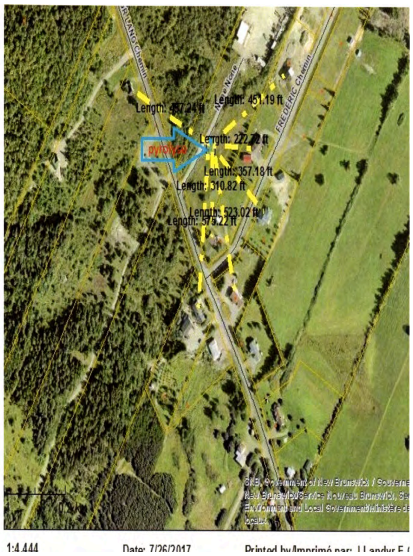

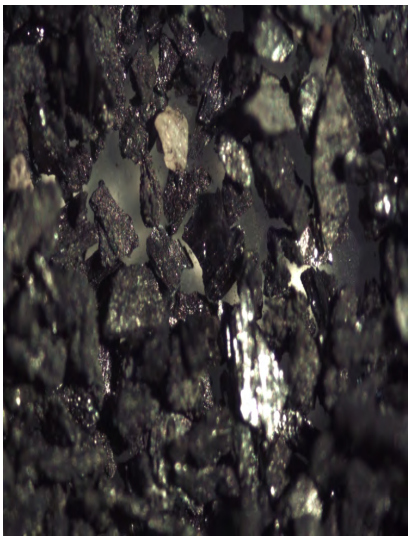

Technical description of the technology selected by Gestion Claude Plourde Ltd for the pyrolysis of OTR tyres

Report 1c

No. Plourde-1c-2017

November 10th, 2017

GECA ENVIRONNEMENT

EXPERT-CONSEIL ENVIRONNEMENT-RÉSIDUS-BIOCHARS

Technical description of the technology selected by Gestion Claude Plourde Ltd for the pyrolysis of ORT tyres

Report 1c

Presented to

Gestion Claude Plourde Ltd

For the intent of submitting to the New Brunswick government for the exploitation permit of a tyre pyrolysis system at St-Basile, NB

Production team

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for GECA Environnement

Québec, Qc
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Disclaimer

In the making of this report, it is expressly acknowledged that GECA Environnement did not conduct any data collection, have not specifically tested the pyrolyser components and did not directly measure any parameter of the pyrolyser system whatsoever (air emissions, sounds, odours, chemical concentration, etc.).

All of the empirical data and technical plans (the « Facts ») on which GECA Environnement bases its conclusions have been provided by the manufacturer or have been obtained through the most recent literature devoted to the subject of pyrolysis of OTR tyres.

Considering that GECA Environnement has taken every reasonable effort to ensure the accuracy of the Facts contained in this report, and considering its prospective nature, in the event that the Facts later prove to be inaccurate or false, GECA Environnement shall in no way be held responsible for any mistaken assumptions or conclusions arising from the Facts.

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Introduction

Waste tyres represent direct negative impacts to the environment due to their slow decomposition rate (80-100 years), toxic gas emissions, the release of toxic elements when heated by solar energy, and their water holding capacity as a niche for insects and diseases (Martinez et al. 2013). Besides, waste tyre dumps occupy considerable surfaces. These storage facilities cannot be reclaimed because of the emptiness in the tires resulting in geothechnically unstable landfills. In addition, they offer large potential for fire and explosions, during which large amount of contaminant go directly to the ground and to the air. Negative environmental impact are amplified with truck tyres as compared to car tyres primarily due to their size and weight as well as their chemical characteristics (Ucar et al. 2005).

It is well known that that waste tyre recycling could provide important environment and economic benefits (Lopez et al. 2009). Among them, waste tyre recycling generates different products with high energetic value: oils, black carbon and gas resulting in economic benefits. These issues are particularly important now days, when there is an average of one tyre that is discarded every day for every person on earth!

Among different methods for recycling waste tyres, pyrolysis is potentially the best since it produces new products that can easily be used in other industries and, such as for the black carbon, return to the tyre industry. Waste tyre pyrolysis is a common and well-known approach (Napoli et al. 1997). This industry has long evolved with environmental laws and regulations, resulting in the development of very clean technologies.

Information relative to passenger vehicle tyres are very well documented. Although slightly less known for truck tyres, even if they represent a large part of the waste volume, we can easily find information on pyrolysis of these large tyres. Their chemistry is different as well as the ratio of their content and that of the resulting pyrolysis products (Table 1).

This approach is still weakly implemented in Canada for several reasons. First, the tyres are recycled by manufacturing carpet type of products that are exported to other countries such as in Russia. Once these carpets are used, they are discarded to landfills, thus pushing the problem to later time and to someone else. Some people use them for building retaining walls, but they do pollute during their lifetime outside. The main obstacles to waste tyre pyrolysis development are the price of the technologies, and the public concern relative to the atmospheric gas emissions, risk of fire or explosion, odour and noise generated during operations, soil and water contamination.

The actual technologies that are on the market for waste tyre pyrolysis usually respond to environmental norms and regulations. For this project, the developer Gestion Claude Plourde Ltd will warranty that he will do all that is under his control for complying with laws and regulations for the safety of the public and the environment. It is important to keep in mind that the pyrolysis solution is among the cleanest and safest way of managing the waste tyres when the technologies comply with the laws and regulations.

Table 1. Char (black carbon), oil and gas yield resulted from truck tyre pyrolysis under a temperature of 500^{o}C

Product	Average yield
Char (carbon black)	40%
Gas	21.5%
Oil	17.5 % (53% max)
Fibres	11.1%
Steel	10%

Ref: Laresgoiti et al. 2000; Roy et al. 1999; Ucar et al.2005; Tang L., Huang H. 2004.

Objectives of the report

Gestion Claude Plourde Ltd has mandated GECA Environnement to describe the pyrolysis technology he selected in order to apply for a permit. This is in complementary to the environmental evaluation made by James Landry for Environnement Contrôle & Protection Inc. (2017).

The objectives of this report are two fold:

1) Describe the 6th generation waste tyre pyrolysis technology made by Xinxiang Huayin Renewable Energy Equipment Co., Ltd, China

2) Analyse if the above mentioned waste tyre pyrolysis technology will potentially respect the environmental norms of the province of New-Brunswick, Canada

It is important to note that this report is based solely on the technical plans and information supplied by the manufacturer, the pyrolysis oil, gas and char chemical analyses presented by the manufacturer as well as in the information found in the literature.
GECA did not visit the pilot plant in China neither did the air emissions, and other parameters were measured on-site
(sound, odour, chemical concentrations, etc.).

