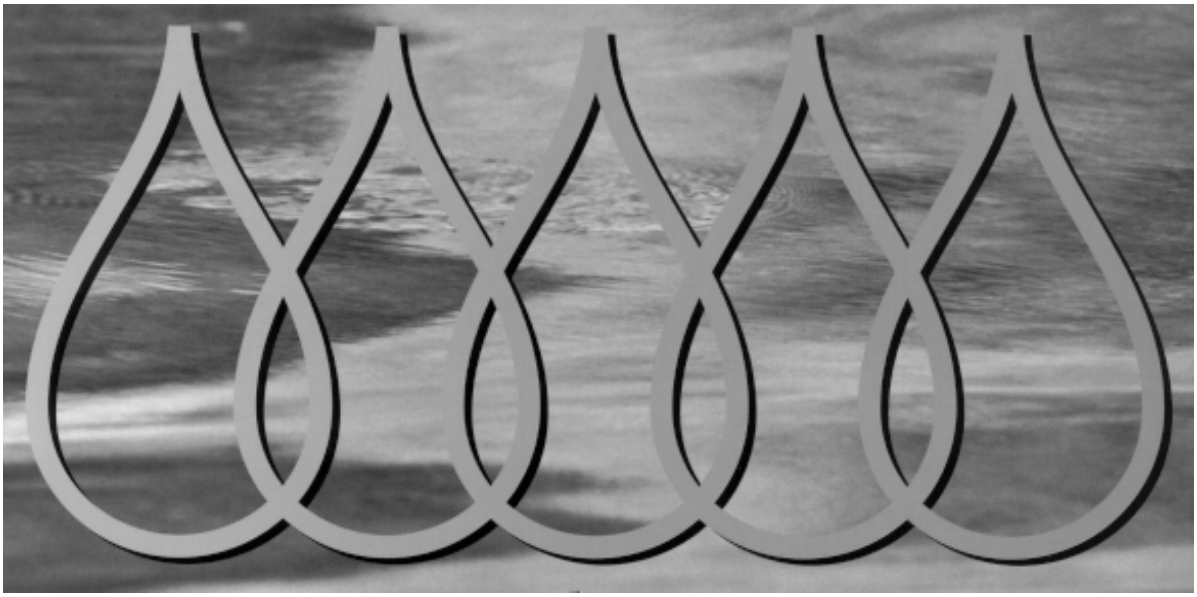
NEW WASTEWATER TREATMENT TECHNOLOGIES

TECHNICAL DATA SHEET

ÉCOPHYLTRE-P CONSTRUCTED WETLAND WITH SAND BED FILTERING SYSTEM

Application fields:	**Level of technical data sheet:**
Commercial and institutional	***Standard***

June 2009
Revision October 2009
Revision July 2012



Québec

TECHNICAL DATA SHEET: BF-20
AND APPENDIX – TRANSITION PROCEDURES

1. GENERAL DATA

- **Name of the technology**

  Écophyltre-P Constructed Wetland with sand bed filtering system.

- **Legislation governing implementation of this technology**

  Each installation requires prior authorization from the *Ministère du Développement durable, de l'Environnement et des Parcs*, under section 32 of the *Environment Quality Act*.

- **Name and contact information of promoter**

  HG Environnement (a division of HG Spec Inc.)
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  Blainville, Québec J7C 5N5
  Tel. 450 434-3384
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  Contact: Jean-Sébastien Grenier, Eng.

2. DESCRIPTION OF THE TECHNOLOGY

- **General**

  The complete treatment sequence includes a septic tank with or without a prefilter, as the case may be, the Écophyltre-P Constructed Wetland and a sand bed filtering system.

  The Écophyltre-P Constructed Wetland is a subsurface horizontal flow constructed wetland (HSS) that consists of a filtering medium in which reeds enable water to flow through the system and contribute to natural aeration. Operation of the system requires a continuous mechanical supply of air and the application of a basic product twice a year.

  The sand bed filtering system is a horizontal flow filter consisting of a sand filtering medium. It can be positioned under or alongside the Écophyltre-P Constructed Wetland.

