THE EVALUATION OF LIQUID HYDROCARBON CONTAMINATION OF SOIL AROUND PETROCHEMICAL TANK FARMS AT A DURBAN REFINERY.

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By

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I, ______________________, declare that this dissertation represents my own work and to the best of my knowledge, the exact nature of this research has not been carried out anywhere in South Africa or outside this country.

Signature: _________________________ Date: ______/______/ 2004

I approve the final submission of the above dissertation.

Supervisor/s Name: 1. _______________________ 2. _______________________

Signature: 1. _______________________ 2. _______________________

SIGNED AT: ________________________ DATE: _____/_____/ 2004

DEDICATION

This dissertation is dedicated to my wife, Sanitha and my children, Shetal and Kishal for their infinite patience with me during the course of my studies.

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ABSTRACT

The primary objective of this study was to determine the levels of liquid hydrocarbon contamination present in the soil within the SAPREF refinery. The secondary objective arising from this was the development of a gas chromatographic (GC) method using a fifty metre PONA (Paraffin, Olefin, Naphthalene and Aromatic) capillary column and the split injection technique, for the analysis. Toluene was the solvent selected, with the Standard method for the BÜCHI extraction system, to extract the hydrocarbons present in the soil samples taken at the five different tank farm sites in the refinery. The main purpose of the analysis and evaluation was to enable the refinery to establish environmental control measures to reduce the contamination of the soil in the area.

The GC method was able to determine levels of contamination by hydrocarbons ranging from decane ($C_{10}H_{22}$) to triacontane ($C_{30}H_{62}$), with good precision. The tank farms showed evidence of contamination at the top (15 cm depth), middle (1 m) and bottom (2 m). The total contamination levels varied from <1 mg/kg to approximately 800 mg/kg.

Contamination levels varied at the three different depths at the five tank farms selected for investigation. Hydrocarbon contamination levels varied from 0 mg/kg to approximately 140 mg/kg at the South Tank farm (STF), from 0 mg/kg to approximately 160 mg/kg at the Mogas Tank Farm, from about 0.2 m/kg to approximately 780 mg/kg at the Gasoil Tank Farm, from 0 mg/kg to approximately 540 mg/kg at the North Tank Farm (NTF) and from 0 mg/kg to approximately 60 mg/kg at the Luboil Tank Farm.

The overall contamination at the surface (15 cm depth) varied from 0 mg/kg to approximately 700 mg/kg. At the middle (1 m depth) the contamination varied from 0 mg/kg to 800 mg/kg and the bottom (2 m depth) showed an overall contamination varying from 0 mg/kg to approximately 300 mg/kg. The Gasoil Tank Farm showed the greatest amount of contamination at the top and middle. The Luboil Tank Farm showed the lowest contamination levels at all three depths. A possible explanation for this was that the entire tank farm site was covered with about 10 cm of concrete, hence preventing any serious pollution of the soil from the surface. Several tank samples were analysed and the results compared with surrounding soil samples. The contamination appears to be similar to material from the tanks based on evidence from chromatograms, but conclusive evidence can only be produced with a detailed further study.

The chromatographic method that was developed is suitable for the determination of hydrocarbons with boiling points below 450^{o}C. It is, however, very difficult to determine the entire range of hydrocarbons present in the soil, using a single column via the GC method. The range determined can be expanded by the use of other capillary columns or by the use of two-dimensional gas chromatography. The GC-TOF-MS method with its fast data acquisition rates, combined with spectral continuity across peaks, allows for the development of algorithms that can be used to locate peaks and deconvolute complex chromatographic coelutions to extract the spectrum of each analyte for easy library identification. This method, although costly, could be considered for further development if the total hydrocarbon content needs to be determined.

The analysis conducted will be useful in determining whether any remediation measures were necessary at the refinery. However, a more detailed breakdown of the type of hydrocarbons present in the soil would indicate which specific remedial measures would be feasible.

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APPENDIX A

ABBREVIATIONS

ANOVA	-	Analysis of Variance
AR	-	Analytical (grade) Reagents
ASE	-	Accelerated solvent extraction
ASTM	-	American Society for Testing and Materials
BP1-PONA	-	Paraffin, Olefin, Naphthene and Aromatic (BP1 = phase type, i.e. 100% dimethyl polysiloxane)
BS	-	British Standards
BTEX	-	Benzene, Toluene, Ethyl benzene and Xylene
CH_3	-	methane (group)
CGC	-	Capillary column gas chromatography
CIA	-	Chemical Industries Association
cm/sec	-	centimetres per second
CSIR	-	Council for Scientific and Industrial Research
DDT	-	Dichlorodiphenyltrichloroethane
DCM	-	Dichloromethane or Methylene Chloride
DIN	-	Deutsche Industrie Norm (German Standard)
DIS	-	Draft International Standards
DOE	-	Department of the Environment (UK)
DTI	-	Department of Trade and Industry
FID	-	Flame ionisation detector
GC	-	Gas Chromatograph
GC-MS	-	Gas Chromatography – Mass Spectrometry
GC-TOF-MS	-	Gas Chromatograph-Time of Flight-Mass Spectrometry
HPLC	-	High Performance Liquid Chromatography

HRCGC	-	High Resolution Capillary Gas Chromatography
HSE	-	Health, Safety and Environment
IR	-	Infra Red
ISO/TC	-	International Standards Organization/Technical Committee
km/h	-	kilometres per hour
min	-	minute/s
µg	-	microgram
µL	-	microlitre
MAP	-	Microwave-assisted process
NTF	-	North Tank Farm
OHSAct	-	Occupational Health and Safety Act
PAH	-	Polycyclic aromatic hydrocarbons
PCB	-	polychlorinated biphenyl
PTGC	-	Programmed Temperature Gas Chromatography
PVC	-	polyvinyl chloride
QRA	-	quantitative risk assessment
RAP	-	Risk Assessment Profile
RSD	-	Relative Standard Deviation
SABS	-	South African Bureau of Standards
SAPREF	-	South African Petroleum Refinery
SFE	-	Supercritical fluid extraction
SGE	-	Scientific Glass Engineering International Pty. Ltd.
SMS	-	Shell Method Series
SPSS	-	Statistical Product and Service Solution
STF	-	South tank Farm
TF	-	Tank Farm

TMB	-	Top, Middle and Bottom
TPH	-	Total Petroleum Hydrocarbons
UCS	-	United Classification System
UK	-	United Kingdom
US	-	United States
UV	-	Ultraviolet
VAM	-	Valid Analytical Method
VOC	-	Volatile Organic Carbon

CHAPTER 1

1. INTRODUCTION

Public awareness of environmental issues has increased in recent years. Scientists and environmentalists are facing the challenge of overcoming the detrimental effects of the contamination of air, water and soil through the mismanagement of waste and other by-products of society. Future generations face the threat of problems resulting from the effects of present irresponsible behaviour towards the environment. Scientists are continuously seeking new ways
to identify the various types of environmental contaminants and to develop methods to measure and reduce this contamination.

Petroleum refineries around the world are becoming very aware of the problems created by the disposal, leakage and dumping of their products. Local refineries acknowledge the hazards posed by their products to the environment. In South Africa, the Council for Scientific and Industrial Research (CSIR) has conducted extensive investigations on both air and water pollution (Archibald and Molefe, 1997; Connel, 1997; Hounsome, 1997). Until recently, no one has realised the full impact of the cumulative effects of contamination and pollution on the soil. Scientists have realised that the degradation of petroleum products is very slow, resulting in their effects being felt several generations after their initial release.

Environmental contamination by petroleum products is of significant concern throughout the world. In the United States there are over two million underground storage tanks subject to the federal underground storage tank regulations designed to minimize potential releases. Other sources of petroleum contamination are aboveground tanks, terminals, pipelines and accidental spills. An understanding of the risks associated with releases from these sources is crucial to effective decision making about both prevention and remediation of releases. Risk assessment efforts for petroleum hydrocarbons are frustrated significantly by the complex nature of petroleum products, the lack of adequate knowledge about movement of petroleum components in soil and the lack of knowledge about the toxicity of these components (Heath, et al. 1993). Although refinery personnel are aware that the soil is being constantly contaminated, the extent of contamination within refinery installations is generally unknown.

This study focuses on only one aspect of pollution in the environment, i.e. the contamination of soil by hydrocarbons at a local refinery. The area chosen for study is close to other industries, residential areas and the sea; hence, any pollution will impact directly on people, the surrounding vegetation and the marine life. Soil sampling was carried out at five different tank farms, chosen after discussion with refinery personnel. This was carried out using an auger specially adapted for this purpose. Hydrocarbon extraction from the soil was accomplished using an established method and a BÜCHI B 811 universal extraction apparatus.

Several techniques exist for the analysis of hydrocarbons. Hydrocarbon mixtures are characterized in two ways, viz. by structural group analysis and boiling range determination, i.e. by distillation or gas chromatographic simulated distillation. The principal techniques employed for determining the content of paraffins, naphthalenes and aromatic compounds are mass spectrometry (MS), high performance liquid chromatography (HPLC), and capillary column gas chromatography (CGC). MS methods alone do not provide individual component information, while HPLC methods are not always acceptable because of the variation of response factors for a given type of hydrocarbon within various hydrocarbon sample matrices, its lack of capacity to furnish carbon number distribution and component identification (Matisovă, 1992). The instrumental technique chosen for analysis by this study was capillary gas chromatography.

It should be noted that that the determination of the amount of hydrocarbons present in the soil at the tank farms was the primary focus of this project. This by no means implies that hydrocarbons were the only contaminants in the soil analysed. The contamination by inorganic metals, polychlorobiphenyls (PCB's), and polyaromatic hydrocarbons (PAH's) and other organic materials are ever present in the soil in this environment and can be determined by selective chromatographic and mass spectrometric techniques.

The scope of this method was limited to the determination of alkane hydrocarbons by the capillary gas chromatography method. The assumption was made that any hydrocarbons found in the range determined (C_{10}-C_{30}) would most likely be equivalent to the amount of total petroleum hydrocarbons (TPH). Furthermore, since the refinery production is based on crude oil as a raw material, it was also assumed that the majority of the contamination would naturally arise from this source.

The aim of this research was to develop a capillary gas chromatographic method to isolate, identify and quantify the liquid hydrocarbons in the soil from the refinery. The method involved the use of a Gas Chromatograph (GC) capable of split injection and fitted with a BP1-PONA (Paraffin, Olefin, Naphthalene and Aromatic) capillary column.

The objectives of this project were to:

1. isolate, identify and quantify the range of liquid hydrocarbon contaminants obtained using high resolution capillary gas-liquid chromatography;
2. compare the levels of hydrocarbon contamination at the five different tank farms;
3. compare the levels of hydrocarbon contamination at different depths at each site;
4. compare the hydrocarbon contamination of the soil at each tank farm with the tank contents;
5. recommend possible preventative and remedial action, based on the results obtained.

The study was limited to sites at a local refinery, but national and international refineries will certainly benefit from parallel aspects within their refineries. It is envisaged that further studies may be carried out to identify other organic and inorganic components, which could prove very useful to the petroleum industry.

CHAPTER 2

2. REVIEW

2.1 Human Impact and Pollution

Pressure from the concerned public about environmental contamination has resulted in refineries, both local and international, making an effort to address issues of air, water and more recently, soil contamination. This has lead to local refineries investigating the possibility of introducing environmental standards using proper legislation, safety, responsible care and bioremediation measures which meet international requirements. They have also begun to look into suitable laboratory methods to identify levels of contamination in soil at their installations. The ability to determine the levels of contamination at their sites is of paramount importance to refineries. It will enable them to assess the levels of contamination resulting from their daily operations and thus ensure that they will be able to implement decontamination measures adequately. This will ensure the credibility of their operations and contribute to a safer and cleaner environment (Harrison, 1994).

Investigations into environmental problems have become more common in industry. The contamination of air and water has always been a great cause for concern amongst environmentalists for many years. The pollution of the atmosphere and the accompanying hazards have recently become more evident from the increasing number of reports of patients with respiratory ailments by medical practitioners (Freedman, 1995). These reports indicate a greater incidence of these cases in the highly industrialized areas. A great deal of publicity is generated locally and internationally when air or water pollution occurs either through negligence or operational errors. Locally, the CSIR has conducted extensive investigations on both air and water pollution and have produced several publications in this regard (Archibald and Molefe, 1997; Hounsome, 1997; Connel, 1998).

Volatile components found in petroleum evaporate into the atmosphere while non-volatiles that leach into groundwater are gradually released as polluted water into streams, rivers and the sea. Petroleum refineries around the world are aware of the problems created by the disposal, leakage and dumping of their products on the environment. Until recently, no one has realised the full impact of the cumulative effects of this contamination and pollution on the soil. Scientists have also realised that the degradation of these petroleum products is very slow resulting in their effects being felt for generations in the future. While a concerted effort has been made over many years to control environmental (i.e. air, soil and water) contamination by industrial effluent and products from oil refineries, discussions with some refinery personnel and some environmental analysts has revealed deficiencies in the area of analysis of contaminated soil at refinery sites.

Pollution of the marine and estuarine environments by petroleum hydrocarbons is a worldwide phenomenon. Large-scale crude oil spills are the most obvious source of pollution. Since the 1970's the impact of chronic, low level hydrocarbon input from sources such as oil refineries has been recognised as having long-term ecological consequences, even when there is no visible evidence of acute effects. The environment near petroleum refineries or tanker terminals is frequently subject to oil spills, and often exposed to continuous discharge of contaminated process effluents. Chronic oil pollution of the coastal environment is associated with cities, where hydrocarbons are often discharged into storm or sanitary sewers. In some cases these can cause long term ecological damage (Mackey & Hodgkinson, 1996).

Every pollutant has a source. The source is particularly important, because it is the logical place to eliminate pollution. The demands of increasing population coupled with the desire of most people for a higher material standard of living has resulted in worldwide pollution on a massive scale. Environmental pollution is generally divided among the categories of water, air, and land or soil pollution. All three of these areas are linked. Improperly discarded hazardous wastes can leach into groundwater that is eventually released as polluted water into streams. The most serious kind of pollutant that is likely to contaminate the geosphere, particularly soil, consists of hazardous wastes. Although humans have been exposed to hazardous substances such as noxious volcanic gases in prehistoric times, the modern industrial era has seen the creation of problems with hazardous wastes that pose real threats to the environment and mankind (Manahan, 1994).

The exact amount of contamination within refinery installations is unknown. Refinery personnel are aware that the soil is being constantly contaminated, but no one knows to what degree and the exact nature of this contamination. Refinery environmentalists are also aware of the pollution caused directly through refinery production. The air and water monitoring systems in place have proved to be very efficient in controlling pollution in these areas, but there is little or no monitoring of soil pollution. At the refinery chosen for this research the well-equipped laboratories do not have any system in place for monitoring soil contamination. This research was motivated by the curiosity to determine the amount of contamination caused by refinery products and pollutants on soil at the refinery site.

Air, water and soil at petroleum-contaminated sites are typically sampled and analysed for some specific compounds such as benzene, toluene, ethyl benzene, xylene (BTEX), lead and total petroleum hydrocarbons (TPH). The BTEX and polyaromatic hydrocarbons (PAH) components of petroleum products can be identified and quantified, and their toxicity and mobility in the environment are relatively well understood. However, although chemical analysis for TPH is relatively simple and inexpensive, this measure of petroleum components presents challenges to risk assessors. For instance, the label "total" implies that analysis for TPH includes all petroleum hydrocarbons, which is far from true. Although several methods are available, each actually measures only a specific range of the hydrocarbon components. Weathering, environmental factors and transport processes cause variation of petroleum product composition over time. The same concentration of TPH at two different sites may therefore represent very different mixtures and thus very different risks to human health and the environment (Heath, et al., 1993).

Land above a high water table will be greatly affected by any organic contaminants as it acts as a sieve for the contaminants entering the soil. The high water table complicates the picture by transporting leakages horizontally. The chosen area for this study is low lying and in close proximity to the sea resulting in concern for the possibility of marine pollution through seepage. A major cause for concern at present is the extent of contamination close to the tank farms. Loss of product from the tanks needs to be monitored and controlled to ensure that the refineries are cost effective. The levels of contamination at different depths need to be checked to prevent any further damage to the ecosystem.

Since various areas of concern were raised by refinery personnel, they are addressed under separate subheadings, viz. soil, ISO 14001 and legislation, safety and responsible care, sampling techniques, extraction, chromatography and bioremediation.

2.2 Soil

The type of soil, its characteristics and behaviour towards different pollutants contribute to its future preservation and composition. Mechanical properties of soil are largely determined by particle size and strongly influence the behaviour of polluting agents like hydrocarbons. According to the United Classified System (UCS), the four major categories of soil particle sizes are the following:

Gravel (2-60 mm); sand (0,06-2 mm); silt (0,06-0,006 mm); clay (less than 0,002 mm), (Manahan, 1994).

Soil porosity and permeability determine the ease of flow of water through it. The general region in which water is held is called the aeration zone and the water present in it is called vadose water. At lower depths, adequate amounts of water will fill voids to produce a zone of saturation, the upper level of which is the water table. Water in the zone of saturation is called groundwater. The surface tension of water is drawn slightly above the water table to a region known as the capillary fringe (Manahan, 1994). The diagram below illustrates this:

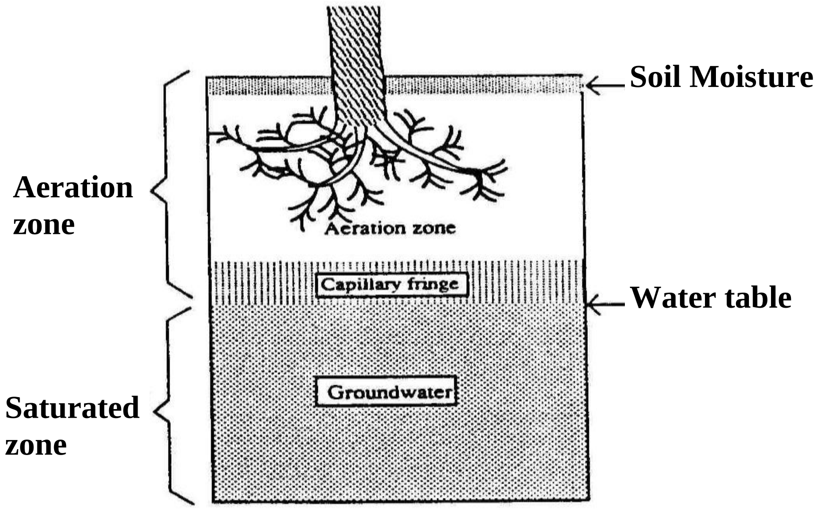

Figure 2.1: Some major features of the distribution of water underground (Manahan, 1994).

The soil type encountered in this study falls in the category of sands (0.06-2 mm)(Boulding, 1994); the samples were primarily sea sand typical of the Bluff and Prospecton area.

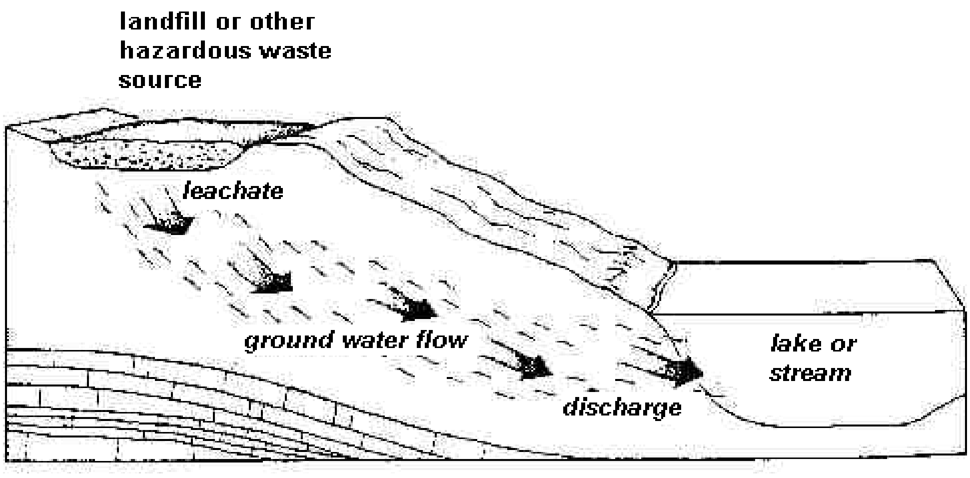

Figure 2.2: Discharge of groundwater contaminated by hazardous waste landfill into a body of water. (Manahan, 1994)

The figure above illustrates a typical pathway for the entry of hazardous waste materials into the hydrosphere. The refinery site at which this research was conducted is close to the sea and the profile of contamination shown above is similar to that of the refinery site studied. Any contamination present at the refinery site is likely to move seawards via canals or streams and thus pose a threat to the marine environment.

The refinery has a waste oil landfill site. Oil from this source, together with any oil that may leak into the soil from the tanks in the tank farms poses a potential pollution hazard. The typical pathway for this oil would be:

- leach into the soil
- come into contact with the ground water flow from the water table
- subsequent discharge into the canals and then to the sea.

2.3 <u>ISO 14001 and Legislation</u>

All manufacturing organizations have some impact on the natural environment through the resources they use, the processes and activities they undertake, and the waste they create. Many organizations do not actively seek ways of reducing these impacts. Every business, no matter how small, can reduce their impact on the environment if improvements are planned and carried out in a structured manner (Whitelaw, 1997).

Since everyone has an impact on the environment by the mere act of living from day to day, a good environmental management system allows an organization to control its environmental impacts and reduce such impacts continuously. Environmental management is the process whereby organizations assess, in a methodical way, the impacts of their activities on the natural environment, and take action to minimize these impacts (SABS ISO 14001:1996). International Standards for environmental management are intended to provide organizations with the elements of an effective environmental management system. This can be integrated with other management requirements to assist organizations to achieve environmental and economic goals. Many organizations are putting environmental risk assessment high on their agenda when considering risk management in general. Environmental issues are integrated within their overall business strategy and the views of a whole spectrum of stakeholders are considered during the strategic decision-making process. Many laws governing the control of contamination exist. They do, however, require continuous updating or amendment. It is very difficult keeping up to date with national legislation and virtually impossible keeping up to date with international legislation (Whitelaw, 1997).

In the simplest of terms the whole concept of the ISO 14001 standard requires an organization to: *Control and reduce its impact on the environment* (Whitelaw, 1997).

2.4 Safety and the Responsible care program

In recent years many organizations have been actively addressing the question of health and safety in the workplace, partly in response to legal requirements but mostly in response to the fear of litigation and the pressures of increasing insurance premiums and other insured costs. With the ever-increasing need to comply with statutory legislation and national regulations, they are realising that installing a documented occupational health and safety management system can often highlight potential legislation shortfalls (Whitelaw, 1997). Audits of key aspects of safety enable most organizations to comply with the requirements of the Occupational Health and Safety Act (OHSAct).

During the 1970's and the early 1980's the chemical industry suffered from a very poor environmental reputation. The public often saw it as a major polluter. Its high environmental visibility, coupled with a public perception of "big uncaring business", resulted in significant pressure from green action groups. The conception and development of "Responsible care" was the industry's response. Responsible care is the chemical industry's branded program of principles and codes of practice designed to demonstrate that its members take health, safety and environmental issues into account in their everyday operations. Members of the Chemical Industries Association (CIA) are committed to managing their activities so that they provide protection for the health and safety of employees, customers, the public and the environment. The program's two main thrusts were:

1. To improve the industry's performance in the areas of environment, health, safety, product safety, distribution and relations with the public.
2. To enable organizations to demonstrate that such improvements were taking place.

(Whitelaw, 1997).

2.5 Sampling, Extraction and Chromatography

2.5.1 Sampling

Sampling as the first important step in every determination in analytical chemistry seldom receives due attention. Many authors support this view since mistakes made during sampling cannot be corrected later. With today's possibilities of trace and ultra-trace analysis, sampling has gained more significance (Markert, 1994).

Conditions for sampling become more important as more demands are placed on the quality of the analytical results. Sampling forms an essential part of the VAM (Valid Analytical Method) program (introduced by the DTI, Department of Trade and Industry, in the United Kingdom). Although analyses are carried out carefully, the results will be of no value unless the portion of the sample taken for analysis is truly representative of the bulk material. Several factors affect representativity, the most influential being the degree of preliminary information available on the site to be sampled (Crosby & Patel, 1995)

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Bernd Markert also suggests that a preliminary investigation should be carried out before any sampling or analytical program is specified or undertaken, and the effort devoted to it will depend on the objective of the investigation. The principle objectives of the preliminary investigation are to gain knowledge about the present condition of the site, past activities on the site and the effects they may have had on the neighbouring land (Markert, 1994).

Soil profiles for the refinery sites were not available but the general composition of the soil is known; the sites under study are located within a refinery that has been in production for over forty years. The refinery tank sites contain raw material (crude oil) and finished products ranging from solvents to gasoil and waxes.

Sampling patterns are based on the estimation of distribution of soil constituents in an area or on the type of substance input. The premise is that the distribution of soil constituents is homogeneous. Non-systematic sampling patterns are generally shaped like the letters N, S, W, or X, and also along a single diagonal or along a zig-zag traverse. Sampling points are fixed by taking samples after several paces and continuing this procedure until the necessary number of samples is obtained. Sampling points are located within the sections of concentric circles and the lines of the eight main points of the compass. Circular grids imply a uniform extension of contamination in all directions, which is not usually the case. Various types of sampling grids are found, these include rectangular grids, triangular grids, three-dimensional grids and others. The choice of a particular type depends on the requirements of sampling. Apart from sampling grids another type of sampling, called judgment sampling, is practiced. This includes sampling special spots of interest based on preliminary information of a site (Markert, 1994).

The random sampling technique is used primarily in irregular occurrences of contamination. "Random" in sampling terminology means without bias, not haphazard. Increments must be taken in such a way that any portion of the bulk material has the same probability of being included in the sample. Random sampling is generally used when there is very little information available about the material under test, or in the sampling of manufactured products, or in the sampling for physical properties e.g. particle size. Several grid patterns, e.g. bottle rack grid, diagonal grid, rectangular grid, etc., are used for sampling (Crosby & Patel, 1995).

Examples of various fixed grid plans available are shown below:

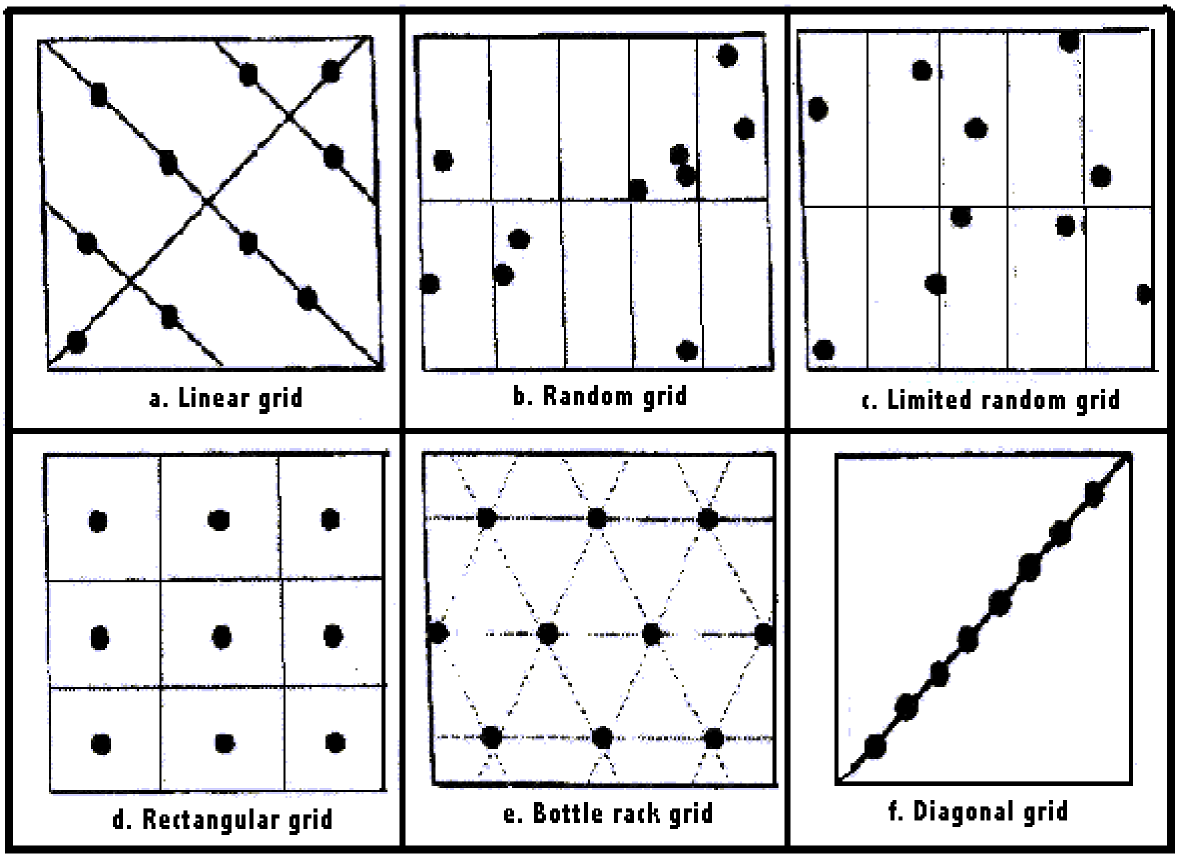


Figure 2.3: Examples of various fixed grid plans (Markert, 1994 edited)

Once an appropriate grid is selected, the depth of sampling has to be fixed. Two principal approaches have to be considered:

1. metric (depth related) sampling,
2. soil-horizon related sampling.

For environmental considerations and especially for matters concerning soil and groundwater protection ISO 10381, Part 1, recommends sampling of soil horizons which is more representative and either exposed in nature, in a trial pit, or from core samples. Mixing of techniques within one project should be restricted, and in any case reasons should be reported (Markert, 1994). For the purpose of this study, depth related sampling was carried out since one of the aims was to establish how much hydrocarbons had leached into the lower levels of the soil.

The sample quantity necessary was a matter of long discussion within ISO/TC 190. The first approach based on a table from the German standard DIN 18123 for particle size shows limits for soils of < 2 mm and > 60 mm were 1000 g and 18000 g respectively. It was obvious that these figures used as standard values would lead to uncontrollable masses of soil in the laboratory. In conjunction with ISO 11464, it was decided that at least 500 g of fine soil (<2 mm) as sampled in the field should be obtained for chemical analysis. The lower limits discussed were between 200 g and 1000 g, but the majority of experts were of the opinion that 200 g might not be enough when considering retention samples, while 1000 g would be too cumbersome to handle (Market, 1994). This led to 500 g being considered as the mass that would be adequate for analysis and retention.

A manually driven soil auger was the only equipment that would enable safe digging up to a depth of 2 m. The choice of the type of auger was made possible by studying the manual for "Procedures for testing soils" (ASTM Committee D-18, 1964). The refinery did not allow any mechanically or electrically driven machinery on site. A manually driven auger was therefore used.

The choice of container was made after considering the type of analyte(s) and the matrix involved. The prime functions of the container are to protect the sample from degradation by external agents and contamination from the local environment. The container must not contribute extraneous analytes to the sample or adsorb analytes and other components from the sample. For some samples moisture change must be avoided by the use of airtight containers to ensure that the original characteristics and composition of the sample will be preserved until the commencement of the analysis. Glass containers are suitable for most samples, especially solids, since there is little chance of transfer of constituents to or from the glass and the sample (Buszewski, 2000).

Sampling may sometimes prove to be a hazardous operation. The problems encountered vary depending on the nature of the product to be sampled, the equipment used and the location. The object of any safety assessment should be to reduce risks to an acceptable minimum whilst still enabling the work to be carried out.

The safety assessment must include:

1. hazards resulting from the nature of the product to be sampled,
2. hazards arising from any equipment used, and,
3. hazards on site

(Crosby and Patel, 1995).

2.5.2 Extraction

The use of separating funnels for extractions in analytical work is common, but the reliability of this method for accurate analysis is questionable. The traditional method of extraction of hydrocarbons from soil and sediment is the Soxhlet extraction. Recent developments have shown that hydrocarbons can be extracted from environmental sample matrices with relative ease using new technologies such as supercritical fluid extraction (SFE), accelerated solvent extraction (ASE), and microwave-assisted processes (MAP), working either in a monomode or multimode manner. One of the drawbacks of the new technological methods is to determine when the target compounds have been completely removed from the matrix without prolonging unnecessary extraction time. Most new methods use the conventional Soxhlet method as a reference. The conventional Soxhlet method has also undergone several improvements over recent years (Garcia-Ayuso, Luque-Garcia & Luque de Castro, 2000). One such improvement is the BÜCHI B-811 extraction system which is designed for easy and time saving operation.

The Soxhlet extraction method has been a primary tool in organic analysis but it does have limitations. The efficiency of a Soxhlet extraction depends on the solubility of the individual organic components in the selected solvent and the ability of the solvent to penetrate the matrix. Extraction is often maximized by using lengthy multiple stage extractions, multiple solvent extraction or physical agitation e.g. refluxation or ultrasonication. The method is also inappropriate for low molecular weight volatile compounds as they may be lost in the solvent reduction stage or masked by the solvent in GC analysis. Improved techniques like microwave digestion and supercritical fluid extraction (SFE) provide comparable or improved extraction yields often and are less time consuming (Waterman, et al., 2000).

The BÜCHI B-811 extraction system used for this study has the ability to conduct extractions in four modes. They were: Soxhlet Standard, Soxhlet warm, Hot extraction and Continuous. The mode that was chosen for the soil extractions, after experimentation, was the Soxhlet Standard mode. In this mode (Appendix C, C-1) the upper heating element does not switch on thus ensuring a minimum loss of volatile material during extraction of the samples. The basic procedure for all the modes is the same (Appendix C, C-1to C-5). The notable difference in the "Soxhlet warm" mode is that, in addition to the normal heating, an upper heating element switches on and warms the solvent in the extraction chamber. During the "Hot extraction" method, the glass valve opens for a short while and allows fresh solvent to enrich the extract at constant intervals and in the "Continuous" method the glass valve remains open with the optical sensor being inactive (BÜCHI Labortechnik AG Postfach, 1996).

2.5.3 Chromatography

Petroleum mixtures consist primarily of relatively unreactive complex hydrocarbons covering a wide boiling range. Such mixtures are difficult to separate by most analytical techniques. Therefore, the petroleum industry has for many years played a leading role in the development of chromatographic methods of analysis (Adlard, 1998).

Quantitative measurement of hydrocarbons using GC is difficult because there is no single column that can completely separate target compounds very quickly from a complex hydrocarbon matrix (Agilent Technologies, 2003).

Publications largely lack information regarding the analysis of soils for hydrocarbon contamination. Most methods, especially the American Society for Testing and Materials (ASTM) are very specific as to the use of multidimensional techniques. There was little evidence obtainable specifically for the analysis of soils by chromatography alone, at the time the searches were conducted. However, there was evidence of the initial stages of the development of a "Journal of soil contamination" by Heath, Koblis and Sager. There were also some ASTM designated methods for soil investigation.

The refinery expressed the need for the determination of levels of contamination in the soil at their site; the potential benefit of this type of analysis would be to address some of the environmental problems they were experiencing and alleviate some of the pressure from the environmental action groups. This study would serve as a first step in identifying some of the hydrocarbon groups present in the soil to enable proper remedial action.

Numerous advances have been made with developments in liquid and supercritical fluid chromatography, silica capillary columns with bonded stationary phases and selective detectors. Fused silica capillary columns offer excellent resolution but cannot separate all mixtures. The disadvantage of single capillary column analysis is that every peak must be identified, or at least classified according to the chemical group to which it belongs. Peak identification in a chromatogram is performed on the basis of retention data and information from gas chromatography coupled with mass spectrometry (GC-MS). This combined technique has gained wide acceptance in petroleum chemistry (Adlard, 1998).

Quantitation in capillary GC by flame ionisation detection (FID) is more accurate than most other techniques. A particular advantage of GC analysis is that the quantitative response of the FID is approximately the same for equal weights of any hydrocarbon above hexane, so that, to a first approximation, relative peak areas can be used directly for determination of weight percent values (Hàla et al., 1981). The hydrocarbon standard (Appendix C, Figure C2, p.161-162) shows that this is a reasonable approximation as can be seen from the areas obtained for the hydrocarbon standards, despite minor variation. The present state of development of the instrumentation and column technology of capillary GC offers:

- the availability of various injection systems (split/splitless being the most often used) and the possibility of on-column injection of large volumes using a precolumn from on-line coupled high performance liquid chromatography and high-resolution capillary gas chromatography (HPLC-HRCGC).
- Accurate column oven temperature control (better than 0.02^{o}C)
- Columns with conventional and chemically bonded stationary phases of different polarity and temperature stability.

- Automation using computerized data systems, including improvements in methods for handling and interpreting chromatograms, which provide highly detailed and reliable information on the composition of complex hydrocarbon mixtures.

In practice it is virtually impossible to achieve complete resolution of even a limited number of components in a single isothermal run and complex mixtures are laboriously analysed by isothermal GC at several temperatures. Temperature programming is preferred to isothermal operation because narrow peaks are obtained throughout the chromatogram and compounds with a wide range of boiling points can be chromatographed in a single run. This is essential for the analysis of complex hydrocarbon mixtures (Matisová, 1992).

According to a review article by Matisová, the best inter laboratory reproducibility of retention data of alkyl benzenes was obtained with the non-polar stationary phase squalane and the polydimethylsiloxanes. As squalane has certain shortcomings as a stationary phase for capillary columns, including low temperature stability and the difficulty of preparing stable columns from glass or fused silica tubing, the polydimethylsiloxane stationary phases are preferred. The stability of these columns means that analysis times can be reduced by temperature programming to higher temperatures (Matisová, 1992).

The PONA column that was chosen for the analysis of liquid hydrocarbons was the non-polar BP1 (100% dimethyl polysiloxane), which was claimed by the manufacturers to be suitable for the analysis of Petroleum Hydrocarbons and gasoline range hydrocarbons. It has an operating temperature from –60^{o}C to 280/300^{o}C. It is 50 m long with an ID of 0.15 mm and film thickness of 0.5 micron (Supelco catalogue, 1999).

The type of detector chosen for analysis was the flame ionization detector (FID). The FID responds to virtually all compounds with some exceptions, in particular water and carbon disulphide. The lack of response to air and water makes the FID especially suitable for the analysis of air pollutants or aqueous samples. Ionization detectors operate on the principle that the electrical conductivity of a gas is directly proportional to the concentration of charged particles within the gas. The FID has the widest linear range of any detector in common use. The linear range of a detector is defined as the ratio of the largest to the smallest concentration within which the detector response is linear and for the FID it is 10^6 and 10^7. The response of the FID is independent of temperature, carrier gas and flow rate. This makes it well suited, possibly the best detector, for quantitative analysis (McNair and Bonelli, 1969).

The temperature of the column is one of the factors that is critical for efficient separation. Isothermal programs work well when only a few mixtures/compounds are involved. Since petroleum hydrocarbons are made up of a large variation of organic compounds, an isothermal program would not be feasible for efficient separation of these compounds.

Programmed temperature gas chromatography (PTGC) is a logical extension of the isothermal method and resulted from the limitations of the constant temperature technique for the analysis of complex mixtures and wide boiling range samples. Temperature programming is the controlled change of column temperature during an analysis. It is used to improve, simplify or accelerate the separation, identification and determination of sample components (McNair and Bonelli, 1969).

Three types of programming are commonly used. The first, which is natural or ballistic, is a normal temperature program that increases consistently with time. The second, which is linear, begins with a starting temperature held for a short time, then a fixed ramp rate which is finally held at a final temperature. The final type constitutes a staggered configuration where temperature is increased and held at varying intervals. This type is the matrix or multi-linear program (McNair and Bonelli, 1969).

For the purpose of this study the linear program method was chosen as it proved to be the most suitable configuration for this type of analysis after minor experimentation with the other types of programming. Temperature programming was used for this study as it allows for the proper selection of a program that resulted in well resolved and symmetrical peaks. It also has the advantage of a shorter total analysis time than isothermal operation.

Although PTGC was able to produce good separation of the hydrocarbons in the soil, a characteristic shift in the baseline becomes noticeable when large amounts of hydrocarbons are present. This is characteristic of the vaporization of the liquid phase which is often referred to as *bleeding*. If a column bleeds it produces noise, a shifting baseline and a change in column characteristics. The number of high temperature liquid phases is quite limited (McNair and Bonelli, 1969).

The column used had a maximum temperature of 300^{o}C. When analyzing a complex mixture, conventional one-dimensional GC often results in unresolved peaks in a limited time region and limited detection sensitivities. Dual column or 2-D GC is often used to compensate bleeding.

Recently much attention has been focused on comprehensive two-dimensional gas chromatography (GC x GC) and its use in examining complex samples containing numerous components, many of which would result in overlapping peaks if examined by a normal (one-dimensional) gas chromatography system. With two-dimensional gas chromatography, sequential fractions from the effluent of one GC column, are injected, after thermal/cryogenic focusing, onto a second column, which may use a different property to effect a separation (e.g. a typical system might use a standard separation based on boiling point to effect the first separation, and then use a second column, which separates by polarity, to better resolve the first column fraction). The eluent from the second column must then be sent to a high-speed detector (Bertsch, W. 2000).

Comprehensive two-dimensional gas chromatography (GC x GC) is a hyphenated technique employed for the analysis of complex samples. Two-dimensional techniques can provide considerable improvement in complex separations since the components of a mixture are subject to two independent separation processes. Although only a single detector is employed, at the exit of the second column, prior knowledge of the fractionating characteristics selected from the first column permit a two-dimensional representation of the full separation scheme to be developed. Sample components are thus distributed over a retention plane defined by two orthogonal axes, in which each axis corresponds to the separation time along one GC column. The two-dimensional pattern (or image) serves to group sample components into chemical classes forming distinct patterns that are amenable to formal methods of classification and discrimination. Thus, sample compositional class identification can be readily achieved as opposed to specific labelling, as is normally the goal with conventional 1-D chromatography (Xie, Adams and Marriot, 2003)

Two-dimensional gas chromatography (GC x GC or 2D-GC), provides unique capabilities in high resolution gas chromatography. GC x GC employs a single GC containing two separation columns of different selectivity connected in series with a modulation unit in between to perform solute focusing and re-injection into a short, high-speed second column When analyzing a complex mixture conventional one-dimensional GC most often results in,

1. unresolved peaks in a limited time region and,
2. limited detection sensitivities.

With 2D-GC compound resolution is significantly enhanced. This implies that in the GC x GC chromatogram, unlike conventional GC, the information of compound classes can be clearly observed (Wang, DiSanzo & McElroy, 2003).

There are now sufficient applications studies in comprehensive two-dimensional gas chromatography to allow us to recognize the value of the 2D separation space that is generated by the technique. Many studies focus on the enhanced separation that is achieved in GC x GC and often point out the ability of the two-column arrangement to provide separation of components that co-elute on the first column of the set used. The first column in a normal GC x GC arrangement (non-polar-polar phase) may not necessarily be the best one to use if only a single column analysis is to be conducted. However, for some components, the first column provides less separation than may be achieved on an alternative phase while the second column will recover and generally surpass the resolution loss of that column for those components. This arrangement will provide a more suitable ‘total solution’ to sample component resolution (Marriott and Western, 2003).

Whilst comprehensive two-dimensional chromatography (GC x GC) has the ability to resolve many more components than one-dimensional GC in an equivalent time, it is difficult to positively identify many of the components, due to detector limitations. The detection methods available for GC x GC are limited to those with very fast data acquisition capabilities. FID has been the detection method of choice for GC x GC analysis, where the data acquisition rate is typically between 50 to 200 Hz. Recently, time of flight mass spectrometers (TOFMS) have gained popularity as fast GC detectors, and a small number of reports describing the use of GC x GC-TOFMS have appeared in the literature. Quadrupole mass spectrometers have been commercially available in their present form for some time and are found in many laboratories; they are extremely popular and are less expensive than the new generation TOFMS instruments. Where TOFMS instruments have a reported capability to acquire 100 mass spectra per second, quadrupole MS instruments are limited by the quadrupole duty cycle, and the requirement to scan individual ions from each mass in the scan range; they therefore have a more limited data acquisition speed. This together with support from LECO personnel prompted the analysis of selected samples by TOFMS at their American laboratories (Marriott and Shellie, 2003). This method could be developed for the determination of a wider range of hydrocarbons as a basis for further study.

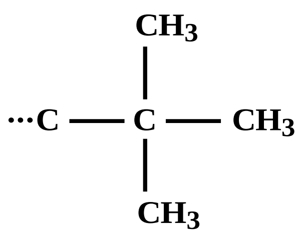
Chromatography is an established technique for the determination of hydrocarbons. There have been many developments in chromatographic analysis in recent years and combined gas chromatography methods with mass spectrometric methods are generally preferred for the analysis of complex hydrocarbons.

2.6 Bioremediation

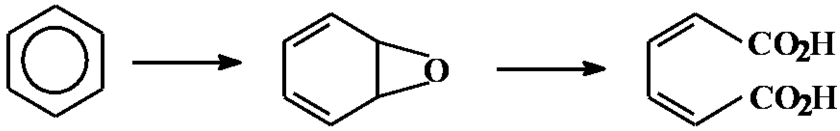
Bioremediation (bio = organism, mediation from Latin, remedium = correct or remove an evil) involves the ability of certain bacteria and fungi to degrade hazardous materials. The degradation is done to obtain metabolic energy by the decomposers. Its primary values are that it is naturally cheaper than other remedies (cost savings of 30% to 70%), but it can also be quite slow. In 1996, there were more than one hundred and sixty cleanup sites using bioremediation in the United States (Miller and Gardiner, 1998).

Bioremediation is an effective but slow process. It is favoured by conditions that aid microbial growth. The first step is to identify the problem materials that must be degraded and to know which organisms will do that completely. The soil conditions are modified to favour growth of the organism or organisms. Soil aeration, the amount of water, suitable pH and soil temperature may all need adjustment. Inoculation (seeding) with the correct microorganisms may be necessary. Often the soil may need leaching after bioremediation, so general soil permeability is important (Miller and Gardiner, 1998).

Hydrocarbon degradation by microbial oxidation is an important environmental process because it is the primary means by which petroleum wastes are eliminated from water and soil. Hydrocarbons vary significantly in their biodegradability and microorganisms show a strong preference for straight-chain hydrocarbons. The reason for this preference is that branching inhibits β-oxidation at the site of the branch. The presence of a quaternary carbon (below) particularly inhibits alkane degradation.



Despite their chemical stability, aromatic rings are susceptible to microbial oxidation. The overall process leading to ring cleavage is,



in which cleavage is preceded by addition of -OH to adjacent carbon atoms. Among the microorganisms that attack aromatic rings is the fungus *Cunninghamella elegans*.

It metabolises a wide range of hydrocarbons e.g. C_3 - C_{32} alkanes; alkenes; and aromatics, including naphthalene, biphenyl, and phenanthrene, etc. (Hinchee, Kittel & Reisinger, 1995).

Biotransformation is what happens to any substance that is metabolised and thereby altered during biochemical processes by an organism. Metabolism is divided up into catabolism, the breaking down of more complex molecules; and anabolism, the building up of life molecules from simpler materials. The substances subjected to biotransformation may be naturally occurring or anthropogenic (made by human activities). They may consist of xenobiotic molecules that are foreign to living systems. An important biochemical process that occurs in the biodegradation of many synthetic and hazardous waste materials is co-metabolism. Co-metabolism does not serve a useful purpose to an organism in terms of providing energy or raw material to build biomass, but occurs concurrently with normal metabolic processes (Lloyd, E.D. and Holliday, G.H. 1997).

2.6.1 Finding the right organisms

All organisms do not decompose all kinds of substances. The first requirement is to find one or more effective microorganism for each problem substance needing degrading. Two approaches are generally used to find the best organism, viz.:

1. Search for a high population of soil already contaminated, and

2. Add the pollutant to a soil sample and then look for an active decomposer.

Each organism is then isolated, numbers increased, and the increase used as inoculum into a soil –pollutant mixture to see if the organism is the decomposer and is stable in the system.

Trials on oil contaminated sandy beach soil between Haifa and Acre, Israel was treated with 5 g F-1 per kg of sand (a modified urea-formaldehyde polymer containing 18% N and 10% P as P_2O_5). This was inoculated with a mixed bacterial culture obtained by enrichment culture procedure using crude oil as a carbon and energy source and F-1 as the hydrogen and phosphorus source and sea water as the source of other minerals. After 28 days the average hydrocarbon content of the sand decreased by 85%. An untreated control plot showed only 15% decrease in hydrocarbons measured (Rosenberg et al., 1992).

2.6.2 Enzymes in waste degradation

Enzyme systems hold the key to biodegradation of hazardous wastes. For most biological treatment process currently in use, enzymes are present in living organisms in contact with the wastes. In some cases it is possible to use cell-free extracts of enzymes removed from bacterial or fungal cells to treat hazardous wastes. The enzymes may be present in solution or, more commonly, immobilized in biochemical reactors (Manahan, 1994).

2.6.3 Degradation of organic compounds

There are several groups of microorganisms capable of partial or complete degradation of hazardous organic compounds. Actinomycetes are microorganisms that are morphologically similar to both bacteria and fungi. They are involved in the degradation of a variety of organic compounds, including degradation resistant alkanes. Other compounds attacked include pyridine, phenols, nonchlorinated and chlorinated aromatics. Fungi are noted for their ability to attack long-chain and complex hydrocarbons and are more successful than bacteria in the initial attack on PCB compounds. The classes of synthetic organic compounds that can be degraded by microorganisms include non-halogenated and halogenated alkanes (dichloromethane), non-halogenic compounds (benzene), halogenated aromatic compounds (hexachlorobenzene), phenols, PCB's, phthalate esters, and pesticides (chlordane, parathion) (Manahan, 1994).

2.6.4 Microbial Oxidation of Hydrocarbons

The degradation of hydrocarbons by microbial oxidation is an important environmental process because it is the primary means by which petroleum wastes are eliminated from water and soil. Bacteria capable of degrading hydrocarbons include Micrococcus, Pseudomonas, Mycobacterium, and Nocardia.

The most common initial step in the microbial oxidation of alkanes involves conversion of a terminal -CH_3 group to a -CO_2 group. More rarely, the initial enzymatic attack involves the addition of oxygen to a nonterminal carbon, forming a ketone. After formation of a carboxylic acid from the alkane, further oxidation normally occurs by a process illustrated by the following reaction, a β-oxidation:

$$\mathbf{CH_3CH_2CH_2CH_2CO_2H + 3\ O_2 \rightarrow CH_3CH_2CO_2H + 2\ CO_2 + 2H_2O}$$

Since 1904, it has been known that the oxidation of fatty acids involves oxidation of the β-carbon atom, followed by removal of two-carbon fragments. A complicated cycle with a number of steps is involved. The residue at the end of each cycle is an organic acid with two fewer carbon atoms than its precursor at the beginning of the cycle.

The biodegradation of petroleum is essential to the elimination of oil spills (about 5×10^6 metric tons per year world-wide). This oil is degraded by both marine bacteria and filamentous fungi. In some cases, the rate of degradation is limited by available nitrate and phosphate.

The physical form of crude oil makes a large difference in its degradability. Degradation in water occurs at the water-oil interface. Therefore, thick layers of crude oil prevent contact with bacterial enzymes and O_2. Bacteria, apparently synthesize an emulsifier that keeps the oil dispersed in the water as a fine colloid and therefore accessible to the bacterial cells.

Eriksson et al., were able to show that a hydrocarbon mixture containing p-xylene, naphthalene, β-naphthalene and straight aliphatic hydrocarbons (C_{14} to C_{17}) was aerobically degraded without lag phase by a natural uncontaminated potting soil at 20^oC and 6^oC. Concentrations of between approximately 10 and 50 ppm were degraded to below detection (ppb levels) within five days at 20^oC. At 6^oC, degradation was only down to 10% of the initial concentration (Eriksson et al., 1999).

CHAPTER 3

3. MATERIALS AND METHODS

3.1 SAMPLING

3.1.1 Introduction

The nature of the sites and the restrictions posed by the sampling areas demanded that a checklist of materials be examined before entering the refinery for sampling. The checklist consisted of the following materials for sampling:

Trolley with crate for samples, an auger, spade, large stainless steel spatula, 500 mL sample bottles, aluminium foil, a pair of scissors, labels, marking pens, paper towels, wet wipes, measuring tape, thermometer (0 – 110^{o}C), pens, sticky tape, gloves, rubber mallet, clipboard with sample data sheets (see Appendix A, Table A-1, p.130-131), AR grade acetone, deionised water, laboratory coats, safety glasses, stopwatch, torch, safety shoes, string, bin bag, ear protection and helmet.

3.1.2 Planning

A coordinated effort with the Environmental officer, Safety officer and Laboratory manager resulted in decisions regarding the sampling sites, the tank farms where the samples were taken, the number of samples taken, the depths at which the samples were taken and the type of equipment used and the safety requirements. The sampling was carried out around tank farms at the local refinery after the negotiations were complete. One hundred and eight samples of soil were collected for analysis.

The planning involved making decisions on the following aspects:

3.1.2.1 *Sampling sites*

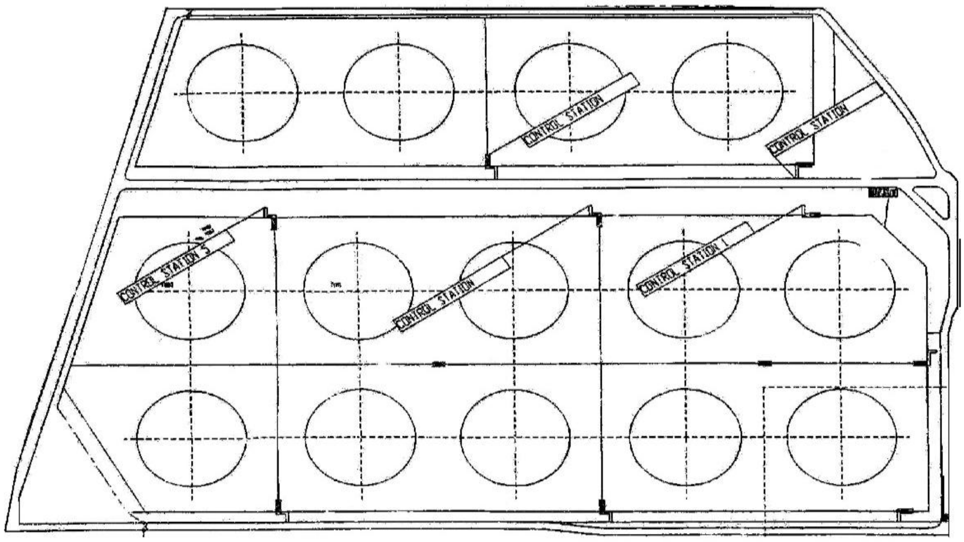
A decision was taken upon discussion with relevant refinery personnel to investigate five of the nine tank farms at the refinery.

The sites were:

South Tank Farm (STF), North Tank farm (NTF), Mogas, Gasoil and Luboil Tank farms.

These sites were identified on a map provided by the refinery. This map was not open for public scrutiny owing to the strategic position of the refinery. It is also for this reason that no maps showing the actual sampling points could be produced in this report. The figure below (Figure 3.1, p.35) gives a good indication of the layout of a typical tank farm. The area of the tank farms varied from approximately 25000 m^2 to over 100000 m^2 at the tank installations. Sampling was carried out at random but preselected points surrounding the tanks within each tank farm. (See 3.1.2.4, p.36).

The tank farms that were excluded contained primarily solvents and slops. An example of a tank farm appears below.



========	**Circuit road**
(bund wall symbol)	**Bund walls with ladder over walks**
(control station symbol)	Control stations used to check tank levels
¤	Tanks

Scale: 1 cm = 25 m

Figure 3.1: A typical tank farm showing tanks surrounded by bund walls

3.1.2.2 ***Site investigation***

An on-site visit was made to each tank farm with the laboratory manager to gather information about the sampling area and to establish whether any problems would arise. It also assisted in determining the soil type and the feasibility of using the auger for sampling. This was done to ensure that problems during sampling would be minimized.

However, it was not possible to identify any hazards or obstruction below the surface without any engineering detail. This detail was not available for security reasons. It was for this reason that a site clearance certificate was required to enable us to proceed, although with caution.

3.1.2.3 ***Sample number and depth***

The sampling area is close to the sea and has a low water table (see Figure 2.1, p.9). This could support the assumption that the soil might be waterlogged at depths of approximately two metres below the surface. It was therefore decided to sample to a maximum depth of 2 m from the surface. It was not practical to use the auger beyond this depth without any detailed knowledge of the sites. Samples were taken at three depths, viz. 15 cm, 1 m and 2 m. Three samples of approximately 500 g soil were taken from each hole. With the aid of the site map it was decided to take samples at thirty-six random points. This resulted in a total of one hundred and eight samples. The number of samples chosen would also enable reasonable statistical evaluations to be made.

3.1.2.4 ***Sampling points***

For the purposes of this investigation, a rectangular grid with squares of area 1 cm^2 was used (see Figure 2.3 (d), p.15). This grid pattern was chosen for its uniformity, but random points for sampling were chosen by superimposing the grid on the map of the tank farm. The choice of sampling pattern involved a combination of the rectangular grid and judgement sampling. (See Review 2.5.1, p.13)

The actual sampling points at the refinery were identified by checking the direction of the marked point relative to due north on the map. Thereafter distances were measured in two directions from adjacent bund walls surrounding the tank; the point of intersection was the point where the hole was dug. The distance from the closest tank to this point was also measured. The maps of the tank farms have details that are not for public scrutiny and therefore cannot be shown in this report.

3.1.2.5 ***Sample quantity***

For the purpose of this project approximately 500 g of soil sample was taken to be a reasonable amount for safe handling, analysis and retention. (See Review 2.5.1, p.16)

3.1.2.6 ***Sampling equipment***

A diagram of the auger used can be seen in Figure 3.2 (p. 46) and pictures of the auger can be seen in Plates 3.3, 3.4 and 3.5 (pp.41-43). The original auger had to be lengthened by one metre by the Technikon Natal Engineering department to enable us to reach the depth of 2 m for sampling. A manually driven auger had to be used for digging since mechanically or electrically driven equipment was unsafe for the refinery environment.

3.1.2.7 ***Sample containers***

Glass bottles of 500 mL capacity with split caps for easy sealing were used. 120 mL amber bottles with hard plastic inert caps were used for the extracts. All new sample equipment was rinsed thoroughly with distilled water and Analytical Reagent (AR) grade acetone and oven dried.

3.1.2.8 ***Sample log and labeling***

The following details were recorded on a sample data sheet during sampling:

Date/Tank, Hole number, Sample number, Distance from the tank, Direction, Problems/Remarks (see Appendix A, Table A-1, p.130-131).

The following data was noted on a Refinery sample log table, after sampling:

Date, Time of sampling, Hole number, Sample number, Location, Depth, Soil temperature, and ambient temperature (see Appendix A, Table A-2, p.132-133).

Sample bottles included the Date, Sample location, Tank area/number, Time of sampling, Temperature of sample, ambient temperature, and Sample number.

3.1.2.9 ***Safety***

A full Risk Assessment Profile (RAP) by refinery personnel was conducted before sampling on the sites were allowed. Strong emphasis was placed on the safe operation within the sampling sites. Any obstruction during sampling had to be reported and an alternate area chosen for digging. Each site had to be demarcated with hazard warning tape while sampling. The site had to be restored to its original condition after sampling was complete.

3.1.3 <u>Sampling procedure</u>

The required documentation and equipment necessary to carry out the sampling was obtained on arrival at the refinery. At the tank farm site, the exact sampling point was identified as follows:

From the point marked on the map, the distance relative to the scale (1 cm = 25 m) was measured from two adjacent bund walls surrounding the tanks, such that they intersected at the sampling point. This was the point at which digging commenced. Plate 3.1 shows the sampling equipment in the foreground while the digging point is being located.

Plate 3.1: Photograph shows a sampling site being located and some of the sampling equipment in the foreground.

The date, hole number, sample number, distance from the closest tank and direction was recorded on the data sheet. The ambient temperature was also recorded. The surface at the sampling point was cleared with a spade and digging commenced.

The spade was used to dig from the surface down to 15 cm in a square formation of spade width. The 15 cm point was measured using the measuring tape. The photograph below shows a typical hole dug down to the 15 cm level followed by auger digging shown by the circular hole.

Plate 3.2: Photograph showing overhead view of hole dug for sampling at the Luboil Tank Farm.

When the 15 cm point was reached, sufficient soil was transferred to a sheet of aluminium foil spread on the ground nearby. A thermometer was placed in the soil for one minute (timed using a stop watch) and the temperature was measured. This was carried out in situ at the 15 cm depth, but the difficulty with getting the thermometer to the 1 m and 2 m depths prevented in situ measurement of temperature. The sample was transferred with the aid of a stainless steel spatula into a 500 mL glass bottle. A pre-cut sheet of aluminium foil was placed over the mouth of the bottle after the soil was compacted. This was done to prevent any interaction of the hydrocarbons in the soil with the plastic coating in the lid and to prevent the loss of volatiles. The lid was then screwed in place. The two-piece lid was designed not to cause any tear in the foil seal area.

An appropriate label with the sample details was attached to the bottle. The auger was put into operation at this point. Each spoil full of soil was discarded until the next depth was reached, i.e. 1 m.

Plate 3.3: The picture above shows digging in progress at the Luboil Tank Farm with the auger, before obtaining the middle sample at the 1 m depth.

The Plate 3.3 shows manual digging with the auger in progress. The auger was twisted clockwise until the spoil was full, it was then withdrawn and the soil removed. This process was continued until each sampling point was reached. Markings on the auger made it possible for easy identification of the 1m and 2 m points while digging was in progress.

The photograph below shows soil being transferred to a piece of foil on paper before the temperature was recorded and the soil filled into a sample bottle.

Plate 3.4: Sample from the auger being transferred to the foil before filling the sample bottle.

Intermediate cleaning of all apparatus was carried out by rinsing with distilled water and acetone. A paper towel was used for removal of stubborn adhesive soils from the auger when required before the rinsing step. All waste was placed in a refuse bag carried for this purpose. The sample bottles were secured in a box and placed in a mobile trolley. The log sheet was filled in and remarks made indicating any problems during sampling or with the nature of the soil.

The photograph below shows the auger next to the sample hole. The adapted trolley is at the left while on the right information is being logged on a data sheet.

Plate 3.5: Photograph shows sampling being carried out at the Luboil site.

At each required level a spoil full of sample was removed and placed on a new sheet of foil, and the procedure of taking temperature, filling the bottle, sealing and labelling completed. On completion of the sampling at each point, the holes were refilled with soil and the area restored to its original state.

The above procedure was carried out for the thirty-six holes dug for the one hundred and eight samples taken. Only one site on the Luboil tank farm required chipping equipment to penetrate about 10 cm of concrete before sampling could be carried out.

3.1.4 Sample preservation and transportation

All samples were placed in a crate in the boot of a car after completion of sampling at each site. At the end of the sampling day, samples were transported to the laboratory and refrigerated at 4^{o}C. The entire sampling exercise was carried out in seven consecutive days. The minimum temperature recorded for the soils sampled was 21.0^{o}C and the maximum recorded was 30.5^{o}C while the average was 26.0^{o}C. The average ambient temperature was 26.0^{o}C.

The picture shows all the samples with varying degrees of contamination on the laboratory bench prior to being transferred to the refrigerator.

Plate 3.6: Soil samples on the laboratory bench top before refrigeration.

3.1.5 Problems experienced during sampling

There were three occasions during which sampling with the auger presented problems serious enough to warrant a change of sampling point.

The first problem was when a rock or large stone was encountered after the 1m sampling point at a South Tank Farm (STF) site. The two samples taken at the 15 cm and 1 m depth had to be discarded and a complete set taken at a new point a few metres away.

The second problem, also at the STF site, presented itself in the form of an underground pipe at approximately 1m. This prevented further digging at that point. Sampling was carried out at another point parallel to the tank without further problems.

The final problem was caused by loose soil below the 1m level. This was in the form of sludge which may have indicated that the water table at this point seemed to be higher than at the other sampling points covered. The soil could not be retrieved with the auger as it gradually flowed out of the auger and refilled the hole. A polyvinyl chloride (PVC) pipe, wide enough to allow the auger spoil through and long enough to prevent any collapse of sludge, was used. The pipe was approximately 2 m long. It was hammered to slightly below 2 m and served as a collar preventing any soil from flowing out freely from the auger. The sample was taken at the 2 m point by removing smaller portions. The soil was wet when it was removed. Another point nearby was also chosen as an alternative when the problem of loose soil was encountered, but was abandoned when it was found to be similar to the chosen spot.

Figure 3.2 below illustrates how the final problem mentioned above was overcome.

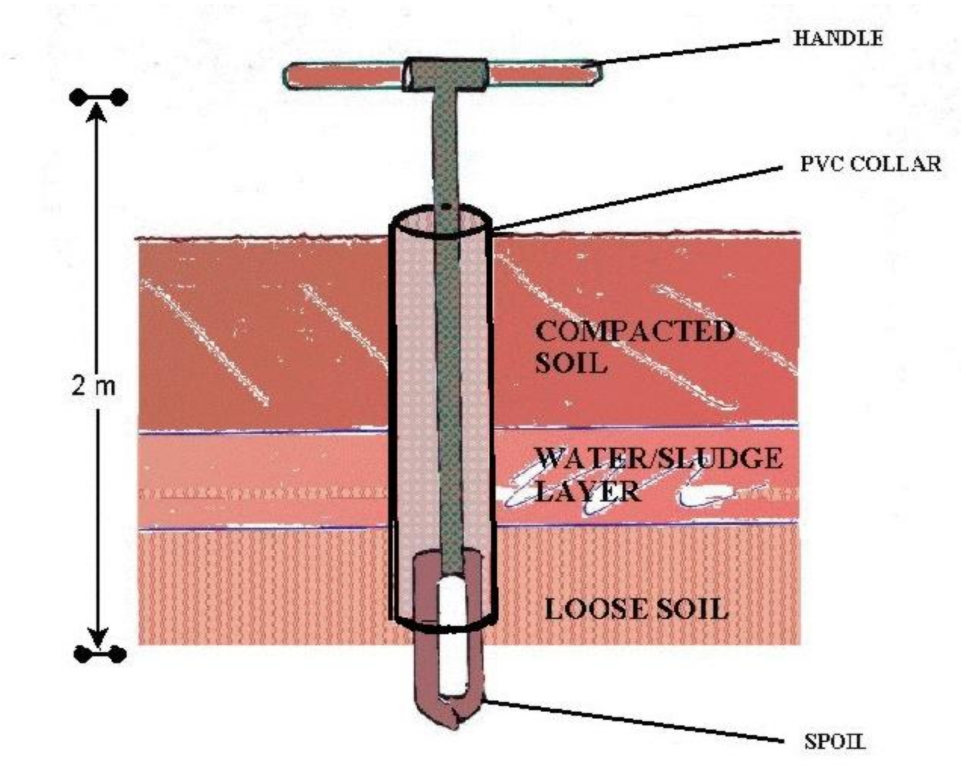


Figure 3.2: Diagram showing improvisation for sampling with the auger using a PVC pipe.

Other problems encountered were minor. They were due to a very claylike soil mass at two points 2 m deep. This presented problems with cleaning, but was overcome by using high pressure washing from a tap followed by rinsing with distilled water and acetone to enable quick drying.

3.2 Extraction

3.2.1 Introduction

A Standard electronic top-loading and an analytical balance were used for the weighing of soil samples.

The separating funnel method required a 500 mL separation funnel, filter funnels, a 100 mL measuring cylinder and beakers.

The BÜCHI method consisted of a soxhlet extraction apparatus with cooling water supply, fitted to a bank of heating mantles. Glass sample tubes (25 mm diameter x 70 mm length) with ground glass frits were used to hold the sample for extraction. Solvent beakers were used to introduce solvent for the extractions as these did not have a pouring lip of an ordinary beaker and formed an air tight seal when attached to the BÜCHI apparatus.

HPLC grade toluene was used as the extraction solvent. Its purity and specifications can be seen on the data sheet provided (see Appendix B, Toluene data sheet, p.145). Other solvents used for comparison were dichloromethane and isooctane. Other materials used were acetone, beakers, measuring cylinders, spatula, pipettes, pumpette, a water bath, 120 mL amber bottles, 4 mL GC vials and labels.

For the extraction of the samples, two decisions had to be made.

- Firstly, a single method for the extractions had to be chosen.
- Secondly, the appropriate solvent for extraction had to be determined.

Three methods were available for extraction using different types of solvents. They were:

1. A manual extraction method using separating funnels and filtration apparatus.
2. A manual method using a soxhlet apparatus and round-bottomed flasks including heating mantles.
3. An automated method using the BÜCHI B-811 universal extraction system capable of four modes of extraction.

The methods, ASTM D 473-81 and SMS 1432 (confidential method for solvent extraction developed by Shell international) were used as guidelines for the extraction of the hydrocarbons from the soil by the first two methods above. No updates were available for these methods. The BÜCHI B-811 method is described in the manual supplied with the instrument (BÜCHI Extraction system B-811, 1996). This method was developed by BÜCHI and incorporates a bank of four soxhlet extractors with heating mantles at the base (see Figure 3.3, p.52 for diagram).

Many solvents are recommended for hydrocarbon extraction, but the efficiency of these solvents for the extraction of hydrocarbons is not known exactly. From the three solvents chosen i.e. toluene, dichloromethane and isooctane, it was necessary to establish which solvent was the most appropriate for the extraction process by using at least one of the methods mentioned above. The BÜCHI method, being the most up-to-date, was chosen for this.

Research was conducted by Christophers (1999) to determine the best extraction solvent and the optimum time required for the extraction of hydrocarbons by the BÜCHI method. The extraction time, however, was limited to two hours. It is for this reason that further confirmation was required (see 4.2.3, p.65). During this research, the four modes of extraction (see p.19 and Appendix B, p.146-147) were also tested. This research showed that toluene was the most consistent extraction solvent over the time intervals chosen while the other solvents showed inconsistencies at the different extraction times.

Ramadheen (1999) also carried out research on the recoveries obtained from the extraction of hydrocarbons from the soil samples. Overall average recoveries obtained were greater than 85% on the samples tested.

An attempt was made to check the feasibility of the separating funnel extraction method against the automated BÜCHI B-811 method. This was carried out to test the feasibility of using the separating funnel method as a backup for the BÜCHI method. The reason for this was that two heating units had failed during previous operation of the BÜCHI and caused delays in the extraction of samples. The procedure follows:

- five sample composites, each containing soil from the top, middle and bottom of randomly chosen holes, were made from STF T 1109, Mogas T 1310, Gasoil mid 7801-4, North Tank Farm (NTF) T 1104 and Luboil mid T 4808-12. The composite was made by transferring the soil from each of the top (15 cm depth), middle (1 m depth) and bottom (2 m depth) sample bottles to separate pieces of aluminium foil. Approximately 300 g (with an error of <1 g) of the soil was added from each of the samples into a large glass beaker and mixed with a steel spatula. From this, a 50 g sample was drawn for extraction.

- 50 g of the soil sample composite was transferred via a wide stem funnel into a 500 mL separating funnel.
- a 40 mL aliquot of solvent was added to the soil.
- the sample was manually extracted by shaking the separating funnel for three minutes.
- The separating funnel was left on a stand for one minute after which the solvent was drained into a 120 mL amber glass bottle.
- The procedure was repeated twice with 40 mL of solvent used each time.
- The bottle with the extract was stoppered and labelled.

This method was found to be seriously flawed. The problems experienced during this method are explained under "Discussion" (see 5.2.2, p.93).

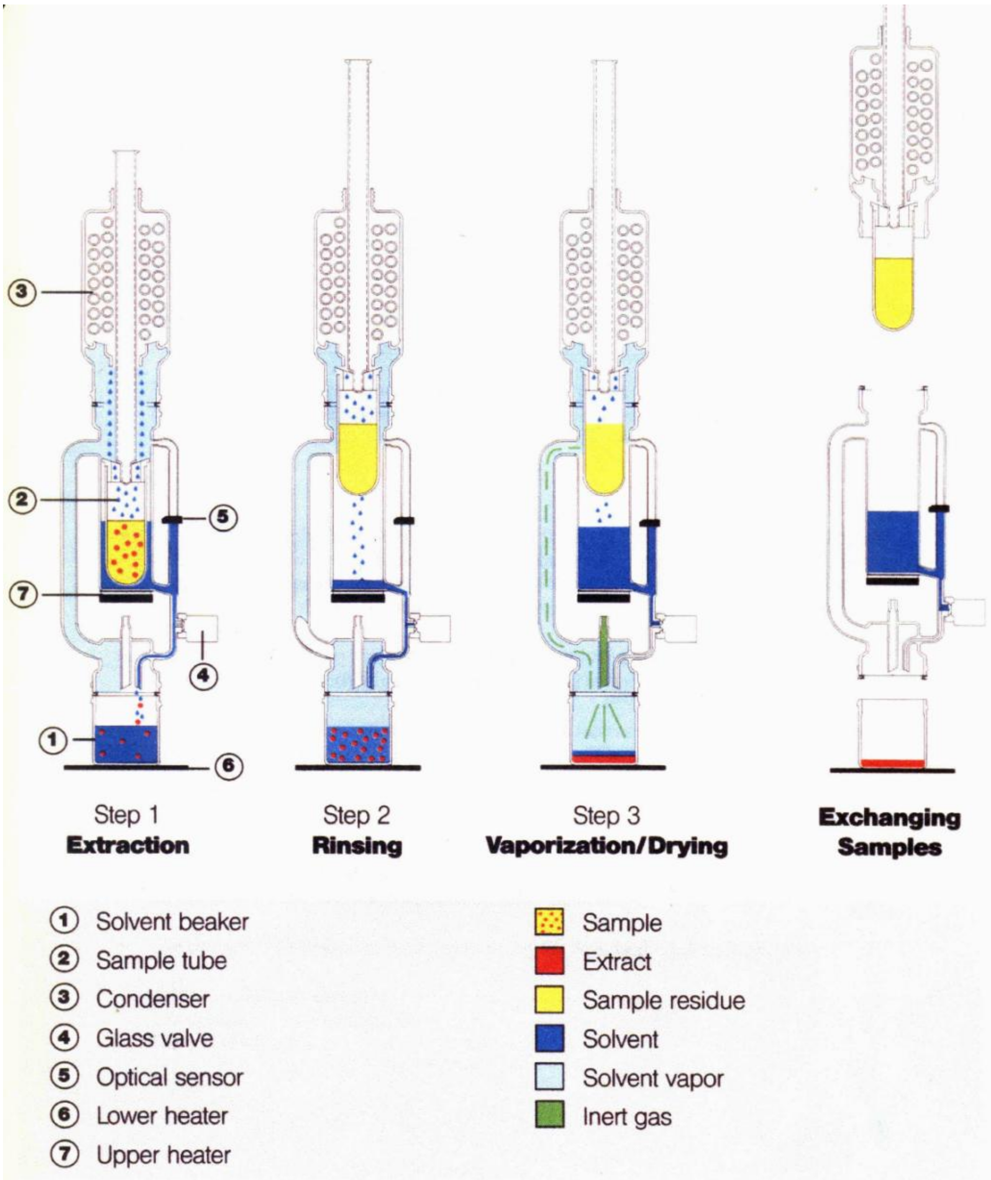
3.2.2 The BÜCHI Universal Extraction Soxhlet method

The following procedure was employed for the soil extractions:

1. An empty glass sample tube was weighed.
2. 50 g of the soil sample was transferred into the glass sample tube and the exact mass was determined on an analytical balance.
3. The glass sample tube was fitted into the BÜCHI apparatus.
4. 120 mL of toluene was added to the solvent beaker, which was then attached to the extraction chamber above the heating mantle in the apparatus.
5. The cooling condensers were locked in place.
6. The cooling water flow rate was adjusted to approximately 60 litres/hour.
7. The program for toluene was selected and the extraction process started. For the program the boiling point setting used was 111^{o}C. The program number for the heat setting in the instrument was 12. A typical extraction program is shown in Appendix B, p.148.
8. After 2 hours, the solvent remaining in the glass sample tube was drained into the solvent beaker.
9. The solution was left to cool in the closed system for approximately ten to fifteen minutes.
10. After cooling the solvent extract was transferred into a 120 mL amber bottle and refrigerated at 4^{o}C for further analysis by GC. No further dilutions of the extracts were performed. The average solvent loss experienced was no more than 5%

The picture below illustrates the BÜCHI extraction apparatus and its components.

With the B-811 Universal Extraction System, BÜCHI has set a new standard for solid-liquid extraction. The three steps of the extraction process are electronically monitored and controlled. Up to fifty programs can be stored for various applications. The integrated heating system makes it possible to use solvents with boiling points of up to 150°C. Cold and hot extraction using one of the four methods is possible without having to convert the unit.



The four extraction methods:
With its technical configuration, the BÜCHI B-811 Universal Extraction System is able to perform solid–liquid extractions using the following methods:

- **Soxhlet Standard**
- **Soxhlet warm**
- **Hot extraction**
- **Continuous flow** **(BÜCHI Labortechnik AG Postfach, 1996)**

Figure 3.3: The BUCHI extraction unit showing automatic extraction in three steps.

3.2.3 Confirmation of Optimum Extraction Time

This exercise was carried out to confirm that the two-hour minimum extraction time would be best suited to the extractions that were to be undertaken. This was to ensure that extraction time was optimised to avoid unnecessary delays which could result from such a large number of samples being analysed.

A random sample (T 1114) from the STF was chosen for this analysis. Samples of the soil were weighed exactly as described for the procedure using the BÜCHI extraction system. All other parameters used were kept constant except for the time of extraction. The extractions were carried out for 1, 2, 3, and 4 hours. After completion of extraction, the extracts were placed on a hot water bath to evaporate the solvent. The solvent beakers were allowed to cool in a desiccator after which they were weighed accurately. The mass of the residue was determined and the percentage yield was calculated using the mass of residue and the total mass of soil used. (See Table 4.2 and Figure 4.1, p. 65)

3.3 Chromatography

3.3.1 Introduction

The following instrument, fittings, and standards were used for analysis:

- A Varian 3800 gas chromatograph (GC) capable of split injection.
- The GC was fitted with a flame ionisation detector (FID).
- a BP1-PONA (100% dimethyl polysiloxane) SGE column, 50 m long with an internal diameter of 0.15 mm and film thickness 0.5 μm.
- the GC was linked to a personal computer run by the version 5.3 Star software and attached to a printer.
- a standard 1μL SGE syringe with a Chaney adapter was used for the injection of samples via a focus liner fitted to the inlet port of the column.
- A hydrocarbon standard prepared in the laboratory in 0.1% $^{m}/_{v}$ proportions of hydrocarbons ranging from C_5 to C_{28} was used for the calibration of the instrument. The solvent was toluene.
- Nitrogen, hydrogen and air of GC quality.

3.3.2 The Chromatography method

The Varian Star Software version 5.3 program was used for the method development. This program controlled the GC parameters automatically via a computer link. Information was easily stored and retrieved when required.

The new column had to be conditioned before attempts were made to develop the method. This was carried out according to the manufacturer's specifications. Nitrogen was used to provide an inert atmosphere and prevent degeneration of the column packing material. The capillary column was conditioned using the following parameters:

Temperature of conditioning	**-**	**5^{o}C/min up to 300°C**
Carrier gas flow	-	30 mL/min N_2 (regulated)
Split ratio	-	1 : 50
Actual carrier flow	-	0.6 mL/min

The detector end of the column was not connected. The column was left overnight under the above conditions. The duration of conditioning was approximately 24 hours. A solenoid valve automatically regulated the carrier flow. After the conditioning was complete the detector end of the column was connected and the parameters for the GC were selected according to the manufacturers test conditions to run the test mix provided. This test mix contained heptane, toluene, ethylbenzene, m-xylene, p-xylene, o-xylene and nonane in cyclohexane as solvent (see Appendix C, p159-160). The chromatogram obtained was compared with the chromatogram supplied by the manufacturer (see Figure 4.2 (a) and (b), p. 66). The only deviation from the manufacturer's recommendations was that nitrogen instead of hydrogen was used as a carrier gas.

3.3.3 GC optimisation, standardization and calibration

Initial optimisation of the GC was completed using a sample extract from the STF and a prepared alkane hydrocarbon standard. The GC parameters were set out as per the manufacturers specifications for testing conditions, as a starting point (see Appendix C, p.160). The temperature-programming mode was used. A 0.5 μL sample of the extract was injected into the column via a focus liner attached to the injection port. A minimum of two injections was performed for each individual parameter selected.

The following conditions were kept fixed throughout the optimisation:

- injector temperature: 240^{o}C
- detector temperature: 280 ^{o}C
- measured carrier flow after splitter: Nitrogen, 0.6 mL/min
- Air and hydrogen flow.

The following conditions were varied individually, until optimum separation of the sample was achieved with good baseline resolution:

- the initial column temperature was varied every ten degrees from 50^{o}C to 120^{o}C.
- the initial hold time was varied at 2, 5 and 10 minutes.
- The ramp rate was varied every five degrees from 5 ^{o}C to 20 ^{o}C.
- the final column temperature was varied every ten degrees from 250^{o}C to 280^{o}C.
- the final hold time was varied every 5 minutes from 5 to 20 minutes.
- the split ratios used were, 1:25; 1:50; 1:60; 1:75; and 1:100. Injection of sample was also made in the splitless mode.
- the detector range was varied from 10^{-12} to 10^{-10} afs.

During method development, the optimum conditions (Appendix B, p.149-154) were obtained based on the best peak response observed for replicate measurements of the alkane standard. This was conducted over approximately one month and these conditions were then used for the calibration of the instrument and subsequent analysis of the liquid hydrocarbon extracts.

After the instrument was stabilised under the conditions programmed, analysis of the samples was carried out as follows:

- the individual standards were injected sequentially, in duplicate, to establish their retention times for calibration.
- the retention times were programmed into the star software and stored.
- the alkane hydrocarbon standard was calibrated under the operating conditions chosen.
- chromatograms were obtained for the analyses of all the samples including the solvent blank.

3.3.4 Alkane hydrocarbon standard

Suppliers could provide alkane standards but they were too expensive. A range of individual alkane standards from C_5 to C_{28} was available in the laboratory. The C_{20} and C_{28} standards were obtained from the South African Petroleum Refinery (SAPREF) laboratory. The choice of the range of standards was made based on the ability of the column to separate the highest alkane hydrocarbon possible within the optimised temperature program range.

Individual alkane standards of 0.1% $^{m}/_{v}$ were prepared for pentane (C_5), heptane (C_7), octane (C_8), n-decane (C_{10}), undecane (C_{11}), dodecane (C_{12}), tridecane (C_{13}), tetradecane (C_{14}), pentadecane (C_{15}), hexadecane (C_{16}), heptadecane (C_{17}), octadecane (C_{18}), eicosane (C_{20}), and octacosane (C_{28}) in toluene. 0.1 g of each alkane standard was weighed accurately and made up to volume with toluene in a 100 mL Analytical (A) grade volumetric flask (see Appendix A, Table A-3, p.134, for actual masses used.)

A 0.1 % $^{m}/_{v}$ alkane hydrocarbon standard was prepared by weighing 0.1 g of each standard into a 100 mL A-grade volumetric flask and diluting to volume with toluene. Individual standards of 0.1% $^{m}/_{v}$ concentration in toluene were used to establish their identities and retention times for calibration. This alkane hydrocarbon standard was analysed concurrently with the sample extract chosen during the optimization process. The aim was to produce optimum separation in a minimum amount of time. The alkane hydrocarbon standard was used for the calibration of the GC before analysis of the petroleum hydrocarbon extracts.

3.3.5 Analysis

The procedure for the analysis of the sample extracts is listed below:

- a portion of each of the extracted samples from the 120 mL bottles was decanted into labelled GC vials of 4 mL capacity.
- 0.5 μL of the liquid hydrocarbon extract was injected into the GC. Each analysis was carried out in duplicate. The numerical order of samples was followed during analysis i.e. from 1 to 108. No samples were diluted.
- toluene blanks were run intermediately at random to flush out the injection port and column.
- blank runs without injection of sample or solvent were carried out periodically to check that the column was not retaining any residual matter.
- the alkane hydrocarbon standard was analysed after every ten samples. This served to check that there was minimal drift in the calibration, that the injections were consistent, that the instrument performed at its optimum and to serve as a calibration step.
- tank samples taken from the five tank farms were diluted to 0.1 % $^{m}/_{v}$ in toluene for comparison with extracts.
- sample number sixty-five was analysed consecutively several times to examine the reproducibility of the chromatography method. A statistical analysis was performed on the sample to determine whether any significant level of variation existed during the analysis of hydrocarbons by the method used.

3.3.6 Evaluation

The objectives of this project were met by conducting the following evaluations:

Firstly, the hydrocarbon distribution is compared for the top, middle and bottom samples. This was done for selected sites at each tank farm. The reason for this was that it was not practical to show all thirty six sites within this report. The actual results can be found in Appendix A, Table A-6, p.143. Based upon recommendations by refinery personnel, the GC method in the Varian Star software program was modified (see Appendix B, p.155-158) to bracket hydrocarbon in the two ranges, viz. C_{10}-C_{20} and C_{21}-C_{30}. These are commonly known as the Diesel range organics or DRO's (Restek Corporation, 1994). The concentration of hydrocarbons at the three different depths, viz. top (15 cm), middle (1 m) and bottom (2 m) are presented in Figures 4.6 to 4.11 (p.73 – 78).

Since toluene showed evidence of contamination by hydrocarbons from C_5 to C_9 (see Figure 4.5, p.70), only hydrocarbons above C_{10} were selected for inclusion in the determinations. The inclusion of any hydrocarbons below C_{10} would have resulted in inaccuracies in calculations for the hydrocarbon content.

The second part of the evaluation involved the determination of the total hydrocarbon content at each sample point at the five tank farms. The amount of hydrocarbons found at the three levels, i.e. top, middle and bottom are shown in Figures 4.12 to 4.16 (pp. 81-85). The calculated results are shown in Table 4.5, p.80. The average peak areas for duplicate analysis are shown on the table. The areas shown exclude the areas obtained for hydrocarbons below C_{10} including toluene.

The hydrocarbon content for each sample was calculated using the following equation:

$$Cs = \frac{Cc \times Vt \times D}{Ws} \times \frac{1\ mg}{1000\ \mu g}$$

Where:

Cs = concentration of TPH, hydrocarbon range or specific analytes (mg/kg or mg/L)

Cc = concentration from calibration curve in μg/mL. (If CF is used for calculations, this value is area calibration/CF).

CF = Calibration factor for the standard

$$= \frac{\text{Total area of calibration standard (average of six readings)}}{\text{Concentration of calibration standard (mg/L)}}$$

Vt = Volume of extract (mL)

D = Dilution factor, if dilution was performed on the sample prior to analysis. If no dilution was made, D = 1, dimensionless.

Ws = Weight of sample extracted (kg). If a water sample, then the units are L.

(Characterization of C_6 to C_{35} hydrocarbons in environmental samples, 1998, http://search.yahoo.com/bin/search?p=hydrocarbons+in+soil)

The final evaluation involved analysis of tank samples from each of the tank sites where the samples were taken and comparing these with at least one sample site from each tank farm. This was done to determine whether any similarities in the results could identify the tanks as possible sources of contamination at these sites (see Figures 4.17 (a) to (e), p. 86-88).

The CF value was calculated as follows:

The total area of calibration was determined by taking the average of the areas for the standards determined (minus area < C10). The concentration was taken as an average of 0.1 g per 100 mL (~0.1%) or 1000 mg/L (See masses of standards, Appendix A, Table A-3, p. 134).

Then, CF = 6511800 / 1000 = 6511.8

An example of the calculation of the values listed in Table 4.5, p. 80 is shown below:

Consider Sample 1 for Hole No. 1 which has a sample mass of 50.7808 g and average peak area (Top sample) of 37290. Therefore,

Cs = concentration of hydrocarbons

$$= ((37290 / 6511.8)\ \mu g/mL \times 120\ mL \times 1\ mg/1000\mu g) / 50.7808 \times 10^{-3}\ kg$$

$$= 13.53\ mg/kg$$

3.3.7 Other analyses

Samples number 21 and a few other samples and toluene were sent to SAPREF refinery for comparative analysis on their Gas Chromatograph incorporating a PONA analyser. This analyser consists of five packed columns in series. These samples including toluene and pure crude oil samples, viz. Arab extra light, Arab medium, Iranian light, Iranian heavy, Iraq light and Kuwait were also sent to the LECO Corporation for analysis at their United States laboratory using the Gas chromatograph linked to a time-of-flight mass spectrometer (GC-TOFMS).

CHAPTER 4

4. RESULTS

4.1 SAMPLING

The following table shows the number of holes dug and the total number of samples taken per tank farm. (See details in Table A-1, p. 130-131; Table A-2, p. 132-133; Table A-5, p. 135-142).

Table 4.1: Total number of samples taken at each tank farm.

TANK FARM	NUMBER OF HOLES DUG	NUMBER OF SAMPLES
STF	18	54
MOGAS	4	12
GASOIL	5	15
NTF	6	18
LUBOIL	3	9
TOTAL	**36**	**108**

4.2 EXTRACTIONS

4.2.1 Separating funnel method

This method produced too many procedural problems (see Discussion, p.93). The results produced were not reproducible and hence unreliable. It was for this reason that no results were reported.

4.2.2 BÜCHI Universal extraction soxhlet method

The mass of each sample taken for the extraction process is shown in Appendix A, Table A-5, p.135-142. The average mass taken for each sample extraction was 50 g.

4.2.3 Confirmation of optimum extraction time

Table 4.2 below shows the mass used for each hourly extract, the residue obtained after evaporation of the extract and the corresponding percentage yield. This was used to confirm the optimum extraction time that would be used for the extractions using toluene by the BÜCHI method.

Table 4.2: Average mass yields produced for the hourly extractions of a soil sample (STF T 1114) using toluene and the BÜCHI B-811 extraction system

EXTRACTION TIME	1 HOUR	2 HOURS	3 HOURS	4 HOURS
SOIL MASS	50,8302	51,3216	51,0835	50,5908
RESIDUE	1,0976	1,1851	1,1829	1,1718
% YIELD	**2,16**	**2,31**	**2,32**	**2,32**

The following graph in Figure 4.1 illustrates that the yields produced after two hours of extraction form a plateau indicating little significant change with time of extraction.

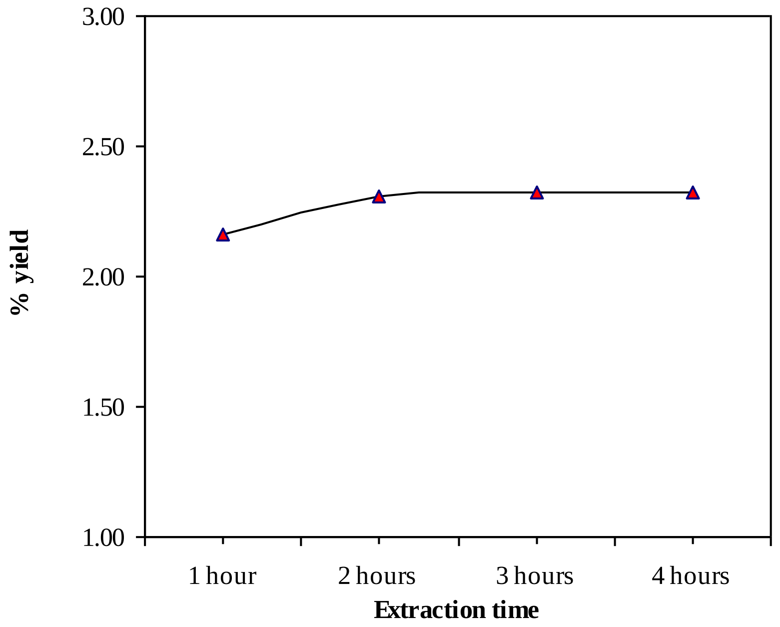


Figure 4.1: Average yields obtained for the sample using the BÜCHI with time-based extraction and toluene as solvent.

4.3 CHROMATOGRAPHY

4.3.1 Column conditioning

The figures below show the chromatogram supplied by the column manufacturers

(Figure 4.2 (a)) compared with that obtained in the laboratory after conditioning the capillary BP1-PONA column (Figure 4.2 (b)). It is important to note that the laboratory chromatogram was produced with nitrogen as the carrier gas instead of hydrogen, as used by the manufacturer. Retention times including relative retention cannot be duplicated under these conditions. The reason for this is explained later (see 5.3.1, p. 95). Computer graphics has produced satellite peaks (shoulders) in Figure 4.2 (b) thus distorting the chromatogram. These are absent in the original chromatograms. See Appendix C, p.159, for a report of the results obtained.

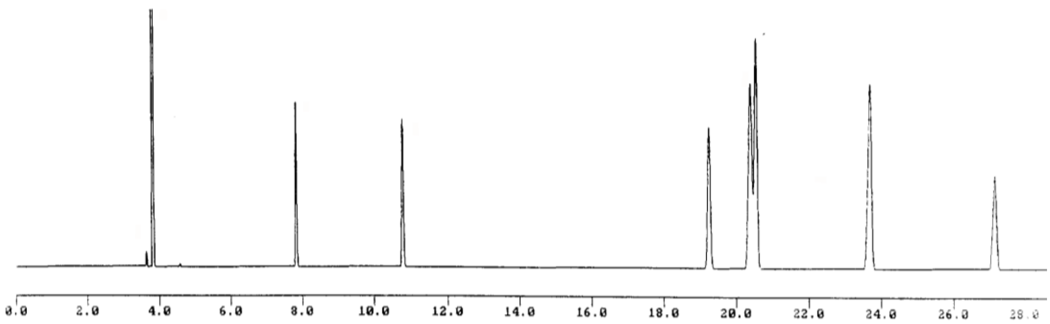


Figure 4.2 (a): **Chromatogram supplied by the manufacturer for their test-mix analysed on the BP1-PONA column.**

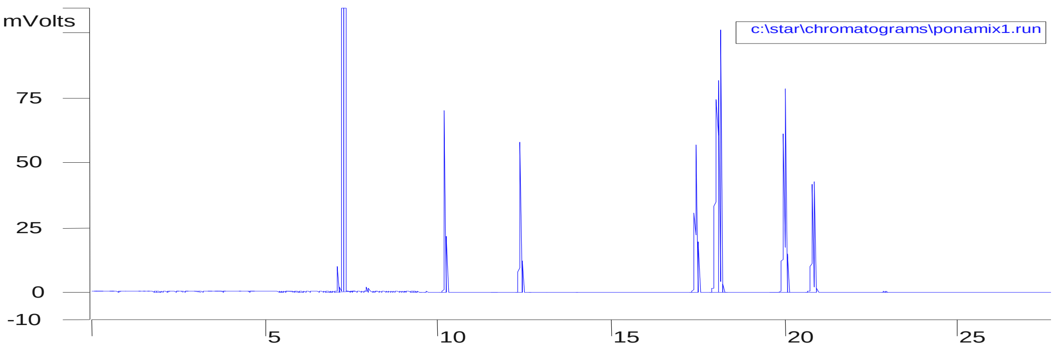


Figure 4.2 (b): **Chromatogram obtained in the laboratory for the supplied test-mix analysed on the BP1-PONA column.**

4.3.2 Method development and optimization of gas chromatograph

The development of the GC method for the analysis of the hydrocarbons resulted in the selection of the following parameters as final operating conditions for analysis by the Varian 1079 with a FID:

Injector temperature: ………………………………………		240 ^{o}C
Detector temperature:……………………………………...		280 ^{o}C
Temperature program:	Initial column temperature…	100 ^{o}C
	Initial hold time……………	2 minutes
	Ramp rate………………….	10 ^{o}C/min.
	Final column temperature…	280 ^{o}C
	Hold time……………….	15 min.
Split ratio……………………………………………….		1 : 50
Detector range…………………………………………..		32 x 10^{-12} afs
Carrier gas flow rate (Nitrogen, N_2) ……………………		0.6 mL/min.
Carrier gas velocity (optimum for N_2 = 10-15 cm/sec)...		11 cm/sec
Injection volume……………………………………….		0.5 µL

The detailed parameters for the method used appear in Appendix B, p.149-154.

The mass of each alkane hydrocarbon used in the alkane hydrocarbon standard was recorded (see Appendix A, Table A-3, p.134). A typical chromatogram of the alkane hydrocarbon standard that was analysed under the optimised conditions determined appears below (Figure 4.3). See Appendix C, p.161-162 for a report of the results obtained.

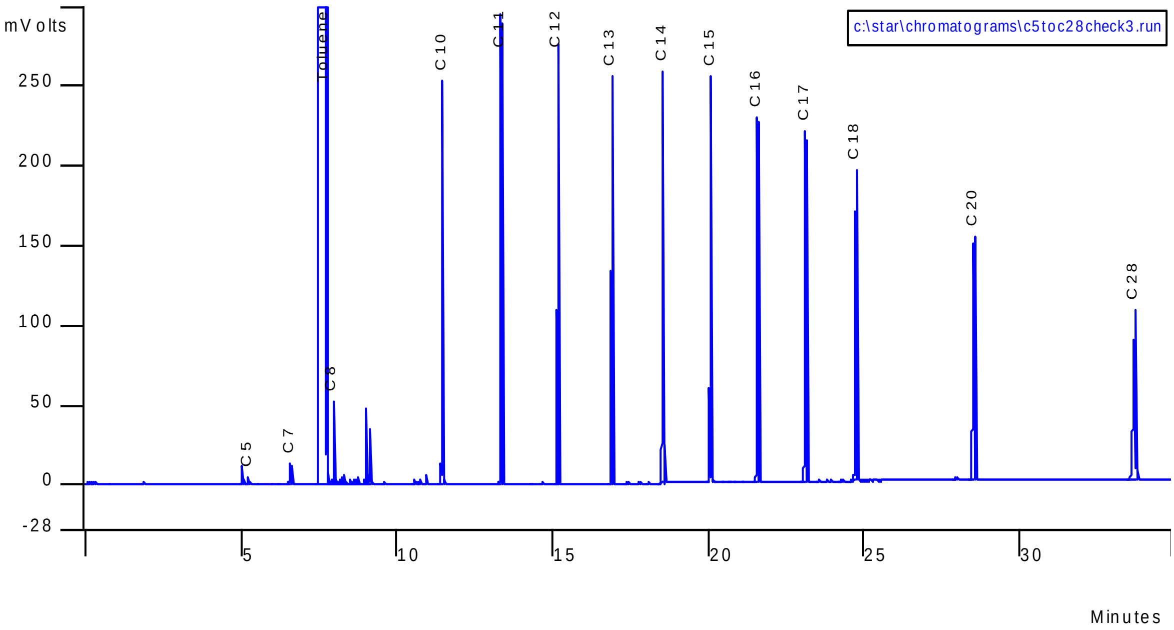


Figure 4.3: Chromatogram of the prepared Alkane hydrocarbon standard

4.3.2.1 Alkane hydrocarbon standard retention times

Table 4.3 below shows the retention times obtained for the hydrocarbon standard used during analysis. The average values shown were used for the calibration of the instrument and analysis of the extracts. The standard deviations of the values obtained also appear on the table. These average retention times were programmed into the Star software method before analysis of the extracts commenced.

Table 4.3: Gas Chromatograph Standard Retention times used for calibration and analysis

HYDROCARBON STANDARD	RETENTION TIME (minutes)						MEAN (minutes)	STANDARD DEVIATION
	1	2	3	4	5	6		
C_5	5.203	5.209	5.192	5.201	5.199	5.198	**5.200**	***0.006***
C_7	6.554	6.577	6.548	6.549	6.558	6.538	**6.554**	***0.013***
Toluene	7.678	7.698	7.662	7.667	7.683	7.658	**7.674**	***0.015***
C_8	7.957	7.978	7.940	7.947	7.964	7.938	**7.954**	***0.015***
C_{10}	11.453	11.478	11.435	11.438	11.460	11.428	**11.449**	***0.019***
C_{11}	13.345	13.368	13.326	13.328	13.348	13.318	**13.339**	***0.018***
C_{12}	15.175	15.194	15.156	15.156	15.174	15.146	**15.167**	***0.017***
C_{13}	16.908	16.925	16.890	16.888	16.904	16.879	**16.899**	***0.017***
C_{14}	18.543	18.558	18.524	18.521	18.535	18.513	**18.532**	***0.016***
C_{15}	20.078	20.091	20.059	20.055	20.067	20.047	**20.066**	***0.016***
C_{16}	21.590	21.602	21.570	21.563	21.576	21.555	**21.576**	***0.017***
C_{17}	23.136	23.147	23.114	23.105	23.118	23.097	**23.120**	***0.019***
C_{18}	24.762	24.773	24.737	24.725	24.739	24.716	**24.742**	***0.022***
C_{20}	28.564	28.572	28.529	28.506	28.526	28.494	**28.532**	***0.031***
C_{28}	33.753	33.762	33.701	33.658	33.690	33.643	**33.701**	***0.048***

4.3.3 Operational Checks

During analysis, blank injections were performed to ensure that there were no contaminants remaining in the column. A typical chromatogram can be seen below (Figure 4.4). The chromatogram with the report appears in Appendix C, Figure C3, p.163.

Any trace amounts of hydrocarbons evident from the blank analysis were flushed out by injecting toluene until there was no evidence of contaminating hydrocarbons. A typical toluene run is shown in Figure 4.5 below (see Appendix C, Figure C4, p.164 for the report).

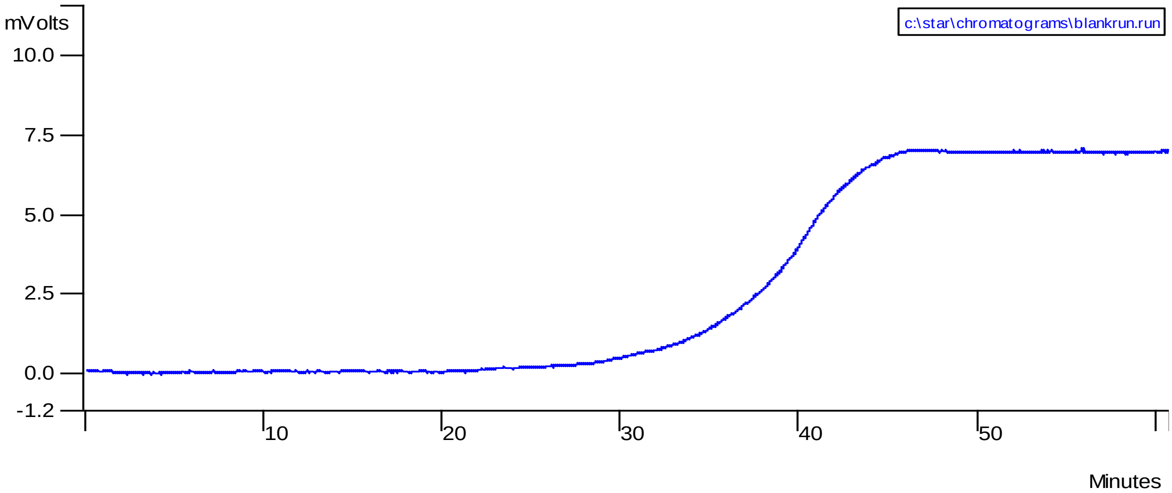


Figure 4.4: Chromatogram of blank run

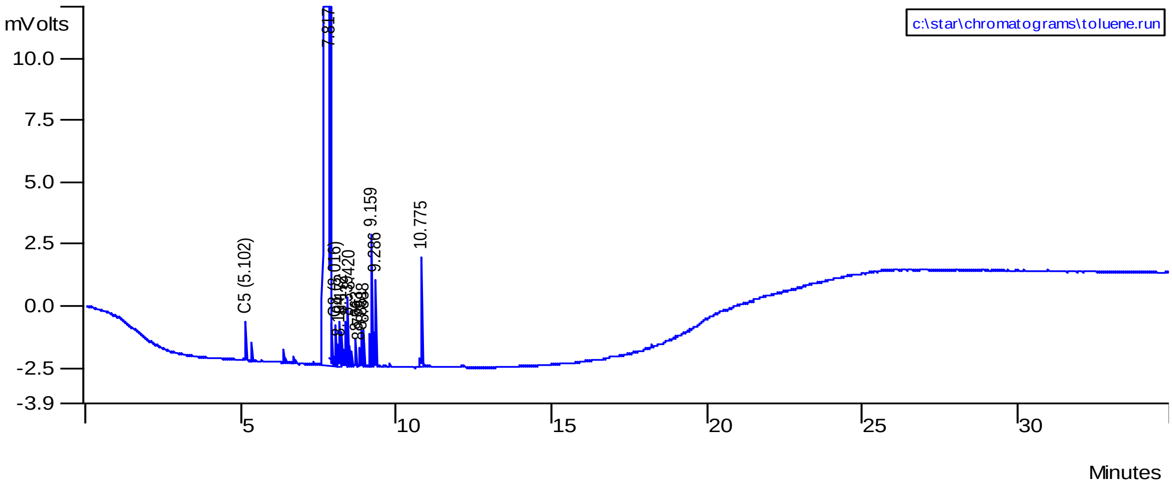


Figure 4.5: Chromatogram of Toluene

Sample 65 (Mogas T 1309, Middle sample) was selected for statistical evaluation to determine whether any significant variation occurred during manual injection. The precision of the replicate analysis was determined by calculating the standard deviation, and the coefficient of variation, i.e. relative standard deviation expressed as a percentage (%RSD). It was assumed that this calculation would give a reasonable indication of the reproducibility of the injections made during the chromatography method. The Table 4.4 below shows the results obtained after nine multiple injections were carried out. The statistical analysis shows the average, standard deviation and coefficient of variation of the values obtained during analysis by chromatography.

TABLE 4.4: Statistical analysis to determine the manual injection reproducibility of a single sample (Sample extract no. 65)

SAMPLE EXTRACT No.	MASS OF SAMPLE	TOTAL HYDROCARBON PEAK AREA	HYDROCARBON CONTENT (% from report)
65-1	50.4014	120503741	1.575
65-2		120596166	1.584
65-3		117346071	1.540
65-4		115184953	1.510
65-5		115920462	1.514
65-6		115607556	1.517
65-7		114565545	1.512
65-8		118386844	1.553
65-9		117113679	1.530
Average		**117247224**	**1.537**
Standard Deviation		**2209067.3**	**0.028**
Coefficient of Variation (% RSD)		**1.884**	**1.818**

4.3.4 Evaluation of hydrocarbon contamination at the five tank farms

4.3.4.1 Hydrocarbon contamination levels at selected sites

The analysis of the one hundred and eight samples produced too many chromatograms to place in a single report. Although all the samples were analysed, random holes for the samples were selected from each tank farm for presentation. Owing to the large number of samples taken at the South Tank Farm, two holes were chosen. Each hole yielded three samples taken at different depths, i.e. 15 cm (top), 1 m (middle) and 2 m (bottom).

