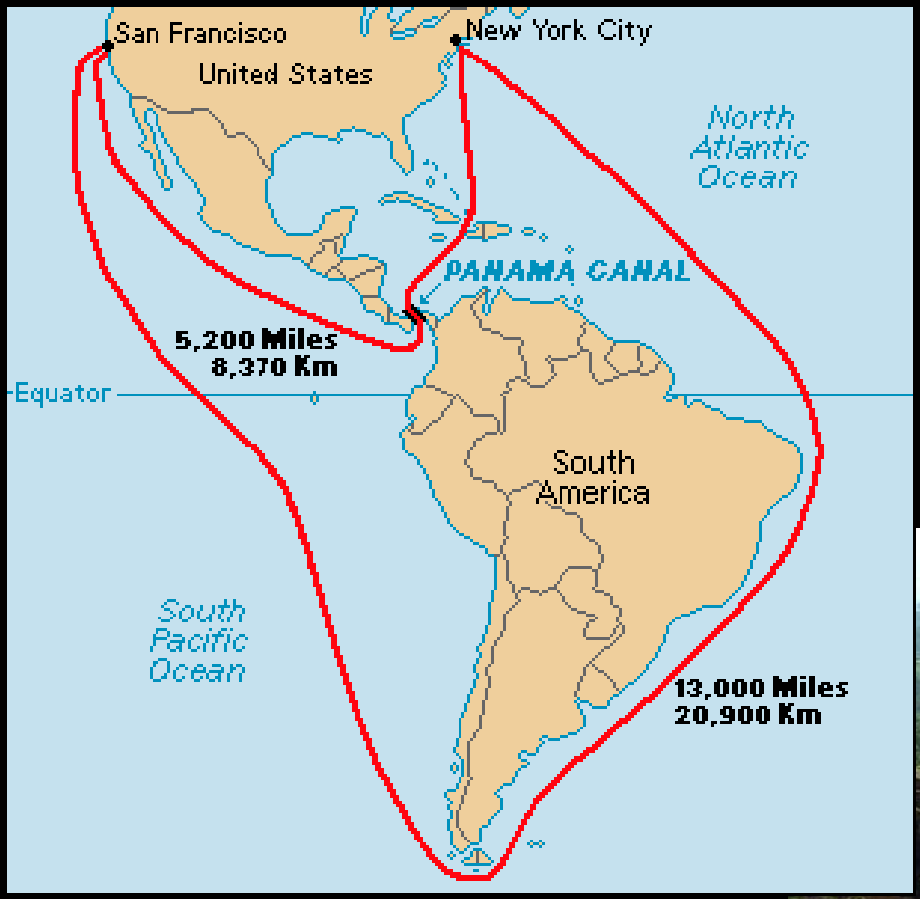
What's Past is Prologue in Geotechnical Engineering

