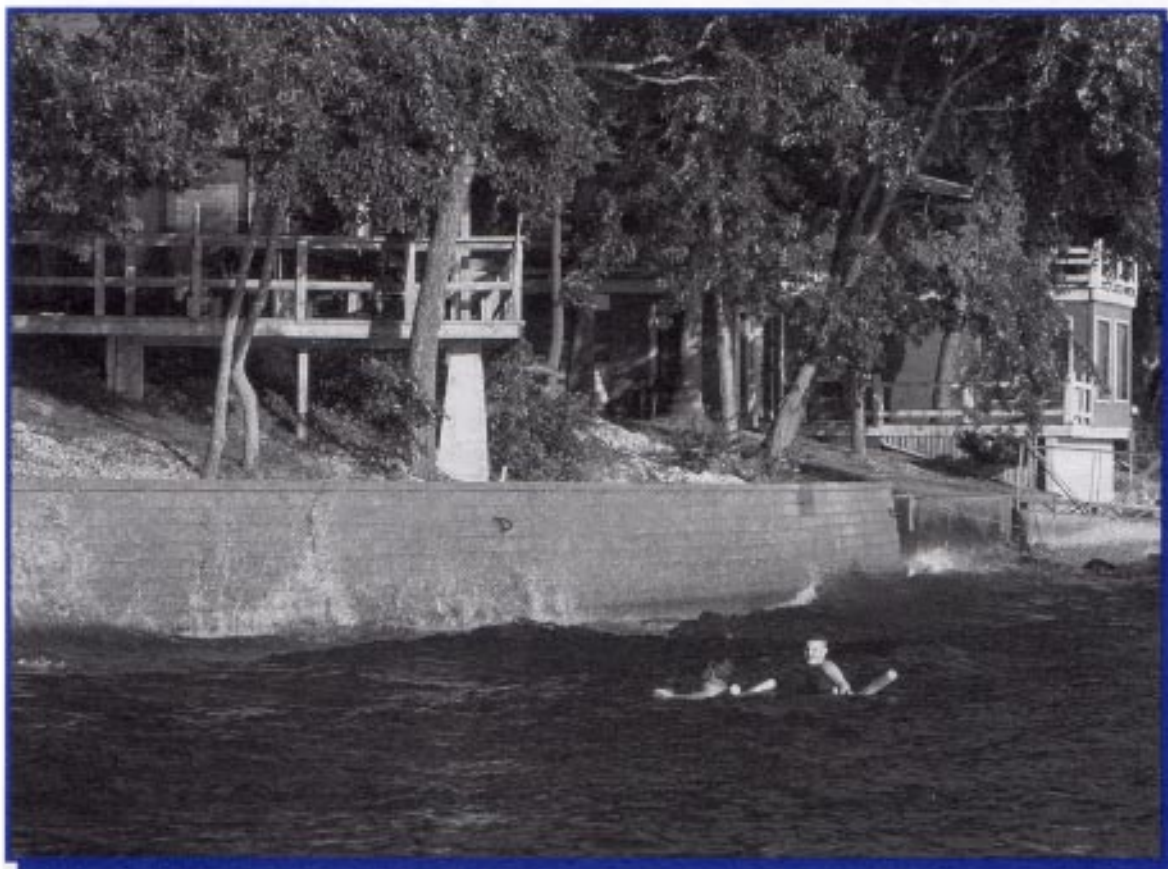


This Technical Bulletin is the first in a series of informational papers in which we will be providing application ideas and "how-to" tips for VERSA-LOK Retaining Wall Systems.

# SHORELINE, WATERWAY AND RETENTION POND PROTECTION

The VERSA-LOK segmental retaining wall system has rapidly earned engineering approval for use on a growing number of diverse shoreline and waterway installations. Basic design, engineering and installation guidelines are presented for use of VERSA-LOK Segmental Retaining Walls (SRWs) in retention pond, lake and stream shoreline, storm channel, and other waterway applications. These guidelines are not intended for use on any particular installation, as site conditions and specific design parameters may vary from those used in this bulletin. A final, project specific design should be prepared by a qualified professional engineer based on actual site conditions.