The samples chosen for presentation are:

1. South tank farm: T 1114, Hole 7, Samples 19, 20, 21 and T1118, Hole 13, Samples 37, 38, 39.
2. Mogas tank farm: T 1309, Hole 22, Samples 64, 65, 66.
3. Gasoil tank farm: T 1322, Hole 24, Samples 70, 71, 72.
4. North tank farm: T 1104, Hole 31, Samples 91, 92, 93.
5. Luboil tank farm: middle of T 4815/6/7/9, Hole 36, Samples 106, 107, 108.

The chromatograms for each of the above samples follow. The chromatogram for the top (15 cm depth) is followed by chromatograms for the middle sample (1 m depth) and bottom (2 m depth) consecutively. The chromatograms are followed by a bar graph representing hydrocarbons bracketed in the ranges C_{10} - C_{20} and C_{21} - C_{30}. The chromatograms with detailed reports are in Appendix C, Figures C5-C22, p.165-244.

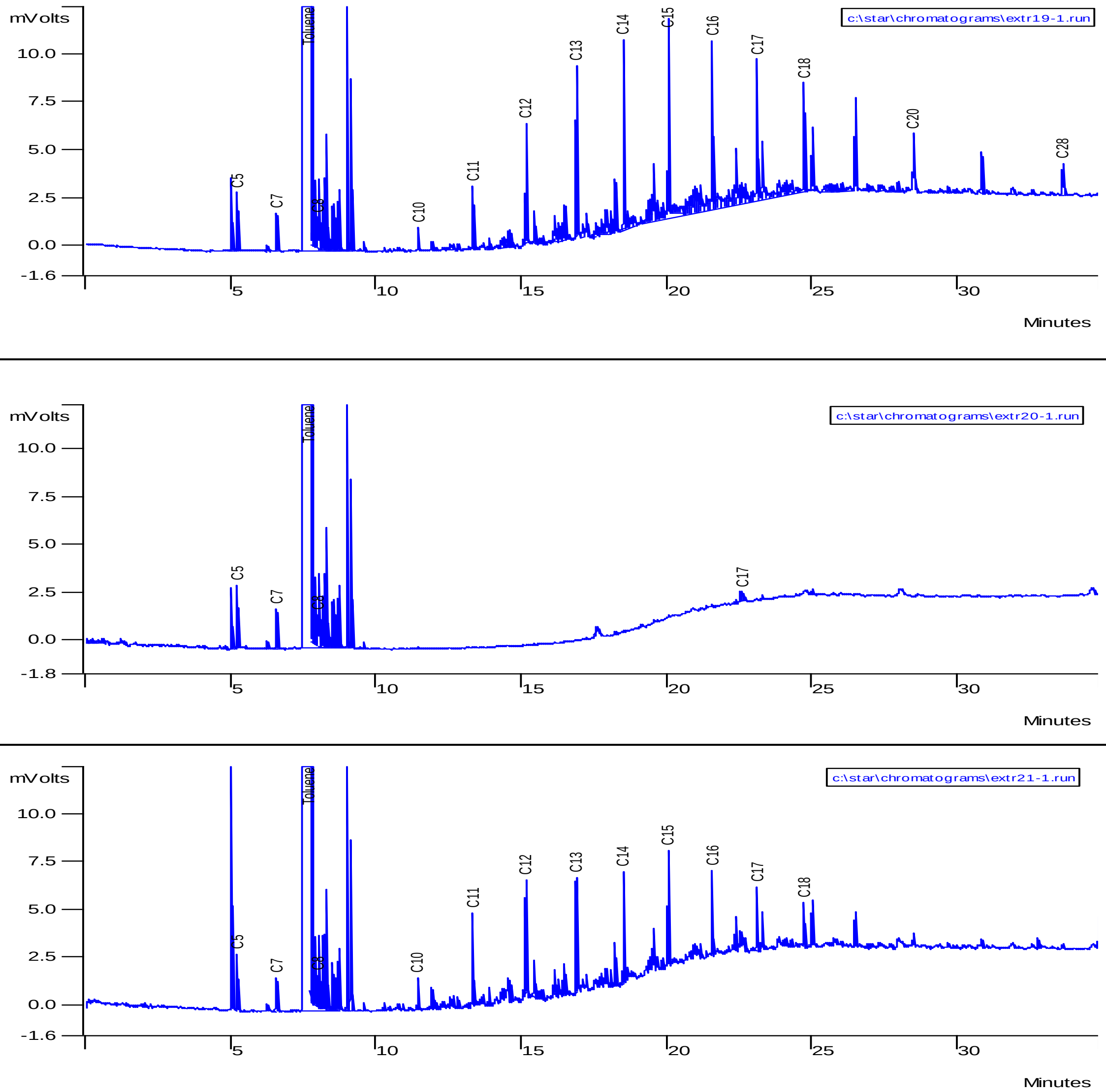


Figure 4.6 (a): Chromatograms showing the hydrocarbons found in top, middle and bottom samples taken at STF T1114 (Hole 7)

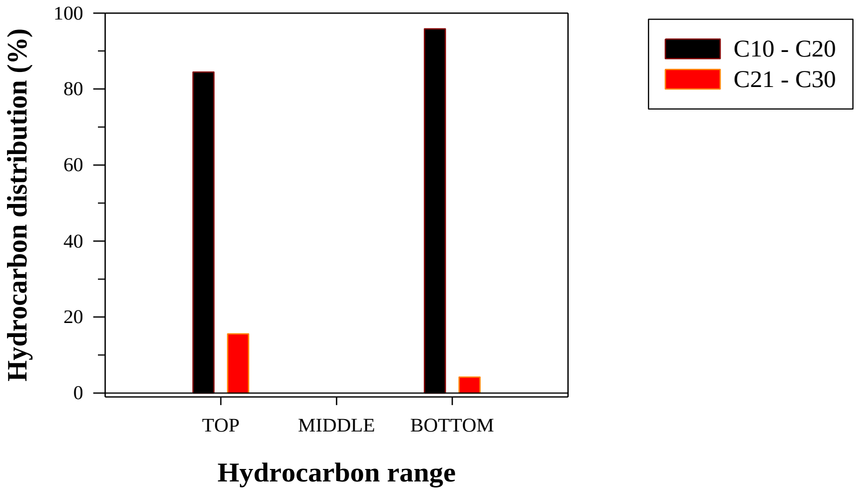


Figure 4.6 (b): Hydrocarbon contamination levels at STF T1114 obtained from the above chromatograms.

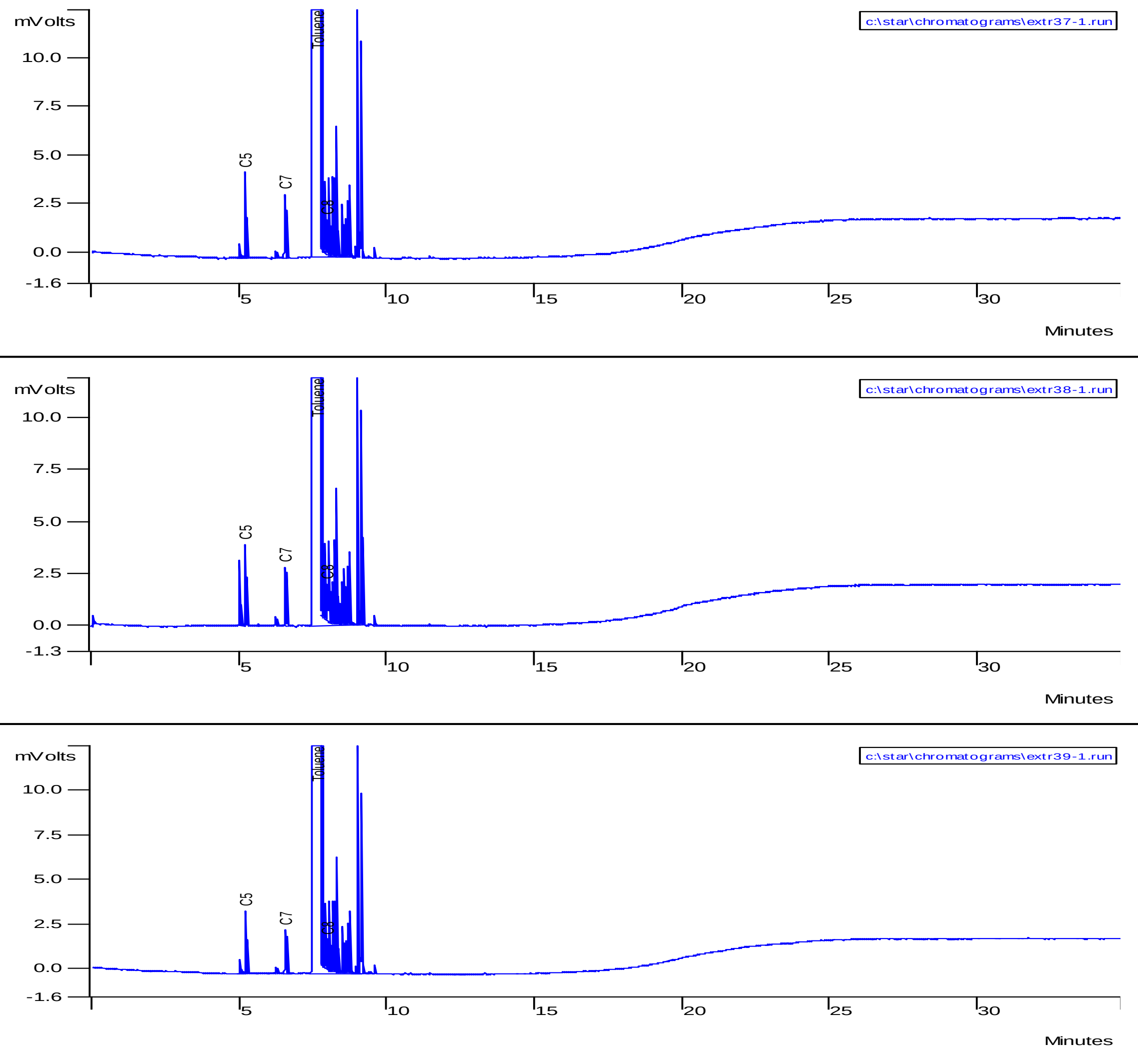


Figure 4.7 (a): **Chromatograms showing the hydrocarbons found in top, middle and bottom samples taken at STF T1118 (Hole 13)**

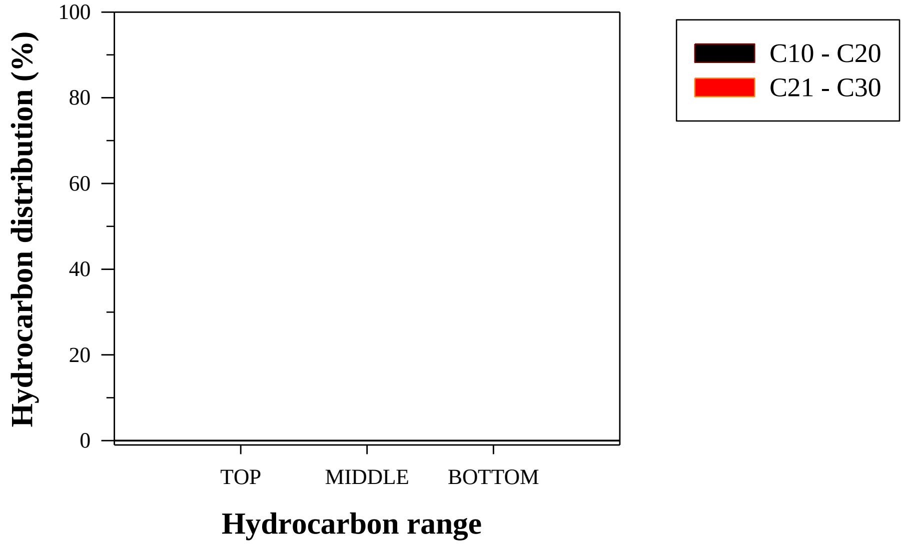


Figure 4.7 (b): **Hydrocarbon contamination levels at STF T1118 obtained from the above chromatograms.**

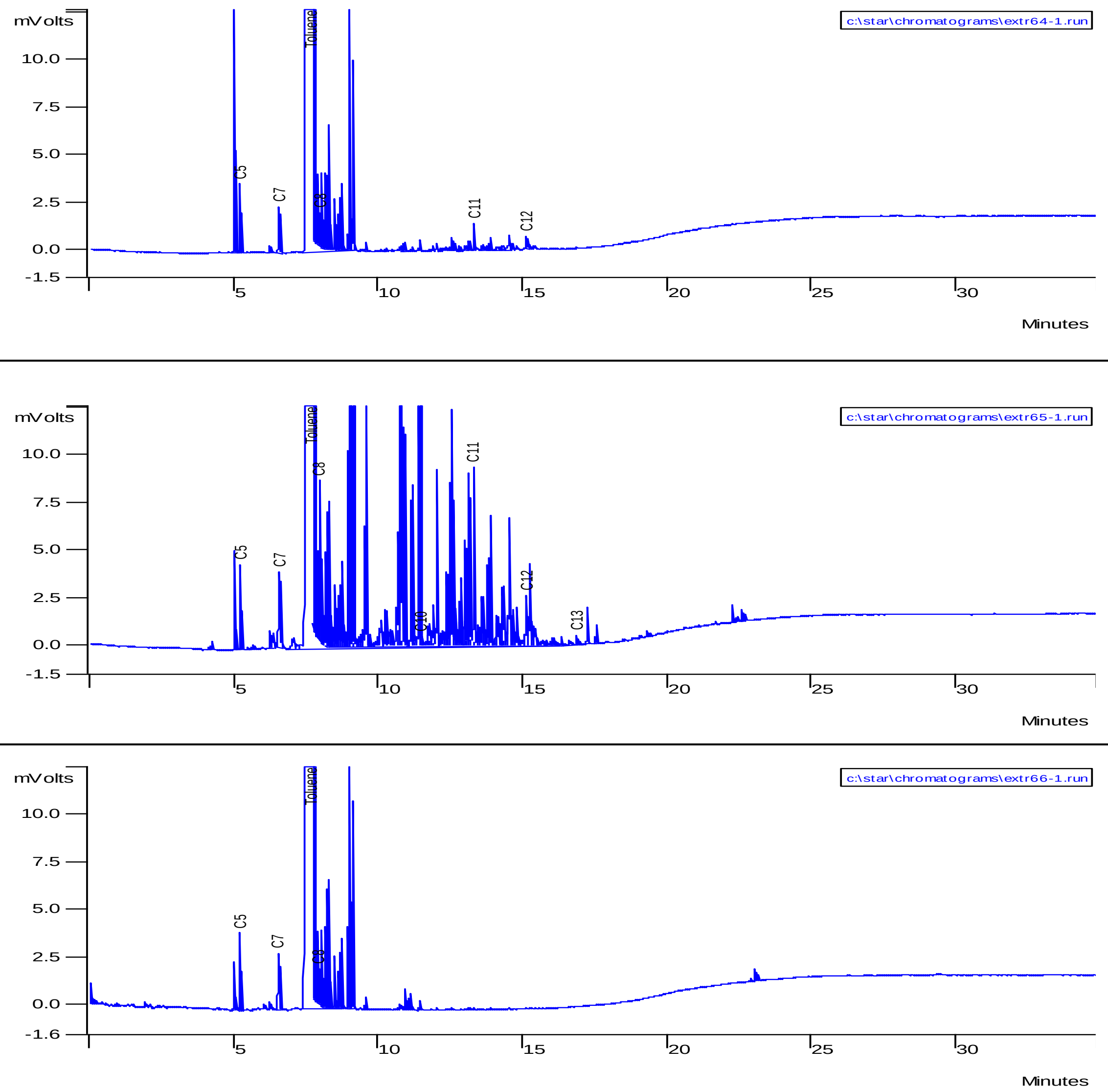


Figure 4.8 (a): **Chromatograms showing the hydrocarbons found in top, middle and bottom samples taken at MOGAS T1309 (Hole 22)**

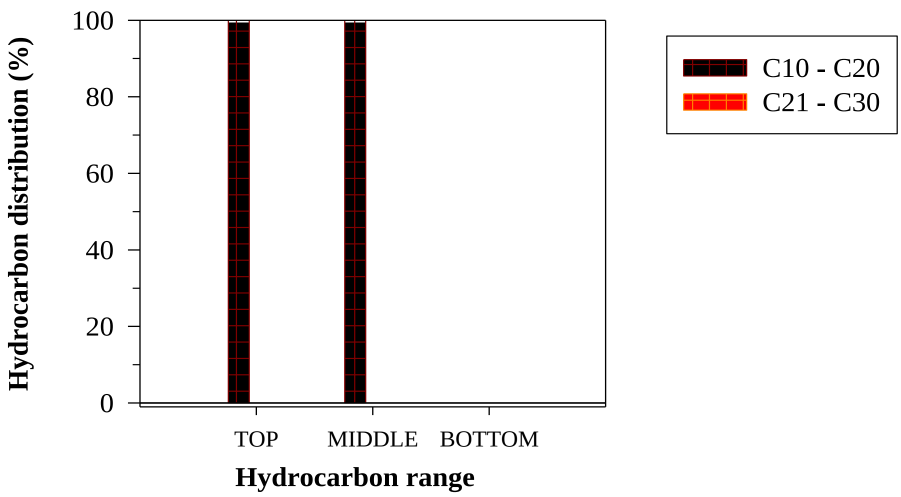


Figure 4.8 (b): **Hydrocarbon contamination levels at MOGAS T1309 obtained from the above chromatograms.**

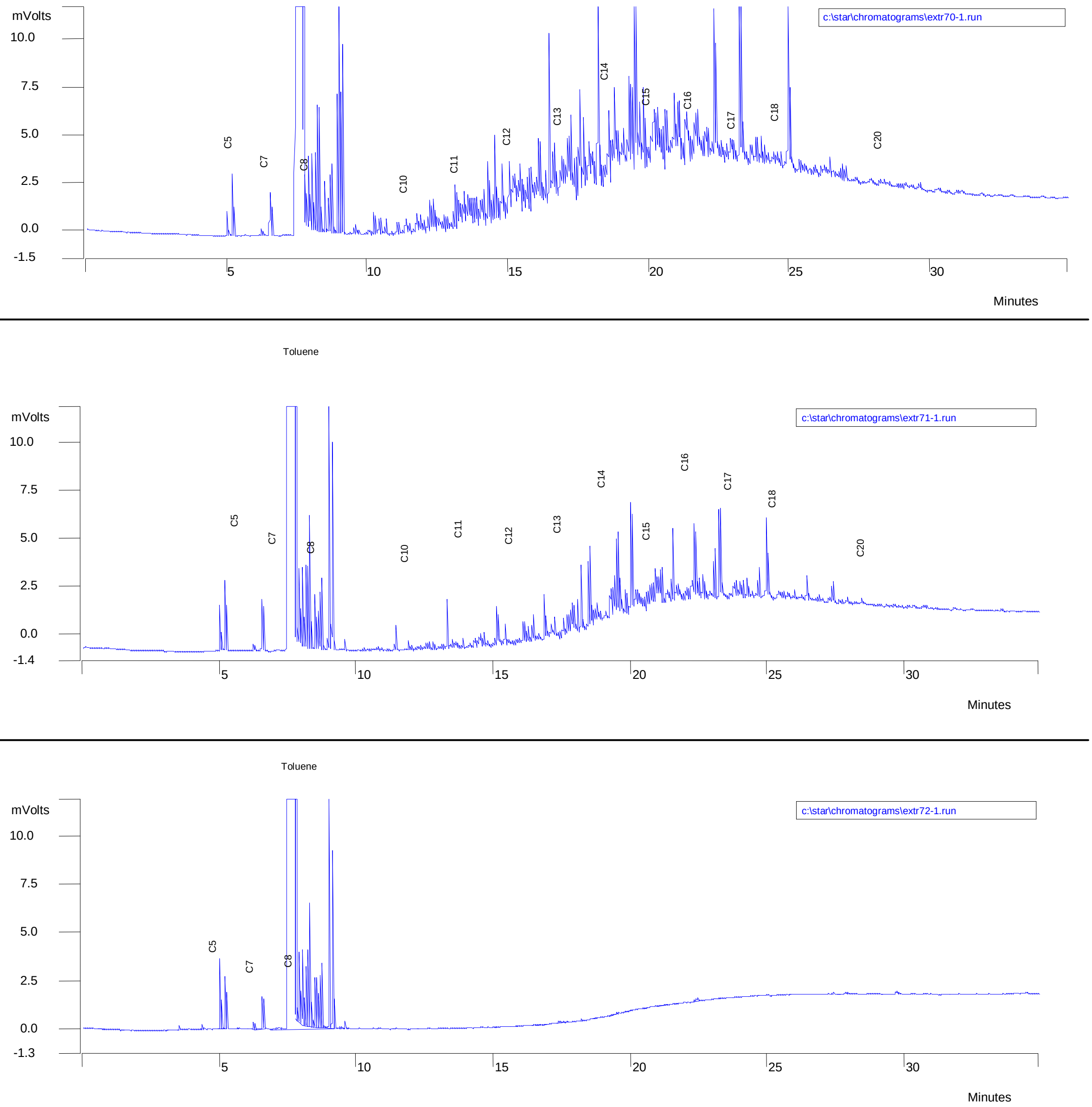


Figure 4.9 (a): **Chromatograms showing the hydrocarbons found in top, middle and bottom samples taken at GASOIL T1322 (Hole 24)**

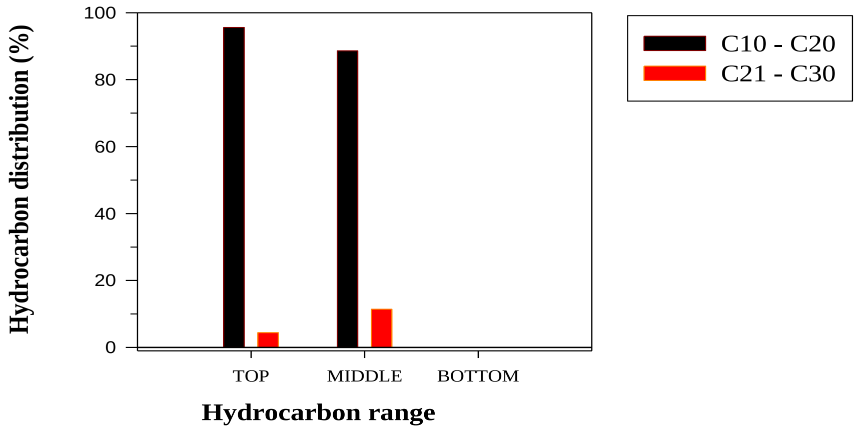


Figure 4.9 (b): **Hydrocarbon contamination levels at GASOIL T1322 obtained from the above chromatograms.**

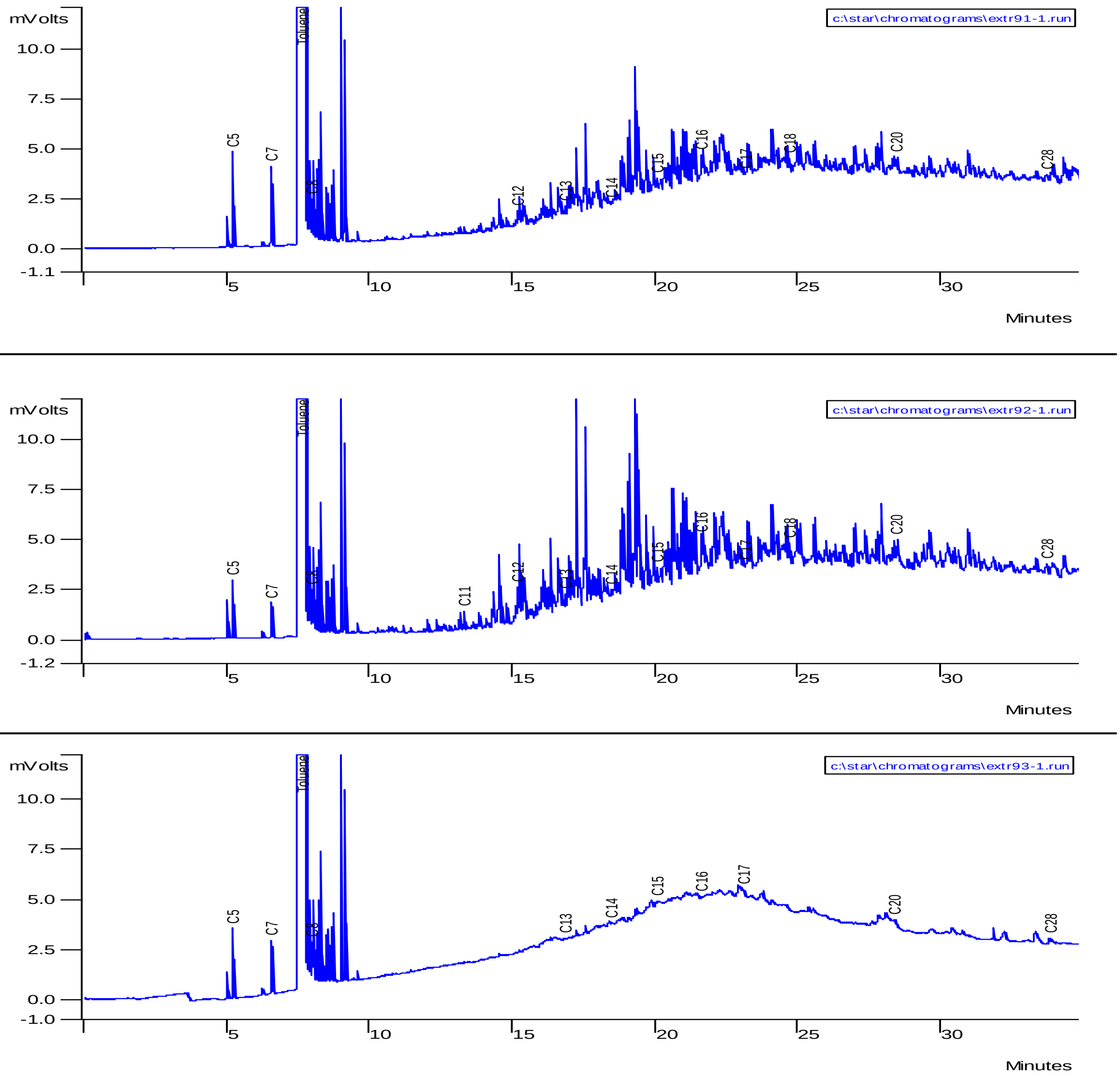


Figure 4.10 (a): **Chromatograms showing the hydrocarbons found in top, middle and bottom samples taken at NTF T1104 (Hole 31)**

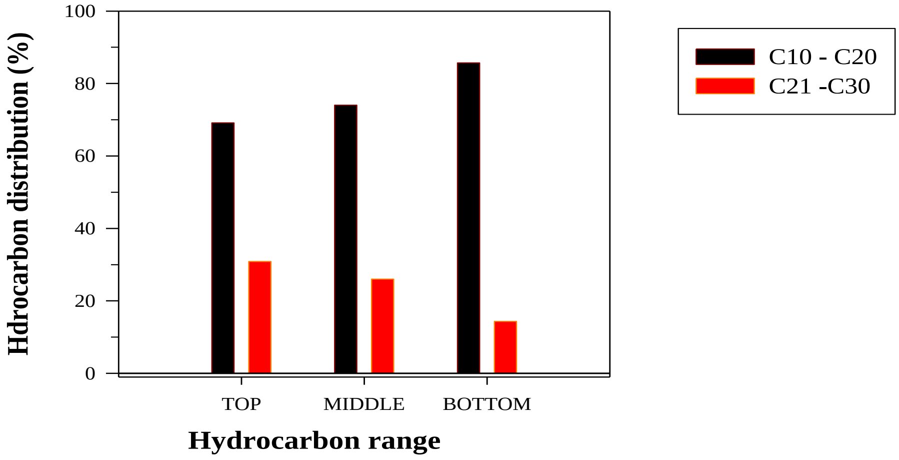


Figure 4.10 (b): **Hydrocarbon contamination levels at NTF T1104 obtained from the above chromatograms.**

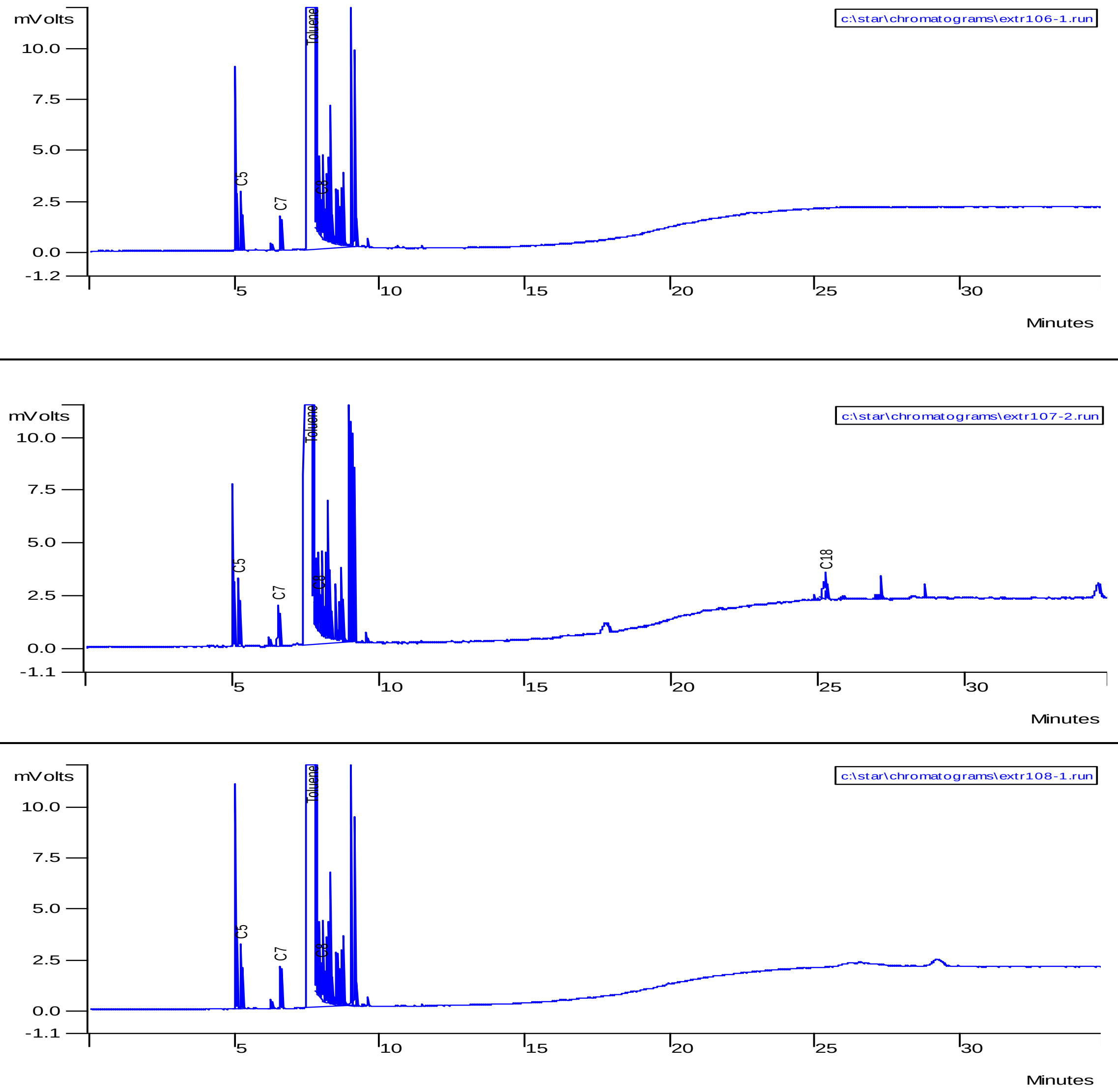


Figure 4.11 (a): **Chromatograms showing the hydrocarbons found in top, middle and bottom samples taken at LUBOIL T4815/6/7/9 (Hole 36)**

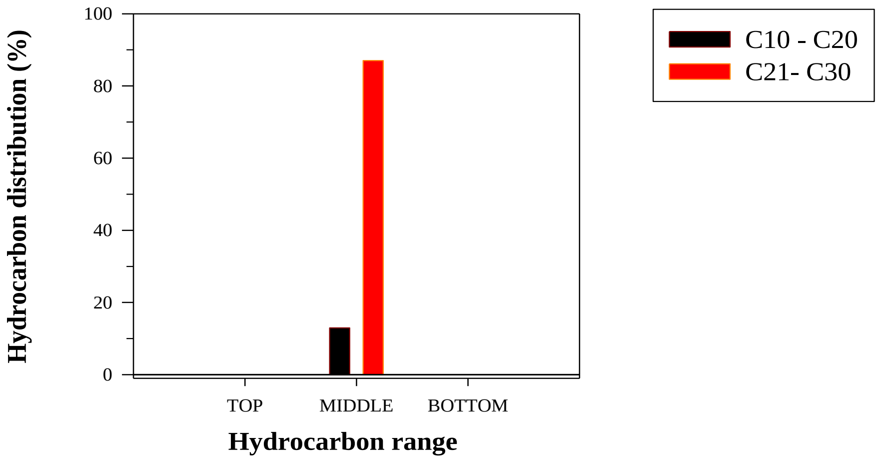


Figure 4.11 (b): **Hydrocarbon contamination levels at LUBOIL (Middle of) T4815/6/7/9 obtained from the above chromatograms.**

4.3.4.2 **<u>Comparison of the overall levels of hydrocarbon contamination found at 15 cm, 1 m and 2 m depth at the five tank farms.</u>**

Table 4.5 below (p. 80) shows the values calculated in mg/kg (parts per million). The graphs that follow show the estimated amount of the hydrocarbons at the five tank farms. The range evaluated was from C_{10} to C_{30}. The graphs show a measure of the amount of hydrocarbons found at the three different sampling depths, viz. 15 cm depth (Top), 1 m depth (Middle) and 2 m depth (Bottom).

The calculation procedure appears in Section 3.3.6, p. 60-61.

TABLE 4.5: Measured Hydrocarbon Content At Tank Farms (mg/kg)

Tank Farm site	Hole No.	MASS OF SAMPLE			AVERAGE PEAK AREA*			HYDROCARBON CONTENT (mg/kg)		
		TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM	TOP	MIDDLE	BOTTOM
STF T1106	**1**	50.7808	50.3036	50.4381	37290	5323	1346	13.53	1.95	0.49
	2	50.9134	50.8515	49.9575	0	0	0	0.00	0.00	0.00
STF T1108	**3**	50.6813	50.8513	50.7294	0	33043	1518	0.00	11.97	0.55
STF T1110	**4**	50.8560	50.3979	50.5664	0	7014	2020	0.00	2.56	0.74
	5	50.6135	51.196	50.8109	777	142327	13420	0.28	51.23	4.87
STF T1112	**6**	50.9785	50.3816	50.2624	30583	7241	5689	11.06	2.65	2.09
***STF T1114**	**7**	50.8732	49.999	51.0945	376776	3845	128955	136.48	1.42	46.51
STF T1113	**8**	48.8514	50.8402	49.7083	91823	4162	0	34.64	1.51	0.00
STF T1111	**9**	50.2046	50.8178	50.807	0	0	0	0.00	0.00	0.00
STF T1109	**10**	50.747	51.6693	50.5732	2011	4500	0	0.73	1.60	0.00
STF T1107	**11**	50.5949	51.5572	50.3395	0	1050	0	0.00	0.38	0.00
STF T1105	**12**	49.4535	50.5829	50.1099	0	5102	139094	0.00	1.86	51.15
STF T1118	**13**	49.7427	51.2761	50.4936	0	2549	2126	0.00	0.92	0.78
STF T1117	**14**	50.5513	49.2119	49.8823	632	2127	1369	0.23	0.80	0.51
STF T1116	**15**	49.4089	50.1518	50.2724	130655	201749	4099	48.73	74.13	1.50
	16	50.2144	50.4295	51.0086	26899	0	41019	9.87	0.00	14.82
STF T1115	**17**	50.6318	50.4395	50.1265	26410	0	0	9.61	0.00	0.00
STF T1114	**18**	49.9683	50.0762	50.829	0	624	0	0.00	0.23	0.00
Mogas T 1307	**19**	50.2198	49.4691	51.2346	0	77950	126754	0.00	29.04	45.59
Mogas T 1306	**20**	49.8466	50.6417	49.6733	0	952	7428	0.00	0.35	2.76
Mogas T 1310	**21**	51.042	50.9403	50.9373	19632	51590	3356	7.09	18.66	1.21
Mogas T 1309	**22**	49.6531	50.4014	50.9683	24114	429255	0	8.95	156.95	0.00
Gasoil T 1315	**23**	50.06	50.1188	50.3351	947043	2120111	3733	348.63	779.54	1.37
Gasoil T 1322	**24**	50.0177	50.8185	50.5946	1850670	611122	4117	681.84	221.61	1.50
Gasoil mid T 7801-4	**25**	50.1674	50.1346	51.2842	328477	137455	275037	120.66	50.52	98.83
Gasoil mid T 1317/8-1324/5	**26**	50.6698	50.3335	50.4279	2723	468651	654	0.99	171.58	0.24
Gasoil T 1203/4	**27**	50.3186	50.5709	51.3967	367759	1860947	12619	134.68	678.13	4.52
NTF T 1101	**28**	50.2653	49.3224	51.1163	0	0	1245	0.00	0.00	0.45
NTF T 1102	**29**	49.6065	50.4714	50.3558	1045489	6162	0	388.38	2.25	0.00
NTF T 1103	**30**	50.3446	50.3096	49.9295	3681	568	0	1.35	0.21	0.00
NTF T 1104	**31**	50.1101	50.3967	50.6765	1270283	1465938	223806	467.15	536.04	81.39
NTF T 1326	**32**	50.0281	49.9256	50.5529	12596	898	73377	4.64	0.33	26.75
NTF T 1327	**33**	50.833	50.0534	48.609	6698	1888	765889	2.43	0.69	290.36
LUBOIL mid T4801-5	**34**	50.4518	50.1639	49.9416	36895	157623	35518	13.48	57.90	13.11
LUBOIL mid T4808-12	**35**	49.9853	50.7113	51.8673	695	21878	0	0.26	7.95	0.00
LUBOIL mid T4815-9	**36**	50.555	50.9806	51.2513	1160	16413	0	0.42	5.93	0.00

* Average of duplicate analysis.

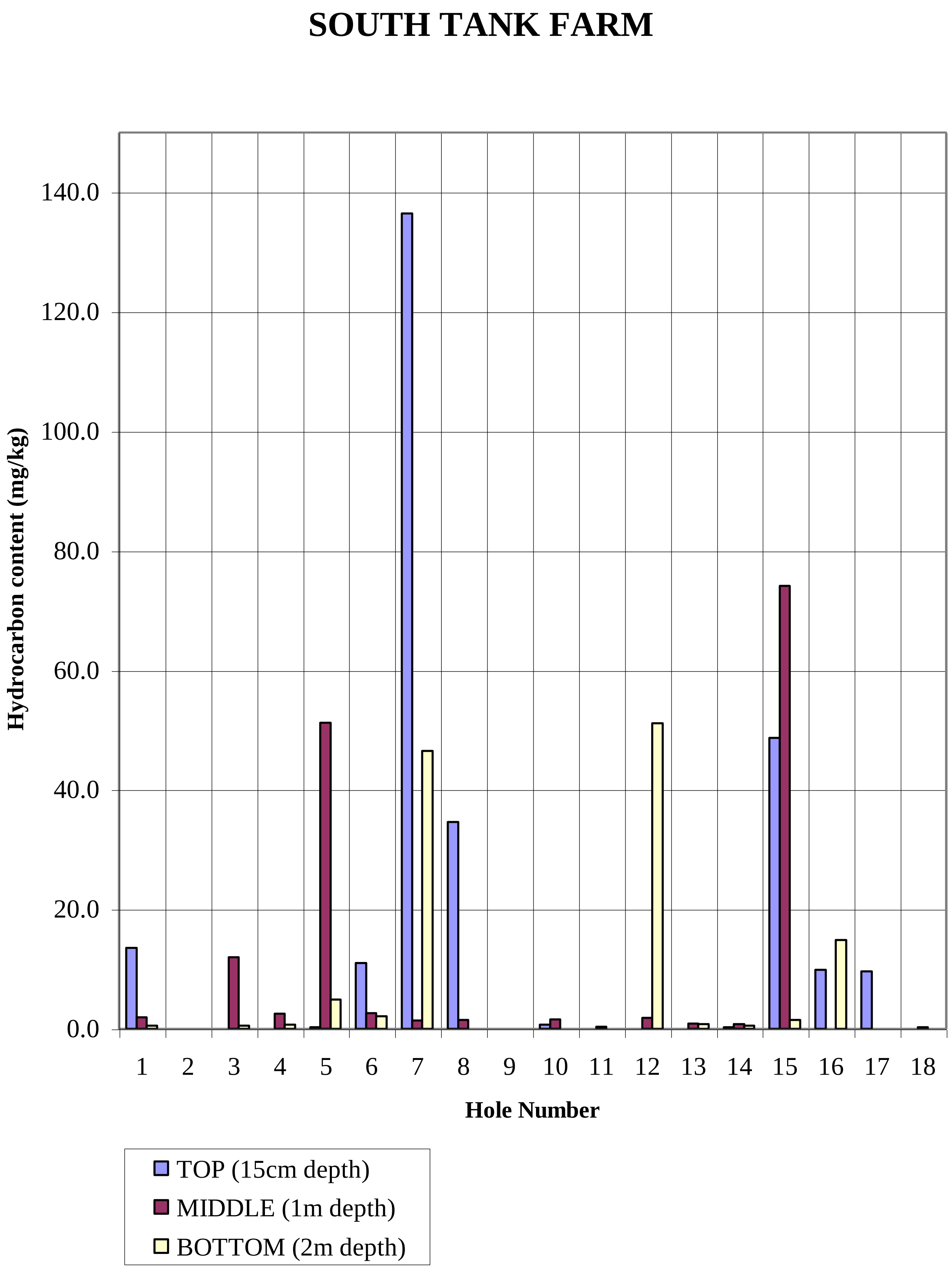


Figure 4.12: Graph shows levels of hydrocarbon found in samples taken at 15 cm, 1 m and 2 m depths at the eighteen random holes within the South Tank Farm (STF).

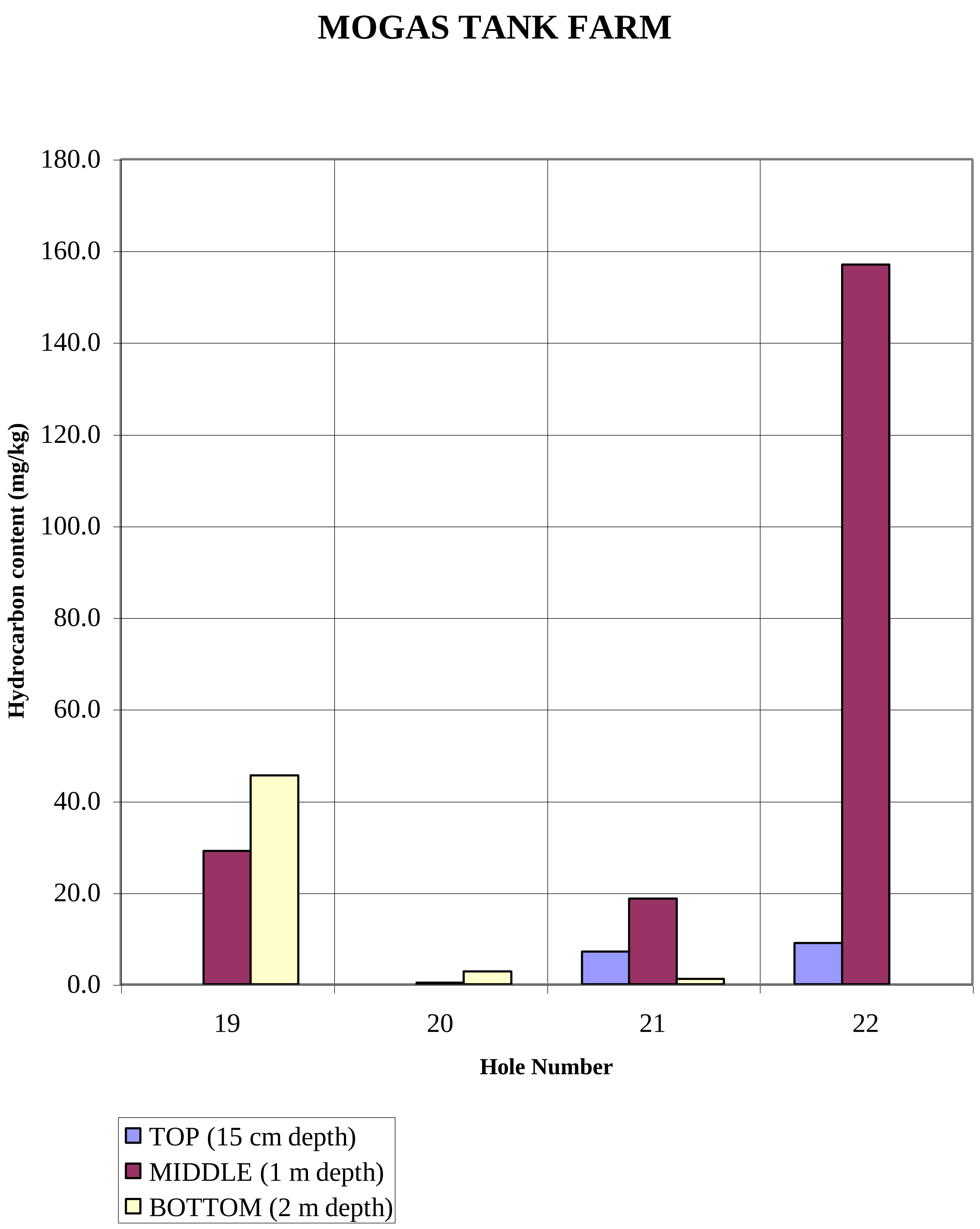


Figure 4.13: Graph shows levels of hydrocarbon found in samples taken at 15 cm, 1 m and 2 m depths at the four random holes within the Mogas Tank Farm.

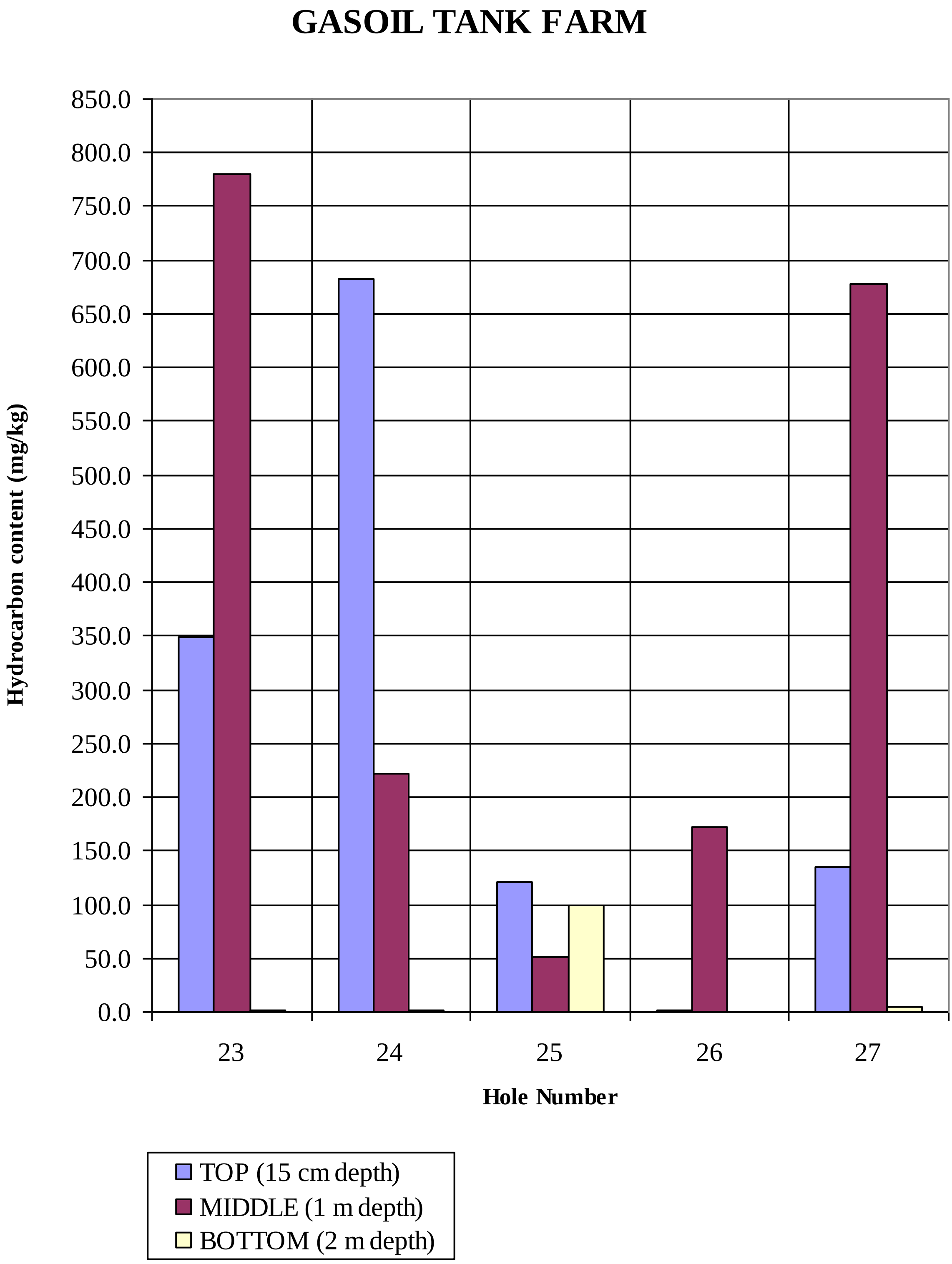


Figure 4.14: Graph shows levels of hydrocarbon found in samples taken at 15 cm, 1 m and 2 m depths at the five random holes within the Gasoil Tank Farm.

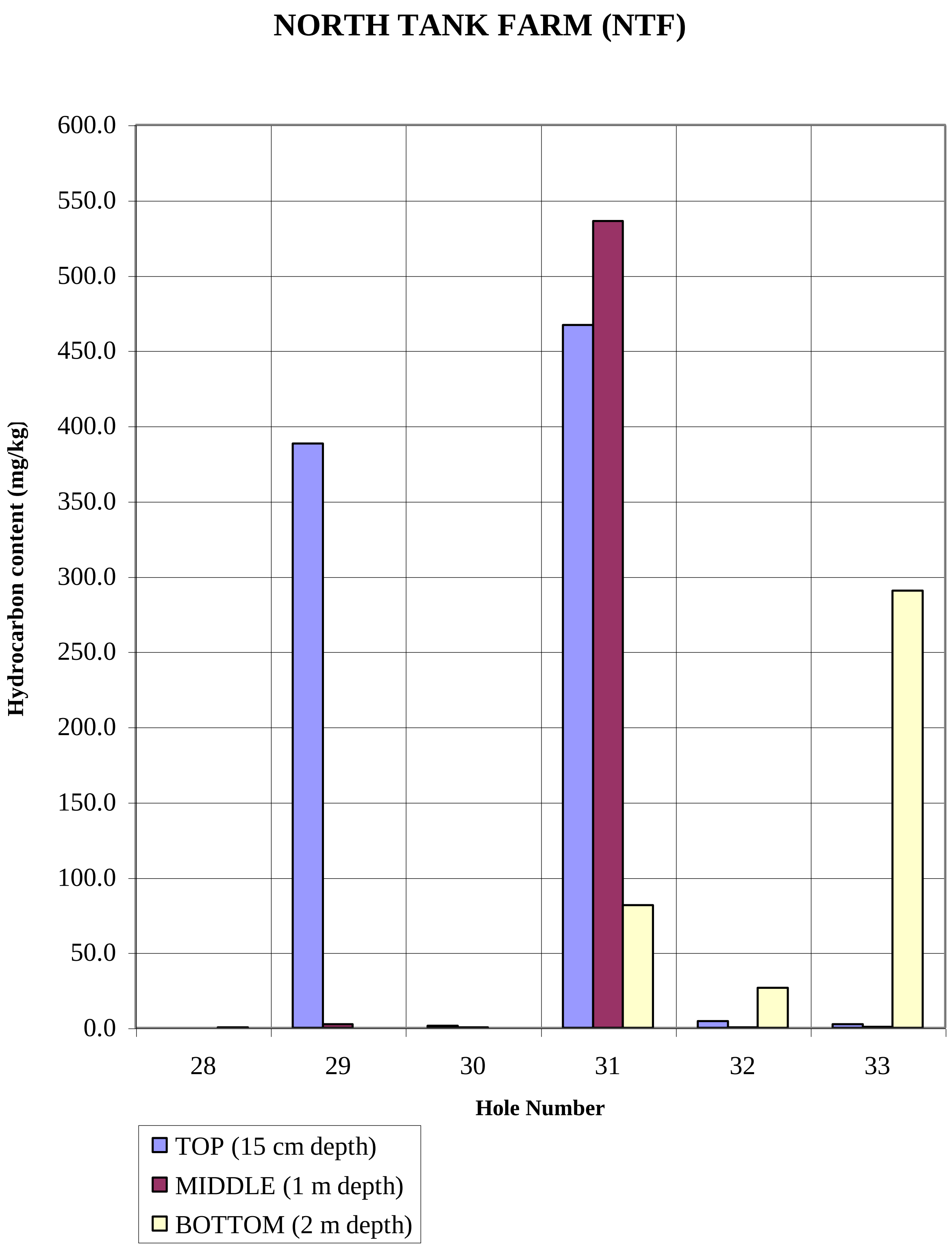


Figure 4.15: Graph shows levels of hydrocarbon found in samples taken at 15 cm, 1 m and 2 m depths at the six random holes within the North Tank Farm.

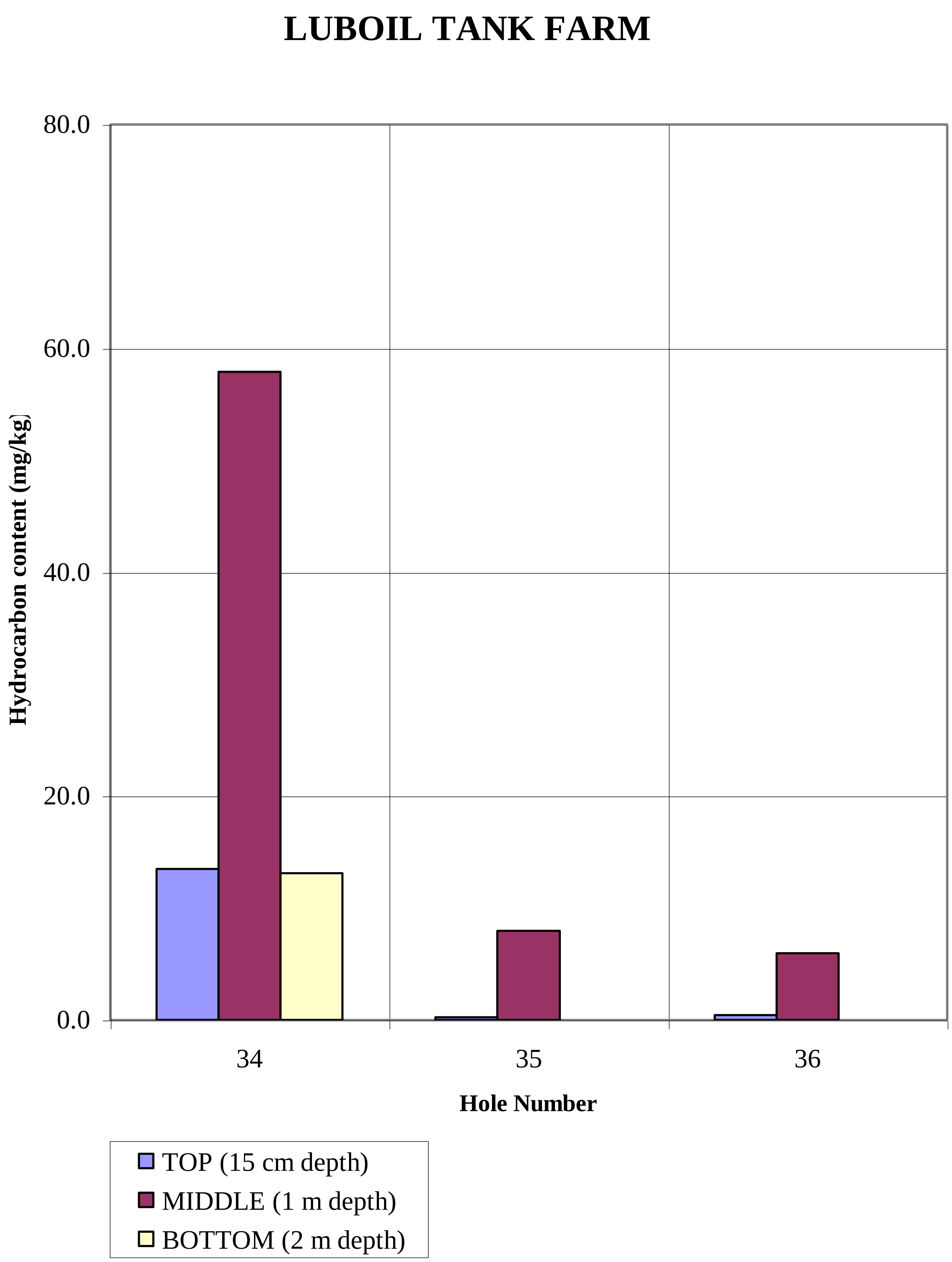


Figure 4.16: Graph shows levels of hydrocarbon found in samples taken at 15 cm, 1 m and 2 m depths at the three random holes within the Luboil Tank Farm.

4.3.4.3 Comparison of the levels of measured hydrocarbons at various sites with levels obtained in tank samples

The graphs that follow illustrate the amount of hydrocarbons found in the soil versus that obtained in tank samples e.g. the amount of hydrocarbon obtained from a sample at the STF is compared with the amount obtained in a sample of raw crude taken from a nearby tank within the STF. A comparison was drawn at all five tank farms. The ranges evaluated were: C_{10} to C_{20} and C_{21} to C_{30}. The bar graphs for the soil samples show the amount of hydrocarbon found at the three different depths, viz. 15 cm depth (Top), 1 m depth (Middle) and 2 m depth (Bottom).

Figure 4.17 (a) shows the comparison between samples taken at hole number 7 and the seven different types of crude oil used at the refinery.

Figures 4.17 (b) to (e) show comparisons between selected samples and crude oil products taken from corresponding tanks adjacent to the sampling points.

The actual values obtained are shown in Table A-6, Appendix A, p.143.

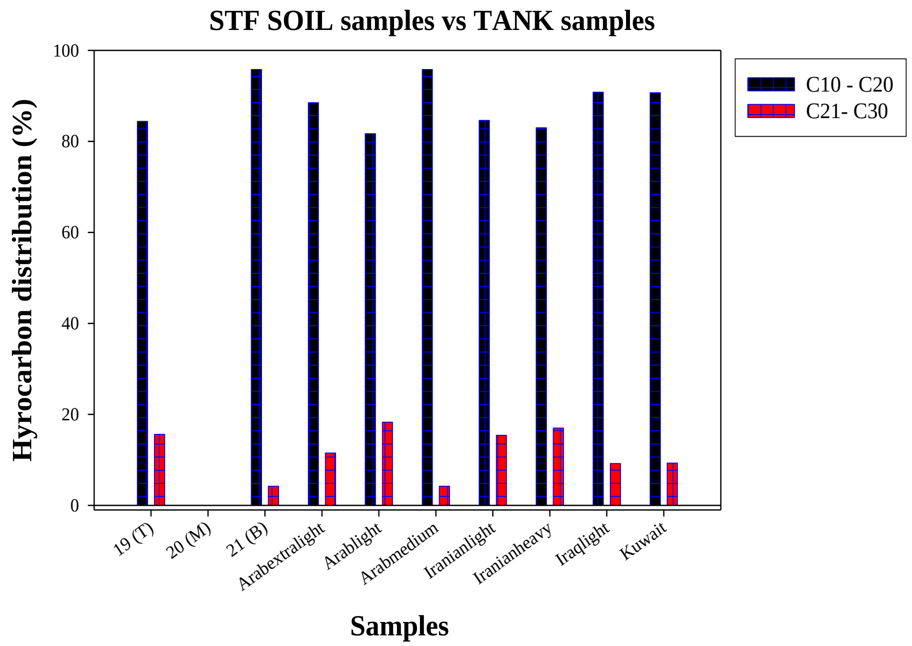


Figure 4.17 (a): Comparison of hydrocarbon levels in soil extracts at STF T1114 (Samples 19, 20 & 21) with levels in tank samples of various crude types in storage at the STF

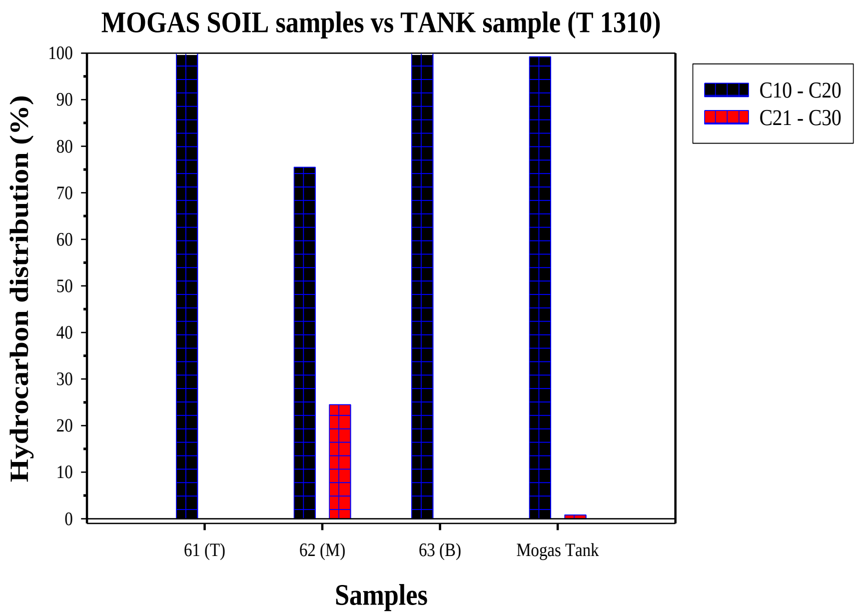


Figure 4.17 (b): **Comparison of hydrocarbon levels in soil extracts at MOGAS T 1310 area (Samples 61, 62 & 63) with levels in corresponding tank sample (T 1310)**

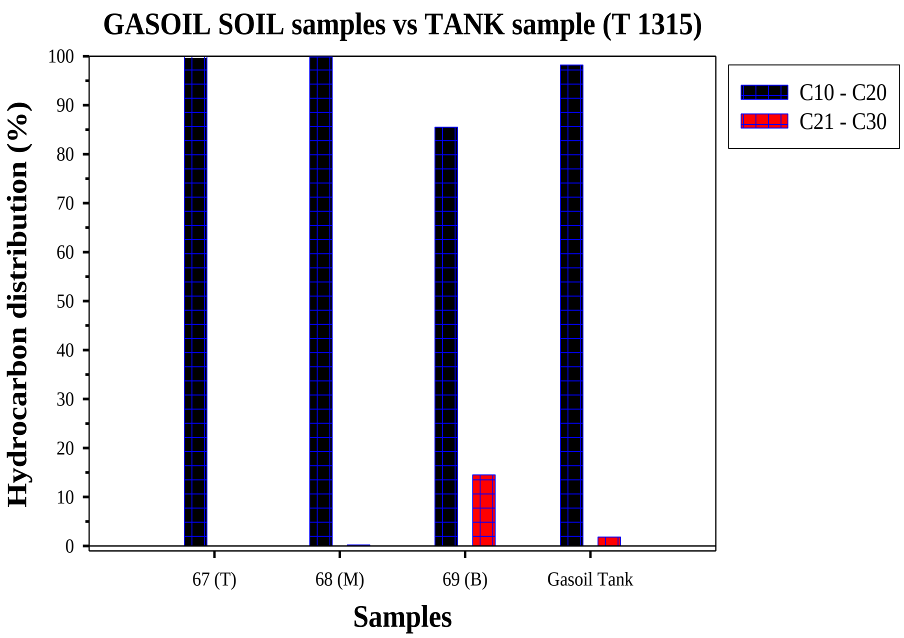


Figure 4.17 (c): **Comparison of hydrocarbon levels in soil extracts at GASOIL T 1315 area (Samples 67, 68 & 69) with levels in corresponding tank sample (T 1315)**

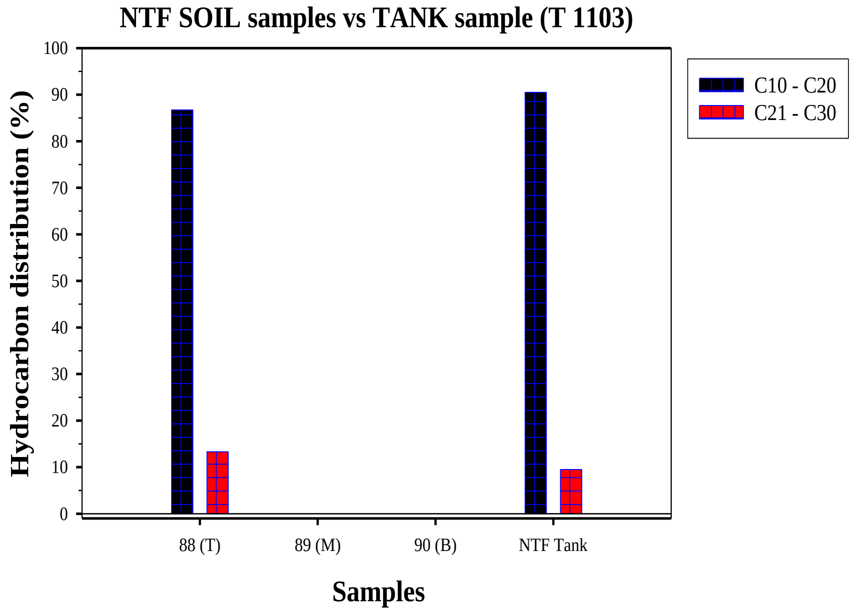


Figure 4.17 (d): **Comparison of hydrocarbon levels in soil extracts at NTF T 1103 area (Samples 88, 89 & 90) with levels in corresponding tank sample (T 1103)**

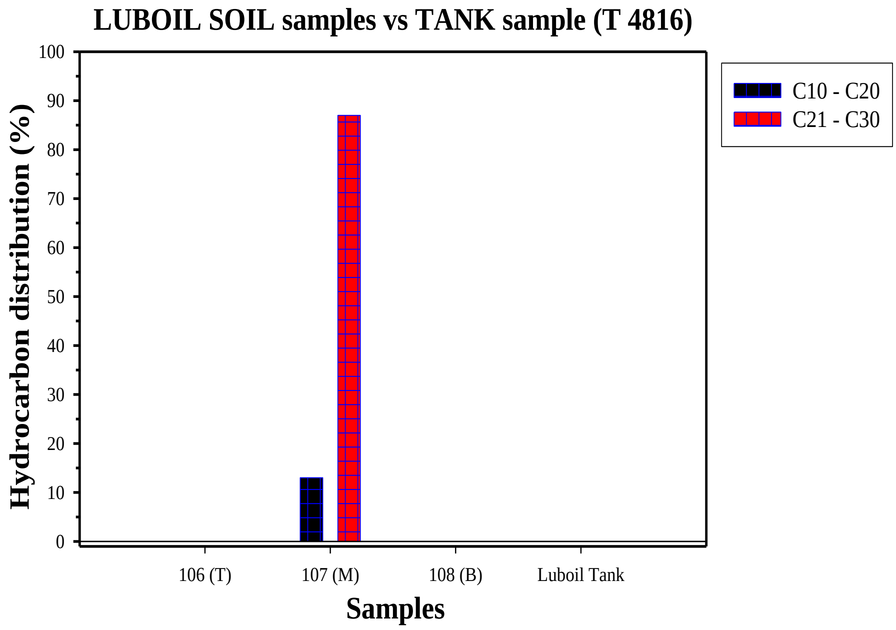


Figure 4.17 (e): **Comparison of hydrocarbon levels in soil extracts at LUBOIL T 4815-9 area (Samples 106, 107 & 108) with levels in corresponding tank sample (T 4816)**

4.4 SAMPLES SENT TO REFINERY FOR ANALYSIS

The analysis of all the samples sent to the refinery could not be completed owing to problems experienced by the analyst. Sample number 21 from STF T 1114 was analysed and the results appear in Appendix D, Figure D1, p.346. The method was named “hexane isomers” by the refinery technician and no explanation or reason was given for this choice. A reasonable comparison with this analysis could not be drawn as the refinery personnel could not verify the results produced. The gas chromatograph illustrates a poor response towards the sample supplied and inadequate separation of these samples was achieved.

4.5 SAMPLES SENT TO LECO CORPORATION FOR ANALYSIS

The same set of samples sent to the refinery was sent to LECO cooperation. GC-TOF-MS analysis performed by LECO Corporation was able to separate and identify one hundred and eighty two components (see Appendix D, Figure D2, p. 347-352). However, if one examines the results carefully, it can be seen that several compound were repeated.

The above were compared with results obtained by the CGC method used by this project. The results for this appear in Appendix C, Figure C7, p.173-175.

CHAPTER 5

5. DISCUSSION

5.1 SAMPLING

The choice of sampling sites was made only after taking cognisance of the layout of tanks within the tank farms. Digging for samples had to be conducted away from incoming and outgoing piping. An engineer's clearance was required to ensure that sampling was carried out correctly and safely. This required an ongoing input from engineers as sampling was conducted at the various sites. Engineers were able to tell from detail site diagrams whether the points chosen were safe for sampling and thus advised us accordingly. They were, however, not aware of the exact location of any obstruction or the behaviour of the water table.

The number of samples taken at each tank farm corresponds in proportion to the approximate size of each tank farm. The smallest tank farm being approximately 25000m^2 while the largest, the STF, was more than 100000m^2. Table 4.1 (Results, p. 63) shows the number of holes dug and the number of samples taken after the top, middle and bottom samples were considered. The largest number of samples was taken from the South tank farm (STF) as it contained the largest number of tanks and covered the greatest area in comparison to the other tank farms studied. A total of thirty six holes were dug at the five tank farms. Three samples were obtained from each hole taken at the 15 cm depth (top), 1 m depth (middle) and 2 m depth (bottom). The analysis of these samples formed the basis for this study.

The Auger used provides one of the simplest methods for sampling. The depths of auger sampling was limited by the presence of a water table, soil characteristics and equipment used (ASTM Designation: D1452-637, 1963). The Auger provided a simple but safe option for sampling at the refinery. Electrically driven machinery was forbidden owing to the hazards they would have posed at the sampling sites.

Keeping the samples refrigerated before extraction of hydrocarbons was essential to prevent loss of volatiles. Although a precautionary measure was taken to refrigerate samples, this did not present a problem during analysis as only hydrocarbons from decane (C_{10}, boiling point 171-174^{o}C) and above were evaluated after analysis. The average ambient temperature was 26.5^{o}C during sampling and this did not present any problems with sample evaporation.

The decision to sample at the three different depths was made to establish whether there was any difference in the contamination levels at the different depths. It was also anticipated that if any contamination by hydrocarbons were present then the samples taken at the three different levels would give an indication of whether the contamination was progressing downwards or stagnating at certain levels. This, of course, would be influenced by conditions within the ground at the varying periods of contamination.

Some of the problems experienced during sampling (see 3.1.5, p.45) were unavoidable. They could have been prevented by using engineers to probe the sampling area and provide a detailed profile of each sampling site. This, however, would have been too expensive and was beyond the scope of this project. The simplest methods employed were effective at the time of sampling.

5.2 EXTRACTIONS

5.2.1 Solvent Choice and Yield

Toluene proved to be the most suitable solvent for the extraction of hydrocarbons from the soil as it produced consistent yields over the time periods tested as proved by Christophers, 1999. The confirmatory test performed showed that a two-hour extraction period gave an optimum yield of 2.3 % for the soil sample extracted. Extraction periods beyond two hours showed no significant change in the yield (see Table 4.2, p.65). It would therefore not have been productive to use a longer extraction time.

The toluene chosen for analysis was an HPLC grade solvent (see Material Safety Data Sheet (MSDS) in Appendix B, p.145). All batches were analysed by the GC to check for any variations in purity. A typical chromatogram can be seen in Figure 4.5, p.70 and Appendix C, p.164.

For the purpose of calculation and uniformity, it was assumed that all recoveries obtained were at the maximum (100%). The determination of the exact recoveries over the entire range of samples taken is an area that provides scope for further study.

5.2.2 Separating funnel method

This method has been used successfully with liquid extractions. It was therefore used to check for its feasibility as an alternative or backup for the BÜCHI method should any problems arise. Furthermore, this method did not require any electricity to function effectively.

The separating funnel method was beset with problems. The main problem was the transfer and removal of the exact mass of soil samples from the separating funnel. Reproducibility with this method was seriously affected since it requires manual shaking over a selected time interval. No mechanical shakers were available. Filter mediums were required as it was impossible to prevent soil from draining out of the separating funnels. Most filtering mediums including the types with ground glass frits retained some of the hydrocarbon extract despite several rinses with solvent. It was also difficult to establish the number of extractions required per sample for complete recovery of the hydrocarbons. Overall this method proved to be very laborious and time consuming.

These are some of the problems that made this method unusable. The results proved to have no statistical value and those recorded were discarded.

The method could be used successfully as a cold extraction method, but only with major modifications to the equipment used and this could prove to be an expensive option.

5.2.3 BÜCHI Universal Soxhlet method

The efficiency of this method was established by Ramadheen, 1999 and Christophers, 1999. This method requires minimal input from the operator once it has been set up for extraction. It also proved to be very effective for the extraction of the hydrocarbons from the soil because of its design. The only problem experienced with this method was the electrical failure of one of the heaters. This resulted in more time being spent on extraction, but no loss in the efficiency produced by the instrument.

Duplicate analysis of the samples was conducted simultaneously to minimize problems with reproducibility. This method also showed that there was negligible variation in the yields produced from two hours and beyond. The two-hour extraction time chosen was the logical choice for the completion of extractions within a reasonable time.

Recent developments in extraction methods for petroleum hydrocarbons have produced the supercritical fluid extraction (SFE) method and microwave assisted extraction (Clement and Yang, 1999). According to Clement and Yang, the online SFE-IR method produced results that were comparable to those obtained by using a Standard Soxhlet extraction – IR method. Microwave digestion methods were first proposed in the mid 1970s and have now become an important method for sample preparation. Some of the main advantages are that extractions or decomposition can be carried out in less than ten minutes and since volatile losses are minimized, smaller sample sizes may be used. (Skoog, West and Holler, 1996). The use of this method for the extraction of hydrocarbons could be another area for research.

5.2.4 Confirmation of optimum extraction time

Figure 4.1 (p.65) shows that extraction times beyond one and a half hours reached a yield plateau, hence the selection of two hours as the time for extraction.

5.3 CHROMATOGRAPHY

5.3.1 Column Conditioning

The conditioning of the column prior to analysis was a pre-requisite by the manufacturer. This was carried out as shown in Section 3.3.2, p.55. A test mix provided was analysed to establish that the parameters and operating conditions met the manufacturer's specifications. Although nitrogen instead of hydrogen (as used by the manufacturer) was used as a carrier gas, the major components identified by the manufacturer's chromatogram were identified during testing. The significant difference was the variation in retention times observed between the manufacturers and the laboratory chromatogram (see Fig. 4.2 (a) & (b), p.66). This difference was due primarily to the variation in the carrier gas velocities for hydrogen (30-50 cm/sec.) and nitrogen (10-15 cm/sec.), (SGE solutions, 2002).

The Figure 4.2 (b), p.66, is a computer graphic presentation of the chromatogram with evidence of satellite peaks. These are absent in the original chromatogram. Various manipulations with the Varian Star graphics program were not successful in correcting the problem. The original chromatograms do not show evidence of these satellite peaks.

Grob and Grob compared hydrogen and nitrogen as the carrier gases for their analysis during tests conducted with CGC. They concluded that nitrogen showed reduced separation efficiency and required a longer analysis time (Grob and Grob, 1979).

Although one would not doubt the authenticity of the statements made by the Grob and Grob research, advances in chromatography have proved that nitrogen can be used effectively under the right conditions. This can be seen by comparing the two chromatograms in Figures 4.2 (a) and 4.2 (b) and the conditions under which they were obtained.

The manufacturer's chromatogram (Figure 4.2 (a)) was obtained under isothermal conditions with hydrogen as the carrier gas. The column performance report (Appendix C, p.160) shows that the number of theoretical plates for peak 9 was 316623. The number of theoretical plates gives an indication of the column efficiency, i.e. the larger the number of theoretical plates (n), the greater the separation efficiency of the column. The calculated value of 'n' for peak 9 in Figure 4.2 (b) was 692357. This implies that by using temperature programming, it was possible to improve the efficiency of separation and reduce separation time of the testmix by approximately five minutes. This was achieved using nitrogen as a carrier gas.

5.3.2 Method development and optimization of gas chromatograph

Owing to the large number of compounds being separated a capillary column instead of a packed column was preferred for the analysis of the petroleum hydrocarbons. Several types of capillary columns were available for the analysis of petroleum hydrocarbons, but, the BPI non-polar column (100% Dimethyl polysiloxane) was chosen, as it was the most suited to the refinery's needs at that time.

A 0.1 % $^{m}/_{v}$ concentration of the hydrocarbon standards was chosen for analysis as good separation was produced using the parameters selected for the gas chromatograph. The chromatogram in Figure 4.3 (p. 68) shows the separation achieved by the BP1-PONA column after several trials were conducted during the development of the method. The chromatogram of the hydrocarbon standards demonstrates that efficient separation was achieved by the Varian 3800 Gas chromatograph and the column chosen. The peaks were separated within an optimum time limit after experimentation with the various parameters (see Materials and Methods 3.3.3, p.56). The chromatogram and report can be seen in Appendix C, Figure C2, p.161-162.

The possibility of overloading the column always existed despite the injection of a small volume of sample. The splitter on the GC was therefore employed to split the sample ratio further. A 1:50 split ratio was employed for all samples (standards included) during analysis.

The limiting factor of the method was the range of hydrocarbons that could be determined. The 50 m PONA column was only able to separate hydrocarbons up to C_{30}. The column had a maximum operating temperature of 300^{o}C. The high cost of additional standards prevented any trials being carried out with hydrocarbons beyond C_{30}.

Periodic blank runs, without toluene, were carried out to ensure that there was no carry over from previous samples. This also helped to confirm that any errors introduced by the previous samples were negligible.

The average retention times for the alkane hydrocarbon standards shown in Table 4.3 (p.69) were obtained after repeated analysis of the hydrocarbon standard. It should be noted that the ranges from C_{10} to C_{30}, were chosen for evaluation as the toluene showed evidence contamination by hydrocarbons lower than C_{10} (See Figure 4.5, p.70) The last peak shown with a retention time of 10.775 is just below the average retention time obtained for C_{10} (see Table 4.3, p.69). From the standard deviations obtained for the retention time for each standard, it can be seen that the reproducibility of the results are very good. This also indicates that a reasonable and acceptable degree of precision is shown by the results.

The statistical evaluation for the sample 65 in Table 4.4 p.71 shows that the standard deviation for the replicate analysis was 0.028 and the relative standard deviation was approximately 1.8%. This is indicative of good reproducibility with the injections made. On the basis of the analysis it can be assumed that the overall precision of the methods used was also good. This sample was chosen at random to verify that the reproducibility with the method chosen was reasonable. The assumption was that if this sample produced good precision, then there was a likelihood that all the samples, which were analysed in the same way, would also have good precision.

5.3.3 Assessment of contamination

Figures 4.6 (a) to 4.11 (a), (p.73–78), show the chromatograms obtained from the analysis of the soil samples. The top (15 cm), middle (1 m) and bottom (2 m) sample chromatograms appear in sequence. The Figures 4.6 (b) to 4.11 (b), (p.73–78), show the hydrocarbon contamination levels in the ranges C_{10} - C_{20} and C_{21} - C_{30} found at the five tank sites selected. The randomly selected samples represent some of the one hundred and eight samples analysed.

The hydrocarbon distribution between the two ranges chosen was determined from the reports obtained for the chromatograms. The star program was used to bracket each range and produce the percentages in the proportions that are presented graphically (see Appendix A, Table A-4, p.134). Figures 4.17 (a) to (e) were also determined in a similar manner using data from Appendix A, Table A-6, p.143).

No definite specification limits exist in this country for hydrocarbon contamination in soil. It can, however, be said that any contamination present in the soil is unacceptable, but this is an impossibility at a site such as the refinery. Since intensive studies on soil contamination are fairly recent, environmental technologists should encourage the determination of acceptable levels of this type of pollution in the soil.

The quantification of the hydrocarbons and, more specifically, the selected range of hydrocarbons identified by this analysis is just one step in determining the types of contamination present in the soil. The scope of this study was limited by the range of standards that could be analysed. Furthermore, the maximum operating temperature of the column was 300°C. This study identified the range of hydrocarbons ($< C_{30}$) with good efficiency under the optimum conditions determined.

The refinery would not allow any definite location for the sampling sites to be published; hence the positions identified on Table 4.5, p.80 show only the tank farm sites where sample holes were dug. The actual sampling positions are identified with a little more accuracy in Appendix A, Table A-1, p.130-131. In Table 4.5, the tank farm sites indicated with a forward slash (/) show that sampling was conducted next to multiple tanks, while a hyphen (-) shows that samples were taken between the tanks indicated.

5.3.3.1 Evaluation of contamination at the Tank Farms

5.3.3.1 (a) *SOUTH Tank Farm (STF)*

The first part of the evaluation (Figures 4.6 to 4.11) shows the hydrocarbon contamination within the ranges chosen at each of the selected sites at the five tank farms. These selections were made at random. They show the amount of contamination at the sample sites but may not necessarily be an actual reflection of the contamination at every hole dug at the corresponding tank farms as shown by Table 4.5, p.80.

Figures 4.6 (a) and (b) (p. 73) for STF T 1114, Hole 7, shows that the top (15 cm depth) has approximately 60 % more contamination by hydrocarbons in the C_{10} - C_{20} range than the C_{21} - C_{30} range. The middle region (1 m depth) shows no contamination by hydrocarbons in either range. The bottom (2 m depth) shows that contamination by C_{10} - C_{20} is approximately 90 % more than C_{21} - C_{30} (see Appendix A, Table A-6, p.143). One might expect a typical pattern for contamination should be decreasing levels of hydrocarbon contamination deeper in the soil if we were to assume that all contamination was from the surface. The chromatogram in Figure 4.6(a) presents a different picture. The absence of contamination at the 1m depth (middle) and notable contamination at the 2m depth (bottom) could indicate that hydrocarbons are being transported horizontally across the water table from adjacent areas, or that a period had lapsed before any contamination had taken place. This is supported by the fact that the refinery has been built on a reclaimed swampland with an ever present water table. It is possible for organic matter to be transported across the soil below the surface over time. The refinery has a waste oil deposit site (called Midmar) which could also contribute to soil pollution below the surface as it is adjacent to the South Tank Farm.

Figures 4.7 (a) and (b) (p.74) show that this area of the STF (i.e. STF T 1118) is totally free from hydrocarbon contamination at all depths. A study of Table 4.5 (p.80) shows that < 1 mg/kg of hydrocarbon contamination was present at the 1 m and 2 m depths. This implies that the area around the tank farm was relatively free from contamination by hydrocarbons. A study of other samples in the South Tank Farm show varying trends, e.g. Only STF T 1116, Hole 16, showed some similarity to STF T 1114 above. STF T 1116, Hole 15 shows evidence of greater contamination at the 1 m depth (middle sample) when compared with the top and bottom samples. (See Figure 4.12, p.81)

The refinery has been in operation for over 40 years. Several types and grades of crude oil have passed through the refinery system over the years. If it were possible to determine the age of the hydrocarbon contamination found at different depths selected then, it would be easier to target the actual contamination source after examining the crude types used at the refinery. Another possibility would be to determine an exact profile of the crude types used by the refinery and compare these to the hydrocarbon profile found in the soil to establish the possible causes of the contamination in the soil. Since this determination was beyond the scope of this project, one can only speculate about the possible sources that were responsible for the contamination of the soil in the areas studied. Crude oil types have changed over the years and hence profiles may have changed accordingly, thus making proper identifications difficult.

5.3.3.1 (b) ***MOGAS Tank Farm***

Figures 4.8 (a) and (b), show that the contamination at Mogas Tank 1309 is entirely due to hydrocarbons within the C_{10} - C_{20} range. Both the top and middle samples appear to be the same according to the graph. The graph (Figure 4.8 (b), p.75) can be misleading if it is not studied in conjunction with the chromatograms. The chromatograms show that hydrocarbons contamination at the 1 m depth is greater than that at the 15 cm depth. This can be seen by the presence of a greater number of hydrocarbon peaks with larger areas evident from the chromatograms in the middle sample. A study of the reports for both chromatograms reveals that there was a small difference in the areas obtained indicating that there was a possibility that there was more contamination in the middle. There is an absence of contamination at the 2 m depth. Much of the contamination evident at the Mogas Tank farm is present in the form of low DRO's.

5.3.3.1 (c) ***GASOIL Tank Farm***

The chromatograms for T 1322 indicate that surface contamination in this tank area has travelled below the surface down to the 1 m depth, but no evidence of further migration downwards as illustrated by absence of hydrocarbon contamination at the 2 m depth. The graph, Figure 4.9 (b), p.76, shows that there is a slight increase in hydrocarbons in the C_{21} - C_{30} range and an almost proportional decrease in the C_{10} – C_{20} range.

The trends in the chromatogram for the middle sample appear to be the same as the top sample but are reduced, thus indicating that the same source of contamination is probably responsible for the contamination at both depths. The possibility of some natural biodegradation of the hydrocarbons having taken place cannot be excluded although this cannot be proved by studying the chromatograms and graphs alone.

Other tank sites at this tank farm show varying amounts of contamination at all the levels, e.g. Sample 25 (Gasoil mid T 7801-4) has the highest amount of contamination when compared with the other samples taken in this area.

5.3.3.1 (d) ***NORTH Tank Farm (NTF)***

This area shows evidence of contamination by the entire range of hydrocarbons throughout the top, middle and bottom. An unusual situation can be seen from Figure 4.10 (b) (p.77) where, the proportion of the $C_{10} – C_{20}$ range gradually increases as the proportion of the C_{21} - C_{30} decreases. This may be explained by a process which is similar to size exclusion chromatography. Smaller molecules (low range hydrocarbons) "filter" through the soil more easily than those with larger particles which tend to be retained for longer periods. The soil, in this instance, behaves like the stationery phase in a chromatographic column. The chromatograms do not, however, show patterns which identify with the graphs. To dispel any doubts about the amount of contamination, the chromatogram has to be studied in conjunction with the report. The reports for the top middle and bottom chromatograms do have areas which increase gradually. The only explanation for the bottom sample having a larger area than the middle chromatogram is that the peaks are broader and hence the area may be greater as a result.

5.3.3.1 (e) ***LUBOIL Tank Farm***

Evidence of some contamination at the 1 m depth can be seen from Figures 4.11 (a) and (b) (p.78). There is no evidence of contamination at the top and bottom. The presence of contamination in the middle (1 m depth) would imply that some residual contamination exists. The absence of any contamination at the top could mean that the contamination present in the middle may have been old or that hydrocarbons migrated across the water table over time.

This is supported by the fact that this was the only tank farm that had solid concrete around all the tanks in the area. This was done to stop or slow down the seepage of products from the tanks into the soil. This anti-pollution measure seemed to be working well at this tank farm.

5.3.3.2 Comparison of the overall contamination around the five tank farms

The contamination by hydrocarbons at the different depths for each tank farm is shown graphically in Figures 4.12 to 4.16 (pp.81-85). The graphs illustrate collective hydrocarbon contamination found at the 15 cm, 1 m, and 2 m depths for each tank farm. The graphs show the amount of hydrocarbon (C_{10} - C_{30}) contamination found in the top, middle and bottom samples taken at each sample hole. The calculated values are shown on Table 4.5, p.80. These calculations were performed according to the procedure in section 3.3.6, p.61. Each hole number identified on the X-axis corresponds to three samples taken at the three depths mentioned, while the Y-axis shows the hydrocarbon content in mg/kg or parts per million.

5.3.3.2 (a) Contamination measured at the *SOUTH Tank Farm (STF)*

Approximately 50% of the samples measured are virtually free from contamination around this tank farm (i.e. < 1 mg/kg). Exceptions include Hole 7 (STF T1114) and Hole 15 (STF T 1116), which show higher contamination at all three depths relative to the other holes where samples were taken. The top sample, STF T 1114, Hole 7, has the highest level of contamination when compared with the other seventeen holes at STF. There was visible evidence of contamination around this tank when sampling was conducted, and this may be explained by operator negligence during tank sampling. From the analysis and calculations performed, samples from hole number 2 (STF T1106) and number 9 (STF T1111) show no evidence of any contamination. STF T1114 and STF T1116 show a high level of contaminants in comparison with the other areas at the STF site. STF T1114 has hydrocarbon contamination of >130 ppm (mg/kg) at the surface as shown by the top sample while STF T1116 shows >45 mg/kg at the surface.

The bottom (2m depth) of STF T1114 shows contamination by hydrocarbons at >45mg/kg while STF T1116 shows >70% contamination by hydrocarbons in the middle zone (1m depth). The only tanks that show any contamination >20 mg/kg are STF T1110, STF T1114, STF T1113, STF T1105 and STF T1116. The other sites at which samples were taken all show contamination by hydrocarbons of well below 20mg/kg.

Since the contamination pattern throughout the South Tank Farm show no consistency, the possible causes of the more severe contamination in other identified areas may be due to poor practices with regard to crude oil transfer and sampling. One cannot rule out the possibility of this contamination arising from the accumulative effect of pollution over several years. The areas that have shown no presence of hydrocarbons within the STF do create some doubt about the lateral movement of organics (hydrocarbons) in the water table and how frequently it occurs.

5.3.3.2 (b) <u>Contamination measured at the *MOGAS Tank Farm*</u>

The graphs show that at the 1m depth all the sites have some contamination. They vary from as little as 0.3 mg/kg to approximately 157 mg/kg. The least contaminated tank area was T1306 (Hole 20) while T1309 (Hole 22) shows contamination levels at the 1m depth of >150 mg/kg. T1307 (Hole 19) was the only tank area that had any notable contamination at the 2m depth. This was slightly more than 45 mg/kg while tanks 1306, 1310, and 1309 all have <3 mg/kg at the 2m depth. Only T1309 and 1310 (Hole 21) showed any evidence of contamination at the surface (15 cm) and this was <10 mg/kg.

5.3.3.2 (c) <u>Contamination measured at the *GASOIL Tank Farm*</u>

The Gasoil Tank Farm shows a large variation in contamination at the surface (15cm depth samples) at levels from 1.0 mg/kg to approximately 680 mg/kg. The middle samples show contamination levels at the 1m depth varying from 50.0 mg/kg to approximately 780 mg/kg while the contamination at the 2m depth at this tank farm is < 5 mg/kg with the exception of the sample taken midway between T7801 and T7804 (Hole 25) which shows hydrocarbon contamination levels of approximately 100 mg/kg.

This tank farm shows the highest overall contamination when compared to all the other tank farms studied. It might be prudent for the refinery environmental managers to further investigate this site to find reasons for the higher contamination levels.

5.3.3.2 (d) <u>Contamination measured at the *NORTH Tank Farm (NTF)*</u>

This tank farm shows sporadic contamination with Hole 31 (NTF 1104) being the only site with notable contamination at all three depths. Samples taken near T1101 (Hole 28) and T1103 (Hole 30) at this tank farm showed that the overall contamination at all the levels (i.e. top, middle and bottom) was < 2.0 mg/kg. However, T1102 (Hole 29) and T1104 (Hole 31) sites have surface contamination of >380 mg/kg and >460 mg/kg respectively. Only T1104, T1326 (Hole 32) and T1327 (hole 33) were contaminated at the 2m depth with hydrocarbon content varying from >2 mg/kg to approximately 470 mg/kg.

5.3.3.2 (e) Contamination measured at the *LUBOIL Tank Farm*

The sample taken midway between T4801 and T4805 (Hole 34) was the only sample that showed any contamination at the 2m depth (approximately 13 mg/kg) and any notable contamination at the 15cm depth (approximately 14 mg/kg). All three sampling sites showed some contamination at the 1m depth and this varied from 6 mg/kg to 58 mg/kg. This tank farm, however, showed a lower overall contamination in comparison with the other four tank farms.

5.3.3.3 Hydrocarbon contamination in soil compared with hydrocarbons in the tank samples in their vicinity

A study of the chromatograms (Appendix C, Figures C36-C42, p.302-345) for each of the tank samples shown in Figure 4.17 (a) (p.86) shows that there was a good probability of the top, middle, bottom soil samples taken at STF T1114 at hole number 7 being contaminated by samples from within the tanks. This is supported by the fact that sample 19 (top sample from hole 7, STF T1114) shows all the characteristic peaks found in all the tank samples except for Arab Medium. Sample 21 (Appendix C, Figure C7, p.173-175), which is the bottom sample, has characteristic peaks similar to the Arab Medium Tank (Appendix C, Figure C38, p.317-319) sample and separation of hydrocarbons up to the region of C_{18} is visible. It is difficult to say conclusively that some of the contamination at the 2m depth (sample 21) was not also from the other tank samples, as the hydrocarbon range found at this depth is also found in other tank samples. The overall picture presented by the graph in Figure 4.17 (a) does indicate that the source of contamination at the STF appears to be the tanks in the vicinity. This was one of the tanks that had visible crude oil contamination at the surface. This is supported by the fact that the majority of the chromatographic profiles of the soil samples match those of the tank samples.

A study of the chromatograms for the Mogas Tank and soil samples (Appendix C, T 1310, Figure C23-C26, p.245-257) reveals that the majority of the components separated are in the C_{10}-C_{20} range. This is as expected from this sample since it contains very little of the high range DRO viz. C_{21}-C_{30}. Separation of components in the C_{21}-C_{30} range show no definite pattern and relatively few components are separated in this region with exception of the middle sample which shows some hydrocarbon contamination in this region. Figure 4.17(b) also helps to confirm that the contamination present in the soil at this tank farm is likely to be contamination resulting from the Mogas Tank.

The top and middle samples for the Gasoil samples and the tank sample compare favorably with regard to the components separated in the range from C_{10}-C_{20}. The bottom sample shows evidence of hydrocarbons in the C_{21}-C_{30} range. The tank sample, in comparison, has <5 mg/kg of hydrocarbons in the same range. The chromatograms for the soil and tank samples reveal separation of majority of the components below C_{20} (Appendix C, Figures C27-C30, p.258-283). There is a general absence of any hydrocarbons > C_{20}. This is indicative of the soil having been contaminated by product from the tanks.

Figure 4.17 (d) shows that the top sample is similar to the tank sample graphically. Chromatograms of the soil samples at T1103 (Appendix C, Figures C31-C34, p.284-298) indicate that there is very little contamination in this area, but the chromatograms for T 1104 (Appendix C, Figures C17-C19, p.215-235) have a chromatographic profile that is similar to that of the Tank sample (T 1103, Appendix C, Figure C34, p.293-298) implying that any contamination at this site was probably from the tank. In this case the choice made for the comparison with the tank sample was a bad one as there was very little contamination at the site chosen. This graph and those of the other tank farms does however show that the any surface contamination at all the tank farms has a good probability of being sample from the tanks. The absence of any contamination at the 1 m and 2 m depth may also imply that the contamination at this area was most likely to be recent.

The Luboil tank has a unique contamination profile. The tank sample shows no presence of hydrocarbons in the range examined. This is characteristic of samples from the Luboil tank farm. All the products within the tanks contain distillate products with boiling points >450^{o}C. This may explain why there is an absence of hydrocarbons below C_{30} in the tank sample. The reason for contamination at the 1 m level could be explained by possible residual contamination from other crude types being transferred in the vicinity of this site, or there may have been some lateral movement of other tank samples along the water table. One would expect lateral movement to affect the soil at levels below the 1 m depth, however this is not evident from the graph in Figure 4.17 (e). The absence of separated hydrocarbons both in the chromatograms and graphs would be an indication that there is a possible limitation with the column which does not “see” hydrocarbons present in the Luboil samples. As this was not an anticipated problem, further examination of this site may be necessary to remove any doubt about the amount of contamination at this site and its source.

It is very difficult to state conclusively that the tanks were solely responsible for all the contamination of the soil at the tank farms since factors such as the lateral movement of hydrocarbons could not be ruled out. Concreting the areas around the tanks may be a solution to curbing the rapid pollution of the soil, but it is difficult to recommend this type of anti-pollution measure without discussions with environmentalists and safety personnel at the refinery.

5.3.3.4 Analysis conducted at the Refinery and at LECO Cooperation

The analysis by the refinery and LECO cooperation was suggested as an after thought. The separation of sample 21 was made in an attempt to draw a comparison between refinery and the GC- TOFMS and the CGC method used. The refinery conducts PONA analysis via a GC analyser consisting of five packed columns attached in series. The columns could only analyse samples with boiling points below 200^{o}C. The refinery method also applied the use of a SPB-1 column which proved to be inadequate for the separation of the hydrocarbons. This can be seen from the chromatogram produced (Appendix D, Figure D1, p.346). The results produced show that the refinery was not able to conclusively quantify the contaminants present in the samples although some separation was achieved. Their attempt at analysing sample 21 supplied proved to be fruitless owing to the limitations of their GC columns. This was one of their motivations for supporting this project.

Dutta and Harayama agree that GC is the best choice and has largely been employed for the regular analysis of crude oil. They also state that GC analysis was useful for the determination of biodegradability of n-alkanes. TOFMS, on the other hand, has received attention because it is a mild ionization technique and allows analysis of compounds of theoretically unlimited mass. (Dutta & Harayama, 2001)

The LECO cooperation also claims that the GC-TOFMS is able to perform hydrocarbon analysis in a much shorter time with greater efficiency than with the GC alone. A study of the chromatogram for sample 21 (Appendix D, Figure D2, p.347-349) proves that errors abound if no attention is paid to detail during analysis. The results for the GC-TOFMS analysis show that dodecane (peaks 31, 32, 40 and 46); 1,3,5-cycloheptatriene (peaks 6 to 13); hexadecane (peaks 48, 50 and 51); and nonadecane (peaks 53, 55, and 57), have vastly different retention times, whereas, in each group the compound should effectively be the same.

Furthermore, cycloheptatriene has the same formula mass as toluene, indicating that this compound is most probably the solvent which was used to extract the sample (i.e. toluene). Since this analysis was carried out in America, it was not possible to identify the cause of the above problem or provide suitable explanation for the results. This does not provide good motivation for the use of TOFMS or GC-TOFMS in preference to the CGC method used in this project. However this lack of evidence does not imply that the GC-TOFMS method is inferior in any way. On the contrary, if used effectively, this method would prove to be as efficient if not superior in some aspects to the CGC method.

This CGC research project was conducted with a view to develop a method for the determination of hydrocarbon contamination in soil around the refinery. The information would be used to control or prevent deliberate pollution of the environment. The separation for Sample 21 achieved by the CGC method (Appendix C, Figure C7, p.173-175) may be compared with the refinery and LECO methods. It does prove to be better than the refinery method and compares favourably with the GC-TOFMS method. It does, however, have its limitations. The availability and cost of the standards limited the number of components that this method could identify with accuracy. Further development of this method with a wider band of standards would be useful in establishing the maximum hydrocarbon limit that could be evaluated by the column and the method. A more in-depth study of the intermediate hydrocarbons present would help to identify the various other contaminants present in the soil and thus make more effective remedial measures possible. There is also a need to determine the minimum detectable quantity (MDQ) for hydrocarbons by this method. The column was able to achieve good separation of the hydrocarbons present in the soil sample with good baseline resolution of the many peaks found. Many components remain unidentified because of a lack of knowledge of the pollutants in the soil. Further research is required to identify how much the column bleed was affecting analysis.

CHAPTER 6

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

The GC method was able to identify various levels of contamination present at the five tank farms. All the tank farms showed evidence of some level of contamination by hydrocarbon in the range determined. The results could not provide conclusive evidence of either the presence or absence of contamination by liquid hydrocarbons above triacontane. This was the limitation of the method. Some areas within the refinery showed high contamination levels, while approximately 50% showed very little or no presence of contamination by the hydrocarbons in the ranges analysed. The highest contamination level was observed at the Gasoil Tank farm with a hydrocarbon level of about 780 mg/kg. This was observed at the middle (1 m depth). Sites which showed no contamination (indicated by zero) were spread equally between the top (15 cm depth) and the bottom (2 m depth), thus indicating that most of the contamination existed in the middle (see Table 4.5, p.80).

Heath et al., state that many states in the United States use 100 mg/kg as a maximum level for TPH contamination in soil. If this were considered as a general specification limit for hydrocarbon in soil, then all areas with contamination above this level at the Sapref site would become areas of concern. This would also imply that remedial measures in these areas would be urgent.

It is difficult to state conclusively whether the overall levels of contamination by the liquid hydrocarbons is significant, as no specification limits have been identified. However, any contamination by liquid hydrocarbons should be viewed seriously as the cumulative effects of this contamination could be hazardous to the environment particularly in the light of the proximity of the water table.

The level of contamination at the different depths varies at all the tank farms. The Gasoil tank farm needs to be examined more carefully after specification limits for contamination levels are established as this tank farm showed evidence of more contamination than the other tank farms. The overall contamination is generally lower at the 2 m depth and this may be an indication that some biodegradation could be occurring naturally. This would, nevertheless, require further study for confirmation of this process.

The levels of hydrocarbon contamination found in the soil make it necessary for the refinery to consider remediation measures. Since soil contamination below the surface cannot be observed in the same manner as air or water contamination, good remediation practices will go a long way towards ensuring a safer environment for all.

The comparison of the tank samples with surrounding soil samples show similarities in the composition of hydrocarbons measured. Satisfactory correlation between the tank and soil samples exists and one can conclude that the soil in the vicinity is most likely to have been contaminated by these tanks. The possibility of hydrocarbons being transported through the water table cannot be ruled out.

The chromatography method that was developed proved to be reliable and reproducible. The Star interface program also proved to be free from any communication problems with the GC. The method produced repeatable results with confidence. This is confirmed by Table 4.3, p.69, which shows that an overall standard deviation of < 0.05 was achieved during the analysis of the standards. The statistical evaluation of extract no. 65 shows that a high degree of precision with sample injection was obtained for the replicate analysis which produced a standard deviation of <0.03 and a coefficient of variation of 1.818. This indicated that the method could be used with confidence for the determination of hydrocarbons in soil, although it was limited to the evaluation of liquid hydrocarbons from decane to triacontane (C_{10} to C_{30}).

Linton, Sponsler & Xu support the fact that temperature programming becomes essential for analysis with sample mixtures containing analytes that vary in volatility. Temperature programming enables all samples to be eluted within the programmed time and prevents band broadening, hence its preference over isothermal analysis during chromatography.

Extraction of the hydrocarbons from the soil by the BÜCHI method was more efficient than the separating funnel method. The separating funnel method proved to be unreliable and inconsistent owing to operational problems (see 5.2.2, p. 93). It is therefore not recommended for extractions involving soil samples in general. The BÜCHI method, however, involves minimal handling of the soil samples and conducts the extractions within a closed system. This prevented the loss of volatiles present in the hydrocarbon extracts. This, therefore, is still a reliable method that can be used.

The limiting factor with the BÜCHI, which is contributed by its design, is that only four samples can be analysed at each extraction step. This makes the method time consuming when analysing a large number of samples. The method could be improved by further experimentation with the various modes available for operation. This should improve the recoveries marginally.

Several solvents are recommended for the extraction of hydrocarbons from soil and water. Solvents that are usually used are, dichloromethane, n-pentane, hexane, iso-octane, toluene and sometimes chloroform and methanol. Each solvent has its merits, but analysis using a particular solvent depends primarily on the range of hydrocarbons being determined. This project employed toluene as the solvent for the extraction of the hydrocarbons based on trials conducted by Christophers. Although dichloromethane could also have been used for this exercise, it was slightly less consistent than toluene in the trials conducted (see Fig B1, Appendix B, p.144). The only disadvantage noticed with toluene was that it contained impurities consisting of hydrocarbons $<C_{10}$. It did, however, prove to be an effective solvent for the extraction of hydrocarbons in the ranges determined.

The supercritical fluid extraction and microwave assisted extraction methods could be used as alternatives to the soxhlet extraction method. These methods compare favourably with extractions by the soxhlet method (Clement and Yang, 1999).

An engineers survey and report of all the sampling sites would have aided in making better decisions with regard to sampling sites and depths at which sampling was conducted. As refinery personnel had little knowledge about the degree of contamination taking place, decisions about digging beyond the 2 m depth could not be made with conviction. The ability to identify the exact site to be examined for contamination would have assisted in drawing better conclusions about contamination at the refinery.

The auger provided the simplest method for soil sampling. The only disadvantage of using a manual auger was the amount of time sacrificed during sampling. A mechanical auger would have saved time but would not have ensured the safety of people doing the sampling since unknown hazards abound at the refinery site.

Depth sampling proved to be the logical choice for sampling as the information obtained on contamination at the different depths obtained about contamination at the different depth would be more useful to the refinery should they choose to pursue remedial measures.. Surface or single depth sampling would have provided limited information since it can already be observed that there was a large amount of variation at the different depths. This can be seen in Figures 4.12 to 4.16 (pp.81-85).

6.2 RECOMMENDATIONS

A physical study of all the sites is recommended. This together with the results produced by the GC analysis of the hydrocarbons would help to identify which remediation measures should be implemented. Minimum levels for hydrocarbon contamination need to be established. This will assist in determining whether the contamination levels found at the various sites are acceptable.

As a starting point, the Gasoil and NTF, which on average seem to be more contaminated than the other tank farms, should undergo further surveys to establish whether the contamination levels pose any danger to the environment.