General information

Site address: 687 Mgr Lang St-Basile, NB, E7C 2B7

Company: Gestion Claude Plourde Ltd

Owner: Claude Plourde

Feedstock: Waste OTR (off the road) tyres

Certificates of the technology

The pyrolysis technology selected by Cloude Plourde Ltd has obtained several certificates:

- **CE**: The European Conformity indicates to governmental officials that the product may be legally placed on the European market
- **ISO14001:** It indicate the international standard that specifies requirements for an effective environmental management system (EMS)
- **ISO9001:** ISO 9001 outlines the requirements for an organization to maintain high quality system
- **SGS:** SGS, Formerly Société Générale de Surveillance, is a multinational company headquartered in Geneva, Switzerland which provides inspection, verification, testing and certification services for technologies. They state if the technology conforms or not to their high standard.
- **BV:** The Bureau Veritas S. A. (formerly BVQI, Bureau Veritas Quality International) is an international certification agency for quality assurances and control
- **TUV:** Technischer Überwachungs-Verein is a German institution for the control and normalisation and certify for product safety certification, the selected technology has received 11 patents certifications.

Therefore, the pyrolysis technology selected by Gestion Claude Plourde Ltd has received several certifications relatives to environmental and control safety. It is important to note that the German regulations, from which they got certificates, are stricter than most countries in the world including Canada.

A. Pyrolysis technology Layout and description

A.1. General information on the layout and the technology

- The system is a batch pyrolysis plant for transforming 10 t/batch of waste truck tyres, 1 batch/day.
- The pyrolyser technology occupies surface 525 m^2.
- At least 5 meters around the pyrolyser will be preserved as working space. It will follow engineer guidance.
- A plastic dome above the pyrolysis system will be installed along with a concrete floor slab and oil recuperation system in case of spill. They will be designed by engineers and mandated by Gestion Claude Plourde Ltd and will be conformed to environmental and safety regulations of NB.
- The overall surface occupation of the entire system including storage of tyres prior to transformation, feedstock pre-conditioning (shredder and others), pyrolyser technology, storage of oil, char, and metal, water tank, and parking lots for loading, transportation and the dome above the pyrolysis technology will be defined by engineers that will be mandated by Gestion Claude Plourde Ltd.
- The total weight of the pyrolyser technology is 43 000 kg to which will be added the other equipments listed above.
- The pyrolyser will consume pyrolytic oil in the furnace for heating the reactor. This oil is generated by tyre pyrolysis.
- The motor specification in the reactor is 380V/220V, 50 Hz.

The table 2 contains detailed characteristics of the pyrolyser components which are briefly illustrated in Figure 1 while the dimensions are presented in Figure 2.