- **Detailed Description**

  The septic tank must have a prefilter in all applications where a garbage disposal or low-pressure distribution system for the wetland is in use, with an inner meshing of less than 1.6 mm of air space.

  The bottom of the Écophyltre-P Constructed Wetland is sealed with a waterproof bituminous membrane or geomembrane liner. A protective geotextile, covering the entire width of the basin, holds a layer of round or crushed stone 50 to 150 mm in diameter at the inlet, which helps circulate effluent from the septic tank (distribution trench) and at the outlet of the Écophyltre-P Constructed Wetland to recover treated water (collecting trench). The average depth of the wetland is approximately 1 m.

The wetland filtering medium consists of a special mixture prepared for the company HG Environnement, known as "QV PHRAGMIX-01", and ranges in thickness of 0.5 m at the inlet to 1 m at the outlet. The species of plant in use is the common water reed *Phragmites australis*. A layer of coarse sand covers the filtering medium of the wetland to form a horizontal layer ranging in thickness of 0.3 m at the inlet to 0.01 m at the outlet.

A perforated pipe distributes water laterally at the inlet of the artificial wetland, while another recovers treated water at the outlet of the wetland. An outlet regulator controls the water level in the basin. A layer of natural fibers 0.45 m thick (in the direction of flow) acts as a filter between the wetland filtering medium and the round or crushed stone in the collecting trench, over the entire width and depth of the basin.

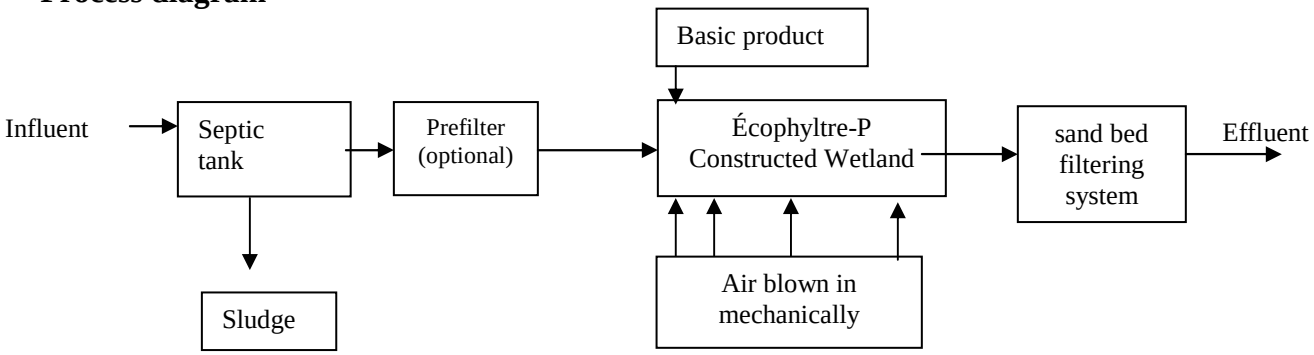
A 0.6 kW blower forces air through four air pipes placed along the bottom of the wetland. Two air pipes form a loop in the distribution trench, a third is located below the Écophyltre-P Constructed Wetland and a fourth is placed below the collection trench. Two valves help adjust air flow in the air pipes beneath the wetland and collection trench.

The bottom of the filtering island is sealed with a waterproof geomembrane liner. A protective geotextile covers the entire width of the basin to protect the geomembrane liner.

Water is distributed at the intake of the filter along the surface using a 75 mm diameter perforated pipe placed in at least 20 mm of clean stone. Water is collected in a trench filled with at least 20 mm of clean stone at the outlet of the filter, in which a 75 mm diameter perforated pipe has been placed. The distribution and collecting areas cover the entire width of the filter.

Sand in the sand bed filtering system that was tested during trials had an effective diameter (D_{10}) of approximately 0.3 mm. Another layer of geotextile was placed on top of the sand bed filtering system to prevent natural soil from contaminating the contents of the sand bed.

- **Process diagram**



- **Description of the technology evaluated during demonstration trials**

Demonstration site

Demonstration trials were conducted between November 7, 2004 and October 26, 2005 at the test facility of the *Bureau de normalisation du Québec* (BNQ) located at 17263 chemin de la Grande-

Ligne, in the Lac-Saint-Charles sector of Québec City. The source of influent was a vacuum sewer and was representative of undiluted domestic wastewater. Influent was heated to a temperature of at least 18^{o} C during the winter.