Deborah J. Goodings

George Mason University

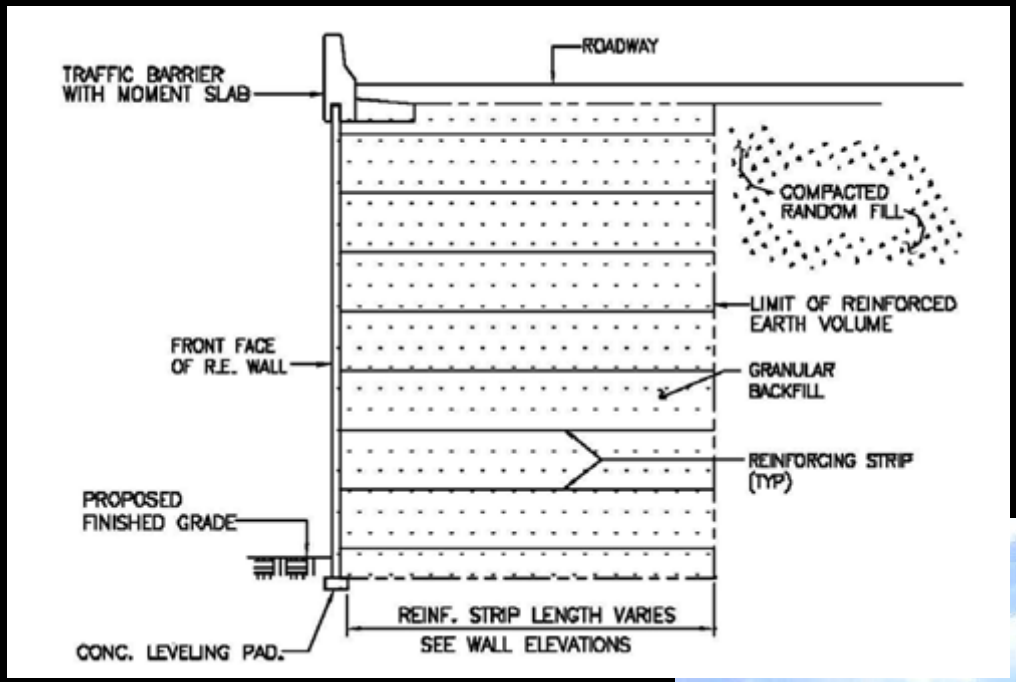


Panama Canal


North Atlantic Ocean
London
Europe
Asia
SUEZ CANAL
7,200 Miles
11,600 Km
Mumbai
Africa
Equato
Indian Ocean
12,300 Miles
19,800 Km
South Atlantic Ocean