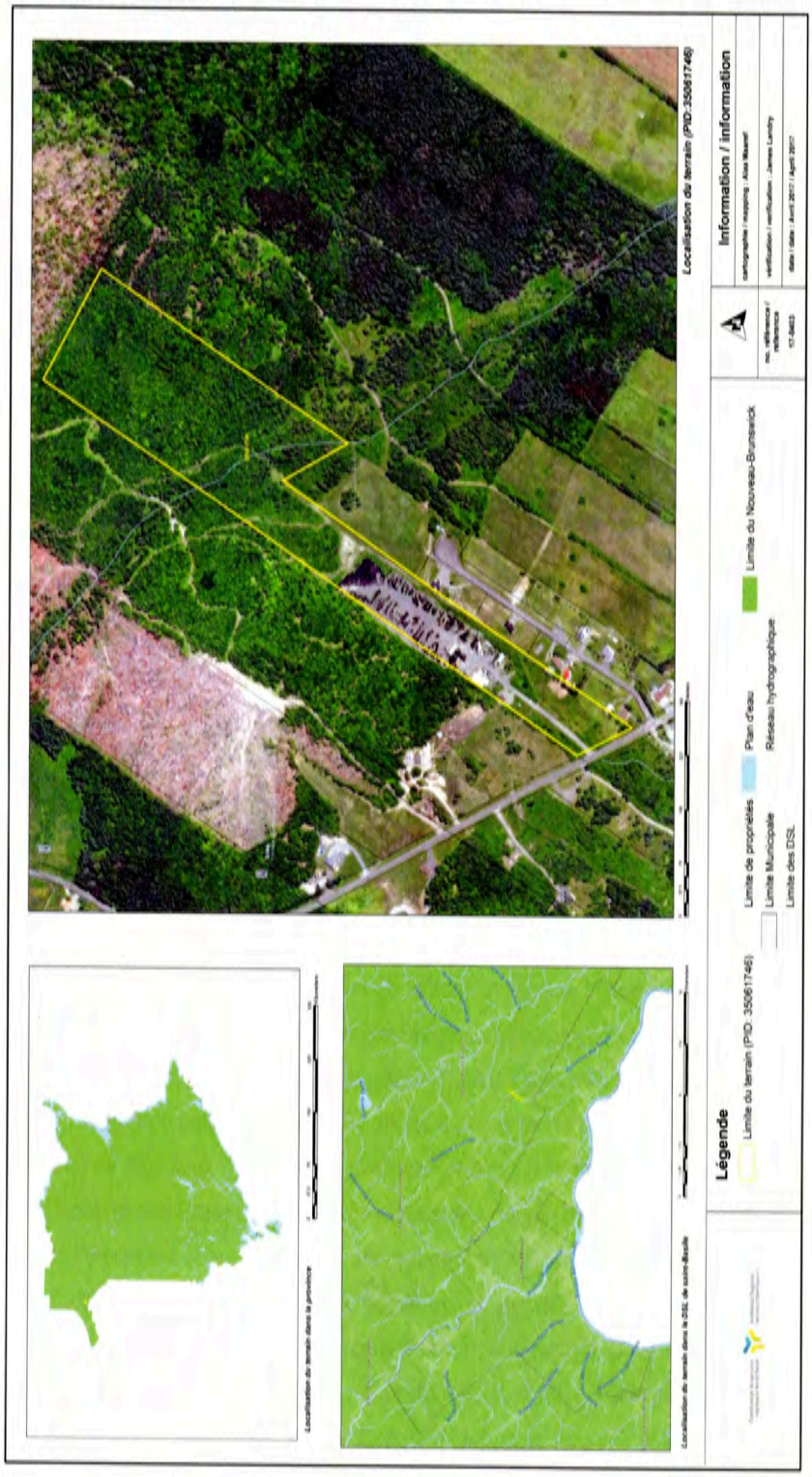


Figure 1. Site localisation and hydrological system

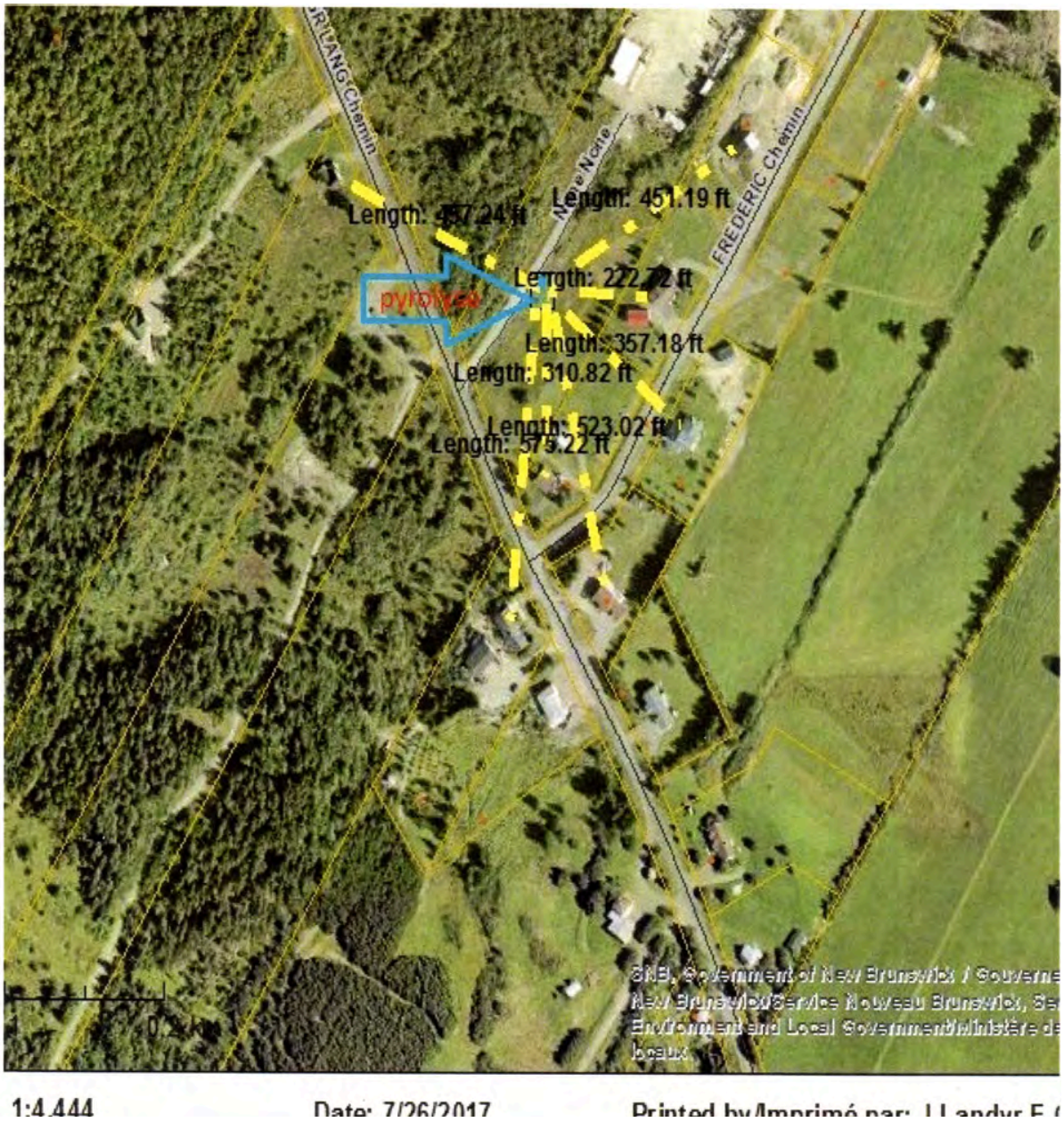
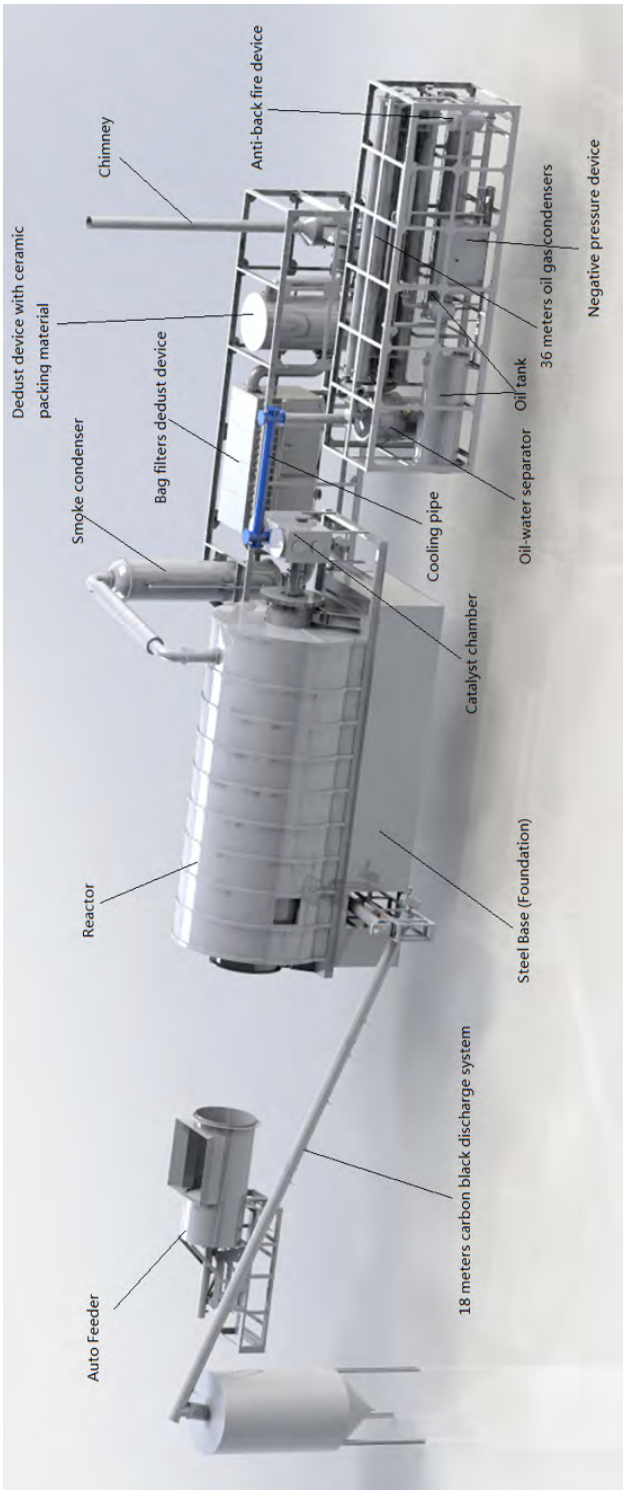


