



Subsoil Salinity Tool Application on Abandoned Well Sites in Southern Alberta: Industry and Consulting Perspectives, Challenges, and Solutions

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Outline

- Remediation before the Subsoil Salinity Tool (SST)
- The SST – Cenovus learnings
- Results, challenges, solutions

Site history

Six salt impacted sites in SE Alberta

- Drilled: 1969 – 1980
- Depth: 723 – 1245 m
- Target: gas
- Soils with elevated sodium and chloride
 - exceedance of Alberta Tier 1 (AESRD, 2010) for EC and SAR

Remediation before the SST

Remediation guidelines for EC and SAR:

- Alberta Tier 1 (AESRD, 2010)
- Background

What about chloride?

- 250 mg/kg?
- 500 mg/kg?
- 1000 mg/kg?
- Doesn't matter?

Example Site – ‘Capone’

Phase 2 ESAs identified salinity issues

Remediation targeted EC, SAR and chlorides <250 mg/kg

EC and SAR were naturally elevated in background soils



Example site 'Capone'



Example site 'Capone'



Example site 'Capone'



SST – Cenovus Perspective

Undertook SST analysis on six sites

- Tier 2a, Tier 2b and Tier 2c

Thought remediation was over

Example site 'Gotti'

- Preliminary chloride guideline of 190 mg/kg

SST – Cenovus Perspective

Left with some questions:

- Was such a low guideline required to be protective of receptors?
- How did the remediation requirements from SST compare to Alberta Tier 1 (AESRD, 2010)?
- Can you use Alberta Tier 1 (AESRD, 2010) for soils with elevated chlorides?

Findings

- Cost/Benefit
- Three challenges



Results

Table 1: Estimated Volumes and Remediation Costs at Five Sites

	Exceeding Tier 1 Guidelines*	Exceeding 250 mg/kg* Chloride	Exceeding SST Guidelines**
Volume of Soil (m ³):	21,700	24,662	14,214
Remediation Cost:	\$2,389,387	\$2,715,533	\$1,565,588
*root zone plus subsoil estimates			

**includes root zone soil exceeding Tier 1 guidelines and subsoil exceeding SST guidelines



Results

Table 2: Estimated Savings Using SST Guidelines at Five Sites

	Relative to Tier 1	Relative to 250 mg/kg
Soil not landfilled (m ³):	7,486	10,448
Saved worker hours:	3,267	4,560
Saved truck loads:	363	506
Remediation cost savings:	\$824,283	\$1,150,429
Cost of SST data collection and analysis:	\$184,128	\$184,128
Net Cost Savings:	\$640,155	\$966,301

And just as protective to the environment

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Challenge 1: When to use SST?

- Justifications/rationale
- Tier 1 versus Tier 2 (SST or other methods)
- Optional versus mandatory scenarios
- Cost savings?
- Mock scenarios / gap analysis
- Avoiding over or under remediating
- Higher certainty with endpoint ~ more defensible closure ~ simplified liability management?

Challenge 2: Stringent SST Guidelines?

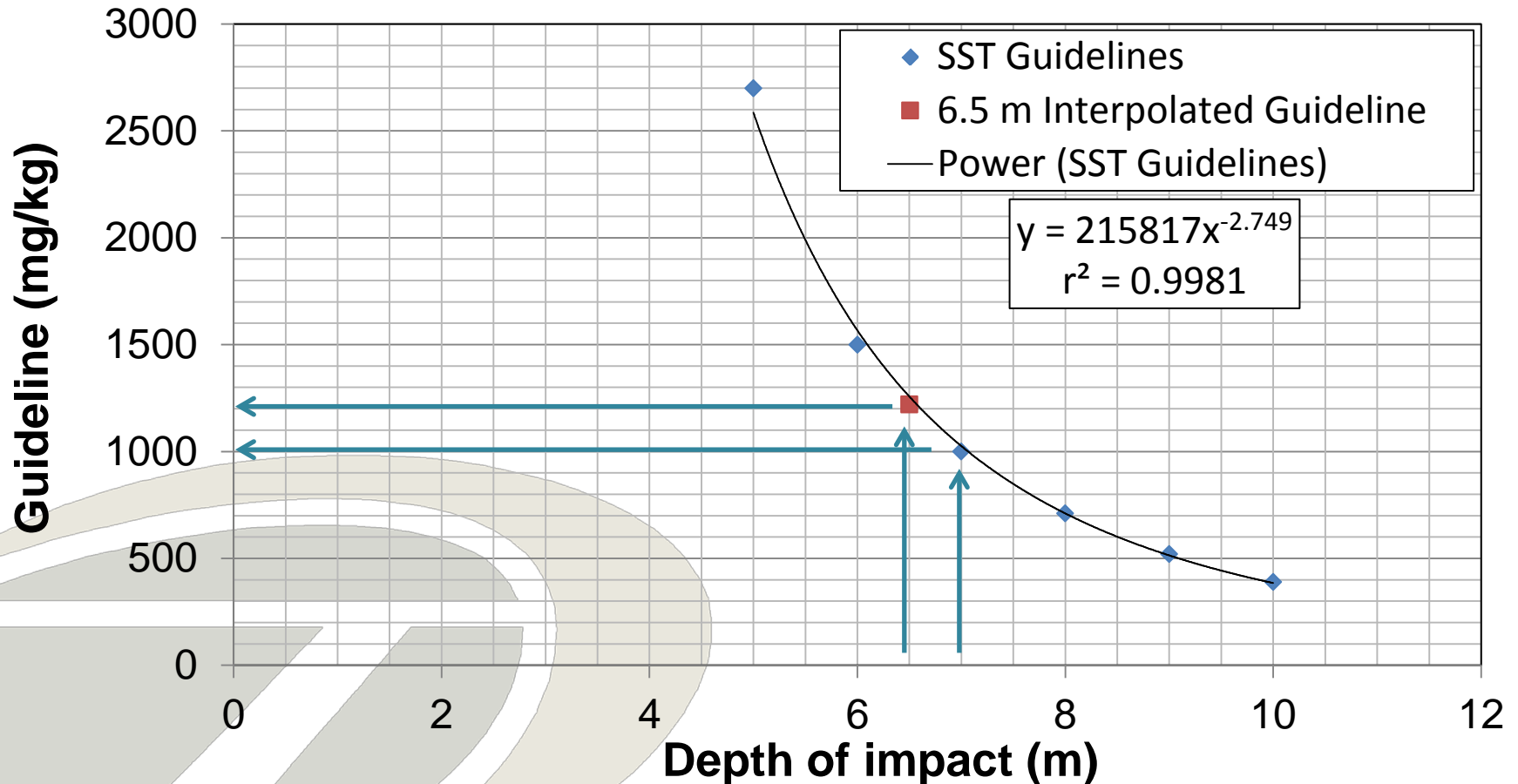
Table 3: Tier 2 Chloride Guidelines

Site	Initial SST Output*	Refined Guideline	Limiting Pathway / Receptor	Example Peripheral Subarea Guideline	Shallow Groundwater Guideline
Moran	370	1,030	Root zone	1,000	-
Luciano	1,400	1,600	Root zone	2,100	6,000
Costello	400	1,160	Aquatic Life	1,100	-
Gambino	170	700	Aquatic Life	700	1,700
Gotti	190	1,080	Aquatic Life	670	1,000

