Evaluation of infiltration testing methods for design of stormwater drywell systems

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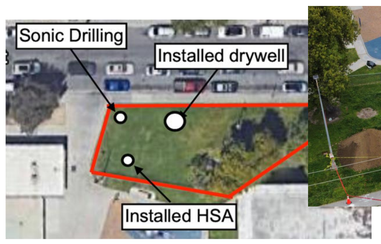
Introduction:

- Infiltration infrastructure like drywells offer promising solutions for stormwater infiltration and groundwater replenishment
- LA County methods for estimating the capacity of drywells (GS200.1) have found to be not very accurate.
- Drywells are expensive to build, and we need good estimates of drywell capacity to invest wisely.
- This study aims to Identify and evaluate infiltration testing methods that are accurate for drywell capacity estimation across various well sizes.
- SSBP (steady-state borehole permeability) method was developed in this study to precisely estimate drywell infiltration capacity.

Methods:

- Three distinct sites were investigated: Bethune Park, LA County, and two sites in the city of Glendale, CA.
- Drywells, HSA wells, and sonic wells were installed at each site using appropriate construction methods and materials.
- Measurements of ponding head (H) and flow rate (Q) were recorded at various intervals during the infiltration tests.
- Water levels were monitored in adjacent wells during infiltration tests to assess potential groundwater mounding effects.
- The performance of different well types and construction methods was compared based on the test results and analysis.



Bethune Site Testing:

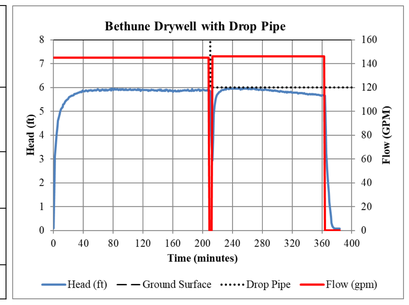
- Conducted two tests in full-scale drywell (48” dia.).
- Conducted a test in a test well drilled using HSA and completed with 3” dia. perforated pipe wrapped in fabric.
- Conducted two tests in a test well drilled using Sonic drilling and completed with 2” dia. slotted pipe with no fabric.
- All wells completed with sandpack from ~48-60 ft depth and 10 ft of screen/perf. pipe.
- Wells were approximately 25 ft apart.

Glendale Site Testing:

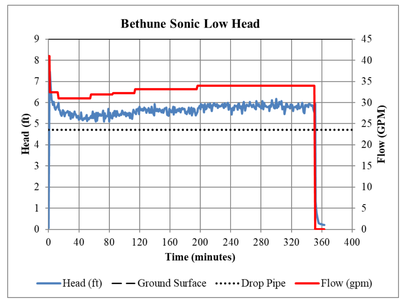
- Conducted a test in existing full-scale drywell (48” dia.)
- Conducted a test in a test-well drilled using HSA and completed with 2” dia. slotted pipe with no fabric
- Conducted two tests in a test-well drilled using Sonic
- Conducted low-head and high-head test on same day in full-scale drywell
- Conducted one test in HSA well and two tests in Sonic well (low head and high head

Bethune Site Results:

Test	Boring Diameter (in.)	Well Completion	Drop Pipe Below Water Level	Head (ft)	Flow (gpm)	K_s (ft/day)
Drywell with drop pipe	48	6-in slotted	Yes	5.7	146	135
Drywell w/o drop pipe	48	6-in. slotted	No	6.1	142	120
HSA High Head	8	3-in. Perf wrapped	Yes	59	31	4.4
Sonic H=6 ft	8	2-in. slotted	Yes	5.9	34	105



- The HSA well provided a much lower K_s estimate than either the drywell or the sonic well, likely due to clogging
- Sonic Ks estimate was 22% less than the drywell (105 ft/day versus 135 ft/day) given same head elevation
- No groundwater perching observed in test wells 25 ft away



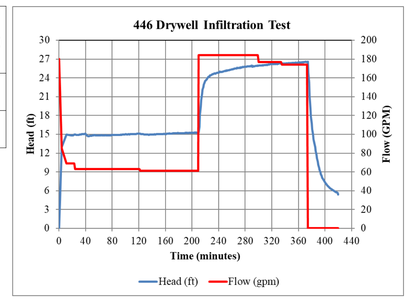
Bethune Sonic

- Steady state was not achieved in high-head test, likely due to low permeability confining layer at top of filter pack
- K_s results in Sonic well decreased as flow rate and head increased
  - Likely due to head losses across screen and filter pack
  - 4-inch PVC screen recommended in permeable soils

Test	Drop Pipe below Water Level	Head (ft)	Flow (gpm)	K_s (ft/day)
Sonic H=6 ft	Yes	5.9	34	105
Sonic H=12 ft	Yes	12.5	83	80
Sonic H=20 ft	No	20.7	117	52

Glendale Site 1 Results:

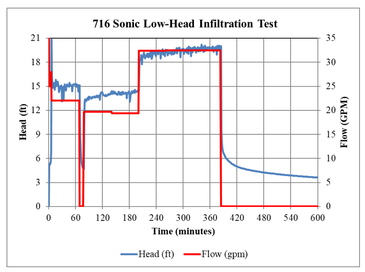
Test	Test Duration (min)	Head (ft)	Flow (gpm)	K_s (ft/day)
G1-Dry Low Head	209	15	61	16
G1-Dry High Head	370	26.5	174	20



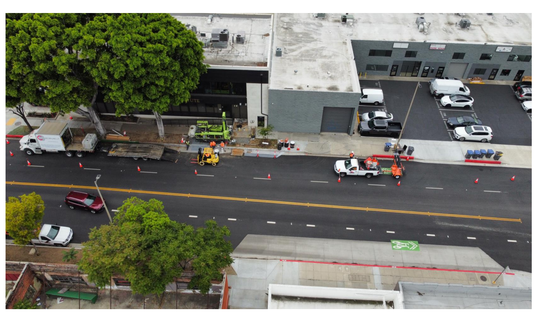
- Low-head test (15 ft) for first half and high-head test (26.5 ft) for second half of test
- K_s increased 25% from low-head to high-head test, likely due to higher K_s in upper part of well
- Not at steady-state after 370 minutes

Glendale Site 2 Results:

Test	Well Completion	Head (ft)	Flow (gpm)	K_s (ft/day)
G2-Dry Low Head at 4.0 hr	6-inch slotted	13.0	169	54
G2-Dry Low Head at 7.7 hr	6-inch slotted	19.9	228	41
G2-HSA at 2.5 hr	2-inch slotted	44.6	2.4	0.21
G2-HSA at 5.4 hr	2-inch slotted	44.8	2.7	0.24
G2-Sonic Low Head at 3.3 Hr	4-inch slotted	14.5	19	13
G2-Sonic Low Head at 6.3 Hr	4-inch slotted	19.6	33	14



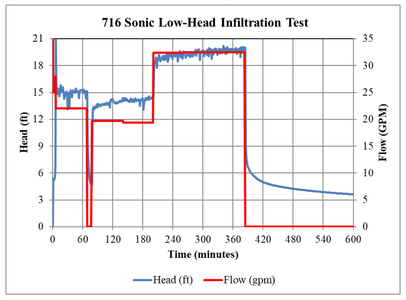
- Drywell test not at steady state after 460 min
- Sonic test underpredicts K_s in drywell by 66%
- HSA well clogged, even after well development

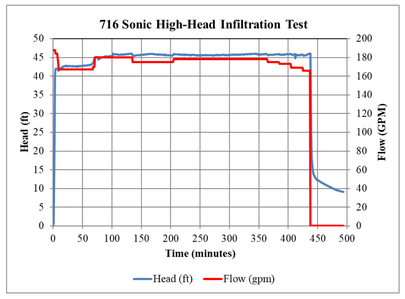


Glendale Site 2 Sonic Results:

Test	Test Duration (min)	Head (ft)	Flow (gpm)	K_s (ft/day)
G2-Sonic Low Head at 3.3 Hr	200	14.5	19	13
G2-Sonic Low Head at 6.3 Hr	380	19.6	33	14
G2-Sonic High Head at 4.2 Hr	250	45.6	178	16
G2-Sonic High Head at 7.3 Hr	437	45.9	166	15

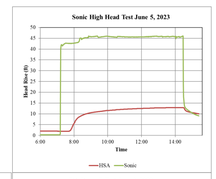
- Very little change in K_s at higher head
- Neither test achieved steady state
- Water did not drain quickly after water turned off due to groundwater perching

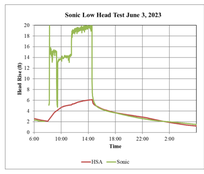


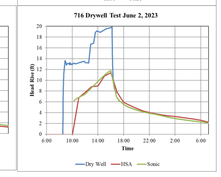


Groundwater Mounding at Glendale Site 2

- Groundwater mound was still evident after several days
- Explains why steady-state was not achieved
- May explain why Sonic test provided lower K_b than drywell







Conclusion:

- Sonic wells may underestimate drywell capacity but don't clog.
- HSA wells clog and cannot predict drywell performance.
- Small test wells with 2-inch screens can underestimate capacity; 4-inch screens is strongly suggested.
- Drop pipes are needed for 2-inch casing tests; recommended for 4-inch but not required for 6-inch.
- Maximize the flow rates during the field tests for accurate capacity assessment.
- Falling head rate post-test indicates perching and mounding.
- Caving in clean sands affects drilling; test upper 10 ft for accurate data.

Acknowledgement:

Safe Clear Water Program – Measure W, Upper Los Angeles River (ULAR) Watershed

Special thanks to:

LA County Public Work, LA County Department of Park and, Recreation, DPR, City of Glendale, and Students at Cal Poly Pomona