L&D Vol. 2 Updates

Post-Construction BMPs

Overview

- OEPA Review of L&D Vol. 2 for BMPs
- Vegetated Filter Strip
- Vegetated Biofilter + Example
- Detention / Retention Basins
- Stream Grade Control
- Manufactured Systems
- Bioretention
- Infiltration Trench

Overview

- **OEPA Review of L&D Vol. 2 for BMPs**
- **Vegetated Filter Strip**
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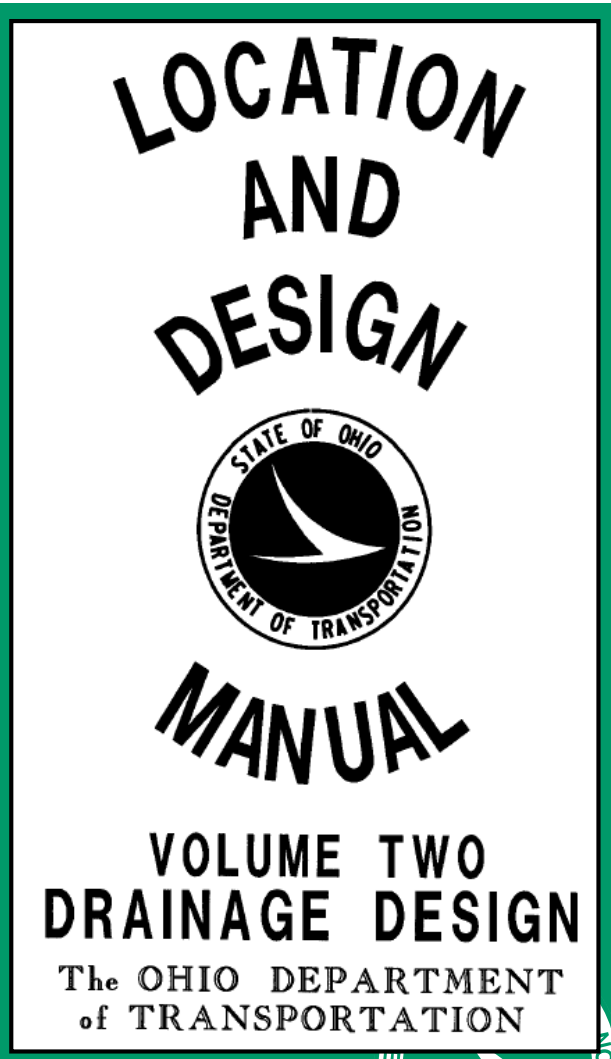
OEPA Review of L&D Vol. 2

- Ohio EPA Construction General Permit: Any land disturbance over 1 ac. must meet requirements in NPDES permit
- CGP: Roadway projects by public entities can use ODOT's L&D, Vol. 2 as an alternate to post-construction BMP requirements
- L&D post-construction BMP guidance reviewed by Ohio EPA

OEPA Review of L&D Vol. 2

- **OEPA recommended changes to:**
  - Improve design consistency / L&D interpretation
  - Improve BMP performance
- **Comments included in ODOT's MS4 Permit Audit**



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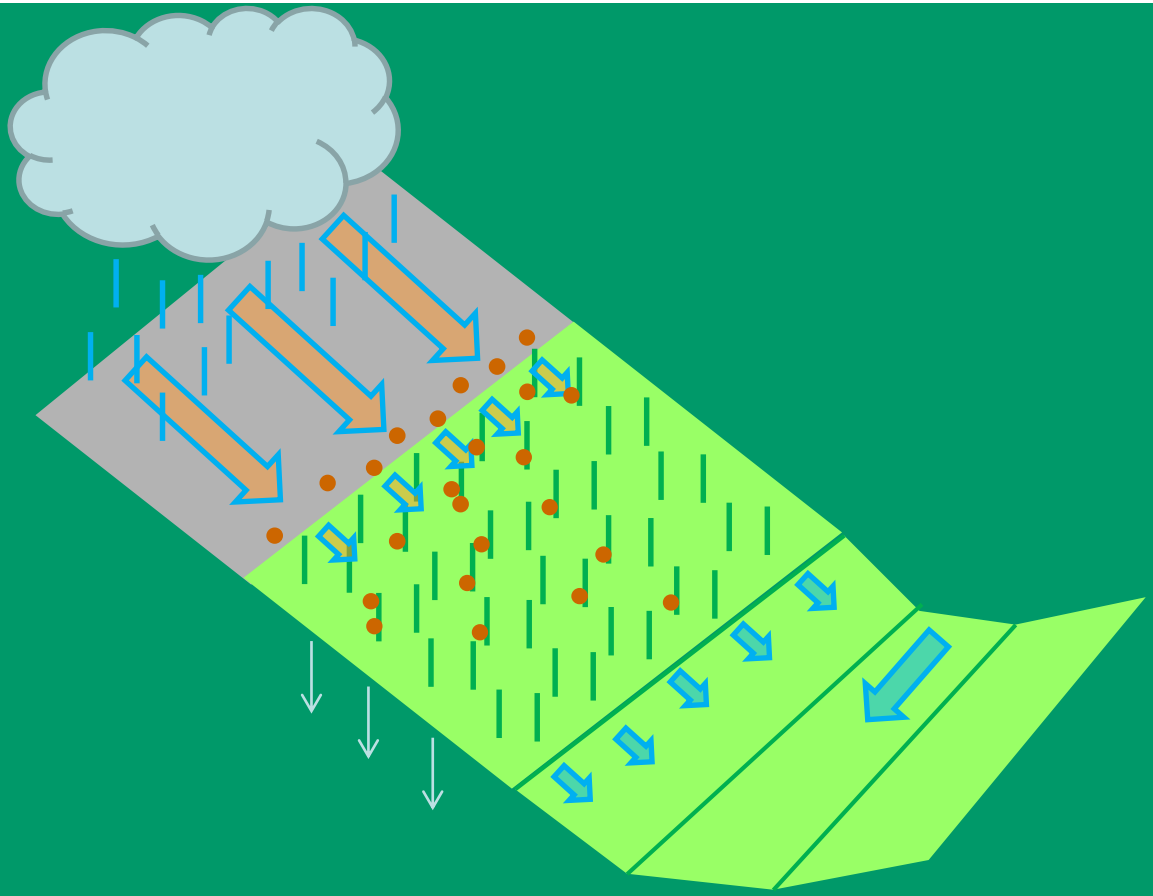
Vegetated Filter Strip

- L&D Vol. 2 Section 1117.2.1
- Provides quality treatment only

Vegetated Filter Strip Treatment Processes



Vegetated Filter Strip Previous

Table 1117-3

Maximum Pavement Width	Slope (H:V)	Filter Strip Width
22 feet	3:1 and flatter	15 feet or greater
34 feet	3:1 and flatter	25 feet or greater
46 feet	6:1 and flatter	25 feet or greater

- Add more options between 22 ft and 34 ft pavement widths
- Increase max. pavement width for three 12 ft lanes and one 12 ft shoulder

Vegetated Filter Strip Updated

Table 1117-3

Maximum Pavement Width (ft.)	Slope (H:V)	Filter Strip Width (ft. minimum)
22	3:1 and flatter	15
24	3:1 and flatter	17
26	3:1 and flatter	18.5
28	3:1 and flatter	20.5
30	3:1 and flatter	22
32	3:1 and flatter	24
34	3:1 and flatter	25
48	6:1 and flatter	25

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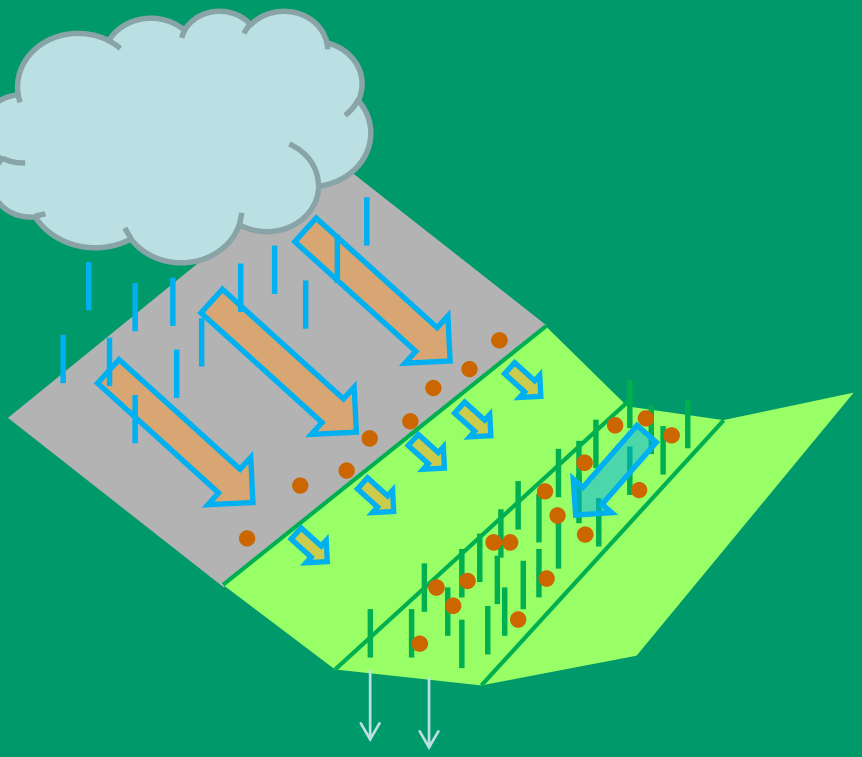
Vegetated Biofilter

- L&D Vol. 2 Section 1117.2.2
- Provides quality treatment only

Vegetated Biofilter Treatment Processes



Vegetated Biofilter Sizing

- **Previous:**
  - Max. EBW = 10 ft

$$EBW = 5.4A^{0.356}$$

- **Updated:**
  - Max. WQ_F velocity = 1 ft/sec
  - Max. WQ_F depth = 4 inches
  - Solve for normal depth and velocity using Manning's Equation

$$Q = \frac{1.49}{n} * AR^{2/3} * S^{1/2}$$

Vegetated Biofilter Project Example

- Design example at the end
- Design process
- Common issues

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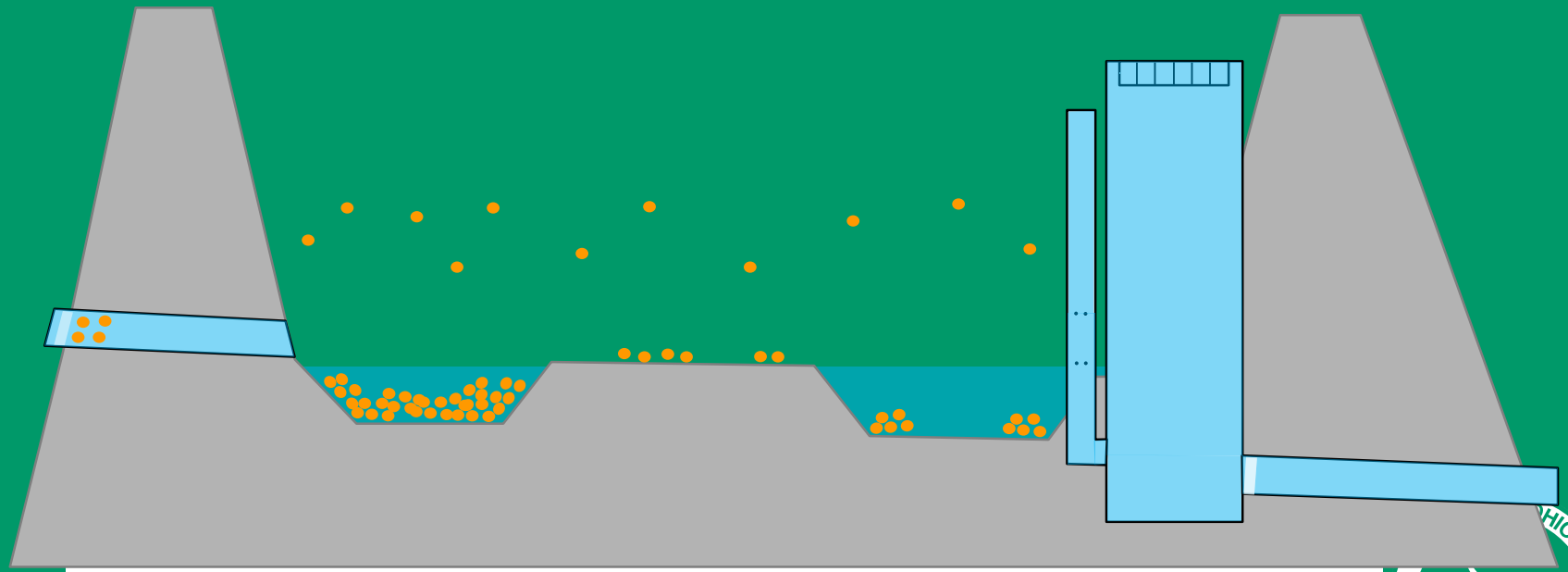
Extended Detention Basin

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

Extended Detention Basin Treatment Processes



Detention / Retention Basins

- No changes to design requirements in L&D
- Clarifications to existing requirements
- Detailed design examples

