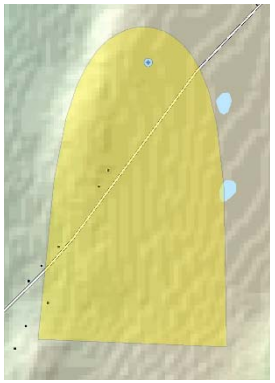
Well Head Protection Areas for Small Municipal Systems

Colin Walker, CBCL Limited

Study Purpose	Study Methods	Study Results	Next Steps
Well Head Protection	WHPA Delineation	WHPA Maps	Planning and Data Collection

WHPA = Well Head Protection Area



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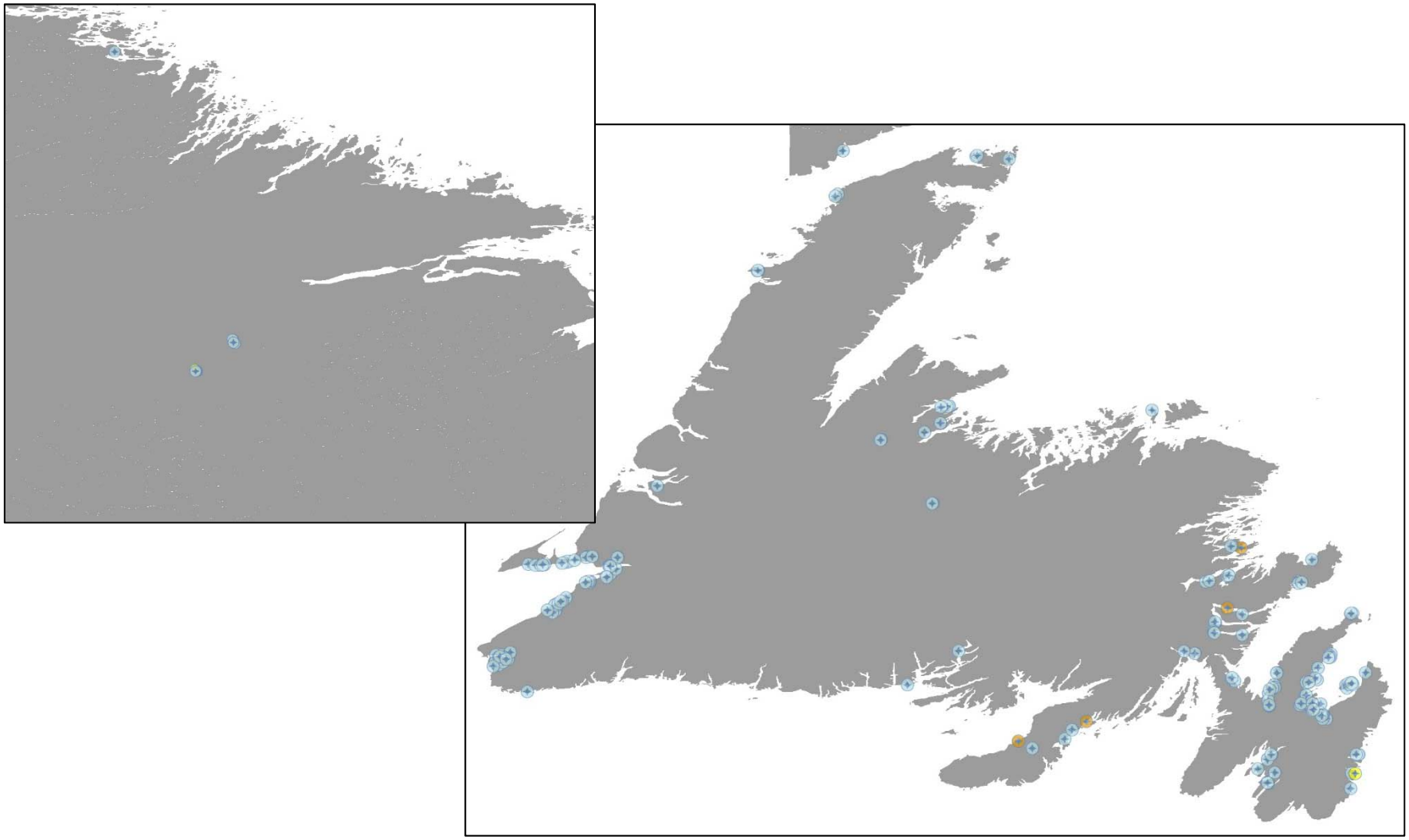

