

# Eco-Toxicity of Sulphate Relative to Chloride and Ion-Specific Soil Guidelines

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# Rationale

- Most Alberta salinity issues/releases are NaCl
- However,  $\text{SO}_4$ -based salinity issues also occur
- Alberta salinity guidelines based on EC
- EC guidelines are based on NaCl phytotoxicity
- Guidelines appropriate for sulphate?

# Overview

- Basis for existing EC guidelines
- Relative phytotoxicity of sulphate vs. chloride:
  - Literature summary
  - Experimental design
  - Results and analysis
  - Conclusions

# Basis for Alberta EC Guidelines

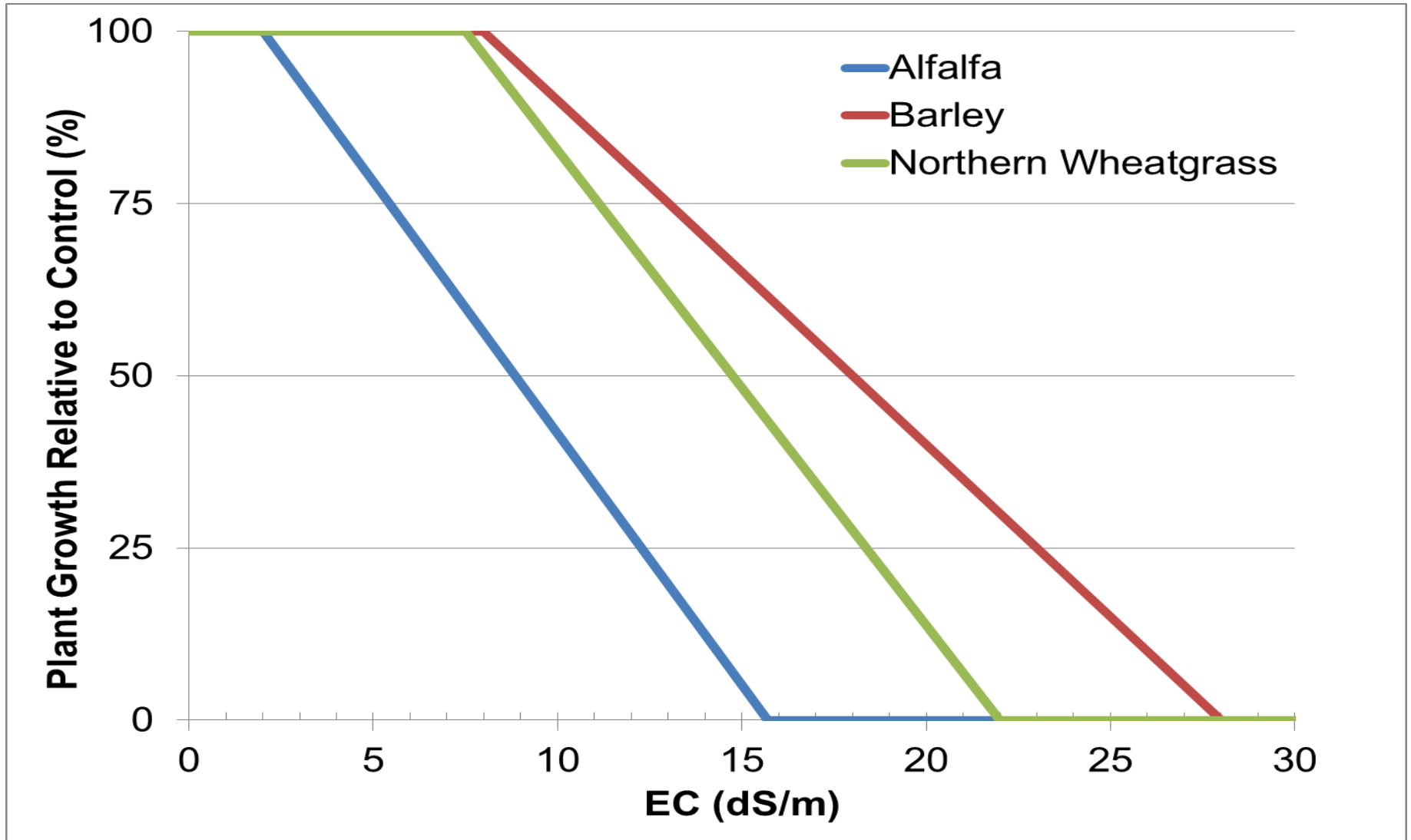
- Based on effects on plant growth
- Does not use “species sensitivity distribution” approach as per other eco-contact guidelines
- Considers literature data on the toxicity of salts, **primarily NaCl**, to plants
- Sets semi-quantitative ranges for EC



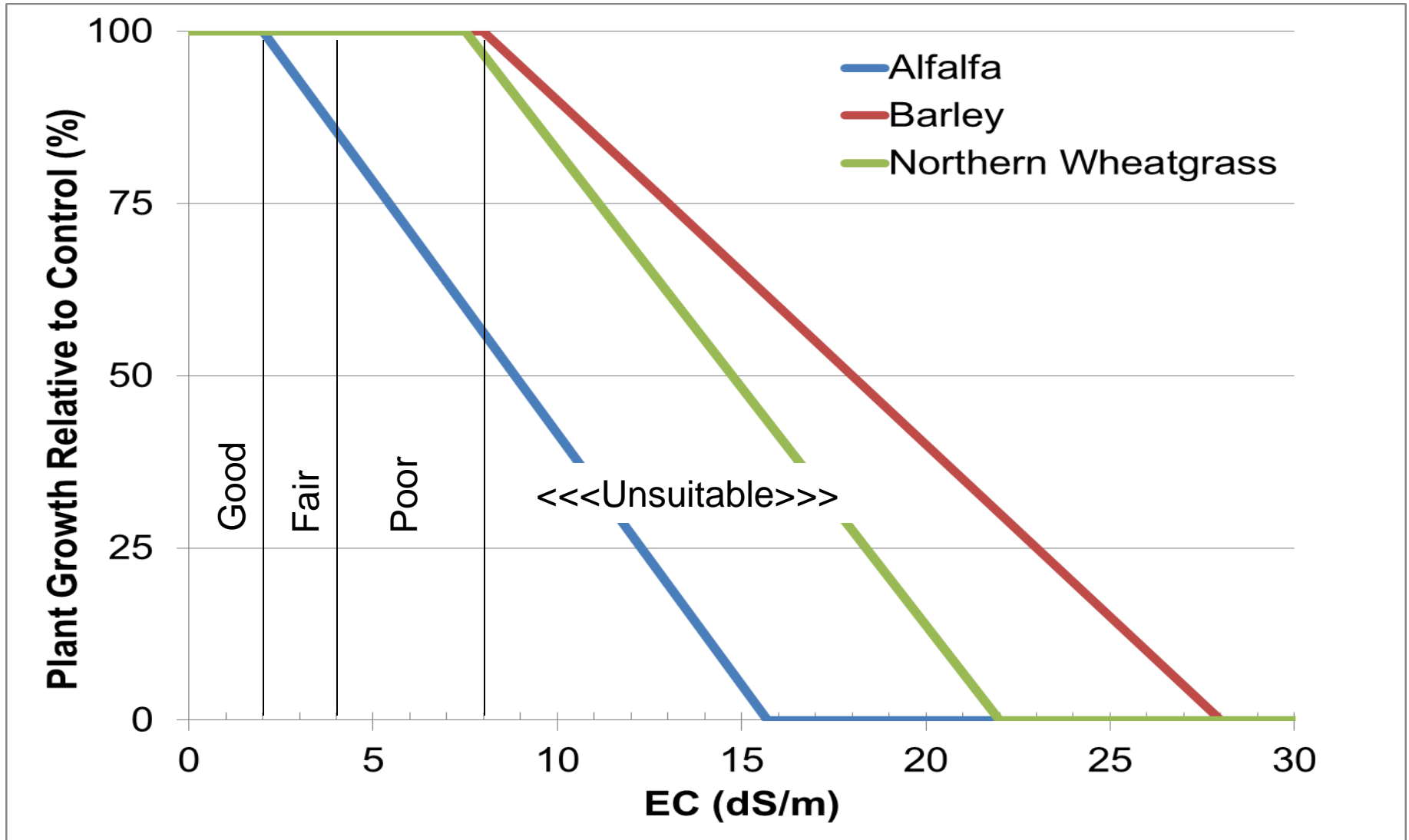
# Alberta EC Guidelines (dS/m)