*Prior to implementing techniques described in this presentation
 Guidelines are approximate, expressed in mg/kg for subsoil and mg/L for groundwater

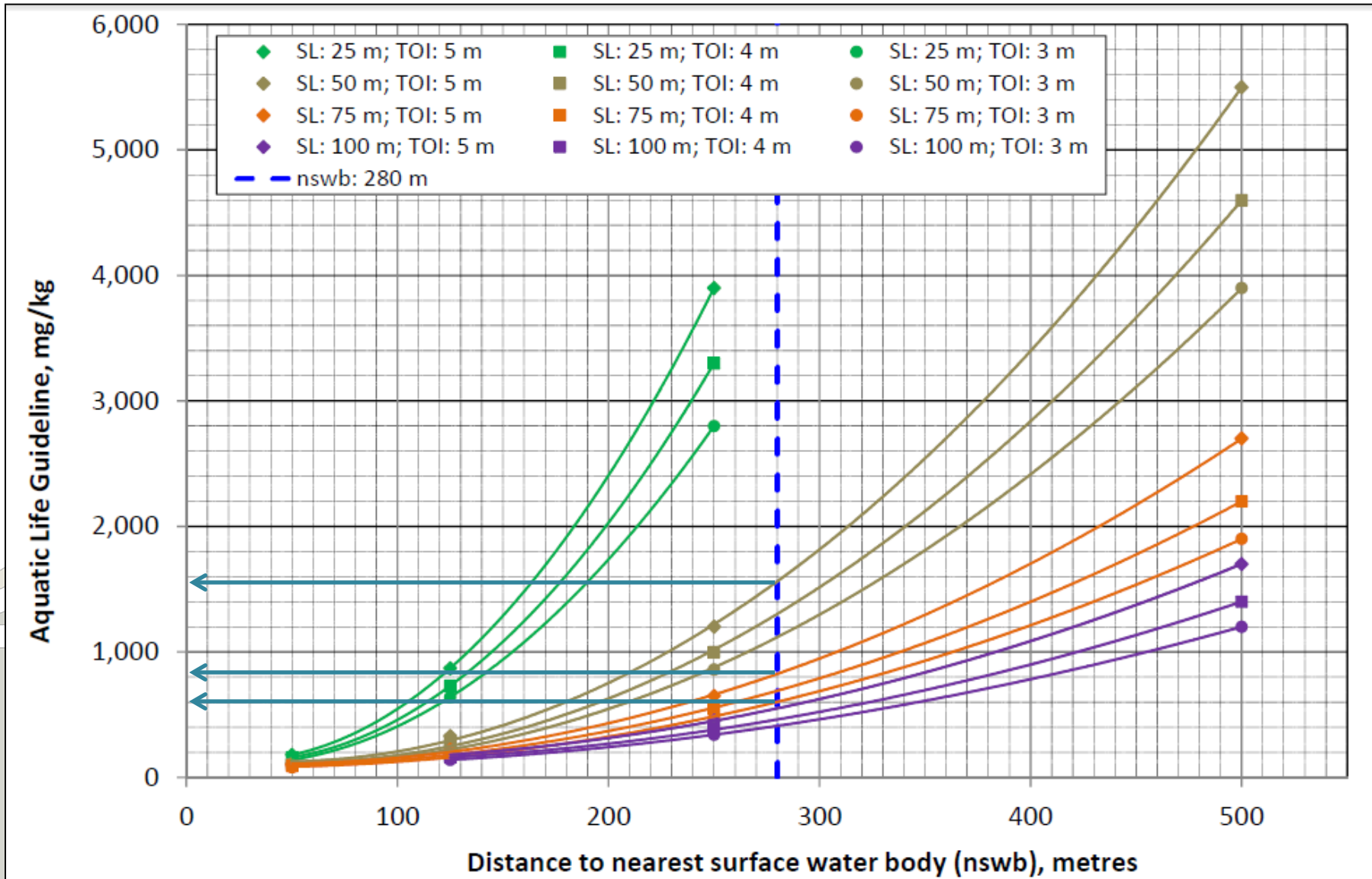
Guideline Interpolation

- Aquatic Life Guideline Relative to Depth of Impact



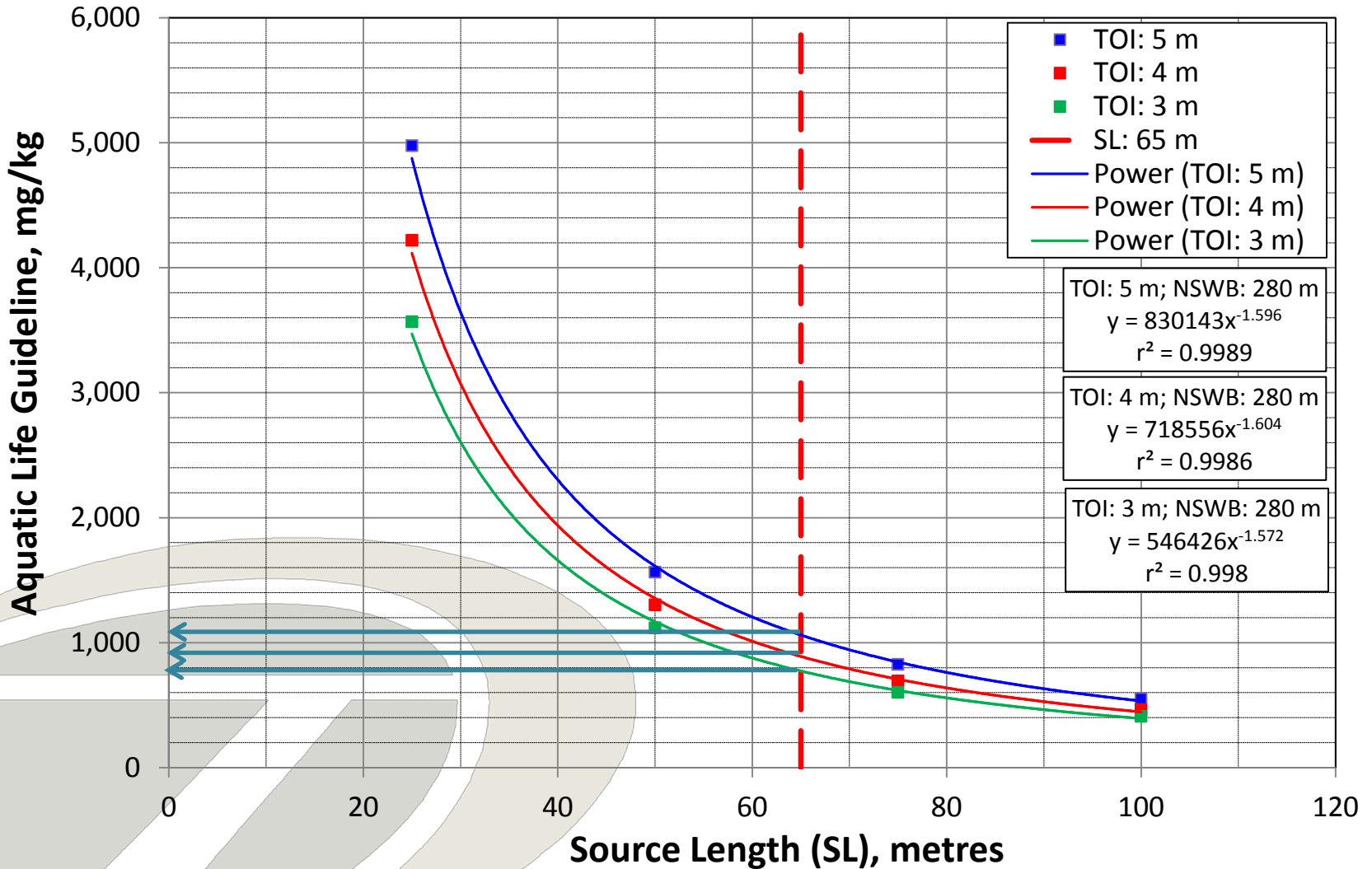
SST Soil Chloride Guideline Interpolation

