



ST. MARY'S

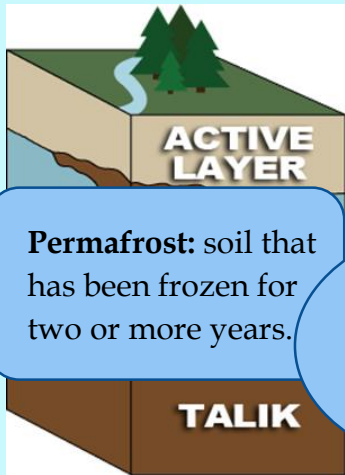
THE ACTIVE LAYER NETWORK

A collaborative project between the US Geological Survey, Yukon River Inter-Tribal Watershed Council, and Yukon River Communities. A five year summary report for St. Mary's.



Introduction

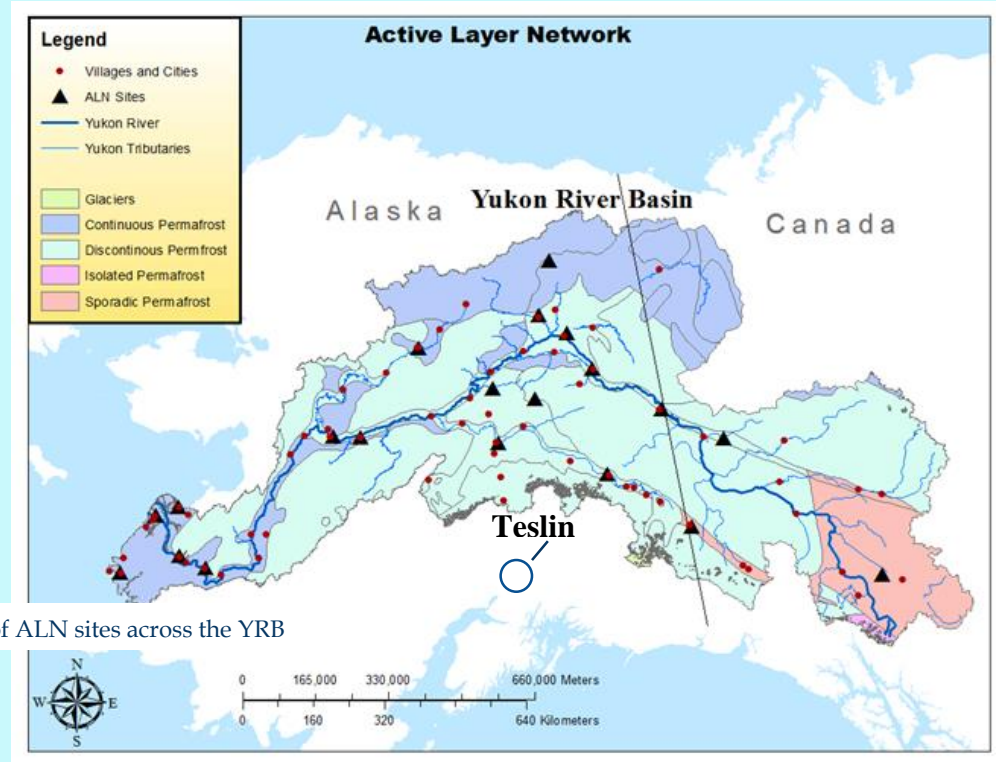
The Active Layer Network (ALN) was launched in 2009 as a cooperative project between the United States Geological Survey (USGS), the Yukon River Inter-Tribal Watershed Council (YRITWC), and Yukon River Basin (YRB) communities. The active layer is the soil above the permanently frozen ground that thaws during the summer months and freezes again in the autumn. By measuring the depth of the active layer in late summer, at the time of maximum thaw over several years, we are able to better understand the effects of a warming climate on permafrost. Over the 2009 and 2010 field seasons twenty ALN sites were installed across the YRB.



Active Layer: layer of soil above the permafrost that freezes and thaws with the seasons.

Permafrost: soil that has been frozen for two or more years.

Talik: year round unfrozen ground in permafrost areas.



