Irrigation Water Quality – What's in the Water?

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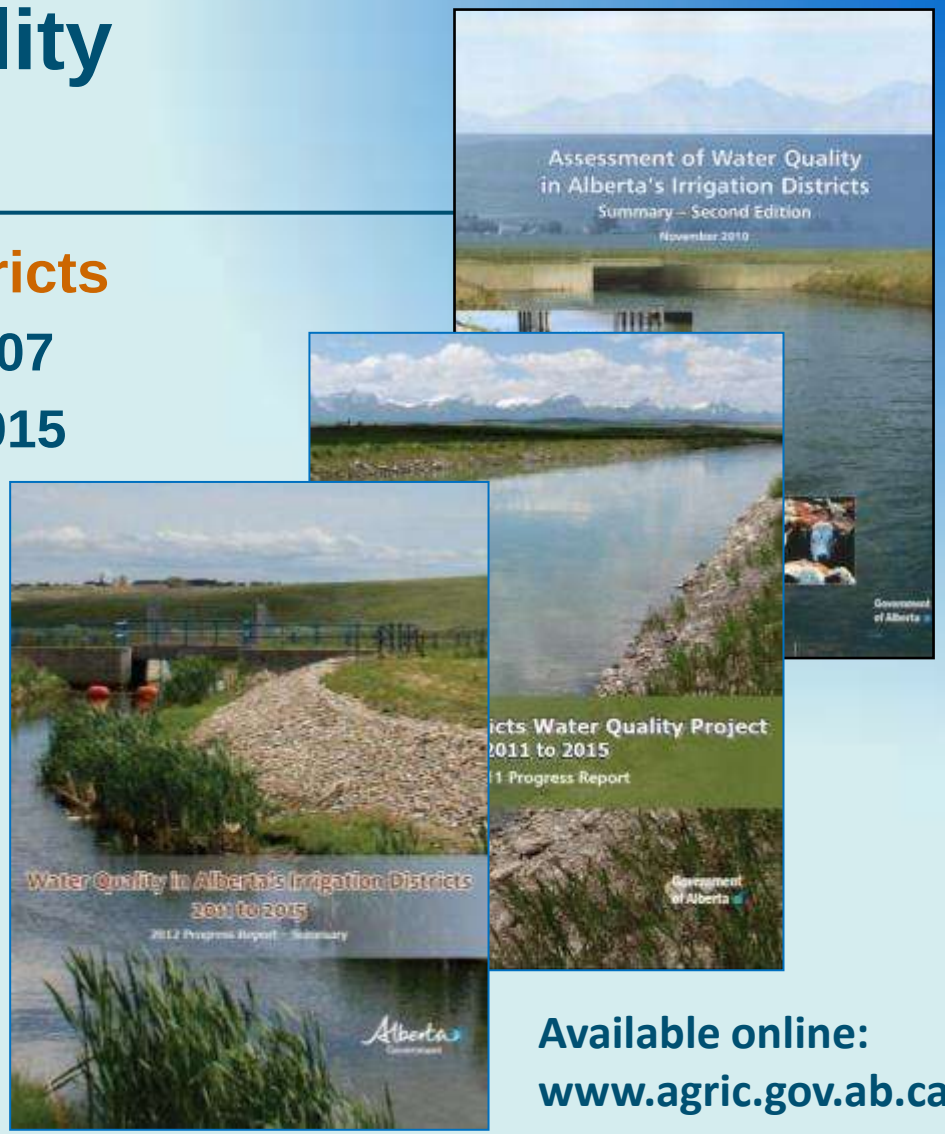
Irrigation Crop Update
Lethbridge

Why Monitoring Irrigation Water Quality

- **Value added productivity**
  - Specialty crops and processing industry
  - Livestock industry
- **40 municipalities**
  - Drinking and industrial
- **Wildlife habitat**
- **Recreation**
  - Fishing, boating, camping, golfing

Irrigation Water Quality Monitoring

- **Monitoring in irrigation districts**
  - Previous study 2006 & 2007
  - Current 2011 to 2015
- **Partners**
  - ARD, Irrigation council, AIPA, and AAFC
- **Steering committee**
  - Irrigation districts
  - Producers
  - Processing industry
  - AIPA
  - ARD, AESRD



