

# CLEANUP FUND FACT SHEET

## CONTAMINATED SEDIMENT TREATMENT TECHNOLOGY DEMONSTRATION SERIES

### NUMBER 2

### Ecologic Waste Destructor Laboratory Scale Demonstration

#### Contaminated Sediment Treatment Technology Program

The Great Lakes Cleanup Fund is a \$55 million program established by Environment Canada to fund development and demonstration projects of processes and technologies with potential for cleaning up the Great Lakes. Contaminated sediment in Great Lakes' harbours and connecting channels is one of the problem areas targeted by Environment Canada for development and demonstration work under the Cleanup Fund. One of the programs created to address this problem is the Contaminated Sediment Treatment Technology Program (COSTTEP).

The mandate of COSTTEP is to demonstrate promising technologies for *treating* contaminated sediment and to communicate the results of the demonstrations to individuals and agencies involved in the decision making process at each Great Lakes Area of Concern (contamination site). The program began in 1990 and is scheduled to run until 1994. In the early years of the program the focus has been on demonstrating technologies at laboratory or bench scale. In subsequent years more emphasis will be placed on pilot and then full scale demonstrations. Demonstration costs are paid either wholly or partially by COSTTEP.

This series of Fact Sheets is intended to summarize the demonstration work of COSTTEP. Fact Sheet Number 1 gives an overview of the Great Lakes Cleanup Fund, COSTTEP and the sediment contamination problems in the Great Lakes. All other Fact Sheets are specific to a technology demonstration project. Fact Sheets are available from the Environment Canada - Communications Directorate in Ontario Region.

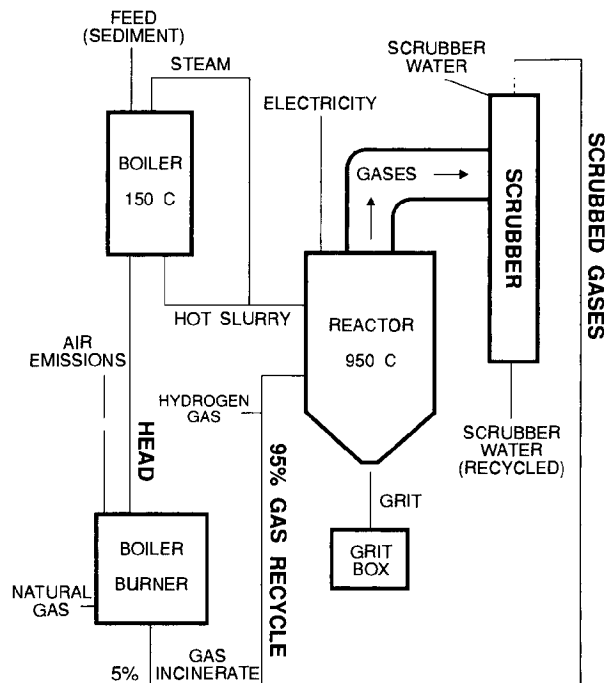
#### Ecologic Technology

Ecologic, a Canadian company based in Rockwood, Ontario, was formed in 1986 to develop a means to safely and economically destroy hazardous wastes. Using chemical theory that at elevated temperatures hydrogen in the gas phase reacts with organic molecules to produce smaller, lighter and less toxic molecules, Ecologic developed the Ecologic Waste Destructor. The technology is designed to have very high destruction efficiencies, to have

no production of dioxins or furans, to have continuous monitoring and process control, to be suitable for aqueous wastes, to be mobile and to be moderately priced.

