VPUU Kick-About Sanitation System Operations Manual

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Sanitation System Overview

The sanitation system installed at the kick-about was designed to address the immediate needs of the container ablution facilities to be installed in January 2011, by providing the capability to process approximately 100 uses per day. However, it is understood that this usage could change in the future, so system was also designed to remain flexible for later expansion and creative wastewater reuse efforts. The design and construction of the sanitation system was a collaborative effort between Worcester Polytechnic Institute, Violence Prevention through Urban Upgrading, the University of Cape Town, and 4EVR Plastics. While these joint design efforts have resulted in a design that is expected to be reliable, it includes the use of new, experimental technologies that have not yet been test in informal settlements. As a result, it's important to continually monitor the system and adjust maintenance procedures as necessary to assure it's continual operation. This manual details expected maintenance, operation, and inspection procedures.

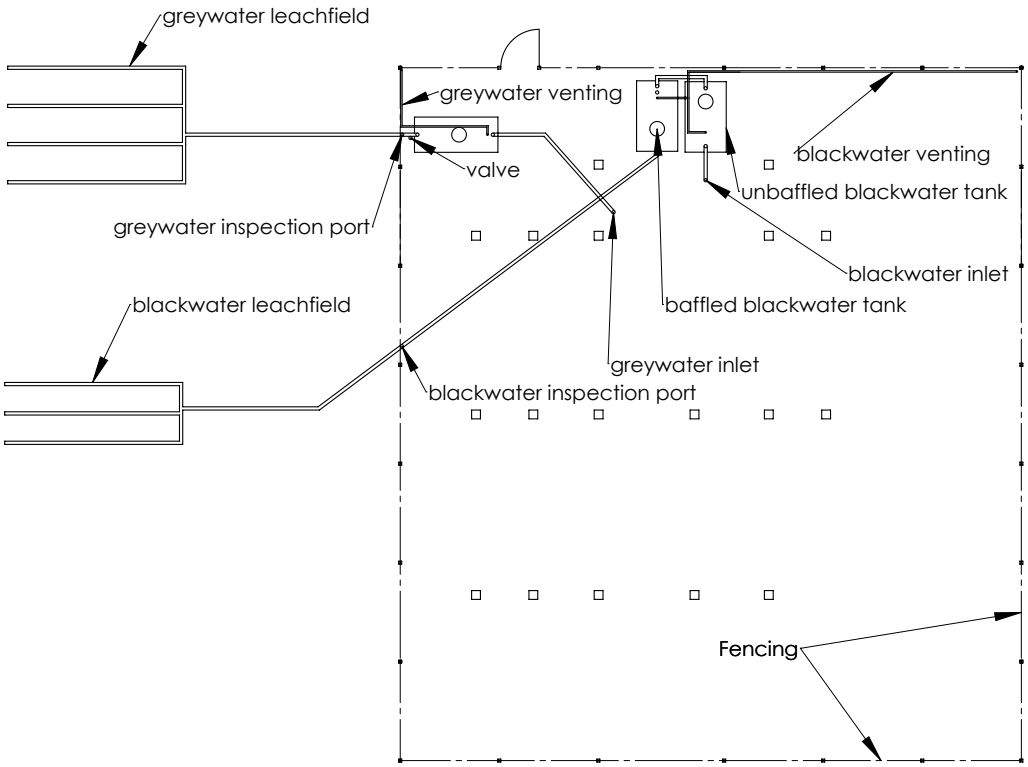


Figure 1: Sanitation System Overview

Greywater and Blackwater Separation

To accomplish this, the system was designed so that the water from the two basins and two showers, known as greywater, is processed separately from the water from the two toilets, known as blackwater. Greywater is much cleaner than blackwater, which makes it well suited for future use as recycled flush water or for watering plants. The blackwater requires further treatment before it can be released to the environment and certainly if reuse is considered, and therefore it is processed independently. Treating the greywater and blackwater separately ensures that each is treated properly, helps to reduce opearions and maintenance (O&M) cost by only treating water as needed, and allows upgrades and changes to be made to each system. A complete diagram of the system can be seen above in Figure 1.

Greywater System

The greywater system, as seen in Figure 1, is comprised of two major components: the 2200 liter greywater tank and the greywater leach field. First, the wastewater exits the basins and showers and flows into the greywater tank, where it collects. Because the greywater may start to produce odors if left in the tank for too long, the tank is equipped with a valve that allows it to be emptied at will, which we anticipate may be as often as once a day. When emptied, the water from the tank flows into the leach field – a series of pipes with drainage holes that allow the wastewater to drain into the ground. The leach field functions similar to a soak-away, but provides the advantage of spreading the water over a larger area. This helps to ensure that the ground will be able to absorb all the water without becoming saturated and flooding, and increases sanitation. The greywater leach field was placed closeto the surface, to allow future possibilities of watering grass with wastewater. If the tank becomes full before the release valve is opened, it is equipped with an overflow pipe that allows excess water to drain into the leach field.

Blackwater System

The blackwater system (Figure 1), is composed of three major components: two 3600 liter blackwater tanks and a blackwater leach field. First, the wastewater exits the toilets and flows into the unbaffled blackwater tank. Here most of the solids settle out of the wastewater and collect at the bottom of the tank. The wastewater remains here for a while, as bacteria present in the tank break down the solids and help to clean the wastewater. As new wastewater enters the tank, it displaces the partially treated water in the middle of the tank into the baffled tank, as seen in Figure 2 below. The baffled tank

is equipped with two chambers, which further help to settle out solids and clean the water with bacteria. This process of using multiple tanks and chambers to better clean the water is known as having an anaerobic baffled reactor (ABR). When the final chamber fills to the top, the water from the tank flows into the black water leach field, draining the water into the ground. Despite the recommendation of the manufacturer 4EVR Plastics, the blackwater tanks were not entirely encased in concrete during installation. This change in procedure was made at the discretion of VPUU William Trom, who stated "the VPUU often makes changes to manufacturer's specifications as needed when installing equipment."

