The Power of Tier 2

Project Cost Certainty and the Real Return on Investment using Site-Specific Approaches

Trevor Burgers,
Millennium EMS Solutions Ltd.

RemTech October 14, 2021

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Topics of Conversation

- Myths About Tier 2
- What is Risk?
- Why is Tier 1 Conservative?
  - Deeper Analysis of DUA Pathway
  - Tier 2 options
- Cost Certainty in Tier 2 Projects

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Myths about Tier 2 / Site Specific Approaches

- ✗ It is more complex and expensive than Tier 1
- ✗ It takes longer to achieve site closure than Tier 1
- ✗ It is not as protective of human and ecological receptors as Tier 1

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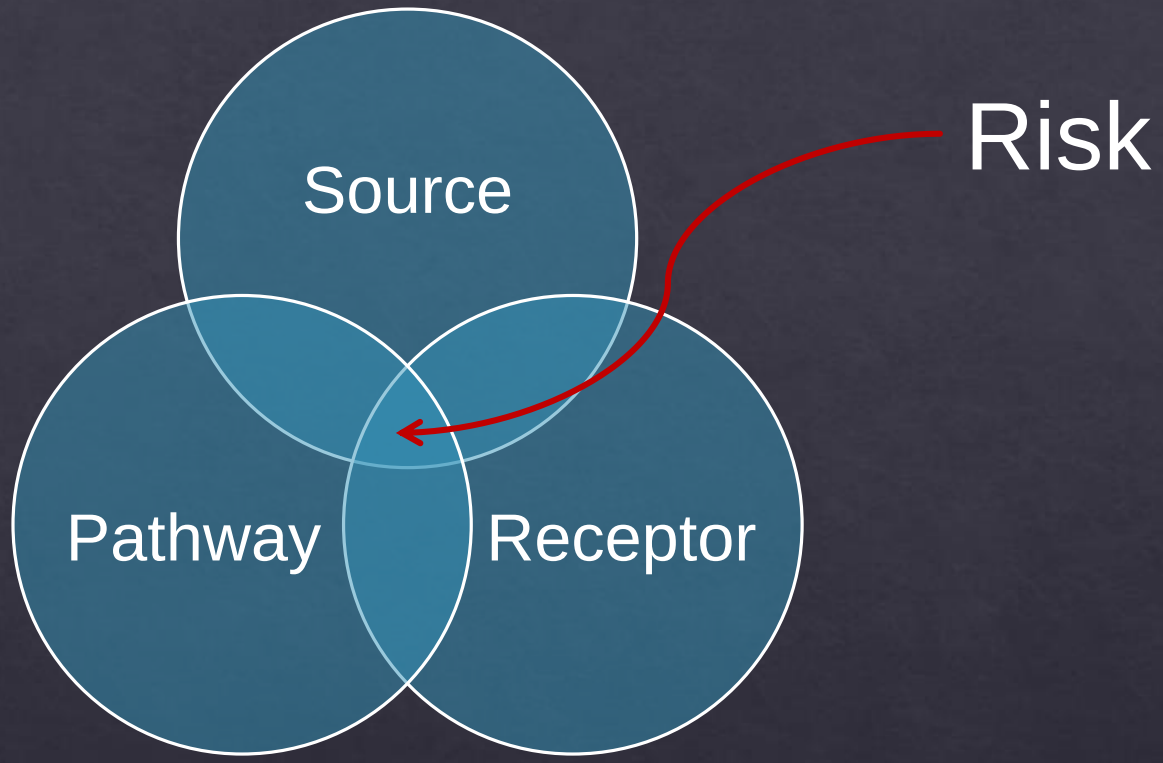
What is Risk?



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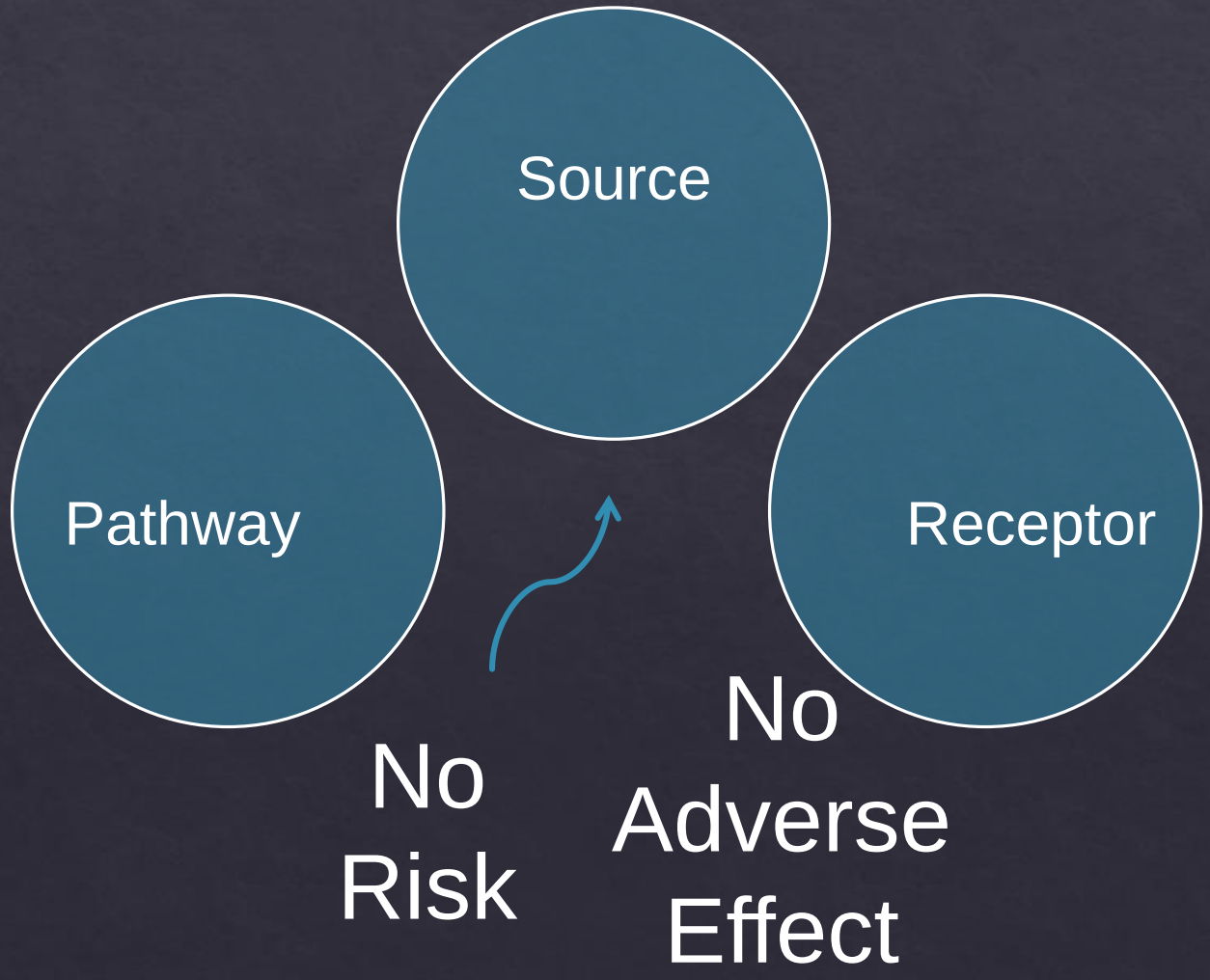
What is Risk?



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What is Risk?

"Risk (is) that if we do not develop a pragmatic method to remediate impacted sites, they will not be cleaned up before, oil and gas is no longer on the landscape."

Jonas Fenn Sask. MER

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Question Period?

With respect to the DUA pathway,

Q: Why are the Tier 1 soil guidelines conservative?

Q: What parameters of the Tier 1 CSM make the Tier 1 soil guidelines conservative?

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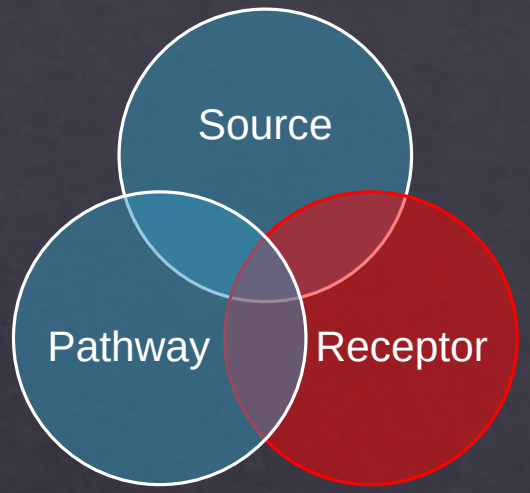
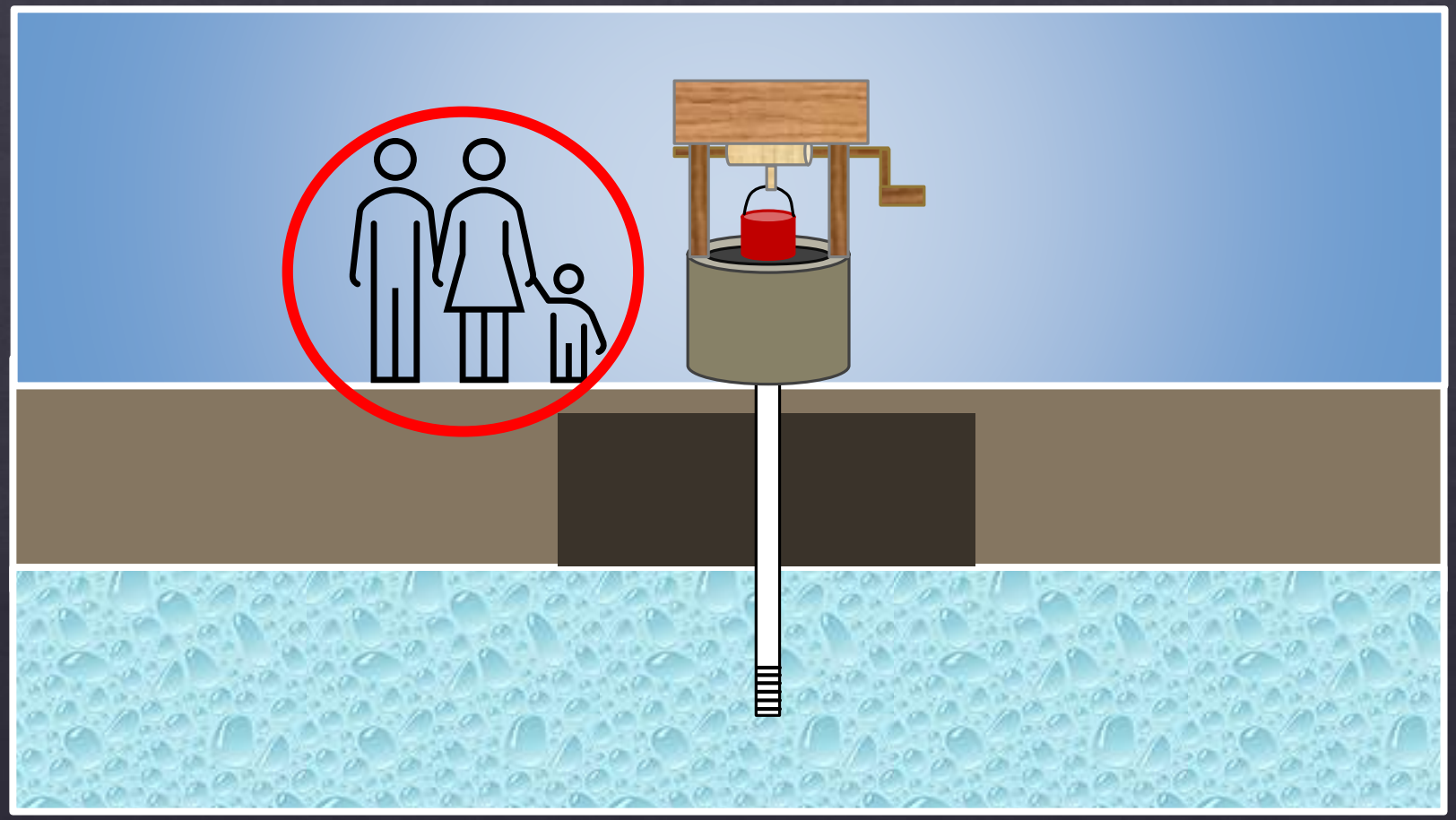


Why Tier 1 is Conservative?



