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# *Constructed Wetland Value-Added Products*

## Project Overview

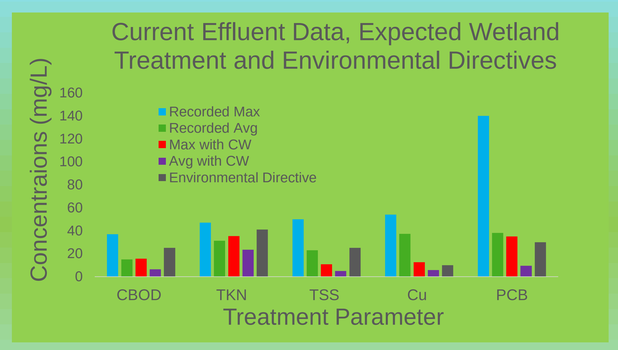
We designed a **constructed wetland (CW)** for use at the **Town of Wolfville's** ageing wastewater treatment plant.

In addition to designing the wetland, we set out to design a profitable and sustainable **value-added product process** that incorporates the wetland. `

**Harvested cattail biomass** from the wetland is made into useful products through **pyrolysis**! The process covers everything from **harvest to pyrolysis**.

## Wetland Design Details

**Size**: 75 046 $m^2$ (7.5 Ha)
**Aspect Ratio**: 3.05:1
**Bed slope**: 0.00925
**Harvest**: 32 855 kg wet cattail 11,477 kg dry Cattail
**Subsurface Flow**
Provides sufficient treatment for projected demand (see chart below)

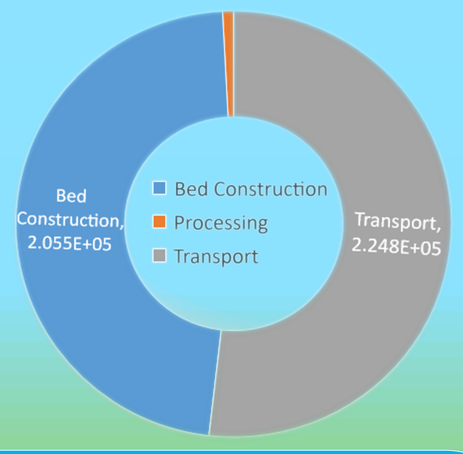



## Process Design Details

**Process Flow: harvest**, **shredding**, **drying** and **pyrolysis** to create **biochar**, **bio-oil** and **syngas**

**Production Rate:** 450 kg **dry cattail**/h
→ 157 kg **biochar**/h,
135 kg **bio-oil** /h,
157 kg **syngas**/h
**Production Hours: 49 hours**

**Project Emissions by Component (kg $CO_2$ eq)**

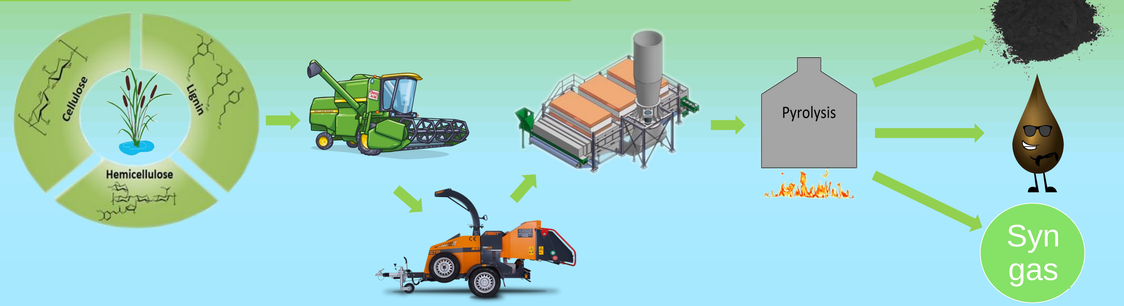



## Conclusion and Recommendations

- The designed wetland can provide **adequate water treatment**
- The designed pyrolysis process can produce **several value-added products**
- The process can be **profitable** and **carbon neutral**, however **project scale is an issue**
- To achieve carbon neutrality and profitability, **more biomass** (**approximately 10x**) must be grown and consumed than what the current wetland is designed to produce

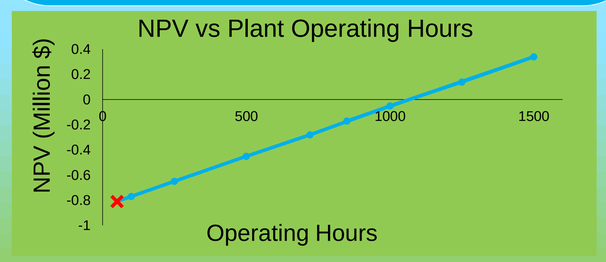
## Design Process

**Iteration**: improve, refine expand
**Product Selection**: biomass
**Crop and Wetland Selection**: cattail and subsurface flow
**Production Avenue Selection**: pyrolysis to biochar
**Production Process Selection**: harvest, dry, pyrolysis
**Detailed Design**: wetland, dryer, pyrolysis reactor
**Integration**: harvesting, shredding and heat integration
**Analysis**: economic, environmental, safety




## Economics– Operating Hours

**2 harvests** at **11,000 kg (dry cattail)** gives a total annual harvest of **22,000 kg**. For a production rate of **450 kg/h**, this means operating hours are limited to **49 hours.** This results in a **net present Value (NPV)** for the project of **-$0.8 million**. All other conditions remaining constant, **operating hours must be increased by obtaining a larger amount of feed biomass to obtain profit** (see chart below)




## Life Cycle Analysis

- **432.7 Tonnes CO2 eq** emitted annually
- **50.4 Tonnes CO2 eq** captured from biomass post-processing
- **382.3 Tonnes CO2 eq** net annual emissions
- Process reduces project emissions by **11.6%**
- Required annual harvest for carbon negative is **142.2 Tonnes dry cattail**

## References


- **Picture of Wetland** - Abydoz Environmental Ltd. Stephenville – Abydoz. Retrieved March 31, 2021, from https://www.abydoz.com/stephenville
- **Tunnel Dryer Model** - Worley, M. (2011). Biomass Drying Technology Update. Biomass Drying Technology Update Benefits of Drying Fuel, 36.


## Further Readings


- Grosshans, R. E. (2014). Cattail (Typha spp.) Biomass Harvesting for Nutrient Capture and Sustainable Bioenergy for Integrated Watershed Management.
- Grosshans, R., Grieger, L., Ackerman, J., Gauthier, S., Swystun, K., Gass, P., & Roy, D. (2014). Cattail Biomass in a Watershed-Based Bioeconomy: Commercial-scale harvesting and processing for nutrient capture, biocarbon and high-value bioproducts. March, 39. www.iisd.org