The treatment system consisted of the following:

- a septic tank with an effective volume of 2.46 m^3 equipped with a prefilter;
- one model RE-1080 Écophyltre-P Constructed Wetland, with overall dimensions of 6 m in length and 6 m in width;
- one sand bed filtering system consisting of a bed of sand with an effective diameter (D_{10}) of approximately 0.3 mm. Overall dimensions were 2.5 m in length by 6 m in width, with a 0.6 m thick layer of sand between the stone-sand interface of the distribution zone and the bottom of the bed. The effective length of the sand bed filtering system (between the distribution zone and collecting zone) was 1.6 m, yielding an effective area of 9.6 m^2. The bottom of the island had a 5% downward slope aimed downstream. During trials, the sand bed filtering system was mounted under the Écophyltre-P Constructed Wetland.

Loading rates observed

The average flow rate of influent during trials was 1.08 m^3/d.

The septic tank complied with guidelines set out in section 3.4 of the *Guide pour l'étude des technologies conventionnelles de traitement des eaux usées d'origine domestique* (Conventional domestic wastewater treatment technologies guide) prepared by the *Ministère du Développement durable, de l'Environnement et des Parcs*.

The following average loading rates were observed in the constructed wetland:

- Linear hydraulic loading rate (LHLR) of 0.18 m^3/m-d;
- Superficial loading rate (in comparison with effective area) of 0.05 m^3/m^2-d;
- Linear mass loading rate of 30 g BOD_5/m-d (supposing 30% removal in the septic tank);
- Superficial mass loading rate of 8.5 g BOD_5/m^2-d (supposing 30% removal in the septic tank).

The average loading rates were observed in the sand bed filtering system:

- Linear hydraulic loading rate (LHLR) of 0.18 m^3/m-d;
- Superficial loading rate (in comparison with effective area) of 0.11 m^3/m^2-d;
- Linear mass loading rate of 0.43 g BOD_5/m-d;
- Superficial mass loading rate of 0.27 g BOD_5/m^2-d.

3. PURIFIYING PERFORMANCES OBTAINED DURING TRIALS

During demonstration trials, the source of raw domestic wastewater was from homes. The temperature of the wastewater at the inlet of the treatment system was kept at a minimum 18° C. Concentrations observed in septic tank influent were as follows:

Characteristics observed in septic tank influent[(1)]

Parameter	Average value	Minimum value	Maximum value	Standard deviation
BOD_5C (mg/L)	**236**	**60**	**360**	**60**
TSS (mg/L)	**239**	**86**	**360**	**51**
Fecal coliforms (CFU/100 ml)	**1,776,000[(2)]**	**110,000**	**55,000,000**	**n/a**
Temperature (°C)	**19.6**	**16.4**	**21.7**	**n/a**

(1) Based on 118 test results for BOD_5C and SS, and 348 test results for fecal coliforms. Temperature was constantly monitored.
(2) Geometric mean.
CFU: Colony-forming units.

Under the application conditions described in section 2, the following concentrations were obtained in effluent from the Écophyltre-P Constructed Wetland during demonstration trials:

Characteristics observed in effluent from the Écophyltre-P Constructed Wetland [(1)]

Parameter	Average value	Minimum value	Maximum value	Standard deviation
BOD_5C (mg/L)	**2.4**	**2**	**7**	**0.92**
TSS (mg/L)	**< 3.0**	**1**	**9**	**1.26**
Fecal coliforms (CFU/100 ml)	**240[(2)]**	**2**	**7,000**	**n/a**

(1) Based on 120 test results for BOD_5C and SS, and 354 test results for fecal coliforms.
(2) Geometric mean.

