The Fate and Effects of JP-5 Fuel in Antarctic Soil:

A Controlled Experiment at Scott Base, Antarctica.

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Abstract

Hydrocarbon contamination of Antarctic soils is evident in limited areas where accidental fuel spills have occurred, usually near scientific bases or field camps. To understand the short-term fate and effects of fuel spills on Antarctic soils a contained experiment was established at Scott Base, Antarctica.

Soil cores (105 x 10.5 cm diameter and 30 cm high) were filled with a sieved fraction (< 6.7 mm) of soil (Typic Anhyorthel), buried to the ground surface, and left to equilibrate over winter. Fuel (60 mL of JP-5, an equivalent depth of 7 mm) was applied in droplets, evenly to each of 63 cores. The remaining 42 cores were kept as controls. Ten cores (five control and five JP-5 treated) were weighed daily to monitor changes in moisture and snowfall, and to quantify the volatile loss of JP-5 fuel. *In-situ* temperatures (2, 5 and 20 cm depth) of both control and JP-5 treated cores were measured in triplicate at hourly intervals. Cores were destructively sampled in triplicate 0.1, 1, 3, 7, 14, 21, 28, 35, 42, 358, 365, 372, 379, and 397 days after fuel application and samples were returned, frozen, to New Zealand for total petroleum hydrocarbon (TPH) and microbial analyses.

During destructive core sampling fuel penetration was observed to have reached a mean maximum depth of 15 cm ten days after JP-5 application, and 17 cm after one year. A large proportion (between 35% and 60%) of the fuel applied was lost to volatilisation within six weeks following the spill. The volatile loss of JP-5 fuel, as determined by weighing cores after correcting for moisture addition and evaporation of snowfall was about 9% after 18 hours, 26% after one week, and 35% after six weeks. The TPH content of the soil decreased in the 0-2.5 cm depth range from 46 000 mg kg^{-1}, two hours after fuel application, to 9 000 mg kg^{-1} after six weeks. In the depth range from 2.5 cm to the mean maximum depth of fuel penetration the TPH content of the soil decreased from 45 000 mg kg^{-1} two hours after fuel application to 10 000 mg kg^{-1} after six weeks. The corresponding volatile loss of JP-5 fuel, as determined from TPH concentrations within the total depth of fuel contaminated soil was about 50% after one week, and 60% after six weeks. Differences in the exact total fuel loss as recorded by weighing cores and TPH were attributed to various errors within each technique. The application of fuel had no measurable effect on soil temperature at 2 cm, 5 cm, and 20 cm depth, even though the surfaces of JP-5 treated cores were visibly darker than the control cores. The colour difference however had decreased markedly after three weeks.

No differences were observed in the mean numbers of culturable heterotrophic bacteria and hydrocarbon-degrading microbes between JP-5 treated and control cores six weeks after the spill. It is, therefore, inferred that the initial application of fuel was non-toxic to culturable heterotrophic bacteria and hydrocarbon-degrading microbes.

Soil surface albedo measurements were also made over three previously contaminated sites in the Ross Sea region, and were found to be lower where the surface remained darkened by hydrocarbons, compared to nearby controls.

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Thank you most of all Jesus Christ.

You have made known to me the path of life (Psalm 16:11).

For those in our nation, especially the children,

who may never have the opportunity

to visit the Antarctic continent.

Table of Contents

List of Figures

List of Tables


The earth is defiled by its people.
Isaiah 24:5

Chapter One

Introduction

1.1 Background

Antarctic soils have formed under extreme climatic conditions where soil development processes operate on a slower timescale than elsewhere in the world. As a result Antarctic soils are particularly susceptible to human impact, and recovery from disturbances may be in the order of hundreds to thousands of years (Campbell *et al.* 1998, Beyer *et al.* 1999). Hydrocarbon fuels have been used in Antarctica since the "heroic age of exploration", when man set foot on the continent in the early 1900's. Since then, and increasingly after the International Geophysical Year (IGY) in 1956, there has been a greater reliance on hydrocarbon fuels to support scientific research activities at now more than 50 scientific bases and numerous field camps around the continent (Myers *et al.* 1980, Szabo 1994).

Each year approximately 90 million litres of petroleum products are used in Antarctica for heating, generating electricity, distilling water, and transportation (Cripps and Shears 1997, after SCAR 1989). McMurdo Station for example, the largest of Antarctic bases, stores up to 34 million litres of fuel per year, compared to the 54 000 litres stored by Scott Base (Waterhouse 2001, after Kennicutt *et al.* 1998). While management strategies are in place to prevent hydrocarbon spills for individual countries operating in Antarctica (Antarctica New Zealand 1998), contamination has inevitably occurred.

Such contamination may be the direct result of periodic leakages of fuel over time, from pipelines, refuelling stations, and storage vessels, and in more extreme cases from the collapse of storage tanks or bladders (Tumeo and Wolk 1994, Gore 1999).

Spills associated with geological drilling projects, and from hydrocarbon based drill fluids have also been recorded (Parker *et al.* 1973; Cameron *et al.* 1977).

Hydrocarbon contamination of the Antarctic soil environment is generally localised and limited to specific areas around current and decommissioned base and field camps where fuels have been stored and handled (Krzyszowska 1990, Cripps and Priddle 1991).

Because of the range of activities that fuel is required for in Antarctica, the physicochemical characteristics of hydrocarbons that have been spilled also varies (Table 1.1).

Table 1.1 Characteristics of fuels used in the Antarctic.

Fuel type	*General description*	*Reference*
Fuel in general	Most unleaded, however leaded fuels have been used.	Myers *et al.* 1980
Diesel Fuel Arctic (DFA)	"Light" fuel comprised of low molecular weight *n*-alkane hydrocarbons, such as C_8–C_{15}.	Tumeo and Wolk 1994
Special Antarctic Blend (SAB)	Refined oil, primarily comprising of straight chain alkanes ranging in length from C_8-C_{20}.	Cavanagh *et al.* 1998
BP- Visco	Heavy refined lubricating oil consisting primarily of aliphatic hydrocarbons and small amounts of aromatic compounds and low levels of resins and asphaltenes.	Cavanagh *et al.* 1998
Jet A-1 (JP-8)	Helicopter turbine kerosene. Compositionally similar to a light diesel (C_9–C_{16}), predominant *n*-alkane is C_{11}.	Gore *et al.* 1999
Jet A-2	Helicopter turbine oil. Synthetic lubricating oil composed of aliphatic esters.	Gore *et al.* 1999
Hydraulic and transmission oils	Helicopter mineral oils characterised by the presence of hopanes and steranes.	Gore *et al.* 1999
JP-5	Diesel variant consisting primarily of short chain *n*-alkanes.	Waterhouse 2001

Generally, once a fuel spill has occurred in the Antarctic soil environment it is subject to three main fate processes: volatilisation, subsurface redistribution, and biodegradation. From the onset of a hydrocarbon fuel spill in the Antarctic soil environment it is anticipated that light fraction hydrocarbons are lost to volatilisation (Konlechner 1987, Green 1992) while the remaining fuel is redistributed in the subsurface soil. Where a spill is of sufficient volume, in areas where there is ice-cemented permafrost, the fuel will penetrate down to the permafrost surface and then along the impermeable layer (Parker *et al.* 1973, Cameron *et al.* 1977, Balks and Campbell 1995). Over time fuel may then be removed by microbial degradation (Kerry 1993; Wardell 1995, Aislabie *et al.* 1998).

In areas where fuel spills have occurred, long-term impacts on the soil environment may include an elevation in: soil temperature (Balks *et al.* 2000), soil hydrocarbon concentrations (Aislabie *et al.* 1998, 1999, 2001), and microbial numbers (Aislabie *et al.* 1998, 2001). To understand the long-term fate and effects of fuel spills on the Antarctic soil environment information is required on the biological, chemical, and physical response of Antarctic soils immediately after hydrocarbon contamination.

1.2 Experimental context & thesis structure

A contained fuel spill experiment (Chapter Four) was established in the vicinity of Scott Base, in the Antarctic summer season of 1999/2000 as part of a FRST funded joint programme between Landcare Research and the University of Waikato to examine the impact of fuel spills on Antarctic soils. Soil was packed into cores and left to equilibrate over the winter period. Preliminary laboratory experimentation (Chapter Three) was then undertaken in New Zealand to determine the optimum application rate of JP-5 fuel to the soil cores. On return to Antarctica in the 2000/01 summer season, JP-5 was applied to the soil cores and soil samples were collected over a 42 day period. Samples were taken back to New Zealand and distributed between the various parties involved in the programme for geochemical and microbial analysis. Some microbial analysis is included in this thesis (Chapter Five). During the summer season of 2001/02 (one year after fuel application) additional samples were taken for the programme, and a second temperature experiment undertaken.

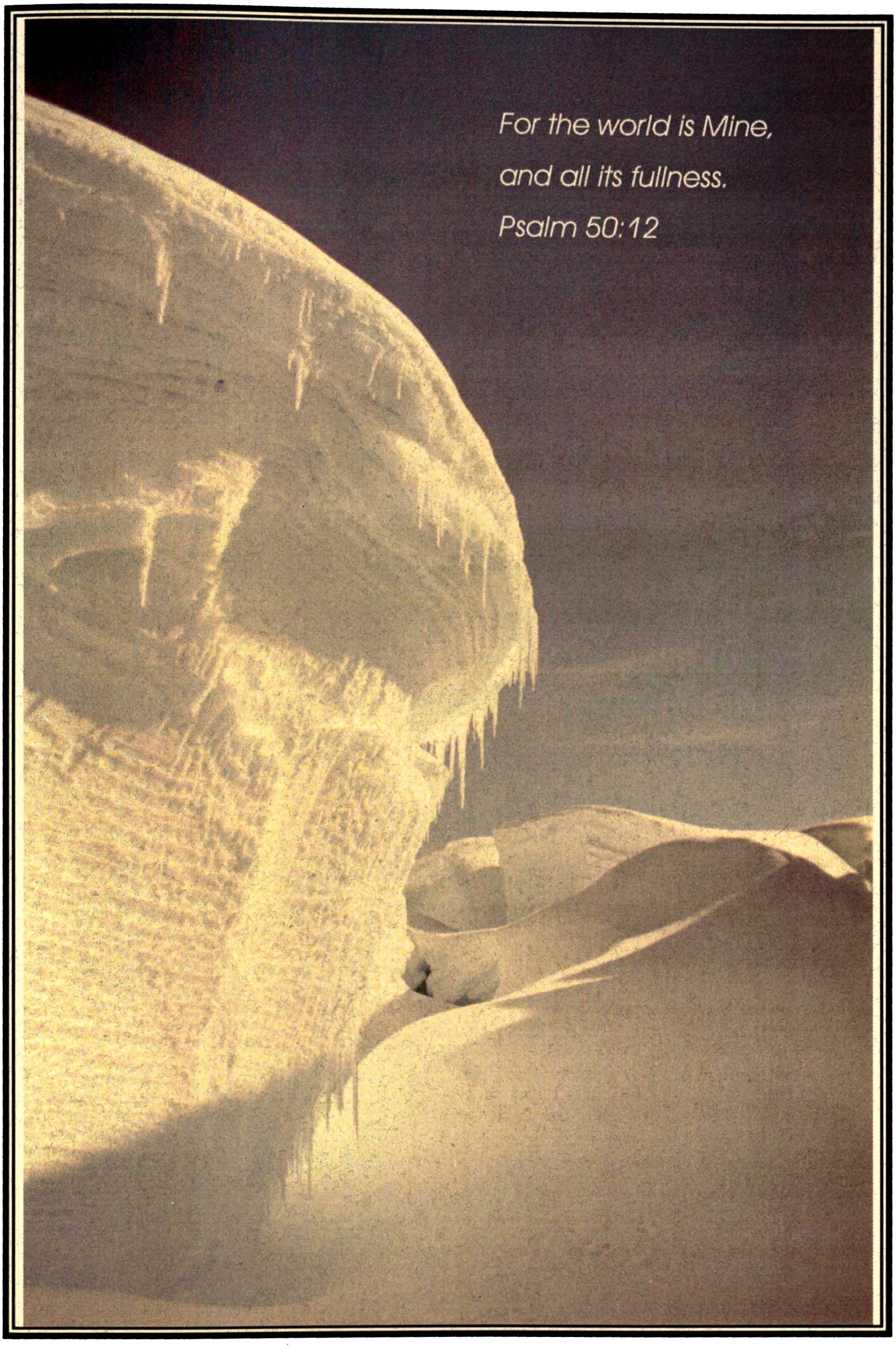
To investigate the effect of hydrocarbon contamination on soil surface albedo, measurements over existing hydrocarbon contaminated soil surfaces were made in the 2000/01 summer season at Scott Base, Marble Point and Bull Pass (Chapter Six).

1.3 Thesis objectives

The overall objective of this thesis was to determine the short-term biological and physical response of Antarctic soil to a controlled spill of JP-5 fuel.

Specific objectives were to:

- Undertake preliminary laboratory experiments to determine the optimum application rate of JP-5 fuel for the Scott Base contained experiment.
- Quantify the fate of fuel once released into the Antarctic soil environment:
    - The proportion of fuel lost from the soil to volatilisation.
    - The extent of downward movement of fuel into the soil.
- Determine whether the application of fuel increased the soil temperature at various depths.
- Determine whether the application of fuel increased the numbers of culturable heterotrophic bacteria and hydrocarbon degrading microbes 42 days following the spill.
- Test the hypothesis that existing darkened hydrocarbon-contaminated surfaces have lower albedo compared to uncontaminated surfaces.
- Observe whether the soil surface moisture content has any influence on albedo.


For the world is Mine,
and all its fullness.
Psalm 50:12

Chapter Two

Literature Review

2.1 Hydrocarbon contamination in Antarctica

While the presence of hydrocarbons in the Antarctic environment has been traced to natural sources such as biogenic synthesis (Green *et al.* 1992) and post-combustion products, both international (Platt and Mackie 1981) and local (Mazzera *et al.* 1999), the major source of hydrocarbon contamination in Antarctic soils is from accidental fuel spills.

Fuel spills in Antarctica are generally localised and limited to specific areas around current and decommissioned base and field camps where fuels have been stored and handled (Krzyszowska 1990, Cripps and Priddle 1991). In the vicinity of the H. Arctowski Polish Antarctic station for example, oil spills have polluted an area of 2400 m^2 (Krzyszowska 1990). Spills generally occur during fuel transfer as either a large (Table 2.1) or small-scale event, as well as through periodic release over time from leaking pipes, and storage drums.

Table 2.1 Large fuel spills in the Antarctic soil environment.

Spill quantity (litres)	*Site, year*	*Cause*	*Reference*
273,600	McMurdo Station 1984/85	Tank collapse	Tumeo and Wolk (1994)
380,000	Ross Ice Shelf, between 1980 and 1989	Periodic release	Tumeo and Larson (1994)
11,400	Ross Ice Shelf, 1993	Fuel line failure	Tumeo and Larson (1994)
1000	Faraday Research Station, 1992	Tank collapse	Cripps and Shears (1997)

The use of fuel directly for research purposes has also been a cause of hydrocarbon contamination. Cameron *et al.* (1977), for example, record instances of diesel fuel and drill fluid leaks and spills associated with the Dry Valley Drilling Project (DVDP).

2.2 Effect of fuel spills on Antarctic ecosystems

According to the legal framework of the Antarctic Treaty System (ATS), Antarctica extends to 60° South of the equator and as a result encompasses a large number of quite separate ecosystems, including various terrestrial, freshwater, marine and oceanic island ecosystems. Antarctic ecosystems can be identified at widely different scales (Benninghoff and Bonner 1985), from a film of snow algae on a snow crystal to the biota of the southern ocean. Ecosystems also have varying degrees of resistance and resilience towards disturbance. Therefore in terms of hydrocarbon contamination, there are varied impacts on different ecosystems. In the Marine environment, for example, pollution from fuel spills can result in the immediate toxicity to surrounding marine life (Cripps and Shears 1997), but recovery time may be much faster in the marine, than in the soil environment.

2.3 Management of fuel spills in Antarctic soils

2.3.1 Soil removal

Historically the physical removal of contaminated soil was often the most immediate and seemingly effective response in the Antarctic environment. For example over 40 barrels of sand impregnated with Diesel Fuel Arctic (DFA) were removed from a drill fluid leakage site at Lake Vida in the Victoria Valley, but this was insufficient to clean up the contaminated area (Cameron *et al.* 1977). Excavated soil was historically returned to the country responsible, for appropriate disposal. It is currently prohibitively expensive to transport contaminated soil from Antarctica to lower latitudes (Aislabie *et al.* 2001). Where excavated, contaminated soil is now stockpiled to await on-site treatment from a suitable technology (Tumeo and Guinn 1997).

2.3.2 Fuel spill-prevention and documentation

Because Antarctic operations are so reliant on hydrocarbon fuels and with environmental awareness of the impacts, a number of measures to prevent contamination have been developed. Preventative measures are outlined in field manuals for those countries signatory to the Antarctic Treaty. Instructions for the prevention of fuel spills in the New Zealand field manual for example include minimising handling of fuel, the use of sorbant pads and spill trays, regular equipment checks, and refuelling out of the wind (Antarctica New Zealand, 1998).

Where fuel spills do occur, documentation requirements exist, whereby records of the type, amount, and estimated recovery of spilled material are kept (Antarctica New Zealand, 1998).

2.4 The fate of hydrocarbons in permafrost soil environments

2.4.1 Introduction to hydrocarbon phase distribution

The soil environment is a multi-phase system (Figure 2.1) consisting of solid, aqueous, and gaseous phases. When fuel is released into the soil environment it will partition between these, as well as the residual (free liquid) phase. Mechanisms that determine phase partitioning relationships are complex and vary widely depending on individual soil and environmental conditions, as well as the type of fuel spilled. The overall fate of hydrocarbon compounds however is governed by the phase in which they predominately occur.

Compared to more temperate regions the fate of hydrocarbons in permafrost-affected areas such as Antarctica maybe somewhat simplified, because of the near impermeable permafrost surface and small groundwater fluxes (Braddock and McCarthy 1996, Chuvilin *et al.* 2000).

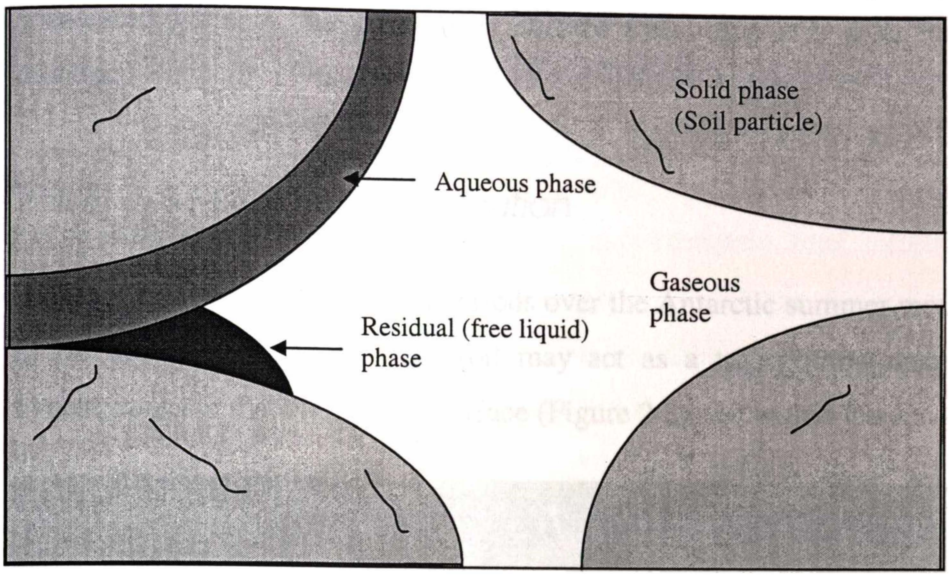


Figure 2.1 Phase distribution of hydrocarbons in the soil environment (adapted from MfE 1999).

2.4.2 Volatilisation

Given the absence of snow cover, the loss of volatile fuel components will always follow a fuel spill to the soil surface. Hydrocarbons up to C_{13} and C_{14} in length have been recorded to have volatilised from an experimental oil spill at Cape Bird, Antarctica (Konlechner 1985). It is anticipated that significantly higher proportions of volatile hydrocarbons will be retained in Antarctic soils than in temperate regions, where components up to C_{17} may be lost (Konlechner 1985). In measuring hydrocarbon concentrations after a controlled spill (6.3 litres per m^2) of Special Antarctic Blend (SAB) in the top 3 cm of beach sand at Davis Station, Green (1992) recorded a 99% loss over a 60 day period, which was attributed to volatilisation.

2.4.3 Oxidation

The physical degradation of various fuel components may also result from the processes of photooxidation, by singlet oxygen and OH radicals, as well as chemical oxidation (after Corban 1994). While no data are available to quantify fuel losses due to oxidation in contaminated Antarctic soils, oxidation may be considered a viable loss pathway in surface soils, especially over the summer months.

2.4.4 Melt-water redistribution

Melt-water is present for limited periods over the Antarctic summer months and if in the vicinity of contaminated soil may act as a transporting mechanism of hydrocarbons in the, both on the surface (Figure 2.2) and within the subsurface.

Figure 2.2 A small melt-water stream over the soil surface at Scott base, Antarctica.

While such redistribution generally occurs with the residual phase because of fuel immiscibility, aqueous phase transport has also been suggested. Konlechner (1985) for example found that *n*-alkanes of up to C_{32} length had penetrated to a depth of 2 cm in underlying soils. Because the oil used in this experiment was solid at field temperature (McKee Crude) it was suggested that the major transport mechanism was through contaminated soil water, as the site received a constant supply of water from a melting snow bank (Konlechner 1985). The redistribution of fuel by melt-water is however generally limited by the soil surface topography and would require sloped ground, and an area where melt-water occurs.

2.4.5 Subsurface redistribution within the active layer

Where fuel spills have occurred in the Antarctic terrestrial environment sometimes observations of fuel movement have been reported. Wardell (1995) records the horizontal fuel movement of approximately four meters from an underground pipeline to a nearby roadway ditch. However, the volume of fuel and time since spill were unknown. Balks and Campbell (1995) observed the subsurface migration of DFA fuel down to and along the ice-cemented surface of the permafrost. As a result it was noted that large spills contaminate a greater subsurface area than what is observed on the soil surface. This is consistent with Cameron *et al.* (1977) who observed the migration of drill fluid to the permafrost surface and then along the ice cemented layer. Parker *et al.* (1973) also observed the vertical migration of fuel (DFA) where it was recorded to have percolated down 30 cm until the movement was arrested by apparently impermeable permafrost.

Gore *et al.* (1999) noted the absence of turbine kerosene compared to lubricating oil at 20 cm depth ten years after a spill of less than approximately 10 litres. The lack of environmental mobility of the lubricating oil is considered to have been a function of its higher density and viscosity. In an experimental fuel spill where Special Antarctic Blend (SAB) was applied at an application rate of 6.0 litres per m^2 Kerry (1993) noted that hydrocarbons had penetrated to 15 cm depth. No observations were made however below this point.

2.4.6 Hydrocarbon interaction with the permafrost layer

While the permafrost layer is a seemingly impermeable barrier, recent studies have indicated that the unfrozen pore water can act as a conduit for contaminant diffusion into frozen soil (Biggar and Neufeld 1996). Specific mechanisms responsible for this phenomena are believed to be gravity drainage and capillary suction into cracks and fissures, induced by thermal contraction (Biggar *et al.* 1998).

2.4.7 Bioaccumulation

The uptake and accumulation of various fuel components by flora and fauna of both terrestrial and surrounding aquatic ecosystems is also a likely fate pathway when hydrocarbons become redistributed within and out of the soil environment. After the spill of diesel fuel at Faraday Research Station, Galindez Island, Antarctica, residual fuel was flushed by rainwater into the littoral zone and caused intertidal limpets to have elevated concentrations of both *n*-alkanes and PAH for over a month after the spill.

2.4.8 Biodegradation

The breakdown of various fuel components by indigenous soil microbes is a natural process and occurs throughout the world, including cold environments (Margesin and Schinner, 1999). A number of indicators of *in situ* biodegradation have been investigated at various sites in Antarctica. One indicator of *in situ* biodegradation is the use of alkane/isoprenoid ratios, typically heptadecane/pristane and octadecane/phytane. Where decreases in alkane/isoprenoid exist compared to fresh product, biodegradation is considered to have occurred (Gore *et al.* 1999). Pristane and phytane are more resistant to degradation than other hydrocarbons and therefore serve as constants if alkane biodegradation is occurring (Kerry 1993). In examining various petroleum hydrocarbons ten years after spillage at a Helipad in Bunger Hills, Antarctica Gore *et al.* (1999) compared heptadecane/pristane and octadecane/phytane ratios of Jet A1 (turbine kerosene) at 20 cm depth and found no significant difference. Insufficient Jet A1 was present in the surface sample for analysis. Gore *et al.* (1999) concluded that subsurface conditions of soils at Bunger Hills were unfavourable for the biodegradation of C_{9-14} hydrocarbon fractions. In a controlled fuel spill experiment at Davis Station, Kerry (1993) also used alkane/isoprenoid ratios as indicators of biodegradation. Results showed that ratios were significantly lower one year after a spill where fertiliser had been applied, and only in surface samples (0-3 cm). The alkane/isoprenoid ratios for two surface crude oil crusts of a non-fertilised experimental spill at Cape Bird, Ross Island showed no changes after 13 months, indicating that no surface *n*-alkane biodegradation had occurred. *In vitro* investigations however demonstrated that biological degradation of the C_{13} alkane Tridecane had occurred (Konlechner 1985).

2.5 Effect of fuel spills on soil properties in permafrost environments

2.5.1 Soil biological properties

2.5.1.1 Vegetation mortality

Where vegetation is present in the permafrost soil environment it is likely that the application of fuel will cause mortality. The application of crude oil in a winter Arctic experimental fuel spill for example caused mortality of surrounding Black Spruce (Collins *et al.* 1994), while the application of McKee crude oil to the Antarctic moss *Bryum antarcticum* also caused mortality (Konlechner 1985).

2.5.1.2 Soil microbial diversity

The presence of hydrocarbon fuels in the Antarctic soil environment can also change the structure of the microbial community. Aislabie *et al.* (2001) for example observed a shift in the genera of filamentous fungi, where *Chrysosporium* was most abundant at control sites compared to *Phialophora*, which dominated oil-contaminated soils. In addition to shifting species diversity Cameron *et al.* (1977) has noted a reduction in species diversity at drill sites where diesel fuel leaks and spills had occurred. Cameron *et al.* (1977) suggested that in response to fuel spills ammonifier and hydrocarbon degraders may become the prominent species even to the extent of eliminating all of the indigenous microbial population.

2.5.1.3 Soil microbial abundance

In areas where fuel spills have occurred in the Antarctic soil environment, elevated numbers of culturable heterotrophic bacteria, hydrocarbon-degrading bacteria, and fungi have been recorded from between one and 40 years after the spill (Table 2.2).

Table 2.2 Microbial properties of hydrocarbon contaminated and control soils from the Ross Sea region (after Aislabie *et al.* 2001).

Location	*Depth (cm)*	*Culturable heterotrophic bacteria (g^{-1} dried weight)*	*MPN of hydrocarbon degrading microbes (g^{-1} dried weight)*
Scott Base	0-1	3.4×10^6	33
Control	1-7	4.1×10^5	230
	7-15	4.7×10^4	13
	15-30	2.5×10^3	13
Contaminated	0-2	6.1×10^7	1.2×10^8
(Drum storage)	2-10	1.4×10^7	1.2×10^8
Marble Point	0-3	3.7×10^5	< 10
Control	3-15	8.6×10^4	< 10
	15-32	2.4×10^4	< 10
Contaminated	0-3	5.3×10^7	1.1×10^7
	3-12	4.2×10^7	1.8×10^6
	12-27	6.6×10^6	8.8×10^4

2.5.2 Soil chemical properties

2.5.2.1 Total petroleum hydrocarbons (TPH)

Depending on the size of the fuel spill and the specific properties of the soil environment, the total petroleum hydrocarbon (TPH) concentration of the soil will increase where fuels have been spilled. Table 2.3 shows typical TPH concentrations at hydrocarbon-contaminated sites in Antarctica.

Table 2.3 TPH concentrations at hydrocarbon contaminated sites in Antarctica (after Aislabie *et al.* 2001).

Site	*Depth (cm)*	*TPH (mg/kg dry weight)*
Scott Base	0-2	20300
	2-10	21200
Marble Point	0-3	29100
	3-12	18300
	12-27	200
Wright Valley	0-2	< 30*
	2-8	260*
	8-16	1260

* = Surface soil having been predominately removed

2.5.3 Soil physical properties

2.5.3.1 Soil structure

The introduction of hydrocarbon contaminants into the active layer of a soil can cause microstructural changes. White and Coutard (1999) for example observed evidence which suggested that the application of Arctic diesel fuel caused the reorganisation of the silt microfabric, as well as changes to intra-particle porosity of a Caen silt soil. Mechanisms responsible for these observations were considered to be a function of both cyrogenic processes and the contaminant concentration.

2.5.3.2 Soil water retention and hydrophobicity

No significant differences were found in moisture retention between hydrocarbon contaminated Scott Base and Bull Pass soils in Antarctica compared to controls (Balks *et al.* submitted).

The hydrophobicity of hydrocarbon contaminated Scott Base and Bull Pass soils were found to be higher when compared to controls soils (Balks *et al.* submitted).

2.5.3.3 Soil temperature and permafrost thaw

Balks *et al.* (submitted) recorded increased soil surface temperatures (up to 7 °C during mid-afternoon sunny periods) at hydrocarbon-contaminated sites, when compared to control soils at Scott Base. It was suggested that increased temperatures may have been the result of decreased albedo at the sites where soil surfaces were darkened by the presence of hydrocarbons. Albedo has an important influence on the development of Antarctic soils (Beyer *et al.* 1999) as it is a factor that affects the summer diurnal thermal regime (Campbell, *et al,* 1997).

In studying the long-term active layer effects of crude oil experimentally spilled on Alaskan permafrost Collins (1983) found that the average thaw depth four years after a summer spill had increased to 72 cm compared to 48 cm in the control. While the thaw depth remained essentially the same for the additional two years that measurements were made, the thaw depth from a similar winter spill continued to increase over this period to an average depth of 92 cm. Soil temperatures 5 cm below the black oiled moss covered surface were found to be consistently warmer (maximum 31 °C) compared to non-impacted surfaces (maximum 18 °C). It was assumed that a change in albedo due to the surface oil was responsible for the increased depth of thaw.

2.6 Hydrocarbon remediation in permafrost soil environments

2.6.1 Soil washing/flushing

Soil washing involves excavating contaminated soil and removing hydrocarbons from the soil matrix by actively leaching the contaminants from the soil into a leaching medium. While effective, this technology is limited by the clay content of the soil and additionally produces toxic waste fluids and sludge's that, in turn, require disposal (Whitlock and Wingrove 1993). Even though Antarctic soils have low clay contents, the logistics of utilising soil washing techniques in the Antarctic environment would need to be carefully considered, and would be unlikely to be practiced on a large-scale.

2.6.2 Soil fixation/stabilisation

Soil fixation is an immobilisation process whereby the contaminated soil is excavated and mixed with water and other compounds to stabilise contaminants. The resulting material then requires disposal in a landfill (Whitlock and Wingrove 1993).

2.6.3 Bioremediation

Bioremediation is the acceleration of natural biodegradation through the modification of the environmental conditions that govern microbial functioning (Margesin and Schinner, 1999). In addition to accelerating hydrocarbon removal bioremediation is seen as an advantageous alternative because contaminants are degraded to non-hazardous by-products (Wardell, 1995). The potential for bioremediation is primarily based on the presence of hydrocarbon degrading species at the contaminated site, and secondly on the species capability to degrade contaminants.

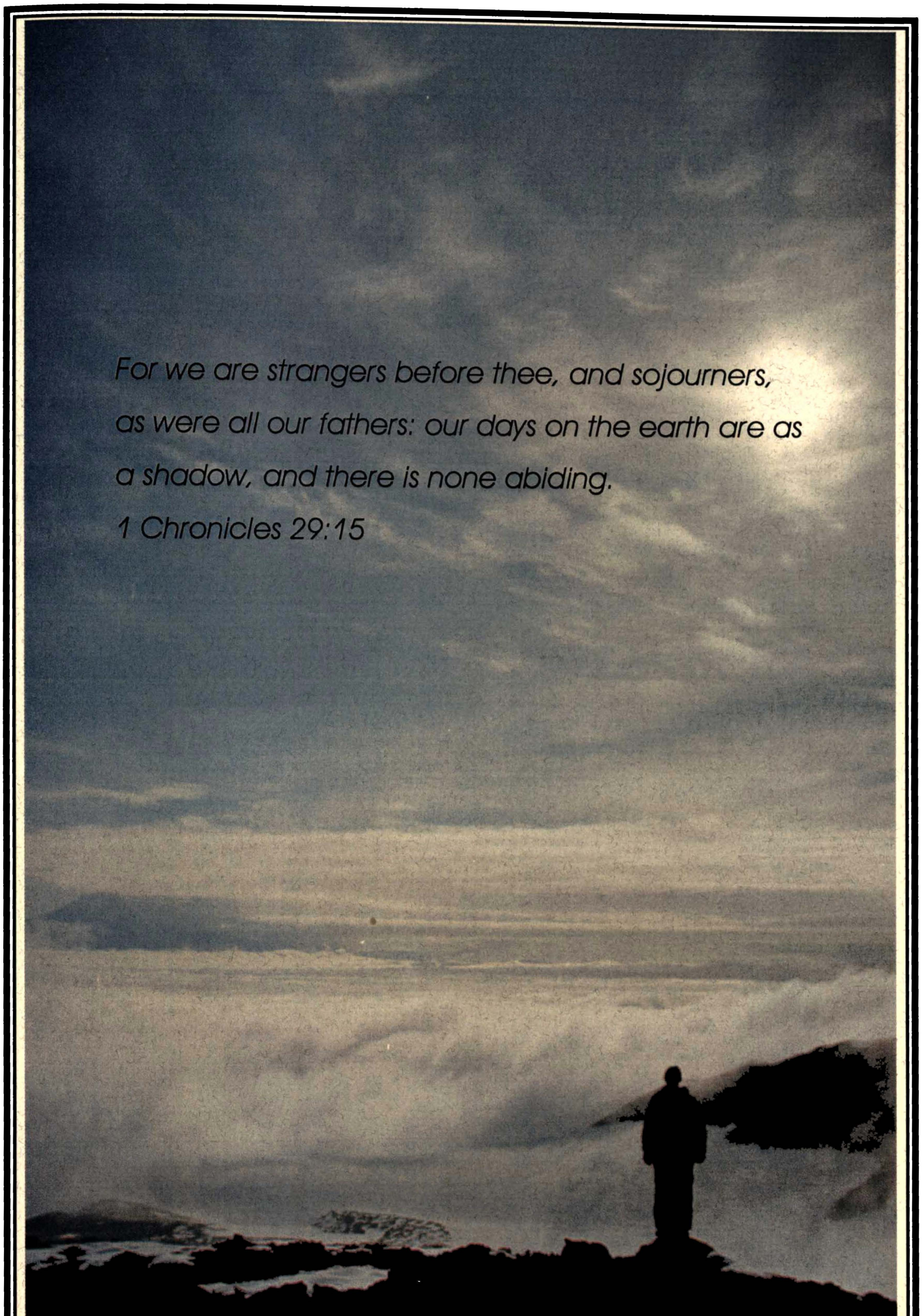
2.6.4 Bioremediation and the Antarctic soil environment

In addition to indicators of biodegradation (section 2.4.8), hydrocarbon tolerant microbial isolates have been obtained from a number of sites at hydrocarbon contaminated Antarctic soils. Konlechner (1985) for example obtained 111 microbial isolates from Ross Island and Southern Victoria Land soil samples. The microbial isolates found were essentially psychrophilic in nature and capable of significant growth at or near $0^{o}C$. Kerry (1990) also isolated a range of bacteria from petroleum-contaminated soils in the Vestfold Hills of Antarctica. Because hydrocarbon-degrading bacteria have been isolated from fuels spills in various regions of the Antarctic continent, and have been found to degrade specific hydrocarbons (Kerry 1990, Aislabie *et al.* 1998), the potential exists for the application of bioremediation.

The large-scale application of bioremediation in contaminated Antarctic soils may, however, be restricted by the constraints of temperature, moisture, oxygen, nutrient content, and the presence of microbial inhibitory substances (Kerry 1993, Balks *et al.* 1998, Aislabie *et al.* 1998).

2.7 Future management of fuel spills in permafrost soil environments

With advancing technology in the field of information transfer systems, non-invasive techniques such as Ground Penetrating Radar (GPR), GIS and Remote sensing are now being used to document and monitor fuel spills in Antarctica and other permafrost regions (Rees 1999, Babicka and Goldsworthy 2000). While having the advantage of observing changes in contaminated areas over time, non-invasive techniques also minimise the environmental effects associated with excavating soil for treatment, which at some sites may exceed the impact of the initial fuel spilt (Balks and Campbell 1995). Soil excavation can cause permafrost melt, which may lead to quite severe environmental impacts such as altered stream flows, soil shrinkage, land slumping and salinisation (Campbell *et al.* 1994, De Poorter and Dalziell 1996).


For we are strangers before thee, and sojourners,
as were all our fathers: our days on the earth are as
a shadow, and there is none abiding.
1 Chronicles 29:15

Chapter Three

Preliminary Laboratory Experimentation

3.1 Context of experimentation

In order to determine the short-term fate and effects of fuel on Antarctic soil properties, a fuel spill experiment was prepared at Scott Base during the Antarctic summer season of December 1999/January 2000 by packing soil into contained cores (Chapter Four). Prior to fuel application in December 2000 it was necessary to decide the optimum rate and technique for fuel application. The rate of fuel application needed to be large enough to assess the macro-scale effects (volatilisation, fuel penetration, soil temperature response), as well as the effect on soil microbial numbers. Of particular interest in preliminary investigation was the amount of applied fuel that may be lost to volatilisation, and the depth to which the fuel would penetrate. A series of preliminary laboratory experiments were undertaken at the University of Waikato to investigate the effects of fuel volume and application technique on the resulting fuel distribution within soil cores. The scale and scope of these experiments were limited by the availability of Antarctic soil samples and also time constraints.

3.2 Background to experimental design

3.2.1 Fuel composition

The fuel chosen for the experimental spill at Scott Base was a light diesel fuel, JP-5 (section 4.5.1). JP-5 fuel consists primarily of short chain n-alkanes and was chosen as it is a fuel commonly used at Scott Base. Because no JP-5 fuel was available for the preliminary experimentation, a similar light diesel fuel, JP-8 (Jet A-1) was used (Table 3.1). The predominant hydrocarbon range of JP-8 is C_9-C_{16}.

Table 3.1 Specific characteristics of JP-8 fuel (Air BP, 1993).

Physical characteristic	**Parameter**
Boiling Range	156-258 °C
Viscosity (at –20 °C)	3.5 cSt
Density (at 15 °C)	0.804 kg/l
Flash Point	44 °C

3.2.2 Fuel application rate

The rate of fuel application in experimental fuel spills onto soil is often described in terms of litres per m^2. Table 3.2 illustrates the range of typical fuel application rates in experimental fuel spills, where 5 litres per m^2 was considered in the range of a "moderate" spill, and 12 litres per m^2 a "heavy" spill (Sexstone and Atlas 1977).

Table 3.2 Application rate and technique used in experimental fuel spills.

Application rate ($l.m^2$)	*Application technique*	*Fuel type*	*Reference*
5 12	Poured through a perforated plate	Crude oil (Prudhoe)	Sexstone and Atlas 1977
2.5	Poured (heated prior to application because was solid at field temperature)	Crude oil (McKee)	Konlechner 1985*
6.3	-	Special Antarctic Blend (SAB)	Green *et al.* 1992*
6.0	Watering can	Special Antarctic Blend	Kerry 1993*
< 2	As an emulsion with water from a pressurised spray can	Range of synthetic lubricants and mineral oils	Haigh 1995
> 2	Watering can		Haigh 1995
3.1	Poured evenly over surface	Special Antarctic Blend (SAB), BP-Visco	Cavanagh *et al.* 1998*

*= Experimental fuel spill in the Antarctic soil environment.

3.2.3 Fuel application technique

Because the experimental fuel spill at Scott Base was to involve the application of fuel to individual soil cores (section 4.5.1) rather than over a given surface area of soil (Table 3.1), it was considered appropriate to use a more controlled application technique than described in previous studies (Table 3.1).

3.3 Experiment One: Application rates & techniques

3.3.1 Background

An initial experiment was undertaken to simulate the effect of adding fuel at application rates of 1.3, 5, and 12.7 litres per m^2 (equivalent to 10 mL, 40 mL, and 100 mL on each field sized Scott Base core).

3.3.2 Objective

To observe the effect of the fuel application technique (dripping and pouring) on the volatilisation and penetration of JP-8 fuel in soil cores.

3.3.3 Experimental design and methods

- Four plastic PVC cores were cut to a size of approximately proportional volume and surface area (5 cm x 7.5 cm deep) to those cores in the field (10.5 cm internal diameter x 30 cm deep, section 4.4.4).

- Cores were capped at the base with a thin layer of plastic, weighed, and packed to a mean bulk density of 1.77 g cm^{-3} with a sieved fraction (< 6.7 mm) of the Antarctic soil (Typic Anhyorthel). The soil used was the remainder of that from the Scott Base contained experiment (section 4.4) and packed using a method adapted from Fireman (1944).

- Soil cores were then reweighed and placed in a 4°C refrigerator for 3 days to obtain conditions as similar to those in the field, as was reasonably possible.

- Based on application rates of 1.3, 5, and 12.7 litres per m^2 approximately 2.5 mL, 10 mL, or 25 mL of JP-8 fuel was added, within a fume hood, to each core surface by dripping (non saturated flow) using a "Pump" drink bottle, and pouring (saturated flow) using a measuring cylinder. Both of the 25 mL applications however were poured on.

- Cores were then left inside the fume hood and weighed 1 hour 20 minutes and 22 hours 45 minutes after fuel application to assess volatilisation loss.

- Cores were dismantled 22 hours 45 minutes after fuel application by removing the plastic base and extruding soil out using a plunger apparatus.

- Observations of soil saturation and fuel movement were recorded.

3.3.4 Results

3.3.4.1 Volatilisation

Fuel was lost consistently from individual cores with a greater percentage of fuel being lost where application rates were low (Table 3.3). While the total weight loss from cores increased where application rates were higher, the differences between 10 mL and 25 mL applications were not greatly apparent. No apparent difference in volatilisation was observed between application techniques (dripping and pouring).

Table 3.3 Total core weight loss (g) 22 hours 45 minutes after fuel application.

Application volume (mL) and technique (p = pour, d = drip)	*Weight of fuel applied (g)**	*Soil core weight loss (g)*	*% Fuel loss*
2.5 p	1.27	0.62	48.82
2.5 d	1.62	0.68	41.63
10 p	8.05	1.66	21.75
10 d	8.20	1.66	18.29
25 p	19.46	1.70	8.53
25 d	18.07	1.55	9.16

* As recorded 1 hour 20 minutes after fuel application

3.3.4.2 Visual contamination and fuel movement

The surfaces of both cores that received 2.5 mL of JP-8 fuel were only slightly stained 22 hours 45 minutes after fuel application (Figure 3.1), and a thin layer of lightly darkened soil was observed, only at the surface of the core, once soil material was extruded (Figure 3.2 a).

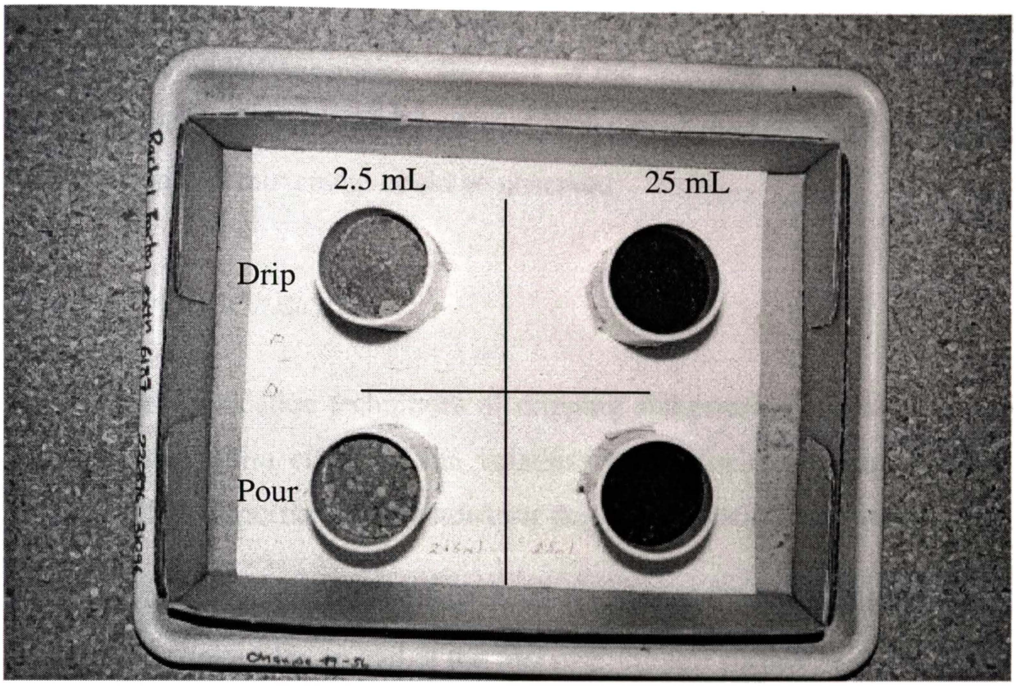


Figure 3.1 Surface colouration 22 hours 45 minutes after dripping and pouring 2.5 mL and 25 mL JP-8 fuel.

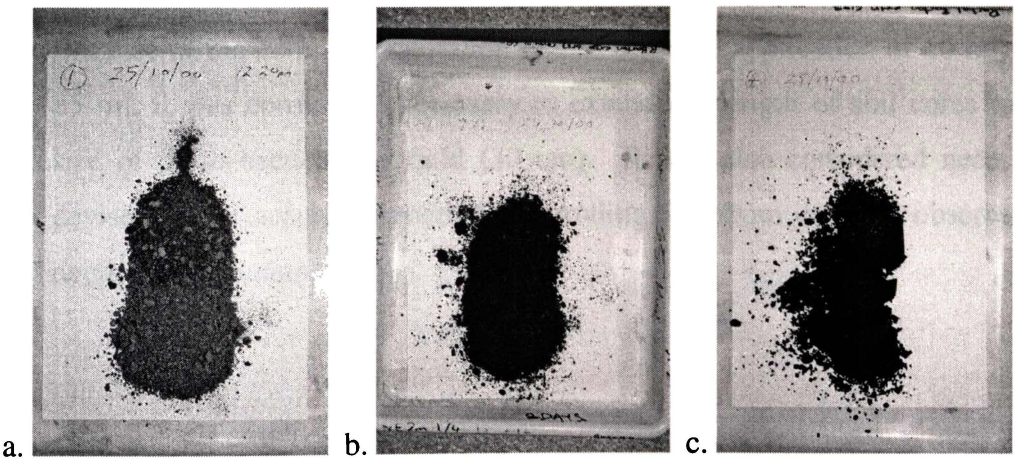


Figure 3.2 Visible fuel saturation of soil 22 hours 45 minutes after JP-8 fuel application (pour treatment) of (a) 2.5 mL, (b) 10 mL, and (c) 25 mL.

Due to the soil spreading out once extruded from the core the exact depth of fuel penetration was unable to be recorded for the 2.5 mL application. Cores that received 10 mL and 25 mL of fuel were both completely darkened by the fuel (Figure 3.2 b, c). The extent to which the soil was saturated was also evidenced by the degree to which the underlying paper onto which they were extruded became saturated. The 10 mL application for example showed no visible evidence of fuel seeping into the paper while the 25 mL application completely saturated the underlying paper. Because of the complete saturation of soil after the application of 10 mL and 25 mL no indication of the effect of fuel application technique on fuel movement could be observed.

3.3.5 Conclusions

- The fuel application techniques of dripping and pouring appeared to have no direct short-term effect on the volatilisation of fuel from experimental soil cores. It is important to note however that no replication was used.

- The dripping application of fuel from the "Pump" drink bottle did not allow for an accurate even spread of the fuel over the soil surface.

- To obtain a more accurate total percentage loss of fuel, the weight of fuel added should be recorded immediately after fuel application.

- Because of the complete saturation of soil after the application of 10 mL and 25 mL it was considered necessary to extend the length of soil cores to the size of those used in the field (30 cm). It was also considered necessary devise a more accurate system for extruding soil from cores to observe the depth of fuel penetration.

3.4 Experiment Two: Application techniques continued

3.4.1 Background

A second experiment was undertaken to further assess the volatilisation of fuel from soil cores using different application techniques, and to obtain a more accurate measure of fuel penetration depths.

3.4.2 Objective

To observe the effect of fuel application technique (dripping evenly over the soil surface, dripping in a single place, and pouring) on the volatilisation and movement of JP-8 fuel from soil cores.

3.4.3 Experimental design and methods

- Three cores (5cm x 30 cm deep, approximately quarter of the volume to those used at Scott Base, section 4.2.4) were capped at the base with a thin layer of plastic, weighed, and packed with Antarctic soil (section 3.3.3) to a mean bulk density of 1.73 g cm^{-3}.

- Cores were reweighed before being placed in a 4°C refrigerator for 17 hours.

- Cores were then removed from the refrigerator and placed in a fume hood (Figure 3.3 a).

- Based on the application rate of 12.7 litres per m^2 approximately 25 mls of JP-8 fuel was added to each core by dripping evenly (using a 25 mL pipette), dripping in a single place (using a burette, Figure 3.3 b) and pouring, from a measuring cylinder.

- Cores were weighed at various times over a 12-day period to assess fuel volatilisation loss.

- Cores were then dismantled by removing the plastic base and extruding soil out, using a plunger apparatus, into a larger split piece of PVC pipe.

- Observations of fuel movement and soil saturation were recorded.

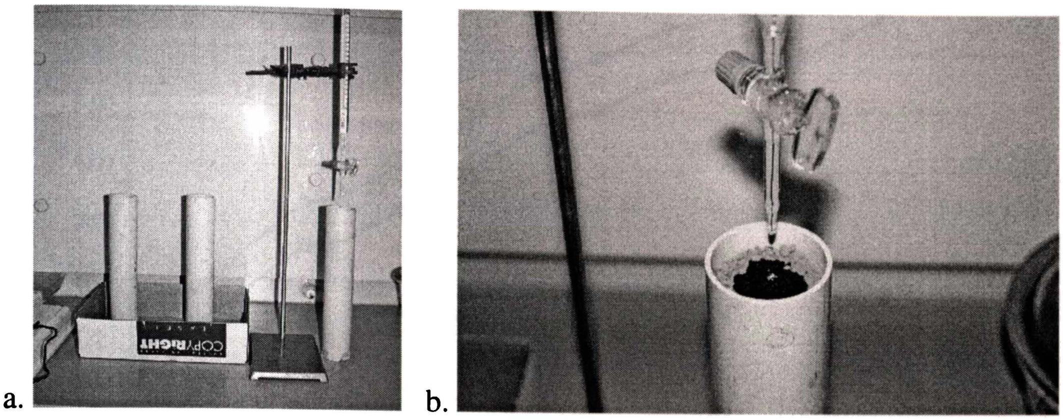


Figure 3.3 Experimental cores (a) Set-up in fume hood, (b) Slow drip application technique.

3.4.4 Results

3.4.4.1 Volatilisation

The weight of soil cores consistently decreased over the 12-day period (Figure 3.4), with the total weight loss at the point of core destruction around 40 % of the original weight of fuel applied (Appendix One). Weight loss from individual cores occurred in a similar manner and the effect of application technique on volatilisation is therefore considered negligible.

3.4.4.2 Fuel movement

Fuel penetrated to the depth of 22 cm consistently in each of the three cores and a slightly lighter transition zone was observed between 18 cm to 22 cm (Figure 3.5).

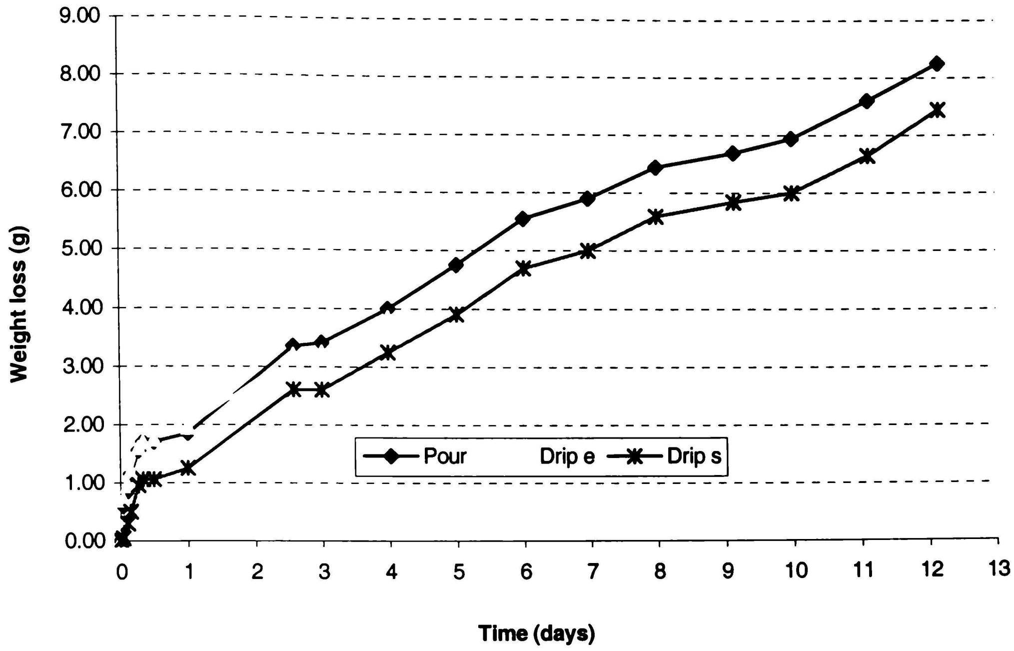


Figure 3.4 Weight loss (g) after 25 mL application of JP-8 fuel using various application techniques.

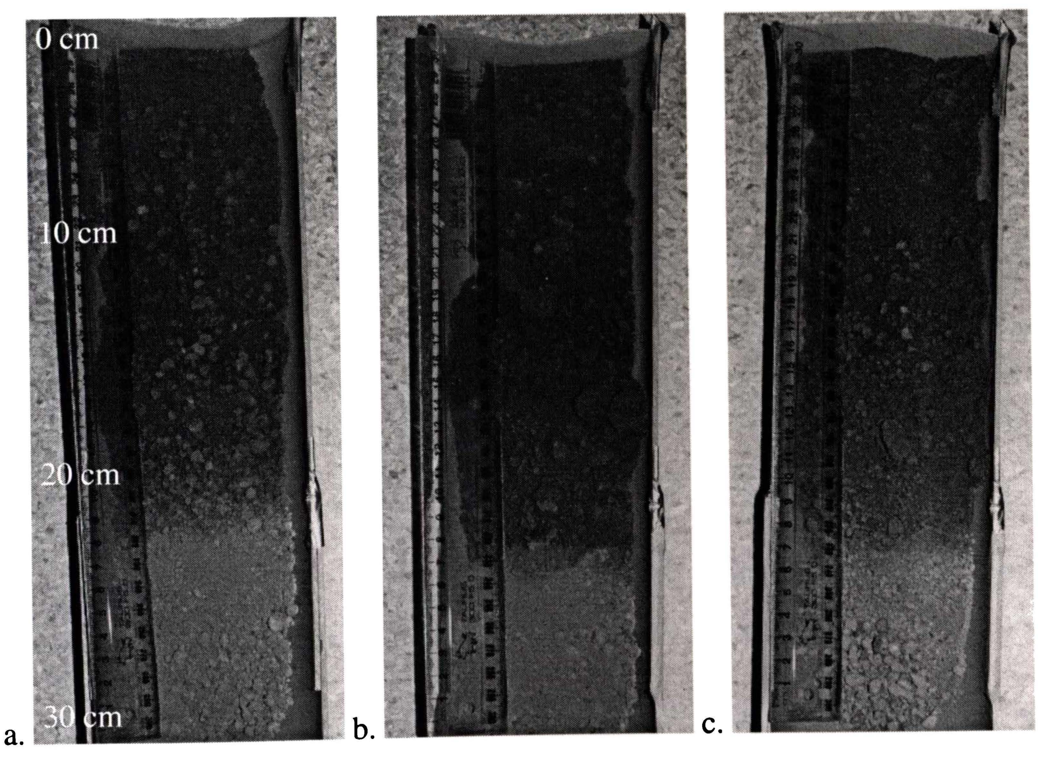


Figure 3.5 Fuel penetration 12 days after 25 mL application of JP-8 fuel by (a) dripping evenly, (b) dripping in a single place, and (c) pouring, over the soil surface

3.4.5 Conclusions

- The fuel application techniques of dripping evenly, singly, and pouring appeared to have no direct short-term effect on the volatilisation and movement of fuel in experimental soil cores.

- Because the volatilisation of fuel was still occurring when cores were dismantled, a longer time period is required to show complete short-term trends. The use of replication for given treatment cores, is also considered necessary to determine variation within treatments.

- The potential weight changes due to soil moisture gains and losses from and to the atmosphere were also considered necessary to monitor.

3.5 Experiment Three: Fuel and water application rates at variable temperature

3.5.1 Background

A third experiment, with replication and conditions similar to those in Antarctica, was designed to record volatilisation and movement of both fuel and water in soil cores, using a variety of application rates. Additionally the importance of temperature on the volatilisation of fuel and water was observed.

3.5.2 Objectives

- To observe the effect of the fuel application rate on the volatilisation and movement of JP-8 fuel from soil cores.
- To compare the volatilisation of fuel with that of water.
- To observe the effect of temperature on the volatilisation of fuel and water.

3.5.3 Experimental design and methods

A total of 28 cores (mean bulk density of 1.87 cm^{-3}), prepared in the same way to those used in Experiment Two (section 3.4.3) were divided into 8 treatments (Table 3.4). Fuel or water was added to each core by dripping evenly over the soil surface with a pipette to avoid saturated flow.

Because soil temperature can influence the volatilisation of fuel components from the soil surface (Jarsjo *et al.* 1994) it was considered necessary to better emulate the Antarctic field conditions, as much as was practically possible.

To better emulate Antarctic conditions the cores were placed in plastic bags and stored in a "chilly bin" surrounded by ice/ice water to maintain, temperature at approximately 0°C (Figure 3.6).

Table 3.4 Treatment design for experiment three.

Application volume (mL) of fuel (f) and water (w)	*Application rate (L.m^2)*	*Replication (Number of Cores)*
Control	-	3
5 f	2.5	5(3)
15 f	7.6	5(2)
25 f	12.7	5(2)
40 f	20.4	4(1)
5 w	2.5	2
15 w	7.6	2
25 w	12.7	2

() = Number of cores that leaked and were no longer useful as a replicate.

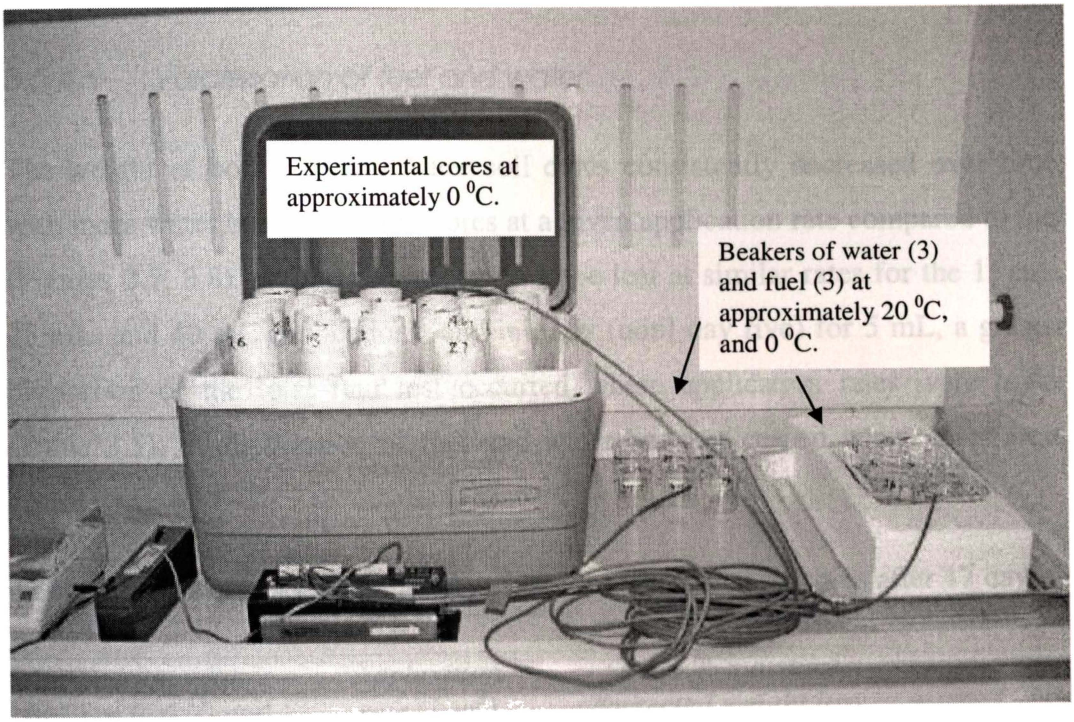


Figure 3.6 Treatment set-up for experiment three.

Twelve, 100 mL beakers, 6 filled with JP-8 and 6 with water, were used to determine volatilisation at different temperatures. After being filled to near the surface, beakers were divided into two sets, each containing three JP-8 beakers and three water beakers. Both sets were then placed in a fume hood, one set at room temperature (approximately 20°C), and the other set in an ice bath (approximately 0°C). Because beakers were not filled with a volume equivalent to experimental cores (Table 3.4), a comparison of the weight loss from a free-liquid and sediment surface was therefore unable to be made.

To assess volatilisation cores and beakers were removed and weighed daily, at which time the ice was replaced surrounding both the "chilly bin" and beakers. Moisture loss from experimental cores was corrected for by applying the mean weight change from the control cores to the mean weight change in the remaining experimental cores (Appendix Two). After 17 days cores were dismantled and the soil extruded as in Experiment Two (section 3.4.3), and fuel and water movement observed.

3.5.4 Results

3.5.4.1 Volatilisation of fuel and water

The weight of both fuel and water soil cores consistently decreased over time, with more water being lost from cores at a given application rate compared to fuel (Figures 3.7, 3.8). While fuel appeared to be lost at similar rates for the 15 mL, 25 mL, and 40 mL applications, and initially (until day five) for 5 mL, a greater proportion of the total fuel lost occurred where application rates were lower (Table 3.5). Volatilisation of fuel and water had not ceased when cores were destructed.

Table 3.5 Total moisture corrected weight loss (%) from soil cores after 17 days.

Application volume (mL) of fuel (f) and water (w)	*Application rate (L.m^2)*	*Total % moisture corrected weight loss (of volume applied)*
Control	-	-
5 f	2.5	48.2
15 f	7.6	24.6
25 f	12.7	16.8
40 f	20.4	9.7
5 w	2.5	84.5
15 w	7.6	76.7
25 w	12.7	63.1

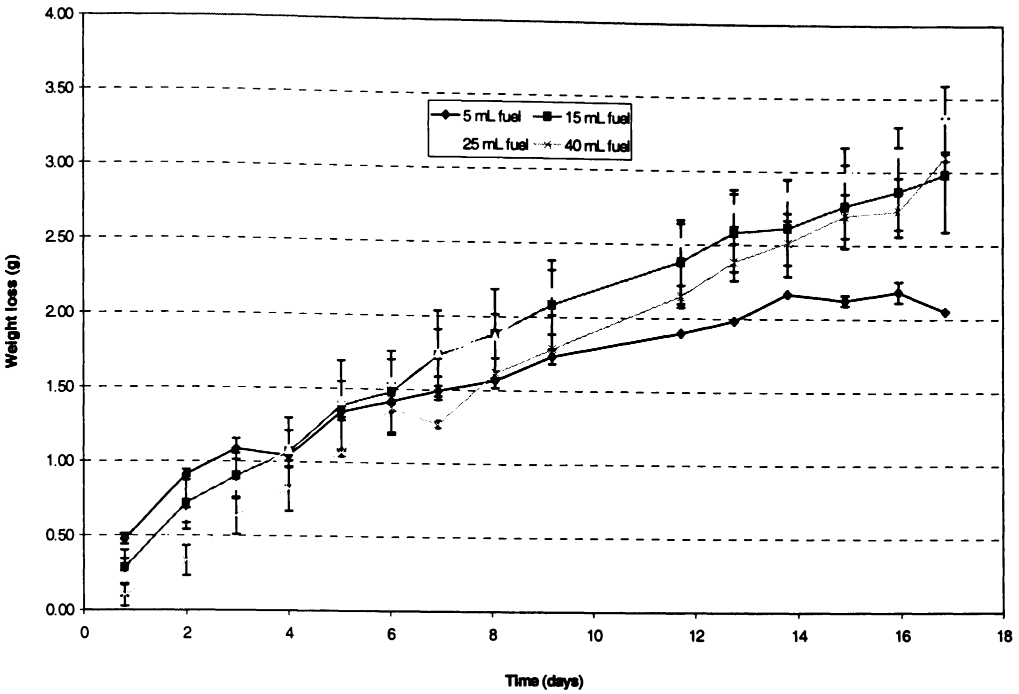


Figure 3.7 Weight loss (g) of fuel applied at different application rates.

