SUMMERLAND LAKEFRONT GEOGRAPHICAL INDICATION

February 2021

Technical Documentation

Documentation in support of a formal application to the BC Wine Authority for the creation of a new Geographical Indication named Summerland Lakefront, a sub-division of the Okanagan Valley Geographic Indication.

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Cover photo: The northern portion of the Summerland Lakefront GI along the west shore of Okanagan Lake. Photo taken from Matsu Drive looking north toward Peachland. Photo Credit: Lionel Trudel.

Summerland Lakefront Geographical Indication

TECHNICAL DOCUMENTATION

EXECUTIVE SUMMARY

The central concept of this Geographic Indication (GI) is to encompass the contiguous landscape composed of glaciolacustrine (lake bottom) and deltaic sediments along the western shore of Okanagan Lake within the District of Summerland. The glaciolacustrine sediments provide predominantly silty, carbonate(lime)-rich, stone-free soils on elevated benches above Okanagan Lake. The deltaic sediments at the mouth of Trout Creek are variable, often stony, and lie just above the elevation of Okanagan Lake. The vineyards located on these lakefront experience climatic conditions that are strongly moderated by the lake. The vineyards located on the surface of the glaciolacustrine bench have predominantly east and south-easterly aspects with good sun exposure. This set of conditions provides for excellent growing conditions for viticulture.

The total area of the GI just over 760 ha (1,880 ac) of which 550 ha are located on the glaciolacustrine bench above the lakeshore and 255 ha lie on the Trout Creek delta. The GI spans approximately 12 km of lakefront. There are an estimated 65 ha of vineyards in the GI producing predominantly white wine grapes.

The area of the GI is dominated by the glaciolacustrine deposits along the Summerland lakefront. These are that same materials that comprise the lakefront landscapes of the Naramata and Skaha Benches and intermittently elsewhere along the shores of the southern end of Okanagan Lake. Weathering of these sediments over the last 10,000 years has produced the soil types used for viticulture in the GI. The dominant soil series (Penticton, Olhausen, Naramata and Osoyoos) found in the GI are all well suited to irrigated viticulture.

Within the Summerland Lakefront GI, the frost-free period usually begins in the middle of April and runs until late October and produces a growing season length of over 190 days, long enough for the production of many *Vitis vinifera* grape varieties. While there is considerable interannual variation in the frost-free period, there is a significant trend toward slightly longer growing seasons in recent years. Within the context of the Okanagan Valley, the 20-year growing degree-day average of 1,330 for the GI, represents intermediate heat conditions.

These conditions are particularly well suited to growing noble white grape cultivars for production of well-balanced fruit-forward wines. White grapes occupy 68% of the producing vineyard area with Gewurztraminer and Pinot gris together occupying more than half of that area. The moderately cool climate allows for production of premium quality Pinot noir and Merlot, which are the dominant red wine cultivars grown in the GI.

BACKGROUND

This document follows a modification of the conceptual framework presented in April 2019 to the Bottleneck Drive Association for the creation of several Geographic Indications within the boundaries of the District of Summerland, British Columbia. The framework concept was developed following discussions with Rick Thrussell of Sage Hills Winery who provided vision for the initial work and acted as liaison with the Association and local grape growers.

This is one of a series of technical reports that outline the extent and character of proposed Summerland Geographical Indications which are subdivisions of the Okanagan Valley Geographic Indication (GI). This document describes the extent and rationale for a Summerland Lakefront GI. It follows the proposed framework with adjustments based on the merger of two proposed GI's into this one.

This work was initiated in response to the release of a set of recommendations prepared by industry representatives to the BC Wine Authority and the BC Ministry of Agriculture (Appellation Task Force 2015). The intent of this report is to provide the required technical documentation for the formal application to the BC Wine Authority for GI status.

GEOGRAPHIC EXTENT AND BOUNDARY

The Concept

The central concept of this Geographic Indication (GI) is to encompass the landscape composed of glaciolacustrine (lake bottom) and deltaic sediments along the western shore of Okanagan Lake within the District of Summerland. The glaciolacustrine sediments provide predominantly silty, carbonate(lime)-rich, stone-free soils on elevated benches above Okanagan Lake. The deltaic sediments of the Trout Creek are often stony and lie just above the elevation of Okanagan Lake. The climate conditions within the GI are strongly influenced (i.e., moderated) by the lake. The elevated sites on the glaciolacustrine bench have predominantly east and south-easterly aspects with good sun exposure. This set of conditions provides for excellent growing conditions for viticulture (Figure 1).

Figure 1. Vineyards at Evolve Vineyards typify site conditions within the GI, with open exposure to Okanagan Lake, good air drainage and an easterly aspect. The Naramata Bench is seen in the background across the lake.

Extent and Boundary

The geographic extent of the GI is shown as the shaded areas in Figure 2. It covers the Summerland lakefront area from Callan Road (Punta Del Norte) in the north to Trout Creek in the south. The total area of the GI is roughly 760 ha of which 550 ha are located on the glaciolacustrine bench above the lakeshore and 255 ha lie on the Trout Creek delta. The GI spans approximately 12 km of lakefront.

