

Undercarriage Decontamination System

Assembly and Operating Instructions

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Introduction

This project was originally created by Mechanical and Environmental Engineering Senior Design Students at the University of Delaware. The task was to tackle the issue of decontaminating vehicles entering and/or exiting farms in order to prevent further disease outbreaks. Along with the death of livestock, disease outbreaks can be transmitted to humans and can threaten a farmer's livelihood. Many farms have to deal with depopulation after poultry houses become diseased and they constantly have vehicles driving around the property.

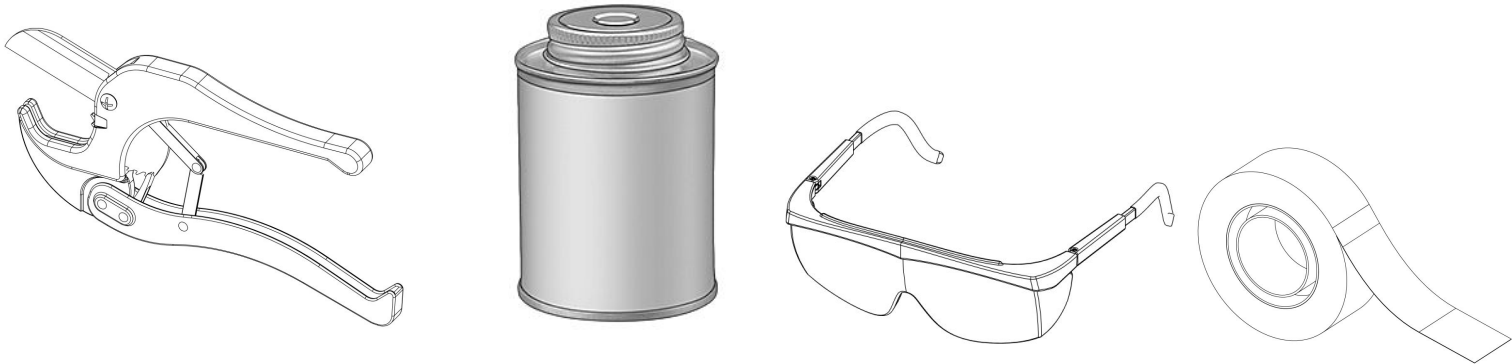
The team's goal was to create a low-cost, open source, undercarriage wash system that has the ability to wash and disinfect vehicles that may have come into contact with the disease. Currently, small scale farmers do not have any means of cleaning the underside of their vehicles or collecting the effluent; they may power wash the outside of the vehicle but this action misses the underside and anything that was on the tires has now been left behind on the ground. Other wash systems exist, but they are permanent and take up a large amount of space. They also can cost tens of thousands of dollars which many small scale farmers cannot necessarily afford. The team believes that this assembly works effectively and helps remediate the issue of contamination for a fraction of the cost (~280 dollars).

The assembly steps included in this manual are meant to be clear and precise so that anyone has the ability to read and replicate them. Pictures have been provided to serve as a visual aid.

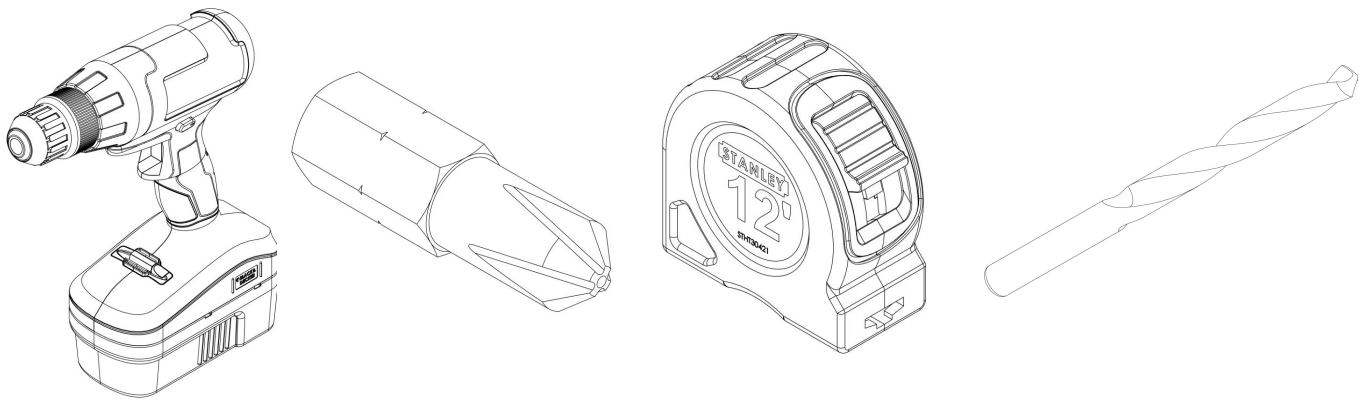
University of Delaware Senior Design Team - 12 December 2016

