FINAL REPORT

NUMERICAL MODELING, RISK ASSESSMENT, AND SITE REMEDIATION

— A Study of Soil and Groundwater Contamination at the Hoosier Gas Plant Site

Prepared by

Energy and Environment Program
Faculty of Engineering
University of Regina

Prepared for

Mr. Russell Roy, P.Eng.
Environmental Affairs
TransGas - SaskEnergy

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EXCUTIVE SUMMARY

The Hoosier Gas Plant Site has been contaminated by benzene, toluene, ethyl-benzene, and xylenes (BTEX). Although a number of investigation projects have been undertaken, insight of site contamination, pollutant migration, biodegradation kinetics, and interactions among different phases is still unavailable. Many questions remain to be answered, such as:

(1) What happen underground?
(2) Are there specific impacts on the community?
(3) What will happen in the future if we do not take any remediation action?
(4) Which remediation technologies are suitable for the site?
(5) What clean-up efficiency is needed?
(6) When should we take actions?
(7) Where should be the focus for the actions?

Answers to the above questions will help decision-makers to get insight into the current site situation. They will then know what they have to spend for, what they don't have to; how much they really have to spend, and how much is still uncertain. These will also be very helpful when they are discussing the problems (and the relevant decisions) with the local authorities.

> *A good decision will help to reduce a big amount of costs, while a not-so-good one may mean a number of consequences to the present and the future. For a complicated system, such as the site-contamination problem under consideration, this good decision should be based on good and thorough research efforts.*

This project is to conduct a thorough study of the site to answer the above questions, according to the letter of September 19, 1997 from the Environmental Affairs, TransGas (see Appendix One). In detail, it consists of the following tasks:

- Modeling for the fate of petroleum contaminants in subsurface under various remediation scenarios,
- Environmental impact and risk assessments under various remediation scenarios,
- Recommended decisions for problem solving,
- Decision analysis for remediation actions,
- Operations analyses for monitoring networks (For Cantuar Field Site) (see Appendices Four to Six).

The results indicate that the above tasks have been successfully fulfilled.

The element of modeling for the fate of petroleum contaminants in subsurface is one of the most challenging tasks in this study. A large-scale numerical simulation model is developed for the site (Our program is the only organization in western Canada being also to conduct this type of simulation). The results are useful for:

- quantitatively answering questions related to site contamination situations under various remediation scenarios;
- predicting spatial distribution of contaminant concentrations in different time periods under each given remediation scenario;
- providing necessary inputs for further environmental impact and risk assessments.

The results of environmental impact and risk assessments are useful for:

- answering questions related to impacts and risks of the subsurface contamination under a variety of remediation scenarios;
- quantifying risks of different land use options under each given remediation scenario;
- identifying spatial distribution of risky zones and hot spots, required clean-up efficiency, and timing for remediation actions;
- providing necessary bases for decisions of remediation actions.

The task of remediation system design is undertaken based on analysis of site conditions, research of technology suitability, experimental studies for a number of remediation alternatives, as well as support of the earlier simulation and risk assessment tasks. The research outputs contain:

- recommendation for several remediation technologies that are feasible and applicable to the site;
- provision of detailed designs for the recommended remediation techniques;

This report consists of six parts. Part 1 is an introduction of the project and the study site. Part 2 details the methdology of numerical simulation for the fate of petroleum contaminants in subsurface. Part 3 illustrates formulation of the developed numerical model for the Hoosier Gas Plant Site, as well as modeling results for predicting concentrations of benzene, toluene, ethyl-benzene, and xylenes in different temporal and spatial units under various remediation scenarios. Part 4 is to assess environmental risks of the subsurface contamination at the site, given different land use options, remediation scenarios, and evaluation criteria. Part 5 presents the results of remediation system design, where technologies that are feasible and applicable to the site are recommended, with the detailed designs provided. Part 6 is devoted to the summary of this project, which is followed by appendices.

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APPENDICES

Appendix One: Letter of September 19, 1997 from the Environmental Affairs, TransGas (RE: Faculty of Engineering Research Proposal)

Appendix Two: Progress Report (Submitted on December 10, 1997)

Appendix Three: Letter to Russell Roy on December 16, 1998 (RE: Submission of Four Interim Reports)

Appendix Four: Design of a Monitoring Network for Detecting Underground Contamination — A Study for the Cantuar Field Site (SW 30-16-16 W3M)

Appendix Five: Design of the Phase III Monitoring Program for the Cantuar Field Site (SW 30-16-16 W3M)

Appendix Six: Design for the Phase IV monitoring wells at the Cantuar Field Site (SW 30-16-16 W3M)