	Good	Fair	Poor	Unsuitable
Topsoil	<2	2-4	4-8	>8
Subsoil	<3	3-5	5-10	>10

# USDA Salinity Tolerance Data



# USDA Salinity Tolerance Data (Selected)





# Comparative Plant Toxicity – Chloride vs. Sulphate

Study	Species	More Toxic Anion?
Rogers et al. (1998)	Alfalfa	Chloride
Magistrad (1942)	Alfalfa	Chloride
Eaton (1942)	Various	~
Meiri et al. (1971)	Beans	~
Bilski et al. (1987)	Potato	Sulphate
Renault et al. (2001)	Dogwood	Chloride
Franklin et al. (2002)	Jack Pine	Chloride
Crosser et al. (2001)	Spruce, Pine	~
Nguyen et al. (2006)	Spruce, Pine	Chloride
Carter (1980)	Siberian Larch	Chloride
Niu and Rodriguez (2008)	Rose	Chloride

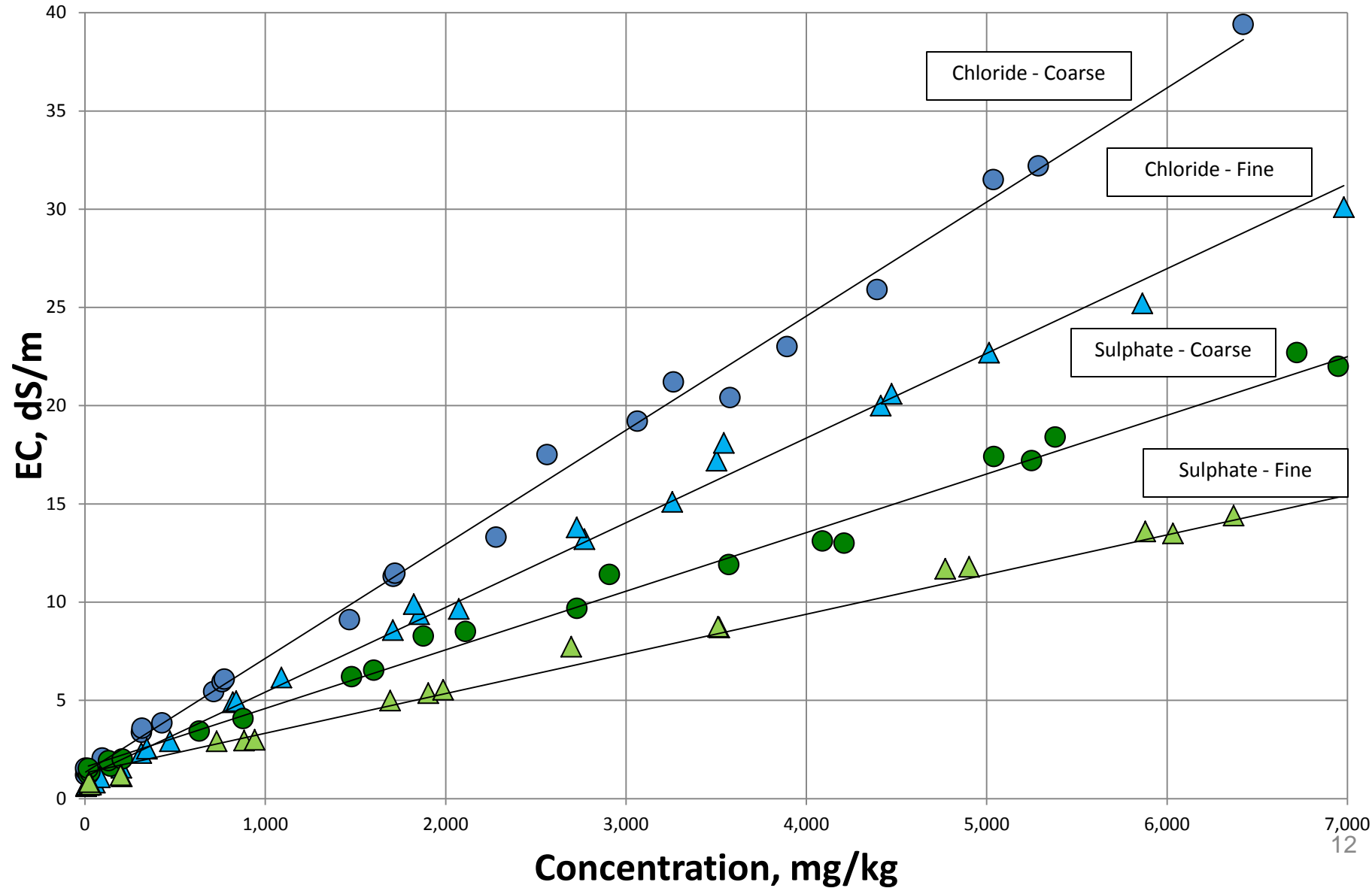
# Experimental Design

- Exova Ecotox Lab in Edmonton – Darlene Lintott
- Environment Canada Protocols
- 3 Plant Species:
  - Alfalfa
  - Barley
  - Northern Wheatgrass
- 2 Soils
  - Coarse
  - Fine
- Parallel ecotoxicity test sets with NaCl and Na<sub>2</sub>SO<sub>4</sub>





