Infiltration Basins

Leif Hauge, PE, P. Hydrologist
Land Resources Division
Waukesha County Dept. of Parks and Land Use

Infiltration Basin Definition

- Open Impoundment (could be under-lot)
- Excavation or Embankment
- Flat floor, usually densely vegetated
- Soils selected or engineered for adequate drainage

Infiltration Applicability

- Where sources are not too dirty (Tier 1, Tier 2, fueling)
- Filtering layer
- Water table, bedrock separation

Benefits

- Reduces runoff volume and peaks
- Reduces pollutant loadings
- Reduces thermal impacts to stream
- Groundwater recharge
- Preserves base flow in streams

Planning / Design Standards

- WDNR CPS 1003 – Infiltration Basin
- WDNR CPS 1002 – Site Evaluation (soils and infiltration rates)
- WDNR CPS 1004 – Bioretention (engineered soils)
- WDNR CPS 1001 – Wet Detention (forebay design)
- WDNR CPS 1005 – Vegetated Infiltration Swale (pre-treatment)

Table 1: Evaluation Requirements Specific to Proposed Infiltration Devices

Infiltration Device	Tests Required[1]	Minimum Number of Borings/Pits Required	Minimum Drill/Test Depth Required Below the Bottom of the Infiltration System
Irrigation Systems[2]	Pits or borings	NA[2]	5 feet or depth to *limiting layer*, whichever is less.
Rain Garden[2]	Pits or Borings	NA[2]	5 feet or depth to limiting layer, whichever is less.
Infiltration Trenches (≤ 2000 sq feet impervious drainage area)	Pits or borings	1 test/100 linear feet of trench with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer, whichever is less.
Infiltration Trenches (> 2000 sq ft of impervious drainage area)	• Pits or borings • Mounding potential	1 pit required and an additional 1 pit or boring/100 linear feet of trench, and sufficient to determine variability	Pits to 5 feet or depth to limiting layer Borings to 15 feet or depth to limiting layer
Bioretention Systems	• Pits or borings • Mounding potential	1 test/50 linear feet of device with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer
Infiltration Grassed Swales	Pits or borings	1 test/1000 linear feet of swale with a minimum of 2, and sufficient to determine variability	5 feet or depth to limiting layer
Surface *Infiltration Basins*	• Pits or borings • Mounding potential	2 pits required per infiltration area with an additional 1 pit or boring for every 10,000 square feet of infiltration area, and sufficient to determine variability	Pits to 10 feet or depth to limiting layer Borings to 20 feet or depth to limiting layer

Infiltration Basin Design Criteria

- Proximity to building basements, footings
- Avoid excessive slopes (200 ft setback from 20% downgradient slopes)
- Provide for draw-down
- Pre-treatment (residential 60% TSS removal, commercial 80%)
- Infiltration rate measured or Table 2