Under the application conditions described in section 2, the following concentrations were obtained in effluent from the sand bed filtering system during demonstration trials:

Characteristics observed in effluent from the sand bed filtering system[1]

Parameter	Average value	Standard deviation	AADL[2]	ASDL[3]	APDL[4]
BOD_5C (mg/L)[5]	**2.1**	**1.1**	**2.4**	**n/a**	**2.7**
TSS (mg/L)[6]	**< 3.0**	**0.1**	**3.0**	**n/a**	**3.0**
Fecal coliforms (CFU/100 ml)[5]	**5[7]**	**n/a**	**13**	**18**	**29**

(1) Based on 120 test results for BOD_5C and SS, and 350 test results for fecal coliforms.
(2) Average annual discharge limit (AADL) defined on the basis of a 99th percentile limit for an average of twelve results with a confidence level of 95%.
(3) Average seasonal discharge limit (ASDL) defined on the basis of a 99th percentile limit for an average of six results with a confidence level of 95%.
(4) Average periodic discharge limit (APDL) defined on the basis of a 99th percentile limit for an average of three results with a confidence level of 95%.
(5) On the basis of a lognormal distribution.
(6) On the basis of a delta-lognormal distribution.
(7) Geometric mean.

In the Committee's opinion AADL and APDL calculations were valid only for application conditions that are similar to those observed during testing.

Trials did not determine the long-term effects on purification performances, in particular effects due to an aging filtering medium.

4. OPERATION AND MAINTENANCE

The owner must be given a copy of the guides entitled *Écophyltre-P Constructed wetland Wastewater Treatment System – Operating Manual for Residential Use* (March 2005) and *The Sand Bed Filtering System – Owner's Manual – Commercial Application* (January 2009), produced by HG Environnement. It is important to note that a basic product must be spread twice a year over stones in the Écophyltre-P Constructed Wetland distribution trench to stimulate plant growth and to assist in the removal of phosphates.

The supplier of the technology is responsible for recommendations in these guides regarding use, operation, inspection and maintenance.

5. APPLICATION FIELDS

The testing conditions for the demonstration setup of the Écophyltre-P Constructed Wetland treatment system with sand bed filtering system complied with the requirements of the following application fields:

Commercial and institutional

6. PERFORMANCE CLASSIFICATION

Based on monitoring during testing, the performance of the Écophyltre-P Constructed Wetland treatment system with sand bed filtering system, for the loading instances observed on the demonstration setup, achieved the following performance classifications:

Parameter	Performance classification		
	Average annual concentration	Average seasonal concentration	Average periodic concentration
BOD_5C (mg/L)	**5**	**n/a**	**5**
TSS (mg/L)	**10**	**n/a**	**10**
TP (mg/L)	**1[(1)]**	**ND**	**ND**
Fecal coliforms (CFU/100 ml)	**200**	**200**	**200**

[(1)] Performance classification assigned in accordance with technical data sheet BF 7-S.
ND: No performance classification was determined for this parameter.

7. VERIFICATION OF PERFORMANCE MONITORING

The *Comité d'évaluation des nouvelles technologies de traitement des eaux usées* (New wastewater treatment technologies evaluation committee) ("the Committee") has verified the engineering and technology performance monitoring reports that were prepared according to specifications in the document entitled *Procédure de validation de la performance des nouvelles technologies de traitement des eaux usées d'origine domestique* (Performance verification procedure for new domestic wastewater technologies).

In the opinion of the Committee, data collected collected during demonstration trials carried out at the test facility of the *Bureau de normalisation du Québec* were consistent with the evaluation guidelines defined in procedures for the publication of a ***Standard*** technical data sheet.

The technology must be designed, installed and maintained in compliance with the targeted purifying performances.

This performance description may be revised upward or downward if other results are obtained.

This technical data sheet is a description of the performance obtained by the technology on the basis of testing, and does not constitute a certification or any other form of accreditation. The Committee and the *Ministère des Affaires municipales, des Régions et de l'Occupation du territoire* and the *Ministère du Développement durable, de l'Environnement et des Parcs* cannot be held responsible for the poor performance of a wastewater treatment system that has been designed according to information contained in this technical data sheet.

The company remains responsible for the information provided, and the verifications made by the Committee do not release the design engineer and manufacturer or distributor from their obligations, guarantees and responsibilities.