Problem and Need

Numerous studies indicate that permafrost is thawing and the active layer is deepening. Permafrost thaw will likely lead to changes in groundwater flows and the quantity and quality of the rivers, streams, and lakes in the YRB. Additionally, changes in the thickness of the active layer may have profound effects on human infrastructure such as houses, sewage lagoons, and water systems.



"Drunken Houses" that are falling over due to permafrost thaw

Previous Work

Faculty at the University of Alaska – Fairbanks (UAF) pioneered permafrost and active layer network studies in Alaska through the development of the global Circumpolar Active Layer Monitoring Program (CALM). The primary goal of CALM is to observe the response of the active layer and near surface permafrost to climate change over long (multi-decadal) time scales. The data collected as part of the ALN is submitted to the CALM program and available online at <http://www.gwu.edu/~calm/>.

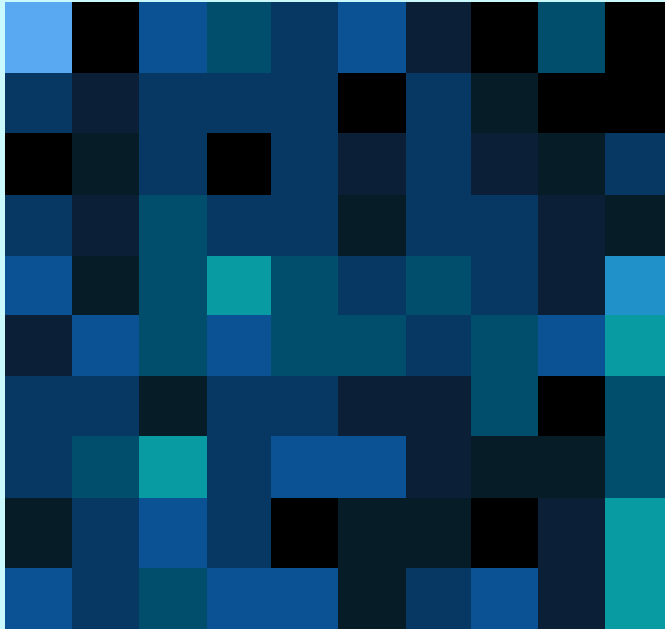
Results from manual measurements. The colors in each square represent how far from the surface the permafrost is, which is also the depth of the active layer. The darker the color the deeper the active layer.