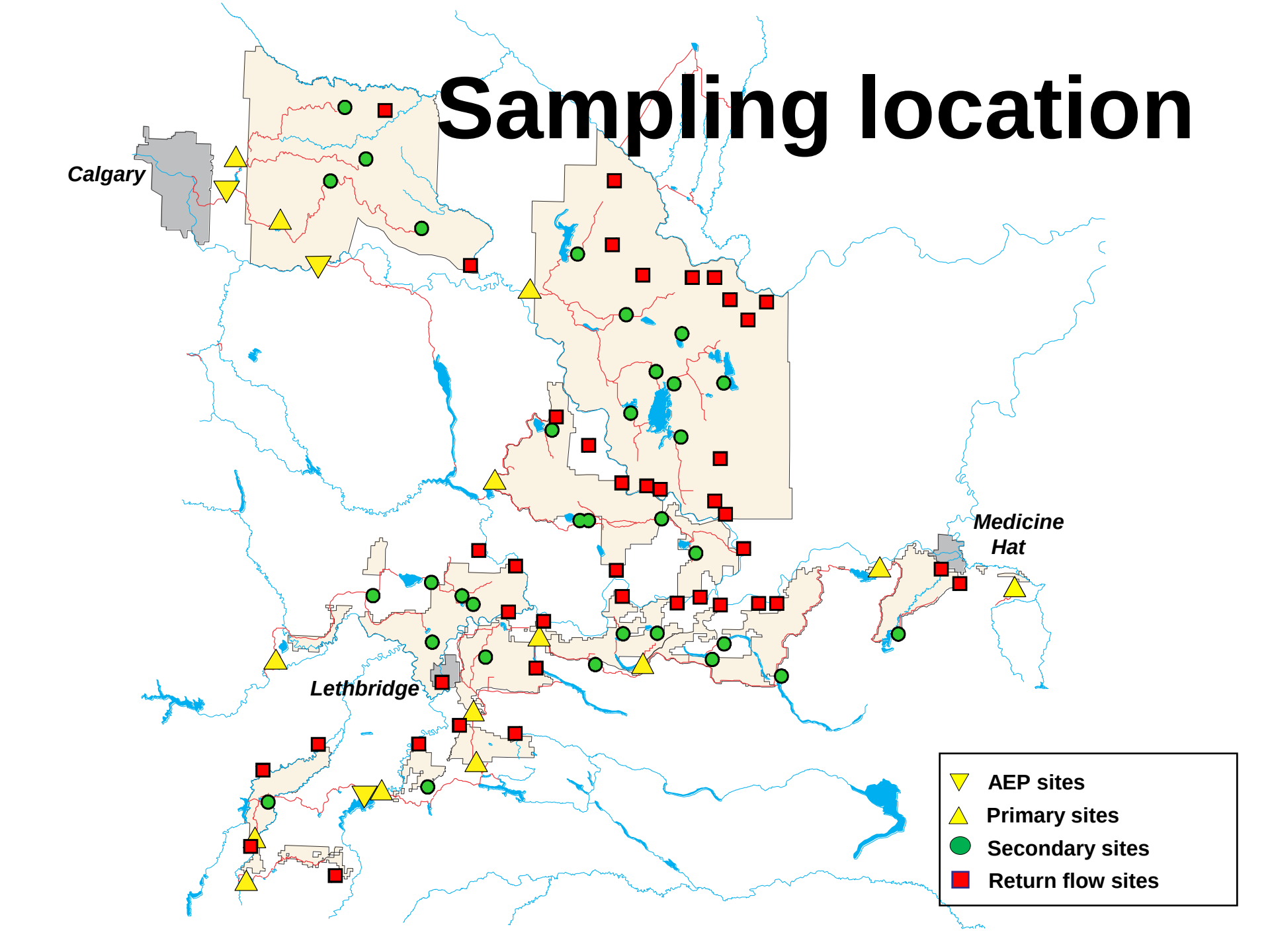
Available online:
www.agric.gov.ab.ca

Project Objective

- **Assess Water Quality**
  - **Food production**
    - Irrigation
    - Livestock water
  - **Aquatic environment**
    - Impact of irrigation return on rivers
  - **Change in water quality**
    - Source to end of each districts
  - **Difference between irrigation districts**
  - **Link effect of land use**
  - **Establish a baseline database**

Sampling Design

- 4 times per season
  - June to August
  - Higher irrigation demand
- ~90 sites


Sampling location
Calgary
Medicine Hat
Lethbridge
AEP sites
Primary sites
Secondary sites
Return flow sites

Study Design

- **4 times per season**
  - June to August
  - Higher irrigation demand
- **~ 90 sites**
- **> 160 parameters**
  - Nutrients
  - Salts
  - Metals
  - Physicals
  - Biologicals
  - Pesticides
- **Guidelines**
  - Irrigation, livestock water, aquatic life, and recreation

Guidelines

Science based (maximum) concentration of a substance that is safe for a specific water use

- **Irrigation guidelines**
  - **Protect the most sensitive crop species**
    - Exception for fecal coliform
      - (Human health)
  - **Based on sensitivity of crop to pollutants and max irrigation rates**

- **Livestock watering guidelines**
  - **Protect all livestock species**
  - **Based on toxicity to animal, daily intake, and potential bioaccumulation**

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Guidelines

- **Protection of Aquatic Life**
  - Protect the most sensitive species and life forms over long term.
- **Recreation**
  - Fecal coliform

Water Quality Guidelines

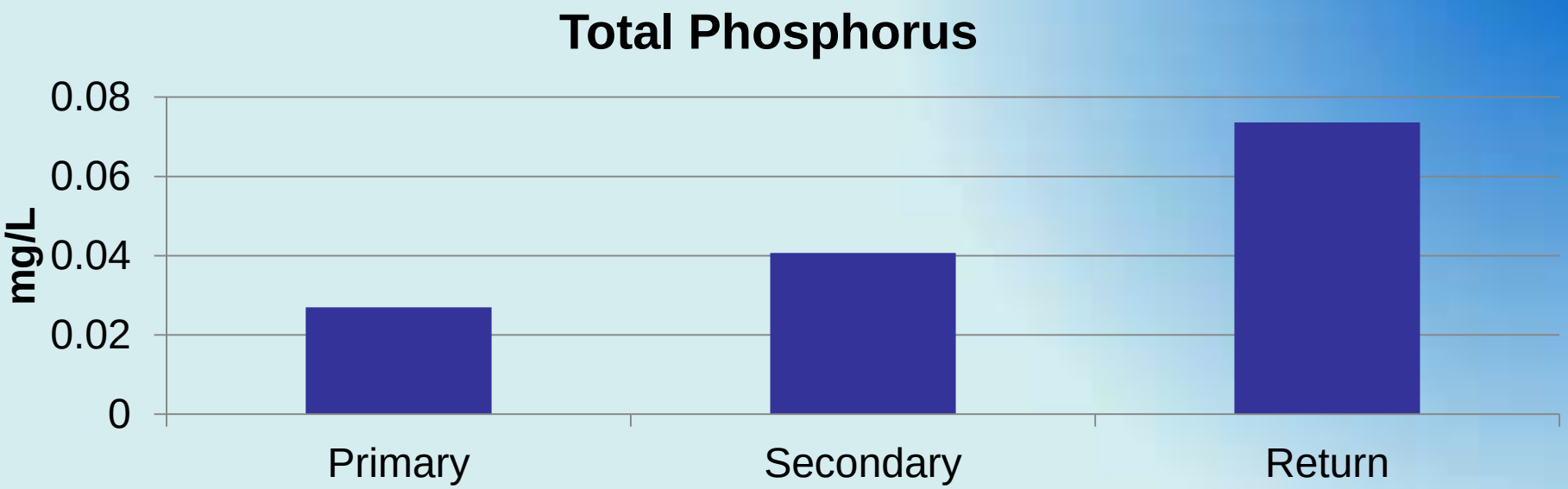
Parameters	#	Irrigation	Livestock	Aquatic life
Nutrients	9	-	2	3
Salts	18	3	3	1
Metals	25	18	16	16
Physicals	3	-	-	1
Pesticides	107	7	22	35
Biologicals	6	2	-	-
Total	168	30	43	56

