Summary Report 2007 – 2011

Climate and Feasibility Assessment of Growing Wine Grapes in the Lillooet-Lytton Area

Harvest at Roshard Vineyard 2011.

Prepared by

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And

"A taste of our own"

BRITISH COLUMBIA GRAPEGROWERS' ASSOCIATION

For

Investment Agriculture Foundation of British Columbia

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Agriculture and Agri-Food Canada (AAFC) is pleased to participate in the delivery of this publication and is committed to working with our industry partners and the Investment Agriculture Foundation of BC to increase public awareness of the importance to the agriculture and agri-food industry in Canada. Opinions expressed in this publication are those of the authors and not necessarily AAFC's.

This innovative project would not have been possible without the cooperation of Investment Agriculture Foundation of BC (IAF), the various landowners and vineyard managers and interested individuals who have contributed much time and expertise. The B.C. grape and wine industry needs this type of undertaking to explore the risks associated with the potential development of new grape growing regions. The British Columbia Grapegrowers' Association expresses appreciation to all the people who supported this project and to those who assisted in the preparation of this publication.

Copies of this publication and annual progress reports are available free of charge on websites identified under communication in this report and at a nominal fee from:

British Columbia Grapegrowers' Association
Administration Services
451 Atwood Road, Grand Forks, BC, VOH 1H9.
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Trade Names

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PROJECT DESCRIPTION

Concept/Goal

To provide production and climatic information to better assess the feasibility and suitability of commercial grape production in the Lytton-Lillooet area of British Columbia.

Objectives/Mechanism

1) To test the suitability and performance of wine grape varieties in the Lillooet-Lytton region.

   Mechanism: Measure, compile and compare information relating to grape phenology and vineyard management, production, and fruit quality from a wine grape planting established in 2005 and two others established in 2006.

2) To develop a detailed climatic profile of the area.

   Mechanism: Compile and interpret climate data via weather stations and supplemental temperature data loggers.

PROJECT TIMING

The starting date for this project was March 1, 2007 with an original planned completion date December 31, 2009. A project extension to continue data collection and vineyard evaluation was granted establishing a new completion data at April 2012.

Funding

Funding and support from the former BC Ministry of Sustainable Resource Management and the BC Ministry of Agriculture and Lands, provided funds to produce 250 vines of each variety to plant four identical test plantings. This funding also made possible the purchase of three Weatherhawk climate stations.

Funding to continue and expand the project was possible because of a successful application for funds by British Columbia Grapegrowers' Association to Investment Agriculture Foundation of British Columbia and the commitment of funds and in-kind contributions from other agencies and individuals. Landowners who participated in the project volunteered their time, labour and absorb all the costs associated with vineyard establishment and maintenance.

Total funding plus in-kind contributions for this project totaled $212,600.

PROJECT BACKGROUND

The study area is located in south-central British Columbia in a narrow north-south valley with the south flowing Fraser River in the middle. The Coast Mountains are on the west; and the Clean Mountains Range on the East. The largest settlements in the study area are Lytton in the south and Lillooet 63 km north of Lytton. Big Bar Creek approximately 130 km north of Lillooet is the northern boundary of the study area. The study area extends over a distance of 200 km.

Hardy Vitis labrusca varieties of American grapes such as Campbell Early, Concord, Niagara, Agawam, Sheridan and a European variety, Chasselas were produced in the area in the early 1940's. These varieties were generally planted near homes and not on wind exposed terraces. The American varieties are well suited for fresh markets and jam, juice or jelly production, but not for the wine industry because they have flavours undesirable to the wine industry. French Hybrid varieties Foch, De Chaunac (Seibel 9549), Aurora (Seibel 5279) and others were introduced in the 1960's. The old V. labrusca varieties and some of the French hybrids were sufficiently winter hardy and ripened but by the late 1980's none were popular with wineries. In 2003 several local landowners and local supporters felt a need to assess the feasibility of producing Vitis vinifera grape varieties important to the British Columbia wine industry. Four test sites equipped with climate stations were to be established, two in the Lillooet area and two in the Lytton area. The selection of varieties and propagation of 4500 vines to plant 50 vines of each variety at each of four sites took place in 2004 and 2005. One of the participants withdrew after the propagation program started. A fourth participant was not found, leaving the Ruddock Ranch 30 km north of Lytton and the Roshard property in Lillooet as project participants. Planting of the Roshard and Ruddock properties occurred on June 1 and 2 of 2005. Vines surplus to the project were planted and cared for in a nursery at the Roshard site and were offered at no cost to anyone who asked for the plants. In 2006 Wonderland Farm and Pietila vineyard requested vines and began participation in the test project. Vines for the Wonderland Farm and Pietila vineyard were removed from the Roshard nursery in mid to late May and June 2006 and were immediately transplanted to the new sites. All remaining vines were given away.

COMMUNICATIONS

Information about this project was published in various media articles and in annual Progress Reports available on the following web sites.

District of Lillooet http://www.lillooetbc.com/business.aspx;

Village of Lytton: http://www.lytton.ca/siteengine/activepage.asp?PageID=78

British Columbia Grapegrowers' Association: http://www.grapegrowers.bc.ca

Fraser Basin Council http://www.fraserbasin.bc.ca/publications/fbc_reports.html and British Columbia Ministry of Agriculture http://www.al.gov.bc.ca/grape/factsheets.htm

TO TEST THE SUITABILITY AND PERFORMANCE OF WINE GRAPE VARIETIES IN THE LILLOOET-LYTTON REGION.

Project Grape Varieties

Fifteen wine grape selections representing the most important varieties of the 2004 grape crop plus three promising experimental wine grape varieties were selected for the project (nine red and nine white). Fifty vines of each variety were planted at Roshard and Ruddock vineyard. Pietila vineyard requested 25 vines of 10 varieties and Wonderland Farm requested 25 vines of 15 varieties.

