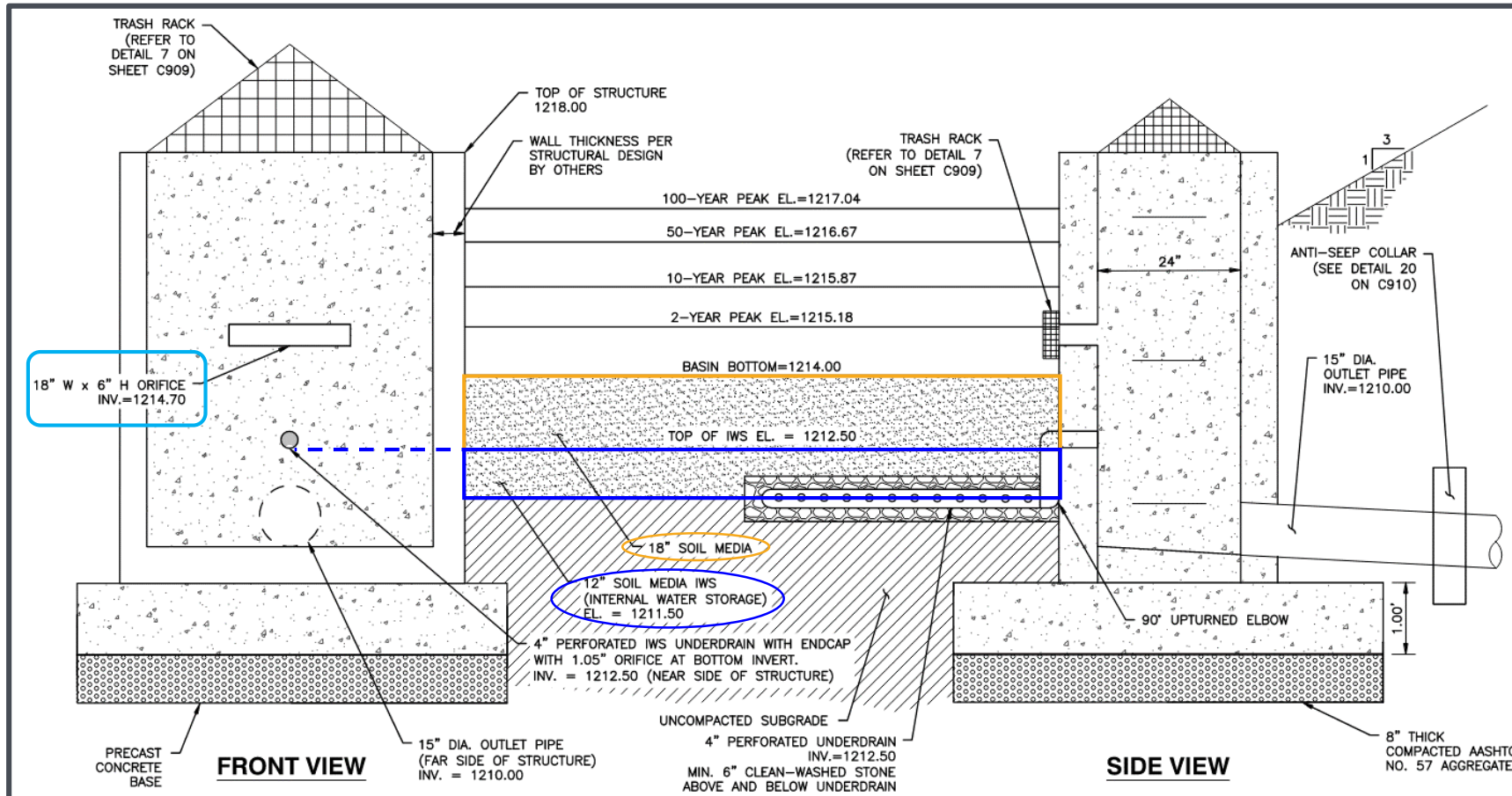
MRC Variations

- Commonly Used Applications:
 - Surface
 - Bioretention Basin/Infiltration Basin
 - Constructed Wetland
 - Subsurface
 - Prefabricated Systems
 - Perforated Pipes

Bioretention Basin/Infiltration Basin



Bioretention Basin/Infiltration Basin



Bioretention Basin/Infiltration Basin

Pond 4P Custom Stage Data Storage

Description: Custom Stage Data

Allow Exfiltration:

Embed Inside: Nothing

Stage Type:

- Surface Area
- Incremental Storage
- Cumulative Storage

Storage Multiplier: 1.00

Voids: (%)

| Line | Elevation (feet) | Surface-Area (sq-ft) | Voids (%) |
|------|------------------|----------------------|-----------|
| 1 | 1,211.50 | 12,025 | 0.0 |
| 2 | 1,212.50 | 12,025 | 15.0 |
| 3 | 1,213.00 | 12,025 | 30.0 |
| 4 | 1,214.00 | 12,025 | 30.0 |
| 5 | 1,216.00 | 14,725 | 100.0 |
| 6 | 1,218.00 | 17,560 | 100.0 |
| 7 | 1,220.00 | 20,800 | 100.0 |
| 8 | | | |

Shape: Prismatic

Stage Voids Use Large units

Recalculate storage at any elevation

OK Cancel Help

Edit Pond 5P - 324-420 HYD-POST-IMPORT

General Storage Outlets Tailwater Advanced Notes

| # | Invert (feet) | Description | Inside |
|---|---------------|------------------------|--------|
| 1 | 1,211.50 | Internal Water Storage | |
| 2 | 1,212.50 | Soil Media | |
| 3 | 1,214.00 | Open Water Storage | |
| 4 | | | |
| 5 | | | |
| 6 | | | |

Pond 5P Custom Stage Data Storage

Description: Internal Water Storage

Allow Exfiltration:

Embed Inside: Nothing

Stage Type:

- Surface Area
- Incremental Storage
- Cumulative Storage

Storage Multiplier: 1.00

Voids: 15.0 (%)

| Line | Elevation (feet) | Surface-Area (sq-ft) |
|------|------------------|----------------------|
| 1 | 1,211.50 | 12,025 |
| 2 | 1,212.50 | 12,025 |
| 3 | | |

Bottom of Basin at Native Soil

1' Internal Water Storage (IWS) at 50% media void

1.5' Additional Media at 100% media void

Pond 5P Custom Stage Data Storage

Description: Soil Media

Allow Exfiltration:

Embed Inside: Nothing

Stage Type:

- Surface Area
- Incremental Storage
- Cumulative Storage

Storage Multiplier: 1.00

Voids: 30.0 (%)

| Line | Elevation (feet) | Surface-Area (sq-ft) |
|------|------------------|----------------------|
| 1 | 1,212.50 | 12,025 |
| 2 | 1,213.00 | 12,025 |
| 3 | 1,214.00 | 12,025 |

Pond 2P Custom Stage Data Storage

Description: Open Storage

Allow Exfiltration:

Embed Inside: Nothing

Stage Type:

- Surface Area
- Incremental Storage
- Cumulative Storage

Storage Multiplier: 1.00

Voids: 100.0 (%)

| Line | Elevation (feet) | Surface-Area (sq-ft) |
|------|------------------|----------------------|
| 1 | 1,224.00 | 11,900 |
| 2 | 1,226.00 | 14,750 |
| 3 | 1,228.00 | 17,825 |
| 4 | 1,230.00 | 21,125 |
| 5 | | |

Bioretention Basin/Infiltration Basin

Edit Pond 4P - 324-420 HYD-POST-IMPORT

General | Storage | Outlets | Tailwater | Advanced | Notes

| # | Invert (feet) | Description | Routing |
|----|---------------|--------------------------|-----------|
| 1 | 1,210.00 | Outlet Culvert | Primary |
| 2 | 1,212.50 | Upturned Elbow | Device 1 |
| 3 | 1,214.70 | Overflow Orifice | Device 1 |
| 4 | 1,218.00 | Outlet Control Structure | Device 1 |
| 5 | 1,218.50 | Emergency Spillway No. 4 | Secondary |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |

Tip: For standpipes and other compound outlets, enter the final outlet device FIRST. Click here for details.

Edit Outlet...

OK Cancel Apply Help

1' Internal Water Storage (IWS) at 50% media void

First orifice set above the 1.2"/2-HR storm water surface elevation (WSEL)

1.18' ponding depth for 2-YR storm (2' maximum)
Measured from top of media (1224.00)

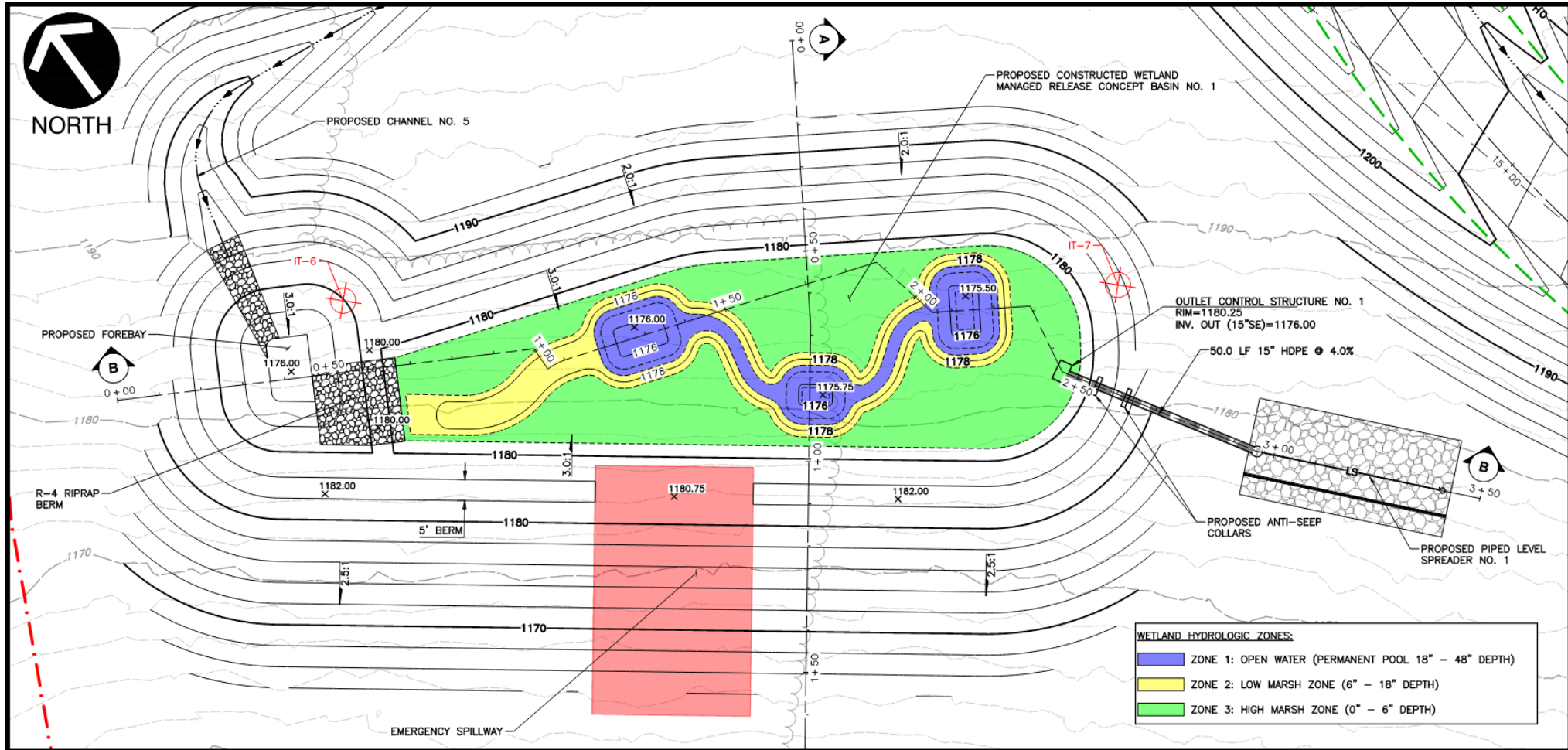
3.04' ponding depth for 100-YR storm (4' maximum)
Measured from top of media (1224.00)