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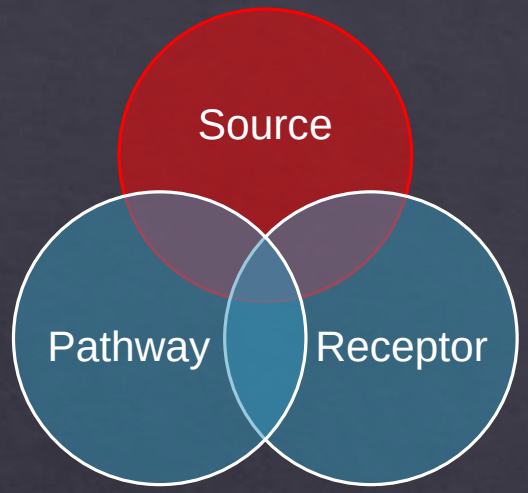

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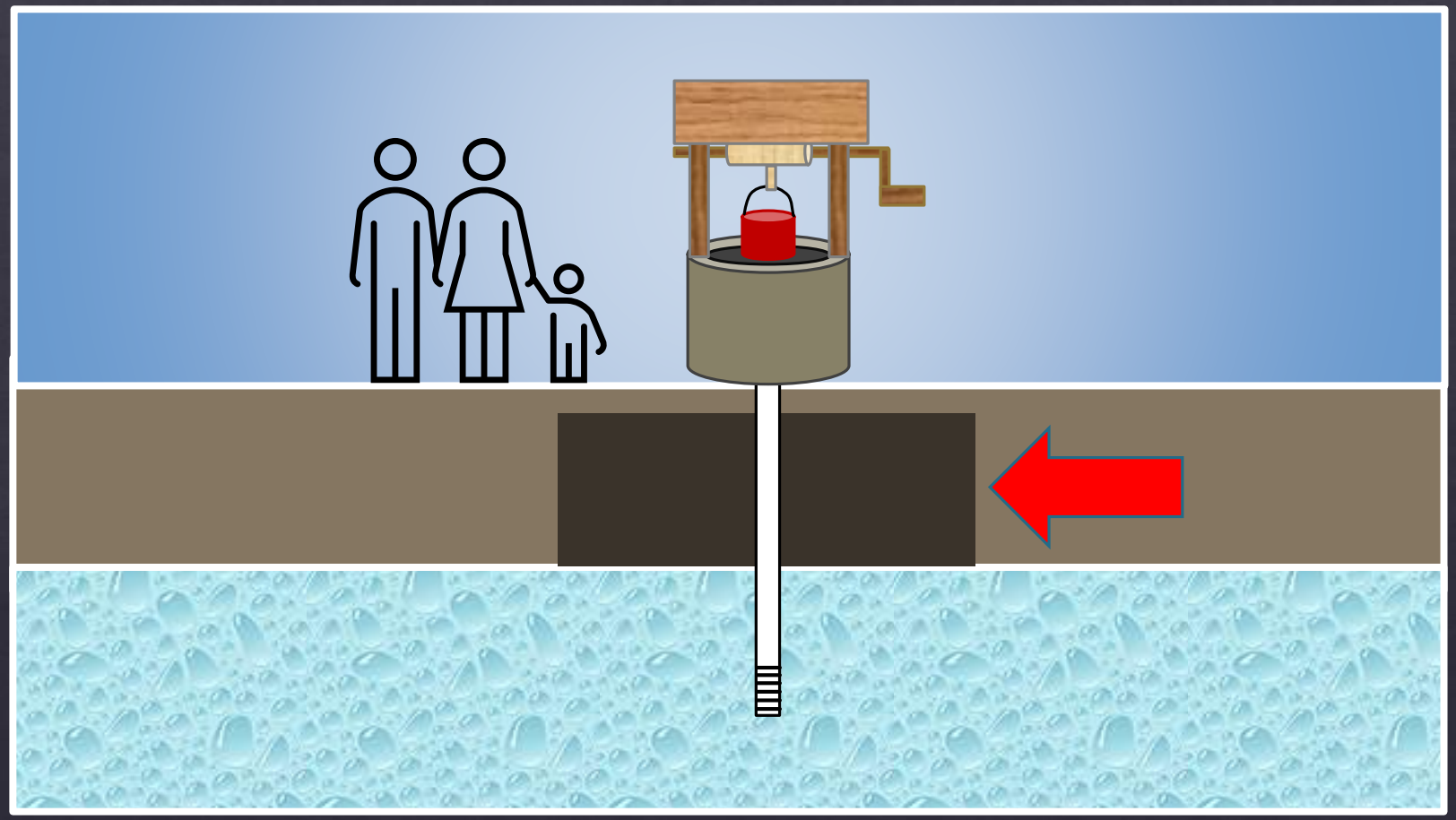

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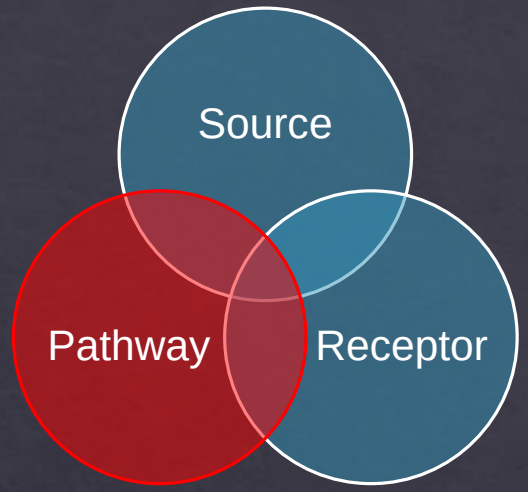

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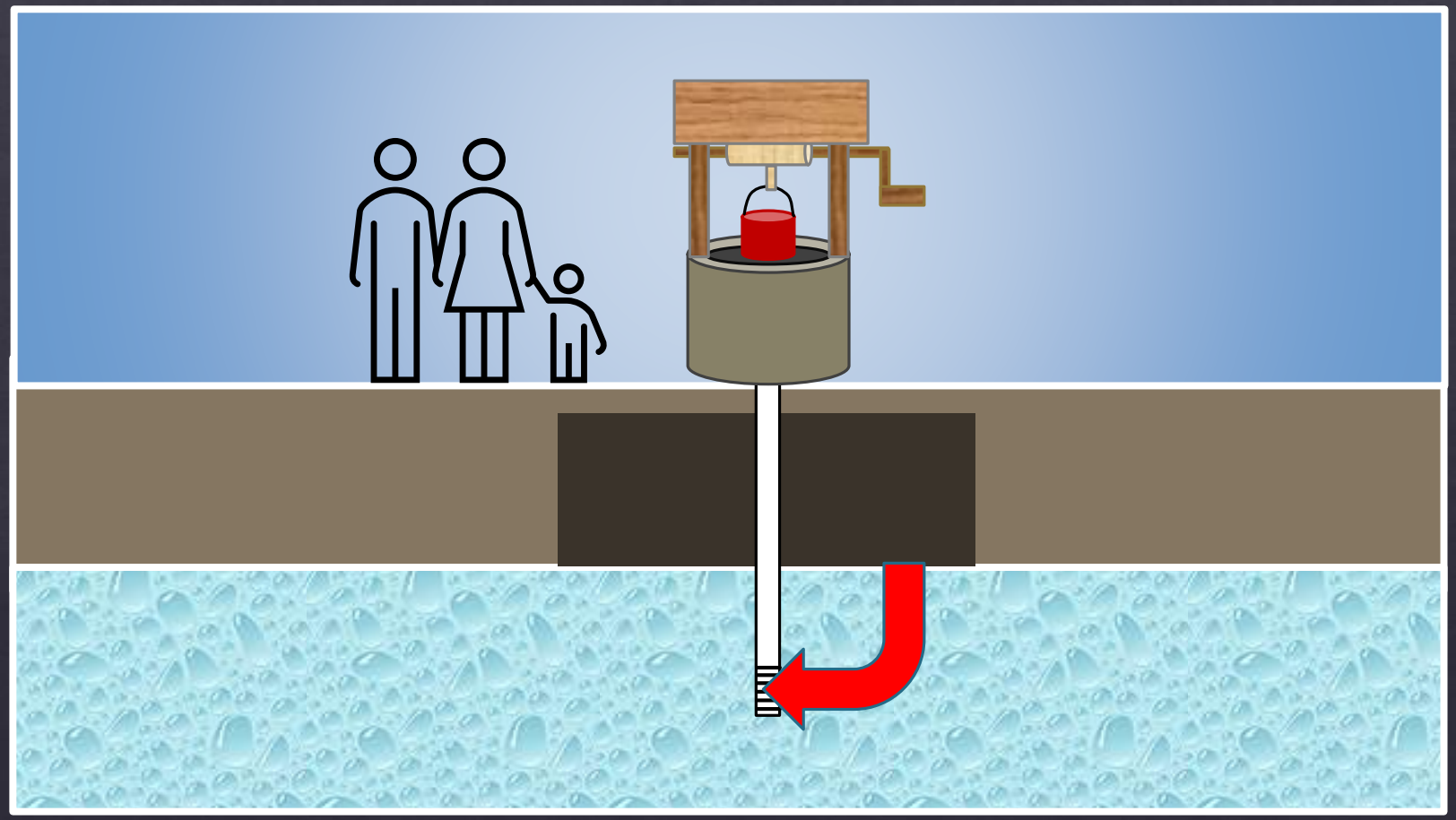

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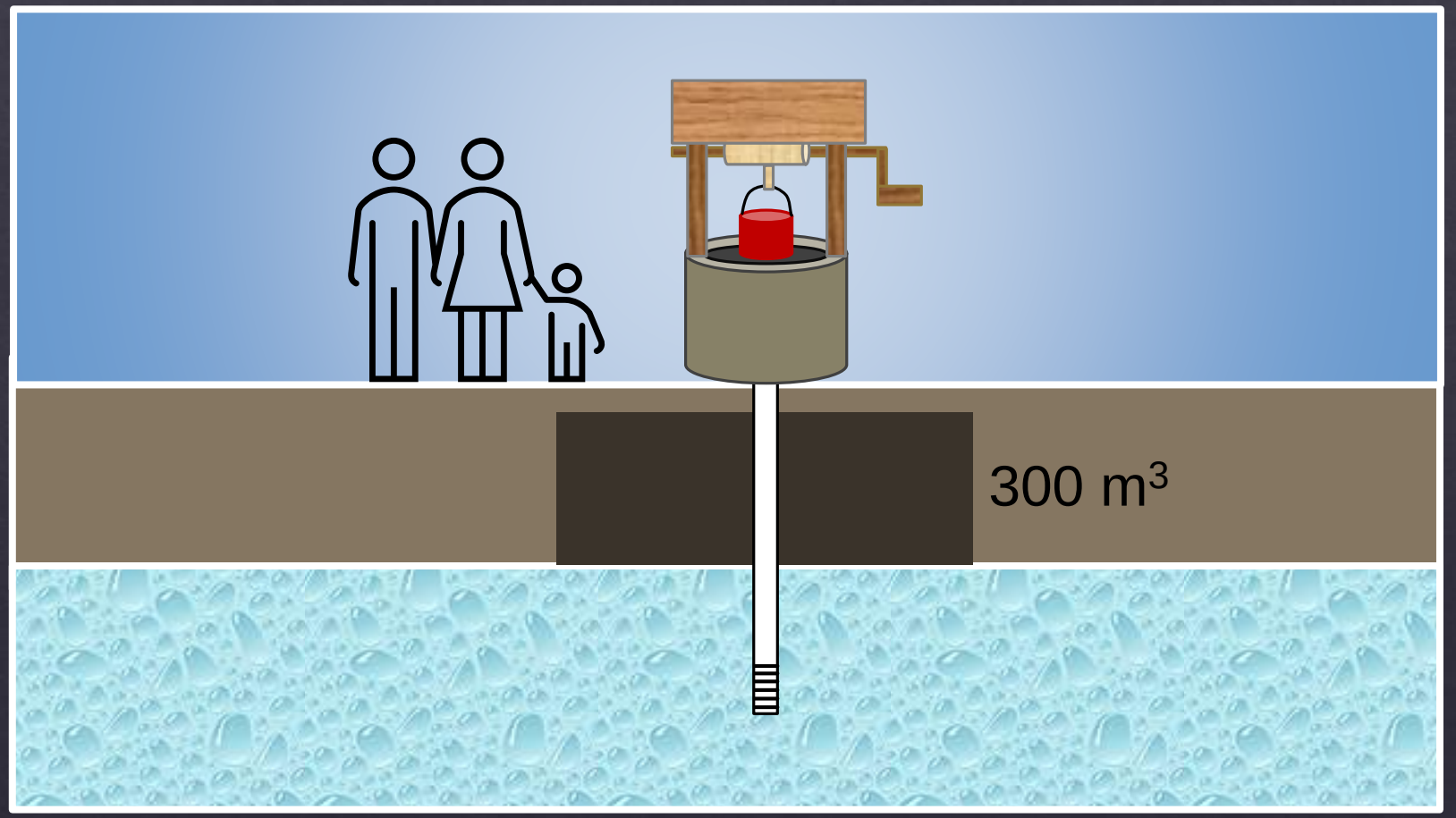