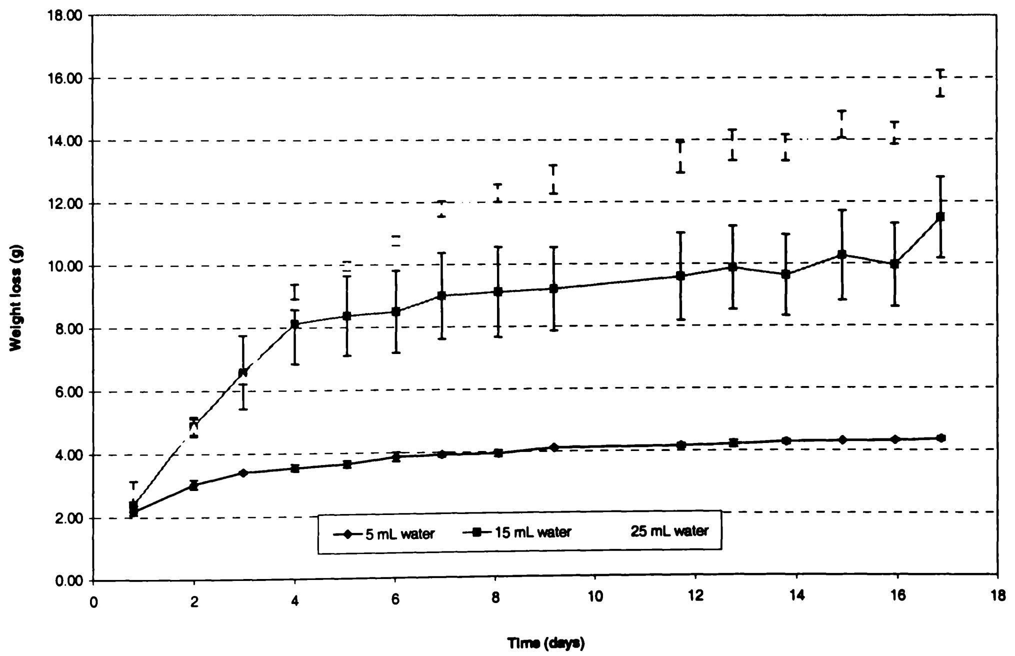


Figure 3.8 Weight loss (g) of water applied at different application rates.

3.5.4.2 Volatilisation of fuel and water at 0°C and 20°C

Greater volatilisation of water occurred at room temperature (approximately 20°C) compared to 0°C, while no apparent difference in the volatilisation of fuel at room temperature and 0°C was observed.

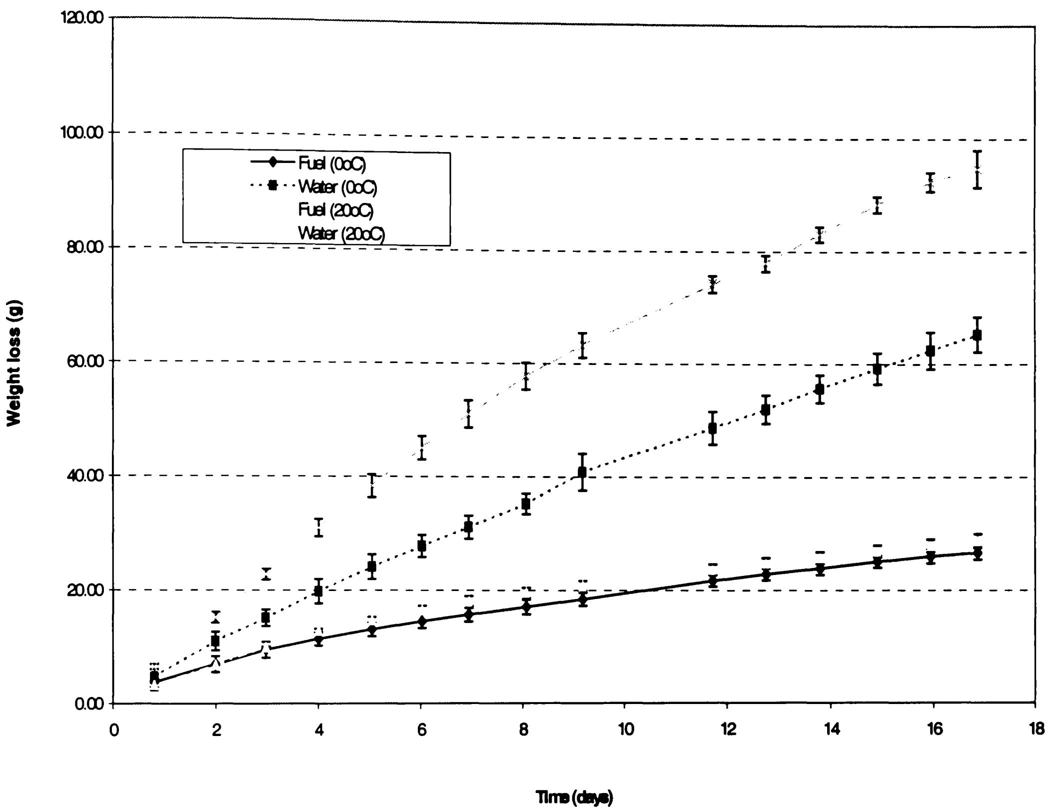


Figure 3.9 Weight loss (g) of water and fuel at 0°C and 20°C.

3.5.4.3 Fuel and water movement

Fuel penetrated to depths of 5 cm, 14 cm, and 22 cm consistently where 5 mL, 15 mL, 25 mL of fuel was applied to respective cores. Where 40 mL of fuel was applied, the soil within the core remained completely coated with fuel. Penetration of water within experimental cores was near visually indistinguishable.

3.5.5 Conclusions

- Fuel is lost to volatilisation at a lower rate than water.
- Based on the application rate fuel appears to volatilise at a similar rate until it is lost proportional to the original volume applied.
- A greater percentage fuel is lost where application rates are low.
- Higher temperatures (approximately 20°C compared to 0°C) appear to have a relatively minor effect volatilisation of fuel, compared to that of water.

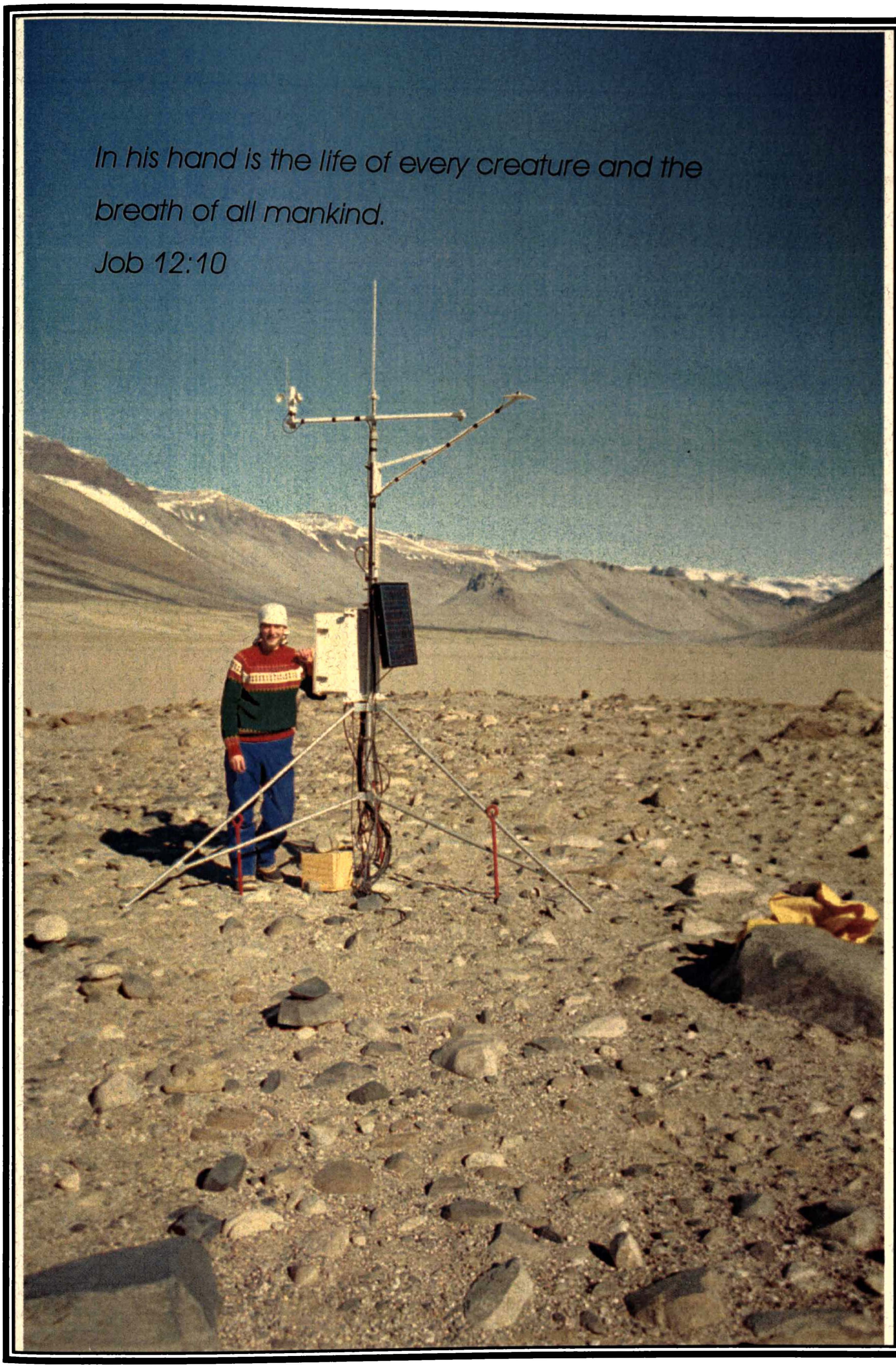
3.6 Discussion & application for the Scott Base contained experiment

3.6.1 Fuel application rate

With the anticipation of potential temporal fuel penetration, the application volume of 15mL used in the preliminary experimentation was chosen. It was also anticipated that this volume would allow for notable short-term volatilisation without completely being removed from the soil over a short time frame. Given that the soil cores used in the preliminary laboratory experiments were approximately quarter the volume of those at Scott Base (sections 3.4.3, 4.4.4) the total volume of fuel applied would therefore be 60 mL, an application rate of 6.9 litres per m^2. Such an application rate is considered in the range of a "moderate" spill (Sexstone and Atlas 1977), and is similar to other experimental fuel spills in the Antarctic soil environment, for example 6.3 litres per m^2 (Green *et al.* 1992) and 6.0 litres per m^2 (Kerry 1993).

3.6.2 Fuel application technique

The fuel application techniques used at various application rates throughout preliminary experimentation appeared to have little effect on the fate (volatilisation and movement) of fuel. A technique that was therefore practical for dripping fuel over the soil surface was chosen, and was a 30 mL syringe.


In his hand is the life of every creature and the
breath of all mankind.
Job 12:10

Chapter Four

Scott Base Contained Experiment

4.1 Introduction

A contained experiment was established in the vicinity of Scott Base, in the Antarctic summer season of 1999/2000, to examine the short-term impact of fuel spills on Antarctic soils. Having undertaken preliminary laboratory experimentation the optimum application rate and technique of JP-5 fuel to the soil cores was determined (section 3.6). On return to Antarctica in the summer of 2000/01, JP-5 was applied to the soil cores and soil samples were collected over a 42 day period. Samples were then taken back to New Zealand and microbial analysis undertaken (Chapter Five). During the summer season of 2001/02 (one year after fuel application) additional samples were collected, and a second temperature experiment undertaken.

4.2 Objectives

The main objectives of the Scott Base contained experiment covered in this chapter were:

- To quantify the fate of fuel once released into the Antarctic soil environment:
    - The proportion of fuel lost from the soil to volatilisation.
    - The extent of downward movement of fuel into the soil.
- To determine whether the application of fuel increased the soil temperature at various depths.

4.3 Site location

The contained fuel spill experiment was established on a flat section of hill approximately 200 m north of Scott Base on Ross Island, Antarctica (Figure 4.1).

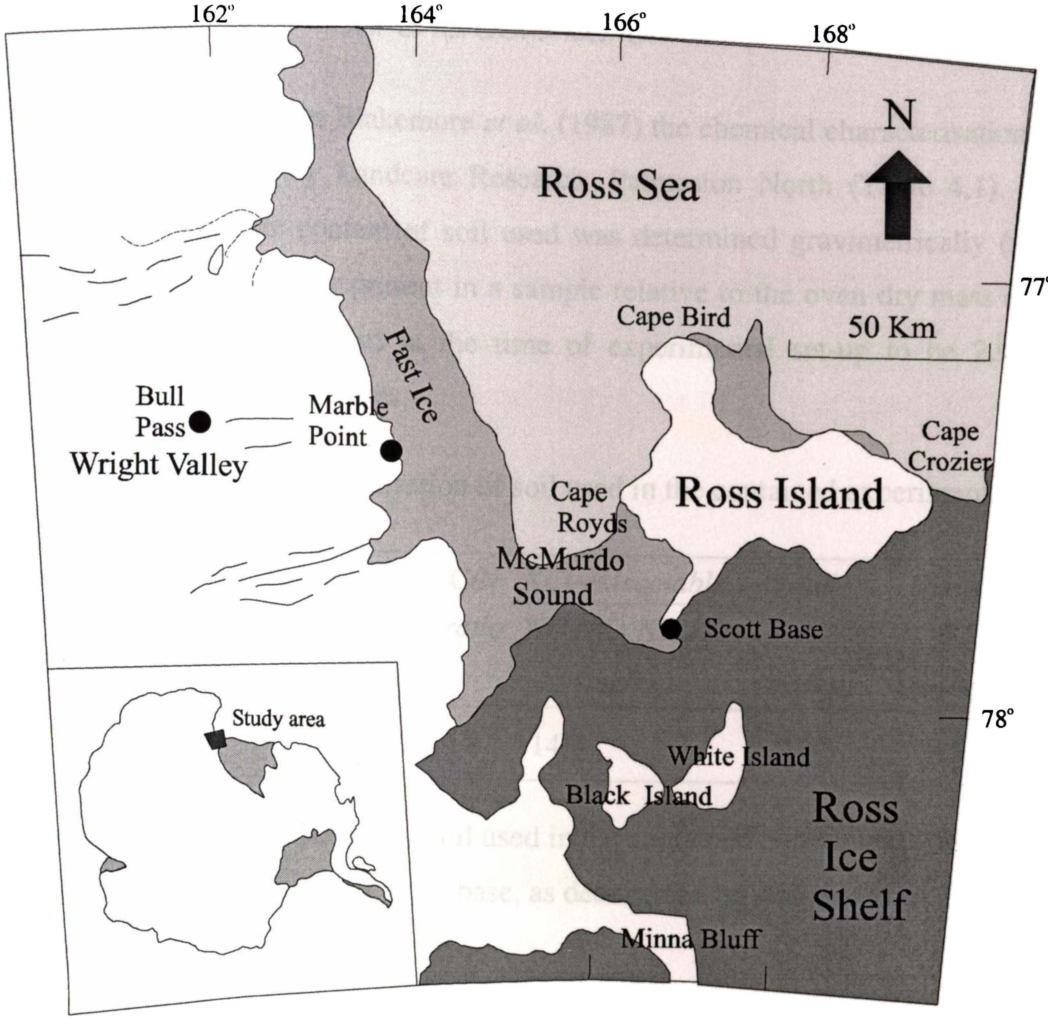


Figure 4.1 Location of Scott Base, Ross Island, Antarctica.

4.4 Experimental design

4.4.1 Soil classification and description

Soil was obtained from a bulldozer side-cast mound that was formed as a result of a permafrost disturbance trial on the hill behind Scott Base. The side-cast mound had no history of petroleum contamination. The soil was dominated by scoriacious basaltic gravels and was classified following Soil Survey Staff (1998) as a Typic Anhyorthel. When dry the soil colour was yellowish grey (2.5Y 6/1), and olive black (5Y 3/1) when moist. According to the New Zealand soil classification (Milne 1995) the soil was non-plastic, non-sticky, loose, single grained, gravelly loamy sand.

4.4.2 Soil chemical characterisation

Following methods from Blakemore *et al.* (1987) the chemical characterisation of soil was undertaken by Landcare Research, Palmeston North (Table 4.1). In addition the moisture content of soil used was determined gravimetrically (as a ratio of the mass of water present in a sample relative to the oven dry mass after drying at 105 °C overnight) at the time of experimental set-up to be 2.9 %, uniformly throughout the cores.

Table 4.1 Chemical characterisation of soil used in the contained experiment.

pH	*EC (1:5) (mS/cm)*	*Total C (%)*	*Total N (%)*	*C/N ratio*	*KCl-extractable NO_3-N (mg/kg)*	*KCl-extractable NH_4-N (mg/kg)*	*Total P (mg/kg)*	*Olsen P (mg/kg)*
9.05	0.46	0.10	0.01	8	14.8	1.7	1993	9.5

The chemical characterisation of soil used in the contained experiment was typical of other soil in the vicinity of Scott base, as determined by Aislabie *et al.* (2001).

4.4.3 Soil particle size analysis

Soil was sieved through a 6.7 mm sieve to remove large stones and homogenise the material. Further sieving determined that the proportion of soil between 6.7 mm and 2 mm was 42%, while the fine earth fraction (< 2 mm) was 58%. Particle size analysis of the fine earth fraction (autoclaved) was undertaken by the pipette method (Claydon 1989), following hydrogen peroxide pre-treatment, suspension in sodium hexametaphosphate and ultrasonic dispersion (Table 4.2).

Table 4.2 Particle size analysis of the fine earth (< 2 mm) fraction (%).

Coarse Sand 2.0-0.6 mm	*Medium Sand 0.6-0.2 mm*	*Fine Sand 0.2-0.06 mm*	*Silt 0.06-0.002 mm*	*Clay < 0.002 mm*
50	21	12	8.5	8.5

4.4.4 Soil core design

Plastic PVC pipe, 3 mm thick and with an internal diameter of 10.5 cm was cut into 105, 30 cm lengths. Each pipe was then cut lengthways and taped together using duct tape to enable ease of destructive sampling later in the experiment (section 4.5.4.2). Plastic caps were attached to one end of the pipes and taped in place to contain the soil (Figure 4.2). Cores that were to be used for measuring volatilisation (section 4.5.2) had rope handles attached 1 cm from the core surface to allow carrying.

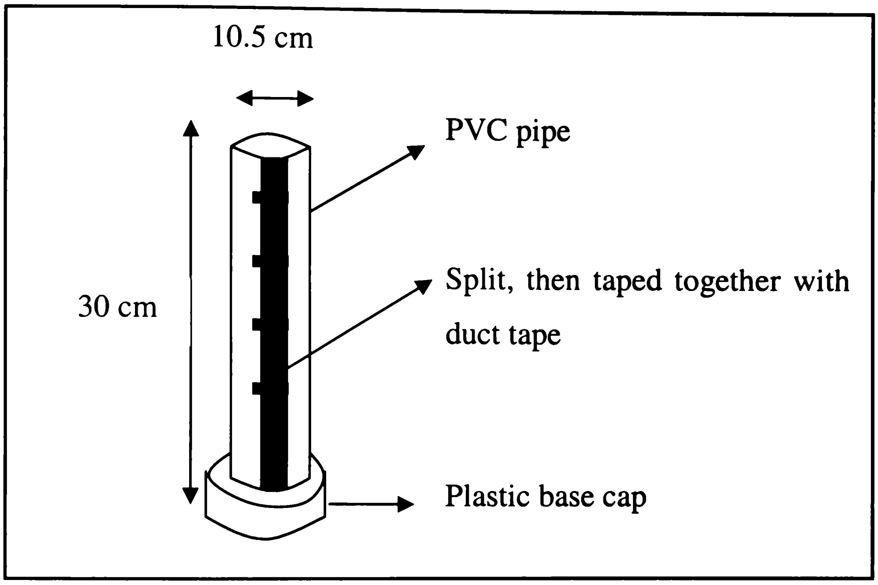


Figure 4.2 Design of soil cores used in the contained experiment.

The cores were filled with the sieved soil using a trowel (Figure 4.3) and packed to a mean bulk density of 1.67 cm^{-3} with a method adapted from Fireman (1944). Control cores were placed upright within three baskets (42 cores) and JP-5 treatment cores within four baskets (63 cores) and buried to the soil surface (Figure 4.4). The baskets separating the treatments were placed approximately four meters apart to avoid cross contamination, and individual cores were numbered (Figure 4.5). In order to ensure similar *in-situ* conditions cores were left to equilibrate over the winter period.

Figure 4.3 Packing experimental soil cores at Scott Base.

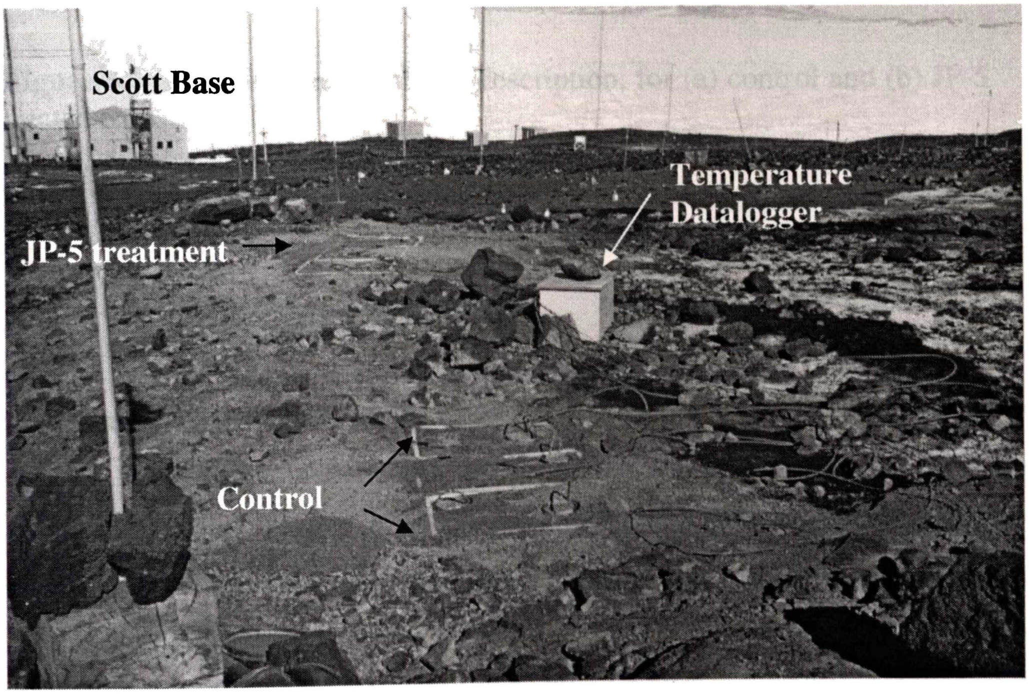


Figure 4.4 Experimental site of control and JP-5 treatment soil cores.

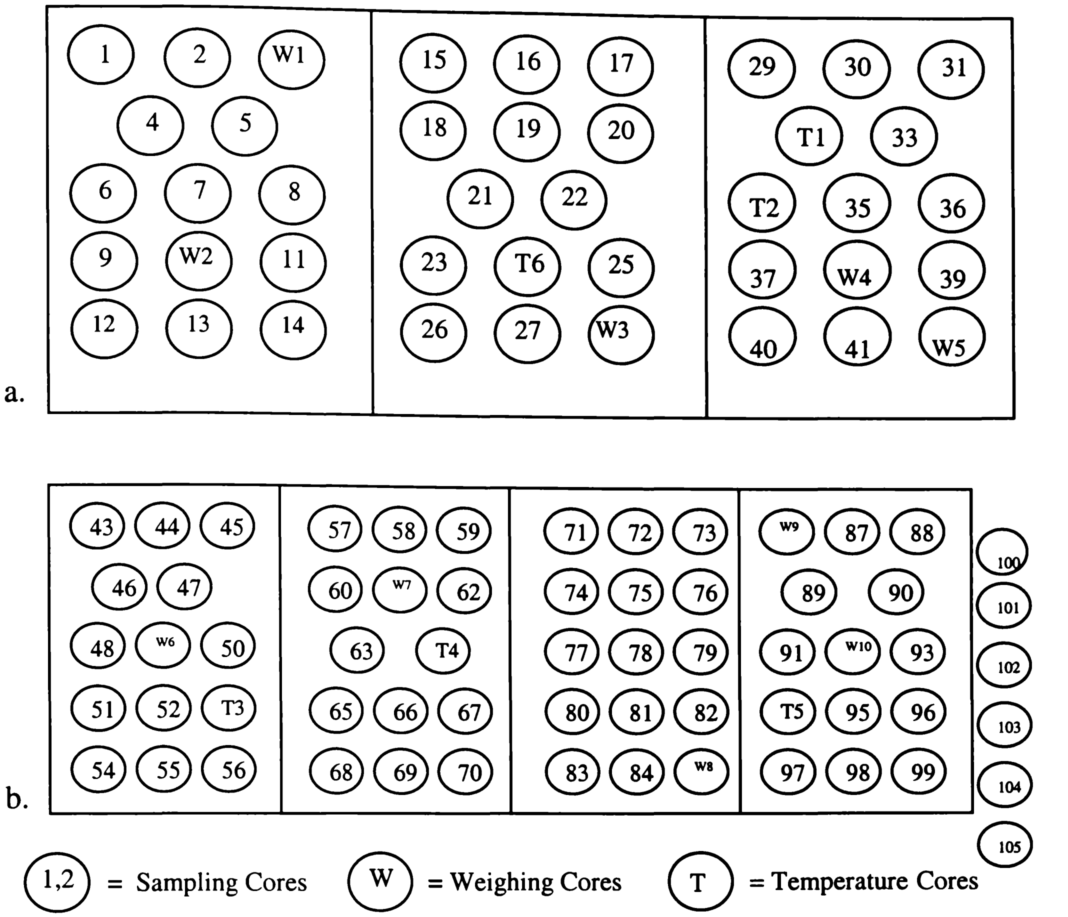


Figure 4.5 Soil core placement and description, for (a) control and (b) JP-5 treated cores.

4.5 Methods

4.5.1 Fuel application

In December 2000 following the melt and evaporation of all snow-cover from the cores, 60 mL of JP-5 fuel (an equivalent depth of 7 mm) was applied to the 63 soil cores in the JP-5 treatment (based on preliminary laboratory experimentation, section 3.6). Fuel was evenly distributed over the soil surface in droplets, using a 30 mL syringe, to avoid saturated flow (Figure 4.6 a). Cores 58, 73, 89, and 99 inadvertently received 90 mL, while core 88, and 98 received 30 mL (Table 4.3).

4.5.2 Volatilisation and snowfall

Ten cores were prepared for use to quantify the volatilisation loss of JP-5 fuel, as well as to monitor weight changes due to snowfall and moisture accumulation or evaporation. Five control and five JP-5 treated cores (Figure 4.5) were cased with plastic sheaths to facilitate their removal and replacement during weighing (Figure 4.6 b). Weighing cores were removed daily from the sheaths, capped with a PVC lid to prevent any soil from being lost during transportation and carried two at a time to scales 200 meters downhill in front of Scott Base where they were weighed to ±1 g accuracy. Cores were weighed daily for 42 days with the exception of days 12, 19, 25, 32, 34, 35, 39.

4.5.3 Temperature

4.5.3.1 Experiment One: 5 cm, 20 cm depth

A total of 12 thermistor temperature probes were installed in the top of six soil cores (three control and three JP-5 treated, Figure 4.5) at depths of 5 cm and 20 cm. Temperature probes were wired to a Campbell Scientific CR10x datalogger located between treatments (Figure 4.4) and hourly measurements were recorded for a total of 20 days, with measurements commencing three days prior to fuel application. Data was downloaded using the Campbell Scientific PC208W 3.01 support software programme.

4.5.3.2 Experiment Two: 2 cm, 5 cm depth

A second experiment, similar to that in section 4.5.3.1 was repeated in December 2001, whereby 12 thermistor temperature probes were installed within six cores (three control and three JP-5 treated) at 2 cm and 5 cm depth. In addition to having probes at a higher depth (2 cm) the cores were also modified by inserting thermistors through small holes in the sides of cores, and taping them in place (Figure 4.6 c). The placement of probes through the cores allowed for a more accurate measurement of temperature at the given soil depths. Cores were then buried to the ground surface within individual baskets, next to remaining sampling cores. Hourly measurements were recorded for a total of 20 days, with measurements commencing 13 days prior to fuel application.

4.5.4 Destructive sampling

4.5.4.1 Core removal

Cores were chosen from the experimental site and removed (Figure 4.6 d) in triplicate 0.1, 1, 3, 7, 14, 21, 28, 35, 42, 357, 365, 372, 379, 397 days after fuel application (Table 4.3).

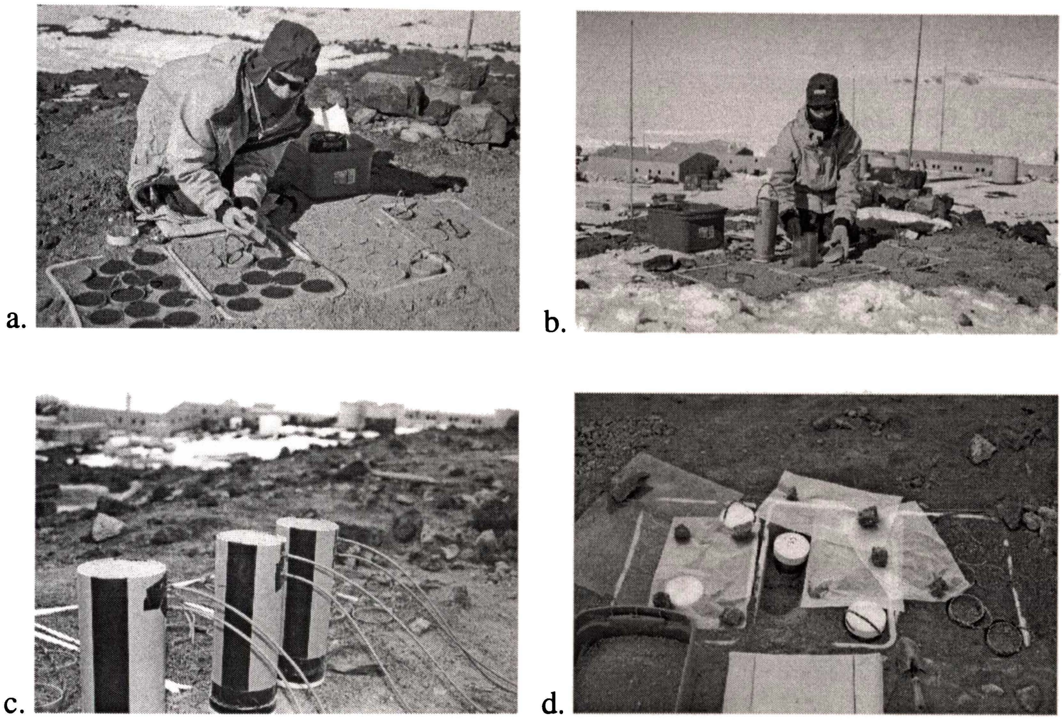


Figure 4.6 Experimental procedures used in the Scott Base contained experiment: (a) Application of fuel onto JP-5 treated cores, (b) Plastic sheaths for removable weight cores, (c) Temperature probes in control cores at 2 cm and 5 cm depth, (d) Core removal process during destructive sampling.

During the removal of cores, plastic and PVC caps were placed over surrounding cores to protect them from the addition of soil (Figure 4.6 d). A PVC cap was also taped in place over the top of the sampling core to prevent any soil from being lost during transportation to the laboratory. The holes from which the cores were removed were then backfilled with a mixture of sieved (< 6.7 mm) and larger (generally < 5 cm) soil.

Table 4.3 Sampling schedule for control and JP-5 treated cores.

Time since fuel application (day)	*Date*	*Control cores sampled*	*JP-5 treated cores sampled*
0.1	13 Dec 00	5, 27, 41	43, 101, 100
1	14 Dec 00	-	102, 103, 104
3	16 Dec 00	-	105, 82, 84
7	20 Dec 00	13, 26, 40	*58, 59, 87
10	23 Dec 00	-	44, 83, *88, 57
14	27 Dec 00	12, 23, 37	45, 80, *89, 90
21	3 Jan 01	9, 21, 39	46, 60, 93
28	10 Jan 01	14, 18, 36	47, 62, 81
35	17 Jan 01	11, 15, 33	*99, 50, 96, 78
42	24 Jan 01	6, 16, 35	48, 77, 95
358	6 Dec 01	-	51, 63, 74
365	13 Dec 01	1, 4, 19	71, 75, *98, 97
372	20 Dec 01	-	67, 69, 70
379	27 Dec 01	2, 17, 20	72, *73, 76, 91
397	14 Jan 02	7, 8, T2	79, x, y
Remaining cores		22, T6, 25, 29, 30, 31, T1	(52, T3, 54, 55, 56, T4, 65, 66, 68, T5) – x,y

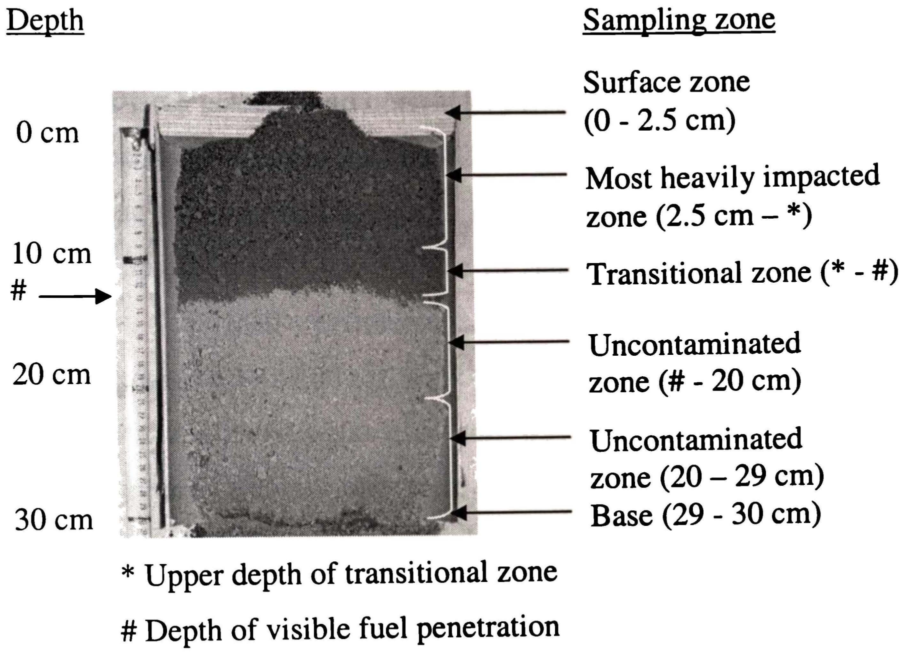
* Fuel application rate inconsistent with 6.9 litres per m^2.

x, y = unknown cores.

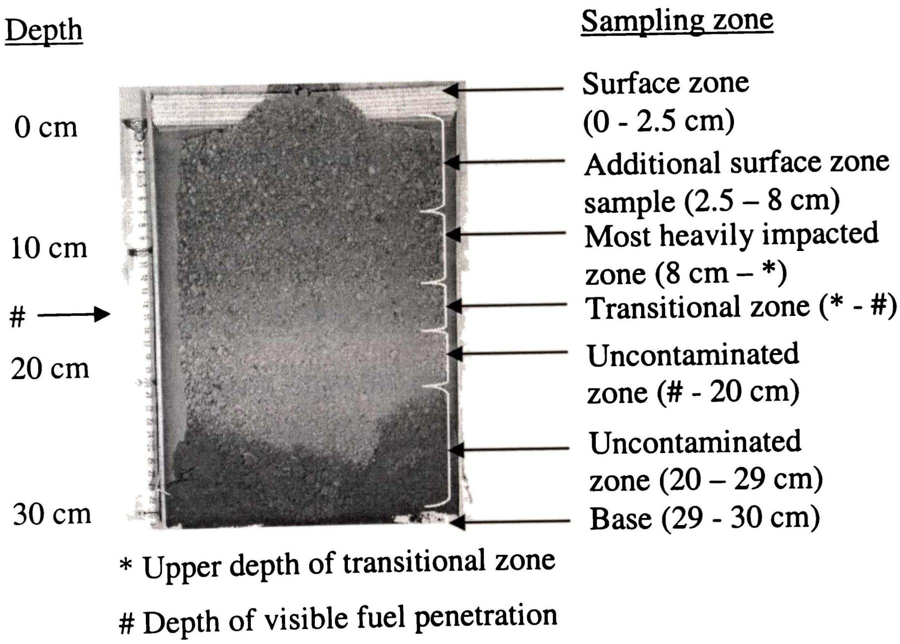
With the exception of day 7, where the fuel application rate was inconsistent with 6.9 litres per m^2 additional cores were sampled to give core triplicates (Table 4.3).

4.5.4.2 Aseptic sampling

Control cores were sampled at depth ranges of 0 – 2.5 cm, 2.5 – 10 cm, 10 – 20 cm, and 20 – 30 cm, while JP- 5 treated cores were sampled in various zones, according to the depth of visible fuel penetration (Figure 4.7).



a.



b.

Figure 4.7 Sampling zones used for JP-5 treated soil cores from (a) day 0.1 to 365, and (b) day 372 to 379.

From day 0.1 to day 365 cores were sampled according to three major visible contaminated zones: the surface zone, most heavily impacted zone, and the transitional zone. Additional uncontaminated zones, below the depth of visible fuel penetration were also sampled (Figure 4.7 a). From day 372 to day 379 an additional sample was taken between 2.5 – 8 cm, as this region consistently appeared visually lighter than soil below (Figure 4.7 b).

During sampling cores were placed in an upright position on the bench and using an ethanol swabbed spoon the surface zone (0 - 2.5 cm) was sampled aseptically into a *WHIRL-PAK®* bag for microbial analysis. The *WHIRL-PAK®* bag was then shaken up and down approximately three times to randomise soil before sub-samples were taken for total petroleum hydrocarbon (TPH) analysis (approximately 150 g poured into a 250 mL gas-tight tin) and geochemical (C, N, P, pH, EC) analysis (approximately 100 g of soil was poured into a 100 mL plastic screw cap container). Sub-samples were poured from the *WHIRL-PAK®* bag into the various containers to avoid microbiological contamination of the remaining sample (approximately 150g). An additional sub-sample of approximately 15g was taken and the soil moisture content determined gravimetrically (as a ratio of the mass of water present in a sample relative to the oven dry mass after drying at 105 °C overnight).

After sampling the surface zone, the core was split lengthways down the length of duct tape and the bottom cap removed (Figure 4.2). Two plastic inserts of equivalent diameter to the core (10.5 cm) were swabbed with ethanol and placed on the core surface at 2.5 cm depth, followed by two halves of wood to prevent soil spilling from the core surface when the core was placed horizontally on the bench. Using the same method as for the surface zone, remaining samples (section 4.5.4.2) were taken.

A record of all samples and their individual soil moisture contents is contained in Appendix Four.

Samples for geochemical analysis were kept at room temperature while the TPH tins and *WHIRL-PAK®* bags were stored at – 20°C before being sent, frozen, to New Zealand for analysis.

4.5.4.3 Weighing core oven dry mass (g)

At the completion of the Scott Base contained experiment (January 2002), the 10 weighing cores (Figure 4.5) were destructed (Table 4.3) and soil moisture contents determined gravimetrically to obtain the total oven dry mass (g) for each core, and therefore the total weighing core error (Appendix Five). From control weighing cores samples were taken at depths of 0 – 2.5 cm, 2.5 – 10 cm, 10 – 20 cm, 20 – 27 cm, and 27 – 30 cm, while from JP5-treated cores at depths of 0 – 2.5 cm, 2.5 – 8 cm, 8 – 17 cm, 17 – 27 cm, and 27 – 30 cm.

4.5.5 Total Petroleum Hydrocarbon (TPH) Analysis

Levels of total petroleum hydrocarbons were determined by extracting the samples in methylene chloride, and then analysing the extracts by capillary gas chromatography with a flame ionisation detector, essentially as outlined in EPA method 8015 (US EPA 1987). Because the TPH was measured in mg kg^{-1}soil, the percentage fuel loss was calculated based on the total mass of soil contaminated within cores (Appendix Six).

4.6 Results

4.6.1 Soil colouration

Fuel application darkened core surfaces (Figure 4.8) however the surface colouration diminished over time. Three weeks after fuel application darkened core surfaces could still be seen, but the discolouration was markedly reduced (Figure 4.12 b).

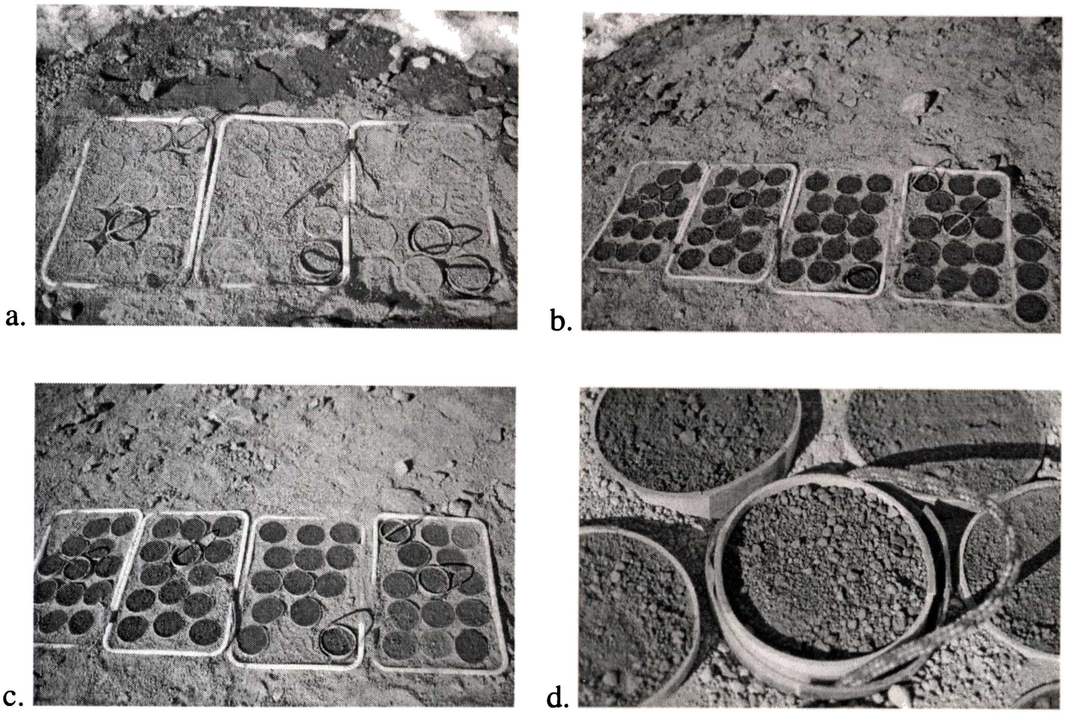


Figure 4.8 Surface colouration of (a) control cores, (b) JP-5 treated cores 0.1 days after fuel application, and (c, d) JP-5 treated cores 5 days after fuel application.

After three weeks the surface 1 cm of JP-5 treated cores appeared visibly drier than the dark hydrocarbon contaminated soil in the core below. A weakly cemented surface crust (3 mm – 5 mm) was also visible at this time and covered between half and all of the core surface. By week four the dry surface layer had extended to a depth of between 1.5 cm and 2.5 cm respectively, and surface crusts (5 mm) were still visible. One year after fuel application, while it was more difficult to visually distinguish hydrocarbon-contaminated soil, a lighter coloured surface layer was consistently noted in JP-5 treated cores to a depth of up to 8 cm

(Figure 4.7 b). Weakly cemented surface crusts of 2 cm were also present in many of the JP-5 treated cores one year after fuel application. The reduction in soil colour and the formation of the surface crust are considered to be the result of fuel volatilisation.

4.6.2 Core weight changes

Prior to fuel application the mean control core weight was 82.8 g heaver than the mean JP-5 treated core weight (Figure 4.9), and was due to random variation between individual core weights (Appendix Seven). During fuel application JP-5 treated cores gained on average 52.8 g of fuel. Immediately following fuel application JP-5 treated cores progressively lost weight (Figure 4.9).

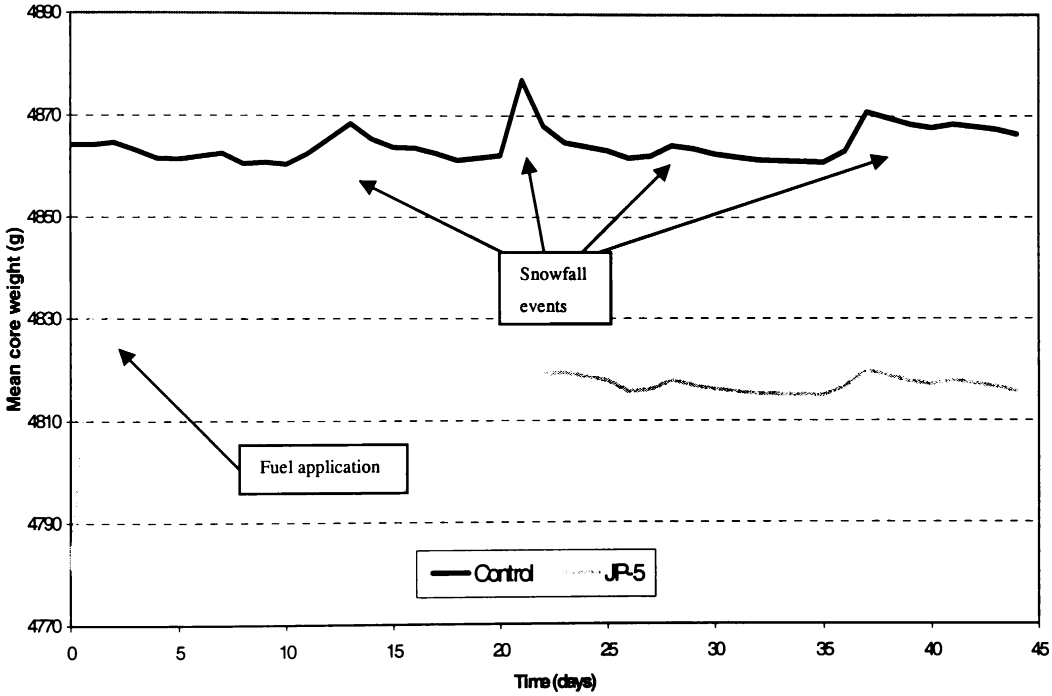


Figure 4.9 Mean weight of control and JP-5 Treated cores after fuel application.

4.6.2.1 Snowfall events

During the 44 days in which the cores were monitored for weight changes, a total of four snowfall events occurred (Figures 4.9 – 4.13). While snow cover over the core surfaces generally only lasted one day (Figures 4.11, 4.12), weight gains associated with snowfall remained for a number of days (Figure 4.14).

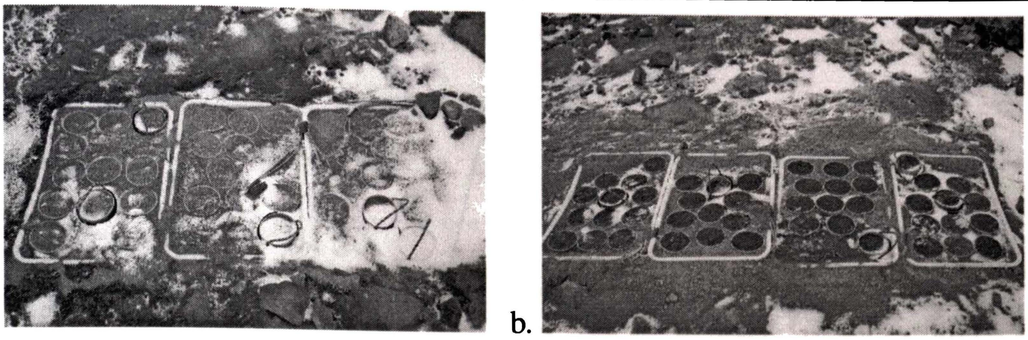


Figure 4.10 Snow cover over (a) control surfaces, and (b) JP-5 treated surfaces during snowfall event one, 12 days after fuel application.

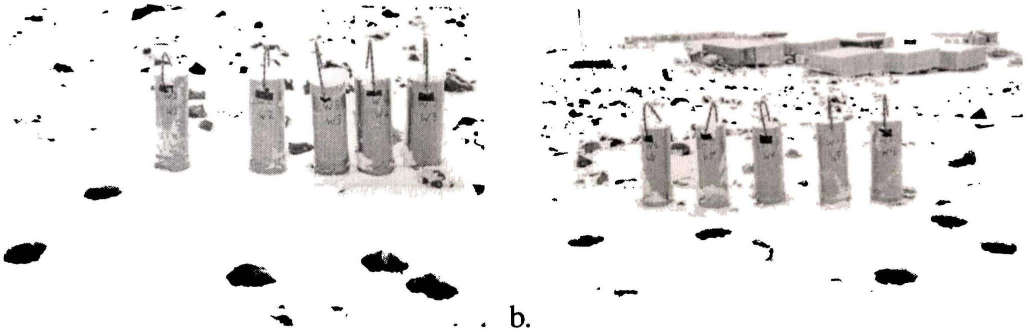


Figure 4.11 Snow cover over (a) control surfaces, and (b) JP-5 treated surfaces at 8:30 am during snowfall event two, 20 days after fuel application.

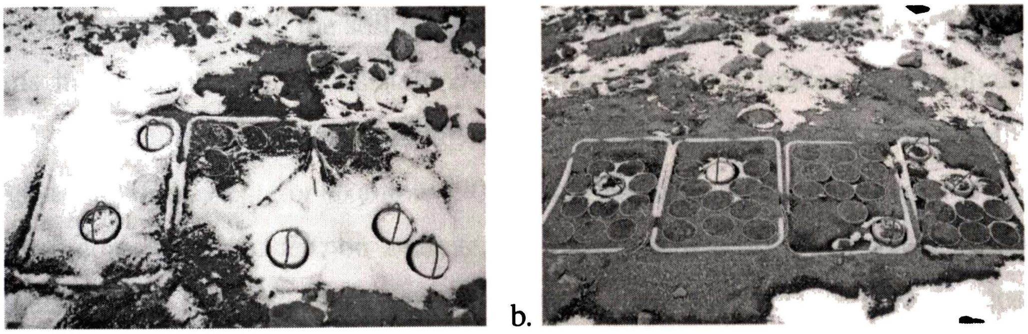


Figure 4.12 Snow cover over (a) control surfaces, and (b) JP-5 treated surfaces at 12:45 pm, during snowfall event two, 20 days after fuel addition.

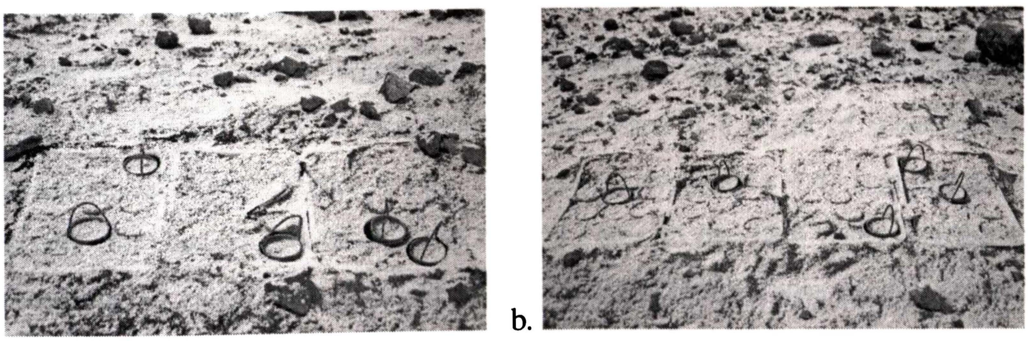


Figure 4.13 Snow cover over (a) control surfaces, and (b) JP-5 treated surfaces during snowfall event three, 27 days after fuel addition.

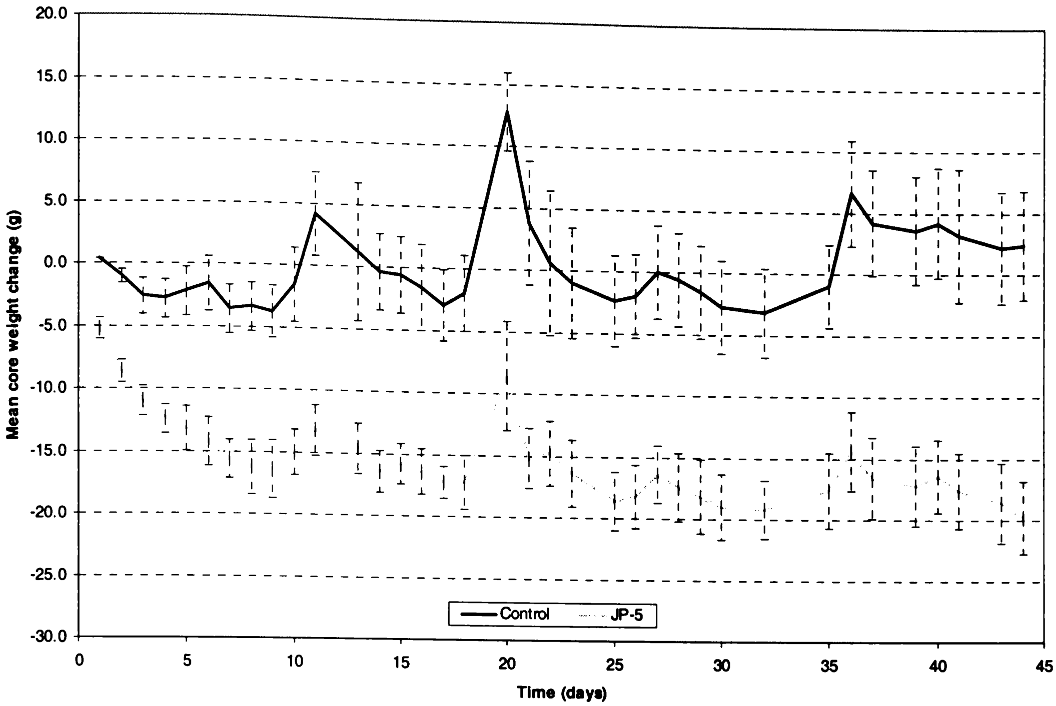


Figure 4.14 Mean core weight change (g) after fuel application.

Core weight gains recorded immediately after the loss of snow cover are attributed to increases in the soil moisture content of the soil surface. Core weight gains however were not consistent over control and JP-5 treated cores (Figure 4.14), with more snow accumulating over control surfaces. At the time of the largest snowfall event for example, 20 days after fuel application (Figure 4.11) control cores accumulated, on average, 12.8 g of snow while JP-5 treated cores gained 8.6 g (Appendix Eight). Snowfall was also observed to be lost preferentially over fuel-contaminated surfaces (Figures 4.11, 4.12).

4.6.2.2 Volatilisation of fuel

In order to calculate JP-5 volatilisation from core weights it was necessary to correct for changes in soil moisture gains and losses as a result of snowfall and evaporation of water (Figure 4.14). The correction (Table 4.4) was made by applying the changes recorded in the control cores to the JP-5 cores, subject to moisture being gained or lost (Appendix Eight). However it was recognised that this introduced some error as more weight was gained in control cores at times of snowfall events (Figure 4.14, Appendix Eight), thus underestimating the mean moisture corrected fuel loss.

Table 4.4 Mean weight change in JP-5 treated cores and moisture corrected fuel loss.

Time (h, d)	*Core weight loss (g)*		*Mean moisture corrected fuel loss (g)*	*Mean moisture corrected fuel loss (%)**
	mean	*s.d.*		
18 h	5	0.8	5	9
7 d	16	1.5	12	26
44 d	20	2.9	17	35

* As % of fuel applied

4.6.2.3 Soil weighing core oven dry mass (g)

By comparing the soil oven dry mass of the weighing cores at the time of experimental set-up (December 1999/January 2000) with the time of core destruction (January 2002) an estimate of the total error involved with core weights was found to be 2.9% (Appendix Five).

4.6.3 Fuel movement total petroleum hydrocarbons (TPH)

Ten days after JP-5 application, fuel had visually penetrated to a mean maximum depth of 15 cm, and 17 cm after one year (Table 4.5). Levels of TPH were markedly reduced six weeks after fuel application, and were at similar levels in the surface (0 - 2.5 cm), and the 2.5 cm to maximum depth of visible fuel penetration, depth ranges (Table 4.5, Appendix Six). The TPH concentrations were below detectable levels (< 30 mg/kg dry wt) in all samples from control soil cores and in soil samples from below the depth of visible fuel penetration in JP-5 treated cores. Individual hydrocarbon components appeared to have volatilised at a similar rate from both the surface contaminated zone (0 – 2.5 cm) and the most heavily impacted zone (Figure 4.15, 4.16).

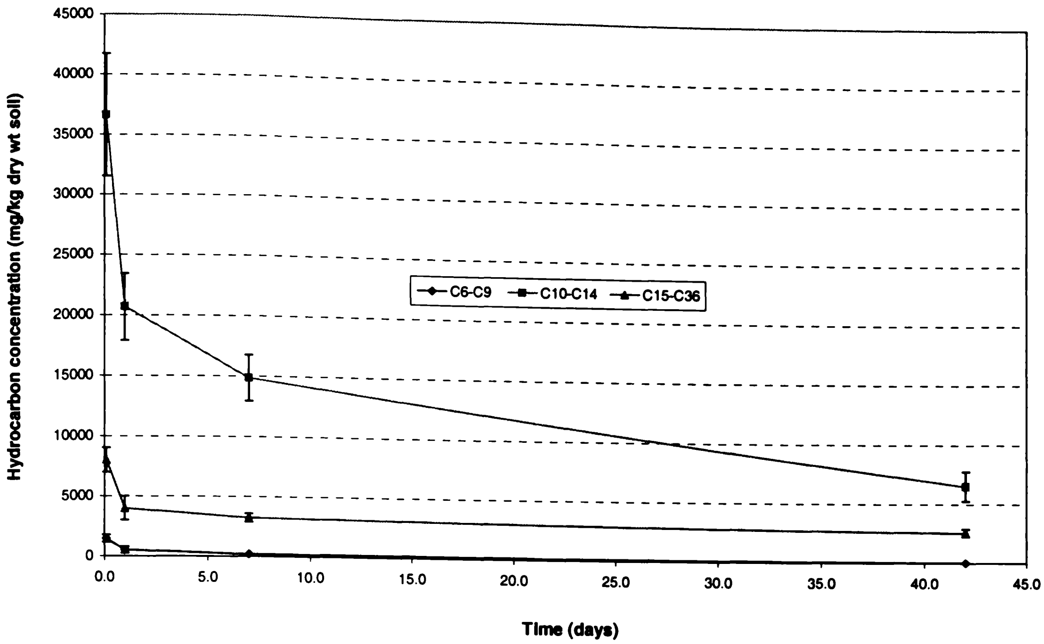


Figure 4.15 Mean concentration of selected hydrocarbon components between 0-2.5 cm over the 42 day sampling period.

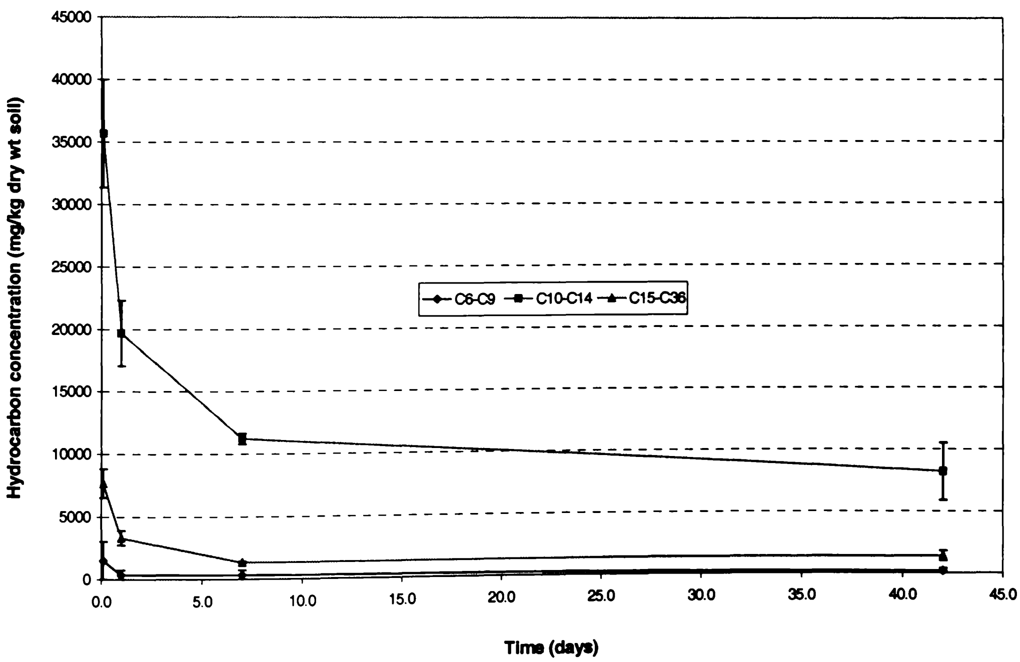


Figure 4.16 Mean concentration of selected hydrocarbon components between 2.5 cm and the mean depth of fuel penetration (#), over the 42 day sampling period.

Table 4.5 Mean depth of visible fuel penetration and total petroleum hydrocarbon content (TPH) (mg/kg dry wt soil) at the soil surface (0-2.5 cm depth), and in the remaining fuel contaminated zone (2.5-# cm depth), following the application of 7 mm of JP-5 to soil cores.

Days since fuel application	*Mean depth of fuel penetration, # (cm)*	*TPH 0-2.5 cm*		*TPH 2.5-* cm*	
		mean	*s.d.*	*mean*	*s.d.*
0.1	9	46 000	6 500	45 000	6 000
1	10	25 000	4 000	23 000	2 000
3	12.5				
7	14	19 000	2 000	13 000	500
10	15				
42	15	9 000	1 000	10 000	2 500
365	17				

*Upper depth of transitional zone, # Depth of visible fuel penetration (Figure 4.7)

4.6.3.1 Volatilisation of fuel using TPH concentrations

The volatile loss of JP-5 fuel as, calculated from the TPH concentrations within the total depth of fuel contaminated soil, was about 50% after one week, and 60% after six weeks (Appendix Six).

4.6.4 Temperature

4.6.4.1 Experiment One

For the week following fuel application JP-5 treated cores appeared slightly warmer compared to control cores at 5 cm depth during mid afternoon sunshine (diurnal maximum temperature), while no apparent differences were observed at 20 cm depth (Figure 4.17, 4.18). Variation between triplicate cores (Appendix Nine) shows that observed temperature differences during the diurnal maximum are not significant, and are likely to result from random variation in the depth of temperature probes.

4.6.4.2 Experiment Two

Similarly no apparent difference (Appendix Ten) in soil temperatures were observed between JP-5 treated and control soils at 2 cm and 5 cm depths (Figure 4.19, 4.20).