Design

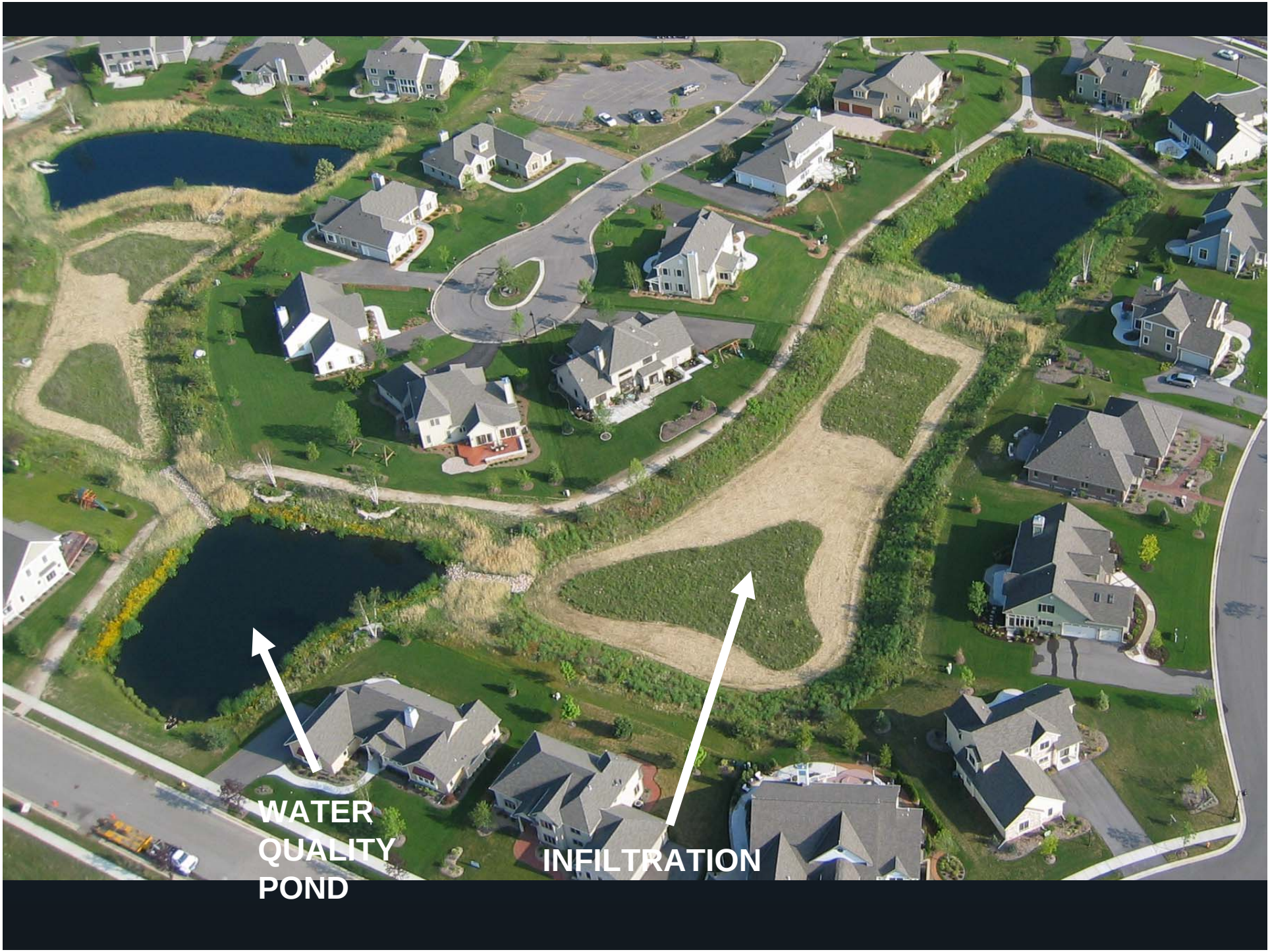
- Depth
  - Not to exceed 24 inches
  - Internally drained areas special cases
  - maximum draw down within 24-72 hours (to preserve vegetation)
- 4:1 side slopes
- 1 foot freeboard
- Maintenance access, 15-ft minimum, outside of flow channels
- Take topsoil re-application into account in design infiltration rate
- Emergency spillway – 100-year event


Basin on top of hill

Vegetation

- No sod
- Turf grass allowable
- Basin cannot double as recreation area
- Native seeding per qualified area native nursery – cover crop
- Seed - late Fall, early Spring, or use plugs


Native grasses


WATER
QUALITY
POND
INFILTRATION

Basin Planning Criteria

- 100-foot private well setback
- Must be on outlot, if in land division
- Structure protection, 2 / 50-ft setbacks if ponding depth is 12 in.