Detention / Retention Basins

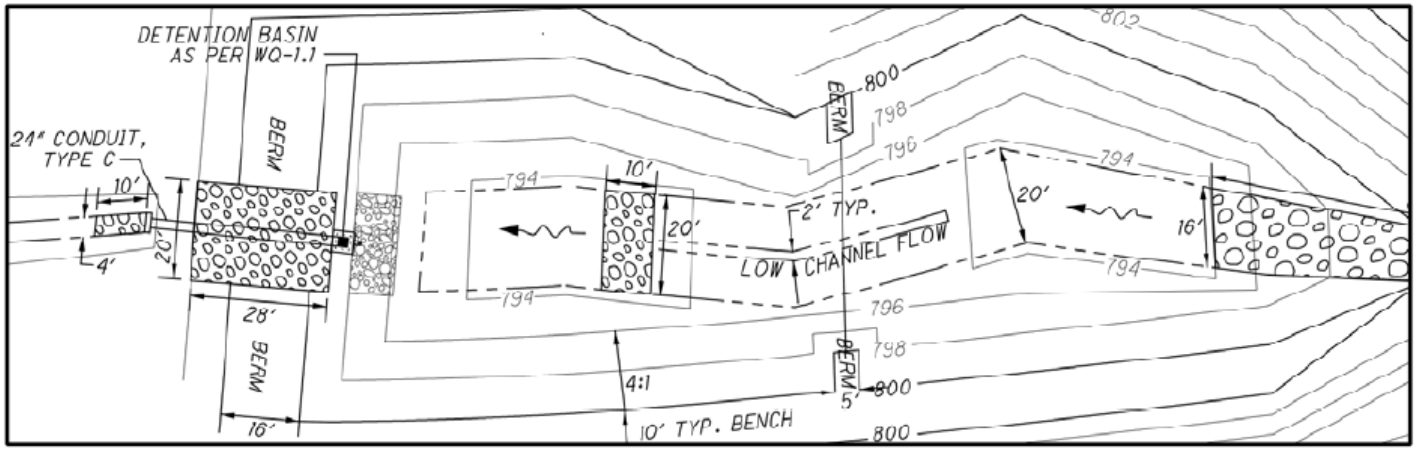
- Treatment requirements
- WQ_V calculation
- Forebay and micropool
- Stage vs. storage curve
- Water quality outlet sizing
- Drawdown curve
- Overflow sizing
- Anti-seep collars

EXTENDED DETENTION BASIN EXAMPLE (CONTINUED)

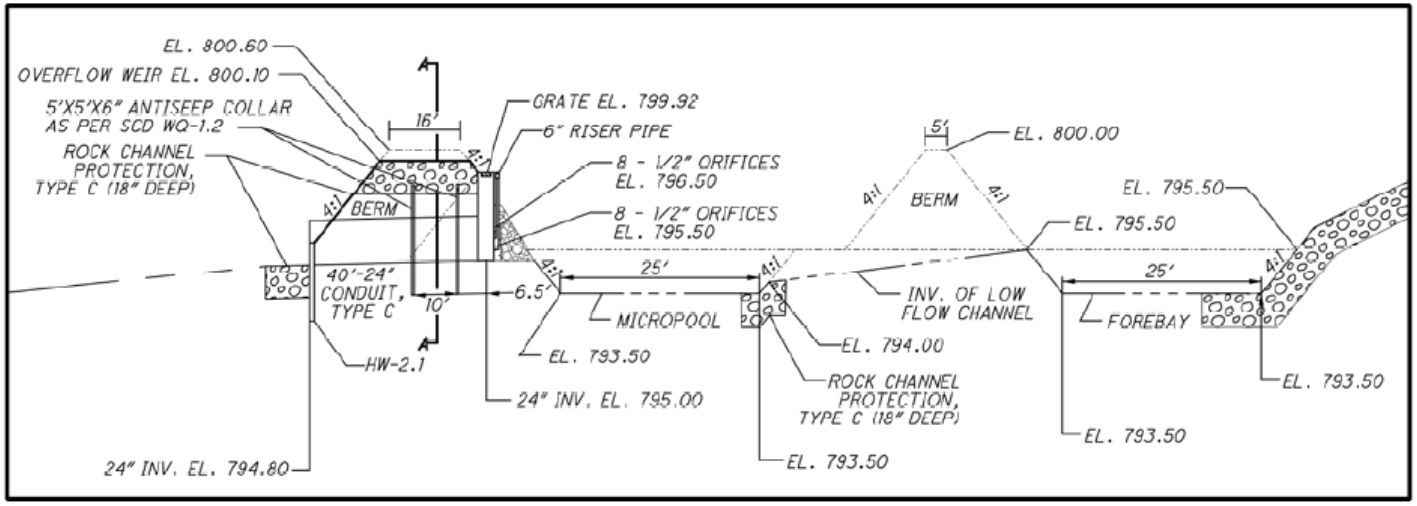
1117-6

REFERENCE SECTION
1117

Detention Basin Plan View:



Detention Basin Profile View:



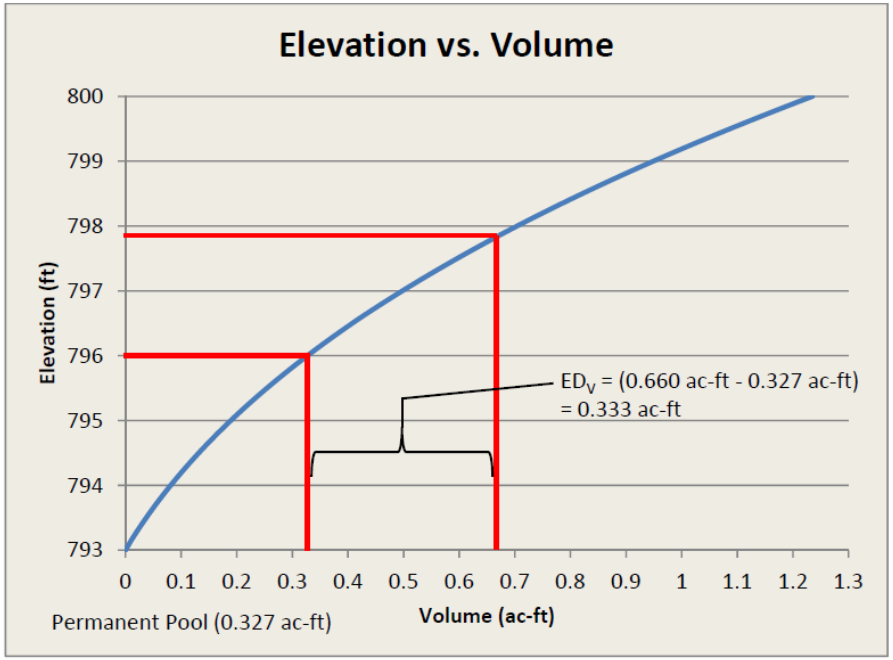
RETENTION BASIN EXAMPLE (CONTINUED)

1117-7

REFERENCE SECTION 1117

Elevation vs. Volume Table:

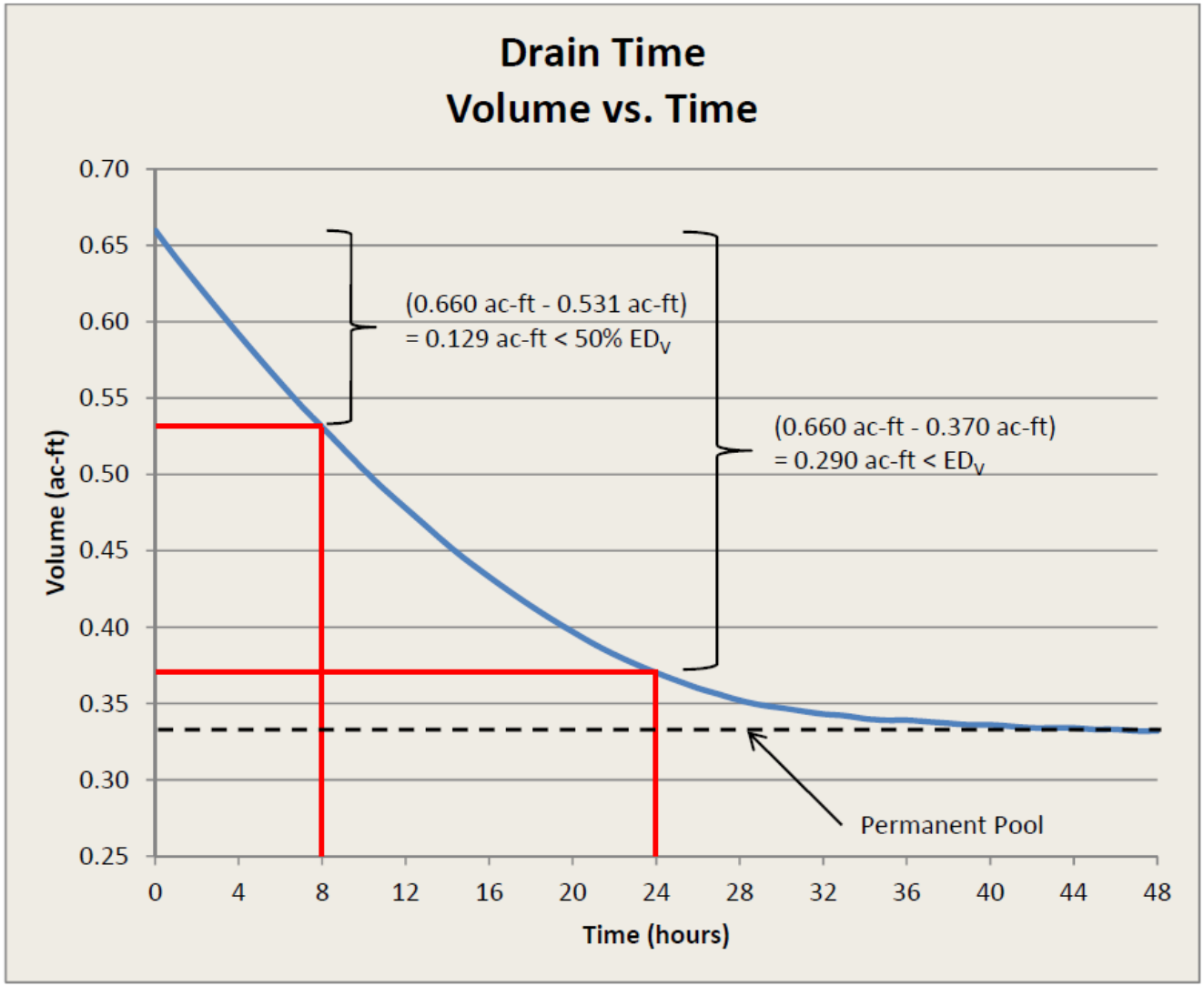
Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)	Elevation (feet)	Storage (acre-feet)
793	0	795.4	0.241	797.8	0.66
793.2	0.014	795.6	0.268	798	0.704
793.4	0.029	795.8	0.297	798.2	0.75
793.6	0.046	796	0.327	798.4	0.797
793.8	0.063	796.2	0.359	798.6	0.846
794	0.081	796.4	0.391	798.8	0.897
794.2	0.101	796.6	0.425	799	0.949
794.4	0.121	796.8	0.461	799.2	1.003
794.6	0.143	797	0.498	799.4	1.058
794.8	0.166	797.2	0.536	799.6	1.115
795	0.189	797.4	0.576	799.8	1.174
795.2	0.215	797.6	0.617	800	1.235



RETENTION BASIN EXAMPLE (CONTINUED)

1117-7

REFERENCE SECTION
1117



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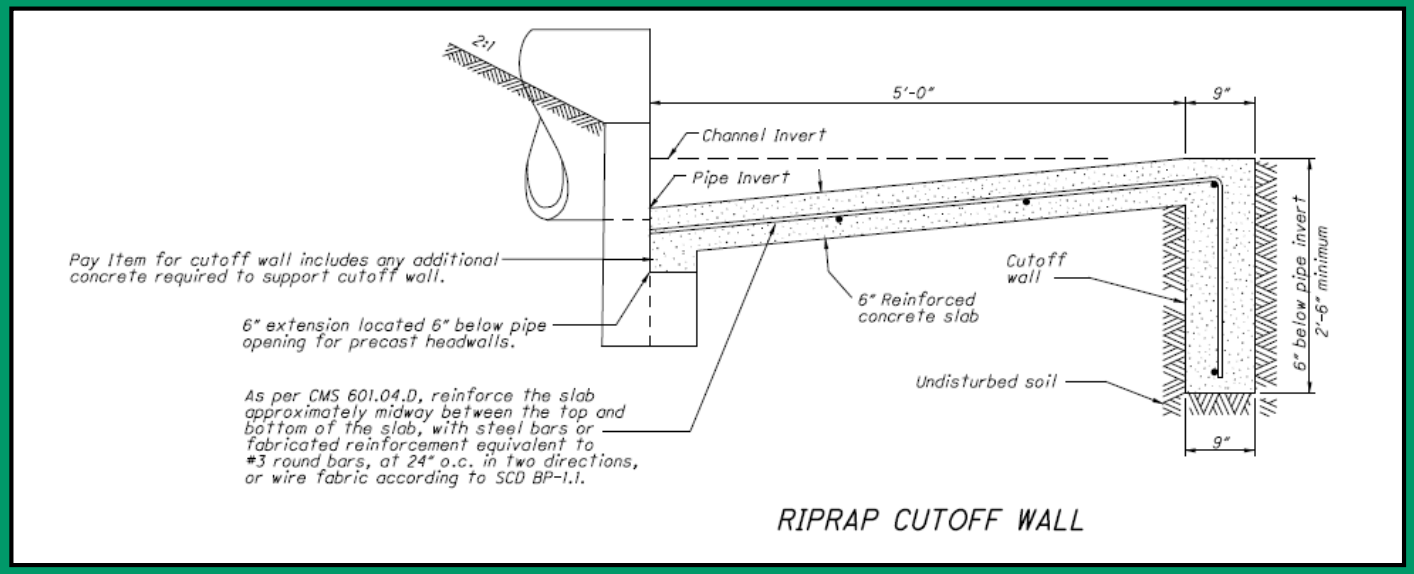
Credit for Stream Grade Control



