In terms of employment for Envirosoil, there are three full-time employees and approximately eight part-time employees. It is expected that the additional of a PERC treatment capability would marginally add to the employment demand of the company.

The company depends on the services of a number of Nova Scotia based contractors. This includes service for trucking, laboratory analysis, oil recycling and skimming, and engineering and environmental. In the event that the company processes PERC contaminated soils, the company would require additional services from these suppliers.

3.5 Case Studies Similar in Nature

The company has undertaken a considerable amount of analysis as to the feasibility of providing a remediation service for PERC contaminated soil. As part of this evaluation, the company has examined the performance record of LTTD equipment in remediation PERC contaminated soil. In particular, a number of case studies similar-in-nature have been examined. Envirosoil believes that a number of key case studies lend themselves as indicators of potential performance of the LTTD equipment and PERC.

The following are the case studies:

Case Studies

Case 1 Thermal Desorption at the Metaltec Superfund Site
Franklin Borough, NJ, USA
Dec 1994 – Jan 1995

Trichloroethene (TCE) – 7,600 mg/kg

Note: This project is practically identical to the operation Envirosoil is proposing, including the technology and contaminants.

Case 2 DRE Emissions Test Results – SFP Airport Plot 50
San Francisco, CA, USA
Mar 1996

Trichloroethene (TCE) – 369.4 grams/hr @ 20 ton/hour treatment rate
99.995% DRE

Note: This project has less detail than the project listed above, however the technology and contaminants are the same.

Case 3 Longhorn Army Ammunition Plant Burning Ground No. 3
Karnack, TX, USA
Feb – Dec 1997

Trichloroethene (TCE) – 1,000 mg/kg

Note: This project is very similar with respect to the technology, however the secondary treatment is slightly different using a catalytic oxidizer and a packed bed scrubber for off gas treatment. The contaminant is the same as Envirosoil proposes to treat.

Case 4 Envirosoil Limited Demonstration
Bedford, NS, Canada
Oct 1996

Pentachlorophenol (PCP) – 720 – 890 – mg/kg (99.99995% DRE)

Note: The technology is the exact equipment that Envirosoil proposes to use. The only difference between this case study and the proposed project is the contaminant treated is PCP rather than TCE, which have the same treatment requirements via LTTD and can achieve the same results.

Details of these important case studies are in Appendix G: Case Studies Similar in Nature.

During research completed for similar case studies, no documented case studies were found for projects in Canada. This stands to reason, as the United States has been documenting the remediation of Superfund Sites, supervised by the USEPA for many years and have had more opportunity to document the effective treatment of soil via LTTD. Thus, the case studies provided are primarily based on projects completed in the United States, except for the Demonstration Test completed by Envirosoil, in Bedford, in October 1996.

A demonstration test on a spiked volume of impacted soil to further demonstrate the LTTD treatment capacity could be made as a condition of the facility approval. Although, by definition, Low Temperature Thermal Desorption (LTTD) is not considered incineration, the "CCME National Guidelines for Hazardous Waste Incinerators" could be used as a general guideline for the demonstration, with operating conditions being set a site specific based on the demonstration results.

3.6 Alternative Methods of Treatment

Alternative methods of treatment of the volatilized PERC have been considered, including condensing (wet scrubbers and strippers). The issues associated with condensing as an alternate for off gas treatment is excess impacted water from the condensing process, to be treated verses the selected technology, which removes the contaminant from the soil and the gas stream leaving both void of contaminants.

Additionally, the existing technology has been proven to treat the proposed contaminants and requires minimal modification to established operating procedures. This allows for effective treatment using existing trained operating personnel.

3.7 *Detailed Discussion of Perchlorotheylene and its Daughter Products*

→ *Introduction:* It is proposed to receive soil impacted with PERC at the Envirosoil plant, Bedford, NS. This soil would then be subject to treatment with a Low Temperature Thermal Desorption (LTTD) unit to remove the PERC from the soil. Whilst PERC is the primary contaminant of concern, other solvents could also be present as a result of natural PERC degradation (e.g. trichloroethene (DCE) and vinyl chloride (VC)). The degradation of PERC is discussed later.

PERC has historically been most commonly used in the dry-cleaning industry and as an industrial solvent. PERC is a chlorinated solvent and is a dense, non-aqueous phase liquid (DNAPL) which means that it has a density greater than that of water. Therefore, upon contact with the water table, migration can continue down through the saturated zone within soil or rock, until an impermeable layer is reached.

→ *Fate in the Environment:* PERC can exist in up to four physical phases:

- Non-aqueous phase liquids or free phase product (NAPLs);
- Dissolved in groundwater;
- Sorbed onto soil particles; and
- As a vapour.

