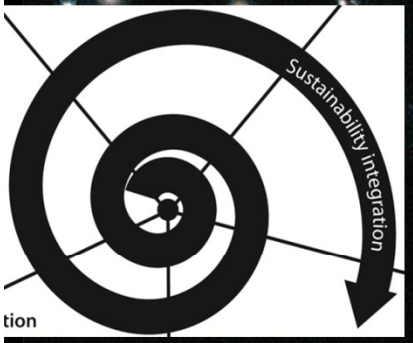
Beyond 'Smiley Faces': Combining Sustainable Return On Investment and Environmental Life-Cycle Tools to Assess the Sustainability of Remedial Options



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2014 INTERNATIONAL WORKSHOP ON ENVIRONMENT AND ALTERNATIVE ENERGY
October 24, 2014 Kennedy Space Center, FL

Order of Presentation

- Overview of Green and Sustainable Remediation (GSR) Frameworks
- Tiered Frameworks and Life-Cycle Tools
- Sustainable Return on Investment
- Landfill Mining Project

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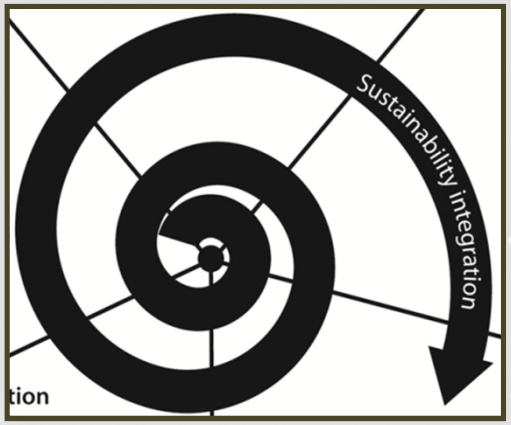
LIFE-CYCLE TOOLS

Origin of Green and Sustainable Remediation

- "The remedy is worse than the disease" - Francis Bacon

- ~2006 … Include environmental footprint and sustainability in remediation lifecycle
- Sustainable Remediation
  - Protects human health and the environment
  - Maximizes the environmental, social, and economic benefits throughout the project life cycle
  - Metrics based on site and client –specific conditions



