



**South Trinidad Chamber
of Industry and Commerce**

Annotated Bibliography

**The Environmental Impact of Onshore
Oil Production in Trinidad and Tobago
1907 -2007**

December 2007

Project sponsored by bpTT and Petrotrin

ANNOTATED BIBLIOGRAPHY

**OF RESEARCH AND PUBLICATIONS ON THE
ENVIRONMENTAL IMPACT OF ONSHORE OIL
PRODUCTION IN TRINIDAD AND TOBAGO**

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Message from the STCIC

December 2007 marks 100 years of commercial oil production in Trinidad and Tobago. The majority of these operations in the past 100 years have been located in South Trinidad. In this 100 year the oil industry has transformed Trinidad and Tobago from an agrarian economy to the first industrialized State in the English speaking Caribbean. While this transformation has brought with it many economic advantages and opportunities for Trinidad and Tobago it has also left an environmental legacy that must be assessed if significant restoration and remediation are to take place. There is also the consequence of the socioeconomic impact of the decline of the land based oil industry on the people living in fence line communities in the South of Trinidad many of whom depend on the oil industry and agriculture for economic survival.

It is against this background that the STCIC conceptualized, in 2005, a project entitled “*An impact assessment of commercial extraction of petroleum in South Trinidad and proposals for remediation and restoration.*” The project was, at the time, discussed with a wide range of stakeholders in the energy sector that included, the major Oil Companies, Government Ministries, State Agencies and international agencies resident in Trinidad and Tobago. All stakeholders agreed that the project was both important and timely.

This project consist of three components of which this Annotated Bibliography is component one. The second component of the project entails building a GIS enabled database of traditional oil fields and related geospatial data. The third and final component of the project entails developing and executing a sampling and analytical programme to provide baseline data and profiling of the respective oil fields within Trinidad.

Component one of this project (the Annotated Bibliography) took approximately four months and involved reviewing journals, conference proceedings reports and newspaper clippings dating as far back as 1908. The material that has been collected in this Annotated Bibliography is a useful tool for persons involved in the HS&E fraternity in the Trinidad and Tobago energy sector, persons writing Environmental Impact Assessment reports and persons writing research papers on the impact of oil on the environment. The bibliography will also be made available online to members of the STCIC via the STCIC website, www.stcic.org. This bibliography represents the first ever bibliography of research on the impact of oil on the environment in Trinidad and Tobago. In this regard, it is a unique contribution to the body of knowledge on environmental management in Trinidad and Tobago.

The STCIC would like to take this opportunity to thank two of its member’s bpTT and Petrotrin for sponsoring this project. We would also like to thank the project consultant, Sharda Surujdeo-Maharaj and those persons and agencies in the private and public sector that opened their doors to this project.

Introduction

This compilation of annotated references is by no means complete. It represents four months of data collection from approximately ten sources, which include libraries from across the country as well as government institutions, ministries and oil companies. A total of 860 references were collected, which includes 109 conference papers, 23 journal articles, 121 report summaries and 475 newspaper articles.

It is clear from this collection of references that a complete assessment of the impact of oil exploration in South Trinidad has never been undertaken. There are some references to site specific measurements of water-based or air contaminants but these are few and far apart. Numerous newspaper articles describe the damage, destruction and despair which occur after an oil pollution event but few describe the long term impacts of oil exploratory activities on the natural environment of this country. The contained references describe the evolution of a health and safety culture in oil companies in Trinidad, which is now at an international level. However, emphasis has remained on the human and social impacts of oil exploration activities, with little understanding or appreciation to ecological and biotic changes in our natural environment due to oil exploration.

Over the past 100 years of commercial oil exploration, over 12,000 wells have been drilled across the southern landscape, many of which have remained active but many have also become inactive or abandoned. What is clear from the contained references is that there has been an increase in environmental awareness by oil companies with local operations over the past thirty to forty years, the result of which has been a decrease in the number and frequency of oil spills and accidents reported. Oil companies are becoming more efficient in managing and controlling pollution from their specific operations but there still remain concerns with respect to those historical operations – wells, rigs, oil pipelines – which have become abandoned or derelict and hence, prove to be a threat to human and environmental health. Therefore, there is a need to comprehensively assess the onshore drilling and production activities and quantify the level of impacts in terms of habitat fragmentation, biodiversity, biotic metrics and air/water/land pollution.

This bibliography is the first phase of a two-part project undertaken by the STCIC. The second phase of this project that would support and enhance the above recommendation of a complete oil pollution assessment, involves the development of an Oil Operations Geographic Information System (OOGIS). This GIS, which will be done in conjunction with oil companies and government ministries, would contain active and inactive exploration wells as well as the related geospatial data.

A bibliography of this kind has never been attempted before and it is hoped that it will prove to be a worthy resource to present and future researchers in the oil sector, as well as those interested in the oil industry and its impacts on the local environment. This collection can spark new multi-disciplinary research for example, the economic assessment of oil pollution, health impacts on persons of lower income brackets living in oil producing areas or trends in production and economics of the fishing industry over the past 100 years due to ecological impacts of oil exploration. It is also hoped that this collection would continue to grow as literature becomes available.

In closing, I would like to thank the librarians at the West Indiana Section of The University of the West Indies Main Library, the Environmental Management Authority (EMA) Information Services, the National Library and Information Systems Authority (NALIS), the Ministry of Energy Library and the Institute of Marine Affairs for accommodating me during my data collection. I also extend my thanks to representatives of Petrotrin, the American Chamber of Industry and Commerce (AMCHAM), BGTT and BPTT for their time. Thanks also to Ms. Sheeba Sreenivasan for editing this volume.

Sharda Surujdeo-Maharaj
Project Consultant

Theses

Baccus, S. 2001. Mitigating the environmental impacts of oil discharges in a crude oil storage facility. M.Sc. Thesis (Environmental Engineering), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

In Trinidad and Tobago water pollution is the most common form of petroleum pollution, especially in the rivers in South-Western Trinidad, where oil is produced from onshore oilfields. This study examines the operation of a crude oil tank farm, with the intention of mitigating the environmental impacts caused by oil discharges arising out of tank bleeding activities.

A waste audit was conducted to identify the deficient areas of the operations. It was discovered that the volume of tank bleed water from the tank farm operation could not be reduced, as the water was co-produced with the crude oil.

Sampling and testing revealed the presence of oil in the form of a stable emulsion, as well as a high amount of suspended solids, in the tank farm effluent. Particle size distribution analysis proved to be a useful tool in determining the stages of wastewater treatment required and the most applicable separation technologies to remove the oil and suspended solids from the tank bleed water.

Key words: water pollution, petroleum effluent, oily emulsion, suspended solids, mitigation, separation technology.

Banswah, A.B. 1996. An assessment of the noise level from a compressor station. M.Sc. Thesis (Petroleum Engineering), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The noise source of Petrotrin's Compressor Stations at #1 Barrackpore, South Trinidad has definite directional properties towards the north. Correspondingly, the sound energy radiated towards the south is much less than in any other direction.

The sound power level of the noise source has been calculated to be about 127dB, while the directivity factor varies from a high of 3.63 to the north with a low of 0.26 towards the south.

The potential danger zone with respect to human hearing sensitivity exists within an area of approximately 32,000 sq. feet, around the noise source. This implies that the potential danger zone extends for about 100 feet from the acoustic centre of the noise source, in all directions. Any person who must enter this area for official reasons, must either:

Wear protective gears to minimize hearing loss from excessive noise levels;

Limit their exposure time within the potential danger zone.

It is recommended that employees who must work at noisy Compressor Stations should undergo audiogram tests at least twice per year, in order to determine any hearing loss due to continual exposure to excessive noise levels.

Keywords: noise levels, compressors, audiogram testing.

Chadeesingh, D.R. 2003. Bioremediation of petroleum wastes: kinetic modelling of the process and development of an algorithm for optimisation of nutrient addition. M.Sc. Thesis (Petroleum Engineering), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The hazardous nature as well as the alarming volume of non-aqueous liquid and solid wastes generated by the petroleum industry pose serious problems not just in terms of the risks posed to human health but also to various forms of animal and plant life and the ecosystem in general. The need to dispose of such wastes in an environmentally acceptable as well as cost effective manner presents not just a technical challenge but a critical imperative. Bioremediation via the land-treatment technique has evolved as one of the most favourable options in this regard in the last few decades. This technology is still only evolving and a survey of the literature reveals critical 'gaps', three of which are addressed in this report.

First, an improved model based on Michaelis-Menten kinetics is developed to facilitate improved predictions of the rate as well as extent of contaminant degradation. Secondly, a new quantitative algorithm in regards to the addition of nutrients to stimulate microbial activity and consequently optimal biotransformation of the contaminants is presented. Further, a natural, local source of microorganisms has been identified to improve the degradation process via bioaugmentation, thus presenting an alternative to the use of genetically engineered microbial strains – an approach vigorously resisted by many environmental agencies and governments.

Keywords: bioremediation, petroleum waste, kinetic modelling, algorithms, nutrient.

Dhanraj, D.K. 1998. The ecology of hydrocarbon degrading bacteria at a natural oil seep. M. Phil. Thesis (Zoology), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The La Brea region in Trinidad is an area of extensive natural oil seepage that also contains the world's largest known asphalt lake. This study explored the abundance and distribution of indigenous microorganisms within an area of extensive natural oil seepage, in the marine environment at La Brea, Trinidad. Sampling a natural oil seep area provides an opportunity to test the hypothesis that an extensive continuous input of hydrocarbons into the marine environment over an evolutionary time period should result in the development of a benthic ecosystem with a significant oil degrading and oil tolerant population of microorganisms.

Sediment samples were collected during a wet and dry season from up to ten (10) stations that varied in exposure to anthropogenic hydrocarbons. Quantification of total bacteria was made using epifluorescence microscopy and Most Probable Number (MPN) analyses. Total polyaromatic hydrocarbon (PAH), organic carbon and sediment types were also determined at the various stations.

Areas immediately surrounding active petroleum seepage generally had higher numbers of bacteria than other areas. During the wet season, November 1995, total bacterial numbers ranged from 3.38 cells/g sediment, at an area of moderate hydrocarbon seepage (Station 7), to 0.786×10^9 cells/g sediment at the largest petroleum seep (Station 5). In the dry season, May 1996, total bacterial numbers ranged from 0.749×10^9 cells/g sediment, at a moderate petroleum seep (Station 1), to 0.50×10^9 cells/g sediment at the most active seep station (Station 5).

The fraction of total heterotrophic bacteria in sediments represented by the hydrocarbon utilisers ranged from 2 to 100% in concordance with increasing exposure to petroleum. All bacteria at the most active seep were hydrocarbon utilisers. The majority of the other stations had values less than 20% HCU bacteria.

This study shows that in La Brea seep sediments, the majority of hydrocarbon degrading bacteria, numerically and metabolically appear to correlate with the concentration of petroleum. The occurrence and numbers of the microbial hydrocarbon utilisers illustrate their ubiquity and persistence and thus indicates the microbial potential for removal and conversion of hydrocarbons in the environment examined.

Keywords: ecology, hydrocarbon degrading bacteria, sediments.

Elias-Samlalsingh, N. 2000. Toxicity identification evaluation of produced water using *Metamysidopsis insularis* (Brattegard, 1970b). M. Phil. Thesis (Zoology), The University of the West Indies St. Augustine, Trinidad and Tobago, West Indies.

Culture techniques, life history, and suitability for use in toxicity testing of, the tropical estuarine mysid *Metamysidopsis insularis* (phylum: Arthropoda, class: Crustacea, order: Mysidacea, family: Mysidae) was determined. Toxicity identification evaluation or TIE (Burgess et al., 1996; Marine Toxicity Identification Evaluation (TIE), Phase-1 Guidance Document) was carried out on produced water (PW) effluents from seven inland petroleum installation discharge sites in Trinidad and Tobago. The TIE Phase-1 procedure was used to characterise the cause(s) of toxicity in the produced water effluents, using an untested tropical mysid.

The optimal laboratory conditions for culturing *Metamysidopsis insularis*, was a salinity of 25 to 30 ‰, temperature (25 to 27°C) and dissolved oxygen (7.0 mg/L). *Metamysidopsis insularis* reared in the laboratory were harvested daily (ten individuals per day) for a period of 26-days. The standard body length was used to determine the growth phases and moult cycles. Any distinguishing characteristics of these phases were recorded.

During the 26-day period, five major growth phases and eleven moults were identified. These growth phases were, early juveniles (days 0–1), juveniles (days 2–5), late juveniles (days 6–10), early adults (days 11–17) and adults (>17 days old). The first moult occurred within 24h (day 0-1) of release from the brood pouch. The moulting activity continued at regular intervals until sexual maturity (days 11–17), after which it became infrequent. Distinguishing morphological features such as pleopods in males and reproductive structures in males and females became visible in the late juvenile phase.

Toxicity Identification Evaluations using juveniles (48h old at the beginning) were conducted to establish an acute (24h-LC50) toxicity test response for the whole produced water and its fractions. The TIE procedures involve various manipulations such as aeration, filtration, ethylenediaminetetraacetic acid (EDTA) addition, sodium thiosulphate addition, C₁₈ Solid Phase Extraction (SPE) procedure and graduated pH procedures. The whole effluent toxicity for the produced water effluents ranged from 5.9 to 12.3% (initial 24h-LC50) and 0.09 to 17.5% (baseline 24h-LC50). The whole effluent acute toxic-unit response (TUa) for all sites ranged from 8.1 to 17.0 TUa (initial toxicity test) and 5.7 to 1,111 TUa (baseline toxicity test).

The Phase-1 effluent toxicity characterisation procedures revealed that the primary cause of toxicity in all samples were nonpolar organic compounds and sulphides. Other potential toxicants identified were ammonia, volatile organic compounds, metals, particulate matter, oxidants and pH dependent toxicants. Whole effluent toxicity can also be due to ionic composition and the stable oil-in-water emulsion, which consists of fine oil droplets (<0.1 µm to 10 µm with an average diameter of 2.5 µm).

These results show that the TIE procedure can be successfully applied to determining and characterising the toxicity of effluents in the Caribbean using the indigenous mysid species *Metamysidopsis insularis* (Brattegard, 1970b).

Keywords: toxicity, produced water, life history, indigenous species.

Gajadhar, S. 2000. Opportunities for waste minimisation at the kerosine/jet A-1 treating section of an integrated petroleum refinery. M.Sc. Thesis (Engineering), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The objective of this project is to identify opportunities for waste minimisation at the Kerosine/Jet A-1 Treating Section of an integrated petroleum refinery, in order to reduce the risk of negative impacts of the operation on the environment. This project is conducted and submitted in fulfilment of programme requirements for the completion of the Master of Science Degree in Environmental Engineering.

The principal analytical tool used in the project is a waste audit of the facility, coupled with analysis of samples drawn during a plant test run, in order to determine the extent of waste generation. The theme of the project is one of application of sound engineering theory and principles to the solution of environmental problems.

Several opportunities have been identified that, when implemented, will lead to a reduction in the quantity and an improvement in the quality of wastewater generated at the facility. In many cases, the implementation will lead to the improved product quality of the specification sensitive jet fuel. The opportunities include the automation of the control of the treating and washing fluid injection rate, the automation of the settler level control, the installation of a kerosene feed cooler, the use of an alternative, low cost technology to achieve superior mass transfer in the treating and washing operations in the plant and the use of a superior quality wash water sourced from the waste stream of another refinery operation. The proposals are evaluated to be technically and economically feasible, some with very attractive rates of return.

Keywords: waste minimisation, kerosene treating section, petroleum refinery.

Hollingsworth, W. 1982. Loss/gain analysis of materials in a lubricating oil blending plant. M.Sc. Thesis (Engineering, Production Engineering and Management), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

This is an Operations Research type of consultancy project undertaken to investigate apparent losses and gains of products during transportation, storage, blending and packaging of basic oils, additives and blended lubricants at a local Lubricating Oil (LO) Blending Plant. The attempt was to minimise and control all handling losses and explain the reasons for the apparent gains.

Because of the confidential nature of the operations, the plant is not identified by name, and the through-put figures (obtainable, and listed as well as used in the analysis) are representative samples only. The products are identified by letters (A, B, C, etc.) for the same reason.

It was found that only human and mechanical errors and inefficiencies were responsible for the apparent losses and gains by way of incorrect application of operating and recording techniques, and the use of non-standard, inaccurate and poorly maintained measuring equipment.

Keywords: loss/gain analysis, lubricating oil.

Khan, A.A. 1990. Fingerprinting of pelagic and stranded pollutants in the marine environment. M.Phil Thesis (Chemistry), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The deleterious effects of a crude oil spill or discharge in the marine environment are well documented. From the point of view of environmental management agencies, additional problems are encountered in determining the exact source of the spill and in trying to obtain some measure of compensation. This thesis addresses the problem of identifying the source of an oil spill and in providing a foundation from which litigation and/or liability costs may be derived from an offending party responsible for the spill.

To achieve these goals a multimethod chemical analysis system was employed to characterise various chemical components in a crude oil. Hierarchical cluster analysis was used to compare similar chemical data for spill and suspect source samples. An attempt was also made to determine the degree of weathering to which a spill sample may be subjected before the fingerprinting system developed yielded ambiguous results.

Analytical techniques of infrared, synchronous scan fluorescence and atomic absorption spectroscopy, together with carbon-13 nuclear magnetic resonance spectrometry and capillary gas chromatography, were combined into the multimethod fingerprinting system. The SPSS/PC+ software package was used for statistical interpretation of data.

The combination of these five analytical techniques was found to provide good correlation between spill and suspect sources even after exposure to one week of weathering. The application of carbon-13 nuclear magnetic resonance in crude oil fingerprinting however posed some problems and further refinement of this technique is needed.

One of the final outcomes of this study was the creation of a data bank containing chemical fingerprint data for a number of local crude oils. At present samples of crude oil from thirty-five fields have been characterised using the techniques of infrared, fluorescence and atomic absorption spectroscopy. The carbon-13 nuclear magnetic resonance spectra of nineteen have also been acquired.

An attempt was also made to quantify the distribution of tar and plastics in the Gulf-of-Paria, Trinidad. The results obtained were however inconclusive.

Keywords: fingerprinting, petroleum, oil spills, databank.

Lynch, K.F. 1991. The petrochemical industry in Trinidad and Tobago. M.Sc. Thesis (Economics), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The study analyses the petrochemical industry in Trinidad and Tobago and the prospects for the development of the industry within the international environment.

The present international industry is assessed and predictions are made about its future in light of existing trends. Case studies of two oil exporting developing countries, Venezuela and Saudi Arabia are reviewed to see the lessons which may be available for Trinidad and Tobago's industry.

The evolution of the domestic industry is analysed in terms of its organisational structure, the planning exercise and the performance throughout the last thirty years. A strategy for the future development of the industry is outlined. Generally, it was found that environmental awareness has been a significant influence on the industry. This has influenced the research and development activities as well as the move out of 'smokestack' industries. Research and development in the life, material and physical sciences will be as influential on the future of the industry.

Trinidad and Tobago's industry is small by international standards, but it represents a substantial investment of national resources. It is also not feasible to follow the example of some oil exporting developing countries and enter bulk chemical and other 'smokestack' industries which are being abandoned by some large scale chemical producers (for environmental and economic reasons).

To maximise the benefits to be derived, there is need for the country to review its industry and undertake detailed analyses for the international industry and devise a long term strategy.

Keywords: development, domestic oil industry, economics.

Mc Kenzie, P.F. 1982. A study of the well servicing accidents and vehicular accidents at an oil producing company in Trinidad. M.Sc. Thesis (Engineering, Production Engineering and Management), The University of the West Indies St. Augustine, Trinidad and Tobago, West Indies.

Maintaining a safe working environment is usually one of the objectives of a Company's management. Some of the advantages derived therefrom are low employee turnover, improved industrial relations and better image for the Company.

At the Company under study two areas of high accident frequency have been singled out. These are:-

- 1) Well servicing accidents
- 2) Vehicular accidents

This study analyses accidents in these two areas with a view to making recommendations as to which direction an accident prevention programme should take. The effectiveness of a 'defensive driving course' instituted in 1976 has also been studied.

Having examined the accident data in the Well Servicing Section over the period January 1979 to December 1981, the following conclusions can be drawn:-

The Production Floorman position was the one most prone to accidents accounting for 81% of rig accidents.

In the case of Company accidents, casual workers were involved in a relatively high number of accidents – 38% of total.

'Handling materials and equipment' was the most prevalent cause of accidents followed by 'Struck by falling or moving object'; these accounting for 25.5% and 24.4% of the total respectively.

Incomplete accident forms made a complete analysis impossible.

Having examined the Vehicular Accident reports of the Company for the period January 1978 to December 1980 and having reviewed other related data, the following conclusions can be drawn:

The Company's management needs to play a more significant role in the matter of fleet safety.

Vehicle abuse is partly due to the fact that vehicles are leased.

The Safety Section can be made more effective in the matter of accident prevention if increased manpower, proper training and greater scope of function are provided.

It is hoped that the implementation of the recommendations made in this report would contribute to a significant reduction in the number and severity of accidents at the Company.

Keywords: well servicing accidents, vehicular accidents.

McLean, K. 1988. Civil engineering and management in land-based petroleum production in Trinidad. M.Sc. Thesis (Construction Engineering and Management), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

Civil Engineering in petroleum production is held by many to be relatively insignificant. This common belief is probably based on the fact that expenditure on civil engineering is very small in comparison with that of the other well known producing activities. It is therefore the broad objective of this work to show that despite this fact, civil engineering is as important as any of the other activities and requires adequate attention, if the overall efficiency of the industry is to be improved. This work therefore will address the whole question of the improvement of civil engineering management within the environment of the petroleum producing industry. The task is approached in three stages which form the three parts of this thesis. These parts are as follows:

Part I - The historical and economic impact of petroleum

Part II – Civil engineering and petroleum production

Part III – Indigenous problems and recommendations

Part I covers the historical development and the economic significance of petroleum to the world in general and to Trinidad and Tobago in particular. This section should be of importance to our national planners and decision makers. It is the author's belief that better long-term policies cannot be made unless the persons involved in decision-making have an overall appreciation of the important role that petroleum has played in forming the very economic and social fabric of Trinidad and Tobago, and its potential to continue to do so for decades to come.

This history is important also in presenting the petroleum industry not only as an economic benefit but for the political power it commands. Its astute use in this regard by the multinationals to achieve their global objectives under the disguise of benefits to developing countries, can sensitise policy makers into clearer interpretations of any foreign assistance. In this way a more efficient industrial framework would be possible.

Part II places the practice of civil engineering in perspective with its counterparts in petroleum production. It examines the technological relations with other activities and highlights aspects of them that should be of importance to the civil engineering personnel. Apart from this technical aspect, this section examines the existing management systems that are being used to implement civil projects. The analysis however stops short of recommendations as this aspect is scheduled to be dealt with in part III. Part II thus provides the technical foundation that is necessary for the execution of management principles and also lays the background against which such (management) practices are expected to be performed.

Part III identifies the technical and managerial problems of civil engineering that have developed essentially because of the petroleum environment in Trinidad. These problems are analysed and recommendations made towards some kind of solution or mitigation of their effects. The opportunity is taken in this part to present appropriate details in the form of a guide. In this way persons wishing to conduct similar exercises might be facilitated. A chapter on the law and civil engineering as it relates to the producing sector is included as a final contribution towards identification of problems and recommended solutions.

A word of caution however is offered. This work is intended for a general audience of persons who may be involved in the producing business. It does not attempt to address actual construction sites management activities. Therefore, management's control of surveying, pavement construction and such are not discussed in any details, as these are probably well known to most civil engineering personnel or are adequately covered in other texts. Rather this work pays attention to the supporting activities where most of the delays and inefficiency exist.

Keywords: civil engineering, management, petroleum producing industry.

Mohammed, A(ddita). 1992. The history of Point Fortin, 1900 to 1930s. M.A. Thesis (History), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

This paper investigated the history of Point Fortin in the period 1900 to 1930s. Secondary material in the form of books, theses, journals, newspapers, government reports and papers, as well as oral interviews with knowledgeable people on the topic suggested that the oil industry played a central role in the development of Point Fortin in most of the period covered in this research paper. This view was further substantiated by documents and the 'in-house' magazine of the oil company based in Point Fortin.

The evidence shows that the activities of the oil company had a great impact on the social and economic development of Point Fortin. The Company succeeded in setting up a social structure based on categories and grades related to employment. Senior Staff workers represented the upper class, Junior Staff workers became the middle class, and the labouring class represented the lower class. The policy of the Company was to make living conditions of the upper class as comfortable as possible, to provide some semblance of comfort for the middle class, and the labouring class was left to fend for themselves. Yet, the activities of the company in Point Fortin led to a growth in its population, the promotion of business activity, and an improvement in communication links with the rest of the world. These results indicate that in the period 1900 to the 1930s, the oil company in Point Fortin was, to a great extent, responsible for the shaping and development of Point Fortin as a distinct oil-town.

Keywords: social development, economic development, population growth.

Mohammed, A(zad). 2000. Cellular, histopathological and molecular responses of *Corbula caribea* (Mollusca, Bivalvia) from a natural oil seep, to field and/or experimental exposure to polycyclic aromatic hydrocarbons. Ph.D. Thesis (Zoology), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

Corbula caribea (Mollusca, Bivalvia) is the most common non-polychaete macrofaunal organism identified at a large natural oil seep at La Brea in south Trinidad. It is hypothesised that chronic exposure to potentially toxic contaminants at the seep has stimulated these organisms to develop adaptive mechanisms that allow them to tolerate these conditions.

The concentrations of polycyclic aromatic hydrocarbons (PAHs) was determined in water and sediment samples collected from 10 stations in the vicinity of the seep. Eleven PAHs were identified in water samples during the November 1995 sampling period. The total concentration of PAH ranged between 517 and 2301 µg/L [API (American Petroleum Institute) #34 Trinidad crude oil equivalents]. In sediment samples the concentrations of total PAH ranged from 18.5 to 101 µg/g (API #34 Trinidad crude oil equivalents) dry weight of sediments. The PAH levels in water were significantly higher than the maximum of 300 ng/L recommended by the USEPA (1992) for the protection of marine life.

Animals from the seep were assayed in a closed continuous flow system with each of four PAH, typical of the seep site (naphthalene, acenaphthene, phenanthrene and dibenzothiophene), at concentrations up to 10 times the levels detected in sediment samples. No mortality was detected following 72-hour exposures. Two of the main histopathological changes evident following exposure to toxicant concentrations greater than the levels detected at the seep were metaplasia of stomach epithelia and atrophy of intestinal epithelia. However, these responses were not evident in animals examined from the field. Using stereological methods, it was possible to quantify cellular responses at different toxicant concentrations. With the stomach, normalised metaplastic responses showed an exponential increase with increasing toxicant concentration. Within the gills and palps mobilisation of adipogranular cells increased with increasing toxicant concentrations. Animals from the seep also showed high concentrations of adipogranular cells in the palps and gills. A metric which we have termed the 'Cellular Response Index' (the ratio of spaces to adipogranular cells within the vascular junction of the palps), enabled us to relate the degree of cellular mobilisation to the ambient toxicant concentration.

It is possible that these animals may possess innate homeostatic mechanisms that allow them to ameliorate the potentially deleterious effects of contaminants at the seep and at exposure concentrations that reflect field levels. However, at concentrations that exceed

these levels the neutralising capacity of these mechanisms is exceeded and toxicant induced responses are manifest.

Subsequently, investigations were conducted to determine if molecular responses might be responsible for the apparently enhanced tolerance of *Corbula caribea* within its natural environment. Investigations focused on components of the mixed function oxygenase (MFO) system (cytochrome P-450, cytochrome b₅ and NADPH-ferrihemoprotein reductase) which are reportedly involved in the metabolic detoxification of xenobiotics. Microsomal extracts prepared from animals collected at the seep showed no cytochrome P-450 or cytochrome b₅ activity. However, NADPH-ferrihemoprotein reductase activity was demonstrated using serial cryostat sections. In seep animals this activity proved to be significantly higher than in animals from two non-seep reference sites. At the latter sites, total PAH levels were significantly lower than at the seep site. Hence, it is likely that the ability of *Corbula caribea* from the seep to tolerate high levels of PAH may be due to the presence of this adaptive mechanism.

Keywords: histopathology, adaptive mechanisms, petroleum exposure.

Mulchansingh, V. C. 1967. The origins, growth and development of the oil industry in Trinidad and Tobago and its impact on the economy, 1857-1965. Ph.D., Arts, The Queen's University of Belfast, Belfast, Ireland.

Though the oil industry in Trinidad had its inception in 1857, it was not before the turn of the century that exploration was commenced in earnest. It was not long however before oil overtook the other major products – cocoa, sugar and asphalt – as the island's chief export. In the course of the last sixty years 160 companies have been formed to exploit Trinidad's oil, 9000 wells have been drilled with a one-third success and production has risen to some 135,000 barrels a day in recent years.

Keywords: history, development, petroleum exploration, drilling.

Mungal, R. 2000. A study of the characteristics, pollution prevention and control processes of produced water. M. Phil. Thesis (Engineering). The University of the West Indies, St. Augustine, Trinidad and Tobago.

This thesis deals with an investigation of current treatment and control processes in operation throughout Petrotrin's producing fields, followed by setting up and implementing an environmental monitoring programme to identify and quantify the major contaminants in the produced waters. The programme was designed so that data could be used for determination of impact on the environment, assist in pollution abatement technology selection and meaningful setting of regulatory standards.

An environmental monitoring programme was implemented at seventeen effluent discharge sites to monitor the contaminant levels in the effluent waters and at points upstream and downstream of the points of discharge in the waterway waters. Parameters studied on a monthly basis included pH, temperature, total suspended solids, dissolved oxygen, mineral oil and grease and sulphide content. Parameters studied quarterly included nutrients, polynuclear aromatic hydrocarbons (PAHs), trace heavy metals and chemical organic demand (COD).

Detailed analysis of the produced water indicated that measurable oil and grease content were in the free, emulsified and dissolved form. The levels of dissolved oil and grease in the effluents at most of the installations were substantial. For example, ten (10) installations showed levels above 200 mg/L, while three (3) had levels between 100-200 mg/L. The remaining four (4) sites have levels below 100 mg/L. The implication of these results is that it is impossible for most of the current treatment and control processes to meet regulatory discharge limits that recommend a maximum average of 50 mg/L based on oil and grease. Further research revealed that substantial reduction of the oil and grease contents in the effluent can be achieved by secondary treatment processes (chemical addition followed by induced air/gas flotation – ICF) giving up to 93% reduction and tertiary processes (activated carbon and air stripping) giving reductions up to 42%. Three approaches for setting standards for the discharge of produced water for the island's unique environment were evaluated and presented. A management plan for produced water generated in Petrotrin operations is also presented in this thesis.

Keywords: treatment mechanisms, environmental impact, mitigation measures.

Nansingh, P. 1993. Biological sensitivity of coastal environments in Trinidad to oil spills. M.Phil. Thesis (Zoology), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The coastline of Trinidad is considered a high risk zone to accidental oil spills. The extent of potential damage is in part related to the biological composition of the intertidal region of coastal habitats. This information can be quantified into an oil spill biological sensitivity index to coastal habitats.

The intertidal zones of fifteen representative coastal sites, were sampled quantitatively for macrofauna. Sampling was done once during a dry season and a wet season. On soft substrate sites, macrofauna were obtained from six replicate 0.1m² quadrats. On hard substrate sites, macrofauna were obtained from five replicate 0.1m² quadrats. In the mangrove swamp, macrofauna from six mangrove roots were sampled at each station.

Faunal parameters (density, biomass, species diversity and a species list), together with existing physical data at each site, were used to develop the oil spill biological sensitivity index.

The index is based on a scale of 1 to 10. Sheltered habitats with high productivity are the most sensitive to spilt oil, and are given an index value of 10. Exposed habitats with low productivity are the least sensitive to spilt oil, and are given a value of 1. The index applied to coastal habitats in Trinidad is as follows: mangrove swamps (10), coral-algal reefs (9), sheltered rocky coasts (8), sheltered tidal flats (7), mixed sand and gravel beaches (6), sheltered fine to medium grained sand beaches (5), exposed rocky shores (4), exposed tidal flats (3), exposed medium to coarse grained sand beaches (2), and eroding wavecut platforms (1).

This oil spill biological sensitivity index can be used in contingency planning for potential oil spills and in preparing resource maps of the coastline of Trinidad.

Keywords: biological sensitivity index, coastal areas, intertidal zones.

Paramanatham, V. 1993. Isolation and characterization of paraffin-utilising fungi. M. Phil. Thesis (Agriculture), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

Paraffin deposition is a major production problem in the petroleum industry and all methods now used to overcome the problem have tremendous disadvantages either in terms of cost or as hazards to the health and safety of workers. The discovery of microorganisms that could degrade these deposits may provide an effective, less costly and less hazardous means of alleviating the problems caused by the deposits.

Using standard enrichment techniques, five fungi were isolated from paraffin deposits and characterised as potential organisms for use in enhanced oil recovery programmes. Three of these isolates belong to the genus *Aspergillus* and one each to *Penicillium* and *Curvularia*.

Laboratory studies were conducted to understand their environmental and nutritional requirements. Fungal isolates were tested for their ability to grow on complex carbohydrates, hydrocarbons and petroleum distillates.

All isolates needed nitrogen for growth and were found to grow over a wide range of pH. These fungi belong to the group of mesophiles. Different isolates were able to efficiently utilise or oxidise petroleum distillates with different boiling points. This indicates that combination inoculation strategy would be more effective due to the complementary nature of the isolates and possible synergistic effects that can emerge by co-inoculation.

Keywords: paraffin deposition, microbial analyses, nutrients, pH.

Persadie, D. 1985. A study of safety promotion in an oil industry. M.Sc. Thesis (Engineering, Production Engineering and Management), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

Safety promotion is a vital function in modern industry, since accidents are costly, disruptive and cause human suffering in several ways. The maintenance of high standards of industrial health is an integral part of modern safety promotion.

The objective of this study is to investigate the Safety Promotion Activities and Programme during the period of 1979 to 1984 in Texaco, Pointe-a-Pierre (presently Trintoc, Pointe-a-Pierre). This study was done in the researcher's own organisation which is an oil company with specific reference to the multiplant refining division.

Several aspects of the Safety Program were examined and compared with guidelines outlined in published literature by safety organisations and experts. Recommendations are made accordingly. It is recognised that there is a need for management to publish a clearly defined safety policy to be distributed to all employees. Areas where good, effective programmes should be developed include Occupational Health and Hygiene and Environmental Monitoring.

The two standard rates, frequency and severity are used as measures of work-injury experience. The Accident and Injury Record downward trend from 1979 shows a reverse in 1984, where there was a slight increase in the number of accidents. This is attributed to the atmosphere of uncertainty created by the Company with retrenchment, job insecurity and the decision for government to take control, disturbing the emotional set of the worker. Now as these issues are settled a decrease of accidents in 1985 have been observed.

It is concluded that policies, edicts, rules and procedures regarding safety will not prevent accidents by themselves. Man as an individual is the weak link, in spite of the fact that it is man who has the most to lose by injuries. The Goal to achieve is "Profitable Production Without Accident." Then safety, while not first will achieve its proper recognition as a dynamic force for progress for the individual, his employer and society.

Keywords: safety promotion, policies, personal responsibility.

Ram, R. 1986. Some effects of petroleum residues on the Cromarty Series (Entic pelluderts). M.Phil. Thesis (Soil Sciences), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

The effects of crude petroleum on a single soil, Cromarty Series (Entic perlluderts), was investigated.

Due to petroleum pollution there were some readily distinguished effects. These included a blackening of the soil, the presence of a characteristic soil odour and introduction of water repellent behaviour. Bulk density was reduced while there was aggregation of the smaller sized particles and the formation of stable aggregates. Total void space could not be determined as water did not penetrate the cores.

The induced water-repellent nature of the soil appeared to interfere with chemical analytical methods which did not involve the use of strong acids or bases. Some of these were pH determination, cation exchange capacity and available phosphorus (Truog). The efficacy of these tests are based on the soil coming in close contact with the respective medium and the water-repellent nature of the polluted soil appears to reduce their requirement. Results showed an elevated pH, reduced cation exchange capacity and a peculiar increase in available phosphorus.

Analyses using strong bases and acids or high temperatures were not affected. There was an approximate seven fold increase in oxidisable carbon together with a fractional increase in nitrogen. Yields of humic and fulvic acids increased significantly, in absolute terms, but appeared as a reduction when considered as a fraction of the total organic carbon. Functional group analysis showed that the organic matter from the polluted soils had molecules with higher relative molecular masses or less functional groups per molecule. Sodium hydroxide did not remove all the petroleum (organic matter) from the soil; carbon tetrachloride was found to be a better extractant for petroleum compounds when used in a soxhlet extractor.

Key words: crude petroleum, Cromarty Series, temperature, acid/base.

Ricketts, H.E. 1993. The Trinidad and Tobago oil industry: a case study of TRINTOC, a politicised machine bureaucracy. M.Phil. Thesis (Social Sciences), The University of the West Indies, Mona, Jamaica.

