DISCOVERY BAY WOMEN'S CLUB

ENGINEERING EVALUATION

for

LARGE ON-SITE SEWAGE SYSTEM (LOSS)
(LOSS System I.D. No. JEF002)

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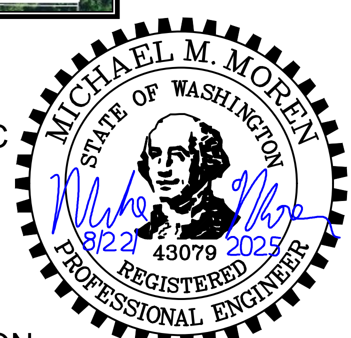

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August 22nd, 2025

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EXECUTIVE SUMMARY

The Large On-site Sewage System (LOSS) Subsurface Drip System (SDS) drainfield serving the Discovery Bay Leaseholder Association (DBLA)/Discovery Bay Women's Club (DBWC) has failed. The Washington State Department of Health required an engineering investigation/evaluation of the failure as well as recommendations for correcting the failure. Aqueous Solutions Engineering (Aqueous) was retained by DBLA to conduct the engineering evaluation and recommend potential solutions for repair.

This engineering investigation/evaluation of the DBLA/DBWC LOSS did confirm that the subsurface drip system (SDS) drainfield is indeed failing, and that the primary cause of the failure is low-end overloading due mostly to design error, but with some installation error as well.

All six dripfield zones are located on sloped topography (which is not uncommon), and the *Typical Dripfield Layout* design detail – Detail #3 on LOSS Repair Record Drawing Sheet OS2.05 – was not designed to prevent low-end overloading. The detail allows for a dripfield zone to fill from the bottom up during a dose (charging low-end laterals first), and then drain from the top down after the pump shuts off (continuing to charge low-end laterals last). Supply and Return Manifolds were run up the slope, and manifold and dripline check valves were not incorporated into the design, thus allowing the draindown to occur. A field evaluation confirmed that the failure is occurring in the bottom 1/4 to 1/3 of Zones 4, 5, and 6, with perhaps a little of Zone 3. Some additional draindown of the Supply Lines for these zones may also be occurring, as these Supply Lines run downhill from a high point near the northwest corner of Zone 3.

The preferred layout method on sloped sites is to use short top-end, or high-end, manifolds, which significantly minimizes any draindown, and also distributes effluent into the driplines more evenly. It also does not require any manifold and dripline lateral check valves (i.e. much more O&M friendly).

Additionally, the dripfield zone layouts were configured in a layout that can allow for "linear loading", or loading in a narrower band perpendicular to the slope direction, as opposed to the recommended wide (longer driplines) and shallow (fewer driplines down the slope) configuration.

Also, the *Typical Dripline Trench* detail – Detail #1 on Record Drawing Sheet OS2.04 – showed a typical dripline installation with only 5-1/4" to 7-1/4" of cover. WAC 246-272B-06650 specifies that dripline must be installed to a minimum depth of eight inches into original, undisturbed soil. This is generally interpreted as eight inches of cover over the dripline, minimum. The Netafim design guide/manual recommends 8" – 12" of cover, and perhaps more if freezing is a concern. Jefferson County lowland frost depth is considered 12". During the field investigation, one small section of dripline in a failed area was found to only have 1-1/2" of cover, though other adjacent areas met the minimum depth requirement.

The LOSS Repair design specified 18" dripline spacing. The field investigation found one small area (a failed area) with only 6"-7" of separation. The design called for level dripline installation (i.e. parallel to topographical contours). One failed section of drainfield had driplines running up-gradient from the manifold. All of these issues have contributed to the low-end drainfield failure, but the predominant cause of failure is the drainfield zone configuration that allows for significant low-end overloading.

Unfortunately, the nature of these design and installation errors are significant enough that a repair of the existing SDS drainfield is not reasonable; there would be too much damage to the drip system. In addition, due to the amount of driplines, transport, and manifold piping installed that would have to be removed, and the disturbance that would cause, an SDS redesign & re-install would be more subject to failure, even if designed & installed correctly. Because of this, a trench-type pressure distribution drainfield would probably be the best replacement since the trenches would be cut into the native soil deeper than what the existing driplines are installed at; the trench bottoms will be able to be installed in mostly undisturbed soil. Aqueous Solutions Engineering will need to work with the WA DOH on this recommended solution and DBWC on this solution, as it will take some careful design. With this repair/modification, a new dosing tank & control panel would be incorporated much closer to the drainfield site.

Other design, installation, and operational issues that were discovered, but that are more easily correctable, include:

- Blended effluent from the recirculating gravel filter (RGF) being sent to the drainfield dosing tank, instead of the cleanest effluent directly from the RGF;

- The LOSS Repair Engineering Report stated that the effluent from the RGF will be "*recirculated to the inlet of the septic tank to allow for maximum denitrification potential*", however this was not incorporated into the design drawings, nor was it installed. As a result, Total Nitrogen reduction has been very poor, and alkalinity has been depleted, which could cause a low pH condition that could negatively affect treatment performance. Additionally, the denitrification that would result in this process configuration would also reduce the BOD load upstream of the RGF, allowing for even better nitrification in the RGF.

- The design engineer-recommended RGF recirculation ratio of 7:1 was only presented in the LOSS Engineering Report, Record Drawings, and O&M manual as being based on the Design Flow of 8,000 GPD. No mention was made of adjusting the recirc. ratio to the actual average daily flow, which has been much less than the design flow (about 3,000 – 3,500 GPD during the peak summer season). It does not appear the operational adjustments were ever made to adjust for the actual average daily flow. Thus, the actual recirc. ratio has been very high: about 15:1 to 20:1. This has allowed for the generation of excess brown aerobic sludge that plugs the Dosing Tank effluent filter and dripfield headworks filter, requiring much more maintenance than should be necessary, and has also compromised other downstream components like solenoid valves (i.e. due to sludge build-up).

- Not one of the dripfield zone air/vacuum breakers was easily accessible for O&M (supply & return manifold pressure checks, valve ball seating inspection, etc. Valve boxes were mostly filled with soil.

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1. INTRODUCTION

Aqueous Solutions Engineering (ASE, Aqueous) was retained by Discovery Bay Leasehold Association (DBLA)/Discovery Bay Women's Club (DBWC) to conduct an engineering evaluation of the Large On-site Sewage System (LOSS) serving the DBWC community in Gardiner, Jefferson County, Washington. The evaluation of the LOSS is required by the Washington State Department of Health (WADOH) – LOSS Program due to reported failure of the Subsurface Drip System (SDS) drainfield that was recently installed in year 2020. The WA DOH issued a Notice of Violation (NOV) letter to DBLA dated May 1st, 2025 which included the requirement of an engineering evaluation of the LOSS.

Aqueous first conducted a records review of the following LOSS engineering documents:

- LOSS Repair Record Drawings (dated 12/22/2020, by ADC Wastewater Engineering)
- LOSS Repair Engineering Report (dated 4/4/2019, by ADC Wastewater Engineering)
- LOSS Soil Logs
  - (dated/logged 2/1/2019, by ADC Wastewater Engineering)
  - (dated/logged 2/8/2019, logs & site evaluation by WA DOH)
- LOSS Repair Construction Specifications (dated 9/30/2019)
- LOSS Operations & Maintenance Manual (dated 12/21/2020, by ADC)
- "Septic Repair Timeline" notes from DBLA covering October 2017 through May, 2019

Aqueous also re-reviewed the following documents:

- Netafim™ *Wastewater Reuse & Drip Design Guide* (versions W062 6/08, and W062 11/12)
- Geoflow™ *Subsurface Drip Dispersal and Reuse – Design, Installation and Maintenance Guidelines* (version October 2007 v.2)
- WA DOH *Recommended Standards and Guidance for Performance, Application, Design, and Operation and Maintenance (for) Subsurface Drip Systems* (version July 2012)

Aqueous made two site visits to conduct field evaluations of the LOSS: one on May 27th, 2025, and one on August 6th, 2025. The field evaluations included:

- Confirming and evaluating the drainfield failure (i.e. surfacing) and configuration relative to the design configuration;
- Reviewing drainfield area topography and assumed surface drainage patterns;
- Inspecting the SDS headworks configuration & operation;
- Evaluating flow meter operation (SDS Supply, SDS Return/Filter Backflush, and RGF Supply), and performing a flow calibration check of the SDS Supply flow meter;
- Evaluating primary treatment (septic tank) and secondary treatment (RGF and recirc./SDS dose tank) configurations and operations relative to design documents and O&M manual;
- Evaluating the Control Panel settings & operations; and
- Discussing operations & maintenance, and system issues with the LOSS Operator (Shold Excavating) DBWC Facilities Manager.

