UBC Social, Ecological Economic Development Studies (SEEDS) Student Reports

UBC Waste Vegetable Oil Pilot

Bryn Endacott

Jesse Neufeld

Keenan Ngo

Derek Rempel

Matt Shufelt

University of British Columbia

CIVL 201

April 2010

UBC Waste Vegetable Oil Pilot Project

Feasibility and Proposed Design

Delivered to Geoff Hill

CIVIL 201

Community Service Learning Project

Bryn Endacott

Jesse Neufeld

Keenan Ngo

Derek Rempel

Matt Shufelt

Executive Summary

This report is for the CIVIL 201 Community Service Learning Project. The project Waste Vegetable Oil Pilot Project, is to plan and construct a vegetable oil treatment facility. As a pilot project, this demonstrates the feasibility of waste vegetable oil (WVO) as an alternative fuel source that can be extended to a larger scale such as UBC plant operations or employed in a developing country as a less costly fuel source. Our project, UBC Waste Vegetable Oil Pilot Project is to design and construct a system designed to demonstrate the collection, treatment, and distribution of WVO. Straight Vegetable oil (SVO), commonly Canola oil in Canada, can be used in diesel vehicles provided that the vehicle has been converted to a diesel hybrid. Considered here is the feasibility of WVO as an alternative fuel source. The design based on the knowledge gained in research involves a six part filtration system, de-watering, and gravity settling to quickly and easily remove impurities from WVO. This should assure maximum quality and efficiency when used in diesel hybrids.

Table Of Contents

LIST OF ILLUSTRATIONS

Tables

Figures

1.0 Introduction

The social movement towards greater sustainability makes straight vegetable oil (SVO) an ideal fuel source. SVO has the ability to reduce climate change and high costs for fossil fuels makes using straight vegetable oil (SVO) as an alternative fuel source for diesel converted hybrid vehicles an ideal source. Waste vegetable oil (WVO) is the least costly and most abundant source of useable vegetable oil that can be used in combustion engines. Because of impurities associated with recycled material, treatment is required to cleanse the oil. The UBC Waste Vegetable Oil Pilot Project is the beginning of what aspires to be a large movement to reduced fossil fuel dependance and exhibit greater sustainability.

The following report outlines the background to the project, the scope, as well as the group and stakeholder activities. The roles and responsibilities are discussed with their relevant communication planning. The planning and design stages are provided to show how the conceptual design moved towards the final design. A further analysis involves a procurement plan to obtain the required materials within a $1000 budget and an assessment of the difficulty and risk involved.

2.0 Community Organization Background

Our contact, Geoff Hill, is one of the founders of The Biodiesel Project at UBC. The Biodiesel Project, sponsored and hosted by the Environmental Youth Alliance, was started as a means for Mr. Hill and one of his colleagues to have an environmentally friendly way to get to their favourite rock climbing locations. The goal of the project was to design, build and test an affordable community scale biodiesel processing facility which was financially self sustainable and could supply biodiesel fuel at a competitive rate. The Biodiesel Project currently has a small scale pilot and research plant operating on the UBC campus. It supplies fuel to the UBC Plant Operations maintenance vehicles using waste fry oil from campus restaurants. At first, the project's objective was to have the landscaping vehicles run on 20% biodiesel; however, that target has since been surpassed and now all of the diesel UBC Plant Operation vehicles run on 20% biodiesel.

Aside from The Biodiesel Project, Mr. Hill is also working on a SVO project. From his website, www.switchover.ca, Mr. Hill offers diesel-SVO hybrid conversions for diesel vehicles. A diesel-SVO hybrid vehicle is able to run on pure vegetable oil using a simple diesel start up and shut down of the vehicle. A diesel-SVO hybrid can save up to 95% in fuel costs and is carbon neutral.

3.0 CSL Project Definition

The UBC Waste Vegetable Oil Pilot Project addresses the need of our client, Mr. Hill, to demonstrate readily that SVO is a feasible option to run multiple vehicles off of. It will show that the infrastructure can be built on campus to easily sustain multiple users of the system and show that it can save them money. Ultimately, the design of the vegetable oil filtration and distribution system should incorporate room for expansion to include full fleets of vehicles; should there be interested companies or entities this can be incorporated both on campus and off campus.

The stakeholders of this project are our client Geoff Hill, the consumers of the treated oil, and Brenda Sawada of UBC Social, Ecological, Economic, Development studies (SEEDS). For Mr. Hill, this project is the next step in his dream of seeing vegetable oil become a viable option for fuel in vehicles. He sees it as a sustainable method of transportation and hopes that people who see this project will see it as he does. This project is meant to demonstrate to these people, particularly companies with fleets of vehicles, that used vegetable oil is a cheap and efficient alternative to gasoline or diesel.

Mr. Hill has been working with biodiesel and SVO for several years and wishes to take the project to the next level. Recently he has moved towards an SVO design which he has demonstrated on his own personal truck. He now would like to advance SVO so that collected vegetable oil from a restaurant can be processed and used in diesel-hybrid vehicles. At this point, Mr. Hill uses brand new vegetable oil for his vehicle, but realizes that this is not a feasible option for most people or on a larger scale. As a result, he requires us to design a collection, filtration and distribution system to obtain WVO and make it useable in diesel-hybrids vehicles.

He requires a system that is easy to use and comparable to pumping fuel from a gas station. Mr. Hill also hopes that we can keep the costs of the designed infrastructure under $1000 for the particular size we decided upon. This size was left ambiguous by Mr. Hill, but he felt that we should be able to process approximately 1000 L of WVO. Mr. Hill also would like us to contact most of the entities involved in the process through him since he has already made a lot of connections through his own vehicle project. He believes he would have more pull than we would since he is much more experienced and has a great knowledge of the subject matter.

Once this system is operational, consumers will be able to quickly pick up treated vegetable oil that is useable in their diesel-hybrid vehicles. These consumers are directly involved in this project because they will help in testing the system. Brenda Sawada of UBC SEEDS is involved in this project because of the sustainability this project shows. SEEDS is an academic program that brings together students, faculty, and staff in projects that address sustainability issues. SVO reduces greenhouse gas emissions from diesel-hybrid vehicles both in the fossil fuel treatment as well as the combustion engine. It reduces the need to transport gasoline or diesel fuel and recycles vegetable oil rather than using new SVO. The life cycle of WVO thus increases sustainability and promotes implementation of effective sustainable practices.