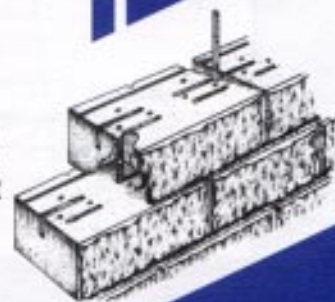
## ADVANTAGES OF THE VERSA-LOK SYSTEM

There are several advantages of using the VERSA-LOK SRW system for water management, shoreline and stream bank erosion control and open channel applications:

- ▶ The system is free draining. Because no mortar is used between units, the VERSA-LOK wall allows water to weep through joints in the wall. This helps to minimize buildup of hydrostatic pressure behind the wall.
- ▶ VERSA-LOK's unique dry stack system is a relatively flexible structure that is founded on an aggregate leveling pad foundation. This allows minor movement and settlement of the system without visual distress. VERSA-LOK SRW units move and adjust relative to each other without loss of function.



**VERSA-LOK**<sup>®</sup>  
Retaining Wall Systems



- ▶ VERSA-LOK units are solid, durable, high-strength concrete SRW units. These characteristics make the system highly resistant to rapid water flow velocities, face spalling and destructive impact from floating debris.
- ▶ VERSA-LOK SRWs are generally easier and faster to erect than systems requiring formwork or poured, reinforced footings. SRW units can be installed manually without the need for heavy equipment.

## TECHNICAL AND INSTALLATION ISSUES

Whenever an SRW will be placed permanently or periodically in water, certain precautionary measures are required during project development. These concerns include: foundation, hydrostatic pressure, adequate internal drainage, fines migration, rapid draw down conditions, scour protection, ice and surface water drainage.

### FOUNDATION

A competent foundation is essential to the structural integrity of any SRW, especially those located in water environments. Often, suitable conditions for a foundation do not exist at a shoreline site. In this case all silts and sediments must be excavated to provide a solid base for the aggregate leveling pad.

Water is often encountered where the base of the wall will be constructed. The contractor can address this in several ways. They can avoid building a special foundation by dewatering the construction

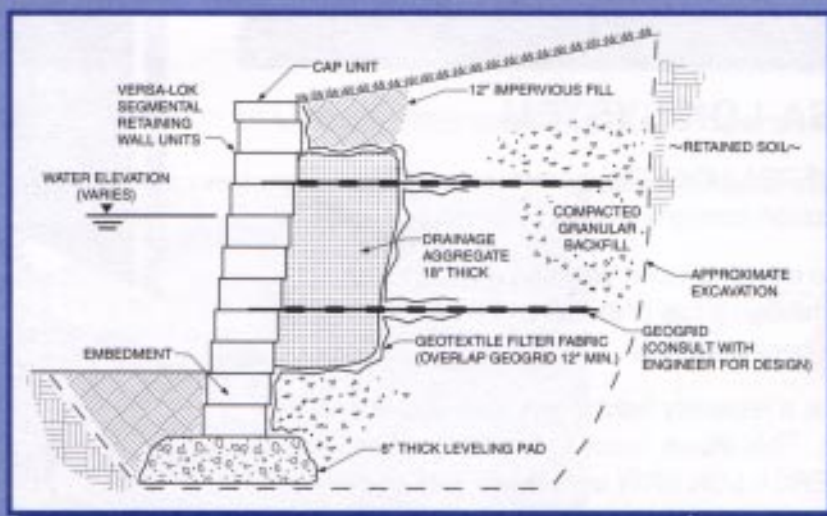
area prior to base preparation. This generally includes sealing off the foundation area with sand bags or sheet piles and removing the water with pumps.

