

Improving on-farm food safety through good irrigation water quality

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AIPA 2017 Water Conference
Lethbridge, AB
November 20-22, 2017



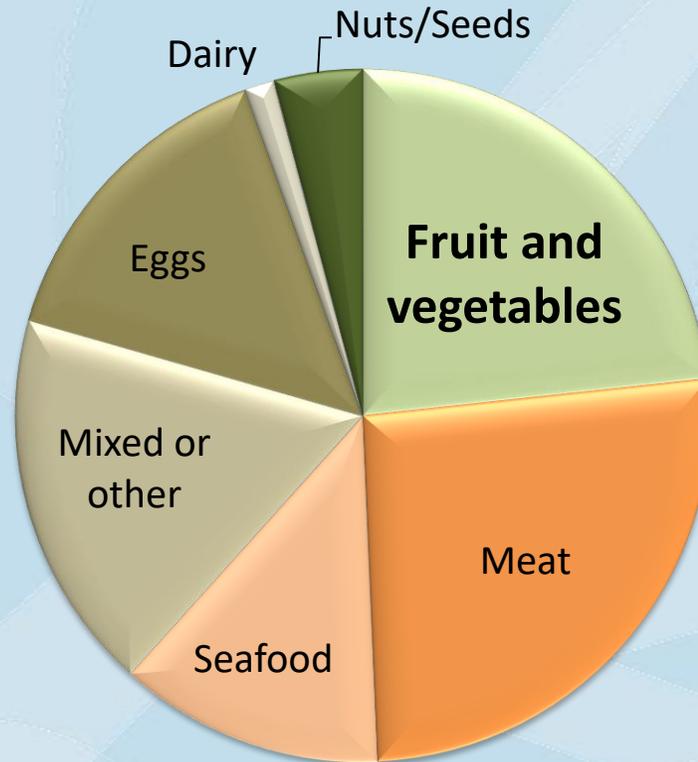
Irrigation and Farm Water Branch Water Quality Section

Andrea Kalischuk
Director

Jamie Wuite
Executive Director



115 reported foodborne outbreaks in Canada (2008-2014)



Food sources associated with foodborne outbreaks in Canada (2008-2014)

- 3301 illnesses, 225 hospitalizations, 30 deaths
- >23% attributed to produce

Source: Canada Communicable Disease Report

<http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/15vol41/dr-rm41-11/ar-01-eng.php>

Food recalls issued by CFIA (Canadian Food Inspection Agency) since Aug 2017

Food Source	Number of recalls due to pathogens
Seafood	3
Chicken	2
Vegetables	2
Dairy	2
Other	1



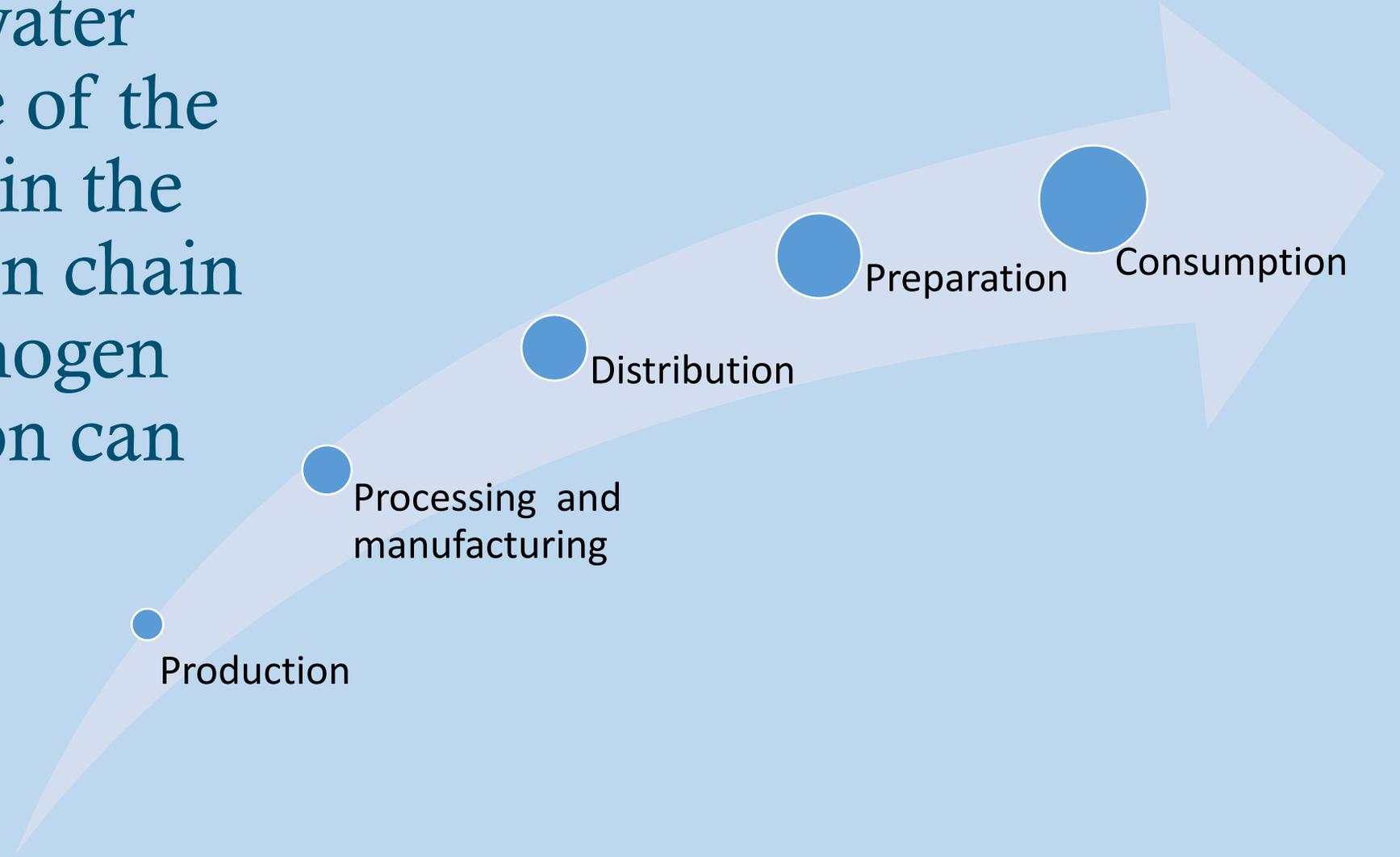
- Active national recall of MANY types/brands of vegetables (*Listeria*), no reported illnesses.
- August – voluntary recall of broccoli florets due to *E. coli* O26.



