Hydrologic Evaluation of Established Rain Gardens Using a Runoff Simulator

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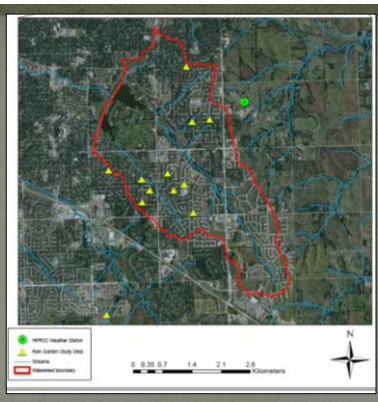
Bioretention

- Residential vs. Commercial scale
- "Rain garden"
- Components
  - Plant selection
  - Grading
  - Inlet/outlet
  - Compost amended
  - 3" mulch layer

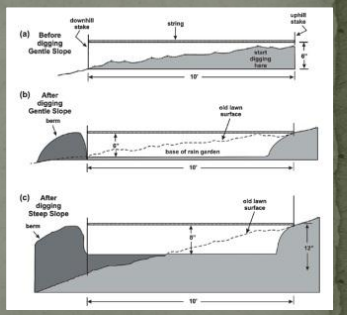
Questions of Interest

- How well are rain gardens functioning after four years?
  - What is the infiltration capacity
  - What is the drain time
  - How are the plants doing
- Do installed rain gardens meet design standards?
  - Holding capacity for water quality volume
  - Overflow outlet stability
  - Other location and design factors



Study Evaluations

- Construction
- Water volume capacity
- Infiltration rate and drain time
- Outlet integrity



Rain Garden Size Characteristics

Rain Garden Site	Surface Area (ft^2)	Construction Date	Roof Contributing Area (ft^2)	Total Catchment (ft^2)	Garden:Catchment Ratio (%)
1	110	2007	535	535	20
2	99	2007	699	699	14
3	116	2007	393	1175	10
4	99	2007	551	1271	7.8
5	52	2007	836	836	6.2
6	86	2007	855	1205	7.1
7	60	2007	247	247	24
8	97	2007	319	419	23
9	137	2008	550	550	25
10	126	2008	757	757	17
11	122	2008	586	779	16
12	106	2009	935	935	11

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Design Storm

- Water Quality Volume Storm Criteria
  - 1.19 inches in Lincoln, NE
- SCS Type II Distribution
  - Compressed to 30 minutes
- HEC-HMS Hydrograph Creation
  - Curve Number Method
  - Kinematic Wave transform

Storm water runoff simulator

- Portable tank/pump system for rain garden evaluation
- 500 gal. conical-bottom tank on a trailer
- 6.5 hp centrifugal trash pump
- Magnetic flow meter
- V-port control valve

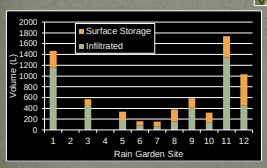
Modified runoff simulator

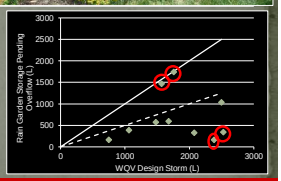
Simlated Inflow of WQV Storm

- Volume-based Design Storm – DRY Run
  - "Design Storm"
  - Applied at most discernible inlet to rain garden
  - Stopped at pending overflow
- Overflow storm – WET Run
  - Evaluate overflow of outlet and berms

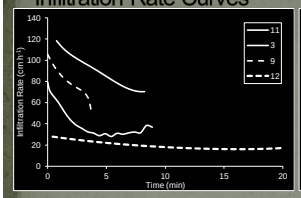
Storage Capacity

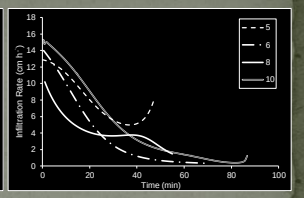
- Bioretention guidelines: store WQ
- General failure of rain gardens to
- Average **Ratio of the Volume Ap**
- Surface storage vs. subsurface st

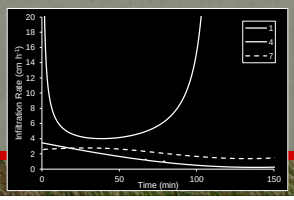




Infiltration Rate Curves







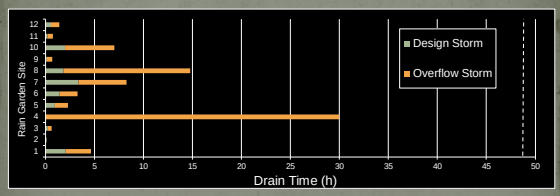
Infiltration Rate

Site ID	Design Storm: Infiltration Rate (Inches per hour)	Design Storm: Meets NebGuide Criteria? (0.25 in h^{-1})	Overflow Storm: Infiltration Rate (Inches per hour)	Overflow Storm: Meets NebGuide Criteria? (0.25 in h^{-1})
1	1.63	Y	1.35	Y
2	--	--	--	--
3	11.0	Y	17.7	Y
4	0.07	N	0.08	N
5	1.96	Y	1.54	Y
6	0.15	N	0.66	Y
7	0.54	Y	0.41	Y
8	1.44	Y	0.35	Y
9	26.7	Y	7.20	Y
10	0.16	N	0.26	Y
11	27.7	Y	5.00	Y
12	6.38	Y	0.94	Y
Geometric Mean	1.63		1.08	

- **82% of 22 infiltration tests met or exceeded minimum criteria**

Drainage Time

- 24 to 48 hour drain criteria



Overflow Structure

- Designed to insure weir-like overflow
- Most in this study poorly designed
- Outflow structure remained dry
- Design flaws:
  - Poor grading resulting in outflow structure not being lowest elevation
  - Lack of overflow structure
  - Lack of adequate rock or erosion control

Findings Summarized

- Volume storage capacity generally undersized
- Improper grading of berm and overflow common
  - however, no catastrophic failures
- Infiltration rate does not appear to limit performance
- Drainage times less than maximum criteria (48 hours)
- Floating mulch common

Recommendations

- Amend top six inches of clay and silty clay with compost
- Increase design area of gardens to match WQV
- Level garden bottom
- Level berm at water inlet elevation
- Create outlet at slightly lower elevation than berm*
- Use a shredded mulch, not chipped mulch

* Outlet elevation should control volume storage capacity

Questions and Comments?

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Examples of Poor Function