Pond 4P: MRC Basin No. 3 - 324-420 HYD-POST-IMPORT

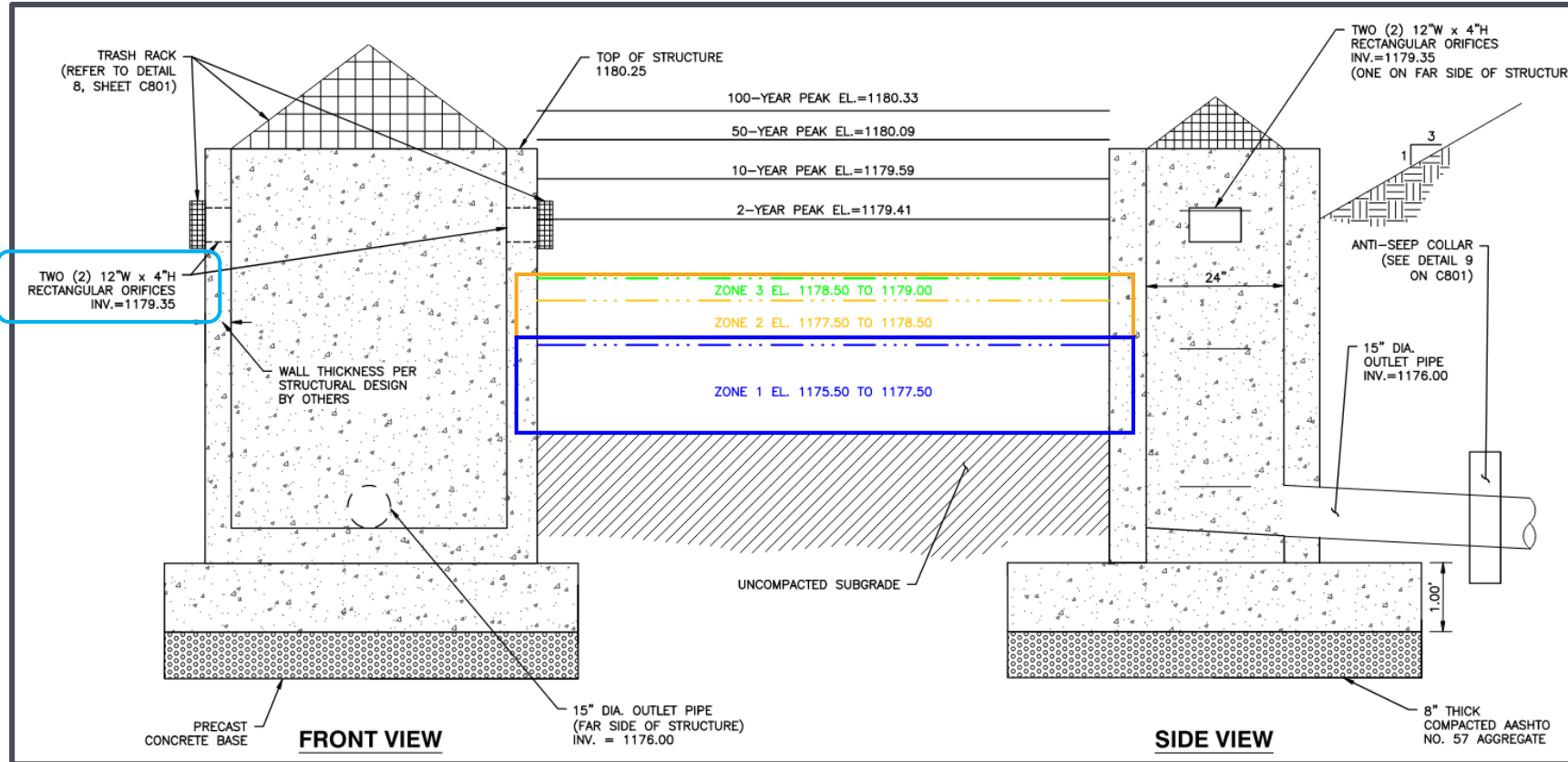
Summary | Hydrograph | Discharge | Storage | Profile | Events | Sizing

| Event | Inflow (cfs) | Outflow (cfs) | Primary (cfs) | Secondary (cfs) | Elevation (feet) |
|--------|--------------|---------------|---------------|-----------------|------------------|
| 1-YR | 12.91 | 0.71 | 0.71 | 0.00 | 1,214.97 |
| 1.2-HR | 11.83 | 0.04 | 0.04 | 0.00 | 1,214.66 |
| 2-YR | 16.00 | 1.65 | 1.65 | 0.00 | 1,215.18 |
| 10-YR | 23.98 | 3.50 | 3.50 | 0.00 | 1,215.87 |
| 50-YR | 33.42 | 4.80 | 4.80 | 0.00 | 1,216.67 |
| 100-YR | 37.97 | 5.28 | 5.28 | 0.00 | 1,217.04 |

Constructed Wetland



Constructed Wetland



Constructed Wetland

Pond 4P Custom Stage Data Storage

Description: Custom Stage Data

Stage Type:
 Surface Area
 Incremental Storage
 Cumulative Storage

Embed Inside: Nothing

Storage Multiplier: 1.00

Voids: 100.0

| Line | Elevation (feet) | Surface-Area (sq-ft) | Perimeter (feet) |
|------|------------------|----------------------|------------------|
| 1 | 1,175.50 | 56 | 46.0 |
| 2 | 1,176.00 | 205 | 96.0 |
| 3 | 1,177.00 | 580 | 153.0 |
| 4 | 1,177.50 | 1,036 | 280.0 |
| 5 | 1,178.00 | 1,751 | 366.0 |
| 6 | 1,178.50 | 2,367 | 391.0 |
| 7 | 1,179.00 | 6,212 | 376.0 |
| 8 | 1,180.00 | 7,371 | 396.0 |

Shape: Irregular

Allow Exfiltration

Stage Voids Use Large units

Recalculate storage at any elevation

OK Cancel Help

Bottom of Basin at Native Soil

3.5' Permanent Pool = Internal Water Storage + Additional Media

Notice – There are no actual voids applied to the storage data. Due to the nature of the constructed wetland and the required permanent pool, the IWS/additional media is assumed to be the permanent pool.

Constructed Wetland

Edit Pond 4P - MRC Example - Constructed Wetland

General | Storage | Outlets | Tailwater | Advanced | Notes

| # | Invert (feet) | Description | Routing |
|----|---------------|----------------------|-----------|
| 1 | 1,176.00 | Culvert | Primary |
| 2 | 1,179.35 | 12" W x 4" H Orifice | Device 1 |
| 3 | 1,180.25 | Type M Inlet | Device 1 |
| 4 | 1,180.75 | Emergency Spillway | Secondary |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |

Tip: For standpipes and other compound outlets, enter the final outlet device FIRST. Click here for details. [Edit Outlet...](#)

OK Cancel Apply Help

First orifice set above the 1.2"/2-HR storm water surface elevation (WSEL)

0.41' ponding depth for 2-YR storm (2' maximum)
Measured from top of media (1779.00)