# Concentration vs EC – Cl and SO<sub>4</sub>

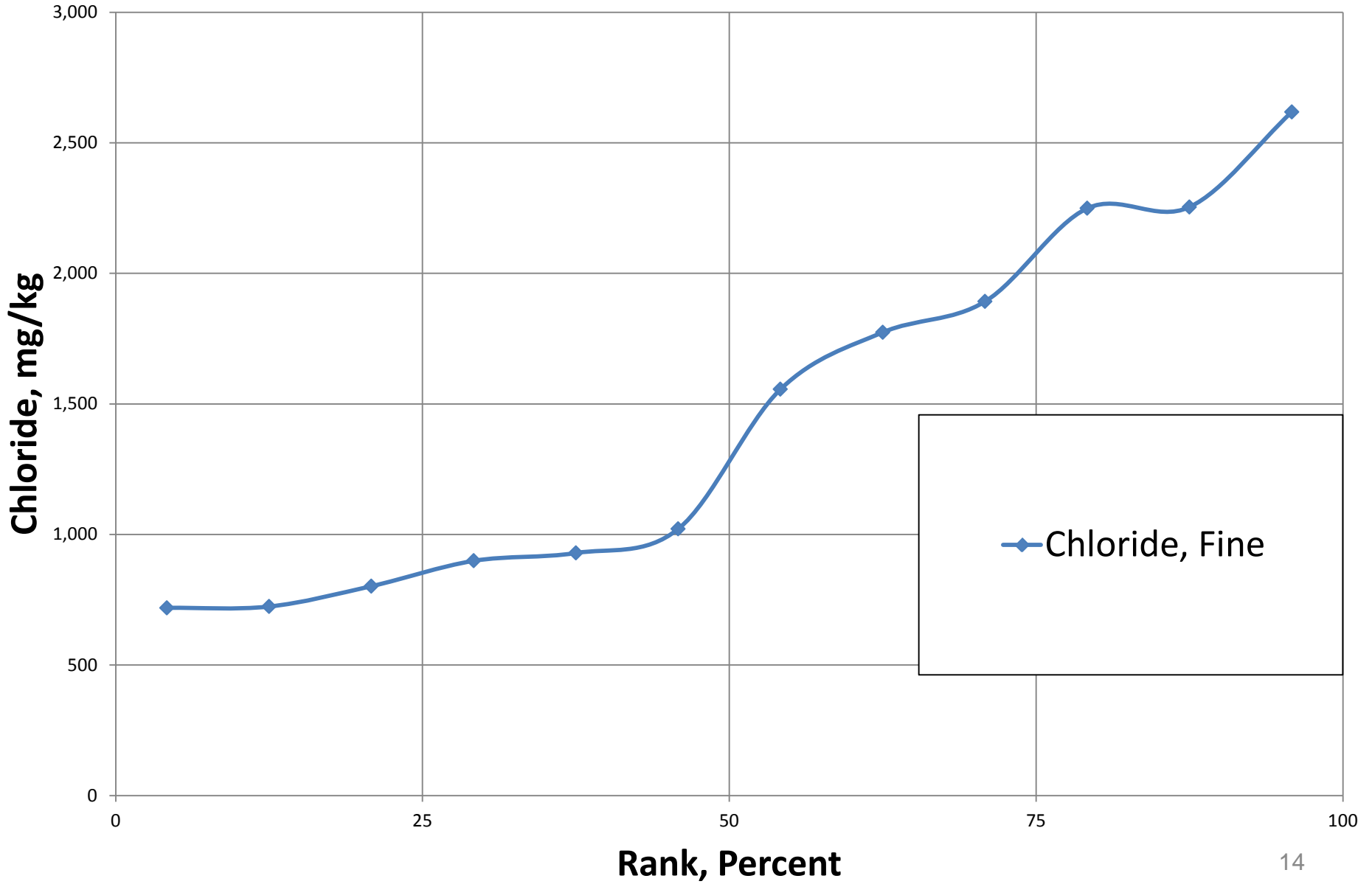


# Concentration/Conductivity Relationships

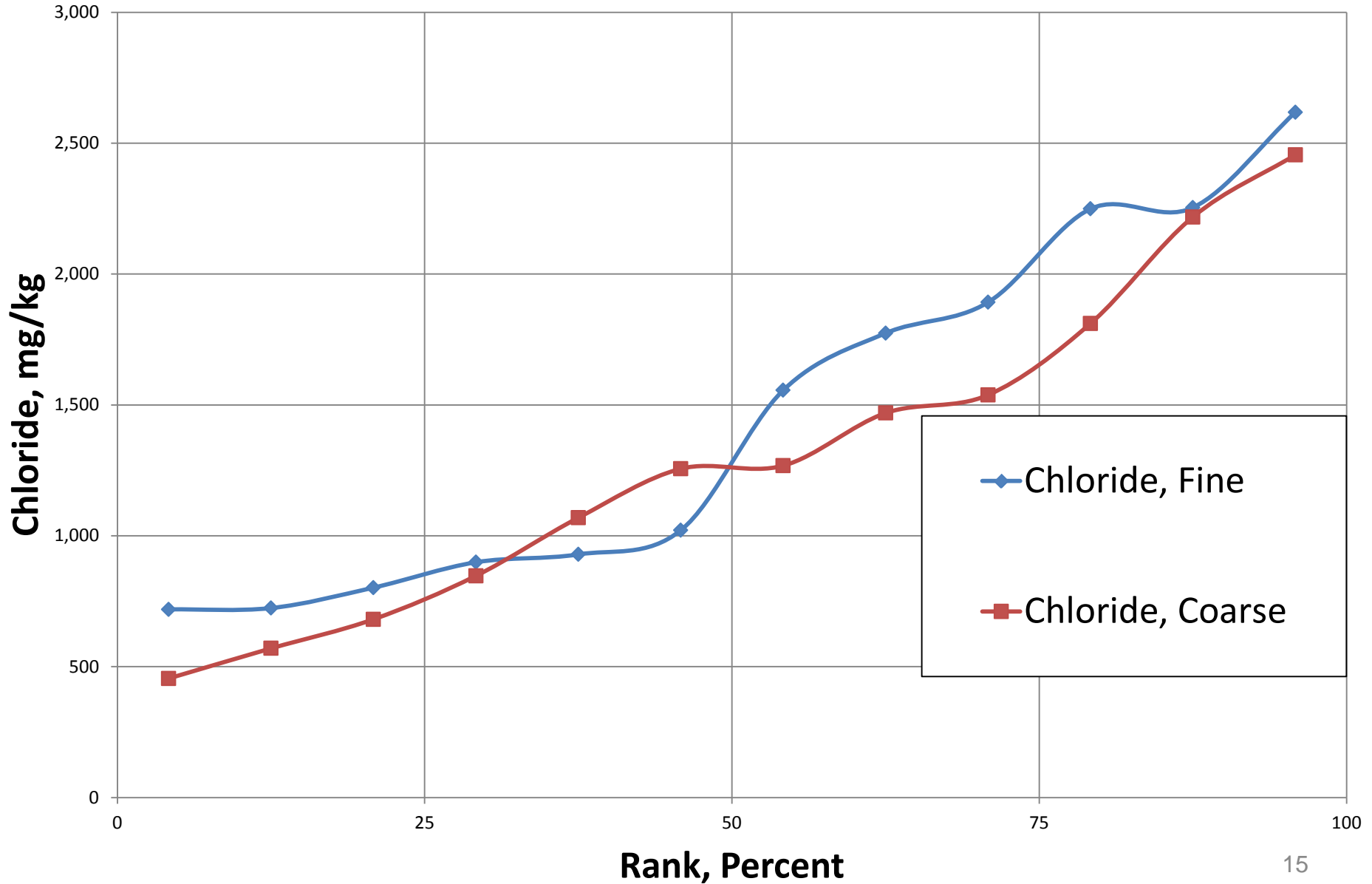
Anion	Soil	Relationship
Chloride	Coarse	$EC=0.00581[Cl]+1.33$
Chloride	Fine	$EC=0.00431[Cl]+1.12$
Sulphate	Coarse	$EC=0.00298[SO_4]+1.61$
Sulphate	Fine	$EC=0.00202[SO_4]+1.31$