8. SUPPLIER RECOMMENDATIONS

Primary treatment:

- A septic tank that complies with guidelines set out in section 3.4 of the *Guide pour l'étude des technologies conventionnelles de traitement des eaux usées d'origine domestique* (Conventional domestic wastewater treatment technologies guide) prepared by the *Ministère du Développement durable, de l'Environnement et des Parcs*.

Écophyltre-P Constructed Wetland:

- Basin dimensions:
  - Area: $A \geq Z\ Q\ \ln(Ca/Ce)$
    - A: Effective area (m^2), not exceeding 309 m^2 (5.15 m x 60 m)
    - Z: constant dependent on the temperature (T) of wastewater in the wetland basin:
      at $T = 6^o$ C: Z = 6.9 d/m
      at $T = 4^o$ C: Z = 7.7 d/m
      at $T = 2^o$ C: Z = 8.7 d/m
    - Q: flow rate of primary effluent to the constructed wetland basin (m^3/d)
    - ln(Ca/Ce): natural logarithm of the ratio of the BOD_5 concentration in influent compared to the BOD_5C concentration in effluent from the wetland basin, where Ca ≤ 200 mg/L and Ce = 15 mg/L

    The effective area must not exceed 309 m^2 (5.15 m x 60 m).
  - Effective width: $W \geq Q/LHLR$
    - W: effective width (m)
    - Q: flow rate of primary effluent to the basin (m^3/d)
    - LHLR: linear hydraulic loading rate (m^3/m-d)

    The LHLR must not exceed 0.288 m^3/m-d.
    The effective width must not exceed 60 m.
    The effective width corresponds to the overall width, due to the almost vertical slopes at each end.
  - Effective length: $L = A/W$
    - L: effective length (m)
    - A: effective area (m^2)
    - W: effective width (m)

    The effective length must not exceed 5.15 m.
    The effective length is less than the overall length of approximately 3 m, due to the geometry of the distribution and collection trenches and layers of natural fibers.

Sand bed filtering system:

The effective width varies according to the flow rate: $W_e \geq Q/LHLR$

- W_e: effective width (m)
- Q: flow rate of sand bed filtering system influent (m^3/d)
- LHLR: linear hydraulic loading rate (m^3/m-d)

The effective width must not exceed 60 m.
The effective width corresponds to the overall width, due to the almost vertical slopes at each end.

For the sake of sustainable development and protection of biological diversity, the promoter suggests that the common water reed (*Phragmites australis*) in the Écophyltre-P Constructed Wetland wastewater treatment system be gradually replaced by cattails (*Typha sp.*) or bulrushes (*Scirpus* sp.). Before the *Ministère* can issue the necessary authorizations, however, the performance levels of the modified treatment system using replacement plants must be recognized by the *Comité d'évaluation des nouvelles technologies de traitement des eaux usées* (New wastewater treatment technologies evaluation committee) "the Committee").

1. TRANSITION PERIOD

The company HG Spec Inc. agrees to replace common water reeds (*Phragmites australis*) with cattails or bulrushes in its constructed wetland system, and to complete the necessary performance verification steps before June 30, 2014.

During the transition period, beginning January 1, 2010 and ending June 30, 2014, introduction of the Écophyltre-P Constructed Wetland systems using common water reed (*Phragmites australis*) will be limited to the territory defined and approved by the *Ministère du Développement durable, de l'Environnement et des Parcs* (Figure 1). The promoter and the *Direction du patrimoine écologique et des parcs* of the *Ministère* must enter into a specific one-of-a-kind agreement for use of this type of system outside of the defined territory.

As of July 1, 2014, only constructed wetlands that incorporate non-invasive plants will be allowed for use in Québec, and any documents that make reference to constructed filtering wetlands involving the use of common water reed (*Phragmites australis*) will be modified or removed from the *Ministère*'s website.

If the performances of replacement plants are recognized before June 30, 2014, the promoter shall proceed with the approval process of a new technical data sheet for the new procedure and shall request that the Committee withdraw its technical assessment record for the Écophyltre-P Constructed Wetland involving use of the common water reed (*Phragmites australis*).

