

Proper Water Management

In previous articles we have written about the proper compaction, installation and drainage procedures needed to ensure a wall that will last a lifetime. What additional design procedures can be used to further improve SRWs? How about water management details? Water management is something each design engineer needs to carefully consider on each wall project. Proper planning and detailing for each site are topics our engineering department is frequently asked about and our hope is to share information we have obtained over the past thirty years with industry professionals for future use. Managing water is critical to long-lasting performance of each SRW and the following details can greatly improve the performance of SRWs, especially under adverse water conditions.

Surface water considerations above the retaining wall to prevent the saturation of infill soils.

1. Identify localized water sources such as storm drains and drop structures. Consult with project site civil engineer to ensure that water will not be introduced into the reinforced mass. Consider excess irrigation or natural downspouts.

a. Surface drainage

- i. Must drain away from the top and bottom of the wall.
- ii. Slopes above walls should have swales placed above so water is not allowed to flow over the top of the wall.
- iii. During construction, surface water must not be allowed to pond or be trapped in the area above the wall or at the toe of the wall. Surface water must be directed away from partially constructed walls at the end of each day's construction.
- iv. Provisions, such as check valves, to prevent flooding from broken lines or heads must be put in place to stop over irrigation above walls.

- v. Surface water that cannot be diverted from the wall must be collected with surface drainage swales and drained laterally in order to disperse the water around the wall structure. Construction of a typical swale system shall be in accordance with Figure 1. See also Chapter 12 of Best Practices for SRW Design for further discussion on above wall considerations.

b. Additional Wall Rock should be added around all storm drains and drop structures to aid in draining any areas of the pipe that may leak.

c. If there are any utilities within the reinforcement zone, place gravel around them to generate good compaction levels.

Ground water fluctuation can be seasonal with elevated water tables or naturally occurring in the presence of springs within the retained soil.

2. Use a combination of blanket and chimney drains.

- a. If site soils are used that do not have granular characteristics a chimney and blanket drain should be considered to ensure the infill mass stays as dry as possible. Unless otherwise directed by the geotechnical engineer, a blanket and chimney drain should be used when infill soils have a less than 30-degree friction angle when determined without the use of cohesion.