Chloride and sulphate concentrations in mg/kg, EC in dS/m

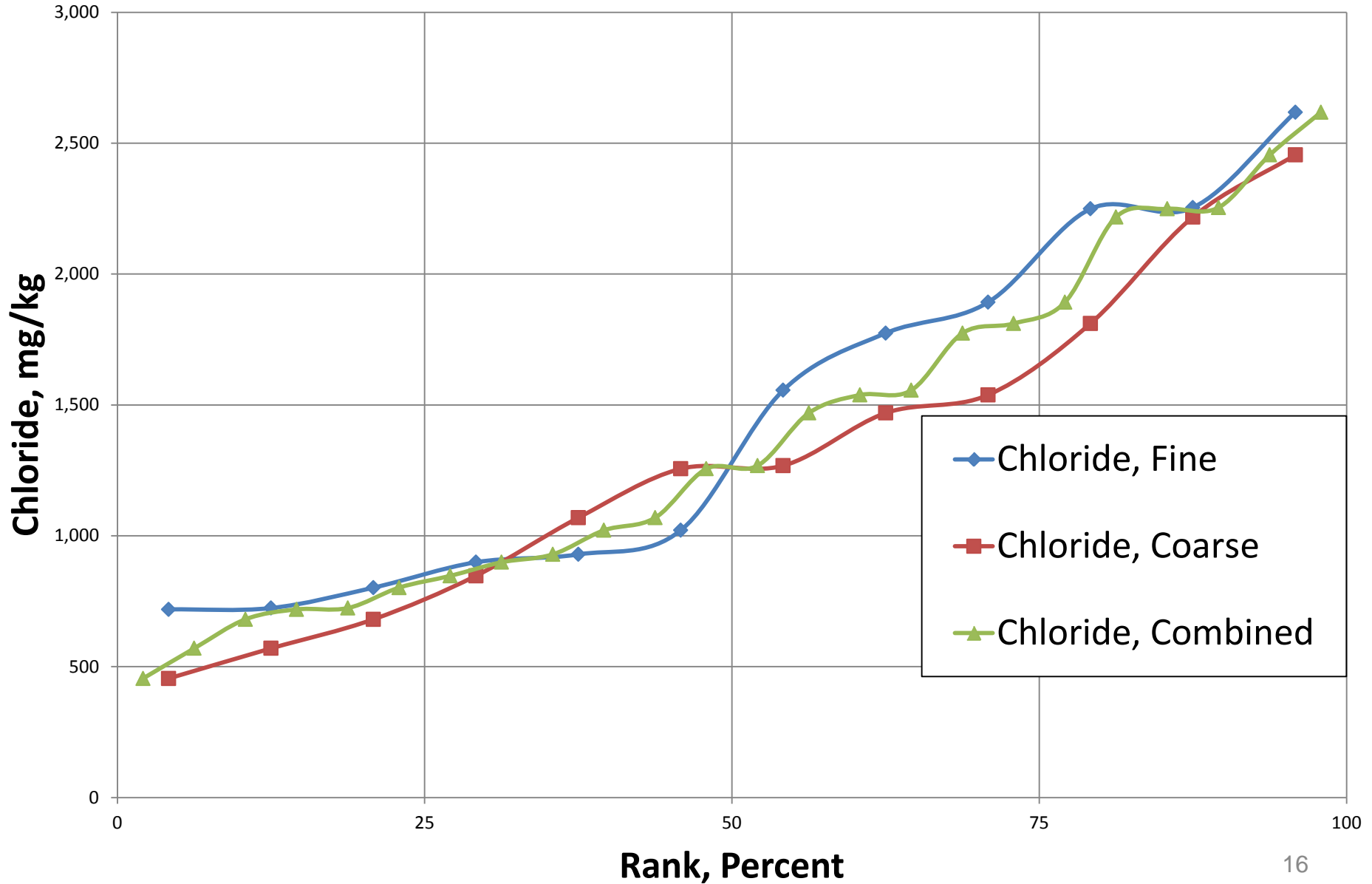
# SSD for Chloride



# SSD for Chloride