Rather than dewatering, sometimes a reinforced aggregate base can be placed in the wet. Depending on site conditions, this type of base may also provide a sufficient foundation over soft soils. A reinforced base consists of 3/8" to 3/4" open-graded, free-draining material (no fines) reinforced with geogrid and wrapped in geotextile fabric as shown in figure 2. The geotextile reduces the movement of fine particles of foundation soil into the granular base. This helps to keep the base intact and firm, ready for placement of the VERSA-LOK units. The contractor may opt to place a poured concrete footing in the wet, with the concrete displacing water during the pour. This type of footing, however, must be placed below the frost line in northern climates. (Determination of frost depth should be made by a geotechnical engineer.)

For shoreline applications, minimum embedment of SRW units shall be 1 ft, (two VERSA-LOK units). When wall height exceeds five feet, minimum embedment shall be increased to 1.5 ft (three VERSA-LOK units). Additional embedment beyond these minimums may be needed depending on wave and current conditions.

### HYDROSTATIC PRESSURE

Lack of adequate drainage provisions for water in the retained soils can cause a buildup of hydrostatic pressure behind the wall when the water level is



**TYPICAL SECTION**  
RETENTION POND  
(SCALE: NONE)

1

lower in front of the wall.

Standard design methods assume no hydrostatic pressure on the SRW. Also, typical designs do not routinely take into account the reduction in soil strengths and loss of interaction between soil and geogrid reinforcing caused by saturation. Therefore, it is important to remove accumulated water behind the wall as soon as possible. In most cases, an engineered drainage system can be designed to quickly remove excess water behind the wall.

## ADEQUATE INTERNAL DRAINAGE

Most retaining wall failures are caused by poor drainage, so the significance of providing proper drainage from behind an SRW cannot be overemphasized.

There are three components of a good internal drainage system that will effectively help control the problems brought on by excess ground and/or surface water accumulation:

**Drainage aggregate** should be clean, open-graded 3/8" to 3/4" diameter granular material, with no fines, to allow for the free flow of water through the system. A minimum of 18" of this granular aggregate should be placed immediately behind the wall. Geotextile filter fabric must separate this material from other backfill materials.

**Drainage blanket** When groundwater rises seasonally into the compacted granular backfill and retained soil zones, a blanket drain may be

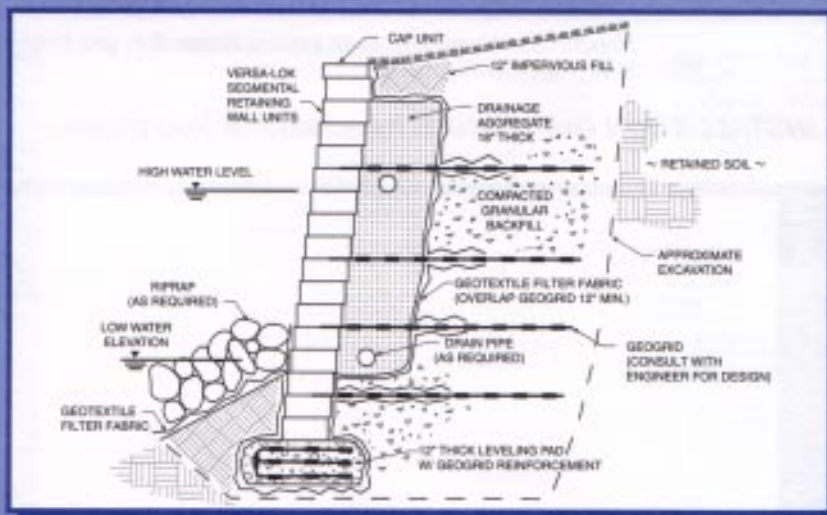


*VERSA-LOK Retaining Wall Systems have been used on many agency shoreline projects.*

necessary to remove water as it seeps into this soil mass (see figure 3A). The drainage aggregate layer is extended horizontally to form a blanket across the entire width of the reinforced wall and soil zone.