2009

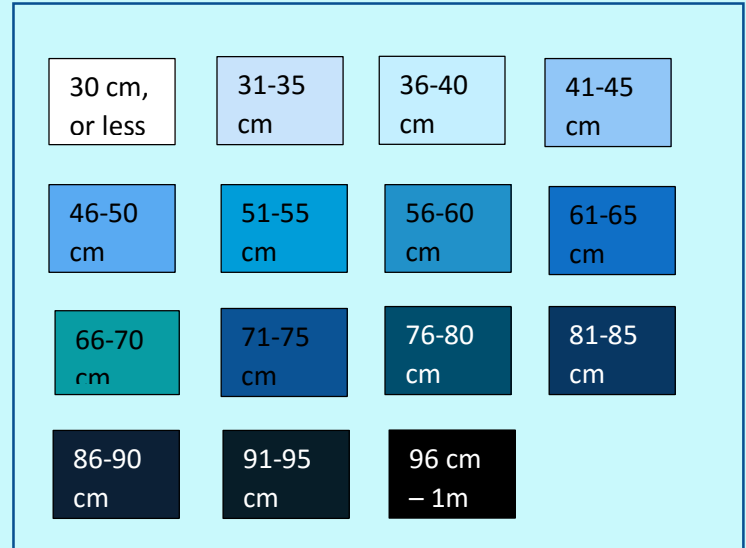
Average depth = 83.3 cm

Minimum depth = 56 cm

Maximum depth = 1 meter



Key

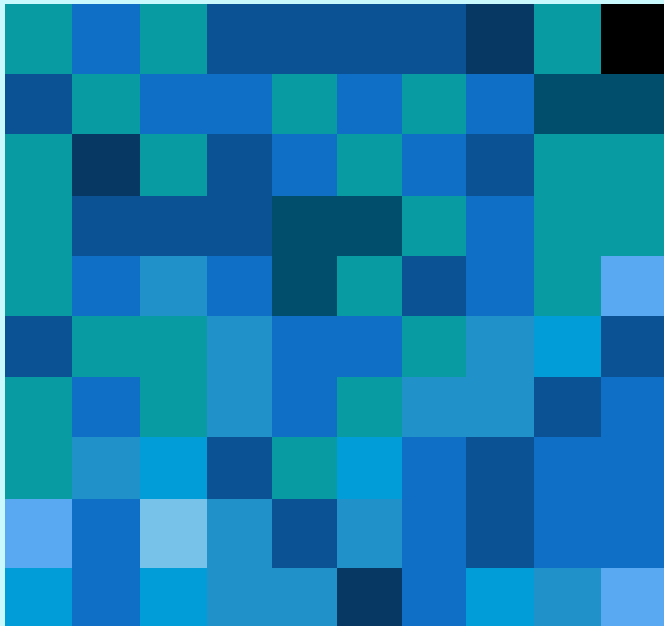


2010

Average depth = 66.3 cm

Minimum depth = 45 cm

Maximum depth = 1 meter

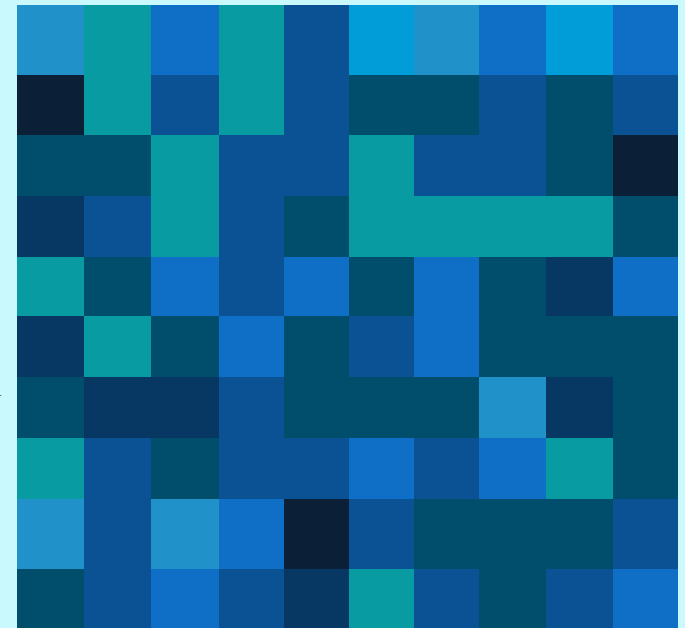


2011