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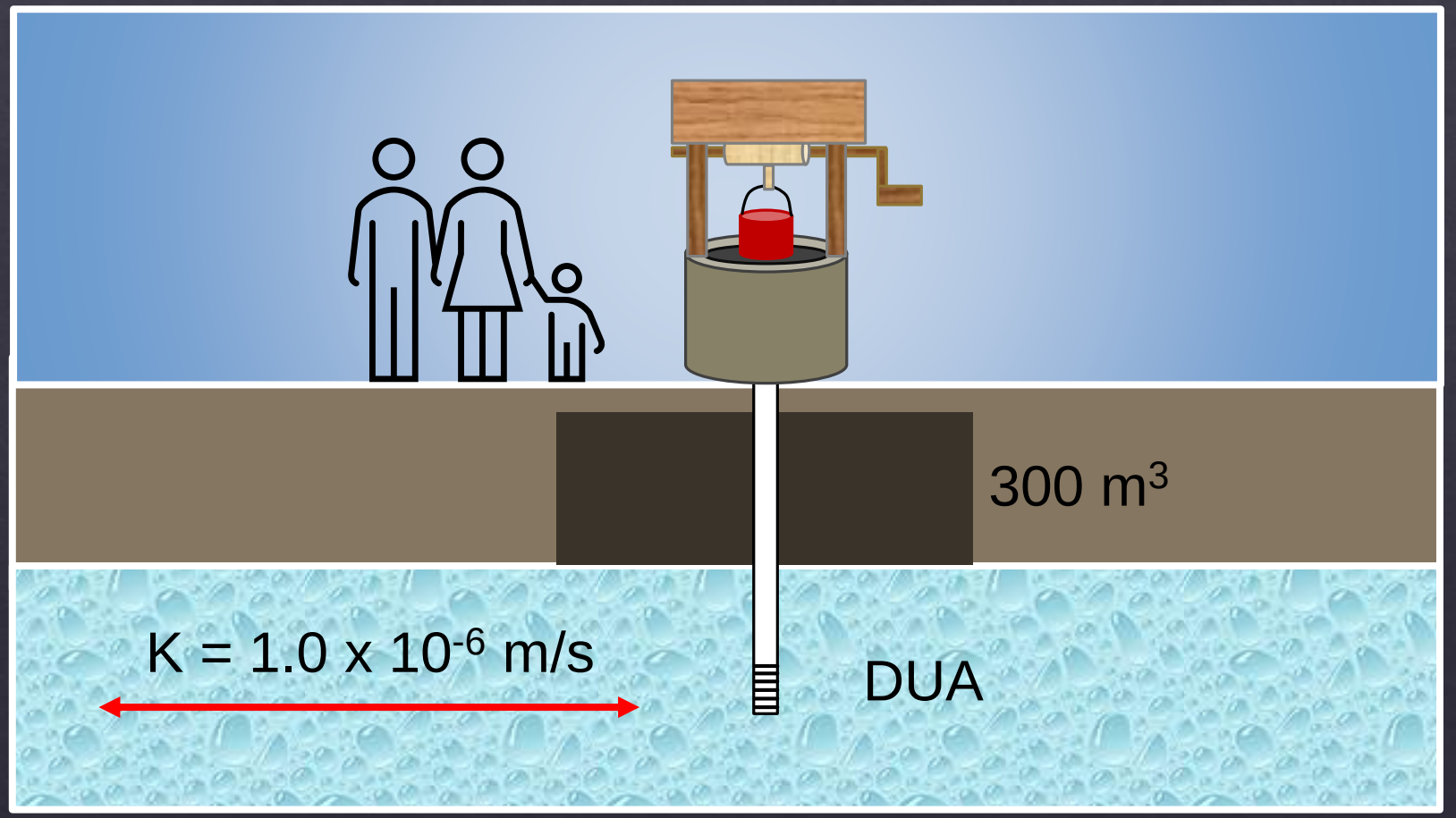

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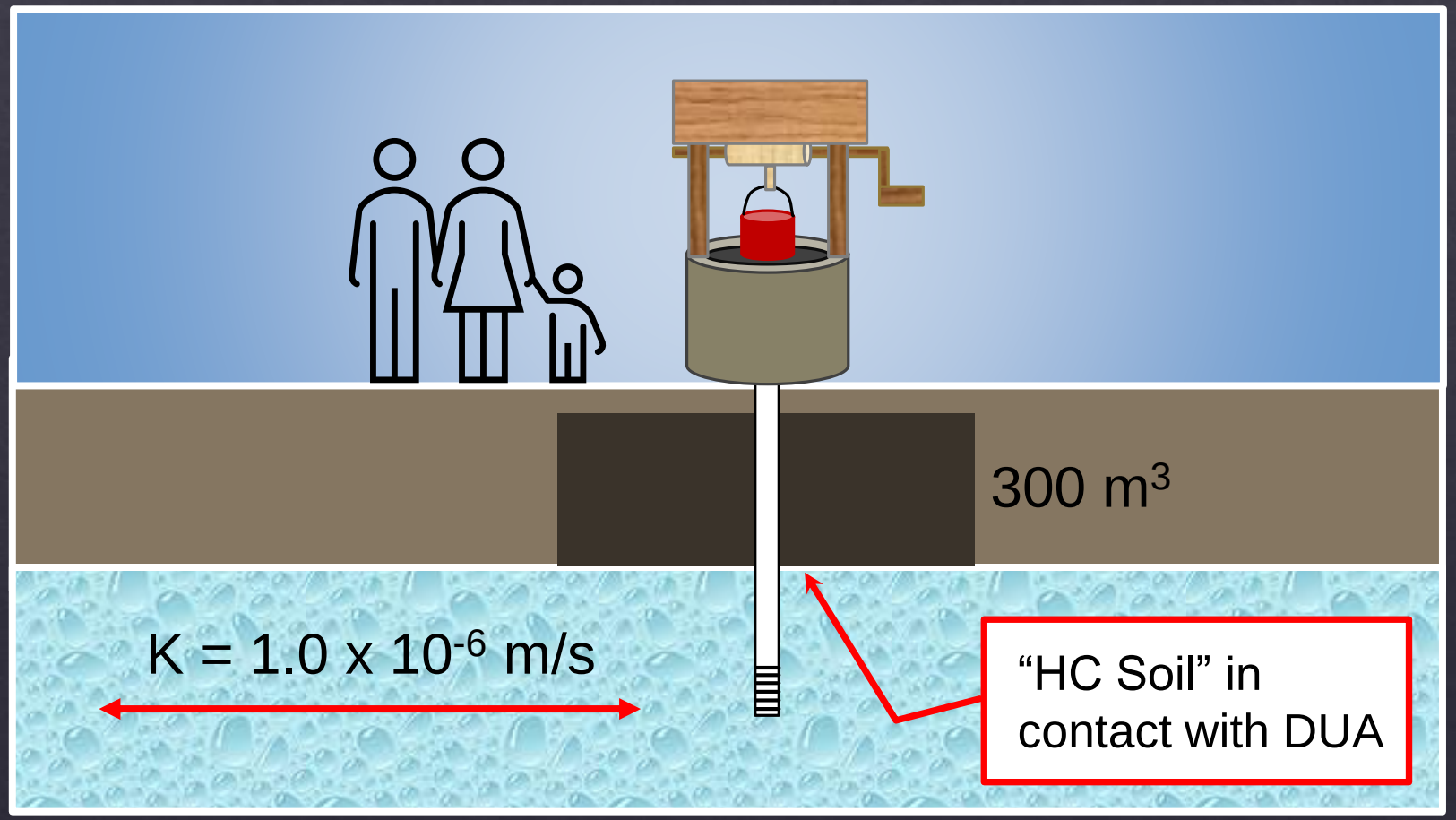

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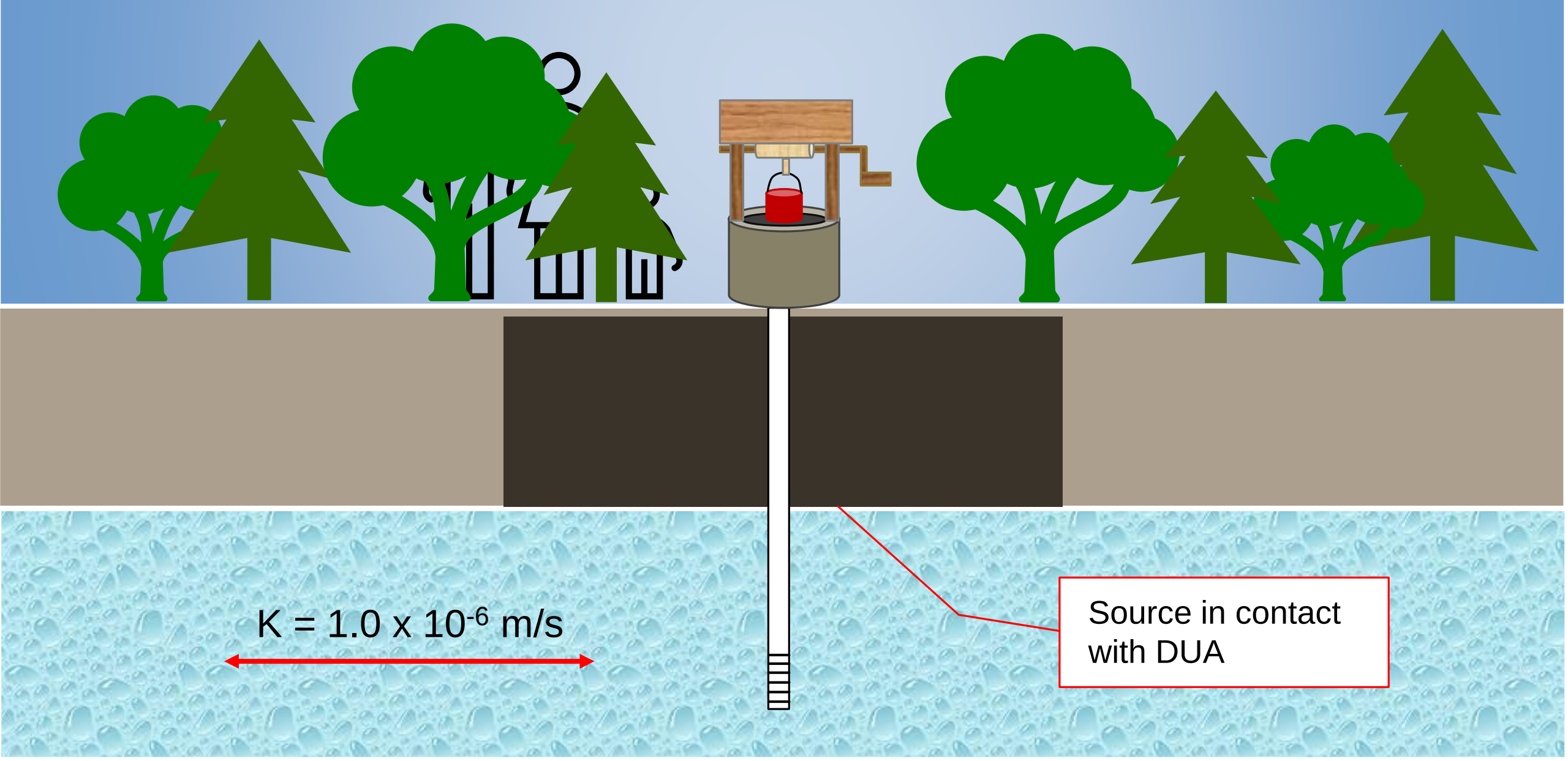