Aqueous evaluated the limited wastewater flow data available. Aqueous also reviewed final effluent sample results dating back to 2022, and specified additional sampling (and reviewed results) of the RGF filtrate, and the primary septic tank effluent.

This Report presents the evaluation and findings, a conclusion, and makes recommendations in moving forward to get the LOSS into compliance with the WA DOH.

2. LOSS FAILURE, DESIGN, AND OPERATIONAL EVALUATION

2.A. LOSS DRAINFIELD AND DRAINFIELD FAILURE

SECTION SUMMARY

The SDS drainfield failure (i.e. saturated ground, surfacing effluent) is in the lowest 1/4 to 1/3 of Zones 4, 5, and 6, with perhaps a little of Zone 3. The primary cause of the SDS failure was found to be low-end overloading due to a significant design error with the "Typical Dripfield Layout" detail. A "Top-End" or "High-End" manifold design should have been used on this sloped site.

Other potential design errors that may contribute to the failure include "linear loading" zone layouts (i.e. narrower zones down the slope as opposed to wide zones along the slope), shallow dripline cover (the "Typical Dripline Trench detail of 5-1/4" to 7-1/4" does not meet minimum cover requirements in WAC 246-272B-06650 (3) of 8 inches), and a typical layout that does not allow for uniform dripline lateral flushing (short dripline laterals and very long dripline laterals within the same zone).

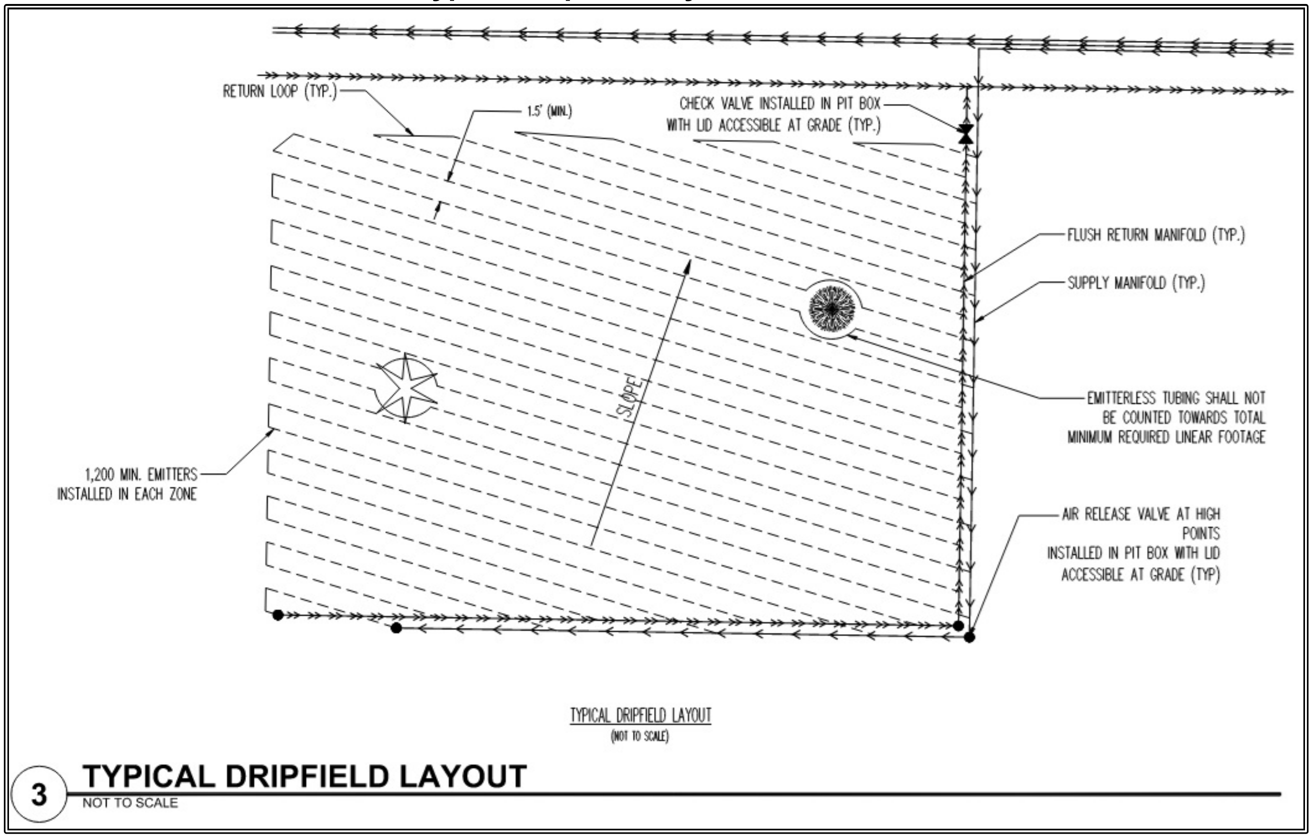
In addition, installation errors were also observed, including inadequate dripline cover (only 1-1/2" in one location), inadequate dripline spacing (only 6"-7" in one location), and sloped dripline installation. The extend of these installation errors is not well understood because the dripfield network is buried; only a small area of failure was investigated, and these errors were discovered within this area.

As is known, the entire drainfield was designed and installed on a sloped site. Sloped topography presents special challenges to dripfield design, but good design layout and installation should address this. There are several methods to address layout on sloped sites to prevent adverse effects. SDS drainfields on sloped topography are common in the Pacific Northwest.

In reviewing the LOSS Repair Record Drawings (dated 12/22/2020), several design issues were noted that could (and did) have a significant negative impact on the subsurface drip system drainfield performance that led to the SDS failure.

The primary cause of failure was found to be a significant design error as shown in the "Typical Dripfield Layout" – Detail No. 3 – in the LOSS Repair Record Drawings (presented on the following page).

Sheet OS2.05 – Detail No. 3 – Typical Dripfield Layout:



This detail has long zone Supply and Return Manifolds running up the slope from bottom to top of the zone. Another detail – Detail #2 on Sheet OS2.04 – shows both the Supply and Return Manifold size as 2"Ø. Without Supply Manifold check valves between every dripline lateral, or every few dripline laterals, and without dripline lateral check valves at the ends of the laterals just before they connect to the Return Manifold, the entire dripfield zone will drain down to the bottom of the zone after the pump shuts off, causing low-end overloading, or low-end drainage. In addition, when the pump starts pumping, the zone fills from the bottom up, so the lowest laterals are being filled (and dosing) first.

During the May 27th, 2025 site visit, it was observed that the bottom 1/3 of Zones 4, 5, and 6 were the areas that were failing. There was no failure (ground saturation or ponding) within the top 2/3s of those zones. **<u>The failure is clearly primarily from low-end overloading.</u>**

It is not understood why the SDS drainfield was designed this way. The construction specifications called for Netafim dripline. The three subsurface dripline design guides/manuals referenced in Section 1 of this report – Netafim™ Guide, Geoflow™ Guidelines, and WADOH SDS RS&Gs – all discuss the potential for low-end overloading on sloped sites, and discuss design methods to prevent low-end overloading. The most common method used is to use short top-end, or high-end, Supply and Return Manifolds. This method doesn't require the use of numerous manifold and dripline check valves, and the short manifold lengths have minimal draindown volume, and they allow for more equal effluent distribution into the dripline laterals.

