PEI Water

A Water Act Backgrounder
September 2015
Outline

• Water in our lives
• The amount of water and how we use it
• Protecting the environment
• Water quality
• Water management
Water in our lives

We need it for life

It helps support our economy

...and we value it for many other reasons as well

Recreation

Wildlife habitat
PEI Average Annual Amounts

Evapotranspiration: 440 mm

Precipitation: 1100 mm

Surface Run Off: 260 mm

Groundwater: 400 mm

Water Cycle
Water Quantity
Groundwater in PEI

• Generous, stable, predictable amounts virtually anywhere due to high recharge rate through the thick sandstone bedrock
• Susceptible to contaminants.
• Sole source of drinking water
• Supplies most of the water for industrial, commercial and agricultural uses.
• Annual groundwater recharge stacked on a soccer field would be 300 km high
• Annual groundwater usage stacked on a soccer field would be 4 km high
• A portion of pumped groundwater is returned to the aquifer

Fresh Groundwater Usage

- Residential 52%
- Industrial/Commercial 30%
- Livestock 6%
- Irrigation 2%
- Geothermal 11%

Image: courtesy USGS
How wells work

- Groundwater occupies pore spaces in our sandstone bedrock
- It flows from higher elevations to lower elevations
- Wells “divert” some groundwater from its natural flow path

Water Table

Non-pumping well

Pumping well

Cone of depression

Well depth 30-50 m

Groundwater flow paths

Groundwater discharge to stream (base-flow)

300 – 400 m
How wells work

- Lower water table around a pumping well (cone of depression) can affect the level in nearby wells.
- The cone of depression size varies with pumping rate, usually a distance of 100-200 m from a high capacity well.

[Diagram showing groundwater flow paths, water table, well depth, and cone of depression.]
How wells work

- Lower water table around a pumping well (cone of depression) can affect the level in nearby wells.
- The cone of depression size varies with pumping rate, usually a distance of 100-200 m from a high capacity well.

- A small lowering of the water table can result in a large impact on streams.
High capacity wells on PEI

- Produce more than 50 gallons /min
  - require a permit
- >200 high capacity wells
  - (~20,000 private wells are low capacity – no permit required)
- Local water stress in some watersheds from high municipal and industrial water usage

Number of High Capacity Wells
Long Term Groundwater Levels

- Essentially flat with seasonal fluctuations

- Dry conditions
  - quickly followed by return to normal conditions

Note the dry conditions in late 2001 and early 2002.
Where Groundwater Flows

- Watershed Boundary
- Surface Run Off
- Percolation
- Groundwater
- Groundwater Divide
- Precipitation
Strong Connection Between Groundwater and Surface Water

- Groundwater discharge (base flow) forms ~60% of average annual stream flow

- Most of groundwater flow occurs in the shallow part of the aquifer

- Groundwater levels:
  - High – spring
    - due to melting of accumulated snow, precipitation and low evapotranspiration
  - Low - late summer
    - due to high evapotranspiration
Seasonal Headwater Streams

• Parts of headwater streams dry up naturally
  o Due to seasonal variation of groundwater table
  o Range from tens to hundreds meters
  o Dry section could be even longer in some dry years

• High groundwater extraction could lengthen the dry area in summer and early fall.
Natural Seasonal Headwater Streams

Headwater Streams (natural variation)

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<td>j</td>
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</table>

Spring–Fall Dry Stream Length (m)

Observations by the Kensington North Watershed Association
Impact Site – Winter River Headwater

- High extraction rate
- Increases natural drying up of headwater in Brackley area
  - Total length of dry area > 2 km
  - Actual distance of additional amount from pumping cannot be easily determined as pumping has been going on since the 1930s
- Well fields established before water was regulated
  - Current extraction at the Brackley and Union well fields is higher than that allowed under the water extraction policy established in 2010
- City of Charlottetown is required to create a new pumping rate plan
Water Quality
Where Water Gets Its Characteristics

- Characteristics depend on what materials it comes in contact with, both natural and man-made.

- Rain water is slightly acidic.

- Run-off from rainfall washes materials such as soil, bacteria and other contaminants from the land surface directly into streams.

- Percolating water dissolves some of the minerals in the soil.

- Elements like calcium and magnesium (which make water “hard”) enter groundwater.

- Man-made contaminants on or near the ground surface can also be dissolved into groundwater.

