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ENIRONMENTAL SITE REMEDIATION: ARE WE REALLY HELPING THE PLANET

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The Environment
Where we live and work vs the Planet

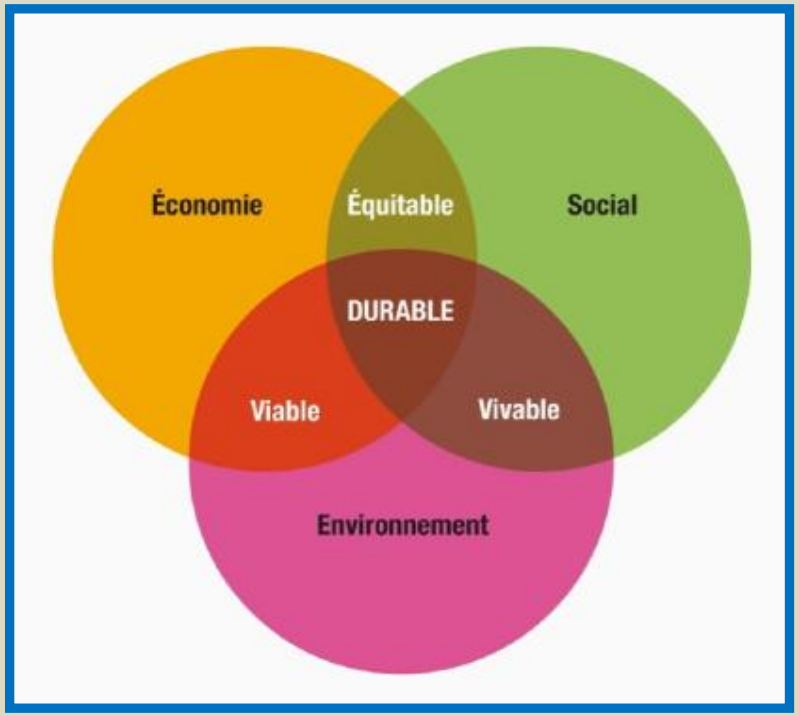
Quebec Regulations

- Environmental Quality Act (1972), Section IV, art. 20: no one is permitted to emit or allow to be emitted a contaminant into the environment above legal standards.
- Environmental Policy for the protection of soils and the remediation of contaminated sites (MDDEP - 1988).
- The environmental Law 72 and regulations concerning the protection and remediation of sites (2003).
- Law 42 on Greenhouse gases – is a project submitted for review.

OBJECTIVES

- In the spirit of sustainable development we must learn to expand our understanding of «the environment» when planning an environmental remediation of a contaminated site.
- Demonstrate that there can be very negative impacts on the environment as a result of a site decontamination.
- Note that at least the Quebec laws are failing to adequately address this issue by a lack of regulation and a «fermeture d'esprit» toward change.
- To suggest a different approach.