The 2008 Netafim™ design guide/manual includes several figures, and a discussion, on how to lay out a SDS zone with top-end manifolds:

Page 26 of the 2008 Netafim™ design guide/manual

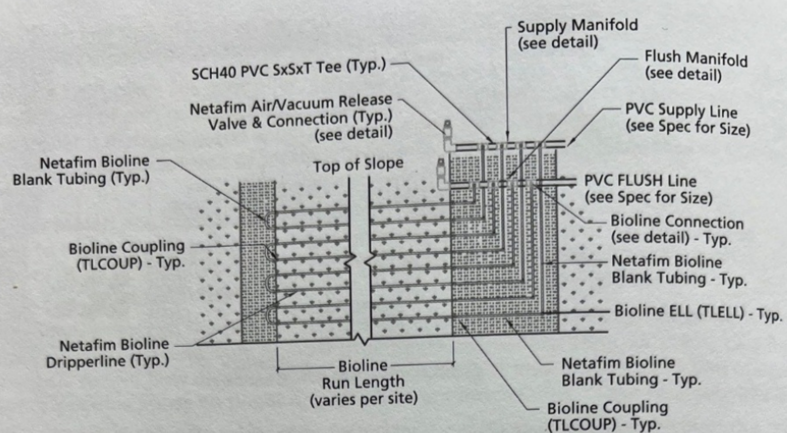


Figure 13 - "Top Feed" Same Side Supply and Flush Manifolds for Slope Layouts

This patented "Top Feed" layout can only be used with Netafim Bioline dripperline. Top feed layouts are popular when working on slopes because they lessen the drainage. This layout is using same side supply and flush manifolds.

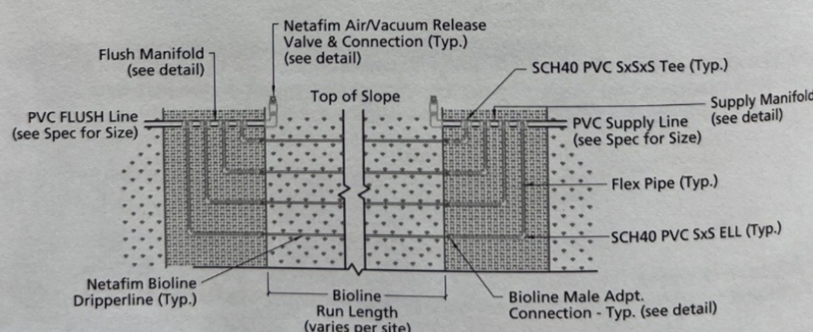


Figure 14 - "Top Feed" Opposite Side Supply and Flush Manifolds for Slope Layouts

This is an opposite side supply and flush manifold version of the patented top-feed layout that can only be used with Netafim Bioline dripperline.

Page 29 of the 2008 Netafim™ design guide/manual

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DRAINBACK CONSIDERATIONS

When the dosing cycle ends, much of the effluent remaining in the system will drain out of the dripperline. The effluent will drain to the lowest parts of the dripperline zone, and even on a nominal (1%) slope, this could cause localized soil overloading. It is important to anticipate where the effluent will flow when the dosing event ends. There are a number of design approaches that address this issue, several of which follow. The optimal approach will be to use the "top loading" concept which is a patent-protected design approach that can only be used with Netafim Bioline. (See page 30 for more information).

One of the reasons why Bioline dripperline is a good solution on slopes is due to its pressure compensation feature. Bioline drippers deliver the same flow from 7 to 70 psi, so changes in pressure at the dripper due to elevation-created pressure variances do not affect the delivery rate of the drippers.

Other products allow additional flow anywhere higher pressures exist and as such, the soil can become saturated very quickly at the base of the slope. With Bioline, all areas of the slope are dripped at the same rate. There is no need to increase field size with Bioline. Simply use as much of the slope as possible to deliver to. (See Figures 14 & 15).

Install With the Contour: Dripperline must be installed along the contour of the slope (as level as possible), not up and down the slope. Otherwise, all the effluent in the dripperline will drain rapidly to the emitters at the base of the slope, which can overload the soil.

Feed from the Bottom of the Field: As a rule, drip fields on a slope should be fed from the bottom and flushed from the top (when not using the "Top Feed" layout). This technique will prevent the main lines and manifolds from draining to the field during rest periods. This strategy assumes that the field is uphill from the supply line. The supply manifold should "stair step" through a series of check valves, with a limited number of lines between each check valve. Check valves limit the down gradient flow of the water when the pump shuts down.

Page 30 of the 2008 Netafim™ design guide/manual

TOP FEED MANIFOLDS

Note: This design is protected by U.S. Patent 5,984,574. If Netafim Bioline® is being used, licensing rights to this patented design may be freely applied. If any product other than Netafim Bioline is designed or installed, it is a violation of U.S. patent law.

Top Loading: Top loading refers to feeding each lateral or group of laterals individually from supply and flush manifolds mounted higher than the dripperline laterals. Each drip lateral on the contour of the slope is fed by a feed line connected to the supply manifold. At the end of the dripperline lateral, another feed line is fed upward to the flush manifold. Air/Vacuum relief valves are then located on both the supply and return manifolds.

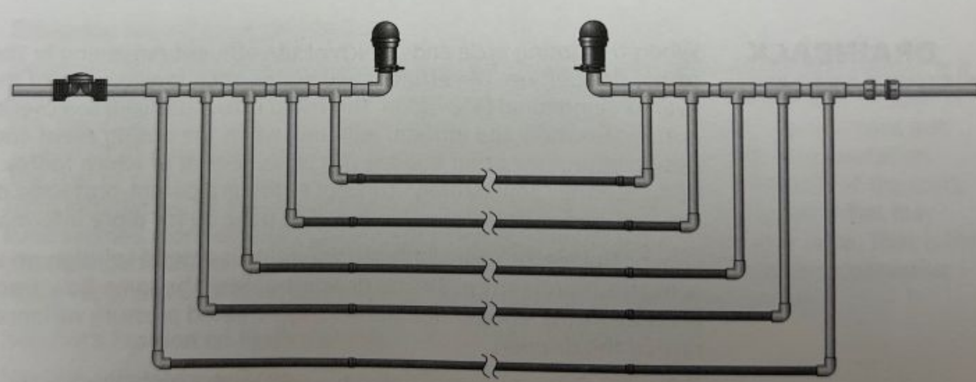


Figure 17 - Simple Application of Tubing Across (Perpendicular) the Slope. *The object is to lessen the effect of water migrating down the slope.*