Figure 2. Site localisation and hydrological system



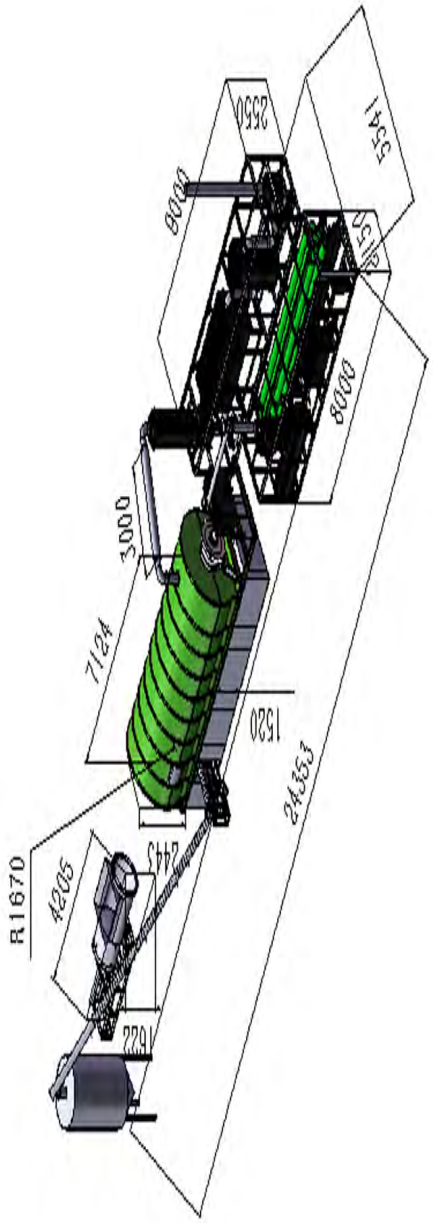


Figure 3. Pyrolyser systems

Figure 4. Pyrolyser dimensions (cm)

A.2. Pyrolysis process description (Figures 1 and 2)

- The waste tyres will be shredded into halves before pyrolysis.
- The reactor should be preheated prior to pyrolysis. It takes 3 to 4 hours to preheat the reactor. Different fuels could be used for this purpose: pyrolytic oil, coal, wood or natural gas. The burner of the furnace used for preheating should be selected depending on the selected fuel type. Gestion Claude Plourde Ltd plans to use pyrolytic oil in this burner.
- When the reactor has reached its temperature (550°C), the feedstock (shredded truck tyres) is loaded into the reactor by an auto-feeder.
- The syngas comes out from the reactor during 3 to 4 hours of pyrolysis. The syngas goes through the catalyst chamber, where the impurities and the paraffin are removed.
- Thereafter, the syngas goes through the condenser that has a cooling pipe system filled with water that is completely separated from the syngas. It does come in contact with the syngas such as done for glycol cooling system. The syngas condense in the condenser into an oil component and the remaining (non-condensable gases) go toward the dedusting system.
- The oil-water separator is a safety device, which prevents the non-condensed syngas from returning to the reactor.
- The oil goes to an oil tank from the condenser. This small oil tank is regularly emptied toward a large oil tank.
- For the remaining gases (CH_4, C_2H_6, C_3H_8, C_4H_{10} and H_2), those that have not condensed into oil, they will go through the anti-back fire device, toward the combustion system to be burned as energy for the reactor.
- The gases that were not burn nor dust condensed into oil, will pass through a new technology dust removing system made by a German company for dedusting and removing almost completely the left over of sulphuric gas. The dedusting system will ensure that no smoke will go through the chimney.
- Finally, after all the syngas has been extracted from the tyres, some char will remain inside the reactor. Once the reactor has cool down, the 12 m screw char discharging device will be used to remove the char and the metal from the reactor.
- The reactor has to be completely cool down before opening it to remove the metal and recharging again.
- Steel wires will be discharged at the end of the pyrolysis process by using a hook.

Briefly,

- The overall pyrolysis process takes 24 hours/batch, 10 t/batch.
- There are different safety features in the system for temperature, pressure and air emissions. The system obtained different environmental and safety certificates.
- Different components of the processing plant will be added to the actual technology, as to
    - store the tyres, prepare the feedstock, stock the products (char, oil, metal), protect the pyrolysis system and the electrical control panels and electronic control of the pyrolysis technology. A large plastic dome will cover the facility which includes the pyrolyser, along with char, oil and steel storage, electrical and electronic control panels.

