



# CASE STUDY: PREFERENTIAL CATION EXCHANGE AND FLOW ALONG NEEDLE PUNCHING BUNDLES IN EXHUMED COMPOSITE FINAL COVER GEOSYNTHETIC CLAY LINERS

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## Introduction

### Geosynthetic Clay Liner (GCL):

- Factory-made hydraulic barrier; often used in MSW landfill final covers
- Advantages:
  - Easy to install (simply unroll on site)
  - Potentially very low hydraulic conductivity (k)
- Disadvantages:
  - Sensitive to chemical interactions
  - Ion exchange can alter properties
- Typical GCL cross section:

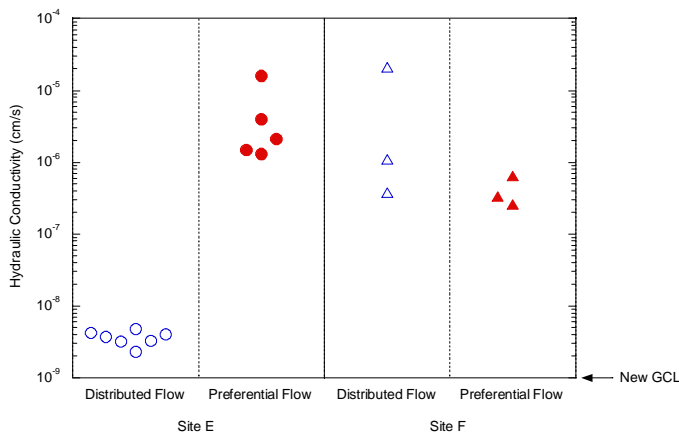


## Background

- GCLs deployed in landfill final covers have recently been shown to dramatically increase in in-situ k (Benson and Meer 2007, Benson et al. 2007)
- Performance of GCLs overlain by geomembrane is still unclear

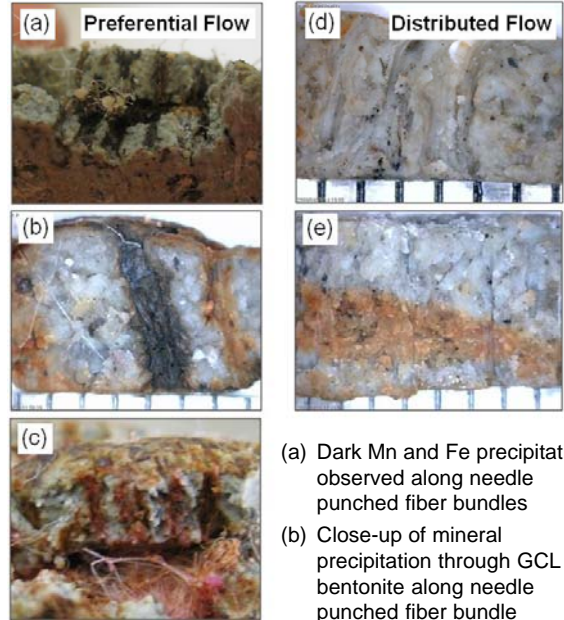
## Results

- GCLs were exhumed from two MSW landfill final covers 3-6 years after construction
- GCLs permeated with 0.01 M CaCl<sub>2</sub>, followed by dye; k classified by dye distribution observed during subsequent dissection:



## Preferential Flow Paths

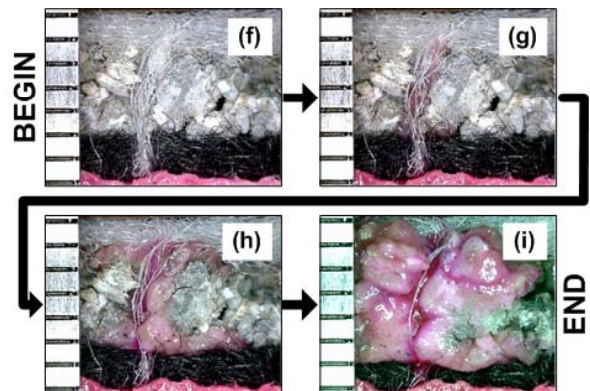
### Site E GCL cross sections:



- (a) Dark Mn and Fe precipitation observed along needle punched fiber bundles
- (b) Close-up of mineral precipitation through GCL bentonite along needle punched fiber bundle
- (c) Permeation with Rhodamine WT dye shows flow coincident with mineral precipitation
- (d) Bentonite surrounding needle punched fiber bundles of non-preferential flow GCL (bundle indentation visible)
- (e) Non-preferential flow GCL cross section, staining not concentrated along needle punched fiber bundles

## Hydration Cross Sections

Time lapse video hydration cross sections on New GCLs incriminate preferential hydration:



- (f) Saturated paper towel underlying GCL visible
- (g) Wicking of water up needle punched fiber bundle visible
- (h) Hydration of Bentonite outward from fiber bundle
- (i) Hydration continues outward from fiber bundle