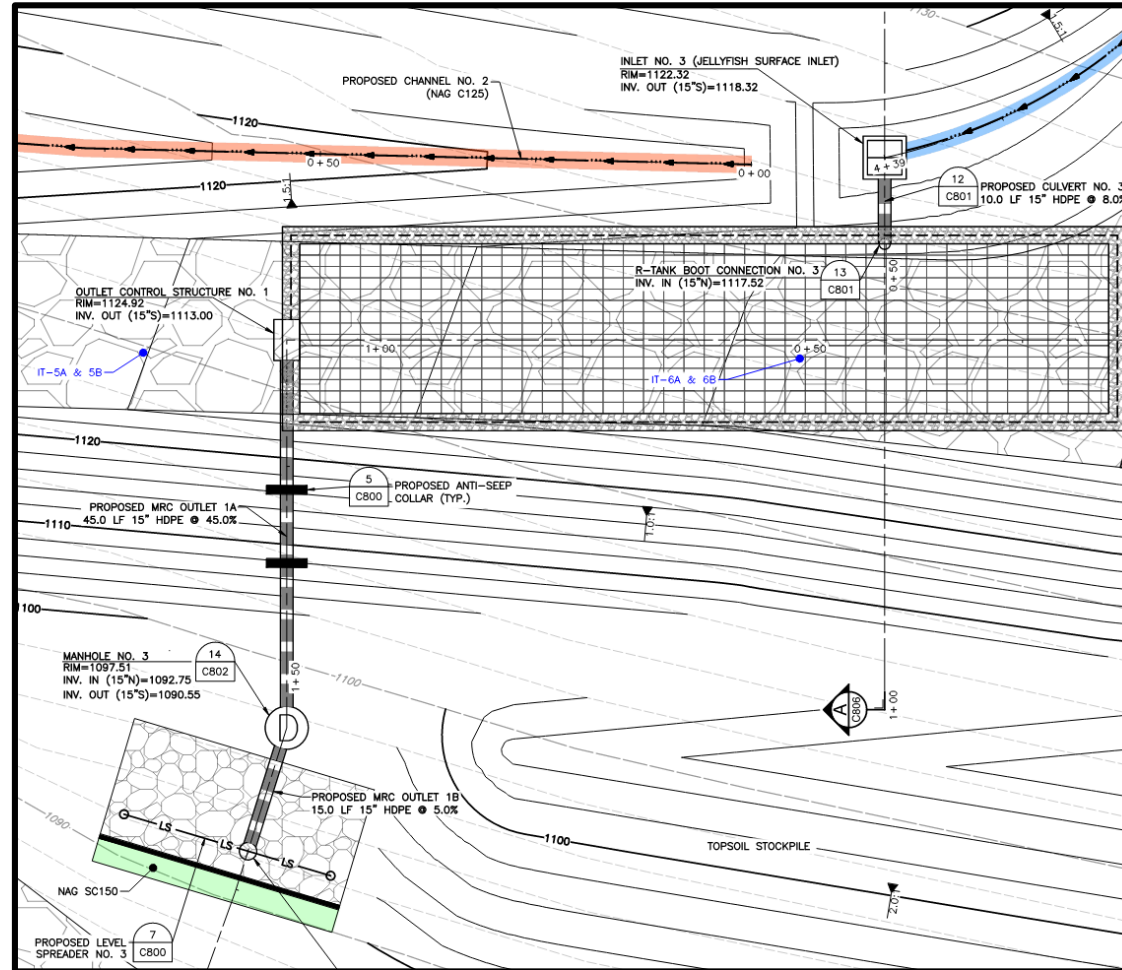
1.33' ponding depth for 100-YR storm (4' maximum)
Measured from top of media (1779.00)

Pond 4P: Constructed Wetland - MRC Basin No. 1 - MRC Example - Construct

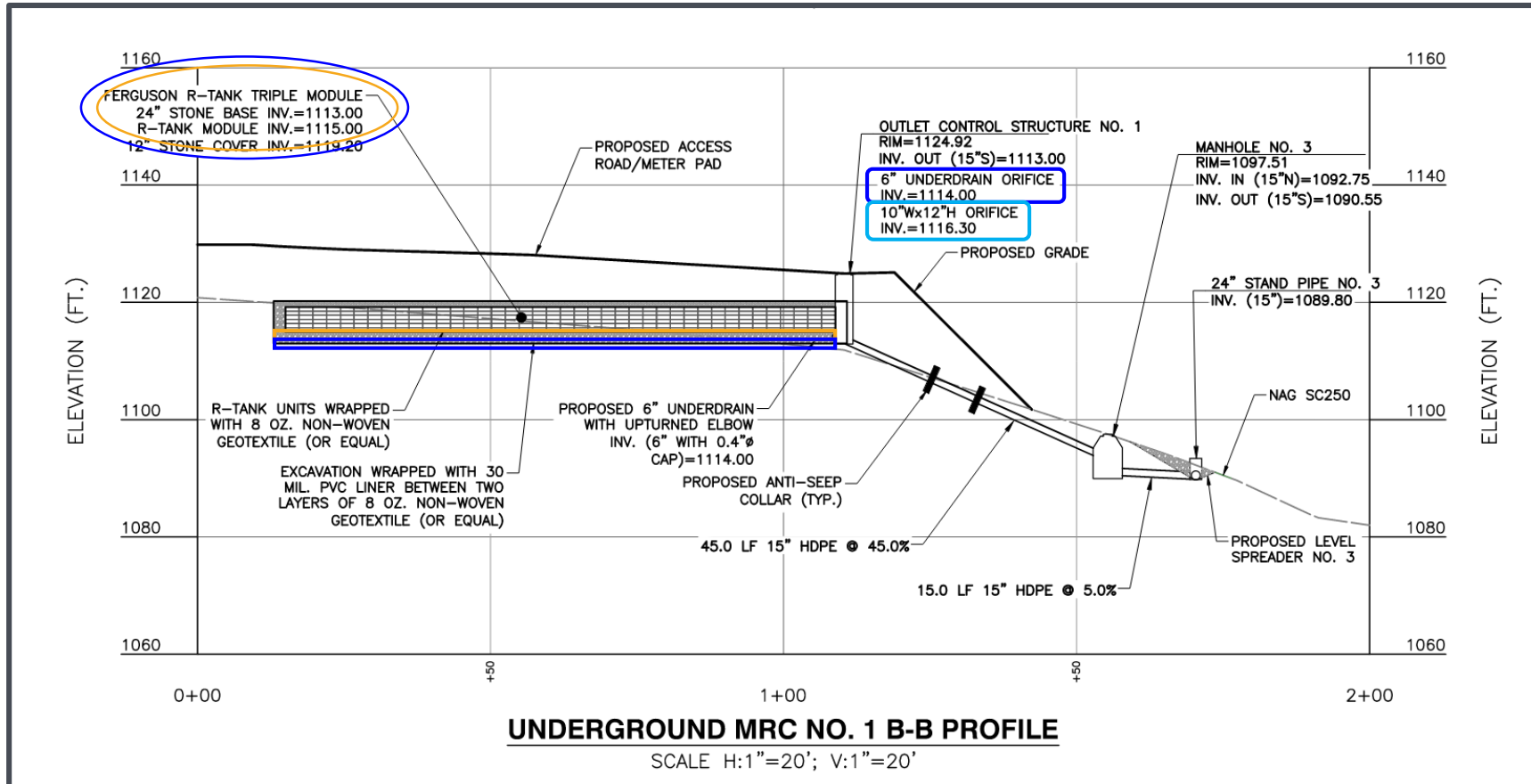
Summary | Hydrograph | Discharge | Storage | Profile | Events | Sizing

| Event | Inflow (cfs) | Outflow (cfs) | Primary (cfs) | Secondary (cfs) | Elevation (feet) |
|---------------|--------------|---------------|---------------|-----------------|------------------|
| 1-Year | 3.25 | 0.00 | 0.00 | 0.00 | 1,179.34 |
| 1.2-IN/2-Hour | 3.62 | 0.00 | 0.00 | 0.00 | 1,178.42 |
| 2-Year | 4.46 | 0.09 | 0.09 | 0.00 | 1,179.41 |
| 10-Year | 7.80 | 0.78 | 0.78 | 0.00 | 1,179.59 |
| 25-Year | 10.04 | 1.82 | 1.82 | 0.00 | 1,179.85 |
| 50-Year | 11.89 | 2.43 | 2.43 | 0.00 | 1,180.09 |
| 100-Year | 13.87 | 3.78 | 3.78 | 0.00 | 1,180.33 |

