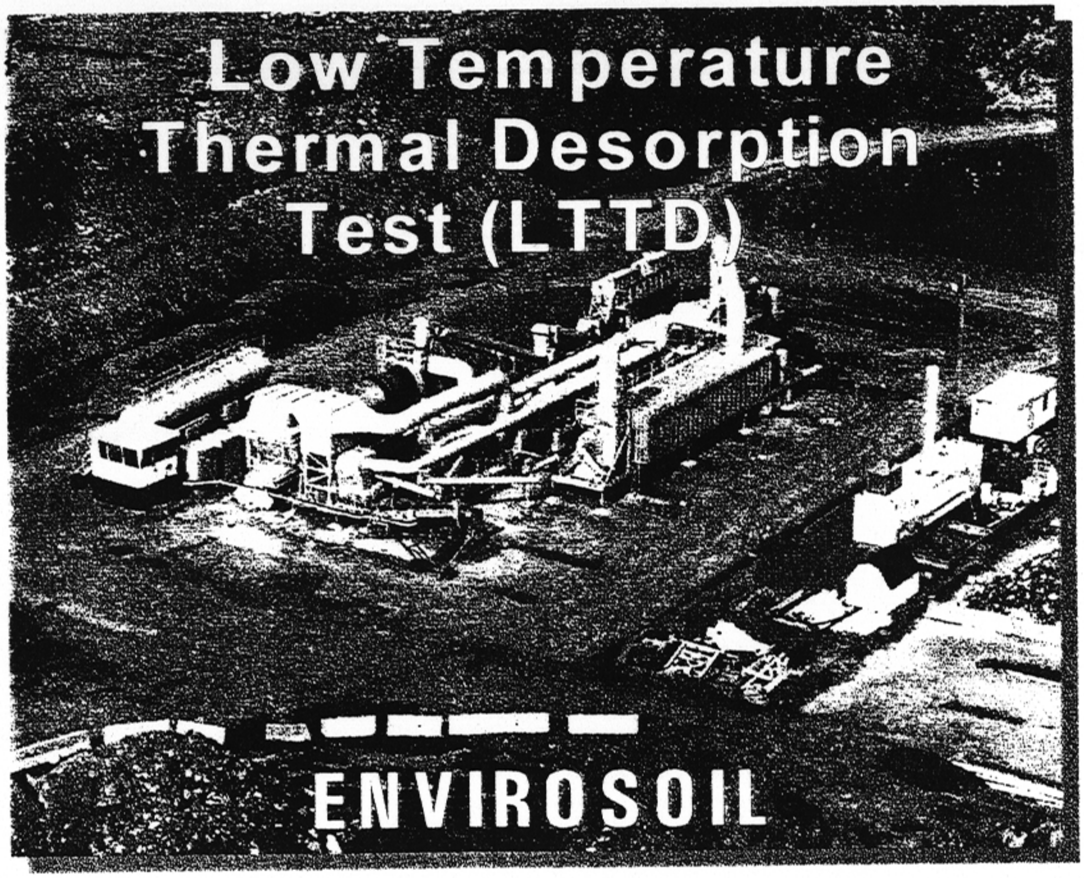
- Case 4 -
Envirosoil Limited Demonstration



For PAH and Pentachlorophenol Impacted Soils

Final Report From

Jacques Whitford
Environment Limited

Envirosoil

Project No. 10294
May, 1997

SPI
DIVISION OF ASTEC

FAXED

October 10, 1996

Mr. Steve Handrahan
Envirosoil LTD.
P.O. Box 48100
Bedford, Nova Scotia B4A 3Z2

Re: OPERATIONAL PARAMETERS FOR PAH/PENTACHLOROPHENOL TEST BURN

Dear Steve:

Attached is a data summary of the items monitored during the test runs conducted at your plant on October 10th, 1996. Below is a list of parameters that should be considered when running the plant under the test burn conditions (with high concentrations and higher processing temperatures):

1) ***LOWER FUEL PRESSURES***
During the test with the 20,000 ppm material, the fuel pressure was lowered at both burners until it produced what we thought to be an adequate supply of oxygen in the process stream. This was necessary to ensure an adequate oxygen supply to allow for the oxidation of the contaminants. Since the STU burner modulates downward to compensate for the heat from the contaminants, its blower input also modulates downward. This is why we need to ensure that enough air is injected by the burner at the lower firing rates. The fuel pressures were originally set at 69 psi (PTU) and 72 psi (STU). We lowered these to the 60-65 psi range to produce more excess air. This should be repeated when running the higher concentrations planned for the test burn. When the plant is operating with typical concentrations of contaminants (i.e. approximately 7500 ppm or less), the fuel pressures should be returned to the original settings.

2) ***LOWER BAGHOUSE INLET TEMPERATURE***
During the test burn conditions, the system was operated with a lower baghouse temperature than normal. This allowed for a greater margin of safety in case a slug of contaminants were to cause a spike in STU temperatures. By operating the baghouse with an inlet temperature of 375-400°F, the system could more likely tolerate a temperature spike at this point in the process.