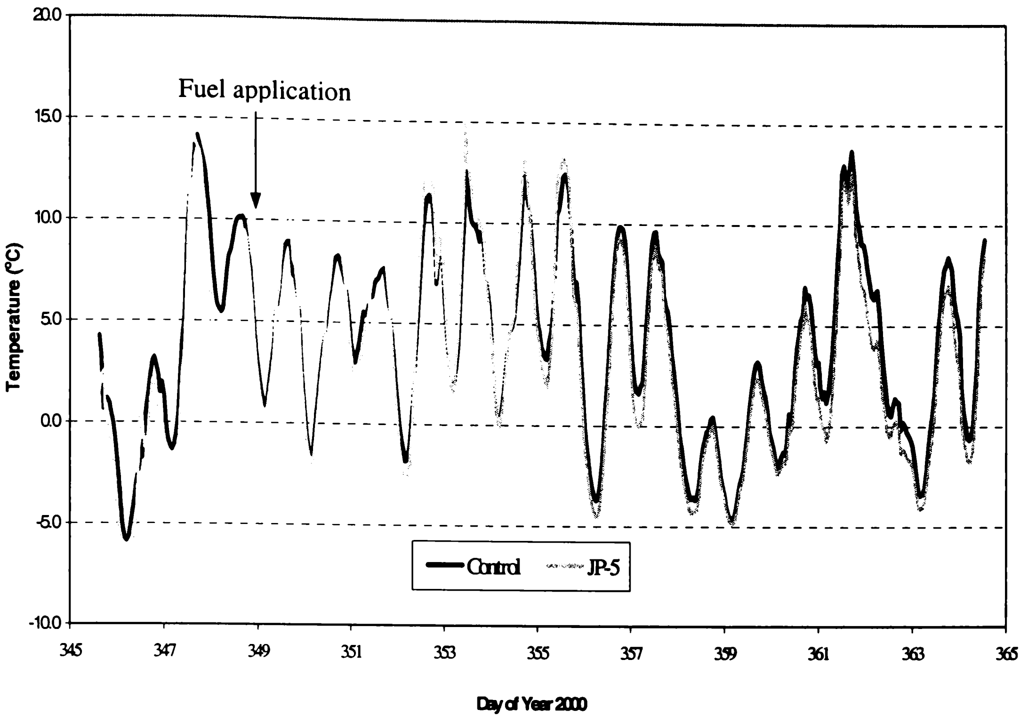


Figure 4.17 Mean soil temperatures before and after fuel application at 5 cm depth for control and JP-5 treated cores.

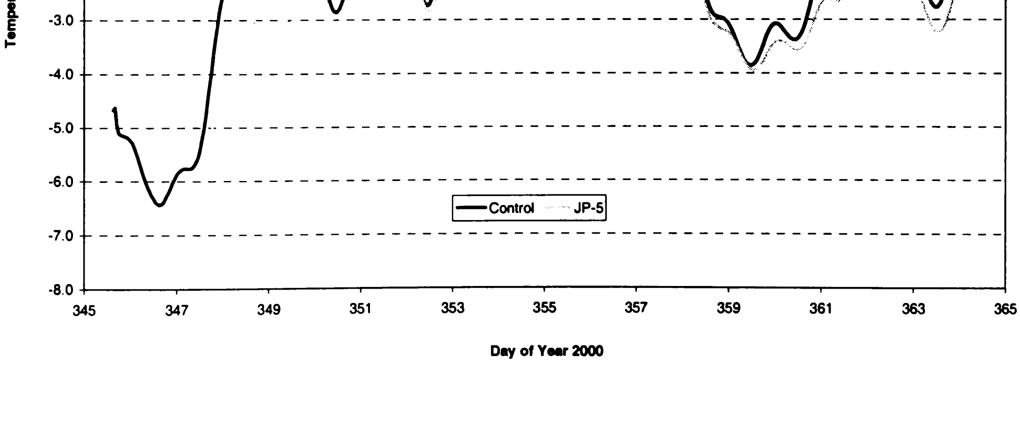


Figure 4.18 Mean soil temperatures before and after fuel application at 20 cm depth for control and JP-5 treated cores.

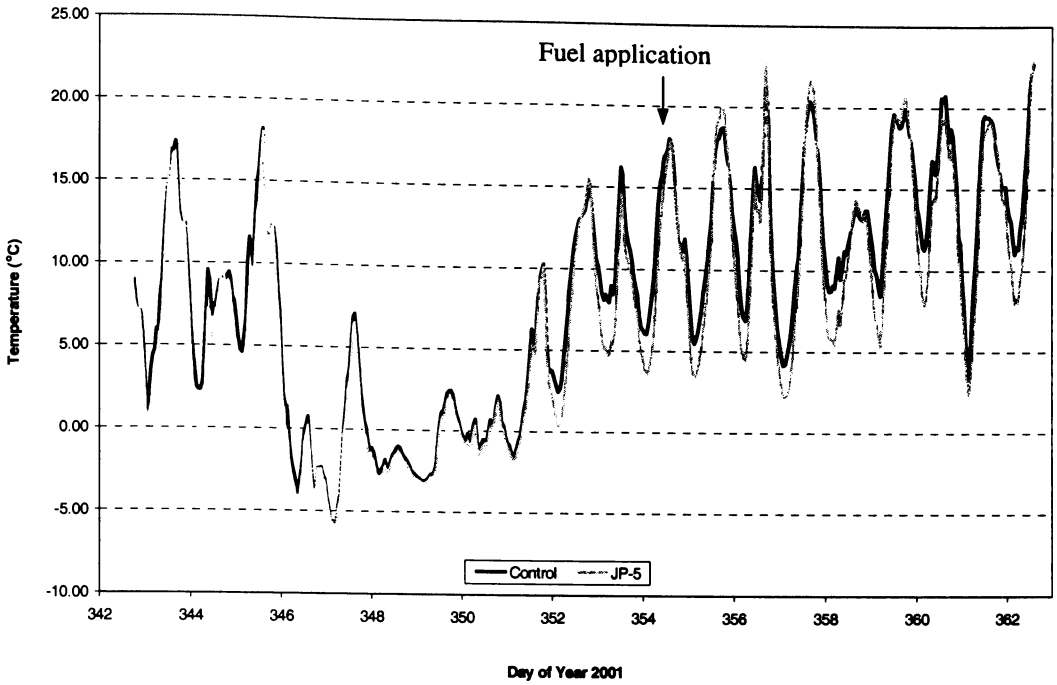


Figure 4.19 Mean soil temperatures before and after fuel application at 2 cm depth for control and JP-5 treated cores.

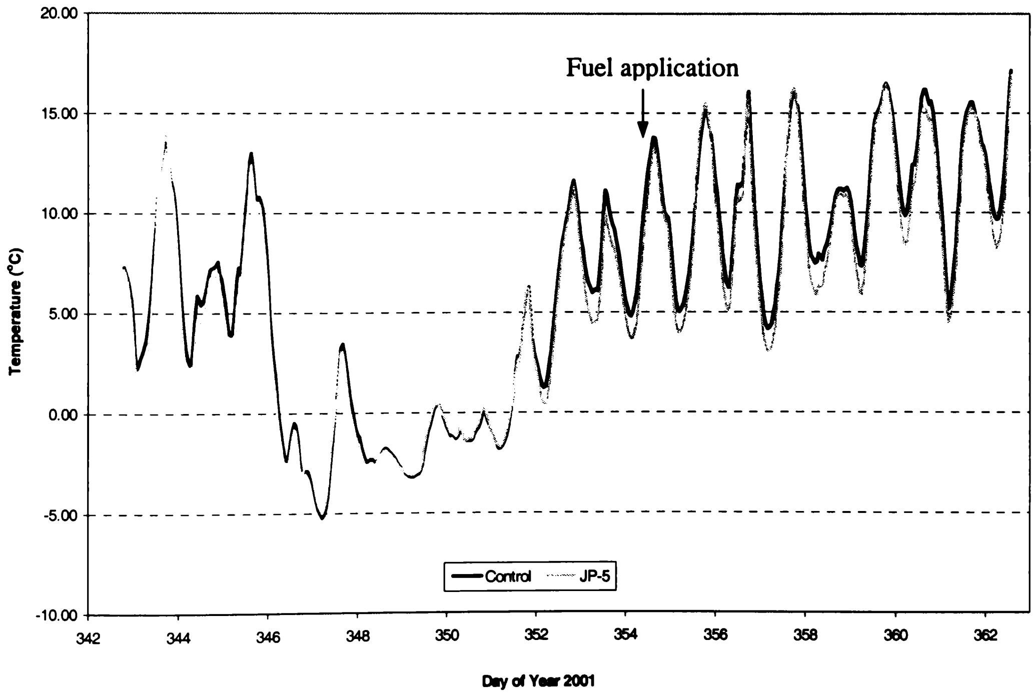


Figure 4.20 Mean soil temperatures before and after fuel application at 5 cm depth for control and JP-5 treated cores.

4.6.5 Soil moisture contents

4.6.5.1 Control cores

Soil moisture contents within control cores generally increased with depth, with the greatest differences between sampling zones occurring between the soil surface (0–2.5 cm) and 2.5–10 cm depth (Figures 4.21, 4.22). With exception of the surface 0–2.5 cm, which was influenced by the presence of snowfall, the mean soil moisture contents at any given depth varied over the 42 sampling period and showed no trend (Figure 4.21), while appearing fairly constant over selective days after one year (Figure 4.22) The average soil moisture content in the surface 2.5 cm over the 42 day period was 2.2 %, compared with 2.8 % between 2.5 cm and 10 cm, and 3.0 % between 10 and 30 cm. Elevated soil moistures were recorded within the bottom 1 cm of the core (5.1 % mean) where damp soil or an ice-cemented layer (5 mm – 10 mm) was consistently observed (Appendix Eleven).

4.6.5.2 JP-5 treated cores

The combined gravimetric soil moisture and fuel content of the JP-5 contaminated surface zone (0 - 2.5 cm) decreased markedly in the first week after fuel application, indicating the volatile loss of hydrocarbons (Figure 4.23). Levels of fuel and moisture continued to decrease after the first week, and were consistently lower on selective days one year after fuel application (Figure 4.24, Appendix Eleven).

The soil moisture contents of the uncontaminated zones in the JP-5 treated cores were similar to the moisture contents at equivalent depths in control cores for comparative sampling days (Figure 4.21-4.24).

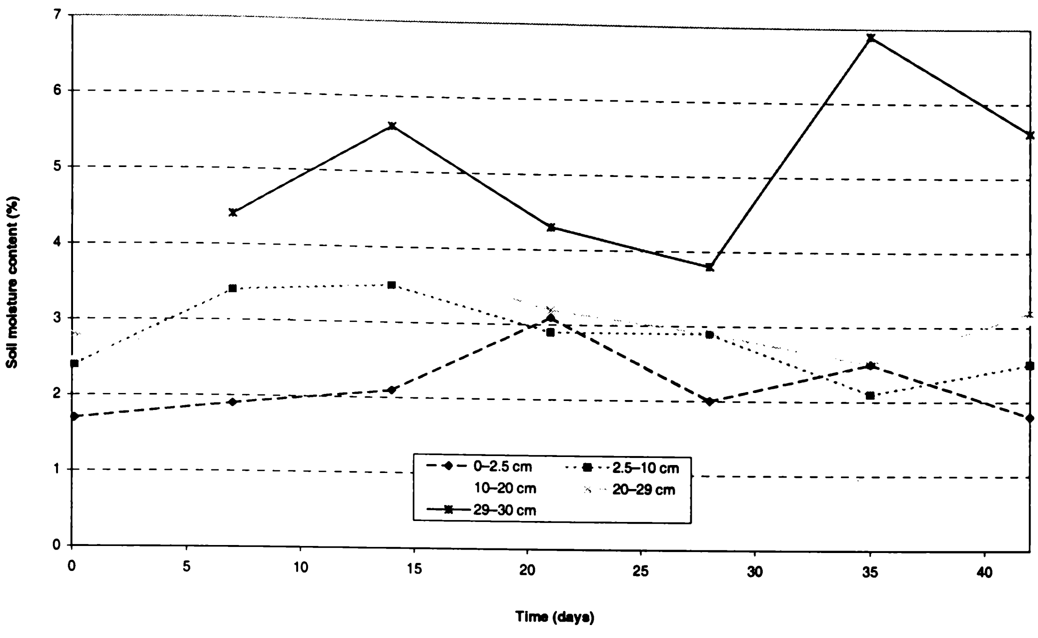


Figure 4.21 Mean gravimetric soil moisture content (%) of control cores over 42 day sampling period.

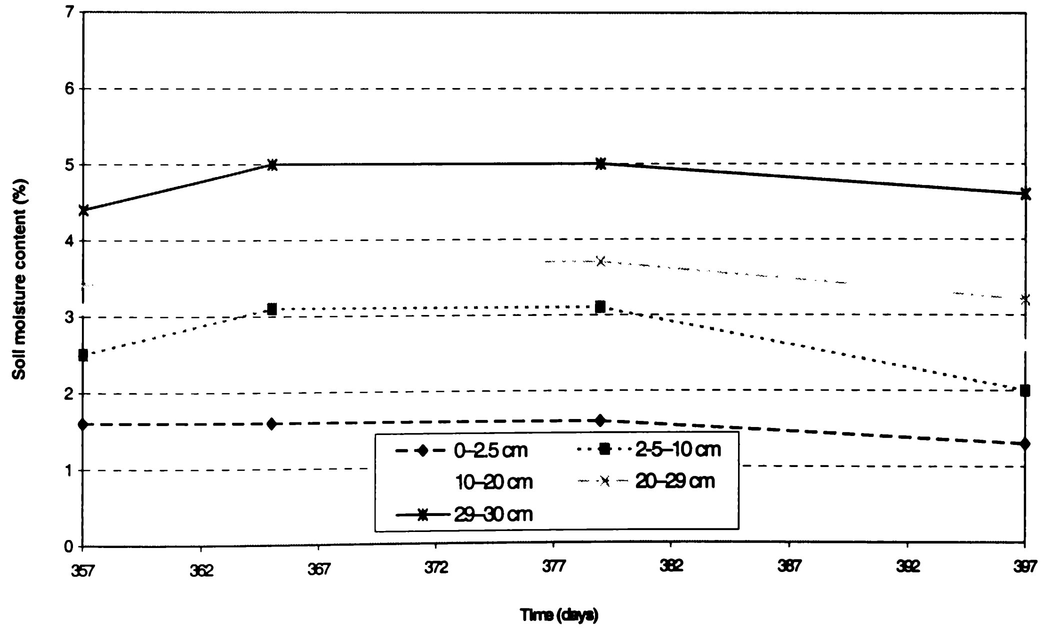


Figure 4.22 Mean gravimetric soil moisture content (%) of control cores over selected days after one year.

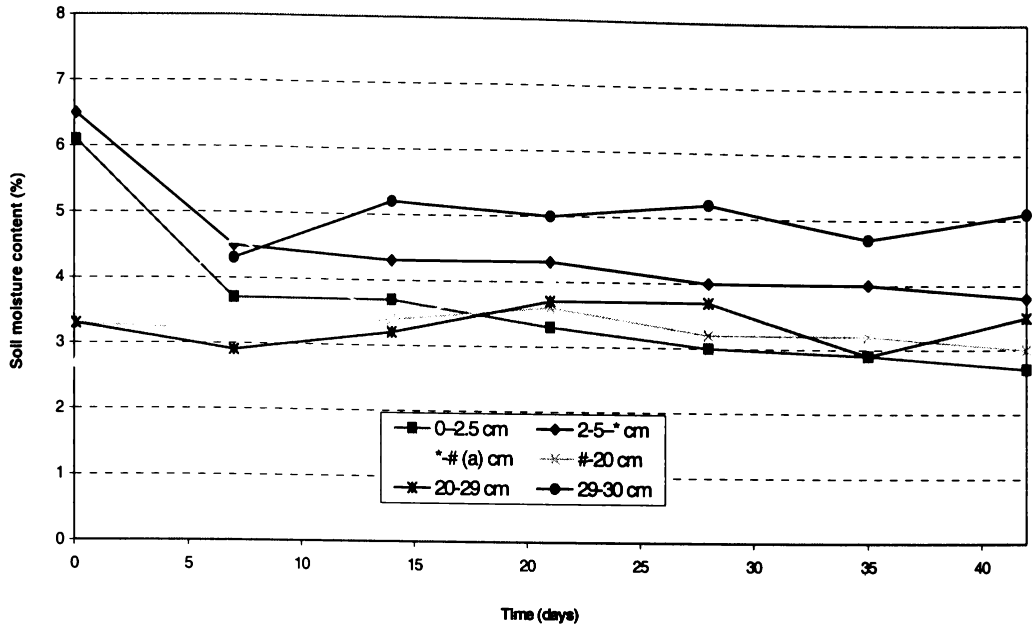


Figure 4.23 Mean gravimetric soil moisture and fuel contents (%) of JP-5 contaminated zones, and moisture content (%) of uncontaminated zones over 42 day sampling period.

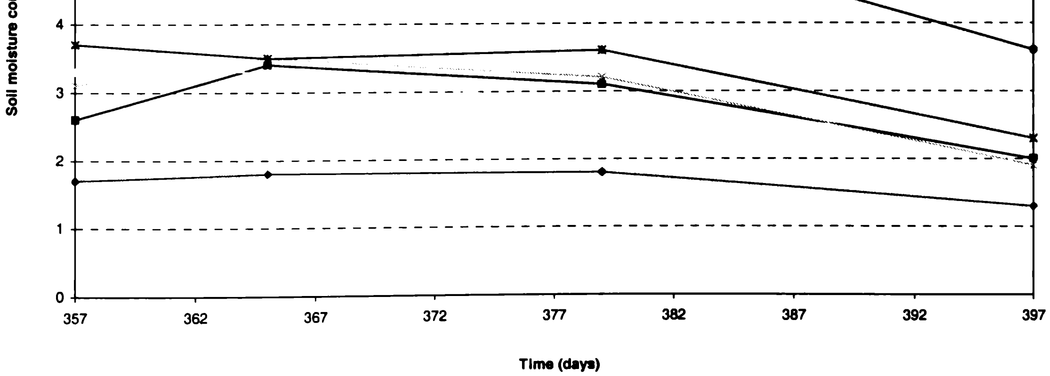


Figure 4.24 Mean gravimetric soil moisture and fuel contents (%) of JP-5 contaminated zones, and moisture content (%) of uncontaminated zones on selected days after one year.

4.7 Discussion

4.7.1 Preferential accumulation and loss of snowfall

Even though there was a slight topographic depression in the positioning of control cores, compared to the JP-5 treatment (Figure 4.4), the lower accumulation of snow on JP-5 treated cores after snowfall events (section 4.6.2.1) may have been due to hydrophobic fuel contaminated surfaces. Balks *et al.* (submitted) for example found the hydrophobicity of hydrocarbon contaminated Scott Base and Bull Pass soils to be higher, when compared to controls soils.

While it is likely that snow was preferentially lost from JP-5 treated surfaces because there was a lower accumulation of snow on these surfaces (Figures 4.11, 4.12) the assumed lower surface albedo of the JP-5 treated surfaces may have also contributed. Where snow cover is less than 15 cm deep for example, absorption of incoming solar radiation by the underlying surface may become significant in helping to melt the layer from below Oke (1987).

4.7.2 Fuel volatilisation

4.7.2.1 Short-term fuel loss

The initial loss of between 35% and 60% fuel after six weeks is within the range of other experimental fuel spills in the Antarctic soil environment. Using TPH analysis for example, the volatilisation loss of 99 % (Special Antarctic Blend applied at 6.3 litres per m^2) was recorded from the surface 3 cm of beach sand, over a 60 day period at Davis Station, Antarctica (Green *et al.* 1992).

Based on findings in preliminary laboratory experimentation (sections 3.3.4.1, 3.5.4.1) it is anticipated that had JP-5 fuel been applied at a rate greater than 6.9 litres per m^2 the percentage fuel loss would have been less, over the six week period.

4.7.2.2 Soil core weights and TPH fuel loss

The differences between the total proportion of fuel lost to volatilisation after six weeks (approximately 35% compared to 60%), as recorded respectively by daily core weights (section 4.6.2.2) and TPH concentrations (section 4.6.3.1) are considered to be the result of various errors within each technique.

In addition to the approximate 2.9% total error in the soil weighing cores (section 4.6.2.3) it was noted that more weight was gained in control cores during snowfall (Figure 4.14), thus underestimating the moisture corrected fuel loss (Appendix Eight).

Similarly errors are present in the TPH analysis technique, where only a small fraction of the total sample is analysed. The total percentage fuel loss of JP-5 is likely to have been less if calculated from TPH samples over a greater range of depths within contaminated soil in each core, as TPH was generally observed to decrease with depth for any given day sampled (Table 4.5).

The most accurate estimation of the total volatile loss of JP-5 from the Scott Base contained experiment is therefore likely to lie somewhere in between 35% and 60%, as given by the soil core weighing method and TPH analysis.

4.7.3 Other possible fate loss pathways of fuel

Due to the absence of liquid water and a permafrost layer the leaching and subsurface redistribution of fuel was negligible. The loss of fuel to photooxidation under sunny conditions may have contributed to the total fuel loss observed after six weeks. Biodegradation however is considered to be minimal. Although hydrocarbon-degrading bacteria were present, numbers were not elevated compared to control soil (section 5.4.2) and it is therefore anticipated that the selective enrichment of hydrocarbon-degrading bacteria would need to occur prior to significant biodegradation. In undertaking a similar fuel spill experiment (application rate of 6.3 litres per meter^2) in Antarctica, Green *et al.* (1992) found no evidence to suggest that biodegradation of fuel had occurred after a period of 60 days.

4.7.4 Soil TPH concentrations

The TPH levels from the Scott Base contained experiment were in the range of those reported by Aislabie *et al.* (2001) at existing hydrocarbon contaminated Scott Base and Marble Point sites (Table 2.3). It is noteworthy however that the TPHs reported by Aislabie *et al.* (2001) were predominately recorded a number of years after contamination, and it is therefore likely that such spills were of much larger magnitude, allowing time for various environmental fate loss processes (volatilisation, leaching and biodegradation). The type of hydrocarbon contamination of soils reported by Aislabie *et al.* (2001) may also have contributed to comparable TPHs, and it is known that heavier molecular weight hydrocarbons are more persistent in the environment (Corban 1994).

Unlike Chaineau *et al.* (2000), who reported the selective vertical infiltration of the lightest hydrocarbon components into an agricultural soil after a controlled fuel spill, no apparent differences in the concentration of selected hydrocarbon components in the contaminated zone was observed (Figures 4.15, 4.16).

4.7.5 Factors affecting fuel movement

4.7.5.1 Fuel application rate

While the fuel penetration depth of 15 cm after 10 days (Table 4.5) was the same as that noted by Kerry (1993) in an experimental spill of 6.0 litres per m^2 (Special Antarctic Blend), it is anticipated that a greater subsurface redistribution of fuel would have occurred, had the spill been larger. Previous observations of much larger fuel spills in the subsurface of Antarctic soils, for example, have shown fuel migrating down to and along the ice-cemented surface of the permafrost (Balks and Campbell 1995).

4.7.5.2 Soil moisture content

It is likely that the low soil moisture contents (1.5 - 3%) within the Scott Base contained experiment had a significant influence on the downward vertical movement and adsorption of fuel within soil cores. The influence of moisture content on hydrocarbon retention has been studied by Jarsjo *et al.* (1994), who showed that an increase in soil moisture content (from air-dry to 50% of water retention capacity) had a corresponding decrease in kerosene retention of 10% in clay and sandy loam soils, 40% in peat, and 70% in sand.

4.7.6 Temperature

4.7.6.1 Diurnal variation

Diurnal variations in soil temperature during successive summers (section 4.6.4.1, 4.6.4.2) were similar to what has been observed previously at Antarctic sites. Kerry (1993) in undertaking an experimental fuel spill on soil in the Vestfold Hills recorded temperatures at 1 cm and 5 cm depth over a summer period. Soil temperatures at 1 cm depth were found to be above 0°C for 100% of the time and above 10°C for 21% of the time. At 5 cm depth temperatures were also found to be up to 5°C. Such temperatures occurred on still sunny days for one or two hours in mid afternoon. In undertaking temperature measurements at Scott Base during a clear sky summer day Campbell *et al.* (1997b) additionally found that the maximum diurnal soil surface temperature was approximately 6 °C warmer than at 1 cm depth, and 11 °C warmer than at 6 cm depth. It was also observed that the summer diurnal variability in soil temperature was almost completely damped out at 24 cm depth (Campbell *et al.* 1997b).

4.7.6.2 Impact of hydrocarbons on soil temperature

Soil temperature is a measure of the intensity of the heat within a soil at any given point and is determined by factors that affect the heat availability at the soil surface and those that influence the dissipation of the available heat down the soil profile (Hanks and Ashcroft 1980). One of the main soil surface factors controlling heat availability is the surface colour, and it was anticipated that the darkened core surfaces immediately after fuel application (section 4.6.1) would have increased the soil temperature. Not only have soil surfaces artificially darkened with charcoal increased soil temperature (Figure 4.25), but temperatures at existing hydrocarbon-contaminated sites have been recorded elevated up to

7°C, compared to control soils during mid-afternoon sunny periods (Balks *et al.* submitted).

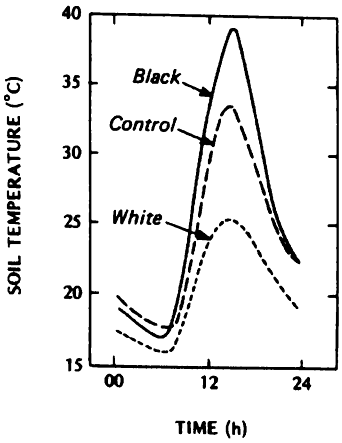


Figure 4.25 The effect of surface colour on soil temperature (Oke 1987).

The soil moisture content is also a factor that strongly determines heat dissipation as it influences physical processes such as conduction (Hanks and Ashcroft 1980). Therefore while the darkened soil surface immediately after fuel application may have contributed to the absorption of solar radiation due to lower albedo, it may have been compensated for by evaporative cooling as fuel volatilised. Such a relationship is likely, for example in measuring soil temperatures and albedo in a bare, tilled, agricultural soil, Richard and Cellier (1998) recorded soil heat fluxes to be low during rainy periods due to high evaporation, while at the same time low albedo due to the moist soil surface.

4.7.7 Soil moisture transfer

The transfer of soil moisture within experimental cores from the uniform soil moisture of 2.9% at the time of experimental set-up (section 4.4.2) to 2.2% in the 0–2.5 cm surface, and 5.1% at the base (29–30 cm) one year after equilibrating (section 4.6.5.1). Because the moisture contents of Antarctic soils are extremely low it is likely that the mechanisms involved soil moisture transfer involve the vapour phase, and could result from vapour fluxes with soil temperature changes and following snowfalls (Campbell *et al.* 1997a).

4.8 Conclusions

- The volatile loss of JP-5 fuel, as determined by core weights after correcting for moisture addition and evaporation of snowfall was about 9% after 18 hours, 26% after one week, and 35% after six weeks, during sunny conditions.

- The total petroleum hydrocarbon content of the soil decreased in the 0-2.5 cm depth range from 46 000 mg/kg after 2 hours to 9 000 mg/kg after six weeks, and from 45 000 mg/kg after 2 hours to 1 000 mg/kg after six weeks in the 2.5 cm to the mean maximum depth of fuel penetration depth range (15 cm).

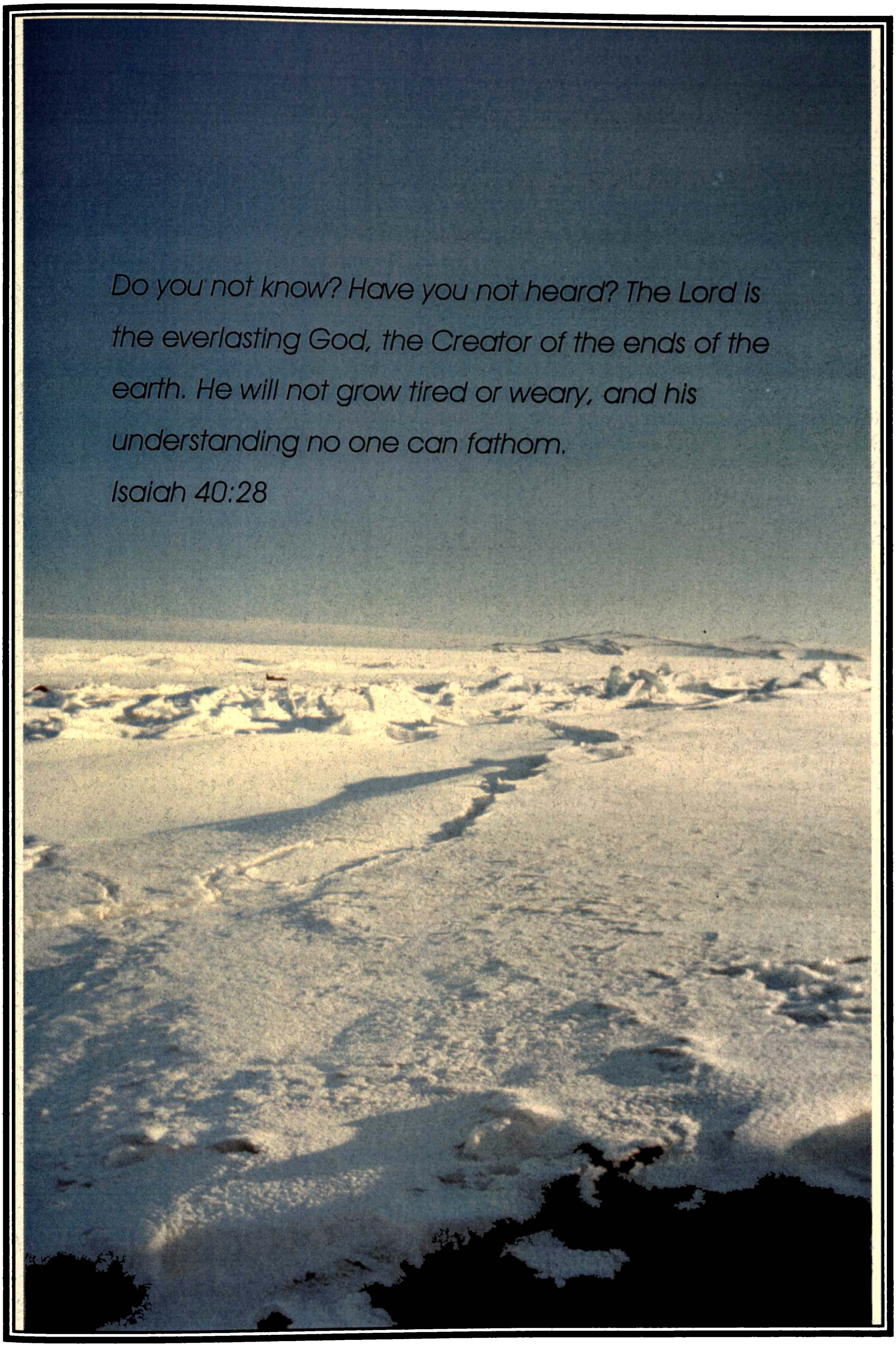
- The corresponding volatile loss of JP-5 fuel, as calculated from TPH concentrations within the total depth of fuel contaminated soil was about 50% after one week, and 60% after six weeks.

- Due to errors present in the methods used for determining the total volatile loss of JP-5 from the Scott base contained experiment, the most accurate estimation of the total volatile loss is therefore likely to lie somewhere in between those given by the soil core weighing method and from TPH analysis (35% and 60%).

- Had JP-5 fuel been applied at a rate greater than 6.9 litres per m^2 the percentage fuel loss would have been less, over the six week period.

- Fuel penetrated into the dry, bare soil to a mean maximum depth of 15 cm after ten days, and 17 cm after one year.

- The application of JP-5 fuel had no measured effect on the diurnal soil temperature at 2 cm, 5 cm, and 20 cm depth, under sunny summer conditions.


Do you not know? Have you not heard? The Lord is the everlasting God, the Creator of the ends of the earth. He will not grow tired or weary, and his understanding no one can fathom.
Isaiah 40:28

Chapter Five

Microbial Response in the Scott Base Contained Experiment

5.1 Background

In areas where fuel spills have occurred in the Antarctic soil environment, hydrocarbon-degrading microbes have previously been isolated (Konlechner 1985, Kerry 1990, Tumeo and Wolk 1994), and found to have degradative potential (Kerry 1990, Aislabie *et al.* 1998). Enumeration of hydrocarbon-degrading microbes and culturable heterotrophic bacteria at fuel contaminated Antarctic sites has also shown elevated numbers up to 40 years after the spill, compared to control soils (Balks *et al.* 1998, Aislabie *et al.* 2001).

While experimental fuel spills in the Arctic have shown a greater microbial response one year after fuel application (Sexstone and Atlas 1977), the exact time taken for the selective enrichment of hydrocarbon-degrading microbes observed in Antarctic soils is currently unknown (Balks *et al.* 1998, Aislabie *et al.* 2001).

5.2 Objectives

The aim of the following experimentation was to determine whether the application of JP-5 fuel in the Scott Base contained experiment (Chapter Four):

- Had an initial toxic effect on culturable heterotrophic bacteria and hydrocarbon degrading microbes.
- Increased the numbers of culturable heterotrophic bacteria and hydrocarbon degrading microbes within 42 days following the spill.

5.3 Methodology

5.3.1 Culturable heterotrophic bacteria

Enumeration of culturable heterotrophic bacteria was determined using serial dilutions and a standard viable plate count method described by Aislabie *et al.* (2001).

5.3.1.1 Media preparation

R2A agar was made by dissolving 18.2 g of powder medium for every litre of deionised water inside individual 1000 mL Schott bottles. Schott bottles were shaken gently to allow for dissolution of powder and autoclaved at 121°C for 20 minutes. When autoclaved the Schott bottle lids were loosened half a turn to allow for release of pressure and were not filled to the surface so to avoid overflow. Once out of the autoclave Schott bottles were then inverted to ensure complete mixing of the media and were placed in a 50°C oven to cool. Inside a laminar flow unit, to avoid microbiological contamination, approximately 20 mL of the media was poured into Petri dishes (9 cm diameter x 1 cm high). Petri dishes were then left to cool before being stored, upside down at 4°C until required.

5.3.1.2 Dilution buffer

Dilution buffer to be used for serial dilutions was made by dissolving 4 g Na_2HPO_4 and 2 g KH_2PO_4 per litre of deionised water. Buffer solution (9 mL) was dispensed into individual test tubes, autoclaved at 121°C for 20 minutes and stored at 4°C until required.

5.3.1.3 Sample preparation

Soil (5 g wet weight, section 4.5.4.2) was added aseptically using an ethanol swabbed spoon to a 100 mL Schott bottle containing 45 mL 0.1% (w/v) sterile tetra-sodium pyrophosphate solution (1 mL solution contains 0.1 g soil) and 15 g glass beads (3 mm). The Schott bottle was then shaken at 220 rpm for one hour on a Heidolph Unimax 2010 shaker plate at 4°C.

5.3.1.4 Serial dilutions

A dilution series was carried out where 1 mL of the above solution (0.1 g soil) was vortexed with 9 mL of sterile buffer solution for one minute (0.01 g soil). The procedure was repeated to give a dilution of 0.001 g soil. Agar plates were inoculated, in triplicate with 0.1 mL of the 0.001 g soil dilution, which was spread around the plate using a sterile glass spreader. Plates were then incubated at 16°C for four weeks.

5.3.1.5 Viable plate counts

Numbers of visible bacterial colonies on agar plates (Figure 5.1 a) were counted four weeks after inoculation, and converted to numbers of bacteria per gram of dried soil (Appendix Twelve).

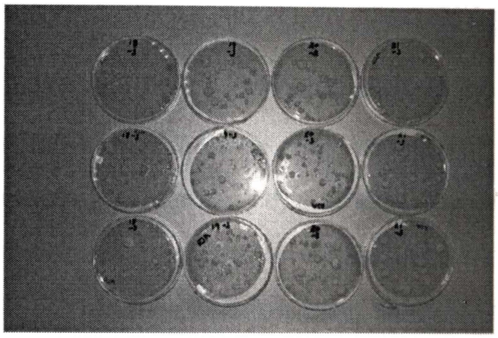
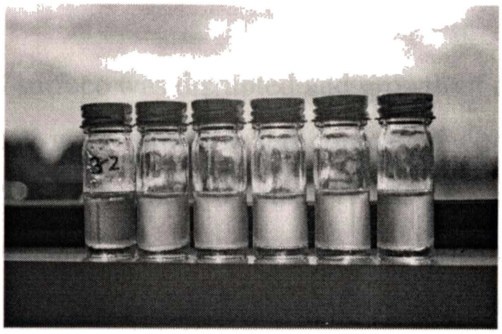
a.  b. 

Figure 5.1 Experimental techniques used to enumerate (a) Culturable heterotrophic bacteria (colonies visible after four weeks), and (b) Hydrocarbon-degrading bacteria (MPN dilution series with control tube (left) and positive turbid tubes).

5.3.2 Hydrocarbon degrading microbes

Enumeration of hydrocarbon degrading microbes was determined using a five-tube Most Probable Number (MPN) technique described by Aislabie *et al.* (2001).

5.3.2.1 Media preparation

Bushnell Haas Media (Difco) was made by dissolving 3.27 g of powder medium for every litre of water. The solution was stirred constantly using a magnetic flea while 10 mL aliquots were dispensed into individual 25 mL universals.

Universals were then autoclaved at 121°C for 20 minutes and stored in a 4°C fridge.

5.3.2.2 Serial dilutions

Samples were prepared and a dilution series carried out as described in sections 5.3.1.3, and 5.3.1.4. Suspensions of soil in the dilution buffer were prepared to give soil concentrations of 0.1, 0.01, 0.001, 0.0001, and 0.00001 g of soil per mL. Six individual Bushnell Haas tubes (5 replicates and 1 control) were each inoculated with 1 mL of the dilutions. All tubes then received 50 µl of JP-5 fuel, which had been sterilised by passing the fuel through a 0.2 µm Supor® membrane. In addition control tubes for each dilution received 0.2 mL of concentrated HCl. All tubes were then incubated at 16 °C for 6 weeks.

5.3.2.3 Enumeration of bacteria

Tubes were scored as positive where the oil surface was disrupted and growth of a bacterial film in tubes was visible (or tubes were turbid) when compared with controls (Figure 5.1 b). Using the MPNES program (Woomer *et al.* 1990), numbers of hydrocarbon-degrading microbes were detected based on the number of positive tubes within each dilution series. Where the dilution series did not cover the complete range (to give 0 positive tubes), the next dilution was assumed to have been 0 (Appendix Thirteen).

5.4 Results

5.4.1 Culturable heterotrophic bacteria

No apparent differences in the mean numbers of culturable heterotrophic bacteria were observed between control and JP-5 treated cores 42 days after the application of fuel (Table 5.1, Appendix 12).

Table 5.1 Mean numbers of culturable heterotrophic bacteria (g^{-1}dried weight soil) in control and JP-5 treated cores 0.1 and 42 days after fuel application.

Soil Depth (cm)	*Day 0.1 Control*	*Day 0.1 JP-5 treated*	*Day 42 Control*	*Day 42 JP-5 treated*
0-2.5	5.4×10^5	5.0×10^5	6.0×10^5	3.6×10^5
2.5-#	7.5×10^5	8.5×10^5	9.3×10^5	1.1×10^6
#-20	6.6×10^5	7.6×10^5	9.0×10^5	1.4×10^6
20-30	8.0×10^5	7.6×10^5	7.8×10^5	7.6×10^5

Controls =10 cm; JP-5 treated day 0.1 = 9 cm; JP-5 treated day 42 =15 cm.

5.4.2 Hydrocarbon-degrading microbes

No apparent differences in the mean numbers of hydrocarbon degrading microbes were observed between JP-5 treated and control cores 42 days after the application of fuel (Table 5.2, Appendix 13).

Table 5.2 Mean numbers of hydrocarbon degrading microbes in control and JP-5 treated cores 0.1 and 42 days after fuel application (g^{-1}dried weight soil).

Soil Depth (cm)	*Day 0.1 Control*	*Day 0.1 JP-5 treated*	*Day 42 Control*	*Day 42 JP-5 treated*
0-2.5	2.1×10^2	7.9×10^1	3.8×10^2	8.8×10^2
2.5-#	1.7×10^2	8.6×10^1	6.2×10^2	5.5×10^2
#-20	3.3×10^2	9.7×10^2	2.7×10^3	1.5×10^3
20-30	2.5×10^3	9.7×10^2	1.6×10^3	1.7×10^3

Controls =10 cm; JP-5 treated day 0.1 = 9 cm; JP-5 treated day 42 =15 cm.

5.5 Discussion

5.5.1 Initial effect of fuel on soil microbes

The numbers of culturable heterotrophic bacteria and hydrocarbon degrading microbes were in the range of those detected by Aislabie *et al.* (2001) at uncontaminated Scott Base and Marble Point sites (Table 2.2). Unlike findings from Aislabie *et al.* (2001) however, the numbers of both culturable heterotrophic bacteria and hydrocarbon degrading microbes in control and contaminated samples were in the same order of magnitude. Aislabie *et al.* (2001) has typically recorded higher numbers of microbes (2 orders of magnitude) in oil-contaminated soils compared to control sites. Therefore, because no apparent differences in the mean numbers of culturable heterotrophic bacteria and hydrocarbon degrading microbes were observed between JP-5 treated and control cores, within six weeks after the spill (Tables 5.1, 5.2), the application of JP-5 fuel using a non-saturated flow technique, at 6.9 litres per m^2 is considered to have been non-toxic. Similarly, Wardell (1995) considered JP-8 fuel to be non-toxic to indigenous soil species retrieved from fuel-contaminated soil surrounding McMurdo Station, Antarctica. One of the factors that may have affected the toxicity of JP-5 fuel when spilled is application rate, and it could be that a larger application (saturated flow) may have initially been toxic to soil microbes.

It is anticipated that time is the major limiting factor in the selective enrichment of hydrocarbon-degrading microbes in soil from the Scott Base contained experiment. Elevated numbers compared to control soil may therefore be observed over time periods longer than 42 days.

The process of selective enrichment however may also be constrained by various unfavourable conditions in the Antarctic soil environment.

5.5.2 Constraints to selective enrichment of hydrocarbon-degrading microbes

5.5.2.1 Soil temperature

Soil temperatures in Antarctica remain consistently below zero for most of the year, significantly reducing and even halting microbial activity (Wardell 1995). Tumeo and Guinn (1997) report that soil temperatures in Antarctica tend to be well below the optimum range of both psychrophilic and mesophilic microbes. Temperatures within the range for microbial activity do however occur in coastal Antarctic regions for short periods during summer (Kerry 1993). Based on the growth characteristics of two toluene-degrading isolates (*Pseudomonas* species) Rhodes (1999) anticipated that the degradation of fuel components in contaminated Scott Base soils was possible when soil temperatures were greater than or equal to 6°C, over the Antarctic summer months. Temperatures above 6°C have been consistently recorded in the surface 5 cm of soil during the 2000, and 2001 summer seasons (section 4.6.4).

5.5.2.2 Soil moisture availability

As a result of the gravel dominated texture and low organic matter, Antarctic soils have an extremely low water-holding capacity. Such low moisture content is thought to constrain microbial activity (Kerry 1993). Balks *et al.* (2000) found that in the top 10 cm of three Antarctic soils, where moisture content ranged between 1% and 5%, moisture content was at or below the moisture content at 1500-kPa, confirming the limited water availability near the surface of Antarctic soils. Soil moisture may however be available from melt-water during parts of the summer period (Konlechner 1985).

5.5.2.3 Soil nutrient content

Nutrients are generally limited in the Antarctic soil environment but, where added to contaminated soil, they may enhance microbial activity. In assessing the constraints to biodegradation Balks *et al.* (1998) found that total nitrogen levels were uniformly extremely low at Scott Base, Bull Pass, and Lake Vida and considered nutrient availability one of the main factors limiting microbial activity. The addition of nitrogen to contaminated Scott Base soil has been observed to increase the rates of hexadecane and naphthalene mineralisation (Aislabie *et al.* 1998).

5.5.2.4 Soil oxygen concentrations

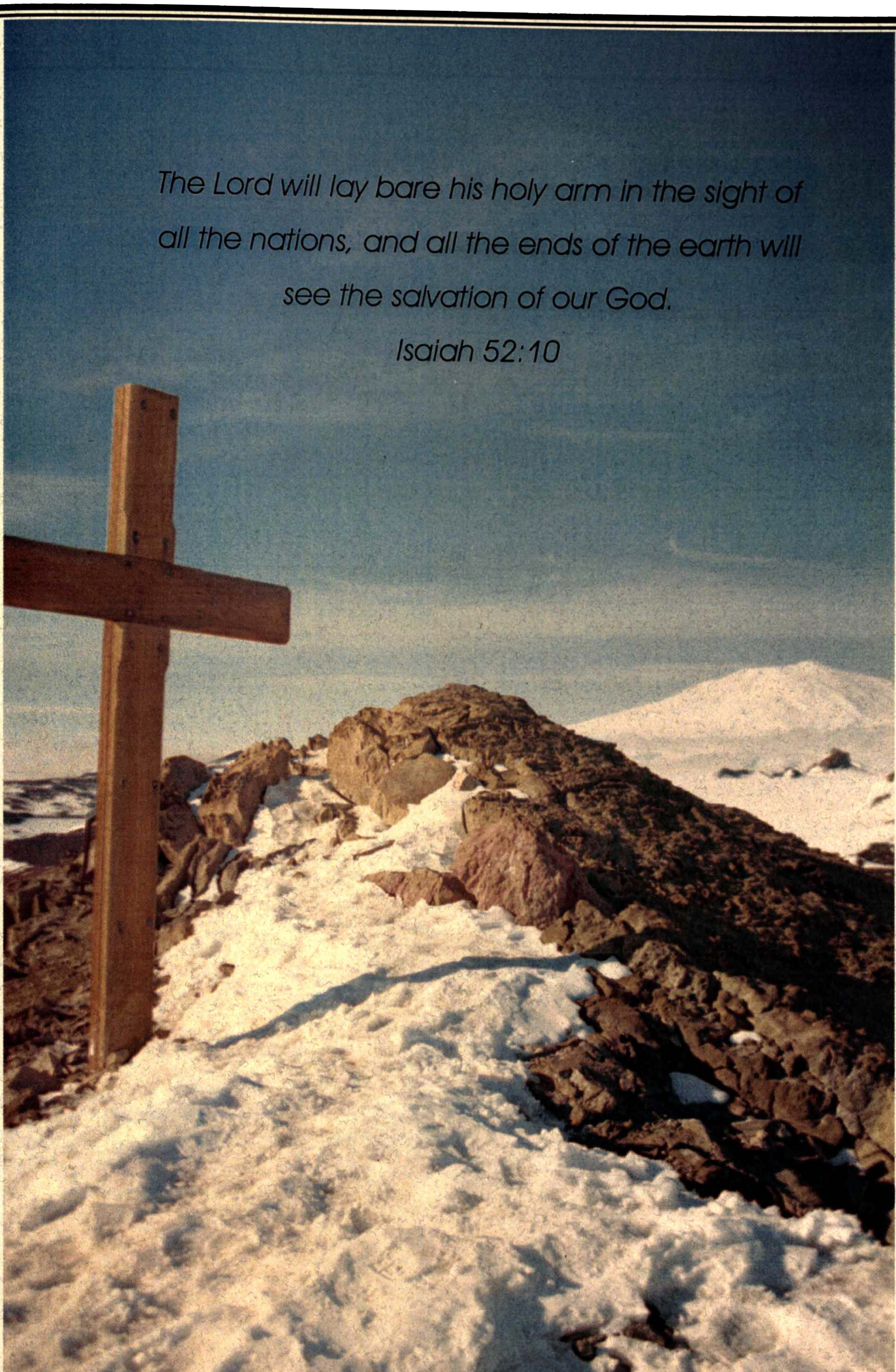
The gravel dominated texture of Antarctic soils means that oxygen concentrations are not likely to inhibit or constrain microbial functioning, at least in surface soil. With increasing depth however oxygen limitations arise, and may be the reason for limited biological activity (Konlechner 1985) and the absence of biodegradation (Kerry 1993) observed at depth.

5.5.2.5 Microbial inhibitory substances

The presence of various substances in the Antarctic soil environment may also limit microbial activity. Where volatilisation of fuel immediately after a spill is in some way inhibited, the presence of toxic volatile hydrocarbon components may prevent microbial activity (Kerry 1993). On the other hand fuel additives may inhibit microbial activity. Aislabie *et al.* (1998), for example, found an absence of hydrocarbon degrading microbes in a site where lead-containing MoGas had been spilled. It was thought that lead levels (50 μg of organic lead g^{-1} of soil) were high enough to be toxic to bacteria. While JP-5 is an unleaded fuel and contains relatively few additives (Kupecz *pers comm*), other fuels used in Antarctica contain various antifreeze, antioxidant, antistatic, corrosion inhibiting, and metal deactivating additives (Waterhouse 2001), and it is unknown how these may affect microbial functioning.

5.6 Conclusion

The application of JP-5 fuel was non-toxic to culturable heterotrophic bacteria and hydrocarbon degrading microbes, and it is anticipated that selective enrichment of hydrocarbon degrading microbes is limited by time. The enrichment of hydrocarbon degrading microbes however could also be constrained by soil conditions such as low temperature, moisture, and nutrient concentrations.


The Lord will lay bare his holy arm in the sight of
all the nations, and all the ends of the earth will
see the salvation of our God.
Isaiah 52:10

Chapter Six

Hydrocarbon Contaminated Soil Albedo Measurements

6.1 Background

Albedo is the percentage of solar radiation reflected by an object (Goward 1987), and is an important factor in the development of Antarctic soils as it affects the diurnal thermal regime (Campbell, *et al,* 1997, Beyer *et al.* 1999). Where fuel spills have occurred in Antarctica, the soil surface becomes darkened and, depending on the volume and composition of fuel spilled, may remain a darker colour for a period of years (Broadbent 1994, Balks *et al.* 2000). One of the main factors that determine albedo is the soil surface colour, and it is known that dark surfaces have a lower albedo (Oke 1987, Buol *et al.* 1989). It has been hypothesised (Balks *et al.* 2000) that increased soil temperatures observed at hydrocarbon-contaminated Antarctic sites are, in part, a result of lower soil surface albedo at these sites.

6.2 Objective

The following measurements seek to confirm that the surface albedos of darkened hydrocarbon-contaminated sites are lower than those of nearby control soil surfaces. Additionally measurements were made to observe the effect of the soil surface moisture content on albedo.

6.3 Site descriptions

Albedo measurements were taken over hydrocarbon contaminated, and various control surfaces at Scott Base, Marble Point, and Bull Pass (Figures 6.1 – 6.3). The history of the soil hydrocarbon contamination and characteristics of the sites are summarised in Table 6.1.

Table 6.1 Site descriptions where albedo measurements were made at Scott Base, Marble Point and Bull Pass (after Balks *et al.* 2000).

Description	*Scott Base*	*Marble Point*	*Bull Pass*
Contamination history	Drum storage area for hydraulic and lubricating oils between 1960s – 1990s. Spills occurred during movement and distribution of drums.	Spills assumed to be from hydraulic and lubricating oils used at the Old Marble Point Camp between late 1950s and early 1960s.	Spill site of Diesel Fuel Arctic (DFA) in 1985 from seismic borehole drilling. Contaminated surface was removed.
TPH (*u*g g^{-1} dry weight)	25 100 (0-2 cm)	29 100 (0-3 cm)	< 30 (0-3 cm)
Class of hydrocarbons	C_{10}-C_{40} *n*-alkanes, PAH	C_{13}-C_{40} *n*-alkanes, PAH, hopanes	C_{10}-C_{40} *n*-alkanes, Monoaromatic compounds
***Soil Classification**	Typic Anhyorthel	Calcic Anhyorthel	Nitric Anhyorthel
Parent lithology and material	Predominately mafic, scoriaceous basalt dominated till over scoria basalt bedrock.	Predominately calcareous, marble dominated glacial till with common granite and gneiss.	Predominately siliceous, silt dominated glacial till over granite bedrock.
Brief soil description	Stony, gravely sands derived mainly from basalt with ice-cemented permafrost below about 30 cm	2 cm of desert pavement gravels over sandy gravel with > 30 % boulders/stones. Ice-dominated horizon from 87-100+ cm.	2 cm of gravel desert pavement over 1+ m of silt with a few large rocks. Visible salt accumulation on profile face. No ice-cement.

*Soil classification after Soil Survey Staff (1998)

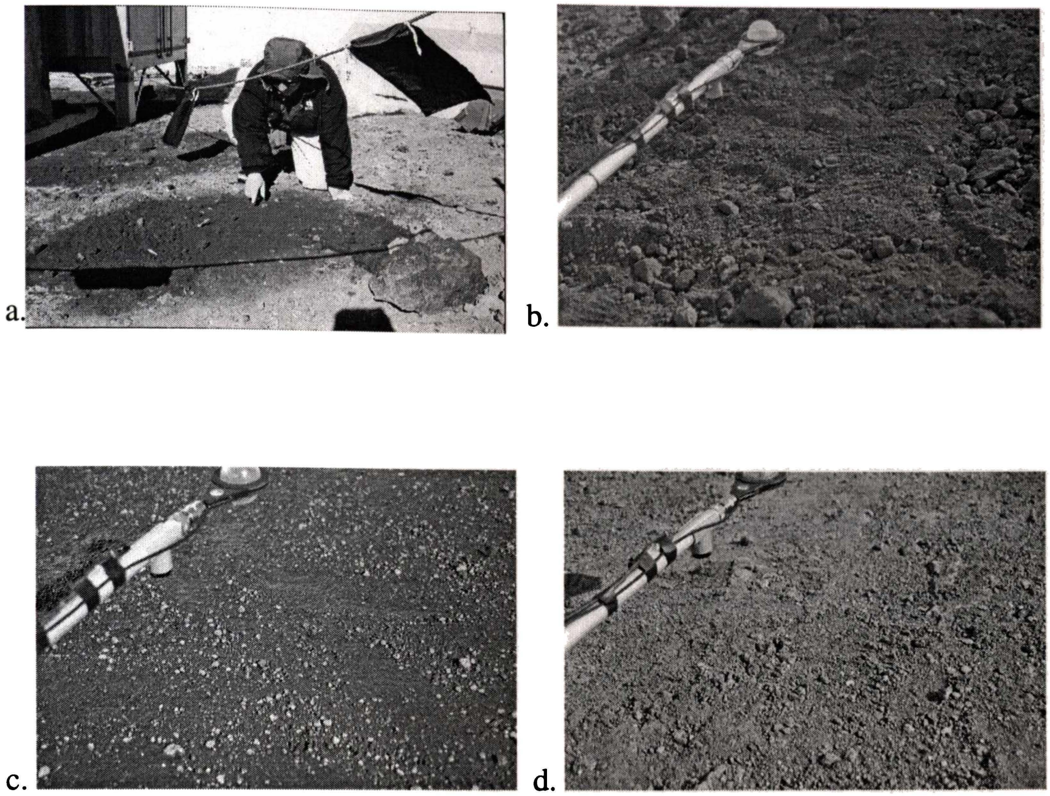


Figure 6.1 Soil surfaces over which albedo was measured at Scott Base: (a, b) hydrocarbon contaminated, (c) water saturated, and (d) control sites.

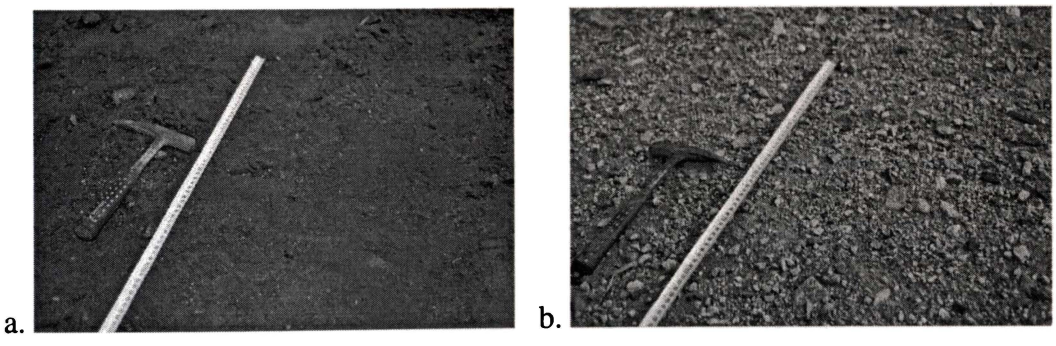


Figure 6.2 Soil surfaces over which albedo was measured at Marble Point: (a) hydrocarbon contaminated, and (b) control sites.

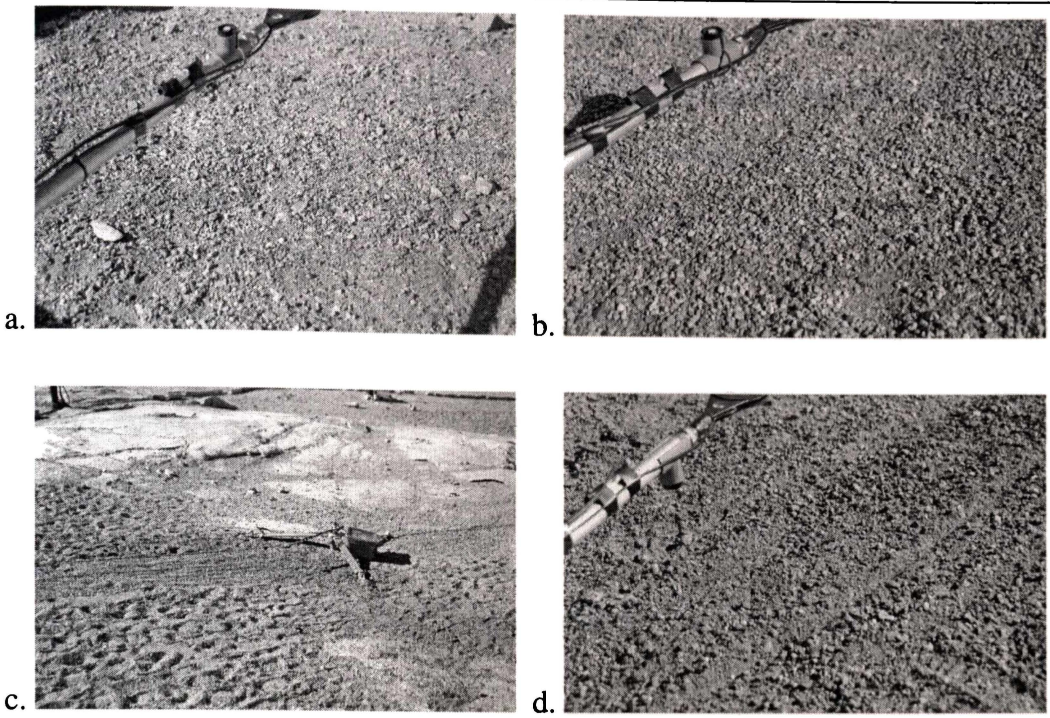


Figure 6.3 Soil surfaces over which albedo was measured at Bull Pass: (a) hydrocarbon contaminated, (b) control, and (c, d) moist appearing sites.

6.4 Methods

A single LI200X Pyranometer (Campbell Scientific, Inc.) was installed inside a PVC joint and clipped to the end of a 1-meter aluminium pole that was attached to a surveying tripod (Figure 6.4).

Figure 6.4 The author taking an albedo measurement over a hydrocarbon-contaminated surface at Marble Point.

To detect reflected short-wave solar radiation ($K\uparrow$) the tripod was extended 25 cm above the soil surface and the pyranometer positioned parallel to the surface using a plumb line (Figure 6.4). Measurements were recorded at one-minute intervals using a Campbell Scientific CR10x datalogger. The pyranometer was then rotated 180^{o} and the above procedure repeated to detect incoming ($K\downarrow$) short-wave solar radiation. Measurements on hydrocarbon-contaminated and adjacent control sites were made within five minutes of each other (Appendix Fourteen). All measurements were made under clear sky, high sun elevation conditions, as noted by Gowand (1987).

Albedo (α) was determined as the ratio of reflected ($K\uparrow$) to incoming ($K\downarrow$) short-wave solar radiation (kW m^{-2} mV^{-1}) (Oke, 1987).

$$(\alpha) = \frac{K\uparrow}{K\downarrow}$$

Gravimetric soil moisture contents were also determined for the surface 0-1cm at each site.

6.5 Results

Compared to control soils, albedos were consistently lower over both Scott Base and Marble Point surfaces that remained darkened by hydrocarbon contamination (Table 6.2). At Bull Pass, where the soil surface was no longer darkened by hydrocarbons (Figure 6.3 a, b) no difference in albedo between the hydrocarbon-contaminated and the control surface was observed (Table 6.2).

Lower albedos were also recorded at both Scott Base and Bull Pass in sites where soil surface moisture contents appeared elevated, compared to controls (Table 6.2).

Table 6.2 Soil surface albedo and gravimetric soil moisture content (%) for hydrocarbon contaminated and control surfaces.

Site	*Surface albedo (%)*	*Soil Moisture (%) (0-1 cm)*
Scott Base		
Contaminated	5	1.0
Control	10	1.0
Water saturated	7	15.8
Marble Point		
Contaminated	10	1.0
Control	17	0.8
Bull Pass		
Contaminated	20	0.1
Control	21	0.1
Moist appearing	15	0.3

6.6 Discussion

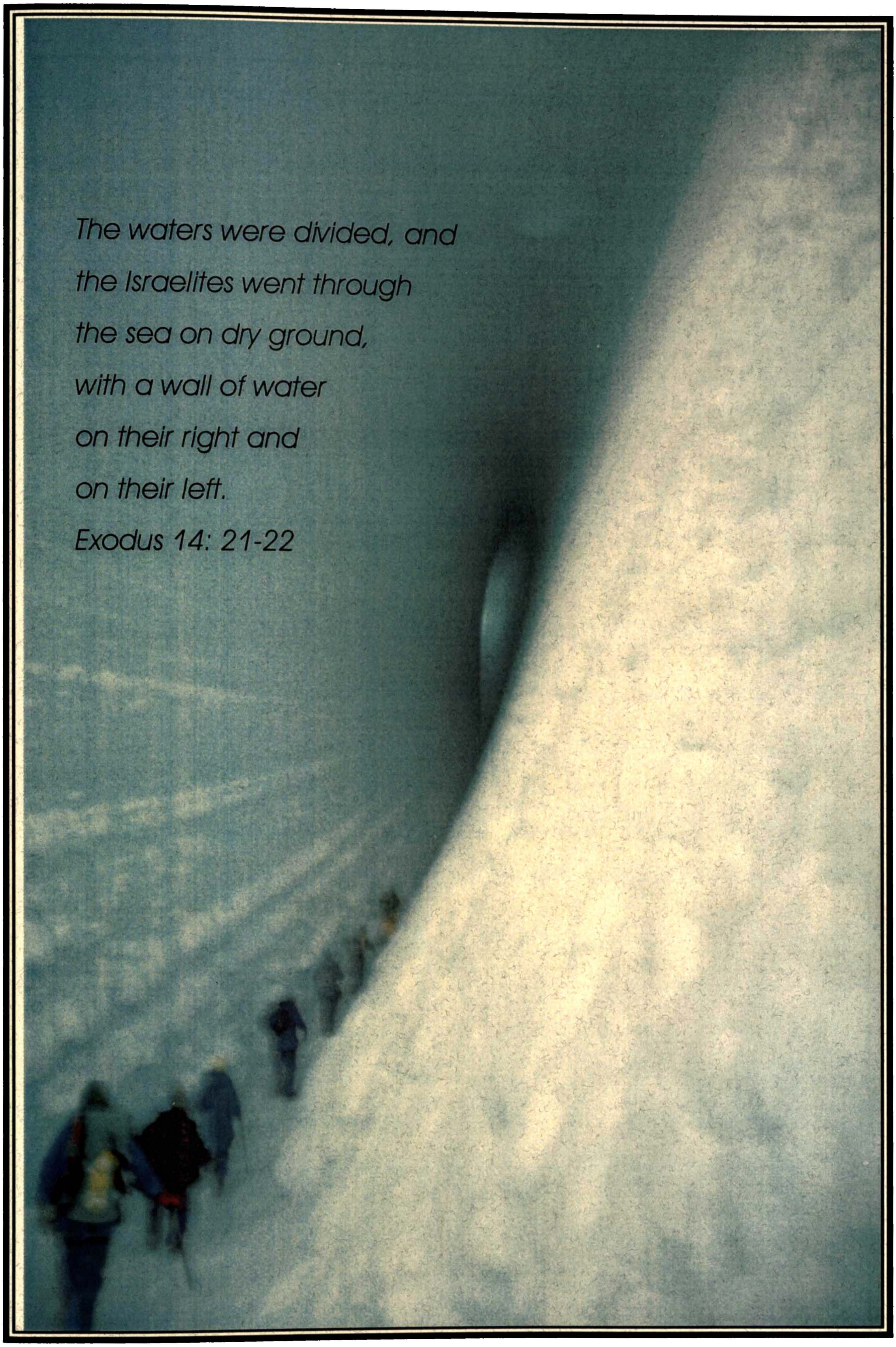
The difference in albedo between hydrocarbon-contaminated and control surfaces are likely to be directly related to soil colour. Because the contaminated soil surface at the Bull Pass site had been removed (Table 6.1), leaving a surface with no darkening or other evidence of hydrocarbon contamination (Figure 6.3 a, b), it was expected that the albedos of control and hydrocarbon-contaminated surfaces would be similar, which was the case (Table 6.2). This corresponds to the similar soil surface temperatures observed in control and hydrocarbon-contaminated sites at Bull pass by Balks *et al.* (2000).