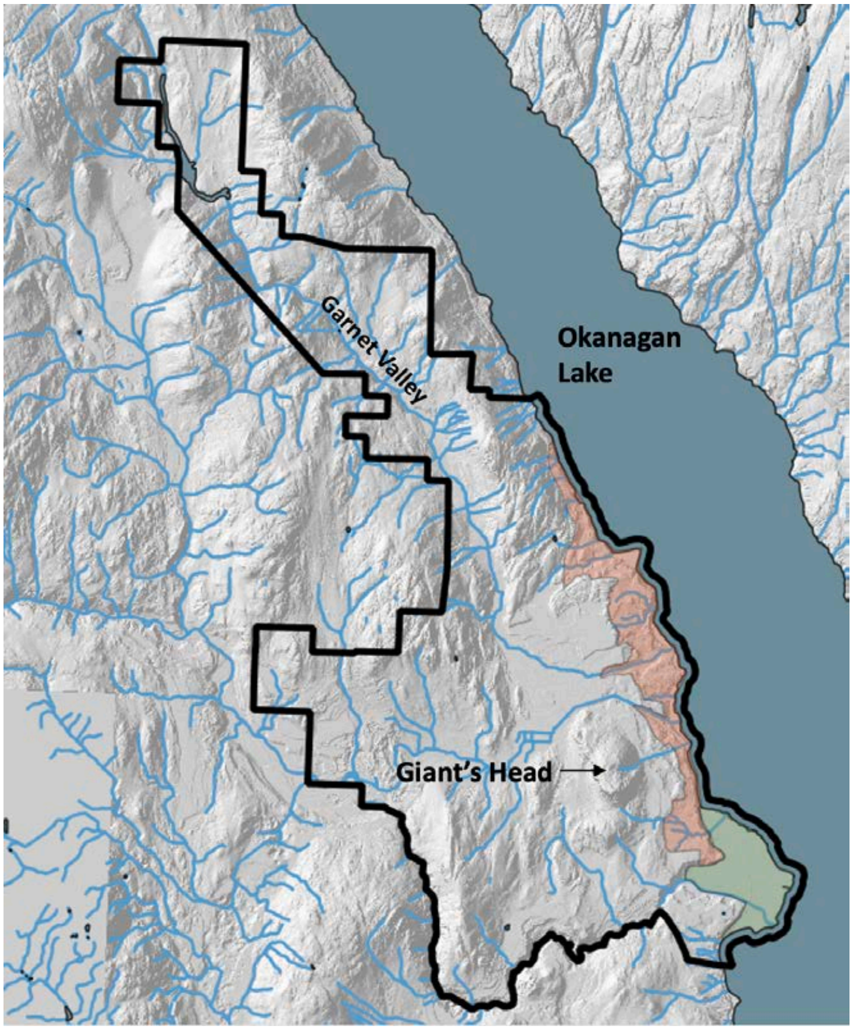

Figure 2. The municipal boundary of the District of Summerland (black line) and the two landscape elements of the Summerland Lakefront GI. The pink shading shows the extent of glaciolacustrine sediments. The green shading shows the extent of the deltaic sediments at the mouth of Trout Creek delta. Base map is a hi-resolution topographic map derived from LIDAR.

For the most part, the western boundary of the GI is defined by the break in the soil conditions from stone-free silty loam to gravelly sandy loam. This boundary is based on detailed soil mapping for the Summerland area (Wittneben 1986). The soil types that are found in the GI are described in the section on soil development.

One of the guiding principles in boundary placement is to try and avoid crossing individual property lot boundaries, a situation that would leave some vineyards partially in and partially out of a given GI. So, while it is soil type that defines the western boundary, we use either nearby road right-of-way or prominent natural features to place the exact boundary. In this way, the boundary is easily discernable on the ground and no vineyards are split.

The eastern boundary of the GI follows 12 km of Okanagan Lake shoreline within the District of Summerland. In the southern portion of the GI (Figure 3), this lakeshore boundary is shows as it runs along the Trout Creek delta between markers 1 and 2. At the mouth of Trout Creek the boundary runs up the creek to the top of the delta and the beginning of the canyon to the west (marker 3). The boundary follows the base of the escarpment before running up to the surface of the bench to intersect with Gartrell Rd and Happy Valley Rd. The boundary then runs north along Happy Valley Rd to Welsh Ave. At this point the boundary drops down to meet Front Bench Rd and runs north to approximately Eden Rd (marker 4) and Walters Rd. Using the road network in this way creates a rather sinuous boundary, but it captures well the extent of the glaciolacustrine deposits in the area, the formative element in the establishment of the eastern boundary of the GI.

Figure 3. The southern portion of the GI hosts extensive agriculture on the glaciolacustrine benches above Trout Creek and Okanagan Lake.

From Walters Rd, the boundary runs northward to intersect Hwy 97 (Figure 4, marker 5) then climbs to the top of the escarpment north of Hwy 97 and around the bench to Peach Orchard Rd at marker 6. There is little agriculture in this central portion of the GI. Most of the land use is residential.