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3) *COMBUSTION AIR TEMPERATURE*
An item that could also be improved is the combustion air temperature for the burners. During our trial runs, we recorded combustion air temperatures around 340°F for the PTU and 540°F for the STU. Since the STU is to be operated in its lower firing rate range, it could help to lower the STU combustion air temperature to around 350°F. This will have the effect of raising STU excess air. (At a lower temperature a given air volume will contain more mass.) This adjustment involves opening the manual damper on the STU combustion air system slightly, to achieve the lower temperature.

4) *OXIDATION IN THE PTU*
We did not have noticeable oxidation of contaminants occurring in the PTU during the trial burn. At the PTU temperatures which we were achieving, oxidation could begin in the PTU for the lighter compounds. If this were to happen, the result would be; puffing at the PTU drum seals, and possibly, PTU soil and gas temperatures which become closer together. If puffing occurs, the operator should raise the burner suction pressure to overcome dusting from the drum seals. As long as the draft system is not difficult to control, there should not be a problem with allowing some oxidation in the PTU.

5) *IDENTIFY CONTAMINANT CONCENTRATIONS*
If contaminant blends other than those which we discussed are to be used, the composite heat value should be calculated like we did earlier last week. This is based on heating values for the individual hydrocarbon types. The total energy should then be assumed to be liberated in the STU. Overheating in the STU will occur if the burner cannot modulate downward enough to prevent a temperature rise. Overheating could cause damage to the downstream components (heat exchanger and baghouse).

The items listed above should be considered when attempting to operate under the test burn conditions or any conditions where the heat exchanger could be subjected to higher temperatures than it can tolerate. The adjustment listed above will be helpful in running under these conditions on a short-term basis. If these operating conditions become standard or long-term conditions, another type of cooling device should be utilized, such as an evaporative gas cooling chamber (ECC). This type of gas cooling device is more suited for higher operating temperatures, temperature spikes and acid gases which result from the processing of chlorinated hydrocarbon contaminants.

Please convey these items to Ken Brown, Cecil Smith and any others involved in plant operations under these conditions so that they will all be familiar with these particular items of concern.

If there are any questions or if we can be of further assistance, please contact me anytime.

Yours truly,

ASTEC / SPI DIVISION

Wendell R. Feltman, P.E.
Division Vice President

cc: Tom Copeland

PROJECT NO. 10294/6

FINAL REPORT TO

ENVIROSOIL LIMITED

ON

LOW TEMPERATURE THERMAL DESORPTION TEST FOR PAH AND PENTACHLOROPHENOL IMPACTED SOILS ROCKY LAKE ROAD, BEDFORD, NOVA SCOTIA

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May 9, 1997

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1. INTRODUCTION

This report presents the results of a study to evaluate the effectiveness of a low-temperature thermal desorption system (LTTD) operated by Envirosoil Limited for the remediation of soils contaminated with polycyclic aromatic hydrocarbons (PAH) and pentachlorophenol (PCP). From late 1995 through late 1996, a series of studies were conducted and permission was obtained from the Nova Scotia Department of the Environment to perform a full-scale demonstration test of the Envirosoil system using impacted soil.

2. BACKGROUND AND NEED

2.1 Overview

As of late 1996, there are no systems permitted in the Province of Nova Scotia to remediate soils which have been impacted by PAHs and pentachlorophenols. There are a number of sites which have been contaminated by these materials creating a growing need to perform the remedial work. As time passes, the contaminants may spread, perhaps migrating off the original site, and the liability for the cleanup may become clouded by changes in ownership, activity, and the cessation of business through bankruptcy.

In the US, a number of firms have developed LTTD technology, and information suggests the successful application of this technology to PAH and pentachlorophenol contamination. Envirosoil Ltd. had undertaken an extensive review of the available technologies, and in 1995 obtained an LTTD unit from Soil Purification Inc., a US supplier in Chattanooga, Tennessee. Envirosoil's intent was to use the plant at their existing soil recycling facility and to pursue other opportunities both nationally and internationally. After successfully treating their stockpiles of petroleum hydrocarbon impacted soils, and with an experienced operating staff available, Envirosoil researched the applicability of LTTD technology to the growing need for PAH and pentachlorophenol impacted soil remediation, and began work toward this test.

2.2 Need for Facility in Nova Scotia

PAHs are most commonly found associated with industrial processes that use heavy petroleum fuels such as bunker fuel oil, creosotes, and coal. The "Priority Substance List Assessment Report on Polycyclic Aromatic Hydrocarbons" (PSLAR) produced by Environment Canada states the major sources of PAH releases to aquatic and soil environments include creosote treated products, spills of petroleum products, and metallurgical and coking plants. A major source of PAH contaminants in the US is the manufactured coal gas plants that were once used for lighting.