As a result of the constraints and ambiguities presented to us, we have to make several assumptions about the design of our collection, filtration and distribution infrastructure. We assumed that users of the system will want to-notch fuel for their vehicles, so we will be implementing a filtration and settling system to maximize the quality of the oil. We also assumed that the oil we obtain from the restaurant will not be too acidic, and we won’t need to add anything to it to neutralize it. We also assume that we will be given enough space to build the infrastructure during second semester and that all the parts will fit together properly without serious time consuming problems. We will have to assume several simple aspects of our implementation process such as finding a restaurant nearby willing to co-operate with us, being able to find a transport vehicle to get the used oil from the restaurant to our processing area and having a worker available who will transport and process the oil once we have built the infrastructure.

4.0 Scope of Project

The vegetable oil vehicle pilot project is designed to show that using vegetable oil to power vehicles around the UBC campus is a feasible option and should be considered for future operations. By completing this design and implementing the plan, we can demonstrate that efficient infrastructure can be built on campus to easily distribute necessary vegetable oil to vehicles running off it. The design will have room for mass expansion should the UBC Plant Operations decide this option is possible to implement within their fleet of vehicles. This is a necessary project to complete in that it will greatly increase the sustainability of vehicles using the system, and could potentially increase the sustainability of the UBC Plant Operations fleet.

Vegetable oil as a substitute for diesel fuel eliminates greenhouse gas emissions of a vehicle, making it carbon neutral, and uses a resource already available on campus. This eliminates the need to import more fuel onto campus than necessary and lessens the environmental footprint left by diesel fuel.

By completing this design and implementing it, this project will demonstrate that using vegetable oil as a vehicle fuel is a practical and sustainable solution. It will also show that users of the vegetable oil fuel can save money when compared to buying diesel fuel from gas pumps. This will offer more incentive for onlookers to convert their vehicles and request to use our designed infrastructure. We hope that by submitting this project design to the UBC SEEDS program, it will be used by future students who can further implement the design and expand what we have created.

By completing this project, we hope to accomplish two main goals. Firstly, we want to create a fully detailed design of the infrastructure needed so that companies or entities on campus or off campus can use the design to build their own system of any capacity. Secondly, we wish to implement our specific design on campus either at the UBC Farm or at UBC Plant Operations on a small scale to demonstrate that our design works properly for a few vehicles and could potentially be expanded to include many more vehicles.

As a result of the outcomes we wish to incur, we also have to take into account the legality of the system for its users. It is entirely possible that the infrastructure we wish to build may not be legal on a large scale such as the UBC Plant Operations fleet. This will ultimately determine what types of companies or entities can eventually use our design and it will show exactly how feasible our design of infrastructure is.

5.0 Activity Definition

5.1 Term 1: Research and Proposal

The first thing to do after signing up for this project was to meet as a group. The purpose of this meeting was to get to know each other, find out what knowledge we had of SVO as a fuel, and what steps to take next in meeting with our mentor and our client. After preliminary research, we met with our mentor, Hayes Zirnhelt. During this meeting we discussed what the steps of the design process are and what we need to do in order to complete are project. We identified the scope of the project and planed some question to ask the client.

Our meeting with Mr. Hill gave us an opportunity to see his SVO truck. He explained about SVO as a fuel and further refined the project scope. We talked during the meeting about where to obtain the vegetable oil from and how to transport it to the treatment facility. We also talked about what we need to do to treat the oil so that it is ready for use in vehicles.

After getting information from our mentor and our client, we had further meetings as a team to discuss how and where to obtain vegetable oil. We identified the scope and created several different designs for the project. From these conceptual designs, we came up with a proposal design that appeared to be the best. The next step was to split the report up into individual sections for each team member to write. After each member had finished their part, we compile the final report and began to edit it. The report was then presented to our professor Susan Nesbit, the client Geoff Hill, and Brenda Sawada of UBC SEEDS.

5.2 Term 2: Research and Build

In order to continue the project, our proposal must meet Mr. Hill's approval. After that we can find where around the UBC campus we will obtain the large quantities of oil needed. In order to keep building cost down we will investigate places around campus that supply materials for free or at a discount price. The materials that cannot be obtained from the UBC campus will have to order. We will work in association with Mr. Hill to find a place where we can set up the facility and store materials for the build. Additionally, we will need to find transportation for the WVO. On the three build days we will construct the system of tanks, pumps, and filters. A truck will need to be equipped with a pump and tank, and the oil collected and transported after which the system can be tested.

6.0 Activity Schedule

Below are the completed and proposed task schedules for this project as well as the roles and responsibilities corresponding to these tasks.

6.1 Term Tasks

Table 1: Completed Tasks

Term 1	Date
Meet as a group	October 20, 2009
Meet with our mentor	October 24, 2009
Meet with the client	November 6, 2009
Meet as a group	November 12, 19, 26, 2009
Develop a design	November 26-29 2009
Write up the report	November 26 – 29, 2009
Compile the report	November 29, 2009
Edit the report	December 1 – 3, 2009
Finish the report	December 4, 2009
Submit the report	December 4, 2009

Table 2: Proposed Tasks

Term 2	Date
Present the report	January 4 – 15, 2010
Find where to specifically get oil	January 15 – February 15, 2010
Find materials around UBC	January 15 – February 15, 2010
Locate transportation	January 15 – February 15, 2010
Find a location	January 15 – February 15, 2010
Order required parts	February 15, 2010
Build the system	First Build Day
Equip the truck	First Build Day
Collect the oil	Second Build Day
Fill the system	Second Build Day
Test the system	Third Build Day
Run the system	Third Build Day

6.2 Roles and Responsibilities

Table 3: Involved Participants and Their Roles

Name	Scope
Bryn Endacott	Write the Activity Definition Write the Activity Schedule Write the Resource Planning Drive the truck to get the oil
Derek Rempel	Write a scope statement Write the Project Definition Manage the pumps
Jesse Neufeld	Write the Procurement Planning Write the Risk Planning Draw some graphs and tables Install the pipes

Keenan Ngo	Draw the Conceptual Design Draw the Detailed Design Communicate through e-mail with Hayes, Geoff Hill, and Brenda Sawada
Matt Shufelt	Write the Background Write the Communication Planning Install the Tanks
Hayes Zirnhelt	Mentor Meet with us and help out Provide us with Geoff Hill's contact info
Geoff Hill	The client, main stakeholder Inform us on what must be done Communicate with Plant Ops Approve the report
Susan Nesbit	Help our team out with the design process along the way Evaluate the report and project
Brenda Sawada	SEEDS contact Provide details on UBC sustainability

7.0 Communications Planning

- We will contact a restaurant on UBC campus through Geoff Hill to obtain vegetable oil.