The tank farm sites which show visible signs of contamination after surface inspection should be isolated and studied with the intention of controlling or reducing the pollution problem that could have further implications on the environment. Sampling and crude oil transfer procedures by operators will need to be reviewed and training provided as required.

The CGC analysis should be developed to extend the range of hydrocarbons and perhaps other contaminants that can be determined. This may require in-depth comparison with the GC-TOFMS technique to establish which method would be more feasible and at which range. This will help to identify many of the contaminants present, hence assisting further in exact remediation measures being chosen. The 2D-GC method is another area that could be explored as a cheaper option to the GC-TOFMS.

Further study by the GC-TOF-MS technique is recommended for a proper QRA (Quantitative risk assessment). The GC-MS/GC-TOFMS will certainly be an interesting area of analysis that could be explored for further study.

Other extraction methods, e.g. microwave assisted extraction and SFE should be examined and compared with the BÜCHI method to determine which would be the most efficient and time saving method for extraction.

Faster mechanical methods of sampling should be explored with due regard to safety.

The biodegradation of petroleum is essential to the remediation of oil spills (about 5×10^6 metric tons annually worldwide). Both marine bacteria and filamentous fungi degrade this oil. In some cases, the rate of degradation is limited by available nitrate and phosphate (Hinchee, Kittel & Reisinger, 1995).

Active remediation procedures abound in texts dealing with bioremediation. The measures that are applied will depend on the type of contamination and its extent. The selection of an appropriate remedial technique can be tailored to each site depending on the composition and concentration of contaminants, soil and hydrogeological characteristics, as well as environmental conditions. Remediation can be carried out *in situ* (in place) or *ex situ* (after the excavation of soil). *In situ* is recommended as it is considered to be more expedient and cost effective with slow to moderate rates of remediation. *Ex situ* on the other hand is labour-intensive and costly, but will generally allow more rapid reaction rates (Connor and Fox, 1998). Whatever method is chosen, it must be done with prior quantitative risk assessment to ensure that measures taken are effective.

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APPENDIX A

TABLES

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TABLE A-1: Sample Data Sheets

DATE/ Tank	HOLE No.	SAMPLE Numbers	DISTANCE FROM TANK (m)	DIRECTION FROM TANK	PROBLEMS / REMARKS
14/4/99 **STF** T1106	1	1, 2, 3	10	E	Struck hard terrain. Moved to another point. Auger spoil embedded in soil. Removed after approx. ½ hour. Slow progress
T1106	2	4, 5, 6	7	N	O.K.
T1108	3	7, 8, 9	7	SE	-
T1110	4	10, 11, 12	2.7	N	Concrete at surface ~ 7 m. Best site at 2,7 m.
T1110 **15/4/99**	5	13, 14, 15	7 4	SW S	Problems - struck rock at 1 m +. Sample retaken on 15/4/99
T1112	6	16, 17, 18	6	SW	-
T1114	7	19, 20, 21	5.7	NW	Looks highly contaminated
T1113	8	22, 23, 24	8.7	NW	Problems encountered at 1 m - hard substance - or piping - could not tell - new sample taken
T1111	9	25, 26, 27	7	N	-
T1109	10	28, 29, 30	8	S	First 15 - 20 cm - soil stony - compacted with blue stone.
T1107	11	31, 32, 33	11	S	-
T1105	12	34, 35, 36	3.7	SE	Soil O.K.- sandy - similar to beach sand
16/4/99 T1118	13	37, 38, 39	7.6	NE	Soil below 1 m - black (brackish). Above and below 1 m - like sea sand.
T1117	14	40, 41, 42	6.5	W	1 m - black; 2 m - greyish black - soil distinctly different.
T1116	15	43, 44, 45	6	S	-
T1116	16	46, 47, 48	16	N	Opposite hole 15 - soil again brownish grey below 1 m.
T1115	17	49, 50, 51	6	S	Multicoloured layers of soil - shades of brown and grey.
T1114	18	52, 53, 54	14	SE	Sample retaken - problems at 1 m.

TABLE A-1: Sample Data Sheets

DATE/ Tank	HOLE No.	SAMPLE Numbers	DISTANCE FROM TANK (m)	DIRECTION FROM TANK	PROBLEMS / REMARKS
19/4/99 MOGAS T1307	19	55, 56, 57	3.9	SW	1 m below - soil moist and yellowish - could be product from tank! At 2 m sample wet.
T1306	20	58, 59, 60	6	SE	15 cm - soil compact and moist. Soil beyond 1 m - very wet flows out of Auger - PVC collar used
T1310	21	61, 62, 63	7	NW	Approx. 2 hours excavation - from 1 to 2 m soil in form of greyish brown to black slurry.
T1309	22	64, 65, 66	4.2	E	Soil from brown to black
19/4/99 GASOIL T1315	23	67, 68, 69	5	NW	Soil wet at 2 m.
T1322	24	70, 71, 72	4	NE	-
20/4/99 mid T7801-4	25	73, 74, 75	10.3	SW of T7804	Surface gravel removed. Soil very compact below 1 m. Soil mostly like sea sand. Sample taken next to waste well.
T1317/18/ 24/25	26	76, 77, 78	5.4	SE of T1318	Sample wet at 2 m.
T1203/4	27	79, 80, 81	9.2	E of T1203	-
NTF T1101	28	82, 83, 84	6.4	N	Soil -orange brown ~ 10 cm. Contaminated with oil owing to oil spills around tank. Soil looks clean but wet below 1m. PVC collar used.
T1102	29	85, 86, 87	9.3	SE	Tank under maintenance at time of sampling.
T1103	30	88, 89, 90	4.8	E	-
T1104	31	91, 92, 93	5.4	SW	-
T1326	32	94, 95, 96	3.8	S	-
T1327	33	97, 98, 99	5.5	SE	At 2 m -soil tacky - very sticky. Black - looks oily.
21/4/99 LUBOIL T4805	34	100, 101, 102	7	NW of T4805	Single sample taken between tanks 4803/1/5/4. Had to break through 10 cm of concrete at start. Soil moist at 2 m.
T4809	35	103, 104, 105	4	SE of T4809	Sample taken between tanks 4808/9/10/12. Site looks polluted on surface - black. Soil extremely compact at 2 m.
T4816	36	106, 107, 108	5.2	NE of T 4816	Sample taken between tanks 4815/6/7/9. Soil very compact at 2 m - clayey. PVC collar used for 2 m sampling.

TABLE A-2: Refinery sample log table

DATE	TIME	HOLE No.	SAMPLE No.	LOCATION	DEPTH (m)	SOIL TEMP. (^oC)	AMBIENT TEMP. (^oC)
1999/04/14	11h20	1	1	STF - T1106	0.15	26	26
	11h30		2		1	25	
	12h05		3		2	29	
	12h15	2	4	STF - T1106	0.15	26	26
	12h30		5		1	28	
	12h40		6		2	26	
	13h35	3	7	STF - T1108	0.15	26	26
	13h45		8		1	26.5	
	13h59		9		2	27	
	14h20	4	10	STF - T1110	0.15	27	26
	14h28		11		1	29.5	
	14h35		12		2	29	
1999/04/15	09h35	5	13	STF - T1110	0.15	21	25.5
	09h43		14		1	23	
	09h50		15		2	25	
	10h10	6	16	STF - T1112	0.15	21	25.5
	10h17		17		1	23	
	10h24		18		2	24	
	10h54	7	19	STF - T1114	0.15	27	26
	11h02		20		1	28	
	11h45		21		2	28	
	12h55	8	22	STF - T1113	0.15	27	28
	13h15		23		1	27	
	13h20		24		2	27	
	13h38	9	25	STF - T1111	0.15	28	28
	13h45		26		1	29	
	13h50		27		2	28	
	14h20	10	28	STF - T1109	0.15	22	28
	14h30		29		1	24	
	14h38		30		2	25	
	14h48	11	31	STF - T1107	0.15	30	28
	14h55		32		1	29	
	15h02		33		2	29	
	15h30	12	34	STF - T1105	0.15	22	28
	15h34		35		1	23.5	
	15h40		36		2	24	
1999/04/16	08h55	13	37	STF - T1118	0.15	26.5	23
	09h03		38		1	28	
	09h14		39		2	28	
	09h32	14	40	STF - T1117	0.15	26	26
	09h37		41		1	27	
	09h42		42		2	27	
	10h30	15	43	STF - T1116	0.15	23	25
	10h40		44		1	23	
	10h46		45		2	24	
	10h56	16	46	STF - T1116	0.15	28	25
	11h10		47		1	27.5	
	11h15		48		2	27	
	11h38	17	49	STF - T1115	0.15	23	24
	11h45		50		1	24	
	11h55		51		2	24	
	12h10	18	52	STF - T1114	0.15	24	24
	12h20		53		1	26	
	12h50		54		2	26	

TABLE A-2: Refinery sample log table

DATE	TIME	HOLE No.	SAMPLE No.	LOCATION	DEPTH (m)	SOIL TEMP. (^oC)	AMBIENT TEMP. (^oC)
1999/04/19	09h07	19	55	MOGAS - T1307	0.15	24.5	24
	09h15		56		1	26	
	09h24		57		2	24	
	09h35	20	58	MOGAS - T1307	0.15	24	24
	09h45		59		1	24	
	11h10		60		2	24	
	12h50	21	61	MOGAS - T1310	0.15	30	28
	12h55		62		1	27	
	13h45		63		2	27	
	14h00	22	64	MOGAS - T1309	0.15	26	24
	14h08		65		1	24	
	14h15		66		2	25	
	14h40	23	67	GASOIL - T1315	0.15	29.5	28
	14h47		68		1	28.5	
	14h55		69		2	29	
	15h09	24	70	GASOIL - T1322	0.15	27	28
	15h15		71		1	26.5	
	15h20		72		2	27	
1999/04/20	08h47	25	73	GASOIL - mid T7801/2/3/41322	0.15	25	27
	09h00		74		1	26.5	
	09h30		75		2	27	
	09h39	26	76	GASOIL - mid T1317/8-T1324/5	0.15	24	26
	09h50		77		1	26	
	09h55		78		2	26.5	
	10h15	27	79	GASOIL - T1203/4	0.15	25	28
	10h23		80		1	27	
	10h30		81		2	27	
	11h15	28	82	NTF - T1101	0.15	28	29
	11h23		83		1	30.5	
	12h50		84		2	30.5	
	13h07	29	85	NTF - T1102	0.15	24	25
	13h15		86		1	24	
	13h25		87		2	25	
	13h50	30	88	NTF - T1103	0.15	24	26
	14h02		89		1	25	
	14h12		90		2	25	
	14h23	31	91	NTF - T1104	0.15	27	26
	14h34		92		1	27	
	14h44		93		2	26.5	
	15h09	32	94	NTF - T1326	0.15	27	28
	15h23		95		1	28	
	15h30		96		2	28	
	15h40	33	97	NTF - T1327	0.15	25	26
	15h50		98		1	27	
	15h55		99		2	27	
1999/04/21	09h25	34	100	LUBOIL – mid T4801/3/4/5	0.15	29	28
	09h35		101		1	30	
	09h45		102		2	29	
	10h30	35	103	LUBOIL – mid T4808/9/10/12	0.15	26	30
	10h40		104		1	27	
	10h48		105		2	27	
	11h35	36	106	LUBOIL - mid T4815/6/7/9	0.15	25	30
	11h45		107		1	28	
	12h15		108		2	29	

TABLE A-3: Mass of each alkane used in the preparation of the hydrocarbon standard

ALKANE STANDARD	FORMULA	MASS USED
Pentane	C_5H_{12}	0.1011
Heptane	C_7H_{16}	0.1011
Octane	C_8H_{18}	0.1011
n-decane	$C_{10}H_{22}$	0.1055
Undecane	$C_{11}H_{24}$	0.1172
Dodecane	$C_{12}H_{26}$	0.1090
Tridecane	$C_{13}H_{28}$	0.1005
Tetradecane	$C_{14}H_{30}$	0.1040
Pentadecane	$C_{15}H_{32}$	0.1063
Hexadecane	$C_{16}H_{34}$	0.1010
Heptadecane	$C_{17}H_{36}$	0.1060
Octadecane	$C_{18}H_{38}$	0.1016
Eicosane	$C_{20}H_{42}$	0.1054
Octasan	$C_{28}H_{58}$	0.1012

TABLE A-3: Mass of each alkane used in the preparation of the hydrocarbon standard

ALKANE STANDARD	FORMULA	MASS USED
Pentane	C_5H_{12}	0.1011
Heptane	C_7H_{16}	0.1011
Octane	C_8H_{18}	0.1011
n-decane	$C_{10}H_{22}$	0.1055
Undecane	$C_{11}H_{24}$	0.1172
Dodecane	$C_{12}H_{26}$	0.1090
Tridecane	$C_{13}H_{28}$	0.1005
Tetradecane	$C_{14}H_{30}$	0.1040
Pentadecane	$C_{15}H_{32}$	0.1063
Hexadecane	$C_{16}H_{34}$	0.1010
Heptadecane	$C_{17}H_{36}$	0.1060
Octadecane	$C_{18}H_{38}$	0.1016
Eicosane	$C_{20}H_{42}$	0.1054
Octasan	$C_{28}H_{58}$	0.1012

TABLE A-4: Total measured concentration (%m/m) of hydrocarbons at five chosen tank farms

TANK FARM SITE	HOLE No.	HYDROCARBON CONTENT (%m/m)	
		C_{10} - C_{20}	C_{21} - C_{30}
STF T1114	19	84.45	15.56
	20	0.00	0.00
	21	95.82	4.18
STF T1118	37	0.00	0.00
	38	0.00	0.00
	39	0.00	0.00
MOGAS T1309	64	100.00	0.00
	65	100.00	0.00
	66	0.00	0.00
GASOIL T1322	70	95.58	4.42
	71	88.59	11.41
	72	0.00	0.00
NTF T1104	91	69.14	30.87
	92	74.02	25.99
	93	85.68	14.33
LUBOIL Middle T4815/6/7/9	106	0.00	0.00
	107	12.97	87.04
	108	0.00	0.00

TABLE A-4: Total measured concentration (%m/m) of hydrocarbons at five chosen tank farms

TANK FARM SITE	HOLE No.	HYDROCARBON CONTENT (%m/m)	
		C_{10} - C_{20}	C_{21} - C_{30}
STF T1114	19	84.45	15.56
	20	0.00	0.00
	21	95.82	4.18
STF T1118	37	0.00	0.00
	38	0.00	0.00
	39	0.00	0.00
MOGAS T1309	64	100.00	0.00
	65	100.00	0.00
	66	0.00	0.00
GASOIL T1322	70	95.58	4.42
	71	88.59	11.41
	72	0.00	0.00
NTF T1104	91	69.14	30.87
	92	74.02	25.99
	93	85.68	14.33
LUBOIL Middle T4815/6/7/9	106	0.00	0.00
	107	12.97	87.04
	108	0.00	0.00

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

STF

TANK / AREA	**STF T 1106**		
HOLE NUMBER	**1**		
SAMPLE NUMBER	**1**	**2**	**3**
Mass Soil + Glass thimble	112.0879	112.3192	112.3649
Mass Glass thimble	61.3071	62.0156	61.9268
Mass of Soil taken	**50.7808**	**50.3036**	**50.4381**
TANK / AREA	**STF T 1106**		
HOLE NUMBER	**2**		
SAMPLE NUMBER	**4**	**5**	**6**
Mass Soil + Glass thimble	113.2198	112.1834	112.0087
Mass Glass thimble	62.3064	61.3319	62.0512
Mass of Soil taken	**50.9134**	**50.8515**	**49.9575**
TANK / AREA	**STF T 1108**		
HOLE NUMBER	**3**		
SAMPLE NUMBER	**7**	**8**	**9**
Mass Soil + Glass thimble	112.6143	112.1570	112.7483
Mass Glass thimble	61.9330	61.3057	62.0189
Mass of Soil taken	**50.6813**	**50.8513**	**50.7294**
TANK / AREA	**STF T 1110**		
HOLE NUMBER	**4**		
SAMPLE NUMBER	**10**	**11**	**12**
Mass Soil + Glass thimble	113.1647	111.7167	112.5933
Mass Glass thimble	62.3087	61.3188	62.0269
Mass of Soil taken	**50.8560**	**50.3979**	**50.5664**
TANK / AREA	**STF T 1110**		
HOLE NUMBER	**5**		
SAMPLE NUMBER	**13**	**14**	**15**
Mass Soil + Glass thimble	112.5493	112.9340	113.0729
Mass Glass thimble	61.9358	61.7380	62.2620
Mass of Soil taken	**50.6135**	**51.1960**	**50.8109**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

STF

TANK / AREA	**STF T 1112**		
HOLE NUMBER	**6**		
SAMPLE NUMBER	**16**	**17**	**18**
Mass Soil + Glass thimble	113.3056	112.0412	112.4935
Mass Glass thimble	62.3271	61.6596	62.2311
Mass of Soil taken	**50.9785**	**50.3816**	**50.2624**
TANK / AREA	**STF T 1114**		
HOLE NUMBER	**7**		
SAMPLE NUMBER	**19**	**20**	**21**
Mass Soil + Glass thimble	112.8085	111.6040	113.3247
Mass Glass thimble	61.9353	61.6050	62.2302
Mass of Soil taken	**50.8732**	**49.9990**	**51.0945**
TANK / AREA	**STF T 1113**		
HOLE NUMBER	**8**		
SAMPLE NUMBER	**22**	**23**	**24**
Mass Soil + Glass thimble	110.1687	112.8659	111.6410
Mass Glass thimble	61.3173	62.0257	61.9327
Mass of Soil taken	**48.8514**	**50.8402**	**49.7083**
TANK / AREA	**STF T 1111**		
HOLE NUMBER	**9**		
SAMPLE NUMBER	**25**	**26**	**27**
Mass Soil + Glass thimble	112.5186	112.5540	112.9902
Mass Glass thimble	62.3140	61.7362	62.1832
Mass of Soil taken	**50.2046**	**50.8178**	**50.8070**
TANK / AREA	**STF T 1109**		
HOLE NUMBER	**10**		
SAMPLE NUMBER	**28**	**29**	**30**
Mass Soil + Glass thimble	112.8052	113.5973	113.0037
Mass Glass thimble	62.0582	61.8280	62.4305
Mass of Soil taken	**50.7470**	**51.6693**	**50.5732**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

STF

TANK / AREA	**STF T 1107**		
HOLE NUMBER	**11**		
SAMPLE NUMBER	**31**	**32**	**33**
Mass Soil + Glass thimble	113.1514	113.3814	112.7530
Mass Glass thimble	62.5575	61.8242	62.4135
Mass of Soil taken	**50.5949**	**51.5572**	**50.3395**
TANK / AREA	**STF T 1105**		
HOLE NUMBER	**12**		
SAMPLE NUMBER	**34**	**35**	**36**
Mass Soil + Glass thimble	111.1863	112.9884	112.0438
Mass Glass thimble	61.7328	62.4055	61.9339
Mass of Soil taken	**49.4535**	**50.5829**	**50.1099**
TANK / AREA	**STF T 1118**		
HOLE NUMBER	**13**		
SAMPLE NUMBER	**37**	**38**	**39**
Mass Soil + Glass thimble	112.0615	113.1858	112.8496
Mass Glass thimble	62.3188	61.9097	62.3560
Mass of Soil taken	**49.7427**	**51.2761**	**50.4936**
TANK / AREA	**STF T 1117**		
HOLE NUMBER	**14**		
SAMPLE NUMBER	**40**	**41**	**42**
Mass Soil + Glass thimble	112.6963	111.0071	112.2685
Mass Glass thimble	62.1450	61.7952	62.3862
Mass of Soil taken	**50.5513**	**49.2119**	**49.8823**
TANK / AREA	**STF T 1116**		
HOLE NUMBER	**15**		
SAMPLE NUMBER	**43**	**44**	**45**
Mass Soil + Glass thimble	111.8266	112.0409	112.7518
Mass Glass thimble	62.4177	61.8891	62.4794
Mass of Soil taken	**49.4089**	**50.1518**	**50.2724**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

STF

TANK / AREA	**STF T 1116**		
HOLE NUMBER	**16**		
SAMPLE NUMBER	**46**	**47**	**48**
Mass Soil + Glass thimble	112.1489	112.8072	112.7284
Mass Glass thimble	61.9345	62.3777	61.7198
Mass of Soil taken	**50.2144**	**50.4295**	**51.0086**
TANK / AREA	**STF T 1115**		
HOLE NUMBER	**17**		
SAMPLE NUMBER	**49**	**50**	**51**
Mass Soil + Glass thimble	112.9480	112.2591	112.4419
Mass Glass thimble	62.3162	61.8196	62.3154
Mass of Soil taken	**50.6318**	**50.4395**	**50.1265**
TANK / AREA	**STF T 1114**		
HOLE NUMBER	**18**		
SAMPLE NUMBER	**52**	**53**	**54**
Mass Soil + Glass thimble	111.9953	112.4850	112.7642
Mass Glass thimble	62.0270	62.4088	61.9352
Mass of Soil taken	**49.9683**	**50.0762**	**50.8290**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

MOGAS

TANK / AREA	**MOGAS T 1307**		
HOLE NUMBER	**19**		
SAMPLE NUMBER	**55**	**56**	**57**
Mass Soil + Glass thimble	111.5391	111.4988	113.1779
Mass Glass thimble	61.3193	62.0297	61.9433
Mass of Soil taken	**50.2198**	**49.4691**	**51.2346**
TANK / AREA	**MOGAS T 1306**		
HOLE NUMBER	**20**		
SAMPLE NUMBER	**58**	**59**	**60**
Mass Soil + Glass thimble	112.1608	112.3348	111.9288
Mass Glass thimble	62.3142	61.6931	62.2555
Mass of Soil taken	**49.8466**	**50.6417**	**49.6733**
TANK / AREA	**MOGAS T 1310**		
HOLE NUMBER	**21**		
SAMPLE NUMBER	**61**	**62**	**63**
Mass Soil + Glass thimble	113.0728	112.7637	113.1078
Mass Glass thimble	62.0308	61.8234	62.1705
Mass of Soil taken	**51.0420**	**50.9403**	**50.9373**
TANK / AREA	**MOGAS T 1309**		
HOLE NUMBER	**22**		
SAMPLE NUMBER	**64**	**65**	**66**
Mass Soil + Glass thimble	111.5316	112.6594	113.2814
Mass Glass thimble	61.8785	62.2580	62.3131
Mass of Soil taken	**49.6531**	**50.4014**	**50.9683**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

GASOIL

TANK / AREA	**GASOIL T 1315**		
HOLE NUMBER	**23**		
SAMPLE NUMBER	**67**	**68**	**69**
Mass Soil + Glass thimble	112.0853	111.7917	112.4935
Mass Glass thimble	62.0253	61.6729	62.1584
Mass of Soil taken	**50.0600**	**50.1188**	**50.3351**
TANK / AREA	**GASOIL T 1322**		
HOLE NUMBER	**24**		
SAMPLE NUMBER	**70**	**71**	**72**
Mass Soil + Glass thimble	112.3293	112.5000	112.7510
Mass Glass thimble	62.3116	61.6815	62.1564
Mass of Soil taken	**50.0177**	**50.8185**	**50.5946**
TANK / AREA	**GASOIL mid T 7801/2/3/4**		
HOLE NUMBER	**25**		
SAMPLE NUMBER	**73**	**74**	**75**
Mass Soil + Glass thimble	112.1899	111.8591	113.7383
Mass Glass thimble	62.0225	61.7245	62.4541
Mass of Soil taken	**50.1674**	**50.1346**	**51.2842**
TANK / AREA	**GASOIL mid T 1317/8 – T 1324/5**		
HOLE NUMBER	**26**		
SAMPLE NUMBER	**76**	**77**	**78**
Mass Soil + Glass thimble	112.6045	112.2192	112.9083
Mass Glass thimble	61.9347	61.8857	62.4804
Mass of Soil taken	**50.6698**	**50.3335**	**50.4279**
TANK / AREA	**GASOIL T 1203/4**		
HOLE NUMBER	**27**		
SAMPLE NUMBER	**79**	**80**	**81**
Mass Soil + Glass thimble	112.8136	112.2364	112.4207
Mass Glass thimble	62.4950	61.6655	61.0240
Mass of Soil taken	**50.3186**	**50.5709**	**51.3967**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

NTF

TANK / AREA	**NTF T 1101**		
HOLE NUMBER	**28**		
SAMPLE NUMBER	**82**	**83**	**84**
Mass Soil + Glass thimble	112.1717	111.4345	113.5814
Mass Glass thimble	61.9064	62.1121	62.4651
Mass of Soil taken	**50.2653**	**49.3224**	**51.1163**
TANK / AREA	**NTF T 1102**		
HOLE NUMBER	**29**		
SAMPLE NUMBER	**85**	**86**	**87**
Mass Soil + Glass thimble	111.6290	112.3139	112.5919
Mass Glass thimble	62.0225	61.8425	62.2361
Mass of Soil taken	**49.6065**	**50.4714**	**50.3558**
TANK / AREA	**NTF T 1103**		
HOLE NUMBER	**30**		
SAMPLE NUMBER	**88**	**89**	**90**
Mass Soil + Glass thimble	112.2617	112.5224	112.1775
Mass Glass thimble	61.9171	62.2128	62.2480
Mass of Soil taken	**50.3446**	**50.3096**	**49.9295**
TANK / AREA	**NTF T 1104**		
HOLE NUMBER	**31**		
SAMPLE NUMBER	**91**	**92**	**93**
Mass Soil + Glass thimble	111.9042	112.0741	112.0632
Mass Glass thimble	61.7941	61.6774	61.3867
Mass of Soil taken	**50.1101**	**50.3967**	**50.6765**
TANK / AREA	**NTF T 1326**		
HOLE NUMBER	**32**		
SAMPLE NUMBER	**94**	**95**	**96**
Mass Soil + Glass thimble	111.3357	111.8593	112.5769
Mass Glass thimble	61.3076	61.9337	62.0240
Mass of Soil taken	**50.0281**	**49.9256**	**50.5529**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

NTF

TANK / AREA	**NTF T 1327**		
HOLE NUMBER	**33**		
SAMPLE NUMBER	**97**	**98**	**99**
Mass Soil + Glass thimble	112.6329	111.7365	109.9977
Mass Glass thimble	61.7999	61.6831	61.3887
Mass of Soil taken	**50.8330**	**50.0534**	**48.6090**

TABLE A-5: Mass of soil samples used for BÜCHI extractions with toluene as solvent.

LUBOIL

TANK / AREA	**LUBOIL mid T 4801/3/4/5**		
HOLE NUMBER	**34**		
SAMPLE NUMBER	**100**	**101**	**102**
Mass Soil + Glass thimble	111.7641	112.1012	111.9920
Mass Glass thimble	61.3123	61.9373	62.0504
Mass of Soil taken	**50.4518**	**50.1639**	**49.9416**
TANK / AREA	**LUBOIL mid T 4808/9/10/12**		
HOLE NUMBER	**35**		
SAMPLE NUMBER	**103**	**104**	**105**
Mass Soil + Glass thimble	111.9806	113.0955	113.2379
Mass Glass thimble	61.9953	62.3842	61.3706
Mass of Soil taken	**49.9853**	**50.7113**	**51.8673**
TANK / AREA	**LUBOIL mid T 4815/6/7/9**		
HOLE NUMBER	**36**		
SAMPLE NUMBER	**106**	**107**	**108**
Mass Soil + Glass thimble	112.5527	113.4711	113.6520
Mass Glass thimble	61.9977	62.4905	62.4007
Mass of Soil taken	**50.5550**	**50.9806**	**51.2513**

TABLE A-6: Measured hydrocarbon levels (%m/m) in tank samples compared with levels found at selected sites

STF T1114 vs Tank samples

Tank Farm	Hydrocarbon levels (% m/m)	
site	C_{10} - C_{20}	C_{21} - C_{30}
Arabextralight	88.5	11.5
Arablight	81.7	18.3
Arabmedium	95.8	4.2
Iranianlight	84.6	15.4
Iranianheavy	83.0	17.0
Iraqlight	90.8	9.2
Kuwait	90.7	9.3
19 (T)	84.4	15.6
20 (M)	0.0	0.0
21 (B)	95.8	4.2

MOGAS T1310 vs Mogas Tank sample

Tank Farm	Hydrocarbon levels (% m/m)	
site	C_{10} - C_{20}	C_{21} - C_{30}
61 (T)	100.0	0.0
62 (M)	75.5	24.5
63 (B)	100.0	0.0
Mogas Tank	99.2	0.8

GASOIL T1315 vs Gasoil Tank sample

Tank Farm	Hydrocarbon levels (% m/m)	
site	C_{10} - C_{20}	C_{21} - C_{30}
67 (T)	100.0	0.0
68 (M)	99.8	0.2
69 (B)	85.5	14.5
Gasoil Tank	98.2	1.8

NTF T1103 vs NTF Tank sample

Tank Farm	Hydrocarbon levels (% m/m)	
site	C_{10} - C_{20}	C_{21} - C_{30}
88 (T)	86.7	13.3
89 (M)	0.0	0.0
90 (B)	0.0	0.0
NTF Tank	90.5	9.5

LUBOIL T4815-9 vs Luboil Tank sample

Tank Farm	Hydrocarbon levels (% m/m)	
site	C_{10} - C_{20}	C_{21} - C_{30}
106 (T)	0.0	0.0
107 (M)	13.0	87.0
108 (B)	0.0	0.0
Luboil Tank	0.0	0.0

APPENDIX B

METHODS and DATA SHEETS

Pages 144-158

EXTRACTION: Step 1

The actual extraction process takes place in step 1 (see Appendix B, p.??). The procedure used is determined according to the extraction method selected. The function of the various extraction methods will be explained in the following sections

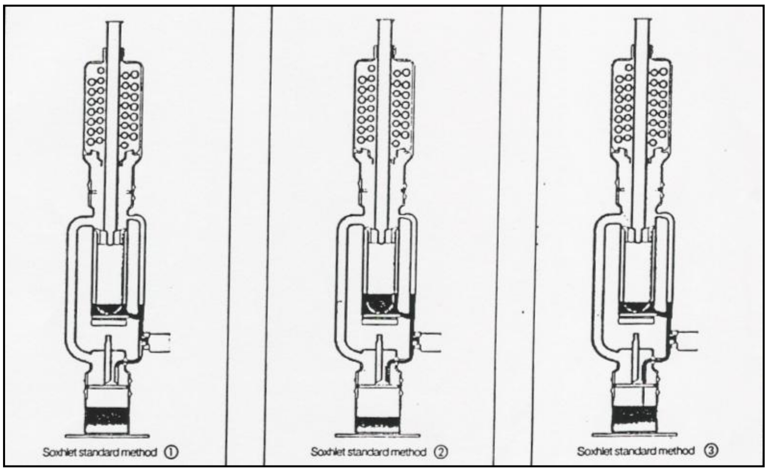


Figure B2: Procedure for Soxhlet standard

1. Soxhlet standard

(a) The solvent evaporates, rises up to the condenser and condenses. The glass valve is closed.

(b) The solvent level increases up to the optical sensor. The sample is extracted.

(c) The optical sensor detects the solvent level and opens the glass valve. The solvent with the extract flows back into the solvent cup.

If the preprogrammed number of cycles is reached and/or if the extraction time is up, the system goes to the next step.

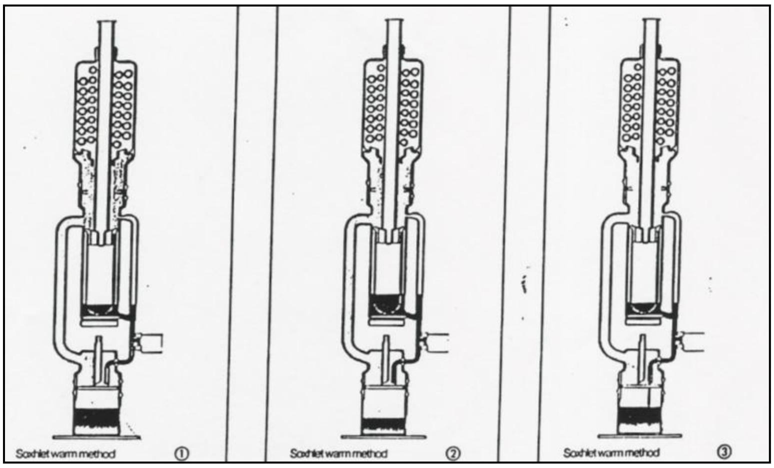


Figure B3: Procedure for Soxhlet warm

2. Soxhlet warm

(a) The solvent evaporates, rises up to the condenser and condenses. The glass valve is closed.

(b) The solvent level in the extraction vessel increases up to the optical sensor. The sample is extracted. After the first level is detected, the upper heating element turns on and warms the solvent in the extraction chamber.

(c) The optical sensor detects the solvent level and opens the glass valve. The solvent with the extract flows back into the solvent cup.

If the programmed number of cycles is reached and/or if the extraction time is up, the system goes to the next step. The upper heating element is turned off.

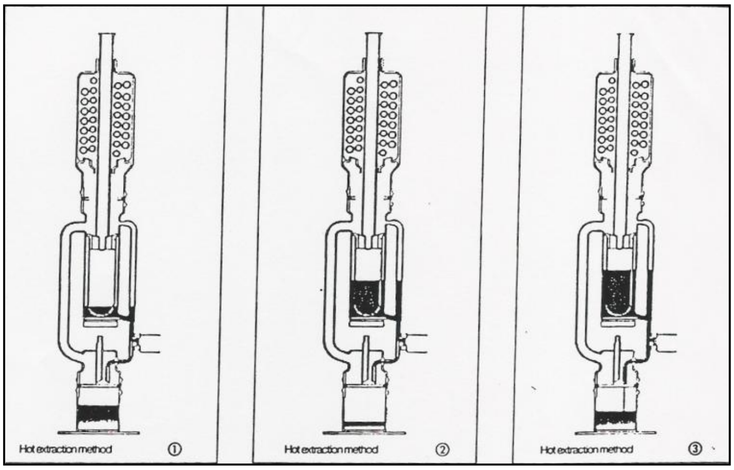


Figure B4: Procedure for Soxhlet Hot extraction

3. Hot extraction

(a) The solvent evaporates, rises up to the condenser and condenses. The glass valve is closed.

(b) The solvent level in the extraction vessel increases up to the optical sensor. The sample is extracted. After the first level is detected, the upper heating element turns on and warms the solvent in the extraction chamber.

(c) The optical sensor detects the solvent level. The glass valve is opened for a short time and allows a few milliliters of solvent to flow into the solvent cup. In this manner, the extraction chamber always has a fresh supply of solvent and an enrichment of the extract in the extraction chamber is prevented.

When the programmed extraction time is up, the system goes to the next step. The upper heating element is turned off.

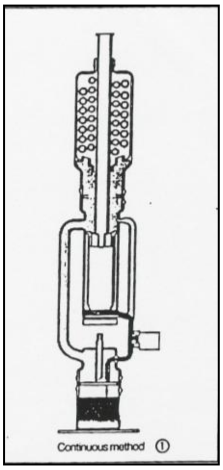


Figure B5: Procedure for the continuous method

4. Continuous

(a) The solvent evaporates, rises up to the condenser and condenses. The glass valve is-open, the optical sensor is inactive.

(b) When the programmed extraction time is up, the system goes to the next step.

Soxhlet standard Mode - Programming Example

Program description:
A standard extraction according to Soxhlet is carried out. The solvent level is detected by the optical sensor and this releases a magnetic valve which then allows solvent to flow.

Key	Display	Description
SELECT	The **Mode** display blinks	Select the Soxhlet Standard mode using the ▲/▼ keys
⏩	Display **STEP 1** blinks	(STEP 1 = Extraction phase)
⏩	Display **HEATING** blinks	Select the heating level (1-20) using the ▲/▼ keys Select Level 9 for naphtha 40/60
⏩	Display **CYCLES** blinks	Select the number of cycles using the ▲/▼ keys If the number of cycles = 0 is entered, then the only stop criteria used is the extraction time.
⏩	Display **H: MIN** blinks	Select the extraction time (0 bis 99:99 h) using the ▲/▼ keys. If no time limit is entered, then the only stop criteria used is the number of cycles. If both parameters are entered (time and number of cycles), then both criteria must be fulfilled before the device goes to the next step.
⏩	Display **STEP 2** blinks	(STEP 2 = Rinse phase)
⏩	Display **HEATING** blinks	Select the heating level (1-20) using the▲/▼ keys Select Level 9 for naphtha 40/60 If the extracted product is to be dried in an inert gas, the inert gas supply must be activated by pressing the Inert Gas key. The inert gas valve is automatically opened up during the appropriate step.
⏩	Display **H: MIN** blinks	Select the rinse time (0 bis 99:99 h) using the ▲/▼ keys. The only stop criteria used for **STEP 2** is the rinse time.
⏩	Display **STEP 3** blinks	(STEP 3 = Drying phase)
⏩	Display **HEATING** blinks	Select the heating level (1-20) using the ▲/▼ keys Select Level 4 for naphtha 40/60
⏩	Display **H: MIN** blinks	Select the drying time (0 bis 99:99 h) using the ▲/▼ keys. The only stop criteria used for **STEP 3** is the drying time.
SELECT	No display blinks	The program you have entered is stored as program 0.

Method: extractrun

Star Chromatography Workstation - Method Listing
3800 GC
Module Address: 44

Front Injector Type 1079

Oven Power: On
Coolant: Off

Temp.(°C)	Rate(°C/min)	Hold(min)	Total(min)
240	0	35.00	35.00

Time (min)	Split State	Split Ratio
Initial	On	50

Front Injector EFC Type 1

Pressure(psi)	Rate (psi/min)	Hold(min)	Total(min)
60.0	0.00	35.00	35.00

Column Oven

Coolant: Off
Stabilization Time: 0.50 min

Temp.(°C)	Rate(°C/min)	Hold(min)	Total(min)
100	0.0	2.00	2.00
280	10.0	15.00	35.00

Front FID Detector

Oven Power : On
Temperature : 280°C
Electronics : On
Time Constant : Fast

Time (min)	Range	Autozero
Initial	12	yes

Output Port A

Time (min)	Signal Source	Attenuation
Initial	Front	1

Output Port B

Time (min)	Signal Source	Attenuation
Initial	Front	1

Output Port C

Time (min)	Signal Source	Attenuation
Initial	Front	1

Data Acquisition

```
Detector Bunch Rate     : 4 points (10.0 Hz)
Monitor Length          : 32 bunched points (3.2 sec)
Front FID/TSD Scale     : 10 Volts
Middle FID/TSD Scale    : 10 Volts
Rear FID/TSD Scale      : 10 Volts
```

Integration Parameters Address 44 Channel Front

```
Subtract Blank Baseline       : No
Initial S/N Ratio             : 5
Initial Peak Width            : 4 sec
Initial Tangent Height %      : 10%
Monitor Noise                 : Before every run
Measurement Type              : Peak Area
Initial Peak Reject Value     : 1000 counts
Report Unidentified Peaks     : Yes
Report Missing Peaks          : No
Normalize Results             : No
```

Calibration Setup Address 44 Channel Front

```
Calculation Type              : External Standard
Number of Calibration Levels  : 1
Curve Origin                  : Ignore
Curve Fit                     : Linear
Weighted Regression           : (None)
Replicate Treatment           : Keep Replicates Separate
Replicate Tolerance           : Add replicates within tolerance of 0.5%
Calibration Range tolerance   : 10%
Out-of-Tolerance Action       : No Action
```

Verification Setup Address 44 Channel Front

```
Deviation Tolerance     : 15.0%
Out-of-Tolerance Action : No Action
```

```
Peak Table  Address 44  Channel Front

Reference Peaks Time Windows   :Width: 0.10 min. Retention Time 2.0%
Other Peaks Time Windows       :Width: 0.10 min. Retention Time 2.0%

Peak Name          : C5
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 5.200 min
Uses Standard      :
Level 1 Amount     : 0.1011
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +1.1974e+004x
+0.0000e+000

Peak Name          : C7
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 6.554 min
Uses Standard      :
Level 1 Amount     : 0.1011
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +6.2692e+003x
+0.0000e+000

Peak Name          : Toluene
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 7.674 min
Uses Standard      :
Level 1 Amount     : 1
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +O.0000e+000xA3 +0.00OOe+OOOxA2 +O.OOOOe+OOOx
+0.0000e+000

Peak Name          : C8
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 7.954 min
Uses Standard      :
Level 1 Amount     : 0.1011
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +6.1491e+OO3x
+0.0000e+000

Peak Name          : C10
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 11.   449
min
Uses Standard      :
Level 1 Amount     : 0.1055
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +3.7207e+005x
+0.0000e+000

Peak Name          : C11
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 13.339
min
Uses Standard      :
Level 1 Amount     : 0.1172
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +4.4432e+005x
+0.0000e+000
```

```
Peak Name          : C12
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 15.167
min
Uses Standard      :
Level 1 Amount     : 0.1090
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +4.7406e+005x
+0.0000e+000

Peak Name          : C13
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 16.899
min
Uses Standard      :
Level 1 Amount     : 0.1005
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +4.8951e+005x
+0.0000e+000

Peak Name          : C14
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 18.532
min
Uses Standard      :
Level 1 Amount     : 0.1040
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +5.2519e+005x
+0.0000e+000

Peak Name          : C15
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 20.066
min
Uses Standard      :
Level 1 Amount     : 0.1063
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +5.8771e+005x
+0.0000e+000

Peak Name          : C16
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 21.576
min
Uses Standard      :
Level 1 Amount     : 0.1010
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +5.9675e+005x
+0.0000e+000

Peak Name          : C17
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 23.120
min
Uses Standard      :
Level 1 Amount     : 0.1060
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +5.8383e+005x
+0.0000e+000
```

```
Peak Name          : C18
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 24.742
min
Uses Standard      :
Level 1 Amount     : 0.1016
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +5.7898e+005x
+0.0000e+000

Peak Name          : C20
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 28.532
min
Uses Standard      :
Level 1 Amount     : 0.1054
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +0.0000e+000x
+0.0000e+000

Peak Name          : C28
Attributes         : Ref:N  Std:N  RRT:N  Lock:N Group:O     Time: 33.701
min
Uses Standard      :
Level 1 Amount     : 0.1012
Level 2 Amount     : 1
Level 3 Amount     : 1
Coefficients       : +0.0000e+000x^3 +0.0000e+000x^2 +4.9634e+005x
+0.0000e+000
```

<u>Time Events Table Address 44 Channel Front</u>

      Time Events Table Empty

<u>Report Format: Module 3800 Address 44 Channel Front</u>

```
Title                          : PONA COLUMN EXPERIMENT
Print Chromatogram             : Yes
   Chromatogram Options        :
Start Retention Time           : 0.00 minutes
End Retention Time             : 35.00 minutes
Initial Attenuation            : 32
Initial Zero Offset            : 5
Length in Pages                : 1
Initial Chart Speed            : 0.0 cm/min
Minutes per Tick               : 10.0
Autoscale                      : Off
Time Events                    : Off
Chromatogram Events            : Off
Retention Times                : On
Peak Names                     : On
Baseline                       : On

Print Results                  : Yes
   Results Options             :
Units                          : %
Number of Decimal Digits       : 3
Show Peak Group Totals         : No
Run Log                        : Off
Error Log                      : Off
Calibration Report             : Off
Revision Log                   : On
Notes                          : Off
Method Notes                   : Off
Convert Results to ASCII?      : Off

Calibration Block Reports
Print Report                   : No
Convert Report to ASCII?       : Off

Print Copies                   : 1
```

Method: extract run-grouping

Star Chromatography Workstation - Method Listing

3800 GC
Module Address: 44

Front Injector Type 1079

Oven Power: On
Coolant: Off

Temp.(°C)	Rate(°C/min)	Hold(min)	Total(min)
240	0	35.00	35.00

Time (min)	Split State	Split Ratio
Initial	On	50

Front Injector EFC Type 1

Pressure(psi)	Rate (psi/min)	Hold(min)	Total(min)
60.0	0.00	35.00	35.00

Column Oven

Coolant: Off
Stabilization Time: 0.50 min

Temp.(°C)	Rate(°C/min)	Hold(min)	Total(min)
100	0.0	2.00	2.00
280	10.0	15.00	35.00

Front FID Detector

Oven Power : On
Temperature : 280°C
Electronics : On
Time Constant : Fast

Time (min)	Range	Autozero
Initial	12	yes

Output Port A

Time (min)	Signal Source	Attenuation
Initial	Front	1

Output Port B

Time (min)	Signal Source	Attenuation
Initial	Front	1

Output Port C

Time (min)	Signal Source	Attenuation
Initial	Front	1

Data Acquisition

```
Detector Bunch Rate     : 4 points (10.0 Hz)
Monitor Length          : 32 bunched points (3.2 sec)
Front FID/TSD Scale     : 10 Volts
Middle FID/TSD Scale    : 10 Volts
Rear FID/TSD Scale      : 10 Volts
```

Integration Parameters Address 44 Channel Front

```
Subtract Blank Baseline       : No
Initial S/N Ratio             : 5
Initial Peak Width            : 4 sec
Initial Tangent Height %      : 10%
Monitor Noise                 : Before every run
Measurement Type              : Peak Area
Initial Peak Reject Value     : 1000 counts
Report Unidentified Peaks     : Yes
Report Missing Peaks          : No
Normalize Results             : No
```

Calibration Setup Address 44 Channel Front

```
Calculation Type               : External Standard
Number of Calibration Levels   : 1
Curve Origin                   : Ignore
Curve Fit                      : Linear
Weighted Regression            : (None)
Replicate Treatment            : Keep Replicates Separate
Replicate Tolerance            : Add replicates within tolerance of 0.5%
Calibration Range tolerance    : 10%
Out-of-Tolerance Action        : No Action
```

Verification Setup Address 44 Channel Front

```
Deviation Tolerance     : 15.0%
Out-of-Tolerance Action : No Action
```

Peak Table Address 44 Channel Front

Reference Peaks Time Windows :Width: 0.10 min. Retention Time 2.0%
Other Peaks Time Windows :Width: 0.10 min. Retention Time 2.0%

Peak Name : **Toluene (includes < C10)**
Attributes : Ref:N Std:N RRT:N Lock:N **Group:1** Time: 0.001 min
Uses Standard :
Level 1 Amount : 0.1
Level 2 Amount : 1
Level 3 Amount : 1
Coefficients : +0.0000e+000x^3 +0.0000e+000x^2 +1.1974e+004x
+0.0000e+000

Peak Name : **C10-C20**
Attributes : Ref:N Std:N RRT:N Lock:N **Group:2** Time: 11.000
min
Uses Standard :
Level 1 Amount : 0.1
Level 2 Amount : 1
Level 3 Amount : 1
Coefficients : +0.0000e+000x^3 +0.0000e+000x^2 +6.2692e+003x
+0.0000e+000

Peak Name : **C21-C30**
Attributes : Ref:N Std:N RRT:N Lock:N **Group:3** Time: 25.000
min
Uses Standard :
Level 1 Amount : 0.1
Level 2 Amount : 1
Level 3 Amount : 1
Coefficients : +0.0000e+000x^3 +0.0000e+000x^2 +0.0000e+000x
+0.0000e+000

Time Events Table Address 44 Channel Front

Solvent Reject	:	0.0010	until	11. 0000
Group **C10-C20**	:	11.0010	until	25.0000
Group **C21-C30**	:	25.0001	until	35.0000

<u>Report Format: Module 3800 Address 44 Channel Front</u>

```
Title                          : PONA COLUMN EXPERIMENT
Print Chromatogram             : Yes
   Chromatogram Options        :
Start Retention Time           : 0.00 minutes
End Retention Time             : 35.00 minutes
Initial Attenuation            : 32
Initial Zero Offset            : 5
Length in Pages                : 1
Initial Chart Speed            : 0.0 cm/min
Minutes per Tick               : 10.0
Autoscale                      : Off
Time Events                    : Off
Chromatogram Events            : Off
Retention Times                : On
Peak Names                     : On
Baseline                       : On

Print Results                  : Yes
   Results Options             :
Units                          : %
Number of Decimal Digits       : 3
Show Peak Group Totals         : Yes
Run Log                        : Off
Error Log                      : Off
Calibration Report             : Off
Revision Log                   : On
Notes                          : Off
Method Notes                   : Off
Convert Results to ASCII?      : Off

Calibration Block Reports
Print Report                   : No
Convert Report to ASCII?       : Off

Print Copies                   : 1
```

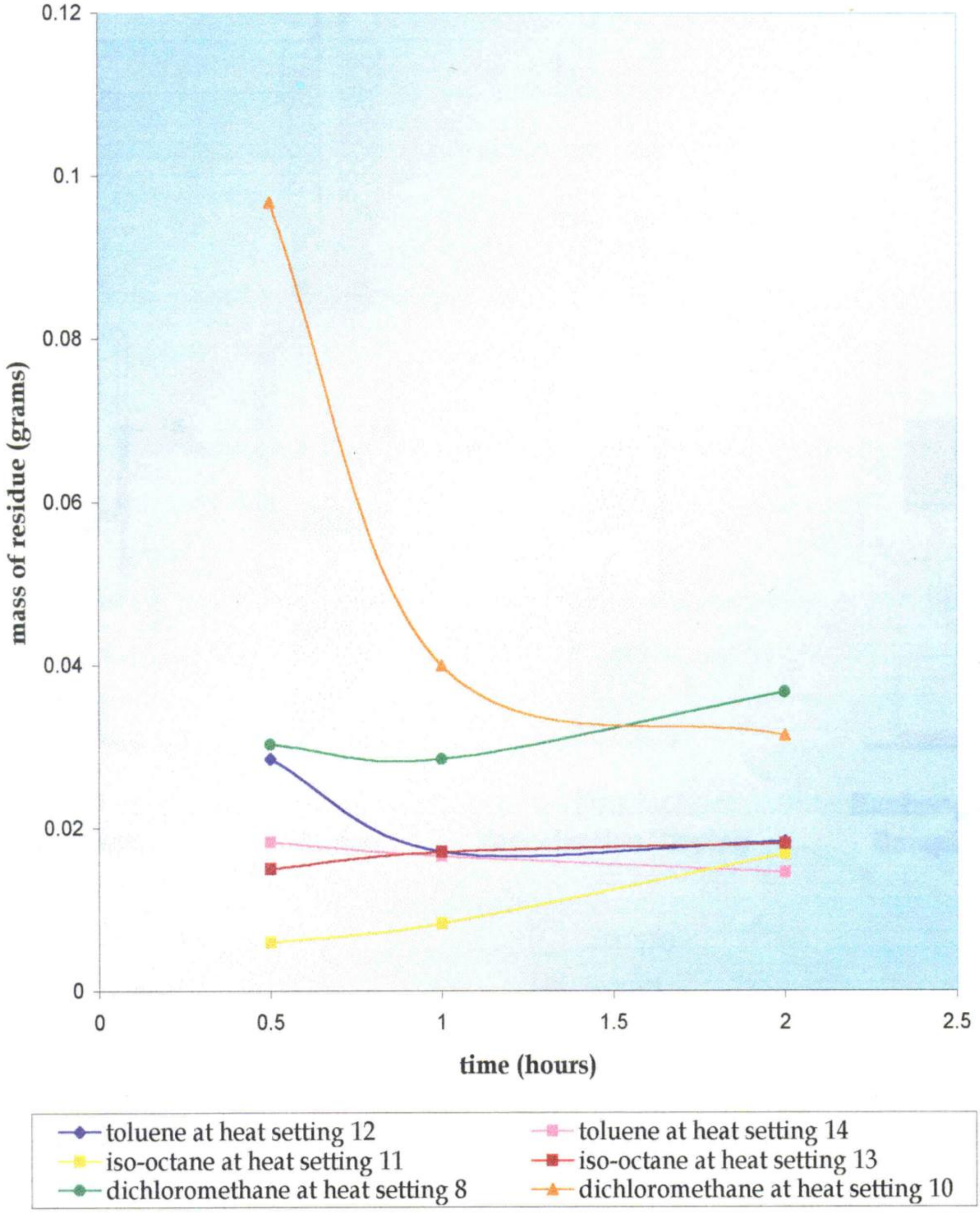


Figure B1: **Graph showing the comparison of solvent, time and heat setting parameters for a representative sample**

TOLUENE

Product Number AH347
Packaged in AL Glass Bottles

Specifications:

Water: Less than 0.030% by Karl Fischer titration
Ultraviolet absorbance:

Wavelength, nm	Maximum Absorbance
284	1.000
300	0.100
325	0.025
350	0.005
400	0.005

Refractive index: 1.4957 ± 0.0000 at 20°C
Residue: Less than three mg/L
Substances darkened by sulfuric acid: Passes ACS test
Sulfur compounds: Less than 0.003% as S

Physical Properties:

Molecular weight: 92.14
Boiling point: 110.62°C
Vapor pressure: 28.5 Torr at 20°C
Freezing point: -94.99°C
Refractive index: 1.4969 at 20°C
Density: 0.8669 g/mL (7.234 lb/gal) at 20°C
0.8623 g/mL (7.196 lb/gal) at 25°C
Dielectric constant: 2.38 at 25°C
Dipole moment: 0.31 D at 20°C
Solvent group: 7
Polarity index (P'): 2.4
Eluotropic value on alumina: 0.29
Viscosity: 0.59 cP at 20°C
Surface tension: 28.53 dyn/cm at 20°C
Solubility in water: 0.074% at 20°C
Solubility of water in toluene: 0.074% at 20°C

Regulatory and Safety Data:

DOT Hazard Class: 3, Pkg Grp II, UN 1294, Flammable Liquid
Store in an area designed for flammable storage, or in an approved metal cabinet, away from direct sunlight, heat, and sources of ignition.
EPA Waste Code(s): U220, F005
Flash point: 40°F (4°C) by closed cup
Lower explosive limit: 1.1%
Upper explosive limit: 7.1%
Time Weighted Average: 50 ppm ACGIH

Refer to Material Safety Data Sheet for additional regulatory, health and safety information.

Suggested Applications:

For HPLC, Spectrophotometry and applications requiring ACS Reagent Grade solvents.

APPENDIX C

CHROMATOGRAMS

Pages 159-345

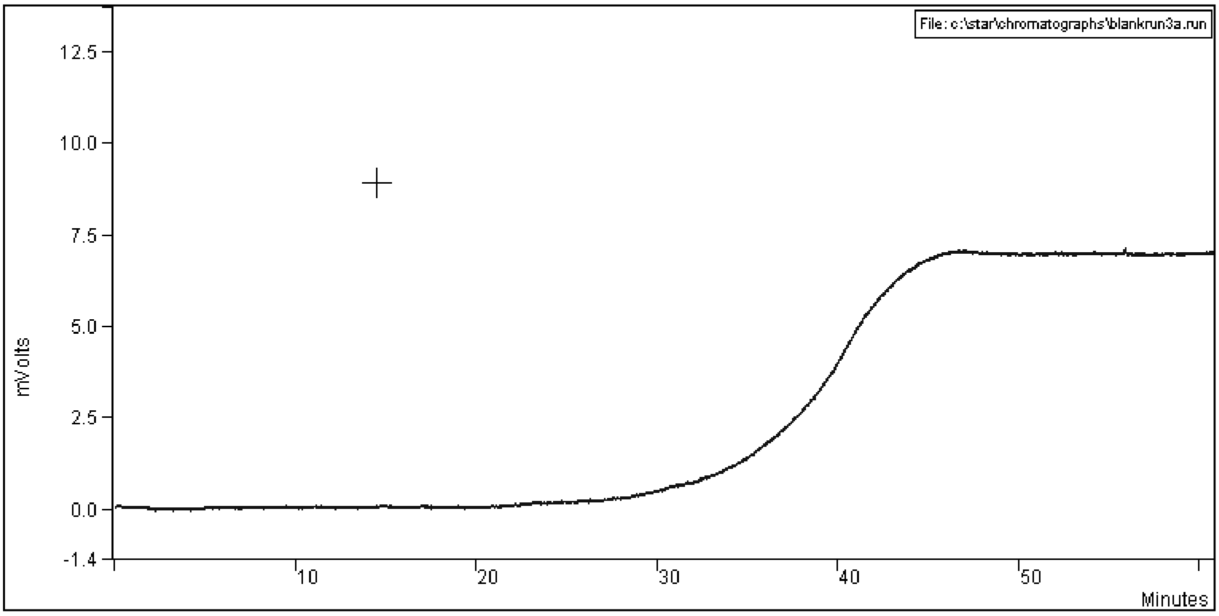


Figure C3: Chromatogram of a typical blank run. (Note that the time exceeds actual programmed run time).

Title	:	PONA COLUMN EXPERIMENT
Method File	:	c:\star\extractrun.mth
Sample ID	:	**blankrun3a**
Operator	:	SHAN
Instrument	:	Varian Star 3800
Channel	:	Front = FID
Run Time	:	60.938 min
Peak Measurement	:	Peak Area
Calculation Type	:	External Standard

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
----	----------	--------	-------	-------	--------	-----	----
----	----------	========	-------	=======	========	-----	----
	Totals:	0.00		0.000	0		

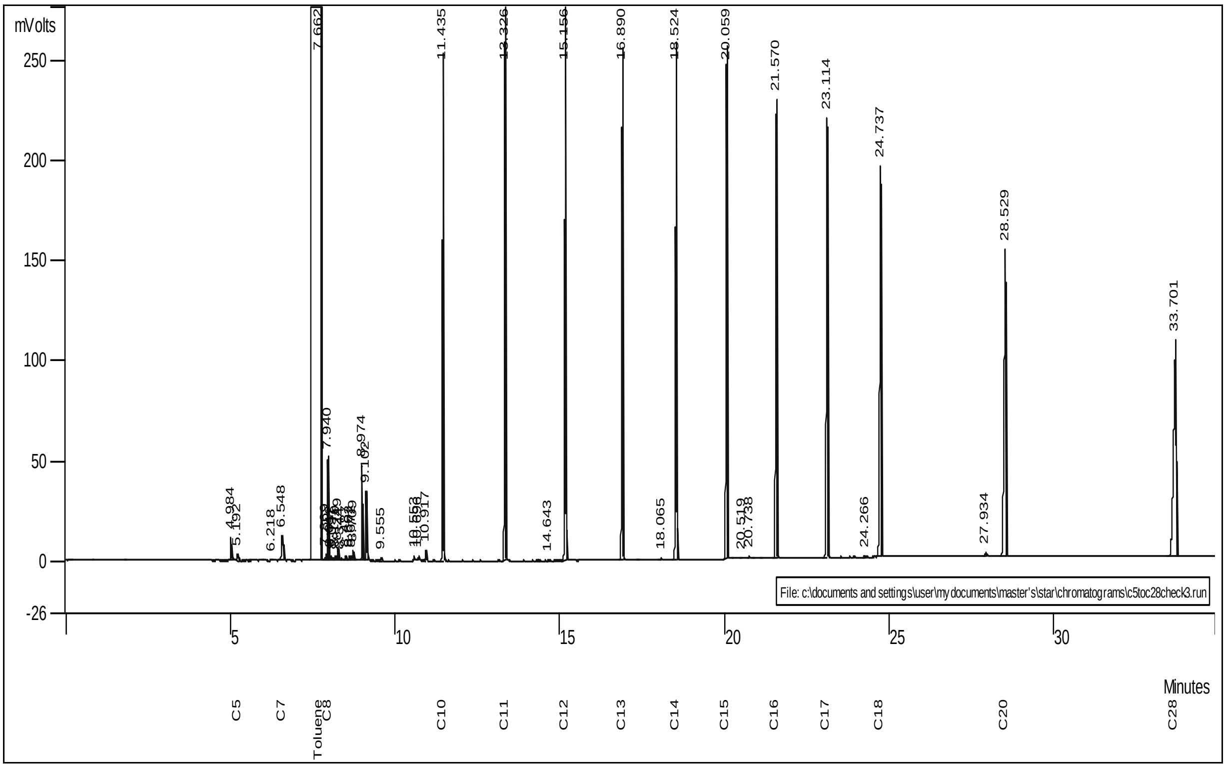
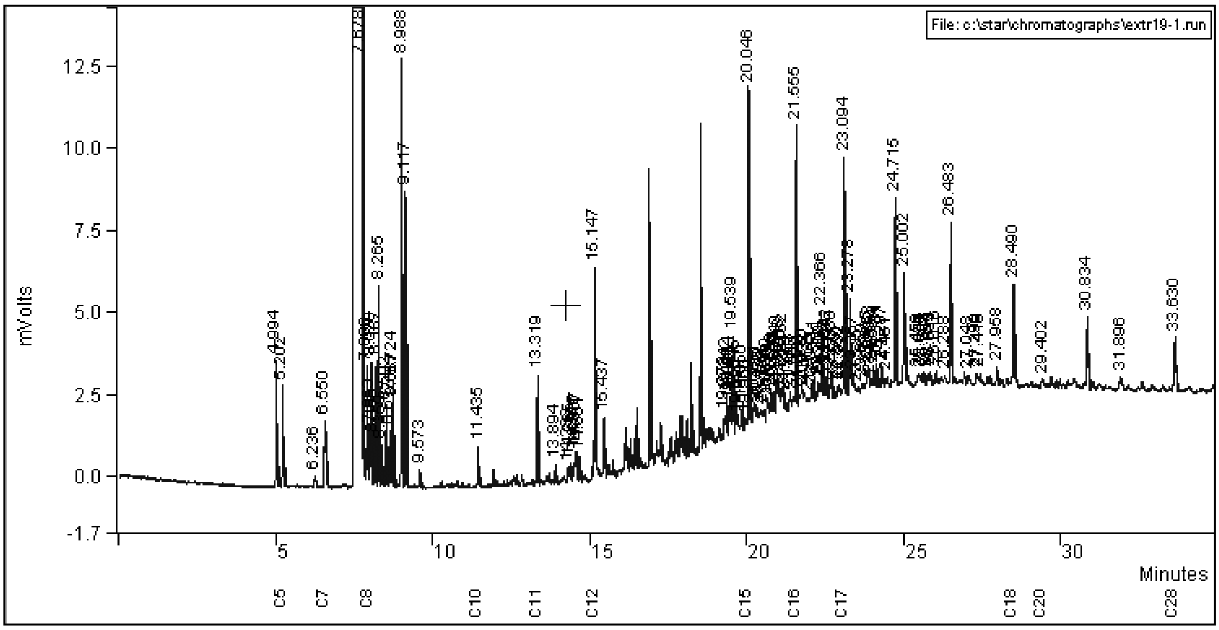


Figure C2: Chromatogram of intermediate standard run showing retention times for hydrocarbon standard.

Title : PONA COLUMN EXPERIMENT
Method File : C:\Star\Extractrun.mth
Sample ID : c5toc28check3
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.021	4.984	0.000	25222	BB	2.0
2	C5	0.007	5.192	-0.009	8275	BB	2.1
3		0.001	6.218	0.000	1114	BB	0.0
4	C7	0.047	6.548	-0.029	56641	BB	4.5
5		94.388	7.662	0.000	112828784	BB	11.3
6		0.004	7.869	0.000	4357	TF	0.0
7		0.055	7.940	0.000	65650	TF	0.0
8	C8	0.003	8.012	0.020	3330	TF	0.0
9		0.001	8.091	0.000	1236	TF	0.0
10		0.004	8.170	0.000	4912	TF	0.0
11		0.007	8.249	0.000	8803	TS	0.0
12		0.002	8.344	0.000	2219	TF	0.0
13		0.003	8.487	0.000	4052	TF	0.0
14		0.003	8.602	0.000	4010	TF	0.0
15		0.003	8.672	0.000	3729	TF	0.0
16		0.006	8.709	0.000	7676	TF	0.0
17		0.063	8.974	0.000	75348	BV	1.5
18		0.070	9.102	0.000	83149	VB	2.4
19		0.003	9.555	0.000	3209	BB	1.8
20		0.003	10.553	0.000	3839	BB	1.7
21		0.003	10.696	0.000	3467	BB	1.6
22		0.007	10.917	0.000	8684	BB	1.7
23	C10	0.406	11.435	-0.045	485391	BB	1.8
24	C11	0.514	13.326	-0.044	614547	BB	2.0
25		0.001	14.643	0.000	1083	BB	1.7
26	C12	0.498	15.156	-0.042	595839	BB	2.0
27	C13	0.463	16.890	-0.040	553682	BB	2.0
28		0.002	18.065	0.000	2461	BB	1.8
29	C14	0.483	18.524	-0.039	577901	BB	2.1
30	C15	0.488	20.059	-0.038	583439	BB	2.2
31		0.001	20.519	0.000	1293	BB	2.2
32		0.001	20.738	0.000	1355	BB	1.8
33	C16	0.474	21.570	-0.040	566512	BB	2.3
34	C17	0.495	23.114	-0.043	591422	BB	2.5
35		0.002	24.266	0.000	1929	BB	2.2
36	C18	0.475	24.737	0.000	568239	BB	2.7
37		0.005	27.934	0.000	5761	BB	2.7
38	C20	0.490	28.529	-0.065	585663	BB	3.6
39	C28	0.497	33.701	-0.088	593615	BB	5.2
Totals:		99.999		-0.502	119537838		



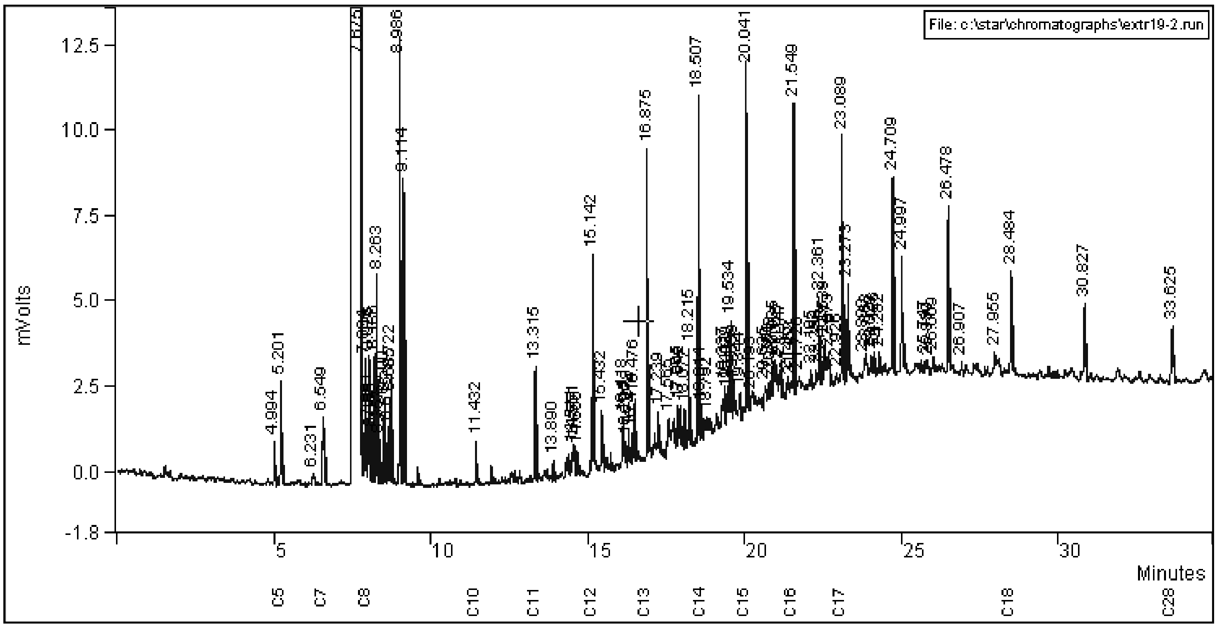


Figure C5: **Duplicate chromatograms of Sample 19 (Extract 19-1 and 19-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at STF T1114.**

```
Title                  : PONA COLUMN EXPERIMENT
Method File            : C:\Star\Extractrun.mth
Sample ID              : extr19-1
Operator               : SHAN
Instrument             : Varian Star 3800
Channel                : Front = FID
Run Time               : 34.965 min
Peak Measurement       : Peak Area
Calculation Type       : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.007	4.994	0.000	8710	BP	2.0
2	C5	0.006	5.202	0.001	7294	PB	2.3
3		0.001	6.236	0.000	1279	BB	3.8
4	C7	0.008	6.550	-0.027	8924	BB	4.3
5		99.611	7.678	0.000	115856456	BP	11.6
6		0.005	7.886	0.000	5422	TS	0.0
7	C8	0.002	7.963	-0.029	2602	TF	0.0
8		0.006	8.028	0.000	6888	TF	0.0
9		0.002	8.106	0.000	1940	TF	0.0
10		0.006	8.187	0.000	6518	TF	0.0
11		0.008	8.265	0.000	9146	TS	0.0
12		0.002	8.359	0.000	1898	TF	0.0
13		0.003	8.502	0.000	4047	TF	0.0
14		0.002	8.617	0.000	2629	TF	0.0
15		0.003	8.687	0.000	3947	TF	0.0
16		0.004	8.724	0.000	4908	TF	0.0
17		0.017	8.988	0.000	20254	VV	0.0
18		0.019	9.117	0.000	21608	VB	0.0
19		0.001	9.573	0.000	1028	BB	1.9
20	C10	0.002	11.435	-0.045	2107	BB	1.6
21	C11	0.005	13.319	-0.051	5914	BB	1.7
22		0.001	13.894	0.000	1366	BB	1.9
23		0.001	14.283	0.000	1159	BV	2.4
24		0.002	14.365	0.000	2059	VV	3.4
25		0.002	14.515	0.000	1846	VV	2.5
26		0.002	14.557	0.000	2000	VV	2.3
27		0.001	14.661	0.000	1423	VV	1.9
28	C12	0.010	15.147	-0.051	11245	PB	1.7
29		0.004	15.437	0.000	4165	BB	1.9
30		0.002	19.278	0.000	1806	VV	2.1
31		0.003	19.342	0.000	3275	VV	2.8
32		0.001	19.413	0.000	1535	VV	2.3
33		0.003	19.444	0.000	3120	VV	3.7
34		0.008	19.539	0.000	9378	VV	2.8
35		0.002	19.645	0.000	2232	VV	2.1
36		0.001	19.696	0.000	1262	VV	0.0
37		0.003	19.850	0.000	3507	VV	4.5
38		0.001	19.960	0.000	1219	VV	3.1
39	C15	0.023	20.046	-0.051	26221	VV	1.8
40		0.002	20.251	0.000	2032	TF	0.0
41		0.001	20.326	0.000	1347	TF	0.0
42		0.001	20.430	0.000	1165	TF	0.0
43		0.002	20.529	0.000	1864	TF	0.0
44		0.002	20.640	0.000	2446	VV	4.5
45		0.001	20.672	0.000	1485	VV	4.5
46		0.004	20.786	0.000	4629	VV	0.0
47		0.002	20.854	0.000	2529	VV	0.0
48		0.005	20.940	0.000	5904	VV	4.4
49		0.003	21.018	0.000	3481	VV	0.0
50		0.003	21.085	0.000	3115	VV	0.0
51		0.004	21.152	0.000	4542	VV	5.3
52		0.002	21.220	0.000	2639	VV	0.0
53		0.003	21.363	0.000	3945	VV	0.0
54		0.002	21.460	0.000	2133	VV	0.0
55	C16	0.017	21.555	-0.056	20195	VV	2.1
56		0.002	21.670	0.000	2392	VV	0.0
57		0.003	21.730	0.000	3983	VV	0.0
58		0.003	21.832	0.000	3197	VV	0.0
59		0.002	21.962	0.000	2746	VV	0.0
60		0.002	22.042	0.000	2236	VV	0.0
61		0.003	22.111	0.000	3511	VV	0.0
62		0.003	22.259	0.000	3827	VV	0.0
63		0.002	22.300	0.000	1759	VV	0.0
64		0.007	22.366	0.000	8606	VV	3.0

65		0.002	22.468	0.000	2710	VV	0.0	
66		0.003	22.542	0.000	3284	VV	0.0	
67		0.004	22.680	0.000	5063	VV	0.0	
68		0.002	22.777	0.000	2143	VV	0.0	
69		0.001	22.880	0.000	1544	VV	0.0	
70		0.002	22.932	0.000	2372	VV	0.0	
71	C17	0.016	23.094	-0.063	19119	VV	2.3	
72		0.008	23.278	0.000	9103	VV	3.3	
73		0.003	23.367	0.000	3499	VV	0.0	
74		0.002	23.525	0.000	2011	VV	0.0	
75		0.002	23.650	0.000	2018	VV	0.0	
76		0.003	23.805	0.000	3175	VV	0.0	
77		0.002	23.868	0.000	2674	VV	0.0	
78		0.001	23.939	0.000	1209	VV	0.0	
79		0.003	24.034	0.000	3125	VV	0.0	
80		0.002	24.131	0.000	2285	VV	0.0	
81		0.003	24.287	0.000	3058	VV	0.0	
82		0.001	24.461	0.000	1728	VV	0.0	
83		0.012	24.715	0.000	14451	VB	2.8	
84		0.008	25.002	0.000	9617	BB	2.5	
85		0.002	25.458	0.000	2537	BV	6.4	
86		0.001	25.548	0.000	1097	VV	3.6	
87		0.001	25.628	0.000	1373	VV	3.1	
88		0.001	25.754	0.000	1176	VV	3.0	
89		0.001	25.835	0.000	1295	VP	3.3	
90		0.001	26.016	0.000	1353	VV	2.8	
91		0.001	26.288	0.000	1390	VV	4.1	
92		0.012	26.483	0.000	13696	VB	2.6	
93		0.001	27.048	0.000	1077	BB	4.1	
94		0.001	27.299	0.000	1323	BV	3.9	
95		0.001	27.418	0.000	1443	VB	8.0	
96		0.002	27.958	0.000	1913	BV	3.1	
97	C18	0.007	28.490	-0.104	8705	BB	2.8	
98	C20	0.001	29.402	0.447	1154	BB	0.0	
99		0.007	30.834	0.000	7592	BB	3.3	
100		0.001	31.896	0.000	1692	BB	5.1	
101	C28	0.006	33.630	-0.159	7376	BB	4.1	
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Totals:		99.998		-0.188	116308425			

Title : PONA COLUMN EXPERIMENT
Method File : C:\Star\Extractrun.mth
Sample ID : extr19-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	Status Codes
1		0.003	4.994	0.000	3096	BB	2.3	
2	C5	0.006	5.201	-0.000	7109	BB	2.2	
3		0.001	6.231	0.000	1229	BB	3.9	
4	C7	0.007	6.549	-0.028	8674	BB	4.4	
5		99.645	7.675	0.000	115584200	BP	11.6	
6		0.005	7.884	0.000	5374	TS	0.0	
7	C8	0.002	7.961	-0.031	2596	TF	0.0	
8		0.006	8.026	0.000	6783	TF	0.0	
9		0.002	8.105	0.000	1844	TS	0.0	
10		0.005	8.186	0.000	6317	TS	0.0	
11		0.008	8.263	0.000	8974	TS	0.0	
12		0.002	8.357	0.000	2039	TS	0.0	
13		0.004	8.500	0.000	4122	PV	0.0	
14		0.002	8.615	0.000	2593	VV	0.0	
15		0.003	8.685	0.000	3883	VV	0.0	
16		0.004	8.722	0.000	5199	VB	0.0	
17		0.017	8.986	0.000	19986	BV	1.4	
18		0.018	9.114	0.000	21420	VB	2.4	
19	C10	0.002	11.432	-0.048	2125	BB	1.7	
20	C11	0.005	13.315	-0.055	5990	BB	1.7	
21		0.001	13.890	0.000	1302	BB	1.9	
22		0.002	14.511	0.000	1743	VV	2.2	
23		0.002	14.551	0.000	2029	VP	2.1	
24		0.001	14.656	0.000	1336	PB	1.9	
25	C12	0.009	15.142	-0.056	10863	BB	1.7	
26		0.003	15.432	0.000	4034	BB	1.9	
27		0.003	16.118	0.000	3469	VV	2.0	
28		0.001	16.205	0.000	1282	VP	1.6	
29		0.002	16.278	0.000	1864	PB	1.8	
30		0.001	16.414	0.000	1634	BV	1.8	
31		0.003	16.476	0.000	3434	VB	1.8	
32	C13	0.014	16.875	-0.055	16427	BB	1.7	
33		0.002	17.239	0.000	1854	BB	1.6	
34		0.002	17.565	0.000	2448	VB	0.0	
35		0.002	17.865	0.000	2695	BV	2.0	
36		0.003	17.942	0.000	3619	VP	2.0	
37		0.002	18.077	0.000	2078	PB	1.7	
38		0.005	18.215	0.000	6289	BB	1.9	
39		0.016	18.507	0.000	18654	BV	1.7	
40	C14	0.002	18.614	0.051	2359	VB	2.2	
41		0.001	18.792	0.000	1151	BB	2.9	
42		0.004	19.337	0.000	4519	BP	2.5	
43		0.001	19.407	0.000	1378	PV	2.0	
44		0.002	19.439	0.000	2588	VV	3.3	
45		0.007	19.534	0.000	8375	VP	2.8	
46		0.001	19.639	0.000	1460	PB	2.2	
47		0.002	19.844	0.000	2623	BB	3.9	
48	C15	0.019	20.041	-0.056	21543	VB	1.8	
49		0.001	20.193	0.000	1614	TF	0.0	
50		0.002	20.635	0.000	2624	BV	4.6	
51		0.002	20.760	0.000	2522	VV	4.7	
52		0.001	20.848	0.000	1207	VV	2.5	
53		0.003	20.935	0.000	3387	VV	3.4	
54		0.001	21.013	0.000	1475	VB	3.3	
55		0.002	21.147	0.000	1864	BP	2.1	
56		0.002	21.357	0.000	1974	BV	3.1	
57		0.001	21.452	0.000	1200	VV	3.1	
58	C16	0.015	21.549	-0.061	17941	VP	2.0	
59		0.002	21.726	0.000	2009	PB	0.0	
60		0.001	22.105	0.000	1581	VP	2.8	
61		0.001	22.254	0.000	1489	PV	2.4	
62		0.006	22.361	0.000	6679	VV	2.2	
63		0.001	22.463	0.000	1511	VV	2.5	
64		0.004	22.539	0.000	4268	VV	3.0	

65		0.004	22.673	0.000	4924	VV	7.0	
66		0.002	22.926	0.000	1897	PV	8.6	
67	C17	0.015	23.089	-0.068	17137	VB	2.1	
68		0.006	23.273	0.000	7264	BV	2.4	
69		0.001	23.800	0.000	1406	BV	2.5	
70		0.001	23.863	0.000	1682	VV	2.8	
71		0.002	24.029	0.000	2473	VV	3.4	
72		0.001	24.126	0.000	1649	VB	2.3	
73		0.002	24.282	0.000	2005	BB	3.1	
74		0.012	24.709	0.000	13605	BB	2.2	
75		0.008	24.997	0.000	8852	BB	2.5	
76		0.001	25.747	0.000	1155	BV	2.9	
77		0.001	25.830	0.000	1128	VB	0.0	
78		0.001	26.009	0.000	1015	BB	2.3	
79		0.011	26.478	0.000	13300	BB	2.6	
80		0.001	26.907	0.000	1045	BB	2.7	
81		0.001	27.955	0.000	1640	BB	0.0	
82	C18	0.007	28.484	-0.110	8492	BB	2.8	
83		0.006	30.827	0.000	7536	BB	3.2	
84	C28	0.006	33.625	-0.164	7282	BB	4.0	
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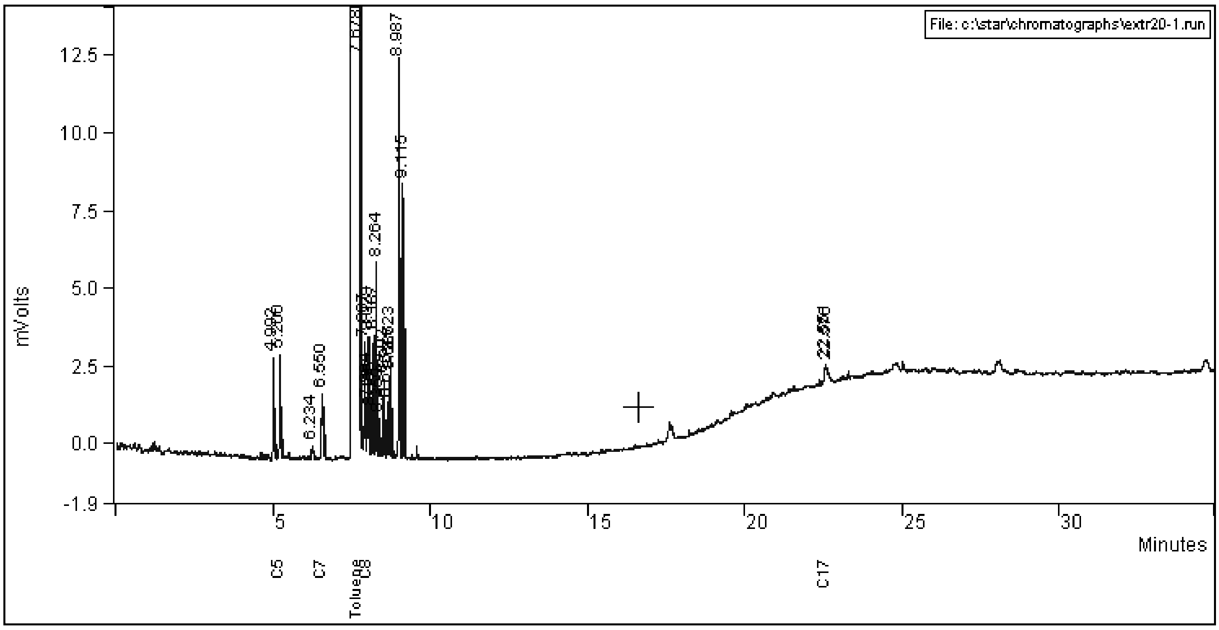
	Totals:	99.994		-0.681	115995435			



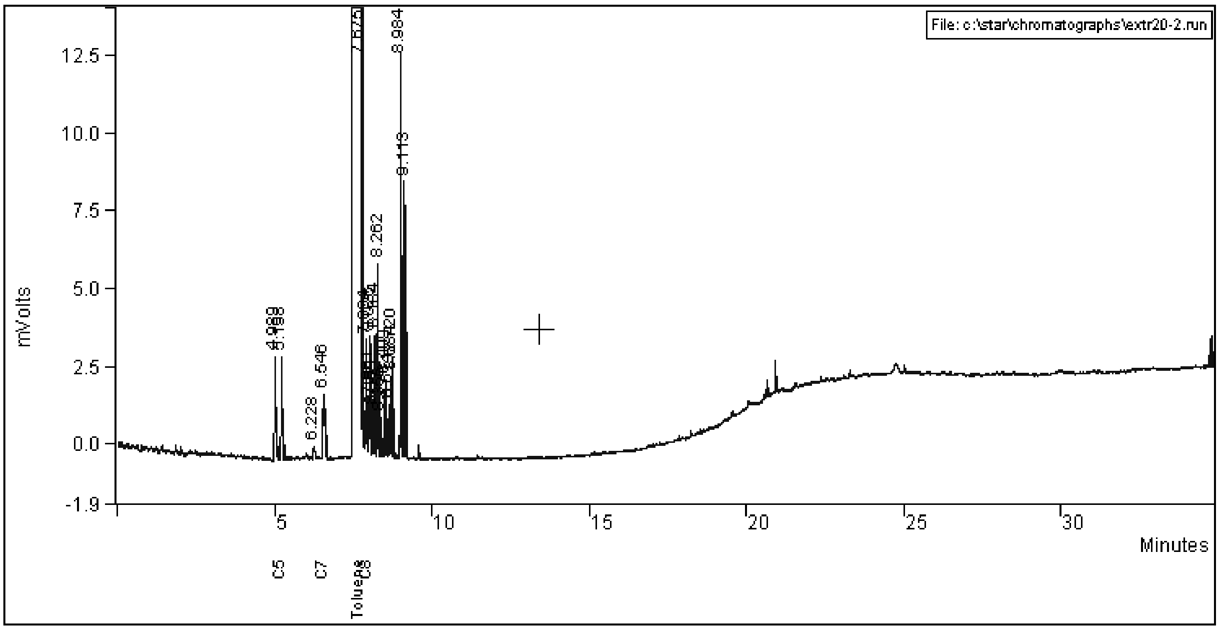


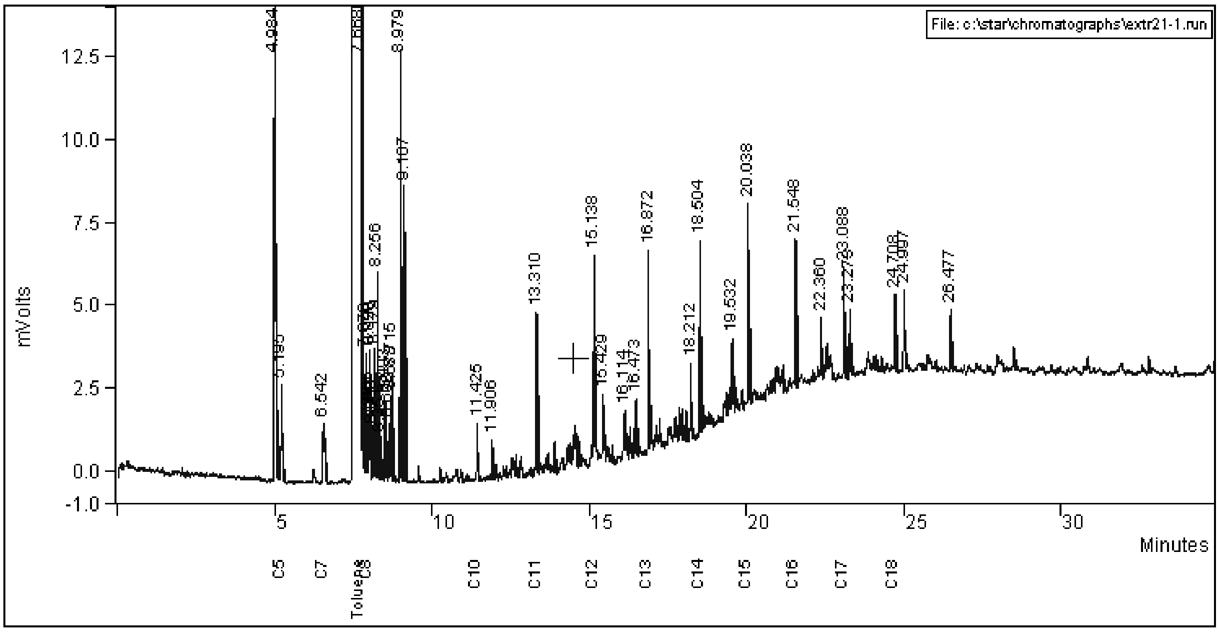
Figure C6: **Duplicate chromatograms of Sample 20 (Extract 20-1 and 20-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at STF T1114.**

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr20-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.992	0.000	7086	BB	2.0
2	C5	0.213	5.200	0.008	7504	BB	2.2
3		0.000	6.234	0.000	1264	BB	3.5
4	C7	0.048	6.550	0.003	8865	BB	4.3
5	Toluene	1.040	7.678	0.017	117379736	BB	11.8
6		0.000	7.887	0.000	5656	TF	0.0
7	C8	0.013	7.964	0.024	2640	TF	0.0
8		0.000	8.028	0.000	7208	TF	0.0
9		0.000	8.106	0.000	1907	TF	0.0
10		0.000	8.187	0.000	6699	TF	0.0
11		0.000	8.264	0.000	9360	TF	0.0
12		0.000	8.359	0.000	1926	TF	0.0
13		0.000	8.502	0.000	3982	TF	0.0
14		0.000	8.616	0.000	2575	TF	0.0
15		0.000	8.686	0.000	3895	TF	0.0
16		0.000	8.723	0.000	4887	TF	0.0
17		0.000	8.987	0.000	19698	TS	0.0
18		0.000	9.115	0.000	20816	TS	0.0
19		0.000	22.551	0.000	1915	BV	4.8
20	C17	0.001	22.576	-0.538	1405	VV	7.0
	Totals:	1.315		-0.486	117499024		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr20-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	
1		0.000	4.989	0.000	7576	BB	2.0	
2	C5	0.212	5.198	0.006	7463	BB	2.2	C
3		0.000	6.228	0.000	1462	BB	3.9	
4	C7	0.048	6.546	-0.001	8937	BB	4.4	
5	Toluene	1.049	7.675	0.014	118309264	BB	11.9	
6		0.000	7.884	0.000	5554	TS	0.0	
7	C8	0.013	7.961	0.022	2603	TF	0.0	
8		0.000	8.026	0.000	6955	TF	0.0	
9		0.000	8.104	0.000	1886	TF	0.0	
10		0.000	8.184	0.000	6735	TF	0.0	
11		0.000	8.262	0.000	9341	TF	0.0	
12		0.000	8.356	0.000	1870	TF	0.0	
13		0.000	8.499	0.000	3953	TF	0.0	
14		0.000	8.614	0.000	2704	TF	0.0	
15		0.000	8.684	0.000	3952	TF	0.0	
16		0.000	8.720	0.000	4889	TF	0.0	
17		0.000	8.984	0.000	19819	BV	1.4	
18		0.000	9.113	0.000	21416	VB	2.4	
	Totals:	1.322		0.041	118426379			



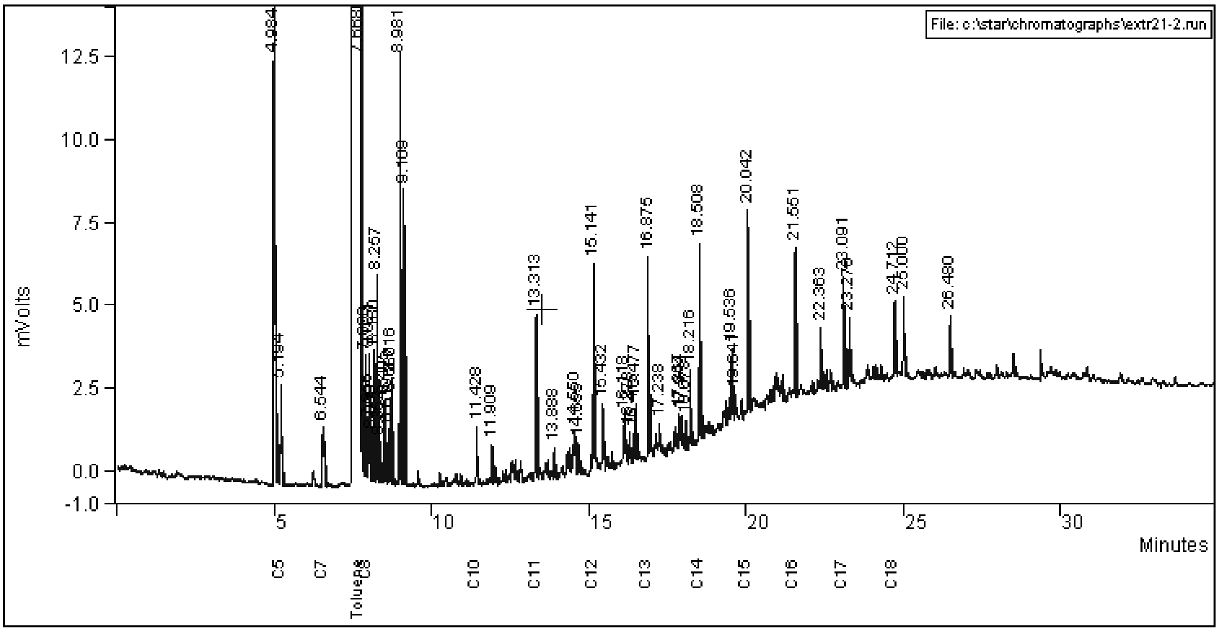


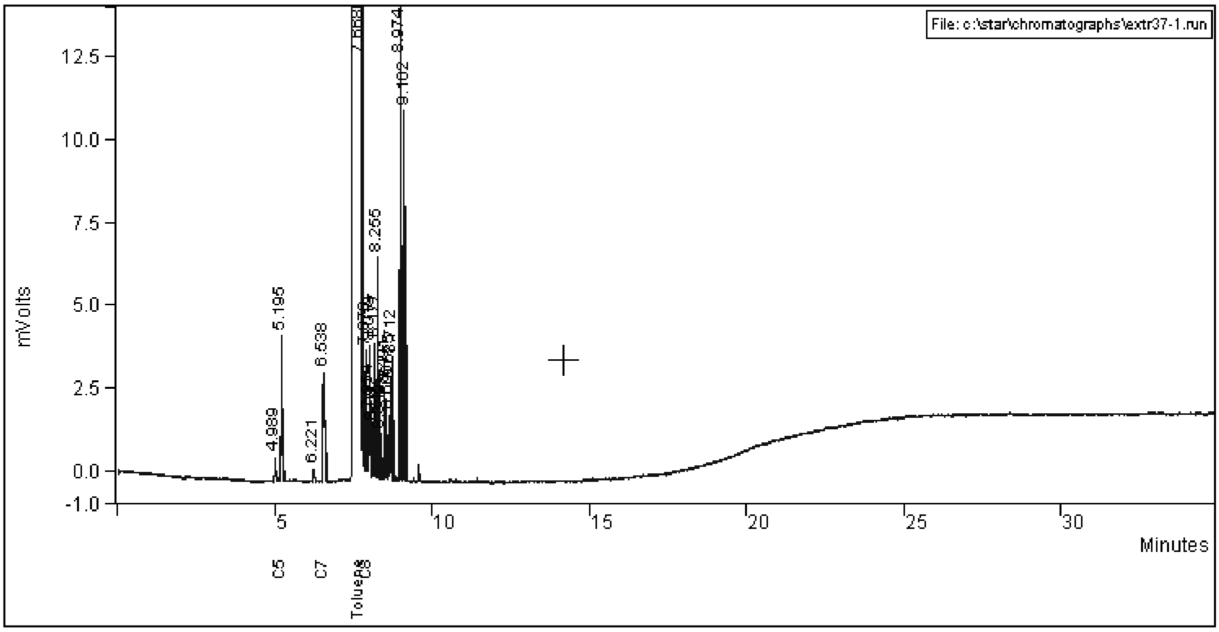
Figure C7: Duplicate chromatograms of Sample 21 (Extract 21-1 and 21-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at STF T1114.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr21-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	
1		0.000	4.984	0.000	47862	BB	2.0	
2	C5	0.198	5.195	0.003	6960	BB	2.3	C
3	C7	0.043	6.542	-0.005	7953	BB	4.5	
4	Toluene	1.050	7.668	0.007	118512848	BB	11.9	
5		0.000	7.878	0.000	5637	TS	0.0	
6	C8	0.012	7.955	0.016	2592	TF	0.0	
7		0.000	7.995	0.000	1472	TF	0.0	
8		0.000	8.020	0.000	5660	TF	0.0	
9		0.000	8.098	0.000	1875	TF	0.0	
10		0.000	8.179	0.000	6700	TF	0.0	
11		0.000	8.256	0.000	9247	TS	0.0	
12		0.000	8.351	0.000	1928	TF	0.0	
13		0.000	8.493	0.000	3890	TF	0.0	
14		0.000	8.608	0.000	2682	TF	0.0	
15		0.000	8.678	0.000	3882	TF	0.0	
16		0.000	8.715	0.000	4949	TF	0.0	
17		0.000	8.979	0.000	20040	BV	1.4	
18		0.000	9.107	0.000	21567	VB	2.4	
19	C10	0.002	11.425	-0.009	2945	BB	1.6	
20		0.000	11.906	0.000	2113	BB	1.7	
21	C11	0.005	13.310	-0.016	8560	BB	1.6	
22	C12	0.006	15.138	-0.018	10306	BB	1.7	
23		0.000	15.429	0.000	5110	BB	1.9	
24		0.000	16.114	0.000	2017	BB	1.5	
25		0.000	16.473	0.000	2990	BB	1.7	
26	C13	0.006	16.872	-0.017	11118	BB	1.8	
27		0.000	18.212	0.000	5136	BB	1.9	
28	C14	0.006	18.504	-0.020	10690	BB	1.7	
29		0.000	19.532	0.000	5893	BB	2.4	
30	C15	0.006	20.038	-0.021	11082	BB	1.8	
31	C16	0.005	21.548	-0.021	9006	BB	1.9	
32		0.000	22.360	0.000	3859	BB	2.0	
33	C17	0.004	23.088	-0.026	7242	BB	2.0	
34		0.000	23.273	0.000	4470	BB	2.2	
35	C18	0.003	24.708	-0.028	5472	BB	2.2	
36		0.000	24.997	0.000	6110	BB	2.4	
37		0.000	26.477	0.000	5141	BB	2.6	
	Totals:	1.346		-0.155	118787004			

```
Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : extr21-2
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	
1		0.000	4.984	0.000	48582	BV	2.0	
2	C5	0.232	5.194	0.002	8147	VB	2.3	C
3	C7	0.044	6.544	-0.003	8149	BB	4.6	
4	Toluene	1.053	7.668	0.007	118826144	BB	11.9	
5		0.000	7.880	0.000	5736	TS	0.0	
6	C8	0.013	7.956	0.017	2750	TF	0.0	
7		0.000	8.021	0.000	7133	TF	0.0	
8		0.000	8.099	0.000	1958	TF	0.0	
9		0.000	8.180	0.000	6955	TF	0.0	
10		0.000	8.257	0.000	9426	TF	0.0	
11		0.000	8.352	0.000	1967	TF	0.0	
12		0.000	8.495	0.000	4075	TF	0.0	
13		0.000	8.610	0.000	2728	TF	0.0	
14		0.000	8.680	0.000	3936	TF	0.0	
15		0.000	8.716	0.000	4941	TF	0.0	
16		0.000	8.981	0.000	20054	BV	1.4	
17		0.000	9.109	0.000	21622	VB	2.4	
18	C10	0.002	11.428	-0.006	2940	BB	1.6	
19		0.000	11.909	0.000	2160	BB	1.7	
20	C11	0.005	13.313	-0.013	8717	BB	1.6	
21		0.000	13.888	0.000	2033	BB	1.9	
22		0.000	14.550	0.000	1322	BB	1.3	
23		0.000	14.655	0.000	2015	BB	1.9	
24	C12	0.006	15.141	-0.015	10627	BB	1.7	
25		0.000	15.432	0.000	5303	BB	2.0	
26		0.000	16.118	0.000	2082	BB	1.5	
27		0.000	16.278	0.000	1801	BB	2.0	
28		0.000	16.415	0.000	1550	BV	1.8	
29		0.000	16.477	0.000	3170	VB	1.8	
30	C13	0.006	16.875	-0.014	10988	BB	1.7	
31		0.000	17.238	0.000	1306	BB	1.6	
32		0.000	17.867	0.000	2205	BV	2.0	
33		0.000	17.944	0.000	2372	VB	0.0	
34		0.000	18.078	0.000	1673	BB	1.7	
35		0.000	18.216	0.000	5198	BB	1.9	
36	C14	0.006	18.508	-0.016	10900	BB	1.7	
37		0.000	19.536	0.000	5906	BB	2.4	
38		0.000	19.641	0.000	1153	BB	1.8	
39	C15	0.006	20.042	-0.017	11099	BB	1.7	
40	C16	0.005	21.551	-0.018	8976	BB	1.9	
41		0.000	22.363	0.000	4099	BB	2.0	
42	C17	0.004	23.091	-0.023	7272	BB	2.0	
43		0.000	23.276	0.000	4913	BB	2.3	
44	C18	0.003	24.712	-0.025	5399	BB	2.2	
45		0.000	25.000	0.000	5895	BB	2.4	
46		0.000	26.480	0.000	5157	BB	2.6	
	Totals:	1.385		-0.124	119122534			



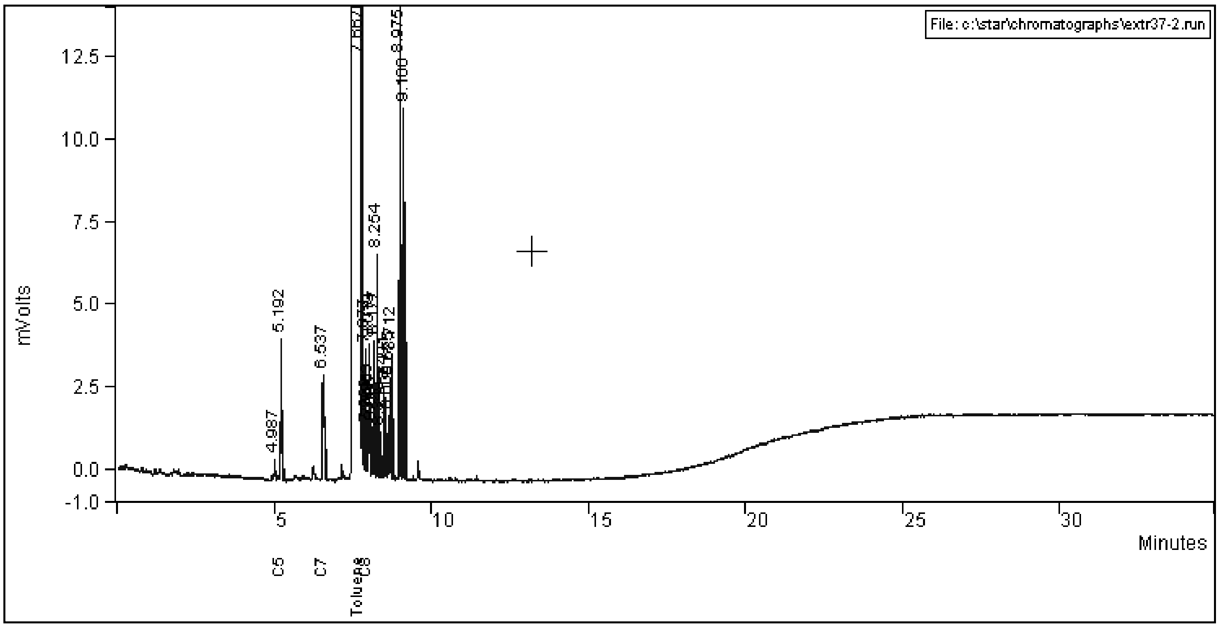


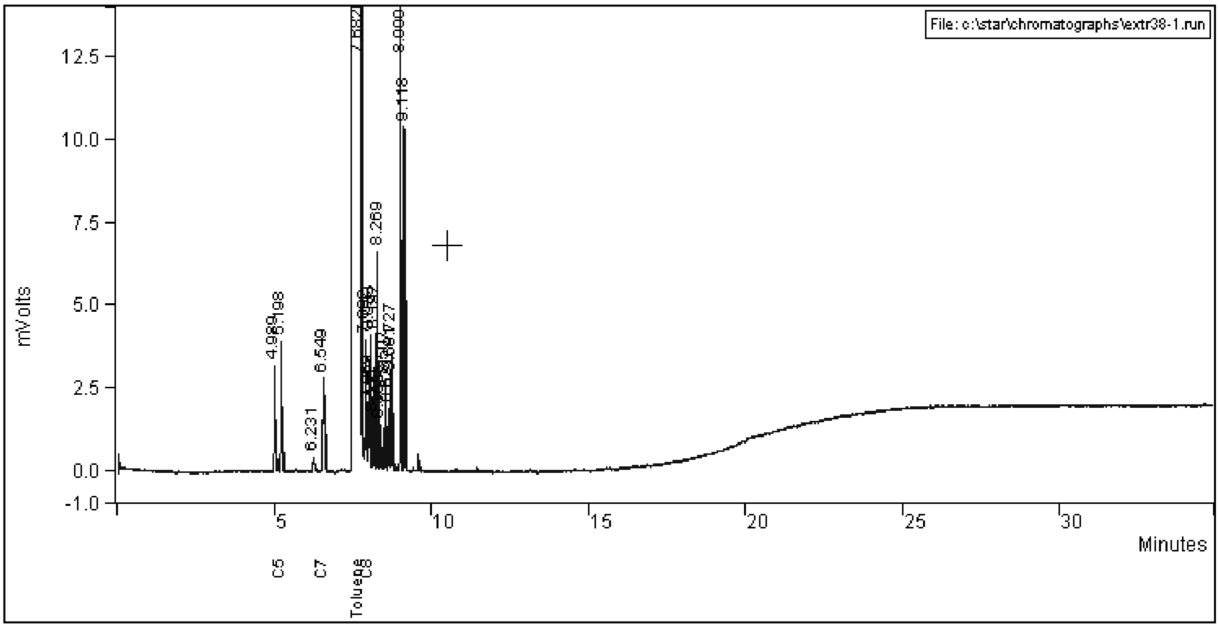
Figure C8: **Duplicate chromatograms of Sample 37 (Extract 37-1 and 37-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at STF T1118.**

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr37-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.989	0.000	1491	BV	2.0
2	C5	0.264	5.195	0.003	9300	PB	2.0
3		0.000	6.221	0.000	1173	BB	3.0
4	C7	0.070	6.538	-0.009	13050	BB	4.0
5	Toluene	1.049	7.668	0.007	118345296	BB	11.9
6		0.000	7.878	0.000	5775	TF	0.0
7	C8	0.014	7.954	0.015	2958	TF	0.0
8		0.000	8.019	0.000	7444	TF	0.0
9		0.000	8.097	0.000	2014	TF	0.0
10		0.000	8.177	0.000	6933	TF	0.0
11		0.000	8.255	0.000	9889	TS	0.0
12		0.000	8.349	0.000	2070	TS	0.0
13		0.000	8.491	0.000	4160	TF	0.0
14		0.000	8.606	0.000	3140	TF	0.0
15		0.000	8.675	0.000	4368	TF	0.0
16		0.000	8.712	0.000	5560	TF	0.0
17		0.000	8.974	0.000	24069	BV	1.4
18		0.000	9.102	0.000	25906	VB	2.3
	Totals:	1.397		0.016	118474596		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr37-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.987	0.000	1268	BB	1.8
2	C5	0.260	5.192	0.000	9161	BB	1.9
3	C7	0.069	6.537	-0.010	12843	BB	4.1
4	Toluene	1.052	7.667	0.006	118749440	BB	7.2
5		0.000	7.877	0.000	4536	TF	0.0
6		0.000	7.903	0.000	1226	TF	0.0
7	C8	0.014	7.953	0.014	2852	TF	0.0
8		0.000	7.991	0.000	1694	TF	0.0
9		0.000	8.019	0.000	5623	TF	0.0
10		0.000	8.096	0.000	1936	TF	0.0
11		0.000	8.177	0.000	7041	TF	0.0
12		0.000	8.254	0.000	9985	TS	0.0
13		0.000	8.349	0.000	2082	TS	0.0
14		0.000	8.491	0.000	4121	BP	1.3
15		0.000	8.606	0.000	2739	PV	1.3
16		0.000	8.675	0.000	4365	VV	1.4
17		0.000	8.712	0.000	5490	VB	1.4
18		0.000	8.975	0.000	24149	BP	1.4
19		0.000	9.100	0.000	25983	PB	2.3
	Totals:	1.395		0.010	118876534		



