CHAPTER 1
INTRODUCTION

1.1 Introduction

Non-Aqueous phase liquid (NAPL) is a term used to denote any liquid that is immiscible in water. Typically, NAPL, represent contaminated petroleum hydrocarbons in the subsurface, which is still an important problem in contaminant hydrology. NAPLs are divided into two categories, Light Non-Aqueous Phase Liquids (LNAPL) and Dense Non-Aqueous Phase Liquids (DNAPL). This categorization is based on the specific gravity, which governs some important aspects of NAPL transport in the subsurface.

-Light Non Aqueous Phase Liquid (LNAPL) :With a density lower than water when LNAPL reach the water table, they will float over water table and move laterally due to the slope of water table. They will spread over a wide area but it is reasonably easy to predict their movement in the subsurface and remove them from a contaminated site.

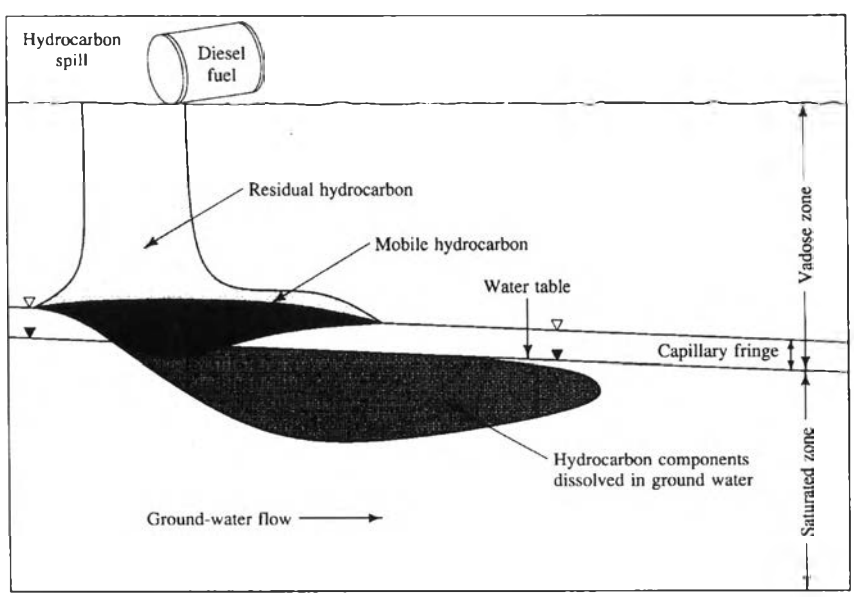

Figure 1.1: Subsurface distribution of a LNAPL spill : Fetter, C.W. (1992) Contaminant Hydrology

-Dense Non Aqueous Phase Liquid (DNAPL) : With a density higher than water, DNAPL will move vertically downward to the bottom of aquifers. In some cases, they can move downward up to 100-200 meters depending on soil properties. DNAPL may not move in the same direction of groundwater and their movement depends on subsuraface stratigraphy, which makes it very difficult to remediate a DNAPL contamination.

1.2 Objectives

Computer code U_DYSAC2 (Muraleetharan and Wei 1999a) has been developed for static and dynamic analysis of saturated and unsaturated porous media. The code uses three-phase analysis (soil, water and air) to explain the behavior of unsaturated porous media. The main objective of this thesis is to modify U_DYSAC2 computer code for applications in environmental problems by replacing the air phase with a DNAPL phase and analyze DNAPL transport patterns in the subsurface.

The main objective will be achieved by:

1. Modifying governing equations to predict transport behaviors of DNAPL through porous media.
2. Implementing these governing equations into the finite element computer code, U_DYSAC2
3. Validating the model by comparing the predictions against laboratory and centrifuge model tests on DNAPL transport through saturated soils.

1.3 Hypotheses

1. Computer code U_DYSAC2 can be used to simulate transport patterns of DNAPL with appropriate modifications.
2. Modified U_DYSAC2 will be able to simulate the observed behavior reasonably well.

1.4 Scope of the study

The U_DYSAC2 computer code will be modified to be able to simulate the DNAPL transport through the saturated soils. The air-phase and related constitutive relationships governing multiphase flow in U_DYSAC2 will be replaced with DNAPL and corresponding relationships by assuming very low water solubility fluid and isothermal conditions.

Parametric studies will be performed to evaluate the effects of soil and DNAPL physical properties on transport patterns.

The modified computer code will be validated by comparing the predictions against previous laboratory and centrifuge model tests on DNAPL transport through saturated soils.