Upon release to the subsurface, chlorinated solvent NAPLs (e.g., PERC, TCE) generally migrate downwards to the saturated zone (with some lateral migration likely also). At the water table, chlorinated solvents can penetrate through the water table and continue to migrate downward through the saturated zone. These "dense" NAPL products are referred to as DNAPL. Migration of DNAPL through the saturated zone is strongly influenced by changes in aquifer permeability and texture, with vertical migration being prevented once an impermeable layer is encountered. This can then result in horizontal or lateral migration of DNAPLs.

Soluble chlorinated solvents can dissolve into water percolating through the unsaturated (vadose) zone and be carried to the groundwater where they can form a free-phase liquid, separate to groundwater or remain in solution, depending upon their concentration and solubility. Dissolved chlorinated solvents can also attach to organic carbon within the aquifer or vadose zone matrix, so reducing (or preventing) their rate of migration. Volatile hydrocarbons can also partition from the NAPL, dissolved and sorbed phases into the gaseous phase as soil vapours in the unsaturated zone.

→ *Degradation:* The biodegradation of PERC is presented graphically as Appendix N, and generally follows the following path:

In order for this degradation to occur, hydrogen is required. Basically, a hydrocarbon atom displaces a chlorine atom and produces the next daughter

product and acid. However, for this process to occur, the following conditions must be present:

1. The soil environment must be anaerobic (lacking in oxygen) and have a low oxidation-reduction potential.
2. There must be an adequate supply of organic carbon in the soil.

The likelihood of these conditions being met at the Envirosoil site are low, especially as impacted soil removed from the ground will have increased in volume and oxygen content from its condition in the ground (i.e. will not be anaerobic).

→ *Leachability*: In order to assess the potential leachability of PERC, it is necessary to consider the way the compound separates between its three physical phases (solid, liquid and vapour). To do this, consideration is given to the Koc (soil absorption coefficient) of the compound. The Koc essentially provides an assessment of the affinity a chemical has for adsorption to soil instead of leaching from the soil as a liquid or vapour. The higher the Koc, the more likely the chemical is to adsorb to the soil and not leach. The actual "strength" of the bond with the soil is also linked with the concentration of organic carbon in the soil so, the more organic carbon present, the higher the adsorption "strength".

Based upon the Koc of PERC and its daughter products, leaching of PERC and TCE is likely to be minimal (Koc of 155 and 166cm^3/g, respectively). However, DCE and VC could be expected to leach more with Kocs of less than 60cm^3/g (similar to Benzene). The level of leaching would, as stated above, be very much dependent upon the organic content of the soils. As discussed in the previous section, the environment for PERC impacted soil at the site (i.e. stored in soil piles) is not favorable for anaerobic degradation and therefore, the potential for the daughter products DCE and VC to be generated is low.

→ *Fugitive Emissions – Emissions from Stockpiles and LTTD Unit:* If a worst case condition for the stockpiles is assumed, i.e. that the soil is fully saturated with solvents, and the nearest receptor is 500m from the facility (approximate location of on-site buildings), emissions from solvents from the stockpiled soil are likely to have no adverse effect upon human health. It is anticipated that dilution of volatile emissions in air will reduce vapour concentrations to negligible levels.

Chemical and Physical Properties: The applicability of LTTD to the treatment of PERC impacted soils should be considered relevant based upon the known ability of the system to treat TCE and other chlorinated solvents. TCE is also used as an industrial solvent in its own right in a number of situations e.g. paint and glue, degreasing agent, correction fluid, ,spot removers. TCE has similar health effects to PERC and migrates as a DNAPL also. In addition, PERC and TCE have similar physical and chemical properties so should react similarly when exposed to LTTD. A pilot test has also been carried out at the site for PCP, with positive

results. PCP has chemical and physical properties which would indicate that thermal desorption of soils impacted by PCP would be more difficult (i.e. lower vapour pressure, low Henry's Law Constant). Generally, chemicals with relatively low vapour pressures, high adsorptivity to soil or high solubility in water are less likely to vaporize and become airborne than chemicals with high vapour pressures or less adsorptivity or solubility. It is this ability to vaporize that forms the basis of the LTTD treatment system. If the chemicals could not vaporize, they could not then be destroyed in the Secondary Treatment Unit (STU) of the system. Therefore, if the proposed technology is able to treat PCP and TCE, it should theoretically be able to treat PERC.

A comparison of the relevant physical and chemical properties is provided in Table 1 below.

