Sustainable Remediation Forum (SURF)
SURF 24: November 12, 2013
Member Webinar

Members participated in SURF 24 via webinar on November 12, 2013 to hear "Updates and Case Studies in Sustainable Remediation." The 1.5-hour webinar marked the 24th time that various stakeholders in remediation—industry, government agencies, environmental groups, consultants, and academia—came together to discuss the use of sustainability concepts throughout the remediation life cycle. Previous meeting minutes are available at http://www.sustainableremediation.org/library/meeting-minutes/.

Welcome and Updates

Nick Garson (SURF President) welcomed SURF members to SURF 24 and provided the following updates:

- Organization Chart
  Nick reviewed SURF's organization chart, which shows the Board of Trustees, committees, and technical initiatives. The chart is available to members on the website under "Member Resources," "Board Documents" at http://www.sustainableremediation.org/documents/.
- Nominations for 2014 Board of Trustees
  Nick encouraged SURF members to nominate others (or themselves!) for one of the open Board and At-Large positions. Nominations are due by the end of 2013, and members will vote in January 2014.
- Membership Renewals
  It's that time of year! Nick reminded members to renew their membership on the website.
- SURF 25
  Nick announced that SURF 25 will be held in early February 2014. After the webinar, additional meeting details were formalized. SURF 25 will be held in Pasadena, California from February 5-7, 2014. Visit SURF's website for additional information.

Nick ended his welcoming remarks by reading an antitrust statement and emphasized that SURF does not endorse any specific tool or product, including those presented in the case studies during the meeting.

Appreciation Awards

Paul Hadley (California Department of Toxic Substances Control) awarded appreciation awards to Melissa Harclerode (CDM Smith), Carl Lenker (Gannett Fleming), and Jeramy Jasmann (Colorado State University) for their work on the Groundwater Conservation and Reuse Technical Initiative. A brochure and a journal article are complete and will be published early next year. Paul received an appreciation award as well, with Nick thanking him for all of his hard work leading the initiative.

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Case Study #1

Matt Vanderkooy (Geosyntec Consultants) presented the first case study, “Evaluating Remediation Sustainability: Does it Matter Which Tool You Use?” Three sustainability tools (i.e., SimaPro, SRT, and SiteWise™) were compared as part of a life-cycle assessment for a coal tar contaminated site. Three remedies were considered in the assessment: excavation and off-site treatment, in situ thermal stabilization, and in situ smoldering combustion. The attributes of each tool and the results of the comparison are highlighted in the table below. Presentation slides are provided in Attachment 1.

Sustainability Tool	Attributes	Summary of Results
SRT	• Plug and play • Built-in data and calculations • Inflexible	Able to perform simple assessments
SiteWise™	• Remediation expertise required • Remediation-focused sustainability data • Flexible	Able to perform complex assessments
SimaPro	• Remediation expertise required • Comprehensive sustainability database • Uncertainty and contribution analyses • Flexible	Able to perform complex assessments with detailed analysis

Discussions after the presentation focused on the cost of SimaPro, which is $5,720 for a one-year license or $11,500 for an indefinite license.

Case Study #2

Curt Stanley (Shell) presented the second case study, “Benchmarking Sustainable Remediation Decision-Support Tools for Use in a Tiered Assessment Framework.” Shell and other SURF organizations advocate incorporating sustainability into remediation projects using a tiered approach. (For more information about the tiered approach, see pages 19 and 20 of the SURF 19 meeting notes.) The case study presented tested this approach at a retail gas station in the United Kingdom. Benchmarking results showed that simple and rapid sustainability assessments can result in robust remediation decisions (see table below). Presentation slides are provided in Attachment 2.

Assessment Type	Summary of Results
Qualitative	• Able to differentiate between different remediation options • Unable to resolve subtleties • Able to perform quickly and easily
Semi-quantitative	• Debatable whether additional numbers added robustness • Difficult with single assessor
Quantitative	• Data hungry, but not all valuation data exists • Able to resolve subtleties

Discussions after the presentation focused on the following topics:

- Project Objectives
  Curt emphasized the importance of having a clear understanding of the project's objectives (e.g., cleanup objectives, boundaries, criteria for economic and societal perspectives) so that all stakeholders are in alignment. He believes it is critical to be aligned on these objectives so that potential remedies can be evaluated consistently across all three assessment tiers.

- Metrics
  Curt discussed the metrics used to evaluate the social aspects of the triple bottom line. The protection of human health and the environment was assumed; additional metrics included ethical and equity considerations (e.g., low income), impacts on the neighborhood, and community involvement. A community representative was included in the process and was encouraged to discuss issues not included in the social indicator category. Curt said that this input was crucial when determining the importance and weight of specific criteria and allowed the focus to be on the issues that were important to stakeholders.

- Necessary Skill Set
  Curt commented on the skill set needed to help remediation professionals address the triple bottom line, saying that someone is needed who is good at communicating with stakeholders and people in general. He believes it is important to have a person on the team with a different perspective to help balance the viewpoints. On high-risk sites, Curt recommends including a facilitator to help stakeholders understand their common objectives.

Attachment 1
Case Study #1

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Evaluating Remediation Sustainability: Does it Matter Which Tool You Choose

Matt Vanderkooy, Michaye McMaster
mvanderkooy@geosyntec.com
November 12, 2013

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Objective

- Objective: Does Tool Choice Matter?
  - Same Remedy Choice?
  - Capabilities – Uncertainty & Optimize
  - Optimal Applications

Overview

- Contaminated Site
- Tools
  - SRT™, SiteWise™, SimaPro
- Using Tools
- Results
- Conclusions

