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REPORT ON

ADDENDUM TO WELL CAPACITY TESTING REPORT SILVER STAR RESORT VERNON, BRITISH COLUMBIA

Submitted to:

Big White Utilities
P.O. Box 2039, Station "R"
Kelowna, British Columbia
V1X 4K5

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May 3, 2002

022-4027

May 3, 2002 022-4027

Big White Utilities
P.O. Box 2039, Station "R"
Kelowna, British Columbia
V1X 4K5

Attention: Mr. Maurice Valcourt, Vice President

RE: ADDENDUM TO WELL CAPACITY TESTING REPORT
SILVER STAR RESORT, VERNON, BRITISH COLUMBIA

Dear Sir:

Golder Associates Ltd. (Golder) is pleased to submit this addendum to our report on well capacity testing at Silver Star Resort. The original report issued by Golder on this project is entitled "Well Capacity Testing, Silver Star Resort, Vernon, British Columbia" and was issued under Golder File Number 022-4027 on March 28, 2002.

This addendum is issued in response to verbal comments received from Mr. Mike Stamhuis, P.Eng., Director of Engineering for the North Okanagan Water Authority (NOWA) regarding the original report, in particular the methodology utilized in establishing the long term safe yield of water wells within the fractured bedrock aquifer on Silver Star Mountain. In general terms, the scope of this assignment is the same as the original body of work, which is to assess the long-term sustainable yield available from three unused water supply wells at the Silver Star Resort. The initial report includes details on the pumping test methodology, observations made during testing and water quality sampling, as well as the methodology used to determine long-term capacity for each well.

This addendum report includes some background on the work completed to date, our understanding of the issues raised by NOWA and a response to the issues, along with data to support our response. This includes background on the wells and fractures in bedrock on Silver Star Mountain, more details on the methodology used in evaluating long-term yields in bedrock wells in British Columbia, as well as information on trends in both static water levels and precipitation in the area, those factors which ultimately effect aquifer levels, recharge, and in turn long-term well yield.

Authorization to proceed with this work was given verbally by Mr. Maurice Valcourt of Big White Utilities on February 28, 2002.

1.0 BACKGROUND

1.1 Silver Star Aquifer Overview

Silver Star Resort is located approximately 15 km northeast of Vernon, in the Shuswap Highlands of the Okanagan Valley. Through on-going development of the resort, both surface water and groundwater have been utilized as a source for potable water. The source of groundwater is from fractures in bedrock, generally encountered from 40 m to 70 m depth.

There are eleven water wells known to exist at Silver Star Resort. Wells 1 through 5 are located in the village area and are currently, or were previously, used to supply the demands of the village. The wells reportedly yield between 60 gpm and 120 gpm of water. Well 6 provides water for the Paradise Restaurant, a day lodge on the north side of the resort, and is located approximately 40 m south of the restaurant, between the Putnam Chair Lift and a surface water reservoir. Wells 7 through 11 are located primarily north and east of the village area. Based on available well log information, all wells at the Silver Star Resort intercept water bearing fractures at between 40 to 70 m depth. The following table summarizes the wells selected for well capacity testing as part of this investigation:

Table 1
Summary of Well Details

Well Number	Well Name / Location	Easting	Northing	Approx. Ground Surface Elevation (m amsl)
Well 7	Base of Yellow Chair Lift	354573	5580612	1428
Well 8	Base of Putnam Chair Lift	356068	5584522	1150
Well 10	Top of Vance Chair Lift	353261	5581638	1889

Well 7 (Yellow Chair) was reportedly drilled in 1993 by Dan-Gare Drilling Ltd. of Vernon, B.C. The geology encountered was described as clay and rocks from ground surface to 39 m depth and rock from 39 m to 142 m. According to the well log, the major water bearing fracture zone is located at a depth of between 55 m and 67 m, with no increase in water found below 104 m depth. The well is constructed of 15 cm (6-inch) diameter steel casing from ground surface to a depth of 41 m, with an open hole in the bedrock extending to 140 m depth. The water level in Well 7 was observed to be located at 30 m below ground surface (bgs) on March 11, 2002.

Well 8 (Putnam) was reportedly drilled in 1993 by Dan-Gare Drilling of Vernon, B.C. According to the driller's log, the major water bearing fracture zones are located at a depth of 43 m, between 49 m to 55 m and between 80 m to 85 m, with no significant increase in water found below 122 m depth. The total depth of this well is reported to be 140 m. The well is constructed of 15 cm (6-inch) diameter steel casing from ground surface to a depth of 12 m, with an open hole in the bedrock extending to 140 m depth. Based on March 2002 conditions, Well 8 is a flowing artesian well.

The limited information available for Well 10 indicates that the total depth of this 15 cm (6-inch) diameter well is approximately 67 m, however no details on the geology or major water bearing fracture zones are available for review at this time. The water level in Well 10 was observed to be located at 18.4 m below ground surface (bgs) on March 18, 2002.

Golder is currently conducting a study to define the extent of the aquifer represented by the fractures in the bedrock as well as the total capacity of the aquifer.

1.2 Rated Yields for Wells in Aquifer

Based on the results of the three well capacity tests conducted at Silver Star Resort in January and February 2002, Well 8, located at the based of Putnam Chair lift, is capable of yielding 11 US gpm; Well 7, located at the base of the Yellow Chair lift, is capable of yielding 2 US gpm; and, Well 10, located at the top of the Vance Chair lift, is capable of yielding 10 US gpm.