Source of information and images:

<http://inspection.gc.ca/about-the-cfia/newsroom/food-recall-warnings/complete-listing/eng/1351519587174/1351519588221?ay=0&fr=0&fc=0&fd=1&ft=1>

Irrigation water
represents one of the
many places in the
food production chain
– where pathogen
contamination can
occur



Foodborne illness outbreaks linked to irrigation water

- Direct evidence of irrigation causing foodborne illness is relatively rare worldwide.
 - *E. coli* O157 and *Salmonella* have been implicated.
- There have been no incidences of foodborne illnesses linked to irrigation water in Alberta.



“Smoking gun”
Salmonella outbreak linked to irrigation
water on a Mexican farm



ELSEVIER

Agricultural Water Management

Volume 98, Issue 9, July 2011, Pages 1395–1402

Irrigation water issues potentially related to the 2006 multistate *E. coli* O157:H7 outbreak associated with spinach

Richard J. Gelting¹, Mansoor A. Baloch, Max A. Zarate-Bermudez², Carol Selman³

Centers for Disease Control and Prevention, National Center for Environmental Health, Division of Emergency and Environmental Health Services, Environmental Health Services Branch, 4770 Buford Highway, MS F-60, Atlanta, GA 30341, United States

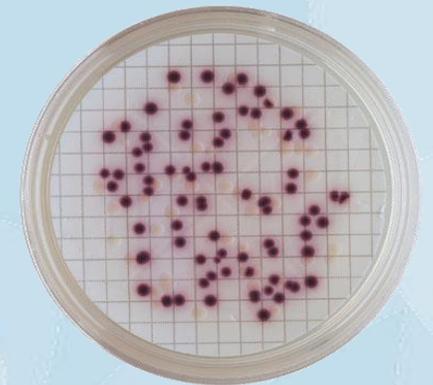
Peppers were apparently the perps in the salmonella outbreak that sickened some 1,300 people in the U.S. and Canada since April. The Food and Drug Administration (FDA) announced that it traced the responsible bacterial strain—*Salmonella* Saintpaul—to a Serrano pepper grown on a Mexican farm that irrigated its fields with water contaminated with it.

Food safety of irrigated produce

In the USA, the Food Safety Modernization Act (FSMA, USA) stipulates the **maximum permissible amount of generic *E. coli*** that can be present in irrigation water.



Geometric mean (5 samples) = 126 *E. coli* per 100 ml
Statistical threshold value = 410 *E. coli* per 100 ml



E. coli colonies growing on a Petri dish (filtered from water)

Food safety of irrigated produce

In Canada, the Safe Food for Canadians Act does not include an irrigation water quality provision, but water quality standards are part of the CanadaGAP food safety program.

Distribution chains may require compliance with food safety programs (which may include meeting irrigation water quality standards).

Based on CCME surface water quality guideline = 100 generic *E. coli* per 100 ml



Food safety - not just for produce eaten raw! Two flour recalls (*E. coli* O121)

Canada hit with another flour recall, more illnesses due to 2nd *E. coli* outbreak

35 illnesses may now be linked to tainted flour products

By Sophia Harris, CBC News | Posted: Jun 10, 2017 5:00 AM ET | Last Updated: Jun 10, 2017 5:00 AM ET