Nova Scotia industry depends heavily on petroleum fuels for energy needs. The province has mined and used coal throughout its entire history and has steel and coking plants throughout the province. There are wood preservative facilities identified in Atlantic Canada as having PAH and pentachlorophenol impacted soils, and these facilities continue to generate wastes containing these products. A facility is required to provide treatment options for these soils.

The PSLAR has stated that the PAHs benzo [a] pyrene, benzo[b] fluoranthene, benzo [j] fluoranthene, benzo [k] fluoranthene, and indeno [1,2,3-cd] pyrene are considered to be entering the environment in a quantity or concentration or under conditions that may constitute a danger to human life or health. There are presently no treatment options in Atlantic Canada. A permanent facility would provide options and help to ensure these impacted soils are dealt with properly and expeditiously.

An additional opportunity is the exporting of this technology. The LTTD technology can be applied to most organic contaminants such as chlorinated compounds and pesticides. The mobility of the Envirosoil LTTD plant along with a successful operating history in Nova Scotia, would give Envirosoil and Nova Scotia an advantage when competing nationally and internationally for environmental cleanup opportunities.

3. PREPARATION FOR TESTING

3.1 Benchscale Testing

The demonstration test was based on the results of three bench scale tests that were commissioned by Envirosoil and performed by Minuvar Limited of Fredericton, New Brunswick. These tests were designed to show that the process temperatures were appropriate to the contaminants. The results of the benchscale tests are presented in a separate report, and highlights of that report are discussed below.

Three tests were carried out with the primary treatment stage set at the following temperatures: 495 °C (923 °F), 505 °C (941 °F), and 510 °C (950 °F). The second stage was operated at 914 °C (1677 °F) to 968 °C (1774 °F). The residence time was 1.5 seconds. Input material was tested for PAHs, pentachlorophenol, and total petroleum hydrocarbons (TPH). The destruction and removal efficiencies were found to exceed 99.99% for all PAHs other than two compounds for which the input material was too low in PAH to determine DREs beyond 99.97%. The input and output dioxin levels were also measured, and the off-gases showed toxic equivalent quantity (TEQ) levels of 0.22, 0.25, and 0.16 ng/m3, respectively, meeting the CCME guideline of 0.5 ng/m3.

Based on the encouraging results of the benchscale tests, Envirosoil proceeded with the design of a full-scale demonstration test and received from the Nova Scotia Department of Environment approval to conduct the test.

3.2 Contractor Selection

Requests for tender were issued to three stack testing firms to work with Jacques Whitford in conducting the demonstration tests. CanadEER was awarded the contract for stack testing. Wellington Environmental Consultants Incorporated and Zenon Laboratories were designated to be the analytical laboratories for the stack testing. Chemical analysis for the feedstock, treated materials and ambient air samples was conducted by MDS Environmental Services of Halifax.

3.3 Pre-Test Plan

A Pre-Test Plan was submitted to NSDOE by Jacques Whitford Environment Limited on behalf of Envirosoil Limited, which included the stack testing component from CanadEER. Three tests on three successive days were scheduled. During each day of testing, it was planned that the LTTD unit would be brought to equilibrium on test material prior to the commencement of stack sampling. Stack samples would be taken to measure the emissions of:

PAH
Pentachlorophenol
Polychlorinated dibenzo-p-dioxins (PCDD)

Polychlorinated dibenzofurans (PCDF)
Metals
Hydrogen chloride (HCl)
Particulate matter (PM)

The Pre-Test Plan outlined the LTTD plant operating conditions. The Primary Treatment Unit (PTU) temperature would be held constant at a different temperature for each run. The Secondary Treatment Unit (STU) temperature would be held constant at 955 °C ± 14 °C (1750 °F ± 25°F) for all 3 runs. The scheduled operating temperatures are summarized below (Table 1).

Table 1 Test Run Operating Temperatures

Run #	PTU Temp °C (°F)	STU Temp °C (°F)
1	455 (850)	955 (1750)
2	482 (900)	955 (1750)
3	510 (950)	955 (1750)

The operating temperatures are dependent on several factors including soil moisture content, soil feed rate and contaminant type. Plant operating temperatures would be held constant with a typical allowance of ± 14 °C (± 25 °F) for slight variance in feed consistency. A chart recorder in the control house would provide a continuous plot of the PTU and STU operating temperatures.

Soil sampling would be conducted on the material entering the system and also on the processed material. At the end of each test, a composite sample of the feed and the discharge soil would be sent to the laboratory for analysis. Other standby sampling included water sampling for any runoff from the material preparation area, but there was no precipitation during the tests.

Ambient air monitoring was also planned using two high-volume air samplers, modified for semi-volatile organics. The samplers would be located approximately 150 m upwind; and 150 m downwind of the LTTD unit. These samplers were intended to determine if there were emissions associated with the handling of the feedstock materials, and the background levels of the contaminants.