A simplified process schematic is displayed in *Figure 1*. Waste, diluted with water or solvents if too viscous to be pumped, is preheated and then pumped into the reactor vessel through atomizing nozzles. Hydrogen gas and nitrogen gas are also injected into the reactor. Nitrogen

FIGURE 1  
 EcoLogic destructor schematic



is needed to purge the unit of all oxygen. Recirculating off-gases are also re-injected into the reactor. The waste and gases "swirl" through the reactor until they exit at the bottom. Solids exit downwards and are captured in a quenching tank. Gases rise up through the central ceramic tube where further reduction reactions occur. The reactor is kept above 950 degrees Celsius by "Glo Bar" heaters. The gases then exit through the top of the reactor and enter the scrubber unit where they are quenched with water and scrubbed with carbon steel and polypropylene filter material. The scrubbed gas, containing very light hydrocarbons, is recirculated except for roughly 5 per cent which is diverted to the boiler burner and used as a supplementary fuel. Scrubber water is recirculated until it is too 'dirty' for use.

## Laboratory Scale Demonstration Project

The laboratory scale EcoLogic unit is located at the Rockwood laboratories.



The reactor is six feet long and has a one foot inside diameter. The laboratory scale unit has most of the features shown in the process schematic or has equipment which mimics the full scale process. The laboratory scale unit can process up to five litres of feed material in a four hour run.

FIGURE 2: Photograph of laboratory unit.

EcoLogic performed a set of ten demonstration runs at laboratory scale for COSTTEP. Four of the runs processed diluted Hamilton Harbour sediment, two processed Hamilton Harbour sediment with trichlorobenzene added, two processed Thunder Bay Harbour sediment and two processed sediment from Sheboygan Harbour, Wisconsin. Each run processed approximately five litres of diluted sediment. A full analytical program was carried out and the Wastewater Technology Centre laboratory analysed five sets of duplicate samples as a check on the results. Table 1 summarizes the testing and analytical program and results.

## Results and Discussion

Overall the results of the bench scale testing program were positive, indicating that the EcoLogic process has potential in the sediment treatment field; however, there were some poor results and some processing problems indicating that EcoLogic has some fine-tuning of the process ahead of them.

Mixed results were obtained for the Hamilton Harbour sediment runs. The main contaminant in this sediment is polyaromatic hydrocarbons (PAHs) which are associated with coal and coal residues. PAHs were destroyed by the reactor in some of the runs but were actually created in two of the runs (note the Reactor Destruction Efficiencies in Table 1). This is a common occurrence for most heat based processes, however the theory of the EcoLogic system is that reactive hydrogen will break down organic molecules such as PAHs in the reactor chamber. Obviously this does not happen in all cases. PAH molecules were subsequently destroyed by the system in the gaseous incineration phase or removed by the scrubbers (note the Destruction Removal Efficiency) so that only extremely small amounts of PAHs were released to the atmosphere. Heavy metals are also a serious contaminant of Hamilton Harbour sediment and testing showed that, as predicted, the metals were not

TABLE 1  
Demonstration and analytical program and results

RUN #	SEDIMENT	CONTAMINANT OF CONCERN	FEED CONC. (mg/l)	WTC LAB. AUDIT	REACTOR D.E. (%) **	D.R.E. (%) **	GRIT CONC.* (mg/l)
1	Hamilton Harb.	PAH ^	287.	No	67.9	99.9939	ND
2	Hamilton Harb.	PAH	246.	Yes	85.2	99.9960	ND
3	HH Spike TCB	Trichlorobenzene	23.	Yes	99.9954	99.9990	ND
4	HH Spike TCB	Trichlorobenzene	365.	No	99.9999	100.0000	.007
5	Hamilton Harb.	PAH	272.	No	-150.20	99.9911	.130
6	Sheboygan	PCB ^^	7.4	No	99.40	99.9990	.0023
7	Thunder Bay	Chlorophenols	11.9	Yes	100.0000	100.0000	ND
8	Hamilton Harb.	PAH	329.0	Yes	-1.1	99.9836	3.9
9	Sheboygan	PCB	4.6	Yes	99.80	99.9941	.43
10	Thunder Bay	Chlorophenols	56.0	No	96.8	99.9960	.017

\* Grit is the solid residue after reaction. Concentration is of the contaminant of concern.

