

Preliminary Biodegradation Correlation for Bioventing

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INTRODUCTION

- Soil contamination with total petroleum hydrocarbons (TPH) is a problem



<http://apps.colliergov.net/pud/d/pollcntrl/images/TDI09.10.02B.JPG>

SOURCES of CONTAMINATION



<http://www.brinkenv.com/gsa/asfills.jpg>

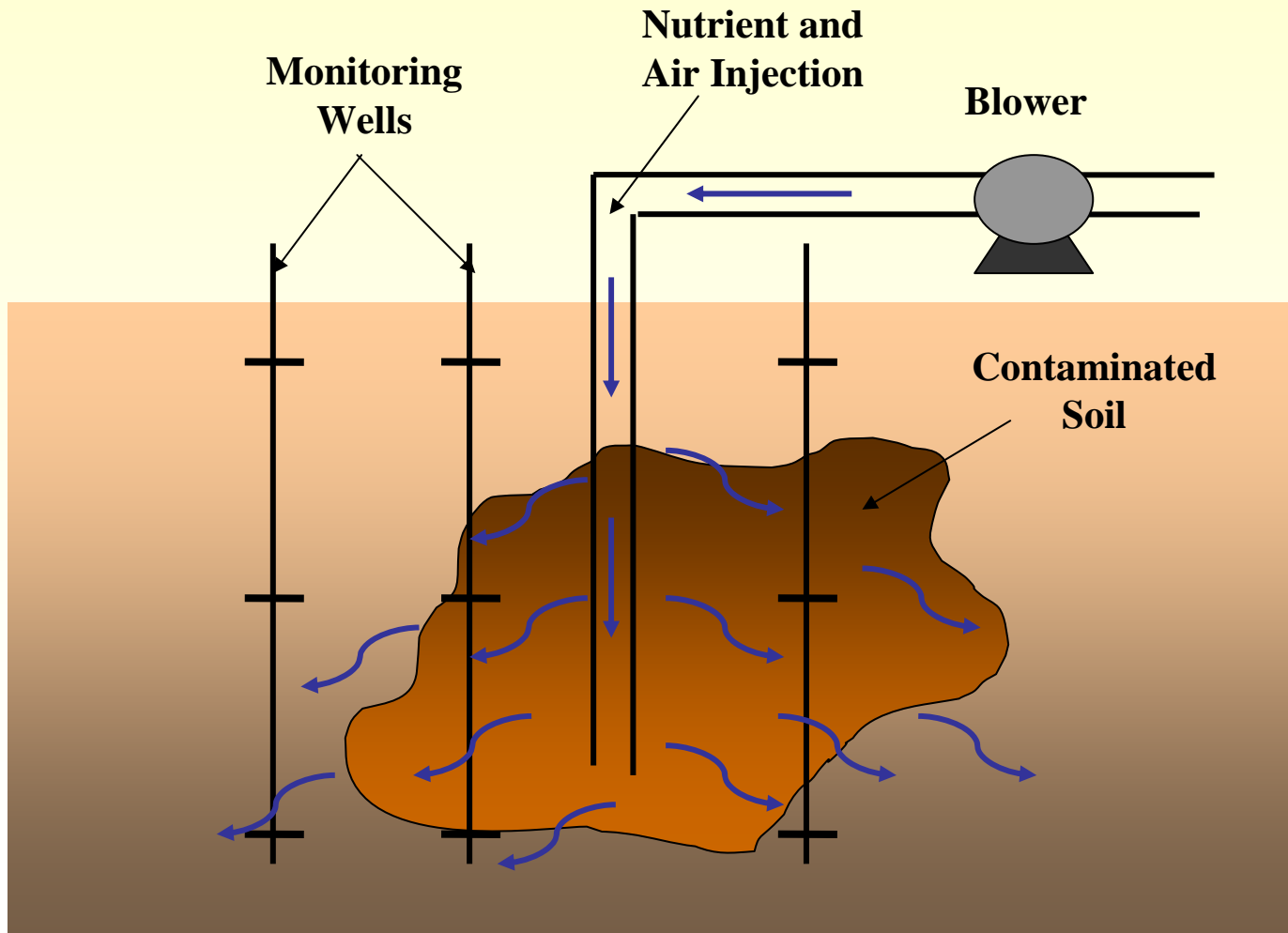


<http://www.epa.gov/reg5rcra/wptdiv/r5lust/Leaking%20Tank.jpg>

BIOREMEDIATION

- Effective technique for cleaning petroleum contaminated soil
 - ✓ Natural attenuation
 - ✓ Phytoremediation
 - ✓ Landfarming
 - ✓ Biopiles
 - ✓ Bioaugmentation
 - ✓ Bioventing