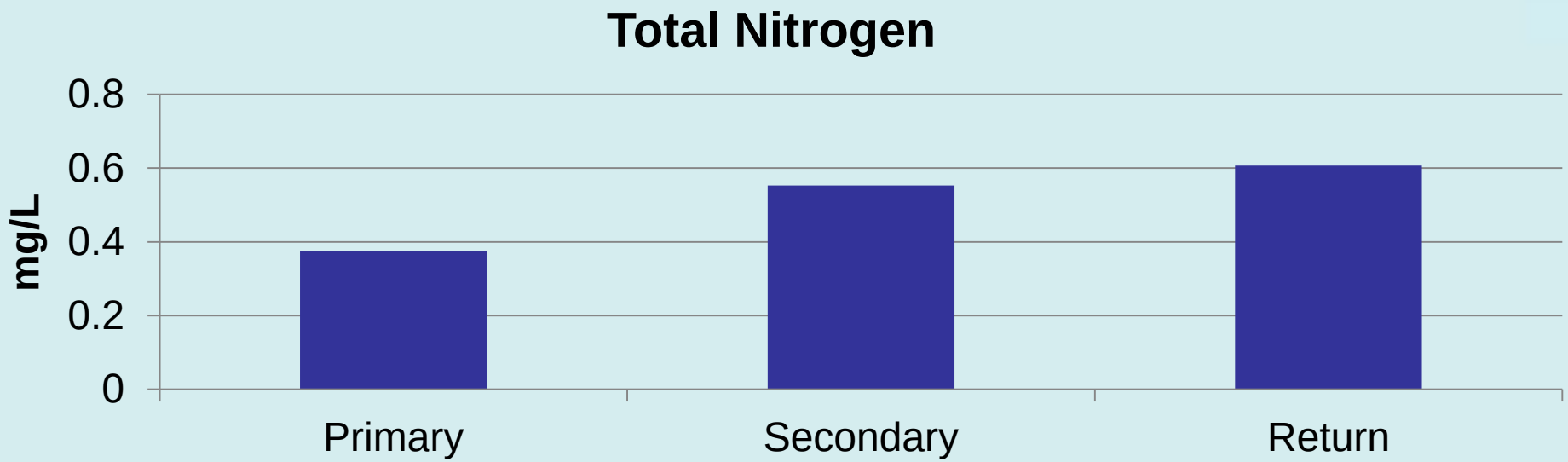
So what is in the irrigation water?

- Results are based on all sites and 5 years of data (~1600 samples)

Nutrients

- **Phosphorus and nitrogen**
  - **Different forms and fractions**
  - **Essential for plant growth**
  - **Can promote algal growth**
    - Problematic for water flow
    - Eutrophication ($<O_2$)
  - **Guidelines: no values but existing levels should not increase**