Subsurface – Modular System

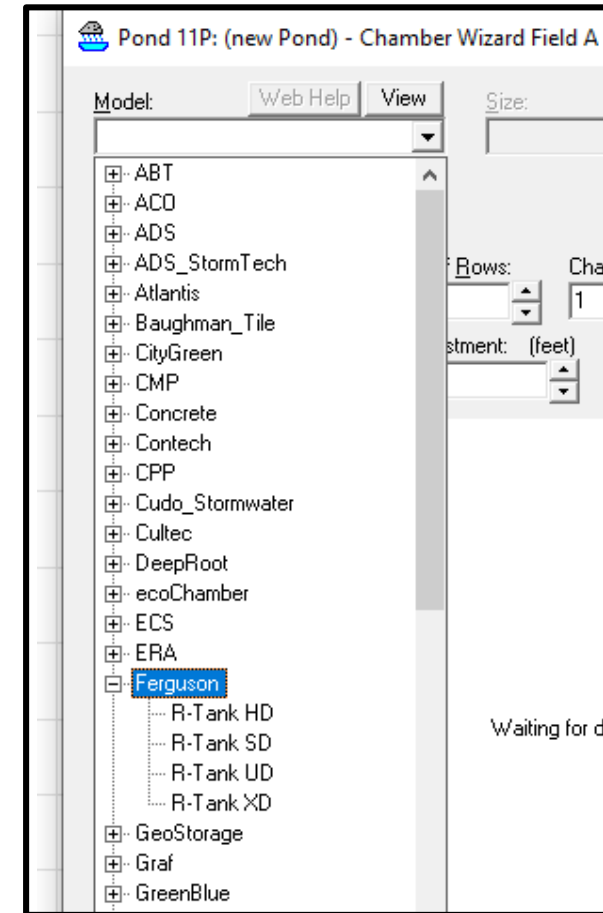
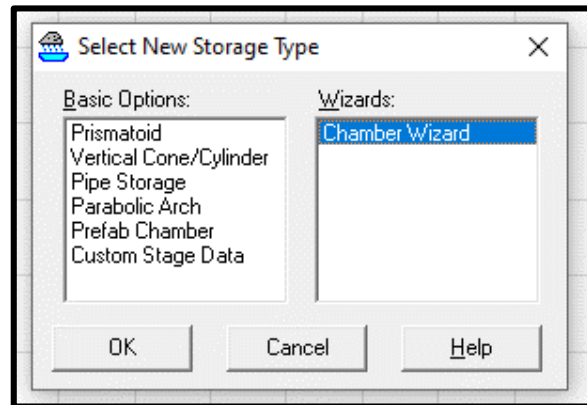


Subsurface – Modular System



Subsurface – Modular System

- HydroCAD has a handy built-in feature that allows the user to select from a variety of manufacturers and their systems



Subsurface – Modular System

Pond 1P: Managed Release Concept No. 1 - Chamber Wizard Field A

Model: Ferguson R-Tank HD Size: 3

Chamber Cost: (\$/ea) 0.00 Excavation: (\$/cy) 0.00 Stone: (\$/cy) 0.00

Ferguson R-Tank HD
 Inside= 15.7"W x 50.4"H => 5.24 sf x 2.35'L = 12.3 cf
 Outside= 15.7"W x 50.4"H => 5.51 sf x 2.35'L = 12.9 cf

Additional Materials: Show Costs

| # | Qty | Description | \$ Price |
|---|-----|-------------|----------|
| 1 | | | |
| 2 | | | |
| 3 | | | |

40 Chambers/Row x 2.35' Long = 93.83' Row Length + 24.0" End Stone x 2 = 97.83' Base Length

15 Rows x 15.7" Wide + 24.0" Side Stone x 2 = 23.69' Base Width

24.0" Stone Base + 50.4" Chamber Height = 7.20' Field Height

600 Chambers x 12.3 cf = 7,369.0 cf of Displacement

600 Chambers x 12.9 cf = 7,756.8 cf of Displacement

16,682.3 cf of Field - 7,756.8 cf of Chambers = 8,925.5 cf of Stone x 40.0% Voids = 3,570.2 cf of Stone Storage

Chamber Storage + Stone Storage = 10,939.2 cf of Storage

Overall Storage Efficiency = 65.6%

Overall System Size = 97.83' x 23.69' x 7.20'

600 Chambers
 617.9 cy Field
 330.6 cy Stone

Number of Rows: 15 Chambers per Row: 40

Row Spacing: (inches) 0.0

Side Stone: (inches) 24.0

End Stone: (inches) 24.0

Stone Cover: (inches) 12.0

Stone Base: (inches) 24.0

Side Z: (run/rise) 0.0

Field Description: Field A

Stone Voids: (%) 40.0

Stone Invert: (feet) 1,113.00

Allow Exfiltration

OK Cancel Help Print Export

Bottom of Basin at Native Soil

1' Internal Water Storage (IWS) at 0% voids (unvegetated)

2' Media: 1' ISW + 1' Additional Media

Edit Pond 1P - MRC Example - R-Tank

General | Storage | Outlets | Tailwater | Advanced | Notes

| # | Invert (feet) | Description | Routing |
|----|---------------|----------------|----------|
| 1 | 1,090.55 | Outlet B | Primary |
| 2 | 1,113.00 | Outlet A | Device 1 |
| 3 | 1,114.00 | Upturned Elbow | Device 2 |
| 4 | 1,116.30 | Driftice/Grate | Device 2 |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |

Tip: For standpipes and other compound outlets, enter the final outlet device FIRST. Click here for details.

Edit Outlet...

OK

Edit Pond 1P - MRC Example - R-Tank

General | Storage | Outlets | Tailwater | Advanced | Notes

Starting Elev: (feet) 1,114.00 Automatic Starting Elev.

Base Flow: (cfs) Automatic Base Flow



Subsurface – Modular System

Edit Pond 1P - MRC Example - R-Tank

General | Storage | **Outlets** | Tailwater | Advanced | Notes

| # | Invert (feet) | Description | Routing |
|----|---------------|----------------|----------|
| 1 | 1,090.55 | Outlet B | Primary |
| 2 | 1,113.00 | Outlet A | Device 1 |
| 3 | 1,114.00 | Upturned Elbow | Device 2 |
| 4 | 1,116.30 | Orifice/Grate | Device 2 |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |

Tip: For standpipes and other compound outlets, enter the final outlet device FIRST. Click here for details.