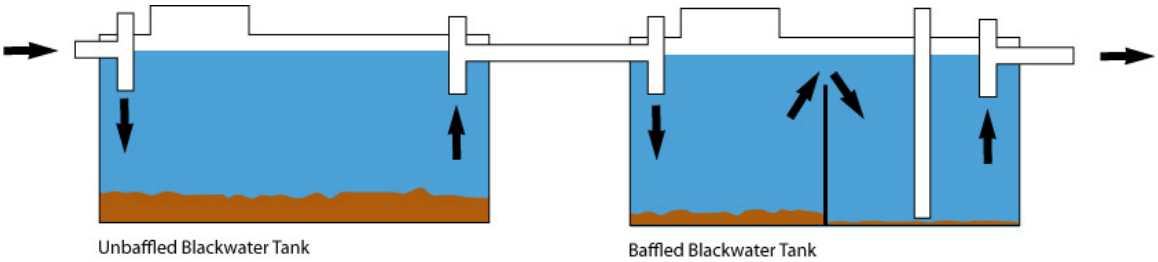


Figure 2: ABR Operation of the Blackwater Tanks

Connecting Toilet Facilities to System

The following steps detail the correct procedure for connecting the ablutions container plumbing to the sanitation system.

1. Connect the outlets from the showers and basins to the greywater input, labeled "showers and basins." If any pipe needs to be run horizontally, ensure the pipe slopes downward approximately 1m for every 40m of pipe.
2. Install screens or grates on all basin and shower drains. This will prevent trash or other waste (like hair) from getting into the system and causing clogs.
3. Connect the outlets from the toilets to the blackwater input, labeled "toilets." Again, make sure the minimum slope of each connecting pipe is downward at approximately 1m for every 40m of pipe. If the slope is less than this, the water may not move into tanks. If the slope is greater than this, the water may move downhill too fast and not carry the solid waste with it.

Sanitation System Operations and Maintenance

Emptying the Greywater Tank

Although greywater is relatively clean, it contains soap and human waste residue that can cause odors if the water is left to sit too long. As discussed in the "Greywater

System" section above, the greywater tank is equipped with a valve that allows it to be emptied every day. To operate this valve and empty the tank, follow the procedure below.

1. Slowly turn the valve handle (shown below) counter-clockwise until stop point is reached to open value.
2. Wait 30 minutes.
3. Turn the valve handle clockwise to close.

If odors and scum build-up are not problems, the system can be allowed to operate without surging. However, surging the leach field will provide a more even distribution of wastewater into the ground. If grass is planted above the leach field, or the leach area becomes too soft, surging is the recommended.

Removing Sludge from the Blackwater Tanks

Why the Tanks Need to be Pumped

The blackwater tanks make use of anaerobic baffled reactor technology, which uses bacteria to break down and eliminate the solid organic wastes introduced from the toilets. Unfortunately, human waste contains some compounds that the bacteria cannot fully digest, which forms sludge in the bottom of the tank. Over time, this sludge builds up and eventually begins to fill the tank, reducing the space in the tank for liquid and impairing the operation of the system. When this occurs, usually every two or three years, the tank will need to be pumped out, to ensure the toilets are able to continue flushing properly. Because most of the solids will settle in the first of the unbaffled blackwater tank, this tank may need to be pumped more frequently than the baffled tank.

How to Tell When the Tanks Need to be Pumped

The section below titled "Monthly Inspection Procedure" details a method of sticking a probe into the tank once a month to monitor sludge levels. Using this method should provide an accurate predication of when the tanks will need to be pumped. However, if at any time the toilets slow or stop flushing, the tanks should be checked to see if they are too full and need to be pumped. The "Monthly Inspection Procedure" section details how to properly open the tanks and check sludge level. When pumping is required, contact a service provider.

Things to Remember When Having Tanks Pumped

Normally, septic tanks are pumped by removing the manhole cover and lowering a hose into the tank, which sucks out solids and liquids. This procedure will work fine for the unbaffled blackwater tank, but care needs to be taken to ensure the baffled

blackwater tank is pumped correctly, because it has a divider in the middle of the tank. If this tank is not pumped correctly, one side of the tank may retain sludge and water in it, which could put undue pressure on the internal baffle, damaging it and impairing the function of the tank. The following steps detail how to properly pump the baffled blackwater tank. The actual pumping will need to be done by a sanitation professional, but a VPUU O&M worker should be present to make sure the pumping is executed according to this procedure.

If possible, do not pump tanks during the wintertime, when the water table in the ground rises up, potentially causing the tanks to lift or shift during pumping.

1. The chamber under the manhole cover should be pumped first to reduce strain on the baffle. To do this, connect the pump hose to the manhole cover, as seen in the picture below. Run the pump until approximately half the chamber has been emptied.
2. Connect the pump to the access pipe and empty all solids and liquids from this chamber.
3. Return pump to manhole and finish pumping chamber until empty.

