

Source Water Protection

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Water and First Nations



Why is source water so important to First Nations?

- Water is the most life sustaining gift on Mother Earth and is the interconnection among all living beings
- Water sustains us, flows between us, within us, and replenishes us

Water & First Nations

- Water comes in many forms and all are needed for the health of Mother Earth and for our health
- The sacred water element teaches us that we can have great strength to transform even the tallest mountain while being soft, pliable, and flexible

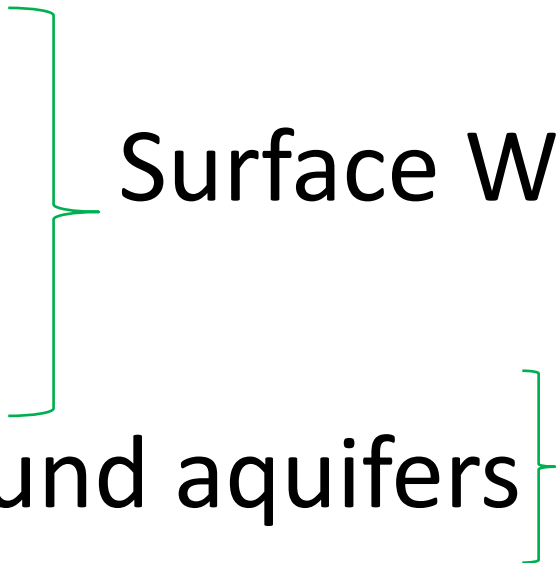
Water & First Nations

- Our traditional activities depend on water for:
 - Transportation
 - Drinking
 - Cleaning
 - Purification
- Water provides habitat for the plants and animals we gather as medicines and foods
- Our ability to access good water shapes these traditional activities and our relationships with our surroundings

Source Water

What is Source Water?

Source water is untreated water from:

- Streams
 - Rivers
 - Lakes
 - Underground aquifers
- Surface Water
- Groundwater
- 
- A diagram consisting of two green curly braces. The first brace groups the items 'Streams', 'Rivers', and 'Lakes' and points to the text 'Surface Water'. The second brace groups the item 'Underground aquifers' and points to the text 'Groundwater'.