SUSTAINABLE DEVELOPMENT



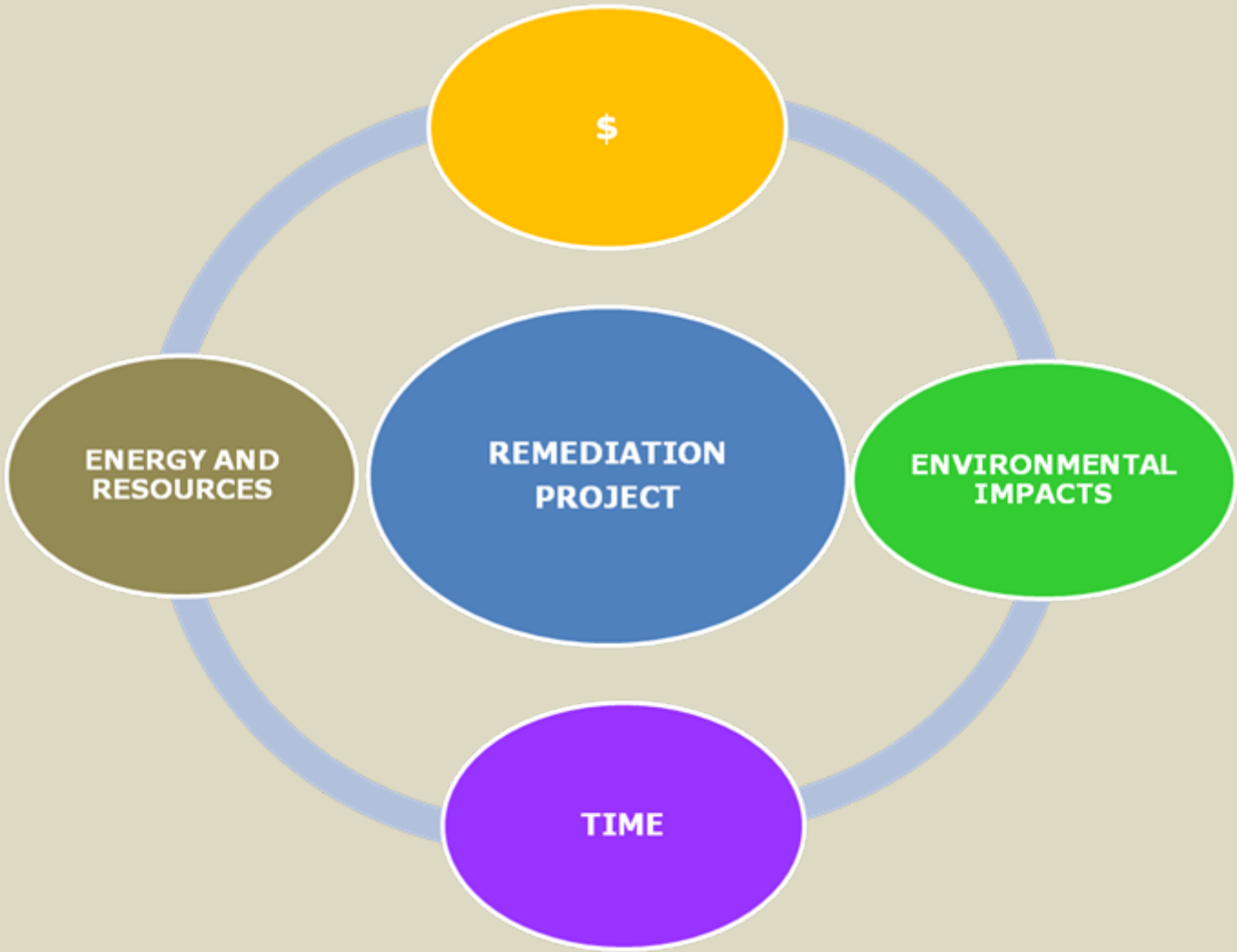
- **Viable**
  - The zone in which economic growth is based upon renewable resources.

- **Vivable (What is this in English)**
  - Where society and the environment coexist.