Purpose — Methods — Results — Next

municipal groundwater supplies

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- Planning tool for municipalities
- More detail than existing circular zones
- Reference point for more detail on:
  - Usage data
  - Aquifer response data

study purpose

Purpose | Methods | Results | Next

multi-barrier approach

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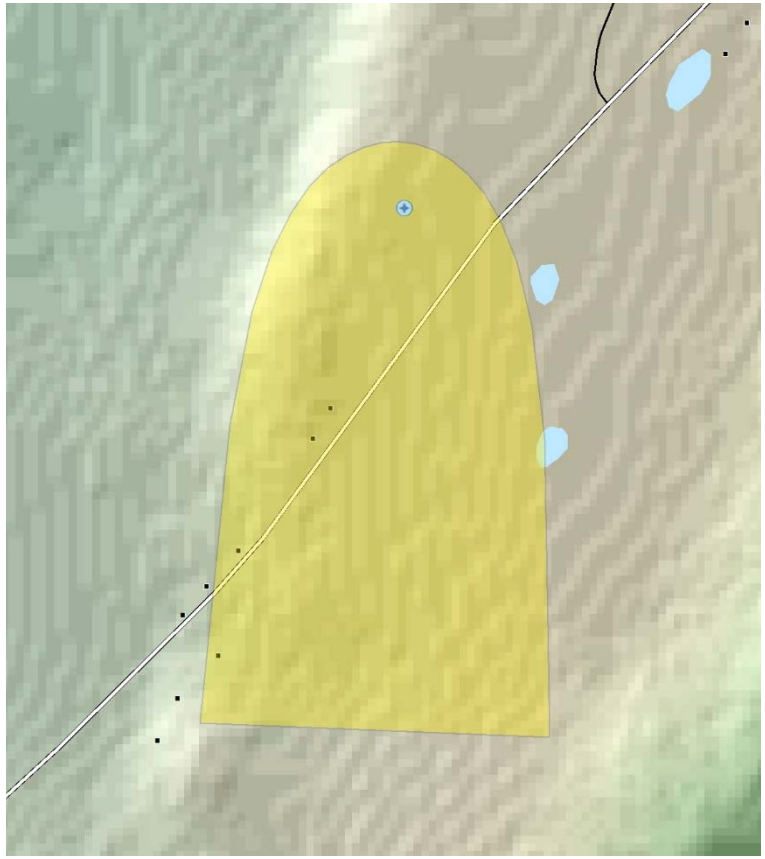
1. Protect the source
2. Provide treatment
3. Monitor and regulate to ensure safe water

multi-barrier approach

- Based on groundwater flow paths
- Based on travel time to the well(s)
- 20-year “capture zones”



Purpose | Methods | Results | Next

well head protection areas

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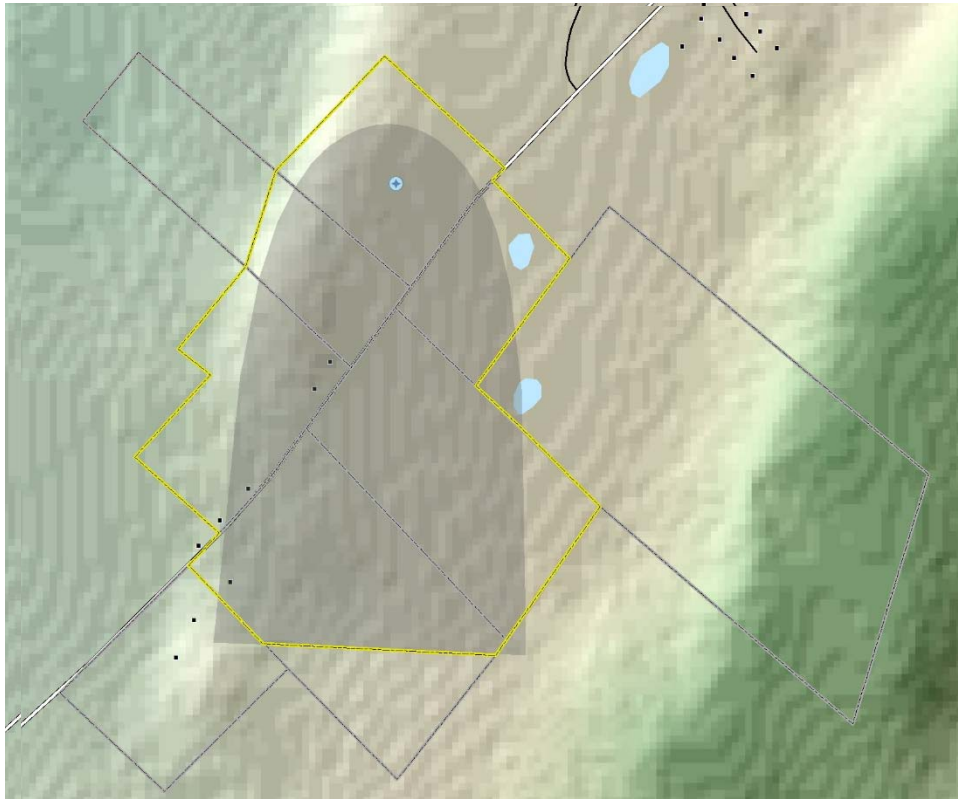
- Committee
- Properties within WHPA:
  - Ownership
  - Land uses
- Zoning
- Non-conforming uses
- Development approvals



well head protection planning

- Established method of delineation

- Repeatability
  - Updated well information
  - Updated aquifer information
  - Large dataset

