

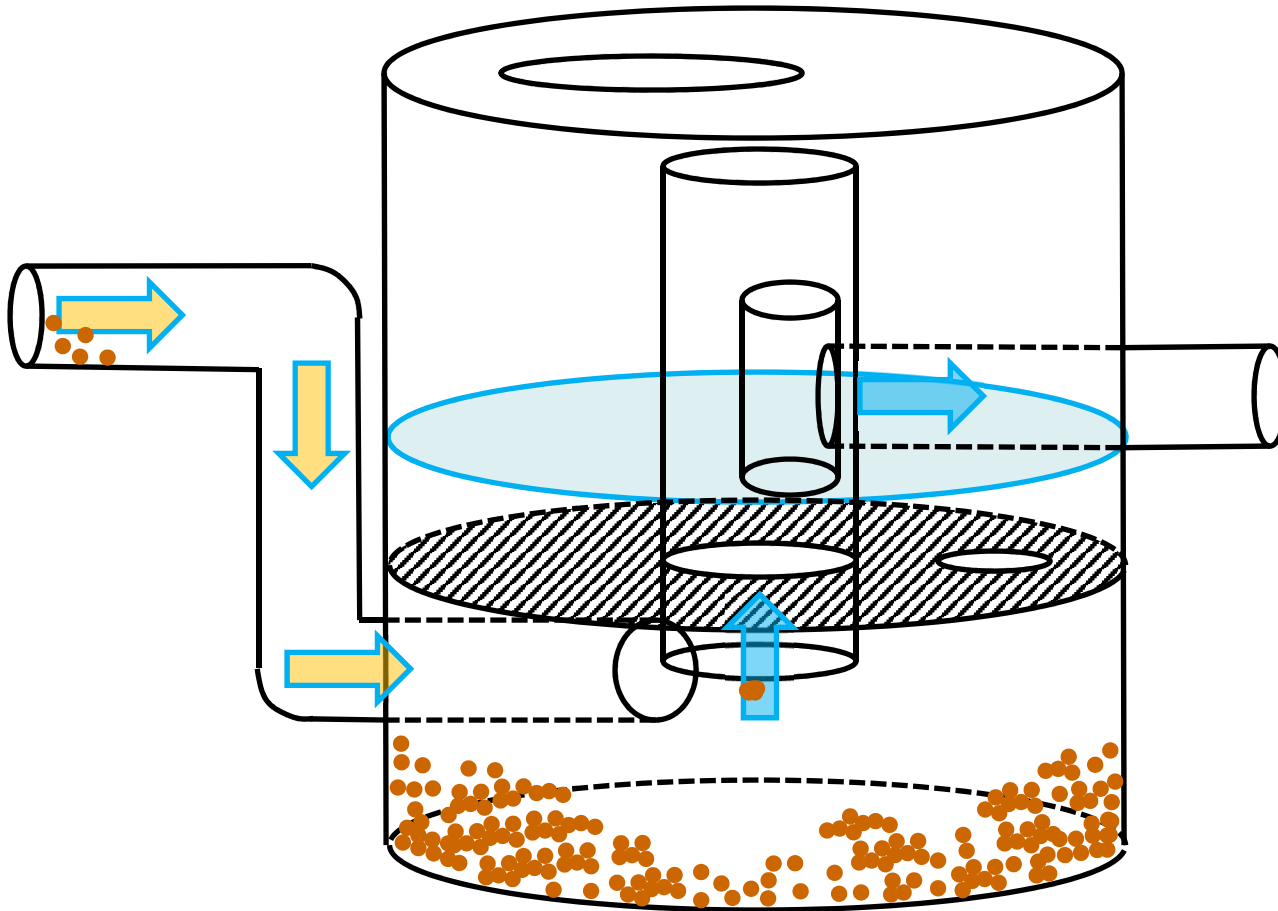
# Manufactured System Design

# Manufactured Systems

- ☉ L&D Vol. 2 Section 1117.1
- ☉ Provides quality treatment only



# Manufactured System Treatment Processes



# Design Process

- ④ Treatment Goals
- ④ Siting Analysis
- ④ Manufactured System Sizing
- ④ Other Considerations



