
Principal Factors Affecting *Escherichia coli* Densities at Lake Winnipeg Beaches

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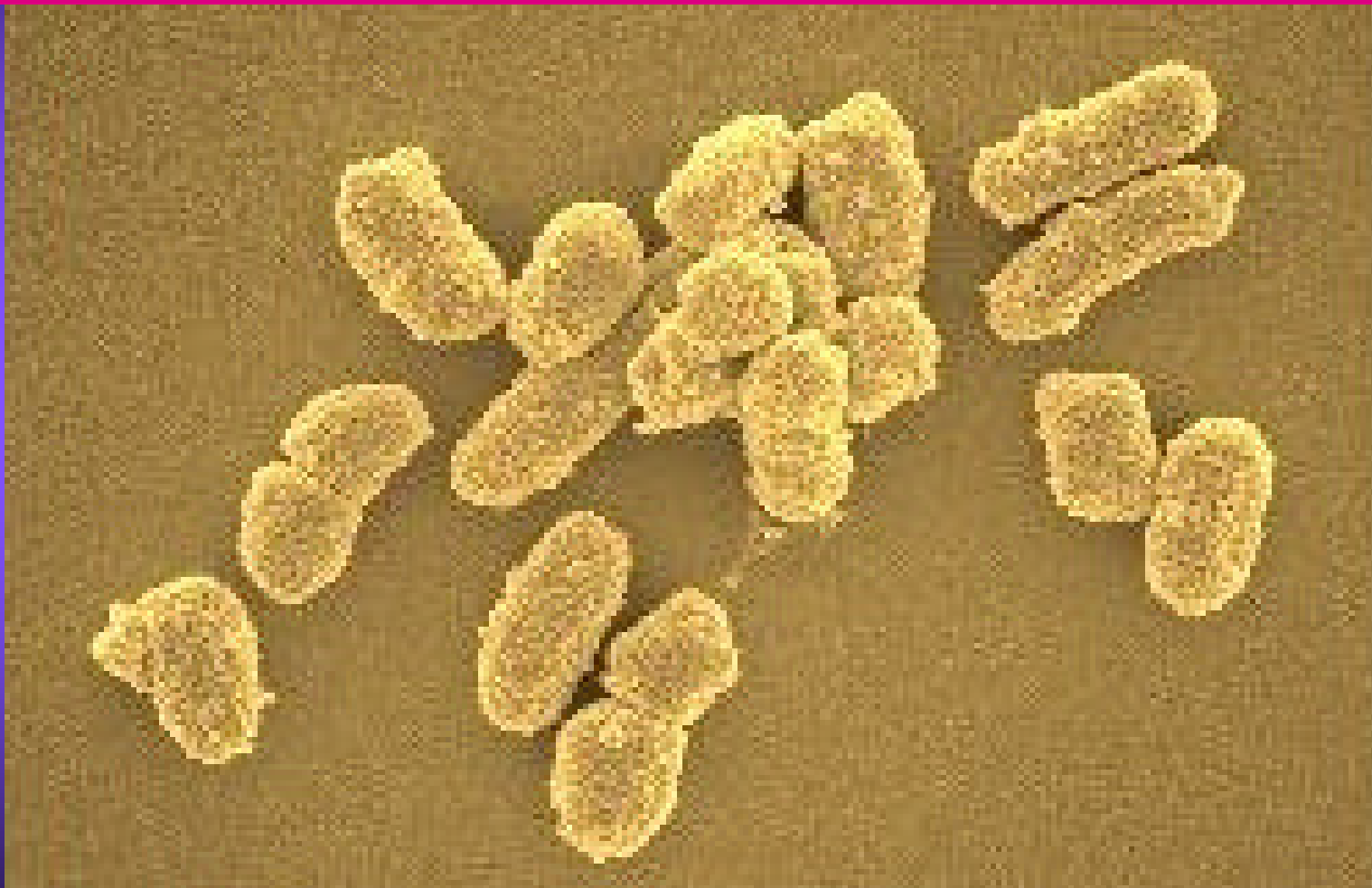
Acknowledgements

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Outline

- Basic facts about *Escherichia coli*
- Brief review of historical *E. coli* presence at Lake Winnipeg beaches
- Reservoir of available *E. coli*
- Mechanism of transfer from the reservoir to beach water
- Source of *E. coli* contributions to the reservoir and important related findings
- Next steps

E. coli



Facts About *E. coli*

- Unique to lower digestive tract of warm-blooded animals including humans, livestock, wildlife, and birds (but not fish, amphibians, insects, etc.)
- Shed to the environment in large numbers with fecal material

Facts About *E. coli* (continued)

- Generally not pathogenic (except for example, *E. coli* O157:H7), but closely related to other pathogens
 - that is, as densities of *E. coli* increase, densities of other human pathogens also increase, resulting in a higher risk of bather-related infections

Facts About *E. coli* (continued)

- Typically survive for less than 48 hours outside of the digestive tract
- A recreational water quality objective has been established in Manitoba of 200 *E. coli* / 100 mL
- Manitoba's objective is derived directly from the Guidelines for Canadian Recreational Water Quality, developed jointly by federal, provincial, and territorial governments

***E. coli* at Lake Winnipeg Beaches**

- Lake Winnipeg beaches have been routinely monitored for bacteria since the early 1980s
- Occasional exceedances of the recreational water quality objective have been observed
- When exceedances persist, beaches are posted with signs advising against swimming

***E. coli* at Lake Winnipeg Beaches (continued)**

- Lake Winnipeg beaches have been posted on two occasions
 - during the fall of 1993, three beaches were briefly posted
 - during the summer of 2003, two beaches were briefly posted
- Following beach postings in 2003, extensive investigations were undertaken to identify the source of the bacteria and the factors surrounding their transfer to bathing water

Watershed?