Suez Canal

FHWA Design Manual



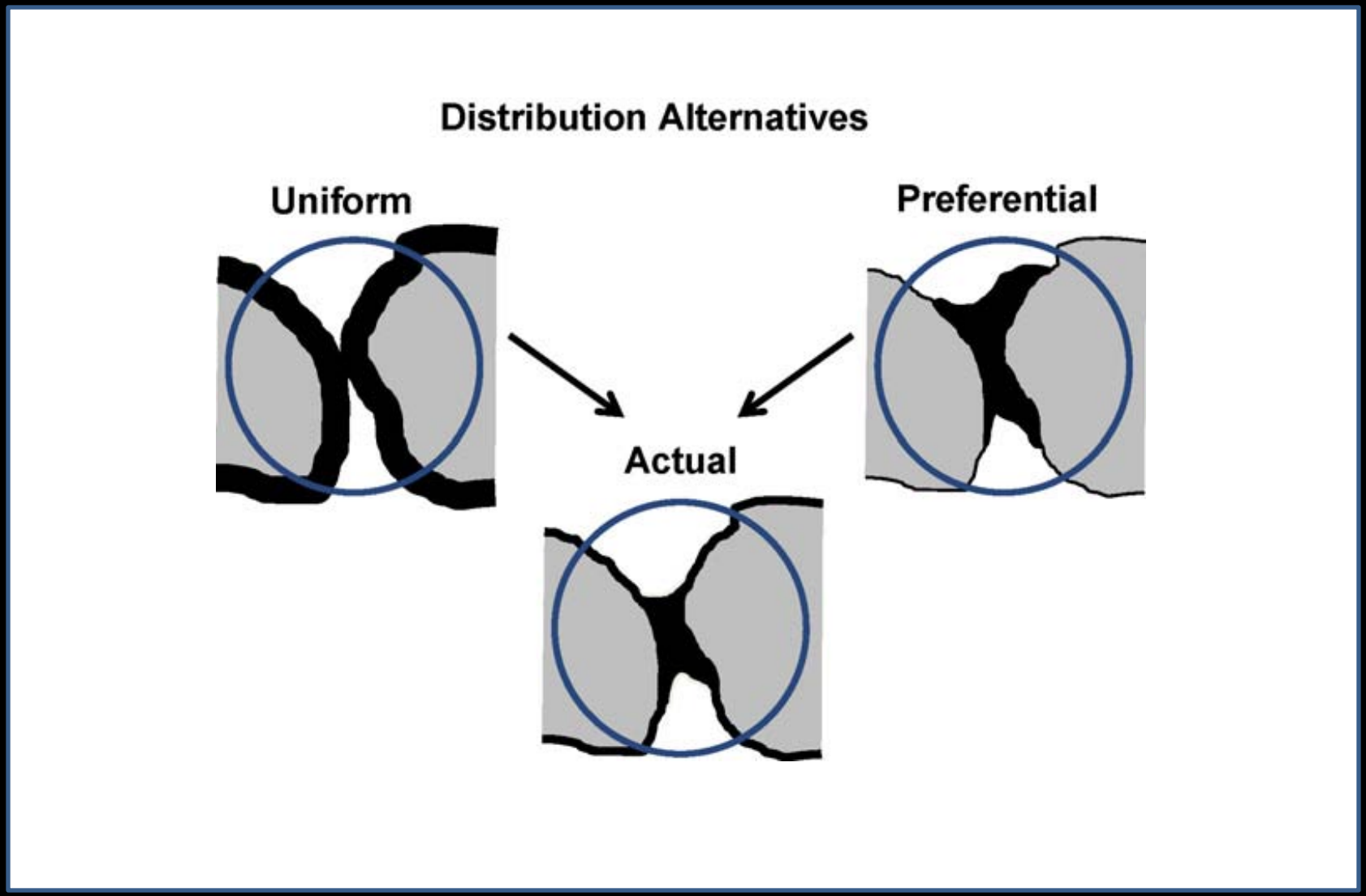
MSE walls

I-64/I-295 intersection in VA
[Roads to the Future]

Bio-mediated Soil Improvement

The natural process:

- Bacteria extracting nitrogen from urea
- Produces carbon dioxide & ammonia as byproducts
- Add water: ammonia become ammonium hydroxide
- Add calcium: ammonium hydroxide becomes crystals of calcium carbonate = limestone



Bio-mediated soil improvement by DeJong et al., Ecological Engg, 2010, vol 36, p197-210

Potential benefits:

- Reduction in permeability
- Increase in shear strength
- Reduction in potential for soil liquefaction

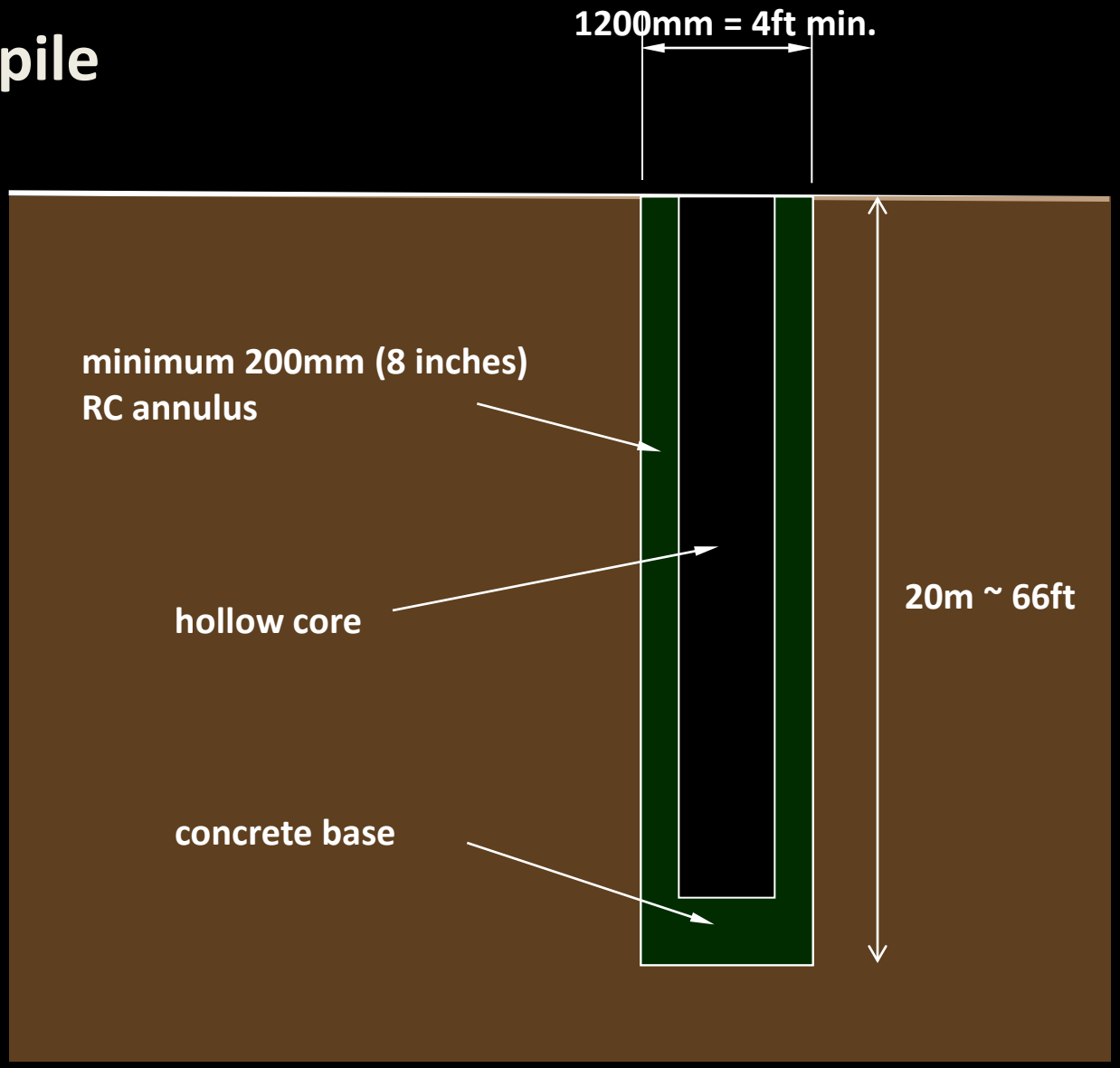
Challenges to field implementation:

- Soil type
- Groundwater chemistry
- In situ temperatures
- Uniformity of effects in ground

Sustainable and Reusable (SuRe) Pile

Balfour Beatty Ground Engineering
Andrew McNamara – City University

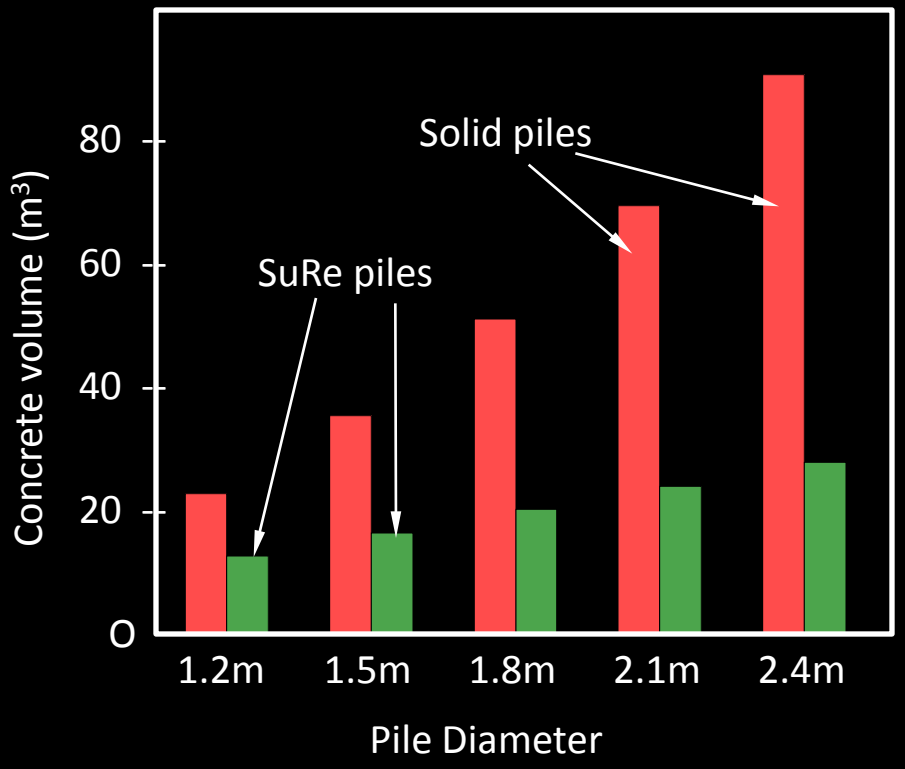
SuRe pile


1200mm = 4ft min.
minimum 200mm (8 inches)
RC annulus
hollow core
concrete base
20m ~ 66ft