OK Cancel Apply Help

1' Internal Water Storage (IWS) at 0% media void

First orifice set above the 1.2"/2-HR storm water surface elevation (WSEL)

1.49' ponding depth for 2-YR storm (2' maximum)
Measured from top of media (1115.00)

3.99' ponding depth for 100-YR storm (4' maximum)
Measured from top of media (1115.00)

Edit Pond 1P - MRC Example - R-Tank

General | **Storage** | Outlets | Tailwater | Advanced | Notes

Starting Elev: (feet) Automatic Starting Elev.

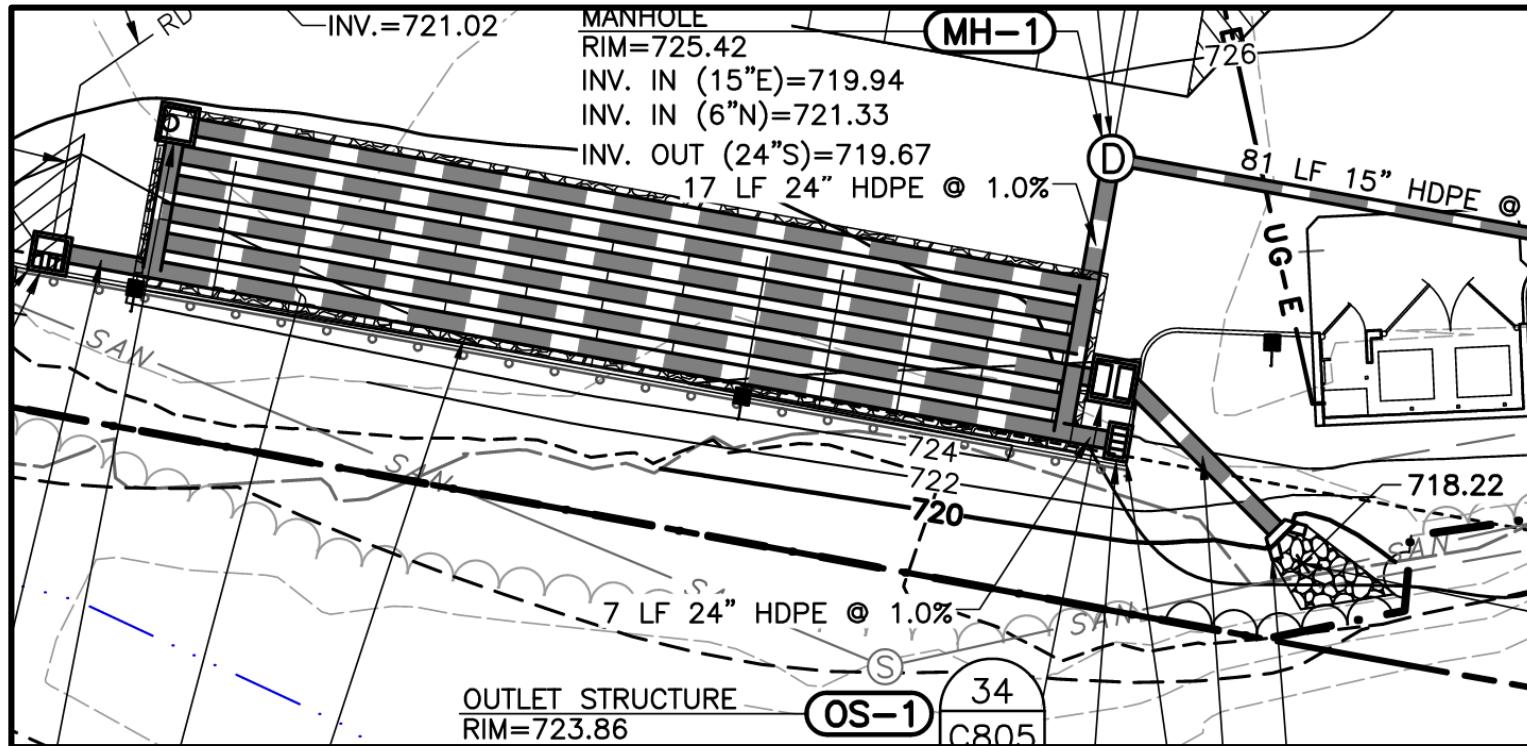
Base Flow: (cfs) Automatic Base Flow

Pond 1P: Managed Release Concept No. 1 - MRC Exa...

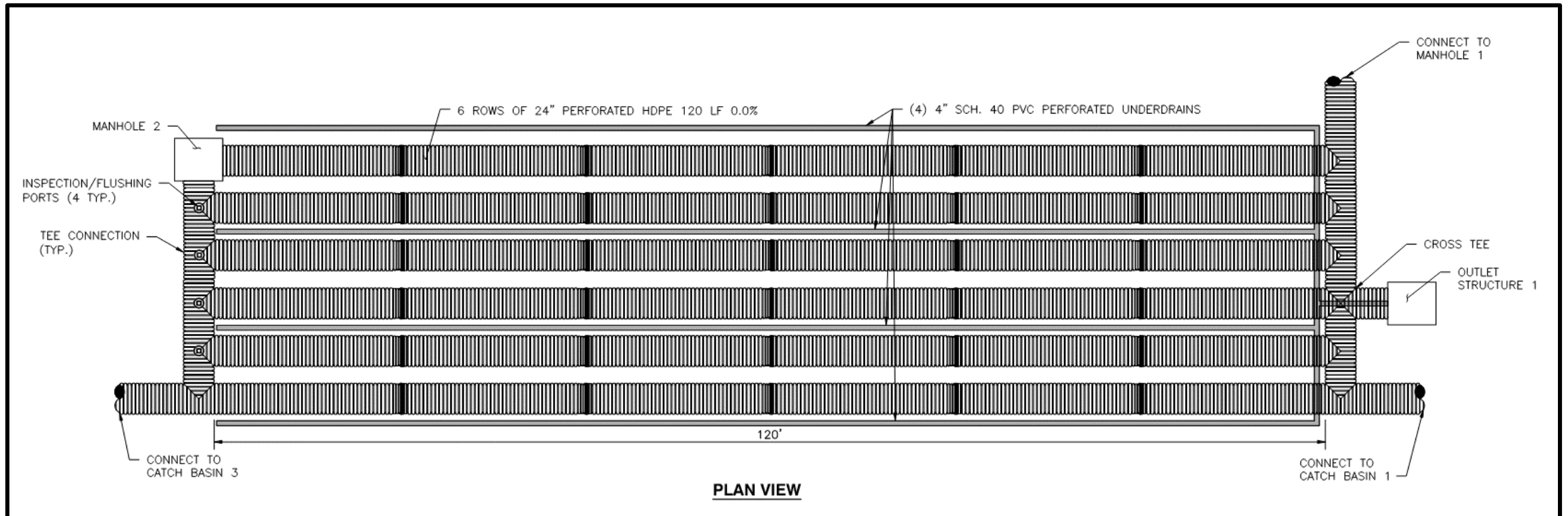
Summary | Wizards | Hydrograph | Discharge | **Storage** | Profile | Ev...