3.4 Feedstock Material

The feedstock material for this test was designed to simulate a common level and mix of contamination in the soil. An appropriate concentration of PAH and pentachlorophenol (PCP) impacted soil could not be obtained from an off-site source; therefore, the soil for this test was blended with a liquid creosote and pentachlorophenol mixture obtained from a wood preserving company in the province.

The soil feed stock for the demonstration test burn was selected from existing hydrocarbon impacted soil awaiting thermal treatment at the facility. Approximately 500 tonnes of soil which had been prescreened to 50 mm (2") was used.

Approximately 1,100 gallons (5 000 litres) of creosote and 900 gallons (4 080 litres) of a pentachlorophenol/mineral oil mixture was transported to the Envirosoil facility and combined in a 5,000 gallon tank. This mixture was applied to the soil at the uniform rate of 4 gallons per tonne with the aid of pumps, metering line and a soil conveyor system. The resulting PAH and pentachlorophenol impacted soil was collected, mixed, and stockpiled on the existing asphalt bioremediation treatment pad. This provided containment for the soil and a means to collect and treat runoff water, if required following precipitation events.

Two composite samples of the prepared feed soil were collected and analyzed for TPH, PAH and pentachlorophenol. Results are shown in Tables 2 and 3; the average soil constituents included 2,500 mg/kg Total PAH, 805 mg/kg pentachlorophenol and an average 19,100 mg/kg TPH, which comprised the above constituents as well as a proportion of mineral oil which is used as a carrier oil for pentachlorophenol in the wood preserving industry.

Table 2 Pre-Test Analysis Of PAH and Pentachlorophenol Envirosoil Demonstration Test, October 16-18, 1996

Parameter	Pre-Test Soil Sample 1 (mg/kg)	Pre-Test Soil Sample 2 (mg/kg)
Naphthalene	110	155
Perylene	5.48	6.85
1-Methylnaphthalene	158	220
2-Methylnaphthalene	311	328
Acenaphthylene	1.89	1.91
Acenaphthene	281	347
Fluorene	228	275
Phenanthrene	559	660
Anthracene	94.3	112
Fluoranthene	235	281
Pyrene	157	183
Benz (a) anthracene	37.5	42
Chrysene	45.1	50.6
Benzo (b) Fluoranthene	15.3	15.7
Benzo (k) Fluoranthene	15.3	15.7
Benzo (a) Pyrene	15.3	19.0
Indeno (1,2,3 - cd) Pyrene	6.03	7.75
Dibenzo (a,h) Anthracene	2.08	3.37
Benzo (g,h,i) Perylene	4.77	6.18
1-Chloronaphthalene	< 0.05 [1]	< 1 [2]
2-Chloronaphthalene	< 0.05 [1]	< 1 [2]
Total PAH	**2282**	**2730**
Pentachlorophenol	720	890

Notes:

Samples analyzed by MDS Environmental Services, Ltd., Halifax, N.S.

[1] = Value is below detection limit (Detection limit of soil sample was 0.05 mg/Kg)

[2] = Value is below detection limit (Detection limit of soil sample was 1 mg/Kg)

Table 3 Pre-Test Analysis of Soil TPH Concentrations
Envirosoil Demonstration Test, October 16-18, 1996

Sample ID	Date	BTEX Parameters Concentration in mg/kg (Dry Weight Basis)					Total Petroleum Hydrocarbons Concentration in mg/kg (Dry Weight Basis)				Resemblance
		Benzene	Toluene	Ethyl-Benzene	Xylenes	Total BTEX	C6-C10	C11-C20	C21-C32	TPH	
Pre-Test Soil Sample 1	10/9/96	nd	nd	3.35	14.8	18.15	322	13300	4200	17822	Weathered fuel oil fraction.
Pre-Test Soil Sample 2	10/9/96	nd	nd	3.62	15.2	18.82	236	15500	4650	20386	Weathered fuel oil fraction.
LOQ		0.4	0.4	0.4	0.8	2.0	4	15	15	34	

Notes:
1 nd = not detected
2 LOQ = Analytical "limit of quantification" (Solvent Extraction - GC - FID)
3 Samples analyzed by MDS Environmental Services, Halifax, N.S

4. PLANT DESIGN AND CONFIGURATION

4.1 Overview of LTTD Technology

The SPI ASTEC Portable Soil Purification System has been designed and constructed to effectively purify soils contaminated with petroleum products. The system is designed to be both versatile and highly portable.

The SPI system is based on the concept of Low Temperature Thermal Desorption (LTTD) which is the process of contaminant removal by transforming contaminants from one phase to another. The system targets an operational temperature which is slightly greater than the highest boiling point of the compounds under treatment, but less than the auto-ignition temperatures. As the soil is heated to this point, the contaminants reach their respective boiling points at which time the compounds vaporize and become part of the gas stream. This removal mechanism is physical transfer from the liquid phase to the vapour phase.

The gases are then removed by negative pressure and routed into a secondary combustion chamber where they are further heated to a point above the auto-ignition temperatures of the specific compounds. The result of this process is a transformation of organic compounds into carbon dioxide and water.