- The eighteen selection included early maturing, (150 days frost free period) varieties Cocseji Zamatos, Gewurztraminer, Muscat Ottonel, Riesling Muscat; mid season (160 to 170 days frost free period) Chardonnay, Limberger, Pinot blanc, Pinot Gris Pinot Noir, Sauvignon Blanc, Tinta Madeira, Zweigeltrebe; late maturing (170 to 180 days frost free period) Cabernet Franc, Cabernet Sauvignon, Chancellor, Johannisberg Riesling, Merlot, and very late maturing varieties (180 frost free days or more) Syrah.
- A small vineyard of Marechal Foch, an early maturing, hardy French hybrid planted at the Roshard site in approximately 1972, was included in the evaluations for comparisons of hardiness and earliness.
- The hardiest test planting varieties included Cabernet Sauvignon; Chardonnay; Chancellor; Gewurztraminer; Limberger; Pinot Noir; Johannisberg Riesling. Moderately hardy varieties include Cabernet Franc; Cocseji Zamatos; Pinot Blanc; Pinot Gris; Tinta Madeira Riesling Muscat; Zweigeltrebe. Least hardy include Merlot; Muscat Ottonel; Sauvignon Blanc; Syrah.
- Fifty vines each of Petite Verdot (red, late, hardy) and Viognier (white, late, moderately hardy) were added to Roshard Vineyard June 1, 2006. Ten vines each of new hardy wine grape varieties (red) Marquette; Frontenac and ES 5-17 plus (white) Louise Swenson; Frontenac Gris; Frontenac Blanc; and a pink fresh market variety Summerset were planted at Roshard Vineyard June 2010. A small number of the hardy varieties Marquette (red) and Louise Swenson (white) were planted at Pietila Vineyard and Wonderland Farm. These varieties are all reported to be hardy to between -30°C and -35°C. They are not part of the current project, but their evaluation by the vineyard owners may provide useful information in future years.
- Information about vineyards development; phenology events and specific dates for bud break, bloom, harvest dates; vine maturity in early October and fruit quality at harvest are provided in annual progress reports. Accumulated harvest dates, Brix, total acid and pH values for varieties in test vineyards for 2007 to 2011, including the Foch variety, are provided in the 2011 progress report.

Significant events at test vineyards 2005-2006.

2005 Roshard and Ruddock vineyards were planted. Vine growth at Roshard vineyard exceeded one metre; vines were staked and protected with milk cartons; powdery mildew was a serious problem; plants did not fully mature prior to winter. Ruddock vineyard growth was variable, seldom exceeding 40 cm; the vineyard was very weedy and hand moved sprinkler irrigation was not always timely. Vines did not mature fully prior to winter.

2006 Canes that were not matured at the end of 2005 were killed during the winter at both Roshard and Ruddock vineyard. At the Roshard site plants recovered from winter damage and a late spring frost; grew vigorously and produced a limited crop on some vines. Vines at the Ruddock site recovered from the winter; had moderate vigor; weeds were still a problem. Vines for Pietila and Wonderland vineyard were removed from the nursery in late May to June while they were actively growing and suffered vine losses and serious transplant shock on replanting.

Significant events at test vineyards 2007-2011.

2007 Some vines at Roshard Vineyard had trunk damage resulting from the 2006-2007 winter. A limited crop was produced on all varieties at Roshard vineyard. There was some trunk damage to some vines at Ruddock vineyard. Ruddock vineyard vines produced excess vigour and some fruit. Low vigour in Pietila vineyard appeared to be related to poor irrigation water quality and some winter damage. Wonderland vineyard had some winter damage but recovered and grew well. Tensiometers were installed at all sites to help schedule irrigation programs. Additional funds became available enabling an expanded climate network to be installed between August and December. This permitted climatic data collection at all vineyard sites and at 83 additional sites throughout the study area. The additional funds also permitted the hiring of a part time technician to assist in monitoring the vineyards and collection of climatic data. There was a tour of Ruddock and Roshard vineyards in September with Hon. Pat Bell, BC Minister of Agriculture and Lands and his guests.

2008 The Roshard test vineyard had vigorous growth and production of an estimated half crop. Foch produced a normal crop. Ruddock vineyard had some winter damage and produced some fruit. Pietila vineyard had low vigor. Vines at Wonderland vineyard have generally recovered from transplant shock and produced good growth. Vines at Wonderland Farm were stripped of bloom to encourage better growth. Ruddock vineyard owners accidently sprayed vineyard weeds with an unknown broad leaf weed killer. Almost all vines died.

2009 There was extensive damage to canes and trunks of all varieties in all test vineyards from low temperatures during Dec. 2008. There was some winter damage to Foch at Roshard vineyard, but Foch produced a normal crop. Vineyard recovery from the roots and trunks of all varieties, at all sites, was late and slow. Owners of the Pietila vineyard replaced varieties Cabernet Sauvignon, Merlot, Pinot Noir, Pinot Gris and Tinta Madeira with Cabernet Franc and Pinot Gris grafted to more lime tolerant Riparia Gloire and Couderc-3309 grape rootstocks and own rooted Foch. The remaining own rooted vines at Pietila vineyard had low vigour. Vines at Wonderland Farm and Roshard vineyards recovered partially by September. There was a limited crop from a few varieties at test sites. Fall frost Oct. 11 and 12 froze all foliage and immature shoots in all test vineyards.

In 2009, Canada Food Inspection Agency informed test vineyard owners that the original source for Limberger in test vineyards was recently found to contain a quarantinable grape virus. All known vines propagated from that source have been put under quarantine. The virus does not spread naturally. Vines in test plantings were allowed to remain for evaluation but propagation from these vines is not permitted.

2010 A limited crop produced at all sites. The Roshard vineyard had new growth, much from secondary buds, the trunk and root area as well as from cordons but vines generally lacked vigour. Vines planted on mid slope at Wonderland Farm have recovered well but vines at the bottom of the slope had poor growth. Own rooted vines at Pietila vineyard continue to have low vigour while grafted vines and Foch grew well.

2011 Budbreak in test vineyards consisted of a mixture of primary and secondary buds. Foch produced a normal crop. Test varieties produced a limited crop at all sites. Vines on the upper slope at Wonderland Farm grew well while vines at the bottom of the slope did not grow well. Own rooted vines in the Pietila vineyard continued to have low vigour while the grafted vines and Foch had sufficient growth to produce a half crop in 2012. Large quantities of root damaging root lesion, dagger and pin nematodes were identified as likely contributors to low vine vigour at the Roshard vineyard.

Wildlife such as wasps, birds, deer and bears are a problem at all sites. Pietila vineyard has deer fencing. Roshard Vineyard has a perimeter fence which acts like a deer fence plus electric fencing to protect the grape crop from bears. Early varieties such as Foch and Riesling Muscat are susceptible to wasp damage. None of the test vineyards are protected from birds.

DEVELOP A DETAILED CLIMATIC PROFILE OF THE AREA

- The project climate network consists of three Weatherhawk and two Davis Vantage Pro 2 weather stations; 87 temperature data loggers (iButtons) and 12 Hobo Pro temperature data loggers. The Hobo Pro 2 data loggers were added to the climate network to enable verification of the iButton data.
- Project weather stations and data loggers are located on private property and reserve land and range in location from approximately 15 km south of Lytton; north from Lytton along both sides of the Fraser River past Lillooet to the vicinity of Big Bar Creek. Several data loggers are also located in the Botanie valley and east from Lytton along the Thompson River. Data loggers are located at elevations ranging from 155m to 575m.
- Data from the weather stations was collected every two months; data from iButtons was collected every four months; data from the Hobo Pro 2 data loggers was collected annually. The final date for data collection was January 2012.
- Detailed climatic records at vineyard sites as well as climatic information gathered from the project climate network as well as the Environment Canada climate stations at Lillooet and Lytton is compiled and analysed and provided in annual progress reports. Detailed climate events at test vineyards are contained in the 2011 Progress Report.
- All climatic data collected from the project network is provided to participants at the Pacific Agri-Food Research Centre (PARC) in Summerland, B.C. where it is analysed, stored and climatic data summaries prepared. Tabular and graphic presentations of extreme minimum winter temperatures, total growing degree days and length of frost free periods obtained from data analysis by PARC is provided in annual progress reports.
- Minimum winter temperatures from Environment Canada weather stations at Lillooet and Lytton are compared to minimum winter temperatures at Environment Canada weather stations in Kamloops, Kelowna, Penticton, Summerland and Osoyoos in annual progress reports.
- Climatic data from the project climate network identifies climatic differences in frost free periods, growing degree days and extreme minimum temperatures between the Environment Canada weather station locations at Lytton and Lillooet and sites of the current project climate network. There are differences among the current project data collection sites for the frost free periods, growing degree days and extreme minimum winter temperatures.