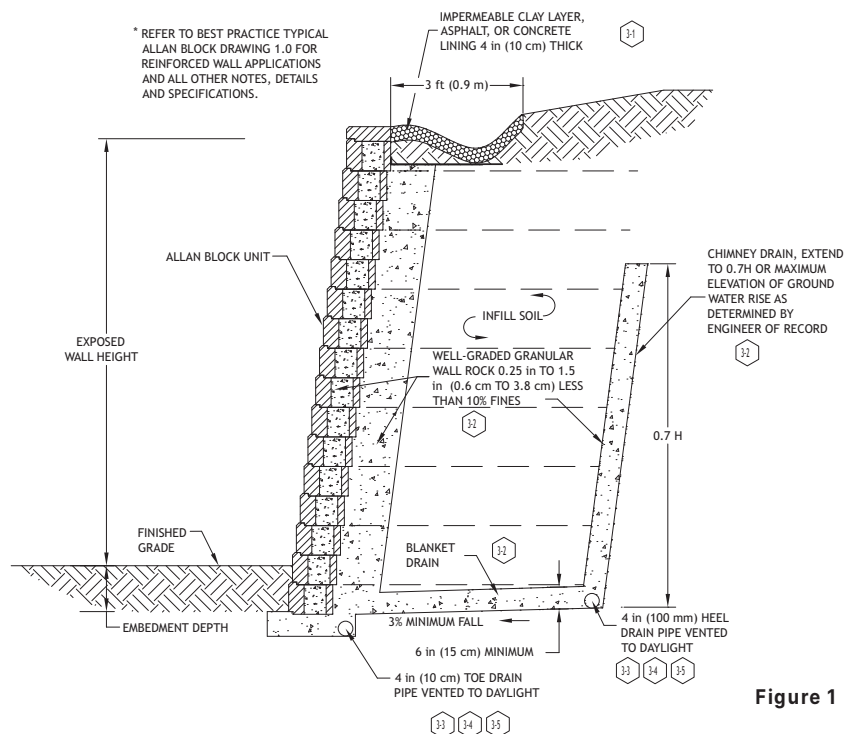


Figure 1

- b. If migrating subsurface water is on the site a chimney and blanket drain should be used.
- c. See Allan Block Chimney and Blanket Drain detail (Figure 1).
- d. Drain material to be consistent with Wall Rock material. Material must be well-graded compactible aggregate, 0.25 - 1.5 in, (6 - 38 mm) with no more than 10% passing the #200 sieve. (ASTM D422).
- e. Manufactured chimney and blanket drains to be approved by the geotechnical and/or the local engineer of record prior to use.

Drainage Considerations within the Structure and Proper Pipe Considerations.

- 3. Location, type, and venting of drain pipes.
 - a. Utilize Water Management Sections 1.4 and 1.5 in the Allan Block Spec Book.
 - b. 4 in (10 cm) perforated flexible drain pipe or rigid perforated pipes are recommended.
 - c. When a rigid perforated pipe is used, it should be placed with holes down.
 - d. All drain pipes must exit to daylight or be connected to an underground drainage system. Use Figure 2 for examples of venting to daylight.
 - e. It is recommended that a minimum 1% gradient be maintained on the placement of the pipe with outlets on 50 ft (15 m) centers, or 100 ft (30 m) centers if the pipe is crowned between the outlets.

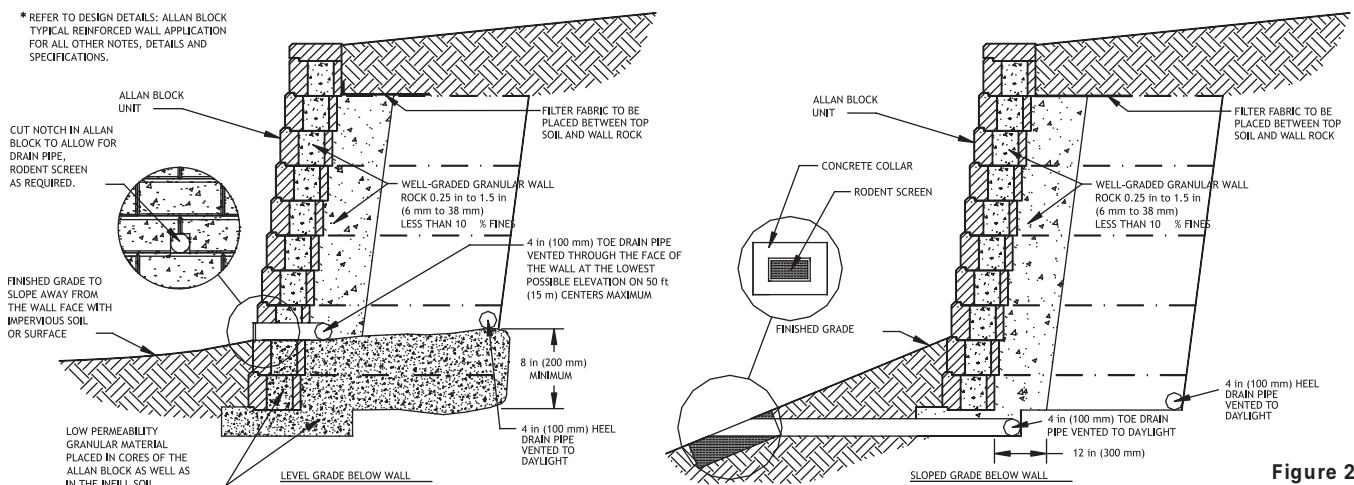


Figure 2

- f. It is recommended that all pipe outlets be configured to be protected from crushing or plugging from other materials or debris.
- g. Wall Drain Pro is a solution to protecting the pipe from crushing and plugging while quickly connecting to the toe and/or heel drains. See Figures 3 & 4.