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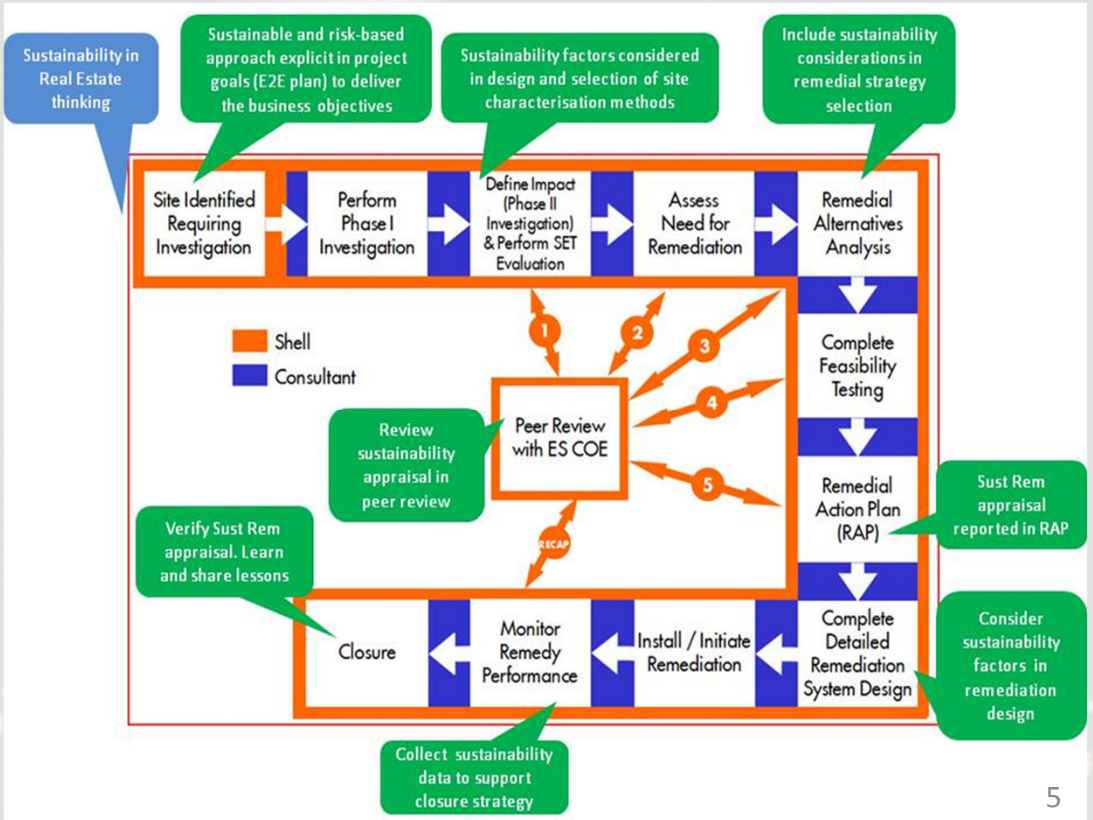
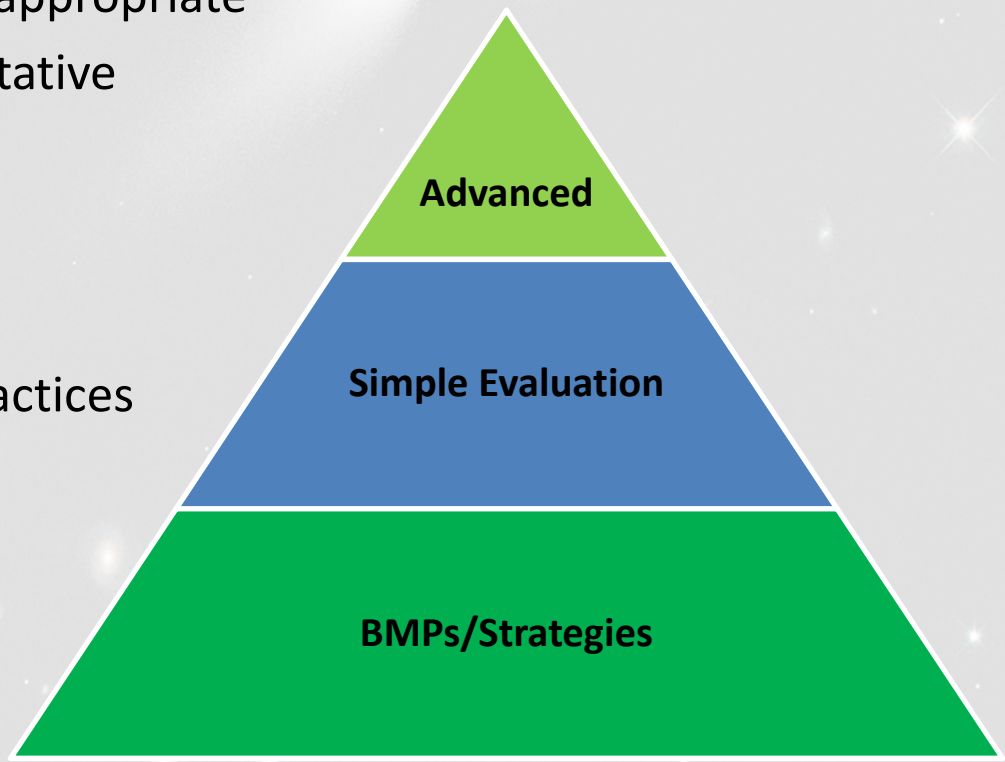
Why GSR?