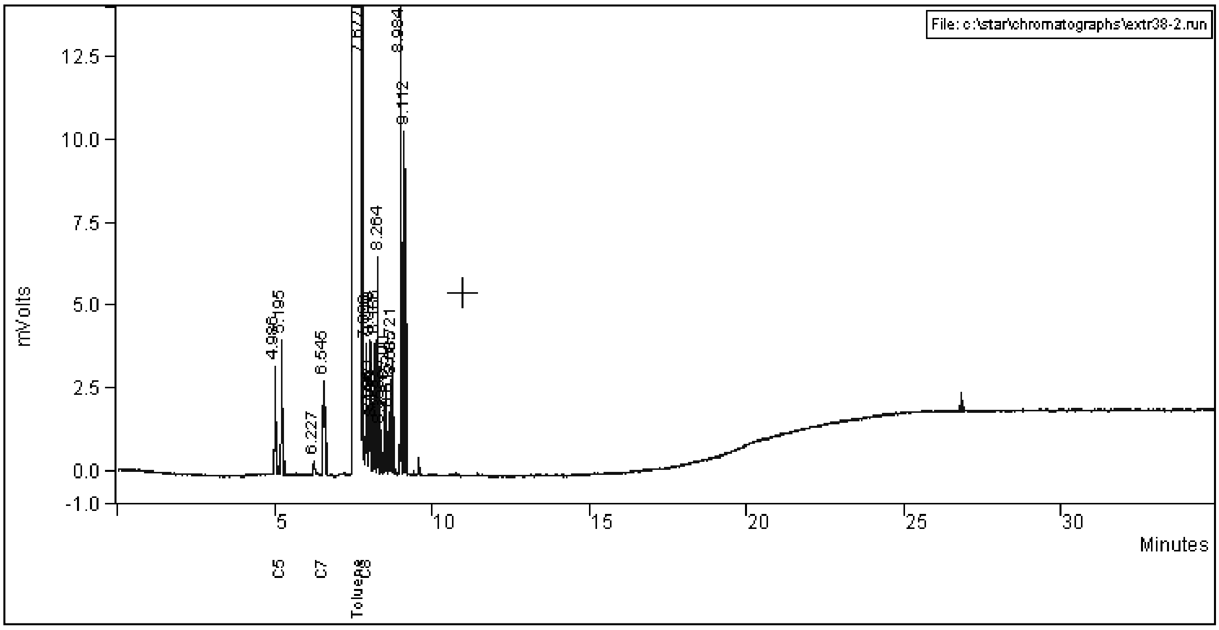


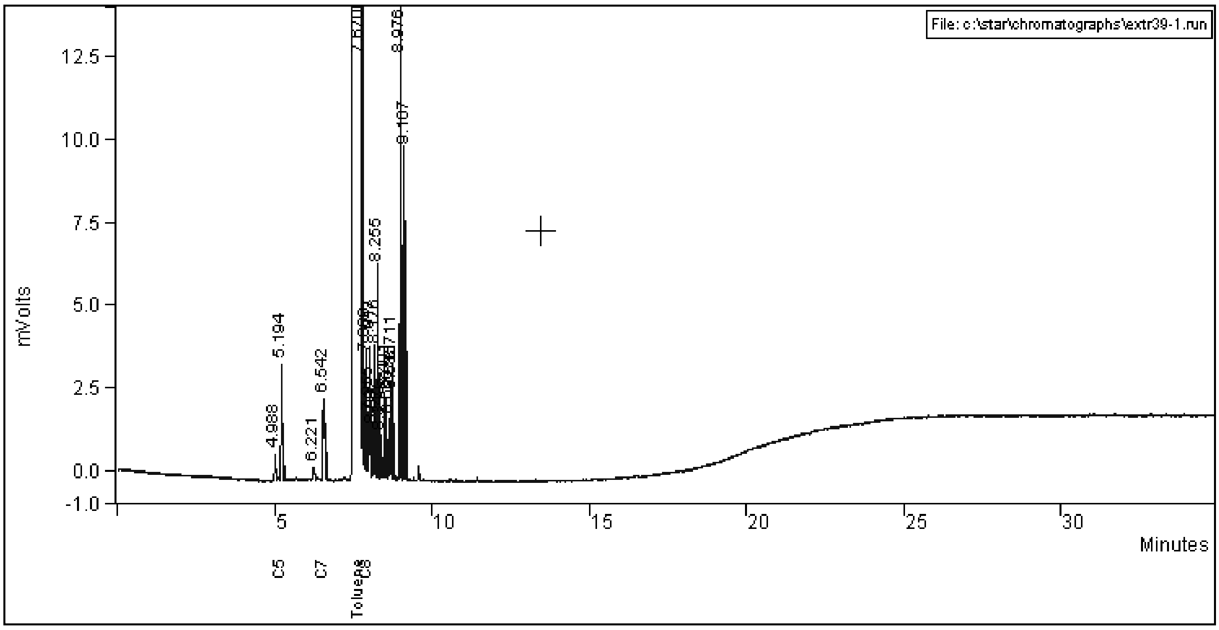
Figure C9: Duplicate chromatograms of Sample 38 (Extract 38-1 and 38-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at STF T1118.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr38-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.989	0.000	7017	BV	2.0
2	C5	0.250	5.198	0.006	8793	VB	2.1
3		0.000	6.231	0.000	1343	BB	3.4
4	C7	0.063	6.549	0.002	11746	BB	4.2
5	Toluene	1.057	7.682	0.021	119207440	BP	11.9
6		0.000	7.892	0.000	5634	TS	0.0
7	C8	0.013	7.969	0.030	2772	TF	0.0
8		0.000	8.033	0.000	7278	TF	0.0
9		0.000	8.111	0.000	1977	TF	0.0
10		0.000	8.192	0.000	6836	TF	0.0
11		0.000	8.269	0.000	9729	TS	0.0
12		0.000	8.363	0.000	2047	TS	0.0
13		0.000	8.507	0.000	4094	TF	0.0
14		0.000	8.621	0.000	2739	TF	0.0
15		0.000	8.691	0.000	4179	TF	0.0
16		0.000	8.727	0.000	5293	TF	0.0
17		0.000	8.990	0.000	22531	VV	0.0
18		0.000	9.118	0.000	24302	VB	0.0
	Totals:	1.383		0.059	119335750		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr38-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.986	0.000	6639	BV	1.8
2	C5	0.246	5.195	0.003	8663	VB	1.9
3		0.000	6.227	0.000	1253	BB	3.4
4	C7	0.063	6.545	-0.002	11831	BB	4.1
5	Toluene	1.051	7.677	0.016	118556104	BP	11.9
6		0.000	7.886	0.000	5722	TS	0.0
7	C8	0.013	7.963	0.024	2746	TF	0.0
8		0.000	8.003	0.000	1292	TF	0.0
9		0.000	8.028	0.000	5940	TF	0.0
10		0.000	8.106	0.000	2009	TF	0.0
11		0.000	8.186	0.000	6839	TF	0.0
12		0.000	8.264	0.000	9743	TS	0.0
13		0.000	8.358	0.000	2048	TF	0.0
14		0.000	8.500	0.000	4089	TF	0.0
15		0.000	8.615	0.000	2846	TF	0.0
16		0.000	8.685	0.000	4208	TF	0.0
17		0.000	8.721	0.000	5327	TF	0.0
18		0.000	8.984	0.000	22648	VV	0.0
19		0.000	9.112	0.000	24471	VB	0.0
	Totals:	1.373		0.041	118684418		



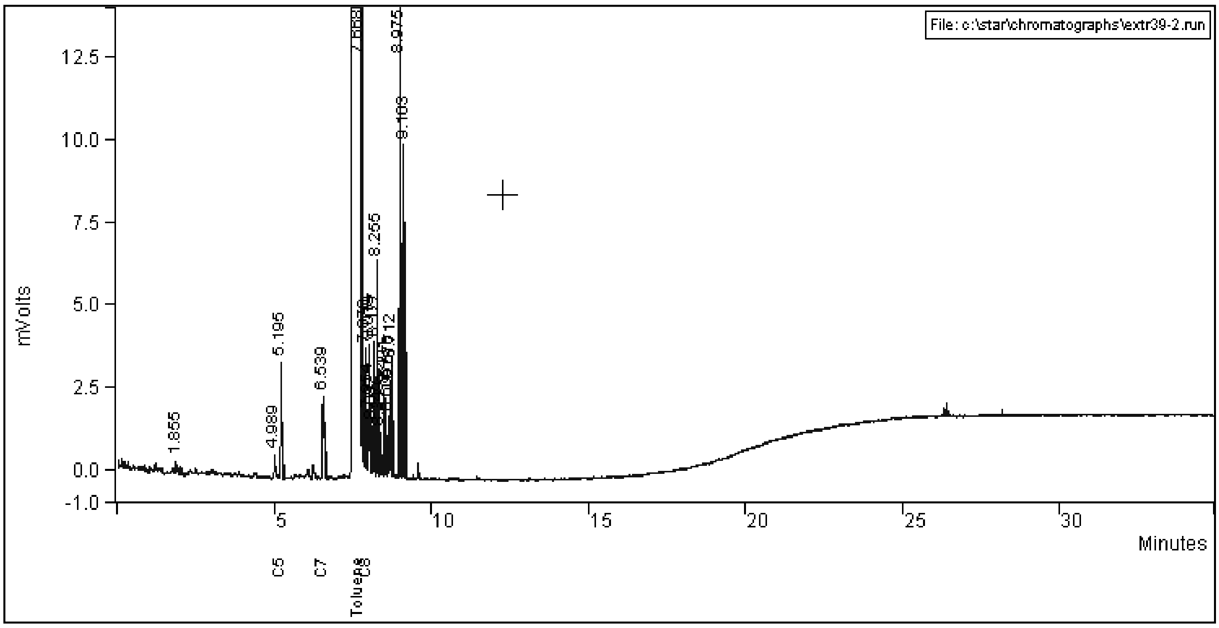


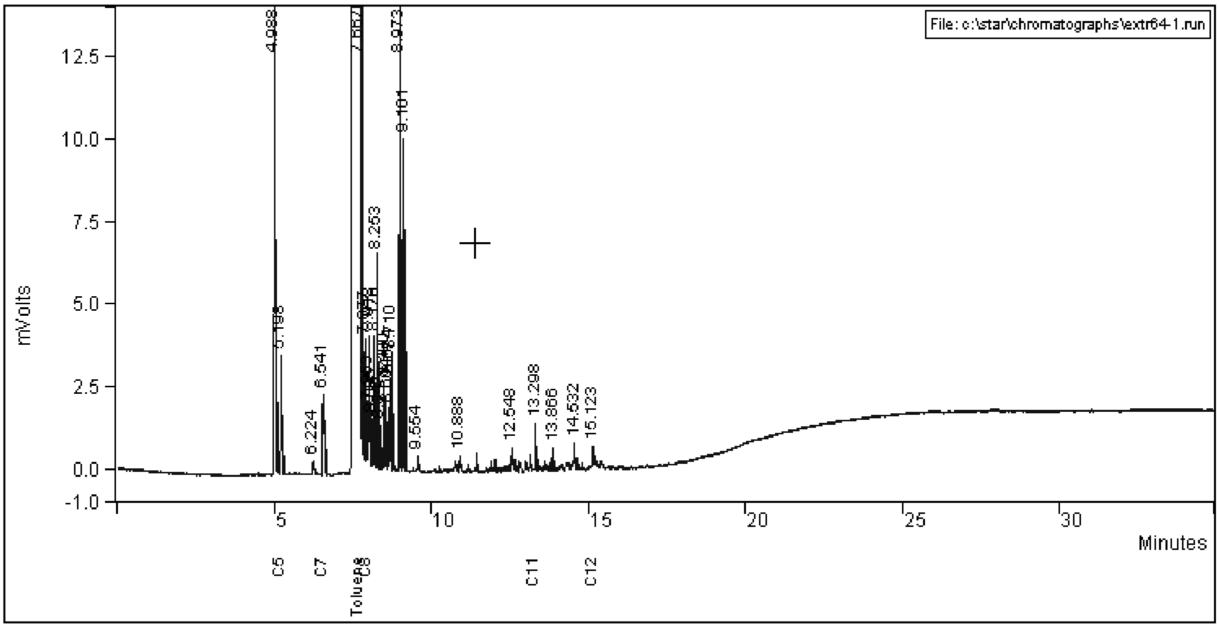
Figure C10: Duplicate chromatograms of Sample 39 (Extract 39-1 and 39-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at STF T1118.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr39-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.988	0.000	1758	BB	2.1
2	C5	0.230	5.194	0.002	8109	BB	2.2
3		0.000	6.221	0.000	1236	BB	3.5
4	C7	0.058	6.542	-0.005	10865	BB	4.3
5	Toluene	1.053	7.670	0.009	118805472	BB	11.9
6		0.000	7.880	0.000	5648	TF	0.0
7	C8	0.014	7.955	0.016	2889	TF	0.0
8		0.000	8.017	0.000	7155	TF	0.0
9		0.000	8.097	0.000	1993	TF	0.0
10		0.000	8.176	0.000	6784	TF	0.0
11		0.000	8.255	0.000	9615	TS	0.0
12		0.000	8.349	0.000	2024	TF	0.0
13		0.000	8.491	0.000	4130	TF	0.0
14		0.000	8.606	0.000	2684	TF	0.0
15		0.000	8.685	0.000	3640	TF	0.0
16		0.000	8.711	0.000	5655	TF	0.0
17		0.000	8.976	0.000	22121	TF	0.0
18		0.000	9.107	0.000	23783	TF	0.0
	Totals:	1.355		0.022	118925561		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr39-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	1.855	0.000	1173	BB	2.0
2		0.000	4.989	0.000	1302	BB	1.7
3	C5	0.219	5.195	0.003	7700	BB	2.0
4	C7	0.057	6.539	-0.008	10580	BB	4.3
5	Toluene	1.053	7.668	0.007	118788056	BB	11.9
6		0.000	7.878	0.000	5660	TS	0.0
7	C8	0.014	7.954	0.015	2827	TF	0.0
8		0.000	8.019	0.000	7198	TF	0.0
9		0.000	8.097	0.000	1924	TF	0.0
10		0.000	8.177	0.000	7060	TF	0.0
11		0.000	8.255	0.000	9721	TF	0.0
12		0.000	8.349	0.000	2074	TF	0.0
13		0.000	8.491	0.000	4079	TF	0.0
14		0.000	8.606	0.000	2795	TF	0.0
15		0.000	8.676	0.000	4152	TF	0.0
16		0.000	8.712	0.000	5165	TF	0.0
17		0.000	8.975	0.000	22156	BV	1.4
18		0.000	9.103	0.000	23907	VB	2.4
	Totals:	1.343		0.017	118907529		



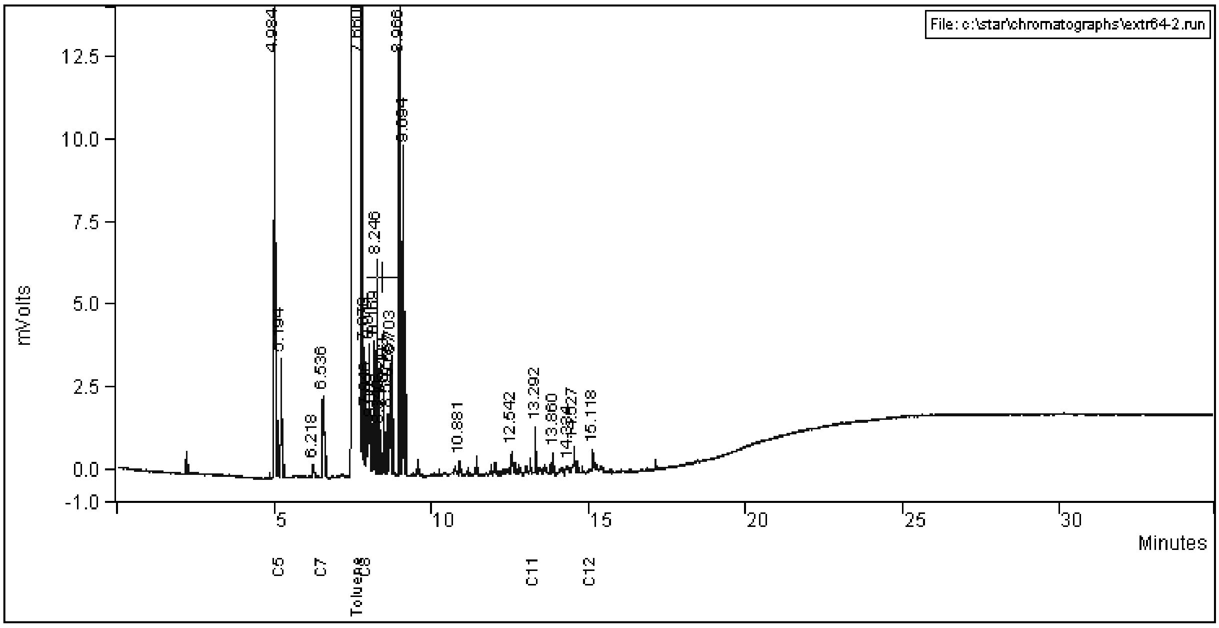


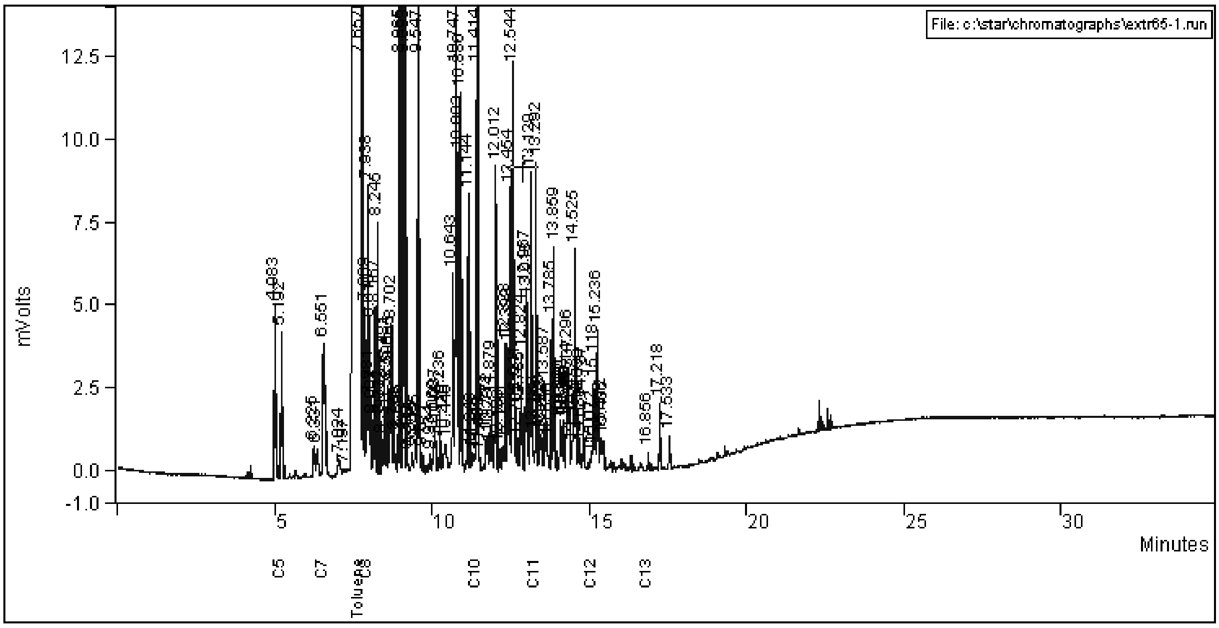
Figure C11: Duplicate chromatograms of Sample 64 (Extract 64-1 and 64-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at MOGAS T1309.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr64-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	
1		0.000	4.988	0.000	42145	BB	1.9	
2	C5	0.239	5.198	0.006	8413	VB	2.2	C
3		0.000	6.224	0.000	1362	BB	3.7	
4	C7	0.059	6.541	-0.006	10936	BB	4.3	
5	Toluene	1.060	7.667	0.006	119594960	BB	12.0	
6		0.000	7.877	0.000	5711	TS	0.0	
7	C8	0.014	7.953	0.014	2816	TF	0.0	
8		0.000	8.018	0.000	7279	TF	0.0	
9		0.000	8.095	0.000	1984	TF	0.0	
10		0.000	8.176	0.000	6921	TF	0.0	
11		0.000	8.253	0.000	9725	TS	0.0	
12		0.000	8.347	0.000	2044	TF	0.0	
13		0.000	8.490	0.000	4003	TF	0.0	
14		0.000	8.604	0.000	2783	TF	0.0	
15		0.000	8.674	0.000	4201	TF	0.0	
16		0.000	8.710	0.000	5316	TF	0.0	
17		0.000	8.973	0.000	22510	TF	0.0	
18		0.000	9.101	0.000	23892	TF	0.0	
19		0.000	9.554	0.000	1199	VB	1.8	
20		0.000	10.888	0.000	1410	BB	2.9	
21		0.000	12.548	0.000	1705	PV	2.2	
22	C11	0.002	13.298	-0.028	2721	BB	1.7	
23		0.000	13.866	0.000	1464	VP	1.9	
24		0.000	14.532	0.000	2623	VP	2.3	
25	C12	0.001	15.123	-0.033	1316	BV	1.7	
	Totals:	1.375		-0.041	119769439			

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr64-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	
1		0.000	4.984	0.000	40908	BB	1.9	
2	C5	0.232	5.194	0.002	8148	BB	2.1	C
3		0.000	6.218	0.000	1286	BB	3.4	
4	C7	0.055	6.536	-0.010	10286	BB	4.2	
5	Toluene	1.052	7.660	-0.001	118690872	BP	11.9	
6		0.000	7.870	0.000	5648	TS	0.0	
7	C8	0.013	7.946	0.007	2704	TF	0.0	
8		0.000	8.011	0.000	7079	TF	0.0	
9		0.000	8.089	0.000	1993	TF	0.0	
10		0.000	8.169	0.000	6848	TF	0.0	
11		0.000	8.246	0.000	9665	TS	0.0	
12		0.000	8.340	0.000	2104	TF	0.0	
13		0.000	8.483	0.000	4226	TF	0.0	
14		0.000	8.597	0.000	2764	TF	0.0	
15		0.000	8.667	0.000	4167	TF	0.0	
16		0.000	8.703	0.000	5231	TF	0.0	
17		0.000	8.966	0.000	22343	PV	0.0	
18		0.000	9.094	0.000	23618	VB	0.0	
19		0.000	10.881	0.000	1183	BB	2.7	
20		0.000	12.542	0.000	1663	VV	2.3	
21	C11	0.002	13.292	-0.034	2629	BB	1.7	
22		0.000	13.860	0.000	1382	VB	1.9	
23		0.000	14.334	0.000	1174	VV	5.7	
24		0.000	14.527	0.000	2704	VP	2.2	
25	C12	0.001	15.118	-0.038	1166	BV	1.6	
	Totals:	1.355		-0.074	118861791			



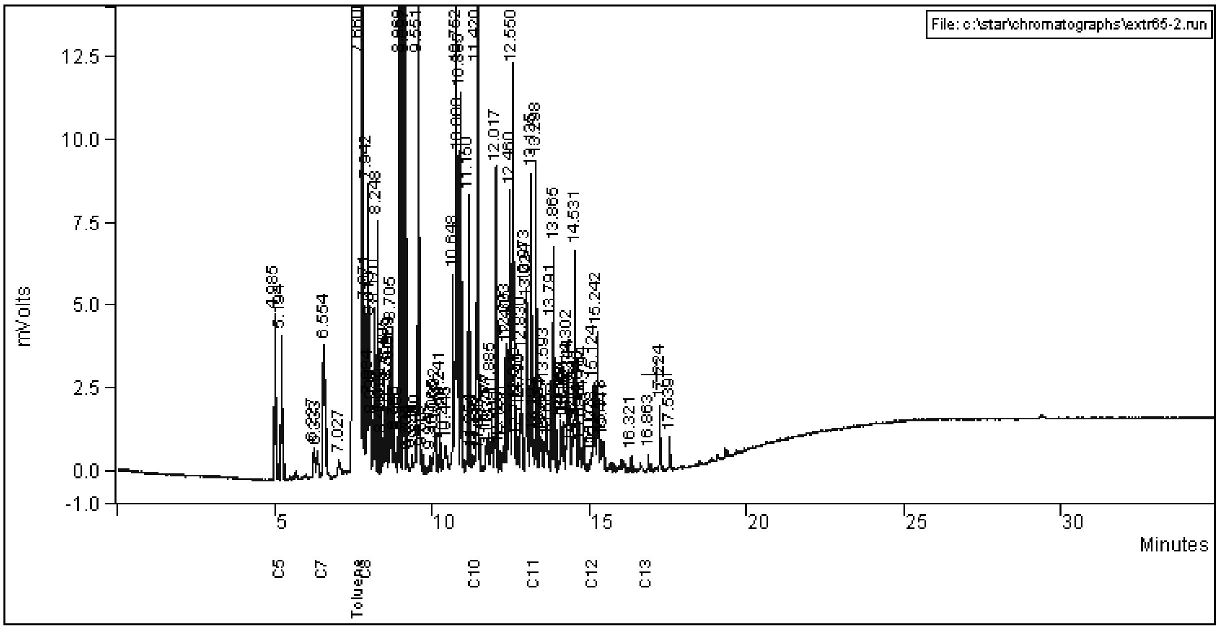


Figure C12: Duplicate chromatograms of Sample 65 (Extract 65-1 and 65-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at MOGAS T1309.

```
Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : extr65-1
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.983	0.000	10871	BP	1.8
2	C5	0.278	5.192	-0.000	9797	PB	2.0
3		0.000	6.225	0.000	3174	BV	3.4
4		0.000	6.331	0.000	2848	VB	3.5
5	C7	0.104	6.551	0.004	19406	BB	4.6
6		0.000	7.024	0.000	4225	BV	6.4
7		0.000	7.197	0.000	1463	VV	0.0
8	Toluene	1.060	7.657	-0.004	119653312	VP	12.0
9		0.000	7.869	0.000	7581	TF	0.0
10	C8	0.060	7.938	-0.001	12500	TF	0.0
11		0.000	7.981	0.000	2081	TF	0.0
12		0.000	8.010	0.000	6434	TF	0.0
13		0.000	8.087	0.000	2187	TF	0.0
14		0.000	8.167	0.000	8601	TF	0.0
15		0.000	8.245	0.000	11564	TS	0.0
16		0.000	8.337	0.000	3675	TF	0.0
17		0.000	8.397	0.000	1649	TF	0.0
18		0.000	8.481	0.000	4925	TF	0.0
19		0.000	8.523	0.000	2993	TF	0.0
20		0.000	8.596	0.000	5051	TF	0.0
21		0.000	8.665	0.000	5273	TF	0.0
22		0.000	8.702	0.000	7332	TF	0.0
23		0.000	8.785	0.000	2691	TF	0.0
24		0.000	8.896	0.000	2015	TF	0.0
25		0.000	8.965	0.000	50236	TF	0.0
26		0.000	9.093	0.000	86513	TF	0.0
27		0.000	9.200	0.000	1768	TF	0.0
28		0.000	9.344	0.000	1810	TF	0.0
29		0.000	9.455	0.000	2756	TF	0.0
30		0.000	9.547	0.000	36625	TF	0.0
31		0.000	9.677	0.000	1581	TF	0.0
32		0.000	9.934	0.000	1324	TF	0.0
33		0.000	10.060	0.000	2030	TF	0.0
34		0.000	10.087	0.000	4104	TF	0.0
35		0.000	10.236	0.000	3927	TF	0.0
36		0.000	10.376	0.000	2950	TF	0.0
37		0.000	10.440	0.000	2396	TF	0.0
38		0.000	10.643	0.000	14276	TF	0.0
39		0.000	10.747	0.000	47197	TF	0.0
40		0.000	10.803	0.000	16769	TF	0.0
41		0.000	10.880	0.000	25597	TF	0.0
42		0.000	11.144	0.000	15999	TF	0.0
43		0.000	11.248	0.000	1446	TF	0.0
44		0.000	11.323	0.000	1678	TF	0.0
45	C10	0.056	11.414	-0.020	79977	TF	0.0
46		0.000	11.482	0.000	1307	TF	0.0
47		0.000	11.712	0.000	2875	TF	0.0
48		0.000	11.772	0.000	2572	TF	0.0
49		0.000	11.828	0.000	1240	TF	0.0

50		0.000	11.879	0.000	6112	TF	0.0
51		0.000	12.012	0.000	19258	TF	0.0
52		0.000	12.123	0.000	1705	TF	0.0
53		0.000	12.230	0.000	2388	TF	0.0
54		0.000	12.328	0.000	8504	TF	0.0
55		0.000	12.399	0.000	7198	TF	0.0
56		0.000	12.454	0.000	16284	TF	0.0
57		0.000	12.544	0.000	33640	TF	0.0
58		0.000	12.641	0.000	4107	TF	0.0
59		0.000	12.705	0.000	2316	TF	0.0
60		0.000	12.785	0.000	3226	TF	0.0
61		0.000	12.824	0.000	6963	TF	0.0
62		0.000	12.967	0.000	10525	TF	0.0
63		0.000	13.018	0.000	10259	TF	0.0
64		0.000	13.129	0.000	17449	TF	0.0
65		0.000	13.188	0.000	2293	TF	0.0
66	C11	0.012	13.292	-0.034	19886	TF	0.0
67		0.000	13.428	0.000	3571	TF	0.0
68		0.000	13.468	0.000	2372	TF	0.0
69		0.000	13.587	0.000	6680	TF	0.0
70		0.000	13.656	0.000	2638	TF	0.0
71		0.000	13.785	0.000	9564	TF	0.0
72		0.000	13.859	0.000	13614	TF	0.0
73		0.000	14.060	0.000	3200	TF	0.0
74		0.000	14.088	0.000	2744	TF	0.0
75		0.000	14.157	0.000	3826	TF	0.0
76		0.000	14.261	0.000	2387	TF	0.0
77		0.000	14.296	0.000	6987	TF	0.0
78		0.000	14.337	0.000	4575	TF	0.0
79		0.000	14.420	0.000	1427	TF	0.0
80		0.000	14.477	0.000	3920	TF	0.0
81		0.000	14.525	0.000	16396	TF	0.0
82		0.000	14.639	0.000	4826	TF	0.0
83		0.000	14.689	0.000	1380	TF	0.0
84		0.000	14.787	0.000	4823	TF	0.0
85		0.000	15.017	0.000	1120	TF	0.0
86		0.000	15.072	0.000	1444	TF	0.0
87	C12	0.004	15.118	-0.038	7543	TF	0.0
88		0.000	15.236	0.000	12087	TF	0.0
89		0.000	15.372	0.000	3840	TF	0.0
90		0.000	15.436	0.000	2431	TF	0.0
91	C13	0.001	16.856	-0.033	1205	VV	0.0
92		0.000	17.218	0.000	4413	VB	0.0
93		0.000	17.533	0.000	2014	BB	1.9
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	Totals:	1.575		-0.126	120503741		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr65-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.985	0.000	10819	BB	1.9
2	C5	0.282	5.194	0.002	9918	VB	2.1
3		0.000	6.227	0.000	3220	BV	3.6
4		0.000	6.333	0.000	2952	VB	3.6
5	C7	0.108	6.554	0.007	20189	BB	4.7
6		0.000	7.027	0.000	3312	BV	6.1
7	Toluene	1.061	7.660	-0.001	119745664	VP	12.0
8		0.000	7.871	0.000	7568	TF	0.0
9	C8	0.060	7.942	0.003	12510	TF	0.0
10		0.000	7.984	0.000	2106	TF	0.0
11		0.000	8.013	0.000	6460	TF	0.0
12		0.000	8.090	0.000	2285	TF	0.0
13		0.000	8.170	0.000	8648	TF	0.0
14		0.000	8.248	0.000	11542	TS	0.0
15		0.000	8.340	0.000	3605	TF	0.0
16		0.000	8.400	0.000	1632	TF	0.0
17		0.000	8.485	0.000	4872	TF	0.0
18		0.000	8.527	0.000	2969	TF	0.0
19		0.000	8.599	0.000	4927	TF	0.0
20		0.000	8.669	0.000	5203	TF	0.0
21		0.000	8.705	0.000	7150	TF	0.0
22		0.000	8.788	0.000	2713	TF	0.0
23		0.000	8.900	0.000	1932	TF	0.0
24		0.000	8.969	0.000	50102	TF	0.0
25		0.000	9.097	0.000	86421	TF	0.0
26		0.000	9.204	0.000	1628	TF	0.0
27		0.000	9.349	0.000	1768	TF	0.0
28		0.000	9.460	0.000	2695	TF	0.0
29		0.000	9.551	0.000	36497	TF	0.0
30		0.000	9.682	0.000	1502	TF	0.0
31		0.000	9.940	0.000	1367	TF	0.0
32		0.000	10.065	0.000	1889	TF	0.0
33		0.000	10.092	0.000	4172	TF	0.0
34		0.000	10.241	0.000	3921	TF	0.0
35		0.000	10.381	0.000	2877	TF	0.0
36		0.000	10.445	0.000	2637	TF	0.0
37		0.000	10.648	0.000	14365	TF	0.0
38		0.000	10.752	0.000	47200	TF	0.0
39		0.000	10.808	0.000	16847	TF	0.0
40		0.000	10.885	0.000	25578	TF	0.0
41		0.000	11.150	0.000	16056	TF	0.0
42		0.000	11.254	0.000	1392	TF	0.0
43		0.000	11.330	0.000	1671	TF	0.0
44	C10	0.056	11.420	-0.014	80218	TF	0.0
45		0.000	11.486	0.000	1379	TF	0.0
46		0.000	11.717	0.000	2898	TF	0.0
47		0.000	11.777	0.000	2594	TF	0.0
48		0.000	11.834	0.000	1215	TF	0.0
49		0.000	11.885	0.000	6134	TF	0.0
50		0.000	12.017	0.000	19349	TF	0.0

51		0.000	12.129	0.000	1721	TF	0.0
52		0.000	12.235	0.000	2390	TF	0.0
53		0.000	12.333	0.000	8533	TF	0.0
54		0.000	12.405	0.000	7209	TF	0.0
55		0.000	12.460	0.000	16336	TF	0.0
56		0.000	12.550	0.000	33701	TF	0.0
57		0.000	12.646	0.000	4111	TF	0.0
58		0.000	12.711	0.000	2364	TF	0.0
59		0.000	12.790	0.000	3199	TF	0.0
60		0.000	12.830	0.000	7029	TF	0.0
61		0.000	12.973	0.000	10549	TF	0.0
62		0.000	13.024	0.000	10364	TF	0.0
63		0.000	13.135	0.000	17597	TF	0.0
64		0.000	13.193	0.000	2301	TF	0.0
65	C11	0.012	13.298	-0.028	19897	TF	0.0
66		0.000	13.433	0.000	3564	TF	0.0
67		0.000	13.474	0.000	2324	TF	0.0
68		0.000	13.593	0.000	6667	TF	0.0
69		0.000	13.663	0.000	2678	TF	0.0
70		0.000	13.791	0.000	9528	TF	0.0
71		0.000	13.865	0.000	13712	TF	0.0
72		0.000	14.067	0.000	3279	TF	0.0
73		0.000	14.093	0.000	2743	TF	0.0
74		0.000	14.164	0.000	3858	TF	0.0
75		0.000	14.267	0.000	2355	TF	0.0
76		0.000	14.302	0.000	7034	TF	0.0
77		0.000	14.344	0.000	4557	TF	0.0
78		0.000	14.427	0.000	1364	TF	0.0
79		0.000	14.484	0.000	3918	TF	0.0
80		0.000	14.531	0.000	16553	TF	0.0
81		0.000	14.646	0.000	4860	TF	0.0
82		0.000	14.696	0.000	1411	TF	0.0
83		0.000	14.794	0.000	4561	TF	0.0
84		0.000	15.023	0.000	1149	TF	0.0
85		0.000	15.078	0.000	1400	TF	0.0
86	C12	0.004	15.124	-0.032	7559	TF	0.0
87		0.000	15.242	0.000	12241	TF	0.0
88		0.000	15.378	0.000	3842	TF	0.0
89		0.000	15.441	0.000	2517	TF	0.0
90		0.000	16.321	0.000	1045	VV	0.0
91	C13	0.001	16.863	-0.026	1161	VV	0.0
92		0.000	17.224	0.000	4410	VB	0.0
93		0.000	17.539	0.000	2007	BB	1.9
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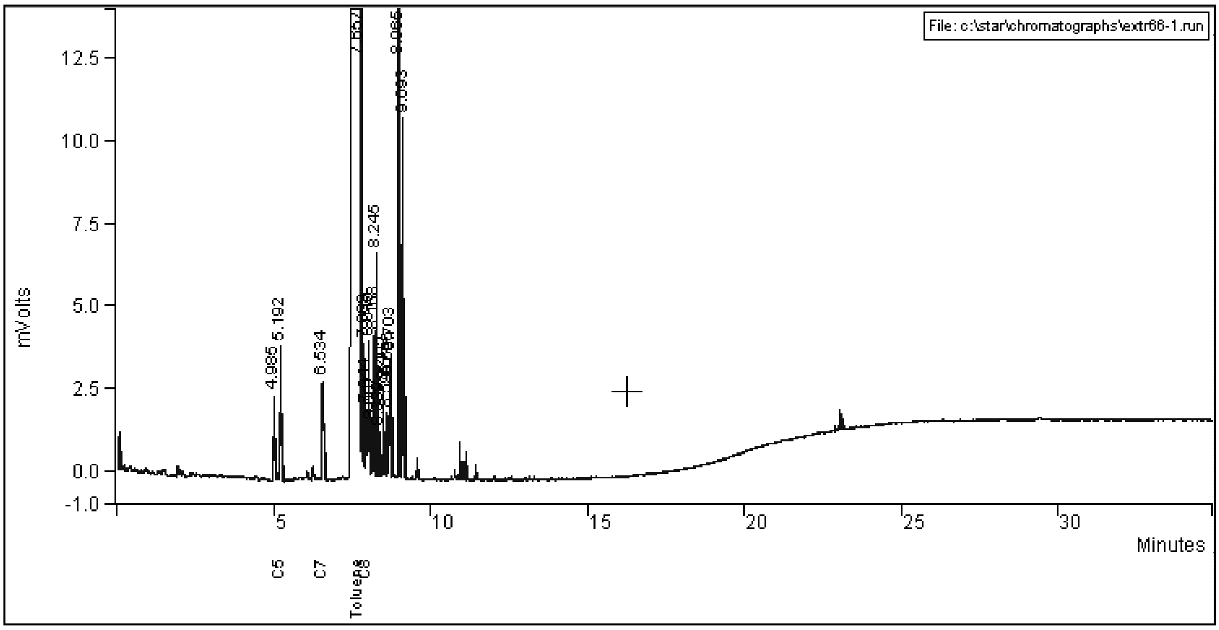
	Totals:	1.584		-0.089	120596166		



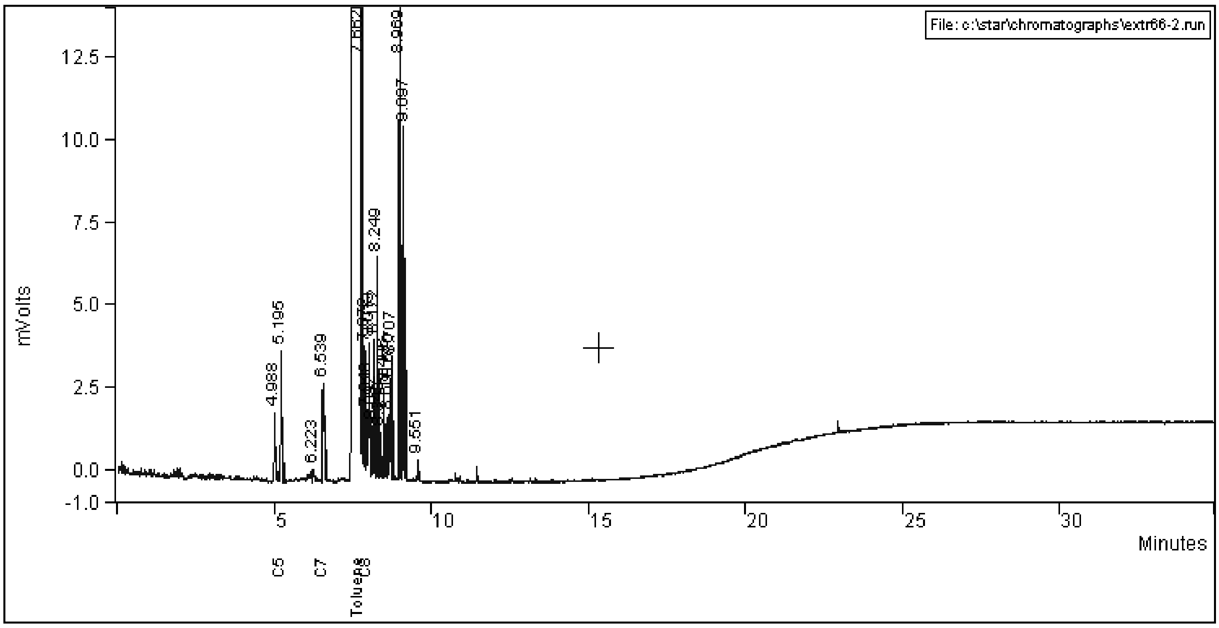


Figure C13: Duplicate chromatograms of Sample 66 (Extract 66-1 and 66-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at MOGAS T1309.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr66-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.985	0.000	5876	BB	2.1
2	C5	0.279	5.192	0.000	9812	BB	2.3
3	C7	0.070	6.534	-0.013	13079	BB	4.4
4	Toluene	1.066	7.657	-0.004	120300600	BB	12.1
5		0.000	7.869	0.000	5853	TS	0.0
6	C8	0.014	7.944	0.005	3003	TF	0.0
7		0.000	8.010	0.000	7450	TF	0.0
8		0.000	8.087	0.000	2056	TF	0.0
9		0.000	8.168	0.000	7190	TF	0.0
10		0.000	8.245	0.000	9992	TS	0.0
11		0.000	8.339	0.000	1959	TS	0.0
12		0.000	8.482	0.000	4200	TF	0.0
13		0.000	8.596	0.000	3061	TF	0.0
14		0.000	8.666	0.000	4347	TF	0.0
15		0.000	8.703	0.000	5471	TF	0.0
16		0.000	8.965	0.000	23752	BV	1.4
17		0.000	9.093	0.000	25902	VB	2.4
	Totals:	1.429		-0.012	120433603		

```
Title               : PONA COLUMN EXPERIMENT
Method File         : c:\star\extractrun.mth
```
Sample ID : extr66-1
```
Operator            : SHAN
Instrument          : Varian Star 3800
Channel             : Front = FID
Run Time            : 34.965 min
Peak Measurement    : Peak Area
Calculation Type    : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)	
1		0.000	4.988	0.000	4758	BB	2.0	
2	C5	0.272	5.195	0.003	9568	BB	2.3	C
3		0.000	6.223	0.000	1344	BB	3.8	
4	C7	0.071	6.539	-0.008	13181	BB	4.4	
5	Toluene	1.061	7.662	0.001	119663096	BB	12.0	
6		0.000	7.872	0.000	5779	TS	0.0	
7	C8	0.014	7.948	0.009	2988	TF	0.0	
8		0.000	8.013	0.000	7495	TF	0.0	
9		0.000	8.092	0.000	2168	TF	0.0	
10		0.000	8.172	0.000	7213	TF	0.0	
11		0.000	8.249	0.000	9996	TF	0.0	
12		0.000	8.343	0.000	2095	TF	0.0	
13		0.000	8.486	0.000	4277	TF	0.0	
14		0.000	8.601	0.000	2866	TF	0.0	
15		0.000	8.670	0.000	4364	TF	0.0	
16		0.000	8.707	0.000	5488	TF	0.0	
17		0.000	8.969	0.000	24031	TF	0.0	
18		0.000	9.097	0.000	25837	TF	0.0	
19		0.000	9.551	0.000	1246	BB	1.7	
	Totals:	1.418		0.005	119797790			

