Sediment Barrier - Silt Fence State-of-the-Practice

This state-of-the practice literature review is intended to provide a summary of existing design guidance and performance-based research for silt fence when used as a temporary sediment control barrier for sheet flow applications to minimize sediment transport from a disturbed area susceptible to erosion. Furthermore, this document provides recommendations for further research testing to assist in the development of design guidance.

Keywords: silt fence, sediment barrier, perimeter control, sediment control, erosion

1. INTRODUCTION

Silt fence is a temporary sediment barrier used downstream of a disturbed area consisting of a geotextile material anchored into the soil and supported by posts. It is one of the most frequently used structural sediment control practice that does not cause disruption of additional off-site space (*1*). Silt fence is generally placed at the toe of fill slopes, along the edge of waterways, and along the site perimeter. This state-of-the-practice document provides an overview of existing design guidance and research on silt fence sediment barrier applications.

2. TREATMENT EFFECTIVENESS

Silt fence retains sediment from small, disturbed areas by reducing the velocity of sediment-laden runoff and promoting sediment deposition. Sediment is captured by silt fence as a result of ponding runoff on the upslope side of the silt fence. Although some removal of large particles through impingement on the silt fence may occur, the primary mechanism for sediment removal is deposition through gravity not filtration.

The filtration efficiency of a geotextile material is limited by the size of the pore passages, often resulting in small soil particles (e.g. clays) passing through the void spaces. In addition, the flow-through capacity of the silt fence material has the potential to degrade over time as pores in the material become clogged with sediment, thereby restricting the flow-through rate (*2*, *3*). Clogging can lead to silt fence failure when the depth and volume of the impounded runoff increase to the point that the height and/or the strength of the silt fence is exceeded.

The U.S. Environmental Protection Agency (USEPA) reports the following effectiveness ranges for silt fences constructed of geotextile fabric: average total suspended solids (TSS) removal of 70%, sand removal of 80 to 90%, silt-loam removal of 50 to 80%, and silt-clay-loam removal of 0 to 20% (*4*). However, these USEPA treatment values from the Nationwide Urban Runoff Program (NURP) are not applicable to every geographic location and site The actual sediment trapping efficiency will vary widely for a given design because of differences in hydrologic regimes and soil types (*5*).

Manufacturer reported silt fence geotextile flow rates, evaluated through ASTM D4491, are often misleading as they are reported for clear-water conditions. Research studies have been conducted to correlate reported clear water flow-through rates with sediment-laden flow rates. Through a series of scaled experiments, Whitman et al. reported sediment-laden flow rates through silt fence geotextiles at an average of 126.3 L/min/m^2 (3.1 gal/min/ft^2) for woven silt fence and 65.2 L/min/m^2 (1.6 gal/min/ft^2) for nonwoven silt fence. These were 3% and 1% of the manufacturer reported flow through rates of 4,482 L/min/m^2 (110 gal/min/ft^2) for woven and 6,723 L/min/m^2. (165 gal/min/ft^2) for nonwoven (*6*). Test bed and rainfall simulator research has been performed on silt fence at the University of Central Florida Stormwater Management Academy Research and Testing Laboratory (SMARTL). Research focused on determining performance efficiencies in turbidity and sediment concentration removal, and the determination of flow-through rates on simulated construction sites in real time. Test results revealed that woven and nonwoven silt fence achieved 14% and 52% average turbidity reduction efficiency, and 23% and 56% average sediment concentration removal efficiency, respectively. Evaluation of sediment concentration reduction based on percent removal does not correctly account for the sediment concentration transported and deposited downstream. Fabric flow rates were functions of the rainfall intensity, embankment slope, and field conditions, which all fluctuate with every rainfall event (*7*). Full-scale performance-based silt fence testing conducted at the Auburn University Erosion and Sediment Control Testing Facility (AU-ESCTF) indicated structural performance is the most critical component in improving water quality and capturing sediment. Results of silt fence testing showed sediment retention values of >90% if silt fence does not experience structural failure (*8*)).