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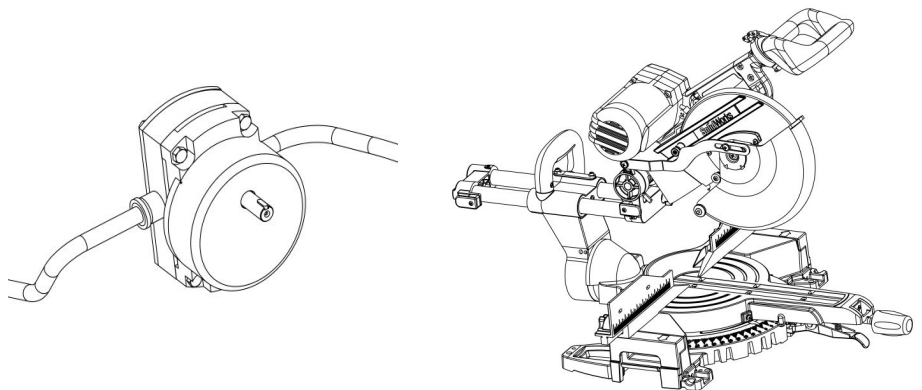
Tools Required For Assembly



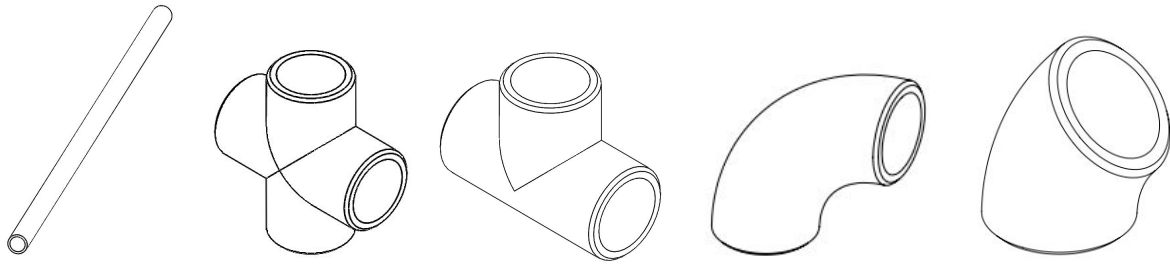
PVC Cutters
PVC Primer and Glue
PPE - Safety Glasses
Thread Seal (Teflon) Tape