In cases where groundwater regularly flows into this reinforced zone, a chimney drain can provide an additional drainage path to channel water from behind the wall (see figure 3B). A geotextile filter fabric should wrap these additional drainage systems to prevent contamination with adjoining soils. They must also have adequate thickness, properly graded and sized granular aggregate, and sufficient permeability to carry away anticipated water flows.

**Drainage pipe** In many cases, the drainage



**TYPICAL SECTION**  
SHORE PROTECTION  
(SCALE: NONE)

2

aggregate zone will include a perforated drainage pipe at the base to carry accumulated water away from the structure. Additional drain pipes may be designed into the system at intermediate levels when high water levels or sustained water levels are known. All drainage pipe should have adequate flow capacity and positive slope to direct water by gravity to locations beyond the SRW system.

## FINES MIGRATION

In wall systems that will have water moving through the backfill, fine soil particles can migrate into the drainage aggregate zone(s) if not stopped, and eventually clog them. Geotextile filter fabrics allow water to pass through their pores but restrict movement of these fine soil particles. Selecting an appropriate geotextile (based on both the opening size in the fabric and the grain size of the fines in the surrounding soil) is important to prevent the fabric itself from clogging.

## RAPID DRAW DOWN

Rapidly fluctuating water levels in front of a wall can cause large water loads on an SRW. As water in front of the wall recedes quickly, the soil behind the wall may not drain as rapidly, causing a temporary hydrostatic pressure on the wall. Rapid draw down of the water level may occur after flooding in a channel, or when a detention pond quickly drains after a storm event.

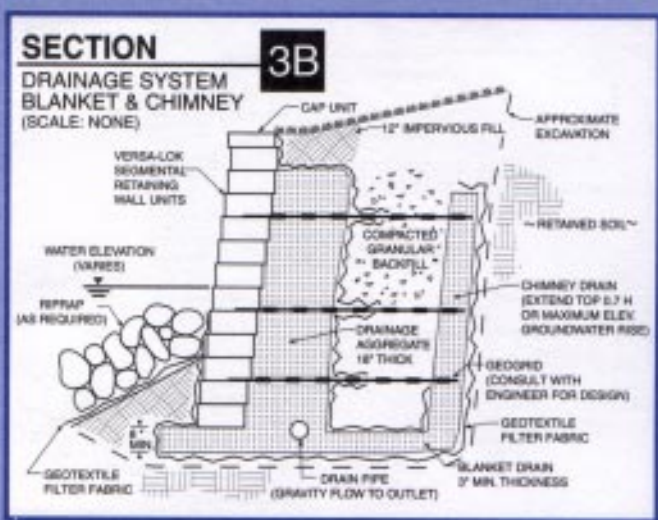
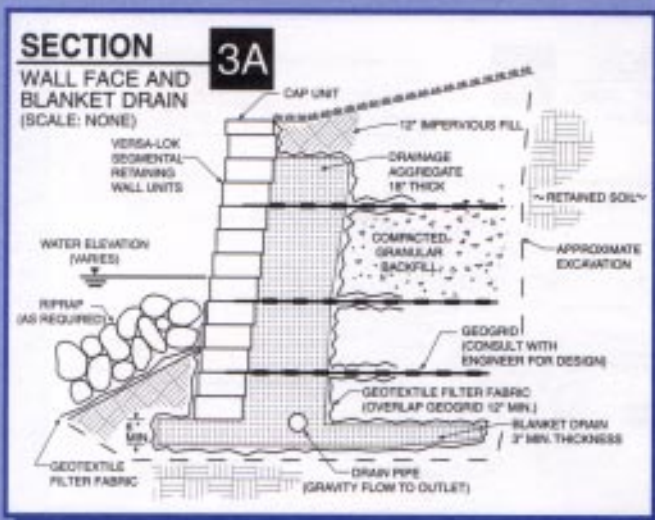
Rapid draw down pressures can be addressed in the design in two ways. Depending on the severity, it may be possible to eliminate such pressures by

improving the internal drainage with drainage blankets and chimney drains. If this is not sufficient nor practical, the engineer can design for the additional hydrostatic pressure by increasing the length and strength of the geogrid reinforcement.

