

Is Litter Making You Bitter?

Stormwater Awareness Week
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Outline

- Introductory remarks
- The ASTM trash testing standard, E3332
- The STEPP verification program
- A case study of testing done according to the standard

Why me?

- Chair of the ASTM subcommittee E64.01 Stormwater Control Measures – Laboratory Evaluation
- Chair of the Stormwater Testing and Evaluation of Products and Practices (STEPP) program and I have been involved with STEPP for over 10 years
- Managed a product testing lab so I have tested many stormwater control measures

Current state

- Information on the performance of trash capture devices (TCDs) is often anecdotal and there is no central source
 - Most data is from manufacturers, who may be biased...
- How can we provide better information??



Preferred state

- Standardized test reports
- Independently verified data
- A central repository for data



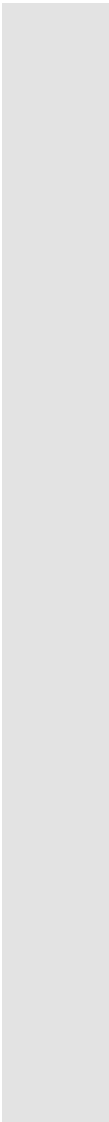
Testing



ASTM INTERNATIONAL



E3332-23 Standard Test Method for Determining Trash and/or Debris Capture Performance of Stormwater Control Measures

- Allows for testing of more than just trash capture performance
 - Includes a standard trash 'recipe' to allow results to be compared
- 

Performance parameters

- The new standard contains guidelines on testing for:
 - hydraulics
 - mesh blinding
 - trash capture
 - plastic bead capture
 - debris capture
 - scour
- The standard is “cafeteria style”
 - allows for testing of only those parameters that are important, not all tests must be done to meet the requirements of the standard

Hydraulics



- The purpose of the hydraulics test is to establish a baseline
 - Simply measure water elevations at 5 flow rates, repeat 3 times to confirm reproducibility
 - This test will be modified to account for different types of systems.

% Restriction



- The purpose of this test is to determine the impact of blocking the mesh/screen by taping off different, known, percentages of the mesh/screen area

Trash capture



- The trash capture test is the heart of the standard
 - A key component is a mass-based trash recipe that can be reproduced by anyone
 - Since it is assumed all the devices can capture trash the focus is on quantifying how much can be captured and stored.

Plastic Beads



- The test conditions are the same as the trash capture test, but
 - The bead test includes
 - Buoyant beads to simulate hydrocarbon capture
 - use results carefully
 - non-buoyant beads so devices without a screen/filter may get different capture results than in the trash test

Debris Capture



- The debris test uses 90% artificial leaves and 10% trash
 - A source of artificial leaves is recommended
- In both tests the big difference will be headloss, due to the shape difference