Page 31of the 2008 Netafim™ design guide/manual

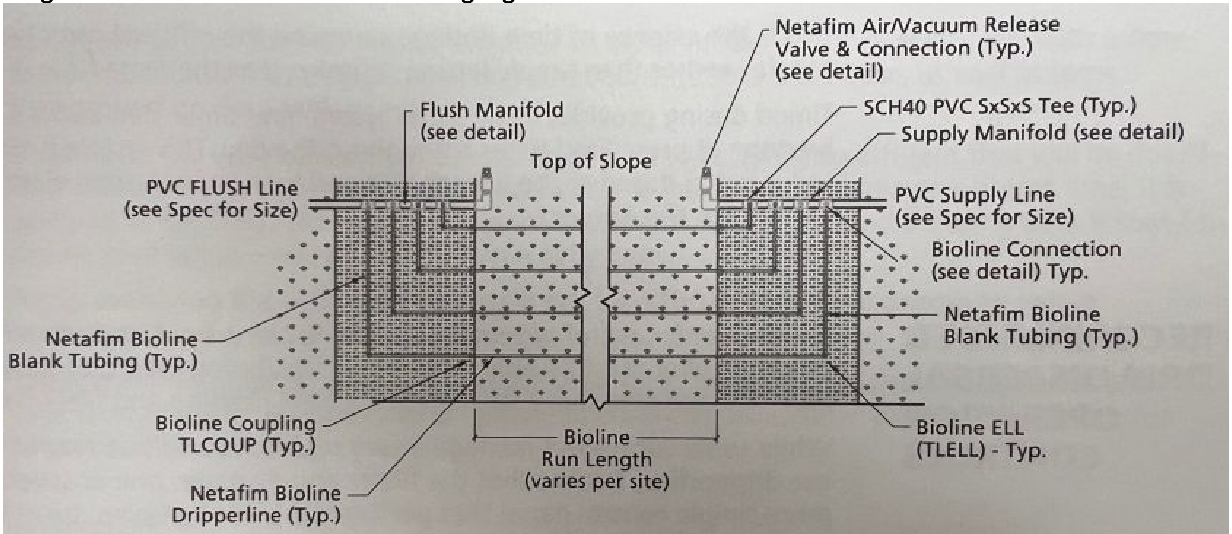


Figure 18 - "Top Feed" Opposite Side Supply and Flush Manifold for Slope Layouts

This patented "Top Feed" layout features supply and flush manifolds above the dripperline laterals. Blank tubing or flex connections attach to individual Bioline laterals. This layout minimizes drain down because supply and flush manifolds are not running up and down the slope and acting as conduits to allow the effluent to move to the base of the slope.

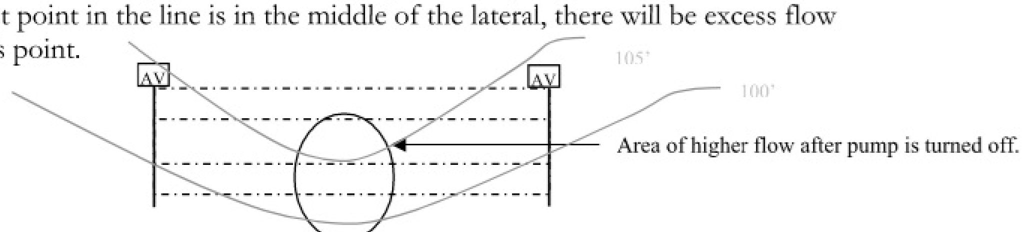
The 2007 Geoflow™ design guide/manual also addresses "low-head drainage":

Page 12 of the 2007 Geoflow™ design guide

C. Low Head Drainage

At the end of each dosing cycle, consideration must be taken for gravity. Where is the water going to drain when the pump shuts off? Water in the dripline will flow down to the lowest point within the drip zone. This is called "low head drainage." Use the following precautions to mitigate low head drainage.

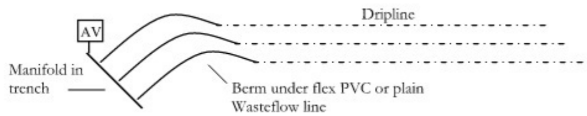
i. The dripline should run along the contour if at all possible because water will run to the lowest point of the line every time the pump is turned off. If the lowest point in the line is in the middle of the lateral, there will be excess flow at this point.



12 GEOFLOW Inc. 800-828-3388/415-927-6000 www.geoflow.com

Page 13 of the 2007 Geoflow™ design guide

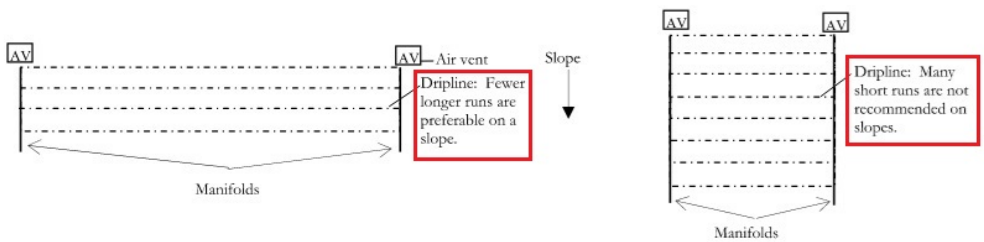
ii Have the dripline pass over an elevated berm between the manifold and beginning of the tubing to reduce gravity flow out of the lateral. In looped systems, elevating the loop will keep the effluent in its respective run.



iii. Use check valves or multiple zones to isolate the drip laterals. Check valves should only be used if there is no risk of freezing in the manifolds. They are placed on the supply and return manifolds coupled with an airvent on the downhill side. If unsure, as a rule of thumb, use a maximum of 1500 ft of Geoflow dripline within each zone or section.

iv. Install short manifolds with fewer longer dripline runs.

v. Slope the supply and return manifolds down to the pump tank so the effluent drains back down to the tank when the pump is turned off. Open the zone valves fully to drain the lines quickly.



Concentrate drip lines at the top of the hill with wider spacing towards the bottom. In the case of compound slopes consult a professional irrigation designer or engineer.

The WA DOH July 2012 SDS RS&Gs also discuss low-end loading and methods on how to address it:

Page 21 of the July 2012 SDS RS&Gs

Discharge from turbulent flow emitters even when used with a pressure regulator can be affected by elevation differences. The discharge from pressure compensating emitters is relatively constant even when emitter elevations vary. Regardless of which type of emitter is utilized air/vacuum valves allow dripline to drain between doses so discharge tends over time to be greater at low points in the system, which can result in "spot loading" over time. For this reason dripline should always be installed along contours as level as possible.

3.8.6.9. SDS on sloped sites must be designed and installed to prevent low-level drainage (see Drainback and the Chimney Effect in Appendix D) to lower dripline or other lower level components such as tanks, valve boxes, etc.

Low level drainage can be prevented by installing reliable check valves on manifolds between dripline laterals, by feeding dripline from above (See Figure 4 in this document or Figure 3B Pressure Distribution RS&G), by constructing earth dams where dripline is connected to manifolds, by installing dripline at a lower elevation than manifolds, and by connecting dripline to manifolds up gradient to the dripline contour.

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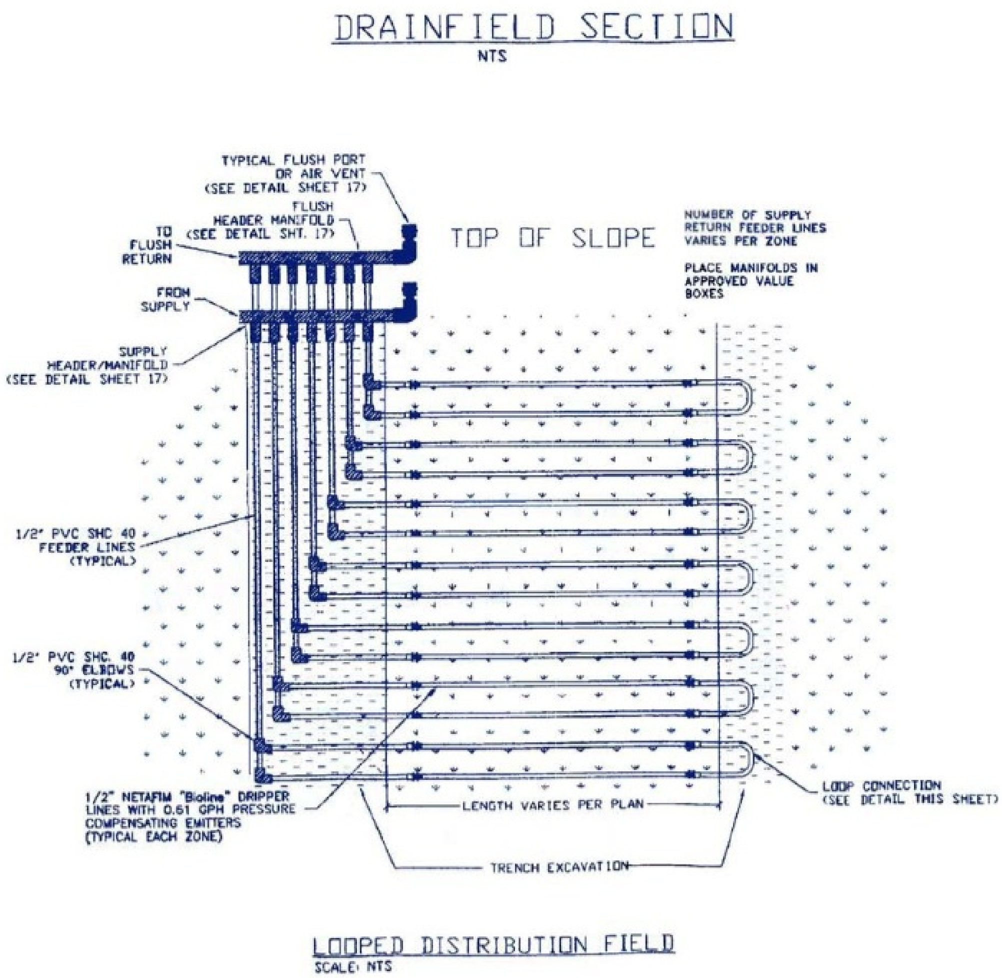
Page 34 of the July 2012 SDS RS&Gs