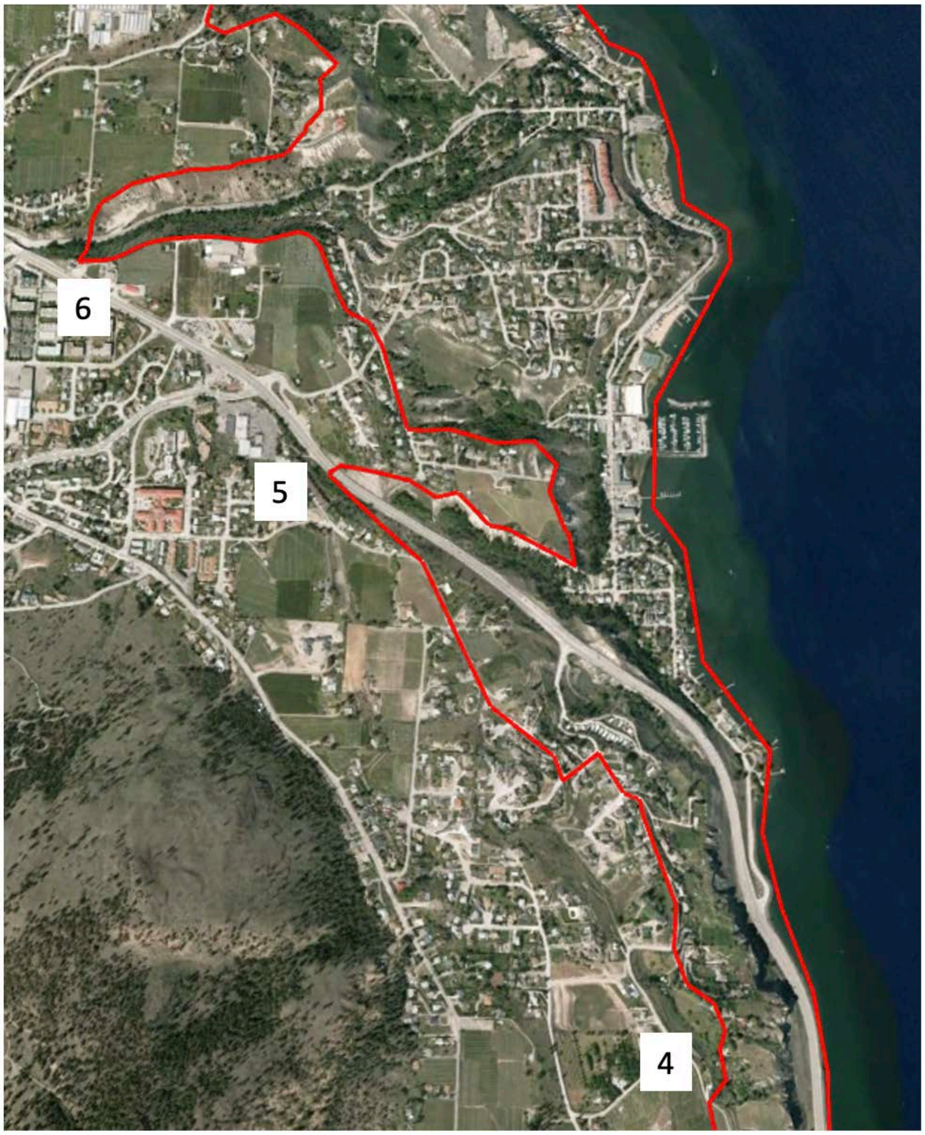

Figure 4. In the central portion of the GI the boundary follows the escarpment above Hwy 97 to encompass the residential areas of Peach Orchard Road and lower town.

North of Peach Orchard Rd, the boundary follows a small ridge that runs just west of Fosbery Rd until it intersects with Matsu Drive in the vicinity of Sage Hills winery (Figure 5). Matsu Drive follows the natural break between rock outcrops and gravelly soil to the west and terraced glaciolacustrine landform to the east. In this portion of the GI, the glaciolacustrine landform extends approximately 1 km wide, covers about 160 ha of undulating orchard lands and vineyards (see cover photo).

Figure 5. The central portion of the GI incorporates the farmland north and east of Matsu Dr. This road follows the boundary between the glaciolacustrine soils and the gravelly glaciofluvial soils of the adjacent Summerland Bench GI.

The boundary runs from the junction of Matsu Rd and Hwy 97 northward along the highway right-of-way some 4 km to Callan Rd (Figure 6). While much of this portion of the GI is steep hillside, there are several recently established vineyards located on the glaciolacustrine terraces that exist between the highway and the lakeshore along this stretch.

Figure 6. The northern extent of the GI runs between Hwy 97 and Okanagan Lake as far north as the Callan Road interchange. The interchange marks the extent of arable glaciolacustrine materials along this part of the Okanagan Lake shoreline.