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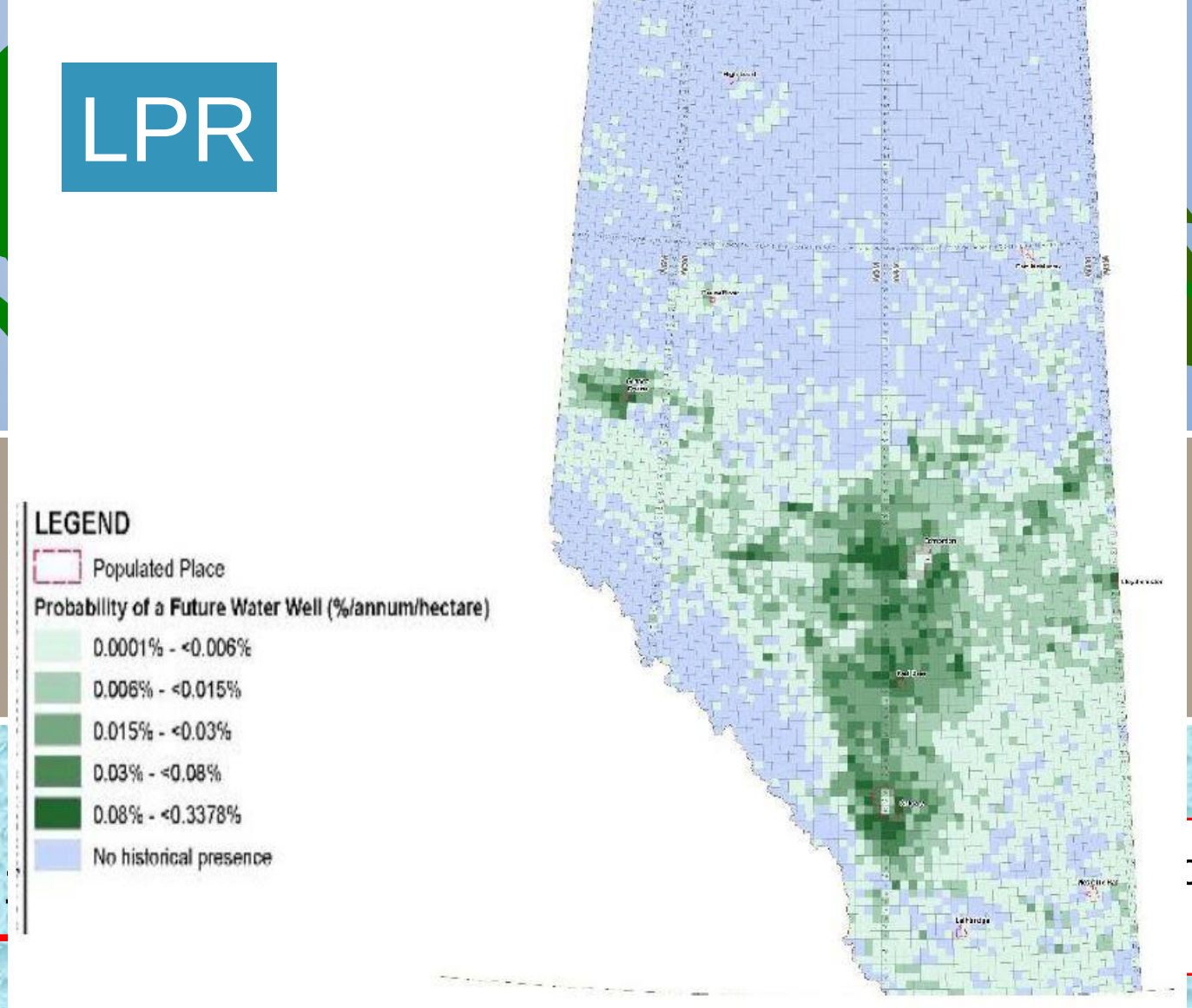
LPR



K = 1.0 x

ontact

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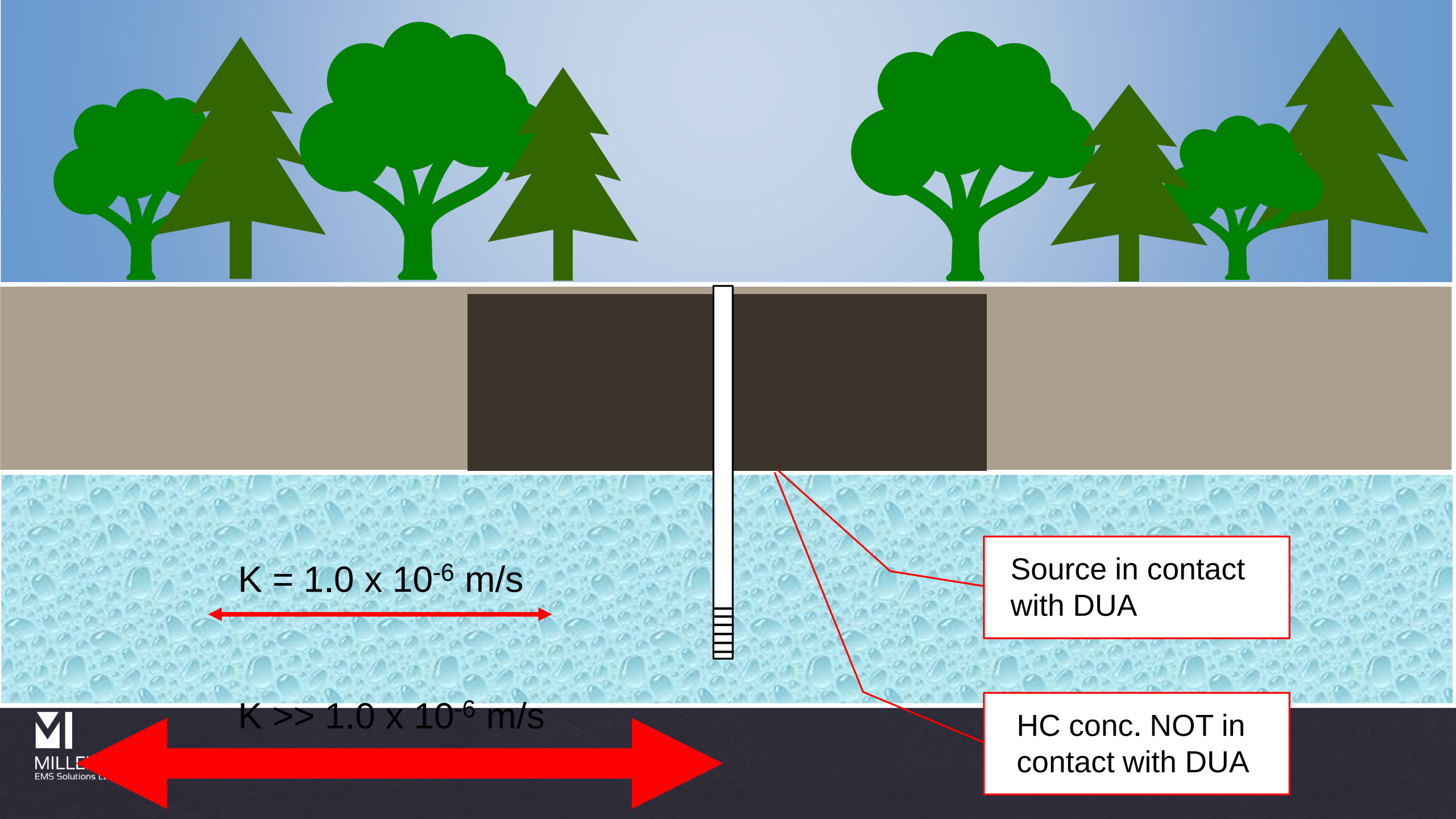
K = 1.0 x 10-6 m/s
K >> 1.0 x 10-6 m/s
Source in contact with DUA
HC conc. NOT in contact with DUA

Tier 2 Barrier Unit

Parameter	Tier 1 (mg/kg)	Tier 2 (mg/kg)
Benzene	0.046	7.9
Toluene	0.52	110
Ethylbenzene	0.073	120
Xylene	0.99	65

Tier 2 = Model Based

Barrier Unit

- At least 5 m of massive, undisturbed, unfractured fine grained material meeting appropriate guidelines with a bulk hydraulic conductivity < 10^{-7} m/s or
- An equivalent thickness of natural, undisturbed material that is more than 5 m thick and is supported by technical information.

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At Tier 2 = Barrier Unit

Parameter	Min. barrier Unit Thickness (m)
Benzene	4.95
Toluene	0.45
Ethylbenzene	0.27
Xylene	0.16

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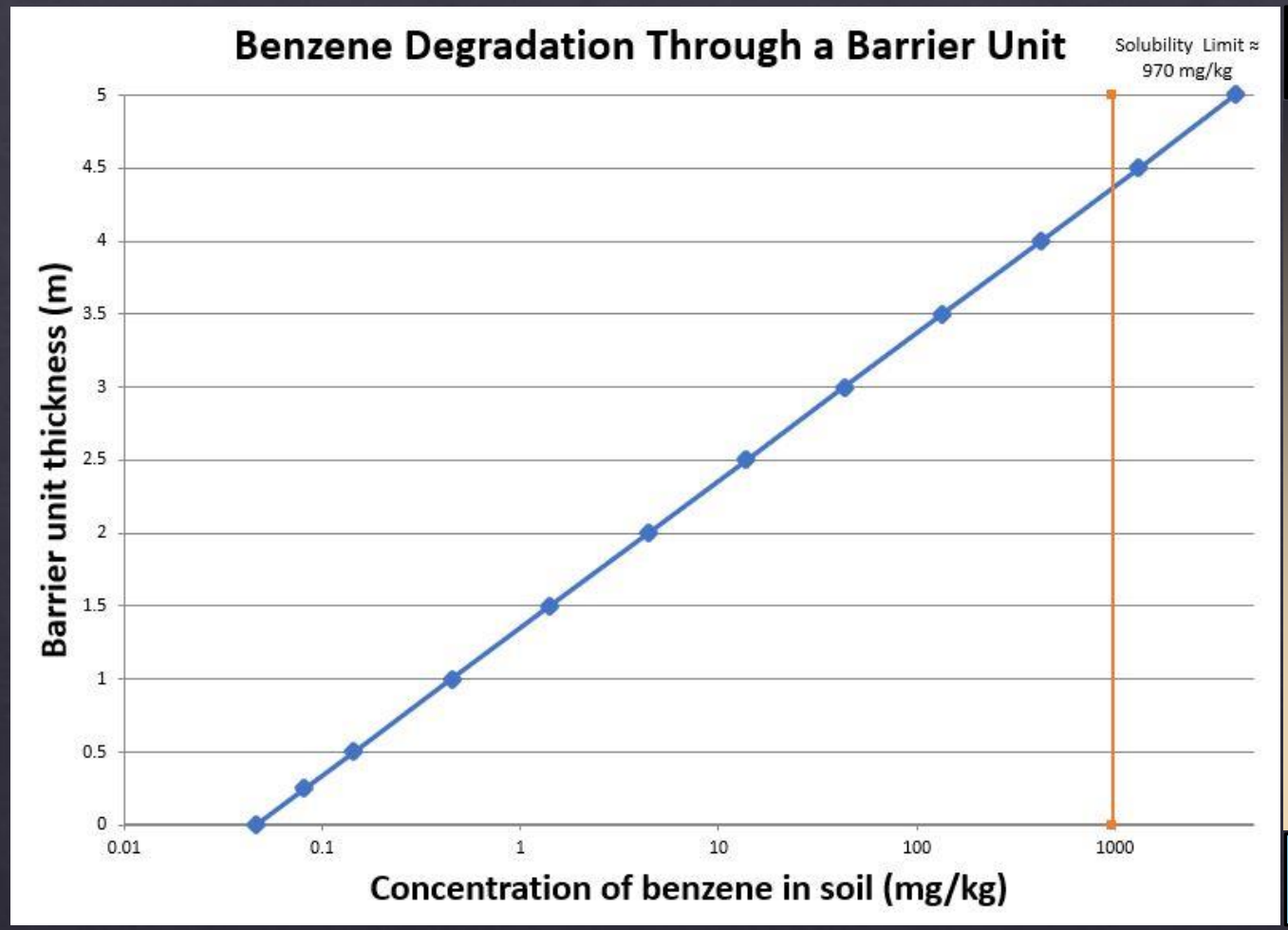
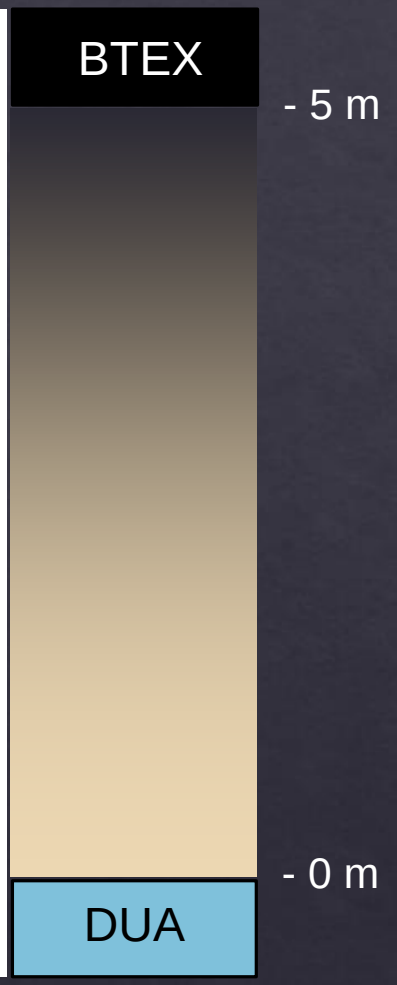
BTEX > DUA