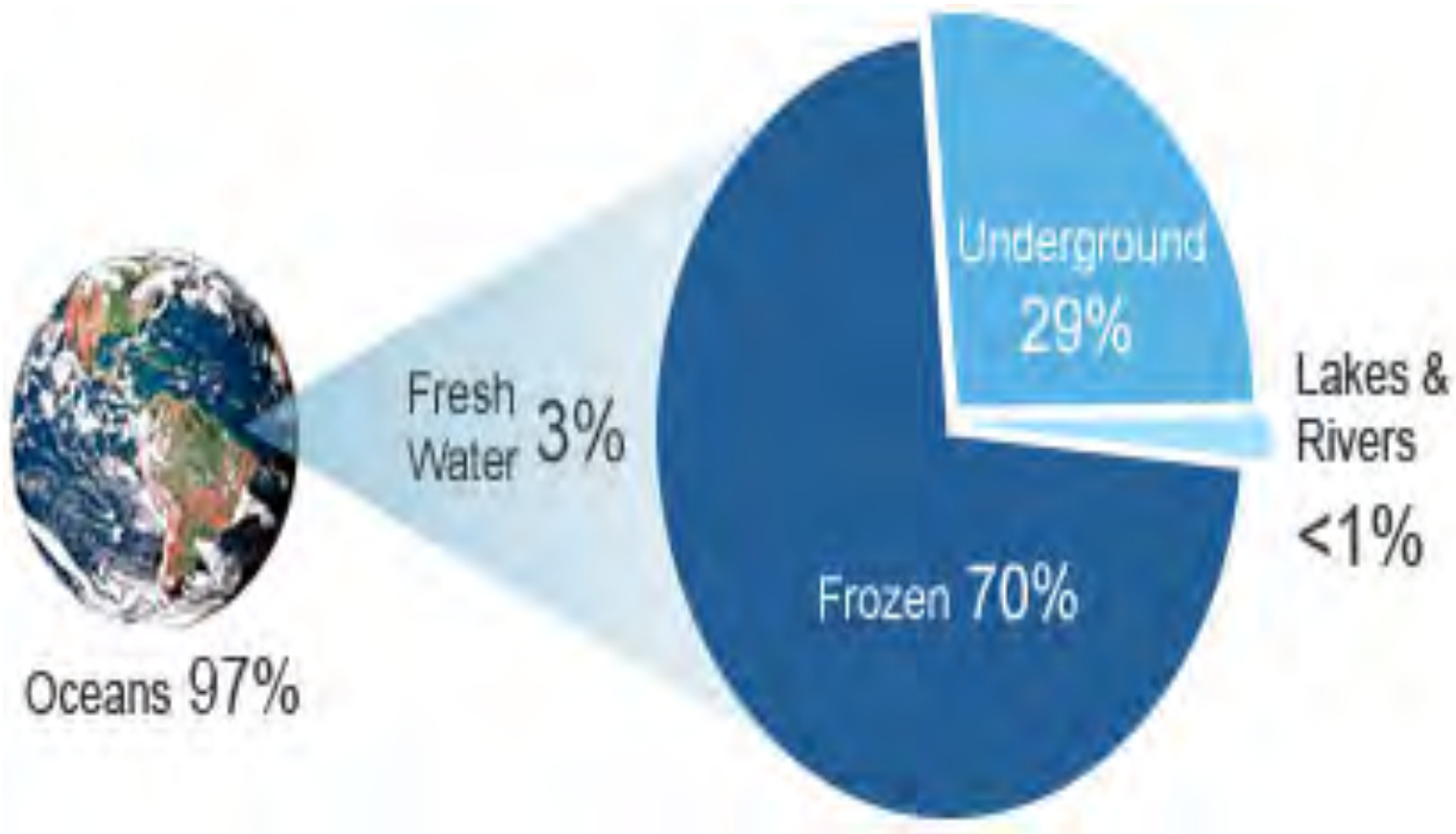
Surface Water

- Surface water is found above the Earth's surface.
- Surface water can be contaminated by:
 - rainwater runoff from:
 - Homes
 - Businesses
 - Roads and parking lots
 - Fertilizers & pesticides from lawns and gardens
 - Fluids leaking from automobiles

Surface Water

- Surface water can also be contaminated by:
 - Air pollution – smoke stacks, forest fires, pollen
 - Burning fossil fuels – emissions from vehicles, planes, ships, etc.
- Global warming
 - Warmer air temperatures increases the water temperature and result in death of aquatic animals and marine species which later results in water pollution.

Earth Water Budget

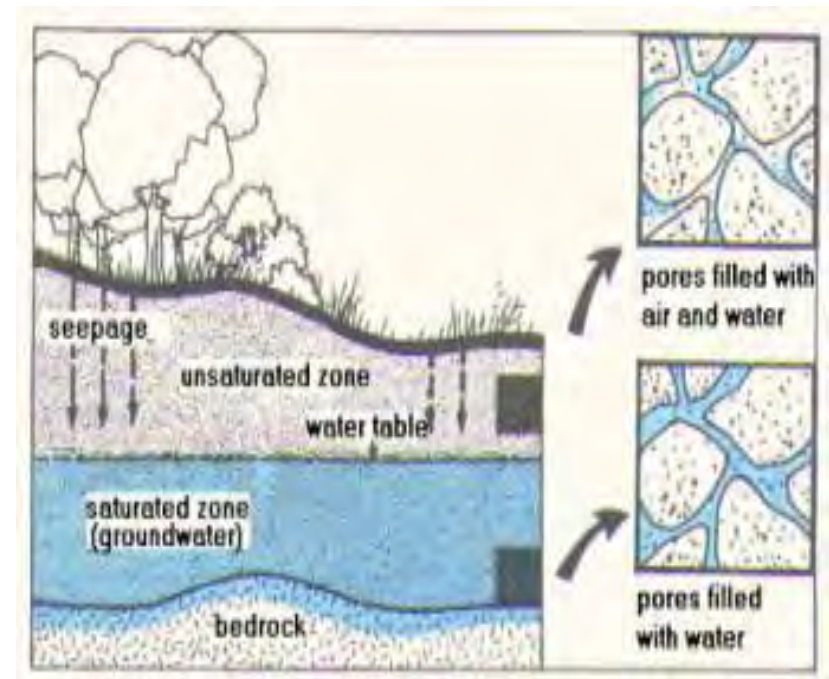


Groundwater

- Flow of groundwater through saturated rock is under the influence of a hydraulic gradient (flow movement from higher to lower pressure)
- Water is stored and moves below ground in saturated rock units called aquifers
- A typical groundwater system consists of
 - Rainfall recharge percolating into the land surface where it reaches the water table and flows through rock or sediment units toward natural discharge points
- The residence time for groundwater can be as short as days and weeks to centuries and millennia

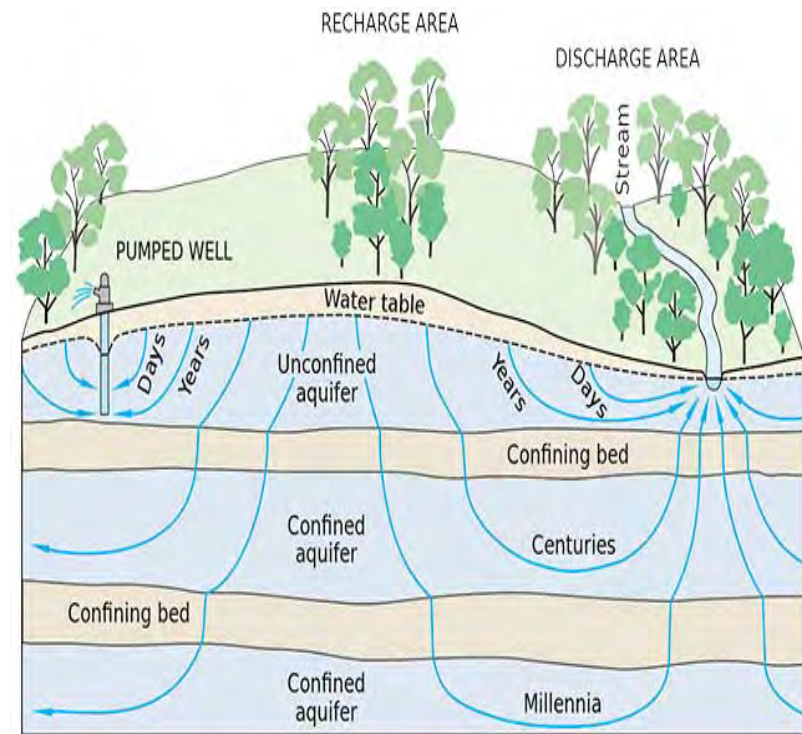
Subsurface Water

- Unsaturated zone
 - Soil pores contain both water and air
- Saturated zone
 - Pore spaces of soil or rock filled only with water – groundwater
- Water table
 - Designation between both zones
 - Fluctuates with precipitation inputs and discharge outputs