Tableau 2

Table 2. Description of the pyrolysis system components

Component	Dimensions	Characteristics and comments
	5-meter distance should be reserved around the pyrolyser to allow staff security for handling and maintenance.	
Auto feeder	Length 4 205 cm, radius 1 622cm; 60-ton hydraulic pressure with foundation and ladder.	Takes 2-3 hours to prepare and load 10 tons of tyres into the reactor. Maximal size of particles = 1.4 m. Could be adjusted on demand (up to 1.8 m).
	Pyrolyser itself	
Reactor	R: 1 670 cm, length: 7 124 cm; 16 mm thickness Q345R pressure vessel and boiler steel plates; base, rollers, gear, reducer and insulation layer. Burner installed on the fire furnace door or beside the fire furnace door.	Prior to pyrolysis process the reactor should be preheated by burning fuel in the combustion system. Preheating process consumes 450 kg of pyrolytic oil. Required 3-4 hours to preheat the reactor prior to pyrolysis process. Temperature inside the reactor during pyrolysis reachs 550 °C. The reactor works under very small constant negative pressure. Although the reactor has the ability to bear the pressure, if the pressure in the reactor reaches 0,02 Mpa the alarm will ring. The worker should open the safety valve and release the pressure. If the pressure reaches 0,3 Mpa the safety valve will release the pressure automatically.
Steel foundation	Width: 5 541 cm, height: 1 520 cm	Supports reactor
Catalytic chamber		The chamber has two layers and two double rooms. It contains molecular ring, which sorbs the dust and paraffin from the syngas to improve oil quality. It decreases the pressure, when the syngas changes pipe size. It slows down the oil movement speed in order to guarantee the oil can be completely cool down.
	Condenser system (total length: 8 000 cm, total width: 2 150 cm)	
Cooling (condenser) pipe		First step of gas cooling (gas temperature can reach 300 °C) by heat-exchange method which use water piping surrounding the syngas. The non-condensed gas will be recycled into a burner (furnace) for reactor heating.
Syngas condensers	Length: 8 000 cm, width: 2 150 cm; 36-meter split into 6 x 6 m condensers; placed in three layers. German technology	The design guarantees the oil yield rate. Easy to clean. Glycol could be added to water to prevent it from freezing, but the piping should be replaced accordingly. If the engineers suggest the use of glycol, a demand will be completed.
Oil back block system		The syngas is block to go back to the reactor by this system. Oil goes to the oil tank; syngas goes to the condensers.
Oil tanks (2 tanks)	Big oil storage tank: Volume: 25 t -50 t	Small tank oil storage is provided by the pyrolysis manufacturer. Small tank will be used

	to be determined Small tank fabricated of Q235B: Volume: 2.2-2.3 m^3.	only during processing, not for long time storage. The large tanks will be bought by Claude Plourde Ltd and installed by the proper company for this type of equipment.
Anti-back fire device (Gas recycling system)		Some gas (CH_4, C_2H_6, C_3H_8, C_4H_{10}, H_2) cannot be cooled down under normal pressure; these gases will be recycled in the anti-back fire device and will be send to furnace to burn and heat the reactor.
Pressure release device		Should be opened before discharging the char allowing small resilient gas to escape to avoid potential instant combustion.
Water cooling reservoir	Volume: 70-80 m^3, depth: 2 m, width: 4 m, length: 10 m	The water should be kept at the liquid state. The optimal water temperature for condensate the syngas is ≤ 25 °C.
Water cooling tower	To be determined	Not included in the quotation list. The water should be allowed to cool after being passed in the condenser through a simple system such as a cooling tower.
		Dedusting system
Syngas condenser	Connected to the reactor by 3-m long pipe	The dust and sulfur gas are removed by a new German technology dust removing system using a composite ceramic material. The syngas passes through condenser, which cools it down.
Dedusting system:	Length: 8 000 cm, width: 2 550 cm	The non-condensed syngas goes through the ceramic packing material filter, which sorbs the dust from the syngas and sulphur components.
Chimney	Height: 10 m., diameter: 0.26 m	Ultra-low gas emissions (Table 2) are released to the atmosphere through the chimney.
	Carbon black discharging system	
Carbon black discharging device	Tank height: 1 622 cm; pipe: 18 000 cm	Once the cooling down of the black carbon is completed, it can be packed in the bags through a12 m screw inside to discharge it. Requires 4-5 hours for cooling the reactor and discharging the char.
The hook		After 1-2 hours since the char discharge, steel wires can be discharged.
		Electric panel
Electric panel and Electronic control system	380V/220V, 50 Hz. To be determined when all the additional components from what is provided by the pyrolysis manufacturer will be added	The exact need in electrical power will be determined when all the additional components from what is provided by the pyrolysis manufacturer will be added

Table 3. Equipment components not included in the pyrolysis technology, which should be separately purchased by Gestion Claude Plourde Ltd

System	Equipment
Protection building	Large plastic dome (Length: 100', width: 50', height: 30') will be installed following engineer's plans
Concrete floor slab	A concrete floor slab with safety systems in case of oil spill will be constructed following engineer's plans
Feedstock pre-conditioning et material handling	Shredder, loader and other potential equipment for handling feedstock and products will be purchased from standard equipment suppliers
Supports	Stainless steel plates and other supports for the tanks will be made and installed
Oil tanks	Large oil storage tank (25-50 t) will be purchased and installed by a specialize firm
Water reservoir	A water reservoir for the cooling system will be purchased and installed following engineer's plans
Water cooling tower	Could be purchased on shelve

Table 4. Duration/capacity of each step in the pyrolysis process

Step	Duration
Batch capacity	10 m. tons/batch
Number of batches	1/day, about 20-25/month
Duration of the entire process	24 hrs for 10 tons
Loading of 10 t of waste tyres	2-3 hrs
Reactor preheating	3-4 hrs
Pyrolysis in the reactor	12-14 hrs
Cooling and discharging the reactor	4-5 hrs
Steel removing	1-2 hrs

A.3. Control system

The pyrolyser is equipped with a control system, pressure gauges, alarm system and safety valves. Also, two water sealing devices: oil water separator and anti-back fire device are installed in order to impede the syngas to back up toward the reactor and distribute in the system.

According to the manufacturer, one should take particular attention to the pressure control.

A.4. Pyrolyser plant exploitation and maintenance

The pyrolyser plant can be operated by 4 employees. Principal operations include: tyre shredding, reactor feeding, tyre charging, char discharging, steel discharging, pyrolyser maintenance, technology control, etc. Also, because of the security reasons the workers will never stay alone on-site.

A.5. Baseline noise surrounding the facility

The noise generated by the shredder for tyre pre-conditioning will be limited to noise for a single standard shredder. In order to respect the adjacent neighbourhood, this operation will be exerted only once or twice a week and only during day time.
The pyrolyser itself generates 75 Db. Accordingly to the Noise occupational exposure regulation limits in Canada, this level of noise is within the acceptable.

B. Air emission characteristics

The pyrolyser generates two types of gas: syngas and exhaust gas.

B.1. Exhaust gas

Exhaust gas is emitted to the environment via the chimney with the water vapor. Physico-chemical characteristics of this exhaust gas are presented in the table 4.