The lower soil albedos recorded at the water saturated Scott Base site, and moist appearing Bull Pass site, compared to controls (Table 6.2) could be associated with the darker soil surface colour (Figures 6.1 c, d, 6.3 b, c, d), or thermal properties of the moist soil surface. Lower albedos have previously been recorded over a wet soil surface. Richard and Cellier (1998) for example observed lower albedos on a bare agricultural soil, during rainy periods when the soil surface was wet, compared to dry periods.

While a number of factors affect albedo, such as the astronomical, geographic and atmospheric settings (Robinson, 1966), it is unlikely that these contributed to the observed differences between albedos at the three control sites (Table 6.2), since measurements were made under fairly constant clear sky, high sun elevation conditions. Variations are however, more likely to be the result of differences in particle size, surface roughness or mineral composition of the soil surface (Table 6.1).

6.7 Conclusion

Albedo is lower where a soil surface remains darkened by hydrocarbon contamination, or has an elevated soil moisture content compared to controls. The soil surface colour of hydrocarbon contaminated sites, and thermal properties of the moist soil surface are likely mechanisms responsible for these observations.


The waters were divided, and
the Israelites went through
the sea on dry ground,
with a wall of water
on their right and
on their left.
Exodus 14: 21-22

Chapter Seven

Thesis Conclusions

7.1 Conclusions

- The volatilisation of JP-8 fuel in preliminary laboratory experiments at application rates of 2.5, 7.6, 12.7, and 20.4 litres per m^2 showed that a greater percentage of the total fuel lost to volatilisation occurred where application rates were the lowest.

- The volatilisation of the lightweight fuel JP-5, as recorded by soil core weight loss, and calculated from THP, after being spilled onto bare Antarctic soil at an application rate of 6.9 litres per m^2, was about 9% after 18 hours, 26% after one week, and 35% after six weeks, compared to 50% after one week, and 60% after six weeks for respective techniques, under sunny summer conditions.

- Fuel penetrated into the dry, bare Antarctic soil to a mean maximum depth of 15 cm after ten days, and 17 cm after one year, following the application of JP-5 fuel using a non-saturated flow technique, at 6.9 litres per m^2, under sunny summer conditions.

- The total petroleum hydrocarbon content of the soil decreased in the 0-2.5 cm depth range from 46 000 mg/kg after 2 hours to 9 000 mg/kg after six weeks, and from 45 000 mg/kg after 2 hours to 1 000 mg/kg after six weeks in the 2.5 cm to the mean maximum depth of fuel penetration depth range (15 cm), following the application of JP-5 fuel at a rate of 6.9 litres per m^2 onto bare Antarctic soil, under sunny summer conditions.

- No differences were observed in the mean temperature between JP-5 treated and control soil at depths of 2 cm, 5 cm, and 20 cm, after the application of JP-5 fuel at a rate of 6.9 litres per m^2 under sunny summer conditions.

- The application of JP-5 fuel at a rate of 6.9 litres per m^2 caused no immediate deference in the mean numbers of culturable heterotrophic bacteria and hydrocarbon-degrading microbes between JP-5 treated and control soil under sunny summer conditions. The application of JP-5 fuel is therefore considered to have been non-toxic to culturable heterotrophic bacteria and hydrocarbon-degrading microbes.

- No differences in the mean numbers of culturable heterotrophic bacteria and hydrocarbon-degrading microbes were observed between JP-5 treated and control soil after a six week period, following the application of JP-5 fuel at a rate of 6.9 litres per m^2, under sunny summer conditions.

- The albedo of hydrocarbon contaminated Antarctic soil surfaces which remain darkened by hydraulic and lubricating fuels up to 40 years after spillage, are lower when compared to nearby control surfaces, under high sun, clear sky conditions.

- The albedo of Antarctic soil surfaces which have elevated soil moisture contents are lower when compared to nearby control surfaces, under high sun, clear sky conditions.

7.2 Future research

Given that the above results were obtained specific to a set number of variables, which directly influenced the fate and effects of fuel, future research could therefore focus around modifying some of these. Possible relationships could include quantifying:

- The significance of other potential fate pathways such as oxidation and aqueous phase movement.

- The effect of application volume, rate (saturated flow) or fuel type on the fate (volatilisation and subsurface redistribution) of fuel.

- The effect of application volume, rate (saturated flow) or fuel type (additives) on soil microbial toxicity.

They all march in line, not swerving from their course.
They do not jostle each other;
each marches straight
ahead.
Joel 2:7-8

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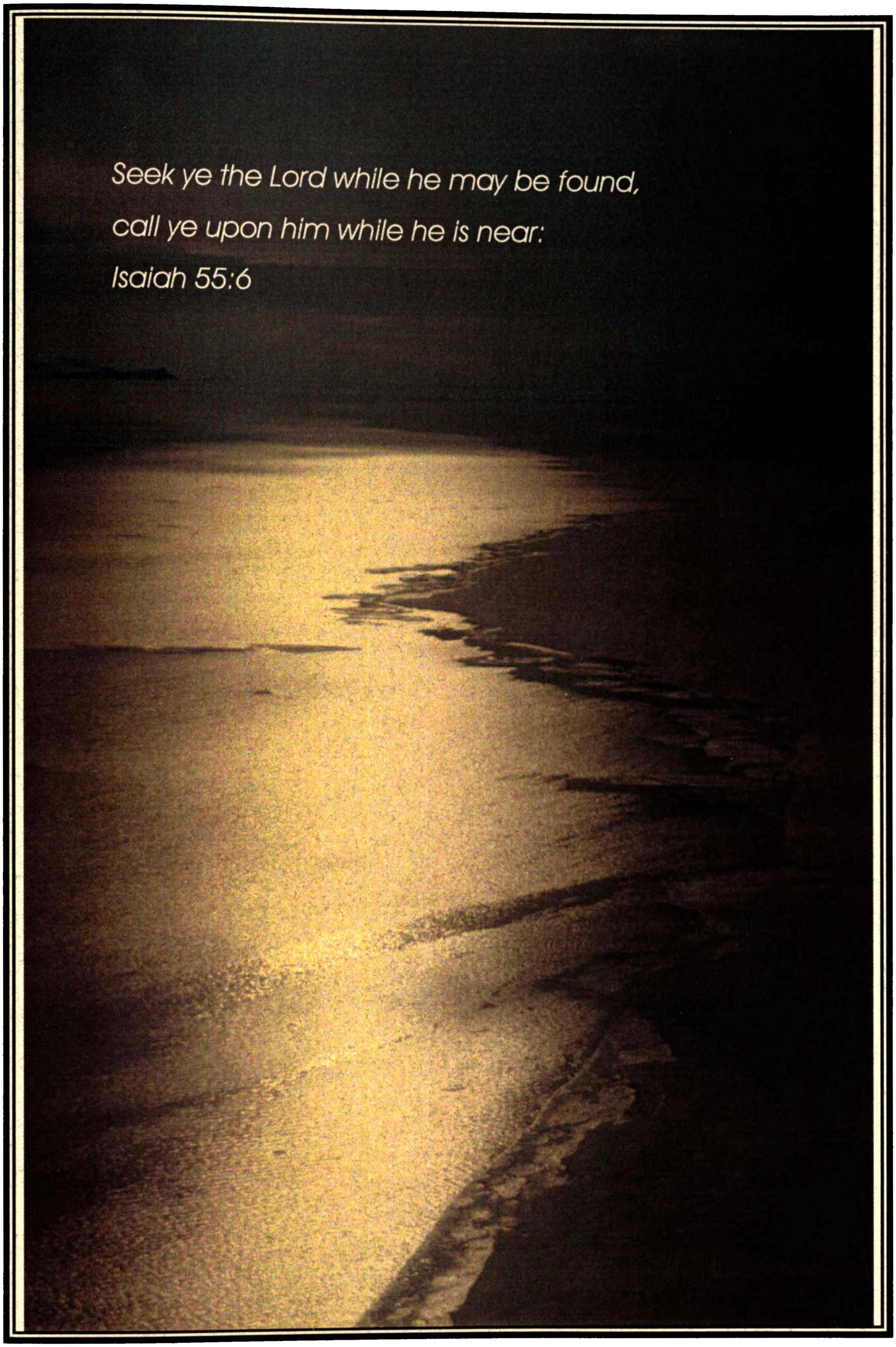
Seek ye the Lord while he may be found,
call ye upon him while he is near:
Isaiah 55:6

Appendix One

Preliminary Laboratory Experiment Two: Soil core weight loss (g, %) after fuel application

	Fuel application technique					
	Pour		*Drip e*		*Drip s*	
Weight fuel applied (g)	***20.2***		***20.35***		***19.8***	
Time (days)	***Weight lost (g)***	***Weight lost (%)***	***Weight lost (g)***	***Weight lost (%)***	***Weight lost (g)***	***Weight lost (%)***
0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.04	0.60	2.97	0.70	3.44	0.05	0.25
0.10	0.85	4.21	0.95	4.67	0.30	1.52
0.16	1.15	5.69	1.20	5.90	0.50	2.53
0.26	1.55	7.67	1.60	7.86	0.95	4.80
0.33	1.70	8.42	1.70	8.35	1.05	5.30
0.49	1.70	8.42	1.75	8.60	1.05	5.30
1.00	1.85	9.16	1.95	9.58	1.25	6.31
2.57	3.35	16.58	3.20	15.72	2.60	13.13
3.00	3.40	16.83	3.25	15.97	2.60	13.13
3.99	4.00	19.80	3.85	18.92	3.25	16.41
5.02	4.75	23.51	4.45	21.87	3.90	19.70
6.01	5.55	27.48	5.25	25.80	4.70	23.74
6.98	5.90	29.21	5.50	27.03	5.00	25.25
8.00	6.45	31.93	6.10	29.98	5.60	28.28
9.15	6.70	33.17	6.30	30.96	5.85	29.55
10.00	6.95	34.41	6.50	31.94	6.00	30.30
11.12	7.60	37.62	7.15	35.14	6.65	33.59
12.17	8.25	40.84	7.90	38.82	7.45	37.63

Appendix Two

Preliminary Laboratory Experiment Three: Soil core weight loss (g, Total %) after fuel and water application

	Weight							Time (days)								Total %
Control	*(g) added*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*12*	*13*	*14*	*15*	*16*	*17*	*weight loss*
Core 1		0.00	0.05	0.15	0.55	0.3	0.35	0.45	0.2	0.15	0.2	0.25	0.35	0.7	0.55	0.9	
Core 2		0.00	0	0.45	0.65	0.45	0.25	0.5	0.35	0.3	0.4	0.5	0.45	0.8	0.65	1	
Core 3		0.00	0.3	0.5	1.00	0.40	0.55	0.65	0.6	0.5	0.6	0.65	0.65	1.05	0.95	1.25	
Mean		0.00	0.12	0.37	0.73	0.38	0.38	0.53	0.38	0.32	0.40	0.47	0.48	0.85	0.72	1.05	
s.d.		0.00	0.16	0.19	0.24	0.08	0.15	0.10	0.20	0.18	0.20	0.20	0.15	0.18	0.21	0.18	
5 mL fuel																	
Core 1	4.25	0.45	1.05	1.40	1.75	1.75	1.85	2.00	1.95	2.05	2.30	2.45	2.65	3.00	2.85	3.10	
Core 2	4.25	0.50	1.00	1.50	1.80	1.70	1.75	2.05	1.95	2.05	2.30	2.45	2.65	2.95	2.95	3.10	
Mean	4.25	0.47	1.02	1.45	1.77	1.73	1.80	2.02	1.95	2.05	2.30	2.45	2.65	2.98	2.90	3.10	
Corrected	4.25	0.47	0.91	1.08	1.04	1.34	1.42	1.49	1.57	1.73	1.90	1.98	2.17	2.13	2.18	2.05	48.24
s.d.	0.00	0.04	0.04	0.07	0.04	0.04	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.00	
15 mL fuel																	
Core 1	12.20	0.35	0.85	1.30	1.85	1.70	1.85	2.30	2.30	2.40	2.70	3.15	3.15	3.70	3.65	4.15	
Core 2	12.05	0.35	1.00	1.40	2.00	2.10	2.15	2.55	2.55	2.70	3.10	3.25	3.40	3.85	3.85	4.35	
Core 3	12.15	0.15	0.65	1.10	1.55	1.50	1.60	1.95	1.95	2.10	2.55	2.75	2.75	3.30	3.25	3.60	
Mean	12.13	0.28	0.83	1.27	1.80	1.77	1.87	2.27	2.27	2.40	2.78	3.05	3.10	3.62	3.58	4.03	
Corrected	12.13	0.28	0.72	0.90	1.07	1.38	1.48	1.73	1.88	2.08	2.38	2.58	2.62	2.77	2.87	2.98	24.59
s.d.	0.05	0.12	0.18	0.15	0.23	0.31	0.28	0.30	0.30	0.30	0.28	0.26	0.33	0.28	0.31	0.39	
25 mL fuel																	
Core 1	20.20	0.35	0.80	1.25	1.95	1.95	2.10	2.40	2.40	2.65	3.05	3.35	3.45	4.05	4.05	4.65	
Core 2	20.05	0.20	0.75	1.10	1.70	1.75	1.90	2.10	2.10	2.35	2.80	3.10	3.25	3.70	3.75	4.40	
Core 3	20.05	0.10	0.70	1.25	1.80	1.70	1.80	2.35	2.25	2.45	2.90	3.20	3.25	3.70	3.75	4.20	
Mean	20.10	0.22	0.75	1.20	1.82	1.80	1.93	2.28	2.25	2.48	2.92	3.22	3.32	3.82	3.85	4.42	
Corrected	20.10	0.22	0.63	0.83	1.08	1.42	1.55	1.75	1.87	2.17	2.52	2.75	2.83	2.97	3.13	3.37	16.75
s.d.	0.09	0.13	0.05	0.09	0.13	0.13	0.15	0.16	0.15	0.15	0.13	0.13	0.12	0.20	0.17	0.23	
40 mL fuel																	
Core 1	31.95	0.00	0.60	1.20	1.75	1.65	1.75	2.30	2.25	2.45	2.95	3.20	3.30	3.85	4.05	4.50	
Core 2	32.05	0.15	0.8	1.45	2.05	1.7	2.10	2.35	2.45	2.65	3.1	3.45	3.6	4.15	4.3	4.55	
Core 3	32.10	0.08	0.70	1.33	1.90	1.68	1.93	2.33	2.35	2.55	3.03	3.33	3.45	4.00	4.18	4.53	
Mean	32.03	0.1	0.45	1	1.55	1.45	1.75	1.8	2	2.1	2.55	2.85	3	3.55	3.45	4.15	
Corrected	32.03	0.10	0.33	0.63	0.82	1.07	1.37	1.27	1.62	1.78	2.15	2.38	2.52	2.70	2.73	3.10	9.68
s.d.		0.08	0.10	0.13	0.15	0.02	0.18	0.03	0.10	0.10	0.08	0.13	0.15	0.15	0.13	0.03	

5 mL water																	
Core 1	5.10	2.25	3.25	3.80	4.35	4.10	4.35	4.50	4.40	4.45	4.60	4.75	4.80	5.15	5.05	5.45	
Core 2	5.20	2.10	3.05	3.75	4.20	3.95	4.15	4.40	4.25	4.40	4.50	4.60	4.70	5.15	5.00	5.35	
Mean	5.15	2.17	3.15	3.77	4.27	4.02	4.25	4.45	4.32	4.42	4.55	4.67	4.75	5.15	5.02	5.40	
Corrected	5.15	2.17	3.03	3.41	3.54	3.64	3.87	3.92	3.94	4.11	4.15	4.21	4.27	4.30	4.31	4.35	84.47
s.d.	0.07	0.11	0.14	0.04	0.11	0.11	0.14	0.07	0.11	0.04	0.07	0.11	0.07	0.00	0.04	0.07	
15 mL water																	
Core 1	15.00	2.50	5.05	6.50	7.60	7.85	8.10	8.40	8.40	8.65	9.05	9.40	9.55	9.95	10.05	10.55	
Core 2	14.95	2.50	5.45	8.15	9.40	9.65	9.95	10.35	10.45	10.55	11.05	11.30	11.40	12.00	11.95	12.40	
Mean	14.97	2.50	5.25	7.32	8.50	8.75	9.02	9.37	9.42	9.60	10.05	10.35	10.47	10.98	11.00	11.47	
Corrected	14.97	2.38	4.88	6.59	8.12	8.37	8.49	8.99	9.11	9.20	9.58	9.87	9.62	10.26	9.95	11.47	76.63
s.d.	0.04	0.00	0.28	1.17	1.27	1.27	1.31	1.38	1.45	1.34	1.41	1.34	1.31	1.45	1.34	1.31	
25 mL water																	
Core 1	24.80	2.60	5.00	7.00	9.00	10.45	11.20	12.00	12.40	12.80	13.55	13.95	14.30	14.90	15.00	15.50	
Core 2	25.25	3.15	5.40	7.25	9.25	10.25	11.40	12.35	12.80	13.45	14.25	14.65	14.90	15.50	15.50	16.10	
Mean	25.03	2.87	5.20	7.13	9.13	10.35	11.30	12.18	12.60	13.13	13.90	14.30	14.60	15.20	15.25	15.80	
Corrected	25.03	2.76	4.83	6.39	8.74	9.97	10.77	11.79	12.28	12.73	13.43	13.82	13.75	14.48	14.20	15.80	63.14
s.d.	0.32	0.39	0.28	0.18	0.18	0.14	0.14	0.25	0.28	0.46	0.49	0.49	0.42	0.42	0.35	0.42	

Appendix Three

Preliminary Laboratory Experiment Three: Fuel and water weight loss from beakers at 0°C and 20°C

Fuel (0° C)	Weight (g) added	Time (days)														
		1	2	3	4	5	6	7	8	9	12	13	14	15	16	17
Beaker 1	78.60	3.25	6.80	9.60	11.30	13.10	14.60	15.70	17.00	18.35	21.35	22.55	23.45	24.80	25.65	26.35
Beaker 2	79.25	5.40	8.40	10.80	12.70	14.25	15.65	16.85	18.40	19.60	22.80	24.05	25.15	26.25	27.35	28.00
Beaker 3	75.10	2.75	5.65	8.05	10.30	11.85	13.25	14.45	15.75	17.30	20.85	21.95	23.00	24.10	24.95	25.65
Mean	77.65	3.80	6.95	9.48	11.43	13.07	14.50	15.67	17.05	18.42	21.67	22.85	23.87	25.05	25.98	26.67
s.d.	2.23	1.41	1.38	1.38	1.21	1.20	1.20	1.20	1.33	1.15	1.01	1.08	1.13	1.10	1.23	1.21
Water (0° C)																
Beaker 1	93.55	5.20	12.80	16.70	22.15	26.55	30.00	33.40	37.35	44.50	52.00	54.85	58.45	62.35	66.15	68.80
Beaker 2	87.90	4.60	10.60	13.80	18.00	22.40	26.70	30.30	34.05	38.35	46.70	50.65	53.95	57.30	60.10	62.65
Beaker 3	87.85	4.50	9.60	14.85	19.25	23.40	26.60	29.55	34.30	39.65	47.25	50.35	54.55	58.00	61.05	64.50
Mean	89.77	4.77	11.00	15.12	19.80	24.12	27.77	31.08	35.23	40.83	48.65	51.95	55.65	59.22	62.43	65.32
s.d.	3.28	0.38	1.64	1.47	2.13	2.17	1.93	2.04	1.84	3.24	2.91	2.52	2.44	2.74	3.25	3.16
Fuel (20° C)																
Beaker 1	76.60	3.10	6.75	9.80	12.60	14.50	16.00	17.40	18.90	20.10	22.85	23.95	24.85	25.90	26.90	27.65
Beaker 2	75.75	3.05	7.00	10.05	13.30	15.40	17.40	19.05	20.55	21.70	24.65	25.80	26.85	28.00	29.05	30.00
Beaker 3	76.85	3.80	6.90	10.00	12.70	14.35	16.10	17.85	19.30	20.70	23.40	24.55	25.55	26.75	27.75	28.55
Mean	76.40	3.32	6.88	9.95	12.87	14.75	16.50	18.10	19.58	20.83	23.63	24.77	25.75	26.88	27.90	28.73
s.d.	0.58	0.42	0.13	0.13	0.38	0.57	0.78	0.85	0.86	0.81	0.92	0.94	1.01	1.06	1.08	1.19
Water (20° C)																
Beaker 1	101.45	6.95	14.85	22.55	30.40	39.00	46.35	52.35	58.65	64.25	74.25	77.85	82.60	87.40	91.75	95.40
Beaker 2	91.15	6.05	14.50	21.95	29.85	36.10	42.65	48.25	55.05	60.75	72.65	76.50	82.10	87.70	91.15	91.15
Beaker 3	97.60	6.60	16.25	23.80	32.70	39.95	46.10	52.40	59.55	64.85	75.65	79.35	84.65	90.00	94.25	97.55
Mean	96.73	6.53	15.20	22.77	30.98	38.35	45.03	51.00	57.75	63.28	74.18	77.90	83.12	88.37	92.38	94.70
s.d.	5.20	0.45	0.93	0.94	1.51	2.01	2.07	2.38	2.38	2.21	1.50	1.43	1.35	1.42	1.64	3.26

Appendix Four

Samples taken and soil moisture contents

Core #	OST #	Sample*	Sample Depth (cm)	Weight tin (g)	Weight tin + soil (g)	Oven dry weight tin + soil (g)	Gravimetric mositure content (%)
				Soil Moisture			
*(Wrl = Micro WHIRL-PAK® bag , TPH = TPH tin, Geo = Geochemical, SM = Soil Moisture)							
Note that the moisture content includes fuel content at JP-5 contaminated sample depths							
Sampling day 0.1 - 13/12/00 - JP-5 treated							
43	1	Wrl,TPH,Geo,SM	0-2.5	1.76	14.39	13.57	6.50
	2	Wrl,TPH,Geo,SM	2.5-9	1.76	13.35	12.53	7.09
	2a	Geo	9-10				
	3	Wrl,TPH,Geo,SM	> 10	1.78	12.05	11.79	2.51
101	4	Wrl,TPH,Geo,SM	0-2.5	1.79	16.30	15.48	5.67
	5	Wrl,TPH,Geo,SM	2.5-9	1.74	16.51	15.60	6.18
	6	Wrl,TPH,Geo,SM	9-10	1.74	16.56	16.07	3.31
	Base	SM	> 10	1.75	24.44	23.44	4.42
100	7	Wrl,TPH,Geo,SM	0-2.5	1.75	12.11	11.47	6.23
	8	Wrl,TPH,Geo,SM	2.5-9	1.77	16.04	15.17	6.09
	9	Wrl,TPH,Geo,SM	9-10	1.75	11.82	11.60	2.15
	Base	SM	> 10	1.76	20.84	20.26	3.04
Sampling day 0.1 - 13/12/00 - Control							
5	10	Wrl,TPH,Geo,SM	0-2.5	1.76	11.18	11.02	1.72
	11	Wrl,TPH,Geo,SM	2.5-10	1.76	11.04	10.79	2.70
	12	Wrl,TPH,Geo,SM	10-20	1.76	11.22	10.95	2.84
	13	Wrl,TPH,Geo,SM	20-30	1.74	9.13	8.91	3.00
27	14	Wrl,TPH,Geo,SM	0-2.5	1.77	14.67	14.43	1.81
	15	Wrl,TPH,Geo,SM	2.5-10	1.78	10.61	10.38	2.57
	16	Wrl,TPH,Geo,SM	10-20	1.76	13.34	13.05	2.51
	17	Wrl,TPH,Geo,SM	20-30	1.75	19.86	19.36	2.78
41	18	Wrl,TPH,Geo,SM	0-2.5	1.76	14.85	14.66	1.45
	19	Wrl,TPH,Geo,SM	2.5-10	1.77	16.42	16.12	2.06
	20	Wrl,TPH,Geo,SM	10-20	1.74	16.45	16.12	2.23
	21	Wrl,TPH,Geo,SM	20-30	1.78	15.92	15.55	2.67
	Base	SM		1.77	28.93	28.19	2.71
Sampling day 1 - 14/12/00 - JP-5 treated							
102	22	Wrl,TPH,SM	0-2.5	1.76	19.43	18.73	3.98
	23	Wrl,TPH,SM	2.5-10	1.72	19.99	19.19	4.35
	24	Wrl,TPH,SM	10-30	1.72	17.94	17.54	2.50
	Base	SM		1.72	18.78	18.28	3.07
103	25	Wrl,TPH,SM	0-2.5	1.71	24.22	23.17	4.86
	26	Wrl,TPH,SM	2.5-10	1.77	26.95	25.78	4.88
	27	Wrl,TPH,SM	10-20	1.73	20.27	19.81	2.53
	28	Wrl,TPH,SM	20-30	1.72	19.81	19.41	2.23
	Base	SM		1.74	16.65	16.11	3.76
104	29	Wrl,TPH,SM	0-2.5	1.73	21.45	20.66	4.02
	30	Wrl,TPH,SM	2.5-10	1.76	25.71	24.59	4.69
	31	Wrl,TPH,SM	10-20	1.75	18.72	18.28	2.58
	32	Wrl,TPH,SM	20-30	1.75	20.94	20.44	2.64
	Base	SM		1.72	18.47	17.80	4.03

Sampling day 3 - 16/12/00 - JP-5 treated							
105	33	Wrl,TPH,SM	0-2.5	1.74	20.92	20.30	3.24
	34	Wrl,TPH,SM	2.5-12.5	1.76	24.48	23.41	4.69
	35	Wrl,TPH,SM	12.5-20	1.75	20.04	19.63	2.20
	36	Wrl,TPH,SM	20-30	1.75	20.10	19.67	2.32
		SM	Base	1.79	17.11	16.65	2.98
82	37	Wrl,TPH,SM	0-2.5	1.81	27.00	26.07	3.70
	38	Wrl,TPH,SM	2.5-13	1.69	27.64	26.44	4.65
	39	Wrl,TPH,SM	13-20	1.74	29.33	28.70	2.30
	40	Wrl,TPH,SM	20-30	1.71	25.18	24.59	2.48
		SM	Base	1.74	20.93	20.05	4.57
84	41	Wrl,TPH,SM	0-2.5	1.72	23.50	22.53	4.45
	41	Wrl,TPH,SM	2.5-12	1.74	20.99	20.22	4.03
	43	Wrl,TPH,SM	12-20	1.74	20.72	20.16	3.00
	44	Wrl,TPH,SM	20-30	1.75	25.44	24.68	3.19
		SM	Base	1.76	22.86	21.68	5.62
Sampling day 7 - 20/12/00 - Control							
13	45	Wrl,TPH,Geo,SM	0-2.5	1.76	16.23	16.03	1.35
	46	Wrl,TPH,Geo,SM	2.5-10	1.76	12.58	12.24	3.12
	47	Wrl,TPH,Geo,SM	10-20	1.75	13.21	12.87	2.99
	48	Wrl,TPH,Geo,SM	20-30	1.76	24.54	23.97	2.52
		SM	Base	1.77	12.32	11.83	4.68
26	49	Wrl,TPH,Geo,SM	0-2.5	1.74	13.20	12.94	2.25
	50	Wrl,TPH,Geo,SM	2.5-10	1.73	11.98	11.51	4.55
	51	Wrl,TPH,Geo,SM	10-20	1.80	13.52	13.12	3.39
	52	Wrl,TPH,Geo,SM	20-30	1.73	23.49	22.96	2.45
		SM	Base	1.72	12.37	11.99	3.59
40	53	Wrl,TPH,Geo,SM	0-2.5	1.73	12.15	11.94	2.01
	54	Wrl,TPH,Geo,SM	2.5-10	1.77	18.90	18.47	2.53
	55	Wrl,TPH,Geo,SM	10-20	1.76	20.06	19.56	2.75
	56	Wrl,TPH,Geo,SM	20-30	1.75	20.68	20.12	2.94
		SM	Base	1.77	13.77	13.19	4.84
Sampling day 7 - 20/12/00 - JP-5 treated							
59	60	Wrl,TPH,Geo,SM	0-2.5	1.67	16.56	16.05	3.39
	61	Wrl,TPH,Geo,SM	2.5-12	1.76	15.27	14.67	4.44
	61a	TPH,Geo,SM	12-14	1.71	11.21	10.76	4.78
	62	Wrl,TPH,Geo,SM	14-20	1.75	14.67	14.16	3.90
	63	Wrl,TPH,Geo,SM	20-30	1.71	16.97	16.50	3.08
		SM	Base	1.76	16.26	15.56	4.83

87	64	Wrl,TPH,Geo,SM	0-2.5	1.83	16.74	16.14	3.99
	65	Wrl,TPH,Geo,SM	2.5-12	1.76	13.82	13.28	4.54
	65a	TPH,Geo,SM	12-14	1.80	9.82	9.47	4.36
	66	Wrl,TPH,Geo,SM	14-20	1.80	13.25	12.96	2.49
	67	Wrl,TPH,Geo,SM	20-30	1.81	19.14	18.67	2.73
		SM	Base	1.77	14.33	13.84	3.83
Sampling day 10 - 23/12/00 - JP-5 treated							
44	68	Wrl,TPH,SM	0-2.5	1.74	13.51	13.09	3.57
	69	Wrl,TPH,SM	2.5-13	1.78	16.44	15.78	4.51
	69a	TPH,SM	13 -16	1.78	9.50	9.14	4.69
	70	Wrl,TPH,SM	16-20	1.68	12.98	12.68	2.68
	71	Wrl,TPH,SM	20-30	1.74	11.68	11.42	2.63
		SM	Base	1.72	14.44	13.66	6.18
83	72	Wrl,TPH,SM	0-2.5	1.74	16.15	15.56	4.08
	73	Wrl,TPH,SM	2.5-13	1.74	20.87	20.17	3.70
	73a	TPH,SM	13 -16	1.71	13.11	12.61	4.43
	74	Wrl,TPH,SM	16-20	1.73	17.78	17.23	3.40
	75	Wrl,TPH,SM	20-30	1.74	15.20	14.69	3.82
		SM	Base	1.75	13.38	12.85	4.53
57	80	Wrl,TPH, SM	0-2.5	1.69	15.05	14.45	4.50
	81	Wrl,TPH, SM	2.5-12	1.69	16.84	16.17	4.42
	81a	TPH, SM	12-15	1.71	12.21	11.76	4.31
	82	Wrl,TPH, SM	15-20	1.73	13.75	13.34	3.45
	83	Wrl,TPH, SM	20-30	1.70	13.93	13.42	4.19
		SM	Base	1.75	13.01	12.10	8.05
Sampling day 14 - 27/12/00 - Control							
12	84	Wrl,TPH, D, SM	0-2.5	1.71	16.52	16.20	2.18
	85	Wrl,TPH, D, SM	2.5-10	1.77	17.54	16.89	4.09
	86	Wrl,TPH, D, SM	10-20	1.75	16.23	15.64	4.09
	87	Wrl,TPH, D, SM	20-30	1.75	14.83	14.28	4.20
		SM	Base	1.76	18.25	17.26	5.99
23	88	Wrl,TPH, D, SM	0-2.5	1.71	19.68	19.36	1.78
	89	Wrl,TPH, D, SM	2.5-10	1.79	15.86	15.38	3.38
	90	Wrl,TPH, D, SM	10-20	1.75	16.33	15.87	3.14
	91	Wrl,TPH, D, SM	20-30	1.79	18.03	17.49	3.36
		SM	Base	1.75	14.22	13.48	5.89
37	92	Wrl,TPH, D, SM	0-2.5	1.78	18.79	18.41	2.22
	93	Wrl,TPH, D, SM	2.5-10	1.76	16.22	15.76	3.15
	94	Wrl,TPH, D, SM	10-20	1.75	17.35	16.79	3.59
	95	Wrl,TPH, D, SM	20-30	1.74	18.00	17.36	3.96
		SM	Base	1.72	14.01	13.40	4.99
Sampling day 14 - 27/12/00 - JP-5 treated							
45	96	Wrl,TPH, D, SM	0-2.5	1.76	13.51	13.08	3.64
	97	Wrl,TPH, D, SM	2.5-12	1.73	16.88	16.29	3.91
	97a	TPH,D,SM	12-14	1.73	13.58	13.20	3.15
	98	Wrl,TPH, D, SM	14-20	1.76	13.65	13.20	3.79
	99	Wrl,TPH, D, SM	20-30	1.77	19.23	18.67	3.24
		SM	Base	1.75	14.16	13.40	6.11

80	100	Wrl,TPH, D, SM	0-2.5	1.76	15.54	15.07	3.40
	101	Wrl,TPH, D, SM	2.5-11	1.76	13.84	13.32	4.31
	101a	TPH,D,SM	11-13	1.76	9.06	8.79	3.79
	102	Wrl,TPH, D, SM	13-20	1.72	12.26	11.89	3.49
	103	Wrl,TPH, D, SM	20-30	1.72	13.34	12.93	3.55
		SM	Base	1.78	16.05	15.41	4.52
90	107	Wrl,TPH, D, SM	0-2.5	1.80	13.30	12.85	3.91
	108	Wrl,TPH, D, SM	2.5-13	1.76	13.38	12.84	4.62
	108a	TPH,D,SM	13-15	1.76	14.07	13.68	3.19
	109	Wrl,TPH, D, SM	15-20	1.76	15.98	15.57	2.89
	110	Wrl,TPH, D, SM	20-30	1.76	13.68	13.33	2.95
		SM	Base	1.71	12.76	12.23	4.84
Sampling day 21 - 3/1/01 - Control							
9	111	Wrl,TPH,SM	0-2.5	1.76	11.02	10.77	2.67
	112	Wrl,TPH,SM	2.5-10	1.75	14.39	14.02	2.90
	113	Wrl,TPH,SM	10-20	1.71	17.87	17.39	3.00
	114	Wrl,TPH,SM	20-30	1.71	15.60	15.16	3.15
		SM	Base	1.72	14.54	14.09	3.49
21	115	Wrl,TPH,SM	0-2.5	1.69	13.62	13.29	2.75
	116	Wrl,TPH,SM	2.5-10	1.76	17.17	16.73	2.82
	117	Wrl,TPH,SM	10-20	1.68	17.42	16.92	3.18
	118	Wrl,TPH,SM	20-30	1.71	17.43	16.94	3.15
		SM	Base	1.77	13.53	12.92	5.19
39	119	Wrl,TPH,SM	0-2.5	1.71	18.56	17.93	3.74
	120	Wrl,TPH,SM	2.5-10	1.74	16.75	16.29	3.11
	121	Wrl,TPH,SM	10-20	1.72	16.02	15.41	4.24
	122	Wrl,TPH,SM	20-30	1.77	17.52	17.00	3.34
		SM	Base	1.75	16.28	15.68	4.16
Sampling day 21 - 3/1/01 - JP-5 treated							
46	123	Wrl,TPH,SM	0-2.5	1.76	12.59	12.27	2.97
	124	Wrl,TPH,SM	2.5-13	1.75	16.67	16.01	4.44
	124a	TPH,SM	13-15	1.75	16.40	15.79	4.17
	125	Wrl,TPH,SM	15-20	1.77	16.64	16.12	3.49
	126	Wrl,TPH,SM	20-30	1.79	15.50	15.01	3.56
		SM	Base	1.75	16.53	15.88	4.39
60	127	Wrl,TPH,SM	0-2.5	1.72	11.94	11.56	3.73
	128	Wrl,TPH,SM	2.5-14	1.74	18.44	17.77	3.96
	128a	TPH,SM	14-16	1.80	17.73	17.15	3.60
	129	Wrl,TPH,SM	16-20	1.77	18.72	18.04	3.97
	130	Wrl,TPH,SM	20-30	1.71	16.11	15.50	4.25
		SM	Base	1.71	15.08	14.28	5.96
93	131	Wrl,TPH,SM	0-2.5	1.69	16.37	15.89	3.28
	132	Wrl,TPH,SM	2.5-14	1.70	17.26	16.55	4.62
	132a	TPH,SM	14-16	1.68	15.92	15.33	4.13
	133	Wrl,TPH,SM	16-20	1.66	14.46	14.02	3.43
	134	Wrl,TPH,SM	20-30	1.67	17.10	16.58	3.43
		SM	Base	1.65	19.49	18.64	4.73

Sampling day 28 - 10/01/01 - Control

14	135	Wrl,TPH,Geo,SM	0-2.5	1.72	13.09	12.87	1.86
	136	Wrl,TPH,Geo,SM	2.5-10	1.71	15.67	15.26	2.94
	137	Wrl,TPH,Geo,SM	10-20	1.71	15.75	15.35	2.88
	138	Wrl,TPH,Geo,SM	20-30	1.66	14.48	14.15	2.58
		SM	Base	1.76	14.21	13.76	3.58
18	139	Wrl,TPH,Geo,SM	0-2.5	1.79	12.02	11.83	1.92
	140	Wrl,TPH,Geo,SM	2.5-10	1.74	15.59	15.24	2.49
	141	Wrl,TPH,Geo,SM	10-20	1.77	14.04	13.70	2.75
	142	Wrl,TPH,Geo,SM	20-30	1.74	15.55	15.14	3.02
		SM	Base	1.75	14.14	13.57	4.63
36	143	Wrl,TPH,Geo,SM	0-2.5	1.75	12.35	12.11	2.27
	144	Wrl,TPH,Geo,SM	2.5-10	1.79	16.98	16.48	3.29
	145	Wrl,TPH,Geo,SM	10-20	1.71	17.49	16.97	3.28
	146	Wrl,TPH,Geo,SM	20-30	1.72	13.58	13.22	3.10
		SM	Base	1.73	16.90	16.40	3.26

Sampling day 28 - 10/01/01 - JP-5 treated

47	147	Wrl,TPH,Geo,SM	0-2.5	1.70	16.68	16.23	3.01
	148	Wrl,TPH,Geo,SM	2.5-13	1.72	14.75	14.19	4.34
	148a	TPH,Geo,SM	13-15	1.71	16.02	15.53	3.44
	149	Wrl,TPH,Geo,SM	15-20	1.75	15.05	14.63	3.14
	150	Wrl,TPH,Geo,SM	20-30	1.80	15.35	14.90	3.26
		SM	Base	1.69	15.78	14.99	5.61
62	151	Wrl,TPH,Geo,SM	0-2.5	1.73	13.42	13.10	2.78
	152	Wrl,TPH,Geo,SM	2.5-13	1.70	16.76	16.21	3.66
	152a	TPH,Geo,SM	13-15	1.71	14.89	14.43	3.53
	153	Wrl,TPH,Geo,SM	15-20	1.71	14.83	14.33	3.81
	154	Wrl,TPH,Geo,SM	20-30	1.64	14.37	13.76	4.76
		SM	Base	1.69	17.69	16.69	6.22
81	155	Wrl,TPH,Geo,SM	0-2.5	1.72	15.03	14.60	3.23
	156	Wrl,TPH,Geo,SM	2.5-12	1.73	14.62	14.09	4.14
	156a	TPH,Geo,SM	12-14	1.72	16.68	16.17	3.42
	157	Wrl,TPH,Geo,SM	14-20	1.74	15.53	15.15	2.80
	158	Wrl,TPH,Geo,SM	20-30	1.75	13.70	13.34	3.00
		SM	Base	1.76	13.66	13.21	3.76

Sampling day 35 - 17/01/01 - JP-5 treated

50	163	Wrl,TPH,SM	0-1	1.74	12.92	12.62	2.69
	164	Wrl,TPH,SM	1-14	1.74	16.19	15.66	3.63
	164a	TPH,SM	14-16	1.73	15.30	14.81	3.60
	165	Wrl,TPH,SM	16-20	1.76	12.78	12.46	2.91
	166	Wrl,TPH,SM	20-30	1.74	14.82	14.46	2.82
		SM	Base	1.73	14.70	14.06	4.91
96	167	Wrl,TPH,SM	0-1	1.77	13.47	13.17	2.50
		SM	1-2	1.71	17.48	16.88	3.81
	168	Wrl,TPH,SM	2-15	1.74	12.18	11.84	3.24
	168a	TPH,SM	13-15	1.72	14.26	13.81	3.55
	169	Wrl,TPH,SM	15-20	1.75	12.00	11.70	2.85
	170	Wrl,TPH,SM	20-30	1.74	13.78	13.46	2.67
		SM	Base	1.73	12.15	11.35	7.75

78	X 183	Wrl,TPH,SM	0-1	1.71	17.84	17.25	3.64
	X 184	Wrl,TPH,SM	1-13	1.76	15.60	14.97	4.54
	X 184:	TPH,SM	13-15	1.73	10.67	10.43	2.68
	X 185	Wrl,TPH,SM	15-20	1.71	13.18	12.83	3.07
	X 186	Wrl,TPH,SM	20-30	1.75	13.65	13.30	2.96
		SM	Base	1.65	20.76	19.53	6.40
Sampling day 35 - 17/01/01 - Control							
11	171	Wrl,TPH,SM	0-2.5	1.72	14.44	14.09	2.78
	172	Wrl,TPH,SM	2.5-10	1.66	13.39	13.16	2.00
	173	Wrl,TPH,SM	10-20	1.70	14.12	13.84	2.25
	174	Wrl,TPH,SM	20-30	1.73	14.54	14.23	2.40
		SM	Base	1.75	16.29	15.49	5.52
15	175	Wrl,TPH,SM	0-2.5	1.76	13.48	13.18	2.50
	176	Wrl,TPH,SM	2.5-10	1.71	16.34	16.05	1.97
	177	Wrl,TPH,SM	10-20	1.80	15.63	15.33	2.21
	178	Wrl,TPH,SM	20-30	1.77	14.92	14.60	2.46
		SM	Base	1.70	19.36	18.32	5.88
33	179	Wrl,TPH,SM	0-2.5	1.77	15.18	14.89	2.12
	180	Wrl,TPH,SM	2.5-10	1.71	12.26	12.00	2.41
	181	Wrl,TPH,SM	10-20	1.72	11.09	10.86	2.50
	182	Wrl,TPH,SM	20-30	1.77	13.22	12.90	2.76
		SM	Base	1.72	19.33	17.68	9.37
Sampling day 42 - 24/01/01 - JP-5 treated							
48	183	Wrl,TPH,Geo,SM	0-2.5	1.76	12.75	12.43	2.84
	184	Wrl,TPH,Geo,SM	2.5-12	1.70	14.28	13.73	4.41
	184a	TPH,Geo,SM	12-14	1.68	13.44	13.07	3.11
	185	Wrl,TPH,Geo,SM	14-20	1.70	14.54	14.12	3.29
	186	Wrl,TPH,Geo,SM	20-30	1.78	17.58	17.11	2.99
		Wrl,TPH,Geo,SM	Base	1.69	18.41	17.54	5.23
77	187	Wrl,TPH,D,SM	0-2.5	1.67	12.04	11.74	2.91
	188	Wrl,TPH,D,SM	2.5-14	1.68	18.71	18.14	3.35
	188a	TPH,D,SM	14-16	1.66	11.19	10.87	3.42
	189	Wrl,TPH,D,SM	16-20	1.67	14.67	14.30	2.88
	190	Wrl,TPH,D,SM	20-30	1.75	14.12	13.65	3.80
		SM	Base	1.71	10.70	10.24	5.10
95	191	Wrl,TPH,D,SM	0-2.5	1.66	14.18	13.88	2.40
	192	Wrl,TPH,D,SM	2.5-14	1.70	15.50	14.98	3.77
	192a	TPH,D,SM	14-16	1.74	12.68	12.25	3.93
	193	Wrl,TPH,D,SM	16-20	1.66	18.62	18.15	2.73
	194	Wrl,TPH,D,SM	20-30	1.71	14.52	14.03	3.77
		SM	Base	1.77	14.00	13.40	4.94
Sampling day 42 - 24/01/01 - Control							
6	195	Wrl,TPH,Geo,SM	0-2.5	1.71	12.16	11.98	1.76
	196	Wrl,TPH,Geo,SM	2.5-10	1.73	12.61	12.38	2.03
	197	Wrl,TPH,Geo,SM	10-20	1.74	16.54	16.15	2.63
	198	Wrl,TPH,Geo,SM	20-30	1.73	13.11	12.78	2.92
		SM	Base	1.80	14.60	14.13	3.71

16	199	Wrl,TPH,Geo,SM	0-2.5	1.72	11.54	11.38	1.67
	200	Wrl,TPH,Geo,SM	2.5-10	1.72	14.30	13.96	2.66
	201	Wrl,TPH,Geo,SM	10-20	1.73	12.83	12.48	3.14
	202	Wrl,TPH,Geo,SM	20-30	1.74	13.84	13.44	3.33
		SM	Base	1.71	11.10	10.35	8.01
35	203	Wrl,TPH,Geo,SM	0-2.5	1.74	15.61	15.34	1.99
	204	Wrl,TPH,Geo,SM	2.5-10	1.74	15.18	14.80	2.83
	205	Wrl,TPH,Geo,SM	10-20	1.76	14.90	14.45	3.42
	206	Wrl,TPH,Geo,SM	20-30	1.72	18.12	17.56	3.41
		SM	Base	1.75	12.25	11.73	4.97
Sampling day 357 - 6/12/01 - JP-5 treated							
51	207	Wrl,TPH,SM	0-2.5	1.76	13.31	13.12	1.67
	208	Wrl,TPH,SM	2.5-14	1.75	22.31	21.76	2.68
	208a	TPH,SM	14-16	1.71	13.40	13.07	2.77
	209	Wrl,TPH,SM	16-20	1.76	12.38	12.10	2.63
	210	Wrl,TPH,SM	20-30	1.71	22.19	21.57	3.06
		SM	Base	1.75	16.39	15.83	3.81
63	211	Wrl,TPH,SM	0-2.5	1.72	15.87	15.61	1.80
	212	Wrl,TPH,SM	2.5-15	1.74	20.78	20.32	2.38
	212a	TPH,SM	15-17	1.75	17.01	16.42	3.87
	213	Wrl,TPH,SM	17-20	1.74	16.42	15.85	3.85
	214	Wrl,TPH,SM	20-30	1.71	22.78	21.95	3.94
		SM	Base	1.70	15.65	14.64	7.26
74	215	Wrl,TPH,SM	0-2.5	1.80	15.86	15.65	1.50
	216	Wrl,TPH,SM	2.5-15	1.70	17.74	17.32	2.61
	216a	TPH,SM	15-17	1.65	14.33	13.90	3.38
	217	Wrl,TPH,SM	17-20	1.77	18.00	17.54	2.81
	218	Wrl,TPH,SM	20-30	1.72	17.47	16.82	4.11
		SM	Base	1.73	13.61	12.93	5.73
Sampling day 365 - 13/12/01 - JP-5 treated							
71	219	Wrl,TPH,Geo,SM	0-2.5	1.75	12.73	12.58	1.38
	220	Wrl,TPH,Geo,SM	2.5-15	1.76	15.38	14.95	3.13
	220a	TPH,Geo,SM	15-17	1.77	12.22	11.89	3.19
	221	Wrl,TPH,Geo,SM	17-20	1.82	13.05	12.66	3.46
	222	Wrl,TPH,Geo,SM	20-30	1.76	13.98	13.59	3.18
		SM	Base	1.73	12.12	11.11	9.72
75	223	Wrl,TPH,Geo,SM	0-2.5	1.76	15.37	15.08	2.12
	224	Wrl,TPH,Geo,SM	2.5-15	1.73	16.66	16.13	3.57
	224a	TPH, Geo, SM	15-17	1.75	15.87	15.38	3.45
	225	Wrl,TPH,Geo,SM	17-20	1.70	12.69	12.27	3.86
	226	Wrl,TPH,Geo,SM	20-30	1.71	10.30	9.97	3.87
		SM	Base	1.68	13.90	13.03	7.15
97	227	Wrl,TPH,Geo,SM	0-2.5	1.74	12.92	12.71	1.91
	228	Wrl,TPH,Geo,SM	2.5-15	1.76	14.98	14.50	3.62
	228a	TPH, Geo, SM	15-17	1.78	13.86	13.45	3.38
	229	Wrl,TPH,Geo,SM	17-20	1.78	14.67	14.27	3.10
	230	Wrl,TPH,Geo,SM	20-30	1.76	14.45	14.01	3.41
		SM	Base	1.75	13.86	13.03	6.88

Sampling day 365 - 13/12/01 - Control							
1	231	Wrl,TPH,Geo,SM	0-2.5	1.70	11.34	11.18	1.62
	232	Wrl,TPH,Geo,SM	2.5-10	1.77	16.34	15.98	2.44
	233	Wrl,TPH,Geo,SM	10-20	1.74	13.42	13.06	3.14
	234	Wrl,TPH,Geo,SM	20-30	1.74	13.84	13.37	3.84
		SM	Base	1.78	17.22	16.39	5.39
4	235	Wrl,TPH,Geo,SM	0-2.5	1.77	12.58	12.40	1.67
	236	Wrl,TPH,Geo,SM	2.5-10	1.65	14.69	14.40	2.25
	237	Wrl,TPH,Geo,SM	10-20	1.77	12.26	11.93	3.08
	238	Wrl,TPH,Geo,SM	20-30	1.67	14.75	14.33	3.20
		SM	Base	1.76	13.16	12.72	3.90
19	239	Wrl,TPH,Geo,SM	0-2.5	1.72	15.37	15.16	1.57
	240	Wrl,TPH,Geo,SM	2.5-10	1.72	16.13	15.73	2.77
	241	Wrl,TPH,Geo,SM	10-20	1.71	16.37	15.93	3.01
	242	Wrl,TPH,Geo,SM	20-30	1.74	14.62	14.20	3.24
		SM	Base	1.75	16.10	15.55	3.83
Sampling day 372 - 20/12/01 - JP-5 treated							
67	243	Wrl,TPH,SM	0-2.5	1.76	17.66	17.37	1.82
	244	Wrl,TPH,SM	2.5-8	1.76	14.74	14.23	3.93
	245	Wrl,TPH,SM	8-15	1.77	16.27	15.85	2.90
	245a	TPH,SM	15-17	1.75	12.17	11.80	3.51
	246	Wrl,TPH,SM	17-20	1.77	15.59	15.09	3.61
	247	Wrl,TPH,SM	20-30	1.76	16.83	16.20	4.19
		SM	Base	1.74	11.75	10.86	8.93
69	248	Wrl,TPH,SM	0-2.5	1.72	14.23	14.01	1.77
	249	Wrl,TPH,SM	2.5-8	1.74	17.33	16.86	3.02
	250	Wrl,TPH,SM	8-15	1.75	16.89	16.36	3.50
	250a	TPH,SM	15-17	1.72	18.29	17.75	3.27
	251	Wrl,TPH,SM	17-20	1.77	16.05	15.49	3.90
	252	Wrl,TPH,SM	20-30	1.80	17.07	16.41	4.29
		SM	Base	1.76	14.60	13.76	6.56
70	253	Wrl,TPH,SM	0-2.5	1.71	15.96	15.69	1.89
	254	Wrl,TPH,SM	2.5-8	1.73	14.78	14.35	3.33
	255	Wrl,TPH,SM	8-15	1.80	15.34	14.88	3.40
	255a	TPH,SM	15-17	1.77	17.75	17.25	3.14
	256	Wrl,TPH,SM	17-20	1.76	17.75	17.19	3.53
	257	Wrl,TPH,SM	20-30	1.73	15.77	15.12	4.60
		SM	Base	1.79	12.51	11.71	7.53
Sampling day 379 - 27/12/01 - JP-5 treated							
72	258	Wrl,TPH,Geo,SM	0-2.5	1.70	11.30	11.12	1.92
	259	Wrl,TPH,Geo,SM	2.5-8	1.75	16.67	16.29	2.58
	260	Wrl,TPH,Geo,SM	8-15	1.73	15.02	14.52	3.76
	260a	TPH,Geo,SM	15-17	1.75	15.34	14.94	2.92
	261	Wrl,TPH,Geo,SM	17-20	1.81	14.05	13.64	3.28
	262	Wrl,TPH,Geo,SM	20-30	1.77	14.36	13.85	4.02
		SM	Base	1.76	10.85	10.34	5.65

76	263	Wrl,TPH,Geo,SM	0-2.5	1.82	16.44	16.22	1.52
	264	Wrl,TPH,Geo,SM	2.5-8	Soil spill			
	265	Wrl,TPH,Geo,SM	8-15	1.78	15.24	14.83	3.05
	265a	TPH,Geo,SM	15-17	1.75	16.78	16.43	2.33
	266	Wrl,TPH,Geo,SM	17-20	1.76	17.87	17.31	3.45
	267	Wrl,TPH,Geo,SM	20-30	1.71	16.52	15.97	3.69
		SM	Base	1.71	15.11	14.42	5.18
91	268	Wrl,TPH,Geo,SM	0-2.5	1.68	17.31	17.01	1.87
	269	Wrl,TPH,Geo,SM	2.5-8	1.81	13.21	12.89	2.83
	270	Wrl,TPH,Geo,SM	8-15	1.72	14.43	13.98	3.54
	270a	TPH,Geo,SM	15-17	1.66	18.52	18.00	3.10
	271	Wrl,TPH,Geo,SM	17-20	1.79	13.91	13.57	2.84
	272	Wrl,TPH,Geo,SM	20-30	1.76	15.85	15.40	3.23
		SM	Base	1.77	17.98	17.12	5.31
Sampling day 379 - 27/12/01 - Control							
2	273	Wrl,TPH,Geo,SM	0-2.5	Soil spill			
	274	Wrl,TPH,Geo,SM	2.5-10	1.78	16.10	15.77	2.26
	275	Wrl,TPH,Geo,SM	10-20	1.70	12.88	12.60	2.54
	276	Wrl,TPH,Geo,SM	20-30	Soil spill			
		SM	Base	1.75	16.06	15.39	4.72
17	277	Wrl,TPH,Geo,SM	0-2.5	1.72	13.34	13.15	1.67
	278	Wrl,TPH,Geo,SM	2.5-10	1.73	17.84	17.24	3.76
	279	Wrl,TPH,Geo,SM	10-20	1.68	14.81	14.18	4.76
	280	Wrl,TPH,Geo,SM	20-30	1.74	13.78	13.30	3.99
		SM	Base	1.70	12.10	11.55	5.36
20	281	Wrl,TPH,Geo,SM	0-2.5	1.72	14.49	14.29	1.57
	282	Wrl,TPH,Geo,SM	2.5-10	1.75	16.79	16.30	3.25
	283	Wrl,TPH,Geo,SM	10-20	1.77	16.03	15.50	3.74
	284	Wrl,TPH,Geo,SM	20-30	1.81	13.95	13.52	3.51
		SM	Base	1.69	18.15	17.32	5.07
Sampling day 397 - 14/01/02 - JP-5 treated							
79	285	Wrl,TPH,Geo,SM	0-2.5	1.76	22.27	21.96	1.51
	286	Wrl,TPH,Geo,SM	2.5-10	1.75	30.69	29.99	2.42
	288	Wrl,TPH,Geo,SM	10-20	1.76	27.58	27.11	1.82
	289	Wrl,TPH,Geo,SM	20-30	1.77	25.36	24.59	3.26
		SM	Base	1.79	72.59	69.54	4.31
x	290	Wrl,TPH,Geo,SM	0-2.5	1.73	29.42	29.16	0.94
	291	Wrl,TPH,Geo,SM	2.5-10	1.75	23.05	22.85	0.94
	292	Wrl,TPH,Geo,SM	10-20	1.71	36.42	36.00	1.21
	293	Wrl,TPH,Geo,SM	20-30	1.74	26.19	25.94	1.02
		SM	Base	1.74	65.72	63.80	3.00
y	295	Wrl,TPH,Geo,SM	0-2.5	1.77	24.42	24.06	1.59
	296	Wrl,TPH,Geo,SM	2.5-10	1.72	22.43	21.89	2.61
	297	Wrl,TPH,Geo,SM	10-20	1.73	36.03	35.15	2.57
	298	Wrl,TPH,Geo,SM	20-30	1.76	16.72	16.32	2.67
		SM	Base	1.74	72.49	70.03	3.48

Sampling day 397 - 14/01/02 - Control

7	300	Wrl,TPH,Geo,SM	0-2.5	1.70	28.02	27.72	1.14
	301	Wrl,TPH,Geo,SM	2.5-10	1.72	33.71	33.14	1.78
	302	Wrl,TPH,Geo,SM	10-20	1.77	49.41	48.23	2.48
	303	Wrl,TPH,Geo,SM	20-30	1.80	64.66	62.74	3.05
		SM	Base	1.76	39.96	38.35	4.21
8	304	Wrl,TPH,Geo,SM	0-2.5	1.70	35.14	34.69	1.35
	305	Wrl,TPH,Geo,SM	2.5-10	1.74	30.81	30.23	2.00
	306	Wrl,TPH,Geo,SM	10-20	1.71	37.97	37.00	2.68
	307	Wrl,TPH,Geo,SM	20-30	1.72	17.92	17.43	3.02
		SM	Base	1.75	36.64	35.19	4.16
T2	308	Wrl,TPH,Geo,SM	0-2.5	1.72	47.90	47.28	1.34
	309	Wrl,TPH,Geo,SM	2.5-10	1.73	22.26	21.81	2.19
	310	Wrl,TPH,Geo,SM	10-20	1.65	25.71	25.07	2.66
	311	Wrl,TPH,Geo,SM	20-30	1.70	21.78	21.09	3.44
		SM	Base	1.72	43.96	41.72	5.30

Cores sampled where application rate was inconsistent with 6.93 litres per m2

Day 7 - 20/12/00 - 90 ml JP-5 fuel applied

58	57	Wrl,TPH,Geo,SM	0-2.5	1.71	12.60	12.07	4.87
	58	Wrl,TPH,Geo,SM	2.5-18	1.72	15.21	14.54	4.92
	58a	TPH,Geo,SM	18-21	1.75	13.98	13.41	4.68
	59	Wrl,TPH,Geo,SM	21-30	1.70	15.80	15.26	3.86
		SM	Base	1.75	11.92	11.20	7.06

Day 10 - 23/12/00 - 30 ml JP-5 fuel applied

88	76	Wrl,TPH,SM	0-2.5	1.71	14.20	13.74	3.72
	77	Wrl,TPH,SM	2.5-6	1.81	18.73	18.13	3.54
	77a	TPH,SM	6-10	1.79	9.99	9.73	3.26
	78	Wrl,TPH,SM	10-20	1.79	15.96	15.52	3.11
	79	Wrl,TPH,SM	20-30	1.79	15.87	15.42	3.22
		SM	Base	1.75	10.96	10.46	5.47

Day 14 - 27/12/00 - 90 ml JP-5 fuel applied

89	104	Wrl,TPH,Geo,SM	0-2.5	1.73	16.92	16.36	3.70
	105	Wrl,TPH,Geo,SM	2.5-20	1.74	13.69	13.12	4.71
	105a	TPH,Geo,SM	20-24	1.72	14.81	14.33	3.70
	106	Wrl,TPH,Geo,SM	24-30	1.76	19.28	18.76	2.96
		SM	Base	1.74	18.40	17.84	3.34

Day 35 - 17/01/01 - 90 ml JP-5 fuel applied

99	159	Wrl,TPH,SM	0-1	1.74	12.73	12.38	3.24
	160	Wrl,TPH,SM	1-20	1.78	16.95	16.31	4.23
	161	TPH,SM	20-23	1.79	12.79	12.35	4.02
	162	Wrl,TPH,SM	23-30	1.74	13.31	12.90	3.55
		SM	Base	1.73	14.99	14.36	4.76

Appendix Five

Weighing core oven dry mass (g) & total % error

Comparison of oven dry mass (g) in weighing cores between experimental set-up (1999) and destruction (2002)

Core	Weight container (g)	Weight core + soil (kg) +- 5g	Weight cores + soil (g)	wt cores + moist. - mass cont. (= mass soil + moisture)	Top up (ml)	Top up (g)	Total mass soil (g)	Oven dry mass (g)
w1	479.14	4.83	4830	4350.86	85	79.628	4430.488	4301
w2	480.08	4.44	4440	3959.92	290	271.672	4231.592	4108
w3	482.54	4.5	4500	4017.46	270	252.936	4270.396	4146
w4	481.88	4.675	4675	4193.12	190	177.992	4371.112	4244
w5	481.66	4.415	4415	3933.34	280	262.304	4195.644	4073
w6	480.84	4.485	4485	4004.16	390	365.352	4369.512	4242
w7	479.8	4.325	4325	3845.2	320	299.776	4144.976	4024
w8	483.48	4.25	4250	3766.52	200	187.36	3953.88	3839
w9	478.86	4.455	4455	3976.14	230	215.464	4191.604	4070
w10	484.3	4.3	4300	3815.7	340	318.512	4134.212	4014

Core	Weight core (g)	Weight soil (g)	Oven dry mass (g) 2002	Oven dry mass (g) 1999	Mean (99 & 02)	Difference (99 & 02)	% of Mean	Total error
w1	482	4425	4283	4301	4292	18	0.4	
w2	483	4335	4213	4108	4161	105	2.5	
w3	483	4409	4243	4146	4195	97	2.3	
w4	484	4424	4277	4243	4260	34	0.8	
w5	485	4354	4195	4073	4134	122	3.0	1.8
				Note that total error in JP-5 treated cores includes remaining fuel				
w6	487	4366	4245	4242	4244	3	0.1	
w7	484	4298	4174	4024	4099	150	3.7	
w8	487	4338	4210	3839	4025	371	9.2	
w9	485	4304	4178	4070	4124	108	2.6	
w10	489	4321	4197	4013	4105	184	4.5	4.0
								2.9

Oven dry mass calculations (g) after destruction of weighing cores 3/01/02

Total* = Sum weight of individual core sections

Total# = Total weight of soil in whole core

			Soil Moisture				
Core	Sample Depth (cm)	Sample weight (g)	Weight tin (g)	Weight tin + soil (g)	Oven dry weight tin + soil	Gravimetric mositure (%)	Oven dry mass (g)
W1	0-2.5	262	1.757	11.753	11.590	1.63	258
	2.5-10	1247	1.648	14.862	14.570	2.21	1219
	10-20	1369	1.764	13.887	13.480	3.36	1323
	20-27	950	1.705	15.669	15.195	3.39	918
	27-30	587	1.713	12.314	11.920	3.72	565
Total*		4415					4283
Total#		4425					
W2	0-2.5	303	1.742	13.346	13.151	1.68	298
	2.5-10	1123	1.670	15.895	15.599	2.08	1100
	10-20	1412	1.694	15.510	15.112	2.88	1371
	20-27	871	1.780	15.462	15.050	3.01	845
	27-30	622	1.750	15.296	14.810	3.59	600
Total*		4331					4213
Total#		4335					
W3	0-2.5	301	1.759	14.503	14.280	1.75	296
	2.5-10	1181	1.696	16.474	16.020	3.07	1145
	10-20	1359	1.715	17.681	17.131	3.44	1312
	20-27	998	1.779	14.929	14.504	3.23	966
	27-30	548	1.767	15.708	15.105	4.33	524
Total*		4387					4243
Total#		4409					
W4	0-2.5	295	1.771	14.691	14.450	1.853	290
	2.5-10	1186	1.728	14.073	13.742	2.681	1154
	10-20	1278	1.684	15.550	15.080	3.390	1235
	20-27	1069	1.776	14.047	13.633	3.374	1033
	27-30	586	1.765	14.285	13.845	3.514	565
Total*		4414					4277
Total#		4424					
W5	0-2.5	356	1.751	13.715	13.475	2.006	349
	2.5-10	1195	1.728	12.964	12.600	3.240	1156
	10-20	1282	1.759	17.582	17.060	3.299	1240
	20-27	942	1.751	13.700	13.277	3.540	909
	27-30	563	1.815	13.875	13.419	3.781	542
Total*		4338					4195
Total#		4353					