- relative to distance to nearest surface water body: for source length (SL) and top of impact (TOI) categories



SST Soil Chloride Guideline Interpolation

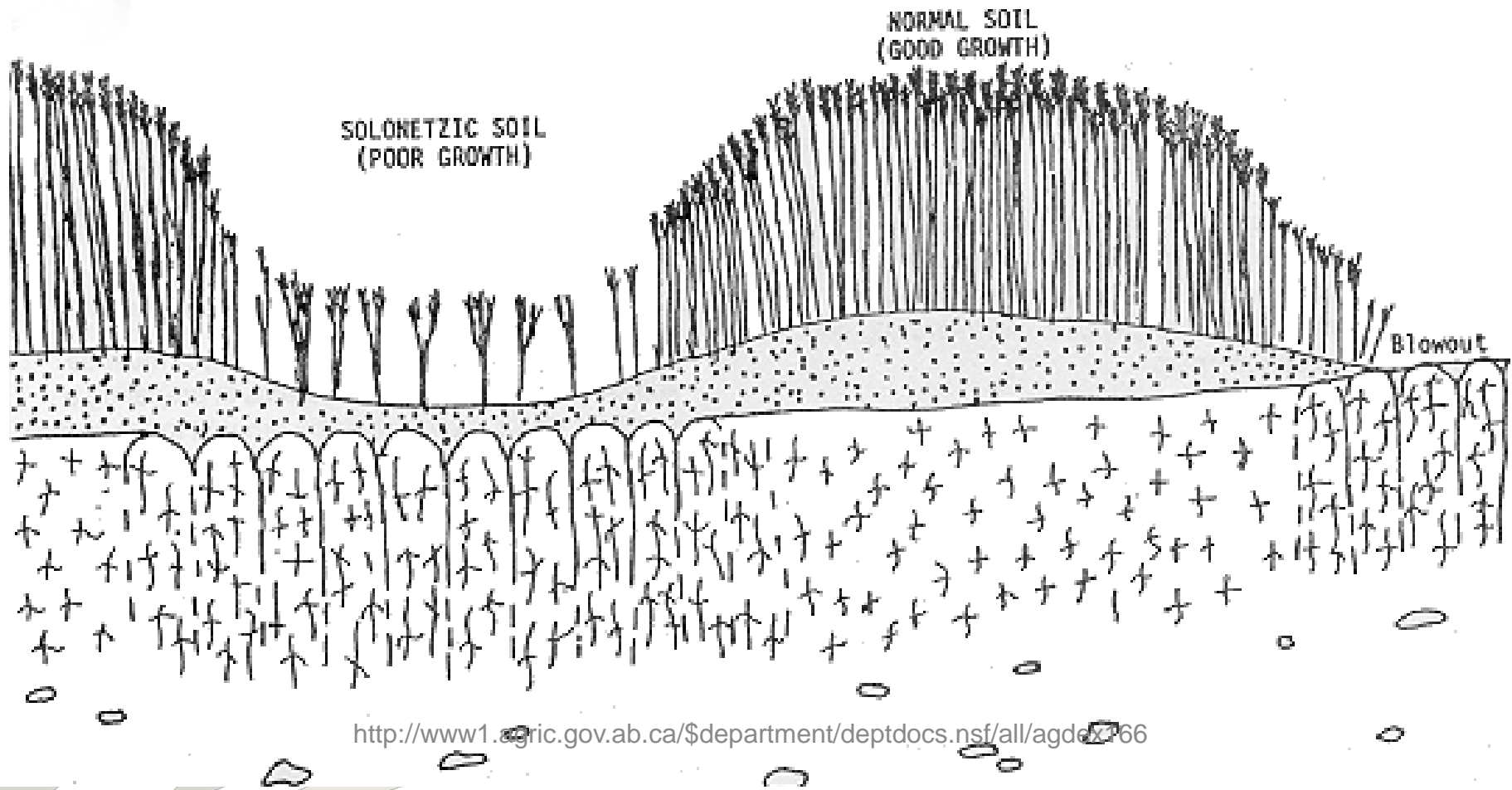
- relative to source length: for precise distance to nearest surface water body and top of impact (TOI) categories



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Challenge 2: Stringent SST Guidelines?