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Contaminated Site

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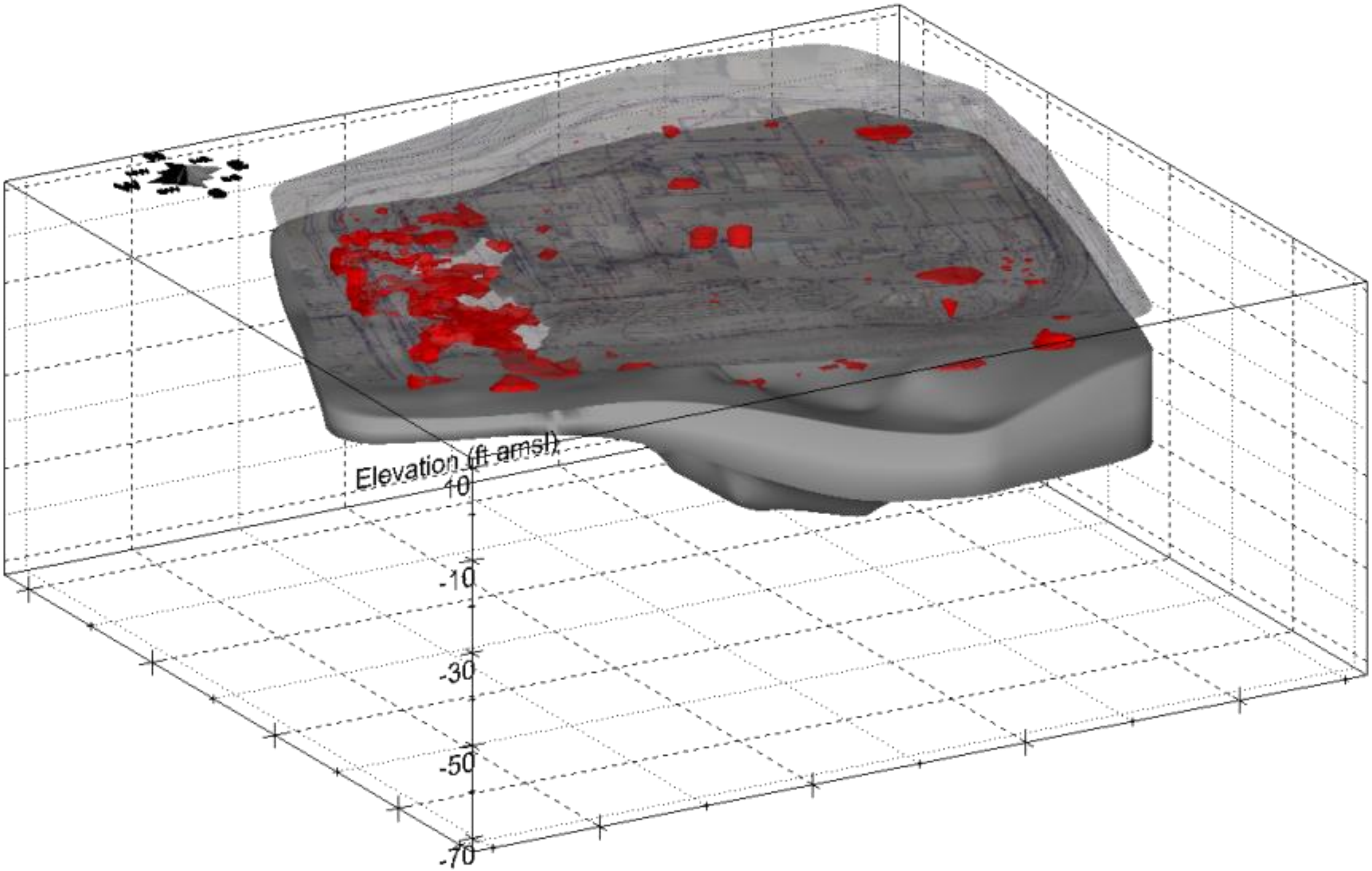
1954

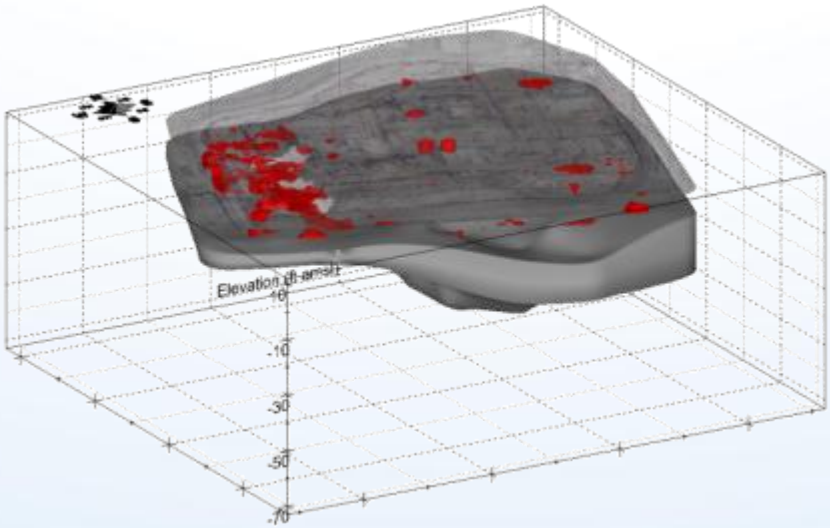
2013

925 tons of Coal Tar DNAPL in 56,000 yd^3 of Soil



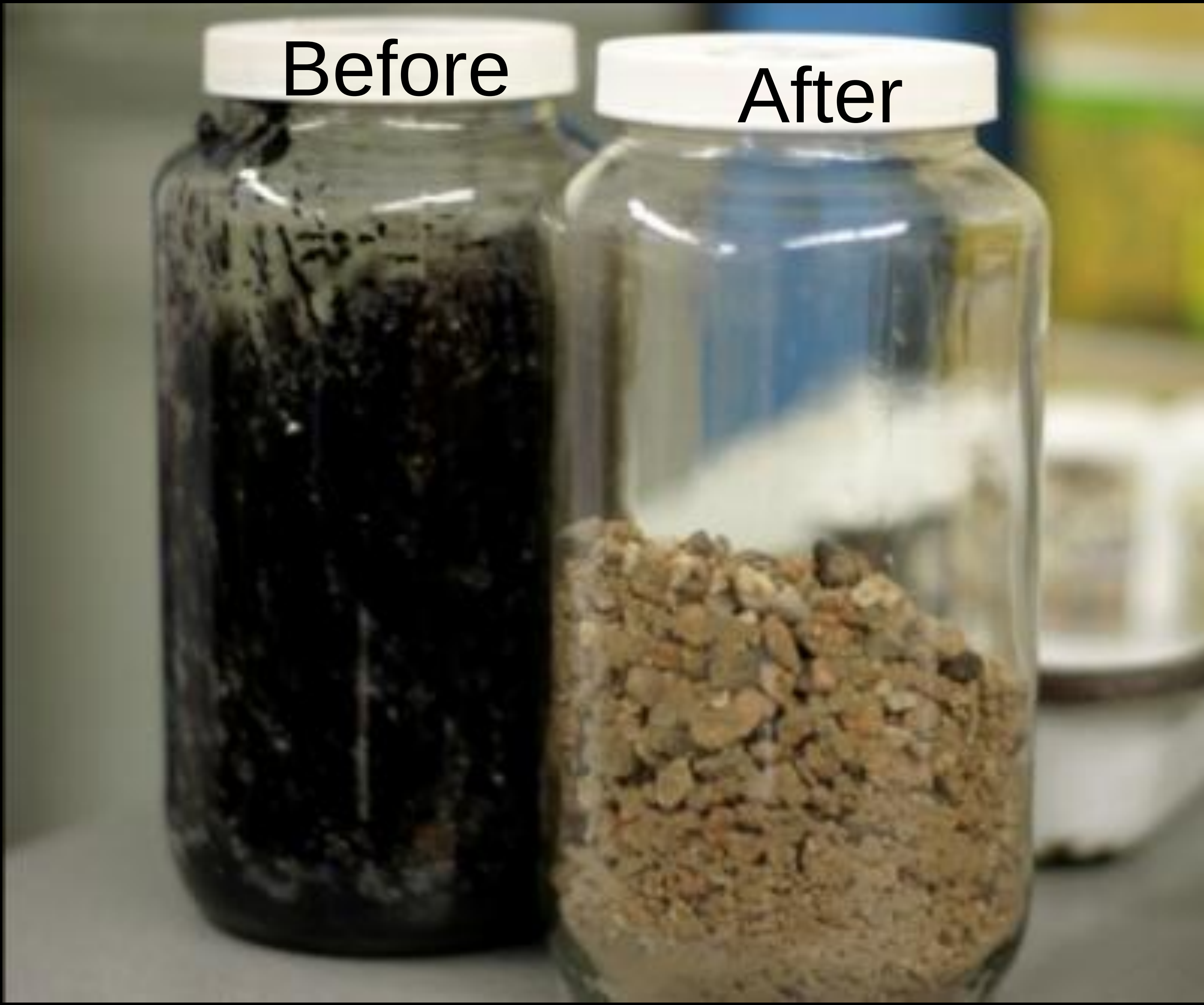
Remedies Evaluated

Short name	Expanded name
Excavation	Excavation & Off-Site Treatment
Thermal	In-Situ Thermal Stabilization
STAR	In-situ Smoldering Combustion