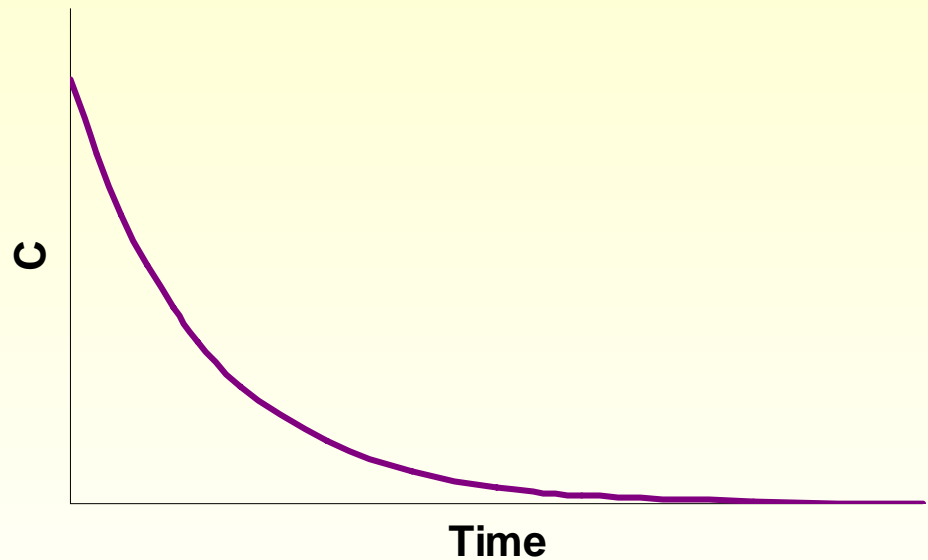
BIOVENTING



BIODEGRADATION KINETICS

$$-\frac{dC}{dt} = k \cdot C$$

$$\ln\left(\frac{C}{C_o}\right) = -k \cdot t$$



C: TPH concentration

C_o : initial concentration of TPH

t : time

k: degradation rate constant

FACTORS AFFECTING BIOVENTING

✓ Environmental condition

Controllable

✓ Soil properties

✓ Contaminant characteristics

Non-controllable

BENEFITS OF A MODEL

- Biodegradation kinetics are required for prediction purposes
- Field experiments are time consuming and expensive
- Biodegradation rate kinetics are not transferable from one site to another

