

Errata Sheet

Complying with the Edwards Aquifer Rules Technical Guidance on Best Management Practices RG-348 (Revised July 2005)

March 28, 2009

This errata sheet lists errors and corrections noted in “Complying with the Edwards Aquifer Rules Technical Guidance on Best Management Practices” (Revised July 2005). The list indicates the location (chapter, section, and page number) of the noted error and summarizes the proposed revision.

Location	Comment	Errata
3.2.1 Table 3-1 Page 3-4	The * for “Sand Filter System”, “AquaLogic Cartridge System”, “Bioretention”, and “Permeable Concrete” were incorrectly located.	The electronic version of the manual has the correct table.
3.2 Page 3-10	The BMP applicability section for “Grassy Swales” is not given a section number and proper labeling as indicated in the Table of Contents.	Revise to <u>3.2.4 Grassy Swales</u>
3.2 Pages 3-12 to 3-24	The section numbers for the subsequent BMP Applicability sections do not agree with the Table of Contents. Table of Contents Text 3.2.5 Vegetative Filter Strips <u>3.2.4 Vegetative Filter Strips</u> 3.2.6 Sand Filter Systems <u>3.2.5 Sand Filter Systems</u> etc.	These will be corrected in the next printing.
3.3.2 Page 3-35	The calculation for water quality volume, Equation 3.10, should be $WQV = \text{Rainfall depth} \times \text{Runoff Coefficient} \times \text{Area} \times 1.2$	The 20% increase was omitted.
3.3.2 Page 3-30	A variable in Equation 3.4 is clarified to be A = drainage area (ac)	The term “tributary” is not consistent with terms used in other calculations.
3.3.2 Page 3-33	Two variables in Equation 3.8 are clarified to be $A_I = \text{impervious drainage area to the BMP (ac)}$ and $A_P = \text{pervious drainage area to the BMP (ac)}$	The term “tributary” is not consistent with terms used in other calculations.
3.4.5	<u>3.4.5 Grassy Swales</u>	The channel slope

<p>Pages 3.52 & 3.53</p>	<p>On Page 3-52, the manual states that the “channel slope should be at least 0.5% and no greater than 2.5%.”</p> <p>On Page 3-53, the manual states that the “channel slope for a grassy swale is specified as at least 1% and should be no steeper than 2.5%.”</p>	<p>for a grassy swale should be specified as at least 0.5% and no greater than 2.5%.</p>																								
<p>3.4.7 Page 3-59</p>	<p>The calculations for A_f should be, $A_f = \text{Capture Volume} / 18$ for sand filters with a separate sedimentation basin and $A_f = \text{Capture Volume} / 10$ for sand filters facilities that combine sedimentation and filtrations in a single basin.</p>	<p>The area of the filtration basin must be sized for the entire volume of the pond.</p>																								
<p>3.4.2 Page 3-38</p>	<p>3.4.2 Basin Lining Requirements</p> <p>Impermeable liners should be used for water quality basins (retention, extended detention, sand filters, wet ponds and constructed wetlands) located over the recharge zone and in areas with the potential for groundwater contamination. Impermeable liners may be compacted clay, geosynthetic clay liners (GCLs), concrete or geomembrane. Compacted clay liners should meet the specifications in Table 3-6 and have a minimum thickness of 12 inches.</p> <p>Table 3-6 Clay Liner Specifications (COA, 2004)</p> <table border="1" data-bbox="251 842 1427 1167"> <thead> <tr> <th>Property</th> <th>Test Method</th> <th>Unit</th> <th>Specification</th> </tr> </thead> <tbody> <tr> <td>Permeability</td> <td>ASTM D-2434</td> <td>cm/sec</td> <td>1×10^{-6}</td> </tr> <tr> <td>Plasticity Index of Clay</td> <td>ASTM D-423 & D-424</td> <td>%</td> <td>Not less than 15</td> </tr> <tr> <td>Liquid Limit of Clay</td> <td>ASTM D-2216</td> <td>%</td> <td>Not less than 30</td> </tr> <tr> <td>Clay Particles Passing</td> <td>ASTM D-422</td> <td>%</td> <td>Not less than 30</td> </tr> <tr> <td>Clay Compaction</td> <td>ASTM D-2216</td> <td>%</td> <td>95% of Standard Proctor Density</td> </tr> </tbody> </table> <p>Geosynthetic clay liners (GCLs) are factory manufactured hydraulic barriers typically consisting of bentonite clay or other very low permeability material, supported by geotextiles and/or geomembranes which are held together by needling, stitching, or chemical adhesives. These liners must have a hydraulic conductivity of less than 5×10^{-9} cm/sec, when tested by ASTM D5887. A minimum of 12 inches of soil cover is recommended.</p> <p>If a geomembrane liner is used it should have a minimum thickness of 30 mils and be ultraviolet resistant. Suitable geotextile fabric should be placed on the top and bottom of the membrane for puncture protection and the liners covered with a minimum of 6 inches of compacted topsoil. The geotextile fabric (for protection of geomembrane) should be nonwoven geotextile fabric and meet the specifications in Table 3-7. The topsoil should be stabilized with appropriate vegetation.</p> <p>Table 3-7 Geotextile Fabric Specifications (COA, 2004)</p>	Property	Test Method	Unit	Specification	Permeability	ASTM D-2434	cm/sec	1×10^{-6}	Plasticity Index of Clay	ASTM D-423 & D-424	%	Not less than 15	Liquid Limit of Clay	ASTM D-2216	%	Not less than 30	Clay Particles Passing	ASTM D-422	%	Not less than 30	Clay Compaction	ASTM D-2216	%	95% of Standard Proctor Density	
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Property	Test Method	Unit	Specification (min)
Unit Weight	ASTM D-5261	oz/yd ²	8
Filtration Rate	ASTM D-4491	cm/sec	0.20
Puncture Strength	ASTM D-4833	lb	125
Mullen Burst Strength	ASTM D-3786	psi	400
Tensile Strength	ASTM D-4632	lb	200
Equiv. Opening Size	US Standard Sieve	No.	80