- Automated calculation and mapping

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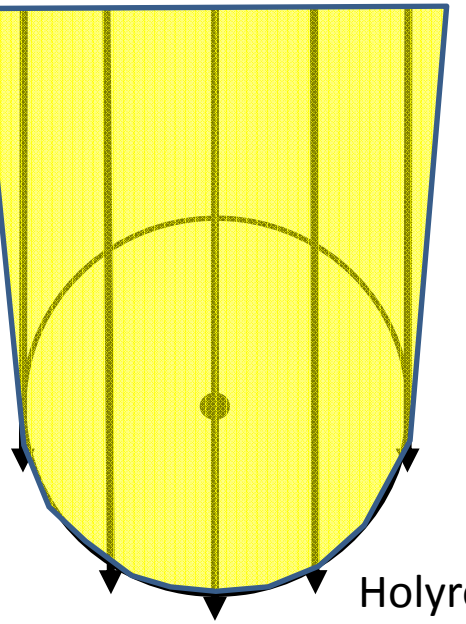
Calculated zone dimensions:

- Well location and ID
- Pumping rate
- Aquifer thickness
- Hydraulic conductivity
- Groundwater gradient, flow direction and porosity
- Travel time



Holyrood Well #5

Well ID	EAST	NORTH	PUMPING RATE	K	WELL DEPTH	GRADIENT	POROSITY	DAYS	DEGREES
1	755781	5211394	185	1.12E-06	49	0.125	0.10	7300	144
10.1	569867	5425283	163	4.12E-08	107	0.032	0.20	7300	322
10.2	569849	5425279	163	1.05E-07	42	0.031	0.20	7300	323
13	658382	5247323	260	2.00E-06	91	0.100	0.35	7300	80
14	394028	5367779	163	1.00E-05	58	0.035	0.35	7300	196
26	369162	5348641	42	2.00E-07	40	0.025	0.10	7300	159
27	363053	5338164	147	3.77E-05	15	0.012	0.35	7300	132
28	362898	5337937	55	3.77E-05	15	0.012	0.35	7300	133
31	362335	5341940	61	2.00E-07	56	0.014	0.10	7300	179
32	363082	5343159	42	2.00E-07	39	0.014	0.10	7300	148
33	361404	5336692	44	2.00E-07	29	0.060	0.10	7300	157
34	364581	5343328	175	2.00E-07	51	0.017	0.10	7300	114
35	367171	5345678	101	2.00E-07	54	0.021	0.10	7300	196
40	517714	5680180	20	9.77E-08	71	0.025	0.10	7300	149
41	516322	5678563	9	2.67E-07	26	0.017	0.10	7300	157
48	335839	5298712	5	1.39E-07	50	0.077	0.10	7300	236

255 Wells

master database

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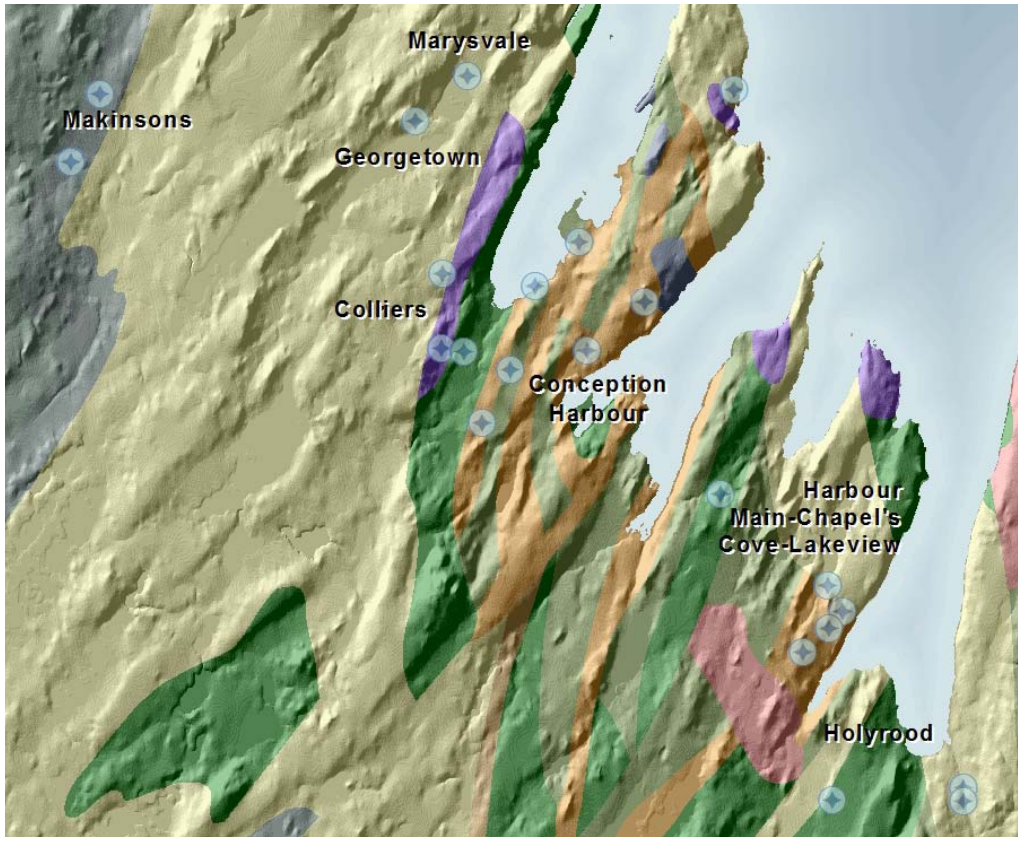