STAR is combustion:

1. Light DNAPL/NAPL on fire in situ
2. Supply Oxygen to Combustion Front
3. Extract and Treat Combustion Gases (mainly CO2 with some CO and VOCs)
4. End of BBQ → just a bit of ash
   End of STAR → clean soil


Before
After

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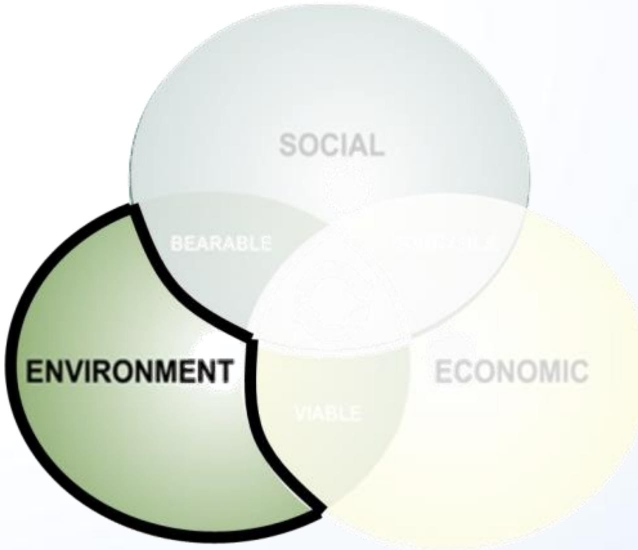
Sustainability Tools

Tool & Sustainability

- Triple Bottom Line
- Green Remediation

- **CO_2** → Climate Change Impacts
- **NO_x** → Green House Gas and Eutrophication
- **SO_x** → Acid Rain
- **PM_{10}** → Particulate Matter
- **Energy** → General Energy/Resource Usage



REMEDIATION Summer 2011

Paul J. Favara
Todd M. Krieger
Bob Boughton
Angela S. Fisher
Mohit Bhargava

Guidance for Performing Footprint Analyses and Life-Cycle Assessments for the Remediation Industry

Tools

Tool	Attributes
SRT™	• Publically Available • Plug and Play • Built in Data/Calculations • Inflexible
SiteWise™	• Publically Available • Requires Remediation Expertise • Has Remediation Focused Sustainability Data • Flexible
SimaPro	• Commercially Available • Requires Remediation Expertise • Comprehensive Sustainability Database • Flexible • Good Uncertainty and Contribution Analyses

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Modeling Remedies In the Tools

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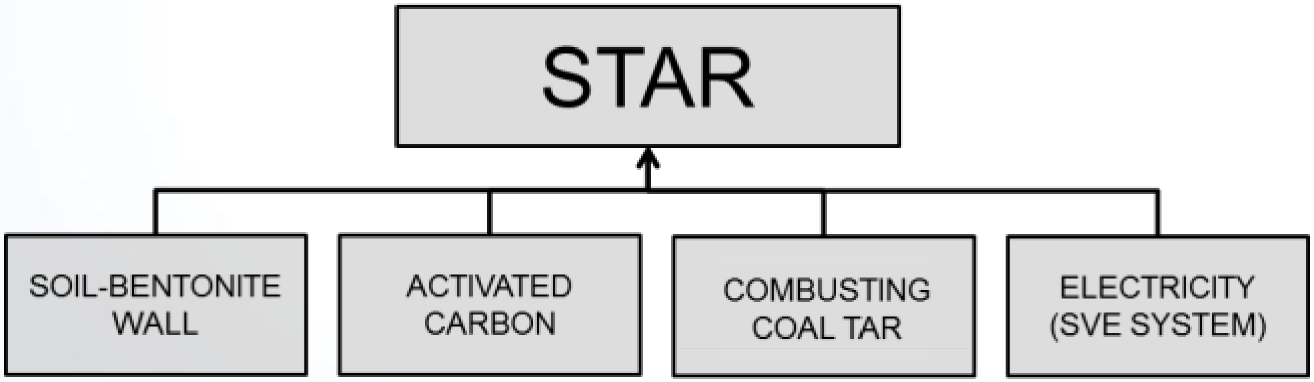
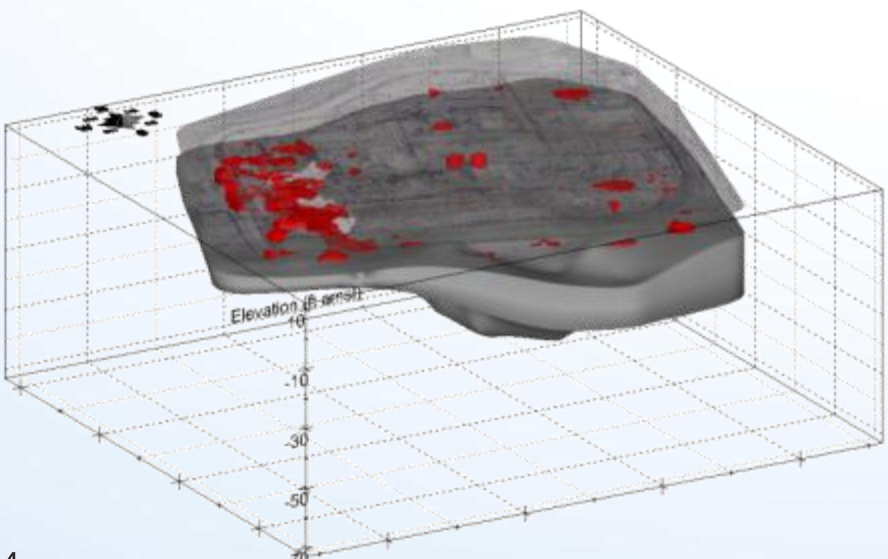
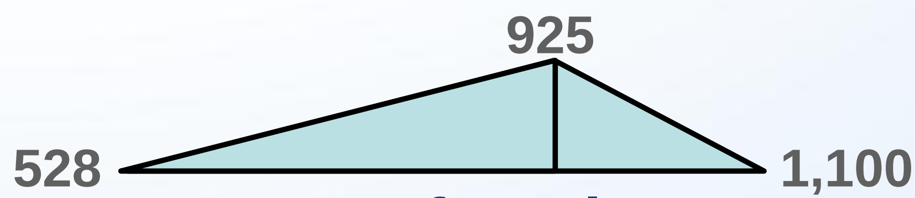
Identifying Inputs