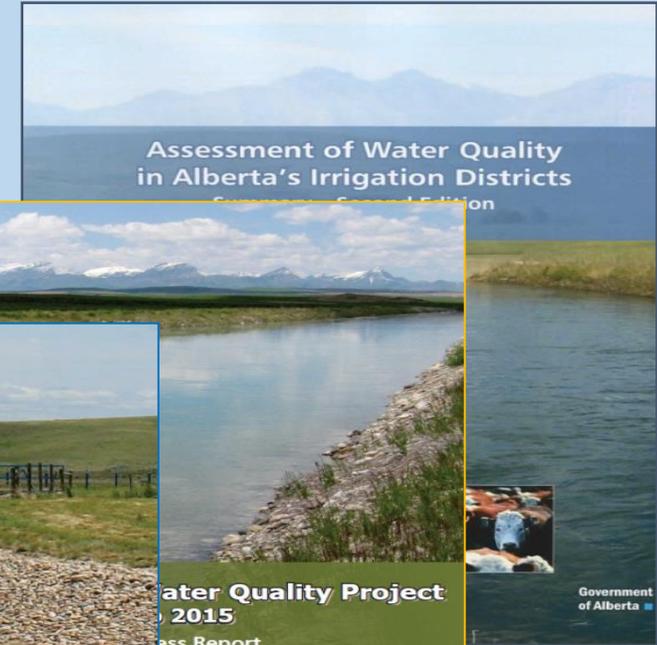
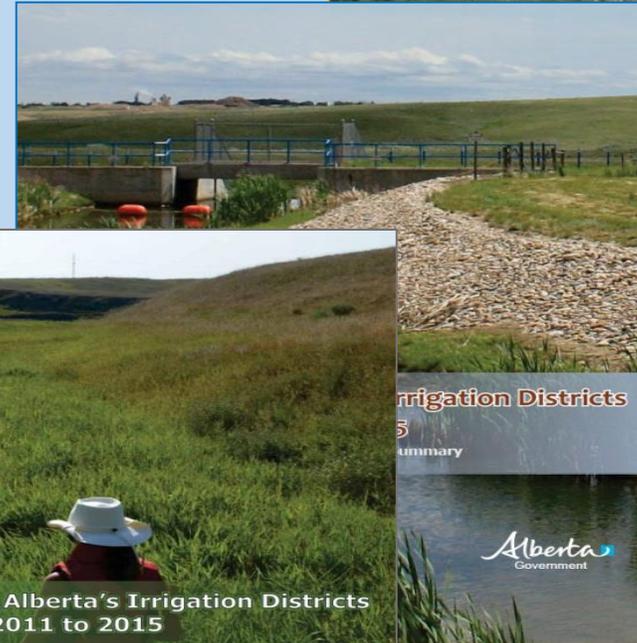
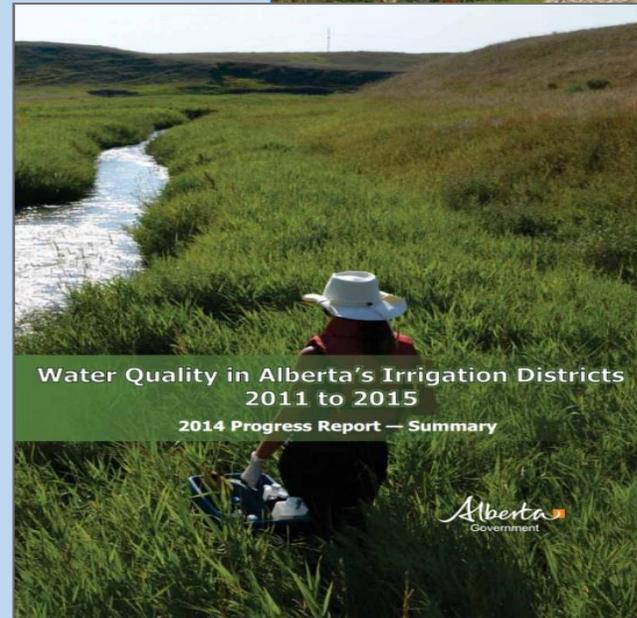
“No one really knows how General Mills' flour became contaminated *E. coli* can spread through animal feces, so wildlife pooping in and around fields might be the culprit. But *untreated irrigation water* could spread the bacteria, too, Chapman said, or there could be some sort of cross-contamination during the milling process.”

Quote: <https://www.livescience.com/55336-why-uncooked-flour-can-make-you-sick.html>

Irrigation Water Quality Monitoring

(2011 - 2017)

- AF, Irrigation districts, AIPA, and AAFC
- Monitoring
 - ~90 sites
 - >160 parameters
 - Physical
 - Chemical
 - Biological (*E. coli*, pathogens, algae)



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

The key is to be proactive rather than reactive

- The GoA in partnership with the irrigation districts has been monitoring Alberta's irrigation water annually since 2011.
- The data indicated that Alberta's irrigation water quality is generally very good.

VIDEO | **Dangerous *E. coli* found in several rural Alberta areas**

CBC News Posted Jun 25, 2012 4:54 PM MT



Chris Bolton - Benchmark Labs

<http://www.cbc.ca/news/canada/calgary/dangerous-e-coli-found-in-several-rural-alberta-areas-1.1132774>

Ensuring that Alberta's Irrigation Water Quality Meets Increasingly Stringent Food Safety Standards