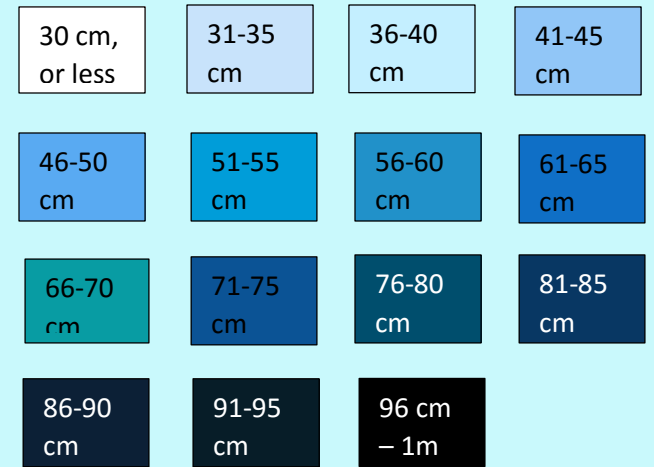
Average depth = 71.9 cm

Minimum depth = 54 cm

Maximum depth = 86 cm



Key

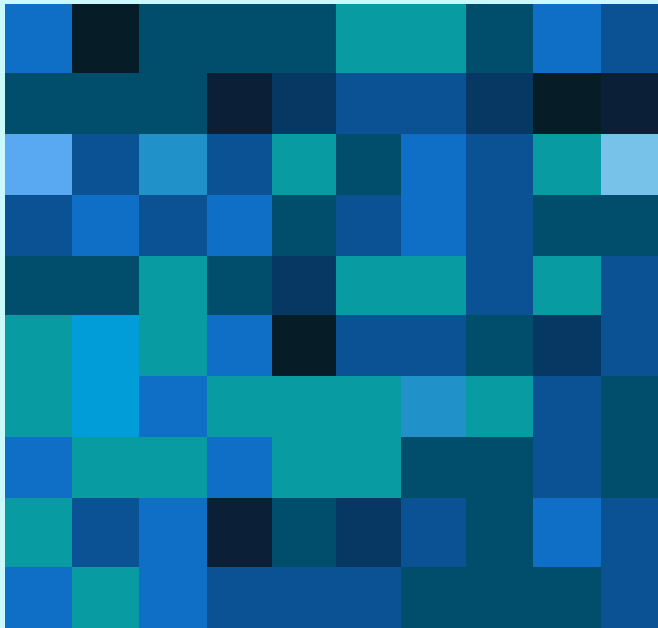


2012

Average
depth =
72 cm

Minimum
depth =
47 cm

Maximum
depth =
93 cm



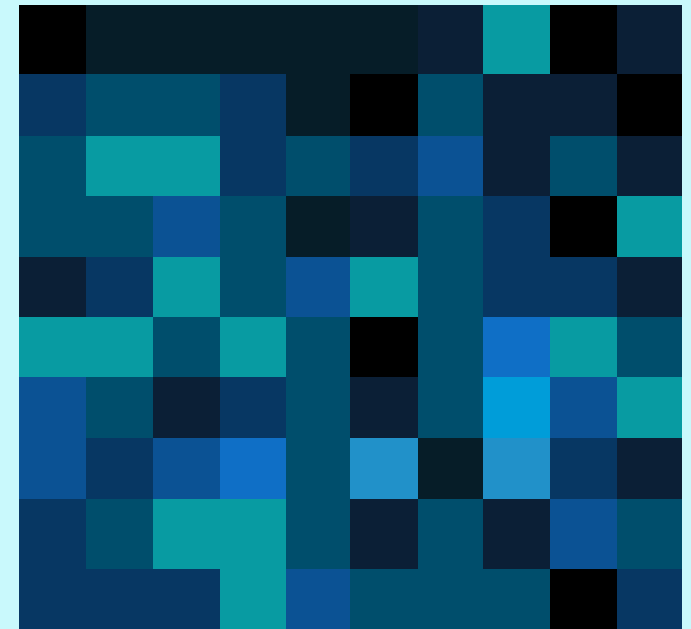
2013 There is no data available for this year.