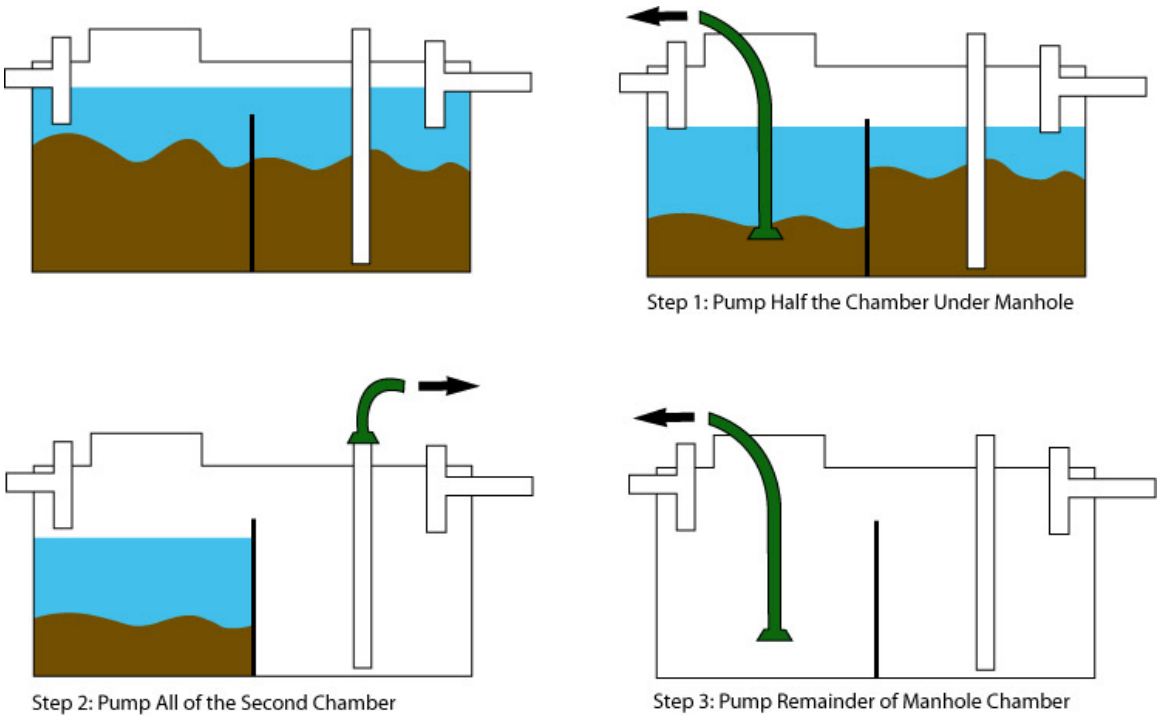


Figure 3: Proper Tank Pumping Procedure

Operating Toilet Systems

The sanitation system was designed to allow the toilets to be used normally and reliably on a daily basis. While there is no special procedure for using the toilets, there are a few items of maintenance that must be completed by a VPUU worker or caretaker to ensure that toilets continue working and the sanitation system remains clog free, as detailed below.

1. Provide the toilets with proper toilet paper. Alternative materials like cement bags or newspaper will not dissolve in water and will clog piping or the blackwater tanks.
2. Provide each toilet with a trashcan to prevent users from flushing trash and other non-organic products that will not dissolve in water.
3. Post signs in toilet stalls that educate users only to use toilet paper and not to flush trash.

Additionally, it would be beneficial to have a chalkboard in the ablutions containers where users place a tally each time they use the basin, shower, and/or toilet. The caretaker or a VPUU employee could record these numbers over a period of time in order to better understand the usage of the facility. This record could help determine the success of the system, as well as impact future developments.

Sanitation System Inspections

Daily Inspection Procedure

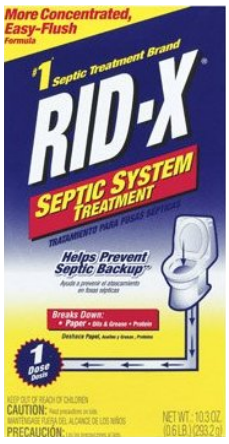
The sanitation system was designed to allow the toilets, basins, and showers to be used normally with very few special procedures required. However, a VPUU worker should complete a few daily inspections to ensure the system continues to function properly and prevent larger problems in the future. These inspection points are listed below.

1. Ensure all facilities are working properly. The toilets should flush and the basins and showers should drain properly without restriction. If not, this may indicate a problem with plumbing, or a full tank. The section "Monthly Inspection Procedure" details how to open the tanks and check if they are too full.
2. Make sure all toilets are provided with toilet paper.
3. Make sure all toilets are provided with trashcans to prevent users from flushing trash. These trashcans will need to be emptied when they are full, so the trash is properly disposed of.
4. Inspect the screens or grates installed on the basin and shower drains. If these are becoming clogged with trash or hair, they should be cleaned.

Monthly Inspection Procedure

Blackwater Tank Additives

As discussed in the section "The Blackwater System," the blackwater tanks contain bacteria, which help to break down and process solid wastes. Additives are commercially available that help enhance the activity of this bacteria, especially during periods of low system use. Because the number of uses of this system may vary, it is recommended an additive is added to the system once per month, by flushing the additive powder down the toilet. An example additive is shown below, but comparable brands can be found in hardware stores, or on the internet.



Inspecting Blackwater Tank Sludge Levels

As discussed in the section "The Blackwater System," sludge can build up in the blackwater tanks and must be occasionally emptied. The following procedure details how to measure determine sludge level in the tanks to determine when pumping is required.

CAUTION: The inside of the blackwater tanks are unsanitary and should not be handled without taking proper safety precautions. All workers performing the following procedure should wear latex gloves, take care not to spill any liquid on themselves, and wash any contaminated areas with soap immediately afterwards.

1. Remove the manhole cover from the first blackwater tank.
2. Take a 2m long pole and wipe it clean with a rag.
3. Lower the pole down into the manhole until it reaches the bottom of the tank.
4. Slowly remove the pole from the tank.
5. If there is a black sludge mark on the pole covering more than 1m, the tank will need to be pumped.
6. Replace the manhole cover.
7. Repeat steps 1-6 to test the first chamber of the second tank.
8. Remove the cap from the second chamber access pipe on the second tank.
9. Repeat steps 2-5.
10. Replace the cap to the first chamber access pipe.

