

MODULE 4

EXAMPLES



MODULE 4

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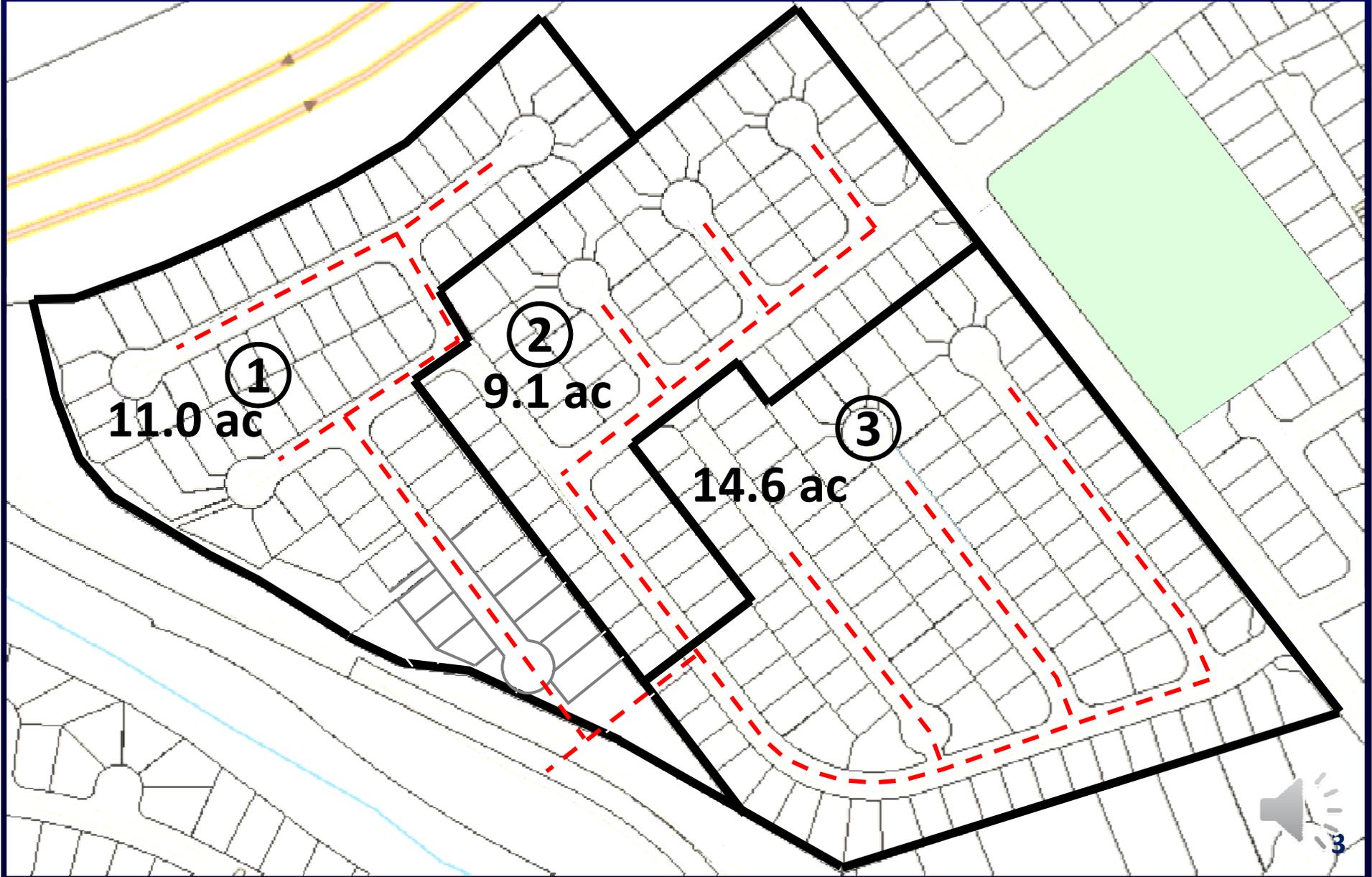
EXAMPLES

- A. 35 acre Residential Development
- B. 3.4 acre Commercial Development
- C. 4,000 sq-ft Restaurant on $\frac{3}{4}$ acre site
- D. 37 acre Residential Development



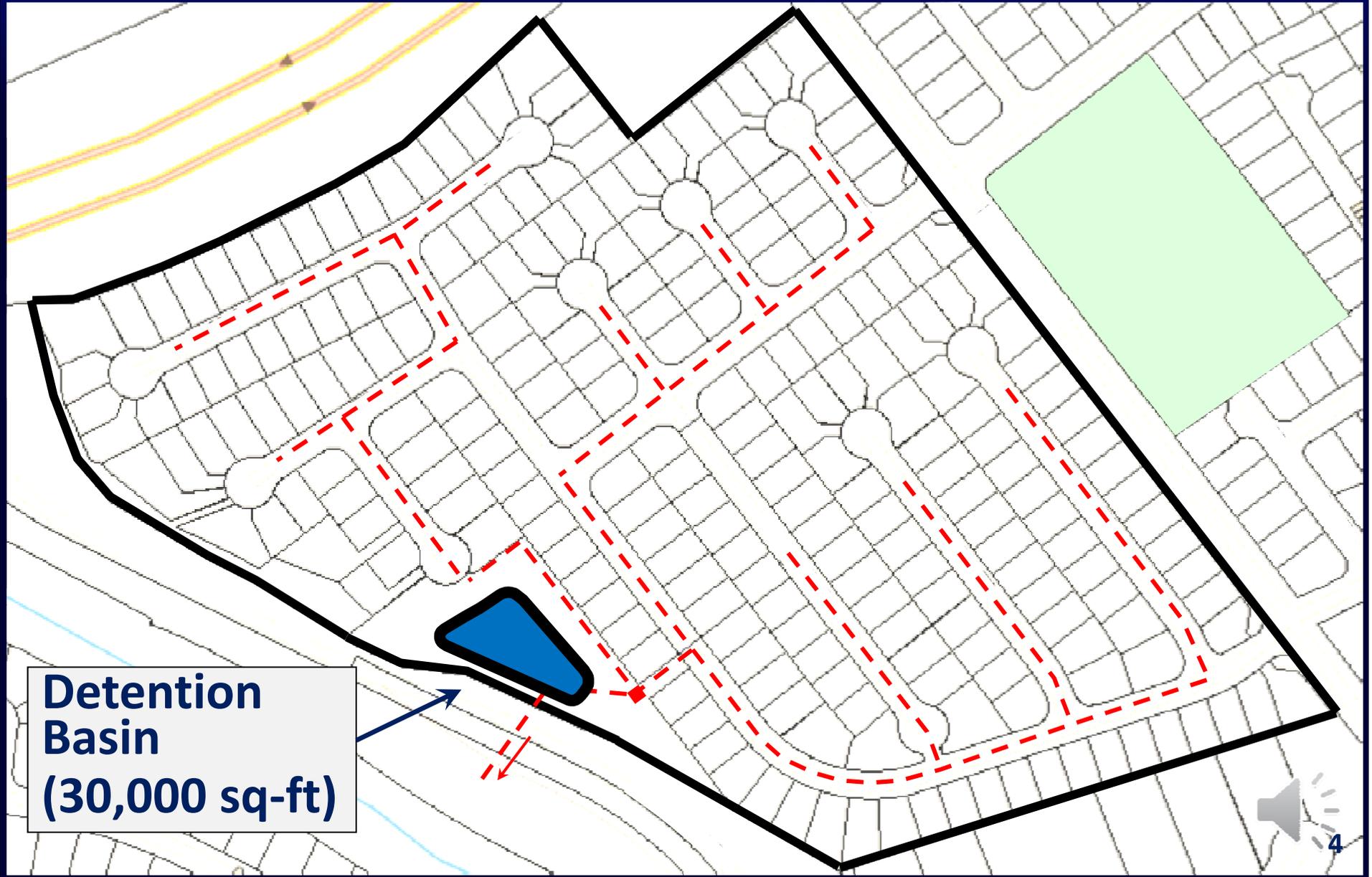
35 ACRE RESIDENTIAL DEVELOPMENT

Site & Drainage Plan



35 ACRE RESIDENTIAL DEVELOPMENT

WQ Management Scheme under Old Rules



Does this WQ Management Scheme
comply with the Retention & Biofiltration
requirements specified in the new Rules?

- Yes
- No
- Maybe
- I Don't Know



It depends...

If any Retention BMPs are feasible, then it doesn't comply.

If all Retention BMPs are infeasible, and any Biofiltration BMPs are feasible, then it doesn't comply.

If all Retention and Biofiltration BMPs are infeasible, then it complies.



What's the first step to get the answer?