Installation methods for GCLs and geomembrane liners vary according to the site requirements. Figure 3-14 shows a typical installation on an earthen slope with the top of the liner keyed in above the maximum water level of the basin. Figure 3-15 presents an example of geomembrane liner attached to the exterior of a concrete or rock wall. The “liquid membrane” shown in the figure is a hot fluid-applied, rubberized asphalt typically used for waterproofing and roofing applications, such as Hydrotech 6125 or equivalent.

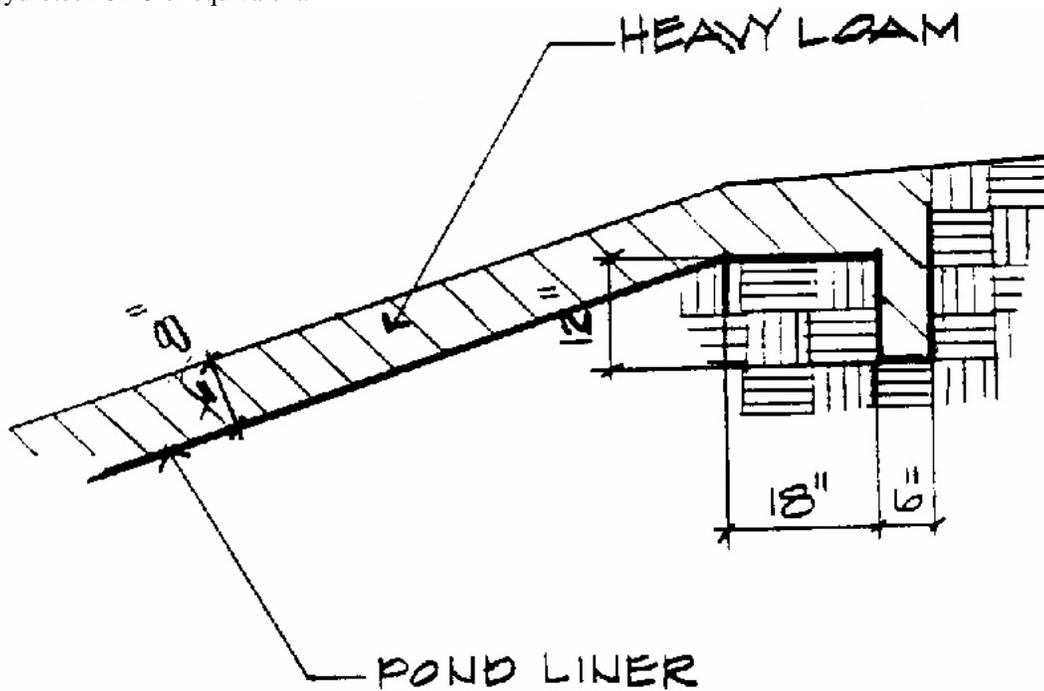


Figure 3-14 Example of Liner Installation on Earthen Slope (Courtesy COA)