## SCOUR PROTECTION

Scour (the erosive force of moving water) at the toe of an SRW is due to continuous wave action, or fast moving, unsteady channel and river flow velocities. If left unprotected, the foundation of an SRW may deteriorate from these erosive forces. In non-critical (steady, uniform flow) applications, a combination of riprap and a geotextile filter fabric placed to prevent migration of fines through voids in the riprap, will generally eliminate the problem (see figure 2). In highly turbulent water conditions, and non-uniform critical channel flows, a qualified engineer will require specific knowledge about flow rates and causes of scour – perhaps a complete hydraulic analysis – to adequately design an SRW system for these applications.

Establishing limits for riprap coverage on an SRW water application is very site specific. Generally, placement of riprap protection should extend out from the wall until the slope in front levels out. If the riprap is placed on an already flat surface, a minimum distance of five feet out from the wall is recommended. Riprap must be properly graded to function well and carefully placed so that large angular pieces do not puncture or displace the geotextile filter fabric on which they are placed. Selection of riprap sizes for foundation protection is based primarily on flow velocity and flow depth.



## ICE FORCES

In colder climates, ice forces can dictate the design of an SRW placed in a water environment. Where these forces are extreme, such as seasonal occurrence of large, thick ice sheets, it may be impractical to design an SRW for these ice loads. Generally, there are three types of conditions that need to be considered: thermal expansion and contraction, uplift, and impact of large floating blocks of ice. Temperature changes can create a horizontal force on the wall where ice is confined between two SRWs or a single wall and a second immovable object. Changes in water level acting on heavy ice sheets can exert uplift or downward forces on the adjacent SRW. Impact forces of floating ice slabs in high velocity streams also need to be considered. Although solid VERSA-LOK units provide superior durability, SRWs cannot be easily designed and built to resist large forces exerted against the front of the wall. However, where a wall is pushed out of alignment by large ice forces, the wall units often can be reused to realign the wall.

## SURFACE WATER DRAINAGE CONTROL

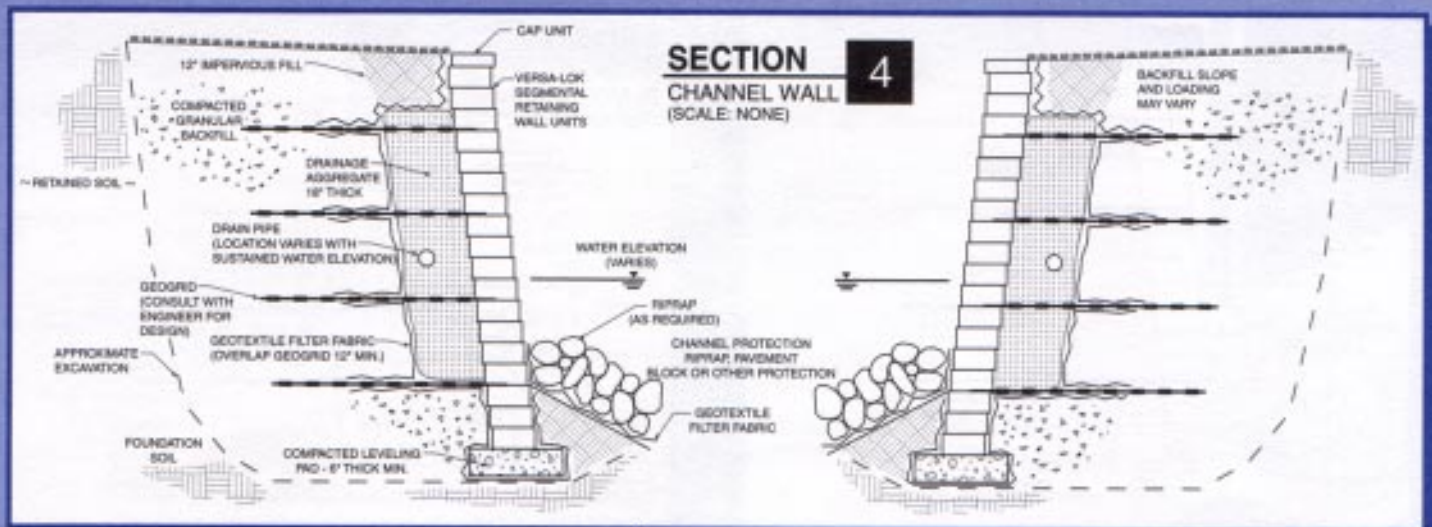
Finished grading at the top of the wall should provide positive drainage away from the SRW. Properly designed drainage swales should include either a 4" thick concrete lining or 4" of low permeability soil covered with 4" to 6" of topsoil that will support growth of surface vegetation. A minimum gradient for drainage swales at the top of an SRW is 2%. Where walls will be over topped with flood waters,