W6	0-2.5	307	1.797	10.745	10.620	1.397	303
	2.5-8	1013	1.691	12.619	12.360	2.370	989
	8-17	1112	1.677	16.043	15.666	2.624	1083
	17-27	1127	1.707	14.171	13.805	2.936	1094
	27-30	801	1.691	15.673	15.255	2.990	777
Total*		4360					4245
Total#		4366					
W7	0-2.5	312	1.650	14.104	13.944	1.285	308
	2.5-8	996	1.736	15.759	15.417	2.439	972
	8-17	1425	1.770	17.946	17.523	2.615	1388
	17-27	1040	1.736	14.382	14.058	2.562	1013
	27-30	510	1.760	14.572	14.144	3.341	493
Total*		4283					4174
Total#		4298					
W8	0-2.5	312	1.774	13.604	13.424	1.522	307
	2.5-8	888	1.736	15.589	15.235	2.555	865
	8-17	1370	1.664	16.016	15.680	2.341	1338
	17-27	1162	1.747	17.735	17.366	2.308	1135
	27-30	584	1.741	16.284	15.800	3.328	565
Total*		4316					4210
Total#		4338					
W9	0-2.5	349	1.813	14.583	14.388	1.527	344
	2.5-8	806	1.793	13.867	13.581	2.369	787
	8-17	1330	1.756	17.692	17.242	2.824	1292
	17-27	1175	1.747	14.001	13.668	2.717	1143
	27-30	634	1.773	14.831	14.385	3.416	612
Total*		4294					4178
Total#		4304					
W10	0-2.5	360	1.716	12.046	11.900	1.413	355
	2.5-8	859	1.683	14.063	13.788	2.221	840
	8-17	1286	1.693	15.520	15.130	2.821	1250
	17-27	1156	1.671	18.192	17.737	2.754	1124
	27-30	647	1.708	14.685	14.306	2.921	628
Total*		4308					4197
Total#		4321					

Appendix Six

TPH Analysis

Total TPH 0-2.5 cm

OST	day 0.1	OST	day 1	OST	day 7	OST	day 42
1	46000	22	27000			183	9010
4	52000	25	28000	60	20000	187	10500
7	39000	29	21000	64	17200	191	7830
mean	45667		25333		18600		9113
sd	6506		3786		1980		1338
% remaining			55.47		40.73		19.96
% loss			44.53		59.27		80.04

Total TPH 2.5-# cm # Day 0.1 = 9 cm; day 1 =10 cm, day 7 =14 cm, day 42 =

OST	day 0.1	OST	day 1	OST	day 7	OST	day 42
2	51000	23	26000			184	11500
5	43000	26	22000	61	13200	188	6920
8	40000	30	22000	65	12700	192	10900
mean	44667		23333		12950		9773
sd	5686		2309		354		2489
% remaining			52.24		28.99		21.88
% loss			47.76		71.01		78.12

C6-C9 0-2.5 cm

OST	0.1	OST	1	OST	7	OST	42
1	1820	22	540			183	23
4	1180	25	770	60	200	187	18
7	1400	29	256	64	200	191	23
mean	1467		522		200		21
sd	325		257		0		3
% remaining			35.59		13.64		1.45
% loss			64.41		86.36		98.55

C6-C9 2.5-# cm

OST	day 0.1	OST	day 1	OST	day 7	OST	day 42
2	1800	23	70			184	190
5	1200	26	500	61	300	188	170
8	1530	30	550	65	410	192	200
mean	1510		373		355		187
sd	300		264		78		15
% remaining			24.72		23.51		12.36
% loss			75.28		76.49		87.64

C10-C14 0-2.5 cm

OST	day 0.1	OST	day 1	OST	day 7	OST	day 42
1	36700	22	21500			183	6760
4	41700	25	22900	60	16200	187	7620
7	31500	29	17600	64	13500	191	5150
mean	36633		20667		14850		6510
sd	5100		2747		1909		1254
mean			56.41		40.54		17.77
% loss			43.59		59.46		82.23

C10-C14 2.5-# cm

OST	day 0.1	OST	day 1	OST	day 7	OST	day 42
2	40400	23	22700			184	10100
5	34600	26	18100	61	11500	188	5620
8	32000	30	18200	65	10900	192	8820
mean	35667		19667		11200		8180
sd	4300		2627		424		2308
% remaining			55.14		31.40		22.93
% loss			44.86		68.60		77.07

C15-C36 0-2.5 cm

OST	day 0.1	OST	day 1	OST	day 7	OST	day 42
1	8000	22	5000			183	2220
4	9000	25	4000	60	3000	187	2860
7	7000	29	3000	64	3490	191	2660
mean	8000		4000		3245		2580
sd	1000		1000		346		327
% remaining			50.00		40.56		32.25
% loss			50.00		59.44		67.75

C15-C36 2.5-# cm

OST	day 0.1	OST	day 1	OST	day 7	OST	day 42
2	9000	23	4000			184	1200
5	7000	26	3000	61	1390	188	1130
8	7000	30	3000	65	1330	192	1860
mean	7667		3333		1360		1397
sd	1155		577		42		403
% remaining			43.48		17.74		18.22
% loss			56.52		82.26		81.78

Total % fuel loss over six weeks from soil cores as calculated from TPH

Day	*Sample depth (cm)*	*Soil depth (cm)*	*Soil volume cm3*	*Dry mass of soil (g)**	*Dry mass of soil (kg)*	*TPH (mg/kg)*	*TPH (g/kg)*	*TPH in core section (g)*	*TPH loss (g)*	*TPH loss (%)*
0.1	0-2.5	2.5	216.5	361.6	0.362	46000	46	16.63		
	2.5-9	6.5	562.9	940.0	0.940	45000	45	42.30		
								58.93		
7	0-2.5	2.5	216.5	361.6	0.362	19000	19	6.87		
	2.5-14	11.5	995.9	1663.2	1.663	13000	13	21.62		
								28.49	**30.44**	**51.66**
42	0-2.5	2.5	216.5	361.6	0.362	9000	9	3.25		
	2.5-15	12.5	1082.5	1807.8	1.808	10000	10	18.08		
								21.33	**37.60**	**63.80**

* As calculated from the volume of the core occupied by the given depth of soil (core surface area = 86.6 cm2) and soil core bulk density of 1.67 g.cm3

Appendix Seven

Daily weight (g) of soil weighing cores

Day	*0**			*1*	*2*	*3*	*4*	*5*	*6*
Core	***Weight (g) before fuel 13-Dec***	***Weight (g) after fuel 13 -Dec***	***Fuel applied* (g)***	***14-Dec-00***	***15-Dec-00***	***16-Dec-00***	***17-Dec-00***	***18-Dec-00***	***19-Dec-00***
Controls									
W1	4906	4906	0	4907	4906	4904	4903	4904	4905
W2	4834	4834	0	4834	4831	4829	4828	4828	4829
W3	4867	4867	0	4868	4867	4866	4866	4866	4866
W4	4894	4894	0	4894	4894	4892	4892	4893	4894
W5	4820	4820	0	4820	4818	4817	4818	4819	4819
Mean	4864	4864	0	4865	4863	4862	4861	4862	4863
JP-5									
W6	4817	4871	54	4867	4863	4861	4859	4859	4859
W7	4747	4799	52	4794	4791	4789	4787	4787	4785
W8	4797	4850	53	4844	4841	4839	4837	4836	4835
W9	4763	4815	52	4809	4807	4804	4804	4803	4802
W10	4783	4836	53	4831	4826	4823	4822	4820	4819
Mean	4781	4834	53	4829	4826	4823	4822	4821	4820

7	8	9	10	11	13	14	15	16	17	18
20-Dec-00	*21-Dec-00*	*22-Dec-00*	*23-Dec-00*	*24-Dec-00*	*26-Dec-00*	*27-Dec-00*	*28-Dec-00*	*29-Dec-00*	*30-Dec-00*	*31-Dec-00*
4904	4903	4903	4904	4907	4905	4904	4904	4903	4902	4903
4827	4827	4825	4827	4830	4831	4829	4828	4828	4826	4827
4864	4865	4865	4869	4874	4870	4869	4869	4868	4866	4868
4891	4892	4892	4893	4902	4897	4896	4896	4894	4893	4894
4817	4817	4817	4820	4829	4824	4821	4821	4820	4819	4819
4861	4861	4860	4863	4868	4865	4864	4864	4863	4861	4862
4856	4856	4856	4856	4857	4857	4855	4856	4855	4854	4855
4784	4784	4783	4785	4788	4786	4784	4785	4785	4783	4784
4834	4834	4833	4835	4835	4835	4833	4833	4833	4832	4831
4801	4800	4801	4802	4804	4802	4800	4800	4799	4799	4799
4818	4816	4816	4818	4821	4818	4817	4818	4817	4817	4816
4819	4818	4818	4819	4821	4820	4818	4818	4818	4817	4817

20	21	22	23	25	26	27	28	29	30	32	35
02-Jan-01	*03-Jan-01*	*04-Jan-01*	*05-Jan-01*	*06-Jan-01*	*08-Jan-01*	*09-Jan-01*	*10-Jan-01*	*11-Jan-01*	*12-Jan-01*	*13-Jan-01*	*15-Jan-01*
4915	4907	4904	4904	4903	4903	4905	4905	4904	4903	4903	4905
4840	4829	4828	4827	4826	4826	4828	4827	4826	4825	4825	4826
4883	4873	4871	4869	4867	4868	4870	4869	4868	4866	4866	4869
4910	4902	4897	4895	4894	4895	4897	4896	4895	4894	4893	4897
4837	4829	4824	4821	4819	4819	4821	4821	4820	4819	4818	4819
4877	4868	4865	4863	4862	4862	4864	4864	4863	4861	4861	4863
4864	4856	4857	4855	4853	4853	4855	4855	4854	4853	4853	4854
4796	4787	4787	4786	4783	4784	4785	4784	4784	4783	4782	4785
4838	4833	4833	4832	4830	4831	4833	4832	4831	4830	4830	4831
4808	4801	4802	4800	4798	4798	4800	4799	4798	4797	4797	4799
4822	4818	4818	4816	4814	4814	4816	4814	4813	4813	4813	4814
4826	4819	4819	4818	4816	4816	4818	4817	4816	4815	4815	4817

36	37	39	40	41	43	44	358	374	386
18-Jan-01	***19-Jan-01***	***20-Jan-01***	***22-Jan-01***	***23-Jan-01***	***24-Jan-01***	***26-Jan-01***	***06-Dec-02***	***22-Dec-02***	***03-Jan-02***
4911	4909	4909	4908	4908	4907	4907	4905	4908	4907
4834	4831	4830	4830	4830	4829	4827	4817	4819	4818
4878	4875	4874	4876	4875	4873	4879	4902	4895	4892
4903	4900	4900	4899	4899	4898	4897	4914	4915	4908
4828	4827	4826	4829	4825	4825	4823	4843	4847	4839
4871	4868	4868	4868	4867	4866	4867	4876	4877	4873
4861	4859	4858	4858	4857	4857	4855	4845	4854	4853
4785	4783	4782	4783	4782	4781	4780	4778	4782	4782
4835	4832	4832	4833	4831	4830	4829	4821	4823	4825
4801	4799	4799	4800	4799	4797	4796	4792	4790	4789
4817	4815	4814	4815	4814	4813	4812	4809	4807	4810
4820	4818	4817	4818	4817	4816	4814	4809	4811	4812

Appendix Eight

Mean daily weight change (g) of soil weighing cores

Day	1	2	3	4	5	6	7	8	9
Core									
W1	-1	0	2	3	2	1	2	3	3
W2	0	3	5	6	6	5	7	7	9
W3	-1	0	1	1	1	1	3	2	2
W4	0	0	2	2	1	0	3	2	2
W5	0	2	3	2	1	1	3	3	3
Control	-0.4	1.0	2.6	2.8	2.2	1.6	3.6	3.4	3.8
s.d.	0.0	0.5	1.4	1.5	1.9	2.2	1.9	1.9	2.1
W6	4	8	10	12	12	12	15	15	15
W7	5	8	10	12	12	14	15	15	16
W8	6	9	11	13	14	15	16	16	17
W9	6	8	11	11	12	13	14	15	14
W10	5	10	13	14	16	17	18	20	20
JP-5	5.2	8.6	11.0	12.4	13.2	14.2	15.6	16.2	16.4
s.d.	0.8	0.9	1.2	1.1	1.8	1.9	1.5	2.2	2.3
Mean weight loss (g) from soil cores									
Control	0.4	-1.0	-2.6	-2.8	-2.2	-1.6	-3.6	-3.4	-3.8
JP-5	-5.2	-8.6	-11.0	-12.4	-13.2	-14.2	-15.6	-16.2	-16.4
Mean moisture corrected fuel loss (g)									
	4.8	7.6	8.4	9.6	11.0	12.6	12.0	12.8	12.6
Mean moisture corrected fuel loss (%)									
Control	-0.4	1.0	2.6	2.8	2.2	1.6	3.6	3.4	3.8
JP-5	9.8	16.3	20.8	23.5	25.0	26.9	29.5	30.7	31.1
	9.4	17.3	23.4	26.3	27.2	28.5	25.9	34.1	34.9

	*	*						*	*	*
10	*11*	*13*	*14*	*15*	*16*	*17*	*18*	*20*	*21*	*22*
2	-1	1	2	2	3	4	3	-9	-1	2
7	4	3	5	6	6	8	7	-6	5	6
-2	-7	-3	-2	-2	-1	1	-1	-16	-6	-4
1	-8	-3	-2	-2	0	1	0	-16	-8	-3
0	-9	-4	-1	-1	0	1	1	-17	-9	-4
1.6	-4.2	-1.2	0.4	0.6	1.6	3.0	2.0	-12.8	-3.8	-0.6
2.9	3.4	5.5	3.0	3.0	3.4	2.9	3.1	3.2	5.0	5.8
15	14	14	16	15	16	17	16	7	15	14
14	11	13	15	14	14	16	15	3	12	12
15	15	15	17	17	17	18	19	12	17	17
13	11	13	15	15	16	16	16	7	14	13
18	15	18	19	18	19	19	20	14	18	18
15.0	13.2	14.6	16.4	15.8	16.4	17.2	17.2	8.6	15.2	14.8
1.9	2.0	2.1	1.7	1.6	1.8	1.3	2.2	4.4	2.4	2.6
-1.6	4.2	1.2	-0.4	-0.6	-1.6	-3.0	-2.0	12.8	3.8	0.6
-15.0	-13.2	-14.6	-16.4	-15.8	-16.4	-17.2	-17.2	-8.6	-15.2	-14.8
13.4	9.0	13.4	16.0	15.2	14.8	14.2	15.2	-4.2	11.4	14.2
1.6	-4.2	-1.2	0.4	0.6	1.6	3.0	2.0	-12.8	-3.8	-0.6
28.4	25.0	27.7	31.1	29.9	31.1	32.6	32.6	16.3	28.8	28.0
30.0	20.8	26.5	31.5	30.5	32.7	35.6	34.6	3.5	25.0	27.4

23	25	26	27	28	29	30	32	35	36*	37*	39*
2	3	3	1	1	2	3	3	1	-5	-3	-3
7	8	8	6	7	8	9	9	8	0	3	4
-2	0	-1	-3	-2	-1	1	1	-2	-11	-8	-7
-1	0	-1	-3	-2	-1	0	1	-3	-9	-6	-6
-1	1	1	-1	-1	0	1	2	1	-8	-7	-6
1.0	2.4	2.0	0.0	0.6	1.6	2.8	3.2	1.0	-6.6	-4.2	-3.6
4.4	3.7	3.4	3.7	3.7	3.8	3.8	3.6	3.3	4.3	4.3	4.4
16	18	18	16	16	17	18	18	17	10	12	13
13	16	15	14	15	15	16	17	14	14	16	17
18	20	19	17	18	19	20	20	19	15	18	18
15	17	17	15	16	17	18	18	16	14	16	16
20	22	22	20	22	23	23	23	22	19	21	22
16.4	18.6	18.2	16.4	17.4	18.2	19.0	19.2	17.6	14.4	16.6	17.2
2.7	2.4	2.6	2.3	2.8	3.0	2.6	2.4	3.0	3.2	3.3	3.3
-1.0	-2.4	-2.0	0.0	-0.6	-1.6	-2.8	-3.2	-1.0	6.6	4.2	3.6
-16.4	-18.6	-18.2	-16.4	-17.4	-18.2	-19.0	-19.2	-17.6	-14.4	-16.6	-17.2
15.4	16.2	16.2	16.4	16.8	16.6	16.2	16.0	16.6	7.8	12.4	13.6
1.0	2.4	2.0	0.0	0.6	1.6	2.8	3.2	1.0	-6.6	-4.2	-3.6
31.1	35.2	34.5	31.1	33.0	34.5	36.0	36.4	33.3	27.3	31.4	32.6
32.1	37.6	36.5	31.1	33.6	36.1	38.8	39.6	34.3	20.7	27.2	29.0

40 *	41 *	43 *	44 *	358	374	386
-2	-2	-1	-1	1	-2	-1
4	4	5	7	17	15	16
-9	-8	-6	-12	-35	-28	-25
-5	-5	-4	-3	-20	-21	-14
-9	-5	-5	-3	-23	-27	-19
-4.2	-3.2	-2.2	-2.4	-12.0	-12.6	-8.6
4.5	5.4	4.5	4.4	6.8	20.8	18.6
13	14	14	16	26	17	18
16	17	18	19	21	17	17
17	19	20	21	29	27	25
15	16	18	19	23	25	26
21	22	23	24	27	29	26
16.4	17.6	18.6	19.8	25.2	23.0	22.4
3.0	3.0	3.3	2.9	3.2	5.7	4.5
4.2	3.2	2.2	2.4	12.0	12.6	8.6
-16.4	-17.6	-18.6	-19.8	-25.2	-23.0	-22.4
12.2	14.4	16.4	17.4	13.2	10.4	13.8
-4.2	-3.2	-2.2	-2.4	-12.0	-12.6	-8.6
31.1	33.3	35.2	37.5	47.7	43.6	42.4
26.9	30.1	33.0	35.1	35.7	31.0	33.8

Appendix Nine

Experiment One: Soil temperature at 5 cm and 20 cm depth

[redacted]

	Core	T1	T1	T2	T2	T3	T3	T4	T4	T5	T5	T6	T6
	Probe	9	2	7	5	11	8	1	10	6	12	4	3
	Depth	5	20	5	20	5	20	5	20	5	20	5	20
Day of	(cm)*	C	C	C	C	JP-5	JP-5	JP-5	JP-5	JP-5	JP-5	C	C
year	Time (h)	*Treatment (C = Control, JP-5 = JP-5 treated)											
345	1500	4.75	-4.80	4.02	-4.89	2.70	-5.81	-0.34	-5.99	1.83	-4.74	3.90	-4.34
345	1600	4.98	-4.75	1.44	-4.85	3.50	-5.84	0.61	-6.02	2.71	-4.80	3.21	-4.30
345	1700	2.38	-4.70	-0.30	-4.82	3.35	-5.86	0.97	-6.06	3.08	-4.84	-0.12	-5.31
345	1800	2.87	-4.66	0.88	-4.87	0.92	-5.82	-0.50	-5.98	1.53	-4.82	-0.21	-5.80
345	1900	2.93	-4.64	0.76	-4.94	0.58	-5.72	-1.07	-5.83	0.78	-4.72	-0.21	-5.82
345	2000	2.43	-4.63	0.73	-4.97	-0.51	-5.69	-1.59	-5.85	0.36	-4.72	-0.30	-5.84
345	2100	1.66	-4.63	0.42	-4.99	-1.68	-5.69	-2.18	-5.89	-0.08	-4.75	-0.49	-5.86
345	2200	0.84	-4.64	-0.03	-5.00	-2.78	-5.70	-2.81	-5.94	-0.60	-4.79	-0.83	-5.90
345	2300	-0.19	-4.66	-0.58	-5.01	-4.16	-5.73	-3.57	-6.00	-1.27	-4.82	-1.38	-5.94
346	0	-1.34	-4.70	-1.43	-5.02	-5.53	-5.77	-4.55	-6.06	-1.96	-4.87	-1.97	-5.99
346	100	-2.97	-4.76	-2.73	-5.06	-6.84	-5.83	-5.49	-6.12	-2.90	-4.92	-2.68	-6.04
346	200	-4.35	-4.85	-4.35	-5.13	-8.04	-5.91	-6.48	-6.19	-3.83	-4.98	-3.50	-6.11
346	300	-5.40	-4.97	-5.28	-5.23	-8.91	-6.00	-7.41	-6.28	-4.97	-5.06	-4.39	-6.18
346	400	-6.20	-5.11	-5.92	-5.34	-9.23	-6.10	-8.07	-6.37	-6.04	-5.15	-5.09	-6.26
346	500	-6.38	-5.26	-5.79	-5.46	-9.13	-6.21	-8.35	-6.46	-6.46	-5.27	-5.31	-6.33
346	600	-6.19	-5.41	-5.50	-5.59	-8.50	-6.34	-8.26	-6.57	-6.41	-5.40	-5.22	-6.40
346	700	-5.52	-5.56	-4.73	-5.71	-7.30	-6.46	-7.79	-6.68	-5.88	-5.55	-4.81	-6.48
346	800	-4.70	-5.69	-3.86	-5.81	-5.95	-6.60	-7.27	-6.79	-5.24	-5.71	-4.27	-6.56
346	900	-4.11	-5.80	-3.21	-5.90	-4.63	-6.73	-6.64	-6.90	-4.55	-5.87	-3.59	-6.63
346	1000	-3.17	-5.89	-2.52	-5.97	-2.98	-6.85	-6.04	-7.01	-3.89	-6.03	-3.14	-6.70
346	1100	-2.42	-5.98	-2.04	-6.04	-0.81	-6.96	-1.39	-7.10	-3.37	-6.18	-2.75	-6.76
346	1200	-1.29	-6.05	-1.09	-6.08	1.65	-7.00	4.02	-7.12	-2.63	-6.30	-2.02	-6.82
346	1300	-1.80	-6.10	-1.75	-6.18	-1.76	-6.98	4.24	-7.10	-1.81	-6.41	-1.67	-6.86
346	1400	-0.04	-6.13	-0.50	-6.26	-4.00	-6.99	1.38	-7.07	-1.08	-6.49	-0.68	-6.88
346	1500	1.38	-6.14	1.07	-6.27	-2.14	-7.02	0.20	-7.04	-1.77	-6.54	-0.10	-6.90
346	1600	1.92	-6.13	1.94	-6.26	0.29	-7.05	-1.34	-6.85	-0.36	-6.57	0.12	-6.90
346	1700	3.13	-6.09	3.12	-6.21	2.35	-7.05	-0.37	-6.67	1.55	-6.57	0.66	-6.89
346	1800	4.06	-6.03	3.80	-6.14	3.20	-7.05	0.33	-6.59	2.72	-6.56	1.11	-6.86
346	1900	4.29	-5.95	3.90	-6.04	2.79	-7.03	0.37	-6.55	3.00	-6.52	1.29	-6.83
346	2000	3.87	-5.85	3.37	-5.94	1.67	-7.00	0.01	-6.52	2.73	-6.47	1.22	-6.79
346	2100	3.12	-5.75	2.80	-5.84	0.68	-6.96	-0.52	-6.50	2.36	-6.40	0.93	-6.75
346	2200	-	-5.65	2.35	-5.74	-0.37	-6.92	-1.17	-6.48	2.00	-6.33	0.60	-6.71
346	2300	2.57	-5.56	2.54	-5.64	-0.75	-6.87	-1.36	-6.46	2.48	-6.24	0.76	-6.66
347	0	1.81	-5.47	1.53	-5.56	-2.02	-6.82	-1.85	-6.46	1.75	-6.16	0.44	-6.61
347	100	0.38	-5.42	0.20	-5.51	-3.21	-6.79	-2.68	-6.45	0.35	-6.07	-0.35	-6.58
347	200	-0.64	-5.37	-0.56	-5.47	-3.85	-6.77	-3.31	-6.44	-0.65	-5.99	-0.99	-6.56
347	300	-1.26	-5.35	-0.86	-5.46	-4.12	-6.75	-3.66	-6.43	-1.30	-5.91	-1.37	-6.53
347	400	-1.57	-5.34	-0.90	-5.45	-4.14	-6.74	-3.77	-6.43	-1.75	-5.86	-1.52	-6.51
347	500	-1.45	-5.36	-0.54	-5.46	-3.75	-6.74	-3.56	-6.44	-1.86	-5.83	-1.38	-6.49
347	600	-0.96	-5.37	0.17	-5.47	-2.99	-6.75	-3.01	-6.44	-1.43	-5.82	-0.95	-6.48
347	700	-0.08	-5.39	1.23	-5.47	-1.84	-6.75	-2.22	-6.44	-0.56	-5.82	-0.22	-6.46
347	800	1.49	-5.38	3.05	-5.45	0.27	-6.75	-0.97	-6.42	0.92	-5.82	1.05	-6.43
347	900	3.68	-5.36	5.38	-5.40	3.17	-6.73	1.08	-6.40	3.05	-5.82	2.78	-6.39
347	1000	4.87	-5.30	6.32	-5.33	4.09	-6.71	2.11	-6.39	3.86	-5.82	3.77	-6.34
347	1100	6.85	-5.20	8.15	-5.22	6.60	-6.67	3.66	-6.33	5.46	-5.79	5.14	-6.27
347	1200	10.00	-5.05	11.10	-5.05	11.11	-6.58	6.87	-6.25	8.40	-5.73	7.39	-6.18
347	1300	12.60	-4.86	13.26	-4.85	14.58	-6.46	9.83	-6.16	10.76	-5.66	9.23	-6.07
347	1400	14.30	-4.61	14.63	-4.60	16.58	-6.30	12.13	-6.06	12.54	-5.55	10.42	-5.94
347	1500	15.02	-4.32	14.99	-4.31	16.55	-6.11	12.99	-5.93	13.13	-5.41	10.85	-5.79
347	1600	15.20	-4.00	14.90	-4.00	15.97	-5.88	12.41	-5.77	13.07	-5.23	10.92	-5.62
347	1700	15.98	-3.66	15.37	-3.67	16.49	-5.62	12.24	-5.58	12.12	-5.01	11.12	-5.43
347	1800	15.74	-3.32	14.41	-3.34	15.65	-5.34	11.72	-5.38	12.72	-4.75	10.86	-5.23
347	1900	15.55	-2.97	13.80	-3.00	14.47	-5.06	10.71	-5.17	13.11	-4.45	10.65	-5.02
347	2000	14.97	-2.64	13.62	-2.69	10.19	-4.79	8.51	-4.97	13.03	-4.16	10.29	-4.81
347	2100	13.87	-2.33	13.15	-2.40	5.19	-4.55	7.95	-4.77	12.76	-3.87	10.08	-4.61

347	2200	12.29	-2.05	12.03	-2.15	2.55	-4.34	7.30	-4.59	11.97	-3.61	9.48	-4.43
347	2300	11.08	-1.82	10.47	-1.94	2.55	-4.17	6.26	-4.44	10.99	-3.36	8.68	-4.26
348	0	9.66	-1.64	9.06	-1.78	2.33	-4.05	4.99	-4.32	9.79	-3.13	7.73	-4.12
348	100	7.98	-1.50	7.75	-1.66	1.50	-3.97	3.84	-4.21	8.67	-2.93	6.80	-3.99
348	200	6.39	-1.41	6.61	-1.59	0.82	-3.92	3.00	-4.12	7.71	-2.75	6.13	-3.88
348	300	5.57	-1.38	6.26	-1.56	0.40	-3.90	2.38	-4.06	6.80	-2.61	5.60	-3.78
348	400	5.08	-1.38	6.24	-1.56	0.24	-3.90	2.21	-4.01	6.16	-2.51	5.38	-3.71
348	500	4.76	-1.42	6.26	-1.59	0.83	-3.91	2.24	-3.99	5.72	-2.43	5.30	-3.65
348	600	4.72	-1.48	6.48	-1.62	1.75	-3.93	2.62	-3.97	5.36	-2.39	5.46	-3.59
348	700	5.69	-1.54	7.61	-1.66	3.57	-3.94	3.68	-3.96	6.11	-2.37	6.23	-3.54
348	800	6.95	-1.60	8.62	-1.68	5.09	-3.96	4.81	-3.95	6.97	-2.36	7.05	-3.49
348	900	#####	-1.66	8.97	-1.71	5.58	-3.98	5.26	-3.92	7.13	-2.35	7.47	-3.45
348	1000	#####	-1.69	9.25	-1.71	6.09	-3.99	5.60	-3.89	7.19	-2.35	7.73	-3.40
348	1100	#####	-1.68	9.88	-1.68	6.64	-3.97	7.03	-3.84	7.53	-2.35	8.10	-3.32
348	1200	#####	-1.65	10.66	-1.62	7.90	-3.92	7.01	-3.75	8.18	-2.33	8.61	-3.22
348	1300	#####	-1.59	11.08	-1.54	9.43	-3.86	7.67	-3.66	8.61	-2.30	8.87	-3.13
[redacted]													
348	1700	#####	-1.12	11.20	-1.09	10.76	-3.46	8.83	-3.30	8.75	-2.08	8.67	-2.80
348	1800	#####	-0.98	10.29	-0.97	9.77	-3.33	8.21	-3.19	9.39	-2.03	8.13	-2.72
348	1900	#####	-0.84	9.27	-0.87	8.59	-3.20	7.17	-3.09	9.15	-1.96	7.53	-2.66
348	2000	#####	-0.73	8.20	-0.79	7.13	-3.08	6.00	-3.01	8.49	-1.89	6.88	-2.60
348	2100	#####	-0.64	6.59	-0.74	5.29	-2.97	4.77	-2.95	7.59	-1.83	5.80	-2.38
348	2200	#####	-0.60	5.17	-0.72	3.14	-2.89	3.63	-2.92	6.33	-1.78	4.20	-1.99
348	2300	#####	-0.59	3.90	-0.74	1.98	-2.82	2.47	-2.91	4.66	-1.74	3.17	-1.94
349	0	#####	-0.64	2.88	-0.80	1.24	-2.79	1.59	-2.92	3.38	-1.73	2.42	-2.02
349	100	#####	-0.72	2.22	-0.90	0.76	-2.78	1.03	-2.95	2.60	-1.74	1.86	-2.14
349	200	#####	-0.84	1.48	-1.04	0.17	-2.79	0.45	-3.00	1.80	-1.79	1.31	-2.27
349	300	#####	-0.99	1.08	-1.19	-0.04	-2.82	0.08	-3.06	1.34	-1.86	0.92	-2.41
349	400	#####	-1.15	0.96	-1.36	0.06	-2.87	-0.05	-3.12	1.17	-1.95	0.74	-2.54
349	500	#####	-1.31	1.49	-1.52	0.56	-2.92	0.35	-3.19	1.65	-2.06	0.92	-2.67
349	600	#####	-1.47	2.80	-1.66	1.51	-2.97	1.22	-3.26	2.61	-2.17	1.61	-2.78
349	700	#####	-1.62	3.39	-1.81	1.76	-3.03	2.01	-3.33	3.33	-2.28	2.28	-2.90
349	800	#####	-1.75	4.44	-1.92	3.28	-3.08	2.58	-3.38	4.30	-2.39	3.07	-2.99
349	900	#####	-1.84	6.40	-1.98	5.63	-3.11	4.28	-3.42	6.26	-2.48	4.52	-3.06
349	1000	#####	-1.90	6.57	-2.03	6.34	-3.14	5.18	-3.45	6.44	-2.55	5.12	-3.12
349	1100	#####	-1.91	7.41	-2.03	7.31	-3.13	5.78	-3.43	7.09	-2.59	5.81	-3.13
349	1200	#####	-1.89	8.74	-1.99	9.16	-3.09	7.11	-3.37	8.56	-2.60	6.82	-3.12
349	1300	#####	-1.83	9.29	-1.91	10.47	-3.02	8.17	-3.32	9.19	-2.58	7.32	-3.10
349	1400	#####	-1.75	9.72	-1.80	11.29	-2.93	8.92	-3.25	9.79	-2.54	7.71	-3.06
349	1500	#####	-1.63	9.98	-1.68	11.48	-2.82	9.26	-3.16	10.12	-2.48	7.90	-3.00
349	1600	#####	-1.48	9.98	-1.53	11.38	-2.69	9.21	-3.06	10.28	-2.40	7.90	-2.94
349	1700	#####	-1.33	9.56	-1.38	10.45	-2.55	8.67	-2.96	10.01	-2.30	7.62	-2.87
349	1800	#####	-1.19	7.96	-1.26	8.22	-2.43	7.26	-2.86	8.67	-2.20	6.65	-2.80
349	1900	#####	-1.05	7.96	-1.14	8.04	-2.30	6.51	-2.76	8.64	-2.09	6.43	-2.73
349	2000	#####	-0.94	7.25	-1.05	6.64	-2.19	5.75	-2.68	8.05	-1.99	5.92	-2.67
349	2100	#####	-0.86	5.91	-1.00	4.64	-2.10	4.28	-2.62	6.66	-1.91	4.96	-2.63
349	2200	#####	-0.83	3.49	-0.99	2.29	-2.05	2.57	-2.60	4.30	-1.84	3.40	-2.62
349	2300	#####	-0.84	1.95	-1.02	1.07	-2.02	1.45	-2.59	2.69	-1.80	2.18	-2.61
350	0	#####	-0.89	0.37	-1.09	-0.36	-2.01	0.20	-2.61	1.19	-1.79	0.93	-2.63
350	100	#####	-1.00	-0.89	-1.22	-1.51	-2.04	-0.87	-2.66	-0.10	-1.81	-0.16	-2.67
350	200	#####	-1.14	-1.40	-1.38	-1.90	-2.09	-1.48	-2.72	-0.72	-1.87	-0.80	-2.74
350	300	#####	-1.32	-1.93	-1.58	-2.33	-2.17	-1.86	-2.82	-1.32	-1.97	-1.34	-2.83
350	400	#####	-1.52	-1.70	-1.79	-2.59	-2.27	-2.24	-2.93	-1.45	-2.10	-1.59	-2.94
350	500	#####	-1.73	-0.48	-1.99	-1.74	-2.39	-1.84	-3.04	-0.57	-2.25	-1.02	-3.06
350	600	#####	-1.92	0.96	-2.18	-0.34	-2.50	-0.75	-3.14	0.65	-2.41	-0.02	-3.17
350	700	#####	-2.10	2.03	-2.34	1.02	-2.62	0.44	-3.24	1.69	-2.56	1.00	-3.27
350	800	#####	-2.25	2.90	-2.47	2.17	-2.72	1.37	-3.34	2.52	-2.71	1.85	-3.37
350	900	#####	-2.36	3.82	-2.56	3.44	-2.81	2.14	-3.41	3.39	-2.83	2.67	-3.44
350	1000	#####	-2.43	4.85	-2.60	4.76	-2.88	3.20	-3.46	4.35	-2.94	3.51	-3.50
350	1100	#####	-2.46	5.77	-2.60	5.97	-2.91	5.30	-3.46	5.18	-3.02	4.32	-3.53
350	1200	#####	-2.44	6.71	-2.56	6.90	-2.91	5.18	-3.40	6.23	-3.05	5.12	-3.50

350	1300	#####	-2.39	7.52	-2.48	7.85	-2.87	5.89	-3.33	7.20	-3.03	5.73	-3.46
350	1400	#####	-2.30	8.19	-2.37	9.17	-2.80	6.89	-3.26	8.06	-2.98	6.30	-3.41
350	1500	#####	-2.18	8.87	-2.23	10.16	-2.70	7.63	-3.18	8.75	-2.91	6.78	-3.34
350	1600	#####	-2.03	9.27	-2.08	10.63	-2.58	8.05	-3.08	9.26	-2.82	7.08	-3.27
350	1700	#####	-1.86	9.37	-1.91	10.46	-2.45	8.06	-2.97	9.51	-2.72	7.19	-3.19
350	1800	#####	-1.69	9.01	-1.75	9.96	-2.31	7.77	-2.87	9.63	-2.61	7.10	-3.11
350	1900	#####	-1.51	8.48	-1.59	8.94	-2.17	7.19	-2.76	9.35	-2.49	6.85	-3.02
350	2000	#####	-1.35	8.07	-1.45	7.74	-2.05	6.38	-2.66	8.82	-2.37	6.49	-2.95
350	2100	#####	-1.20	7.54	-1.33	6.56	-1.94	5.61	-2.58	8.35	-2.25	6.09	-2.87
350	2200	#####	-1.08	6.72	-1.23	5.04	-1.86	4.65	-2.52	7.59	-2.14	5.48	-2.80
350	2300	#####	-0.99	5.24	-1.18	3.41	-1.80	3.49	-2.47	6.52	-2.05	4.58	-2.76
351	0	#####	-0.95	3.98	-1.15	2.19	-1.77	2.47	-2.45	5.65	-1.97	3.88	-2.72
351	100	#####	-0.93	3.56	-1.16	1.31	-1.77	1.69	-2.44	5.00	-1.90	3.38	-2.70
351	200	#####	-0.96	3.17	-1.19	0.70	-1.79	1.12	-2.45	4.49	-1.87	2.92	-2.69
351	300	#####	-1.00	3.89	-1.24	0.79	-1.82	1.12	-2.46	4.79	-1.85	3.06	-2.69
351	400	#####	-1.06	4.58	-1.30	0.92	-1.87	1.57	-2.49	5.13	-1.86	3.41	-2.69
351	500	#####	-1.13	5.29	-1.36	2.02	-1.92	2.29	-2.52	5.59	-1.87	4.00	-2.70
351	600	#####	-1.19	6.20	-1.41	3.62	-1.98	3.61	-2.56	6.05	-1.89	4.82	-2.70
351	700	#####	-1.27	5.74	-1.47	3.54	-2.05	4.12	-2.60	5.97	-1.91	4.97	-2.72
351	800	#####	-1.33	5.73	-1.50	4.16	-2.11	4.41	-2.64	6.09	-1.93	5.19	-2.73
351	900	#####	-1.36	6.23	-1.51	5.47	-2.14	4.93	-2.66	6.65	-1.94	5.50	-2.71
351	1000	#####	-1.38	6.65	-1.51	6.62	-2.14	6.03	-2.65	7.23	-1.94	5.90	-2.68
351	1100	#####	-1.40	6.49	-1.50	7.62	-2.13	6.33	-2.62	7.57	-1.94	6.07	-2.64
351	1200	#####	-1.40	7.35	-1.46	8.68	-2.11	6.45	-2.56	8.09	-1.93	6.46	-2.58
351	1300	6.90	-1.38	7.71	-1.41	9.16	-2.05	7.14	-2.55	8.45	-1.91	6.62	-2.52
351	1400	7.15	-1.34	7.86	-1.34	9.34	-1.98	7.44	-2.50	8.49	-1.87	6.60	-2.46
351	1500	7.68	-1.29	8.23	-1.26	9.65	-1.89	7.64	-2.44	8.55	-1.82	6.60	-2.41
351	1600	7.95	-1.22	8.34	-1.18	9.34	-1.81	7.59	-2.38	8.70	-1.77	6.51	-2.36
351	1700	8.26	-1.15	8.43	-1.09	9.31	-1.71	7.34	-2.32	8.99	-1.69	6.40	-2.31
351	1800	7.81	-1.07	7.49	-1.02	8.21	-1.63	6.52	-2.26	8.57	-1.62	5.90	-2.27
351	1900	7.04	-1.00	6.75	-0.95	6.77	-1.56	5.51	-2.22	7.87	-1.55	5.26	-2.24
351	2000	6.09	-0.94	5.93	-0.91	5.21	-1.50	4.44	-2.18	7.07	-1.49	4.57	-2.22
351	2100	4.80	-0.90	4.95	-0.88	3.55	-1.46	3.28	-2.15	6.11	-1.44	3.82	-2.21
351	2200	3.17	-0.89	3.78	-0.89	1.65	-1.45	2.00	-2.15	4.92	-1.41	2.88	-2.22
351	2300	1.92	-0.92	2.38	-0.94	-0.16	-1.47	0.72	-2.16	3.72	-1.39	1.92	-2.25
352	0	0.80	-0.98	0.85	-1.02	-1.70	-1.52	-0.54	-2.19	2.54	-1.40	1.00	-2.30
352	100	-0.27	-1.07	-0.03	-1.14	-2.81	-1.59	-1.57	-2.24	1.49	-1.42	0.15	-2.36
352	200	-1.07	-1.20	-0.49	-1.29	-3.59	-1.70	-2.37	-2.31	0.77	-1.47	-0.50	-2.44
352	300	-1.86	-1.36	-1.02	-1.47	-4.26	-1.84	-3.08	-2.40	0.13	-1.55	-1.06	-2.54
352	400	-2.52	-1.54	-1.50	-1.66	-4.85	-1.99	-3.59	-2.51	-0.43	-1.65	-1.48	-2.64
352	500	-2.48	-1.72	-1.24	-1.86	-4.24	-2.15	-3.51	-2.63	-0.39	-1.77	-1.40	-2.75
352	600	-2.00	-1.91	-0.60	-2.05	-3.19	-2.32	-2.87	-2.75	-0.02	-1.90	-0.96	-2.86
352	700	-1.02	-2.10	0.56	-2.24	-1.53	-2.47	-1.73	-2.87	1.06	-2.04	-0.09	-2.96
352	800	0.55	-2.25	2.19	-2.39	1.04	-2.61	-0.18	-2.98	2.69	-2.19	1.22	-3.05
352	900	2.49	-2.37	4.10	-2.50	3.88	-2.71	1.64	-3.07	4.50	-2.32	2.77	-3.11
352	1000	4.25	-2.45	5.70	-2.56	6.35	-2.79	3.28	-3.15	6.05	-2.44	4.16	-3.16
352	1100	6.20	-2.47	7.43	-2.56	8.63	-2.82	5.04	-3.19	7.70	-2.53	5.52	-3.18
352	1200	7.96	-2.44	9.14	-2.50	10.71	-2.81	6.78	-3.21	9.46	-2.58	6.84	-3.17
352	1300	9.92	-2.34	10.80	-2.38	13.07	-2.74	9.02	-3.18	11.23	-2.59	8.07	-3.13
352	1400	10.84	-2.20	11.51	-2.21	13.84	-2.64	10.40	-3.12	11.93	-2.56	8.72	-3.05
352	1500	11.84	-2.00	12.32	-1.99	14.53	-2.49	11.26	-2.97	12.56	-2.49	9.27	-2.93
352	1600	12.21	-1.77	12.46	-1.74	14.38	-2.29	11.25	-2.80	12.67	-2.36	9.38	-2.80
352	1700	12.01	-1.53	12.04	-1.48	13.44	-2.06	10.87	-2.64	12.48	-2.19	9.14	-2.67
352	1800	12.01	-1.27	12.04	-1.21	12.83	-1.82	10.22	-2.48	12.43	-2.01	9.00	-2.52
352	1900	10.43	-1.03	10.19	-0.98	10.14	-1.61	9.13	-2.33	11.10	-1.82	8.09	-2.40
352	2000	7.40	-0.83	7.16	-0.80	6.66	-1.42	6.80	-2.19	8.30	-1.64	6.37	-2.28
352	2100	8.70	-0.65	9.09	-0.63	8.61	-1.24	6.85	-2.04	9.52	-1.47	6.97	-2.15
352	2200	10.07	-0.50	10.89	-0.49	9.70	-1.09	7.91	-1.91	11.45	-1.32	8.09	-2.03
352	2300	8.34	-0.39	8.60	-0.41	7.41	-0.99	7.17	-1.82	9.87	-1.20	7.24	-1.95
353	0	6.55	-0.32	6.52	-0.35	5.97	-0.93	6.12	-1.74	7.80	-1.09	5.95	-1.90
353	100	4.85	-0.27	4.79	-0.32	4.27	-0.89	4.74	-1.70	5.94	-1.00	4.70	-1.86
353	200	3.39	-0.26	3.27	-0.32	2.76	-0.87	3.34	-1.63	4.27	-0.93	3.54	-1.82
353	300	2.25	-0.28	2.14	-0.36	1.68	-0.87	2.16	-1.61	2.98	-0.88	2.57	-1.80

353	400	1.64	-0.35	1.55	-0.44	1.18	-0.89	1.44	-1.61	2.23	-0.88	1.92	-1.80
353	500	1.74	-0.44	1.77	-0.55	1.65	-0.93	1.35	-1.63	2.29	-0.91	1.84	-1.82
353	600	2.77	-0.55	2.89	-0.67	3.16	-0.99	2.26	-1.66	3.30	-0.97	2.40	-1.84
353	700	4.05	-0.66	4.27	-0.79	4.82	-1.05	3.39	-1.70	4.61	-1.05	3.28	-1.88
353	800	6.27	-0.74	6.77	-0.87	7.64	-1.10	5.28	-1.74	6.79	-1.13	4.83	-1.91
353	900	8.20	-0.79	8.78	-0.92	9.75	-1.14	7.41	-1.76	8.83	-1.21	6.45	-1.95
353	1000	10.04	-0.79	10.92	-0.91	12.74	-1.15	9.22	-1.76	10.98	-1.26	8.34	-1.95
353	1100	13.11	-0.73	13.86	-0.83	16.93	-1.11	13.90	-1.73	13.80	-1.28	10.64	-1.92
353	1200	12.28	-0.64	12.72	-0.71	14.22	-1.06	12.90	-1.62	13.22	-1.24	10.46	-1.88
353	1300	11.10	-0.51	11.59	-0.55	13.31	-0.97	11.47	-1.51	12.07	-1.15	9.58	-1.81
353	1400	10.41	-0.35	10.90	-0.35	12.89	-0.85	10.60	-1.41	11.34	-1.02	8.95	-1.71
353	1500	10.35	-0.18	10.82	-0.16	12.61	-0.71	10.16	-1.31	11.07	-0.88	8.60	-1.61
353	1600	10.41	-0.02	10.75	0.01	12.24	-0.57	9.72	-1.21	10.88	-0.74	8.35	-1.50
353	1700	10.26	0.12	10.38	0.15	11.57	-0.44	9.19	-1.12	10.73	-0.61	8.02	-1.40
353	1800	9.81	0.24	9.89	0.27	10.52	-0.33	8.37	-1.05	10.31	-0.50	7.56	-1.32
353	1900	10.41	0.34	10.66	0.38	10.76	-0.23	8.14	-0.97	10.95	-0.40	7.78	-1.23
353	2000	9.81	0.43	10.10	0.46	9.59	-0.16	8.06	-0.91	10.68	-0.32	7.74	-1.17
353	2100	8.01	0.50	8.19	0.51	7.57	-0.11	6.91	-0.87	8.99	-0.25	6.78	-1.14
353	2200	7.05	0.55	7.59	0.54	6.45	-0.08	5.88	-0.83	8.21	-0.18	6.09	-1.10
353	2300	6.01	0.57	6.52	0.55	4.77	-0.06	4.96	-0.81	7.48	-0.14	5.41	-1.08
354	0	4.62	0.55	4.86	0.52	3.65	-0.07	3.89	-0.81	5.87	-0.10	4.43	-1.08
354	100	3.79	0.51	3.96	0.46	3.14	-0.09	3.44	-0.82	4.91	-0.09	3.71	-1.09
354	200	2.08	0.42	2.14	0.36	1.33	-0.15	2.29	-0.85	3.22	-0.11	2.49	-1.12
354	300	0.47	0.30	0.48	0.23	-0.22	-0.22	0.96	-0.90	1.53	-0.15	1.21	-1.17
354	400	-0.44	0.15	-0.41	0.06	-0.99	-0.31	-0.13	-0.97	0.52	-0.21	0.31	-1.23
354	500	0.03	-0.02	0.48	-0.12	-0.18	-0.41	-0.28	-1.05	1.02	-0.31	0.38	-1.30
354	600	0.94	-0.21	1.61	-0.31	0.82	-0.53	0.43	-1.14	1.95	-0.44	1.03	-1.39
354	700	1.67	-0.40	2.53	-0.50	1.75	-0.66	0.98	-1.25	2.63	-0.59	1.60	-1.49
354	800	2.83	-0.57	3.90	-0.66	3.18	-0.79	1.91	-1.36	3.91	-0.74	2.49	-1.59
354	900	3.97	-0.71	5.34	-0.79	4.90	-0.90	2.86	-1.46	5.18	-0.89	3.58	-1.68
354	1000	4.29	-0.83	5.48	-0.89	4.78	-1.01	3.42	-1.57	5.51	-1.02	4.04	-1.77
354	1100	4.53	-0.90	5.66	-0.94	5.28	-1.10	3.71	-1.62	5.70	-1.12	4.25	-1.82
354	1200	5.12	-0.94	6.22	-0.96	6.22	-1.16	4.08	-1.66	6.04	-1.20	4.67	-1.85
354	1300	6.33	-0.95	7.28	-0.94	8.05	-1.19	5.24	-1.69	7.06	-1.26	5.36	-1.86
354	1400	7.87	-0.93	8.81	-0.90	9.76	-1.20	6.54	-1.71	8.53	-1.30	6.27	-1.86
354	1500	9.63	-0.88	10.26	-0.83	11.79	-1.18	7.89	-1.70	9.86	-1.32	7.43	-1.84
354	1600	11.82	-0.77	12.06	-0.71	13.87	-1.13	9.87	-1.68	11.72	-1.32	8.69	-1.80
354	1700	13.66	-0.62	13.60	-0.55	15.42	-1.04	11.19	-1.63	13.27	-1.28	9.78	-1.73
354	1800	13.35	-0.44	12.85	-0.38	14.16	-0.94	11.55	-1.56	13.21	-1.22	9.70	-1.67
354	1900	12.29	-0.24	11.71	-0.19	12.03	-0.82	10.18	-1.47	12.13	-1.12	9.19	-1.59
354	2000	11.92	-0.02	11.24	0.01	10.81	-0.68	9.47	-1.36	11.83	-0.99	8.93	-1.49
354	2100	10.12	0.19	9.64	0.18	8.38	-0.55	7.91	-1.24	10.34	-0.85	8.06	-1.40
354	2200	7.94	0.36	8.01	0.32	6.12	-0.44	6.10	-1.14	8.71	-0.70	6.96	-1.31
354	2300	6.30	0.49	6.39	0.41	4.54	-0.34	4.75	-1.04	7.42	-0.57	5.88	-1.24
355	0	5.23	0.56	5.01	0.45	3.37	-0.27	3.69	-0.98	6.40	-0.46	4.90	-1.18
355	100	4.71	0.59	4.71	0.45	2.67	-0.23	3.08	-0.94	6.00	-0.38	4.38	-1.14
355	200	3.78	0.56	4.09	0.40	1.59	-0.23	2.38	-0.94	5.20	-0.34	3.79	-1.13
355	300	3.18	0.50	4.12	0.32	0.91	-0.26	1.76	-0.96	4.66	-0.32	3.42	-1.14
355	400	2.72	0.40	3.97	0.22	0.37	-0.31	1.42	-1.00	4.31	-0.33	3.26	-1.16
355	500	2.53	0.30	4.03	0.12	0.60	-0.37	1.25	-1.05	3.86	-0.37	3.30	-1.19
355	600	3.39	0.19	5.09	0.02	2.09	-0.44	2.16	-1.10	4.39	-0.42	4.10	-1.21
355	700	4.08	0.07	5.10	-0.09	3.37	-0.52	2.94	-1.16	4.95	-0.48	4.61	-1.25
355	800	5.29	-0.03	6.23	-0.17	5.45	-0.59	4.15	-1.21	6.23	-0.55	5.32	-1.27
355	900	7.80	-0.08	9.07	-0.20	9.87	-0.62	6.62	-1.23	8.79	-0.61	7.35	-1.25
355	1000	10.51	-0.09	11.51	-0.20	13.76	-0.63	10.67	-1.28	11.01	-0.67	9.35	-1.23
355	1100	10.95	-0.08	11.40	-0.17	13.68	-0.64	13.38	-1.22	10.92	-0.69	9.81	-1.21
355	1200	11.73	-0.01	12.03	-0.07	14.19	-0.60	12.61	-1.13	11.43	-0.69	10.07	-1.14
355	1300	12.92	0.11	13.31	0.10	15.02	-0.50	12.67	-1.01	12.54	-0.65	10.71	-1.03
355	1400	12.97	0.27	13.38	0.28	14.12	-0.37	12.19	-0.89	13.10	-0.56	10.95	-0.91
355	1500	12.87	0.45	13.37	0.49	13.66	-0.22	11.67	-0.77	13.09	-0.46	10.70	-0.43
355	1600	12.39	0.65	12.71	0.68	12.78	-0.06	11.23	-0.66	12.62	-0.34	10.00	0.52
355	1700	10.59	0.82	10.75	0.86	10.31	0.07	9.26	-0.55	10.80	-0.21	9.03	0.68
355	1800	8.25	0.96	8.51	1.01	7.80	0.19	5.97	-0.31	8.61	-0.08	7.65	0.64

355	1900	6.58	1.07	6.97	1.13	6.29	0.29	4.49	-0.23	7.09	0.03	6.49	0.56
355	2000	7.11	1.13	7.71	1.20	6.59	0.38	4.01	-0.24	7.43	0.12	6.41	0.49
355	2100	6.01	1.15	6.30	1.21	4.74	0.42	3.01	-0.28	6.35	0.18	5.53	0.39
355	2200	3.47	1.10	3.67	1.15	2.36	0.42	1.29	-0.36	4.02	0.20	3.84	0.29
355	2300	1.53	1.01	1.74	1.04	0.70	0.38	-0.12	-0.48	2.14	0.19	2.42	0.17
356	0	-0.09	0.88	0.02	0.89	-0.85	0.32	-1.46	-0.63	0.49	0.16	1.11	0.05
356	100	-1.24	0.71	-1.11	0.68	-1.89	0.22	-2.48	-0.82	-0.72	0.08	0.05	-0.09
356	200	-2.25	0.49	-2.11	0.42	-2.88	0.09	-3.35	-1.04	-1.82	-0.04	-0.89	-0.24
356	300	-2.96	0.23	-2.82	0.13	-3.55	-0.08	-3.98	-1.28	-2.60	-0.20	-1.62	-0.41
356	400	-3.48	-0.05	-3.36	-0.18	-4.03	-0.27	-4.48	-1.51	-3.17	-0.39	-2.20	-0.60
356	500	-3.94	-0.34	-3.79	-0.50	-4.46	-0.48	-4.89	-1.74	-3.66	-0.60	-2.71	-0.80
356	600	-4.14	-0.64	-3.95	-0.82	-4.62	-0.70	-5.15	-1.96	-3.92	-0.83	-3.05	-1.01
356	700	-4.02	-0.94	-3.71	-1.12	-4.42	-0.93	-5.19	-2.17	-3.84	-1.08	-3.12	-1.23
356	800	-3.37	-1.21	-2.82	-1.41	-3.67	-1.15	-4.95	-2.38	-3.32	-1.32	-2.80	-1.44
356	900	-2.21	-1.47	-1.50	-1.66	-2.44	-1.36	-4.18	-2.57	-2.21	-1.57	-2.04	-1.64
356	1000	-0.92	-1.69	-0.09	-1.88	-1.15	-1.56	-3.19	-2.72	-0.92	-1.80	-1.13	-1.83
356	1100	0.96	-1.86	2.03	-2.05	0.81	-1.73	-1.69	-2.83	0.90	-2.01	0.21	-2.00
356	1200	2.41	-1.99	3.56	-2.16	2.38	-1.87	-0.38	-2.89	2.40	-2.19	1.48	-2.15
356	1300	4.03	-2.06	5.28	-2.20	4.19	-1.97	1.08	-2.92	3.86	-2.34	2.75	-2.27
356	1400	5.90	-2.07	7.06	-2.18	6.46	-2.03	2.78	-2.90	5.55	-2.44	4.19	-2.34
356	1500	7.81	-2.02	8.71	-2.10	8.67	-2.04	4.64	-2.85	7.00	-2.50	5.42	-2.39
356	1600	9.17	-1.92	9.83	-1.97	9.91	-2.02	5.94	-2.77	8.08	-2.51	6.22	-2.39
356	1700	10.47	-1.77	10.97	-1.78	10.82	-1.95	6.88	-2.66	9.26	-2.48	6.95	-2.37
356	1800	11.06	-1.58	11.22	-1.58	10.79	-1.86	7.27	-2.55	9.82	-2.42	7.26	-2.32
356	1900	11.10	-1.36	11.15	-1.35	10.29	-1.74	7.23	-2.44	9.99	-2.31	7.28	-2.25
356	2000	11.00	-1.13	10.96	-1.12	9.56	-1.61	7.00	-2.32	10.06	-2.18	7.25	-2.17
356	2100	10.18	-0.89	10.31	-0.90	8.24	-1.47	6.30	-2.21	9.64	-2.03	6.88	-2.08
356	2200	8.63	-0.68	9.37	-0.70	6.57	-1.33	5.39	-2.10	8.95	-1.87	6.26	-1.99
356	2300	6.48	-0.50	6.88	-0.54	3.84	-1.22	3.79	-2.01	7.01	-1.71	5.08	-1.92
357	0	4.60	-0.37	4.55	-0.44	1.54	-1.13	2.02	-1.92	5.17	-1.55	3.79	-1.86
357	100	3.19	-0.28	3.30	-0.38	0.27	-1.06	0.82	-1.86	3.86	-1.42	2.81	-1.81
357	200	1.85	-0.25	2.50	-0.37	-0.97	-1.02	-0.24	-1.83	2.71	-1.31	1.95	-1.77
357	300	1.35	-0.26	2.08	-0.41	-1.07	-1.00	-0.59	-1.81	2.12	-1.25	1.64	-1.74
357	400	1.09	-0.32	2.17	-0.48	-1.28	-1.02	-0.66	-1.83	1.82	-1.22	1.53	-1.74
357	500	1.19	-0.41	2.70	-0.58	-0.88	-1.07	-0.54	-1.87	1.82	-1.23	1.84	-1.75
357	600	1.26	-0.52	3.00	-0.68	-0.40	-1.13	-0.41	-1.92	1.75	-1.26	2.19	-1.77
357	700	2.43	-0.63	4.31	-0.77	1.45	-1.19	0.57	-1.96	2.95	-1.32	3.30	-1.78
357	800	3.89	-0.72	5.75	-0.85	3.58	-1.25	2.04	-2.00	4.58	-1.38	4.62	-1.80
357	900	5.61	-0.78	7.42	-0.88	6.01	-1.29	3.63	-2.04	6.22	-1.43	6.06	-1.79
357	1000	7.26	-0.80	8.88	-0.88	7.92	-1.32	5.87	-2.03	7.58	-1.47	7.30	-1.77
357	1100	8.57	-0.79	10.00	-0.84	9.00	-1.31	6.63	-1.98	8.62	-1.49	8.24	-1.72
357	1200	9.45	-0.73	10.60	-0.74	9.27	-1.28	7.26	-1.90	9.18	-1.47	8.72	-1.66
357	1300	9.71	-0.63	10.49	-0.62	9.92	-1.21	7.51	-1.78	9.26	-1.42	8.65	-1.60
357	1400	8.70	-0.52	9.14	-0.47	8.89	-1.12	7.06	-1.65	8.39	-1.34	7.85	-1.53
357	1500	8.60	-0.38	8.99	-0.30	8.72	-0.99	6.51	-1.52	8.06	-1.24	7.43	-1.44
357	1600	8.66	-0.23	8.71	-0.15	8.41	-0.85	6.40	-1.40	7.93	-1.14	7.09	-1.35
357	1700	6.77	-0.12	6.78	-0.03	6.13	-0.73	4.99	-1.31	6.40	-1.03	5.81	-1.28
357	1800	6.09	-0.02	6.56	0.07	5.32	-0.61	3.92	-1.25	5.88	-0.94	5.24	-1.21
357	1900	5.63	0.05	6.32	0.13	4.61	-0.52	3.39	-1.22	5.57	-0.85	4.96	-1.16
357	2000	4.78	0.09	5.38	0.15	3.60	-0.46	2.76	-1.22	4.84	-0.79	4.41	-1.13
357	2100	3.44	0.09	3.84	0.13	2.27	-0.43	1.80	-1.31	3.60	-0.75	3.48	-1.12
357	2200	2.54	0.07	2.93	0.08	1.41	-0.43	0.95	-1.30	2.74	-0.73	2.73	-1.12
357	2300	1.52	0.01	1.81	0.00	0.39	-0.45	0.17	-1.36	1.75	-0.74	1.93	-1.14
358	0	0.51	-0.08	0.76	-0.11	-0.61	-0.51	-0.66	-1.45	0.74	-0.77	1.09	-1.18
358	100	-0.76	-0.20	-0.60	-0.26	-1.84	-0.59	-1.58	-1.56	-0.50	-0.83	0.10	-1.24
358	200	-1.53	-0.34	-1.32	-0.43	-2.55	-0.69	-2.31	-1.69	-1.32	-0.91	-0.66	-1.30
358	300	-2.18	-0.51	-2.04	-0.62	-3.20	-0.82	-2.89	-1.84	-2.02	-1.02	-1.32	-1.39
358	400	-2.87	-0.70	-2.78	-0.84	-3.80	-0.96	-3.44	-1.99	-2.69	-1.15	-1.96	-1.50
358	500	-3.36	-0.91	-3.30	-1.06	-4.21	-1.12	-3.89	-2.14	-3.19	-1.31	-2.49	-1.61
358	600	-3.69	-1.13	-3.62	-1.29	-4.56	-1.30	-4.26	-2.30	-3.60	-1.48	-2.89	-1.75
358	700	-3.89	-1.34	-3.80	-1.53	-4.72	-1.48	-4.51	-2.46	-3.84	-1.67	-3.15	-1.89
358	800	-3.77	-1.56	-3.69	-1.76	-4.49	-1.66	-4.52	-2.64	-3.69	-1.86	-3.17	-2.03
358	900	-3.91	-1.77	-3.84	-1.99	-4.55	-1.84	-4.60	-2.81	-3.73	-2.06	-3.30	-2.18