- An interactive map has been developed that allows users of Google Earth to interactively view the location of project weather stations and iButton locations and test vineyard locations. Using Google Earth users are able to view the location, find the latitude, longitude and elevation of a point of interest, and better understand the topography of the area. To download and install Google Earth click on this link http://earth.google.com/download-earth.html and follow the instructions.
- A Geographical Information System (GIS) project has produced a series of 36 calculated solar radiation maps of the study and the surrounding area in support of this project. The maps are available as portable document format (pdf) files for viewing and download free of charge at http://www.solarradiationmapping.ca/ Each map sheet also contains the iButton number, location and elevation and provides supplemental climatic data for 2007 to 2010 that includes Extreme Minimum Temperatures, Growing Degree Days, Frost Free Period and the dates of the last spring frost and the first fall frost. In addition to their use for grape site selection, these maps are suitable for any agricultural crop or project that requires knowledge of the amount of calculated solar radiation or climatic data in the area.

Project Results and Conclusions

To test the suitability and performance of wine grape varieties in the Lillooet-Lytton region.

Based on the viticulture data collected

- Removal of actively growing vines from the nursery resulted in severe transplant shock and plant losses in the Pietila and Wonderland vineyards.
- Man made terraces require pre planting investigation and preparation.
- Soil and water tests should be conducted prior to planting to determine soil and water quality. Soil test for nematodes in previously cropped land should also be conducted prior to planting.
- Use of tensiometers is helpful to scheduling irrigation. Tensiometers need to be installed properly and require maintenance and servicing.
- All of the grape varieties, at all sites, were severely injured by low temperatures during Dec. 2008.
- Foch is the only variety to produce a full crop each year during the test period.
- Early varieties and mid season varieties generally matured with higher Brix in 2008 compared to late maturing varieties, with the exception of Merlot which had good Brix values most years.

- Fruit maturity was earlier on the western aspect of the Pietila vineyard compared to the northern aspect of Wonderland Farm or the Roshard vineyard which has very little slope
- Recovery of severely winter injured vines may take several years.
- The use of V. vinifera vines grafted to lime tolerant grape rootstocks at the Pietila vineyard produced more vine growth compared to own rooted V. vinifera vines
- Annual vine phenology records provided in progress reports include vine maturity in early October; harvest dates and fruit quality data. Harvest dates and fruit quality analysis data for 2007 to 2011 is provided in the progress report for 2011.

To develop a detailed climatic profile of the area.

Based on the climatic data collected

- There is insufficient rainfall in the study area to grow grapes without good quality irrigation water.
- The slopes of the Pietila and Wonderland vineyards illustrate that slopes are beneficial for late spring and early fall frost avoidance.

The project climatic data suggests a range of V. vinifera wine grape varieties can be produced in portions of the study area but not in all areas.

Climatic data from the project climate network provided the following information:

- **Growing Degree Days** in the study area (range 859 to 1729) are sufficient to produce very early to late maturing varieties of V. vinifera wine grapes. The site with the least number of growing degree days (represented by iButton 44 in 2011) is located in the Botanie Valley; the site with the greatest number of growing degree days (represented by iButton 75 in 2009) is located in the Big Bar Creek area. Based on the average number of growing degree days from all project data collection sites from 2007 to 2011, the overall study area recorded an average of 1306 growing degree days.
- **Average Growing Degree Days for data collection sites in the years 2008 to 2011.**
    1. Growing Degree Days averaging less than 1000 is represented by an iButton at 1 site (44).
    2. Growing Degree Days averaging 1001 to 1100 is represented by an iButton at 1 site (6) as well as the weather stations at Diamond S Ranch and Half Way Ranch.

3. Growing Degree Days averaging 1101 to 1200 is represented by iButtons at 7 sites (2, 5, 28, 29, 53, 60, 73 as well as the weather stations at Grossler Ranch and Ruddock Ranch.
4. Growing Degree Days averaging 1201 to 1300 is represented by iButtons at 20 sites (3, 4, 13, 16, 17, 18, 19, 22, 30, 36, 37, 43, 45, 46, 55, 56, 57, 59, 69, 70)
5. Growing Degree Days averaging 1301 to 1400 is represented by iButtons at 49 sites (8, 9, 10, 11, 12, 14, 15, 20, 21, 23, 24, 25, 26, 27, 31, 33, 34, 35, 39, 40, 41, 42, 47, 48, 50, 41, 52, 54, 58, 61, 62, 63, 64, 65, 66, 67, 68, 71, 72, 76, 77, 78, 81, 82, 83, 84, 85, 86, 87).
6. Growing Degree Days averaging 1401 to 1500 is represented by iButtons at 8 sites (17, 32, 38, 49, 74, 79, 80)

- **The frost free periods** in the study area (range 142 to 221 days) are sufficient to produce very early, early, or mid season maturing V. vinifera wine grapes. Parts of the study area have a frost free season suited to very late maturing wine grapes. Based on average data from all project data collection sites from 2007 to 2011 the study area has an overall average frost free period from April 22 to October 15, an average of 176 days.

  The site with the shortest frost free period (represented by iButton 70 in 2007, 44 in 2010) are located south of Lillooet and in the Botanie Valley and sites with the longest frost free period (represented by iButtons 40 in 2010, 43 in 2010) are located near Lytton.