Modeling Approach

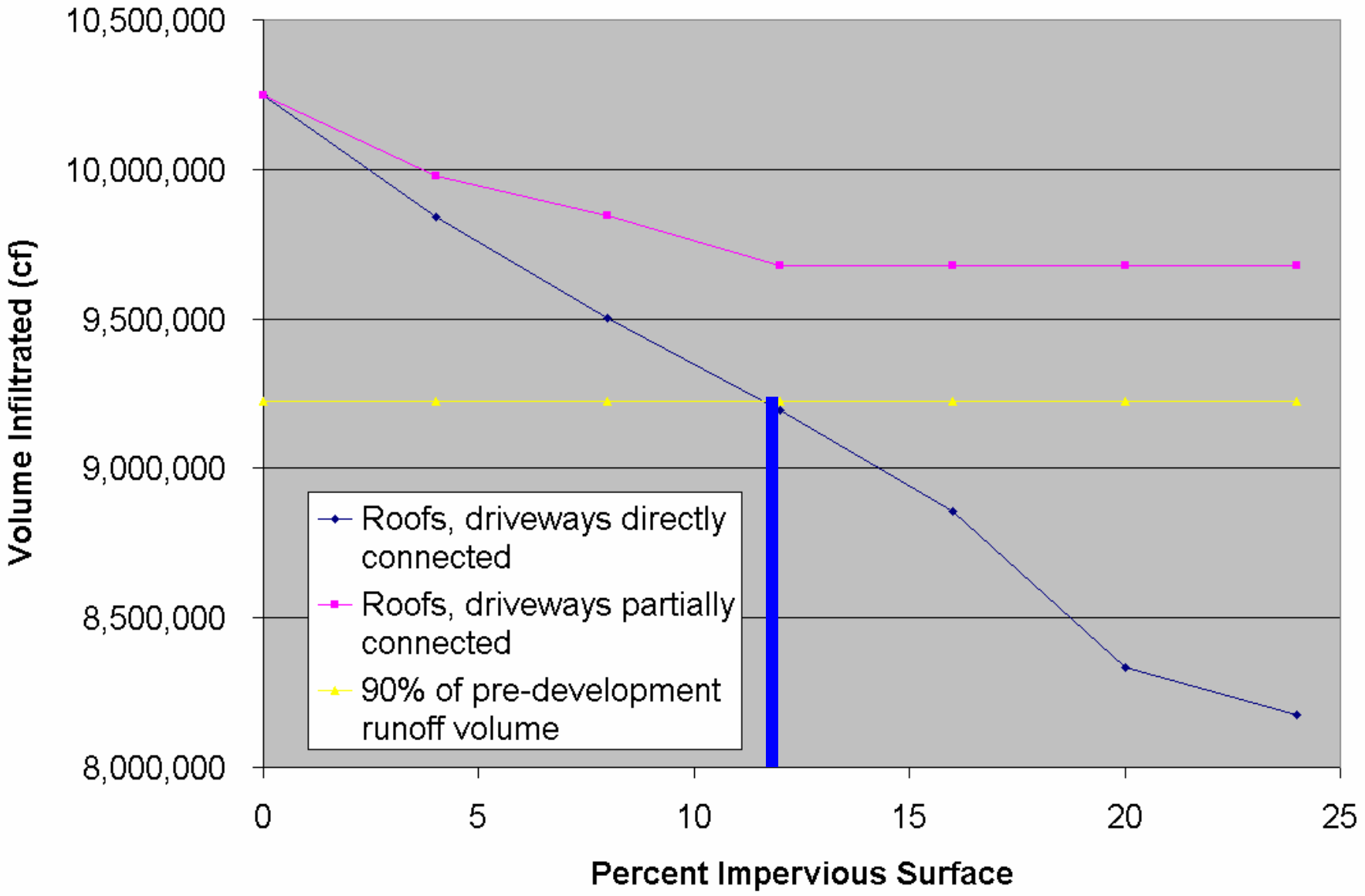
- Calculate 2-year 24-hour storm runoff using TR-55 method
- Design basin with dead storage for 25% (or 10%) of that volume
- Select depth based on drawdown time. Aim for 24 hrs.
- Does not give credit for dynamic routing