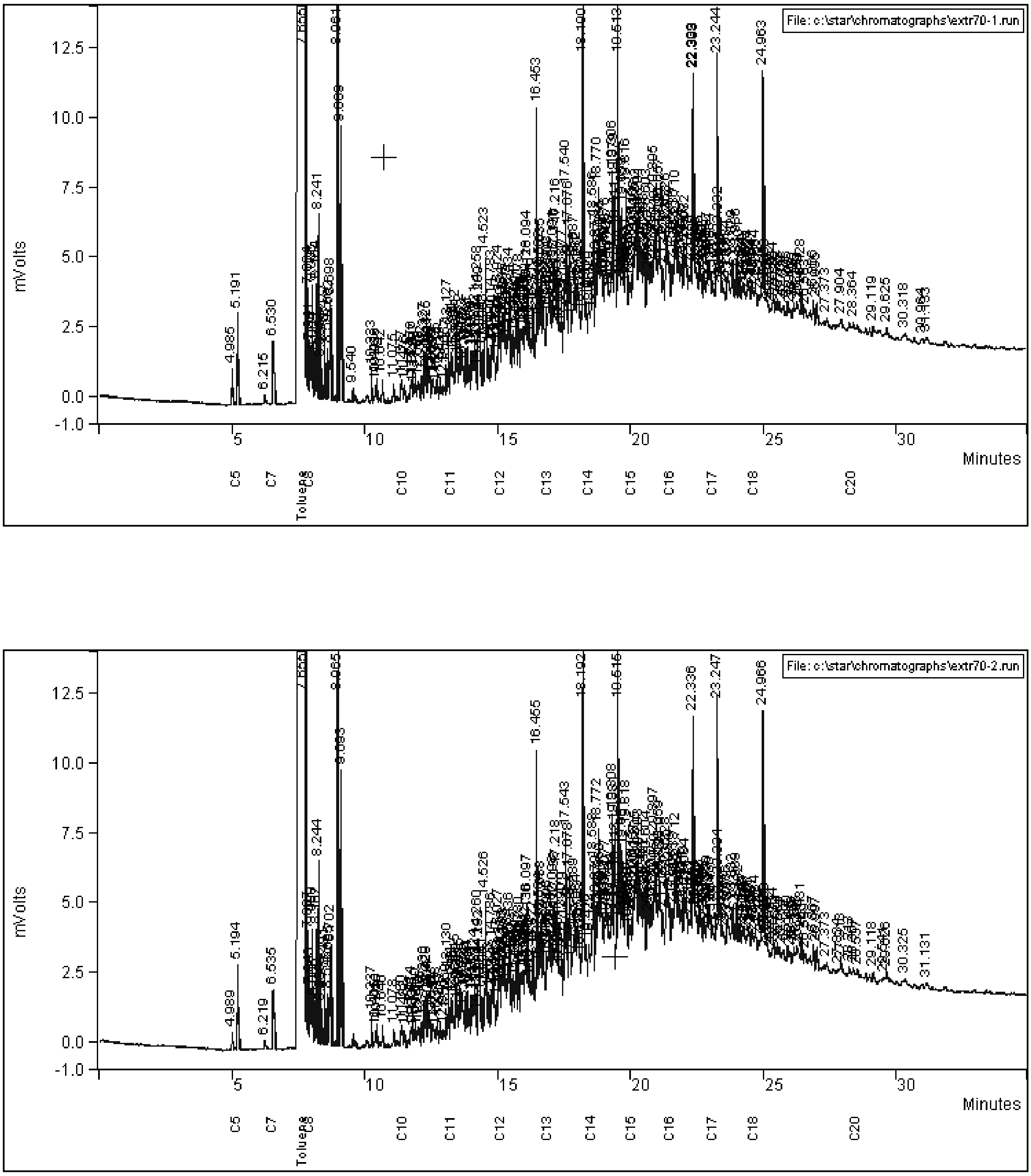


Figure C14: Duplicate chromatograms of Sample 70 (Extract 70-1 and 70-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at GASOIL T1322.

```
Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : extr70-1
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.985	0.000	2795	BB	2.1
2	C5	0.210	5.191	-0.001	7374	BB	2.1
3		0.000	6.215	0.000	1133	BB	3.5
4	C7	0.051	6.530	-0.017	9433	BB	4.2
5	Toluene	1.049	7.655	-0.006	118315912	BB	11.9
6		0.000	7.864	0.000	5759	TS	0.0
7	C8	0.013	7.941	0.002	2689	TF	0.0
8		0.000	8.006	0.000	7253	TF	0.0
9		0.000	8.084	0.000	2007	TF	0.0
10		0.000	8.164	0.000	6953	TF	0.0
11		0.000	8.241	0.000	9773	TS	0.0
12		0.000	8.335	0.000	1983	TS	0.0
13		0.000	8.477	0.000	3951	TF	0.0
14		0.000	8.592	0.000	2719	TF	0.0
15		0.000	8.662	0.000	4207	TF	0.0
16		0.000	8.698	0.000	5466	TF	0.0
17		0.000	8.961	0.000	22227	TF	0.0
18		0.000	9.089	0.000	23767	TF	0.0
19		0.000	9.540	0.000	1264	VV	1.9
20		0.000	10.233	0.000	2343	BP	1.7
21		0.000	10.401	0.000	1560	VV	3.2
22		0.000	10.436	0.000	1568	VB	2.4
23		0.000	10.642	0.000	2012	BB	2.5
24		0.000	11.075	0.000	1732	BB	1.9
25		0.000	11.377	0.000	3218	BV	4.0
26	C10	0.001	11.476	0.042	1988	VP	3.3
27		0.000	11.740	0.000	1127	VV	0.0
28		0.000	11.770	0.000	2277	VV	2.6
29		0.000	11.829	0.000	1155	VV	2.2
30		0.000	11.887	0.000	2605	VV	2.4
31		0.000	12.008	0.000	2797	VV	4.1
32		0.000	12.122	0.000	2510	PV	2.4
33		0.000	12.227	0.000	5099	VV	2.5
34		0.000	12.325	0.000	3703	VV	1.9
35		0.000	12.401	0.000	3373	VV	3.0
36		0.000	12.429	0.000	1159	VV	4.2
37		0.000	12.510	0.000	1496	VV	2.3
38		0.000	12.544	0.000	1428	VV	0.0
39		0.000	12.609	0.000	1097	VV	10.8
40		0.000	12.705	0.000	3377	VP	3.5
41		0.000	12.814	0.000	1806	PV	2.1
42		0.000	12.944	0.000	1124	VV	3.0
43		0.000	13.057	0.000	2338	VV	2.3
44		0.000	13.127	0.000	5092	VV	2.0
45		0.000	13.241	0.000	5039	VV	3.5
46	C11	0.003	13.292	-0.034	4432	VV	3.9
47		0.000	13.412	0.000	6080	VV	3.2
48		0.000	13.462	0.000	2746	VV	3.2
49		0.000	13.572	0.000	7949	VV	4.3

50		0.000	13.653	0.000	5414	VV	0.0
51		0.000	13.700	0.000	2202	VV	4.2
52		0.000	13.784	0.000	5071	VV	3.4
53		0.000	13.861	0.000	4671	VV	2.9
54		0.000	13.984	0.000	3127	VV	2.5
55		0.000	14.058	0.000	4281	VV	3.4
56		0.000	14.121	0.000	5660	VV	3.4
57		0.000	14.191	0.000	1179	VV	2.7
58		0.000	14.258	0.000	6830	VV	2.1
59		0.000	14.289	0.000	4857	VV	3.2
60		0.000	14.366	0.000	3755	VV	3.8
61		0.000	14.458	0.000	3698	VV	2.5
62		0.000	14.523	0.000	13986	VV	2.7
63		0.000	14.651	0.000	3753	VV	3.0
64		0.000	14.783	0.000	9966	VV	2.7
65		0.000	14.840	0.000	4784	VV	5.1
66		0.000	14.939	0.000	2408	VV	3.2
67		0.000	15.024	0.000	9002	VV	2.5
68		0.000	15.057	0.000	2711	VV	4.2
69		0.000	15.119	0.000	3388	VV	0.0
70	C12	0.004	15.164	0.008	6692	VV	0.0
71		0.000	15.235	0.000	12911	VV	0.0
72		0.000	15.326	0.000	3675	VV	0.0
73		0.000	15.373	0.000	5209	VV	0.0
74		0.000	15.434	0.000	11738	VV	5.3
75		0.000	15.557	0.000	8423	VV	6.5
76		0.000	15.643	0.000	3561	VV	0.0
77		0.000	15.691	0.000	5894	VV	4.1
78		0.000	15.778	0.000	7616	VV	3.1
79		0.000	15.849	0.000	4292	VV	3.5
80		0.000	15.887	0.000	2989	VV	0.0
81		0.000	15.936	0.000	6326	VV	0.0
82		0.000	15.991	0.000	5132	VV	0.0
83		0.000	16.039	0.000	6329	VV	0.0
84		0.000	16.094	0.000	9523	VV	2.7
85		0.000	16.128	0.000	6766	VV	4.8
86		0.000	16.183	0.000	4005	VV	0.0
87		0.000	16.230	0.000	3596	VV	0.0
88		0.000	16.319	0.000	11145	VV	6.7
89		0.000	16.453	0.000	25012	VV	2.0
90		0.000	16.535	0.000	4183	VV	0.0
91		0.000	16.582	0.000	9825	VV	0.0
92		0.000	16.635	0.000	9566	VV	0.0
93		0.000	16.711	0.000	9045	VV	0.0
94		0.000	16.827	0.000	8723	VV	0.0
95		0.000	16.862	0.000	3280	VV	0.0
96	C13	0.004	16.903	0.014	7168	VV	0.0
97		0.000	16.939	0.000	11347	VV	0.0
98		0.000	17.035	0.000	7159	VV	0.0
99		0.000	17.091	0.000	10399	VV	0.0
100		0.000	17.136	0.000	14389	VV	0.0
101		0.000	17.216	0.000	12764	VV	3.3
102		0.000	17.269	0.000	5007	VV	0.0
103		0.000	17.312	0.000	3254	VV	0.0
104		0.000	17.339	0.000	2732	VV	0.0
105		0.000	17.387	0.000	9174	VV	5.7
106		0.000	17.477	0.000	7595	VV	2.7
107		0.000	17.540	0.000	27481	VV	3.9
108		0.000	17.676	0.000	19041	VV	4.6
109		0.000	17.756	0.000	3407	VV	0.0
110		0.000	17.887	0.000	23844	VV	0.0
111		0.000	17.982	0.000	11431	VV	0.0
112		0.000	18.020	0.000	6102	VV	0.0

113		0.000	18.057	0.000	6785	VV	0.0
114		0.000	18.128	0.000	4175	VV	0.0
115		0.000	18.190	0.000	46197	VV	2.4
116		0.000	18.313	0.000	8532	VV	0.0
117		0.000	18.420	0.000	10340	VV	0.0
118	C14	0.002	18.469	-0.055	3042	VV	0.0
119		0.000	18.586	0.000	26210	VV	7.4
120		0.000	18.677	0.000	17352	VV	0.0
121		0.000	18.770	0.000	21771	VV	0.0
122		0.000	18.865	0.000	15476	VV	0.0
123		0.000	18.904	0.000	7146	VV	0.0
124		0.000	18.950	0.000	7040	VV	0.0
125		0.000	19.029	0.000	13903	VV	0.0
126		0.000	19.076	0.000	10804	VV	0.0
127		0.000	19.111	0.000	10459	VV	0.0
128		0.000	19.194	0.000	5343	VV	0.0
129		0.000	19.242	0.000	10593	VV	0.0
130		0.000	19.306	0.000	22128	VV	4.6
131		0.000	19.379	0.000	16918	VV	0.0
132		0.000	19.411	0.000	11978	VV	6.2
133		0.000	19.513	0.000	43626	VV	2.4
134		0.000	19.604	0.000	4565	VV	0.0
135		0.000	19.659	0.000	18472	VV	0.0
136		0.000	19.711	0.000	10466	VV	0.0
137		0.000	19.816	0.000	24739	VV	0.0
138		0.000	19.864	0.000	5404	VV	0.0
139		0.000	19.928	0.000	8848	VV	0.0
140		0.000	19.966	0.000	5838	VV	0.0
141		0.000	20.012	0.000	7586	VV	0.0
142	C15	0.005	20.075	0.016	9146	VV	0.0
143		0.000	20.110	0.000	10688	VV	0.0
144		0.000	20.165	0.000	10439	VV	0.0
145		0.000	20.202	0.000	18813	VV	0.0
146		0.000	20.291	0.000	17484	VV	0.0
147		0.000	20.348	0.000	7473	VV	0.0
148		0.000	20.399	0.000	13845	VV	0.0
149		0.000	20.493	0.000	22107	VV	0.0
150		0.000	20.603	0.000	21054	VV	0.0
151		0.000	20.684	0.000	8108	VV	0.0
152		0.000	20.749	0.000	11965	VV	0.0
153		0.000	20.818	0.000	11623	VV	0.0
154		0.000	20.895	0.000	19414	VV	0.0
155		0.000	20.948	0.000	12809	VV	0.0
156		0.000	21.057	0.000	20455	VV	0.0
157		0.000	21.096	0.000	14341	VV	0.0
158		0.000	21.201	0.000	16235	VV	0.0
159		0.000	21.326	0.000	16689	VV	0.0
160		0.000	21.363	0.000	9278	VV	0.0
161		0.000	21.425	0.000	17848	VV	0.0
162	C16	0.007	21.548	-0.021	12229	VV	0.0
163		0.000	21.636	0.000	14780	VV	0.0
164		0.000	21.710	0.000	22290	VV	0.0
165		0.000	21.789	0.000	15165	VV	0.0
166		0.000	21.872	0.000	8036	VV	0.0
167		0.000	21.921	0.000	10484	VV	0.0
168		0.000	22.007	0.000	15913	VV	0.0
169		0.000	22.082	0.000	15788	VV	0.0
170		0.000	22.177	0.000	9475	VV	0.0
171		0.000	22.256	0.000	11386	VV	0.0
172		0.000	22.333	0.000	33214	VV	3.3
173		0.000	22.398	0.000	6020	VV	3.2
174		0.000	22.460	0.000	6966	VV	0.0
175		0.000	22.501	0.000	7166	VV	0.0

176		0.000	22.585	0.000	10832	VV	0.0
177		0.000	22.641	0.000	11046	VV	0.0
178		0.000	22.742	0.000	8290	VV	0.0
179		0.000	22.785	0.000	4199	VV	0.0
180		0.000	22.845	0.000	6349	VV	0.0
181		0.000	22.897	0.000	10734	VV	0.0
182		0.000	22.984	0.000	12953	VV	0.0
183		0.000	23.063	0.000	8884	VV	0.0
184	C17	0.003	23.121	0.007	5253	VV	0.0
185		0.000	23.244	0.000	35411	VV	3.2
186		0.000	23.332	0.000	16534	VV	0.0
187		0.000	23.437	0.000	7077	VV	0.0
188		0.000	23.489	0.000	8833	VV	0.0
189		0.000	23.634	0.000	12473	VV	0.0
190		0.000	23.671	0.000	7860	VV	0.0
191		0.000	23.829	0.000	16710	VV	0.0
192		0.000	23.986	0.000	15230	VV	0.0
193		0.000	24.101	0.000	11342	VV	0.0
194		0.000	24.181	0.000	5854	VV	0.0
195		0.000	24.239	0.000	7035	VV	0.0
196		0.000	24.296	0.000	3498	VV	0.0
197		0.000	24.372	0.000	5256	VV	0.0
198		0.000	24.424	0.000	9595	VV	0.0
199		0.000	24.547	0.000	7653	VV	0.0
200		0.000	24.604	0.000	4570	VV	0.0
201	C18	0.004	24.684	-0.053	8061	VV	0.0
202		0.000	24.812	0.000	6287	VV	0.0
203		0.000	24.963	0.000	35336	VV	3.4
204		0.000	25.053	0.000	8971	VV	0.0
205		0.000	25.169	0.000	2358	VV	0.0
206		0.000	25.260	0.000	2193	VV	0.0
207		0.000	25.364	0.000	6664	VV	0.0
208		0.000	25.502	0.000	5477	VV	0.0
209		0.000	25.588	0.000	4178	VV	0.0
210		0.000	25.709	0.000	4486	VV	0.0
211		0.000	25.896	0.000	4297	VV	0.0
212		0.000	25.995	0.000	1970	VV	0.0
213		0.000	26.126	0.000	2780	VV	0.0
214		0.000	26.241	0.000	3300	VV	0.0
215		0.000	26.289	0.000	1775	VV	0.0
216		0.000	26.428	0.000	4135	VV	0.0
217		0.000	26.563	0.000	1145	VB	0.0
218		0.000	26.866	0.000	2391	PP	2.2
219		0.000	26.995	0.000	2801	PB	2.2
220		0.000	27.373	0.000	1245	BB	3.3
221		0.000	27.904	0.000	1136	VB	3.9
222	C20	0.000	28.364	-0.164	1207	VV	3.0
223		0.000	29.119	0.000	1166	PV	2.9
224		0.000	29.625	0.000	1090	BB	2.9
225		0.000	30.318	0.000	1830	BB	9.0
226		0.000	30.964	0.000	1059	PV	3.2
227		0.000	31.133	0.000	1664	VP	3.8
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	Totals:	1.356		-0.262	120256323		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr70-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.989	0.000	1572	BB	2.5
2	C5	0.210	5.194	0.002	7388	BB	2.3
3		0.000	6.219	0.000	1122	BB	3.8
4	C7	0.051	6.535	-0.012	9487	BB	4.4
5	Toluene	1.051	7.655	-0.006	118628448	BB	11.9
6		0.000	7.867	0.000	5795	TS	0.0
7	C8	0.014	7.943	0.004	2832	TF	0.0
8		0.000	8.008	0.000	7470	TF	0.0
9		0.000	8.086	0.000	2015	TF	0.0
10		0.000	8.167	0.000	7005	TF	0.0
11		0.000	8.244	0.000	9861	TS	0.0
12		0.000	8.338	0.000	2050	TF	0.0
13		0.000	8.481	0.000	3991	TF	0.0
14		0.000	8.596	0.000	2797	TF	0.0
15		0.000	8.665	0.000	4270	TF	0.0
16		0.000	8.702	0.000	5547	TF	0.0
17		0.000	8.965	0.000	22399	TF	0.0
18		0.000	9.093	0.000	24117	TF	0.0
19		0.000	10.237	0.000	2065	BP	1.6
20		0.000	10.405	0.000	1652	VV	2.8
21		0.000	10.439	0.000	1614	VB	2.2
22		0.000	10.646	0.000	2003	BB	2.5
23		0.000	11.078	0.000	1328	BB	1.7
24		0.000	11.380	0.000	3110	BV	4.0
25	C10	0.001	11.482	0.048	2057	VP	3.3
26		0.000	11.741	0.000	1139	VV	0.0
27		0.000	11.774	0.000	2315	VV	2.6
28		0.000	11.833	0.000	1185	VV	2.5
29		0.000	11.890	0.000	2641	VV	2.3
30		0.000	11.981	0.000	1141	VV	2.9
31		0.000	12.010	0.000	1637	VV	3.1
32		0.000	12.125	0.000	2491	VV	2.3
33		0.000	12.230	0.000	5238	VV	2.6
34		0.000	12.328	0.000	3762	VV	2.0
35		0.000	12.404	0.000	4583	VV	4.0
36		0.000	12.512	0.000	1513	VV	2.2
37		0.000	12.547	0.000	1461	VV	0.0
38		0.000	12.613	0.000	1135	VV	10.2
39		0.000	12.708	0.000	3371	VP	3.4
40		0.000	12.817	0.000	1797	PV	2.1
41		0.000	12.946	0.000	1123	VV	2.6
42		0.000	13.060	0.000	2387	VV	2.4
43		0.000	13.130	0.000	5158	VV	2.0
44		0.000	13.244	0.000	5086	VV	3.5
45	C11	0.003	13.295	-0.031	4569	VV	4.1
46		0.000	13.415	0.000	6226	VV	3.2
47		0.000	13.465	0.000	2762	VV	3.1
48		0.000	13.575	0.000	8128	VV	4.3
49		0.000	13.655	0.000	5510	VV	0.0

50		0.000	13.703	0.000	2337	VV	4.4
51		0.000	13.786	0.000	5213	VV	3.5
52		0.000	13.864	0.000	4774	VV	2.9
53		0.000	13.986	0.000	3248	VV	2.5
54		0.000	14.061	0.000	4337	VV	3.4
55		0.000	14.124	0.000	5815	VV	3.4
56		0.000	14.194	0.000	1221	VV	2.6
57		0.000	14.260	0.000	6853	VV	2.1
58		0.000	14.292	0.000	5048	VV	3.1
59		0.000	14.368	0.000	3827	VV	3.8
60		0.000	14.461	0.000	3839	VV	2.5
61		0.000	14.526	0.000	14318	VV	2.7
62		0.000	14.653	0.000	3908	VV	3.0
63		0.000	14.786	0.000	10249	VV	2.7
64		0.000	14.843	0.000	4950	VV	5.2
65		0.000	14.941	0.000	2447	VV	3.2
66		0.000	15.027	0.000	9103	VV	2.6
67		0.000	15.063	0.000	2852	VV	4.1
68		0.000	15.122	0.000	3477	VV	0.0
69	C12	0.004	15.166	0.010	6841	VV	0.0
70		0.000	15.238	0.000	13117	VV	0.0
71		0.000	15.330	0.000	3834	VV	0.0
72		0.000	15.376	0.000	5418	VV	0.0
73		0.000	15.436	0.000	11849	VV	5.3
74		0.000	15.560	0.000	8686	VV	6.7
75		0.000	15.645	0.000	3796	VV	0.0
76		0.000	15.693	0.000	6043	VV	4.0
77		0.000	15.780	0.000	7818	VV	3.1
78		0.000	15.852	0.000	4468	VV	3.5
79		0.000	15.890	0.000	3294	VV	0.0
80		0.000	15.939	0.000	6294	VV	0.0
81		0.000	15.994	0.000	5441	VV	0.0
82		0.000	16.042	0.000	6418	VV	0.0
83		0.000	16.097	0.000	9823	VV	2.8
84		0.000	16.130	0.000	6905	VV	0.0
85		0.000	16.186	0.000	4180	VV	0.0
86		0.000	16.232	0.000	3721	VV	0.0
87		0.000	16.322	0.000	11530	VV	6.8
88		0.000	16.455	0.000	25376	VV	2.1
89		0.000	16.537	0.000	4423	VV	0.0
90		0.000	16.584	0.000	10090	VV	0.0
91		0.000	16.638	0.000	9753	VV	0.0
92		0.000	16.712	0.000	9472	VV	0.0
93		0.000	16.829	0.000	8940	VV	0.0
94		0.000	16.865	0.000	3319	VV	0.0
95	C13	0.004	16.905	0.016	7274	VV	0.0
96		0.000	16.941	0.000	11710	VV	0.0
97		0.000	17.038	0.000	7462	VV	0.0
98		0.000	17.093	0.000	10595	VV	0.0
99		0.000	17.138	0.000	14803	VV	0.0
100		0.000	17.218	0.000	13040	VV	3.3
101		0.000	17.271	0.000	5122	VV	0.0
102		0.000	17.313	0.000	3663	VV	0.0
103		0.000	17.341	0.000	2676	VV	0.0
104		0.000	17.390	0.000	9503	VV	5.9
105		0.000	17.479	0.000	7874	VV	2.7
106		0.000	17.543	0.000	28101	VV	3.9
107		0.000	17.678	0.000	19543	VV	4.6
108		0.000	17.758	0.000	3532	VV	0.0
109		0.000	17.889	0.000	24569	VV	0.0
110		0.000	17.984	0.000	11790	VV	0.0
111		0.000	18.023	0.000	6332	VV	0.0
112		0.000	18.059	0.000	7130	VV	0.0

113		0.000	18.131	0.000	4120	VV	0.0
114		0.000	18.192	0.000	47518	VV	2.5
115		0.000	18.316	0.000	8756	VV	0.0
116		0.000	18.422	0.000	10685	VV	0.0
117	C14	0.017	18.588	0.064	29917	VV	7.3
118		0.000	18.679	0.000	17837	VV	0.0
119		0.000	18.772	0.000	22424	VV	4.3
120		0.000	18.868	0.000	15700	VV	0.0
121		0.000	18.906	0.000	7415	VV	0.0
122		0.000	18.952	0.000	7259	VV	0.0
123		0.000	19.042	0.000	14532	VV	0.0
124		0.000	19.077	0.000	11214	VV	0.0
125		0.000	19.111	0.000	7144	VV	0.0
126		0.000	19.196	0.000	9051	VV	0.0
127		0.000	19.244	0.000	10902	VV	0.0
128		0.000	19.308	0.000	22471	VV	4.6
129		0.000	19.381	0.000	17389	VV	0.0
130		0.000	19.413	0.000	12261	VV	6.3
131		0.000	19.515	0.000	44531	VV	2.4
132		0.000	19.608	0.000	4649	VV	0.0
133		0.000	19.661	0.000	18965	VV	0.0
134		0.000	19.714	0.000	10802	VV	0.0
135		0.000	19.818	0.000	25398	VV	0.0
136		0.000	19.866	0.000	5455	VV	0.0
137		0.000	19.930	0.000	9153	VV	0.0
138		0.000	19.968	0.000	5913	VV	0.0
139		0.000	20.014	0.000	7958	VV	0.0
140	C15	0.005	20.076	0.017	9580	VV	0.0
141		0.000	20.113	0.000	10723	VV	0.0
142		0.000	20.167	0.000	11184	VV	0.0
143		0.000	20.205	0.000	18640	VV	0.0
144		0.000	20.293	0.000	17811	VV	0.0
145		0.000	20.351	0.000	7666	VV	0.0
146		0.000	20.401	0.000	14206	VV	0.0
147		0.000	20.492	0.000	22563	VV	0.0
148		0.000	20.604	0.000	21626	VV	0.0
149		0.000	20.687	0.000	8353	VV	0.0
150		0.000	20.750	0.000	12144	VV	0.0
151		0.000	20.820	0.000	12059	VV	0.0
152		0.000	20.897	0.000	19648	VV	0.0
153		0.000	20.950	0.000	13392	VV	0.0
154		0.000	21.059	0.000	20747	VV	0.0
155		0.000	21.098	0.000	14575	VV	0.0
156		0.000	21.202	0.000	16622	VV	0.0
157		0.000	21.328	0.000	16879	VV	0.0
158		0.000	21.365	0.000	9639	VV	0.0
159		0.000	21.428	0.000	17924	VV	0.0
160	C16	0.007	21.550	-0.019	12626	VV	0.0
161		0.000	21.638	0.000	15067	VV	0.0
162		0.000	21.712	0.000	22425	VV	0.0
163		0.000	21.789	0.000	15427	VV	0.0
164		0.000	21.873	0.000	8430	VV	0.0
165		0.000	21.924	0.000	10498	VV	0.0
166		0.000	22.010	0.000	16070	VV	0.0
167		0.000	22.084	0.000	15921	VV	0.0
168		0.000	22.181	0.000	9521	VV	0.0
169		0.000	22.257	0.000	11987	VV	0.0
170		0.000	22.336	0.000	34272	VV	3.3
171		0.000	22.404	0.000	5874	VV	3.2
172		0.000	22.461	0.000	6800	VV	0.0
173		0.000	22.503	0.000	7326	VV	0.0
174		0.000	22.588	0.000	11081	VV	0.0
175		0.000	22.644	0.000	11483	VV	0.0

176		0.000	22.744	0.000	8262	VV	0.0
177		0.000	22.787	0.000	4314	VV	0.0
178		0.000	22.845	0.000	6134	VV	0.0
179		0.000	22.899	0.000	10945	VV	0.0
180		0.000	22.986	0.000	13628	VV	0.0
181		0.000	23.064	0.000	10464	VV	0.0
182	C17	0.002	23.129	0.015	3826	VV	0.0
183		0.000	23.247	0.000	36244	VV	3.2
184		0.000	23.334	0.000	16585	VV	0.0
185		0.000	23.440	0.000	7543	VV	0.0
186		0.000	23.492	0.000	8943	VV	0.0
187		0.000	23.636	0.000	13067	VV	0.0
188		0.000	23.677	0.000	7893	VV	0.0
189		0.000	23.832	0.000	17021	VV	0.0
190		0.000	23.989	0.000	15506	VV	0.0
191		0.000	24.102	0.000	11430	VV	0.0
192		0.000	24.182	0.000	5851	VV	0.0
193		0.000	24.244	0.000	7329	VV	0.0
194		0.000	24.298	0.000	3747	VV	0.0
195		0.000	24.375	0.000	5288	VV	0.0
196		0.000	24.426	0.000	9468	VV	0.0
197		0.000	24.551	0.000	7568	VV	0.0
198		0.000	24.606	0.000	4407	VV	0.0
199	C18	0.005	24.684	-0.052	8252	VV	0.0
200		0.000	24.810	0.000	6704	VV	0.0
201		0.000	24.966	0.000	35893	VV	3.4
202		0.000	25.059	0.000	4402	VV	0.0
203		0.000	25.091	0.000	3752	VV	0.0
204		0.000	25.149	0.000	3397	VV	0.0
205		0.000	25.259	0.000	2210	VV	0.0
206		0.000	25.364	0.000	6817	VV	0.0
207		0.000	25.501	0.000	5751	VV	0.0
208		0.000	25.584	0.000	4422	VV	0.0
209		0.000	25.714	0.000	4754	VV	0.0
210		0.000	25.900	0.000	4539	VV	0.0
211		0.000	25.995	0.000	2199	VV	0.0
212		0.000	26.128	0.000	2999	VV	0.0
213		0.000	26.245	0.000	3414	VV	0.0
214		0.000	26.296	0.000	1952	VV	0.0
215		0.000	26.431	0.000	4180	VV	0.0
216		0.000	26.549	0.000	1284	VV	0.0
217		0.000	26.867	0.000	2475	PP	2.3
218		0.000	26.997	0.000	3057	PB	2.4
219		0.000	27.373	0.000	1618	VB	3.6
220		0.000	27.834	0.000	1036	VV	4.2
221		0.000	27.913	0.000	1858	VV	4.7
222		0.000	28.213	0.000	1115	BV	3.3
223		0.000	28.367	0.000	1431	VV	3.2
224	C20	0.000	28.537	0.009	1176	VB	2.9
225		0.000	29.118	0.000	1186	PB	2.8
226		0.000	29.541	0.000	1216	VV	11.8
227		0.000	29.626	0.000	1685	VB	4.5
228		0.000	30.325	0.000	1415	BB	9.7
229		0.000	31.131	0.000	1346	PP	4.9
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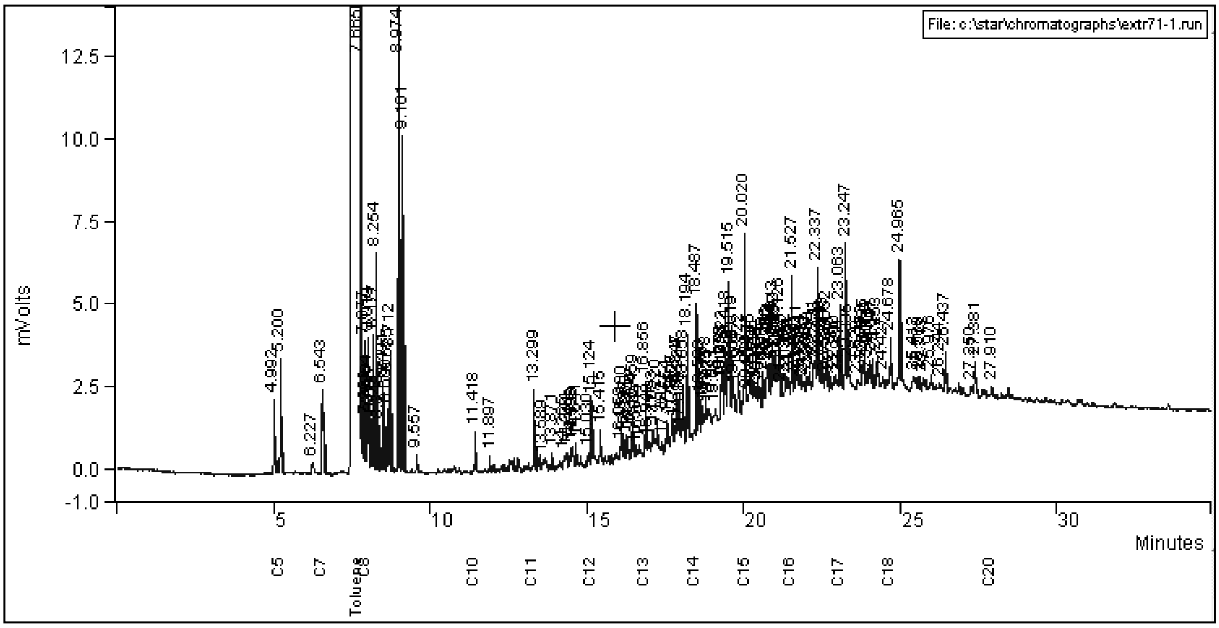
	Totals:	1.374		0.065	120614943		



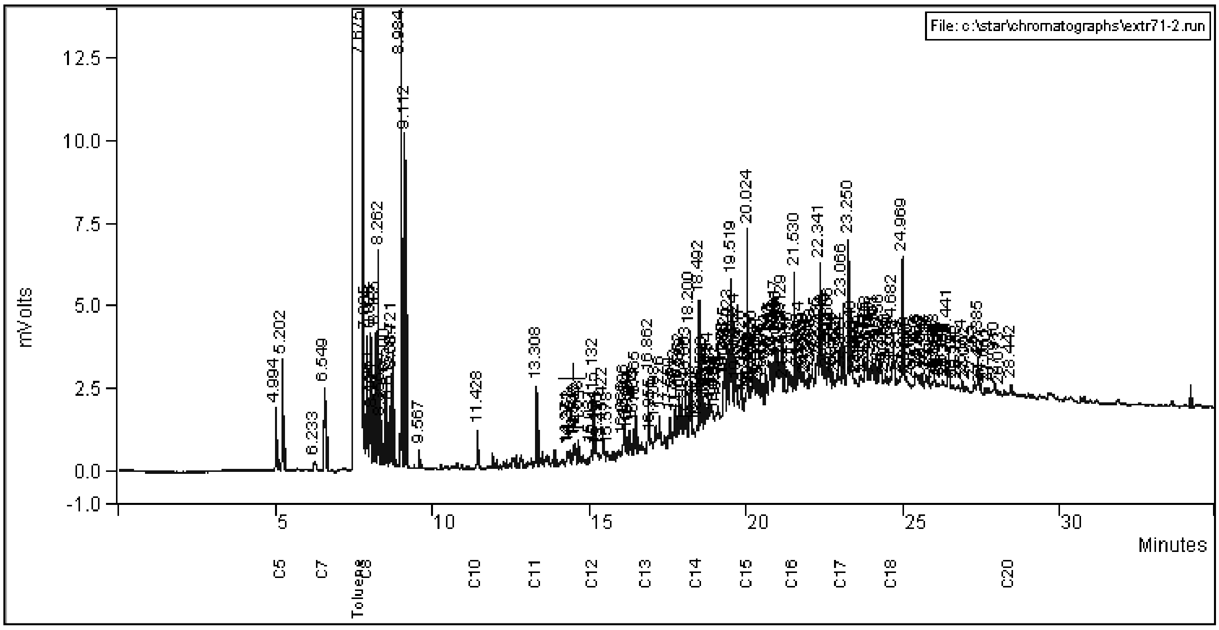


Figure C15: Duplicate chromatograms of Sample 71 (Extract 71-1 and 71-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at GASOIL T1322.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr71-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.992	0.000	5343	BB	2.2
2	C5	0.238	5.200	0.008	8359	VB	2.3
3		0.000	6.227	0.000	1050	BB	3.7
4	C7	0.060	6.543	-0.004	11109	BB	4.3
5	Toluene	1.051	7.665	0.004	118551448	BB	7.3
6		0.000	7.877	0.000	4471	TF	0.0
7		0.000	7.903	0.000	1221	TF	0.0
8	C8	0.013	7.954	0.015	2797	TF	0.0
9		0.000	7.990	0.000	1720	TF	0.0
10		0.000	8.019	0.000	5587	TF	0.0
11		0.000	8.096	0.000	1999	TF	0.0
12		0.000	8.177	0.000	6869	TF	0.0
13		0.000	8.254	0.000	9765	TS	0.0
14		0.000	8.348	0.000	2016	TS	0.0
15		0.000	8.491	0.000	3954	BP	1.4
16		0.000	8.606	0.000	2770	PV	1.4
17		0.000	8.675	0.000	4259	VV	1.4
18		0.000	8.712	0.000	5398	VB	1.4
19		0.000	8.974	0.000	22629	BV	1.4
20		0.000	9.101	0.000	24382	VB	2.4
21		0.000	9.557	0.000	1151	BB	2.0
22	C10	0.001	11.418	-0.016	1996	BB	1.6
23		0.000	11.897	0.000	1004	VB	1.9
24	C11	0.003	13.299	-0.027	4773	BP	1.7
25		0.000	13.589	0.000	1029	VV	2.9
26		0.000	13.871	0.000	1339	VP	1.9
27		0.000	14.265	0.000	1148	VV	2.7
28		0.000	14.344	0.000	1933	VV	4.4
29		0.000	14.493	0.000	1651	VV	3.7
30		0.000	14.538	0.000	1750	VV	2.8
31		0.000	14.641	0.000	1720	VV	2.0
32		0.000	15.030	0.000	1018	VV	2.2
33	C12	0.002	15.124	-0.032	3890	VV	1.8
34		0.000	15.415	0.000	3433	VP	2.6
35		0.000	16.059	0.000	1593	VV	2.1
36		0.000	16.100	0.000	3100	VV	2.1
37		0.000	16.187	0.000	1295	VV	1.8
38		0.000	16.260	0.000	2210	VV	2.2
39		0.000	16.396	0.000	1858	VV	2.0
40		0.000	16.459	0.000	3144	VV	2.0
41		0.000	16.587	0.000	1260	VV	6.8
42		0.000	16.644	0.000	1033	VV	3.1
43	C13	0.003	16.856	-0.033	5166	VV	2.0
44		0.000	16.949	0.000	2496	VV	0.0
45		0.000	17.093	0.000	2123	VV	3.1
46		0.000	17.220	0.000	2606	VV	2.6
47		0.000	17.392	0.000	1285	VP	6.7
48		0.000	17.554	0.000	3567	VV	4.2
49		0.000	17.707	0.000	3983	VV	4.3

50		0.000	17.762	0.000	1593	VV	0.0
51		0.000	17.847	0.000	4052	VV	2.8
52		0.000	17.924	0.000	3956	VV	4.1
53		0.000	17.986	0.000	1045	VV	0.0
54		0.000	18.058	0.000	3904	VV	2.5
55		0.000	18.194	0.000	7934	VV	2.3
56	C14	0.004	18.487	-0.037	7910	VV	2.0
57		0.000	18.593	0.000	3178	VV	6.1
58		0.000	18.678	0.000	3063	VV	0.0
59		0.000	18.778	0.000	2955	VV	0.0
60		0.000	18.875	0.000	2071	VV	0.0
61		0.000	19.081	0.000	1006	VV	0.0
62		0.000	19.252	0.000	1903	BV	2.1
63		0.000	19.276	0.000	1631	VV	0.0
64		0.000	19.322	0.000	3703	VV	3.1
65		0.000	19.418	0.000	6149	VV	2.7
66		0.000	19.515	0.000	12780	VV	2.7
67		0.000	19.619	0.000	3872	VV	2.1
68		0.000	19.665	0.000	2544	VV	5.0
69		0.000	19.822	0.000	3798	VV	3.1
70		0.000	20.020	0.000	11467	VV	1.9
71	C15	0.001	20.078	0.019	1340	VV	0.0
72		0.000	20.216	0.000	7224	VV	7.0
73		0.000	20.296	0.000	3134	VV	0.0
74		0.000	20.353	0.000	1067	VV	0.0
75		0.000	20.403	0.000	2278	VV	0.0
76		0.000	20.501	0.000	3195	VV	6.3
77		0.000	20.608	0.000	3689	VV	3.2
78		0.000	20.736	0.000	3311	VV	3.7
79		0.000	20.762	0.000	2811	VV	0.0
80		0.000	20.824	0.000	3328	VV	3.4
81		0.000	20.913	0.000	7238	VV	4.6
82		0.000	20.992	0.000	4226	VV	0.0
83		0.000	21.055	0.000	3634	VV	0.0
84		0.000	21.126	0.000	6026	VV	3.7
85		0.000	21.198	0.000	1903	VV	0.0
86		0.000	21.332	0.000	3835	VV	0.0
87		0.000	21.364	0.000	1181	VV	0.0
88		0.000	21.434	0.000	2899	VV	0.0
89	C16	0.005	21.527	-0.042	9034	VV	2.3
90		0.000	21.640	0.000	2567	VV	0.0
91		0.000	21.711	0.000	4768	VV	0.0
92		0.000	21.794	0.000	3336	VV	0.0
93		0.000	21.875	0.000	1498	VV	0.0
94		0.000	21.928	0.000	1472	VV	0.0
95		0.000	22.009	0.000	2355	VV	0.0
96		0.000	22.083	0.000	3131	VV	0.0
97		0.000	22.231	0.000	4166	VV	9.8
98		0.000	22.271	0.000	1819	VV	0.0
99		0.000	22.337	0.000	10442	VV	2.6
100		0.000	22.440	0.000	3206	VV	0.0
101		0.000	22.513	0.000	2954	VV	0.0
102		0.000	22.594	0.000	1103	VV	0.0
103		0.000	22.652	0.000	4063	VV	5.3
104		0.000	22.746	0.000	1181	VV	0.0
105		0.000	22.900	0.000	1529	VV	0.0
106		0.000	22.989	0.000	1142	VV	0.0
107	C17	0.003	23.063	-0.051	5851	VV	2.7
108		0.000	23.247	0.000	11226	PV	2.7
109		0.000	23.335	0.000	1803	VB	0.0
110		0.000	23.629	0.000	1880	PV	4.2
111		0.000	23.772	0.000	2514	VV	2.7
112		0.000	23.835	0.000	2695	VV	3.1

113		0.000	23.907	0.000	1234	VV	2.2
114		0.000	24.004	0.000	3346	VV	3.4
115		0.000	24.097	0.000	2587	VV	2.3
116		0.000	24.253	0.000	3673	VV	3.0
117		0.000	24.427	0.000	1859	VV	3.0
118	C18	0.002	24.678	-0.059	4227	VP	2.3
119		0.000	24.965	0.000	12381	VB	2.5
120		0.000	25.412	0.000	2565	BV	6.6
121		0.000	25.588	0.000	1170	VV	2.7
122		0.000	25.713	0.000	1186	VV	2.7
123		0.000	25.976	0.000	1328	VV	2.7
124		0.000	26.244	0.000	1042	VB	3.1
125		0.000	26.437	0.000	3419	BP	2.6
126		0.000	27.250	0.000	1395	VV	4.3
127		0.000	27.381	0.000	3685	VB	2.8
128	C20	0.000	27.910	-0.618	1035	BB	3.1
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	Totals:	1.386		-0.873	119026400		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr71-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.994	0.000	4417	BP	2.2
2	C5	0.229	5.202	0.010	8048	PB	2.3
3		0.000	6.233	0.000	1137	BB	3.8
4	C7	0.058	6.549	0.003	10817	BB	4.4
5	Toluene	1.049	7.675	0.014	118311704	BB	11.9
6		0.000	7.885	0.000	5651	TS	0.0
7	C8	0.013	7.961	0.022	2783	TF	0.0
8		0.000	8.026	0.000	7223	TF	0.0
9		0.000	8.104	0.000	2071	TF	0.0
10		0.000	8.185	0.000	6863	TF	0.0
11		0.000	8.262	0.000	9693	TS	0.0
12		0.000	8.356	0.000	1984	TF	0.0
13		0.000	8.500	0.000	4005	TF	0.0
14		0.000	8.615	0.000	2785	TF	0.0
15		0.000	8.684	0.000	4220	TF	0.0
16		0.000	8.721	0.000	5354	TF	0.0
17		0.000	8.984	0.000	22691	TF	0.0
18		0.000	9.112	0.000	24482	TF	0.0
19		0.000	9.567	0.000	1018	BB	1.9
20	C10	0.001	11.428	-0.006	2055	BB	1.6
21	C11	0.003	13.308	-0.018	4492	VB	1.7
22		0.000	14.271	0.000	1003	VV	2.4
23		0.000	14.353	0.000	1948	VV	4.8
24		0.000	14.501	0.000	1687	VV	3.8
25		0.000	14.546	0.000	1671	VV	2.7
26		0.000	14.648	0.000	1670	VV	2.1
27		0.000	15.037	0.000	1136	VV	2.4
28	C12	0.002	15.132	-0.024	4017	VV	1.8
29		0.000	15.184	0.000	1543	VV	1.8
30		0.000	15.270	0.000	1016	VV	0.0
31		0.000	15.422	0.000	3761	VV	2.7
32		0.000	15.578	0.000	1052	VV	6.7
33		0.000	16.066	0.000	1032	VV	4.0
34		0.000	16.106	0.000	2806	VV	2.8
35		0.000	16.193	0.000	1117	VV	2.3
36		0.000	16.267	0.000	2027	VV	3.2
37		0.000	16.403	0.000	1655	VV	2.7
38		0.000	16.465	0.000	2920	VV	2.3
39	C13	0.002	16.862	-0.027	4356	PV	2.1
40		0.000	16.955	0.000	1243	VV	0.0
41		0.000	17.098	0.000	1518	VV	0.0
42		0.000	17.226	0.000	1832	VV	3.9
43		0.000	17.559	0.000	3311	VV	2.8
44		0.000	17.712	0.000	4014	VV	3.3
45		0.000	17.767	0.000	1778	VV	2.0
46		0.000	17.852	0.000	4238	VV	2.3
47		0.000	17.929	0.000	4168	VV	2.5
48		0.000	17.992	0.000	1256	VV	0.0
49		0.000	18.063	0.000	4681	VV	2.1

50		0.000	18.200	0.000	9793	VV	2.1
51		0.000	18.322	0.000	1695	VV	0.0
52		0.000	18.426	0.000	2067	VV	5.7
53	C14	0.005	18.492	-0.032	9359	VV	1.9
54		0.000	18.598	0.000	5327	VV	4.3
55		0.000	18.684	0.000	5710	VV	4.0
56		0.000	18.784	0.000	5057	VV	3.5
57		0.000	18.881	0.000	6057	VV	0.0
58		0.000	18.958	0.000	1478	VV	0.0
59		0.000	19.032	0.000	3129	VV	0.0
60		0.000	19.087	0.000	5279	VV	0.0
61		0.000	19.258	0.000	6870	VV	3.8
62		0.000	19.280	0.000	2292	VV	3.8
63		0.000	19.325	0.000	6510	VV	4.4
64		0.000	19.423	0.000	10321	VV	4.4
65		0.000	19.519	0.000	18285	VV	3.3
66		0.000	19.624	0.000	6677	VV	2.8
67		0.000	19.669	0.000	7618	VV	0.0
68		0.000	19.826	0.000	10281	VV	6.6
69		0.000	19.939	0.000	3590	VV	0.0
70		0.000	20.024	0.000	15953	VV	2.0
71	C15	0.002	20.083	0.024	3301	VV	0.0
72		0.000	20.120	0.000	1788	VV	0.0
73		0.000	20.220	0.000	12830	VV	0.0
74		0.000	20.301	0.000	6636	VV	0.0
75		0.000	20.356	0.000	2822	VV	0.0
76		0.000	20.408	0.000	5861	VV	0.0
77		0.000	20.507	0.000	8749	VV	0.0
78		0.000	20.614	0.000	9166	VV	0.0
79		0.000	20.743	0.000	6859	VV	0.0
80		0.000	20.765	0.000	5233	VV	0.0
81		0.000	20.829	0.000	6542	VV	0.0
82		0.000	20.917	0.000	12088	VV	0.0
83		0.000	20.996	0.000	7462	VV	0.0
84		0.000	21.059	0.000	6599	VV	0.0
85		0.000	21.129	0.000	10369	VV	5.5
86		0.000	21.201	0.000	7748	VV	0.0
87		0.000	21.336	0.000	11365	VV	0.0
88		0.000	21.437	0.000	7433	VV	0.0
89	C16	0.008	21.530	-0.039	14251	VV	2.7
90		0.000	21.646	0.000	6898	VV	0.0
91		0.000	21.714	0.000	9989	VV	0.0
92		0.000	21.800	0.000	8485	VV	0.0
93		0.000	21.881	0.000	4405	VV	0.0
94		0.000	21.931	0.000	4984	VV	0.0
95		0.000	22.013	0.000	7028	VV	0.0
96		0.000	22.088	0.000	8799	VV	0.0
97		0.000	22.235	0.000	10833	VV	0.0
98		0.000	22.273	0.000	4073	VV	0.0
99		0.000	22.341	0.000	16493	VV	3.1
100		0.000	22.442	0.000	8644	VV	0.0
101		0.000	22.516	0.000	7784	VV	0.0
102		0.000	22.597	0.000	3860	VV	0.0
103		0.000	22.656	0.000	10327	VV	0.0
104		0.000	22.749	0.000	7755	VV	0.0
105		0.000	22.852	0.000	3860	VV	0.0
106		0.000	22.902	0.000	6334	VV	0.0
107		0.000	22.994	0.000	5991	VV	0.0
108	C17	0.008	23.066	-0.048	15239	VV	3.5
109		0.000	23.250	0.000	20169	VV	3.1
110		0.000	23.340	0.000	10958	VV	0.0
111		0.000	23.440	0.000	2881	VV	0.0
112		0.000	23.497	0.000	6471	VV	0.0

113		0.000	23.638	0.000	7803	VV	0.0
114		0.000	23.677	0.000	2629	VV	0.0
115		0.000	23.775	0.000	8276	VV	0.0
116		0.000	23.838	0.000	6871	VV	0.0
117		0.000	23.911	0.000	4703	VV	0.0
118		0.000	24.007	0.000	9560	VV	0.0
119		0.000	24.101	0.000	7726	VV	0.0
120		0.000	24.185	0.000	3954	VV	0.0
121		0.000	24.256	0.000	10526	VV	0.0
122		0.000	24.378	0.000	3375	VV	0.0
123		0.000	24.430	0.000	7517	VV	0.0
124		0.000	24.559	0.000	5050	VV	0.0
125	C18	0.007	24.682	-0.055	13304	VV	0.0
126		0.000	24.819	0.000	5297	VV	0.0
127		0.000	24.969	0.000	21274	VV	3.5
128		0.000	25.076	0.000	7566	VV	0.0
129		0.000	25.190	0.000	3309	VV	0.0
130		0.000	25.262	0.000	1821	VV	0.0
131		0.000	25.416	0.000	11693	VV	0.0
132		0.000	25.509	0.000	3900	VV	0.0
133		0.000	25.592	0.000	5862	VV	0.0
134		0.000	25.718	0.000	4831	VV	0.0
135		0.000	25.798	0.000	4815	VV	0.0
136		0.000	25.909	0.000	3421	VV	0.0
137		0.000	25.978	0.000	5023	VV	0.0
138		0.000	26.066	0.000	2708	VV	0.0
139		0.000	26.139	0.000	3053	VV	0.0
140		0.000	26.247	0.000	4876	VV	0.0
141		0.000	26.300	0.000	3013	VV	0.0
142		0.000	26.441	0.000	7908	VV	0.0
143		0.000	26.596	0.000	4877	VV	0.0
144		0.000	26.753	0.000	4973	VV	0.0
145		0.000	26.874	0.000	3799	VV	0.0
146		0.000	27.002	0.000	4354	VV	0.0
147		0.000	27.253	0.000	5557	VV	0.0
148		0.000	27.385	0.000	5025	VV	0.0
149		0.000	27.457	0.000	1584	VV	0.0
150		0.000	27.611	0.000	1801	VV	0.0
151		0.000	27.702	0.000	1605	VV	0.0
152		0.000	27.910	0.000	4175	VV	0.0
153		0.000	28.073	0.000	1452	VV	0.0
154	C20	0.000	28.442	-0.086	1586	VV	0.0
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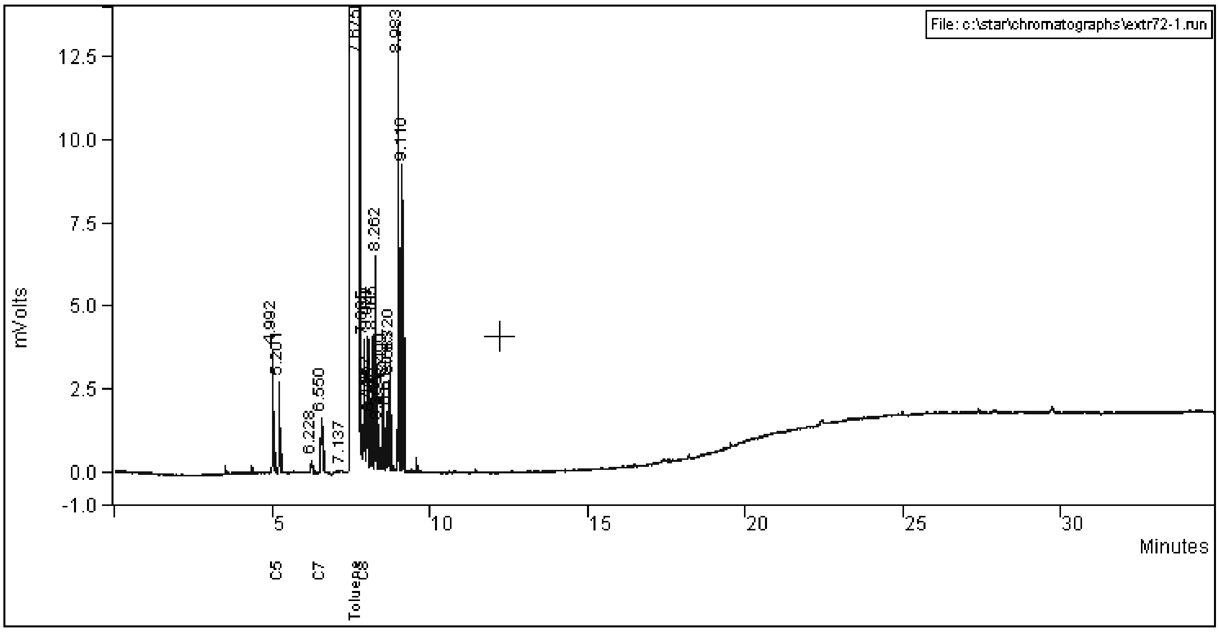
	Totals:	1.387		-0.262	119223111		



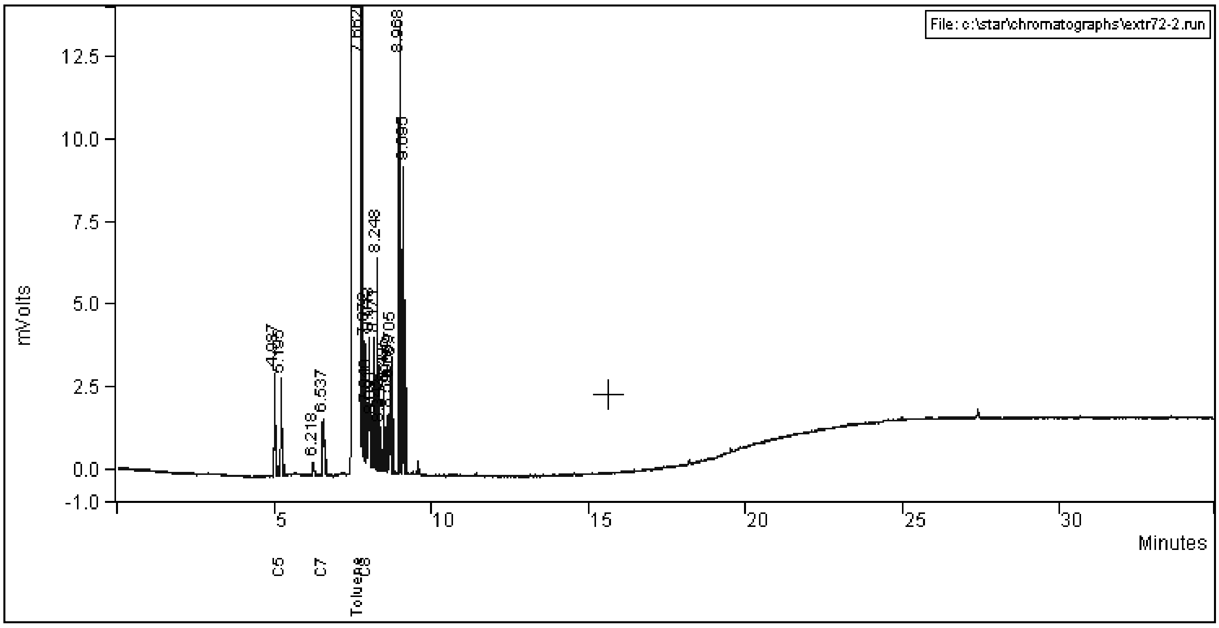


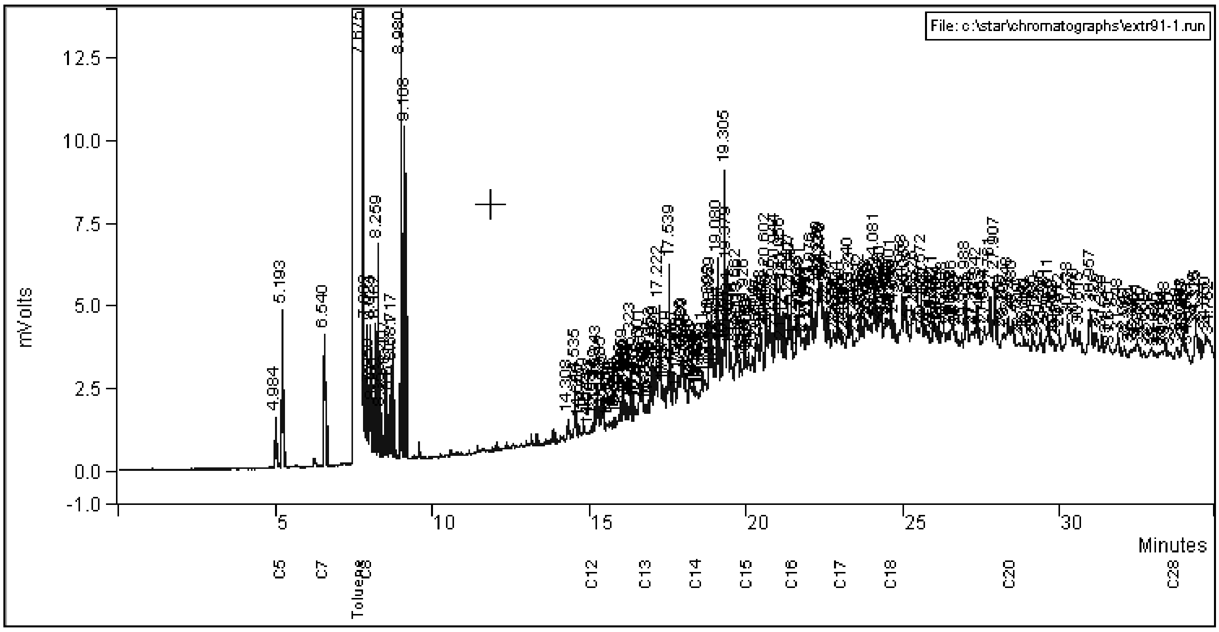
Figure C16: Duplicate chromatograms of Sample 72 (Extract 72-1 and 72-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at GASOIL T1322.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr72-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.992	0.000	8444	BB	2.1
2	C5	0.184	5.201	0.010	6481	BB	2.2
3		0.000	6.228	0.000	1342	BB	3.7
4	C7	0.040	6.550	0.003	7528	VB	4.4
5		0.000	7.137	0.000	1002	VV	0.0
6	Toluene	1.062	7.675	0.014	119809264	VB	12.0
7		0.000	7.885	0.000	5670	TS	0.0
8	C8	0.013	7.962	0.023	2778	TF	0.0
9		0.000	8.027	0.000	7238	TF	0.0
10		0.000	8.105	0.000	1991	TF	0.0
11		0.000	8.185	0.000	6820	TF	0.0
12		0.000	8.262	0.000	9618	TS	0.0
13		0.000	8.356	0.000	2014	TF	0.0
14		0.000	8.499	0.000	3966	TF	0.0
15		0.000	8.614	0.000	2667	TF	0.0
16		0.000	8.683	0.000	4117	TF	0.0
17		0.000	8.720	0.000	5119	TF	0.0
18		0.000	8.983	0.000	20799	TF	0.0
19		0.000	9.110	0.000	22108	TF	0.0
	Totals:	1.299		0.050	119928966		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr72-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.987	0.000	6725	BB	1.9
2	C5	0.187	5.195	0.003	6575	VB	2.1
3		0.000	6.218	0.000	1216	BB	3.4
4	C7	0.039	6.537	-0.010	7369	BB	4.3
5	Toluene	1.061	7.662	0.001	119703240	BB	12.0
6		0.000	7.872	0.000	5635	TS	0.0
7	C8	0.013	7.949	0.010	2769	TF	0.0
8		0.000	8.013	0.000	7308	TF	0.0
9		0.000	8.091	0.000	2001	TF	0.0
10		0.000	8.171	0.000	6822	TF	0.0
11		0.000	8.248	0.000	9624	TS	0.0
12		0.000	8.342	0.000	1988	TS	0.0
13		0.000	8.485	0.000	3983	TF	0.0
14		0.000	8.599	0.000	2643	TF	0.0
15		0.000	8.669	0.000	4087	TF	0.0
16		0.000	8.705	0.000	5169	TF	0.0
17		0.000	8.968	0.000	20692	TF	0.0
18		0.000	9.095	0.000	22051	TF	0.0
	Totals:	1.300		0.004	119819897		



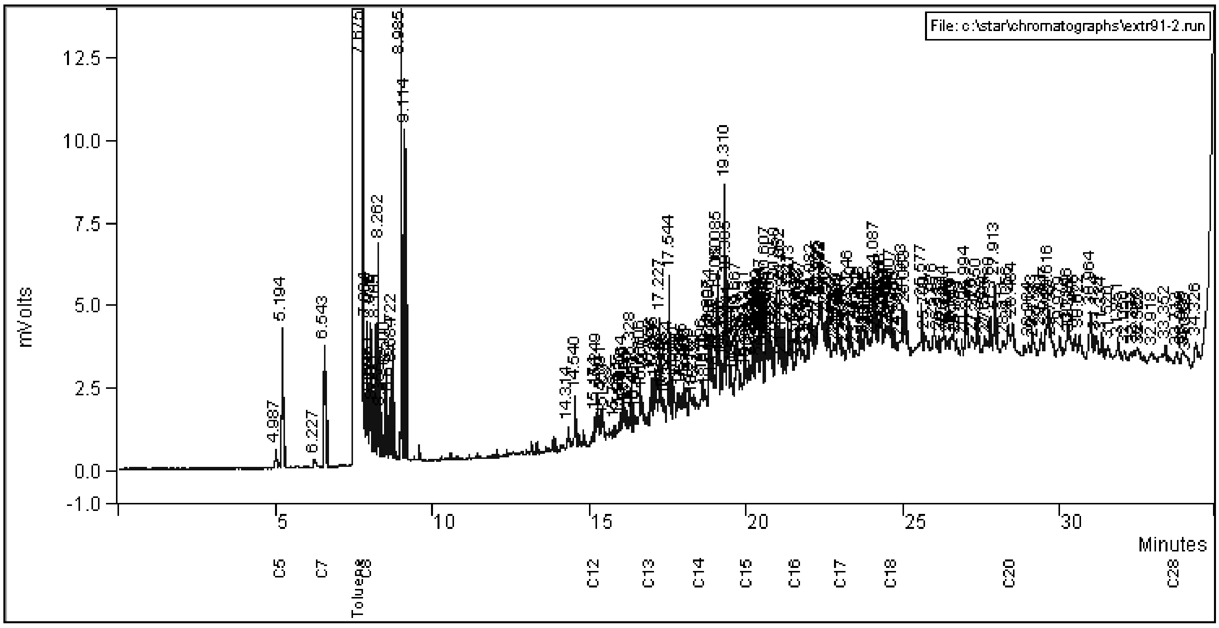


Figure C17: Duplicate chromatograms of Sample 91 (Extract 91-1 and 91-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at NTF T1104.

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Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : extr91-1
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.984	0.000	3254	BP	1.7
2	C5	0.300	5.193	0.001	10565	PB	1.9
3	C7	0.087	6.540	-0.007	16314	BB	4.1
4	Toluene	1.033	7.675	0.014	116582224	BB	11.7
5		0.000	7.882	0.000	5489	TS	0.0
6	C8	0.013	7.958	0.019	2743	TF	0.0
7		0.000	8.023	0.000	6949	TF	0.0
8		0.000	8.101	0.000	1784	TS	0.0
9		0.000	8.182	0.000	6598	TS	0.0
10		0.000	8.259	0.000	9488	TS	0.0
11		0.000	8.353	0.000	2003	TS	0.0
12		0.000	8.497	0.000	3942	TF	0.0
13		0.000	8.611	0.000	2772	TF	0.0
14		0.000	8.681	0.000	4123	TF	0.0
15		0.000	8.717	0.000	5288	TF	0.0
16		0.000	8.980	0.000	22476	TF	0.0
17		0.000	9.108	0.000	24121	TF	0.0
18		0.000	14.308	0.000	1679	VV	0.0
19		0.000	14.535	0.000	4765	VV	2.4
20		0.000	14.650	0.000	1464	VV	3.4
21		0.000	14.799	0.000	1754	VV	2.9
22		0.000	14.944	0.000	1486	VV	0.0
23		0.000	15.084	0.000	1338	VV	0.0
24	C12	0.002	15.169	0.013	2974	VV	4.1
25		0.000	15.243	0.000	5900	VV	3.5
26		0.000	15.385	0.000	4452	VV	5.9
27		0.000	15.445	0.000	2425	VV	10.0
28		0.000	15.571	0.000	1583	VV	0.0
29		0.000	15.620	0.000	1692	VV	0.0
30		0.000	15.700	0.000	1263	VV	0.0
31		0.000	15.793	0.000	2039	VV	0.0
32		0.000	15.858	0.000	1108	VV	0.0
33		0.000	15.929	0.000	2303	VV	0.0
34		0.000	15.988	0.000	2371	VV	0.0
35		0.000	16.059	0.000	3728	VV	4.0
36		0.000	16.110	0.000	3610	VV	0.0
37		0.000	16.191	0.000	2566	VV	0.0
38		0.000	16.268	0.000	2271	VV	0.0
39		0.000	16.323	0.000	5269	VV	2.5
40		0.000	16.402	0.000	2825	VV	0.0
41		0.000	16.463	0.000	2347	VV	0.0
42		0.000	16.601	0.000	7854	VV	4.2
43		0.000	16.661	0.000	6953	VV	0.0
44		0.000	16.760	0.000	1843	VV	0.0
45		0.000	16.813	0.000	2308	VV	0.0
46	C13	0.001	16.869	-0.020	2435	VV	0.0
47		0.000	16.953	0.000	7922	VV	5.6
48		0.000	17.039	0.000	5548	VV	0.0
49		0.000	17.101	0.000	8307	VV	0.0
50		0.000	17.222	0.000	11484	VV	2.8

51		0.000	17.271	0.000	3557	VV	0.0
52		0.000	17.342	0.000	4288	VV	0.0
53		0.000	17.378	0.000	3640	VV	0.0
54		0.000	17.479	0.000	5856	VV	0.0
55		0.000	17.539	0.000	16151	VV	2.9
56		0.000	17.685	0.000	8146	VV	0.0
57		0.000	17.763	0.000	2428	VV	0.0
58		0.000	17.820	0.000	7108	VV	0.0
59		0.000	17.926	0.000	8980	VV	0.0
60		0.000	17.989	0.000	6296	VV	0.0
61		0.000	18.056	0.000	6410	VV	0.0
62		0.000	18.186	0.000	6563	VV	0.0
63		0.000	18.231	0.000	2497	VV	0.0
64		0.000	18.268	0.000	2636	VV	0.0
65		0.000	18.324	0.000	4254	VV	0.0
66		0.000	18.381	0.000	2602	VV	0.0
67		0.000	18.422	0.000	2873	VV	0.0
68	C14	0.002	18.483	-0.041	2740	VV	0.0
69		0.000	18.591	0.000	8967	VV	0.0
70		0.000	18.681	0.000	8517	VV	0.0
71		0.000	18.802	0.000	10372	VV	5.2
72		0.000	18.859	0.000	8444	VV	0.0
73		0.000	18.911	0.000	6672	VV	0.0
74		0.000	18.973	0.000	4788	VV	0.0
75		0.000	19.080	0.000	23181	VV	4.8
76		0.000	19.180	0.000	8018	VV	0.0
77		0.000	19.251	0.000	5988	VV	0.0
78		0.000	19.305	0.000	20132	VV	2.5
79		0.000	19.379	0.000	13353	VV	3.0
80		0.000	19.434	0.000	7197	VV	0.0
81		0.000	19.500	0.000	10877	VV	0.0
82		0.000	19.662	0.000	14150	VV	8.4
83		0.000	19.713	0.000	8634	VV	0.0
84		0.000	19.811	0.000	7395	VV	0.0
85		0.000	19.926	0.000	13048	VV	0.0
86		0.000	19.975	0.000	4656	VV	0.0
87		0.000	20.016	0.000	2455	VV	0.0
88	C15	0.006	20.067	0.008	9977	VV	0.0
89		0.000	20.196	0.000	12344	VV	0.0
90		0.000	20.303	0.000	7862	VV	0.0
91		0.000	20.347	0.000	9167	VV	0.0
92		0.000	20.438	0.000	9126	VV	0.0
93		0.000	20.491	0.000	10213	VV	0.0
94		0.000	20.602	0.000	19514	VV	3.8
95		0.000	20.686	0.000	5528	VV	0.0
96		0.000	20.755	0.000	12003	VV	0.0
97		0.000	20.822	0.000	8987	VV	0.0
98		0.000	20.944	0.000	25040	VV	8.5
99		0.000	21.056	0.000	14200	VV	0.0
100		0.000	21.121	0.000	5464	VV	0.0
101		0.000	21.182	0.000	14397	VV	0.0
102		0.000	21.322	0.000	17855	VV	0.0
103		0.000	21.407	0.000	16678	VV	0.0
104	C16	0.004	21.521	-0.049	7114	VV	0.0
105		0.000	21.626	0.000	15089	VV	0.0
106		0.000	21.681	0.000	10620	VV	0.0
107		0.000	21.746	0.000	6077	VV	0.0
108		0.000	21.799	0.000	11746	VV	0.0
109		0.000	21.927	0.000	13293	VV	0.0
110		0.000	22.013	0.000	9972	VV	0.0
111		0.000	22.076	0.000	16648	VV	0.0
112		0.000	22.219	0.000	16725	VV	0.0
113		0.000	22.289	0.000	12932	VV	0.0

114		0.000	22.326	0.000	9346	VV	0.0
115		0.000	22.376	0.000	18739	VV	0.0
116		0.000	22.501	0.000	13297	VV	0.0
117		0.000	22.582	0.000	18725	VV	0.0
118		0.000	22.780	0.000	18093	VV	0.0
119		0.000	22.825	0.000	4643	VV	0.0
120		0.000	22.894	0.000	14591	VV	0.0
121		0.000	22.989	0.000	11786	VV	0.0
122	C17	0.005	23.082	-0.032	9767	VV	0.0
123		0.000	23.149	0.000	4337	VV	0.0
124		0.000	23.240	0.000	18228	VV	0.0
125		0.000	23.333	0.000	16261	VV	0.0
126		0.000	23.484	0.000	12688	VV	0.0
127		0.000	23.622	0.000	19167	VV	0.0
128		0.000	23.696	0.000	8437	VV	0.0
129		0.000	23.763	0.000	8568	VV	0.0
130		0.000	23.823	0.000	13207	VV	0.0
131		0.000	23.902	0.000	6849	VV	0.0
132		0.000	23.950	0.000	9278	VV	0.0
133		0.000	24.081	0.000	23622	VV	0.0
134		0.000	24.152	0.000	5868	VV	0.0
135		0.000	24.228	0.000	11543	VV	0.0
136		0.000	24.280	0.000	11299	VV	0.0
137		0.000	24.353	0.000	6109	VV	0.0
138		0.000	24.415	0.000	8597	VV	0.0
139		0.000	24.495	0.000	12097	VV	0.0
140		0.000	24.543	0.000	5626	VV	0.0
141		0.000	24.601	0.000	13179	VV	0.0
142	C18	0.009	24.699	-0.038	16833	VV	0.0
143		0.000	24.958	0.000	27694	VV	0.0
144		0.000	25.058	0.000	23048	VV	0.0
145		0.000	25.168	0.000	5896	VV	0.0
146		0.000	25.326	0.000	33476	VV	0.0
147		0.000	25.488	0.000	7164	VV	0.0
148		0.000	25.572	0.000	17881	VV	0.0
149		0.000	25.697	0.000	14864	VV	0.0
150		0.000	25.799	0.000	9216	VV	0.0
151		0.000	25.876	0.000	5183	VV	0.0
152		0.000	25.971	0.000	15766	VV	0.0
153		0.000	26.049	0.000	4764	VV	0.0
154		0.000	26.114	0.000	8828	VV	0.0
155		0.000	26.204	0.000	9735	VV	0.0
156		0.000	26.288	0.000	11409	VV	0.0
157		0.000	26.426	0.000	12428	VV	0.0
158		0.000	26.522	0.000	8292	VV	0.0
159		0.000	26.586	0.000	13236	VV	0.0
160		0.000	26.697	0.000	11904	VV	0.0
161		0.000	26.857	0.000	11882	VV	0.0
162		0.000	26.988	0.000	23030	VV	0.0
163		0.000	27.166	0.000	9567	VV	0.0
164		0.000	27.225	0.000	8058	VV	0.0
165		0.000	27.342	0.000	19517	VV	0.0
166		0.000	27.485	0.000	6176	VV	0.0
167		0.000	27.584	0.000	11084	VV	0.0
168		0.000	27.761	0.000	23278	VV	0.0
169		0.000	27.907	0.000	27624	VV	0.0
170		0.000	28.150	0.000	7004	VV	0.0
171		0.000	28.207	0.000	7005	VV	0.0
172		0.000	28.348	0.000	15531	VV	0.0
173	C20	0.003	28.480	-0.048	19407	VV	0.0
174		0.000	28.709	0.000	11337	VV	0.0
175		0.000	28.841	0.000	9800	VV	0.0
176		0.000	28.973	0.000	10930	VV	0.0

177		0.000	29.106	0.000	7913	VV	0.0
178		0.000	29.188	0.000	6856	VV	0.0
179		0.000	29.385	0.000	15111	VV	0.0
180		0.000	29.538	0.000	6807	VV	0.0
181		0.000	29.611	0.000	10492	VV	0.0
182		0.000	29.768	0.000	10891	VV	0.0
183		0.000	29.894	0.000	4399	VV	0.0
184		0.000	29.972	0.000	9891	VV	0.0
185		0.000	30.238	0.000	25335	VV	0.0
186		0.000	30.470	0.000	9548	VV	0.0
187		0.000	30.615	0.000	13206	VV	0.0
188		0.000	30.957	0.000	20446	VV	0.0
189		0.000	31.126	0.000	10989	VV	0.0
190		0.000	31.329	0.000	8353	VV	0.0
191		0.000	31.511	0.000	10059	VV	0.0
192		0.000	31.615	0.000	3018	VV	0.0
193		0.000	31.848	0.000	12988	VV	0.0
194		0.000	32.041	0.000	6671	VV	0.0
195		0.000	32.232	0.000	4056	VV	0.0
196		0.000	32.332	0.000	3837	VV	0.0
197		0.000	32.451	0.000	5238	VV	0.0
198		0.000	32.515	0.000	3496	VV	0.0
199		0.000	32.669	0.000	3929	VV	0.0
200		0.000	32.917	0.000	6911	VV	0.0
201		0.000	33.025	0.000	2046	VV	0.0
202		0.000	33.149	0.000	2558	VV	0.0
203		0.000	33.244	0.000	2362	VV	0.0
204		0.000	33.348	0.000	4482	VV	0.0
205		0.000	33.500	0.000	3640	VV	0.0
206	C28	0.002	33.710	0.009	4266	VV	0.0
207		0.000	33.893	0.000	2449	VV	0.0
208		0.000	33.917	0.000	1314	VV	0.0
209		0.000	33.953	0.000	1074	VV	0.0
210		0.000	34.058	0.000	1513	VV	0.0
211		0.000	34.310	0.000	3353	VV	0.0
212		0.000	34.325	0.000	3427	VV	0.0
213		0.000	34.650	0.000	5495	VV	0.0
214		0.000	34.752	0.000	3484	VB	0.0
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	Totals:	1.467		-0.171	118505136		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr91-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.987	0.000	1373	BV	2.5
2	C5	0.302	5.194	0.002	10638	VB	2.3
3		0.000	6.227	0.000	1040	BB	3.8
4	C7	0.088	6.543	-0.004	16381	BB	4.5
5	Toluene	1.037	7.675	0.014	117006640	BB	11.8
6		0.000	7.884	0.000	5557	TS	0.0
7	C8	0.013	7.961	0.022	2748	TF	0.0
8		0.000	8.002	0.000	1260	TF	0.0
9		0.000	8.026	0.000	5717	TF	0.0
10		0.000	8.104	0.000	1899	TF	0.0
11		0.000	8.185	0.000	6741	TF	0.0
12		0.000	8.262	0.000	9586	TS	0.0
13		0.000	8.356	0.000	2028	TS	0.0
14		0.000	8.500	0.000	4026	TF	0.0
15		0.000	8.616	0.000	2787	TF	0.0
16		0.000	8.684	0.000	4149	TF	0.0
17		0.000	8.722	0.000	5354	TF	0.0
18		0.000	8.985	0.000	22538	TF	0.0
19		0.000	9.114	0.000	24230	TF	0.0
20		0.000	14.314	0.000	1413	VV	2.2
21		0.000	14.540	0.000	4085	VV	2.2
22	C12	0.001	15.174	0.018	2310	VV	2.9
23		0.000	15.249	0.000	4923	VV	2.7
24		0.000	15.391	0.000	3573	VV	2.8
25		0.000	15.451	0.000	1480	VP	4.4
26		0.000	15.797	0.000	1043	VV	3.7
27		0.000	15.934	0.000	1218	VV	5.3
28		0.000	15.992	0.000	1535	VV	2.7
29		0.000	16.064	0.000	2879	VV	2.7
30		0.000	16.114	0.000	2593	VV	4.6
31		0.000	16.196	0.000	1528	VV	2.9
32		0.000	16.271	0.000	1248	VV	0.0
33		0.000	16.328	0.000	3676	VV	2.0
34		0.000	16.407	0.000	1364	VV	2.9
35		0.000	16.469	0.000	1134	VV	0.0
36		0.000	16.606	0.000	4975	VV	2.9
37		0.000	16.666	0.000	4193	VV	6.9
38	C13	0.003	16.958	0.069	4963	VV	4.2
39		0.000	17.045	0.000	3615	VV	2.9
40		0.000	17.103	0.000	4843	VV	0.0
41		0.000	17.227	0.000	8198	VV	2.4
42		0.000	17.279	0.000	2236	VV	0.0
43		0.000	17.348	0.000	2325	VV	0.0
44		0.000	17.384	0.000	1485	VV	7.6
45		0.000	17.484	0.000	3325	VV	4.2
46		0.000	17.544	0.000	11766	VV	2.6
47		0.000	17.690	0.000	3760	VV	5.6
48		0.000	17.822	0.000	3244	VV	0.0
49		0.000	17.928	0.000	2452	VV	0.0

50		0.000	17.995	0.000	2508	VV	0.0
51		0.000	18.062	0.000	2531	VV	0.0
52		0.000	18.190	0.000	3062	VV	0.0
53		0.000	18.276	0.000	1105	VV	0.0
54		0.000	18.330	0.000	1663	VV	0.0
55	C14	0.003	18.596	0.072	4636	VV	0.0
56		0.000	18.679	0.000	3144	VV	0.0
57		0.000	18.807	0.000	6300	VV	4.1
58		0.000	18.864	0.000	5765	VV	0.0
59		0.000	18.916	0.000	4060	VV	0.0
60		0.000	18.979	0.000	2813	VV	0.0
61		0.000	19.060	0.000	6023	VV	3.5
62		0.000	19.085	0.000	10677	VV	4.3
63		0.000	19.186	0.000	4219	VV	0.0
64		0.000	19.257	0.000	3478	VV	0.0
65		0.000	19.310	0.000	15621	VV	2.3
66		0.000	19.385	0.000	9389	VV	2.6
67		0.000	19.441	0.000	4218	VV	0.0
68		0.000	19.504	0.000	4403	VV	0.0
69		0.000	19.625	0.000	1510	VV	0.0
70		0.000	19.667	0.000	6368	VV	0.0
71		0.000	19.719	0.000	4685	VV	0.0
72		0.000	19.815	0.000	2950	VV	0.0
73		0.000	19.931	0.000	6788	VV	8.5
74		0.000	19.980	0.000	2027	VV	0.0
75	C15	0.002	20.071	0.012	4258	VV	0.0
76		0.000	20.165	0.000	1502	VV	0.0
77		0.000	20.194	0.000	1221	VV	0.0
78		0.000	20.289	0.000	1871	VV	0.0
79		0.000	20.311	0.000	1942	VV	0.0
80		0.000	20.343	0.000	1213	VV	0.0
81		0.000	20.359	0.000	2143	VV	0.0
82		0.000	20.403	0.000	1294	VV	0.0
83		0.000	20.434	0.000	1669	VV	0.0
84		0.000	20.447	0.000	2888	VV	0.0
85		0.000	20.478	0.000	1190	VV	0.0
86		0.000	20.493	0.000	3062	VV	0.0
87		0.000	20.524	0.000	1135	VV	0.0
88		0.000	20.607	0.000	8689	VV	3.3
89		0.000	20.644	0.000	3509	VV	0.0
90		0.000	20.692	0.000	3057	VV	0.0
91		0.000	20.760	0.000	6872	VV	0.0
92		0.000	20.827	0.000	4278	VV	0.0
93		0.000	20.950	0.000	15229	VV	7.6
94		0.000	21.062	0.000	8786	VV	0.0
95		0.000	21.126	0.000	2274	VV	0.0
96		0.000	21.187	0.000	6760	VV	0.0
97		0.000	21.327	0.000	9195	VV	0.0
98		0.000	21.413	0.000	8745	VV	0.0
99		0.000	21.524	0.000	2664	VV	0.0
100	C16	0.002	21.608	0.038	4333	VV	0.0
101		0.000	21.633	0.000	4059	VV	0.0
102		0.000	21.687	0.000	5702	VV	0.0
103		0.000	21.752	0.000	3099	VV	0.0
104		0.000	21.805	0.000	4826	VV	0.0
105		0.000	21.932	0.000	5588	VV	0.0
106		0.000	22.019	0.000	4880	VV	0.0
107		0.000	22.082	0.000	9478	VV	0.0
108		0.000	22.178	0.000	3218	VV	0.0
109		0.000	22.223	0.000	5046	VV	0.0
110		0.000	22.295	0.000	7133	VV	0.0
111		0.000	22.332	0.000	5742	VV	0.0
112		0.000	22.382	0.000	10196	VV	0.0

113		0.000	22.507	0.000	7381	VV	0.0
114		0.000	22.587	0.000	9564	VV	0.0
115		0.000	22.787	0.000	6656	VV	0.0
116		0.000	22.829	0.000	1920	VV	0.0
117		0.000	22.899	0.000	3758	VV	0.0
118		0.000	22.923	0.000	2926	VV	0.0
119		0.000	22.994	0.000	4975	VV	0.0
120	C17	0.002	23.087	-0.027	3296	VV	0.0
121		0.000	23.246	0.000	8779	VV	0.0
122		0.000	23.340	0.000	5608	VV	0.0
123		0.000	23.451	0.000	3873	VV	0.0
124		0.000	23.628	0.000	6595	VV	0.0
125		0.000	23.700	0.000	2772	VV	0.0
126		0.000	23.766	0.000	3374	VV	0.0
127		0.000	23.825	0.000	5319	VV	0.0
128		0.000	23.907	0.000	1991	VV	0.0
129		0.000	23.957	0.000	2809	VV	0.0
130		0.000	24.087	0.000	11926	VV	0.0
131		0.000	24.156	0.000	2214	VV	0.0
132		0.000	24.234	0.000	4901	VV	0.0
133		0.000	24.288	0.000	4859	VV	0.0
134		0.000	24.358	0.000	2141	VV	0.0
135		0.000	24.421	0.000	3308	VV	0.0
136		0.000	24.501	0.000	4909	VV	0.0
137		0.000	24.548	0.000	2207	VV	0.0
138		0.000	24.607	0.000	5266	VV	0.0
139	C18	0.002	24.706	-0.031	4084	VV	0.0
140		0.000	24.852	0.000	1729	VV	0.0
141		0.000	24.963	0.000	6880	VV	0.0
142		0.000	25.063	0.000	7340	VV	0.0
143		0.000	25.577	0.000	3747	BP	2.5
144		0.000	25.709	0.000	1931	PV	3.4
145		0.000	25.976	0.000	2525	VB	3.0
146		0.000	26.119	0.000	1024	BP	2.1
147		0.000	26.222	0.000	1627	PV	4.3
148		0.000	26.294	0.000	2864	VV	3.1
149		0.000	26.430	0.000	1954	VV	3.8
150		0.000	26.525	0.000	1657	VV	3.7
151		0.000	26.591	0.000	3098	VV	4.6
152		0.000	26.701	0.000	1535	VP	2.3
153		0.000	26.862	0.000	1356	PP	2.2
154		0.000	26.994	0.000	7174	PV	3.5
155		0.000	27.176	0.000	2593	VV	4.6
156		0.000	27.225	0.000	1581	VV	6.9
157		0.000	27.350	0.000	5482	VV	4.1
158		0.000	27.594	0.000	2234	VV	3.4
159		0.000	27.675	0.000	1484	VV	3.9
160		0.000	27.768	0.000	3946	VV	2.8
161		0.000	27.913	0.000	8851	VV	3.4
162		0.000	28.211	0.000	1126	VV	3.3
163		0.000	28.356	0.000	3921	VV	3.7
164	C20	0.001	28.484	-0.044	4750	VB	4.7
165		0.000	28.984	0.000	1906	VV	4.3
166		0.000	29.113	0.000	2531	VV	3.5
167		0.000	29.178	0.000	1381	VV	6.6
168		0.000	29.391	0.000	3447	VV	3.6
169		0.000	29.547	0.000	3261	VV	4.3
170		0.000	29.616	0.000	9022	VV	5.6
171		0.000	29.752	0.000	2029	VP	6.4
172		0.000	29.979	0.000	3069	VV	4.0
173		0.000	30.246	0.000	6189	VV	5.9
174		0.000	30.315	0.000	2510	VV	9.0
175		0.000	30.476	0.000	2947	VV	3.6

176		0.000	30.622	0.000	3841	VB	4.9
177		0.000	30.964	0.000	8458	BV	4.9
178		0.000	31.134	0.000	4933	VV	6.8
179		0.000	31.334	0.000	3162	VV	3.8
180		0.000	31.520	0.000	2622	VV	5.4
181		0.000	31.851	0.000	3780	VV	5.2
182		0.000	32.050	0.000	1436	VB	4.2
183		0.000	32.337	0.000	1302	VV	5.9
184		0.000	32.458	0.000	2249	VV	6.2
185		0.000	32.522	0.000	1188	VV	8.6
186		0.000	32.918	0.000	2646	PV	5.9
187		0.000	33.352	0.000	1655	VB	3.3
188	C28	0.001	33.712	0.011	2143	PV	5.2
189		0.000	33.900	0.000	1928	VV	3.5
190		0.000	33.955	0.000	1770	VV	3.5
191		0.000	34.032	0.000	1347	VB	0.0
192		0.000	34.326	0.000	3210	BB	6.6
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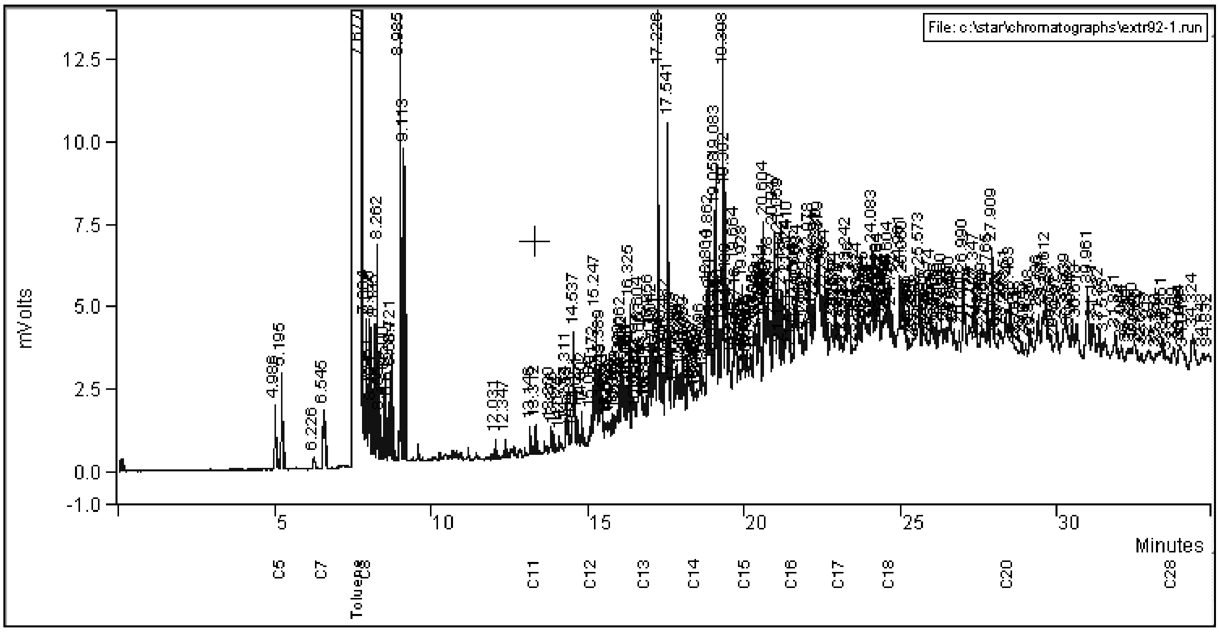
	Totals:	1.457		0.152	117826545		



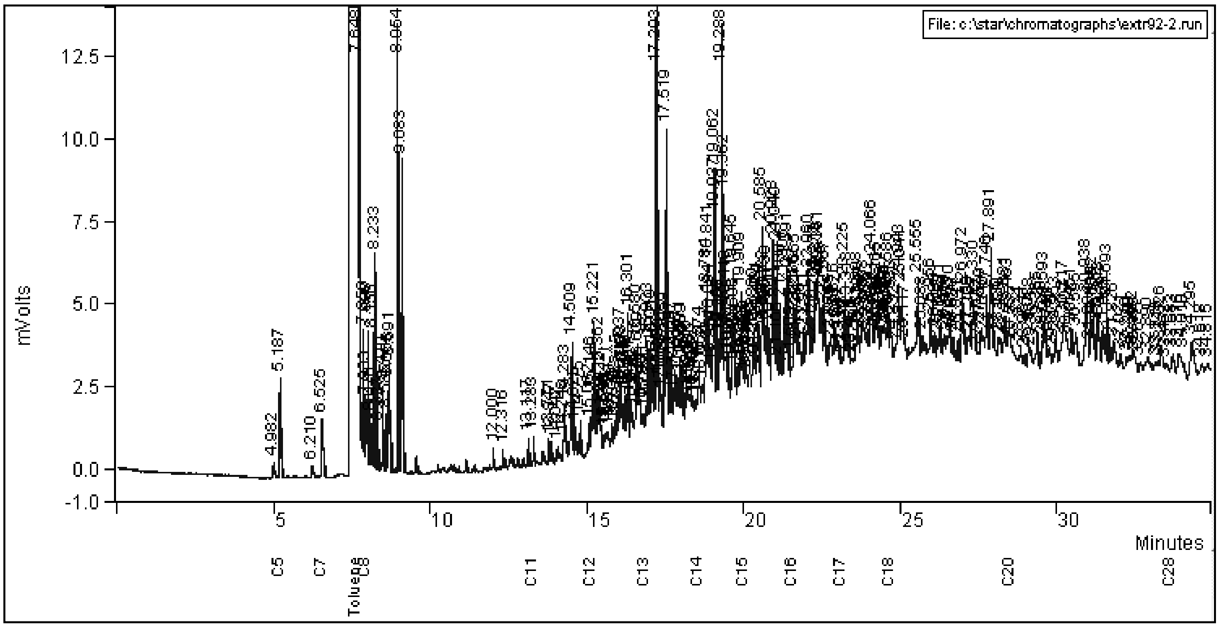


Figure C18: Duplicate chromatograms of Sample 92 (Extract 92-1 and 92-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at NTF T1104.

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Title               : PONA COLUMN EXPERIMENT
Method File         : c:\star\extractrun.mth
Sample ID           : extr92-1
Operator            : SHAN
Instrument          : Varian Star 3800
Channel             : Front = FID
Run Time            : 34.965 min
Peak Measurement    : Peak Area
Calculation Type    : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.986	0.000	4979	BP	2.5
2	C5	0.204	5.195	0.003	7185	PB	2.3
3		0.000	6.226	0.000	1177	BB	3.9
4	C7	0.042	6.545	-0.002	7830	BB	4.5
5	Toluene	1.025	7.677	0.016	115661840	BP	11.6
6		0.000	7.884	0.000	5910	TS	0.0
7	C8	0.014	7.961	0.022	2849	TF	0.0
8		0.000	8.026	0.000	7343	TF	0.0
9		0.000	8.104	0.000	1967	TF	0.0
10		0.000	8.185	0.000	6912	TF	0.0
11		0.000	8.262	0.000	9642	TS	0.0
12		0.000	8.356	0.000	2011	TS	0.0
13		0.000	8.500	0.000	3881	TF	0.0
14		0.000	8.615	0.000	2673	TF	0.0
15		0.000	8.684	0.000	4077	TF	0.0
16		0.000	8.721	0.000	5165	TF	0.0
17		0.000	8.985	0.000	21370	VV	0.0
18		0.000	9.113	0.000	22906	VB	0.0
19		0.000	12.031	0.000	1232	BP	1.8
20		0.000	12.347	0.000	1235	VV	1.8
21		0.000	13.146	0.000	1978	VV	1.8
22	C11	0.001	13.312	-0.014	2028	VV	2.0
23		0.000	13.800	0.000	1735	VV	2.3
24		0.000	13.876	0.000	1349	VP	2.3
25		0.000	14.075	0.000	1332	VV	4.1
26		0.000	14.273	0.000	1025	VV	2.6
27		0.000	14.311	0.000	4936	VV	2.4
28		0.000	14.431	0.000	1150	VV	0.0
29		0.000	14.537	0.000	10419	VV	2.2
30		0.000	14.651	0.000	2410	VV	2.9
31		0.000	14.802	0.000	2191	VV	2.3
32		0.000	15.089	0.000	2176	VV	3.2
33	C12	0.003	15.172	0.016	5597	VV	3.7
34		0.000	15.247	0.000	11946	VV	2.7
35		0.000	15.389	0.000	8425	VV	4.7
36		0.000	15.448	0.000	3437	VV	7.1
37		0.000	15.573	0.000	2184	VV	0.0
38		0.000	15.623	0.000	2258	VV	0.0
39		0.000	15.703	0.000	1593	VV	0.0
40		0.000	15.795	0.000	2639	VV	6.8
41		0.000	15.861	0.000	1650	VV	0.0
42		0.000	15.928	0.000	3068	VV	0.0
43		0.000	15.990	0.000	3943	VV	2.9
44		0.000	16.062	0.000	6272	VV	3.1
45		0.000	16.112	0.000	6084	VV	4.8
46		0.000	16.194	0.000	4002	VV	0.0
47		0.000	16.268	0.000	3943	VV	0.0
48		0.000	16.325	0.000	8799	VV	2.1
49		0.000	16.404	0.000	4194	VV	3.1

50		0.000	16.465	0.000	3136	VV	0.0
51		0.000	16.506	0.000	1072	VV	0.0
52		0.000	16.604	0.000	9757	VV	3.2
53		0.000	16.663	0.000	9875	VV	7.4
54		0.000	16.764	0.000	2126	VV	0.0
55		0.000	16.817	0.000	2714	VV	0.0
56	C13	0.002	16.873	-0.016	2819	VV	0.0
57		0.000	16.956	0.000	11257	VV	4.3
58		0.000	17.042	0.000	6838	VV	3.0
59		0.000	17.101	0.000	9913	VV	0.0
60		0.000	17.226	0.000	32391	VV	2.0
61		0.000	17.275	0.000	3409	VV	0.0
62		0.000	17.343	0.000	6110	VV	0.0
63		0.000	17.380	0.000	3511	VV	0.0
64		0.000	17.482	0.000	8590	VV	4.3
65		0.000	17.541	0.000	26523	VV	2.4
66		0.000	17.689	0.000	10361	VV	5.9
67		0.000	17.765	0.000	2672	VV	0.0
68		0.000	17.824	0.000	9177	VV	0.0
69		0.000	17.927	0.000	5408	VV	0.0
70		0.000	17.992	0.000	5836	VV	0.0
71		0.000	18.059	0.000	7596	VV	6.3
72		0.000	18.187	0.000	7137	VV	0.0
73		0.000	18.228	0.000	2632	VV	0.0
74		0.000	18.271	0.000	2708	VV	0.0
75		0.000	18.327	0.000	4547	VV	0.0
76		0.000	18.380	0.000	1983	VV	0.0
77		0.000	18.428	0.000	3065	VV	0.0
78	C14	0.002	18.482	-0.042	3433	VV	0.0
79		0.000	18.596	0.000	9427	VV	0.0
80		0.000	18.684	0.000	8602	VV	0.0
81		0.000	18.804	0.000	12907	VV	4.1
82		0.000	18.862	0.000	12394	VV	0.0
83		0.000	18.914	0.000	8534	VV	0.0
84		0.000	18.976	0.000	5518	VV	0.0
85		0.000	19.058	0.000	12189	VV	3.3
86		0.000	19.083	0.000	20195	VV	4.0
87		0.000	19.183	0.000	9017	VV	0.0
88		0.000	19.254	0.000	7386	VV	0.0
89		0.000	19.308	0.000	29727	VV	2.3
90		0.000	19.382	0.000	17892	VV	2.5
91		0.000	19.439	0.000	9204	VV	0.0
92		0.000	19.505	0.000	10266	VV	0.0
93		0.000	19.620	0.000	3780	VV	0.0
94		0.000	19.664	0.000	11988	VV	3.2
95		0.000	19.716	0.000	9120	VV	0.0
96		0.000	19.812	0.000	7090	VV	0.0
97		0.000	19.928	0.000	14354	VV	4.8
98		0.000	19.977	0.000	4355	VV	0.0
99		0.000	20.018	0.000	2159	VV	0.0
100	C15	0.003	20.068	0.009	6164	VV	0.0
101		0.000	20.109	0.000	3027	VV	0.0
102		0.000	20.199	0.000	11207	VV	0.0
103		0.000	20.305	0.000	8411	VV	0.0
104		0.000	20.348	0.000	9322	VV	0.0
105		0.000	20.441	0.000	9946	VV	0.0
106		0.000	20.493	0.000	10135	VV	0.0
107		0.000	20.604	0.000	16089	VV	2.9
108		0.000	20.641	0.000	6274	VV	0.0
109		0.000	20.689	0.000	5978	VV	0.0
110		0.000	20.758	0.000	13397	VV	0.0
111		0.000	20.824	0.000	9025	VV	0.0
112		0.000	20.947	0.000	27604	VV	6.7

113		0.000	21.059	0.000	15899	VV	3.7
114		0.000	21.123	0.000	4878	VV	0.0
115		0.000	21.184	0.000	14667	VV	0.0
116		0.000	21.324	0.000	17962	VV	0.0
117		0.000	21.410	0.000	16837	VV	8.6
118		0.000	21.521	0.000	6942	VV	0.0
119	C16	0.004	21.604	0.035	7724	VV	0.0
120		0.000	21.630	0.000	8124	VV	0.0
121		0.000	21.684	0.000	11538	VV	0.0
122		0.000	21.745	0.000	5878	VV	0.0
123		0.000	21.801	0.000	11152	VV	0.0
124		0.000	21.929	0.000	11830	VV	0.0
125		0.000	22.078	0.000	28236	VV	0.0
126		0.000	22.173	0.000	6893	VV	0.0
127		0.000	22.220	0.000	9325	VV	0.0
128		0.000	22.291	0.000	12158	VV	0.0
129		0.000	22.330	0.000	10077	VV	0.0
130		0.000	22.379	0.000	18883	VV	0.0
131		0.000	22.503	0.000	14868	VV	0.0
132		0.000	22.584	0.000	17813	VV	0.0
133		0.000	22.781	0.000	16804	VV	0.0
134		0.000	22.826	0.000	4573	VV	0.0
135		0.000	22.894	0.000	8434	VV	0.0
136		0.000	22.917	0.000	5522	VV	0.0
137		0.000	22.992	0.000	10720	VV	0.0
138	C17	0.005	23.086	-0.028	8396	VV	0.0
139		0.000	23.152	0.000	3696	VV	0.0
140		0.000	23.242	0.000	17622	VV	0.0
141		0.000	23.336	0.000	14646	VV	0.0
142		0.000	23.441	0.000	3937	VV	0.0
143		0.000	23.488	0.000	5113	VV	0.0
144		0.000	23.624	0.000	18027	VV	0.0
145		0.000	23.698	0.000	7083	VV	0.0
146		0.000	23.764	0.000	7883	VV	0.0
147		0.000	23.825	0.000	12660	VV	0.0
148		0.000	23.903	0.000	5920	VV	0.0
149		0.000	23.954	0.000	8008	VV	0.0
150		0.000	24.083	0.000	23223	VV	0.0
151		0.000	24.156	0.000	5265	VV	0.0
152		0.000	24.228	0.000	11201	VV	0.0
153		0.000	24.284	0.000	10705	VV	0.0
154		0.000	24.354	0.000	5211	VV	0.0
155		0.000	24.417	0.000	8230	VV	0.0
156		0.000	24.446	0.000	3049	VV	0.0
157		0.000	24.499	0.000	7712	VV	0.0
158		0.000	24.545	0.000	5404	VV	0.0
159		0.000	24.604	0.000	13075	VV	0.0
160	C18	0.008	24.702	-0.035	14610	VV	0.0
161		0.000	24.961	0.000	25118	VV	0.0
162		0.000	25.060	0.000	20914	VV	0.0
163		0.000	25.166	0.000	5921	VV	0.0
164		0.000	25.254	0.000	5316	VV	0.0
165		0.000	25.305	0.000	2626	VV	0.0
166		0.000	25.375	0.000	7479	VV	0.0
167		0.000	25.498	0.000	9855	VV	0.0
168		0.000	25.573	0.000	15877	VV	0.0
169		0.000	25.707	0.000	11751	VV	0.0
170		0.000	25.802	0.000	7324	VV	0.0
171		0.000	25.882	0.000	4007	VV	0.0
172		0.000	25.974	0.000	13693	VV	0.0
173		0.000	26.046	0.000	3287	VV	0.0
174		0.000	26.116	0.000	6782	VV	0.0
175		0.000	26.210	0.000	7824	VV	0.0

176		0.000	26.290	0.000	9509	VV	0.0
177		0.000	26.427	0.000	10291	VV	0.0
178		0.000	26.527	0.000	6536	VV	0.0
179		0.000	26.590	0.000	10473	VV	0.0
180		0.000	26.698	0.000	6975	VV	0.0
181		0.000	26.860	0.000	10141	VV	0.0
182		0.000	26.990	0.000	19727	VV	0.0
183		0.000	27.174	0.000	7075	VV	0.0
184		0.000	27.227	0.000	6489	VV	0.0
185		0.000	27.347	0.000	16714	VV	0.0
186		0.000	27.488	0.000	3423	VV	0.0
187		0.000	27.589	0.000	8808	VV	0.0
188		0.000	27.664	0.000	5816	VV	0.0
189		0.000	27.765	0.000	11002	VV	0.0
190		0.000	27.909	0.000	19556	VV	0.0
191		0.000	28.022	0.000	3454	VV	0.0
192		0.000	28.148	0.000	5057	VV	0.0
193		0.000	28.209	0.000	4500	VV	0.0
194		0.000	28.351	0.000	11270	VV	0.0
195	C20	0.003	28.483	-0.045	15488	VV	0.0
196		0.000	28.624	0.000	3095	VV	0.0
197		0.000	28.711	0.000	1205	VV	0.0
198		0.000	28.843	0.000	5044	VV	0.0
199		0.000	28.979	0.000	3256	VV	0.0
200		0.000	29.108	0.000	5076	VV	0.0
201		0.000	29.185	0.000	3303	VV	0.0
202		0.000	29.386	0.000	10219	VV	0.0
203		0.000	29.541	0.000	7312	VV	0.0
204		0.000	29.612	0.000	10299	VV	0.0
205		0.000	29.763	0.000	6659	VV	0.0
206		0.000	29.893	0.000	1812	VV	0.0
207		0.000	29.972	0.000	5303	VV	0.0
208		0.000	30.239	0.000	11433	VV	0.0
209		0.000	30.333	0.000	4158	VV	0.0
210		0.000	30.472	0.000	5255	VV	0.0
211		0.000	30.618	0.000	6025	VB	0.0
212		0.000	30.961	0.000	11967	BV	4.7
213		0.000	31.131	0.000	6821	VV	6.5
214		0.000	31.332	0.000	4356	VV	3.6
215		0.000	31.515	0.000	3929	VV	5.4
216		0.000	31.851	0.000	5762	VV	5.1
217		0.000	32.044	0.000	2303	VV	3.7
218		0.000	32.234	0.000	1533	VV	3.3
219		0.000	32.329	0.000	2057	VV	4.8
220		0.000	32.450	0.000	3256	VV	5.1
221		0.000	32.525	0.000	1301	VV	7.6
222		0.000	32.673	0.000	1180	VP	2.7
223		0.000	32.917	0.000	2121	PB	5.1
224		0.000	33.152	0.000	1066	BV	4.2
225		0.000	33.241	0.000	1525	VV	0.0
226		0.000	33.351	0.000	3901	VV	4.3
227		0.000	33.493	0.000	1333	VV	4.8
228	C28	0.002	33.709	0.008	4153	VV	5.6
229		0.000	33.904	0.000	3377	VV	4.8
230		0.000	33.948	0.000	2331	VV	8.6
231		0.000	34.018	0.000	2628	VP	4.8
232		0.000	34.324	0.000	8117	PV	5.6
233		0.000	34.643	0.000	2235	VV	5.1
234		0.000	34.832	0.000	2079	VB	7.6
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	Totals:	1.318		-0.073	117491502		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr92-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.982	0.000	1114	BV	2.2
2	C5	0.208	5.187	-0.005	7328	VB	2.2
3		0.000	6.210	0.000	1368	BB	3.8
4	C7	0.043	6.525	-0.022	7968	BB	4.5
5	Toluene	1.030	7.648	-0.013	116206736	BB	11.7
6		0.000	7.856	0.000	5836	TS	0.0
7	C8	0.014	7.933	-0.006	2863	TF	0.0
8		0.000	7.998	0.000	7349	TF	0.0
9		0.000	8.076	0.000	1890	TS	0.0
10		0.000	8.156	0.000	6864	TS	0.0
11		0.000	8.233	0.000	9705	TS	0.0
12		0.000	8.327	0.000	1986	TS	0.0
13		0.000	8.470	0.000	3908	TF	0.0
14		0.000	8.585	0.000	2660	TF	0.0
15		0.000	8.655	0.000	4089	TF	0.0
16		0.000	8.691	0.000	5202	TF	0.0
17		0.000	8.954	0.000	21611	TF	0.0
18		0.000	9.083	0.000	23285	TF	0.0
19		0.000	12.000	0.000	1087	BB	1.6
20		0.000	12.316	0.000	1190	VV	1.8
21		0.000	13.117	0.000	1466	BV	1.7
22	C11	0.001	13.283	-0.043	1796	BB	1.9
23		0.000	13.771	0.000	1715	PV	2.0
24		0.000	13.847	0.000	1329	VV	1.9
25		0.000	14.047	0.000	1054	VV	2.1
26		0.000	14.246	0.000	1069	VV	2.4
27		0.000	14.283	0.000	4120	VV	2.2
28		0.000	14.509	0.000	10464	VV	2.1
29		0.000	14.625	0.000	2655	VV	2.8
30		0.000	14.775	0.000	2472	VV	2.1
31		0.000	15.062	0.000	2302	VV	2.7
32	C12	0.003	15.146	-0.010	5639	VV	3.6
33		0.000	15.221	0.000	12221	VV	2.6
34		0.000	15.362	0.000	8780	VV	4.4
35		0.000	15.422	0.000	3364	VV	6.0
36		0.000	15.549	0.000	2031	VV	0.0
37		0.000	15.598	0.000	1357	VV	0.0
38		0.000	15.678	0.000	1321	VV	0.0
39		0.000	15.770	0.000	2268	VV	4.8
40		0.000	15.836	0.000	1387	VV	0.0
41		0.000	15.902	0.000	2678	VV	0.0
42		0.000	15.965	0.000	3600	VV	2.8
43		0.000	16.037	0.000	5938	VV	2.8
44		0.000	16.088	0.000	5759	VV	4.6
45		0.000	16.169	0.000	3488	VV	3.4
46		0.000	16.245	0.000	3526	VV	3.0
47		0.000	16.301	0.000	8318	VV	2.1
48		0.000	16.381	0.000	3553	VV	3.0
49		0.000	16.441	0.000	2361	VV	0.0

50		0.000	16.580	0.000	8982	VV	3.0
51		0.000	16.639	0.000	8965	VV	7.1
52		0.000	16.740	0.000	1733	VV	0.0
53		0.000	16.793	0.000	2119	VV	0.0
54	C13	0.001	16.850	-0.039	2218	VV	0.0
55		0.000	16.933	0.000	10286	VV	4.1
56		0.000	17.019	0.000	6406	VV	2.9
57		0.000	17.077	0.000	8735	VV	0.0
58		0.000	17.203	0.000	31915	VV	2.0
59		0.000	17.253	0.000	3091	VV	0.0
60		0.000	17.320	0.000	5483	VV	0.0
61		0.000	17.357	0.000	2493	VV	0.0
62		0.000	17.459	0.000	7046	VV	4.3
63		0.000	17.519	0.000	25183	VV	2.4
64		0.000	17.667	0.000	8864	VV	6.0
65		0.000	17.744	0.000	2306	VV	0.0
66		0.000	17.801	0.000	7963	VV	0.0
67		0.000	17.906	0.000	4592	VV	0.0
68		0.000	17.971	0.000	4865	VV	0.0
69		0.000	18.039	0.000	5591	VV	5.0
70		0.000	18.165	0.000	5293	VV	0.0
71		0.000	18.208	0.000	1828	VV	0.0
72		0.000	18.252	0.000	2135	VV	0.0
73		0.000	18.306	0.000	3958	VV	0.0
74		0.000	18.357	0.000	1685	VV	0.0
75		0.000	18.402	0.000	1753	VV	0.0
76		0.000	18.463	0.000	1862	VV	0.0
77	C14	0.005	18.574	0.050	8161	VV	0.0
78		0.000	18.664	0.000	6152	VV	0.0
79		0.000	18.784	0.000	11023	VV	4.0
80		0.000	18.841	0.000	10886	VV	3.2
81		0.000	18.894	0.000	7395	VV	0.0
82		0.000	18.957	0.000	4917	VV	0.0
83		0.000	19.037	0.000	10893	VV	3.2
84		0.000	19.062	0.000	18780	VV	4.0
85		0.000	19.162	0.000	7150	VV	0.0
86		0.000	19.235	0.000	5790	VV	0.0
87		0.000	19.288	0.000	27895	VV	2.3
88		0.000	19.362	0.000	16505	VV	2.5
89		0.000	19.419	0.000	8157	VV	0.0
90		0.000	19.485	0.000	7375	VV	0.0
91		0.000	19.602	0.000	2583	VV	0.0
92		0.000	19.645	0.000	10192	VV	3.1
93		0.000	19.696	0.000	6669	VV	0.0
94		0.000	19.794	0.000	4477	VV	0.0
95		0.000	19.909	0.000	11455	VV	4.7
96		0.000	19.958	0.000	3335	VV	0.0
97		0.000	19.997	0.000	1594	VV	0.0
98	C15	0.002	20.049	-0.010	4316	VV	0.0
99		0.000	20.086	0.000	1901	VV	0.0
100		0.000	20.180	0.000	7201	VV	0.0
101		0.000	20.286	0.000	6203	VV	0.0
102		0.000	20.330	0.000	6410	VV	0.0
103		0.000	20.371	0.000	1076	VV	0.0
104		0.000	20.421	0.000	7096	VV	0.0
105		0.000	20.474	0.000	7938	VV	0.0
106		0.000	20.585	0.000	13429	VV	2.9
107		0.000	20.622	0.000	5113	VV	0.0
108		0.000	20.670	0.000	4378	VV	0.0
109		0.000	20.739	0.000	10367	VV	0.0
110		0.000	20.806	0.000	6365	VV	0.0
111		0.000	20.928	0.000	21516	VV	5.7
112		0.000	21.040	0.000	12505	VV	3.5

113		0.000	21.106	0.000	2704	VV	0.0
114		0.000	21.166	0.000	9169	VV	0.0
115		0.000	21.306	0.000	13341	VV	0.0
116		0.000	21.391	0.000	11383	VV	5.8
117		0.000	21.505	0.000	2959	VV	0.0
118	C16	0.003	21.586	0.017	5469	VV	0.0
119		0.000	21.612	0.000	5862	VV	0.0
120		0.000	21.665	0.000	8346	VV	0.0
121		0.000	21.728	0.000	3786	VV	0.0
122		0.000	21.785	0.000	6598	VV	0.0
123		0.000	21.911	0.000	6946	VV	0.0
124		0.000	22.060	0.000	19476	VV	0.0
125		0.000	22.150	0.000	3865	VV	0.0
126		0.000	22.202	0.000	6023	VV	0.0
127		0.000	22.272	0.000	8774	VV	0.0
128		0.000	22.313	0.000	7716	VV	0.0
129		0.000	22.361	0.000	13909	VV	0.0
130		0.000	22.485	0.000	10055	VV	0.0
131		0.000	22.567	0.000	11331	VV	0.0
132		0.000	22.765	0.000	8950	VV	0.0
133		0.000	22.809	0.000	2347	VV	0.0
134		0.000	22.876	0.000	8281	VV	0.0
135		0.000	22.972	0.000	5854	VV	0.0
136		0.000	23.067	0.000	3693	VV	0.0
137	C17	0.001	23.136	0.022	1274	VV	0.0
138		0.000	23.225	0.000	10878	VV	0.0
139		0.000	23.318	0.000	7619	VV	0.0
140		0.000	23.425	0.000	1393	VV	0.0
141		0.000	23.466	0.000	1521	VV	0.0
142		0.000	23.608	0.000	7733	VV	0.0
143		0.000	23.678	0.000	3634	VV	0.0
144		0.000	23.747	0.000	4274	VV	0.0
145		0.000	23.808	0.000	7210	VV	0.0
146		0.000	23.885	0.000	3134	VV	0.0
147		0.000	23.936	0.000	4210	VV	0.0
148		0.000	24.066	0.000	14145	VV	0.0
149		0.000	24.138	0.000	2316	VV	0.0
150		0.000	24.211	0.000	6474	VV	0.0
151		0.000	24.265	0.000	5912	VV	0.0
152		0.000	24.335	0.000	2176	VV	0.0
153		0.000	24.399	0.000	4148	VV	0.0
154		0.000	24.439	0.000	1512	VV	0.0
155		0.000	24.479	0.000	3861	VV	0.0
156		0.000	24.527	0.000	2524	VV	0.0
157		0.000	24.586	0.000	6929	VV	0.0
158	C18	0.003	24.683	-0.054	5609	VV	0.0
159		0.000	24.832	0.000	1605	VV	0.0
160		0.000	24.943	0.000	9013	VV	0.0
161		0.000	25.041	0.000	10005	VV	0.0
162		0.000	25.117	0.000	1714	VP	0.0
163		0.000	25.555	0.000	6571	VP	2.6
164		0.000	25.688	0.000	2311	PV	3.1
165		0.000	25.956	0.000	3317	PB	3.1
166		0.000	26.098	0.000	1492	BP	2.1
167		0.000	26.192	0.000	2021	PV	3.3
168		0.000	26.271	0.000	3235	VV	2.6
169		0.000	26.410	0.000	3080	VV	3.1
170		0.000	26.505	0.000	2349	VV	4.1
171		0.000	26.570	0.000	4391	VV	4.5
172		0.000	26.680	0.000	1878	VB	2.2
173		0.000	26.841	0.000	1954	BP	2.8
174		0.000	26.972	0.000	10626	PV	3.7
175		0.000	27.158	0.000	3497	VV	5.6

176		0.000	27.208	0.000	3039	VV	7.4
177		0.000	27.330	0.000	10016	VV	4.6
178		0.000	27.470	0.000	1136	VV	0.0
179		0.000	27.570	0.000	5099	VV	4.7
180		0.000	27.646	0.000	3646	VV	0.0
181		0.000	27.746	0.000	8288	VV	3.3
182		0.000	27.891	0.000	17134	VV	3.5
183		0.000	28.130	0.000	3216	VV	3.5
184		0.000	28.188	0.000	2573	VV	5.3
185		0.000	28.331	0.000	7691	VV	3.8
186		0.000	28.463	0.000	7750	VV	4.8
187	C20	0.001	28.535	0.007	4986	VV	7.2
188		0.000	28.824	0.000	2732	VV	2.5
189		0.000	28.961	0.000	1267	VV	2.2
190		0.000	29.088	0.000	3495	VV	2.9
191		0.000	29.164	0.000	1866	VV	3.6
192		0.000	29.365	0.000	5677	VP	3.2
193		0.000	29.520	0.000	2514	PV	2.6
194		0.000	29.593	0.000	7338	VV	3.3
195		0.000	29.750	0.000	3614	VV	4.6
196		0.000	29.875	0.000	1208	VV	2.3
197		0.000	29.953	0.000	4337	VV	3.3
198		0.000	30.217	0.000	11202	VV	6.8
199		0.000	30.307	0.000	3934	VV	7.2
200		0.000	30.451	0.000	5276	VV	3.6
201		0.000	30.595	0.000	5574	VB	4.5
202		0.000	30.938	0.000	11209	BV	4.7
203		0.000	31.034	0.000	1124	VV	0.0
204		0.000	31.105	0.000	4554	VV	5.9
205		0.000	31.142	0.000	4315	VV	5.3
206		0.000	31.292	0.000	2188	VV	2.6
207		0.000	31.318	0.000	3353	VV	3.5
208		0.000	31.469	0.000	2377	VV	3.4
209		0.000	31.503	0.000	2567	VV	7.1
210		0.000	31.593	0.000	2231	VV	0.6
211		0.000	31.826	0.000	4784	VV	5.1
212		0.000	32.021	0.000	2330	VV	3.5
213		0.000	32.216	0.000	1839	VV	3.3
214		0.000	32.309	0.000	2230	VV	4.2
215		0.000	32.432	0.000	3581	VV	6.0
216		0.000	32.490	0.000	1278	VP	7.0
217		0.000	32.655	0.000	1175	PP	2.1
218		0.000	32.890	0.000	1999	PB	4.3
219		0.000	33.129	0.000	1170	BV	4.5
220		0.000	33.215	0.000	1506	VV	0.0
221		0.000	33.326	0.000	4186	VV	4.3
222		0.000	33.462	0.000	1369	VV	4.9
223	C28	0.002	33.683	-0.018	4415	VV	5.6
224		0.000	33.876	0.000	6401	VV	4.5
225		0.000	34.010	0.000	1935	VP	16.0
226		0.000	34.295	0.000	8202	PB	5.8
227		0.000	34.618	0.000	1324	BV	5.3
228		0.000	34.815	0.000	1353	VB	8.6
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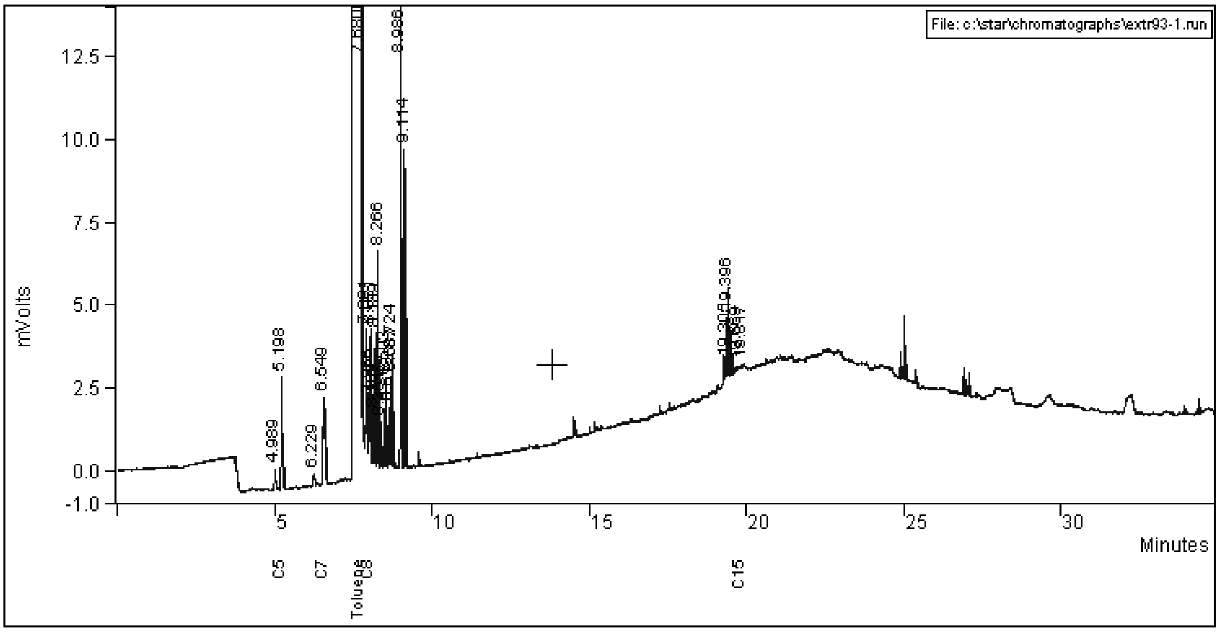
	Totals:	1.317		-0.124	117500603		



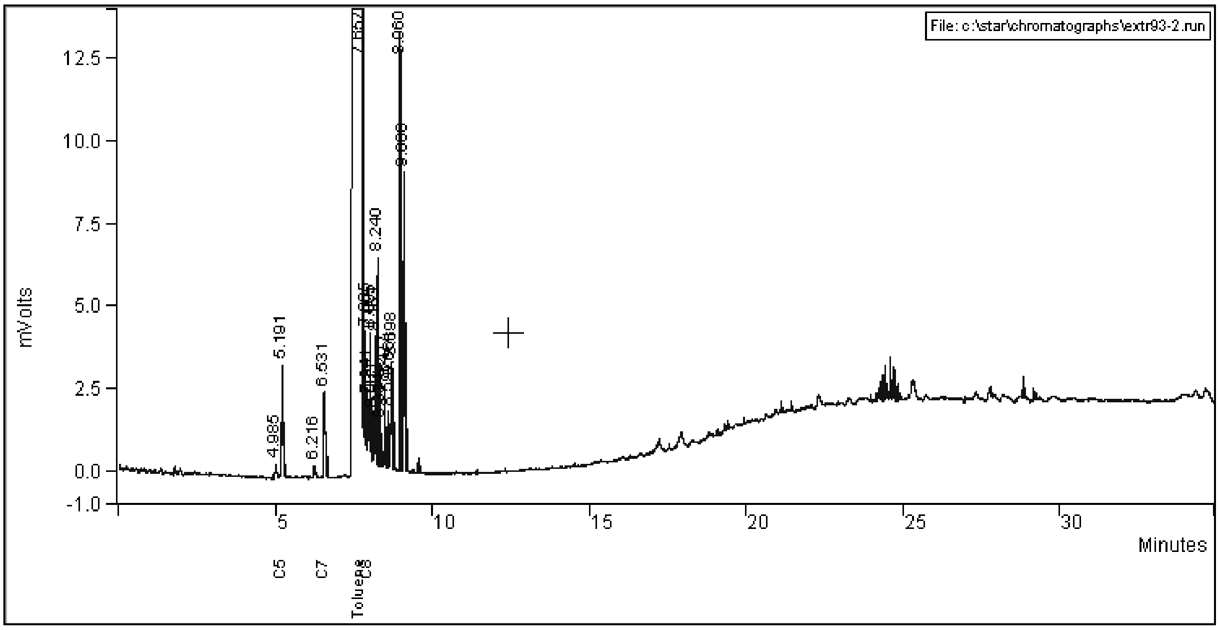


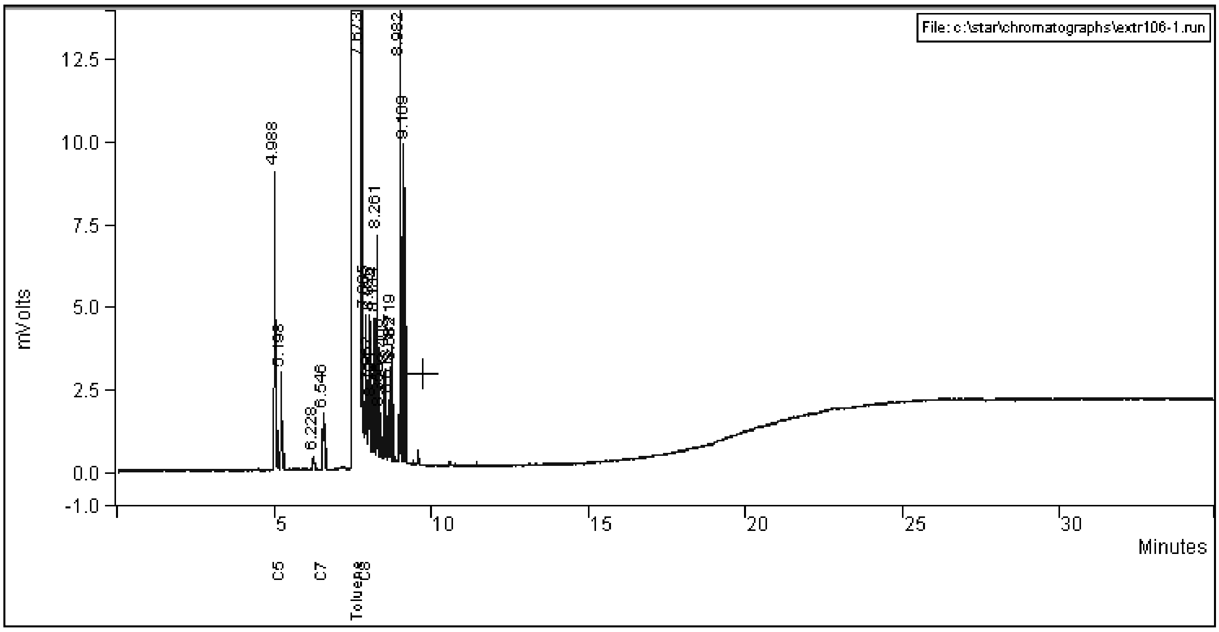
Figure C19: Duplicate chromatograms of Sample 93 (Extract 93-1 and 93-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at NTF T1104.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr93-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.989	0.000	1597	BV	2.3
2	C5	0.243	5.198	0.006	8556	PB	2.4
3		0.000	6.229	0.000	1253	BB	4.1
4	C7	0.064	6.549	0.002	12013	BB	4.6
5	Toluene	1.076	7.680	0.019	121369784	BB	12.2
6		0.000	7.891	0.000	5671	TS	0.0
7	C8	0.013	7.966	0.027	2793	TF	0.0
8		0.000	8.031	0.000	7304	TF	0.0
9		0.000	8.109	0.000	1982	TF	0.0
10		0.000	8.189	0.000	6881	TF	0.0
11		0.000	8.266	0.000	9702	TS	0.0
12		0.000	8.361	0.000	2041	TF	0.0
13		0.000	8.503	0.000	4098	TF	0.0
14		0.000	8.618	0.000	2719	TF	0.0
15		0.000	8.687	0.000	4118	TF	0.0
16		0.000	8.724	0.000	5253	TF	0.0
17		0.000	8.986	0.000	21262	TF	0.0
18		0.000	9.114	0.000	22655	TF	0.0
19		0.000	19.305	0.000	1057	VV	3.3
20		0.000	19.396	0.000	1215	VV	0.3
21		0.000	19.669	0.000	1306	VV	0.0
22	C15	0.001	19.817	-0.242	1625	VV	0.0
	Totals:	1.397		-0.188	121494885		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr93-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.985	0.000	1099	BB	2.5
2	C5	0.232	5.191	-0.001	8161	BB	2.1
3		0.000	6.216	0.000	1186	BB	3.7
4	C7	0.062	6.531	-0.016	11515	BB	4.4
5	Toluene	1.041	7.657	-0.004	117424136	BB	11.8
6		0.000	7.865	0.000	5446	TS	0.0
7	C8	0.013	7.941	0.002	2648	TF	0.0
8		0.000	8.005	0.000	6991	TF	0.0
9		0.000	8.083	0.000	1927	TF	0.0
10		0.000	8.163	0.000	6600	TF	0.0
11		0.000	8.240	0.000	9350	TS	0.0
12		0.000	8.334	0.000	1922	TS	0.0
13		0.000	8.477	0.000	3845	TF	0.0
14		0.000	8.592	0.000	2654	TF	0.0
15		0.000	8.661	0.000	3964	TF	0.0
16		0.000	8.698	0.000	4972	TF	0.0
17		0.000	8.960	0.000	20382	TS	0.0
18		0.000	9.088	0.000	21749	TS	0.0
	Totals:	1.348		-0.019	117538547		



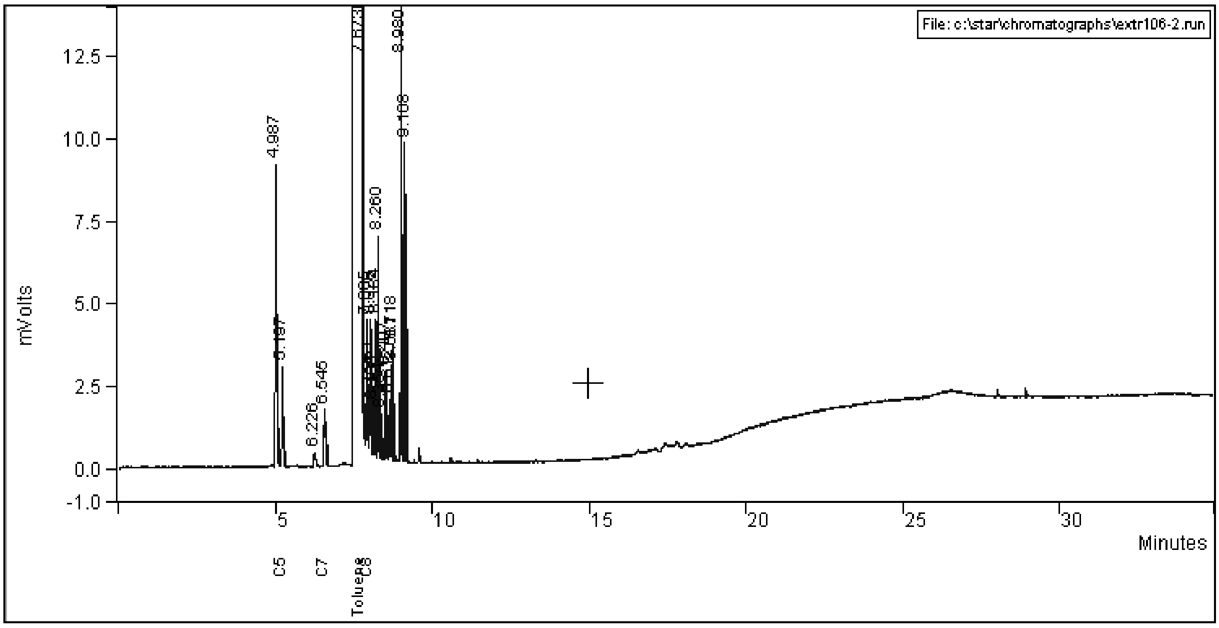


Figure C20: Duplicate chromatograms of Sample 106 (Extract 106-1 and 106-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at LUBOIL site in middle of T4815/6/7/9.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr106-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.988	0.000	20325	BV	2.0
2	C5	0.211	5.198	0.006	7418	VB	2.2
3		0.000	6.228	0.000	1341	BB	3.7
4	C7	0.040	6.546	-0.001	7422	BB	4.4
5	Toluene	1.069	7.673	0.012	120618704	BB	12.1
6		0.000	7.885	0.000	5901	TS	0.0
7	C8	0.014	7.962	0.023	2838	TF	0.0
8		0.000	8.026	0.000	7519	TF	0.0
9		0.000	8.104	0.000	2053	TF	0.0
10		0.000	8.184	0.000	7109	TF	0.0
11		0.000	8.261	0.000	9937	TS	0.0
12		0.000	8.356	0.000	2020	TS	0.0
13		0.000	8.498	0.000	4146	TF	0.0
14		0.000	8.613	0.000	2754	TF	0.0
15		0.000	8.682	0.000	4255	TF	0.0
16		0.000	8.719	0.000	5297	TF	0.0
17		0.000	8.982	0.000	21525	TF	0.0
18		0.000	9.109	0.000	22861	TF	0.0
	Totals:	1.334		0.040	120753425		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr106-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.987	0.000	20255	BB	1.8
2	C5	0.206	5.197	0.005	7262	VB	2.1
3		0.000	6.226	0.000	1404	BB	3.6
4	C7	0.040	6.545	-0.002	7482	BB	4.4
5	Toluene	1.072	7.673	0.012	120900840	BB	12.1
6		0.000	7.885	0.000	5930	TS	0.0
7	C8	0.014	7.961	0.022	2855	TF	0.0
8		0.000	8.026	0.000	7435	TF	0.0
9		0.000	8.103	0.000	2032	TF	0.0
10		0.000	8.184	0.000	7100	TF	0.0
11		0.000	8.260	0.000	9953	TS	0.0
12		0.000	8.354	0.000	1990	TS	0.0
13		0.000	8.497	0.000	4093	TF	0.0
14		0.000	8.612	0.000	2727	TF	0.0
15		0.000	8.681	0.000	4257	TF	0.0
16		0.000	8.718	0.000	5299	TF	0.0
17		0.000	8.980	0.000	21549	TF	0.0
18		0.000	9.108	0.000	23028	TF	0.0
	Totals:	1.332		0.037	121035491		

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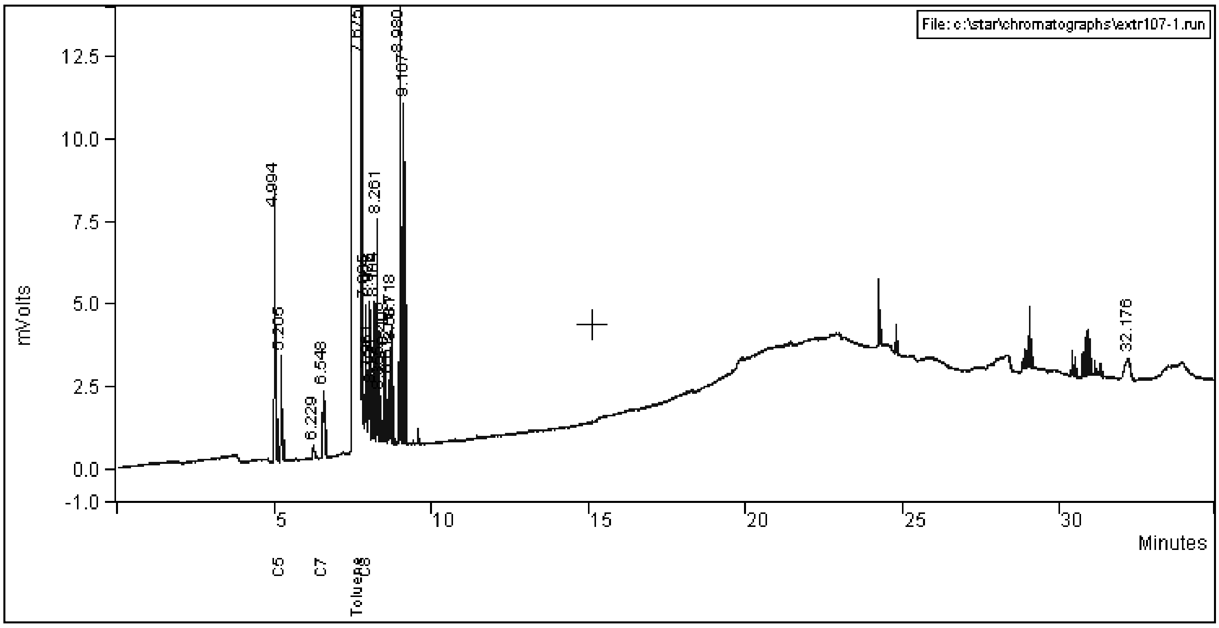


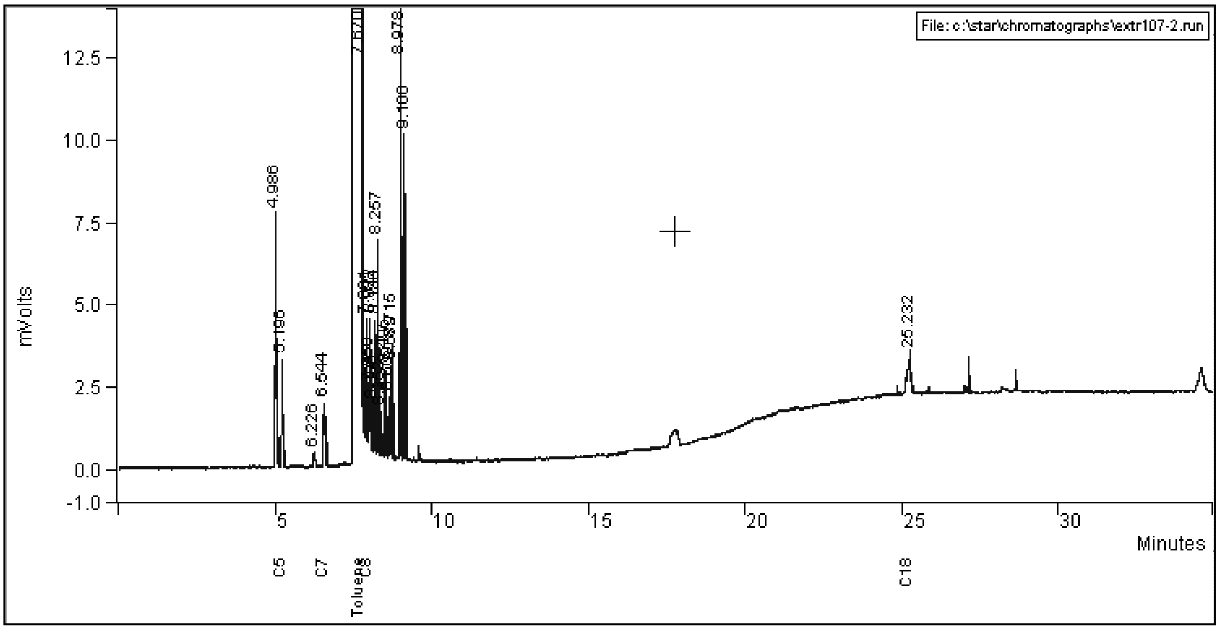


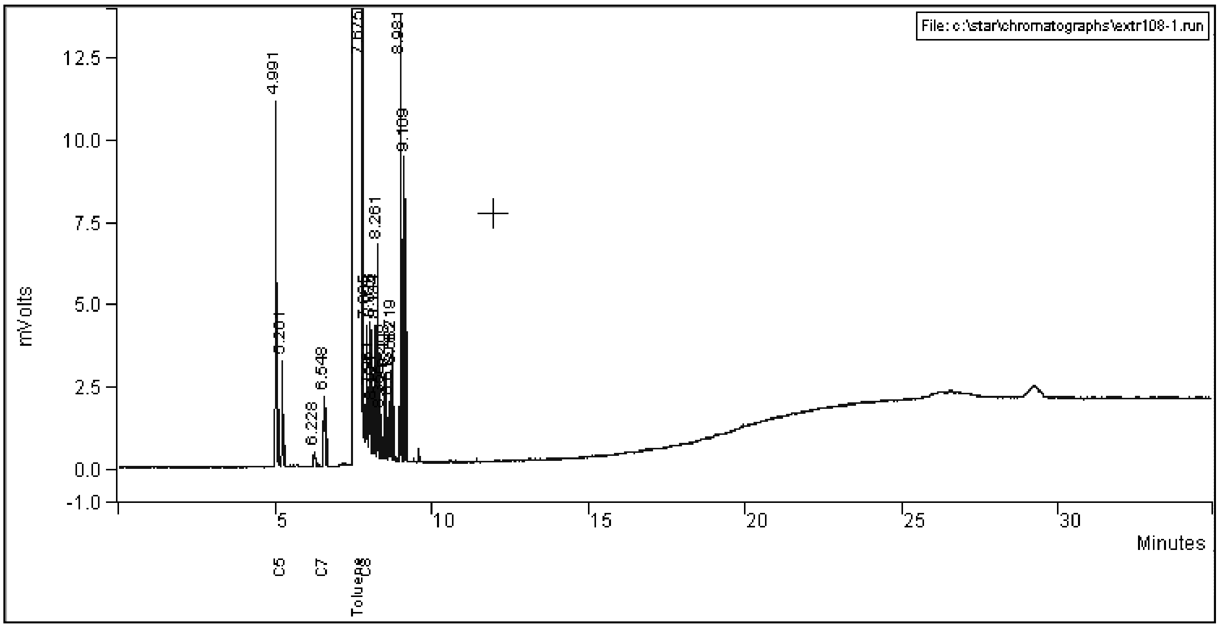
Figure C21: Duplicate chromatograms of Sample 107 (Extract 107-1 and 107-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at LUBOIL site in between T4815/6/7/9.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr107-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.994	0.000	19802	BP	2.4
2	C5	0.233	5.205	0.013	8214	PB	2.4
3		0.000	6.229	0.000	1639	BV	4.1
4	C7	0.051	6.548	0.001	9482	PB	4.6
5	Toluene	1.091	7.675	0.014	123088064	BP	12.4
6		0.000	7.885	0.000	5960	TS	0.0
7	C8	0.014	7.961	0.022	2887	TF	0.0
8		0.000	8.026	0.000	7561	TF	0.0
9		0.000	8.104	0.000	2129	TF	0.0
10		0.000	8.184	0.000	7280	TF	0.0
11		0.000	8.261	0.000	10155	TS	0.0
12		0.000	8.355	0.000	2119	TF	0.0
13		0.000	8.498	0.000	4131	TF	0.0
14		0.000	8.612	0.000	2874	TF	0.0
15		0.000	8.681	0.000	4419	TF	0.0
16		0.000	8.718	0.000	5507	TF	0.0
17		0.000	8.980	0.000	22657	TF	0.0
18		0.000	9.107	0.000	24135	PB	0.0
19		0.000	32.176	0.000	6950	BB	11.3
	Totals:	1.389		0.050	123235965		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr107-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.986	0.000	17266	BB	2.0
2	C5	0.230	5.196	0.004	8080	BB	2.2
3		0.000	6.226	0.000	1368	BB	3.7
4	C7	0.047	6.544	-0.003	8680	BB	4.5
5	Toluene	1.058	7.670	0.009	119319504	BB	12.0
6		0.000	7.881	0.000	5773	TS	0.0
7	C8	0.013	7.958	0.019	2745	TF	0.0
8		0.000	8.022	0.000	7188	TF	0.0
9		0.000	8.100	0.000	1876	TS	0.0
10		0.000	8.180	0.000	6752	TS	0.0
11		0.000	8.257	0.000	9687	TS	0.0
12		0.000	8.352	0.000	1958	TS	0.0
13		0.000	8.495	0.000	3779	TS	0.0
14		0.000	8.609	0.000	2556	TF	0.0
15		0.000	8.679	0.000	4159	TF	0.0
16		0.000	8.715	0.000	5255	TF	0.0
17		0.000	8.978	0.000	22153	TF	0.0
18		0.000	9.106	0.000	23520	TF	0.0
19	C18	0.003	25.232	0.495	6153	VV	6.1
	Totals:	1.351		0.524	119458452		



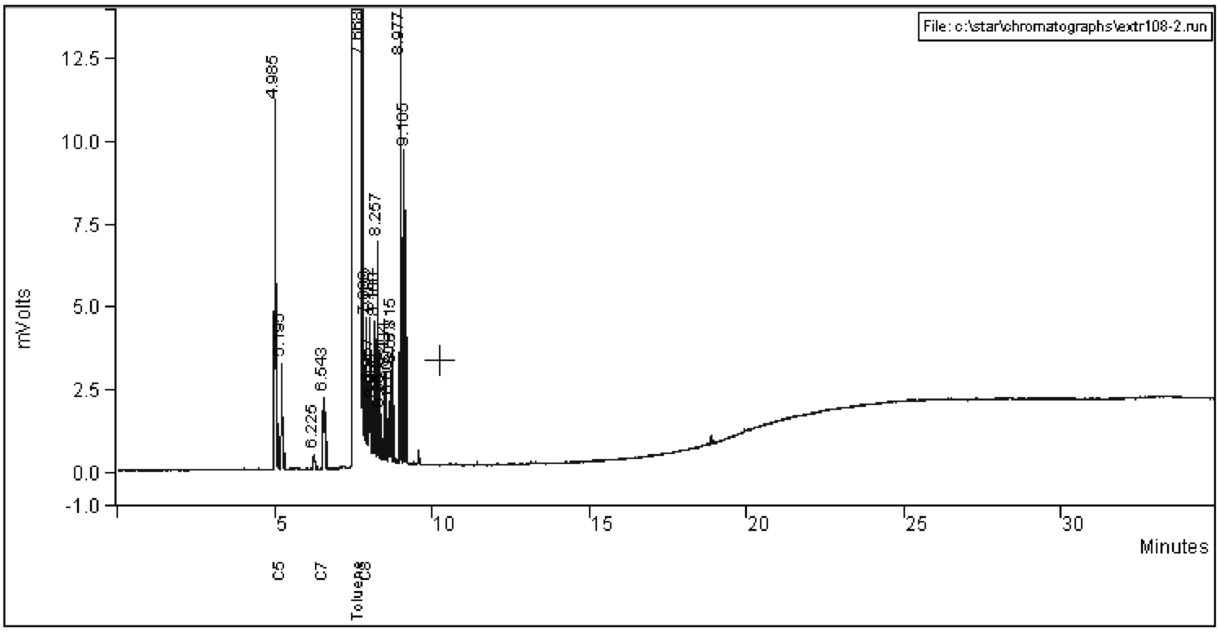


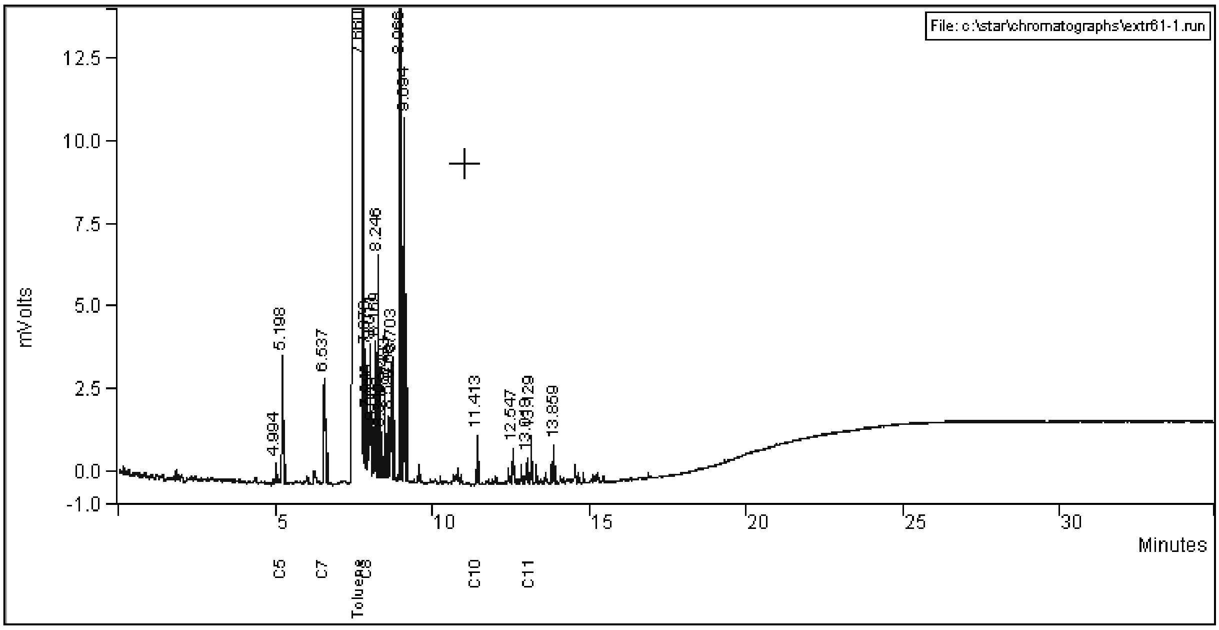
Figure C22: Duplicate chromatograms of Sample 108 (Extract 108-1 and 108-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at LUBOIL site in between T4815/6/7/9.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr108-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.991	0.000	25466	BP	2.0
2	C5	0.222	5.201	0.009	7823	PB	2.3
3		0.000	6.228	0.000	1569	BB	3.8
4	C7	0.050	6.548	0.001	9331	BB	4.5
5	Toluene	1.061	7.675	0.014	119727296	BB	12.0
6		0.000	7.885	0.000	5702	TS	0.0
7	C8	0.013	7.961	0.022	2736	TF	0.0
8		0.000	8.026	0.000	7256	TF	0.0
9		0.000	8.104	0.000	1998	TF	0.0
10		0.000	8.184	0.000	6808	TF	0.0