- Enhance the evaluation of remedial options
  - Environmental, social and economic factors
  - Improve Environmental, Social, and Economic outcomes
  - Facilitate acceptance
- Maximize Triple bottom line and protect HHE
- It's the right thing to do!



Smiley Faces to Life Cycle Analysis

- Tiered Assessment Frameworks
  - SURF, SURF-UK, ASTM, ITRC, EPA, Sustainable Remediation Initiative
  - Basic to advanced as appropriate
  - Qualitative → Quantitative
- Life cycle approach
  - Holistic and iterative
  - Collaboration
  - Best management practices
  - Evaluation
  - Balance



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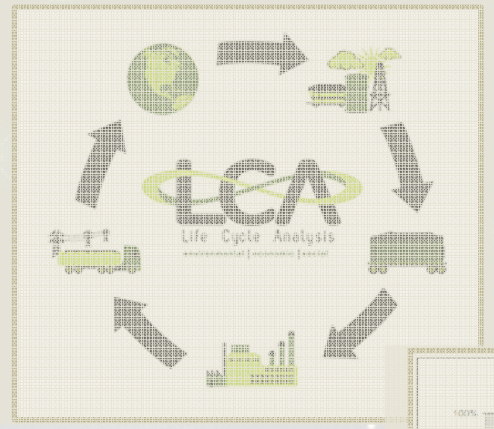
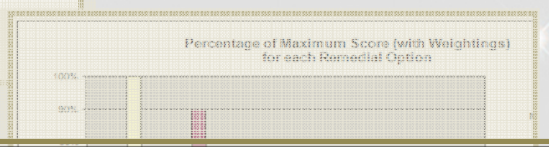
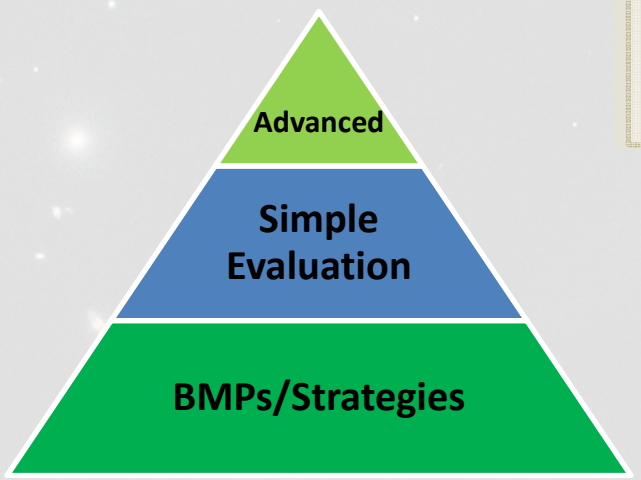
Smiley Faces to Life Cycle Analysis