Aquifers

- A geological formation that contains sufficient saturated and permeable material to yield significant quantities of water
 - Unconsolidated sands and gravels
 - Sedimentary strata (sandstone, limestone, etc.)
 - Fractured igneous and metamorphic rock units
- Two main functions
 - Storage of water – function of porosity
 - Conduit of water – function of the size or thickness of the aquifer and the permeability of the aquifer material



Key Hydraulic Properties

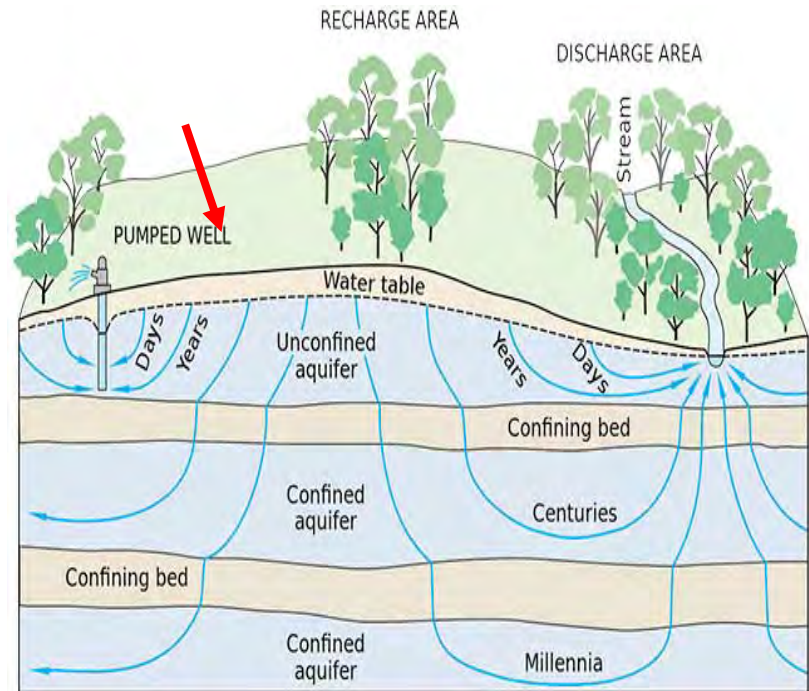
- Porosity (%)
 - The ratio of the volume of void spaces in a rock or sediment relative to the total volume of the rock or sediment
- Permeability or hydraulic conductivity (length/time)
 - The capacity or of a porous rock or sediment to transmit a fluid through pore openings
 - Takes into account how connected pore spaces are
 - Finer the grain size of the material, the lower the hydraulic conductivity
 - Clay (low)
 - Gravel (high)

Confining Layers

- A geological unit that has little to no permeability and is located stratigraphically adjacent to one or more aquifers
- They form the upper and lower boundaries of aquifers and are responsible for water storage
- Aquafuge
 - Composed of impermeable material that does not contain or transmit water (igneous rock unit)
- Aquaclude/Aquatard
 - A low-permeability unit composed of materials that are often saturated yet cannot transmit water efficiently (clay unit)

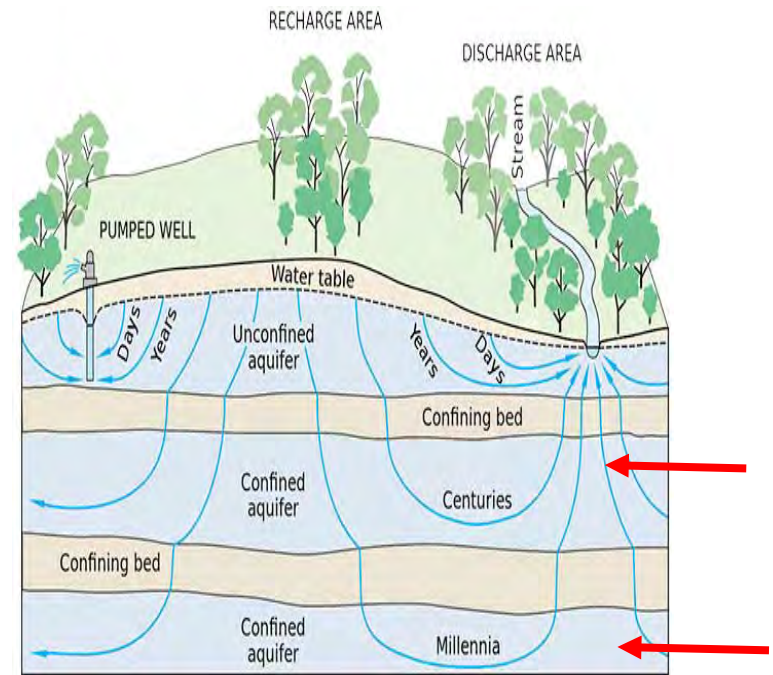
Unconfined Aquifers

- Found close to the land surface with a lower confining layer
- Water table is free to rise and fall
- Recharge from
 - Surface by downward seepage from the unsaturated zone
 - Upward seepage from underlying rock units (aquatard)
- Short residence time of days to years