\*\* D.E. = destruction efficiency; D.R.E. = destruction removal efficiency and represents removal by all means (reactor, boiler burner, scrubber)

^ PAH = polyaromatic hydrocarbons, total of 16 U.S. EPA priority pollutant PAHs

^^ PCB = polychlorinated biphenyls, total of all measured congeners

ND = not detected (below analytical detection limit)

affected by the process and remained in the solid waste (grit) fraction of the effluent products.

Trichlorobenzene added to Hamilton Harbour sediment for two of the runs was almost completely destroyed by the reactor. PCBs in Sheboygan Harbour sediment were very effectively destroyed by the reactor, however the Destruction Removal Efficiencies (DREs) in both runs were slightly less than the 99.9999 per cent required by some legislation for PCBs. Similarly the chlorophenols in Thunder Bay sediment were destroyed fairly well by the reactor.

The grit recovered from the reactor in all ten runs was either completely cleaned of organic contaminants or cleaned to non-hazardous standards. Scrubber water was in most cases (Runs 1,2,3,4,5,6,8,9) not clean enough to be discharged to surface water and would need to be treated on larger scale tests.

## Conclusions

In their final report EcoLogic staff drew several conclusions. In summary these are:

1. The EcoLogic process will decontaminate polluted harbour sediments;
2. Polyaromatic Hydrocarbons, especially higher molecular weight ones, are harder to process than most chlorinated organics;
3. Some harbour sediments have very high organic content which means that the reactor reduces the volume of the solids substantially (because the organics are destroyed);
4. The test program was successful in demonstrating proof of concept.

The Wastewater Technology Centre, as the auditing agency for the project, also had conclusions about the project. In summary these are:

1. The EcoLogic conclusions as found in their final report are correct in a general sense;
2. The EcoLogic *laboratory scale unit* demonstrated that organic chemical destruction is achievable by this process, but several mechanical or process flaws exist which need to be corrected if the process is to succeed at a larger scale;
3. The maximum solids content which the EcoLogic process can handle is approximately 20 per cent. Dredged sediment usually has a solids content of 20 - 50 per cent (depending on the dredging method). This means that in some cases EcoLogic will have to add water to sediment before treating it. This is not necessarily a disadvantage but does have implications for the unit cost of the process, the unit processing time and site considerations (source of water, storage of water);
4. The EcoLogic staff were very responsive to suggestions and appear to be genuinely committed to developing a high quality process. All work was performed at or above the level requested.

## Future Directions

EcoLogic have already been engaged by the federal Great Lakes Cleanup Fund and the Ontario Ministry of the

Environment to demonstrate the technology at pilot scale at Hamilton Harbour. This will be the first time the pilot scale unit has been tested. (A Factsheet will be prepared for this project).

The pilot unit has an innovative computerized process control system, an improved feed system and complete air stream scrubber systems which should improve the overall performance of the system.

EcoLogic are now looking for other demonstration sites either at pilot scale or full scale and hope to begin commercial operations in the near future.

The EcoLogic process will be rated against all other technologies demonstrated in COSTEP and those demonstrated by other programs such as the U.S. Assessment and Remediation of Contaminated Sediments (ARCS) Program at the conclusion of the demonstration phase of the program. This rating will be published in the final report of the program (1994).

## More Information

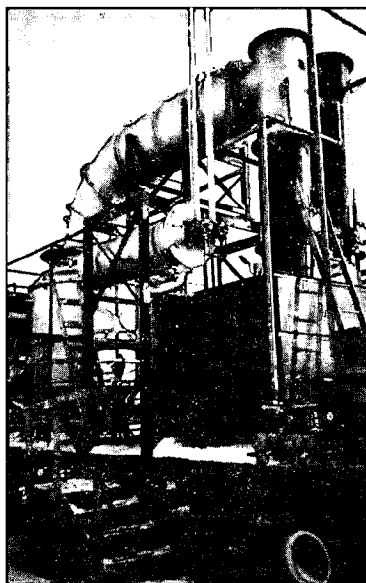
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For more information on the Great Lakes Cleanup Fund or more Factsheets contact:

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**FIGURE 3:**  
EcoLogic pilot scale  
destructor unit  
under construction  
at Hamilton Harbour.