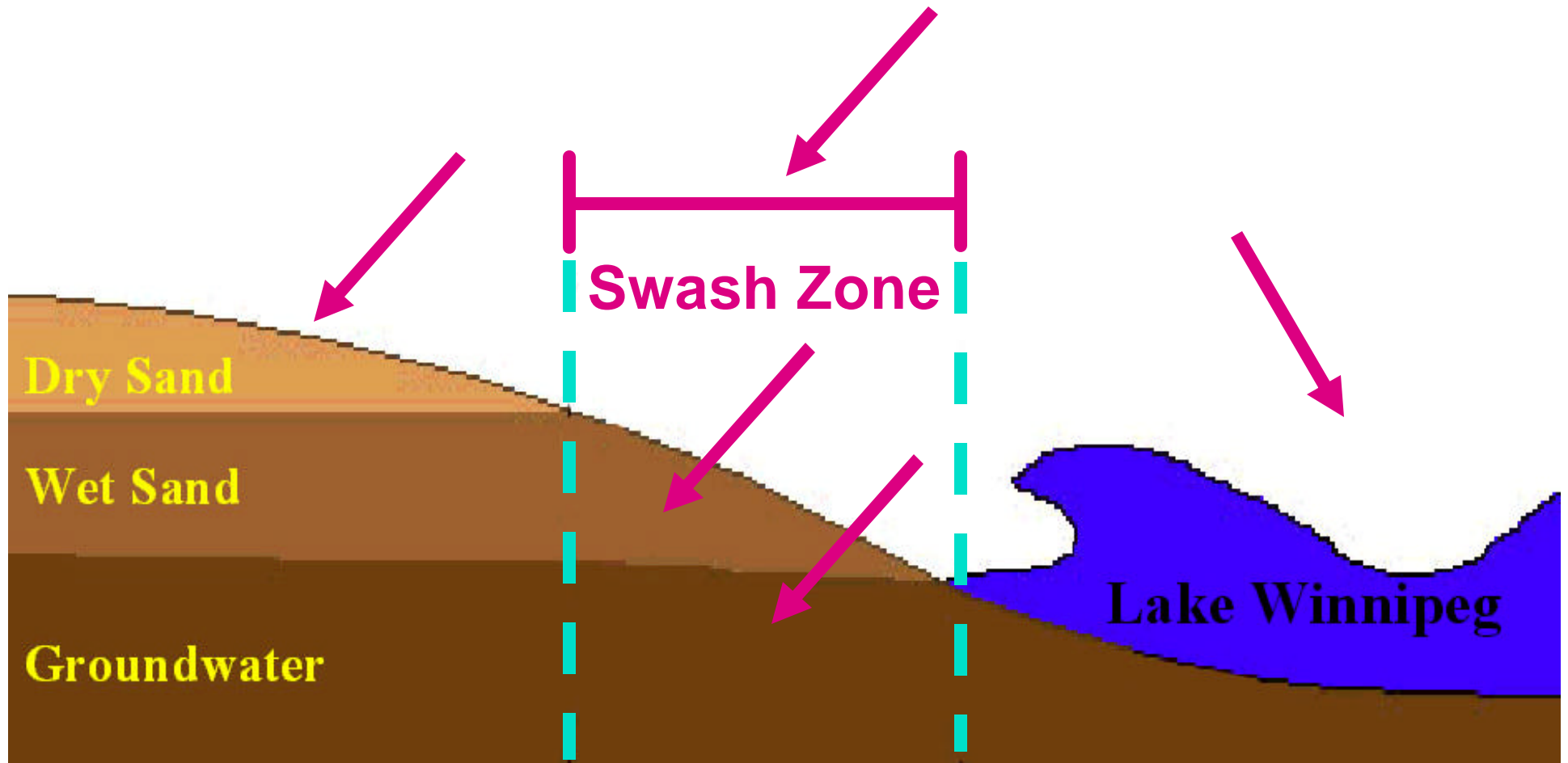
Effluents?



