CHAPTER 6

CONCLUSION AND DISCUSSION

According to the goals of this thesis, the laboratory experiments were expected to be able to determine mathematical relationship between electrical resistivity of Quaternary sediments from Mae-Hia landfill under different parameters. Also they were expecting to indicate the quantity distribution of a contaminant plume in Mae-Hia landfill by using the obtained mathematical relationship.

As reported in Chapter 5, the accomplishments of this laboratory experiment were:

- The resistivity values of the partial saturate and fully saturated sediment samples with 25%, 50%, and 100% leachate solutions. In the case of when the samples were fully saturated the resistivity values are summarized in Table 6.1 below.

Table 6.1 The resistivity values of fully saturated sediment samples.

Sediment type	0% leachate	25% leachate	50% leachate	100% leachate
Sand	579	4.8	2.45	1.2
Clayey Sand	68.7	9.92	4.23	2.36
Sandy clay	26.34	12.7	6.97	3.76
Clay	24.13	12.22	6.55	3.54

- The graph, plotting the resistivity value of saturated sample against the resistivity of the leachate solution, offered the Archie's formation factor (F) of sand, clayey sand, sandy clay and clay are equal to 2.90, 5.77, 7.850, and 7.50 and the product of cementation factor (m) and the pore geometry factors (a) (in term of -am) are 1.49, -1.63, -1.92, and -2.24.

- The plotting between the resistivity values of partially saturated sample against the certain saturation degree of the sediment, which provided a mathematic relationship that fitted with Archie's equation and the saturation exponent (n) for each soil was also derived, for sand, clayey sand, sandy clay and clay, the saturation exponent are 2.06, 2.58, 3.52, 2.46 respectively.

- Also the contaminated quantity interpretations of Mea-Hia landfill were succeeding.

These laboratory experiments were successful not only because they achieved the primary objectives, but also because they successfully controlled several variables that are typically difficult to control in the laboratory.

The resistivity experiment offered a new perspective. It was found that if the sediments contain large amounts of a conducting mineral, and if they are saturated with a highly saline pore fluid, they surprisingly tend to have a higher resistivity than a more insulating sediment like quartz sand. This phenomenon is strongest when the sediment is partial saturated.

The experiments also produced a range of electrical resistivities for each type of sediment under different leachate concentrations and for several saturation indexes. Those range of electrical resistvites offered a successful attempt to evaluate the mathematical relationship between electrical resistivity and porosity, formation resistivity factor (F), the Archie cementation factor (m), the pore geometry factor (a), and the saturation exponent (n) (see Chapter 5). These mathematical relationships and empirical parameters went beyond the results of Archie's experiment that only produced a rough empirical value for clean consolidated sandstone. These empirical values for unconsolidated sediment and clay-rich sediment can now be used for practical applications.

Using these empirical relations may now enable the estimation of the maximum and minimum resistivity of contaminated zones, and the interpretation of field data can now be much better constrained. In the case study described in Chapter 5, some quantitative predictions could be made, such as when the saturation degree of the sediment and its grain size are known, and then the degree of contamination is predictable. However, one limitation remains, to correctly interpretation an area with low salinity pore fluid still was unable.

There are many more potential application of this empirical relationship. For example, to improve the measurement of hydraulic properties in a groundwater investigation where a pumping test is not sufficiently reliable. Because the porosity, a critical parameter, can only be roughly estimated. Using the empirical relationships developed by this experiment, pore fluid can be collected from a particular layer, and knowing the resistivity of the fluid, the bulk density, and sediment type, the exactly effective porosity of the layer can be accurately estimated. In the case that the area is truly contaminated, this will be one of the most effective ways to monitoring the velocity of pollutant migration

The results of this project can also be applied to sites, where the contaminated fluid has a high salinity, such as brine. This will allow for geophysicists can monitor areas that are subject to sea-water intrusion. Further laboratory study may be able to empirically verify relationships that are more complex than the Archie's equation, enabling valid application for all pore fluids of any salinity.

In order to get more reliable measurements, an improved resistivity box could be fabricated using higher-quality materials. All of electrodes should be high quality and made of non- electrolyzing stainless steel. The box should be modified to a larger model with one more set of six electrodes, so the measurements will be able to detect the changing resistivity while the pore fluid is draining through the sample. Two or three micro-tensiometers must be attached inside the core of sample, so the resistivity value can be measured at a known degree of saturation. Lastly, a more practical draining system must be designed that is more efficient and less intrusive than a vacuum pump.

For application to real contaminated sites, the above improvements should allow more detailed mapping of the distribution of total dissolved solids. Perhaps practical software could be developed that can combine this obtained empirical resistivity function, resistivity database, a lithological database and a hydrogeochemical database, into a GIS system. This may allow detailed mapping of plumes of contaminated groundwater.