- Only applicable to "Waters of the U.S." as defined in L&D Vol.2.
- Credit for project areas that drain to the grade control ONLY.
- Paired with quality BMP

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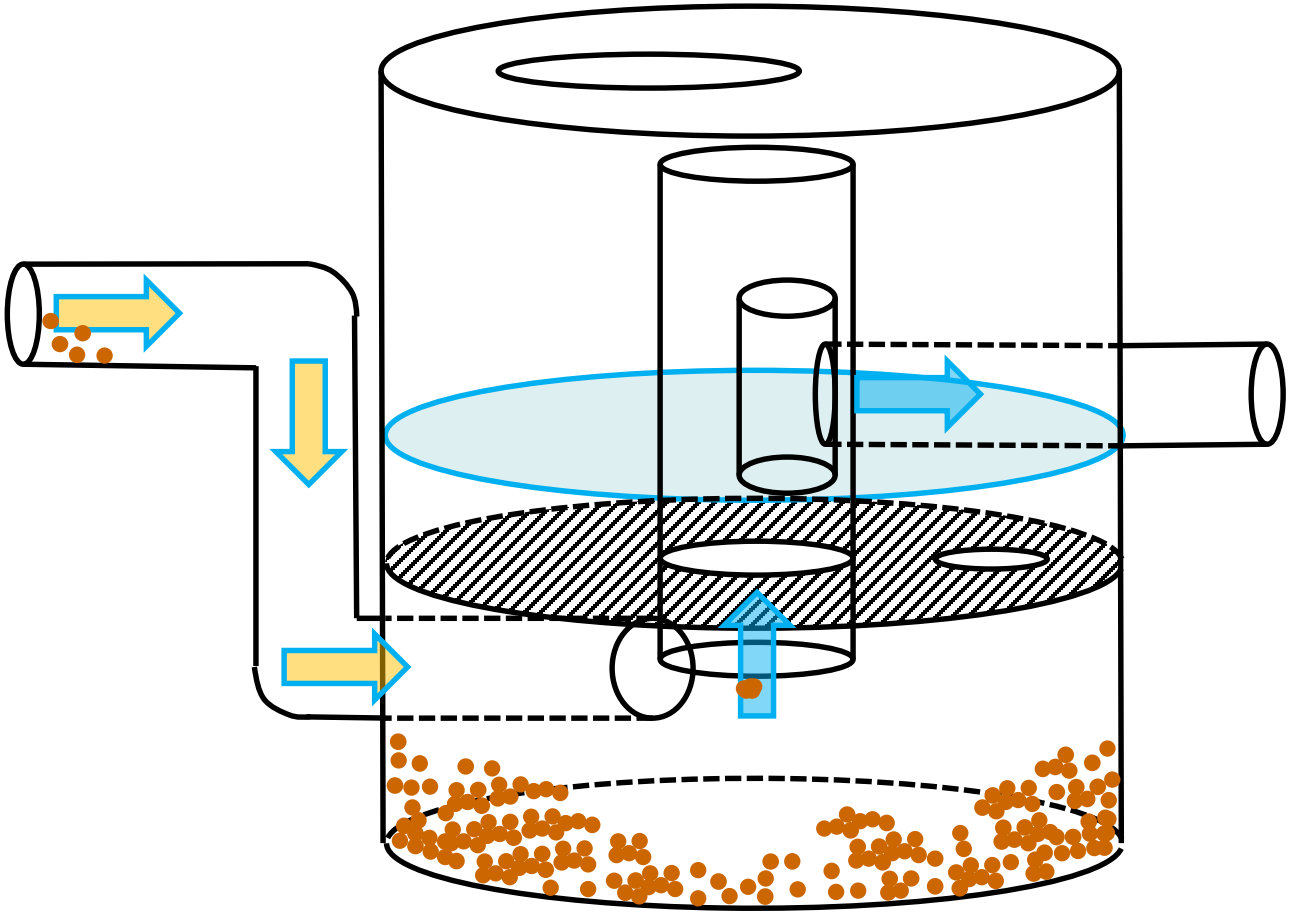
Manufactured Systems

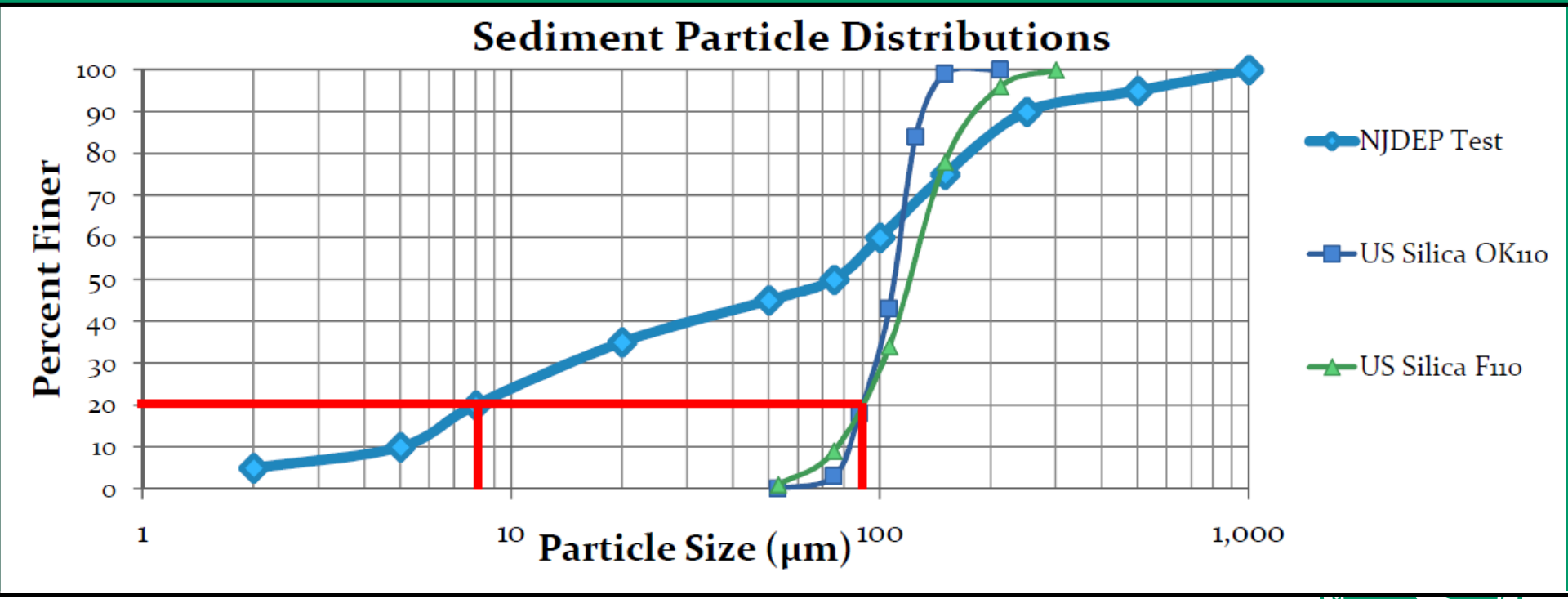
- L&D Vol. 2 Section 1117.1
- Provides quality treatment only

Manufactured System Treatment Processes



Manufactured System Testing

- ODOT SS995 – testing for manufactured systems



Manufactured System Research

- ODOT / OSU research of sediment in runoff from Ohio roads
- 12 sites
- Rainfall, runoff, and sediment monitoring
- 30 month research
- Inform future testing requirements

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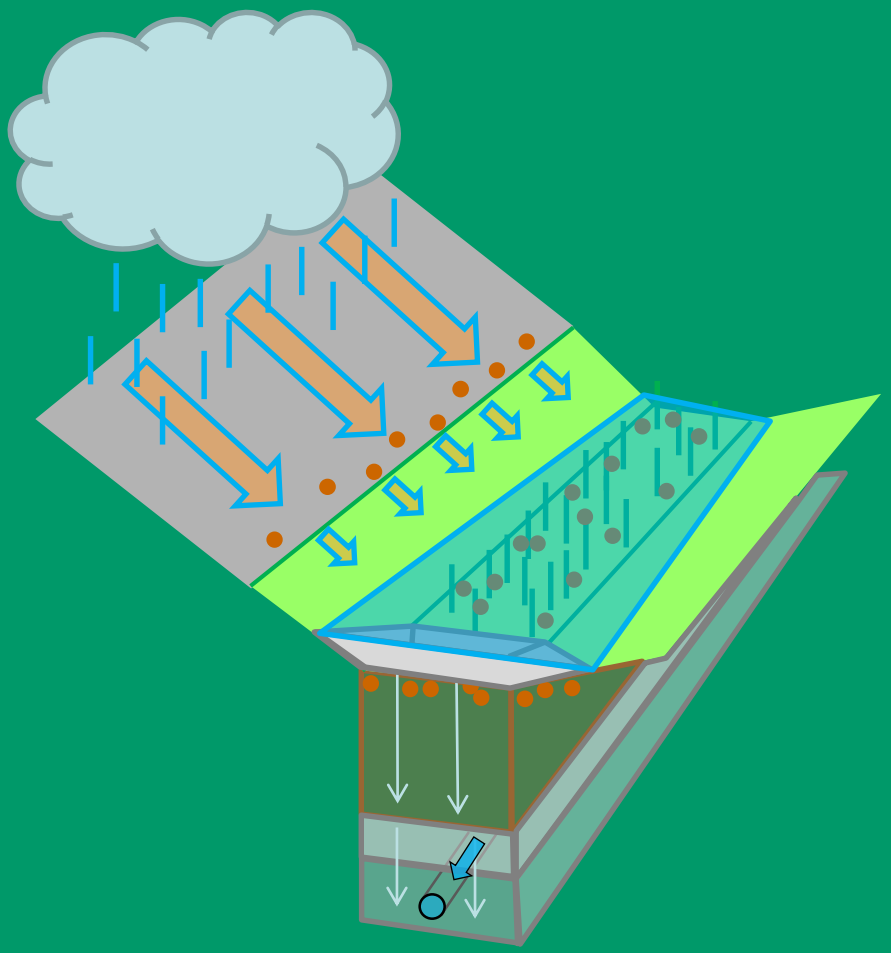
Bioretention Cell

- L&D Vol. 2 Section 1117.5
- Provides quality and quantity treatment

Bioretention Cell Treatment Processes



Bioretention Cell Sizing

- **Previous:**

$$A = \frac{WQv \cdot D}{3600 \cdot K \cdot T \cdot (h + D)}$$

- **Current:**
  - Cell area = 5% of impervious tributary area
  - Simplify calculations
  - Consistent with the rest of Ohio
  - Consistent with other states
  - Pretreatment requirements

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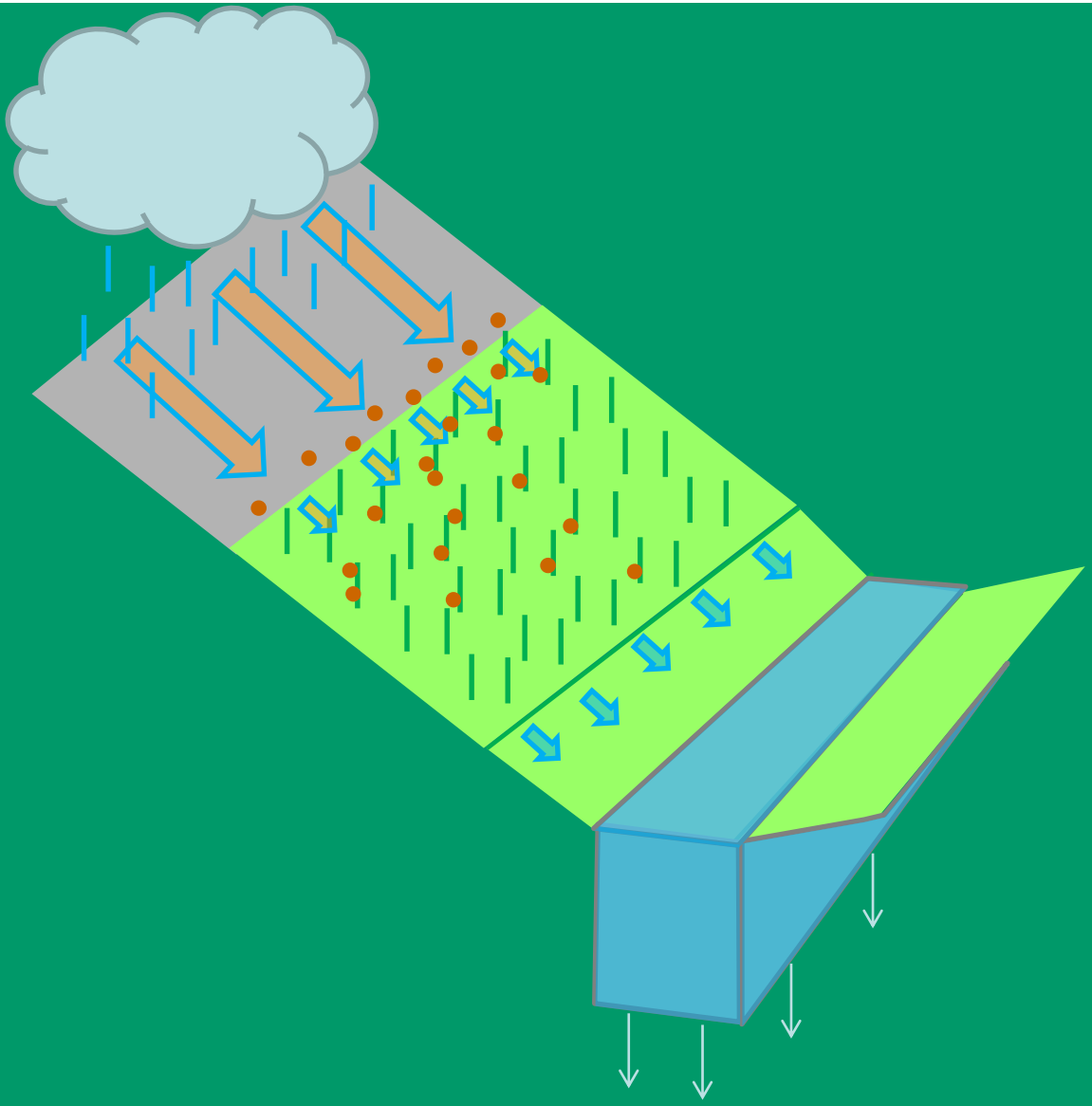
Infiltration Trench

