ENVIRONMENTAL MANAGEMENT PLANS

MOUNT MACKENZIE RESORT

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1.0 INTRODUCTION

This document outlines Environmental Management and Environmental Monitoring Plans for the Mount Mackenzie Resort project. The individual Environment Management and Monitoring Plans discussed in this document include:

- Erosion and Sediment Control Plan
- Water Management Plan
- Solid Waste Management Plan
- Liquid Waste Management Plan
- Drainage Control/Stormwater Management Plan
- Non-point Source Waste Discharge Control Plan
- Vegetation Management Plan
- Grizzly Bear Management Plan
- Air Quality Management and Monitoring Plan
- Spill Contingency Plan
- Terms of Reference for Environmental Monitoring
- Additional Monitoring Plans

2.0 EROSION AND SEDIMENT CONTROL PLAN

2.1 Background

Issues of water quality and the impacts on the aquatic environment resulting from erosion and sediment have been raised. The control of sediment following construction has been addressed as a by-product of the hydrologic and hydraulic design of the drainage works within the development area. Methodologies to control erosion and sediment discharges through construction to full build out of the development can be developed in a conceptual manner through the use of an understanding of the issues involved and in developing an implementation process for the control of erosion during construction.

The types of erosion and a typical application of erosion control techniques are shown on Figure 1. As can be seen there are numerous sediment sources and methodologies that can be utilized to reduce or eliminate the sediment discharges to the aquatic environment.

One key factor influencing the selection of erosion control methodologies is the erodability of the soils. The soil texture greatly influences the erodability of the material and hence the degree of effort and care required to manage soil erosion. Shown on Figure 2 is a range of erodability factors for a range of soil textures. The soils of the development area have not yet been mapped in sufficient detail to allow the formulation of a comprehensive sediment control plan.

Another factor influencing the erodability of soils is the exposure in terms of slope length and steepness. The potential for erosion increases with greater slope steepness and length. The description of slope gradient is shown in Table 1. The description of slope length as it relates to erodability is shown in Table 2.

Table 1. Slope Gradient Classes

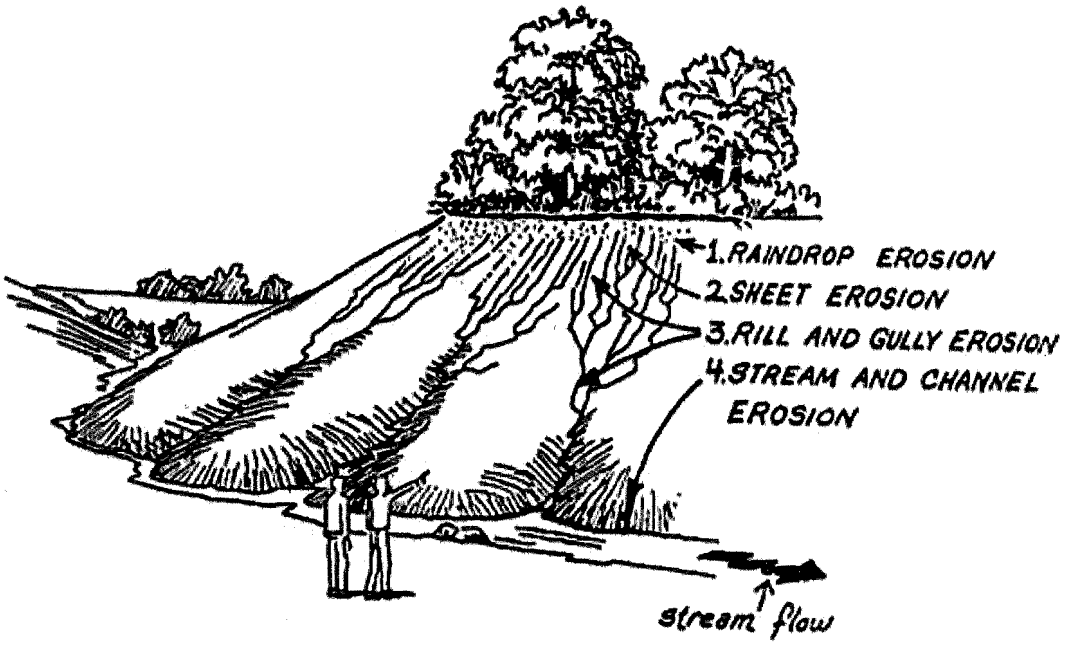
Slope* (%)	Description
0 – 10	Gentle
10 – 15	Moderate
Over 15	Steep

*Vertical distance: horizontal distance between two contours computed as a percentage

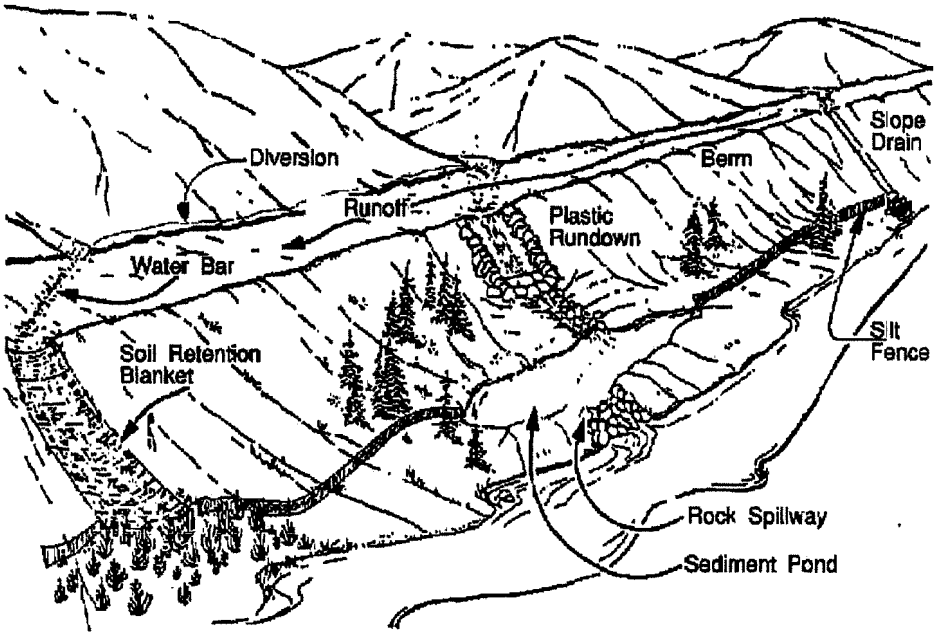
Table 2. Slope Length Classes

Length*	Description
Under 70 m	Moderate
Over 70 m	Long

* Slope length is measured down the slope face



Typical Erosion Types

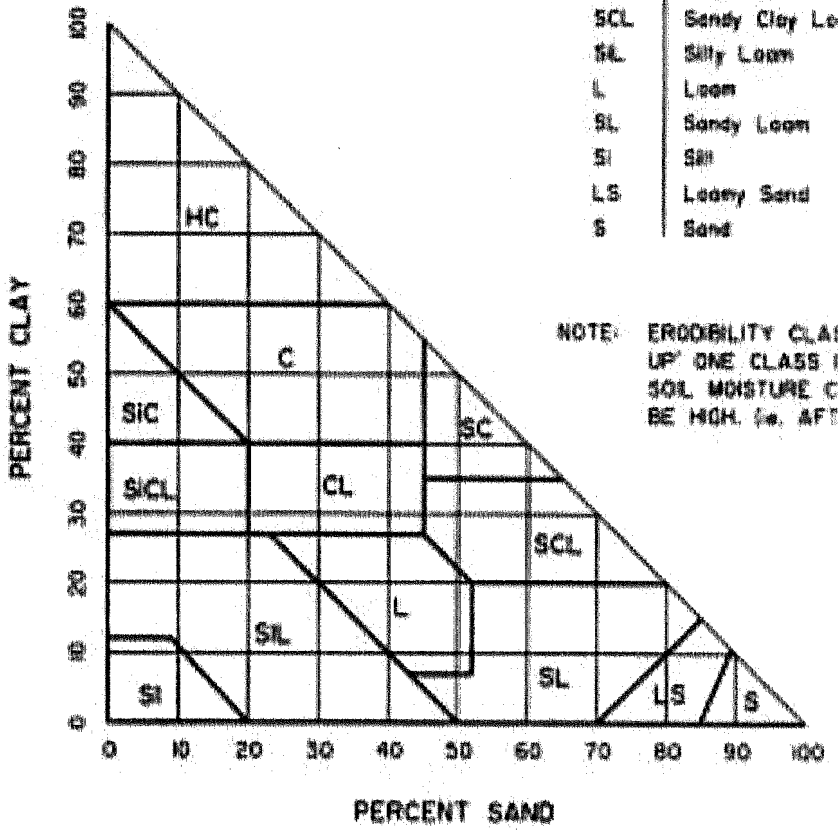


Potential Mitigation Works

Figure 1
Erosion and Mitigation

KEY	SOIL TYPE	SOIL ERODIBILITY (K)
HC	Heavy Clay	Low
C	Clay	Low
SiC	Silt Clay	Medium
SC	Sandy Clay	Low
SiCL	Silty Clay Loam	Medium
CL	Clay Loam	Medium
SCL	Sandy Clay Loam	Medium
SiL	Silty Loam	High
L	Loam	High
SL	Sandy Loam	Medium
Si	Silt	High
LS	Loamy Sand	Low
S	Sand	Low

NOTE: ERODIBILITY CLASSIFICATIONS (K) SHOULD BE 'BUMPED UP' ONE CLASS IN SITUATIONS WHERE THE INITIAL SOIL MOISTURE CONTENT OF THE SITE IS LIKELY TO BE HIGH. (ie. AFTER SNOW MELT)



SOIL TEXTURE CLASSES, PERCENTAGES OF CLAY AND SAND IN THE MAIN TEXTURAL CLASSES OF SOIL; THE REMAINDER OF EACH CLASS IS SILT.

SOIL TEXTURE NOMOGRAPH

Figure 2
Soil Texture and Erodability

The erosion potential derived from the combination of slope steepness and slope length is shown in Table 3.

Table 3. Erosion Potential

Gradient	Length	Low	Medium	High
Gentle	Moderate	Low	Low	Moderate
	Long	Low	Moderate	High
Moderate	Moderate	Low	Moderate	High
	Long	Moderate	High	High
Steep	Moderate	Moderate	High	High
	Long	Moderate	High	High

As can be seen the erosion potential increases with the steepness of the slope and the length of the exposed surface. The planning and implementation of erosion prevention measures must include consideration of the slope, its length and the type of soil.

2.2 Erosion and Sediment Control Principles

The conceptual sediment and erosion control plan is based on an adaptive methodology that can be employed in developing the detailed design and construction techniques that will be utilized. Implementation of the Erosion and Sediment Control Plan will include ten elements. This represents a comprehensive and integrated approach for achieving stream protection during construction. Only four of the elements actually involve better design and selection of practices. Three of the elements emphasize non-structural techniques for erosion prevention, while the last three elements involve management techniques.

The ten elements of an effective erosion and sediment control plan include:

1. minimize needless clearing and grading;
2. protect waterways and stabilize drainage ways;
3. phase construction to limit soil exposure;
4. stabilize exposed soils immediately;
5. protect steep slopes and cuts;
6. install perimeter controls to filter sediments;
7. employ advanced sediment settling controls;
8. ensure contractors are trained;
9. adjust the plan at the construction site; and
10. practice adaptive management.

2.2.1 Minimize Needless Clearing and Grading.

Some areas of a development site should never be cleared and graded, or these activities restricted. This includes stream buffers, forest conservation areas, wetlands, springs, highly erodable soils, steep slopes and environmental areas.

2.2.2 Protect Waterways and Stabilize Drainage Ways

Streams and waterways are particularly susceptible to sedimentation. Clearing adjacent to a waterway will not be permitted, and a silt fence should be installed along the perimeter of the riparian buffer. Existing drainage ways should be identified; as these will likely be the major routes that eroded sediments will take to reach streams, rivers and storm sewers. Drainage ways are also prone to erosion due to the high velocity of runoff. Erosion should be minimized.

2.2.3 Phase Construction to Limit Soil Exposure

Large areas of grading should be avoided since this maximizes erosion potential. Construction phasing, where only a portion of the site is disturbed at one time, minimizes sediment load potential.

2.2.4 Stabilize Exposed Soils Immediately

To provide soil stabilization, it is important to establish cover over the denuded area within a short period of the soils being exposed. Covers such as grass, mulch, erosion control blankets, hydroseeding, and plastic sheeting can be used to achieve this.

2.2.5 Protect Steep Slopes and Cuts

Steep slopes are the most highly erodable surfaces within construction sites. Steep slopes are generally defined with slopes of 6H:1V to 3H:1V or greater. Where possible, clearing and grading of steep slopes should be avoided. Otherwise, special techniques, such as uphill flow diversion and silt fencing, should be used to prevent runoff from flowing down the slopes.

