

Waterloo Emitter™

The Waterloo Emitter™ is a simple, low cost device designed for the controlled release of oxygen or other amendments, to encourage and sustain the growth of microorganisms required for in-situ bioremediation of contaminated groundwater.

The patented technology* enables direct diffusion into an aquifer of fluids (gas or liquid) through silicone or LDPE tubing which is wrapped around a frame. The frame allows insertion of sampling or monitoring devices for down-hole monitoring of groundwater conditions and remediation performance.

Ideal for the bioremediation of BTEX and MTBE using oxygen and diffusion. The diffusive process provides immediate bioavailability of molecular oxygen for aerobic biodegradation enhancement, with no loss of amendment gas due to 'bubbling'. The Waterloo Emitter can also enhance desirable abiotic reactions (pH adjustment, hydrolysis, etc.).

A simulation calculator for the Waterloo Emitter is available in Microsoft Excel for downloading from www.solinst.com. The Calculator allows the input of your application's specifics and will estimate the output of oxygen through diffusion into the aquifer as well as the oxygen supply consumption rate.

Simple Flexible System

Waterloo Emitters are available to fit 2", 4" and 6" (50 mm, 100 mm and 150 mm) wells. They can be installed in cased wells or open boreholes.

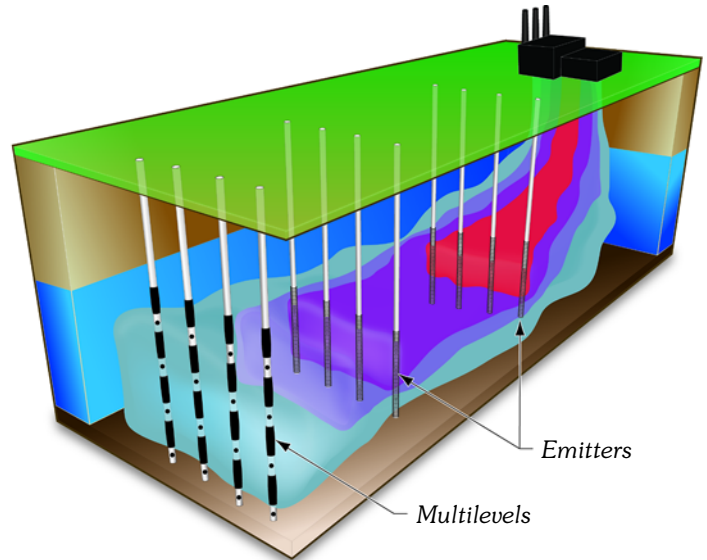
A series of Emitters can be stacked in a single well to ensure coverage of the full thickness of the contaminant plume. They can be used in conjunction with packers and/or circulating pumps to focus the diffusive release, or to increase the radius of influence. Emitters can also be connected from one well to another to allow easy management of the gas supply.

Almost any appropriate fluid (gas or liquid) can be used with the Waterloo Emitter diffusion technology, to apply specific chemicals to a contaminated groundwater plume for enhanced bioremediation, abiotic reactions such as pH adjustment, or for tracer tests.

The new 1.8" (46 mm) Emitters fit easily into existing 2" (50 mm) monitoring wells. For shallow applications in suitable soils, they can be installed through larger direct push casing, resulting in the lowest cost installation of any bioremediation enhancement device.



6", 3.8" & 1.8" Waterloo Emitters



Schematic showing staged plume remediation using Waterloo Emitters, monitored by a transect of CMT or Waterloo Multilevel Systems

Applications

- Oxygen release for aerobic bioremediation of BTEX and MTBE
- Hydrogen release for anaerobic reductive dechlorination of solvents
- Introduction of dissolved SF₆, argon, etc for use as tracers
- Release of CO₂ for pH adjustment
- Light alkane release to promote co-metabolic biodegradation of MTBE
- Horizontal wells

Advantages/Benefits

- Low cost
- Controlled, uniform release for constant microbial activity
 - No amendment loss due to 'bubbling'
- Easy installation and removal
- No cleanup required on decommissioning
- Very low operating and maintenance costs
- No electricity required
- No slurry to mix, handle or inject
- No hazardous materials to ship or handle
- Suitable for many forms of remediation

* U.S. Patent # 5,605,634

Operating Principles

The Waterloo Emitter consists of silicone or polyethylene tubing coiled around a PVC frame. When a fluid is introduced into the tubing, a concentration gradient is created between the inside of the tubing and the groundwater.