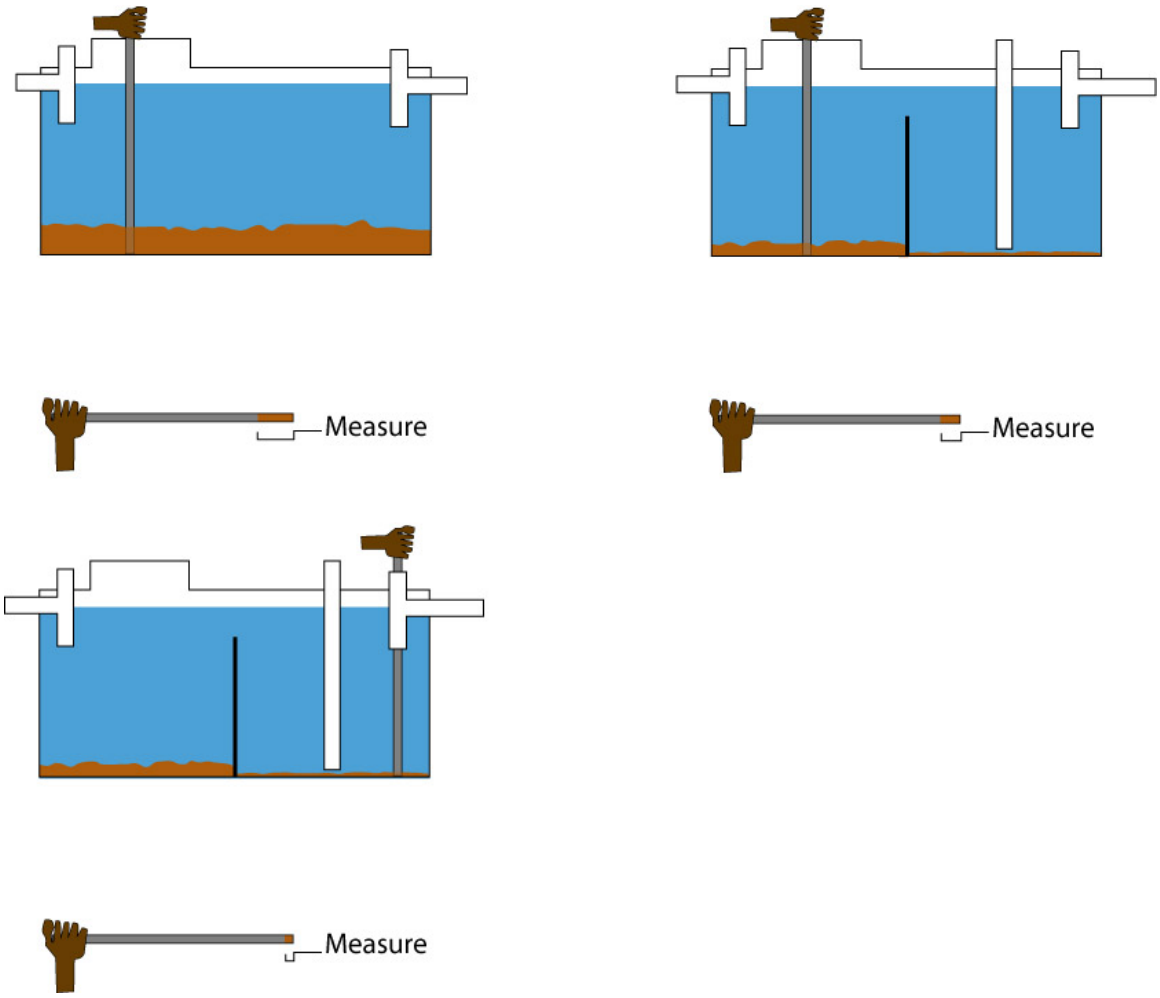


Figure 4: Inspecting Sludge Levels

Inspecting Greywater Tank

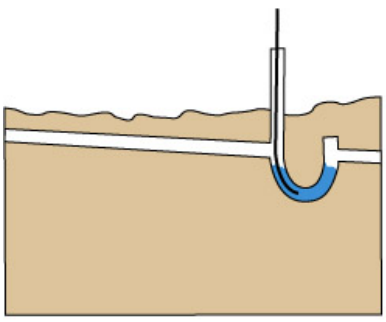
As discussed in section the "Greywater Tank," wastewater should normally only remain in the greywater tank for a maximum twenty-four hours. Despite this, the tank should be inspected once a month to ensure soap scum is not forming and no solid trash has collected in the tank. To inspect the tank, open the manhole cover and look inside. Any trash or scum build up should be scooped out; trying to rinse contaminants out of the tank could clog the leach field.

Inspecting Water Quality

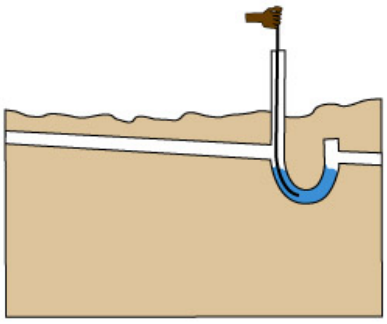
Besides ensuring the system continues to function, inspections also need to be performed to ensure the system is meeting health standards and not creating a hazard for residents and workers in the area. As seen in the diagram below, two inspection points have been built into the system, to allow water leaving the greywater and blackwater systems to be inspected before it enters the ground, as seen in Figure 1. The following steps detail how to extract water from these test points. The following procedure should be completed by a VPUU worker or a UCT representative and samples can be sent to UCT for testing (contact Kevin Winter at 021 650 2875, Kevin.Winter@uct.ac.za).

CAUTION: The water leaving the blackwater tanks is unsanitary and should not be handled without taking proper safety precautions. All workers performing the following procedure should wear latex gloves, take care not to spill any liquid on themselves, and wash any contaminated areas with soap immediately afterwards.