2.2.6 Install Perimeter Controls to Filter Sediments

Perimeter controls should be implemented at the edge of the construction site to retain or filter runoff before it leaves the site. Silt fences and earth dikes or diversion are the two most common controls.

2.2.7 Employ Advanced Sediment Settling Controls

Even when the best Erosion and Sediment Control measures are employed, high concentrations of sediments may be discharged during larger storms. Therefore, the Erosion and Sediment Control plan should include some sediment traps or basins to allow captured sediments to settle out. To improve the trapping efficiency, these basins must

be designed to incorporate features such as larger volumes, use of baffles, skimmers and other outlet devices, and multi-cell construction. Regular inspection and maintenance are also critical to the operation of these practices.

2.2.8 Ensure Contractors are Trained

The most important element in the implementation of an Erosion and Sediment Control plan is the training and experience of the contractors, as they are usually responsible for installation and maintenance of the practices. In the end, everyone is responsible for erosion and sediment control. Therefore, training and education is important for everyone, from the developer down to the homebuilder. Everyone is working towards the same goal of protecting the waterways.

2.2.9 Adjust the Plan at the Construction Site

For an Erosion and Sediment Control plan to be effective, it may have to be modified due to discrepancies between planned and as-built grades, weather conditions, altered drainage and unforeseen requirements. Regular inspections are needed to ensure that Erosion and Sediment Control controls are working properly. Inspections should be conducted every seven days and following heavy rainstorms or snowmelt events.

2.2.10 Practice Adaptive Management

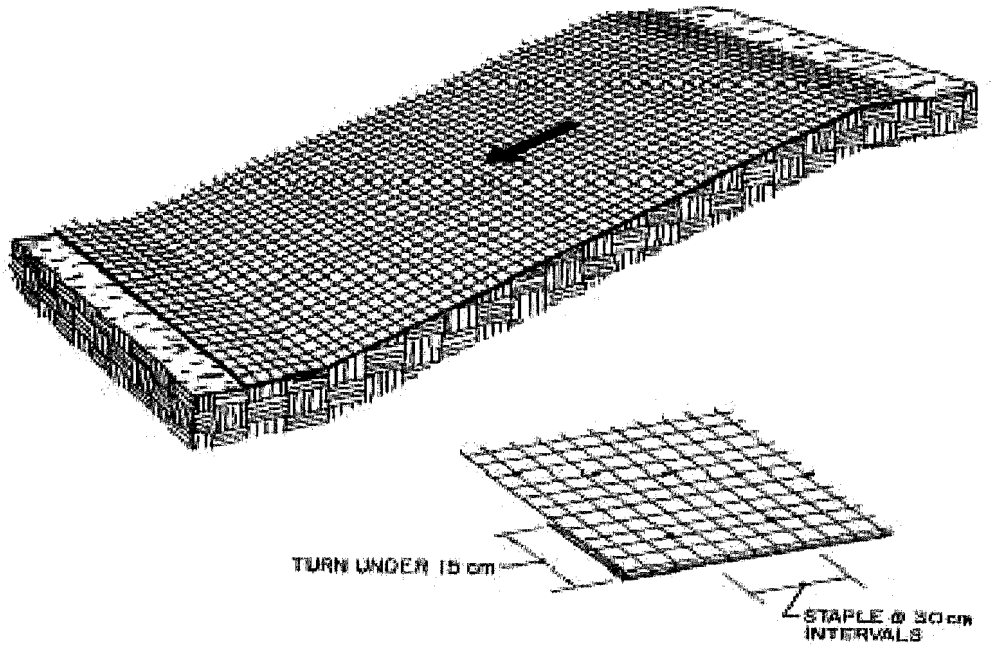
After a rainstorm, it is usually clear whether an Erosion and Sediment Control plan worked or not. If the storm was unusually large or intense, it is likely that many of the controls will require repair, clean out, or reinforcement. Therefore a quick response to assess and correct damages of the controls is required. An adaptive management process must be implemented into the Erosion and Sediment Control Plan to obtain the desired results.

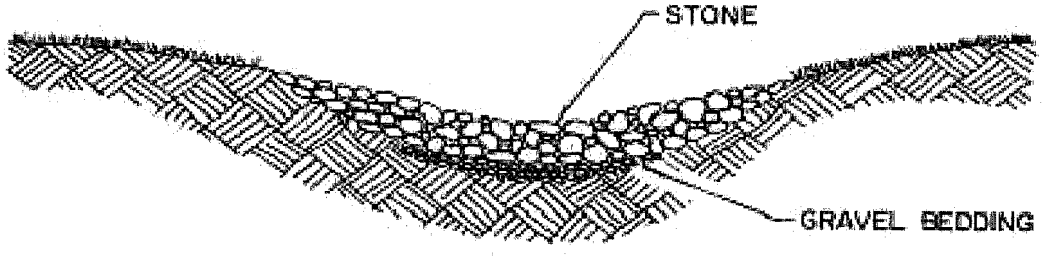
2.3 Erosion Control Techniques

Many erosion and control techniques exist for short term and long-term applications. During construction the need is initially for short-term controls that relate to actual construction activities and that can be implemented on a daily basis. As construction draws to an end or where a pause in construction activity occurs there is a need for long-term methods.

One of the most effective long-term methodologies is to provide an effective cover for susceptible soils. The cover can be in the form of matting that can be applied to flat surfaces or channels as shown on Figure 3 and on Figure 4. The specification of the soil cover must be to meet the anticipated conditions and be tailored for the soils to which it is applied.

The channel protection may also include the use of rock check dams to slow the water and to promote sedimentation or settling of sediments in the water. A typical rock check dam is shown on Figure 5.

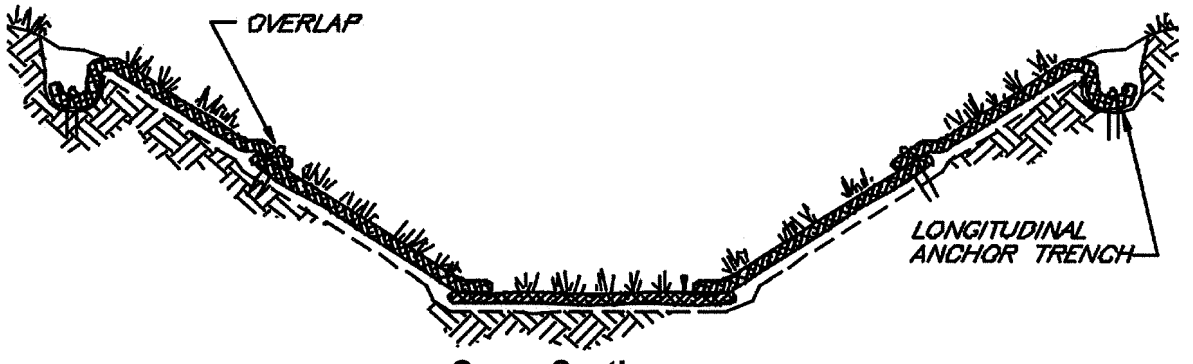




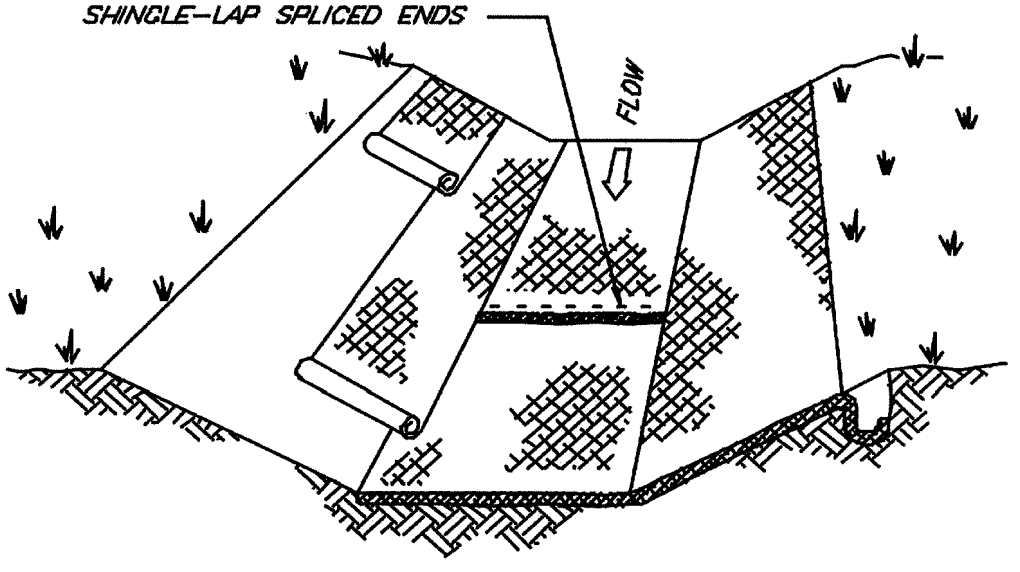
WITH STONE CENTRE

WITHOUT STONE CENTRE

Figure 3
Slope Protection



Cross-Section



Typical Placement

Figure 4
Grass Lined Channel

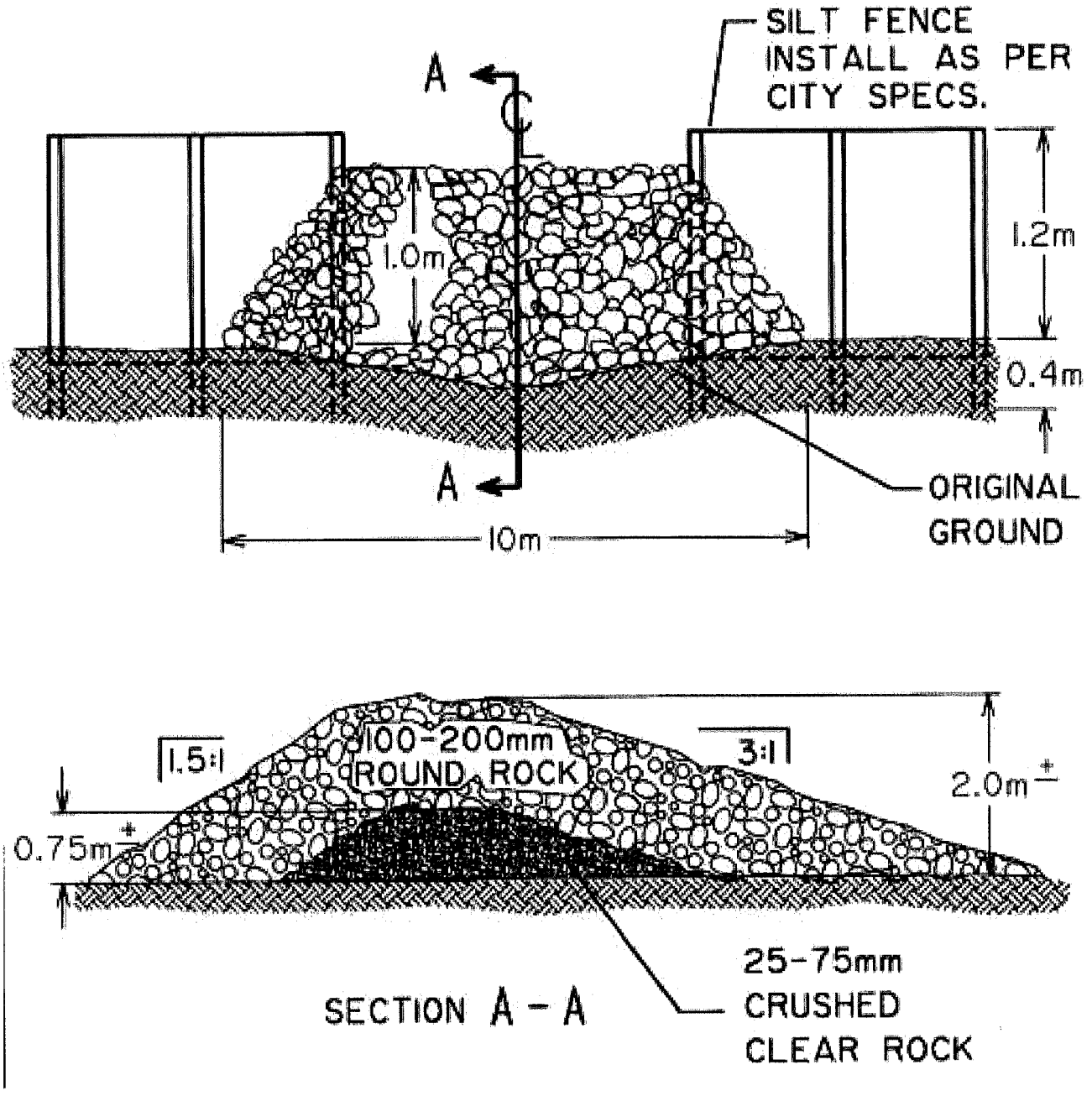


Figure 5
Rock Check Dams

On slopes a facility similar to a channel rock check dam can be employed with success. The sediment barriers on slopes can be comprised of silt fencing or brush barriers as shown on Figure 6. Silt fencing has become a relatively inexpensive practice in controlling sediment on construction sites. They can be utilized provided the limitations to their use are recognized in developing the Erosion and Sediment Control plan. The limitations on the use of silt fences are shown on Figure 7.