- 5 m

- 0 m

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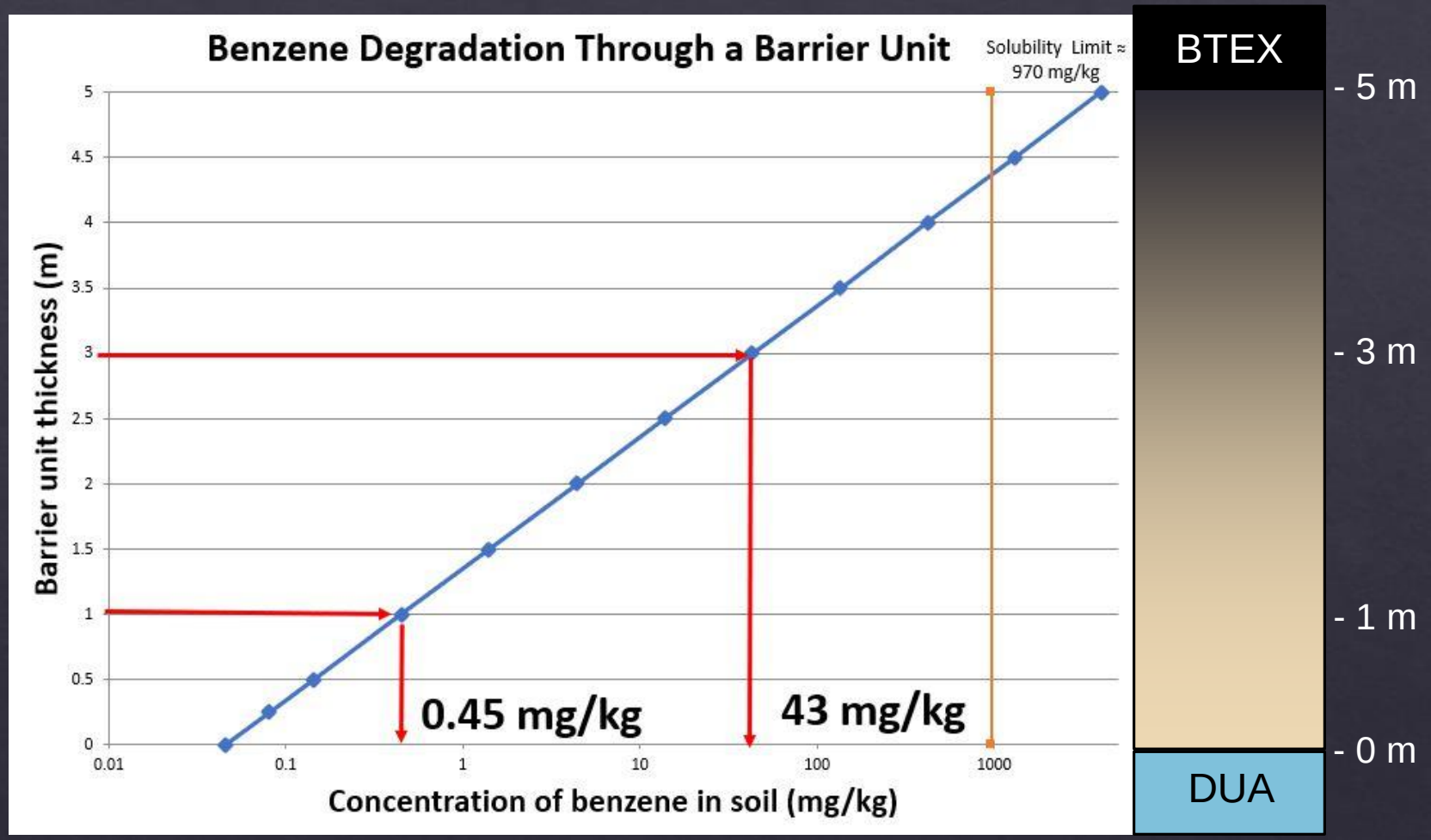
BTEX > DUA



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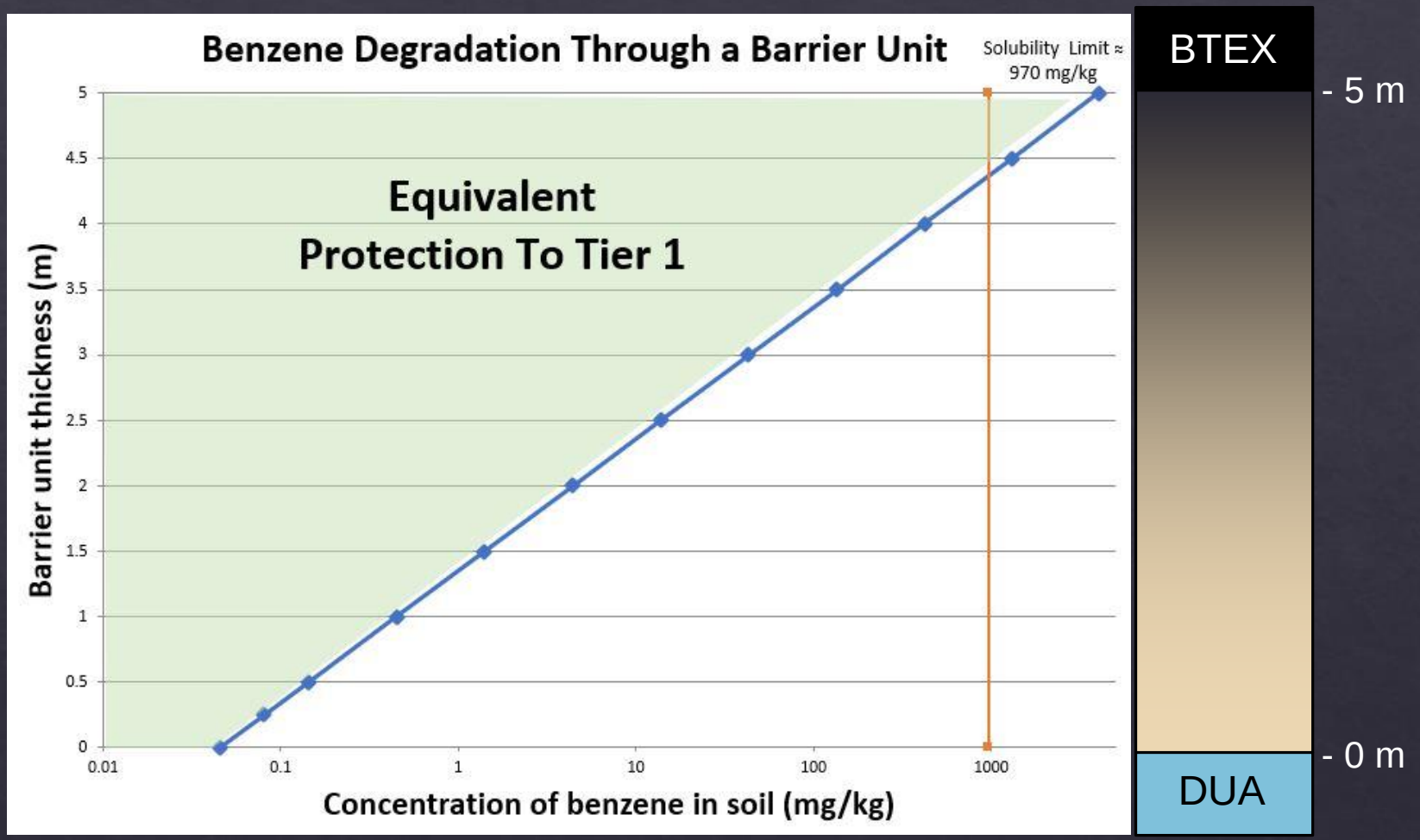
BTEX > DUA



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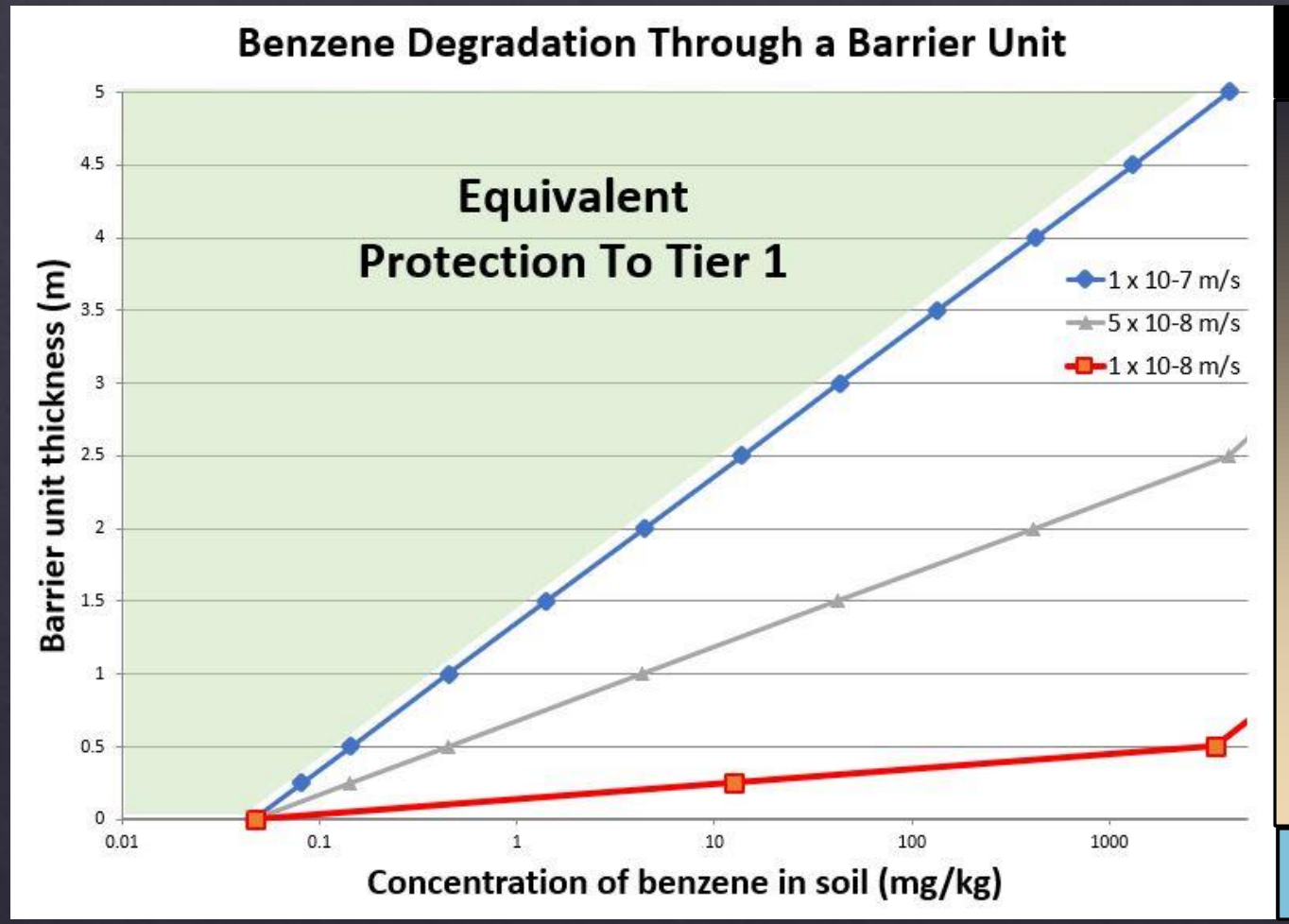