Total Phosphorus
mg/L
0.08
0.06
0.04
0.02
0
Primary
Secondary
Return

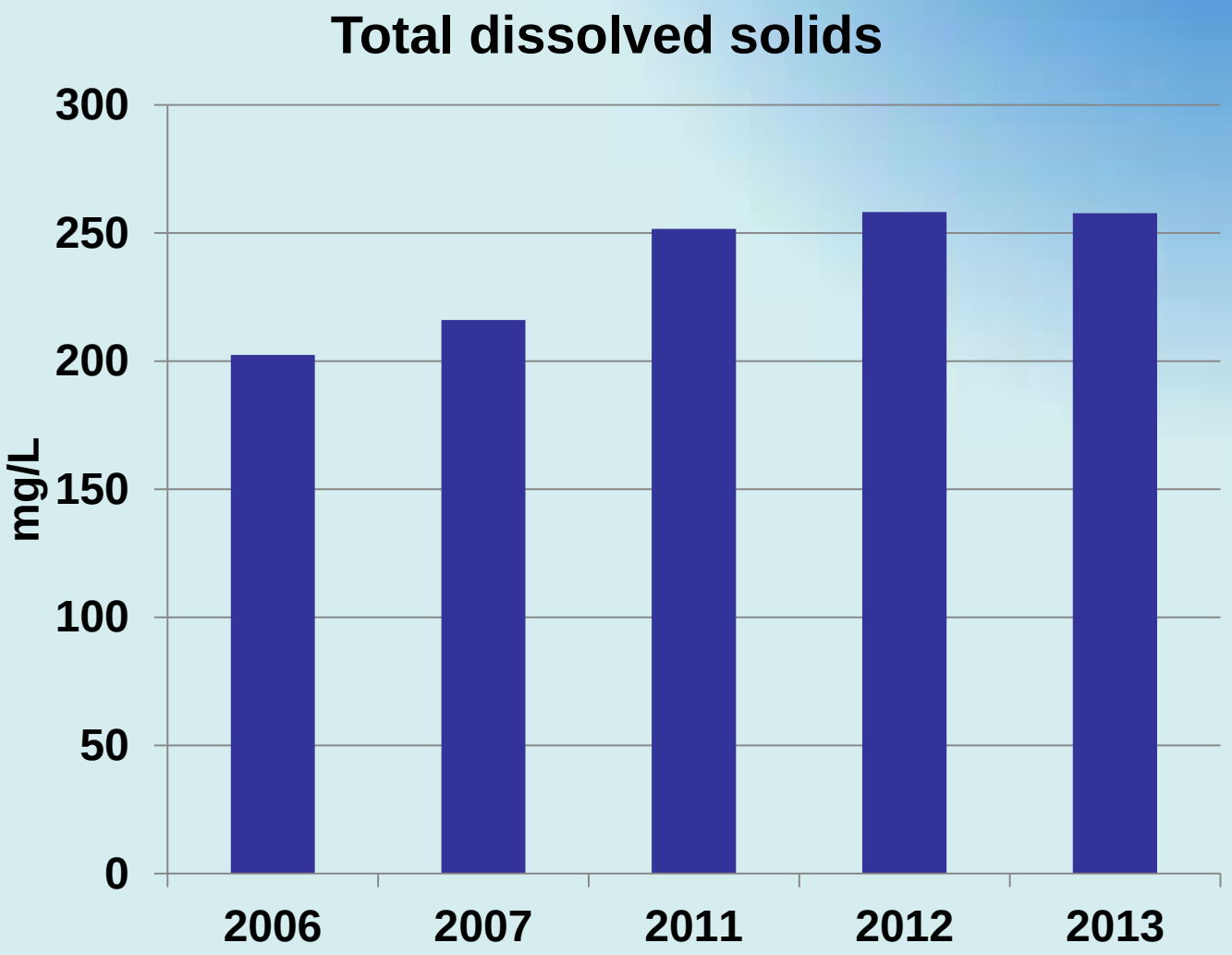

Total Nitrogen
mg/L
0.8
0.6
0.4
0.2
0
Primary
Secondary
Return

Salinity

- **Individual and combined salts**
  - **Sodium, potassium, calcium, chloride, sulphate…**
  - **Totals dissolved solids, electric conductivity, SAR**
  - **Problematic a high concentration**
    - Root water uptake
    - Soil structure
  - **Guidelines (compliance):**
    - TDS = 500 – 3500 mg/L (95%)
    - SAR - EC = 5 – 1 dS/m (99.7%)
    - Cl = 100 mg/L (100%)
    - SO_4 = 1000 mg/L (99.7%)

EID Secondary Sites (reservoir effect)

- **Salts increase over time and distance**
  - **Evaporation**



Metals

- **Inorganic substances from geological formation**
  - **25 different**
  - **Aluminum, arsenic, copper, iron, mercury, zinc, etc.**
  - **Can be from industrial release**
  - **Several could be toxic**
  - **Guidelines for 21 metals (compliance)**
    - 18 Irrigation (>98%)
    - 16 Livestock (>99%)
    - 16 Protection of aquatic life (Aluminum = 37%, Iron 69%)

Physical Parameters

- **Temperature, pH, turbidity (suspended solids)**
  - **Aquatic life guideline**
    - pH (6.5 – 9.0) (5% >pH 9.0)
  - **Could affect guideline value of other parameters**
  - **Turbidity results**
    - Decreases in reservoir
    - Decreases during season

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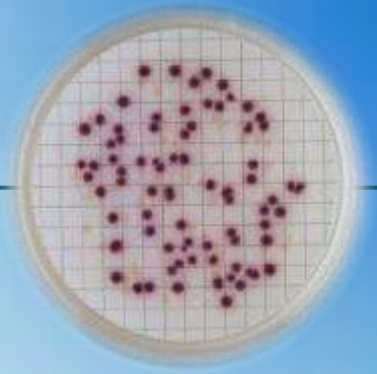
Biological Parameters

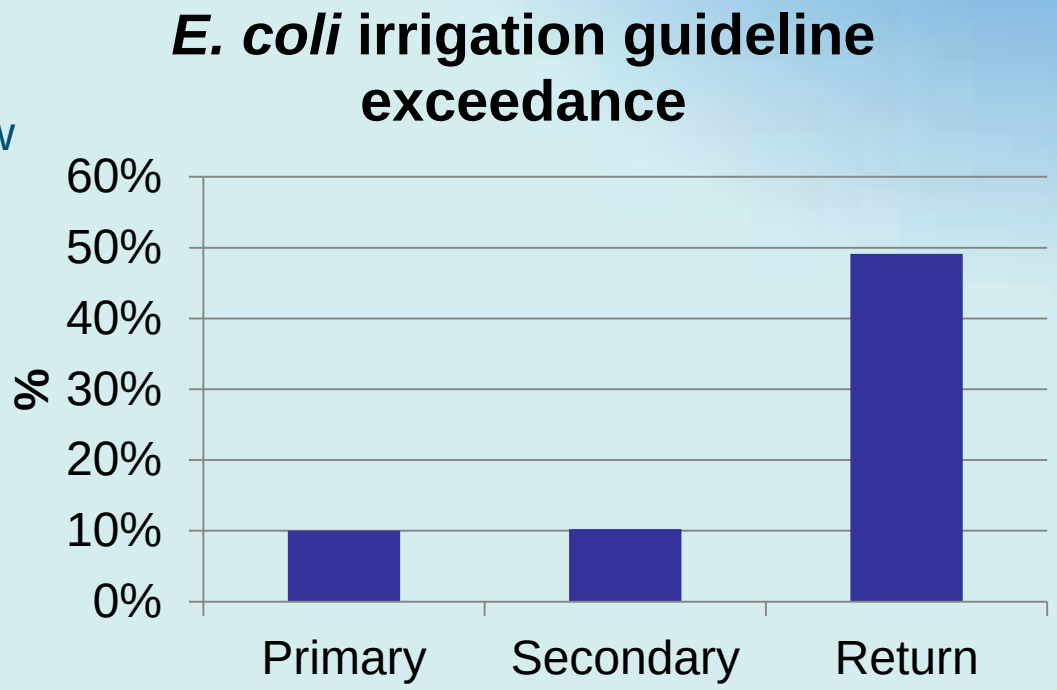
- **Fecal bacteria**
  - **Indicator of fecal contamination and risk of presence of pathogens**
    - *E. coli* and fecal coliform