- L&D Vol. 2 Section 1117.6.1
- Provides quality and quantity treatment

Infiltration Trench Treatment Processes



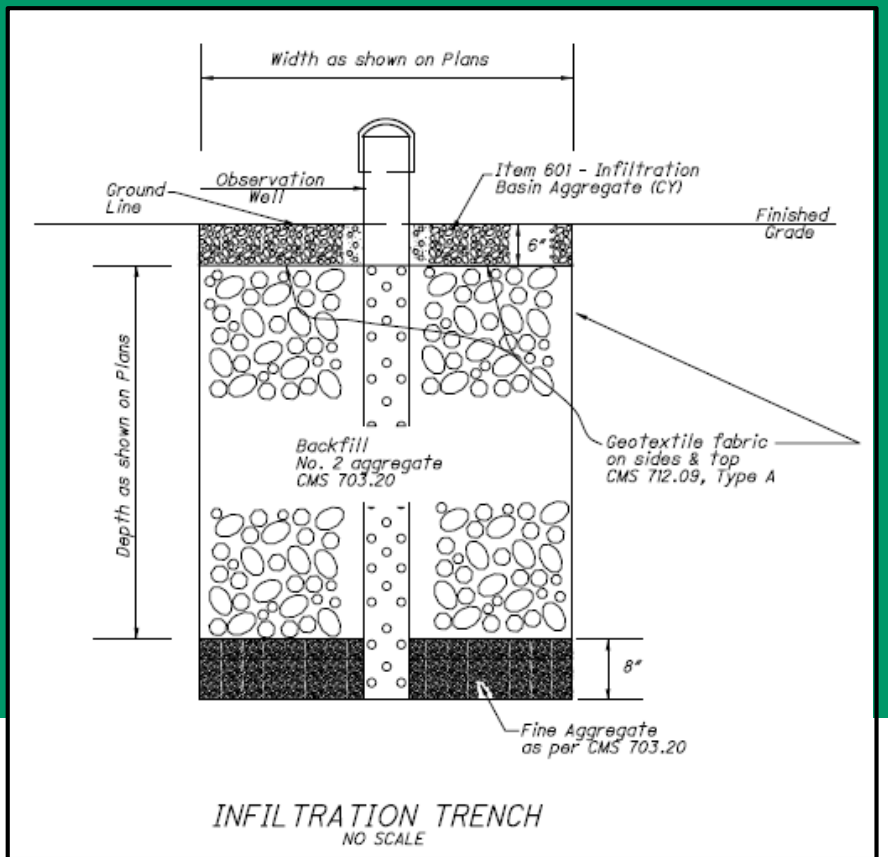
Infiltration Trench

- **Previous:**
  - Length of Trench:

$$L_t = \frac{43560 \cdot WQv}{3600 \cdot K \cdot T \cdot (b + 2\,D) + 0.4\left[D^2 + (b \cdot D)\right]}$$

- **Current: follow ODNR Rainwater and Land Development Manual**

$$A_{\min} = \frac{WQ_v}{Porosity * (E * T)}$$



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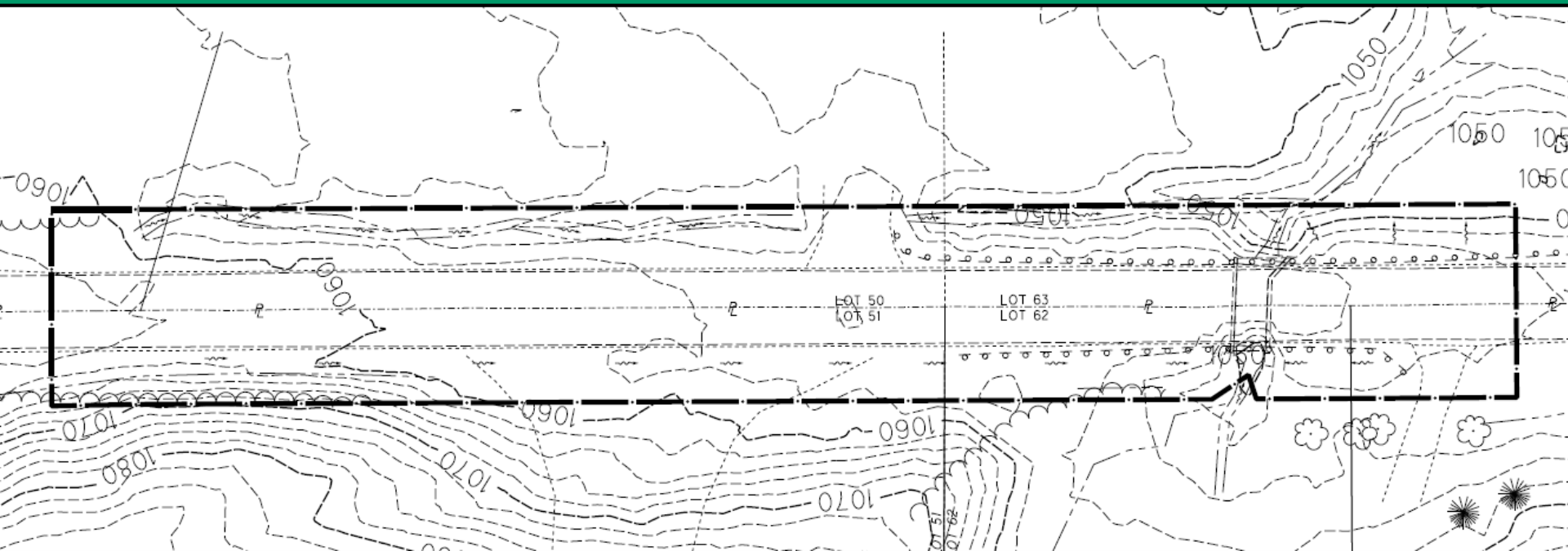
Vegetated Biofilter Project Example

- Rural highway redevelopment
- Improve shoulders
- All within existing right-of-way

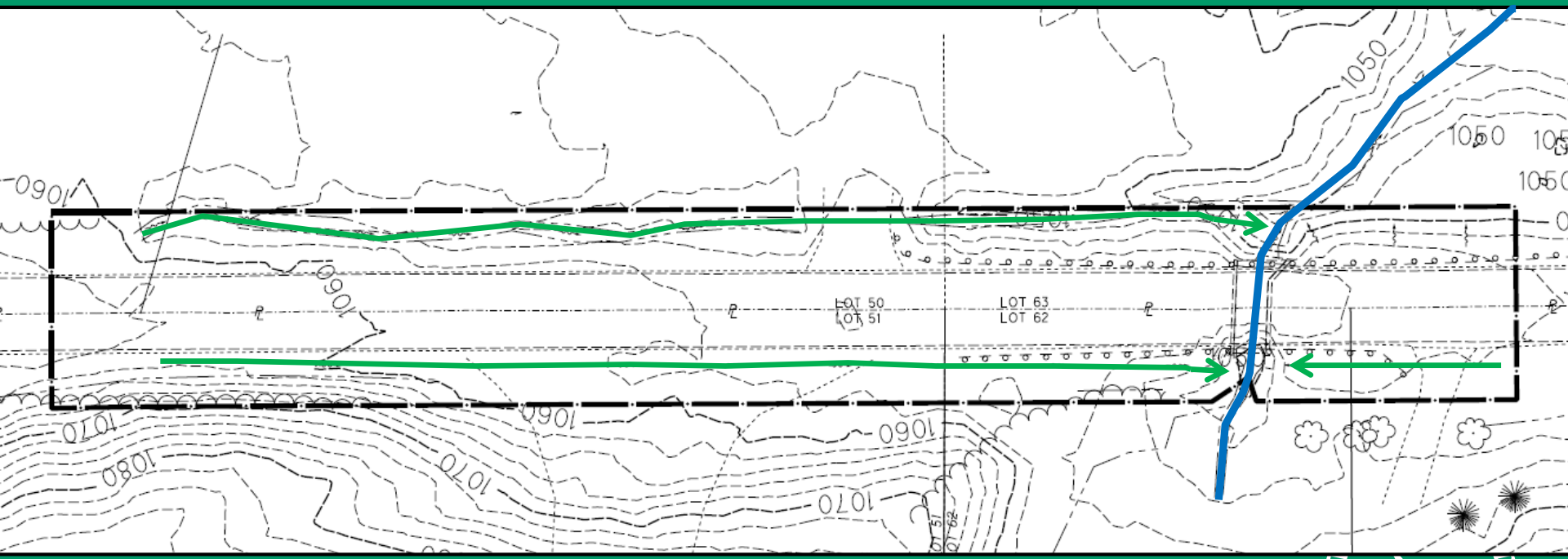


Treatment Goals

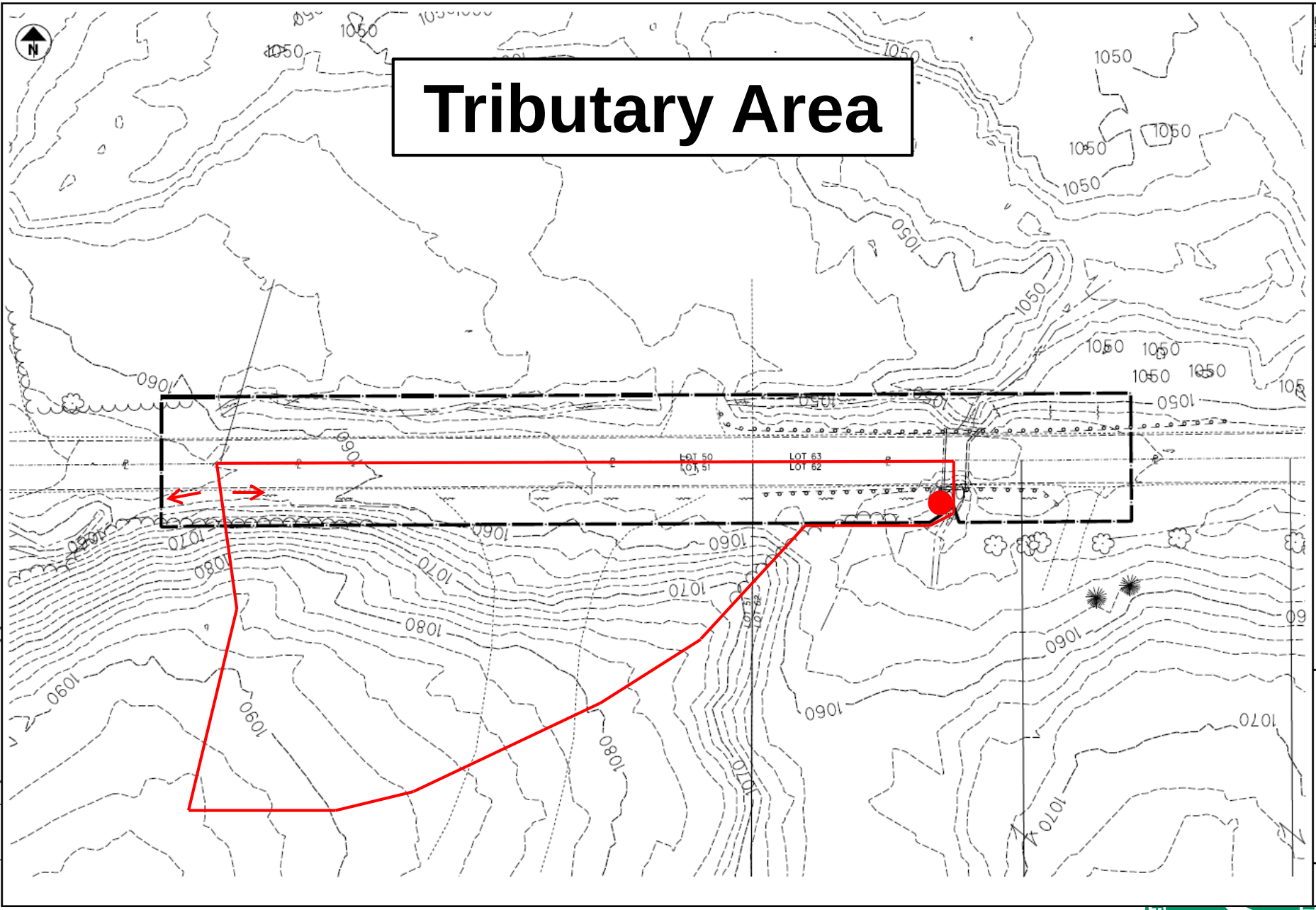
- **Treatment requirement = 0.57 ac**
- **All disturbance within existing R/W**
  - Quality treatment only

Veg. Biofilter Sizing

- Size a vegetated biofilter for each ditch and pick the best one for the project.