Property	PCP	TCE	PERC
Molecular Weight	266.34	131.4	165.8
Density (g/cm^3)	1.98	1.46	1.63
Vapour Pressure Pa at (20^oC)	0.0147[1]	7998[2]	1866[2]
Solubility (mg/L)	1.95E+03	1100	200
Henry's Law Constant	1.0E-6	0.422	0.754
Koc	19,958	166	155

Note:

1. Howard et al, 1991
2. Verschueren, K, 1983

References:

→ US EPA, 1996. Soil Screening Guidance: Technical Background Document.
→ Howard, P.H. et al, 1991. Handbook of Environmental Degradation Rates.
→ Verschueren, K, 1983. Handbook of Environmental Data on Organic Chemicals

3.8 Chemicals Stored at Site

Envirosoil does not currently bulk store any chemicals at their site. In the event of a PERC related operation, common dry lime would be stored in a covered facility at the site. This dry lime would be used in the Dry Scrubber Unit of the LTTD operation as it relates to PERC.

Section 4.0

Environmental Setting

Section 4.0 Environmental Setting

4.1 General Operational Area

Envirosoil Limited is located within the confines of the 3,600 acre site of the Municipal Group of Companies. This large tract of land is accessed by way of Rocky Lake Road, Waverley, Nova Scotia. These aforementioned lands are mostly located in the boundaries of Waverley, although to the south, some of the area is located within of boundaries of Bedford.

In terms of the prevalence of the actual operations of the Municipal Group of Companies on these lands, they take place directly across form the Bedford Industrial Park. At one point in time, the head office for the Municipal Group of Companies was actually located in this industrial park. Large tracks of this 3,600 acre site remain in natural state area and are not currently used for any commercial activity.

The Envirosoil operation is located in a 13 acre site within the quarry section of the aforementioned lands. This area contains the following related to Envirosoil:

- Field office and parking for employees and company vehicles
- Impermeable clay lined facility for incoming contaminated soils
- LTTD equipment
- Loader for handling and movement of soils
- Impermeable clay lined and poly lined lagoons for storage of drilling muds (to be treated)
- Storage area for equipment and tools
- Settling pond for containment of run-off and storm events.
- Access roads and general site facilities

The Envirosoil operation is accessed from the Rocky Lake Road through the quarry main gates and then through select access road on the premises. Envirosoil is approximately ½ kilometer into the quarry area from the main entrance.

4.2 Other Surrounding Areas

Outside the 3,600 acre site of the Municipal Group of Companies and Envirosoil are located a number of commercial sites. Most notably are the operations located with the adjacent Bedford Industrial Park. Envirosoil's closest neighbors would be located within this Industrial Park. They would such entities as:

- (Irving) StressCon Limited
- HRM Municipal sites including transport service facilities.
- Ready Mix Cement

- Kel-Anne Organics (retailer of soils, mulch, etc.)

We note that the principle railroad that links Halifax to other parts of Canada runs alongside part of the Rocky Lake Road as its faces the Municipal Group of Companies and the Envirosoil operation.

In terms of understanding the location and surrounding areas of the Envirosoil operation, refer to the following:

- Appendix C: Site: Topographical Detail
- Appendix D: Site: Land use Detail
- Appendix E: Site: Overhead Photos
- Appendix F: Site: Various Photos: Envirosoil Site & Equipment

4.3 Physiography

The area is situated in the Southern Upland physiographic region of Nova Scotia (Roland, 1982). This region is a resistant, erosional plain with a maximum topography of less than 300 m and gentle slope towards the Atlantic Ocean. A major controlling factor in the general physiographic features of the area is the underlying bedrock geology, which affects topography, drainage, groundwater flow, surfacial geology and soil types. On the northern border of Halifax Regional Municipality, the surface is much like a plateau with long, low ridges running east and west. Large angular blocks of greywacke cover the ground and the soil is usually thin. The intervening hollows are swampy flats which have their long axes generally oriented parallel to the strike of the bedrock features. Drainage is poor and small peat bogs are common (Roland, 1982).

4.4 Geology

Geological mapping in the area of the Envirosoil facility indicates that bedrock is part of the Meguma Group Goldenville Formation principally comprised of fractured greywacke and slate bedrock. Overburden materials are discontinuous and consist of a thin veneer of glacial till, where present.

The Envirosoil facility is hydraulically isolated from the underlying bedrock by means of a clay liner system. The clay is approximately 400 mm thick and is capped by approximately 200 mm to 300 mm of gravel.

A monitor well network consisting of ten (10) monitor wells was previously installed around the perimeter of the clay liner to monitor groundwater levels and quality. Field observations made during the installation of the monitor wells indicated the presence of a thin layer of granular overburden overlying fractured greywacke bedrock.

4.5 Atmospheric Conditions (See Appendix H: Atmospheric Conditions)

The wind directions in the Halifax region are dominated by southerly and northwesterly winds. The southern winds are generally lighter and are more prevalent in the warmer months than the northwesterly winds which commonly follow the passage of a cold front through the area. The Envirosoil site probably experiences some effects of the land-breeze, sea-breeze cycles that are more commonly observed in the summer months. These would likely add somewhat to the frequency of southern winds and westerly winds at the site compared to the frequency distribution observed at Halifax Airport, a more inland site.