- **Average frost free periods for data collection sites in the years 2007-2011.:**

1. The Grossler weather station averaged less than 160 frost free days.
2. Frost free periods averaging 160 to 165 frost free days are represented by iButtons at 7 sites (28, 29, 44, 60, 70, 82, 84).
3. Frost free periods averaging 166 to 170 frost free days are represented by iButtons at 6 sites (8, 13, 22, 59, 69, 73) as well as weather station at the Roshard vineyard and Ruddock Ranch.
4. Frost free periods averaging 171 to 175 frost free days are represented by iButtons at15 sites (5, 10, 16, 30, 31, 32, 33, 39, 51, 52, 61, 76, 79, 85, 86) as well as the weather station at Half Way Ranch.
5. Frost free periods averaging 176 to 180 frost free days are represented by iButtons at 51 sites (1, 2, 3, 4, 6, 9, 11, 12, 14, 15, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 34, 35, 36, 37,38, 41, 42, 45, 46, 47, 48, 49, 50, 53, 54, 55, 56, 57, 62, 63, 65, 66, 67, 68, 71, 72, 75, 77, 78, 80, 87).
6. Frost free periods averaging 181 to 185 frost free days are represented by iButtons at 5 sites (58, 64, 74, 81).
7. Frost free periods averaging 186 to 205 frost free days are represented by iButtons at three sites (40, 43, 83) as well as the weather station at the Diamond S Ranch.

- **Extreme minimum winter temperature is the limiting climatic factor to the production of Vitis vinifera wine grapes in the study area.** Extreme minimum winter temperatures warmer than -20°C are preferred for V. vinifera grape production. Temperatures -23°C or warmer usually do not result in winter damage to fully acclimated Vitis vinifera vines. Temperatures between -23°C to -25°C may severely injure the least and moderately hardy V. vinifera grape varieties and may cause some damage to hardy V. vinifera grape varieties. V. Vinifera varieties usually do not survive temperatures colder than -25°C.

    1. Extreme minimum temperatures colder than -23°C were not recorded at 13 data collection sites represented by iButtons (2, 14, 15, 20, 33, 34, 50, 62, 63, 66, 67, 80, 81) which are scattered in the area from Lytton to approximately 35 km north of Lytton.
    2. Extreme minimum temperatures of -23.1°C to -23.9°C were recorded at least once at 25 data collection sites represented by iButtons (3, 4, 5, 16, 17, 18, 19, 21, 24, 26, 27, 35, 37, 41, 42, 43, 47, 48, 49, 51, 52, 64, 68, 71, 87) which are scattered throughout the study area South of Lillooet.
    3. Extreme minimum temperatures of -24°C to -25°C were recorded at least once at 27 data collection sites represented by iButtons (1, 6, 11, 23, 25, 32, 36, 38, 39, 40, 44, 45, 46, 54, 55, 58, 59, 61; 65, 70, 82, 83, 84, 85, 86 as well as the weather stations at Roshard vineyard and Ruddock Ranch). These iButton sites are scattered throughout the study area, predominantly south of Lillooet but include several north of Lillooet and in the Lillooet area.
    4. Extreme minimum temperatures of -25.1°C to -26°C were recorded at least once at 8 data collection sites represented by iButtons (10, 12, 13, 53, 56, 57, 69 as well as the weather station at Grossler Ranch). These iButton sites include areas south of Lillooet as well as several sites in north and east Lillooet.
    5. Extreme minimum temperatures of -26.1°C to -27°C were recorded at least once at 3 data collection sites represented by iButtons (7, 9, 22) which includes part of Fountain Flats and area south of Lillooet.
    6. Extreme minimum temperatures of -27°C to -31.4°C were recorded at least once at 15 data collection sites represented by iButtons (8, 28, 29, 30, 31, 60, 72, 73, 74, 75, 76, 77, 78, 79 as well as the weather station at Diamond S Ranch). These iButton sites include the area near Big Bar Creek, Bridge River, Lillooet airport and part of Fountain Flats.

The data shows that:

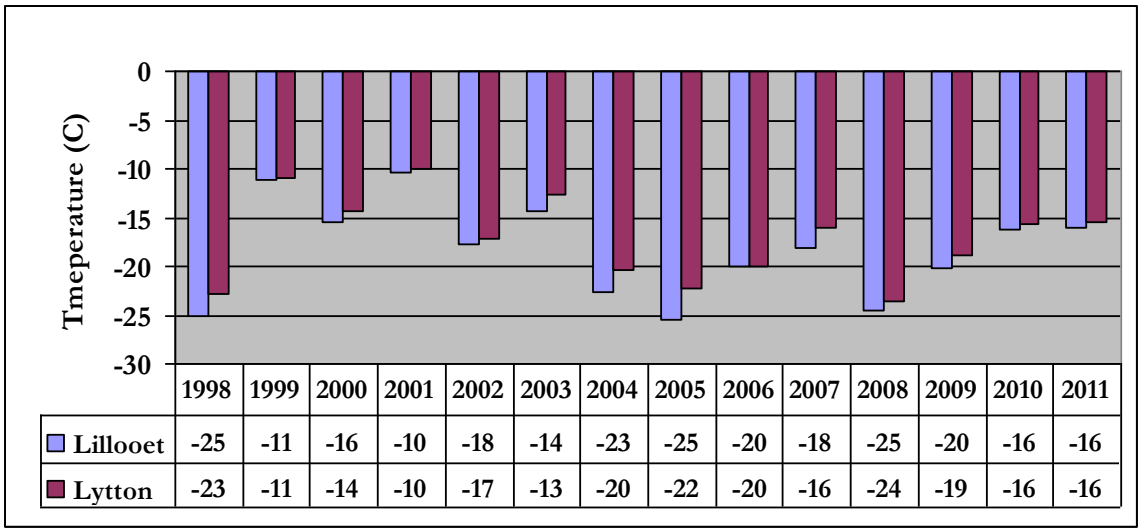
- 41.5% of data collection sites did not record temperatures colder than -24°C.
- 30% of data collection sites are located in a high risk area.
- 28.5 % of data collection sites are poorly suited or non-suited for Vitis vinifera wine grapes.

Damaging winter temperatures are events that are difficult to predict and may not occur consistently. Grape variety susceptibility to low temperatures may vary when the same variety is grown in different areas.

This variation may be influenced by temperatures prior to cold events (acclimation); differences in vine age, nutrition, water content of the vine, micro climates, site or physiological status of the vines due to management.