Determine if the project soils support infiltration:

Use the NRCS Web Soil Survey and the ASCE default infiltration rates

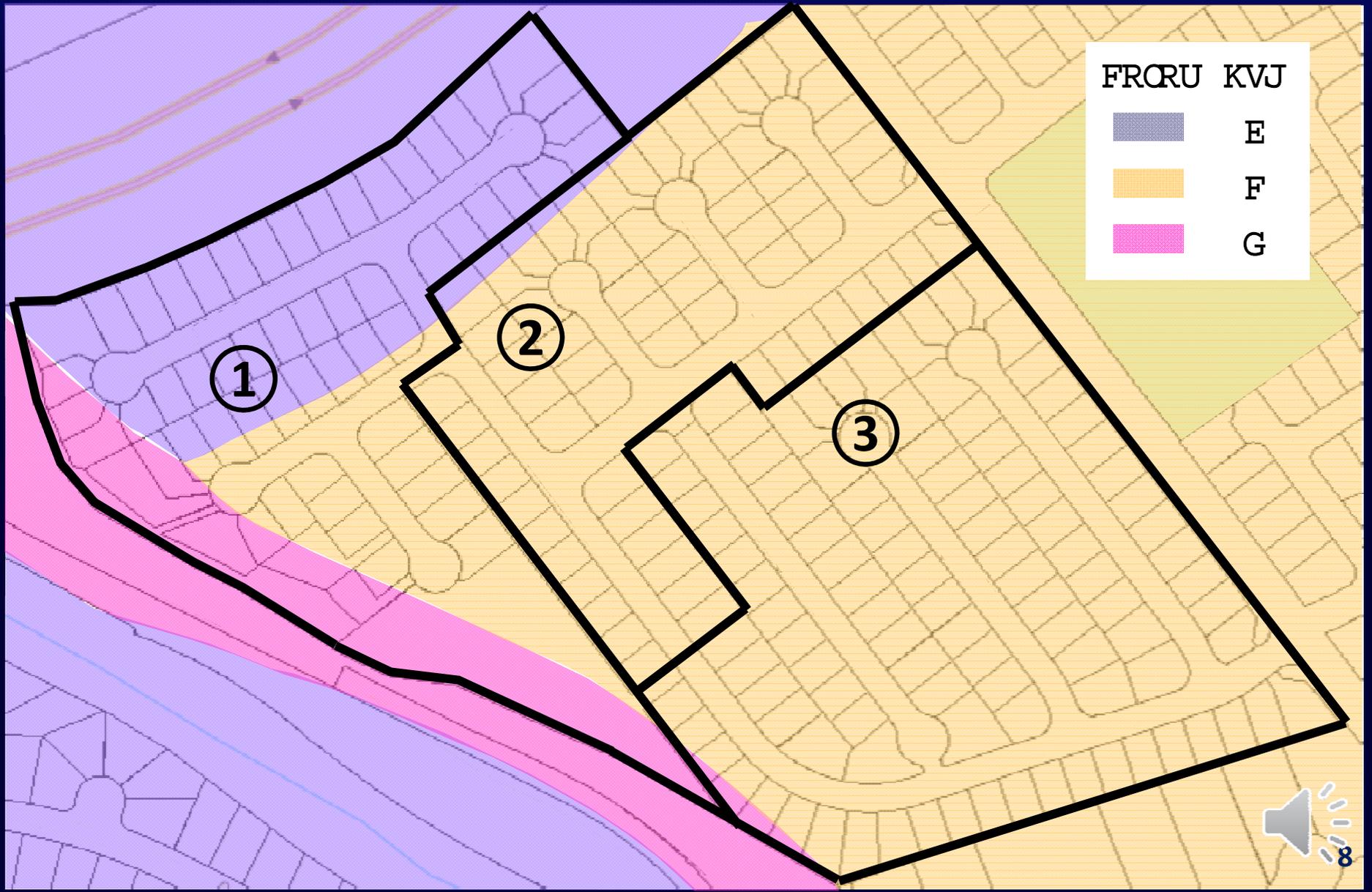
or

Perform field measurements



35 ACRE RESIDENTIAL DEVELOPMENT

Hydrologic Soil Groups (NRCS Web Soil Survey)



So, retention may be possible...

- An exemption from Retention may not be claimed in the HSG “B” area solely based on infiltration rates. As much of the WQV as possible must be retained here unless an exemption is claimed for another reason
- An exemption from all Retention BMPs may be claimed in the HSG “C” and “D” areas. Whatever part of the WQV not retained in “B” must be biofiltered where ever feasible (i.e., no exemption claimed)



35 ACRE RESIDENTIAL DEVELOPMENT

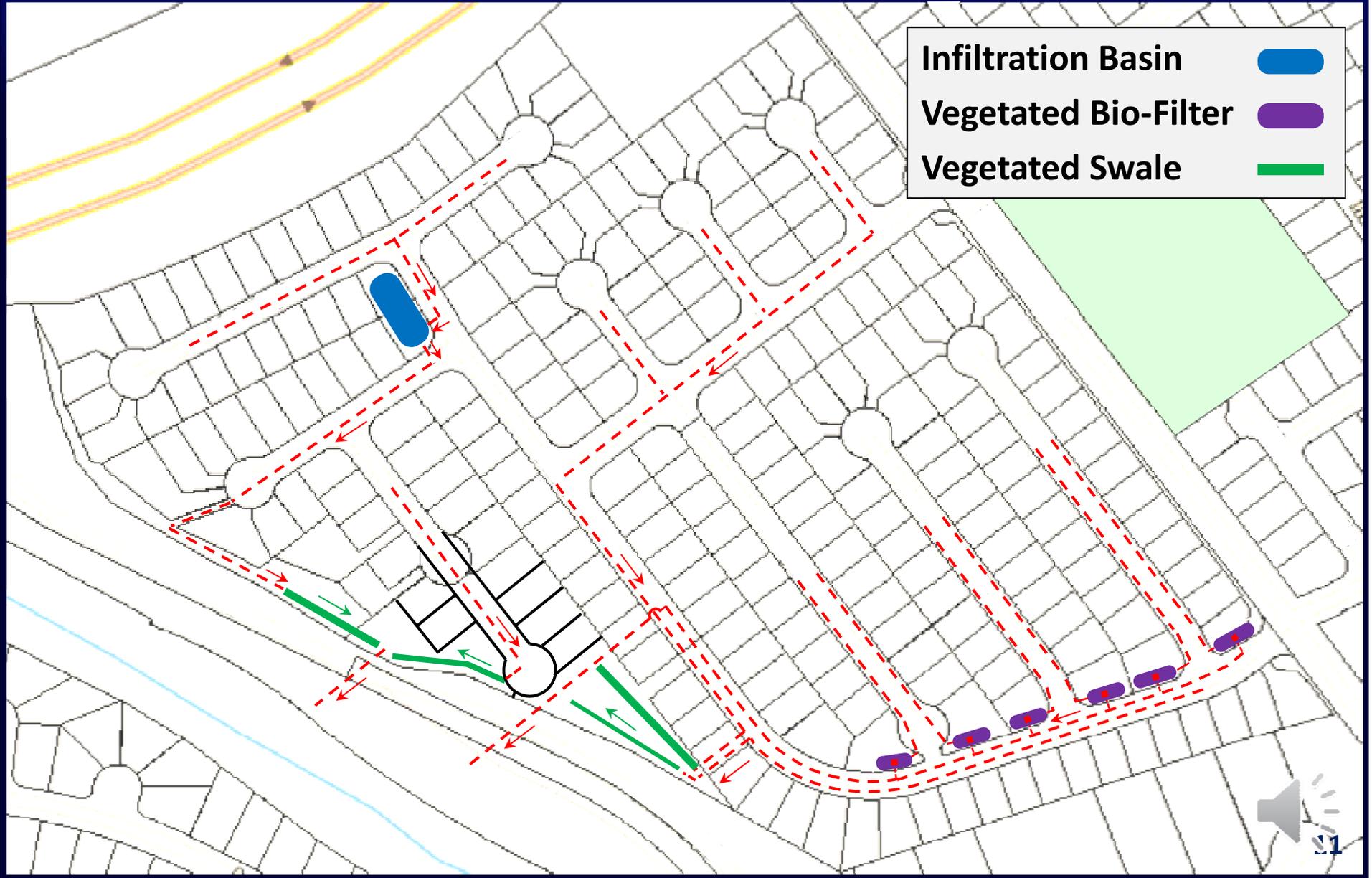
BMPs that could achieve compliance

	BMP	Drainage Area		
		1	2	3
<i>Retention</i>	Infiltration Basin	✓		
	Infiltration Trench	✓		
	Subsurface Infiltration	✓		
	Dry Well	✓		
	Bioretention Basin	✓		
	Permeable Pavement	✓		
<i>Biofiltration</i>	Green Roof			
	Bioretention Filter	✓	✓	✓
	Dry Swale	✓	✓	✓
	Downspout Disconnect	✓	✓	✓
	Vegetated Swale	✓	✓	✓
	Vegetated Buffer Strip			
	Tree Box Filter	✓	✓	✓



35 ACRE RESIDENTIAL DEVELOPMENT

One Possible WQ Management Scheme



35 ACRE RESIDENTIAL DEVELOPMENT

BMP Sizing Worksheet: Vegetated Bio-Filter

Project: 35 acre Residential Development

Date: Dec- 2012

1. Water Quality Volume

- | | | |
|---|--------------|-------|
| a. BMP Tributary Drainage Area, A | <u>1.70</u> | ac |
| b. % Impervious Area, I | <u>50</u> | % |
| c. Water Quality Design Storm Depth, P | <u>1.0</u> | in |
| d. Volumetric Runoff Coefficient, C | <u>0.5</u> | |
| e. Water Quality Volume, WQV | <u>3,083</u> | cu-ft |

2. Filter Bed Surface Area

- | | | |
|---|--------------|--------|
| a. Planting Media Depth, I_m (2.0 - 5.0 ft) | <u>2.0</u> | ft |
| b. Maximum Ponding Depth, d_p (12 in) | <u>6.0</u> | in |
| c. Planting Media Coefficient of Permeability, k | <u>1</u> | ft/day |
| d. Filter Bed Drain Time, t | <u>48</u> | hrs |
| e. Filter Bed Surface Area, A_{BMP} | <u>1,370</u> | sq-ft |