3.4.11
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3.4.11 AquaLogic™ Cartridge Filter System

In the San Antonio area, computer controlled cartridge filter systems emerged as a variation of the conventional sand filter design. The cartridge system consists of a series of below grade canisters containing disposable filter cartridges connected to a common manifold, which connects to a sub-surface drain line. A small computer coupled to a rain sensor automatically controls the sedimentation and filtration process to maximize the resulting TSS removal efficiencies. The basin can be open to the elements, or covered and placed beneath pavement or impervious coverings.

The filtration cartridges must be contained in a filtration chamber completely separate from the sedimentation chamber. The volume of the sedimentation chamber should be equal to the design

Revision to
design criteria

capture volume. The small computer controls flow between the chambers by opening and closing a bladder valve at programmable intervals; timed to release the capture volume from the sedimentation to the filtration chamber after sufficient sedimentation so that drainage of the total basin occurs within 72 hours.

The following sections guide design of the basin. If the designer experiences difficulty meeting these requirements for a particular basin, please contact SWAF, Inc. dba AquaLogic™ of San Antonio, Texas, for assistance in custom designing a basin which will satisfy the needs of the property owner, provide economical construction, and meet the requirements of the AquaLogic™ system. Based on the configuration of the individual basin, on a case by case basis, modifications to the basin dimensions contained in the Design Criteria presented below can be made with prior written approval of the AquaLogic system manufacture, SWAF, Inc. (www.aqualogic-usa.com).

Design Criteria

- (1) *Capture Volume* – The volume of sedimentation chambers shall be increased by a factor of 20 % to accommodate reductions in the available storage volume due to deposition of solids in the time between full-scale maintenance activities.
- (2) *Basin Geometry* – The AquaLogic™ basin is made up of separate sedimentation and filtration chambers. The sedimentation chamber can be concrete or earthen lined. The filtration chamber shall be concrete lined. Except for the minimum basin dimensions presented herein, the shape of the sedimentation and filtration chambers are arbitrary and may be aesthetically incorporated into the overall project design.

The water depth in the sedimentation chamber when full shall be at least 2 feet and no greater than 10 feet. The floor of the sedimentation chamber shall be sloped (1% nominal) to collect and drain to through-wall pipe(s), which will direct inflow to the filter chamber. The sub-floor elevation of the filtration chamber shall be a minimum of 42 inches below the lowest finished floor elevation of the sedimentation chamber. The minimum horizontal area needed for the filtration chamber is dependent on the space requirements to accommodate the number of filter canisters required to treat the design capture volume (see Design Sheet No. 1).

The AquaLogic™ filtration system can be constructed underground, thus accommodating additional ground surface pavement area. If constructed underground, a minimum level of ventilation and light is required for personnel safety. For cleaning and maintenance, the sedimentation chamber must have a minimum floor to ceiling clearance of 78 inches; and grated access with minimum dimensions of 36 by 48 inches, sectioned so each section does not exceed 75 pounds in weight. This access shall be located in landscape areas, concrete islands, or out of paths of vehicular traffic; and located directly above an OSHA compliant access ladder. Sedimentation chambers greater than 600 sq-ft in plan area shall have an additional grated opening for each additional 600 sq-ft of plan area, or portion thereof; and positioned to facilitate air flow across the sedimentation chamber. The additional opening(s) shall have minimum dimensions of 24 by 36 inches, sectioned so each section does not exceed 100 pounds in weight.