FIGURES

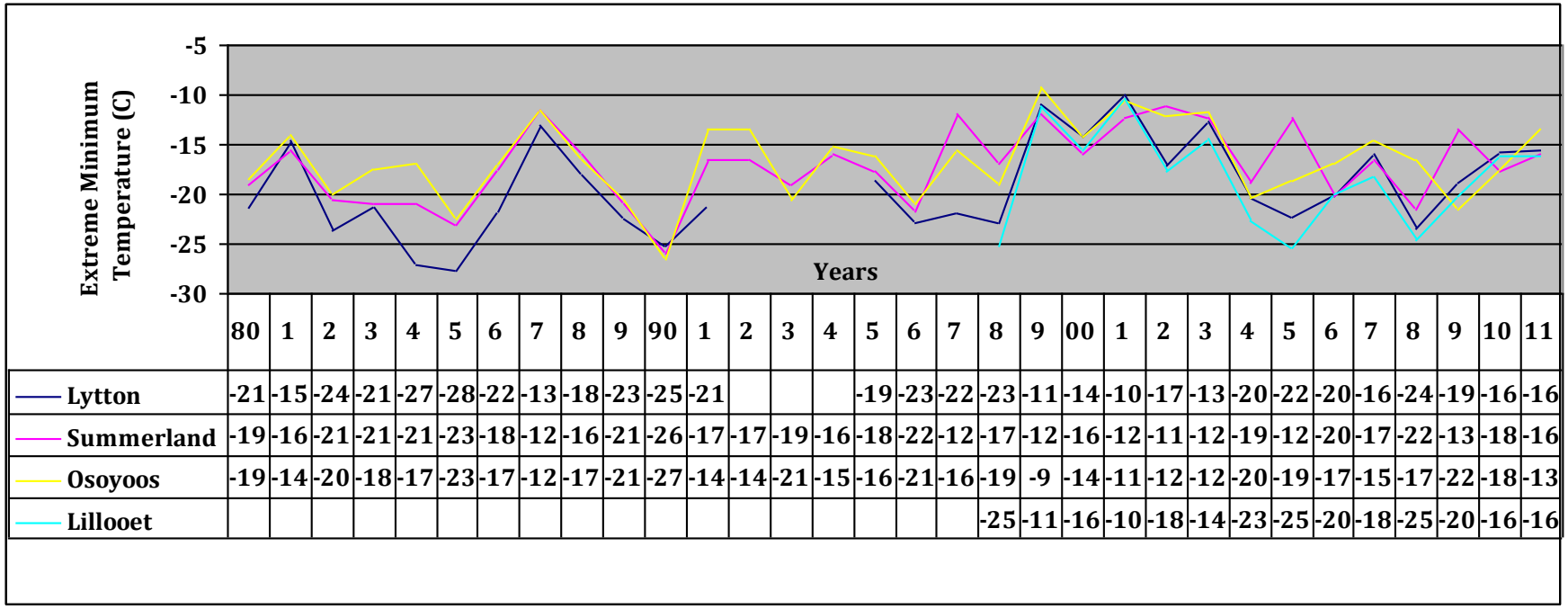
Figure 1 Extreme Minimum Temperatures at Lillooet and Lytton Environment Canada Climate Stations 1998-2011



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Lillooet	-25	-11	-16	-10	-18	-14	-23	-25	-20	-18	-25	-20	-16	-16
Lytton	-23	-11	-14	-10	-17	-13	-20	-22	-20	-16	-24	-19	-16	-16

Figure 1 is a graphic and tabular representation of extreme minimum winter temperatures over a 14 year period at Environment Canada climate stations in Lillooet and Lytton. The data demonstrates that it is generally colder at Lillooet than at Lytton. The frequency of temperature occurrences between -23°C to -25°C at Lillooet is 1 every 3.5 years while in Lytton it is 1 every 7 years. Temperatures colder than -25°C did not occur during this 14 year time period. Climatic data from the project climate network shows that during 2007 to 2011 extreme minimum temperatures colder than -23°C did not occur at 13 data collection sites; extreme minimum temperatures between -23°C and -25°C occurred at least once at 50 data collection sites and extreme minimum temperatures colder than -25°C occurred at least once at 24 data collection sites. Figure 1 illustrates the need for careful site selection for grape production

Figure 2 Extreme Minimum Temperatures at Selected Environment Canada Climate Stations 1980 to 2011

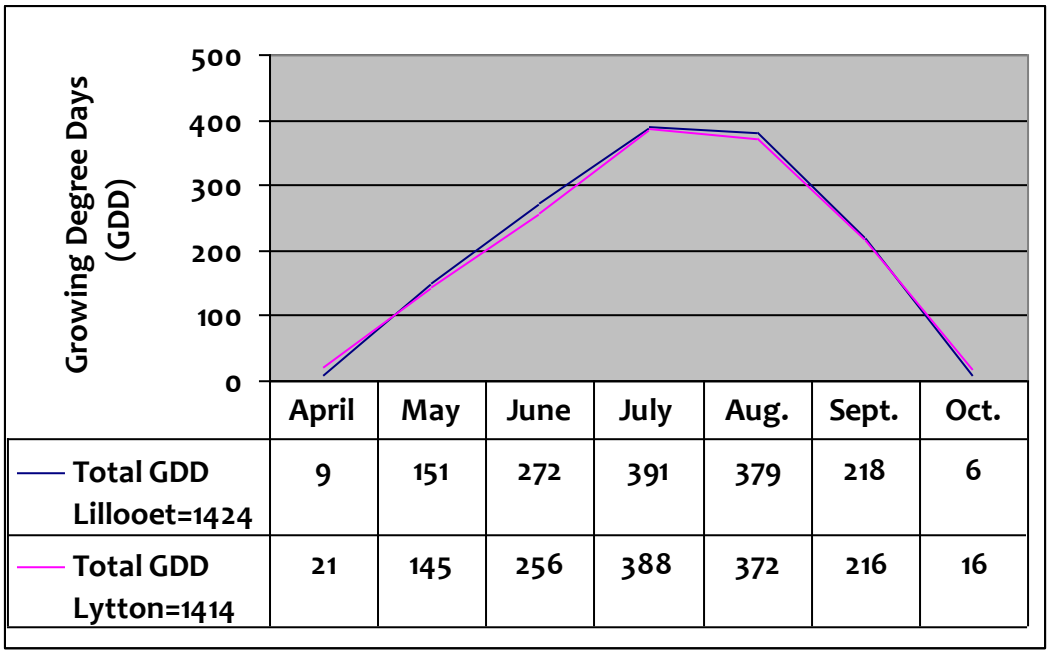


	80	1	2	3	4	5	6	7	8	9	90	1	2	3	4	5	6	7	8	9	00	1	2	3	4	5	6	7	8	9	10	11
Lytton	-21	-15	-24	-21	-27	-28	-22	-13	-18	-23	-25	-21				-19	-23	-22	-23	-11	-14	-10	-17	-13	-20	-22	-20	-16	-24	-19	-16	-16
Summerland	-19	-16	-21	-21	-21	-23	-18	-12	-16	-21	-26	-17	-17	-19	-16	-18	-22	-12	-17	-12	-16	-12	-11	-12	-19	-12	-20	-17	-22	-13	-18	-16
Osoyoos	-19	-14	-20	-18	-17	-23	-17	-12	-17	-21	-27	-14	-14	-21	-15	-16	-21	-16	-19	-9	-14	-11	-12	-12	-20	-19	-17	-15	-17	-22	-18	-13
Lillooet																			-25	-11	-16	-10	-18	-14	-23	-25	-20	-18	-25	-20	-16	-16

Figure 2 provides a graphic and tabular comparison of extreme minimum winter temperatures at four Environment Canada climate stations over a 32 year period. The longest period for which continuous data is available from the current Lillooet station is 14 years.