- We will secure a space needed to set up our infrastructure in with Mr. Hill.

- We will contact the companies needed to obtain our materials one month before our first build day. The materials sources are McMaster-Carr, Princess Auto, Can-Am Containers.

- We will determine if we need extra workers to build our system and round them up two weeks in advance of the build day. These will be volunteer class-mates.

8.0 Conceptual Design

The scope of this project is to plan and construct a vegetable oil treatment facility. As a pilot project, this project demonstrates the feasibility of WVO as an alternative fuel source that can be extended to a larger scale such as UBC plant operations or employed in a developing country as a less costly fuel source. The system is designed to demonstrate the collection, treatment, and distribution of WVO. Since the oil is going to be used in vehicles it needs to be of a high enough quality so that it does not damage the engine and is easy enough to use so that it remains low cost and attainable. The materials used must be sustainable and must consider safety of the operator as well. In understanding the goals and constraints of this project, a criterion matrix was used to select the best design. The criteria included: ease of use, costs, quality of oil, sustainability, safety, size, and time.

8.1 Criterion Matrix

8.1.1 Ease of Use

Most crucial to this project is the feasibility for a worker to easily use the system. Being able to construct a simple solution would create interest from UBC Plant Operations and influence a large scale operation. Ease of use of the system is evaluated by efficiency and timeliness of the WVO treatment and ease of maintenance.

8.1.2 Costs

It is important to be aware of our resources and to implement them in the maximum efficiency through our choice of procured materials. The treatment cannot be expensive to the operator or the customers nor can it exceed the maximum budget unless reasonably justified. Completion should be within the budget and have a low maintenance cost.

8.1.3 Quality of the Oil

It is paramount that the oil produced through this project is at a standard equal to diesel fuel so that it can be used without corroding or damaging the internal workings of consumer vehicles. The treated oil should be comparable to new SVO and useable in diesel converted hybrid vehicles.

8.1.4 Sustainability

This is a sustainable project as WVO contributes 50% less carbon dioxide than regular diesel. Additionally, it is important that all components of the project are least harmful to the environment

8.1.5 Safety

The safety of the operator should be considered when handling the WVO. Because of the chemicals involved in bio-diesel processing, it was deemed at the beginning of this project that bio-diesel would not be considered.

8.1.6 Set up Space

Due to the limited scale of this project it is ideal to take as little space as possible in a laboratory or garage. The system must also be adjacent to an open doorway so that delivery and pick-up of the WVO and treated oil can be performed.

8.1.7 Time

The time it takes to treat the oil is a consideration as the volume used must not be limited by the time it takes to treat a certain amount of WVO. It is expected that this pilot project be able to sustain several vehicles on a regular basis.

The criteria of the WVO treatment system is compiled into a decision making criterion matrix. Each criteria is subjectively ranked 0-10 with ease of use, costs, and quality of oil having a weight factor of two as they are the three most important aspects. Our three best designs, using gravity feed, a shelf unit, or filter and pumps are compared. The result is an evaluation of three preliminary designs that are comparable and a recommendation of the best design. See Table 4: Criterion Matrix

Table 4: Criterion Matrix

Criteria	*Weighting*	*Gravity*	*Gravity Weighted*	*Shelf Unit*	*Shelf Weighted*	*Filter*	*Filter Weighted*
Ease of Use	2	6	12	1	2	9	18
Costs	2	8	16	6	12	4	8
Quality	2	5	10	6	12	10	20
Sustainability	1	8	8	6	6	8	8
Safety	1	5	5	2	2	8	8
Set Up	1	6	6	3	3	7	7
Time	1	2	4	4	4	9	9
Total			61		41		78

8.2 Design Analysis

Designs 1 and 2 can be found in Appendix B and Design 3 can be found in Appendix A. From this matrix it is clear that Design 3 is the most desirable option.

Design 1 is the simplest design that uses two tanks to gravity settle the oil. The tanks are connected by a pipe and require a single pump. However, the use of gravity would mean that one tank has to be above the other creating a dangerous toppling hazard. Due to oil's high viscosity, the time it takes to treat a single batch of WVO would too long.

Design 2 is similar to design 1 as it uses gravity to treat the WVO. Since the oil is in multiple containers, settling times could be reduced but the danger of falling oil jugs would remain. This would not be very easy to use as the operator would be required to lift the jugs and pour them into the storage tank periodically.

Design 3 is the most ideal. Filter treatment has a higher capital and maintenance cost. On the other hand, the direct benefits can be seen in a very fast process that is easy to use for the operator. A detailed description is included in the proceeding section.