3. BMP Area

- | | | |
|---|--------------|-------|
| a. Side Slopes (length per unit height), z | <u>0</u> | |
| b. Freeboard, f | <u>1</u> | ft |
| c. Filter Bed Width, w_b | <u>20.00</u> | ft |
| d. Filter Bed Length, l_b | <u>69</u> | ft |
| e. Top Width, w_t | <u>20.00</u> | ft |
| f. Top Length, l_t | <u>69</u> | ft |
| g. Min. Top Surface Area excluding pretreatment, A_{BMP} | <u>1,370</u> | sq-ft |



35 ACRE RESIDENTIAL DEVELOPMENT

WQ Management Scheme Comparison

BMP	BMP Qty	Footprint (sq-ft)	Lots Lost	Approx. Cost ¹ (\$1000)
Detention Basin <i>(Old Rules)</i>	1	30,000	8	\$125 - \$250
Infiltration Basin Vegetated Bio-Filters Vegetated Swales	11	20,000 - 40,000	4	\$100 - \$300
Infiltration Basin Tree Box Filters	80	5,000 – 25,000 ²	2	\$650 - \$800

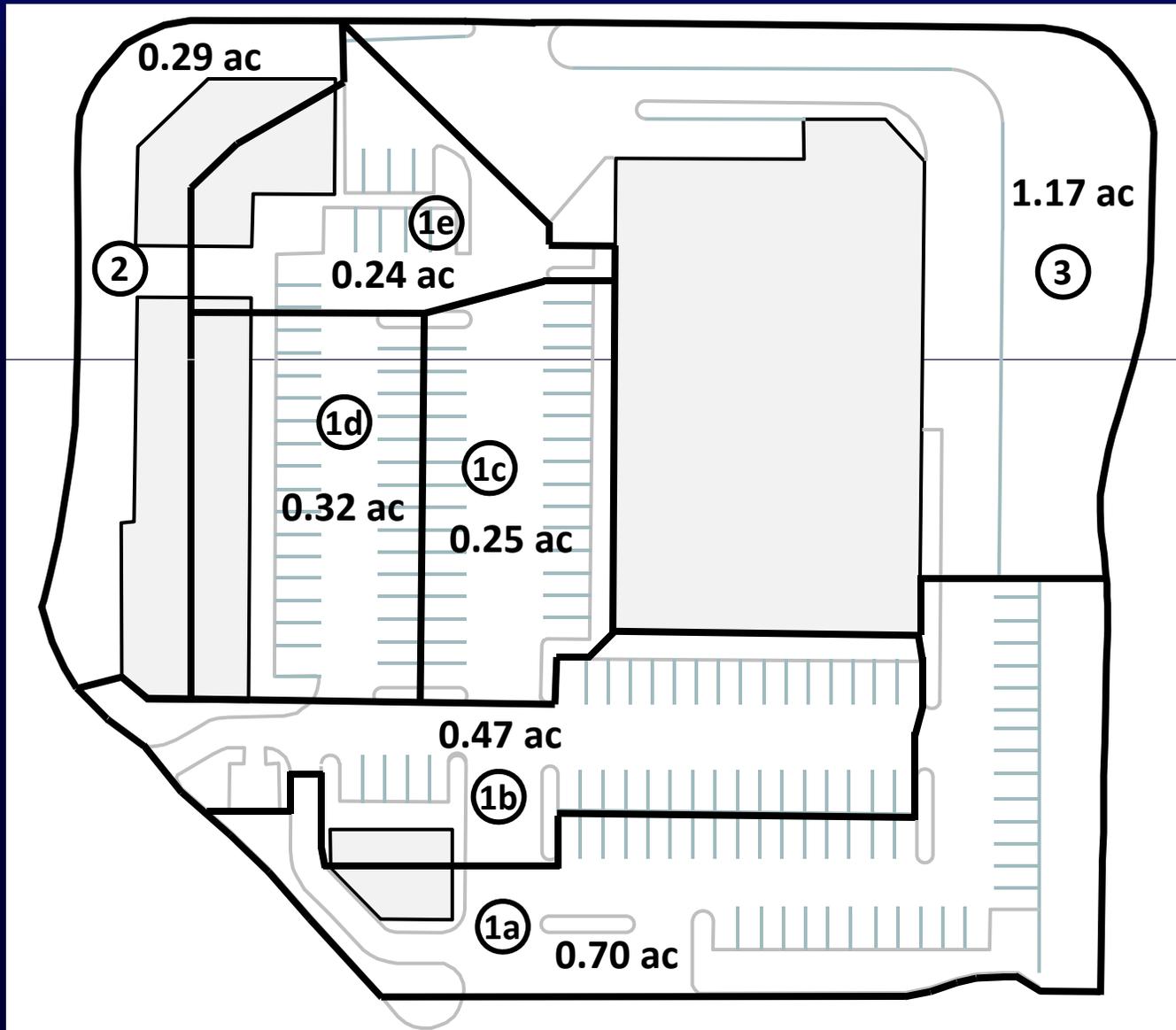
¹ Excludes land acquisition and maintenance

² Excludes Tree Box Filters which are below grade



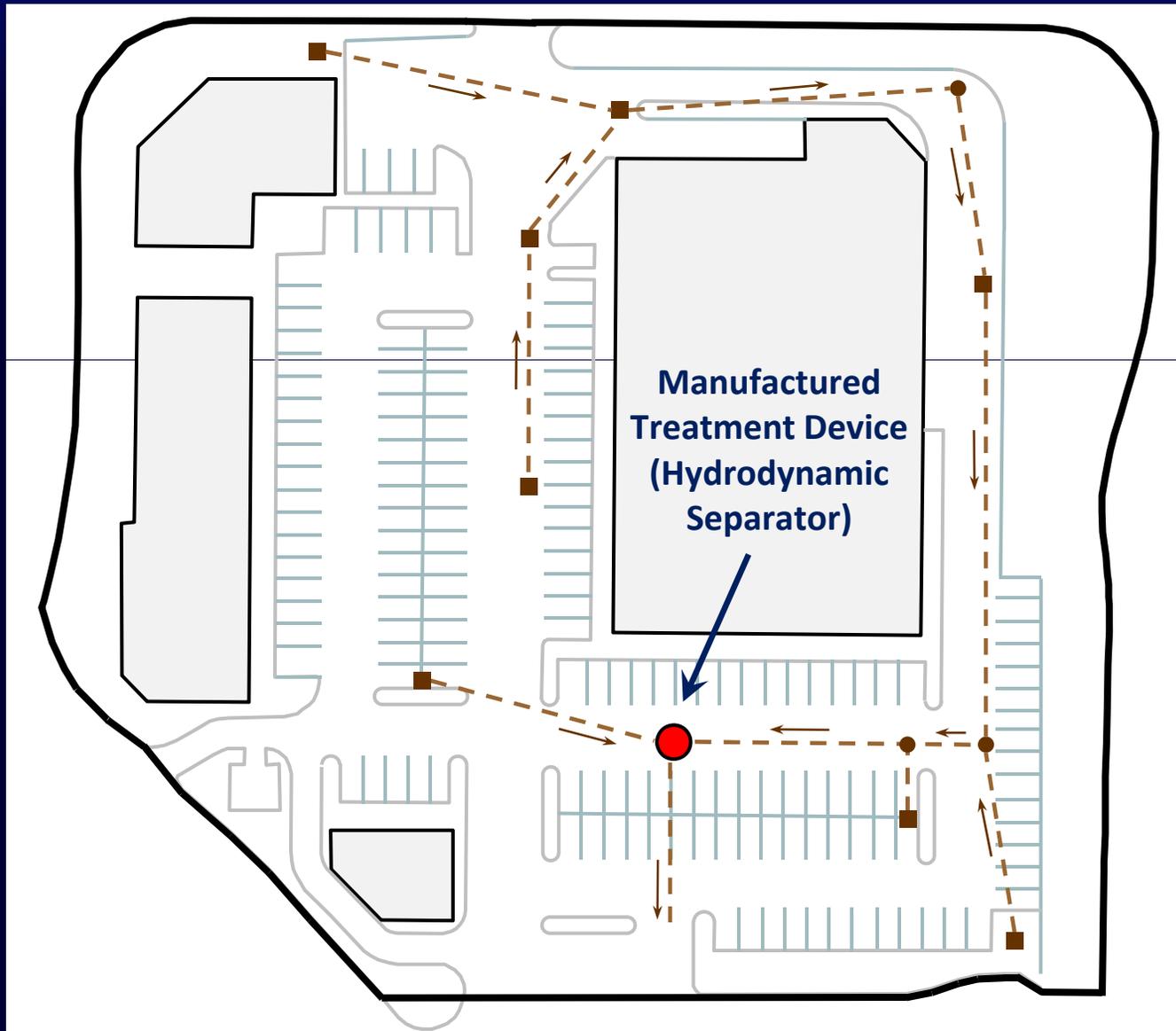
3.4 ACRE COMMERCIAL DEVELOPMENT

Site & Drainage Plan



3.4 ACRE COMMERCIAL DEVELOPMENT

WQ Management Scheme under Old Rules



Does this WQ Management Scheme
comply with the Retention & Biofiltration
requirements specified in the new Rules?

- Yes
- No
- Maybe
- I Don't Know



It depends...