If constructed underground, the filtration chamber must have grated access with minimum dimensions of 24 by 36 inches, sectioned so each section does not exceed 75 pounds in weight. This access shall be locating in landscape areas, concrete islands, or out of paths of vehicular traffic; and located directly above an OSHA compliant access ladder. Filtration chambers greater than 600 sq-ft in plan area

shall have additional grated openings for each additional 600 sq-ft of plan area, or portion thereof; and positioned to facilitate air flow across the filtration chamber. The additional opening(s) shall have minimum dimensions of 24 by 24 inches.

The required number of filter canisters (FCs) to treat the water quality volume can be found from the following formula:

$$\text{FCs} = \text{WQV} \times 7.48 \times 0.000293 \times 1.05$$

Where:

$$\text{FCs} = \text{Number of Filter Canisters (Including a 5 \% Reserve)}$$

$$\text{WQV} = \text{Water Quality Volume in Cubic Feet}$$

- (3) *Cartridge Configuration* – The filter cartridge is contained in a slotted PVC housing which keeps the cartridge ends sealed such that all flow must pass through the entry slots, then the media prior to discharge via the inner core tube of the cartridge. The complete length of the filter cartridge housing is wrapped in a geotextile fabric conforming to the specifications described in Section 3.4.2. Each filter canister shall be approximately equally spaced with the available filtration area and should be connected to a 4 inch Scheduled 40 PVC underdrain piping system. A diagram illustrating the standard filter cartridge configuration is presented on Design Sheet No. 1.
- (4) *Media Properties* – The media used for filtration should have a mean filtration rating (average pore size) of 10 microns or as needed to achieve 90 % removal efficiency for TSS, as rated by the media manufacturer. The media cartridges shall be of the type distributed by SWAF, Inc. (www.aqualogic-usa.com) of San Antonio, Texas, or equivalent. The media shall be pleated polyester wrapped around a central core and have semi-flexible molded end caps configured to match the canister sealing rings to restrict bypass around the cartridge ends; and shall be 2.75 inch (outside diameter) by 29.25 inches in length.
- (5) *Underdrain Pipe Configuration* – The underdrain piping (manifold) provides a point of connection for the required number of filter canisters and carries the filtered outflow to a single point of discharge (pond outfall); and is custom prefabricated and installed by SWAF, Inc. All underdrain piping shall be Schedule 40 PVC with solvent weld joints; and shall consist of a main collector pipe with minimum diameter of 4 inches and standard female threaded adapters at each point of filter canister connections. Foam block-outs will be placed in the female threaded adapters until time of installation of the filter canisters. The manifold shall be anchored in a minimum 12 inch layer of waterproof grout finished flush with the top of the provided foam block-outs, and shaped to prevent ponding. The manifold must be grouted immediately after installation to prevent damage to the manifold assembly. See Design Sheet No. 1 for schematic representing a standard underdrain piping profile.

The filtration chamber area (RIA_F) must take into account sufficient room to place the upright filter canisters and room to access the individual canisters. The manifold system allows versatility in the design dimensions of the filter chamber. A manifold row is made up of sections consisting of two filter canister connections per section, with a maximum of 25 sections per row. The minimum filter chamber length is 3 ft-7 in., which includes 3 sections (6 filter canisters). Provide 9 inches to length of the filter chamber per each additional section of manifold. The

minimum filter chamber width is 3 ft-3 in. for one row of canisters. The minimum width for 2, 3 and 4 manifold rows is 5 ft, 8 ft and 11 ft, respectively.

- (6) *Flow Splitter* – The inflow structure to the sedimentation chamber should incorporate a flow-splitting device capable of isolating the capture volume and bypassing the 25-year peak flow around the basin with the sedimentation chamber full. Excess runoff should be bypassed to a suitable outfall.
- (7) *Sedimentation Chamber Inlet* – Energy dissipation is required at the sedimentation chamber inlet so that flows entering the basin are distributed uniformly and at low velocity in order to prevent resuspension and encourage quiescent conditions necessary for deposition of solids.
- (8) *Sedimentation Chamber Outlet* – The outflow structure from the sedimentation chamber into the filtration chamber shall be a concrete wall containing one or more in-pipe bladder valve(s) for discrete control of the sedimentation holding period and timed release to allow inflow to the filtration chamber. The thru-wall pipe shall be protected in the sedimentation chamber with a cast iron grate to prevent the entrance of loose basin debris. The on/off operation of the bladder valve shall be rain sensor controlled such that the sedimentation period is not less than 15 hours after the rainfall event stops. The sedimentation time period can be varied seasonally to achieve optimum removal of the captured volume within 72 hours. A manual valve must be accessible at all times, including when the chamber is full. AquaLogic™ will furnish the in-pipe bladder valve and on/off control. See Design Sheet No. 1 for schematic representing a standard in-pipe bladder valve profile.
- (9) *Control Panel and Components* – A rainproof enclosure houses the solar powered rechargeable battery, the logic board controller, and an air compressor. A rain sensor automatically initiates the system. An emergency override switch shall be provided in the control panel to close the bladder valve in an emergency, such as a hazardous material spill. The control panel shall allow adjustment to the duration of the sedimentation period after the rainfall event stops, where the capture volume is held in the sedimentation chamber before release into the filtration chamber.