2.0 METHODOLOGY FOR DETERMINING YIELD IN BEDROCK WELLS

Well capacity was estimated using the methodology outlined in the guidance document published by the B.C. Ministry of Water, Land and Air Protection (MWLAP) entitled "*Evaluating Long-Term Well Capacity for a Certificate of Public Convenience and Necessity (CPCN)*" (1999). The recommended methodology for estimating the long-term well capacity for a fractured bedrock aquifer is to conduct a minimum 72-hour pumping test during low water level periods (late fall-winter for the interior of B.C.). MWLAP recommends that the following four criteria be considered when evaluating well capacity:

1. adequate pumping test procedures;

2. estimated drawdown in pumping well extended to a minimum of 100 day period;

3. total available drawdown in the pumping well; and,

4. other factors, such as well interference and water quality.

The well capacity (Q) for a specific well, using information from the well log and the pumping test, is calculated as follows:

Q = 0.7 (70% of the available drawdown) x 100 day specific capacity x available drawdown in the pumping well

The 100 day specific capacity is estimated by projecting the drawdown of the 72-hour pumping test to 100 days and the available drawdown is determined to be the height of water between the static water level and the dominant water yielding set of fractures.

The 100 day projection period is utilized as it extends the pumping period from the mid-winter period (Dec/Jan) when the lowest static water levels typically exist to April/May when recharge typically occurs to an aquifer from spring snowmelt/runoff. This time period is intended to represent the period when the recharge to the aquifer is the lowest and hence worst case conditions.

Golder has provided a copy of the CPCN document along with this report.

3.0 CONCERNS RAISED BY NOWA

Our understanding is that the issue of concern raised by NOWA is the reliability of the well capacities determined for Well 7, Well 8 and Well 10. The concern is based on the apparent decline in yields in the existing producing wells in the Village, including Well 1 through Well 5. Mr. Stamhuis from NOWA has indicated that the available water from the wells collectively has been as low as 60 USgpm in 1999, which is down to 50 percent of the total capacity of the wells as established when the wells were initially tested.

4.0 REVIEW OF FACTORS WHICH POTENTIALLY EFFECT WELL YIELDS

Individual well yield and total aquifer yield in fractured bedrock aquifers are a function of several factors including:

1. Annual precipitation
2. Static Water Levels and Annual recharge
3. Mutual well interference due to simultaneous pumping of adjacent wells
4. Chemical and/or sediment buildup in bedrock fractures
5. Total annual withdrawal from aquifer

Each of these factors and how they may influence well yields at Silver Star are discussed in the following sections.

4.1 Total Annual Aquifer Withdrawal

In order to assess if total annual aquifer withdrawals have effected the yield in existing wells, Golder reviewed data provided by NOWA on pumping volume and water levels in the existing production wells in the village. Unfortunately, the quality of the data and period of coverage, which do not extend back to when the wells were initially commissioned, does not allow for a comparison of annual withdrawals.

4.2 Mutual Well Interference

The NOWA data reviewed by Golder show that mutual well interference does occur between wells during simultaneous operation. As part of an on-going evaluation of the bedrock aquifer, Golder has installed pressure transducers to continuously monitor the levels in two pumping and two non-pumping wells in the village. This information along with daily pumping volumes at each well currently in use will allow for a more detailed analysis of the extent of well interference in the village area.

The pumping tests conducted in January 2002 on the three unused wells, were completed during the peak water demand period for the village and during the period when static water levels are historically the lowest in the bedrock aquifer. As indicated in Golder's original report, there were no indications of well interference in the village wells created as a result of the testing of the unused wells.

4.3 Annual Precipitation

Climate information is collected at Silver Star Mountain Resort on a daily basis throughout the ski season and sporadically throughout the off season. The climate in the area consists of warm summers and cool, moist winters. In order to assess if seasonal or long-term trends in precipitation have potentially effected aquifer yield, Golder reviewed available data from the nearest long-term reporting weather station at Coldstream Ranch, located approximately 20 km south of the site. Table 2, which is presented as an attachment to this letter, summarizes the available data for this site, which has been reporting climate data since 1981.

Based on a review of the data, mean annual total precipitation for the Coldstream Ranch is 480 mm. The maximum annual precipitation for the site is 616 mm recorded in 1996 and the minimum is 362 recorded in 2000. A plot of the annual recorded precipitation for each year since 1981 is shown in Figure 1. In order to visualize trends in annual precipitation in the area, which we have assumed to include Silver Star, a plot of cumulative precipitation difference (CPD), or the cumulative variation from the mean, was prepared using the data. The plot shown in Figure 2 indicates that a large variation in annual precipitation has occurred commencing in 1994 and ending in 2001. The peak of the CPD curve over this period indicates the end of 4 successive years of above average precipitation and the downslope of the curve indicates 4 successive years of less than normal precipitation. It should be noted that two of the lowest precipitation years on record occurred in the last 3 years. Although data for 2002 is not complete, the accumulated snow pack at Silver Star is reportedly far greater than normal, which indicates that precipitation for 2002 may be higher than the last few years.