2. TERRITORY OF APPLICATION

For the period of January 1, 2010 to June 30, 2014, the territory that the *Ministère* has defined for use of the Écophyltre-P Constructed Wetland process using common water reed (*Phragmites australis*) is as follows:

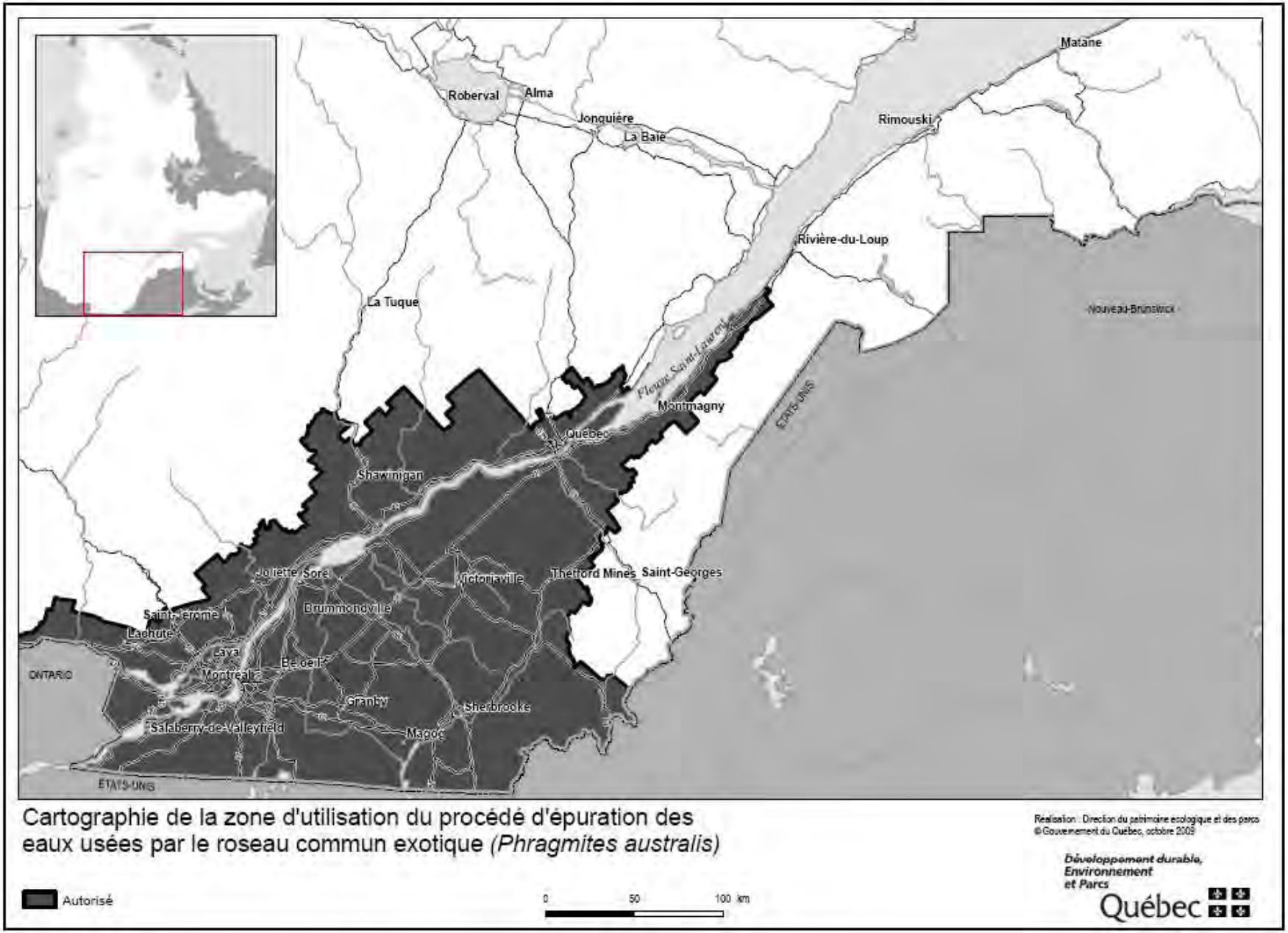


Figure 1. Territory for application of the Écophyltre-P Constructed Wetland process authorized for the period of January 1, 2010 to June 30, 2014.

This appendix may be revised once future performance results for processes using cattails or bulrushes become available.