SURFICIAL GEOLOGY AND LANDFORMS

Over the last several million years, glaciers have scoured the valley and left behind the rounded bedrock summits like those of Giant's Head and Okanagan Mountain. During the retreat of ice following the last glaciation event, this incredibly rugged terrain below 500 m elevation was buried by sediment emanating from melting glaciers. Most of the valley bottom is now filled with sand and gravel. At lowest elevations there are also thick deposits of silty material geologists refer to as glaciolacustrine materials. These materials are the lake bottom sediments of Glacial Lake Penticton. The sediments were deposited by glacial meltwater that flowed into temporary lakes (known as glacial lakes) that formed between the valley wall and a stagnating ice tongue during deglaciation some 9,000 to 11,000 year ago (Figure 7). A detailed reconstruction of deglaciation events in the Summerland area is described in a regional glacial history report by Hugh Nasmith (1962).

It is postulated by geologists that Glacial Lake Penticton formed when glacial debris and ice blocked the southward drainage of meltwater from the Okanagan Valley. Glacial Lakes have short and tumultuous histories, with highly fluctuating water levels, periodic draining and filling and outflow floods. Ice marginal lakes formed as the stagnant ice lobe melted in place through the process of downwasting. Downwasting is a deglaciation process whereby the thickness of glacier ice decreases over time to expose higher elevation terrain first and lower elevation later. As the elevation of the ice decreased, the level of impounded water dropped. There are glaciolacustrine deposits found well above the highest elevations of the Summerland Lakefront GI in Prairie Valley for instance. However, little of these higher elevation deposits remain at the surface, they have either been buried by subsequent depositional events or have been eroded. Only below approximately 450 m elevation, or about 100 m above the current level of Okanagan Lake, are these sediments extensively preserved. Today they provide the parent materials for highly productive soils used for horticultural purposes.

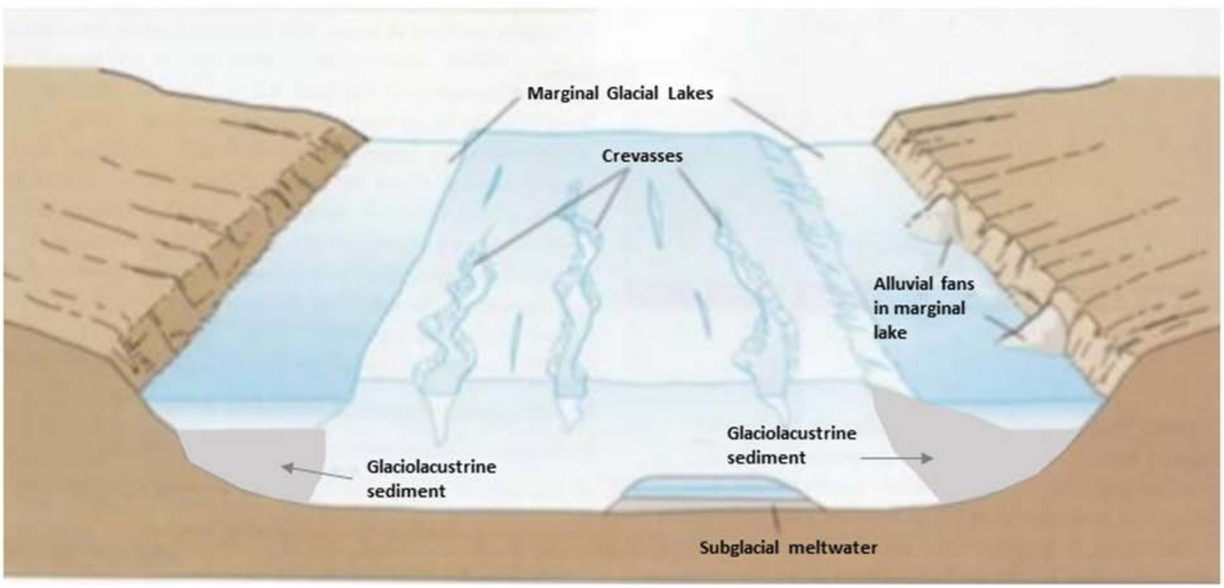

Figure 7. Conceptual illustration of the formation of marginal glacial lakes during de-glaciation. In the south Okanagan Valley these marginal lakes are collectively referred to as Glacial Lake Penticton. Sediment was deposited between the ice margin and the valley wall and in this illustration depicts the formation of the silty bluffs and terraces (i.e., benches) evident today along the Summerland waterfront. Adapted from and re-drawn based on Bilton (2012).

The presence and extent of lake-bottom or glaciolacustrine sediment defines much of the extent of the Summerland Lakefront GI and therefore the surficial geology of the GI is dominated by glaciolacustrine deposits. These are that same materials that comprise the lakefront landscapes of the Naramata and Skaha Benches and intermittently elsewhere along the shores of the southern end of Okanagan Lake. These sediments are particularly well preserved in the bluffs above the shoreline between Summerland and Penticton. The various terraces, gullies and escarpment slopes that exist on this material today are due to erosion since deglaciation. This creates a unique and in places dissected landscape along the Summerland lakefront (Figure 8).

Figure 8. Exposures of well-preserved deposits of glaciolacustrine sediments can be seen along Hwy 97 south of the Summerland Research and Development Centre (a). These deposits are composed primarily of silt and fine sands. Much of the Summerland Lakefront GI can be seen in the photo looking south toward Penticton (b). Agricultural land in the foreground sits on a glaciolacustrine terrace.