The data shows that Lytton had six occurrences of temperatures -23°C to -25°C during the 32 year period compared to Osoyoos and Summerland which each had two occurrences. Lillooet had four occurrences of temperatures -23°C to -25°C during a 14 year period from 1989 to 2011 while Lytton had two occurrences and Summerland and Osoyoos each had none.

Figure 3 Average Monthly Growing Degree Days at Lillooet and Lytton Environment Canada Climate Stations 1998 - 2011



	April	May	June	July	Aug.	Sept.	Oct.
Total GDD Lillooet=1424	9	151	272	391	379	218	6
Total GDD Lytton=1414	21	145	256	388	372	216	16

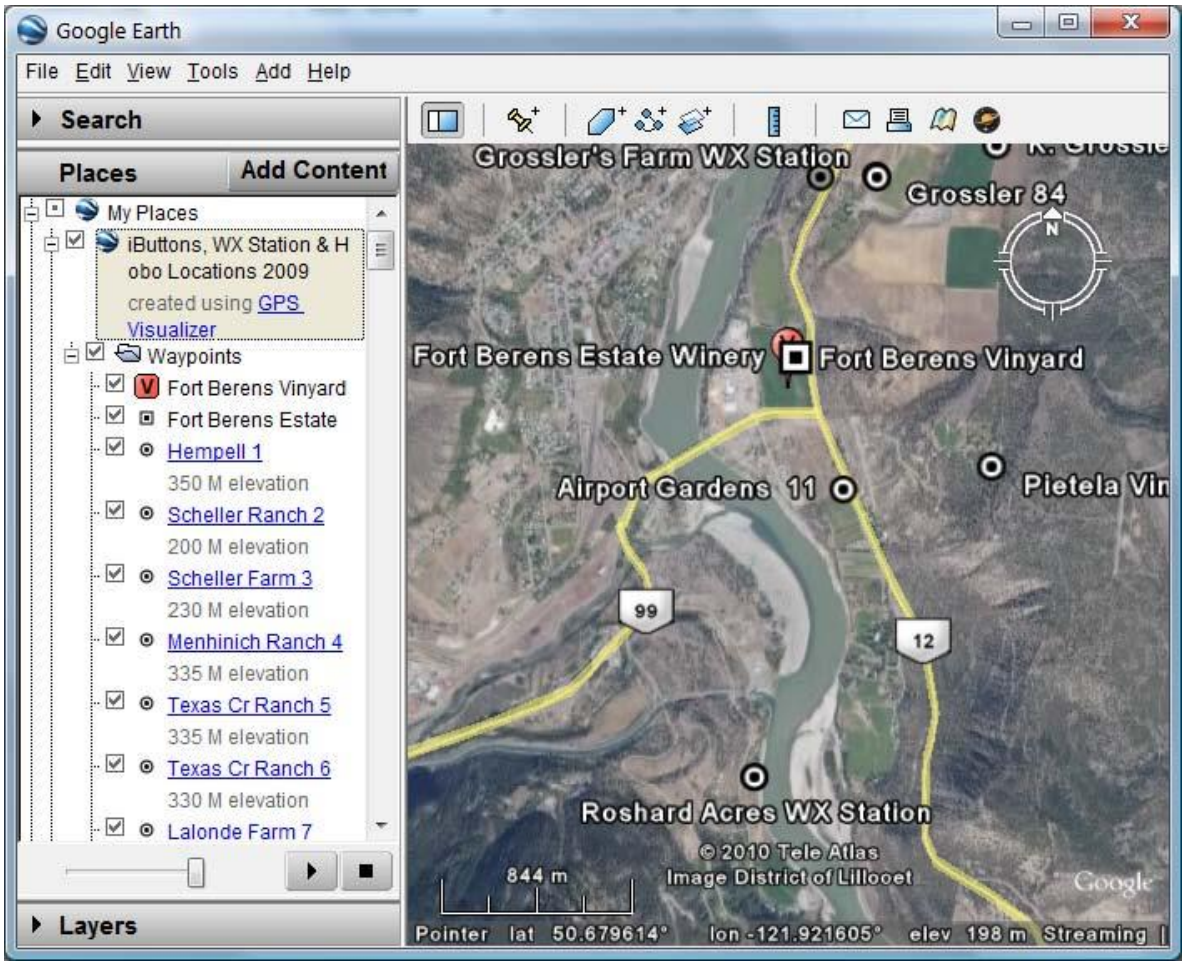
Figure 3 is a graphic and tabular representation of the average monthly accumulation of growing degree days at the Lillooet and Lytton Environment Canada climate stations over a 14 year period. The data illustrates how the average growing degree day accumulations are distributed over the growing season. The first fall frost in the study area is likely by the third week of October. That event, as well as the lack of growing degree days during most of October illustrates the need to select varieties that mature within the frost free period and available growing degree days plus the use of management practices that encourage early fruit maturity and early vine acclimation.

MAP OF PROJECT STUDY AREA

iButton and Weather Station locations – Google Earth Maps

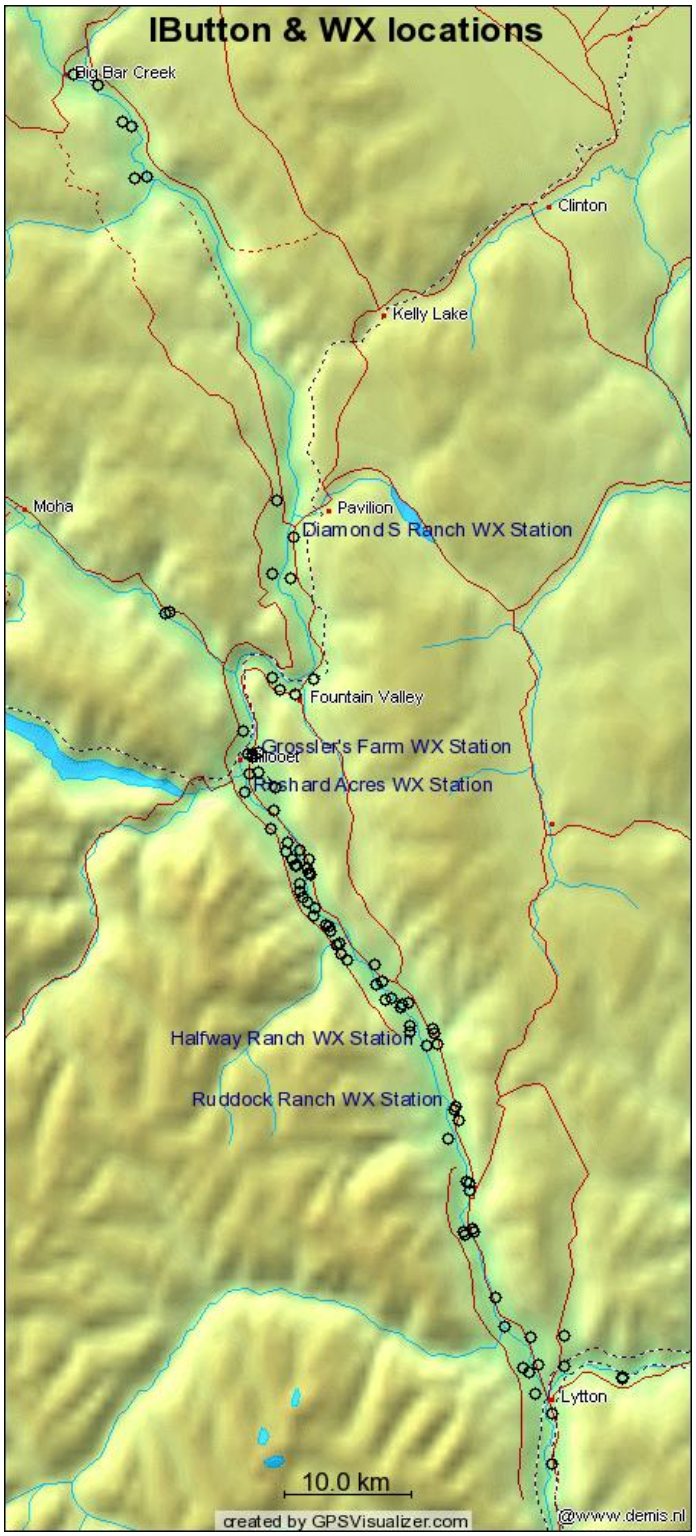
A data set has been created that allows users of Google Earth to interactively view the weather stations, Hobo & iButton temperature data loggers, and test vineyard locations. Using Google Earth you are able to see the locations, find the latitude, longitude and elevation of a point of interest, and better understand the topography and geography of the area. To download and install Google Earth click on this link http://earth.google.com/download-earth.html and follow the instructions.

