Water Quality Considerations for Surface and Subsurface Agricultural Drainage

What is drainage water?

Drainage water includes:

- Surface drainage that moves excess water off fields or the farm either naturally (i.e., runoff) or by constructed channels.
- Subsurface drainage installed to remove groundwater from the root zone or from low-lying wet areas. Subsurface drainage is typically done through the use of buried pipe drains (e.g., tile drainage).

WHAT ARE THE WATER QUALITY CONCERNS WITH DRAINAGE WATER?

Drainage water can be a source of nutrients, salts, and other contaminants that can deteriorate water quality. Drainage water will eventually reach irrigation canals, wetlands, creeks, rivers, or lakes. These water bodies are used for drinking water, irrigation, industrial use, and/or recreation activities, and most sustain aquatic ecosystems.

There are many water quality parameters that may be of concern for drainage water. In general, these parameters include:

Nutrients:

- **Nitrogen (N)** as nitrate is highly soluble and readily leaches through the soil profile. Excess N in surface water may be a concern for aquatic life, and nitrate contamination can be a concern for groundwater potability.
- **Phosphorus (P)** has low solubility and generally remains near the soil surface. Phosphorus can be in drainage water bound to sediment or in a dissolved form. Excess P can contribute to toxic algal blooms.

Total suspended solids (TSS) are generally inorganic particles in the water column. A high concentration of TSS negatively affects water clarity, and this can be detrimental to aquatic life.

Pathogens are disease-causing organisms that can cause illness in humans and/or livestock. Water that is in contact with livestock, human, or wildlife feces is at risk of pathogen contamination.

Pesticides include herbicides, insecticides, and fungicides. Drainage water may contain pesticides in the dissolved form or bound to soil particles. If present in water, pesticides may be of concern for aquatic life, human health, and crop production.

Metals can be introduced to aquatic systems as a result of human activities and the weathering of soils and rocks. An excess of metals can be poisonous to humans, other animals, and plants.

Salts:

- **Electrical conductivity (EC)** indicates the level of dissolved salts. A high EC will stress plants and cause productivity losses.
- **Sodium adsorption ratio (SAR)** is a measure of salt levels as determined by sodium, calcium, and magnesium. A high SAR will negatively affect crop production by degrading soil structure and reducing soil aeration and water movement.
- **Chloride (Cl^-)** is completely soluble and very mobile in soils. Chloride can be used as an indicator of manure contamination in groundwater. At high concentrations, Cl^- can be toxic to aquatic life and negatively affect crops.
- **Total dissolved solids (TDS)** include salts, organic matter, and minerals. Salts readily leach through the soil profile and their accumulation can cause salinization problems where water discharges.

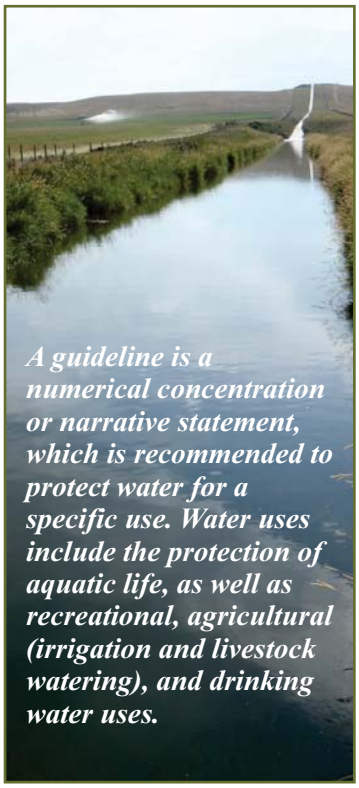
Main parameters that should be considered when testing agricultural drainage water quality, with specific recommendations in brackets. The risk can be evaluated by referring to provincial water quality guidelines.

	Surface drainage	Subsurface drainage	Risk
Nutrients	✓ (N, P)	✓ (nitrate)	aquatic life, drinking water
Salts	✓ (TDS, SAR)	✓ (TDS, Cl^-)	aquatic life, agricultural use[z]
Total suspended solids	✓		aquatic life
Metals		✓ (aluminum, arsenic, iron, vanadium)	aquatic life, agricultural use, drinking water
Pathogens	✓ (*E. coli*)	✓ (*E. coli*)	recreation, agricultural use, drinking water
Pesticides	✓ (dicamba, MCPA)		aquatic life, recreation, agricultural use

[z] Agricultural use may include crop irrigation and/or livestock watering.

ARE THERE WATER QUALITY GUIDELINES FOR DRAINAGE WATER?