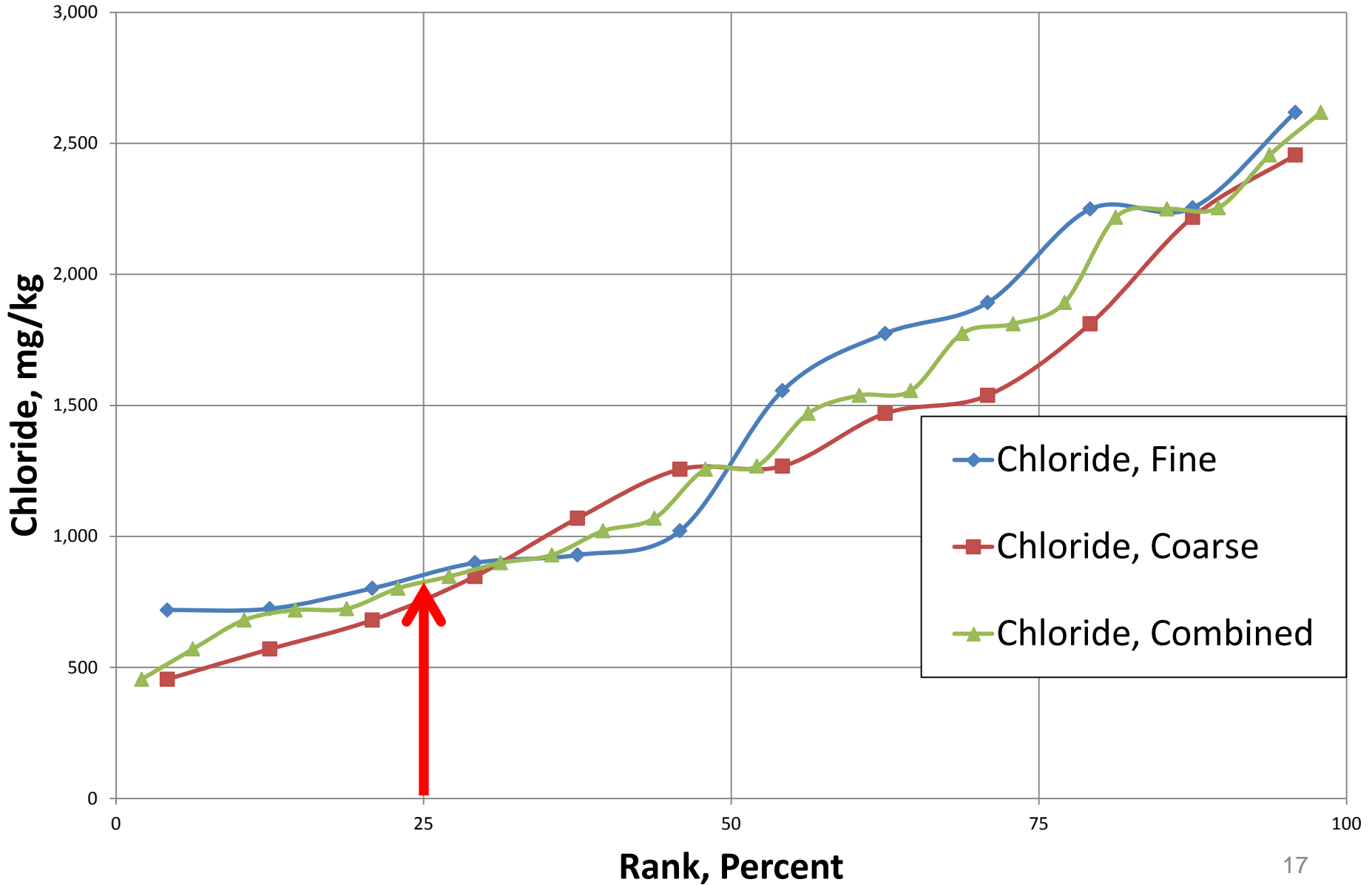


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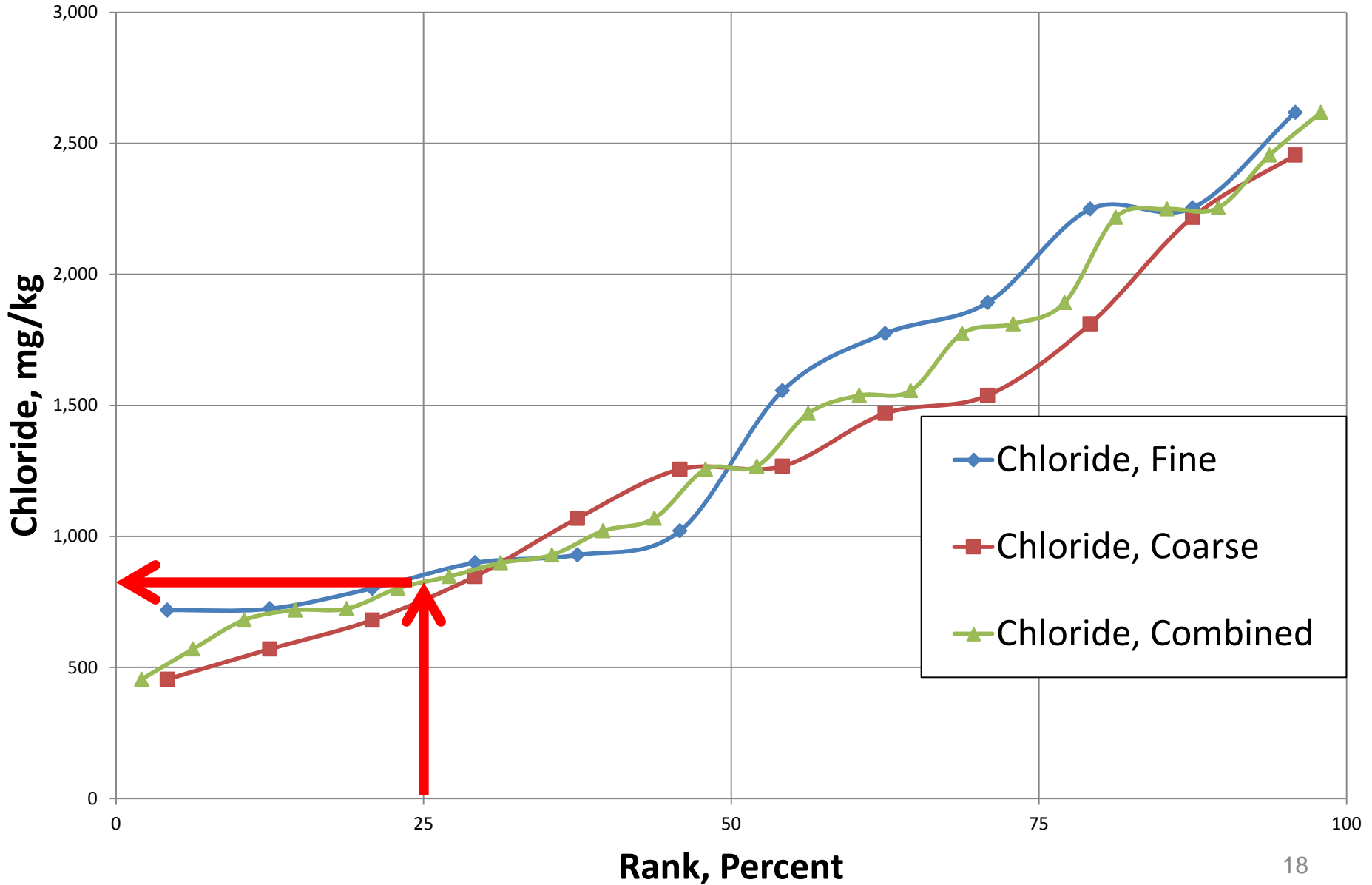