Once you have Google Earth running on your computer, open the file "iButtons.kmz" (which can be downloaded from either the Village of Lytton or District of Lillooet websites) with Google Earth. In "My Places' expand the icon titled 'iButtons, WX Station & Hobo Locations 2009", expand the "Waypoints" folder and then click on the iButton number or weather station location of interest.



A portion of the study area on Google Earth showing several locations with a weather station, several iButton locations and the side bar with iButton locations.

PROJECT STUDY AREA IN THE LILLOOET-LYTTON AREA

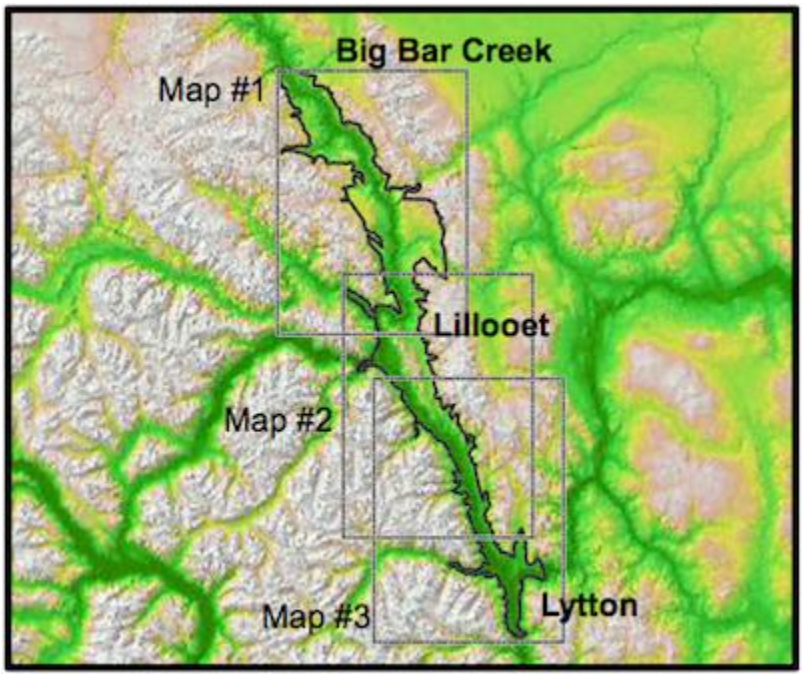


SOLAR RADIATION MAPS

Maps to support decision making in agriculture, energy and natural resource management.

Lillooet - Lytton Maps

This series of 36 maps has been produced in support of developing a "Climate and Feasibility Assessment of Growing Wine Grapes in the Lillooet-Lytton Area, British Columbia" – a research partnership that includes the British Columbia Grapegrowers' Association, local property owners, Investment Agriculture Foundation of BC, and local, provincial and federal agencies. Further information on this project can be found on web sites listed under communications.



These maps are in jpeg and pdf format and are designed to be plotted on 34 by 44 inch paper. This will result in a map at 1:50,000 scale. Three map sheets are required to show the extent of the study area. A set of three maps has been prepared for each month. A large zip file (33 Mb) containing all 36 pdf files is available for download. Use the drop-down menu to download these maps.

ADDITIONAL COMMENTS

- Site selection (location) is a fundamental and irreversible decision and is the single most important decision affecting the life and profitability of the vineyard. In addition to the viticulture and climatic data, interactive Google Earth and Calculated Solar Radiation maps provided by this project, the

following comments are provided to assist in site selection for grape production.

- Grapes are a heat loving crop and grow best where winters are mild and summers are long, dry and warm. More emphases should generally be placed on climate and topography of the site than on soil characteristics. Better sites for V. vinifera have at least 160 days frost free season; at least 1100 growing degree days; extreme minimum winter temperatures not colder than -24°C; long hours of solar radiation in September and October and are sheltered from strong winds.
- Important components to selecting sites for grape production in the study area are climate, topography soil and water. There are many components of climate including temperature, solar radiation, rainfall and wind. The study area has insufficient rainfall and supplemental irrigation is required.
- High wind speed during winter months can dry soils which may result in root desiccation; remove snow cover in the winter resulting in low temperature damage to roots and breakage of vine branches. High wind speeds during the summer months may cause shoot breakage and tatter leaves; creates moisture stress in vines; and reduces photosynthesis for days if winds are persistent; reduces berry size and increases berry skin thickness. Interplanting tall annual crops between rows of grapes or use of snow fencing or wind breaks or shelter belts with 50% wind speed reduction are beneficial to vineyards in windy areas.
- The climate of a vineyard site is also affected by the local topography. Topography includes the elevation, slope, and aspect. The relative elevation of a site must be considered in relation to the surrounding elevation. Poor relative elevation may place a site in cold air pooling areas (frost pockets), cold air drainage channels from surrounding mountains, or terraces (benches) which restrict air flow and causes air to pool, like lakes. Trees or other obstructions can also block air flow. Under radiant cooling conditions; clear skies, the earth loses heat at night and this warm air cools to adjacent layers of air. The cooler air moves downhill on a slope like water, displacing the warmer air to higher elevations, producing temperature inversions. Air temperatures again decrease above the inversion. A slope (5% to 20%) is desirable in vineyard sites as it accelerates drainage of denser cold air to lower levels, reducing the risk of late spring and early fall frosts and cold air pooling.
- Slopes greater than 20% raise concerns about soil erosion and equipment use. Slopes greater than 10% may require some form of terracing or use of self levelling equipment.
- The aspect or prevailing compass direction of a slope affects the exposure to solar radiation on the vineyard and therefore the amount of heat accumulated at the site. South or west aspects warm earlier in the day and accumulate