9.0 Detailed Design

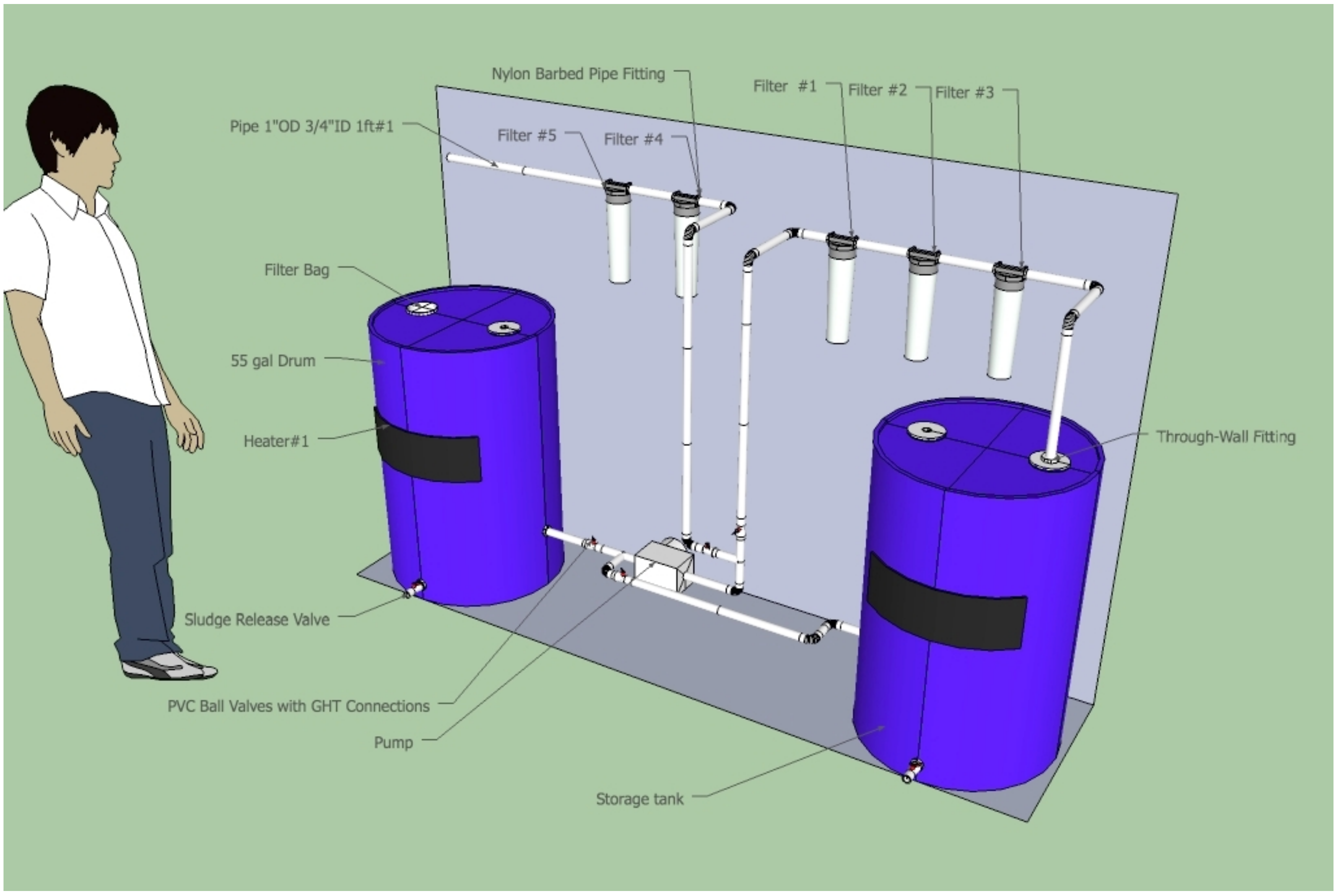

Figure 1: Front ¾ View

A design that incorporates an easy to use system and a high quality product at minimal cost is the most ideal. This system needs to be easy enough to use so that it isn't much harder than obtaining regular diesel fuel. Additionally, it will only be used if the quality of fuel is equal to diesel and the costs are lower. There are three major problems in WVO. Food and water impurities are removable by filters and treatment. However, the acidity of WVO depends on the supplied source and it is important that this source have a low acidic level. This design uses a series of progressively smaller filters to eliminate particles down to a size no larger than 1 micron (1 micron = millionth of meter) in combination with gravitational settling.

To create useable vegetable oil from WVO, oil is first obtained from a restaurant and transported to the treatment facility via tank on the back of a truck. The WVO is pumped through a bag filter to eliminate large particles and into the first of two 55 gal (218L) metal drums. Here it is heated to separate the water from the oil and increase its viscosity. Once it has been sufficiently de-watered, it can be more easily pumped through piping that connects to the first three filters and the second 55gal drum. This is the storage tank for holding the treated vegetable oil. When a consumer requires oil, valves along the pipes are turned and the oil is pumped through the remaining two filters and into the owner's vehicle. The major components of this operation are the de-water drum, storage tank, piping, pump, and filters. See Figure 2: Front View with Dimensions.