| Event | Inflow (cfs) | Primary (cfs) | Elevation (feet) | Storage (cubic-feet) |
|---------|--------------|---------------|------------------|----------------------|
| 1-YR | 2.30 | 0.06 | 1,116.37 | 4,522 |
| 1.2/2HR | 1.15 | 0.00 | 1,115.23 | 2,300 |
| 2-YR | 3.20 | 0.22 | 1,116.49 | 4,739 |
| 5-YR | 4.53 | 1.07 | 1,116.84 | 5,431 |
| 10-YR | 5.75 | 2.41 | 1,117.23 | 6,188 |
| 25-YR | 7.63 | 3.98 | 1,117.80 | 7,294 |
| 50-YR | 9.41 | 4.99 | 1,118.35 | 8,366 |
| 100-YR | 11.40 | 5.03 | 1,118.99 | 9,599 |

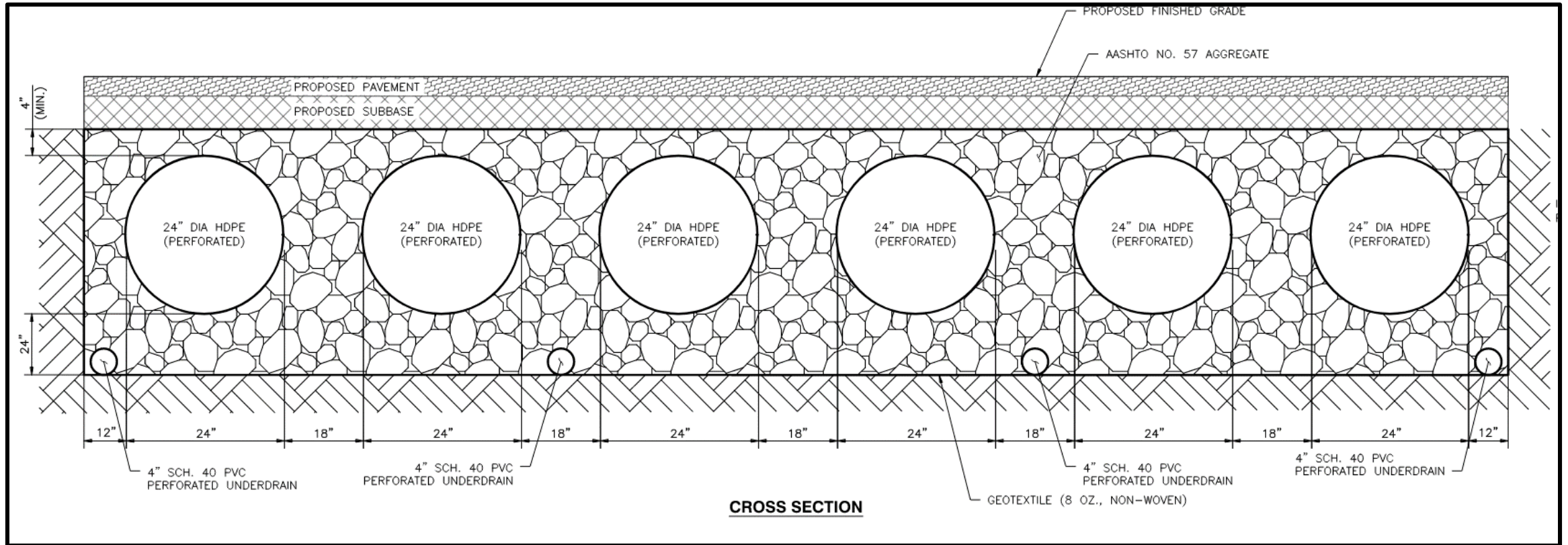
Subsurface – Pipe System



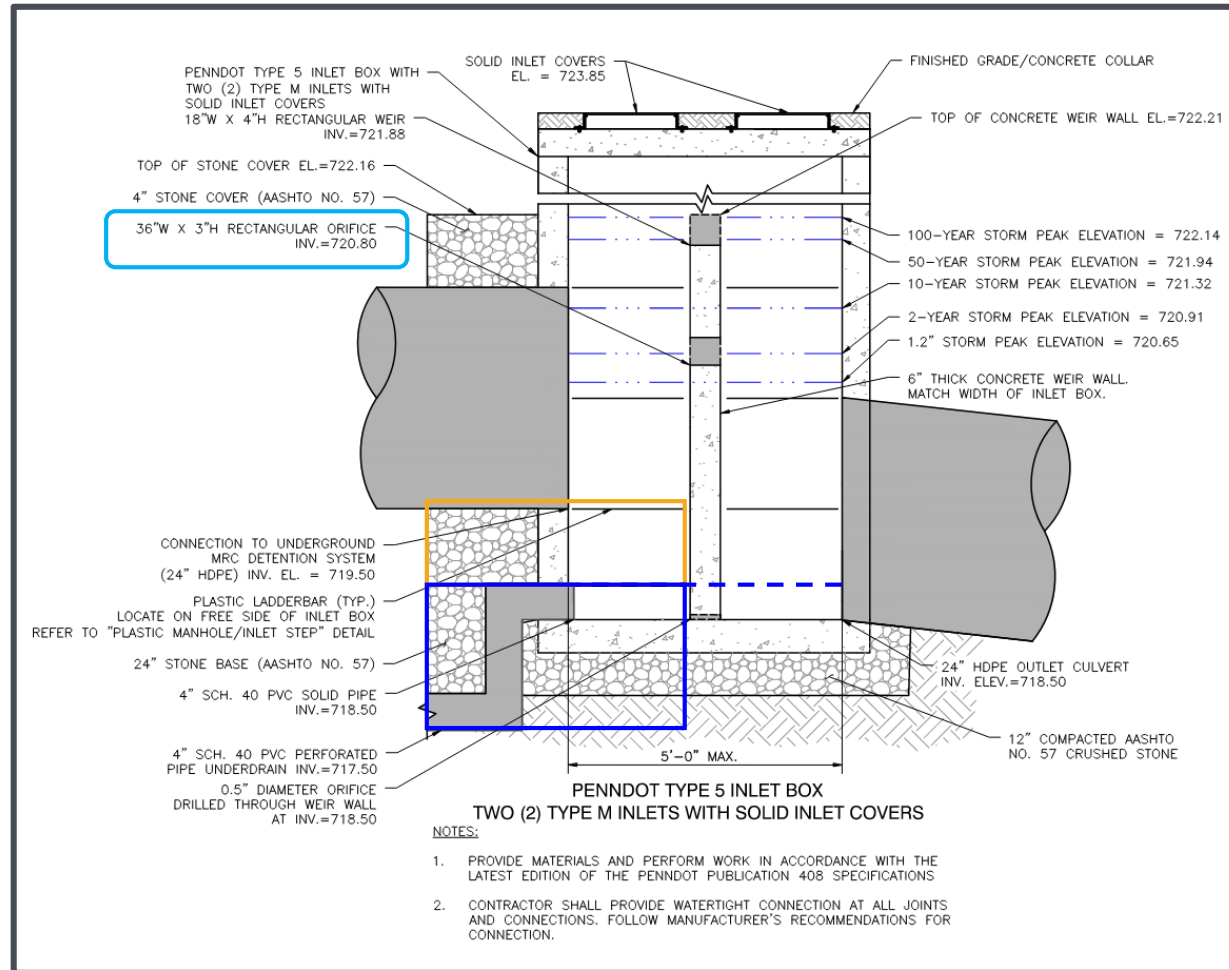
Subsurface – Pipe System



Subsurface – Pipe System



Subsurface – Pipe System



Subsurface – Pipe System

Pond 1P: MRC UNDERGROUND DETENTION SYSTEM - Chamber Wizard Field A

Model: ADS N-12 Pipe
 Inside= 23.8"W x 23.8"H => 3.10 sf x 20.00'L = 62.0 cf
 Outside= 28.0"W x 28.0"H => 3.92 sf x 20.00'L = 78.4 cf

Additional Materials: Show Costs

| # | Qty | Description | \$ Price |
|---|-----|-------------|----------|
| 1 | | | |
| 2 | | | |
| 3 | | | |

28.0" Wide + 18.0" Spacing = 46.0" C-C Row Spacing

6 Chambers/Row x 20.00' Long + 2.33' Header x 2 = 124.67'
 Row Length + 12.0" End Stone x 2 = 126.67' Base Length

6 Rows x 28.0" Wide + 18.0" Spacing = 5 - 12.0" C-C
 Stone x 2 = 23.50' Base Width

24.0" Stone Base + 28.0" Chamber H
 Cover = 1.67' Field Height

36 Chambers x 62.0 cf + 21.50' Header x 3.10 sf x 2 =
 2,365.3 cf Chamber Storage

36 Chambers x 78.4 cf + 21.50' Header x 3.92 sf x 2 =
 2,992.0 cf Displacement

13,891.4 cf Field - 2,992.0 cf Chambers = 10,899.4 cf
 x 40.0% Voids = 4,359.8 cf Stone Storage

Chamber Storage + Stone Storage = 6,725.1 cf
 Overall Storage Efficiency = 48.4%

Overall System Size = 126.67' x 23.50' x 4.67'

36 Chambers
 514.5 cy Field
 403.7 cy Stone

Stone Invert: (feet) 717.50

Allow Exfiltration

**Bottom of Basin
at Native Soil**

**1' Internal Water Storage (IWS)
at 0% voids (unvegetated)**

**2' Media:
1' ISW + 1' Additional Media**

Edit Pond 1P - MRC Example - Perforated Pipes

General | Storage | Outlets | Tailwater | Advanced | Notes

| # | Invert (feet) | Description | Routing |
|----|---------------|--------------------------------|-----------|
| 1 | 717.50 | Exfiltration | Discarded |
| 2 | 718.50 | 24" HDPE Outlet Culvert | Primary |
| 3 | 718.50 | Orifice/Grate | Device 2 |
| 4 | 720.80 | Orifice/Grate | Device 2 |