The rock check dams used in channels are often utilized for extended periods and may become permanent installations. For a more temporary use, straw bales can be utilized as shown on Figure 8.

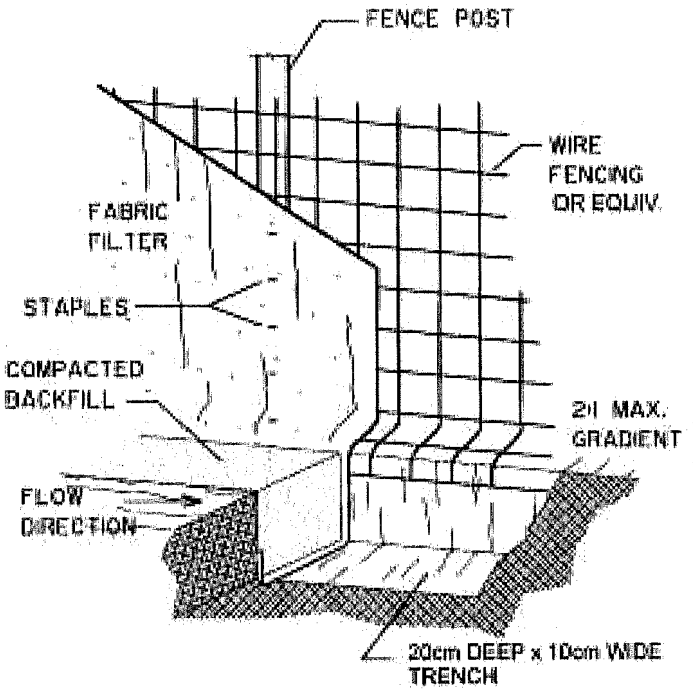
Portions of the Mount Mackenzie Resort (MMR) development may include a piped drainage system. This will be most common in the urbanized areas where the impervious surface areas are greatest. In these areas the construction management of erosion and sediment control will require additional techniques and facilities. Inlets into the pipe system can be temporarily modified to limit the sediment entering the pipe system through the use of inlet installations as shown on Figure 9.

The treatment of runoff conveyed by the pipe system will be required, as the pipes do not provide sediment removal in the same way as grass lined channels. The *Land Development Guidelines* (DFO 1992) provide the basis for designing the end of pipe sediment basins as shown on Figure 10.

2.4 Additional Erosion Control for Ski Slopes

Sediment control for the ski runs will be similar to that for the other development areas, as described in the foregoing sections. In addition, sediment control will incorporate specific recommendations from *Ski Area Best Management Practices (BMPs)* (Sibbernsen *et al.* 2001). These recommendations include the following:

- All improvements on one part of the mountain should be completed before work begins on other parts of the ski area.
- Construction should be planned such that any slope started can be finished during one summer construction season and the area reclaimed permanently before winder snows cover the ground.
- A contingency plan for erosion control is necessary to address any possibility that finishing a run could be delayed by an early snowfall.
- Cross slope water bars should be the first choice for the control of hill slope runoff and erosion.
- On steeper slopes, frequent small waterbars work better than a few large ones.
- Waterbars should extend well off bare slopes into adjacent vegetation.
- Waterbars must be inspected and repaired during spring snowmelt and cleaned of sediment following large rainstorms.



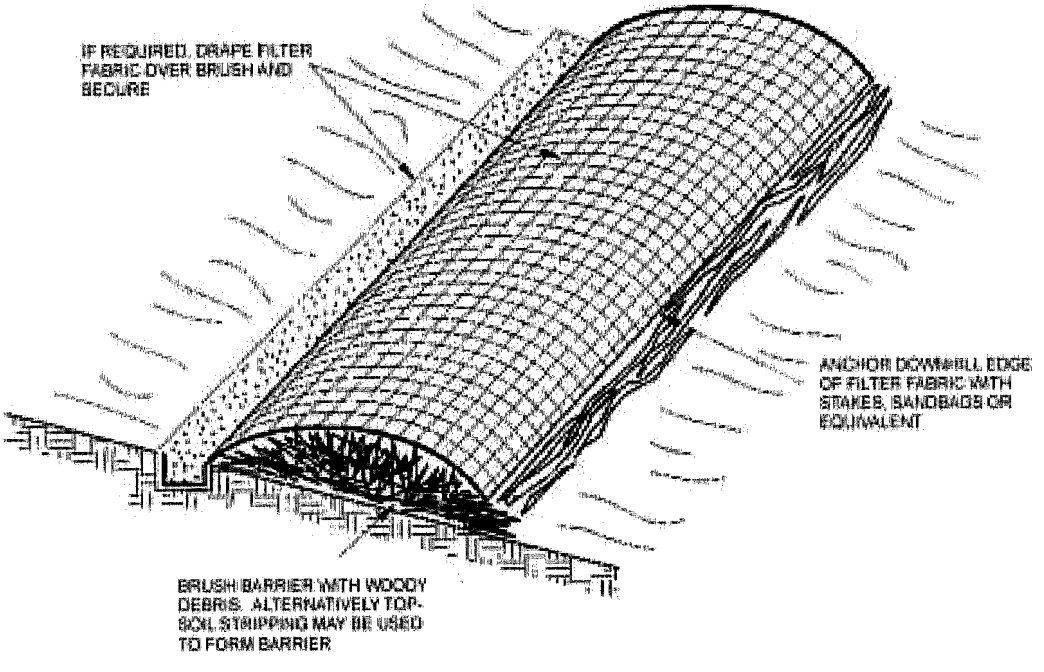
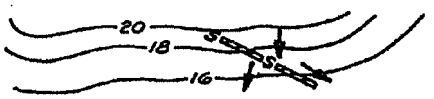
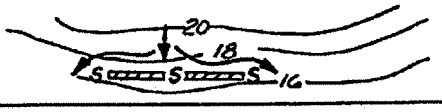


Figure 6
Sediment Barriers

Slope and/or Length of Slope
5% to 10%: no more than 50 feet
10% to 20%: no more than 25 feet
more than 20%: no more than 15 feet



Silt fence is not **aligned parallel** to slope contours

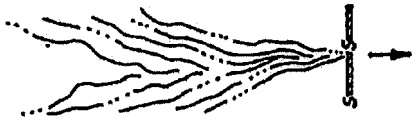


Edges of the silt fence are not **curved uphill,** allowing flow to bypass the fence

Contributing length to fence is greater than 100 feet

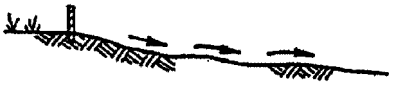
Fabric is not **entrenched deeply** enough to prevent undercutting

Spacing between posts is greater than eight feet



Fence receives **concentrated flow** without reinforcement

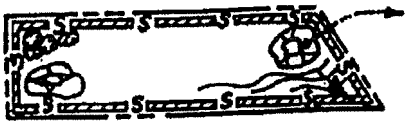
Installed **below an outlet pipe** or weir



Silt fence is ***upslope*** of the exposed area

Silt fence alignment does not consider **construction traffic**

Sediment deposits behind silt fence reduce capacity and increase breach potential



Alignment of silt fence **mirrors the property line or limits of disturbance,** but does not reflect ESC needs

Figure 7
Silt Fence Limitations

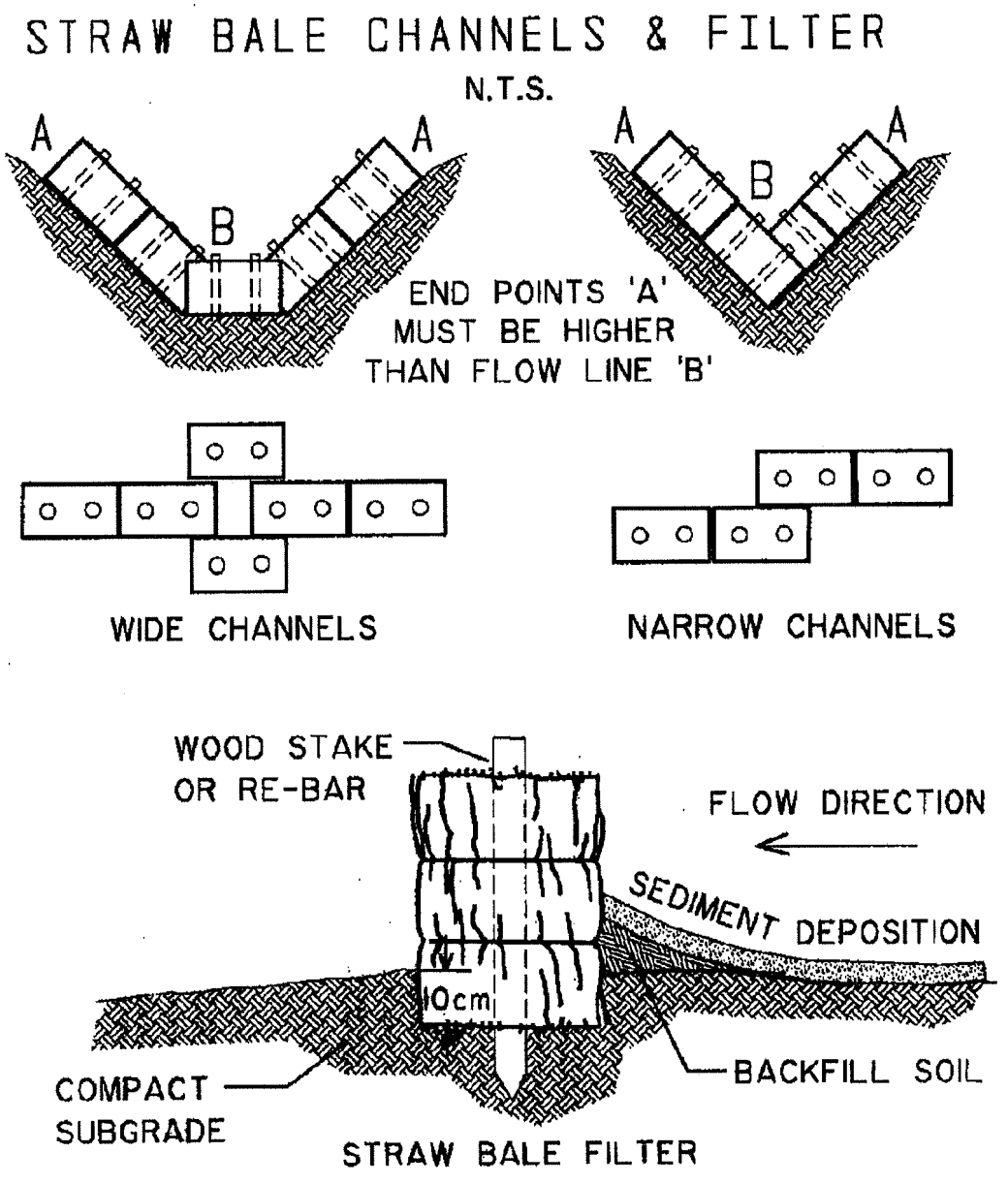
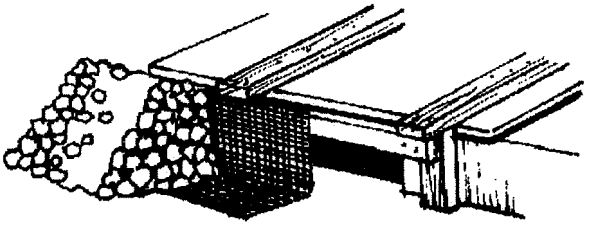
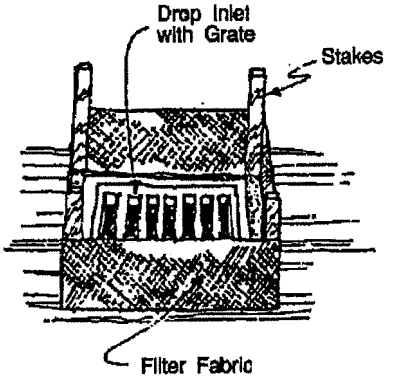
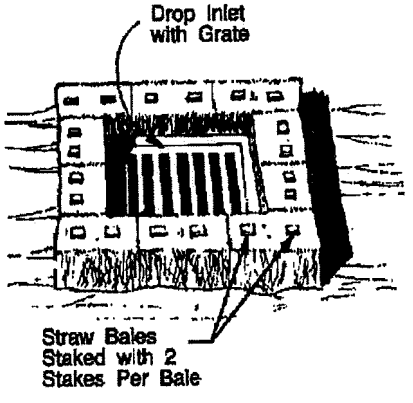


