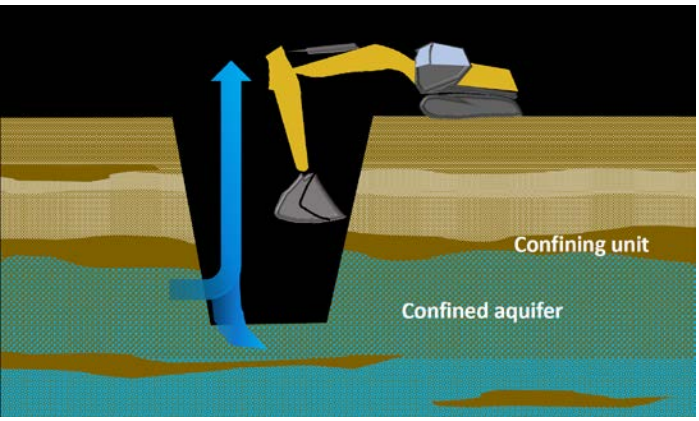
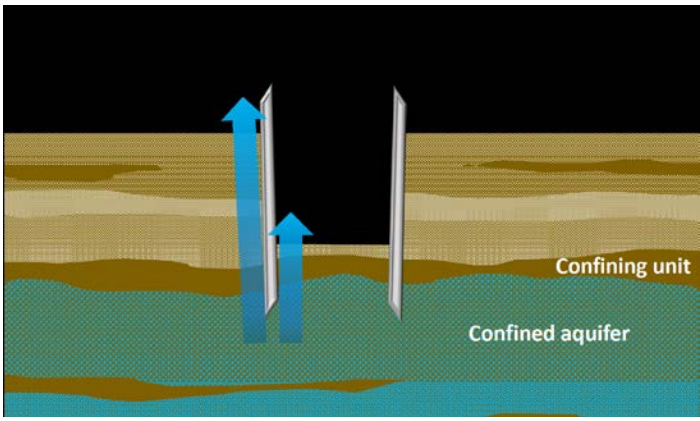
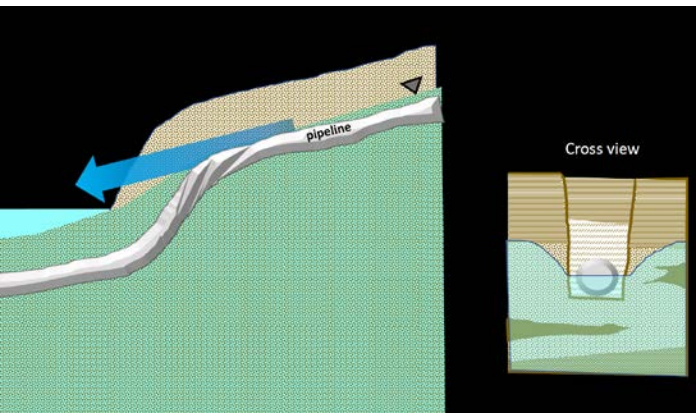
This fact sheet describes 10 ways that oil pipeline construction can change water flow in geologic settings like northern Minnesota. *This landscape is a relatively flat continental interior, where bedrock is covered by heterogenous packages of sediments like clay-rich glacial till, sandy outwash and glaciolacustrine clays. Many kettle lakes, streams and wetlands now cover the landscape. Each of the 10 hydrologic impacts described here are either documented or suspected along the Enbridge Line 3/93 corridor.* ***Importantly, due diligence could have identified all of these risks before construction.*** *For each water or wetland crossing, Enbridge should have determined (or been compelled to determine) aquifer characteristics and pressures, the depth and thickness of confining units, the moisture content of peat, the depth of contact between peat and mineral soil, and natural seasonal fluctuations in the water table over one full hydrologic year.*



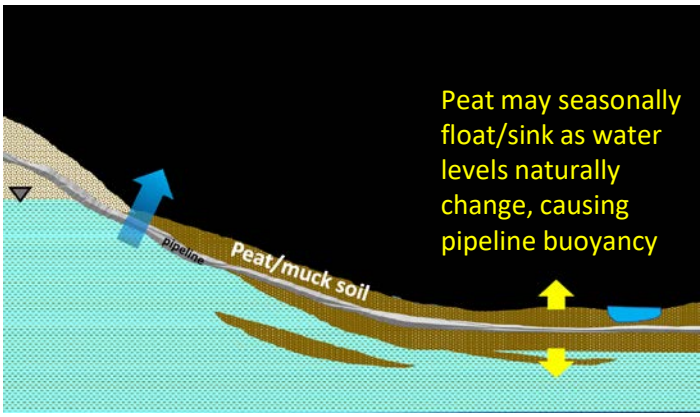
<u>#1 Deep Excavation (e.g. Clearbrook aquifer breach)</u> Builders excavate through confining unit, causing confined aquifer water to flow upward. Different temperature and chemistry can disrupt wetlands and surface water bodies. Depressurization of confined aquifer can dry up nearby springs and wetlands.