- Variable geology
  - Limited ability to predict flow rate based on rock type
- Limited usage data
- Limited well information
- 255 wells

setting

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- Collect and improve well data
  - Usage, pumping rate
  - Population served
  - depth, geology

well data

- Provincial registry
- Well logs database
- Aquifer tests
- Operator Interviews
- Mapping (mean depth)

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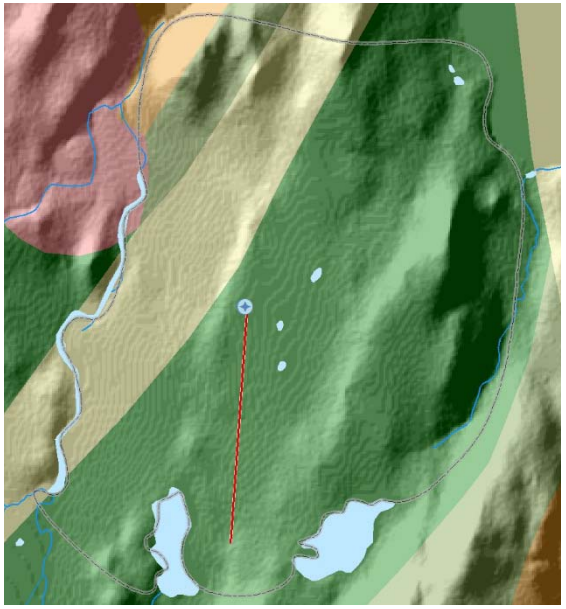
well data

- Conceptual model of groundwater flow
  - Topography
  - Surface water features
  - Geology mapping