The gas stream, now consisting of carbon dioxide and water, enters a heat exchanger where the gases are cooled prior to the final exhaust gas treatment in the baghouse. The particulate matter in the gas stream is intercepted in the baghouse and returned to the soil discharge system. The gases are discharged from the baghouse stack which has continuous monitoring of excess oxygen and total combustibles.

4.2 SPI Technology, Experience and Design Features

Envirosoil's LTTD plant was manufactured by Soil Purification Inc. (SPI), a subsidiary company of Astec Industries Inc. located in Chattanooga, Tennessee. Astec is a leading producer of asphalt plants and equipment for various construction businesses. Use of asphalt equipment to treat soil resulted in Astec's SPI product line specially designed to purify soil. Astec's experience with material handling equipment, dryers, and baghouses gave them a solid foundation to design and build soil purifying equipment. Astec/SPI maintain a manufacturing, design, and technical support facility in Chattanooga, Tennessee. SPI provides a complete service to the soil purifying industry including research and development, design, manufacturing, technical assistance and training to the plant operators. Their assistance to the plant operators is both on-site and at their facility in Chattanooga.

The SPI product line includes equipment for purifying soils with organic contaminants such as petroleum hydrocarbons, and pesticides, PAHs, and chlorinated compounds. SPI has manufactured more than 50 soil purification plants that are presently operating throughout North America.

SPI has developed features unique to their plants; the PTU seals provide a tight seal between the PTU drum and the plant frame. This helps greatly in maintaining the negative operating pressure of the system and controls fugitive emissions. The secondary treatment unit (STU) is designed to promote mixing of the gases with the flame. The gases enter ports located around the entire perimeter of the STU at the flame location. An integral part of the STU's efficiency is the isothermal conditions created by the gas mixing and the initial flame contact that the gases experience.

4.3 Envirosoil Plant Layout

4.3.1 Current Configuration

Envirosoil's LTTD plant is a parallel flow or co-current system and consists of:

- Material feed / preparation unit
- Rotary drum dryer - (Primary Treatment Unit (PTU))
- Processed material discharge system - Pugmill

These components are followed by the exhaust gas treatment system which consists of:

- Cyclonic multi-tube dust collector
- Afterburner - (Secondary Treatment Unit, STU)
- Gas cooling unit - Heat exchanger
- Particulate filtration system - Baghouse

The LTTD plant flow diagram and process schematic are provided in Appendix 4.

4.3.2 Future Equipment Options

Envirosoil's LTTD plant is modular in design and can be modified to accommodate different treatment operating parameters for different soils being treated.

Heat Exchanger vs Quench Chamber

The existing LTTD plant configuration uses a heat exchanger and pre-cooler unit to cool the gases exiting the STU. The heat exchanger is very portable, is easily assembled, and does not require additional services, such as water, to operate. When operating without the pre-cooler unit, the heat exchanger does not add any additional air to the gas stream requiring treatment, thus maximizing production. The pre-cooler unit will bleed cooling air from the heat exchanger intake fan into the gas stream as it exits the STU. This will allow higher treatment temperatures in the STU while maintaining the required maximum allowable temperature in the heat exchanger. However, it also reduces plant production rates.

Acid gas in the gas treatment stream is an important consideration. The heat exchanger and pre-cooler unit do not provide any means of acid gas scrubbing. Over time, treatment of acid gases with the stainless steel heat exchanger would result in damage to the unit.

A quench chamber which injects water into the hot gases would have greater cooling capabilities than the heat exchanger and pre-cooler. Due to the quench chamber cooling efficiencies, higher temperatures in the STU could be easily achieved. A caustic solution could be added to the cooling water to neutralize acid gases formed in the STU. The quench chamber would also have an effect on the plant production rates as it adds steam to the gas volume moving through the plant. Because of the modular design of the LTTD plant, the quench chamber could easily be designed to replace the heat exchanger.

4.4 Control Systems

4.4.1 Operating System Philosophy

Control House

The LTTD plant operator controls all primary plant functions from a central control house. Large windows provide the operator with a view of the plant. Remote cameras are utilized in locations that are not visible from the control house. The cameras are designed with rotational controls and zoom ability so the operator is able to inspect components during operation.

The controls are divided into major groups and are located in the control house in a set-up designed to promote ease of operation. All automated controls have manual backups.

Motor Control Panel - The motor control panel has controls and indicators for all plant motors and actuators. They control the stop/start functions and automatically modulate the pressure and flow of air, gas, fuel, and water throughout the plant. Pressure differential and temperature indicators are used to monitor the flow of gases though the plant. The motor controls are interlocked to ensure the proper sequence of starting and stopping. The failure of any key motor will initiate a shut down of the plant. Ammeters are used to monitor the load on the large motors. All motors have a visual and audible alarm if any component malfunctions.