- Identify Materials and Energy Used







Tons of Coal Tar

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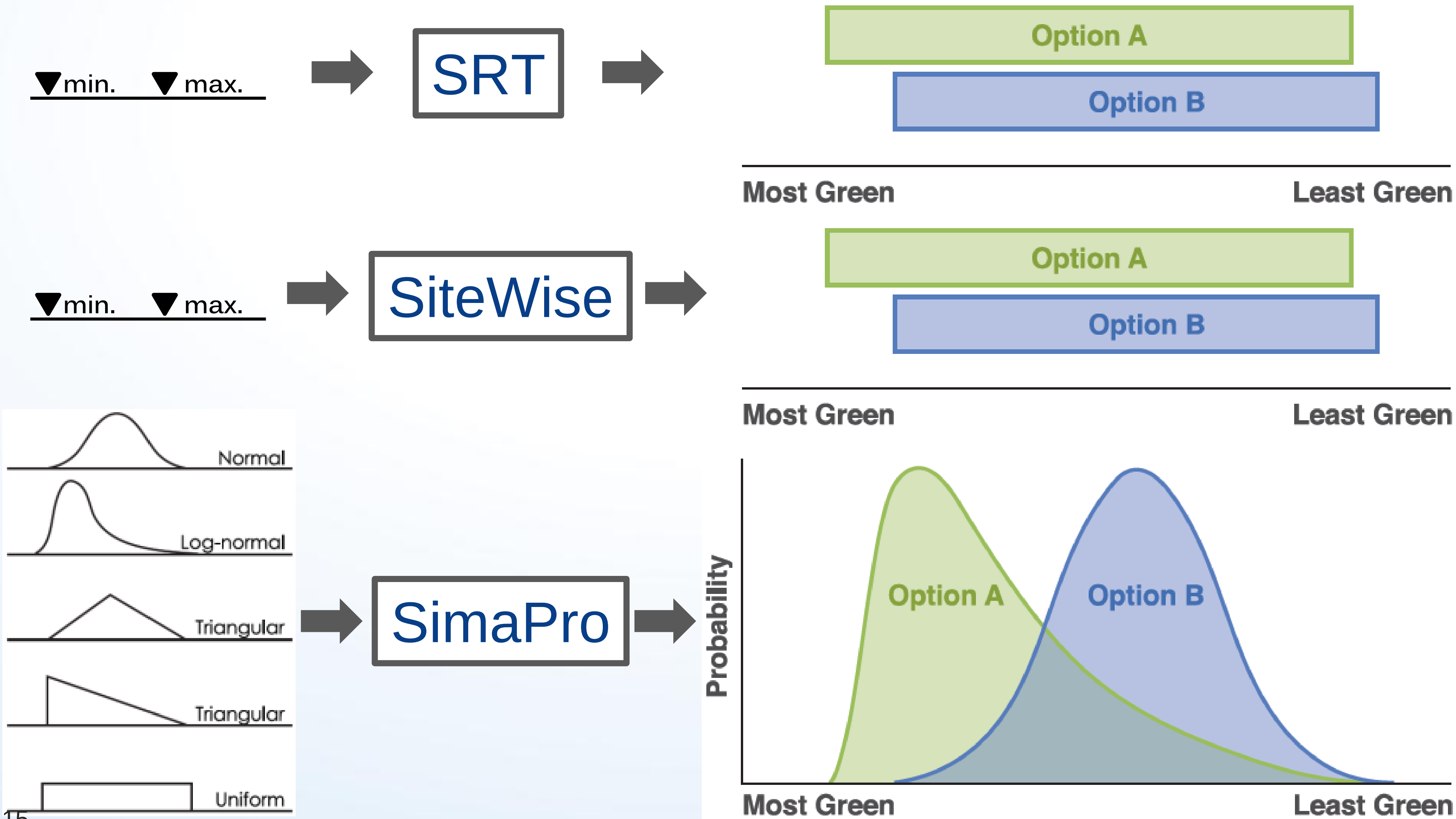
Analyzing Uncertainty



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Results

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Status

Calculating unce

Mean 741

SD 50.4

0.11
0.1
0.09

Phase	Activities	GHG Emissions metric ton	Total energy Used MMBTU	Water Consumption gallons	NOx emissions metric ton	SOx Emissions metric ton	PM10 Emissions metric ton	Accident Risk Fatality	Accident Risk Injury
Remedial Investigation	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Remedial Action Construction	Consumables	41.51	5.4E+02	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	763.94	9.6E+03	4.1E+04	1.0E+01	2.9E-01	5.2E-02	5.0E-06	1.3E-03
	Residual Handling	155.17	2.8E+03	NA	5.6E-01	2.9E-01	1.5E+00	2.1E-04	1.7E-02
	Sub-Total	960.63	1.29E+04	4.05E+04	1.09E+01	5.83E-01	1.60E+00	2.17E-04	1.83E-02
Remedial Action Operations	Consumables	2,270.84	1.3E+04	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	3,205.10	1.8E+04	8.6E+05	1.4E+00	6.0E+00	1.6E-02	1.6E-04	4.1E-02
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	5,475.94	3.04E+04	8.57E+05	1.41E+00	5.96E+00	1.56E-02	1.65E-04	4.15E-02
Longterm Monitoring	Consumables	0.00	0.0E+00	NA	NA	NA	NA	NA	NA
	Transportation-Personnel	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Transportation-Equipment	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Equipment Use and Misc	0.00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Residual Handling	0.00	0.0E+00	NA	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
	Sub-Total	0.00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total		**6.4E+03**	**4.3E+04**	**9.0E+05**	**1.2E+01**	**6.5E+00**	**1.6E+00**	**3.8E-04**	**6.0E-02**

Test - Notepad

File Edit Form

```
SimaPro 7.3

Database:
Project:
Calculation :
Method:
Aggregation:

Impact categ
Unit    m2a
Mean    2.1E
Median  1.53
SD      1.89
CV (Coeffici
2.5%    5.94E3  4.61E6  1.21E4  2.47E4  527  8.29E5  1.26E5  2.37E4  568  4.98E5  -96.8  0.106  7.33E3  1.28E4  1.4
97.5%   8.75E4  6.07E6  2.94E4  1.2E5  5.9E3  7.39E6  6.01E6  1.18E5  1.61E3  7.11E5  315  0.427  1.23E4  1.89E4  2.0
Std.err.of mean 0.0901  0.00679  0.0258  0.0714  0.0988  0.186  0.187  0.0675  0.0289  0.00877  0.138  0.0359  0.0125  0.0

Runs    100

        Agricultural land occupation    Climate change  Fossil depletion        Freshwater ecotoxicity  Freshwater eutrophi
        m2a     kg CO2 eq       kg oil eq       kg 1,4-DB eq    kg P eq kg 1,4-DB eq    kg U235 eq      kg 1,4-DB eq    kg
1       10582.377       5200959.8       11834.155       25306.116       3108.5879       1373250.1       1511248.9       268
2       18973.341       4830551.4       14752.021       42182.631       927.87176       3076354.6       272492.86       453
3       8070.0921       5073643.8       16899.389       68454.515       649.30473       1186835.5       395603.75       653
4       12211.192       5049777.3       18316.451       47905.606       932.01839       3040295.7       238353.35       495
5       9804.7027       4648747.4       12722.437       34811.473       802.17368       1403383.5       333989.22       364
6       29211.309       4638661.3       18778.631       58396.181       2122.4516       1572093.3       166844.48       580
7       37268.257       4784998.4       12349.001       22038.391       1055.9041       1024960.5       182312.3        229
8       20373.368       5020808.7       11866.264       92754.947       620.81071       1196172.6       413474.48       895
9       9421.7507       5023398 20453.701       75797.587       1236.2015       2819092 1315949.6       74590.866       787
10      8669.7016       5002380 23391.153       52971.076       1246.0524       4316726.7       927840.92       52431.486
11      25301.196       5574713.9       15545.955       37082.296       1928.4741       969614.33       412050.22       384
12      42220.374       5453174.4       14318.849       59473.462       1729.738        1828434.7       7207426.4       598
```