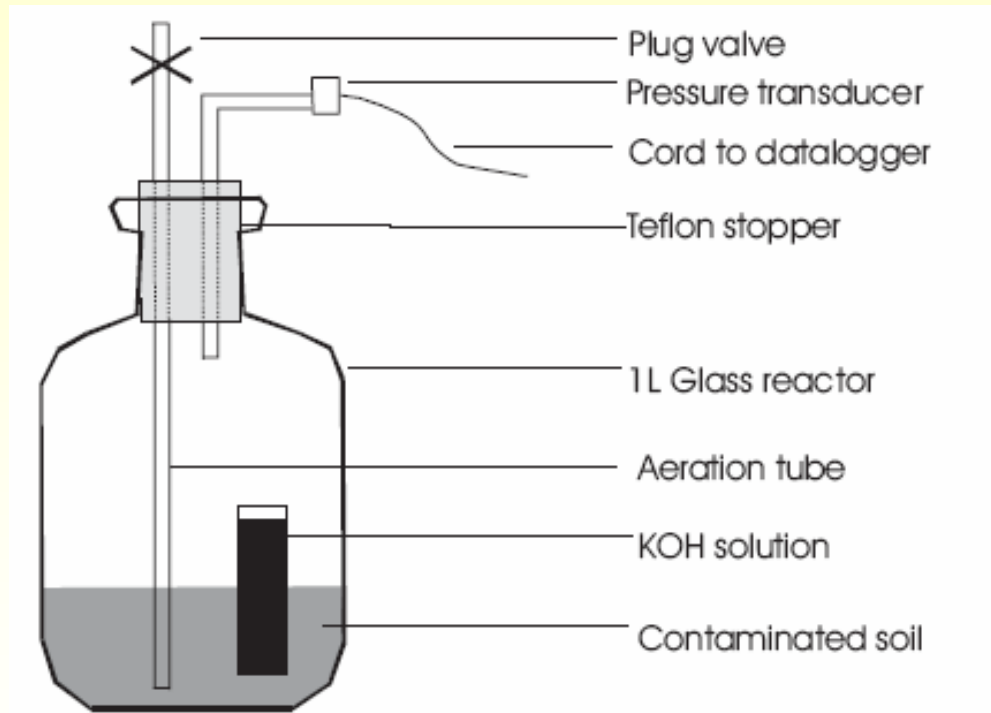
OBJECTIVES

- Identifying the factors affecting biodegradation rate, including
 - ✓ soil properties
 - ✓ Contaminant concentration
- Correlating these factors with biodegradation rate constant

METHODOLOGY OVERVIEW

- Simulate field conditions
- Use a respirometer
- Test variety of soils
- Synthetic gasoline
- Optimal environmental conditions
- Develop a model

RESPIROMETER



SOIL PROPERTIES

Soil Characteristics	Delhi	Elora	Brookston	Simcoe	Soil B
% Sand	86.5	34	21	61.9	25.9
% Silt	9	50	35.1	30.2	14.1
%Clay	4.5	15.9	43.9	7.9	60
%Organic Matter	1.2	3.1	1.5	1.5	2.1
CEC (cmol/kg)	8.27	18.9	28.5	5.5	16.2

EXPERIMENTAL CONDITIONS

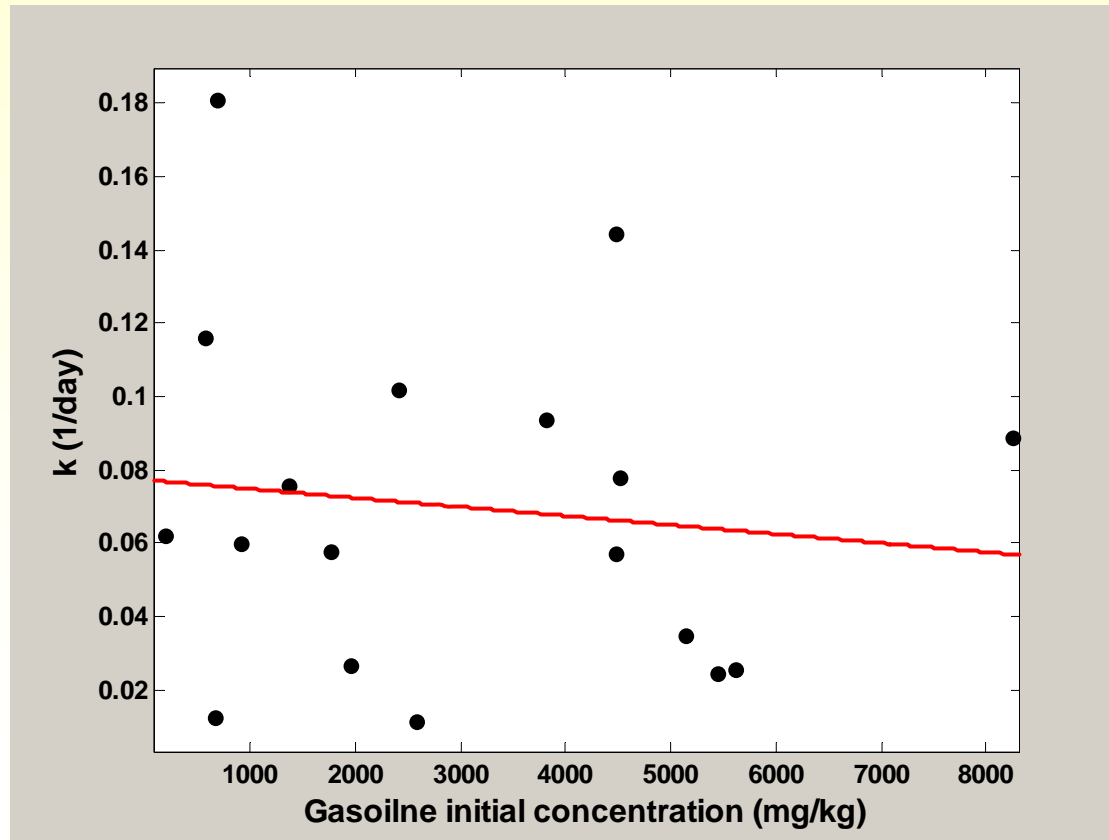
Contaminant type	Synthetic gasoline
Initial concentration	200-8000 (mg/kg dry soil)
Nitrogen source	NH ₄ Cl
C:N ratio	10:1
Water content	18% (wt)
Temperature	25°C