As is evident by the windrose (See Appendix H: Atmospheric Conditions), dominant wind directions would be away from developed areas in the vicinity of the Envirosoil facility, and more towards the surrounding undeveloped lands.

4.6 Watercourses: (See Appendix O: Map of Watercourses)

There are no major water courses in the immediate vicinity (i.e. within 1 km) of the Envirosoil facility. The closest water courses to the facility are as follows:

- Lily Lake – approx 1.5 km west
- Rocky Lake – approx 1.5 km northwest
- Anderson Lake – approx 1.8 km south
- Marshall Brook – approx 1 km southeast
- Parkers Brook – approx 2.2 km southwest (drains from Lily Lake)
- Several small swamps/marshes in various directions – all greater than 1 km from the Envirosoil facility

The facilities' clay liner system is sloped, directing all surface run-off to the on-site storm water collection pond. Run-off collected in the pond combines with a portion of the quarry run-off, passing through the quarry's lower settling ponds and ultimately to Lily Lake (1.5 km west).

4.7 Hydrogeological Setting

Geological mapping in the area of the Envirosoil facility indicates that bedrock is part of the Meguma Group Goldenville Formation principally comprised of fractured greywacke and slate bedrock. Overburden material is discontinuous and consists of a thin veneer of glacial till, where present.

Monitor wells were originally installed at the Envirosoil facility in 1992/1993 to monitor groundwater conditions and to confirm that the soil treatment operations are not adversely impacting groundwater at the site. Observations made during the drilling program confirmed that a thin layer of overburden overlying fractured bedrock was present. The monitor wells have been installed to depths ranging between approximately

3 and 6 m below grade, and are screened across the water table. The annulus around the screened section has been backfilled with silica sand, above which a bentonite seal was placed.

Based on monitoring data collected to date, the depth to the groundwater table at the site generally ranges from just below grade to approximately 4.5 m below grade. The direction of groundwater flow has been determined to generally be to the north/northwest under average horizontal gradients ranging from 0.2% to 0.65%. In general, average seasonal groundwater fluctuations have been in the order of approximately 1 m across the site, but have been as high as 1.6 m in the up-gradient monitor wells. The seasonal fluctuations do not appear to affect the direction of groundwater flow at the site.

Hydraulic conductivity tests were recently conducted at the site however, sufficient draw down in the wells tested could not be achieved to facilitate recovery measurements and hydraulic conductivity determinations. Based on literature review (Freeze and Cherry's *Groundwater*, dated 1979), the range in hydraulic conductivity values for fractured bedrock are in the order of 10^{-6} cm/s to 10^{-2} cm/s. Given the fact that draw down could not be achieved during testing, the hydraulic conductivity at the Envirosoil facility is likely in the order of 10^{-2} cm/s.

Freeze and Cherry's *Groundwater* also provide typical porosity ranges for various media types. For slate, the typical range is between 0 and 10%. Given that the bedrock at the site is fractured, porosity in the order of 10% is assumed.

Based on the determined horizontal gradient ranges, the estimated hydraulic conductivity, and the estimated porosity, the average horizontal groundwater flow is estimated to be in the order of approximately 63m/year to 205 m/year.

4.8 General Habitat

The types of plant communities and wildlife species present in and near the facility were determined from interpretation of air and site photos as well as from previous surveys conducted in and near the Rocky Lake quarry.

The facility is located within the Rocky Lake Quarry which supports a very sparse vegetation cover. Most areas of the quarry contain scattered patches of weedy herbaceous plants and grasses which have colonized areas not regularly disturbed such as ditches and berms. Species characteristic of these areas include coltsfoot (*Tussilago farfara*), field rush (*Juncus tenuis*), tickle-grass (*Agrostis hyemalis*), pearly everlasting (*Anaphalis margaritacea*), Canada bluegrass (*Poa compressa*), pineapple-weed (*Matricaria matricarioides*), New York aster (*Aster novi-belgii*), butter-and-eggs (*Linaria vulgaris*), white sweet clover (*Melilotus alba*), and evening-primrose (*Oenothera biennis*). The edge of the settling pond of the facility is vegetated with emergent aquatic plants including broad-leaved cat-tail (*Typha latifolia*), bulrush (*Scirpus cyperinus*), and creeping bent-grass (*Agrostis stolonifera*). There are several areas near the facility where some residual soil is present and where there is little ongoing disturbance. Downy alder

(*Alnus viridis*) dominates these areas. This species is able to grow on the poor mineral soils as a result of its ability to fix nitrogen from the atmosphere. Other tree and shrub species have established with the alders including willows (*Salix* spp.), meadowsweet (*Spiraea alba*), steeplebush (*Spiraea tomentosa*) and seedlings of trembling aspen (*Populus tremuloides*), and gray birch (*Betula populifolia*).