3. DESIGN CONSIDERATIONS

Silt fence should be designed to withstand the design storm without damaging the integrity of the system, without structural failure, and to retain sediment. Sediment retention depends primarily on the surface area of the impounded runoff and the flow rate through the geotextile. The capability to withstand the design storm depends primarily on employing the appropriate hydrologic design for the drainage area and slope length and specifications for appropriate silt fence materials.

Silt fence design and installation standards are two critical factors that ultimately influence performance. Sizing, design, and implementation of practices is dictated by the USEPA Construction General Permit. The permit provides sizing guidance for the design of practices that are intended to create impoundments. Volume-based practices are sized by one of two options: (a) calculating volume of runoff from a 2-yr, 24-hr storm; or (b) using a volume sizing factor (VSF) of 252 m^3/ha (3,600 ft^3/ac) drained (*9*). A design using the USEPA VSF accounts for 2.5 cm (1.0 in.) of runoff volume per unit area. This volume can be correlated to a 0.6 cm (1.56 in.) rainfall depth using a Curve Number (CN) of 94, representative of a hydrologic soil group D on newly graded areas (pervious areas only, no vegetation), typical of construction sites with highly disturbed and compacted soils. The USEPA recommends drainage areas be considered based on local design storm and hydrologic conditions so that silt fence is not expected to overtop (*1*). State environmental agencies, such as the Alabama Department of Environmental Management (ADEM), dictate that sediment control measures must be properly selected based on site-specific conditions and shall be designed and maintained to minimize erosion and maximize sediment removal resulting from a 2-yr, 24-hr storm event (*10*)

While the USEPA and state agencies outline performance and design expectations, a designed-based approach using local hydrological parameters and site conditions is not currently used for the design and placement of silt fence sediment barriers on construction sites. Construction stormwater design manuals are developed by state environmental agencies as well as by state transportation agencies; however, many temporary practices are designed using "rules-of-thumb" rather than site-specific design-based approaches (*11*). For example, design guidance for silt fence sediment barriers is typically given as 0.25 ac (0.1 ha) and 0.5 ac (0.2 ha) of contributing drainage area for every 100 linear ft (30.5 m) of unreinforced or reinforced silt fence, respectively (*12*–*18*).

Limitations in silt fence design approaches have long been recognized by professionals within the industry. In 2004, a spreadsheet-based silt fence assessment tool, "Silt Fence Aid", was created to estimate the performance of silt fence designs. The tool relies on detailed user inputs including: site parameters (i.e., up-slope length, width along slope, slope to fence, etc.), soil information (i.e., particle size characteristics, cover factor, eroded size distribution, etc.), hydrologic information (i.e., design rainfall depth), silt fence geotextile properties (i.e., fabric type or discharge coefficient), and impoundment information (i.e., length of extension, angle of extension between the toe, and performance factor). The spreadsheet-based tool estimates silt fence failures due to scouring of toe and total mass of sediment discharged through silt fence (*19*). The spreadsheet-based tool estimates silt fence performance based on these input parameters. This model-based tool failed to be widely adopted or used by stormwater professionals and the USEPA has questioned its accuracy due to the use of clean water flow-through rates reported by silt fence manufacturers, rather than sediment-laden flow rates encountered in field applications (*1*).

In 2007, another silt fence tool was developed for highway construction applications that relied on the rational method to determine appropriate silt fence tieback (i.e. J-hook) spacing using local hydrologic parameters (*20*). This tool can predict stormwater runoff and impoundment storage per unit length of silt fence, which can assist designers in selecting appropriate tieback dimensions and interval spacing used on highway construction sites. However, this tool has limited application to J-hook configurations and is developed specifically for linear highway construction applications.

3.1 Hydrology

One key hydrologic variable in silt fence design is the contributing drainage area. Design manuals often recommend maximum drainage areas contributing to a perimeter control to limit the volume of runoff treated by the practice. The USEPA recommends 30.5 m of silt fence per 0.1 ha (100 ft per 0.25 ac) of contributing area (roughly 0.3 m per 30.5 m^2 [1 ft per 100 ft^2]), while recognizing that this is highly variable, depending on climate. Several state and federal guidelines follow this USEPA rule of thumb, requiring a minimum of 30.5 m of silt fence per 0.1 ha (100 ft per 0.25 ac) of drainage area (*12*–*18*, *21*, *22*). When using reinforced silt fence, some guidance allows up to 0.2 ha (0.5 ac) of drainage area for each 30.5 m (100 ft) of silt fence (*13*).