General description of the chimney and exhaust gas

- Surface area of the chimney: 0.0572 m^2
- Chimney height: 10 m
- The exhaust gas temperature: 39-44 ^oC;
- Stack gas velocity: 5.9-6.2 m/s
- Oxygen 7.43-7.49 %
- Humidity 3.4-3.5 %
- Dry standard flow rate 1 054-1 078 m^3/h.

Once the syngas has passed through the condenser, the purification system, and the non-condensable gases are burn, catalyst chamber, the dedusting, the very small left over content in the chimney is described in the following table.

Comparing concentrations presented in the Air quality regulation–Clean Air Act confirms that the concentrations emitted by the pyrolyser exhaust gas are considerably lower than the norms.

Table 5. Exhaust gas properties

Compounds	Measured $\mu g/m^3$/ rate kg/h	Analytical method	**Ambient air norms at ground level in New Brunswick and Canada [1], $\mu g/m^3$**
O	0.01	SEPA, 2003	
H_2S	0.01/1.39*10^{-8}/ 0,01	Analytical method, SEPA 2003	1 hr: 15; 24 hrs: 5
SO_2	15/0.730	Stationary source, HJ/T57-2000	1 hr: 450 to 900; 24 hrs: 150-300; annual: 30 to 60; 20[1]
NO_2	618/0.639	Stationary source, Fixed potential electrolysis methodHJ693-2014	1 hr: 400; 24 hrs: 200; annual: 100; 45[1]
VOC	No information		
Particulate matter	04/3.7x10^{-4}	GB/T 16157-1996	24 hrs: 120; 1 an: 70 (geometries average)
CO	25/16/0.0258	SEPA 2003	1 hr: 35 000; 8 hrs: 15 000; annual: 6 000[1]
Benzene C_6H_6	0.06	SEPA, 2003	30[1]
Toluene C_7H_8	0.05	SEPA, 2003	1.880[1]
Etylbenzene C_8H_{10}	<0.01	SEPA, 2003	
Xylene C_8H_{10}	<0.02	SEPA, 2003	2.300[1]

Tableau 5

Non-methane hydrocarbon	1.3	Stationary source, Gas chromatography, HJ/JT 38-1999	
Sn	$1.00x10^{-4}$	Stationary source emission. Determination of tin-Graphite furnace abs method HJ/T 65-2001	
Pb	$2.43x10^{-4}$	Stationary source emission. Determination of lead-Flame atomic absorption spectrophotometric method HJ685-2014	
Cd	$<5.00x10^{-4}$	Stationary source emission. Flame atomic absorption spectrophotometric HJ/T 641-2001	
Be	$<5.00x10^{-5}$	Stationary source emission. Determination of berilium-graphite furnace ABS, method: HJ 684-2014	
Ni	$9.67x10^{-3}$	Stationary source emission. Determination of nickel-flame ABS, method: HJ/T 63,1-2001	
Hg	<0.025	Stationary source emission. Determination of mercury. Cold atomic absorption spe Method HJ 543-2009	
Sb	$<5.00x10^{-5}$	Determination of metals in ambient particulate matter: HJ 657-2013	
Co	$1.99x10^{-4}$	The same as above	
Se	$<2.69x10^{-4}$	The same as above	
As	$1.35x10^{-4}$	Analytical method of monitoring of ambient air and exhausted air SEPA 2003	
Cu	$9.78x10^{-4}$	The same as above	
Mn	$1.54x10^{-3}$	The same as above	
Ft	<0.7	Stationary source emission. Determination of fluoride, ion selective method. HJ/T 67-2001	
Cl	<0.2	Determination of fluoride, ion chromatography. HJ 549-2009	
As+Ni	$9.81x10^{-2}$	SEPA 2003	
Cr+Sn+Sb+Cu+Mn	0.0178	SEPA 2003	
CH_2O (formaldehyde)	0.7	Determination of formaldehyde-acatylacetone spectrophotometric method GB/T 15516-1995	65[1]

B.2. Syngas

The pyrolysis technology also generates a syngas from the non-condensable gas after the other gas was condensed into oil. This gas is not emitted to the atmosphere. This gas is rather recycled in burner of the furnace for heating the reactor.

Table 6. Syngas properties before condensation into oil (this gas is not emitted to the atmosphere)

Compound	Content %
Vapor	0.06
Dust	0.01
Oxygen	1,31
Carbon dioxide, CO_2	11.61
Nitrogen	2.44
Nitrogen oxide, NO	0.01
Carbon Monoxide	1.08
Hydrogen	26.86
Methane, CH_4	26.45
Ethane, C_2H_6	14.42
Ethylene, C_2H_4	5.38
Ethyne, C_2H_2	1.02
Propane, C_3H_8	1.64
Propylene, C_3H_6	2.24
Propyne, C_3H_4	0.13
Butane, C_4H_{10}	1.56
Butylene, C_4H_8	0.04
1,3-Butadiene, C_4H_6	3.54
Pentane, C_5H_{12}	0.08
2-Methyl-1,3Butadien, C_5H_8	0.06
Benzol (coal-tar)	0.03
Styrene, C_8H_8	0.01
H_2S	0.01

*Analysis methods have not been provided by the manufacturer

C. Fuel Burning

Pyrolytic oil generated by the pyrolyser is used for heating the reactor.

One batch of pyrolysis consumes 450 kg (492.7 L) of pyrolytic oil. Considering one-year of production (300 days), about 135 tons (147 810 L) of pyrolytic oil is expected to be used. The pyrolytic oil burner will be installed in the reactor furnace.

No other fuel is expected to be burned except at the start up of the plant during which a similar oil will be used (e.g. heavy oil no. 6).

D. Liquid effluent characteristics

There is no liquid effluent besides the pyrolytic oil described in the following.

D.1. Water

The pyrolysis plant will use water in a closed system to cool down the syngas for condensing the gas into the oil. A water reservoir of about 70-80 m^3 will be constructed for this cooling system. The reservoir will potentially be made of concrete. The material and plans will be made by the engineers that will be mandated by Gestion Claude Plourde Ltd. No water will come out of the system unless there is evaporation from the reservoir which will be replaced.