The Emitter works in accordance with Fick's Law, whereby diffusion will occur until there is equilibration in chemical concentration inside and outside of the tubing. With the Emitter technology, the oxygen (or other amendment) is replenished regularly, and the groundwater flow around the Emitter is continuous, hence an equilibration point is never reached. This results in a continuous flow, through diffusion, being maintained from inside the Emitter to the groundwater.

When a gas is applied to the Emitter there is a direct correlation between an increase in applied pressure and an increase in the amount of gas that will diffuse into the groundwater.

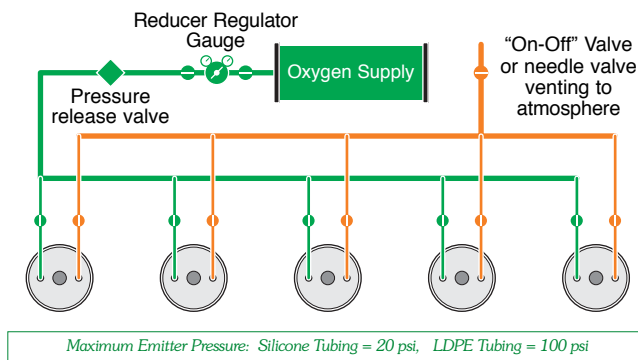


Installation

The 51" (130 cm) long Waterloo Emitters can be installed singly or placed in line one on top of the another. These stacked Emitters can be designed to ensure that the full thickness of the contaminant plume will receive the bioremediation enhancement.

If an enhancement gas is to be used for remediation, a small to medium sized gas cylinder can be used. Emitter tubing is selected and pressure is set according to the amount of enhancement gas required. A single gas cylinder can be used to supply multiple Emitters connected in series.

Replenishment of the gas inside the Emitter tubing can be accommodated by periodic purging (weekly/bi-weekly), or a needle bleed valve can be used at the end of the system to allow slow, constant replenishment to occur.



Plan view of oxygen line plumbing for a row of 5 Waterloo Emitters.

BTEX TPH Remediation Case Study

Waterloo Emitters were installed starting in May 2004, in accordance with Ministry of Environment Certificate of Approval, at a food processing plant in Guelph, Ontario to remediate groundwater contaminated from leaking gasoline and chemical storage tanks. The contaminant plume containing BTEX and TPH occurs within shallow sands and gravels, silty tills, and underlying weathered dolostone to a depth of approximately 13 m. Numerical modeling was used to help determine the best locations for placement of Waterloo Emitters which would be used to diffuse oxygen into the contaminant plume to enhance the natural biodegradation of BTEX and TPH.

A total of 10 Emitters were installed inside 2" diameter overburden wells and 12 were installed inside 2" diameter bedrock wells. Emitters were connected to a bottled oxygen

supply, which delivers oxygen at between 15-25 psi. At 20 psi, 1.8" Emitters using silicone tubing will release approximately 4.1 litres of oxygen per day to the aquifer.

As of November 2004, use of the Emitters had resulted in the following observations:

- Emitter wells averaged 12 mg/L of dissolved oxygen (43.0 mg/L max.), a 900% increase over concentrations prior to Emitter installation.
- The areal extent of the plume has decreased.
- Core plume concentrations of BTEX and TPH have decreased by 20% in the overburden aquifer and 39% in the bedrock aquifer.

The use of the Waterloo Emitter on this project has been determined to be very effective, and will continue toward full site remediation.

Please visit the Solinst Website for more case studies, papers and resources