2014 to 2017



Growing Forward 2 

A federal-provincial-territorial initiative

Alberta 
Government

Canada 

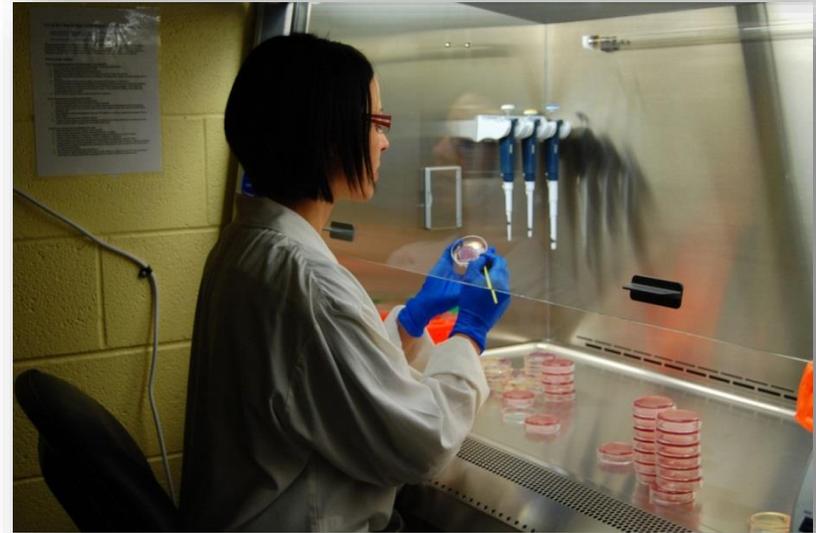
Study goal & outcomes

- Determine the major sources of *E. coli* in irrigation water (**Microbial Source Tracking**)
 - Enable implementation of appropriate mitigation measures in locations where *E. coli* guidelines are exceeded
 - Ensure that Alberta's irrigation water quality meets increasingly stringent food safety standards



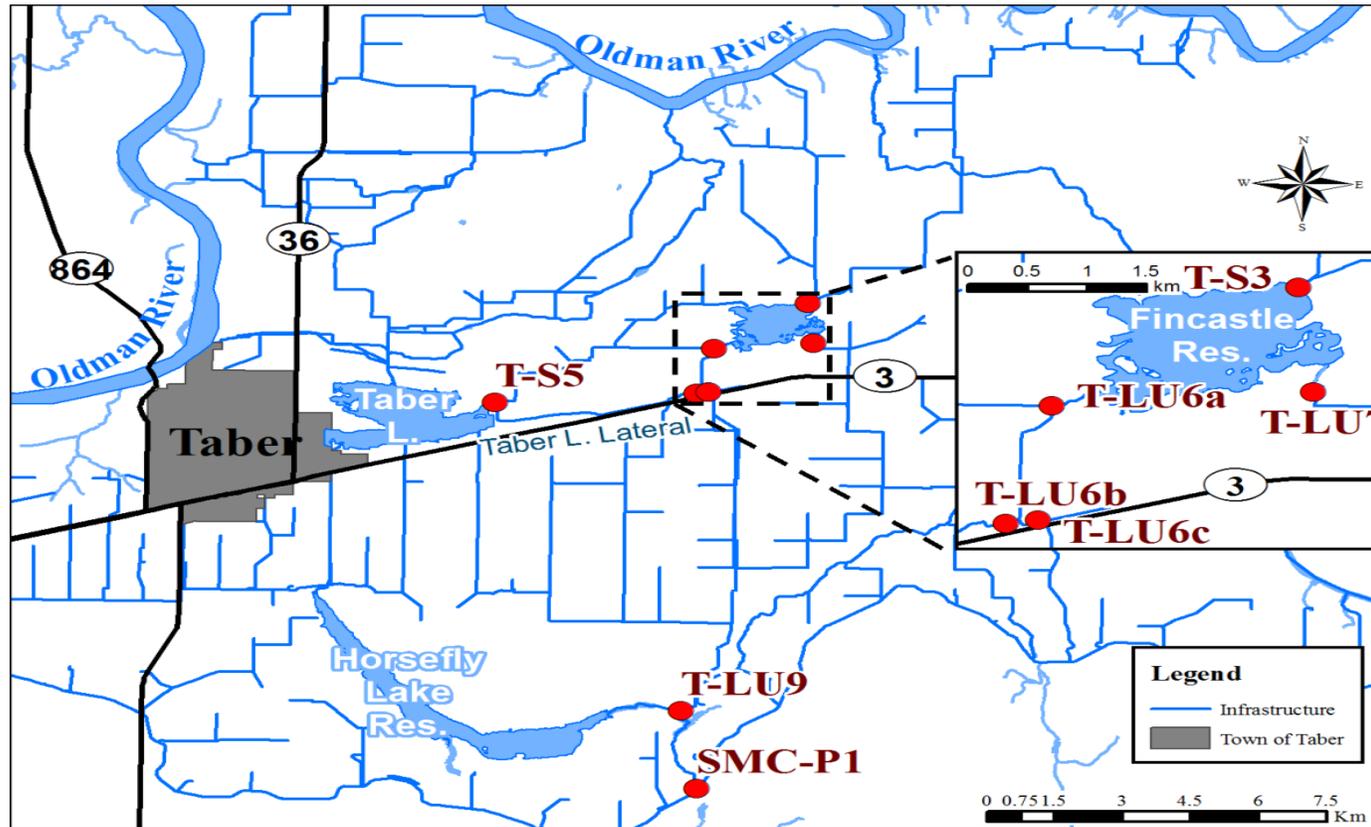
Introduce team

- Lisa Tymensen – Principal Investigator
- Cassandra Jokinen – Project Lead
- Jan Warren – Advisor
- Allison McNaughton – Term Technician