Subsurface Drip Systems - Recommended Standards and Guidance
Effective Date: July 1, 2012

Figure 4. Looped Drip Distribution Field with Supply and Return Manifolds



NOTES:

1) INSTALL DRIPPER LINES (AS CLOSE AS POSSIBLE) LEVEL WITH GRADE CONTOURS.
2) INSTALL BERMS OR SWELLS TO DIVERT STORM WATER RUN-OFF.

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Page 42 of the July 2012 SDS RS&Gs

Drainback and the Chimney Effect

Drainback
"Drainback" can be serious problems with improperly designed or installed drip systems in fine textured soils. Designers and installers should be aware of the cause and means to prevent these problems. "Drainback" occurs when effluent accumulates during dosing in the trench or channel in which dripline is installed and then flows by gravity to lower points in the system, such as into manifold or transport piping trenches. If the dose volume is sufficient, effluent can eventually pond or break out to the surface.

The problem occurs in fine textured soils when the combination of emitter discharge rate, pump run time and total dose volume exceeds the infiltrative capacity of the soil. Installation technique and soil conditions during installation can contribute to the problem. Vibratory plows or insertion tools where dripline follows a pulled "bullet" can compact or smear the soil, particularly when the soil is too wet during installation. This can reduce the infiltrative capacity of the soil and encourage effluent to follow the channel or trench in which the dripline is installed. On sloped sites, where multiple dripline segments connect to a sloped trench carrying transport piping, the cumulative flow into the trench can be significant.

The problem can be solved in a number of ways. Transport and manifold piping should always be installed up gradient from dripline (see Pressure Distribution RS&G Figure 3B for example). Earthen dams can be constructed where dripline connects to the manifold or transport piping to prevent passage of effluent. Select dripline with the lowest available discharge rate (currently 0.5 and 0.6 GPH) in fine textured soils. Design drip systems to dose frequently (see Design Standards and Tables in Appendix A for minimum dose frequency for each soil type). Pump run times should not exceed manufacturer's recommendations for the soil type and designers should consider the volume of effluent that drains between doses. Select an installation technique and follow manufacturer's instructions to minimize smearing. Consult knowledgeable dripline installers for other hints.

With all of these design guidelines addressing the potential for low-end loading on sloped sites, and also providing methods on how avoid low-end overloading, it appears that there was a significant design oversight with the LOSS Repair design.

Another potential design issue that may also contribute to low-end overloading of certain zones, is the potential of draindown of a portion of the Supply Lines. Sheet OS1.02 in the Record Drawings shows a topographical high point of the Supply Lines for Zones 3, 4, 5, & 6 near the northwest corner of Zone 3, and then from there, the Supply Lines run downhill to the Supply Manifolds for those four zones. So, those zone Supply Lines could potentially drain down to the lowest point of those zones, and out the lowest driplines. There were no air/vacuum breakers at that high point in the Supply Lines, so a vacuum might be created, preventing the draindown of those sections of the Supply Lines. However the zone Pressure Reducing Valves are located in a valve box near that high point, and on the May 27th 2025 site visit, that valve box was partially filled with water or effluent, signifying a leaky fitting(s) or valve(s). A leaky fitting or valve could also act as a slow vacuum breaker and allow that Supply Line to drain down.

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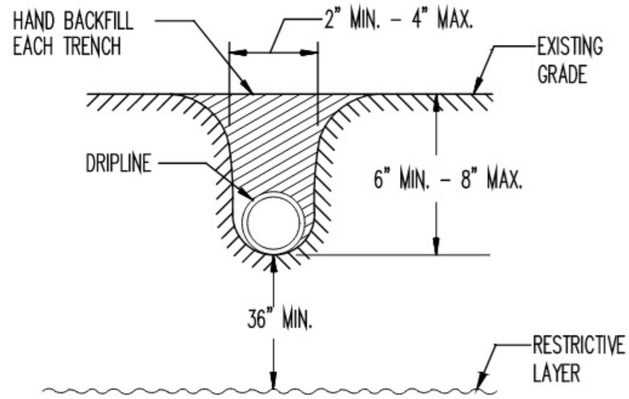
Other design issues were noted in the LOSS Repair Record Drawings. Detail #1 on Sheet OS2.04 shows a typical dripline trench:



1 **TYPICAL DRIPLINE TRENCH**
NOT TO SCALE

The Netafim™ Bioline Dripline has an outside diameter of almost ¾". With the detail above, this would mean that the cover over the top of the dripline would only be 5-1/4" to 7-1/4". This is shallower cover than the minimum dripline cover requirements as specified in WAC 246-272B (LOSS Code) and shallower than what is typically recommended.

WAC WAC 246-272B-06650 – Subsurface Drip Systems, paragraph *(3)* states:

> *"The dripline must be installed to a minimum depth of eight inches into original, undisturbed soil. Where frost is a concern, the design engineer should consider deeper placement."*

Aqueous has always interpreted this requirement to mean that the top of the dripline must have a minimum depth of cover of eight inches.

In Jefferson County, Washington, the lowland frost depth is considered 12 inches.

The 2012 Netafim™ design guide recommends that dripline be installed 8 to 12 inches below the surface:

Page 29 of the 2008 Netafim™ design guide/manual

DRIP TUBING INSTALLATION

One of the prime benefits of Bioline® is its ability to deliver effluent at a prescribed rate into the biologically-active layer of the soil that supports the roots of plants, trees and turfgrass. In conjunction with the effluent-purifying capabilities of the soil, the root systems provide valuable uptake of the effluent as well.

To maximize the soil's biological activity, the drip tubing will normally be installed 8 to 12 inches below the soil surface. Check local codes for depth of burial.

Colder climates may require deeper placement or additional cover to avoid freezing during periods of inactivity. **Frost Depth is 12" in lowland Jefferson County, Washington.**

Where conditions allow, manifold trench depth should be the same as the dripperline depth in order for the air/vacuum relief valves to work most effectively. In freezing climates, manifolds may have to be placed below the frost line.

During the May 27th, 2025 site visit, Aqueous discovered a failed area of dripline that had a small section of dripline with only 1-1/2 inches of cover, while other sections nearby had 6" to more than 8" of cover (but were still failing). Inadequate cover will also allow effluent to surface, however these failure spots would generally be localized. Regardless, based on the Jefferson County lowland frost depth of 12 inches, requirements and recommendations in WAC 246-272B and the Netafim™ design manual, the driplines should have been designed with a minimum of 8 inches of cover, with a preferred cover of 12 inches based on frost depth.