Confined Aquifers

- Bound by impermeable rock units or confining layers
- Often under significant pressure from overlying rock units
- Recharge from
 - Area where aquifer crops out into the unsaturated zone
 - Slow downward leakage through a confining layer
- Longer residence time of centuries to millennia



Watersheds



What is a Watershed?

- A watershed is an area of land where surface water from rain and melting snow or ice converges or drains to a single point at a lower elevation, usually the exit of a basin
- A watershed is separated from neighbouring watersheds by higher elevation points on the landscape.

Watersheds

- An effective way to manage water resources is to take into account the whole watershed
- Influences on water quality upstream can influence the quality of water in all areas downstream within a watershed
- To understand water quality issues
 - Important to test soil and water upstream
 - Help to identify source areas of pollution

Delineating a Watershed

- Why delineate a watershed?
 - This will give you an idea of what water flows into a specific site.
 - These bodies of water (and soil) can be tested so you know what is entering your system.
 - It can narrow down an issue
- Can be performed by
 - Hand: using a topographic map
 - GIS software
 - Online: using programs and tools provided by the MNR

MNR's Ontario Flow Assessment Tool

- www.ontario.ca/page/watershed-flow-assessment-tool

The screenshot displays the Ontario Flow Assessment Tool interface. At the top, the Ontario Ministry of Natural Resources and Forestry logo is visible, along with the text "Ontario Flow Assessment Tools III" and "Powered by Land Information Ontario". A language selector for "Français" is in the top right. Below the header is a navigation bar with tabs: "Navigation" (highlighted), "Map Layers", "OFAT III", "Find Information", and "Markup and Printing". The main interface includes a search bar, a "Bookmarks" section with "Add", "Remove Bookmark", and "Go To" buttons, and a "Map Navigation" section with buttons for "In", "Out", "Pan", "Initial", "Previous", "Next", and "Help". The central map area shows a topographic map of a region in Ontario, with a red-shaded watershed area. Labels on the map include "THUNDER", "GRAVEL RIVER", "KAMA CLIFFS", "Verd Island", and "Pays Plat". A scale bar indicates 20 km and 10 miles. Coordinates 49.193482, -87.599268 are shown at the bottom left of the map. On the left side, a "Create Watershed" panel is open, showing a form with "Name: Watershed 2", "Coordinate System: UTM", and "Pour point coordinates: Lat/Long". It also has a "Create from Map Point" button and a table with "Watershed 1" listed. At the bottom of the page, there are links for "ACCESSIBILITY", "PRIVACY", "IMPORTANT NOTICES", and "FEEDBACK", along with copyright information: "© QUEEN'S PRINTER FOR ONTARIO, 2013" and "IMAGERY COPYRIGHT NOTICES".

Source Water Protection

Source Water Protection

- After the Walkerton tragedy in 2000, source water protection quickly became a household topic.
- After the Walkerton inquest, the Safe Drinking Water Act 2002 was implemented.
- This started the process of ensuring and regulating safe drinking water for everybody

What is source water protection?

- It is the protection of water resources such as lakes, rivers and groundwater from contamination or overuse.
- Water is critical to all aspects of our lives. Protecting water sources is important because it ensures there is enough safe water for all of our uses - now and in the future.

Source water protection also:

- Safeguards human health
- Keeps water treatment costs to a minimum
- Protects our way of life – spawning grounds, fishing, hunting etc.

SWP & First Nations

- ***From the Toronto Star, June 1, 2016***
- Many First Nations still suffer from the lack of safe drinking water.
- Currently, Grassy Narrows First Nation is probably one of the most notable situations
 - Mercury has contaminated the Wabigoon River and surrounding lakes
 - This occurred from the 1960' to early1970's from a pulp and paper mill

- Scientists have found dangerously high concentrations of mercury in area lakes more than 50 years after initial contamination
- One meal of walleye from nearby Clay Lake, a traditional fishing area, contains up to 150 times the amount of mercury deemed safe by the U.S. Environmental Protection Agency

- Many other remote reserves lack safe drinking water due to other situations:
 - Failing/outdated infrastructure
 - Lack of funding
 - Access to water resources
 - Shortage of trained personnel

- According the Ontario Field Naturalists Club (ofnc.ca) 2016:
- More than 80 First Nations communities in Canada are currently under “boil water advisories” and 21 communities are deemed to be at high-risk for contamination

Source Water

Threats

Threats

- Abuse of water resources – lack of conservation
- Natural
 - Erosion
 - Bedrock type
 - Sediment/soil present
 - Vegetation loss
 - Snow/rainwater runoff