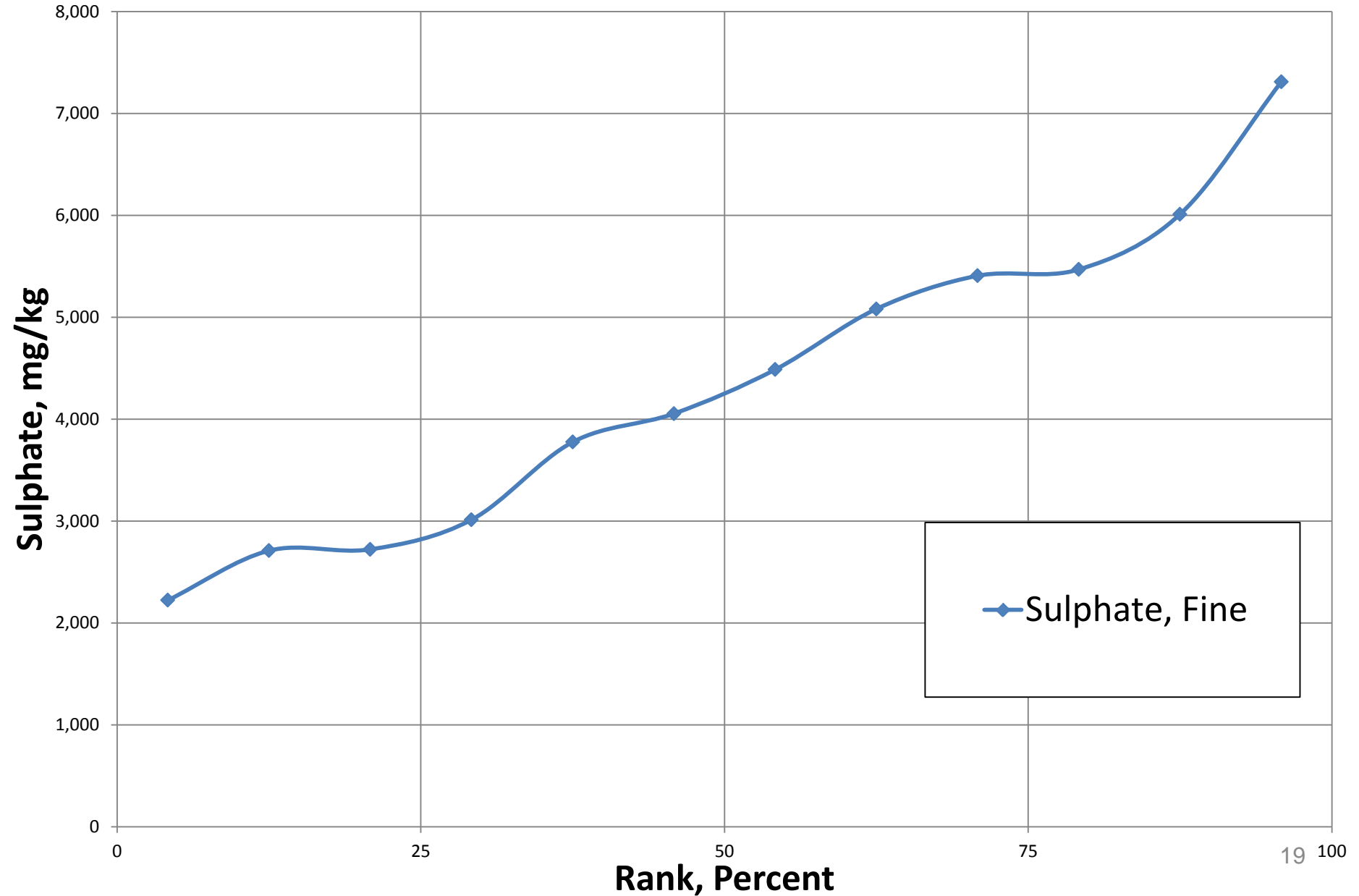
# SSD for Chloride



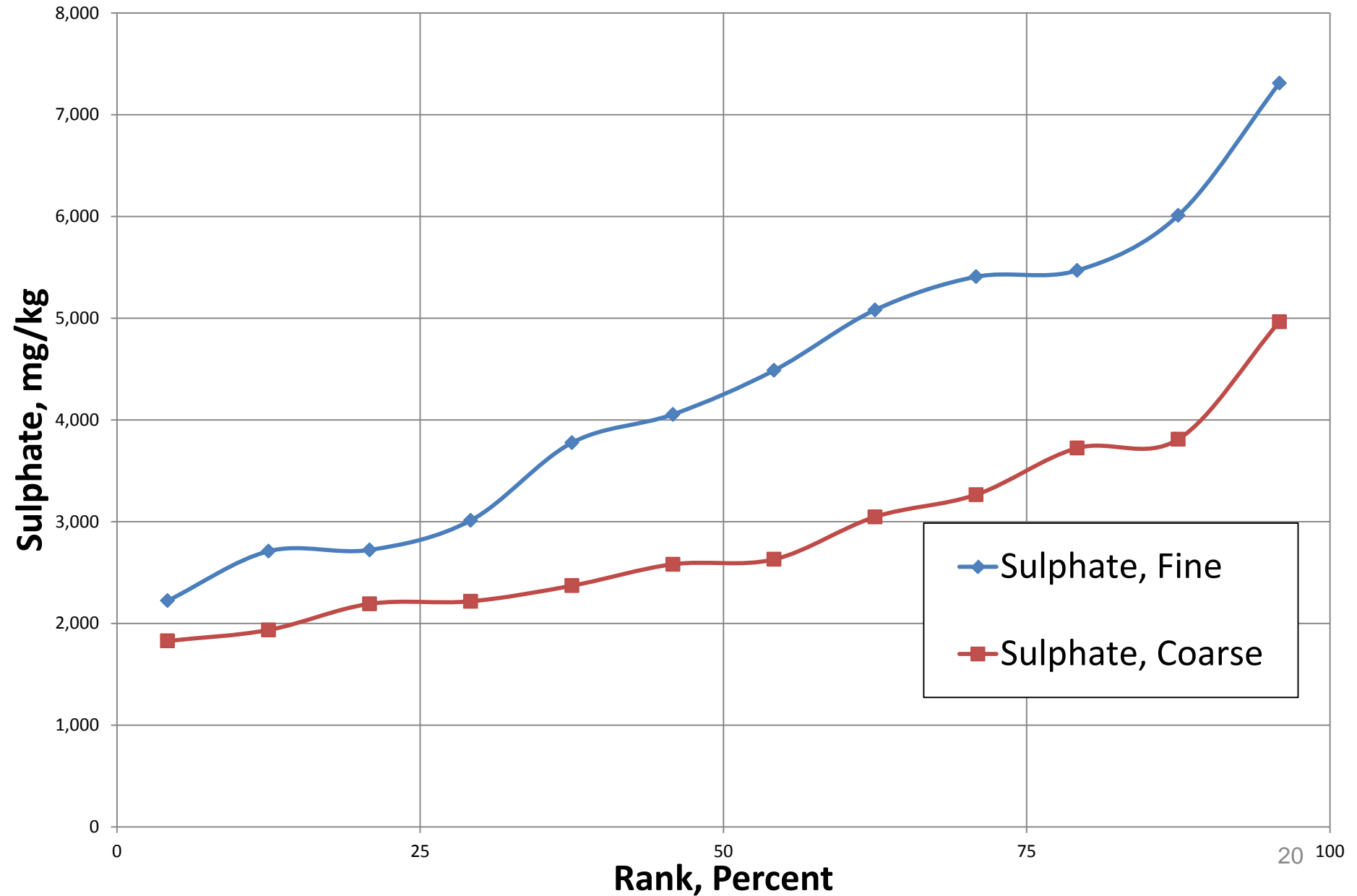
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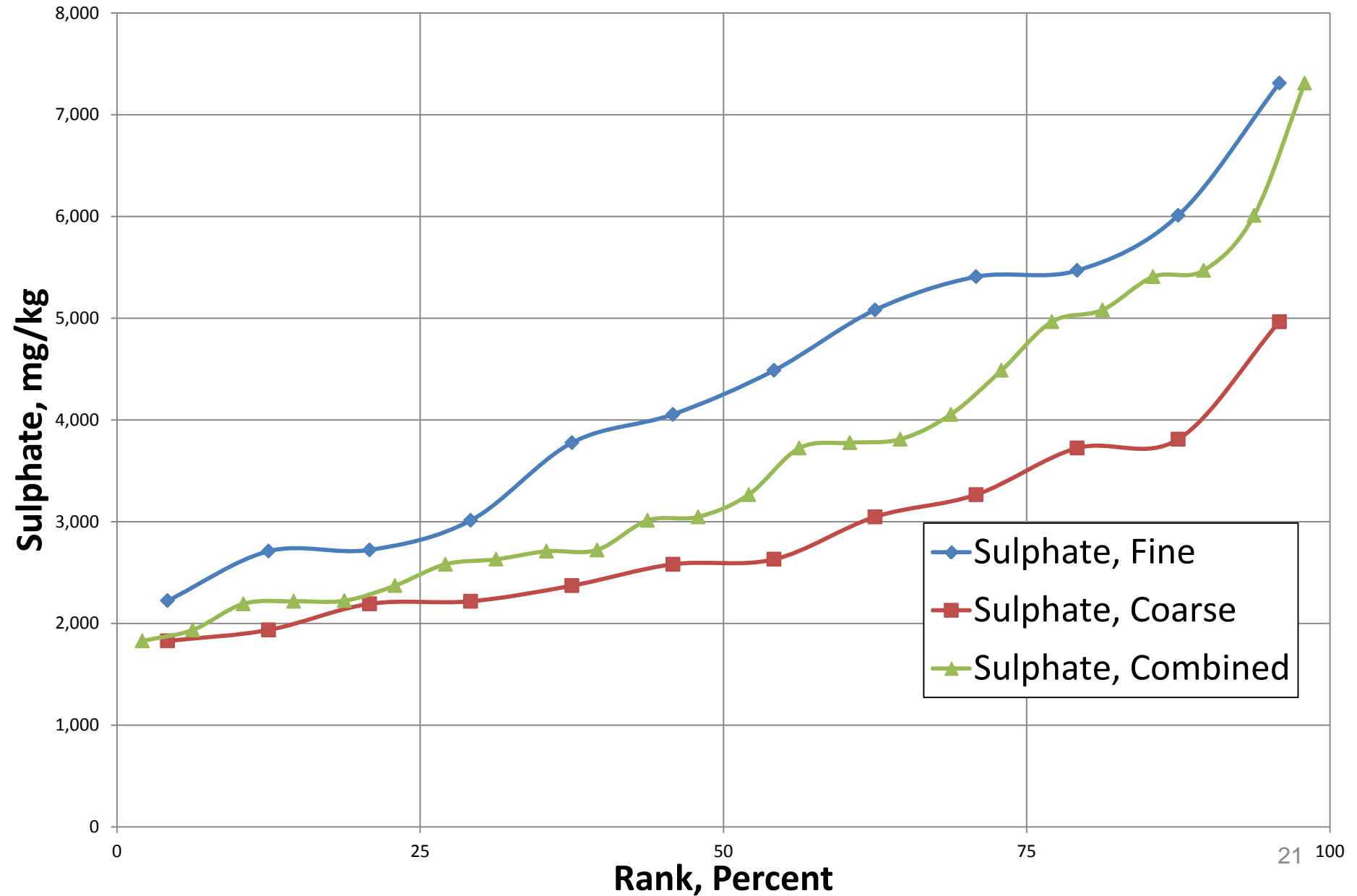
# SSD for Sulphate