4.4 Static Water Levels and Annual Recharge

Information was obtained from the Ministry of Water, Land and Air Protection (MWLAP) Groundwater Management Section regarding historical static water levels in the fractured bedrock on Silver Star Mountain. The ministry operates a monitoring well on the mountain as part of their province-wide observation well network. MWLAP Observation Well MW-047 is located approximately 100 m northwest of the microwave tower near the peak of Silver Star Mountain. The well is a 50 mm diameter borehole, which extends to 91 m depth in the fractured bedrock and was commissioned for the monitoring of groundwater levels in 1965. The borehole log for the well, which is attached to this report, does not indicate the depth of fractures in the well, however, it is assumed that water-bearing fractures were encountered near the bottom of the borehole. The well is monitored at the end of each month and a plot of the static water levels in the well is presented in Figure 3.

Data from the observation well was used to determine for each year the mean annual static water level (MSWL), lowest recorded static water level (LRSWL), highest recorded static water level (HRSWL) and total yearly fluctuation. The LRSWL is representative of conditions during the mid-winter period when static water levels are historically lowest and the HRSWL of conditions during spring snowmelt when runoff provides recharge to the bedrock aquifer. Figure 4 shows the yearly fluctuations in LRSWL and HRSWL in MW-047. The maximum variation in LRSWL is approximately 3 m, ranging from 7 m in 1996-1997 to almost 10 m in 1988. As shown in Figure 5, these extremes correspond to periods following the lowest and highest annual precipitation years recorded at Coldstream Ranch respectively. The data indicate that a strong correlation with precipitation exists and that there is no long-term trend of decline in water levels during the peak winter demand period.

The maximum variation in HRSWL is approximately 5 m, ranging from 6 m in 1985-1986 to almost 1 m in 1995. These extremes also correspond to periods following the lowest and highest annual precipitation years recorded at Coldstream Ranch respectively. The data also indicate that a strong correlation with precipitation exists and that there is no long-term trend of decline in water levels during spring recharge.

4.5 Chemical and/or Sediment Buildup in Fractures

Deteriorating yields in wells completed in fractured bedrock can occur over time due to the accumulation of small particles or sediment in the fractures within the bedrock. Precipitation of calcium and manganese carbonate or related sulphates, incrustation of iron and manganese compounds and plugging caused by iron-reducing bacteria can also limit the capacity of fractures to transmit water. The chemical equilibrium of the groundwater within the bedrock is a function of the type of rock and residence time of groundwater within the aquifer. The equilibrium is upset when a well is pumped, particularly when drawdown during pumping becomes excessive. According to the literature, the most prevalent cause of deteriorating well yields in metamorphic bedrock aquifers is fissure (fracture) plugging by sedimentation and mineralization.

The results of water quality testing on Well 7, Well 8 and Well 10 in January 2002 indicate that iron levels are high in Well 8 (0.85 mg/l total) and Well 10 (0.17 mg/l total). High iron levels can be an indicator of an elevated potential for clogging of fractures to occur.

Golder has not reviewed the groundwater quality for other wells in the area, however it is conceivable that other wells completed in the same aquifer may have a propensity to become clogged. This should be investigated further as the reportedly declining yields in the wells within the village may be a result of reduced flow through fractures caused by sedimentation or mineralization.

5.0 DISCUSSION

Based on the review above regarding each of the factors which potentially effect well yield, it is apparent that there is a strong correlation between annual precipitation in the Silver Star Area and levels in the bedrock aquifer on the ski hill. In determining the individual well yields for Well 7, Well 8 and Well 10 at Silver Star, 70 percent of available drawdown in each borehole has been assumed to be constantly available. The remaining 30 percent of available drawdown is not considered available and is applied as a factor of safety intended to account for the seasonal fluctuations in static water levels in the aquifer.

The data from MW-047 indicate that mid-winter static water levels (LRSWL), which represent the worst case conditions for an operating well at Silver Star, have historically fluctuated by as much as 3 m. As shown in the following table, a fluctuation of this magnitude is not expected to exceed the 30 percent of available drawdown allocated as a factor of safety in determining the long-term yield in each well:

Table 3
Effect of Yearly Fluctuation in Mid-Winter Static Levels on Well Yield

Well No.	Available Drawdown (ADD in m)	30 % of ADD	Expected SWL Fluctuation (m)	Fluctuation Exceeds 30 %	Potential Effect on Well Yield
Well 7	25	7.5	3	No	Low
Well 8	80	24	3	No	Low
Well 10	46	13.8	3	No	Low

6.0 CONCLUSION

In response to the concerns raised by NOWA regarding the reliability of the calculated long-term well yields for Well 7, Well 8 and Well 10 at Silver Star Mountain, Golder has reviewed historical climate and static water level data for the area to determine the relative influence of these factors on well yield.

There is an apparent strong correlation between precipitation in the area and static water levels within the bedrock aquifer on Silver Star Mountain. Years of high total precipitation correspond with years when static water levels are highest and years with low total precipitation correspond with years when static water levels are the lowest. This is reflected in the lowest static water levels recorded on the site in 1999, which occurred during a period when three of the four lowest precipitation years on record were reported.