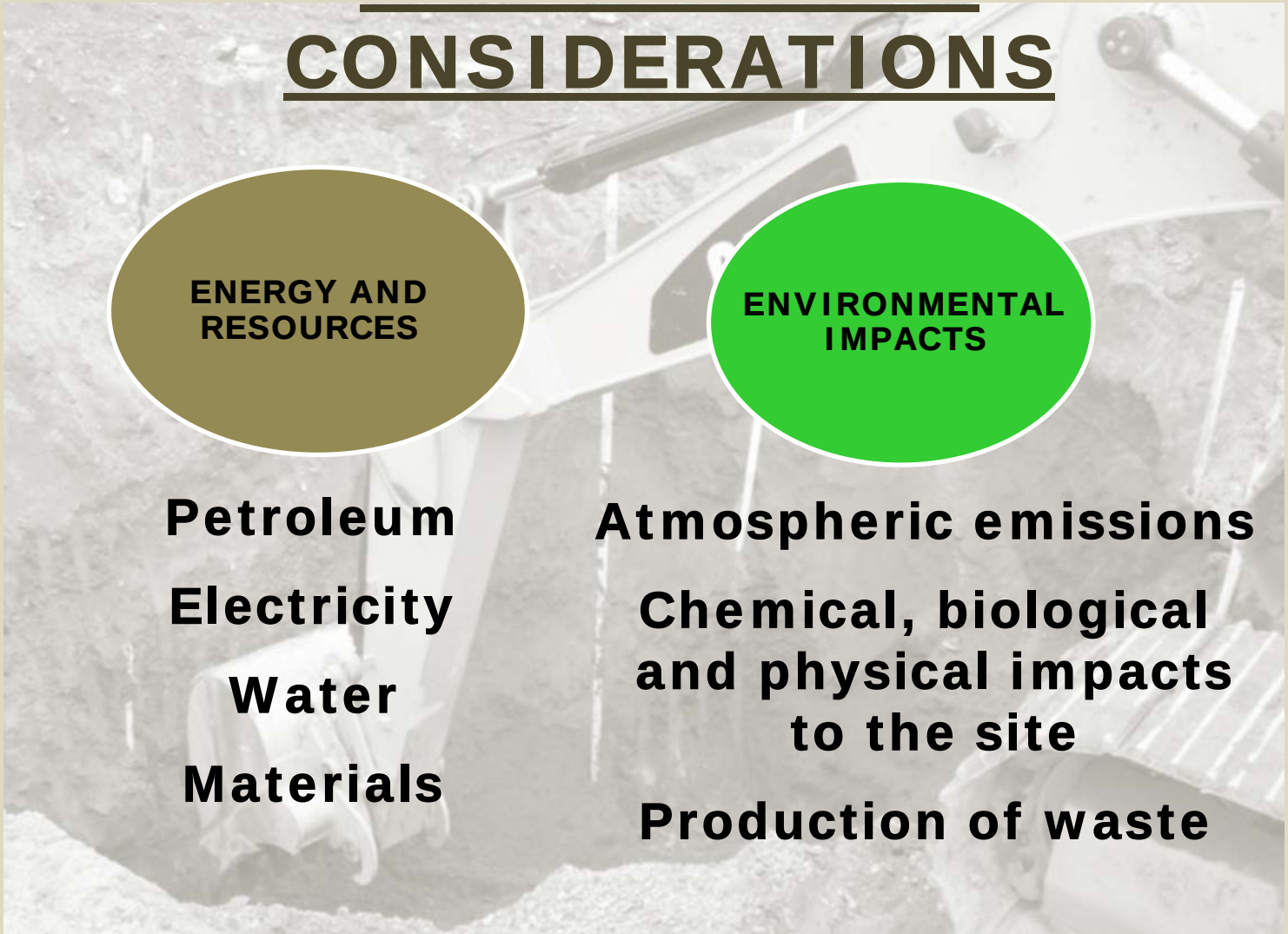
- **Equitable**
  - Equitable commerce respecting human rights.

- **SUSTAINABLE (Durable)**
  - The area where aspects of the economy, society and the environment exist in harmony. Heaven maybe?

MAIN CONSIDERATIONS IN THE SELECTION OF A REMEDIAL APPROACH



SUSTAINABLE DEVELOPMENT CONSIDERATIONS



EXAMPLES

1) Two site remediation projects using excavation and disposal technics (dig and dump)

2) One site remediation project using in situ technics

STEPS CONSIDERED

- EXCAVATION
- WATER MANAGEMENT
- TRANSPORT
- BACKFILL

EXAMPLE 1

- Site is located in a remote area (way long gone)
- Volume of impacted soil and parameters of concern
  - 5 600 m^3 : petroleum hydrocarbons C_{10}-C_{50} and BTEX
- Mass of contaminants
  - approximately 10 tonnes (HP C_{10}-C_{50} , BTEX)
- Groundwater Management (HP C_{10}-C_{50} ,BTEX)

  Over 150 000 litres recovered in 4 carbon cannisters
- Excavation
  - 500 hours of hydraulic shovel
  - 100 hours of loader
- Backfill
  - 5 000 m^3 clean gravel backfill (500 truck deliveries)
  - Gravel pit was situated approximately 100 m from the site
- Transport of impacted soils to «dump» destination
  - 369 trips with trucks
  - Destination : soil treatment center approximent 300 km distant

EXAMPLE 1
CONTEXT

1) Expropriation (oddly enough it was expropriated for environmental reasons)

2)Timeframe - Once negotiated with gov't – ASAP

3)Cost - 1M - timeframe took precedent

4)Regulation - Application of Law 72

4.1) Energy and material use – Not considered

4.2) Environmental impacts – Not considered

ENERGY AND RESOURCES

EXAMPLE 1

PARAMETERS CONSIDERED	
Petroleum products used (L)	129 500
Électricity consumed (kWh)	Minimal
Water consumed (L)	Minimal
Natural resources used	5 000 m^3 of clean gravel fill
Reduce / reuse / recycle (JJ)	Soils were treated at a recycling centre