The UESPA Construction General Permit only provides sizing guidance for the design of a sediment basin or impoundment area, where the designer is to provide storage for either: (1) the calculated volume of runoff from a 2-yr, 24-hr storm; or (2) a volume sizing factor (VSF) of 3,600 ft^3/ac drained (*9*). A design using the 3,600 ft^3/ac VSF accounts for a 1.56 in. rainfall depth using a Curve Number (CN) of 94, representative of a hydrologic soil group D on newly graded areas (pervious areas only, no vegetation) (*23*)(USDA-NRCS 1986). The USEPA further claims the fence should be stable enough to withstand runoff from a 10-yr peak storm and recommends the drainage area be selected on the basis of design storms and local hydrologic conditions so that the silt fence is not expected to overtop (*5*). The American Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA) require no formal silt fence design, however, they do recommend 0.1 ha of drainage area per 30.5 m (0.25 ac per 100 ft) of fence and maximum gradient behind the barrier of 2H:1V (*21*, *22*). The North Carolina Department of Transportation (NCDOT) gives the option of designing based on the 0.1 ha (0.25 ac) of contributing area per 30.5 m (100 ft) of silt fence or designing to the 10-year peak storm runoff (*12*).

The USEPA recommends the drainage area be restricted so that the predicted depth of water at the fence under the design rainfall event does not go above 15 cm (0.5 ft). This allows for some sediment build-up before overtopping becomes a problem (*1*). The FHWA states ponding water should be limited to a height of 0.46 m (1.5 ft) (*22*). NCDOT recently adopted the use of designed outlets to prevent overtopping. These consist of either washed gravel placed on a hardware cloth support or 31 cm (12 in.) or larger fiber wattles placed in a gap in the silt fence. In both cases, the flow rates at the outlet are much higher than would occur through the fabric, reducing the development of an impoundment, which might cause failure. However, it is likely that less sediment is being trapped with this outlet in place because of the reduction in the impoundment.

3.2 Slope-Length

The USEPA recognizes design slope lengths should be based on sediment load and flow rates, stating that the values presented in Table 1 should be adjusted for climatic conditions instead of a one-size-fits-all approach. The Pennsylvania Department of Environmental Protection (PA-DEP) published additional guidance for the use of super silt fence, as shown in Table 1. Super silt fence is installed using chain link reinforcement and 6.4 cm (2.5 in.) diameter steel posts embedded 91 cm (36 in.) into the ground (*17*). In addition, the PA-DEP developed guidance for selecting appropriate slope lengths for values not shown in the FHWA table guidance. These procedures are summarized in Table 1 notes.

Table 1: Maximum Slope Lengths for Silt Fences

Slope (%)	460 mm (18 in.) Fence (*22*)	760 mm (30 in.) Fence (*22*)	Super Silt Fence (*17*)
≤2	75 m (250 ft)	150 m (500 ft)	305 m (1,000 ft)
5	30 m (100 ft)	75 m (250 ft)	168 m (550 ft)
10	15 m (50 ft)	45 m (150 ft)	99 m (325 ft)
15	10 m (35 ft)	30 m (100 ft)	66 m (215 ft)
20	8 m (25 ft)	21 m (70 ft)	53 m (175 ft)
25	6 m (20 ft)	17 m (55 ft)	41 m (135 ft)
30	5 m (15 ft)	14 m (45 ft)	30 m (100 ft)
35	5 m (15 ft)	12 m (40 ft)	26 m (85 ft)
40	5 m (15 ft)	10 m (35 ft)	23 m (75 ft)
45	3 m (10 ft)	9 m (30 ft)	18 m (60 ft)
50	3 m (10 ft)	8 m (25 ft)	15 m (50 ft)

Notes (*17*): Breaks/change in slope above silt fence change the slope length above fence. To determine the maximum allowable slope length for the entire slope, use the following procedure:

(a) Determine the length and percent of the slope segment immediately above the fence.
(b) Subtract the length of this segment from the allowable slope length for that percent slope. If the result is positive, find the percentage of the allowable slope length that has been used (slope length ÷ allowable slope length).
(c) Subtract the result from 1.00 to determine the unused percentage of allowable slope length.
(d) Determine the maximum allowable slope length for the percent slope of the remaining segment.
(e) Multiply this allowable slope length by the remainder from step (c) above.
(f) Add the result from step *(b)* to that from step *(e)*.