The panel shall be mounted on a 2-3/8" O.D. galvanized pole embedded in concrete or attached to an accessible location on the filtration chamber sidewall. The control box mounting pole with attached solar cell must be located in a clear area which receives maximum daytime sunlight or the system may fail to operate properly during extended periods of overcast rainy weather. No trees may be planted near the support pole blocking sunlight from the solar cell. A continuous 3/4", non-metallic, rigid electrical conduit is required from the exterior pole-mounted electronic control box to the filter chamber inlet valve for the passage of an airline control hose. A minimum number of wide radius 90° sweeping bends are recommended.
- (10) *Maximum Drawdown Time* – The timed release of the capture volume from the sedimentation to the filtration chambers shall occur within 72 hours after the end of the rain event.
- (11) *Safety Considerations* – Open basins shall be fenced to provide safety to the public including small children. Earthen side slopes in the sedimentation chamber should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. The primary spillway opening must not permit access by small children. All maintenance activities, including entering "confined space" shall be performed in accordance

	<p>with applicable OSHA regulations. Note, both covered and open basins may be considered “confined space”.</p> <p>(12) <i>Landscaping and Stabilization</i> – The areas adjacent to the basin must be suitably stabilized using a combination of landscaping in addition to synthetic stabilization systems so that they will maintain themselves during the wetting and drying operations of the sedimentation chamber.</p> <p>(13) <i>Filtration Chamber Discharge</i> – The filtration chamber discharge pipe (from underground piping) shall extend and/or connect to a permitted discharge point for the treatment basin such that filtered effluent may flow by gravity at all times to discharge. Provide a manual shut off isolation valve to prevent flow from the filtration chamber. Provide adequate erosion controls at the point of discharge.</p> <p>For discharge conditions requiring pumping, provide a wet well to collect the effluent from the underdrain piping by gravity. A power company connection will be required for the sump pump. The pump shall be capable of delivering 100% of the design capacity, and should be selected to operate within 20% of their best operation efficiency. Provide a high water alarm system to warn of pump failure consisting of a red light located at least 5 ft above ground level. Provide a power switch in the wet well vicinity. The alarm and switch should be vandal and weather resistant; and a sign should be placed at the wet well clearly displaying the name and phone number of a responsible party that may be contacted if the alarm is activated. Insure that the discharge point from the sump pump is installed in a suitable location.</p> <p>(14) <i>Maintenance Access</i> – The AquaLogic™ basin can be maintained by hand operations without the need for heavy construction equipment. Sediment removal is performed by hand sweeping and bagging. However, the design of the basin shall consider maintenance needs and the efficient replacement of filters and sediment removal in the layout of access openings and ladders. Provide for 24/7 unrestricted personnel and vehicular access drives (if required) to the sedimentation and filtration chambers access points. Access drives should be a minimum of 8 ft wide and not exceed 15 % grade. Provide pick-up vehicle turn-around if access road is greater than 200 ft. Open and underground chamber access openings are preferred to be located off parking lots and traffic areas, and out of the path of normal vehicular and pedestrian traffic. Landscape areas, curbed islands or restricted vehicle pavement markings should be considered for underground chamber access locations.</p>	
<p>3.5.13 Page 3-99</p>	<p>3.5.13 <u>AquaLogic™ Cartridge Filter System</u></p> <p>Cartridge Filters require regular routine maintenance; however, the key element in the maintenance program is timely replacement of the filter cartridges, and removal of sediment from the sedimentation and filtration chambers. In general, the bottom portion of the filter will clog with sediment prior to the upper portions of the filter. If this occurs, the filter can be rotated top to bottom to optimize the life of the filter. The filters shall be rotated or replaced as needed to insure proper drainage of the basin within the specified time period. Sediment shall not accumulate in the sedimentation or filtration chambers greater than 2 inches in depth.</p> <p>It is also important to check and verify that the other elements of the overall treatment system are functioning properly in order to extend the life of the filter cartridges. It is recommended that</p>	<p>Revision to maintenance criteria</p>