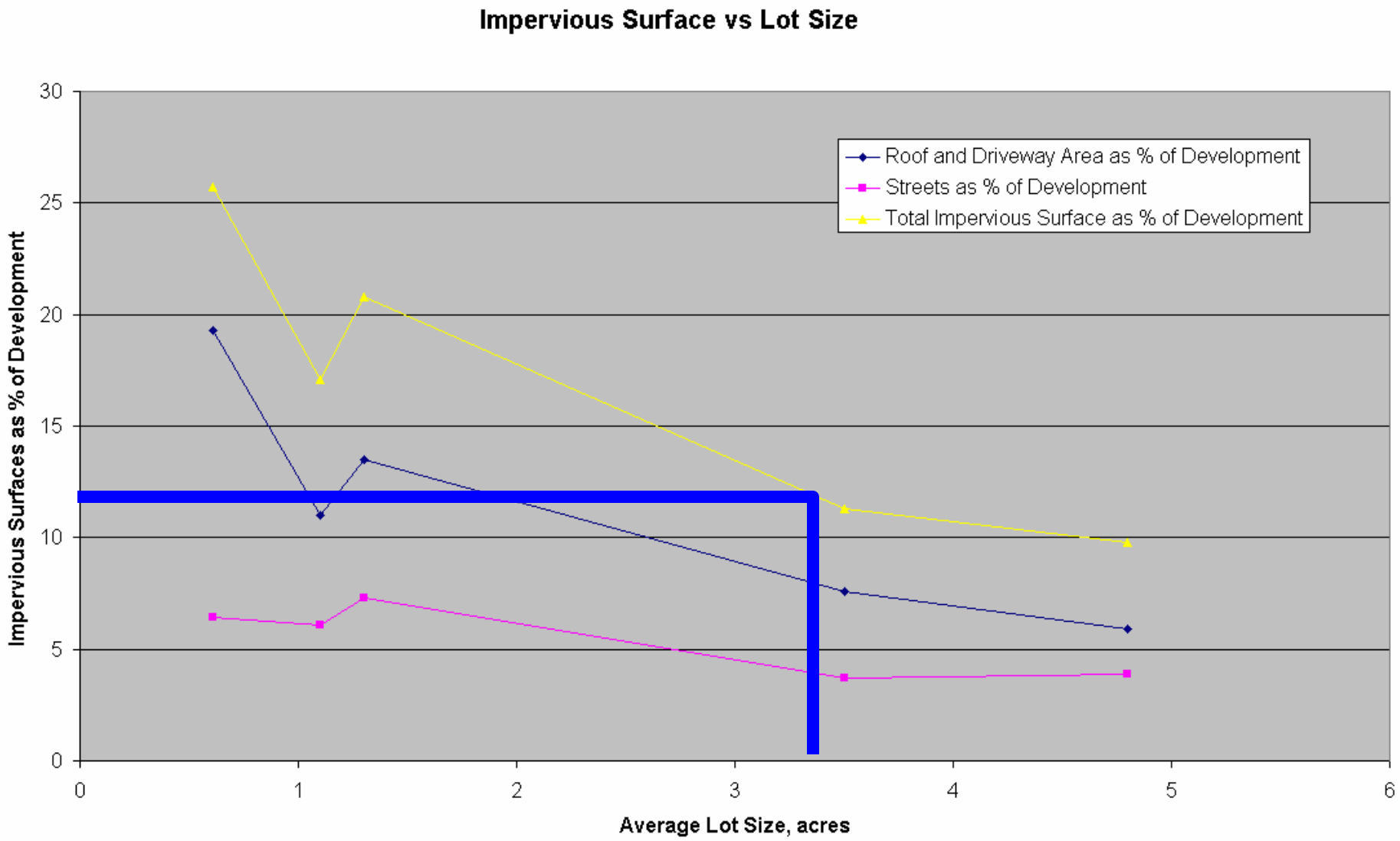
SLAMM Example

- Hypothetical 100-acre subdivision
- Silty soils
- 0.03 in/hr dynamic infiltration rate – roadside ditches – 2-foot bottom
- Roofs and driveways directly / partially connected
- Undeveloped condition cropped, B soils, CN 70


Direct Connection to
Conveyances

Volume Infiltrated As A Function Of % Imperviousness




Impervious Surface vs Lot Size
Impervious Surfaces as % of Development
30
25
20
15
10
5
0
0
1
2
3
4
5
6
Average Lot Size, acres
Roof and Driveway Area as % of Development
Streets as % of Development
Total Impervious Surface as % of Development


37,000 sf
90
120
Feet

Other Possibilities

- Use RECARGA to determine effective infiltration area in cases where dynamic routing is valid (eg. infiltration vegetated swales)?
- Discuss modeling approach with our staff before investing a lot of time and effort.