- **Pathogens**
  - **Disease causing microbes**
    - *Campylobacter*
    - *Salmonella*
    - *E. coli* O157:H7

Coliform Bacteria



- **Fecal coliform guidelines**
  - **Irrigation**
    - 100 bacteria/100mL
    - Apply to food eaten raw
  - **Recreation**
    - 200 bact. /100mL
    - Apply to lakes and reservoirs



Pathogens

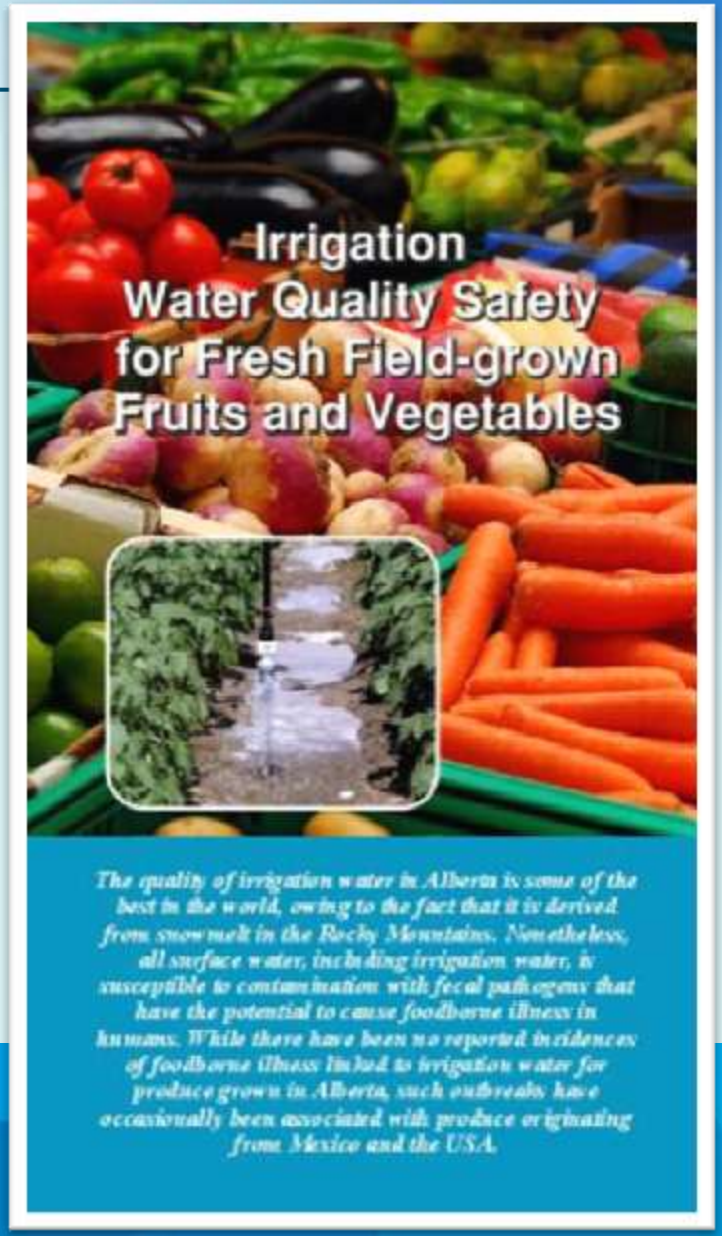
- No specific guidelines for pathogens

	E. Coli O157:H7	*Salmonella*	*Campylobacter*
2012	0	0	4 samples
2013	0	1 sample	7 samples

- n= 42 samples (21 sites)/year
  - Site selection based on high fecal coliform data