D.2. Oil

About 4.25 tons (4 653.5 L) per batch of pyrolytic oil will be generated. About 450 kg (492.7 L) of this oil will be stored on-site for heating the pyrolyser. The remaining oil will be collected in the oil tanks and transported to the consumer regularly. Gestion Claude Plourde Ltd has already discussion with a consumer nearby so that the oil does not remain on-site and will be transported only in short distance.

The concentrations of different compounds in this oil are presented in Table 7.
Accordingly to Environment Canada classification (2004), the oil possess high relatively sulphur content. Therefore, it is important to consider the corrosive effect of the oil by selecting equipment resistant to corrosion.

The oil tanks will be purchased at Phoenix Petroleum Ltd. Company; the tank characteristics correspond the oil storage regulations of Canada. Rules of storage and transportation of pyrolytic oil will be applied.

Table 7. Pyrolytic oil properties

Property	Concentration, units	Analytical methods
Ash content	0.030 % (m/m)	ASTM D482-12
pH	5	
Gross catalytic value	44.30 MJ/kg	ASTM D 4868-00 (2010)
Net catalytic value	41.72 MJ/kg	ASTM D 4868-00 (2010)
Solidification Point	<-50 ^{o}C	GB/T510-83 (2004)
Water content	0.10 % (V/V)	ASTM D95-05 (2010)
Total sulphur content	6380 mg/kg	ASTM D4294-10
Carbon Residue-Micro Method	0.15 % (m/m)	ASTM D4530-11
Density at 15 ^{o}C	0.9133 g/cm^{3}	ASTM D1298-12b
Kinematic viscosity at 50 ^{o}C	2.962 mm^{2}/s	ASTM F445-12
Flash point by PMCC	<40.0^{o}C	ASTM D93-12 (Procedure A)

E. Waste storage and handling

The manufacturer has provided quantitative information relative to the ratio of the products generated by the pyrolyser. The values are comparable to those reported in the literature (Table 1). The manufacturer has provided physico-chemical characteristics of these products (Table 7 and 8). The oil is described in the precedent section, the gases in the B section. The steel and the char are discussed further.

E.1. Steel

Pyrolysis of 10 t (one batch) of truck tyres will generate about 1.25 t of steel. The steel will be pressed on-site and will be transported to the Scrap yard (Gala enterprises company) once per month. Thus, a maximum of 25 tons (20 working days) of steel will be accumulated and stored on-site. i.e. when a full truck load can pick it up. The steel does not need protection for the weather. The steel will be stored on a dedicated area at the back yard of the property.

E.2. Char (black carbon)

Char is also produced at a rate of 3.25 tons per batch. The char will be stored on-site in the super bags specially selected for it and will be transported once every 10 days. Thus, a maximum of 35 tons of char will be stored on-site.

The characteristics of the char generated by the pyrolyser are presented in the Table 8. The char generated by pyrolyser has basic pH, and is also highly calorific and inflammable. Rules of storage and transportation of dangerous goods will be applied to it.

Table 8. Char properties

Property	Values	Analytical methods
Iodine absorption value	112 g/kg	GB/T3780.1-2006
DBP absorption value (B)	10^{-5} m^3/kg	GB/T3780.2-2007
CTABA Adsorption of specific surface area	103 m^2/kg	GB/T37780.5-2008
Nitrogen adsorption surface area	103 m^2/kg	GB/T10722-2003
STSA	103 m^2/kg	GB/T10722-2003
Heating loss (125 ºC)	1.3	GB/T3780.8-2008
Ash content (125ºC)	19.6	GB/T3780.10-2009
500 µm	2.2220	GB/T3780.21-2008
45 µm	49.656	GB/T3780.21-2008
pH	9.6	GB/T3780.7-2006
Impurity	No information	GB/T3780.12-2007
Tensile strength MPa	-23.7	GB/T3780.18-2007
Elongation at break %	-174	GB/T3780.18-2007

E.3. Waste tyre storage

The tyres will be accumulated from different regions of New Brunswick, other provinces of Canada and the North Eastern States. The maximal quantity of tyres stored on-site will reach the equivalent of one-year of pyrolyser capacity that is approximately 2 500 tons. The owner already owns the authorisation of waste tyre storage on his property, obtained in 2016.

F. Chemical storage and handling

F.1. Water

The cooling of the condensable gas requires water. The cooling system contains large volume of water (reservoir of 70-80 m^3). The water contained in the reservoir will not be in contact with the soil nor in contact with the pyrolysis products (gas or oil). The reservoir will be covered to reduce evaporation. No water is handled.

F.2. Oil

The oil coming out of the pyrolysis system will be temporary stored in the small tank. No handling is made in the pyrolyser unit. The oil from this tank will be transferred to the large tank once a day through piping and a pump. The design will be completed by engineers that will be mandated by Gestion Claude Plourde Ltd. The oil in the large reservoir will be handle following rules and regulations for that type of material such as done for petroleum products. A small reservoir for bad batches will be installed, this oil will be burn directly on-site by the reactor burner.

F.3. Other chemicals

There is no other chemical expected in the facility else than some very small amount of grease for the maintenance of parts of the pyrolysis system and other machines such as the shredder. There will be a specific place for their storage that will be included in the engineer and architect plans. Their handling and storage will follow the recommendations for these types of products.

G. Contingency plan

The contingency plan and protocols for the storage, spill, and transportation will be provided following the collaborative work with the engineers and architect mandated by Gestion Claude Plourde Ltd.

H. Measures taken for assuring good neighbourhood with the local community

H.1. Context

A public audience occurred when the pyrolysis project was presented by Monsieur Claude Plourde from Gestion Claude Plourde Ltd and Monsieur James Landry from Vanderlaand Inc. on June the 20th, 2016. Several concerns were expressed by the local community. Herein, the measures taken by Gestion Claude Plourde Ltd to assure good relationship with the local community.

Concerns are related to

- Noise
- Water quality
- Air quality, odour
- Traffic
- Explosion and fire risks
- Aesthetics, property value
- Potential expansion

The following explains how Gestion Claude Plourde Ltd intends to limit its potential impacts for its neighbourhood.

H.2. Noise generated by the pyrolyser plant and related activities

Concerns relative to noise at during operation at the pyrolyser plant were listed by the audience: backhoe, loader, jackhammer. All these machines generate some noise.