This thesis is a case study of the Trinidad and Tobago Oil Company (TRINTOC), a state-owned enterprise, the result of a merger between a TEXACO branch plant, TEXACO Trinidad Incorporated (TEXTRIN), and a former branch plant of the transnational SHELL which was nationalised in 1974, and renamed the Trinidad and Tobago Oil Company (TRINTOC, Point Fortin). The structure and culture of the company are examined and evaluated in relation to the company's mission statement and within the broader context of current issues in organisational theory.

The theoretical basis of the study is the argument that modern day organisational theory is increasingly being affected by Japanese practice. This practice is a synthesis of scientific management, human relations theory, and industrial engineering and is having a profound effect on modern organisations. The structure, culture and merger problems of TRINTOC are analysed/evaluated from this point of view.

The argument is that TRINTOC 1985 is a politicised machine bureaucracy. It was nationalised by the government as a result of political pressure from below to save jobs and without any careful examination of the structure. The current structure is simply a superimposition of two merged structures, one positioned on top of the other.

The thesis also examines the cultural problems which have arisen as a direct result of the merger, pointing out the effects of the merger on them, and the reactions of the workforce. The culture is fragmented, since two cultures exist side by side in the same organisation. What is more, national ethnic divisions impact on the organisation and make it politically difficult to restructure.

The conclusion makes some recommendations for improvements, suggesting refocusing of operations on refining, and the privatisation by leasing, of the remainder of the operations. It steers clear of any suggestions to further merge the operations of TRINTOC with any other oil company, and also any suggestion of divesting the enterprise to foreign ownership and control. A call is also made for a re-examination by TRINTOC of its internal human relations and human resource problems in light of the important issues and questions raised by the theoretical chapter.

Keywords: organisational theory, politics, culture.

Tamasar, R. 1995. A history of Amoco Trinidad Oil Company 1961–1991. MA Thesis (History), The University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies.

Amoco Trinidad Oil Company is one of the leading companies which operate in Trinidad and Tobago. It is a wholly owned subsidiary of Amoco Production Company of the United States. Amoco Trinidad Oil Company commenced operations in Trinidad in 1961 and is engaged in exploration for and production of crude oil and natural gas in its licensed acreage off the east coast.

This research paper seeks to examine the exploration, drilling and production activities of Amoco Trinidad Oil Company in the period 1961 – 1991. Emphasis is placed on its social contributions to the national community as well as its role in protecting the environment.

Two methods of historical research were used for this paper. Both primary and secondary sources concerning Amoco Trinidad Oil Company and the local petroleum industry were examined, while oral interviews were also conducted. An analysis of data from these sources revealed that through its exploration and drilling programme, Amoco Trinidad Oil Company was able to discover three major oil fields – Teak, Samaan and Poui – as well as three prolific gas reserves – Cassia, Flamboyant and Immortelle. Between 1975 – 1991, the company became the leading producer of crude oil and natural gas in Trinidad and Tobago.

Virtually all of the low grade sulphur crude oil produced by the company is exported to the United States, while its natural gas output is sold to the National Gas Company for use as fuel in Trinidad and Tobago Electricity Commission's generating plants or as feedstock for the manufacture of petrochemicals in industries at the Point Lisas Industrial Estate. Amoco

Trinidad Oil Company also recognises that it has a social obligation to the national community in which it operates and provides grants and other forms of assistance to community development projects, schools and cultural groups.

Keywords: exploration, drilling, production, social contributions, environmental protection.

Toney, H. C. 1977. An appraisal of Petroleum Policy in Trinidad and Tobago 1962-1975. M.Sc. Mineral Sciences, The Pennsylvania State University, Pennsylvania, U.S.A.

This thesis summarises the economic development in Trinidad and Tobago since the time of Columbus to World War 2 and examines the post-war approaches to economic change and the economic trends and major features of the 1960s and 1970s.

Keywords: economic development, economic change.

Books

Abdullah, B. 2005. Peak oil paradigm shift. The urgent need for a sustainable energy model. Medianet Limited, St. James, Trinidad and Tobago.

This book discusses the need to find alternative, sustainable sources of energy since it is postulated that world oil production will peak in the near future. It discusses why a paradigm shift is needed, when peak oil will occur, oil and natural gas consumption, alternatives to these sources of fuel, implementing the required paradigm shift and the relationship between peak oil and climate change.

Beeby-Thompson, A. 1960. Oil Pioneer: selected experiences and incidents associated with sixty years of world-wide petroleum exploration an oilfield development. Sidgwick and Jackson, London, England.

Oil pioneer is the autobiography of Mr. Beeby-Thompson, much of whose long eventful life has been devoted to serving the oil industry. The method adopted in telling the story is chronological until 1904 when he had taken the plunge and established his firm of consulting petroleum engineers in London. Thereafter he treats region by region over the period, often lasting some decades through which he has watched and influenced its development.

Boopsingh, T.M. 1980. Trinidad and Tobago: the petroleum industry - the next decade. Ministry of Energy-based industries, Port of Spain, Trinidad and Tobago.

This paper is a discussion on the oil and gas production and the change over from the former to the latter in the 1970s. It discusses the economic and production prospects for the 1980s, which at that time represented the next decade.

Boopsingh, T.M. 1990. Oil, gas and development: a view from the South. Longman Trinidad, Port of Spain, Trinidad and Tobago, West Indies

In this book, the author gives a local and international perspective of the oil and gas industry in Trinidad. It looks at how energy sources impact on society, oil pricing, overviews petroleum taxation and licencing systems, production costs and managing petroleum reserves.

Boopsingh, T.M. and T.A. Byer. 1993. Caribbean Energy Sector Review and Perspectives. Trinidad and Tobago, West Indies

This study is a comprehensive review of the prospects for energy in the Caricom countries of the region, over the medium term. The principal areas which this study consider to be important are petroleum, electricity, domestic capital and human resources. Discussion of these are developed and the economics and policies relating to petroleum management are explored.

Cipriani, A.A. 1946 His best orations. Surprise Print Shop, Trinidad and Tobago, West Indies.

In one of his speeches, Captain Cipriani talks of the oil industry destroying the cocoa industry in Trinidad and Tobago, both physically and economically.

Higgins, G.E. 1996. A history of Trinidad Oil. Trinidad Express Publishers, Port-of-Spain, Trinidad and Tobago.

This book is a detailed description of the development of the oil industry in Trinidad and Tobago, from the last 18th century visits to the Pitch Lake in La Brea to the production details at the end of

1990. It describes the history of many of the early oil companies and their successors, and includes details of major explosions, fires and accidents, which can be considered environmental impacts. Most importantly, this book contains photos of early and late drilling exercises and important personalities in the history of Trinidad oil.

Penny, W.F. 1955. A history of oil in Trinidad. Based on the work of W.F. Penny and J. Lonsdale Harris. Committee of Trinidad Oil Companies, London, England.

Not available at time of data collection.

Persad, K. 1992. The petroleum encyclopaedia of Trinidad and Tobago. K. Persad and Associates, Port of Spain, Trinidad and Tobago.

This book is an overview of oil and gas industry in Trinidad and it explores the status and outlook of the industry in terms of exploration, production, refining and petrochemical products. It also looks at the petroleum legislations and taxation processes used and examines the political climate at that time. It contains information of petroleum geology and statistical tables of production values for 1991.

Ramlogan, R. and N. Persadie. 2004. Developing Environmental Law and Policy in Trinidad and Tobago. Lexicon Trinidad Limited, San Juan, Trinidad.

This book overviews environmental legislation in Trinidad and Tobago since its colonisation, and discusses the evolution of the Environmental Management Act, the institutional framework for environmental management in Trinidad and Tobago, the impact of the changes in environmental legislation, the weaknesses of the environmental act and the allocation of financial resources and protection of the environment. It includes within its appendices a collection of important legislations and policies including the National Environmental Policy and a list of the existing legislative framework for protection of the environment in Trinidad and Tobago.

Reports

Point Lisas Industrial Port Development Corporation Ltd. and Institute of Marine Affairs.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1982. Point Lisas Environmental Protection Project, Volume 1- Executive Summary. Institute of Marine Affairs, Chaguaramas. 33p.

This is the executive summary for a seven-part report on the Point Lisas Environmental Protection Project. This summary indicated that the Gulf coast area of Central Trinidad is predominantly used for sugar cane cultivation and as a result, much of the natural environment is disturbed. The investigations carried out for this project revealed that the natural vegetation of the Estate and environs has been already irreversibly altered, apart from a small area around the Couva River mouth.

The Executive summary recommends that development works be made with due regard to the living components of the environment and that removal of mangroves and paving of rivers must not be encouraged. This report also recommends that discharge of wastes which are harmful to plants, anInstitute of Marine Affairsls and humans be controlled. The concern of the environmental effects of thermal inputs was also mentioned and discussed. The major atmospheric pollutants namely carbon dioxide, hear, dust, odour and noise, sulphur dioxide, ammonia should also be controlled.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1981. Point Lisas Environmental Protection Project, Volume 2- Rivers and Mangroves. Institute of Marine Affairs, Chaguaramas. 81pp.

This report summarises the quality of rivers and mangroves in the Point Lisas area prior to the construction of the Point Lisas Industrial Estate. In this report, the Couva and 'LNG' rivers are recognised as tidal rivers characterised by salt water intrusion. The absence of this intrusion was noted in the 'B.C.' and Savonetta Rivers and hence, these two rivers were populated by freshwater species.

The mangrove fauna at Point Lisas appear typical of the Gulf of Paria. It is recommended that good water quality be maintained despite the construction of the industrial park and the changes in land use so as to perpetuate life in the rivers and coastal waters of Point Lisas.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1981. Point Lisas Environmental Protection Project, Volume 3 – Flora of the Gulf of Paria Coast of Trinidad from Couva to Claxton Bay. Institute of Marine Affairs, Chaguaramas. 28p.

This report indicates that human activity in the area resulted in the development of a number of altered environments, each supporting a peculiar flora comprising mainly of weeds (both native and introduced) and crop plants. These activities include human settlements, which support fruit trees, ornamentals, garden vegetables and herbs; farmland which support mostly sugarcane and some weeds; roadside verge which supports a vigorous adventive flora which exhibit great species diversity and public dumps which are mostly located in mangrove areas and result in the destruction of the mangroves.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1981. Point Lisas Environmental Protection Project, Volume 4 – Marine Water Quality. Institute of Marine Affairs, Chaguaramas. 69p.

This report indicates that the offshore waters around Point Lisas appear to be characteristic of coastal estuarine conditions. Slightly elevated temperatures in south Lisas Bay together with high

ammonia, nitrate and nitrite concentrations were the only significant features in the physical and nutrient parameters measures. However, the presence of trace metals (mercury, lead, copper and zinc) were often recorded at levels above the acceptable EPA standards for marine waters. Concentrations of hydrocarbons were also found to be high in south Lisas Bay and north Claxton Bays, while no significant levels of chlorinated hydrocarbons (pesticides) were recorded in the whole area. Sediment quality investigations showed levels of trace metals indicative of low level pollution in a coastal environment. It is however, important to note that concentrations of mercury, lead, copper and hydrocarbons, in south Lisas Bay show a potential for future build-up which could cause problems if allowed to continue.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1981. Point Lisas Environmental Protection Project, Volume 5 – The Zooplankton. Institute of Marine Affairs, Chaguaramas. 92p.

This report indicates that Lisas Bay is tending towards a eutropic situation. Runoff from the land has increased due to destruction of the fringing mangroves by the reclamation activities and by silt leaching from the reclaimed land into the remaining mangroves. The inner part of Lisas Bay is under the most stress, due to its proximity to the Federation Chemicals and Tringen cooling water effluent channels. The concentrations of trace metals in the sediments were highest in Lisas Bay than in any other of the four bays. The conditions of stress in inner Lisas Bay were reflected by the zooplankton population, in that, the lowest true mean standing crop for the four bays was recorded here. However, highest diversity indices were recorded in Lisas Bay as a whole. The high diversity indices were not a reflection of zooplankton population stability, but an influx to the nutrient enriched waters during the dry season.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1981. Point Lisas Environmental Protection Project, Volume 6 – The Benthos. Institute of Marine Affairs, Chaguaramas. 101p.

The Lisas Bay area is highly stressed due to high nutrient, trace metals and hydrocarbon concentrations as well as input of commercial effluents and destruction of fringing mangrove. The conditions of stress in the inner part of the south Lisas Bay were reflected in the benthic communities. Densities and diversities increased along the transect with distance from the source of pollution.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1981. Point Lisas Environmental Protection Project Volume 7 – Fisheries. Institute of Marine Affairs, Chaguaramas. 25p.

A study was made of the finfish, shrimp and crabs of Point Lisas in the Gulf of Paria. One hundred and twenty species of fish, eleven species of shrimp and nine species of crab were presented. The diversity index for fish was high. The fishes *Cathoropsspixii* and *Diapterus rhombeus* dominate the catch. The most abundant commercial fish was *Micropogon furnieri*. Four species of commercially important shrimp were abundant. The area is important as a nursery ground, with juvenile fish, shrimp and crabs occurring from August to April. Of commercially important fish species, *Caranx hippos* and *M. furnieri*, in addition to four shrimp species use the area as a nursery ground. Seasonality is marked along various species in the three groups, and among the fishes the clupeoids appear in the wet season and sciaenids in the dry season.

Point Lisas Industrial Port Development Corporation Ltd and Institute of Marine Affairs. 1981. Point Lisas Environmental Protection Project Volume 8 – Fisheries. Institute of Marine Affairs, Chaguaramas. 40p.

The companies producing the largest quantities of waste and thus those with the potential for having the most significant environmental impact are: Caroni (B.C.), T&TEC, Fertrin, ISCOTT, Fedchem/Tringem, Texaco, and possibly Trinidad Cement's combined operations.

The important wastes are those in liquid forms. The thermal input will be tremendous and may well interact synergistically with other contaminants. Other important parameters that will need monitoring are pH, ammonia (in Fertrin's effluent) and suspended solids.

As regards the total Point Lisas environment, the major (air) pollutants will be carbon dioxide, heat, dust, odour and noise, together with irregular discharges of sulphur dioxide, ammonia and miscellaneous vented process gases.

Institute of Marine Affairs

Juman, R. and S. Sookbir. 2006. Preliminary assessment of the ecological status of the Godineau Swamp, South Trinidad. Description of the present ecological characteristics of the Godineau Swamp. Institute of Marine Affairs, Hilltop Lane, Chaguaramas.

The Godineau/South Oropuche wetland is an estuarine system on the southwest coast of Trinidad. The boundary of this wetland was delineated, the extent and changes in the plant communities mapped, and the structure and productivity of the mangrove swamp assessed. The delineated wetland measured 3,171 ha and drains a catchment basin of 42,473 ha. The predominant vegetation type was tidal marsh, which occupied 55% of the wetland and included freshwater and saltwater marsh, and areas used as pasture land. Other plant communities included mangrove forest, terrestrial forest and short-crop agriculture. In 1969, the predominant vegetation was rice, which covered 1,429 ha. However in 2003, rice cultivation was not observed and abandoned rice fields has either reverted to marsh or were under short crop cultivation. The mangrove forest measures 711 ha and was dominated by *Rhizophora mangle*. Mean biomass and basal area were $7.7 \pm 2.6 \text{ kg m}^{-2}$ and $11.5 \pm 3.1 \text{ m}^2 \text{ ha}^{-1}$ respectively. Mangrove productivity, as indicated by litterfall rates varied spatially and seasonally with a mean rate of $4.0 \pm 1.6 \text{ g dry wt. m}^2 \text{ d}^{-1}$. Although this wetland has been impacted by hydrological alterations and oil exploration activities, it is still a productive system.

Juman, R. and S. Sookbir. Preliminary assessment of the ecological status of the Godineau Swamp, South Trinidad. Description of the present hydrological regime in the Godineau Swamp. Institute of Marine Affairs, Hilltop Lane, Chaguaramas.

The Godineau Swamp is an estuarine system on the southwest coast of Trinidad. The catchment basin for this wetland measures 42,473 ha, and empties into the Gulf of Paria via the Godineau River and Mosquito Creek. The wetland and catchment basin have traditionally been used for agriculture, and later for oil exploration activities, which began in the early 20th century. These activities have been mainly responsible for the hydrological alteration of this system. This study attempts to describe the present drainage pattern in the wetland and associated drainage area using aerial photographs, hydrographic and topographic maps. Annual freshwater discharge into the Gulf of Paria was estimated at $6.0 \text{ m}^3 \text{ s}^{-1}$, using an empirical water balance model. Discharge was considerably higher in the wet season months. A harmonic analysis was conducted on tidal data collected at the mouth of the Godineau River. This analysis indicated that the tide in Godineau Swamp is a mixed semi-diurnal tide. Tides are micro-tidal with spring tide range of 97cm, neap tide range of 44 cm and a mean semi-diurnal range of 77 cm. Knowledge of the hydrology of the Godineau Swamp is critical if we are to predict and manage changes in this wetland environment.

Institute of Marine Affairs (IMA). 2006. Development of a National Programme of Action (NPA) for the Protection of the Marine Environment from Land-based Sources and Activities. IMA, Hilltop Lane, Chaguaramas.

This report describes the physical characteristics of our local marine environments, major historic and ongoing land use activities and it overviews the state of the local riverine systems. With references included, the impacts of major land use activities on the estuarine and marine environments are described in details. It described incidence of oil spills and contamination in South Trinidad with corresponding concentration values.

Institute of Marine Affairs (IMA), 2001. Environmental Incident Report. Report on the investigation of a fish kill at PETROTRIN dams. Institute of Marine Affairs, Chaguaramas, Trinidad.

The Institute of Marine Affairs (IMA) was informed of a fish kill that occurred in tow of the five dams at the PETROTRIN Compound (Dam 2 and Dam 5) on Wednesday 25 July 2001. A site visit was made by the IMA on Thursday 26 July 2001 during which water and sediment samples were obtained from four dams. Samples were also taken from the Guaracara River upstream of the intake point and at the water discharge point. Dam 3 was used as the control station since it was described as environmentally stable by PETROTRIN officials.

Water samples were analysed for physical and chemical parameters. Physical parameters included dissolved oxygen, pH, temperature, salinity and conductivity. Chemical parameters include nitrates, nitrites, free ammonia, reactive phosphates, chlorophyll 'a' and dissolved/dispersed petroleum hydrocarbons. Sediment samples were analysed for absorbed/adsorbed petroleum hydrocarbons and extractable cadmium, chromium, copper, lead and nickel. Dead fish were identified as Black tilapia (*Oreochromis mossambicus*).

High DDPH (9653.45 μgL^{-1}) and AAPH (28.99 μg^{-1}) concentrations were found at the Guaracara River and indicate significant contamination by petroleum hydrocarbons. DDPH concentrations at the dams ranged from 1.71 μgL^{-1} (Dam 4) to 26.43 μgL^{-1} (Dam 3) and indicate little or no impact by petroleum hydrocarbons. Similarly, AAPH concentrations found at Dam 3 and Dam 5 were 2.23 μg^{-1} and 9.09 μg^{-1} respectively, which indicated little or no impact by petroleum hydrocarbons.

The cause of the fish kills can be attributed to contamination by petroleum hydrocarbons (AAPH and DDPH) and heavy metals. The extremely low DO levels combined with the high levels of Chlorophyll 'a', ammonia and reactive phosphates may be contributing factors to the fish kill in dams 2 and 5 at the PETROTRIN compound.

Institute of Marine Affairs (IMA), 2001. Environmental Incident Report. Report on the investigation of an oil spill in the Oropuche River, South Oropuche Swamp, Trinidad. Institute of Marine Affairs, Chaguaramas, Trinidad.

On April 21 2001, the media reported an oil spill in the Oropuche River, South Oropuche Swamp. The source of the oil spill was reported to be a ruptured pipeline owned by the Petroleum Company of Trinidad and Tobago (PETROTRIN). The Institute of Marine Affairs (IMA) responded to this report and sent out a team of researchers on April 24 2001 to investigate the extent and impacts of the oil spill on the surrounding wetland ecosystem.

The IMA team mapped the extent of the swamp impacted by the oil spill using a Global Positioning System (GPS), investigated the impact of the oil spill on some aspects of the biota, took photographs of the affected areas and collected water samples at six stations to measure level of Dissolved/Dispersed Petroleum Hydrocarbons (DDPH).

The total length of the Oropuche River impacted by the oil spill was estimated at 4.6km. The effect of the oil spill was more evident downstream and extended 3.2km west. Mangrove forest fringing the banks of the Oropuche River was affected by the oil spill. The breathing roots (pneumatophores) of the black and white mangroves were coated with oil as well as the prop

roots of the red mangrove. The effect was seen up to the high water mark. Six caimans, as well as the prop root fauna, were observed coated with oil. No fishes or birds were observed covered in oil.

The DDPH level at the control station, which was further upstream and showed no visible signs of an oil spill, was relatively high (9.32 µg/L) indicating that this river system is subjected to some amount of pollution from oil exploration activities. DDPH levels at the source of the oil spill and further downstream (Station 1 and 4) were highest, 51.74 µg/L and 54.57 µg/L respectively, indicating that the effects of the spill were more evident downstream.

Institute of Marine Affairs (IMA), 2001. National Report on Environmental Problems of the Marine Coastal areas, Trinidad and Tobago. Institute of Marine Affairs, Chaguaramas, Trinidad.

This report overviews water, air and land pollution issues for coastal regions of the country and indicate that oil exploration and refining activities contribute towards coastal pollution.

Mc Shine- Mutunhu, H. 1985. Couva River diversion—a problem in environmental planning. Institute of Marine Affairs, Hilltop Lane, Chaguaramas. 27pp.

This report discusses the ecological and sociological impacts of the Couva River diversion. Some of the ecological impacts include loss of benthic habitat, loss of biodiversity, loss of wetlands, alterations of the natural drainage system and the input of industrial effluents. Sociological impacts include loss of livelihood for commercial shellfish traders, discomfort due to erosion and stagnation of water during construction and accumulation of untreated waste.

Government Reports

Inspector of Mines, 1906. Report of the Inspector of Mines for the two years ending 31st August 1906. Laid before a legislative council in 1906. pp.6.

It must be remembered that commercial production began in 1908 but prior to this, oil was distilled from asphalt. According to the report for 1904-1906 in the asphalt industry, there were 2 non-fatal accidents in 1904 and 1 non-fatal accident in 1905. The report however states that there was no obligation on the part of the owners or managers to report accidents to the authorities at the time and hence, the above figures are approximate and only represent fatal or almost fatal accidents.

Inspector of Mines, 1909. Report of the Inspector of Mines for 1908. Council paper No. 67 of 1909. Council paper No. 67 of 1909. pp.3.

This report summarises the activities of the oil industry under the heading 'Borings'. It indicates that successful borings were made by two oil companies in this year and it also summarises chemical composition of the oil collected locally.

Inspector of Mines, 1910. Report of the Inspector of Mines for 1909-1910. Council paper No. 85 of 1910. pp.6.

In the section entitled 'Borings,' the exploration for petroleum was discussed in some detail.

Inspector of Mines, 1911. Report of the Inspector of Mines for 1910-1911. Council paper No. 142 of 1911.

The activities within the asphalt and oil industries were discussed and it was indicated that no accidents of any serious nature were reported.

Inspector of Mines, 1912. Report of the Inspector of Mines for 1911-1912. Council paper No. 100 of 1912.

In this year's report, there is a table of the accidents which occurred at the Mines, Borings and Quarries industries. According to the list, there is only one entry for oil fields (Trinidad Oilfields Limited) and it is reported that there was only one serious accident which occurred for this company at that time.

Inspector of Mines, 1913. Report of the Inspector of Mines for 1912-1913. Council paper No. 103 of 1913.

A table of the list of accidents within the Mines, Oilfields and Quarries is included in this report. According to this table, there are now four companies working on oil exploration and extraction and there were five accidents reported for this year. The table lists all the minor, serious and fatal accidents in all the companies listed.

Inspector of Mines, 1914. Report of the Inspector of Mines for 1913-1914. Council paper No. 126 of 1914. pp.6.

This report contains a table of the accidents reported in the Mines, Oilfields and Quarries industry. According to this table, there are four oil companies which reported a total of twelve accidents for this year. Like previous reports, the table lists the accidents according to minor, serious and fata.

Inspector of Mines, 1915. Report of the Inspector of Mines for 1914-1915. Council paper No. 98 of 1915. pp.6.

A table of the accidents occurring in the Mines, Oilfields and Quarries industry is included and according to this table, there were sixteen accidents reported in the five companies which were involved in oil exploration.

Inspector of Mines, 1916. Administrative report of the Inspector of Mines for the nine months ended 31st December, 1915. Council paper No. 88 of 1916. pp.6.

There are at least four companies involved in the oil industry during the year 1915 and there were sixteen accidents reported in total. This information is contained in a table which summarises the accidents in the Mines, Oilfields and Quarry industry.

Inspector of Mines, 1917. Report of the Inspector of Mines for 1916. pp. 4.

This report summarises the activities within the oil industry over the year 1916 and includes a table of the accidents within the Mines, Oilfields and Quarry industries. According to this data, there are at least four companies involved in oil exploration and there were approximately twenty accidents reported in this industry.

Inspector of Mines, 1918. Report of the Inspector of Mines for 1917. pp. 4.

This report includes a summary table of the accidents in the Mines, Oilfields and Quarry industries for the year 1917 and indicates that there were at least forty accidents during that year.

Inspector of Mines, 1919. Report of the Inspector of Mines for 1918. pp. 4.

This report includes a summary table of the accidents in the Mines, Oilfields and Quarry industries for the year 1918 and indicates that there were at least forty accidents during that year.

Inspector of Mines, 1920. Report of the Inspector of Mines for 1919. pp. 4.

This report summarises the accidents and important events in the Mining, Oilfield and Quarry industries for the year 1919. There was one fire recorded in this year during the transferring process of petrol into an underground storage facility. This report also summarises accidents in these three industries and indicates that there are at least four oilfield companies which reported approximately twenty accidents for this year.

Inspector of Mines, 1921. Report of the Inspector of Mines for 1920. pp. 6.

This report contains a table of accidents for the Mines, Oilfields and Quarry industry for the year 1920. It indicates that there are at least four companies working at oil exploration and extraction and that these reported approximately thirty accidents for this year.

Inspector of Mines, 1922. Administrative Report of the Director of Land and Mines and Sub-Intendent of Crown Lands for the year 1921. pp. 18.

Like previous years, this report contains a table of the accidents reported in the Mines, Oilfields and Quarries during the year of 1921. According to this table, there are at least ten companies working within the oil sector and within these, there were at sixty-five accidents reported.

Inspector of Mines, 1922. Administrative Report of the Acting Director of Land and Mines, the Acting Sub-Intendant of Crown Lands and the Crown Surveyor for the year 1922. Council Paper No. 48 of 1923.

The table of accidents in the Mines, Quarry and Oilfield industry indicate that there are at least eight companies active in the oil industry and that these companies reported a total of forty accidents in the year 1922.

Inspector of Mines, 1927. Administrative Report of the Inspector of Mines for the year 1926. pp. 5.

There is no table of accidents included in this report however, it describes an accident which occurred when a well became ignited and caused five fatalities. It also contains information on the leases for oil exploration, drilling activities and oil extraction which occurred during this year.

Inspector of Mines, 1928. Administrative Report of the Inspector of Mines for the year 1927. pp. 4.

This report, like that of the previous year, does not contain a table of accidents but instead describes one accident of great importance because three employees were severely burnt and one succumbed to his injuries. The report also summarises the revenue derived from the petroleum industry.

Inspector of Mines, 1929. Administrative Report of the Inspector of Mines for the year 1928. pp. 4.

This report describes one important accident where a well ignited at night and caused the death of sixteen people. The report also contains other information relevant to the petroleum industry including lease arrangements, profits and quantities extracted for that year.

Inspector of Mines, 1930. Administrative Report of the Inspector of Mines for the year 1929. Council Paper No. 49 of 1930. pp. 9.

This report includes a statement by the Acting Petroleum Technologist who describes the number of new wells and their locations as well as the changes in operation techniques in the exploration and extraction of oil. It also includes a note on an increase in inspections of drilling and production machinery and the willingness of operating companies to co-operate with the Mines Office as regards conservation problems and in carrying out safety measures for the better protection of the employees.

Inspector of Mines, 1931. Administrative Report of the Inspector of Mines for the year 1930. Council Paper No. 56 of 1931. pp. 7.

The Petroleum Technologist includes a report in which he indicates the recent finds in the oil for the year 1930 as well as the number of new wells and total functional wells for this year. He also reports that there were seven fatal accidents as well as one oilfield fire but does not indicate if the fatalities were as a result of the fire.

Inspector of Mines, 1932. Administrative Report of the Inspector of Mines for the year 1931. Council Paper No. 50 of 1932. pp. 8.

The report of the Petroleum Technologist summarises the production and drilling statistics for this year. It also indicates that there were no fatal accidents as well as no well fires for this period.

Inspector of Mines, 1933. Administrative Report of the Inspector of Mines for the year 1932. pp. 8.

This report summarises the production statistics for the year 1932 and includes comments in the use of new equipment for exploration exercises. It also indicates that there was one fatal accident and twenty-two others reported for this year. An analysis of these accidents showed that 48 percent were due to carelessness or inattention to what was going on by the man injured, the balance were unavoidable. There were no well fires reported in this year.

Inspector of Mines, 1934. Administrative Report of the Inspector of Mines for the year 1933. Council Paper No. 47 of 1934. pp. 8.

This report indicates that there were three fatal accidents and twenty-four reportable accidents during this year. An analysis of these accidents indicate that 66.6 percent of the fatal accidents and 20 percent of the other accidents were due to carelessness on the part of the deceased or injured man; the balance were unavoidable. The report also described two well fires as well as lightning storms and cyclones which struck the southern region of the island and caused considerable damage to wooden derricks as well as to Xmas tree connections, which resulted in wild sprays of oil.

Inspector of Mines, 1935. Administrative Report of the Inspector of Mines for the year 1934. Council Paper No. 67 of 1935. pp. 9.

This report summarises the activities in the petroleum industry as well as new introductions in oil exploration technologies. It also indicates that there were three fatal accidents and thirty-one other reportable accidents. An analysis of these show that forty-seven percent of the whole were classified as unavoidable and 35 percent carelessness on the part of the deceased or injured man.

Inspector of Mines, 1936. Administrative Report of the Inspector of Mines for the year 1935. Council Paper No. 60 of 1936. pp. 8.

This report also summarises well activity and production statistics for the year 1935. It indicates that there were 31 reportable accidents, three of which were fatal. Of these accidents, twenty-one were either due to carelessness on the part of the workmen involved, or were unavoidable. There were no oilfield fires reported for this year.

Inspector of Mines, 1937. Administrative Report of the Inspector of Mines and the Petroleum Technologist for the year 1936. pp. 11.

This report indicates that there were 54 reportable accidents on the oilfields during this year. Sixteen were avoidable, twenty-six due to carelessness and 13 to bad practices and one to disobedience. Five of these accidents were fatal. The report also indicates that minor injuries to rigmen are increasing. Three boiler explosions were also reported for this year and in at least two cases, negligence was a contributory cause.

Inspector of Mines, 1938. Report of the Inspector of Mines and the Petroleum Technologist for the year 1935. Council Paper No. 32 of 1938. pp. 9.

This report does not indicate accident statistics however it does include a note on the collection of water samples from twenty-six wells because the variation of salt water was found to be related to faulting in a number of fields. Also included is a note that "several companies took considerable trouble to prevent pollution of streams of oil. It is hoped that other operators will follow their example, since there are several sections of coast line which are still being fouled by oil."

Inspector of Mines, 1939. Report of the Inspector of Mines and the Petroleum Technologist for the year 1938. pp. 9.

Aside from petroleum production and drilling statistics, this report indicates that there were two large and one small tank fire, of which one was due to lightning and no persons were injured. Seven fatal accidents were reported in the oilfields during this year. The report also notes that anti-pollution measures were pursued by some companies with the result that pollution of certain rivers improved considerably. It also reports that in other instances, little work was done and hence, some rivers and parts of the foreshore were still being fouled by oil.

Inspector of Mines, 1940. Report of the Inspector of Mines and the Petroleum Technologist for the year 1939. pp. 9.

This report indicates that there were six fatal accidents in the petroleum industry and that all of these were due to carelessness on the part of the workmen or were unavoidable.

Inspector of Mines, 1941. Report of the Inspector of Mines and the Petroleum Technologist for the year 1940. pp. 3.

Aside from petroleum statistics such as acreage under oil exploration and revenue derived from petroleum products, this report indicates that there were eight fatal accidents in the year 1940 which increased from the previous year (1939=6). It also indicated that five of the accidents occurred in refining installations whilst three occurred during drilling operations.

Inspector of Mines, 1942. Report of the Inspector of Mines and the Petroleum Technologist for the year 1941. pp. 3.

This report indicates that there were six fatal accidents which occurred in 1941 as compared to eight in 1940 and four which occur in other industries. Three of these accidents occurred in

refining installations and three occurred during drilling operations. This report also includes a note, written by the Acting Assistant Petroleum Technologist, of the number of freshwater wells drilled in the colony during the year of 1941 and the conversion of four oil wells to freshwater wells.

Inspector of Mines, 1943. Report of the Inspector of Mines and the Petroleum Technologist for the year 1942. pp. 3.

This report contains all the petroleum production and drilling statistics and also indicates that there were four fatal accidents within this industry for the year 1942.

Inspector of Mines, 1944. Report of the Inspector of Mines and the Petroleum Technologist for the year 1943. pp. 3.

This report contains all the petroleum production and drilling statistics and also indicates that there were no fatal accidents within this industry for the year 1943.

Inspector of Mines, 1945. Report of the Inspector of Mines and the Petroleum Technologist for the year 1944. pp. 3.

This report contains all the petroleum production and drilling statistics and also indicates that there were seven fatal accidents within this industry for the year 1944.

Inspector of Mines, 1946. Report of the Inspector of Mines and the Petroleum Technologist for the year 1945. pp. 3.

This report contains all the petroleum production and drilling statistics and also indicates that there were one fatal accidents within this industry for the year 1945.

Colony of Trinidad and Tobago, 1947. Report of the Inspector of Mines and the Petroleum Technologist for the year 1946. pp. 3.

This report contains all the petroleum production and drilling statistics and also indicates that there were two fatal accidents within this industry for the year 1946.

Colony of Trinidad and Tobago, 1948. Administrative report of the Mines Department, 1947. pp. 3.

This report contains all the petroleum production and drilling statistics and also indicates that there were four fatal accidents within this industry for the year 1947.

Colony of Trinidad and Tobago, 1951. Administrative Report of the Petroleum Department for the year 1950. pp. 13.

This report contains all the petroleum production and drilling statistics and also indicates that there were fifty-two accidents on the oilfields, of which two were fatal. It also indicates that the larger companies try to implement safety precautions and train their employees in the safe handling of tools and equipment and that these moves have steadily improved the accident rate.

Colony of Trinidad and Tobago, 1952. Administrative Report of the Petroleum Department for the year 1951. pp. 12.

Aside from petroleum production and drilling statistics, this report indicates that there were sixty-eight serious accidents and six people were killed by the explosion of a drilling well which occurred due to negligence.

Colony of Trinidad and Tobago, 1953. Administrative Report of the Petroleum Department for the year 1952. pp. 12.

This report indicates that there were eighty accidents which were of a serious nature which is defined as those involving a fracture, amputation, deep incision or multiple injuries. Twenty-eight of these occurred to drilling and production rigmen and fifty-two to people employed in other occupations on the oilfields. Three fatal accidents occurred during this year and the circumstances leading to their deaths are described. This report also indicates that larger companies maintain very efficient safety departments and that every effort is made to reduce the accident rate by education workmen to avoid dangerous practices and by constant inspection of equipment and plant.

Colony of Trinidad and Tobago, 1954. Administrative Report of the Petroleum Department for the year 1953. pp. 11.

During this year, sixty-eight serious accidents were reported in the petroleum industry. Two of these occurred on drilling rigs and were fatal, thirty-three others were on drilling or production rigs and thirty three were in other departments of the industry. This report also indicates that the Safety Departments of the larger companies are very vigilant for poor safety practices and that safety competitions between various departments, special instruction classes and propaganda have resulted in the accident rate of the local industry being comparable with that of the United States of America.

Colony of Trinidad and Tobago, 1955. Administrative Report of the Petroleum Department for the year 1954. pp. 9.

Aside from petroleum production and drilling statistics, this report indicates that there were forty six serious accidents in the year 1954, of which drilling and production rigs accounted for twenty-three and twenty occurred in other departments in the industry. Three fatal accidents occurred; two were due to electrocution whilst one was the result of the collapse of a small steel derrick on a water well.

Colony of Trinidad and Tobago, 1956. Administrative Report of the Petroleum Department for the year 1955. pp. 10.

Included in the petroleum statistics is the number of accidents reported for the year 1955. There were 669 accidents reported in this year, of which 33 were serious and occurred on drilling and production rigs. There were three fatal accidents, two dying of electrocuting and one from fatal burns. The larger companies continue to maintain an active campaign of safety to reduce accident rates, which compare favourably with statistics for the United States of America and United Kingdom.