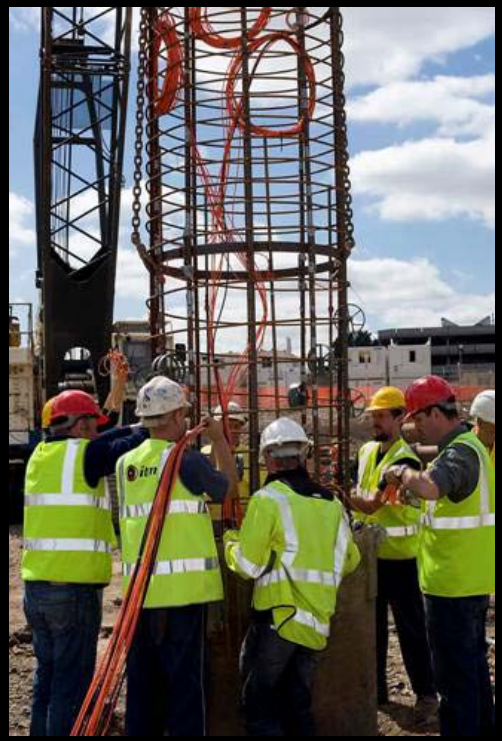
Concrete volumes for 20m long piles
SuRe hollow vs solid

Pile Diameter	Concrete volume	
	Hollow	Solid
1.2m	13m^3	23m^3
1.5m	16m^3	35m^3
1.8m	20m^3	52m^3
2.1m	24m^3	69m^3
2.4m	28m^3	90m^3

(1m ~ 3.3 ft) **(1m^3 ~ 1.3 yd^3)**



Rebar Cage Instrumention:
strain gages, piezometers, fiber optics
rod extensometer



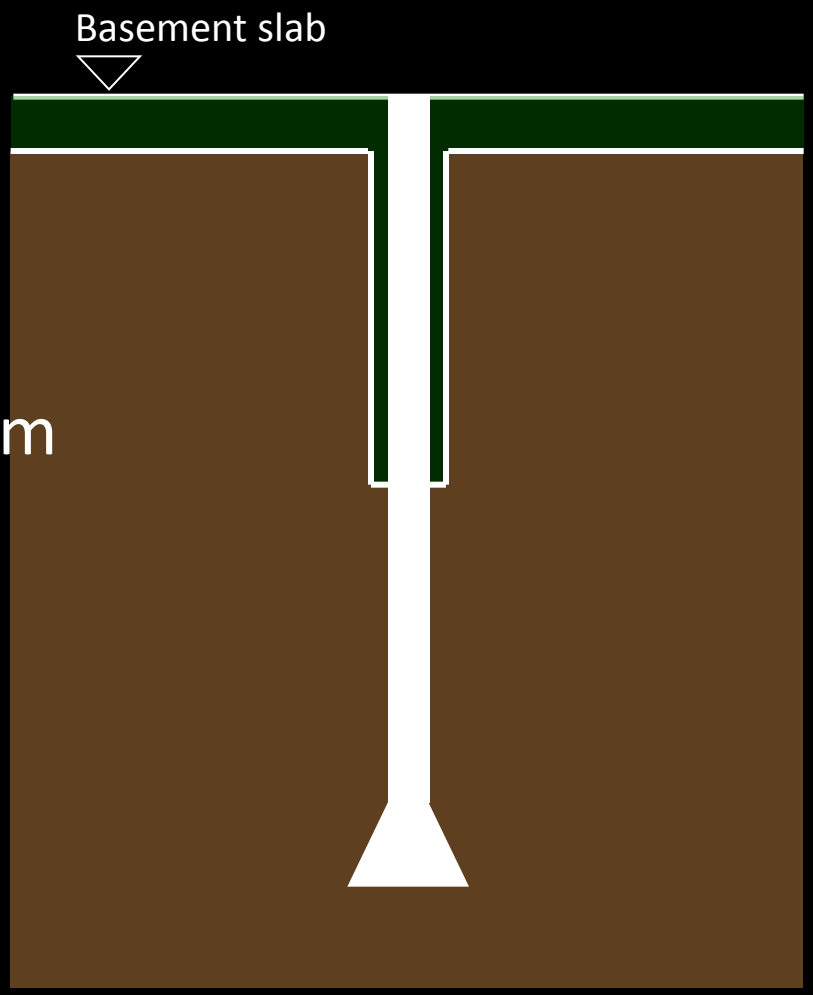
Steel Shell Interior Casing Instrumentation
strain gages, piezometers, fiber optics
rod extensometer