Shoreline Erosion



Riprap to prevent erosion



Storm water Runoff



Threats

- Anthropogenic (Human caused)
 - Construction/mining – freshly exposed rock and soil make contact with flowing water
 - Industrial waste discharges and spills
 - Petroleum leaks/spills from trucks, tankers, pipelines and storage tanks
 - Agriculture – fertilizers, herbicides and pesticides

Threats

- Urban storm water runoff (contacts spilled fuel, feces, dissolved metals)
- Malfunctioning on site sewage systems
- Wastewater treatment facility issues
- Improperly constructed/used landfill sites

Pipeline Breach



Effluent from pulp & paper mills



Well 5 - Walkerton

WELL 5 MEMORIAL

This plaque marks the location of Walkerton's former Well 5 which supplied a portion of the town's drinking water from 1978 into the spring of 2000. In mid May of the year of 2000, extremely heavy rains washed a toxic blend of biological pathogens through the soils and into the vulnerable shaft of Well 5 and ultimately into Walkerton's Municipal drinking water system. The resulting contamination of the town's drinking water system lead to the deaths of seven people and caused thousands of others to fall ill. It is hoped that all those who visit this location will reflect upon the multiple causes of this tragedy and will be filled with a renewed reverence for the comprehensive stewardship of the waters that sustain us all.

MUNICIPALITY



OF BROCKTON

Point Source vs. Non Point Source

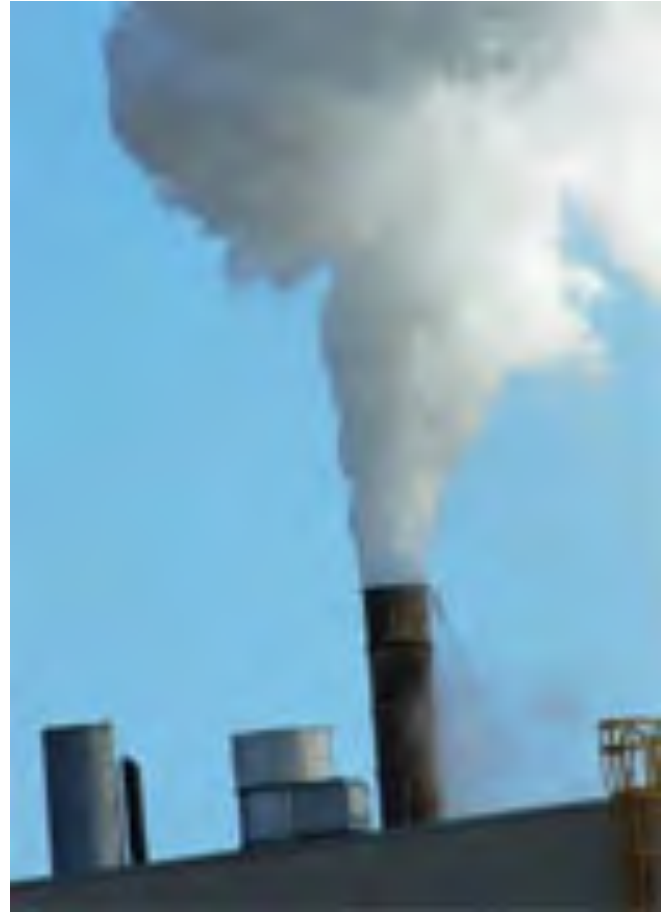
Point Source

- Identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack

Point Source



Industrial effluent



Fallout from atmospheric pollution

Non Point Source

- When pollution comes from a source that can't be tied to a specific location
- This kind of pollution occurs when
 - leaking septic tanks or storm water runoff that has picked up things like sediment, fertilizer, pet waste, or oil drain into streams and rivers that empty into our source water

Non-Point Source



Salts from road maintenance



Faulty septic system

Contaminants

- Environmental protection
 - Important to understand the processes that transport pollutants or change the nature of pollutants
 - The effectiveness of these processes depend on properties of the pollutant and its water and soil environment
- Contaminants in the environment driven to change by
 - Physical forces
 - Biological activity



Fates of contaminants

- Numerous fates of contaminants in the water and soil environments
 - Remain unchanged
 - Movement and transport
 - Within or into other phases
 - Transformations
 - Biodegradation
 - Bioaccumulation
- Water is a conveyor of contaminants
- Soils can act as an
 - Obstacle to contaminant movement
 - Sorbtion to solid soil particles
 - Mean of contaminant transport
 - Wind and water flow of sediments

NAPL - Nonaqueous Phase Liquids

- Common threat to surface and groundwater contamination
- Oil, gasoline and other petroleum products
- Act as a long-term source of groundwater contamination
- Higher toxicity
 - Small amounts have the potential to contaminate very large volumes of soil and groundwater
- Remediation techniques
 - Physical removal of contaminated soil
 - Bioremediation
 - Excessive pumping of contaminated water



Video of groundwater flow model

Remediation

How do we fix it???