Colony of Trinidad and Tobago, 1957. Administrative Report of the Petroleum Department for the year 1956. pp. 9-10.

This year's report saw the return of the accident statistics table which describes the number of accidents according to non-serious, serious and fatal within the drilling and production and other departments of the industry. There were a total of 508 accidents reported for the year of 1956

with 48 serious accidents and three fatal accidents. This report continues to describe the intensive safety programme embarked upon by the larger companies with great success. The Trinidad Oil Company Limited was awarded safety awards from the American Petroleum Institute.

Colony of Trinidad and Tobago, 1958. Administrative Report of the Petroleum Department for the year 1957. pp. 9-10.

The total number of accidents reported for the year 1957 were 408 of which five were fatal accidents occurring on drilling rigs. The intensive Safety Campaign conducted by the larger companies continued to gain recognition in 1957 with the American Petroleum Institute of Accident Prevention awarding the Trinidad Oil Company Limited five safety awards.

Colony of Trinidad and Tobago, 1959. Administrative Report of the Petroleum Department for the year 1958. pp. 8.

This report summarises the accidents in the Petroleum Industry according to Company and drilling or other departmental activities. According to this report, there were 525 reported accidents, which was an increase from the previous year. There were six fatalities of which four were associated with Marine Operations. There were also two fatalities on land, one from the premature discharge of a perforated gun and the other from a blowout of a drilling well.

Colony of Trinidad and Tobago, 1960. Administrative Report of the Petroleum Department for the year 1959. pp. 11-12.

This report indicates that there were 504 accidents reported for the year 1959 with six fatalities. A brief description of the fatalities is included in the report. The report also includes revenue, drilling and production statistics for this year.

Colony of Trinidad and Tobago, 1961. Administrative Report of the Petroleum Department for the year 1960. 33 pp.

This report describes the activities in the petroleum sector in great detail, including the search for submarine oil and natural gas supplies. However, it does not contain details on accidents or incident reports.

Government of Trinidad and Tobago. 1964. Report of the Commission of Enquiry into the Oil Industry of Trinidad and Tobago 1963-1964. Andre Deutsch, London, England.

This report explores the present and future prospects of the oil industry of Trinidad and Tobago in the context of the world oil industry and then reviews the oil industry in this country and ends with recommendations which would ensure greatest possible stability with growth in the industry.

Trinidad and Tobago Ministry of Petroleum and Mines. 1966. Annual review of petroleum developments in 1966 in Trinidad and Tobago. Government of Trinidad and Tobago, Port-of-Spain. Pp. 35.

This report overviews the activities in the oil and gas industry for the year 1967. There are no statistics on accidents but discussion on methods of oil extraction and major oil producing companies.

Trinidad and Tobago Ministry of Petroleum and Mines. 1967. Annual review of petroleum developments in 1967 in Trinidad and Tobago. Government of Trinidad and Tobago, Port-of-Spain. Pp. 36.

This report overviews the activities in the oil and gas industry for the year 1967. There are no statistics on accidents but discussion on methods of oil extraction and major oil producing companies.

Trinidad and Tobago Ministry of Petroleum and Mines, 1969. Annual Administrative Report for the year 1968. pp. 18.

This report indicates that there were 250 accidents in 1968 as compared to 239 in 1967. There was only one fatal accident in the production operations which decreased from 7 in 1967. A table is included of the accident statistics for 1968 according to companies, type of accident (fatal, serious or minor) and division of the oil sector (production, drilling or other).

Trinidad and Tobago Ministry of Petroleum and Mines, 1970. Annual Administrative Report for the year 1969. pp. 18.

This report indicates that there was an increase in safety consciousness as reflected in a 33.2 percent decrease in the number of accidents as compared to the previous year's statistics. The total number of field accidents was 167, of which only 5 resulted in fatalities. About 66 percent of the accidents were classified as minor whilst 34 percent of the accidents were regarded as serious accident. This report also indicates that six reports of pollution from the oil industry were received by the Ministry of which three were from farmers. In four of these cases, there was damage to crops while in the other cases, the Moulai River and the Gulf of Paria were polluted. The quantity of crude involved in the damage to crops was estimated at 200 barrels. Five barrels polluted the Moulai River.

Trinidad and Tobago Ministry of Petroleum & Mines. 1971. Annual Report for the year 1970. Government Printery, Trinidad and Tobago.

During 1970, the total number of accidents reported in the field was 116 which represents a decrease of about 30.5% from the total number of accidents reported in 1969.

About 45% of the accidents were classified as serious and consisted mainly of: eye injuries; injuries to head, chest and back, caused by either falls or falling objects; severe strains, caused by lifting of heavy objects; and the amputation or fracture of limbs, fingers and toes. The other 55% were classified minor accidents, and included typical routine accidents such as squeezed fingers and limbs; minor bruises and cuts to body; strained muscles; and slight injuries resulting from falls. There were several accidents which although not strictly falling under the jurisdiction of the Ministry of Petroleum and Mines, were brought to its attention and investigated by the Ministry. Among them were three (3) fatal accidents. Descriptions of the accidents are given in this report.

This report also summarises the accident statistics according to company, location and activity.

Trinidad and Tobago Ministry of Petroleum & Mines. 1972. Annual Report for the year 1971. Government Printery, Trinidad and Tobago.

The total number of accidents reported in the field for 1971 was 112. This figure represents a decrease of about 3.5% in comparison with the number of accidents reported in 1970.

Approximately 30% of the accidents were classified as serious whilst the remaining 70% were minor accidents. There were several accidents which caused both destruction to equipment and loss of lived. There were numerous accidents which, although not falling under the jurisdiction of the Ministry of Petroleum and Mines were brought to our attention and investigations were carried

out. Among them were three (3) fatal accidents. Descriptions of serious and fatal accidents are contained in this report. This report also contains summary statistics for accidents for the year 1971.

Trinidad and Tobago Ministry of Petroleum & Mines. 1973. Annual Report for the year 1972. Government Printery, Trinidad and Tobago.

The total number of serious and lost-time accidents reported for the 1972 was 173. This figure represents an increase of about 53.5% in comparison with the number of accidents reported in 1971. Approximately, 42% of the accidents were classified as serious whilst the remaining 58% were minor accidents, including bruises, sprains, muscular pains, small cuts, and contusions to various parts of the body.

Of the total number of accidents three were fatal. Accidents that occur in plants and factories within oil companies' compounds fall under the jurisdiction of the Industrial Safety Division of the Ministry of Labour. Since these accidents are associated with the oil industry, some of the serious and fatal accidents were investigated by officers of the Ministry of Petroleum and Mines. Amongst these were three (3) fatal accidents, the details of their death are described. This report also contains a summary table of accidents.

Trinidad and Tobago Ministry of Petroleum & Mines. 1974. Annual Report for the year 1973. Government Printery, Trinidad and Tobago.

For the year 1973, accidents occurring in the oilfields numbered 222. This figure represents an increase of about 28.3% in comparison with the 1972 total of 173, and corresponds with the increase in activity during 1973. These accidents were classified as serious and non-serious, depending on the extent of the injury. Approximately 33% of the accidents were serious whilst the remaining 67% were considered minor. Several accidents caused both destruction to equipment and loss of lives. In all, there were seven (7) fatal accidents, the largest number recorded to date for any one year. This report summarises the accidents which occurred and the resultant damage to persons involved.

Trinidad and Tobago Ministry of Petroleum & Mines. 1975. Annual Report for the year 1974. Government Printery, Trinidad and Tobago.

Accidents reported for the year 1974 numbered 219. This figure showed a slight decrease of 1.4 percent compared to the 1973 total of 222. Serious accidents comprised 14.6 percent of the total. It should be noted that although there was an increase in activity in the Amoco and Trinidad Tesoro oil fields, the number of accidents decreased considerably from the 1973 totals of 82 and 36 respectively. It appears that the influence of safety programmes is having a significant effect. Of the accidents occurring during this year, 85.4 percent were considered non-serious or minor. There were several accidents which caused destruction to equipment and two unfortunately resulted in loss of life. This report contains descriptions of these. A table of the accidents statistics for this year is included.

Trinidad and Tobago Ministry of Petroleum & Mines. 1976. Annual Report for the year 1975. Government Printery, Trinidad and Tobago.

Accidents reported for the year 1975 numbered 311. This figure represents an increase of 41 percent compared to the 1974 total of 219. Serious accidents comprised 12.3 percent. There were three fatal accidents in 1975 and details of these are described in this report. A table of the accident statistics for this year is also included.

Trinidad and Tobago Ministry of Petroleum & Mines. 1977. Annual Report for the year 1976. Government Printery, Trinidad and Tobago.

The number of accidents reported in 1976 were 854, which represents a 154 percent increase from the previous year. This increase is mainly due to the inclusion of refinery accidents which fall under the jurisdiction of the Factories Inspectorate Division, and were omitted in previous years. The number of fatal accidents increased from 2 in 1975 to 6 in 1976. Serious accidents comprised 10.5 percent. This report also describes a number of fires during the year 1976 and the extent of the damage is described in detail. Accident statistics is also tabulated and included in this report.

Government of Trinidad and Tobago. 1977. National oil spill clean-up plan. Government of Trinidad and Tobago Printery, Port of Spain. Pp25.

This plan is designed to provide protection of the environment, both land and marine, from all oil spills. Spills greater than 20,000 barrels will require the co-operation and assistance of external agencies, since the cost of protection from oil spills in volume in excess of 20,000 BBLs is not commensurate with the associated risk. Furthermore, it is much easier to obtain cheaper protection by associating and co-operating with external agencies established for this purpose. The plan recognises that other types of pollution may occur e.g. petrochemical and toxic products but noted that this will require individual plans for each type of product.

Trinidad and Tobago Ministry of Petroleum & Mines. 1978. Annual Report for the year 1977. Government Printery, Trinidad and Tobago.

In 1977, the number of accidents numbered 783. Accidents in the drilling and producing operations numbered 395. Serious accidents represented 10.7 percent of the total. There were eight fatalities and the circumstances of each of these fatal accidents are detailed in this report. This report also contains an account of a well blow-out which resulted in the pollution of surrounding streams however, most of the oil was recovered by an anti-pollution team. A table of the accident statistics is also included.

Trinidad and Tobago Ministry of Petroleum & Mines. 1979. Annual Report for the year 1978. Government Printery, Trinidad and Tobago.

The total number of accidents reported in 1978 was 877, which was an increase from the previous year. Accidents which occurred in the field numbered 376, of which 13.8 percent was classified as serious. There were three fatal accidents and details of these are described in the report. A table of accident statistics is also included.

Trinidad and Tobago Ministry of Petroleum & Mines. 1980. Annual Report for the year 1979. Government Printery, Trinidad and Tobago.

There were 687 accidents in the Energy Sector in 1979, which is a 22 percent decrease from the previous year. There were 411 accidents in the field of which 8.3 percent were classified as serious. Three fatal accidents occurred in this year and details of these are described in this report. A table of the accident statistics is also included.

Trinidad and Tobago Ministry of Petroleum & Mines. 1981. Annual Report for the year 1980. Government Printery, Trinidad and Tobago.

There were 830 accidents reported for 1980, which is an increase of 21 percent from previous years. Accidents occurring during drilling and producing operations numbered 490 whilst refinery accidents totalled 340. Serious accidents accounted for 8 percent of the total whilst non-serious

accidents accounted for 91 percent of the total. There were four fatal accidents in 1980 and these were described in detail. Accident statistics are also included in this report.

Trinidad and Tobago Ministry of Energy and Natural Resources. 1982. Annual Report for the year 1981. Government Printery, Trinidad and Tobago.

There were 652 accidents in 1981 which was a decrease from the previous year. There were 318 accidents during drilling and production operations and 334 refinery accidents. There were 55 serious accidents, 277 non-serious accidents and 5 fatal accidents. Accidents statistics are included in this report.

Trinidad and Tobago Ministry of Energy and Natural Resources. 1983. Annual Report for the year 1982. Government Printery, Trinidad and Tobago.

There were 558 accidents reported in 1982, which was a decrease from the 1982 figure. There were 268 accidents which occurred during drilling and production operations and 290 accidents which occurred during refinery activities. There were 55 serious accidents, 205 non-serious accidents and one fatality in this year. Accident statistics are included.

Trinidad and Tobago Ministry of Energy and Natural Resources. 1984. Annual Report for the year 1983. Government Printery, Trinidad and Tobago.

There were 500 accidents reported in the Energy Industry for the year 1984, which was a decrease from the previous year's figure. There were 279 refinery accidents and 154 drilling and production operation accidents for this year. Serious accidents numbered 77 whilst non serious accidents totalled 139. There were 6 fatal accidents reported for this year and the details of these are described. Accident statistics are also included.

Trinidad and Tobago Ministry of Energy and Natural Resources. 1985. Annual Report for the year 1984. Government Printery, Trinidad and Tobago.

There were 455 accidents reported for 1984, which is a decrease from the previous year. Refinery accidents totalled 222 whilst accidents which occurred during drilling and producing operations numbered 157. There were 90 serious accidents, 143 non-serious accidents and 1 fatality. A summary table of accidents statistics is also included.

Pollution incident report for this year indicate that there were 89 reported incidents of pollution resulting in the escape of 1206cubic metres of crude oil. Of this amount, 892 cubic metres were recovered. Further details of the pollution events are described in this report.

Trinidad and Tobago Ministry of Energy and Natural Resources. 1986. Annual Report for the year 1985. Government Printery, Trinidad and Tobago.

There were 572 accidents reported for 1985 which was an increase from the previous year. There were 230 refinery accidents and 257 accidents which occurred during drilling and production operations. There were 235 serious accidents and 104 non-serious accidents with a total of 17 fatalities. Details of accident statistics are summarised in this report.

There were 90 incidents of pollution which resulted in the escape of 13,737 barrels of oil. Of this, 90.5% of the oil was recovered. This report indicates that the Petroleum Testing Laboratory continued its activities in 1985 of analysing the concentrations levels of residual chemicals in effluent streams of oil companies.

Government of the Republic of Trinidad and Tobago. 1997. National oil spill contingency plan. Ministry of Energy and Energy Industries, Port of Spain.

The National Oil Spill Contingency Plan (NOSCP) for Trinidad and Tobago is divided into two main parts. The first part outlines the overall strategy which defines the policy, responsibilities and rationale for the operational aspects of the plan. The second part forms the operational plan and provides the procedures to be followed when a spill occurs.

Ministry of Energy and Energy Industries, 1998. Green Paper for proposed Energy Policy for the Republic of Trinidad and Tobago. Ministry of Energy and Energy Industries, Government Printery, Port of Spain.

The general policy goal for the energy sector is to achieve optimal returns from the exploitation of the country's natural resources for the benefit of all its citizens. The specific sub sectoral goals must be consistent with and are derived from the stated general goal and should be viewed from the country's perspective rather than those of the individual sub sectors.

The Energy Policy Green Paper presents, for discussion and debate, energy related policy issues which are linked to the hydrocarbon sector in Trinidad and Tobago. A notable exception is the fact that it does not directly address issues pertaining to the generation and distribution of electricity which is a major energy source. The document, however, does address natural gas supply issues which, as they pertain to a fuel, have a direct impact on the generation of electricity. It is the intention that this Green Paper will be published for public comment from which, thereafter, a National Energy Policy will evolve.

The Energy Policy Green Paper identifies and discusses the major policy measures which can contribute to the achievement of the general policy goal. The major areas identified include, but are not limited to the following:

- Strengthening of the administrative machinery of the energy sector
- Promotion of upstream hydrocarbon exploration and development activities
- Commercial development of the country's natural gas reserves
- Increasing the efficiency of the retail marketing operations
- Development of new and renewable energy options
- Research, development and transfer of technology.

Trinidad and Tobago Ministry of Petroleum and Mines. 1976. Accidents and Safety in the Drilling and Production Sectors in the Oil Industry.

There has been an alarming increase in accidents over the period 1975 – 1976 when compared with 1973 – 1974. An examination of the Ministry's role, requirements, existing legislation and priorities indicate that the Ministry is unable with its present staff to fulfil the obligations thrust upon it by the great upsurge in activity within the Producing Division of the Oil Industry.

Consequently the report concludes that an increase in the Ministry's field staff is necessary if supervision is to be maintained and adequate safeguards implemented, in order to allow the continued rate of growth of the industry. The report also suggest that improved training programmes within the private sector of the oil industry may also be necessary. This report makes several recommendations, long term and short term including amendments to the legal framework. This report contains an appendix describing accidents and incidents in the oil industry for the year 1975 – 1976.

Government of Trinidad and Tobago. 1979. Commission of Enquiry into the effect of the operations of Texaco (Trinidad) Inc. on the social and economic development of the Republic of Trinidad and Tobago. Government of Trinidad and Tobago Printery, Trinidad and Tobago.

This paper is a note to cabinet on the discussions between the Government of Trinidad and Tobago and the Texaco with respect to establishing oil refining plants in this country.

Environmental Management Authority

Environmental Management Authority (EMA), 2001. State of the Environment Report 2000. Ministry of the Environment, Government of Trinidad and Tobago. 74p.

In this report, the quality of our air, the pollutant emissions to it and the existing policy and institutional mechanisms to control air pollution are examined. A wide range of pollutants has been identified as the cause of our diminished air quality. These include: particulate matter, sulphur dioxide, oxides of nitrogen, carbon monoxide, ozone, lead, volatile organic compounds, asbestos, ozone depleting substances and greenhouse gases (carbon dioxide, methane, nitrous oxide). Most of these compounds affect human health and many target the respiratory tract. Other affected organs/systems include the oxygen-carrying capacity of the blood, the nervous system, kidneys, cardiovascular and reproductive systems and the numerous other toxic effects produced by the volatile organic compounds. On the other hand, ozone depleting substances and greenhouse gases, are not directly toxic to human beings, but affect the atmospheric processes that are required for life on earth. Ozone depleting substances impair the formation of ozone, decreasing stratospheric ozone levels. This results in an increase in the transmittance of ultraviolet radiation and an increase in skin cancers and cataracts in people. Greenhouse gases contribute to global warming, and so may affect life on earth through climate change and sea level rise.

The sources of air pollutants are varied. Combustion of fossil fuels and incineration of waste material are major sources for a number of ambient air pollutants, including particulate matter, sulphur dioxide, carbon monoxide, carbon dioxide and lead (from leaded gasoline combustion). Volatile organic compounds enter the atmosphere through evaporation of solvents as well as incomplete combustion. Ozone depleting substances are emitted from leaks in refrigeration units, as well as through their use as aerosol propellants and fire-fighting equipment. Asbestos is emitted mainly from friction pads in vehicles, construction materials and insulation. However, not all major sources of air pollution are anthropogenic (man-made).

The issue of air pollution control in Trinidad and Tobago is complex, because of the multitude of air pollution sources — from micro business to heavy industry. The 2000 report concludes with a number of priorities for action to improve the quality of our air. These include the establishment of ambient air quality standards, an ambient air monitoring network, and a regular air pollutant inventory to fill the need for accurate air pollutant emission data. Also required is the development and implementation of legislation and standards to control air emissions from all sectors of the economy, from heavy industry to micro business and finally, the development and support of on-going public education programmes, which are vital to achieving success in any air pollution control strategy. It is only through such educational projects that the public can be sensitised to the problems associated with contaminated air, and the ways in which we can prevent further deterioration of our atmosphere.

Environmental Management Authority, 1999. State of the Environment Report 1999. Ministry of Environment, Government of Trinidad and Tobago. 45p.

The EMA during 1998 and 1999 conducted an extensive survey into the legislative and institutional landscape to determine in the first instance the extent of existing laws relating to environmental protection, and secondly, how those laws impact on enforcement, effectiveness, behaviour and interaction among agencies. The core problems affecting implementation of

existing laws were examined and new measures for the protection of the environment were developed.

This challenge exercise reviewed a cross section of the legal framework spanning some 50 agencies of government to determine the extent of the legislative authority they possess, the effectiveness of their laws, their interpretation and specific use with respect to environmental protection for Trinidad and Tobago.

What emerged was a picture of overlapping areas of responsibility, unclear roles and ambiguous terminology in the wording of certain legislation. However, what was discovered is that despite the general malaise attendant with developing countries towards protection of the environment and the lack in most instances of proper safe guards and regulations for that purpose, Trinidad and Tobago in this regard has on its statute books over 100 pieces of legislation.

Some of this legislation needs to be supported by newer more relevant and specific regulations or amendments to the respective acts to give more teeth to certain agencies with regards to the protection of the environment. In this report, reference is made to these acts in Appendix A. The report also signals the need not only for legislative reform but also for the simultaneous implementation of public awareness programmes that will educate and instill a sense of national pride among the population in the continued fight against the destruction of our beautiful environment.

Environmental Management Authority (EMA), 1998. Trinidad and Tobago: State of the Environment 1998 Report. Ministry of the Environment, Government of Trinidad and Tobago. 48p.

This fourth assessment of the state of the environment of Trinidad and Tobago focuses on WATER but does not treat with the resource in its totality. It deals only with the freshwater component of the resource and the environments that are supported by it or those that are responsible for its production - essentially the inland aspects. While it is recognised that marine waters are part of the hydrologic (water) cycle, and that whatever is done on land affects the marine area, sea water and associated environments are not addressed in this report.

The data accessed and analysed and the information available for this report have revealed that Trinidad is not a freshwater-scarce country although there are large variances of raw water availability caused by physiography. With a population of 1.3 million persons and annual maximum rainfall of 3800mm in some parts of the country, the water scarcity experienced by some sections of the population is due in part to the cost and efficiency of tapping water from a number of small sources, to increased run-off and to leakages from the distribution system.

Increasing run-off is a direct consequence of the types of human activity taking place in the watershed e.g. loss of vegetation particularly on hill slopes. These activities are both authorised and unauthorised and include quarrying, timber harvesting, residential and infrastructure development, slash and burn agriculture, squatting and annual uncontrolled fires.

The quality of water to be sourced and distributed is also of great concern. The various assessments, partial and comprehensive, all demonstrate worrying signs of substandard water quality. Comprehensive data sets that would have derived from consistent monitoring and recording of the status of water is non-existent. The one area that has attracted most attention for repeated study and research over the years is the Caroni River Basin, which supplies potable water to over 40% of the population. Notwithstanding the intermittent studies, the conclusions on the same watercourses by different studies all demonstrate deteriorating water quality induced by human activity. The effects of natural factors on water quality, such as iron in groundwater, are very limited and do not usually pose high risks to the water supply.

The major threats and potential threats to water quality are sewage, high strength organic wastes from agricultural farms and agro-processing plants, grey water containing phosphates and nitrates from homes and toxic wastes from landfills and industrial effluents. Groundwater, which is linked to surface water in the water continuum is exposed to the same threats by these pollutants. In addition, on account of their location, aquifers in the vicinity of underground fuel storage tanks

may become contaminated by carcinogenic hydrocarbons such as benzene, toluene and xylene. Those aquifers, which are located close to the sea and are overpumped, are subjected to saltwater intrusion as already experienced in the El Socorro gravels.

Freshwater wetlands are affected primarily by suspended soil particles, drying out and salinisation. Species diversity and abundance are reduced.

Environmental Management Authority (EMA), 1996. State of the Environment 1996 Report. Ministry of the Environment, Government of Trinidad and Tobago. 74p.

This first report of the Environmental Management Authority (EMA) overviews the natural resources of Trinidad and Tobago and the activities and/or conditions threatening the security of these resources. In a section entitled "Impacts of Land Use on the Environment," some of the pollution issues with respect to petroleum mining and the use of petrochemical products are discussed.

Agard J. R., Gowrie M. 2003. Environmental Vulnerability Index (EVI): Provisional indices and profiles for Trinidad and Tobago. State of the Environment Report 2001 & 2002. Ministry of the Environment, Government of Trinidad and Tobago. 53p.

This state of the environment report presents in one consolidated text, a review of the environmental vulnerability of Trinidad and Tobago, using an Environmental Vulnerability Index composed of 48 environmental vulnerability indicators. The index focuses on the vulnerability of the environment to natural risks and to humans. It is based on the premise that the vulnerability of the environment to events in the near future can be determined from the calculated probability of their actual occurrence in the recent past. The main strength of the EVI is that it is an impartial measure and provides simplified summary information and, also the detailed data required to highlight specific areas of concern for environmental managers, scientists and the general public. It thus helps identify mechanisms that tend to degrade the state of the environment which provide goods (e.g. food, fibre, oxygen) and services (e.g. water purification, waste treatment, pollination, recreation) that support human well-being.

The indicators are divided into 5 categories of environmental vulnerability such as meteorological events (6 indicators), geological events (3 indicators), country characteristics (7 indicators), biological factors (8 indicators) and anthropogenic factors (24 indicators). The indicators are scored on a global vulnerability scale of 1-7, where 4 are average and scores 1-3 indicate below average vulnerability while scores of 5-7 indicate above average vulnerability.

The results show that for Trinidad, indicators scoring 7 on the EVI are, intensive farming (especially poultry farming), human population density (especially in urban areas), rate of removal of natural vegetation (especially in the northern range), oil spills (especially on land), vehicle density (most air pollution is from vehicles), fertiliser usage (especially on Caroni lands), degraded land (especially from fires), water usage per capita (more of half of the water produced is unaccounted for) and mining activity (development activity in the petrochemical sector is exceptionally aggressive). In other words nearly all of Trinidad's major environmental vulnerabilities are anthropogenic in nature and due to poor management of the environment by human beings.

The good news is that since humans are the sole source of all the environmental problems (as compared to hurricanes, volcanoes etc. on other islands) then they can be managed by modifying human behaviour using moral persuasion and vigorous enforcement of environmental laws.

Tobago on the other hand is a far better place to live from an environmental vulnerability standpoint. The major environmental vulnerabilities in Tobago are due to the elevated density of endemic species per square kilometre that is fairly typical for an island, high density of people living in coastal settlements, high percentage of degraded land in the coastal zone and high water usage per capita. For its size Tobago has more unique biodiversity than Trinidad and so protection of its remaining natural vegetation is an urgent priority.

Accident/Incident reports

Teesdale, B. 1982. Blowout of Well PL333. Ministry of Energy and Natural Resources, Port of Spain.

This report describes the blowout of a well in one of the Trintoc farms, which resulted in vegetation becoming covered in oil and a farmer losing his crop because of the pollution. It describes the clean-up activities which were described as commendable.

Ministry of Energy and Ministry of Justice and National Security. 1991. Joint investigation of the explosion and fire at the Fluidised Catalytic Cracking Unit, Trintoc Refinery, Pointe-a-Pierre on June 5, 1991. Trintoc, Point-a-Pierre.

This report described a major explosion and fire which resulted in serious damage to the vessel it involved as well as to nearby plants and equipment. One worker was killed and 12 others were injured, 2 of them seriously.

Trinidad and Tobago Oil Company Limited. 1981. Report of the major incident investigating committee on damage to turbo-alternator No. 4 and destruction of turbo-alternator No. 3 on the morning of January 16, 1981 at Trintoc's Point Fortin Refinery Power Station. Trintoc, Point Fortin.

This report describes the circumstances leading up to the explosion of an alternator which caused physical damage to the building it was contained in. It also described the damage to person who were in the vicinity of the explosion.

Trinidad and Tobago Ministry of Petroleum and Mines. 1963. Report on the Inquest into the causes and circumstances of the death of Hardy Forteau. Trinidad and Tobago Ministry of Petroleum and Mines, Port of Spain.

This report describes the accident which resulted in the death of Mr. Hardy Forteau. The report also contained photos of the damaged well.

Trinmar Limited. 1996. Report on Investigation of accident on Well #670. Trinmar, Point-a-Pierre.

On December 15, 1996 at approximately 16.40 hrs the South West Field Production personnel and Contractor workers went to Well #670 to put the well on Production. On completion of installing the piping and oil/gas separator, the pipe fittings were tested for leaks. After the test, the gauger was in process of opening the well when a loud explosion was heard. This explosion caused the piping to shear and the separator was propelled into the sea. One other employee suffered from post traumatic shock.

BPAmoco Energy Company of Trinidad and Tobago. 1999. Accident Investigation Report – Oil Storage Tank #3 Roof fire. BPAmoco, Galeota.

This report gives a detail description of the events which lead to the fire noted on storage tank no. 3 and the control of its spread and subsequent extinguishing.

Texaco Trinidad Inc. 1984. Fire on No. 4 VDU – Nov. 4, 1984. Point-a-Pierre.

This report summarises the events leading up to a fire which took place on a pump and line and describes the damages done to person and property.

Trinidad and Tobago Petroleum Company Limited. 1990. Report of an independent team appointed by management to investigate the Blowout at Well No. PS 604 on June 2, 1990. Trinidad and Tobago Petroleum Company Limited, Santa Flora.

This report describes the blowout of a well which resulted in pollution in the Los Bajos area and the measures used to control the blowout.

Ministry of Energy. 1989. Investigation into Blowout of Trintopec's Fz 884. Ministry of Energy, Port of Spain.

This report describes the events which lead to the blowout of Fz 884 and the resulting pollution of residential and forested areas.

Miscellaneous reports

BpTT. 2005. Sustainability Report 2005. BpTT, Port of Spain, Trinidad.

This report contains information of BpTT production activities as well as their community involvement and engagement and environmental commitment. It describes aspects of their environmentally sound operations, in terms of environmental management, environmental and social impact assessments, oil spill and gas leak response mechanisms, produced water monitoring and human health and safety policies.

Ministry of Energy and Energy-based Industries. 1991. Interim Report. Petroleum Study for Government of Trinidad and Tobago. Robert W. Pleasant and Associates, New York, USA.

This report provides Consultant's assessment of the adequacy and international competitiveness of the country's existing investment framework for petroleum exploration and production and recommendations for improvements. The study contains Consultant's analysis of technical, legislative, contractual, regulatory and fiscal aspects affecting Trinidad and Tobago's energy and production sector and the interrelationship of such factors. Proposals for changes to the current fiscal system are supported by detailed economic analyses contained in this report. On key issues, specifics as to current practices in other countries are included.

Craig, D.R. 1960. Oil and gas conservation in Trinidad. Calgary, Albertha, Canada.

This report summarises the results of a survey of the drilling and production statistics of Trinidad. During the survey a problem related to natural gas conservation was raised, the issue being that all waste gas at that time was being vented to the atmosphere. The suggestion is made in this report to burn the vented gas so that a visual check on the amount of gas wasted can be made.

Siung-Chang, A. 1991. Report of the Cabinet appointed committee to plan a sustainable programme to clean up major rivers and waterways in Trinidad and Tobago. IMA, Hilltop Lane, Chaguaramas.

This report overviews the major sources of pollution in local rivers as the following: animal wastes, sewage, oil, pesticides, silt and solid waste, salt water intrusion and industrial wastes. It describes each category of pollutants in detail and makes recommendations how these can be dealt with in order to reduce the adverse effects these contaminants have on local freshwater systems.

Boodoosingh, M. 1992. A review of possible impacts of human activities on fisheries in the Coastal Waters of Trinidad, with Emphasis on the Gulf of Paria. Fisheries Division, Ministry of Agriculture, Land and Marine Resources, St. Clair, POS. pp. 126

The major objectives of this exercise were to compile relevant information on the possible effects of environmental degradation and other human induced effects on marine fisheries, within the coastal waters of Trinidad. In order to approach this task from a fisheries perspective, pertinent technical and theoretical principles were consulted and information collected concerning:

Environmental factors that might affect fish and fisheries at various levels;

Shoreline and nearshore characteristics of the island, which would influence the types and distribution of various aquatic species;

Identified natural resources, their distribution and abundance;

Types and distribution of human activities (coastal zone utilisation) that would influence environment quality including human settlement, natural resource exploitation, industrial activity, shoreline modification and commercial activity.

Modes of entry and estimates of inputs of potential perturbing factors

Factors affecting the distribution and dynamics of identified perturbing factors, i.e. seasonal effects of currents, and freshwater inputs;

Research data and documented observations regarding the effects of these perturbing factors on marine life or on the ecosystems that are important to fish as a source of food or as a habitat during particular life stages.

Historical perspectives of the perceptions of environmental problems affecting Trinidad, and the institutional and legal frameworks that have been conceived with the intention of dealing with identified problems, and their efficacy, was also attempted. This was done to highlight their deficiencies, thus some of the factors inhibiting effective environmental and natural resource management. Each coastline was assessed separately.

From the data, the pollution concerns included:

Sewage inputs, which could promote the occurrence of algal blooms and related fish kills

Sediment input, generated from quarrying and inappropriate agricultural activities, which could inhibit coral growth

The risk of oil pollution incidents (spills), from tankers travelling westward, which could foul the coastline, impacting most severely in sheltered inlets

Solid waste inputs, affecting boating activities, and the cluttering of benthic habitats – especially coral communities and rocky shores.

Marshall, R. C. (Captain). 1925. Report on Forestry in Trinidad and Tobago. Report of the Conservator of Forests, Government of Trinidad and Tobago.

This report summarises the attempts to make Trinidad self-sufficient with respect to lumber production in 1925. It includes a description of the forested areas at that time, the distribution of forests according to administrative and executive charges, forest reserves, research and timber trade. Includes a small account of the oil industry and its role in forestry with predictions, by the author at that time, of the oil industry not lasting longer than 50 years.

George, C. 1982. The possible application of an oil spill vulnerability index to the Trinidad Coastline. Institute of Marine Affairs (IMA), Hilltop Lane, Chaguaramas. Pp. 16/

There is a general lack of local information on the dynamics of marine pollution, and the present paper attempts to describe a modified and tentative oil spill vulnerability index to the Trinidad coastline as an essential first step towards a scientific basis for protection and management measures.

The study must be regarded as merely preliminary. The coastal areas of Trinidad have been classified into nine categories, based on grain size of sandy beaches, wavecut platforms, rocky headlands, gravel beaches and sheltered wetlands and their vulnerability to oil spill damage indicated. The probable residence time of oil pollutants in the classified coastal environment is also indicated.

The need for maps indicating the sensitivity of the various coastal areas to oil spill damage is discussed as an integral part of an oil spill clean-up plan. Further studies are required to quantify oil polluting sources and to prepare environmental sensitivity maps. The dynamics of the littoral zone need to be studied with respect to the effects of wind, currents, tides, and sea state measured at different times of the year and over a long period.

United Nations Development Program/Environmental Management Authority (UNDP/EMA). 1997. Pollution Inventory Study for Trinidad and Tobago. Ecoengineering Consultants Limites, St. Augustine, Trinidad.

This study, based mainly on existing sources of data supplemented by interviews with selected facilities, initiated the process of preparing a comprehensive pollutant inventory of Trinidad and Tobago.

At the present time, Trinidad and Tobago is experiencing a renewed development thrust which is most apparent in the heavy industrial sector. In parallel with this renewed development thrust, the country is moving to protect its environment, including the regulation of discharges by setting standards and enforcing them. A baseline year of 1996 was agreed between the EMA and Ecoengineering, this being the latest year for which much of the accessible data was available. Data and estimates in this report are classified by media, geographical areas and types of sources. To the extent that it was possible, the data was aggregated first at the level of municipalities and counties, and then at the national level. Sources of pollutants in air and liquid media were also classified as point or non-point.

Potential sources of pollutants were identified in 91 economic sectors/subsectors. As expected the sources included all economic sectors: industry, commerce, tourism, transportation, residential. Industry includes the major sectors (petroleum, petrochemical), as well as medium and small manufacturers. A comprehensive pollutant inventory for Trinidad and Tobago will assist the EMA (and other Government Agencies) in prioritizing establishment of subsidiary legislation, tracking changes in the types and quantities of pollutants entering the natural environment, and establishing enforcement priorities.

Sergeant, K. S. Racha and M. John. 2003. The Petroleum Sector: The case study of Trinidad and Tobago. Trends, policies and impact 1985-2000. Prepared for CEPAL/GTZ "A Natural Resource-Cluster Development Strategy: Its Growth, Distributive and Environmental Implications" project. Financed by GTZ, Germany. Published in Santiago de Chile.

This study reviews energy policy in Trinidad and Tobago over the period 1985-2002, a period of declining economic performance, structural adjustment and eventual recovery premised on gas based industrial development. The purpose of the study is to examine developments in the Oil and Gas Sector under successive governments during the period. It outlines the policy goals and instruments used to implement the stated policies. It concludes with a discussion of the impact on various sectors.

Water Resources Agency. 2001. National Report on Integrating the Management of Watersheds and Coastal Areas in Trinidad and Tobago. Ministry of Public Utilities and the Environment, GoTT, 125pp.

The Water Resources Agency has a rain gauge network of one hundred and ten (110) recording and non-recording rainfall gauges and a network of twenty-eight (28) stream-flow stations, for the

monitoring of the hydrological regime. These stations are well distributed over both islands but major deficiencies exist in relation to their upkeep and the quality of information provided. The groundwater network in the twin island state boasts of one hundred and sixty-eight (168) production wells and one hundred and ten (110) observation wells. The Agency has recently completed the installation of a telemetry network consisting of eighty-one (81) sensors with the objective of providing automatic recording and transmission of hydrological and hydro-meteorological data from the river basin to the central office. Much still needs to be done by way of the quality control process before the telemetry system can have the desired impact on data provision and management nationally.