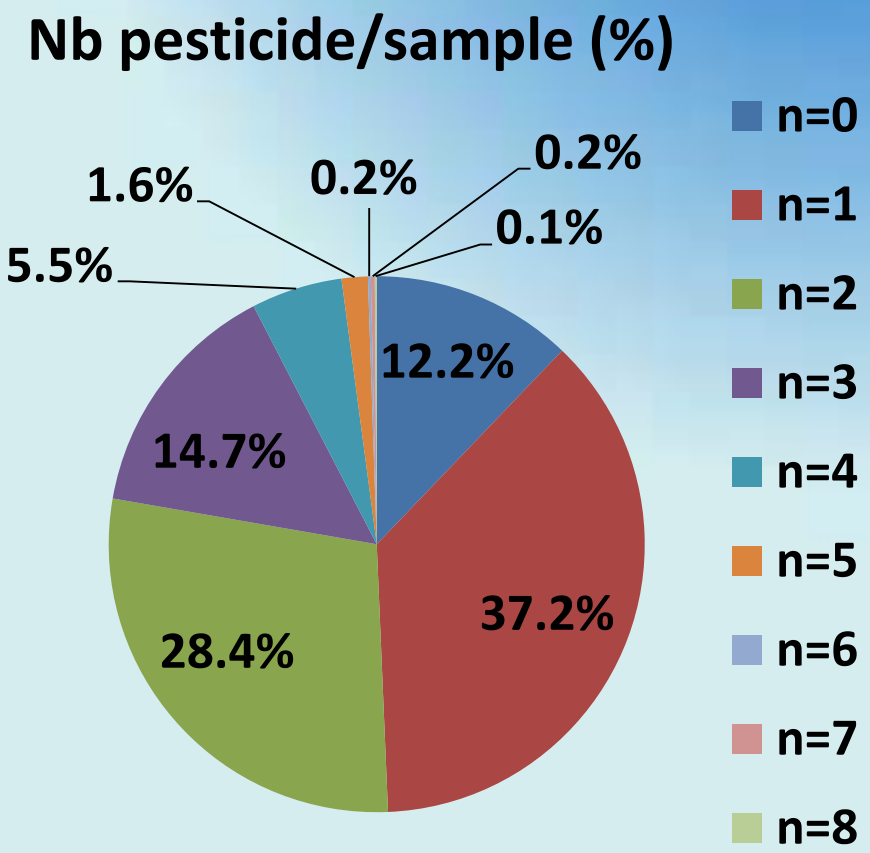
Key Messages on Pathogens

- There have been no incidences of foodborne illnesses linked to irrigation water in Alberta.
- The commercial production and processing chain includes many safety practices.
- Consumers are part of the chain and should always wash fresh produce prior to consumption.
  - Never drink untreated water.



Pesticides

- 107 pesticides
  - Collaboration with AAFC
  - 50 herbicides
  - 45 insecticides
  - 12 fungicides, nematicides, acaricides, bactericide



Pesticide Detection Frequency

- 31/107 detected
- Comparable to other studies
- Follow sales and chemical properties

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Pesticide Guidelines Exceedances

No evidence of field damage reported?

- **No irrigation guidelines for 2,4-D or glyphosate**
  - Other guidelines are generally met
- **Dicamba**
  - Guideline:

0.006	µg/L	Other crops (sunflower)	(100%)
0.06	µg/L	Legumes (soybean)	(36%)
0.6	µg/L	Cereals, hays and pastures	(2%)

- **MCPA**
  - Guideline:

0.025	µg/L	Other crops (lettuce)	(100%)
0.16	µg/L	Cereals, hays and pastures	(15%)

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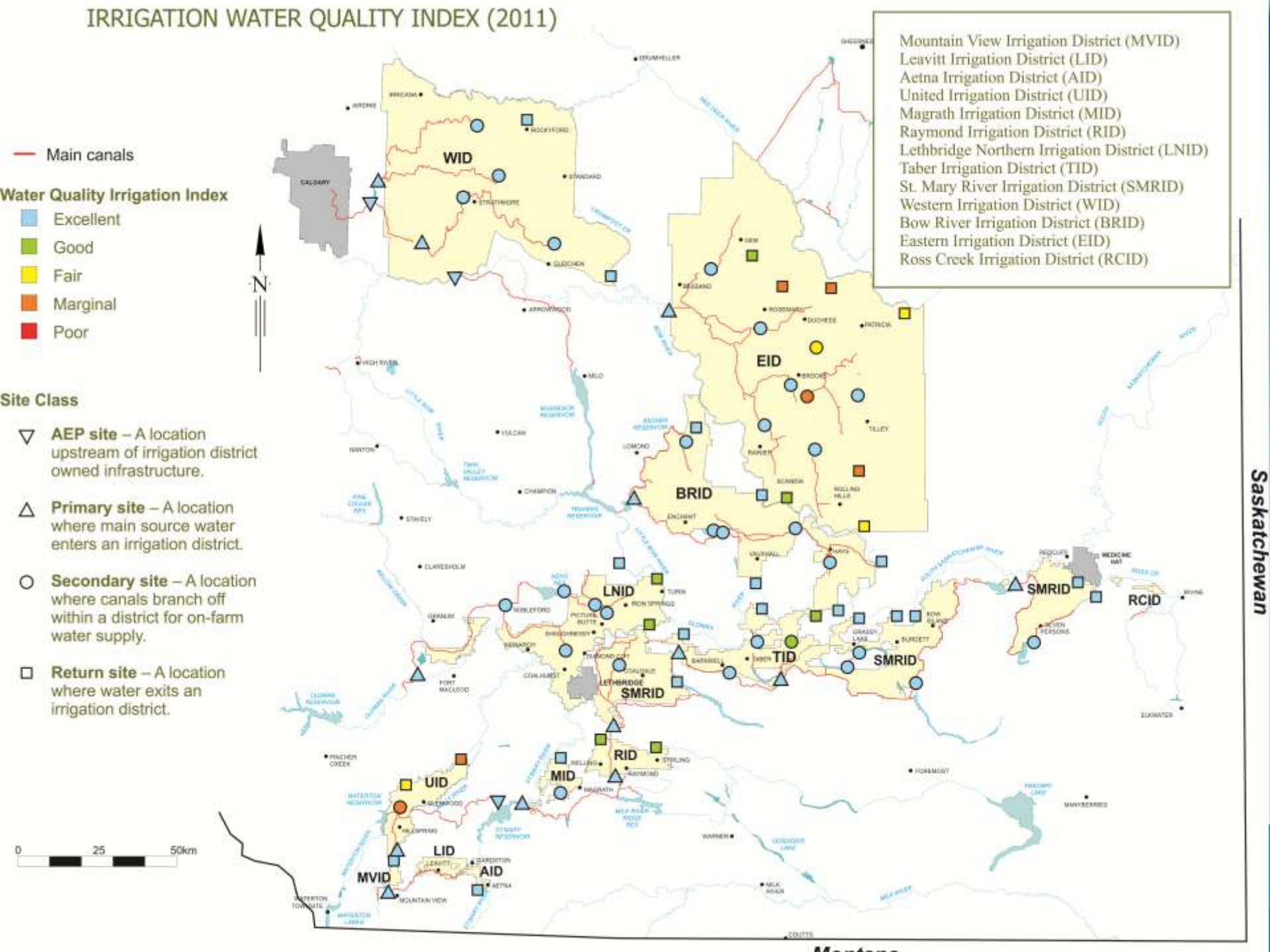
Water Quality Indices