2014

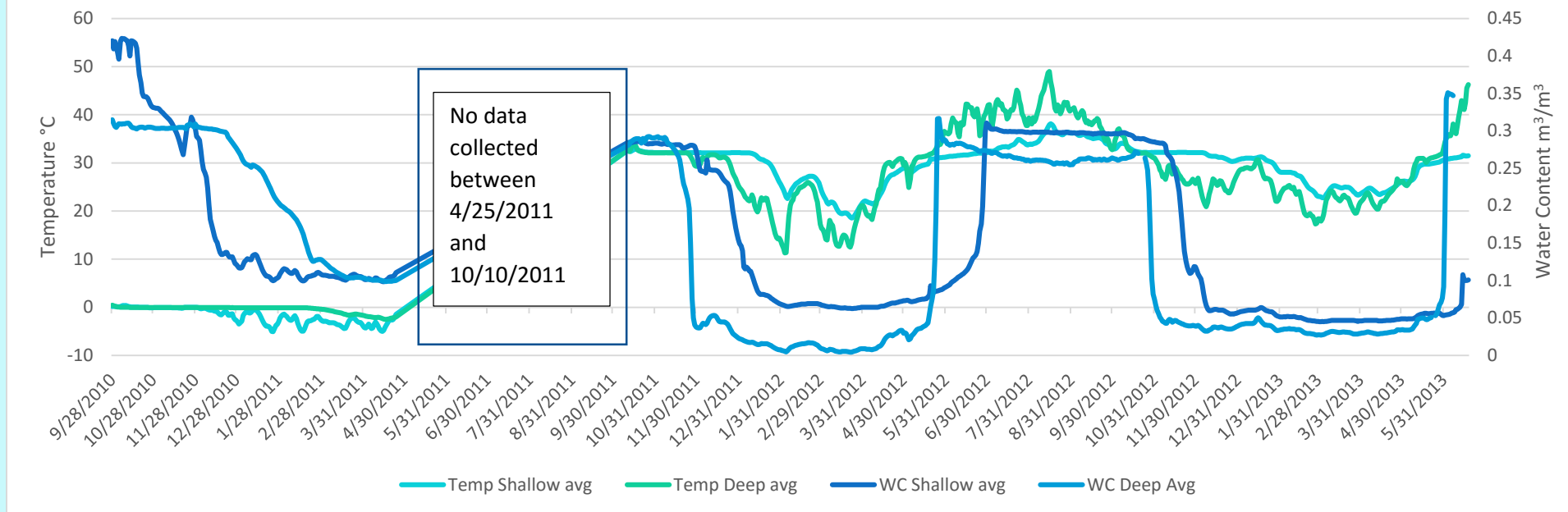
Average
depth =
80.3 cm

Minimum
depth =
55 cm

Maximum
depth =
1 meter

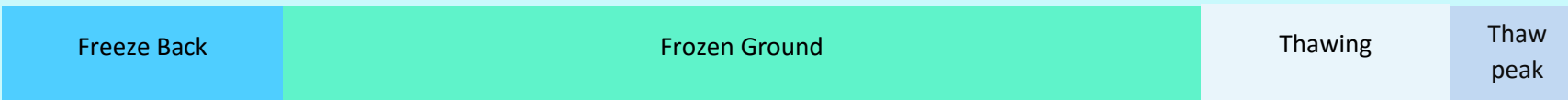


St. Mary's Soil Sensor Data 2010-2013



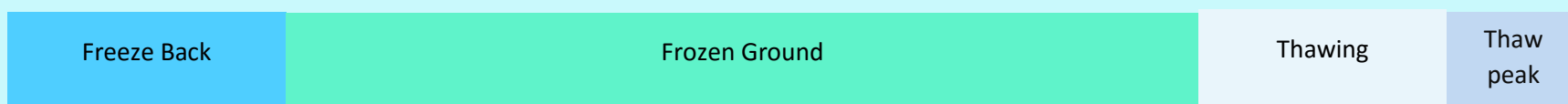
Annual soil moisture and temperature °C Averages 2010-2011

Soil measurements	September	October	November	December	January	February	March	April	May	June	July	August
shallow soil moisture	0.416	0.382	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	no data	no data	no data
deep soil moisture	0.310	0.306	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	no data	no data	no data
Shallow soil temperature	0.170	0.074	-0.063	-1.428	-2.401	-2.818	-3.237	-3.624	no data	no data	no data	no data
Deep soil temperature	0.337	-0.031	-0.059	-0.070	-0.087	-0.162	-1.168	-2.163	no data	no data	no data	no data



Annual soil moisture and temperature °C Averages 2011-2012

Soil measurements	September	October	November	December	January	February	March	April	May	June	July	August
shallow soil moisture	no data	0.284	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	0.137	0.300	0.298
deep soil moisture	no data	0.288	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	0.279	0.266	0.258
Shallow soil temperature	no data	0.229	0.082	0.056	-0.911	-3.527	-6.323	-3.936	-1.231	-0.169	0.822	2.176
Deep soil temperature	no data	0.321	-0.131	-1.024	-6.351	-5.779	-9.067	-3.448	-0.271	3.844	4.997	5.824