Main Finding of Lake Winnipeg Studies in 2003 and 2004

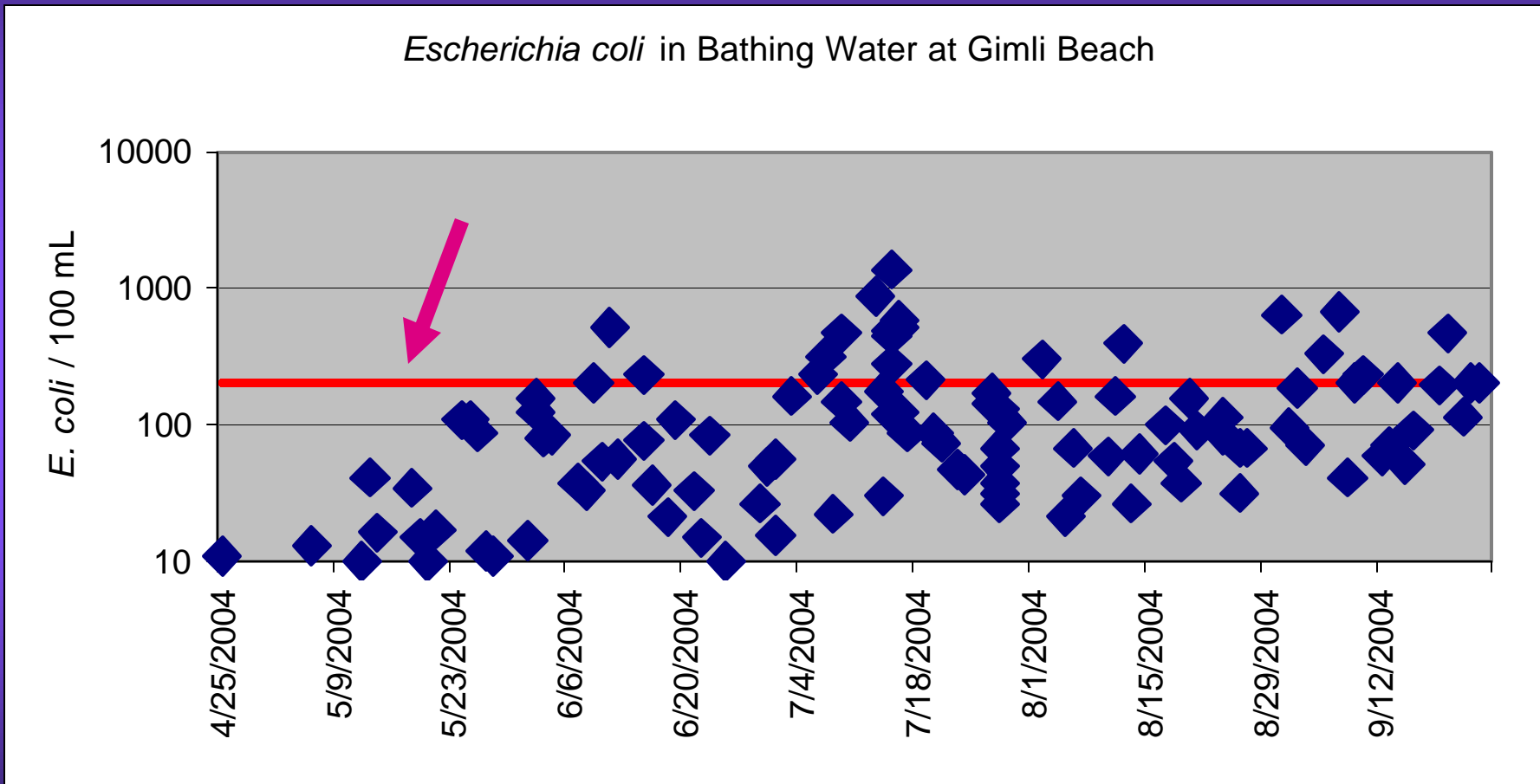
- Wet sand underlying foreshore beaches is the main reservoir of *E. coli* that is available for transfer to bathing water