Several state agencies in the Southeastern U.S. (i.e. Alabama, Georgia, Mississippi, North Carolina, and Tennessee) have developed restricted guidance for slope lengths upstream of silt fence as shown in Table 2.

Table 2: Maximum Slope Lengths for Silt Fences (*12–14*, *18*, *24*)

Slope (%)	Slope Limitation
≤ 2	31 m (100 ft)
2 to 5	23 m (75 ft)
5 to 10	15 m (50 ft)
10 to 20	7.6 m (25 ft)
> 20	4.6 m (15 ft)

4. MATERIAL CONSIDERATIONS

Typical silt fence systems are comprised of various components that include: (1) geotextile fabrics, (2) reinforcement/supporting material, (3) posts, and (4) staples/nails. The material property considerations for these components are discussed below.

4.1 Geotextile Fabrics

Silt fence systems are typically comprised of either a nonwoven or a woven geotextile fabric. Nonwoven geotextile consists of strands of polypropylene that are bonded together through processes such as thermal bonding, chemical bonding with binders, or needle punching where fibers are mechanically intertwined using needles. Woven geotextiles fabric by contrast consists of threads woven together, similar to a basket.

Geotextile fabrics are often required to satisfy ASTM and AASHTO requirements for use as a silt fence material. Table 3 summarizes the AASHTO M288-17 requirements that geotextile fabric shall meet when used as a temporary silt fence as it relates to maximum post spacing, grab strength, permittivity, apparent opening size, and ultraviolet stability. Typically, state highway agencies are required to follow AASHTO M288-17 guidance as a requirement to receive federal aid.

Table 3: Temporary Silt Fence Property Requirements (*25, 26*)

	Test Methods	Units	Supported Silt Fence[(a)]	Requirements, Unsupported Silt Fence	
				Geotextile Elongation >50%[(b)]	Geotextile Elongation <50%[(b)]
Maximum post spacing		m (ft)	1.2 (4)	1.2 (4)	2 (6.5)
Grab strength	ASTM D4632/D4632M	N (lb.)			
Machine direction			400 (90)	550 (125)	550 (125)
X-Machine direction			400 (90)	450 (100)	450 (100)
Permittivity[(c)]	ASTM D4491	sec^{-1}	0.05	0.05	0.05
Apparent opening size	ASTM D4751	mm (US Sieve #)	0.60 (30) max avg. roll value	0.60 (30) max avg. roll value	0.60 (30) max avg. roll value
Ultraviolet stability (retained strength)	ASTM D4355/D4355M	%	70% after 500 hr of exposure	70% after 500 hr of exposure	70% after 500 hr of exposure

Notes:

(a) Silt fence shall consist of 1.63 mm (14 ga.) steel wire with a mesh spacing of 150 by 150 mm (6 by 6 in.) or prefabricated polymeric mesh of equivalent strength
(b) As measured in accordance with ASTM D4632 / D4632M
(c) These default filtration values are based on empirical evidence with a variety of sediments. For environmentally sensitive areas, a review of previous experience and/or site or regionally specific geotextile tests, such as ASTM D5141, should be performed by the agency to confirm suitability of these requirements.

Table 3 provides a summary of the geotextile requirements of several agencies as it relates to type of material, fabric width, and fabric weight. Most of the agencies that were surveyed rely on the AASHTO M288 and ASCE standard for material requirements.