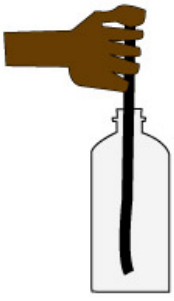
1. Remove the screw cap from the blackwater test access point. As seen in Figure 5, lower a 1.5m tube down into the inspection point.
2. When the tube reaches the bottom, put a thumb over the exposed end of the tube.
3. Extract the tube from the inspection point and put the wet end of the tube in a plastic collection bottle.
4. Release thumb from tube to deposit the liquid into the collection bottle.
5. Repeat this procedure from the greywater collection. Be sure to use a separate collection bottle.



Step 1: Insert Tube into Inspection Point



Step 2: Place Thumb Over Top of Tube

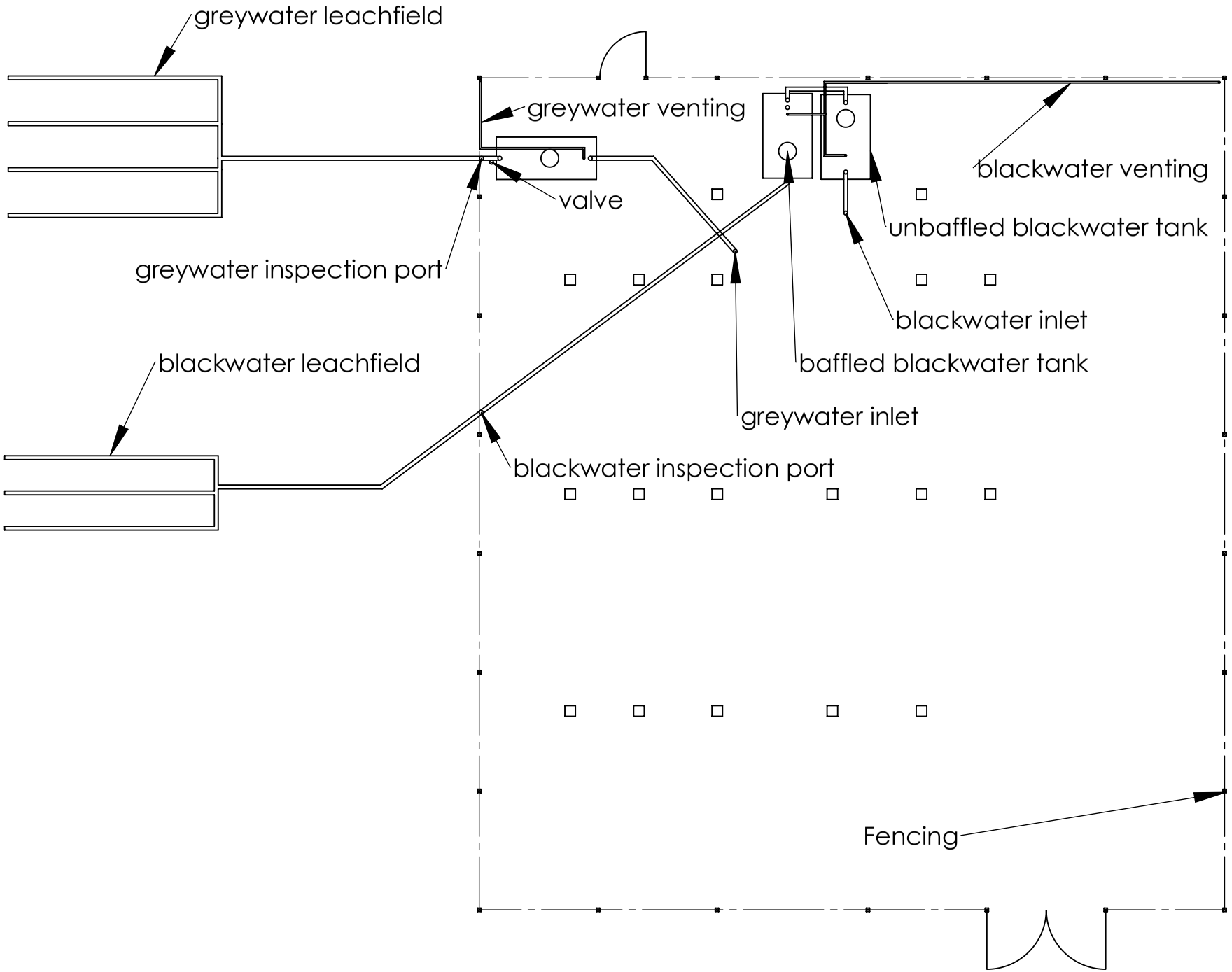


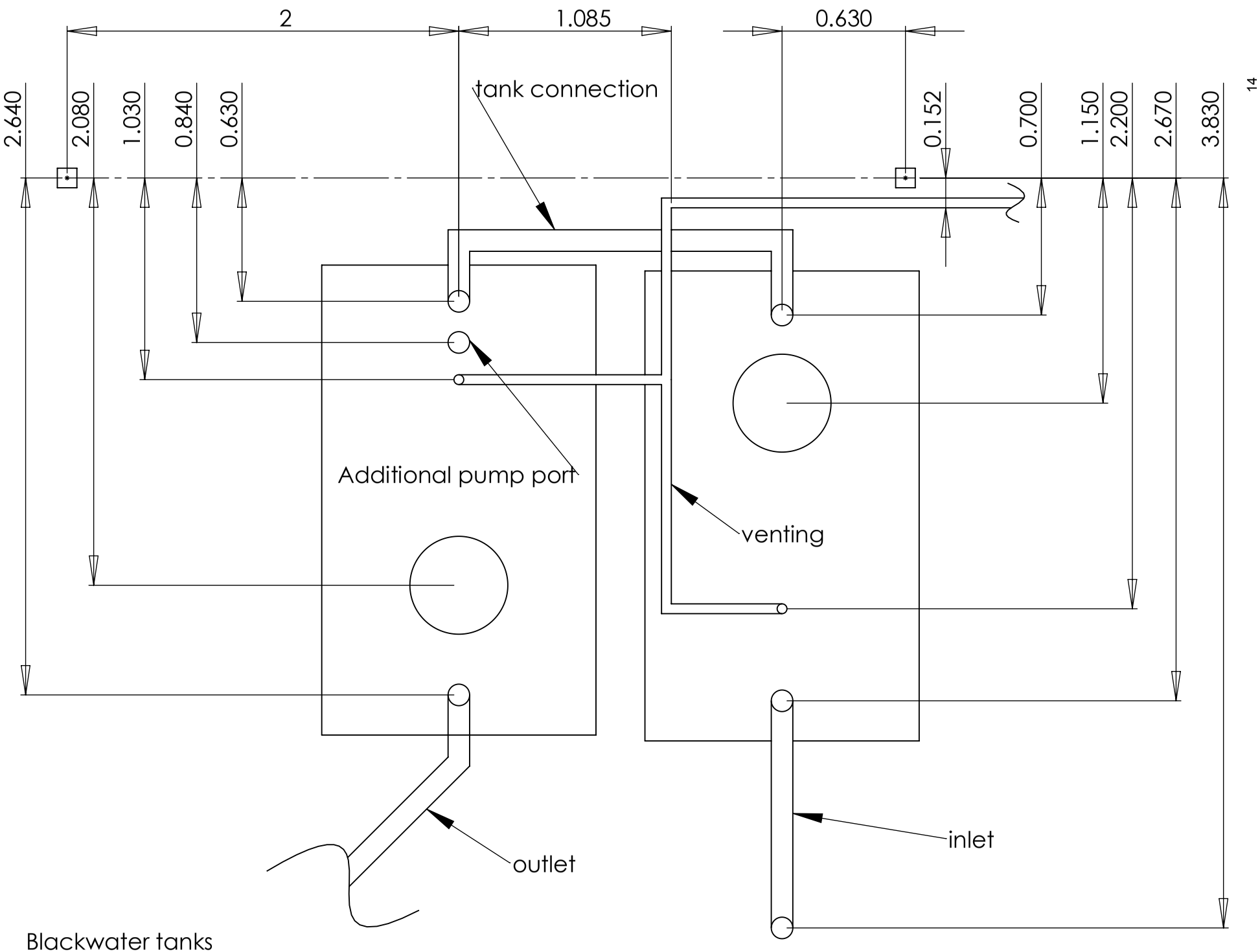
Step 3: Insert Tube into Collection Bottle

Step 4: Release Thumb and Drain Water

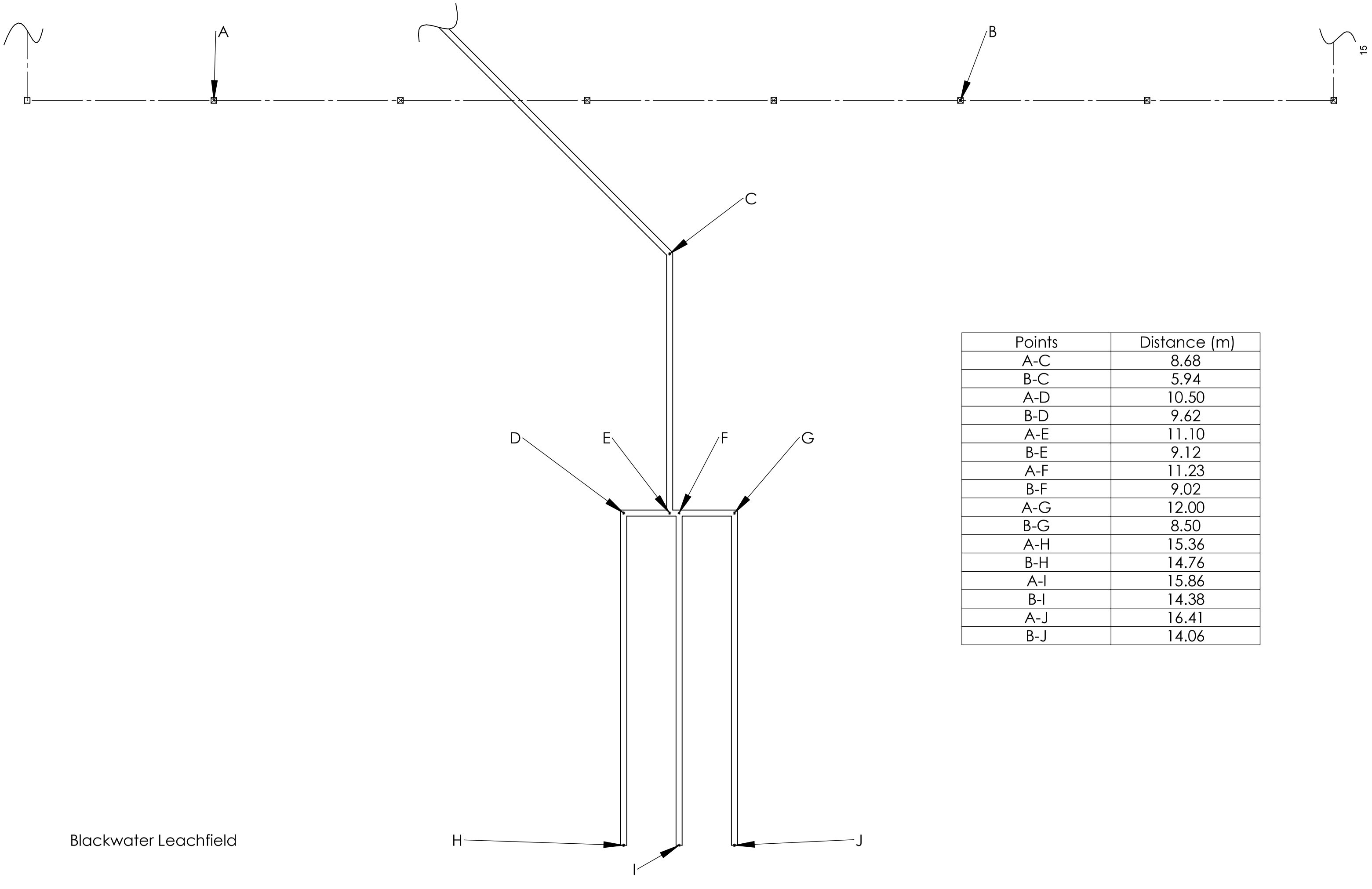
Figure 5: Collecting Water Quality Samples