Burner Control Panel - The plant has a burner control panel for both the PTU and the STU. These panels automate burner control functions and provide feedback to verify the results thus. temperature is easy to control. This is important as fluctuations in the feed material will occur. These adjustments can also be made manually by the operator. A chart recorder is used to provide a continuous record of the operating temperatures.

Programmable Digital Controllers - Automated functions are controlled with Universal Digital Controllers(UDC) located in the individual control panels. Pre-set operating parameters are programmed into the UDC.

Operating Philosophy

It is the treatment temperature and retention time of the gases and soils in both the STU and PTU that will effect the successful treatment of soils by LTTD. The STU temperature is the only parameter that remains constant throughout the treatment process. All other parameters will vary depending on the feed material and feed rate, and operating temperatures. The operator must therefore ensure that the plant is operating within its design limitations. The following description is a typical scenario of the plant operator's procedures.

Treatment Plan - A treatment plan is reviewed by the operator which will:

1. Characterize the soil by contaminant type, and contaminate concentration.

2. Select PTU operating temperatures for the type of soil. Historical operating temperatures have been developed for different organic contaminants.

3. The soil retention times in the PTU will vary and are dictated by the operating temperatures, the soil feed material, and the design capacities of the plant. The PTU operating conditions will have the greatest affect on the plant production. It is therefore important to understand the parameters and how they are inter-related.

   Plant Production Rate: Providing cost effective solutions to environmental problems requires maximizing production rates while still achieving all of the operating goals. While any one of the individual components of the Envirosoil LTTD plant could be the limiting factor with respect to production rates, in almost all cases, it will be the volume of air flow through the plant. All plant motors and conveyors are adequately sized so as not to be the limiting factor.

   Retention Time: The retention time is controlled by the drum speed, the angle of inclination of the drum, and the design and layout of the flighting inside the drum. The flights in the drum are angled pieces of steel that collect and cast the soil inside the drum as it rotates. The drum speed is the only variable controlled by the operator. The drum inclination is fixed. The flights are also fixed, but could be modified if desired. The retention time will decrease with an increase in drum speed.

   Burner Combustion Efficiency: The PTU burner will be most efficient when it uses the least amount of combustion air to accomplish the heating requirements inside the PTU drum. This will occur at slower drum speeds and longer retention times with more soil in the drum.

   The plant operator's goal is to achieve maximum production while still operating within the environmental guidelines. To do this he must minimize the combustion gases added to the system. As the drum speed is reduced, the soil volume inside the drum increases, and the combustion efficiency increases. Simply, there is more soil exposed to the heat inside the drum thus there is a reduction in the combustion air added to the system and the result is an increase in the production rate.

4. STU operating temperatures are held constant. For treatment of petroleum hydrocarbons. 1450°F has been repeatedly documented as sufficient to achieve treatment of the volatilized gases. For treatment of PAHs and PCPs the only demonstrated temperature is 1750°F. This could vary in future applications where a different temperature has been successfully demonstrated.

5. The gas retention times in the STU are not directly controlled by the operator but are dictated by the soil feed rate, soil composition, operating temperatures, and plant design. In short, the retention time depends upon the volume of gas moving through the plant. From an operational perspective, the operator will not focus on the retention time but instead, he will be more aware of the factors affecting the volume of gas through the plant. The gas moving through the plant is limited or monitored by the heat exchanger cooling capacity, the temperature sensors, the baghouse pressure differential, and the stack monitoring equipment. If the temperatures of the gases entering the baghouse are too high, the operator can increase the cooling capacity of the heat exchanger using damper controls or the dilution air system. If the plant cooling capacity is at maximum production, then the operator must reduce the gases through the plant with adjustments made at the feed system and PTU. The best indicator of the STU efficiency is the gas analyzer on the baghouse. It will continuously monitor oxygen levels and unburned combustibles in the baghouse gases. If either of these parameters are out of the desired operating range, then the operator must make adjustments to the feed rate of gases to the system in the PTU.

6. Identify any other treatment concerns. The operator must look for other considerations in the treatment plan. The first step is to know what is in the soil. If chlorine is present in the feed material, then plans for acid gas scrubbing would be required. Most heavy metals have boiling points well in excess of the operating temperatures of the PTU. However, there are a couple of heavy metals with lower boiling points that could be a concern. In this situation, the operator might select lower PTU temperatures and longer retention times to achieve treatment of the organic contaminants while still leaving the heavy metals in the soil.

4.4.2 Routine Operation Control Systems

Start Up Procedures

The Envirosoil LTTD Plant is designed to be started in a specific sequence and electrical controls are designed to maintain this procedure. All controls are electrically interlocked to ensure the proper startup procedure is followed. The startup procedures are designed to protect the workers as well as the individual plant components. The procedures are detailed step by step in the operator's manual.