Pilot study: Taber Irrigation District

Site selection based on concurrent 'Land-use study'



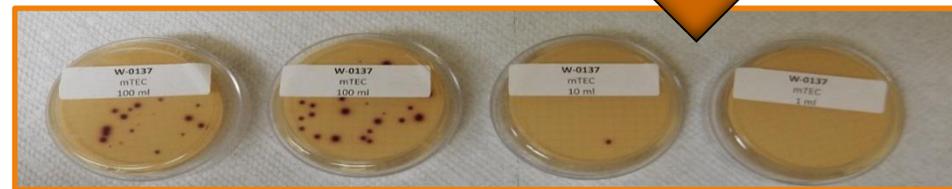


Water sampling

Water samples waiting to be filtered



Filtering a water sample



E. coli growing on Petri dishes

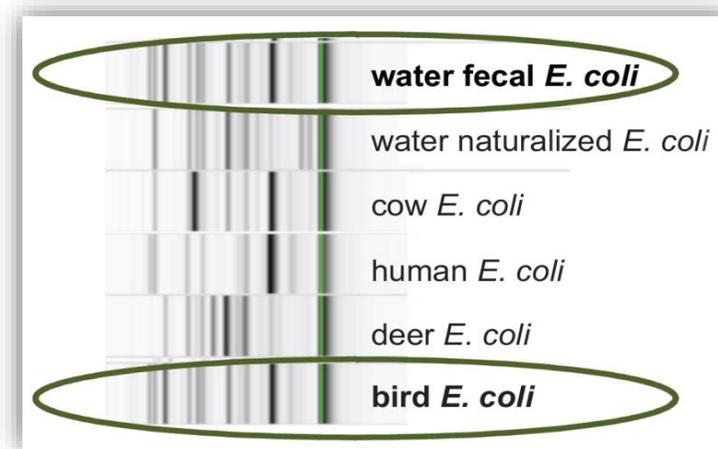
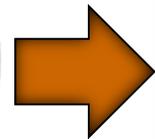


Water and fecal sampling and analyses

- Water sampled every two weeks from May – Sept of 2014 and 2015
- Feces sampled from livestock, wildlife, sewage
- Quantification and DNA fingerprinting of *E. coli*