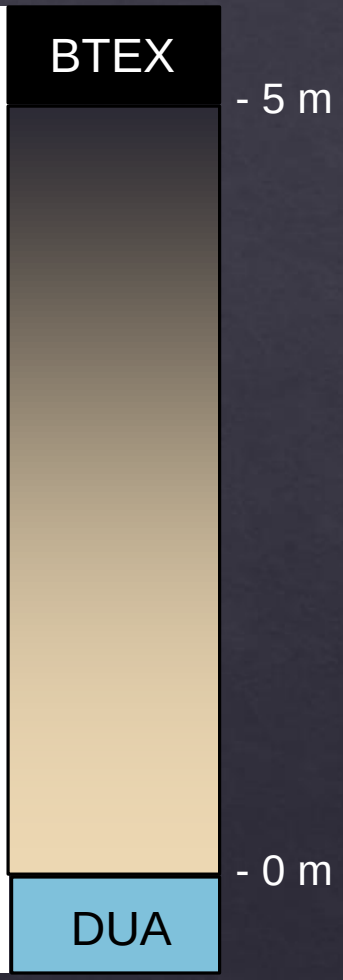

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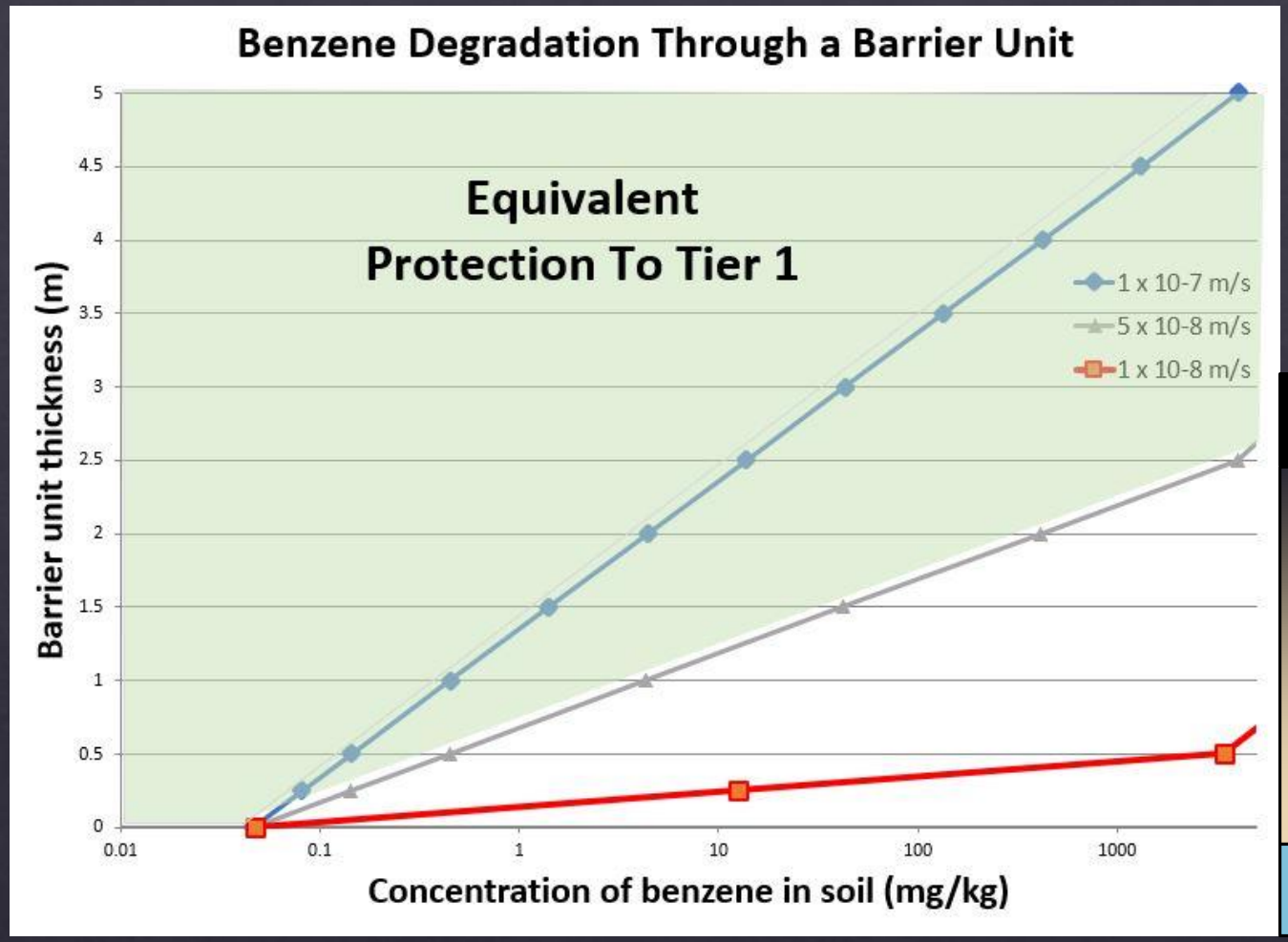
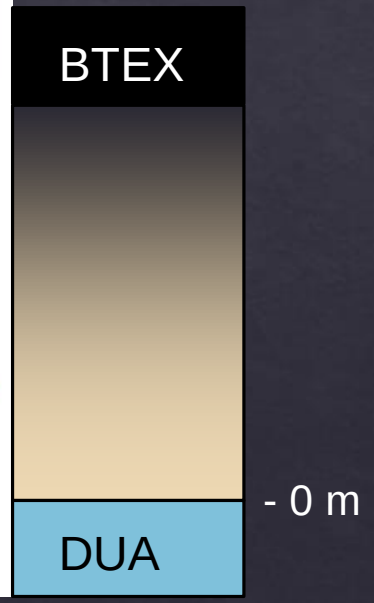
BTEX > DUA





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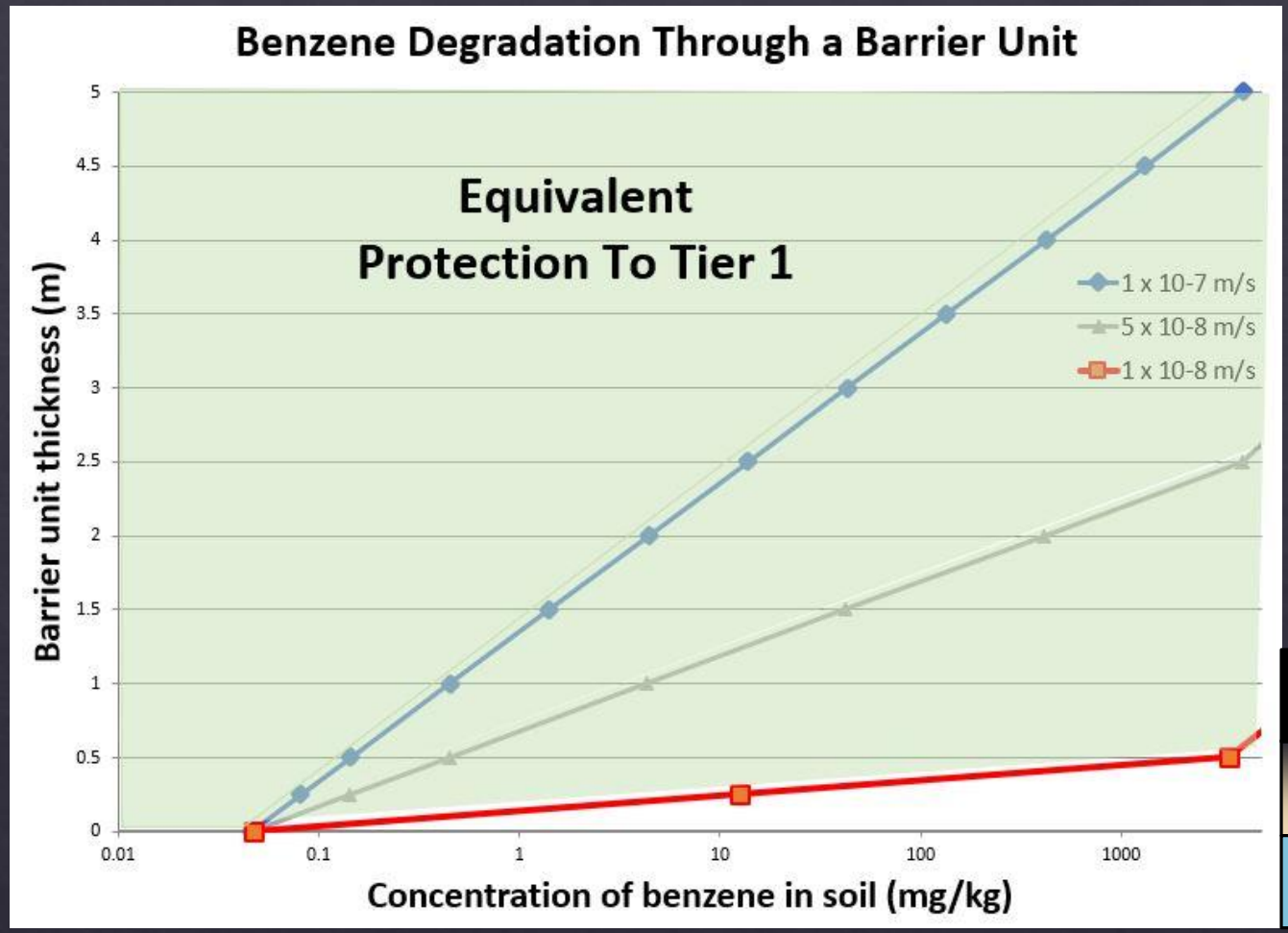
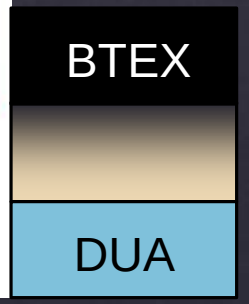
BTEX > DUA





- 0 m

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Audience Participation

With respect to the DUA pathway

1. Have you had a site where soil BTEX conc. > Tier 1?
2. At these sites, was the Soil in direct contact with a verified DUA?
3. Did these Sites have an actual domestic water well installed and at one time was being used?