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groundwater flow data

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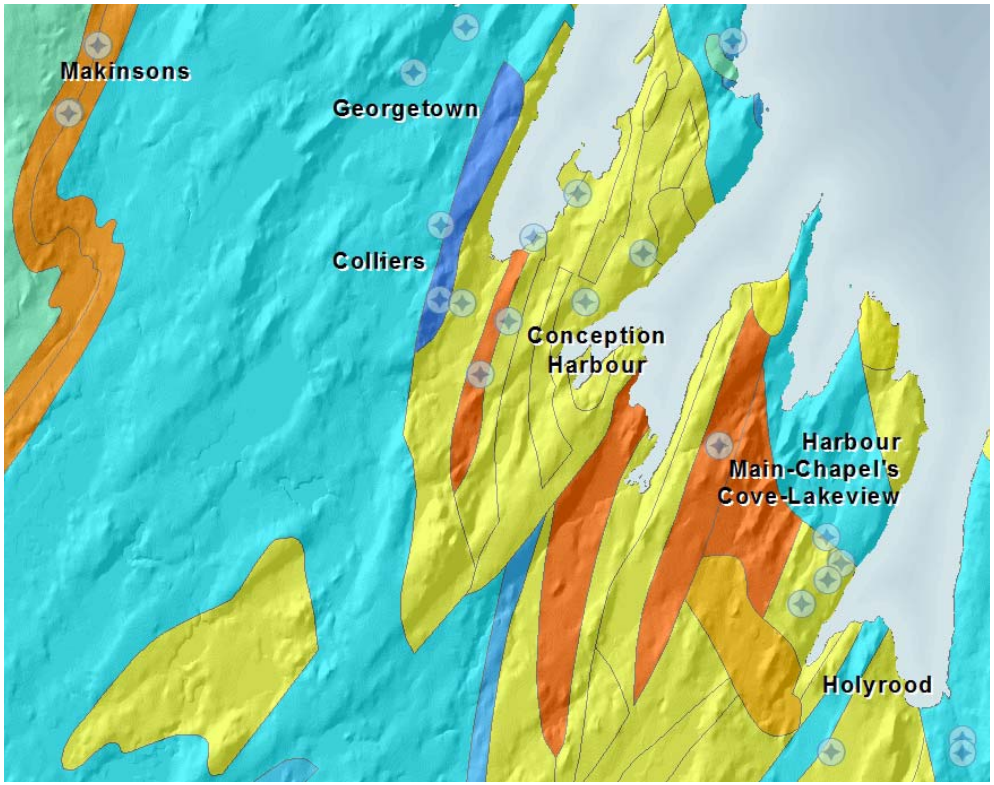
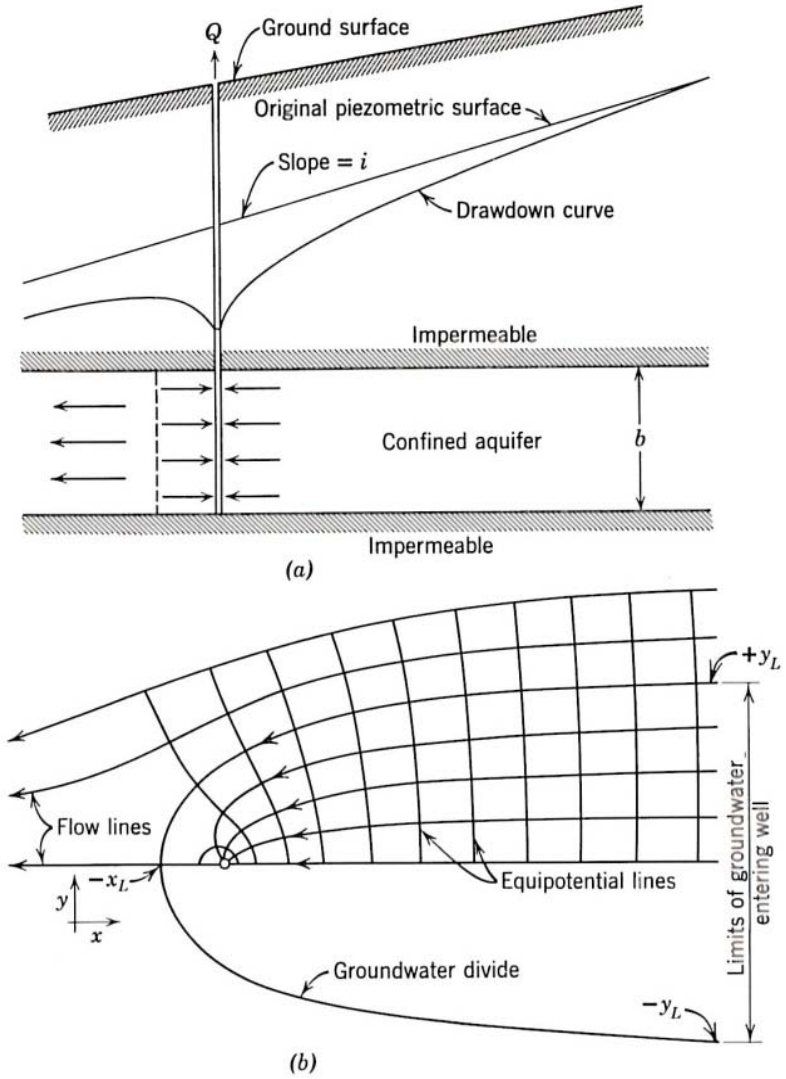
- Nearby aquifer tests
- Mapping and spatial - statistical analysis of airlift yield data



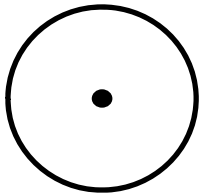
hydraulic conductivity

- Superposition of Theim equation and 1D flow field
  - Bear and Jacob (1967)
  - Todd (1980)
  - Ceric and Haitjema (2005)

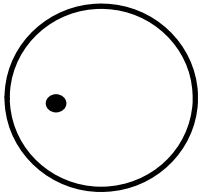


analytical model

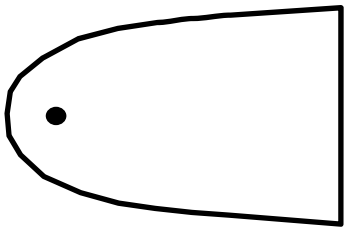
- Time of travel parameter:
  - Small — Circular