Typical Lake Winnipeg Beach Profile



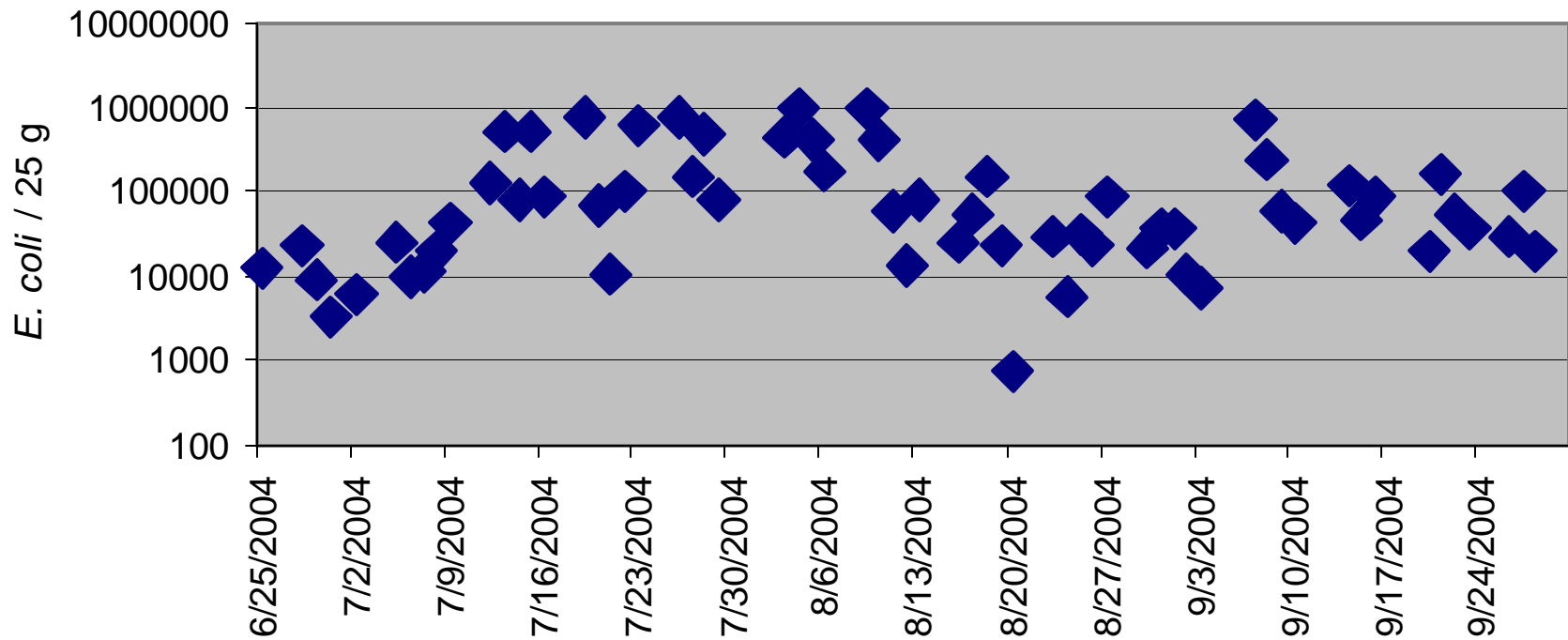
E. coli in Bathing Water

Escherichia coli in Bathing Water at Gimli Beach



E. coli in Wet Beach Sand

Escherichia coli in Beach Sand at Gimli Beach



63rd Street Beach, Chicago IL

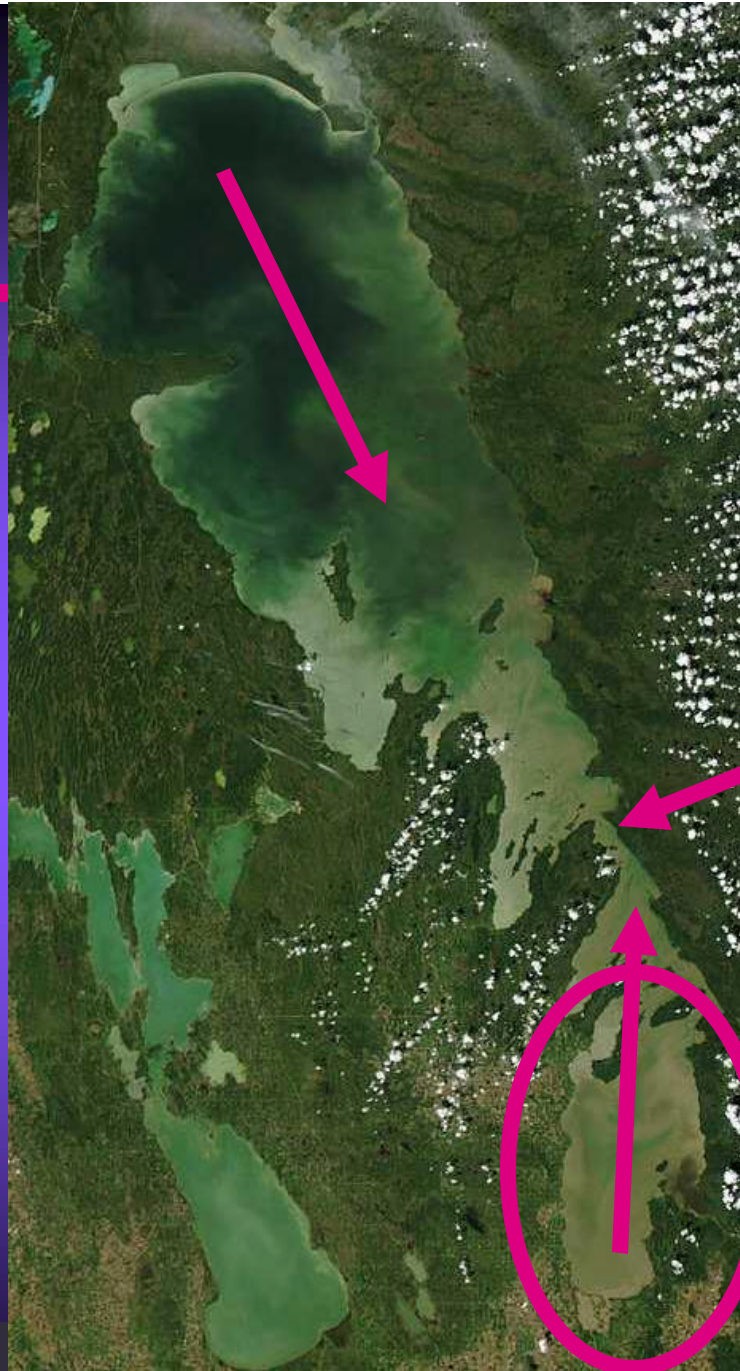
- Richard L. Whitman and Meredith B. Nevers
- “Foreshore Sand as a Source of *Escherichia coli* in Nearshore Water of a Lake Michigan Beach”
- Applied and Environmental Microbiology, September 2003, p. 5555-5562

Whitman's and Nevers' Conclusions

that beach sand:

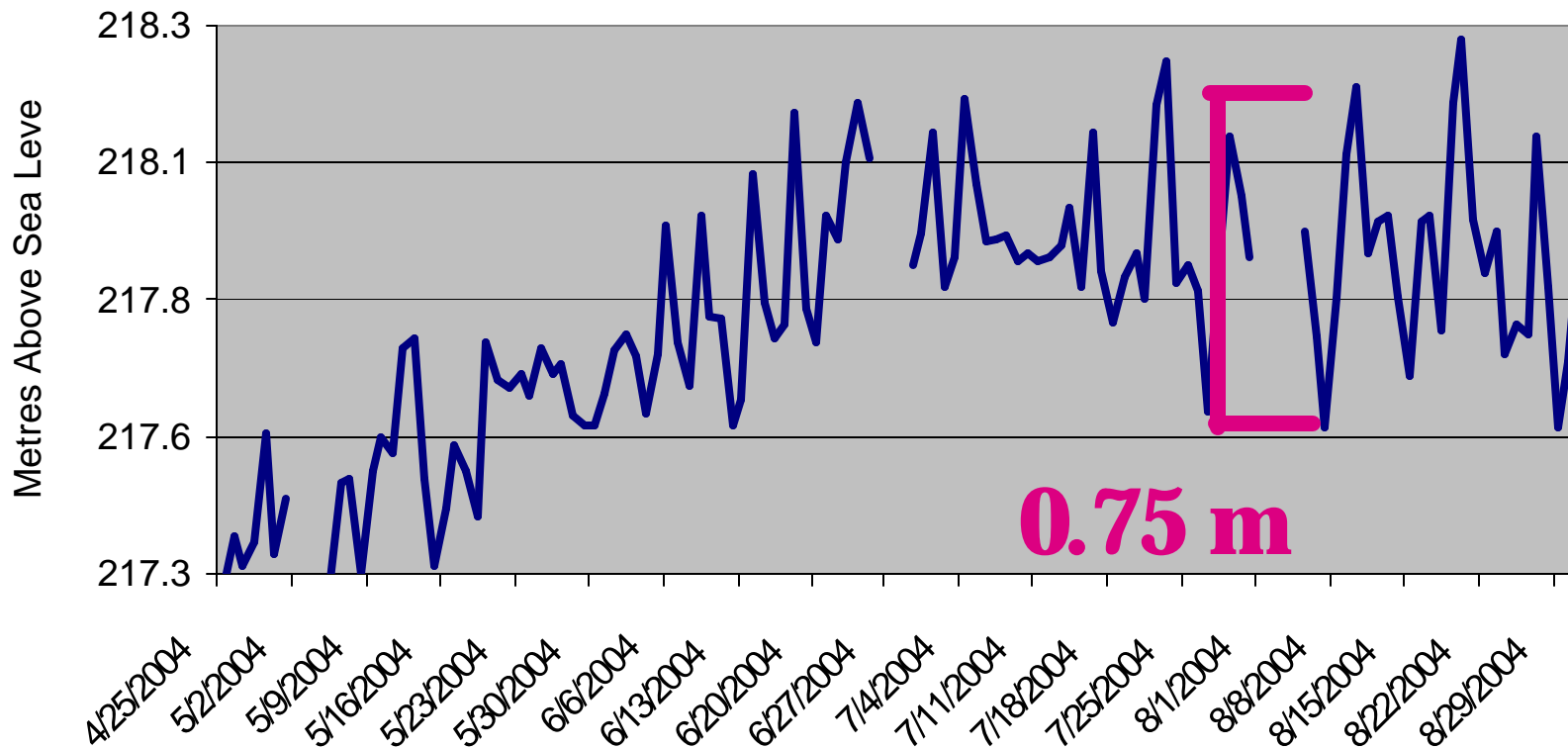
- (1) plays a major role in bacterial lake water quality
- (2) is an important source of indicator bacteria to the water rather than a net sink
- (3) may be environmentally, and perhaps hygienically, problematic
- (4) is possibly capable of supporting an autochthonous, high density of indicator bacteria for sustained periods, independent of lake, human, or animal input