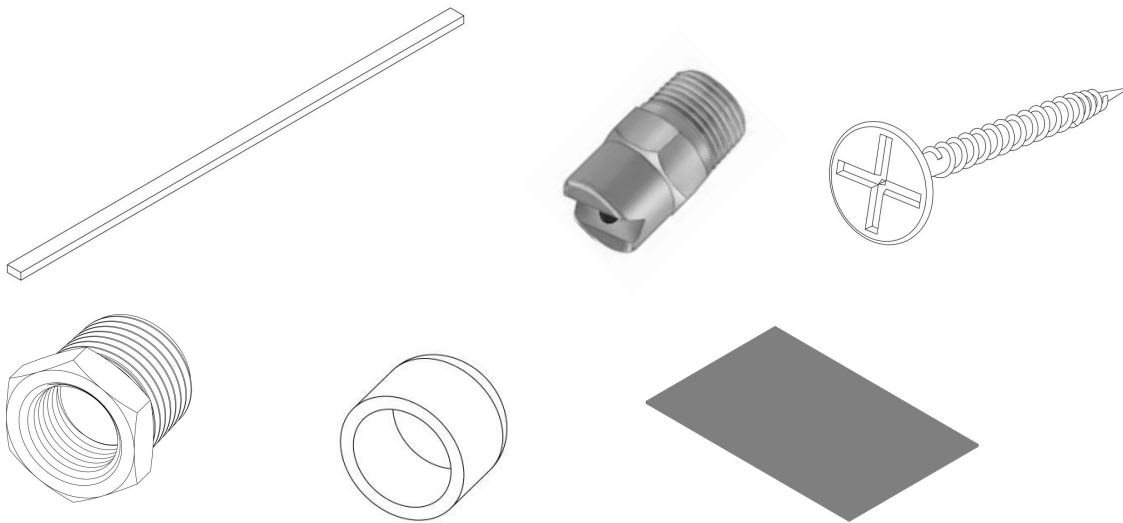
Cordless Drill
Bit Tip
Tape Measure
3/32" Drill Bit
½ HP Utility Pump & Hoses
Miter Saw



Materials Required For Assembly

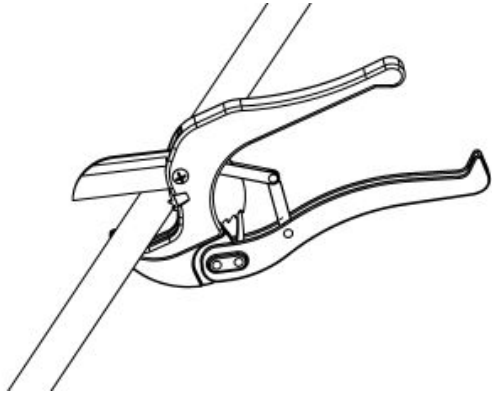


- 40 feet of $\frac{3}{4}$ " schedule 40 PVC pipe
- 2 - $\frac{3}{4}$ " PVC crosses
- 1 - $\frac{3}{4}$ " PVC Tee
- 2 - $\frac{3}{4}$ " PVC Tee to $\frac{1}{2}$ " thread
- 2 - $\frac{3}{4}$ " PVC 90 degree elbows
- 2 - $\frac{3}{4}$ " PVC 90 degree elbows, $\frac{1}{2}$ " threads
- 4 - $\frac{3}{4}$ " PVC 45 degree elbows



- 2 - 16 ft 2x4" boards
- 2 - 12 ft 2x4" boards
- 2 - 16 ft 1x4" boards
- 2 - 12 ft 1x4" boards
- 2 - $\frac{3}{8}$ " Flat Spray Nozzle 50 degrees
- 2 - $\frac{3}{8}$ " Flat Spray Nozzle 80 degrees
- 1 - Box of 2 $\frac{1}{2}$ " wood screws
- 4 - $\frac{1}{2}$ " male x $\frac{3}{8}$ " female brass bushing
- 4 - $\frac{3}{4}$ " PVC End Caps