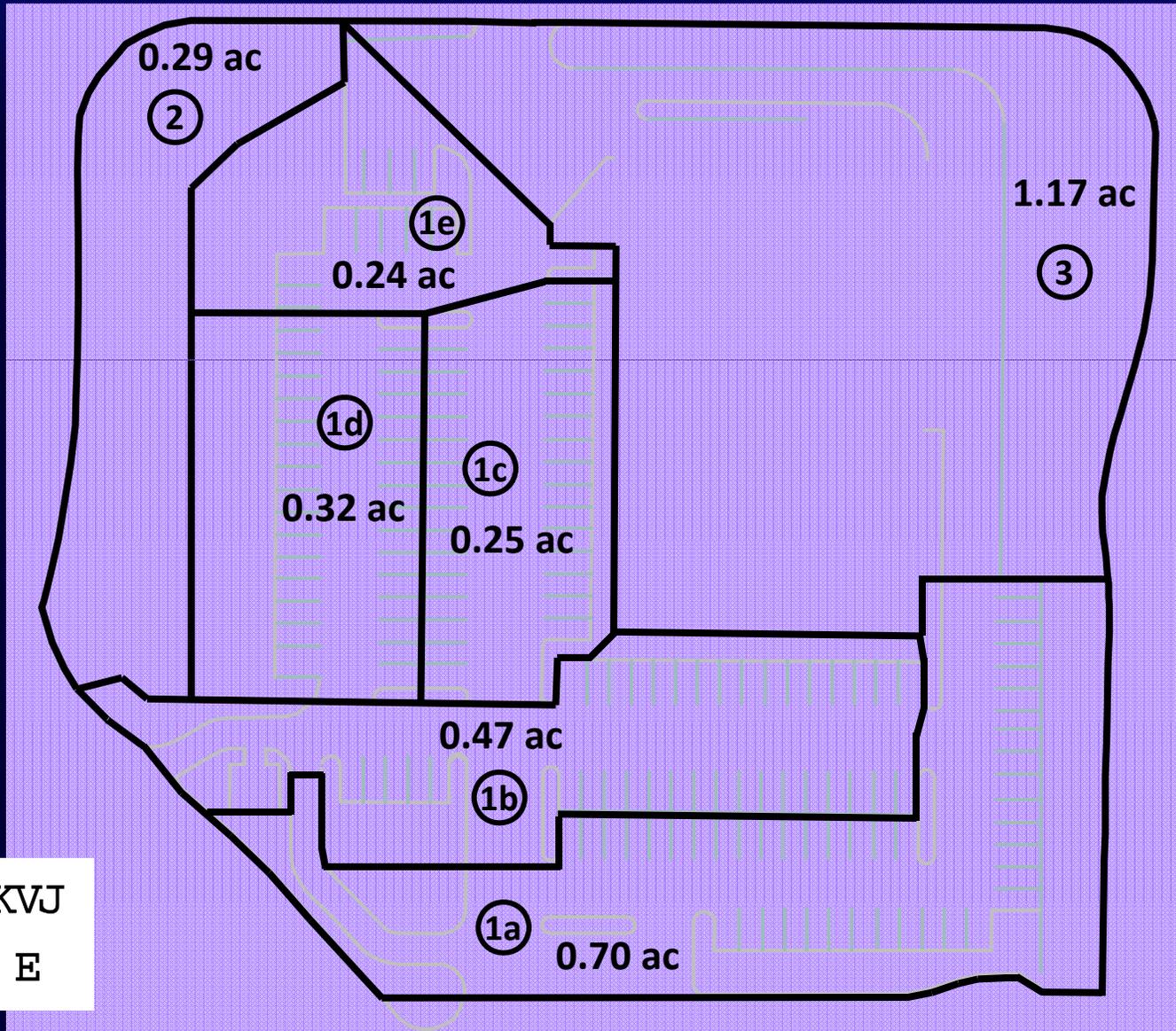
If any Retention or Biofiltration BMPs are feasible, then it doesn't comply.

If all Retention and Biofiltration BMPs are infeasible, then it complies.



3.4 ACRE COMMERCIAL DEVELOPMENT

Hydrologic Soil Groups (NRCS Web Soil Survey)



FRORU KVJ



E



So, retention and biofiltration may be possible...

- An exemption from Retention may not be claimed solely based on infiltration rates.
- The WQV must be either retained or biofiltered, unless an exemption from every Retention BMP and every Biofiltration BMP is claimed



3.4 ACRE COMMERCIAL DEVELOPMENT

BMPs that could achieve compliance

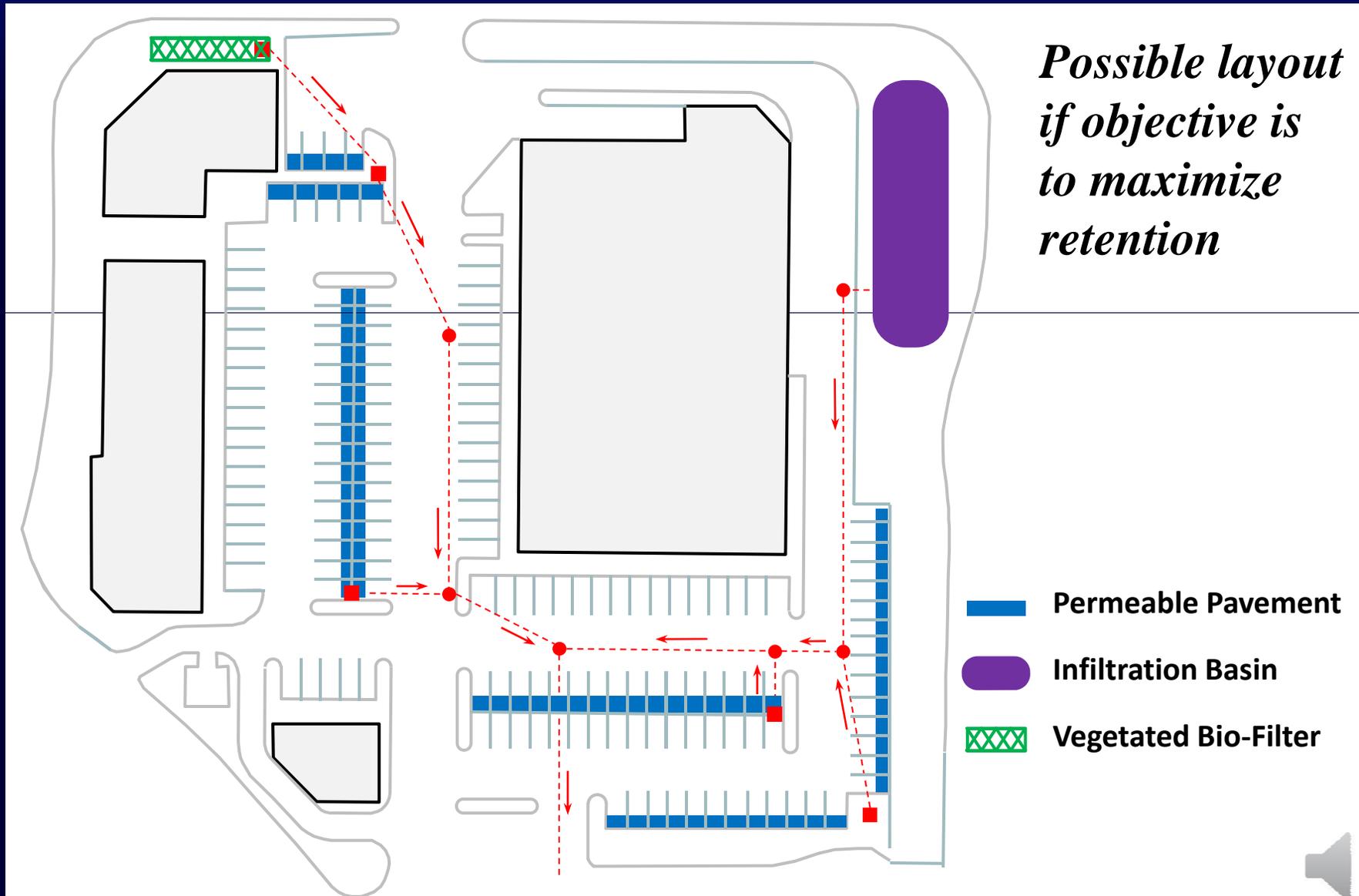
	BMP	Drainage Area						
		1a	1b	1c	1d	1e	2	3
<i>Retention</i>	Infiltration Basin							✓
	Infiltration Trench	✓	✓	✓	✓	✓		✓
	Subsurface Infiltration	✓	✓	✓	✓	✓		✓
	Dry Well							✓
	Bioretention Basin							✓
	Permeable Pavement	✓	✓	✓	✓	✓		
<i>Biofiltration</i>	Green Roof	✓	✓		✓	✓	✓	✓
	Bioretention Filter	✓	✓	✓	✓	✓	✓	✓
	Dry Swale							
	Downspout Disconnect						✓	✓
	Vegetated Swale						✓	
	Vegetated Buffer Strip							
	Tree Box Filter	✓	✓	✓	✓	✓		✓