Remediations

- Educate – proper use and maintenance of on-site sewage systems and landfill site use
 - Have information pamphlets for homeowners
- Erosion prevention techniques
 - Riprap or gabions along river banks
 - planting dogwoods, willows or other types of vegetation with good root systems
 - Control/divert stormwater runoff
- Create a source water protection plan

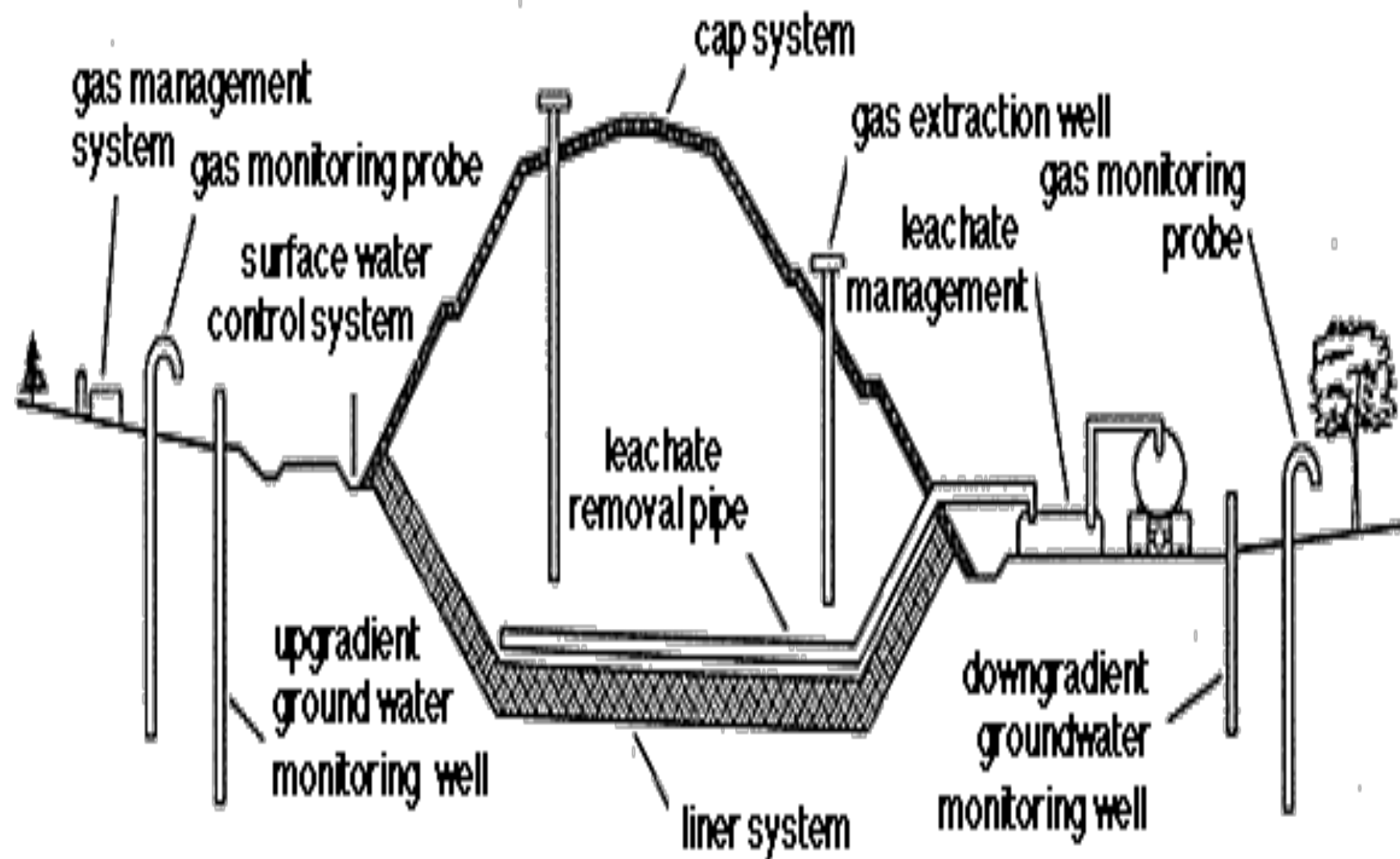
Remediations

- Continuous monitoring and conservation of water resources
- Potential hazard identification & removal
 - Old storage tanks
 - Update aging infrastructure
- Brownfield
 - Land once previously used for industry but now being cleaned up to host a new business development
 - Hydrocarbon spills, pesticides, solvents, lead

Landfill sites

- **Proper use of landfill sites**
 - Segregate refuse types:
 - Paints
 - Electronics
 - Batteries
 - Household cleaners
 - Line cells with rubber membrane to prevent leachate from entering groundwater
 - Create wetlands to improve run off before it enters source water
 - Install groundwater monitoring wells if possible

Typical schematic of a state-of-the-art landfill



On-site sewage systems

What should not go down your drain:

- Pesticides
 - Paints & Paint thinners
 - Solvents
 - Disinfectants
 - Poisons
 - Household chemicals
 - Pharmaceuticals
-
- These will cause important soil microorganisms that treat the wastewater to die.
 - Organic chemicals can flow untreated through the soil, thus contaminating the underlying groundwater.

On-Site Sewage Systems

Other Tips To Maintain A Healthy Septic System

- Do not put too much water into the septic system; typical water use is about 50 gallons per day for each person in the family
- Do not add materials (chemicals, sanitary napkins, applicators, and so on) other than domestic wastewater
- Do not pour grease or cooking oils down the sink drain
- Be aware of the location of your tank and drainfield

On-Site Sewage Systems

- Periodically have the solids pumped out of the septic tank.
- Maintain adequate vegetative cover over the drainfield (black soil & sod)
- Keep automobiles and heavy equipment off the system – prevents compaction & potential damage
- Do not plan any building additions, pools, driveways, or other construction work near the septic system.