11		0.000	8.261	0.000	9602	TS	0.0
12		0.000	8.356	0.000	1928	TS	0.0
13		0.000	8.498	0.000	4031	TF	0.0
14		0.000	8.613	0.000	2700	TF	0.0
15		0.000	8.682	0.000	4068	TF	0.0
16		0.000	8.719	0.000	5087	TF	0.0
17		0.000	8.981	0.000	20492	TF	0.0
18		0.000	9.109	0.000	21927	TF	0.0
	Totals:	1.346		0.046	119865820		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr108-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.985	0.000	25624	BB	2.0
2	C5	0.227	5.195	0.003	7975	VB	2.3
3		0.000	6.225	0.000	1520	BB	3.8
4	C7	0.051	6.543	-0.004	9540	BB	4.5
5	Toluene	1.067	7.668	0.007	120358800	BB	12.1
6		0.000	7.880	0.000	5787	TS	0.0
7	C8	0.014	7.957	0.018	2851	TF	0.0
8		0.000	8.022	0.000	7453	TF	0.0
9		0.000	8.099	0.000	2043	TF	0.0
10		0.000	8.180	0.000	6949	TF	0.0
11		0.000	8.257	0.000	9755	TS	0.0
12		0.000	8.351	0.000	1960	TS	0.0
13		0.000	8.494	0.000	4087	TF	0.0
14		0.000	8.609	0.000	2715	TF	0.0
15		0.000	8.678	0.000	4131	TF	0.0
16		0.000	8.715	0.000	5193	TF	0.0
17		0.000	8.977	0.000	20958	TF	0.0
18		0.000	9.105	0.000	22566	TF	0.0
	Totals:	1.359		0.024	120499907		



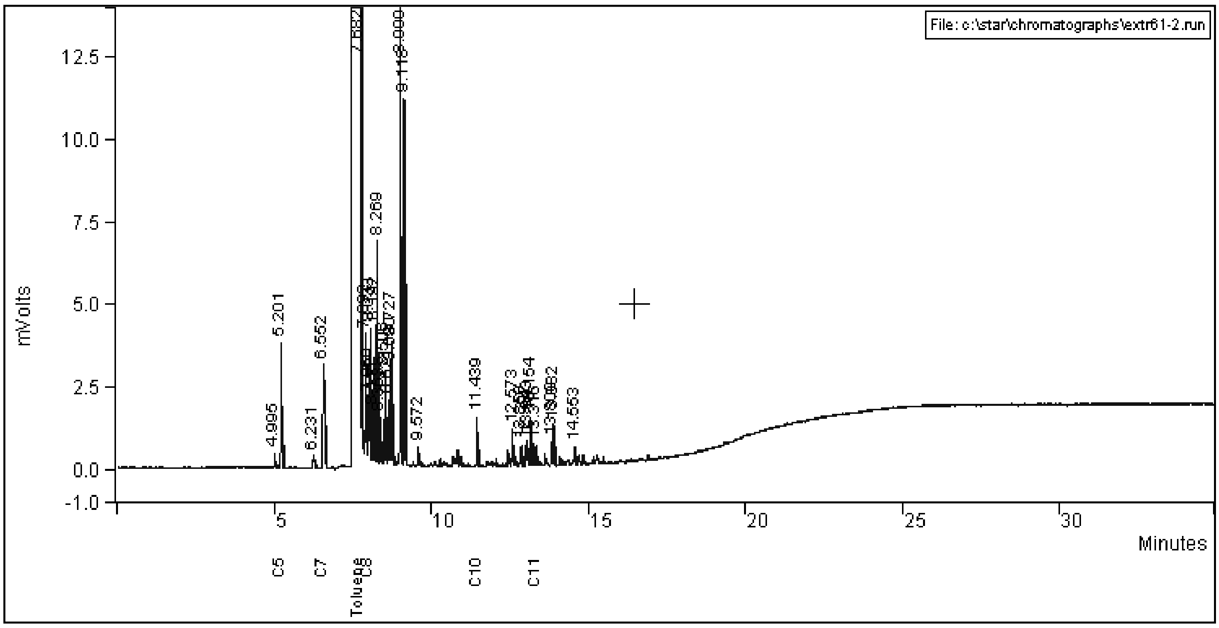


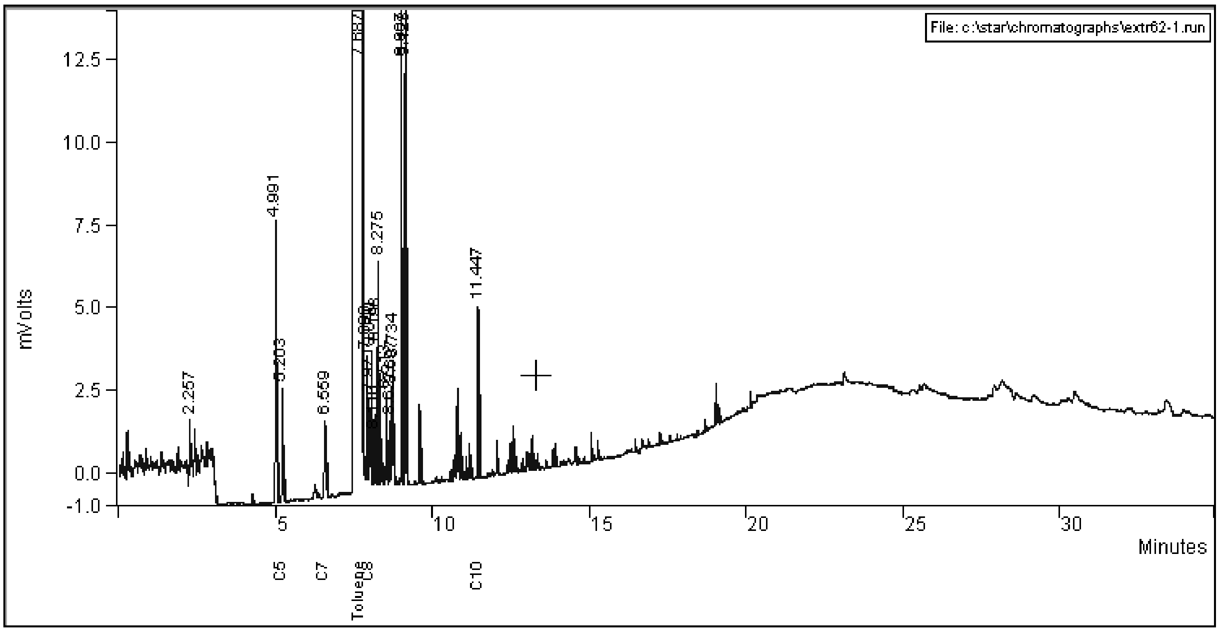
Figure C23: Duplicate chromatograms of Sample 61 (Extract 61-1 and 61-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at MOGAS T1310.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr61-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.994	0.000	1576	BB	0.0
2	C5	0.255	5.198	0.006	8985	BB	2.2
3	C7	0.072	6.537	-0.010	13432	BB	4.3
4	Toluene	1.063	7.660	-0.001	119983344	BB	12.0
5		0.000	7.870	0.000	5606	TS	0.0
6	C8	0.014	7.946	0.007	2865	TF	0.0
7		0.000	8.011	0.000	7310	TF	0.0
8		0.000	8.089	0.000	1991	TF	0.0
9		0.000	8.169	0.000	7122	TF	0.0
10		0.000	8.246	0.000	10067	TS	0.0
11		0.000	8.340	0.000	2210	TF	0.0
12		0.000	8.483	0.000	4514	TF	0.0
13		0.000	8.597	0.000	3363	TF	0.0
14		0.000	8.667	0.000	4406	TF	0.0
15		0.000	8.703	0.000	5624	TF	0.0
16		0.000	8.966	0.000	24856	BV	1.4
17		0.000	9.094	0.000	26421	VB	2.4
18	C10	0.002	11.413	-0.021	2576	BB	1.7
19		0.000	12.547	0.000	2648	BB	2.0
20		0.000	13.018	0.000	1128	BB	1.5
21	C11	0.002	13.129	-0.197	2695	BB	1.7
22		0.000	13.859	0.000	2103	BB	1.7
	Totals:	1.408		-0.216	120124842		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr61-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.995	0.000	1007	BV	2.3
2	C5	0.262	5.201	0.009	9218	VB	2.3
3		0.000	6.231	0.000	1271	BB	3.7
4	C7	0.073	6.552	0.005	13608	BB	4.3
5	Toluene	1.066	7.682	0.021	120270520	BB	12.1
6		0.000	7.892	0.000	5707	TS	0.0
7	C8	0.014	7.968	0.029	2900	TF	0.0
8		0.000	8.033	0.000	7411	TF	0.0
9		0.000	8.111	0.000	2043	TF	0.0
10		0.000	8.192	0.000	7026	TF	0.0
11		0.000	8.269	0.000	10099	TS	0.0
12		0.000	8.363	0.000	2158	TS	0.0
13		0.000	8.506	0.000	4202	TF	0.0
14		0.000	8.621	0.000	2949	TF	0.0
15		0.000	8.690	0.000	4415	TF	0.0
16		0.000	8.727	0.000	5621	TF	0.0
17		0.000	8.990	0.000	24979	TF	0.0
18		0.000	9.118	0.000	26694	TF	0.0
19		0.000	9.572	0.000	1149	BB	1.9
20	C10	0.002	11.439	0.005	2660	BB	1.7
21		0.000	12.573	0.000	2943	VV	2.0
22		0.000	12.850	0.000	1173	VB	1.7
23		0.000	12.992	0.000	1147	BV	1.8
24		0.000	13.043	0.000	1460	VV	1.7
25		0.000	13.154	0.000	2606	VB	1.7
26	C11	0.001	13.316	-0.010	1121	BB	1.7
27		0.000	13.809	0.000	1397	BV	1.9
28		0.000	13.882	0.000	2313	VB	1.7
29		0.000	14.553	0.000	1047	BB	2.0
	Totals:	1.418		0.059	120420844		



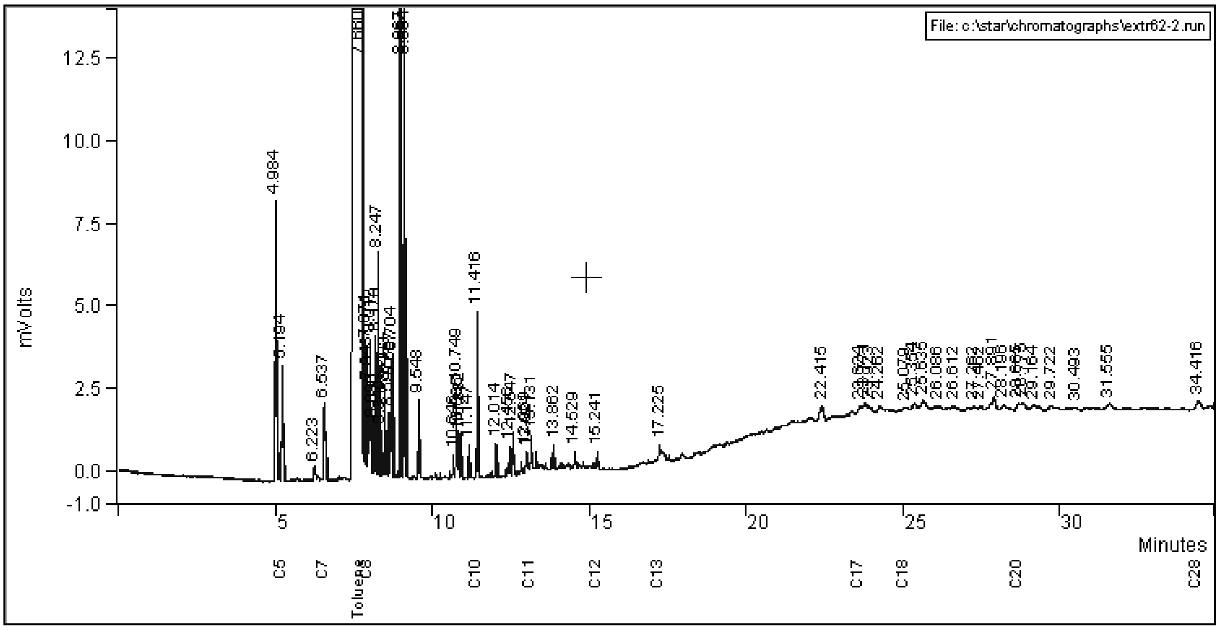


Figure C24: **Duplicate chromatograms of Sample 62 (Extract 62-1 and 62-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at MOGAS T1310.**

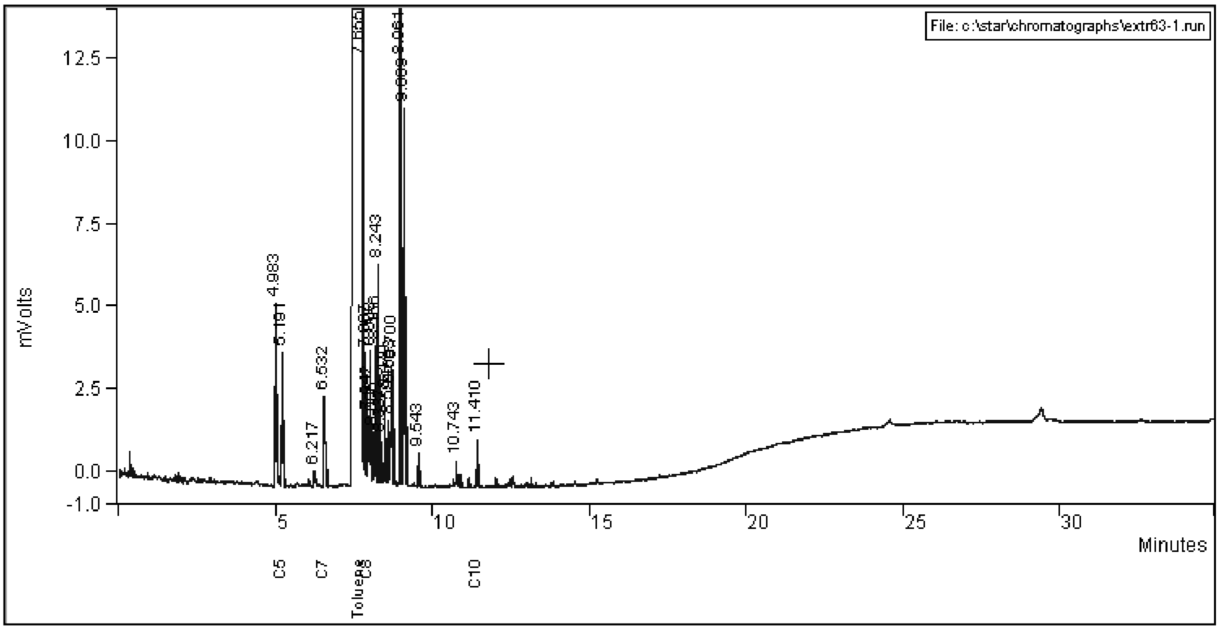
```
Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
```
Sample ID : extr62-1
```
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	2.257	0.000	3118	BB	0.0
2		0.000	4.991	0.000	18660	BB	2.0
3	C5	0.233	5.203	0.011	8198	BB	2.2
4	C7	0.056	6.559	0.012	10516	BB	4.4
5	Toluene	1.073	7.687	0.026	121043840	BB	12.1
6		0.000	7.898	0.000	6088	TS	0.0
7	C8	0.020	7.971	0.032	4060	TF	0.0
8		0.000	8.040	0.000	7461	TF	0.0
9		0.000	8.118	0.000	2028	TF	0.0
10		0.000	8.198	0.000	7096	TF	0.0
11		0.000	8.275	0.000	10167	TS	0.0
12		0.000	8.513	0.000	4465	BP	1.4
13		0.000	8.627	0.000	2985	PV	1.4
14		0.000	8.697	0.000	4379	VV	1.5
15		0.000	8.734	0.000	5569	VB	1.4
16		0.000	8.997	0.000	26629	BB	1.4
17		0.000	9.123	0.000	33474	BB	2.3
18	C10	0.006	11.447	0.013	9075	BB	1.6
Totals:		1.388		0.094	121207808		

```
Title               : PONA COLUMN EXPERIMENT
Method File         : c:\star\extractrun.mth
Sample ID           : extr62-2
Operator            : SHAN
Instrument          : Varian Star 3800
Channel             : Front = FID
Run Time            : 34.965 min
Peak Measurement    : Peak Area
Calculation Type    : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.984	0.000	18642	BB	2.0
2	C5	0.233	5.194	0.002	8197	BB	2.2
3		0.000	6.223	0.000	1567	BV	3.8
4	C7	0.056	6.537	-0.010	10358	BB	4.4
5	Toluene	1.071	7.660	-0.001	120888872	BB	12.1
6		0.000	7.871	0.000	5749	TS	0.0
7	C8	0.019	7.943	0.004	3986	TF	0.0
8		0.000	8.012	0.000	7437	TF	0.0
9		0.000	8.090	0.000	2034	TF	0.0
10		0.000	8.170	0.000	7070	TF	0.0
11		0.000	8.247	0.000	10136	TS	0.0
12		0.000	8.340	0.000	2180	TS	0.0
13		0.000	8.483	0.000	4128	TF	0.0
14		0.000	8.597	0.000	2937	TF	0.0
15		0.000	8.667	0.000	4359	TF	0.0
16		0.000	8.704	0.000	5582	TF	0.0
17		0.000	8.967	0.000	26483	TF	0.0
18		0.000	9.094	0.000	33431	TF	0.0
19		0.000	9.548	0.000	4739	BB	1.9
20		0.000	10.646	0.000	1660	VV	1.8
21		0.000	10.749	0.000	5279	VV	1.7
22		0.000	10.805	0.000	2179	VV	1.6
23		0.000	10.882	0.000	2943	VB	1.8
24		0.000	11.147	0.000	1807	BB	1.7
25	C10	0.006	11.416	-0.018	8894	BB	1.7
26		0.000	12.014	0.000	2025	PB	1.7
27		0.000	12.456	0.000	1656	VV	1.7
28		0.000	12.547	0.000	3411	VP	2.0
29		0.000	12.969	0.000	1030	BV	1.8
30		0.000	13.021	0.000	1021	VV	1.9
31	C11	0.001	13.131	-0.195	2097	VB	1.9
32		0.000	13.862	0.000	1355	VB	1.8
33		0.000	14.529	0.000	1098	VP	2.0
34	C12	0.001	15.241	0.085	1172	BB	1.8
35	C13	0.001	17.225	0.336	1024	BV	3.0
36		0.000	22.415	0.000	2785	BB	6.6
37	C17	0.001	23.624	0.510	1444	VV	9.6
38		0.000	23.771	0.000	3657	VV	0.0
39		0.000	23.923	0.000	1462	VP	29.4
40		0.000	24.262	0.000	1156	PB	0.0
41	C18	0.001	25.079	0.342	2072	BV	16.4
42		0.000	25.354	0.000	2625	VV	11.2
43		0.000	25.635	0.000	4834	VV	14.0
44		0.000	26.086	0.000	2851	VV	0.0
45		0.000	26.612	0.000	3512	VV	28.5
46		0.000	27.262	0.000	1611	VV	0.0
47		0.000	27.462	0.000	1331	VV	12.6
48		0.000	27.891	0.000	4857	VV	9.9
49		0.000	28.196	0.000	2673	VV	10.7

50	C20	0.000	28.665	0.137	1612	VV	9.9
51		0.000	28.775	0.000	2707	VV	17.3
52		0.000	29.164	0.000	1877	VV	0.0
53		0.000	29.722	0.000	1771	VV	13.7
54		0.000	30.493	0.000	1871	VP	13.7
55		0.000	31.555	0.000	2389	VB	15.6
56	C28	0.001	34.416	0.715	2263	PP	10.8
Totals:	1.391	1.907	121137898				



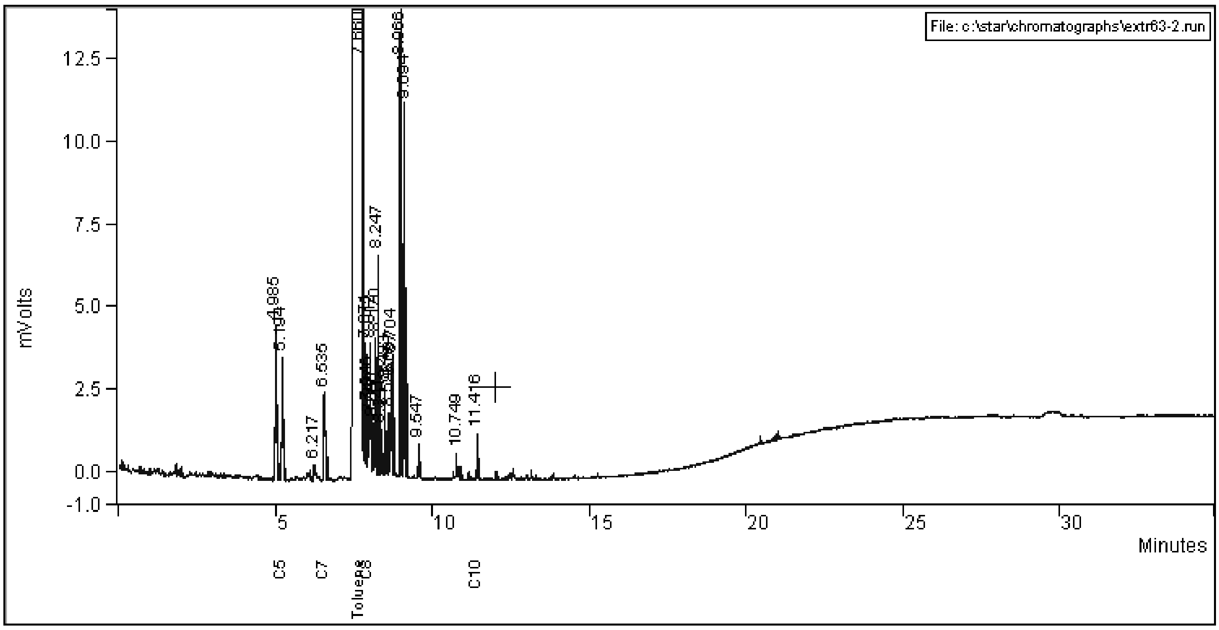


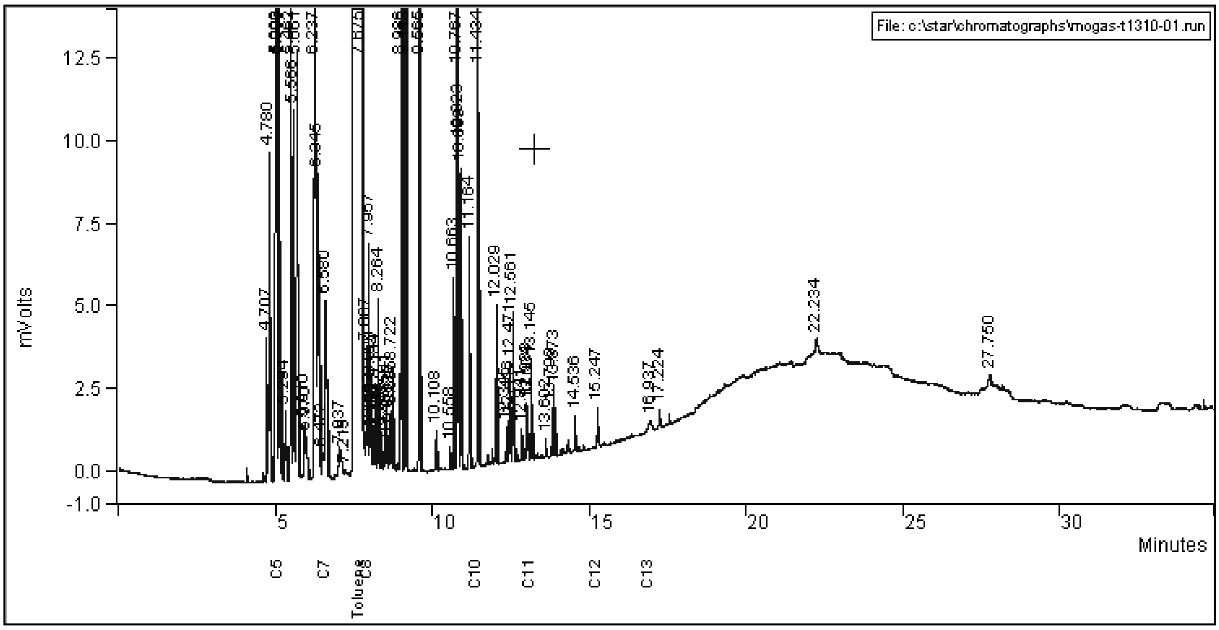
Figure C25: Duplicate chromatograms of Sample 63 (Extract 63-1 and 63-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at MOGAS T1310.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr63-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.983	0.000	10632	BB	1.7
2	C5	0.245	5.191	-0.001	8631	BB	1.9
3		0.000	6.217	0.000	1455	BB	3.2
4	C7	0.060	6.532	-0.015	11217	BB	4.1
5	Toluene	1.064	7.655	-0.006	120097984	BB	12.0
6		0.000	7.867	0.000	5752	TS	0.0
7	C8	0.015	7.942	0.003	3079	TF	0.0
8		0.000	8.008	0.000	7317	TF	0.0
9		0.000	8.086	0.000	2031	TF	0.0
10		0.000	8.166	0.000	7122	TF	0.0
11		0.000	8.243	0.000	9875	TF	0.0
12		0.000	8.337	0.000	2189	TF	0.0
13		0.000	8.479	0.000	4388	TF	0.0
14		0.000	8.594	0.000	2907	TF	0.0
15		0.000	8.663	0.000	4299	TF	0.0
16		0.000	8.700	0.000	5445	TF	0.0
17		0.000	8.961	0.000	24239	TF	0.0
18		0.000	9.089	0.000	27272	TF	0.0
19		0.000	9.543	0.000	2083	BB	1.8
20		0.000	10.743	0.000	1326	BV	1.6
21	C10	0.002	11.410	-0.024	2483	BB	1.6
	Totals:	1.386		-0.043	120241726		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr63-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.985	0.000	10081	BB	1.9
2	C5	0.232	5.194	0.002	8167	BB	2.0
3		0.000	6.217	0.000	1441	BB	3.9
4	C7	0.060	6.535	-0.012	11122	BB	4.3
5	Toluene	1.063	7.660	-0.001	119885000	BB	12.0
6		0.000	7.871	0.000	5703	TS	0.0
7	C8	0.015	7.946	0.007	3154	TF	0.0
8		0.000	7.987	0.000	1245	TF	0.0
9		0.000	8.012	0.000	5949	TF	0.0
10		0.000	8.090	0.000	1976	TF	0.0
11		0.000	8.170	0.000	7180	TF	0.0
12		0.000	8.247	0.000	9887	TS	0.0
13		0.000	8.341	0.000	2139	TF	0.0
14		0.000	8.483	0.000	4144	TF	0.0
15		0.000	8.598	0.000	2751	TF	0.0
16		0.000	8.667	0.000	4212	TF	0.0
17		0.000	8.704	0.000	5332	TF	0.0
18		0.000	8.966	0.000	23569	BV	1.4
19		0.000	9.094	0.000	26908	VB	2.4
20		0.000	9.547	0.000	1923	BB	1.7
21		0.000	10.749	0.000	1340	BV	1.6
22	C10	0.002	11.416	-0.018	2531	BB	1.7
	Totals:	1.372		-0.022	120025754		



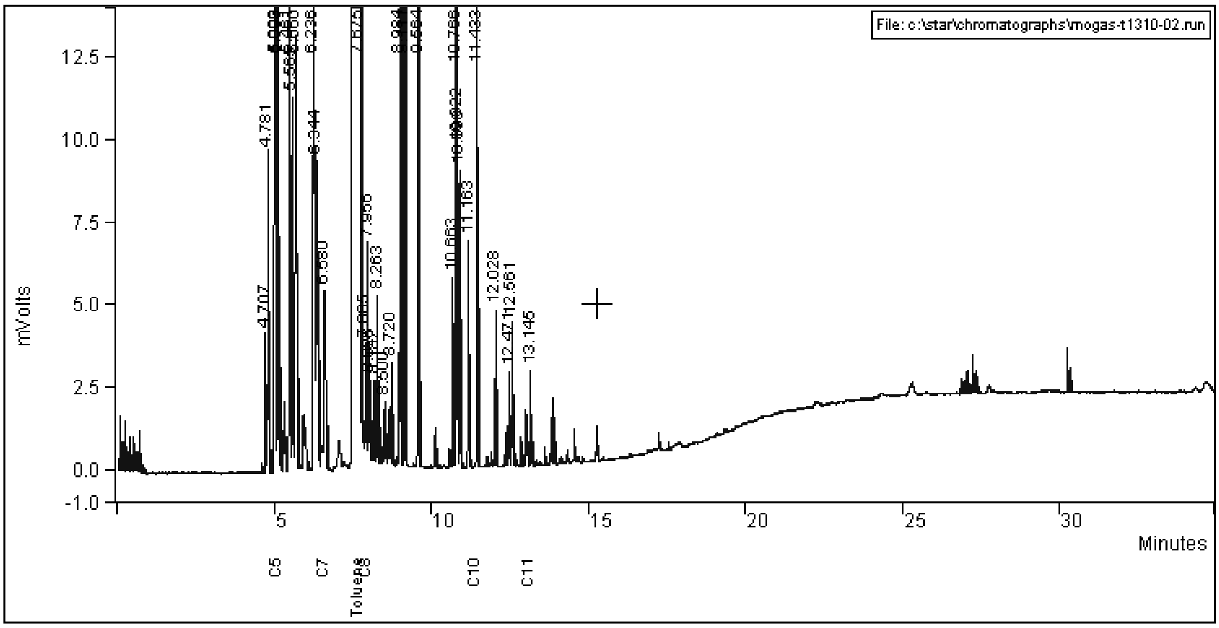


Figure C26: Duplicate chromatograms of sample from T1310 showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

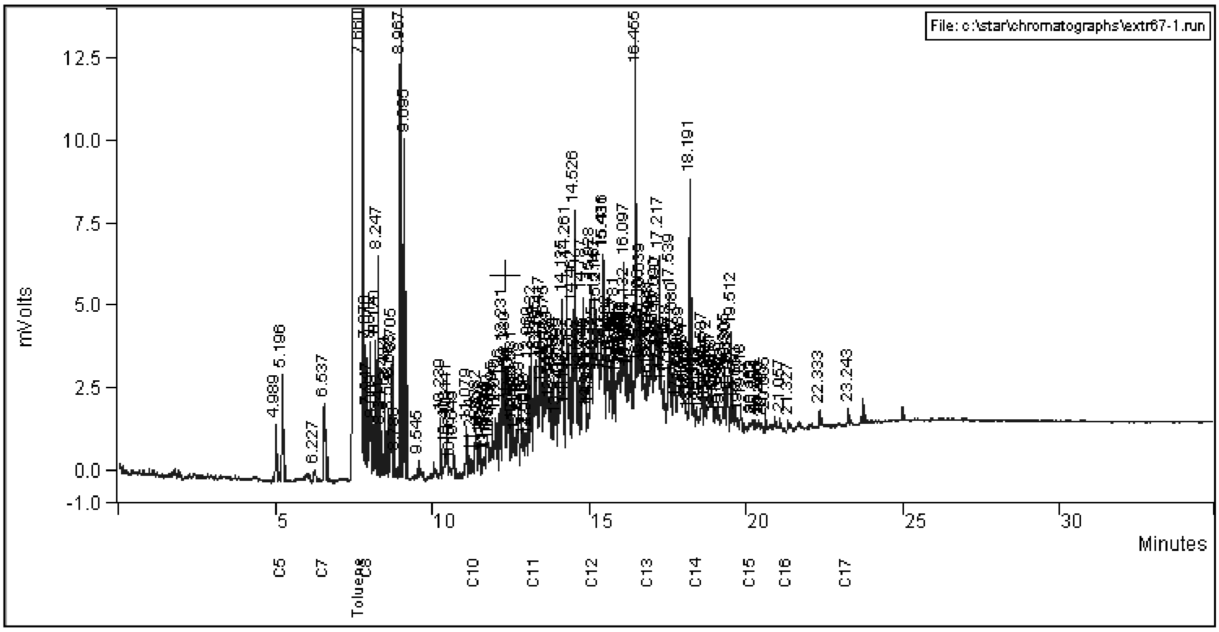
Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Mogas-T1310-01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.707	0.000	6978	BV	1.2
2		0.000	4.780	0.000	17104	VB	1.3
3		0.000	5.003	0.000	119882	BV	2.6
4	C5	1.147	5.099	-0.093	40344	VP	1.8
5		0.000	5.294	0.000	5123	PV	2.2
6		0.000	5.462	0.000	49302	VV	2.7
7		0.000	5.566	0.000	30667	VV	2.7
8		0.000	5.661	0.000	38639	VV	3.0
9		0.000	5.910	0.000	5679	VV	3.4
10		0.000	5.970	0.000	4189	VB	4.2
11		0.000	6.237	0.000	59505	BV	3.9
12		0.000	6.345	0.000	37643	VV	3.9
13		0.000	6.472	0.000	1110	TF	0.0
14	7	0.128	6.580	0.033	23849	VB	4.5
15		0.000	7.037	0.000	6505	VV	6.8
16		0.000	7.215	0.000	1404	VV	0.0
17	Toluene	1.069	7.675	0.014	120627624	VB	12.1
18		0.000	7.887	0.000	5395	TF	0.0
19	C8	0.044	7.957	0.018	9104	TF	0.0
20		0.000	8.002	0.000	1146	TF	0.0
21		0.000	8.028	0.000	3644	TF	0.0
22		0.000	8.106	0.000	1191	TS	0.0
23		0.000	8.184	0.000	4805	TS	0.0
24		0.000	8.264	0.000	7928	TS	0.0
25		0.000	8.356	0.000	2153	TS	0.0
26		0.000	8.501	0.000	3065	TF	0.0
27		0.000	8.545	0.000	1134	TF	0.0
28		0.000	8.615	0.000	2899	TF	0.0
29		0.000	8.685	0.000	2745	TF	0.0
30		0.000	8.722	0.000	4863	TF	0.0
31		0.000	8.986	0.000	75333	TF	0.0
32		0.000	9.113	0.000	158614	TF	0.0
33		0.000	9.565	0.000	46918	VB	1.5
34		0.000	10.108	0.000	2236	BB	1.6
35		0.000	10.558	0.000	1281	BV	1.7
36		0.000	10.663	0.000	10361	VV	1.6
37		0.000	10.767	0.000	38446	VV	1.6
38		0.000	10.823	0.000	16803	VV	1.6
39		0.000	10.899	0.000	15806	VB	1.6
40		0.000	11.164	0.000	12215	BB	1.6
41	C10	0.033	11.434	-0.000	47590	BB	1.6
42		0.000	12.029	0.000	8509	VB	1.6
43		0.000	12.345	0.000	2001	BV	1.7
44		0.000	12.416	0.000	2309	VV	1.7
45		0.000	12.471	0.000	5378	VV	1.7
46		0.000	12.561	0.000	9575	VB	1.8
47		0.000	12.841	0.000	1643	BB	1.7
48		0.000	12.983	0.000	3056	BV	1.7
49		0.000	13.034	0.000	2907	VV	1.7

50	C11	0.003	13.145	-0.181	5103	VB	1.7
51		0.000	13.602	0.000	1071	BB	1.7
52		0.000	13.799	0.000	2641	BV	1.7
53		0.000	13.873	0.000	3657	VB	1.7
54		0.000	14.536	0.000	2027	BB	1.8
55	C12	0.001	15.247	0.091	2478	BB	1.8
56	C13	0.001	16.937	0.048	1410	BV	10.1
57		0.000	17.224	0.000	1095	BB	1.9
58		0.000	22.234	0.000	1637	BB	4.1
59		0.000	27.750	0.000	1668	BB	4.9
Totals:		2.426		-0.070	121609387		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Mogas-T1310-02
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.707	0.000	6619	BV	1.2
2		0.000	4.781	0.000	16394	VB	1.3
3		0.000	5.003	0.000	114294	BV	2.6
4	C5	1.077	5.098	-0.094	37903	VB	1.7
5		0.000	5.461	0.000	48187	BV	2.7
6		0.000	5.565	0.000	29766	VV	2.7
7		0.000	5.660	0.000	36936	VB	2.9
8		0.000	6.236	0.000	58410	BV	3.8
9		0.000	6.344	0.000	35041	VB	3.8
10	C7	0.115	6.580	0.033	21492	BB	4.2
11	Toluene	1.058	7.675	0.014	119321584	BB	11.9
12		0.000	7.885	0.000	4925	TS	0.0
13	C8	0.042	7.956	0.017	8685	TF	0.0
14		0.000	8.026	0.000	4570	TF	0.0
15		0.000	8.182	0.000	6061	TS	0.0
16		0.000	8.263	0.000	7825	TS	0.0
17		0.000	8.500	0.000	3461	BB	1.3
18		0.000	8.720	0.000	3370	BB	1.2
19		0.000	8.984	0.000	74159	BP	1.4
20		0.000	9.111	0.000	157081	PB	2.2
21		0.000	9.564	0.000	46356	BB	1.5
22		0.000	10.663	0.000	9867	BV	1.6
23		0.000	10.766	0.000	37714	VV	1.6
24		0.000	10.822	0.000	16495	VV	1.6
25		0.000	10.898	0.000	15503	VB	1.6
26		0.000	11.163	0.000	11929	BB	1.6
27	C10	0.033	11.433	-0.001	46906	BB	1.6
28		0.000	12.028	0.000	8060	BB	1.6
29		0.000	12.471	0.000	4613	BB	1.6
30		0.000	12.561	0.000	9248	BB	1.8
31	C11	0.003	13.145	-0.181	5062	BB	1.7
Totals:		2.328		-0.212	120208516		



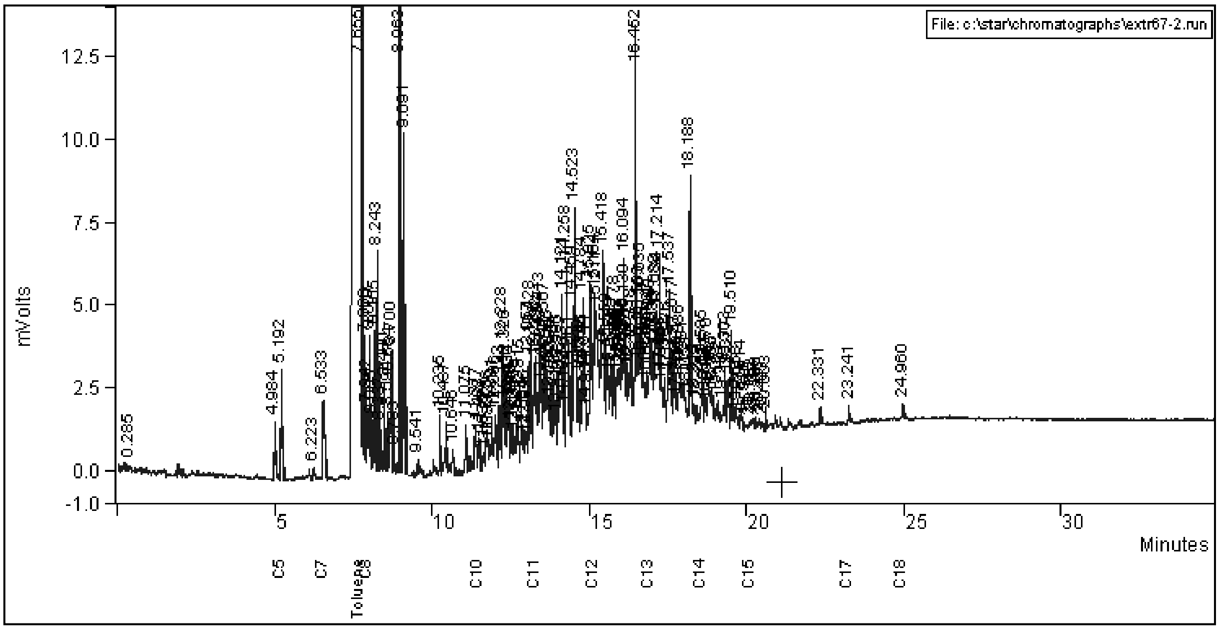


Figure C27: Duplicate chromatograms of Sample 67 (Extract 67-1 and 67-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at GASOIL T1315.

Title	:	PONA COLUMN EXPERIMENT
Method File	:	c:\star\extractrun.mth
Sample ID	:	**extr67-1**
Operator	:	SHAN
Instrument	:	Varian Star 3800
Channel	:	Front = FID
Run Time	:	34.965 min
Peak Measurement	:	Peak Area
Calculation Type	:	Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.989	0.000	4136	BB	2.3
2	C5	0.217	5.196	0.004	7625	PB	2.2
3		0.000	6.227	0.000	1205	BB	3.9
4	C7	0.055	6.537	-0.010	10324	BB	4.4
5	Toluene	1.056	7.660	-0.001	119143424	BB	11.9
6		0.000	7.870	0.000	5691	TS	0.0
7	C8	0.014	7.947	0.008	2833	TF	0.0
8		0.000	8.012	0.000	7240	TF	0.0
9		0.000	8.089	0.000	1970	TF	0.0
10		0.000	8.170	0.000	7143	TF	0.0
11		0.000	8.247	0.000	10022	TS	0.0
12		0.000	8.341	0.000	2191	TF	0.0
13		0.000	8.484	0.000	4059	TF	0.0
14		0.000	8.598	0.000	2832	TF	0.0
15		0.000	8.668	0.000	4344	TF	0.0
16		0.000	8.705	0.000	5589	TF	0.0
17		0.000	8.788	0.000	1009	TS	0.0
18		0.000	8.967	0.000	23172	TF	0.0
19		0.000	9.095	0.000	24833	TF	0.0
20		0.000	9.545	0.000	1162	VV	1.8
21		0.000	10.239	0.000	3469	VV	1.7
22		0.000	10.408	0.000	2402	VV	4.4
23		0.000	10.441	0.000	3634	VV	2.2
24		0.000	10.561	0.000	1269	VV	2.3
25		0.000	10.649	0.000	2877	VB	3.4
26		0.000	11.079	0.000	4433	VV	1.9
27		0.000	11.234	0.000	1789	VV	2.3
28	C10	0.004	11.382	-0.052	6272	VV	4.3
29		0.000	11.493	0.000	4451	VV	4.2
30		0.000	11.593	0.000	1187	VV	2.8
31		0.000	11.638	0.000	1562	VV	4.2
32		0.000	11.710	0.000	1775	VV	2.1
33		0.000	11.740	0.000	2547	VV	0.0
34		0.000	11.779	0.000	2062	VV	3.4
35		0.000	11.835	0.000	2162	VV	0.0
36		0.000	11.895	0.000	4553	VV	2.9
37		0.000	12.010	0.000	6342	VV	3.9
38		0.000	12.126	0.000	6100	VV	3.3
39		0.000	12.231	0.000	11548	VV	2.7
40		0.000	12.330	0.000	6732	VV	2.1
41		0.000	12.413	0.000	5457	VV	5.2
42		0.000	12.434	0.000	3754	VV	3.5
43		0.000	12.512	0.000	2554	VV	2.8
44		0.000	12.531	0.000	1102	VV	0.4
45		0.000	12.551	0.000	3355	VV	3.9
46		0.000	12.616	0.000	2149	VV	0.0
47		0.000	12.721	0.000	6737	VV	4.7
48		0.000	12.818	0.000	5287	VV	2.4
49		0.000	12.885	0.000	1965	VV	0.0

50		0.000	12.948	0.000	3104	VV	0.0
51		0.000	12.993	0.000	1817	VV	0.0
52		0.000	13.060	0.000	7534	VV	2.4
53		0.000	13.132	0.000	9231	VV	2.4
54		0.000	13.243	0.000	11181	VV	4.4
55	C11	0.007	13.295	-0.031	10954	VV	4.6
56		0.000	13.417	0.000	13610	VV	3.9
57		0.000	13.464	0.000	4927	VV	0.0
58		0.000	13.575	0.000	17504	VV	4.7
59		0.000	13.658	0.000	9509	VV	0.0
60		0.000	13.708	0.000	5147	VV	0.0
61		0.000	13.788	0.000	8568	VV	3.8
62		0.000	13.864	0.000	8622	VV	3.1
63		0.000	13.921	0.000	3031	VV	5.9
64		0.000	13.989	0.000	7051	VV	2.4
65		0.000	14.072	0.000	7452	VV	0.0
66		0.000	14.125	0.000	14317	VV	3.0
67		0.000	14.196	0.000	3215	VV	3.2
68		0.000	14.261	0.000	20304	VV	3.8
69		0.000	14.365	0.000	8584	VV	4.6
70		0.000	14.462	0.000	11648	VV	2.3
71		0.000	14.526	0.000	24626	VV	2.7
72		0.000	14.653	0.000	8245	VV	5.2
73		0.000	14.746	0.000	5987	VV	3.9
74		0.000	14.787	0.000	12227	VV	3.3
75		0.000	14.846	0.000	9550	VV	6.3
76		0.000	14.938	0.000	3323	VV	0.0
77		0.000	14.983	0.000	2308	VV	0.0
78		0.000	15.028	0.000	19030	VV	4.2
79		0.000	15.125	0.000	4902	VV	0.0
80	C12	0.008	15.167	0.011	14145	VV	0.0
81		0.000	15.214	0.000	23794	VV	0.0
82		0.000	15.335	0.000	5047	VV	0.0
83		0.000	15.416	0.000	20252	VV	6.6
84		0.000	15.431	0.000	17782	VV	7.1
85		0.000	15.562	0.000	15297	VV	7.0
86		0.000	15.645	0.000	5278	VV	0.0
87		0.000	15.693	0.000	8628	VV	0.0
88		0.000	15.781	0.000	10279	VV	3.2
89		0.000	15.852	0.000	5653	VV	0.0
90		0.000	15.889	0.000	7045	VV	0.0
91		0.000	15.940	0.000	6166	VV	0.0
92		0.000	15.990	0.000	8946	VV	0.0
93		0.000	16.050	0.000	6719	VV	0.0
94		0.000	16.097	0.000	13955	VV	3.0
95		0.000	16.132	0.000	7934	VV	0.0
96		0.000	16.185	0.000	5424	VV	0.0
97		0.000	16.241	0.000	6684	VV	0.0
98		0.000	16.321	0.000	14814	VV	0.0
99		0.000	16.455	0.000	36657	VV	2.0
100		0.000	16.538	0.000	5330	VV	0.0
101		0.000	16.586	0.000	11100	VV	0.0
102		0.000	16.639	0.000	11843	VV	0.0
103		0.000	16.712	0.000	9284	VV	0.0
104		0.000	16.829	0.000	11189	VV	0.0
105		0.000	16.862	0.000	2833	VV	0.0
106	C13	0.004	16.908	0.019	7097	VV	0.0
107		0.000	16.941	0.000	13593	VV	0.0
108		0.000	17.038	0.000	7943	VV	0.0
109		0.000	17.090	0.000	10285	VV	0.0
110		0.000	17.137	0.000	13955	VV	0.0
111		0.000	17.217	0.000	14555	VV	2.9
112		0.000	17.272	0.000	5133	VV	0.0

113		0.000	17.311	0.000	5387	VV	0.0
114		0.000	17.386	0.000	7331	VV	0.0
115		0.000	17.478	0.000	6020	VV	3.3
116		0.000	17.539	0.000	19122	VV	4.1
117		0.000	17.680	0.000	12443	VV	5.4
118		0.000	17.754	0.000	2935	VV	0.0
119		0.000	17.839	0.000	7587	VV	0.0
120		0.000	17.889	0.000	7906	VV	0.0
121		0.000	17.984	0.000	7695	VV	0.0
122		0.000	18.025	0.000	2472	VV	0.0
123		0.000	18.056	0.000	4301	VV	0.0
124		0.000	18.129	0.000	1643	VV	0.0
125		0.000	18.191	0.000	23514	VV	2.3
126		0.000	18.315	0.000	3994	VV	0.0
127		0.000	18.398	0.000	4788	VV	0.0
128	C14	0.001	18.474	-0.050	1958	VV	0.0
129		0.000	18.587	0.000	8560	VV	0.0
130		0.000	18.674	0.000	4234	VV	0.0
131		0.000	18.714	0.000	1799	VV	0.0
132		0.000	18.772	0.000	8352	VV	0.0
133		0.000	18.871	0.000	4164	VV	0.0
134		0.000	18.908	0.000	2889	VV	0.0
135		0.000	18.958	0.000	1275	VV	0.0
136		0.000	19.076	0.000	7692	VV	0.0
137		0.000	19.188	0.000	1889	VV	0.0
138		0.000	19.242	0.000	3078	VV	0.0
139		0.000	19.305	0.000	5693	VV	0.0
140		0.000	19.380	0.000	4358	VV	0.0
141		0.000	19.411	0.000	2365	VV	6.8
142		0.000	19.512	0.000	9351	VV	3.0
143		0.000	19.660	0.000	3587	VV	0.0
144		0.000	19.711	0.000	1475	VV	0.0
145		0.000	19.818	0.000	3480	VV	0.0
146	C15	0.001	20.163	0.104	1092	VV	0.0
147		0.000	20.202	0.000	1646	VV	0.0
148		0.000	20.294	0.000	1305	VV	0.0
149		0.000	20.396	0.000	1418	VV	0.0
150		0.000	20.493	0.000	1256	VP	0.0
151		0.000	20.605	0.000	1140	PB	0.0
152		0.000	21.057	0.000	1054	VV	1.7
153	C16	0.001	21.327	-0.242	1325	PV	2.2
154		0.000	22.333	0.000	1171	BB	2.1
155	C17	0.001	23.243	0.129	1113	BB	2.2
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	Totals:	1.369		-0.111	120228334		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr67-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	0.285	0.000	1218	VB	0.0
2		0.000	4.984	0.000	3844	BB	2.1
3	C5	0.233	5.192	-0.000	8211	BB	2.3
4		0.000	6.223	0.000	1136	BB	0.0
5	C7	0.056	6.533	-0.014	10434	BB	4.4
6	Toluene	1.056	7.655	-0.006	119118144	BB	11.9
7		0.000	7.866	0.000	5830	TS	0.0
8	C8	0.014	7.942	0.003	2810	TF	0.0
9		0.000	8.007	0.000	7486	TF	0.0
10		0.000	8.085	0.000	2019	TF	0.0
11		0.000	8.165	0.000	7239	TF	0.0
12		0.000	8.243	0.000	9887	TS	0.0
13		0.000	8.337	0.000	2063	TF	0.0
14		0.000	8.480	0.000	3999	TF	0.0
15		0.000	8.594	0.000	2713	TF	0.0
16		0.000	8.664	0.000	4287	TF	0.0
17		0.000	8.700	0.000	5536	TF	0.0
18		0.000	8.783	0.000	1107	TS	0.0
19		0.000	8.963	0.000	23253	TF	0.0
20		0.000	9.091	0.000	24809	TF	0.0
21		0.000	9.541	0.000	1013	BV	1.8
22		0.000	10.235	0.000	3089	BB	1.6
23		0.000	10.437	0.000	3418	BB	1.6
24		0.000	10.646	0.000	2444	BB	3.3
25		0.000	11.075	0.000	4369	PB	2.0
26		0.000	11.377	0.000	5569	VV	4.0
27	C10	0.003	11.488	0.054	3931	VP	3.9
28		0.000	11.635	0.000	1346	VV	3.2
29		0.000	11.736	0.000	4051	VV	5.2
30		0.000	11.775	0.000	1818	VV	2.7
31		0.000	11.832	0.000	1862	VV	2.8
32		0.000	11.891	0.000	4360	VV	2.7
33		0.000	12.006	0.000	5933	VV	3.6
34		0.000	12.123	0.000	5693	VV	3.0
35		0.000	12.228	0.000	11176	VV	2.4
36		0.000	12.326	0.000	6528	VV	2.0
37		0.000	12.411	0.000	5270	VV	5.1
38		0.000	12.430	0.000	3505	VV	5.0
39		0.000	12.509	0.000	2708	VV	2.5
40		0.000	12.545	0.000	3140	VV	3.8
41		0.000	12.613	0.000	2418	VV	3.1
42		0.000	12.714	0.000	6292	VV	4.4
43		0.000	12.815	0.000	4948	VV	2.2
44		0.000	12.881	0.000	1792	VV	0.0
45		0.000	12.946	0.000	2915	VV	3.2
46		0.000	12.987	0.000	1560	VV	5.6
47		0.000	13.057	0.000	7309	VV	2.3
48		0.000	13.128	0.000	8975	VV	2.3
49		0.000	13.238	0.000	10766	VV	4.1

50	C11	0.007	13.292	-0.034	10693	VV	4.4
51		0.000	13.413	0.000	13521	VV	3.6
52		0.000	13.460	0.000	4710	VV	0.0
53		0.000	13.567	0.000	17250	VV	4.5
54		0.000	13.655	0.000	9193	VV	0.0
55		0.000	13.705	0.000	4921	VV	0.0
56		0.000	13.785	0.000	8347	VV	3.6
57		0.000	13.861	0.000	8441	VV	2.9
58		0.000	13.917	0.000	2761	VV	5.6
59		0.000	13.986	0.000	6863	VV	2.4
60		0.000	14.067	0.000	7079	VV	0.0
61		0.000	14.121	0.000	14288	VV	2.8
62		0.000	14.192	0.000	3000	VV	2.8
63		0.000	14.258	0.000	20079	VV	3.8
64		0.000	14.361	0.000	8310	VV	4.2
65		0.000	14.459	0.000	11367	VV	2.3
66		0.000	14.523	0.000	24174	VV	2.6
67		0.000	14.649	0.000	7987	VV	4.4
68		0.000	14.745	0.000	5392	VV	3.8
69		0.000	14.784	0.000	12560	VV	3.4
70		0.000	14.844	0.000	9076	VV	5.7
71		0.000	14.934	0.000	3193	VV	0.0
72		0.000	15.025	0.000	20931	VV	4.0
73	C12	0.011	15.164	0.008	19020	VV	6.8
74		0.000	15.211	0.000	23436	VV	0.0
75		0.000	15.418	0.000	42706	VV	7.0
76		0.000	15.559	0.000	14994	VV	6.5
77		0.000	15.642	0.000	5205	VV	0.0
78		0.000	15.689	0.000	8507	VV	5.7
79		0.000	15.778	0.000	10321	VV	3.1
80		0.000	15.849	0.000	5356	VV	0.0
81		0.000	15.886	0.000	6797	VV	0.0
82		0.000	15.936	0.000	6482	VV	0.0
83		0.000	15.989	0.000	8742	VV	0.0
84		0.000	16.046	0.000	6533	VV	0.0
85		0.000	16.094	0.000	14662	VV	2.9
86		0.000	16.130	0.000	7351	VV	4.6
87		0.000	16.182	0.000	5396	VV	0.0
88		0.000	16.237	0.000	6544	VV	0.0
89		0.000	16.318	0.000	14722	VV	0.0
90		0.000	16.452	0.000	36192	VV	2.0
91		0.000	16.535	0.000	5171	VV	0.0
92		0.000	16.583	0.000	11114	VV	0.0
93		0.000	16.635	0.000	11750	VV	4.2
94		0.000	16.708	0.000	9640	VV	0.0
95		0.000	16.826	0.000	10762	VV	0.0
96		0.000	16.860	0.000	2263	VV	0.0
97	C13	0.004	16.907	0.018	7145	VV	0.0
98		0.000	16.938	0.000	13456	VV	0.0
99		0.000	17.036	0.000	7751	VV	0.0
100		0.000	17.088	0.000	10169	VV	0.0
101		0.000	17.134	0.000	13547	VV	0.0
102		0.000	17.214	0.000	14720	VV	2.7
103		0.000	17.268	0.000	5172	VV	0.0
104		0.000	17.310	0.000	4992	VV	0.0
105		0.000	17.382	0.000	7151	VV	0.0
106		0.000	17.476	0.000	6121	VV	3.1
107		0.000	17.537	0.000	18999	VV	3.9
108		0.000	17.677	0.000	12516	VV	5.1
109		0.000	17.750	0.000	2814	VV	0.0
110		0.000	17.837	0.000	7340	VV	0.0
111		0.000	17.886	0.000	7891	VV	0.0
112		0.000	17.981	0.000	7821	VV	0.0

113		0.000	18.053	0.000	6543	VV	0.0
114		0.000	18.188	0.000	25177	VV	2.3
115		0.000	18.313	0.000	3902	VV	0.0
116		0.000	18.395	0.000	4669	VV	0.0
117	C14	0.006	18.585	0.061	11390	VV	10.4
118		0.000	18.671	0.000	4315	VV	0.0
119		0.000	18.713	0.000	1690	VV	0.0
120		0.000	18.770	0.000	8226	VV	0.0
121		0.000	18.867	0.000	4205	VV	0.0
122		0.000	18.905	0.000	3044	VV	0.0
123		0.000	19.072	0.000	9055	VV	0.0
124		0.000	19.239	0.000	4772	VV	0.0
125		0.000	19.303	0.000	5754	VV	4.9
126		0.000	19.377	0.000	6749	VV	6.2
127		0.000	19.510	0.000	10002	VV	2.8
128		0.000	19.658	0.000	3044	VV	0.0
129		0.000	19.707	0.000	1418	VV	0.0
130		0.000	19.814	0.000	3660	VV	0.0
131		0.000	19.926	0.000	1482	VV	0.0
132	C15	0.002	20.110	0.051	2838	VV	0.0
133		0.000	20.162	0.000	2835	VV	0.0
134		0.000	20.290	0.000	1389	VV	0.0
135		0.000	20.397	0.000	1964	VV	0.0
136		0.000	20.493	0.000	1315	VP	0.0
137		0.000	20.603	0.000	1185	PB	0.0
138		0.000	22.331	0.000	1245	BB	2.1
139	C17	0.001	23.241	0.127	1167	BB	2.2
140	C18	0.001	24.960	0.223	1042	BB	2.3
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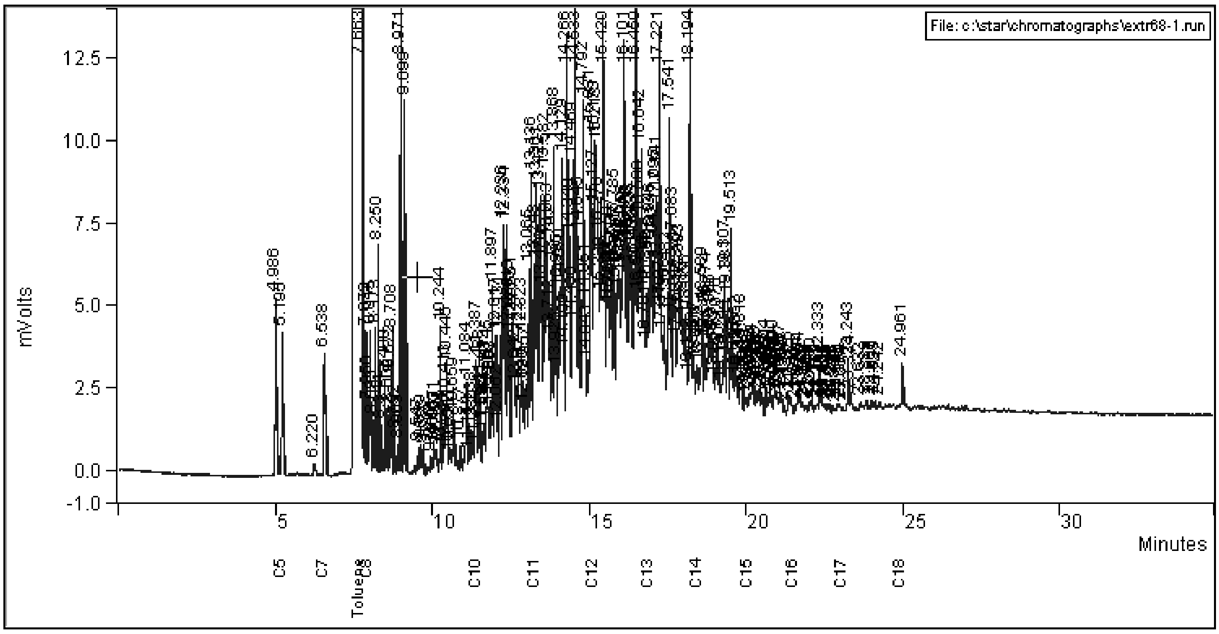
	Totals:	1.394		0.491	120183707		



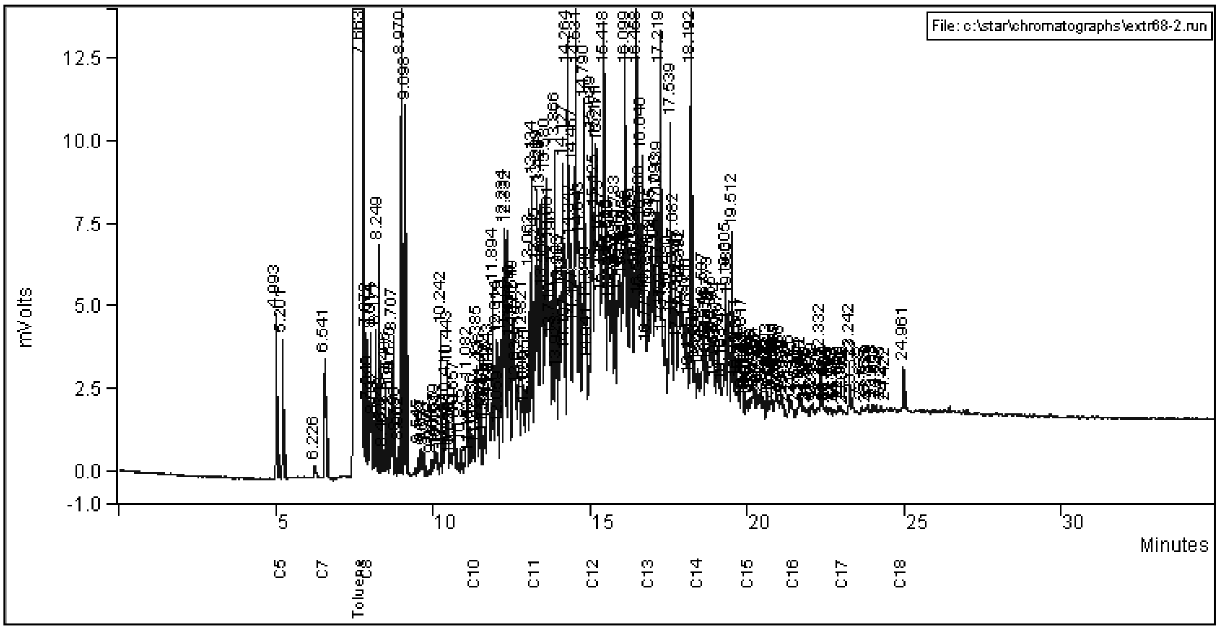


Figure C28: Duplicate chromatograms of Sample 68 (Extract 68-1 and 68-2) showing retention times for hydrocarbons obtained in the soil extracts from the middle sample taken at GASOIL T1315.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr68-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.986	0.000	11983	BB	1.9
2	C5	0.287	5.195	0.003	10110	VB	2.1
3		0.000	6.220	0.000	1213	BB	3.5
4	C7	0.083	6.538	-0.009	15490	BB	4.3
5	Toluene	1.039	7.663	0.002	117275840	BP	11.8
6		0.000	7.873	0.000	6225	TS	0.0
7	C8	0.014	7.950	0.011	2987	TF	0.0
8		0.000	8.015	0.000	7707	TF	0.0
9		0.000	8.093	0.000	2085	TF	0.0
10		0.000	8.173	0.000	7362	TF	0.0
11		0.000	8.250	0.000	10361	TS	0.0
12		0.000	8.344	0.000	2373	TF	0.0
13		0.000	8.488	0.000	4295	TF	0.0
14		0.000	8.602	0.000	3130	TF	0.0
15		0.000	8.672	0.000	4679	TF	0.0
16		0.000	8.708	0.000	6468	TF	0.0
17		0.000	8.792	0.000	2001	TS	0.0
18		0.000	8.903	0.000	1445	TF	0.0
19		0.000	8.971	0.000	25222	TF	0.0
20		0.000	9.099	0.000	27331	TF	0.0
21		0.000	9.547	0.000	2128	VV	0.0
22		0.000	9.629	0.000	2020	VV	0.0
23		0.000	9.686	0.000	1626	VB	0.0
24		0.000	9.946	0.000	1398	VV	2.6
25		0.000	10.031	0.000	2229	VV	2.1
26		0.000	10.067	0.000	1679	VV	0.0
27		0.000	10.123	0.000	1802	VV	3.2
28		0.000	10.244	0.000	8684	VV	1.7
29		0.000	10.324	0.000	1061	VV	2.0
30		0.000	10.413	0.000	5836	VV	4.4
31		0.000	10.445	0.000	6829	VV	2.6
32		0.000	10.531	0.000	1036	VV	0.0
33		0.000	10.565	0.000	1607	VV	3.9
34		0.000	10.659	0.000	6217	VV	3.8
35		0.000	10.877	0.000	2027	VP	3.4
36		0.000	11.084	0.000	8154	VV	2.1
37		0.000	11.154	0.000	1202	VV	0.0
38		0.000	11.238	0.000	2883	VV	2.6
39		0.000	11.280	0.000	1029	VV	0.0
40	C10	0.010	11.387	-0.047	14344	VV	4.4
41		0.000	11.488	0.000	9290	VV	4.1
42		0.000	11.596	0.000	2136	VV	3.1
43		0.000	11.642	0.000	3611	VV	4.4
44		0.000	11.717	0.000	3402	VV	2.6
45		0.000	11.745	0.000	5909	VV	0.0
46		0.000	11.786	0.000	3310	VV	0.0
47		0.000	11.838	0.000	4753	VV	3.1
48		0.000	11.897	0.000	13751	VV	2.3
49		0.000	12.017	0.000	14996	VV	4.2

50		0.000	12.062	0.000	1835	VV	2.5
51		0.000	12.131	0.000	12190	VV	3.2
52		0.000	12.236	0.000	22207	VV	2.7
53		0.000	12.334	0.000	16753	VV	2.2
54		0.000	12.413	0.000	12816	VV	4.1
55		0.000	12.438	0.000	6974	VV	4.9
56		0.000	12.523	0.000	8294	VV	2.7
57		0.000	12.551	0.000	13848	VV	6.6
58		0.000	12.642	0.000	7317	VV	0.0
59		0.000	12.722	0.000	13208	VV	5.1
60		0.000	12.823	0.000	12364	VV	3.3
61		0.000	12.890	0.000	4107	VV	0.0
62		0.000	12.957	0.000	10742	VV	0.0
63		0.000	13.065	0.000	14434	VV	2.4
64		0.000	13.136	0.000	20167	VV	2.2
65		0.000	13.248	0.000	21981	VV	4.5
66	C11	0.016	13.301	-0.025	26829	VV	3.4
67		0.000	13.422	0.000	28990	VV	4.2
68		0.000	13.470	0.000	11158	VV	0.0
69		0.000	13.582	0.000	37025	VV	4.1
70		0.000	13.663	0.000	23026	VV	5.4
71		0.000	13.712	0.000	9671	VV	0.0
72		0.000	13.792	0.000	18804	VV	3.5
73		0.000	13.868	0.000	25781	VV	2.5
74		0.000	13.925	0.000	5455	VV	0.0
75		0.000	13.995	0.000	13473	VV	2.5
76		0.000	14.070	0.000	16334	VV	0.0
77		0.000	14.129	0.000	32312	VV	4.8
78		0.000	14.199	0.000	5722	VV	0.0
79		0.000	14.266	0.000	44929	VV	4.1
80		0.000	14.349	0.000	22381	VV	5.2
81		0.000	14.430	0.000	6231	VV	0.0
82		0.000	14.469	0.000	24095	VV	2.9
83		0.000	14.533	0.000	53481	VV	2.6
84		0.000	14.645	0.000	24930	VV	3.6
85		0.000	14.792	0.000	37381	VV	2.6
86		0.000	14.851	0.000	17217	VV	6.3
87		0.000	14.943	0.000	6645	VV	0.0
88		0.000	15.031	0.000	42670	VV	4.6
89		0.000	15.127	0.000	15820	VV	0.0
90	C12	0.014	15.173	0.017	24678	VV	0.0
91		0.000	15.213	0.000	29390	VV	0.0
92		0.000	15.276	0.000	20736	VV	0.0
93		0.000	15.338	0.000	8193	VV	0.0
94		0.000	15.420	0.000	75848	VV	6.5
95		0.000	15.567	0.000	26418	VV	7.2
96		0.000	15.608	0.000	6303	VV	7.2
97		0.000	15.649	0.000	9787	VV	0.0
98		0.000	15.696	0.000	17169	VV	0.0
99		0.000	15.785	0.000	19854	VV	3.2
100		0.000	15.856	0.000	11192	VV	0.0
101		0.000	15.893	0.000	11723	VV	0.0
102		0.000	15.939	0.000	15368	VV	0.0
103		0.000	15.993	0.000	16033	VV	0.0
104		0.000	16.056	0.000	14435	VV	0.0
105		0.000	16.101	0.000	46564	VV	4.4
106		0.000	16.188	0.000	14184	VV	0.0
107		0.000	16.258	0.000	22820	VV	0.0
108		0.000	16.323	0.000	21434	VV	0.0
109		0.000	16.400	0.000	13982	VV	0.0
110		0.000	16.459	0.000	55945	VV	2.0
111		0.000	16.542	0.000	9056	VV	0.0
112		0.000	16.590	0.000	20477	VV	0.0

113		0.000	16.642	0.000	24126	VV	3.7
114		0.000	16.714	0.000	17310	VV	0.0
115		0.000	16.781	0.000	6613	VV	0.0
116		0.000	16.852	0.000	21375	VV	0.0
117	C13	0.007	16.913	0.024	11981	VV	0.0
118		0.000	16.946	0.000	25799	VV	0.0
119		0.000	17.042	0.000	14628	VV	0.0
120		0.000	17.095	0.000	18277	VV	0.0
121		0.000	17.141	0.000	25171	VV	0.0
122		0.000	17.221	0.000	31670	VV	2.4
123		0.000	17.273	0.000	9353	VV	0.0
124		0.000	17.316	0.000	9735	VV	0.0
125		0.000	17.388	0.000	13977	VV	0.0
126		0.000	17.482	0.000	11185	VV	3.3
127		0.000	17.541	0.000	38661	VV	3.5
128		0.000	17.683	0.000	24685	VV	5.3
129		0.000	17.758	0.000	7378	VV	0.0
130		0.000	17.842	0.000	17479	VV	0.0
131		0.000	17.893	0.000	21001	VV	0.0
132		0.000	17.986	0.000	10655	VV	0.0
133		0.000	18.056	0.000	15412	VV	0.0
134		0.000	18.133	0.000	2985	VV	0.0
135		0.000	18.194	0.000	42296	VV	2.4
136		0.000	18.317	0.000	8617	VV	0.0
137		0.000	18.401	0.000	9965	VV	0.0
138	C14	0.004	18.482	-0.042	7406	VV	0.0
139		0.000	18.589	0.000	16858	VV	7.3
140		0.000	18.676	0.000	13378	VV	0.0
141		0.000	18.774	0.000	15319	VV	0.0
142		0.000	18.866	0.000	10664	VV	0.0
143		0.000	18.911	0.000	6902	VV	0.0
144		0.000	18.955	0.000	2929	VV	0.0
145		0.000	19.076	0.000	20325	VV	0.0
146		0.000	19.190	0.000	3692	VV	0.0
147		0.000	19.244	0.000	7004	VV	0.0
148		0.000	19.307	0.000	14055	VV	4.0
149		0.000	19.381	0.000	16338	VV	5.4
150		0.000	19.513	0.000	20626	VV	2.9
151		0.000	19.616	0.000	3374	VV	0.0
152		0.000	19.662	0.000	7369	VV	0.0
153		0.000	19.711	0.000	4258	VV	0.0
154		0.000	19.818	0.000	10903	VV	0.0
155		0.000	19.929	0.000	3896	VV	0.0
156		0.000	19.968	0.000	1482	VV	0.0
157		0.000	20.013	0.000	2612	VV	0.0
158	C15	0.002	20.073	0.014	2876	VV	0.0
159		0.000	20.113	0.000	2508	VV	0.0
160		0.000	20.166	0.000	3266	VV	0.0
161		0.000	20.204	0.000	5377	VV	0.0
162		0.000	20.293	0.000	4535	VV	0.0
163		0.000	20.350	0.000	2157	VV	0.0
164		0.000	20.398	0.000	4353	VV	0.0
165		0.000	20.493	0.000	5421	VV	0.0
166		0.000	20.604	0.000	5630	VV	0.0
167		0.000	20.687	0.000	1837	VV	0.0
168		0.000	20.757	0.000	4102	VV	0.0
169		0.000	20.821	0.000	2788	VV	0.0
170		0.000	20.900	0.000	4845	VV	0.0
171		0.000	20.949	0.000	2717	VV	0.0
172		0.000	20.985	0.000	1901	VV	0.0
173		0.000	21.057	0.000	3965	VV	0.0
174		0.000	21.121	0.000	3173	VV	0.0
175		0.000	21.199	0.000	2877	VV	0.0

176		0.000	21.326	0.000	5076	VV	0.0
177		0.000	21.415	0.000	3575	VV	0.0
178	C16	0.001	21.546	-0.023	1969	VV	0.0
179		0.000	21.634	0.000	3099	VV	0.0
180		0.000	21.694	0.000	4339	VV	0.0
181		0.000	21.786	0.000	2623	VV	0.0
182		0.000	21.873	0.000	1349	VV	0.0
183		0.000	21.924	0.000	1641	VV	0.0
184		0.000	22.011	0.000	2400	VV	0.0
185		0.000	22.080	0.000	2908	VV	0.0
186		0.000	22.229	0.000	2465	VV	0.0
187		0.000	22.258	0.000	1174	VV	0.0
188		0.000	22.333	0.000	5915	VV	0.0
189		0.000	22.423	0.000	2090	VV	0.0
190		0.000	22.506	0.000	1501	VV	0.0
191		0.000	22.586	0.000	1386	VV	0.0
192		0.000	22.644	0.000	1716	VV	0.0
193		0.000	22.742	0.000	1095	VV	0.0
194		0.000	22.841	0.000	1273	VV	0.0
195		0.000	22.896	0.000	1869	VV	0.0
196		0.000	22.984	0.000	1584	VV	0.0
197	C17	0.001	23.064	-0.050	1184	VV	0.0
198		0.000	23.243	0.000	5872	VV	0.0
199		0.000	23.334	0.000	2435	VV	0.0
200		0.000	23.632	0.000	1775	VV	0.0
201		0.000	23.829	0.000	1650	VV	0.0
202		0.000	23.987	0.000	2013	VV	0.0
203		0.000	24.099	0.000	1433	VV	0.0
204		0.000	24.242	0.000	1863	VV	0.0
205	C18	0.002	24.961	0.224	4461	VV	0.0
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	Totals:	1.480		0.099	119592227		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr68-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.993	0.000	11149	BB	2.0
2	C5	0.280	5.201	0.009	9863	VB	2.2
3		0.000	6.226	0.000	1267	BB	3.6
4	C7	0.083	6.541	-0.006	15406	BB	4.2
5	Toluene	1.036	7.663	0.002	116840944	BP	11.7
6		0.000	7.872	0.000	6218	TS	0.0
7	C8	0.014	7.949	0.010	2944	TF	0.0
8		0.000	8.014	0.000	7592	TF	0.0
9		0.000	8.092	0.000	2071	TF	0.0
10		0.000	8.172	0.000	7360	TF	0.0
11		0.000	8.249	0.000	10299	TS	0.0
12		0.000	8.343	0.000	2359	TF	0.0
13		0.000	8.402	0.000	1020	TF	0.0
14		0.000	8.486	0.000	4260	TF	0.0
15		0.000	8.601	0.000	3059	TF	0.0
16		0.000	8.670	0.000	4557	TF	0.0
17		0.000	8.707	0.000	6408	TF	0.0
18		0.000	8.790	0.000	1949	TS	0.0
19		0.000	8.902	0.000	1441	TF	0.0
20		0.000	8.970	0.000	25086	TF	0.0
21		0.000	9.098	0.000	27179	TF	0.0
22		0.000	9.545	0.000	2052	TF	0.0
23		0.000	9.627	0.000	1925	TF	0.0
24		0.000	9.684	0.000	1600	TF	0.0
25		0.000	9.944	0.000	1360	VV	0.0
26		0.000	10.029	0.000	2189	VV	0.0
27		0.000	10.065	0.000	1655	VV	0.0
28		0.000	10.121	0.000	1763	VV	0.0
29		0.000	10.242	0.000	8530	VV	0.0
30		0.000	10.323	0.000	1027	VV	0.0
31		0.000	10.411	0.000	5653	VV	0.0
32		0.000	10.443	0.000	6847	VV	0.0
33		0.000	10.529	0.000	1037	VV	0.0
34		0.000	10.563	0.000	1553	VV	0.0
35		0.000	10.657	0.000	6188	VV	0.0
36		0.000	10.875	0.000	2075	PV	0.0
37		0.000	11.082	0.000	8171	VV	0.0
38		0.000	11.153	0.000	1193	VV	0.0
39		0.000	11.236	0.000	3042	VV	0.0
40		0.000	11.278	0.000	1057	VV	0.0
41	C10	0.010	11.385	-0.049	14431	VV	0.0
42		0.000	11.486	0.000	9338	VV	0.0
43		0.000	11.594	0.000	2177	VV	0.0
44		0.000	11.640	0.000	3612	VV	0.0
45		0.000	11.715	0.000	3446	VV	0.0
46		0.000	11.743	0.000	5872	VV	0.0
47		0.000	11.784	0.000	3319	VV	0.0
48		0.000	11.835	0.000	4757	VV	0.0
49		0.000	11.894	0.000	13753	VV	0.0

50		0.000	12.014	0.000	14884	VV	0.0
51		0.000	12.059	0.000	1830	VV	0.0
52		0.000	12.129	0.000	12044	VV	0.0
53		0.000	12.234	0.000	22111	VV	0.0
54		0.000	12.332	0.000	16682	VV	0.0
55		0.000	12.410	0.000	12672	VV	0.0
56		0.000	12.431	0.000	7023	VV	0.0
57		0.000	12.521	0.000	8355	VV	0.0
58		0.000	12.549	0.000	13731	VV	0.0
59		0.000	12.639	0.000	7329	VV	0.0
60		0.000	12.719	0.000	13198	VV	0.0
61		0.000	12.821	0.000	12368	VV	0.0
62		0.000	12.888	0.000	4178	VV	0.0
63		0.000	12.955	0.000	10811	VV	0.0
64		0.000	13.063	0.000	14433	VV	0.0
65		0.000	13.134	0.000	20122	VV	0.0
66		0.000	13.245	0.000	21995	VV	0.0
67	C11	0.016	13.299	-0.027	26742	VV	0.0
68		0.000	13.420	0.000	28871	VV	0.0
69		0.000	13.468	0.000	11143	VV	0.0
70		0.000	13.580	0.000	36677	VV	0.0
71		0.000	13.661	0.000	22941	VV	0.0
72		0.000	13.710	0.000	9573	VV	0.0
73		0.000	13.790	0.000	18633	VV	0.0
74		0.000	13.866	0.000	25666	VV	0.0
75		0.000	13.923	0.000	5388	VV	0.0
76		0.000	13.993	0.000	13411	VV	0.0
77		0.000	14.067	0.000	16338	VV	0.0
78		0.000	14.127	0.000	31965	VV	0.0
79		0.000	14.197	0.000	5660	VV	0.0
80		0.000	14.264	0.000	44651	VV	0.0
81		0.000	14.347	0.000	22183	VV	0.0
82		0.000	14.427	0.000	6295	VV	0.0
83		0.000	14.467	0.000	23876	VV	0.0
84		0.000	14.531	0.000	53238	VV	0.0
85		0.000	14.643	0.000	24670	VV	0.0
86		0.000	14.790	0.000	37181	VV	0.0
87		0.000	14.849	0.000	17191	VV	0.0
88		0.000	14.941	0.000	6626	VV	0.0
89		0.000	15.029	0.000	42381	VV	0.0
90		0.000	15.125	0.000	15806	VV	0.0
91	C12	0.014	15.171	0.015	24651	VV	0.0
92		0.000	15.211	0.000	29154	VV	0.0
93		0.000	15.273	0.000	20646	VV	0.0
94		0.000	15.336	0.000	8304	VV	0.0
95		0.000	15.418	0.000	75245	VV	0.0
96		0.000	15.565	0.000	26262	VV	0.0
97		0.000	15.599	0.000	6279	VV	0.0
98		0.000	15.648	0.000	9658	VV	0.0
99		0.000	15.694	0.000	17065	VV	0.0
100		0.000	15.783	0.000	19723	VV	0.0
101		0.000	15.854	0.000	11115	VV	0.0
102		0.000	15.891	0.000	11590	VV	0.0
103		0.000	15.936	0.000	15309	VV	0.0
104		0.000	15.991	0.000	15843	VV	0.0
105		0.000	16.055	0.000	14416	VV	0.0
106		0.000	16.099	0.000	46254	VV	0.0
107		0.000	16.186	0.000	14078	VV	0.0
108		0.000	16.256	0.000	22835	VV	0.0
109		0.000	16.322	0.000	21184	VV	0.0
110		0.000	16.398	0.000	13903	VV	0.0
111		0.000	16.458	0.000	55544	VV	0.0
112		0.000	16.540	0.000	9058	VV	0.0

113		0.000	16.588	0.000	20214	VV	0.0
114		0.000	16.640	0.000	23874	VV	0.0
115		0.000	16.712	0.000	16980	VV	0.0
116		0.000	16.773	0.000	6547	VV	0.0
117		0.000	16.851	0.000	21374	VV	0.0
118	C13	0.007	16.911	0.022	11993	VV	0.0
119		0.000	16.945	0.000	25420	VV	0.0
120		0.000	17.041	0.000	14408	VV	0.0
121		0.000	17.093	0.000	18166	VV	0.0
122		0.000	17.139	0.000	25008	VV	0.0
123		0.000	17.219	0.000	31417	VV	0.0
124		0.000	17.271	0.000	9301	VV	0.0
125		0.000	17.313	0.000	9709	VV	0.0
126		0.000	17.386	0.000	13826	VV	0.0
127		0.000	17.480	0.000	11110	VV	0.0
128		0.000	17.539	0.000	38376	VV	0.0
129		0.000	17.682	0.000	24488	VV	0.0
130		0.000	17.757	0.000	7385	VV	0.0
131		0.000	17.840	0.000	17265	VV	0.0
132		0.000	17.892	0.000	20776	VV	0.0
133		0.000	17.984	0.000	10508	VV	0.0
134		0.000	18.055	0.000	15306	VV	0.0
135		0.000	18.131	0.000	3007	VV	0.0
136		0.000	18.192	0.000	42063	VV	0.0
137		0.000	18.316	0.000	8464	VV	0.0
138		0.000	18.399	0.000	9888	VV	0.0
139	C14	0.004	18.481	-0.043	7269	VV	0.0
140		0.000	18.587	0.000	16818	VV	0.0
141		0.000	18.675	0.000	9697	VV	0.0
142		0.000	18.712	0.000	3468	VV	0.0
143		0.000	18.773	0.000	15294	VV	0.0
144		0.000	18.865	0.000	10552	VV	0.0
145		0.000	18.910	0.000	6775	VV	0.0
146		0.000	18.952	0.000	2962	VV	0.0
147		0.000	19.074	0.000	20280	VV	0.0
148		0.000	19.188	0.000	3716	VV	0.0
149		0.000	19.242	0.000	6835	VV	0.0
150		0.000	19.305	0.000	13998	VV	0.0
151		0.000	19.380	0.000	16317	VV	0.0
152		0.000	19.512	0.000	20555	VV	0.0
153		0.000	19.616	0.000	3453	VV	0.0
154		0.000	19.661	0.000	7319	VV	0.0
155		0.000	19.710	0.000	4253	VV	0.0
156		0.000	19.817	0.000	9257	VV	0.0
157		0.000	19.862	0.000	1658	VV	0.0
158		0.000	19.927	0.000	3746	VV	0.0
159		0.000	19.968	0.000	1578	VV	0.0
160		0.000	20.012	0.000	2588	VV	0.0
161	C15	0.002	20.072	0.013	2896	VV	0.0
162		0.000	20.111	0.000	2494	VV	0.0
163		0.000	20.165	0.000	3166	VV	0.0
164		0.000	20.204	0.000	5381	VV	0.0
165		0.000	20.292	0.000	4445	VV	0.0
166		0.000	20.349	0.000	2227	VV	0.0
167		0.000	20.397	0.000	4403	VV	0.0
168		0.000	20.493	0.000	5260	VV	0.0
169		0.000	20.603	0.000	5612	VV	0.0
170		0.000	20.685	0.000	1752	VV	0.0
171		0.000	20.756	0.000	4094	VV	0.0
172		0.000	20.819	0.000	2716	VV	0.0
173		0.000	20.899	0.000	4752	VV	0.0
174		0.000	20.947	0.000	2699	VV	0.0
175		0.000	20.985	0.000	1791	VV	0.0

176		0.000	21.056	0.000	3947	VV	0.0
177		0.000	21.119	0.000	3134	VV	0.0
178		0.000	21.199	0.000	2781	VV	0.0
179		0.000	21.326	0.000	4980	VV	0.0
180		0.000	21.415	0.000	3428	VV	0.0
181	C16	0.001	21.545	-0.024	1938	VV	0.0
182		0.000	21.634	0.000	3018	VV	0.0
183		0.000	21.692	0.000	4210	VV	0.0
184		0.000	21.788	0.000	2491	VV	0.0
185		0.000	21.872	0.000	1458	VV	0.0
186		0.000	21.925	0.000	1479	VV	0.0
187		0.000	22.007	0.000	2312	VV	0.0
188		0.000	22.079	0.000	2781	VV	0.0
189		0.000	22.228	0.000	2661	VV	0.0
190		0.000	22.332	0.000	5804	VV	0.0
191		0.000	22.422	0.000	2134	VV	0.0
192		0.000	22.504	0.000	1344	VV	0.0
193		0.000	22.586	0.000	1445	VV	0.0
194		0.000	22.644	0.000	1716	VV	0.0
195		0.000	22.742	0.000	1084	VV	0.0
196		0.000	22.896	0.000	1673	VV	0.0
197		0.000	22.985	0.000	1647	VV	0.0
198	C17	0.001	23.062	-0.052	1514	VV	0.0
199		0.000	23.242	0.000	5519	VV	0.0
200		0.000	23.333	0.000	2458	VV	0.0
201		0.000	23.633	0.000	2373	VV	0.0
202		0.000	23.768	0.000	1583	VV	0.0
203		0.000	23.829	0.000	1398	VV	0.0
204		0.000	23.988	0.000	1707	VV	0.0
205		0.000	24.097	0.000	1294	VV	0.0
206		0.000	24.245	0.000	1697	VV	0.0
207		0.000	24.422	0.000	1158	VV	0.0
208	C18	0.002	24.961	0.224	3198	BB	2.4
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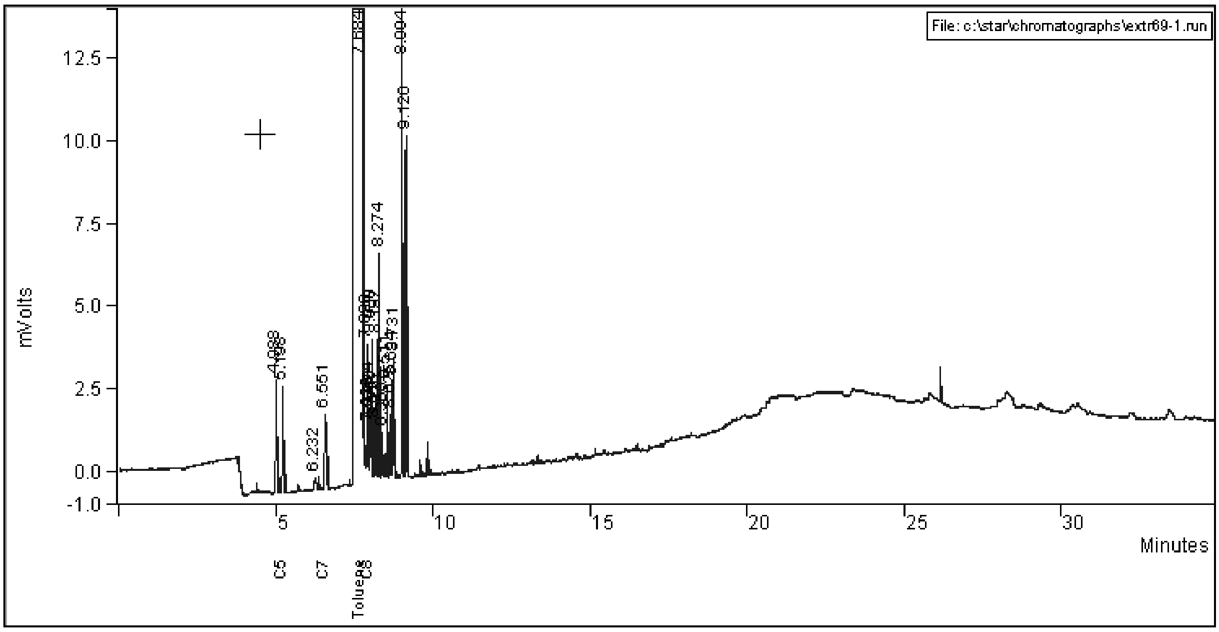
	Totals:	1.470		0.094	119141354		



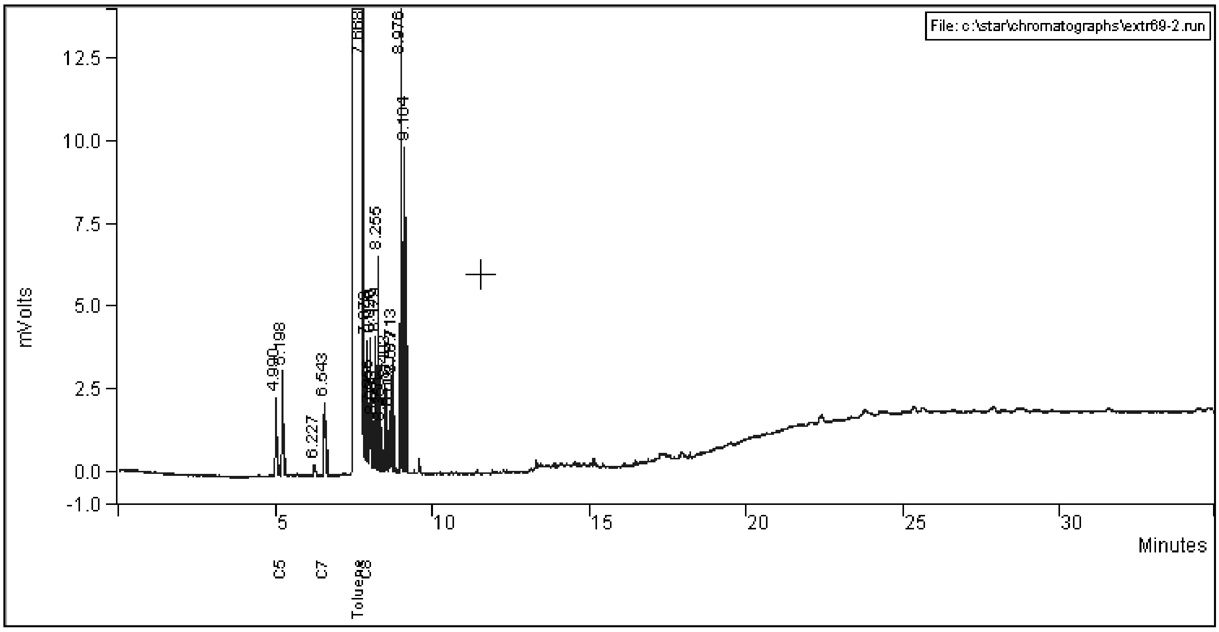


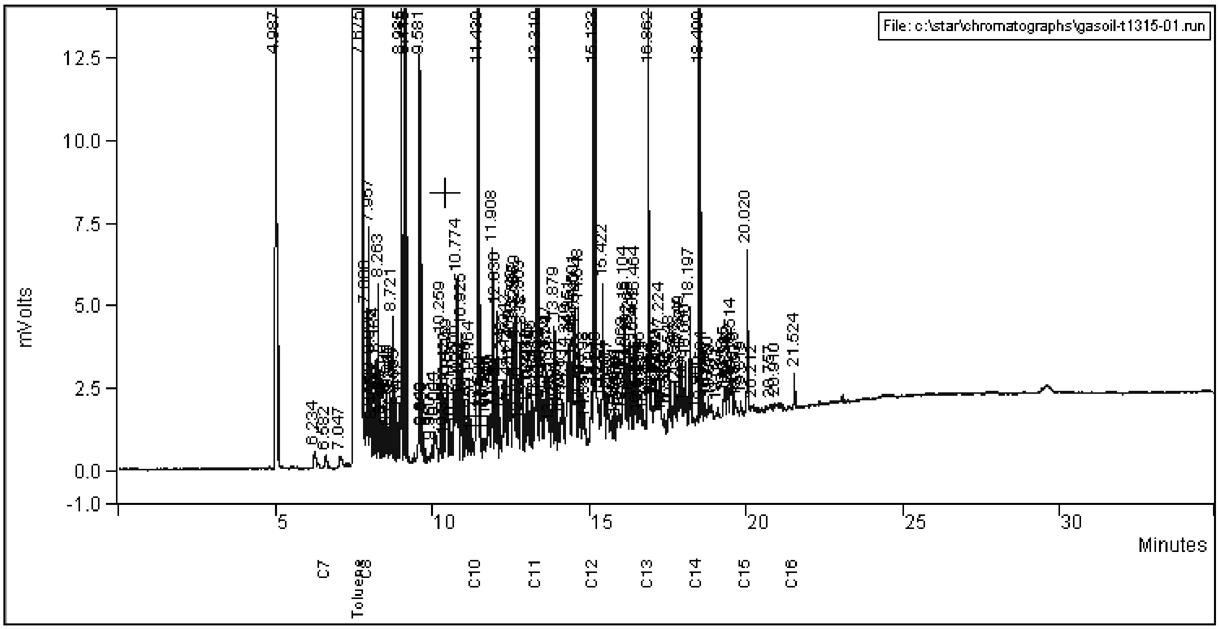
Figure C29: Duplicate chromatograms of Sample 69 (Extract 69-1 and 69-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at GASOIL T1315.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr69-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.988	0.000	7987	BB	2.2
2	5	0.221	5.198	0.006	7772	BB	2.3
3		0.000	6.232	0.000	1262	BV	3.9
4	7	0.054	6.551	0.004	10026	BB	4.5
5	Toluene	1.093	7.684	0.023	123321496	BB	7.2
6		0.000	7.898	0.000	4693	TF	0.0
7	8	0.006	7.923	-0.016	1257	TF	0.0
8		0.000	7.974	0.000	2870	TF	0.0
9		0.000	8.010	0.000	1763	TF	0.0
10		0.000	8.038	0.000	5796	TF	0.0
11		0.000	8.116	0.000	2094	TF	0.0
12		0.000	8.197	0.000	7172	TF	0.0
13		0.000	8.274	0.000	10049	TS	0.0
14		0.000	8.368	0.000	2052	TS	0.0
15		0.000	8.511	0.000	4096	BP	1.4
16		0.000	8.625	0.000	2857	PV	1.3
17		0.000	8.694	0.000	4373	VV	1.5
18		0.000	8.731	0.000	5478	VB	1.4
19		0.000	8.994	0.000	22684	PB	1.4
20		0.000	9.120	0.000	24145	BB	2.4
	Totals:	1.374		0.017	123449922		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr69-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.990	0.000	5581	BP	2.1
2	5	0.213	5.198	0.006	7503	PB	2.3
3		0.000	6.227	0.000	1210	BB	3.6
4	7	0.052	6.543	-0.004	9647	BB	4.4
5	Toluene	1.064	7.668	0.007	120049552	BB	12.0
6		0.000	7.879	0.000	5699	TS	0.0
7	8	0.013	7.956	0.016	2758	TF	0.0
8		0.000	8.020	0.000	7276	TF	0.0
9		0.000	8.098	0.000	1978	TF	0.0
10		0.000	8.179	0.000	6863	TF	0.0
11		0.000	8.255	0.000	9680	TS	0.0
12		0.000	8.350	0.000	1945	TS	0.0
13		0.000	8.493	0.000	4161	TF	0.0
14		0.000	8.607	0.000	2743	TF	0.0
15		0.000	8.677	0.000	4223	TF	0.0
16		0.000	8.713	0.000	5325	TF	0.0
17		0.000	8.976	0.000	22166	TF	0.0
18		0.000	9.104	0.000	23440	TF	0.0
	Totals:	1.342		0.025	120171750		



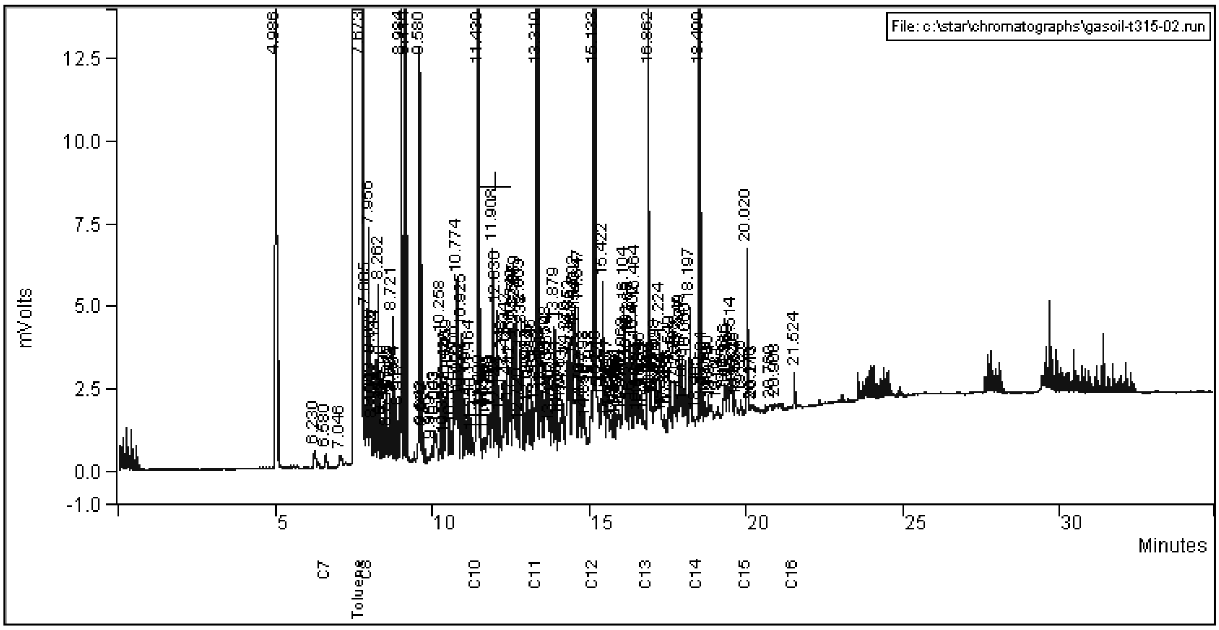


Figure C30: Duplicate chromatograms of sample from T1315 showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Gasoil-T1315-01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.987	0.000	58260	BB	2.0
2		0.000	6.234	0.000	1868	BV	3.8
3	C7	0.008	6.582	0.035	1521	BB	4.2
4		0.000	7.047	0.000	1704	BV	6.0
5	Toluene	1.060	7.675	0.014	119609568	BP	12.0
6		0.000	7.886	0.000	6751	TF	0.0
7	C8	0.045	7.957	0.017	9315	TF	0.0
8		0.000	8.003	0.000	1033	TF	0.0
9		0.000	8.026	0.000	4293	TF	0.0
10		0.000	8.105	0.000	1270	TF	0.0
11		0.000	8.184	0.000	5777	TF	0.0
12		0.000	8.263	0.000	7986	TS	0.0
13		0.000	8.356	0.000	2249	TF	0.0
14		0.000	8.417	0.000	1807	TF	0.0
15		0.000	8.500	0.000	2909	TF	0.0
16		0.000	8.545	0.000	1184	TF	0.0
17		0.000	8.615	0.000	3197	TF	0.0
18		0.000	8.684	0.000	2815	TF	0.0
19		0.000	8.721	0.000	6688	TF	0.0
20		0.000	8.805	0.000	3158	TS	0.0
21		0.000	8.917	0.000	2498	TF	0.0
22		0.000	8.985	0.000	40169	TF	0.0
23		0.000	9.115	0.000	44695	TF	0.0
24		0.000	9.581	0.000	25237	TF	0.0
25		0.000	9.643	0.000	1742	TF	0.0
26		0.000	9.699	0.000	2123	TF	0.0
27		0.000	9.960	0.000	1305	VV	0.0
28		0.000	10.044	0.000	1928	VV	0.0
29		0.000	10.083	0.000	4320	VV	0.0
30		0.000	10.259	0.000	7305	VV	0.0
31		0.000	10.336	0.000	1147	VV	0.0
32		0.000	10.420	0.000	6677	VV	0.0
33		0.000	10.459	0.000	5007	VV	0.0
34		0.000	10.571	0.000	2869	VV	0.0
35		0.000	10.666	0.000	7784	VV	0.0
36		0.000	10.774	0.000	18490	VV	0.0
37		0.000	10.823	0.000	2821	VV	0.0
38		0.000	10.925	0.000	10532	VV	0.0
39		0.000	11.096	0.000	4966	VV	0.0
40		0.000	11.164	0.000	4639	VV	0.0
41		0.000	11.250	0.000	1553	VV	0.0
42	C10	0.047	11.430	-0.004	67800	VV	0.0
43		0.000	11.500	0.000	4225	VV	0.0
44		0.000	11.653	0.000	1558	VV	0.0
45		0.000	11.728	0.000	1930	VV	0.0
46		0.000	11.760	0.000	2333	VV	0.0
47		0.000	11.791	0.000	2605	VV	0.0
48		0.000	11.850	0.000	2513	VV	0.0
49		0.000	11.908	0.000	14165	VV	0.0

50		0.000	12.030	0.000	12364	VP	0.0
51		0.000	12.144	0.000	3309	PV	0.0
52		0.000	12.248	0.000	6551	VV	0.0
53		0.000	12.342	0.000	7993	VV	0.0
54		0.000	12.421	0.000	3598	VV	0.0
55		0.000	12.469	0.000	5581	VV	0.0
56		0.000	12.540	0.000	12332	VV	0.0
57		0.000	12.597	0.000	7841	VV	0.0
58		0.000	12.659	0.000	8372	VV	0.0
59		0.000	12.720	0.000	2623	VV	0.0
60		0.000	12.803	0.000	7739	VV	0.0
61		0.000	12.838	0.000	5475	VV	0.0
62		0.000	12.983	0.000	4292	VV	0.0
63		0.000	13.035	0.000	4206	VV	0.0
64		0.000	13.074	0.000	2551	VV	0.0
65		0.000	13.146	0.000	4661	VV	0.0
66		0.000	13.261	0.000	3396	VV	0.0
67	C11	0.036	13.310	-0.016	58769	VV	0.0
68		0.000	13.432	0.000	6436	VV	0.0
69		0.000	13.484	0.000	3454	VV	0.0
70		0.000	13.597	0.000	8681	VV	0.0
71		0.000	13.674	0.000	7381	VV	0.0
72		0.000	13.718	0.000	1227	VV	0.0
73		0.000	13.798	0.000	4166	VV	0.0
74		0.000	13.879	0.000	8704	VP	0.0
75		0.000	14.003	0.000	1797	PV	0.0
76		0.000	14.075	0.000	2401	VV	0.0
77		0.000	14.137	0.000	5587	VV	0.0
78		0.000	14.270	0.000	6631	VV	0.0
79		0.000	14.351	0.000	11503	VV	0.0
80		0.000	14.433	0.000	5137	VV	0.0
81		0.000	14.501	0.000	10724	VV	0.0
82		0.000	14.540	0.000	8579	VV	0.0
83		0.000	14.648	0.000	9104	VV	0.0
84		0.000	14.703	0.000	1811	VV	0.0
85		0.000	14.798	0.000	4721	VV	0.0
86		0.000	14.856	0.000	1698	VV	0.0
87		0.000	15.038	0.000	5232	VV	0.0
88	C12	0.030	15.133	-0.023	51071	VV	0.0
89		0.000	15.216	0.000	4915	VV	0.0
90		0.000	15.277	0.000	3193	VV	0.0
91		0.000	15.422	0.000	17882	VV	0.0
92		0.000	15.577	0.000	5112	VV	0.0
93		0.000	15.703	0.000	1766	VV	0.0
94		0.000	15.791	0.000	2224	VV	0.0
95		0.000	15.861	0.000	1011	VV	0.0
96		0.000	15.900	0.000	1588	VV	0.0
97		0.000	15.944	0.000	2296	VV	0.0
98		0.000	15.998	0.000	1779	VV	0.0
99		0.000	16.068	0.000	3478	VV	0.0
100		0.000	16.104	0.000	11108	VV	0.0
101		0.000	16.192	0.000	4538	VV	0.0
102		0.000	16.266	0.000	6902	VV	0.0
103		0.000	16.326	0.000	2594	VV	0.0
104		0.000	16.402	0.000	5865	VV	0.0
105		0.000	16.464	0.000	8434	VV	0.0
106		0.000	16.545	0.000	1500	VV	0.0
107		0.000	16.594	0.000	2713	VV	0.0
108		0.000	16.646	0.000	3162	VV	0.0
109		0.000	16.720	0.000	2324	VV	0.0
110		0.000	16.862	0.000	40287	VV	0.0
111	C13	0.001	16.914	0.025	1302	VV	0.0
112		0.000	16.956	0.000	4357	VV	0.0

113		0.000	17.050	0.000	2184	VV	0.0
114		0.000	17.097	0.000	4285	VV	0.0
115		0.000	17.142	0.000	3865	VV	0.0
116		0.000	17.224	0.000	6417	VV	0.0
117		0.000	17.278	0.000	1366	VV	0.0
118		0.000	17.313	0.000	1092	VV	0.0
119		0.000	17.392	0.000	1506	VP	0.0
120		0.000	17.486	0.000	1431	PV	0.0
121		0.000	17.548	0.000	6394	VV	0.0
122		0.000	17.708	0.000	5579	VV	0.0
123		0.000	17.765	0.000	2410	VV	0.0
124		0.000	17.849	0.000	5956	VV	0.0
125		0.000	17.927	0.000	5980	VV	0.0
126		0.000	17.990	0.000	1552	VV	0.0
127		0.000	18.060	0.000	4785	VV	0.0
128		0.000	18.197	0.000	9481	VV	0.0
129		0.000	18.406	0.000	1185	VV	0.0
130	C14	0.014	18.490	-0.034	25520	VV	0.0
131		0.000	18.594	0.000	3363	VV	0.0
132		0.000	18.680	0.000	2984	VV	0.0
133		0.000	18.780	0.000	3019	VV	0.0
134		0.000	18.873	0.000	2705	VV	0.0
135		0.000	19.081	0.000	3116	VV	0.0
136		0.000	19.253	0.000	1828	VV	0.0
137		0.000	19.315	0.000	3925	VV	0.0
138		0.000	19.386	0.000	1346	VV	0.0
139		0.000	19.418	0.000	2745	VV	0.0
140		0.000	19.514	0.000	6649	VV	0.0
141		0.000	19.620	0.000	1930	VV	0.0
142		0.000	19.663	0.000	1960	VV	0.0
143		0.000	19.819	0.000	1873	VV	0.0
144	C15	0.006	20.020	-0.039	10342	VV	0.0
145		0.000	20.212	0.000	3094	VV	0.0
146		0.000	20.757	0.000	1323	VV	0.0
147		0.000	20.910	0.000	1212	VV	0.0
148	C16	0.001	21.524	-0.045	2273	VB	0.0
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	Totals:	1.248		-0.070	120642992		

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Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : Gasoil-T1315-02
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.986	0.000	54856	BB	1.9
2		0.000	6.230	0.000	1899	BV	3.8
3	C7	0.008	6.580	0.033	1469	BB	4.1
4		0.000	7.046	0.000	1709	BV	6.0
5	Toluene	1.057	7.673	0.012	119229024	BP	11.9
6		0.000	7.885	0.000	6765	TF	0.0
7	C8	0.045	7.956	0.017	9312	TF	0.0
8		0.000	8.003	0.000	1068	TF	0.0
9		0.000	8.026	0.000	4266	TF	0.0
10		0.000	8.104	0.000	1259	TF	0.0
11		0.000	8.184	0.000	5739	TF	0.0
12		0.000	8.262	0.000	7987	TS	0.0
13		0.000	8.355	0.000	2200	TF	0.0
14		0.000	8.416	0.000	1777	TF	0.0
15		0.000	8.500	0.000	2888	TF	0.0
16		0.000	8.544	0.000	1177	TF	0.0
17		0.000	8.615	0.000	3193	TF	0.0
18		0.000	8.684	0.000	2826	TF	0.0
19		0.000	8.721	0.000	6653	TF	0.0
20		0.000	8.804	0.000	3174	TS	0.0
21		0.000	8.917	0.000	2488	TF	0.0
22		0.000	8.984	0.000	40184	TF	0.0
23		0.000	9.114	0.000	44534	TF	0.0
24		0.000	9.580	0.000	25238	TF	0.0
25		0.000	9.642	0.000	1735	TF	0.0
26		0.000	9.699	0.000	2060	TF	0.0
27		0.000	9.959	0.000	1311	VV	0.0
28		0.000	10.043	0.000	1970	VV	0.0
29		0.000	10.083	0.000	4310	VV	0.0
30		0.000	10.258	0.000	7242	VV	0.0
31		0.000	10.335	0.000	1098	VV	0.0
32		0.000	10.420	0.000	6646	VV	0.0
33		0.000	10.459	0.000	4976	VV	0.0
34		0.000	10.570	0.000	2933	VV	0.0
35		0.000	10.666	0.000	7763	VV	0.0
36		0.000	10.774	0.000	18517	VV	0.0
37		0.000	10.823	0.000	2816	VV	0.0
38		0.000	10.925	0.000	10544	VV	0.0
39		0.000	11.096	0.000	4910	VV	0.0
40		0.000	11.164	0.000	4535	VV	0.0
41		0.000	11.250	0.000	1535	VV	0.0
42	C10	0.047	11.430	-0.004	67388	VV	0.0
43		0.000	11.499	0.000	4180	VP	0.0
44		0.000	11.653	0.000	1562	VV	0.0
45		0.000	11.727	0.000	1872	VV	0.0
46		0.000	11.759	0.000	2320	VV	0.0
47		0.000	11.791	0.000	2606	VV	0.0
48		0.000	11.850	0.000	2480	VV	0.0
49		0.000	11.908	0.000	14057	VV	0.0

50		0.000	12.030	0.000	12345	VP	0.0
51		0.000	12.144	0.000	3300	PV	0.0
52		0.000	12.248	0.000	6477	VV	0.0
53		0.000	12.342	0.000	7965	VV	0.0
54		0.000	12.421	0.000	3577	VV	0.0
55		0.000	12.468	0.000	5621	VV	0.0
56		0.000	12.540	0.000	12346	VV	0.0
57		0.000	12.597	0.000	7815	VV	0.0
58		0.000	12.659	0.000	8379	VV	0.0
59		0.000	12.720	0.000	2629	VV	0.0
60		0.000	12.803	0.000	7810	VV	0.0
61		0.000	12.838	0.000	5453	VV	0.0
62		0.000	12.983	0.000	4299	VV	0.0
63		0.000	13.035	0.000	4225	VV	0.0
64		0.000	13.074	0.000	2559	VV	0.0
65		0.000	13.146	0.000	4626	VV	0.0
66		0.000	13.261	0.000	3404	VV	0.0
67	C11	0.036	13.310	-0.016	58674	VV	0.0
68		0.000	13.432	0.000	6475	VV	0.0
69		0.000	13.484	0.000	3539	VV	0.0
70		0.000	13.598	0.000	8836	VV	0.0
71		0.000	13.674	0.000	7492	VV	0.0
72		0.000	13.720	0.000	1224	VV	0.0
73		0.000	13.799	0.000	4226	VV	0.0
74		0.000	13.879	0.000	8846	VP	0.0
75		0.000	14.003	0.000	1844	PV	0.0
76		0.000	14.075	0.000	2450	VV	0.0
77		0.000	14.137	0.000	5788	VV	0.0
78		0.000	14.270	0.000	6793	VV	0.0
79		0.000	14.352	0.000	11751	VV	0.0
80		0.000	14.433	0.000	5197	VV	0.0
81		0.000	14.502	0.000	10854	VV	0.0
82		0.000	14.540	0.000	8657	VV	0.0
83		0.000	14.647	0.000	9160	VV	0.0
84		0.000	14.702	0.000	1846	VV	0.0
85		0.000	14.798	0.000	4826	VV	0.0
86		0.000	14.856	0.000	1839	VV	0.0
87		0.000	15.038	0.000	5395	VV	0.0
88	C12	0.030	15.133	-0.023	51038	VV	0.0
89		0.000	15.216	0.000	4942	VV	0.0
90		0.000	15.277	0.000	3412	VV	0.0
91		0.000	15.422	0.000	18187	VV	0.0
92		0.000	15.577	0.000	5281	VV	0.0
93		0.000	15.656	0.000	1014	VV	0.0
94		0.000	15.703	0.000	1935	VV	0.0
95		0.000	15.791	0.000	2333	VV	0.0
96		0.000	15.862	0.000	1091	VV	0.0
97		0.000	15.899	0.000	1671	VV	0.0
98		0.000	15.944	0.000	2350	VV	0.0
99		0.000	15.998	0.000	1857	VV	0.0
100		0.000	16.068	0.000	3470	VV	0.0
101		0.000	16.104	0.000	11127	VV	0.0
102		0.000	16.192	0.000	4521	VV	0.0
103		0.000	16.266	0.000	6952	VV	0.0
104		0.000	16.327	0.000	2676	VV	0.0
105		0.000	16.402	0.000	5962	VV	0.0
106		0.000	16.464	0.000	8653	VV	0.0
107		0.000	16.544	0.000	1371	VV	0.0
108		0.000	16.594	0.000	2747	VV	0.0
109		0.000	16.646	0.000	3244	VV	0.0
110		0.000	16.718	0.000	2450	VV	0.0
111	C13	0.023	16.862	-0.027	40324	VV	0.0
112		0.000	16.916	0.000	1398	VV	0.0

113		0.000	16.955	0.000	4397	VV	0.0
114		0.000	17.050	0.000	2279	VV	0.0
115		0.000	17.098	0.000	4312	VV	0.0
116		0.000	17.142	0.000	3935	VV	0.0
117		0.000	17.224	0.000	6444	VV	0.0
118		0.000	17.279	0.000	1348	VV	0.0
119		0.000	17.313	0.000	1111	VV	0.0
120		0.000	17.393	0.000	1538	VP	0.0
121		0.000	17.486	0.000	1407	PV	0.0
122		0.000	17.549	0.000	6322	VV	0.0
123		0.000	17.708	0.000	5668	VV	0.0
124		0.000	17.765	0.000	2447	VV	0.0
125		0.000	17.849	0.000	5961	VV	0.0
126		0.000	17.927	0.000	5922	VV	0.0
127		0.000	17.990	0.000	1542	VV	0.0
128		0.000	18.060	0.000	4784	VV	0.0
129		0.000	18.197	0.000	9495	VV	0.0
130		0.000	18.405	0.000	1167	VV	0.0
131	C14	0.014	18.490	-0.034	25499	VV	0.0
132		0.000	18.594	0.000	3386	VV	0.0
133		0.000	18.680	0.000	3015	VV	0.0
134		0.000	18.780	0.000	2966	VV	0.0
135		0.000	18.874	0.000	2803	VV	0.0
136		0.000	19.081	0.000	3126	VV	0.0
137		0.000	19.253	0.000	2240	VV	0.0
138		0.000	19.316	0.000	4182	VV	0.0
139		0.000	19.386	0.000	1422	VV	0.0
140		0.000	19.418	0.000	2870	VV	0.0
141		0.000	19.514	0.000	6856	VV	0.0
142		0.000	19.620	0.000	2014	VV	0.0
143		0.000	19.664	0.000	1311	VV	0.0
144		0.000	19.820	0.000	2296	VV	0.0
145	C15	0.006	20.020	-0.039	10322	VV	0.0
146		0.000	20.170	0.000	1237	VV	0.0
147		0.000	20.213	0.000	1359	VV	0.0
148		0.000	20.760	0.000	1253	VV	0.0
149		0.000	20.908	0.000	1079	VV	0.0
150	C16	0.001	21.524	-0.045	2391	VB	0.0
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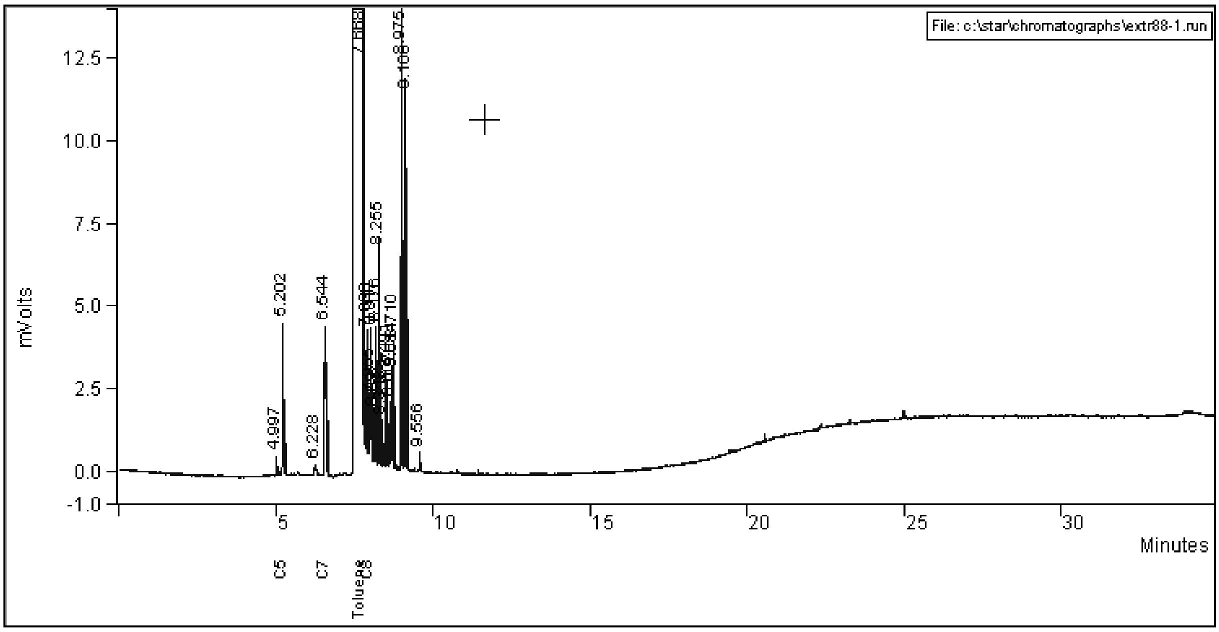
	Totals:	1.267		-0.126	120263305		



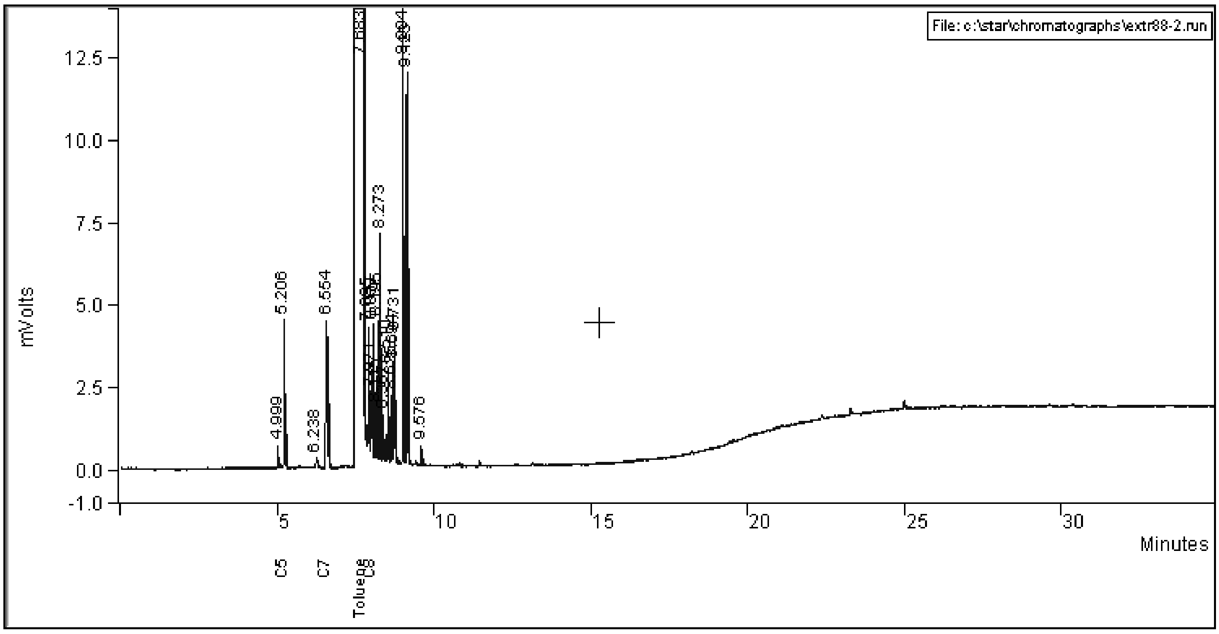


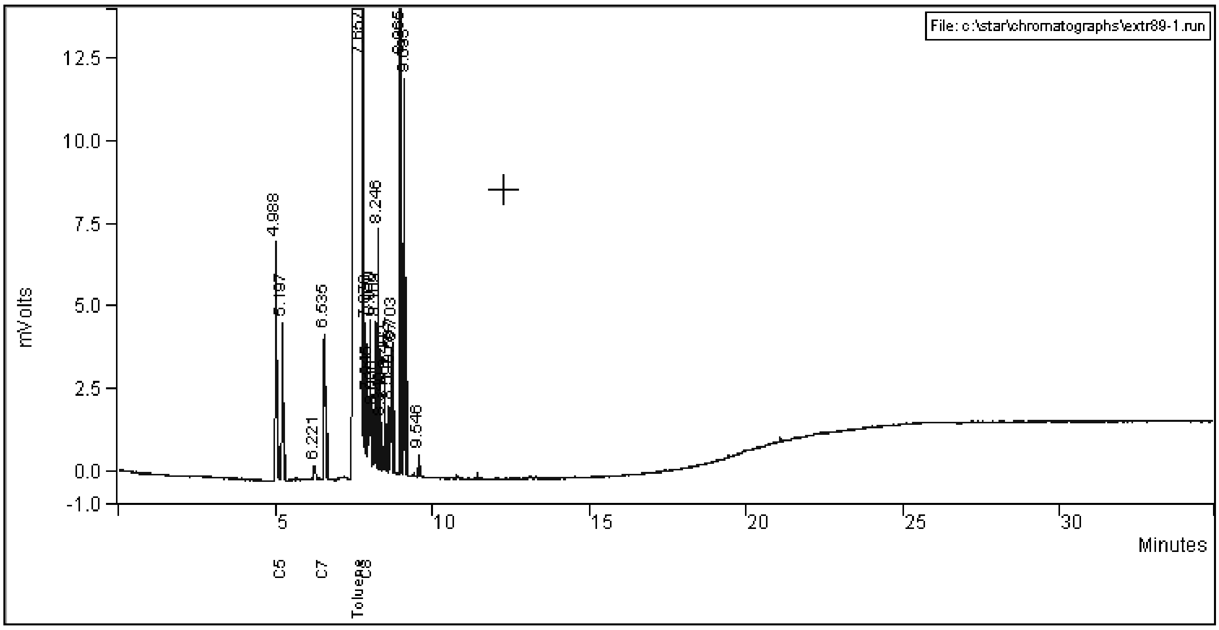
Figure C31: Duplicate chromatograms of Sample 88 (Extract 88-1 and 88-2) showing retention times for hydrocarbons obtained in the soil extracts from the top sample taken at NTF T1103.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr88-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.997	0.000	1403	BV	2.2
2	C5	0.310	5.202	0.010	10913	VB	2.2
3		0.000	6.228	0.000	1005	BB	3.5
4	C7	0.105	6.544	-0.003	19524	BB	4.3
5	Toluene	1.053	7.668	0.007	118808656	BB	11.9
6		0.000	7.880	0.000	5583	TF	0.0
7	C8	0.014	7.955	0.016	2978	TF	0.0
8		0.000	8.017	0.000	7209	TF	0.0
9		0.000	8.097	0.000	2054	TF	0.0
10		0.000	8.176	0.000	7097	TF	0.0
11		0.000	8.255	0.000	10205	TF	0.0
12		0.000	8.348	0.000	2111	TF	0.0
13		0.000	8.491	0.000	4372	TF	0.0
14		0.000	8.607	0.000	3061	TF	0.0
15		0.000	8.684	0.000	3907	TF	0.0
16		0.000	8.710	0.000	6511	TF	0.0
17		0.000	8.975	0.000	26265	TF	0.0
18		0.000	9.106	0.000	28502	TF	0.0
19		0.000	9.556	0.000	1084	TS	0.0
	Totals:	1.482		0.030	118952440		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr88-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.999	0.000	1722	BV	2.4
2	C5	0.314	5.206	0.014	11048	VB	2.3
3		0.000	6.238	0.000	1308	BB	4.0
4	C7	0.105	6.554	0.007	19520	BB	4.4
5	Toluene	1.058	7.683	0.022	119406440	BB	12.0
6		0.000	7.895	0.000	5724	TS	0.0
7	C8	0.014	7.971	0.032	2943	TF	0.0
8		0.000	8.037	0.000	7431	TF	0.0
9		0.000	8.115	0.000	2060	TF	0.0
10		0.000	8.195	0.000	7054	TF	0.0
11		0.000	8.273	0.000	10211	TS	0.0
12		0.000	8.367	0.000	2107	TS	0.0
13		0.000	8.510	0.000	4339	TF	0.0
14		0.000	8.625	0.000	3038	TF	0.0
15		0.000	8.694	0.000	4531	TF	0.0
16		0.000	8.731	0.000	5847	TF	0.0
17		0.000	8.994	0.000	26408	TF	0.0
18		0.000	9.123	0.000	28693	TF	0.0
19		0.000	9.576	0.000	1019	TS	0.0
	Totals:	1.491		0.075	119551443		



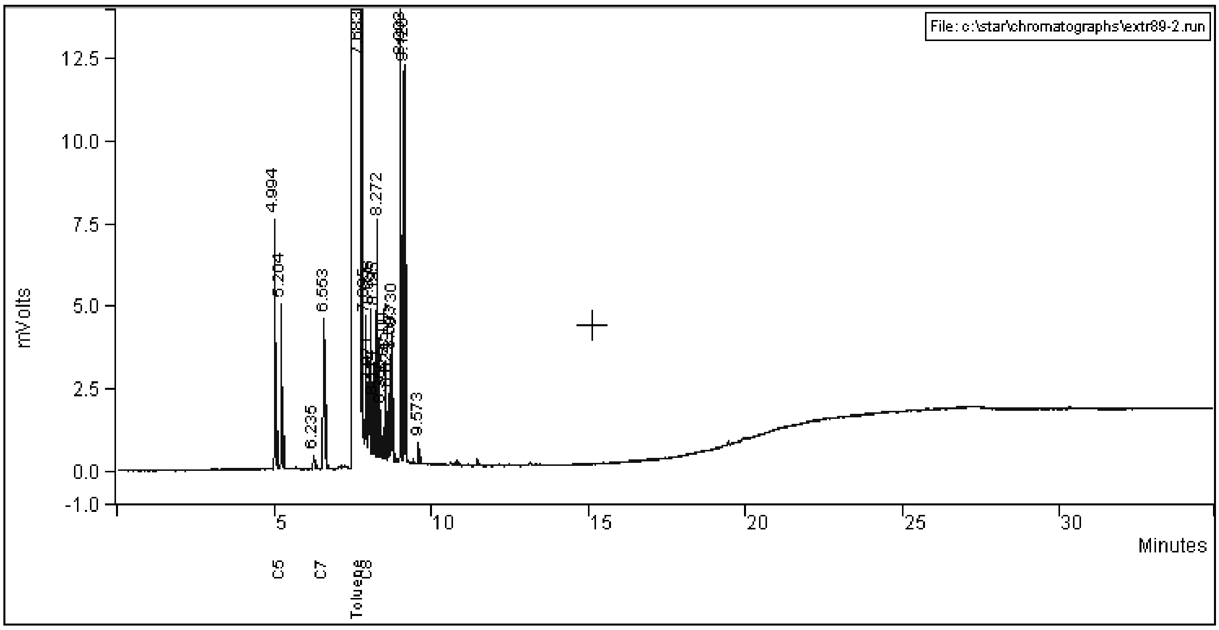


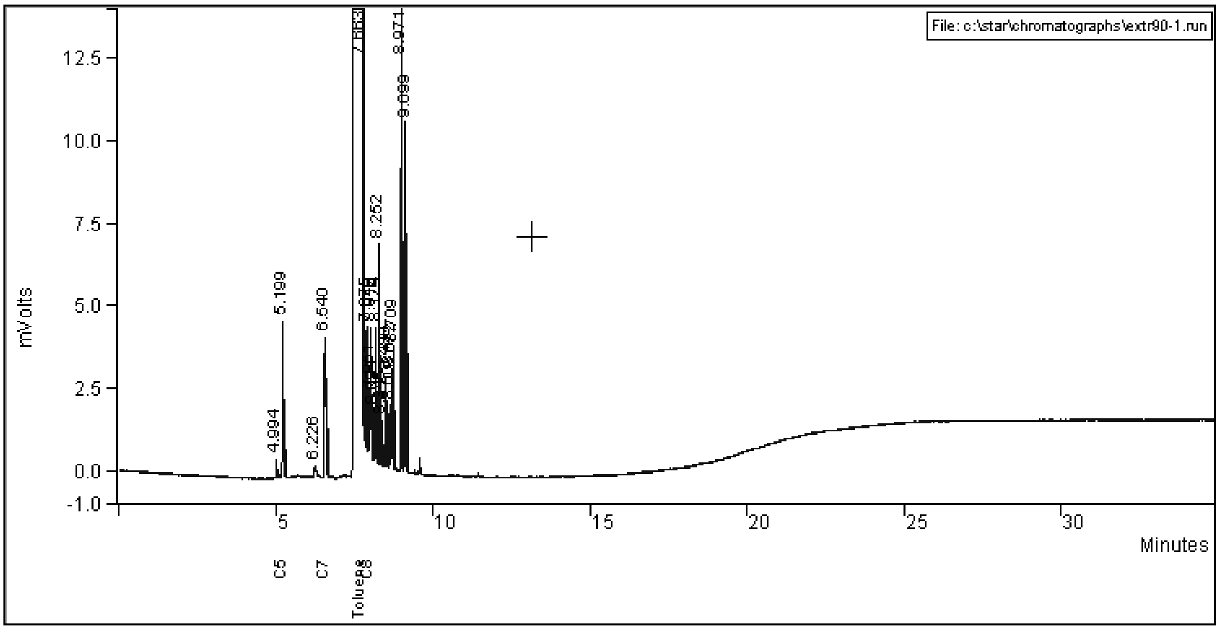
Figure C32: Duplicate chromatograms of Sample 89 (Extract 89-1 and 89-2) showing retention times for hydrocarbons obtained in the soil extracts from the midddle sample taken at NTF T1103.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr89-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.988	0.000	16741	BB	2.0
2	C5	0.332	5.197	0.005	11666	VB	2.3
3		0.000	6.221	0.000	1440	BB	3.8
4	C7	0.103	6.535	-0.012	19268	BB	4.4
5	Toluene	1.065	7.657	-0.004	120139512	BB	12.0
6		0.000	7.870	0.000	6100	TS	0.0
7	C8	0.015	7.945	0.006	3093	TF	0.0
8		0.000	8.010	0.000	7986	TF	0.0
9		0.000	8.088	0.000	2233	TF	0.0
10		0.000	8.169	0.000	7527	TF	0.0
11		0.000	8.246	0.000	10811	TS	0.0
12		0.000	8.340	0.000	2192	TS	0.0
13		0.000	8.482	0.000	4503	TF	0.0
14		0.000	8.597	0.000	3025	TF	0.0
15		0.000	8.667	0.000	4664	TF	0.0
16		0.000	8.703	0.000	5906	TF	0.0
17		0.000	8.965	0.000	26235	TF	0.0
18		0.000	9.093	0.000	28967	TF	0.0
19		0.000	9.546	0.000	1144	TS	0.0
	Totals:	1.515		-0.005	120303013		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr89-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.994	0.000	16356	BP	1.8
2	C5	0.325	5.204	0.012	11417	PB	2.1
3		0.000	6.235	0.000	1463	BB	3.6
4	C7	0.103	6.553	0.006	19304	BB	4.3
5	Toluene	1.063	7.683	0.022	119895088	BB	12.0
6		0.000	7.895	0.000	6084	TS	0.0
7	C8	0.015	7.971	0.032	3085	TF	0.0
8		0.000	8.036	0.000	7917	TF	0.0
9		0.000	8.114	0.000	2200	TF	0.0
10		0.000	8.195	0.000	7499	TF	0.0
11		0.000	8.272	0.000	10767	TS	0.0
12		0.000	8.366	0.000	2197	TS	0.0
13		0.000	8.509	0.000	4422	TF	0.0
14		0.000	8.624	0.000	3011	TF	0.0
15		0.000	8.693	0.000	4737	TF	0.0
16		0.000	8.730	0.000	5832	TF	0.0
17		0.000	8.993	0.000	26166	TF	0.0
18		0.000	9.120	0.000	28691	TF	0.0
19		0.000	9.573	0.000	1170	BB	1.6
	Totals:	1.506		0.072	120057406		



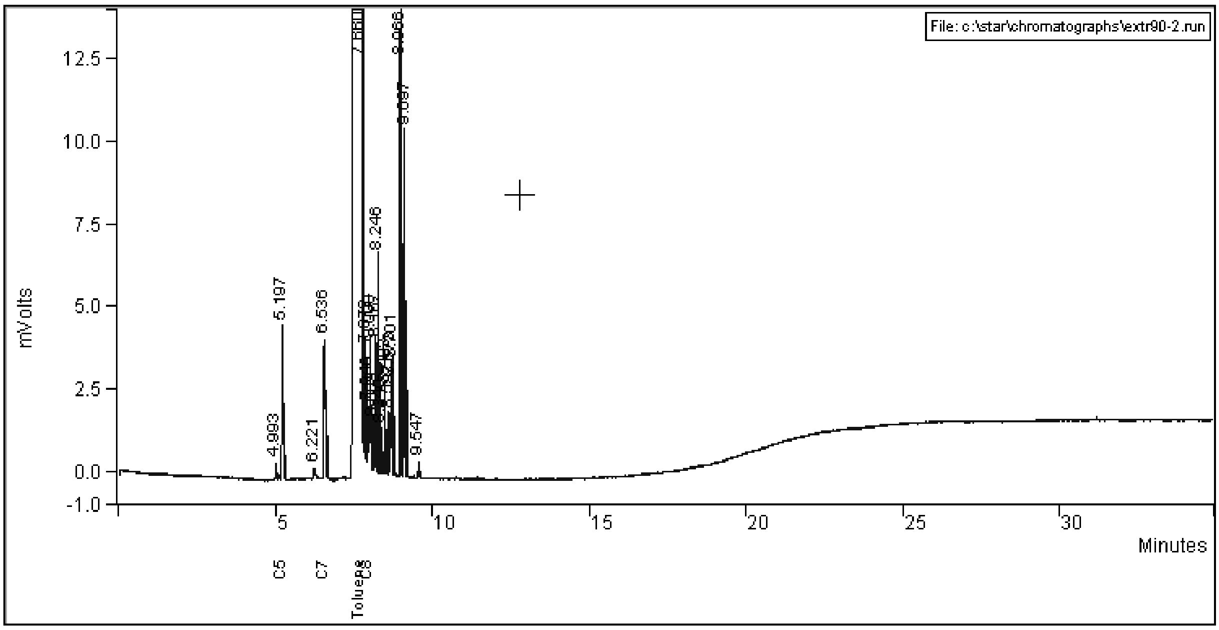


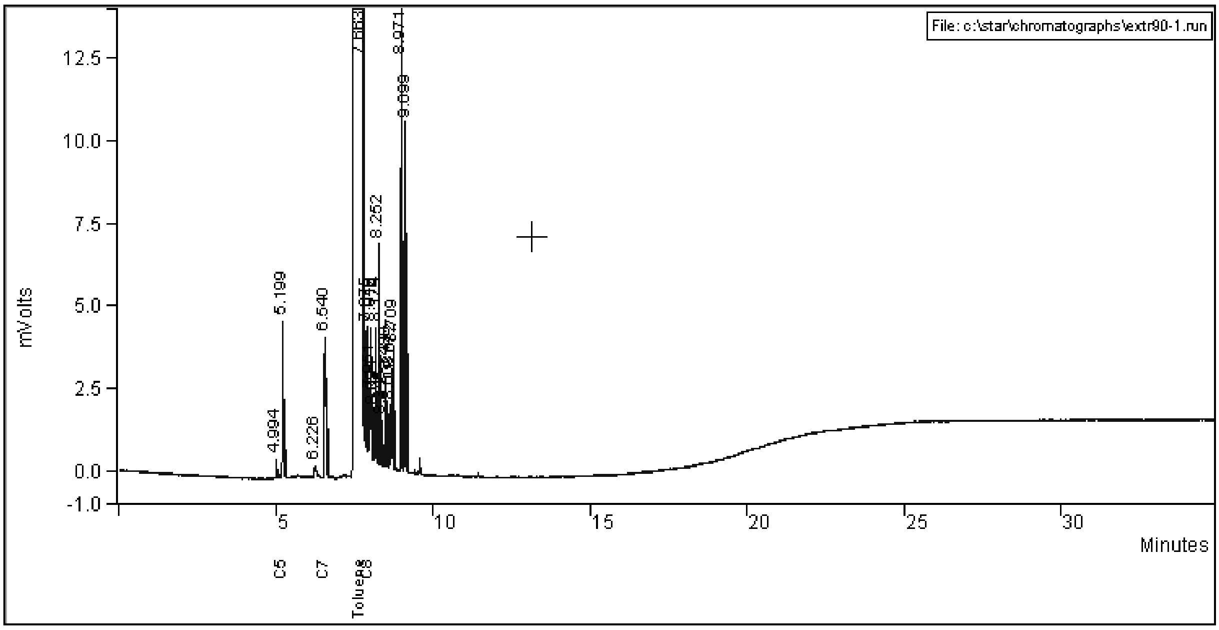
Figure C33: Duplicate chromatograms of Sample 90 (Extract 90-1 and 90-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at NTF T1103.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr90-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.994	0.000	1256	BV	2.2
2	C5	0.317	5.199	0.007	11157	VB	2.2
3		0.000	6.226	0.000	1127	BB	3.6
4	C7	0.098	6.540	-0.007	18192	BB	4.3
5	Toluene	1.061	7.663	0.002	119685912	BB	12.0
6		0.000	7.875	0.000	5748	TS	0.0
7	C8	0.014	7.951	0.012	2842	TF	0.0
8		0.000	8.016	0.000	7328	TF	0.0
9		0.000	8.094	0.000	2055	TF	0.0
10		0.000	8.174	0.000	7018	TF	0.0
11		0.000	8.252	0.000	9924	TS	0.0
12		0.000	8.346	0.000	2040	TS	0.0
13		0.000	8.488	0.000	4250	TF	0.0
14		0.000	8.603	0.000	2881	TF	0.0
15		0.000	8.672	0.000	4331	TF	0.0
16		0.000	8.709	0.000	5545	TF	0.0
17		0.000	8.971	0.000	23835	TF	0.0
18		0.000	9.099	0.000	25628	TF	0.0
Totals:		1.490		0.014	119821069		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr90-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.993	0.000	1214	BV	2.3
2	C5	0.317	5.197	0.005	11151	PB	2.2
3		0.000	6.221	0.000	1197	BB	3.7
4	C7	0.098	6.536	-0.011	18218	BB	4.3
5	Toluene	1.057	7.660	-0.001	119277480	BB	12.0
6		0.000	7.872	0.000	5588	TS	0.0
7	C8	0.014	7.946	0.007	2854	TF	0.0
8		0.000	8.008	0.000	7160	TF	0.0
9		0.000	8.089	0.000	2012	TF	0.0
10		0.000	8.167	0.000	6886	TF	0.0
11		0.000	8.246	0.000	9924	TS	0.0
12		0.000	8.340	0.000	2018	TS	0.0
13		0.000	8.483	0.000	4182	TF	0.0
14		0.000	8.597	0.000	2834	TF	0.0
15		0.000	8.673	0.000	3514	TF	0.0
16		0.000	8.701	0.000	6299	TF	0.0
17		0.000	8.966	0.000	23653	TF	0.0
18		0.000	9.097	0.000	25486	TF	0.0
19		0.000	9.547	0.000	1134	TS	0.0
	Totals:	1.486		0.000	119412804		



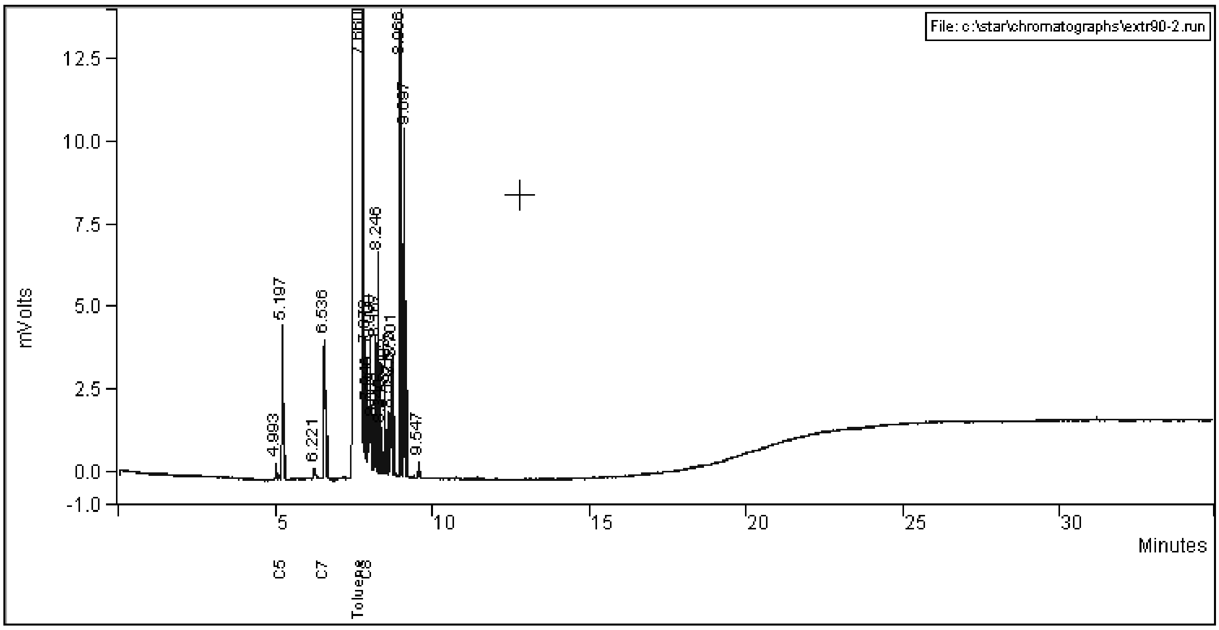


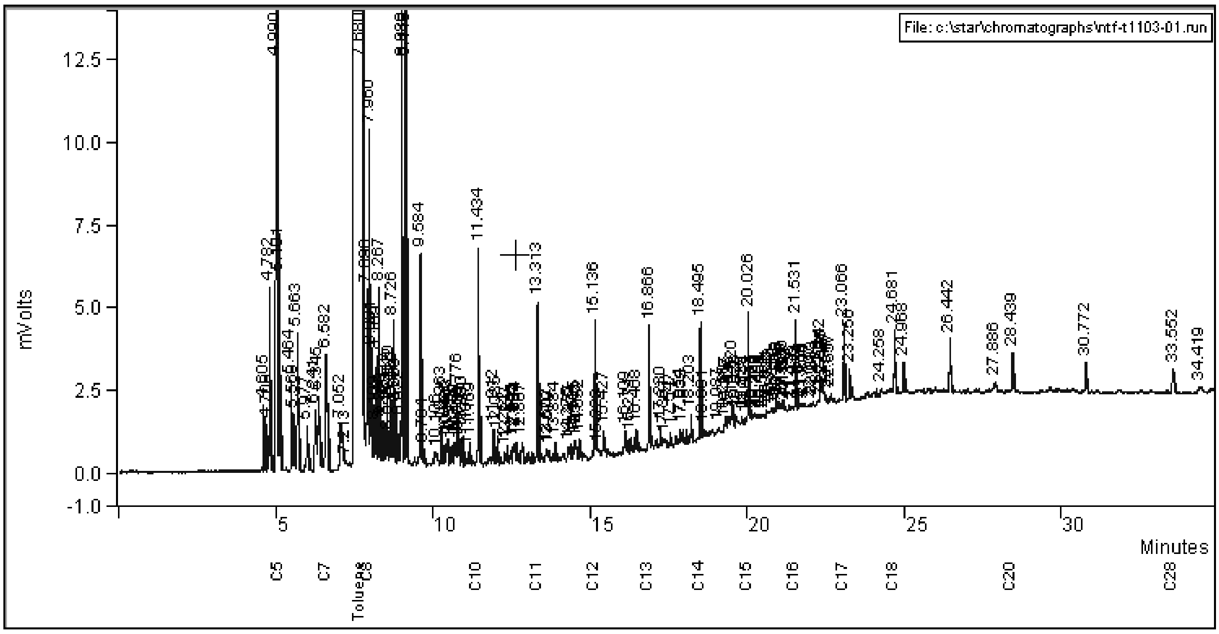
Figure C33: Duplicate chromatograms of Sample 90 (Extract 90-1 and 90-2) showing retention times for hydrocarbons obtained in the soil extracts from the bottom sample taken at NTF T1103.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr90-1
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.994	0.000	1256	BV	2.2
2	C5	0.317	5.199	0.007	11157	VB	2.2
3		0.000	6.226	0.000	1127	BB	3.6
4	C7	0.098	6.540	-0.007	18192	BB	4.3
5	Toluene	1.061	7.663	0.002	119685912	BB	12.0
6		0.000	7.875	0.000	5748	TS	0.0
7	C8	0.014	7.951	0.012	2842	TF	0.0
8		0.000	8.016	0.000	7328	TF	0.0
9		0.000	8.094	0.000	2055	TF	0.0
10		0.000	8.174	0.000	7018	TF	0.0
11		0.000	8.252	0.000	9924	TS	0.0
12		0.000	8.346	0.000	2040	TS	0.0
13		0.000	8.488	0.000	4250	TF	0.0
14		0.000	8.603	0.000	2881	TF	0.0
15		0.000	8.672	0.000	4331	TF	0.0
16		0.000	8.709	0.000	5545	TF	0.0
17		0.000	8.971	0.000	23835	TF	0.0
18		0.000	9.099	0.000	25628	TF	0.0
	Totals:	1.490		0.014	119821069		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : extr90-2
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.993	0.000	1214	BV	2.3
2	C5	0.317	5.197	0.005	11151	PB	2.2
3		0.000	6.221	0.000	1197	BB	3.7
4	C7	0.098	6.536	-0.011	18218	BB	4.3
5	Toluene	1.057	7.660	-0.001	119277480	BB	12.0
6		0.000	7.872	0.000	5588	TS	0.0
7	C8	0.014	7.946	0.007	2854	TF	0.0
8		0.000	8.008	0.000	7160	TF	0.0
9		0.000	8.089	0.000	2012	TF	0.0
10		0.000	8.167	0.000	6886	TF	0.0
11		0.000	8.246	0.000	9924	TS	0.0
12		0.000	8.340	0.000	2018	TS	0.0
13		0.000	8.483	0.000	4182	TF	0.0
14		0.000	8.597	0.000	2834	TF	0.0
15		0.000	8.673	0.000	3514	TF	0.0
16		0.000	8.701	0.000	6299	TF	0.0
17		0.000	8.966	0.000	23653	TF	0.0
18		0.000	9.097	0.000	25486	TF	0.0
19		0.000	9.547	0.000	1134	TS	0.0
	Totals:	1.486		0.000	119412804		



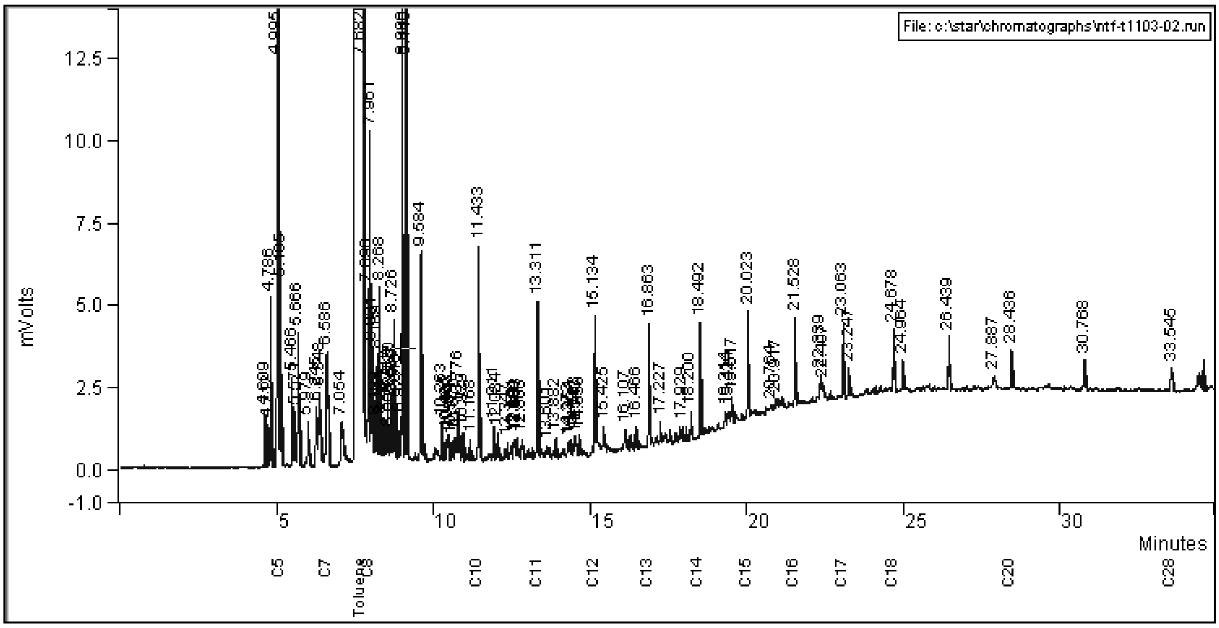


Figure C34: Duplicate chromatograms of tank sample from NTF T1103 showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : NTF-T1103-01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.605	0.000	3111	PP	1.2
2		0.000	4.708	0.000	2295	PV	1.2
3		0.000	4.782	0.000	9306	VB	1.3
4		0.000	4.990	0.000	104144	BV	2.3
5	C5	0.368	5.101	-0.091	12956	VB	1.8
6		0.000	5.464	0.000	8150	BV	3.2
7		0.000	5.568	0.000	4571	VV	2.7
8		0.000	5.663	0.000	12027	VB	2.9
9		0.000	5.977	0.000	4128	VB	3.1
10		0.000	6.241	0.000	6911	BV	3.9
11		0.000	6.345	0.000	9427	VV	3.9
12	C7	0.089	6.582	0.035	16574	VB	4.5
13		0.000	7.052	0.000	8657	BV	6.2
14		0.000	7.213	0.000	1388	VV	0.0
15	Toluene	1.047	7.680	0.019	118112224	VP	11.8
16		0.000	7.890	0.000	7693	TF	0.0
17	C8	0.064	7.960	0.021	13235	TF	0.0
18		0.000	8.031	0.000	5971	TF	0.0
19		0.000	8.109	0.000	1241	TF	0.0
20		0.000	8.189	0.000	6018	TF	0.0
21		0.000	8.267	0.000	7942	TS	0.0
22		0.000	8.360	0.000	2302	TF	0.0
23		0.000	8.421	0.000	1809	TF	0.0
24		0.000	8.505	0.000	2857	TF	0.0
25		0.000	8.549	0.000	1113	TF	0.0
26		0.000	8.620	0.000	3152	TF	0.0
27		0.000	8.689	0.000	2683	TF	0.0
28		0.000	8.726	0.000	6566	TF	0.0
29		0.000	8.809	0.000	2858	TS	0.0
30		0.000	8.922	0.000	2135	TF	0.0
31		0.000	8.989	0.000	37915	TF	0.0
32		0.000	9.118	0.000	42059	TF	0.0
33		0.000	9.584	0.000	13950	TF	0.0
34		0.000	9.704	0.000	1175	TF	0.0
35		0.000	10.106	0.000	1789	TF	0.0
36		0.000	10.263	0.000	2570	TF	0.0
37		0.000	10.425	0.000	2515	TF	0.0
38		0.000	10.463	0.000	1708	TF	0.0
39		0.000	10.572	0.000	1844	TF	0.0
40		0.000	10.671	0.000	2515	TF	0.0
41		0.000	10.776	0.000	5100	TF	0.0
42		0.000	10.828	0.000	1115	TF	0.0
43		0.000	10.930	0.000	2768	TF	0.0
44		0.000	11.101	0.000	1395	TF	0.0
45		0.000	11.169	0.000	1428	TF	0.0
46	C10	0.010	11.434	0.000	13631	TF	0.0
47		0.000	11.912	0.000	2522	VV	0.0
48		0.000	12.035	0.000	2583	VV	0.0
49		0.000	12.252	0.000	1115	VV	0.0
50		0.000	12.347	0.000	1500	VV	0.0

51		0.000	12.545	0.000	2031	VV	0.0
52		0.000	12.602	0.000	1332	VV	0.0
53		0.000	12.664	0.000	1350	VV	0.0
54		0.000	12.807	0.000	1239	VV	0.0
55	C11	0.006	13.313	-0.013	9635	VV	0.0
56		0.000	13.602	0.000	1349	VV	0.0
57		0.000	13.679	0.000	1097	VV	0.0
58		0.000	13.884	0.000	1295	VV	0.0
59		0.000	14.275	0.000	1073	VV	0.0
60		0.000	14.357	0.000	1727	VV	0.0
61		0.000	14.505	0.000	1631	VV	0.0
62		0.000	14.545	0.000	1302	VV	0.0
63		0.000	14.652	0.000	1337	VV	0.0
64	C12	0.005	15.136	-0.020	8045	VV	0.0
65		0.000	15.223	0.000	1566	VV	0.0
66		0.000	15.427	0.000	2973	VV	0.0
67		0.000	16.109	0.000	1881	VV	0.0
68		0.000	16.271	0.000	1154	VV	0.0
69		0.000	16.468	0.000	1495	VV	0.0
70	C13	0.004	16.866	-0.023	7297	PV	0.0
71		0.000	17.230	0.000	1786	VV	0.0
72		0.000	17.361	0.000	1039	VV	0.0
73		0.000	17.547	0.000	1166	VP	0.0
74		0.000	17.854	0.000	1203	VV	0.0
75		0.000	17.932	0.000	1200	VV	0.0
76		0.000	18.203	0.000	1982	PV	0.0
77	C14	0.004	18.495	-0.029	6717	VV	0.0
78		0.000	18.601	0.000	1005	VV	0.0
79		0.000	19.087	0.000	1411	VV	0.0
80		0.000	19.260	0.000	1008	VV	0.0
81		0.000	19.317	0.000	1927	VV	0.0
82		0.000	19.426	0.000	1377	VV	0.0
83		0.000	19.520	0.000	3563	VV	0.0
84		0.000	19.626	0.000	1289	VV	0.0
85		0.000	19.829	0.000	1769	VV	0.0
86		0.000	19.938	0.000	1244	VV	0.0
87	C15	0.004	20.026	-0.033	7424	VV	0.0
88		0.000	20.175	0.000	1348	VV	0.0
89		0.000	20.222	0.000	1607	VV	0.0
90		0.000	20.302	0.000	1080	VV	0.0
91		0.000	20.408	0.000	1660	VV	0.0
92		0.000	20.503	0.000	1677	VV	0.0
93		0.000	20.611	0.000	2325	VV	0.0
94		0.000	20.743	0.000	1362	VV	0.0
95		0.000	20.830	0.000	1210	VV	0.0
96		0.000	20.919	0.000	2708	VV	0.0
97		0.000	20.996	0.000	1511	VV	0.0
98		0.000	21.060	0.000	1597	VV	0.0
99		0.000	21.130	0.000	1850	VV	0.0
100		0.000	21.197	0.000	1752	VV	0.0
101		0.000	21.333	0.000	2032	VV	0.0
102		0.000	21.426	0.000	1298	VV	0.0
103	C16	0.004	21.531	-0.038	6675	VV	0.0
104		0.000	21.644	0.000	1206	VV	0.0
105		0.000	21.715	0.000	1646	VV	0.0
106		0.000	21.805	0.000	1465	VV	0.0
107		0.000	22.007	0.000	2049	VV	0.0
108		0.000	22.083	0.000	1379	VV	0.0
109		0.000	22.236	0.000	1335	VV	0.0
110		0.000	22.342	0.000	2728	VV	0.0
111		0.000	22.395	0.000	1698	VV	0.0
112		0.000	22.427	0.000	1262	VV	0.0
113		0.000	22.517	0.000	1204	VV	0.0

114		0.000	22.657	0.000	1952	VV	0.0
115	C17	0.003	23.066	-0.048	5737	VV	0.0
116		0.000	23.250	0.000	2735	VV	0.0
117		0.000	24.258	0.000	1211	VV	4.0
118	C18	0.003	24.681	-0.056	5027	VB	2.4
119		0.000	24.968	0.000	2286	BB	2.5
120		0.000	26.442	0.000	4433	BB	2.6
121		0.000	27.886	0.000	1160	BB	4.2
122	C20	0.001	28.439	-0.089	3410	BB	2.8
123		0.000	30.772	0.000	3189	BB	3.3
124	C28	0.001	33.552	-0.149	2717	BB	3.8
125		0.000	34.419	0.000	1144	BB	7.2
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	Totals:	1.613		-0.514	118695225		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : NTF-T1103-02
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.609	0.000	2613	BP	1.2
2		0.000	4.712	0.000	2168	PV	1.3
3		0.000	4.786	0.000	8972	VP	1.4
4		0.000	4.995	0.000	97366	PV	2.3
5	C5	0.348	5.105	-0.087	12241	VB	1.9
6		0.000	5.466	0.000	8331	BV	3.3
7		0.000	5.571	0.000	4787	VV	2.8
8		0.000	5.666	0.000	12004	VB	3.0
9		0.000	5.979	0.000	4251	VB	3.2
10		0.000	6.245	0.000	6984	BV	3.9
11		0.000	6.348	0.000	9166	VV	3.9
12	C7	0.090	6.586	0.039	16818	VB	4.5
13		0.000	7.054	0.000	8096	BV	6.1
14	Toluene	1.040	7.682	0.021	117316192	BB	11.7
15		0.000	7.890	0.000	7623	TF	0.0
16	C8	0.063	7.961	0.022	13127	TF	0.0
17		0.000	8.031	0.000	5913	TF	0.0
18		0.000	8.109	0.000	1257	TF	0.0
19		0.000	8.189	0.000	5969	TF	0.0
20		0.000	8.268	0.000	7845	TS	0.0
21		0.000	8.361	0.000	2223	TF	0.0
22		0.000	8.422	0.000	1774	TF	0.0
23		0.000	8.505	0.000	2824	TF	0.0
24		0.000	8.550	0.000	1068	TF	0.0
25		0.000	8.620	0.000	3139	TF	0.0
26		0.000	8.689	0.000	2697	TF	0.0
27		0.000	8.726	0.000	6523	TF	0.0
28		0.000	8.810	0.000	2746	TS	0.0
29		0.000	8.922	0.000	2057	TF	0.0
30		0.000	8.990	0.000	37668	TF	0.0
31		0.000	9.119	0.000	41393	TF	0.0
32		0.000	9.584	0.000	14679	VB	1.9
33		0.000	10.263	0.000	2043	BP	1.7
34		0.000	10.425	0.000	2119	VV	3.6
35		0.000	10.463	0.000	1428	VB	2.3
36		0.000	10.571	0.000	1099	BV	1.8
37		0.000	10.670	0.000	1973	VV	2.0
38		0.000	10.776	0.000	4668	VV	3.1
39		0.000	10.929	0.000	2503	PB	3.0
40		0.000	11.168	0.000	1140	PB	1.5
41	C10	0.009	11.433	-0.001	12407	BB	1.7
42		0.000	11.911	0.000	2210	VV	1.9
43		0.000	12.034	0.000	2166	VB	1.8
44		0.000	12.347	0.000	1242	VV	2.4
45		0.000	12.541	0.000	1006	PV	2.0
46		0.000	12.600	0.000	1072	VV	2.3
47		0.000	12.663	0.000	1023	VB	1.8
48		0.000	12.806	0.000	1059	BV	1.7
49	C11	0.005	13.311	-0.015	8257	BB	1.6
50		0.000	13.601	0.000	1000	BV	2.8

51		0.000	13.882	0.000	1350	VP	1.9
52		0.000	14.273	0.000	1227	VV	2.6
53		0.000	14.354	0.000	1741	VV	3.6
54		0.000	14.503	0.000	1675	VV	3.4
55		0.000	14.543	0.000	1134	VV	2.8
56		0.000	14.650	0.000	1278	VV	2.0
57	C12	0.006	15.134	-0.022	10007	VV	1.7
58		0.000	15.425	0.000	3317	VV	2.5
59		0.000	16.107	0.000	2339	BV	2.1
60		0.000	16.466	0.000	1244	VB	1.7
61	C13	0.004	16.863	-0.026	6797	BB	1.7
62		0.000	17.227	0.000	1096	BB	1.7
63		0.000	17.929	0.000	1245	VP	1.9
64		0.000	18.200	0.000	1792	BB	1.9
65	C14	0.004	18.492	-0.032	6585	BB	1.7
66		0.000	19.314	0.000	1831	BV	3.1
67		0.000	19.424	0.000	1002	VV	3.8
68		0.000	19.517	0.000	2539	VP	3.3
69	C15	0.004	20.023	-0.036	6673	VB	1.8
70		0.000	20.764	0.000	1135	VV	6.5
71		0.000	20.917	0.000	1521	VV	3.8
72	C16	0.003	21.528	-0.041	5597	VB	2.0
73		0.000	22.339	0.000	1999	VV	2.6
74		0.000	22.407	0.000	2409	VV	6.0
75	C17	0.003	23.063	-0.051	5306	VB	2.1
76		0.000	23.247	0.000	2071	BV	2.2
77	C18	0.002	24.678	-0.059	4550	BB	2.3
78		0.000	24.964	0.000	2355	BB	2.4
79		0.000	26.439	0.000	4306	BB	2.5
80		0.000	27.887	0.000	1602	BB	4.9
81	C20	0.001	28.436	-0.092	3435	BB	2.8
82		0.000	30.768	0.000	3020	BB	3.2
83	C28	0.002	33.545	-0.156	2894	BB	4.0
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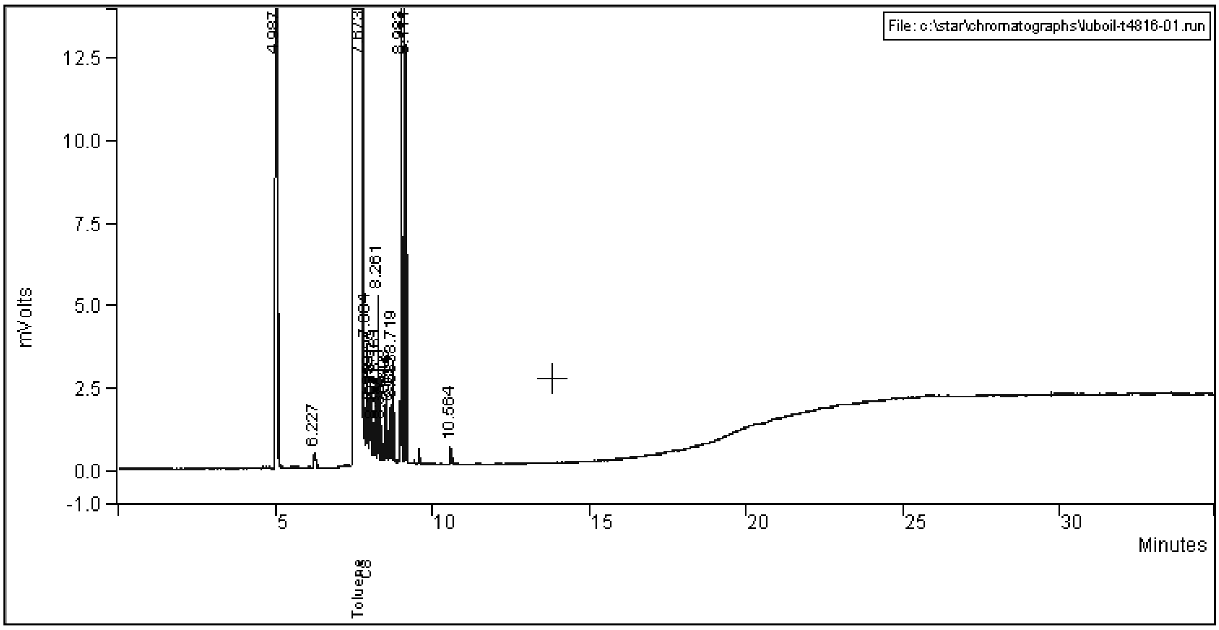
	Totals:	1.584		-0.536	117816001		



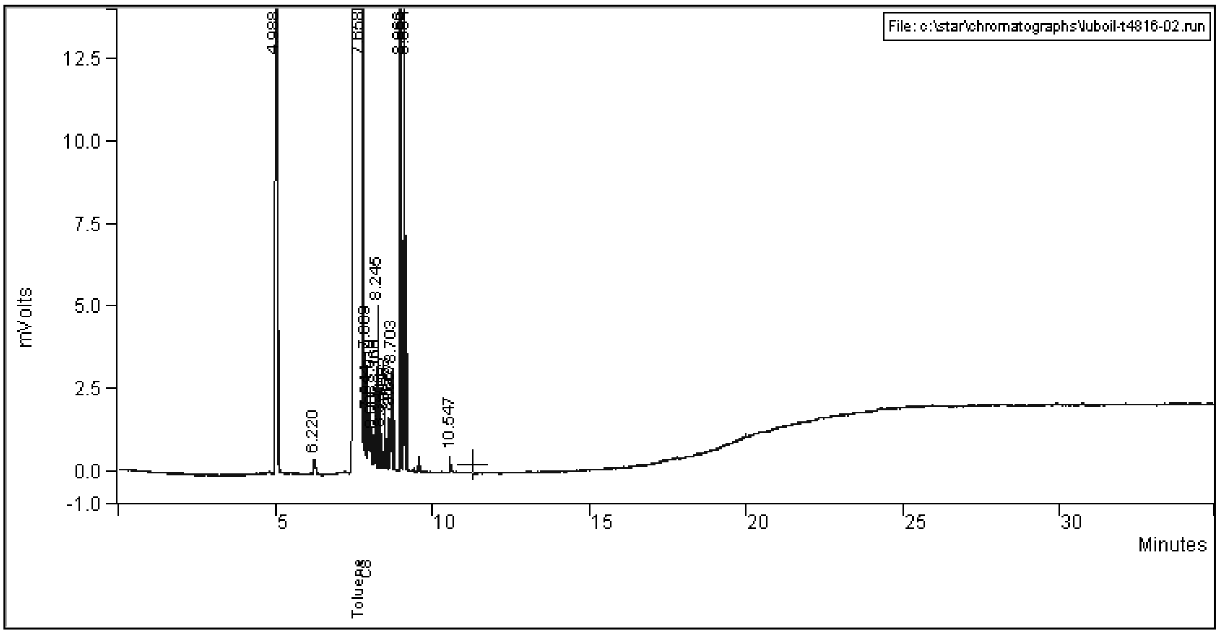


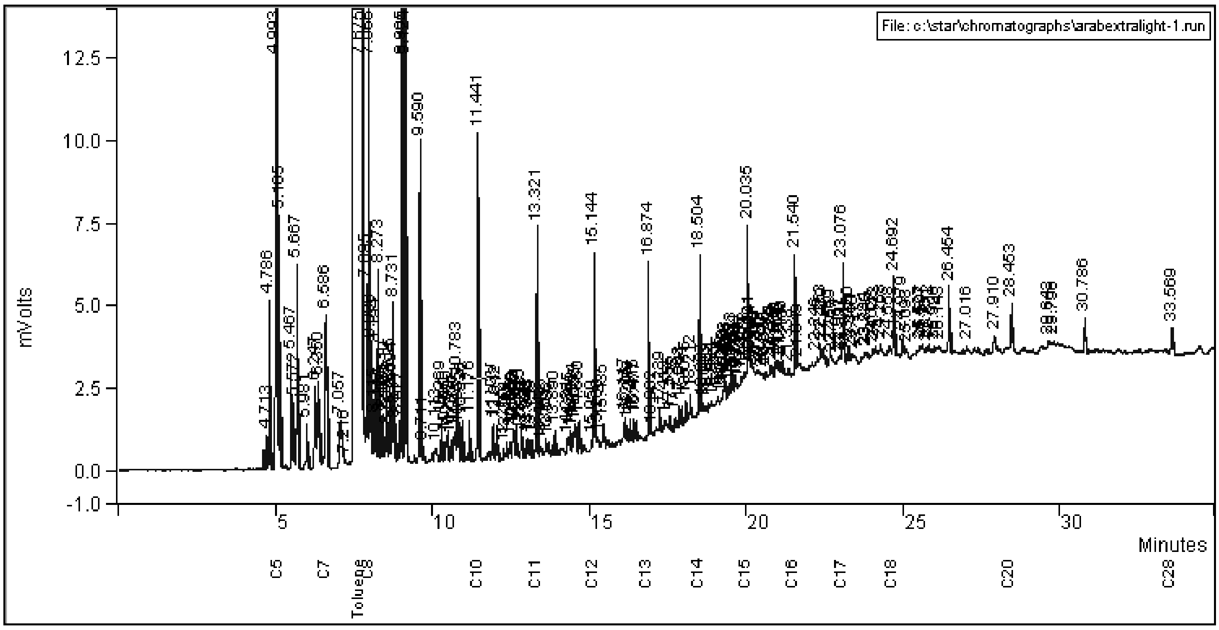
Figure C35: Duplicate chromatograms of tank sample from Luboil T4816 showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Luboil-T4816-01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.987	0.000	74638	BB	1.9
2		0.000	6.227	0.000	1645	BB	3.8
3	Toluene	1.052	7.673	0.012	118744344	BB	11.9
4		0.000	7.884	0.000	4977	TS	0.0
5	C8	0.010	7.959	0.020	2166	TF	0.0
6		0.000	8.025	0.000	3413	TF	0.0
7		0.000	8.103	0.000	1219	TF	0.0
8		0.000	8.181	0.000	4757	TF	0.0
9		0.000	8.261	0.000	7325	TS	0.0
10		0.000	8.355	0.000	1591	TS	0.0
11		0.000	8.498	0.000	2801	TF	0.0
12		0.000	8.614	0.000	2436	TF	0.0
13		0.000	8.683	0.000	2547	TF	0.0
14		0.000	8.719	0.000	4768	TF	0.0
15		0.000	8.983	0.000	32432	TF	0.0
16		0.000	9.111	0.000	33930	TF	0.0
17		0.000	10.564	0.000	1138	BB	1.8