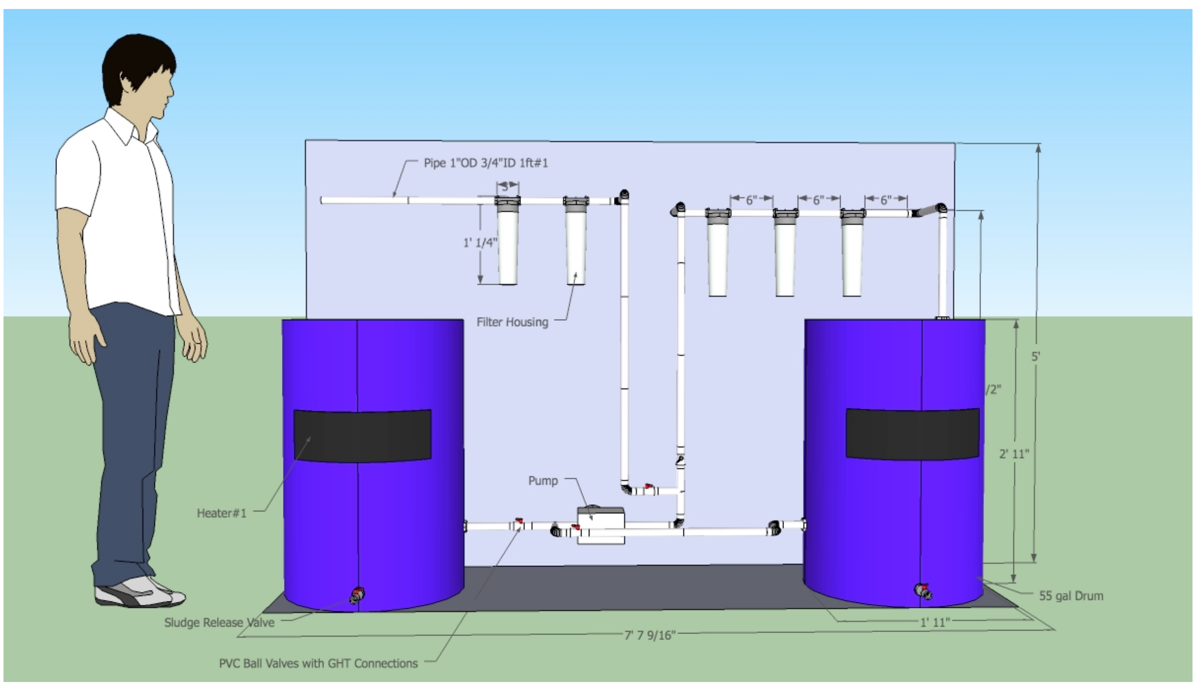

Figure 2: Front View with Dimensions

9.1 De-water Drum

The de-water drum is the beginning of the process where WVO is passed through a bag filter to eliminate large food impurities. External heaters warm the WVO to separate the water from the oil. When significant water and sludge has accumulated, the drum can be emptied and cleaned through the sludge release valve. After the water has been separated from the oil, the oil is passed on into the pump.

9.2 The Piping

The pump provides the pressure to move the oil through the piping. Black Buna-N rubber tubing was chosen as the desired piping for its oil-resistance, durability, and flexibility. All pipes will have an inner diameter of 3/4" and an outer diameter of 1". The rubber tubing connects the de-water drum to the pump, filters, and storage tank.

9.3 The Pump

The pump provides pressure so that the oil can be pumped up to the filters. The tubing splits after the pump and oil flow is controlled by PVC ball valves. The oil moves initially to the first three filters and the storage tank.

9.4 The Filters

The filters are double ended rayon with thinned steel core string-wound cartridges. Each is housed in a separate filter housing that the oil passes through in series. The first three filters remove 50 micron, 20 micron, and 10 micron impurities which should be of a high enough quality of useable oil. The last two filters, 5 micron and 1 micron, are to ensure the oil is high quality and that the hybrid vehicle is not affected by residue build up.

9.5 The Storage Tank

Once the oil has passed through the three filters, it can be stored until needed in the storage tank. When oil is needed, the pump moves the oil through the secondary tubing and the final two filters to the fuel nozzle.

The process of treating WVO is shown in Figure 3: Flow Diagram. The WVO is first moved along the red line through the first three filters into the storage tank. When oil is required for a vehicle, the valves are turned to change the flow and the flow moves along the yellow line.

Over a yet undefined time period, sludge will accumulate at the bottom of both the de-water drum as well as the storage tank. Removal of this waste will be via the sludge release valves into an external bucket. If the sludge is viscous enough that it does not flow, it may be shoveled out by hand. The waste will then be taken by truck back to the source of WVO and returned to the tank. Afterwards, West Coast Reduction will dispose of the waste.

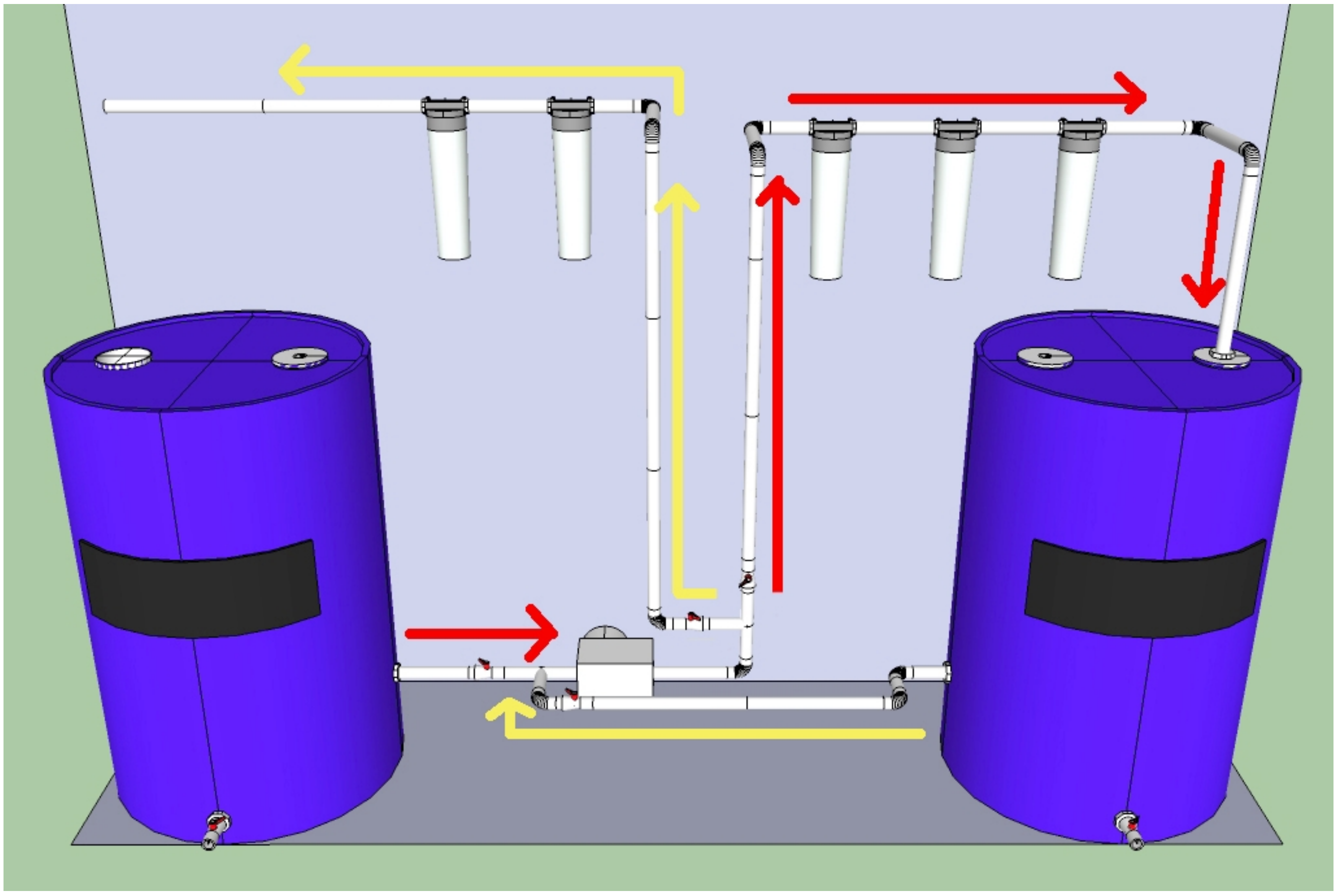

Figure 3: Flow Diagram

10.0 Procurement Planning

Due to the scope, large number of variables, and potential budget for this project, a multi-pronged approach to gathering WVO and materials has been developed. It will be broken into two parts, SVO collection and materials gathering.

