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INNOVATIONS IN CIRCULAR ECONOMY FOR STREAM RESTORATION AND NAVIGATIONAL SEDIMENT DREDGING PROJECTS

Beneficial Reuse

Meggen Janes, M.Sc., P.Eng.

What's the Issue

- Excess soil comes from many infrastructure projects such as
  sediment dredging, navigational control, culvert rehabilitation, shoreline restoration and stormwater management pond (SWMP) cleanout
- Routine cost for managing this material is in every municipal budget
- Innovation needed to expand the tool-box of approaches giving Conservation Authorities and municipalities more options

Regulatory Framework

Export of sediment or liquid soils are regulated in Ontario under O. Regulation 406/19

"Soil, or soil mixed with rock, that has been excavated as part of a project and removed from the project area for the project"

Exemptions and non-applications apply to support more streamlining but MECP generic or risk-based soil quality standards still apply.

“drainage works” includes a drain constructed by any means, including the improving of a natural watercourse, and includes works necessary to regulate the water table or water level within or on any lands or to regulate the level of the waters of a drain, reservoir, lake or pond, and includes a dam, embankment, wall, protective works or any combination thereof;

Non-Application

Clarification was also made to the definition of “infrastructure” to clarify that it includes drainage works under the *Drainage Act*

A Few Rules to be Keep in Mind

Description
Wet soil or sediment that has a slump of more than 150 millimetres (mm). Soil observations to be completed.

Transportation
Trucks with a locking system. Soil movement to be tracked and documented.

Reuse
Reuse Site accepting liquid soil needs to have a site-specific instrument in place to accept the liquid soil

Storage
Liquid soil must be stored: in a location that is accessible for inspection; stores no more than 10,000 m^3 of liquid soil at any one time; and is stored in a leakproof container on an impermeable surface

Quality
Soil Quality Standards need to be considered.

Soil Quality

After January 1, 2025, landfill moratorium for soil that meets*

	Table 1	Table 2.1 (RPI) *	Table 3 (RPI)	Primary Risk	Mitigation Measures
PHC F2	10	10	98	IA	No buildings within 30 m
PHC F3	240	240	300	PSO	Soil or hard barrier
PHC F4	120	2,800	2,800	PSO	Soil or hard barrier
Benzo (a) pyrene	0.49	0.31	0.57	Soil contact	HSP or barrier
Dibenz(a,h)anthracene	0.16	0.57	0.57	Soil contact	HSP or barrier

Your text here

RPI – residential, parkland, institutional
PSO – plants and soil organisms

Soil Management Hierarchy

- Hyper-local Reuse
- Local Soil Reuse Controlled by Project Leader
- Product Manufacturing
- Soil Reuse Site
- Soil Treatment Facility and Landfill Disposal

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HYPER-LOCAL REUSE

Leave it in Place!

- Multiple tools to leave soil in place through stabilization, here's one approach:
- Bank or shoreline reuse and stabilization using biocementation.
- Microbial-induced-calcite-precipitation (MICP)
- Injection, percolation or addition of select microorganisms (or use of indigenous microbes) that precipitate calcite
- Can increase slope stability, soil strength and reduce liquefaction
- Field application planned for shoreline in Vancouver area along Fraser River