- Solonchetic soils interspersed with chernozemic soils

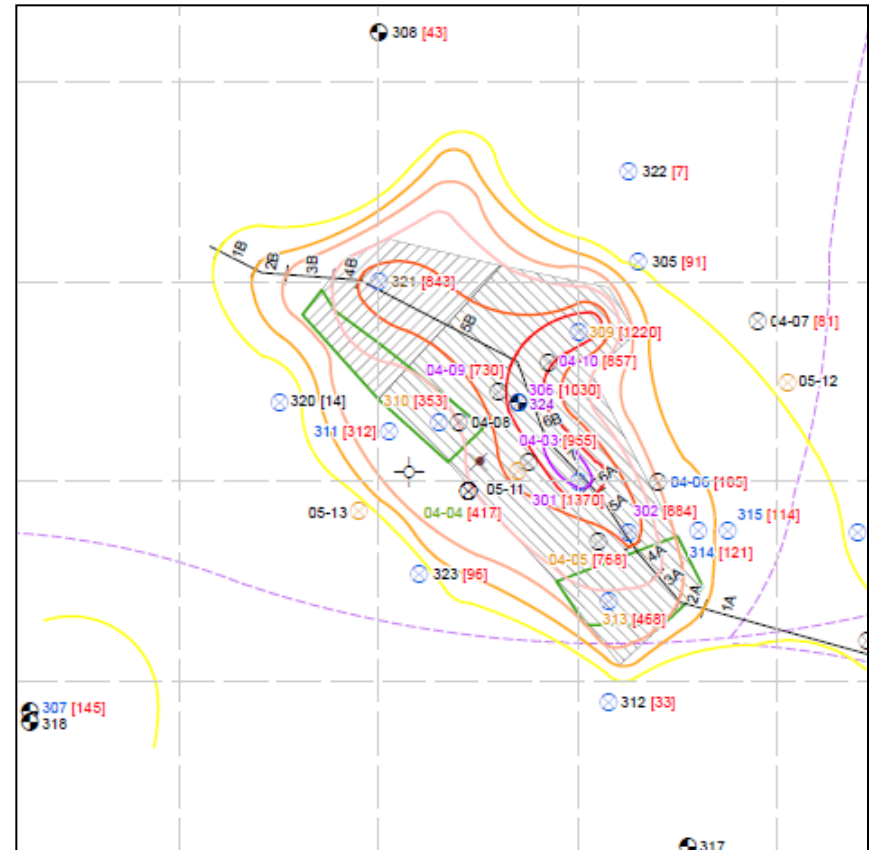
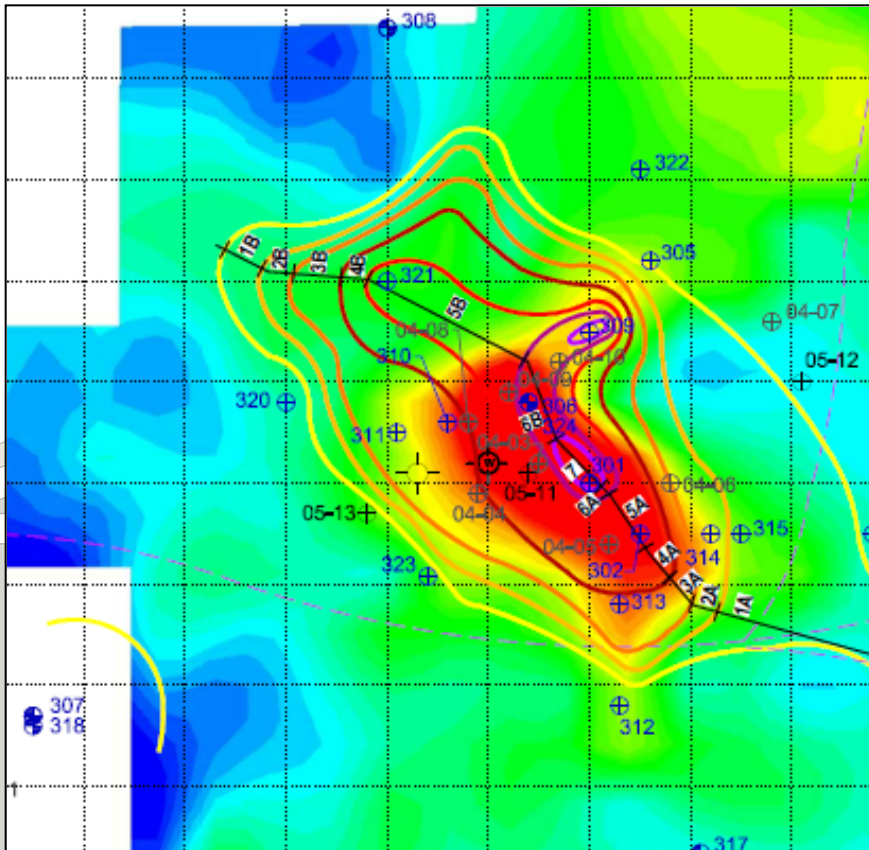


Challenge 2: Stringent SST Guidelines?