.227
.211
.106
.125
.108
.0274
.642
.113
.0298
.015
.0301
.164
.276
.0405

Results

Remedy	Rank
Best	1
Middling	2
Least	3

- **Philosophy:** Overall Results should be easy to understand like the table above

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SRT™ Ranking

Remedy	Tons CO_2	Tons NO_x	Tons SO_x	Tons PM_{10}	Energy (kWh)		Over All Score	Over All Rank
STAR								
Thermal	760	4	6	1.0	2,400,000		6	**1**
Excavation	12,000	99	0.095	5	44,000,000		9	**2**

Color	Scoring Legend
Green	- Lowest Value; Score 1
Yellow	- 2nd Lowest Value; Score 2
Red	- Highest Value; Score 3

Developing the ranking. Alternative ranking schemes possible – typically lead to same conclusion.

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SiteWise™ Ranking

Remedy	Tons CO_2	Tons NO_x	Tons SO_x	Tons PM_{10}	Energy (kWh)		Over All Score	Over All Rank
STAR	7,100	14	7.2	1.8	3,354,000		6	**1**
Thermal	34,000	160	160	0.77	40,560,000		10	**2**
Excavation	45,000	480	26	70	40,560,000		13	**3**

Color	Scoring Legend
Green	- Lowest Value; Score 1
Yellow	- 2nd Lowest Value; Score 2
Red	- Highest Value; Score 3

Developing the ranking. Alternative ranking schemes possible – typically lead to same conclusion.

SimaPro - Ranking

Impact Categories[4]	Values			Units[4]
	STAR	Thermal	Excavation	
Agricultural land occupation	32,400	201,000	80,300	m^2a
Climate change	4,920,000	38,400,000	41,900,000	kg CO_2 eq
Fossil depletion	9,130	123,000	138,000	kg oil eq
Freshwater ecotoxicity				
Freshwater eutrophication				
Human toxicity				
Ionizing radiation				
Marine ecotoxicity				
Marine eutrophication				
Metal depletion				
Natural land transformation				
Ozone depletion				
Particulate matter formation				
Photochemical oxidant formation				
Terrestrial acidification				
Terrestrial ecotoxicity				
Urban land occupation				
Water depletion				

Impact Categories	Values and Ranks			Units[3]
	STAR	Thermal	Excavation	
Agricultural land occupation	5.97	36.9	14.8	/pers/years
Climate change	713	5,570	6,070	/pers/years
Fossil depletion	7.08	95.3	107	/pers/years
Freshwater ecotoxicity	3,660	49,800	55,900	/pers/years
Freshwater eutrophication				
Human toxicity				
Ionising radiation				
Marine ecotoxicity				
Marine eutrophication				
Metal depletion				
Natural land transformation				
Ozone depletion				
Particulate matter formation				
Photochemical oxidant formati				
Terrestrial acidification				
Terrestrial ecotoxicity				
Urban land occupation				
Water depletion				
Summed Weighted Rankings (Normalized Single Score)[2]	2			
Remedial Alternative Ranking[4]	1			

Impact Categories[4]				
	STA			
Agricultural land occupation	1			
Climate change	1			
Fossil depletion	1			
Freshwater ecotoxicity	1			
Freshwater eutrophication	1			
Human toxicity	1			
Ionizing radiation	1			
Marine ecotoxicity	1			
Marine eutrophication	1			
Metal depletion	1			
Natural land transformation	1	2	3	--
Ozone depletion	1	2	3	--
Particulate matter formation	1	2	3	--
Photochemical oxidant formation	1	2	3	--
Terrestrial acidification	1	2	3	--
Terrestrial ecotoxicity	1	3	2	--
Urban land occupation	1	2	3	--
Water depletion	1	2	3	--
Summed Normalized Rankings	18	40	50	--
Remedial Alternative Ranking[5]	1	2	3	--

Remedy	SimaPro Rank
STAR	1
Thermal	2
Excavation	3

SimaPro - Ranking

Remedy	SimaPro Rank
STAR	1
Thermal	2
Excavation	3

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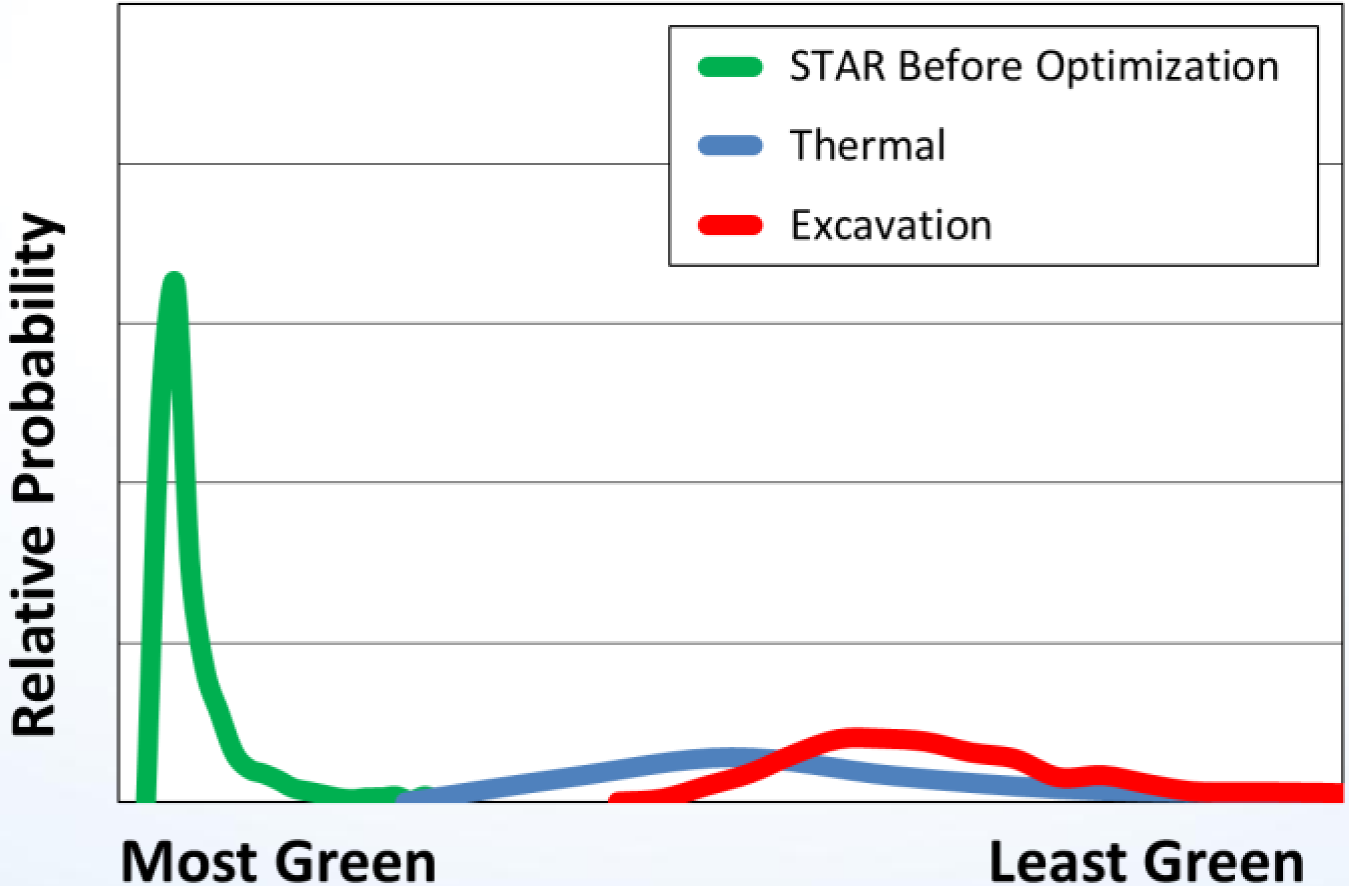
Tool Comparison