- Tiered Assessment Frameworks







	1	2	3
GWP	☹	☺	😐
Waste	☹	☺	☺
Species	☹	☺	😐
Community	☹	☺	☺

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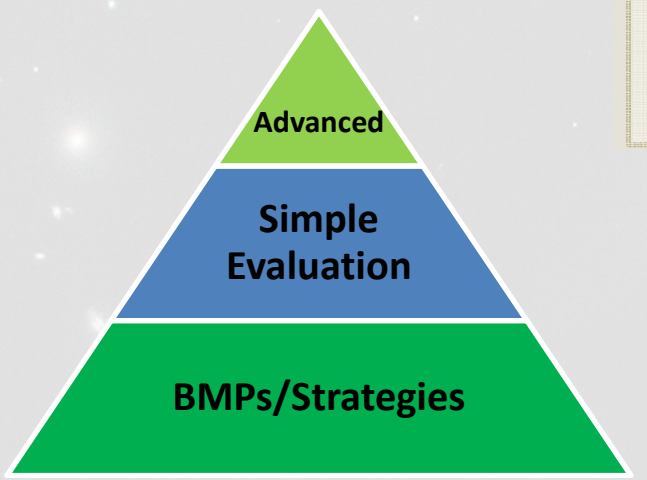
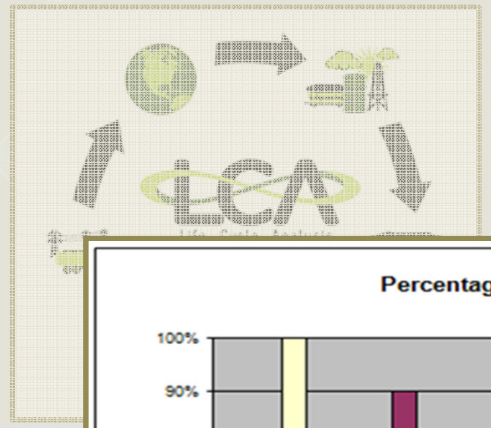
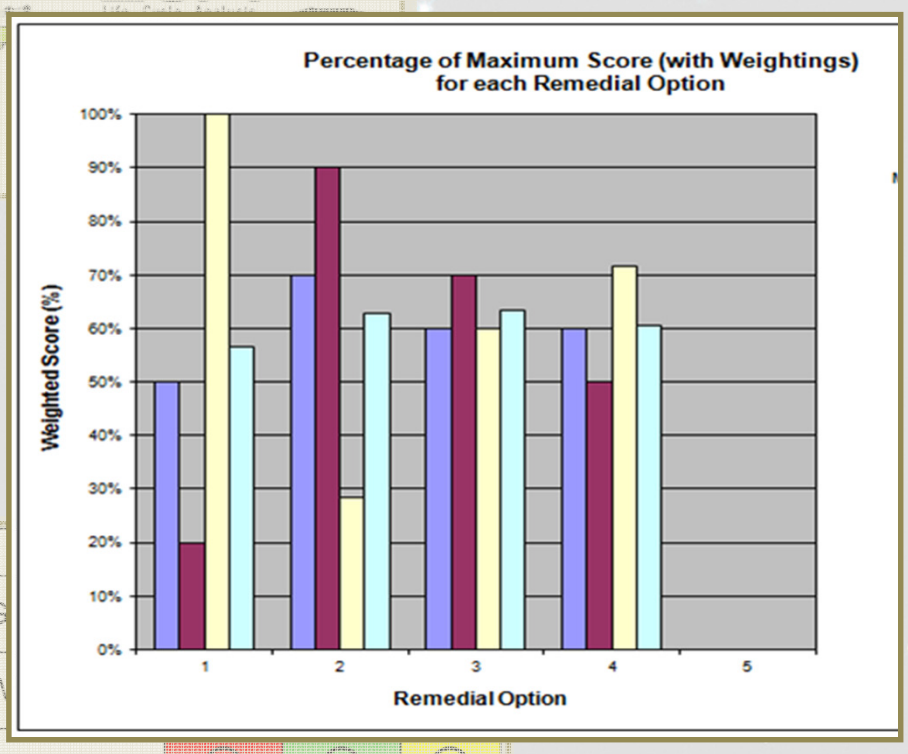
Smiley Faces to Life Cycle Analysis