Table 3: Geotextile Material Requirements for Silt Fence Installations

Agency	Material	Width	Weight
AASHTO Drainage Manual, NCDEQ	synthetic fabric	76 to 91 cm (30 to 36 in.) (NCDEQ)	NR
ALSWCC	woven and nonwoven	61 – 81 cm (24-32 in.), wire reinforced (Type A) 81 cm (24 in.), non-reinforced (Type B)	Meets AASHTO M288 Requirements
ALSWCC, ALDOT, NCDOT, NY, TX	woven and nonwoven	no requirements (NY) 61 to 84 cm (24 to 44 in.)	153 g/m^2 (4.5 $oz./yd^2$) (NY)
CALTRANS, Iowa DOT	woven	91 cm (36 in.)	NR
GADOT	woven, nonwoven, non-calendered woven	56 to 91 cm (22 to 36 in.)	NR
WA	NR	NR	NR

Note: NR = no requirement

4.2 Reinforcement

Silt fence systems can either be supported or unsupported and will be specified on the plan set. Supported silt fence systems typically are supported by either a wire or polypropylene grid materials. Table 4 provides a summary of the material requirements for reinforcement support.

Table 4: Material Requirements for Wire Backing

Agency	Diameter	Vertical Spacing	Horizontal Spacing	Above Ground Installed Height
AASHTO Drainage Manual, AASHTO M288-17, ALDOT, NCDEQ, NY	1.63 mm (14 ga) min.	15 cm (6 in.)	15 to 30 cm (6 to 12 in.) [(a)]	76 to 91 cm (30 to 36 in.)[(b)] or no requirements
GADOT	2.59 mm (10 ga) min. top & bottom wire 1.98 mm (12.5 ga) min. all other	at least 6 horizontal wires	30 cm (12 in.)	66 cm (26 in.)
NCDOT	2.59 mm (10 ga) top wire 1.98 mm (12.5 ga) all other	5 horizontal wires	30 cm (12 in.)	81 cm (32 in.)
TX	2.05 mm (12 ga) min.	5 cm (2 in.)	10 cm (4 in.)	NR
WA	NR	5 cm (2 in.)	5 cm (2 in.)	NR
ALSWCC[(c)] (Type A-reinforced),	1.63 mm (14 ga) min.	15 cm (6 in.)	15 cm (6 in.) [(c)]	61 to 81 cm (24 to 32 in.)
CALTRANS, Iowa DOT	NR	NR	NR	NR

Notes:
NR = no requirement
(a) ALDOT allows up to 12 in. (30 cm)
(b) NY – 30 in. (76 cm), AASHTO DM - 36-in. (91 cm)
(c) AL Handbook recognizes that ALDOT allows up to a 30 cm (12 in.) horizontal spacing

4.3 Posts

Post selection is often based on the selected material type for a silt fence system. Steel posts are typically used with wire reinforced silt fence systems, whereas hardwood posts are commonly used with polypropylene mesh reinforced or unreinforced silt fence systems.

Steel posts are available in "U", "C", or more commonly, "T" shaped. The letter refers to the cross-section shape. These posts come in different lengths (i.e., 1.2, 1.5, or 1.8 m [4, 5, or 6 ft]) and unit weights (i.e., 1.41, 1.71, 1.86, or 1.98 kg/m 0.95, [1.15, 1.25, or 1.33 lb./ft]). The unit weight for steel posts is important as it applies to the strength of the post and its ability to resist the forces imposed on it that may result in deflection and bending. Installed heights for silt fence that use steel posts range from 61 to 81 cm (24 to 32 in.) above the ground and will depend on the site specific plan.

Wooden posts used for silt fence are usually specified to be 5.1 by 5.1 cm (2 by 2 in.) hardwood or a 6.4 by 6.4 cm (2.5 by 2.5 in.) southern pine. Installed height for hardwood post silt fence is typically between 61 to 81 cm (24 to 32 in.) above the ground. Most installation requirements specify a minimum of 46 to 61 cm (18 to 24 in.) of the post driven into the ground. A summary of material requirements from various agencies for posts used to support silt fences is shown in Table 5.