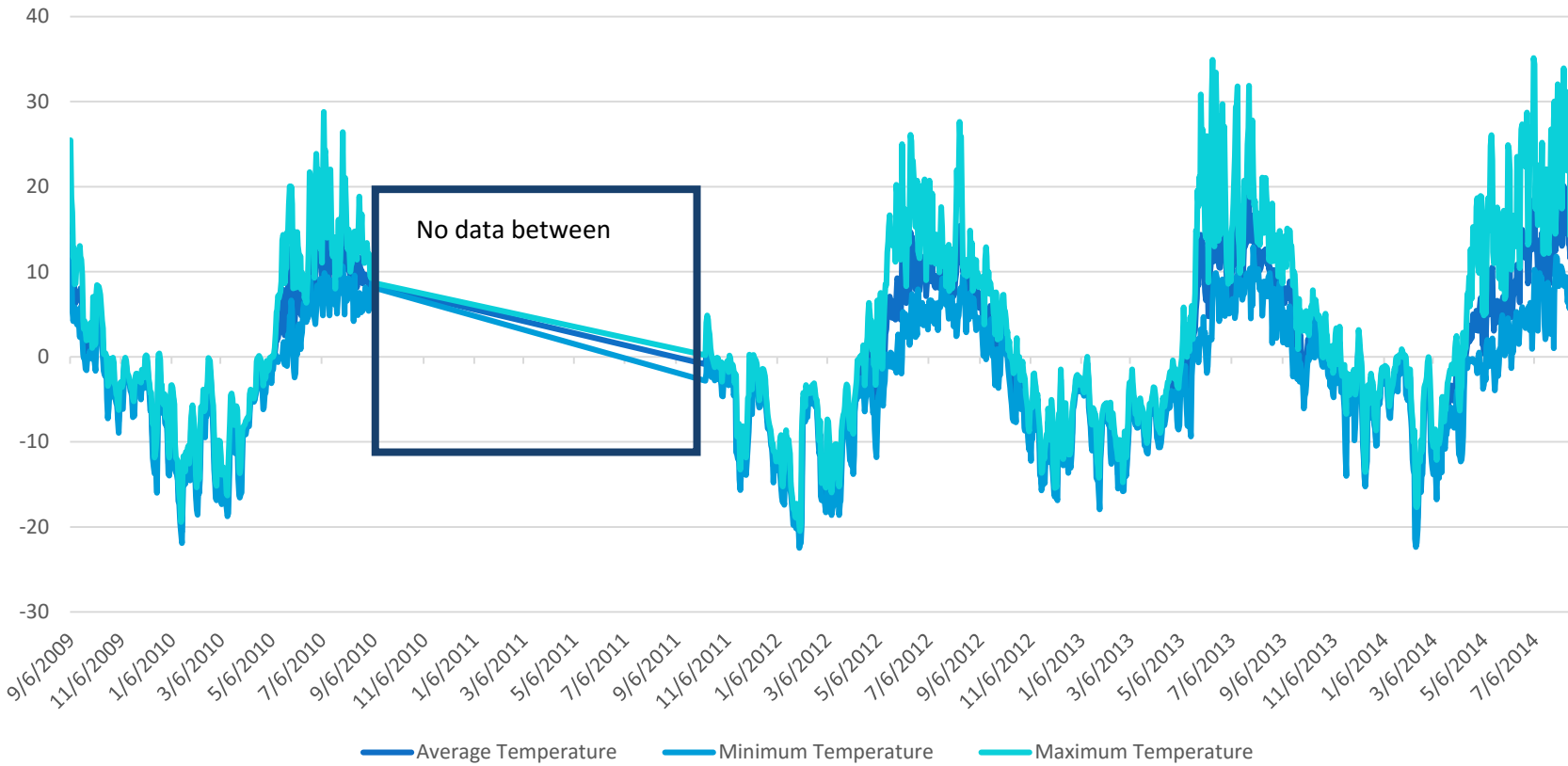


Annual soil moisture and temperature °C Averages 2012-2013

Soil measurements	September	October	November	December	January	February	March	April	May	June	July	August
shallow soil moisture	0.297	0.213	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	0.071	no data	no data
deep soil moisture	0.261	0.238	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	0.325	no data	no data
Shallow soil temperature	1.740	0.444	0.089	-0.421	-0.845	-3.107	-4.321	-4.214	-1.854	-0.492	no data	no data
Deep soil temperature	3.312	0.618	-2.476	-3.966	-2.601	-5.597	-5.731	-4.913	-1.301	3.919	no data	no data