10.1 SVO Collection

For the collection of the waste oil we investigated some options, attempting to remain on campus. From a walk around campus, we identified three WVO containers in the University Village. As far as we know, these establishments are in a contract type agreement with West Coast Reductions for their oil collection, and we did not approach any of them, as per instructions from our client.

The possibility of collecting oil from UBC Food Services is a promising path, as we believe it would provide a scalable volume to use. That is, while this project is in the pilot scale, under 1000L, our oil needs would be met. However, if the project was scaled up, we would be able to easily collect more oil. Again, we have not contacted UBC Food Services yet.

10.2 Materials Gathering

For materials gathering we investigated a number of approaches. These included:

- Scavenging UBC for parts
- Purchasing parts on-line

- Scavenging local junkyards

- Online adds, and used stores for parts

A decision was made to source and price all the materials needed online, while still searching locally for parts. Because of this, the attached price list is maximum value. By finding more parts used, the price will go down. We felt that it was important to present a maximum cost for budgeting purposes. The materials needed are described below, and a spreadsheet is attached see Appendix C: Cost Analysis. The following is a list of parts needed.

Table 5: Material Cost

Pump

#	Item	Price / Unit	Source	Note
1	110v Pony Pump	$99.99	Princess Auto	Local

Storage Bin

#	Item	Price/ Unit	Source	Note
2	55 Gallon (208 L)	$56.00	Can-Am Cont.	Local

Pipe and Fittings

#	Item	Price/ Unit	Source	Note
6	PVC Ball Valves	$12.08	Mcmaster Carr	
8	Thru Hull Fittings	$14.69	Mcmaster Carr	
30	Bar to NPT adapters	$2.95	Mcmaster Carr	
40	Ft of Tubing	$2.00	Mcmaster Carr	

Filter System

#	Item	Price/ Unit	Source	Note
5	Filter Housings	$24.31	Mcmaster Carr	
1	50 Micron Filter	$4.42	Mcmaster Carr	
1	20 Micron Filter	$4.80	Mcmaster Carr	
1	10 Micron Filter	$4.96	Mcmaster Carr	
1	5 Micron Filter	$5.21	Mcmaster Carr	
1	1 Micron Filter	$5.32	Mcmaster Carr	
1	Filter Sock	$7.63	Mcmaster Carr	

Other Parts

#	Item	Price/ Unit	Source	Note
2	Tank Heater	$36.19	Mcmaster Carr	
1	Thermometer	$20.14	Mcmaster Carr	
1	Fuel Nozzle	$24.64	Mcmaster Carr	
10	Ft of Clear Tubing	$3.75	Mcmaster Carr	

Total Price : $ 903.68

11.0 Risk Assessment

Due to the scale and relative complexities there are number of risks that this project is exposed to. The risks are grouped by category and possible solutions are presented below.

11.1 Legal Risks

There are legal risks associated with this project. The first risk is that our potential oil sources may already have contracts with West Coast Reductions. This could limit our ability to collect a sufficient amount of WVO. During the pilot stage of the project this should not be a problem. However, if the project moves to a larger commercial scale, this could become an issue. One option would be to negotiate new contracts with existing oil sources. It would be wise to consult professional legal sources before moving to a large or commercial scale, as the particular legalities are beyond the scope of this report.

Another potential legal risk is the taxation of the fuel. According to the BC government website, biodiesel is not taxed provincially as a fuel.[1] In addition, biodiesel is exempted from the federal excise tax.[2] As of writing this report, we were unable to find specific references to SVO. In the USA, SVO is not registered with the Environmental Protection Agency, and is not a legal fuel. As with the collection legal risks, professional legal and accounting services should be consulted with before moving this project beyond the pilot scope.

11.2 Safety Risks

The main safety risks associated with this project are with the filtering stage. As it is a pressurized system, a break in a line or connection could spray oil. Due to this, the operator should wear a safety shield over their face at all time while around the filter bank. SVO has a much lower risk of flammability than gasoline, but there still exists a risk of fire. A suitable (Class B or K) fire extinguisher should be kept both in the filtering room, and in the transport vehicle.

---

1 (http://www.sbr.gov.bc.ca/business/Consumer_Taxes/Motor_Fuel_Tax/key_fuel_programs/alternate_fuel.htm)

2 (http://www.wiseenergy.ca/index_files/biodiesel.htm)

11.3 Feasibility Risks

One of the main areas of risk lie in whether this project is feasible or not. It has many unknowns at this stage, from location and infrastructure, to potential legal risks. The solution to some of the legal risks is to simply “fly under the radar,” which is worry some to say the least. It is hoped that the scale and “pilot project” of the project will shield it. Another feasibility risk is whether operators will want to use the project. While all efforts have been made to balance cost with ease of use, someone will still have to collect and filter the oil. If a business solution develops from the project, it would be the case of simply hiring someone, but at this stage, it could be a challenge. While many people worldwide have successfully used SVO to power their vehicles, it is not clear yet how effective our heated filtering system will be. Again, the cost and effectiveness have been balanced.