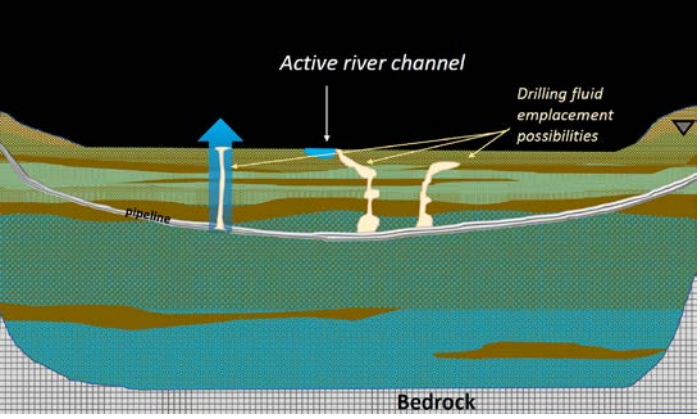
<u>#2 Sheet Piling (e.g. Fond du Lac and La Salle valley aquifer breaches)</u> Builders install sheet piling through confining unit, causing confined aquifer water to flow upward. Different temperature and chemistry can disrupt wetlands and surface water bodies. Depressurization of confined aquifer can dry up nearby springs and wetlands.



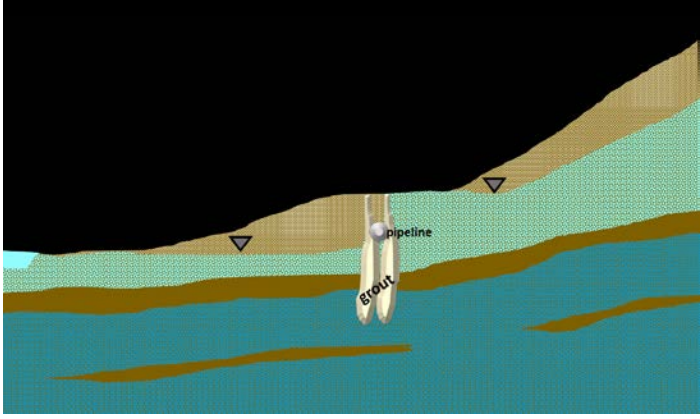
<u>#3 'French drain' effect (e.g. Walker Brook, suspected at Moose Lake)</u> Groundwater flows into trench and preferentially flows parallel to pipeline, despite preventative construction methods. Different temperature and water inflow can disrupt wetlands and surface water bodies. Excessive flow may pose risk to pipeline integrity.



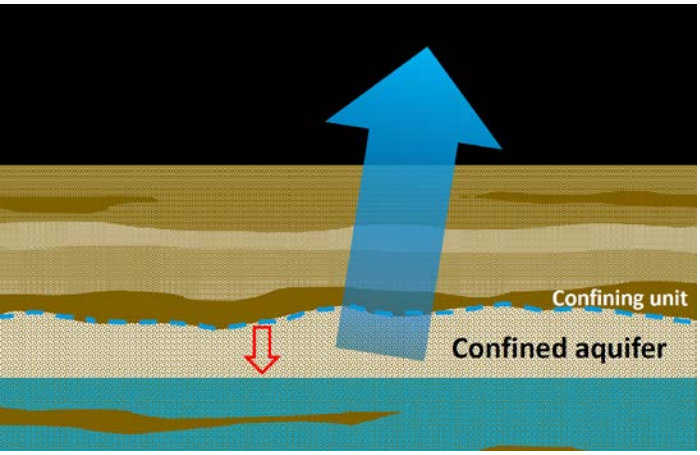
<u>#4 Peat disturbance/destruction (e.g. Walker Brook)</u> Disturbance or destruction of peat layer causes 'piping effect' as water table aquifer or confined aquifer preferentially flows upward through punctures. Also, in some geologic settings pipeline will be buoyant with peat, posing risk to pipeline integrity.