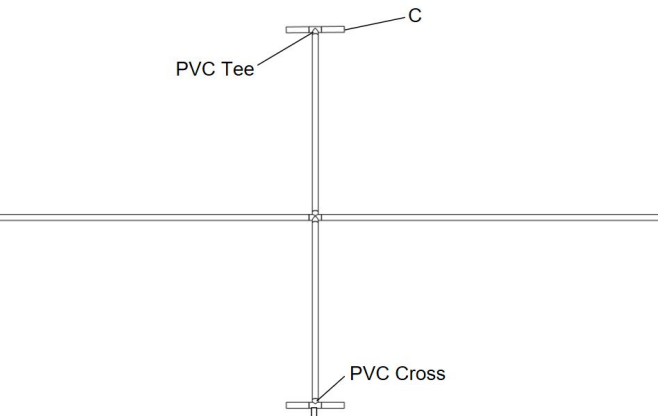
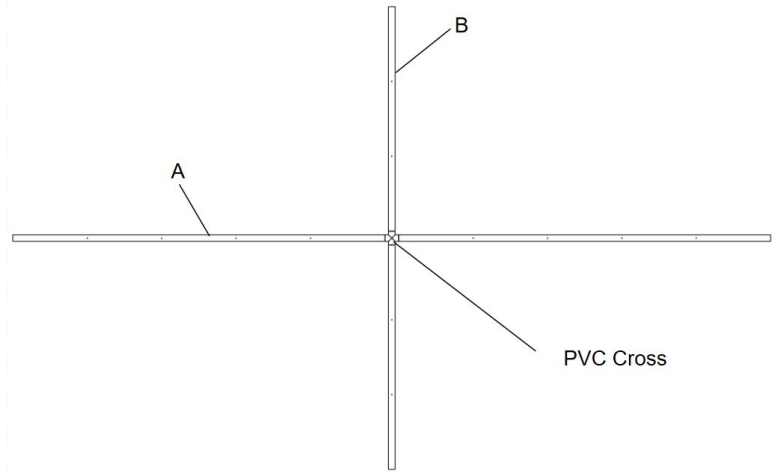
Spray System Setup



Wear safety glasses. Locate PVC cutters and PVC pipe. Cut the following lengths. Each length will be referred to as its own letter.

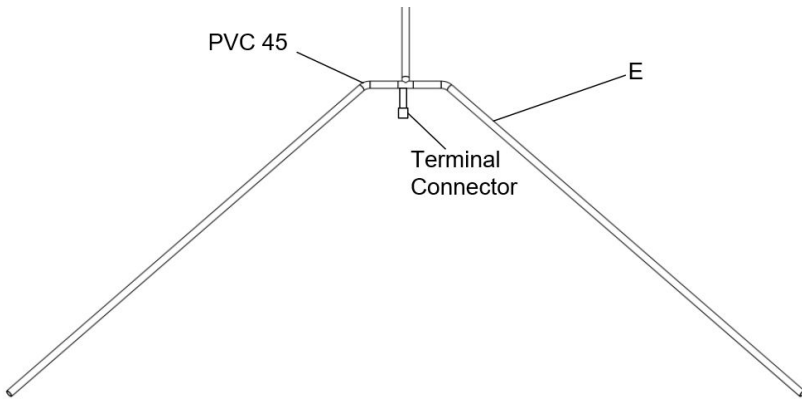
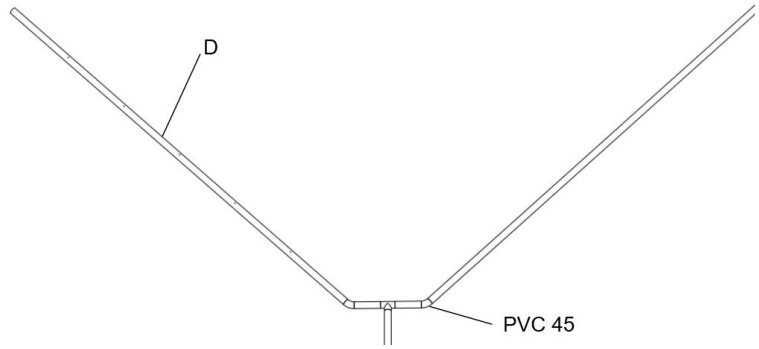
- 2 x 60" -> A
- 2 x 18" -> B
- 5 x 4" -> C
- 2 x 52" -> D
- 2 x 46" -> E
- 4 x 15" -> F

Attach an A pipe to the left and right of the PVC cross. Attach a B pipe to the top and bottom