Calculations for long-term well yield in Well 7, Well 8 and Well 10 were completed by Golder according to the recommended guidelines in British Columbia which account for seasonal fluctuations in static water levels within bedrock. The guidelines recommend using a factor of safety of 30 percent applied to the available drawdown in a well to account for both seasonal and yearly fluctuation in static water levels.

A review of the historical climate and static water level data in the area indicates that the yearly fluctuation in static water levels during the mid-winter period, which represents worst-case conditions, is approximately 3 m. This amount falls well within the 30 percent factor of safety allocated for available drawdown in the three wells and therefore, we do not expect that yearly fluctuations will effect the available yield in these wells.

Historical static water levels which have been recorded in a MWLAP observation well located on the ski hill for 35 years, show no evidence of declining levels in the bedrock aquifer.

7.0 LIMITATIONS

This report was prepared for the exclusive use of Big White Ski Resort. The report is based on a review of data and information contained in third party reports provided to Golder by Big White Ski Resort and Silver Star Resort, as well as data collected in the field by Golder. We accept no responsibility for any deficiency, misstatements or inaccuracies contained in the reviewed reports as a result of omissions, misinterpretations or fraudulent acts on the part of the authors of the third party reports. Golder has relied in good faith on information provided by the individuals noted in the reports.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based of it, are the responsibilities of such third parties.

This assessment was performed according to current professional standards and practices in the environmental field. If new information is discovered during future work, including excavations, borings or other studies, Golder should be requested to re-evaluate the conclusions presented in this report and to provide amendments as required.

8.0 CLOSURE

We trust that this report provides you with the information that you require at this time. Should you have any questions or require additional information, please do not hesitate to contact the undersigned.

Yours very truly,

GOLDER ASSOCIATES LTD.

Remi Allard, M.Eng, P.Eng.
Senior Hydrogeologist

Reviewed by: Don Chorley, P.Geo.
Associate, Senior Hydrogeologist

RA/DC/mh
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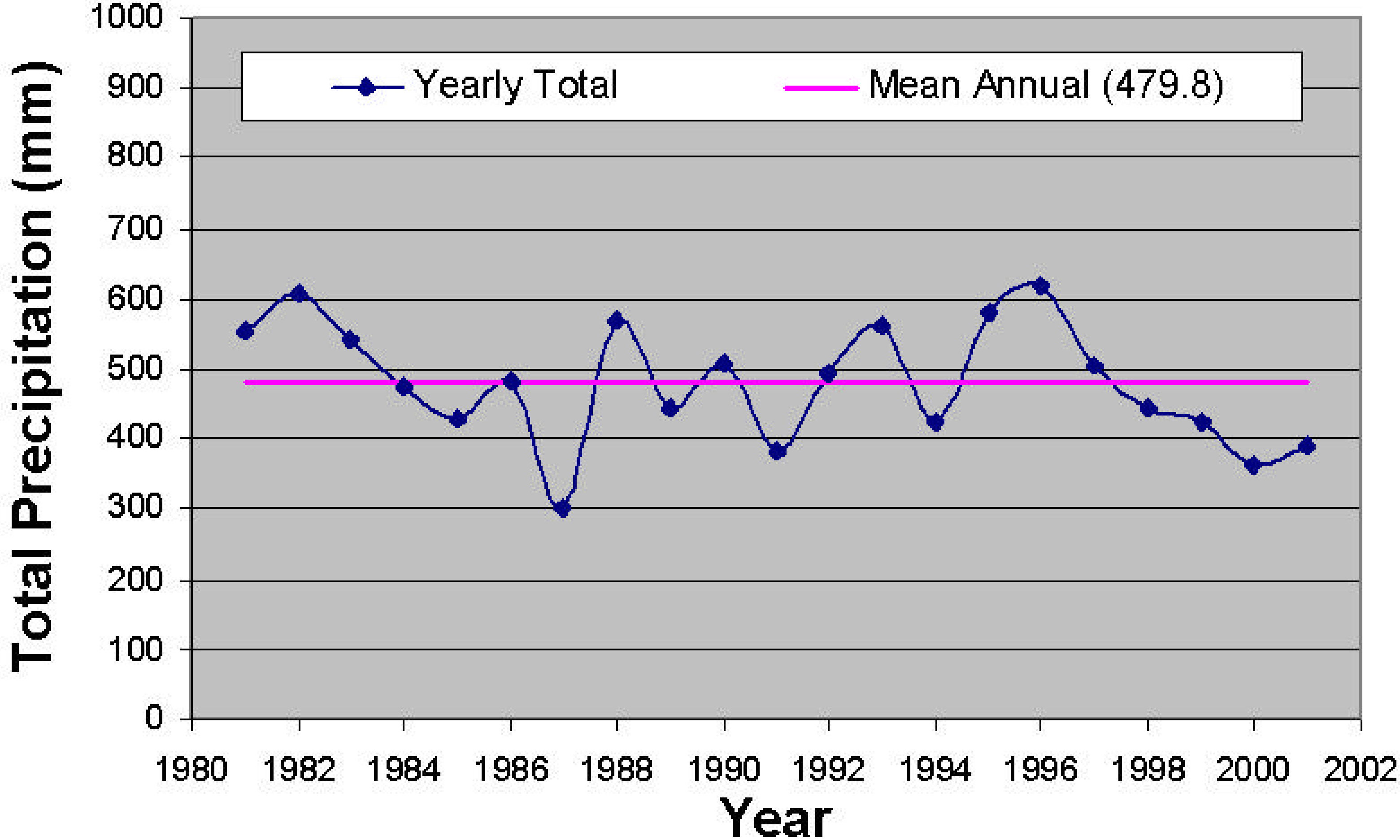
Table 2
Total Monthly Precipitation
Coldstream Ranch
Vernon, British Columbia