- Groundwater discharge carries soluble materials such as nitrate into streams.
Chemical Contaminants

• Both natural and man-made

Natural Contaminant Examples:
• Weathering of rock:
  • Arsenic
  • Uranium
  • Barium
• Sea water intrusion:
  • Salt

Man-made Contaminant Examples:
• Road salt
• Fertilizer (nitrate)
• Pesticides
• Oil or gas spills
Bacterial Contaminants

- Pose most serious health threat from drinking water.
- Often from inadequate wells or septic systems

Leaking septic tanks
- Most common source of *E. coli* contamination

Poor Well Construction / Maintenance
- Can allow the entry of surface or near-surface sources of bacteria from soils or from septic systems
High Capacity Wells and Sea Water Intrusion

- Factors affecting sea water intrusion
  - Local geology/hydrogeology
  - Surface elevation/fresh groundwater level
  - Wells
    - Distance from shore
    - Pumping rate and duration of pumping

- PEI sea level rise study
  - Sea level rise will not impact sea water intrusion significantly
  - Pumping by high capacity wells within a few hundred meters of the coast is much greater issue

Image: USGS
Estuary Anoxia

- Nutrients cause excess plant growth (sea lettuce).
- Sea lettuce mats suffocate other life.
- When sea lettuce dies, decay process uses up oxygen, causes discolorations and odours (anoxic events).
Anoxic Events

- Occur annually
  - early summer to fall
  - happening earlier, lasting longer, even into fall
- Nutrient / circulation relationship
  - Nutrient = nitrate
  - North shore has naturally small tides - less flushing

Addressing Anoxic Events:
- Flushing
  - Very little can be done as causeways and bridges that restrict flow have been fixed
  - Other issues (e.g. sills that restrict circulation) are addressed as structures are repaired/replaced.
- Nutrient loading
  - Reduction of nitrate loads needed
  - Harvest not a solution
    - High cost
    - Would need to be continuous
    - As soon as stopped, sea lettuce grows back
    - By-catch of other species
    - Not sustainable - currently no way to offset costs
Nitrate in Surface Water

- Some systems are above fresh water aquatic life guideline
- Mostly from groundwater
  - Run-off a smaller proportion
- Slight decline in levels in most streams in the last few years
PEI Sources of Nitrate

- Agriculture
- Background
- Septic
- Municipal
- Industrial
High capacity wells - Nitrate

- Decreasing Nitrate Concentration With Depth
- ~75% of water comes from top 20 m
- Fewer & Smaller Fractures With Depth
- High capacity wells do not draw nitrate deeper into the aquifer
Nitrate Reductions Required (%)

- Science based method for setting targets developed.
  - Addresses both estuary and drinking water issues
- Most of the province needs no reduction in leaching.
- Most areas that need reduction need a significant amount of reduction

Water Act Consultations
Siltation

• Impacts on fish and aquatic life
  o Difficulty finding prey food
  o Poor respiration
  o Poor reproduction
    • Opportunity
    • Success

• Monitoring efforts have not captured the full extent of the issue

• Current research by UPEI/ CRI to make recommendations for monitoring methods (expected early 2016)
  o Expected that continuous (automated) monitoring will be a cornerstone
Fish Kills

- 1962-2015 (documented)
- Pesticide cause
Surface Water Pesticides

- All 9 rivers had at least one detection
- Guidelines for 4 pesticides detected
- Without Guidelines:
  Metalaxyl, Clothianidin, Thiamethoxan, Chlorantranilprole, Hexazinone

Max Detections vs. Long Term Guidelines
(Canadian Water Quality Guidelines for the Protection of Aquatic Life)

- Atrazine
- Imidacloprid
- Linuron
- Metribuzin

Detected Value (max) vs. Guideline Value
Bacteria

- Impact is on the shellfishery
  - Contamination dictates where bivalve shellfish may be harvested.

- Sources
  - Some are natural
    - Birds
    - Seals
  - Mostly related to human activity
    - Livestock/manure
    - Urban run-off
    - Municipal wastewater effluent
Climate Change

- Global temperatures are rising

- Impacts
  - Rising sea levels
  - Less winter ice
  - Precipitation
    - Stronger events
    - Similar overall amounts but a bit more in the near future (bit less in long-term)
    - Less snow yet more precipitation in winter; less precipitation in summer

- Adaptation crucial but challenges of uncertainty in impacts

- Groundwater impacts are unclear
  - Changes in timing of recharge with less winter snow
  - Amount of recharge – overall change may be minimal?
  - Rising sea levels will have negligible impacts on sea water intrusion

- Surface water impacts
  - Baseflow timing change – spring freshet timing change
  - High storm run off events more frequent
Water Management Tools

- Watershed Management
- Water Conservation
- Water Supply Planning
- Water Security
- Economic Development Challenges
- Land Use Planning
- Regional Cumulative Effects
- Water Act Consultation