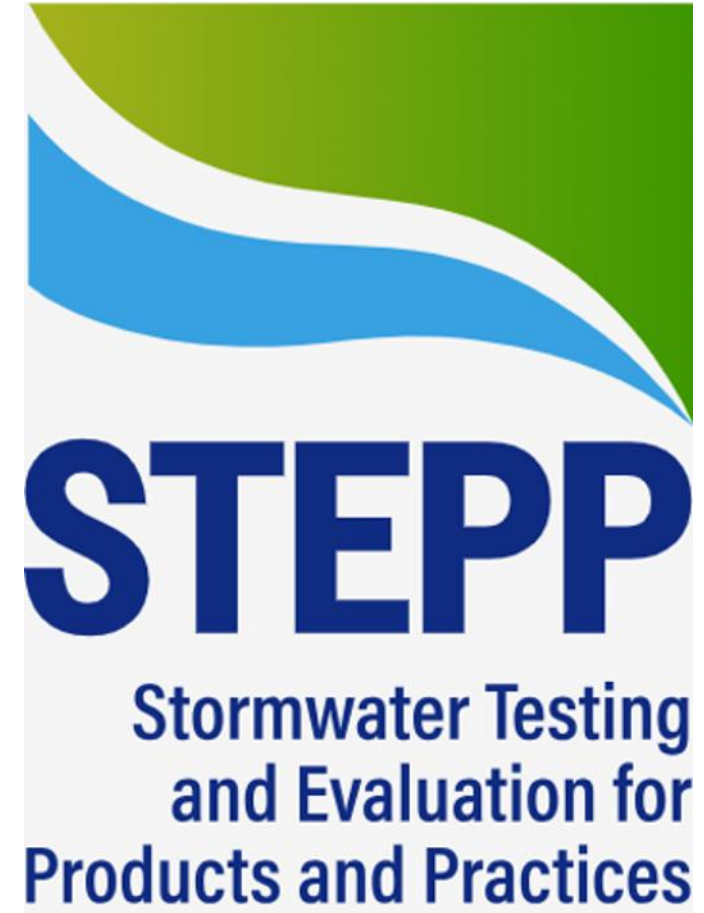
Scour Test

- All these devices store captured trash until maintenance
- The scour test looks at the effect of high flow rates on trash retention
 - Offline systems are tested for scoured material after 5 minutes at 125% flow
 - Online systems are tested for scoured material after 5 minutes at 200% flow

What the standard is not

- The standard does not provide pass/fail criteria
 - provides data for verification
- The next step is certification, where an Authority Having Jurisdiction (AHJ) allows the verified technology to be deployed in its jurisdiction

Verification



The process

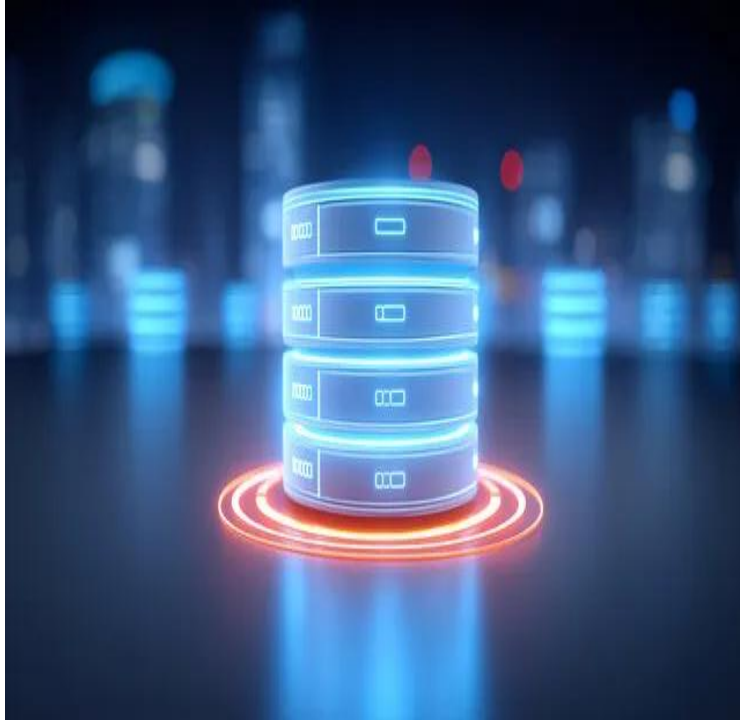
- Proponent submits an application to STEPP
- Upon approval, proponent submits a QAPP to STEPP
- Once the QAPP is approved, testing starts
- Once testing is completed, the report is submitted for verification

The process



- It only verifies testing done according to an ASTM standard so, for now, only TCDs & HDSs are being verified
- All testing is 3rd party witnessed, and reports are independently verified by the STEPP Expert Review Group (SERG)
- Reports are also posted for public comment

Database



- Once verified, a verification report is published in the STEPP verified technology database, can be found at <http://stormwatertesting.org>
- STEPP now has 2 trash capture devices (TCDs) in the verification pipeline and one verified report

Skimmer removal model-08-06-26.xls

STEPP – NMSA

ms4nmsa.org/stepp/

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STEPP Verification and Concurrence Verification List

Verification documents are available via the links provided below. To request additional information, please contact Seth Brown, STEPP Director, at seth.brown@nationalstormwateralliance.org. Note that a fee may be charged based upon the information request.