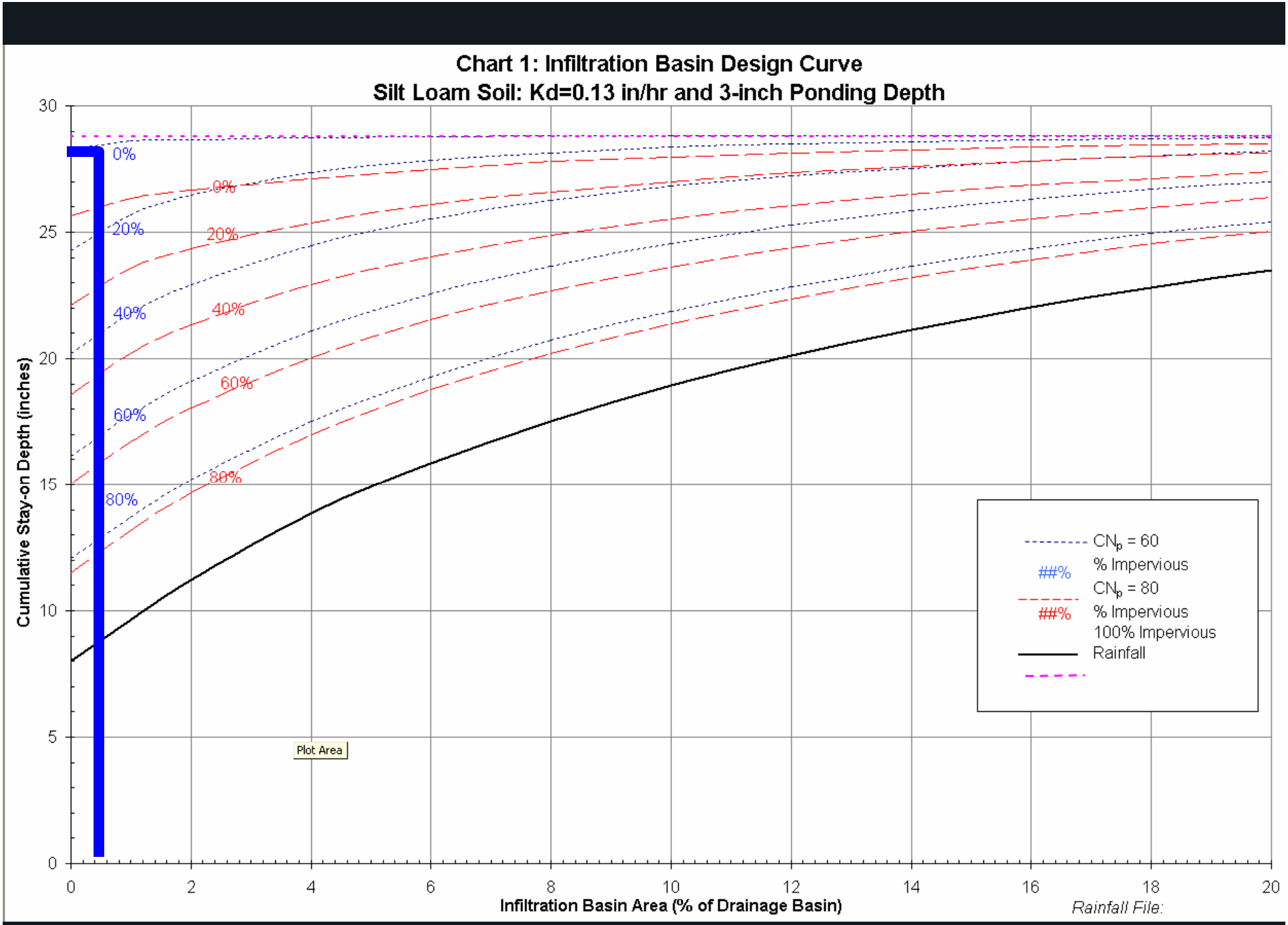


Chart 1: Infiltration Basin Design Curve
Silt Loam Soil: Kd=0.13 in/hr and 3-inch Ponding Depth
Cumulative Stay-on Depth (inches)
Infiltration Basin Area (% of Drainage Basin)
0
5
10
15
20
25
30
0
2
4
6
8
10
12
14
16
18
20
0%
0%
20%
20%
40%
40%
60%
60%
80%
80%
Plot Area
CNp = 60
##% % Impervious
CNp = 80
##% % Impervious
100% Impervious
Rainfall
Rainfall File:

Table 2: Design Infiltration Rates for Soil Textures Receiving Stormwater

Soil Texture[1]	Design Infiltration Rate Without Measurement inches/hour[2]
Coarse sand or coarser	3.60
Loamy coarse sand	3.60
Sand	3.60
Loamy sand	1.63
Sandy loam	0.50
Loam	0.24
Silt loam	0.13
Sandy clay loam	0.11
Clay loam	0.03
Silty Clay loam	0.04[3]
Sandy clay	0.04
Silty clay	0.07
Clay	0.07

[1]Use sandy loam design infiltration rates for fine sand, loamy fine sand, very fine sand, and loamy fine sand soil textures.