Lifting One Section of Tube

Completed pile cap

Pile re-use:

- Evaluate pile integrity
- Extend pile length
- Possibility of future under ream



Geothermal Heating

Haley & Aldrich

Stanford University

- Converting to central geothermal system (~150 bldgs)
- ME designed closed system – 800 wells
- H&A designed open system
  - 8 withdrawal wells and 18 recharge wells
- Wells 300ft to 600 ft deep
- Peak flow 16,000 gallons/min
- Cut carbon footprint by 50%
- Modelling effect on warming groundwater

Landfills to Energy

Geosyntec

Sustainable Landfills

Hickory Ridge Solar Cells on Exposed Geomembrane Cover
(Republic Services - Atlanta)

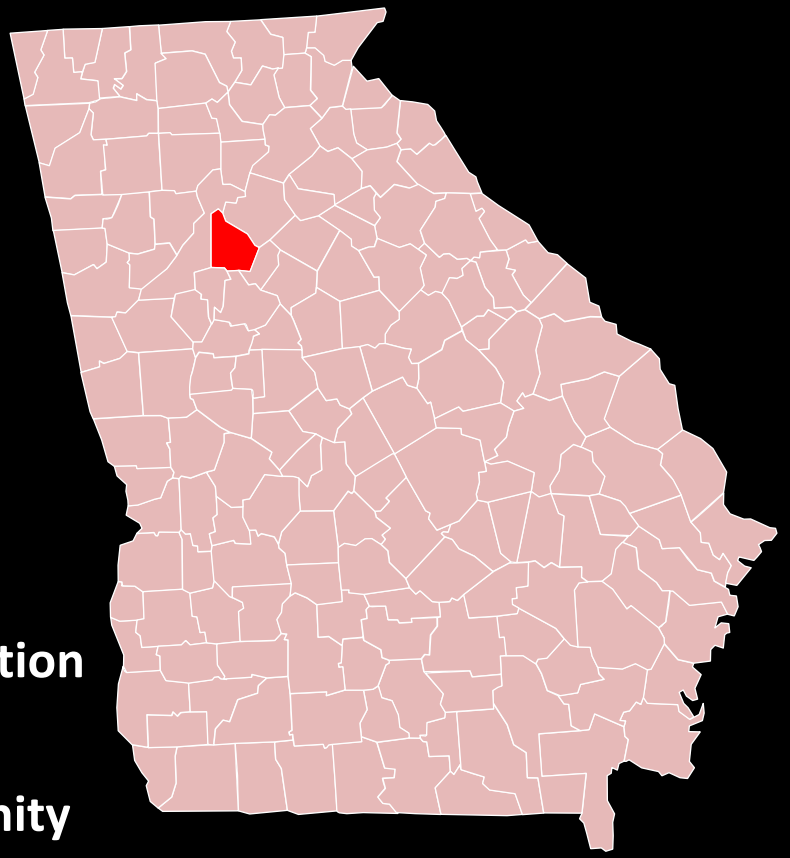
Public Parks, Trails, and Wind Turbines (Fresh Kills Landfill, NY)

Landfill gas (LFG)

- 40%-60% methane
- most of remainder: carbon dioxide
- other trace:
  - nitrogen
  - oxygen
  - water vapor
  - sulfur