Isolate *E. coli*
from water and
fecal samples

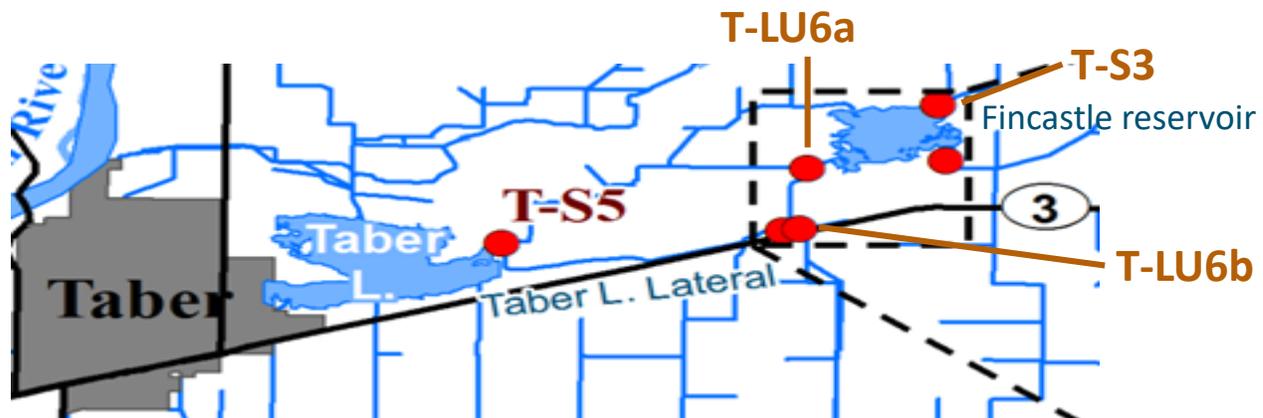


DNA fingerprinting

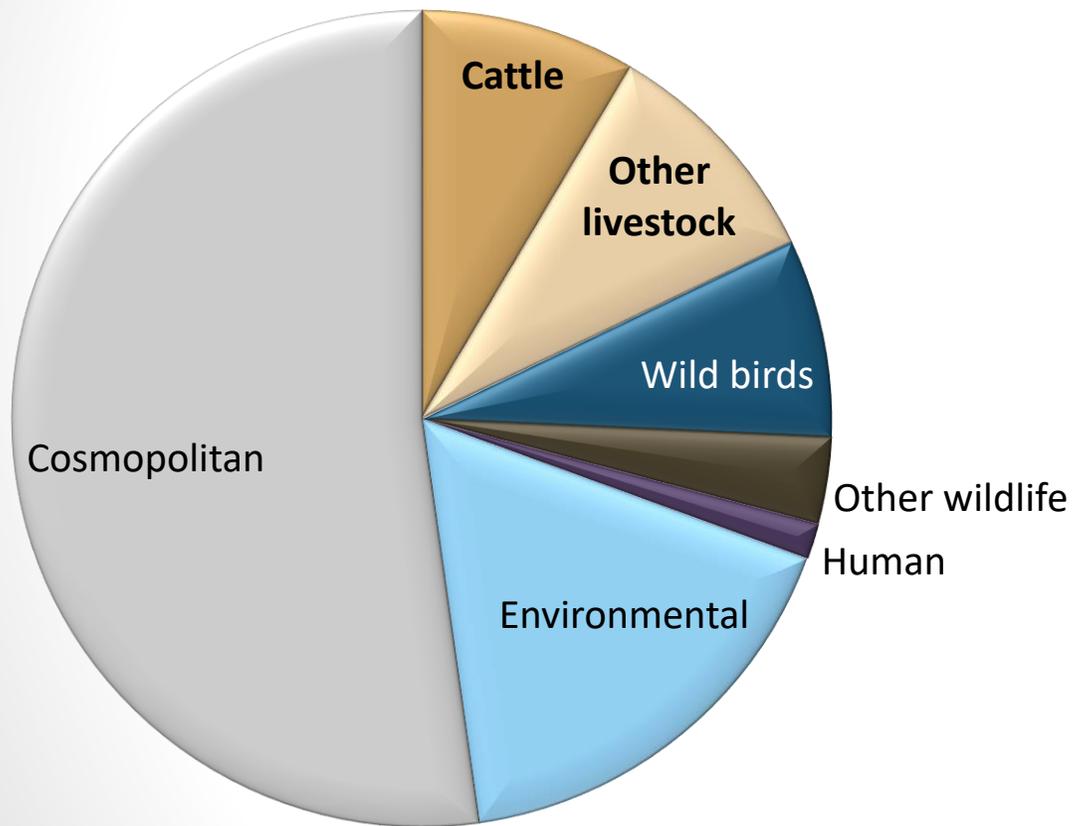


Findings

- Generally low *E. coli* concentrations
- Exceedance of Alberta Surface Water Quality Guideline for *E. coli* highest at 3/8 sites (T-LU6a, T-LU6b, T-S3)



Cattle manure and wildlife (birds) are the two main sources of *E. coli* in the TID



Are the *E. coli* exceedances associated with precipitation events?

	date	T-LU6a	T-LU6b	Accum ppt 48h (mm)	
Early	10-Jun-14	82	107	4.6	Exceedances correspond with precipitation
	17-Jun-14	175	105	50.3	
	7-Jul-14	77	156	14.6	
	21-Jul-14	115	53	0.3	
	5-Aug-14	31	340	0.5	
	19-Aug-14	45	79	0.9	
	2-Sep-14	65	67	0.1	
	22-Sep-14	16	14	0	
Late	25-May-15	1	14	0.4	Exceedances during drought
	8-Jun-15	84	190	0.1	
	22-Jun-15	7	84	0	
	6-Jul-15	40	121	10.3	
	27-Jul-15	132	81	1.5	
	17-Aug-15	120	125	1.1	
	31-Aug-15	240	120	0	
	15-Sep-15	104	150	10.7	
	28-Sep-15	224	77	0	

E. coli concentrations (CFU / 100 ml)
GL exceedances in blue

2014

2015

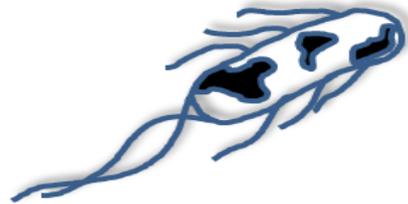


Types of *E. coli*

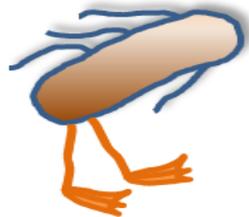
Host-specific

- Live only in the gut of a specific host

Cow



Bird
(waterfowl)



Cosmopolitan

- Can associate with many different hosts

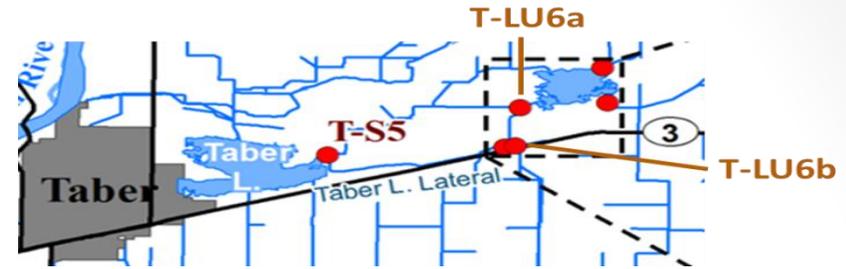


Cow & Bird
& Environment

- Also appear to adapt to the environment ...which may help them spread between different hosts...