1) The level of noise generated by all these equipment is within the range accepted by the ministry regulations through the noise occupational exposure limits of Canada.
2) The pyrolyser plant is surrounded in part by forest. It is well known that arborescent vegetation considerably reduces noise. For this purpose, the trees are planted in the cities in order to create protecting walls against noise. Thus, the level of noise generated by the pyrolyser site will be low;
3) If this is accepted by the city and the ministry, Gestion Claude Plourde Ltd will install the pyrolyser in the backyard of his property in order to distance the source of the noise from the adjacent habitations thus minimising even more the noise;
4) Gestion Claude Plourde Ltd will install wall made of concrete blocks in the front of the plant to limit noise as well;
5) All operations will be executed during daytime during the week in order to decrease its impact.
6) It is important to take into consideration that these pieces of equipment will not operate constantly during 8 hrs per day, but rather periodically. For example, the shredder and pre-conditioning of the tyres will be done only once a week.

   All these measures will ensure low noise level released from the facility site.

H.3. Water quality

The local community expressed a concern relative to water pollution by oils and other products that they think may be generated by the pyrolysis plant.

1) The laws and regulations require Gestion Claude Plourde Ltd to conform its installation for water protection, without which it can not obtain its permit.
2) Gestion Claude Pourde Ltd has already taken action for this problematic. In September 2017, he has requested pyrolyser localisation approval, relative to municipal regulations and water position near its land.
3) There will be no water emission from the site. The water is used in a closed system that will recirculate water over and over and a reservoir that will be protected by a dome. Thus the rain water will not come in contact with oil or with this water used in the pyrolyser.
4) The concrete slab under the dome where the pyrolysis plant and the oil reservoirs will be installed will have a spill safety system designed by engineers and conform to laws and regulations in case of water and/or oil is spilled.
5) The char will be packed directly at the exit of the pyrolyser. It will be stored under the dome roof in super sacks.
6) Only a small amount of steel will be kept on-site and away from the creek. Also it will be stored under the dome roof in order to protect water from pollution.
7) Pyrolysis waste tyres protect against water pollution by bacteria and insects that develop when the tyres are stored in the open.
8) Pyrolysis of waste tyres is a solution to avoid water pollution caused by landfilling them as they release toxins to the environment over long period of time, and when the heat increases in the landfill, they emits even more toxins and develop high risk of explosion.

   All these security measures will protect water from contamination.

H.4. Air quality

The local community indicated concerns about the risk of air pollution, mainly odour, resulting from the pyrolyser.

1) Air quality is seriously controlled by environmental regulations, therefore Gestion Claude Plourde Ltd will undertake all possible measures to control it.
2) Accordingly to the information received from the manufacturer, the exhausted gas generated by pyrolyser will not generate air pollution. It is because the pyrolyser is equipped with a condensing system, an effective dedusting filtering system. And a recycling of the non-condensable gases that will be burn in the reactor's burner.
3) A client of the pyrolyser manufacturer who operates the pyrolyser since several years in Finland, has been contacted in regard to several environmental and safety aspects. His indicated the absence of air pollution and that he was conformed to laws and regulations of the European Union, which is particularly strict in term of environmental control.
4) The odour often caused by industries is usually related to sulphur and chloride, both of which will be particularly trapped by the dedusting and filtering system.

H.5. Traffic

Local community has expressed an anxiety concerning the amplification of the traffic on the chemin Mgr Lang.

- Gestion Claude Plourde Ltd expect one truck load of steel per month, one truck load of char per month, one truck of oil per day or less and about two trucks of waste tyres per week, except at the beginning where the tyres are already one site, there will be rare trucks for waste tyres.
- The frequency of transport circulation related to pyrolyser operations will be in average 5 trucks/weeks. This is minimal and much less than any food restaurant activities and gas stations. It is thus minimal and will not cause considerable traffic changes in the community.

H.6. Risk of explosion and fire

It is understandable that the population is concerned about possible explosion and fire. There are important safety features on the technology.

- Accordingly to laws and regulations, Gestion Claude Plourde Ltd is required to have a contingency plan for the facility. This will be prepared by experts and approved by the Regional Emergency Management Coordinators (REMC). All possible measures to decrease the risk shall be established and clearly described in the plan.
- The risk of fire and explosion is decreased by different safety features of the pyrolysis technology. Two levels of safety for pressure control will be installed, detection of temperature, automatic stop of the reactor when it reaches certain threshold will be installed.
- In addition, only a small amount of tyres will be kept on-site comparatively to landfilling the tyres since they will be process soon after their arrival. The goal is to transform them as soon after receiving them as possible. Comparatively, landfilling or large pile of tyres cause temperature increase and, as we saw in the past, may catch into fire, which cause important air and water pollution very difficult to control and remediate. Such as small pile of tyres at Gestion Claude Plourde Ltd site has nearly no risk of fire.

H.7. Aesthetics, property value and possibility to sell them

The participants of the audience expressed the anxiety that they will not be able to sell their properties because the pyrolyser abimes the aesthetics or decrease the value of the neighbourhood.

- In order to minimise this anxiety, Gestion Claude Plourde Ltd will construct the pyrolyser on the back yard of his property, as far as it is accepted by the city and the environment, distancing from the road.
- In addition, Gestion Claude Plourde Ltd has the intent to keep as much trees as possible so that it is not viewed by the neighbours.
- It is important to note that the actual value of neighbour's land has already received lower evaluation. This occurred in the past because of the restrictions on land use associated to the fact that there was a water reservoir near by for the municipality, but which can not be used anymore due to contamination.
- In the past, there have been commercial activities on this Gestion Claude Plourde Ltd site (scrap yard, waste tyres accumulation), the value of the surrounding properties is expected to be unaffected by the installation of a pyrolyser.

H.8. Potential expansion

During the public audience, Gestion Claude Plourde Ltd was asked if he was planning to expand his facility.

- Claude Plourde answered "Probably no", indicating no plan for expansion.
- The selected technology will not allow him for much expansion since there is the possibility to make only one batch per day and he is planning now to do so.
- The land surface does not allow for much expansion.
- In the event that the company would like to expand, he will have to go through a proposal to the government along with environmental regulations and norms.

H.9. Note

Worthily of noticing that following the public audience, a petition against the pyrolyser construction has been produced. The petition was signed by 174 persons.

- The number of persons who signed the petition greatly exceeds the number of persons who live in the neighbourhood. Only SIX habitations (radius of 100 m) can be found around the site.
- Waste tyre pyrolysis is among the most progressive, modern, and environmentally friendly technology to get rid of harmful waste tyres.

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