Another potential design issue is the layout of zones and driplines in a narrower configuration on the slope versus a preferred (and manufacturer-recommended) wide layout. A narrow layout of laterals relative to slope contours increases the number of dripline rows needed and increases the potential for "linear loading" and effluent breakout. The Netafim™ design manual addresses this narrow versus wide layout configuration:

Page 25 of the 2012 Netafim™ design guide/manual

WASTEWATER REUSE AND DRIP DISPERSAL GUIDE

MINIMIZING LINEAR LOADING BY WORKING WITH TOPOGRAPHY

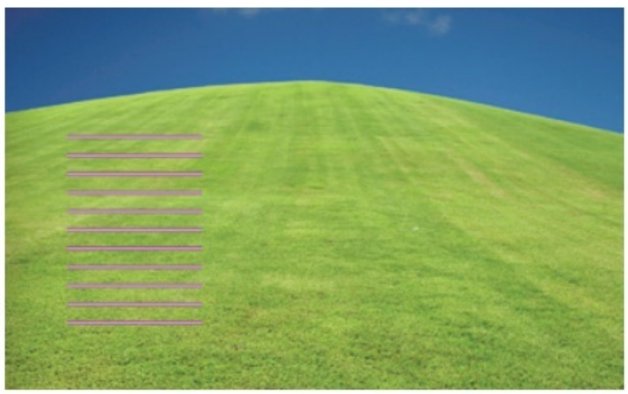


Figure 11 - Less Desirable Slope Layout
Laterals do not take advantage of the broad area of available soil to work with. This bunching of laterals increases the number of rows needed and increases the chance of saturation at the base of the slope.

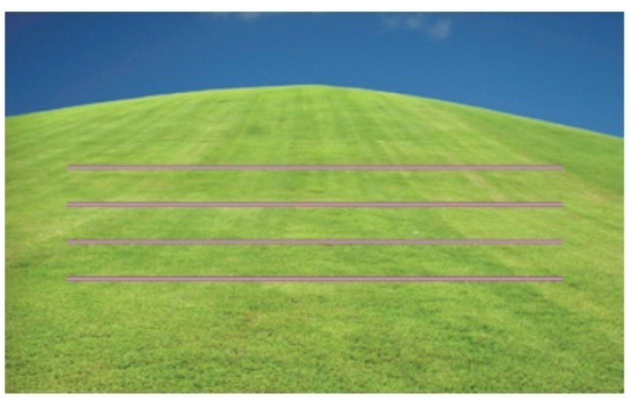
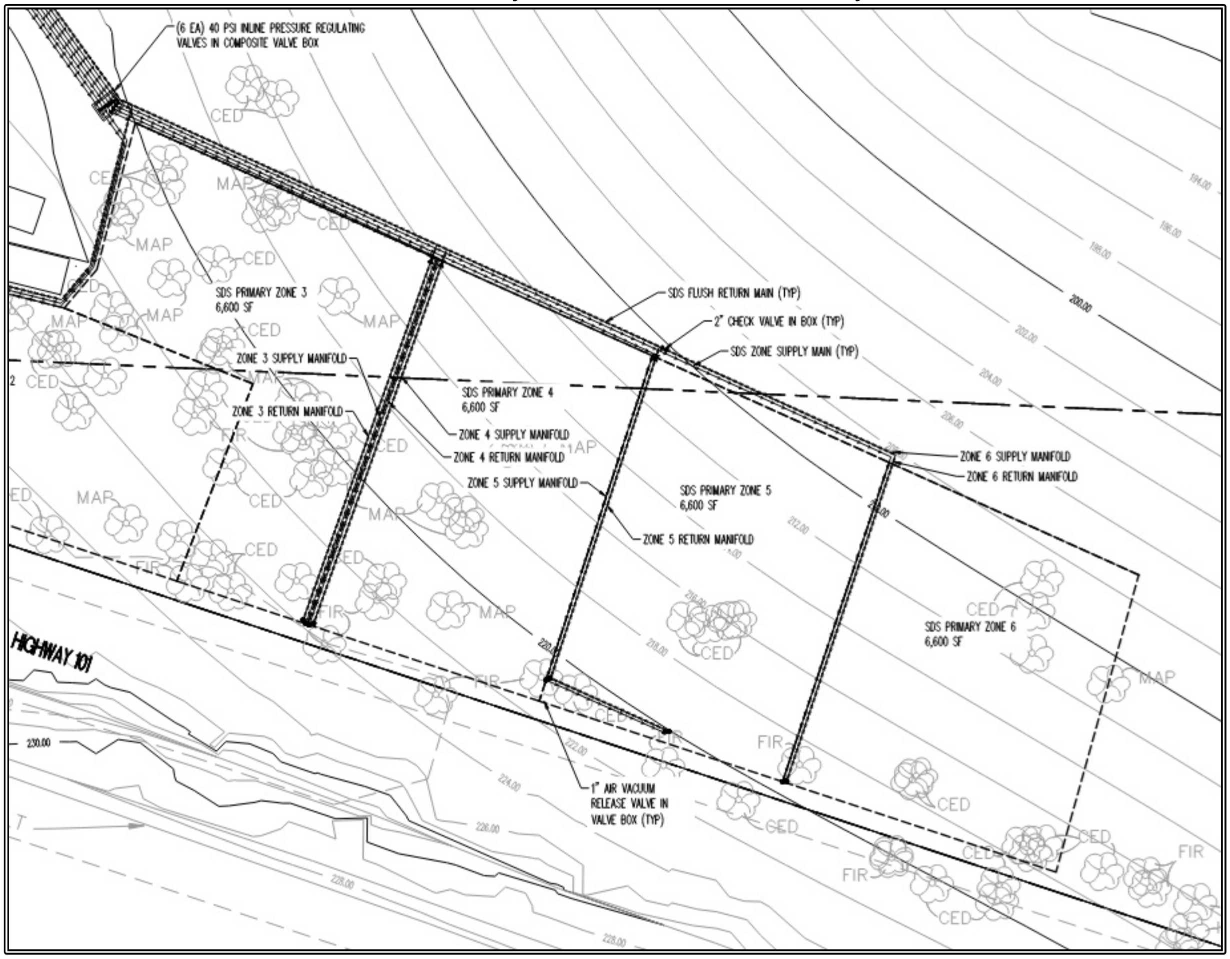


Figure 12 - More Desirable Slope Layout
Laterals move across (perpendicular) to the slope. Extending the laterals across the slope reduces the number of dripperline rows and increases the amount of workable soil.

The design layout of Zones 4, 5, 6, and a portion of Zone 3, as shown on Sheet OS1.02 of the LOSS Repair Record Drawings, has the zone configuration narrower down the slope, requiring many more rows of dripline laterals:

Sheet OS1.02 shows narrower zone layouts relative to contour layout for Zones 4, 5, & 6:



As stated in the Netafim™ design manual, "The bunching of laterals increases the number of rows needed and increases the chance of saturation at the base of the slope."

This could also be contributing to the drainfield failure of these three zones.

Another potential design issue has to do with the "*Typical Dripfield Layout*" detail (see Page 6 of this Report) and dripline flushing. The detail shows 15 individual dripline laterals, with very short dripline laterals in the low and high corners, and long dripline runs in the middle of the zones. When there are very short dripline laterals and very long dripline laterals within a zone, the short ones get the majority of the flushing due to less friction loss, and the long ones get minimal flushing and can thus build up sludge/bioslime. The Netafim™ design manual recommends keeping the dripline lateral lengths roughly equal to allow for nearly equal flushing velocities:

Page 24 of the 2012 Netafim™ design guide/manual

PIPING LAYOUT

There are many ways to lay out drip dispersal fields. It is common design practice to arrange the tubing so that dripperline lateral lengths are roughly equal and approximately 300 feet in length (refer to page 27 for actual lateral lengths for the various Bioline flow rates and dripper intervals.) Lengths greater than these may:

- Require the pump(s) to create more head and flow
- May not allow the dripperline to perform optimally
- May require too large of a drip field area to precisely manage.