358	1000	-3.71	-1.97	-3.56	-2.21	-4.22	-2.01	-4.61	-2.97	-3.54	-2.25	-3.23	-2.34
358	1100	-3.10	-2.16	-2.89	-2.40	-3.53	-2.17	-4.27	-3.11	-2.94	-2.45	-2.84	-2.50
358	1200	-1.94	-2.31	-1.90	-2.58	-2.22	-2.31	-3.37	-3.22	-1.81	-2.63	-2.15	-2.64
358	1300	-0.87	-2.45	-0.92	-2.72	-1.28	-2.43	-2.46	-3.30	-0.88	-2.78	-1.43	-2.77
358	1400	-0.58	-2.56	-0.41	-2.83	-1.08	-2.53	-1.97	-3.36	-0.60	-2.91	-1.04	-2.88
358	1500	-0.23	-2.64	0.02	-2.90	-0.59	-2.61	-1.45	-3.41	-0.22	-3.01	-0.64	-2.98
358	1600	-0.07	-2.69	-0.01	-2.94	-0.59	-2.67	-1.26	-3.44	-0.12	-3.10	-0.52	-3.06
358	1700	0.54	-2.72	0.59	-2.95	0.06	-2.71	-0.86	-3.45	0.34	-3.16	-0.16	-3.12
358	1800	0.63	-2.73	0.63	-2.95	0.17	-2.73	-0.59	-3.46	0.47	-3.21	0.00	-3.16
358	1900	0.02	-2.73	-0.05	-2.94	-0.51	-2.76	-0.81	-3.47	-0.02	-3.24	-0.30	-3.20
358	2000	-0.72	-2.74	-0.87	-2.93	-1.46	-2.77	-1.43	-3.48	-0.72	-3.26	-0.81	-3.23
358	2100	-1.73	-2.74	-1.79	-2.93	-2.34	-2.79	-2.14	-3.50	-1.49	-3.27	-1.45	-3.26
358	2200	-2.60	-2.77	-2.58	-2.94	-3.09	-2.80	-2.80	-3.51	-2.25	-3.29	-2.13	-3.29
358	2300	-3.21	-2.80	-3.13	-2.98	-3.57	-2.82	-3.28	-3.53	-2.76	-3.30	-2.68	-3.32
359	0	-3.63	-2.86	-3.59	-3.03	-4.03	-2.85	-3.64	-3.56	-3.21	-3.33	-3.11	-3.35
359	100	-4.24	-2.94	-4.20	-3.10	-4.59	-2.90	-4.06	-3.60	-3.82	-3.37	-3.60	-3.39
359	200	-4.70	-3.03	-4.61	-3.19	-5.03	-2.95	-4.47	-3.64	-4.31	-3.42	-4.02	-3.45
359	300	-4.83	-3.13	-4.66	-3.29	-5.11	-3.01	-4.76	-3.69	-4.46	-3.49	-4.25	-3.51
359	400	-4.86	-3.23	-4.70	-3.40	-5.17	-3.08	-4.90	-3.75	-4.55	-3.56	-4.39	-3.58
359	500	-4.69	-3.34	-4.59	-3.50	-4.99	-3.15	-4.93	-3.82	-4.44	-3.64	-4.34	-3.65
359	600	-4.19	-3.44	-4.13	-3.60	-4.51	-3.22	-4.71	-3.89	-4.00	-3.73	-4.07	-3.72
359	700	-3.47	-3.53	-3.41	-3.69	-3.77	-3.29	-4.29	-3.95	-3.30	-3.81	-3.59	-3.79
359	800	-2.77	-3.61	-2.64	-3.76	-3.11	-3.36	-3.75	-4.01	-2.60	-3.90	-3.05	-3.85
359	900	-2.41	-3.67	-2.31	-3.81	-2.79	-3.42	-3.46	-4.07	-2.23	-3.97	-2.73	-3.91
359	1000	-2.00	-3.71	-1.97	-3.85	-2.28	-3.47	-3.12	-4.12	-1.86	-4.04	-2.36	-3.96
359	1100	-0.94	-3.72	-0.78	-3.85	-1.07	-3.51	-2.34	-4.16	-0.87	-4.09	-1.64	-4.00
359	1200	0.08	-3.72	0.29	-3.84	-0.29	-3.53	-1.61	-4.18	-0.16	-4.13	-0.88	-4.03
359	1300	1.17	-3.69	1.41	-3.81	0.75	-3.54	-0.70	-4.19	0.81	-4.14	-0.03	-4.04
359	1400	2.05	-3.64	2.29	-3.75	1.43	-3.54	0.02	-4.18	1.60	-4.14	0.69	-4.05
359	1500	3.10	-3.56	3.27	-3.66	2.35	-3.52	0.69	-4.16	2.60	-4.11	1.42	-4.03
359	1600	3.61	-3.46	3.76	-3.55	2.57	-3.48	1.04	-4.13	3.14	-4.08	1.82	-4.01
359	1700	3.66	-3.35	3.91	-3.42	2.45	-3.44	1.10	-4.09	3.36	-4.02	1.93	-3.97
359	1800	3.47	-3.23	3.56	-3.29	2.20	-3.38	1.08	-4.03	3.19	-3.95	1.92	-3.93
359	1900	2.65	-3.11	2.64	-3.16	1.39	-3.32	0.68	-3.98	2.42	-3.87	1.46	-3.88
359	2000	2.15	-2.99	2.13	-3.05	0.90	-3.25	0.33	-3.92	1.94	-3.79	1.11	-3.82
359	2100	1.86	-2.90	1.60	-2.96	0.59	-3.19	0.06	-3.86	1.58	-3.70	0.85	-3.76
359	2200	1.02	-2.83	0.60	-2.89	-0.26	-3.14	-0.41	-3.81	0.78	-3.62	0.31	-3.71
359	2300	0.03	-2.78	-0.35	-2.86	-1.07	-3.10	-1.06	-3.77	-0.10	-3.56	-0.42	-3.67
360	0	-0.36	-2.76	-0.70	-2.85	-1.42	-3.07	-1.42	-3.73	-0.47	-3.50	-0.82	-3.64
360	100	-0.86	-2.76	-1.16	-2.86	-1.88	-3.05	-1.81	-3.70	-0.90	-3.47	-1.22	-3.61
360	200	-1.44	-2.78	-1.74	-2.90	-2.42	-3.05	-2.16	-3.69	-1.43	-3.45	-1.61	-3.60
360	300	-1.96	-2.82	-2.18	-2.96	-2.83	-3.07	-2.57	-3.68	-1.92	-3.44	-2.00	-3.60
360	400	-1.77	-2.87	-1.79	-3.02	-2.51	-3.09	-2.54	-3.69	-1.69	-3.45	-1.98	-3.61
360	500	-1.53	-2.93	-1.41	-3.08	-2.24	-3.12	-2.39	-3.70	-1.42	-3.47	-1.85	-3.62
360	600	-1.25	-2.99	-1.01	-3.15	-1.96	-3.15	-2.28	-3.72	-1.14	-3.50	-1.65	-3.64
360	700	-1.34	-3.05	-1.11	-3.21	-2.13	-3.19	-2.26	-3.74	-1.22	-3.53	-1.62	-3.67
360	800	-0.94	-3.09	-0.52	-3.25	-1.62	-3.22	-2.24	-3.76	-0.88	-3.57	-1.40	-3.69
360	900	0.71	-3.12	1.30	-3.27	-0.03	-3.24	-1.07	-3.78	0.73	-3.60	-0.25	-3.70
360	1000	0.26	-3.14	0.60	-3.28	-0.47	-3.27	-0.91	-3.80	0.40	-3.63	-0.24	-3.73
360	1100	1.10	-3.14	1.54	-3.27	0.42	-3.28	-0.61	-3.80	1.09	-3.65	0.23	-3.73
360	1200	2.77	-3.11	3.37	-3.23	2.03	-3.28	0.55	-3.79	2.65	-3.66	1.36	-3.72
360	1300	4.18	-3.06	4.74	-3.17	3.12	-3.26	1.65	-3.77	3.94	-3.66	2.44	-3.70
360	1400	5.11	-2.98	5.35	-3.08	3.88	-3.24	2.40	-3.74	4.65	-3.64	3.24	-3.67
360	1500	5.92	-2.88	6.11	-2.96	5.27	-3.19	3.19	-3.69	5.36	-3.60	3.75	-3.62
360	1600	6.15	-2.75	6.51	-2.81	5.35	-3.12	3.66	-3.64	5.70	-3.54	3.91	-3.57
360	1700	7.64	-2.59	8.20	-2.62	6.49	-3.03	4.41	-3.56	7.04	-3.45	4.81	-3.48
360	1800	7.11	-2.43	7.50	-2.44	5.52	-2.93	3.99	-3.48	6.49	-3.36	4.60	-3.40
360	1900	7.38	-2.26	7.56	-2.26	5.29	-2.82	3.85	-3.38	6.69	-3.24	4.66	-3.31
360	2000	6.80	-2.09	6.86	-2.08	4.24	-2.71	3.19	-3.29	6.14	-3.12	4.31	-3.22
360	2100	5.75	-1.93	5.93	-1.93	2.95	-2.61	2.29	-3.21	5.35	-3.00	3.70	-3.13
360	2200	3.90	-1.80	4.51	-1.80	1.26	-2.53	1.05	-3.13	4.05	-2.87	2.78	-3.05
360	2300	3.10	-1.69	3.83	-1.71	0.38	-2.45	0.18	-3.07	3.46	-2.76	2.25	-2.98
361	0	3.41	-1.61	3.80	-1.64	0.58	-2.39	0.06	-3.02	3.64	-2.67	2.27	-2.91

361	100	1.94	-1.57	2.19	-1.63	-0.45	-2.36	-0.30	-2.99	2.18	-2.59	1.49	-2.87
361	200	1.29	-1.56	1.88	-1.64	-0.77	-2.35	-0.85	-2.97	1.56	-2.54	0.99	-2.84
361	300	1.45	-1.57	2.45	-1.65	-1.00	-2.36	-0.89	-2.97	1.86	-2.50	1.18	-2.81
361	400	0.69	-1.61	1.94	-1.69	-1.98	-2.38	-1.45	-2.97	1.10	-2.49	0.92	-2.80
361	500	1.08	-1.65	2.70	-1.73	-1.34	-2.40	-1.25	-2.98	1.26	-2.49	1.43	-2.79
361	600	2.00	-1.68	3.73	-1.77	-0.06	-2.43	-0.31	-2.98	1.88	-2.50	2.39	-2.77
361	700	2.82	-1.72	4.34	-1.79	1.27	-2.44	0.60	-3.00	2.69	-2.51	3.19	-2.74
361	800	4.66	-1.73	6.21	-1.79	3.63	-2.46	2.06	-2.99	4.54	-2.53	4.57	-2.71
361	900	6.47	-1.71	7.90	-1.76	5.84	-2.46	3.68	-3.03	6.19	-2.54	6.10	-2.66
361	1000	8.16	-1.65	9.38	-1.68	8.03	-2.43	5.99	-2.93	7.72	-2.53	7.49	-2.59
361	1100	10.01	-1.55	10.89	-1.56	9.94	-2.38	7.45	-2.82	9.23	-2.49	8.90	-2.48
361	1200	13.15	-1.39	13.69	-1.37	13.66	-2.28	9.99	-2.70	11.48	-2.41	10.89	-2.35
361	1300	13.75	-1.18	13.86	-1.15	13.96	-2.14	10.77	-2.59	11.94	-2.30	11.32	-2.22
361	1400	13.30	-0.94	13.07	-0.90	13.39	-1.99	10.60	-2.45	11.57	-2.15	10.97	-2.07
361	1500	12.85	-0.66	12.46	-0.62	12.38	-1.79	10.07	-2.29	11.00	-1.97	10.46	-1.91
361	1600	13.94	-0.36	13.57	-0.31	13.16	-1.56	10.28	-2.11	11.89	-1.77	10.84	-1.73
361	1700	15.17	-0.05	14.51	-0.01	13.85	-1.32	11.13	-1.91	13.05	-1.56	11.43	-1.54
361	1800	14.13	0.24	12.91	0.25	12.16	-1.10	10.35	-1.74	12.12	-1.36	10.76	-1.36
361	1900	12.34	0.50	11.21	0.48	9.76	-0.89	8.62	-1.57	10.57	-1.16	9.49	-1.21
361	2000	11.52	0.75	10.56	0.70	8.42	-0.69	7.52	-1.40	10.08	-0.95	8.75	-1.06
361	2100	10.75	0.96	10.17	0.87	7.15	-0.52	6.56	-1.26	9.60	-0.76	8.30	-0.92
361	2200	9.61	1.12	9.73	1.00	6.01	-0.38	5.63	-1.14	9.09	-0.60	7.89	-0.80
361	2300	9.57	1.25	9.69	1.10	5.74	-0.27	5.25	-1.04	9.39	-0.46	7.89	-0.70
362	0	9.31	1.33	8.73	1.15	4.80	-0.20	4.80	-0.98	9.18	-0.35	7.54	-0.63
362	100	8.40	1.38	8.05	1.18	3.65	-0.16	4.13	-0.93	8.55	-0.26	7.02	-0.58
362	200	7.41	1.41	7.63	1.19	2.66	-0.15	3.52	-0.91	7.90	-0.19	6.41	-0.55
362	300	6.33	1.41	7.23	1.18	1.88	-0.17	3.02	-0.89	7.18	-0.13	5.93	-0.53
362	400	5.89	1.38	7.27	1.15	1.60	-0.19	2.91	-0.88	6.95	-0.09	5.89	-0.51
362	500	5.95	1.34	7.62	1.12	2.20	-0.22	3.23	-0.89	6.66	-0.07	6.27	-0.49
362	600	5.98	1.27	7.68	1.07	2.82	-0.28	3.63	-0.91	6.33	-0.06	6.58	-0.48
362	700	4.74	1.16	5.86	0.99	1.85	-0.36	2.81	-0.98	4.92	-0.07	5.82	-0.50
362	800	3.37	1.06	4.61	0.91	1.04	-0.43	1.84	-0.99	3.72	-0.09	4.83	-0.52
362	900	2.04	0.94	3.15	0.81	0.06	-0.51	0.61	-1.05	2.48	-0.13	3.68	-0.53
362	1000	1.28	0.81	2.27	0.70	-0.16	-0.59	0.10	-1.14	1.65	-0.20	2.75	-0.55
362	1100	0.55	0.65	1.37	0.54	-0.66	-0.69	-0.83	-1.28	0.67	-0.31	1.78	-0.60
362	1200	0.49	0.48	0.87	0.38	-0.66	-0.80	-1.47	-1.41	0.43	-0.45	0.53	-0.65
362	1300	0.64	0.30	0.74	0.11	-0.41	-0.91	-1.47	-1.53	0.45	-0.61	0.14	-0.67
362	1400	1.06	0.11	1.41	-0.14	0.16	-1.03	-1.12	-1.64	0.91	-0.77	0.43	-0.77
362	1500	1.43	-0.08	1.92	-0.34	0.46	-1.15	-0.77	-1.74	1.11	-0.94	0.75	-0.90
362	1600	1.31	-0.26	1.69	-0.51	0.18	-1.28	-0.81	-1.83	0.76	-1.10	0.70	-1.03
362	1700	1.33	-0.42	1.66	-0.65	0.10	-1.39	-0.86	-1.91	0.60	-1.25	0.45	-1.17
362	1800	-0.23	-0.57	0.10	-0.79	-1.50	-1.50	-1.97	-2.00	-0.77	-1.40	-0.37	-1.30
362	1900	0.08	-0.71	0.69	-0.91	-1.11	-1.60	-1.93	-2.08	-0.38	-1.55	-0.20	-1.42
362	2000	-0.10	-0.85	0.46	-1.03	-1.32	-1.70	-1.93	-2.16	-0.51	-1.69	-0.24	-1.53
362	2100	-0.45	-0.98	0.07	-1.15	-1.67	-1.80	-2.15	-2.24	-0.87	-1.84	-0.45	-1.64
362	2200	-0.67	-1.11	-0.19	-1.27	-1.77	-1.89	-2.27	-2.32	-1.08	-1.97	-0.59	-1.75
362	2300	-0.88	-1.24	-0.45	-1.39	-1.91	-1.99	-2.37	-2.40	-1.23	-2.10	-0.75	-1.85
363	0	-1.14	-1.36	-0.76	-1.51	-2.19	-2.08	-2.52	-2.48	-1.49	-2.22	-0.97	-1.95
363	100	-1.95	-1.49	-1.78	-1.64	-2.90	-2.17	-2.97	-2.56	-2.26	-2.34	-1.54	-2.05
363	200	-2.81	-1.61	-2.76	-1.77	-3.66	-2.27	-3.55	-2.65	-3.07	-2.45	-2.22	-2.15
363	300	-3.50	-1.74	-3.49	-1.90	-4.25	-2.35	-4.09	-2.73	-3.72	-2.55	-2.82	-2.25
363	400	-3.62	-1.88	-3.58	-2.05	-4.27	-2.44	-4.29	-2.82	-3.86	-2.67	-3.07	-2.35
363	500	-3.49	-2.02	-3.41	-2.20	-4.06	-2.53	-4.22	-2.91	-3.73	-2.78	-3.09	-2.45
363	600	-3.22	-2.16	-3.11	-2.36	-3.76	-2.62	-4.09	-3.00	-3.50	-2.90	-3.00	-2.55
363	700	-2.35	-2.30	-2.08	-2.50	-2.86	-2.70	-3.60	-3.08	-2.70	-3.02	-2.50	-2.65
363	800	-1.03	-2.41	-0.50	-2.61	-1.55	-2.78	-2.72	-3.16	-1.42	-3.14	-1.58	-2.74
363	900	-0.19	-2.50	0.37	-2.70	-0.93	-2.85	-1.99	-3.23	-0.65	-3.24	-0.87	-2.83
363	1000	0.55	-2.57	1.22	-2.75	-0.23	-2.90	-1.43	-3.28	0.04	-3.33	-0.27	-2.91
363	1100	1.69	-2.60	2.44	-2.76	0.97	-2.94	-0.64	-3.31	1.09	-3.39	0.54	-2.96
363	1200	3.13	-2.59	4.11	-2.73	2.49	-2.95	0.41	-3.33	2.50	-3.43	1.65	-2.99
363	1300	4.90	-2.54	6.05	-2.66	4.31	-2.94	1.81	-3.32	4.28	-3.44	3.03	-3.00
363	1400	6.11	-2.46	7.25	-2.55	5.35	-2.91	2.85	-3.31	5.48	-3.42	4.08	-2.99
363	1500	7.27	-2.35	8.38	-2.41	6.33	-2.86	3.82	-3.27	6.57	-3.37	5.06	-2.95

363	1600	8.23	-2.20	9.25	-2.23	7.16	-2.78	4.68	-3.21	7.48	-3.30	5.85	-2.90
363	1700	8.42	-2.02	9.44	-2.03	7.31	-2.69	5.00	-3.14	7.72	-3.20	6.21	-2.83
363	1800	8.77	-1.83	9.89	-1.81	7.63	-2.59	5.22	-3.05	8.09	-3.07	6.59	-2.73
363	1900	8.53	-1.63	9.43	-1.58	7.02	-2.47	5.07	-2.96	7.74	-2.92	6.44	-2.63
363	2000	8.33	-1.42	9.13	-1.36	6.13	-2.35	4.46	-2.85	7.30	-2.76	6.01	-2.52
363	2100	6.64	-1.24	7.18	-1.18	4.32	-2.24	3.41	-2.75	5.82	-2.60	5.04	-2.41
363	2200	5.87	-1.07	6.80	-1.01	3.41	-2.13	2.53	-2.64	5.24	-2.44	4.51	-2.30
363	2300	5.32	-0.92	6.44	-0.87	2.76	-2.03	2.02	-2.55	4.98	-2.29	4.18	-2.20
364	0	4.75	-0.82	5.23	-0.78	1.83	-1.95	1.43	-2.47	4.34	-2.17	3.71	-2.11
364	100	1.76	-0.77	1.80	-0.76	-0.79	-1.91	-0.18	-2.45	1.45	-2.06	1.86	-2.06
364	200	0.55	-0.75	0.62	-0.76	-1.34	-1.88	-1.12	-2.45	0.27	-1.99	0.82	-2.02
364	300	-0.04	-0.76	0.10	-0.80	-1.56	-1.87	-1.55	-2.49	-0.28	-1.94	0.25	-2.00
364	400	-0.75	-0.82	-0.59	-0.89	-2.14	-1.88	-2.06	-2.49	-0.99	-1.92	-0.32	-1.99
364	500	-0.84	-0.92	-0.63	-1.00	-2.10	-1.91	-2.30	-2.47	-1.16	-1.94	-0.58	-2.01
364	600	-0.51	-1.03	-0.14	-1.12	-1.65	-1.96	-2.11	-2.45	-0.83	-1.98	-0.44	-2.03
364	700	-0.20	-1.15	0.38	-1.25	-1.17	-2.02	-1.90	-2.49	-0.43	-2.04	-0.19	-2.07
364	800	1.54	-1.26	2.58	-1.35	0.94	-2.07	-0.59	-2.52	1.46	-2.11	1.23	-2.11
364	900	2.81	-1.35	3.93	-1.43	2.50	-2.11	0.52	-2.56	2.77	-2.19	2.45	-2.14
364	1000	5.73	-1.39	7.11	-1.46	5.59	-2.14	2.85	-2.60	5.45	-2.25	4.57	-2.16
364	1100	7.83	-1.39	8.94	-1.43	8.01	-2.14	4.85	-2.56	7.43	-2.29	6.42	-2.15
364	1200	8.89	-1.34	9.68	-1.35	9.26	-2.12	6.01	-2.54	8.24	-2.28	7.35	-2.13
364	1300	9.68	-1.24	10.37	-1.22	10.13	-2.07	6.73	-2.50	8.67	-2.24	7.82	-2.09

[redacted]

Time	5cm Control	s.d.	5 cm JP-5	s.d.	20 cm Control	s.d.	20 cm JP-5	s.d.
345.63	4.2	0.5	1.4	1.6	-4.7	0.3	-5.5	0.7
345.67	3.2	1.8	2.3	1.5	-4.6	0.3	-5.6	0.7
345.71	0.7	1.5	2.5	1.3	-4.9	0.3	-5.6	0.7
345.75	1.2	1.6	0.6	1.0	-5.1	0.6	-5.5	0.6
345.79	1.2	1.6	0.1	1.0	-5.1	0.6	-5.4	0.6
345.83	1.0	1.4	-0.6	1.0	-5.1	0.6	-5.4	0.6
345.88	0.5	1.1	-1.3	1.1	-5.2	0.6	-5.4	0.6
345.92	0.0	0.8	-2.1	1.3	-5.2	0.6	-5.5	0.6
345.96	-0.7	0.6	-3.0	1.5	-5.2	0.7	-5.5	0.6
346.00	-1.6	0.3	-4.0	1.8	-5.2	0.7	-5.6	0.6
346.04	-2.8	0.2	-5.1	2.0	-5.3	0.7	-5.6	0.6
346.08	-4.1	0.5	-6.1	2.1	-5.4	0.7	-5.7	0.6
346.13	-5.0	0.6	-7.1	2.0	-5.5	0.6	-5.8	0.6
346.17	-5.7	0.6	-7.8	1.6	-5.6	0.6	-5.9	0.6
346.21	-5.8	0.5	-8.0	1.4	-5.7	0.6	-6.0	0.6
346.25	-5.6	0.5	-7.7	1.1	-5.8	0.5	-6.1	0.6
346.29	-5.0	0.4	-7.0	1.0	-5.9	0.5	-6.2	0.6
346.33	-4.3	0.4	-6.2	1.0	-6.0	0.5	-6.4	0.6
346.38	-3.6	0.5	-5.3	1.2	-6.1	0.5	-6.5	0.6
346.42	-2.9	0.4	-4.3	1.6	-6.2	0.4	-6.6	0.5
346.46	-2.4	0.4	-1.9	1.3	-6.3	0.4	-6.7	0.5
346.50	-1.5	0.5	1.0	3.4	-6.3	0.4	-6.8	0.4
346.54	-1.7	0.1	0.2	3.5	-6.4	0.4	-6.8	0.4
346.58	-0.4	0.3	-1.2	2.7	-6.4	0.4	-6.9	0.3
346.63	0.8	0.8	-1.2	1.3	-6.4	0.4	-6.9	0.3
346.67	1.3	1.0	-0.5	0.8	-6.4	0.4	-6.8	0.2
346.71	2.3	1.4	1.2	1.4	-6.4	0.4	-6.8	0.3
346.75	3.0	1.6	2.1	1.5	-6.3	0.5	-6.7	0.3
346.79	3.2	1.6	2.1	1.5	-6.3	0.5	-6.7	0.3
346.83	2.8	1.4	1.5	1.4	-6.2	0.5	-6.7	0.3
346.88	2.3	1.2	0.8	1.4	-6.1	0.6	-6.6	0.3
346.92	1.5	1.2	0.2	1.6	-6.0	0.6	-6.6	0.3
346.96	2.0	1.0	0.1	2.1	-6.0	0.6	-6.5	0.3
347.00	1.3	0.7	-0.7	2.1	-5.9	0.6	-6.5	0.3
347.04	0.1	0.4	-1.8	1.9	-5.8	0.6	-6.4	0.4
347.08	-0.7	0.2	-2.6	1.7	-5.8	0.7	-6.4	0.4
347.13	-1.2	0.3	-3.0	1.5	-5.8	0.7	-6.4	0.4
347.17	-1.3	0.4	-3.2	1.3	-5.8	0.6	-6.3	0.4
347.21	-1.1	0.5	-3.1	1.0	-5.8	0.6	-6.3	0.5
347.25	-0.6	0.6	-2.5	0.9	-5.8	0.6	-6.3	0.5
347.29	0.3	0.8	-1.5	0.9	-5.8	0.6	-6.3	0.5
347.33	1.9	1.0	0.1	1.0	-5.8	0.6	-6.3	0.5
347.38	3.9	1.3	2.4	1.2	-5.7	0.6	-6.3	0.5
347.42	5.0	1.3	3.4	1.1	-5.7	0.6	-6.3	0.5
347.46	6.7	1.5	5.2	1.5	-5.6	0.6	-6.3	0.4
347.50	9.5	1.9	8.8	2.1	-5.4	0.7	-6.2	0.4
347.54	11.7	2.2	11.7	2.5	-5.3	0.7	-6.1	0.4
347.58	13.1	2.3	13.8	2.5	-5.0	0.8	-6.0	0.4
347.63	13.6	2.4	14.2	2.0	-4.8	0.8	-5.8	0.4
347.67	13.7	2.4	13.8	1.9	-4.5	0.9	-5.6	0.3
347.71	14.2	2.6	13.6	2.5	-4.3	1.0	-5.4	0.3
347.75	13.7	2.5	13.4	2.0	-4.0	1.1	-5.2	0.4
347.79	13.3	2.5	12.8	1.9	-3.7	1.2	-4.9	0.4
347.83	13.0	2.4	10.6	2.3	-3.4	1.2	-4.6	0.4
347.88	12.4	2.0	8.6	3.8	-3.1	1.3	-4.4	0.5

347.92	11.3	1.6	7.3	4.7	-2.9	1.3	-4.2	0.5
347.96	10.1	1.2	6.6	4.2	-2.7	1.4	-4.0	0.6
348.00	8.8	1.0	5.7	3.8	-2.5	1.4	-3.8	0.6
348.04	7.5	0.6	4.7	3.7	-2.4	1.4	-3.7	0.7
348.08	6.4	0.2	3.8	3.5	-2.3	1.4	-3.6	0.7
348.13	5.8	0.4	3.2	3.3	-2.2	1.3	-3.5	0.8
348.17	5.6	0.6	2.9	3.0	-2.2	1.3	-3.5	0.8
348.21	5.4	0.8	2.9	2.5	-2.2	1.2	-3.4	0.9
348.25	5.6	0.9	3.2	1.9	-2.2	1.2	-3.4	0.9
348.29	6.5	1.0	4.5	1.4	-2.2	1.1	-3.4	0.9
348.33	7.5	0.9	5.6	1.2	-2.3	1.1	-3.4	0.9
348.38	8.2	1.1	6.0	1.0	-2.3	1.0	-3.4	0.9
348.42	8.5	1.1	6.3	0.8	-2.3	1.0	-3.4	0.9
348.46	9.0	1.3	7.1	0.4	-2.2	0.9	-3.4	0.9
348.50	9.6	1.4	7.7	0.6	-2.2	0.9	-3.3	0.9
348.54	10.0	1.6	8.6	0.9	-2.1	0.9	-3.3	0.9
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348.71	9.9	1.8	9.4	1.1	-1.7	1.0	-3.0	0.8
348.75	9.2	1.5	9.1	0.8	-1.6	1.0	-2.8	0.7
348.79	8.4	1.2	8.3	1.0	-1.5	1.0	-2.8	0.7
348.83	7.5	0.9	7.2	1.2	-1.4	1.1	-2.7	0.7
348.88	6.2	0.6	5.9	1.5	-1.3	1.0	-2.6	0.7
348.92	4.7	0.7	4.4	1.7	-1.1	0.8	-2.5	0.6
348.96	3.5	0.5	3.0	1.4	-1.1	0.7	-2.5	0.7
349.00	2.7	0.3	2.1	1.1	-1.2	0.8	-2.5	0.7
349.04	2.0	0.3	1.5	1.0	-1.3	0.8	-2.5	0.7
349.08	1.4	0.1	0.8	0.9	-1.4	0.8	-2.5	0.6
349.13	1.0	0.1	0.5	0.8	-1.5	0.8	-2.6	0.6
349.17	0.9	0.2	0.4	0.7	-1.7	0.7	-2.6	0.6
349.21	1.2	0.4	0.9	0.7	-1.8	0.7	-2.7	0.6
349.25	2.2	0.8	1.8	0.7	-2.0	0.7	-2.8	0.6
349.29	2.8	0.8	2.4	0.8	-2.1	0.7	-2.9	0.5
349.33	3.8	1.0	3.4	0.9	-2.2	0.7	-2.9	0.5
349.38	5.5	1.3	5.4	1.0	-2.3	0.7	-3.0	0.5
349.42	5.8	1.0	6.0	0.7	-2.3	0.7	-3.0	0.5
349.46	6.6	1.1	6.7	0.8	-2.4	0.7	-3.0	0.4
349.50	7.8	1.4	8.3	1.1	-2.3	0.7	-3.0	0.4
349.54	8.3	1.4	9.3	1.2	-2.3	0.7	-3.0	0.4
349.58	8.7	1.4	10.0	1.2	-2.2	0.7	-2.9	0.4
349.63	8.9	1.5	10.3	1.1	-2.1	0.8	-2.8	0.3
349.67	8.9	1.5	10.3	1.1	-2.0	0.8	-2.7	0.3
349.71	8.6	1.4	9.7	0.9	-1.9	0.9	-2.6	0.3
349.75	7.3	0.9	8.1	0.7	-1.7	0.9	-2.5	0.3
349.79	7.2	1.1	7.7	1.1	-1.6	0.9	-2.4	0.3
349.83	6.6	0.9	6.8	1.2	-1.6	1.0	-2.3	0.4
349.88	5.4	0.7	5.2	1.3	-1.5	1.0	-2.2	0.4
349.92	3.4	0.1	3.1	1.1	-1.5	1.0	-2.2	0.4
349.96	2.1	0.2	1.7	0.8	-1.5	1.0	-2.1	0.4
350.00	0.6	0.4	0.3	0.8	-1.5	0.9	-2.1	0.4
350.04	-0.5	0.5	-0.8	0.7	-1.6	0.9	-2.2	0.4
350.08	-1.1	0.4	-1.4	0.6	-1.8	0.9	-2.2	0.4
350.13	-1.6	0.4	-1.8	0.5	-1.9	0.8	-2.3	0.4
350.17	-1.6	0.1	-2.1	0.6	-2.1	0.8	-2.4	0.4
350.21	-0.8	0.4	-1.4	0.7	-2.3	0.7	-2.6	0.4
350.25	0.5	0.7	-0.1	0.7	-2.4	0.7	-2.7	0.4
350.29	1.5	0.7	1.1	0.6	-2.6	0.6	-2.8	0.4
350.33	2.4	0.7	2.0	0.6	-2.7	0.6	-2.9	0.4
350.38	3.2	0.8	3.0	0.7	-2.8	0.6	-3.0	0.3
350.42	4.2	0.9	4.1	0.8	-2.8	0.6	-3.1	0.3
350.46	5.0	1.0	5.5	0.4	-2.9	0.6	-3.1	0.3
350.50	5.9	1.1	6.1	0.9	-2.8	0.6	-3.1	0.2

350.54	6.6	1.3	7.0	1.0	-2.8	0.6	-3.1	0.2
350.58	7.2	1.3	8.0	1.1	-2.7	0.6	-3.0	0.2
350.63	7.8	1.5	8.8	1.3	-2.6	0.7	-2.9	0.2
350.67	8.2	1.5	9.3	1.3	-2.5	0.7	-2.8	0.3
350.71	8.3	1.5	9.3	1.2	-2.3	0.8	-2.7	0.3
350.75	8.1	1.4	9.1	1.2	-2.2	0.8	-2.6	0.3
350.79	7.7	1.2	8.5	1.1	-2.0	0.9	-2.5	0.3
350.83	7.3	1.1	7.6	1.2	-1.9	0.9	-2.4	0.3
350.88	6.8	1.0	6.8	1.4	-1.8	0.9	-2.3	0.3
350.92	6.1	0.9	5.8	1.6	-1.7	1.0	-2.2	0.3
350.96	4.9	0.5	4.5	1.8	-1.6	1.0	-2.1	0.3
351.00	3.9	0.1	3.4	1.9	-1.6	1.0	-2.1	0.3
351.04	3.5	0.1	2.7	2.0	-1.6	1.0	-2.0	0.4
351.08	3.0	0.2	2.1	2.1	-1.6	0.9	-2.0	0.4
351.13	3.5	0.6	2.2	2.2	-1.6	0.9	-2.0	0.4
351.17	4.0	0.8	2.5	2.3	-1.7	0.9	-2.1	0.4
351.21	4.6	0.9	3.3	2.0	-1.7	0.8	-2.1	0.4
351.25	5.5	1.0	4.4	1.4	-1.8	0.8	-2.1	0.4
351.29	5.4	0.5	4.5	1.3	-1.8	0.8	-2.2	0.4
351.33	5.5	0.4	4.9	1.1	-1.9	0.8	-2.2	0.4
351.38	5.9	0.5	5.7	0.9	-1.9	0.7	-2.2	0.4
351.42	6.3	0.5	6.6	0.6	-1.9	0.7	-2.2	0.4
351.46	6.3	0.3	7.2	0.7	-1.8	0.7	-2.2	0.3
351.50	6.9	0.6	7.7	1.2	-1.8	0.7	-2.2	0.3
351.54	7.1	0.6	8.3	1.0	-1.8	0.6	-2.2	0.3
351.58	7.2	0.6	8.4	1.0	-1.7	0.6	-2.1	0.3
351.63	7.5	0.8	8.6	1.0	-1.7	0.7	-2.1	0.3
351.67	7.6	1.0	8.5	0.9	-1.6	0.7	-2.0	0.3
351.71	7.7	1.1	8.5	1.1	-1.5	0.7	-1.9	0.4
351.75	7.1	1.0	7.8	1.1	-1.5	0.7	-1.8	0.4
351.79	6.4	1.0	6.7	1.2	-1.4	0.7	-1.8	0.4
351.83	5.5	0.8	5.6	1.4	-1.4	0.7	-1.7	0.4
351.88	4.5	0.6	4.3	1.6	-1.3	0.8	-1.7	0.4
351.92	3.3	0.5	2.9	1.8	-1.3	0.8	-1.7	0.4
351.96	2.1	0.3	1.4	2.0	-1.4	0.8	-1.7	0.4
352.00	0.9	0.1	0.1	2.2	-1.4	0.8	-1.7	0.4
352.04	0.0	0.2	-1.0	2.2	-1.5	0.7	-1.8	0.4
352.08	-0.7	0.3	-1.7	2.2	-1.6	0.7	-1.8	0.4
352.13	-1.3	0.5	-2.4	2.3	-1.8	0.7	-1.9	0.4
352.17	-1.8	0.6	-3.0	2.3	-1.9	0.6	-2.0	0.4
352.21	-1.7	0.7	-2.7	2.0	-2.1	0.6	-2.2	0.4
352.25	-1.2	0.7	-2.0	1.7	-2.3	0.5	-2.3	0.4
352.29	-0.2	0.8	-0.7	1.6	-2.4	0.5	-2.5	0.4
352.33	1.3	0.8	1.2	1.4	-2.6	0.4	-2.6	0.4
352.38	3.1	0.9	3.3	1.5	-2.7	0.4	-2.7	0.4
352.42	4.7	0.9	5.2	1.7	-2.7	0.4	-2.8	0.4
352.46	6.4	1.0	7.1	1.9	-2.7	0.4	-2.8	0.3
352.50	8.0	1.2	9.0	2.0	-2.7	0.4	-2.9	0.3
352.54	9.6	1.4	11.1	2.0	-2.6	0.4	-2.8	0.3
352.58	10.4	1.5	12.1	1.7	-2.5	0.5	-2.8	0.3
352.63	11.1	1.6	12.8	1.6	-2.3	0.5	-2.6	0.3
352.67	11.4	1.7	12.8	1.6	-2.1	0.6	-2.5	0.3
352.71	11.1	1.7	12.3	1.3	-1.9	0.7	-2.3	0.3
352.75	11.0	1.7	11.8	1.4	-1.7	0.7	-2.1	0.3
352.79	9.6	1.3	10.1	1.0	-1.5	0.8	-1.9	0.4
352.83	7.0	0.5	7.3	0.9	-1.3	0.8	-1.8	0.4
352.88	8.3	1.1	8.3	1.4	-1.1	0.9	-1.6	0.4
352.92	9.7	1.4	9.7	1.8	-1.0	0.9	-1.4	0.4
352.96	8.1	0.7	8.2	1.5	-0.9	0.9	-1.3	0.4
353.00	6.3	0.3	6.6	1.0	-0.9	0.9	-1.3	0.4
353.04	4.8	0.1	5.0	0.9	-0.8	0.9	-1.2	0.4
353.08	3.4	0.1	3.5	0.8	-0.8	0.9	-1.1	0.4
353.13	2.3	0.2	2.3	0.7	-0.8	0.9	-1.1	0.4

353.17	1.7	0.2	1.6	0.5	-0.9	0.8	-1.1	0.4
353.21	1.8	0.0	1.8	0.5	-0.9	0.8	-1.2	0.4
353.25	2.7	0.3	2.9	0.6	-1.0	0.7	-1.2	0.4
353.29	3.9	0.5	4.3	0.8	-1.1	0.7	-1.3	0.4
353.33	6.0	1.0	6.6	1.2	-1.2	0.6	-1.3	0.4
353.38	7.8	1.2	8.7	1.2	-1.2	0.6	-1.4	0.3
353.42	9.8	1.3	11.0	1.8	-1.2	0.6	-1.4	0.3
353.46	12.5	1.7	14.9	1.8	-1.2	0.7	-1.4	0.3
353.50	11.8	1.2	13.4	0.7	-1.1	0.7	-1.3	0.3
353.54	10.8	1.0	12.3	0.9	-1.0	0.7	-1.2	0.3
353.58	10.1	1.0	11.6	1.2	-0.8	0.8	-1.1	0.3
353.63	9.9	1.2	11.3	1.2	-0.6	0.8	-1.0	0.3
353.67	9.8	1.3	10.9	1.3	-0.5	0.9	-0.8	0.3
353.71	9.6	1.3	10.5	1.2	-0.4	0.9	-0.7	0.4
353.75	9.1	1.3	9.7	1.2	-0.3	0.9	-0.6	0.4
353.79	9.6	1.6	10.0	1.6	-0.2	0.9	-0.5	0.4
353.83	9.2	1.3	9.4	1.3	-0.1	0.9	-0.5	0.4
353.88	7.7	0.8	7.8	1.1	0.0	0.9	-0.4	0.4
353.92	6.9	0.8	6.8	1.2	0.0	1.0	-0.4	0.4
353.96	6.0	0.6	5.7	1.5	0.0	0.9	-0.3	0.4
354.00	4.6	0.2	4.5	1.2	0.0	0.9	-0.3	0.4
354.04	3.8	0.1	3.8	0.9	0.0	0.9	-0.3	0.4
354.08	2.2	0.2	2.3	0.9	-0.1	0.9	-0.4	0.4
354.13	0.7	0.4	0.8	0.9	-0.2	0.8	-0.4	0.4
354.17	-0.2	0.4	-0.2	0.8	-0.3	0.8	-0.5	0.4
354.21	0.3	0.2	0.2	0.7	-0.5	0.7	-0.6	0.4
354.25	1.2	0.4	1.1	0.8	-0.6	0.7	-0.7	0.4
354.29	1.9	0.5	1.8	0.8	-0.8	0.6	-0.8	0.4
354.33	3.1	0.7	3.0	1.0	-0.9	0.6	-1.0	0.3
354.38	4.3	0.9	4.3	1.3	-1.1	0.5	-1.1	0.3
354.42	4.6	0.8	4.6	1.1	-1.2	0.5	-1.2	0.3
354.46	4.8	0.7	4.9	1.0	-1.2	0.5	-1.3	0.3
354.50	5.3	0.8	5.4	1.2	-1.2	0.5	-1.3	0.3
354.54	6.3	1.0	6.8	1.4	-1.3	0.5	-1.4	0.3
354.58	7.7	1.3	8.3	1.6	-1.2	0.5	-1.4	0.3
354.63	9.1	1.5	9.8	2.0	-1.2	0.6	-1.4	0.3
354.67	10.9	1.9	11.8	2.0	-1.1	0.6	-1.4	0.3
354.71	12.3	2.2	13.3	2.1	-1.0	0.7	-1.3	0.3
354.75	12.0	2.0	13.0	1.3	-0.8	0.7	-1.2	0.3
354.79	11.1	1.6	11.4	1.1	-0.7	0.8	-1.1	0.3
354.83	10.7	1.6	10.7	1.2	-0.5	0.9	-1.0	0.3
354.88	9.3	1.1	8.9	1.3	-0.3	0.9	-0.9	0.3
354.92	7.6	0.6	7.0	1.5	-0.2	1.0	-0.8	0.4
354.96	6.2	0.3	5.6	1.6	-0.1	1.0	-0.7	0.4
355.00	5.0	0.2	4.5	1.7	-0.1	1.0	-0.6	0.4
355.04	4.6	0.2	3.9	1.8	0.0	1.0	-0.5	0.4
355.08	3.9	0.2	3.1	1.9	-0.1	0.9	-0.5	0.4
355.13	3.6	0.5	2.4	2.0	-0.1	0.9	-0.5	0.4
355.17	3.3	0.6	2.0	2.0	-0.2	0.9	-0.5	0.4
355.21	3.3	0.8	1.9	1.7	-0.3	0.8	-0.6	0.4
355.25	4.2	0.9	2.9	1.3	-0.3	0.8	-0.7	0.4
355.29	4.6	0.5	3.8	1.1	-0.4	0.7	-0.7	0.4
355.33	5.6	0.5	5.3	1.1	-0.5	0.7	-0.8	0.4
355.38	8.1	0.9	8.4	1.7	-0.5	0.6	-0.8	0.4
355.42	10.5	1.1	11.8	1.7	-0.5	0.6	-0.9	0.4
355.46	10.7	0.8	12.7	1.5	-0.5	0.6	-0.9	0.3
355.50	11.3	1.1	12.7	1.4	-0.4	0.6	-0.8	0.3
355.54	12.3	1.4	13.4	1.4	-0.3	0.7	-0.7	0.3
355.58	12.4	1.3	13.1	1.0	-0.1	0.7	-0.6	0.3
355.63	12.3	1.4	12.8	1.0	0.2	0.5	-0.5	0.3
355.67	11.7	1.5	12.2	0.9	0.6	0.1	-0.4	0.3
355.71	10.1	1.0	10.1	0.8	0.8	0.1	-0.2	0.3
355.75	8.1	0.4	7.5	1.4	0.9	0.2	-0.1	0.2

355.79	6.7	0.3	6.0	1.3	0.9	0.3	0.0	0.3
355.83	7.1	0.7	6.0	1.8	0.9	0.4	0.1	0.3
355.88	5.9	0.4	4.7	1.7	0.9	0.5	0.1	0.4
355.92	3.7	0.2	2.6	1.4	0.8	0.5	0.1	0.4
355.96	1.9	0.5	0.9	1.1	0.7	0.5	0.0	0.5
356.00	0.3	0.7	-0.6	1.0	0.6	0.5	-0.1	0.5
356.04	-0.8	0.7	-1.7	0.9	0.4	0.5	-0.2	0.6
356.08	-1.7	0.7	-2.7	0.8	0.2	0.4	-0.3	0.6
356.13	-2.5	0.7	-3.4	0.7	0.0	0.3	-0.5	0.7
356.17	-3.0	0.7	-3.9	0.7	-0.3	0.3	-0.7	0.7
356.21	-3.5	0.7	-4.3	0.6	-0.5	0.2	-0.9	0.7
356.25	-3.7	0.6	-4.6	0.6	-0.8	0.2	-1.2	0.7
356.29	-3.6	0.5	-4.5	0.7	-1.1	0.1	-1.4	0.7
356.33	-3.0	0.3	-4.0	0.9	-1.4	0.1	-1.6	0.7
356.38	-1.9	0.4	-2.9	1.1	-1.6	0.1	-1.8	0.6
356.42	-0.7	0.6	-1.8	1.2	-1.8	0.1	-2.0	0.6
356.46	1.1	0.9	0.0	1.5	-2.0	0.1	-2.2	0.6
356.50	2.5	1.0	1.5	1.6	-2.1	0.1	-2.3	0.5
356.54	4.0	1.3	3.0	1.7	-2.2	0.1	-2.4	0.5
356.58	5.7	1.4	4.9	1.9	-2.2	0.1	-2.5	0.4
356.63	7.3	1.7	6.8	2.0	-2.2	0.2	-2.5	0.4
356.67	8.4	1.9	8.0	2.0	-2.1	0.3	-2.4	0.4
356.71	9.5	2.2	9.0	2.0	-2.0	0.3	-2.4	0.4
356.75	9.8	2.2	9.3	1.8	-1.8	0.4	-2.3	0.4
356.79	9.8	2.2	9.2	1.7	-1.7	0.5	-2.2	0.4
356.83	9.7	2.2	8.9	1.6	-1.5	0.6	-2.0	0.4
356.88	9.1	1.9	8.1	1.7	-1.3	0.7	-1.9	0.4
356.92	8.1	1.6	7.0	1.8	-1.1	0.8	-1.8	0.4
356.96	6.1	0.9	4.9	1.8	-1.0	0.8	-1.6	0.4
357.00	4.3	0.5	2.9	2.0	-0.9	0.8	-1.5	0.4
357.04	3.1	0.3	1.7	1.9	-0.8	0.9	-1.4	0.4
357.08	2.1	0.4	0.5	1.9	-0.8	0.8	-1.4	0.4
357.13	1.7	0.4	0.2	1.7	-0.8	0.8	-1.4	0.4
357.17	1.6	0.5	0.0	1.6	-0.8	0.8	-1.4	0.4
357.21	1.9	0.8	0.1	1.5	-0.9	0.7	-1.4	0.4
357.25	2.2	0.9	0.3	1.2	-1.0	0.7	-1.4	0.4
357.29	3.3	0.9	1.7	1.2	-1.1	0.6	-1.5	0.4
357.33	4.8	0.9	3.4	1.3	-1.1	0.6	-1.5	0.4
357.38	6.4	0.9	5.3	1.4	-1.2	0.6	-1.6	0.4
357.42	7.8	0.9	7.1	1.1	-1.2	0.5	-1.6	0.4
357.46	8.9	0.9	8.1	1.3	-1.1	0.5	-1.6	0.3
357.50	9.6	0.9	8.6	1.1	-1.0	0.5	-1.5	0.3
357.54	9.6	0.9	8.9	1.2	-0.9	0.6	-1.5	0.3
357.58	8.6	0.7	8.1	0.9	-0.8	0.6	-1.4	0.3
357.63	8.3	0.8	7.8	1.1	-0.7	0.6	-1.2	0.3
357.67	8.2	0.9	7.6	1.0	-0.6	0.7	-1.1	0.3
357.71	6.5	0.6	5.8	0.8	-0.5	0.7	-1.0	0.3
357.75	6.0	0.7	5.0	1.0	-0.4	0.7	-0.9	0.3
357.79	5.6	0.7	4.5	1.1	-0.3	0.7	-0.9	0.4
357.83	4.9	0.5	3.7	1.0	-0.3	0.7	-0.8	0.4
357.88	3.6	0.2	2.6	0.9	-0.3	0.7	-0.8	0.4
357.92	2.7	0.2	1.7	0.9	-0.3	0.7	-0.8	0.4
357.96	1.8	0.2	0.8	0.9	-0.4	0.7	-0.8	0.5
358.00	0.8	0.3	-0.2	0.8	-0.5	0.6	-0.9	0.5
358.04	-0.4	0.5	-1.3	0.7	-0.6	0.6	-1.0	0.5
358.08	-1.2	0.5	-2.1	0.7	-0.7	0.5	-1.1	0.5
358.13	-1.8	0.5	-2.7	0.6	-0.8	0.5	-1.2	0.5
358.17	-2.5	0.5	-3.3	0.6	-1.0	0.4	-1.4	0.5
358.21	-3.0	0.5	-3.8	0.5	-1.2	0.4	-1.5	0.5
358.25	-3.4	0.4	-4.1	0.5	-1.4	0.3	-1.7	0.5
358.29	-3.6	0.4	-4.4	0.5	-1.6	0.3	-1.9	0.5
358.33	-3.5	0.3	-4.2	0.5	-1.8	0.2	-2.1	0.5
358.38	-3.7	0.3	-4.3	0.5	-2.0	0.2	-2.2	0.5

358.42	-3.5	0.2	-4.1	0.5	-2.2	0.2	-2.4	0.5
358.46	-2.9	0.1	-3.6	0.7	-2.4	0.2	-2.6	0.5
358.50	-2.0	0.1	-2.5	0.8	-2.5	0.2	-2.7	0.5
358.54	-1.1	0.3	-1.5	0.8	-2.6	0.2	-2.8	0.4
358.58	-0.7	0.3	-1.2	0.7	-2.8	0.2	-2.9	0.4
358.63	-0.3	0.3	-0.8	0.6	-2.8	0.2	-3.0	0.4
358.67	-0.2	0.3	-0.7	0.6	-2.9	0.2	-3.1	0.4
358.71	0.3	0.4	-0.2	0.6	-2.9	0.2	-3.1	0.4
358.75	0.4	0.4	0.0	0.5	-2.9	0.2	-3.1	0.4
358.79	-0.1	0.2	-0.4	0.4	-3.0	0.2	-3.2	0.4
358.83	-0.8	0.1	-1.2	0.4	-3.0	0.2	-3.2	0.4
358.88	-1.7	0.2	-2.0	0.4	-3.0	0.3	-3.2	0.4
358.92	-2.4	0.3	-2.7	0.4	-3.0	0.3	-3.2	0.4
358.96	-3.0	0.3	-3.2	0.4	-3.0	0.3	-3.2	0.4
359.00	-3.4	0.3	-3.6	0.4	-3.1	0.2	-3.2	0.4
359.04	-4.0	0.4	-4.2	0.4	-3.1	0.2	-3.3	0.4
359.08	-4.4	0.4	-4.6	0.4	-3.2	0.2	-3.3	0.4
359.13	-4.6	0.3	-4.8	0.3	-3.3	0.2	-3.4	0.4
359.17	-4.6	0.2	-4.9	0.3	-3.4	0.2	-3.5	0.3
359.21	-4.5	0.2	-4.8	0.3	-3.5	0.2	-3.5	0.3
359.25	-4.1	0.1	-4.4	0.4	-3.6	0.1	-3.6	0.3
359.29	-3.5	0.1	-3.8	0.5	-3.7	0.1	-3.7	0.3
359.33	-2.8	0.2	-3.2	0.6	-3.7	0.1	-3.8	0.3
359.38	-2.5	0.2	-2.8	0.6	-3.8	0.1	-3.8	0.4
359.42	-2.1	0.2	-2.4	0.6	-3.8	0.1	-3.9	0.4
359.46	-1.1	0.5	-1.4	0.8	-3.9	0.1	-3.9	0.4
359.50	-0.2	0.6	-0.7	0.8	-3.9	0.2	-3.9	0.4
359.54	0.9	0.8	0.3	0.9	-3.8	0.2	-4.0	0.4
359.58	1.7	0.9	1.0	0.9	-3.8	0.2	-4.0	0.4
359.63	2.6	1.0	1.9	1.0	-3.8	0.2	-3.9	0.4
359.67	3.1	1.1	2.3	1.1	-3.7	0.3	-3.9	0.4
359.71	3.2	1.1	2.3	1.1	-3.6	0.3	-3.8	0.4
359.75	3.0	0.9	2.2	1.1	-3.5	0.4	-3.8	0.4
359.79	2.3	0.7	1.5	0.9	-3.4	0.4	-3.7	0.4
359.83	1.8	0.6	1.1	0.8	-3.3	0.5	-3.7	0.4
359.88	1.4	0.5	0.7	0.8	-3.2	0.5	-3.6	0.4
359.92	0.6	0.4	0.0	0.6	-3.1	0.5	-3.5	0.3
359.96	-0.2	0.2	-0.7	0.6	-3.1	0.5	-3.5	0.3
360.00	-0.6	0.2	-1.1	0.5	-3.1	0.5	-3.4	0.3
360.04	-1.1	0.2	-1.5	0.5	-3.1	0.5	-3.4	0.3
360.08	-1.6	0.1	-2.0	0.5	-3.1	0.4	-3.4	0.3
360.13	-2.0	0.1	-2.4	0.5	-3.1	0.4	-3.4	0.3
360.17	-1.8	0.1	-2.2	0.5	-3.2	0.4	-3.4	0.3
360.21	-1.6	0.2	-2.0	0.5	-3.2	0.4	-3.4	0.3
360.25	-1.3	0.3	-1.8	0.6	-3.3	0.3	-3.5	0.3
360.29	-1.4	0.3	-1.9	0.6	-3.3	0.3	-3.5	0.3
360.33	-1.0	0.4	-1.6	0.7	-3.3	0.3	-3.5	0.3
360.38	0.6	0.8	-0.1	0.9	-3.4	0.3	-3.5	0.3
360.42	0.2	0.4	-0.3	0.7	-3.4	0.3	-3.6	0.3
360.46	1.0	0.7	0.3	0.9	-3.4	0.3	-3.6	0.3
360.50	2.5	1.0	1.7	1.1	-3.4	0.3	-3.6	0.3
360.54	3.8	1.2	2.9	1.2	-3.3	0.3	-3.6	0.3
360.58	4.6	1.2	3.6	1.1	-3.2	0.4	-3.5	0.3
360.63	5.3	1.3	4.6	1.2	-3.2	0.4	-3.5	0.3
360.67	5.5	1.4	4.9	1.1	-3.0	0.5	-3.4	0.3
360.71	6.9	1.8	6.0	1.4	-2.9	0.5	-3.3	0.3
360.75	6.4	1.6	5.3	1.3	-2.8	0.6	-3.3	0.3
360.79	6.5	1.6	5.3	1.4	-2.6	0.6	-3.1	0.3
360.83	6.0	1.5	4.5	1.5	-2.5	0.7	-3.0	0.3
360.88	5.1	1.2	3.5	1.6	-2.3	0.7	-2.9	0.3
360.92	3.7	0.9	2.1	1.7	-2.2	0.7	-2.8	0.3
360.96	3.1	0.8	1.3	1.8	-2.1	0.7	-2.8	0.3
361.00	3.2	0.8	1.4	1.9	-2.1	0.7	-2.7	0.3

361.04	1.9	0.4	0.5	1.5	-2.0	0.7	-2.6	0.3
361.08	1.4	0.5	0.0	1.4	-2.0	0.7	-2.6	0.3
361.13	1.7	0.7	0.0	1.6	-2.0	0.7	-2.6	0.3
361.17	1.2	0.7	-0.8	1.6	-2.0	0.7	-2.6	0.3
361.21	1.7	0.8	-0.4	1.5	-2.1	0.6	-2.6	0.3
361.25	2.7	0.9	0.5	1.2	-2.1	0.6	-2.6	0.3
361.29	3.5	0.8	1.5	1.1	-2.1	0.6	-2.7	0.3
361.33	5.1	0.9	3.4	1.3	-2.1	0.5	-2.7	0.3
361.38	6.8	1.0	5.2	1.4	-2.0	0.5	-2.7	0.3
361.42	8.3	1.0	7.2	1.1	-2.0	0.5	-2.6	0.3
361.46	9.9	1.0	8.9	1.3	-1.9	0.5	-2.6	0.2
361.50	12.6	1.5	11.7	1.8	-1.7	0.6	-2.5	0.2
361.54	13.0	1.4	12.2	1.6	-1.5	0.6	-2.3	0.2
361.58	12.4	1.3	11.9	1.4	-1.3	0.7	-2.2	0.2
361.63	11.9	1.3	11.2	1.2	-1.1	0.7	-2.0	0.3
361.67	12.8	1.7	11.8	1.4	-0.8	0.8	-1.8	0.3
361.71	13.7	2.0	12.7	1.4	-0.5	0.9	-1.6	0.3
361.75	12.6	1.7	11.5	1.0	-0.3	0.9	-1.4	0.3
361.79	11.0	1.4	9.7	1.0	-0.1	1.0	-1.2	0.3
361.83	10.3	1.4	8.7	1.3	0.1	1.0	-1.0	0.4
361.88	9.7	1.3	7.8	1.6	0.3	1.1	-0.8	0.4
361.92	9.1	1.0	6.9	1.9	0.4	1.1	-0.7	0.4
361.96	9.1	1.0	6.8	2.3	0.5	1.1	-0.6	0.4
362.00	8.5	0.9	6.3	2.5	0.6	1.1	-0.5	0.4
362.04	7.8	0.7	5.4	2.7	0.7	1.1	-0.5	0.4
362.08	7.2	0.6	4.7	2.8	0.7	1.1	-0.4	0.4
362.13	6.5	0.7	4.0	2.8	0.7	1.1	-0.4	0.4
362.17	6.4	0.8	3.8	2.8	0.7	1.0	-0.4	0.4
362.21	6.6	0.9	4.0	2.3	0.7	1.0	-0.4	0.4
362.25	6.7	0.9	4.3	1.8	0.6	1.0	-0.4	0.4
362.29	5.5	0.6	3.2	1.6	0.5	0.9	-0.5	0.5
362.33	4.3	0.8	2.2	1.4	0.5	0.9	-0.5	0.5
362.38	3.0	0.8	1.0	1.3	0.4	0.8	-0.6	0.5
362.42	2.1	0.7	0.5	1.0	0.3	0.8	-0.6	0.5
362.46	1.2	0.6	-0.3	0.8	0.2	0.7	-0.8	0.5
362.50	0.6	0.2	-0.6	0.9	0.1	0.6	-0.9	0.5
362.54	0.5	0.3	-0.5	1.0	-0.1	0.5	-1.0	0.5
362.58	1.0	0.5	0.0	1.0	-0.3	0.5	-1.1	0.4
362.63	1.4	0.6	0.3	1.0	-0.4	0.4	-1.3	0.4
362.67	1.2	0.5	0.0	0.8	-0.6	0.4	-1.4	0.4
362.71	1.1	0.6	-0.1	0.7	-0.7	0.4	-1.5	0.3
362.75	-0.2	0.2	-1.4	0.6	-0.9	0.4	-1.6	0.3
362.79	0.2	0.5	-1.1	0.8	-1.0	0.4	-1.7	0.3
362.83	0.0	0.4	-1.3	0.7	-1.1	0.4	-1.9	0.3
362.88	-0.3	0.3	-1.6	0.6	-1.3	0.3	-2.0	0.2
362.92	-0.5	0.3	-1.7	0.6	-1.4	0.3	-2.1	0.2
362.96	-0.7	0.2	-1.8	0.6	-1.5	0.3	-2.2	0.2
363.00	-1.0	0.2	-2.1	0.5	-1.6	0.3	-2.3	0.2
363.04	-1.8	0.2	-2.7	0.4	-1.7	0.3	-2.4	0.2
363.08	-2.6	0.3	-3.4	0.3	-1.8	0.3	-2.5	0.2
363.13	-3.3	0.4	-4.0	0.3	-2.0	0.3	-2.5	0.2
363.17	-3.4	0.3	-4.1	0.2	-2.1	0.2	-2.6	0.2
363.21	-3.3	0.2	-4.0	0.3	-2.2	0.2	-2.7	0.2
363.25	-3.1	0.1	-3.8	0.3	-2.4	0.2	-2.8	0.2
363.29	-2.3	0.2	-3.1	0.5	-2.5	0.2	-2.9	0.2
363.33	-1.0	0.5	-1.9	0.7	-2.6	0.2	-3.0	0.2
363.38	-0.2	0.6	-1.2	0.7	-2.7	0.2	-3.1	0.2
363.42	0.5	0.7	-0.5	0.8	-2.7	0.2	-3.2	0.2
363.46	1.6	1.0	0.5	1.0	-2.8	0.2	-3.2	0.2
363.50	3.0	1.2	1.8	1.2	-2.8	0.2	-3.2	0.3
363.54	4.7	1.5	3.5	1.4	-2.7	0.2	-3.2	0.3
363.58	5.8	1.6	4.6	1.5	-2.7	0.3	-3.2	0.3
363.63	6.9	1.7	5.6	1.5	-2.6	0.3	-3.2	0.3

363.67	7.8	1.7	6.4	1.5	-2.4	0.4	-3.1	0.3
363.71	8.0	1.7	6.7	1.5	-2.3	0.5	-3.0	0.3
363.75	8.4	1.7	7.0	1.5	-2.1	0.5	-2.9	0.3
363.79	8.1	1.5	6.6	1.4	-1.9	0.6	-2.8	0.3
363.83	7.8	1.6	6.0	1.4	-1.8	0.7	-2.7	0.3
363.88	6.3	1.1	4.5	1.2	-1.6	0.7	-2.5	0.3
363.92	5.7	1.1	3.7	1.4	-1.5	0.7	-2.4	0.3
363.96	5.3	1.1	3.3	1.5	-1.3	0.7	-2.3	0.3
364.00	4.6	0.8	2.5	1.6	-1.2	0.8	-2.2	0.3
364.04	1.8	0.1	0.2	1.2	-1.2	0.8	-2.1	0.3
364.08	0.7	0.1	-0.7	0.9	-1.2	0.7	-2.1	0.3
364.13	0.1	0.1	-1.1	0.7	-1.2	0.7	-2.1	0.3
364.17	-0.6	0.2	-1.7	0.6	-1.2	0.7	-2.1	0.3
364.21	-0.7	0.1	-1.9	0.6	-1.3	0.6	-2.1	0.3
364.25	-0.4	0.2	-1.5	0.6	-1.4	0.6	-2.1	0.3
364.29	0.0	0.3	-1.2	0.7	-1.5	0.5	-2.2	0.3
364.33	1.8	0.7	0.6	1.1	-1.6	0.5	-2.2	0.3
364.38	3.1	0.8	1.9	1.2	-1.6	0.4	-2.3	0.2
364.42	5.8	1.3	4.6	1.5	-1.7	0.4	-2.3	0.2
364.46	7.7	1.3	6.8	1.7	-1.7	0.4	-2.3	0.2
364.50	8.6	1.2	7.8	1.7	-1.6	0.5	-2.3	0.2
364.54	9.3	1.3	8.5	1.7	-1.5	0.5	-2.3	0.2

Appendix Ten

Experiment Two: Soil temperature at 2 cm and 5 cm

[redacted]

Control temperatures at 2 cm depth were carried out in duplicate (Probe T5 unavailable)