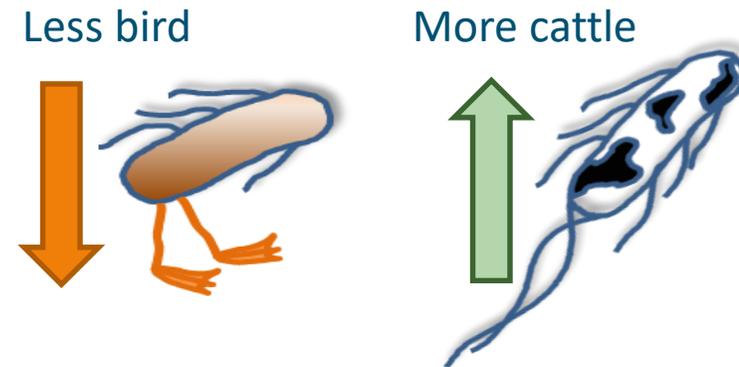


Lateral M (T-LU6a)



2014: *E. coli* GL exceedances

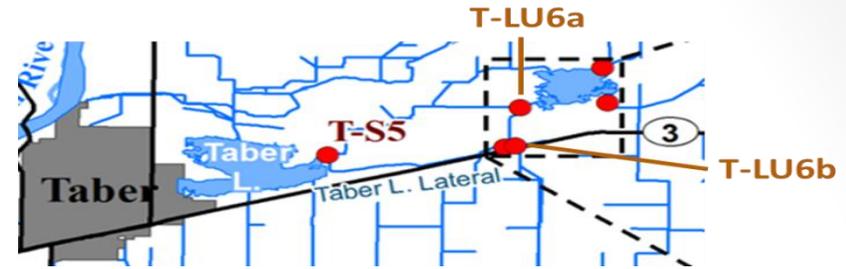
- 2/8 (25%) samples >GL
- Spring/early summer
 - Cooler, wetter spring – corresponding with increased exceedances due to cattle *E. coli*



Likely source: runoff from pastured cattle or manured fields



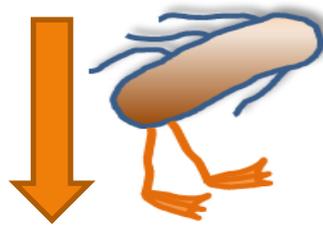
Lateral M (T-LU6a)



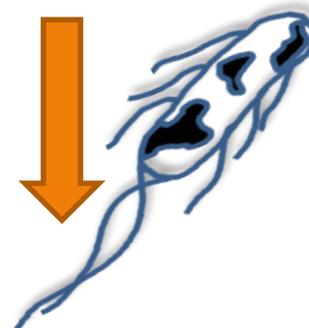
2015: *E. coli* GL exceedances

- 5/9 (56%) samples >GL
- Late summer /early fall
 - Warmer, dryer (not associated with precipitation)

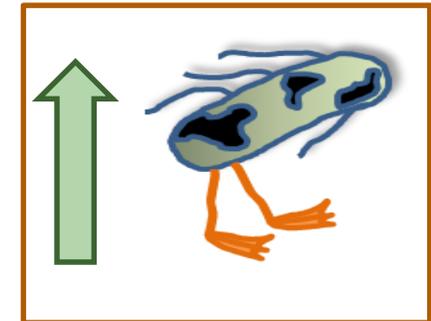
Less bird



Less cattle



More cosmopolitan



Increased during July, Aug,
Sept

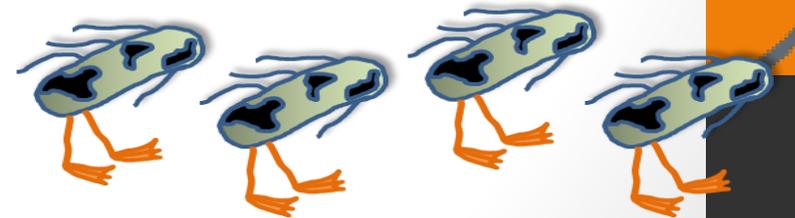
Likely source: increased cosmopolitan *E. coli* from July-Sept suggests that GL exceedances may be primarily due to environmental growth of *E. coli*.



Growth of *E. coli* in the environment (‘naturalization’)

- Factors that can promote environmental growth of *E. coli*
 - Nutrients
 - Warm temperatures
 - Sediment (earthen canals)
 - Vegetation / algae

Ultimately, need to (1) prevent the canal sediment from becoming ‘loaded’ with *E. coli*; (2) prevent nutrients from entering the water (food for *E. coli* and algae); and/or, (3) prevent disruption of the canal sediments (through engineering solutions!)



What's next?

Mitigating risk to market access for Alberta's irrigated agriculture through a next generation approach to water quality

2017 to 2019



Western Irrigation District
Eastern Irrigation District
Bow River Irrigation District
St. Mary River Irrigation District
Lethbridge Northern Irrigation District