Current water demand in Trinidad and Tobago amounts to 317 MCM/year while the water supply figure amounts to 273 MCM/year, representing a 44 MCM/year deficit. Investments over the last five (5) years to address the past and existing deficits amount to \$US 431 million, including the imminent installation of a desalination plant at Point Lisas and the application of new technologies for locating and abstracting deep groundwater in bedrock aquifers. Ironically, investments in water resources management initiatives have been limited to just under \$US 5.5 million over a corresponding period. WRA/MIN. Environment: Integrating the Management of Watersheds and Coastal Areas in Trinidad and Tobago

Pollution is a problem that is on the rise throughout the country. The main water pollutants are urban, domestic and industrial waste, solid and toxic agricultural products and waste, sediments, petrochemicals and oil spills from the oil and energy industries, waste from fishing vessels, ships, tourist facilities and yachts. The pollutants affect both inland freshwater and coastal water resources, including the beaches and shores. The most serious threats to groundwater come from nitrate and bacterial contamination arising from agrochemical use and sewage effluents from pit latrine soak-aways and septic tanks. Another serious concern is saltwater intrusion as a result of over-abstraction in coastal aquifers.

Like other countries, economic growth and development coupled with growth of the human population is resulting in environmental degradation of watersheds, water resources and coastal areas. For Trinidad and Tobago, a twin island state, the coastal habitats and ecosystems assume significant WRA/MIN. Env: Integrating the Management of Watersheds and Coastal Areas in Trinidad and Tobago importance. The coastal areas support a variety of life systems and valuable natural assets and within them are located key industries and economic activities. Similar to the watersheds, these areas are subjected to threats arising from a variety of land based activities. The country experiences much of the full range of environmental problems, from widespread pollution of its waterways and coastal areas, chemical spills, illegal dumping, deforestation, excessive soil erosion, fisheries and wildlife depletion. These problems are attributed to poor land use practices and an inadequate legal and institutional framework for watershed/water resources and coastal zone management. The watersheds and coastal areas are also under threat from natural disasters (tropical storms, earthquakes, floods and droughts) as well as climate change and sea level rise.

Ministry of Energy. 2006. Pollution Statistics Report. Pollution Statistics for the period 01/01/2000 – 10/31/2006. Riverside Plaza, Port of Spain.

This short report contains information on the number of incidents, estimated quantity spilled, estimated quantity recovered, estimated net loss and percent recovered for oil companies active for the six year period of 2000-2006. It also contains information of the cumulative oil loss from land and marine operations as well as pollution information for Petrotrin and Trinmar for the same period.

CARSEA 2007. Caribbean Sea Ecosystem Assessment (CARSEA). A sub-global component of the Millennium Ecosystem Assessment (MA), J. Agard, A. Cropper, K. Garcia, eds., Caribbean Marine Studies, Special Edition, 2007.

The peoples of the Caribbean are defined by the Sea whose shores they inhabit. In the rich diversity of cultures and nations making up the region, the one uniting factor is the marine ecosystem on which each ultimately depends. Three key messages can be highlighted at the outset. First, some of the vital services which human communities derive from the Caribbean Sea ecosystem are being placed in jeopardy, often by the very activities and industries whose long-term future depends on the continuing provision of those services. Second, a reduction in the stresses being placed on the natural functions of the Caribbean Sea will require new ways of working together amongst the disparate political authorities making up the region. Finally, the combination of dependence on the integrity of its marine ecosystem and vulnerability to global forces beyond its control puts the Caribbean in a special position which merits recognition and concrete action by the international community.

Hansard Report. 2001. Oral Answers to Questions (Dr. A. Nanan). Monday May 14, 2001.

This reference contains only a section of the complete Hansard Report. In it, questions about oil spills are asked to the Minister of the Environment (Dr. A. Nanan) and his responses were recorded.

Trinidad and Tobago Oil Company Limited. 199. Investigation of chronic oil pollution at Point Ligoure. Executive Summary. (Available from Ministry of Energy library).

This report outlines the concentrations of oil monitored at different streams in the Point Ligoure area.

Techno Consultants Inc. and Cosmo Oil Co. Ltd. 1995. The study of pollution prevention and control within the petroleum sector in the Republic of Trinidad and Tobago. Report for the Pan International Cooperation Agency, Japan International Cooperation Agency (JICA) and The Ministry of Energy and Energy Industries, The Republic of Trinidad and Tobago.

This report overviews petroleum pollution across Trinidad and Tobago, identifies areas of concern and the activities which contribute towards the pollution of the natural environment and makes suggestions as to methods of reducing the environmental impacts.

Conference Papers

1983 Oil Spill Pollution Control Seminar

Agard, J.B.R. 1983. Sensitivity of the Trinidad and Tobago coastline to spilled oil. Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

An important part of contingency planning for potential oil spills is the identification of priority areas most likely to be seriously damaged in the event of a spill. On the basis of a literature review and assessment of available information on the local environment, the major Trinidad and Tobago coastal environments have been classified on a scale of 1 to 10 in terms of potential sensitivity to oil spill damage. The scale is based on oil residence times together with the anticipated long-term biological impacts. Generally speaking areas with low biomass, high wave activity and tidal currents rank low on the scale (sensitivity Index 1 and 2), whereas sheltered areas with high biomass rank highest (sensitivity Index 9 and 10). This index when converted to a colour code and displayed on maps of the Trinidad and Tobago coastline can provide a focus for oil spill strike teams during the initial period of a spill. In addition areas of special importance together with boom locations to protect the most sensitive areas are easily shown. An example of how this strategy may be applied to a hypothetical spill in the Port-of-Spain Harbour area is illustrated.

Keywords: sensitivity, coastlines, oil spills.

Charles, E. 1983. An oil product spill– a hazardous material spill. Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

The volume of oil products – which are all hazardous materials – transported by road in Trinidad and Tobago is considerable. As yet the Trinidad and Tobago public is not fully conscious of the astronomical damage that could be done to both life and environment if a spill caused by some accident, occurs with one of the road tank wagons that transport these products. The object of this paper is threefold, viz:

- i. To identify the possible hazards that are congruent with oil products
- ii. To critically assess and evaluate the present emergency response system as operative in Trinidad and Tobago, and
- iii. To provide an impulse for the development of a more specific counter-pollution method, i.e., the development of a contingency plan to meet the Hazardous Materials Challenge offered by oil products.

Keywords: oil spill hazards, emergency response system, counter pollution techniques.

Hinds, H.C. 1983. Response to a potential environmental disaster (The collision of the Aegean Captain and the Atlantic Express). Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

At about 7:00pm on July 1979, two fully laden, very large crude carriers VLCCs, the 210,000 DWT Aegean Captain and the 293,000 DWT Atlantic Express collided 16km off Tobago. Twenty-six crewmen lost their lives.

The scene for the greatest ever potential oil spill of 3.5 million bbls of oil has been set. Of great concern to the Government of Trinidad and Tobago was the threat of oil pollution to the coast lines of Tobago and North Trinidad, and the world renowned coral reef off Buccoo Pt., Tobago. This paper also gives a chronological record of the events which took place following the accident.

Keywords: accident, response, carrier collision.

Hinds, H.C. 1983. A brief review of the natural process that degrade oil and their effects on petroleum hydrocarbons in the marine environment. Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

This paper overviews the processes which result in oil spills, the factors that affect spreading of a spill, the effects of wind and current on slick movement, biodegradation and emulsification which would affect the size and spread of the oil spill.

Keywords: oil degradation, marine environment, Trinidad.

Norman, P.E. 1983. Oil pollution monitoring by the Institute of Marine Affairs. Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

Thirteen sample stations were identified around Trinidad and water samples were collected at each site for analysis of dissolved or dispersed hydrocarbons in seawater. The results did not indicate exceptional levels at any location, however, three stations did show higher levels than the others. These are No. 12 at Pt. Galeota, No. 7 near Point Fortin and La Brea and No. 9 at Icacos. The first two can be explained by the proximity to oil operations at Pt. Galeota, Pt. Fortin and La Brea, as well as the marine oilfields in these areas, but the levels at Icacos cannot be readily explained.

Keywords: hydrocarbon concentrations, Trinidad, seawater.

Palmer, N. 1983. Legal problems concerning the recovery of costs associated with massive and injurious oil spills from maritime accidents in the context of Trinidad and Tobago. Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

This article overviews important maritime oil spills till 1983, both regional and international, and makes recommendations based on these cases as to the kinds of measures and policies that Trinidad and Tobago should put into place to make companies guilty of spilling oil responsible.

Keywords: oil spills, damages, costs, maritime accidents.

Walton, W. 1983. Minimizing oil content in produced water: the environmental and economic ramifications. Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

The purpose of this paper is to offer solutions to the problem of oil pollution and its control. It uses examples to discuss the causes of the loss of oil in produced water and calculates the revenue lost from having high concentrations of petroleum in produced water.

Keywords: oil pollution, control, Trinidad and Tobago.

Wong, E. 1983. Sampling of oil pollution. Ministry of Energy and Natural Resources and Trinidad and Tobago Coast Guard. 1983 Oil Spill Pollution Control Seminar. Farrell House Hotel, Claxton Bay, Trinidad.

Various techniques used in the collection of representative samples needed in the identification of an oil spill or as part of a routine petroleum pollution monitoring programme are discussed. Sample types include dissolved and dispersed hydrocarbons in water, original oil from suspect spill source, surface oil, oil in sediment, tissue, floating tarballs and beach sampling.

Keywords: representative sample, oil spill, monitoring.

American Chamber of Commerce of Trinidad and Tobago (AMCHAM) Annual Health, Safety and Environment (HSE) Conference.

Alderdice, I. 2002. Sustainable development and the oil and gas industry. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Population growth, social inequality, pollution, global warming, poverty, over-exploitation of natural resources and biodiversity loss, are a few examples of the many challenges facing the world today. Sustainable Development is about meeting these challenges and improving the standard of living for the benefit of the maximum number of people.

These issues concern governments, communities, environmental and social action groups and individuals all over the world. Business too, has a fundamental role to play in delivering Sustainable Development. In particular, Sustainable Development is becoming increasingly recognised as a critical issue for the oil and gas industry to address and act upon.

This paper will:

- i. Provide some global context and background information on why sustainable development is becoming a major issue;
- ii. Clearly explain the concept of sustainable development;
- iii. Describe BP's overall approach to sustainable development;
- iv. Give some specific examples of BP's approach;
- v. Outline two differing tools which have been developed to allow oil and gas projects to assess their performance against sustainable development criteria.

Keywords: sustainable development, petroleum industry, Trinidad.

Aliasgar, C., C. Ramroop and K. Ramnath. 2001. Groundwater management project of the Erin Sands aquifer. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Petrotrin plans to increase its Enhanced Oil Recovery (EOR) oil production from its current production of approximately twenty-seven thousand (27,000) barrels of oil per day (bopd) by another twenty thousand (20,000) bopd. Hence, a substantial volume of water, high quality, low Total Dissolved Solids (TDS) is required to generate steam. The water will be drawn from eleven (11) wells from the Erin Sands Aquifer which is located at Forest Reserve, South Trinidad. The Groundwater Management Programme involves the monitoring of large amounts of freshwater extracted from the Erin Sands Aquifer so that aquifer dewatering will be prevented. The project is a requirement of the Inter-American Development Bank loan and commenced in October 2000 and is expected to last approximately one (1) year. The approach to this programme consists of four main steps which involve conducting Aquifer Performance Tests (APT), performing step-drawdown tests, using groundwater models and revising the existing groundwater monitoring programme. Based on the analysis of the results and the output from the groundwater models, recommendations will be made to improve the groundwater monitoring programme so as to preserve the life of the aquifer.

Keywords: Erin sands, groundwater management.

Andre, P. and R. Harbajan-Sankar. 2000. Exercise programmes for oil spill contingency plans: The Petrotrin experience. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Prior to 1996 Petroleum Company of Trinidad and Tobago Limited (PETROTRIN) had no clear division of responsibilities for oil spill preparedness and response. From January 1996 the responsibility for the preparation, reviewing and updating of contingency plans, arranging and executing drills and exercises, was assigned to the Health, Safety and Environmental Department. Since then Petrotrin has developed oil spill contingency plans for its assigned area under the National Oil Spill Contingency Plan (NOSCP) as well as for its areas of operation throughout the Southern part of Trinidad, including marine areas of the East and West coasts.

These plans are developed to prepare for and respond to accidental hydrocarbon spills in a timely and appropriate manner in order to minimise the severity of environmental damage and to hasten the recovery of any damaged ecosystem.

Petrotrin recognizes that the ultimate test of any contingency plan is measured by performance in a real emergency. Each contingency plan, therefore, includes an Exercise Programme which progressively prepares response teams to perform effectively in realistic representations of all the risks that the contingency plan is designed to meet.

Four exercise categories are identified which allow different aspects of the plant to be exercised separately and promote understanding of the purpose and the scope of the whole plan. These are: notification, tabletop, equipment deployment and incident management. Over the past three and half years, Petrotrin has conducted several exercises in each category at various locations. This paper discusses the processes for planning and conducting exercises, the purposes and objectives, and the benefits of such exercises.

Keywords: oil spill, contingency plans, response teams.

Archbald, R., D. Joseph and S. Dyal. 2001. Implementation of process safety management at PETROTRIN's Point a Pierre Refinery. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Petroleum Company of Trinidad and Tobago Limited (PETROTRIN) has voluntarily adopted OSHA's 1910.119 Standard, Process Safety Management (PSM) of Highly Hazardous Chemicals, for the process plants within the Pointe-a-Pierre Refinery. The PSM standard contains requirements for preventing or minimising the consequences of catastrophic releases of toxic, reactive, flammable, or explosive chemicals.

In 1999 the Ministry of Energy and Energy Industries started conducting a series of audits on the process plants in the PAP refinery. The audits are being done as Gap Analyses to determine how closely Petrotrin's actual safety management procedures and practices compare with the OSHA 1910.119 PSM standard.

Petrotrin's insurers, in their usual conduct of audits of the refinery operations, have indicated that the implementation of appropriate loss mitigation methods such as PSM guidelines is a preferred course of action for companies such as ours. In the current insurance climate an adverse report from the insurance investigators could increase premiums.

Implementation of the PSM standard commenced in 2000 and a project team has been set up to manage and coordinate the activity. The first phase of implementation completed addresses four (4) of the fourteen (14) elements and it to be completed by December 2002. This paper highlights the elements of the PSM and the implementation of the elements in PETROTRIN's PAP refinery.

Keywords: Occupational Health and Safety Standards, hazard prevention.

Asson, E.D. 2001. Safety culture and safety culture survey. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Organisations are being driven to adopt new approaches in the way their businesses are managed by factors associated with Globalisation and its implicit demand to become more efficient, cost effective and generally to remain competitive. The implementation of new approaches for managing Occupational Health and Safety (OHS) is also included in this drive as firms attempt to demonstrate responsible management to various stakeholders.

These new approaches invariably are methods that have been developed and successfully implemented by the industry leaders and have become benchmarks against which OHS performance is compared. However, these approaches either reflect or fit exactly into a safety culture context that supports their successful implementation.

Safety Culture itself has been described by various researchers in the field as evolutionary in nature, with organisations going through and reflecting different levels of development over time. It is now common knowledge that new initiatives to manage and progress the OHS performance must consider the nature of the current safety culture in order to develop effective strategies for them to be successfully implemented.

Safety professionals therefore must now, as a matter of necessity, be equipped with the appropriate tools to accurately assess the Safety Culture of their organisations in order to define the stage in the evolutionary process they occupy and also to understand the factors that most influence the culture. This is required before identifying the appropriate method for implementation to move the OHS culture and performance forward.

This paper discusses the Safety Culture issue and the importance of understanding the significant factors that shape it as a prerequisite for successfully implementing new approaches for managing and improving the overall performance of any organisation. This paper also describes a Safety Culture survey method that has been successfully tested for assessing Safety Culture that utilises both quantitative and qualitative methodologies in an exciting and flexible approach that takes cognizance of certain typical survey limitations.

Keywords: safety culture, management, organisational performance.

Boodoosingh, H. 2001. Complementing the traditional safety management programme with a behaviour-based approach. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Injuries and illnesses result from exposure to hazards. The traditional approach to safety management has focussed on the identification and analysis of potential hazardous conditions followed by the selection and application of suitable hazard control mechanisms. The ideal time for performing such an exercise is during the design stage. Eliminations or substitution can remove the hazard altogether. However, in cases where this is not feasible, the hierarchy of hazard control outlined by the National Safety Council recognises that engineering is the next most effective hazard control mechanism. This is followed by warnings, training, procedures and use of personal protective equipment. In spite of applying one or more of these hazard control mechanisms, injuries and illnesses continue to occur.

In order to understand the root cause of injuries and illnesses one must further analyse all the factors that contribute to their occurrence. Such an analysis will show that injuries and illnesses are caused by exposure to hazards resulting not only from at-risk conditions but also from at-risk behaviours. Achieving excellence in safety performance therefore requires an approach that goes beyond the traditional focus of safety management and into areas that also focus on eliminating at-risk behaviours.

This paper seeks to discuss Atlantic LNG's experiences in promoting a work culture that focusses on employing both the traditional and behaviour-based approaches to safety management.

Keywords: hazard control mechanisms, work culture, traditional and behavioural safety management approaches.

Boodoosingh, H. 2000. Safety management at Atlantic LNG. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Atlantic LNG Company of Trinidad and Tobago operates a 3 million tonnes per annum Liquefied Natural Gas (LNG) plant located at Point Fortin, Trinidad. The plant which is supported by a marine loading terminal and two 102,000 cubic meters storage tanks was commissioned during the first quarter of 1999 and delivered its first shipment of LNG in April 1999. Recognising that the production, storage and export of LNG entail the handling of large quantities of flammable hydrocarbons, safety considerations were an essential element throughout the conceptual and detailed design stages of the facility. The result is a facility designed to avoid the release of hazardous material, minimise the quantities of any releases which do occur and mitigate the consequences and hazards by passive means supplemented by active techniques where necessary.

The purpose of this paper is to provide an outline of the safety features of the Atlantic LNG Plant and to show how the various systems complement each other and provide a comprehensive overall safe design aimed at the protection of people, property and the environment.

Keywords: hazard prevention, health and environmental safety.

Boodoosingh, H. 2001. Complementing the traditional safety management programme with a behaviour-based approach. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Injuries and illnesses result from exposure to hazards. The traditional approach to safety management has focussed on the identification and analysis of potential hazardous conditions followed by the selection and application of suitable hazard control mechanisms. The ideal time for performing such an exercise is during the design stage. Eliminations or substitution can remove the hazard altogether. However, in cases where this is not feasible, the hierarchy of hazard control outlined by the National Safety Council recognises that engineering is the next most effective hazard control mechanism. This is followed by warnings, training, procedures and use of personal protective equipment. In spite of applying one or more of these hazard control mechanisms, injuries and illnesses continue to occur.

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This paper seeks to discuss Altantic LNG's experiences in promoting a work culture that focusses on employing both the traditional and behaviour-based approaches to safety management.

Keywords: hazard control mechanisms, work culture, traditional and behavioural safety management approaches.

Chitaman, J. and K. Ramnath. 2001. Using available sulphur dioxide (SO₂) emissions as an indicator of the vulnerability of Trinidad to air pollution. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The vulnerability of Trinidad to air pollution can be determined using available air quality monitoring data. The most substantial air quality data existing to date is continuous and intermittent concentrations of sulphur dioxide (SO₂) monitored by Petrotrin at Pointe-a-Pierre. The data obtained from this monitoring program can be used to determine the maximum twenty-four (24) hour SO₂ (ug/m³) concentrations in some cases for Trinidad. Values calculated can be utilised under the premise that SO₂ is a general indicator of air pollution, and that the highest concentrations obtained in the recent past are specific indicators of vulnerability to air pollution in the future.

Keywords: air pollution, sulphur dioxide.

Clarke-Marshall, C.M. 2003. Preliminary description of socio-economic aspects of the fisheries of the South Oropouche (Godineau) Swamp. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The effective functioning of wetlands is centered on the sustainable management of human activities and traditional uses. An understanding of the social and economic conditions of communities and users within and adjacent to the Godineau Swamp is fundamental to developing appropriate and effective management strategies to encourage sustainable use.

The Godineau Swamp is the second largest wetland system of the Gulf of Paria, Trinidad. Traditionally, this wetland has supported a fish and shellfish industry, provided land for agriculture, livestock farming and housing. Oil exploration has taken place in the Godineau Swamp for the last 50 years and the Swamp continues to provide several opportunities for eco-tourism.

The paper is based on a study which examined the socio-economic baseline of the South Oropouche (Godineau) Swamp. With the current dearth of data on the Swamp, the main objective of the study was to establish a socio-economic baseline for the communities and users of the South Oropouche (Godineau) Swamp, particularly its socio-demographic profiles as well as highlight the types of existing uses. The paper describes the fishers of the South Oropouche (Godineau) Swamp one of the major user groups and attempts to highlight the

socio-cultural and economic attributes of its fishery. The information generated will be used to develop effective strategies for managing the Swamp.

Keywords: socio-economic baseline, Godineau Swamp.

Cook, J. 2001. Creating a pollution prevention ethic in Trinidad and Tobago. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

This paper explains the evolution of the term pollution prevention and defines this term clearly. It then describes how local legislation is a strategy for action that will facilitate pollution prevention and what benefits can be derived from pollution prevention.

Keywords: pollution prevention, legislation.

Croft, R. 2002. Road safety at BP Trinidad and Tobago LLC. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Road safety is recognised as one of the highest risks in BP's worldwide operations. In Trinidad and Tobago, we consider road safety to be our number one safety risk. Elements of BpTT's journey to improve road safety are described with comments on the issues faced and progress made. Issues faced include: culture, history, laws, vehicle equipment, privacy, enforcement, and differences in perception of risk. The status and degree of success that the various elements have achieved to date are described. Suggestions will be made on the priority of elements for other companies when setting out to achieve road safety improvement.

Keywords: road safety, risk, BpTT.

de la Bastide, A. 2000. HSE Management for drilling in an oil and gas company. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

HSE Management Systems (HSE-MS) are in place for Shell companies worldwide. Requirements usually address three features:

- (1) A Hazard and Effects Management Process (HEMP) to identify HSE controls,
- (2) Quality management framework to organise the HSE controls, and
- (3) Integration of HSE controls in to the business through policies, procedures, monitoring systems, audits, etc.

The Trinidad Shell E & P (TSEP) HSE-MS Policy was devised in accordance with corporate guidelines, and addresses the above mentioned features. The drilling element of the TSEP HSE-MS was elaborated to form the HSE Plan for the Drilling Operation in Quarter 4, 1999. This Operations HSE plan identifies the general and specific HSE issues relevant to the offshore drilling operation in Trinidad and Tobago, and the actions to manage them safely and successfully. It is complemented by an Emergency Response Plan, the Stena Tay Safety Case, and interface documents.

The environmental element of the Operations HSE Plan was guided by the conclusions of an Environmental Impact Assessment for Drilling. EIA consultations were conducted in both Trinidad and Tobago and included stakeholders, NGOs and CBOs. The EIA conclusions were also integrated in the TSEP Waste Management System and TSEP Oil Spill Contingency Plan, which are also important for drilling operations in Trinidad and Tobago. The well drilled in Quarter 4 1999 was drilled without any health, safety and environmental incidents, which implies that the HSE-MS applied is a working system.

Keywords: health, safety, policy, monitoring systems.

Elias-Samlalsingh, N. 2000. Toxicity identification evaluation procedures for toxicity characterisation of a petroleum wastewater effluent (produced water) using *Metamysidopsis insularis*. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

This paper summarises the method that can be used locally for testing the toxicity of produced water using a local toxicity test species. The paper also summarises the characteristics of produced water, the need for treating this type of effluent and the environmental fate and effects of produced water components on the environment.

Keywords: toxicity, produced water, indigenous species.

Gopaul, H. 2002. Water resources management in the caribbean: Issues and challenges. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The population of the region generally regards the responsibility for water resources management and protection as residing within the domain of the State and state agencies. This is far from the truth, since we are all users of the resources and as a result should be also be viewed as managers. The role of the State should be seen as catalysts and facilitators. In the case of water resources, the state should be creating the enabling environment for private sector involvement and/or guaranteeing the necessary investment for increased supply and developing the relevant policies to address resources use conflicts.

The general population has an important role to play. They must become involved in the management of the resources, including that of protection and conservation. The involvement of the general population in water resources management requires awareness building, which leads to empowerment. People generally act out of their own self-interest and self-preservation. They need to understand what is at stake, what they can do and how their involvement will make a difference, and will be of benefit to them. In addition, conflict resolution in relation to water resources becomes easier if all parties are aware of the impacts to them.

While the challenges facing water resources management in the Caribbean appear to be great, there is hope for the region. More and more governments are recognising the need for a holistic approach of the resource. A small step, but nevertheless a step in the right direction.

Water resources management is likely to be a top environmental management priority in the region for the foreseeable future as we prepare for the World Summit on Sustainable Development in August 2002; the Third World Water Forum in March 2003 and seek to put in place the adaptation strategies for the impacts of climate change and variability.

Keywords: water resource management, Caribbean.

Grannum-Modeste, G. 2003. Waste management as an HSE tool: A case study of the Atlantic LNG Company of Trinidad & Tobago. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

By implementing very simple, low cost practices over a fifteen month period, the Atlantic LNG Company of T&T was able to realise a cost savings of One hundred and seventeen thousand, one hundred and ninety-six dollars TT (\$117,196.00).

Keywords: waste, health, safety, environment, management.

Hosein, M., P.J. Andre and R. Mungroo. 2001. Development of a revised National Oil Spill Contingency Plan for Trinidad and Tobago. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The National Oil Spill Contingency Plan (NOSCP) for Trinidad and Tobago was first developed in 1977. It is applicable to all oil pollution incidents occurring on land and waterways in Trinidad and Tobago and in the marine areas defined by the country's two hundred mile Exclusive Economic Zone and the Trinidad and Tobago/Venezuela Delimitation Treaty of 1990. As a party to the United Nations Convention on the Law of the Sea (UNCLOS) the country has a responsibility to protect and preserve the marine environment.

In addition, Trinidad and Tobago ratified the International Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC 1990) in the year 2000 and has already taken steps to enact the appropriate legislation for complying with requirements of this agreement as well with those of several others relating to oil pollution in the marine environment. In order to fulfil the obligations of these conventions, the Ministry of Energy and Energy Industries (MOEEI) accepted an offer by the Petroleum Company of Trinidad and Tobago Limited (PETROTRIN) to review and update the NOSCP.

This exercise, expected to be completed in 2002, will provide strategies for response to Tier 3 incidents, complemented by sensitivity, risk assessment and trajectory maps. Phase 1 of the project deals with the marine pollution from shipping, offshore installations, coastal and nearshore operations and installations while Phase II involves oil pollution incidents on land and waterways.

Phase I is being developed in keeping with the guidelines published by the International Maritime Organization (IMO), which are endorsed by the International Petroleum Industry Environmental Conservation Association (IPIECA), the International Tanker Owners Pollution Federation (ITOPF) and Asociacion Regional de Empresas de Petroleo y Gas Natural en Latinoamerica y el Caribe (ARPEL).

Keywords: contingency plan, oil pollution, prevention strategies.

Jagdeo-Maharaj, D. 2000. Bio-Analysis:- The environmentalist's tool of the future. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Immunoassay Technology is based on the detection and measurement of defined target compounds, using the specific binding characteristics of antibodies. Presently, this technology is one of the most widely used and accepted test systems in the Medical Industry with approximately one billion clinical tests performed in the United States annually.

Immunoassay techniques are currently being introduced into the Environmental Arena where Immuno Assay Test Kits introduced into the market, are able to provide Environmental Professionals and Chemists alike with a fast, accurate and economical method of performing "on-site" analysis of various regulated compounds in various matrices e.g. BTEX/TPH analysis in soil and water samples.

Immuno Assay test kits have been designed to be specific to either individual compounds, e.g. pesticides such as DDT or specific to whole compound groups e.g. Petroleum Hydrocarbons. Each test kit is designed with specificity characteristics which apply to precise environmental applications. Immunoassay Techniques can be used to analyse a variety of matrices e.g. soil, water, sludge, compost and concrete when simple field sample preparation techniques are incorporated with normal procedures. Water matrices however require no prior sample preparation, and can be analysed immediately.

There are several different formats for Environmental Immunoassay Test Systems with each format having different properties and technical principles. These different formats are based on the use of magnetic particles, the use of latex particles or introducing coating polystyrene test tubes and microtiter plates. These different formats allow environmentalists to choose an immunoassay test kit which is specific to their requirements.

Keywords: immunoassays.

Jagdip, D. 2003. A model for estimating the costs of occupational injuries in Trinidad and Tobago. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Almost everyday in Trinidad and Tobago, we hear news of injuries in the workplace. The results range from fatalities to minor cuts and bruises. But notwithstanding the severity or lack thereof, occupational injuries cost.

Some of the costs of injuries are direct and apparent, while others are "hidden". Among the easily identified costs are medical expenses, increased insurance premiums, loss of income due to downtime, the costs of incident investigations, etc. Some of the costs that are more

difficult to calculate include those associated with the erosion of employee morale, negative media reports, and reactive management system corrective actions.

Models are available internationally to assist in the computation of the total cost of an occupational injury, but Trinidad and Tobago is unique in many ways, and some of these models require adjustment to be more applicable here. A lack of relevant, updated legislation, varying levels of medical emergency response capabilities among employers, an abundance of unskilled labour, and a shortage of highly skilled labour are among the many factors to consider.

Starting with readily available and widely accepted models for costing occupational injuries, this paper will identify aspects of these models that require modification to be applicable to the local environment, and develop a model for estimating the costs of occupational injuries in Trinidad and Tobago.

Keywords: modelling, cost analysis, occupational injuries.

Kalpee, T. 2000. Environmental strategies in a difficult business environment. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The historical reputation of the oil industry in Trinidad as an environmentally unregulated industry without proper management of its environmental impacts and inadequate environmental management procedures has led to an unprecedented improvement in operational activities among the larger producers. These improvements have been taking place largely through an increased management awareness of associated significant environmental impacts and the long-term liabilities caused by these unmitigated impacts.

Trinmar Limited has been able to develop solutions to some of these daily operational issues that result in significant environmental impacts. This paper highlights three of these operational issues (oil spills, oily waste disposal and produced water treatment and disposal) to show the processes involved in implementing change in an operation that spans 48 years in the marine environment. It is hoped that these processes may be of assistance to other companies who are in the process of finding solutions to long-standing environmental problems and may offer guidance in the issues that must be considered.

Keywords: environmental management, petroleum operations.

Kalpee, T. 2001. Successful strategies to change a negative environmental history into a corporate strength. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

There are a number of reasons for improving the corporate environmental background of most companies. Such reasons may be based on the restrictions of specific markets or compliance with legislation or to meet the requirements of shareholders. In a few cases, however, the motivation may be based on intolerance by management with a history of poor environmental performance and poor corporate image. In each case, the practical reality of the decision to change requires a plan on which the change can be founded. Though environmental management systems may assist in prescribing specific tasks to be accomplished, and are based on a management commitment to continuous improvement, they seldom deal with the issues of organisational, cultural and individual change that drive the system.

Companies intent on compliance most often see monitoring as the priority. In Trinidad and Tobago where environmental legislation has not been based on environmental baseline and carrying capacity of ecosystems, leading environmental companies deal with an assessment of the ecological and community impact as the first step. Compliance becomes a minimal requirement. Monitoring and analysis then become important to determine the cause of the impact rather than to verify levels of compliance.

Since most long-term environmental solutions are process-related, the determination of system upsets, uncontrolled releases, environmental incidents, waste quantities and waste quality are critical to setting baselines. This step requires total support from operational personnel who may not be part of the decision for environmental change but are charged with

improving incidence reporting. Environmental awareness education then becomes an essential link in communicating the rationale for improvement. The objective is to ensure the employee sees this new reporting requirement as something that should be done and has merit rather than something that has to be done to assign blame. Reports, when statistically analysed, provide the basis for prioritising expenditure and projects and for setting yearly reduction targets.

The company's environmental performance must be benchmarked against leaders and pathfinders in similar industry. Environmental targets must be set annually to close the gap with the leaders. These targets should be linked with company performance indices such as production rates and expenditure, each target achieved being a milestone recognised with reward. Environmental responsibility must be built into job description so that it can be linked with personal reward processes.

All waste streams should be managed using accepted waste management principles, taking the time to ensure proper chains of custody are developed. Simple systems, such as vehicle batteries, used oils and paper can easily set the procedure for more significant types of waste. Annual environmental incident costing must be used to determine tangible reductions in expenditure as performance improves.

All environmental incidents must be treated as emergencies to build trust and credibility with the community normally affected by inaction in these circumstances. Process improvements must be prioritised to ensure those that minimise public and ecological impacts are completed quickly. Simple but well researched environmental projects and family training programmes can be conducted jointly with community organisations and employees to develop mutual understanding of environmental issues.

Development of an environmentally committed workforce and a satisfied management is the foundation on which any environmental management system can then be successfully built for continuous improvement.

Keywords: corporate environmental background.

Kalpee, T. 2001. The limitations of environmental legislation as a tool used to promote positive environmental change. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The majority of existing environmental legislation in Trinidad and Tobago was developed forty to fifty years ago during a period when it would have been extremely difficult to foresee the subsequent industrialisation of the country or the large-scale requirement for natural resources. The failure of these myriad laws, however, to control environmental degradation caused by even these directly regulated industries or the "regular-public" ecologically impacting activities, is cause for serious concern as we commence a renewed thrust towards legislative enactment.

The development of new discharge standards together with environmental clearance requirements, with the Environmental Management Authority as an umbrella coordinating and enforcement body, will undoubtedly bring to life many areas of environmental legislation that were previously dormant. Though many areas of past legislative failure have been and are being addressed, the ability of these renewed legislative processes to bring about environmental benefits through real and rapid ecological improvement, may be limited. These new regulations are being developed, however, against a larger background of established industry, many of which are past their prime for large capital outflow for redesign. Large-scale re-design of industrial processes to ensure compliance will be phased to balance budgets, as this will involve significant capital investment.

There are, however, many areas of concern with the process if the ultimate goal of environmental protections is to be achieved and if the problems of the past are to be rectified. The number of industries to be monitored will require extensive environmental field visits from regulatory agencies and intensive internal monitoring. Since it is not the intention of the regulatory agencies to close industrial facilities, the rate of compliance will be based on the ability of the respective industries to make the required changes within budget restrictions. Thus environmental improvement will be incremental and slow. There is a need, however, for a parallel process that will be to the benefit of all stakeholders. Incentives must be used to

promote true environmental improvements in the shortest possible time given the limitations that exist. Process improvement to meet or surpass environmental discharge standards should be tax deductible if completed within limited time frames. This will ensure that it is done quickly. In this way budgeting is not a serious obstacle to change, as it is presently.

Process improvements are normally designed to surpass environmental legislative standards so that once in place, the need for continuous monitoring by regulatory agencies is significantly reduced. Incentives for the implementation of environmental management systems would allow industry to set up systems which are audited by independent certification bodies rather than the regulatory agencies. These incentives may be linked to reduced permit requirements and reduced reporting requirements. This will ensure that environmental improvements are made within the resource restrictions of the regulatory agencies. The net result is that environmental improvement is faster due to improvement in the quality of discharges, business can continue to produce, less regulatory monitoring is required, and permits are seldom required, after processes are improved, leading to a reduction of bureaucracy in the new process. This direction will also align the local direction to that being taken by many international regulatory agencies.

Keywords: environmental management and protection, process improvement, petroleum sector.

Kalpee, T. 2001. The use of alternative biological indicators to evaluate environmental changes in the Gulf of Paria. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Benthic and pelagic foraminiferal fossil assemblages are extensively used in Trinidad as indicators of paleontological environmental changes that can be correlated with geological events. The sensitivity of these organisms to naturally changing environmental parameters and their short life-histories, has also made them useful in highlighting shorter-term, more recent environmental changes in the marine environment. In fact, the study of recent benthic foraminiferal distributions in polluted marine areas, may be one of the most sensitive and inexpensive markers available for indicating deterioration of marginal marine or nearshore environments (Alves, 1995). Since 1970, studies have been published on the effects of chemical, heavy metal, oil and thermal pollution on these foraminiferal communities.

This preliminary investigation was conducted to highlight the potential of foraminifera as a possible tool in determining environmental changes in the Gulf of Paria. Todd and Bronnimann (1957) developed a foraminiferal population baseline consisting of forty (40) "selected" characteristic species that allow comparisons to be made with existing populations in the Gulf of Paria.

Four nearshore sampling locations were chosen from the North to the South West Gulf of Paria. These locations were at Sea Lots, Pt. Lisas, Brighton and Pt. Ligoure. Five (5) samples were collected from each location for analysis of foraminiferal assemblages as well as chemical parameters. The results from the sites at Brighton showed that organisms may have adapted themselves over geological time to use the hydrocarbon as a food source. At the other locations, TPH (Total Petroleum Hydrocarbons) seemed to be an impacting pollutant. Generally, the Pt. Ligoure and Pt. Lisas sites showed most of the characteristics of environmental stress. The examination of these populations revealed a reduced diversity of species, decreased population abundance and decrease in the size of specimens. Their ability to react to environmental changes makes these organisms ideal for complementing the use of macrofauna for environmental assessments, especially in abiotic macrofaunal zones.