[2] Infiltration rates represent the lowest value for each textural class presented in Table 2 of Rawls, 1998.

[3] Infiltration rate is an average based on Rawls, 1982 and Clapp & Hornberger, 1978.

Table 3: Total Correction Factors Divided into Measured Infiltration Rates

Ratio of Design Infiltration Rates[1]	Correction Factor
1	2.5
1.1 to 4.0	3.5
4.1 to 8.0	4.5
8.1 to 16.0	6.5
16.1 or greater	8.5

[1]Ratio is determined by dividing the design infiltration rate (Table 2) for the textural classification at the bottom of the infiltration device by the design infiltration rate

Example Data Summary Sheet for Infiltration Basin Design

Design Element	Design Data
Site assessment data: (see attached maps)	
Contributing drainage area to basin (subwatershed A)	120 acres
Distance to nearest private well (including off-site wells)	> 100 feet
Distance to municipal well (including off-site wells)	> 1200 feet
Wellhead protection area involved?	No
Ground slope at site of proposed basin	average 3%
Any buried or overhead utilities in the area?	No
Proposed outfall conveyance system/discharge (w/ distances)	35 ft. to CTH "U" Road ditch 1000 ft. to wetland
Any downstream roads or other structures? (describe)	Yes – 36" cmp road culvert
Floodplain, shoreland or wetlands?	No
Soil investigation data (see attached map & soil logs):	
Number of soil investigations completed	3 (in basin area)
Do elevations of test holes extend 4 ft. below proposed bottom?	Yes (see map)
Average soil texture at pond bottom elevation (USDA)	Sandy loam
Infiltration rate at basin bottom and method of analysis	2 in/hr, double-ring infiltrometer
Distance from pond bottom to bedrock	> 5 feet
Distance from pond bottom to seasonal water table	Pond bottom 2 below mottling No water observed in test holes
General basin design data (see attached detailed drawings):	
Basin bottom area	1.5 acres
Effective infiltration area	1.0 acres
1% of development area (120 acres)	1.2 acres
Basin bottom elevation	elev. 900.0
Top of berm elevation (after settling) and width	elev. 904.0 / 10 feet wide
Basin storage below outlet	3.1 ac-ft

Construction

- Sediment
  - Divert flow around basin until site is largely stabilized, including home construction
  - Protect or cover stone trench
  - Construct basin last in sequence
  - Leave 1-2 feet of soil in basin until stable
- Compaction
  - Use only tracked vehicles or dig from side
  - Mitigate compaction, use chisel plow
  - Amend with compost
- Use native vegetation to structure soil, enhance infiltration
- Planting implementation plan required

Covering Stone Trench


Basin failed due to construction sediment


Removed 8 inches of sediment
Stone trench

Home construction uphill from infiltration basin

Engineered Soils

- Amend / engineer if necessary
- Particle size distribution testing before implementation

Construction Inspections

Infiltration Basin With Engineered Soils And Forebay (per WDNR CPS 1003)

Date *Inspector's Initials*

1. **Before engineered soil is installed in the infiltration area,** verify that:
   a. Basin was over-excavated to expose permeable soil (as determined by soil scientist).
   b. Compost used to amend soil meets WDNR Specification S100.
   c. Correct mixture of engineered soil is used (40% sand, 30% topsoil, 30% compost).
2. **Before berm material is placed**, verify that:
   a. Topsoil, stumps, and vegetation are stripped in basin berm footprint
   b. *A 2' x 8' keyway is excavated under berm (if forebay permanent pool will pond >3 ft against embankment).*
   c. The specified material is used to construct basin berm.
3. **Before a forebay liner is placed**, verify that:
   a. Basin interior slopes do not exceed maximum pitches (4:1 above water, 10:1 safety shelf, 2:1 below safety shelf)
   b. Basin bottom and shelf elevations are correct; and
   c. The safety shelf is at least 8 feet wide.
4. **Before the berm is re-compacted around outlet pipes** following installation, verify that:
   a. The correct pipe diameter, drain hole diameter, and materials are used.
   b. The outlet pipe and riser elevations are correct.
   c. Anti-seep collars are installed on outlet pipes.
5. **Before topsoil is re-applied**, verify that:
   a. A *compacted 1-foot clay* **liner** is installed up to the forebay permanent pool elevation.
   b. The **compaction requirement** of 90% Proctor is met by sampling at a minimum of *five* locations along embankment.
   c. The berm elevation is 5% above design height (above existing grade) to allow for settling.
6. Verify that compaction mitigation procedures were followed (deep tilling).and compost / loamy sand topsoil mixture is applied to surface of infiltration area.
7. Verify that **topsoil is re-applied** to all other surfaces above and **including the forebay safety shelf.**
8. Basin bottom elevation, safety shelf elevation, berm elevation, outlet elevations, spillway elevations are correct (part of **as-built survey**). **Basin dewatering** is required to verify bottom elevation and to facilitate sediment removal following construction and site stabilization.