Waste Water Servicing on First Nations Communities

- INAC (2011) findings
- System types
 - 48% facultative lagoon
 - 35% mechanical treatment
 - 5% communal septic system
- 26% of these facilities are at capacity or over capacity
- 28 of 77 are high risk
- 38 of 77 are moderate risk



Waste Water Service Deficiencies

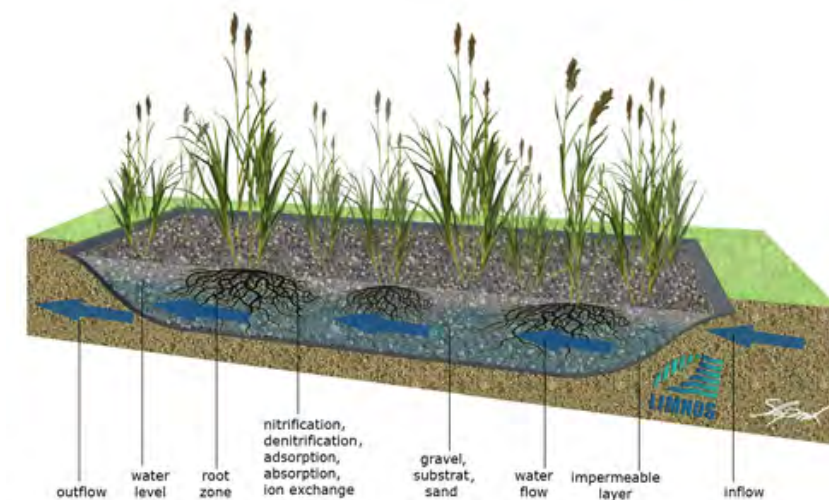
- According to the INAC (2011) :
 - 82% of wastewater systems have poor system reliability
 - 55% of the wastewater systems exceed 75% capacity
 - 23% of the wastewater systems have failed to meet effluent quality guidelines
 - Maintenance is not adequately performed for 49% of the wastewater systems
 - 38% of the wastewater systems have no access to a fully trained operator.
- Potential issues in source water protection

Constructed wetlands



What are they?

- Artificial wastewater treatment systems
- Components
 - Sequence of shallow ponds or channels
 - Impervious liners
 - Aquatic plants
 - Water level and flow direction structures



Why should certain communities use constructed wetlands?

- Viable alternative to treat wastewater
- Lower initial investment requirements than other waste treatment systems
- Low maintenance and personnel requirements
- Effective at treating waste water from smaller populations
- Natural Appearance



Cobalt, ON
constructed wetland

Constructed Wetland Operation

Cobalt, ON

- Town of 1200 residents located in NE Ontario
- First year-round constructed wetland facility to treat raw municipal sewage in Canada
- Cost - \$3.9 million



Basic Components

- Three basic components
 - Grit channel/grinder
 - First stage of treatment
 - Maintenance forebay
 - Sedimentation
 - Annual maintenance
 - Three wetland cells
- 900 m³/day sewage treatment
- 630 m³/day effluent discharge
- BOD₅ and TSS water quality analysis were less than provincial objective targets



Environmental Features of Cobalt Constructed Wetland

- Provides nesting and breeding grounds for many bird species
- Provides habitat and food for many other species of insects, turtles, etc.
- High primary productivity
- Promotes species diversity
 - Colonization of
 - 71 plant species
 - 41 bird species
 - Mammals
- Functions as a carbon sink



What you can do to protect source water

- plant grass, trees, and shrubs in bare areas to reduce and absorb runoff, reduce erosion, and improve habitat.
- Properly dispose of hazardous materials
- Use fertilizers and pesticides sparingly on lawns and gardens.
- Keep trash out of storm drains, where it will clog up the drain or end up in the nearest stream or lake.
- Organize community cleanups.
- Consider using less-toxic household chemicals & more eco friendly biodegradable products.

Source Water Protection Plans

Multi-Barrier Approach

- The key to ensuring clean, safe and reliable drinking water is to understand the drinking water supply from the source all the way to the consumer's tap.
- This knowledge includes understanding the general characteristics of the water and the land surrounding the water source, as well as mapping all the real and potential threats to the water quality.

What is the multi-barrier approach?

- The multi-barrier approach takes all of these threats into account and makes sure there are "barriers" in place to either eliminate them or minimize their impact.
- It includes selecting the best available source (e.g., lake, river, aquifer) and protecting it from contamination, using effective water treatment, and preventing water quality deterioration in the distribution system.

First Step of the Approach

- **Protecting Source Water**
 - Identify source water issues
 - Create committee
 - Create source water protection plan

Second Step

Treatment/Distribution

- **Treatment:**
 - Treatment plants should be designed and constructed based on the results of source water assessments.
 - Upgrades should be performed as necessary.
 - Consider: process required, chemicals used, treatment efficiency, monitoring procedures

Step Two (con't)

- **Distribution**

- After the treated water leaves the plant, the quality must be maintained
- The system operator must ensure sufficient disinfection is present at all points throughout the distribution system
 - Dead ends
 - Flushing lines

Step Two (con't)

- It has been shown that a significant number of outbreaks are caused by breakdowns in the distribution system
- Treated water reservoirs and distribution systems should be designed, constructed, reviewed and upgraded as necessary

Step Three

- **Monitoring**

- Ensure equipment is fitted with warning or automatic control devices (detects contaminants that exist in concentrations above acceptable limits and returns systems to normal operation)
- Allows the treatment process to be adjusted to deal with fluctuations in water quality and ensures that the drinking water is safe at the point of human consumption.
- Use of accredited laboratories ensures sampling test results are accurate.