- Solonetzic soils interspersed with chernozemic soils = bimodal EC
 - Outlier analysis of bimodal data may overlook natural salinity on the landscape? (Solution: three iterations)
 - Practical to stratify a spatially heterogeneous area?
 - Reasonable to use backfill soil with low EC?
 - Provide causal reasoning

Challenge 3: Applying Subarea Guidelines

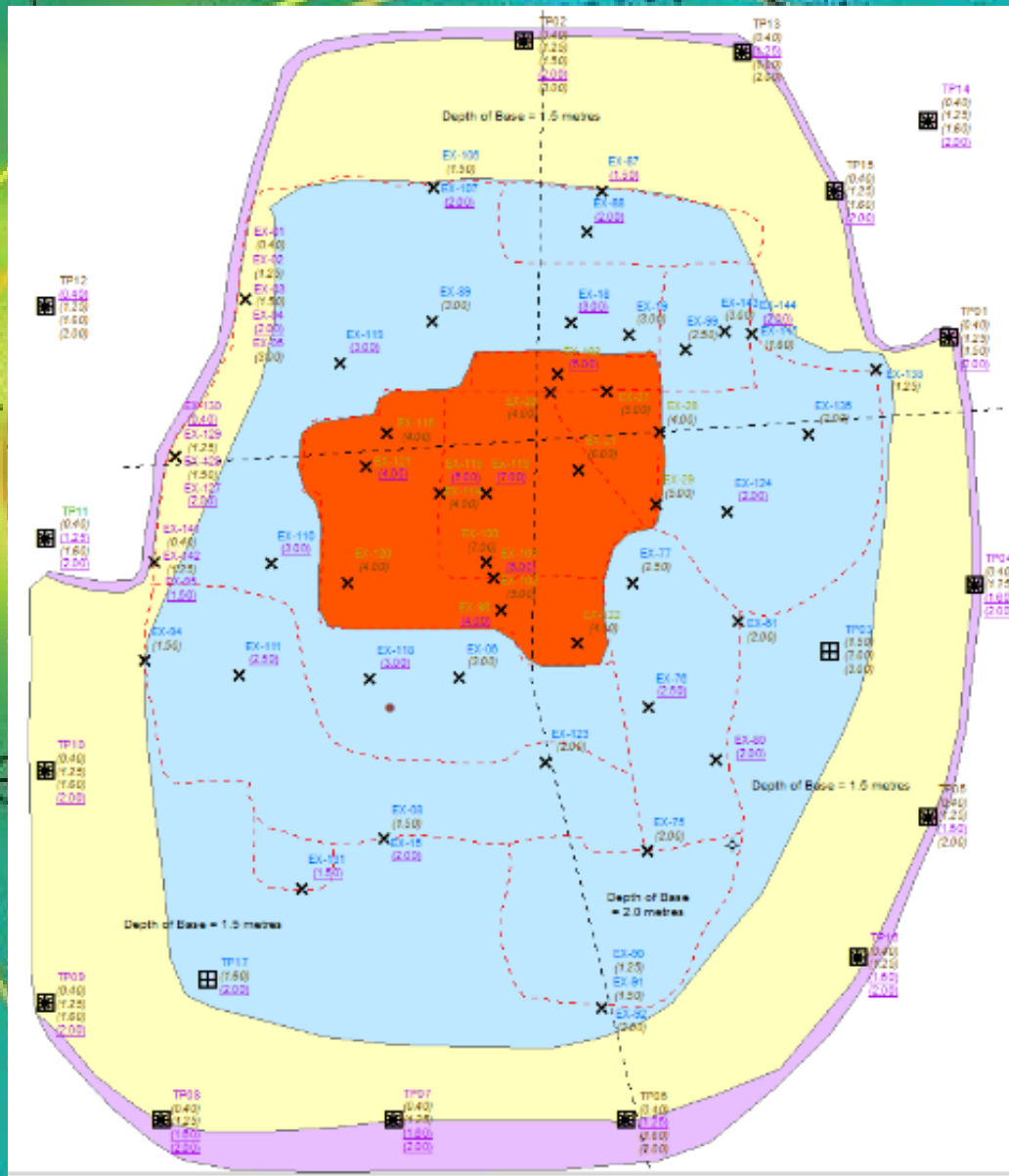
- Refine lateral closure and avoid over remediating the edges
- Prescriptive: extract worst case soils and conserve peripheral salvageable soil – balance volumes



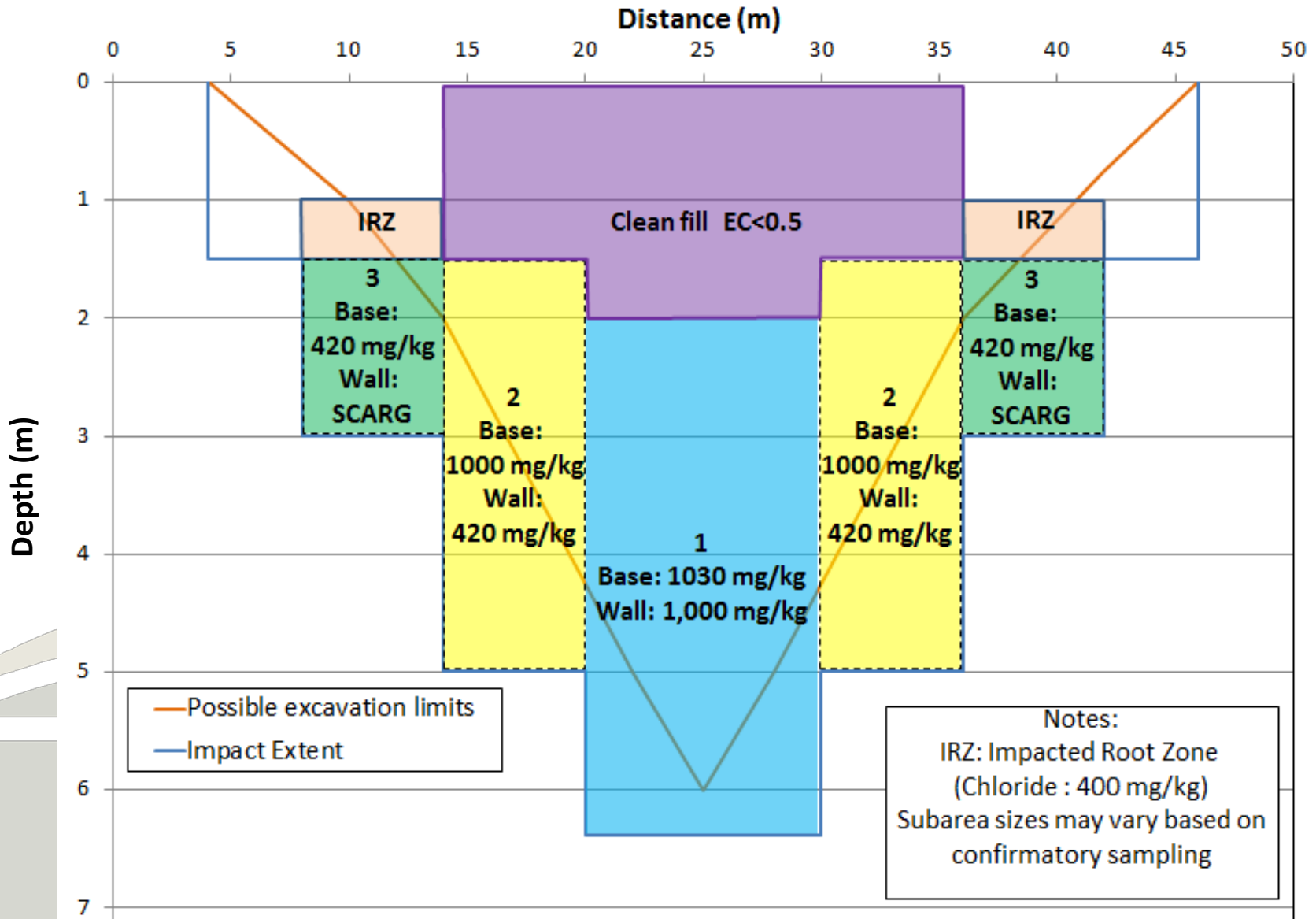
- Impact area divided into subareas, each with a customized guideline