Day of year	Core / Probe / Depth (cm)* / Time (h)	T1	T1	T2	T2	T3	T4	T4	T5	T5	T6	T6
	Probe	1	2	3	4	6	7	8	9	10	11	12
	Depth (cm)*	2	5	2	5	5	2	5	2	5	2	5
		C	C	C	C	C	JP-5	JP-5	JP-5	JP-5	JP-5	JP-5
	Time (h)	*Treatment (C = Control, JP-5 = JP-5 treated)										
342	1900	8.93	6.72	8.92	6.70	8.44	9.92	7.09	9.69	7.01	9.60	7.43
342	2000	7.68	6.40	7.70	6.51	8.19	8.45	6.97	8.49	6.89	8.11	7.06
342	2100	7.20	6.04	7.31	6.24	7.72	7.55	6.60	7.62	6.53	7.19	6.51
342	2200	6.75	5.75	6.91	5.98	7.04	6.34	6.07	6.25	5.95	5.87	5.82
342	2300	5.26	5.24	5.46	5.57	6.18	4.56	5.28	4.52	5.13	4.31	4.99
343	0	2.87	4.16	3.07	4.59	4.86	2.22	4.10	2.30	3.95	2.26	3.84
343	100	0.79	2.64	1.00	3.18	3.15	0.09	2.59	0.19	2.45	0.21	2.35
343	200	1.77	1.97	2.44	2.52	2.17	0.79	1.79	0.68	1.73	0.73	1.62
343	300	3.09	2.22	4.10	2.87	2.17	1.65	1.78	1.31	1.75	1.71	1.73
343	400	3.69	2.60	5.01	3.40	2.28	1.90	1.84	1.61	1.84	2.34	2.01
343	500	3.99	2.88	5.60	3.82	2.33	2.20	1.82	1.72	1.82	2.76	2.25
343	600	5.23	3.26	6.77	4.25	2.57	3.19	1.99	2.82	2.06	4.03	2.67
343	700	5.39	3.67	6.48	4.61	2.91	3.52	2.25	3.15	2.40	4.31	3.13
343	800	7.65	4.41	8.57	5.14	3.62	5.81	2.90	5.17	3.11	6.60	3.99
343	900	8.68	5.23	9.29	5.81	4.48	7.16	3.72	6.35	3.93	7.80	4.94
343	1000	11.32	6.48	11.67	6.80	5.87	10.17	5.03	9.04	5.20	10.58	6.35
343	1100	13.17	7.98	13.31	8.07	7.53	12.73	6.72	11.59	6.82	13.00	8.08
343	1200	14.88	9.23	14.86	9.16	8.96	15.38	8.36	13.90	8.42	15.22	9.58
343	1300	16.70	10.65	16.27	10.43	11.01	17.75	10.22	16.28	10.23	17.68	11.45
343	1400	17.34	11.80	16.26	11.22	12.58	18.21	11.58	16.81	11.48	18.00	12.68
343	1500	17.41	12.44	16.14	11.63	13.58	18.25	12.37	16.98	12.14	17.84	13.21
343	1600	17.94	12.97	16.71	12.02	14.51	19.25	13.13	18.03	12.80	18.77	13.80
343	1700	17.76	13.39	16.64	12.45	15.31	19.39	13.94	18.38	13.56	18.93	14.45
343	1800	15.89	13.17	14.89	12.34	15.24	16.97	13.84	16.14	13.39	16.44	14.05
343	1900	13.22	12.07	12.87	11.57	14.10	13.91	12.73	13.43	12.29	13.48	12.71
343	2000	12.67	11.08	12.32	10.82	12.99	13.04	11.66	12.64	11.28	12.42	11.53
343	2100	12.49	10.80	12.22	10.55	12.48	12.44	11.20	12.08	10.87	11.84	11.01
343	2200	10.69	10.15	10.74	10.10	11.46	10.10	10.32	9.92	10.01	9.70	10.05
343	2300	8.44	8.97	8.74	9.19	9.99	7.33	8.90	7.34	8.63	7.20	8.61
344	0	6.29	7.53	6.78	7.99	8.31	4.84	7.24	5.02	7.05	4.97	7.00
344	100	4.53	6.09	5.25	6.79	6.61	2.84	5.58	3.10	5.52	3.17	5.48
344	200	3.02	4.75	4.13	5.70	5.00	1.47	4.16	1.68	4.15	1.88	4.14
344	300	1.94	3.62	3.19	4.77	3.69	0.25	2.95	0.31	2.97	0.80	3.04
344	400	1.63	2.79	3.11	4.07	2.69	-0.32	1.95	-0.25	2.02	0.50	2.22
344	500	1.45	2.34	3.24	3.71	2.06	-0.51	1.25	-0.61	1.37	0.43	1.77
344	600	1.88	2.05	3.64	3.50	1.64	-0.34	0.77	-0.34	0.97	0.85	1.53
344	700	3.35	2.27	4.87	3.62	1.70	1.01	0.75	0.85	1.06	2.21	1.79
344	800	6.65	3.37	7.75	4.42	2.62	4.46	1.61	3.85	2.04	5.49	2.97
344	900	9.18	5.02	9.92	5.72	4.15	7.18	3.08	6.29	3.54	8.21	4.73
344	1000	8.73	5.94	9.20	6.52	5.21	6.83	4.00	6.24	4.40	8.04	5.73
344	1100	6.67	5.59	6.96	6.22	5.18	5.05	3.90	4.64	4.23	6.13	5.47
344	1200	7.37	5.24	7.57	5.79	5.11	6.39	3.85	5.64	4.07	7.00	5.26
344	1300	7.32	5.27	7.45	5.74	5.46	6.53	4.15	5.95	4.32	7.04	5.42
344	1400	8.11	5.55	8.17	5.89	6.02	7.67	4.66	7.12	4.82	7.98	5.83
344	1500	8.84	5.93	8.73	6.15	6.72	8.71	5.29	8.03	5.38	8.71	6.30
344	1600	9.46	6.42	8.94	6.45	7.50	9.62	5.99	8.89	5.99	9.41	6.84
344	1700	9.55	6.78	9.02	6.63	8.07	9.79	6.53	9.12	6.46	9.49	7.22
344	1800	8.98	6.79	8.76	6.71	8.22	9.07	6.69	8.55	6.56	8.87	7.21
344	1900	9.41	6.79	8.98	6.76	8.24	9.20	6.72	8.61	6.58	8.88	7.16

344	2000	9.73	6.97	9.18	6.88	8.29	9.23	6.82	8.66	6.67	8.85	7.19
344	2100	9.31	7.22	8.87	7.11	8.38	8.46	6.90	8.01	6.76	8.25	7.22
344	2200	8.04	6.62	7.85	6.69	7.54	6.78	6.21	6.46	6.02	6.61	6.41
344	2300	7.70	6.37	7.64	6.53	7.08	6.01	5.74	5.85	5.62	5.89	5.90
345	0	6.60	5.88	6.72	6.17	6.35	4.62	5.09	4.59	4.98	4.68	5.18
345	100	5.64	5.25	5.79	5.67	5.32	3.46	4.27	3.62	4.28	3.76	4.47
345	200	4.62	4.52	4.85	5.07	4.16	2.54	3.49	2.62	3.53	2.84	3.70
345	300	4.42	3.93	4.85	4.56	3.37	2.29	2.90	2.18	2.91	2.55	3.09
345	400	5.11	3.89	5.90	4.61	3.13	2.76	2.72	2.60	2.75	3.16	2.99
345	500	6.13	4.16	7.28	4.96	3.19	3.70	2.75	3.26	2.79	4.03	3.16
345	600	9.39	5.33	10.58	6.07	4.13	6.53	3.53	6.06	3.71	7.15	4.26
345	700	11.13	6.78	12.00	7.49	5.41	8.44	4.72	7.90	5.03	9.41	5.86
345	800	10.77	7.48	11.29	8.17	6.11	8.37	5.44	7.93	5.76	9.57	6.80
345	900	9.72	7.13	9.99	7.81	5.89	7.78	5.34	7.27	5.59	8.65	6.59
345	1000	12.88	7.96	12.77	8.32	6.85	11.26	6.30	10.28	6.55	11.91	7.67
345	1100	15.11	9.41	14.77	9.45	8.43	13.24	7.70	12.32	7.98	13.71	9.11
345	1200	15.90	10.54	15.51	10.40	9.77	13.97	8.70	13.25	9.06	14.22	10.01
345	1300	17.63	11.52	16.93	11.29	11.21	16.52	9.88	15.61	10.29	16.47	11.12
345	1400	18.89	12.72	17.43	12.17	12.97	18.37	11.46	17.39	11.81	18.26	12.69
345	1500	16.55	12.97	15.02	12.33	13.76	16.10	12.09	15.40	12.21	16.21	13.07
345	1600	13.57	11.84	12.14	11.30	12.81	12.94	11.24	12.43	11.15	12.98	11.85
345	1700	12.47	10.78	11.15	10.29	11.81	12.09	10.37	11.55	10.18	11.83	10.74
345	1800	13.19	10.45	12.12	9.97	11.67	13.20	10.27	12.50	10.07	12.61	10.54
345	1900	12.99	10.46	12.29	10.10	11.92	13.15	10.49	12.52	10.29	12.52	10.67
345	2000	12.28	10.22	11.51	9.98	11.73	12.04	10.29	11.28	10.06	11.17	10.33
345	2100	11.31	9.77	10.61	9.62	11.14	10.66	9.76	9.59	9.19	8.26	8.99
345	2200	8.81	8.89	8.29	8.89	10.02	7.81	8.75	7.71	8.26	6.91	7.85
345	2300	7.44	7.66	6.98	7.79	8.59	6.06	7.36	6.00	7.03	5.53	6.68
346	0	4.49	6.25	4.26	6.57	6.99	3.12	5.83	3.10	5.54	3.08	5.32
346	100	2.03	4.43	1.92	4.94	5.02	0.80	4.06	0.88	3.82	0.98	3.72
346	200	1.29	3.07	1.51	3.70	3.51	-0.11	2.68	-0.04	2.54	0.11	2.47
346	300	1.25	2.30	1.52	3.01	2.59	-0.20	1.81	-0.24	1.75	0.03	1.74
346	400	-0.86	1.43	-0.75	2.21	1.65	-2.11	0.89	-1.94	0.87	-1.64	0.93
346	500	-1.81	0.21	-1.68	1.02	0.46	-2.87	-0.20	-2.65	-0.16	-2.42	-0.10
346	600	-2.40	-0.61	-2.37	0.17	-0.35	-3.39	-0.96	-3.20	-0.86	-2.99	-0.82
346	700	-2.86	-1.29	-2.89	-0.55	-1.04	-3.89	-1.63	-3.70	-1.50	-3.51	-1.45
346	800	-3.56	-1.93	-3.69	-1.21	-1.65	-4.54	-2.27	-4.29	-2.10	-4.15	-2.05
346	900	-3.81	-2.53	-3.99	-1.86	-2.23	-4.73	-2.83	-4.50	-2.62	-4.42	-2.59
346	1000	-2.68	-2.63	-2.86	-2.05	-2.34	-3.63	-2.96	-3.53	-2.70	-3.45	-2.64
346	1100	-1.71	-2.32	-2.06	-1.88	-2.06	-2.63	-2.71	-2.61	-2.43	-2.57	-2.33
346	1200	-0.05	-1.72	-0.45	-1.45	-1.42	-0.80	-2.11	-0.95	-1.84	-0.77	-1.66
346	1300	0.49	-1.04	0.14	-0.84	-0.69	-0.32	-1.45	-0.40	-1.20	-0.05	-0.90
346	1400	0.93	-0.65	0.61	-0.52	-0.29	0.16	-1.06	0.14	-0.85	0.49	-0.51
346	1500	-0.98	-0.84	-1.14	-0.59	-0.39	-1.48	-1.12	-1.33	-0.99	-1.10	-0.69
346	1600	-2.70	-1.69	-2.86	-1.29	-1.14	-3.19	-1.76	-3.03	-1.76	-2.85	-1.60
346	1700	-4.10	-2.72	-4.25	-2.21	-2.14	-4.54	-2.61	-4.40	-2.75	-4.38	-2.76
346	1800	-3.83	-3.32	-3.73	-2.82	-2.90	-3.78	-3.07	-4.17	-3.29	-3.99	-3.37
346	1900	-2.59	-3.08	-2.14	-2.60	-3.17	-2.07	-2.70	-2.85	-3.01	-2.31	-2.96
346	2000	-2.63	-2.89	-2.22	-2.40	-3.35	-2.24	-2.45	-2.76	-2.76	-2.33	-2.66
346	2100	-2.45	-2.80	-2.16	-2.32	-3.50	-2.26	-2.36	-2.64	-2.65	-2.29	-2.57
346	2200	-2.95	-2.94	-2.81	-2.48	-3.68	-2.98	-2.53	-3.16	-2.80	-2.99	-2.77
346	2300	-3.08	-3.12	-3.01	-2.70	-3.86	-3.12	-2.72	-3.32	-2.99	-3.20	-3.01
347	0	-4.12	-3.45	-4.12	-3.03	-4.12	-4.24	-3.04	-4.33	-3.33	-4.21	-3.37
347	100	-4.88	-4.00	-4.94	-3.57	-4.47	-5.00	-3.56	-5.08	-3.87	-4.99	-3.94
347	200	-5.55	-4.54	-5.65	-4.11	-4.84	-5.62	-4.05	-5.71	-4.38	-5.66	-4.47
347	300	-5.56	-4.90	-5.64	-4.49	-5.13	-5.54	-4.36	-5.70	-4.71	-5.69	-4.83

347	400	-5.86	-5.09	-5.96	-4.70	-5.30	-5.88	-4.54	-6.03	-4.90	-5.97	-5.01
347	500	-5.63	-5.29	-5.74	-4.94	-5.47	-5.63	-4.73	-5.86	-5.10	-5.83	-5.21
347	600	-4.65	-5.06	-4.75	-4.78	-5.37	-4.60	-4.52	-4.95	-4.88	-4.92	-4.98
347	700	-3.86	-4.64	-3.98	-4.43	-5.09	-3.89	-4.16	-4.24	-4.50	-4.21	-4.59
347	800	-2.13	-4.07	-2.25	-3.94	-4.58	-2.08	-3.62	-2.64	-3.96	-2.63	-4.03
347	900	0.05	-2.87	-0.08	-2.86	-3.51	0.06	-2.54	-0.57	-2.83	-0.44	-2.82
347	1000	1.62	-1.74	1.33	-1.81	-2.38	1.35	-1.53	0.70	-1.80	0.79	-1.75
347	1100	3.22	-0.61	2.94	-0.79	-1.22	2.90	-0.58	2.18	-0.83	2.29	-0.74
347	1200	3.68	0.38	3.64	0.25	-0.07	3.34	0.36	2.72	0.11	2.79	0.25
347	1300	5.08	0.96	5.17	0.95	0.78	4.95	0.97	4.36	0.75	3.97	0.77
347	1400	6.85	2.26	6.88	2.20	2.29	6.91	2.20	6.38	2.08	5.91	2.05
347	1500	7.19	3.13	6.94	3.22	3.39	6.92	3.13	6.62	3.07	6.10	2.99
347	1600	5.49	3.28	5.49	3.51	3.52	5.03	3.14	4.78	3.04	4.45	2.92
347	1700	3.76	2.61	4.21	3.13	3.02	3.40	2.58	3.19	2.38	2.94	2.22
347	1800	2.24	1.75	2.71	2.49	2.32	1.77	1.76	1.63	1.52	1.46	1.35
347	1900	1.19	0.98	1.60	1.76	1.57	0.72	1.00	0.47	0.72	0.37	0.56
347	2000	0.37	0.34	0.67	1.10	0.88	-0.05	0.36	-0.26	0.06	-0.35	-0.08
347	2100	0.07	-0.10	0.20	0.56	0.36	-0.31	-0.08	-0.49	-0.32	-0.59	-0.47
347	2200	-0.82	-0.55	-0.78	0.02	-0.17	-1.25	-0.52	-1.36	-0.74	-1.39	-0.89
347	2300	-1.28	-1.09	-1.17	-0.53	-0.74	-1.64	-1.02	-1.77	-1.23	-1.79	-1.36
348	0	-1.19	-1.37	-1.00	-0.83	-1.02	-1.57	-1.28	-1.71	-1.47	-1.76	-1.59
348	100	-1.49	-1.53	-1.31	-0.97	-1.17	-1.84	-1.43	-1.95	-1.60	-1.98	-1.73
348	200	-2.13	-1.92	-2.04	-1.37	-1.58	-2.50	-1.80	-2.65	-2.00	-2.64	-2.11
348	300	-2.49	-2.24	-2.48	-1.73	-1.95	-2.83	-2.12	-2.98	-2.33	-2.94	-2.42
348	400	-2.66	-2.52	-2.66	-2.05	-2.27	-2.94	-2.38	-3.09	-2.58	-3.05	-2.66
348	500	-2.43	-2.63	-2.40	-2.21	-2.39	-2.66	-2.48	-2.85	-2.66	-2.82	-2.73
348	600	-2.31	-2.62	-2.27	-2.23	-2.38	-2.52	-2.47	-2.71	-2.64	-2.67	-2.70
348	700	-1.88	-2.52	-1.78	-2.15	-2.26	-2.03	-2.36	-2.25	-2.51	-2.23	-2.57
348	800	-2.32	-2.54	-2.33	-2.16	-2.27	-2.48	-2.36	-2.64	-2.51	-2.62	-2.58
348	900	-2.43	-2.70	-2.49	-2.35	-2.44	-2.58	-2.49	-2.75	-2.65	-2.74	-2.73
348	1000	-1.90	-2.63	-1.92	-2.34	-2.49	-2.00	-2.42	-2.21	-2.56	-2.22	-2.64
348	1100	-1.51	-2.41	-1.52	-2.15	-2.40	-1.63	-2.21	-1.82	-2.33	-1.82	-2.40
348	1200	-1.35	-2.25	-1.38	-2.01	-2.25	-1.52	-2.07	-1.68	-2.17	-1.69	-2.24
348	1300	-1.10	-2.10	-1.12	-1.87	-2.03	-1.32	-1.93	-1.48	-2.01	-1.49	-2.09
348	1400	-0.99	-1.97	-1.01	-1.74	-1.86	-1.23	-1.81	-1.43	-1.90	-1.44	-1.99
348	1500	-1.04	-1.89	-1.06	-1.66	-1.74	-1.28	-1.74	-1.46	-1.84	-1.47	-1.94
348	1600	-1.37	-1.95	-1.44	-1.71	-1.76	-1.60	-1.79	-1.75	-1.89	-1.74	-1.99
348	1700	-1.56	-2.06	-1.65	-1.83	-1.86	-1.77	-1.89	-1.93	-2.00	-1.91	-2.10
348	1800	-1.69	-2.15	-1.80	-1.93	-1.95	-1.88	-1.97	-2.05	-2.08	-2.02	-2.18
348	1900	-1.88	-2.26	-2.02	-2.05	-2.06	-2.08	-2.06	-2.25	-2.18	-2.21	-2.28
348	2000	-2.09	-2.39	-2.25	-2.18	-2.19	-2.28	-2.18	-2.45	-2.30	-2.40	-2.40
348	2100	-2.38	-2.55	-2.56	-2.35	-2.36	-2.58	-2.34	-2.74	-2.46	-2.68	-2.55
348	2200	-2.51	-2.71	-2.69	-2.51	-2.51	-2.70	-2.49	-2.87	-2.61	-2.82	-2.70
348	2300	-2.61	-2.82	-2.81	-2.63	-2.63	-2.78	-2.60	-2.96	-2.72	-2.90	-2.81
349	0	-2.74	-2.92	-2.95	-2.75	-2.75	-2.90	-2.70	-3.08	-2.81	-3.02	-2.90
349	100	-2.82	-3.02	-3.04	-2.86	-2.85	-2.98	-2.80	-3.16	-2.90	-3.09	-2.99
349	200	-2.93	-3.12	-3.16	-2.97	-2.96	-3.08	-2.89	-3.25	-2.99	-3.18	-3.07
349	300	-2.97	-3.20	-3.21	-3.05	-3.04	-3.11	-2.96	-3.28	-3.05	-3.21	-3.13
349	400	-2.99	-3.26	-3.22	-3.12	-3.11	-3.12	-3.01	-3.29	-3.10	-3.22	-3.18
349	500	-2.92	-3.28	-3.14	-3.15	-3.13	-3.04	-3.03	-3.22	-3.11	-3.16	-3.19
349	600	-2.85	-3.27	-3.06	-3.15	-3.13	-2.97	-3.02	-3.16	-3.10	-3.10	-3.18
349	700	-2.61	-3.22	-2.79	-3.10	-3.08	-2.73	-2.97	-2.94	-3.05	-2.90	-3.12
349	800	-2.57	-3.13	-2.76	-3.01	-3.00	-2.72	-2.89	-2.92	-2.96	-2.87	-3.04
349	900	-2.51	-3.13	-2.68	-2.99	-2.98	-2.65	-2.88	-2.87	-2.96	-2.83	-3.05
349	1000	-2.05	-3.01	-2.18	-2.87	-2.84	-2.18	-2.76	-2.43	-2.84	-2.44	-2.92
349	1100	-0.85	-2.63	-0.87	-2.50	-2.51	-0.95	-2.39	-1.24	-2.42	-1.33	-2.53

349	1200	0.29	-1.99	0.43	-1.83	-1.95	0.25	-1.75	-0.04	-1.73	-0.13	-1.85
349	1300	1.06	-1.39	1.27	-1.19	-1.39	1.01	-1.15	0.74	-1.09	0.67	-1.20
349	1400	1.11	-0.98	1.33	-0.73	-0.99	1.06	-0.75	0.83	-0.68	0.80	-0.79
349	1500	1.50	-0.77	1.75	-0.49	-0.79	1.49	-0.53	1.25	-0.44	1.20	-0.54
349	1600	2.23	-0.30	2.46	-0.03	-0.34	2.13	-0.09	1.89	0.02	1.83	-0.08
349	1700	2.34	0.02	2.58	0.34	-0.01	2.24	0.23	1.98	0.32	1.90	0.20
349	1800	2.36	0.24	2.61	0.59	0.22	2.24	0.43	1.98	0.50	1.90	0.36
349	1900	2.12	0.31	2.35	0.70	0.31	1.96	0.50	1.71	0.54	1.65	0.39
349	2000	1.44	0.19	1.60	0.60	0.20	1.26	0.37	1.05	0.37	1.00	0.22
349	2100	0.92	-0.08	1.03	0.32	-0.07	0.84	0.13	0.63	0.11	0.54	-0.07
349	2200	0.61	-0.28	0.69	0.09	-0.30	0.53	-0.05	0.35	-0.08	0.28	-0.26
349	2300	0.08	-0.53	0.12	-0.18	-0.56	-0.02	-0.30	-0.16	-0.32	-0.21	-0.50
350	0	-0.16	-0.78	-0.21	-0.47	-0.85	-0.34	-0.56	-0.47	-0.58	-0.53	-0.76
350	100	-0.44	-0.96	-0.52	-0.69	-1.09	-0.64	-0.77	-0.74	-0.77	-0.77	-0.95
350	200	-0.58	-1.17	-0.58	-0.92	-1.32	-0.76	-0.98	-0.89	-0.99	-0.92	-1.15
350	300	-0.20	-1.13	-0.12	-0.85	-1.29	-0.43	-0.96	-0.58	-0.95	-0.60	-1.10
350	400	-0.51	-1.22	-0.59	-0.94	-1.40	-0.81	-1.05	-0.91	-1.05	-0.98	-1.22
350	500	-0.46	-1.29	-0.58	-1.07	-1.51	-0.76	-1.17	-0.87	-1.15	-0.98	-1.33
350	600	0.41	-1.13	0.38	-0.95	-1.37	0.16	-1.03	0.02	-0.97	-0.11	-1.14
350	700	0.69	-0.76	0.76	-0.55	-0.97	0.53	-0.66	0.34	-0.58	0.29	-0.73
350	800	-0.68	-0.96	-0.74	-0.69	-1.07	-0.95	-0.83	-1.04	-0.84	-1.02	-0.99
350	900	-1.21	-1.40	-1.33	-1.15	-1.44	-1.47	-1.27	-1.58	-1.33	-1.55	-1.44
350	1000	-0.82	-1.56	-0.91	-1.36	-1.61	-1.01	-1.42	-1.19	-1.50	-1.18	-1.57
350	1100	-0.47	-1.41	-0.58	-1.23	-1.49	-0.70	-1.26	-0.89	-1.34	-0.84	-1.39
350	1200	-0.49	-1.37	-0.64	-1.19	-1.55	-0.72	-1.23	-0.96	-1.32	-0.90	-1.37
350	1300	-0.48	-1.37	-0.62	-1.19	-1.59	-0.76	-1.24	-0.97	-1.33	-0.90	-1.37
350	1400	0.02	-1.28	-0.19	-1.13	-1.53	-0.25	-1.17	-0.54	-1.25	-0.50	-1.29
350	1500	0.78	-0.95	0.62	-0.85	-1.35	0.54	-0.87	0.25	-0.91	0.28	-0.95
350	1600	0.42	-0.77	0.21	-0.67	-1.13	0.38	-0.67	0.06	-0.70	0.12	-0.75
350	1700	0.78	-0.71	0.55	-0.65	-1.02	0.84	-0.56	0.49	-0.59	0.51	-0.64
350	1800	1.52	-0.42	1.44	-0.36	-0.77	1.54	-0.26	1.21	-0.25	1.25	-0.30
350	1900	2.16	-0.01	2.19	0.07	-0.39	2.10	0.12	1.81	0.18	1.82	0.13
350	2000	1.69	0.18	1.76	0.34	-0.14	1.46	0.27	1.22	0.31	1.30	0.26
350	2100	0.65	-0.10	0.55	0.09	-0.36	0.35	-0.04	0.17	-0.05	0.26	-0.10
350	2200	0.40	-0.39	0.29	-0.23	-0.60	0.15	-0.34	-0.01	-0.34	0.08	-0.38
350	2300	-0.23	-0.66	-0.37	-0.50	-0.82	-0.54	-0.61	-0.65	-0.61	-0.54	-0.65
351	0	-0.61	-0.99	-0.75	-0.82	-1.07	-0.90	-0.94	-1.02	-0.94	-0.92	-0.98
351	100	-0.76	-1.19	-0.93	-1.03	-1.27	-1.09	-1.14	-1.23	-1.14	-1.13	-1.18
351	200	-1.19	-1.43	-1.37	-1.26	-1.51	-1.50	-1.38	-1.61	-1.39	-1.52	-1.44
351	300	-1.36	-1.65	-1.52	-1.48	-1.74	-1.62	-1.58	-1.73	-1.58	-1.65	-1.64
351	400	-1.39	-1.82	-1.52	-1.64	-1.90	-1.64	-1.72	-1.77	-1.72	-1.71	-1.79
351	500	-0.97	-1.80	-1.05	-1.62	-1.89	-1.25	-1.71	-1.41	-1.69	-1.38	-1.76
351	600	-0.60	-1.65	-0.63	-1.47	-1.76	-0.85	-1.57	-1.05	-1.55	-1.03	-1.63
351	700	-0.21	-1.47	-0.18	-1.28	-1.60	-0.36	-1.38	-0.59	-1.35	-0.60	-1.44
351	800	0.38	-1.18	0.48	-0.98	-1.35	0.26	-1.08	0.01	-1.04	-0.02	-1.13
351	900	1.28	-0.78	1.47	-0.55	-0.96	1.12	-0.68	0.83	-0.63	0.80	-0.72
351	1000	1.94	-0.30	2.19	-0.04	-0.47	1.77	-0.22	1.47	-0.16	1.41	-0.26
351	1100	2.94	0.22	3.29	0.50	0.07	2.80	0.29	2.43	0.34	2.33	0.24
351	1200	4.29	0.92	4.80	1.25	0.78	4.15	1.00	3.73	1.05	3.58	0.94
351	1300	5.95	1.93	6.59	2.30	1.83	5.78	1.94	5.28	2.01	5.08	1.89
351	1400	5.65	2.71	6.11	3.11	2.58	5.49	2.66	5.06	2.68	4.87	2.52
351	1500	5.09	2.59	5.45	2.98	2.45	5.12	2.63	4.74	2.58	4.42	2.36
351	1600	7.44	3.23	7.86	3.52	3.24	7.65	3.32	7.31	3.38	6.78	3.14
351	1700	8.87	4.39	9.24	4.64	4.75	9.42	4.61	9.24	4.80	8.55	4.48
351	1800	9.55	5.10	9.84	5.32	5.57	9.87	5.41	9.76	5.60	8.86	5.18
351	1900	10.07	5.92	10.43	6.12	6.52	10.42	6.21	10.45	6.47	9.47	5.92

351	2000	8.60	5.98	8.60	6.22	6.49	8.48	6.25	8.69	6.45	7.79	5.85
351	2100	5.41	5.03	5.07	5.23	5.10	4.83	5.16	5.15	5.26	4.53	4.65
351	2200	3.75	3.69	3.50	3.84	3.39	2.93	3.68	3.21	3.73	2.67	3.21
351	2300	3.85	3.03	3.76	3.18	2.56	2.67	2.84	2.94	2.95	2.37	2.49
352	0	3.69	2.71	3.69	2.91	2.12	2.16	2.30	2.40	2.46	1.78	2.01
352	100	3.14	2.35	3.23	2.65	1.63	1.27	1.72	1.47	1.89	0.94	1.46
352	200	2.56	1.90	2.98	2.35	1.06	0.70	1.13	0.74	1.26	0.56	0.93
352	300	2.03	1.48	2.88	2.13	0.61	0.34	0.66	0.15	0.75	0.46	0.61
352	400	2.15	1.25	3.20	2.05	0.35	0.33	0.35	0.06	0.42	0.73	0.51
352	500	2.77	1.32	4.08	2.19	0.34	0.90	0.25	0.52	0.32	1.29	0.61
352	600	4.06	1.78	5.41	2.68	0.69	1.87	0.48	1.37	0.58	2.56	1.04
352	700	5.50	2.45	6.56	3.33	1.27	3.24	0.97	2.69	1.15	3.90	1.76
352	800	6.85	3.24	7.61	3.99	1.97	4.70	1.62	4.20	1.91	5.20	2.54
352	900	8.52	4.18	9.10	4.77	2.95	6.68	2.56	6.13	2.93	7.03	3.57
352	1000	9.77	5.17	10.29	5.65	4.15	8.35	3.63	7.79	4.05	8.60	4.69
352	1100	11.05	6.14	11.30	6.52	5.41	9.93	4.77	9.50	5.24	10.11	5.84
352	1200	11.81	7.02	12.12	7.29	6.60	11.16	5.81	10.77	6.33	11.17	6.84
352	1300	12.38	7.66	12.63	7.95	7.78	12.20	6.76	11.86	7.29	12.02	7.70
352	1400	12.93	8.29	12.87	8.40	8.76	12.90	7.62	12.68	8.14	12.60	8.43
352	1500	13.18	8.74	13.07	8.76	9.56	13.26	8.26	13.16	8.77	12.83	8.92
352	1600	13.42	9.15	13.30	9.10	10.35	13.70	8.84	13.68	9.33	13.17	9.37
352	1700	13.66	9.46	13.40	9.36	10.99	13.94	9.31	14.07	9.81	13.28	9.71
352	1800	14.47	9.94	14.27	9.78	11.83	15.00	9.90	15.15	10.44	14.05	10.17
352	1900	15.00	10.48	15.11	10.35	12.69	15.73	10.58	16.06	11.20	14.66	10.73
352	2000	14.79	10.86	14.92	10.90	13.11	15.17	11.09	15.73	11.76	14.29	11.13
352	2100	13.07	10.51	12.99	10.68	12.22	12.64	10.64	13.23	11.20	11.95	10.51
352	2200	11.80	9.81	11.78	10.04	10.91	10.75	9.68	11.35	10.18	10.18	9.48
352	2300	10.57	9.11	10.66	9.40	9.81	9.05	8.69	9.58	9.15	8.61	8.50
353	0	10.06	8.50	10.35	8.86	8.86	8.14	7.80	8.60	8.27	7.54	7.61
353	100	9.13	7.96	9.63	8.47	7.93	6.82	6.98	7.23	7.46	6.53	6.86
353	200	8.27	7.29	8.96	7.98	6.92	5.76	6.08	6.00	6.51	5.63	6.07
353	300	7.55	6.64	8.67	7.56	6.09	5.07	5.32	5.07	5.67	5.24	5.46
353	400	7.74	6.34	9.14	7.42	5.56	5.00	4.83	5.01	5.19	5.53	5.20
353	500	7.41	6.22	8.84	7.37	5.23	4.62	4.44	4.69	4.84	5.24	5.02
353	600	7.37	5.97	8.53	7.08	4.87	4.38	4.05	4.60	4.51	5.17	4.74
353	700	8.50	6.12	9.44	7.10	4.93	5.28	3.98	5.59	4.62	5.99	4.84
353	800	8.19	6.28	8.70	7.14	5.03	5.08	4.01	5.58	4.79	5.72	4.90
353	900	8.87	6.24	9.32	6.95	5.03	5.91	4.01	6.34	4.85	6.34	4.89
353	1000	11.61	7.07	12.09	7.59	5.98	8.86	4.77	9.03	5.75	9.01	5.75
353	1100	13.40	8.42	13.70	8.79	7.54	10.86	6.07	11.07	7.13	10.89	7.08
353	1200	16.00	9.84	16.44	10.07	9.42	14.84	7.76	14.67	8.88	14.49	8.81
353	1300	15.80	11.03	15.92	11.27	11.08	14.19	9.24	14.58	10.39	14.26	10.23
353	1400	13.83	10.87	13.46	10.92	10.82	11.37	8.92	12.10	10.03	11.64	9.70
353	1500	12.48	10.24	12.13	10.23	10.24	10.45	8.37	11.34	9.45	10.62	9.02
353	1600	11.78	9.68	11.50	9.65	9.87	9.97	8.03	11.03	9.14	10.21	8.60
353	1700	11.31	9.30	11.05	9.27	9.69	9.51	7.77	10.61	8.90	9.82	8.33
353	1800	10.72	8.97	10.46	8.95	9.47	8.95	7.52	10.08	8.65	9.32	8.06
353	1900	9.59	8.43	9.50	8.49	8.98	7.97	7.10	9.12	8.21	8.40	7.62
353	2000	9.03	7.86	9.07	8.04	8.33	7.38	6.64	8.51	7.72	7.78	7.12
353	2100	8.32	7.38	8.40	7.67	7.54	6.57	6.22	7.63	7.25	6.97	6.64
353	2200	7.13	6.74	7.28	7.14	6.64	5.32	5.62	6.30	6.55	5.79	5.98
353	2300	6.38	6.01	6.61	6.51	5.83	4.48	4.92	5.34	5.76	4.92	5.26
354	0	6.09	5.51	6.38	6.06	5.24	4.02	4.37	4.75	5.15	4.27	4.67
354	100	5.93	5.19	6.20	5.76	4.68	3.60	3.92	4.20	4.64	3.70	4.15
354	200	5.81	4.94	6.30	5.57	4.10	3.38	3.56	3.81	4.19	3.45	3.73
354	300	6.18	4.84	7.31	5.63	3.89	3.81	3.39	3.91	3.93	3.88	3.59

354	400	6.87	5.04	8.46	6.07	3.97	4.35	3.47	4.31	3.96	4.72	3.79
354	500	7.63	5.43	9.51	6.65	4.19	5.08	3.65	4.93	4.11	5.53	4.18
354	600	9.06	6.03	10.97	7.33	4.65	6.34	4.06	6.07	4.53	7.09	4.82
354	700	11.19	6.97	12.86	8.21	5.49	8.45	4.79	8.27	5.42	9.23	5.85
354	800	13.20	8.20	14.65	9.36	6.72	10.80	5.93	10.51	6.72	11.49	7.26
354	900	14.77	9.40	15.89	10.42	8.05	12.71	7.16	12.39	8.05	13.27	8.62
354	1000	15.38	10.33	16.09	11.18	9.27	13.51	8.20	13.21	9.11	14.00	9.66
354	1100	16.60	11.15	17.09	11.80	10.51	15.23	9.21	14.95	10.13	15.46	10.64
354	1200	16.85	11.84	17.20	12.35	11.65	15.93	10.17	15.79	11.12	15.97	11.47
354	1300	17.12	12.27	17.48	12.76	12.69	16.80	10.99	16.64	11.91	16.70	12.16
354	1400	18.06	12.80	17.96	13.06	13.66	18.00	11.83	17.99	12.75	17.64	12.88
354	1500	17.97	13.32	17.59	13.40	14.60	17.86	12.59	18.22	13.53	17.48	13.44
354	1600	16.73	13.21	16.25	13.21	14.78	16.06	12.75	16.69	13.69	15.23	13.20
354	1700	15.15	12.66	14.65	12.63	14.36	14.83	12.57	15.64	13.44	14.34	12.64
354	1800	13.46	11.81	13.06	11.83	13.48	13.26	11.83	14.01	12.55	12.95	11.81
354	1900	11.94	10.86	11.73	10.97	12.44	11.60	10.87	12.39	11.50	11.47	10.85
354	2000	11.15	10.02	11.08	10.24	11.41	10.67	9.98	11.39	10.55	10.53	9.97
354	2100	11.12	9.56	11.18	9.85	10.56	10.41	9.47	11.11	10.04	10.20	9.48
354	2200	11.72	9.49	12.03	9.84	10.16	10.84	9.34	11.43	9.92	10.47	9.32
354	2300	10.70	9.42	11.06	9.89	9.83	8.90	8.99	9.58	9.48	9.09	8.99
355	0	8.83	8.57	9.15	9.15	8.65	6.43	7.63	7.24	8.12	6.86	7.74
355	100	7.11	7.47	7.37	8.14	7.24	4.48	6.17	5.25	6.66	5.00	6.38
355	200	5.88	6.40	6.24	7.16	5.73	3.42	5.00	3.97	5.41	3.96	5.27
355	300	5.17	5.53	5.78	6.38	4.77	3.06	4.20	3.34	4.52	3.65	4.56
355	400	5.32	5.07	6.12	5.99	4.32	3.26	3.80	3.46	4.12	3.93	4.27
355	500	5.69	4.96	6.70	5.90	4.18	3.78	3.67	3.89	4.02	4.32	4.23
355	600	6.45	5.14	7.38	6.05	4.30	4.29	3.78	4.44	4.17	4.95	4.40
355	700	7.37	5.45	8.07	6.27	4.53	5.19	4.00	5.41	4.53	5.68	4.68
355	800	8.41	5.92	8.94	6.61	4.94	6.28	4.43	6.47	5.09	6.55	5.11
355	900	9.44	6.50	9.84	7.05	5.53	7.45	5.01	7.63	5.76	7.54	5.66
355	1000	10.42	7.14	10.72	7.56	6.24	8.60	5.69	8.86	6.54	8.56	6.30
355	1100	11.66	7.87	11.92	8.19	7.10	10.07	6.49	10.35	7.47	9.81	7.04
355	1200	12.89	8.73	13.22	8.93	8.17	11.78	7.48	12.08	8.57	11.27	7.95
355	1300	15.08	9.75	15.39	9.90	9.64	15.18	8.88	15.20	10.12	14.19	9.32
355	1400	17.25	11.27	17.20	11.24	11.83	18.28	11.09	18.18	12.31	17.17	11.50
355	1500	18.00	12.42	17.95	12.31	13.65	19.32	12.70	19.36	13.83	18.22	12.99
355	1600	18.14	13.04	17.96	12.91	14.81	19.49	13.60	19.66	14.61	18.36	13.72
355	1700	18.73	13.60	18.51	13.40	15.79	20.26	14.40	20.52	15.35	19.02	14.39
355	1800	18.79	14.13	18.61	13.90	16.64	20.25	15.08	20.62	15.98	19.02	14.93
355	1900	18.25	14.29	18.38	14.14	16.92	19.74	15.31	20.27	16.16	18.60	15.06
355	2000	17.25	14.12	17.24	14.11	16.63	17.94	15.04	18.69	15.80	17.02	14.69
355	2100	16.29	13.70	16.36	13.77	15.65	16.38	14.34	17.18	15.01	15.60	13.93
355	2200	15.06	13.17	15.20	13.36	14.54	14.47	13.51	15.25	14.06	13.95	13.11
355	2300	13.38	12.37	13.64	12.66	13.32	11.95	12.28	12.62	12.68	11.83	11.95
356	0	12.33	11.42	12.63	11.81	11.96	10.31	10.83	11.01	11.22	10.12	10.62
356	100	11.61	10.74	12.14	11.25	10.85	9.20	9.72	9.79	10.16	9.01	9.61
356	200	10.29	9.95	11.31	10.74	9.21	7.96	8.77	8.20	9.05	8.00	8.70
356	300	8.48	8.91	9.49	9.93	8.03	5.94	7.58	6.20	7.74	6.47	7.66
356	400	7.26	7.80	8.18	8.90	6.92	4.80	6.38	5.08	6.55	5.57	6.66
356	500	6.64	6.99	7.61	8.07	6.09	4.38	5.53	4.62	5.74	5.09	5.96
356	600	6.53	6.46	7.29	7.48	5.52	4.13	4.95	4.41	5.21	4.96	5.48
356	700	7.17	6.27	7.73	7.16	5.25	4.82	4.71	5.12	5.11	5.47	5.35
356	800	9.04	6.59	9.62	7.30	5.51	7.05	5.05	7.03	5.60	7.27	5.75
356	900	12.10	7.81	12.72	8.34	6.70	10.44	6.32	10.10	7.00	10.27	7.06
356	1000	14.20	9.30	14.59	9.70	8.35	13.26	7.99	12.82	8.77	13.09	8.82
356	1100	16.05	10.66	16.55	10.99	10.07	15.74	9.74	15.28	10.54	15.42	10.58

356	1200	15.11	11.47	15.37	11.75	11.01	13.60	10.34	13.95	11.22	13.45	10.94
356	1300	14.79	11.33	14.95	11.57	11.00	13.68	10.11	14.07	11.10	13.24	10.53
356	1400	14.31	11.50	14.19	11.55	11.28	12.73	10.24	13.52	11.32	12.50	10.53
356	1500	15.76	11.52	15.94	11.51	11.57	15.60	10.47	15.94	11.64	14.72	10.71
356	1600	19.62	13.10	20.22	13.05	13.95	21.21	12.96	21.10	14.18	19.78	13.18
356	1700	21.80	14.91	22.53	14.94	16.49	23.15	15.30	23.25	16.46	21.71	15.33
356	1800	18.77	15.49	18.95	15.60	17.14	17.75	15.44	18.77	16.47	17.43	15.25
356	1900	13.64	13.67	13.60	13.91	14.80	11.74	12.91	13.17	13.80	12.05	12.69
356	2000	11.03	11.64	10.98	11.99	12.29	8.98	10.66	10.39	11.49	9.46	10.55
356	2100	9.11	10.02	9.11	10.46	10.32	6.98	8.92	8.28	9.71	7.56	8.93
356	2200	7.57	8.64	7.61	9.16	8.62	5.38	7.47	6.59	8.21	6.06	7.57
356	2300	6.36	7.47	6.43	8.04	7.26	4.13	6.24	5.20	6.92	4.86	6.43
357	0	5.38	6.47	5.50	7.07	6.13	3.10	5.15	4.06	5.81	3.80	5.44
357	100	4.61	5.61	4.77	6.26	5.13	2.30	4.22	3.14	4.85	2.97	4.56
357	200	4.04	4.88	4.30	5.58	4.08	1.85	3.49	2.46	4.04	2.40	3.83
357	300	3.97	4.36	4.52	5.13	3.53	1.90	3.03	2.30	3.49	2.42	3.38
357	400	4.43	4.18	5.08	5.01	3.27	2.11	2.81	2.36	3.23	2.72	3.20
357	500	5.04	4.27	5.72	5.10	3.22	2.67	2.79	2.67	3.15	3.12	3.22
357	600	5.87	4.53	6.54	5.29	3.33	3.37	2.91	3.41	3.27	3.90	3.37
357	700	7.18	5.08	7.70	5.73	3.73	4.65	3.32	4.73	3.80	4.98	3.84
357	800	8.47	5.70	9.00	6.25	4.30	6.39	3.97	6.31	4.52	6.35	4.46
357	900	9.82	6.58	10.35	7.04	5.21	8.00	4.91	7.91	5.54	7.81	5.35
357	1000	10.53	7.20	11.11	7.65	6.02	9.27	5.72	9.09	6.36	8.91	6.09
357	1100	12.62	8.21	13.29	8.60	7.23	11.85	6.97	11.55	7.68	11.25	7.29
357	1200	15.07	9.64	15.76	9.93	8.95	14.70	8.60	14.42	9.47	13.73	8.87
357	1300	17.07	11.07	17.75	11.33	10.87	17.75	10.36	17.31	11.37	16.43	10.56
357	1400	19.05	12.61	19.29	12.68	12.87	20.05	12.30	19.71	13.35	18.60	12.39
357	1500	19.91	13.83	20.03	13.77	14.79	21.26	13.87	21.10	14.89	19.86	13.86
357	1600	20.34	14.67	20.37	14.53	16.31	22.12	15.11	22.20	16.06	20.73	14.97
357	1700	20.03	15.13	20.03	14.98	17.32	21.85	15.93	22.08	16.75	20.52	15.63
357	1800	19.53	15.27	19.45	15.10	17.70	21.20	16.21	21.56	16.89	19.88	15.73
357	1900	18.25	15.07	18.53	15.01	17.50	19.31	16.04	19.66	16.61	18.18	15.46
357	2000	17.10	14.57	17.32	14.62	16.57	16.94	15.10	17.43	15.59	16.00	14.44
357	2100	15.30	13.85	15.60	14.03	15.26	14.15	13.92	15.00	14.39	13.70	13.29
357	2200	13.17	12.72	13.38	13.02	13.38	11.28	12.32	12.25	12.75	11.15	11.76
357	2300	11.49	11.48	11.68	11.88	11.61	9.20	10.75	10.11	11.11	9.23	10.26
358	0	10.16	10.35	10.45	10.84	10.15	7.57	9.33	8.44	9.69	7.66	8.96
358	100	9.12	9.37	9.44	9.95	8.86	6.25	8.07	7.04	8.45	6.41	7.81
358	200	8.48	8.55	8.96	9.20	7.43	5.58	7.08	6.13	7.41	5.66	6.86
358	300	8.27	7.98	9.23	8.77	6.73	5.66	6.48	5.88	6.72	5.82	6.34
358	400	8.49	7.76	9.67	8.74	6.45	5.57	6.19	5.59	6.35	6.20	6.25
358	500	8.20	7.55	9.67	8.66	6.16	5.29	5.73	4.99	5.81	6.09	6.07
358	600	9.30	7.58	10.78	8.74	6.16	6.39	5.60	6.11	5.76	7.39	6.27
358	700	10.30	8.06	11.31	9.14	6.55	7.34	5.90	7.20	6.27	8.25	6.84
358	800	9.25	7.98	9.71	8.94	6.47	6.33	5.74	6.37	6.15	7.12	6.67
358	900	10.15	7.80	10.47	8.58	6.40	8.02	5.73	7.74	6.22	8.41	6.69
358	1000	11.19	8.30	11.18	8.86	7.10	9.40	6.45	9.20	7.02	9.66	7.39
358	1100	11.09	8.54	10.93	8.95	7.60	9.53	6.85	9.57	7.49	9.71	7.71
358	1200	11.60	8.70	11.63	9.04	8.15	10.71	7.27	10.73	7.98	10.69	8.08
358	1300	12.10	8.99	12.08	9.33	9.00	11.83	7.96	11.94	8.74	11.64	8.70
358	1400	12.89	9.41	12.56	9.56	9.83	12.88	8.69	13.09	9.51	12.54	9.33
358	1500	13.54	9.90	13.40	9.95	10.79	13.88	9.47	14.16	10.31	13.46	10.00
358	1600	13.99	10.37	13.71	10.36	11.75	14.38	10.20	14.83	11.03	13.86	10.60
358	1700	13.74	10.59	13.34	10.51	12.29	14.02	10.55	14.65	11.34	13.46	10.77
358	1800	13.52	10.62	12.99	10.50	12.48	13.68	10.66	14.40	11.41	13.06	10.75
358	1900	13.26	10.59	13.01	10.47	12.51	13.43	10.70	14.16	11.42	12.76	10.69

358	2000	13.09	10.54	12.94	10.51	12.29	12.92	10.61	13.67	11.29	12.26	10.53
358	2100	13.58	10.67	13.78	10.74	12.12	13.39	10.74	14.10	11.38	12.74	10.63
358	2200	13.43	10.82	13.95	11.07	11.88	12.95	10.86	13.55	11.38	12.35	10.68
358	2300	12.70	10.68	13.16	11.09	11.39	11.50	10.50	12.03	10.85	10.98	10.24
359	0	11.69	10.28	12.31	10.78	10.66	9.88	9.69	10.40	9.98	9.54	9.47
359	100	10.77	9.70	11.56	10.38	9.70	8.45	8.72	8.93	9.02	8.31	8.63
359	200	9.69	9.03	10.53	9.84	8.23	7.09	7.76	7.36	7.94	7.08	7.71
359	300	9.00	8.36	10.33	9.33	7.35	6.69	7.00	6.63	7.08	6.85	7.06
359	400	8.38	7.91	9.67	9.06	6.82	5.69	6.44	5.72	6.47	6.30	6.66
359	500	7.82	7.33	9.07	8.48	6.22	5.16	5.70	5.06	5.75	5.75	6.06
359	600	9.10	7.32	10.66	8.45	6.15	6.53	5.56	6.25	5.71	7.36	6.18
359	700	11.20	8.03	12.62	9.13	6.74	8.84	6.16	8.44	6.49	9.50	7.06
359	800	12.82	8.98	13.85	9.96	7.64	10.83	7.13	10.23	7.54	11.16	8.11
359	900	14.81	10.06	15.59	10.82	8.77	13.28	8.33	12.49	8.79	13.31	9.32
359	1000	16.82	11.34	17.44	11.90	10.27	15.96	9.85	15.08	10.38	15.73	10.81
359	1100	18.43	12.63	18.84	13.03	11.93	18.07	11.44	17.26	12.02	17.64	12.30
359	1200	19.48	13.75	19.75	14.03	13.54	19.58	12.87	18.94	13.51	18.99	13.60
359	1300	19.40	14.40	19.50	14.65	14.78	19.74	13.85	19.50	14.52	19.16	14.43
359	1400	19.21	14.70	18.96	14.77	15.48	19.48	14.36	19.49	15.02	18.92	14.78
359	1500	18.93	14.80	18.61	14.76	15.94	19.18	14.63	19.42	15.27	18.60	14.90
359	1600	18.99	14.86	18.74	14.76	16.39	19.50	14.89	19.79	15.50	18.78	15.04
359	1700	19.66	15.18	19.42	15.02	17.16	20.49	15.47	20.82	16.08	19.54	15.48
359	1800	19.91	15.61	19.64	15.42	17.90	20.81	16.12	21.26	16.71	19.79	15.97
359	1900	19.40	15.74	19.41	15.59	18.14	20.34	16.40	20.86	16.94	19.33	16.11
359	2000	18.52	15.56	18.48	15.52	17.74	18.81	16.17	19.47	16.62	17.91	15.77
359	2100	17.64	15.19	17.94	15.30	16.97	17.67	15.70	18.32	16.07	16.89	15.24
359	2200	16.63	14.67	16.87	14.94	15.95	15.96	14.99	16.61	15.24	15.26	14.47
359	2300	15.48	14.06	15.65	14.37	14.86	14.08	14.01	14.71	14.18	13.58	13.49
360	0	13.71	13.14	14.09	13.56	13.60	11.95	12.70	12.51	12.82	11.68	12.33
360	100	13.05	12.31	13.88	12.95	12.42	10.87	11.55	11.35	11.70	10.70	11.33
360	200	11.97	11.54	12.93	12.42	10.78	9.51	10.53	9.78	10.58	9.44	10.33
360	300	10.94	10.75	12.09	11.78	9.72	8.33	9.52	8.34	9.43	8.55	9.42
360	400	10.62	10.14	11.96	11.29	8.98	7.71	8.69	7.56	8.57	8.43	8.84
360	500	10.93	9.85	12.74	11.12	8.56	8.27	8.21	7.67	8.05	9.03	8.66
360	600	12.11	10.04	14.19	11.42	8.64	9.59	8.30	8.95	8.19	10.60	9.02
360	700	13.91	10.69	15.77	12.08	9.21	11.64	8.87	11.06	8.97	12.49	9.86
360	800	15.87	11.63	17.62	12.93	10.14	14.30	9.93	13.36	10.13	14.71	10.98
360	900	15.87	12.46	17.24	13.70	11.08	14.53	10.91	13.81	11.15	14.95	11.93
360	1000	15.30	12.40	16.48	13.59	11.33	14.34	11.08	13.98	11.35	14.48	11.92
360	1100	16.65	12.75	17.77	13.81	12.15	16.01	11.71	15.75	12.11	15.79	12.40
360	1200	17.89	13.49	18.81	14.40	13.27	17.17	12.59	17.02	13.08	16.80	13.14
360	1300	20.13	14.55	21.06	15.31	14.66	19.60	13.77	19.43	14.39	19.03	14.29
360	1400	20.15	15.46	20.84	16.14	15.78	19.10	14.63	19.15	15.27	18.79	15.08
360	1500	20.40	15.85	21.09	16.47	16.27	19.45	14.99	19.49	15.62	19.14	15.43
360	1600	19.17	15.82	19.82	16.48	16.27	18.24	14.99	18.30	15.52	17.99	15.35
360	1700	17.60	15.32	18.29	16.08	15.81	16.93	14.60	17.03	15.04	16.69	14.87
360	1800	18.27	14.98	19.14	15.79	15.61	17.64	14.45	17.61	14.83	17.15	14.57
360	1900	17.99	15.15	18.58	15.90	15.84	17.05	14.53	17.24	14.95	16.74	14.62
360	2000	16.25	14.62	16.64	15.32	15.24	14.95	13.87	15.33	14.25	14.89	13.94
360	2100	15.02	13.84	15.35	14.51	14.36	13.66	13.03	14.13	13.42	13.76	13.18
360	2200	11.99	12.70	12.08	13.37	13.03	10.45	11.81	11.01	12.14	10.78	11.95
360	2300	11.53	11.54	11.76	12.15	11.64	9.76	10.58	10.32	10.92	10.00	10.72
361	0	9.21	10.48	9.32	11.14	10.42	7.52	9.43	7.94	9.70	7.93	9.59
361	100	7.58	9.21	7.59	9.85	9.06	6.10	8.20	6.49	8.43	6.61	8.43
361	200	5.15	7.76	5.04	8.39	7.53	3.71	6.76	4.18	6.96	4.40	7.02
361	300	3.10	6.17	2.92	6.79	5.88	1.86	5.26	2.31	5.43	2.58	5.55

361	400	3.73	5.04	3.98	5.65	4.71	2.31	4.27	2.52	4.47	3.02	4.62
361	500	6.36	5.43	7.33	6.10	4.91	4.44	4.45	4.24	4.70	5.11	5.00
361	600	8.17	6.30	9.38	7.08	5.57	5.77	4.95	5.65	5.27	6.73	5.70
361	700	9.80	7.15	10.96	8.02	6.31	7.53	5.58	7.40	6.06	8.43	6.56
361	800	12.35	8.26	13.42	9.08	7.39	10.40	6.70	9.95	7.25	10.89	7.75
361	900	14.83	9.74	15.68	10.45	8.94	13.22	8.26	12.65	8.85	13.42	9.31
361	1000	17.08	11.26	17.78	11.83	10.62	15.90	9.94	15.24	10.55	15.83	10.91
361	1100	19.01	12.84	19.55	13.30	12.50	18.18	11.76	17.59	12.39	17.90	12.61
361	1200	19.30	13.91	19.74	14.33	13.95	18.68	13.02	18.36	13.65	18.46	13.74
361	1300	19.36	14.38	19.45	14.78	14.81	18.53	13.64	18.71	14.33	18.52	14.31
361	1400	19.54	14.80	19.31	14.98	15.41	19.10	14.23	19.20	14.92	18.77	14.77
361	1500	19.45	15.04	19.14	15.10	15.90	19.15	14.70	19.35	15.33	18.71	15.07
361	1600	19.39	15.20	18.87	15.16	16.35	18.97	15.02	19.36	15.60	18.36	15.20
361	1700	18.78	15.18	18.00	15.03	16.53	18.19	15.03	18.72	15.57	17.49	14.98
361	1800	18.33	15.03	16.41	14.04	16.52	17.81	14.96	18.41	15.47	17.12	14.77
361	1900	17.63	14.79	15.83	13.42	16.42	17.07	14.81	17.75	15.31	16.44	14.53
361	2000	16.78	14.41	15.31	13.26	15.96	15.93	14.42	16.69	14.90	15.40	14.10
361	2100	15.64	13.84	14.44	12.97	15.13	14.33	13.73	15.14	14.15	13.99	13.41
361	2200	15.47	13.40	14.73	12.75	14.32	14.12	13.15	14.86	13.56	13.68	12.86
361	2300	15.21	13.19	15.09	12.87	13.92	13.89	12.91	14.46	13.26	13.59	12.67
362	0	13.90	12.73	14.06	12.77	13.29	12.11	12.27	12.57	12.51	11.96	12.09
362	100	13.19	12.08	13.54	12.32	12.32	10.89	11.26	11.38	11.53	10.77	11.15
362	200	12.68	11.58	13.25	12.00	11.04	10.22	10.51	10.50	10.74	10.19	10.48
362	300	11.51	10.99	12.33	11.63	10.23	8.98	9.80	9.08	9.90	9.41	9.91
362	400	10.63	10.26	11.38	10.99	9.43	7.62	8.83	7.67	8.89	8.60	9.21
362	500	10.90	9.89	11.99	10.64	8.94	8.02	8.24	7.67	8.29	9.04	8.95
362	600	10.93	9.79	11.71	10.49	8.69	7.63	7.84	7.56	7.97	9.03	8.82
362	700	12.16	9.92	12.81	10.46	8.74	8.99	7.81	8.99	8.14	10.09	9.01
362	800	13.23	10.45	13.70	10.80	9.20	10.19	8.26	10.13	8.72	10.67	9.36
362	900	15.02	11.23	15.40	11.37	9.98	12.11	9.01	11.88	9.54	12.16	9.93
362	1000	16.52	12.18	16.69	12.14	11.05	13.93	9.97	13.49	10.51	13.72	10.76
362	1100	18.66	13.31	18.47	13.08	12.51	16.82	11.34	16.22	11.88	16.42	12.06
362	1200	20.85	14.76	20.74	14.37	14.43	20.28	13.25	19.60	13.83	19.73	13.96
362	1300	22.17	16.02	21.91	15.68	16.36	22.42	15.19	21.78	15.78	21.73	15.83
362	1400	22.99	17.07	22.37	16.57	17.79	23.40	16.64	22.94	17.18	22.58	17.04

[redacted]

Time	2 cm Control	s.d.	2 cm JP-5	s.d.	5 cm Control	s.d.	5 cm JP-5	s.d.
342.79	8.93	0.01	9.74	0.17	7.29	1.00	7.18	0.22
342.83	7.69	0.01	8.35	0.21	7.03	1.00	6.97	0.08
342.88	7.26	0.08	7.45	0.23	6.67	0.92	6.55	0.05
342.92	6.83	0.11	6.15	0.25	6.26	0.69	5.95	0.13
342.96	5.36	0.14	4.46	0.13	5.66	0.48	5.13	0.15
343.00	2.97	0.14	2.26	0.04	4.53	0.35	3.96	0.13
343.04	0.89	0.15	0.16	0.07	2.99	0.31	2.47	0.12
343.08	2.10	0.48	0.73	0.06	2.22	0.28	1.71	0.09
343.13	3.60	0.72	1.56	0.22	2.42	0.39	1.75	0.02
343.17	4.35	0.93	1.95	0.37	2.76	0.57	1.89	0.10
343.21	4.79	1.14	2.23	0.52	3.01	0.75	1.96	0.25
343.25	6.00	1.09	3.34	0.62	3.36	0.84	2.24	0.38
343.29	5.94	0.77	3.66	0.60	3.73	0.86	2.59	0.47
343.33	8.11	0.65	5.86	0.72	4.39	0.76	3.34	0.58
343.38	8.99	0.43	7.10	0.73	5.17	0.66	4.20	0.65
343.42	11.50	0.25	9.93	0.80	6.38	0.47	5.53	0.72
343.46	13.24	0.10	12.44	0.75	7.86	0.29	7.21	0.76
343.50	14.87	0.01	14.83	0.81	9.12	0.14	8.79	0.69
343.54	16.49	0.30	17.24	0.83	10.70	0.29	10.63	0.71
343.58	16.80	0.76	17.67	0.76	11.87	0.68	11.91	0.67
343.63	16.78	0.90	17.69	0.65	12.55	0.98	12.57	0.56
343.67	17.33	0.87	18.68	0.61	13.17	1.26	13.24	0.51
343.71	17.20	0.79	18.90	0.51	13.72	1.46	13.98	0.45
343.75	15.39	0.71	16.52	0.42	13.58	1.49	13.76	0.34
343.79	13.05	0.25	13.61	0.26	12.58	1.34	12.58	0.25
343.83	12.50	0.25	12.70	0.31	11.63	1.18	11.49	0.19
343.88	12.36	0.19	12.12	0.30	11.28	1.05	11.03	0.17
343.92	10.72	0.04	9.91	0.20	10.57	0.77	10.13	0.17
343.96	8.59	0.21	7.29	0.08	9.38	0.54	8.71	0.16
344.00	6.54	0.35	4.94	0.09	7.94	0.39	7.10	0.13
344.04	4.89	0.51	3.03	0.17	6.50	0.36	5.53	0.05
344.08	3.58	0.78	1.67	0.21	5.15	0.49	4.15	0.01
344.13	2.56	0.88	0.45	0.30	4.03	0.64	2.98	0.05
344.17	2.37	1.05	-0.02	0.45	3.18	0.77	2.06	0.14
344.21	2.35	1.27	-0.23	0.57	2.70	0.89	1.46	0.27
344.25	2.76	1.24	0.06	0.69	2.40	0.97	1.09	0.39
344.29	4.11	1.07	1.36	0.75	2.53	0.99	1.20	0.53
344.33	7.20	0.78	4.60	0.83	3.47	0.90	2.21	0.70
344.38	9.55	0.52	7.23	0.96	4.96	0.79	3.78	0.85
344.42	8.97	0.33	7.04	0.92	5.89	0.65	4.71	0.91
344.46	6.81	0.20	5.27	0.77	5.67	0.52	4.53	0.83
344.50	7.47	0.14	6.34	0.68	5.38	0.36	4.39	0.76
344.54	7.39	0.09	6.51	0.54	5.49	0.24	4.63	0.69
344.58	8.14	0.04	7.59	0.44	5.82	0.24	5.10	0.63
344.63	8.79	0.08	8.48	0.39	6.27	0.41	5.66	0.56
344.67	9.20	0.37	9.31	0.38	6.79	0.62	6.27	0.49
344.71	9.29	0.37	9.47	0.34	7.16	0.79	6.74	0.42
344.75	8.87	0.16	8.83	0.26	7.24	0.85	6.82	0.35
344.79	9.20	0.30	8.90	0.30	7.26	0.85	6.82	0.30

344.83	9.46	0.39	8.91	0.29	7.38	0.79	6.89	0.27
344.88	9.09	0.31	8.24	0.23	7.57	0.70	6.96	0.24
344.92	7.95	0.13	6.62	0.16	6.95	0.51	6.21	0.20
344.96	7.67	0.04	5.92	0.08	6.66	0.37	5.75	0.14
345.00	6.66	0.08	4.63	0.04	6.13	0.24	5.08	0.10
345.04	5.72	0.10	3.61	0.15	5.41	0.22	4.34	0.11
345.08	4.74	0.16	2.67	0.16	4.58	0.46	3.58	0.11
345.13	4.64	0.31	2.34	0.19	3.95	0.60	2.97	0.11
345.17	5.51	0.56	2.84	0.29	3.88	0.74	2.82	0.15
345.21	6.71	0.81	3.66	0.38	4.11	0.89	2.90	0.23
345.25	9.99	0.84	6.58	0.55	5.18	0.98	3.83	0.38
345.29	11.57	0.62	8.58	0.77	6.56	1.06	5.20	0.59
345.33	11.03	0.37	8.62	0.85	7.25	1.05	6.00	0.71
345.38	9.86	0.19	7.90	0.70	6.94	0.97	5.84	0.66
345.42	12.83	0.08	11.15	0.82	7.71	0.77	6.84	0.73
345.46	14.94	0.24	13.09	0.71	9.10	0.58	8.26	0.75
345.50	15.71	0.28	13.81	0.50	10.24	0.41	9.26	0.68
345.54	17.28	0.49	16.20	0.51	11.34	0.16	10.43	0.63
345.58	18.16	1.03	18.01	0.54	12.62	0.41	11.99	0.63
345.63	15.79	1.08	15.90	0.44	13.02	0.72	12.46	0.53
345.67	12.86	1.01	12.78	0.31	11.98	0.77	11.41	0.38
345.71	11.81	0.93	11.82	0.27	10.96	0.78	10.43	0.28
345.75	12.66	0.76	12.77	0.38	10.70	0.88	10.29	0.24
345.79	12.64	0.49	12.73	0.36	10.83	0.96	10.48	0.19
345.83	11.90	0.54	11.50	0.47	10.64	0.95	10.23	0.15
345.88	10.96	0.49	9.50	1.20	10.18	0.84	9.31	0.40
345.92	8.55	0.37	7.48	0.50	9.27	0.65	8.29	0.45
345.96	7.21	0.32	5.87	0.29	8.01	0.50	7.02	0.34
346.00	4.37	0.17	3.10	0.02	6.60	0.37	5.56	0.25
346.04	1.98	0.08	0.89	0.09	4.80	0.32	3.86	0.17
346.08	1.40	0.15	-0.01	0.11	3.43	0.32	2.56	0.11
346.13	1.38	0.19	-0.14	0.15	2.63	0.36	1.76	0.04
346.17	-0.80	0.08	-1.90	0.24	1.76	0.40	0.90	0.03
346.21	-1.75	0.09	-2.65	0.22	0.56	0.42	-0.15	0.05
346.25	-2.38	0.03	-3.19	0.20	-0.26	0.40	-0.88	0.07
346.29	-2.87	0.02	-3.70	0.19	-0.96	0.38	-1.53	0.09
346.33	-3.62	0.09	-4.33	0.20	-1.60	0.36	-2.14	0.11
346.38	-3.90	0.13	-4.55	0.16	-2.20	0.34	-2.68	0.13
346.42	-2.77	0.13	-3.54	0.09	-2.34	0.29	-2.76	0.17
346.46	-1.88	0.25	-2.60	0.03	-2.08	0.22	-2.49	0.20
346.50	-0.25	0.28	-0.84	0.10	-1.53	0.17	-1.87	0.23
346.54	0.32	0.24	-0.26	0.18	-0.86	0.18	-1.18	0.27
346.58	0.77	0.22	0.26	0.20	-0.49	0.18	-0.80	0.28
346.63	-1.06	0.12	-1.30	0.19	-0.60	0.22	-0.93	0.22
346.67	-2.78	0.11	-3.02	0.17	-1.37	0.29	-1.71	0.09
346.71	-4.17	0.11	-4.44	0.09	-2.36	0.32	-2.71	0.08
346.75	-3.78	0.07	-3.98	0.20	-3.01	0.27	-3.24	0.16
346.79	-2.36	0.32	-2.41	0.40	-2.95	0.30	-2.89	0.17
346.83	-2.42	0.29	-2.44	0.28	-2.88	0.48	-2.62	0.16
346.88	-2.31	0.20	-2.40	0.21	-2.88	0.59	-2.53	0.15
346.92	-2.88	0.10	-3.04	0.10	-3.03	0.61	-2.70	0.15
346.96	-3.04	0.05	-3.21	0.10	-3.23	0.59	-2.91	0.16
347.00	-4.12	0.00	-4.26	0.06	-3.53	0.55	-3.25	0.18
347.04	-4.91	0.04	-5.02	0.05	-4.01	0.45	-3.79	0.20
347.08	-5.60	0.07	-5.66	0.05	-4.49	0.37	-4.30	0.22
347.13	-5.60	0.05	-5.64	0.09	-4.84	0.32	-4.63	0.24