APPENDIX A: FINAL DESIGN

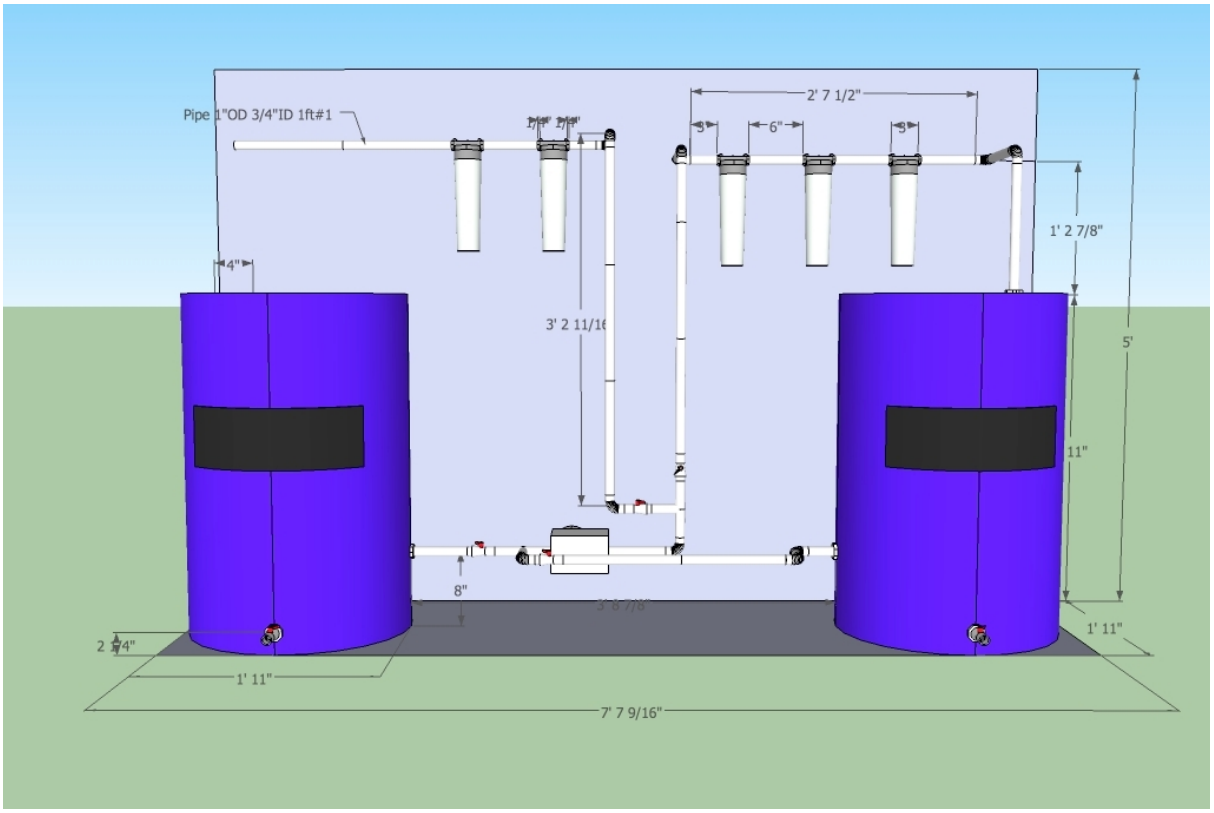

Figure 4: Front Dimensions

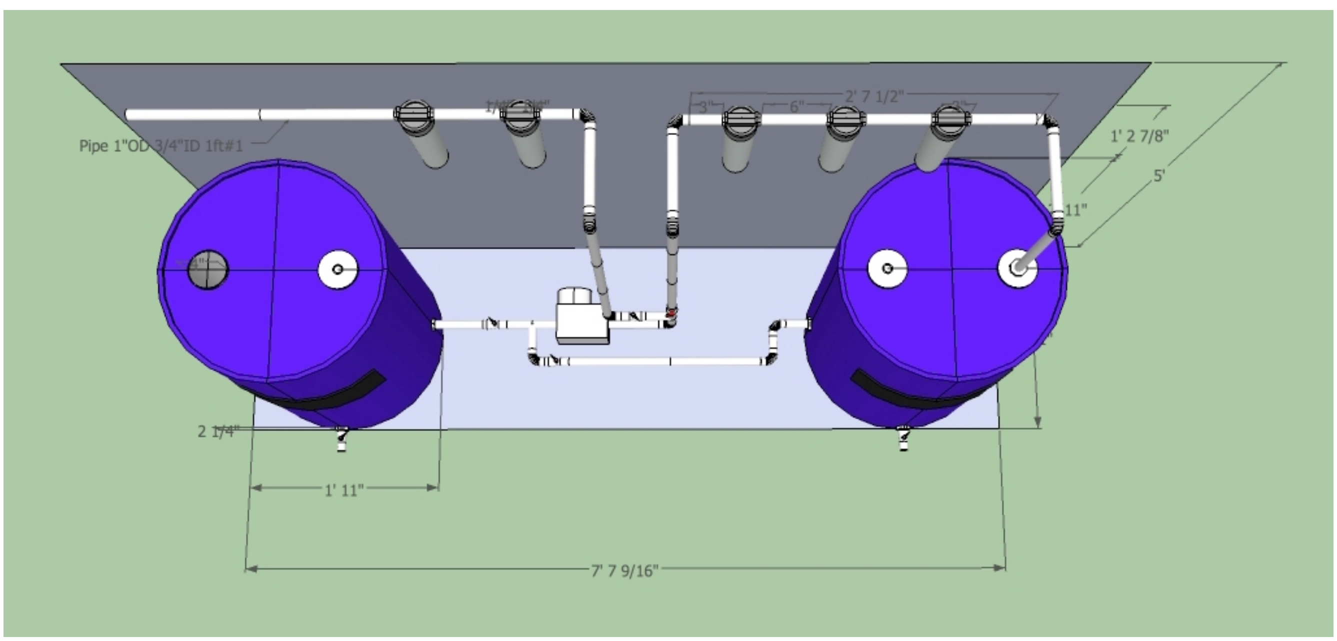

Figure 5: Top Dimensions

APPENDIX B: CONCEPTUAL DESIGNS

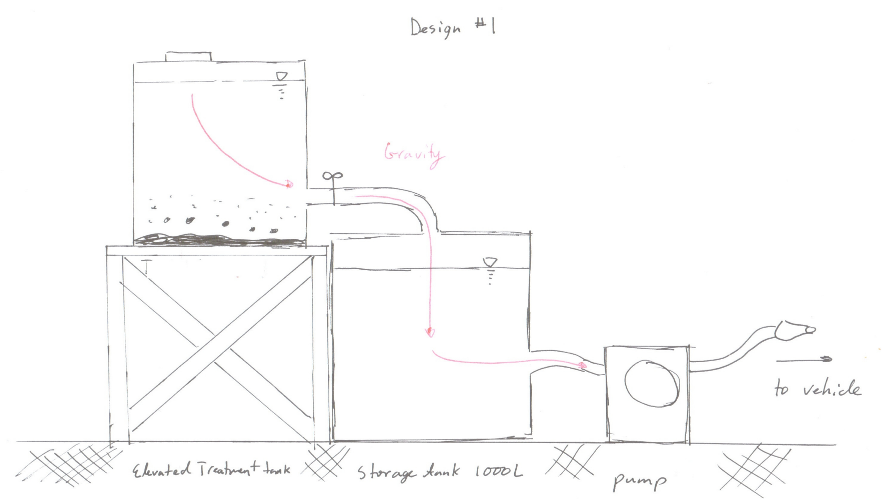

Figure 6: Conceptual Design 1

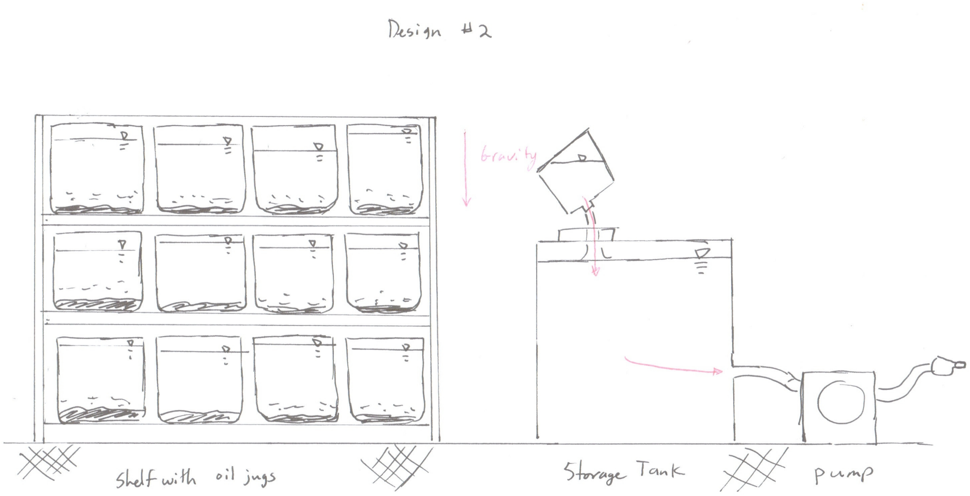

Figure 6: Conceptual Design 2

APPENDIX C: COST ANALYSIS

Table 6: Part List

# Needed	Item	Price Unit	Price Total	Source	Item #	
2	55 Drums	$ 56.00	$ 112.00	Can-Am Containers	O/H 1A2 Leak tested	
6	PVC ball valve	$ 12.08	$ 72.48	Mcmaster Carr	9848K44	
8	Thru Hull	$ 14.69	$ 117.52	Mcmaster Carr	36895K122	
5	Filter Housing	$ 24.31	$ 121.55	Mcmaster Carr	9979T21	
30	Barb to NPT ma	$ 2.95	$ 88.50	Mcmaster Carr	5047K22	
1	50 micron filter	$ 4.42	$ 4.42	Mcmaster Carr	4411K82	
1	20 micron filter	$ 4.80	$ 4.80	Mcmaster Carr	4411K83	
1	10 micron filter	$ 4.96	$ 4.96	Mcmaster Carr	4411K85	
1	5 micron filter	$ 5.21	$ 5.21	Mcmaster Carr	4411K84	
1	1 micron filter	$ 5.32	$ 5.32	Mcmaster Carr	4411K86	
1	filter sock	$ 7.63	$ 7.63	Mcmaster Carr	5783K47	
40	ft of tubing	$ 2.00	$ 80.00	Mcmaster Carr	5235K57	
2	tank heater	$ 36.19	$ 72.38	Mcmaster Carr	35765K328	
1	thermometer	$ 20.14	$ 20.14	Mcmaster Carr	3099K42	
1	Fuel Nozzle	$ 24.64	$ 49.28	Mcmaster Carr	5434K37	
10	ft Clear Tubing	$ 3.75	$ 37.50	Mcmaster Carr	5549K42	
1	Pump	$ 99.99	$ 99.99	Princess Auto	5771233	
Total			$ 903.68			