GREENHOUSE EMISSIONS t.m. CO_2 Equivalent - Example 1

activity		Petro consumed (L)	Incertitude (+/- L)	CO_2 (t.m.)	Incertitude (+/- t.m.)	CH_4 (t.m.)	Incertitude (+/-t.m.)	N_2O (t.m.)	Incertitude (+/- t.m.)	CO_2 equivalent (t.m)	Incertitude (+/-t.m)
Transport	Gasoline	0	0	0,0	0	0	0	0	0	**0**	**0**
	Diesel	109 347	0	299	0	0,013	0	0,009	0	**302**	**0**
Excavation	Gasoline	0	0	0,0	0	0	0	0	0	**0**	**0**
	Diesel	20 110	1190	55	3	2e-3	1e-3	2e-3	1e-3	**56**	**3**
TOTAL										**358**	**3**

Note: 1 L of diesel = 2,73 kg of CO_2

ENVIRONMENTAL IMPACTS

EXAMPLE 1

PARAMETERS CONSIDERED	
Greenhouse Gas emissions (t.m. eq CO_2)	358
Biological and microbiological	-Sedimentation impacts to a near by river - emissions of VOCs to atmosphere
Physical impacts	Disturbed soils and relatively poor compaction
Waste production	Construction debris Treated groundwater
Varia	Liberation of CO_2 during soil treatment and manipulation and the production of gravel backfill

PERSPECTIVES
Example 1

Petro used (L)	emission of CO_2 (t.m. CO_2 eq)	Equivalent Kilometers a small car (km)*	How many times around the world**	Volume of contaminant addressed by the project (approx in L)
129 500	358	1 592 760	40	12,000

*: 9.2 L/100km (Office de l'efficacité énergétique, Guide des données de la consommation d'énergie août 2006)
**:equateur equals 40 075 km.
***:http://www.mddep.gouv.qc.ca/changements/ges/2005/inventaire2005.pdf

EXAMPLE 2

- Site is located in Montreal
- Volume of impacted soil and parameters of concern
  - 20 000 m^3 (PAH , petroleum hydrocarbons C_{10}-C_{50})
- Mass of contaminants
  - Approximately 20 tonnes
- Excavation
  - 2 800 hours of hydraulic shovel
  - 1 850 hours of loader and bull
- Backfill
  - 7 400 m^3 of clean sand
  - 29 000 m^3 of previously treated soil
  - Transport
  - 2 300 trips of truck

EXAMPLE 2
CONTEXT

1)	Sale of the property	
2)	Timeframe	- Immediate
3)	Costs	- cost vs the purchase price
4)	Regulations	- grey zone
4.1)	Energy and materials	– Not considered
4.2)	Environmental Impacts	– Not considered

ENERGY AND MATERIALS

EXAMPLE 2

PARAMETERS CONSIDERED	
Petro used (L)	160 000
Electricity used (kWh)	Minimal
Water used (L)	Minimal
Material used	Treated soils and backfill
Reduce /reuse/recycle	Concrete and excavated clean soils

GREENHOUSE EMISSIONS
t.m. CO_2 Equivalent - Example 2

Activity		Petro Used (L)	Incertitude (+/- L)	CO_2 (t.m.)	Incertitude (t.m.)	CH_4 (t.m.)	Incertitude (+/- t.m.)	N_2O (t.m.)	Incertitude (+/- t.m.)	CO_2 Equivalent (t.m éq.)	Incertitude (+/- t.m éq.)
Transport	Gasoline	4 450	484	11	1	53^{e}-5	6^{e}-5	12^{e}-4	1^{e}-4	**11**	**1**
	Diesel	21 075	422	58	1	253^{e}-5	5^{e}-5	169^{e}-5	3^{e}-5	**59**	**1**
Excavation	Gasoline	0	0	0	0	0	0	0	0	**0**	**0**
	Diesel	134 666	9 190	368	25	16^{e}-3	1^{e}-3	108^{e}-4	7^{e}-4	**372**	**25**
TOTAL										**442**	**27**

ENVIRONMENTL IMPACTS

EXAMPLE 2

PARAMETERS CONSIDERED	
Greenhouse gas emissions (t.m. eq CO_2)	442
Biological and microbiological	- Cutting of a stand of trees -Displacement of an Hawk's nest and a fox den - Liberation of VOC into the atmosphere
Physical aspects	The geotechnical properties of the soil were modified by rework and the importation of treated soil.
Waste production	Construction debris
Varia	Loss of a small green space in the stand of trees cut down.