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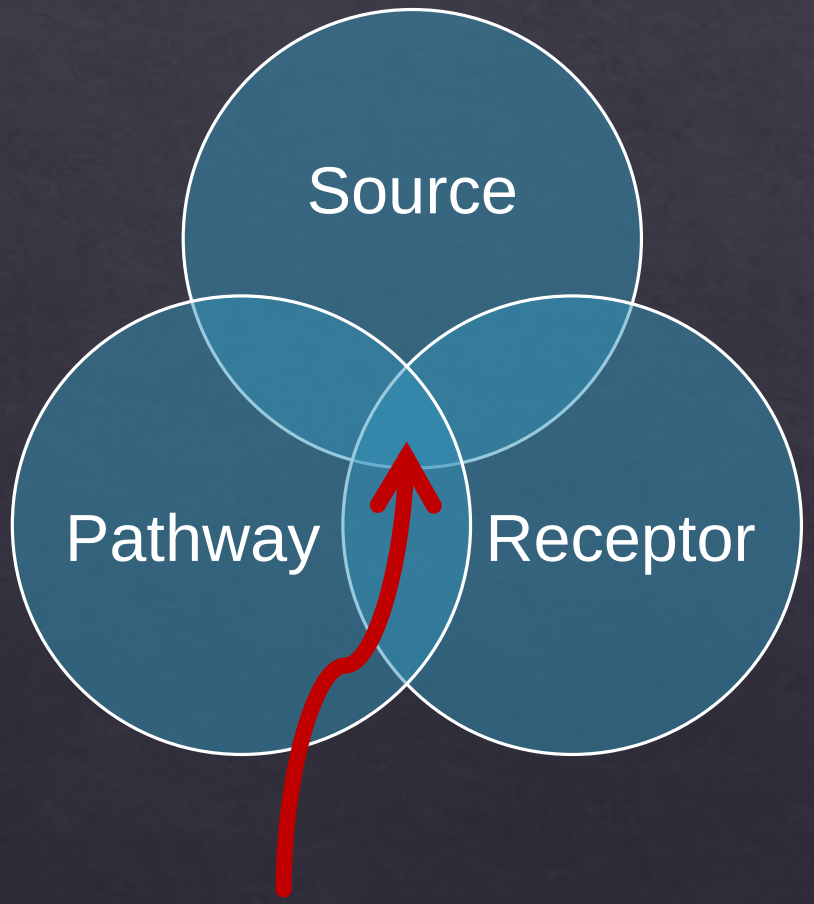
Audience Participation



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Jonas Fenn Sask. MER

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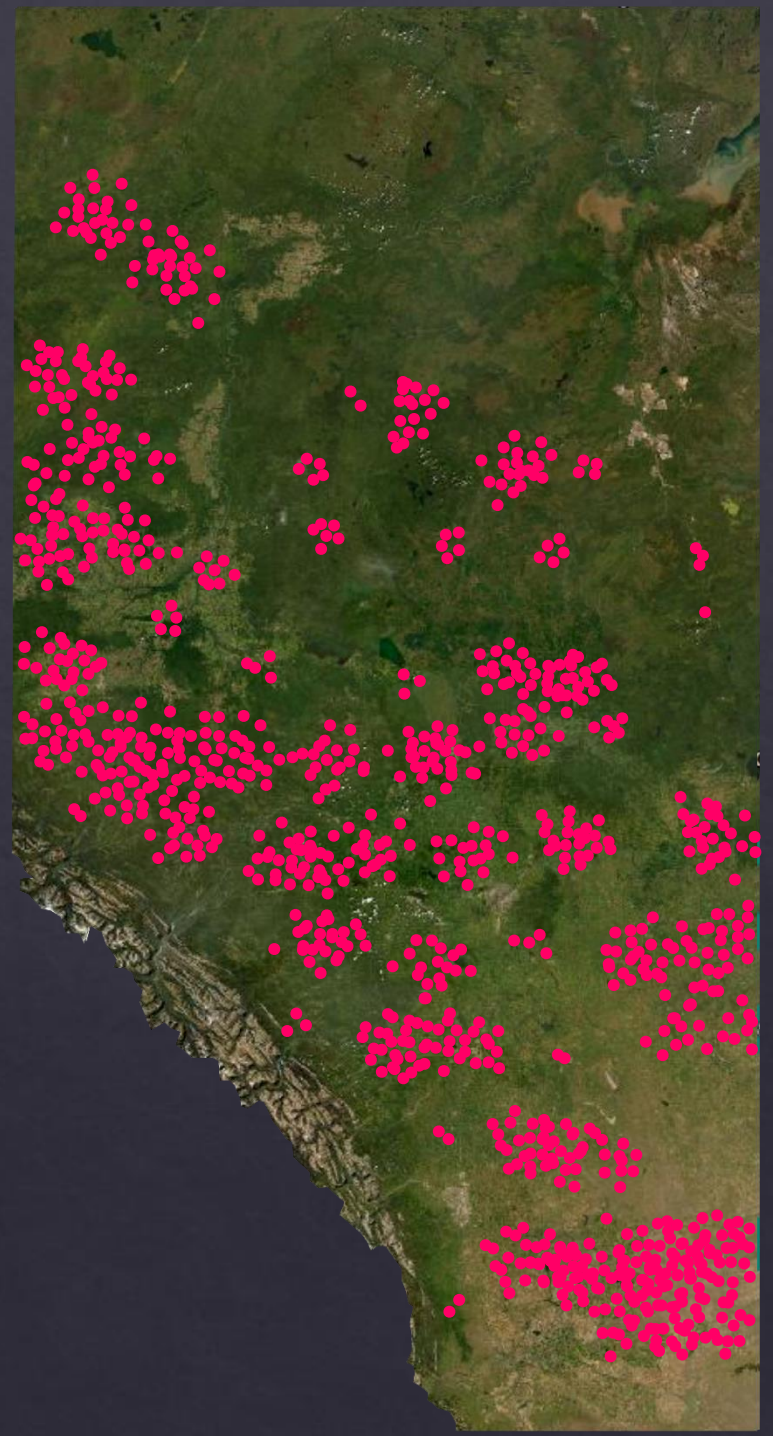
Cost Certainty of Tier 2

- Study Area – All of Alberta
- Diversion of >775,000 m^3 of soil from the landfill
  - Saved 7.8 million liters of fuel
  - Saved 22,400 tonnes of emissions
- >$100 Million Saved to Date



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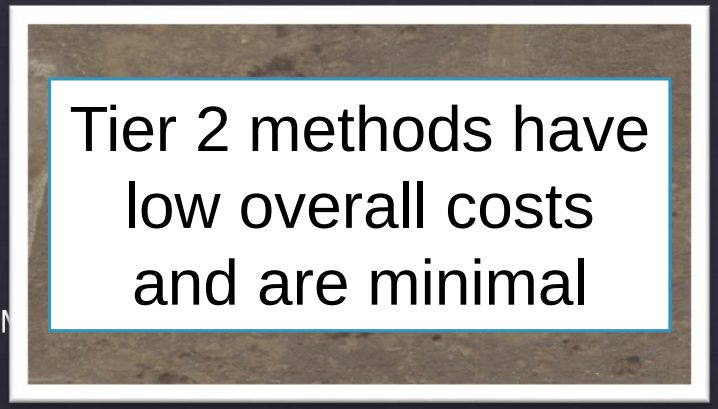
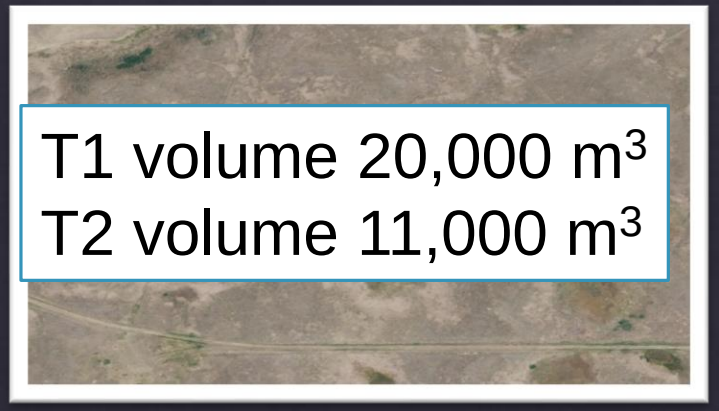
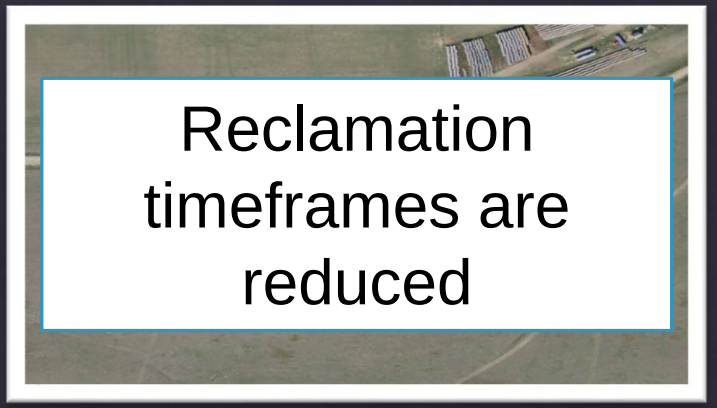
Assessment Sites

- Tier 2 application removed 124,000 m^3 of Tier 1 liability
  - \$2.60/m^3 (All inclusive including all 3rd party contractors, laboratory, consulting fees, expenses, etc.)
- Cost
  - Reduction of costs associated with reduced remediation volumes
- Time
  - Reduced field execution time
  - Reduced reclamation time







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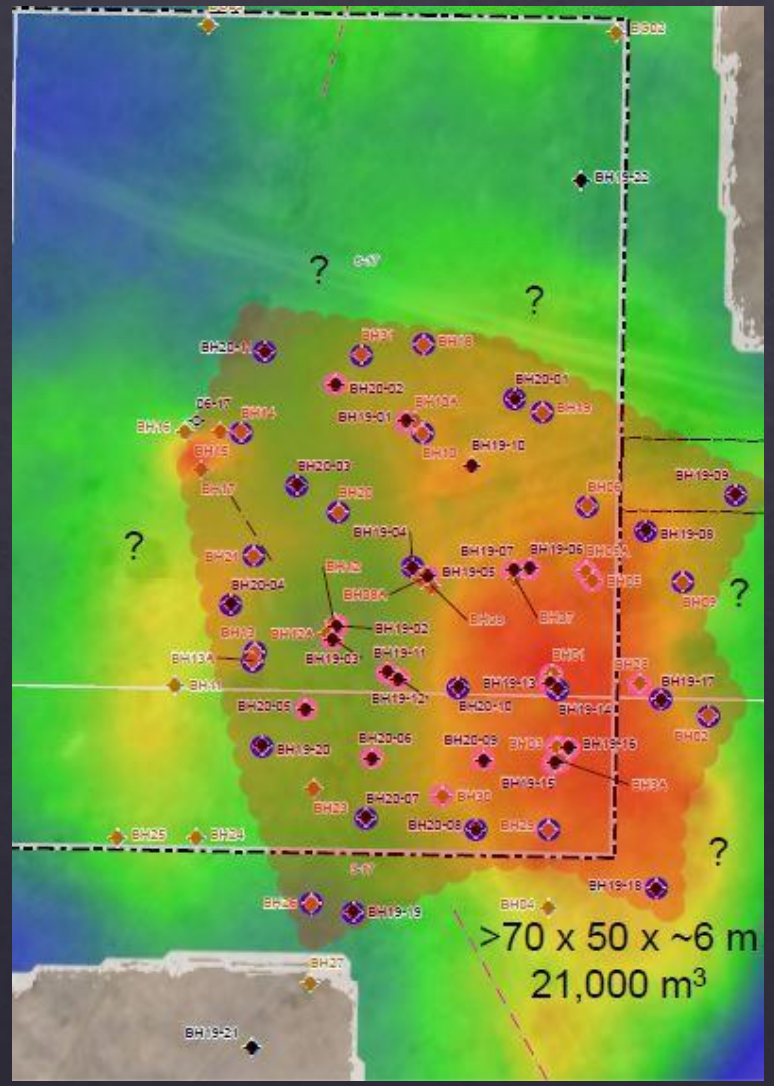
Assessment Sites