Table 5: Material Requirements for Silt Fence Posts

Agency	Min. Length, m (ft)	Type of Post	Size of Post
AASHTO Drainage Manual	1.5 m (5 ft)	Steel T Post w/Projections Wood	1.98 kg/m (1.33 lb./ft) 10.2 cm (4 in.) dia.
AASHTO M288-17	NR	Steel U, T, L, or C Shapes Hardwood Southern Pine	1.96 kg/m (1.32 lb./ft) 3.1 by 3.1 cm (1.2 by 1.2 in.) 6.4 by 6.4 cm (2.5 by 2.5 in.)
ALSWCC	Type A (reinforced): 1.5 m (5 ft)	Steel T Shape	1.9 kg/m (1.25 lb./ft min.)
	Type B (non-reinforced): 1.2 m (4 ft)	Soft Wood Oak Steel	7.6 cm (3 in.) dia or 5 by 10 cm (2 by 4 in.) 3.8 by 3.8 cm (1.5 by 1.5 in.) 1.9 kg/m (1.25 lb/ft min.)
CALTRANS	Refer to plans Refer to plans	Wood Stakes Bar Reinforcement	Refer to plans No. 4 or greater
GADOT	Type A: 1.2 m (4 ft)	Soft Wood Hardwood (ash, hickory or oak) Steel (U, T, or C)	7.6 cm (3 in.) dia or 5 by 10 cm (2 by 4 in.) 3.8 by 3.8 cm (1.5 by 1.5 in.) 1.71 kg/m (1.15 lb/ft) min.
	Type B: 0.9 m (3 ft)	Soft Wood Hardwood (ash, hickory or oak) Steel[a] (U, T, or C)	5 cm (2 in.) dia or 5 by 5 cm (2 by 2 in.) 2.5 by 2.5 cm (1 by 1 in.) 1.12 kg/m (0.75 lb/ft) min.
	Type C: 1.2 m (4 ft)	Soft Wood Oak Steel (U, T, or C)	7.6 cm (3 in.) dia or 5 by 10 cm (2 by 4 in.) 5 by 5 cm. (2 by 2 in) 1.71 kg/m (1.15 lb/ft) min.
IOWA	1.2 m (4 ft) min.	Steel T Posts	1.86 kg/m (1.25 lb/ft) exclusive of anchor plate
NCDEQ	1.5 m (5 ft)	Steel T Shape Hardwood	1.86 kg/m (1.25 lb/ft) 3 by 3 cm (1.2 by 1.2 in.)
NCDOT	5 ft (1.5 m)	Steel T Shape	1.86 kg/m (1.25 lb/ft.)
NY	1.2 m (4 ft) min.	Steel T or L Shape Hardwood Softwood Synthetic	1.98 kg/m (1.33 lb/ft) 3.2 by 3.2 cm (1.25 by 1.25 in.) 3.8 by 3.8 cm. (1.5 by 1.5 in)
TX	1.2 m (4 ft) min.	Hot Rolled Steel - T or Y shape	1.86 kg/m (1.25 lb/ft)
WA	0.7 m (2.3 ft) min.	Wood Steel	3.2 by 3.2 cm (1.25 by 1.25 in.)

Notes:
NR = no requirement
(a) Must use for woven wire supported

4.4 Staples and Nails

Staples and wires are used to secure the geotextile fabric to the posts. Table 6 and 7 provides a summary of the material requirements for wire staples and nails respectively.

Table 6: Material Requirements for Wire Staples

Agency	Wire Staples			
	Diameter mm (Gauge)	**Crown Width, mm (in.)**	**Legs, mm (in.)**	**Staples/Post**
ALSWCC (Type B non-reinforced)	1.1 (17)	19 (0.75)	13 (0.5) long	5 min.
CALTRANS	1.6 (14) min 3.2 (8)[(a)] min.	NR	44 (1.75)	NR
GADOT	1.1 (17) min	19 (0.75)	13 (0.5) long	NR
NCDEQ[2]	NR	NR	NR	3 min.
NCDOT	4 (9)	NR	38 (1.5)	NR
WA[2]	NR	NR	NR	4 min.
Iowa DOT, NY[3], TX	NR	NR	NR	NR

Notes:
NR = no requirement
(a) Minimum gauge wire used at the top when fastening two sections of fence together.
(b) Plastic ties are allowed.
(c) Fasteners shall be heavy duty staples, hog rings, tie wires, or any other fastener compatible with the post material.