DEGRADATION OF TPH

- Measured in three ways:
 - ✓ TPH consumption (TPH extraction followed by gas chromatography (GC-FID))
 - ✓ Oxygen consumption (measuring the pressure reduction in the system)
 - ✓ CO₂ production (trapped in KOH solution followed by titration by 0.1N HCl)

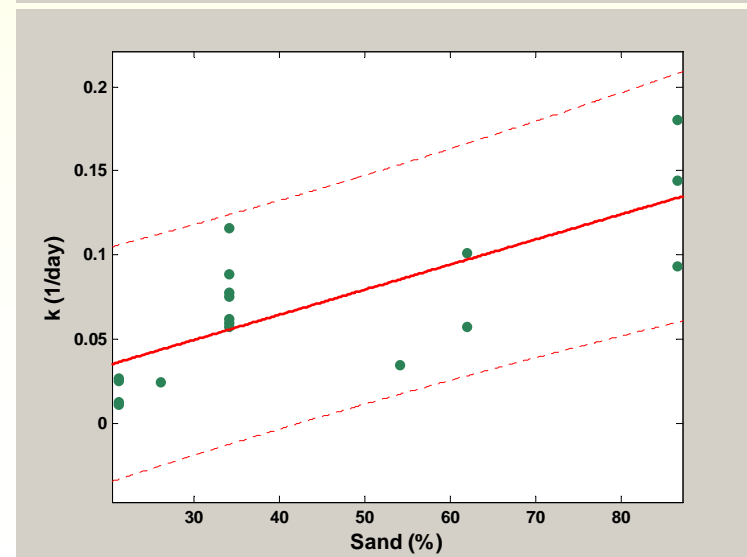
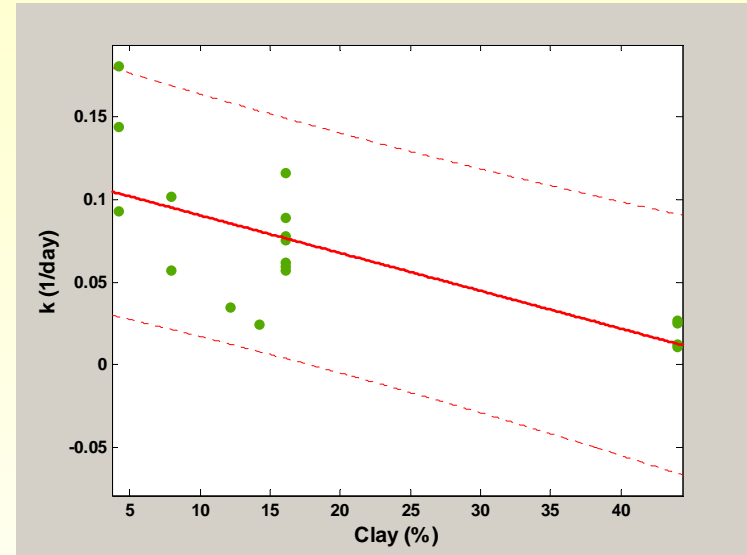
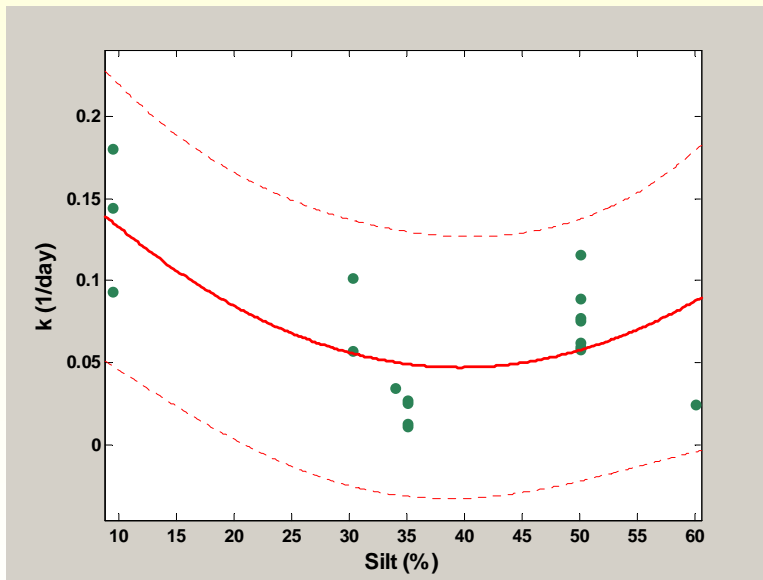
RESULTS