Tier 1



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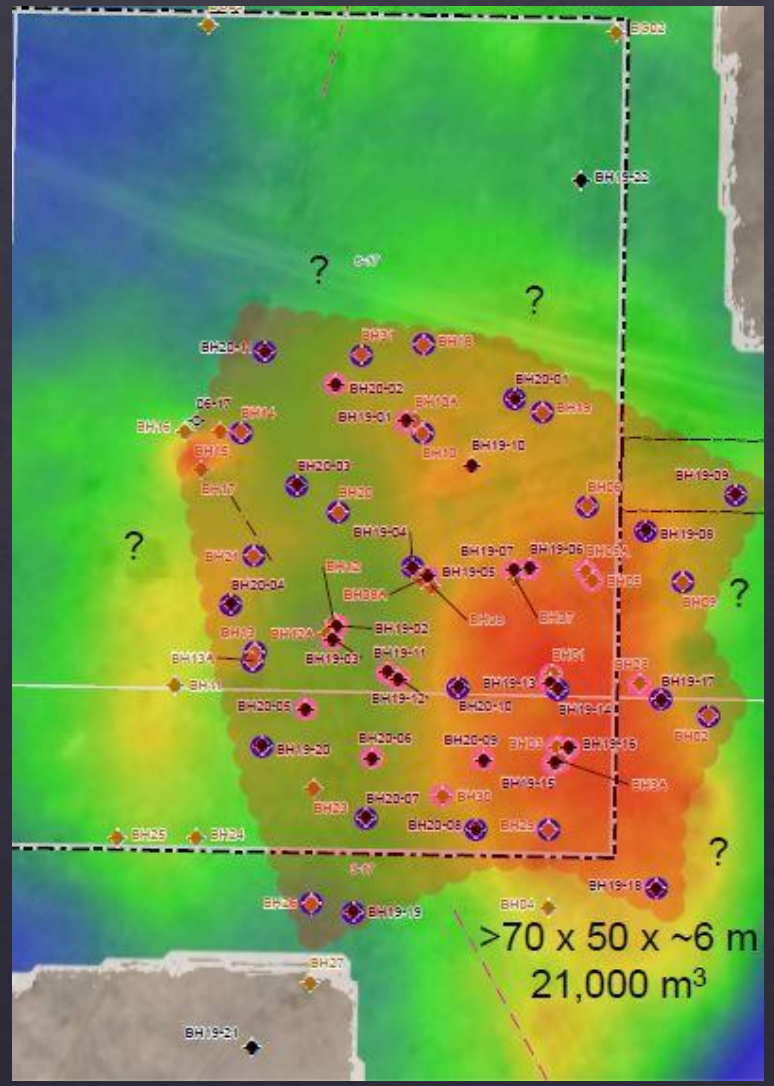
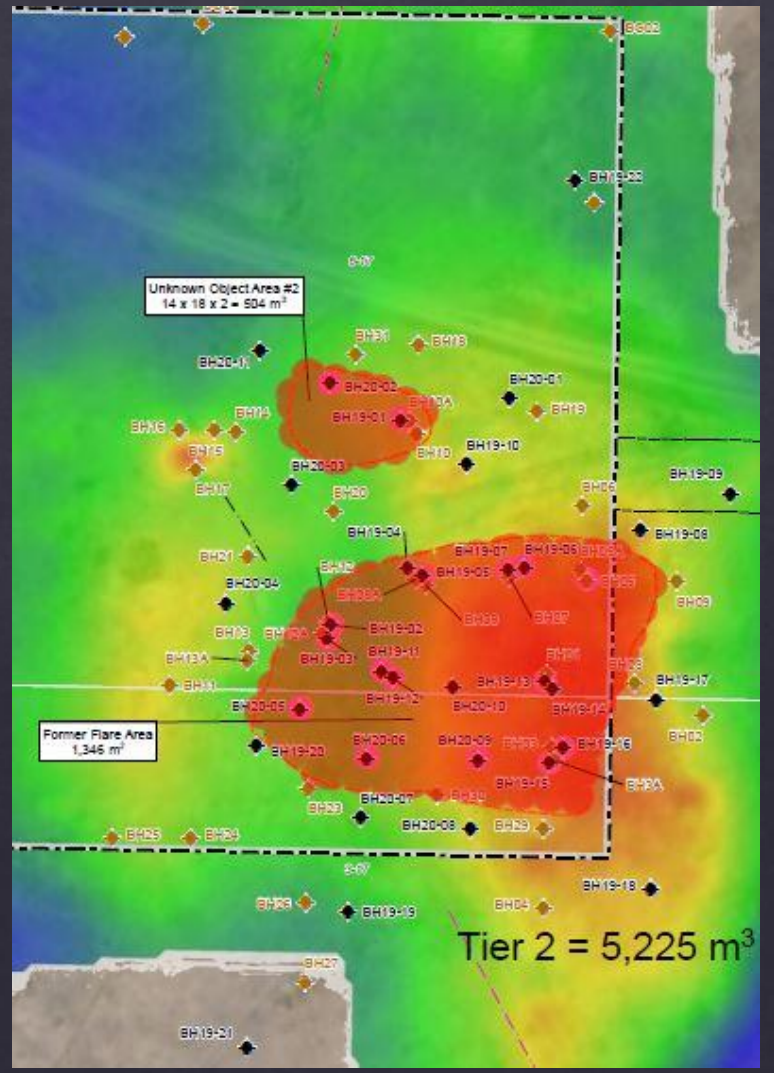
Assessment Sites

Tier 1



Tier 2



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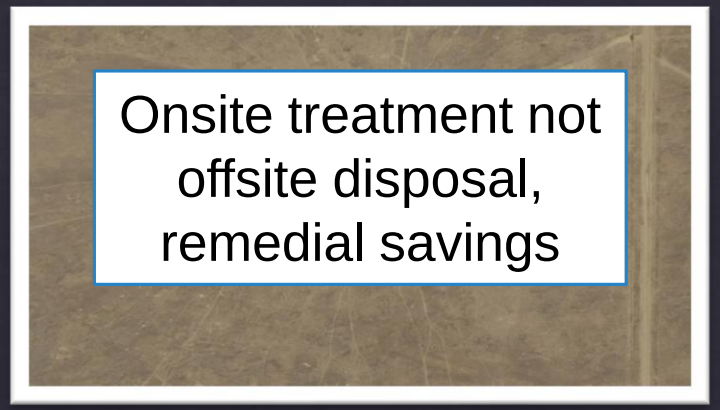
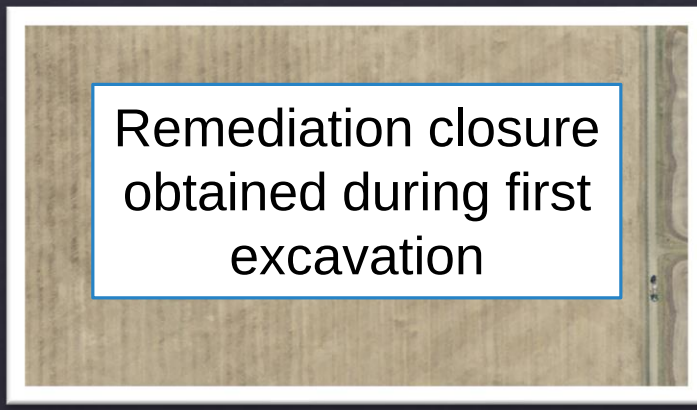
Remediation Sites

- Remediation costs to eliminate 34,900 m^3 of Tier 2 liability
  - $40/$m^3$ total (All inclusive remediation including all costs, 3rd party contractors, laboratory, consulting fees, expenses, etc.)
- Tier 2 application provided certainty on;
  - Remediation Methods
  - Remediation Budget Certainty
  - Closure to the excavation





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Remediation Sites

Tier 1

Sample ID	B	T	E	X
	mg/kg			
Tier 1 Guideline	0.046	0.52	0.073	0.99
EX1-Cell1-TRT1	0.01	0.14	0.575	2.54
EX1-Cell1-TRT2	0.018	0.76	1.05	4.06
EX1-Cell1-TRT3	0.013	0.06	0.363	1.36
EX1-Cell1-TRT4	0.006	0.02	0.269	1.36
EX1-Cell1-TRT5	0.008	0.04	0.116	0.67
EX1-Cell1-TRT6	0.007	0.05	0.075	0.4
EX1-Cell1-TRT7	<0.005	<0.02	0.075	0.42
EX1-Cell1-TRT8	0.01	0.06	0.703	4.58
EX1-Cell1-TRT9	0.008	0.08	1.83	10.5
EX1-Cell1-TRT10	0.05	0.09	1.71	6.7
EX1-Cell1-TRT11	0.283	<0.02	3.63	15.4
EX1-Cell1-TRT12	<0.005	<0.02	0.036	0.19
EX1-Cell1-TRT13	0.007	0.02	0.576	3.65
EX1-Cell1-TRT14	<0.005	<0.02	0.058	0.43
EX1-Cell1-TRT15	<0.005	0.04	0.304	2.12
EX1-Cell1-TRT16	<0.005	<0.02	0.061	0.3
EX1-Cell1-TRT17	<0.005	0.02	0.169	1.1
EX1-Cell1-TRT18	<0.005	<0.02	0.314	2.18
EX1-Cell1-TRT19	0.02	0.04	0.921	4.55
EX1-Cell1-TRT20	0.01	<0.02	0.953	5.75
EX1-Cell1-TRT21	0.008	0.02	0.188	1.18
EX1-Cell1-TRT22	0.007	<0.02	0.224	1.24

Tier 2

Sample ID	B	T	E	X
	mg/kg			
Tier 2 Guideline	1.6	110	120	65
EX1-Cell1-TRT1	0.01	0.14	0.575	2.54
EX1-Cell1-TRT2	0.018	0.76	1.05	4.06
EX1-Cell1-TRT3	0.013	0.06	0.363	1.36
EX1-Cell1-TRT4	0.006	0.02	0.269	1.36
EX1-Cell1-TRT5	0.008	0.04	0.116	0.67
EX1-Cell1-TRT6	0.007	0.05	0.075	0.4
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EX1-Cell1-TRT22	0.007	<0.02	0.224	1.24

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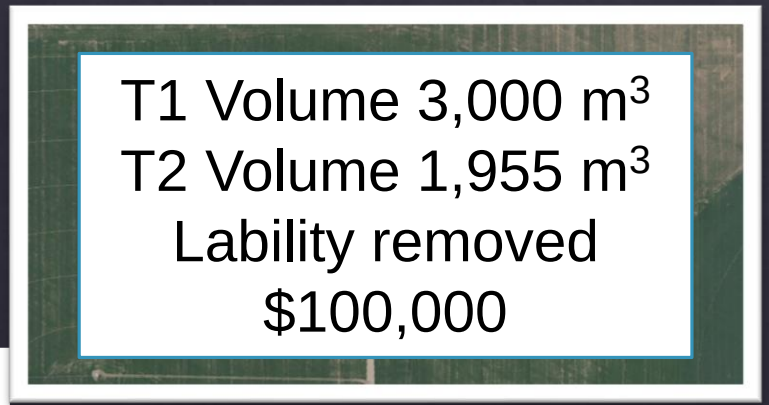
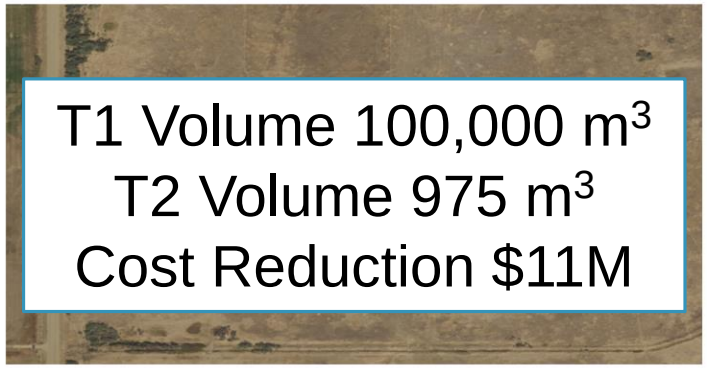
Total Life Cycle

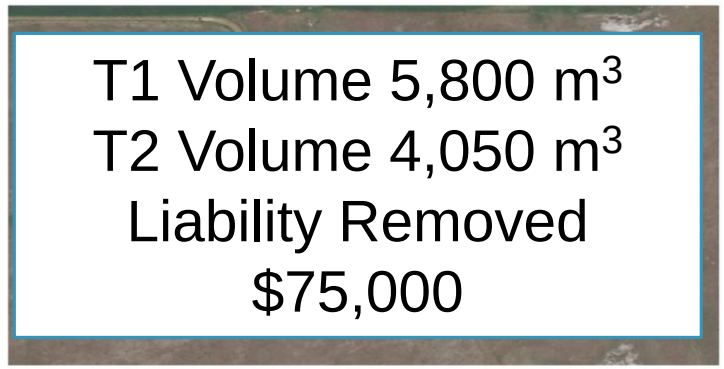
- Total Lifecycle Costs to Reclamation
  - $11/m^3
- Cost Certainty for Budgets – Less Variance
- Project Timeline Certainty



T1 Volume 3,000 m^3
T2 Volume 1,955 m^3
Lability removed
$100,000



T1 Volume 100,000 m^3
T2 Volume 975 m^3
Cost Reduction $11M



T1 Volume 5,800 m^3
T2 Volume 4,050 m^3
Liability Removed
$75,000

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Tier 2
No Remediation

- Correct application of various Tier 2 methods can achieve closure without remediation;
  - Native Prairie Protocol
  - Remote Green Zone Management Limits
  - Approved Guideline requests / SSRA acceptance
- Highlights the importance of Net Environmental Benefits
  - Achieves equivalent or higher levels of Protection

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Wrap Up

- Primary objective is to reduce the environmental liability in relation to generic Tier 1 guidelines and obtain site closure.
  - Protect the environment / Equal Protection
  - Reduce costs
- Can expedite regulatory closure and certification, often without the need for remediation.
  - More $ available to close more sites
- Risk Based Closure

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The Power of Tier 2

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Audience Participation

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