The second landscape element of the GI is the Trout Creek delta. It was not until the ice tongue completely melted and the impounded meltwater had drained that the modern Trout Creek delta began to form where Trout Creek entered the newly established Okanagan Lake at roughly its current elevation of 340 m (Figure 9).

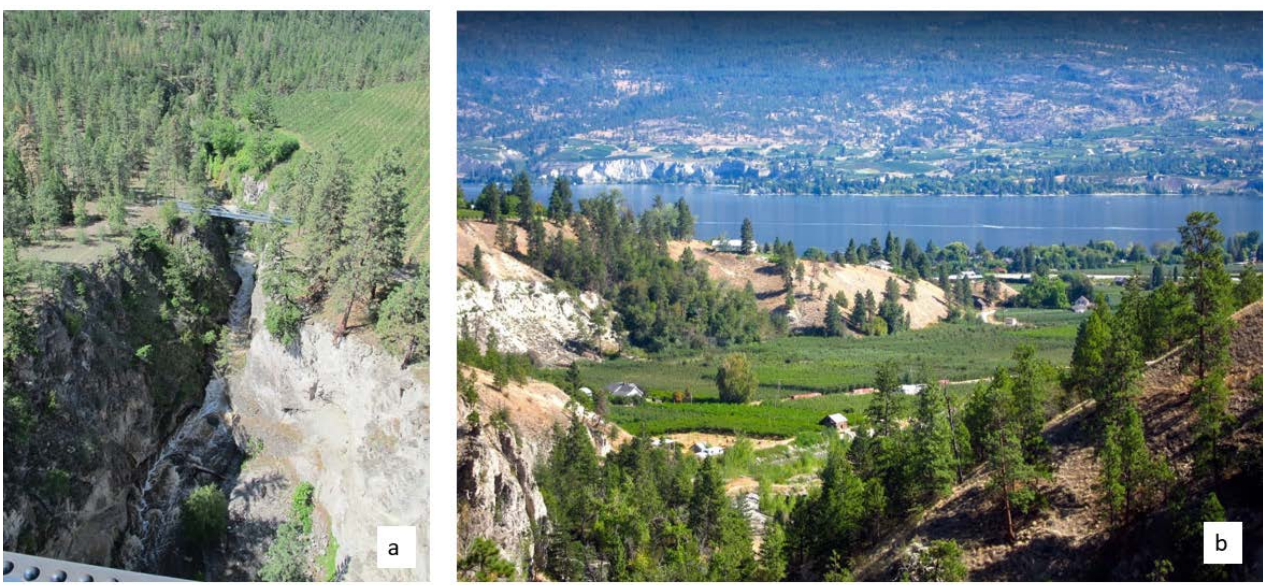

Figure 9. The canyon of Trout Creek looking upstream from the Kettle Valley Railway trestle (a) and looking downstream from the same point showing the termination of the canyon and the upper region of the delta with agricultural lands and Okanagan Lake in the background. Photo Credits: Todd Redding (a) and Summerland Tourism (b).

Large quantities of sediment were carried down to the lake as Trout Creek continued to erode material from its bedrock canyon and from the material left from Glacial Lake Penticton. The bulk of the delta likely formed quickly during this time of early post-glacial history. While Trout Creek still deposits sediment into Okanagan Lake each year, the volume of sediment is now quite small, and the growth of the delta is minimal. Much of the surface of the delta is only a few meters above the currently managed maximum lake level.

Trout Creek is the primary water source for the District of Summerland and is the largest community watershed in the Okanagan. The lower reach of Trout Creek was channelized and diked in 1949 and then further modified in 1973 for flood control. Channelization has prevented overbank flooding from depositing fresh sediment over the delta surface. Nonetheless, the water table remains close to the surface in many places on the delta particularly when the lake level is at its highest in late spring.

Currently, the mainstem of Trout Creek is confined to the southern edge of the delta but previously the creek channel meandered across the full extent of the delta. Typically, in a delta setting there is a main channel feeding multiple smaller channels which together form a network of ephemeral streams. During periods of highest flows, coarse material (gravel and cobbles) is deposited along the main channel(s) while finer materials (silts and sands) are deposited by the smaller stream network through overbank flooding. These deposits generate a range of soil conditions on the delta.

SOIL DEVELOPMENT AND SOIL PROPERTIES

Weathering of the surface geological sediments over thousands of years has produced the soil types used for viticulture in the GI. These soils formed under a semi-arid climate under shrub and grassland vegetation. As a result, they all share the same properties of having an organic matter enriched topsoil layer (unless eroded), and all belong to the Chernozem taxonomic group according to the Canadian System of Soil Classification (Soil Classification Working Group 1998).

In the report *Soils of the Okanagan and Similkameen Valleys,* Wittneben (1986) mapped a half dozen or so common soil series in the GI (Table 1). Soil series are soil mapping units defined by the nature of the soil profile and the type of surficial material within which the soil has formed. Unconsolidated surficial geologic deposits act as what are termed “soil parent materials”. Parent materials weather over time to form soil horizons. These horizons are weathering layers with differing colours and properties such as amount of organic matter and water holding capacity.