347.17	-5.91	0.07	-5.96	0.07	-5.03	0.31	-4.82	0.25
347.21	-5.69	0.08	-5.77	0.12	-5.23	0.27	-5.02	0.25
347.25	-4.70	0.07	-4.82	0.19	-5.07	0.29	-4.79	0.24
347.29	-3.92	0.08	-4.11	0.19	-4.72	0.33	-4.42	0.23
347.33	-2.19	0.09	-2.45	0.32	-4.19	0.34	-3.87	0.22
347.38	-0.02	0.09	-0.32	0.33	-3.08	0.37	-2.73	0.17
347.42	1.47	0.20	0.95	0.35	-1.97	0.35	-1.69	0.14
347.46	3.08	0.20	2.46	0.39	-0.87	0.32	-0.72	0.12
347.50	3.66	0.03	2.95	0.34	0.18	0.23	0.24	0.12
347.54	5.13	0.06	4.43	0.49	0.90	0.10	0.83	0.12
347.58	6.86	0.02	6.40	0.50	2.25	0.05	2.11	0.08
347.63	7.07	0.18	6.55	0.42	3.25	0.13	3.06	0.07
347.67	5.49	0.00	4.75	0.29	3.44	0.14	3.03	0.11
347.71	3.99	0.32	3.18	0.23	2.92	0.28	2.39	0.18
347.75	2.47	0.33	1.62	0.15	2.18	0.39	1.54	0.20
347.79	1.39	0.29	0.52	0.18	1.44	0.41	0.76	0.22
347.83	0.52	0.21	-0.22	0.15	0.77	0.39	0.11	0.22
347.88	0.13	0.10	-0.46	0.14	0.27	0.34	-0.29	0.20
347.92	-0.80	0.03	-1.33	0.08	-0.23	0.29	-0.72	0.18
347.96	-1.22	0.08	-1.73	0.08	-0.79	0.28	-1.20	0.17
348.00	-1.10	0.13	-1.68	0.10	-1.08	0.27	-1.45	0.16
348.04	-1.40	0.12	-1.92	0.07	-1.22	0.28	-1.59	0.15
348.08	-2.08	0.06	-2.59	0.08	-1.62	0.28	-1.97	0.16
348.13	-2.49	0.01	-2.92	0.08	-1.97	0.26	-2.29	0.16
348.17	-2.66	0.00	-3.03	0.08	-2.28	0.23	-2.54	0.15
348.21	-2.41	0.02	-2.77	0.10	-2.41	0.21	-2.62	0.13
348.25	-2.29	0.03	-2.63	0.10	-2.41	0.20	-2.60	0.12
348.29	-1.83	0.07	-2.17	0.12	-2.31	0.19	-2.48	0.11
348.33	-2.32	0.01	-2.58	0.09	-2.32	0.20	-2.48	0.11
348.38	-2.46	0.04	-2.69	0.10	-2.50	0.18	-2.62	0.12
348.42	-1.91	0.01	-2.14	0.12	-2.49	0.15	-2.54	0.11
348.46	-1.51	0.00	-1.76	0.11	-2.32	0.15	-2.31	0.09
348.50	-1.37	0.02	-1.63	0.09	-2.17	0.14	-2.16	0.09
348.54	-1.11	0.01	-1.43	0.10	-2.00	0.12	-2.01	0.08
348.58	-1.00	0.01	-1.37	0.12	-1.85	0.12	-1.90	0.09
348.63	-1.05	0.01	-1.40	0.11	-1.76	0.12	-1.84	0.10
348.67	-1.41	0.05	-1.69	0.09	-1.80	0.13	-1.89	0.10
348.71	-1.61	0.07	-1.87	0.09	-1.92	0.13	-1.99	0.11
348.75	-1.74	0.08	-1.98	0.09	-2.01	0.12	-2.07	0.11
348.79	-1.95	0.10	-2.18	0.09	-2.13	0.12	-2.17	0.11
348.83	-2.17	0.11	-2.38	0.08	-2.25	0.12	-2.29	0.11
348.88	-2.47	0.13	-2.66	0.08	-2.42	0.11	-2.45	0.11
348.92	-2.60	0.13	-2.79	0.09	-2.58	0.11	-2.60	0.11
348.96	-2.71	0.14	-2.88	0.09	-2.69	0.11	-2.71	0.10
349.00	-2.84	0.15	-3.00	0.09	-2.81	0.10	-2.81	0.10
349.04	-2.93	0.15	-3.07	0.09	-2.91	0.10	-2.90	0.10
349.08	-3.05	0.16	-3.17	0.09	-3.01	0.09	-2.98	0.09
349.13	-3.09	0.16	-3.20	0.09	-3.10	0.09	-3.05	0.09
349.17	-3.10	0.16	-3.21	0.09	-3.16	0.08	-3.10	0.09
349.21	-3.03	0.16	-3.14	0.09	-3.18	0.08	-3.11	0.08
349.25	-2.95	0.15	-3.08	0.10	-3.18	0.08	-3.10	0.08
349.29	-2.70	0.13	-2.86	0.11	-3.14	0.08	-3.05	0.08
349.33	-2.67	0.14	-2.84	0.11	-3.05	0.08	-2.96	0.08
349.38	-2.59	0.12	-2.78	0.12	-3.03	0.08	-2.96	0.08
349.42	-2.11	0.09	-2.35	0.15	-2.91	0.09	-2.84	0.08
349.46	-0.86	0.01	-1.17	0.20	-2.54	0.07	-2.44	0.07

349.50	0.36	0.10	0.03	0.20	-1.93	0.08	-1.78	0.06
349.54	1.17	0.15	0.81	0.18	-1.33	0.12	-1.15	0.06
349.58	1.22	0.15	0.90	0.15	-0.90	0.15	-0.74	0.06
349.63	1.62	0.17	1.31	0.15	-0.68	0.17	-0.50	0.05
349.67	2.34	0.16	1.95	0.16	-0.22	0.17	-0.05	0.06
349.71	2.46	0.17	2.04	0.18	0.12	0.19	0.25	0.06
349.75	2.49	0.18	2.04	0.18	0.35	0.21	0.43	0.07
349.79	2.24	0.16	1.77	0.17	0.44	0.23	0.47	0.08
349.83	1.52	0.11	1.10	0.14	0.33	0.24	0.32	0.09
349.88	0.97	0.08	0.67	0.15	0.06	0.23	0.06	0.11
349.92	0.65	0.06	0.39	0.13	-0.16	0.22	-0.13	0.11
349.96	0.10	0.02	-0.13	0.10	-0.42	0.21	-0.37	0.11
350.00	-0.19	0.03	-0.44	0.10	-0.70	0.21	-0.63	0.11
350.04	-0.48	0.06	-0.72	0.07	-0.91	0.20	-0.83	0.10
350.08	-0.58	0.01	-0.86	0.09	-1.14	0.20	-1.04	0.10
350.13	-0.16	0.06	-0.54	0.09	-1.09	0.22	-1.00	0.09
350.17	-0.55	0.06	-0.90	0.09	-1.18	0.23	-1.11	0.10
350.21	-0.52	0.09	-0.87	0.11	-1.29	0.22	-1.22	0.10
350.25	0.40	0.02	0.03	0.14	-1.15	0.21	-1.05	0.08
350.29	0.73	0.05	0.39	0.13	-0.76	0.21	-0.66	0.07
350.33	-0.71	0.04	-1.00	0.05	-0.90	0.19	-0.89	0.09
350.38	-1.27	0.08	-1.53	0.06	-1.33	0.15	-1.35	0.09
350.42	-0.87	0.06	-1.12	0.10	-1.51	0.14	-1.50	0.07
350.46	-0.52	0.08	-0.81	0.10	-1.37	0.13	-1.33	0.06
350.50	-0.56	0.10	-0.86	0.13	-1.37	0.18	-1.31	0.07
350.54	-0.55	0.10	-0.88	0.11	-1.38	0.20	-1.31	0.07
350.58	-0.09	0.14	-0.43	0.15	-1.31	0.20	-1.24	0.06
350.63	0.70	0.11	0.36	0.16	-1.05	0.27	-0.91	0.04
350.67	0.32	0.15	0.19	0.17	-0.86	0.24	-0.70	0.04
350.71	0.66	0.16	0.62	0.19	-0.79	0.20	-0.60	0.04
350.75	1.48	0.05	1.33	0.18	-0.52	0.22	-0.27	0.02
350.79	2.18	0.02	1.91	0.16	-0.11	0.24	0.14	0.03
350.83	1.72	0.05	1.32	0.12	0.13	0.24	0.28	0.03
350.88	0.60	0.07	0.26	0.09	-0.13	0.23	-0.06	0.03
350.92	0.34	0.08	0.07	0.08	-0.41	0.19	-0.35	0.02
350.96	-0.30	0.10	-0.58	0.06	-0.66	0.16	-0.62	0.02
351.00	-0.68	0.10	-0.94	0.06	-0.96	0.13	-0.95	0.02
351.04	-0.84	0.12	-1.15	0.07	-1.16	0.13	-1.15	0.02
351.08	-1.28	0.13	-1.54	0.06	-1.40	0.13	-1.40	0.03
351.13	-1.44	0.12	-1.67	0.06	-1.62	0.13	-1.60	0.03
351.17	-1.45	0.09	-1.70	0.06	-1.79	0.13	-1.74	0.04
351.21	-1.01	0.05	-1.35	0.09	-1.77	0.14	-1.72	0.04
351.25	-0.61	0.03	-0.98	0.11	-1.63	0.15	-1.58	0.04
351.29	-0.19	0.03	-0.52	0.13	-1.45	0.16	-1.39	0.04
351.33	0.43	0.06	0.09	0.15	-1.17	0.19	-1.08	0.05
351.38	1.38	0.13	0.91	0.18	-0.76	0.20	-0.68	0.05
351.42	2.07	0.17	1.55	0.20	-0.27	0.22	-0.21	0.05
351.46	3.12	0.25	2.52	0.24	0.26	0.22	0.29	0.05
351.50	4.55	0.36	3.82	0.30	0.98	0.24	0.99	0.06
351.54	6.27	0.46	5.38	0.36	2.02	0.25	1.95	0.06
351.58	5.88	0.32	5.14	0.31	2.80	0.28	2.62	0.09
351.63	5.27	0.26	4.76	0.35	2.67	0.27	2.53	0.14
351.67	7.65	0.30	7.25	0.44	3.33	0.17	3.28	0.13
351.71	9.06	0.26	9.07	0.46	4.59	0.18	4.63	0.16
351.75	9.70	0.21	9.50	0.55	5.33	0.24	5.39	0.21
351.79	10.25	0.25	10.11	0.56	6.19	0.30	6.20	0.28

351.83	8.60	0.00	8.32	0.47	6.23	0.25	6.18	0.31
351.88	5.24	0.23	4.84	0.31	5.12	0.10	5.02	0.32
351.92	3.63	0.18	2.94	0.27	3.64	0.23	3.54	0.29
351.96	3.81	0.06	2.66	0.29	2.92	0.32	2.76	0.24
352.00	3.69	0.01	2.11	0.32	2.58	0.41	2.26	0.23
352.04	3.18	0.07	1.23	0.27	2.21	0.53	1.69	0.22
352.08	2.77	0.30	0.67	0.09	1.77	0.65	1.11	0.17
352.13	2.46	0.60	0.32	0.15	1.41	0.76	0.67	0.07
352.17	2.67	0.74	0.37	0.34	1.22	0.85	0.43	0.08
352.21	3.43	0.92	0.90	0.39	1.28	0.92	0.39	0.19
352.25	4.73	0.95	1.93	0.60	1.72	1.00	0.70	0.30
352.29	6.03	0.75	3.28	0.61	2.35	1.04	1.29	0.41
352.33	7.23	0.54	4.70	0.50	3.06	1.02	2.02	0.47
352.38	8.81	0.41	6.62	0.45	3.97	0.93	3.02	0.51
352.42	10.03	0.37	8.25	0.41	4.99	0.77	4.12	0.53
352.46	11.18	0.18	9.85	0.31	6.02	0.57	5.28	0.54
352.50	11.97	0.22	11.03	0.23	6.97	0.35	6.33	0.52
352.54	12.51	0.18	12.03	0.17	7.80	0.15	7.25	0.47
352.58	12.90	0.04	12.73	0.16	8.48	0.25	8.06	0.41
352.63	13.13	0.08	13.08	0.23	9.02	0.47	8.65	0.35
352.67	13.36	0.08	13.52	0.30	9.53	0.71	9.18	0.30
352.71	13.53	0.18	13.76	0.42	9.94	0.91	9.61	0.26
352.75	14.37	0.14	14.73	0.60	10.52	1.14	10.17	0.27
352.79	15.06	0.08	15.48	0.73	11.17	1.32	10.84	0.32
352.83	14.86	0.09	15.06	0.73	11.62	1.29	11.33	0.38
352.88	13.03	0.06	12.61	0.64	11.14	0.94	10.78	0.37
352.92	11.79	0.01	10.76	0.59	10.25	0.58	9.78	0.36
352.96	10.62	0.06	9.08	0.49	9.44	0.35	8.78	0.33
353.00	10.21	0.21	8.09	0.53	8.74	0.21	7.89	0.34
353.04	9.38	0.35	6.86	0.35	8.12	0.30	7.10	0.32
353.08	8.62	0.49	5.79	0.19	7.40	0.54	6.22	0.25
353.13	8.11	0.79	5.12	0.10	6.76	0.74	5.48	0.18
353.17	8.44	0.99	5.18	0.30	6.44	0.93	5.07	0.21
353.21	8.13	1.01	4.85	0.34	6.27	1.07	4.77	0.30
353.25	7.95	0.82	4.72	0.41	5.98	1.10	4.43	0.35
353.29	8.97	0.66	5.62	0.36	6.05	1.09	4.48	0.44
353.33	8.45	0.36	5.46	0.34	6.15	1.06	4.57	0.48
353.38	9.10	0.32	6.20	0.25	6.07	0.97	4.58	0.50
353.42	11.85	0.34	8.97	0.09	6.88	0.82	5.43	0.56
353.46	13.55	0.21	10.94	0.11	8.25	0.64	6.76	0.60
353.50	16.22	0.31	14.67	0.18	9.78	0.33	8.48	0.63
353.54	15.86	0.08	14.34	0.21	11.13	0.13	9.95	0.62
353.58	13.65	0.26	11.70	0.37	10.87	0.05	9.55	0.57
353.63	12.31	0.25	10.80	0.47	10.24	0.01	8.95	0.54
353.67	11.64	0.20	10.40	0.56	9.73	0.12	8.59	0.56
353.71	11.18	0.18	9.98	0.57	9.42	0.23	8.33	0.57
353.75	10.59	0.18	9.45	0.58	9.13	0.29	8.08	0.57
353.79	9.55	0.06	8.50	0.58	8.63	0.30	7.64	0.56
353.83	9.05	0.03	7.89	0.57	8.08	0.24	7.16	0.54
353.88	8.36	0.06	7.06	0.54	7.53	0.15	6.70	0.52
353.92	7.21	0.11	5.80	0.49	6.84	0.26	6.05	0.47
353.96	6.49	0.16	4.91	0.43	6.12	0.35	5.31	0.42
354.00	6.23	0.21	4.35	0.37	5.61	0.42	4.73	0.39
354.04	6.06	0.19	3.83	0.32	5.21	0.54	4.24	0.37
354.08	6.05	0.35	3.55	0.23	4.87	0.74	3.83	0.33
354.13	6.75	0.80	3.87	0.05	4.79	0.87	3.64	0.27

354.17	7.67	1.12	4.46	0.23	5.03	1.05	3.74	0.25
354.21	8.57	1.33	5.18	0.31	5.42	1.23	3.98	0.29
354.25	10.02	1.35	6.50	0.53	6.00	1.34	4.47	0.38
354.29	12.03	1.18	8.65	0.51	6.89	1.36	5.35	0.54
354.33	13.93	1.03	10.93	0.50	8.09	1.33	6.63	0.67
354.38	15.33	0.79	12.79	0.45	9.29	1.19	7.94	0.74
354.42	15.74	0.50	13.57	0.40	10.26	0.96	8.99	0.74
354.46	16.85	0.35	15.21	0.26	11.15	0.65	9.99	0.72
354.50	17.03	0.25	15.90	0.09	11.95	0.36	10.92	0.67
354.54	17.30	0.25	16.71	0.08	12.57	0.27	11.69	0.62
354.58	18.01	0.07	17.88	0.21	13.17	0.44	12.49	0.57
354.63	17.78	0.27	17.85	0.37	13.77	0.72	13.19	0.52
354.67	16.49	0.34	15.99	0.73	13.73	0.91	13.21	0.47
354.71	14.90	0.35	14.94	0.66	13.22	0.99	12.88	0.48
354.75	13.26	0.28	13.41	0.55	12.37	0.96	12.06	0.42
354.79	11.84	0.15	11.82	0.50	11.42	0.88	11.07	0.37
354.83	11.12	0.05	10.86	0.46	10.56	0.75	10.17	0.33
354.88	11.15	0.04	10.57	0.48	9.99	0.51	9.66	0.33
354.92	11.88	0.22	10.91	0.48	9.83	0.34	9.53	0.34
354.96	10.88	0.25	9.19	0.35	9.71	0.26	9.15	0.28
355.00	8.99	0.23	6.84	0.41	8.79	0.31	7.83	0.26
355.04	7.24	0.18	4.91	0.39	7.62	0.47	6.40	0.25
355.08	6.06	0.25	3.78	0.32	6.43	0.72	5.23	0.21
355.13	5.48	0.44	3.35	0.29	5.56	0.81	4.43	0.20
355.17	5.72	0.57	3.55	0.34	5.13	0.83	4.06	0.24
355.21	6.19	0.71	4.00	0.29	5.02	0.86	3.97	0.28
355.25	6.92	0.66	4.56	0.35	5.16	0.88	4.12	0.31
355.29	7.72	0.49	5.43	0.24	5.41	0.87	4.40	0.36
355.33	8.68	0.37	6.43	0.14	5.82	0.84	4.88	0.39
355.38	9.64	0.28	7.54	0.09	6.36	0.77	5.47	0.41
355.42	10.57	0.21	8.67	0.16	6.98	0.68	6.17	0.44
355.46	11.79	0.18	10.08	0.27	7.72	0.56	7.00	0.49
355.50	13.06	0.23	11.71	0.41	8.61	0.39	8.00	0.55
355.54	15.24	0.22	14.86	0.58	9.76	0.13	9.44	0.63
355.58	17.23	0.04	17.88	0.61	11.45	0.33	11.63	0.62
355.63	17.98	0.04	18.97	0.65	12.79	0.74	13.17	0.59
355.67	18.05	0.13	19.17	0.71	13.59	1.06	13.98	0.55
355.71	18.62	0.16	19.93	0.80	14.26	1.33	14.71	0.55
355.75	18.70	0.13	19.96	0.84	14.89	1.52	15.33	0.57
355.79	18.32	0.09	19.54	0.85	15.12	1.56	15.51	0.58
355.83	17.25	0.01	17.88	0.84	14.95	1.45	15.18	0.57
355.88	16.33	0.05	16.39	0.79	14.37	1.11	14.43	0.55
355.92	15.13	0.10	14.56	0.65	13.69	0.74	13.56	0.48
355.96	13.51	0.18	12.13	0.43	12.78	0.49	12.30	0.37
356.00	12.48	0.21	10.48	0.47	11.73	0.28	10.89	0.30
356.04	11.88	0.37	9.33	0.41	10.95	0.27	9.83	0.29
356.08	10.80	0.72	8.05	0.13	9.97	0.77	8.84	0.19
356.13	8.99	0.71	6.20	0.27	8.96	0.95	7.66	0.08
356.17	7.72	0.65	5.15	0.39	7.87	0.99	6.53	0.14
356.21	7.13	0.68	4.70	0.36	7.05	0.99	5.74	0.22
356.25	6.91	0.54	4.50	0.42	6.49	0.98	5.21	0.27
356.29	7.45	0.40	5.14	0.33	6.23	0.95	5.05	0.32
356.33	9.33	0.41	7.12	0.13	6.46	0.90	5.46	0.37
356.38	12.41	0.44	10.27	0.17	7.62	0.84	6.79	0.41
356.42	14.40	0.28	13.06	0.22	9.12	0.69	8.53	0.47
356.46	16.30	0.35	15.48	0.24	10.57	0.47	10.29	0.47

356.50	15.24	0.18	13.67	0.26	11.41	0.37	10.83	0.45
356.54	14.87	0.11	13.66	0.42	11.30	0.29	10.58	0.50
356.58	14.25	0.08	12.92	0.54	11.44	0.14	10.70	0.56
356.63	15.85	0.13	15.42	0.63	11.53	0.03	10.94	0.62
356.67	19.92	0.42	20.70	0.80	13.37	0.51	13.44	0.65
356.71	22.17	0.52	22.70	0.86	15.45	0.90	15.70	0.66
356.75	18.86	0.13	17.98	0.70	16.08	0.92	15.72	0.66
356.79	13.62	0.03	12.32	0.75	14.13	0.60	13.13	0.59
356.83	11.01	0.04	9.61	0.72	11.97	0.33	10.90	0.51
356.88	9.11	0.00	7.61	0.65	10.27	0.22	9.19	0.45
356.92	7.59	0.03	6.01	0.60	8.81	0.31	7.75	0.40
356.96	6.39	0.05	4.73	0.55	7.59	0.40	6.53	0.35
357.00	5.44	0.08	3.65	0.50	6.56	0.48	5.46	0.33
357.04	4.69	0.12	2.80	0.44	5.67	0.57	4.54	0.32
357.08	4.17	0.18	2.24	0.34	4.84	0.75	3.79	0.28
357.13	4.24	0.39	2.21	0.27	4.34	0.80	3.30	0.24
357.17	4.76	0.46	2.39	0.31	4.15	0.87	3.08	0.23
357.21	5.38	0.48	2.82	0.26	4.20	0.95	3.05	0.23
357.25	6.20	0.47	3.56	0.29	4.38	0.99	3.19	0.24
357.29	7.44	0.37	4.79	0.17	4.85	1.02	3.65	0.29
357.33	8.74	0.37	6.35	0.04	5.42	1.00	4.32	0.30
357.38	10.09	0.37	7.91	0.10	6.28	0.95	5.27	0.32
357.42	10.82	0.41	9.09	0.18	6.96	0.84	6.06	0.32
357.46	12.96	0.47	11.55	0.30	8.01	0.71	7.31	0.36
357.50	15.42	0.49	14.28	0.50	9.51	0.50	8.98	0.45
357.54	17.41	0.48	17.16	0.67	11.09	0.23	10.76	0.53
357.58	19.17	0.17	19.45	0.76	12.72	0.13	12.68	0.58
357.63	19.97	0.08	20.74	0.77	14.13	0.57	14.21	0.59
357.67	20.36	0.02	21.68	0.83	15.17	0.99	15.38	0.59
357.71	20.03	0.00	21.48	0.84	15.81	1.31	16.10	0.58
357.75	19.49	0.06	20.88	0.88	16.02	1.45	16.28	0.58
357.79	18.39	0.20	19.05	0.77	15.86	1.42	16.04	0.58
357.83	17.21	0.16	16.79	0.73	15.25	1.14	15.04	0.58
357.88	15.45	0.21	14.28	0.66	14.38	0.77	13.87	0.55
357.92	13.28	0.15	11.56	0.60	13.04	0.33	12.28	0.50
357.96	11.59	0.13	9.51	0.52	11.66	0.20	10.71	0.43
358.00	10.31	0.21	7.89	0.48	10.45	0.36	9.33	0.37
358.04	9.28	0.23	6.57	0.42	9.39	0.55	8.11	0.32
358.08	8.72	0.34	5.79	0.30	8.39	0.90	7.12	0.27
358.13	8.75	0.68	5.79	0.11	7.83	1.03	6.51	0.19
358.17	9.08	0.83	5.79	0.36	7.65	1.15	6.26	0.08
358.21	8.94	1.04	5.46	0.57	7.46	1.25	5.87	0.18
358.25	10.04	1.05	6.63	0.68	7.49	1.29	5.88	0.35
358.29	10.81	0.71	7.60	0.57	7.92	1.30	6.34	0.47
358.33	9.48	0.33	6.61	0.45	7.80	1.25	6.19	0.47
358.38	10.31	0.23	8.06	0.34	7.59	1.11	6.21	0.48
358.42	11.19	0.01	9.42	0.23	8.09	0.90	6.95	0.48
358.46	11.01	0.11	9.60	0.09	8.36	0.69	7.35	0.45
358.50	11.62	0.02	10.71	0.02	8.63	0.45	7.78	0.44
358.54	12.09	0.01	11.80	0.15	9.11	0.19	8.47	0.44
358.58	12.73	0.23	12.84	0.28	9.60	0.21	9.18	0.43
358.63	13.47	0.10	13.83	0.35	10.21	0.50	9.93	0.42
358.67	13.85	0.20	14.36	0.49	10.83	0.80	10.61	0.42
358.71	13.54	0.28	14.04	0.60	11.13	1.01	10.89	0.41
358.75	13.26	0.37	13.71	0.67	11.20	1.11	10.94	0.41
358.79	13.14	0.18	13.45	0.70	11.19	1.14	10.94	0.42

358.83	13.02	0.11	12.95	0.71	11.11	1.02	10.81	0.42
358.88	13.68	0.14	13.41	0.68	11.18	0.82	10.92	0.41
358.92	13.69	0.37	12.95	0.60	11.26	0.55	10.97	0.36
358.96	12.93	0.33	11.50	0.53	11.05	0.36	10.53	0.31
359.00	12.00	0.44	9.94	0.43	10.57	0.26	9.71	0.26
359.04	11.17	0.56	8.56	0.33	9.93	0.39	8.79	0.20
359.08	10.11	0.59	7.18	0.16	9.03	0.81	7.80	0.12
359.13	9.67	0.94	6.72	0.11	8.35	0.99	7.05	0.04
359.17	9.03	0.91	5.90	0.34	7.93	1.12	6.52	0.11
359.21	8.45	0.88	5.32	0.37	7.34	1.13	5.84	0.20
359.25	9.88	1.10	6.71	0.58	7.31	1.15	5.82	0.32
359.29	11.91	1.00	8.93	0.54	7.97	1.19	6.57	0.45
359.33	13.34	0.73	10.74	0.47	8.86	1.16	7.59	0.49
359.38	15.20	0.55	13.03	0.47	9.88	1.04	8.81	0.50
359.42	17.13	0.44	15.59	0.46	11.17	0.83	10.35	0.48
359.46	18.64	0.29	17.66	0.41	12.53	0.56	11.92	0.44
359.50	19.62	0.19	19.17	0.36	13.77	0.25	13.33	0.40
359.54	19.45	0.07	19.47	0.29	14.61	0.19	14.27	0.36
359.58	19.09	0.18	19.30	0.33	14.98	0.43	14.72	0.33
359.63	18.77	0.23	19.07	0.42	15.17	0.67	14.93	0.32
359.67	18.87	0.18	19.36	0.52	15.34	0.91	15.14	0.32
359.71	19.54	0.17	20.28	0.66	15.79	1.19	15.68	0.35
359.75	19.78	0.19	20.62	0.75	16.31	1.38	16.27	0.39
359.79	19.41	0.01	20.18	0.78	16.49	1.43	16.48	0.42
359.83	18.50	0.03	18.73	0.78	16.27	1.27	16.19	0.43
359.88	17.79	0.21	17.63	0.72	15.82	1.00	15.67	0.42
359.92	16.75	0.17	15.94	0.68	15.19	0.67	14.90	0.39
359.96	15.57	0.12	14.12	0.57	14.43	0.40	13.89	0.36
360.00	13.90	0.27	12.05	0.42	13.43	0.25	12.62	0.26
360.04	13.47	0.59	10.97	0.34	12.56	0.34	11.53	0.19
360.08	12.45	0.68	9.58	0.18	11.58	0.82	10.48	0.13
360.13	11.52	0.81	8.41	0.12	10.75	1.03	9.46	0.06
360.17	11.29	0.95	7.90	0.47	10.14	1.16	8.70	0.14
360.21	11.84	1.28	8.32	0.68	9.84	1.28	8.31	0.32
360.25	13.15	1.47	9.71	0.83	10.03	1.39	8.50	0.45
360.29	14.84	1.32	11.73	0.72	10.66	1.44	9.23	0.55
360.33	16.75	1.24	14.12	0.69	11.57	1.40	10.35	0.56
360.38	16.56	0.97	14.43	0.58	12.41	1.31	11.33	0.53
360.42	15.89	0.83	14.27	0.26	12.44	1.13	11.45	0.43
360.46	17.21	0.79	15.85	0.14	12.90	0.84	12.07	0.35
360.50	18.35	0.65	17.00	0.19	13.72	0.60	12.94	0.30
360.54	20.60	0.66	19.35	0.29	14.84	0.41	14.15	0.33
360.58	20.50	0.49	19.01	0.20	15.79	0.34	14.99	0.33
360.63	20.75	0.49	19.36	0.19	16.20	0.32	15.35	0.32
360.67	19.50	0.46	18.18	0.16	16.19	0.34	15.29	0.27
360.71	17.95	0.49	16.88	0.17	15.74	0.39	14.84	0.22
360.75	18.71	0.62	17.47	0.27	15.46	0.43	14.62	0.19
360.79	18.29	0.42	17.01	0.25	15.63	0.42	14.70	0.22
360.83	16.45	0.28	15.06	0.24	15.06	0.38	14.02	0.20
360.88	15.19	0.23	13.85	0.25	14.24	0.35	13.21	0.20
360.92	12.04	0.06	10.75	0.28	13.03	0.34	11.97	0.17
360.96	11.65	0.16	10.03	0.28	11.78	0.33	10.74	0.17
361.00	9.27	0.08	7.80	0.24	10.68	0.40	9.57	0.14
361.04	7.59	0.01	6.40	0.27	9.37	0.42	8.35	0.13
361.08	5.10	0.08	4.10	0.35	7.89	0.45	6.91	0.13
361.13	3.01	0.13	2.25	0.36	6.28	0.47	5.41	0.15

361.17	3.85	0.18	2.62	0.37	5.13	0.48	4.45	0.17
361.21	6.85	0.68	4.60	0.46	5.48	0.60	4.71	0.27
361.25	8.78	0.86	6.05	0.59	6.32	0.76	5.31	0.38
361.29	10.38	0.82	7.79	0.56	7.16	0.86	6.07	0.49
361.33	12.89	0.76	10.41	0.47	8.24	0.85	7.23	0.53
361.38	15.26	0.60	13.10	0.40	9.71	0.76	8.81	0.53
361.42	17.43	0.49	15.66	0.36	11.24	0.61	10.47	0.49
361.46	19.28	0.38	17.89	0.30	12.88	0.40	12.25	0.44
361.50	19.52	0.31	18.50	0.16	14.06	0.23	13.47	0.39
361.54	19.41	0.06	18.59	0.11	14.66	0.24	14.09	0.39
361.58	19.43	0.16	19.02	0.23	15.06	0.31	14.64	0.36
361.63	19.30	0.22	19.07	0.33	15.35	0.48	15.03	0.32
361.67	19.13	0.37	18.90	0.50	15.57	0.68	15.27	0.30
361.71	18.39	0.55	18.13	0.62	15.58	0.83	15.19	0.33
361.75	17.37	1.36	17.78	0.65	15.20	1.25	15.07	0.36
361.79	16.73	1.27	17.09	0.66	14.88	1.50	14.88	0.40
361.83	16.05	1.04	16.01	0.65	14.54	1.35	14.47	0.40
361.88	15.04	0.85	14.49	0.59	13.98	1.09	13.76	0.37
361.92	15.10	0.52	14.22	0.60	13.49	0.79	13.19	0.35
361.96	15.15	0.08	13.98	0.44	13.33	0.54	12.95	0.30
362.00	13.98	0.11	12.21	0.32	12.93	0.31	12.29	0.21
362.04	13.37	0.25	11.01	0.32	12.24	0.14	11.31	0.20
362.08	12.97	0.40	10.30	0.17	11.54	0.48	10.58	0.14
362.13	11.92	0.58	9.16	0.23	10.95	0.70	9.87	0.06
362.17	11.01	0.53	7.96	0.55	10.23	0.78	8.98	0.20
362.21	11.45	0.77	8.24	0.71	9.82	0.85	8.49	0.40
362.25	11.32	0.55	8.07	0.83	9.66	0.91	8.21	0.53
362.29	12.49	0.46	9.36	0.64	9.71	0.88	8.32	0.62
362.33	13.47	0.33	10.33	0.30	10.15	0.84	8.78	0.55
362.38	15.21	0.27	12.05	0.15	10.86	0.77	9.49	0.46
362.42	16.61	0.12	13.71	0.22	11.79	0.64	10.41	0.40
362.46	18.57	0.13	16.49	0.31	12.97	0.41	11.76	0.37
362.50	20.80	0.08	19.87	0.36	14.52	0.21	13.68	0.38
362.54	22.04	0.18	21.98	0.38	16.02	0.34	15.60	0.36
362.58	22.68	0.44	22.97	0.41	17.14	0.61	16.95	0.28

Appendix Eleven

Mean soil moisture contents (%) of control and JP-5 treated cores

Mean gravimetric soil moisture content (%) of control cores over 42 day sampling period.

Depth	Day 0.1		Day 7		Day 14		Day 21		Day 28		Day 35		Day 42		Combined	
(cm)	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
0–2.5	1.7	0.2	1.9	0.5	2.1	0.2	3.1	0.6	2.0	0.2	2.5	0.3	1.8	0.2	2.2	0.5
2-5–10	2.4	0.3	3.4	0.1	3.5	0.5	2.9	0.2	2.9	0.4	2.1	0.2	2.5	0.4	2.8	0.5
10–20	2.5	0.3	3.0	0.3	3.6	0.5	3.5	0.7	3.0	0.3	2.3	0.2	3.1	0.4	3.0	0.5
20–29	2.8	0.2	2.6	0.3	3.8	0.4	3.2	0.1	2.9	0.3	2.5	0.2	3.2	0.3	3.0	0.4
29–30	-	-	4.4	0.7	5.6	0.6	4.3	0.9	3.8	0.7	6.9	2.1	5.6	2.2	5.1	0.1

Mean gravimetric soil moisture content (%) of control cores on selected days after one year.

Depth	Day 357		Day 365		Day 379		Day 397		Combined	
(cm)	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
0–2.5	1.6	0	1.6	0.1	1.6	0.1	1.3	0.1	1.5	0.1
2-5–10	2.5	0.3	3.1	0.8	3.1	0.8	2.0	0.2	2.7	0.5
10–20	3.1	0.4	3.7	1.1	3.7	1.1	2.6	0.1	3.3	0.5
20–29	3.4	0.1	3.7	0.3	3.7	0.3	3.2	0.2	3.5	0.2
29–30	4.4	0.9	5.0	0.3	5.0	0.3	4.6	0.6	4.8	0.3

Mean gravimetric soil moisture and fuel contents (%) of JP-5 contaminated zones, and moisture content (%) of uncontaminated zones over 42 day sampling period.

Depth	Day 0.1		Day 7		Day 14		Day 21		Day 28		Day 35		Day 42		Combined	
(cm)	mean	s.d.	mean	s.d.	mean	s.d.	mean	mean	s.d.	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
0–2.5	6.1	0.4	3.7	0.4	3.7	0.3	3.3	0.4	3.0	0.2	2.9	0.6	2.7	0.3	3.6	1.2
2-5–*	6.5	0.6	4.5	0.1	4.3	0.4	4.3	0.3	4.0	0.3	4	0.7	3.8	0.5	4.5	0.9
*-# (a)	2.7	0.8	4.6	0.3	3.4	0.4	4.0	0.3	3.5	0.1	3.2	0.5	3.5	0.4	3.6	0.6
#-20	3.3	1.0	3.2	1.0	3.4	0.5	3.6	0.3	3.2	0.5	3.2	0.1	3.0	0.3	3.3	0.2
20-29	3.3	1.0	2.9	0.2	3.2	0.3	3.7	0.4	3.7	1.0	2.9	0.1	3.5	0.5	3.3	0.3
29-30	-	-	4.3	0.7	5.2	0.8	5.0	0.8	5.2	1.3	4.7	1.4	5.1	0.1	4.9	0.4
Mean depth of (a) (cm)	8-10		12-14		12-14		13-15		13-15		13-15		13-15			

* Mean upper depth of transitional zone (a)
\# Mean depth of visible fuel penetration

Mean gravimetric soil moisture and fuel contents (%) of JP-5 contaminated zones, and moisture content (%) of uncontaminated zones on selected days after one year.

Depth	Day 357		Day 365		Day 397		Day 372		Combined	
(cm)	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
0–2.5	1.7	0.2	1.8	0.4	1.8	0.2	1.3	0.4	1.7	0.2
2-5–*	2.6	0.2	3.4	0.3	3.1	0.3	2.0	0.9	2.8	0.6
*-# (a)	3.3	0.5	3.3	0.1	2.8	0.4	-	-	3.1	0.3
#-20	3.1	0.7	3.5	0.4	3.2	0.3	1.9	0.7	2.9	0.7
20 –29	3.7	0.6	3.5	0.3	3.6	0.4	2.3	1.2	3.3	0.7
29 –30	5.6	1.7	7.9	1.6	5.4	0.2	3.6	0.7	5.6	1.8
Mean depth of a (cm)	15-17		15-17		15-17		-			

Appendix Twelve

Culturable heterotrophic bacteria, viable plate counts

(g/ dried weight soil)

Day 0.1, JP-5 treated

OST #	Soil moisture (%)	Depth (cm)	Number of visible colonies (0.0001 g soil) Plate 1	Plate 2	Plate 3	Mean colonies (0.0001 g soil)	Mean bacteria (g/ wet weight soil)	Mean bacteria (g/ dried weight soil)
1	6.502	0-2.5	38	55	61	51	513333	479956
2	7.091	2.5-9	82	93	99	91	913333	848569
3	2.512	> 9	77	95	101	91	910000	887141
4	5.671	0-2.5	53	67	69	63	630000	594273
5	6.181	2.5-9	88	89	115	97	973333	913172
6	3.312	> 9	57	77	78	71	706667	683262
7	6.233	0-2.5	30	30	47	36	356667	334436
8	6.090	2.5-9	59	64	72	65	650000	610415
9	2.146	> 9	55	67	80	67	673333	658884

[redacted]

Depth (cm)	*Mean*	*s.d.*
0-2.5	500000	137154
2.5-9	845556	171993
> 9	763333	128106

Day 0.1, Control

OST #	*Soil moisture (%)*	*Depth (cm)*	*Number of visible colonies (0.0001 g soil)* Plate 1	Plate 2	Plate 3	*Mean colonies (0.0001 g soil)*	*Mean bacteria (g/ wet weight soil)*	*Mean bacteria (g/ dried weight soil)*
10	1.720	0-2.5	42	46	62	50	500000	491400
11	2.704	2.5-10	46	63	68	59	590000	574046
12	2.841	10-20	54	65	84	68	676667	657443
13	3.002	20-30	69	86	96	84	836667	811550
14	1.814	0-2.5	34	39	41	38	380000	373107
15	2.572	2.5-10	68	72	75	72	716667	698234
16	2.512	10-20	47	53	62	54	540000	526435
17	2.783	20-30	80	87	97	88	880000	855510
18	1.452	0-2.5	60	77	97	78	780000	768674
19	2.062	2.5-10	93	99	105	99	990000	969586
20	2.229	10-20	71	80	92	81	810000	791945
21	2.666	20-30	66	77	85	76	760000	739738

[redacted]

Depth (cm)	*Mean*	*s.d.*
0-2.5	544394	205264
2.5-10	747289	204432
10-20	658608	135003
20-30	802266	60767

Day 42, JP-5 treated

OST #	*Soil moisture (%)*	*Depth (cm)*	*Number of visible colonies (0.0001 g soil)* Plate 1	*Plate 2*	*Plate 3*	*Mean colonies (0.0001 g soil)*	*Mean bacteria (g/ wet weight soil)*	*Mean bacteria (g/ dried weight soil)*
183	2.839	0-2.5	36	37	38	37	370000	359496
184	4.410	2.5-12	109	128	131	123	1226667	1172571
185	3.286	14-20	90	100	114	101	1013333	980035
186	2.987	20-30	55	62	68	62	616667	598247
187	2.914	0-2.5	22	23	25	23	233333	226534
188	3.353	2.5-14	104	106	110	107	1066667	1030901
189	2.885	16-20	173	194	208	192	1916667	1861371
190	3.802	20-30	88	92	99	93	930000	894641
191	2.398	0-2.5	38	46	64	49	493333	481503
192	3.769	2.5-14	94	94	126	105	1046667	1007218
193	2.730	16-20	125	137	154	139	1386667	1348811
194	3.772	20-30	76	78	89	81	810000	779447

[redacted]

Depth (cm)	***Mean***	***s.d.***
0-2.5	355844	130057
2.5-14	1070230	98658
16-20	1396739	453925
20-30	757445	158090

Day 42, Control

OST #	Soil moisture (%)	Depth (cm)	Number of visible colonies (0.0001 g soil)			Mean colonies (0.0001 g soil)	Mean bacteria (g/ wet weight soil)	Mean bacteria (g/ dried weight soil)
			Plate 1	Plate 2	Plate 3			
195	1.759	0-2.5	61	63	69	64	643333	632017
196	2.032	2.5-10	86	92	120	99	993333	973149
197	2.635	10-20	86	87	102	92	916667	892513
198	2.917	20-30	81	95	96	91	906667	880219
199	1.669	0-2.5	45	51	77	58	576667	567042
200	2.656	2.5-10	81	95	96	91	906667	882586
201	3.144	10-20	88	99	90	92	923333	894304
202	3.330	20-30	55	80	97	77	773333	747581
203	1.989	0-2.5	49	64	71	61	613333	601134
204	2.828	2.5-10	85	96	105	95	953333	926373
205	3.417	10-20	92	94	105	97	970000	936855
206	3.415	20-30	61	76	84	74	736667	711510

[redacted]

Depth (cm)	*Mean*	*s.d.*
0-2.5	600064	33389
2.5-10	927369	43376
10-20	907890	29059
20-30	779770	89463

Appendix Thirteen

Most probable number (MPN) of hydrocarbon degrading microbes (g/ dried weight soil)

Day 0.1, JP-5 treated

Triplicate cores, 0-2.5 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
1	0.1	5	93	28-308
	0.01	2		
	0.001	2		
	0.0001	0		
	0.00001	0		
4	0.1	5	138	42-456
	0.01	3		
	0.001	2		
	0.0001	0		
	0.00001	0		
7	0.1	4	21	7-71
	0.01	2		
	0.001	0		
	0.0001	0		
	0.00001	0		
Mean (wet weight)			84	26-278
Mean (dried weight)			79	24-262

Triplicate cores, > 9 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
3	0.1	5	1070	324-3534
	0.01	5		
	0.001	3		
	0.0001	1		
	0.00001	0		
6	0.1	5	1383	419-4566
	0.01	5		
	0.001	3		
	0.0001	2		
	[redacted]			
9	0.1	5	537	163-1773
	0.01	4		
	0.001	4		
	0.0001	3		
	[redacted]			
Mean (wet weight)			997	302-3291
Mean (dried weight)			969	293-3198

Triplicate cores, 2.5-9 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
2	0.1	5	45	14-149
	0.01	1		
	0.001	1		
	0.0001	0		
	0.00001	0		
5	0.1	5	92	28-304
	0.01	2		
	0.001	1		
	0.0001	1		
	0.00001	0		
8	0.1	5	138	42-456
	0.01	3		
	0.001	2		
	0.0001	0		
	0.00001	0		
Mean (wet weight)			92	28-303
Mean (dried weight)			86	26-284

Samples were not diluted at this range and the number of positive tubes (+) is assumed to have been 0

Day 0.1, Control

Triplicate cores, 0-2.5 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
10	0.1	5	325	98-1073
	0.01	4		
	0.001	3		
	0.0001	1		
	0.00001	0		
14	0.1	5	49	15-161
	0.01	2		
	0.001	0		
	0.0001	0		
	0.00001	0		
18	0.1	5	264	80-870
	0.01	4		
	0.001	2		
	0.0001	1		
	0.00001	0		
Mean (wet weight)			213	64-701
Mean (dried weight)			209	63-690

Triplicate cores, 2.5-10 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
11	0.1	5	169	51-559
	0.01	3		
	0.001	2		
	0.0001	1		
	0.00001	0		
15	0.1	5	270	82-892
	0.01	4		
	0.001	3		
	0.0001	0		
	0.00001	0		
19	0.1	5	78	24-258
	0.01	3		
	0.001	0		
	0.0001	0		
	0.00001	0		
Mean (wet weight)			172	52-570
Mean (dried weight)			168	51-555

Triplicate cores, 10-20 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
12	0.1	4	105	32-347
	0.01	5		
	0.001	5		
	0.0001	3		
	[redacted]			
16	0.1	5	205	62-677
	0.01	3		
	0.001	3		
	0.0001	1		
	[redacted]			
20	0.1	5	692	210-2284
	0.01	5		
	0.001	2		
	0.0001	1		
	[redacted]			
Mean (wet weight)			334	101-1103
Mean (dried weight)			326	99-1077

Triplicate cores, 20-30 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
13	0.1	5	2716	822-8967
	0.01	5		
	0.001	4		
	0.0001	3		
	[redacted]			
17	0.1	5	3341	1012-11030
	0.01	5		
	0.001	4		
	0.0001	4		
	[redacted]			
21	0.1	5	1690	512-5581
	0.01	5		
	0.001	4		
	0.0001	1		
	[redacted]			
Mean (wet weight)			2582	782-8526
Mean (dried weight)			2509	760-8284

Day 42, JP-5 treated

Triplicate cores, 0-2.5 cm

OST #	*Soil (g)*	+	*MPN*	*Range P(0.95)*
183	0.1	5	264	80-870
	0.01	4		
	0.001	2		
	0.0001	1		
	0.00001	0		
187	0.1	5	1070	324-3534
	0.01	5		
	0.001	3		
	0.0001	1		
	0.00001	0		
191	0.1	5	1383	419-4566
	0.01	5		
	0.001	3		
	0.0001	2		
	0.00001	0		
Mean (wet weight)			906	274-2990
Mean (dried weight)			882	267-2911

Triplicate cores, 15-20 cm

OST #	*Soil (g)*	+	*MPN*	*Range P(0.95)*
185	0.1	5	1070	324-3534
	0.01	5		
	0.001	3		
	0.0001	1		
	[redacted]			
189	0.1	5	2159	654-7129
	0.01	5		
	0.001	4		
	0.0001	2		
	[redacted]			
193	0.1	5	1383	419-4566
	0.01	5		
	0.001	3		
	0.0001	2		
	[redacted]			
Mean (wet weight)			1537	714-5076
Mean (dried weight)			1492	452-4928

Triplicate cores, 2.5-15 cm

OST #	*Soil (g)*	+	*MPN*	*Range P(0.95)*
184	0.1	5	169	51-556
	0.01	4		
	0.001	1		
	0.0001	0		
	0.00001	0		
188	0.1	5	169	51-559
	0.01	3		
	0.001	2		
	0.0001	1		
	0.00001	0		
192	0.1	5	1383	419-4566
	0.01	5		
	0.001	3		
	0.0001	2		
	0.00001	0		
Mean (wet weight)			574	174-1893
Mean (dried weight)			552	167-1822

Triplicate cores, 20-30 cm

OST #	*Soil (g)*	+	*MPN*	*Range P(0.95)*
186	0.1	5	1690	512-5581
	0.01	5		
	0.001	3		
	0.0001	2		
	0.00001	1		
	[redacted]			
190	0.1	5	2354	713-7774
	0.01	5		
	0.001	3		
	0.0001	2		
	0.00001	3		
	[redacted]			
194	0.1	5	1363	413-4501
	0.01	5		
	0.001	3		
	0.0001	1		
	0.00001	1		
	[redacted]			
Mean (wet weight)			1802	546-5952
Mean (dried weight)			1739	527-5741

Day 42, Control

Triplicate cores, 0-2.5 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
195	0.1	5	325	98-1073
	0.01	4		
	0.001	3		
	0.0001	1		
	0.00001	0		
199	0.1	4	61	18-202
	0.01	4		
	0.001	3		
	0.0001	1		
	0.00001	0		
203	0.1	5	780	236-2575
	0.01	5		
	0.001	3		
	0.0001	0		
Mean (wet weight)			389	117-1283
Mean (dried weight)			381	115-1258

Triplicate cores, 2.5-10 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
196	0.1	5	1690	512-5581
	0.01	5		
	0.001	4		
	0.0001	1		
	0.00001	0		
200	0.1	5	138	42-456
	0.01	3		
	0.001	2		
	0.0001	0		
204	0.1	4	69	21-227
	0.01	4		
	0.001	4		
	0.0001	1		
	0.00001	0		
Mean (wet weight)			632	225-2088
Mean (dried weight)			619	188-2044

Triplicate cores, 10-20 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
197	0.1	5	264	80-870
	0.01	4		
	0.001	2		
	0.0001	1		
	[redacted]			
201	0.1	5	374	113-1236
	0.01	4		
	0.001	2		
	0.0001	3		
	[redacted]			
205	0.1	5	7813	2366-25797
	0.01	5		
	0.001	5		
	0.0001	3		
	[redacted]			
Mean (wet weight)			2817	853-9301
Mean (dried weight)			2722	824-8987

Triplicate cores, 20-30 cm

OST #	*Soil (g)*	*+*	*MPN*	*Range P(0.95)*
198	0.1	5	3165	958-10450
	0.01	5		
	0.001	4		
	0.0001	2		
	0.00001	2		
	[redacted]			
202	0.1	5	325	98-1073
	0.01	4		
	0.001	3		
	0.0001	1		
	0.00001	0		
206	0.1	5	1383	419-4565
	0.01	5		
	0.001	3		
	0.0001	2		
	0.00001	0		
Mean (wet weight)			1624	492-5363
Mean (dried weight)			1574	476-5197

Appendix Fourteen

Hydrocarbon Contaminated Soil Albedo Measurements, 2001

K↓ ↑ C/F/W/M = Respective incomming and reflected short-wave solar radiation (kW m-2 mV-1) over (C) Control, (F) Fuel contaminated, (W) Water saturated, and (M) Moist appearing surfaces.
Net Rad = Additional Net Radiation (kW m-2 mV-1) measurements over respective soil surfaces

Scott Base					*Marble point*					*Bull Pass*				
Date	*Time*	*K*	*Albedo*	*Net Rad*	*Date*	*Time*	*K*	*Albedo*	*Net Rad*	*Date*	*Time*	*K*	*Albedo*	*Net Rad*
		K↓ C					***K↑ F***					***K↑ C***		
18-Jan	1203	621.9		393.7	16-Jan	1020	69.05			17-Jan	1144	118.1		279.8
18-Jan	1204	616.5		389.5	16-Jan	1021	50.88		381	17-Jan	1145	118		278.6
18-Jan	1205	616.9		389.7	16-Jan	1022	57.97		327.6	17-Jan	1146	118.2		275.5
18-Jan	1206	637.8		397.2	16-Jan	1023	46.5		330.9	17-Jan	1147	118.3		276.5
18-Jan	1207	645.9		408.6	16-Jan	1024	38.55		250	17-Jan	1148	118.5		279.5
18-Jan	1208	645.8		409.3	16-Jan	1025	36.5		232.1	17-Jan	1149	118.7		280.1
18-Jan	1209	639.4		404.7	16-Jan	1026	33.33		204.2	17-Jan	1150	118.8		281.9
18-Jan	1210	646.2		407.2	16-Jan	1027	31.53		187.6	17-Jan	1151	119		283.4
18-Jan	1211	641.3		407.4	16-Jan	1028	31.33		179.6	17-Jan	1152	119.2		283.3
18-Jan	1212	642.9		402.6	16-Jan	1029	32.01		177.8	17-Jan	1153	119.3		282.9
18-Jan	1213	645.1		406	16-Jan	1030	33.2		190.2	17-Jan	1154	119.6		286.6
18-Jan	1214	636.2		401.5			***K↓ F***	10.4		17-Jan	1155	119.6		288.7
18-Jan	1215	632.4		399.1	16-Jan	1034	320.5		194.1	17-Jan	1156	119.7		288.1
18-Jan	1216	647.4		404.4	16-Jan	1035	337.9		205.7	17-Jan	1157	119.7		287.9
18-Jan	1217	651.8		410.3	16-Jan	1036	353.8		219.6	17-Jan	1158	119.8		288.5
18-Jan	1218	643		406.4	16-Jan	1037	367.2		229.9	17-Jan	1159	119.9		289.9
		K↑ C	9.1		16-Jan	1038	386.1		242	17-Jan	1200	120.1		291.7
18-Jan	1221	58.41		374.1	16-Jan	1039	377.5		241.5	17-Jan	1201	120.2		292.5
18-Jan	1222	62.43		388.4	16-Jan	1040	365.9		231.4	17-Jan	1202	120.3		294.2
18-Jan	1223	61.45		395.7	16-Jan	1041	361		219.6	17-Jan	1203	120.4		295.2
18-Jan	1224	60.64		386.9	16-Jan	1042	336.7		207.3	17-Jan	1204	120.5		296.1
18-Jan	1225	62.03		395.8	16-Jan	1043	328.5		195.1	17-Jan	1205	120.6		296.3
18-Jan	1226	61.98		394.7	16-Jan	1044	328.2		193.3	17-Jan	1206	120.6		296.8
18-Jan	1227	62.33		401			***K↓ C***			17-Jan	1207	120.6		296.5

18-Jan	1228	59.88		385.3	16-Jan	1048	286.8		134.2	17-Jan	1208	120.8	297.2
18-Jan	1229	60.83		389.5	16-Jan	1049	283		131.9	17-Jan	1209	120.8	296.9
18-Jan	1230	62.53		394.6	16-Jan	1050	283.2		133.2	17-Jan	1210	121.1	298.6
					16-Jan	1051	290.8		136.8	17-Jan	1211	121.2	297.8
18-Jan	1256	57		367	16-Jan	1052	302.7		144.8	17-Jan	1212	121.4	298.2
18-Jan	1257	57.13		362.7	16-Jan	1053	320.8		155.6	17-Jan	1213	121.5	299.7
18-Jan	1258	58.69		372.4	16-Jan	1054	408		188.9	17-Jan	1214	121.6	300.9
18-Jan	1259	60.46		388	16-Jan	1055	407.3		224.4	17-Jan	1215	121.6	301.5
18-Jan	1300	61.57		400.9	16-Jan	1056	417		223.9	17-Jan	1216	121.6	301.4
18-Jan	1301	64.12		410	16-Jan	1057	520.5		271.5	17-Jan	1217	121.8	303.4
18-Jan	1302	59.52		403.8	16-Jan	1058	541		305	17-Jan	1218	121.9	304.3
18-Jan	1303	61.25		387.4	16-Jan	1059	580.5		313.8	17-Jan	1219	122.1	305.2
18-Jan	1304	63.06		405	16-Jan	1100	593.3		342.8	17-Jan	1220	122.2	305.9
18-Jan	1305	63.03		415.9			$\boldsymbol{K \uparrow C}$	17.0		17-Jan	1221	122.2	306.3
		$\boldsymbol{K \downarrow C}$	10.4		16-Jan	1103	100.7		222.9	17-Jan	1222	122.4	306.7
18-Jan	1307	606.6		399.6	16-Jan	1104	105.9		245	17-Jan	1223	122.5	307.3
18-Jan	1308	584.5		378.3	16-Jan	1105	109.5		262.6	17-Jan	1224	122.6	307.7
18-Jan	1309	585.3		378.2	16-Jan	1106	114.3		277	17-Jan	1225	122.5	308
18-Jan	1310	569.1		367.2	16-Jan	1107	108.2		272.5	17-Jan	1226	122.7	308.6
18-Jan	1311	536.2		347.6	16-Jan	1108	102.7		254.3	17-Jan	1227	122.6	309
18-Jan	1312	547.9		341	16-Jan	1109	93.2		231.9	17-Jan	1228	122.8	309.5
18-Jan	1313	582.8		363.8	16-Jan	1110	88.4		211.8	17-Jan	1229	122.8	310.3
18-Jan	1314	566.4		365.6	16-Jan	1111	83.5		198.2	17-Jan	1230	122.9	310.6
18-Jan	1315	580.6		366.4	16-Jan	1112	80.5		188.5	17-Jan	1231	123	310.8
18-Jan	1316	597.6		379.9	16-Jan	1113	80.7		186.9	17-Jan	1232	123.1	311.3
18-Jan	1317	577.9		374.8	16-Jan	1114	84		191.7	17-Jan	1233	123.2	310.5
18-Jan	1318	566.2		362						17-Jan	1234	123.2	311.1
		$\boldsymbol{K \uparrow F}$	5.3		17-Jan	821	41.74		197.7	17-Jan	1235	121.8	308.7
18-Jan	1327	29.95		435.7	17-Jan	822	41.79		198.4	17-Jan	1236	122.7	309.1
18-Jan	1328	31.64		457.4	17-Jan	823	41.84		199.3	17-Jan	1237	123.4	312.4
18-Jan	1329	32.05		472	17-Jan	824	42.04		200.4	17-Jan	1238	123.6	313.1

18-Jan	1330	31.77		467.1	17-Jan	825	42.14		200.8	17-Jan	1239	123.7		313.6
18-Jan	1331	32.12		470.2	17-Jan	826	42.21		200.4	17-Jan	1240	123.7		313.4
18-Jan	1332	32.29		469.9	17-Jan	827	42.42		202.1	17-Jan	1241	123.7		313.8
18-Jan	1333	32.09		465.2	17-Jan	828	42.57		201.9	17-Jan	1242	123.8		314
18-Jan	1334	32.12		465.7	17-Jan	829	42.64		200.6	17-Jan	1243	123.7		313.5
18-Jan	1335	28.69		430.1	17-Jan	830	42.75		201.8	17-Jan	1244	123.8		313.8
18-Jan	1336	31.29		439			$K \downarrow F$	10.8		17-Jan	1245	124		316.4
18-Jan	1337	30.9		446.2	17-Jan	833	395.1		206.9	17-Jan	1246	124.1		315.7
		$K \downarrow F$	5.3		17-Jan	834	412.9		212.2	17-Jan	1247	124.2		314.5
18-Jan	1340	580.4		442.2	17-Jan	835	414		213.6	17-Jan	1248	124.2		315.1
18-Jan	1341	589.7		452.8	17-Jan	836	415.6		213.6	17-Jan	1249	124.3		316.1
18-Jan	1342	584.5		451.4	17-Jan	837	416.5		214.5	17-Jan	1250	124.3		314.9
18-Jan	1343	570.6		445.3	17-Jan	838	417.4		215.4			$K \downarrow C$	20.8	
18-Jan	1344	526.9		409.2	17-Jan	839	418.8		217	17-Jan	1252	597.4		314.8
18-Jan	1345	535.9		404	17-Jan	840	420.2		218.4	17-Jan	1253	597.9		315.7
18-Jan	1346	535.1		402.1	17-Jan	841	421		218.8	17-Jan	1254	598.2		315.5
18-Jan	1347	581		434	17-Jan	842	422.2		219.9	17-Jan	1255	598.6		314.8
18-Jan	1348	586		445.2	17-Jan	843	423.4		221.2	17-Jan	1256	598.2		313.1
18-Jan	1349	585.4		453.8	17-Jan	844	424.5		222	17-Jan	1257	599.3		314.2
18-Jan	1350	584.6		449.3	17-Jan	845	425.6		223.8	17-Jan	1258	599.8		315.2
18-Jan	1351	564.9		434.2	17-Jan	846	426.4		226.2	17-Jan	1259	600.1		315.1
18-Jan	1352	576.4		436.9	17-Jan	847	427.7		229.4	17-Jan	1300	600.7		314.1
18-Jan	1353	550.1		420.6	17-Jan	848	429.4		230			$K \downarrow F$		
18-Jan	1354	558.9		420.7	17-Jan	849	429.8		231.4	17-Jan	1307	587		277.7
		$K \uparrow W$	6.6		17-Jan	850	430.9		232.1	17-Jan	1308	587.2		320.2
18-Jan	1400	36.61		448.9			$K \uparrow C$	25.1		17-Jan	1309	588.2		324.2
18-Jan	1401	37.9		465.6	17-Jan	855	108		176.3	17-Jan	1310	588.7		325.9
18-Jan	1402	39.23		480.4	17-Jan	856	108.2		175.2	17-Jan	1311	588.5		325.8
18-Jan	1403	39.46		483.2	17-Jan	857	108.5		177.4	17-Jan	1312	589.1		323.9
18-Jan	1404	39.44		482.8	17-Jan	858	108.5		177.1			$K \uparrow F$	19.9	
18-Jan	1405	39.86		488.2	17-Jan	859	101.5		178.9	17-Jan	1315	117		318.9

18-Jan	1406	39.34		482.4	17-Jan	900	109.1		178.4	17-Jan	1316	117		326.2
18-Jan	1407	39.21		481.6	17-Jan	901	109.4		180.5	17-Jan	1317	117		327
18-Jan	1408	39.16		477.5	17-Jan	902	109.5		181.7	17-Jan	1318	117		327.1
18-Jan	1409	39.33		477.8	17-Jan	903	109.8		182.5	17-Jan	1319	117		326.4
18-Jan	1410	39.39		478.3	17-Jan	904	110		183	17-Jan	1320	116.9		327.9
18-Jan	1411	39.14		476.8			$K\downarrow C$	25.9		17-Jan	1321	116.5		328.6
18-Jan	1412	39.59		474.9	17-Jan	907	425.1		183.6	17-Jan	1322	116.9		328.9
		$K\downarrow W$			17-Jan	908	426.6		185.1	17-Jan	1323	116.8		330.4
18-Jan	1415	702		476.9	17-Jan	909	427.9		186.9			$K\uparrow M$	14.9	
18-Jan	1416	700		477.9	17-Jan	910	428.8		187.7	17-Jan	1327	87.9		354.1
18-Jan	1417	696.2		475.3	17-Jan	911	430.1		187.7	17-Jan	1328	87.9		353.5
18-Jan	1418	688		473.1	17-Jan	912	430.8		188.6	17-Jan	1329	88		352.5
18-Jan	1419	687.6		470.2	17-Jan	913	432.3		189.4	17-Jan	1330	88.3		352.8
18-Jan	1420	684.7		467.9	17-Jan	914	433.5		189.9	17-Jan	1331	88.4		352.6
18-Jan	1421	686.5		468.8	17-Jan	915	434.6		191.1	17-Jan	1332	88.4		351.9
18-Jan	1422	680.4		465.9	17-Jan	916	435.6		191.6	17-Jan	1333	88.4		351.1
18-Jan	1423	671.6		461	17-Jan	917	436.7		192.2	17-Jan	1334	88.3		353.6
18-Jan	1424	685.7		463.8	17-Jan	918	438.3		192.8	17-Jan	1335	88.2		355.2
18-Jan	1425	687.2		472.9	17-Jan	919	439.3		193.3	17-Jan	1336	88.7		354.9
					17-Jan	920	440.5		194.2	17-Jan	1337	88.6		353.6
					17-Jan	921	441.6		194.6	17-Jan	1338	88.7		351.3
					17-Jan	922	442.7		194.7					