- k vs. TPH initial concentration



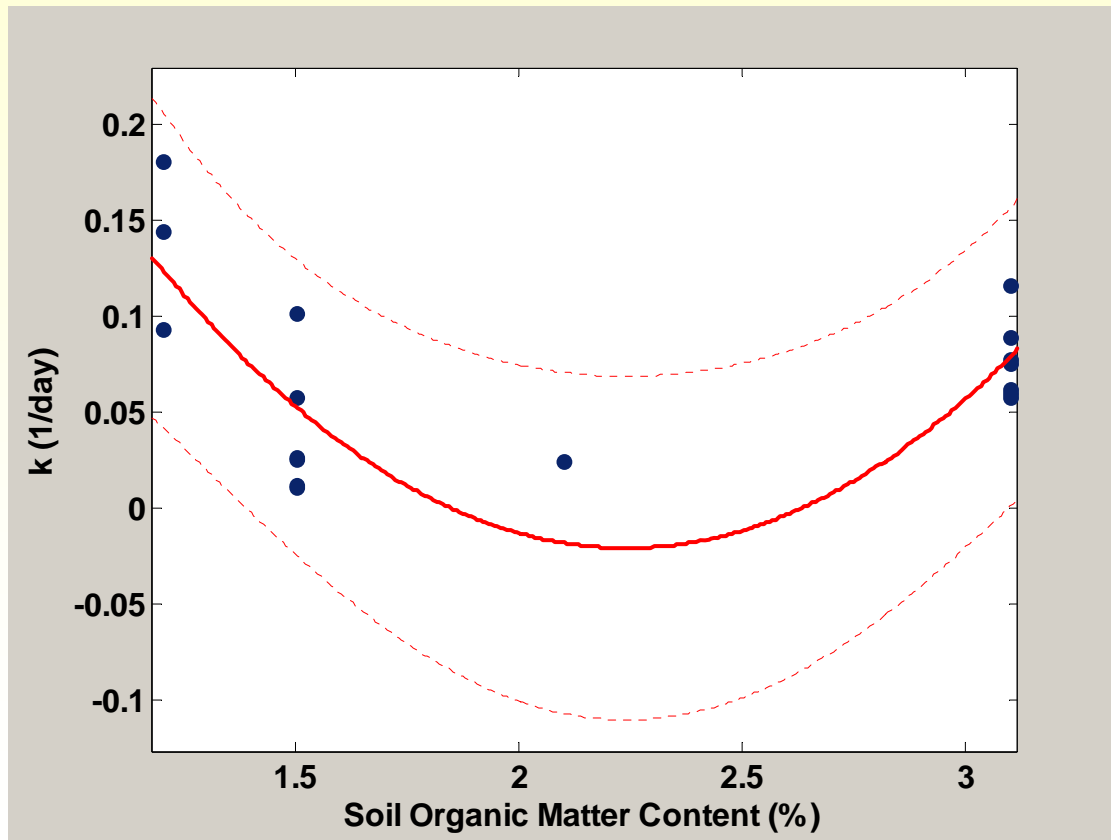
RESULTS – cont.