Typically, the soils formed on glaciolacustrine parent materials are silty or occasionally sandy in texture, are well drained and stone-free with an alkaline pH in the subsoil. Soils found on the delta are much more diverse. Many are stratified (i.e., are composed of intermixed sands and silts overlying gravel) and many show evidence of a periodic high water table. Before water flow control structures were in place on Okanagan Lake and Trout, the delta was subject to flooding of various degrees each year. These control structures have largely removed the flood hazard on the delta and water tables are now maintained at least one meter below ground level for most of the area.

Table 1. The major soil series of the Summerland Lakefront Geographic Indication. Soils formed on glaciolacustrine parent materials are fine sandy loam to silty clay loam texture and are largely stone-free. Soils formed on the Trout Creek delta are highly variable.

Soil Series Name	Landscape position	Profile Characteristics	Viticultural Use
		Soils formed on glaciolacustrine parent materials	
Maynard	Steep slopes and bluffs on escarpments	Little or no A horizon, with calcareous subsoil at or near the surface	Topographically unsuited
Munson	Localized mid and lower slopes	Well-developed A horizon underlain by saline subsoil	Saline subsoil causes low vigour
Olhausen	Widespread on gently sloping surfaces	Surface cover 10-50 cm thick of fine sandy loam wind-blown sediment overlying a calcareous silt loam subsoil	Dominant soil used for viticulture particularly in the northern portion of the GI
Penticton	Level surfaces of the bench	Well-developed topsoil of silty loam texture overlying calcareous silty loam subsoil	High quality soil well suited to viticulture but with limited distribution
Naramata	Level surfaces of the bench	Sandy surface horizon overlying calcareous stratified subsoil	Well suited, soil texture varies with depth
		Soils formed on glaciofluvial parent materials	
Osoyoos	Scattered with the glaciolacustrine landscape	Stone-free loamy sands	This soil has limited distribution, but the uniform sandy texture is well suited to irrigated viticulture
		Soils formed on deltaic parent materials	
Tomlin	Higher elevations on the delta (west of Hwy 97)	Gravelly soil throughout	Limited at this time
Inkaneep	Lower elevations on the delta	Stratified sand and silt, affected by high water table	Limited at this time

The most common soils in the GI belong to the Olhausen and Penticton soil series (Figure 10). They are very similar soils and are managed for viticulture in largely the same way. However, the Olhausen soils have a slightly sandier topsoil due to the addition of wind-blown sand to the profile, most likely in the early post-glacial period many thousands of years ago. Similar to Olhausen soil, the Naramata soil series also exhibits a sandy surface cover over the glaciolacustrine sediments but in this case the sands are derived from water erosion that “washed” the surface of the silty sediments likely in association with the draining of Glacial Lake Penticton. Finally, soils belonging to the Maynard and Munson soil series are found in the gullies and along escarpment slopes and generally do not support extensive vineyard plantings. These soils tend to lack a well-developed topsoil layer and can be highly alkaline or even saline in some places. As such they are less well suited to viticulture than the other soils mapped in the GI.

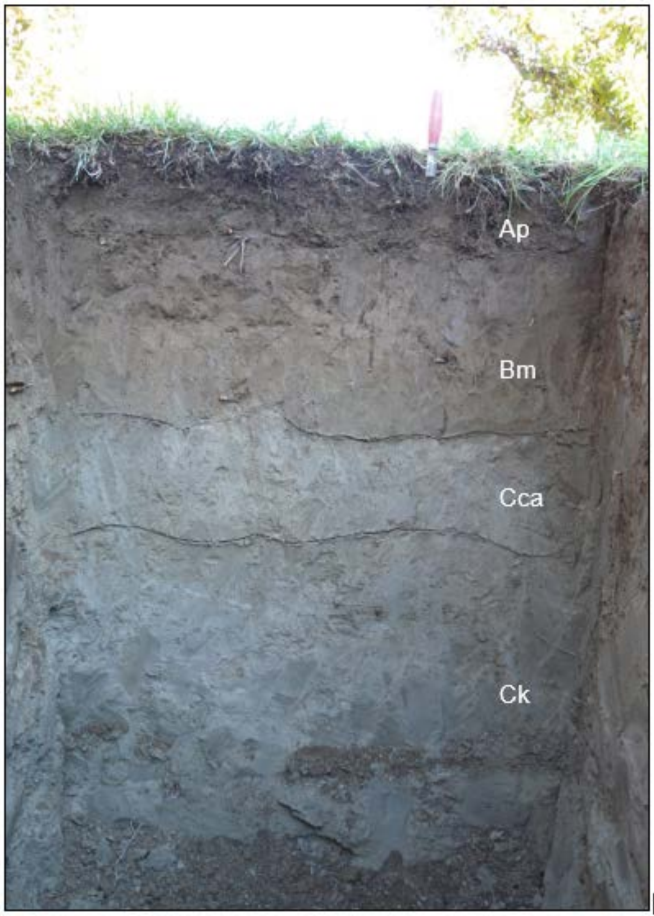

Figure 10. Soil profile of the Penticton silt loam showing the topsoil layers (designated as Ap and Bm), and calcareous subsoil layers (Cca and Ck). The topsoil layers have been leached of soluble materials, have a neutral pH and contain appreciable amounts of organic matter. The subsoil is calcareous., meaning that it contains free lime. This gives the subsoil an alkaline pH.