# Design Process

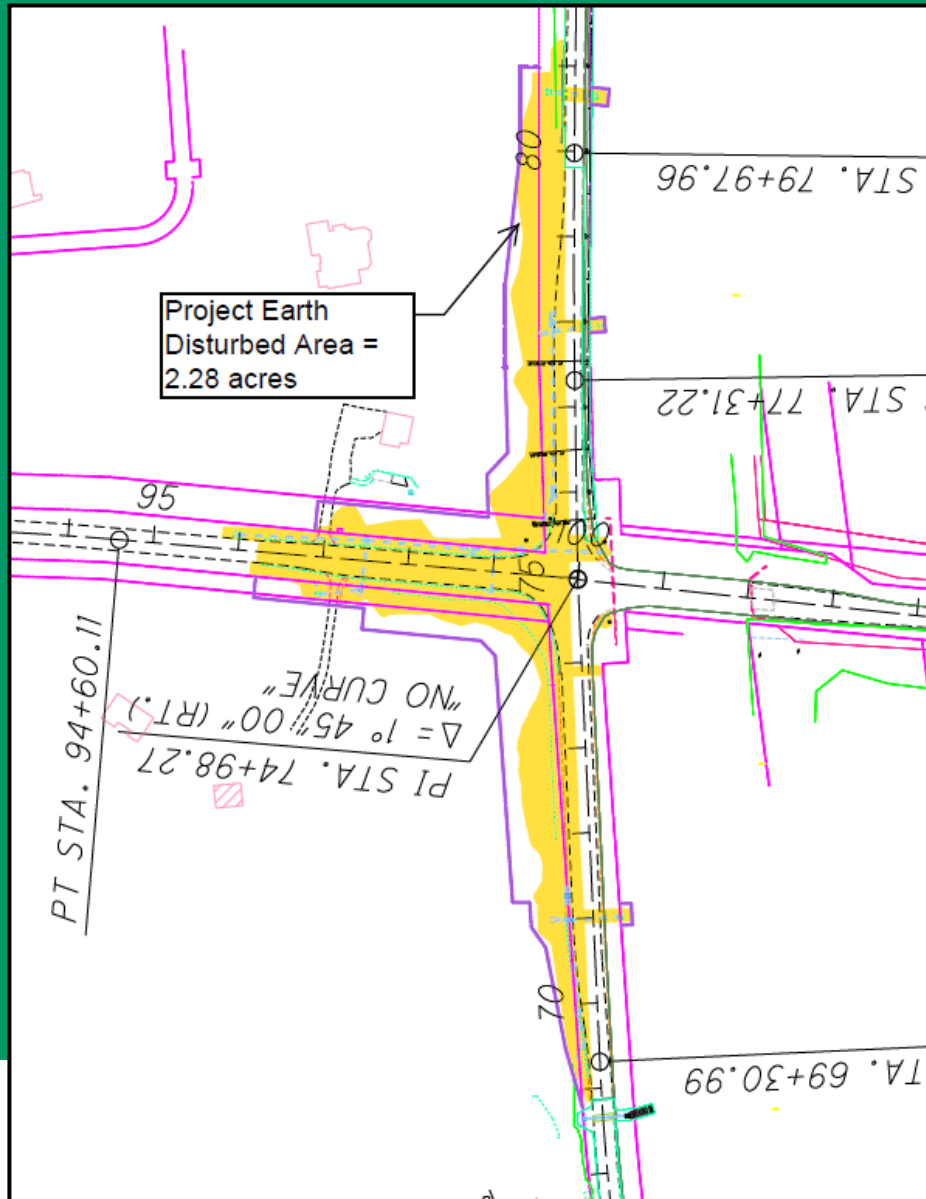
- ④ **Treatment Goals**
- ④ **Siting Analysis**
- ④ **Manufactured System Sizing**
- ④ **Other Considerations**

# Project Example

- 🕒 Intersection improvement
- 🕒 Add turn lane
- 🕒 All within existing right-of-way



# Project Example



# Project Example – Treatment Goals

- ☉ Project EDA = 2.28 ac
- ☉ All within existing right-of-way
- ☉  $A_{ix} = 2.28$  ac;  $A_{in} = 0.0$  ac
- ☉  $T\% = [(A_{ix} \times 20) + (A_{in} \times 100)] / (A_{ix} + A_{in})$
- ☉  $T\% = [(2.28 \times 20) + (0.0 \times 100)] / (2.28 + 0)$
- ☉  $T\% = 20\%$
- ☉  $20\% \times 2.28$  ac = 0.46 ac

# Project Example – Treatment Goals

- 🕒 **Project EDA = 2.28 ac  $\geq$  1 ac**
  - 🕒 Need a post-construction BMP
- 🕒 **All redevelopment**
  - 🕒 Need to treat 0.46 ac (20%)
- 🕒 **All in existing right-of-way**
  - 🕒 All existing right-of-way considered impervious
  - 🕒 Therefore no “new impervious area in new permanent right-of-way”
  - 🕒 Water quality treatment only required

# Design Process

- ④ Treatment Goals
- ④ **Siting Analysis**
- ④ Manufactured System Sizing
- ④ Other Considerations