Treated & Untreated

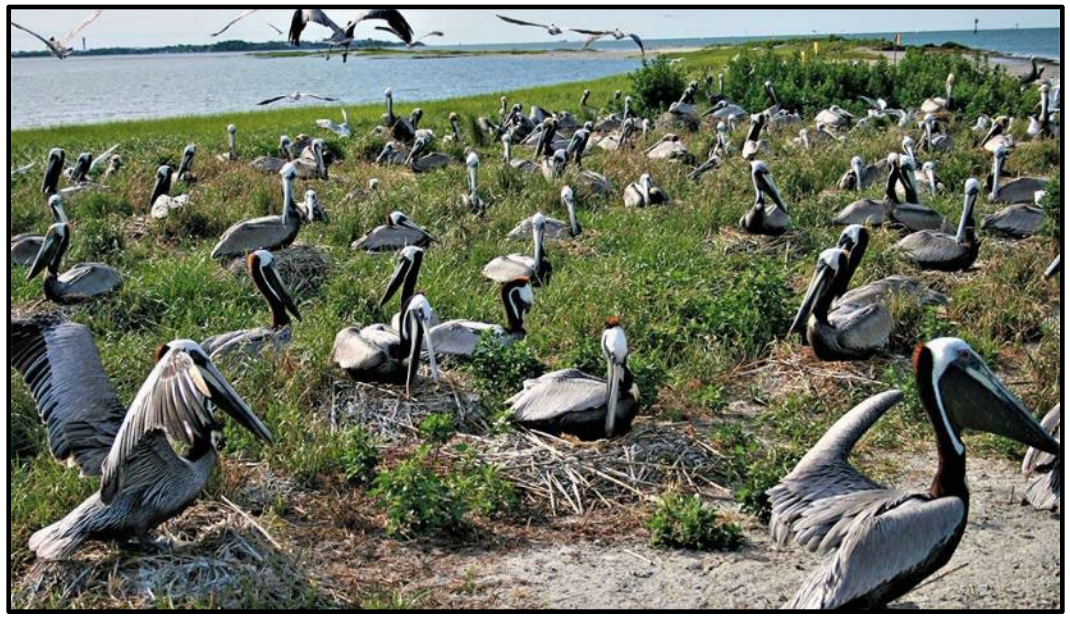
Groundwater Technology

Hyper-locale Reuse

- On-site Reuse scores on sustainability
- Develop Strategy Early
  - Plan for project lifecycle
  - Accommodate space, think ahead
  - Understand your material
  - Understand your project setting, neighbourhood interests.
- Potential uses: backfill, berms, cover material, island development, shore restoration, beach nourishment, revetments, and landscaping.

Beneficial Reuse – Direct Application

- Crab Bank was once a flourishing nesting site for seabirds (including many highly threatened species).
- Less than ~one hectare of land above high tide prior to restoration.