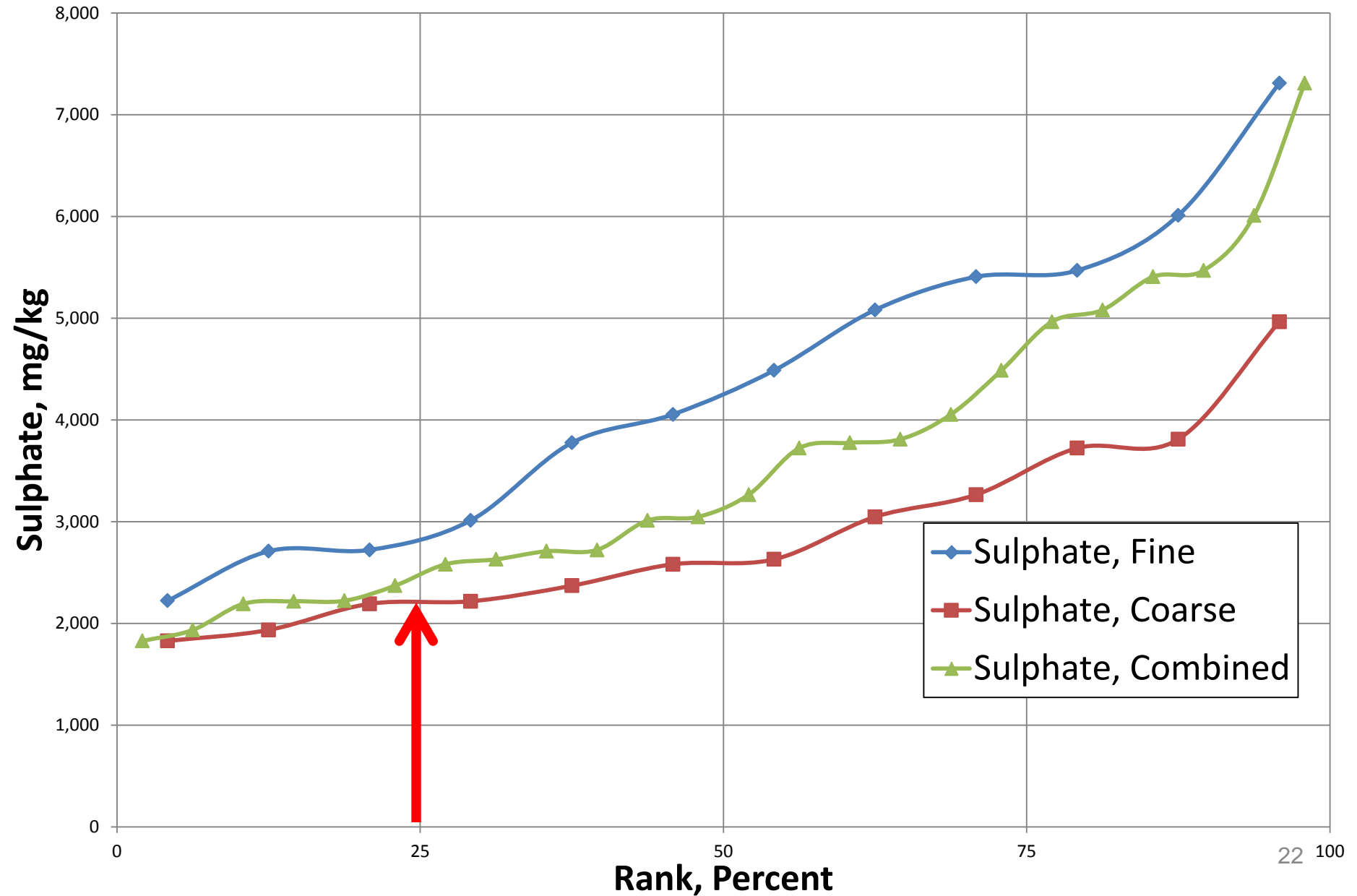
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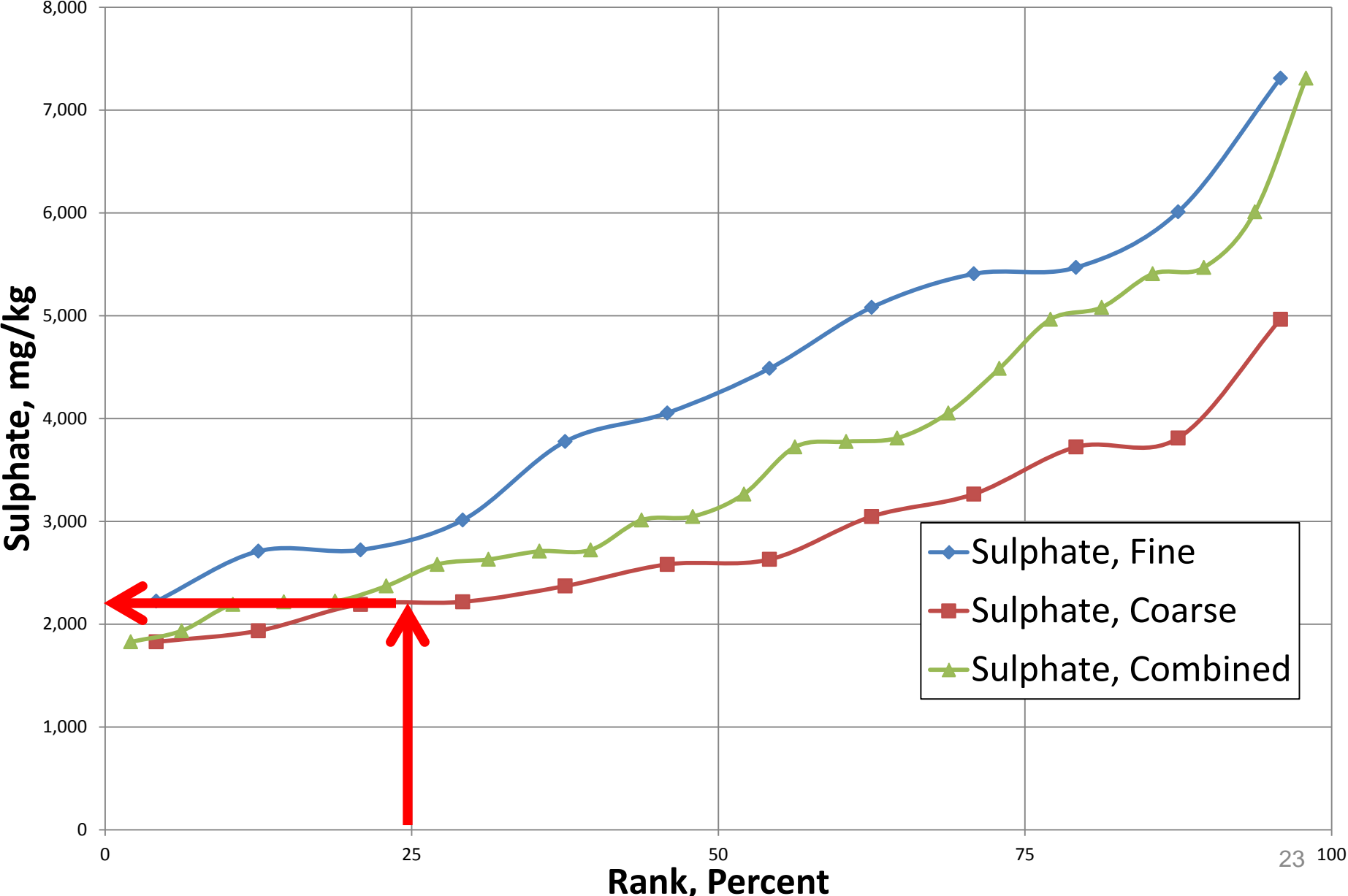
# SSD for Sulphate