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Mean	Rank	Cum. Precip. Departure (CPD)	Cum. Mean
1981	16.7	46.8	33.2	27.8	73.2	67.5	64.6	36.8	58.5	38.0	25.8	63.9	552.8	479.8	6	73.0	552.8
1982	91.5	38.5	40.4	14.8	41.8	55.4	93.1	36.2	64.6	28.0	68.0	35.3	607.6	479.8	2	200.7	580.2
1983	53.9	53.7	31.2	51.8	29.0	57.5	66.0	38.4	34.6	25.8	51.0	49.0	541.9	479.8	7	262.8	567.4
1984	36.8	13.3	37.9	25.2	65.0	63.0	8.1	56.1	32.4	37.2	53.9	43.5	472.4	479.8	12	255.3	543.7
1985	4.2	41.4	13.0	20.2	36.8	46.8	8.8	44.2	69.8	70.4	33.1	37.0	425.7	479.8	15	201.2	520.1
1986	37.7	37.7	30.8	53.2	28.4	82.2	43.8	23.4	78.8	19.0	41.1	3.0	479.1	479.8	11	200.4	513.3
1987	24.4	6.0	21.2	30.4	32.0	7.8	40.8	22.6	13.8	18.3	25.6	57.7	300.6	479.8	21	21.2	482.9
1988	25.6	26.8	15.2	62.2	63.6	85.5	57.6	49.2	56.6	30.4	40.7	56.9	570.3	479.8	4	111.6	493.8
1989	24.3	32.8	24.2	20.2	50.0	62.0	51.0	70.6	25.4	22.0	33.2	26.6	442.3	479.8	14	74.1	488.1
1990	36.0	12.2	16.2	20.2	86.2	94.8	39.8	32.0	10.6	30.2	61.4	69.4	509.0	479.8	8	103.2	490.2
1991	46.0	32.8	11.6	22.0	59.4	50.8	21.0	60.0	5.0	10.8	57.0	6.0	382.4	479.8	19	5.8	480.4
1992	41.8	20.2	16.6	28.2	23.8	37.7	37.6	31.2	49.8	29.2	85.8	89.2	491.1	479.8	10	17.0	481.3
1993	46.0	11.8	21.2	57.6	28.0	54.4	131.2	36.4	44.2	49.0	18.2	62.2	560.2	479.8	5	97.4	487.3
1994	27.0	65.0	15.3	30.2	16.2	58.0	16.0	59.0	16.0	41.4	47.3	31.8	423.2	479.8	17	40.7	482.8
1995	46.6	21.8	41.4	39.5	13.2	74.6	26.4	62.6	21.4	40.0	121.6	71.7	580.8	479.8	3	141.7	489.3
1996	38.2	31.4	26.6	36.0	118.4	48.0	25.2	16.9	72.6	68.4	81.0	54.0	616.7	479.8	1	278.5	497.3
1997	38.9	21.0	33.9	10.4	77.4	43.0	117.4	33.4	65.4	25.2	8.0	28.2	502.2	479.8	9	300.9	497.5
1998	42.2	7.8	33.2	30.6	19.6	36.0	29.0	26.0	28.0	46.2	51.0	94.8	444.4	479.8	13	265.4	494.6
1999	32.6	21.8	20.0	9.6	48.4	45.2	40.6	57.0	19.0	48.8	42.4	38.4	423.8	479.8	16	209.4	490.9
2000	36.2	27.0	25.0	31.8	34.2	36.6	50.4	14.2	47.2	19.6	12.2	28.0	362.3	479.8	20	91.8	484.4
2001	17.0	3.2	16.0	31.0	43.8	77.2	41.0	17.8	16.6	52.0	32.2	40.2	388.0	479.8	18	0.0	479.8
2002	31.8	21.2	-	-	-	-	-	-	-	-	-	-	-				
Mean Monthly	36.2	27.0	25.0	31.1	47.1	56.4	48.1	39.2	39.5	35.7	47.2	47.0	479.8				

Drawing file: Figure 1_Precipitation.dwg May 07, 2002 - 1:20pm



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KELOWNA, B.C.