Trash Capture Device STEPP Verifications

- *StormTrap TrashTrap - STEPP Verification Letter*

Hydrodynamic Separator System (HDS) Concurrence Verifications

- *Advanced Drainage Systems Arcadia Hydrodynamic Separator - STEPP HDS Concurrence Verification Letter*

STEPP Supporters

STEPP Holds Value to Stakeholders of Various Backgrounds

The STEPP program provides value to a variety of stakeholder, including regulators, municipalities, manufacturers of stormwater technologies and treatment devices (MTDs), environmental NGOs, researchers, stormwater practitioners and consultants, land development groups, and others. This

TOP

The Ideal Process

- Testing according to ASTM E3332 and verification by STEPP is the way forward

Manufacturers test TCDs according to ASTM E3332 and submit the report to STEPP



STEPP verifies the report and posts it on the website - stormwatertesting.org



Stormwater managers go to the verified technology database and compare systems of interest



- STEPP has also produced a Clarification Document that will be incorporated into the next revision of E3332
- It is based on experience actually running the test, I will come back to it after the case study

The Case Study - TrashTrap®



Parameters tested

- In 2023 we tested a scale model of an End of Pipe TrashTrap® design according to the requirements of E3332
- Specifically:
 - hydraulics
 - mesh blinding
 - trash capture
 - scour

Configurations tested

- Nets are available in 3 hole sizes, multiple opening sizes and multiple lengths
- In order to allow for scaling over the possible range we tested all **3** hole sizes at each of **2** different lengths,
- In order to simplify scaling we used a 1 sq ft opening