- **Simple synthesis of results**
  - **Irrigation, livestock, aquatic life, or recreation guidelines**
  - **Index calculation:**
    - How many guidelines are exceeded +
    - How often guidelines are exceeded +
    - By how much guideline are exceeded

  = Water quality index

85 – 100	Excellent
70 – 85	Good
55 – 70	Fair
40 – 55	Marginal
0 – 40	Poor

IRRIGATION WATER QUALITY INDEX (2011)



Irrigation Water Quality Index 2011-13

	2011	2012	2013
AID	98	92	82
UID	97	100	56
	51	92	82
	59	89	71
		96	
	55	100	66
MVID	100	100	100
	98	98	91
MID	86	100	98
	93	100	100
	96	96	96
	94	95	75
RID	96	100	94
	82	84	91
	83	98	97

	2011	2012	2013
SMRID	97	98	98
	98	96	98
	96	96	98
	95	97	96
	98	100	100
	100	100	98
	97	98	96
	90	98	96
	98	100	100
	88	96	94
	98	100	100
	95	98	98
	91	67	95
	93	90	92
	92	100	98
TID	95	95	96
	89	90	93
	84	85	91
	96	98	93
	91	95	93
	84	74	89

	2011	2012	2013
LNID	100	98	94
	88	88	82
	81	78	66
	83	81	72
		78	60
	97	98	98
	100	100	98
	96	89	67
	98	97	98
	95	91	73
WID	90	88	98
	94	97	97
	87	95	95
	97	95	91
	91	89	91
	87	93	95
	95	74	95
	91	92	93
	92	94	91

	2011	2012	2013
BRID	94	72	95
	100	100	100
	100	100	98
	87	98	89
	94	89	90
	98	96	92
	100	97	98
		92	94
	96	100	100
	92	98	98
	100	100	100
	100	100	94
	100	100	100

	2011	2012	2013
EID	100	98	98
		55	87
	81	55	95
		84	45
	55	80	93
		74	90
	74	82	88
		74	76
		100	90
	66	84	78
	50	71	79
	48	83	95
	65		
	88	66	71
	94	96	100
	100	100	98
	93	97	93
	47	100	86
	100	100	100
	97	98	100
	95	97	76
	66	67	60

AVG= 90

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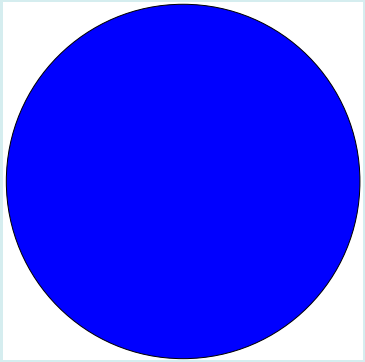
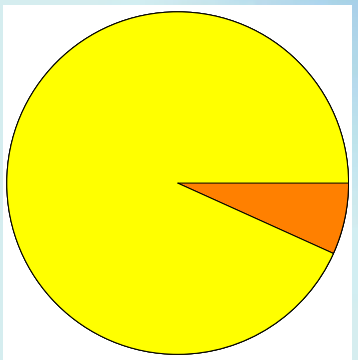
Irrigation Guideline Sub-Index