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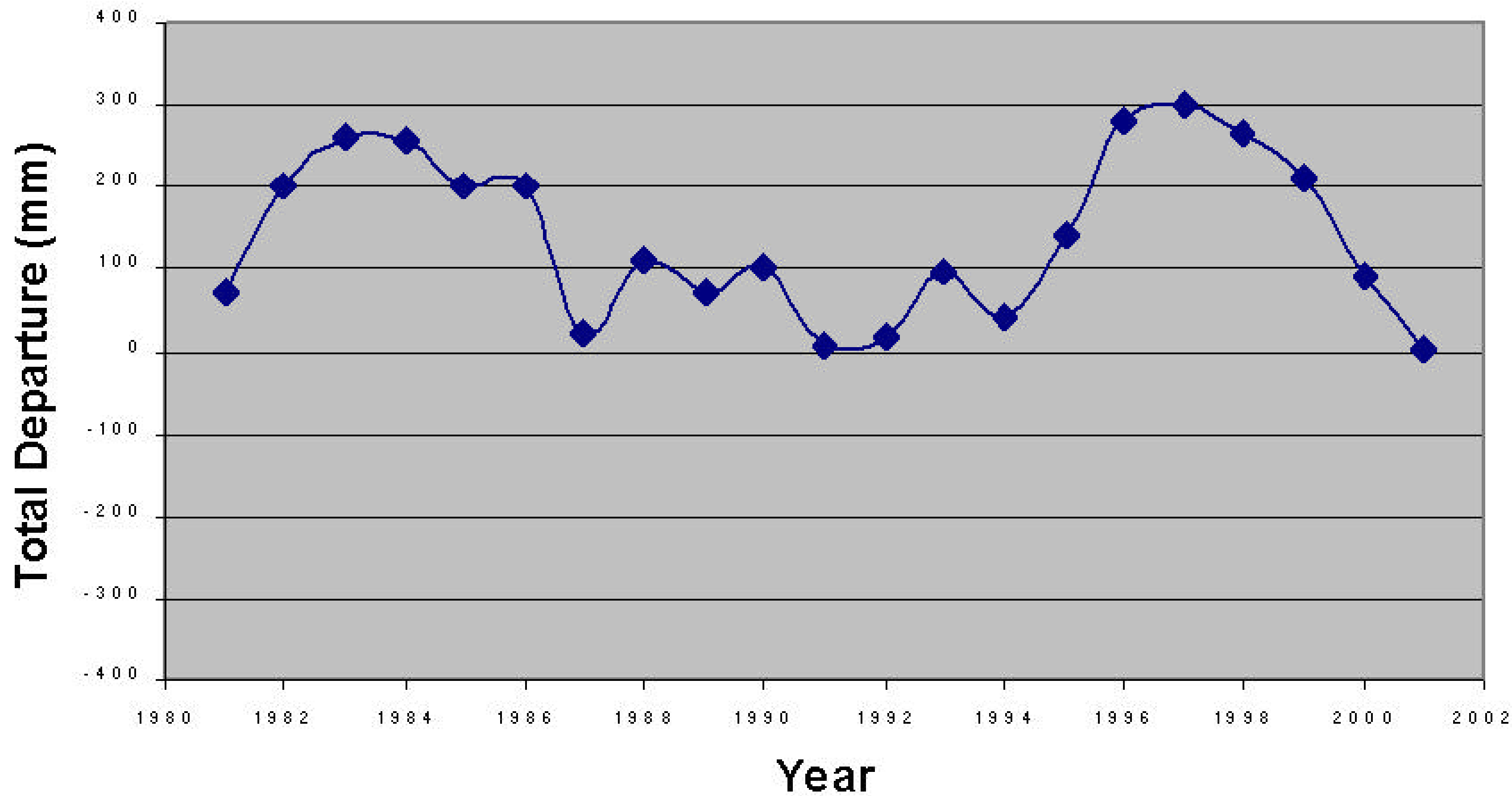
Precipitation at Coldstream Ranch (1981 - 2001)