ORANGE G.L.: 1,500 mg/kg
TOI: 3 metres
BOI: 7 metres

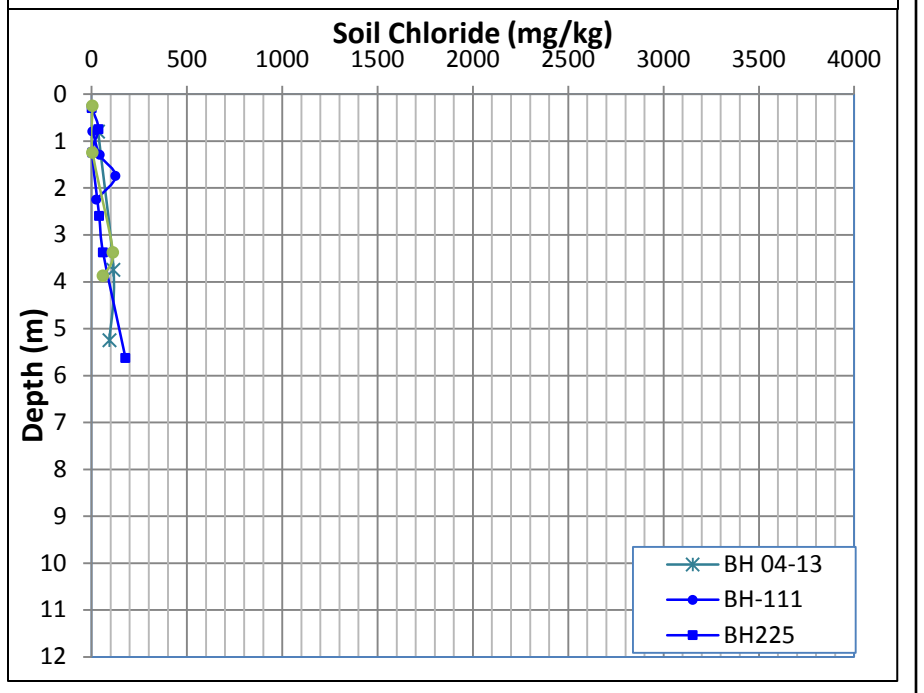
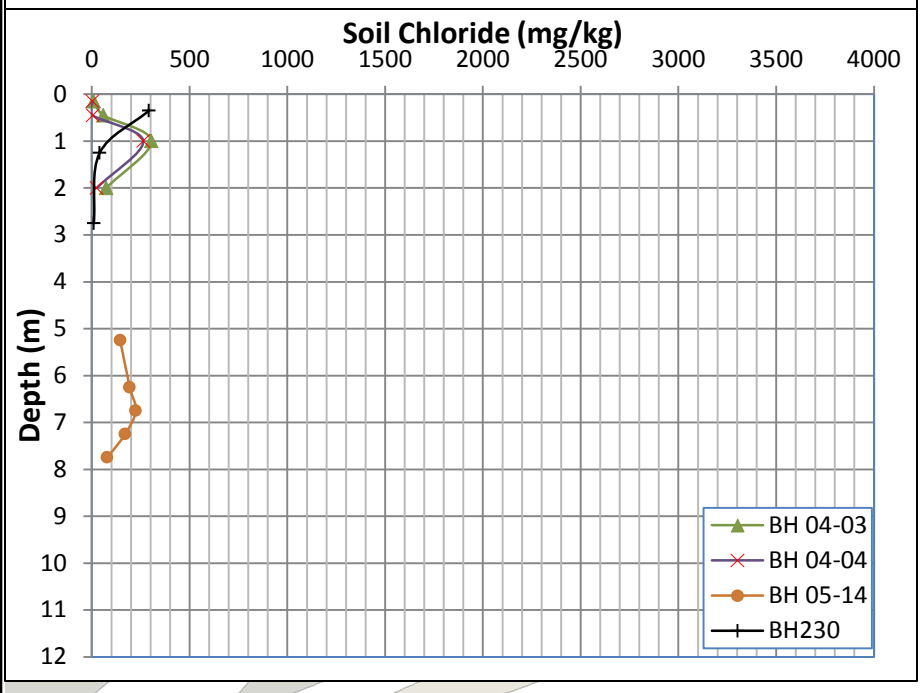
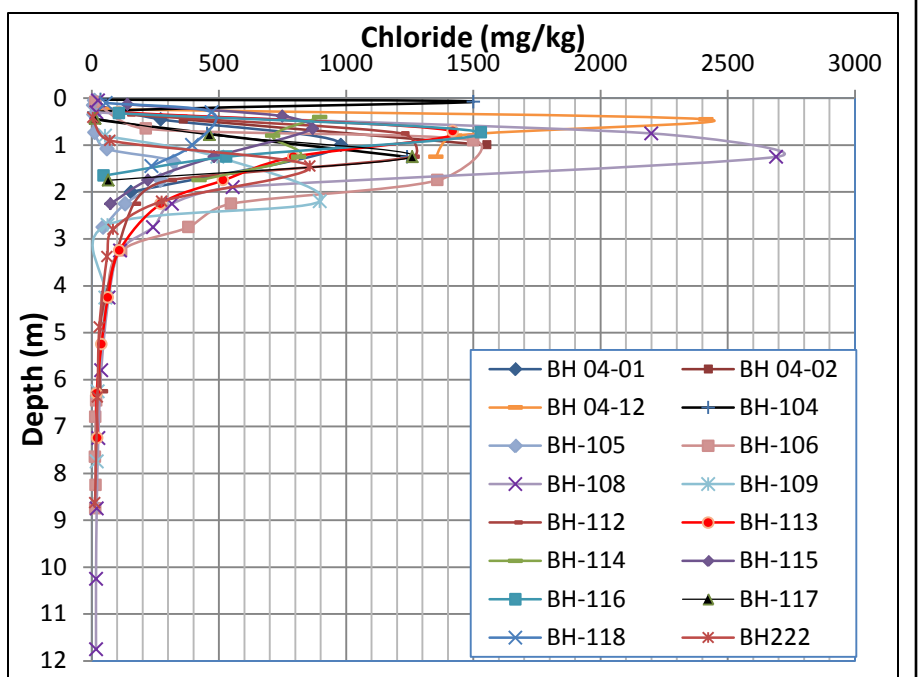
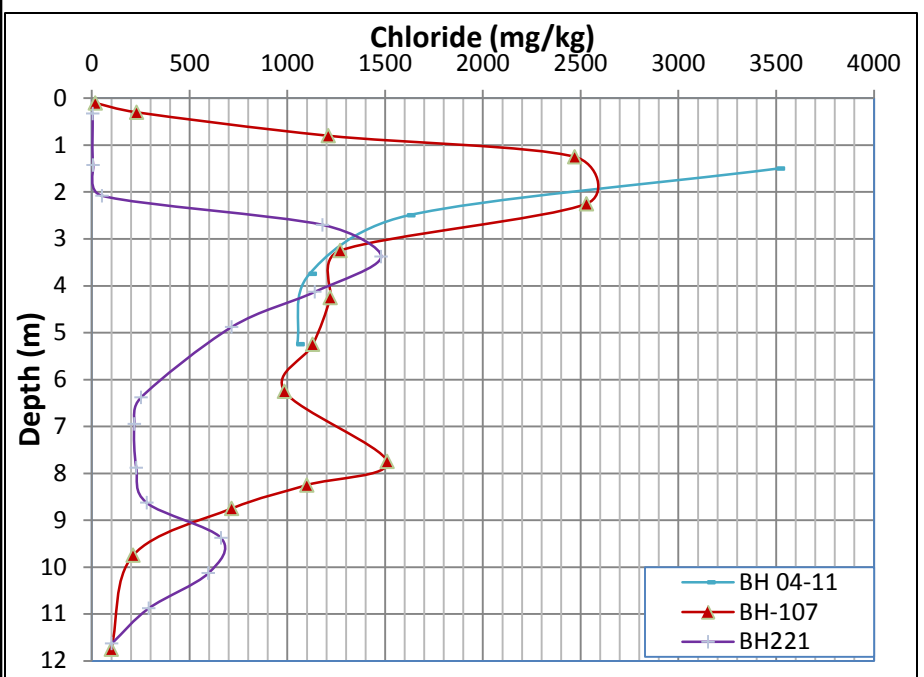
BLUE G.L.: 1,000 mg/kg
TOI: 1.5 metres
BOI: 6 metres