- Tiered Assessment Frameworks







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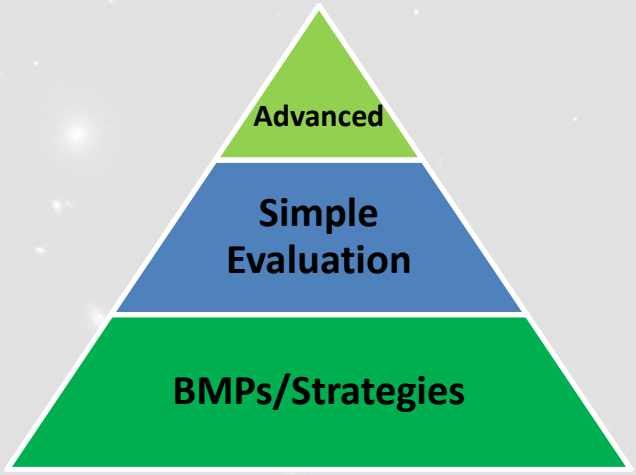
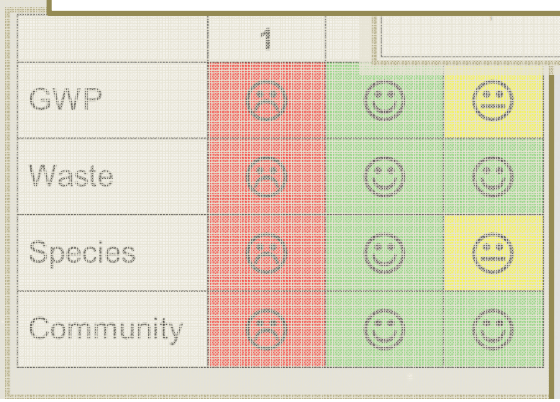
Smiley Faces to Life Cycle Analysis

- Tiered Assessment Frameworks





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Life Cycle Tools

- Spreadsheet-based
  - SRT
  - SiteWise
  - Consultant Tools
- Advanced
  - ecoinvent database of lifecycle inventory data
  - Simapro®
  - GaBi
  - TRACI (and other) Endpoint Models
  - Sustainable Return on Investment

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SUSTAINABLE RETURN ON INVESTMENT

Sustainable Return on Investment

Decisions based on the Triple Bottom Line

- sROI is a full life-cycle cost accounting of the economic, social and environmental impacts in addition to financial performance

Economic Impacts	Social / Community Impacts	Environmental Impacts
Capital Cost	Health & Safety	GHG Emissions
Operation & Maintenance	Property Values	Criteria Air Pollutants
Repairs	Community Satisfaction	Ecosystem Services
Avoided Costs	Aesthetics	Water Quality
Decommissioning	Education	Soil Impacts

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Sustainable Return on Investment
Methodology

Step 1: Define the objectives and desired outcome of the investment / project

Step 2:Identify which strategies should be considered to meet project objectives

Step 3: Establish the conditions without the investment and the boundaries for the life-cycle analysis

Step 4: Incremental impacts are identified and monetized using economic methods and values are vetted through a charette

Step 5: Inputs are incorporated into the model, which is then run

Step 6: Sensitivity analysis is conducted and uncertainty analysis results are evaluated

Sustainable Return on Investment
Economic Valuation Methods

Method	Description
Benefits Transfer	Uses estimations obtained from one context to estimate values in a different context or site
Choice Modeling	Survey approach where respondents choose preferred option from a set of alternative scenarios
Contingent Valuation	Willingness to pay values are elicited from survey respondents
Travel Cost	Value based on the cost of travel to utilize a resource
Replacement Cost	The cost to produce a man-made substitute represents the value of the resource or service
Avoided Cost	Costs that society avoids as a result of the resource or service (e.g. waste or water treatment)
Hedonic Pricing	The value of a resource is derived from its effect on market-priced goods (such as real estate)

Landfill Mining Project

- Manufacturing site for electrical components and X-ray film
- Off-spec films were disposed in on-site industrial landfills
  - Ballfield Landfill
  - On-site Landfill

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Landfill Mining Project

- Step 1 – Objective: Cost effective and sustainable landfill remediation to create additional parkland and enable property transfer
- Step 2 – Strategy: Remove polyethylene terephthalate (PET) from both landfills and recycle
- Step 3 – Baseline: Without the project, only waste from the Ballfield Landfill would be recovered and disposed of offsite
- Step 4 – Impacts: Construction cost, disposal cost, greenhouse gas emissions, criteria air pollutants, and PET recycling benefits

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Landfill Mining Project

- Step 4 – Quantifying inputs:
  - The benefits transfer method is used to estimate economic values by transferring information from reputable and relevant economic studies.
  - The damage estimates for criteria air pollutants include damage to human health, materials, plants and animals, ecology, visibility and aesthetics.
  - The damage estimates for greenhouse gas emissions include net agricultural productivity, human health, property damages from increased flood risk, and ecosystem services.