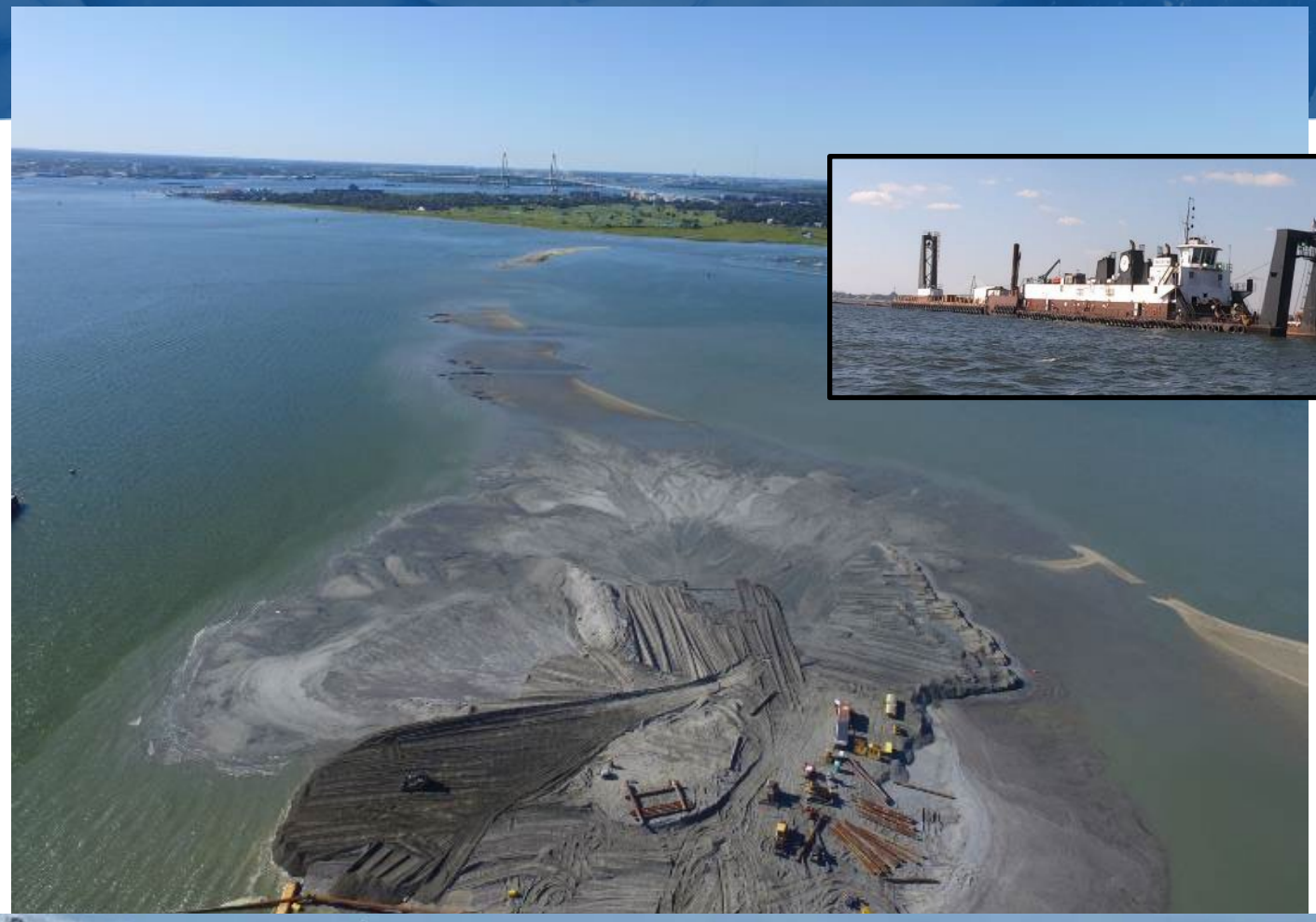


- Several footprints were considered to meet a nesting habitat and cost/benefit criteria.
- Geosyntec modelled the configuration with consideration of material fate and impacts to surrounding areas

Acknowledgement: Marc Gold, Geosyntec-ATM

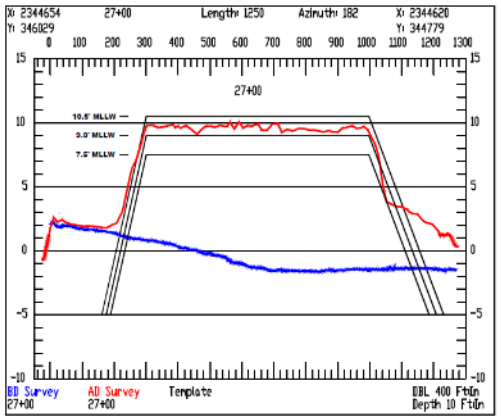
Construction

- Dredging 2021
- Hydraulic dredging and passive dewatering
- Built up expanded island



Success! Beneficial Sediment Reuse restored nesting habitat

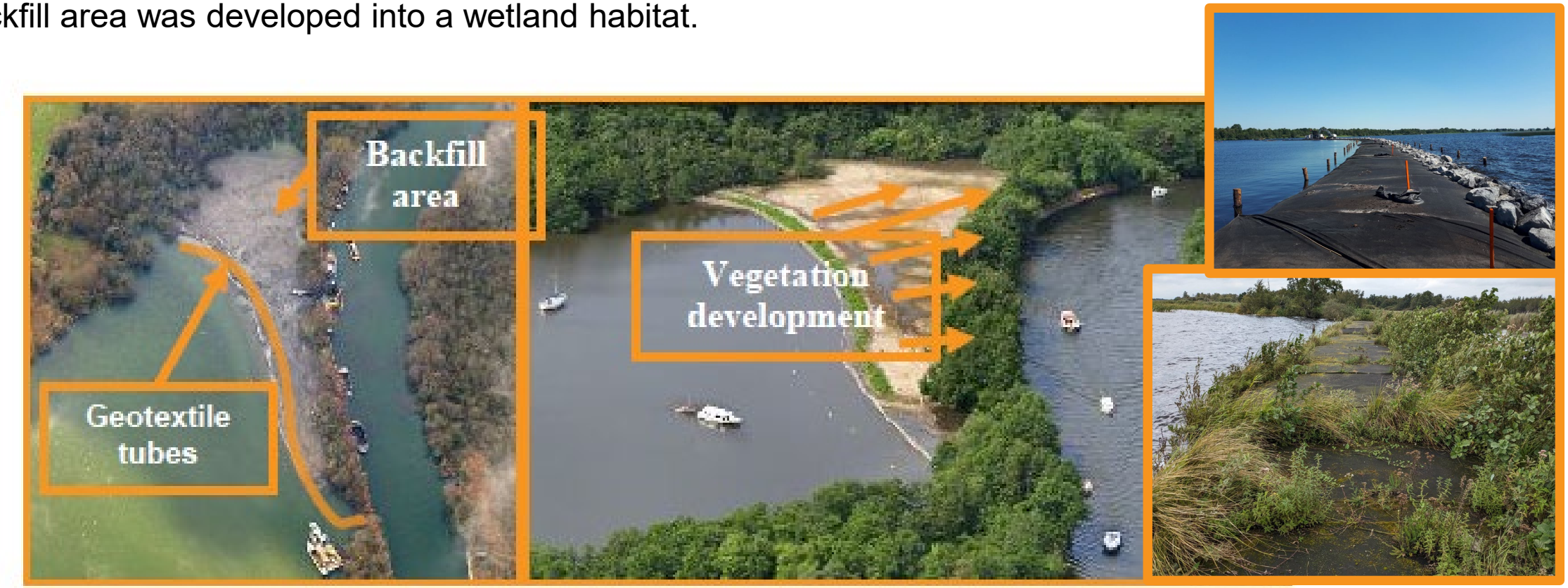
- ~13 hectares of new nesting habitat created
- Ecotourism, shoreline protection
- In 2022, more than 500 nests observed, marking the first time coastal birds have nested since its erosion disappearance