*VERSA-LOK SRWs increase retention pond capacity and maximize usage of surrounding land.*

special attention should be given to minimize erosion at the top of the wall.

Properly designed pond and shoreline protection will incorporate all of the concerns covered in this bulletin into the design and construction of the SRW system. The use of VERSA-LOK will result in a long-lasting, stable and aesthetically pleasing wall. Concrete masonry resists rotting, insect, algae and salt water attack while not affecting the environment through the leaching out of chemicals which are used to treat other wall materials.





*Solid, durable, interlocking SRWs are ideally suited for storm channel and flood control projects.*



*A competent foundation, protected by riprap, provides protection from continuous wave action.*

The information – including technical and engineering data, figures, designs, drawings, details, suggested procedures and suggested specifications – presented in this publication is for general information only. While every effort has been made to ensure its accuracy, this information should not be used or relied upon for any specific application without independent competent professional examination and verification of suitability and applicability. Anyone making use of the material does so at his own risk and assumes any and all liability from such use.

**VERSA-LOK offers a variety of technical support including in-house engineering assistance, design details, and reference literature.**

**Call 1-800-770-4525 or you can also find us at <http://www.versa-lok.com/wall>**

*This bulletin presents basic guidelines only for the design and installation of VERSA-LOK Segmental Retaining Walls in water applications. Additional information covering the subject of SRW design and installation, and hydraulic design criteria, both beyond the scope of this bulletin, is contained in the following reference documents:*

*Design Manual for Segmental Retaining Walls, Second Edition, National Concrete Masonry Association, 1996.*

*Highway Drainage Guidelines, Vol. VI, "Hydraulic Analysis and Design of Open Channels," American Association of State Highway and Transportation Officials, Inc., 1992.*

*Hydraulic Design of Flood Control Channels, U.S. Army Corps of Engineers, EM 1110-2-1601, 1 July 1991.*

*Design of Riprap Revetment, U.S. Federal Highway Administration Hydraulic Engineering Circular No. 11 (HEC-11), March 1989.*

*Hydraulic Design Criteria, U.S. Army Corps of Engineers loose-leaf data-book, available from the National Technical Information Service (NTIS), revised periodically.*

*Retaining and Flood Walls, U.S. Army Corps of Engineers Engineering manual EM 1110-2-2502.*

*Handbook of Hydraulics, Sixth Edition, Brater, E.F. and King, H.W., McGraw-Hill, 1976.*

**Ask for VERSA-LOK'S DESIGN & INSTALLATION GUIDELINES for additional information.**



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U.S. Patent D319,895, U.S. Patent D321,060, U.S. Patent D341,215, U.S. Patent D346,667, U.S. Patent D378,702, U.S. Patent D391,376 and other U.S. patents pending; Canadian Industrial Design Registration No. 63929, No. 71472, No. 73910, No. 73911, No. 73912, No. 77816, No. 79058, and No. 82288.

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