The undisturbed areas outside of the quarry support forest and barrens habitat. The barrens habitats are associated with bedrock outcrops and areas of very thin soil. The area surrounding the quarry has burned a number of times resulting in soil degradation and the establishment of ericaceous shrubs which have inhibited tree regeneration particularly on these very poor sites. This has resulted in the establishment of the barrens habitat in the area. An open tree canopy and dense layer of low shrubs characterize the rock barrens. The most abundant tree species are Jack pine (*Pinus banksiana*), red maple (*Acer rubrum*), red oak (*Quercus rubra*), and black spruce (*Picea mariana*). The dominant shrub species are broom-crowberry (*Corema conradii*), huckleberry (*Gaylussacia baccata*) and lambkill (*Kalmia angustifolia*). The ground vegetation layer consists mainly of reindeer moss lichen (*Cladonia alpestris*), bracken fern (*Pteridium aquilinum*), bunchberry (*Cornus canadensis*), and wintergreen (*Gaultheria procumbens*).

At the margins of the rock barrens is a zone of scrubby, stunted mixed wood forest dominated by a mixture of Jack pine, black spruce, mountain white birch (*Betula cordifolia*), and red maple. The shrub understory is sparse compared to the barrens habitat and is composed mainly of lambkill, huckleberry, lowbush blueberry (*Vaccinium angustifolium*), and false holly (*Nemopanthus mucronata*). The ground vegetation layer is composed mainly of mosses including broom moss (*Dicranum* spp.), knight's-plume moss (*Ptilium crista-castrensis*) and Schreber's moss (*Pleurozium schreberi*).

Dry areas support an open canopied hardwood forest dominated by a mixture of red maple, mountain white birch, and red oak along with some black spruce and Jack pine. The shrub understory is very dense and consists of lambkill, huckleberry, lowbush blueberry, downy alder, and witherod (*Viburnum nudum*). The ground vegetation layer is sparse and is composed largely of bracken fern, wintergreen, broom moss, knight's-plume moss, and sphagnum moss (*Sphagnum* spp.).

Hardwood forest is also present at mesic sites. These stands differ mainly in the relative abundance of shrub and ground vegetation species. At the mesic sites shrub cover is lower and ground vegetation cover is higher. The tree canopy is also denser. The dominant tree species are red oak, red maple and mountain white birch, along with a few black spruce. Lambkill, witherod and downy alder dominate the shrub layer. The most abundant species of the ground vegetation layer are cinnamon fern (*Osmunda cinnamomea*), bracken fern, knight's-plume moss, broom moss, and wintergreen.

Softwood forest is present on sites that are somewhat wetter than the mesic hardwood stands. The dominant tree species of these stands are black spruce, white pine, red maple and a few red oak. The shrub layer is composed mainly of lambkill and witherod with small inclusions of black alder (*Ilex verticillata*), downy alder, and false holly. The

ground vegetation layer consists largely of bracken fern, Schreber's moss, wintergreen, and trailing arbutus (*Epigaea repens*).

The area of the quarry in which the facility is located is unlikely to support any rare or endangered plant species given the intense level of disturbance associated with development of the quarry. There is, however, one uncommon vascular plant species, variegated horsetail (*Equisetum variegatum*) which might be present at this location. This species is listed as uncommon in Nova Scotia (S3) by the Atlantic Canada Conservation Data Centre (ACCDC 2002), however, the Nova Scotia Department of Natural Resources considers the Nova Scotia population to be secure (NSDNR 2002). Variegated horsetail has been found at a number of sites near the Rocky Lake quarry. There is a large population in an abandoned quarry in the Bedford industrial park. Another large population is found in a quartzite quarry near Lake Micmac. Other populations have been found near the DND rifle range in Bedford and at various locations along Highways 118 and 102. This species is often found in seepy areas in ditches or road cuts and moist areas in quarries and tailings ponds. It thrives in these anthropogenic habitats and is rarely found in natural habitats. New populations of this species continue to be found and the possible presence of this species in the quarry would not represent a serious environmental constraint.

The quarry provides poor wildlife habitat. Killdeer (*Charadrius vociferus*) may nest in gravelly areas where disturbance is infrequent. The small shrub thickets in the quarry may provide suitable nesting habitat for Song Sparrow (*Melospiza melodia*), Yellow Warbler (*Dendroica petechia*) and Common Yellowthroat (*Geothlypis trichas*). Wet shrubby areas may provide nesting opportunities for Swamp Sparrows (*Melospiza georgiana*). Few mammal species would be expected to make use of the quarry. Raccoons (*Procyon lotor*) and striped skunks (*Mephitis mephitis*) may forage in the quarry and areas such as berms or soil piles may provide den sites for woodchucks (*Marmota monax*). The settling pond and ditches would provide breeding habitat for a variety of amphibian species including green frog (*Rana clamitans*), northern spring peeper (*Pseudacris crucifer*), wood frog (*Rana sylvatica*), and yellow-spotted salamander (*Ambystoma maculatum*). It is highly unlikely that any rare or particularly sensitive wildlife species regularly use the quarry as habitat.

