PLEASE RETURN TO
SE NTRE
IOL-050
RC - 55

IOL pub-6-151

A Preliminary Inventory of Greenhouse Gas Emissions

Esso Resources Canada Ltd.

Volume 2

May 1991

By: L F Mannix

TABLE OF CONTENTS

VOLUME 1

PREAMBLE 1
EXECUTIVE SUMMARY 2
TABLE OF CONTENTS 8
LIST OF TABLES 10
LIST OF FIGURES 11
ACKNOWLEDGEMENTS 12
INTRODUCTION 13
- Background 13
- Other 14

METHODOLOGY 15
- Scope 15
- Inventory Reporting Structure 16
- Accuracy 19
- Data Gathering 19
- CO2 Equivalent Factors 20

DISCUSSION OF RESULTS 21
- Overall Results (Inventory) 21
- Results by Production Sector 23
  - General 23
  - Natural Gas Production Sector 25
  - Oil Production Sector 26
  - Heavy Oil Production Sector 27
  - Crude Bitumen Production Sector 28
  - Oil Sands Mining Sector 29
  - Coal Production Sector 29
- Results by Geographic Area 30
- Comparisons to Other Inventories 31
- Confidence Limits 32
- Reduction Opportunities and Costs 33
  - General 33
  - Overall Reduction Potential 33
  - Potential Reduction Costs 35
  - Summary of Reduction Potential and Costs 36

CONCLUSIONS AND RECOMMENDATIONS 38
GLOSSARY OF TERMS 40

TABLE OF CONTENTS (cont'd)

APPENDIX 1 41
- Results by Gas Type and Equipment Type 41
- CO_2 41
- Methane 42
- VOC 43
- NO_x 44
- N_2O 44
- CFC 44

APPENDIX 2 (Detailed Methodology) 45
- Methodology All Sectors 45
  - Combustion CO_2 45
  - Combustion CH_4 46
  - Combustion VOC 46
  - Combustion NO_x 46
  - Combustion N_2O 48
  - Surface Facility Equipment Leaks 48
  - Leaks from Surface Casing 53
  - Well Servicing 54
  - Characterization of Emissions 55
- Natural Gas Sector 58
- Oil Sector 60
- Heavy Oil Sector 62
- Crude Bitumen Sector 62
- Oil Sands Mining Sector 63
- Coal Sector 63
- Other 64
- Data Input Sheet 64

VOLUME 2

APPENDIX 3 (Summary of Site Specific Data and Assumptions)
- Introduction
- Summary Results by Division and Area .
- Site Specific Assumptions and Calculations
- Summary of Social Reduction Cost Data
- Sample Social Cost of Service Calculation

VOLUME 3

APPENDIX 4 (Detailed Area specific Data)

IOLpub-6-156

IOL-030

ENVIRONMENT

HEALTH &

SAFETY

1709c -G.1.21

MFI015504 W

Our commitment

Esso
Imperial Oil

Our progress

The ENVIRONMENT

Transferring recovered fuel vapors at Imperial's Finch Avenue distribution terminal in north Toronto.

Imperial Oil Limited is committed to environmental protection and the broader integration of environmental and economic priorities, in all aspects of its business.

IMPERIAL'S POLICY IS TO:

~ Responsibly manage all aspects of its business to ensure that recognized environmental standards and legal requirements are met.

~ Adopt company standards that go beyond legal requirements where benefits to society justify the costs.

~ Ensure that environmental hazards associated with company activities are identified, assessed and managed.

~ Manage its business with the goal of preventing accidents and design, operate and maintain facilities to this end.

~ Respond quickly and effectively to incidents resulting from its operations, cooperating with industry organizations and authorized government agencies.

~ Emphasize individual responsibility and require everyone throughout the organization to adhere to clearly-defined environmental practices and procedures.

~ Integrate environmental considerations in business planning, facilities and product design, operating practices and training programs.

~ Work with industry associations, government agencies and public groups to determine environmental priorities and foster timely development of appropriate laws and regulations, providing advice on the impacts of such measures on the environment, costs and supply.

~ Conduct and support research to improve understanding of the impact of its business on the environment, improve methods of environmental protection and enhance its capability to make operations and products compatible with the environment.

~ Communicate with employees, customers, the public and governments in a timely fashion on the environmental aspects of the company's operations and products.

~ Undertake appropriate reviews, evaluations and performance measurements of its operations to ensure compliance with this environmental policy.

Protecting

AIR

During the past 20 years, ambient air quality in Canada has improved considerably, with substantial progress made in reducing concentrations of sulphur dioxide, lead, carbon monoxide and suspended particles. This improvement has been well documented in recent government publications.

Key air quality issues, however, do remain. In 1989, the company compiled an inventory of its emissions of nitrogen oxides (NOx) and volatile organic compounds (VOCs), which are precursors of ground-level ozone. In a 1991 publication on air quality, Imperial indicated that ground-level ozone, a contributor to urban smog, was the air contaminant that needed the most attention in some Canadian urban areas.

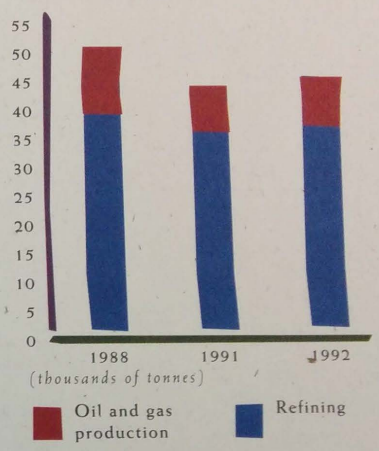
The operations of petroleum and petrochemical facilities are not considered to be the major source of NOx and VOC emissions although some uses for their products do contribute. For example, about half of these emissions in Canada have been attributed to the use of transportation fuels. Nevertheless Imperial has been taking steps to reduce its own emissions of these air contaminants, sometimes well ahead of regulation.