Figure 8
Straw Bale Channel Filter







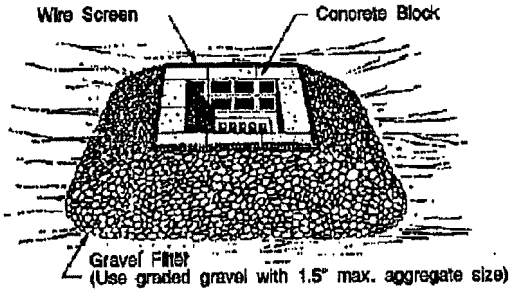
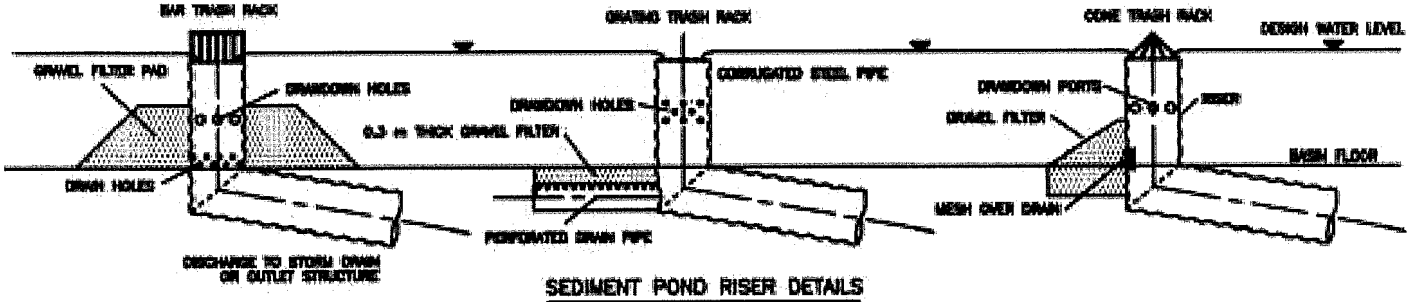
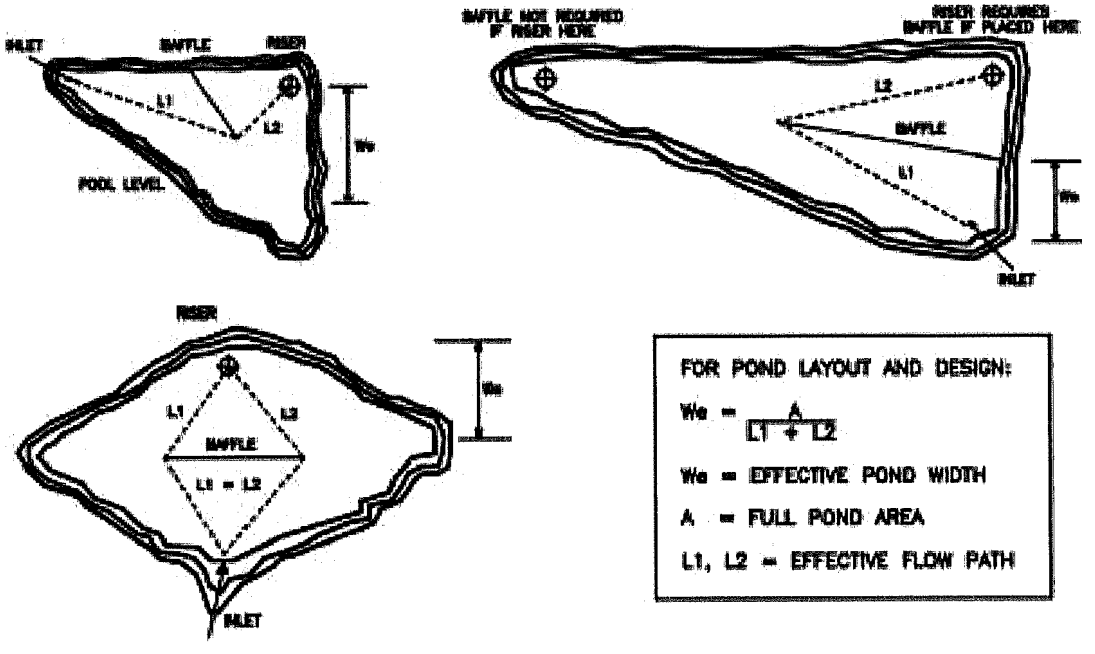


Figure 9
Inlet Types



SEDIMENT POND RISER DETAILS



SEDIMENT POND BAFFLE LAYOUTS

Source: DFO, 1992

Figure 10
Sediment Basin

- The most effective method of treating fine sediments is to disperse runoff through a thick screen of live natural vegetation. Effluent from waterbars, silt fences and detention basins should be passed through a wide vegetation buffer strip before discharge into surface waters.
- Water discharged into buffer strips should be kept dispersed to maximize filtering and infiltration.
- Re-entry into previously disturbed areas with new construction should be delayed until vegetation has completely recovered.

2.5 Sediment Control Summary

The use of appropriate sediment control designs and facilities can minimize and potentially eliminate the environmental impacts resulting from the MMR. The formulation and implementation of an Erosion and Sediment Control must include appropriate designs, contractor education, operational reviews and an adaptive approach to modify any components that are not providing the protection required to prevent adverse environmental impacts.

3.0 WATER MANAGEMENT PLAN

3.1 Introduction

The section addresses water management for MMR. This includes the to provide potable water, snowmaking water, and golf course irrigation water.

3.2 Potable Water Service

3.2.1 Background to Potable Servicing

At the concept stage the options identified for providing potable water service were:

- City of Revelstoke System (Greeley Creek)
- Local Upland Surface Water
- Groundwater
- Other Surface Water Sources (Columbia or Illecillewaet Rivers)

Past reports (Mt. Mackenzie Water and Sewer Study, October 1990 by Urban Systems Ltd.; and the Mount Mackenzie Resort Expansion, Final Concept Report, Section 4 Access and Traffic Impact and Infrastructure Assessment by Urban Systems Ltd., March 2000) developed and reviewed the concept of using the City System to supply potable water to MMR. Although the size and location of development nodes has changed since the 1990 and 2000 plans many of the conclusions from those reports are still valid. The City of Revelstoke System offers a readily available, high quality domestic supply and is the preferred option for providing potable water to MMR. From a water supply standpoint, this is the most desirable option. If for whatever reason an agreement cannot be reached whereby City water would be made available to MMR, one of the other three options would need to be implemented.

The City System would not provide water for golf course irrigation or for snowmaking. Separate systems will be developed for these purposes. The plans for a snowmaking system and an irrigation system are provided in later sections of the water servicing plan.

3.2.2 Water Quality Standards

Guidelines for Canadian Drinking Water Quality (GCDWQ)

The Guidelines for Canadian Drinking Water Quality (GCDWQ) are designed to provide Canadians with access to safe drinking water and have been developed for a variety of microbiological, chemical, physical and radiological parameters. The sixth edition of the GCDWQ was issued by the Federal Health Ministry in 1996 and is recognized throughout Canada as the standard for water quality. A "Summary of Guidelines for

Drinking Water Quality" is published each spring by Health Canada in order to keep interested parties informed of changes to the Guidelines between publications of new editions. The most recent Summary was published in April 2003. Although Alberta, Ontario and Quebec have to some extent mandated that the requirement of the GCDWQ be met, the GCDWQ are not binding on the provinces or water purveyors.

Drinking Water Protection Act (DWPA)

The amended Drinking Water Protection Act and Drinking Water Protection Regulations (DWPR) came into force on May 16, 2003, replacing the Safe Drinking Water Regulation (SDWR) under the Health Act. These new measures, governing drinking water from "source to tap", will better protect the health and safety of British Columbians, according to the Ministry of Health Planning.

The Drinking Water Protection Act defines a water supplier as the owner of a domestic water system supplying drinking water to anything other than a single-family residence. This includes very small water systems, such as those that supply a single business or several residences by well or creek. Water suppliers as defined by the Drinking Water Protection Act would therefore be responsible for providing water that meets the prescribed water quality standards.

Drinking Water Officers of the Ministry of Community Health Planning are working with water suppliers on a case-by-case basis to ensure that water suppliers come into compliance with the DWPA. However, the level of treatment and water quality that Health Officers often require are determined on an individual basis. Invariably, Health Officers will require that a multiple barrier approach to safe drinking water be implemented. Health Officers frequently require that the GCDWQ be met and as a general rule require disinfection (often as chlorination) for all surface water sources, including springs and groundwater sources determined to be under the direct influence of surface water.

3.2.3 Resort Potable Water Flow Projections

The maximum day demand (MDD) is the highest daily demand that occurs in a given year. MDD is used to determine the size of various components of water supply, treatment and distribution systems. Historically, a resort-type community that is focused on winter recreation, such as a ski resort, will see its MDD occur at the peak of the winter season, often around New Year's Eve. In a typical municipality the MDD often occurs in the summer when water use for irrigation is at its maximum. For the resort it was assumed that there were two periods when the MDD could occur:

- in the winter (December or January) when the population of the resort is expected to be at its maximum; and
- In the summer (July) when water used for irrigation purposes is at its maximum.

Potable water demands are typically divided into 4 major development sectors; Industrial, Institutional, Commercial and Residential. At the resort the Industrial and Institutional components will not exist, the Commercial component can be identified as the business sector including stores, restaurants etc. and the Residential component can be identified as the demand from the single and multi-family developments and hotel type residential accommodation.

Residential and Commercial demands can be grouped into three main categories; fire fighting, irrigation and commercial/household (in-building) use. Fire fighting water requirements can be very significant short-term flows and are generally the design parameter used when sizing piping for a water distribution system. However due to the irregularity, and hopefully infrequency, that water for fire fighting is required, fire flows are typically excluded when calculating daily or annual water requirements. The average annual Potable demands can therefore be calculated by adding the irrigation demands and commercial/household demands.

Population estimates are required to facilitate the prediction of water use at the resort and to ensure water facilities are adequately sized. No allowance is made for connecting the neighbouring properties in the Columbia Shuswap Regional District (CSRD) (Southwest Rural Area). The potential to accommodate these areas should be considered during the more detailed predesign phase. Table 4 summarizes the population estimates for each phase of development.

Table 4. Ultimate Resort Bed Unit Estimates

BED UNITS	PHASE					
	1	**2**	**3**	**4**	**5**	**6**
Hotel	600	336	3032	0	0	0
Resort	611	1916	3158	0	209	0
Townhouse	448	1424	64	528	736	204
Single Family	1356	1014	0	612	356	0
TOTAL	**3015**	**4690**	**6254**	**1140**	**1301**	**204**

Demands at a resort can be attributed to overnighters (guests and permanent residents) and to day users (visitors and staff) who do not live or stay at the resort. A good approximation of the daily per capita commercial and household water use for this day population has been found to be 50 litres per capita day (Lpcd).

The population that is spending their days and nights at the resort generate the majority of the water demand. A reasonable estimate of the commercial and household water demand generated by this population at a resort that has embraced water conservation practices can be obtained by using 250 Lpcd times the number of bed units occupied. Again, the experience of Sun Peaks supports this per capita demand estimate.

In keeping with the overall water conservation strategy of MMR (see Section 3.5 below), MMR landscaping requirements will be mandated by covenant. The covenant will restrict the amount and type of landscaping allowed on each lot and will incorporate a xeriscape philosophy. Xeriscaping is defined as water conservation through creative landscaping. The covenants will ensure that each property is developed so that they are sustainable on a limited irrigation allotment. Implementation of a user-pay system based on the volume of water used will encourage water conservation.

When calculating the irrigation demands 150 m^2 of irrigated area was used for all of the single-family lots. The remainder of the lot would be either left as natural vegetation, non-planted areas (driveway, building, patio, rock garden etc.), or landscaping such as native shrubs or other species suited to the area that would not require supplemental irrigation. It was also assumed that 10 Multi-family units and 20 Hotel/Resort units would each have equivalent supplemental irrigation requirements as one single-family lot. Where feasible, irrigation water would be provided for resort, commercial and multi-family areas by using the irrigation system proposed for the resort's golf course.

Data from the British Columbia Ministry of Fish, Agriculture and Foods for Malakwa, BC was used to estimate an annual evapotranspiration value for the resort. To simulate conditions on a maximum day, the average day irrigation demand was then increased by using a peaking factor (1.25). This peak factor is reasonable considering watering restrictions (such as even and odd day watering implemented by the City of Revelstoke) will be incorporated to help minimize peaking, xeriscape to minimize overall residential irrigation requirements, and not all lots will be irrigating since the resort is not expected to be at peak occupancy during the summer months. Based on the evapotranspiration value and the estimate of irrigated landscaped areas the peak day supplemental irrigation requirement for the month of July was estimated at 550m^3/day.