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Landfill Mining Project

- Step 5 – Inputs are incorporated into the model

Baseline	
Construction Costs for Ballfield Landfill Only	$1,965,997
Disposal Cost	$713,700
Total Project Cost	**$2,679,697**

Recycling PET Alternative	
Construction Costs	$3,276,661
PET Recycling Revenue	($2,830,406)
Total Project Cost	**$446,255**

Economic Benefit	**$2,233,442**

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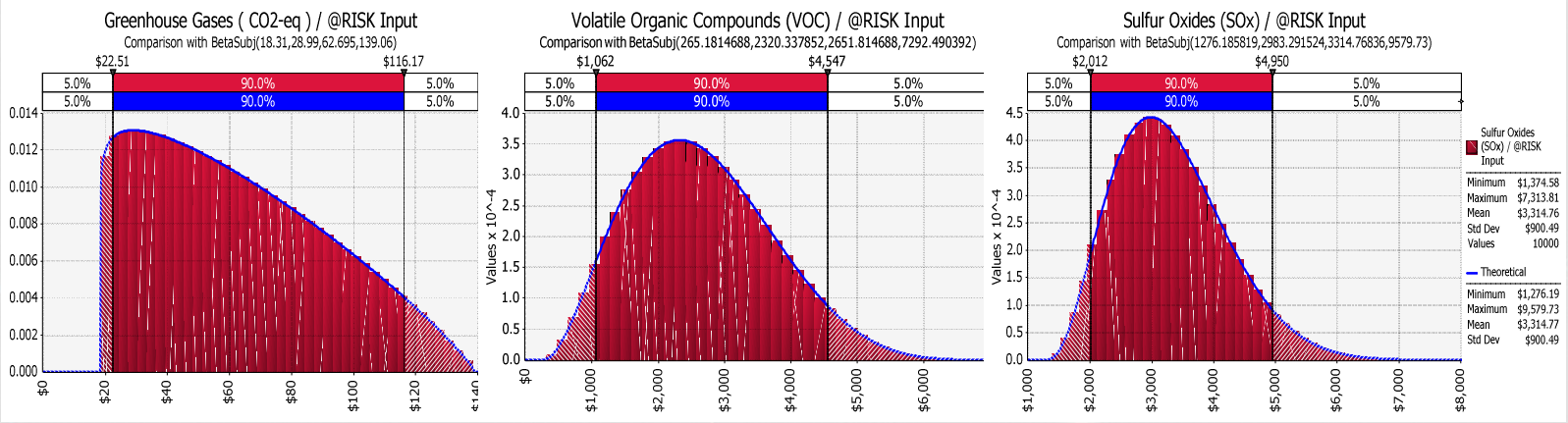
Landfill Mining Project

- Step 5 – Inputs are incorporated into the model

SOCIAL DAMAGE ESTIMATES FROM AIR EMISSIONS OF ENVIRONMENTAL EXTERNALITIES (2013$ per metric ton of air emissions)					
Pollutant	**# of Studies**	**Min**	**Median**	**Mean**	**Max**
Carbon Dioxide (CO2-eq)	5	$18	$29	$63	$139
Sulfur Oxide (SOx)	10	$1,276	$2,983	$3,315	$9,580
Particulate Matter (PM)	12	$1,575	$4,641	$7,127	$26,850
Volatile Organic Compounds (VOC)	5	$265	$2,320	$2,652	$7,292



Landfill Mining Project

- Step 6 – Results are evaluated

Impact category	Incremental Impact (MT)	Value 2013$
Economic Benefit		$2,233,442
Climate change (CO2-eq)	14,426	$904,447
Particulate matter formation (PM)	(368)	($2,619,934)
Terrestrial acidification (SOx)	(10)	($32,830)
Photochemical oxidant formation (VOC)	(0.06)	($166)
	Net Benefit	**$484,959**
	FROI	**500%**
	sROI	**109%**