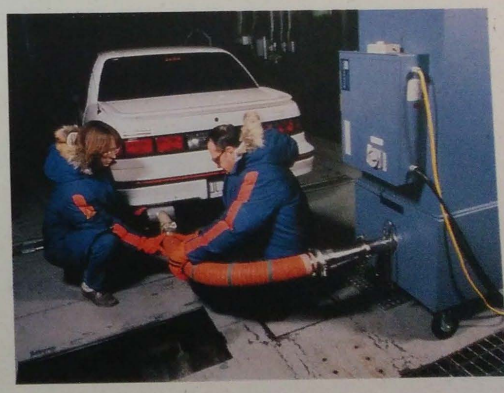
To improve air quality in areas prone to urban smog, gasoline vapor-recovery systems have been put in place at Imperial's major petroleum products distribution terminals in Vancouver, Toronto and Hamilton and at about 470 retail outlets served by them. The company has spent $9 million on these recovery systems, which capture gasoline vapors that would otherwise enter the atmosphere while fuel is being transferred. As well, the company is producing reduced-emission gasolines for the Vancouver area and southern Ontario during the summer months, when local smog levels are at their highest.

Imperial recognizes that other air quality issues — such as greenhouse gases and acid rain — are being addressed in national and international arenas. As a valuable first step in understanding how the company can best contribute, Imperial compiled an inventory of greenhouse gas emissions from its operations and has been tracking sulphur dioxide (SO_2) emissions for several years. More recently, the company and other industry participants have assisted the federal government in developing a new reporting framework, called the National Pollutant Release Inventory. Under this program, in 1994 industries will begin reporting releases of 178 substances into the environment.

Air Emissions

Sulphur dioxide (SO_2)





Laboratory technicians collect exhaust emissions for analysis at the Esso Research Centre in Sarnia, Ont.

Protecting LAND

Preventing operational incidents that result in spills of our process materials or products is one of the basic principles driving our everyday business. We are also concerned with many other aspects of responsible land management.

Across Canada, Imperial has about 2,700 nonproducing oil and gas wells and about 1,000 surplus retail sites. Taking these out of service and, where necessary, cleaning up the soil (remediating) for other uses is a continuing challenge.

In recent years, the company has remediated more than 300 petroleum marketing and retail sites at a cost of about $100 million. Also, during 1992, about 250 surplus oil and gas wells were safely shut down and capped at a cost of about $5 million.

In addition, since 1986, as part of ongoing operations, the company has either replaced or upgraded 1,500 tanks at retail outlets, refineries and other facilities, at a cost of about $100 million.

Given the significant expense of restoring or decommissioning sites, company researchers are working to develop new technologies to complete this work more cost-effectively. Two new portable site-remediation systems hold great promise.

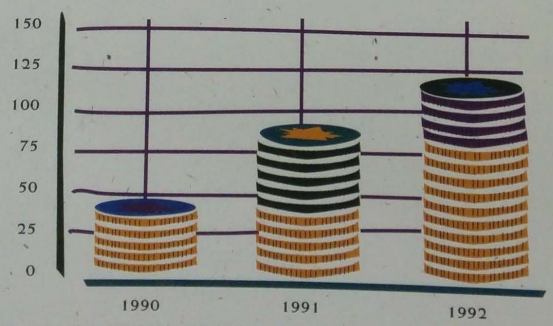
One uses catalytic conversion or heat to destroy petroleum vapors after they have been removed from the soil in a separate process called vapor extraction. Imperial participated in the development and testing of this technology.

The other system treats contaminated ground water in a process that uses hydrogen peroxide and ultraviolet light to destroy residual petroleum.

Imperial has started two soil recycling operations in the province of Quebec, that involve the digesting of petroleum by a mixture of bacteria, oxygen and nutrients.

In addition, a new soil-washing technology developed by resources, refining and research personnel has been successfully tested on industrial properties contaminated by petroleum.

Remediation of non-operating sites
Expenditures



(accumulated millions of dollars)

Protecting

WATER

Many company operations use fresh surface water from rivers and lakes in various processes, such as generating steam. Most of the water is then treated and returned to the local watershed or reused in the processes themselves. For example, at the company's heavy-oil production facility near Cold Lake, Alta. steam is injected to soften bitumen and help bring it to the surface. Treating and reusing the water recovered with the bitumen means 90 percent of it can be recycled to steam generators. This greatly reduces the amount of fresh water required.

Over the past 30 years, Imperial has installed advanced water effluent treatment facilities at numerous operations, and today the company continues to improve the quality of effluent water resulting from production, refining and other manufacturing processes by upgrading water treatment methods, by controlling contaminants at source and by improving detection and monitoring systems.

In Ontario, the quality of water effluent at the Nanticoke refinery and at the Sarnia chemical plant was rated the best in their respective industries by the provincial environment ministry in a 1992 report on industrial effluents.

During the past decade the company has spent $46 million at its operations in Sarnia to upgrade water treatment methods, sewer systems, docking facilities and underground pipelines.