PERSPECTIVES
Example 2

Petro used (L)	CO_2 emissions (t.m. CO_2 eq)	equivalents kilometres for a small car (km)*	Equivalent trips around the world**	Volume of contaminant addressed by the project (approx in L)
160 000	442	1 966 480	49	24,000

*9.2 L/100km (Office de l'efficacité énergétique, Guide des données de la consommation d'énergie août 2006)
**:equateur equals 40 075 km.
***:http://www.mddep.gouv.qc.ca/changements/ges/2005/inventaire2005.pdf

EXAMPLE 3 - IN SITU

- Service – Station located in a remote area (way long gone number 2)
- Volume of impacted soil and parameters of concern
  - 370 m^3 BTEX
  - Soils requiring excavation to reach the impacts: 5400 m3
  - Impacted groundwater as well (at 9 meters)
- Mass of contaminants
  - 370 kg
- Treatment via chemical oxidation
  - 6 000 L H_2O_2
  - 3 300 L solution metal chelates
  - 5 000 L water
- Transport
  - Chemical products: 12 000 km of tanker truck
  - Personal: 24000 km of personnel vehicules

EXAMPLE 3
CONTEXT

1) Removal of underground tanks

2) Timeframe - 3 years

3) Cost - Excavation too expensive
- in situ more reasonable

4) Regulations: - Application of Law 72

4.1) Energy requirements - Not considered

4.2) Environmental Impacts – Not considered

ENERGY AND RESOURCES

EXAMPLE 3

PARAMETERS CONSIDERED	
Petro used (L)	5 100
Electricity used (kWh)	Minimal
Water used (L)	5 000
Materials used	Piping and chemical products
Reduce / reuse / recycle	- chemical storage tanks and infrastructure

GREENHOUSE EMISSIONS
t.m. CO_2 Equivalent - Example 3

Activity		Petro-used (L)	Incertitude (+/- L)	CO_2 (t.m.)	Incertitude (+/- t.m.)	CH_4 (t.m.)	Incertitude (+/- t.m.)	N_2O (t.m.)	Incertitude (+/- t.m.)	CO_2 Equivalent (t.m éq.)	Incertitude (+/- t.m éq.)
Transport	Gasoline	2 208	0	5,2	0	0,0003	0	0,0005	0	**5,4**	**0**
	Diesel	2 888	0	7,9	0	0,0003	0	0,0002	0	**8,0**	**0**
Excavation	Gasoline	0	0	0,0	0	0	0	0	0	**0**	**0**
	Diesel	0	0	0	0	0	0	0	0	**0**	**0**
TOTAL										**13,4**	**0**

ENVIRONMENTAL IMPACTS

EXAMPLE 3

PARAMETERS CONSIDERED	
Petro used (L)	5 100
Greenhouse gas emissions (t.m. eq CO_2)	13,4
Biologic and microbiologic	Not evaluated, but definite changes to the groundwater regime and vadose zone to be expected
Physical state	negligible
Waste production	negligible
Varia	Site looks good