# Siting Analysis

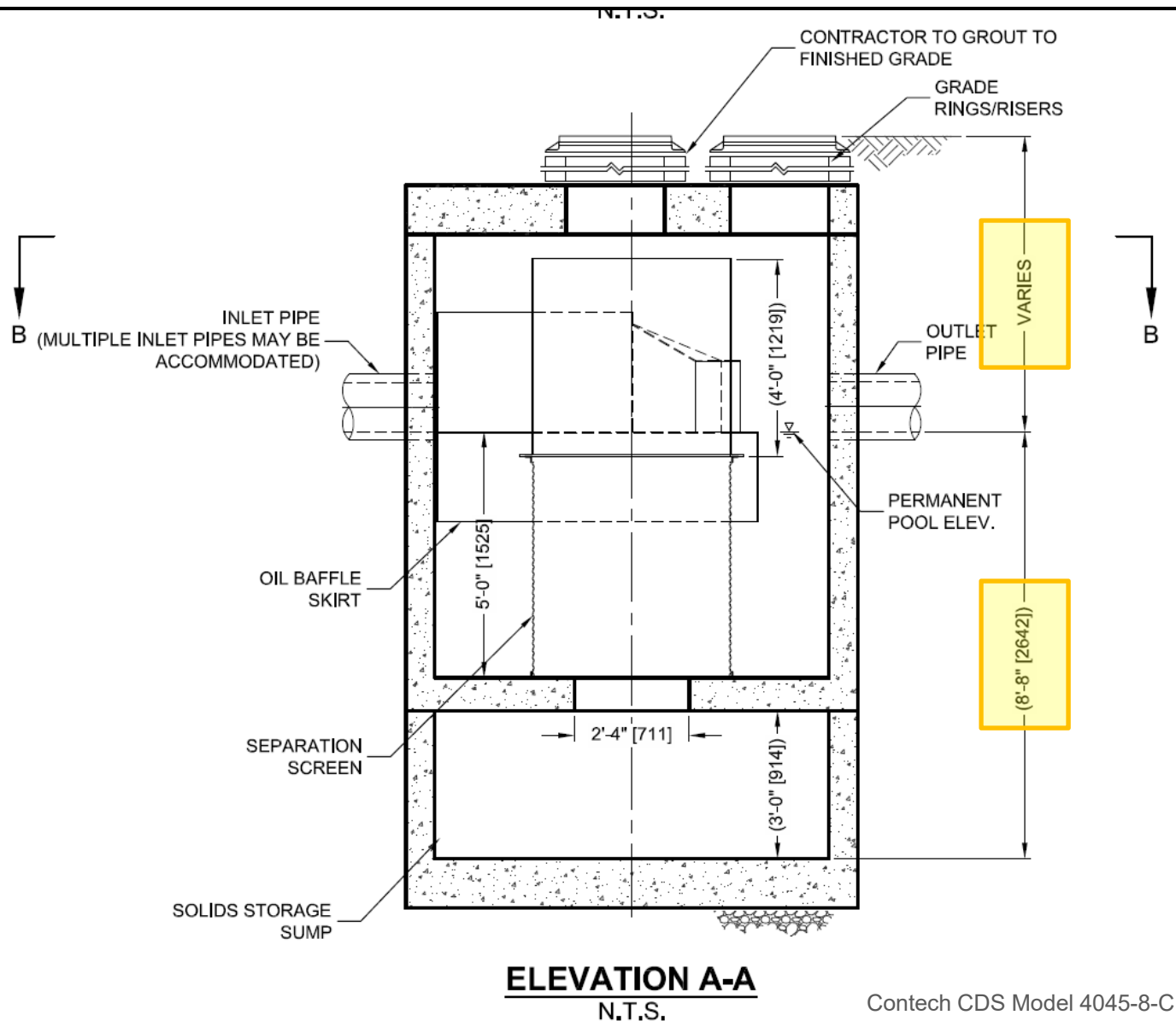
- ④ Manufactured systems near storm sewers
- ④ Avoid underground utilities
- ④ Avoid pipes at depths greater than 10 ft
- ④ Avoid trunk lines (pipes with  $WQ_F$  greater than 6 cfs)
- ④ Site system outside of paved areas for maintenance

# Footprint

| Table 1117-2                          |             |              |  |                            |
|---------------------------------------|-------------|--------------|--|----------------------------|
| Reserved Area for Manufactured System |             |              |  |                            |
| Type                                  | Width (ft.) | Length (ft.) | 611 – Type B<br>Total<br>Conduit<br>Length (ft.) | Weir<br>Height<br>(inches) |
| 1                                     | 15          | 30           | 20   | 6                          |
| 2                                     | 20          | 32           | 30   | 8                          |
| 3                                     | 25          | 33           | 40   | 9                          |
| 4                                     | 25          | 37           | 40   | 12                         |