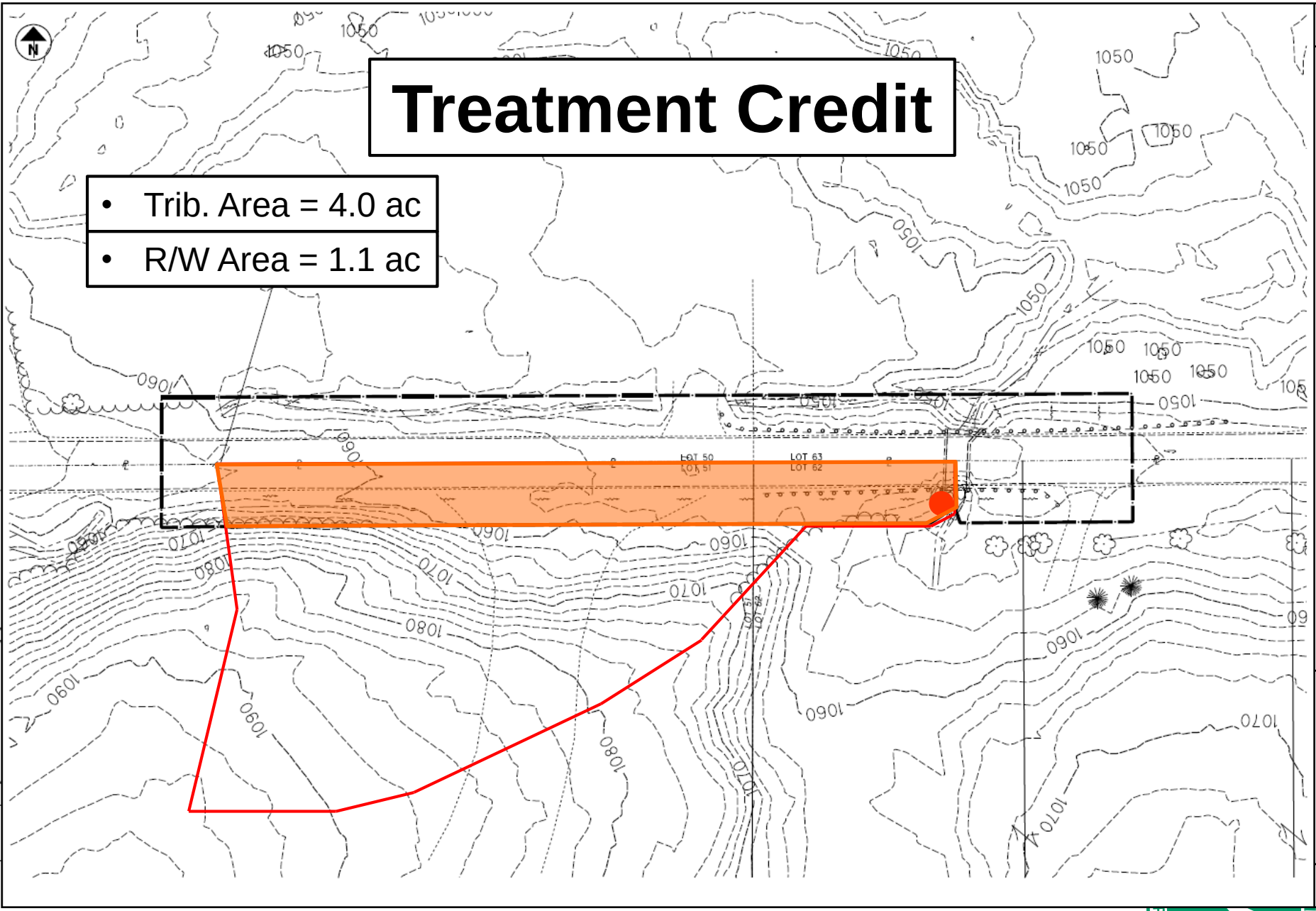


Tributary Area



Treatment Credit

- Trib. Area = 4.0 ac
- R/W Area = 1.1 ac



Runoff Coefficient

- **Depends on what you're calculating**
  - Flow rate – Rational Method; coefficient of runoff
  - Water Quality Volume – Volumetric runoff coefficient
  - Sound alike, but not the same

- **Rational Method**
  - Q = CiA
  - Calculate weighted coefficient

Runoff Coefficient

- **Depends on what you're calculating**
  - Flow rate – Rational Method; coefficient of runoff
  - Water Quality Volume – Volumetric runoff coefficient
  - Sound alike, but not the same

- **Water Quality Volume (WQ_V)**
  - $WQ_V = (P*A*Cq)/12$
  - Cq = Runoff coefficient
  - Cq = 0.858i3 - 0.78i2 + 0.774i + 0.04
  - i = impervious area divided by the total area

Runoff Coefficient

- **Examples:**

- **Determine the Rational Method coefficient of runoff (C) for WQ_F for BMP sizing**
- **Determine the Rational Method coefficient of runoff (C) for culvert sizing**
- **Determine the runoff coefficient (Cq) for WQ_V for BMP sizing**

Runoff Coefficient

- ODOT L&D Vol. 2, Section 1115.6.1

“While all areas within ODOT right-of-way may not be covered by impervious surfaces, the area within existing ODOT right-of-way is considered impervious for the purpose of post-construction BMP design considerations. Therefore, consider all area within existing right-of-way to be impervious with a runoff coefficient of 0.90 when performing post-construction BMP calculations.”

Coefficient of Runoff – WQ_F BMP

- Right-of-Way = 1.1 ac; C = 0.9
- Woods = 2.9 ac; C = 0.3
- Weighted C = [(1.1*0.9)+(2.9*0.3)] / (1.1+2.9) = 0.465

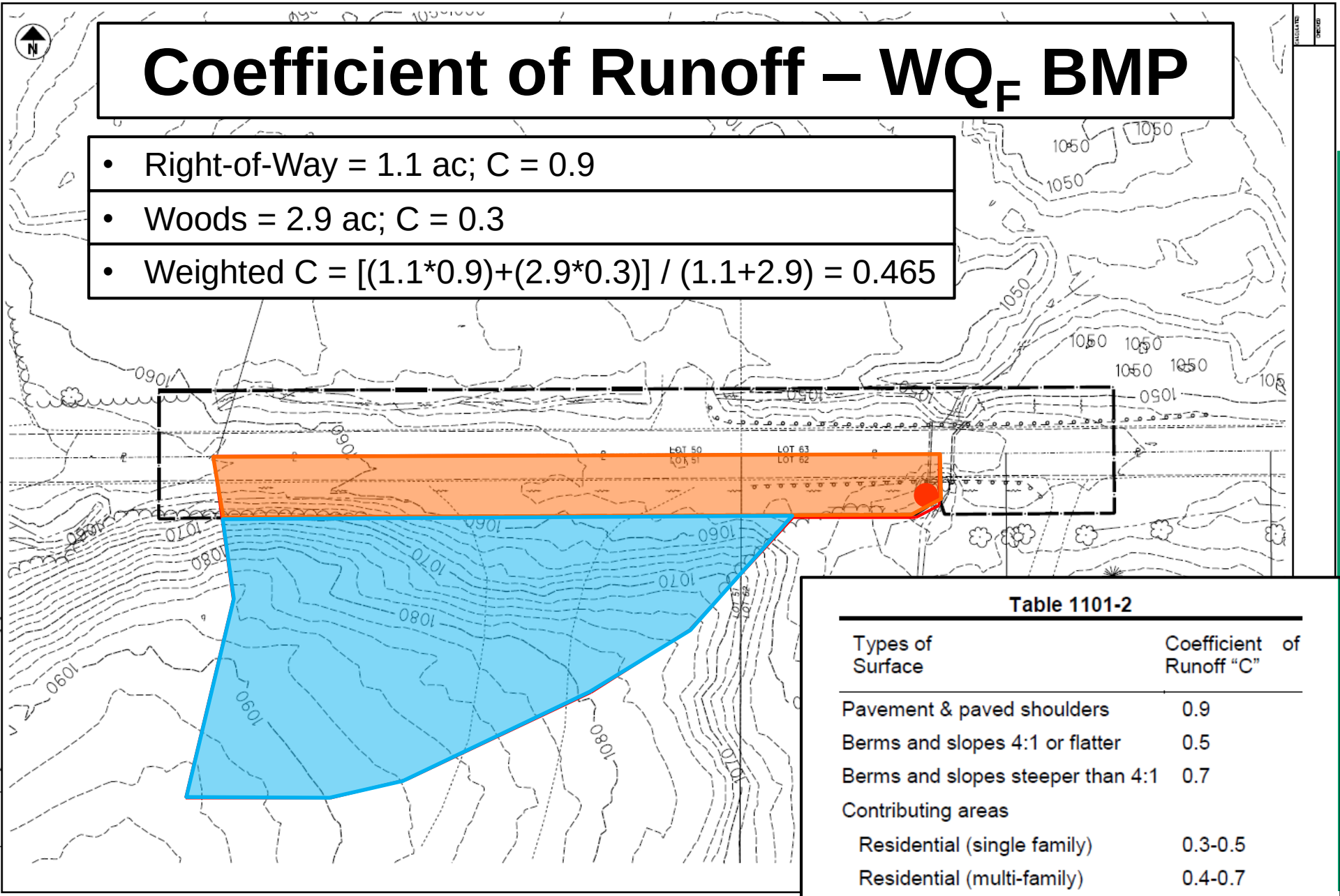
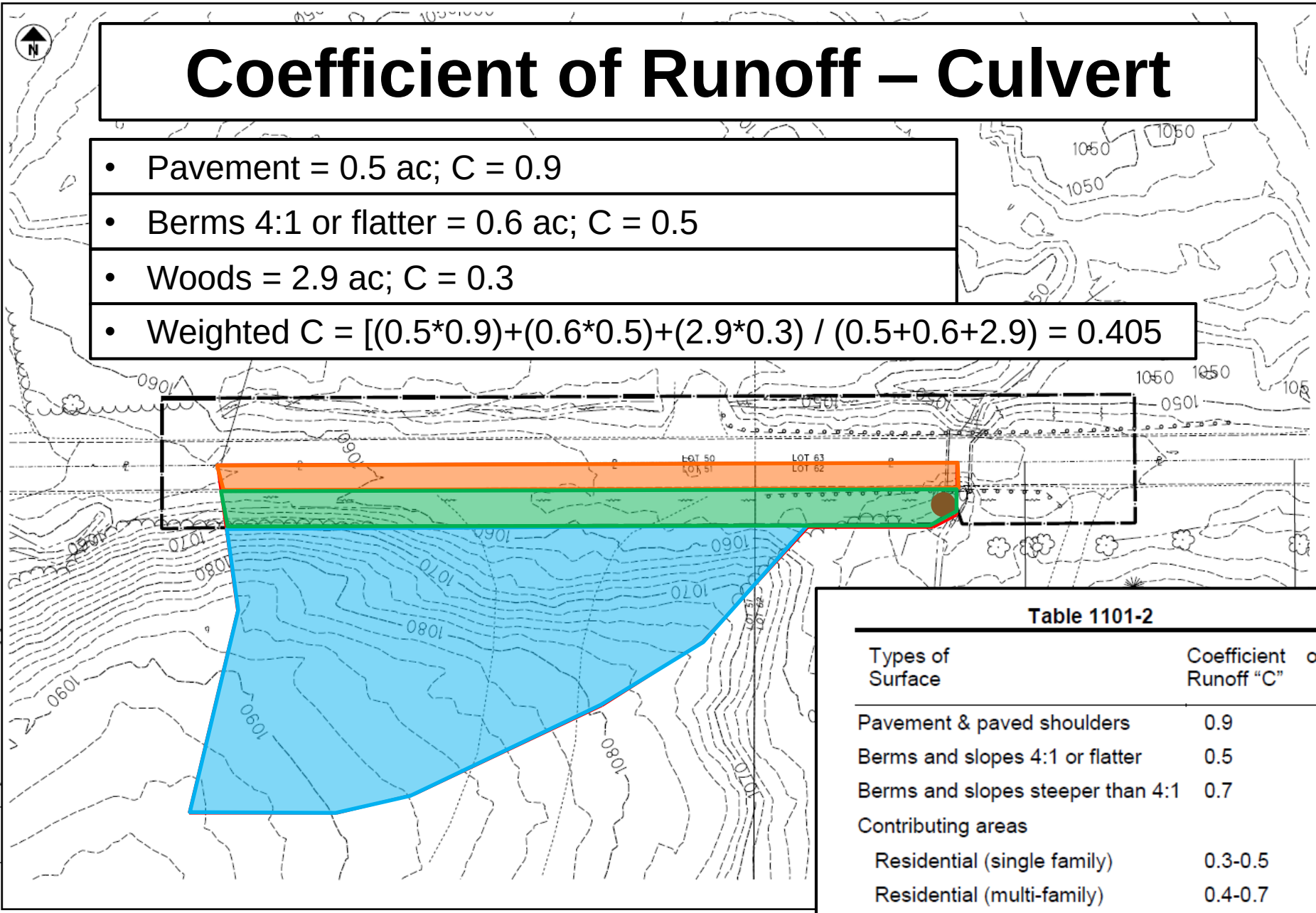