SILVER STAR

Figure 1

Drawing file: Figure 2_CPD.dwg May 07, 2002 - 1:24pm



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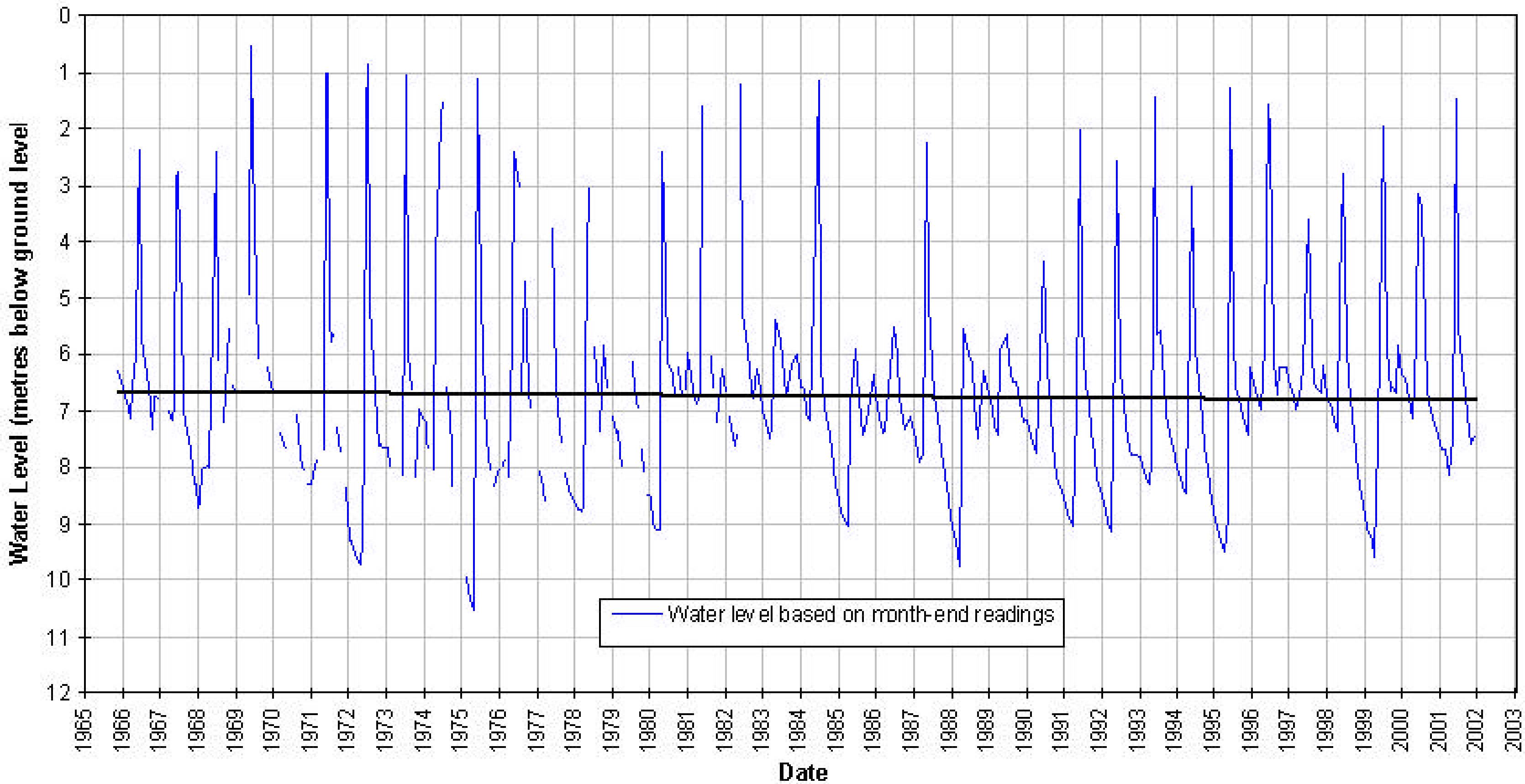
Cumulative Precipitation Departure (CPD) at Coldstream Ranch (1981 - 2001)

SILVER STAR

Figure 2

Drawing file: Figure 3_Hydrograph.dwg May 07, 2002 - 1:24pm



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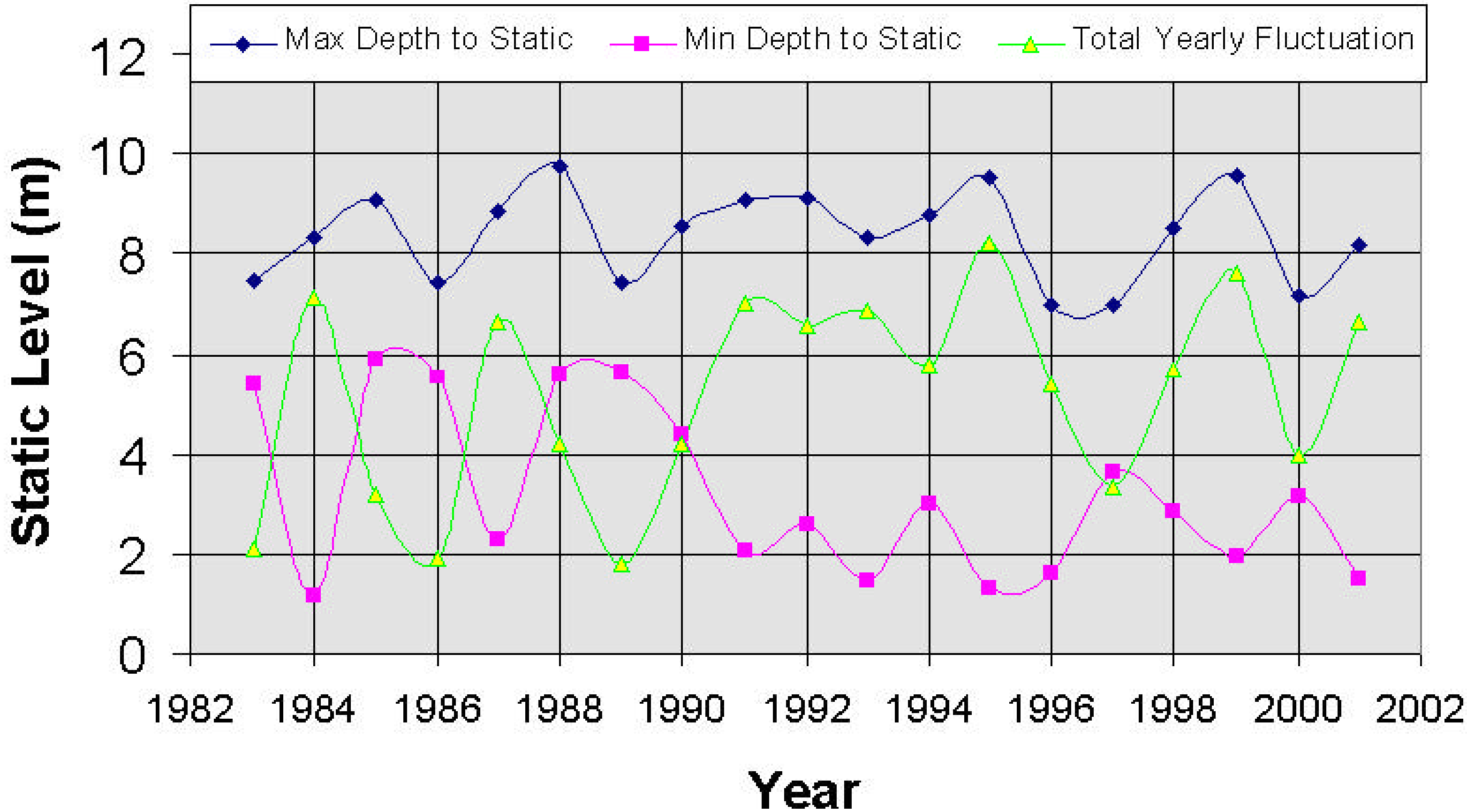
Hydrograph of Observation Well No. 047 Silver Star Mountain Vernon, B.C.