of operation. After the first year, maintenance personnel will have a feel for the operational characteristics of the filter system and subsequent inspections can be reduced if warranted.

The biggest threat to any filtering system is the exposure to heavy sediment loads that clog the filter media. In order to avoid premature exposure to heavy sediment loads, construction within the contributing watershed should be completed prior to exposing the filter system to stormwater runoff. All exposed areas should be stabilized to minimize sediment loads and runoff from unstabilized construction areas should be routed around the filter system and treated separately. A recommended maintenance plan is provided on the following page.

**AQUALOGIC™ STORMWATER FILTRATION SYSTEM
OPERATION AND MAINTENANCE PLAN**

Maintenance Task Item	Description of Maintenance/Repairs to be Performed⁽¹⁾	Typical Frequency⁽²⁾
Basin and Inlet	Visually inspect and note items which need repair or maintenance performed (pipes, concrete drainage structures, retaining walls, cracks, voids or undermining, etc.). Check for erosion areas inside and outside the basin. ⁽³⁾ Insure the inlet and bypass are not clogged.	Each site visit
Trash Removal	Remove trash from the sedimentation and the filtration chambers. Properly dispose of all removed material ⁽⁴⁾ .	Each site visit
Sediment Removal	Remove sediment from the sedimentation and the filtration chambers. Properly dispose of all removed material by sweeping the basin, bagging the waste and removing the bagged waste by hand up the access ladders ⁽⁴⁾ .	When sediment is greater than 2 inches in depth
Bladder Valve	Check for proper operation in "auto" and "manual" mode: repair or replace damage valve.	Each site visit
Canisters	Clean filter canisters as needed; repair or replace damaged canisters.	Each site visit
Cartridges	Remove and dispose of spent cartridges per manufacturer's recommendations. ⁽⁴⁾	As need to insure proper drawdown within 72 hours
Geotextile Wrapping	Inspect geotextile wrapping and repair or replace as needed	At time of filter replacement
Controls	Visually inspect equipment and controls; verify proper function and repair or replace inoperative components.	Each site visit
Concrete Channel, Bypass Weir & Outfall	Visually inspect outfall and verify that discharge is leaving the filter by gravity. ⁽³⁾	Each site visit
Site	Visually inspect site for detrimental debris or spillage that may result in damage to the AquaLogic system.	Each site visit
Facility Operations	Observe the complete facility to evaluate the operation. Review watershed status and determine if any modifications to the facility are warranted ⁽³⁾⁽⁵⁾ .	Each site visit
Wet Well/Sump Pump	If utilized, visually inspect wet well and sump pump to verify proper evacuation and discharge of stormwater. ⁽³⁾	Each site visit
Underdrain	Periodically clean underdrain piping using clean-	Two year Intervals

Piping	out access ports to insure unimpeded discharge of filtered stormwater.		
Security Fencing	Observe that the BMP site fence is closed with locked gates at all times, and fence is undamaged. ⁽³⁾	Each site visit	
Documentation ⁽⁶⁾	Prepare site visit report noting all items of maintenance, repair, or replacement performed during each site visit.	Each site visit	
<p>Notes:</p> <ul style="list-style-type: none"> (1) All maintenance activities, including entering confined space, will be performed in accordance with applicable OSHA regulations. (2) Site visits are carried out once a month or after each significant rainfall event, whichever occurs more often. (3) Owner will be notified of repair or maintenance items, and facility concerns. (4) Properly dispose of trash, sediment and cartridges in accordance with applicable regulations. (5) At least two inspections per year shall be done during or immediately following wet weather. (6) Documentation to be maintained on-site for a minimum time of 5 years to be reviewed by the owner or regulatory agency during normal business hours. 			