The woodlands surrounding the quarry provide habitat for a variety of vertebrate species. Bird surveys conducted in similar habitat types between the Burnside industrial park and Rocky Lake revealed that the most abundant bird species found in the area are Black-capped Chickadee (*Parus atricapillus*), Hermit Thrush (*Catharus guttatus*), American Robin (*Turdus migratorius*), Cedar Waxwing (*Bombycilla cedrorum*), Red-eyed Vireo (*Vireo olivaceus*), Black-throated Green Warbler (*Dendroica virens*), Chestnut-sided Warbler (*Dendroica pensylvanica*), Yellow-rumped Warbler (*Dendroica coronata*), Palm Warbler (*Dendroica palmarum*), Common Yellowthroat, Ovenbird (*Seiurus aurocapillus*), Song Sparrow, White-throated Sparrow (*Zonotrichia albicollis*), Dark-eyed Junco (*Junco hyemalis*), and American Goldfinch (*Carduelis tristis*). Mammals commonly found in the area include red squirrel (*Tamiasciurus hudsonicus*), eastern chipmunk (*Tamias striatus*), porcupine (*Erithizon dorsatum*), boreal redback vole

(*Clethionomys gapperi*), deer mouse (*Peromyscus maniculatus*), varying hare (*Lepus americanus*), raccoon, coyote (*Canis latrans*), and white-tailed deer (*Odocoileus virginianus*). The area also provides habitat for a few American black bear (*Ursus americanus*).

4.9 Migratory Birds Convention Act and Federal Fisheries Act

Envirosoil recognizes that migratory birds, their eggs, nests and young are protected under the *Migratory Birds Convention Act* (MBCA) and the associated regulations. Migratory birds include those species listed in the CWS Occasional Paper Birds Protected in Canada under the Migratory Birds Convention Act. Envirosoil recognizes that "no person shall deposit: or permit to be deposited oil, oil wastes or any other substance harmful to migratory birds in any waters or any area frequented by migratory birds" as set in the Migratory Bird Regulations. Further Envirosoil recognizes that the deposit of a deleterious substance into waters frequented by fish is prohibited under Section 36 of the federal *Fisheries Act.*

4.10 Tansportation and Access

Located off the Rocky Lake Road and approximately ½ kilometer into the quarry from the main gates of the Municipal quarry, Envirosoil is dependent on the truck access from the southwest and northeast orientation of the Rocky Lake Road. This road is asphalt paved.

Envirosoil estimates that approximately ten trucks per day would be related to its own use, additional truck traffic entering the quarry is for the purpose of transporting gravel and related rock products.

The principle access would be from the southwest direction of the Rocky Lake Road. The feed direction would be either through Bedford/Sunnyside area or from the TransCanada Highway through Duke Street to the Rocky Lake Road. Truckers comment that, in most cases, it is more efficient for them to use the TransCanada Highway option particularly if there is an opportunity to bypass the frequent congestion in the Bedford/Sunnyside interchange.

Envirosoil estimates that in the event that it would be treating PERC contaminated soil, there would a negligible increase in truck traffic. This would be likely in the order of two additional trucks per day.

Section 5.0

Valued Environmental Components, Environmental Impact and Impact Mitigation

Section 5.0 Valued Environmental Components, Environmental Impact and Impact Mitigation

This section outlines the environmental attributes, potential impacts and mitigation techniques related to Value Environmental Components (VECS) and the LTTD operation of Envirosoil as it relates to PERC.

5.1 Significant Impacts

5.1.1 Valued Environmental Components VECS

A number of PERC related activities that could affect environmental attributes of the local area have been identified. These represent bio-physical components. These are the impacts which do cause changes to be made in project design. This specifically relates to proactive mitigation techniques which are outlined in the following sections of this Registration Document.

The delineation of the environmental attributes that require monitoring and mitigation was based on consideration of the following:

a. The potential performance of the LTTD equipment at Envirosoil as it relates to PERC.
b. The environmental setting including bio-physical and community.
c. The experience obtained in the performance of the LTTD equipment as operated by Envirosoil over the past eight years.
d. The results of testing as conducted under the requirement, in 1997, of the Department of Environment and Labour
e. The review of cases studies similar-in-nature using similar LTTD equipment.
f. Federal and Provincial Legislation related to possible discharges into the environment.

The primary potential effects would relate to pathways in the form of air and water. This is related to unmitigated effluent in the form of PERC run-off into local ground and surface water and also unmitigated emissions from LTTD stack.

We have identified the following environmental attributes as Valued Environmental Components.