PERSPECTIVES
Example 3

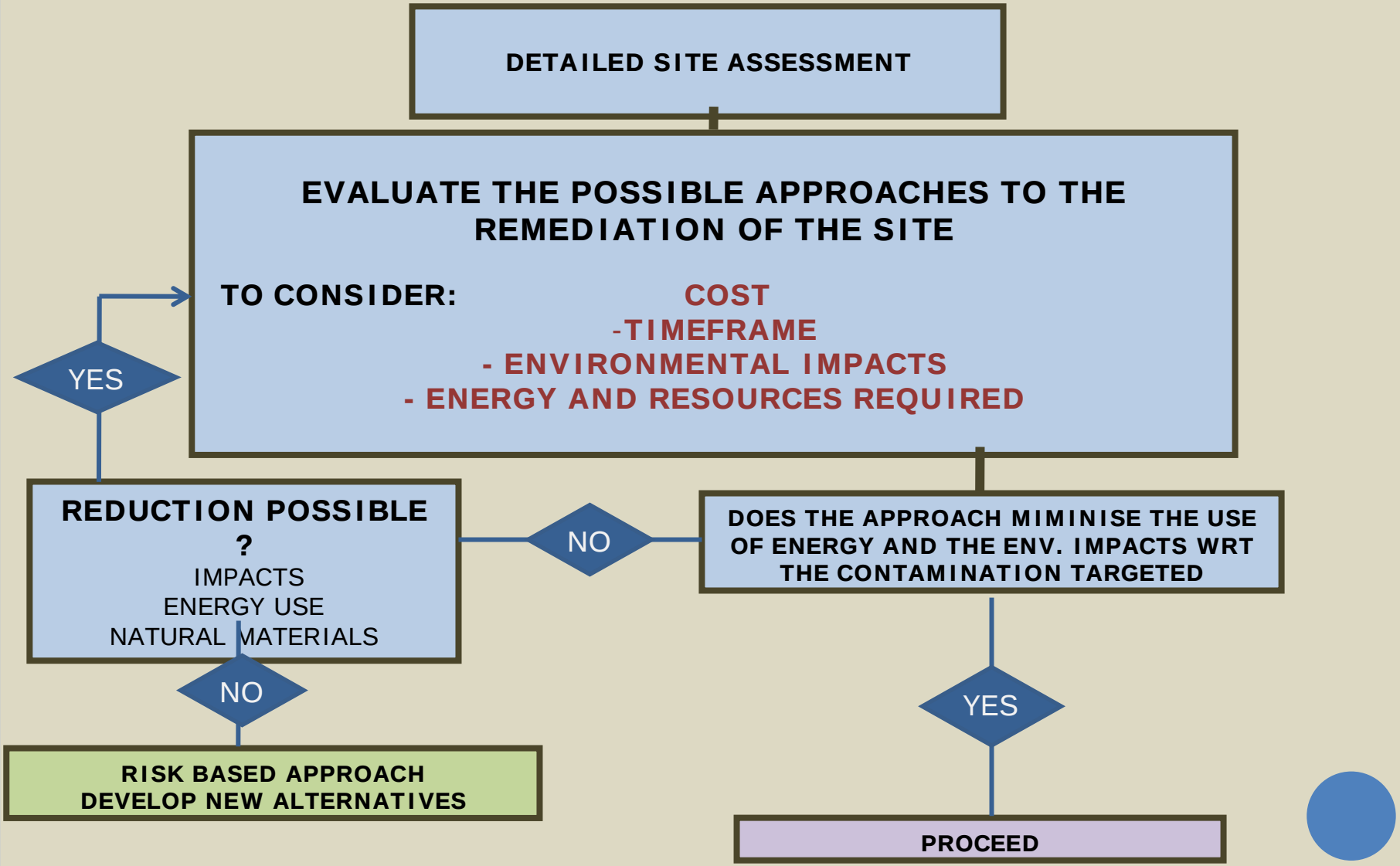
Petro used (L)	CO_2 emissions (t.m. CO_2 eq)	Equivalents kilometres for a small car (km)*	Equivalent trips around the world**	Volume of contaminant addressed by the project (approx in L)
5 100	13	59 617	1,5	500

*: 9.2 L/100km (Office de l'efficacité énergétique, Guide des données de la consommation d'énergie août 2006)
**:equateur equals 40 075 km.
***:http://www.mddep.gouv.qc.ca/changements/ges/2005/inventaire2005.pdf

Comparisons

Project	Contaminant treated (L)	Greenhouse Gas emissions (CO_2 t.m. equivalent)	Petrol used (L)
Example 1 Excavation	12 000	358	129 500
Example 2 Excavation	24 000	442	160 000
Example 3 *In situ*	500	13	5 100
Note: *in-situ project evaded the excavation of 5 500 m^3 of soil thus 20 000 litres of petrol used and 60 tonnes greenhouse gas*			

SUSTAINABLE DEVELOPMENT APPROACH



CONCLUSIONS

- WE NEED MORE INNOVATION AND FLEXIBILITY TO BE ABLE TO BETTER BRING OUR ENVIRONMENTAL PROJECTS (AND INDUSTRY) IN LINE WITH THE SUSTAINABLE DEVELOPMENT PHILOSOPHY.

- OUR LAWS DO NOT ADDRESS OUR INDUSTRY WITH A SUSTAINABLE DEVELOPMENTAL PHILOSOPHY.