| 5 | 721.88 | Broad-Crested Rectangular Weir | Device 2 |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |

Tip: For standpipes and other compound outlets, enter the final outlet device FIRST. Click here for details.

Edit Outlet...

Edit Pond 1P - MRC Example - Perforated Pipes

General | Storage | Outlets | Tailwater | Advanced | Notes

Starting Elev: (feet) 718.50 Automatic Starting Elev.

Base Flow: (cfs) Automatic Base Flow

Subsurface – Pipe System

Edit Pond 1P - MRC Example - Perforated Pipes

General | Storage | Outlets | Tailwater | Advanced | Notes

| # | Invert (feet) | Description | Routing |
|----|---------------|--------------------------------|-----------|
| 1 | 717.50 | Exfiltration | Discarded |
| 2 | 718.50 | 24" HDPE Outlet Culvert | Primary |
| 3 | 718.50 | Orifice/Grate | Device 2 |
| 4 | 720.80 | Orifice/Grate | Device 2 |
| 5 | 721.88 | Broad-Crested Rectangular Weir | Device 2 |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |

Tip: For standpipes and other compound outlets, enter the final outlet device FIRST. Click here for details.

Edit Outlet...

OK Cancel Apply Help

Infiltration at Bottom of Basin (Native Soil)

1' Internal Water Storage (IWS) at 50% media void

First orifice set above the 1.2"/2-HR storm water surface elevation (WSEL)

1.43' ponding depth for 2-YR storm (2' maximum)
Measured from top of media (719.50)

2.64' ponding depth for 2-YR storm (4' maximum)
Measured from top of media (719.50)

Pond 1P: MRC UNDERGROUND DETENTION SYSTEM - MRC Example - Perforated Pipes

Summary | Wizards | Hydrograph | Discharge | Storage | Profile | Events | Size

| Event | Inflow (cfs) | Outflow (cfs) | Discarded (cfs) | Primary (cfs) | Elevation (feet) |
|-----------|--------------|---------------|-----------------|---------------|------------------|
| 1-YR | 2.35 | 0.10 | 0.01 | 0.09 | 720.84 |
| 1.2IN/2HR | 2.58 | 0.02 | 0.01 | 0.01 | 720.65 |
| 2-YR | 2.84 | 0.47 | 0.01 | 0.46 | 720.93 |
| 5-YR | 3.52 | 1.75 | 0.01 | 1.74 | 721.16 |
| 10-YR | 4.05 | 2.34 | 0.01 | 2.33 | 721.34 |
| 25-YR | 4.82 | 3.07 | 0.01 | 3.06 | 721.64 |
| 50-YR | 5.46 | 3.72 | 0.01 | 3.71 | 721.94 |
| 100-YR | 6.12 | 4.53 | 0.01 | 4.52 | 722.14 |



Contact Information



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Project Manager II

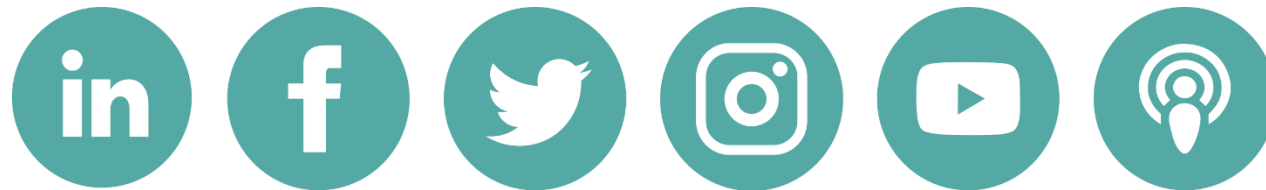
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Questions?

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