Figure 3



Figure 4

- 4. A heel drain should be specified for sites whenever geogrid is used or where migrating water from behind the mass is possible.
 - a. The purpose of the heel drain is to pick up any water that migrates from behind the retaining wall structure at the cut, and route the water away from the reinforced mass during construction and for incidental water for the life of the structure.
 - b. The piping used at the back of the reinforced mass shall have a one percent minimum gradient over the length, but it is not critical for it to be positioned at the very bottom of the cut.
 - c. The heel drain should be vented at 100 ft (30 m) intervals along the entire length of the wall and should not be tied into the toe drain system.

- d. The pipe may be a rigid pipe with holes at the bottom or a corrugated perforated flexible pipe.
- e. For infill soils with a high percentage of sand and/or gravel the heel drain pipe does not need to be surrounded by Wall Rock. When working with soils containing fine grained cohesive soils having a PI of greater than 6 and LL of 30 or greater, 1 ft³ (.03 m³) of Wall Rock is required around the pipe for each 1 ft (30 cm) of pipe length.

Water applications are structures that will be subjected to elevated water tables in the event of rain events or when water will be present for a majority of the lifetime along streams and shorelines.

- 5. Below grade water management plan for water application walls.
 - a. When more than incidental groundwater is known to move through the retained soils.
 - i. The Wall Rock should be placed to the limits of the geogrid lengths up to a height equal to 12 in (30 cm) higher than any water source.
- 6. When a wall is constructed to be a water application such as in a lake, stream, or detention basin.
 - a. The Wall Rock should be placed to the limits of the geogrid lengths up to a height equal to 12 in (30 cm) higher than the determined high-water mark. If the high-water mark is unknown, the entire infill zone should be constructed with Wall Rock.
 - b. The drain pipe should be raised to the low water elevation to aid in the evacuation of water from the reinforced mass as water level fluctuates.
 - c. Embankment protection fabric should be used under the infill mass and up the back of the infill mass to a height of 12 in (30 cm) higher than the determined high-water mark.
 - i. Embankment protection fabric is used to stabilize riprap and foundation soils in water applications and to separate infill materials from the retained soils. This fabric should permit the passage of fines to preclude clogging of the material. Embankment protection fabric shall be a high strength polypropylene monofilament material designed to meet or exceed typical NTPEP specifications; stabilized against ultraviolet (UV) degradation and typically meets or exceeds the values in the Embankment Protection Fabric Table.
- 7. Although water applications are possible and popular in the SRW industry, there are applications where their use should be limited.
 - a. SRW block should not be used in water applications where the water is salt, brackish or has high levels of chemicals that could be negative to the long-term durability of the block.
 - b. If the water application is in cold weather climates, where the wall face is subject to long-term freezing or repeated freeze-thaw cycles, the block must meet higher levels for durability discussed in Allan Block Best Practices for SRW Design, Section 1.14
 - c. In applications where there is a potential for heavy wave action or in cold climates where ice flow impacts are common, the possibility of block displacement is high. Wave action can also cause erosion and possible undermining of the leveling pad. Therefore, rip-rap in front of the wall to protect the toe of the wall from scour effects is recommended.

Embankment Protection Fabric Specifications

Mechanical Property	Determination Method
Tensile Strength = 225 lbs/in (39.4 kN/m)	ASTM D-4595
Puncture Strength = 950 lbs (4228 N)	ASTM D-6241
Apparent Opening Size (AOS) = U.S. Sieve #70 (0.212 mm)	ASTM D-4751
Trapezoidal Tear = 100 lbs (445 N)	ASTM D-4533
Percent Open Area = 4%	COE-02215
Permeability = 0.01 cm/sec	ASTM D-4491

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