Table 7: Material Requirements for Nails

Agency	Nails			
	Diameter mm (gauge)	**Length, mm (in.)**	**Button Heads, mm (in.)**	**Nail/Post**
GADOT	1.63 (14) min	25.4 (1.0)	19 (0.75) long	NR
CALTRANS, Iowa DOT, NCDEQ, NCDOT, NY[(a)], TX, WA	NR	NR	NR	NR

Notes:
NR = no requirement
(a) Fasteners shall be heavy duty staples, hog rings, tie wires, or any other fastener compatible with the post material.

The AASHTO Stormwater Manual requires either 10.2 cm (4 in.) diameter wood or 1.98 kg/m (1.33 lb/ft) of steel post (with projections) at a minimum length of 1.5 m (5 ft). Wire fence reinforcement for silt fences using standard strength filter cloth should be a minimum of 0.91 m (3 ft) in height, a minimum of 1.63 mm (14 ga), and should have a maximum mesh spacing of 15.2 cm (6 in.). Where joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 15.2 cm (6 in.) overlap, and securely sealed.

5. INSTALLATION CONSIDERATIONS

Installation methods will differ based upon material type and design application. For instance, different post types require different methods to fasten the fence or fabric to the posts. Typical standards call for the silt fence to be installed on fairly level ground and follow the land contour (*13*). However, the USEPA has stated that silt fence should always be installed in a bowl shape with limits to the length of individual segments based on the ability of the installation to store the design runoff volume without overtopping (*1*).

Many states have requirements that differ for post spacing, post type, fasteners, installed height, and trenching requirements. The Alabama Soil and Water Conservation Committee (ALSWCC) (*13*), California Department of Transportation (CalTRANS) (*27*), Georgia Soil and Water Conservation Commission (*14*), NCDOT (*12*), the New York Department of Environmental Conservation (NYDEC) (*28*), the Iowa Statewide Urban Design and Specifications Manual (SUDAS) (*29*), Texas Department of Transportation (TxDOT) (*15*), and the Washington Department of Transportation (WSDOT) (*30*)were all reviewed to determine the different installation requirements specified by each agency. The NCDOT specifies that for silt fence to be effective, it is essential that the geotextile is buried in an excavated trench and that the silt fence must be installed properly, backfilled and compacted. TxDOT states that posts should be installed at a slight angle (5 cm [2 in.] offset from vertical) toward the anticipated runoff source. TxDOT also stipulates trenches are to be backfilled and hand tamped. The Iowa SUDAS specifies that all compaction of backfill must be performed with a mechanical tamper or pneumatic tamper. SUDAS also recommends installing silt fence as close to the undisturbed soil as possible. This is likely recommended to try to minimize downstream scour as water flows through and over the silt fence.

NCDOT was the only entity to specify a maximum installed height while all others researched provided a minimum installed height that ranged from 41 to 76 cm (16 to 30 in.). Trenching depth ranged from 10 to 20 cm (4 to 8 in.) while trenching width ranged from 5 to 15 cm (2 to 6 in.). Post spacing also ranged from 1.2 to 3.0 m(4 to 10 ft) with requirements to drive the posts into the ground a minimum depth of 0.3 to 0.6 m (1 to 2 ft). Table 8 was developed to show the common installation component requirements. Those components that were deemed to not fit within the common theme, but were deemed important by the authors, were discussed previously in this section.