Table 7: Part List Notes

Item	**Notes**
55 Drums	Available on the North Shore
PVC ball valve	PVC Ball Valve with Garden Hose Thread Straight, 3/4" NPT Fem Inlet X 3/4" NPT Fem Outlet
Thru Hull	3/4" thru hull
Filter Housing	3/4" NPT Female connection. 1"ID x 2 1/2" to 2 7/8"OD Cartridges
Barb to NPT male	3/4" NPT male to 3/4" Tube, for connecting to thru hulls, and filter houses
50 micron filter	String-Wound Filter Cartridge Rayon, W/ Tinned Steel Core, 10" H, 50 Micron
20 micron filter	String-Wound Filter Cartridge Rayon, W/ Tinned Steel Core, 10" H, 20 Micron
10 micron filter	String-Wound Filter Cartridge Rayon, W/ Tinned Steel Core, 10" H, 10 Micron
5 micron filter	String-Wound Filter Cartridge Rayon, W/ Tinned Steel Core, 10" H, 5 Micron
1 micron filter	String-Wound Filter Cartridge Rayon, W/ Tinned Steel Core, 10" H, 1 Micron
filter sock	2-in-1 High-Capacity Polypro Felt Filter Bag 200/100 Micron, 4 Trade Size, 4-3/32" Dia X 14"
ft of tubing	Oil-Resistant Black Buna-N Rubber Tubing 3/4" ID, 1" OD, 1/8" Wall Thickness
tank heater	Flexible Silicone-Rubber Heater Adhesive Backing, 6" X 6" Sheet, 5 Watts/SQ Inch
thermometer	NSF/Waterproof Pocket Digital Thermometer -40 to 450 Deg F, 4-3/4" Stem Length
Fuel Nozzle	Dispensing Hose Nozzle Aluminum, 3/4" NPT Female Inlet, 13/16" OD Spout
ft Clear Tubing	Clear Tygothane Polyurethane Tubing 3/4" ID, 1" OD, 1/8" Wall Thickness
Pump	110v "pony" pump