Salinity



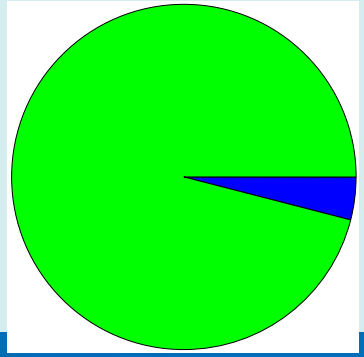
100% excellent

Pesticides



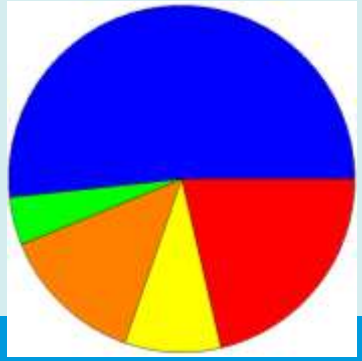
66% excellent

Metals



96% Excellent

Fecal coliforms



51% excellent

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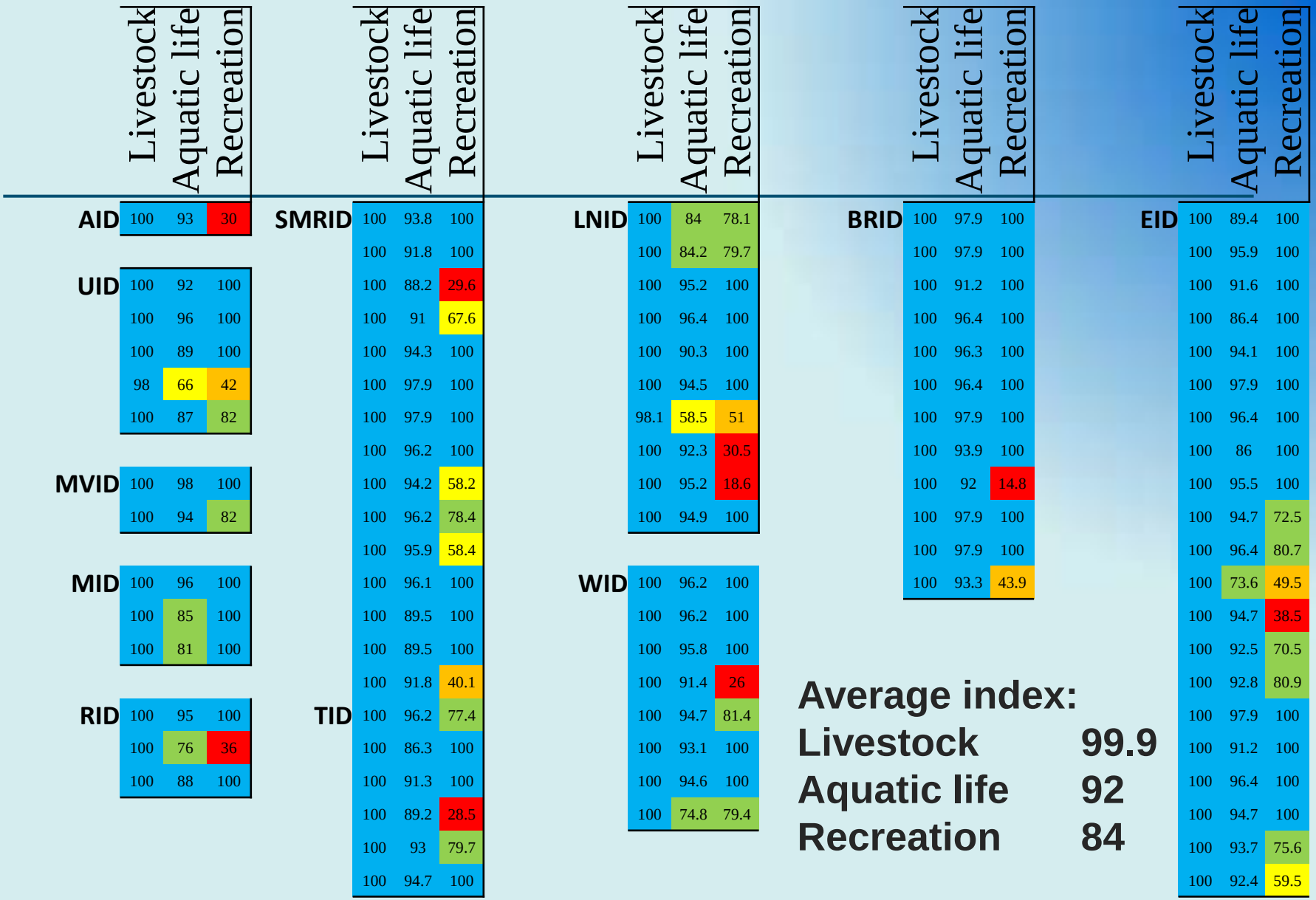
Livestock
Aquatic life
Recreation
AID
100 93 30
UID
100 92 100
100 96 100
100 89 100
98 66 42
100 87 82
MVID
100 98 100
100 94 82
MID
100 96 100
100 85 100
100 81 100
RID
100 95 100
100 76 36
100 88 100
SMRID
100 93.8 100
100 91.8 100
100 88.2 29.6
100 91 67.6
100 94.3 100
100 97.9 100
100 97.9 100
100 96.2 100
100 94.2 58.2
100 96.2 78.4
100 95.9 58.4
100 96.1 100
100 89.5 100
100 89.5 100
100 91.8 40.1
TID
100 96.2 77.4
100 86.3 100
100 91.3 100
100 89.2 28.5
100 93 79.7
100 94.7 100
LNID
100 84 78.1
100 84.2 79.7
100 95.2 100
100 96.4 100
100 90.3 100
100 94.5 100
98.1 58.5 51
100 92.3 30.5
100 95.2 18.6
100 94.9 100
WID
100 96.2 100
100 96.2 100
100 95.8 100
100 91.4 26
100 94.7 81.4
100 93.1 100
100 94.6 100
100 74.8 79.4
BRID
100 97.9 100
100 97.9 100
100 91.2 100
100 96.4 100
100 96.3 100
100 96.4 100
100 97.9 100
100 93.9 100
100 92 14.8
100 97.9 100
100 97.9 100
100 93.3 43.9
EID
100 89.4 100
100 95.9 100
100 91.6 100
100 86.4 100
100 94.1 100
100 97.9 100
100 96.4 100
100 86 100
100 95.5 100
100 94.7 72.5
100 96.4 80.7
100 73.6 49.5
100 94.7 38.5
100 92.5 70.5
100 92.8 80.9
100 97.9 100
100 91.2 100
100 96.4 100
100 94.7 100
100 93.7 75.6
100 92.4 59.5
Average index:
Livestock 99.9
Aquatic life 92
Recreation 84

Conclusions

- **Water quality interpretation is complex**
  - Several parameters do not have guidelines
- **Water quality index score**
  - Irrigation and aquatic life : generally good or excellent
  - Livestock water: all excellent
- **Water quality tend to decrease as it is flowing downstream**
- **Low concern for salinity and metals in irrigation water**
- **Pesticides and bacteria are responsible for lower score**

Support

Government of Alberta

Alberta Irrigation PROJECTS ASSOCIATION

Agriculture and Agri-Food Canada

Agriculture et Agroalimentaire Canada

Water Quality Branch (June 2013)

Basin Water Management Branch

Thanks

Questions?

Do you have specific concern about irrigation water quality ?

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