Table 8: Silt Fence Installation Requirements

Agency	Installed Height of Fabric Above Ground		Trench		Post		Fence to Post Fastener Spacing, cm (in.)	Fabric to Fence Fastener Spacing, cm (in.)
	Max., cm (in.)	Min., cm (in.)	Depth, cm (in.)	Width, cm (in.)	Max. Spacing, m (ft)	Min. Depth, m (ft)		
ALSWCC	81 (32)[a], NR[b]	61 (24)[a], 61 (24)[b]	15 (6)	15 (6)	3.0 [a](10), 1.8 (6)[b]	0.6 (2.0)[a], 0.5 (1.5)[b]	[c]	61 (24)
CalTRANS	NR	61 (24)	15 (6)	15 (6)	1.8 (6)	0.5 (1.5)	[c]	NR
GASWCC	NR	76 (30)[d]	15 (6)	5 (2)	1.8 (6)[e], 1.2 (4)[f]	0.5 (1.5)	NR	NR
NYDEC	NR	41 (16)	15 (6)	10 (4)	3.0 (10)	0.4 (1.3)	NR	61 (24)[g]
NCDOT	61 (24)	46 (18)	20 (8)	10 (4)	2.4 (8)[h], 1.8 (6)[i]	0.6 (2.0)	NR	NR
Iowa DOT	NR	48 (19)	30.5 (12)[j]	10 (4)[j]	2.4 (8)	0.7 (2.3)	NR	NR
TxDOT	NR	76 (30)[m]	15 (6)	15 (6)	2.4 (8)	0.5 (1.5)	NR	38 (15)
WSDOT	NR	61 (24)	10 (4)	10 (4)	1.8 (6)	0.6 (2.0)	15 (6)	NR

Notes:

NR = no requirement
(a) Type A (reinforced)
(b) Type B (non-reinforced)
(c) Min. of four evenly spaced
(d) Height of posts, fabric height is variable
(e) Nonsensitive areas
(f) Sensitive areas
(g) Along top and a midsection of fence
(h) With wire backing
(i) Without wire backing
(j) Min of 31 cm (12 in.) of fabric inserted a minimum of 15 cm (6 in.) deep (fabric may be folded below ground line)
(k) No flow concentration
(l) Expected flow concentration
(m) Assumed based upon minimum post length of 1.2 m (4 ft), and minimum depth of 0.5 m (1.5 ft)

6. MAINTENANCE CONSIDERATIONS

State requirements for maintaining silt fence are very similar (Table 9). While there are some variations on the point at which sediment had to be removed, most settle on half of the height of the silt fence. Immediate repair or replacement is required if there is evidence of damage, undercutting, or clogging. AASHTO lists the expected usable life for silt fence as five months (*21*).

Table 9: Maintenance requirements among surveyed states

Guidance	Accumulated Sediment Removal Height	Other Common Notes
ASCE	30%	Replace/repair immediately if damaged/undercut, maintain adequate storage, replace if there are bulges, second fence below first can be installed as alternative to replacement
CA	1/3	
MS	1/3-1/2	
AASHTO, ALSWCC, CO, GA, NC, NY, WI, VA, VT	1/2	

7. COMMITTEE DESIGN RECOMMENDATIONS

In most cases, silt fence placement is limited to a maximum drainage area per unit length adjusted by slope and slope length. As pointed out by the USEPA, precipitation varies a great deal across the U.S. and within many states, so the expected flow and volume of runoff will also vary considerably. Rather than recommending drainage areas per unit of silt fence, a more suitable approach would be to recommend permissible flow rates or volume of runoff. While federal and state guidance provide recommendations for generic cases, the maximum drainage area behind a silt fence ideally should be determined on a site-specific basis based on local rainfall and hydrologic conditions and the infiltration characteristics of the soil and cover.

Silt fences are not designed to overtop, but often do, resulting in scour on the downhill side and even failure due to undercutting and collapse. NCDOT uses outlet structures to reduce pooling, but this likely also reduces sediment capture. Alternative outlet systems should be developed to safely release high-runoff events without compromising the sediment capture function of the silt fence. For instance, a weir could be cut into the material at the low point of the silt fence and stone placed on both sides to dissipate the concentrated flow energy.

As demonstrated through this document, specifications vary among states, although some uniformity in standards exists. Based on the lack of scientific knowledge, the committee cannot recommend sound design principles at this time. Further research is needed to develop designed based specifications for silt fence. Currently, researchers at Auburn University are conducting investigations into the effect of various post spacing and silt fence height. Researchers at North Carolina State University and Iowa State University are conducting bench-scale strength testing on various post material and sizes. Other silt fence related research needs include the following:

- determination of adequate post material, strength, size, installation depth, and spacing;
- effectiveness of installation techniques (i.e. trenching, slicing, etc.); and
- effectiveness of high flow dewatering and outlet mechanism.

The committee recommends this document be revisited updated regularly as new research results are disseminated and published.

8. ACKNOWLEDGEMENTS

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