- ENVIRONMENTAL PROJECTS FOR SITE DECONTAMINATION SHOULD HAVE REVIEWED AND INCLUDED A SECTION OF SUSTAINABLE DEVELOPMENT - REMEDIATION VERSUS CONTAMINATION.

- A HIGHER EMPHASIS SHOULD BE GIVEN TO RISK BASED REMEDIATION AND GREEN REMEDIATION.

THANK YOU / MERCI

QUESTIONS ?

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Intergovernmental Panel on Climate Change in its Second Assessment Report, ("1995 IPCC GWP values")

CONSOMMATION DE CARBURANT
TRANSPORT ET EXCAVATION DU SOL CONTAMINÉ
Exemple 1

Destination	Distance Site / Lieu de disposition (km)	Nombre de voyages (aller)	Distance parcourue (km)	Incertitude (+/- km)	Consommation de carburant (L)	Incertitude (+/- L)
Disposition	375	369	276 750	0	109 316	0
Sablière	0,1	500	100	0	31	0
					109 347	**0**

	Consommation moyenne (L/100km)	
	Diesel	**Essence**
Camion léger	12,8	14,9
Camion moyen	21,6	25,8
Camion lourd	39,5	-
Voiture	-	9,2

Camion léger : Poids<3856 kg
Camion moyen :3855<Poids <14970 kg
Camion lourd: Poids>14970 kg

Source: Office de l'efficacité énergétique,
Guide des données de la consommation d'énergie-août 2006

Équipement	Nombre sur le site	Heures travaillées	Consommation* carburant diesel (L/h)	Incertitude (+/- L/h)	Consommation de carburant diesel (L)	Incertitude (+/- L)
Pelle hydraulique	1	500	37	2	18 500	1 000
Chargeuse	1	100	16,1	1,9	1 610	190
				TOTAL	**20 110**	**1 190**

* Données provenant du manufacturier Hewitt

CONSOMMATION DE CARBURANT
TRANSPORT DU SOL CONTAMINÉ
Exemple 2

Destination du sol	Distance site/Lieu de disposition (km)	Nombre de voyages (aller)	Incertitude (+/-)	Distance parcourue (km)	Incertitude (km)	Consommation de carburant (L)	Incertitude (+/- L)
DIESEL							
1	132	32	0	8 448	0	3 337	0
2	62	58	0	7 192	0	2 197	0
3	6	252	0	3 024	0	924	0
4	4	3	0	24	0	5	0
5	21	53	0	2 226	0	879	0
6	37	6	0	444	0	175	0
7 (Sablière)	38	339	0	25 764	0	10 177	0
8	2,5	2 213	391	11 065	1 953	3 380	422
ESSENCE							
Voiture (6)	29	139	0	48 372	0	4 450	0
				TOTAL ESSENCE		**4 450**	**0**
				TOTAL DIESEL		**21 074**	**422**

CONSOMMATION DE CARBURANT
EXCAVATION DU SOL CONTAMINÉ
Exemple 2

Équipement	Nombre sur le site	Jours de travail	Heures de travail	Consommation de carburant* (L/heure)	Incertitude (+/- L/h)	Consommation de carburant (L)	Incertitude (+/- L)
Diesel							
Pelle hydraulique	2	101	808	37	2	59 792	3 232
Pelle hydraulique	4	38	304	37	2	44 992	2 432
Machinerie lourde	1	46	368	16,1	1,9	5 925	699
Machinerie lourde	2	93	744	16,1	1,9	23 957	2 827
					TOTAL DIESEL	**134 666**	**9 190**

*: Données provenant du manufacturier Hewitt

CONSOMMATION DE CARBURANT
TRANSPORT DU SOL CONTAMINÉ
Exemple 3

Destination du sol	Distance site / Lieu de disposition (km)	Nombre de voyages (aller)	Incertitude (+/-)	Distance parcourue (km)	Incertitude (km)	Consommation de carburant (L)	Incertitude (+/- L)
DIESEL							
Livraison produit	300	21	0	12 600	0	2 722	0,00
Camion foreuse	70	3	0	186	0	166	0,00
ESSENCE							
Voiture (1)	300	40	0	24 000	0	2 208	0,00
				TOTAL ESSENCE		**2 208**	**0**
				TOTAL DIESEL		**2 888**	**0**