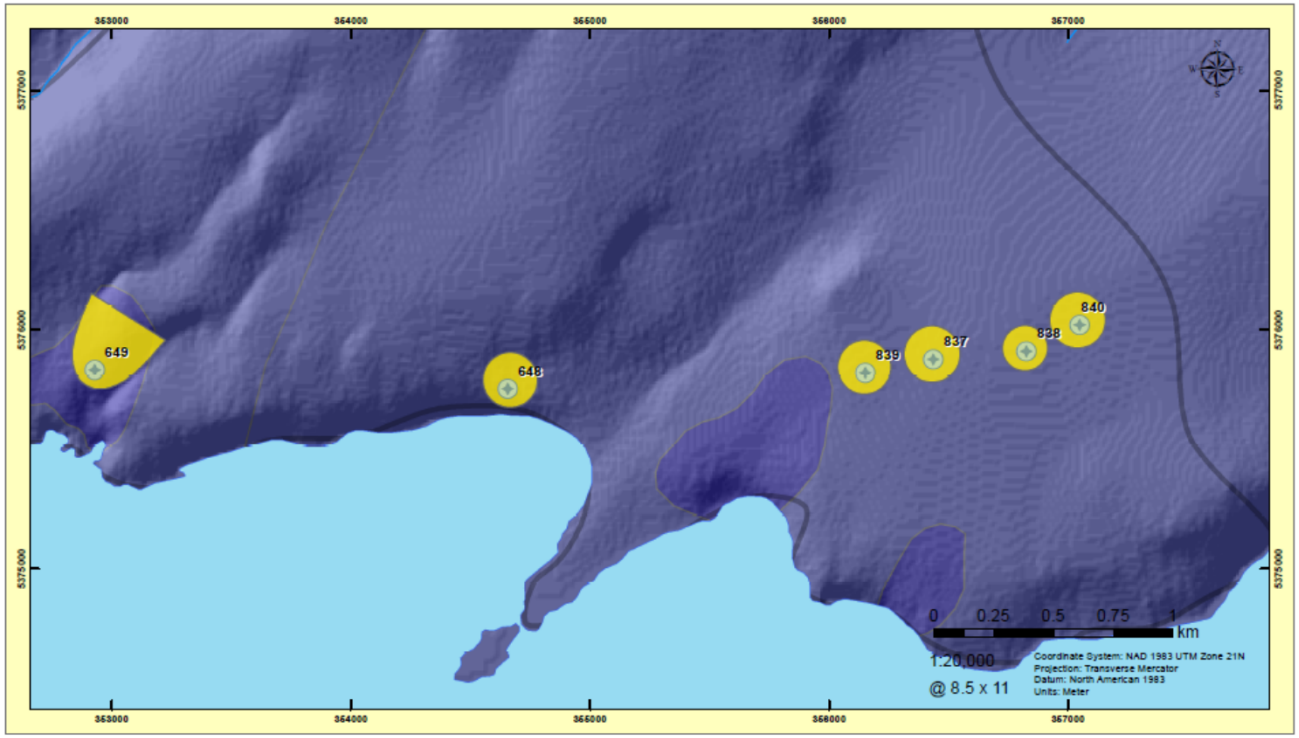
  - Moderate — Circular shifted



  - Large — Boat shaped



- Summary table:
  - Well ID
  - Well depth
  - Population per well
  - Pumping rate
  - Hydraulic conductivity
- Site geology
  - Bedrock type
- Zones



Ship Cove

Bedrock Well
WHPA
Well Field Study Area

Bedrock Geology Carbonate
Codroy Group,
Port au Port Group,

WS_SUB	Well ID	Well Depth (m)	Population	Pumping Rate (cubic metres per day)	Hydraulic Conductivity (m/s)
648	#5 Well - Murdock Wheeler Well	41	34	21	0.000000109
649	#6 Well - Lower Cove Well	41	62	38	0.000000491
837	#3 Well - Bernard Drake Well	64	62	38	0.000000108
838	#2 Well - Howard & Rodney Jesso Well	99	62	38	0.000000057
839	#4 Well - Nancy Rowe Well	72	62	38	0.000000963
840	#1 Well - P.J's Variety Well	64	62	38	0.000000108