Table 1101-2

Types of Surface	Coefficient of Runoff "C"
Pavement & paved shoulders	0.9
Berms and slopes 4:1 or flatter	0.5
Berms and slopes steeper than 4:1	0.7
Contributing areas	
Residential (single family)	0.3-0.5
Residential (multi-family)	0.4-0.7
Woods	0.3
Cultivated	0.3-0.6

Coefficient of Runoff – Culvert

- Pavement = 0.5 ac; C = 0.9
- Berms 4:1 or flatter = 0.6 ac; C = 0.5
- Woods = 2.9 ac; C = 0.3
- Weighted C = [(0.5*0.9)+(0.6*0.5)+(2.9*0.3) / (0.5+0.6+2.9) = 0.405



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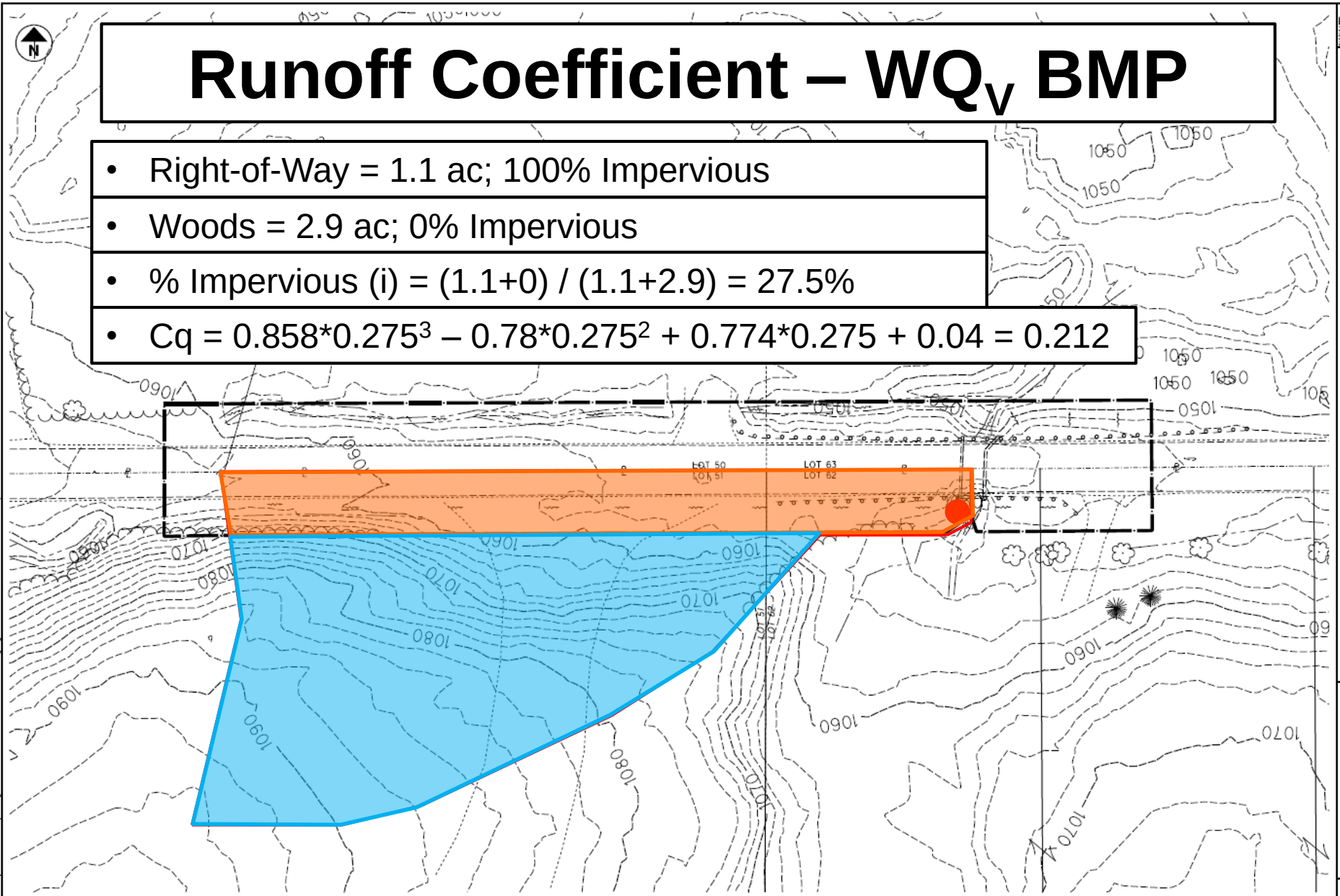
Contributing areas	
Residential (single family)	0.3-0.5
Residential (multi-family)	0.4-0.7
Woods	0.3
Cultivated	0.3-0.6

Runoff Coefficient – WQ_V BMP

- Right-of-Way = 1.1 ac; 100% Impervious
- Woods = 2.9 ac; 0% Impervious
- % Impervious (i) = (1.1+0) / (1.1+2.9) = 27.5%
- $Cq = 0.858*0.275^3 – 0.78*0.275^2 + 0.774*0.275 + 0.04 = 0.212$



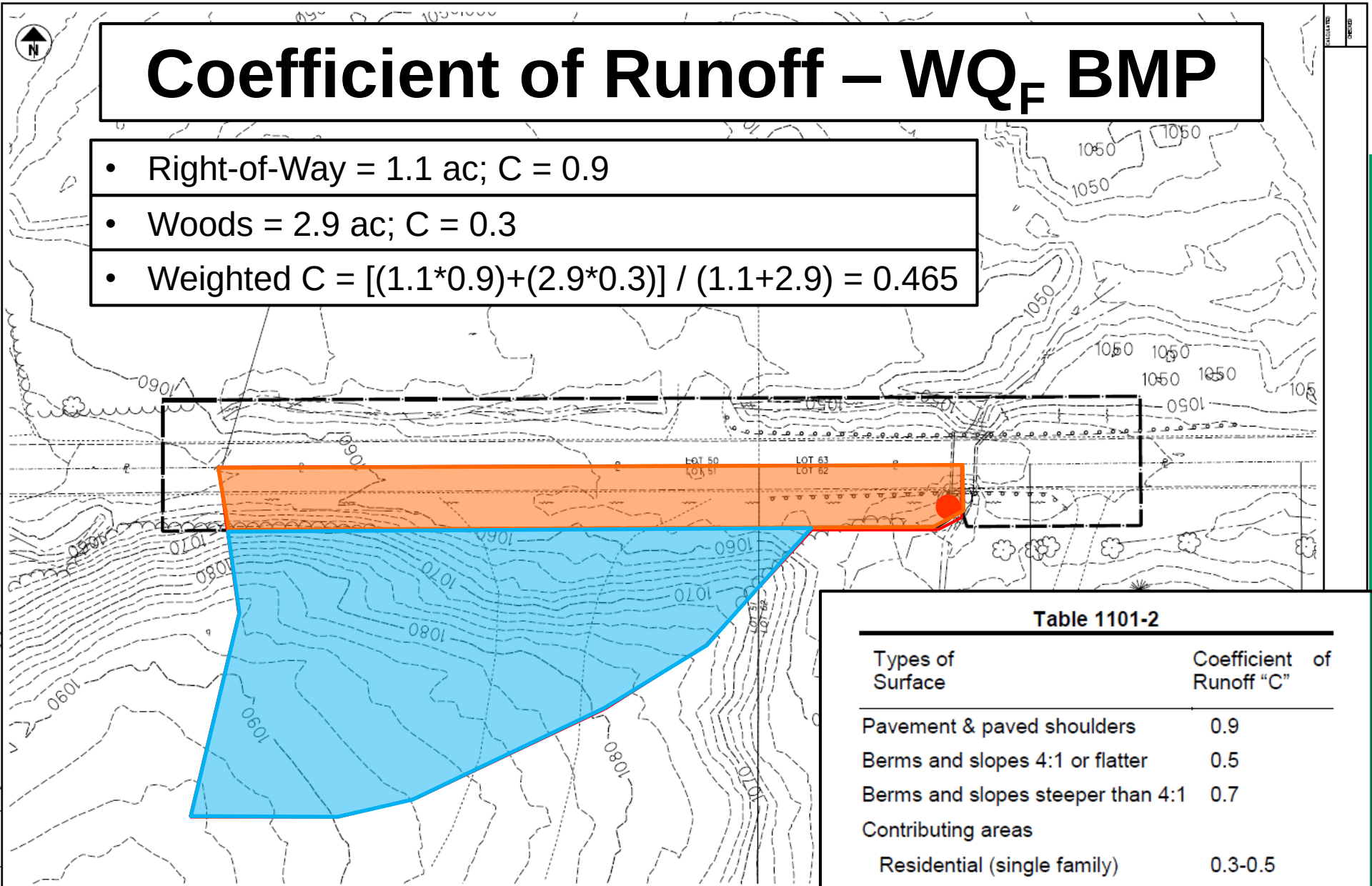
Runoff Coefficient

- **Examples:**

- **C for WQ_F for BMP sizing = 0.465**
- **C for culvert sizing = 0.405**
- **Cq for WQ_V for BMP sizing = 0.212**

Coefficient of Runoff – WQ_F BMP

- Right-of-Way = 1.1 ac; C = 0.9
- Woods = 2.9 ac; C = 0.3
- Weighted C = [(1.1*0.9)+(2.9*0.3)] / (1.1+2.9) = 0.465