Plant Operation

Operating Temperatures

The plant operating temperatures are controlled both automatically and manually with Honeywell Universal Digital Controllers from the plant control house. Thermocouples are located throughout the plant and send signals to readouts in the control house. Thermocouples are located in the following areas:

Location	Description	No. of Thermocouples
PTU	Soil exit temperature	1
	Gas exit temperature	1
Pugmill	Soil discharge temperature	1
STU	Gas exit temperature	1
Heat Exchanger	Temperature Sensor for Emergency Shutdown	1
	Gas inlet temperature	1
	Heated combustion air	1
Baghouse	Gas inlet temperature	1
	Temperature sensor for emergency shutdown	1
	Stack gas temperature	1

Plant Damper Controls

The plant draft is controlled by a series of dampers throughout the plant. All dampers, critical to process control, are remotely operated from the control house. Each critical damper control includes the damper, an actuator motor that opens and closes the damper, and a Honeywell Universal Digital Controller located in the Control house. The dampers are located as described in the following table.

Location	Description	No. of Dampers
PTU	PTU Burner	1
	Combustion air	1
Pugmill	Scavenge duct	1
	Heated air damper	1
STU	STU Burner	1
	Combustion air	1
Heat Exchanger	Ambient air intake	1
	Dilution air	1
	Pre-heated combustion air	1
Baghouse	Induced draft	1

Soil Feed System

The soil feed system consists of 2 feed bins, a collector conveyor, scalping screen, clay shredder, an inclined conveyor with a weigh scale, and a diversion chute at the PTU inlet. The feed bins are powered by variable speed motors thus blending of soils is easily controlled by the operator. Soils are screened to 2" minus and weighed prior to entering the PTU. The diversion chute is hydraulically controlled and is used to divert soils from entering the PTU. The operator would use the diversion chute in situations such as a loss of burner in the PTU.

PTU

The operator will bring the plant to a steady state in the startup procedures prior to introducing soil into the plant. With the PTU drum speed at approximately 50% output, the operator begins feeding soil into the PTU. Since the soil contains contaminate and moisture, the PTU operating temperature falls off and adjustments are required immediately. These adjustments can be done either manually or automatically. The operator continues to increase the feed rates making adjustments to the temperature until the desired feed rate is reached.

The operator will also control the plant draft by the burner suction control on the PTU. The burner suction control is operated at 0.2 - 0.4 inches of water column, which is sufficient to maintain a negative pressure throughout the plant. The burner suction is controlled by the damper on the ID fan on the baghouse. A Honeywell Universal Digital controller is used to control the damper.

Pugmill

The pugmill is used for soil cooling and blending of fines back into the treated soils prior to discharge. Water injection is controlled by a Honeywell Universal Digital controller. Dust control in the pugmill is controlled by the scavenge duct system which collects dust in the pugmill and routes it to the baghouse. The pugmill suction control is maintained at the same level as the burner suction control of the PTU thus balancing the draft throughout the plant. A heated air damper is used to control the temperature inside the pugmill and prevent condensation.

From an operational perspective, the operator maintains temperature in the pugmill by increasing or decreasing water injection. At the same time, the draft through the pugmill is controlled by opening and closing the heated air damper and the scavange duct flow damper. All controls are manual or automatic from the control house.

STU

During operation, vaporized contaminates are received by the STU where they are oxidized by the elevated temperatures. At this point, energy is released adding to the energy being supplied by the STU burner. As the concentration of these vaporized contaminates changes, temperature swings will occur, which will be compensated for by the STU burner system when in automatic control mode. These adjustments may also be made manually, by monitoring the STU outlet temperature and adjusting the burner output accordingly. The fluctuations can be reduced by improving soil characterization and pre-handling efforts prior to treatment.

Heat Exchanger

The heat exchanger is used to cool gases exiting the STU at 1500°F to approximately 400°F. The operator monitors the exit temperature from the heat exchanger to ensure gases entering the baghouse do not exceed 500°F. A damper on the ambient air fan controls the amount of cooling capacity required. The damper is controlled by a Honeywell Universal Digital controller located in the control house.

If STU exit temperatures are higher than 1500°F, a dilution air system is used. The dilution air system pre-cools the gases exiting the STU, prior to their contact with the stainless steel plates of the heat exchanger. Ambient air is diverted from the main intake fan, and injected into the treated gases through vertical stainless steel tubes, located at the entrance to the heat exchanger. The purpose is to maintain a maximum temperature of 1500°F on the stainless steel plates of the heat exchanger. Since the operating temperatures for the demonstration would be held at 1750°F, modifications were made to increase the amount of dilution air available for pre-cooling. An external fan was added to the dilution air duct which provided approximately 7000 cfm of additional cooling air into the treated gases. This proved effective in maintaining the inlet temperature to the heat exchanger at < 1500°F, but it also increased the total amount of gases requiring treatment through the baghouse. An alternative to the heat exchanger is an evaporative cooling chamber (ECC). The ECC uses water to quench the gas stream. A very fine water spray is injected into the hot gases cooling the gases to approximately 400°F. All the water is evaporated in the cooling process leaving the bottom of the unit dry. The ECC would increase the volume of gases being sent to the baghouse but it would be less than the additional dilution air added during the demonstration. In both cases, the heat exchanger and dilution air, and the ECC are located after the STU and before the baghouse.