In the southern portion of the GI, soils belonging to the Osoyoos soil series occur. These are formed on sands of glaciofluvial origin. These are soils with sand and loamy sand textures. They tend to have low moisture holding capacity but are well suited to irrigated viticulture. The Summerland area marks the northern-most extent of the Osoyoos loamy sand which is the dominant soil type along the Black Sage Bench in the southern Okanagan valley.

There are two main soil types on the Trout Creek delta. The Tomlin soil are situated on the western most portion of the delta. The elevation of this portion of the delta is about 15 m above lake elevation so the soils are relatively dry and well drained. The soils are typically composed of loamy surface soil underlain by very gravelly loamy sand. These are the only soils on the delta that do not show evidence of periodic high water table within the upper 100 cm of soil profile. The Inkaneep soil is located on the lower portions of the delta, closer to the lake. It is an imperfectly drained soil, one that historically would have flooded in most years. The soils are composed of interbedded silts and sands (Figure 11).

Figure 11. Profile features of the upper 100 cm of the Inkaneep soil series. The topsoil is dark and typically high in humus while the subsoil shows mottled rusty colours generated by periodic saturation by ground water. The soils are composed of fine sand and silt deposited during past flooding events of Trout Creek. Tree roots are plentiful in the upper 50 cm of the profile.

CLIMATE

A weather station located on the grounds of the Summerland Research and Development Centre (SRDC) provides a good approximation for the weather conditions on the Summerland lakefront. This long-term station, operated by Environment and Climate Change Canada, is supplemented by several small research-oriented temperature monitoring stations located on private property within the agricultural areas of the District of Summerland.

One such monitoring station (station 206) is located off Front Bench Rd in the southern portion of the GI, about 2 km north of the Research Centre. To evaluate how well the long-term weather data from the Research Centre applies to the southern portion of the GI, daily temperature data were compiled and compared for the period 2008 to 2016 (Table 2). The growing degree day accumulations >10°C (GDD>10°C) and the frost-free period (FFP) are indices calculated from daily temperatures that are typically used to evaluate climate conditions for viticulture. While variation existed from year to year between stations due to fine differences in the local topography, temperature averages over the full period showed little difference. We can conclude that the long-term data from SRDC represent the GI well.

Table 2. Daily temperature data for two weather stations, one located within the boundaries of the GI (research monitoring station 206) and the second from the long-term station on the Summerland Research and Development Centre (SRDC), were compiled for two seasonal agroclimatic indices.

Year	GDD>10°C		FFP (days)	
	SRDC[1]	206 [2]	SRDC[3]	206 [2]
2008	1,241	1,178	nd	171
2009	1,427	1,317	169	167
2010	1,238	1,184	194	189
2011	1,195	1,152	186	184
2012	1,333	1,285	196	213
2013	1,415	1,355	190	189
2014	1,389	1,452	206	223
2015	1,520	1,547	203	202
2016	1,363	1,419	197	206
Mean	1,347	1,321	193	194

[1]Data provided by Brad Estergaard, SRDC

[2] Data provided by Steve Losso, SRDC

[3] Data compiled by the author from Environment and Climate Change Canada (2019)

The length of the growing season is calculated as the number of days between the last frost in the spring and the first frost in the fall. Along the Summerland Lakefront GI, the frost-free period usually begins in the middle of April and runs until late October and produces a growing season length of over 190 days, long enough for the production of many *Vitis vinifera* grape cultivars (varieties). The occurrence of frost is very site-specific. It depends on local topography and in some years was significantly longer at station 206 than at SRDC. Interannual variation is significant but there has been a trend toward slightly longer growing seasons in recent years.

The GDD values as recorded at SRDC for the period 1998 to 2018 are illustrated in Figure 12. Within the context of the Okanagan Valley, the 20 year GDD average of 1,330 represents intermediate heat conditons, cooler than the south Okanagan (where GDD totals typically exceed 1,500) but warmer than areas in Kelowna and to the north.