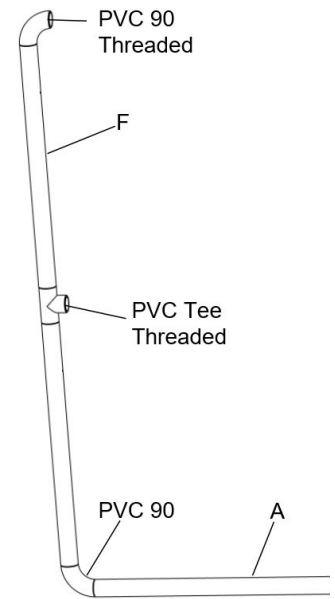
Attach a tee to one of the B pipes.
Attach two C pipes to the tee.
Attach a PVC cross to the other B pipe
Attach three C pipes to the cross.

At the tee intersection, connect a 45 degree elbow and a D pipe to each C pipe. Attach an end cap to each D pipe.



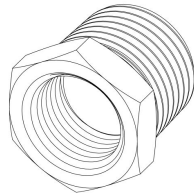
At the cross intersection, connect a 45 degree elbow and an E pipe to the left and right C pipes. Attach an end cap to each E pipe.

Attach a 90 degree elbow to an A pipe. Attach an F pipe to the elbow, followed by the PVC tee with 1/2" threads, another F pipe, and then the PVC 90 degree elbow with the 1/2" threads. Repeat this process for the other A pipe; these will be the side sprays.

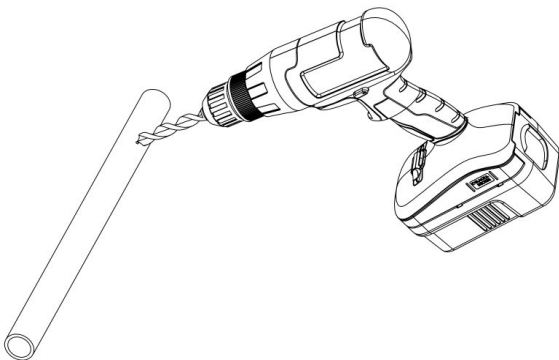
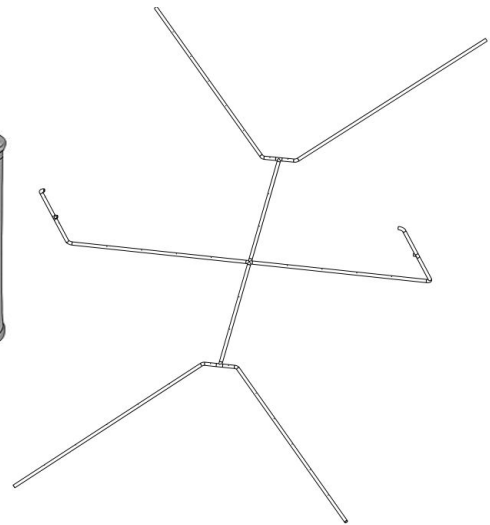




Wrap teflon tape around the nozzle threads in the direction of the threads starting from the end. Wrap teflon tape around the nozzle threads of the bushing in the same fashion. Attach the nozzle to the bushing and then this assembly to the threaded fittings. Attach the 80 degree nozzles to the threaded tees and the 50 degree nozzles to the threaded 90s.



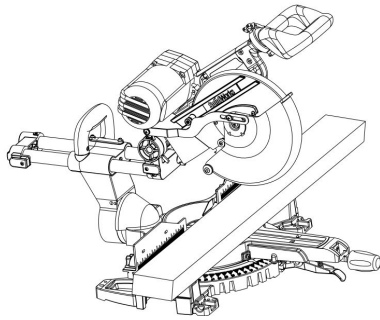
This is the completed spray system. Use PVC primer and glue to permanently connect the system. Apply primer to the inside of the fitting and the outside of the pipe; while the primer is still wet, apply the glue to the same surfaces. Insert the pipe into the fitting and give time to cure.



Using the cordless drill and the 3/32" drill bit, drill holes in the pipe.