Establishment of warm-season (native) and wetland plantings will be separately verified by RLA, of Inc.

ERD 1/30/07

Example Plan for Using Native Plantings for Storm Water Infiltration

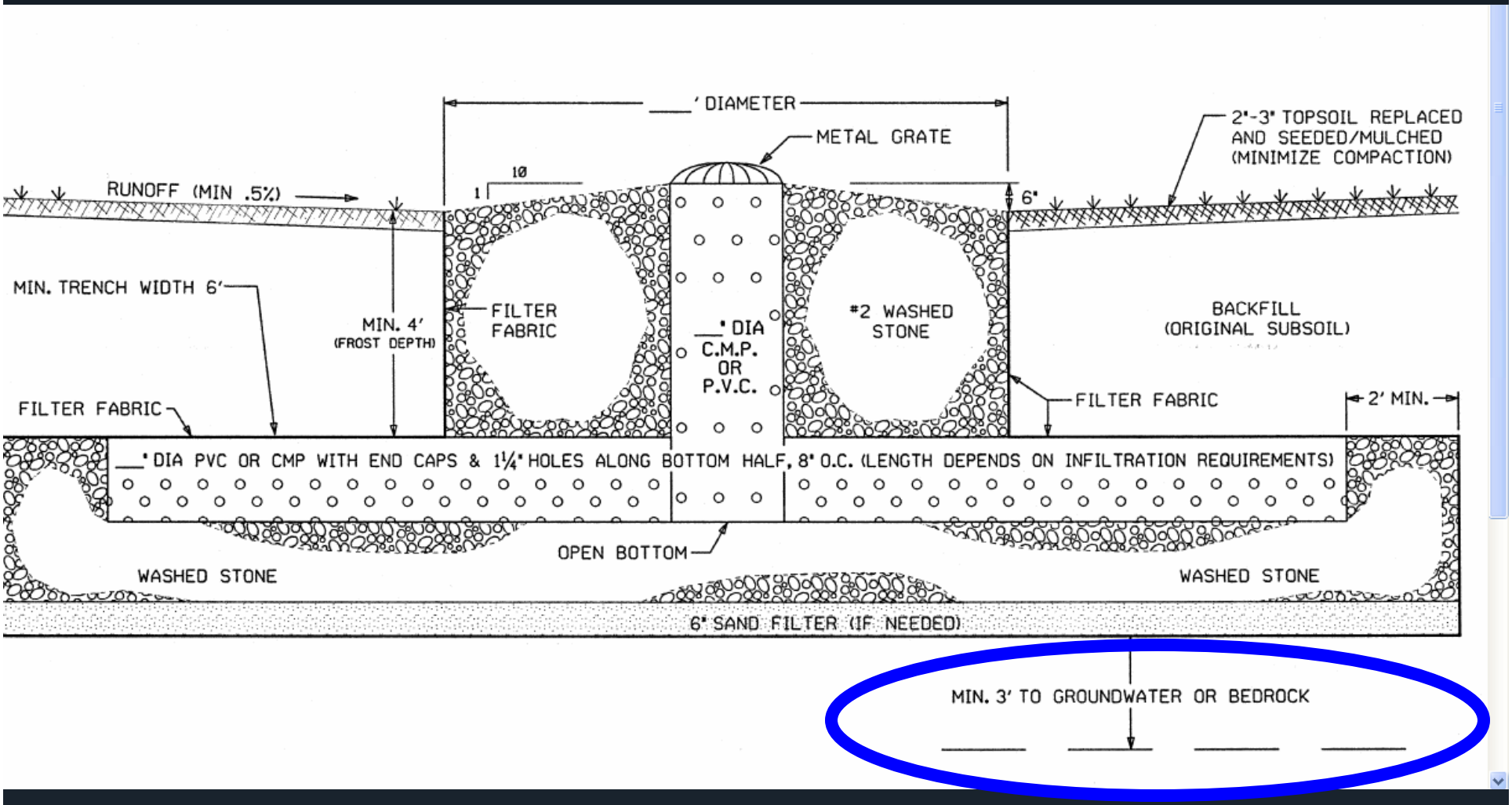
The following information is provided to serve as a general guide for establishing native plantings especially for storm water infiltration. It has been compiled from information provided by staff at Retzer Nature Center – Waukesha County Department of Parks and Land Use. It is not intended to replace the guidance that would be provided by contracting with a qualified professional to prepare a site-specific plan and to direct or perform the plan implementation. **Option A** assumes that the site where the native planting will occur will not need to be graded before the planting takes place. **Option B** assumes that the majority of the project site will have disturbance from grading activities. In this scenario topsoil is stripped and stockpiled and the areas for infiltration areas rough graded before finally having topsoil reapplied and being planted.