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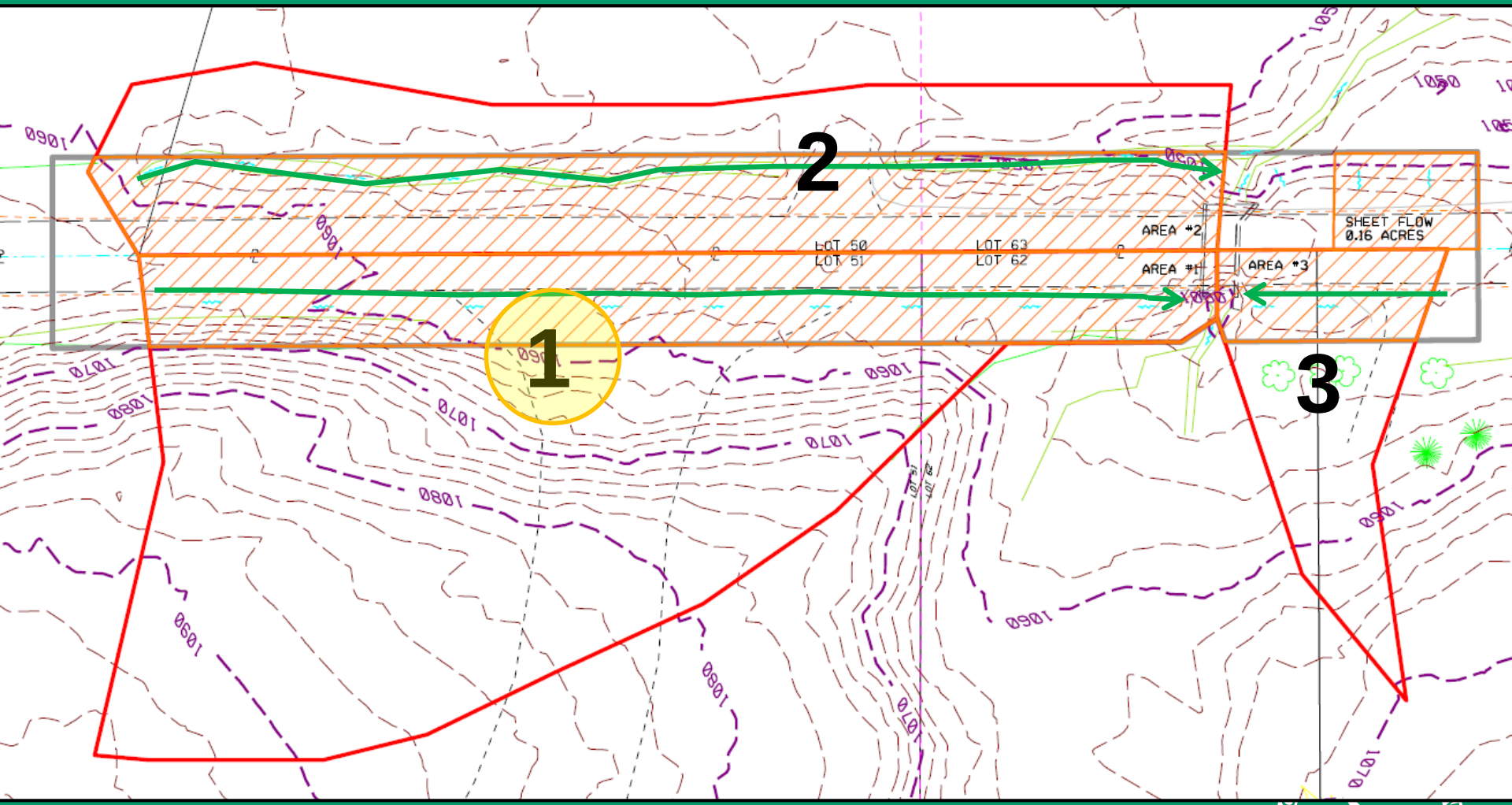
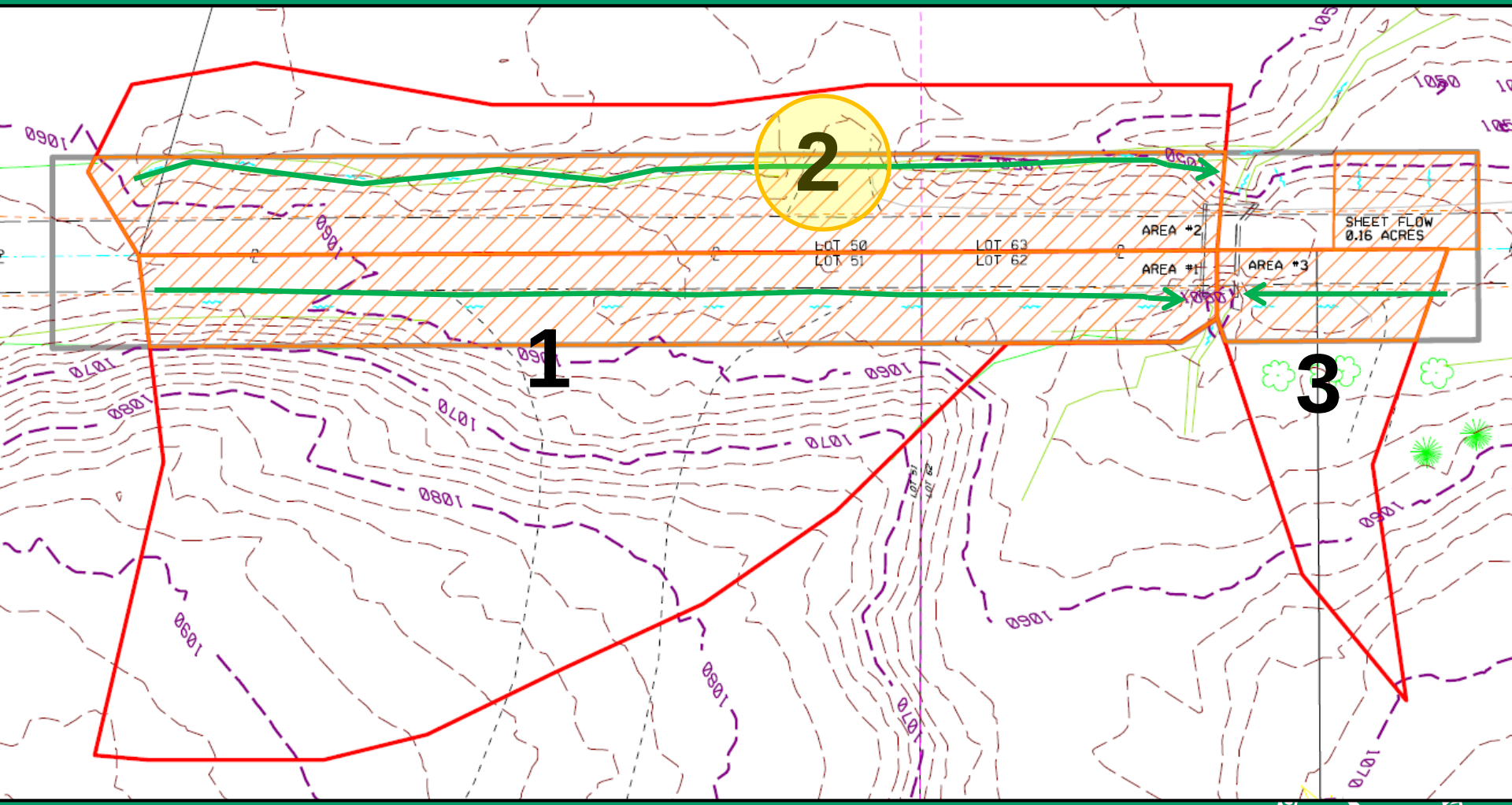
Veg. Biofilter Sizing



Veg. Biofilter Sizing

- **Area 1 (4.0 ac):**
  - 1.1 ac within R/W; C=0.9
  - 2.9 ac woods; C=0.3
  - (1.1ac * 0.9 + 2.9ac * 0.3) / 4.0 ac
  - Weighted C = 0.465
  - WQ_F = 0.465 * 0.65in/hr * 4.0ac = <u>1.209 cfs</u>
  - Treatment credit = 1.1 ac
  - 1.1 ac > 0.57 ac

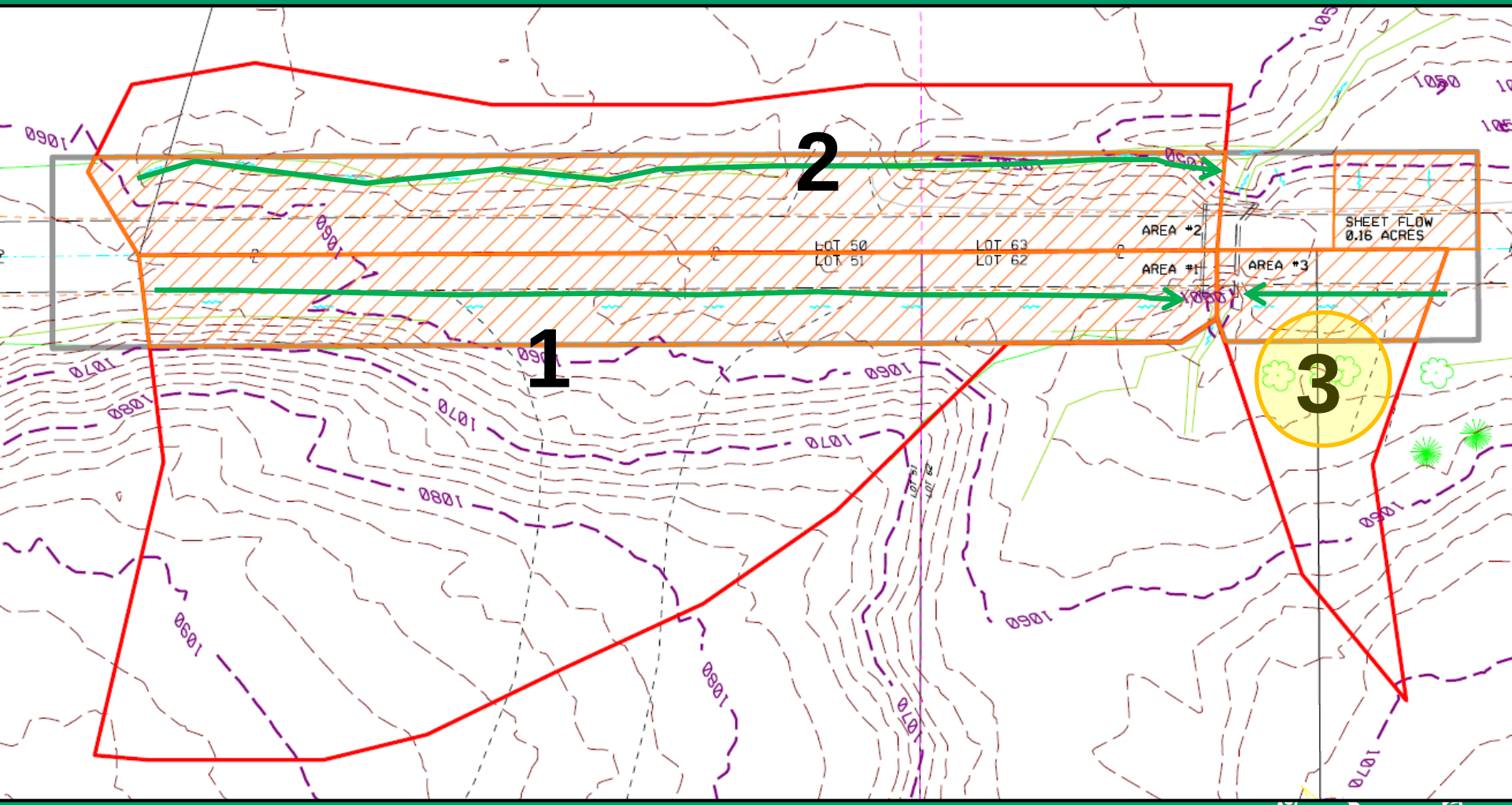
Veg. Biofilter Sizing



Veg. Biofilter Sizing

- **Area 2 (2.1 ac):**
  - 1.3 ac within R/W; C=0.9
  - 0.8 ac woods; C=0.3
  - (1.3ac * 0.9 + 0.8ac * 0.3) / 2.1 ac
  - Weighted C = 0.67
  - WQ_F = 0.67 * 0.65in/hr * 2.1ac = <u>0.915 cfs</u>
  - Treatment credit = 1.3 ac
  - 1.3 ac > 0.57 ac

Veg. Biofilter Sizing



Veg. Biofilter Sizing

- **Area 3 (0.6 ac):**
  - 0.2 ac within R/W
  - Since 0.2 ac < 0.57 ac treatment requirement, don’t go any further

Veg. Biofilter Sizing

- **Determine vegetated biofilter bottom width for Area 1 and Area 2: Manning's Equation:**

Manning's Equation:

$$Q = \frac{1.49}{n} * AR^{2/3} * S^{1/2}$$

Where:

Q = flow rate (cfs)

n = Manning's Roughness Coefficient (0.15)

A = Cross section area of flow (ft^2)

R = Hydraulic Radius (ft) (Area / Wetted Perimeter)

S = Longitudinal Slope of ditch (ft/ft)

Veg. Biofilter Sizing

$$Q = \frac{1.49}{n} * AR^{2/3} * S^{1/2}$$

- Q = WQ_F calculated using Rational Method **Project Specific**

- n = 0.15 (for flow within height of grass)
- Depth <= 4 inches
- Velocity <= 1 fps

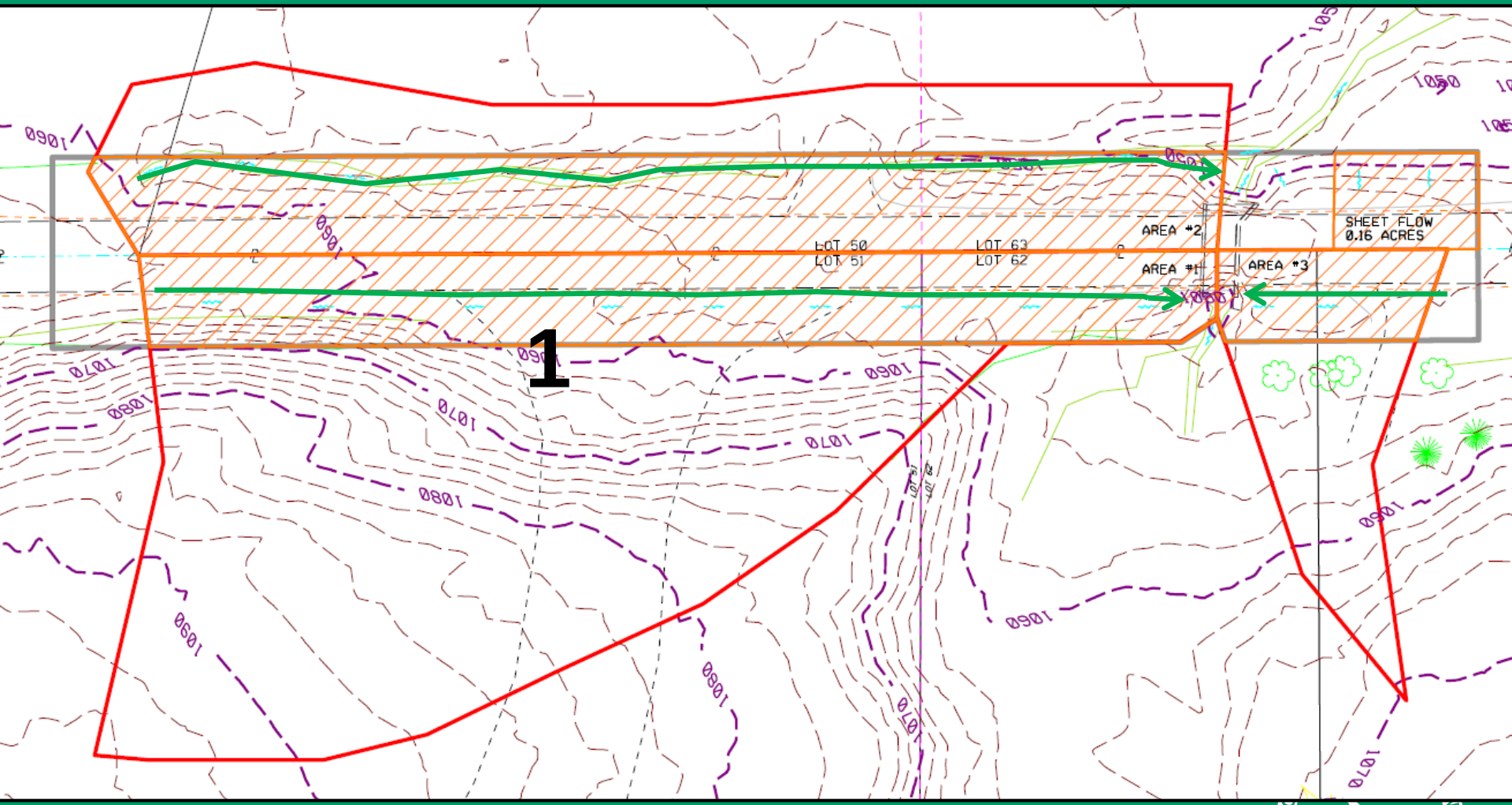
  Specified in L&D

Veg. Biofilter Sizing

- **Use a program or spreadsheet, given:**
  - Q
  - n
  - Channel geometry
  - Longitudinal slope
- **Calculate**
  - Normal depth
  - Average velocity

$$Q = \frac{1.49}{n} * AR^{2/3} * S^{1/2}$$

Veg. Biofilter Sizing



Veg. Biofilter Sizing – Area 1

- Longitudinal slope = 0.01 ft/ft
- Assume fore slope = 2:1
- Assume back slope = 2:1
- Manning's n = 0.15
- Q = 1.209 cfs
- Use trial and error until you find a bottom with that gives a velocity <= 1 fps and a depth <= 4 in