Satellite Image of Lake Winnipeg

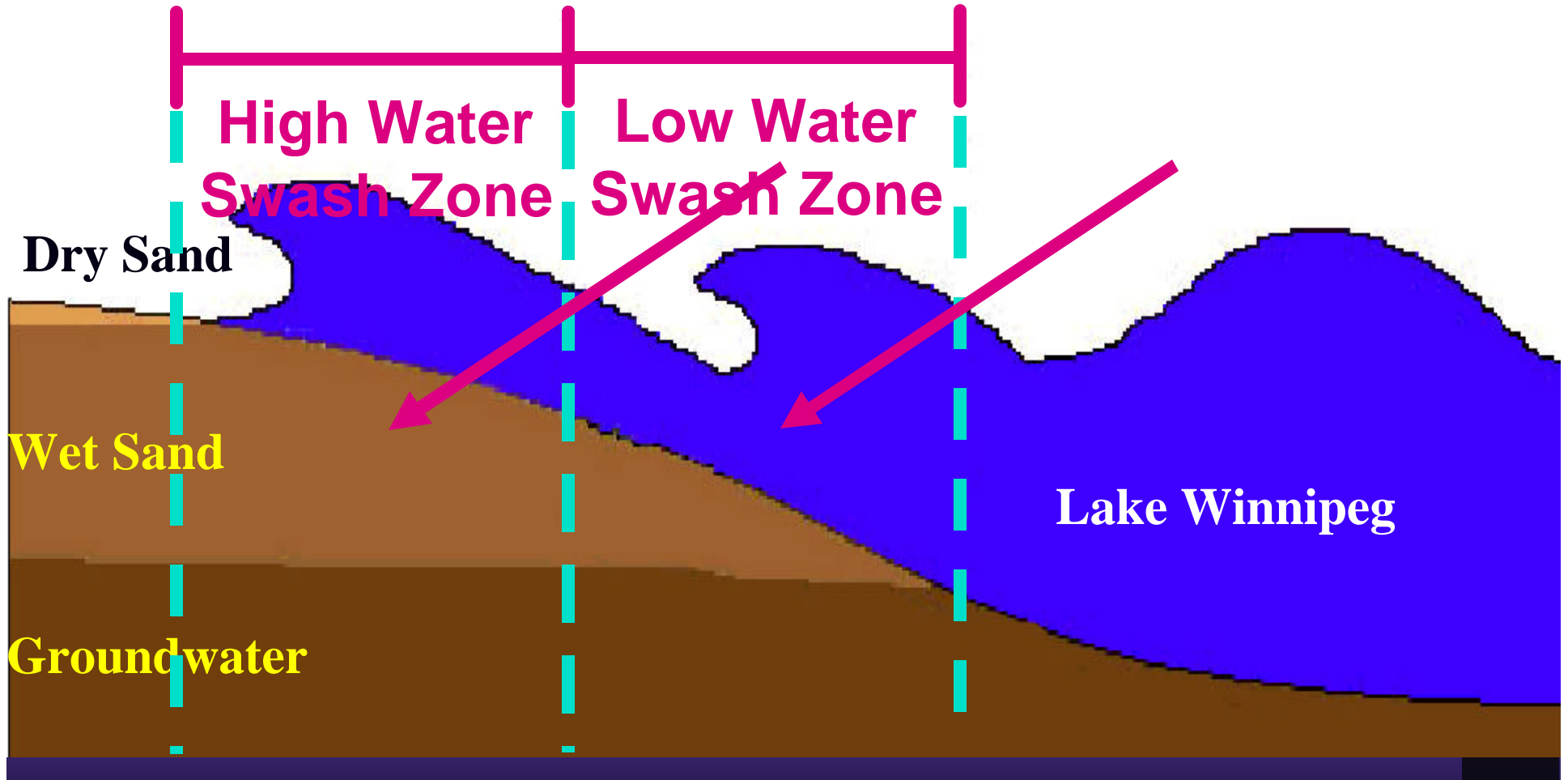


Daily Water Level Changes at Gimli

Water Levels Changes at Gimli During 2004

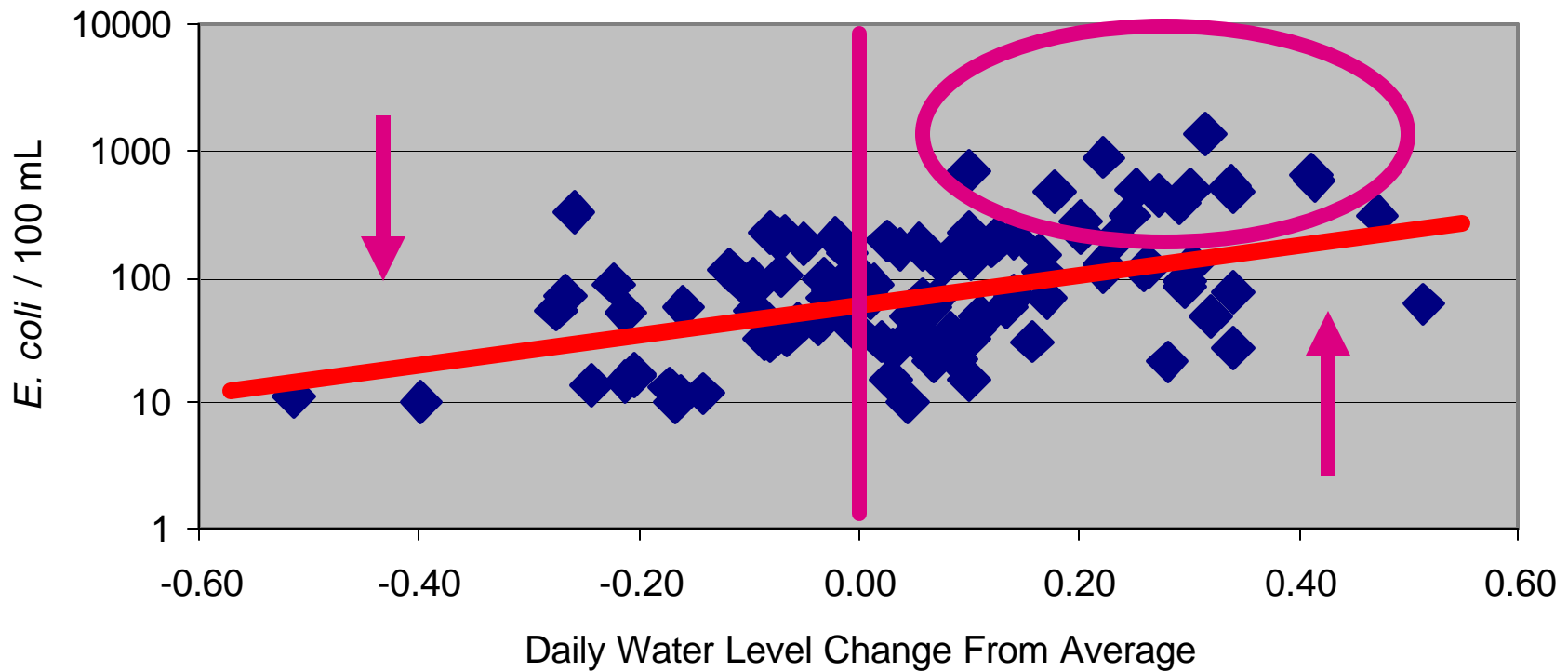


High and Low Water Swash Zones



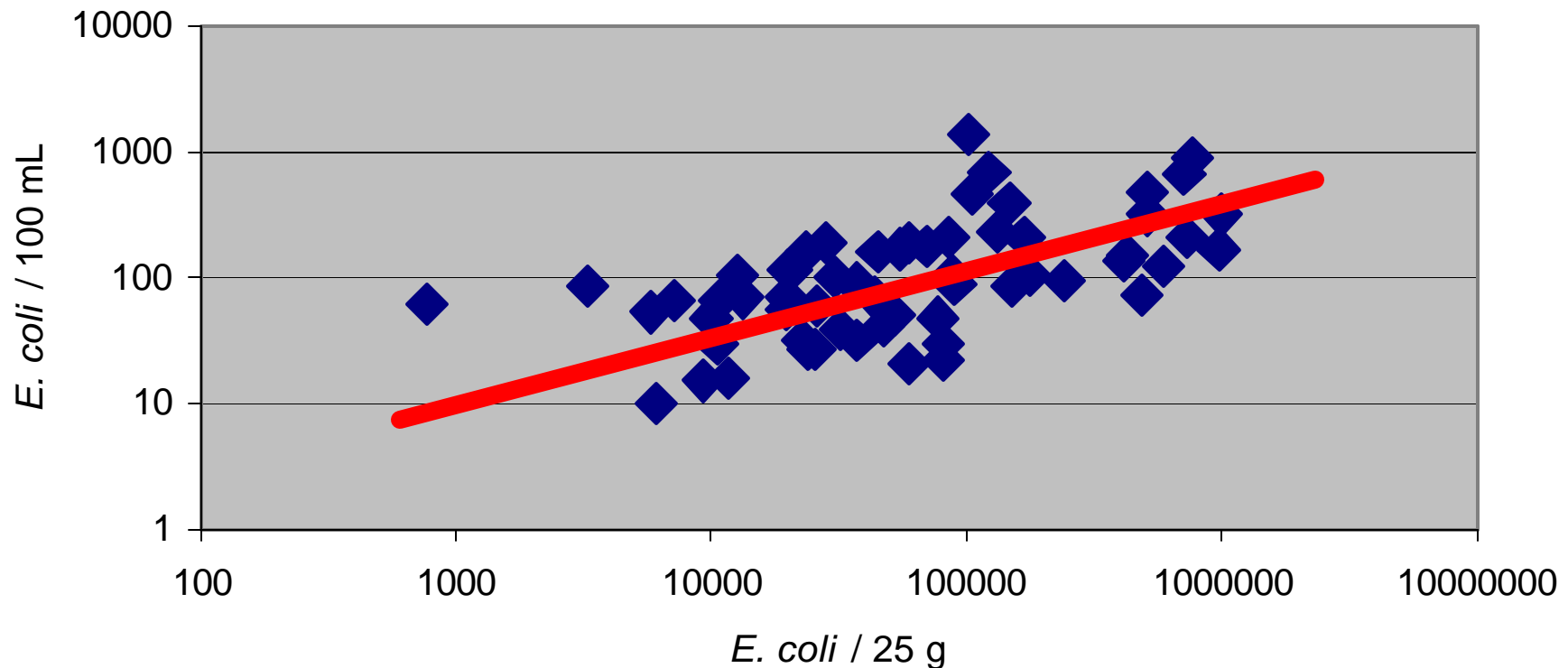