Table 5 summarizes the calculation of maximum day demands for the winter and the summer. These estimates assume bed unit occupancy of 90% for the winter maximum day, and 70% occupancy for the summer maximum. MDD for the commercial and household usage is determined by estimating the appropriate maximum populations and applying the usage per capita demand numbers.

Table 5. Resort Maximum Day Demand

	Overnight Population (@ 250 Lpcd)	Day Use Population (@ 50 Lpcd)	Commercial & Household Demand (m^3/day)	Residential Irrigation Demand (m^3/day)	Total (m^3/day)
Winter MDD	(90% bed unit occupancy) 14,944	3,000	3,885	0	**3,885**
Summer MDD	(70% bed unit occupancy) 11,623	2,325	3,020	550	**3,570**

Demand Summary

The key element to determine is MDD. Some components of the City System, such as the Greeley Water Treatment Plant, must be sized for the overall max day demand. This is primarily governed by the demand created by the City and will occur in the summer. Some components, such as the mains crossing the Illecillewaet, must be able to supply the MDD of Arrow Heights plus MMR. A summary of these demands is provided in Table 6.

Table 6. Maximum Day Demand

	m^3/day
MDD Summer (Resort)	3,570
MDD (City)	25,400
Total (rounded)	**29,000**
MDD Summer (Resort)	3,885
MDD (Arrow Heights)	7,160
Total (rounded)	**11,000**

3.2.4 Connection to City System

Supply (Greeley Creek and Wells)

Greeley Creek

The City's Public Works Superintendent has indicated that in his estimation the City is drawing up to 75% of the entire Greeley Creek flow during certain periods of the year. The estimated MDD of MMR plus the City of Revelstoke at build-out (29,000m3/day) is roughly half of the lowest recorded flow from Greeley Creek (54,000 m3/day). The maximum day demand is anticipated to occur in the summer when Greeley Creek flows are also high. This suggests that the capacity of Greeley Creek is sufficient to supply water for both MMR and the City of Revelstoke; however, it is recommended that long term monitoring be undertaken to confirm the creek's capacity. Analysis of gauged streams in the general area indicates the months with the lowest flows tend to be January to March while flows tend to peak in May through July. Dayton & Knight previously recommended that the City work with WSC to install and monitor a Greeley Creek hydrometric station to confirm the reliable yield of Greeley Creek (D&K, City of Revelstoke Water Treatment Study - Draft 3, February 1996) however, to date no further flow monitoring has been established.

To provide the estimated MDD of 29,000 m^3/day the City will need to increase the quantity of their license on Greeley Creek by 10,800 m^3/day. This is similar to the 9,800 m^3/day (4 cfs) that conditional license C100606 was reduced by in 1996.

Groundwater

Golder Associates completed the hydrogeology for drilling and testing of a well for the City of Revelstoke in the spring of 2003. The City of Revelstoke's Aquifer, Well Head Protection and Management Plan identifies the well as a source for irrigation to the golf course and, in the future a possible alternate water supply and fire reserve in case of an emergency at the Greeley Water Treatment Plant. Preliminary indications from Golder are that this aquifer may have a sustainable capacity in excess of 5000 Igal/min (32,700 m^3/day). Additional wells would need to be developed to take full advantage of this capacity. Initial testing of the aquifer indicates that it meets the GCDWQ except for manganese, which has been measured at levels above the Aesthetic Objective (AO). Golder suspects that long term pumping of the well may result in the manganese levels dropping below the AO. This would mean the well could be used for drinking water with minimal treatment.

City Distribution System

Major components of the City of Revelstoke's water supply system include:

- A Greeley Creek intake
- a pre-treatment settling basin
- a state of the art microfiltration membrane WTP

- a gravity water transmission main (Greeley supply main) consisting of 10.5 km of 300 mm to 450 mm diameter transmission pipe
- a 3,780 m^3 steel reservoir located along the Trans Canada Highway (TCH reservoir)
- a distribution system that includes about 42 km of watermains and 2,700 service connections serving 7,350 people.
- one 400mm diameter steel watermain and one 200 mm diameter AC watermain crossing the Illecillewaet River to Arrow Heights
- Arrow Heights pressure reducing station

Dayton & Knight (D&K) prepared an "Arrow Heights Water Supply Study" in 2001. In the study D&K used demand estimates for MMR generated in the Concept Plan. The report recommended creating a second pressure zone and the following improvements to the distribution for Arrow Heights.

- Construction of a 600,000 USgal (2,270 Arrow Heights water reservoir and watermain to the reservoir (first recommended in a 1967 water study))
- A high pressure by-pass of the existing pressure reducing station
- 1,100,000 USgal/day (4,160 m3/day) zone 2 pump station with zone 1 PRV's
- Other upgrading outside of the Arrow Heights area identified in the D&K study were:
  - WTP expansion
  - Greeley supply main upgrades; and
  - groundwater investigation to supplement and provide back-up for the Greeley Creek supply.

Development of MMR will influence the following existing and proposed components of the City's water supply system. Existing capacities are shown in the following table.

Table 7. Major Water System Components Influenced by Resort Development

	Existing Capacity	Capacity Required at Build-out
Greeley Creek WTP	15,000 m^3/day	29,000 m^3/day
10 km supply main	16,500 m^3/day	29,000 m^3/day
Illecillewaet River Crossings (Arrow Heights supply mains)	13,500 m^3/day (assumes velocity = 1m/s)	11,000 m^3/day
Arrow Heights Reservoir (proposed)	2,270 m^3	N/A
Zone 2 Booster station and zone 1 PRV's (proposed)	4,160 m^3/day	N/A

With adequate storage provided on the south side of the Illecillewaet River, the existing water mains crossing it will be sufficient to meet the ultimate future demands.

The proposed Arrow Heights Reservoir and related pressure reducing station and booster station should be reviewed to ensure they are sized adequately to provide the necessary quantities.

Water Treatment Plant

The City of Revelstoke has used Greeley Creek as a water source since the 1930's. Historically there have been raw water quality concerns with the Greeley Creek source, punctuated by a waterborne disease outbreak in August of 1995. Consequently, a state of the art membrane filtration water treatment plant (WTP) was constructed and began operation in the spring of 2000 to overcome the historical raw water quality issues. The WTP project included improvements to the Greeley Creek intake, disinfection facilities, emergency power supply and an all new computer system to assist the plant operation. The WTP also satisfies the public concern about the use of chemical additives in the treatment process as, other than chlorine for maintenance of distribution system water quality, no chemicals are added to the water. The plant was constructed to have a capacity of 4.0 USmgd (15,000 m^3/day) and provisions to allow expansion to 6.4 USmgd (24,000 m^3/day). Some details on the existing Greeley Creek WTP are as follows:

- Source - Surface Water – Greeley Creek
- Membrane technology – micro-filtration
- UV disinfection
- Ministry of Health Permit Conditions
  - 4-log removal (99.99%) of protozoa
  - 5-log removal (99.999%) of viruses and bacteria
  - Meet GCDWQ

- Chlorine residual in distribution

The ultimate capacity of the water treatment plant required is the maximum day demand of the entire service area, estimated at 29,000m^3/day, which is comprised of the City of Revelstoke (excluding Big Eddy) plus the resort. Therefore, additional capacity of 14,000m^3/day over and above the existing 15,000m^3/day is required. Assuming this can be accomplished by adding filter capacity to the existing Greeley Creek Water Treatment Plant it is estimated this upgrade would cost $3,100,000.

In conjunction with the plant upgrade the 10 km supply main from the WTP will require additional capacity. This can be accomplished by twinning the existing main. The cost of twinning the existing main is estimated at $6,000,000.

The timing for both of the above expansions is largely dependent on the rate of growth of the City itself, the effectiveness of the new golf course well to minimize peak demands and the effectiveness of the City's water conservation program. It is anticipated that an upgrade to the WTP and supply main may be required prior to the completion of Phase 2 of the resort.

3.2.5 Resort Distribution System

As an extension of the City of Revelstoke System the MMR distribution system would be constructed primarily along road right of ways and would be constructed to meet the standards set out by the City. Several concrete or steel reservoirs would be located strategically throughout the development for storing treated water for peak hour requirements, fire flows and emergencies. Each reservoir would be located at a point above its service pod so that intermediate pressure zones could be created through a series of pressure reducing valves (PRVs) providing water to each building at a pressure in the range of 207 kPa (30psi) to 620 kPa (90psi). The use of PRVs will create several pressure zones within each service pod. The PRVs are necessary because of the large variations in elevation throughout the developed area. The precise location of the reservoirs, pipelines, PRV's and booster stations will be determined during predesign. It is anticipated that in addition to the Arrow Heights reservoir and pressure zone, that an additional seven pressure zones will be created.

Because the reservoirs required for the resort will be at elevations significantly above the existing City of Revelstoke pressure limits, pumps will be required to transmit water to the various reservoirs. These pump stations will be significant components of the system and will be required to meet the MDD of the areas they are pumping to. For the purposes of providing off-site cost estimates it has been assumed that 2 additional reservoirs, each requiring a pump station to provide supply, and a total of 25 PRV stations will be required to service the resort.

The storage reservoirs would be sized to include fire protection, peak demand and emergency provisions. Fire protection requirements would be based on recommendations in the most recent version of the Fire Underwriters Survey. The pipe network within each pod would be sized to meet the requirements for fire protection, which are expressed as the ability to supply a specified quantity of flow (dictated by the size and type of building) while maintaining a specified minimum pressure at all points within the pipe network. Looping and interconnections of pipes within each pod as well as between the service pods will be preferred to improve the hydraulics, reliability and flexibility of the distribution system. A schematic of the potable distribution system is provided in Figure 11.

The lower portions of the resort could be serviced using the proposed pressure zones in the Dayton & Knight Arrow Heights Water Supply Study, 2001. If service was to be extended to the Southwest Rural Area, additional pressure reduction is warranted as some of the homes (even if located in the lowest pressure zone) could experience static pressures approaching 130 psi.

3.2.6 Remote Lodges and Restaurants

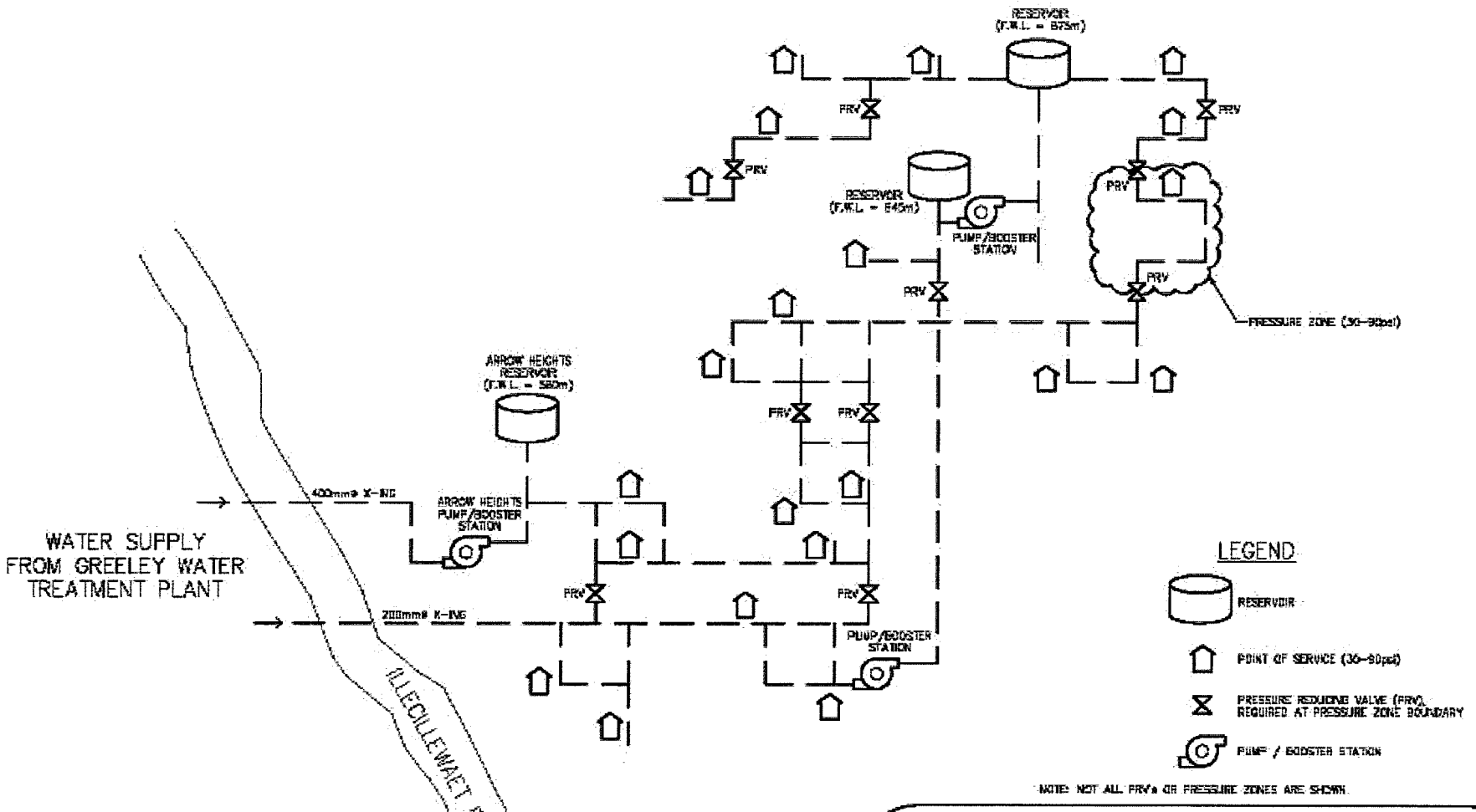
Remote lodges and restaurants should be serviced by on-site water supply schemes. The source of water could be the snowmaking system, a groundwater well or a surface water supply. Each specific site will require detailed investigation. Individual small-scale treatment plants, scaled to the development and of a treatment level dictated by the source water, will be required. The Concept Plan introduces the option of high quality wastewater treatment and recycling which may become economic if on-site supply and disposal options are limited. An additional alternative is to pump and pipe water from the proposed system in the main resort area; however pipe and pumping costs will likely override this option.