Advantages of the ECC are, it has increased cooling capacity over the heat exchanger, and a caustic can be added to the cooling water to neutralize any acid gases produced in the STU.

Dry Lime Scrubbing

A lime injection system was used to neutralize the HCl gases produced in the STU. The system included a storage silo, transfer line, and metering valve. The valve has a variable speed control so the lime injection can be varied while operating depending upon the amount of HCl gas being produced. The lime was added at the gas discharge from the heat exchanger. This provided time for the gases to mix with the lime, prior to the gases reaching the baghouse. Controls for the lime injection are located inside the control house.

Baghouse

The baghouse is relatively free of required operator monitoring as long as inlet temperature and pressure drop across the component is within the specified ranges. The baghouse inlet temperature must not exceed 500°F and the pressure drop should typically run at 3-6 inches water column. Bag life will be increased if the temperature is maintained below 425°F.
There are 2 inlet temperature sensors for the baghouse. Each sensor has its own Honeywell Universal Digital controller. One is used for process control and the second is for high temperature emergency shutdown.

Induced Draft Fan

The baghouse is equipped with an induced draft (I.D.) fan, designed to move approximately (50,000) ACFM of inlet gas and produce a draft for the entire system. The fan is mounted on the baghouse and discharges to atmosphere via a stack which extends approximately 30′ (10 m) from grade. The inlet damper for the fan controls the entire air flow through the plant. The damper actuator is tied to the control system which maintains burner suction pressure at the burner end of the Primary Treatment Unit. The system's induced draft maintains a negative pressure throughout the system and minimizes the risk of fugitive emissions.

Stack Monitoring Equipment

The Envirosoil LTTD plant is equipped with a Servomex model 700B Continuous Emissions Monitor (CEM). The unit is designed to monitor the concentrations of oxygen and unburned combustibles in the exhaust gas stream.

The CEM components consist of a control unit located in the Control House, and a sensor head and sample probe located in the stack.

4.4.3 Process Upset/Safety Control Systems

Soil Characterization

All soil entering the facility is sampled and tested to determine the concentration and type of contaminate in the soils. This information is required for determining the acceptability of the soil into the facility, and for process control during treatment of the soils.

There are several considerations for process control that relate to the soil contaminates:

1. BTU Value of the Soil - The LTTD plant is designed to operate within 25% of the lower explosion limit of the gas mixture in the plant. This equates to a Total Petroleum Hydrocarbon (TPH) content of 15,000 ppm or 1.5%. The plant is capable of operating outside this range but standard operating procedures require a pre-treatment plan that addresses the increased btu value in the soil. During normal operations, with TPH values in

the soil at < 15,000 ppm, the plant is capable of adjusting the burners to account for fluctuations in the soil Btu value. The plant burners are programmed to shut down if fluctuations are greater than expected, and the operating temperatures exceed the treatment plan operating temperatures.

2. Contaminant type - Operating temperatures are selected based upon the type of contaminant being treated in the soil and will vary due to the different boiling points of each contaminant. The STU temperature is held constant to ensure all contaminate is destroyed prior to discharge from the stack. The PTU temperatures are varied to maximize production rates. These values are determined based on historical records of previous treatments. Incorrect assumptions will result in soil treatments not meeting the treatment criteria. These soils would be returned to the plant for re-treatment and adjustments would be made in the PTU operating temperature

   Envirosoil's operating policy is to treat soils to non-detectable levels. To do this and achieve maximum production, temperatures must be varied to determine the optimum treatment temperature. However, no soils have ever failed the treatment criteria. Any residual petroleum hydrocarbons detected in the post-treatment testing were well below the permit requirements.

Soil Sampling and Analysis

Soils are routinely sampled and analyzed throughout the treatment process, All sampling and analysis is by outside independent consultants. The initial sampling is a pre-screening of the soil prior to its entry into the facility. The purpose is to identify all contaminants in the soil and assess their acceptability to treatment by LTTD. Once the acceptability has been confirmed, the soils are sorted into similar categories and stockpiled.

Soils are treated in the LTTD plant by batches with similar soil characterizations. This provides consistency in the feed material and reduces fluctuations in operating conditions. After treatment, soils are sampled and analyzed to confirm effective treatment. The soils are then stockpiled off-site for future re-use.

LTTD Process Safety Features

The LTTD plant is designed to handle process upset occurrences resulting from equipment or operator failure. Some of the possible scenarios that could occur are:

1. <u>Burner failure</u> - If the temperature range is exceeded in either burner, it will automatically shut down. The burners are equipped with a purge cycle and UV scanner to ensure safe lighting. The purge cycle must be completed during each attempt to light the burner. The burner remains locked out until the purge is complete. An Ultraviolet scanner is used to detect the main flame during lighting. If the main flame is not detected, the fuel supply automatically shuts down, and the purge cycle must be initiated.