- k vs. soil type
(clay, sand, and silt)



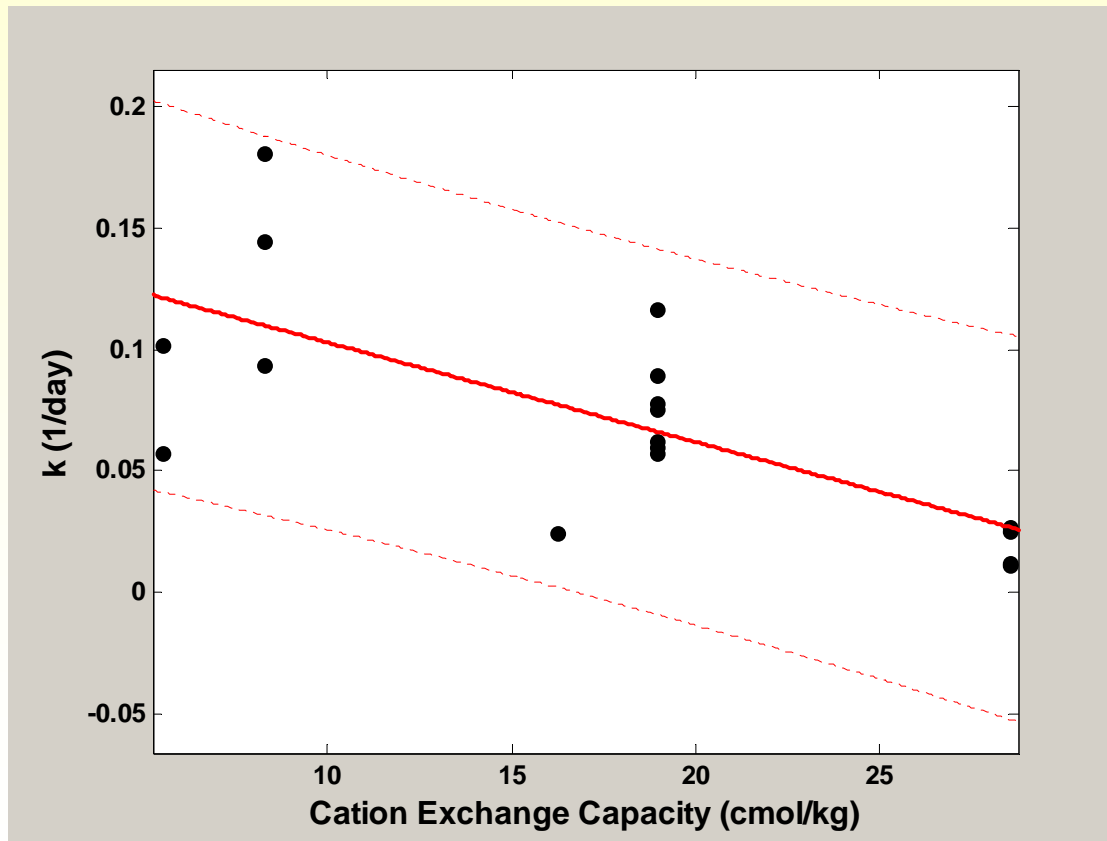
RESULTS – cont.

- k vs soil organic matter



RESULTS – cont.

- k vs soil CEC



RESULTS – cont.