3.3 Snowmaking System

3.3.1 Snowmaking Water Requirements

Snow making will ultimately be provided from about elev. 1350 m down to the lower Village base at 500 m. The snowmaking will be provided to ensure adequate snow coverage on select runs. At build-out, Mt. Mackenzie will cover about 120 hectares using snowmaking equipment. The average coverage depth will be 0.75 m of snow. Using a ratio of 1.86 m^3 of snow per 1 m^3 of water (from Sno.matic, snow making engineers) the requirement for snowmaking is estimated at 500,000 m^3 of water per year.

In order to provide the best possible ski experience it will be necessary to make artificial snow during the early season and in years of low snowfall. Snowmaking would primarily occur during the months of November through to January.



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Mount Mackenzie Resorts Ltd.
MASTER PLAN

WATER DISTRIBUTION SCHEMATIC

URBAN SYSTEMS.

Prepared for: Revelstoke Alpine Village Inc.

FIGURE 11 NOV. 2003

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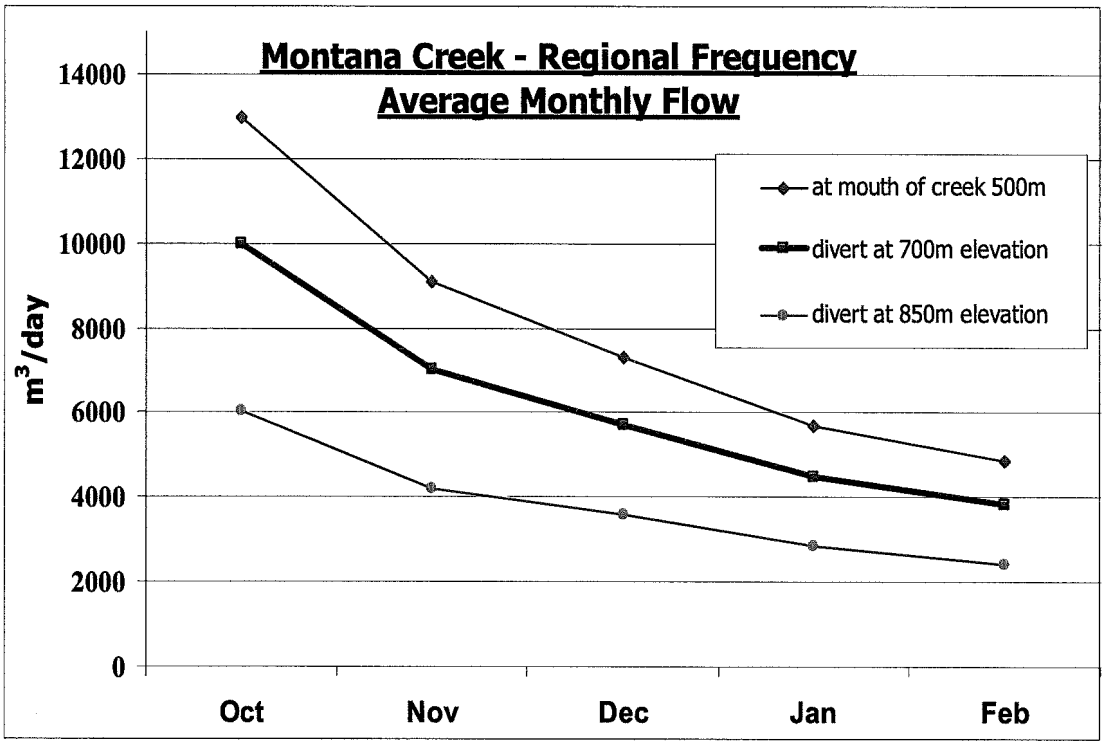
Snowmaking requires relatively high water pressures, 150psi minimum is desired. The maximum flow rate that will be required at the Resort for snowmaking is estimated at 18.9 m^3/min (5,000 USgpm).

3.3.2 Option 1 - Direct Diversion of Montana Creek

Surface water is proposed for the snowmaking system. One option reviewed is to develop a direct diversion on Montana Creek at about elevation 700m. A regional frequency analysis (which compares the flows of similar watersheds to estimate flow in a watershed where data does not exist) was performed to estimate the flows in Montana Creek during November to January when snowmaking would occur. The results of this analysis are shown in Figure 12.

Figure 12. Montana Creek Average Monthly Flow



The regional frequency analysis indicates that an average minimum flow of about 4500 m^3/day could be anticipated from Montana Creek at a diversion point at about 700m in elevation during the snowmaking season. There are two existing water licenses on Montana Creek. They are for a total of 4.5 m^3/day (500 Igal/day each), and are for domestic and stock watering purposes. Assuming the flows during a dry year are roughly 60% of those during an average year, it is reasonable to estimate that 2,700 m^3/day would consistently be available during the snowmaking period in a dry or low flow year. An application to the Water Rights Branch of Land and Water BC to acquire a license on Montana Creek for the purpose of snowmaking is required. During the application

process a more detailed analysis of available flows from Montana Creek may be required. 2,700m^3/day (1.9m^3/min) does not meet the estimated peak flow rate of 18.9m^3/min

Direct diversion of Montana Creek of about 2,700m^3/day (1.9m^3/min) over the three month snowmaking period results in 240,000 m^3/day. This is less than the ultimate annual snowmaking requirement, which is estimated at 500,000m^3. If Montana Creek were the only source of snowmaking water some component of storage would be required to meet the peak flow requirements.

A large component of the area that requires snowmaking is well above the proposed diversion at 700 m on Montana Creek. In order to provide the pressures required for snowmaking significant pumping is required, increasing long-term operations costs.

3.3.3 Option 2 – Storage and Gravity Feed

This option depends on snowmaking water supplied from a reservoir high up the mountain. Pressure for the snowmaking system would come entirely from gravity. No pumping would be required. To accomplish this, a site has been identified at about elevation 1750 m. Static pressures in the snowmaking zone from a reservoir at this elevation would range from 570 psi to 1780 psi. One or more pressure reducing stations are warranted to reduce these static pressures to a more manageable range. The topography of the proposed site is agreeable to development of a pond able to provide the annual snowmaking storage requirement of 500,000 m^3. Geotechnical evaluation of the site will be required at the predesign phase.

To fill the storage pond it is proposed that water be diverted during spring freshet from a small channel located above the pond. Average annual precipitation as snowfall recorded in the Revelstoke area is approximately 400 mm. Snowfall accumulation above the 1750 m level would be more than the recorded depths in Revelstoke. Assuming 50% capture of this during freshette the 130ha area above the ponds would provide 260,000 m^3. Filling the reservoir during freshet would ensure that there would be no impacts on down slope surface water licensees during low flow periods in late summer/fall. A water licence would also be required to divert and store water during the spring freshet period.

3.3.4 Snowmaking Recommendations

In order to meet the maximum projected annual snowmaking requirement a combination of the above options will be required as follows:

- 500,000 m^3 reservoir (including diversion works)
- Montana Creek intake, pump, and pumphouse
- Pressure Reducing Stations (assume 2 required)
- Distribution System (dependent on routing and extent)

3.4 Irrigation System

3.4.1 Irrigation Water Requirements

The area of the proposed golf course is about 65 ha, of this about 50 ha would be irrigated greens, tee-boxes, and fairways. The maximum annual irrigation application rates are estimated at 600 mm per year. This corresponds with a maximum annual irrigation requirement of 300,000 m^3/year. This can be expressed as a maximum demand over the 140 day growing season of 2150 m^3/day.

The potential also exists to irrigate some of the commercial and high density residential (hotels, condos) areas with the separate irrigation supply system. The option will be further investigated and will depend on the capacity and location of irrigation supply system. The advantage of this will be to further reduce summer peak demands on the City's supply system.

3.4.2 Supply and Storage

The City has previously stated that water is not available for Golf Course irrigation. The preferred alternatives identified for golf course irrigation at the Concept stage were reclaimed water from a sewage treatment plant and groundwater. There is also potential for diverting surface water and storm water to detention ponds (which would double as aesthetic ponds) on the golf course. Developing a groundwater source is preferred, especially early on in the development when wastewater flows would be insufficient to meet the irrigation requirements. The other challenges that would need to be overcome if treated effluent was used for irrigation are storage areas and increased levels of treatment over and above those that would be required for disposal to Upper Arrow Lake.

Numerous reports have been prepared on the topic of groundwater in the Airport Bench. In general much of the water is of poor quality for drinking but should not be a concern for irrigation. Well yields of up to 12.6 L/sec (1,090m3/day) have been recorded in the Airport flats area. The recent success of the City in identifying a high capacity deep well for irrigation of the existing golf course is also encouraging. If insufficient capacity for irrigation is derived from one well an additional well may need to be developed.

Storage can be provided in one or more of various water features proposed for the golf course. As noted above, these golf course ponds could also be incorporated into a storm water management plan for MMR. Diverting storm water into storage ponds to later be used for golf course irrigation would serve to reduce the demands on the proposed irrigation wells and provide environmental protection from direct stormwater runoff.

Kala Groundwater Consulting Ltd. has reviewed existing well logs in the general area and have stated that a moderate capacity water well having a sustainable flowrate of 14 L/s is possible in the airport bench area. A properly constructed 250 mm diameter water well capped, yield tested and reported may cost in the order of $26,000. Further hydrogeologic investigations will be required (including the drilling of test wells) to determine suitable locations for any new golf course irrigation wells. Detailed well siting

will consider proximity to the golf course, influence on other existing wells, etc. Estimates for irrigation piping, sprinkler heads, and construction of storage ponds have not been prepared. These costs are considered to be part of the costs associated with development of the golf course and as such will be prepared during the design of the course.

3.5 Water Conservation

3.5.1 General Approach

The water conservation strategy for MMRL should consider the following range of conservation measures at the levels of planning, design, construction, operation and maintenance by the water utility company, and public awareness and education:

- Universal water metering;
- Water accounting and loss control;
- Incentive producing water costing and pricing practices;
- Non-combustible building construction where possible;
- Sprinkler systems in all buildings;
- Impounding of runoff and snow melt water;
- Landscape efficiency;
- Water system pressure management;
- Water saving plumbing fixtures;
- Water saving domestic/commercial appliances and building envelope equipment; and
- Water conservation awareness program.

The following sections provide recommended details of these water conservation measures.

3.5.2 Universal Water Metering

It has been shown that metered water systems typically save substantial amounts of water compared to unmetered water systems. Universal water metering includes both source water metering and service connection metering. Source water metering is essential for water accounting purposes by the water utility. Service connection metering is needed to more accurately track water use and bill customers for their usage. It also informs the customers how much water they are using. All water provided free of charge for public use should also be metered in order to accurately account for water. Source meters and service connection meters should be read at the same relative time in order to facilitate accurate comparisons and analysis. Meters should be tested for accuracy on a regular basis. It is also important that the meters are properly sized to prevent under or over-

registering. These practices will allow for effective leak detection and repairs as part of the normal operation and maintenance program.

3.5.3 Water Accounting and Loss Control

A water accounting system will help track water throughout the system and identify areas that may need attention, particularly where there are large volumes of "non-account" water. Non-account water includes unmetered water as well as water that is metered but not billed. Non-account water should be analyzed to identify recoverable losses and leaks in the system. The water utility company should institute a comprehensive leak detection and repair strategy. This strategy should include regular on-site testing with leak detection equipment. A loss prevention program including pipe inspection, cleaning, lining and other maintenance efforts should compliment the loss control program.