Keywords: foraminifera, bioindicators, oil pollution.

Kalpee, T. 2002. Environmental Impact Assessment in the project life cycle. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Recent changes in the corporate environmental direction in Trinidad and Tobago have now directed a more environmentally focussed project management approach. This direction has resulted from both internal corporate strategic objectives as well as from changes in environmental legislative requirements for projects. The Certificate of Environmental

Clearance Rules recently incorporated into law was designed to improve the environmental planning process of any project that includes any activity listed as potentially impacting. The regulatory project approval process, however, may be the critical path of many projects because of the length of the process.

Project clearance may be withheld if it is determined that the project possesses environmental and social impacts that are significant, permanent or irreversible or if the available project or environmental information is insufficient. In these cases an Environmental Impact Assessment (EIA) may be required. The introduction of the EIA screening process to most projects will fundamentally change the planning process for projects and project clearance process may extend for a period of six to eight months. The EIA process may also result in an alteration to the original scope of the project.

Project Management Units, as the coordinating body of project management in many companies, must determine a strategy to effectively incorporate this new requirement seamlessly into the project management process, to avoid the delays, budget constraints, negative publicity and to develop positive regulatory involvement. This environmental screening process must be seen to be proactive and a necessary quality management tool that will positively affect the results of each project, but benefits can only be derived by a new approach.

Keywords: Environmental Impact Assessment (EIAs), project management.

Kalpee, T. 2002. Minimizing future Health, Safety and Environmental (HSE) risks by strengthening contractor management processes. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Many companies depend on the involvement of contractor personnel for as much as fifty percent (50%) of the project or operational work performed on a daily basis. A few companies have gone further to contract out major aspects of their operational work to contracting companies which then sub-contract smaller parcels of work to smaller contractors with specific skills and experience.

In all cases these contracting relationships bring mutual benefits to the parties involved and are seen as the means by which larger companies can effectively impact employment of the wider workforce of neighbouring communities. The contractors assist companies in providing skill sets that do not have to be developed in-house but which are available when required at a lower overall cost. The contractor also becomes extremely well qualified, experienced and competent in the specific area of work for which the contracting company is registered. This expertise does not normally exist in the company purchasing the service or, if it does, it is not as well developed. Contracting companies are usually well prepared to handle projects or particular operational issues which present risks or hazards, and in fact derive their profits from handling such tasks.

The lack of Trade Union involvement in many Contractor operations has also made them an easier proposition for particular projects than company workers. This absence of Trade Union involvement among many contractors has also been one of the primary reasons for the lack of HSE development of contractor employees. Unions have usually filled the Occupational Safety and Health gaps where the Factory Inspectorate regulations governing such worker issues have been largely inadequate to force the hands of employers who are prepared to have their employees handle all project risks once it makes good business sense. The absence of qualified and experienced HSE personnel in particularly the medium and small category contractor categories (less than 50 employees) has also negatively impacted the awareness of contracting companies to the unfolding requirements of the Environmental Management Act (EM Act). These contractors are therefore unprepared for the new way of conducting business. This is significant since they conduct business on behalf of much larger companies who are themselves fully aware of their corporate responsibilities and the repercussions for disregarding the rules that support the EM Act.

Keywords: contractors, management processes, environmental performance.

Khan, F. 2002. Meeting the challenges of environmental clearance for onshore development drilling In Trinidad. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The Certificate of Environmental Clearance Rules 2001 dictates that any development activity in Trinidad and Tobago will require a Certificate of Environmental Clearance (CEC). On review of the CEC application, the Environmental Management Authority (EMA) can request an Environmental Impact Assessment (EIA) if it deems necessary.

The CEC process poses numerous challenges to both the petroleum exploration and production industry and the EMA due to economic, geophysical and ecological factors. The very nature of the application process and the scope of a development-drilling program can result in unaffordable delays and significant environmental assessment costs. Most onshore drilling in Trinidad takes place in mature and marginal fields where operators cannot tolerate excessive and expensive environmental assessments, mitigation costs and equipment downtime. It is also coincidental that the majority of onshore oilfields in Trinidad are located within heavily forested areas where there may be significant floral and fauna resources

The Petroleum Company of Trinidad and Tobago (Petrotrin) is currently working towards ISO 14001 Environmental Management System certification for its exploration and production operations. Resulting from this exercise was the identification of all environmental aspects and their potential impacts from any type of onshore drilling, whether development or exploration, and the development of environmental operational controls to mitigate these impacts. These procedures were developed through feasibility studies and risk assessments and are formally approved by Petrotrin exploration and production management.

These environmental operational controls not only have benefits such as risk reduction, but can also lend assistance towards reducing delays and costs in obtaining CEC's for development programmes.

Keywords: onshore, drilling, environmental clearance.

Mohammed, A. and N. Elias-Samlalsingh. 2000. Pollution impacts on living systems: Monitoring, prevention and control strategies for managing impacts. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

This paper overviews pollution sources and their impacts on the natural environment. It discusses the use of ecotoxicological tools for assessing pollution impacts and includes possible strategies which can be implemented to mitigate environmental damages.

Keywords: pollution, hydrocarbons, environmental impacts.

Nicodano, C., A. Mazerole, M-I Swaco and J.D.A. McKee. 2001. Experience of safe and efficient drill cuttings disposal through cuttings re-injection. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Increasing concerns arising from the environmental impact of drilling fluids and drill cuttings discharges have driven the introduction of new waste management techniques. Although significant progress has been made by the development of more environmentally friendly drilling fluids, some areas have found waste management techniques that result in no on-site surface waste disposal are an attractive alternative. This awareness, together with the economic and safety issues related to the logistic of cuttings containment and shipping to shore, has hastened the development of cuttings re-injection technology.

Since the mid eighties, when cuttings re-injection was first applied in Alaska, the application of this technology has grown extensively, as well as the scientific knowledge on which it is based. By the early nineties, cuttings re-injection had become well established in the North Sea and North America, and to a lesser extent in South America, Africa and the Far East, in applications that included annular and dedicated well re-injection in both long-term offshore developments and mobile land operations.

There are three main aspects of cuttings re-injection technology, although other considerations arise when addressing deep-water projects and sub-sea technologies. These

are: (1) the underground injection mechanisms; (2) the disposal formation selection and access; and (3) the cuttings transfer and slurrification equipment and techniques. This paper discusses these aspects, describing criteria for selection of the disposal formation, the cap rock and isolation mechanisms in different geological strata, annular versus dedicated well injection, casing design, injection path isolation in the wellbore or annulus, disposal volumes, fracturing and fracture propagation. Equipment selection and configuration, including slurrification systems, re-injection pumps and wellheads, and the required slurry characteristics are included in the discussion. Each aspect is evaluated with the objective of designing a safe, environmentally responsible and efficient cuttings re-injection plan.

Keywords: drill cuttings disposal, waste management techniques.

Pearson, S. and G. Ramcharan. 2003. The role of public consultation in the planning and development of projects in the oil and gas industry. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

With the advent of the Certificate of Environmental Clearance (CEC) Rules in 2001, there has been a significant increase in the role and visibility of the environmental management of activities in Trinidad and Tobago. The process by which proposed activities are to be managed has gained clear favour with third parties – general public and NGOs who may have not been consulted prior to the Rules and as such activities that may have caused significant impacts had gone unchecked by some interested parties.

The consideration of all impacts on human health and the environment are now the underlying concepts for planning activities in Trinidad and Tobago. The use of environmental impact assessment is a fundamental criterion in the process depending on the activity. In addition, public consultation has now become a crucial part of this process, the primary purpose of which is clearly to protect the interests of affected communities and allow public concerns to be recognised at an early stage in the planning of project environmental assessments.

British Gas Trinidad and Tobago (BGTT) has on 4 occasions been involved in the public consultation process in Trinidad both prior to and subsequent to the CEC rules. It is now a fundamental aspect of the Company's project work in terms of delivering improved project sustainability. This paper will explore the impact of the role of public consultations in project planning and development and outline the key lessons learnt in previous consultation programmes for BGTT projects. It will explore the benefits of getting consultation right – putting in place the building blocks of improved relationships with the community addressing the strengths and weaknesses of consultations in terms of its planning, design, site-specific sensitivities, impacts and the decision making process.

Keywords: public consultation, community involvement, petroleum projects.

Rabke, S., J. Candler and V. Swank. 2001. New testing protocols and environmental guidelines offer pollution prevention model for discharge jurisdictions. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Since synthetic-based drilling fluids were introduced in the Gulf of Mexico in 1992, the industry and government regulatory agencies have worked towards realising the full pollution prevention characteristics of the technology without sacrificing the inherent drilling performance benefits. The US Environmental Protection Agency (EPA) first recognised the environmental issues of synthetic-based drilling fluid technology in its Coastal Effluent Limitation guidelines. Concurrently, it determined test protocols existing at the time needed to be improved to measure the environmental performance. In response, joint industry work groups, including EPA scientists and engineers, began identifying and modifying test protocols that would allow continues positive development of synthetic-base fluid technology. On December 28 2000, the EPA published its new Effluent Limitation Guidelines for synthetic-base drilling fluid technology. These standards can not be used as a pollution prevention model for discharge jurisdictions outside of the Gulf of Mexico. This paper will review the development of these guidelines and their applicability to other discharge jurisdictions.

Keywords: testing protocols, drilling fluids, environmental guidelines, pollution prevention model.

Ramcharan, G. 2002. The challenges of implementing ISO 14001 – The British Gas Trinidad and Tobago experience. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Changes to the environmental agenda and the increase in environmental awareness over recent decades have increased pressure on companies to include environmental performance in their business strategies. This has made a fundamental change in the way in which businesses operate – especially in the oil and gas industry. Now, successful companies will not only comply with international and national environmental legislation, but will act on pressures exerted by consumers, non-governmental organisations and stakeholders with regards to environmental performance and rethink their corporate image and position in the global market. Implementing a formalised, systematic approach to environmental management is a means by which these objectives can be achieved.

In 1999, BG Group set an objective for all of its controlled assets worldwide, to implement an Environmental Management System (EMS) in accordance with International Standards by the end of 2002. In January 2000, BG Trinidad and Tobago started the implementation process and achieved accreditation in December of the same year.

The process of attaining an accredited EMS presented BG Trinidad and Tobago with a number of challenges including the establishment of objectives and targets, development of teams to gain worker involvement and the maintenance of the actual EMS itself. Furthermore, it identified a number of areas for improvement covering all aspects of the business including management and staff support in all operational and administrative departments. "It has been suggested that '80% of the [environmental] problems encountered are attitude related and concerns management and procedures, while only 20% are technically related...' (Twiney, 1991).

The full paper will discuss the EMS implementation programme and the associated improvement strategies to develop a more environmentally conscious staff to deliver a successful and sustainable environmental management system.

'BG recognises that achieving an appropriate balance between, environmental, social and economic issues is increasingly a critical component of our business. We need to operate our business in a manner that contributes to the sustainability goals of the country in which we operate as well as international agreements. Our commitment to progressive improvement in our environmental performance is but one aspect of this contribution.' Frank Chapman, Chief Executive, BG Group. (EHS Report, 2000).

Keywords: environmental performance, business strategies.

Ramlogan, R. 2001. The new environmental legal system of Trinidad and Tobago: Challenges for industry. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

This paper overviews the development of environmental laws in Trinidad and Tobago and the difficulties associated with drafting these. It also overviews the problems associated with effective enforcement and the issues involved with improving the institutional approach to environmental management in this country.

Keywords: environmental legislation, enforcement issues, environmental management.

Ramnarine, K. 2001. Developments in Trinidad and Tobago's environmental laws in the year 2000. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Trinidad and Tobago is the most industrialised country in the Commonwealth Caribbean region. As a result of this industrialisation there is the need to regulate via legislation how the operations of industries impact on the environment. The objective of this paper is to outline

the challenges that have been presented as a result of legislative developments in the field of environmental law in the year 2000.

New environmental laws enacted recently and the implementation of older laws, which have been on the statute books for some time, will impact on how companies structure or re-structure their operations to come to terms with these legislative changes.

Environmental issues regarding the way companies are managed now impact directly on company's finances. Environmental Impact Assessments (EIAs) are now required in order to access financing for major capital intensive projects and there is the possibility that companies can face litigation for non-compliance with environmental laws. This litigation almost always incurs substantial cost and has the effect of damaging the image and reputation of the company.

Recent legislative developments indicate that the government of Trinidad and Tobago is placing emphasis on the way the country's environment is managed. This paper looks at the Environmental Management Act of 2000, The Judicial Review Act of 2000, and the establishment of the Environmental Commission.

Keywords: environmental laws, challenges, legislative developments.

Ramnath, K. and V. Quan-Vie. 2000. Developing an emergency response planning and response system using Geographical Information System for an Oil Refinery. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Major emergency situations can arise at petroleum refining installations as a result of a toxic gas release, fire, explosions, and/or chemical spills. The severity can be catastrophic if the situation isn't properly managed. This feasibility study was prepared on the Petroleum Company of Trinidad and Tobago Company Limited refinery located at Point-a-Pierre, Trinidad, West Indies to highlight the importance of Geographical Information System (GIS) in emergency planning and response. GIS can be used to allow users to collect, manage and analyse large volumes of spatially referenced and associated attribute data and display them graphically.

This facility is located in close proximity to residential properties to its East, South and North. In addition, on its 2,500 acres industrial estate, it also supports 200 residential properties and a nature reserve. The system development was based on the three scenarios that could result in an emergency. The steps involved in the determination of the population and sensitive ecosystems that may be at risk and the evacuation system to be adopted based on a three-tier approach for removal to a safe zone.

Keywords: emergency response plan, geographical information system, oil refinery.

Ramoutar, G. 2000. An assessment of surfactant enhanced bioremediation of a petroleum hydrocarbon contaminated soil in a tropical environment. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Commercial surfactants have been recommended by their manufacturers, as an effective treatment technology, for increasing the rate of bioremediation of petroleum hydrocarbon contaminated soils. This paper investigated the application of a non-ionic commercial surfactant to enhance bioremediation of a soil sample contaminated with heavy crude oil, in a tropical environment.

The major problems/constraints that are associated with bioremediation technology include:

- 1) Bioavailability of soil bound petroleum hydrocarbons to biodegrading bacteria
- 2) Adsorption of the petroleum hydrocarbon onto the soil matrix
- 3) The low aqueous solubility of petroleum hydrocarbons
- 4) Bioactivity
- 5) Recalcitrant petroleum hydrocarbons

These all affect the rate of biotransformation and subsequently the rate of biodegradation. The investigation was carried out in order to assess whether the application of a non-ionic surfactant to a contaminated soil sample, increases the rate of bioremediation.

Keywords: bioremediation, petroleum hydrocarbons, soil, tropical environment.

Sookdeo, N. and N. Dave. 2000. Gas detection technology in T&T – A safety perspective. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

With the increased awareness and focus on safety within the broad-based industry in Trinidad and Tobago over the past decade, the use of gas detection systems is on the rise and in some cases is mandatory for safe operating practices. It is important to distinguish between safety applications of gas detection as opposed to that involved with ambient, stack, and indoor air quality monitoring.

Gas detection systems for safety applications are used to detect, measure, and warn the operator of a potentially hazardous environment. As decision-makers and ultimately operators involved in the choice and use of gas detection systems respectively, it is necessary to understand the principles and technology behind gas detection systems for safety related applications. The gas detector and the technology behind the detection mechanism are the most critical components to the operator and a thorough understanding is needed prior to the use of a gas detector. This paper would discuss the following with regards to gas detection systems:

- Theory and Safety applications of gas detection systems – Personal Safety Monitoring, Property Monitoring and Confined Space Entry.

- Current Sensor Technology – Catalytic bead sensors for combustible gases and electrochemical sensors for toxic and oxygen gases

- New and emerging sensor technology, namely “Infra-Red” (IR) Technology and Smart Sensor Technology

- Future trends in gas detection systems and considerations in choosing the most feasible detection system.

Keywords: gas detection, safety, warning systems.

Sookdeo, N. and D. Pena. 2001. Subsurface contamination associated with underground storage tanks (USTs). AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

This paper summarises methods for assessing underground leaking from subsurface storage tanks and suggests remediation techniques and criteria used for assessing success of remediation exercises where leakages have been detected.

Keywords: underground storage tanks, contamination, groundwater.

Sookdeo, N. and Kalpee, T. 2002. Determination of environmental liabilities and development of a facility closure plan for a state oil company and oil and gas operator. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Good business practices by a state oil and gas operator requires a responsibility to decommission uneconomic assets (wells, pipelines, structures) to prevent any ongoing environmental damage resulting from the improper abandonment and closure of all or any of its operations. With the introduction of the International Accounting Standards (IAS)-37 regulations for Contingent Assets and Liabilities, many oil and gas operators are now required to state all environmental liabilities and the associated costs for decommissioning assets in a phased manner. The assets of oil and gas operators can include on-shore and offshore wells, structures, and pipelines.

Prior to the introduction of the IAS-37 accounting standards, many operators ignored the concept of life cycle costing when developing and exploiting assets. The result was that

provisions for the cost of decommissioning of assets when uneconomic were not originally factored into the economic analysis and accounting for major projects or field development. When an asset was spent, improper abandonment resulted in many operators being faced with environment, health and safety (EHS) liabilities and a strain on financial resources for abandonment that were not originally catered for.

With the introduction of the IAS-37 accounting standard, many operators are now required to state current and past liabilities as a result of oil and gas exploitation, the current assets, and a phased closure plan for these assets when uneconomic. Proper life cycle analysis and decommissioning at the end of the asset is crucial for regulatory compliance, due diligence, and reduction of internal and external liabilities. The new trend of stating all past and existing liabilities on the accounts for a state oil and gas operator can have major benefits and challenges. The requirement for the development of a facility closure plan includes (1) the identification of all areas of activity requiring closure, (2) the closure procedures and costs, and (3) the implementation of phasing of items identified for closure. Some of the benefits of a facility closure plan include the reduction of HSE risks, conformance with the IAS-37 standard, financial management, and internal asset management. Some of the challenges faced by an operator in developing a facility closure plan includes the lack or availability of data, limited financial and human resources, limited technical data on reserves, and the lack of environmental baseline data.

The intent of this paper is to highlight the requirements by operators to develop a “facility closure plan” and to determine the closure liabilities associated with the implementation of that plan that would conform to International Accounting Standards 37 and accepted business practice.

Keywords: facility closure plan, closure liabilities, International Accounting Standards 37.

Suite, C. Y. M. 2001. Towards Zero Discharge: Pro-active approach to drill cuttings reuse/treatment/disposal. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

Mud contaminated drill cuttings are a major source of petroleum waste. During typical drilling operations, the waste generated includes drilling fluids and solids, cement returns, enhanced salinity, water, oil and large volumes of drill cuttings. Cuttings contaminated with drilling muds are usually discharged based on current local regulatory guidelines. Cuttings may however carry potential liability issues when improperly managed or disposed. There is the need to develop methods that are both technically and economically feasible.

BPTT LLC is committed to “No hard to the environment”. As such, BP is involved in a continuous, proactive approach to findings suitable alternatives for waste disposal. This includes:-

- Quantify the amount of mud and cuttings currently discharged into the environment
- Reduce drilling waste via the introduction of both a comprehensive waste management and total fluids management system
- Identify existing or required technologies to reduce and eliminate the amount of discharge into the environment
- Define strategies for cuttings handling, storage and transport
- Implement economic and environmentally beneficial use of drilling mud and cuttings

This paper discusses methods for disposal, treatment and reuse of drilling cuttings that are safe, cost effective, reliable, with minimal environmental impact and potential community benefit. It is believed this approach will impact platform design, rig selection, mud types, drilling and completions processes in the local oil sector.

This paper also studies BP newest gas development in Trinidad and looks at plans for waste management.

Keywords: drilling cuttings, waste management techniques.

Tyler, S.D. 2002. Environmental information: Public vs. Confidential. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The protection of confidential business information and the release of environmental information to the public are both good things. Unfortunately, there is the potential conflict between these two good things—they are not complementary. This potential conflict is a serious policy issue that deserves consideration in a proactive and comprehensive manner.

Keywords: environmental information, sharing.

Vieira, K. 2000. LABIDCO land treatment facility management systems. AMCHAM Environmental, Health and Safety Conference, Hilton Hotel and Conference Centre, Trinidad.

The LABIDCO Land Treatment Facility is a specifically designed oily waste processing facility. The facility has been designed and engineered to treat oily waste by the waste treatment process of bioremediation and more specifically “Landfarming”. Landfarming is the bioremediation waste treatment process where specific waste materials are serial spread and manipulated for the objective of having the inherent and naturally occurring or introduced synthetically engineered microbial population degrade the hydrocarbon contaminated waste into an environmentally acceptable form.

Oily wastes are defined as waste contaminated with petroleum hydrocarbons originating from primary crude production operations, upsets and spills and refining or secondary petrochemical processes. Oily waste takes the form of waste solids, sludges and emulsions that contain petroleum hydrocarbons.

The waste hydrocarbons represent uneconomically recoverable crude or refined residual fractions. These are usually because of emulsion formation or absorption or adsorption of hydrocarbons to the mineral solids. These are mixtures of and combinations of clay, silt, and minerals interspersed with relatively small quantities of hydrocarbons of crude origins, brine water, trace metals, and minor quantities of processing chemicals. The metals are mainly nickels, vanadium, iron and manganese metals while the processing chemicals can include defoamers, dehydrating agents, sulphur removal chemicals and demulsifiers. While some production hydrocarbons usually contain water of marine origin, production separation and processing remove most of this liquid. The remaining waste liquids are usually relatively immobile, but are not environmentally acceptable for direct land filling or other casual disposal.

Keywords: waste treatment, bioremediation.

Society of Petroleum Engineers Annual Conferences

Agbon, I.S. 2003. Measuring sustainable economic development indicators with fuzzy sets: The sustainable development index. SPE Hydrocarbon Economics and Evaluation Symposium, 5-8 April, Dallas Texas.

Sustainable economic development means different things to different stakeholders. It encompasses economic, social, political and environmental issues. Therefore, it is very difficult to measure and monitor. There has been marginal success in developing indicators that capture sustainable economic development from the perspective of the host community.

This paper develops a Sustainable Development Index (SDI) that captures the social, economic, political and environmental impact of oil and gas activities on the host community. Using a fuzzy logic model, fuzzified host community dimension indices are developed for indicators such as Life, Education, Economics, Environment, Political Participation, Social Participation (access to jobs, water, electricity, telephones, internet etc), and Gender Equality. The fuzzified outputs are then aggregated and defuzzified into a Sustainable Development Index for the host community. Using the above method, the annual SDI of a host community can be measured over the project lifetime. For a given year, the SDI of different host communities can also be measured and compared.

The paper concludes that a Sustainable Development Impact Assessment (SDIA) study should be carried out before beginning any oil and gas project. This study should be done in addition to the Environmental Impact Assessment (EIA) study. The SDIA study would establish a baseline SDI for the host community and enable oil and gas companies to monitor the sustainable economic development of the host community during the project lifetime. Oil and gas projects that do not increase the SDI of the host community during their life cycle should be rejected.

Keywords: sustainable development index, petroleum production, community enhancement.

Chadeesingh, R.D. and B. A. Persad. 1996. Bioremediation: Its monitoring and progress in an industrial environment in Trinidad, West Indies. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

The scope and nature of the work involved the bioremediation of petroleum contaminated soil in collaboration with the analytical support of an on site laboratory.

Bioremediation is the process by which micro-organisms break down hydrocarbons into simpler innocuous compounds. To optimise and monitor the bioremediation, an onsite process laboratory was set up.

In order to optimize bioremediation the following parameters were given careful consideration:

- i. Quantity and concentration of the contaminants in the soil.
- ii. Nutrient requirements
- iii. Moisture content
- iv. Aeration
- v. Acidity or alkalinity
- vi. Temperature.

Once these conditions were established it was necessary to monitor the process of the oil and grease degradation while maintaining the optimal conditions for microbial activity. A biotreatment study area was constructed in order to test the workability of the parameters required for bioremediation. The pre-tested contaminated soil along with fertiliser and other substances were added and mixed together thoroughly. Samples were taken immediately and analysed. Subsequently, samples were taken every two weeks from the study area and tested. Additional treatment was administered when necessary.

Bioremediation once correctly managed, is an inexpensive process and is a useful tool in the degradation of harmful petroleum products in a relatively short space of time. In the biotreatment study area, bioremediation was successfully achieved in a period of six to eight weeks.

Keywords: bioremediation, petroleum contaminated soils.

Ciaraldi, W.S., H. R. Mohess and A. G. Dalzell. 2004. Major hazards management in Trinidad and Tobago – putting the jigsaw together. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Calgary, Alberta, Canada.

Bp Trinidad and Tobago (BpTT) has a mature offshore oil infrastructure and a growing, highly valuable gas resource. The merger of BpTT and Amoco caused an examination of the operations and facilities through a new set of eyes; particularly those from the North Sea who had lived through the loss of Piper Alpha. This paper outlines how this operator took the lessons from the North Sea and applied them in a pragmatic way to existing assets in a very different country.

Keywords: hazard management, accident prevention, Trinidad and Tobago.

Ciaraldi, W.S. and B. Hedges. 2005. Restoring integrity to aged petroleum production facilities. SPE Asia Pacific Health, Safety and Environment Conference and Exhibition, Jakarta, Indonesia.

BpTT and its local predecessor Amoco have produced oil and gas off the east coast of Trinidad for over 30 years. This production originates from eight offshore fields and is transported to onshore terminals through an extensive pipeline network. Gas is further shipped for domestic use or LNG production. Oil is temporarily stored onshore and then tanker loaded for export. Despite excellent business success for the operator and nation, maturing production, long service time and constrained resources have taken a toll on the technical integrity of facilities.

In late 2000, a major programme to restore integrity was developed, resourced and implementation begun. The restoration strategy was based on a four-step process involving assess, restore, upgrade and sustain. The programme addresses the technical integrity of all assets including offshore topsides, subsea structures/pipelines, onshore terminals, tankage and oil/gas exports systems. It also includes enhancements to process safety protective systems and development of a comprehensive major accident hazards management system.

This paper outlines the many problems, solutions, challenges and successes of the integrity restoration programme. It describes the required organizational commitment to a multi-year improvement campaign and a shared vision of sustained, world-class integrity management. Lessons learned from the programme are now being applied to BP Indonesia operations offshore Java and elsewhere; specific areas of corporate sharing are described.

Keywords: integrity management, petroleum producing facilities, corporate responsibility.

Ciaraldi, W.S. 2005. The essence of effective integrity management - People, process and plant. SPE Asia Pacific Health, Safety and Environment Conference and Exhibition, Kuala Lumpur, Malaysia.

Effective integrity management (IM) is critical to the control of major accident hazards in oil and gas production operations. To achieve effective IM, it is necessary that an aware workforce deploy quality practices to sound facilities. An easy summary statement, but complex and difficult to achieve in practice. Based on the author's experiences with production operations on five continents, important people, process and plant requirements for acceptable IM are reviewed. Pitfalls encountered are also described, with examples of successful recovery noted.

People requirements start with leadership, accountability and competency, but go beyond to shared vision, passion to achieve and willingness to challenge the status quo when necessary. People are the first priority for IM, as they are often able to overcome shortcomings in process and plant; the reverse is generally not possible.

Hazard awareness, understanding and management is the cornerstone process for effective IM. If dangers are known and widely understood, effective means to mitigate and control can be devised, implemented and tracked. Other important processes include robust management of change (MOC), engineering practices, operating procedures, incident investigation processes, emergency response procedures and performance scorecarding.

IM plant requirements start with inherently safer design, quality procurement, fabrication and commissioning. These progress to practices for sustaining safety critical equipment including inspections, chemical treatments, monitoring and effective repair and maintenance programmes. For the latter, testing and assurance around process safety protective systems is especially important. Finally, modifications to facilities to systematically reduce risk should not be forgotten, particularly over the long producing life of some assets. This may involve correcting existing deficiencies or the introduction of new technologies to do things better.

Keywords: effective integrity management, hazard control, trained personnel, plant design.

Colmer, R. 2007. People and sustainable development. Offshore Europe, 4-7 September 2007, Aberdeen, Scotland, UK.

Intellectually all those associated with the Exploration and Production business can articulate the critical role that people play in an industry which is risk based and capital intensive. With demographic pressures and fewer students pursuing science and technology in the developed world the criticality of attracting, developing and retaining people is paramount. In the developing world there is often an ample supply of graduates however the challenge of building real capability and experience cannot be underestimated.

Against the background of the global challenges it is proposed that people be viewed much more as a part of sustainable development. The classic sustainable development model, comprising of economics, the environment and the community has people at every level. To achieve the goal of a long term sustainable contribution from the people currently in the industry and those considering joining will take a major shift from some of the development models currently employed.

This paper examines the significance of a competent trained and motivated workforce against the background of the SD principles. The themes developed are based on extensive contact and discussions with both national and international oil and gas companies around the globe. Getenergy as an independent broker of training and development (learning) has gathered a fascinating insight to the challenges, and some of the possible solutions. The concept of building on the model of sustainable development has been raised and tested at many forums around the world and it is felt that bringing it to OE2007 will enhance the debate and help drive the concept forward.

Keywords: sustainable development, training, petroleum sector.

Deonarine, J.J.D. and B. Seeram. 2001. The effects of petroleum production operations on the environment in Trinidad. SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, USA.

Trinidad is unique in its natural resources. Since the discovery of the first oil well, on land, in 1857 the country has seen an emergence of land operations in the petroleum industry. Drilling operations from 1902 to present continue to impact on the environment, but the adverse effects have been surpassed by production operations. Wells remain on production for many years and while initially they presented no threat to the environment, maintaining integrity of aging infrastructure is an increasing challenge. Leaks from wellheads, leaks from pipelines, and overflows at gathering stations, among others have contributed negatively on the terrestrial environment.

Petrotrin, a state owned company in Trinidad, which has several production operations throughout the south of the country, has inherited production operations and their liabilities from predecessor companies. Over the past few years and continuing into the future, a new approach has been taken in which a "win-win" situation has emerged and will continue to emerge. For example, in the area of wellhead and pipeline leaks, which have effluents from weathered in the environment, rendering them chronically polluted sites, bioremediation is employed. To avoid leaks from corrosion, a preventative maintenance is in place. The basal sediments are being recovered from tanks and taken to a designated site for treatment and remediation. Case studies show the effect of a proper environmental management system on the current infrastructure and installations and the necessary steps being taken to prevent any adverse effect that production operations may have on the terrestrial environment.

Keywords: petroleum production, environmental impacts, pollution prevention.

Deonarine, J.J.D. 2003. State of the environment: The challenges facing the energy industry sector in Trinidad and Tobago. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

The emergence of the petroleum, petrochemical, refining, and processing plants, among others during the past one hundred years in Trinidad has impacted on the environment. Vegetation has been removed to accommodate these industries and at the same time the ecosystem was disturbed. The wildlife, birds, insects and other reptiles had to venture into

other areas convenient to their lifestyle. The tributaries, which continue to empty into the major rivers nearby, have been affected by either sediment or effluent from the various plants and this has interfered with the aquatic life.

Indeed the country would like to continue receiving cheap abundance of gasoline; the country would like to lead the world in the exportation of ammonia, urea, methanol, liquefied petroleum gas; people would like to have a choice of what soaps, detergents, plastics, or other by-products they use; but everyone must be mindful of the adverse effect these and other industries are having on the environment.

During the last ten years there has a closer view on the impact industries are having on the environment. The new industries that are emerging have more stringent rules and laws to follow now, than the ones that were constructed during the last century. Reports such as the Environment Impact Assessments, and baseline studies now play an integral part in the application to construct a new plant. Companies now have to apply for Certificate of Environmental Clearance before any new plant can be built, new well can be drilled, and existing plant can be modified, expanded or abandoned.

The many industries, including the energy industry, that exist in Trinidad have changed the landscape of the environment both in a positive and a negative manner. But now there is a culture evolving namely "we cannot operate like we did in the past." Indeed, profit is the controlling factor for the energy industry to survive, but not at the expense of the environment. The paper presented herein looks at the challenges facing the energy industry as it tries to survive the stern tests of the environmentalists.

Keywords: environmental impact, oil exploration, environmental compliance.

Deonarine J.J.D. 2003. Using Geographical Information System (GIS) Technology in State Owned Company. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

Petrotrin, a state owned company has production operations which span the whole of south Trinidad. The company has numerous wells, miles of gas and oil lines, and the passage of these lines through agricultural areas, towns and villages are a major environmental concern to the company. Many of these installations were inherited from predecessor companies.

Geographical Information System (GIS) technology is only about twenty years old, and its usefulness over the years has shown that it is a cost saving to the company. Groups monitoring GIS have concluded that it is a billion dollar industry if one were to add the value of the software, hardware and services. Other computer software packages are not as beneficial as GIS. In GIS the storage of data is independent of the mode of presentation.

GIS can provide the following information needed for management to make the right decisions:

- i. identify all areas within 100 feet of the wells
- ii. identify all watercourses within 100 feet of installations
- iii. identify all buildings, agricultural lands that are within 100 feet of the gas and crude oil pipelines among others.

Several departments within Petrotrin can look at the same data simultaneously because GIS allows that flexibility. Previously, in using paper maps only one person can look at the information since there were not several copies of these maps circulating. If these maps had to be updated it took a long time. Now with the GIS software and hardware packages more than one person can look at the same data and make faster decisions. The report presented herein conveys the benefits of using GIS in environmental decisions in Petrotrin's production operations.

Keywords: Geographical Information System (GIS), data sharing and efficiency.

Deonarine, J.J.D. and N. Sookdeo. 2004. Developing a model to handle hazardous wastes from the petroleum industry in Trinidad. SPE Annual Technical Conference and Exhibition, Houston, Texas.

The need for paying close attention to the environment has been of paramount importance since the introduction of specific environmental legislation (for example the Environmental Management Act 3/2000) in Trinidad and Tobago. Out of the Environmental Management Act, several pieces of legislation have been drafted to better regulate the industry and include:

- Environmentally Sensitive Areas and Species Rules
- Noise Pollution Rules
- Certificate of Environmental Clearance Rules
- Air Pollution Rules (Draft)
- Water Pollution Rules (Draft)

The only shortcoming is that there are presently no solid and hazardous waste management rules in Trinidad, and the Environmental Management Authority is currently in the process of planning for the development of the rules for the entire country and by extension, the petroleum industry as a whole. The approach to date has been the focus on a simple piece of legislation to govern all industrial sectors. While this may be an approach to the management of common types of wastes encountered in all industrial sectors, it may not be practical for the petroleum industry. Developing a model and testing it against practical data for the petroleum industry can only be the practical way the legislation would be meaningful to the industry.

Keywords: solid waste management, modelling.

Dyal S., A. Nijhawan and K. Ramnath. 1995. Environmental management strategies for an enhanced oil recovery project, Trinidad. SPE Annual Technical Conference and Exhibition, Dallas Texas.

The Government of the Republic of Trinidad and Tobago has embarked on a major energy sector project to recover proven reserves of crude oil contained in onshore and offshore producing fields, using secondary recovery techniques. Onshore reserves of crude oil are produced using steam flooding techniques while offshore reserves are recovered through water injection techniques. These projects are being undertaken by Petrotrin and Trinmar Limited respectively.

An Environmental Impact Assessment (EIA) conducted prior to the start of the projects served to identify key environmental sensitivities associated with each project. Environmental Management Strategies were developed by both companies to mitigate against the potential impacts of each project and are in various stages of implementation. These include: the establishment of Environmental Units, the conduct of employee training programmes, the implementation of preventative maintenance programmes, the introduction of new oily wastewater treatment facilities, application of environmentally acceptable solid waste disposal methods, regular monitoring of effluent quality, ensuring compliance with interim company standards and the development of oil spill contingency plans.

In addition, Petrotrin has begun a groundwater quality monitoring programme, a rationalisation programme for storage facilities and adopted and implemented various components of ARPEL's environmental guidelines. Additional strategies implemented by TRINMAR Limited include risk analysis for submarine pipelines, a gas emission control programme and the conduct of annual Environmental Audits.

Environmental Management Act, 1995 which provides for the establishment and operation of an Environmental Management Authority, has just been enacted. However the enforcement of environmental legislation has been hampered by the lack of coherent effluent standards and regulatory agencies. The onus for managing the environmental impacts of the projects undertaken therefore lie within the respective companies. The extent to which this is done is largely due to their management's commitment to achieving acceptable levels of environmental performance. The Environmental Management Strategies adopted by both companies ensure that activities associated with the projects comply with their respective corporate missions and environmental policy statements.

Keywords: environmental management strategies, oil recovery, onshore fields, offshore fields.

Hassanali M.K. and K. Ramnath. 2000. Meeting the challenges of new environmental regulation. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Stavanger, Norway.

The requirements of the Environmental Management Act of 1995 establish environmental regulations for industries in Trinidad and Tobago. Newly drafted rules and regulations soon to be presented to Parliament will place greater regulatory responsibilities on the energy industry in Trinidad and Tobago, in respect of compliance and its attendant cost.