Figure 3



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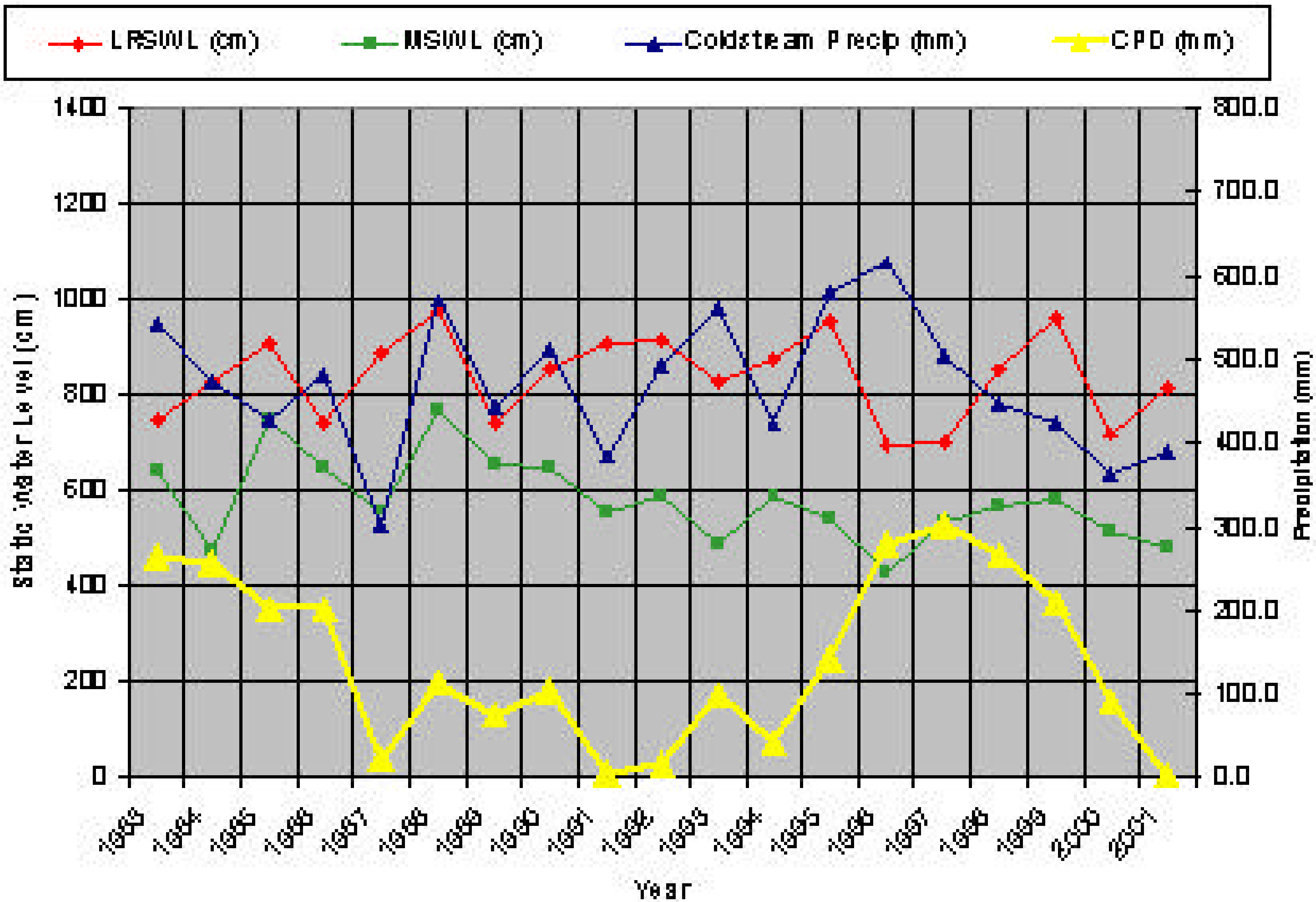
Seasonal Fluctuations in MWLAP Observation Well 047 at Silver Star

SILVER STAR

Figure 4

Drawing file: Figure 5_LRSWL and MSWL.dwg May 07, 2002 - 1:22pm



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Lowest Recorded and Mean Static Water Level (LRSWL and MSWL) in MWLAP ObsWell 047 at Silver Star Resort versus Precipitation Data at Coldstream Ranch

SILVER STAR

Figure 5