Purpose — Methods — **Results** — Next

WHPA maps

Purpose | Methods | **Results** | Next

Red Harbour

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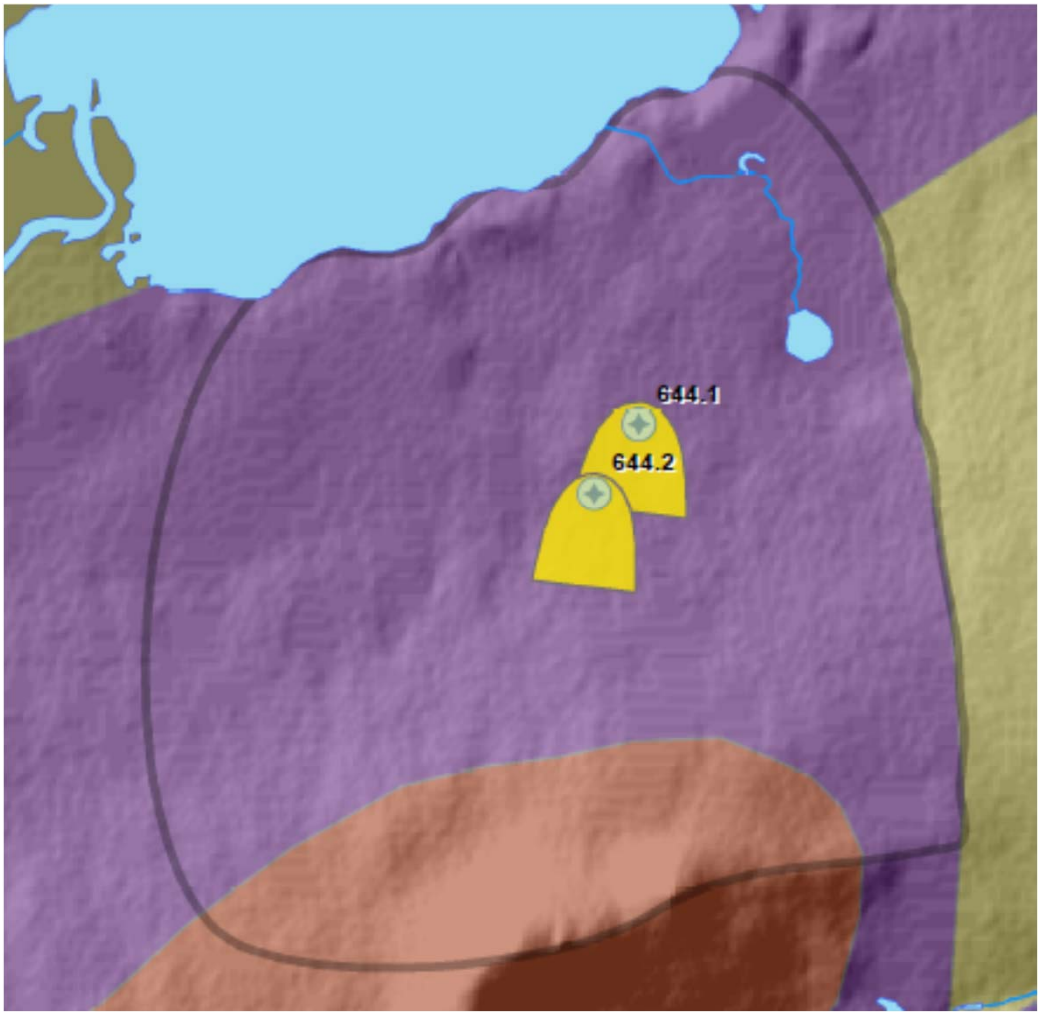
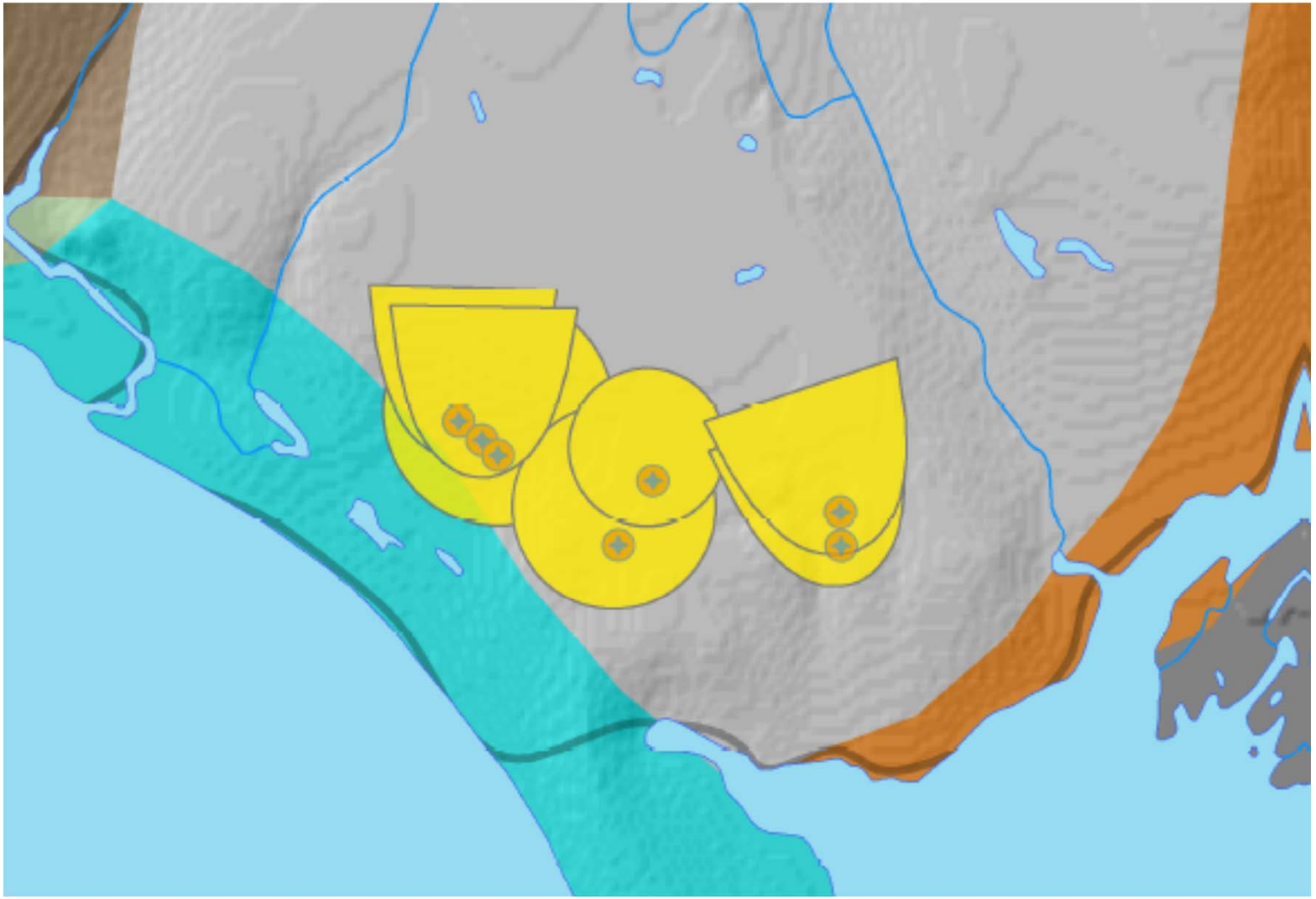