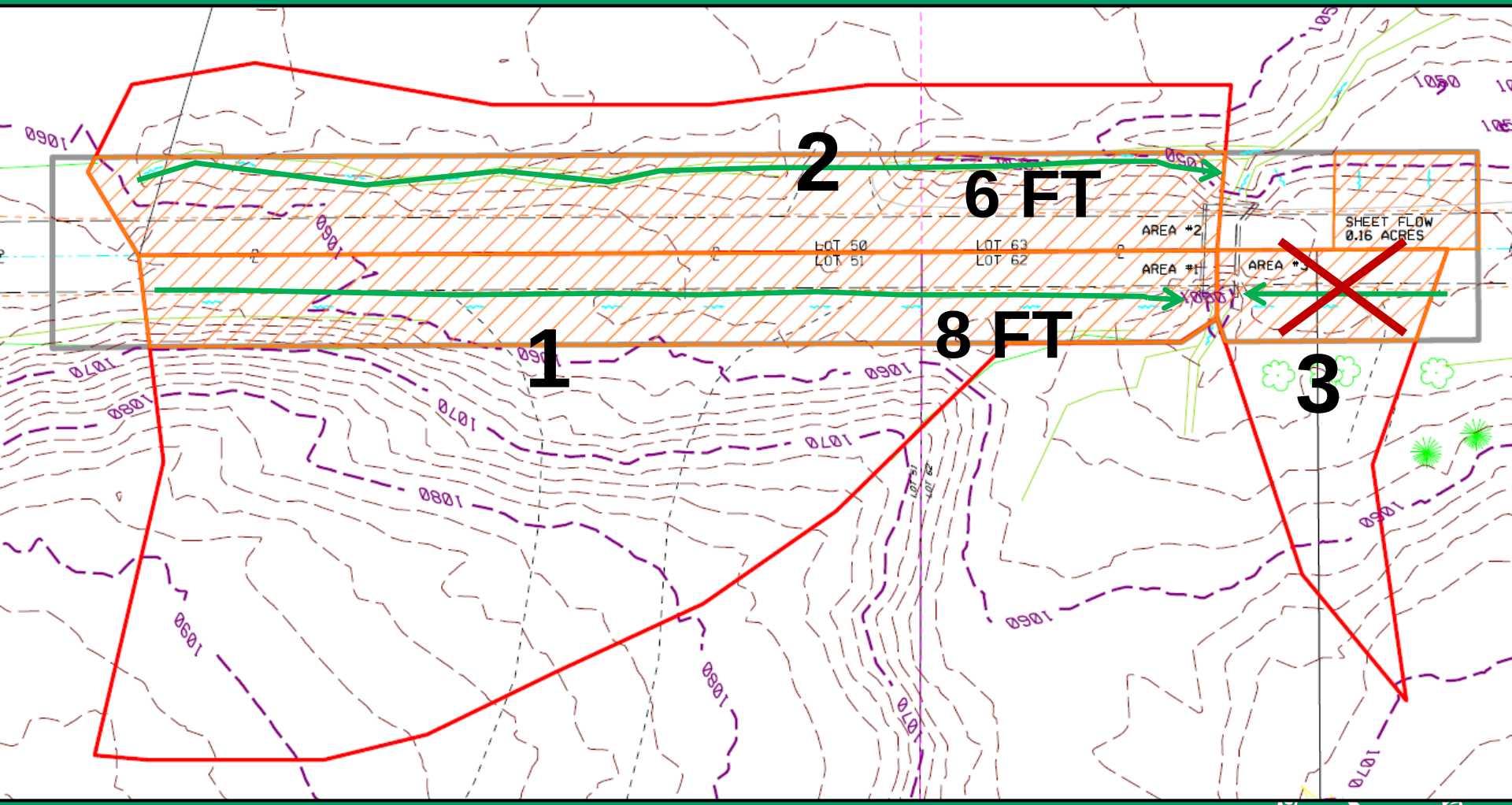
Veg. Biofilter Sizing – Area 1

- FHWA Hydraulic Toolbox 4.20
- ODOT's Excel spreadsheet

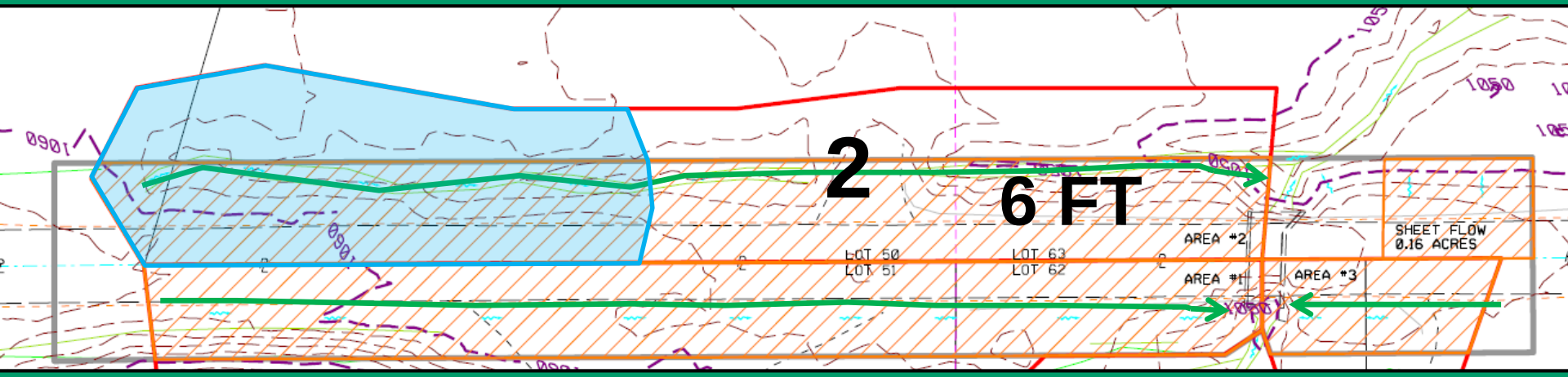
Veg. Biofilter Sizing

Area	Q	s	FS	BS	n	**B**	Vel.	Depth
	cfs	ft/ft	H:V	H:V		**ft**	fps	in
1	1.209	0.01	2:1	2:1	0.15	**8**	0.44	3.83
2	0.915	0.01	2:1	2:1	0.15	**6**	0.43	3.84

Veg. Biofilter Sizing

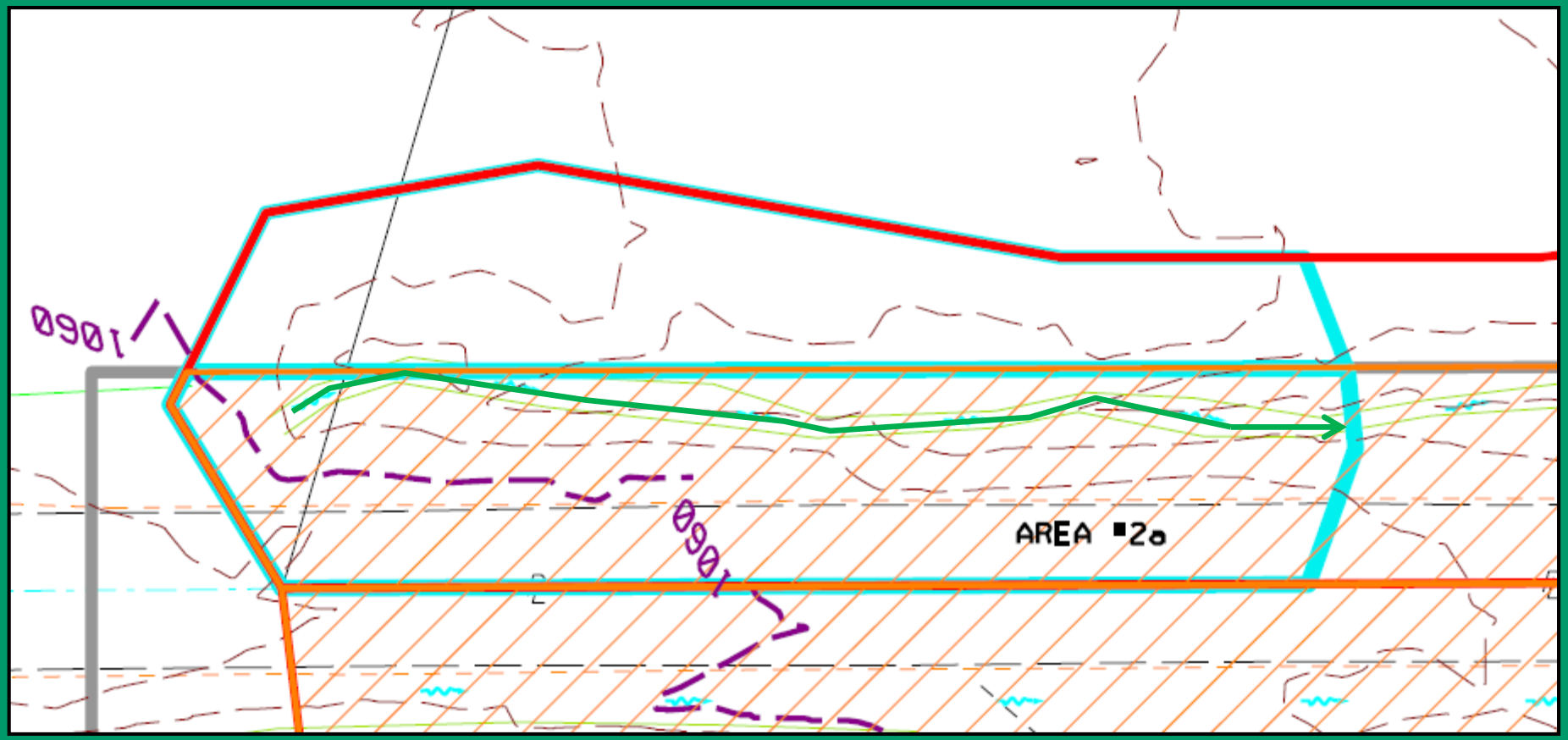


Veg. Biofilter Sizing



- Area 2 treatment credit = 1.3 ac
- Only need 0.57 ac
- Sub-delineate to reduce BMP size

Veg. Biofilter Sizing – Area 2



Veg. Biofilter Sizing – Area 2

- **New area = 0.97 ac**
  - 0.57 ac within R/W; C=0.9
  - 0.40 ac woods; C=0.3
  - (0.57 ac * 0.9 + 0.40 ac * 0.3) / 0.97 ac
  - Weighted C = 0.653
  - WQ_F = 0.653 * 0.65in/hr * 0.97ac = <u>0.412 cfs</u>
  - Treatment credit = 0.57 ac
  - 0.57 ac = 0.57 ac

Veg. Biofilter Sizing

Area	Q	s	FS	BS	n	B	Vel.	Depth
	cfs	ft/ft	H:V	H:V		ft	fps	in
1	1.209	0.01	2:1	2:1	0.15	8	0.44	3.83
2	0.915	0.01	2:1	2:1	0.15	6	0.43	3.84
2a	0.412	0.01	2:1	2:1	0.15	3	0.39	3.54
2a	0.412	0.01	2:1	2:1	0.15	4	0.36	3.02

Veg. Biofilter Considerations

- Add 4” of Item 659 topsoil to the vegetated portion of the shoulder and foreslope
- Add Item 670, Slope Erosion Protection
- At least 80% vegetative cover
- No gullies or erosion down cutting

Is Filtering Occuring?

Is Filtering Occuring?

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Is Filtering Occuring?

Questions ?

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