OPTION A: Native Plant Establishment on Sites Where Grading Does Not Occur

Phase I(A) - Site Preparation & Planting

Planting Site Preparation: The following information is specific to plantings. It is an A-Z planting prescription that explains some of the unique problems associated with a native planting from seed.

a. **Initial Weed Control:** In the spring, the area to be planted needs to be burned or mowed as a "simulated burn" in the early spring. When the field greens up, spray your area with a glyphosphate non-selective herbicide .
    i. Timing: Burn or mow in the preceding fall or current spring.



- Effective device in frozen ground conditions
- Meets definition of injection well


Surface
drain

Trenches vs Injection Wells

- Injection well if:
  - Narrowest top dimension not wider than it is deep
  - Contains piping
- Regulated by NR 815
  - Class V
  - Requires WDNR approval
  - Must be relatively clean, pre-treated
  - Submit reporting form to Bureau of Drinking Water and Groundwater

Reporting Form

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921

Inventory of Injection Wells
Form 3300-253 (5/01)

This information is collected under the authority of the Safe Drinking Water Act.

Notice: Code of Federal Regulations (40 CFR 144.26 Inventory Requirements): owners or operators of all injection wells authorized by rule shall submit inventory information to an approved State Underground Injection Control Program. Personal information collected on this form will be used for inventory purposes. Information will be made accessible to requesters under Wisconsin's Open Records laws (s. 19.32 to 19.39, Wis. Stats.) and requirements.

Date Prepared (Year, Month, Day) | Facility ID Number | Transaction Type (Please check one of the following) ☐ Deletion ☐ Entry Change ☐ First Time Entry ☐ Replacement

Facility Name and Location

Last Name | First | MI | Latitude: DEG MIN SEC N | Longitude: DEG MIN SEC W

Street Address / Route Number | Township N | Range | Section | ¼ Section

City / Town | State | ZIP Code | County | Tribal Land ☐ Yes ☐ No

Legal Contact

Type ☐ Owner ☐ Operator | Last Name | First | MI | Telephone Number (incl. area code)

Organization | Ownership ☐ Private ☐ County / Local Government ☐ State ☐ Federal ☐ Specify Other _____

Street / P.O. Box

City / Town | State | ZIP Code

Well Information

WELL CLASS	WELL TYPE	TOTAL NUMBER OF WELLS	WELL OPERATION STATUS				
			UC	AC	TA	PA	AN

KEY:
DEG = Degree
MIN = Minute
SEC = Seconds
SECT = Section
¼ SECT = Quarter Section
AC = Active
UC = Under Construction
PA = Permanently Abandoned and Aproved by State
AN = Permanently Abandoned and Not Approved by State
TA = Temporarily Abandoned and Not Approved by State

Comments *(Optional)*:

Basin Maintenance

- Maintenance agreement
- Erosion repair
- Standing water = indicator of failure
- Inspections at least annually
- Monitoring well in trench
- Drawdown, sediment removal, replant, deep till
- Control of invasive species
  - Mow native vegetation 1-2 times/year
  - Burn native vegetation every 3 years
  - Spot spraying

Questions?