Relationship between *E. coli* and Lake Level Changes

Escherichia coli and Water Level Changes at Gimli



Relationship Between *E. coli* in Bathing Water and *E. coli* in Beach Sand

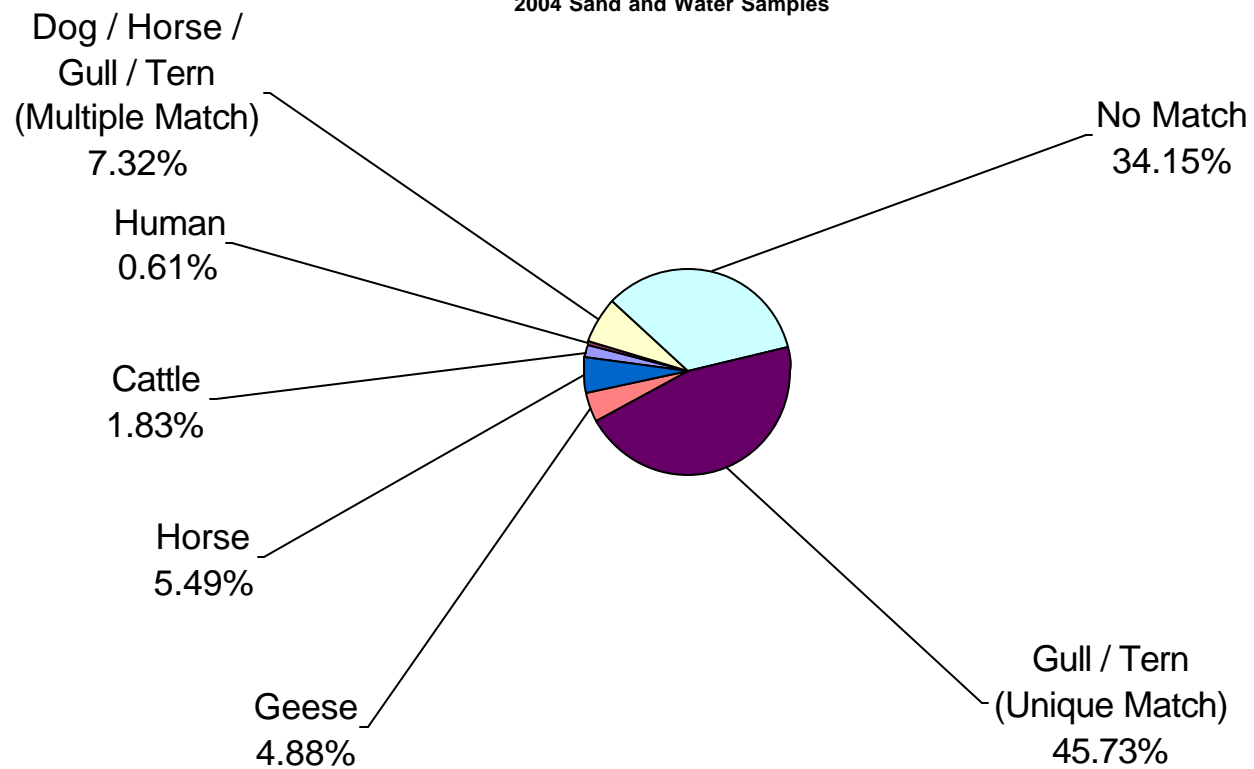
Escherichia coli in Bathing Water Versus *Escherichia coli* in Beach Sand $r^2=0.34$
 $p<0.0000$