more heat compared to east or north aspects. Vines planted on south or west aspects start to grow earlier and may undergo deacclimation during mid winter thaws. Eastern slopes start the process of photosynthesis earlier; have more stable daily temperatures; may be subject to topographic shading in the afternoon and evenings; and are warmer sites than north aspects. Minimum temperatures are generally colder on north slopes. An ideal vineyard site is located in mid slope where spring and fall frost risk is least.

- Grapes can grow successfully on a wide range of soils. The best vineyard soils permit deep and spreading root growth and provide a moderate water holding capacity. They also have good drainage; pH range between 5.5 to 8.2; rooting depth of at least 1 metre; a water table at least two metres below the surface; organic matter content between 2% and 3%; moderate fertility; are not excessively stony and have electrical conductivity less than 1.5 decisiemens per metre.
- Grape roots are not as cold tolerant as the above ground portions of the vine. Plant grape vine roots at least 30cm deep to protect roots from severe winter temperatures.
- Commercial grape production may be extended to colder portions of the current study area by using a number of cultural techniques such as: maximizing snow cover during the winter through the use of cover crops to retain snow or protecting roots by burring the bottom portion of the vines with soil prior to winter (hilling) or protecting the roots and lower part of the trunk with straw; by pruning to a system with lower trunks to facilitate hilling and burring of canes or by using wind breaks and the use of wind machines in the spring or fall and in the winter.
- Vitis vinifera grape varieties not part of the current project but also classified as hardy include very early white varieties Madeline Sylvaner, Madeline Angevine and early white varieties Ortega and Auxerrois as well as a mid season red variety Gamay Noir and a late mid season white variety Kerner.
- Hardy hybrid grape varieties are an alternative to Vitis vinifera varieties for grape production in the region. Marechal Foch has produced a full crop for each year during the study period, and is reported to have produced a full crop since it came into production at the Roshard site. Foch may survive temperatures to -28°C. Other red hybrid varieties as hardy as Foch include Baco Noir and Castel 19637. There are no white French hybrid varieties as hardy and early as Foch.
- New hardy hybrid wine grape varieties Marquette, Frontenac, Frontenac Gris, La Crescent introduced by the University of Minnesota and a new mutation of Frontenac from Quebec called Frontenac Blanc are reported to produce good quality wine and are reportedly hardy between -30°C to -35°C These varieties are in production in cold areas of the mid west USA including Montana as well

as in eastern Canada. A frost free period of 160 days and 1200 growing degree days are required for these varieties. These varieties have recently been planted in British Columbia, but there is no local experience with them to date. Viticulture and enology information and Questions and Answers about these varieties are available from the University of Minnesota web site http://www.grapes.umn.edu/wine.html.

- The current source for these hardy grape plants in Canada is A&M Viticulture Inc. nursery located in Quebec. This nursery can meet British Columbia import requirements and is also the Canadian distributor for the book "Northern Winework", (2nd edition) which provides information about hardy varieties as well as wine making aspects using these varieties. The nursery web site is in French, but Google provides a reasonable translation. http://www.viticultuream.ca.

DOMESTIC MOVEMENT RESTRICTIONS ON GRAPEVINE MATERIAL

All plants and plant parts of all species, hybrids, horticultural varieties and cultivars of Vitis species moving from an area in Canada known to be infested with grape phylloxera, Daktulosphaira vitifoliae, and nematodes of the following genera: Longidorus, Trichodorous and Xiphinema, into British Columbia, must be accompanied by a Movement Certificate issued by the Canadian Food Inspection Agency (CFIA). All of this material is required to be treated with a CFIA approved treatment prior to movement. There are also regulations to the importation of all plants and plant parts of all species, hybrids, horticultural varieties and cultivars of Vitis species moving to B.C. from other countries. Contact your local CFIA office for details on the shipping or importation requirements.

SUGGESTED READING PRIOR TO PLANTING GRAPES:

1. Best Practices Guide for Grapes for British Columbia. 2010. Available from BC Wine Grape Council, PO Box 1218 Peachland, BC. VOH 1X0. Tel. 250 767-2534. Fax 250 767-0093. Email bcwc@telus.net. Website www.bcwg.org
2. Plocjer, Tomas and Robert J. Parke. 2008. Northern Winework Growing Grapes and Making Wine in Cold Climates. Second Edition. Available in Canada from A & M Viticulture Inc. Email coquine@endirect.qc.ca
3. Young, G., M.A. Fenger and H.A. Luttmerding. 1992. Soils of the Ashcroft Map Area. MOE Technical Report 23.Intergrated Management Branch Victoria, BC. This report provides detailed soil and landform information and soil maps that include the study area.
4. Fresh Market Grape Production. Best Practices Guide in British Columbia. 2009-2010 Edition. Available from. British Columbia Grapegrowers' Association 451 Atwood Road, Grand Forks, BC, VOH 1H9. Tel. 877-762-4652; Fax 250-442-4076
5. Michigan State University Extension. 2007. E2930, Winter Injury to Grapevines and Methods of Protection. MSU Bulletin Office 517-353-6740 or order on line at www.emde.msu.msu.edu
6. Michigan State University. SWMREC Special Report 23. The Construction of Equipment for Hilling-Up and Taking-Out Soil Around Grafted Grapevines. http://www.grapes.msu.edu/. Use search and enter SWMREC Special Report 23
7. Heinticks, Geoff. 2001. A Viticulture Primer for Investors and Growers. Dan Taylor, Prince Edward County Economic Development Office, Prince Edward County, Ontario, 28 East Street, Wellington, Ontario, Canada. K0K 3L0, Email pecedo@kos.net Ph. 613 399 3424 Fax. 613 399 1802
8. The following British Columbia Ministry of Agriculture website http://www.al.gov.bc.ca/grape/publications/vinifera.htm provides access to a publication called "Financial Planning Information for Establishing a Vinifera Wine Grape Planting." This publication is out of date (Nov. 2000) but is the only grape cost of production study available in British Columbia. This publication provides a framework to those who wish to update the figures.
9. The following British Columbia Ministry of Agriculture website provides access to various publications related to the BC grape industry as well as InfoBasket, a Ministry search engine for many agriculture topics, including grapes. http://www.al.gov.bc.ca/grape/index.htm