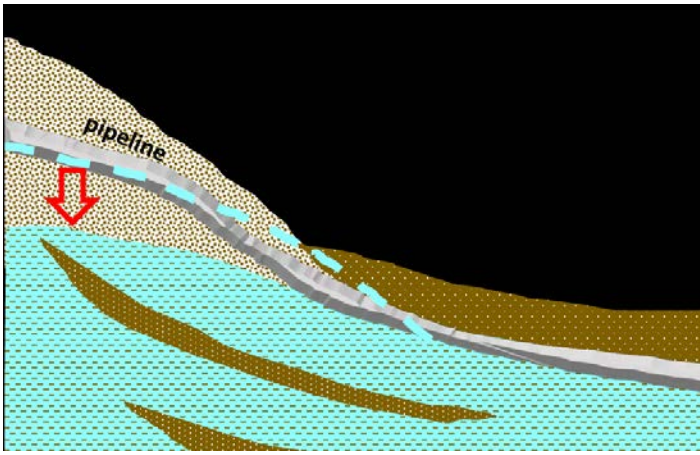
#5 Channelized upwelling at "frac-outs" (e.g. Mississippi River crossing) Majority of horizontal directional drilling (HDD) sites have drilling fluid eruptions/spills, aka "frac-outs" – large volumes of drilling fluid permanently emplaced in floodplain. Dissolved constituents leach into groundwater, and eventually mass will be mobilized into meandering river. "Frac-outs" may breach confining units, causing groundwater upwelling.



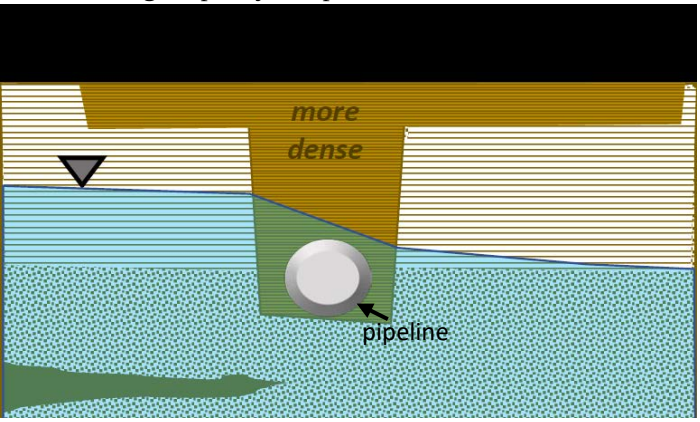
#6 Subsurface hydraulic barrier (e.g. La Salle grout wall and suspected Shell River pipe/trench) In La Salle valley, Enbridge's response to aquifer breach was to inject many tens of thousands of gallons of concrete grout into ground using >150 30-foot long steel pipes. Grout seeped to surface, encasing pipes and creating a permanent 30'-high underground concrete wall ~3000-feet long. Elsewhere, pipeline + trench compaction create hydraulic barrier.



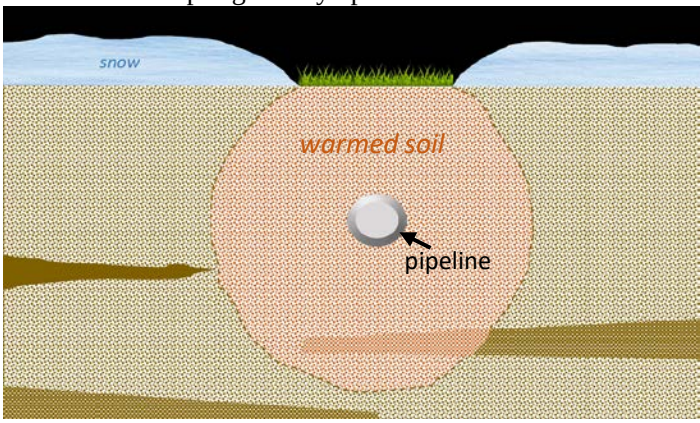
#7 Aquifer compaction after aggressive dewatering Enbridge conducted aggressive dewatering in many places for a variety of reasons, e.g. aquifer breach responses, hillside destabilization response (Walker Brook), trench dewatering during construction, etc. Compaction of un-consolidated aquifers is likely, leading to permanent loss of water storage capacity and possible land subsidence.



#8 Permanent water table drawdown due to draintile/drainage
At several sites, pipeline construction caused groundwater 'piping' and upwelling leading to hillslope destabilization. Enbridge's solution was to install draintile, which will permanently lower the water table and could cause nearby wetlands and springs to dry up.



#9 Soil compaction in trench+work zone Inevitable soil compaction changes water flow, infiltration capacity, vegetation communities, and possibly aquifer recharge.



#10 Year-round heating of soil Pipeline's heat signature is visible in streams, wetlands and uplands; especially severe at corners. Disrupts life cycles of plants, animals.