Kickabout


greywater leachfield
greywater venting
blackwater venting
valve
unbaffled blackwater tank
greywater inspection port
blackwater inlet
blackwater leachfield
baffled blackwater tank
greywater inlet
blackwater inspection port
Fencing

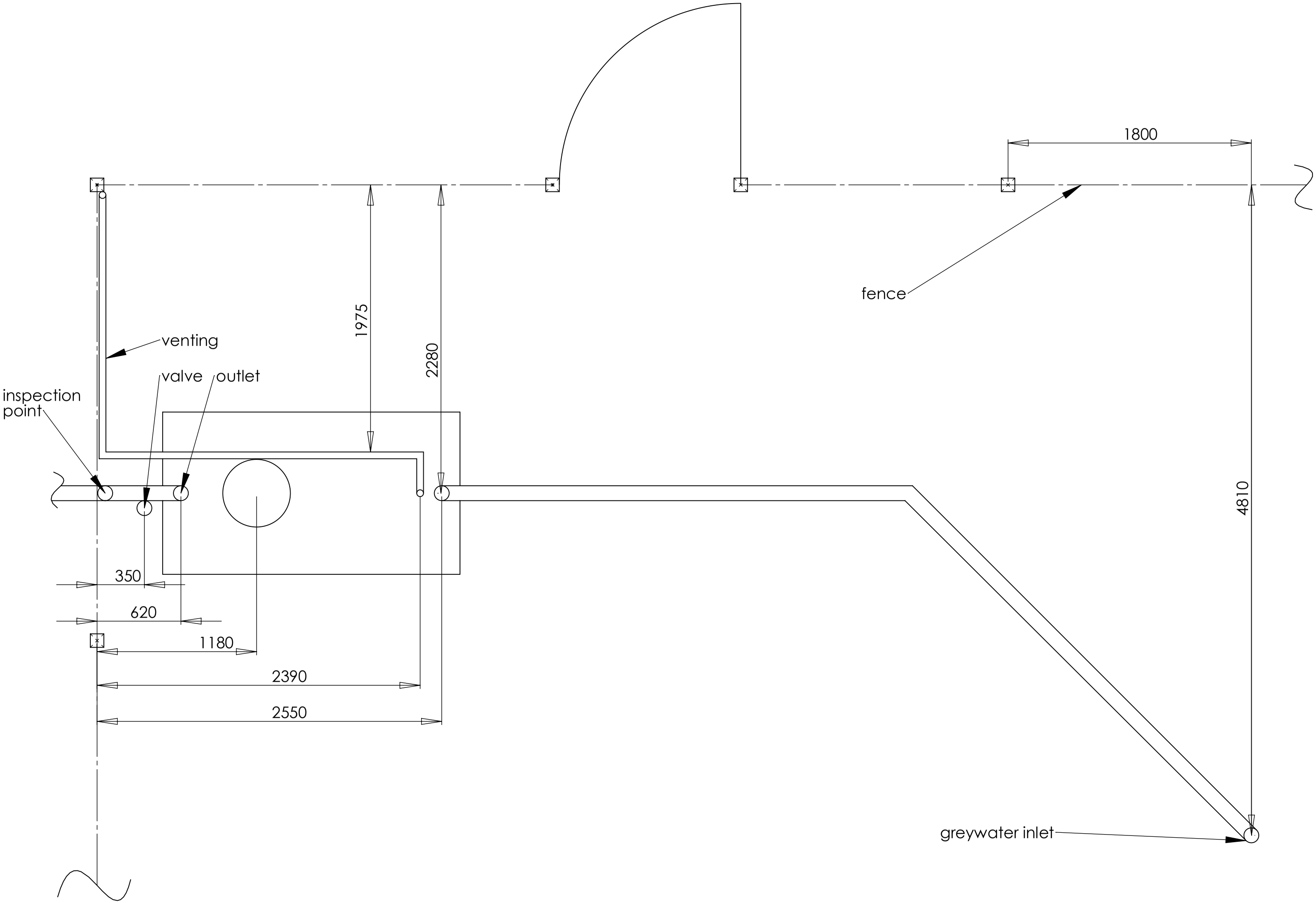


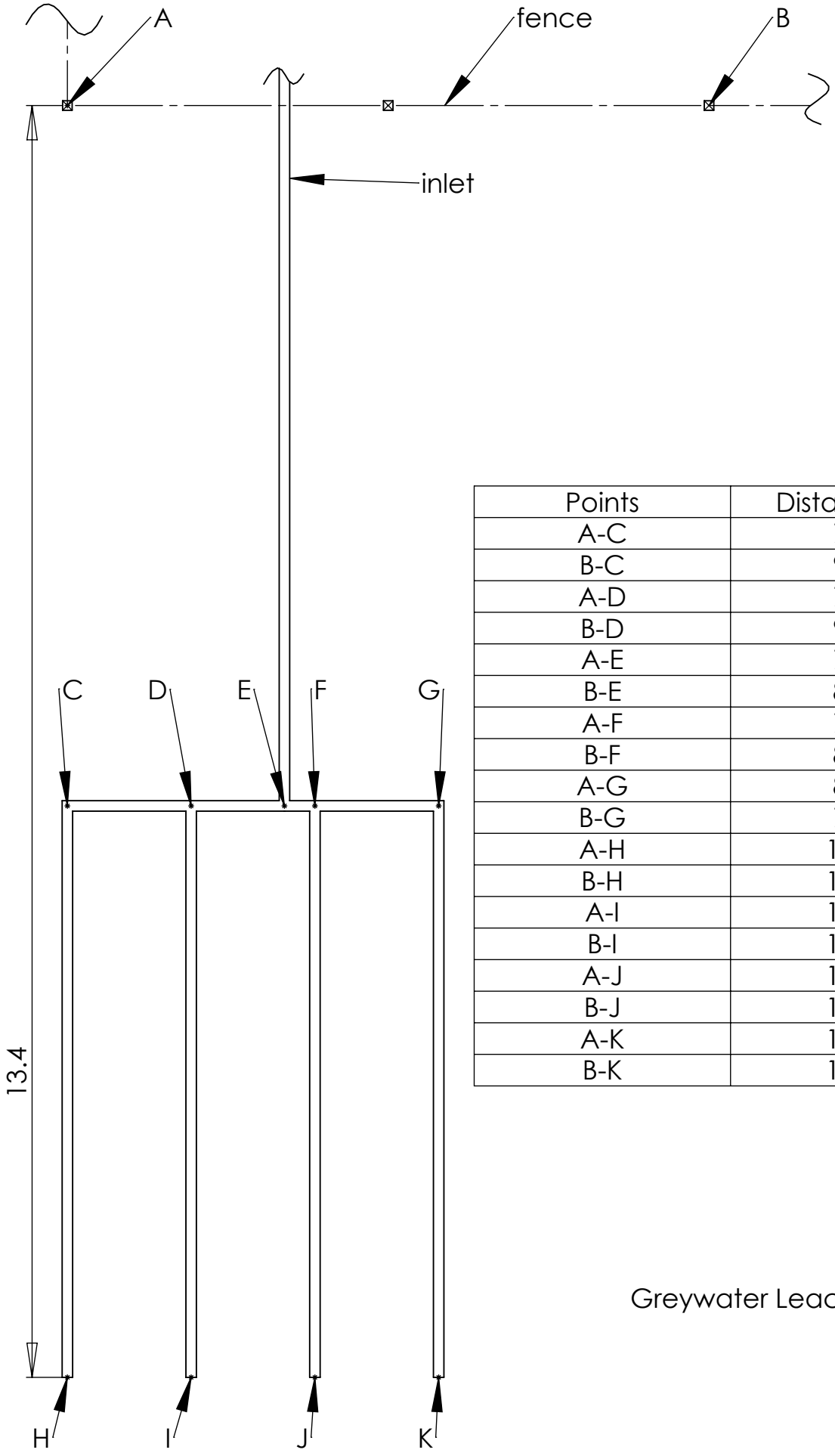
Blackwater tanks



Points	Distance (m)
A-C	8.68
B-C	5.94
A-D	10.50
B-D	9.62
A-E	11.10
B-E	9.12
A-F	11.23
B-F	9.02
A-G	12.00
B-G	8.50
A-H	15.36
B-H	14.76
A-I	15.86
B-I	14.38
A-J	16.41
B-J	14.06

Blackwater Leachfield


1800
fence
1975
2280
venting
valve
outlet
inspection point
350
620
1180
2390
2550
4810
greywater inlet



Points	Distance (m)
A-C	7.35
B-C	9.98
A-D	7.47
B-D	9.15
A-E	7.70
B-E	8.60
A-F	7.80
B-F	8.44
A-G	8.32
B-G	7.88
A-H	13.35
B-H	14.96
A-I	13.42
B-I	14.42
A-J	13.61
B-J	13.98
A-K	13.91
B-K	13.65

Greywater Leachfield

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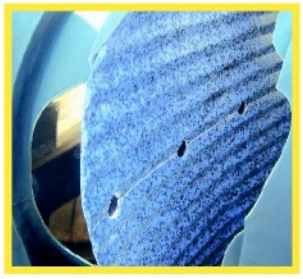
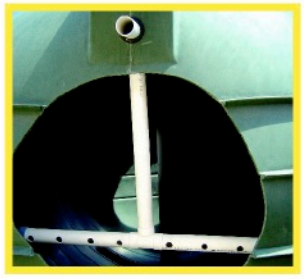
WHY 4EVR?

- Roto-moulded as one integral part to ensure a watertight unit
- Heavy-duty reinforced ribs for extra strength
- Internal baffle for dividing solids and fluids
- Unique internal pipe and tube system ensures no unwanted spillage
- Patented connection system for ease of installation
- Removable manhole cover can be filled with concrete
- Easy access to inlet and outlet
- Can be easily pumped out when necessary
- Our tanks can be linked to increase capacity
- **Fittings included**



An internal baffle separates the floating solids and the fluids



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- *Made from linear low density Polyethylene*
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- *Life expectancy of unit is 2 - 3 times that of traditional tanks*
- *Resistant to action of sewer gasses*
- *No special packaging or heavy lifting equipment required for installation*

CAPACITY	LENGTH	WIDTH	HEIGHT	SERVES
1 400 litre	1.3 m	1.3 m	1.5 m	informal
2 200 litre	2.0 m	1.2 m	1.4 m	8 people
3 600 litre	2.4 m	1.4 m	1.7 m	13 people
6 500 litre	3.1 m	1.8 m	2.3 m	20 people

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