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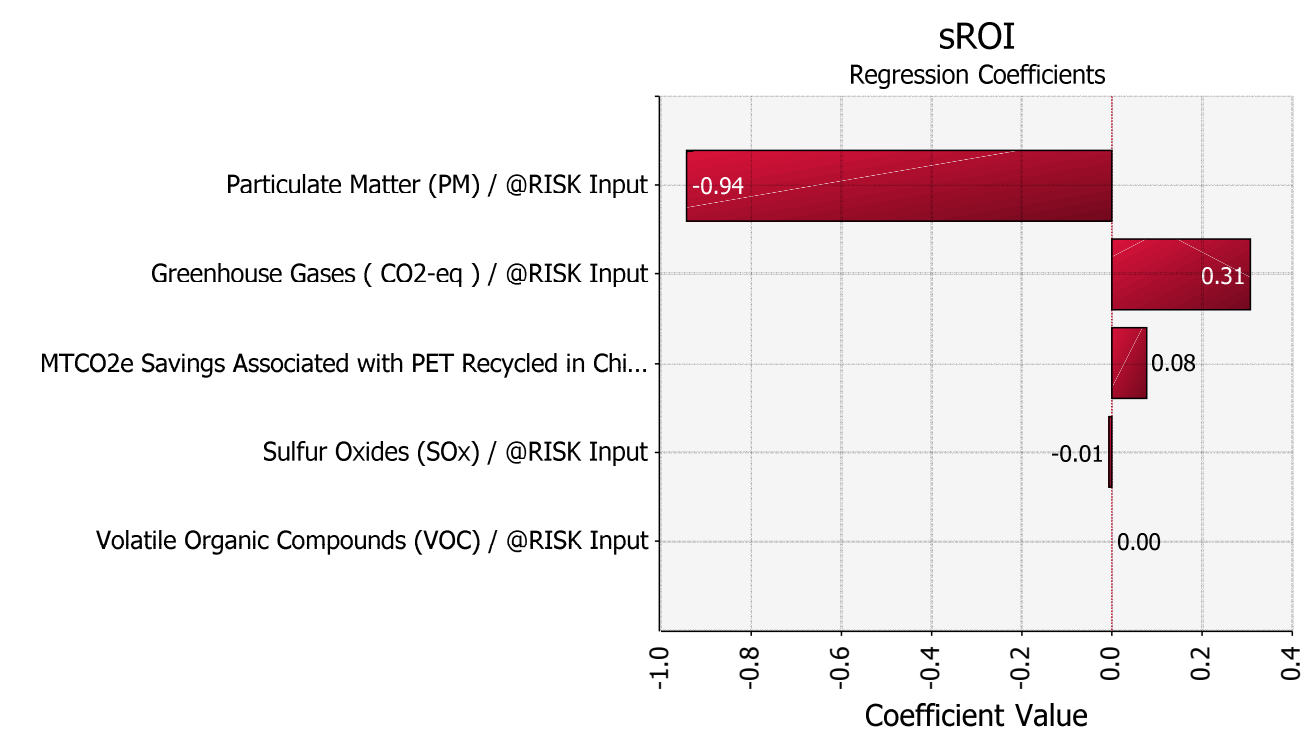
Landfill Mining Project

- Step 6 – Results are evaluated
  - Sensitivity analysis: PM has the greatest effect on the sROI result



