1. INTRODUCTION

1.1. PREAMBLE

Air quality modelling has been used widely to predict ground level concentration for prescribed activities listed under Section 34A of the Environmental Quality Act, 1974 and Schedule of the Environmental Quality (Environmental Impact Assessment) Order, 1987 (Laws of Malaysia, 1999) such as municipal waste incinerators, industrial activities and mining. From the predicted ground level concentration, sensitive areas such as residential area with high ground level concentration is identified and monitored.

Monitoring of certain criteria air pollutant such as particulate matter, nitrogen dioxide and sulphur dioxide is being carried out during the post-EIA (Environmental Impact Assessment) period. This monitoring exercise is usually carried out by accredited laboratory and the cost is borne by the project proponent according to the number of pollutant parameter and its monitoring frequency which is imposed by the Department of Environment (DOE). The monitored ambient air quality result is then submitted as a report known as Environmental Monitoring Report (EMR) which usually comprises of tables, graphs, analysis and synthesis of the monitored result. This EMR is usually submitted to DOE every quarter or at an interval determined by the department.

This research would like to look into the possibility of integrating these two disparate components using a common platform. This platform shall have the capability of integrating the database management system with geo-
referenced mapping. The system is able to present the result in spatial and temporal nature with ease and efficiently. The platform which meets the above criteria is Geographical Information System (GIS).

1.2 AIM AND OBJECTIVES OF STUDY

The aim of this research is to develop an environmental monitoring tool for predicted ground level concentration and monitored ambient air quality of a particular source using a GIS software. This involves

i. the creation of graphical user interface (GUI) for the ease utilization of the application by the final user;

ii. visualization of the predicted ground level concentration result; and

iii. monitored ambient air quality with updating function of existing monitored ambient air result.

The graphical user interface will be based on user-friendly concept and the final product will be in the form of information kiosk.

In order to assess what have been mentioned in the aim of this study in using GIS for environmental monitoring tool in particular ambient air quality, the following have been set as objectives for this research:

1. To integrate ISCST3 air quality model with ArcView GIS software through loose-coupling by using Avenue scripting language.
2. To customize and manipulate ArcView to present the result of predicted air quality model spatially.

3. To customize and present the environmental monitored data temporally in ArcView environment.

1.3 GENERAL APPROACH OF THE STUDY

The approach of the study is to integrate the air quality modelling and the environmental monitoring components within a common platform i.e. GIS. The interrelationship and disparate entity of the three main components is shown in Figure 1.3.1.

There are three important elements involved in this research work. They are as follows:

1. Air Quality Modelling

2. Environmental Monitoring Report

3. Application development using Geographical Information System

This component is further elaborated in the following section.
AIR QUALITY MODELLING

GEOGRAPHICAL INFORMATION SYSTEM

ENVIRONMENTAL MONITORING REPORT

--- Separate entity

Inter relationship

FIGURE 1.3.1: INTERRELATIONSHIP OF AIR QUALITY MODELLING, GEOGRAPHICAL INFORMATION SYSTEM AND ENVIRONMENTAL MONITORING REPORT
A. Air Quality Modelling

An air quality model is a tool used to predict the concentration of a contaminant at a receptor resulting from point, area or volume exhaust sources. Air quality models use mathematical algorithms developed to simplify atmospheric dispersion and dilution phenomena. Typical model input variables include: contaminant emission rate, stack height, gas temperature, discharge velocity, flow rate, terrain topography, property dimensions and building elevations.

Ground level concentration for a particular plant in this research work is predicted by a refined air quality model known as Industrial Source Complex Short Term Version 3 (IS CST3) model which is recommended by the United States Environmental Protection Agency (USEPA) for regulatory compliance (USEPA, 1999). The ISCST3 model uses a Gaussian equation which combines source data, meteorological information, terrain, and dispersion coefficients to predict ground level concentrations of air pollutants (USEPA, 1999). Local meteorological data from the Malaysian Meteorological Department will be used to run the model to reflect the actual weather condition for both surface and upper air condition.

B. Environmental Monitoring Report

An Environmental Monitoring Report is a report summarising the result of monitored environmental criteria for treated wastewater, surface water, stack emission, ambient air quality and ambient noise. The choice and monitoring
frequency of criteria parameter to be monitored by the project proponent is usually in accordance to the existing or established regulations imposed by the Department of Environment or other regulatory authorities. Example of relevant environmental regulation is Environmental Quality (Sewage and Industrial Effluents) Regulations 1979, the proposed Interim National Water Quality Standards for Malaysia, Environmental Quality Act (Clean Air) Regulations, 1978 and recommended Air Quality Guidelines.