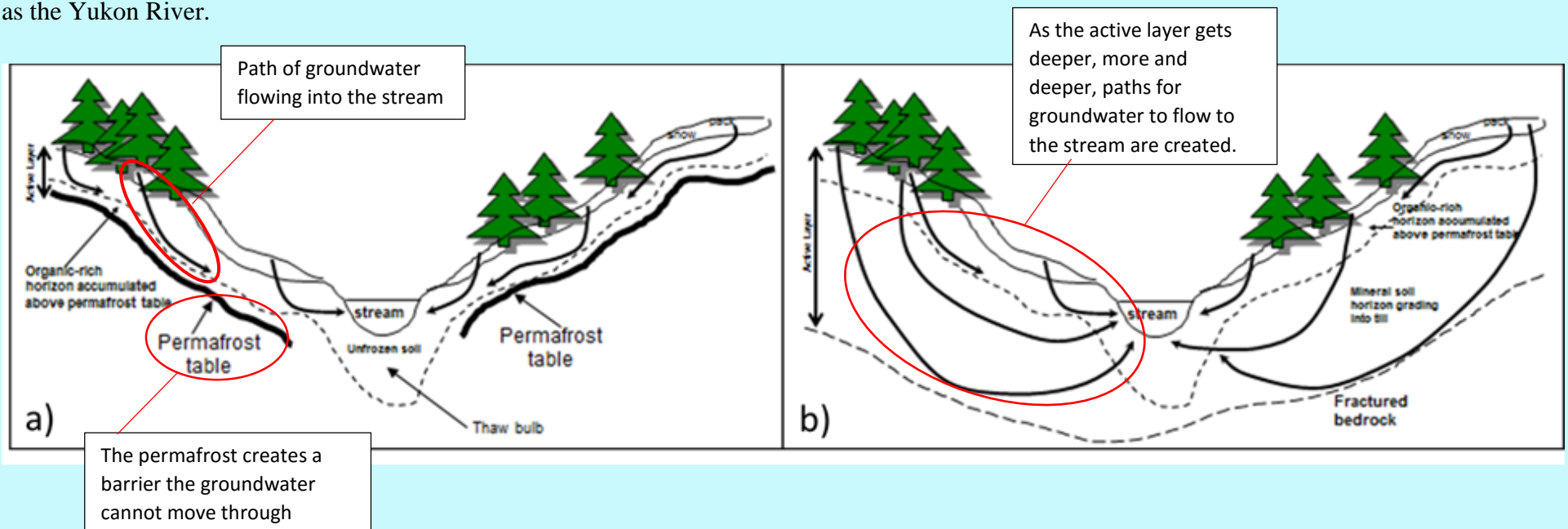
Air Temperature °C St. Mary's



Years	September	October	November	December	January	February	March	April	May	June	July	August
2009-2010	5.78	0.57	-3.58	-5.19	-11.79	-8.73	-12.08	-4.66	3.73	7.80	11.53	10.07
2010-2011	9.06	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data	No data
2011-2012	No data	-0.47	-5.89	-4.60	-14.40	-8.59	-12.17	-3.66	2.51	9.49	9.48	9.45
2012-2013	3.73	-1.21	-8.91	-9.62	-6.52	-9.53	-7.31	-5.66	1.38	12.05	12.22	10.79
2013-2014	4.90	1.65	-2.59	-5.57	-2.10	-8.69	-8.19	-0.51	5.45	9.68	12.35	14.23
4 year average (2009-14)	5.87	0.14	-5.24	-6.25	-8.70	-8.88	-9.94	-3.62	3.27	9.11	11.0	11.13

Next Steps

The ALN project is designed to continue for decades as it can take years to see a definitive change in the depth to the active layer and permafrost degradation. However, early analysis of the ALN and water-quality data suggests that we are seeing a relationship between a thawing active layer and ground water. As the diagram below shows as the active layer deepens new paths for groundwater to flow through are created. This means that more elements in the soil may be dissolved by the water traveling through new paths and these elements may be carried into the nearby streams such as the Yukon River.



As the figure above shows in figure a) the permafrost creates a barrier that groundwater cannot move through, this forces the groundwater to move through shallow paths into the stream; in figure b) the active layer is deeper, which means the permafrost is further down and the groundwater can move through more paths and deeper paths than before. New and deeper paths of groundwater flow can change the chemical composition of the stream this groundwater is flowing into. The results of preliminary analysis at key ALN locations across the YRB suggest that we are seeing a

seasonal change in the chemical composition of the river due to seasonal changes in the depth of the active layer. In order to confirm these findings the ALN and Water-quality monitoring must continue in the future at key locations so that we can collect more data to see if this trend continues into the future.