Sources of *E. coli* in 2004 at Combined Lake Winnipeg Beaches

E. coli Comparison ID™ – DNA Fingerprinting of E. coli
(Discriminant and Comparison Analysis of Ribotype Profiles of E. coli)

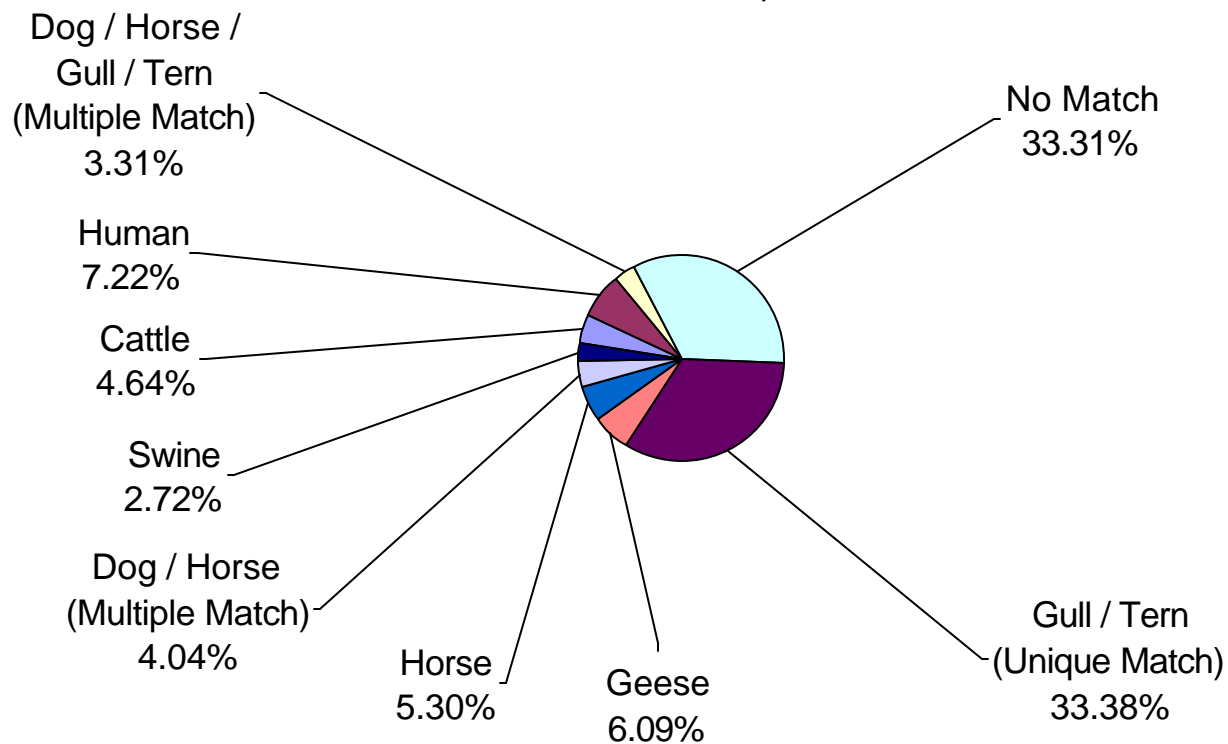
2004 Sand and Water Samples



Sources of *E. coli* (2002, 2003, 2004)

E. coli Comparison ID™ – DNA Fingerprinting of E. coli (Discriminant and Comparison Analysis of Ribotype Profiles of E. coli)

2002 / 2003 / 2004 Samples



Other Important Findings of Lake Winnipeg Studies in 2003 and 2004

- Confirmed that die-off of *E. coli* in Lake Winnipeg water is rapid, with majority dying-off within 48 hours or less
- However, there is strong evidence that re-growth of *E. coli* is occurring and it is presumed that this re-growth is likely occurring in the wet beach sand
 - this is consistent with the findings from the 63 Street Beach in Chicago
- Significantly increased the proportion of identified sources relative to 2003

Conclusions

- Water underlying foreshore sand provided a reservoir of *E. coli* available for dispersion to bathing water
- Wind-induced water level changes on Lake Winnipeg contribute to movement of *E. coli* from the beach area to bathing water
- Majority of *E. coli* are from non-human sources, with largest identified source being gulls and terns
- Strong evidence indicates re-growth likely occurs within the wet beach sand

Next Steps

- Submit findings for publication in a peer-reviewed, scientific journal
- Review beach monitoring and beach posting procedures for implementation during 2005
- Continue implementation of the Manitoba Clean Beaches Program

Closing Remarks

- These findings have significantly advanced our understanding of processes that influence bathing water quality in Lake Winnipeg

Thank You