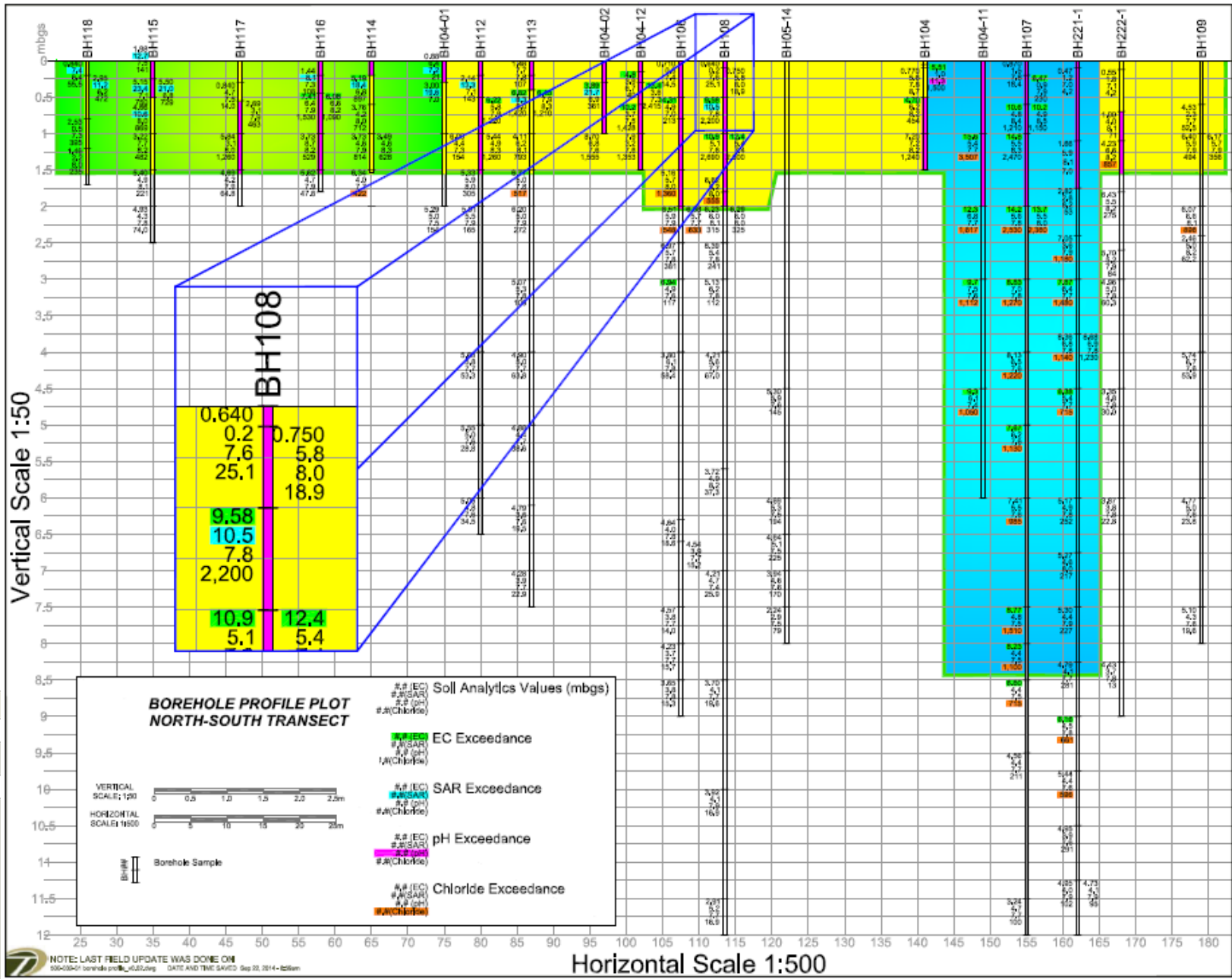


Conceptual Profile of SST Subareas (#) and Respective Guidelines



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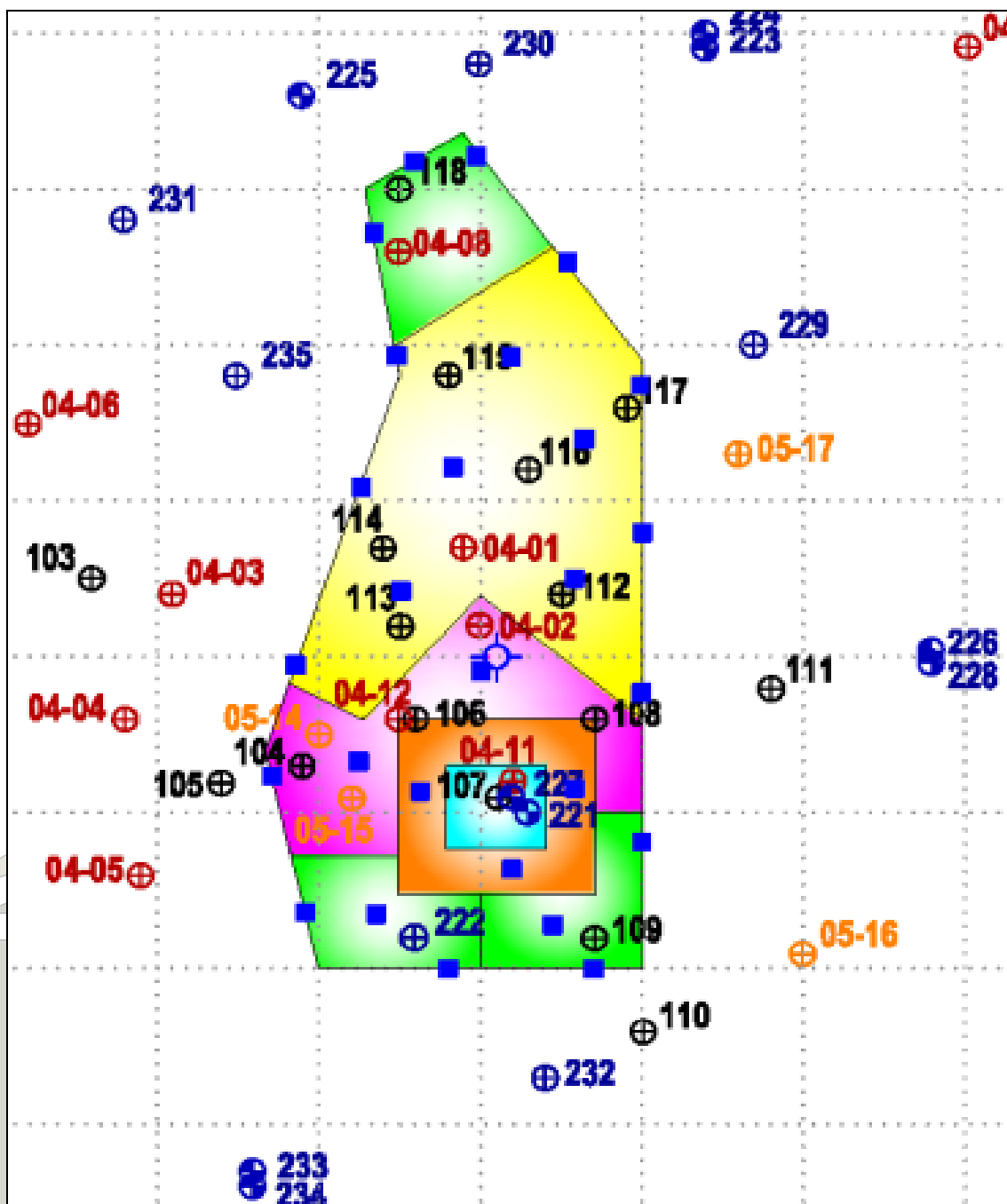




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Remediation Plan

- Prescriptive
- Test pits (blue squares) and confirmatory samples supplement and confirm predicted trends



Summary



- SST was useful on several sites
- Remediation was required
- Net cost savings
- Stringent guidelines: pathway elimination, pre- and post-processing work to avoid over-remediating
- Subarea application: soil conserved by removing worst case and maximizing salvage
- Higher certainty of remedial endpoints, protecting receptors (liability management / closure) – avoid under-remediating

References

- AENV (Alberta Environment). (2001b, May). Salt Contamination Assessment & Remediation Guidelines (Publication No. T/606, ISBN 0-7785-1718-7). Edmonton, AB: Environmental Sciences Division Environmental Service.
- AENV (Alberta Environment). (2011). Subsoil Salinity Tool software v.2.5.2. Alberta Environment Air, Land, and Waste Policy Branch, Edmonton, AB.
- ESRD (Alberta Environment and Sustainable Resource Development). (2014a). Subsoil Salinity Tool software v.2.5.3. Alberta Environment Air, Land, and Waste Policy Branch, Edmonton, AB.
- ESRD (Alberta Environment and Sustainable Resource Development). (2014b, May 21). Alberta Tier 2 Soil and Groundwater Remediation Guidelines (ISBN 978-1-4601-1702-6). Edmonton, AB: Land and Forestry Policy Branch, Policy Division.
- ESRD (Alberta Environment and Sustainable Resource Development). (2014c, May 23). Alberta Tier 1 Soil and Groundwater Remediation Guidelines (ISBN 978-1-4601-1700-2). Edmonton, AB: Land and Forestry Policy Branch, Policy Division.
- Alberta Agriculture and Rural Development. (1993). Management of Solonetzic Soils. Edmonton, AB: Soil and Crop Management Branch. Retrieved from the world wide web Sept 21, 2014. [http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/agdex166](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex166)