It is standard practice to space rows of Bioline 24" apart, however, if the soil is capable of handling higher infiltration rates, there is no reason that the rows cannot be spaced more closely[5]. Check local codes.

Page 44 of the 2012 Netafim™ design guide/manual

IRREGULAR FIELD SHAPE LAYOUT

Triangular field with looping and varied positioning of flush manifolds:

- Used when site limitations dictate unequal dripperline length with respect to dispersal field length
- Loop the Bioline® to increase lateral length and reduce the number of connections
- Keep the Bioline laterals as close to the same length as possible to provide for an equal field flush
- The flush manifold may be located on the same or opposite side of the supply manifold
- As pictured, it may be necessary to make one or more distal end connections to the flush line on an opposing side in order to balance dripperline lateral lengths and to limit the number of connections

To exacerbate the dripline flushing issue with this design, the design called for only 1.0 FT/SEC flushing velocity at the end of the dripline laterals.

Job Name: Discovery Bay RV Resort
Date: 3/15/2019

System Data Input	
Gallons Per Day	8,000
Soil Loading Rate (Gallons / Sq. Ft. / Per Day [GPD])	0.27
Select Emitter Flow Rate (GPH)	0.42
Select Emitter Spacing (inches)	12
Flush Velocity (fps)	1

Having an end-of-dripline-lateral flushing velocity of 2.0 FT/SEC minimum is generally standard practice to keep any particles in suspension in the dripline. A minimum scouring of velocity of 2.0 FT/SEC is considered good practice in hydraulic design. The Netafim™ design manual also recommends a minimum 2.0 FT/SEC flushing velocity:

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Page 26 of the 2012 Netafim™ design guide/manual

> **Netafim's Position on Flush Velocity**
>
> Netafim has historically recommended using a 2 fps flushing velocity. This rate correlates to a Reynolds Number of 9000 which is well into the turbulent flow category (turbulent flow with Bioline begins with 0.9 fps). That said, there is no "correct" number since site and system conditions vary with every system. Among the considerations to be studied are whether the flushing is continuous or intermittent and the quality of the effluent.

Regarding the SDS drainfield failure, Aqueous also reviewed in-situ surface drainage/runoff patterns, and also reviewed the drainfield area soil logs from the design engineer and WA DOH, and neither surface drainage patterns nor compromised soils were found to be potential causes of the drainfield failure.

Surface drainage/runoff from adjacent Highway 101 was also reviewed as a possible cause, however surface runoff from the highway is collected & conveyed in roadside ditches to a small stream/drainage approximately 100 ft. east of the eastern-most end of the SDS drainfield, and there appeared to be no impact to the drainfield from this drainage. There is also an earthen berm/embankment between the highway ditch and the top of the drainfield that would prevent any surface runoff from flowing onto the drainfield. No drainfield failure (i.e. surface saturation) was observed in the top 2/3 to 3/4 of the drainfield zones.

Regarding drainfield area soils, Aqueous reviewed eight soil logs logged by both the design engineer and the WA DOH, and none of the soil logs indicated any groundwater or seepage was encountered. The soil logs were done in early February 2019 (i.e. the middle of winter).

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2.B. RECIRCULATING GRAVEL FILTER (RGF) SYSTEM

SECTION SUMMARY

The design of the Recirculating Gravel Filter (RGF) and drainfield dosing system included sending blended effluent from the RGF recirc. tank directly to the drainfield Dose Tank, not sending the cleanest effluent directly from the RGF (RGF filtrate) to the Dose Tank. Therefore, the TSS and BOD concentrations going to the Dose Tank are typically 3 to 4 times higher than they should be. This system should be modified to send only the cleanest RGF filtrate to the Dose Tank, as this will help to protect the drainfield.

The design engineer-recommended RGF recirculation ratio of 7:1 was only presented in the LOSS Engineering Report, Record Drawings, and O&M manual as being based on the Design Flow of 8,000 GPD. No mention was made of adjusting the recirc. ratio to the actual average daily flow, which has been much less than the design flow (about 3,000 – 3,500 GPD during the peak summer season). It does not appear the operational adjustments were ever made to adjust for the actual average daily flow. Thus, the actual recirc. ratio has been very high: about 15:1 to 20:1. This has allowed for the generation of excess brown aerobic sludge that plugs the Dosing Tank effluent filter and dripfield headworks filter, requiring much more maintenance than should be necessary, and has also compromised other downstream components like solenoid valves (i.e. due to sludge build-up). Nor was there any discussion of adjusting the recirc. ratio down to allow for more denitrification in the recirc. tank, while still trying to achieve near complete nitrification. Aqueous will adjust the recirc. pump timer settings based on the actual average daily flow to enhance system performance.

The LOSS Repair Engineering Report stated that the effluent from the RGF would be "*recirculated to the inlet of the septic tank to allow for maximum denitrification potential*", however this was not incorporated into the design, nor was it installed. The result has been poor Total Nitrogen reduction and depleted alkalinity (and additional BOD going to the RGF that would otherwise be consumed through denitrification). Documented depleted alkalinity could cause a low pH that could negatively affect the performance of the RGF, and overall treatment system performance. This system should be modified to incorporate a nitrate recycle/anoxic return line to the inlet of the septic tank, with the ability to adjust the nitrate recycle rate.

2.C. DRAINFIELD HEADWORKS AND DOSING SYSTEM

SECTION SUMMARY

Several design and operational issues were identified with the drainfield headoworks and dosing system should be improved while the SDS drainfield is still in use.

Only one pressure reducing valve (PRV) was incorporated upstream of the SDS headworks components (automatic backflusing filter, zone valves, flow meter). An o-ring failed in the PRV during this evaluation process, and excessive pressures in the headworks broke some nylon valve bodies, temporarily shutting down the LOSS, and causing expensive repairs. No known O&M service had been done on the PRV (nor was it a PRV meant for wastewater applications). The PRV manufacturer was consulted, and stated that due to the high system pressures possible, that two PRVs in a step-down configuration should be implemented.

A "Cross-over" solenoid valve between the Supply Line and Return/Filter Backflush Line was incorporated into the design, however, it is not understood what this line and valve is used for. It's use procedure is not incorporated in the Record Drawings or O&M Manual. This should be figured out, and corrected if necessary.

No isolation valve (i.e. ball valve) was incorporated on the drainfield Return line upstream of the Field Flush Valve, Cross-Over Valve, Return Flow Meter, or Return Line Pressure Gauge. Therefore, these valves are not serviceable without draining down the entire 1,500+ lineal feet of 2"Ø Return Line. A Return Line isolation ball valve should be added upstream of these components.

The Return Line Flow Meter is on the common line also serving the Filter Backflush. Therefore, Return Line flows cannot be differentiated from the filter backflush flows. If the SDS drainfield will remain in operation for some time, the Return filter should be relocated upstream of the filter backflush line. In addition, a new separate filter backflush line may need to be installed to meet the filter manufacturer's backflushing parameters for effective flushing (there is strong evidence that the filter is not backflushing properly).

3. WASTEWATER FLOW EVALUATION

3.A. WASTEWATER FLOWS

Limited flow data was available to evaluate, however Aqueous was able to examine average daily flows from May 27th, 2025 to July 29th, 2025. Aqueous performed a pump flow and flow meter calibration check of the SDS Supply Flow Meter on May 27th and confirmed that the meter appears to be recording flows fairly accurately. A summary of the flow monitoring is presented in Table 3.1 below.