Case Study of Landfill Gas to Energy
DeKalb County, GA

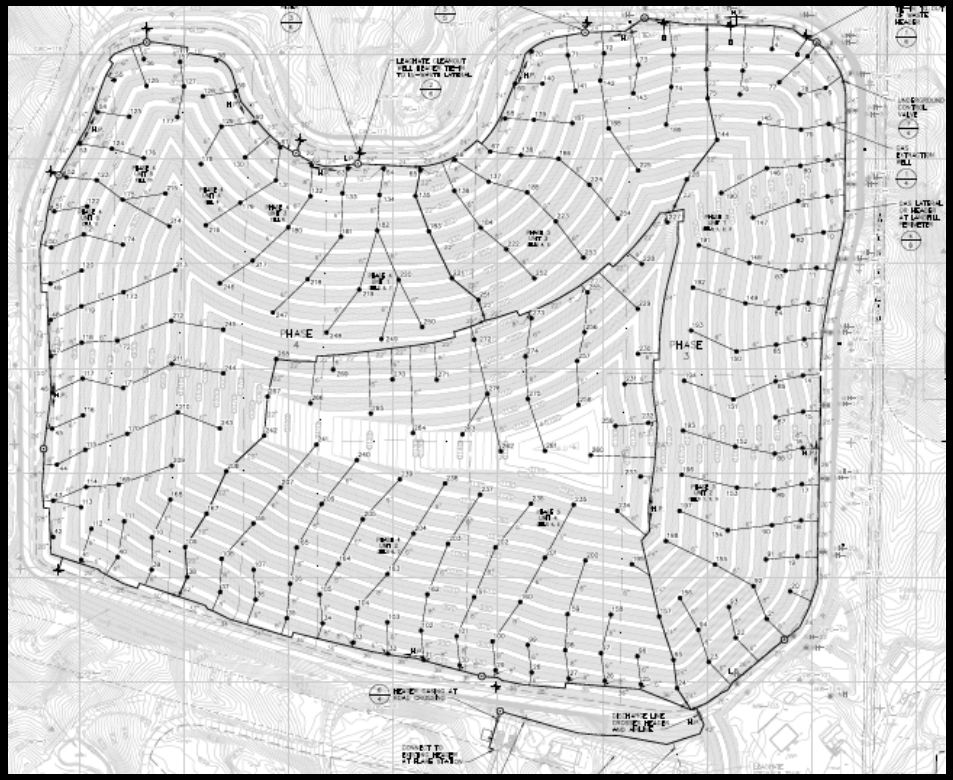
- **East side of Atlanta**
- **> 700,000 residents**
- **> 10,000 businesses**
- **Home to:**
  - **Emory University and Medical Center**
  - **Stone Mountain Park**
  - **Center for Disease Control and Prevention**
  - **10 Municipalities**
  - **Clean, Green, Safe & Thriving Community**




Seminole Road Landfill
DeKalb County, GA
North
Seminole Road Landfill
DeKalb County Public Works Department
DeKalb County, Georgia
Scale: 1" = 200'
Date of Photography: June 7, 2011
Geosyntec


Seminole Road Landfill
DeKalb County, GA
Phases 3 & 4 (Active)
LFG to Electricity Facility
LFG to RNG Facility
Phases 1 & 2/2A (Closed)
North
Seminole Road Landfill
DeKalb County Public Works Department
DeKalb County, Georgia
Scale: 1" = 200'
Date of Photography: June 7, 2011
Geosyntec

Final Expansion Gas System
Final Design and Construction



Second largest landfill in GA

> 80 years of remaining landfill disposal capacity

> 100 years of LFG

DeKalb County Renewable Fuels Facility

- Owned by DeKalb County, GA
- Designed, Engineered, Built and to be Operated by Energy Systems Group
- Facility Operational April 2012
- Building Designed to be LEED (Leadership in Energy and Environmental Design) Certified
- Initial Input of Landfill Gas = 1300 SCFM
- Plant Expandable to Input = 2600 SCFM
- Compressed Natural Gas (CNG) Annual Production = 2,334,755 Diesel Gallon Equivalents (DGE)
- Landfill Gas (400 – 600 BTU/SCF) Processed to Renewable Natural Gas (≥ 950 BTU/SCF)

- Direct Site Emissions Reduced Over the Lifetime of the Facility:
  - Carbon sequestered by 197,266,825 tree seedlings grown for 10 years
  - CO_2 emissions from 320,558,600 propane cylinders used for home barbeques
  - CO_2 emissions from 865,400,050 gallons of gasoline consumed

GASEOUS COMPOUNDS	PRE-PROCESS	POST-PROCESS
Methane	50 – 55%	> 98%
Carbon Dioxide	35 – 40%	< 2%
Total Inert + Oxygen	5.5 – 14%	< 2%

ESG ENERGY SYSTEMS GROUP

Geosyntec