# Maximum Depth



# Maximum Depth



# No Trunk Lines

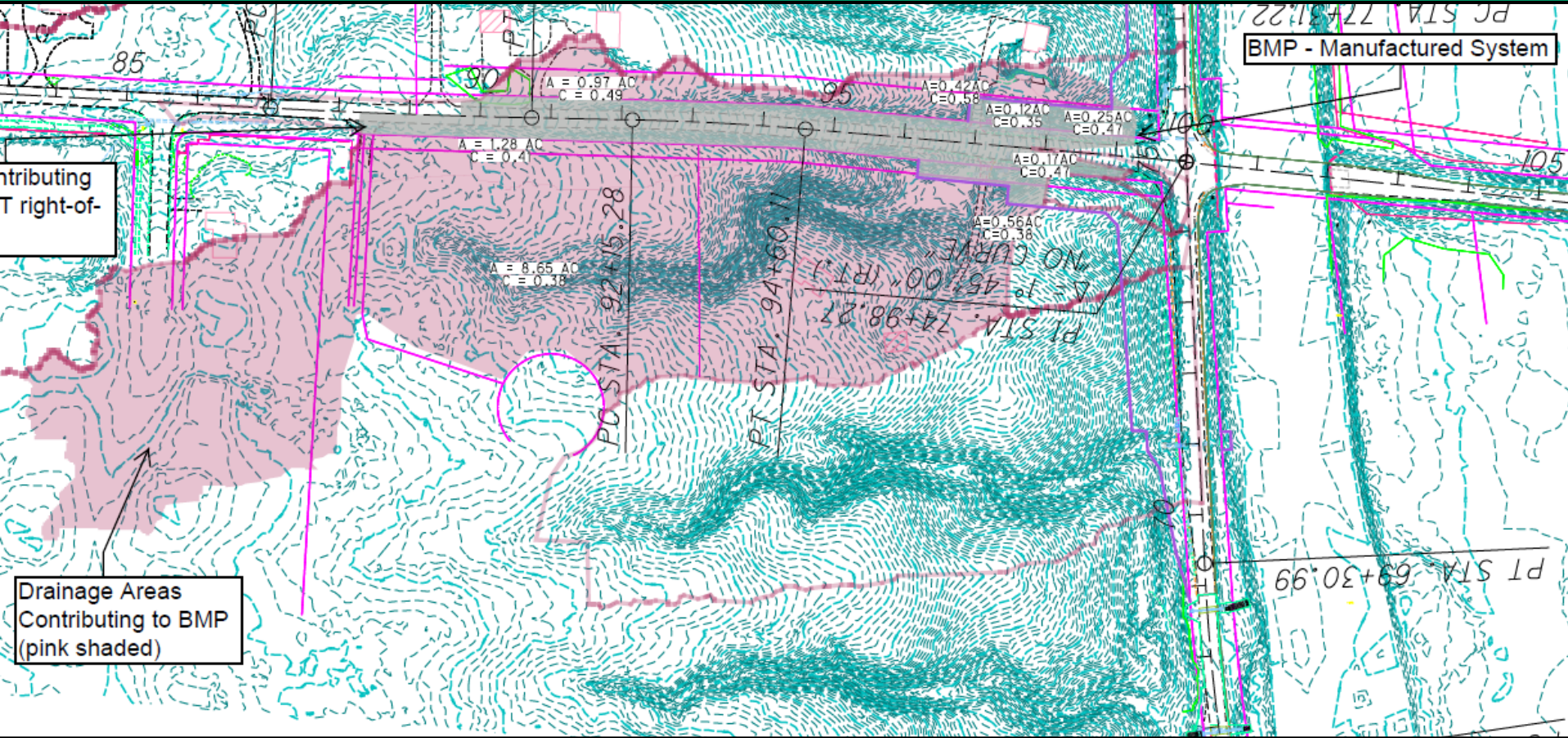
**Table 1117-1**

**Manufactured Systems**

| <b>Type</b> | <b>WQ<sub>f</sub><br/>(cfs)</b> | <b>No. 3<br/>Manhole<br/>Base ID<br/>(inches)</b> | <b>611 – Type B<br/>Conduit<br/>Diameter<br/>(inches)</b> |
|-------------|---------------------------------|---|---|
| 1           | 1                               | 84  | 12  |
| 2           | 2                               | 90  | 15  |
| 3           | 3                               | 96  | 18  |
| 4           | 6                               | 108   | 24  |

# Siting Analysis

- ☉ Tributary area = 12.42 ac
- ☉ Trib. Area within R/W = 1.94 ac



# Design Process

- ④ Treatment Goals
- ④ Siting Analysis
- ④ **Manufactured System Sizing**
- ④ Other Considerations

# Manufactured System Sizing

## Design after January 2019

- ☞ **Water Quality Flow ( $WQ_F$ ):  $Q = CiA$**
- ☞ **Calculate time of concentration to determine  $i$**
- ☞  **$T_c$  = overland + shallow conc. + pipe flow**
  - ☞  $T_o = 16$  min
  - ☞  $T_s = 7$  min
  - ☞  $T_p = 2$  min
- ☞  **$T_c = 16 + 7 + 2 = 25$  min**



| DURATION<br>$t_c$<br>(minutes) | WATER QUALITY INTENSITY [ $i_{wq}$ ]<br>(inches/hour) | DURATION<br>$t_c$<br>(minutes) | WATER QUALITY INTENSITY [ $i_{wq}$ ]<br>(inches/hour) |
|--------------------------------|---|--------------------------------|---|
| 5                              | 2.37  | 33                             | 0.95  |
| 6                              | 2.26  | 34                             | 0.93  |
| 7                              | 2.15  | 35                             | 0.92  |
| 8                              | 2.04  | 36                             | 0.90  |
| 9                              | 1.94  | 37                             | 0.88  |
| 10                             | 1.85  | 38                             | 0.86  |
| 11                             | 1.76  | 39                             | 0.85  |
| 12                             | 1.68  | 40                             | 0.83  |
| 13                             | 1.62  | 41                             | 0.82  |
| 14                             | 1.56  | 42                             | 0.80  |
| 15                             | 1.51  | 43                             | 0.78  |
| 16                             | 1.46  | 44                             | 0.77  |
| 17                             | 1.41  | 45                             | 0.76  |
| 18                             | 1.37  | 46                             | 0.75  |
| 19                             | 1.33  | 47                             | 0.74  |
| 20                             | 1.29  | 48                             | 0.73  |
| 21                             | 1.26  | 49                             | 0.72  |
| 22                             | 1.22  | 50                             | 0.71  |
| 23                             | 1.19  | 51                             | 0.69  |
| 24                             | 1.16  | 52                             | 0.68  |
| 25                             | 1.13  | 53                             | 0.67  |
| 26                             | 1.10  | 54                             | 0.66  |
| 27                             | 1.07  | 55                             | 0.66  |
| 28                             | 1.05  | 56                             | 0.65  |
| 29                             | 1.03  | 57                             | 0.64  |
| 30                             | 1.01  | 58                             | 0.64  |
| 31                             | 0.99  | 59                             | 0.63  |
| 32                             | 0.97  | 60                             | 0.62  |