Crab Bank is now home to seabirds and shorebirds who will be back for many seasons to come. Photo credit: Audubon Society, Adam Boozer

Retainment structures to Receive Excavated/Dredged Material

12,000 m^3 of dredged sediment was reused in a retaining structure made with geotextile tubes.
The backfill area was developed into a wetland habitat.



Biodegradable tubes

Replace regular geotextile tubes with biodegradable tubes from natural material.
Research has been performed on the different types of natural textiles and the sediment dewatering performance.
Supports replacement of petroleum-based synthetics and issues associated with the long-term degradation of synthetics in the environment.
Biodegradable structures have been shown to be more receptive to re-vegetation by deep-rooted plants.

Photo credit: U.S. Army Corp of Engineer, Mobile District, 2016 study.

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PRODUCT MANUFACTURING

Product Manufacturing

Nature of the dredged material is typically low strength and not suitable for use as engineered fill on the commercial market.

However, with some “engineering”, soil could be suitable for:

- Building Blocks
- Agricultural
- General Soil Fill (commercial construction, brownfield cap/cover, etc.)
- Structural Fill (commercial or residential construction fill at foundation grades)
- Embankment/dam core material (fine grained, high plasticity, good for dam cores)
- Landfill cover
- Stabilized road subgrade

Building Blocks

- Technology developed in 2016 and been used in the Netherlands.
- Dewater and add binder – various types and composition based on sediment and end use.
- Sediment/soil compression into building blocks. Various sizes and molds.
- Can produce 5 to 30 MPa strength, at the high end comparable to concrete.
- Cost 20 to 30% more to make the block, excluding lifecycle cost of diversion from landfill

700 m sound barrier/retaining wall constructed from dredged material from excavated wet soil from railway tunnel. Wall contains 65,000 blocks locally produced.
Smaller size blocks (20 by 10 by 10cm).

Sediment Reuse Pilot Study

- Innovative, Reusable Dewatering Technology (GeoPool)
- 98% fine-grained sediment
- ~5000 m^3 dredged from turning basin
- Material dewatered for 4 months

Acknowledgement: Corry Platt and Brian Weyer, Geosyntec

Reuse Evaluation

9 Reuse Alternatives Evaluated

- Brownfield Cap/Cover
- General site fill
- Engineered Fill
- Mechanical Blending
- Turf Grass
- Ecological Restoration
- Agricultural
  - Corn
  - Soybean
  - Compost
  - Acidifier