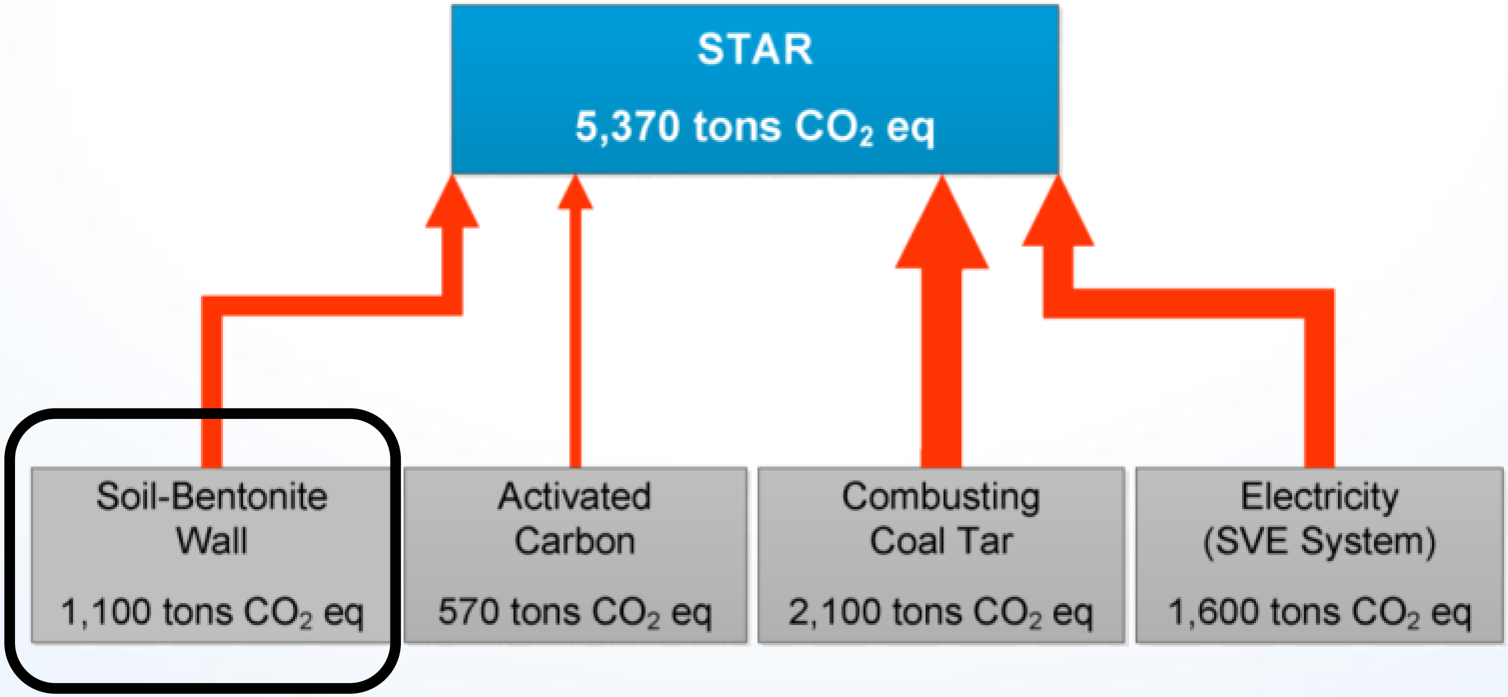
Remedy	SRT Rank	SiteWise Rank	SimaPro Rank
STAR		1	1
Thermal	1	2	2
Excavation	2	3	3

- **Tools reach same conclusion**
- **What about uncertainty analyses and optimization?**
  - **SRT™ poor :: SiteWise™ Good :: SimaPro Best**