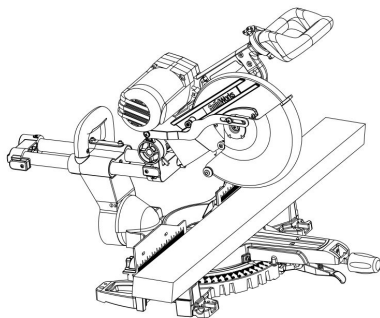
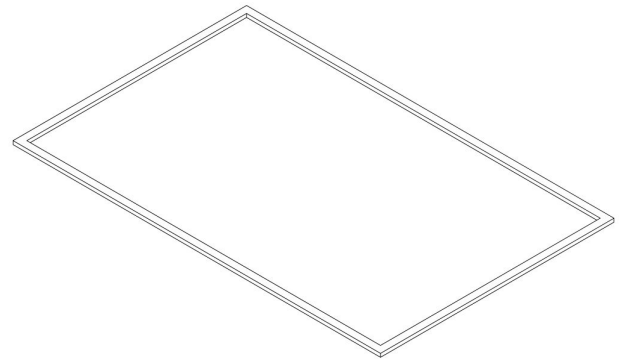
- A pipes - every foot measured from the cross
- B pipes - in the middle at 9"
- D pipes - Measured from the elbow, at 12", 30", and 48"
- E pipes - Measured from the elbow, at 6", 24", and 42"

Collection Basin Setup



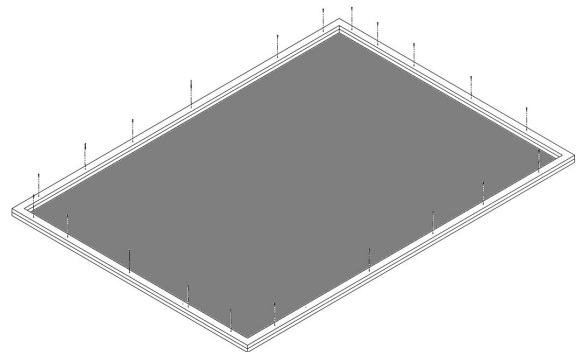
Use the miter saw and cut 2x4s into two lengths of 11'6" and two lengths of 16'. Make 45 degree cuts so that the outer lengths are 11'6" and 16', respectively.

Assemble the boards in this manner, put screws into the corners to create a frame.



Use the miter saw and cut 1x4s into two lengths of 16' and two lengths of 11'.

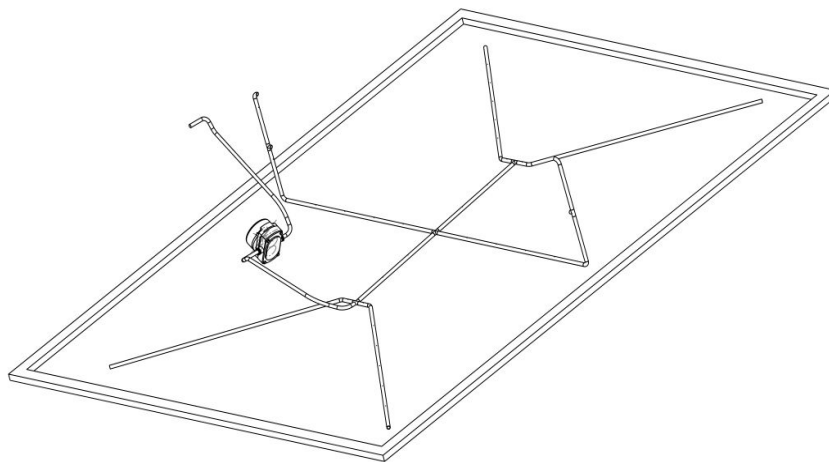
Using a 16x20 foot tarp, place the tarp on the ground then place the 2x4 frame on top of it. Wrap the tarp around the 2x4 frame then place the corresponding 1x4 lengths of top of it starting with the 16' sections. Screw down the 1x4s to sandwich the tarp in place. Place the spray system onto the finished collection tarp.



Operation Instructions

In order for your undercarriage wash system to perform as we intended you must purchase a ½ HP Utility Pump to connect to the system as well as an extra hose if you don't already own one.