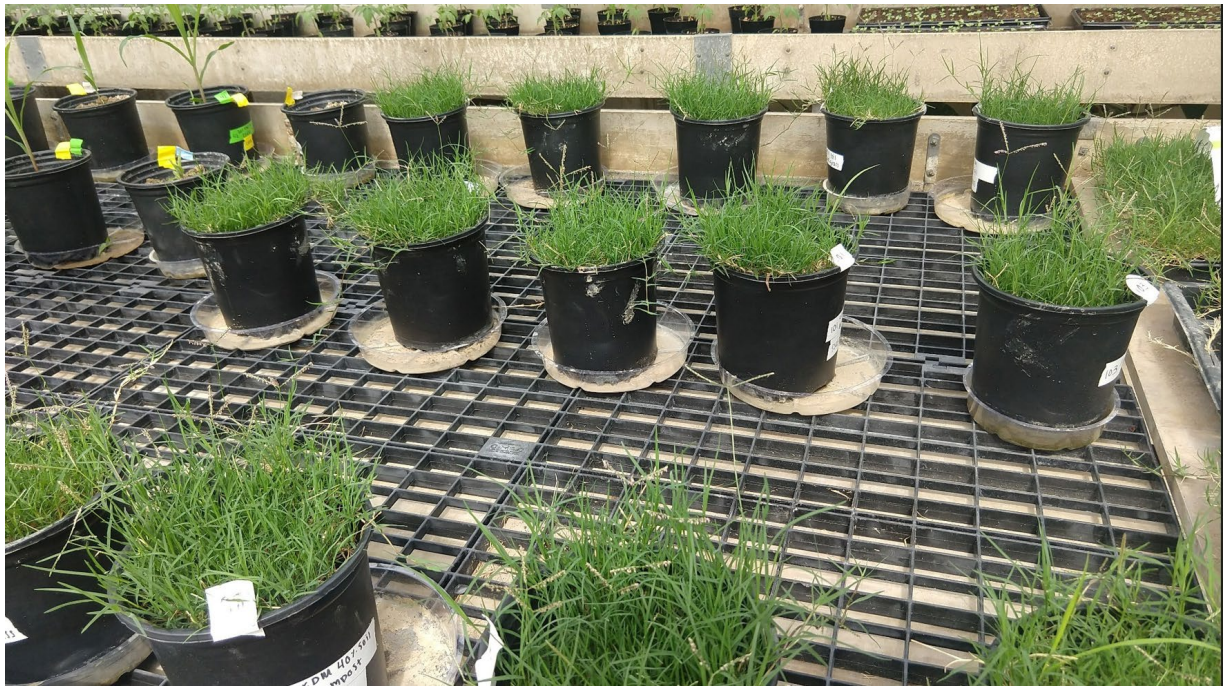
Engineering Fill and Blending Studies

Mechanical Blending – Sand and Compost Test Plots

Engineered Fill Evaluation – Cement Stabilized – 3%, 7%, 10%

Agricultural Reuse

Ag reuse – turf/fescue trials



Ag reuse – Corn trials

Mobile Soil Washing

Soil Washing and/or screening to separate useable fractions of soil.

Fines – disposed

Useable fraction – sand and coarser material for resale, reuse as construction material, beach sand nourishment, etc.

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LOCAL REUSE

Local Reuse

Local Reuse by Project Leader

Enables application of municipal or CA instruments

Risk-based approaches for soil quality and wider range of tools available to demonstrate that soil reuse does not present an environmental concern

Repurpose soil rather than disposal

Local Reuse of Navigational Dredgeate

- >20,000 m^3 of navigation dredgeate moved to a local Soil Reuse Site
- Excess Soil Planning Documents completed
- Transportation and Handling of soil including regular audits and inspections
- Risk based evaluation to verify Soil Placement
- Design, implementation and inspection of Environmental Controls
- Registration on RPRA site
- Significant cost savings over conventional disposal

Local Soil Reuse Site

Cap material for closed landfill

Due diligence assessment evaluated potential for adverse effects to environment

- Use risk assessment tools to confirm sediment placement maintained protection of human and ecological health
- On- and off-site receptors would not be adversely affected

Safe reuse of dredged sediment materials

Beneficial Reuse Attributes

Hyper-local Reuse	Product Manufacturing	Local Reuse	Treatment/ Disposal
• Reduction in GHG, transportation • Planned benefit of landscaping • Circular economy when avoiding new material use • $	• Circular economy benefits in manufacturing building materials • Cost avoidance, creates new product for use • $$	• Improve site for future uses • Potential liability transfer • $$ to $$$	• Liability transfer • Final destination, less onerous planning • $$$$

Recap: Soil Management Hierarchy

- Hyper-local Reuse
- Local Soil Reuse Controlled by Project Leader
- Product Manufacturing
- Soil Reuse Site
- Soil Treatment Facility and Landfill Disposal

Benefits of Reuse Innovations and Circular Economy for Excess Soil

Sustainability

Environmental Stewardship

Social Benefits

Governance

Potential Cost Savings

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