Analyze Uncertainty - SimaPro

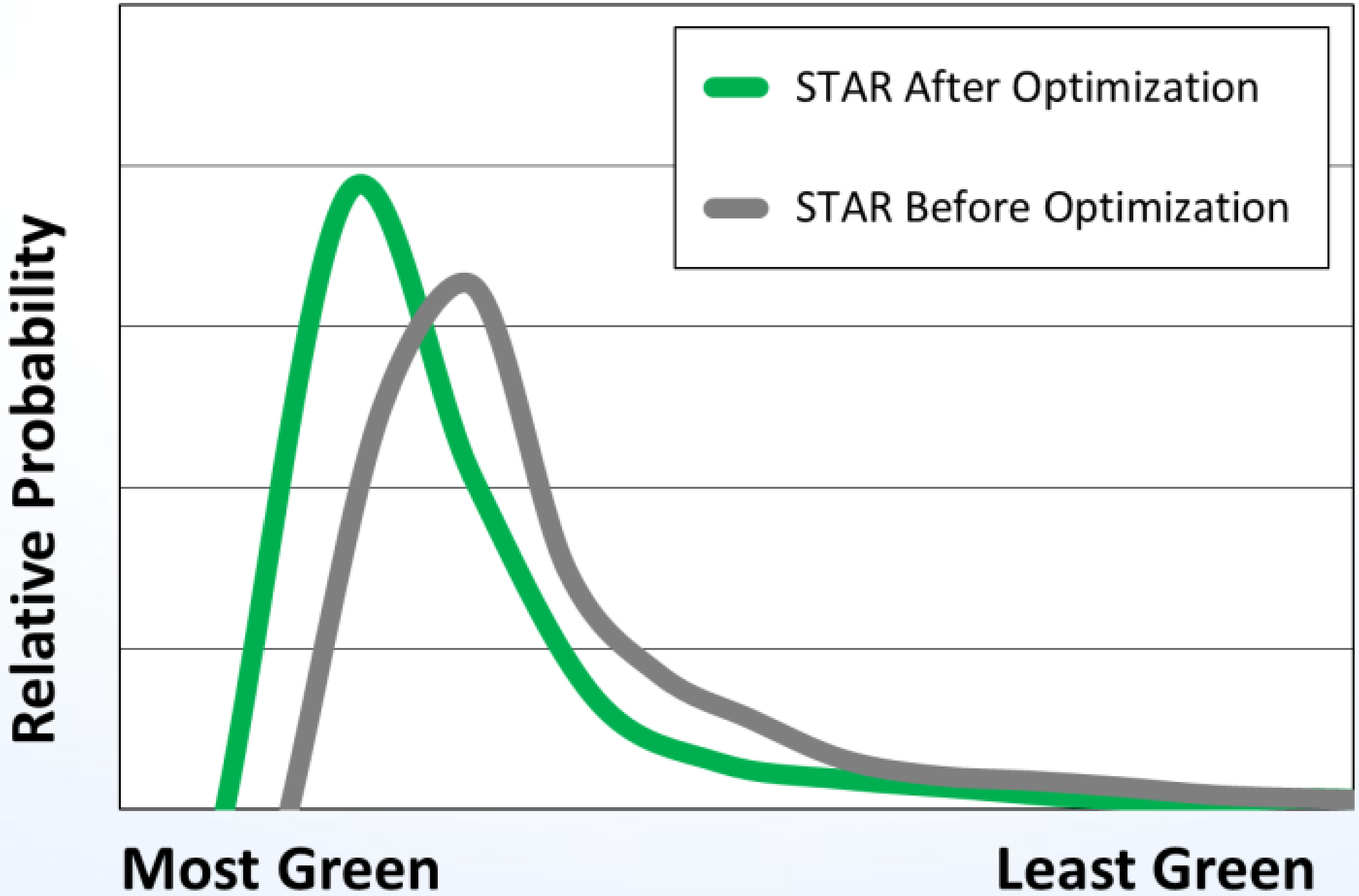


Climate Change Impacts



STAR	5,370 tons CO_2 eq
Thermal	42,300 tons CO_2 eq
Excavation	46,186 tons CO_2 eq

Optimize - SimaPro



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Conclusions

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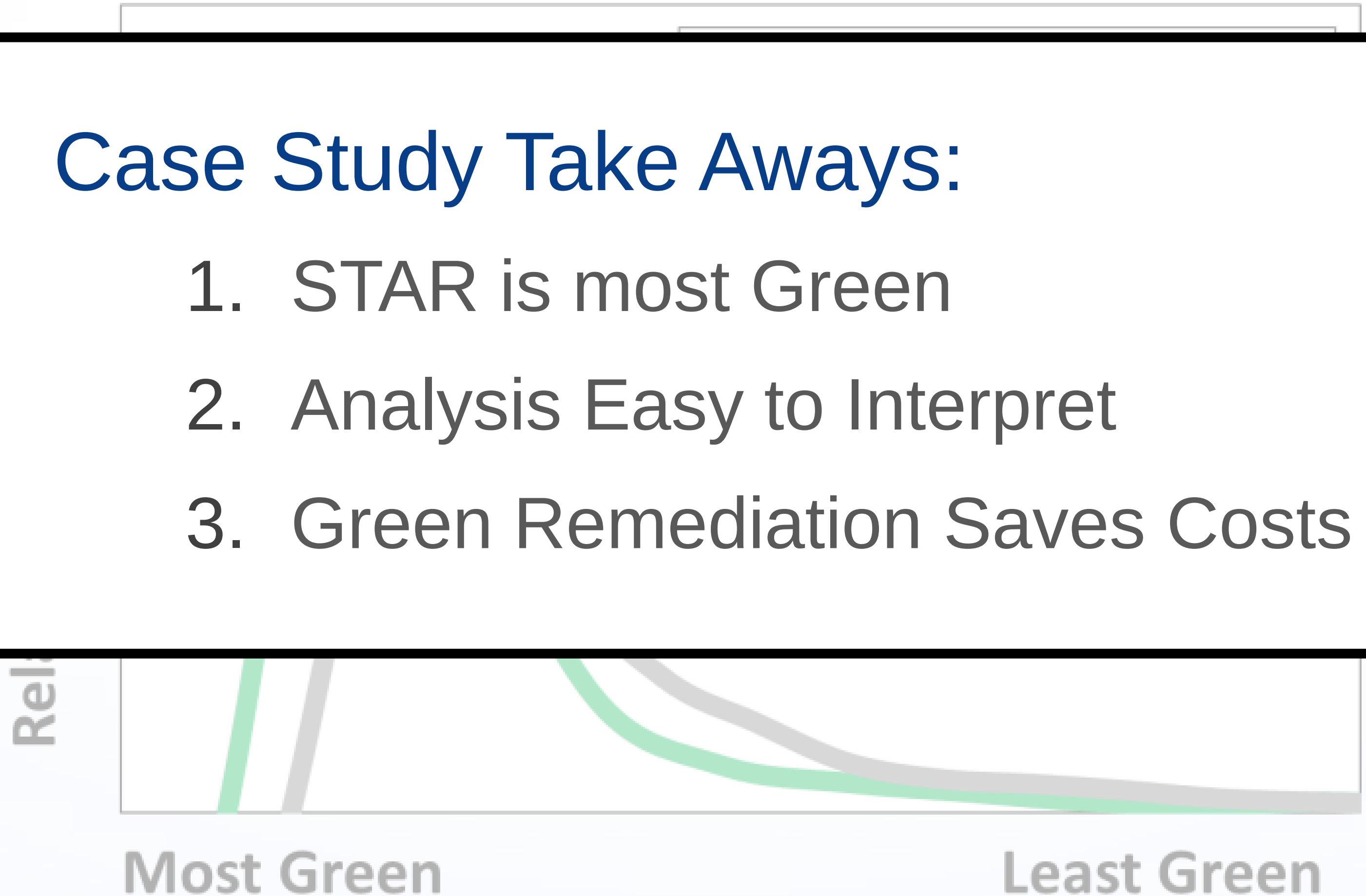

Case Study Take Aways:

1. STAR is most Green
2. Analysis Easy to Interpret
3. Green Remediation Saves Costs

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Conclusion – Tools

- SRT
  - Screening, Simple, Not Flexible
- SiteWise™
  - More Detailed & Flexible
- SimaPro
  - Detailed & Flexible
  - Good at Uncertainty & Optimization
  - Similar Evaluation Cost to SiteWise™

Geosyntec consultants

Thanks, Questions, & Discussion

Matt Vanderkooy
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Attachment 2
Case Study #2

Benchmarking Sustainable Remediation Decision-Support Tools for Use in a Tiered Assessment Framework

Jonathan Smith, Gavin Kerrison & Curt Stanley
Shell Global Solutions – HSE Services

Disclaimer

The companies in which Royal Dutch Shell plc directly or indirectly owns investments are separate entities. In this presentation the expressions "Shell", "Group" and "Shell Group" are sometimes used for convenience where references are made to Group companies in general. Likewise the words "we", "us" and "our" are also used to refer to Group companies in general or those who work for them. The expressions are also used where there is no purpose in identifying specific companies.