There are currently no water quality guidelines for drainage water from agricultural lands in Alberta. However, drainage water that enters an irrigation canal, wetland, creek, river, or lake will affect the quality of the receiving water body. Hence, water quality guidelines for all existing and future water uses of the receiving water body should be considered when examining drainage water. Drainage water should be managed so that receiving water bodies meet relevant water quality guidelines for use.



A guideline is a numerical concentration or narrative statement, which is recommended to protect water for a specific use. Water uses include the protection of aquatic life, as well as recreational, agricultural (irrigation and livestock watering), and drinking water uses.

Surface water quality guidelines for specific parameters.

	Water use			
	Protection of aquatic life	Irrigation	Livestock watering	Recreation
Total nitrogen	Narrative[z]	—	—	—
Total phosphorus	Narrative[z]	—	—	—
SAR	—	5	—	—
Chloride (mg/L)	120–640	100–700[y]	—	—
Total suspended solids (mg/L)	Narrative[x]	—	—	—
Total dissolved solids (mg/L)	—	500–3500[x]	3000	—
E. coli (counts/100 mL)	—	100	—	126[w]

[z] Nitrogen and phosphorus concentrations should be maintained so as to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen levels, and recreational quality.

[y] Dependent on crop type.

[x] Varies based on period of exposure and turbidity of water. See original source for details.

[w] Geometric mean (30-day interval with a minimum of weekly samples).

Source: Environmental Quality Guidelines for Alberta Surface Waters. 2014. Alberta Environment and Parks. http://aep.alberta.ca/water/education-guidelines

WHAT IS THE QUALITY OF DRAINAGE WATER AND RECEIVING WATERS IN ALBERTA?

Alberta Agriculture and Forestry research shows that agricultural drainage water is typically poorer than the quality of the receiving water bodies. Water quality varies based on land use, soil type, and other factors.

Range of water quality of agricultural drainage.

	Surface drainage from pastures (n=2 sites)[z]	Surface drainage from non-manured fields (n=3 sites)[z]	Surface drainage from manured fields (n=8 sites)[z]	Subsurface drainage from manured fields (n=2 sites)[y]
Total nitrogen (mg/L)	2.0–5.3	3.0–9.9	3.8–11.2	4.3–32.5
Total phosphorus (mg/L)	1.35–1.68	0.32–2.06	0.78–4.86	0.03–0.05
Total suspended solids (mg/L)	6–16	4–26	7–19	n/a
Total dissolved solids (mg/L)	97–172	179–450	130–2221	n/a
E. coli (counts/100 mL)	73–110	4–30	1–230	0.5[x]

[z] Median values from 6 years (2007 – 2012) of data (samples per site = 33 to 135), Nutrient Beneficial Management Practices Evaluation Project, Alberta Agriculture and Forestry.

[y] Median values for 2 years (1999 – 2000) of data (samples per site = 5 to 17), unpublished data, Alberta Agriculture and Forestry.

[x] Median value is the same for both sites.

Range of water quality of receiving water bodies.

	Irrigation district source water (n=13 sites)[z]	Irrigation district return water (n= 21 sites)[z]	Oldman River (n=3 sites)[y]	Bow River (n=4 sites)[y]
Total nitrogen (mg/L)	0.2–0.5	0.3–0.8	0.2–0.3	0.2–1.0
Total phosphorus (mg/L)	0.01–0.03	0.01–0.11	0.01–0.02	0.01–0.03
Total suspended solids (mg/L)	2–8	1–65	3–11	2–12
Total dissolved solids (mg/L)	103–382	126–369	156–200	165–228
E. coli (counts/100 mL)	2–30	11–465	3–14	2–28

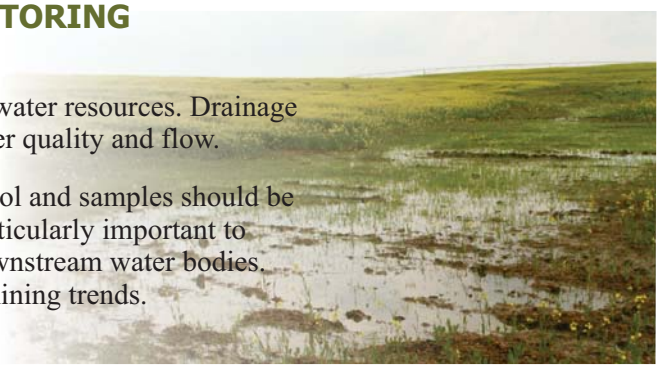
[z] Median values for irrigation water from 7 years (2006 – 2007, 2011 – 2015) of data (samples per site = 16 to 28), Irrigation District Water Quality Project, Alberta Agriculture and Forestry.