Alberta Irrigation
PROJECTS ASSOCIATION



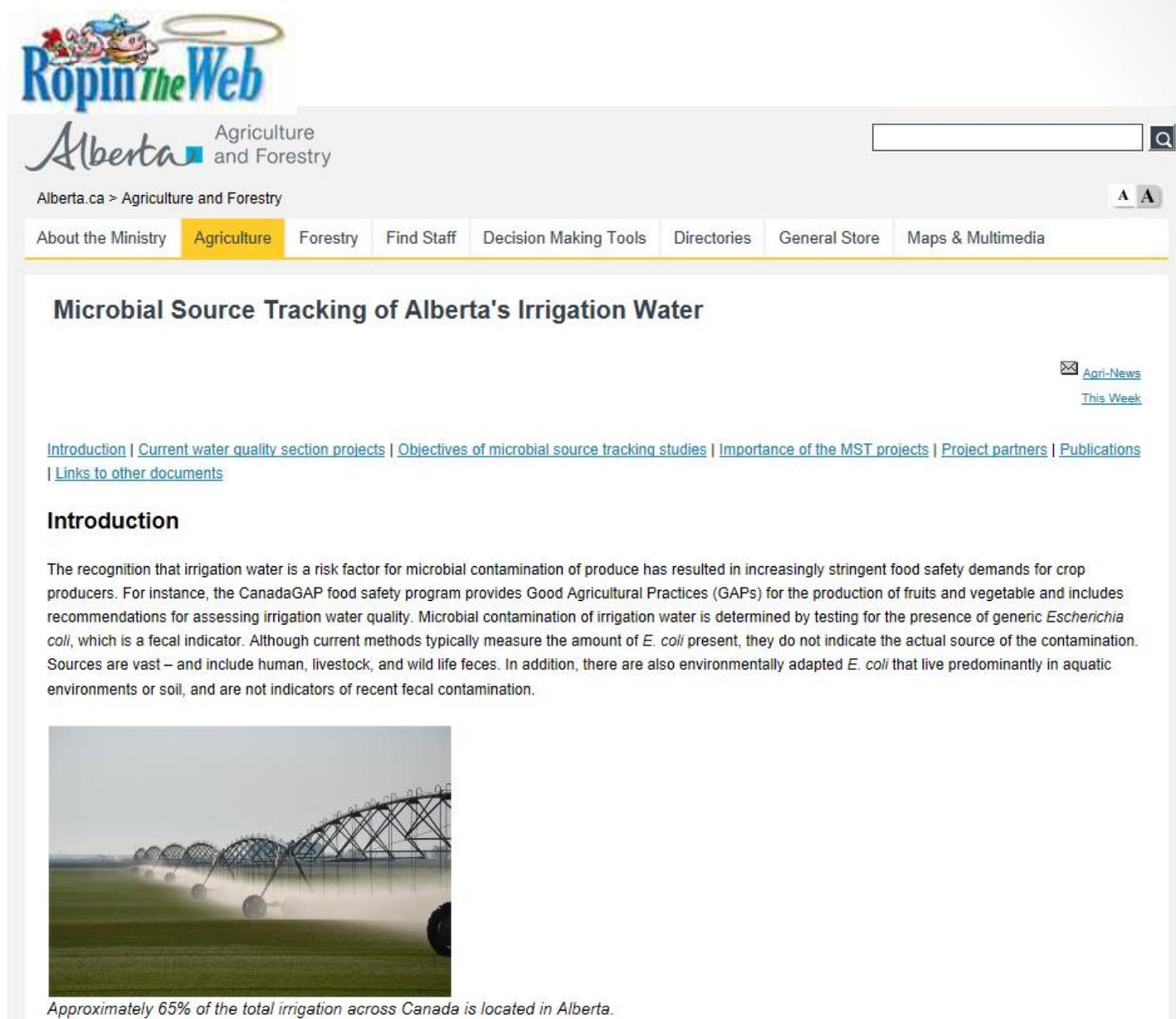
Acknowledgments

- Growing Forward 2 Industry development fund
- Staff from Alberta Agriculture and Forestry
- Irrigation Districts
- Taber Irrigation District including Chris Gallagher and TID board
- Taber area ranchers and feedlot operators



Webpage – Ropin' the Web

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/irr16288](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr16288)



The screenshot shows the website header with the 'Ropin The Web' logo, the 'Alberta Agriculture and Forestry' logo, a search bar, and a navigation menu with 'Agriculture' highlighted. The main content area features the title 'Microbial Source Tracking of Alberta's Irrigation Water', a 'This Week' link, and a list of links including 'Introduction', 'Current water quality section projects', 'Objectives of microbial source tracking studies', 'Importance of the MST projects', 'Project partners', 'Publications', and 'Links to other documents'. The 'Introduction' section contains text about irrigation water as a risk factor for microbial contamination and the use of *Escherichia coli* as a fecal indicator. Below the text is a photograph of a center pivot irrigation system in a field.

Microbial Source Tracking of Alberta's Irrigation Water

[Agri-News This Week](#)

[Introduction](#) | [Current water quality section projects](#) | [Objectives of microbial source tracking studies](#) | [Importance of the MST projects](#) | [Project partners](#) | [Publications](#) | [Links to other documents](#)

Introduction

The recognition that irrigation water is a risk factor for microbial contamination of produce has resulted in increasingly stringent food safety demands for crop producers. For instance, the CanadaGAP food safety program provides Good Agricultural Practices (GAPs) for the production of fruits and vegetable and includes recommendations for assessing irrigation water quality. Microbial contamination of irrigation water is determined by testing for the presence of generic *Escherichia coli*, which is a fecal indicator. Although current methods typically measure the amount of *E. coli* present, they do not indicate the actual source of the contamination. Sources are vast – and include human, livestock, and wild life feces. In addition, there are also environmentally adapted *E. coli* that live predominantly in aquatic environments or soil, and are not indicators of recent fecal contamination.



Approximately 65% of the total irrigation across Canada is located in Alberta.