- Local ground and surface water
- Local airways

We have eliminated a number of other possible VEC's. Specifically we have eliminated:

- *Community Lifestyle:* This includes trucking and LTTD equipment during operations with effects such as lighting, noise, vibration, and related. Regarding trucking, the estimated increase in the number of trucks would two additional trucks per day over the current ten trucks per day. We noted that in most cases truckers use the Bi Centennial Highway connector (through Duke Street). In terms of sound from LTTD equipment or heavy machinery, operations occur as per NSDEL guidelines (range of 55 – 65 DBA). Over the eight years Envirosoil has received no pubic complaints about noise levels of its fixed or mobile equipment.
- *Local Flora and Fauna:* Envirosoil has considered possible impacts on local flora and fauna around the LTTD site. The company believes there will be no impacts herein. The Envirosoil site is 13 acres contained within the parent company's 3,600 acre quarry facility. This quarry facility is the largest rock quarry in Atlantic Canada. The area surrounding (for a minimum of ½ kilometer radius the Envirosoil site) is devoid of vegetation in any form. Noise or vibration from LTTD and mobile equipment is of minimal consequence in this regard. In terms of wildlife, there would be minimal activity of this in the surrounding area and thus no impact.

5.1.2 Potentially Significant Negative Impacts

Envirosoil has concluded that there *are no potentially significant negative impacts* related to the proposed operation of the LTTD equipment as it's relates to PERC. This is based on the following considerations:

- *Storage Pile*: PERC contaminated soil is stored in a controlled and monitored clay lined purpose built facility. Surface and ground water and one-in-50 year storm water pond is regularly monitored as per existing facilities approval.
- *Air Emissions:* Emissions from the stack of the LTTD equipment are monitored as per established operational criteria of the NSDEL as per facilities approval.

The conclusion of Envirosoil is that while there are a number of important local environmental attributes at the site for this undertaking, there are no potential significant negative impacts. Nevertheless, the company undertakes certain mitigations to ensure that its discharges are in compliance with regulatory requirements and bio-physical impacts are managed and negated.

5.1.3 Potentially Positive Impacts

There is a potential for a number of positive impacts related to this proposed operation. These are as follows:

- Within the province of Nova Scotia and a number of urban centers, there are sites that are contaminated with PERC. This proposed PERC treatment operation will serve as a means for possible remediation of these sites.
- With an increasing number of Canadian provinces banning the importation (for treatment) of contaminated soils, Nova Scotia will soon have to find its own source for local remediation.
- There is a likelihood of marginal employment gain by way of the addition of PERC to the treatment services of Envirosoil.

Whilst there is no marked direct economic or employment gain for this proposed operation, there appears to be benefit by way of expanded soil remediation treatment options within the province.

5.1.4 Mitigation Planning

The following relates to VEC issues and mitigations for the company's future operations in the event of an approval being granted for PERC treatment.

Table 5.1
Activities, VEC's and Mitigation Planning

Activity	VEC's	Mitigation
1. Storage of PERC soils at Envirosoil site.	▪ Ground and/or surface water.	▪ Groundwater Monitoring Program ▪ Surface water Monitoring Program ▪ Clay lined self contained facility
2. LTTD operation related to PERC.	▪ Airways	▪ Source emissions testing ▪ Emissions Monitoring Program
3. Handling of treated soils	▪ Ground and/or surface water	▪ Post treatment evaluation to CCME standards (See Appendix I)

5.2 Monitoring and Contingency Plans

5.2.1 Clay Liner System and Potential Effects of Leachate

The Envirosoil facility is hydraulically disconnected from the underlying material by a clay liner system that covers the entire soil treatment and storage area. The clay liner system is approximately 400 mm thick and has in-situ permeability of less than $1X10^{-6}$ cm/s. The main anticipated cause for degradation of the clay liner is by the production of acid during the degradation of the solvents. Limited degradation is anticipated so minimal production of acid should occur. In addition, direct contact upon a clay liner by solvents has not been shown to cause any *significant* effect upon a clay liner (*Physico-Chemical and Microbial Factors Affecting the Passage of Leachate Through Clay Liners (article in) Geoenvironmental Engineering, Thomas Telford, London, 1997*). At worst, the permeability of the liner could be increased by an order of magnitude. Any minimal affect leachate could potentially have on the liner system would not be such that the integrity would be compromised resulting in the downward migration of contaminants. As discussed above, the site conditions at the Envirosoil facility are not favorable for the anaerobic degradation of contaminants.

5.2.2 Groundwater Monitoring Program

In accordance with the facilities current Approval to Operate (Approval No. 2002-026440), the monitor wells (10 total) are monitored every two months for groundwater levels and petroleum hydrocarbons, and quarterly for polycyclic aromatic hydrocarbons (PAHs). Should Envirosoil's Approval be amended to allow for the treatment of soils impacted with PERC, and EPA 624 volatile organic compound (VOC) scan will be added to the suite of chemical analyses performed. This scan includes PERC, its daughter products, as well as other VOCs.

