

VortCapture™ Performance: Full-Scale Laboratory Test Results

Objective

VortCapture™ is an engineered Stormwater360 solution for the removal of trash and organic debris from stormwater runoff. Based on proven Stormwater360 hydrodynamic separator technology, VortCapture™ is a uniquely designed full capture device. It removes all particles 5 mm and greater from treated flows, including neutrally buoyant material. It also effectively removes settleable solids and free-floating oil and grease. Performance of VortCapture™ has been verified through a comprehensive, full-scale, laboratory-testing program. The primary goals of this program included documentation of debris removal and retention, hydraulic characteristics, blinding potential, and sediment removal capabilities.

Test Configuration

A VortCapture™ VC40, which is 4 ft (1.2 m) in diameter, was tested in the Stormwater360 laboratory. The system was equipped with a 16.7 ft² (1.6 m²) perforated aluminum screen with 3/16-inch (4.8 mm) apertures. The percent open area of the screen was 51%.

The laboratory test unit was configured for a peak conveyance flow rate of 2.0 cfs (57 l/s) and a treatment flow of 0.58 cfs (16 l/s). Flow was conveyed from an upstream, 5,600 gal (21,200 l) supply tank to the system in a 12-inch (300 mm) diameter PVC pipe. Flow rates were regulated by a butterfly valve located upstream of the unit, and continuously measured with an ISCO 4250 area-velocity meter. Flow discharged from the VortCapture™ test unit into a 6 ft x 12 ft (1.8 m x 3.6 m) catch tank. Two debris fences covered in landscape fabric spanned the width of the tank, and filtered all water before two 10-horsepower pumps returned it to the supply tank.

Testing was conducted using a mixture of organic material and trash typically found in stormwater runoff. Organic debris consisted primarily of leaf litter, grass clippings, and small twigs. Roadside litter was composed of fast food and candy wrappers, paper scraps, plastics bags, straws, cigarette butts, and other miscellaneous items. The material was mixed together in a 60/40 ratio of organic material to trash.

Debris Retention

VortCapture™ debris retention was documented at flow rates of 0.55 cfs (16 l/s), 1.0 cfs (28 l/s), and 1.6 cfs (45 l/s). Before each trial, 0.28 yd³ (0.21 m³) of debris was added to the treatment chamber of the unit and allowed to saturate for a minimum of 1-hour. Trials ran in 2-hour intervals and the water surface elevation (WSE) in the unit was recorded every 15 minutes.

Visual observations of flow characteristics in the unit were recorded during each test. At the conclusion of each trial the unit was pumped down to allow a thorough inspection of the screen.

At the flow rates tested, VortCapture™ retained 100% of previously captured debris (Table 1).

VortCapture™ VC40 Debris Retention Test Results

Flow Rate		Change in Water Surface Elevation	Debris Retention	Stapling	Flow Patterns
cfs	l/s				
0.55	15	0	100%	none	Preferential swirling with good tangential velocities at screen face
1.0	28	0	100%	none	Preferential swirling with moderate tangential velocities at screen face
1.6	45	0	100%	none	Preferential swirling with high tangential velocities at screen face

Table 1 - VortCapture™ VC40 Debris Retention Test Results

During the tests, debris was observed contacting the screen, but material did not come to rest on the face of the screen. This confirmed what the Stormwater360 CFD (computational fluid dynamics) modeling predicted. It also supported the hypothesis that debris would be deflected because the velocity of water passing parallel to the screen face would be sufficiently greater than the velocity of flow through the screen. After prolonged testing, several pieces of debris remained in contact with the screen in the vicinity of the treatment chamber outlet pipe, but these materials fell from the screen during simulated dry weather conditions. The screen was thoroughly inspected after each test and no stapling of debris to the screen was observed.

Debris Capture

A typical VortCapture™ will remove 100% of the debris load greater than 5 mm in size from a regulated design flow or design storm, and divert higher flow rates around the treatment chamber. The laboratory model VC40 was designed to treat up to 0.58 cfs (16 l/s). To determine the debris trapping efficiency of VortCapture™, tests were conducted at 0.58 cfs (16 l/s), 0.98 cfs (28 l/s), and 1.54 cfs (44 l/s), each lasting 1-hour. Debris was introduced through a 6-inch (150 mm) diameter standpipe located upstream of the unit. A debris fence lined with landscaping fabric was positioned downstream of the test unit to capture any debris potentially lost from the unit.

VortCapture™ trapped 100% of the debris load at 0.58 cfs (16 l/s), the design flow rate.

Mass Loading

To establish the effective storage capacity of the VortCapture™ system, the unit was loaded to a condition of overcapacity (i.e., failure). Debris was added to the laboratory VortCapture™ unit at the beginning of each of the five, 4-hour loading tests conducted at a constant flow rate of 1.5 cfs (42 l/s). Prior to the first test, 0.28 yd³ (0.21 m³) of debris was added to the treatment chamber of the system and allowed to saturate for 1-hour. An additional 0.28 yd³ (0.21 m³) of debris was added to the unit before each subsequent test until 125% of the 1.4 yd³ (1.1 m³) storage volume was consumed.

Flow patterns in the VortCapture™ were monitored throughout each test. A debris fence was located downstream of the unit so that the point at which debris began to be released from the test unit (i.e., maximum storage capacity) could be precisely determined. At the conclusion of the final test, the system was pumped down to allow for a thorough inspection of the debris screen.

No material was lost from the VortCapture™ during tests 1 through 3 (Table 2). During test 4 a significant floating mat of debris had developed but there was still evidence of water circulation below the mat of debris. The water surface elevation in the treatment chamber remained static but it was during this test that a small amount of debris was released (less than 0.04 yd³ (0.03 m³)).

VortCapture™ VC40 Mass Loading Test Results

Test	Water Surface Elevation		Change in Head	Debris Retention	Total Debris in System		Debris Storage Capacity Consumed
	in	mm			yd³	m³	
1	21	533	0	100%	0.28	0.21	25%
2	21	533	0	100%	0.56	0.43	50%
3	21	533	0	100%	0.84	0.64	75%
4	21	533	0	97%	1.1	0.86	100%
5	21	533	0	95%	1.4	1.07	125%

Flow was held constant at 1.5 cfs (42 l/s) throughout testing.

Table 2 - VortCapture™ VC40 Mass Loading Test Results

Based on these tests, a maximum debris storage volume of 1.1 yd³ (0.8 m³) was identified for the VC40. This debris storage volume is extrapolated for all models based on filling one-third of the treatment chamber's volume adjacent to the screen and 1.5 ft (0.4 m) of the 3 ft (0.9 m) sediment storage sump with debris (Table 3). However, as with any stormwater treatment system, regular inspection and maintenance will insure that the system functions optimally.

VortCapture™ Debris Storage Volumes

VortCapture™ Model	Diameter		Debris Storage	
	ft	mm	yd ³	m ³
VC40	4	1200	1.1	0.8
VC50	5	1500	1.9	1.5
VC60	6	1800	3.0	2.3
VC70	7	2100	4.4	3.4
VC80	8	2400	6.2	4.7
VC100	10	3000	11.1	8.5
VC120	12	3700	13.7	10.5

Table 3 - VortCapture™ Debris Storage Volumes