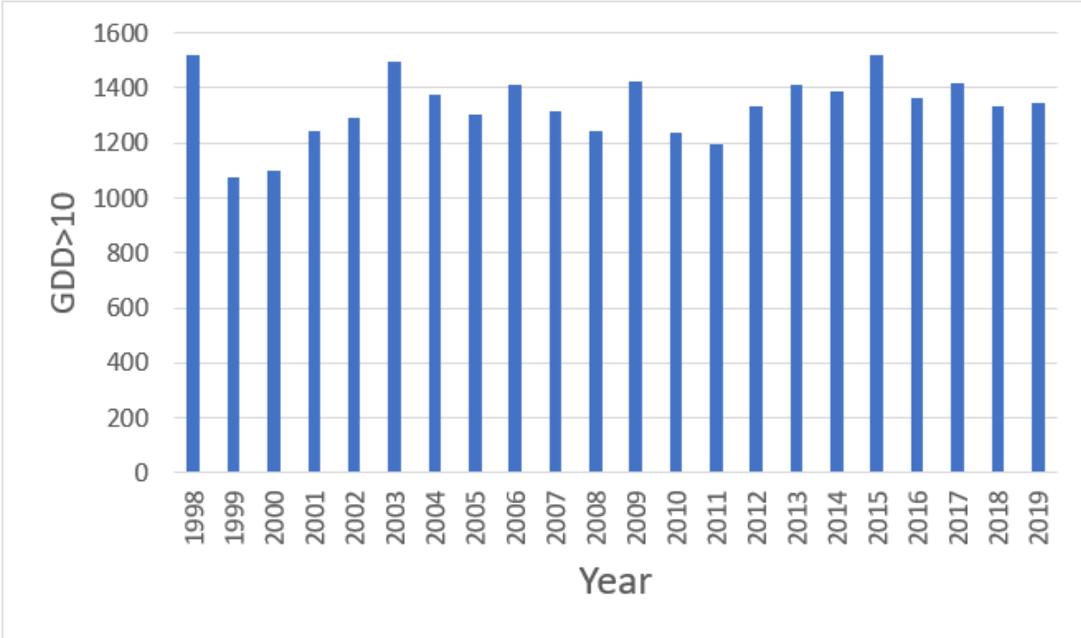

Figure 12. Chart of growing degree day accumulations through the growing season for the years 1998 to 2018 as recorded at SRDC. Data provided by Brad Estergaard, SRDC.

The warmest years were 1998 and 2015 with over 1500 GGD>10. Coolest year was 1999 with an accumulation of 1074 GDD>10. The significant interannual variation in accumulated heat remains an on-going challenge. There was a trend of warmer winter temperatures (not shown) which bode well for viticulture in the region.

VITICULTURAL CHARACTERIZATION

The combination of climate, soils and topography in the Summerland Lakeside GI create highly suitable conditions for producing many noble wine grape cultivars. The east-facing gently sloped sites that predominate in the GI have excellent air drainage and a long frost-free period that allow for an extended fruit maturation period in most years.

Expansion of vineyard area is on-going. As of 2020, there were approximately 65 ha (160 ac) of producing vineyards in the GI. The moderately cool climate allows for production of premium quality Pinot noir and Merlot, which together make up the majority of the producing vineyard area in red wine cultivars (Table 3). There is ample growing season heat to mature these cultivars, and the extended growing season into the cool late summer and fall enhances the development and retention of fruit acids and aromatic compounds that contriute to the sensory quality of the wines.

Table 3. Cultivars and their proportional coverage of the vineyard area of the Summerland Lakefront GI. Data source: BC Wine Authority.

Cultivar	**% Producing area**
Reds	
Pinot Noir	25.1
Merlot	4.6
Cabernet Franc	1.3
Pinot Meunier	1.9
Gamay Noir	1.1
Syrah	0.6
Total	34.6
Whites	
Gewurztraminer	26.7
Pinot Gris	25.2
Chardonnay	3.7
Muscat	2.2
Riesling	2.7
Muscat Ottonel	1.5
Sauvignon Blanc	1.1
Semillon	0.6
Orange Muscat	0.4
Dunklefelder	0.4
Schonburger	0.4
Viognier	0.4
Pinot Blanc	0.2
	65.4

The GI's conditions are particularly well suited to growing noble white grape cultivars for production of well-balanced fruit-forward wines. White grapes occupy 65% of the producing vineyard area with Gewurztraminer and Pinot gris together occupying more than half of that area (Table 3).

The dominant soils of most vineyard sites in the GI are well suited to managing vine vigor through deficit irrigation to achieve optimum canopy density and fruit exposure for producing premium quality fruit. The low water holding capacity of the coarser textured soils in the GI requires more frequent irrigation but enable growers to more easily manipulate vine vigor. Maintenance of floor vegetation on these soils may require between-row irrigation.

REFERENCES

BC Wine Appellation Task Group (2015). *Wine Industry Turning Point: Recommended Changes to the British Columbia Wines of Marked Quality Regulations*. Report submitted to the BC Wine Authority and BC Minister of Agriculture. 42pp

Bilton J. 2012. Glaciofluvial landform images. Downloaded from Google Images http://www.coolgeography.co.uk/A-level/AQA/Year%2012/Cold%20environs/Fluvioglacial/Fluvioglacial%20during.jpg. Accessed June 10, 2018.

Environment and Climate Change Canada. 2019. Canadian Climate Historical Data. https://climate.weather.gc.ca/historical_data/search_historic_data_e.html Accessed November 22, 2019

Nasmith H. 1962. Late Glacial History and Surficial Deposits of the Okanagan Valley, British Columbia. British Columbia Department of Mines and Petroleum Resources, Victoria, BC. 46 pp. plus plates and maps.

Soil Classification Working Group 1998. The Canadian System of Soil Classification 3rd ed. Agric. And Agri-Food Canada. Publ. 1646 (revised) 187 pp.

Wittneben U. 1986. *Soils of the Okanagan and Similkameen Valleys,* Technical Report 18. BC Ministry of Environment. Victoria, BC. 229pp. plus maps