Step Four

- **Management**

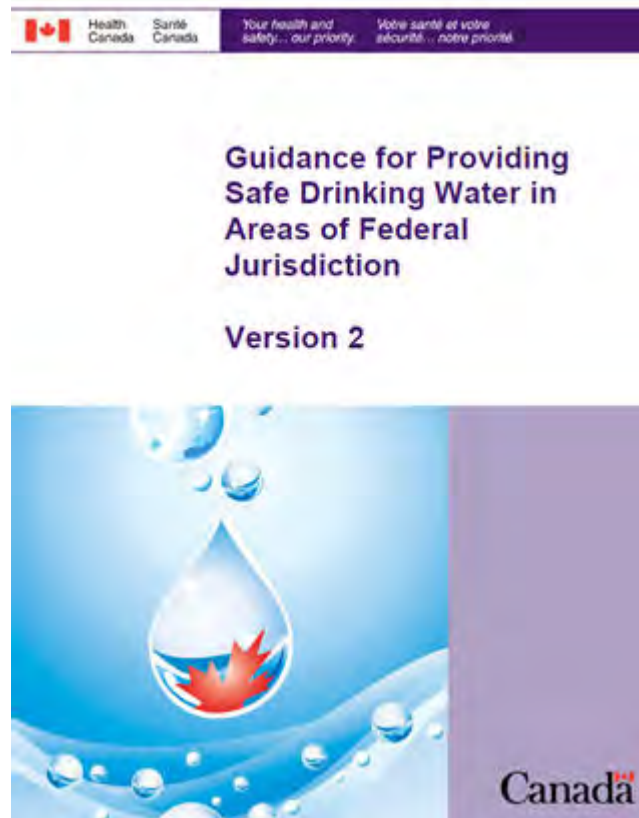
- Having a response plan in place
 - Notify the EHO, Spills action center & Band Council
 - Issuing a boil water advisory, water avoidance, etc.
- This provides a final barrier to protect the public if harmful contaminants should make it through the other barriers

Multi-Barrier Approach

- Individually, the barriers may be inadequate in removing or preventing contamination of drinking water, but together they offer greater assurance that the water will be fit to drink.
- This approach also helps ensure the long-term sustainability of water supply systems

More Information

- <http://healthycanadians.gc.ca/publications/healthy-living-vie-saine/water-federal-eau/index-eng.php>



Creating a Source Water Protection Plan

Pays Plat First Nation's Process

How to create a SWPP

- Here is what Pays Plat did:
- Through funding from the Canadian Environmental Law Association (CELA)
- PPFN hired me to identify SW issues and create a swpp
- First step involved performing community interviews to identify issues regarding the waters surrounding us and any changes noticed over the years
- Created a database with this info. In some cases, I did further interviews with people who had specific information

Pays Plat SWPP (con't)

- Next, I delineated our watershed to identify what lakes/rivers affect us most
- Began walking the land – identifying erosion issues, urban runoff, old underground storage tanks, etc.
- Started performing water and soil sampling and sending samples into an accredited lab for analysis

Pays Plat SWPP (con't)

- Entered this data into a database – this way I can detect any changes in the future
- At this point, I asked for volunteers from the community to sit on an advisory board
- This board identified all the threats to our sw, and placed them in order of severity.

Pays Plat SWPP (con't)

- Next, we did research on how to remediate these threats and the cost associated with that
- We are at the point now where we are trying to secure funding to begin the remediation process

What we discovered

- As our community is located right on highway 17 with 2 bridges going over our main source water - our main concern was highway accidents, especially from transport trucks carrying chemicals
- As well, the Canadian Pacific Railway runs through our community, and the chance for a rail disaster is present.

- Some minor erosion issues along the Pays Plat River
- Highway snow plow turn around trash
 - Dirty diapers
 - Feces
 - Antifreeze, oil, gas containers
- Possible malfunctioning on-site sewage systems

- At this point, we have an emergency response plan in place if an accident occurs on the highway bridge
 - Turn of the low lift pumps at the water treatment plan right away
 - We have a small spills kit as well as the 50 gallon one to help prevent the spread of fuel oil or other type of spill

Websites to access FN SWPP

- More info at:
- <http://www.cela.ca/sites/cela.ca/files/FNSP-Toolkit.pdf>
- [http://www.cela.ca/sites/cela.ca/files/First N
ation SWP Legal Toolkit.pdf](http://www.cela.ca/sites/cela.ca/files/First_Nation_SWP_Legal_Toolkit.pdf)

Sampling Equipment

Some Hands on



Soil Auger



Kemmerer Sampler



Secchi Disk

Citations

- Weiner, Eugene
- Toronto Sun
- Health Canada
- CELA
- Ontario Field Naturalists Club