Note: For  $t_c < 5$  minutes, use  $i = 2.37$  in/hr; for  $t_c > 60$  minutes, use  $i = 0.62$  in/hr. For all other  $t_c$ , use the appropriate value from this table.

# Manufactured System Sizing

## Design after January 2019

☞ Water Quality Flow ( $WQ_F$ ):  $Q = CiA$

☞  $C = 0.41$

☞  $i = 1.13 \text{ in/hr}$

☞  $A = 12.42 \text{ ac.}$

☞  $WQ_F = 0.41 * 1.13 \text{ in/hr} * 12.42 \text{ ac}$

☞  $WQ_F = 5.75 \text{ cfs}$

☞ ODOT Type 4

Table 1117-1

Manufactured Systems

| Type | $WQ_f$<br>(cfs) | No. 3<br>Manhole<br>Base ID<br>(inches) | 611 – Type B<br>Conduit<br>Diameter<br>(inches) |
|------|-----------------|---|---|
| 1    | 1               | 84                                      | 12  |
| 2    | 2               | 90                                      | 15  |
| 3    | 3               | 96                                      | 18  |
| 4    | 6               | 108                                     | 24  |



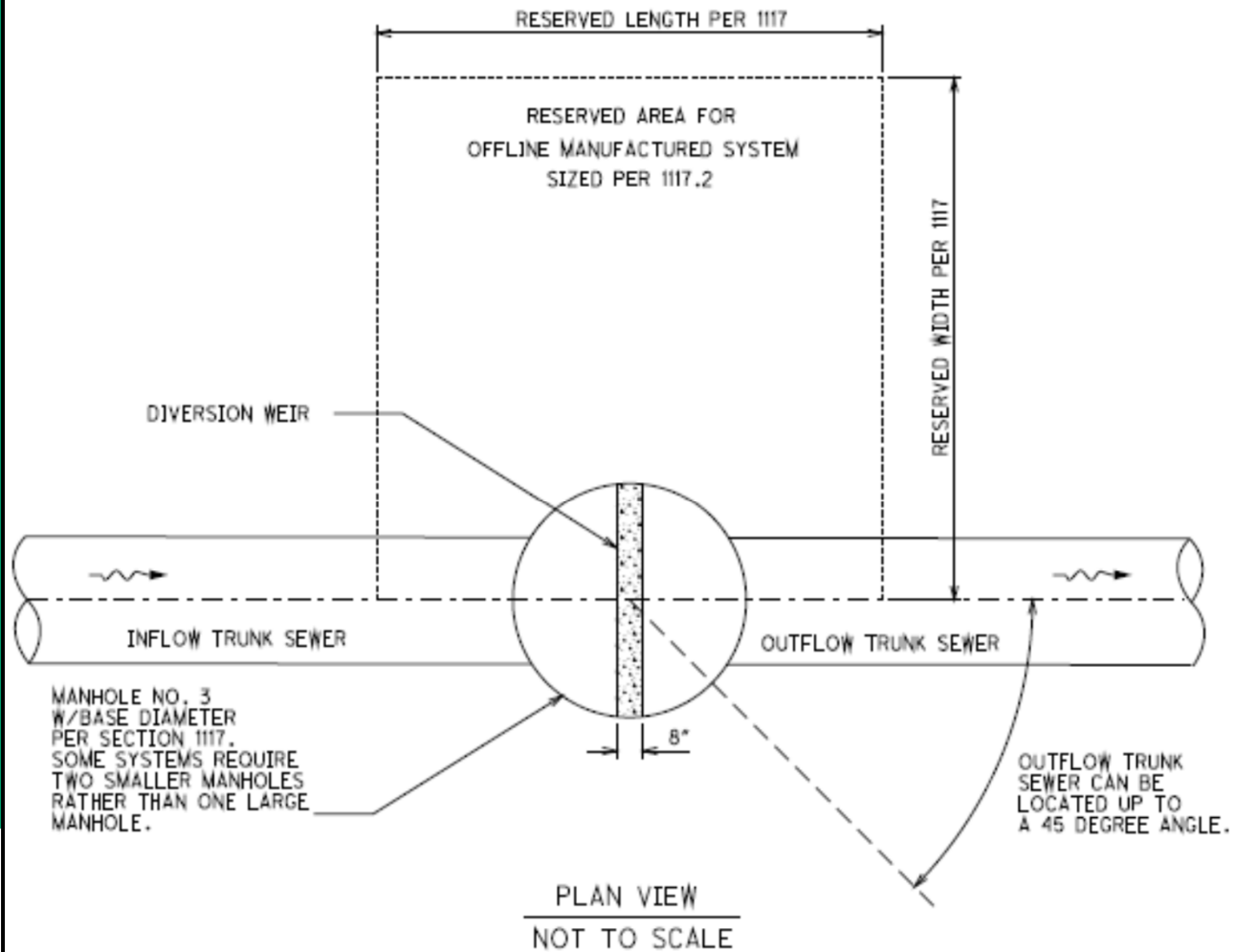
# Manufactured System Sizing

**Table 1117-2**

| <b>Reserved Area for Manufactured System</b> |                        |                         |  |                                     |
|--|------------------------|-------------------------|--|-------------------------------------|
| <b>Type</b>                                  | <b>Width<br/>(ft.)</b> | <b>Length<br/>(ft.)</b> | <b>611 – Type B<br/>Total<br/>Conduit<br/>Length (ft.)</b> | <b>Weir<br/>Height<br/>(inches)</b> |
| 1  | 15                     | 30                      | 20   | 6                                   |
| 2  | 20                     | 32                      | 30   | 8                                   |
| 3  | 25                     | 33                      | 40   | 9                                   |
| 4  | 25                     | 37                      | 40   | 12                                  |

## MANUFACTURED SYSTEM DETAIL

1117-2

REFERENCE SECTION  
1117

# BMP Calcs Spreadsheet



## Ohio Department of Transportation - Office of Hydraulic Engineering Post-Construction BMP Calculation Spreadsheet

### Manufactured Systems

| Drainage Area # | Total Tributary Area (acres) | Tributary Area within R/W (acres) | WQ <sub>F</sub> (cfs) | Required Manufactured System Type | Manufactured System Type Provided |
|-----------------|------------------------------|-----------------------------------|-----------------------|-----------------------------------|-----------------------------------|
| A1              | 12.42                        | 1.94                              | 5.750                 | 4                                 | 4                                 |
| A2              |                              |                                   |                       |                                   |                                   |