Purpose | Methods | **Results** | Next

Sheppardville



Purpose — Methods — **Results** — Next

Stephenville Crossing

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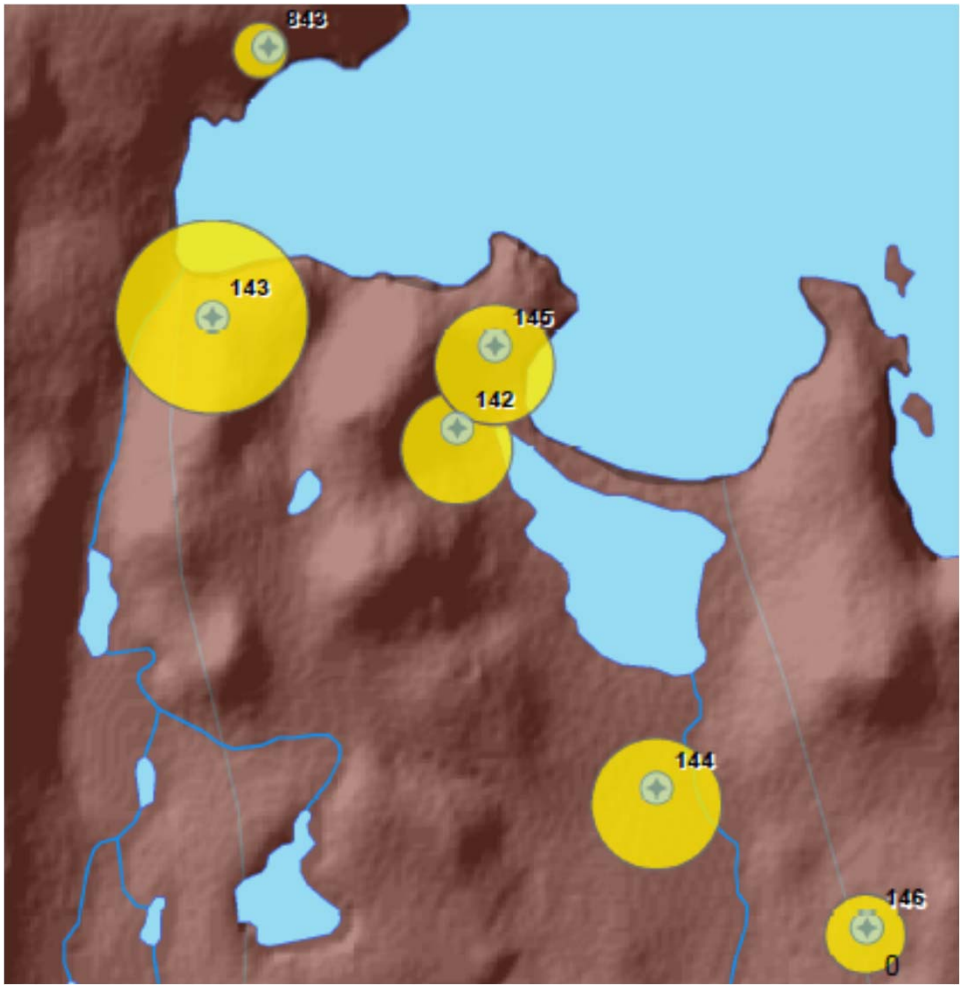

Purpose | Methods | **Results** | Next

Chance Cove

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- 81 circular
- 47 shifted
- 128 boat

- < 5 ha: 118
- 5 to 10 ha: 53
- 10 to 100 ha: 80

- Springdale Industrial Park: 2174 ha circular
- Natuashish: 185 ha circular
- Eastport: 118 ha, boat

WHPA mapping

- Solution changes significantly:
  - Pumping rate
  - Hydraulic conductivity

- Review data table provided
  - feedback / updates on pumping rate
  - population served
  - well depth and aquifer

recommendations

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- Determine the pump type and depth
  - Record on-off schedule over one week to one month of pumping
  - Establish long-term use records
  - Install flow meter

- Measure and record water levels:
  - Static level (non-pumping)
  - Pumping level (pump on, level stabilized)
  - Recovery – series of water levels for one hour after the pump is turned off or static level restored

The automated solution can be re-run to provide an updated zone based on new data.

updated zones

- Form a well head protection committee
- Field reconnaissance of WHPA
- Inventory of land uses and ownership
- Monitoring of well use and water levels
- Monitoring of raw and treated water quality

- Documentation of WHPP
  - Land use guidelines
  - By-laws
  - Voluntary agreements
  - Management strategies
  - Signage
  - Incorporation of WHPP into community or LSD planning strategy

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questions

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