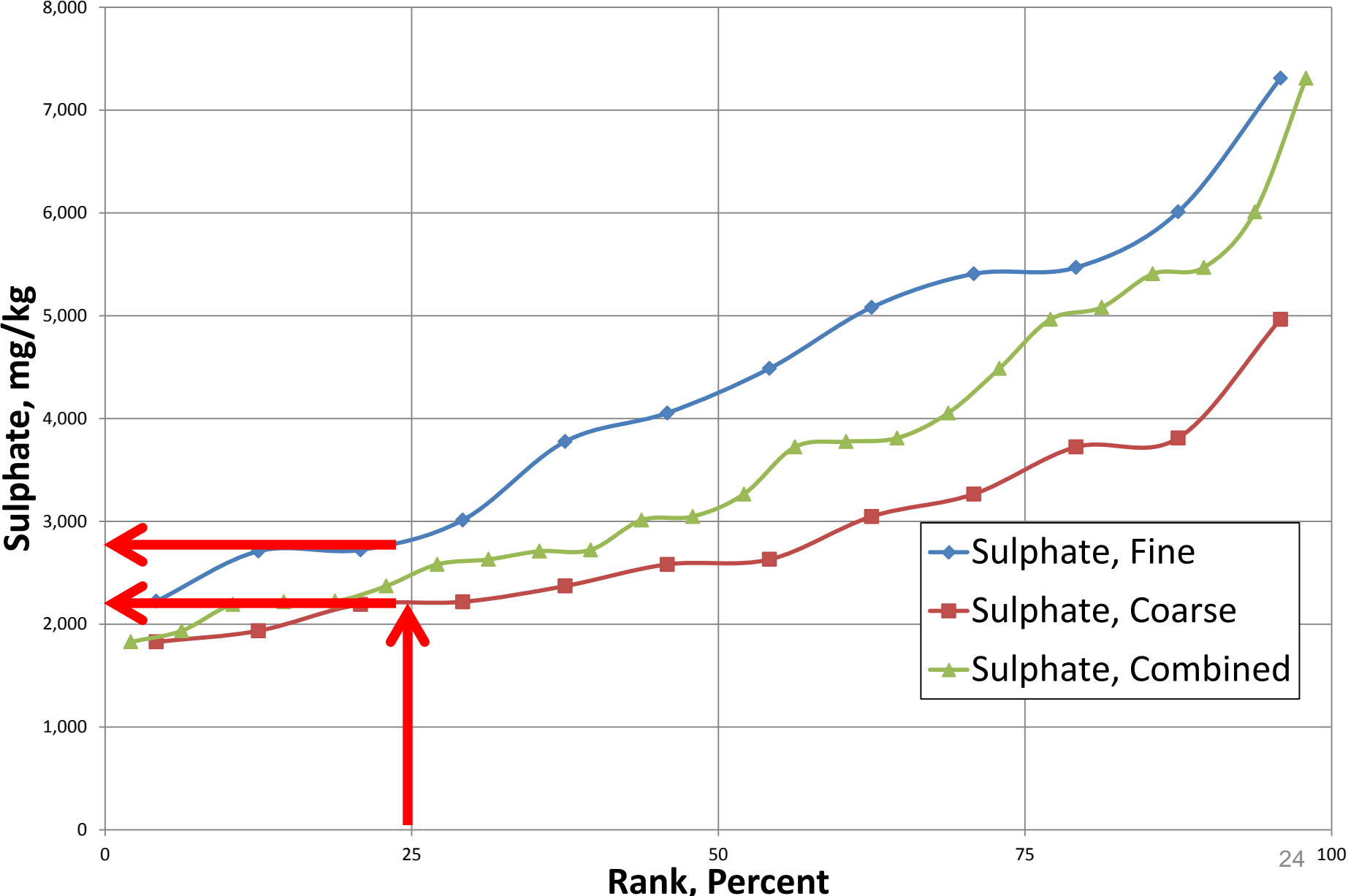
# SSD for Sulphate



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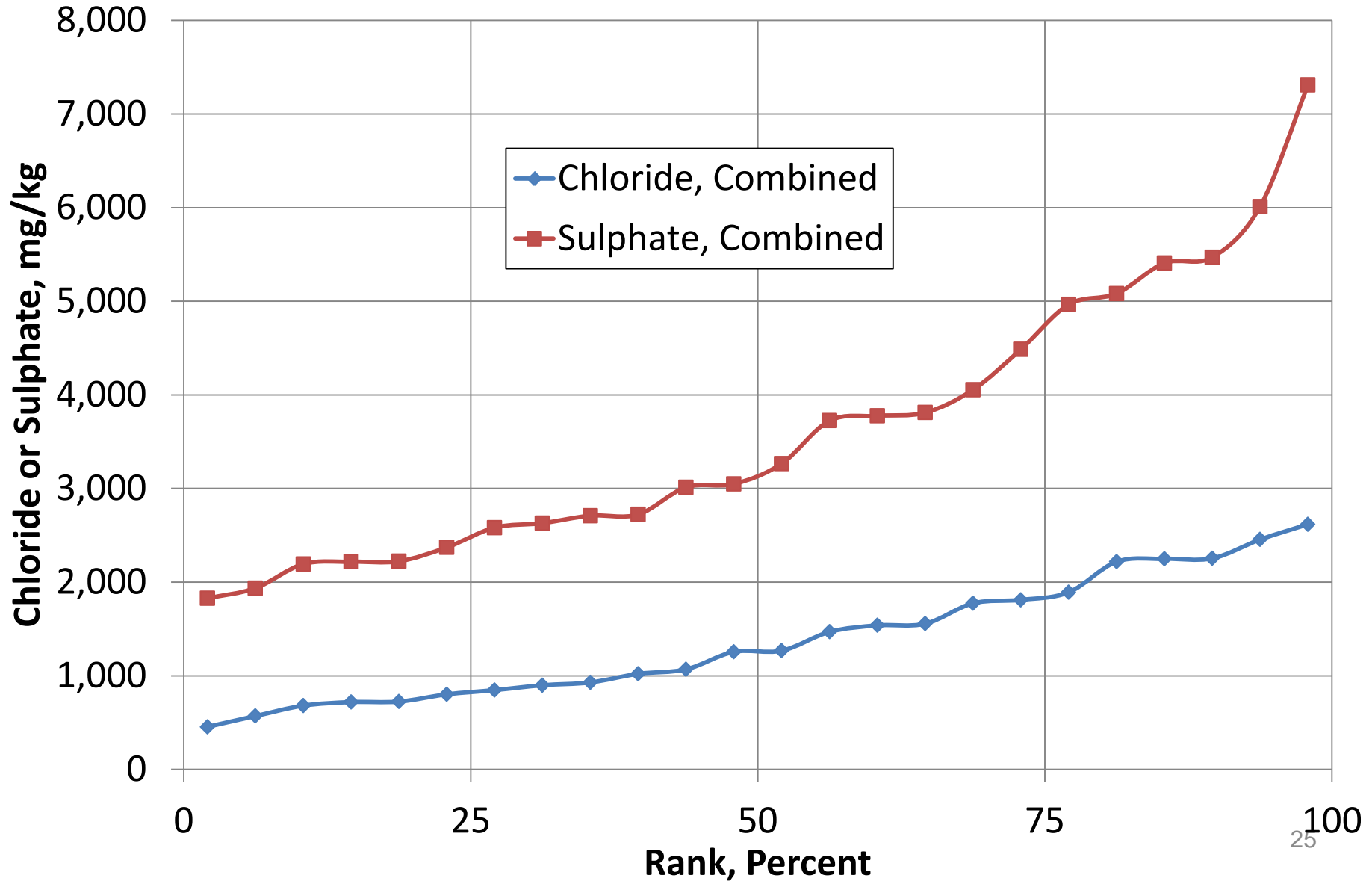


# SSD for Sulphate





# SSDs for Chloride and Sulphate



# Ion-Specific Soil Guidelines – Natural Area, Agricultural & Residential

<b>Anion</b>	<b>Soil</b>	<b>Based on Ion Concentration (mg/kg)</b>	<b>Based on Electrical Conductivity (dS/m)</b>
Chloride	Coarse	840	5.3
Chloride	Fine	840	5.3
Sulphate	Coarse	2,200	8.3
Sulphate	Fine	2,900	8.3

# Conclusions

- Relationships developed for Alberta Soils:
  - EC vs Cl
  - EC vs  $\text{SO}_4$
- Soil guidelines developed for Cl and  $\text{SO}_4$ :
  - Ion concentration basis
  - EC basis
- Sulphate significantly less phytotoxic than chloride in this test