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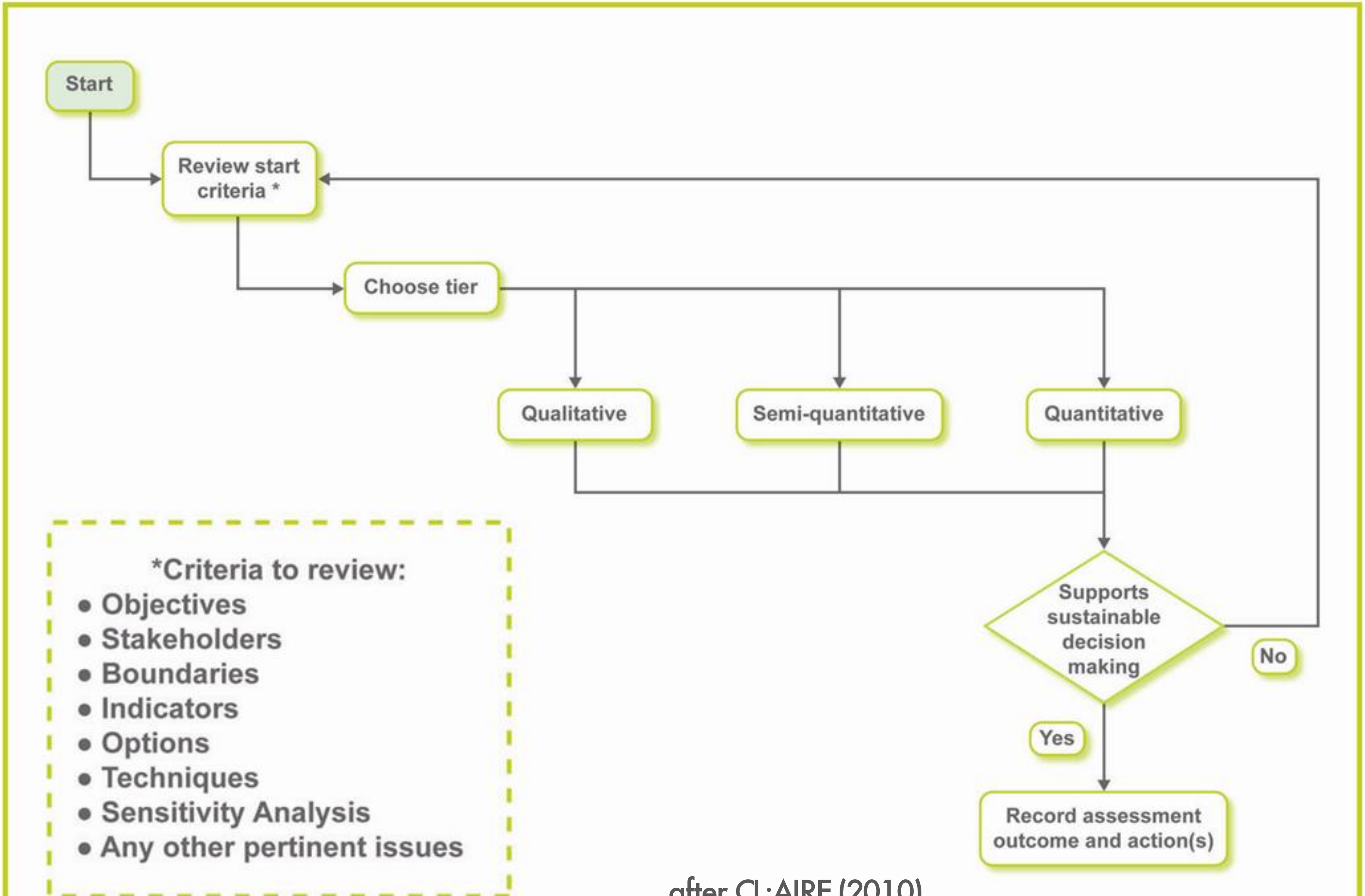
Take-away Message

- Benchmarking shows simple and rapid sustainability assessments can result in robust remediation decisions

PROJECT OBJECTIVES

- To 'road-test' the SuRF-UK sustainable remediation framework
  - Retail filling station in UK
- To compare a single remediation project under different sustainability appraisal tools (e.g. SuRF-UK tier 1-3)
  - Ease of application, and assessor/auditor skill requirement
  - Cost and time
  - Data requirements
  - **Consistency of resulting environmental management decision**
- To collect evidence to inform selection of an appropriate tier of sustainability assessment

SuRF-UK Tiered Assessment Framework



after CL:AIRE (2010)

Scope of sustainability appraisal

- Sustainability appraisal objectives
- Stakeholders
- Boundaries
  - Spatial
  - Temporal
  - Life-cycle
- Sustainability indicators

SuRF-UK sustainable remediation indicator categories

Environmental	Social	Economic
1. Impacts on air (including climate change; 2. Impacts on soil; 3. Impacts on water; 4. Impacts on ecology; 5. Use of natural resources and generation of wastes; 6. Intrusiveness.	1. Impacts on human health and safety; 2. Ethical and equity considerations; 3. Impacts on neighbourhoods or regions; 4. Community involvement and satisfaction; 5. Compliance with policy objectives and strategies; 6. Uncertainty and evidence.	1. Direct economic costs and benefits; 2. Indirect economic costs and benefits; 3. Employment and capital gain; 4. Gearing; 5. Life-span and 'project risks'; 6. Project flexibility.

Benchmarking approach

- Sequential process. Start simple, progress through tiers.
- Qualitative
  - A 'round-table conversation'
  - High/Medium/Low rating for each factor
- Semi-quantitative – Multi-Criteria Analysis
  - Spreadsheet-based
  - Scoring and weightings applied
- Quantitative – Cost-Benefit Analysis
  - Environmental Economic consultancy undertook detailed CBA.
  - CBA considered and used to inform a decision by assessors

Sustainable Assessments Outcome (selected options)

Rank	Tier 1 (Qual.)	Tier 2 (MCA)	Tier 3 (B/C ratio) (CBA)
1	A, B, C	B	A (1.27)
2		A	B (1.09)
5		C	C (0.97)
8		D	F (0.86)
11	E		D (0.8)
14	D, G	E, G	E (0.58)
15	F	F	G (0.4)

A	DPVE
B	DPVE+MNA
C	In situ bioremediation
D	P&T
E	Excavate & dispose
F	Receptor treatment
G	Do nothing

FINDINGS #1

	Qualitative	Semi-quantitative	Quantitative
Time/effort	0.5 – 1 day	1 – 3 days	~1 week
Data	Generic data generally adequate		Site-specific valuation necessary
Practicability: Individual assessor	OK. Sufficiently simple ranking	Difficult to represent range of views	OK – relies on external valuation data
Practicability: Stakeholder group	OK. Sufficiently simple ranking. Enjoyable process!	OK. Considerable debate on scores	OK – debate centred on assumptions embedded in CBA
Summary	Able to differentiate between different types of remediation option. Not able to resolve subtlety. Quick, easy.	Added numbers to qualitative assessment, but debateable whether added robustness. Difficult with a single assessor.	Able to resolve subtlety . Full CBA data hungry – use partial CBA where difference between options. Not all valuation data exists.

FINDINGS #2

- Objectives of sustainability assessment must be clear
  - Scope of assessment must be clear, and agreed, by all parties
- Sustainability factor definition is critical
  - All parties need to be clear what they are scoring/valuing
  - Care needed to avoid double counting, or omission
- Remediation selection

CONCLUSIONS

- Ranking of remediation options is similar in all 3 tiers
  - Management decision was very similar at all tiers
- Clear rules, definitions and participant understanding are critical
- Tiers
  - Qualitative assessment successfully distinguishes between groups of options
  - Quantitative assessment necessary to distinguish subtly different options
  - Start simple, and quantify only where needed to resolve complexity
- For ‘simple’ remediation decisions (e.g. an operational site, no land-use change), a low-tier assessment was robust