| A3              |                              |                                   |                       |                                   |                                   |
| A4              |                              |                                   |                       |                                   |                                   |
| A5              |                              |                                   |                       |                                   |                                   |

Yellow: Requires Input (See instructions tab)

**Total Area Treated by Manufactured Systems (within the right-of-way)**

1.94 acres

(Treatment is for quality only, not quantity)

### BMP Design Considerations

|   |     |      |
|---|-----|------|
| 1. Does the Water Quality flow rate match the system type in L&D Table 1117-1?        | Yes | Good |
| 2. Is the Water Quality flow rate greater than 6 cfs including all contributing area? | No  | Good |
| 3. Is the manufactured system located under a traffic lane?                           | No  | Good |
| 4. Is the storm sewer draining to the manufactured system deeper than 10 feet?        | No  | Good |
| 5. Is there clear maintenance access to the manufactured system?                      | Yes | Good |

# Design Process

- ④ Treatment Goals
- ④ Siting Analysis
- ④ Manufactured System Sizing
- ④ **Other Considerations**

# Sample Plan Note W103

## W103 MANUFACTURED WATER QUALITY STRUCTURE

THIS PLAN UTILIZES MANUFACTURED WATER QUALITY STRUCTURES FOR WATER QUALITY TREATMENT. AREAS HAVE BEEN SHOWN IN THE PLANS FOR PLACEMENT OF AN OFF-LINE SYSTEM. PAYMENT FOR THESE DEVICES SHALL BE MADE AT THE CONTRACT UNIT PRICE FOR ITEM 895, MANUFACTURED WATER QUALITY STRUCTURE, TYPE \_\_\_\_.

Designer Note: This plan note shall be used on all projects that have manufactured water quality structures identified in the plan. If more than one manufactured water quality structure is provided in the plans, a table shall be provided to indicate the location and type of each structure used. Supplemental specification 895 outlines the different types of structures (1-4). **Manufactured systems may not be installed under the roadway or downstream of a connecting pipe more than ten feet deep without approval of the Office of Hydraulic Engineering.**

# Manufactured System Considerations

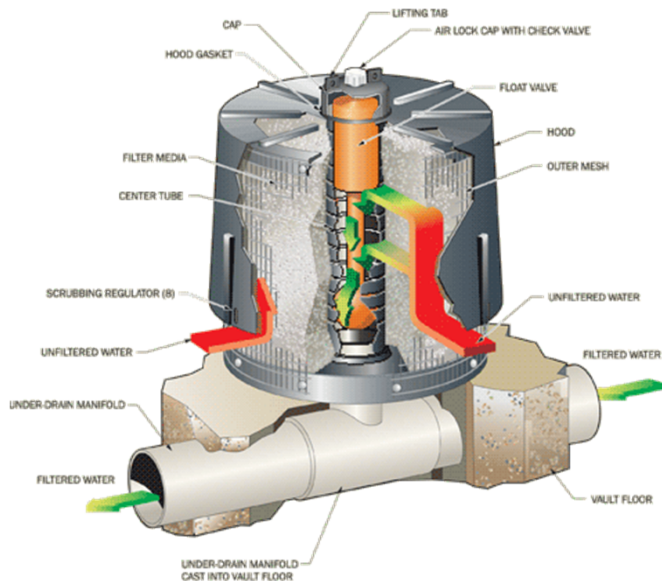
- ④ **Vacuum truck maintenance every 4 – 12 months**
  - ④ Access and safety for maintenance crew
  - ④ Need to close lanes
  - ④ Max. depth of vac truck suction (~20 ft)
- ④ **Max. flow 6 cfs**
  - ④ May need to separate off-site flows