The main environmental regulations and standards pertaining to the petroleum industry are:

Environmental Management Act (1995).

Certificate of Environmental Clearance Rules (1999) (Draft).

Environmentally Sensitive Areas Rules (1999) (Draft).

Environmentally Sensitive Species Rules (1999) (Draft).

Water Pollution Rules (1999) (Draft).

Trinidad and Tobago National Environmental Policy.

Specification for the effluent from industrial processes discharged into the Environment TTBS/EMA standard TTS 547:1998.

Air Pollution (Stationary Sources) Rules.

The Petroleum Company of Trinidad and Tobago Limited (Petrotrin), has responded to this challenge by developing environmental management strategies as well as introducing new technologies in its operations, to reduce impacts on the environment. These strategies include:

Implementation of an ISO 14000 pilot project.

Establishment of a 'Quality Team'.

Participation in the development of standards for liquid effluents and vehicle emissions.

Training of management and supervisory staff.

Monitoring of liquid effluents and air quality.

Conducting environmental impact assessments.

Conducting facility audits.

Assessment of sensitive areas which the company operates within or in close proximity to.

Development and implementation of waste management programmes.

The overall effect of these proactive programmes has improved Petrotrin's environmental performance and compliance.

Petrotrin's corporate commitment to excellence in the management of its environmental responsibilities is pervasive. As a leader in Trinidad and Tobago oil and gas industry, Petrotrin is ever mindful that every environmental event has an ultimate ecological consequence, regardless of its size, and that such a consequence could affect human health, animal and plant life. The overall effort has been worthwhile due to the enormous increase in the understanding of our environment and the improvements being achieved.

Keywords: environmental regulations, standards, environmental performance, compliance.

Hosein A. 1996. Lease operatorship and farmouts: Changing the oil production scenario in Trinidad's land-based fields. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

The history of the oil industry in Trinidad's land-based fields, reflects a domination by foreign multinationals initially, followed with ownership by various state-owned oil companies. Recently however, local entrepreneurs have been afforded the opportunity to participate to some extent, in oil production activities of the land-based operations of the state-owned oil company.

The state-owned oil company of Trinidad and Tobago has over five thousand (5000) inactive wells. Because of limited capital resources and the resultant low priority for reactivation, a programme of leasing blocks of these idle wells to small independent operators was initiated in July 1989. This programme is currently being expanded because of its initial success. In addition, acreages are being offered for farmout operations, again because of the scarcity of capital funds for internal investment and the associated risks involved.

As a consequence of these programmes, the oil production scenario in Trinidad's land-based operations is undergoing a radical transformation. This paper reviews the current status of lease operatorships and farmouts and discusses the key issues involved.

Keywords: leasing, idle wells, operatorship, petroleum production.

Joseph, K. 2003. Proven Performance Improvements in well intervention through outsourcing and continuous learning systems. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

A marine oilfield operator, with over 800 offshore wells, has experienced significant performance improvements using continuous learning systems incorporated in their workover management operations.

The Workover Management Department was outsourced seven years ago to multinational service company together they created a system of benchmarking. Quality control and trend analysis to improve performance and cost effectiveness. Innovation and technology coupled with an international shared learning database resulted in significant reduction of down time, unscheduled events, completion skins, post workover production and workover costs all equating to improved overall profitability. The workover management group operates within a flat structure, results-oriented culture, continuous learning systems, cross-cultural and multi-disciplined staff, cutting-edge IT support systems, and a team based reward structure. The formula, presented in this report, can be introduced to almost any environment and can certainly positively impact low cost operators in the oil industry.

Khan, F. 2002. Development of environmental operational controls for risk Minimization and environmental clearance for onshore drilling operations. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Kuala Lumpur, Malaysia.

With the advent of new environmental legislation in Trinidad and Tobago, all industrial and commercial development activity will require a Certificate of Environmental Clearance (CEC). The Environmental Management Authority (EMA) which is the environmental regulatory agency in Trinidad can request an Environmental Impact Assessment (EIA) if it deems necessary when considering an application for a CEC.

The CEC application process will pose great challenges for the petroleum exploration and production industry where activity levels correlate with fluctuations in crude prices. The application process can take months depending on the scope of the project and there are significant costs in conducting an EIA. This problem is compounded by the fact that most onshore drilling takes place in mature and marginal fields. Operators cannot tolerate excessive and expensive environmental assessments, mitigation costs and equipment downtime. A combination of these problems can result in postponement or cancellation drilling programs.

As part of Petrotrin's drive towards ISO 14001 EMS certification for its exploration and production operations, the Exploration and Production HSE Department in conjunction with

the Drilling Department has identified all environmental aspects, potential impacts, and developed environmental operational controls for onshore drilling operations. These controls were developed through a risk assessment process and are integrated into drilling operations through policies, training and regular audits.

The project management team realised that environmental operational controls will not only have benefits such as risk reduction, but can potentially lend assistance towards reducing delays in obtaining environmental clearance for development programmes.

This paper describes the risk assessment process by which Petrotrin developed policy environmental operational controls for its onshore drilling programmes, the use of these controls to minimize risk, and the novel approach the company is taking in using them for obtaining environmental clearance.

Keywords: risk assessment, environmental policy, risk minimisation.

Kalpee, T.P. 2002. The limitations of increasing environmental legislation as a means by which positive environmental change can be achieved. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Kuala Lumpur, Malaysia.

The failure of existing environmental legislation in Trinidad and Tobago to control environmental degradation is cause for serious concern as a new thrust towards the development of more legislative rules takes place under the Environmental Management Act 2000. These new regulations are being developed against a larger background of established industry, many of which are past their prime for large capital outflow for redesign. Since it is not the intention of the regulatory agencies to close industrial facilities, the rate of compliance will be based on the ability of the respective industries to make the required changes within budget restrictions. Thus it is expected that environmental improvement will be incremental and slow. There is, therefore, a need for a parallel process that will be to the benefit of all stakeholders. Regulatory incentives must be used to promote true environmental improvements in the shortest possible time, given the limitations that exist. Process improvement to meet or surpass environmental discharge standards should be tax deductible if completed within limited time frames. Since these improvements are normally designed to surpass environmental legislative standards, the need for continuous monitoring by regulatory agencies will be significantly reduced. Incentives for the implementation of environmental management systems would allow industry to set up systems which are audited by independent certification bodies rather than the regulatory agencies. Such incentives may be linked to reduce permit and reporting requirements that will undoubtedly lead to significant environmental improvement in the shortest possible time.

Keywords: environmental legislation, regulatory incentives, environmental improvement.

Khan, F., F. Lalla, S. Dyal and K. Ramnath. 2005. Assessing the socioeconomic impact of petroleum exploration and production operations in rural communities in Southern Trinidad. SPE/EPA/DOE Exploration and Production Environmental Conference, Galveston, Texas.

An integral component of an Environmental Impact Assessment is the socio-economic assessment. The purpose of these assessments is to identify and evaluate potential impacts of proposed projects on the socio-economic environment of fence-line communities that would most likely be directly impacted by the project.

With the enactment of the Certificate of Environmental Clearance (CEC) Rules in Trinidad in 2001, Exploration and Production (E&P) companies must now apply to the Environmental Management Authority for an environmental permit for any activity designated under these rules. As a result, oil and gas operators in Trinidad have collected a significant amount of socioeconomic data as part of Environmental Impact Assessments (EIAs) and Environmental Baseline Surveys for CEC applications.

The state owned oil company, Petrotrin, set the standard for conducting socio-economic assessments for energy development projects in Trinidad and did so on a voluntary basis

before the CEC Rules were enacted using guidelines developed by the Regional Association of Oil and Natural Gas Companies in Latin America and the Caribbean (ARPEL).

In conducting socio-economic assessments, surveys were conducted for households, community leaders, business proprietors and focus groups. Generally 25% of the population are interviewed in the process to determine their views and aspirations on potential impacts of oil and gas E&P projects based on their historical experience. If effectively conducted, socio-economic assessments are a valuable tool for determining community needs and ensuring win-win partnerships between oil and gas companies and the communities in which they operate.

This paper describes the process by which Petrotrin has conducted socio-economic assessments for EIAs and Environmental Baseline Surveys for fence-line communities where E&P development activities are planned. It also seeks to give an historical overview of how E&P operations have impacted fence line communities in southern Trinidad over the 20th century.

Keywords: socioeconomic impacts, petroleum exploration, production operations.

Khan F., B. Sinanan, R. Jokhoo, F. Innis and V. Ramlogan. 2005. Health, Safety and Environmental (HSE) risk mitigation for a thermal oil recovery pilot facility in Trinidad. SPE International Improved Oil Recovery Conference in Asia Pacific, Kuala Lumpur, Malaysia.

Enhanced Oil Recovery projects are strategic investment initiatives planned when oil prices are high enough to support economic profitability. The Upper Morne L'Enfer (UMLE) pilot thermal project, within the Forest Reserve oilfield in Trinidad, is the current thermal EOR activity. Within the last ten years, health, safety and environment laws and regulations have evolved and are now more stringently applied and practised. The Forest Reserve field houses many sensitive forested environments. The surface operations include clearing and construction of a site for fluid storage, testing and the generator.

During the project-planning phase, an Environmental Impact Statement (EIA) and a Hazard Operability (HAZOP) Study were conducted to acquire Environmental Management Authority and Ministry of Energy and Energy Industry approvals and address potential safety and environmental risks associated with the project. Baseline data was extracted from an Environmental Impact Assessment that was recently conducted for drilling sixty wells in the same area.

Integrating the environmental baseline into the HAZOP study served to identify and rank both potential environmental and safety hazards, which in turn permitted Petrotrin to prioritize risk mitigation strategies. All parties involved in the risk assessments agreed that the team approach used in the HAZOP study permitted a more efficient and effective forum to identify and mitigate both safety and environmental risks as compared to combining results from individual assessments.

This paper describes how the project's potential safety and environmental risks were assessed and mitigated. The success in minimizing the risk associated with these hazards serves to demonstrate that oil and gas operations can coexist with sensitive environments.

Keywords: safety risks, environmental hazards, mitigation.

Khan, J., W. Lewis and D.H. Maharajh. 1994. Steamflooding experiences at Petrotrin (Trintopec's Operations): A Historical and Technical Perspective. SPE Latin America/Caribbean Petroleum Engineering Conference, Buenos Aires, Argentina.

Thermal oil recovery was first initiated in Trintopec's operations in 1966, with a small cyclic pilot project in the company's Palo Seco field. Since that inception, twenty seven (27) years of thermal recovery, comprising both cyclic and flood-type operations, have witnessed vigorous growth and dynamic expansion to the extent that, by 1993, the thermal recovery statistics of Trintopec's portion of the now overall company's (Petrotrin's) operations are as follows:

- Steamflooding operations exist in all the major land fields, viz.: Palo Seco, Central Los Bajos, Guapo, Fyzabad and Apex-Quarry/Coora/Quarry

- Production from thermal recovery averages 7,5000 bopd, representing 50% of current land production
- A total of approximately 40,000 bspd is being supplied by twenty-three (23) steam generators to more than one hundred and fifty (150) injectors

This paper presents highlights of Trintopec's experiences in the design, implementation and operation of its thermal oil recovery schemes. New concepts, innovations, modelling and monitoring techniques over the past twenty-seven (27) years are outlined.

Lionel, R. 1998. Wellness programmes in Petrotrin: The EAP perspective. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Caracas, Venezuela.

This paper presents the findings of a wellness programme implemented by Petrotrin's Employee Assistance Programme department as part of the corporate Health, Safety and Environment (HSE) strategy. The author defines wellness as "any programme which stimulates and encourages employees to take personal responsibility for improving their psychosocio-cultural functioning thus improving their general competence in work and non-work areas."

The paper also reviews the relationship between Petrotrin's Employee Assistance Programme and organizational goals. Based on quantitative and qualitative methodologies, research data is presented on the factors which militate against wellness in Petrotrin. The findings from six major interventions are also presented and analyzed.

The author concludes that there is economic value to be derived as a result of implementing wellness programmes. Specifically, wellness programmes are proposed as an effective strategy to contain health care and failure costs which are related to the frequency and severity of illnesses both on and off the job. The project described in this paper has made a significant contribution to the integrated HSE programme which began in 1995.

Keywords: employee wellness programme, economic benefits, meeting organisational goals.

Maharaj, U. and S. Roodalsingh. 1996. Oil-in-water testing: The controversy and its effects on produced water monitoring in Trinidad. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

The traditional method for determination of oil and grease in produced water effluents, ASTM D4281, has been reexamined to select alternatives to Freon, to assess its impact on technology selection, and evaluate its appropriateness as an indicator of polyaromatic hydrocarbons. MTBE/Hexane (15/85 by Volume) was found to be the best alternative to Freon. Analysis of the produced water effluents from our oilfields by ASTM D4281 indicated that high levels of oil & grease were often present; however, to select technology appropriately the physical forms of the crude oil needed to be quantified. In our installations, the major contributor to the oil and grease was the dissolved organics, which suggested that tertiary technologies would be required to reduce the levels.

By correlation of analytical results from sixteen (16) produced waters, the ASTM D4281 method was found to be inappropriate as an indicator of polyaromatic hydrocarbons which are presumed to be the major toxic components in a crude oil. This was due to the large contribution of the dissolved organics to the determined oil and grease. The dissolved components were found to be largely non-hydrocarbon — phenols and naphthenic acids. These are predicted to have little or no toxicity at the levels present.

Keywords: oil and grease, ASTM standards, produced water monitoring.

Maharaj, P. and K. Ramnath. Benefits in an environment management system. Unknown.

The Health, Safety and Environment Department within the Petroleum Company of Trinidad and Tobago Limited (Petrotrin) developed and implemented an Environmental Management

System (EMS) for one of its onshore Exploration and Production Districts (South-Central) in accordance with the ISO 14001:1996 Standard. This management system has been reviewed by external auditors in two phases, September 2002 and March 2004 (for different departments), which has since gained international ISO 14001:1996 certification, accredited by the American National Standards Institute and the Registrar

Accreditation Bureau (ANSI/RAB).

As Petrotrin continues to monitor and manage ongoing environmental management programs for the South-Central District, whilst practicing operational controls, the Company continues to experience the benefits associated with sound environmental performance. Legislative compliance programs, governmental recognition, reduced operational costs and other environmental management programs constitute the observable continual improvement strides seen in Petrotrin. However, the most critical benefit driving this EMS for Petrotrin has been employee support and motivation. Employees guided under this management structure operate accordingly with pride and dedication to the functionality of the system, in full response to the commitment from top management.

The EMS for the South-Central District therefore represents the manner in which employees take ownership of, and manage environmental risks in operations. In recognition of the improvements within the operations of the South-Central District with the Environmental Management System, Occupational Health and Safety as well as Quality Management Systems are being developed for implementation in departments within the EMS. Noting the challenges in implementing a management system as well as utilizing the frame work developed for the environmental system, the implementation of the aforementioned systems in accordance with Occupational Health and Safety Assessment Series (OHSAS) 18001 and ISO 9001:2000, are being performed at a much faster rate than the EMS.

Maharaj, U. S. and R.R. Roodalsingh. 1996. Produced water monitoring programme in Petrotrin. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

Our national oil company (Petrotrin) is faced with declining oil production and increasing volumes of co-produced water. An environmental monitoring programme was set up to identify and quantify the major contaminants in our produced waters. The programme was designed so that data could be used for determination of impact on the environment, assist in pollution abatement technology selection and meaningful setting of regulatory standards.

The discharge of highly saline produced water with elevated levels of oil and grease was identified as major concerns. Alternative strategies for handling those effluents were identified, in which, the highly saline waters will be incorporated. Seventeen (17) produced waters were analysed on five (5) occasions to determine the levels of free, emulsified and dissolved oil. The dissolved organics were found to be the major contributor to the oil and grease value, with relatively smaller amounts of free and emulsified oil. This implied that the current technology for free oil removal at most installations is efficient. In order to comply with the current regulatory limit for oil and grease discharge, secondary and tertiary technologies would have to be implemented.

Keywords: pollution assessment, produced water, effluent treatment.

Maharaj, S.P. and K. Ramnath. 2004. Factors affecting waste management of produced water in the petroleum industry of Trinidad and Tobago. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Calgary, Alberta, Canada.

Trinidad and Tobago is considered a small island, with continental scaled industries, and correspondingly sized environmental issues. Environmental management within the petroleum industry in this country has therefore effectively evolved into a series of strategies for salvaging environmental assets of this twin island republic where the environmental sustainability is continuously challenged by the gargantuan waste streams from these operations. With growing public awareness and governmental intervention, greater attention is being focussed on individual activities and waste streams that constitute to environmental degradation, and in particular produced water from the upstream petroleum industry.

The legislative framework of this country represents a centralised policy approach of pollution control for industry, which acts to 'coerce' producers of this waste stream to develop and implement pollution control mechanisms, thus implying a seemingly command and control approach to pollution management. This policy system aims at achieving the desired standards for contaminant levels in the upstream petroleum industry, with the relevant enforcement agencies being adequately prepared to monitor and measure the quality of discharge. This is currently the economic tool for attaining controlled pollution levels, with the implementation of penalties for levels beyond that which is permissible.

Even with effluent standards and pollution fines, the pollution levels associated with petroleum industry operations have not significantly decreased. It is therefore mandatory that newer and more efficient technologies be introduced for waste management to ensure that the effluent standards in this command and control approach are met. In this light, the economic tool of technology standards should be implemented, such that petroleum industry waste can meet the targets set by effluent standards. With the aid of governmental subsidies, grants or even soft loans on such a framework, such economic factors can ensure success to reduce contaminant levels, using optimal technology.

Keywords: waste management, petroleum sector, legislative framework, environmental compliance.

Mohammed, A., K. Ramnath, S. Dyal, F. Lalla and J. Roopchand. Rehabilitation of seven (7) hydrocarbon contaminated sites in a brackish water/lagoon environment in south Trinidad. Protection and restoration of the environment VIII conference, Chania, Greece.

The Petroleum Company of Trinidad and Tobago Limited operates in a wide diversity of tropical habitats in south Trinidad one of which is a brackish water environment known as the Godineau Swamp. Historically, this field was operated by predecessor multinational companies, who at this time employed operational practices (based on the absence of legal requirements), that were not environmentally considerate. Following a detailed environmental audit of the field (also known as the Oropuche Field), seven (7) contaminated sites were found that presented a risk to the lagoon and its associated mangrove swamp ecology. Remediation of the seven (7) sites was done in two (2) phases: phase 1 being sampling and characterisation of the waste as well as determination of migration patterns and phase 2 the actual on-site soil remediation. Phase 1 conducted during the period December 2004 to February 2005, indicated a total of 19,484m³ of contaminated material was TPH being the main contaminant. The average concentration of TPH was 3.25%. Phase 2 remediation was initiated in October 2005 and involved the following three (3) aspects to achieve a TPH concentrations of less than 1%:

Preparation of waste remediation sites adjacent to contaminated sites and excavation and spreading of cells

Bioremediation onsite using naturally occurring bacteria and rototilling

Rehabilitation and closure of the site following accepted lab results.

The benefits of conducting this project in the petroleum industry are to ensure compliance to the national Sensitive Areas Rules and Draft Waste Management Rules of Trinidad and Tobago, conformance to ISO 14001 certification requirements and conservation of biodiversity in the mangrove swamp.

Rajnauth, J., M. Rudder and P. Bradshaw-Niles. 2003. Approval process for new oil and gas field development in Trinidad and Tobago. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

The Ministry of Energy and Energy Industries has the responsibility under the Petroleum Act to approve new oil and gas field developments. During recent years, many new fields have been developed and it is expected that this trend will continue in the future. Furthermore exploration work in deep and ultra deep waters will continue.

This paper describes the general process of approval by the Ministry of Energy and Energy Industries as well as information requirements related to new field development.

The authors hope this paper would be useful to any company involved in oil and gas exploration and development in Trinidad and Tobago and also those companies willing to invest here in the future. It is also the intent of the author that this information will be useful to other regulatory bodies around the world.

Keywords: approval process, oil and gas field development.

Rajnauth, J.J. 2003. Towards sustainability: The Trinidad and Tobago scenario, focusing on strategic environmental planning and energy policy. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

Sustainable Development is often viewed as an economic entity and emphasis has been placed on fostering production growth, investment and market depth and breadth. The environmental, political and social dimensions have frequently been neglected. Therefore sustainable development should be viewed as a concept that frames the relationship between economics, environment, social and political dimensions in a radical new way. It demands both new ways of thinking and new designs for organising at the international, national, organisational and individual level.

Trinidad and Tobago as a developing nation has been encouraging sustainability but key strategic environmental planning and energy policy issues are often neglected. These strategic environmental planning and energy policy issues are important to encourage not only the economics but also environmental, social and political dimensions of sustainable development.

This paper seeks to address some of the strategic environmental planning and energy policy issues that are pertinent in accomplishing sustainability. Strategic Environmental Planning issues of risk management, collaboration, business strategy and competitive advantage would be addressed as well as energy policy issues such as integration, renewable resources, efficiency in energy consumption and energy security.

Keywords: sustainable development, environmental planning, energy policy.

Ramkhalawan, D.C., J. Khan and R.K. Baine. 1995. Thirty years of steamflooding: reservoir management and operational experiences. SPE Annual Technical Conference and Exhibition, Dallas Texas.

The Petroleum Company of Trinidad and Tobago Limited (Petrotrin) has a heavy oil reserves base of 300 million barrels of heavy oil in the southern part of the island of Trinidad. The Company, and its predecessors, first embarked on a thermal recovery programme in its acreage from 1963 with cyclic/steamflooding operations. At the present time, the Company is operating eleven (11) steamfloods and is currently implementing another major project. This paper presents a case history of the Company's thirty-two years of experience in steamflooding, inclusive of reservoir management and monitoring methods, innovations and operating practices. To date (1995 June), the Company has recovered a total of 77 million barrels of heavy oil from its acreage, with a current production level of 9000 BOPD. During this period, new diagnostic methods were initiated, as well as new innovations. These include cluster drilling, slimhole injectors, insulated tubing and packers, non-gravel packed injectors, high volume pumps, limited entry perforating, insulated casing completions, diverting agents, dual injectors, iso-fluid mapping and other reservoir management techniques. In summary, the company has had extensive success in steamflooding operations and continues to utilise this method for exploitation of its heavy oil reserves. With its proven success and existing infrastructure for this type of operation, the company still has major opportunities in heavy oil recovery. Additionally, new methods of operation, financing and project management are being pursued to exploit these reserves. Based on Trinidad's complex geology and heterogeneous reservoirs, heavy oil recovery has been a major success through the company's scope of operations. Several innovations in reservoir management and operating strategies can be implemented in other similarly adverse environments for heavy oil recovery.

Keywords: reservoir management, steamflooding, petroleum operations.

Ramlal, V. The Cruse 'E' Steamflood: Technical, Economic and Environmental Perspectives. SPE Latin American and Caribbean Petroleum Engineering Conference, Port of Spain, Trinidad.

Based on the success of the Cruse 'E' Pilot steamflood, Petrotrin decided to venture into a large-scale project of a similar nature called the Cruse 'E' (IADB) Expansion Steamflood. The project area consisted of 270 acres, with an estimated original oil in place of 31.3 million barrels in the zone of interest, the Upper Cruse 'E' sand. Surface and infrastructure work began in January 1994, which was followed by rig work – drilling, recompletions, and workovers. Sixty (60) new wells comprising twenty-eight (28) injectors and thirty-two (32) offtakes were drilled and completed to form twenty-eight patterns. Also thirty-five (35) existing wells were utilised as offtakes. The project was commissioned in January 1996 when steam injection began. This brought the number of active steamfloods and WASP projects at Petrotrin to eight (8). It was predicted by reservoir simulation that 11 million barrels of heavy oil would be recovered over fifteen (15) years with production peaking in the year 2000.

However, in 1998 when oil production reached 877bopd, the project was adversely affected by environmental concerns to a residential area in the vicinity of the steamflood and it was actually shutdown by order of the regulatory body in November 1998. Extensive environmental work was undertaken in the areas of communication, training and operations to improve the safety and environmental aspects of the steamflood, and ensure that it was brought up to the environmental standards required. After forty (40) months of inactivity, approval was finally obtained in March 2002 from the regulatory body to restart steam injection.

This paper discusses the performance of the steamflood during steam injection and during no injection, the technical, operational and economic aspect of the project, and the environmental upgrade conducted. The paper also discusses the restarting exercise conducted for steam injection and presents future operating strategies.

Ramnath K. and S. Dyal. 1998. Impact assessment study for an onshore exploratory well in a biologically diverse lagoon environment, south Trinidad. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Caracas, Venezuela.

The Petroleum Company of Trinidad and Tobago Limited (Petrotrin) proposed to undertake the drilling of an onshore exploratory well in the vicinity of Debe, South Trinidad.

The Immediate Impact Area (IIA), which constitutes the focus of this study has been defined primarily as an area of one kilometer radius from the proposed surface location. An Environmental Impact Assessment (EIA) was conducted which includes a descriptive statement of the proposal, description of the existing environment and its uses, legal and regulatory requirements, identification and assessment on potential impacts, and recommendations to mitigate against impacts.

Baseline surveys of the physical, biological, agricultural and socio-economic environments were conducted within the Immediate Impact Area (IIA) and environs.

The primary impacting activities identified were site construction and drilling operations. These would impact on the physical, biological, agricultural and socio-economic resources. The environmental issues for this petroleum activity are the effects of effluent discharge, particularly from drilling operations in surface waterways, disturbance of river ecosystem, surface water quality, soil contamination, erosion, dust pollution and increased noise levels. The likely socio-economic impact is short term but positive, in terms of creation of temporary jobs and increased business activity within a socially depressed community.

Environmental Management Strategies were recommended to mitigate the anticipated environmental impacts of the project. It is envisaged that resource deterioration, environmental degradation and habitat destruction associated with this petroleum activity will be minimal, if not negligible. Success in this petroleum activity could see benefits to the wider community and the nation as a whole

Keywords: onshore exploration, biologically diverse lagoon, environmental impacts.

Ramnath, K., S. Dyal, B. Seeram and P. Maharaj. 2001. Development and implementation of an environmental management system for an oil company in south Trinidad in accordance with the ISO 14001 Standard. SPE Latin America/Caribbean Petroleum Engineering Conference, Buenos Aires, Argentina.

Trinidad and Tobago has the oldest petroleum industry in the world. The activities of this industry have historically impacted the environment and newly drafted environmental rules and regulations of Trinidad and Tobago will require sound environmental management systems by all operating companies in the industry.

In order to meet the challenges of these new regulations, the Petroleum Company of Trinidad and Tobago Limited (Petrotrin) is currently pursuing the development and implementation of an Environmental Management System within its Exploration and Production operations in accordance with the ISO 14001 Standard. This project was initiated in October 1999, and is expected to terminate in December 2001 with international certification.

Petrotrin, realising the competitive advantages that can result from the integration of an Environmental Management System into its operating systems, has placed the implementation of the EMS as a company strategic goal.

The project was categorised into three main stages: Development, Implementation and Audit/Certification. To date, the Development Stage has been completed and the implementation stage initiated, with the following successes:

- Allocation of manpower resources in the formation of the Steering and Executive Management Committees, and an EMS Project Team;
- Training of project personnel in ISO 14001/10/11/12 Standards;
- Revision of the company Environmental Policy statement;
- Conducting the Gap Analysis Study;
- Development of the Implementation Plan based on the results of the Gap Analysis;
- Initiated the development of the EMS manual and drafted initial procedures as outlined in the Implementation Plan;
- Collection and analysis of data for identification of Significant Environmental Aspects and impacts for Exploration and Production activities.

The development and implementation of an Environmental Management System in accordance with the world renowned ISO 14001 is expected to derive many benefits to Petrotrin such as reduced operating costs, improved financial performance, increased access to markets, improved environmental performance, improved community relations, improved customer relations and employee involvement and education.

Keywords: environmental management systems, south Trinidad.

Ramnath K. and S. Dyal. 2001. Implementing waste management strategies. SPE/EPA/DOE Exploration and Production Environmental Conference, San Antonio, Texas, USA.

The activities of finding, producing and refining petroleum, can impact the environment, and the greatest impact arises from the release of wastes into the environment in concentrations that are not naturally found. These wastes include hydrocarbons; solids contaminated with hydrocarbons and other pollutants, water contaminated with a variety of dissolved and suspended solids; a wide variety of chemicals and gaseous emissions contaminated with toxic chemicals.

The Petroleum Company of Trinidad and Tobago Limited (PETROTRIN), have developed a number of major capital intensive waste management programmes to ensure the Company's operations have minimal adverse impacts on the surrounding environment. These programmes are:

- Construction of three secondary waste water treatment plants.
- Conversion of barometric condensers to surface condensers at two vacuum distillation units at the Pointe-a-Pierre refinery.

Segregation of storm water drainage from process oily waste water.

Bioremediation of 126,000 barrels of oily wastes stored in two earthen pits at Pointe-a-Pierre refinery.

Bioremediation of approximately 18,000 barrels of oily wastes stored in two earthen pits at Parrylands, Point Fortin oil field.

Installation of three Sulfa-Treat plants for treatment of hydrogen sulphide gas in production operations.

Installation of a Sulphur Recovery Unit (SRU) at Pointe-a-Pierre refinery to convert hydrogen sulphide gas into solid sulphur.

Installation of internal floating roofs at five product storage tanks at the Pointe-a-Pierre refinery.

Steps are being taken by the Environmental Management Authority to strengthen legislation in the near future. Major capital improvements in the implementation of waste management systems by Petrotrin have resulted in reduced impacts on the environment. The overall effort of these proactive programmes has been worthwhile due to the enormous increase in the understanding of our environment and the improvements being achieved.

Keywords: waste management strategies, pollution prevention, strategy implementation.

Ramnath, K. and S. Dyal. 2003. Planting our future with neighbouring communities – a national energy company experience. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Kuala Lumpur, Malaysia.

As the national energy company of Trinidad and Tobago, Petrotrin is committed to the sustainable use of natural resources and environmental protection and seeks to develop and implement a proactive environmental outreach programme with our neighbouring communities.

The elements of Petrotrin's Environmental Outreach Programmes (EOP) are:

Implementation of a school beautification programme, which involved the distribution of plants to 25 selected schools within the Company's operational areas. The objective of this is to increase environmental awareness among children while simultaneously promoting an aesthetically pleasing environment.

Construction of a recreational facility and restoration of the Pointe-a-Pierre Beach adjacent to the island's sole refinery, for residents of the surrounding communities. There is an absence of such facilities along a 70 km stretch on the west coast of Trinidad. The project includes protection of the eroded coastline, and the improvement of the area aesthetically for use by the public for recreational purposes. This facility is estimated to cost over US\$2,000,000, the majority of which will be incurred in the construction of a concrete sea wall which will protect the restored beach from further erosion. Petrotrin recognises the importance and numerous benefits of fostering a harmonious relationship with our neighbours.

Donation of twelve (12) Advanced GLOBE (Global Learning and Observations to Benefit the Environment) Kits to secondary schools over the last three (3) years in commemoration of World Environment Day. Donations have also been given for the printing and publication of a PAHO booklet "Healthy Homes, Healthy Communities" for primary school children.

Participation by students of primary and secondary schools in a Climate Change Essay Competition, which was aimed at increasing their knowledge on the effects of Climate Change.

Petrotrin's Board of Directors and Management stand behind this commitment, championing the company's environmental responsibilities to provide a healthier living and working community.

Keywords: community outreach, corporate responsibility.

Sinanan, B. 2003. Improved solids control techniques for onshore drilling operators in Trinidad. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

For the first time in Trinidad's onshore drilling history, a "closed loop" chemically enhanced centrifugation has been added to a drilling rig's solid's control system. This technology termed "Dewatering" was implemented to achieve environmental, waste minimisation and drilling operations benefits on the Carapal # 1 and Corosan #1 wells in the Catshill field, Central Block, Trinidad.

Data from Corosan #1 is presented and analysed in this paper. Savings on waste minimization amounted to 3.2% of the well cost and savings on non-productive time / drilling operations amounted to 1.4% of the well cost. A total of 4.6 % of the actual well cost has been saved through dewatering of drilling mud and drilling waste.

This innovative means of solids controls and its results has sparked interest among many onshore Trinidad operators whose drilling programs target deeper than usual prospects. This project clarifies the methodology implemented and benefits attained in a locally novel approach to managing drilling mud and waste.

Keywords: solids control, onshore drilling, waste minimisation.

Singh, K. Evolution of field rejuvenation. SPE Latin America/Caribbean Petroleum Engineering Conference, Buenos Aires, Argentina.

At the state oil company of Trinidad and Tobago, (Petrotrin) and its predecessor companies, field rejuvenation has evolved through time from single well targets to the more highly detailed and complex field reservoir characterisation project currently underway.

Initially single well target selection would be done by individual engineers operating their specific field. Generally, the benefit of these actions were not long term and did not significantly affect or arrest the declining production trends. At a more formal level there were studies undertaken in the process of the implementation of a secondary or enhanced oil recovery project. This had the effect of arresting field declines and improving overall recoveries in the target fields.

The foregoing activities were carried out by the operating companies of the day. In the late eighties because of limited capital resources, a programme of leasing blocks of idle wells to small independent local operators was initiated. This programme proved successful in increasing indigenous oil production from idle assets as well as generating positive cash flows. It was therefore expanded and has since included farmouts and joint-venture arrangements with foreign companies participating also.

Currently Petrotrin is concluding a detailed field reservoir characterisation study of one of its most mature fields on land which began production in 1913. The preliminary results have demonstrated the crucial role of reservoir characterisation in evaluating the true potential of mature fields, and its potential for increasing production even from these fields.

Sookdeo, N. 2002. Determination of environmental liabilities and development of a facility closure plan for a state oil and gas company. SPE Annual Technical Conference and Exhibition, San Antonio, Texas, USA.

Good business practices by oil and gas operators require a responsibility to decommission uneconomic assets (wells, pipelines, structures) to prevent any ongoing environmental damage resulting from the improper abandonment and closure of all or any of its operations. With the introduction of the International Accounting Standards (IAS)-37 regulations for Contingent Assets and Liabilities, many oil and gas operators are now required to state current and past liabilities as a result of oil and gas exploitation, their current assets, and a phased closure plan for these assets when deemed uneconomic.

Prior to the introduction of the IAS-37 accounting standards, many operators ignored the concept of life cycle costing when developing and exploiting assets. The result was that provisions for the cost of decommissioning of assets when uneconomic were not originally factored into the economic analysis and accounting for major projects or field development.

When an asset was spent, improper abandonment resulted in many operators being faced with environment, health and safety (EHS) liabilities and a strain on financial resources for abandonment that were not originally catered for.

Proper life cycle analysis and decommissioning of assets is crucial for regulatory compliance, due diligence, and reduction of internal and external liabilities. The requirement for the development of a facility closure plan includes (1) the identification of all areas of activity requiring closure, (2) the closure procedures and costs, and (3) the implementation of phasing of items identified for closure. Some of the benefits of a facility closure plan to an operator include the reduction of HSE risks, conformance with the IAS-37 standard, financial management, and internal asset management. Some of the challenges faced by an operator in developing a facility closure plan include the lack or unavailability of data, limited financial and human resources, limited technical data on oil and gas reserves, and the lack of environmental baseline data.

The intent of this paper is to highlight the requirements by operators to develop a “facility closure plan” and to determine the closure liabilities associated with the implementation of that plan that would conform to International Accounting Standard- 37 and accepted business practice. Reference will be made to the efforts of Petrotrin-Trinmar S.B.U., an oil and gas operator in Trinidad and Tobago in the development of a facility closure plan for all areas of operation.

Keywords: environmental liabilities, facility closure plan, petroleum sector.

Sookdeo N. 2003. Strategies for minimizing produced water impact in a changing regulatory environment: A Trinidad and Tobago experience. SPE Latin America/Caribbean Petroleum Engineering Conference, Port-of-Spain, Trinidad.

Currently, produced water discharges are regulated in Trinidad and Tobago by a voluntary standard for liquid effluent developed by the Trinidad and Tobago Bureau of Standards (TTBS) in 1998. With the imminence of new and stringent legislation for effluent discharges under the Environmental Management Authority's Water Pollution Rules 2000, regulation of produced water will evolve from a voluntary compliance standard to that of mandatory compliance by law. In order to cope with the proposed legislative changes with regards to effluent discharges and a forecasted increase in produced water production, Trinmar, an offshore oil and gas operator in Trinidad and Tobago required new strategies for produced water management, since it is the single largest waste stream by volume within the entire operations of the company. The main strategy for produced water management was to upgrade the existing treatment system for process optimization/compliance with pending legislation and included:

- Upgrade of processes—primary and secondary oil/water separation

- Discharge of produced water from inland to coastal nearshore

- Evaluation of the current produced water treatment system by conducting an engineering study

- Upgrade of current produced water treatment system to ensure regulatory compliance.

The findings of the engineering study indicated that the current produced water treatment system at Trinmar is adequate to ensure water quality for compliance with existing standards that are voluntary and limited to specific parameters. However, with the advent of the new regulations and a projected increase in produced water production by the company, the current system will not be adequate. The most feasible option for produced water management was found to be treatment on-land and disposal in a coastal nearshore or offshore environment to be achieved by upgrading the present produced water treatment system and by modifying the process. The results of the engineering study and proposed process changes are discussed in the subsequent sections of this paper.