This research work will utilise existing monitored ambient air quality reported in the quarterly and half-yearly environmental monitoring report (EMR) of an iron and steel industry located in the Ayer Keroh Industrial Estate, Melaka. The EMR is submitted every quarterly (1998-Mid 2000) and half yearly (Mid 2000–current) to the Department of Environment since September 1998. This report is prepared by Perunding Utama Sdn Bhd, an environmental consultant for both the EIA and Post-EIA stage.

C. Geographical Information System

Geographical Information System (GIS) is a computer based tools to capture, manipulate, process and display spatial or geographically referenced data. It contains both geometry data (coordinates and topological information) and attribute data, i.e. information describing the properties of geometrical objects such as points, lines, and areas. There is a variety of GIS software available freely (i.e. GRASS) or commercially in the market (i.e. ArcView, MapInfo and Idrisi).
In this research work, ArcView 3.1 will be used to integrate the predicted ground level concentration for both EIA and post-EIA stage which will be presented in an iso-contour surrounding the gaseous emission sources. Monitored ambient air quality at certain residential receptors identified in the EIA report of the iron and steel plant will be input into the GIS system. Synthesis and analysis of the data for the predicted and monitored air quality concentration using GIS as an environmental monitoring tool will enable a better management of the surrounding environment.

1.4 STUDY AREA

The case study of this research work is an iron and steel plant located in Ayer Keroh Industrial Area, Mukim of Bukit Katil, Daerah Melaka Tengah, Melaka Bandaraya Bersejarah. Within the industrial area, there are a number of light to medium scale industries operating which include food industries, electronic, rubber products, plastic, steel products and others. Landuse surrounding the study area include residential, commercial, industrial, institutional and recreational land uses (Perunding Utama Sdn Bhd, 1996). Landuse within 3 km radius of the study area is shown in Figure 1.4.1
Source: Perunding Utama Sdn Bhd (1996)

FIGURE 1.4.1: LANDUSE SURROUNDING THE STUDY AREA
The company has been in establishment since 1993 and is involved in manufacturing various type of steel product such as cold and hot rolled steel, sheet steel, steel strip, galvanized steel coil/sheet, pre-painted steel coil/sheet, stainless steel sheet as well as steel and galvanised pipes. In 1996, the company decide to expand its existing plant to increase its production capacity. Hence, an EIA was required for the expansion and later the EMR was submitted quarterly to the Department of Environment.

1.5 ASSUMPTIONS AND LIMITATIONS

The assumptions and limitations made in this research study is as follows:

- **Knowledge of air quality modelling.** In this research work, the end-user is assumed to possess a certain degree of knowledge in air quality modelling in particular the IS CST3 model. For example, the user has the capability to perform error checking on the model output.

- **Limitation in air quality model.** The user is required to understand the limitation of Gaussian based air quality model which is the foundation of the IS CST3 model. Other limitation and assumption made for the IS CST3 is further discussed in Chapter 2 of the dissertation.

- **Non-detection limit in chemical analysis.** In chemical analysis, there is a limitation in the analytical equipment used. Therefore, chemical assume to be below detection limit may not necessarily present in the sample.
Accuracy of monitored data. The monitored data is assumed to be accurate and undisputable. Usually, the result of analysis will undergo certain laboratory quality control procedure which is governed and accredited by SIRIM. The laboratory which perform the monitoring exercise for the case study is an accredited laboratory.

Main focus. The main focus of this study is to integrate an air quality modelling software with GIS and not to validate either the ISCST3 or the GIS methodology.

1.6 THE IMPORTANCE OF THIS TOPIC

This research study is important because the application to be developed will enable the user to monitor and visualize environmental data in particular ambient air quality for the study area with ease and efficiently. With the prediction of ground level concentration, the user could justify its contribution to the surrounding environment. With this application, decision maker such as the plant management and local authority could make more informed judgement during the planning and decision making process for the study area.

1.7 ORGANISATION OF THESIS

Chapter one of this dissertation, introduces the current practise in environmental management i.e. air quality modelling and ambient air quality
monitoring practices in Malaysia. This is followed by the research aim, objectives and a brief description of the study area. The limitation and assumption made in this research was outlined and the importance of this research is also discussed in this chapter.

Chapter two provides a brief review of the three main components. In addition, it reviews the current trend of integrating air quality model and environmental monitoring with geographical information system (GIS).

The methodology of this research is described in chapter three. It involves an overall explanation about the data acquisition, pre-processing, database management, analysis and manipulation and producing the final product.

Chapter four shows the results of the Ambient Air Quality Monitoring tool (AM AQUM) developed for this study. Throughout the chapter, the system functionalities are demonstrated.

In chapter five, the findings and problems faced during the development of the application are presented.
Finally, in the last chapter, some conclusion is drawn about the findings for this research project.