# Manufactured System Considerations

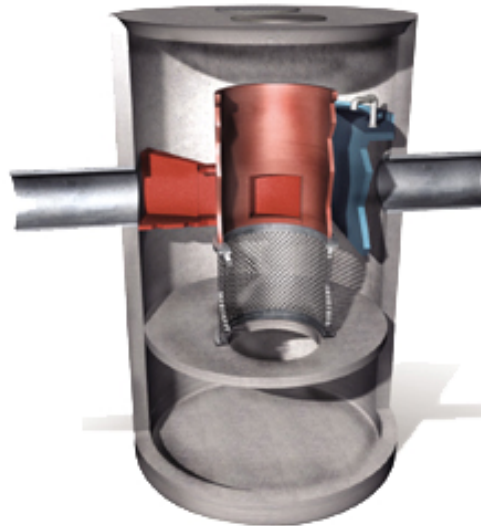
- ④ ODOT Qualified Products List – 31 Products
- ④ Manufactured Water Quality Structure (SS-995)
  - ④ Advance Drainage
  - ④ AquaShield
  - ④ Bio Clean
  - ④ Contech
  - ④ Environment 21
  - ④ Hydro Int.
- ④ All hydrodynamic separators

# Manufactured System Considerations

- Some Cartridge Filters: 80% TARP TSS Distribution
- Hydrodynamic Separators: 80% ODOT Sand, 50% TARP
- Catch Basin Inserts: May Capture > 200 microns



Cartridge (Contech)



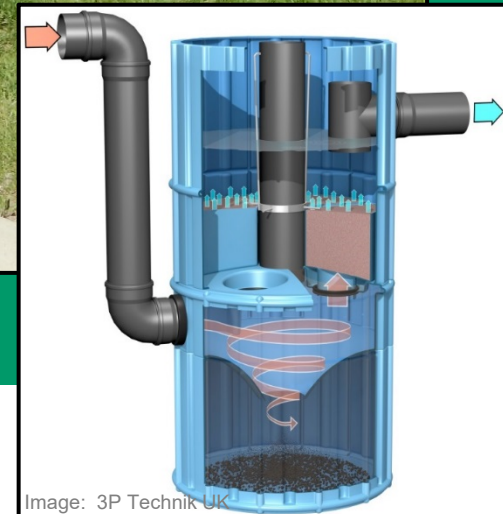
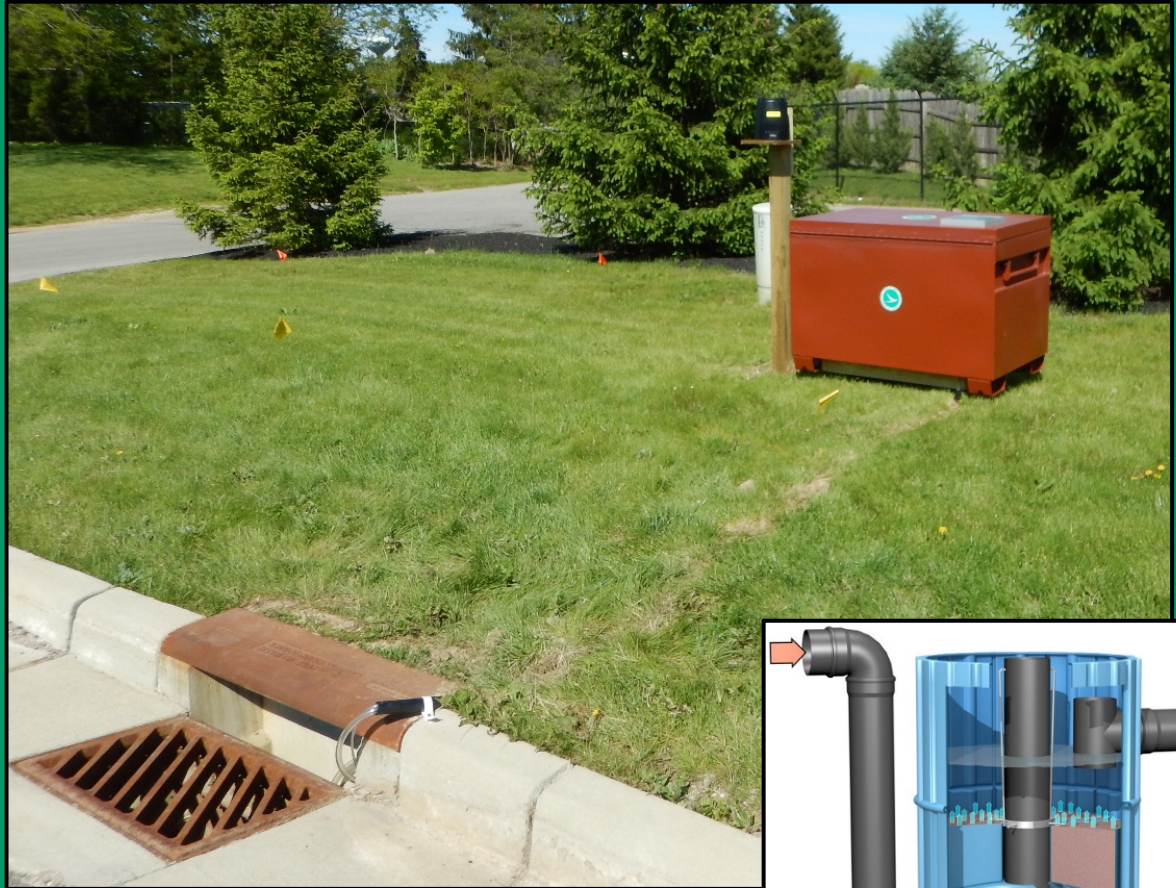
Hydro. Sep. (Contech)