Table 3.1 – Average Daily Flow to LOSS Drainfield

Reading Date	Elapsed No. of Days	Supply Flow Meter[1]			Return Flow Meter[2]			Average Daily Flow Into Drainfield[3]
		Totalizer Reading	Elapsed Volume	Average Daily Flow	Totalizer Reading	Elapsed Volume	Average Daily Flow	
		(gallons)	(gallons)	(gal/day)	(gallons)	(gallons)	(gal/day)	(gal/day)
5/27/2025	-	5565170	-	-	712660	-	-	
6/24/2025	28	5654530	89,360	3,191.4	712683	23	0.8	3,190.6
7/29/2025	35	5768170	113,640	3,246.9	714025	1,342	38.3	3,208.5

[1]The Supply Flow Meter monitors flow to the drainfield. Aqueous Solutions Engineering (Aqueous) performed a basic flow meter calibration check on May 27th, 2025 and found the flow meter to be recording fairly accurately.
[2]The Return Flow Meter monitors return flow from the drainfield, and backflush flow from the disc filter assembly. Flows cannot be distinguished between what is drainfield return flow and what is filter backflush flow. Therefore, the flow into the drainfield (Supply flow minus Return Flow) may be under-reported if there is much filter backflush flow. Aqueous has not yet performed a calibration check of this flow meter.
[3]The total flow into the drainfield, though this may be a little under-reported if there is much filter backflush flow.

Average daily flows of around 3,200 GPD are well below the LOSS Design Flow of 8,000 GPD.

3.B. I&I – OBSERVATIONS AND FURTHER STUDY NEEDED

A flow evaluation of winter-time, or "wet season", wastewater flows was not performed for this LOSS Engineering Evaluation. Some DBWC staff and owners mentioned that they have seen high flows during the winter months when community occupancy is down. DBWC staff have also mentioned higher groundwater and surface runoff during the winter months.

It is recommended to evaluate "wet season" flows, and to conduct an I&I investigation if high flows are observed that might negatively affect the drainfield and treatment system performance. Excessive I&I – Groundwater Infiltration & Surface Water Inflow – can hydraulically overload the drainfield, and it can reduce hydraulic retention times in the septic tank and potentially cause solids transfer to downstream components.

4. WASTEWATER STRENGTH EVALUATION

Aqueous reviewed wastewater strengths of the "final effluent" from the Dose Tank (collected as required by the LOSS Operating Permit) as well as samples from the septic tank effluent and from the RGF basin (i.e. the RGF filtrate) for two additional sample events. The sample results are presented in Table 4.1 below.

Table 4.1 – Effluent Sample Results

Sample Date	Sample Location[1]	BOD_5 (mg/L)	$cBOD_5$ (mg/L)	TSS (mg/L)	O&G (mg/L)	Nitrite/ Nitrate (mg/L)	TKN (mg/L)	TN (mg/L)	Alkalinity (mg/L)
5/31/2022	Dose Tank	-	11.8	19	<5.0	40.8	14.9	55.7	-
7/6/2022	Dose Tank	-	<2.0	25.3	<5.0	43.5	13.4	56.9	-
9/6/2022	Dose Tank	-	42.1	35.2	<5.0	8.95	42.9	51.85	-
1/3/2023	Dose Tank	-	6.3	14.5	<5.0	45.6	<0.2	45.6	-
7/6/2023	Dose Tank	-	<2.0	31.5	<5.0	66.3	13.6	79.9	-
9/5/2023	Dose Tank	5.0	-	8.8	<5.0	60.2	22.2	82.4	-
11/28/2023	Dose Tank	-	9.1	31.8	<5.0	14.3	41.4	55.7	-
1/2/2024	Dose Tank	-	7.5	10.5	<5.0	29.7	29.49	59.19	-
5/28/2024	Dose Tank	-	38.5	18.8	<5.0	17.7	42.9	60.6	-
7/9/2024	Dose Tank	-	38.4	16	<5.0	53.9	49.7	103.6	-
9/3/2024	Dose Tank	-	10.4	20	<5.0	30.5	118.0	148.5	-
1/7/2025	Dose Tank	-	10.1	12	<5.0	35.8	5.2	41	-
5/29/2025	Septic Tank Eff	-	138.7	37	19.0	0.112	88.0	88.1	405
5/29/2025	Dose Tank	-	8.2	26	<5.0	45.4	11.3	56.7	55.3
5/29/2025	RGF Filtrate	-	<2.0	10	<5.0	54.3	5.6	59.9	12
7/8/2025	Septic Tank Eff	-	>30.1	62	13.0	0.12	91.9	92.0	394
7/8/2025	Dose Tank	-	<2.0	13	<5.0	0.148	18.2	18.3	34
7/8/2025	RGF Filtrate	-	<2.0	7	<5.0	49.4	2.0	51.4	<1.0

[1]The effluent sent to the Dose Tank is directly from the Recirculation Gravel Filter (RGF) recirculation tank, so it is a blend of effluent from the septic tank and effluent from the RGF. The cleanest effluent from the RGF – the RGF Filtrate pumped from the RGF pump basin – is not sent directly to the Dose Tank.

As discussed earlier in this Report, the "final effluent" being sent to the Dose Tank, and thus to the SDS Drainfield, is actually the blended effluent in the recirc. tank (i.e. a blend of septic tank effluent and RGF filtrate. The cleanest RGF filtrate does not go directly to the Dose Tank.

As can be seen by this data, the Dose Tank effluent does not consistently meet WA DOH Treatment Level "C", although the LOSS Operating Permit does not require the final effluent to meet Treatment Level "C" since the LOSS Repair drainfield was approved for 36 inches of Vertical Separation.

Reconfiguring the system to send the RGF filtrate to the Dose tank would mean that the final effluent could easily and consistently achieve a Treatment Level "C" status. With final effluent meeting Treatment Level "C" criteria, the required Vertical Separation in the drainfield could be reduced to 24 inches, which would be more suitable for the proposed drainfield repair of a trench-type pressure distribution drainfield.

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5. CONCLUSION

As presented in this Report, the existing subsurface drip system (SDS) drainfield serving the Discovery Bay Women's Club has failed. The failure is caused by low-end overloading, due to improper design not accounting for dripfield zone drain-down on the sloped site. Other design and installation issues are believed to enhance the failure condition.

A reasonable repair of the SDS drainfield is not likely, due to the amount of disturbance that would be created. Similarly, a full re-design of the SDS is not recommended due to the existing SDS infrastructure that would need to be fully removed, thus creating a significant disturbance.

6. RECOMMENDATIONS

6.A. DRAINFIELD RECOMMENDATION

Aqueous Solutions Engineering is recommending the replacement of the failed SDS drainfield with a trench-type pressure drainfield. A trench-type drainfield will allow deeper installation of the infiltrative surface, deeper than what has already been disturbed with the SDS installation. The bottom of the trenches will be able to be installed into native, mostly undisturbed soil.

The drainfield site is challenging. Aqueous will need to carefully evaluate the existing site to determine the feasibility of a pressure distribution drainfield. A small pilot drainfield (a couple of trenches, with flow proportioning) may be warranted to test out the infiltration capacity.

A new drainfield dosing tank and control panel would most likely be incorporated near the drainfield.

Aqueous recommends that DBWC, the WA DOH – LOSS Program, and Aqueous have a meeting to discuss the potential for a trench-type pressure distribution drainfield after some additional topographical information is collected & evaluated for a potential PD layout.

6.B. RECOMMENDATIONS FOR PRIMARY TREATMENT AND RGF MODIFICATIONS

Aqueous is recommending the following modifications to the primary (i.e. septic tank) and secondary (i.e. RGF) treatment system components to enhance overall treatment performance and send cleaner effluent – meeting Treatment Level "C" at a minimum – to the LOSS drainfield:

- Revise the RGF pump timer settings to achieve the desired recirc. ratio based on the actual average daily flow, and consider adjusting the recirc. ratio down (to 4:1 or 5:1) to enhance performance and lower energy consumption;

- Reconfigure RGF system to send cleaner RGF filtrate to the drainfield Dose Tank;

- Reconfigure system in add a nitrate recycle/anoxic return line back to the septic tank inlet, with the ability to adjust the nitrate recycle/anoxic return rate;

- Modify the SDS headworks to provide redundancy of the pressure reducing valve, and install a Return Line isolation valve to allow servicing of downstream valves &components.