Using a hose, begin by attaching the inlet of your utility pump to your municipal water source. Now connect a second hose from the outlet of your utility pump into the terminal connector at the bottom PVC cross.



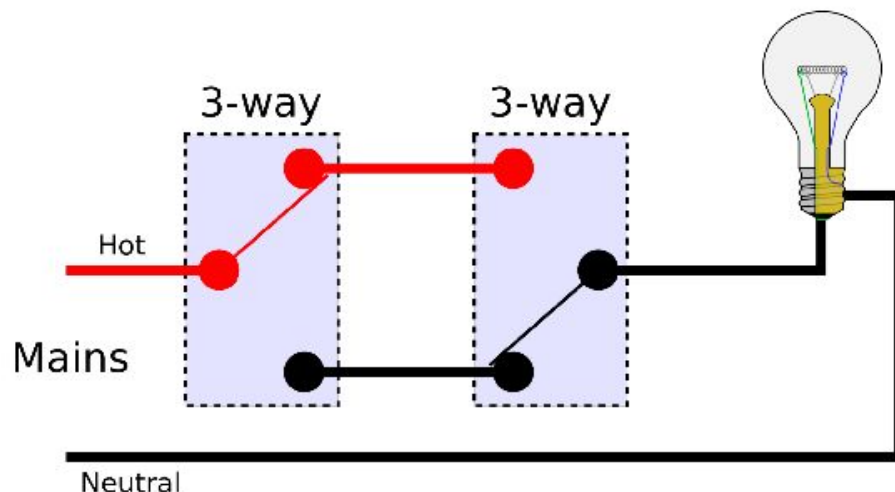
Your undercarriage wash system is now completely set up and ready to be used. Turning your municipal water source on will now start your system, please be sure to prime your pump before beginning a full wash. **DO NOT** start your pump before turning on your municipal water source as this can cause your pump to fail.

To power your system on or off, you first open/close the municipal water source and then start/turn off your utility pump. In order to maximize the amount of coverage you are obtaining the slower you drive through the better. Try to maintain your speed at all times at least under 5 mph, the whole wash should take about 6 minutes. It is highly recommended you pause at different points to further decontaminate any area. You can also add markers to help guide you through the timing.

Optional Features

There are a number of optional features that can be used along with the base design to make the system easier to use and more environmentally friendly.

- Additional water tank:
 - The pump can be attached to a water tank instead of the municipal water source. This will allow the system to be used anywhere on the farm and provide slight improvements to the system water pressure.
 - This add on is recommended if you expect to use the system often or if you would like the system to provide solids removal in addition to the disinfection capabilities.
- Electrical timer to turn on the system:
 - In addition to the base design the users can also install a timer system to turn on the system and leave it running for a set amount of time. This additional system is beneficial if the user expects to only have one person operating the system.
 - The system requires a three way switch that allows the user to turn the system on and off from both sides. The diagram below shows an example schematic of how to wire the system, however if you do not have previous experience with electrical wiring we do not recommend attempting to install this optional feature.



- Effluent collection system
 - An additional effluent collection system can be attached to the collection basin in order to prevent the contaminated disinfectant from running off onto the farmland.
 - This add on is beneficial if the user expects to use a potentially harmful disinfectant, users who utilize food grade disinfectants would not need this add on.
 - This system can be built by removing a four inch section from a corner of the wooden collection basin and then attaching a 4 inch HDPE drain pipe connection and corrugated HDPE drainage pipe. The drainage pipe will then be directed to a 55 gallon drum that has been placed in a 35 inch deep hole with a 25 inch diameter. Alternatively the pipe can be directed towards a 10 foot long, 5 foot wide, and 1 foot deep sand filter composed of a well mixed combination of 70% sand and 30% biochar (the sand filter can be built by excavating a 10 foot long, 5 foot wide, and 1 foot deep trench, covering the bottom with a inch thick layer of gravel and filling the rest of the trench with a 70% sand and 30% biochar mixture).