3.4 ACRE COMMERCIAL DEVELOPMENT

One Possible WQ Management Scheme

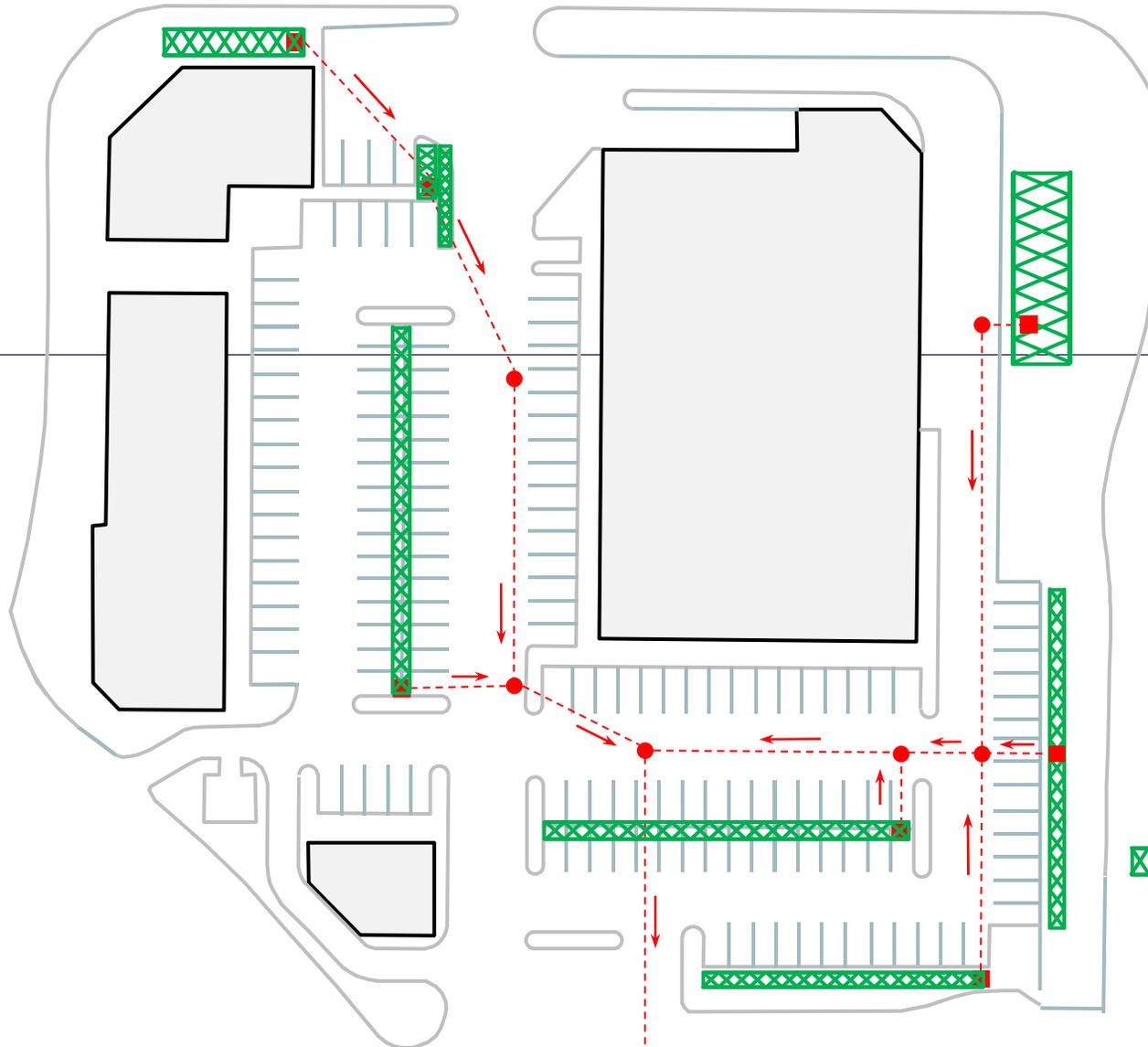
*Possible layout
if objective is
to maximize
retention*



3.4 ACRE COMMERCIAL DEVELOPMENT

Another Possible WQ Management Scheme

*Possible layout
if objective is
to maximize
biofiltration*



 **Vegetated Bio-Filter**



3.4 ACRE COMMERCIAL DEVELOPMENT

BMP Sizing Worksheet: Vegetated Bio-Filter

Project: 3.4 ac Commercial Development, DA 1a **Date:** Dec-2012

1. Water Quality Volume

- a. BMP Tributary Drainage Area, **A** 0.70 ac
- b. % Impervious Area, **I** 80 %
- c. Water Quality Design Storm Depth, **P** 1.0 in
- d. Volumetric Runoff Coefficient, **C** 0.77
- e. Water Quality Volume, **WQV** 1,957 cu-ft

2. Filter Bed Surface Area

- a. Planting Media Depth, I_m (2.0 - 5.0 ft) 2.0 ft
- b. Maximum Ponding Depth, d_p (12 in) 4.0 in
- c. Planting Media Coefficient of Permeability, **k** 1 ft/day
- d. Filter Bed Drain Time, **t** 48 hrs
- e. Filter Bed Surface Area, **A_{BMP}** 903 sq-ft

3. BMP Area

- a. Side Slopes (length per unit height), **z** 0
- b. Freeboard, **f** 0.25 ft
- c. Filter Bed Width, **w_b** 3.78 ft
- d. Filter Bed Length, **l_b** 239 ft
- e. Top Width, **w_t** 3.78 ft
- f. Top Length, **l_t** 239 ft
- g. Min. Top Surface Area excluding pretreatment, **A_{BMP}** 903 sq-ft

BMP Sizing Worksheet: Permeable Pavement

Project: 3.4 ac Commercial Development, DA 1a **Date:** Dec-2012

1. Water Quality Volume

- a. BMP Tributary Drainage Area, **A** 0.70 ac
- b. % Impervious Area, **I** 80 %
- c. Water Quality Design Storm Depth, **P** 1.0 in
- d. Volumetric Runoff Coefficient, **C** 0.77
- e. Water Quality Volume, **WQV** 1,957 cu-ft

2. Maximum Storage Depth

- a. Soil Infiltration Rate, **k** (0.5 min) 0.5 in/hr
- b. Infiltration Rate Safety Factor (2 - 5), **F_s** 4
- c. Drawdown Time, **t** 48 hrs
- d. Max. Storage Depth, **d_{max}** 0.5 ft

3. Design Storage Depths

- a. Pavement Course Thickness, **l_p** 7.0 in
- b. Reservoir Course Thickness, **l_r** 14.0 in
- c. Pavement Course Porosity, **n_p** 0.15
- d. Reservoir Course Porosity, **n_r** 0.35
- e. Total Effective Storage Depth, **d_t** 0.50 ft

4. BMP Area Requirements

- a. Fill Time, **T** 2 hrs
- b. Min. Surface Area, **A_{BMP}** 3,787 sq-ft



3.4 ACRE COMMERCIAL DEVELOPMENT

WQ Management Scheme Comparison

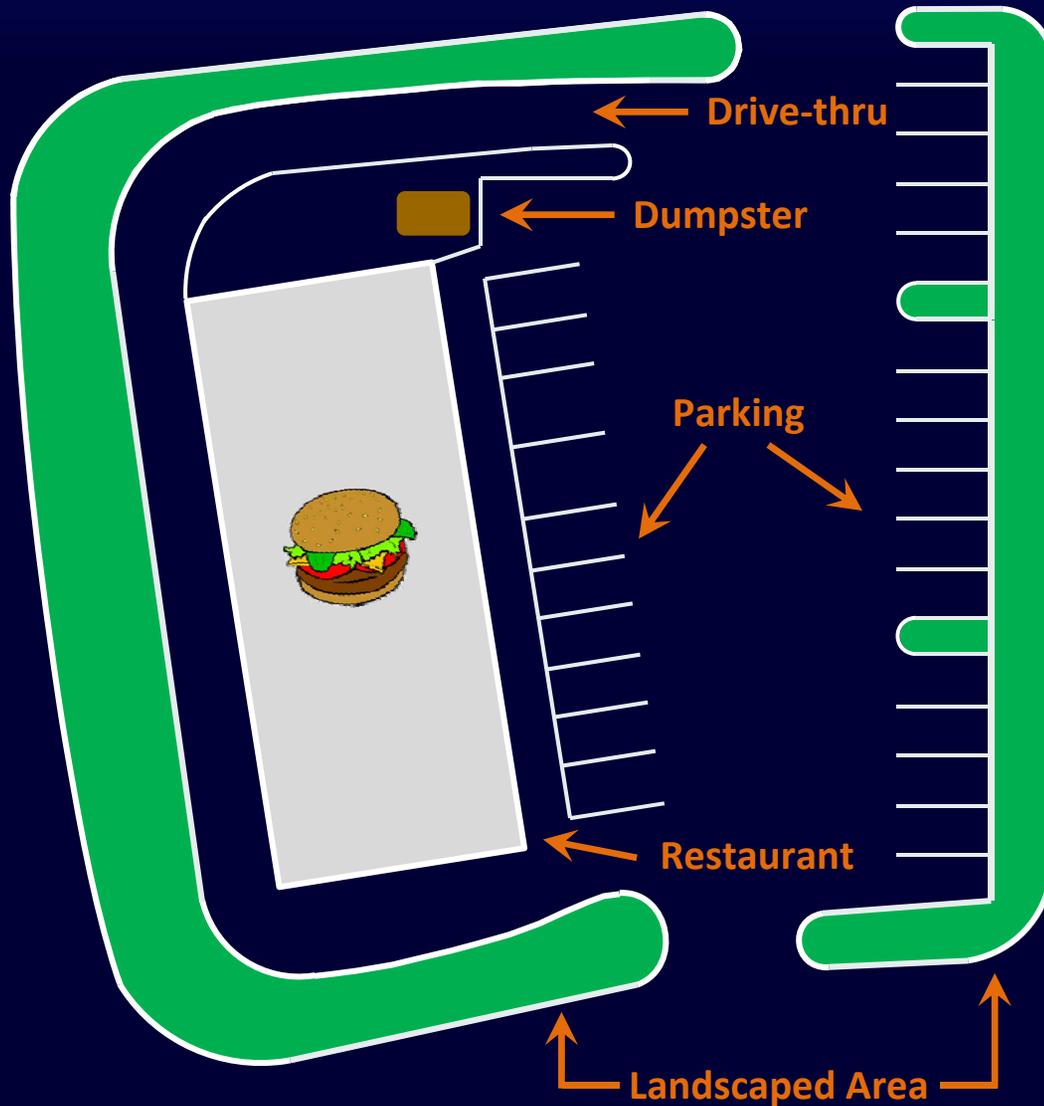
BMP	BMP Qty	Footprint (sq-ft)	Approx. Cost ¹ (\$1000)
Hydrodynamic Separator <i>(Old Rules)</i>	1	25	\$40
Permeable Pavement Infiltration Basin Vegetated Bio-Filter <i>(Maximize Retention)</i>	8	9,000 - 13,000	\$20 - \$120
Vegetated Bio-Filters <i>(Maximize Biofiltration)</i>	7	4,700 – 5,200	\$45 - \$200