3.5.4 Incentive Water Costing and Pricing

The value of costing and pricing as a conservation strategy is that it involves the water customers in understanding the true value of water, and conveys information about that value through prices. A water utility will need to be created to operate the water system under the Certificate of Convenience and Public Necessity (CNCP). The water utility will use cost-of-service accounting, consistent with generally accepted practices established by the CNCP. The customer's bill should correspond to their water usage. Any changes in the water tariff by the water utility will require an application to and approval from the water comptroller's office. The water tariff rate should be structured to promote conservation.

3.5.5 Non-Combustible Building Construction Where Possible

The Master Plan gives serious consideration to fire suppression systems in building structures. All major buildings and buildings over four storeys in height will be constructed of non-combustible materials and have sprinklers installed. All combustible buildings will have sprinklers. The single family and bed and breakfast buildings also should have sprinklers.

3.5.6 Impounding Runoff and Snow Melt Water

Consideration will be given to strategic placement of water impoundment storage areas throughout the development. Runoff and snow melt interception ditches or swales should be located and graded in order to channel the surface runoff into the impoundments. These impoundments would, depending on their locations throughout the resort development, have a dual function of storing water for irrigation and/or fire fighting purposes.

3.5.7 Landscape Efficiency

Outdoor water usage drives maximum-day demand. The maximum-day demand, in turn, drives the demand for larger water supply and storage, transmission and treatment

facilities. Outdoor usage is often the greatest source of water demand in a resort development. Therefore, reducing the outdoor usage can be a highly effective water conservation strategy. The land use vision for the MMRL's base core area, which contains the commercial and higher density residential component of development, includes minimizing hard surfaces and landscaping with low water use native plants as much as possible. The single family and bed and breakfast areas of development will be landscaped to blend with the natural forest setting and avoid a city-type grass lawn landscaping.

3.5.8 Water System Pressure Management

Reducing water pressure in the distribution system can save a significant quantity of water. It can decrease leakage, amount of flow through the open fixtures and stresses on pipes and joints, which may result in leaks. System-wide pressure management during the design stage should ensure that pressures in the system are maintained below 45 – 50 psi through proper placement of pressure-reducing valve stations. Pressure-reducing valves or regulators in the buildings should fine-tune the best pressure range in individual buildings.

3.5.9 Water Saving Plumbing Fixtures

The importance of water conservation through the installation of water conserving plumbing fixtures is generally recognized by the public. The design and construction of commercial and residential components of the resort, from single-family homes to hotels, should feature the following watersaving plumbing fixtures:

- High efficiency lavatory and kitchen faucets. These devices use 1.9 to 8.3 L/min compared with standard faucets, which use 11 to 19 L/min.
- High efficiency showerheads. These devices use 3.8 to 9.5 L/min compared with standard showerheads, which use 11 to 19 L/min.
- Low consumption direct type or flush type toilets. These devices do not use more than 6 L/flush compared to the watersaver water closets, which use 13.35 L/flush.
- Low consumption direct type or flush type urinals. These devices do not use more than 5.7 L/flush. The water supply to urinal flush tanks equipped for automatic flushing should be controlled with a timing device in order to limit operation during normal working hours.
- Low flow aerators should be used on faucets where applicable/possible.

3.5.10 Water Saving Domestic/Commercial Appliances and Building Envelope Equipment

Consideration and encouragement should be given to the use of water-saving appliances, equipment and measures including the following:

- Front loading, horizontal axis, clothes washing machines, which typically use 30 percent less water and 40 to 50 percent less energy than the top loading machines;
- High water (and energy) efficient automatic dishwashers for both domestic and commercial purposes;
- Minimal use of water in air conditioning units and cooling equipment: water used in cooling equipment, in accordance with the manufacturer's recommendations;
- Hot water instant demand systems;
- Installation of water heaters as close to the point of use as possible and well insulated hot water piping; and
- Restricted use of water softeners due to the frequent refresh cycling and high water consumption.

3.5.11 Water Conservation Awareness Program

Public information and education are critical to the success of any conservation program. MMRL should adopt a water conservation awareness program early in the resort's development stage. Public education alone may not produce the same amount of sustained water savings as other more direct approaches but it can greatly enhance the effectiveness of other conservation measures. Customers who are informed and involved are more likely to support the water utility company's conservation planning goals. An information and education program should explain all of the costs involved in supplying potable water to MMRL and demonstrate how water conservation practices will provide water users with long-term savings.

3.6 Conclusions

Potable water to service MMR can be provided by connecting to the City of Revelstoke System. Implementing water conservation strategies will minimize water demands created by the resort. Improvements to the capacity of the WTP and supply mains from the WTP will eventually be required, however, how soon these upgrades are required is highly dependent on the growth rate of the City of Revelstoke itself and is likely not required for several years. Although the limited data suggests there is sufficient capacity, whether an additional supply beyond Greeley Creek may ultimately be required can be identified by undertaking long term flow monitoring on Greeley Creek. The distribution system within the resort will consist of several (seven) pressure zones created using both PRVs and additional reservoirs. Snowmaking can be supplied using a combination of surface water collected from Montana Creek and an as yet unidentified stream near the proposed snowmaking water storage pond at 1750 m in elevation. The city of Revelstoke has previously indicated that it is unwilling to supply irrigation water for the golf course, irrigation water can instead be provided by developing a well or wells.

4.0 SOLID WASTE MANAGEMENT PLAN

4.1 Introduction

This section of the report provides proposed policies and infrastructure for the reduction, reuse and recycling of solid wastes. The following sources are expected to generate waste at the MMR:

- Construction operations, mobile generators;
- Resort facilities, day use areas, and street receptacles;
- Commercial and institutional facilities;
- Hotels;
- Single family and multi family complexes;
- Maintenance facilities; and
- Food service facilities.

A conceptual plan is provided for temporary storage of solid waste prior to off-site disposal. Public health and safety concerns have been considered in the preparation of the conceptual plan, particularly with respect to bear and rodent problems. Plans for the minimization, collection and handling of household hazardous wastes are included. Solid waste disposal is the mandate of the Columbia Shuswap Regional District (CSRD).

4.2 Garbage Collection and Disposal

All domestic waste will be placed in a fully enclosed waste drop-off station, which will be designed as a closed, odourless, and predator proof structure. To assist in reducing odours from the station, consideration will be given to freezing waste in the main transfer station, especially during the summer months.

Due to the presence of wildlife and the potential for animal/human conflicts resulting from unsecured garbage containers, there will be no curbside collection of garbage. Residents will be required to deposit garbage (and recyclable materials; see Section 4.3) at the drop-off station within the resort. All overnight visitors will be required to keep refuse in enclosed predator-proof areas before dropping it off at the resort transfer station.

Food and organic wastes will be generated mainly by the catering and restaurant facilities at the hotel and commercial facilities and at the mountain top teahouse. Separate food waste containers will be provided at this location.

Refuse bins will be provided at ski lifts and on-mountain facilities. These bins will be emptied daily and the collected waste dropped off at the station.

A recognized waste management hauler will be retained to collect and remove the solid waste and recyclable materials from the resort. The non-recyclable refuse will be disposed of at the Revelstoke Landfill operated by the CSRD. The refuse disposal site accepts municipal, residential, commercial and industrial wastes. Residents may also drop off their own waste at the disposal site. At the outset, the hotel and commercial facilities will contract for their own waste collection.

4.3 Recycling

The focus will be placed on waste minimization and recycling programs. To match the recycling programs in place in the Regional District, MMRL will provide for collection of:

- paper (newspaper, magazines, envelopes, telephone books, fax paper);
- cardboard;
- tin and aluminum cans;
- plastic milk jugs; and
- plastics numbered 1, 2, 3, 4, 5 and 6 (except styrofoam).

MMRL will not provide curbside collection of recyclable materials because of the presence of wildlife and the potential for animal/human conflicts. Instead, an enclosed recycling depot will be strategically located within the resort complex to ensure cooperation of residents and guests and to keep garbage away from scavenging wildlife. In addition, dedicated bins for recyclable products will be proved at ski lifts and on-mountain facilities. These bins will be emptied daily and their contents dropped off at the station.

4.4 Criteria for Siting and Sizing Solid Waste Transfer Station

The following considerations should be taken into account during design of the transfer station:

- Screening from public view;
- Fencing to exclude animals (see Section 8.0 Grizzly Bear Management Plan);
- Accessibility along primary daily travel routes of residential users;
- Snow control (i.e., receptacles should function in high snow load conditions). Sheds may be necessary, and manoeuvring room for snow removal equipment);
- Space for one or more compacting animal-proof garbage roll off type bins which allow access to public without need for retaining walls;
- Space for one or more animal-proof compostable material roll off type bins, which allow access to public without need for retaining walls;
- Space for animal proof recycling receptacles for cans, bottles and plastics;

- Space for other items collected for recycling, such as cardboard and newspapers;
- Space for other items that may be collected in the future, such as other plastics;
- Space for Paint care and household hazardous waste collection buildings;
- Stockpile areas for tires and metal goods; and
- Safety measures for public use, such as railings, vehicle barriers and signage.

MMRL initially considers placing the drop-off station at the main parking area. This will be finalized at the detailed design stage of the resort. In addition, although not always necessary, future consideration may be given to staffing the site, and fencing to restrict or control access and materials deposited.

Local waste haulers should review the drop-off station depot before the design is finalized.

4.5 Hazardous and Special Wastes

Those who generate hazardous and special waste will have to contract directly for its proper disposal. Some special arrangements must be made for hazardous wastes, as they are not accepted at any Regional District refuse disposal facility. Prohibited materials at the Regional District Refuse Disposal Site include animal carcasses, lead acid batteries, sludge, log yard waste, smouldering ashes, passenger vehicle tires, and commercially generated OCC (Old Corrugated Cardboard).

4.5.1 Household Hazardous Waste

Hazardous household waste includes all consumer products that are corrosive, toxic, reactive or flammable (paints, solvents, cleaners, etc.). The major users of the household products will be overnight visitors and maintenance staff of the resort. Where the operations of MMR generate household hazardous waste, the resort will arrange for its proper disposal.

4.5.2 Special Waste

Special waste that will be generated includes waste oils and lubricants, refuse from the First Aid facility, and refuse from certain commercial facilities. As refuse from the first aid facility may be considered as Bio-Medical waste, consideration will be given to the co-management of this waste with the nearest hospital. The Ministry of Water, Land and Air Protection will be consulted on appropriate ways to handle special waste and handling will comply with established legislation and regulation.

Maintenance facilities will be equipped with conventional storage and handling equipment for used oils and lubricants. These used oils and lubricants will be collected and managed by a recognized recycling facility.

The operation(s) responsible for the production of special wastes will be required to retain a recognized waste management organization to collect and dispose of these materials.

5.0 LIQUID WASTE MANAGEMENT PLAN

This section addresses the collection, treatment and disposal of sewage generated within the resort. Stormwater is discussed in Section 6.

5.1 Background

Sewage within the City of Revelstoke is treated by a two-celled aerated lagoon system on the north side of the Illecillewaet River. Effluent is discharged into the Illecillewaet River about 350 m upstream of the Airport Road bridge.

Past reports (Mt. Mackenzie Water and Sewer Study, October 1990 by Urban Systems Ltd.; and the Mount Mackenzie Resort Expansion, Final Concept Report, Section 4 Access and Traffic Impact and Infrastructure Assessment by Urban Systems Ltd., March 2000) reviewed treatment alternatives, which included expanding the City's treatment plant and constructing an independent facility. Neither report concluded which alternative was preferred. The March 2000 report identified advantages and disadvantages of connecting to the City's system or building an independent plant, but concluded that a more detailed analysis would be undertaken at the Master Plan Stage.

Since the 1990 study the size and location of the proposed resort development nodes has changed significantly – to the extent that most of the previous analysis is irrelevant to what is being proposed today. In addition, since that time, the province has promulgated the Municipal Sewage Regulations (MSR) – which dictates the level of treatment, amount of redundancy, monitoring requirements for various methods of disposal and financial security requirements (for private utilities). All new discharges, and changes to existing permitted discharges are now required to register under the MSR. There are opportunities within the MSR for entities other than municipalities to have the legal authority to operate the sewage treatment plant and to discharge treated effluent into the environment (Sun Peaks Resort is a good example). The City of Revelstoke, the Columbia Shuswap Regional District, the developer or a 3rd party could undertake governance. It will just require a formal agreement between the relevant participants. However, this Section does not address the issue of governance - rather, it focuses on the technical issues related to collection, treatment and disposal of sewage. In terms of scheduling, the MSR requires an environmental impact study; an operating plan and the application for registration is completed at least 90 days before construction commences.

5.2 On-Site Versus Community Sewer Systems

The magnitude of the development and proposed densities do not lend themselves to the use of on-site sewage systems. "On-site" in this instance means "on individual lots or properties". A community sewer collection system will be used for almost the entire proposed development. The only exception may be remote, high elevation ski service facilities such as restaurants, and a small number of cabins. In these cases, appropriate

sites with percable soils will be sought nearby to install on-site sewage systems that include treatment and subsurface trenches. If sites cannot be found nearby, then sewage will be piped down to the community sewer network along mountain access roads.