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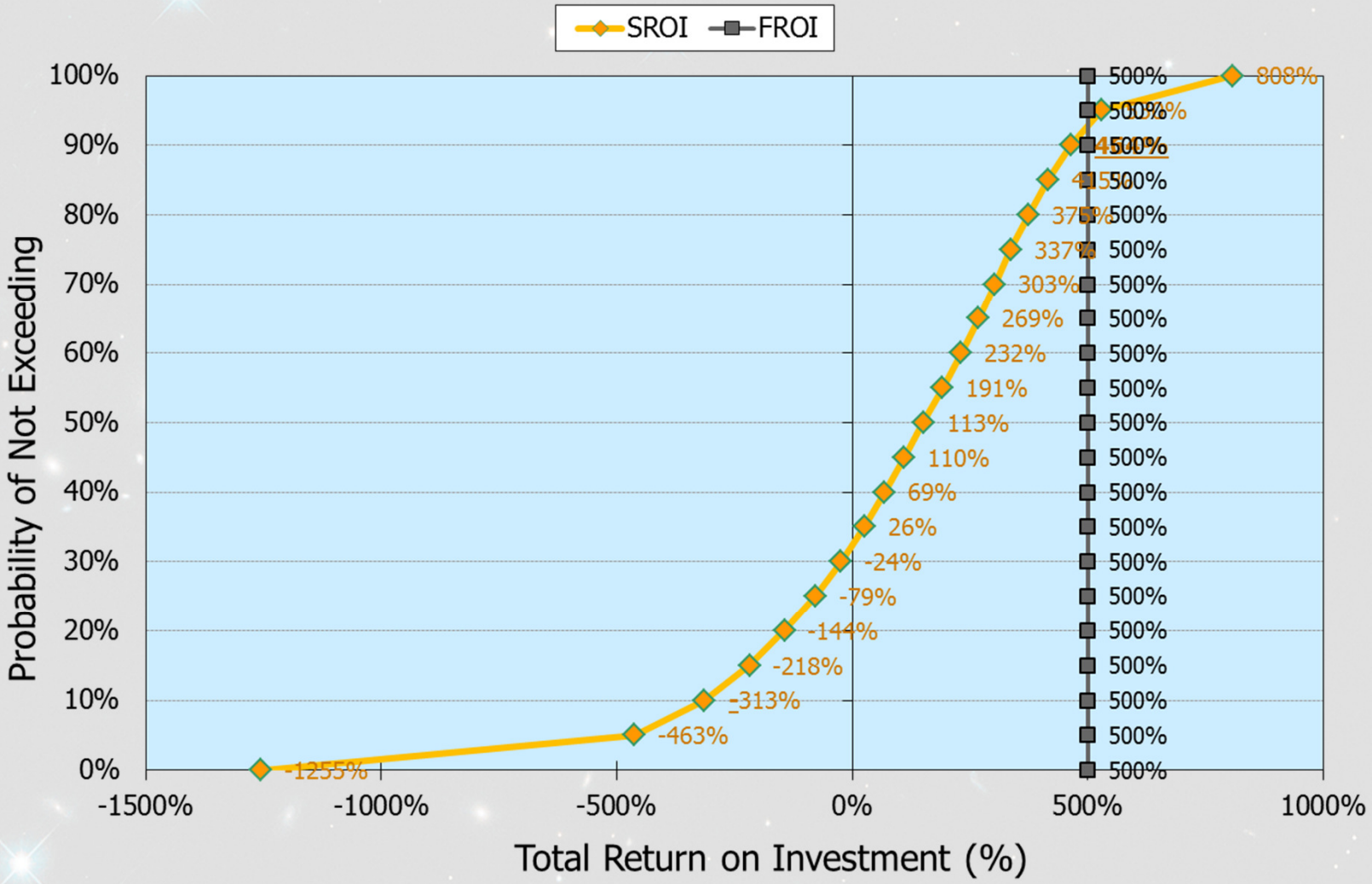
Landfill Mining Project



Summary

- Provides a more comprehensive picture of investments
- Translates social and environmental impacts into economic terms
- Includes an uncertainty analysis to demonstrate the likelihood of realizing costs and benefits
- Combines objective data and expert judgment
- Generates results that are defensible and transparent

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We thank you for your attention …

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For more information, see:

Bohmholdt, A. 2014. Evaluating the Triple Bottom Line Using Sustainable Return on Investment. Remediation Journal, Volume 24, Issue 4, pp. 53-64, Autumn 2014.

YOUR QUESTIONS?

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