Hydraulics

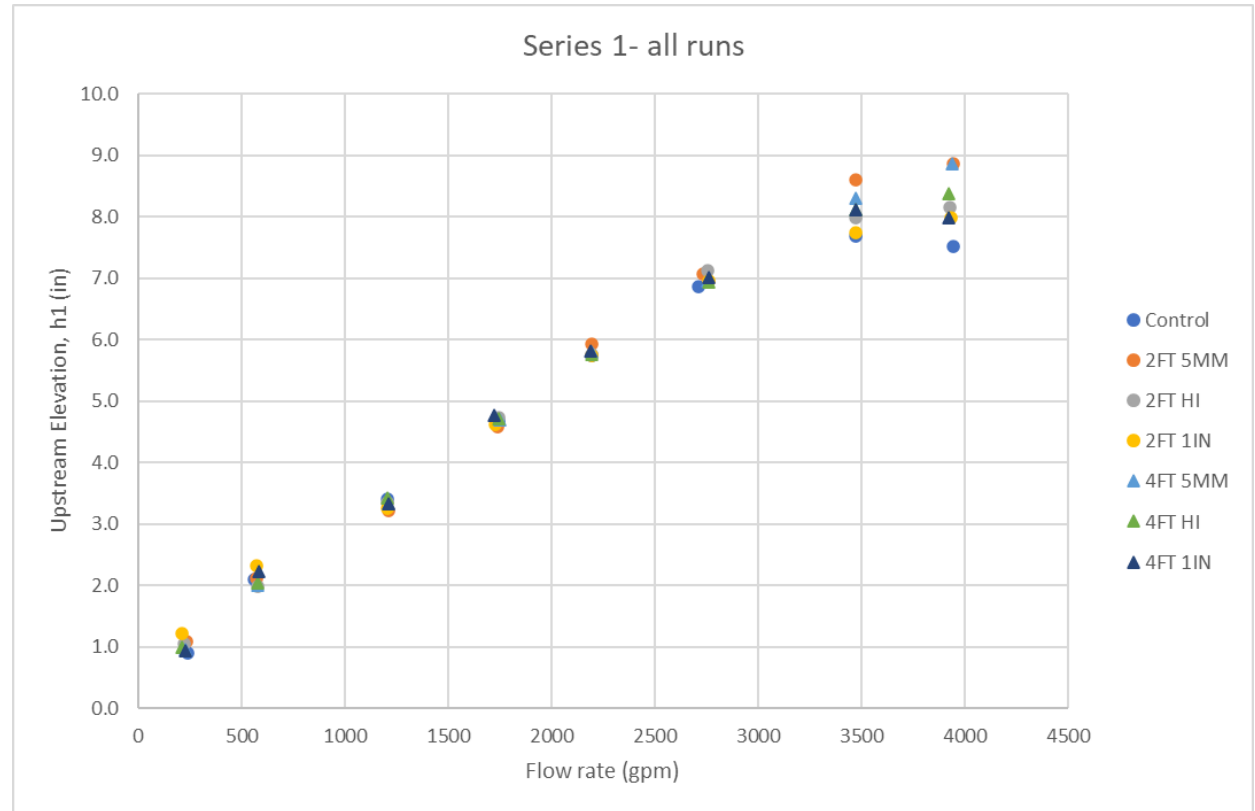


- E3332 requires at testing at least 6 flow rates, from 10% MTFR to 125% MTFR, then every 25% MTFR up to 200%
 - Our pumps only went up to 175%
- Each test is repeated 3 times, generating 3 curves
 - Need to ensure repeatability of the apparatus

Hydraulics (cont.)

- The requirements of two previous slides meant we tested:
- 3 opening sizes, each at 2 lengths, plus a control (no net)
- 8 flows/ configuration
- In triplicate
- The net results (pun intended) was 21 curves with 168 data points

Hydraulics data



Data analysis



- Analysis of covariance (ANCOVA), was used to compare the various curves to each other
 - Used the 95% level of significance
- The analysis showed that there was no significant effect of hole size, or net length

Hydraulics claim

- The final result of the statistical analysis was that headloss was only a function of flow rate
- This made it possible to determine a single headloss coefficient, k_L , for all systems

$$\Delta h' = 1.40 \left(\frac{v^2}{2g} \right)$$

Why h' ?

- The downstream elevation was assumed to be 0"
- The headloss coefficient only applies to higher flows

Mesh blinding



- Once again, multiple configurations were tested
- The critical point was defined as the % restriction at which the net opening was over topped, since no floating trash would be captured at this point
 - This is the maintenance level
- The critical point was related to the amount of unblocked area, not the amount of blocked area, so it varied with net length

Mesh blinding results

Length (ft)	Critical % Restriction
4	88
6	92
8	94

Maintenance level claim

- The final performance claim was simplified to recommending **maintenance when the net is $\leq 85\%$ full**

Trash Capture



- Trash capacity was a function of net length & stretching, resulting in the equation:

dry mass capacity of a net =

**(net volume * NDMC of equivalent 2FT net) *
(1+0.024)* (net length – 2/12)**

Explanation of terms

- NDMC = normalized dry mass capacity
- $1+0.024$ = stretch factor
- $-2/12$ = available length, accounts for the width of the frame

Trash Capture (cont.)

- The dry trash recipe has a very low bulk density
 - Useful for reproducibility but not very realistic
- The largest net, 8' long, 30"x30" opening, would have a dry mass capacity of 44.7 **lbs.**, much less than the "real" wet mass would be

Scour



- This was the easy one
- Performance claim: The nets do not release previously captured trash, even at flows up to **9.77 ft/s**
- (Nets are rated for 5 ft/s, for strength reasons)

What We Learned



Clarification document

- During the process of running the test we found some errors and omissions in the standard
 - Revision process is underway
- In the meantime, STEPP has a clarification document that it uses for verifications
 - Contact STEPP for a copy before testing

Clarification example 1

- While trying to get data for head loss during the hydraulics test, we realized it was impossible, the downstream WSE is undefined
- The Clarification document now recognizes 4 types of system.

Clarification example 2

- The trash 'recipe' contains items that can be purchased, like popsicle sticks and Styrofoam 'peanuts' and items that need to be made, like strips of cloth.
- Realized we needed some kind of QC procedure for the homemade items

Clarification example 3

- The standard calls for comparing the hydraulics data one point at a time and applies a limit of +/- 10%
- The revised standard will use ANCOVA to compare the entire curves to each other and applies a more standard 95% confidence limit

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