¹ Excludes land acquisition and maintenance



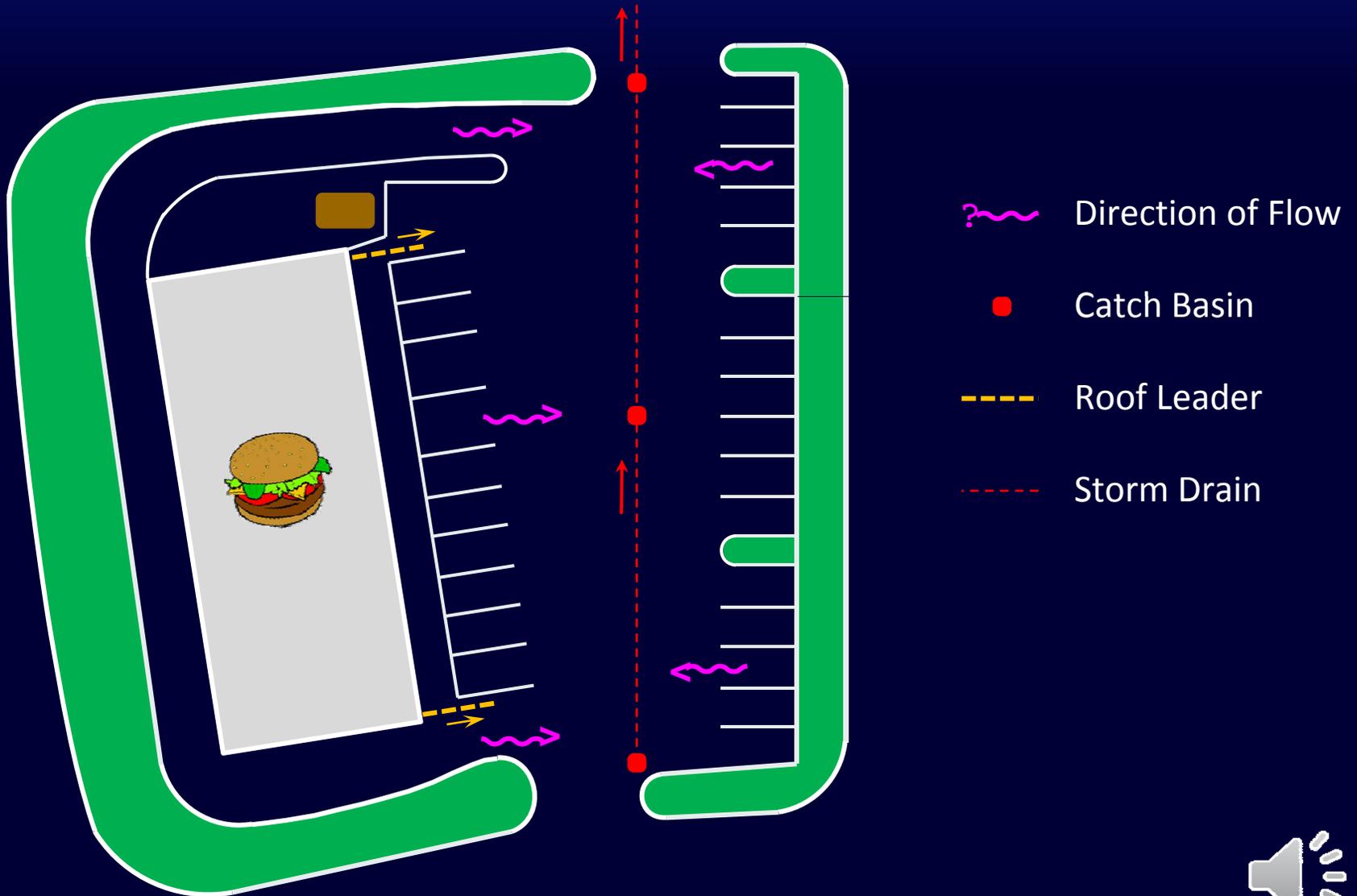
4,000 SQ-FT RESTAURANT ON 0.75 ACRE LOT

Site Plan



4,000 SQ-FT RESTAURANT ON 0.75 ACRE LOT

Site Design & Source Control Under Old Rules



Does this WQ Management Scheme
comply with the requirements for
Priority B projects under the new Rules?

- Yes
- No
- Maybe
- I Don't Know



Site Design is Optional, but Source Control is not

- Does Dumpster have a lid?
- Does Dumpster have secondary containment?
- Is there a “No Dumping” Sign by Dumpster?
- Are catch basins stencilled?