Keywords: produced water management, effluent disposal.

Waterfall K., C. Young and S. K. Al-Anazi. 2006. Health, Safety, Security and Environmental (HSSE) Competence finds a level playing field in the industry. SPE International Conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Abu Dhabi, UAE.

This paper addresses the PetroSkills route to develop and build HSSE competence in staff, including:

- Structure and management of staff competence
- The economic justification
- The nature and function of competence maps
- The contents of the HSSE competence maps
- Creating Job Competence Profiles
- Assessing personal competences
- Developing and Approving Learning Events to fill competence gaps
- Developments in HSSE competence
- Linkage to National / International accredited training

Keywords: management competence, competence maps, accreditation training.

Miscellaneous conferences

Cropper, A. Corporate social responsibility and the energy sector in Trinidad and Tobago. STCIC Trinidad and Tobago Petroleum Conference 2007. Hilton Hotel and Conference Centre, Port of Spain, Trinidad.

This paper overviews the concept of corporate responsibility and how this concept came about. It also discusses corporate responsibility in the context of international regulations and includes a summary of the Global Compact in terms of what it represents and the core principles by which members of this international initiative operate. It relates all these principles to the local context and summarises some of the challenges faced in establishing corporate responsibility in Trinidad and Tobago.

Keywords: corporate responsibility, international regulations, environmental challenges.

Khan, A., I. Chang Yen and L. Chatergoon. 1989. Source identification of an oil spill on Trinidad's east coast. Proceedings of the 1989 Oil Spill Conference (Prevention, Behaviour, Control, Cleanup) February 13-16 1989 San Antonio, Texas, USA.

In April 1986, a large quantity of unrefined crude oil was released into the nearshore marine environment on Trinidad's east coast. The oil was observed to have affected approximately 20 kilometers of coastline. Physical examination of the oil collected revealed that it has the appearance of a light grade crude, was golden brown in colour, and had a characteristic gassy odour. Also observed was a mass mortality of the bivalve *Donax* sp. (chip-chip), which inhabits sandy areas of the intertidal zone.

Oil was extracted from samples of water, beach sand, and chip-chip collected from selected stations along the affected area. Also collected were samples of oil from possible sources located both offshore and at land-based facilities. Chemical characterisation of the oil extracts, using capillary gas chromatography, atomic absorption and fluorescence spectroscopy, and carbon-13 nuclear magnetic resonance spectroscopy, yielded data sets that distinguished the oils in the environment from the suspect source of oil investigated.

Application of statistical pattern recognition techniques, utilizing a hierarchical clustering procedure, to data from both environmental and suspect source samples yielded a high probability match between the spill samples and samples from one of the two oil companies operating in the area.

Keywords: coast, oil pollution, fingerprinting.

Khan, F., J. Sastoo, V. Ramlogan and K. Ramnath. 2004. Mitigating the Health, Safety and Environmental (HSE) risks of an enhanced oil recovery project in a tropical forest. 11th Annual International Petroleum Environmental Conference Albuquerque, New Mexico.

The Petroleum Company of Trinidad and Tobago (Petrotrin) has initiated an Enhanced Oil Recovery (EOR) project that will involve steam flooding in the Upper Morne L'Enfer (UMLE) Sands of the Forest Reserve Oilfield, Trinidad. This project involves the conversion of recently drilled wells to injectors, relocation and retrofit of a 30 year-old steam generator from an adjacent oilfield, construction of a gathering station and installation of gas, water, steam, and crude oil pipelines with associated tie-ins. These facilities will be operational for a 20 to 50 year period. During the project-planning phase, an Environmental Impact Statement and a Hazard Operability (HAZOP) Study were conducted to acquire Environmental Management Authority and Ministry of Energy and Energy Industry approvals and address potential safety and environmental risks associated with the project. Baseline data was extracted from an Environmental Impact Assessment that was recently conducted for drilling sixty wells in the same area. Integrating the environmental baseline into the HAZOP study served to identify and rank both potential environmental and safety hazards, which in turn permitted Petrotrin to prioritise risk mitigation strategies. All parties involved in the risk assessments agreed that the team approach used in the HAZOP study permitted a more efficient and effective forum to identify and mitigate both safety and environmental risks as compared to combining results from individual assessments. This paper describes how the UMLE Steam Flood Project's potential safety and environmental risks were assessed and mitigated. The success in minimising the risk associated with these hazards serves to demonstrate that oil and gas operations can coexist with sensitive environments.

Keywords: mitigation, environmental and safety hazards, steam flooding.

Kishore, R., X. Chin and H. Ramsundar. 2001. Potential impacts of industrial development on coastal fisheries in the Gulf of Paria, Trinidad. Fifty-four Annual Gulf and Caribbean Fisheries Institute Conference, Volume 54, 13-27.

Four fish landing sites on the west coast of Trinidad lie within the area for proposed expansion of an industrial complex. This would increase the complement of industries such as ammonia, methanol, urea, iron and steel production plants. Such development has the potential to change the present fishery related activities of the four sites. In Trinidad and Tobago tourism, industrial development, conservation, recreational and traditional uses including fishing, all compete for access to the coastal zone often leading to use conflicts. The importance of the fisheries sector needs to be better represented in the broader context of coastal area management.

The fishery related activities at these landing sites were characterised through the use of interviews, trawl surveys and secondary data from the Fisheries Division and a fishing association. Potential impacts of the proposed development on fishing activities were evaluated based on a programmatic environmental impact assessment conducted by the Institute of Marine Affairs (IMA). Two hundred and forty four fisherfolk using seventy-seven fishing boats operate from these landing sites exploiting fish resources mainly in the nearshore and offshore areas of the coastal zone of the Gulf of Paria. Changes in the terrestrial and nearshore areas of the coastal zone will result in changes of varying degrees to fishing activities at all landing sites. A major perception by the fisherfolk is the negative impact of increased pollution by this industrial complex on their livelihoods. It is recommended that prior to development any resultant changes, particularly those that cannot be mitigated, be discussed with fisherfolk through consultative workshops and meetings. The final design of the expansion of the industrial estate should accommodate fishery related activities resulting in the least disruption to the landing sites.

Keywords: marine fisheries, landing sites, pollution impacts, fisherfolk perspective.

Laurence, P.T., 1990. Prevention of pollution of rivers and waterways. Ministry of the Environment and National Services Seminar/Exhibition Rivers and Waterways – Our Business Protecting the Environment. Room 101, Engineering Faculty, UWI, St. Augustine.

Trintoc's efforts at preventing pollution of the country's rivers and waterways begin at the earliest stage in the Company's operations – the design of its plants and other facilities. Trintoc's concern extends through operational practices aimed at minimising any spillage of oil, to the use of oil water separators to prevent oil that does get spilled, in spite of these efforts, from entering public waterways. The discussion deals with the efforts Trintoc makes and the facilities presently in place throughout the Company's operations for the protection of rivers and waterways from the major pollutant encountered in these operations – oil.

Keywords: Trintoc, operational environmentally sound practices, oil pollution prevention.

Leach, M. and Fairhead, J. 2001. Science, policy and national parks in Trinidad and Tobago. Working Paper from the project 'Forest Science and Forest Policy: Knowledge, Institutions and Policy Processes'. Also presented at the Workshop 'Changing perspectives on forests: ecology, people and science/policy processes in West Africa and the Caribbean', 26-27 March 2001 at The Institute of Development Studies, University of Sussex.

Since the 1960s there have been various moves to create a system of national parks in Trinidad, including several well-funded initiatives involving international support from the FAO, OAS and most recently a World Bank supported project. Despite many plans, legislation and implementation is blocked. Reasons are to be found in (a) the production of science/policy by an elite (b) the nature of participation, and (c) the way tensions between national bureaucracies interplay with international.

The system, in its varied permutations, continues to be focussed on the preservation not use of lands that are in part privately owned, farmed, forested, hunted, squatted or otherwise illegally used. The rationale, location and extent of the proposed parks has repeatedly been elaborated at a nexus between conservation activists (NGOs), the wildlife section of the Forest Department, conservation biologists at the University of the West Indies, and government and private sector interests in promoting ecotourism. They are supported by international scientists and funders who are keen to establish protected areas to blend international conservation goals with national development.

There is a tension between 'participation' as practised within this science-policy nexus (principally involving several community based conservation organisations promoting a win-win ecotourism agenda and village tour-guiding), and 'participation' by others in the policy process through wider political systems. Land users whose rights and interests would be curtailed express critique via the press, the law, administrative politics and party politics. To date, resolution has been in favour of land users who, although marginalised from the participation managed by the 'project', have succeeded in blocking the national parks legislation politically.

Their success in this is assisted by opposition from (a) other bureaucracies (principally Forestry) which would lose control of resources, should an autonomous national parks authority be established – as donors repeatedly advocate, (b) legislators and politicians concerned by the costs and wisdom of taking large loans, and who are sceptical of the internationally-influenced science shaping the proposals.

Keywords: national parks, culture, policy, bureaucracy.

Okuns, H. 1990. The role of petroleum testing laboratory in pollution monitoring. Ministry of the Environment and National Services Seminar/Exhibition Rivers and Waterways – Our Business Protecting the Environment. Room 101, Engineering Faculty, UWI, St. Augustine

The Petroleum Testing Laboratory at CARIRI was founded in 1972 by the Trinidad and Tobago government under the aegis of the Ministry of Energy. Its main purpose at that time

was to provide independent evaluation of our local crude oil quality for fiscalisation purposes. A few years after its inception and mainly due to complaints of oil pollution by farmers in the South, the laboratory became involved in pollution studies.

As a result of these studies, CARIRI has been able to identify certain problem areas in the industries and the Ministry has been able to work with the companies to improve the quality of the effluent leaving their operations.

Keywords: petroleum testing, oil pollution, monitoring.

Siung-Chang, A. 1990. River pollution problems in Trinidad and Tobago. Ministry of the Environment and National Services Seminar/Exhibition Rivers and Waterways – Our Business Protecting the Environment. Room 101, Engineering Faculty, UWI, St. Augustine.

There are eight major categories of pollutants entering watercourses; these are: sewage, animal wastes, industrial wastes, pesticides, oil, salt intrusion, silt and solid wastes. The impacts of these on local rivers is discussed. Scientific evidence all point to the need for regulation of waste discharges into inland water courses. Many major rivers are polluted and cannot support aquatic life.

Keywords: water pollution, rivers, impacts.

Journal Papers

Marine Pollution Bulletin

George, C. and B.L. Oostman. 1983. The characteristics and dynamics of tar pollution on the beaches of Trinidad and Tobago. *Marine Pollution Bulletin* Volume 14, Number 5, 170-178.

Trinidad and Tobago beaches were periodically sampled for tar between July 1980 and September 1981. This project was carried out by the Institute of Marine Affairs in cooperation with the United Nations. The Caribbean coasts of both islands were almost pristine, whereas pollution on the Atlantic coast beaches was comparable to that of other coasts along major tanker routes. The source of high tar concentrations on the Atlantic coasts may be attributed to the residues from tanker bilge cleanings, which are carried along the South Equatorial Current, eventually to strand on the islands' beaches. In the dry season (January to April) north-westerly currents and north-easterly winds prevail and more tar strands on Trinidad than on Tobago. In the wet season (June to November), however, when currents are more northerly and south-easterly winds prevail, the reverse situation holds and more tar strands on Tobago.

Keywords: tar pollution, beaches, tanker bilge, currents.

Agard, J.B.R. 1985. Total petroleum hydrocarbons in surficial sediments from Port-of-Spain Harbour, Trinidad. *Marine Pollution Bulletin* Volume 16, Number 8, 334-335.

The Gulf of Paria in which Port-of-Spain Harbour is located has been designated as a high risk zone for oil spills. With more than thirty marine platforms, over 150 km of pipeline, and the movement of 70-75 tankers a month within this area, there is growing concern about the risk of oil pollution. The Gulf is a shallow, semi-enclosed water body characterised by seasonal salinity and turbidity fluctuations. In 1982 a benthic survey was undertaken as part of an environmental baseline monitoring programme of coastal marine environments in Trinidad and Tobago. The study area was located just off Port-of-Spain, Trinidad between latitude 10° 39.4', longitude 61° 36' and latitude 10° 5', longitude 61° 30.6'. The results indicate that petroleum hydrocarbons were presented at all the stations sampled. Total petroleum hydrocarbons found ranged from 2.8 µgg⁻¹ at wet season station L1 to 240.5 µgg⁻¹ at wet season station L2 with an arithmetic mean for all stations of 22.3 µgg⁻¹ (dry weight chrysene equivalents). The higher result (240.5 µgg⁻¹) was found adjacent to a fuel storage depot at Sea Lots. Sediment analysis showed the study area to be covered by a marine mud (mean phi 3.7 to 8.1).

Keywords: oil spills, benthic survey, baseline monitoring programme, total petroleum hydrocarbons (TPHs).

Agard, J.B.R., M. Boodoosingh and J. Gobin. 1988. Petroleum residues in surficial sediments from the Gulf of Paria, Trinidad. *Marine Pollution Bulletin* Volume 19, Number 5, 231-233.

This paper describes the concentration of petroleum hydrocarbons in the Gulf of Paria and compares these concentrations with those of other oil producing countries in the world. It was shown that even when compared with some of the greatest oil producing parts of the world, the Gulf of Paria coast of Trinidad is far more polluted by petroleum hydrocarbons.

Keywords: petroleum residues, sediments, pollution.

Singh, J.G., I. Chang Yen, V.A. Stoute and L. Chatergoon. 1992. Hydrocarbon levels in edible fish, crabs and mussels from the marine environment of Trinidad. *Marine Pollution Bulletin* Volume 24 Number 5, 270-272.

The survey was carried out to determine existing hydrocarbon levels in selected marine animals found in the marine environment of Trinidad. Samples of five fish species, the crab *Callinectes sapidus*, and the mussel *Mytella guyanensis*, all of commercial value to the local fisheries industry, were collected and analysed for hydrocarbon levels. Muscle and skin

tissues were analysed in fish, gill and muscle in crabs, and soft body parts in mussels. The variation in hydrocarbon levels with location, species and tissue type for animals examined in this study indicate that contamination of some of these marine organisms with petroleum hydrocarbons has occurred.

Keywords: hydrocarbon concentrations, fish, crab, mussel.

Mohammed, A. and J. Agard. 2004. The occurrence of NADPH-ferrihemoprotein reductase in *Corbula caribea*, from a natural oil seep at La Brea, Trinidad. Marine Pollution Bulletin, Volume 48, Number 7-8, 784-789.

Corbula caribea is the most common non-polychaete macrofaunal organism identified at a large natural oil seep at La Brea in south Trinidad. It is hypothesized that these animals may possess (NADPH-ferrihemoprotein reductase) a component of the Mixed Function Oxygenase system (MFO), which may allow them to ameliorate the potentially deleterious effects resulting from exposure to the high levels of petroleum hydrocarbons within this environment. This study was designed to determine whether organisms from the seep site showed greater enzyme activity when compared to organisms from a non-seep reference site. NADPH-ferrihemoprotein reductase activity was determined by incubating 10 µm cryostat sections with nitro-blue tetrazolium. The reaction product was determined by visual assessment and quantified by measuring the relative mean stain intensity. The intense staining, indicative of enzyme activity was evident in the digestive epithelia of seep animals. Observations indicated that organisms from the seep showed more intense staining, indicating greater enzyme activity, when compared to animals from a non-seep reference site. The relative stain intensity of NADPH-ferrihemoprotein reductase determined for organisms from the seep was 61.30. This was significantly higher than the stain intensity determined for organisms from the non-seep reference site (7.11). This supported visual assessments, which suggested that the seep organisms showed higher enzyme activity than organisms from the non-seep site. The results suggest that NADPH-ferrihemoprotein reductase may be present in *Corbula caribea* from the seep site and not in those from the non-seep site. It is possible that this enzyme may contribute to these animals' ability to tolerate chronic exposure to petroleum hydrocarbons and offer them a selective advantage for survival in the seep environment.

Keywords: *Corbula caribea*, hydrocarbon amelioration.

Transactions AIME

Macready, G.A. 1921. Petroleum industry of Trinidad. Transactions AIME Volume 65, 58-68.

Trinidad, British West Indies, is an island near the north coast of South America, situated between latitudes 10° and 11° N., and opposite the numerous outlets of the Orinoco River Delta. It is separated from Venezuela by the Gulf of Paria (salt water) and straits over 5 mi. (8 km.) wide. The area of the island is approximately 1750 sq. mi. (453,250 hectares) and the population is approximately 400,000. The climate is tropical with an annual rainfall of from 45 to 60 in. (114 to 152 cm.).

The oil fields consist of several units, or fields, located in the southern half of the island. Approximately 90 per cent. of the total production has been yielded by fields situated within 7 mi. (11.3 km.) of the famous asphalt lake and on the southwest peninsula.

The most important producing fields, or units, are the following, which are shown on the accompanying map:

Brighton, or Pitch Lake Field, operated by the Trinidad Lake Petroleum Co., Ltd., is situated beside the famous Pitch Lake; it even encroaches on the lake.

Vessigny Field, operated by the Trinidad Lake Petroleum Co., Ltd., is situated 2 mi. (3.2 km.) south of Pitch Lake.

Lot One Field, operated by the Petroleum Development Co., Ltd., the United British Oilfields of Trinidad, Ltd., and Stollmeyer, Ltd., is situated 3 mi. south of Pitch Lake upon Lot One of Morne l'Enfer Forest Reserve and adjoining properties.

Parry Lands Field, operated by the United British Oilfields of Trinidad, Ltd., and the Petroleum Development Co., Ltd., is situated 3½ mi. south of Pitch Lake on Lot Three of Morne l'Enfer Forest Reserve and adjoining properties.

Point Fortin Field, operated by the United British Oilfields of Trinidad, Ltd., is situated at Point Fortin, 6 mi. southwest of Pitch Lake.

Fyzabad Field, operated by Trinidad Leaseholds, Ltd., is situated several miles southwest of Fyzabad Village and 6 mi. south-southeast of Pitch Lake.

Barrackpore Field, operated by Trinidad Leaseholds, Ltd., is situated several miles south of San Fernando and 15 mi. (24.14 km.) east of Pitch Lake.

Keywords: oil fields, Trinidad.

Redfield, A. 1923. Petroleum reserves of the West Indies. Transactions AIME Volume 68, 1082-1090.

The West Indies are the summits of a submerged mountain chain, the continuation of which must be sought in the mountains of central Honduras. In Haiti, the chain divides, one branch passing through Jamaica and the other through Cuba, the Cayman Islands, and the Misteriosa bank.

Suess divides the West Indies into three zones: The first zone is entirely of volcanic origin and includes many recent volcanic cones. It includes the arcuate string of islands, which extends from Saba and St. Kitts to the Grenadines and Grenada. The western half of Guadeloupe belongs to this group. The second zone consists of a geanticline, of which the sedimentary rocks range from the Jurassic to the Quaternary, but consist chiefly of Lower Tertiary sediments. In the west it is broad, including the whole of the Greater Antilles; but in the east it is restricted to a narrow belt, which includes the Virgin Islands (except Anegada), Anguilla, St. Bartholomew, Antigua, the eastern part of Guadeloupe and part of Barbados. The islands that compose the third zone are flat and low. Like the second, this zone is broad in the west and narrow in the east; it includes the Bahamas, Anegada, Sombrero, Barbuda, and part of Barbados. Geologically, Florida and the plain of Yucatan may be regarded as belonging to it.

Trinidad and Tobago, though geographically adjacent to the Lesser Antilles, are geologically a detached part of the South American continent. The crystalline complexes of northern Trinidad and of Barbados are a continuation, en echelon, of the crystalline axis of the promontory of Paria. The folded Cretaceous and Tertiary of the central and southern parts of Trinidad represent a continuation of the folded sediments of the Paria district of Venezuela.

Keywords: geology, Trinidad, petroleum.

Revista de Biología Tropical

Ragbirsingh, Y. and W. Norville. 2005. A Geographical Information System (GIS) analysis for trace metal assessment of sediments in the Gulf of Paria, Trinidad. Revista de Biología Tropical Volume 53, Supplement 1, 196-206.

The Gulf of Paria is a semi-enclosed shallow basin with increasing coastal development activities along Trinidad's west coast. Sediments present a host for trace metal pollutants from overlying waters, therefore determination of their content is critical in evaluating and detecting sources of marine pollution. This paper presents a Geographic Information System (GIS) analysis of geochemical assessment for trace metals in coastal sediments of the Gulf of Paria. This GIS approach facilitates interpretation of the spatial relationships among key environmental processes. The GIS development involves the integration of spatial and attribute data pertaining to bathymetry, current systems, topography, rivers, land use/land cover and coastal sediments. It employs spatial interpolation and retrieval operations to analyse the total trace metal concentrations of aluminum, copper and lead in the sediments and the clay-enriched sediments, to determine whether they are related to sediment type or are affected by the Gulf of Paria, and to reveal potential hot spots and dispersion patterns. A direct spatial correlation between clay-enriched sediments and high concentrations of lead aluminium and lead is detected, however regions of high concentrations of copper and lead

indicate a relationship to anthropogenic sources. The effectiveness of GIS for visualisation, spatial query and overlay of geochemical analysis is demonstrated.

Keywords: Geographical Information System, metal concentrations, sediments, interpolation.

Ramsundar, H. 2005. The distribution and abundance of wetland ichthyofauna, and exploitation of the fisheries in the Godineau Swamp, Trinidad – Case study. Revista de Biologia Tropical, Volume 53, Supplement 1, 11-23.

The Godineau (South Oropuche) Swamp (3171 ha) on the southwestern coast of Trinidad (10°13' - 15°N, 61°30' - 32°W) is heavily impacted by anthropogenic activities including fishing, oil exploration, drainage manipulation and wetland clearance. To reduce the negative effects of these activities and to manage the swamp more sustainably, more quantitative information is needed on the ecology of the wetland and the activities that occur within it. This study focuses on the distribution of the fish resources and exploited fisheries as a basis for more informed management directives. Sampling was conducted during 2002, in April-May (for dry season) and July-September (for wet season sampling). Ichthyofauna was sampled both day and night using trammel nets and a push seine. Fishing activities were assessed using a questionnaire and informal discussions with fishers. The wetland supports over 29 species of fish distributed over the freshwater, estuarine and saline zones (n=1454). Species distribution is seasonal, with evidence of the wetland being used as a spawning ground. Species richness and species diversity (Shannon-Weiner Index) for the wetland ranged over 2-11 and 0.162-0.967, respectively, in the dry season and 2-7 and 0.036-0.903, respectively, in the wet season. Communities inhabiting the saline and estuarine zones of the wetland were dominated by a single species, *Hexanematichthys bonillai*. Percent Similarity Indices were 41.8% for freshwater, 72.7% for estuarine and 79.8% for estuarine-saline communities. The commercial species accounted for 18% of total catch sampled and consisted of *Centropomus undecimalis*, *Megalops atlanticus*, *Hoplosternum littorale*, *Hoplias malabaricus*, *Ophioscion punctatissimus* and *Macrodon ancycloдон*. Full-time and part-time fishers, including recreational fishers, accounted for 14.3% and 85.7%, respectively of all fishers surveyed (n=56). A conservative estimate of the revenue earned directly at point of sale for fish and shellfish is approximately US\$43000 per annum. Fishing is important in the area. Management directives taking into account the ecology of the target organisms are needed to allow these fishing practices to be continued in a sustainable manner.

Keywords: fish species, freshwater, estuarine, marine, season.

Norville, W. 2005. Spatial distribution of heavy metals in sediments from the Gulf of Paria, Trinidad. Revista de Biologia Tropical Volume 53, Supplement 1, 33-40.

The Gulf of Paria receives heavy metal input from urban runoff, industrial and agricultural activity, sewage and domestic wastes: both from the west coast and from inland areas of Trinidad. Non-residual concentrations of nine metals, as well as total mercury concentrations, were used to determine spatial distributions of heavy metals in sediments in the Gulf of Paria. Surficial sediment samples were collected at 37 stations, which included the mouths of 11 major rivers that flow into the Gulf of Paria. Stations were sampled twice during the wet season (July 1998 and November/December 1998) and twice during the dry season (March 1999 and April 1999). Sediments were analyzed for aluminium (Al), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), zinc (Zn) and mercury (Hg). Total Organic Carbon (TOC) and grain size analyses were also performed on the sediments. Principal component analysis showed that sediments from river mouths subject to greatest land use and anthropogenic inputs were distinct from other sediments in the Gulf of Paria. This was due to higher Pb, Zn, Cu and Hg concentrations (3.53-73.30 $\mu\text{g g}^{-1}$, 45.8-313.9 $\mu\text{g g}^{-1}$, 8.43-39.71 $\mu\text{g g}^{-1}$ and 0.03-0.10 $\mu\text{g g}^{-1}$ respectively). Sediments further from the coast were also distinct due to their higher Al, Fe, Cr and Mn concentrations (1.37-3.16 mg g^{-1} , 9.51-18.91 mg g^{-1} , 17.22-28.41 $\mu\text{g g}^{-1}$ and 323.6 –1,564.2 $\mu\text{g g}^{-1}$ respectively). Cd and Pb were higher in the wet season while Ni was higher in the dry season. Pb, Zn, Cu and Hg were correlated with each other and with TOC. Correlation was also observed between Al, Fe, Cr, Mn and Ni. Al, Fe, Cr and Mn were correlated with percentage clay in sediments. The results suggest that Pb, Zn, Cu and Hg are preferentially removed by organic matter, which settles at

the river-mouths, while Al, Fe, Cr, Mn, and Ni become associated with clay minerals and are transported away from the coast.

Keywords: metals, sediments, total organic carbon, correlations.

Rojas De Astudillo, L., I. Chang Yen and I. Bekele. 2005. Heavy metals in sediments, mussels and oysters from Trinidad and Venezuela. Revista de Biología Tropical Volume 53, Supplement1, 41-51.

The Gulf of Paria is bordered by both Trinidad and Venezuela, from which various metallic pollutants and other contaminants can originate. The Gulf is still a significant source of fish, crabs and shellfish for human consumption to both countries, where concerns over the quality of this marine environment have been long expressed but never properly addressed. In addition, the circulatory current patterns in the Gulf ensure that contaminants originating from either country are likely to affect both countries eventually. Heavy metals were determined in oysters (*Crassostrea rhizophorae* and *C. virginica*), green mussels (*Perna viridis*) and sediments from the Gulf of Paria. Samples were obtained at four sites in Trinidad and three sites in Venezuela in the Gulf of Paria, in addition to comparative samples collected from three sites on the north coast of Venezuela. Edible tissues of twelve shellfish from each location were blended and aliquots digested with concentrated nitric acid, for extraction of cadmium, chromium, copper, lead, nickel and zinc. The solutions were analysed by flame atomic absorption spectroscopy. Mercury was extracted with a mixture of nitric, hydrochloric and sulphuric acids and determined by cold vapour atomic absorption. Sediments were oven-dried at 60°C, before being similarly extracted. Results showed that mercury in sediments at all sites in Trinidad and Venezuela exceeded NOAA and Canadian sediment quality guidelines, while cadmium, copper, nickel, lead and zinc also exceeded these guidelines at several sites. Heavy metal levels in oysters and green mussels varied widely with location. However, oysters from the Gulf of Paria contained significantly higher mean levels of cadmium, copper, nickel and zinc than those from the north coast of Venezuela, but this difference was not apparent in mussels. Cadmium, mercury and zinc in sediments were significantly correlated with those of mussels, but not of oysters, in which copper and zinc at several sites in the Gulf of Paria exceeded local maximum permissible levels (Cu=20 µg g⁻¹ wet wt; Zn=50 µg g⁻¹ wet wt) for human consumption. These findings indicate that while mussels may be better biological indicators of heavy metal pollution in sediments than oysters, the latter may provide copper and zinc contamination. Further research is needed to determine the most appropriate biological indicators of heavy metal and other pollutants in the local marine environment and to develop protocols for their use.

Keywords: metals, sediments, mussels, oysters, Trinidad, Venezuela.

Miscellaneous papers

Pollard, H.J. 1985. The erosion of agriculture in an oil economy: The case of export crop production in Trinidad. World Development Volume 13, Number 7, 819-835.

This paper examines the pressures upon export agriculture in Trinidad that have led to dramatic declines in sugar, cocoa and citrus production over the past two decades. Data drawn from official publications and primary surveys reveal the financial strains on the industry and highlight the adverse impact of the oil economy. The latter is manifested through inflationary pressures on wage rates, the funding of major capital projects offering alternative employment opportunities, the uncontrolled expansion of recurrent expenditure on politically motivated job creation schemes that have aided withdrawal of labour from socially and financially less rewarding agricultural employment, and an escalation in land values which has diminished the need for agricultural improvement. Particular concern for the decline is expressed as efficiency and future viability of the new power-based manufacturing developments have yet to be proved.

Keywords: economic pressures, wages, politics, agriculture, export.

Heileman, L.I. and A. Siung-Chang. 1990. An analysis of fish kills in coastal and inland waters of Trinidad and Tobago, West Indies, 1976-1990. Caribbean Marine Studies Volume 1, Number 2, 126-136.

Reported fish kills for the period 1976 to 1990 for coastal waters and 1980 to 1990 for inland waters of Trinidad and Tobago were investigated. The location, extent, and possible causes of kills; the organisms affected; and the quality of the aquatic environment were determined. Most of the fish kills in inland waters could be attributed to industrial effluents or the disposal or use of chemicals whereas those in coastal waters could be attributed to waste or chemical spills, or natural processes such as oxygen depletion resulting from red tides and other algal blooms. Some in-shore fish kills were preceded by schooling of fish in semi-enclosed bays.

Keywords: fish kills, coastal waters, inland waters, industrial effluents, chemical disposal.

Agard, J.B.R., J. Gobin and R.M. Warwick. 1993. Analysis of marine macrobenthic community structure in relation to pollution, natural oil seepage and seasonal disturbance in a tropical environment (Trinidad, West Indies). Marine Ecology Progress Series Volume 92, 233-243.

Macrobenthic species abundances and biomasses were determined at 31 stations from Pointe-a-Pierre to La Brea, Trinidad. This area is subject to chronic natural oil seepage and spillage from oil production activities. Multivariate analysis was used to define those environmental variables which best explained community composition. The deeper sites were impoverished due to the development of anoxia below a pycnocline which formed during the wet season. Abundance/biomass comparison (ABC) plots indicated that macrobenthic communities near an oil refinery were grossly to moderately stressed while those close to the Trinidad Pitch Lake, one of the largest natural oil seeps in the world, were not. Taxonomic aggregation of the species data to family level resulted in little loss of information in the multivariate analyses and apparently improved the ability of ABC curves to discriminate pollution. Comparisons of the severity of community degradation at these sites using a phylum-level meta-analysis of 'production' were compatible with NE Atlantic data, which augurs well for the more global applicability of this approach. A feature of the Trinidad samples is that they all separate along the upper edge of the meta-analyses 'wedge', due mainly to their higher average proportion of Crustacea relative to Echinodermata and Mollusca. This is explained in terms of the estuarine character of the region, and suggests that the unexplained vertical axis in Warwick & Clarke's (companion article) ordination may be related to natural environmental characteristics.

Keywords: macrobenthic community, pollution, natural seepage, season.

Siung-Chang, A. 1997. A review of marine pollution issues in the Caribbean. Environmental Geochemistry and Health Volume 19, Number 2, 45-55.

Marine pollution and coastal degradation have become serious development issues in the Caribbean. Early evidence of marine pollution was mainly anecdotal, but within the last 10--15 years, work conducted by universities and research institutions in the region has provided the beginnings of a database that identifies several common marine pollution problems. The United Nations Environment Programme (UNEP), the Intergovernmental Oceanographic Commission (IOC) and the Pan American World Health Organization (PAHO/WHO) have also been instrumental in co-ordinating several marine pollution studies. In the English-speaking Caribbean, the University of the West Indies, the Institute of Marine Affairs in Trinidad and Tobago, and the Caribbean Environmental Health Institute located in St Lucia, have taken a lead role in identifying marine pollution problems in their sub-region. For the wider Caribbean a database for petroleum pollution and marine debris has been developed. Land-based sources of marine pollution have been identified as a major problem, with several 'hot spots' identified in mainland countries and in some of the larger industrialised islands. Organic and nutrient pollution, particularly from sewage, is most widespread and is possibly the most serious marine pollution problem in the Caribbean. A lack of capital investment funds to install the appropriate infrastructure to deal with sewage and other liquid effluents is a major stumbling block to solving the problem of marine pollution in the Caribbean. Other factors

include political will and administrative and legal structures to regulate human development activities.

Keywords: marine environments, land-based pollution.

Nansingh, P. and S. Jurawan. 1999. Environmental sensitivity of a tropical coastline (Trinidad, West Indies) to oil spills. Spill Science and Technology Bulletin Volume 5, Number 2, 161-172.

In the wider Caribbean region, Trinidad has been classified as a high risk area for oil spills by the Intergovernmental Marine Consultative Organization. In order to develop an oil spill environmental sensitivity index, the intertidal zones of fifteen representative coastal sites were monitored for physical and biological parameters during the dry and wet seasons. On a scale of 1-10, sheltered habitats with high productivity are the most sensitive to spilt oil with an index value of 10. Exposed habitats with low productivity are the least sensitive with a value of 1. The index applied to coastal habitats in Trinidad is as follows: mangrove swamps (10), coral-algal reefs (9), sheltered rocky coasts (8), sheltered tidal flats (7), mixed sand and gravel beaches (6), sheltered fine to medium-grained sand beaches (5), exposed rocky shores (4), exposed tidal flats (3), exposed medium to coarse-grained sand beaches (2) and eroding wavecut platforms (1). This study demonstrates an approach to effectively combine biological and physical parameters into a single environmental sensitivity index to oil spills.

Keywords: environmental sensitivity index, coastal areas, Trinidad.

Haraksingh, I. 2001. Renewable energy policy development in the Caribbean. Renewable Energy Volume 24, Number 3-4, 647-655.

The Caribbean region is endowed with renewable energy resources which remain largely untapped. With an average insolation of 15-20 MJ m⁻² day⁻¹, investment in some renewable energy technologies is feasible. The major problem confronting the region is lack of financial resources. Petroleum imports continue to dominate the energy scenario except for Trinidad and Tobago and Barbados. However, increased awareness of sustainable development issues throughout the region is a major factor in support of renewable energy implementation and is a driving force for energy policy decision-making. With the necessary joint-venture partnerships and government fiscal incentives, photovoltaic technologies, wind energy and solar energy industries are poised to expand thus reducing the dependency on fossil fuel imports while preserving the environment.

Keywords: renewable energy sources, petroleum, sustainable development.

Seepersad, B., K. Ramnath, S. Dyal and R. Mohammed. 2004. The use of Aniline Blue for the determination of dead phytoplankton, zooplankton and meroplankton in LC50 testing after 96 hours...A re-evaluation of the US Environmental Protection Agency Methodology. Journal of Energy Resources Technology Volume 126, 215-218.

There is a need for a reliable staining technique to distinguish between live and dead organisms following LC50 tests. This is especially so in cases where organisms can be stressed or even become unconscious and appear dead to the aided or naked eyes. Visual observations under such conditions can result in an LC50 value shifting to the lower concentration thereby imposing stiffer guidelines for compliance. Aniline blue can only stain individuals which are physiologically dead imposing an accurate live-dead evaluation and producing a true LC50 value. Guidelines imposed using such data will facilitate compliance and provide an accurate value for an LC50.

Mohammed, A. 2005. Toxicity of water-soluble fractions of four fuels for *Metamysidopsis insularis*, an indigenous tropical mysid species. Environmental Monitoring and Assessment Volume 104, Number 1-3, 37-44.

The toxicity of the water-soluble fraction (WSF) of four fuels (leaded gasoline, unleaded gasoline, diesel, Jet A-1) to *Metamysidopsis insularis*, an indigenous tropical mysid species was determined. Approximately 10000 barrels (bbl) of fuel are consumed daily in Trinidad and

Tobago, and about 50000 bbl are exported. Accidental discharges at points of transfer as well as from inadequate storage facilities, can pose a significant contamination risk to the environment. Organisms were assayed with the WSF under both UV and fluorescent lights. The WSF was prepared using different fuel/seawater (v/v) mixtures. It was found that organisms exposed to diesel, Jet A-1 and unleaded gasoline showed similar toxicological responses under both light regimes, and were more toxic than the leaded gasoline. The results also showed that none of these fuels show photo-induced toxicity. The WSF of the 0.1% mixtures of unleaded gasoline, diesel and Jet A-1 were acutely toxic to *M. insularis*. However, for the leaded gasoline, only the 0.5% mixture was acutely toxic. The high toxicity of these fuels may be due to the presence of light, more soluble fractions. It is therefore likely that these fuels will have significant impacts in our local environment, if any spills occur.

Keywords: toxicity, fuels, indigenous species, Trinidad.