[y] Median values for the rivers from Government of Alberta, South Saskatchewan Regional Plan 2014 – 2024, pp. 179 – 186.

WHAT ARE THE CONSIDERATIONS FOR MONITORING DRAINAGE WATER QUALITY?

Site-specific data collection is needed to understand Alberta's water resources. Drainage water and receiving water bodies should be monitored for water quality and flow.

Water samples should be collected using a standardized protocol and samples should be analyzed by an accredited laboratory. A measure of flow is particularly important to determine total volume and contaminant loads received by downstream water bodies. Long-term monitoring (i.e., >10 years) is beneficial for determining trends.



WHAT APPROVALS ARE NEEDED FOR DRAINAGE?

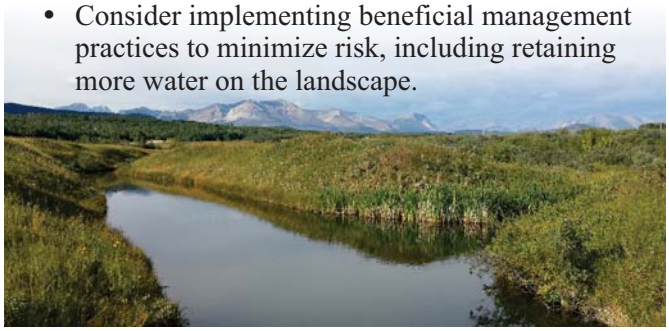
Land owners must obtain provincial approval under the *Water Act* before starting surface or subsurface drainage projects and drainage of wetlands or wet areas may be subject to the *Alberta Wetland Policy*. The approval process will require technical information about the proposed drainage system and may require written consent from downstream neighbouring landowners, irrigation districts, and/or municipalities. Approvals from the Department of Fisheries and Oceans and under the *Public Lands Act* may also be required.

WHAT DOES IT ALL MEAN?

The *Alberta Land Stewardship Act* regulates the development of regional plans to address cumulative effects, including effects on water quality. Even though individual points of agricultural drainage may be small, the cumulative effects of drainage from the landscape can be detrimental to water quality. Drainage into water bodies that supply farm water can effect water quality and subsequently crop and livestock production. Responsible management of land can mitigate or minimize detrimental effects of drainage water on the environment and downstream water bodies.

Important points on drainage water quality are:

- Know the quality and quantity of drainage water.
- Know the quality and quantity of the receiving water body.
- Determine the potential for the drainage water to have detrimental effects on downstream water bodies.
- Consider implementing beneficial management practices to minimize risk, including retaining more water on the landscape.



FOR MORE INFORMATION:

Go to "www.agric.gov.ab.ca" and enter the following titles in the search.

- **Introductory Guide to Surface Water Quality Monitoring in Agriculture**: A guide designed to create awareness of the fundamentals of developing a water quality monitoring program with the primary focus on streams.
- **Services for Agri-processors and Producers Analytical Labs**: A list of accredited analytical laboratories in Alberta including labs that can complete water quality analyses.
- **Rural Water Quality Information Tool**: A tool developed by Alberta Agriculture and Forestry for assessment of the quality and suitability of water sources for privately owned and operated water supplies. This tool allows input of concentration results and compares the results to guidelines.
- **Growing Forward 2**: Provides programs and services to achieve a profitable, sustainable, competitive, and innovative agri-food and agri-products industry. Funds may be available to support agricultural management initiatives aimed at maintaining or improving water quality.
- Alberta-based agricultural water-quality studies:
  - **Water Quality in Alberta's Irrigation Districts**
  - **Alberta Soil Phosphorus Limits Project**
  - **Assessment of Environmental Sustainability in Alberta's Agricultural Watersheds**
  - **Alberta Nutrient Beneficial Management Practices Evaluation Project**
  - **Pesticides in Alberta's Agricultural Watersheds**

Go to "www.aep.alberta.ca" and enter the following titles in the search.

- **Alberta Water Act Approvals**: Further information on approvals may be obtained from local Alberta Environment and Parks offices.
- **Alberta Wetland Policy**: Alberta's Wetland Policy was revised in June 2015. Further information may be obtained from local Alberta Environment and Parks offices.
- **Water Act Contacts**: Local offices can provide more information regarding the approval process.

This fact sheet was prepared by:
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