Basin Insert (Contech)

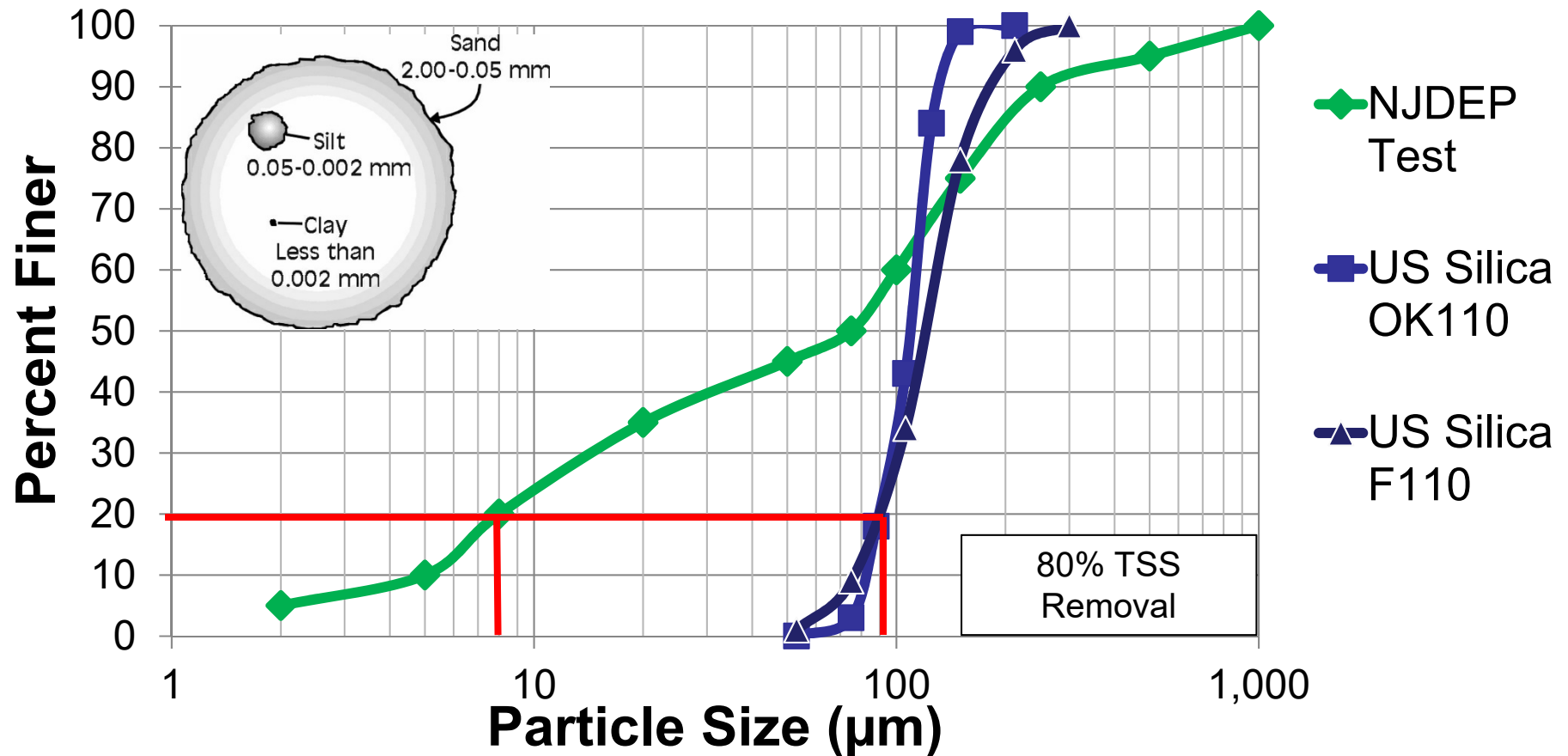


# Research: Particle Size Distribution



# Research: Particle Size Distribution

## Sediment Particle Distributions



# Questions ?

Jon Prier, P.E.  
[jonathan.prier@dot.ohio.gov](mailto:jonathan.prier@dot.ohio.gov)  
614-644-1876