There are no monitor well nests at the site, as they are not deemed necessary. The likelihood that the quantity of soils brought to the site saturated with DNAPL would result in DNAPL migrating through the liner system and coming into contact with groundwater is negligible. Further, assuming a worst-case scenario, if some DNAPL did enter the groundwater regime, it is highly unlikely that perimeter monitor well nests would be able to detect their presence. Monitoring the existing monitor well network for an EPA 624 scan and tracking contaminant levels is deemed more than adequate for the early detection of DNAPL or significant dissolved phase impacts, if they in fact are present.

5.2.3 Groundwater Contingency Plan

The closed site property boundary to the Envirosoil facility is located over 1.0 km down gradient from the facility. Given the maximum estimated groundwater flow velocity of approximately 205 m/year, groundwater impacts would take approximately 2.4 years to reach this down-gradient property boundary, assuming that no attenuation was taking

place. Quarterly monitoring of groundwater for VOCs will provide sufficient early warning should groundwater become impacted at the site.

If, in the unlikely event, through the quarterly monitoring program unacceptable levels of VOCs are detected, the monitor well(s) will be re-sampled to confirm the results. If the impacts are consistently present, a delineation program will be implemented. This delineation program will involve the installation of additional monitor wells at some intermediate distance down-gradient from the impacted well(s) as well as the down-gradient site property boundary. If the on-going monitoring program indicates that impacts are migrating and that natural attenuation alone is not an effective mitigation measure, then a more aggressive remedial/mitigation approach will be implemented. This could be through the installation of a cut-off trench or large diameter pumping wells and the implementation of a groundwater pump and treat system to facilitate remediation and/or contamination migration mitigation. The actual remedial/mitigation approach implemented will be determined if and when it is required and will be based on a detailed remedial options analysis and pilot-scale testing.

5.2.4 Water Surface Monitoring

The facility's clay liner system is sloped, directing all surface run-off to the on-site storm water collection pond. Run-off collected in the pond combines with a portion of the quarry run-off, passing through the quarry's lower settling ponds and ultimately to Lily Lake (1.5 km west). As part of the monitoring program for the current Envirosoil soil treatment operations, the out-fall to Lily Lake is monitored on a monthly basis for petroleum hydrocarbons, PAHs, phenols, and total suspended solids. As part of the existing Envirosoil Approval for the storage of sulphide bearing material, the storm water pond is also monitored on a monthly basis for petroleum hydrocarbons. An EPA 624 VOC scan will be incorporated into the storm water pond and out-fall to Lily Lake monitoring programs.

5.2.5 Surface Water Contingency Plan

Should analytical testing indicate that concentrations of PERC (or other chlorinated compounds) are present in the storm water pond at levels that exceed the current Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life (FAL) criteria, then a surface water treatment program will be immediately initiated (discussed below). Surface water discharge from the storm water pond will be controlled and analytical testing will be conducted to ensure that contaminants are not being discharged.

Surface water treatment will be accomplished via air stripping and/or granular activated carbon (GAC). GAC is very effective in the treatment of PERC, with a percent loading of approximately 5.3% by weight. With respect to other chlorinated compounds, dissolved phase treatability with GAC varies significantly. For example, vinyl chloride is very difficult to treat with GAC, but is highly strippable with an air stripper. If treatment is deemed required through the monthly analytical program, the appropriate treatment

technology (or combination of technologies) will be employed based on the contaminants present and their concentrations. Envirosoil currently has both GAC filters and a mobile air stripper should immediate surface water treatment be required. Other long-term surface water remedial options that will be evaluated if required include engineered wetlands/phytoremediation, which are proven technologies in the remediation of VOCs.

5.3 Air Monitoring

Regular air emissions monitoring is a current requirement of Envirosoil's Operating Approval from the Nova Scotia Department of Environment and Labour. In addition, Envirosoil must ensure compliance with the Nova Scotia Air Quality Regulations. Specific testing for these parameters as is relates to PERC is to be completed at the request of the Department.

Various emission guidelines and operating parameters which require continuous monitoring have also been established within the aforementioned Approval. These parameters are carbon monoxide in the stack gas, gas temperatures and pressures throughout the unit and oxygen concentrations. Envirosoil is required to monitor these parameters to ensure compliance with the established limits and has incorporated shutdown procedures into the operating system if these parameters do not meet the established operational ranges.

Additional monitoring parameters are expected to be incorporated into Approvals for the treatment of PERC materials including material, volume of process chemicals (lime), operating temperatures, and residence time.

Comprehensive stack testing will also be completed every two years by an independent testing firm.