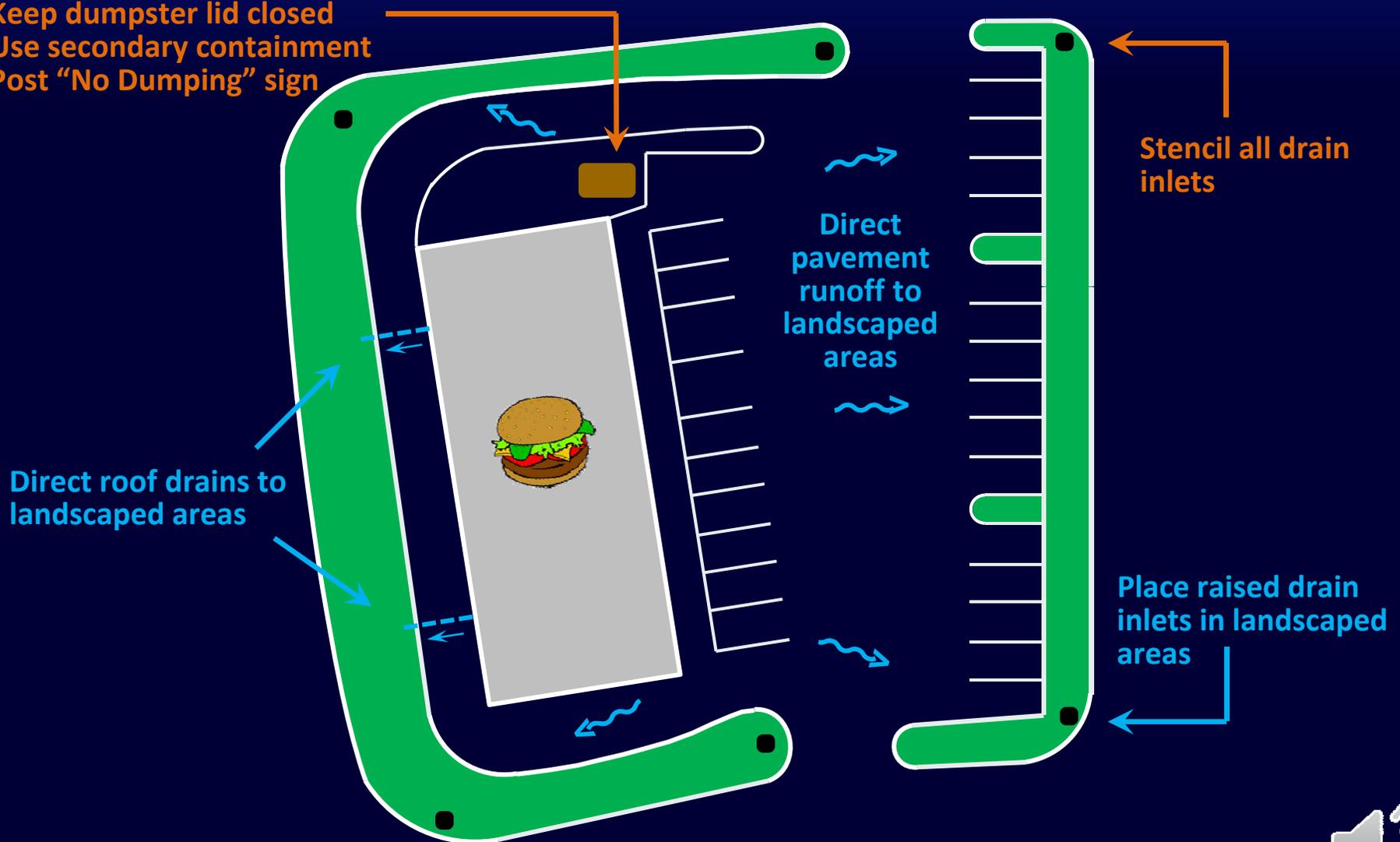
If the answer is YES, then it complies



4,000 SQ-FT RESTAURANT ON 0.75 ACRE LOT

Alternate Site Design & Source Control

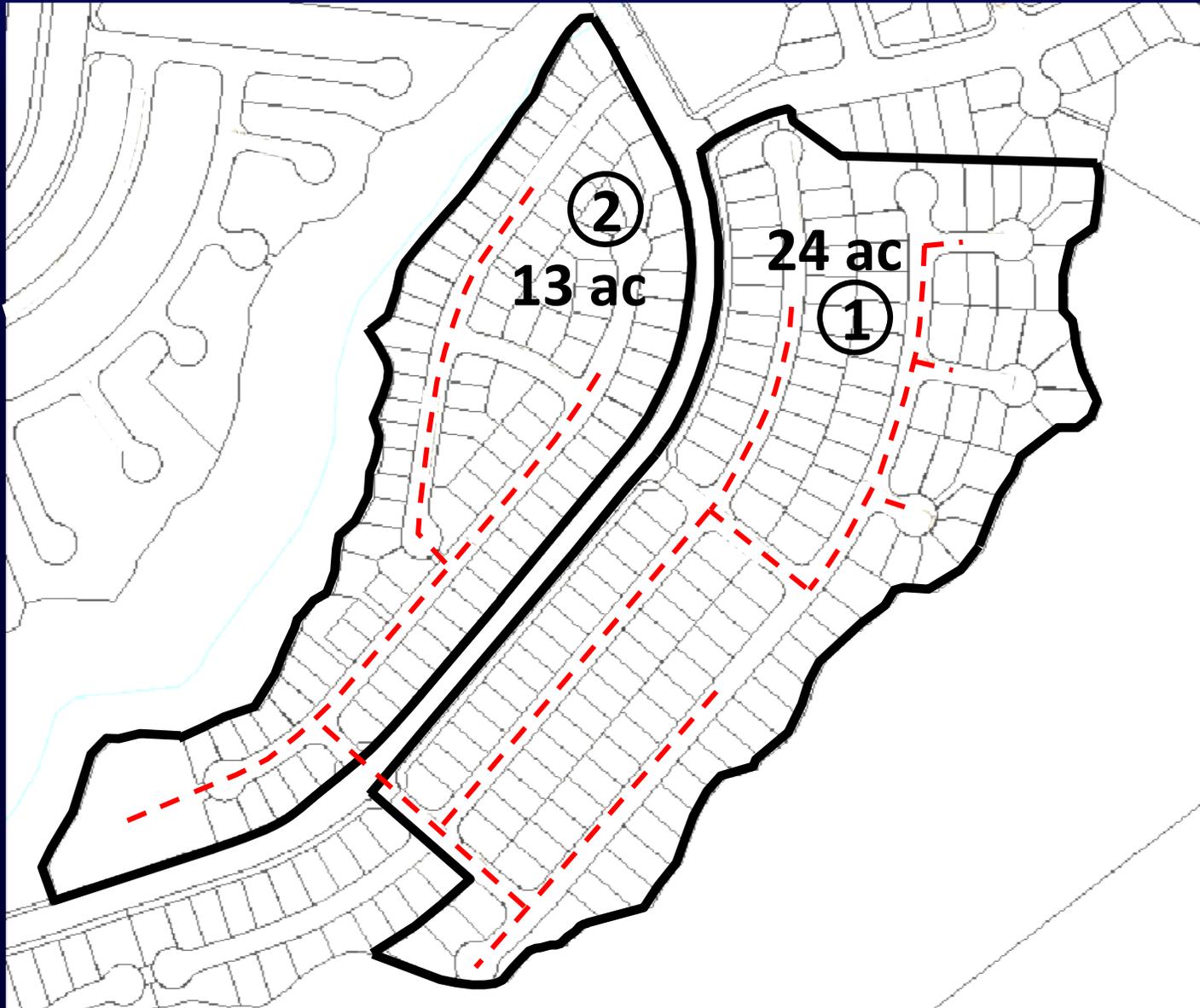
Keep dumpster lid closed
Use secondary containment
Post "No Dumping" sign



Objective: Consider Site Design & Source Control

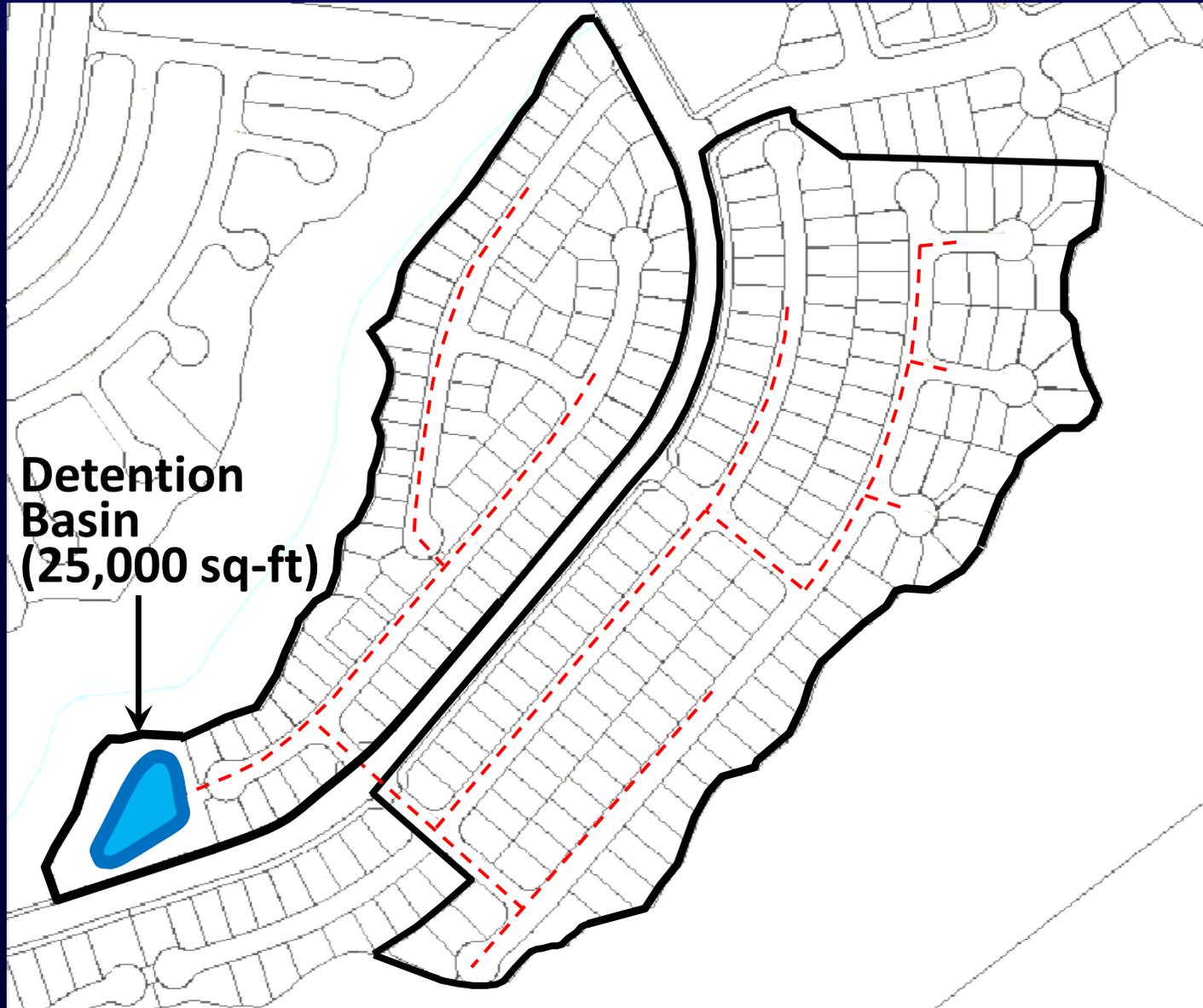
37 ACRE RESIDENTIAL DEVELOPMENT

Site Plan



37 ACRE RESIDENTIAL DEVELOPMENT

WQ Management Scheme under Old Rules



Does this WQ Management Scheme
comply with the Retention & Biofiltration
requirements specified in the new Rules?

- Yes
- No
- Maybe
- I Don't Know



It depends...

If any Retention BMPs are feasible, then it doesn't comply.

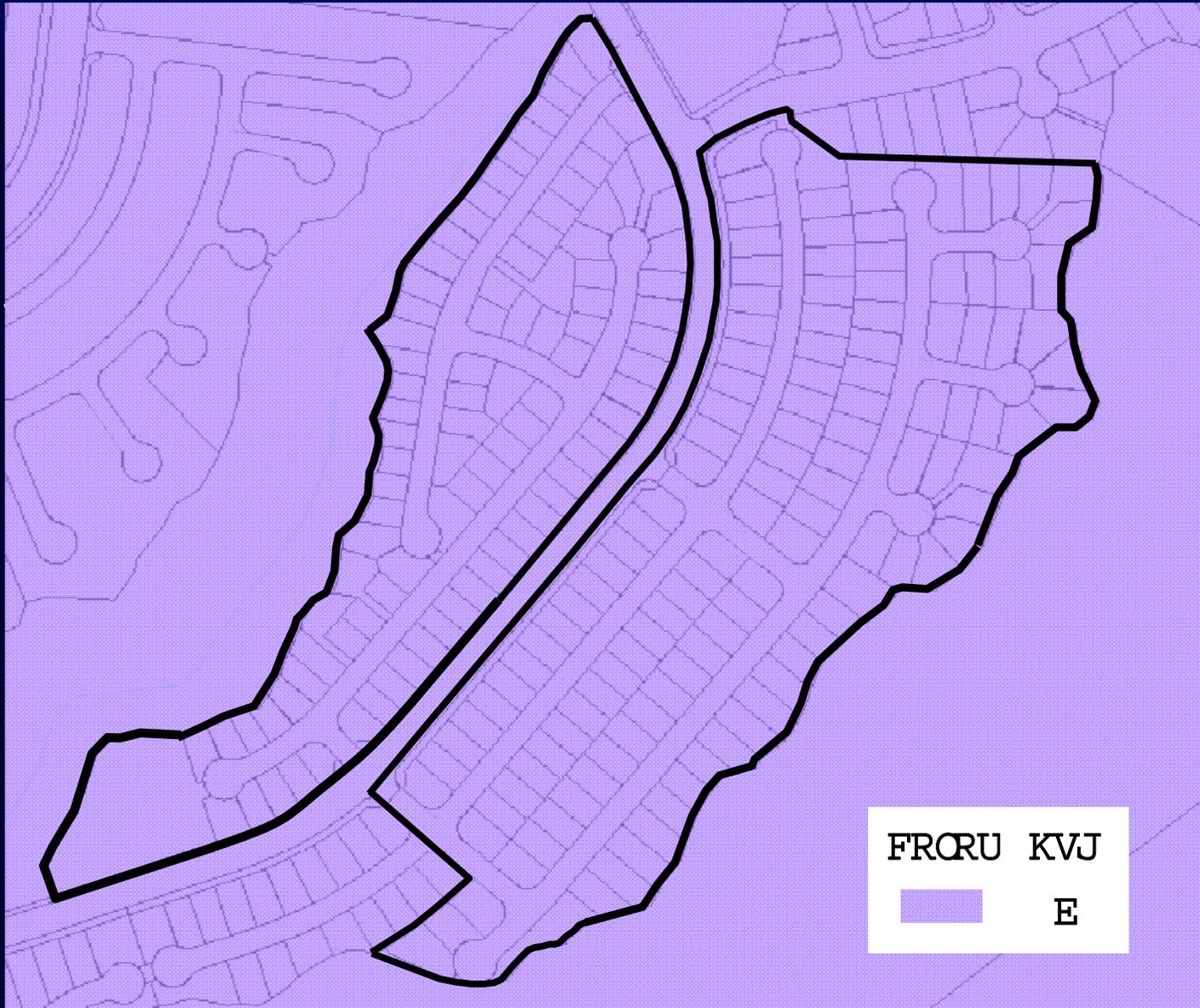
If all Retention BMPs are infeasible, and any Biofiltration BMPs are feasible, then it doesn't comply.