	Totals:	1.062		0.032	118926127		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Luboil-T4816-02
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.988	0.000	73159	BB	2.0
2		0.000	6.220	0.000	1572	BB	3.7
3	Toluene	1.047	7.658	-0.003	118110872	BB	11.9
4		0.000	7.869	0.000	4936	TS	0.0
5	C8	0.010	7.944	0.005	2098	TF	0.0
6		0.000	8.010	0.000	3337	TF	0.0
7		0.000	8.088	0.000	1255	TF	0.0
8		0.000	8.166	0.000	4714	TF	0.0
9		0.000	8.245	0.000	7382	TS	0.0
10		0.000	8.340	0.000	1620	TF	0.0
11		0.000	8.483	0.000	2792	TF	0.0
12		0.000	8.597	0.000	2373	TF	0.0
13		0.000	8.667	0.000	2516	TF	0.0
14		0.000	8.703	0.000	4744	TF	0.0
15		0.000	8.966	0.000	32527	TF	0.0
16		0.000	9.094	0.000	33774	TF	0.0
17		0.000	10.547	0.000	1029	BB	1.8
	Totals:	1.057		0.002	118290700		



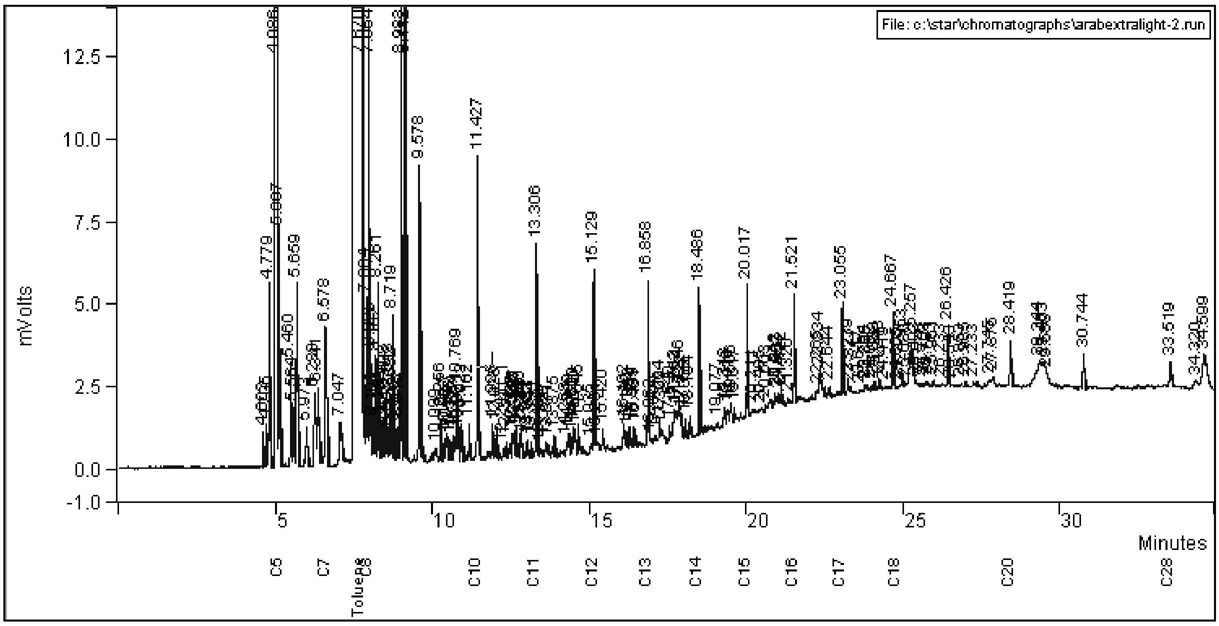


Figure C36: Duplicate chromatograms of sample of crude oil type Arab extra light from STF storage tank showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Arabextralight01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.713	0.000	1665	PV	1.2
2		0.000	4.786	0.000	8573	VB	1.3
3		0.000	4.993	0.000	139107	BV	2.2
4	C5	0.452	5.105	-0.087	15919	VB	1.8
5		0.000	5.467	0.000	10130	BV	3.1
6		0.000	5.572	0.000	5424	VV	2.7
7		0.000	5.667	0.000	17487	VB	2.9
8		0.000	5.981	0.000	3953	VB	3.0
9		0.000	6.247	0.000	9265	BV	3.8
10		0.000	6.350	0.000	10521	VV	3.8
11	C7	0.116	6.586	0.039	21619	VB	4.4
12		0.000	7.057	0.000	9033	BV	6.1
13		0.000	7.216	0.000	1173	VV	6.4
14	Toluene	1.107	7.675	0.014	124879872	VP	12.5
15		0.000	7.895	0.000	7893	TF	0.0
16	C8	0.091	7.965	0.026	18915	TF	0.0
17		0.000	8.036	0.000	6096	TF	0.0
18		0.000	8.115	0.000	1433	TF	0.0
19		0.000	8.194	0.000	6253	TF	0.0
20		0.000	8.273	0.000	8690	TS	0.0
21		0.000	8.365	0.000	2420	TS	0.0
22		0.000	8.426	0.000	1884	TF	0.0
23		0.000	8.510	0.000	3010	TF	0.0
24		0.000	8.554	0.000	1225	TF	0.0
25		0.000	8.625	0.000	3469	TF	0.0
26		0.000	8.694	0.000	2882	TF	0.0
27		0.000	8.731	0.000	7184	TF	0.0
28		0.000	8.814	0.000	1850	TS	0.0
29		0.000	8.927	0.000	2068	TF	0.0
30		0.000	8.995	0.000	44714	TF	0.0
31		0.000	9.124	0.000	48828	TF	0.0
32		0.000	9.590	0.000	20537	TF	0.0
33		0.000	9.711	0.000	1051	TF	0.0
34		0.000	10.113	0.000	2071	TF	0.0
35		0.000	10.269	0.000	2512	TF	0.0
36		0.000	10.430	0.000	2386	TF	0.0
37		0.000	10.470	0.000	1904	TF	0.0
38		0.000	10.578	0.000	1696	TF	0.0
39		0.000	10.677	0.000	2892	TF	0.0
40		0.000	10.783	0.000	7303	TF	0.0
41		0.000	10.835	0.000	1572	TF	0.0
42		0.000	10.936	0.000	3485	TF	0.0
43		0.000	11.176	0.000	2332	TF	0.0
44	C10	0.014	11.441	0.007	19336	TF	0.0
45		0.000	11.919	0.000	2611	TF	0.0
46		0.000	12.042	0.000	2333	TF	0.0
47		0.000	12.260	0.000	1138	VV	0.0
48		0.000	12.354	0.000	1464	VV	0.0
49		0.000	12.482	0.000	1151	VV	0.0

50		0.000	12.553	0.000	1560	VV	0.0
51		0.000	12.562	0.000	1348	VV	0.0
52		0.000	12.609	0.000	1770	VV	0.0
53		0.000	12.671	0.000	1878	VV	0.0
54		0.000	12.815	0.000	1675	VV	0.0
55		0.000	12.853	0.000	1212	VV	0.0
56		0.000	12.996	0.000	1245	VV	0.0
57		0.000	13.048	0.000	1272	VV	0.0
58		0.000	13.159	0.000	1024	VP	0.0
59	C11	0.008	13.321	-0.005	13534	PV	0.0
60		0.000	13.443	0.000	1097	VV	0.0
61		0.000	13.612	0.000	1698	VV	0.0
62		0.000	13.686	0.000	1360	VV	0.0
63		0.000	13.890	0.000	1589	VV	0.0
64		0.000	14.281	0.000	1174	VV	0.0
65		0.000	14.365	0.000	2425	VV	0.0
66		0.000	14.445	0.000	1231	VV	0.0
67		0.000	14.514	0.000	2070	VV	0.0
68		0.000	14.555	0.000	1917	VV	0.0
69		0.000	14.660	0.000	2035	VV	0.0
70		0.000	15.050	0.000	1160	PV	0.0
71	C12	0.007	15.144	-0.012	11353	VV	0.0
72		0.000	15.266	0.000	2377	VV	0.0
73		0.000	15.435	0.000	3255	VV	0.0
74		0.000	16.117	0.000	2121	VV	0.0
75		0.000	16.206	0.000	1081	VV	0.0
76		0.000	16.279	0.000	1529	VV	0.0
77		0.000	16.415	0.000	1352	VV	0.0
78		0.000	16.477	0.000	1229	VV	0.0
79	C13	0.006	16.874	-0.015	10078	VV	0.0
80		0.000	16.982	0.000	1036	VV	0.0
81		0.000	17.239	0.000	1688	VV	0.0
82		0.000	17.412	0.000	2623	VV	0.0
83		0.000	17.555	0.000	1513	VP	0.0
84		0.000	17.725	0.000	1217	PV	0.0
85		0.000	17.863	0.000	1721	VV	0.0
86		0.000	17.941	0.000	1627	VV	0.0
87		0.000	18.075	0.000	1882	VV	0.0
88		0.000	18.212	0.000	3568	VV	0.0
89	C14	0.006	18.504	-0.020	10050	VV	0.0
90		0.000	18.607	0.000	1999	VV	0.0
91		0.000	18.693	0.000	1638	VV	0.0
92		0.000	18.802	0.000	1264	VV	0.0
93		0.000	18.884	0.000	1280	VV	0.0
94		0.000	19.095	0.000	3055	VV	0.0
95		0.000	19.205	0.000	1497	VV	0.0
96		0.000	19.268	0.000	1590	VV	0.0
97		0.000	19.328	0.000	2949	VV	0.0
98		0.000	19.400	0.000	1165	VV	0.0
99		0.000	19.434	0.000	1795	VV	0.0
100		0.000	19.523	0.000	5022	VV	0.0
101		0.000	19.634	0.000	2383	VV	0.0
102		0.000	19.680	0.000	1372	VV	0.0
103		0.000	19.734	0.000	1378	VV	0.0
104		0.000	19.835	0.000	3986	VV	0.0
105		0.000	19.938	0.000	4343	VV	0.0
106	C15	0.007	20.035	-0.024	13303	VV	0.0
107		0.000	20.091	0.000	4559	VV	0.0
108		0.000	20.174	0.000	5932	VV	0.0
109		0.000	20.316	0.000	2593	VV	0.0
110		0.000	20.371	0.000	1733	VV	0.0
111		0.000	20.412	0.000	1968	VV	0.0
112		0.000	20.517	0.000	3307	VV	0.0

113		0.000	20.620	0.000	2102	VV	0.0
114		0.000	20.754	0.000	2110	VV	0.0
115		0.000	20.775	0.000	1663	VV	0.0
116		0.000	20.839	0.000	1580	VV	0.0
117		0.000	20.930	0.000	3027	VV	0.0
118		0.000	21.006	0.000	1821	VV	0.0
119		0.000	21.072	0.000	1794	VV	0.0
120		0.000	21.140	0.000	1785	VV	0.0
121		0.000	21.338	0.000	1404	VV	0.0
122	C16	0.004	21.540	-0.029	7754	PV	0.0
123		0.000	21.649	0.000	1058	VV	0.0
124		0.000	22.246	0.000	1471	VV	4.5
125		0.000	22.353	0.000	2114	VV	3.2
126		0.000	22.439	0.000	3024	VV	5.9
127		0.000	22.669	0.000	2627	VV	4.8
128		0.000	22.757	0.000	1228	VV	8.6
129		0.000	22.917	0.000	1179	VV	10.4
130		0.000	22.997	0.000	1405	VV	0.0
131	C17	0.004	23.076	-0.038	7947	VV	2.2
132		0.000	23.260	0.000	2109	VV	3.5
133		0.000	23.354	0.000	1470	VV	0.0
134		0.000	23.410	0.000	1912	VV	14.3
135		0.000	23.784	0.000	2812	VV	19.1
136		0.000	23.848	0.000	1161	VV	0.0
137		0.000	24.028	0.000	2004	VV	0.0
138		0.000	24.112	0.000	2065	VV	0.0
139		0.000	24.268	0.000	4458	VV	0.0
140		0.000	24.558	0.000	4279	VV	0.0
141	C18	0.004	24.692	-0.045	7023	VV	2.6
142		0.000	24.979	0.000	4101	VV	5.6
143		0.000	25.098	0.000	1660	VP	0.0
144		0.000	25.527	0.000	3140	PV	34.4
145		0.000	25.597	0.000	1944	VV	0.0
146		0.000	25.731	0.000	1091	VV	0.0
147		0.000	25.812	0.000	1731	VV	0.0
148		0.000	25.990	0.000	1570	VV	0.0
149		0.000	26.143	0.000	2311	VV	0.0
150		0.000	26.454	0.000	6802	VB	3.2
151		0.000	27.016	0.000	1338	VV	4.8
152		0.000	27.910	0.000	3014	VV	5.5
153	C20	0.001	28.453	-0.075	4088	BB	2.7
154		0.000	29.643	0.000	1219	VV	5.1
155		0.000	29.796	0.000	1386	VV	0.0
156		0.000	30.786	0.000	3644	BB	3.2
157	C28	0.002	33.569	-0.132	3290	BB	3.8
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Totals:		1.829		-0.396	125674729		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Arabextralight02
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.602	0.000	1731	BV	1.2
2		0.000	4.705	0.000	2113	VV	1.3
3		0.000	4.779	0.000	9485	VV	1.3
4		0.000	4.986	0.000	134389	VV	2.3
5	C5	0.445	5.097	-0.095	15657	VP	1.8
6		0.000	5.460	0.000	9185	PV	3.1
7		0.000	5.564	0.000	4869	VV	2.8
8		0.000	5.659	0.000	15755	VB	2.9
9		0.000	5.973	0.000	3881	VB	3.2
10		0.000	6.238	0.000	8337	BV	3.8
11		0.000	6.341	0.000	9723	VV	3.8
12	C7	0.102	6.578	0.031	19070	VB	4.4
13		0.000	7.047	0.000	8121	BV	6.0
14	Toluene	1.070	7.670	0.009	120691544	VP	12.1
15		0.000	7.884	0.000	7341	TF	0.0
16	C8	0.083	7.954	0.015	17180	TF	0.0
17		0.000	8.025	0.000	5639	TF	0.0
18		0.000	8.103	0.000	1341	TF	0.0
19		0.000	8.182	0.000	5758	TF	0.0
20		0.000	8.261	0.000	8050	TS	0.0
21		0.000	8.353	0.000	2285	TS	0.0
22		0.000	8.415	0.000	1838	TF	0.0
23		0.000	8.498	0.000	2953	TF	0.0
24		0.000	8.542	0.000	1163	TF	0.0
25		0.000	8.613	0.000	3287	TF	0.0
26		0.000	8.682	0.000	2730	TF	0.0
27		0.000	8.719	0.000	6733	TF	0.0
28		0.000	8.802	0.000	1703	TS	0.0
29		0.000	8.915	0.000	1778	TF	0.0
30		0.000	8.983	0.000	41111	TF	0.0
31		0.000	9.112	0.000	44861	TF	0.0
32		0.000	9.578	0.000	18715	TF	0.0
33		0.000	10.099	0.000	1883	TF	0.0
34		0.000	10.256	0.000	2307	TF	0.0
35		0.000	10.417	0.000	2217	TF	0.0
36		0.000	10.457	0.000	1754	TF	0.0
37		0.000	10.565	0.000	1535	TF	0.0
38		0.000	10.664	0.000	2622	TF	0.0
39		0.000	10.769	0.000	6609	TF	0.0
40		0.000	10.821	0.000	1417	TF	0.0
41		0.000	10.923	0.000	3159	TF	0.0
42		0.000	11.162	0.000	2124	VV	0.0
43	C10	0.012	11.427	-0.007	17827	VV	0.0
44		0.000	11.905	0.000	2487	VV	0.0
45		0.000	12.028	0.000	2606	VV	0.0
46		0.000	12.247	0.000	1027	VV	0.0
47		0.000	12.340	0.000	1357	VV	0.0
48		0.000	12.538	0.000	1335	VV	0.0
49		0.000	12.547	0.000	1299	VV	0.0
50		0.000	12.595	0.000	1610	VV	0.0

51		0.000	12.657	0.000	1754	VV	0.0
52		0.000	12.800	0.000	1579	VV	0.0
53		0.000	12.838	0.000	1127	VV	0.0
54		0.000	12.981	0.000	1137	VV	0.0
55		0.000	13.033	0.000	1149	VV	0.0
56		0.000	13.144	0.000	1023	VV	0.0
57	C11	0.008	13.306	-0.020	12835	VV	0.0
58		0.000	13.429	0.000	1067	VV	0.0
59		0.000	13.597	0.000	1618	VV	0.0
60		0.000	13.671	0.000	1599	VV	0.0
61		0.000	13.875	0.000	1581	VV	0.0
62		0.000	14.268	0.000	1143	VV	0.0
63		0.000	14.349	0.000	2417	VV	0.0
64		0.000	14.430	0.000	1249	VV	0.0
65		0.000	14.500	0.000	2013	VV	0.0
66		0.000	14.540	0.000	1907	VV	0.0
67		0.000	14.645	0.000	2106	VV	0.0
68		0.000	15.035	0.000	1322	PV	0.0
69	C12	0.006	15.129	-0.027	11017	VV	0.0
70		0.000	15.251	0.000	1407	VV	0.0
71		0.000	15.420	0.000	3090	VV	0.0
72		0.000	16.102	0.000	2087	VV	0.0
73		0.000	16.190	0.000	1060	VV	0.0
74		0.000	16.263	0.000	1468	VV	0.0
75		0.000	16.399	0.000	1360	VV	0.0
76		0.000	16.461	0.000	1223	VV	0.0
77	C13	0.006	16.858	-0.031	9736	VV	0.0
78		0.000	16.962	0.000	1080	VV	0.0
79		0.000	17.094	0.000	1063	VV	0.0
80		0.000	17.224	0.000	2225	VV	0.0
81		0.000	17.309	0.000	2378	VV	0.0
82		0.000	17.540	0.000	1361	VV	0.0
83		0.000	17.713	0.000	5080	VV	0.0
84		0.000	17.763	0.000	3005	VV	0.0
85		0.000	17.846	0.000	4766	VV	0.0
86		0.000	17.922	0.000	1834	VV	0.0
87		0.000	18.058	0.000	1167	VV	0.0
88		0.000	18.194	0.000	1800	VV	0.0
89	C14	0.005	18.486	-0.038	8451	VV	0.0
90		0.000	19.077	0.000	1022	VV	0.0
91		0.000	19.313	0.000	1937	VV	0.0
92		0.000	19.416	0.000	1218	VV	0.0
93		0.000	19.506	0.000	2633	VV	0.0
94		0.000	19.617	0.000	1042	VV	0.0
95	C15	0.004	20.017	-0.042	8060	VV	0.0
96		0.000	20.211	0.000	1085	VV	0.0
97		0.000	20.485	0.000	1157	VV	0.0
98		0.000	20.603	0.000	1487	VV	0.0
99		0.000	20.912	0.000	2135	VV	0.0
100		0.000	20.987	0.000	1181	VV	0.0
101		0.000	21.053	0.000	1185	VV	0.0
102		0.000	21.122	0.000	1366	VV	0.0
103		0.000	21.320	0.000	1133	VV	0.0
104	C16	0.004	21.521	-0.049	6898	VV	0.0
105		0.000	22.265	0.000	1376	PV	7.6
106		0.000	22.334	0.000	4952	VV	5.5
107		0.000	22.644	0.000	1575	VV	3.6
108	C17	0.004	23.055	-0.059	7166	VV	2.2
109		0.000	23.239	0.000	2158	VV	3.2
110		0.000	23.327	0.000	1488	VV	0.0
111		0.000	23.617	0.000	2199	VV	0.0
112		0.000	23.764	0.000	1903	VV	0.0
113		0.000	23.826	0.000	1240	VV	0.0

114		0.000	24.002	0.000	1560	VV	0.0
115		0.000	24.088	0.000	1577	VV	0.0
116		0.000	24.243	0.000	3021	VV	12.3
117		0.000	24.419	0.000	2151	VV	0.0
118		0.000	24.667	0.000	8713	VV	2.6
119	C18	0.001	24.805	0.068	1093	VV	0.0
120		0.000	24.953	0.000	4038	VV	4.6
121		0.000	25.080	0.000	1328	VV	0.0
122		0.000	25.257	0.000	13396	VV	9.3
123		0.000	25.403	0.000	1447	VV	10.7
124		0.000	25.576	0.000	1387	VV	0.0
125		0.000	25.703	0.000	1447	VV	0.0
126		0.000	25.781	0.000	1366	VV	0.0
127		0.000	25.961	0.000	1539	VV	0.0
128		0.000	26.233	0.000	2511	VV	0.0
129		0.000	26.426	0.000	7027	VV	3.0
130		0.000	26.543	0.000	1157	VV	3.0
131		0.000	26.853	0.000	1898	VV	0.0
132		0.000	26.985	0.000	1355	VV	0.0
133		0.000	27.233	0.000	1179	VV	0.0
134		0.000	27.745	0.000	1445	VV	0.0
135		0.000	27.875	0.000	2097	VV	0.0
136	C20	0.001	28.419	-0.109	4610	VB	3.6
137		0.000	29.344	0.000	8663	BV	16.0
138		0.000	29.463	0.000	7975	VV	0.0
139		0.000	29.588	0.000	1811	VV	33.2
140		0.000	30.744	0.000	4195	BB	3.4
141	C28	0.002	33.519	-0.182	3184	BB	4.0
142		0.000	34.320	0.000	1758	BV	8.5
143		0.000	34.599	0.000	11090	VB	9.4
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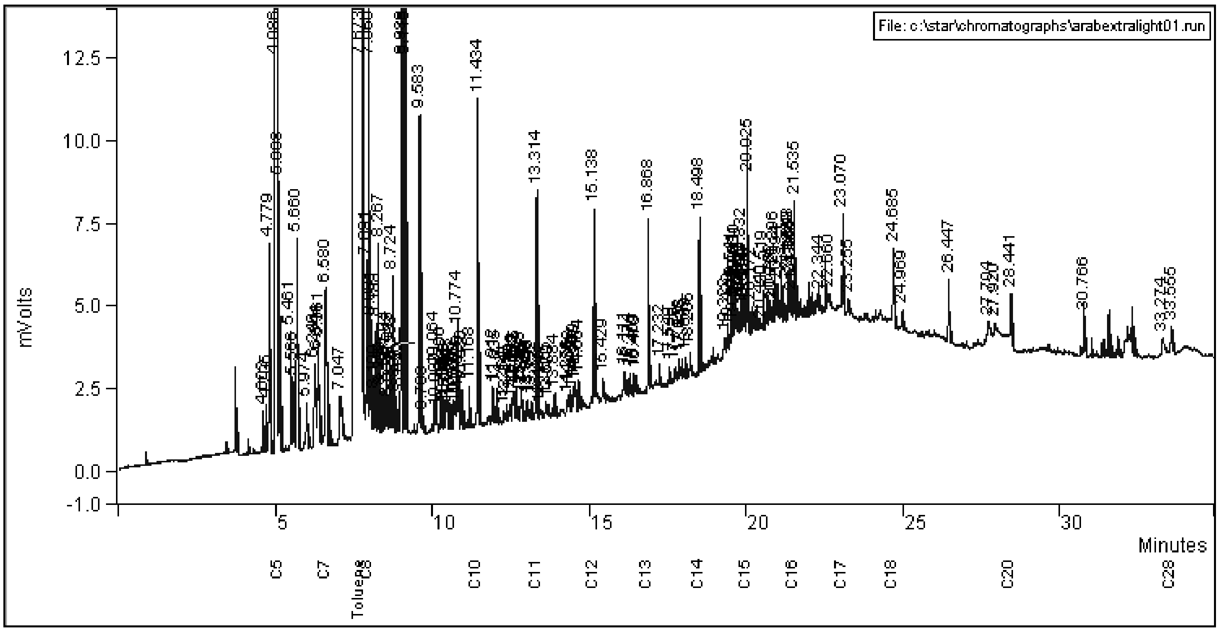
	Totals:	1.753		-0.536	121432399		



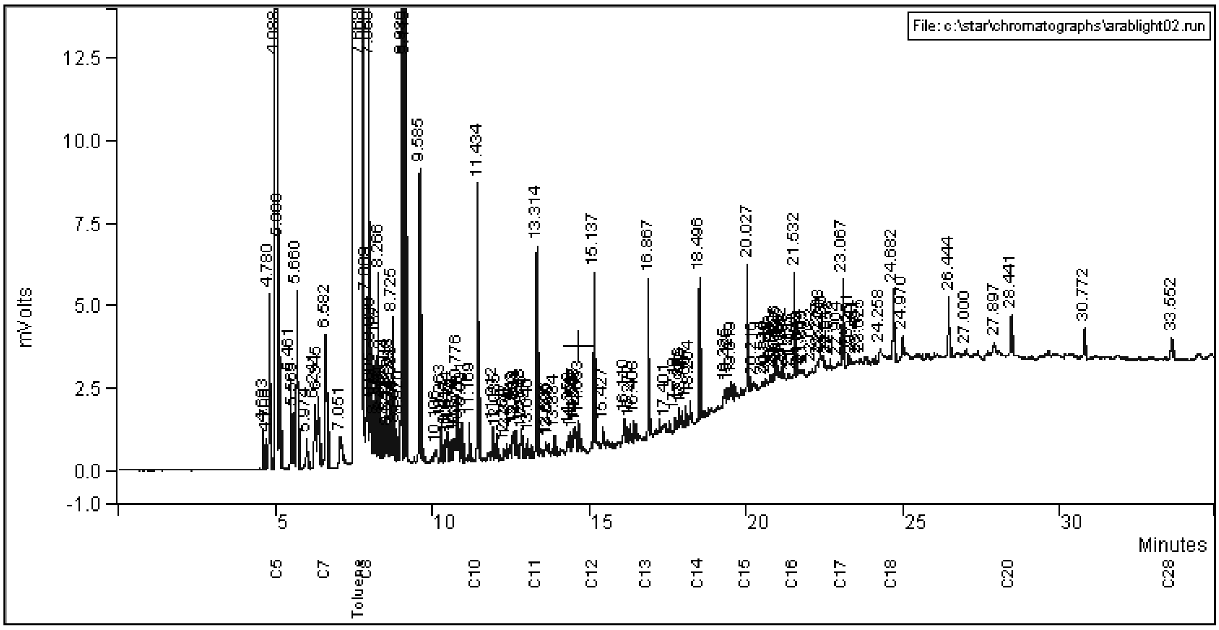


Figure C37: Duplicate chromatograms of sample of crude oil type Arab light from STF storage tank showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Arablight01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.607	0.000	1927	BP	1.3
2		0.000	4.710	0.000	1485	PV	1.3
3		0.000	4.784	0.000	9171	VV	1.4
4		0.000	4.995	0.000	122752	VV	2.5
5	C5	0.437	5.104	-0.088	15373	VV	1.9
6		0.000	5.469	0.000	8200	VV	3.3
7		0.000	5.573	0.000	4861	VV	2.8
8		0.000	5.668	0.000	15698	VB	3.1
9		0.000	5.977	0.000	2848	VB	3.2
10		0.000	6.242	0.000	7428	BV	3.9
11		0.000	6.346	0.000	9125	VV	3.9
12	C7	0.100	6.583	0.036	18636	VB	4.5
13		0.000	7.050	0.000	6259	BV	6.4
14		0.000	7.208	0.000	1115	VV	7.8
15	Toluene	1.108	7.670	0.009	124973728	VP	12.5
16		0.000	7.890	0.000	7137	TF	0.0
17	C8	0.086	7.960	0.021	17908	TF	0.0
18		0.000	8.030	0.000	5948	TF	0.0
19		0.000	8.109	0.000	1395	TF	0.0
20		0.000	8.188	0.000	5920	TF	0.0
21		0.000	8.267	0.000	8503	TS	0.0
22		0.000	8.360	0.000	2418	TF	0.0
23		0.000	8.420	0.000	1666	TF	0.0
24		0.000	8.504	0.000	3128	TF	0.0
25		0.000	8.548	0.000	1160	TF	0.0
26		0.000	8.619	0.000	3643	TF	0.0
27		0.000	8.689	0.000	2814	TF	0.0
28		0.000	8.726	0.000	6653	TF	0.0
29		0.000	8.808	0.000	1656	TS	0.0
30		0.000	8.921	0.000	2066	TF	0.0
31		0.000	8.989	0.000	43824	TF	0.0
32		0.000	9.119	0.000	45504	TF	0.0
33		0.000	9.585	0.000	18183	TF	0.0
34		0.000	10.107	0.000	1875	TF	0.0
35		0.000	10.263	0.000	2314	TF	0.0
36		0.000	10.418	0.000	2115	TF	0.0
37		0.000	10.464	0.000	1950	TF	0.0
38		0.000	10.568	0.000	1733	TF	0.0
39		0.000	10.670	0.000	1782	TF	0.0
40		0.000	10.776	0.000	6533	TF	0.0
41		0.000	10.828	0.000	1460	TF	0.0
42		0.000	10.931	0.000	2947	TF	0.0
43		0.000	11.170	0.000	2323	VV	0.0
44	C10	0.012	11.435	0.001	16577	VV	0.0
45		0.000	11.913	0.000	2403	VV	0.0
46		0.000	12.035	0.000	1835	VV	0.0
47		0.000	12.255	0.000	1079	VV	0.0
48		0.000	12.346	0.000	1350	VV	0.0
49		0.000	12.545	0.000	2644	VV	0.0

50		0.000	12.603	0.000	1728	VV	0.0
51		0.000	12.665	0.000	1608	VV	0.0
52		0.000	12.808	0.000	1677	VV	0.0
53		0.000	12.846	0.000	1271	VV	0.0
54		0.000	12.989	0.000	1065	VV	0.0
55		0.000	13.040	0.000	1187	VV	0.0
56	C11	0.008	13.314	-0.012	12561	PV	0.0
57		0.000	13.436	0.000	1035	VV	0.0
58		0.000	13.606	0.000	1499	VV	0.0
59		0.000	13.679	0.000	1627	VV	0.0
60		0.000	13.885	0.000	1398	VV	0.0
61		0.000	14.276	0.000	1132	VV	0.0
62		0.000	14.358	0.000	2717	VV	0.0
63		0.000	14.439	0.000	1412	VV	0.0
64		0.000	14.508	0.000	1897	VV	0.0
65		0.000	14.548	0.000	1933	VV	0.0
66		0.000	14.654	0.000	2247	VV	0.0
67	C12	0.006	15.138	-0.018	10411	VV	0.0
68		0.000	15.219	0.000	1109	VV	0.0
69		0.000	15.283	0.000	1043	VV	0.0
70		0.000	15.428	0.000	2975	VV	0.0
71		0.000	16.073	0.000	1085	VV	0.0
72		0.000	16.111	0.000	2201	VV	0.0
73		0.000	16.199	0.000	1279	VV	0.0
74		0.000	16.274	0.000	1536	VV	0.0
75		0.000	16.409	0.000	1539	VV	0.0
76		0.000	16.471	0.000	1267	VV	0.0
77		0.000	16.731	0.000	2557	VV	0.0
78	C13	0.006	16.868	-0.021	9822	VV	0.0
79		0.000	16.969	0.000	1278	VV	0.0
80		0.000	17.107	0.000	1048	VV	0.0
81		0.000	17.231	0.000	1671	VV	0.0
82		0.000	17.548	0.000	2320	VV	0.0
83		0.000	17.719	0.000	2134	VV	0.0
84		0.000	17.773	0.000	1024	VV	0.0
85		0.000	17.857	0.000	2339	VV	0.0
86		0.000	17.934	0.000	2074	VV	0.0
87		0.000	18.068	0.000	1986	VV	0.0
88		0.000	18.205	0.000	3691	VV	0.0
89		0.000	18.333	0.000	1670	VV	0.0
90		0.000	18.433	0.000	1567	VV	0.0
91	C14	0.006	18.497	-0.027	10581	VV	0.0
92		0.000	18.602	0.000	3109	VV	0.0
93		0.000	18.691	0.000	3696	VV	0.0
94		0.000	18.793	0.000	3302	VV	0.0
95		0.000	18.875	0.000	2659	VV	0.0
96		0.000	18.919	0.000	1498	VV	0.0
97		0.000	18.962	0.000	1119	VV	0.0
98		0.000	19.015	0.000	1237	VV	0.0
99		0.000	19.091	0.000	3637	VV	0.0
100		0.000	19.201	0.000	3519	VV	0.0
101		0.000	19.326	0.000	8280	VV	0.0
102		0.000	19.429	0.000	6292	VV	0.0
103		0.000	19.521	0.000	8245	VV	0.0
104		0.000	19.628	0.000	4854	VV	0.0
105		0.000	19.672	0.000	3190	VV	0.0
106		0.000	19.722	0.000	3071	VV	0.0
107		0.000	19.829	0.000	5906	VV	0.0
108		0.000	19.937	0.000	7147	VV	0.0
109		0.000	20.028	0.000	12891	VV	0.0
110	C15	0.001	20.088	0.029	2258	VV	0.0
111		0.000	20.221	0.000	10604	VV	0.0
112		0.000	20.302	0.000	4840	VV	0.0

113		0.000	20.361	0.000	2275	VV	0.0
114		0.000	20.413	0.000	3750	VV	0.0
115		0.000	20.500	0.000	9654	VV	0.0
116		0.000	20.614	0.000	4457	VV	0.0
117		0.000	20.653	0.000	3815	VV	0.0
118		0.000	20.747	0.000	5101	VV	0.0
119		0.000	20.770	0.000	4720	VV	0.0
120		0.000	20.833	0.000	5807	VV	0.0
121		0.000	20.926	0.000	8724	VV	0.0
122		0.000	20.998	0.000	4986	VV	0.0
123		0.000	21.062	0.000	4991	VV	0.0
124		0.000	21.133	0.000	5466	VV	0.0
125		0.000	21.201	0.000	5945	VV	0.0
126		0.000	21.334	0.000	9790	VV	0.0
127		0.000	21.445	0.000	6237	VV	0.0
128	C16	0.008	21.533	-0.036	13968	VV	0.0
129		0.000	21.611	0.000	2118	VV	0.0
130		0.000	21.650	0.000	3384	VV	0.0
131		0.000	21.719	0.000	8965	VV	0.0
132		0.000	21.807	0.000	6298	VV	0.0
133		0.000	21.889	0.000	4072	VV	0.0
134		0.000	21.946	0.000	4239	VV	0.0
135		0.000	22.017	0.000	5101	VV	0.0
136		0.000	22.085	0.000	5759	VV	0.0
137		0.000	22.184	0.000	9974	VV	0.0
138		0.000	22.222	0.000	4630	VV	0.0
139		0.000	22.272	0.000	3711	VV	0.0
140		0.000	22.344	0.000	8114	VV	0.0
141		0.000	22.446	0.000	6341	VV	0.0
142		0.000	22.519	0.000	6118	VV	0.0
143		0.000	22.599	0.000	3108	VV	0.0
144		0.000	22.658	0.000	8052	VV	0.0
145		0.000	22.752	0.000	4052	VV	0.0
146		0.000	22.795	0.000	2808	VV	0.0
147		0.000	22.849	0.000	3069	VV	0.0
148		0.000	22.901	0.000	6390	VV	0.0
149		0.000	22.998	0.000	3957	VV	0.0
150	C17	0.009	23.069	-0.045	17269	VV	0.0
151		0.000	23.252	0.000	9308	VV	0.0
152		0.000	23.344	0.000	5647	VV	0.0
153		0.000	23.423	0.000	2939	VV	0.0
154		0.000	23.500	0.000	6814	VV	0.0
155		0.000	23.528	0.000	3476	VV	0.0
156		0.000	23.633	0.000	6708	VV	0.0
157		0.000	23.705	0.000	3573	VV	0.0
158		0.000	23.780	0.000	6853	VV	0.0
159		0.000	23.838	0.000	5120	VV	0.0
160		0.000	23.913	0.000	4255	VV	0.0
161		0.000	24.019	0.000	7879	VV	0.0
162		0.000	24.104	0.000	6436	VV	0.0
163		0.000	24.258	0.000	13501	VV	0.0
164		0.000	24.382	0.000	4037	VV	0.0
165		0.000	24.465	0.000	10557	VV	0.0
166		0.000	24.555	0.000	5079	VV	0.0
167		0.000	24.612	0.000	2767	VV	0.0
168	C18	0.007	24.684	-0.053	13153	VV	0.0
169		0.000	24.825	0.000	6123	VV	0.0
170		0.000	24.904	0.000	5039	VV	0.0
171		0.000	24.971	0.000	8828	VV	0.0
172		0.000	25.080	0.000	10014	VV	0.0
173		0.000	25.188	0.000	3791	VV	0.0
174		0.000	25.255	0.000	2461	VV	0.0
175		0.000	25.422	0.000	12509	VV	0.0

176		0.000	25.512	0.000	3593	VV	0.0
177		0.000	25.598	0.000	6052	VV	0.0
178		0.000	25.718	0.000	6166	VV	0.0
179		0.000	25.798	0.000	4670	VV	0.0
180		0.000	25.913	0.000	4551	VV	0.0
181		0.000	25.982	0.000	6098	VV	0.0
182		0.000	26.073	0.000	2377	VV	0.0
183		0.000	26.135	0.000	3784	VV	0.0
184		0.000	26.250	0.000	9837	VV	0.0
185		0.000	26.447	0.000	10493	VV	0.0
186		0.000	26.538	0.000	1886	VV	0.0
187		0.000	26.597	0.000	4354	VV	0.0
188		0.000	26.692	0.000	3210	VV	0.0
189		0.000	26.725	0.000	1678	VV	0.0
190		0.000	26.772	0.000	1998	VV	0.0
191		0.000	26.870	0.000	5631	VV	0.0
192		0.000	27.005	0.000	5663	VV	0.0
193		0.000	27.102	0.000	3415	VV	0.0
194		0.000	27.251	0.000	3193	VV	0.0
195		0.000	27.278	0.000	1988	VV	0.0
196		0.000	27.371	0.000	4879	VV	0.0
197		0.000	27.468	0.000	2678	VV	0.0
198		0.000	27.620	0.000	4355	VV	0.0
199		0.000	27.714	0.000	8740	VV	0.0
200		0.000	27.911	0.000	4614	VV	0.0
201		0.000	28.008	0.000	1539	VV	0.0
202		0.000	28.065	0.000	3122	VV	0.0
203		0.000	28.222	0.000	2652	VV	0.0
204		0.000	28.445	0.000	9359	VV	0.0
205	C20	0.000	28.542	0.014	2224	VV	0.0
206		0.000	28.614	0.000	1628	VV	0.0
207		0.000	28.855	0.000	2515	VV	0.0
208		0.000	28.928	0.000	1101	VV	0.0
209		0.000	28.994	0.000	1756	VV	0.0
210		0.000	29.116	0.000	1267	VV	0.0
211		0.000	29.258	0.000	1423	VV	0.0
212		0.000	29.527	0.000	1154	VV	0.0
213		0.000	29.629	0.000	1143	VV	0.0
214		0.000	29.802	0.000	1159	VV	0.0
215		0.000	29.911	0.000	1272	VV	0.0
216		0.000	30.775	0.000	3376	VP	3.3
217		0.000	31.822	0.000	1878	VV	7.4
218		0.000	32.052	0.000	1300	VV	5.5
219		0.000	33.378	0.000	1760	VV	15.2
220		0.000	33.556	0.000	5318	VV	4.9
221	C28	0.001	33.786	0.085	1368	VV	0.0
222		0.000	33.890	0.000	2776	VV	26.5
223		0.000	34.333	0.000	3445	VP	11.6
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	Totals:	1.795		-0.105	126203127		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Arablight02
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.603	0.000	1831	BV	1.2
2		0.000	4.706	0.000	1442	VV	1.2
3		0.000	4.780	0.000	8872	VP	1.3
4		0.000	4.988	0.000	118414	PV	2.2
5	C5	0.415	5.099	-0.093	14584	VB	1.8
6		0.000	5.461	0.000	7928	BV	3.1
7		0.000	5.565	0.000	4662	VV	2.7
8		0.000	5.660	0.000	15421	VB	2.9
9		0.000	5.974	0.000	2678	VB	3.1
10		0.000	6.241	0.000	7283	BV	3.9
11		0.000	6.345	0.000	9040	VV	3.9
12	C7	0.099	6.582	0.035	18463	VB	4.5
13		0.000	7.051	0.000	6202	BV	6.3
14	Toluene	1.103	7.668	0.007	124500648	VB	12.5
15		0.000	7.889	0.000	7134	TF	0.0
16	C8	0.086	7.959	0.020	17849	TF	0.0
17		0.000	8.005	0.000	1120	TF	0.0
18		0.000	8.029	0.000	4807	TF	0.0
19		0.000	8.108	0.000	1358	TF	0.0
20		0.000	8.187	0.000	5889	TF	0.0
21		0.000	8.266	0.000	8443	TS	0.0
22		0.000	8.359	0.000	2382	TS	0.0
23		0.000	8.420	0.000	1674	TF	0.0
24		0.000	8.504	0.000	3126	TF	0.0
25		0.000	8.547	0.000	1154	TF	0.0
26		0.000	8.618	0.000	3603	TF	0.0
27		0.000	8.688	0.000	2796	TF	0.0
28		0.000	8.725	0.000	6591	TF	0.0
29		0.000	8.807	0.000	1657	TS	0.0
30		0.000	8.920	0.000	2009	TF	0.0
31		0.000	8.989	0.000	43664	TF	0.0
32		0.000	9.119	0.000	45157	TF	0.0
33		0.000	9.585	0.000	18095	TF	0.0
34		0.000	10.106	0.000	1647	VP	4.6
35		0.000	10.263	0.000	2244	VV	1.7
36		0.000	10.417	0.000	2004	VV	3.2
37		0.000	10.464	0.000	1844	VV	2.4
38		0.000	10.572	0.000	1474	VV	1.9
39		0.000	10.670	0.000	1693	VV	2.2
40		0.000	10.776	0.000	6420	VV	3.3
41		0.000	10.828	0.000	1401	VV	1.8
42		0.000	10.931	0.000	2845	VB	1.9
43		0.000	11.169	0.000	2254	VP	1.7
44	C10	0.012	11.434	0.000	16546	PB	1.7
45		0.000	11.912	0.000	2299	VV	2.0
46		0.000	12.035	0.000	1764	VP	1.9
47		0.000	12.254	0.000	1063	VV	2.5
48		0.000	12.347	0.000	1300	VV	2.5
49		0.000	12.543	0.000	2584	VV	2.0

50		0.000	12.603	0.000	1671	VV	2.3
51		0.000	12.664	0.000	1588	VV	1.7
52		0.000	12.808	0.000	1614	VV	1.9
53		0.000	12.846	0.000	1234	VB	2.2
54		0.000	13.040	0.000	1109	VV	1.7
55	C11	0.007	13.314	-0.012	11887	BP	1.7
56		0.000	13.606	0.000	1329	VV	0.0
57		0.000	13.680	0.000	1151	VV	0.0
58		0.000	13.884	0.000	1242	VV	2.0
59		0.000	14.358	0.000	2454	VV	3.9
60		0.000	14.438	0.000	1248	VV	2.1
61		0.000	14.507	0.000	1787	VV	2.3
62		0.000	14.548	0.000	1843	VV	2.8
63		0.000	14.653	0.000	2139	VV	2.0
64	C12	0.006	15.137	-0.019	9839	VB	1.7
65		0.000	15.427	0.000	1805	BP	2.1
66		0.000	16.110	0.000	1893	VV	2.2
67		0.000	16.272	0.000	1190	VV	2.1
68		0.000	16.408	0.000	1245	PV	2.2
69	C13	0.005	16.867	-0.022	8789	BB	1.7
70		0.000	17.401	0.000	1790	VP	6.5
71		0.000	17.719	0.000	1001	BV	2.3
72		0.000	17.856	0.000	1451	VV	2.2
73		0.000	17.932	0.000	1239	VV	2.3
74		0.000	18.067	0.000	1172	VP	2.1
75		0.000	18.204	0.000	1692	PB	2.7
76	C14	0.005	18.496	-0.028	8102	BP	1.7
77		0.000	19.325	0.000	2298	BV	5.7
78		0.000	19.426	0.000	1111	VV	3.3
79		0.000	19.519	0.000	2168	VP	3.8
80	C15	0.004	20.027	-0.032	8140	VV	1.8
81		0.000	20.216	0.000	1954	VV	7.9
82		0.000	20.514	0.000	1846	VV	0.0
83		0.000	20.612	0.000	1016	VV	0.0
84		0.000	20.770	0.000	2208	VV	0.0
85		0.000	20.831	0.000	1300	VV	0.0
86		0.000	20.926	0.000	3099	VV	6.5
87		0.000	20.997	0.000	1655	VV	0.0
88		0.000	21.062	0.000	1468	VV	0.0
89		0.000	21.132	0.000	1678	VV	0.0
90		0.000	21.197	0.000	1412	VV	0.0
91		0.000	21.333	0.000	1937	VV	0.0
92		0.000	21.429	0.000	1096	VV	0.0
93	C16	0.004	21.532	-0.037	7698	VV	2.2
94		0.000	21.645	0.000	1308	VV	0.0
95		0.000	21.704	0.000	2040	VV	0.0
96		0.000	21.805	0.000	2007	VV	0.0
97		0.000	22.082	0.000	1454	VV	0.0
98		0.000	22.277	0.000	3528	VV	0.0
99		0.000	22.343	0.000	2663	VV	0.0
100		0.000	22.407	0.000	2136	VV	0.0
101		0.000	22.430	0.000	1541	VV	0.0
102		0.000	22.517	0.000	1410	VV	0.0
103		0.000	22.658	0.000	1705	VV	0.0
104		0.000	22.904	0.000	2204	VV	0.0
105	C17	0.005	23.067	-0.047	8579	VV	2.7
106		0.000	23.251	0.000	1904	VV	0.0
107		0.000	23.341	0.000	1375	VV	0.0
108		0.000	23.491	0.000	1724	VV	0.0
109		0.000	23.625	0.000	2122	VV	0.0
110		0.000	24.258	0.000	1108	PB	0.0
111	C18	0.003	24.682	-0.055	5061	BB	2.2
112		0.000	24.970	0.000	1592	BB	2.7

113		0.000	26.444	0.000	5137	BB	2.6
114		0.000	27.000	0.000	1285	VV	4.3
115		0.000	27.897	0.000	3516	VV	7.0
116	C20	0.001	28.441	-0.087	4054	BB	3.0
117		0.000	30.772	0.000	3533	VB	3.4
118	C28	0.002	33.552	-0.149	2811	BB	4.0
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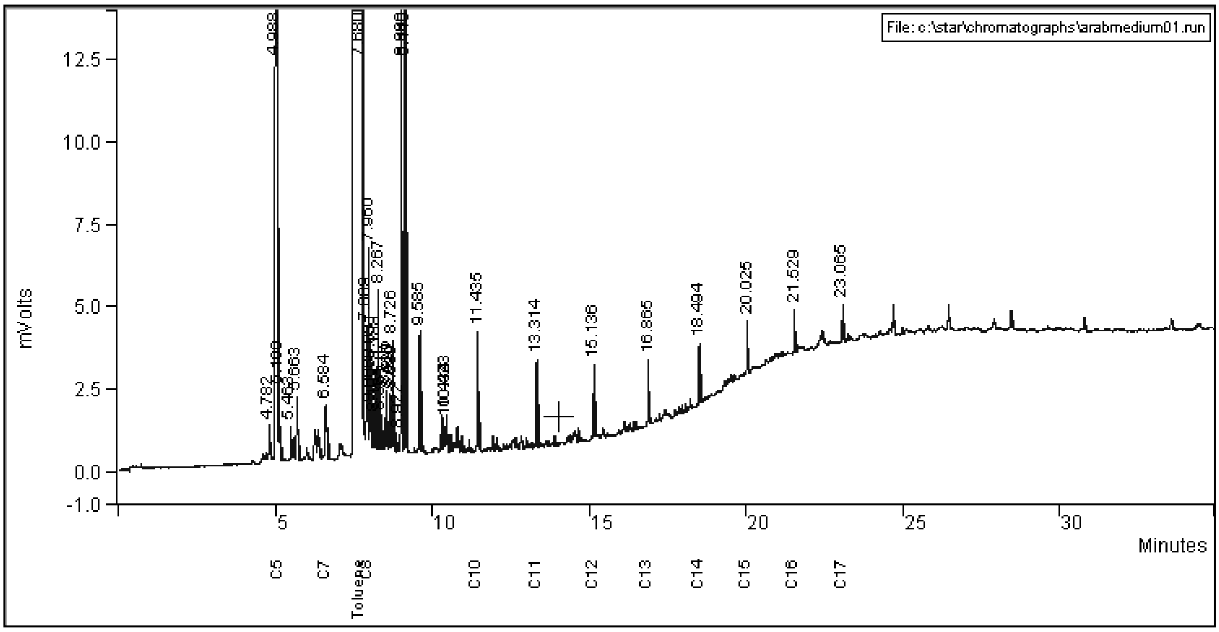
	Totals:	1.757		-0.519	125126743		



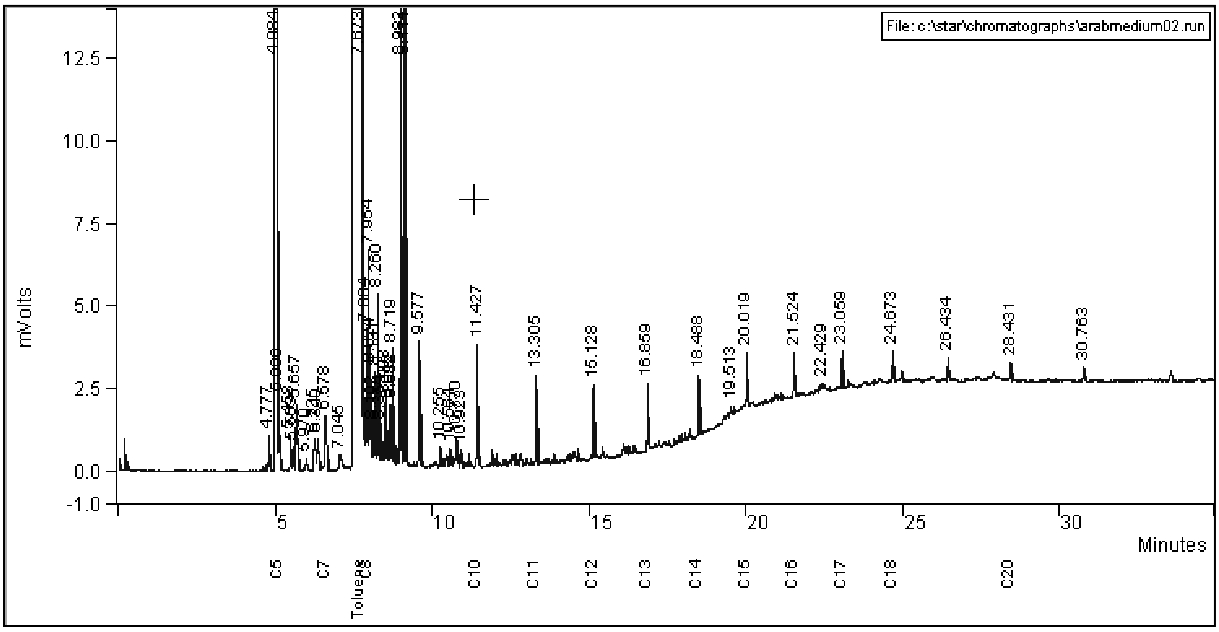


Figure C38: Duplicate chromatograms of sample of crude oil type Arab medium from STF storage tank showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Arabmedium01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.782	0.000	1758	BB	1.4
2		0.000	4.988	0.000	137685	BB	2.1
3	C5	0.094	5.100	-0.092	3304	TS	0.0
4		0.000	5.463	0.000	2736	BB	0.0
5		0.000	5.663	0.000	7130	BB	2.9
6	C7	0.036	6.584	0.037	6698	BB	4.3
7	Toluene	1.043	7.680	0.019	117674848	BB	11.8
8		0.000	7.889	0.000	5624	TF	0.0
9	C8	0.040	7.960	0.021	8271	TF	0.0
10		0.000	8.006	0.000	1097	TF	0.0
11		0.000	8.031	0.000	3686	TF	0.0
12		0.000	8.109	0.000	1197	TF	0.0
13		0.000	8.188	0.000	4925	TF	0.0
14		0.000	8.267	0.000	7303	TS	0.0
15		0.000	8.361	0.000	1799	TF	0.0
16		0.000	8.505	0.000	2715	TF	0.0
17		0.000	8.620	0.000	2670	TF	0.0
18		0.000	8.689	0.000	2445	TF	0.0
19		0.000	8.726	0.000	5171	TF	0.0
20		0.000	8.922	0.000	1069	TF	0.0
21		0.000	8.990	0.000	34266	TF	0.0
22		0.000	9.119	0.000	36534	TF	0.0
23		0.000	9.585	0.000	8375	BB	1.9
24		0.000	10.423	0.000	1321	VV	0.2
25		0.000	10.434	0.000	1119	VB	0.0
26	C10	0.004	11.435	0.001	6182	BB	1.6
27	C11	0.003	13.314	-0.012	4620	BB	1.6
28	C12	0.002	15.136	-0.020	3882	BB	1.7
29	C13	0.002	16.865	-0.024	3661	BB	1.8
30	C14	0.002	18.494	-0.030	3361	BB	1.8
31	C15	0.002	20.025	-0.034	2893	BB	1.7
32	C16	0.001	21.529	-0.040	2653	BB	1.9
33	C17	0.001	23.065	-0.049	2393	BB	2.0
	Totals:	1.230		-0.223	117993391		

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Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : Arabmedium02
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
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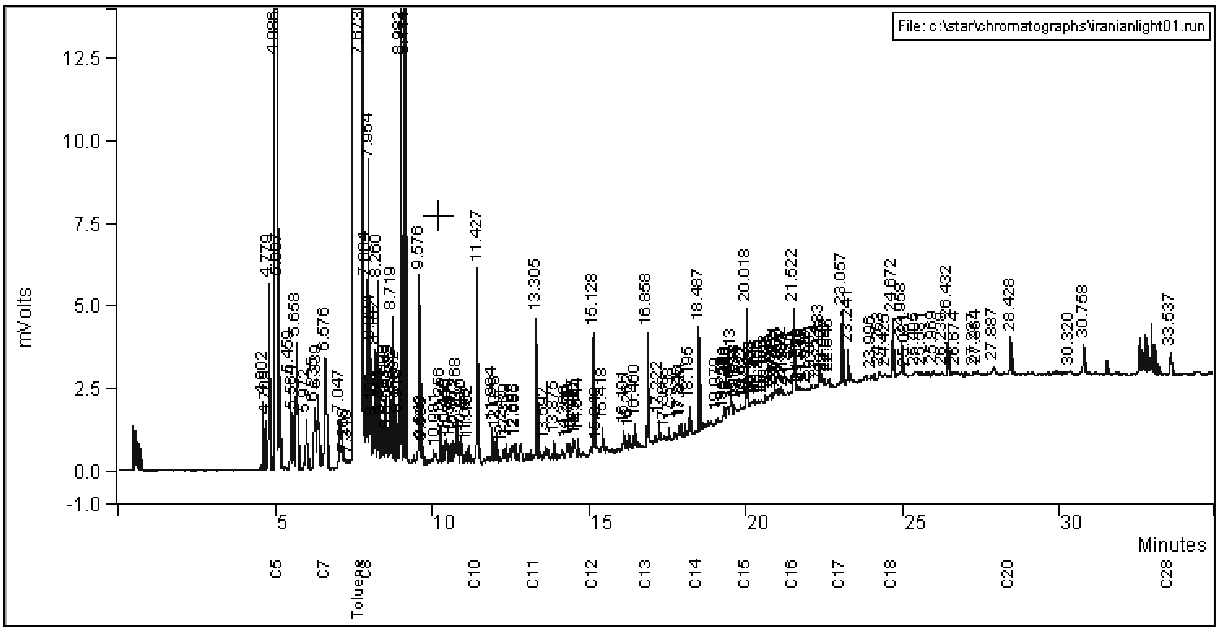
Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.777	0.000	1771	VB	1.3
2		0.000	4.984	0.000	139399	BB	2.0
3	C5	0.094	5.096	-0.096	3300	TS	0.0
4		0.000	5.458	0.000	3100	BV	3.1
5		0.000	5.563	0.000	2016	VV	2.7
6		0.000	5.657	0.000	5756	VB	2.9
7		0.000	5.970	0.000	1038	BB	3.0
8		0.000	6.235	0.000	3663	BV	3.9
9		0.000	6.340	0.000	3580	VB	3.8
10	C7	0.039	6.578	0.031	7278	BB	4.4
11		0.000	7.045	0.000	2519	BB	5.8
12	Toluene	1.057	7.673	0.012	119311296	BB	12.0
13		0.000	7.884	0.000	5539	TS	0.0
14	C8	0.039	7.954	0.015	8115	TF	0.0
15		0.000	8.024	0.000	3857	TF	0.0
16		0.000	8.102	0.000	1199	TF	0.0
17		0.000	8.181	0.000	5123	TF	0.0
18		0.000	8.260	0.000	7550	TS	0.0
19		0.000	8.354	0.000	1873	TF	0.0
20		0.000	8.498	0.000	2755	TF	0.0
21		0.000	8.612	0.000	2638	TF	0.0
22		0.000	8.682	0.000	2504	TF	0.0
23		0.000	8.719	0.000	5345	TF	0.0
24		0.000	8.982	0.000	35189	TF	0.0
25		0.000	9.111	0.000	37417	TF	0.0
26		0.000	9.577	0.000	7926	BB	1.8
27		0.000	10.255	0.000	1066	BB	1.7
28		0.000	10.564	0.000	1183	BV	1.9
29		0.000	10.770	0.000	2597	VV	3.4
30		0.000	10.923	0.000	1489	VB	2.8
31	C10	0.005	11.427	-0.007	7317	BB	1.7
32	C11	0.003	13.305	-0.021	4685	BB	1.6
33	C12	0.002	15.128	-0.028	3972	VB	1.7
34	C13	0.002	16.859	-0.030	3738	BB	1.8
35	C14	0.002	18.488	-0.036	3447	BV	1.8
36		0.000	19.513	0.000	1047	VP	5.7
37	C15	0.002	20.019	-0.040	3003	BB	1.7
38	C16	0.002	21.524	-0.045	2807	BB	2.0
39		0.000	22.429	0.000	1057	VV	5.0
40	C17	0.001	23.059	-0.055	2463	BB	2.0
41	C18	0.001	24.673	-0.064	2283	BB	2.2
42		0.000	26.434	0.000	1933	BB	2.5
43	C20	0.000	28.431	-0.097	1656	BB	2.8
44		0.000	30.763	0.000	1311	BB	3.0
	Totals:	1.249		-0.461	119658800		



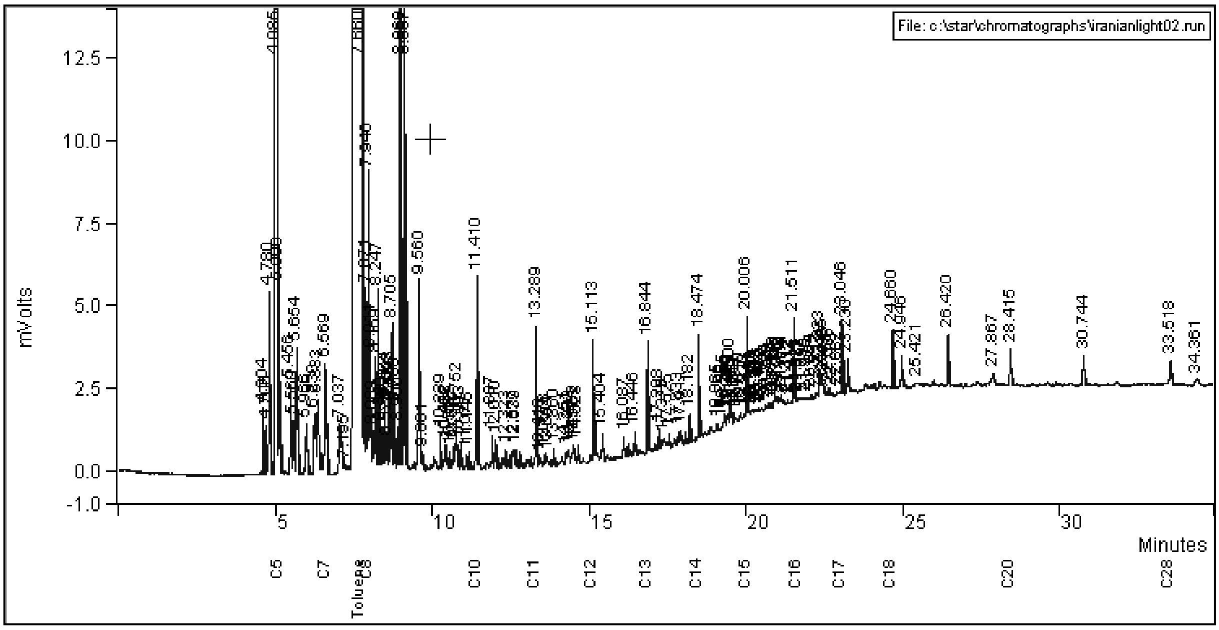


Figure C39: Duplicate chromatograms of sample of crude oil type Iranian light from STF storage tank showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Iranianlight01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.602	0.000	3105	PB	1.1
2		0.000	4.705	0.000	2325	BV	1.2
3		0.000	4.779	0.000	9415	VB	1.3
4		0.000	4.986	0.000	111450	BV	2.2
5	C5	0.344	5.097	-0.095	12091	VB	1.8
6		0.000	5.459	0.000	8185	BV	3.2
7		0.000	5.564	0.000	4525	VV	2.8
8		0.000	5.658	0.000	10939	VB	2.9
9		0.000	5.972	0.000	4584	VB	3.1
10		0.000	6.235	0.000	6942	BV	3.9
11		0.000	6.339	0.000	9474	VV	3.9
12	C7	0.086	6.576	0.029	16076	VB	4.5
13		0.000	7.047	0.000	9531	BV	6.2
14		0.000	7.208	0.000	1297	VV	0.0
15		0.000	7.310	0.000	1257	VV	0.0
16	Toluene	1.058	7.673	0.012	119330616	VP	12.0
17		0.000	7.884	0.000	8079	TF	0.0
18	C8	0.058	7.954	0.015	12049	TF	0.0
19		0.000	8.024	0.000	6126	TF	0.0
20		0.000	8.102	0.000	1308	TF	0.0
21		0.000	8.182	0.000	6247	TF	0.0
22		0.000	8.260	0.000	8092	TS	0.0
23		0.000	8.353	0.000	2302	TF	0.0
24		0.000	8.414	0.000	1781	TF	0.0
25		0.000	8.498	0.000	2892	TF	0.0
26		0.000	8.542	0.000	1084	TF	0.0
27		0.000	8.613	0.000	3142	TF	0.0
28		0.000	8.682	0.000	2762	TF	0.0
29		0.000	8.719	0.000	6707	TF	0.0
30		0.000	8.802	0.000	3022	TS	0.0
31		0.000	8.915	0.000	2082	TF	0.0
32		0.000	8.982	0.000	37695	TF	0.0
33		0.000	9.111	0.000	41773	TF	0.0
34		0.000	9.576	0.000	12673	TF	0.0
35		0.000	9.640	0.000	1009	TF	0.0
36		0.000	9.696	0.000	1088	TF	0.0
37		0.000	10.081	0.000	1474	TF	0.0
38		0.000	10.256	0.000	2292	TF	0.0
39		0.000	10.418	0.000	2270	TF	0.0
40		0.000	10.455	0.000	1430	TF	0.0
41		0.000	10.567	0.000	1527	TF	0.0
42		0.000	10.663	0.000	2148	TF	0.0
43		0.000	10.768	0.000	4392	TF	0.0
44		0.000	10.920	0.000	2292	TF	0.0
45		0.000	11.093	0.000	1126	TF	0.0
46		0.000	11.162	0.000	1041	TF	0.0
47	C10	0.009	11.427	-0.007	12149	TF	0.0
48		0.000	11.904	0.000	2382	TF	0.0
49		0.000	12.026	0.000	2457	TF	0.0

50		0.000	12.245	0.000	1107	VV	0.0
51		0.000	12.339	0.000	1438	VV	0.0
52		0.000	12.593	0.000	1086	VV	0.0
53		0.000	12.655	0.000	1134	VV	0.0
54	C11	0.005	13.305	-0.021	8253	VV	0.0
55		0.000	13.592	0.000	1242	VV	0.0
56		0.000	13.875	0.000	1157	VV	0.0
57		0.000	14.266	0.000	1010	VV	0.0
58		0.000	14.348	0.000	1543	VV	0.0
59		0.000	14.497	0.000	1658	VV	0.0
60		0.000	14.536	0.000	1106	VV	0.0
61		0.000	14.644	0.000	1172	VV	0.0
62	C12	0.004	15.128	-0.028	7359	VV	0.0
63		0.000	15.249	0.000	1091	VV	0.0
64		0.000	15.418	0.000	3215	VV	0.0
65		0.000	16.101	0.000	1760	VV	0.0
66		0.000	16.262	0.000	1116	VV	0.0
67		0.000	16.460	0.000	1637	VV	0.0
68	C13	0.004	16.858	-0.031	6515	PV	0.0
69		0.000	17.222	0.000	1681	VV	0.0
70		0.000	17.388	0.000	1504	VV	0.0
71		0.000	17.538	0.000	1171	VP	0.0
72		0.000	17.846	0.000	1030	VV	0.0
73		0.000	17.924	0.000	1065	VV	0.0
74		0.000	18.195	0.000	2078	VV	0.0
75	C14	0.003	18.487	-0.037	6033	VV	0.0
76		0.000	19.079	0.000	1342	VV	0.0
77		0.000	19.258	0.000	1069	VV	0.0
78		0.000	19.309	0.000	2075	VV	0.0
79		0.000	19.381	0.000	1102	VV	0.0
80		0.000	19.419	0.000	1310	VV	0.0
81		0.000	19.513	0.000	3783	VV	0.0
82		0.000	19.618	0.000	1450	VV	0.0
83		0.000	19.664	0.000	1208	VV	0.0
84		0.000	19.822	0.000	2791	VV	0.0
85		0.000	19.932	0.000	1848	VV	0.0
86	C15	0.004	20.018	-0.041	7240	VV	0.0
87		0.000	20.165	0.000	1814	VV	0.0
88		0.000	20.221	0.000	1714	VV	0.0
89		0.000	20.296	0.000	1395	VV	0.0
90		0.000	20.396	0.000	2219	VV	0.0
91		0.000	20.492	0.000	2179	VV	0.0
92		0.000	20.608	0.000	2563	VV	0.0
93		0.000	20.735	0.000	2608	VV	0.0
94		0.000	20.822	0.000	1353	VV	0.0
95		0.000	20.911	0.000	2973	VV	0.0
96		0.000	20.987	0.000	1559	VV	0.0
97		0.000	21.052	0.000	1617	VV	0.0
98		0.000	21.122	0.000	1936	VV	0.0
99		0.000	21.187	0.000	1754	VV	0.0
100		0.000	21.321	0.000	2102	VV	0.0
101		0.000	21.416	0.000	1556	VV	0.0
102	C16	0.004	21.522	-0.047	6882	VV	0.0
103		0.000	21.633	0.000	1546	VV	0.0
104		0.000	21.685	0.000	1743	VV	0.0
105		0.000	21.815	0.000	1829	VV	0.0
106		0.000	21.928	0.000	1070	VV	0.0
107		0.000	22.081	0.000	1585	VV	0.0
108		0.000	22.224	0.000	1854	VV	0.0
109		0.000	22.333	0.000	2590	VV	0.0
110		0.000	22.426	0.000	1879	VV	0.0
111		0.000	22.507	0.000	1112	VV	0.0
112		0.000	22.646	0.000	1211	VV	0.0

113	C17	0.003	23.057	-0.057	5313	VP	0.0
114		0.000	23.241	0.000	2355	PV	0.0
115		0.000	23.996	0.000	1078	VV	5.3
116		0.000	24.253	0.000	1802	VV	4.1
117		0.000	24.425	0.000	1716	VV	0.0
118	C18	0.003	24.672	-0.065	5812	VV	2.5
119		0.000	24.958	0.000	5823	VV	3.0
120		0.000	25.081	0.000	1092	VV	0.0
121		0.000	25.405	0.000	3634	VV	0.0
122		0.000	25.581	0.000	1203	VV	0.0
123		0.000	25.969	0.000	1709	VV	0.0
124		0.000	26.238	0.000	1887	VV	0.0
125		0.000	26.432	0.000	5009	VV	2.8
126		0.000	26.674	0.000	1661	VV	0.0
127		0.000	27.237	0.000	1149	VV	0.0
128		0.000	27.364	0.000	1042	VV	0.0
129		0.000	27.887	0.000	2083	VV	0.0
130	C20	0.001	28.428	-0.100	4048	PB	3.4
131		0.000	30.320	0.000	1606	VB	18.3
132		0.000	30.758	0.000	3091	BB	3.4
133	C28	0.001	33.537	-0.164	2697	BB	3.8
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	Totals:	1.587		-0.637	119933537		

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Iranianlight02
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.604	0.000	3040	PV	1.2
2		0.000	4.706	0.000	2383	VV	1.2
3		0.000	4.780	0.000	9417	VB	1.3
4		0.000	4.985	0.000	107629	BV	2.3
5	C5	0.353	5.096	-0.096	12421	VB	1.8
6		0.000	5.456	0.000	8087	BV	3.2
7		0.000	5.560	0.000	4419	VV	2.7
8		0.000	5.654	0.000	10946	VB	2.9
9		0.000	5.966	0.000	4832	VB	3.2
10		0.000	6.230	0.000	6908	BV	3.9
11		0.000	6.333	0.000	9536	VV	3.9
12	C7	0.085	6.569	0.022	15864	VB	4.5
13		0.000	7.037	0.000	9566	BV	6.2
14		0.000	7.195	0.000	1360	VV	0.0
15	Toluene	1.051	7.660	-0.001	118633408	VP	11.9
16		0.000	7.871	0.000	8075	TF	0.0
17	C8	0.057	7.940	0.001	11926	TF	0.0
18		0.000	8.011	0.000	6045	TF	0.0
19		0.000	8.089	0.000	1300	TF	0.0
20		0.000	8.169	0.000	6211	TF	0.0
21		0.000	8.247	0.000	7994	TS	0.0
22		0.000	8.340	0.000	2204	TS	0.0
23		0.000	8.400	0.000	1720	TF	0.0
24		0.000	8.484	0.000	2845	TF	0.0
25		0.000	8.528	0.000	1053	TF	0.0
26		0.000	8.598	0.000	3120	TF	0.0
27		0.000	8.668	0.000	2736	TF	0.0
28		0.000	8.705	0.000	6682	TF	0.0
29		0.000	8.788	0.000	2973	TS	0.0
30		0.000	8.900	0.000	2017	TF	0.0
31		0.000	8.968	0.000	37473	TF	0.0
32		0.000	9.097	0.000	41594	TF	0.0
33		0.000	9.560	0.000	12628	TF	0.0
34		0.000	9.681	0.000	1119	TF	0.0
35		0.000	10.239	0.000	2277	TF	0.0
36		0.000	10.402	0.000	2310	TF	0.0
37		0.000	10.438	0.000	1477	TF	0.0
38		0.000	10.552	0.000	1588	TF	0.0
39		0.000	10.647	0.000	2154	TF	0.0
40		0.000	10.752	0.000	4429	TF	0.0
41		0.000	10.903	0.000	2370	TF	0.0
42		0.000	11.077	0.000	1297	TF	0.0
43		0.000	11.146	0.000	1065	TF	0.0
44	C10	0.009	11.410	-0.024	12180	TF	0.0
45		0.000	11.887	0.000	2392	VV	0.0
46		0.000	12.010	0.000	2373	VP	0.0
47		0.000	12.323	0.000	1367	VV	0.0
48		0.000	12.577	0.000	1073	VV	0.0
49		0.000	12.639	0.000	1136	VV	0.0

50	C11	0.005	13.289	-0.037	8258	VV	0.0
51		0.000	13.413	0.000	1036	VV	0.0
52		0.000	13.578	0.000	1355	VV	0.0
53		0.000	13.654	0.000	1097	VV	0.0
54		0.000	13.860	0.000	1397	VP	0.0
55		0.000	14.251	0.000	1130	VV	0.0
56		0.000	14.333	0.000	1618	VV	0.0
57		0.000	14.482	0.000	1680	VV	0.0
58		0.000	14.521	0.000	1189	VV	0.0
59		0.000	14.628	0.000	1291	VV	0.0
60	C12	0.004	15.113	-0.043	7716	VV	0.0
61		0.000	15.404	0.000	3014	VV	0.0
62		0.000	16.087	0.000	2118	VV	0.0
63		0.000	16.446	0.000	1408	VV	0.0
64	C13	0.004	16.844	-0.045	6408	PV	0.0
65		0.000	17.208	0.000	1556	VV	0.0
66		0.000	17.375	0.000	2451	VV	0.0
67		0.000	17.525	0.000	1144	VP	0.0
68		0.000	17.833	0.000	1052	VV	0.0
69		0.000	17.911	0.000	1126	VV	0.0
70		0.000	18.182	0.000	1909	VV	0.0
71	C14	0.003	18.474	-0.050	6141	VV	0.0
72		0.000	19.065	0.000	2018	VV	0.0
73		0.000	19.242	0.000	1171	VV	0.0
74		0.000	19.295	0.000	2011	VV	0.0
75		0.000	19.369	0.000	1081	VV	0.0
76		0.000	19.408	0.000	1412	VV	0.0
77		0.000	19.500	0.000	3918	VV	0.0
78		0.000	19.607	0.000	1328	VV	0.0
79		0.000	19.649	0.000	1079	VV	0.0
80		0.000	19.810	0.000	2063	VV	0.0
81		0.000	19.920	0.000	1675	VV	0.0
82	C15	0.004	20.006	-0.053	7763	VV	0.0
83		0.000	20.152	0.000	2544	VV	0.0
84		0.000	20.208	0.000	2206	VV	0.0
85		0.000	20.282	0.000	1465	VV	0.0
86		0.000	20.338	0.000	1033	VV	0.0
87		0.000	20.385	0.000	1394	VV	0.0
88		0.000	20.478	0.000	2734	VV	0.0
89		0.000	20.594	0.000	2492	VV	0.0
90		0.000	20.723	0.000	2191	VV	0.0
91		0.000	20.810	0.000	1587	VV	0.0
92		0.000	20.899	0.000	3183	VV	0.0
93		0.000	20.976	0.000	1816	VV	0.0
94		0.000	21.042	0.000	1883	VV	0.0
95		0.000	21.111	0.000	2249	VV	0.0
96		0.000	21.174	0.000	2254	VV	0.0
97		0.000	21.312	0.000	2420	VV	0.0
98		0.000	21.412	0.000	1770	VV	0.0
99		0.000	21.511	0.000	7410	VV	0.0
100	C16	0.001	21.621	0.052	1357	VV	0.0
101		0.000	21.677	0.000	1858	VV	0.0
102		0.000	21.795	0.000	2046	VV	0.0
103		0.000	21.915	0.000	1758	VV	0.0
104		0.000	22.064	0.000	2711	VV	0.0
105		0.000	22.217	0.000	1221	VV	0.0
106		0.000	22.323	0.000	3142	VV	0.0
107		0.000	22.405	0.000	3716	VV	0.0
108		0.000	22.496	0.000	1608	VV	0.0
109		0.000	22.636	0.000	2193	VV	0.0
110		0.000	22.728	0.000	1010	VV	0.0
111		0.000	22.882	0.000	1099	VV	0.0
112	C17	0.003	23.046	-0.068	5566	VV	0.0

113		0.000	23.230	0.000	3217	VV	0.0
114	C18	0.002	24.660	-0.077	4255	BB	2.2
115		0.000	24.946	0.000	3200	BB	2.5
116		0.000	25.421	0.000	1426	BV	9.7
117		0.000	26.420	0.000	4185	BB	2.5
118		0.000	27.867	0.000	2359	VB	6.7
119	C20	0.001	28.415	-0.113	3172	BB	2.8
120		0.000	30.744	0.000	2963	BB	3.3
121	C28	0.002	33.518	-0.183	3135	VB	4.1
122		0.000	34.361	0.000	1788	BB	9.7
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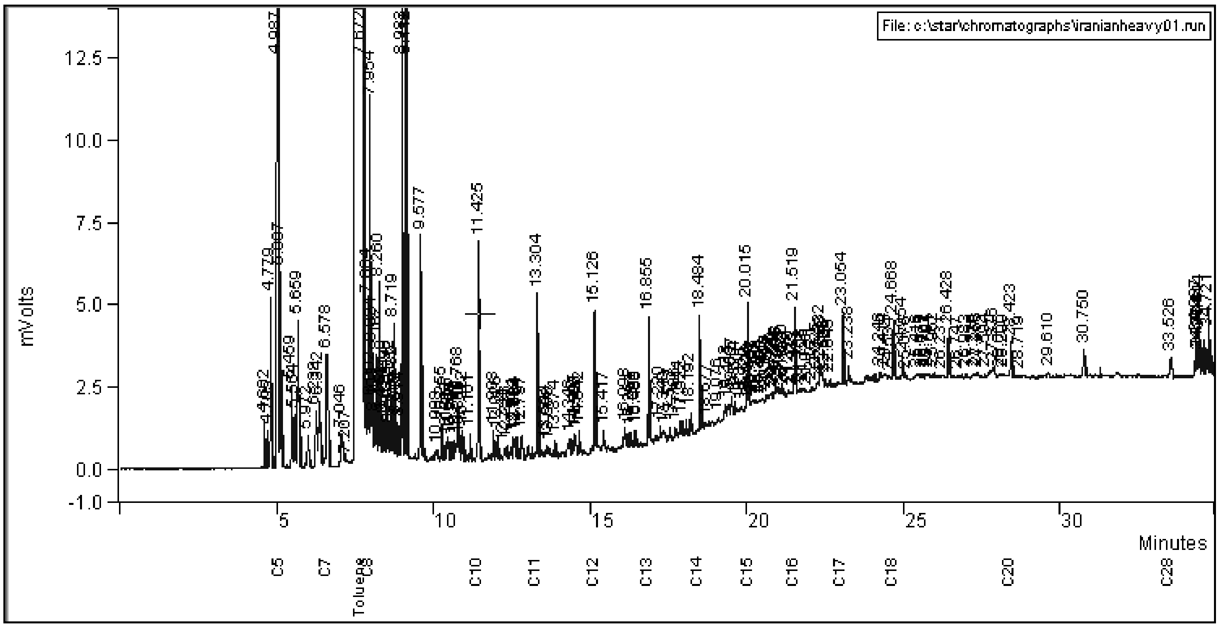
Totals:		1.584		-0.715	119220248		



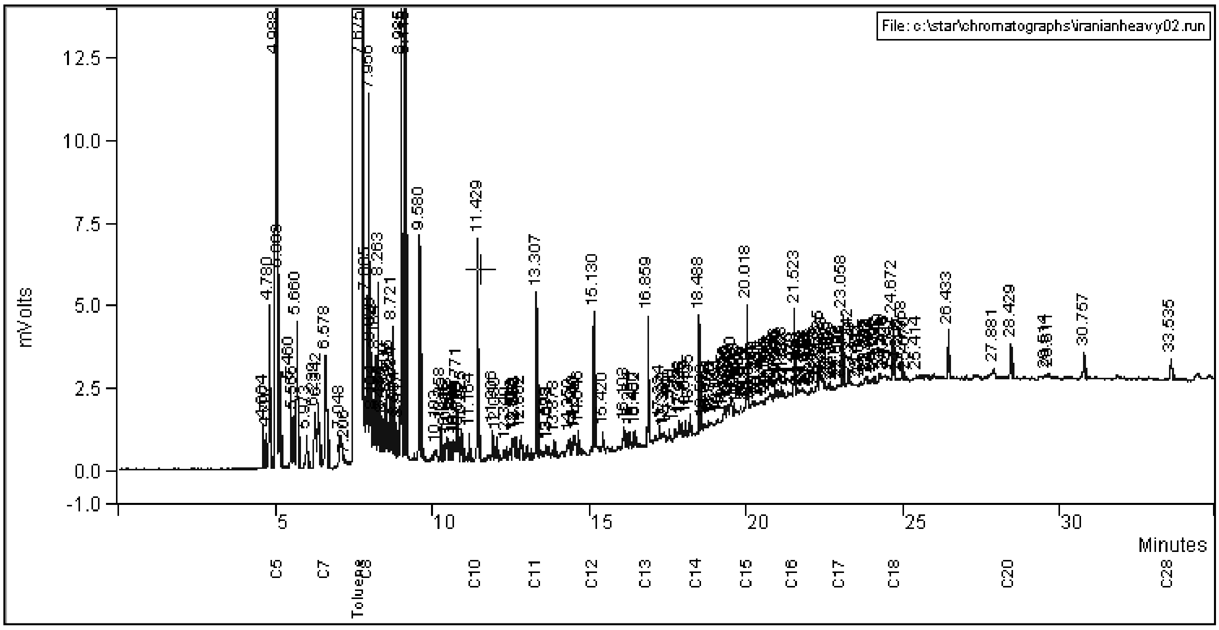


Figure C40: Duplicate chromatograms of sample of crude oil type Iranian heavy from STF storage tank showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

Title : PONA COLUMN EXPERIMENT
Method File : c:\star\extractrun.mth
Sample ID : Iranianheavy01
Operator : SHAN
Instrument : Varian Star 3800
Channel : Front = FID
Run Time : 34.965 min
Peak Measurement : Peak Area
Calculation Type : Percent

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.602	0.000	2258	BP	1.1
2		0.000	4.705	0.000	1813	PV	1.2
3		0.000	4.779	0.000	8737	VB	1.3
4		0.000	4.987	0.000	75252	BV	2.3
5	C5	0.362	5.097	-0.095	12751	VB	1.8
6		0.000	5.459	0.000	7515	BV	3.2
7		0.000	5.564	0.000	4470	VV	2.7
8		0.000	5.659	0.000	13098	VB	2.9
9		0.000	5.972	0.000	3091	VB	3.3
10		0.000	6.238	0.000	6581	BV	3.9
11		0.000	6.342	0.000	8415	VV	4.0
12	C7	0.085	6.578	0.031	15866	VB	4.5
13		0.000	7.046	0.000	6469	BV	6.3
14		0.000	7.207	0.000	1073	VV	0.0
15	Toluene	1.057	7.672	0.011	119266352	VP	11.9
16		0.000	7.884	0.000	6885	TF	0.0
17	C8	0.068	7.954	0.015	14119	TF	0.0
18		0.000	8.002	0.000	1107	TF	0.0
19		0.000	8.024	0.000	4436	TF	0.0
20		0.000	8.103	0.000	1223	TF	0.0
21		0.000	8.182	0.000	5547	TF	0.0
22		0.000	8.260	0.000	7755	TS	0.0
23		0.000	8.353	0.000	2139	TS	0.0
24		0.000	8.414	0.000	1489	TF	0.0
25		0.000	8.498	0.000	2821	TF	0.0
26		0.000	8.542	0.000	1011	TF	0.0
27		0.000	8.612	0.000	3143	TF	0.0
28		0.000	8.682	0.000	2592	TF	0.0
29		0.000	8.719	0.000	6087	TF	0.0
30		0.000	8.802	0.000	1809	TS	0.0
31		0.000	8.914	0.000	1711	TF	0.0
32		0.000	8.982	0.000	38629	TF	0.0
33		0.000	9.112	0.000	41085	TF	0.0
34		0.000	9.577	0.000	14261	TF	0.0
35		0.000	10.098	0.000	1541	TF	0.0
36		0.000	10.255	0.000	2120	TF	0.0
37		0.000	10.413	0.000	1852	TF	0.0
38		0.000	10.455	0.000	1572	TF	0.0
39		0.000	10.566	0.000	1569	TF	0.0
40		0.000	10.662	0.000	1646	TF	0.0
41		0.000	10.768	0.000	5214	TF	0.0
42		0.000	10.819	0.000	1135	TF	0.0
43		0.000	10.922	0.000	2562	TF	0.0
44		0.000	11.161	0.000	1623	TF	0.0
45	C10	0.009	11.425	-0.009	13323	TF	0.0
46		0.000	11.903	0.000	2087	VV	0.0
47		0.000	12.026	0.000	1704	VV	0.0
48		0.000	12.244	0.000	1006	VV	0.0
49		0.000	12.336	0.000	1164	VV	0.0

50		0.000	12.534	0.000	2082	VV	0.0
51		0.000	12.592	0.000	1370	VV	0.0
52		0.000	12.654	0.000	1324	VV	0.0
53		0.000	12.797	0.000	1320	VV	0.0
54	C11	0.006	13.304	-0.023	9966	VV	0.0
55		0.000	13.594	0.000	1348	VV	0.0
56		0.000	13.668	0.000	1310	VV	0.0
57		0.000	13.874	0.000	1318	VP	0.0
58		0.000	14.346	0.000	2006	VV	0.0
59		0.000	14.497	0.000	1589	VV	0.0
60		0.000	14.536	0.000	1483	VV	0.0
61		0.000	14.642	0.000	1662	VV	0.0
62	C12	0.005	15.126	-0.030	8337	VV	0.0
63		0.000	15.417	0.000	2705	VV	0.0
64		0.000	16.098	0.000	1866	VV	0.0
65		0.000	16.261	0.000	1142	VV	0.0
66		0.000	16.396	0.000	1030	VV	0.0
67		0.000	16.458	0.000	1004	VV	0.0
68	C13	0.004	16.855	-0.034	7432	PV	0.0
69		0.000	17.220	0.000	1238	VV	0.0
70		0.000	17.340	0.000	1839	VV	0.0
71		0.000	17.537	0.000	1064	VP	0.0
72		0.000	17.706	0.000	1073	PV	0.0
73		0.000	17.844	0.000	1293	VV	0.0
74		0.000	17.922	0.000	1179	VV	0.0
75		0.000	18.192	0.000	1708	VV	0.0
76	C14	0.004	18.484	-0.040	6735	VV	0.0
77		0.000	18.677	0.000	1057	VV	0.0
78		0.000	19.076	0.000	1681	VV	0.0
79		0.000	19.313	0.000	2216	VV	0.0
80		0.000	19.415	0.000	1629	VV	0.0
81		0.000	19.507	0.000	3243	VV	0.0
82		0.000	19.614	0.000	1558	VV	0.0
83		0.000	19.811	0.000	1921	VV	0.0
84		0.000	19.929	0.000	1588	VV	0.0
85		0.000	20.015	0.000	7950	VV	0.0
86	C15	0.001	20.072	0.013	1202	VV	0.0
87		0.000	20.167	0.000	1320	VV	0.0
88		0.000	20.197	0.000	2320	VV	0.0
89		0.000	20.288	0.000	1518	VV	0.0
90		0.000	20.394	0.000	1340	VV	0.0
91		0.000	20.492	0.000	2573	VV	0.0
92		0.000	20.603	0.000	1714	VV	0.0
93		0.000	20.635	0.000	1736	VV	0.0
94		0.000	20.755	0.000	2488	VV	0.0
95		0.000	20.822	0.000	1603	VV	0.0
96		0.000	20.913	0.000	3305	VV	0.0
97		0.000	20.985	0.000	1871	VV	0.0
98		0.000	21.051	0.000	1793	VV	0.0
99		0.000	21.120	0.000	2252	VV	0.0
100		0.000	21.183	0.000	1883	VV	0.0
101		0.000	21.320	0.000	2679	VV	0.0
102		0.000	21.425	0.000	1257	VV	0.0
103	C16	0.004	21.519	-0.050	7258	VV	0.0
104		0.000	21.708	0.000	1661	VV	0.0
105		0.000	21.795	0.000	1675	VV	0.0
106		0.000	21.921	0.000	1326	VV	0.0
107		0.000	22.071	0.000	1359	VV	0.0
108		0.000	22.225	0.000	1735	VV	0.0
109		0.000	22.332	0.000	2863	VV	0.0
110		0.000	22.388	0.000	2682	VV	0.0
111		0.000	22.506	0.000	1171	VV	0.0
112		0.000	22.645	0.000	1273	VV	0.0

113	C17	0.003	23.054	-0.060	5436	VV	0.0
114		0.000	23.238	0.000	1636	VV	0.0
115		0.000	24.246	0.000	1863	VV	3.7
116		0.000	24.414	0.000	2456	VV	0.0
117		0.000	24.534	0.000	1212	VV	0.0
118	C18	0.003	24.668	-0.069	5972	VV	0.0
119		0.000	24.954	0.000	3317	VV	3.1
120		0.000	25.075	0.000	1234	VV	0.0
121		0.000	25.416	0.000	2509	VV	17.1
122		0.000	25.577	0.000	1267	VV	0.0
123		0.000	25.702	0.000	1185	VV	0.0
124		0.000	25.781	0.000	1103	VV	0.0
125		0.000	25.962	0.000	1886	VV	0.0
126		0.000	26.231	0.000	1427	VV	0.0
127		0.000	26.428	0.000	5161	VV	2.8
128		0.000	26.747	0.000	1440	VV	2.9
129		0.000	26.983	0.000	1358	VV	0.0
130		0.000	27.236	0.000	1350	VV	0.0
131		0.000	27.356	0.000	1167	VV	0.0
132		0.000	27.594	0.000	1136	VV	0.0
133		0.000	27.876	0.000	3837	VV	16.0
134		0.000	28.065	0.000	1134	VV	0.0
135		0.000	28.200	0.000	1229	VV	0.0
136	C20	0.001	28.423	-0.105	4943	VV	3.4
137		0.000	28.719	0.000	1146	VV	0.0
138		0.000	29.610	0.000	1019	VV	0.0
139		0.000	30.750	0.000	3511	PV	4.2
140	C28	0.002	33.526	-0.175	2763	VB	3.9
141		0.000	34.337	0.000	1301	VV	0.6
142		0.000	34.384	0.000	1055	VV	3.3
143		0.000	34.418	0.000	1106	VV	1.7
144		0.000	34.444	0.000	1609	VV	0.7
145		0.000	34.721	0.000	1543	VV	0.9
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	Totals:	1.614		-0.620	119847142		

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Title             : PONA COLUMN EXPERIMENT
Method File       : c:\star\extractrun.mth
Sample ID         : Iranianheavy02
Operator          : SHAN
Instrument        : Varian Star 3800
Channel           : Front = FID
Run Time          : 34.965 min
Peak Measurement  : Peak Area
Calculation Type  : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.604	0.000	2027	PV	1.2
2		0.000	4.707	0.000	1697	VV	1.2
3		0.000	4.780	0.000	8468	VB	1.3
4		0.000	4.988	0.000	69909	BV	2.4
5	C5	0.356	5.098	-0.094	12515	VB	1.8
6		0.000	5.460	0.000	7419	BV	3.2
7		0.000	5.565	0.000	4458	VV	2.7
8		0.000	5.660	0.000	13009	VB	3.0
9		0.000	5.973	0.000	3023	VB	3.2
10		0.000	6.239	0.000	6529	BV	3.9
11		0.000	6.342	0.000	8368	VV	4.0
12	C7	0.085	6.578	0.031	15862	VB	4.5
13		0.000	7.048	0.000	6980	VV	6.5
14		0.000	7.206	0.000	1176	VV	0.0
15	Toluene	1.055	7.675	0.014	119000960	VP	11.9
16		0.000	7.885	0.000	6786	TF	0.0
17	C8	0.067	7.956	0.017	14030	TF	0.0
18		0.000	8.026	0.000	4516	TF	0.0
19		0.000	8.104	0.000	1280	TF	0.0
20		0.000	8.184	0.000	5588	TF	0.0
21		0.000	8.263	0.000	7751	TS	0.0
22		0.000	8.356	0.000	2123	TS	0.0
23		0.000	8.417	0.000	1490	TF	0.0
24		0.000	8.500	0.000	2776	TF	0.0
25		0.000	8.615	0.000	3130	TF	0.0
26		0.000	8.684	0.000	2563	TF	0.0
27		0.000	8.721	0.000	6059	TF	0.0
28		0.000	8.804	0.000	1789	TS	0.0
29		0.000	8.917	0.000	1705	TF	0.0
30		0.000	8.985	0.000	38469	TF	0.0
31		0.000	9.115	0.000	40932	TF	0.0
32		0.000	9.580	0.000	14326	TF	0.0
33		0.000	10.103	0.000	1617	TF	0.0
34		0.000	10.258	0.000	2124	TF	0.0
35		0.000	10.416	0.000	1876	TF	0.0
36		0.000	10.458	0.000	1624	TF	0.0
37		0.000	10.568	0.000	1505	TF	0.0
38		0.000	10.665	0.000	1601	TF	0.0
39		0.000	10.771	0.000	5143	TF	0.0
40		0.000	10.823	0.000	1091	TF	0.0
41		0.000	10.925	0.000	2530	TF	0.0
42		0.000	11.164	0.000	1581	TF	0.0
43	C10	0.009	11.429	-0.005	13285	TF	0.0
44		0.000	11.906	0.000	2037	TF	0.0
45		0.000	12.030	0.000	1675	TF	0.0
46		0.000	12.340	0.000	1078	TF	0.0
47		0.000	12.538	0.000	2025	TF	0.0
48		0.000	12.596	0.000	1343	TF	0.0

49		0.000	12.658	0.000	1288	TF	0.0
50		0.000	12.802	0.000	1315	TF	0.0
51	C11	0.006	13.307	-0.019	9889	PV	0.0
52		0.000	13.598	0.000	1313	VV	0.0
53		0.000	13.672	0.000	1111	VV	0.0
54		0.000	13.878	0.000	1273	VP	0.0
55		0.000	14.350	0.000	1990	VV	0.0
56		0.000	14.500	0.000	1580	VV	0.0
57		0.000	14.540	0.000	1466	VV	0.0
58		0.000	14.646	0.000	1678	VV	0.0
59	C12	0.005	15.130	-0.026	8339	VV	0.0
60		0.000	15.420	0.000	2496	VV	0.0
61		0.000	16.103	0.000	1822	VV	0.0
62		0.000	16.264	0.000	1196	VV	0.0
63		0.000	16.400	0.000	1062	VV	0.0
64		0.000	16.462	0.000	1016	VV	0.0
65	C13	0.004	16.859	-0.030	7517	PV	0.0
66		0.000	17.224	0.000	1281	VV	0.0
67		0.000	17.337	0.000	1172	VV	0.0
68		0.000	17.390	0.000	1044	VV	0.0
69		0.000	17.540	0.000	1085	VP	0.0
70		0.000	17.710	0.000	1127	PV	0.0
71		0.000	17.848	0.000	1518	VV	0.0
72		0.000	17.925	0.000	1336	VV	0.0
73		0.000	18.059	0.000	1180	VV	0.0
74		0.000	18.195	0.000	2152	VV	0.0
75	C14	0.004	18.488	-0.036	7058	VV	0.0
76		0.000	18.593	0.000	1220	VV	0.0
77		0.000	18.678	0.000	1517	VV	0.0
78		0.000	18.784	0.000	1251	VV	0.0
79		0.000	18.868	0.000	1102	VV	0.0
80		0.000	19.081	0.000	2844	VV	0.0
81		0.000	19.188	0.000	1052	VV	0.0
82		0.000	19.255	0.000	1151	VV	0.0
83		0.000	19.316	0.000	2989	VV	0.0
84		0.000	19.385	0.000	1241	VV	0.0
85		0.000	19.419	0.000	2126	VV	0.0
86		0.000	19.510	0.000	4479	VV	0.0
87		0.000	19.618	0.000	2098	VV	0.0
88		0.000	19.666	0.000	1320	VV	0.0
89		0.000	19.715	0.000	1059	VV	0.0
90		0.000	19.819	0.000	3152	VV	0.0
91		0.000	19.933	0.000	1665	VV	0.0
92		0.000	20.018	0.000	9179	VV	0.0
93	C15	0.001	20.075	0.016	1114	VV	0.0
94		0.000	20.209	0.000	5116	VV	0.0
95		0.000	20.294	0.000	2406	VV	0.0
96		0.000	20.351	0.000	1338	VV	0.0
97		0.000	20.401	0.000	1521	VV	0.0
98		0.000	20.499	0.000	4356	VV	0.0
99		0.000	20.605	0.000	2251	VV	0.0
100		0.000	20.640	0.000	1713	VV	0.0
101		0.000	20.736	0.000	2852	VV	0.0
102		0.000	20.757	0.000	1886	VV	0.0
103		0.000	20.823	0.000	2324	VV	0.0
104		0.000	20.916	0.000	4473	VV	0.0
105		0.000	20.989	0.000	2459	VV	0.0
106		0.000	21.053	0.000	2563	VV	0.0
107		0.000	21.123	0.000	3112	VV	0.0
108		0.000	21.187	0.000	3117	VV	0.0
109		0.000	21.323	0.000	4905	VV	0.0
110		0.000	21.430	0.000	2962	VV	0.0
111	C16	0.005	21.523	-0.046	8450	VV	0.0

112		0.000	21.636	0.000	2705	VV	0.0
113		0.000	21.691	0.000	1312	VV	0.0
114		0.000	21.721	0.000	2264	VV	0.0
115		0.000	21.798	0.000	4124	VV	0.0
116		0.000	21.878	0.000	1031	VV	0.0
117		0.000	21.928	0.000	1732	VV	0.0
118		0.000	22.009	0.000	2037	VV	0.0
119		0.000	22.076	0.000	3145	VV	0.0
120		0.000	22.178	0.000	1459	VV	0.0
121		0.000	22.228	0.000	2433	VV	0.0
122		0.000	22.268	0.000	1640	VV	0.0
123		0.000	22.335	0.000	3788	VV	0.0
124		0.000	22.403	0.000	4982	VV	0.0
125		0.000	22.508	0.000	2739	VV	0.0
126		0.000	22.587	0.000	1356	VV	0.0
127		0.000	22.649	0.000	3469	VV	0.0
128		0.000	22.740	0.000	1898	VV	0.0
129		0.000	22.892	0.000	4600	VV	0.0
130		0.000	22.986	0.000	1785	VV	0.0
131	C17	0.004	23.058	-0.056	7718	VV	0.0
132		0.000	23.242	0.000	5589	VV	0.0
133		0.000	23.329	0.000	2728	VV	0.0
134		0.000	23.492	0.000	3525	VV	0.0
135		0.000	23.627	0.000	2994	VV	0.0
136		0.000	23.767	0.000	3423	VV	0.0
137		0.000	23.828	0.000	2011	VV	0.0
138		0.000	23.902	0.000	1519	VV	0.0
139		0.000	24.005	0.000	2750	VV	0.0
140		0.000	24.092	0.000	2018	VV	0.0
141		0.000	24.249	0.000	4119	VV	0.0
142		0.000	24.356	0.000	1320	VV	0.0
143		0.000	24.416	0.000	3180	VV	0.0
144		0.000	24.542	0.000	1849	VV	0.0
145		0.000	24.672	0.000	7081	VV	0.0
146	C18	0.001	24.800	0.063	1221	VV	0.0
147		0.000	24.958	0.000	4120	VV	0.0
148		0.000	25.070	0.000	1701	VV	0.0
149		0.000	25.414	0.000	1047	VV	0.0
150		0.000	26.433	0.000	4737	BP	2.6
151		0.000	27.881	0.000	2318	VP	6.0
152	C20	0.001	28.429	-0.099	3403	VB	2.9
153		0.000	29.514	0.000	1176	VV	0.0
154		0.000	29.611	0.000	1283	VV	7.6
155		0.000	30.757	0.000	3546	VP	3.5
156	C28	0.001	33.535	-0.166	2430	BB	3.9
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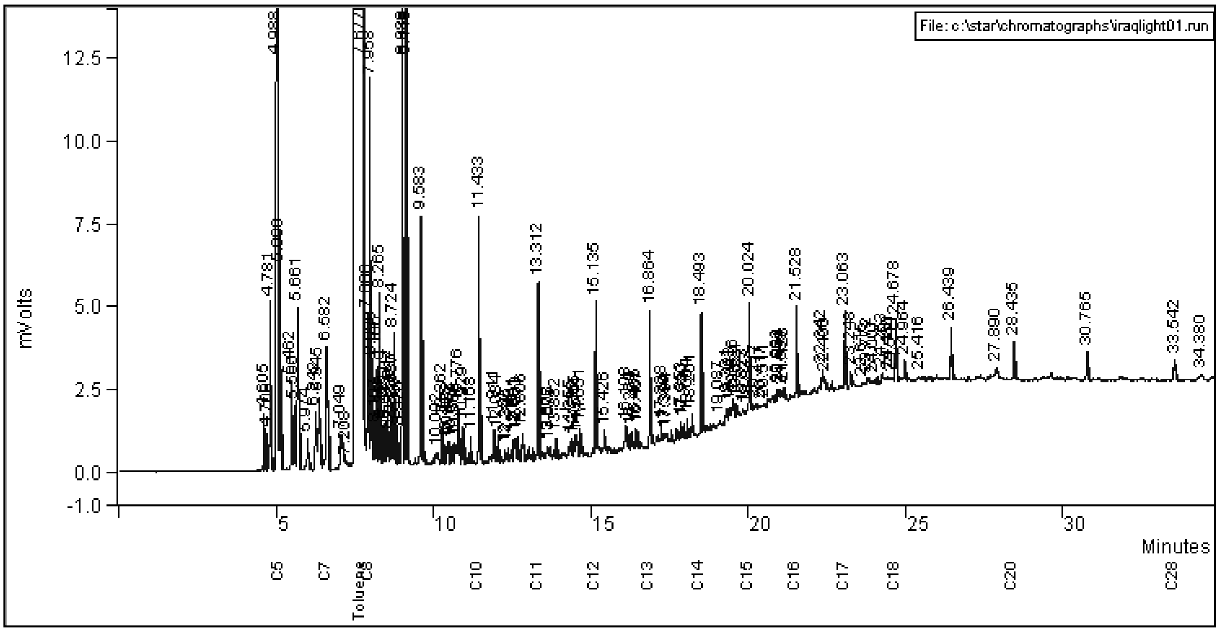
Totals:		1.604		-0.436	119650820		



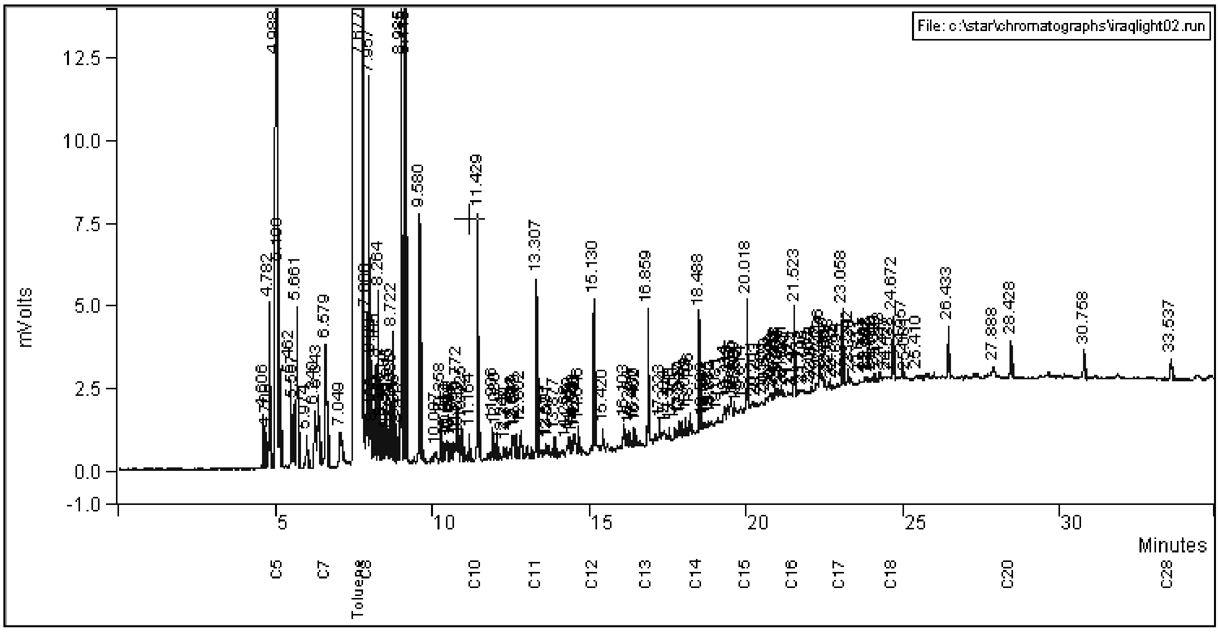


Figure C41: Duplicate chromatograms of sample of crude oil type Iraq light from STF storage tank showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

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Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : Iraqlight01
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.605	0.000	2616	VV	1.2
2		0.000	4.708	0.000	1783	VV	1.3
3		0.000	4.781	0.000	8782	VB	1.3
4		0.000	4.988	0.000	128333	BV	2.2
5	C5	0.377	5.099	-0.093	13245	VP	1.8
6		0.000	5.462	0.000	7837	BV	3.1
7		0.000	5.566	0.000	5222	VV	2.7
8		0.000	5.661	0.000	13926	VB	2.9
9		0.000	5.974	0.000	2965	VB	3.1
10		0.000	6.242	0.000	6582	BV	3.9
11		0.000	6.345	0.000	9374	VV	4.0
12	C7	0.093	6.582	0.035	17352	VB	4.5
13		0.000	7.049	0.000	6512	BV	6.3
14		0.000	7.208	0.000	1093	VV	7.4
15	Toluene	1.054	7.677	0.016	118970160	VP	11.9
16		0.000	7.888	0.000	6792	TF	0.0
17	C8	0.073	7.958	0.019	15244	TF	0.0
18		0.000	8.028	0.000	5567	TF	0.0
19		0.000	8.107	0.000	1247	TF	0.0
20		0.000	8.186	0.000	5560	TF	0.0
21		0.000	8.265	0.000	7792	TS	0.0
22		0.000	8.358	0.000	2186	TF	0.0
23		0.000	8.419	0.000	1711	TF	0.0
24		0.000	8.502	0.000	2836	TF	0.0
25		0.000	8.547	0.000	1205	TF	0.0
26		0.000	8.617	0.000	3230	TF	0.0
27		0.000	8.687	0.000	2622	TF	0.0
28		0.000	8.724	0.000	6091	TF	0.0
29		0.000	8.807	0.000	1934	TS	0.0
30		0.000	8.920	0.000	1611	TF	0.0
31		0.000	8.988	0.000	38552	TF	0.0
32		0.000	9.118	0.000	42104	TF	0.0
33		0.000	9.583	0.000	15778	TF	0.0
34		0.000	10.092	0.000	1705	TF	0.0
35		0.000	10.262	0.000	2428	TF	0.0
36		0.000	10.415	0.000	1897	TF	0.0
37		0.000	10.462	0.000	1394	TF	0.0
38		0.000	10.572	0.000	1460	TF	0.0
39		0.000	10.668	0.000	1528	TF	0.0
40		0.000	10.776	0.000	5370	TF	0.0
41		0.000	10.929	0.000	2902	TF	0.0
42		0.000	11.168	0.000	1592	TF	0.0
43	C10	0.010	11.433	-0.001	14682	TF	0.0
44		0.000	11.911	0.000	2277	VV	0.0
45		0.000	12.034	0.000	2208	VV	0.0
46		0.000	12.252	0.000	1060	VV	0.0
47		0.000	12.345	0.000	1081	VV	0.0
48		0.000	12.541	0.000	2134	VV	0.0
49		0.000	12.601	0.000	1365	VV	0.0

50		0.000	12.663	0.000	1426	VV	0.0
51		0.000	12.806	0.000	1588	VV	0.0
52	C11	0.006	13.312	-0.014	10604	PV	0.0
53		0.000	13.602	0.000	1448	VV	0.0
54		0.000	13.676	0.000	1231	VV	0.0
55		0.000	13.882	0.000	1404	VV	0.0
56		0.000	14.355	0.000	2070	VV	0.0
57		0.000	14.436	0.000	1030	VV	0.0
58		0.000	14.505	0.000	1641	VV	0.0
59		0.000	14.544	0.000	1465	VV	0.0
60		0.000	14.651	0.000	1897	VV	0.0
61	C12	0.005	15.135	-0.021	9084	VV	0.0
62		0.000	15.426	0.000	2748	VV	0.0
63		0.000	16.108	0.000	1957	VV	0.0
64		0.000	16.269	0.000	1290	VV	0.0
65		0.000	16.405	0.000	1272	VV	0.0
66		0.000	16.467	0.000	1197	VV	0.0
67	C13	0.005	16.864	-0.025	7973	PV	0.0
68		0.000	17.228	0.000	1468	VV	0.0
69		0.000	17.339	0.000	1405	VV	0.0
70		0.000	17.394	0.000	1107	VV	0.0
71		0.000	17.853	0.000	1272	VV	0.0
72		0.000	17.930	0.000	1174	VV	0.0
73		0.000	18.064	0.000	1212	VV	0.0
74		0.000	18.201	0.000	2081	VV	0.0
75	C14	0.004	18.493	-0.031	7090	VV	0.0
76		0.000	19.087	0.000	1070	VV	0.0
77		0.000	19.321	0.000	1737	VV	0.0
78		0.000	19.423	0.000	1352	VV	0.0
79		0.000	19.516	0.000	2921	VV	0.0
80		0.000	19.624	0.000	1308	VV	0.0
81		0.000	19.823	0.000	1356	VV	0.0
82		0.000	19.937	0.000	1052	VV	0.0
83	C15	0.004	20.024	-0.035	7065	VV	0.0
84		0.000	20.217	0.000	1920	VV	0.0
85		0.000	20.417	0.000	1044	VV	0.0
86		0.000	20.511	0.000	1199	VV	0.0
87		0.000	20.923	0.000	2111	VV	0.0
88		0.000	20.994	0.000	1224	VV	0.0
89		0.000	21.059	0.000	1115	VV	0.0
90		0.000	21.128	0.000	1311	VV	0.0
91	C16	0.003	21.528	-0.041	5763	VV	0.0
92		0.000	22.342	0.000	1896	VV	2.6
93		0.000	22.406	0.000	1877	VV	5.7
94	C17	0.003	23.063	-0.051	5780	VV	2.2
95		0.000	23.248	0.000	1667	VV	3.1
96		0.000	23.615	0.000	1208	VV	0.0
97		0.000	23.772	0.000	1319	VV	0.0
98		0.000	24.007	0.000	1040	VV	0.0
99		0.000	24.253	0.000	2112	VV	10.8
100		0.000	24.430	0.000	2039	VV	0.0
101		0.000	24.544	0.000	1227	VV	0.0
102	C18	0.003	24.678	-0.059	5623	VV	2.7
103		0.000	24.964	0.000	2924	VV	4.2
104		0.000	25.416	0.000	1785	VV	0.0
105		0.000	26.439	0.000	4181	BB	2.5
106		0.000	27.890	0.000	1305	BB	4.4
107	C20	0.001	28.435	-0.093	3389	BB	2.8
108		0.000	30.765	0.000	2992	BB	3.3
109	C28	0.001	33.542	-0.159	2563	BB	3.8
110		0.000	34.380	0.000	1001	BB	6.8
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Totals:		1.642		-0.553	119550537		

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Title                : PONA COLUMN EXPERIMENT
Method File          : c:\star\extractrun.mth
Sample ID            : Iraqlight02
Operator             : SHAN
Instrument           : Varian Star 3800
Channel              : Front = FID
Run Time             : 34.965 min
Peak Measurement     : Peak Area
Calculation Type     : Percent
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Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.606	0.000	2461	VV	1.2
2		0.000	4.708	0.000	1791	VV	1.3
3		0.000	4.782	0.000	8758	VB	1.3
4		0.000	4.988	0.000	127460	BV	2.2
5	C5	0.376	5.100	-0.092	13211	VB	1.8
6		0.000	5.462	0.000	7820	BV	3.1
7		0.000	5.567	0.000	5224	VV	2.8
8		0.000	5.661	0.000	13965	VB	2.9
9		0.000	5.974	0.000	2921	VB	3.0
10		0.000	6.240	0.000	6652	BV	3.9
11		0.000	6.343	0.000	9132	VV	3.9
12	C7	0.092	6.579	0.032	17084	VB	4.5
13		0.000	7.049	0.000	6516	BV	6.2
14	Toluene	1.054	7.677	0.016	118892280	VP	11.9
15		0.000	7.886	0.000	6740	TF	0.0
16	C8	0.073	7.957	0.018	15186	TF	0.0
17		0.000	8.027	0.000	5494	TF	0.0
18		0.000	8.106	0.000	1265	TF	0.0
19		0.000	8.185	0.000	5580	TF	0.0
20		0.000	8.264	0.000	7760	TS	0.0
21		0.000	8.356	0.000	2207	TF	0.0
22		0.000	8.417	0.000	1728	TF	0.0
23		0.000	8.501	0.000	2848	TF	0.0
24		0.000	8.545	0.000	1205	TF	0.0
25		0.000	8.615	0.000	3216	TF	0.0
26		0.000	8.685	0.000	2614	TF	0.0
27		0.000	8.722	0.000	6111	TF	0.0
28		0.000	8.805	0.000	1942	TS	0.0
29		0.000	8.917	0.000	1635	TF	0.0
30		0.000	8.985	0.000	38614	TF	0.0
31		0.000	9.115	0.000	42072	TF	0.0
32		0.000	9.580	0.000	15729	TF	0.0
33		0.000	10.087	0.000	1580	TF	0.0
34		0.000	10.258	0.000	2395	TF	0.0
35		0.000	10.412	0.000	1890	TF	0.0
36		0.000	10.459	0.000	1393	TF	0.0
37		0.000	10.569	0.000	1432	TF	0.0
38		0.000	10.665	0.000	1538	TF	0.0
39		0.000	10.772	0.000	5390	TF	0.0
40		0.000	10.823	0.000	1007	TF	0.0
41		0.000	10.925	0.000	2949	TF	0.0
42		0.000	11.164	0.000	1559	TF	0.0
43	C10	0.010	11.429	-0.005	14790	TF	0.0
44		0.000	11.906	0.000	2302	VV	0.0
45		0.000	12.030	0.000	1853	VV	0.0
46		0.000	12.247	0.000	1041	VV	0.0
47		0.000	12.340	0.000	1083	VV	0.0
48		0.000	12.538	0.000	2155	VV	0.0
49		0.000	12.597	0.000	1429	VV	0.0

50		0.000	12.658	0.000	1466	VV	0.0
51		0.000	12.802	0.000	1633	VV	0.0
52	C11	0.006	13.307	-0.019	10640	PV	0.0
53		0.000	13.597	0.000	1446	VV	0.0
54		0.000	13.671	0.000	1282	VV	0.0
55		0.000	13.877	0.000	1440	VV	0.0
56		0.000	14.268	0.000	1017	VV	0.0
57		0.000	14.350	0.000	2119	VV	0.0
58		0.000	14.431	0.000	1018	VV	0.0
59		0.000	14.500	0.000	1605	VV	0.0
60		0.000	14.540	0.000	1449	VV	0.0
61		0.000	14.646	0.000	1843	VV	0.0
62	C12	0.005	15.130	-0.026	9162	VV	0.0
63		0.000	15.420	0.000	2789	VV	0.0
64		0.000	16.103	0.000	1810	VV	0.0
65		0.000	16.264	0.000	1107	VV	0.0
66		0.000	16.400	0.000	1113	PV	0.0
67		0.000	16.462	0.000	1007	VV	0.0
68	C13	0.005	16.859	-0.030	9199	BV	1.8
69		0.000	17.223	0.000	1816	VV	2.5
70		0.000	17.384	0.000	2548	VV	10.8
71		0.000	17.540	0.000	1069	VP	3.2
72		0.000	17.708	0.000	1046	PV	4.0
73		0.000	17.847	0.000	1283	VV	3.2
74		0.000	17.924	0.000	1194	VV	3.4
75		0.000	18.059	0.000	1238	VV	2.7
76		0.000	18.196	0.000	2220	VV	3.5
77	C14	0.004	18.488	-0.036	7788	VV	2.0
78		0.000	18.590	0.000	1132	VV	0.0
79		0.000	18.687	0.000	1383	VV	0.0
80		0.000	18.785	0.000	1169	VV	0.0
81		0.000	18.872	0.000	1541	VV	0.0
82		0.000	19.081	0.000	2581	VV	0.0
83		0.000	19.314	0.000	3797	VV	0.0
84		0.000	19.418	0.000	2973	VV	0.0
85		0.000	19.505	0.000	4045	VV	0.0
86		0.000	19.620	0.000	2425	VV	0.0
87		0.000	19.665	0.000	1048	VV	0.0
88		0.000	19.814	0.000	4293	VV	0.0
89	C15	0.007	20.018	-0.041	12431	VV	2.3
90		0.000	20.211	0.000	4638	VV	0.0
91		0.000	20.293	0.000	2244	VV	0.0
92		0.000	20.501	0.000	6289	VV	0.0
93		0.000	20.632	0.000	4368	VV	0.0
94		0.000	20.746	0.000	4075	VV	0.0
95		0.000	20.823	0.000	2409	VV	0.0
96		0.000	20.918	0.000	4257	VV	0.0
97		0.000	20.987	0.000	2657	VV	0.0
98		0.000	21.054	0.000	2526	VV	0.0
99		0.000	21.121	0.000	3237	VV	0.0
100		0.000	21.191	0.000	3312	VV	0.0
101		0.000	21.324	0.000	4464	VV	0.0
102		0.000	21.422	0.000	2494	VV	0.0
103	C16	0.005	21.523	-0.046	8823	VV	2.9
104		0.000	21.712	0.000	5738	VV	0.0
105		0.000	21.796	0.000	3629	VV	0.0
106		0.000	22.006	0.000	4945	VV	0.0
107		0.000	22.074	0.000	3360	VV	0.0
108		0.000	22.232	0.000	5498	VV	0.0
109		0.000	22.336	0.000	4280	VV	0.0
110		0.000	22.401	0.000	5059	VV	0.0
111		0.000	22.507	0.000	2799	VV	0.0
112		0.000	22.648	0.000	4752	VV	0.0

113		0.000	22.742	0.000	2751	VV	0.0
114		0.000	22.894	0.000	3986	VV	0.0
115	C17	0.006	23.058	-0.056	11147	VV	3.9
116		0.000	23.242	0.000	4675	VV	0.0
117		0.000	23.330	0.000	3721	VV	0.0
118		0.000	23.611	0.000	6036	VV	0.0
119		0.000	23.767	0.000	3943	VV	0.0
120		0.000	23.828	0.000	2066	VV	0.0
121		0.000	23.903	0.000	1613	VV	0.0
122		0.000	24.002	0.000	2895	VV	0.0
123		0.000	24.091	0.000	2489	VV	0.0
124		0.000	24.248	0.000	4504	VV	0.0
125		0.000	24.427	0.000	3933	VV	0.0
126		0.000	24.538	0.000	2578	VV	0.0
127	C18	0.004	24.672	-0.065	7045	VV	0.0
128		0.000	24.957	0.000	5754	VV	0.0
129		0.000	25.081	0.000	1580	VV	0.0
130		0.000	25.410	0.000	3407	VV	0.0
131		0.000	26.433	0.000	4144	BB	2.5
132		0.000	27.888	0.000	2060	VB	5.8
133	C20	0.001	28.428	-0.100	3316	BB	2.8
134		0.000	30.758	0.000	2992	BB	3.3
135	C28	0.001	33.537	-0.164	2724	BB	4.0
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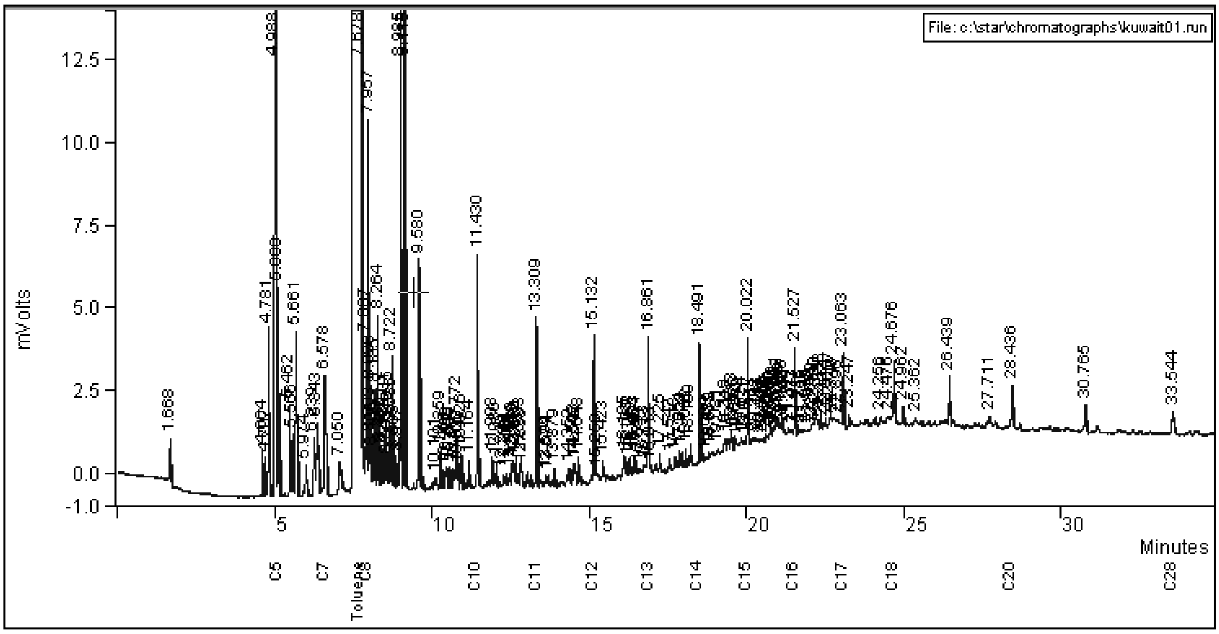
	Totals:	1.649		-0.614	119620384		



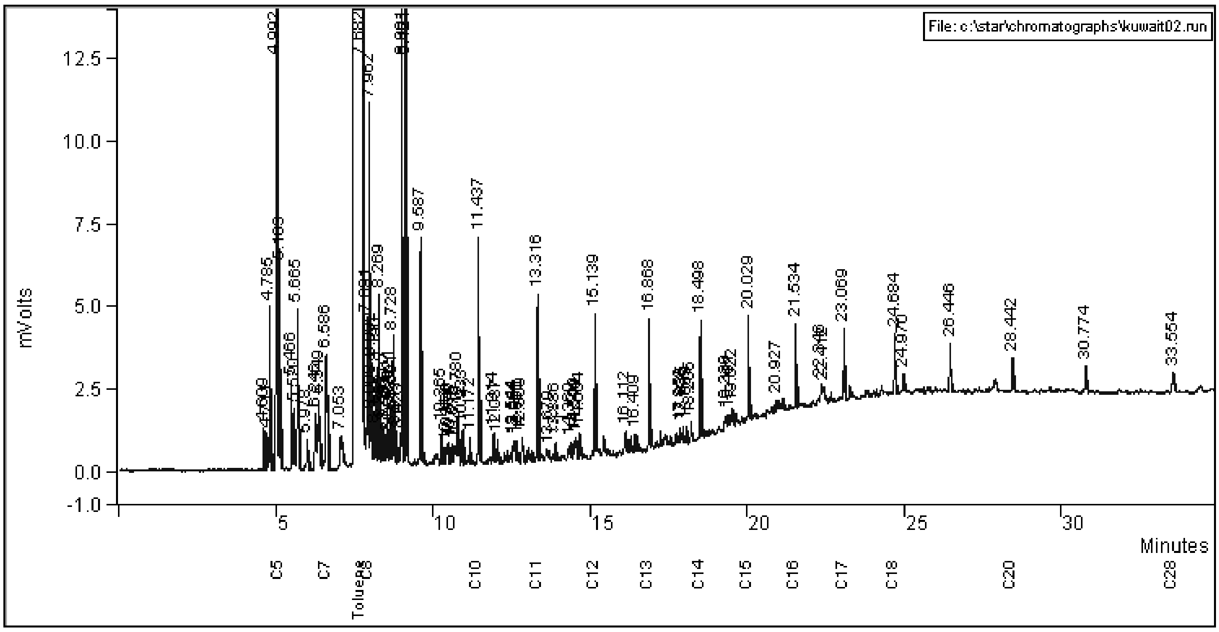


Figure C42: Duplicate chromatograms of sample of crude oil type Kuwait from STF storage tank showing retention times for hydrocarbons obtained and used for comparative analysis with soil samples.

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Title                : PONA COLUMN EXPERIMENT
Method File          : c:\star\extractrun.mth
Sample ID            : Kuwait01
Operator             : SHAN
Instrument           : Varian Star 3800
Channel              : Front = FID
Run Time             : 34.965 min
Peak Measurement     : Peak Area
Calculation Type     : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	1.668	0.000	3123	BB	2.1
2		0.000	4.604	0.000	2108	PV	1.2
3		0.000	4.707	0.000	1824	VV	1.3
4		0.000	4.781	0.000	8616	VB	1.3
5		0.000	4.988	0.000	79209	BV	2.3
6	C5	0.376	5.099	-0.093	13244	VB	1.8
7		0.000	5.462	0.000	7977	BV	3.0
8		0.000	5.566	0.000	5064	VV	2.6
9		0.000	5.661	0.000	14084	VB	2.9
10		0.000	5.974	0.000	2933	VB	3.0
11		0.000	6.239	0.000	6487	BV	3.8
12		0.000	6.343	0.000	8842	VV	3.8
13	C7	0.085	6.578	0.031	15873	VB	4.4
14		0.000	7.050	0.000	6309	BV	6.2
15	Toluene	1.049	7.678	0.017	118332680	VP	11.9
16		0.000	7.887	0.000	6678	TF	0.0
17	C8	0.069	7.957	0.018	14448	TF	0.0
18		0.000	8.003	0.000	1031	TF	0.0
19		0.000	8.028	0.000	4406	TF	0.0
20		0.000	8.106	0.000	1251	TF	0.0
21		0.000	8.185	0.000	5523	TF	0.0
22		0.000	8.264	0.000	7750	TS	0.0
23		0.000	8.356	0.000	2204	TF	0.0
24		0.000	8.417	0.000	1653	TF	0.0
25		0.000	8.501	0.000	2921	TF	0.0
26		0.000	8.545	0.000	1175	TF	0.0
27		0.000	8.615	0.000	3293	TF	0.0
28		0.000	8.685	0.000	2641	TF	0.0
29		0.000	8.722	0.000	6068	TF	0.0
30		0.000	8.805	0.000	1630	TS	0.0
31		0.000	8.917	0.000	1538	TF	0.0
32		0.000	8.985	0.000	38435	TF	0.0
33		0.000	9.115	0.000	41544	TF	0.0
34		0.000	9.580	0.000	14681	TF	0.0
35		0.000	10.101	0.000	1670	TF	0.0
36		0.000	10.259	0.000	2316	TF	0.0
37		0.000	10.408	0.000	1843	TF	0.0
38		0.000	10.460	0.000	1396	TF	0.0
39		0.000	10.559	0.000	1607	TF	0.0
40		0.000	10.665	0.000	1496	TF	0.0
41		0.000	10.772	0.000	5234	TF	0.0
42		0.000	10.823	0.000	1005	TF	0.0
43		0.000	10.926	0.000	2876	TF	0.0
44		0.000	11.164	0.000	1674	TF	0.0
45	C10	0.010	11.430	-0.004	14028	TF	0.0
46		0.000	11.908	0.000	2323	TF	0.0
47		0.000	12.030	0.000	1948	TF	0.0
48		0.000	12.249	0.000	1217	TF	0.0
49		0.000	12.340	0.000	1296	TF	0.0

50		0.000	12.469	0.000	1061	TF	0.0
51		0.000	12.539	0.000	2434	TF	0.0
52		0.000	12.598	0.000	1571	TF	0.0
53		0.000	12.660	0.000	1721	TF	0.0
54		0.000	12.803	0.000	1872	TF	0.0
55		0.000	12.838	0.000	1142	TF	0.0
56	C11	0.006	13.309	-0.017	9947	TF	0.0
57		0.000	13.599	0.000	1185	TF	0.0
58		0.000	13.674	0.000	1116	TF	0.0
59		0.000	13.879	0.000	1394	TF	0.0
60		0.000	14.352	0.000	1979	VV	0.0
61		0.000	14.503	0.000	1561	VV	0.0
62		0.000	14.542	0.000	1462	VV	0.0
63		0.000	14.648	0.000	1837	VV	0.0
64	C12	0.005	15.132	-0.024	8785	VV	0.0
65		0.000	15.250	0.000	1418	VV	0.0
66		0.000	15.423	0.000	2550	VV	0.0
67		0.000	16.105	0.000	1978	VV	0.0
68		0.000	16.193	0.000	1125	VV	0.0
69		0.000	16.267	0.000	1567	VV	0.0
70		0.000	16.403	0.000	1520	VV	0.0
71		0.000	16.464	0.000	1504	VV	0.0
72		0.000	16.594	0.000	1015	VV	0.0
73		0.000	16.733	0.000	1599	VV	0.0
74		0.000	16.861	0.000	9397	VV	0.0
75	C13	0.001	16.913	0.024	1058	VV	0.0
76		0.000	17.225	0.000	1618	VV	0.0
77		0.000	17.542	0.000	1090	VV	0.0
78		0.000	17.713	0.000	1378	VV	0.0
79		0.000	17.851	0.000	1441	VV	0.0
80		0.000	17.928	0.000	1321	VV	0.0
81		0.000	18.062	0.000	1242	VV	0.0
82		0.000	18.199	0.000	2048	VV	0.0
83	C14	0.004	18.491	-0.033	7260	VV	0.0
84		0.000	18.684	0.000	1005	VV	0.0
85		0.000	18.789	0.000	1137	VV	0.0
86		0.000	18.872	0.000	1020	VV	0.0
87		0.000	19.081	0.000	2854	VV	0.0
88		0.000	19.319	0.000	3576	VV	0.0
89		0.000	19.422	0.000	1616	VV	0.0
90		0.000	19.513	0.000	3374	VV	0.0
91		0.000	19.623	0.000	1658	VV	0.0
92		0.000	19.670	0.000	1043	VV	0.0
93		0.000	19.824	0.000	2629	VV	0.0
94		0.000	19.931	0.000	1754	VV	0.0
95	C15	0.004	20.022	-0.037	7415	VV	0.0
96		0.000	20.211	0.000	3235	VV	0.0
97		0.000	20.293	0.000	1385	VV	0.0
98		0.000	20.413	0.000	1735	VV	0.0
99		0.000	20.493	0.000	2299	VV	0.0
100		0.000	20.607	0.000	1302	VV	0.0
101		0.000	20.643	0.000	1101	VV	0.0
102		0.000	20.740	0.000	1441	VV	0.0
103		0.000	20.763	0.000	1416	VV	0.0
104		0.000	20.830	0.000	1983	VV	0.0
105		0.000	20.921	0.000	4401	VV	0.0
106		0.000	20.992	0.000	2509	VV	0.0
107		0.000	21.056	0.000	2228	VV	0.0
108		0.000	21.126	0.000	2509	VV	0.0
109		0.000	21.188	0.000	2015	VV	0.0
110		0.000	21.327	0.000	2354	VV	0.0
111		0.000	21.423	0.000	2208	VV	0.0
112	C16	0.004	21.527	-0.042	6546	VV	0.0

113		0.000	21.716	0.000	1695	VV	0.0
114		0.000	21.798	0.000	1028	VV	0.0
115		0.000	21.935	0.000	1924	VV	0.0
116		0.000	22.029	0.000	1188	VV	0.0
117		0.000	22.079	0.000	1880	VV	0.0
118		0.000	22.183	0.000	4947	VV	0.0
119		0.000	22.338	0.000	2133	VV	0.0
120		0.000	22.442	0.000	1337	VV	0.0
121		0.000	22.514	0.000	1487	VV	0.0
122		0.000	22.657	0.000	3724	VV	0.0
123		0.000	22.748	0.000	2435	VV	0.0
124		0.000	22.896	0.000	2386	VV	0.0
125	C17	0.003	23.063	-0.051	5414	VP	0.0
126		0.000	23.247	0.000	1126	PV	0.0
127		0.000	24.256	0.000	1492	VV	4.4
128		0.000	24.476	0.000	2825	VV	7.9
129	C18	0.004	24.676	-0.061	7076	VV	2.5
130		0.000	24.962	0.000	2135	VV	2.7
131		0.000	25.362	0.000	1585	VV	6.1
132		0.000	26.439	0.000	3839	VB	2.4
133		0.000	27.711	0.000	1831	VV	5.4
134	C20	0.001	28.436	-0.092	5307	VB	3.2
135		0.000	30.765	0.000	3826	BB	3.6
136	C28	0.002	33.544	-0.157	3189	BB	4.3
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	Totals:	1.623		-0.521	118925925		

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Title              : PONA COLUMN EXPERIMENT
Method File        : c:\star\extractrun.mth
Sample ID          : Kuwait02
Operator           : SHAN
Instrument         : Varian Star 3800
Channel            : Front = FID
Run Time           : 34.965 min
Peak Measurement   : Peak Area
Calculation Type   : Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.000	4.609	0.000	1972	BV	1.2
2		0.000	4.711	0.000	1818	VV	1.3
3		0.000	4.785	0.000	8633	VB	1.4
4		0.000	4.992	0.000	78534	BV	2.4
5	C5	0.378	5.103	-0.089	13298	VB	1.8
6		0.000	5.466	0.000	7908	BV	3.1
7		0.000	5.570	0.000	5159	VV	2.7
8		0.000	5.665	0.000	14028	VB	3.0
9		0.000	5.978	0.000	3149	BB	3.2
10		0.000	6.246	0.000	6578	BV	3.9
11		0.000	6.349	0.000	8921	VV	0.0
12	C7	0.087	6.586	0.039	16249	VB	4.5
13		0.000	7.053	0.000	5318	BV	6.1
14	Toluene	1.044	7.682	0.021	117780984	BP	11.8
15		0.000	7.891	0.000	6584	TF	0.0
16	C8	0.069	7.962	0.023	14287	TF	0.0
17		0.000	8.008	0.000	1035	TF	0.0
18		0.000	8.032	0.000	4290	TF	0.0
19		0.000	8.111	0.000	1271	TF	0.0
20		0.000	8.190	0.000	5449	TF	0.0
21		0.000	8.269	0.000	7717	TS	0.0
22		0.000	8.362	0.000	2291	TF	0.0
23		0.000	8.423	0.000	1722	TF	0.0
24		0.000	8.507	0.000	2997	TF	0.0
25		0.000	8.550	0.000	1207	TF	0.0
26		0.000	8.621	0.000	3351	TF	0.0
27		0.000	8.691	0.000	2706	TF	0.0
28		0.000	8.728	0.000	6115	TF	0.0
29		0.000	8.811	0.000	1803	TF	0.0
30		0.000	8.923	0.000	1543	VV	0.0
31		0.000	8.991	0.000	37929	VV	0.0
32		0.000	9.121	0.000	40819	VB	0.0
33		0.000	9.587	0.000	14206	BB	1.8
34		0.000	10.265	0.000	1937	BB	1.6
35		0.000	10.413	0.000	1584	BV	2.7
36		0.000	10.466	0.000	1186	VB	2.2
37		0.000	10.573	0.000	1111	BV	1.8
38		0.000	10.670	0.000	1331	VV	2.1
39		0.000	10.780	0.000	4981	VV	3.3
40		0.000	10.933	0.000	2769	PB	2.6
41		0.000	11.172	0.000	1389	PB	1.5
42	C10	0.009	11.437	0.003	12696	BB	1.7
43		0.000	11.914	0.000	2069	VV	1.9
44		0.000	12.037	0.000	2157	VB	1.8
45		0.000	12.544	0.000	1932	VV	2.0
46		0.000	12.604	0.000	1186	VV	2.4
47		0.000	12.666	0.000	1178	VB	1.8
48		0.000	12.809	0.000	1396	BV	1.9
49	C11	0.005	13.316	-0.010	8756	BB	1.6

50		0.000	13.679	0.000	1074	VB	2.9
51		0.000	13.886	0.000	1031	VB	2.0
52		0.000	14.360	0.000	1850	VV	3.5
53		0.000	14.509	0.000	1506	VV	2.2
54		0.000	14.549	0.000	1456	VV	2.9
55		0.000	14.654	0.000	1786	VV	2.0
56	C12	0.004	15.139	-0.017	7416	VB	1.7
57		0.000	16.112	0.000	1428	VV	1.9
58		0.000	16.409	0.000	1013	BV	1.7
59	C13	0.004	16.868	-0.021	7192	BB	1.7
60		0.000	17.858	0.000	1179	VV	2.1
61		0.000	17.935	0.000	1335	VV	2.1
62		0.000	18.069	0.000	1037	VB	1.8
63		0.000	18.205	0.000	1426	BB	2.1
64	C14	0.004	18.498	-0.026	6819	BP	1.8
65		0.000	19.330	0.000	1920	BV	5.8
66		0.000	19.431	0.000	1522	VV	4.7
67		0.000	19.522	0.000	2012	VP	3.9
68	C15	0.004	20.029	-0.030	7103	BB	1.8
69		0.000	20.927	0.000	1234	VV	3.7
70	C16	0.003	21.534	-0.035	5202	BB	1.9
71		0.000	22.346	0.000	1164	BV	2.4
72		0.000	22.412	0.000	2215	VV	5.1
73	C17	0.003	23.069	-0.045	4750	BB	2.0
74	C18	0.002	24.684	-0.053	4388	BB	2.3
75		0.000	24.970	0.000	1261	BB	2.3
76		0.000	26.446	0.000	3868	BB	2.5
77	C20	0.001	28.442	-0.086	3034	BB	2.8
78		0.000	30.774	0.000	2597	BB	3.2
79	C28	0.001	33.554	-0.147	2375	BB	3.9
----	------------	==========	-------	=======	==========	----	-----
	Totals:	1.618		-0.473	118239722		

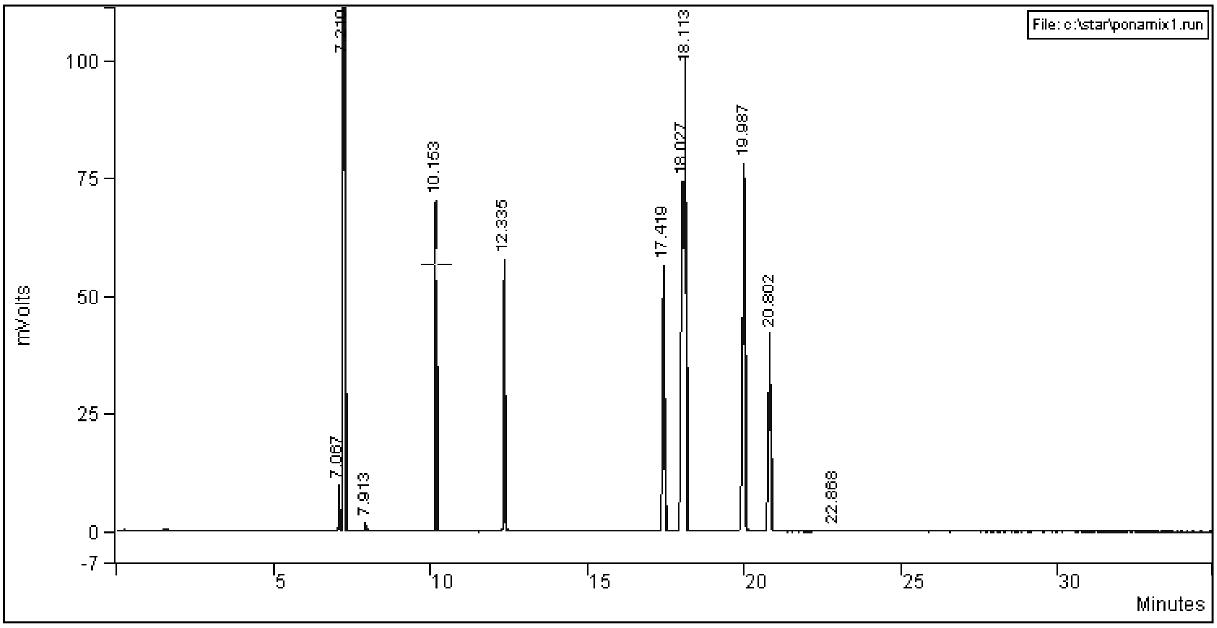
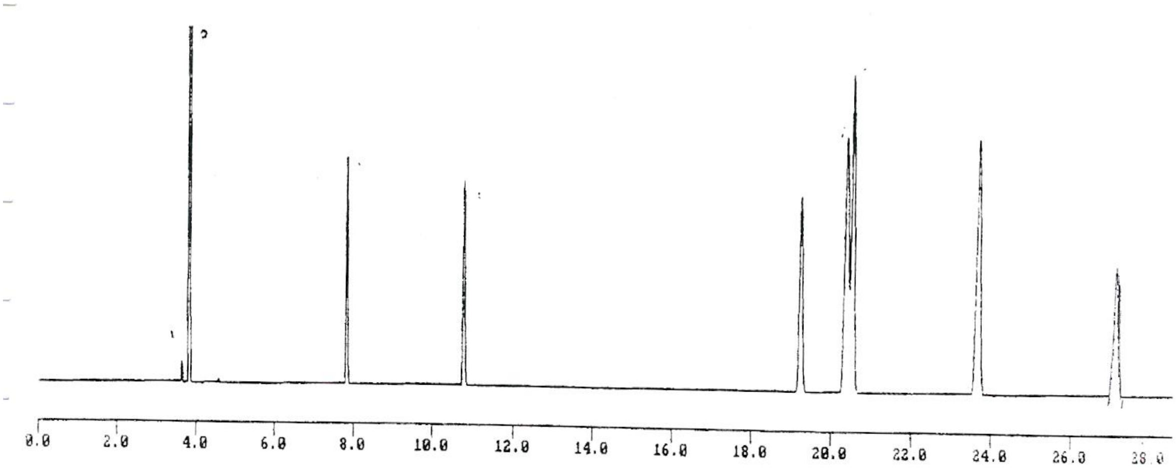


Figure C1(a): Chromatogram obtained for the supplied test mix obtained after the column was conditioned (See also Figure 4.2 (b), p66.)