- Preliminary correlation using SYSTAT

$$\ln(k) = 0.794 \cdot OM + 0.040 \cdot Sand + 0.017 \cdot Clay - 0.263 \cdot \ln(CEC) - 5.891$$

$$r^2 = 0.87$$

k: biodegradation rate constant (1/day)

OM: organic matter content of soil (%)

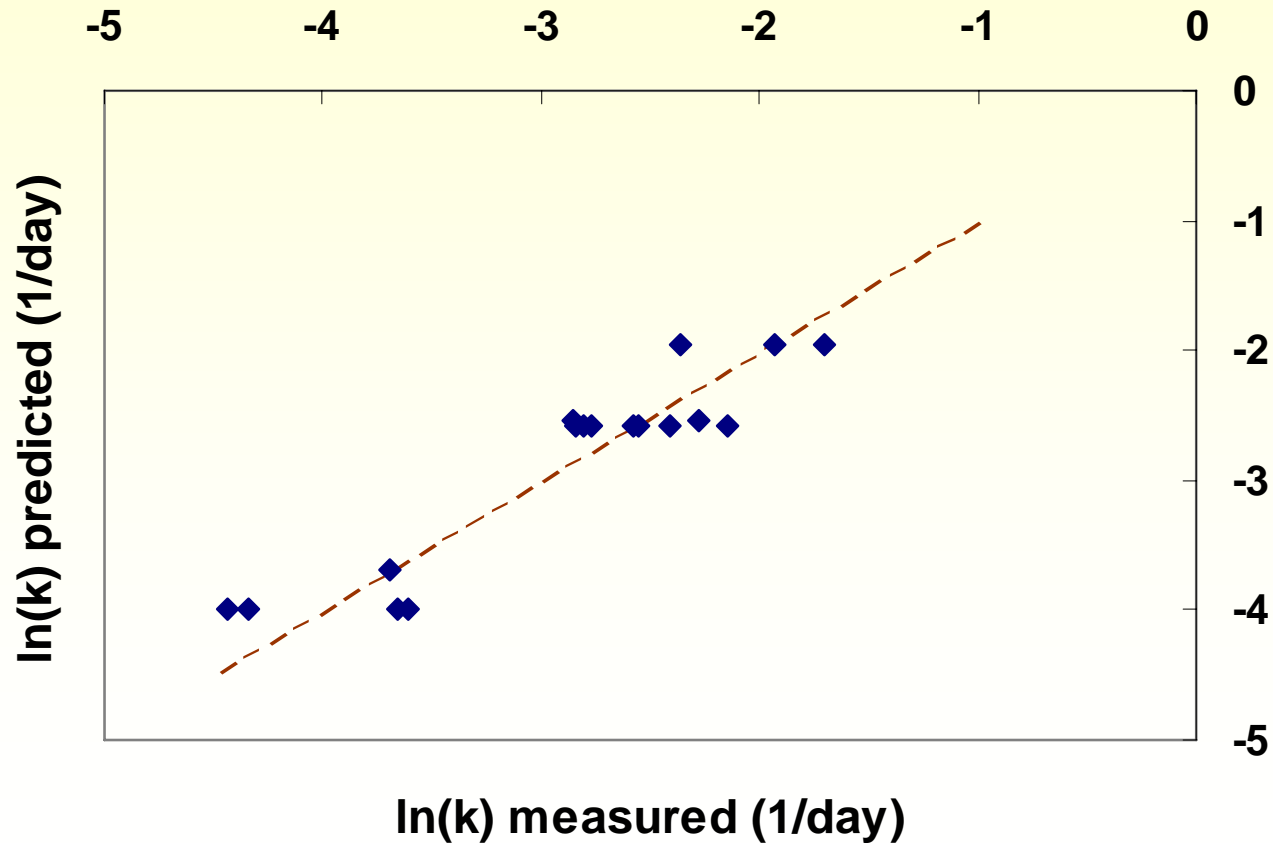
Sand: soil sand content (%)

Clay: soil clay content (%)

CEC: cation exchange capacity of soil (cmol/kg)

RESULTS – cont.

- Predictions vs. measurements



FURHER WORK

- Evaluate effect of other parameters affecting the k value, including:
 - soil microorganism population
 - spill age
- More experiments to improve the reliability of the model

ACKNOWLEDGMENT

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