If all Retention and Biofiltration BMPs are infeasible, then it complies.



37 ACRE RESIDENTIAL DEVELOPMENT

Hydrologic Soil Groups (NRCS Web Soil Survey)



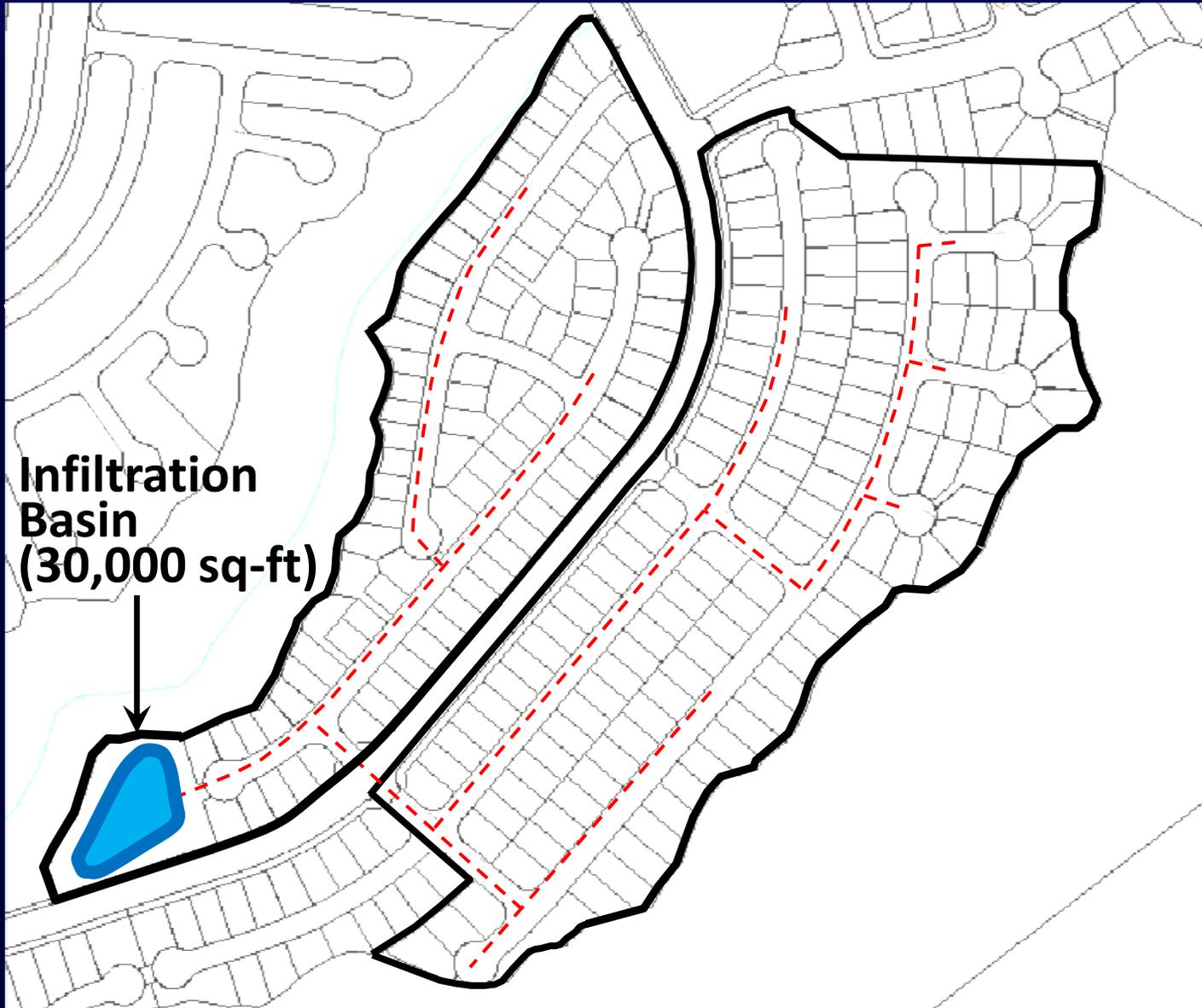
So, retention may be possible...

- An exemption from Retention may not be claimed solely based on infiltration rates. As much of the WQV as possible must be retained unless an exemption is claimed for another reason



37 ACRE RESIDENTIAL DEVELOPMENT

One Possible WQ Management Scheme



37 ACRE RESIDENTIAL DEVELOPMENT

BMP Sizing Worksheet: Infiltration Basin

Project: 37 ac Residential Development Date: Dec-2012

1. Water Quality Volume	
a. BMP Tributary Drainage Area, A	37.40 ac
b. % Impervious Area, I	50 %
c. Water Quality Design Storm Depth, P	1.0 in
d. Volumetric Runoff Coefficient, C	0.5
e. Water Quality Volume, WQV	67,881 cu-ft
2. Maximum Storage Depth	
a. Soil Infiltration Rate, k (0.5 min)	1.5 in/hr
b. Infiltration Rate Safety Factor (2 - 5), F_s	2
c. Drawdown Time, t	48 hrs
d. Max. Storage Depth, d_{max}	3.0 ft
3. Design Storage Depth	
a. Ponding Depth, d_p	3.00 ft
4. Basin Invert Footprint	
b. Reservoir Fill Time, T	2 hrs
c. Min. Bottom Surface Area, A_b	21,722 sq-ft
5. BMP Area Requirements	
a. Side Slopes (length per unit height), z (3.0 min)	3
b. Freeboard, f (1.0 min)	1 ft
c. Invert Width, w_b	200.0 ft
d. Invert Length, l_b	108.6 ft
e. Top Width, w_t	224.0 ft
f. Top Length, l_t	132.6 ft
g. Min. Top Surface Area excluding pretreatment, A_{BMP}	29,705 sq-ft

BMP Sizing Worksheet: Infiltration Trench

Project: 37 ac Residential Development Date: Dec-2012

1. Water Quality Volume	
a. BMP Tributary Drainage Area, A	37.40 ac
b. % Impervious Area, I	50 %
c. Water Quality Design Storm Depth, P	1.0 in
d. Volumetric Runoff Coefficient, C	0.5
e. Water Quality Volume, WQV	67,881 cu-ft
2. Maximum Storage Depth	
a. Soil Infiltration Rate, k (0.5 min)	1.5 in/hr
b. Infiltration Rate Safety Factor (2 - 5), F_s	2
c. Drawdown Time, t	48 hrs
d. Max. Storage Depth, d_{max}	3.0 ft
3. Design Storage Depths	
a. Ponding Depth, d_p	0.00 ft
b. Backfill Material (Trench Rock) Thickness, l_b	8.00 ft
c. Sand Layer Thickness, l_s	0.5 ft
d. Backfill Material Porosity, n_b	0.35
e. Sand Porosity, n_s	0.40
f. Total Effective Storage Depth, d_t	3.00 ft
4. BMP Area Requirements	
a. Reservoir Fill Time, T	2 hrs
b. Min. Surface Area excluding pretreatment, A_{BMP}	21,722 sq-ft



37 ACRE RESIDENTIAL DEVELOPMENT

WQ Management Scheme Comparison

BMP	BMP Qty	Footprint (sq-ft)	Approx. Cost* (\$1000)
Detention Basin <i>(Old Rules)</i>	1	25,000	\$135 - \$270
Infiltration Basin	1	25,000 - 70,000	\$135 - \$270
Infiltration Trench	1	18,000 – 66,000	\$300 - \$1300
Permeable Pavement	10	34,000 – 68,000	\$65 - \$670

* Excludes land acquisition and maintenance



Module Summary



EXAMPLES

- Don't wait until Layout is done to incorporate water quality management scheme
- LID is not always more expensive than non-LID
- More than one LID Retention or LID Biofiltration scheme may work – compare options
- Using the Web Soil Survey is perfectly acceptable, but will result in larger Retention BMPs



EXAMPLES

End of Module 4