```
Title              :     PONA COLUMN EXPERIMENT
Method File        :     c:\star\chromatograms\testmix3.mth
Sample ID          :     ponamix1
Operator           :     SHAN
Instrument         :     Varian Star 3800
Channel            :     Front = FID
Run Time           :     34.965 min
Peak Measurement   :     Peak Area
Calculation Type   :     Percent
```

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.30	7.067	0.000	14043	BV	1.3
2		58.69	7.210	0.000	2759671	VB	2.6
3		0.06	7.913	0.000	2774	BB	1.5
4		3.10	10.153	0.000	145542	BB	1.9
5		3.26	12.335	0.000	153347	BB	2.5
6		4.88	17.419	0.000	229320	BB	3.8
7		8.96	18.027	0.000	421294	BV	6.9
8		7.97	18.113	0.000	374935	VB	4.7
9		8.33	19.987	0.000	391662	VB	4.7
10		4.42	20.802	0.000	207946	BB	4.6
11		0.03	22.868	0.000	1485	BB	4.9
	Totals:	100.00		0.000	4702019		

COLUMN PERFORMANCE REPORT



REMARKS : CONDITIONING 280 deg.C

PEAK	COMPOUND	RETENTION TIME (MIN)	CAPACITY RATIO (K)	KOVATS INDEX
1	SOLVENT	3.81		
2	SOLVENT	4.55		
3	HEPTANE	7.79	1.09	700.00
4	TOLUENE	10.73	1.88	762.35
5	ETHYLBENZENE	19.16	4.14	852.87
6	m-XYLENE	20.29	4.44	860.96
7	p-XYLENE	20.45	4.48	862.03
8	o-XYLENE	23.58	5.32	881.67
9	NONANE	27.02	6.24	900.00

GAS VELOCITY (cm/sec)	22.3
EFFECTIVE PLATES (Peak 9)	235226
THEORETICAL PLATES (Peak 9)	316623
EFFECTIVE PLATES/METRE (Peak 9)	4705
SEPARATION NUMBER (Peaks 8-9)	15.55
SKEW (Peak 9)	0.57

COLUMN SPECIFICATIONS

LENGTH	50 METRE	MAX.TEMPERATURE	300 deg.C
TYPE	BONDED PHASE	I.D.	0.15 mm
MATERIAL	FUSED SILICA	O.D.	0.33 mm
PHASE	BP1 (non polar)		

TESTING CONDITIONS

COLUMN TEMPERATURE	65 deg C	SAMPLE	PONA MIX
DETECTOR TEMPERATURE	280 deg C	SAMPLE SIZE	0.1ul
INJECTOR TEMPERATURE	240 deg C	SPLIT RATIO	60:1
CARRIER GAS	HYDROGEN	SENSITIVITY	32*10E-12 AFS
INLET PRESSURE	42.0 PSI	DETECTOR	FID

COLUMN PERFORMANCE REPORT

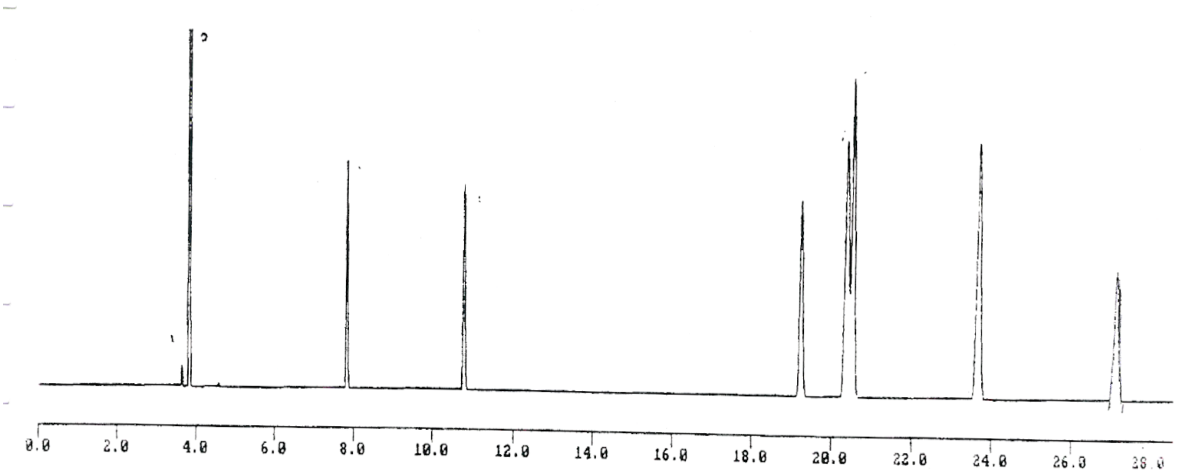


Figure C1(b): Chromatogram obtained for the supplied test mix obtained by the manufacturer.

REMARKS: CONDITIONING 280 deg. C

PEAK	COMPOUND	RETENTION TIME (MIN)	CAPACITY RATIO (K)	KOVATS INDEX
1	SOLVENT	3.81		
2	SOLVENT	4.55		
3	HEPTANE	7.79	1.09	700.00
4	TOLUENE	10.73	1.88	762.35
5	ETHYLBENZENE	19.16	4.14	852.87
6	m-XYLENE	20.29	4.44	860.96
7	p-XYLENE	20.45	4.48	862.03
8	o-XYLENE	23.58	5.32	881.67
9	NONANE	27.02	6.24	900.00

GAS VELOCITY (cm/sec)	22.3
EFFECTIVE PLATES (Peak 9)	235226
THEORETICAL PLATES (Peak 9)	316623
EFFECTIVE PLATES/METRE (Peak 9)	4705
SEPARATION NUMBER (Peaks 8-9)	15.55
SKEW (Peak 9)	0.57

COLUMN SPECIFICATIONS

LENGTH	50 METRE		
TYPE	BONDED PHASE	MAX. TEMPERATURE	300 deg.C
MATERIAL	FUSED SILICA	I.D.	0.15 mm
PHASE	BP1 (non polar)	O.D.	0.33 mm

TESTING CONDITIONS

COLUMN TEMPERATURE	65 deg.C	SAMPLE	PONA MIX
DETECTOR TEMPERATURE	280 deg.C	SAMPLE SIZE	0.1 μL
INJECTOR TEMPERATURE	240 deg.C	SPLIT RATIO	60:1
CARRIER GAS	HYDROGEN	SENSITIVITY	$32*10^{-12}$ AFS
INLET PRESSURE	42.0 PSI	DETECTOR	FID

REMARKS: CONDITIONING 280 deg. C

PEAK	COMPOUND	RETENTION TIME (MIN)	CAPACITY RATIO (K)	KOVATS INDEX
1	SOLVENT	3.81		
2	SOLVENT	4.55		
3	HEPTANE	7.79	1.09	700.00
4	TOLUENE	10.73	1.88	762.35
5	ETHYLBENZENE	19.16	4.14	852.87
6	m-XYLENE	20.29	4.44	860.96
7	p-XYLENE	20.45	4.48	862.03
8	o-XYLENE	23.58	5.32	881.67
9	NONANE	27.02	6.24	900.00

GAS VELOCITY (cm/sec)	22.3
EFFECTIVE PLATES (Peak 9)	235226
THEORETICAL PLATES (Peak 9)	316623
EFFECTIVE PLATES/METRE (Peak 9)	4705
SEPARATION NUMBER(Peaks 8-9)	15.55
SKEW (Peak 9)	0.57

COLUMN SPECIFICATIONS

LENGTH	50 METRE		
TYPE	BONDED PHASE	MAX. TEMPERATURE	300 deg.C
MATERIAL	FUSED SILICA	I.D.	0.15 mm
PHASE	BPl (non polar)	O.D.	0.33 mm

TESTING CONDITIONS

COLUMN TEMPERATURE	65 deg C
DETECTOR TEMPERATURE	280 deg C
INJECTOR TEMPERATURE	240 deg C
CARRIER GAS	HYDROGEN
INLET PRESSURE	42.0 PSI

SAMPLE	PONA MIX
SAMPLE SIZE	0.1 μL
SPLIT RATIO	60:1
SENSITIVITY	$32*10^{-12}$ AFS
DETECTOR	FID

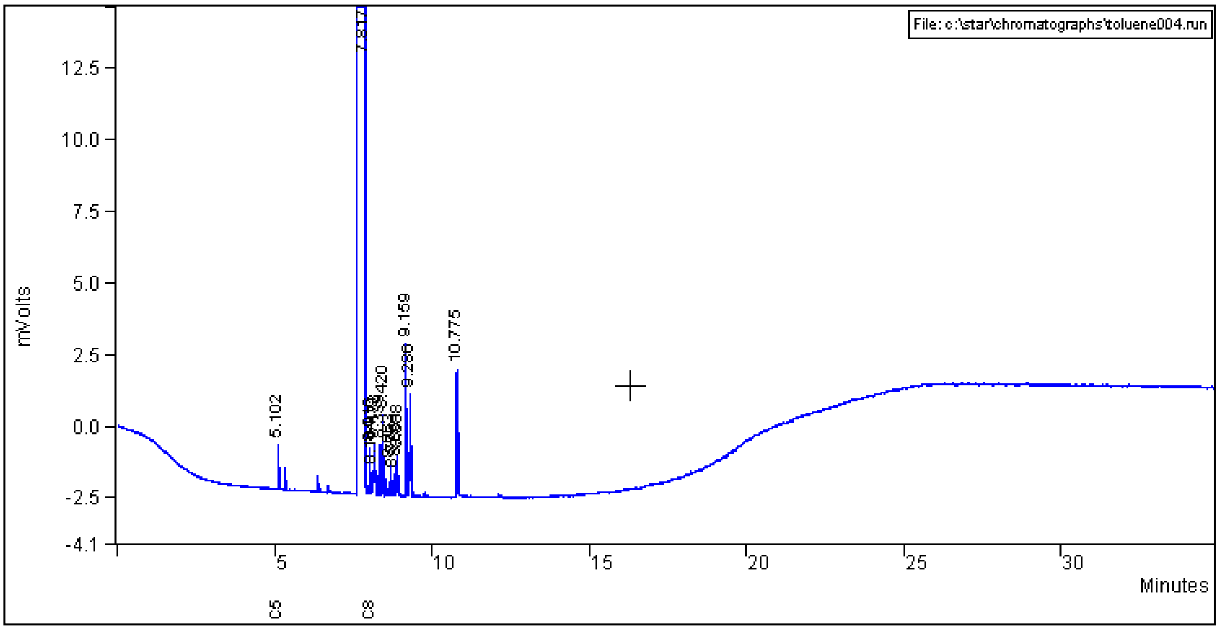


Figure C4: Chromatogram of Toluene showing retention times of hydrocarbons found below C_{10}

Title	:	PONA COLUMN EXPERIMENT
Method File	:	c:\star\extractrun.mth
Sample ID	:	**Toluene**
Operator	:	SHAN
Instrument	:	Varian Star 3800
Channel	:	Front = FID
Run Time	:	34.965 min
Peak Measurement	:	Peak Area
Calculation Type	:	External Standard

Peak No.	Peak Name	Result (%)	Ret. Time (min)	Time Offset (min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1	C5	0.05	5.102	-0.090	1604	BB	1.0
2		0.00	7.817	0.000	60492116	BB	7.2
3	C8	0.01	8.016	0.077	2142	TF	0.0
4		0.00	8.104	0.000	1386	TF	0.0
5		0.00	8.172	0.000	2626	TF	0.0
6		0.00	8.339	0.000	3070	PP	1.6
7		0.00	8.420	0.000	4304	PP	1.4
8		0.00	8.663	0.000	1732	BB	1.4
9		0.00	8.779	0.000	1125	BV	1.4
10		0.00	8.851	0.000	1797	VV	1.5
11		0.00	8.888	0.000	2185	VB	1.4
12		0.00	9.159	0.000	7909	BB	1.4
13		0.00	9.286	0.000	8245	BB	2.4
14		0.00	10.775	0.000	7535	BB	1.5
	Totals:	0.06		-0.013	60537776		

APPENDIX D

OTHER ANALYSES

Pages 346-349

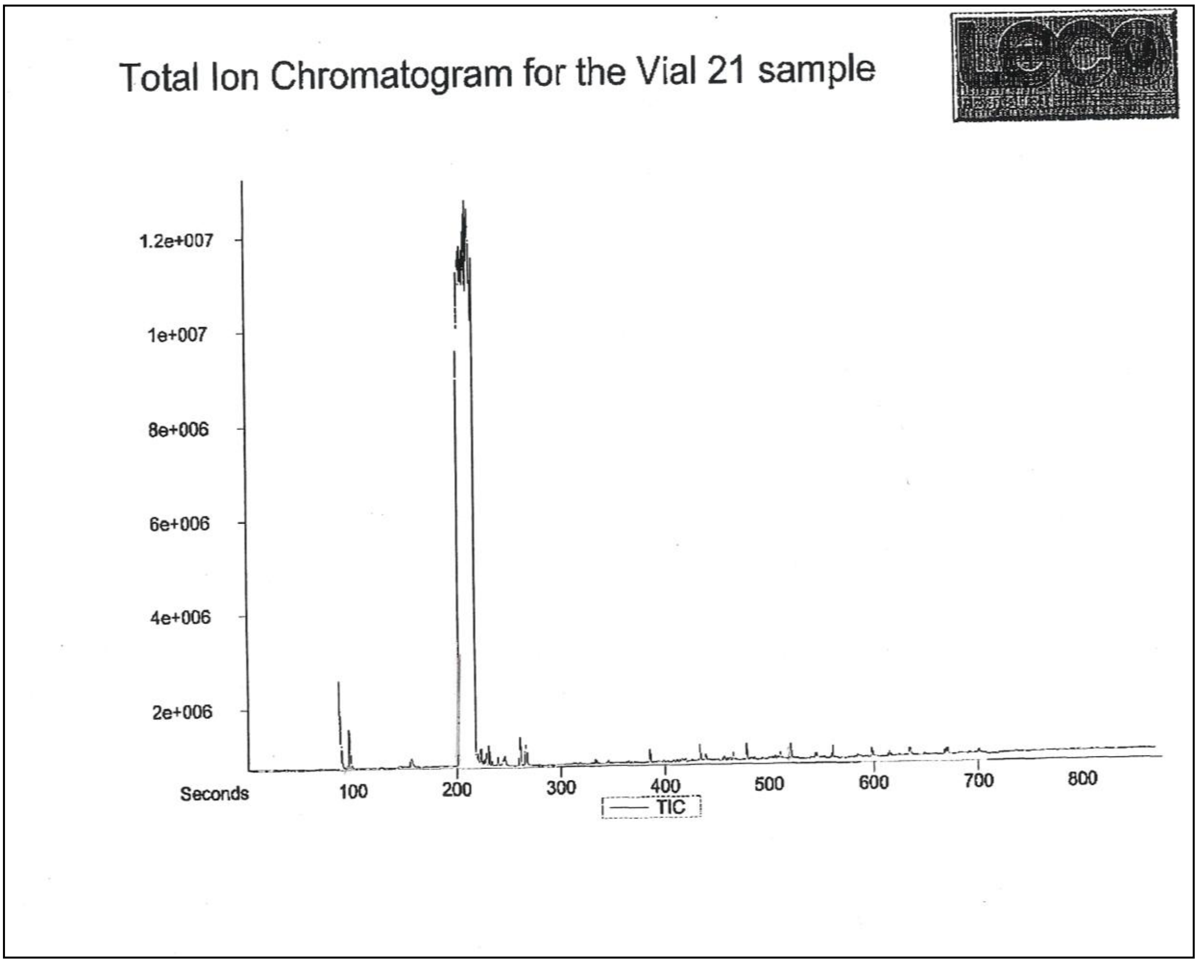


Figure D2: Chromatogram obtained by the LECO cooperation laboratory in North America for analysis of Sample 21 by GC-TOF-MS

Report of results obtained for Sample 21 from analysis completed by the LECO Cooperation laboratory in America on the GC-TOF-MS.

LECO: GC-TOF-MS analysis - Sample 21						
Peak No.	**Name**	**Formula**	**R.T.**	**Similarity**	**CAS**	**Unique Mass**
1	Acetone	C3H6O	87.055	969	67-64-1	43
2	Methylene Chloride	CH2Cl2	96.655	914	75-09-2	49
3	Benzene	C6H6	144.46	868	71-43-2	78
4	Pentane, 2,2,4-trimethyl-	C8H18	156.32	914	540-84-1	57
5	1,6-Heptadien-3-yne	C7H8	203.86	820	5150-80-1	44
6	1,3,5-Cycloheptatriene	C7H8	205.06	926	544-25-2	93
7	1,3,5-Cycloheptatriene	C7H8	206.72	902	544-25-2	93
8	1,3,5-Cycloheptatriene	C7H8	208.19	913	544-25-2	139
9	1,3,5-Cycloheptatriene	C7H8	208.86	895	544-25-2	94
10	1,3,5-Cycloheptatriene	C7H8	210.06	900	544-25-2	140
11	1,3,5-Cycloheptatriene	C7H8	211.92	829	544-25-2	46
12	1,3,5-Cycloheptatriene	C7H8	215.52	828	544-25-2	91
13	1,3,5-Cycloheptatriene	C7H8	217.86	747	544-25-2	97
14	Cyclohexane, 1,3-dimethyl-, cis-	C8H16	219.92	742	638-04-0	97
15	Cyclopentane, 1-ethyl-2-methyl-, cis-	C8H16	223.12	819	930-89-2	97
16	Cyclopentane, 1-ethyl-1-methyl-	C8H16	225.52	716	16747-50-5	55
17	Cycloheptane	C7H14	227.39	702	291-64-5	98
18	Cyclohexane, 1,2-dimethyl-	C8H16	228.06	901	583-57-3	97
19	Cyclohexane, 1,4-dimethyl-	C8H16	230.92	928	589-90-2	55
20	Cyclopentane, (1-methylethyl)-	C8H16	233.79	853	3875-51-2	68
21	cis-1-Methyl-2-ethylcyclopentane	C8H16	239.19	839	0-00-0	55
22	Cyclopentane, propyl-	C8H16	243.79	803	2040-96-2	68
23	Cyclohexane, 1,2-dimethyl-, cis-	C8H16	244.79	897	04/01/07	97
24	Cyclohexane, ethyl-	C8H16	246.39	944	1678-91-7	82
25	Ethylbenzene	C8H10	260.72	955	100-41-4	91
26	Benzene, 1,2-dimethyl-	C8H10	266.32	942	95-47-6	106
27	Heptane, 3-ethyl-2-methyl-	C10H22	301.66	610	14676-29-0	57
28	Decane	C10H22	333.99	859	124-18-5	57
29	Heptane, 5-ethyl-2-methyl-	C10H22	345.52	821	13475-78-0	71
30	Decane, 2-methyl-	C11H24	367.52	819	6975-98-0	57
31	Dodecane	C12H26	385.52	892	112-40-3	57
32	Dodecane	C12H26	393.26	704	112-40-3	57
33	Decane, 3,7-dimethyl-	C12H26	398.52	771	17312-54-8	71
34	trans-2-Undecen-1-ol	C11H22O	402.59	719	75039-84-8	81
35	Octane, 2,3,7-trimethyl-	C11H24	412.06	733	62016-34-6	84
36	2,3-Dimethyldecane	C12H26	414.19	718	17312-44-6	43

Peak No.	Name	Formula	R.T.	Similarity	CAS	Unique Mass
37	Undecane, 2-methyl-	C12H26	416.66	746	7045-71-8	43
38	Benzene, 1,2,3,4-tetramethyl-	C10H14	418.32	776	488-23-3	134
39	Undecane, 3-methyl-	C12H26	419.92	774	1002-43-3	57
40	Dodecane	C12H26	433.66	942	112-40-3	43
41	Undecane, 2,6-dimethyl-	C13H28	439.39	891	17301-23-4	43
42	Benzene, 1-ethyl-4-(1-methylethyl)-	C11H16	447.99	711	4218-48-8	133
43	Cyclohexane, 2-butyl-1,1,3-trimethyl-	C13H26	450.92	824	54676-39-0	69
44	Tridecane, 3-methyl-	C14H30	462.66	720	6418-41-3	57
45	Decane, 2,3,5,8-tetramethyl-	C14H30	465.86	851	0-00-0	71
46	Dodecane	C12H26	478.59	905	112-40-3	57
47	Heptadecane, 2,6,10,14-tetramethyl-	C21H44	510.66	839	18344-37-1	71
48	Hexadecane	C16H34	520.86	917	544-76-3	57
49	2-Hexyl-1-octanol	C14H30O	524.06	720	19780-79-1	85
50	Hexadecane	C16H34	560.66	911	544-76-3	71
51	Hexadecane	C16H34	598.39	925	544-76-3	57
52	Pentadecane, 2,6,10-trimethyl-	C18H38	614.86	755	3892-00-0	57
53	Nonadecane	C19H40	634.06	891	629-92-5	240
54	Heptadecane, 2,6-dimethyl-	C19H40	635.06	871	54105-67-8	183
55	Nonadecane	C19H40	667.99	802	629-92-5	43
56	Heptadecane, 2,6,10,14-tetramethyl-	C21H44	670.19	790	18344-37-1	71
57	Nonadecane	C19H40	700.52	762	629-92-5	57
58						
59						
60						

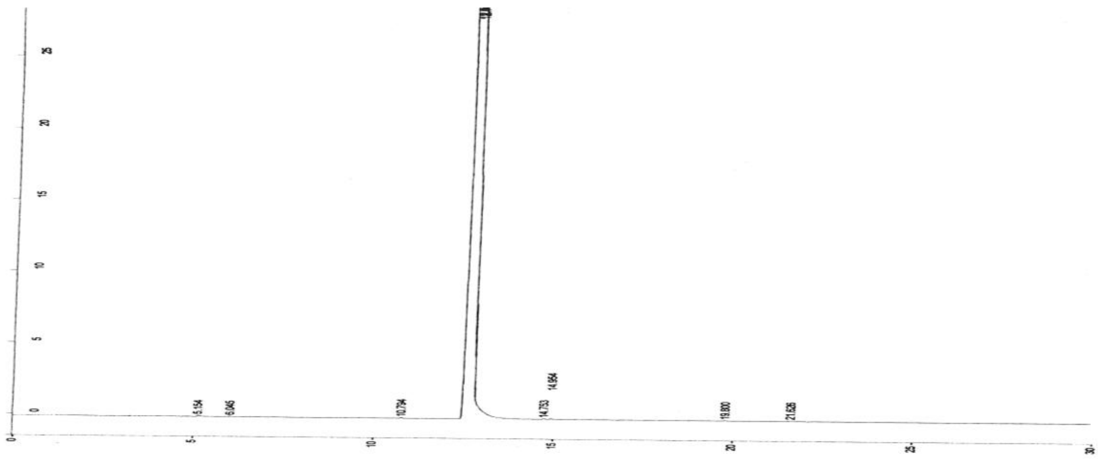


Figure D1: Chromatogram obtained for analysis of Sample 21 by the SAPREF laboratory

Title : HEXANE ISOMERS
Method File : C:\Star\HEXANE ISOMERS.mth
Sample ID : sample21j25
Operator : PRAVIND
Detector Type : ADCB (1 Volt)
Instrument : Varian Star #4
Channel : A = FID-A 10V
Run Time : 30.003 min
Peak Measurement : Peak Area Calculation Type: Percent

Peak No.	Peak Name	Result (% VOL	Ret. Time (min)	Time Offset min)	Area (counts)	Sep. Code	Width 1/2 (sec)
1		0.03	5.154	0.000	412	BB	3.4
2		0.01	6.045	0.000	112	BB	2.8
3		0.01	10.794	0.000	154	BB	2.6
4		45.76	12.656	0.000	682362	BV	10.5
5		15.04	12.694	0.000	224274	VV	0.0
6		39.10	12.732	0.000	583096	VB	5.7
7		0.02	14.753	0.000	240	BV	3.5
8		0.02	14.954	0.000	270	VB	4.0
9		0.01	19.800	0.000	121	BB	3.6
10		0.01	21.626	0.000	166	BB	3.8
Totals:		100.01		0.000	1491207		