Elias-Samlalsingh, N. and J.B.R. Agard. 2004. Application of toxicity identification evaluation procedures for characterizing produced water using the tropical mysid *Metamysidopsis insularis*. Environmental Toxicology and Chemistry Volume 23, Number 5, 1194–1203

Toxicity identification evaluations (TIEs) were performed on seven produced water (PW) effluents from inland discharge facilities operated in Trinidad and Tobago, a Caribbean tropical country with one of the oldest commercial oil industries in the world. The research was performed to determine the presence and magnitude of toxicity and characterise which toxicants are responsible for observed effects. Marine effluent toxicity characterisations with *Metamysidopsis insularis* revealed high whole acute toxic-unit response for produced water ranged from 8.1 to 17.0 acute toxic-unit (initial toxicity test) and 5.7 to 1,111 acute toxic-unit (baseline toxicity test). Toxicity test results for all sites except one, which had the highest toxicity, are comparative with similar studies on produced water. The toxicological causality of this complex mixture differed for each PW with non-polar organics being consistently toxic in all samples. Other potential toxicants contributing to overall toxicity to a much lesser extent were metals, ammonia, and volatile organic compounds. With the use of sodium thiosulfate and filtration manipulations for only PW6 sample, there was very slight reduction in toxicity; therefore, oxidants and filterable materials were not a great contributing factor. Whole effluent toxicity also can be attributed to ionic imbalance and the very stable oil-in-water emulsion that consists of fine oil droplets (less than 0.1–10 µm with an average diameter of 2.5 µm). This investigation is the first of its type in Trinidad and demonstrates clearly the applicability of this test method and local test species for evaluating complex effluents in tropical environments.

Keywords: toxicity, produced water.

Hosein, A. 1996. Increasing oil production through leasing of the idle wells. Journal of Petroleum Technology Volume 48, Number 1, 63-67.

The national oil company of Trinidad and Tobago (Petrotrin) has more than 5,000 idle wells. The company initiated a procedure for leasing these idle wells to small independent operators in July 1989 through a program known as the “lease operatorship” program. This paper reviews the status of lease operatorship activities, examines the benefits and the strategies adopted by the operators as well as some of the important issues involved, describes the requirements for external operatorship, and outlines plans for the future of the program.

Keywords: oil production, wells, increased production.

Ramlogan, R. 2002. Meeting the challenges of environmental imperatives: The hydrocarbon sector in Trinidad and Tobago. Energy Law Journal Volume 23, Number 1, 127-155.

This paper discusses the developments of the hydrocarbon sector in Trinidad and Tobago and the historical perception of the government over the years to this sector and to the environment. It overviews the past and present legislation pertaining to environmental protection and the enforcement procedures associated with these. It reviews the

environmental legislation pre- and post- Environmental Management Act and looks at the impact of these changes in the legal process of the hydrocarbon sector.

Keywords: environmental legislation, petroleum sector, compliance

Certificates of Environmental Clearance (CECs)

Approved Certificates of Environmental Clearance (CECs)

Advanced Oil Company Ltd.. 2003. To conduct exploratory drilling operations for crude oil in Moruga. CEC No. 0384/2003. (EIA required = No)

British Gas Trinidad and Tobago Ltd. (BGTT). 2003. To conduct exploratory drilling operations, for natural gas offshore at Ixora-1 well, in the North Coast Marine Area (NCMA), North Coast, Trinidad. CEC No. 0379/2003. (EIA required = No)

British Gas Trinidad and Tobago Ltd. (BGTT). 2006. To conduct drilling operations and perform a sidetrack on the existing Carapal Ridge 1 (CR1) well located on the Carapal Ridge gas processing facility, Moruga. CEC No. 1329/2006. (EIA required = No)

Jasmin Oil and Gas Ltd.. 2006. To conduct drilling operations on one semi-exploratory oil well in the South Erin Farm Out Block, South Erin. CEC No. 1340/2006. (EIA required = No)

Lease Operators Ltd; Oilbelt Services Ltd.. 2004. To conduct drilling operations and the modification of CEC 0623/2003 to include the addition of fifteen oil wells in the Palo Seco field, St. Patrick county. CEC No. 0806/2004. (EIA required = No)

Lease Operators Ltd; Oilbelt Services Ltd.. 2004. To conduct drilling operations and the modification of CEC 0411/2003 to include the addition of ten oil wells in the Palo Seco field, St. Patrick county. CEC No. 0807/2004. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2003. To conduct exploration activities and the expansion of the drilling programme to include the drilling of five additional wells within Forest Reserve, North Palo Seco and Central Los Bajos, south Trinidad. CEC No. 0508/2003. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2003. To conduct drilling operations for the expansion of sixty wells in order to boost oil production at Forest Reserve. CEC No. 0553/2003. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2005. To decommission nine oil wells at Lamont Estate, Hermitage Village, San Fernando. CEC No. 0988/2005. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2005. To collect continuous core samples from ten to sixteen locations from across the study area at Parrylands. CEC No. 1076/2005. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2005. To conduct oil exploration activities in order to increase oil production from the Morne L'Enfer Field at Forest Reserve. CEC No. 1140/2005. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2005. To complete the decommissioning of six gas wells sites (AM1, AM2, AM3, M1, M2, M3) at the Mahaica Gas Field, Arena Forest Reserve, Arena. CEC No. 1231/2005. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To decommission eight oil well sites: GY-22, Gy-35, Gy-39, Gy-43, Gy-95 and Gy-277) to prevent oil seepages of pollution in an effort to preserve and protect wildlife habitat at Trinity Hills Wildlife Sanctuary. CEC No. 1406/2006. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To complete site decommissioning of one oil well site (Ab 83) for the prevention of further oil leaks, in an effort to protect human health and the environment at Park Street, La Brea. CEC No. 1410/2006. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To complete the decommissioning of one oil well (BP 327) to prevent further oil leaks at Papourie Road, Barrackpore. CEC No. 1529/2006. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To conduct drilling operations on twenty additional development oil wells in the Penal, Barrackpore and Wilson Fields, south Trinidad. CEC No. 1544/2006. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To complete the decommissioning of one oil well site (AO77) for the prevention of further oil leaks to the mangrove swamp at Oropuche. CEC No. 1600/2006. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To decommission 49 wells from San Francique, Penal to Guapo, Point Fortin, to facilitate the construction of the proposed highway from San Francique/Penal. CEC No. 1705/2006. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2007. To decommission nine oil wells (BCO1, BCO2, BCO3, BCO4, BCO5, BCO6, BCO7, BCO8 and BCO9) in the Oropuche Field, Oropuche. CEC No. 1818/2007. (EIA required = No)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2007. To complete the decommissioning of one oil well (PO1) at No. 10, Thick Village, Siparia Road, Fyzabad. CEC No. 1820/2007. (EIA required = No)

Pioneer Petroleum Company Ltd.. 2006. To conduct drilling operations on six wells in Block GU 1 at Guapo. CEC No. 1393/2006. (EIA required = No)

Pioneer Petroleum Company Ltd.. 2006. To conduct drilling operations on ten wells in Block GU1, Guapo and the installation of three two-hundred and fifty barrel storage tanks at the Production Facility, Guapo, Fyzabad. CEC No. 1447/2006. (EIA required = No)

Primera Oil & Gas Ltd.. 2002. To drill four stratigraphic holes in order to core and log information about the geological formation at Constance Estate, Icacos. CEC No. 0218/2002. (EIA required = No)

Primera Oil & Gas Ltd.. 2002. To decommission five crude oil wells in the San Francique West Field, San Francique. CEC No. 0261/2002. (EIA required = No)

Primera Oil & Gas Ltd.. 2003. To conduct works related to the abandonment of two existing oil wells in Fyzabad. CEC No. 0355/2003. (EIA required = No)

Rocky Point Trinidad and Tobago Ltd.. 2003. To conduct drilling operations for the establishment of two replacement wells, PS-319 and PS-520 in Block WD-15, and the exploration for crude oil at Palo Seco. CEC No. 0442/2003. (EIA required = No)

Trinidad Exploration and Development Company Ltd. 2002. To conduct drilling operations for nineteen exploratory wells in South West Peninsula Block at Cedros and Bonasse.. CEC No. 0219/2002. (EIA required = No)

Trinidad Exploration and Development Company Ltd.. 2005. To conduct exploration and drilling activities on one well in the Southwest Peninsula Block, Bonasse Village, Cedros. CEC No. 1222/2005. (EIA required = No)

Venture Production (Trinidad) Ltd.. 2001. To construct, install and operate a 4-slot offshore platform (PL2) and the development of onshore wells, at Point Ligoure Field, off Soomai Trace to Hollywood Corner, Point Ligoure, Point Fortin. CEC No. 0009/2001. (EIA required = No)

Venture Production (Trinidad) Ltd.. 2001. To establish a facility for the extraction, or, production of a crude oil or production or, associated gas condensates, at Forest Reserve, Fyzabad. CEC No. 0063/2001. (EIA required = No)

Venture Production (Trinidad) Ltd.. 2002. To conduct a two-dimensional (2-D) seismic survey, to ascertain the sub-surface conditions, prior to drilling activities, in the Tabaquite Block, Tabaquite. CEC No. 0288/2002. (EIA required = No)

Vermillion Oil and Gas (Trinidad) Ltd.. 2002. To conduct drilling operations on two exploratory wells at the Central Block in Catshill, Moruga and Tableland. CEC No. 0287/2002. (EIA required = No)

Vintage Petroleum Trinidad Ltd.. 2002. To conduct a two-dimensional (2-D) seismic survey, to ascertain the sub-surface conditions, prior to drilling activities, over an area of eleven thousand hectares (11,353 ha) for a period of three months at Moruga and Barrackpore. CEC No. 0131/2001. (EIA required = No)

Vintage Petroleum Trinidad Ltd.. 2002. To establish surface production facilities for the separation, storage, fiscalisation and transfer of well fluids (condensates and natural gas) to

Petrotrin and the National Gas Company of Trinidad and Tobago at Catshill, Moruga. CEC No. 0135/2002. (EIA required = No)

Water and Sewerage Authority (WASA). 2006. To conduct drilling operations for the development and equipping of two replacement water wells at Scotts Road #1 and #2, Morne Diable, Fyzabad. CEC No. 1560/2006. (EIA required = No)

Water and Sewerage Authority (WASA). 2006. To conduct drilling operations for the development and equipping of two replacement wells at Clarke Road #4 and #5, Penal. CEC No. 1564/2006. (EIA required = No)

Pending Certificates of Environmental Clearance (CECs)

British Gas Trinidad and Tobago Ltd. (BGTT). 2006. To conduct drilling operations, on three development wells on the existing surface location of Carapal Ridge 1, in the Central Block, Catshill Road, Moruga. CEC No. 1430/2006. (EIA required = Subject to further information)

British Gas Trinidad and Tobago Ltd. (BGTT). 2006. To conduct drilling operations by re-entering the existing Saunders-1, re-drill and perform formation evaluation work in the reservoir section of the well at Central Block, Catshill Road, Moruga. CEC No. 1606/2006. (EIA required = Subject to further information)

British Gas Trinidad and Tobago Ltd. (BGTT). 2006. To conduct drilling operations on a maximum of two wells from the existing Baraka-1 surface at the Central Block, Catshill, Moruga. CEC No. 1675/2006. (EIA required = Subject to further information)

Jasmin Oil and Gas Ltd.. 2006. To conduct drilling operations and related activities in the Southern Erin Farmout Block, Erin. CEC No. 1720/2006. (EIA required = Subject to further information)

Krishna Persad and Associates Ltd.. 2007. To conduct drilling operations on a side track well, BK10, at No. 7, KPA Trace, G.P. Road, Barrackpore. CEC No. 1905/2007. (EIA required = Subject to further information)

Lease Operators Ltd; Oilbelt Services Ltd.. 2003. To conduct drilling operations related to the modification of CEC 0019/2001 through the addition of six wells to each field at Palo Seco. CEC No. 0623/2003. (EIA required = Subject to further information)

Lease Operators Ltd; Oilbelt Services Ltd.. 2006. To modify CEC 0411/2003 to conduct drilling operations on fifteen additional wells in the Grand Ravine oilfields. CEC No. 1342/2006. (EIA required = Subject to further information)

Lease Operators Ltd; Oilbelt Services Ltd.. 2006. To make modifications of CEC 0623/2003, to conduct drilling operations for thirty additional wells in the Palo Seco oilfields, PS-1, WD-5 and WD-6. CEC No. 1343/2006. (EIA required = Subject to further information)

Optimal Services Ltd.. 2006. To conduct re-drilling operations on six crude oil wells at Block WD4, Grande Ravine, Palo Seco. CEC No. 1357/2006. (EIA required = Subject to further information)

Optimal Services Ltd.. 2006. To conduct drilling operations and establish a storage facility for liquid petroleum and natural gas; To install pipelines from the well locations to the production facility at Block WD4, Grande Ravine, Palo Seco. CEC No. 1497/2006. (EIA required = Subject to further information)

Petro-Canada Trinidad and Tobago Ltd.. 2006. To conduct offshore drill site surveys at Block 1a, Gulf of Paria, west coast, Trinidad. CEC No. 1617/2006. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2004. To conduct drilling operations on oil wells in Parrylands and Forest Reserve Areas, south Trinidad. CEC No. 0682/2004. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To complete the decommissioning of one oil well site (FZ 94) at Hickling Village, Siparia Road, Fyzabad. CEC No. 1378/2006. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To complete the decommissioning of eleven oil wells: AMC1, AMC5, AMC7, AMC8, AMC9, AMC11, AMC12, AMC13, AMC14, AS11 and AS12) for the prevention of the release of hydrogen sulphide emission at Merrimac Estate, Vessigny Village, Vessigny. CEC No. 1623/2006. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2006. To complete decommissioning of one oil well site (AA1) at Balata East Field for the prevention of oil leaks and gas emissions in the district of Basil Trace and Bristol Village, Mayaro. CEC No. 1628/2006. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2007. To conduct activities related to the abandonment of five free standing land wells and nine free standing marine

wells at Sunset Beach, Point Fortin. CEC No. 1787/2007. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2007. To complete the site decommissioning of two oil wells, (7Z787 AND 7Z809) located opposite Omaree Park, Fyzabad. CEC No. 1951/2007. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2007. To complete site decommissioning of one well (7Z903) at Seeram Junction, Delhi Road, Fyzabad. CEC No. 1992/2007. (EIA required = Subject to further information)

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2007. To complete decommissioning of one oil well (FR9) located at the Bernstein Tank Farm, Forest Reserve, Fyzabad. CEC No. 1997/2007. (EIA required = Subject to further information)

Primera Oil & Gas Ltd.. 2007. To conduct drilling operations for twenty wells at Palo Seco. CEC No. 1996/2007. (EIA required = Subject to further information)

T. N. Ramnauth & Company Ltd.; Global HSE Company Ltd. 2004. To conduct drilling operations on twenty-one wells in Block WD 7-m for the replacement of existing well bores at Forest Reserve Field, Fyzabad. CEC No. 0720/2004. (EIA required = Subject to further information)

T. N. Ramnauth & Company Ltd.; Global HSE Company Ltd. 2004. To conduct drilling operations in order to side track eight wells for the replacement of existing well bores at the Forest Reserve Field, Fyzabad. CEC No. 0814/2004. (EIA required = Subject to further information)

Territorial Services Ltd.. 2006. To conduct drilling operations, namely re-drill five existing well bores owned by the Petroleum Company of Trinidad and Tobago at Forest Reserve, Fyzabad. CEC No. 1711/2006. (EIA required = Subject to further information)

Venture Production (Trinidad) Ltd.. 2004. To conduct drilling operations on thirty wells at Block WD 13 and 14 at Forest Reserve, Fyzabad. CEC No. 0738/2004. (EIA required = Subject to further information)

Venture Production (Trinidad) Ltd.. 2004. To conduct offshore drilling operations on ten wells at the Point Ligoure Marine Field in the Gulf of Paria. CEC No. 0739/2004. (EIA required = Subject to further information)

Venture Production (Trinidad) Ltd.. 2007. To conduct drilling operations on twenty wells: three exploration and seventeen development at Tabaquite. CEC No. 1929/2007. (EIA required = Subject to further information)

Environmental Impact Assessments

BHP Billiton (Trinidad-2c) Ltd. 2006. To conduct drilling operations on two gas development wells in the Aripo reservoir off the Well Protection Platform (WPP); the modification of the Central Processing Platform (CPP) to handle gas sales and the construction of an eighty-five kilometer (85km. CEC No. 1361/2006.

EIA not completed at the time of data collection

British Gas Trinidad and Tobago Ltd. (BGTT). 2004. To conduct drilling operations for the completion of three exploration wells, the Corosan, Cone 1, Cone 2 and the Baraka at the Central Block (Catshill, Moruga, Rio Claro and Tableland), Trinidad. CEC No. 0811/2004.

This report contains monitoring data for the three drilling sites, a review of ground water hydrogeology, remote sensing analysis of predominant vegetation types, identification of known archaeological sites within the project area and an assessment of the social impacts of the drilling on communities located near the proposed sites.

British Gas Trinidad and Tobago Ltd. (BGTT). 2006. To conduct drilling operations, on two development wells (Carapal Ridge #2 (CR2) and Carapal Ridge #3 (CR3)) in the Central Block, Catshill, Moruga. CEC No. 1330/2006.

This report contains monitoring data for the three drilling sites, a review of ground water hydrogeology, remote sensing analysis of predominant vegetation types, identification of known archaeological sites within the project area and an assessment of the social impacts of the drilling on communities located near the proposed sites.

Damus Oil Ltd.. 2002. To conduct drilling operations on three oil wells from Block-1, San Francique. CEC No. 0207/2002.

EIA not completed at the time of data collection

Damus Oil Ltd.. 2004. To conduct drilling operations for the completion of twenty-nine wells at Coora Blocks 1 and 2 at Santa Flora, south central Trinidad. CEC No. 0718/2004.

EIA not available at time of data collection

East Coast Drilling and Workover Services Ltd. 2002. To conduct drilling operations on one oil well at Palo Seco. CEC No. 0136/2002.

EIA not available at time of data collection

East Coast Drilling and Workover Services Limited. ? Final Report – Environmental Impact Assessment for the Offset Well and Replacement Wells at PS-3, Palo Seco, Trinidad. Prepared by Institute of Marine Affairs.

This EIA described the waste stream generated by the different operational phases and the physical baseline for the Block PS-3 area. It also includes a summary of the public consultation process and includes an assessment of the impacts of the project activities at Block PS-3 as they relate to the drilling programme, routine operations, accidental condition and cumulative impacts. Some short term impacts include emission of gases from combustion engines

Lease Operators Limited. 2002. Environmental Impact Assessment for Drilling, Workover and production operations Block PS-1, WD-1, WD-5 and WD-6, Palo Seco. Submitted by Environmental Resources Limited. EMA Ref. CEC 0019/2001 March 2002.

The purpose of the EIS is to assess the environmental impacts of Lease Operators Limited proposal to replace 11 existing wells by drilling new wells in an effort to achieve a sustained production output of approximately 700 barrels of oil per day. Chapter 4 of this report summarises the baseline characteristics of the features and resources of the natural environment and developmental setting of the project. It includes information on the history of the oil industry in this area as well as a description of its archaeological resources. The analysis of environmental impacts, hazards and risks summarises the impacts in terms of physical, biological and socioeconomic components in a tabular form which rank the impacts magnitude and probability.

Lease Operators Ltd; Oilbelt Services Ltd.. 2003. To conduct drilling operations for the exploration for crude oil and natural gas. To expand and maintain the current facilities/wells at Grande Ravine Oilfields, St. Patrick County, southwest Trinidad. CEC No. 0411/2003. (EIA required = Yes)

This EIA was conducted to assess the impacts of drilling 10 replacement wells within Block WD-3 at established well sites. This report summarises the environmental impacts to the physical, biological and socio-economic environment in Tables and summarises possible mechanisms by which these could be minimised.

Lennox Production Services Ltd.. 2004. To conduct drilling operations on fourteen wells in Block WD-2, Rancho Quemado, Palo Seco. CEC No. 0916/2004.

This report summarises the regulatory issues as well as the land cover and substratum characteristics and also includes environmental impact and mitigatory strategies.

Moonsie Oil Company Ltd.. 2002. To conduct drilling operations on three oil well at Palo Seco, Block PS-4. CEC No. 0191/2002. (EIA required = Yes). Prepared by Environmental Resources Limited, San Fernando

Moonsie Oil Company Ltd proposed to drill 12 replacement wells within Block PS-4, which covers an area of 908 acres within an oil producing field, at established well-sites. This report describes elevated levels air pollutants in the immediate vicinity of installations but indicates that the overall extent of the environmental impact on the ambient air quality of the wider Block area not to be significant, therefore, the people of the nearby villages were not at risk. Noise pollution was also not to be significant overall within impacts only occurring during particular phases of the operation. Minimal impacts were expected on vegetation and forest type since this area has been under oil mining for over 50 years. Noise from drilling activities were noted to have possible impacts on sensitive forest species in the immediate vicinity however, pumping activities were noted not to exclude the presence of avifauna species. Possible impacts on other biota were also noted.

Neal & Massy Energy Resources Ltd.. 2003. To conduct a three (3-D) dimensional seismic survey to ascertain sub-surface conditions prior to drilling. To establish ten developmental onshore oil wells, one exploratory well and the associated infrastructure for the conduct, storage and fiscalisation o. CEC No. 0380/2003.

EIA not available at time of data collection

Neal & Massy Energy Resources Ltd.. 2003. Environmental Impact Assessment Report for the Moruga West Oil Field. Prepared by EPAS Consultants Ltd., St. Augustine.

This report provides an overview of the project description as well as a description of the existing biophysical and human environments for the study area. It identifies likely impacts (positive and negative) on the environment. These potential impacts are considered for all operations occurring on site that may affect the surrounding community. This document also

identifies recommendations and mitigatory measures to minimise the identified negative impacts and maximise positive impacts.

New Horizon Exploration Trinidad and Tobago Unlimited. 2006. To conduct drilling operations by using stream injection on approximately sixty wells at Parrylands, Point Fortin. CEC No. 1444/2006.

This environmental impact assessment describes plans to drill 60 injection wells from existing production pad sites in Parrylands.

Optimal Services Ltd.. 2003. To conduct drilling operations for the sidetracking of six crude oil wells at Palo Seco. CEC No. 0550/2003.

EIA not available at time of data collection

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2002. To conduct drilling operations for sixty new wells within an existing oil production area at Forest Reserve Area. CEC No. 0197/2002. Prepared by the Health, Safety, Environment and Quality Department, Petroleum Company of Trinidad and Tobago Limited. June 25 2002.

This document serves to support the EIA requested from Petrotrin by EMA. The report identifies some of the aspects and impacts of a drilling program in Forest Reserve area and classifies them according to noise, effluent discharge, air emissions and soil impaction. The report indicated that within the Forest Reserve area, there are no sensitive fauna that will be impacted by drilling, that there will be no drilling waste effluent discharged from the rig site (Storm water runoff will be contained, monitored and treated prior to disposal), that combustion of diesel engines from rigs, mud pumps, generators and trucks will have negligible effects on air quality and is within safe limits for the rig crew and that soil will meet EMA standards.

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2004. Environmental Impact Assessment - Drilling of 39 oil wells in the Point Fortin, Guapo and Fyzabad oil fields. PETROTRIN, Pointe-a-Pierre.

This report summarises the physical, biological and socio-economic environment of the areas in question as well as the impacting activities of the drilling and establishment of the oil wells and the mitigating management plan which would attempt to minimise the environmental impacts.

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2002. Environmental Impact Assessment for the Drilling of thirty-two wells in Parrylands. Version 2. PETROTRIN, Pointe-a-Pierre.

This report summarises the physical, biological and socio-economic environment of the areas in question as well as the impacting activities of the drilling and establishment of the oil wells and the mitigating management plan which would attempt to minimise the environmental impacts.

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2003. Environmental Impact Assessment for the Drilling of sixty wells in Forest Reserve. PETROTRIN, Pointe-a-Pierre.

This report summarises the physical, biological and socio-economic environment of the areas in question as well as the impacting activities of the drilling and establishment of the oil wells and the mitigating management plan which would attempt to minimise the environmental impacts.

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2004. To conduct drilling operations on thirty-nine wells at Guapo, Point Fortin and Fyzabad. CEC No. 0699/2004.

EIA not available at time of data collection

Petroleum Company of Trinidad and Tobago (PETROTRIN). 2005. To conduct drilling operations on thirty-seven wells at Penal, Wilson and Barrackpore. CEC No. 1125/2005.

This report summarises the physical, biological and socio-economic environment of the areas in question as well as the impacting activities of the drilling and establishment of the oil wells and the mitigating management plan which would attempt to minimise the environmental impacts.

Primera Oil & Gas Ltd.. 2003. To conduct drilling operationf related to the exploration for crude oil and natural gas at Fyzabad and San Francique. CEC No. 0429/2003.

This report summarises the regulatory issues as well as the land cover and substratum characteristics and also includes environmental impact and mitigatory strategies.

Primera Oil & Gas Ltd.. 2005. To conduct drilling operations on five replacement oil wells in the Barrackpore and Sunty Fields, south Trinidad. CEC No. 1061/2005.

EIA not available at time of data collection

Primera Oil & Gas Ltd.. 2006. To conduct drilling operations at the Constance Estate, Icacos Block, Icacos. CEC No. 1364/2006.

EIA not completed at time of data collection

Rocky Point Ltd.. 2002. To conduct drilling operation of five replacement wells at Block WD 15, Palo Seco. CEC No. 0208/2002.

EIA not completed at time of data collection

Rocky Point Trinidad and Tobago Ltd.. 2005. To conduct exploration activities for crude oil and natural gas in Block WD-15, Los Charros Road, Palo Seco, St. Patrick county. CEC No. 1038/2005.

EIA not completed at time of data collection

T. N. Ramnauth & Company Ltd.. 2003. To conduct drilling operations on two replacement oil wells in Block WD-7m at Forest Reserve Field, Fyzabad. CEC No. 0482/2003. (EIA required = Yes)

EIA not completed at time of data collection

Trincan Oil Limited. 2002. Environmental Impact Assessment for proposed exploration drilling and the expansion, modification and maintenance of existing production wells at the Morne Diablo Farmout Block at Quinam-Morne Diable Oil field of Siparia, South Trinidad. Prepared by Environmental Resources Limited.

The Morne Diable area has been an operational hydrocarbon production field since 1937. The EIA is for the establishments of 300 shallow exploratory wells (to 150m) and 20 wells (to 2000 m) within an area of 12.3ha. The environmental impacts, hazards and risks include impact screening and scoping tables for physical, biological and socio-economic components. The results of possible impacts to air quality indicate that the nearby village (Mendez Village) will not be impacted. This report indicates a moderate to high disturbance in the study area with respect to impacts to forest cover and vegetation. Further details on the impacts of processing, operations and maintenance hazards are discussed at length.

Trinidad Exploration and Development Company Ltd. 2002. To conduct exploration activities, for crude oil and natural gas, in the south western peninsula, Cedros. CEC No. 0169/2002.

EIA not available at time of data collection

Trinidad Exploration and Development Company Ltd. 2002. To conduct exploration activities, for crude oil and natural gas, in the south western peninsula, Cedros. Prepared by Oil Mop Environmental Services Ltd., San Fernando.

This environmental impact assessment includes a description of the existing physical environment, fauna and flora and the socioeconomic status of the area, drilling operations, potential impacts and associated mitigatory measures.

Venture Production (Trinidad) Ltd.. 2005. To conduct drilling operations in the Tabaquite Field, Tabaquite. CEC No. 1260/2005.

This report summarises the regulatory issues as well as the land cover and substratum characteristics and also includes environmental impact and mitigatory strategies.

Well Services Energy Ltd. (WSEL); Los Bajos Oil Ltd.. 2003. To conduct drilling operations for the exploration for crude oil and natural gas. To expand and maintain the current facilities/wells in South Quarry Farmout Block, at Siparia and Santa Flora in the St. Patrick county. CEC No. 0412/2003.

This report summarises the characteristics of the land surface and substratum in Santa Flora as well as the land cover qualities and habitat in an attempt to understand the environmental impacts of these proposed activities. It also suggest mitigating measures that will be used to reduce environmental impacts.

Magazines

The National Gas Company of Trinidad and Tobago (NGC). 2004. Partnering with Nature and Communities. GASCO News. Volume 17, No. 2 (October 2004), pp. 15-16.

This article described NGC's commitment towards reducing environmental impacts in their developmental projects. It describes the measures being taken to reduce environmental impacts in the construction of the Cross Island Pipeline Project (CIPP) as well as in two other major infrastructural projects namely, Beachfield Upstream Development (BUD) project, Union Industrial Estate (UIE) Development Project.

The National Gas Company of Trinidad and Tobago (NGC). 2005. Partnering with Nature and Communities. GASCO News. Volume 17, No. 4 (March 2005), pp. 8-9.

This article describes the history of the Morne L'Enfer area in La Brea and NGC attempts to reforest the damaged areas of the forest. It also describes the results of a socio-economic survey done in the La Brea communities and summarises the results derived.

The National Gas Company of Trinidad and Tobago (NGC). 1993. The Safety Management Process. GASCO News. Volume 6, No. 2 (October 1993), pp. 10-12.

The vision of an accident free workplace is consistent with total quality performance and the continuous improvement process. However, such superior performance is developed and sustained only in a culture which supports the behaviour of people as they deal with opportunities and risks that challenge performance on a daily basis.

Given that behaviours are manifestations of attitudes, values, perceptions and beliefs and that these tend to be self sustaining, there needs to be a sound strategy to manage the organisational safety culture. This article discusses an approach to the initiating of the safety process in the context of continuous improvement.

The supporting management systems and assignment of accountabilities to support the cultural shift are also discussed.

The National Gas Company of Trinidad and Tobago (NGC). 1998. The Safety Management Process. GASCO News. Volume 11, No. 1 (January 1993), pp. 13-16.

This article describes the phenomenon of global warming with a focus on greenhouse gases and their quantities emitted from gasoline and CNG. It describes the greater efficiency of CNG and its environmental favourability in terms to reduced greenhouse gas emission and it makes recommendations for the public to convert their vehicles to CNG engines in the interest of environmental sustainability.

The National Gas Company of Trinidad and Tobago (NGC). 1998. Leveraging Continual Improvement in the Environment and Safety Process. GASCO News. Volume 12, No. 3 (October 1998), pp. 10-15.

Excellence in performance is a function of the commitment to Environment and Safety – a value mutually reinforcing efficiency in the corporate mainstream. Environment and Safety issues inform the organising principle and logic must be merged with business processes.

The strategies to facilitate continual improvement usually involve a mix of interventions in the management and/or work systems components. These interventions can be broadly categorised as improvements of the mean, reduction of variation and stabilisation.

This paper presents an approach to leveraging the Environment and Safety improvement process by actively engaging the critical success factors, that is, areas of latent failures in the Environment and Safety Management system. The five areas of focus critical to success are:

Job Design

Capacity (Competence)

Resource Allocation

Organisational Climate

Coaching

These critical success factors are used in the application of the interventions and drive the management system. They are therefore applicable in the proactive mode, for example, defining, benchmarking and testing changes in process inputs, and in "fix-as-fail" situations such as in incident investigation and remedy- informed by root cause analysis. These are illustrated by instruments used in interventions and analyses.

Sustained commitment is necessary for success and the effort is facilitated by cross-functional Environment and Safety Management committee.

Moreover, this beyond-compliance approach demands that the organisations be positioned as a learning organisation through the involvement of the line and staff functions.

Leading indicators and online measurement to anticipate future performance, signal opportunities and validate the process are discussed.

The National Gas Company of Trinidad and Tobago (NGC). 1991. We're leading the way to cleaner air! GASCO News, Volume 3, No. 2 (July 1991), pp.3.

This short article described NGC intension to convert all their vehicles to CNG as part of their contribution towards protecting the environment.

The National Gas Company of Trinidad and Tobago (NGC). 2000. The Environmental and Safety Considerations of Project 2000. GASCO News, Volume 13, No. 1 (January 2000), pp.10-12.

This article described the safety measures and activities which ensure the safety of the employers, employees, public and the environment during the construction of their pipeline.

The National Gas Company of Trinidad and Tobago (NGC). 2002. Environment and Safety Policy at NGC. GASCO News, Volume 15, No. 3 (December 2002), pp.2-4.

This article described NGC new policies, vision and strategies towards achieving higher environmental and safety performance.

The National Gas Company of Trinidad and Tobago (NGC). 2006. Reforestation drive at Morne L'Enfer. GASCO News, Volume 18, No. 4 (July 2006), pp.10.

This article describes the tree-planting exercise undertaken by NGC to reforest areas affected by the CIP and BUD projects.

Petroleum Company of Trinidad and Tobago Ltd. (PETROTRIN), 2005. Keeping the environment clean in LNE. Petroconnect Bulletin No. 3 (May 2005)

This article describes Petrotrins' commitment towards Health, Safety and Environment and its move towards bioremediation of contaminated or oil-impacted sites.

Petroleum Company of Trinidad and Tobago Ltd. (PETROTRIN), 2005. Bioremediation update. Petroconnect Bulletin No. 6 (July 2005)

This article describes the progress of Petrotrin's bioremediation exercises which are described as being 75% complete.

Petroleum Company of Trinidad and Tobago Ltd. (PETROTRIN), 2005. Remediating Los Bajos Tank Farm. Petroconnect Bulletin No. 2 (April 2005)

This article describes the activities undertaken by the company towards remediating the tanks in the Los Bajos Farms so that they can be environmentally compliant.

Petroleum Company of Trinidad and Tobago Ltd. (PETROTRIN), 2005. Petromission. November 2000.

This booklet contains articles discussing Petrotrin's activities towards maintaining a clean environment.

Newspaper articles

- Port of Spain Gazette. 1908. Cultivation at La Brea. 8.11.1908.
- Port of Spain Gazette. 1908. The new Trinidad Lake Asphalt Company Limited. 26.11.1908.
- Port of Spain Gazette. 1908. Canadian relations with Trinidad. 30.12.1908.
- Guardian. 1929. Dome oilwell tragedy. 19.05.1929.
- Guardian. 1929. Fyzabad Dome Oilwell Fire. A night of horror. Grim Details retold. 22.01.1929.
- Guardian. 1977. 4 workers burnt on Amoco Platform. 11.06.1977.
- Guardian. 1979. 6 injured workers awarded \$42,000. 22.06.1979.
- Express. 1979. Blowout on Amoco ship. 23.01.1979.
- Guardian. 1979. 2 workers injured at Texaco berth. 26.06.1979.
- Express. 1979. Small fire at Texaco. 28.4.1979.
- Guardian. 1979. Two die in mishap off Point Galeota. 3.12.1979.
- Express. 1979. Bomb found at Tringen fuel line. 8.12.1979.
- Express. 1981. Two die in Texaco fire. 1.02.1981.
- Guardian. 1981. Worker dies in Texaco toxic gas incident. 14.02.1981.
- Guardian. 1981. Blast Ko's Trintoc. 17.01.1981.
- Guardian. 1981. Texaco electrician electrocuted. 18.2.1981.
- Express. 1981. Trintoc launches probe into blast. 20.01.1981.
- Guardian. 1981. Point Fortin refinery still on sidelines. 21.01.1981.
- Express. 1981. Fire Inquiry at Texaco. 8.1.1981.
- Guardian. 1982. Blast victims 'improving'. 10.05.1982.
- Express. 1982. Explosion! And Amoco oil drops by 20,000 barrels. 11.05.1982.
- Guardian. 1982. Fire hits Premier Oil Company. 18.8.1982.
- Express. 1982. Texaco blames rain for fire at refinery. 24.06.1982.
- Express. 1982. ISCOTT damaged by steel. 25.05.1982.
- Guardian. 1982. Texaco explains cause of fire. 26.06.1982.
- Guardian. 1982. Tanker explosion rocks Trintoc jetty. 3.2.1982.
- Guardian. 1982. Texaco to pay for fire at Guaracara. 5.5.1982.
- Express. 1983. 3 killed in tanker explosion. 12.08.1983.
- Guardian. 1983. Pipeline accident causes 27-hour Cassia shutdown. 24.06.1983.
- Express. 1983. Call to fight oil pollution with more \$. 26.11.1983.
- Guardian. 1984. Texaco employee killed in accident. 16.02.1984.
- Guardian. 1984. Panday calls for ISCOTT blast probe. 19.01.1984.
- Express. 1984. Worker plunges to death. 19.07.1984.
- Guardian. 1985. Benefits for the widows. 01.11.1985.
- Guardian. 1985. Faulty hose connection caused fire says NP. 17.06.1985.
- Guardian. 1985. Death at Amoco. 19.11.1985.
- Express. 1985. Ammonia Kos T&TEC workers. 27.04.1985.
- Express. 1986. Where's that report on Trintoc 14?. 1.5.1986.
- Guardian. 1986. Report on harbour tragedy at P-a-P handed to Ramnath. 12.01.1986.
- Guardian. 1986. Blow-out on Amoco platform. 12.10.1986.

Express. 1986. Man suffers burns in gas station fire. 14.02.1986.
Express. 1986. Oil sump explodes. 19.04.1986.
Guardian. 1986. Worker hurt in fall at refinery. 20.08.1986.
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