5.3 Wastewater Flow Projections

Based on the water conservation principles that will be implemented by the resort (See Section 5.7 below), and actual practice at other mountain resorts, the estimated sewage per capita flow rates are:

- 250 Litres per day per overnight guest and resident; and
- 50 litres per day for day visitors and non-resident employees.

These per capita rates include the wastewater generated from the residential and commercial uses within the resort. No significant institutional and/or industrial uses are anticipated at the Resort.

5.3.1 Population Estimates

The purpose of generating population estimates here is to ensure the wastewater facilities are adequately sized. Therefore, these population estimates are focused on the anticipated peak use period of the year – winter, deriving from the resort. No allowance is made for connecting residents of Arrow Heights or the neighbouring properties in the Columbia Shuswap Regional District. The potential to accommodate these areas should be considered during the detailed predesign phase.

Table 8 summarizes the population estimates for ultimate development. These estimates assume a bed unit occupancy of 90% for the maximum day and 40% for the average annual. The day staff and day skiers are assumed 20% of the occupied bed units.

Table 8. Ultimate Population Estimates

Category	Maximum Day	Average Annual
Overnight Guests and Residents	14,944	6,642
Day Staff and Day Skiers	3,000	1,328

5.3.2 Flow Projections

Table 9 summarizes the estimated sewage flows for the maximum day, maximum monthly and average annual based on the per capita flow rates given in Section 7.3.3.

Table 9. Ultimate Estimated Flows

Category	Maximum Day (m^3/d)	Average Annual (m^3/d)
Overnight Guests and Residents	3,736	1,660
Day Staff and Day Skiers	150	66
Total	**3,886**	**1,726**

5.4 Collection System

There are two main types of collection systems. By far the most widespread method of collection is a conventional system where all of the wastewater is transported from individual properties to a sewermain usually located in the street. Alternative collection systems, on the other hand, require an interceptor tank for partial treatment (removal of heavier solids and floating material) on each property before the wastewater is transported to the collection system.

While gravity always represents the preferred energy source for designing a collection system, on sloping topography there will always be some houses that cannot be connected to the collection system with a gravity service. Obvious examples of this would be houses that are substantially below the road elevation. In these instances individual pumps will be required to service these low houses, whether the collection system is conventional or alternative. There are various types of individual pumps available for various applications such as pumping raw sewage (including solids) or pumping septic tank effluent.

5.4.1 Conventional Collection

A conventional collection system transports raw wastewater (includes solids and liquids) through a series of gravity pipes (and small lift stations if the topography requires), from individual properties to the treatment plant. Wastewater moves from sinks and toilets on individual properties through service pipes to a sewermain, usually buried beneath the road right-of-way. The sewermains are minimum 200 mm diameter and include manholes at alignment changes and at a minimum spacing of every 120 to 150 m.

5.4.2 Alternative Collection

In an alternative collection system, suspended solids are removed in septic interceptor tanks before wastewater is transported to the sewermain in the street. Each property requires that a water tight interceptor tank be installed. The alternative collection system most suited to the terrain of the MMR is a small diameter gravity system. The advantages are that sewermain diameters can be reduced, the number of lift stations can be reduced and manholes can be replaced with cleanouts. On the other hand, the interceptor tanks must be monitored and pumped out every 8 - 10 years (assuming 3,800 L tanks are used) for single-family residences.

5.4.3 Evaluation of Collection Methods

Both a conventional collection system and an alternative collection system are technically proven. They have been used in other jurisdictions and have been shown to be consistent with good engineering practices. However, the difficulties inherent with the alternative collection option include:

- individual property owners would be responsible for maintaining their interceptor tanks in much the same way on-site septic tanks are maintained;
- potential for septic odours to be detected;
- a cost of $2,000 per household for the interceptor tank is expected; and
- larger tanks and an accessible area would be required for multi-family and hotel sites.

Based on the above difficulties, the alternative collection system is not recommended.

A conventional collection system is recommended - given the topography and proposed development cells, it is expected very few public lift stations will be required to service the area. The collection system will be designed to deliver flow to one treatment plant.

5.5 Treatment and Disposal Options

5.5.1 General

Two treatment and disposal options are reviewed in some detail in subsequent subsections. As noted earlier, governance is not considered here. Conceptually, each of these options could be owned and operated by the Developer, the City of Revelstoke, the Columbia Shuswap Regional District or a 3rd party.

The concept of making snow with treated effluent was considered, but rejected for the following reasons:

1. Significantly higher treatment cost for filtration, chemical addition and higher levels of redundancy in the treatment plant would be required when the snow is used on ski runs.

2. Significantly higher cost for piping, pumps (capable of achieving 1400 psi) compressors and nozzles (since the treatment plant will be at the 445 m elevation and snowmaking requirements are between 500 and 1350 m elevation.
3. There is a need to have another method of disposal as a safety valve in case all the effluent is not used. Such a safety valve would be a discharge to a surface water body. If a safety valve is developed it doesn't make economic sense to add the extra cost for snowmaking.

Golf course irrigation with effluent is practiced around BC at numerous locations. Examples include Rivershore in Kamloops, Osoyoos, Oliver, Predator Ridge in Vernon, and the Kamloops Golf and Country Club. The estimated irrigation demand for 18 holes of golf during a dry year is 300,000 m^3/year, based on 50 ha irrigated at 0.6 m/year. It is estimated that at ultimate build-out the quantity of wastewater generated will be approximately 630,000 m^3/year. Of course in the early years of development there will be far less effluent available and therefore, there is a need to secure an alternate water supply for golf course irrigation.

Disposal of all effluent on the golf course is not possible because there will eventually be more effluent than the golf course requires. In addition, the MSR requires that an alternate method of disposal be included with a golf course irrigation concept – in case all the effluent cannot be used on the course because of wet conditions or consecutive wet years. If an alternative method, such as river discharge, is included then it is cost effective to use it, to avoid having to build a winter storage lagoon.

Two categories of effluent irrigation are covered in the MSR – Unrestricted Public Access and Restricted Public Access. The Restricted Public Access category makes the most sense for this development because the golf course ponds could provide the required 60 day storage and therefore, there is no need to add the costly filtration process required in the Unrestricted Public Access Category.

Although golf course irrigation is possible and may be incorporated in later stages of the resort development, it is not necessary to include golf course irrigation to demonstrate that wastewater from the development can be appropriately treated and discharged at this time. Therefore, it is not included as a sub option of the two discussed.

There are two logical treatment and disposal servicing options for MMR, given the following facts:

- the City owns and operates a treatment facility in reasonable proximity to the resort;
- the Columbia River has high flow rates and is nearby;
- the Federal and Provincial governments are adding nitrogen and phosphorus to the Arrow Lakes to enhance the fish populations;
- disposal via rapid infiltration is unproven and there are many shallow wells in the area used for potable water;

- storage of effluent during the non-irrigation period (approximately 5 months) for reuse would require an 8.6 ha (assuming an average influent flow of 2,000 m^3/d and a depth of 3.5 m). There is no land within the resort that could be dedicated to this purpose. In addition, an irrigation area of 200 ha would be required to reuse all of the effluent generated in the design year (based on using 400 mm/year in an average precipitation year). This area of irrigable land (even including the proposed golf course) is not available in reasonable proximity.

The two options are:

1. Connect to an Expanded City Plant with discharge to the Illecillewaet River.
2. Construct an Independent Plant with Discharge to the Columbia River.

5.5.2 Option 1 - Connect to an Expanded City Plant

All of the sewage collected in the City of Revelstoke (Arrow Heights and the Big Eddy are not sewered) is directed to their two partially mixed, aerated lagoons. The lagoons are on the north side of the Illecillewaet River. This facility is rated for 4,546 m^3/d and occupies a water surface area of 2.4 ha. Effluent quality has consistently met the terms of the Ministry of Water, Land and Air Protection permit. Flows into the lagoons have averaged 3,025 m^3/d in 2003. In March 2003 flows reached 5,581 m^3/d. In other words, the excess, or remaining, capacity on an average basis is 1,521 m^3/d, but high flows during the year have exceeded the design capacity. Therefore, it will not be possible to connect any of the proposed development into the existing lagoons. The plant will need to be expanded.

The treated effluent is discharged into the Illecillewaet River. Based on Water Survey Canada Results of the Illecillewaet River at Greeley from 1963 to 1988 the lowest flows occur in February. The average flow rate during this period was 7.88 m^3/s. Based on allocating future design flows of 7,870 m^3/d (presented in Urban Systems' October 1990 report) to the City and 3,886 m^3/d to the resort the total flow would be 11,756 m^3/d (0.136 m^3/s). Effluent from a new plant in this location would yield low flow dilution ratios of approximately 58:1. This is below the preferred dilution ratio of 100:1 in the MSR. Consequently, a detailed Environmental Impact Study would be required to assess the required effluent criteria. In general terms, the lower the dilution ratio the better the effluent required by the MSR.

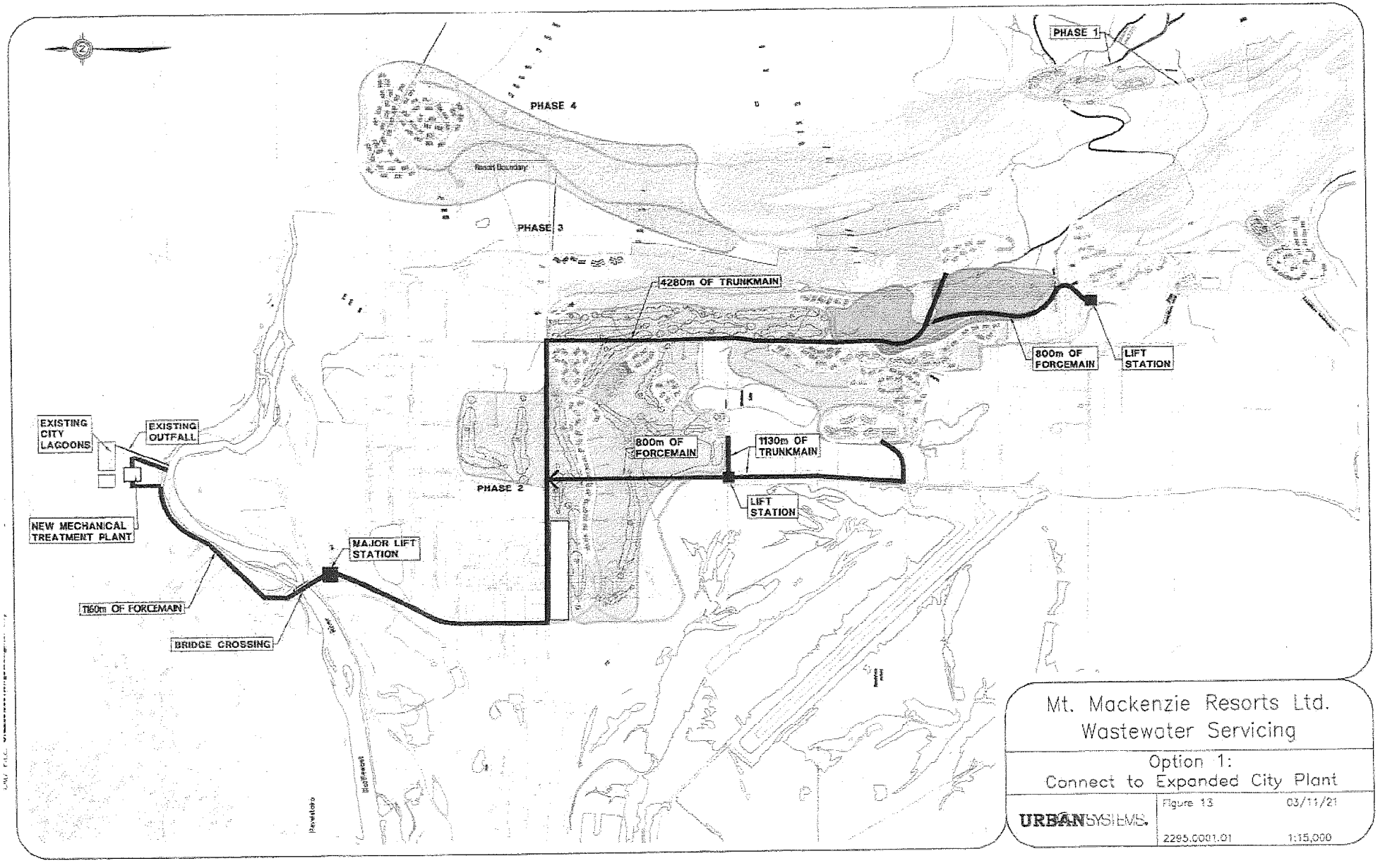
Figure 13 conceptually illustrates the layout of this servicing option. It is necessary to construct approximately 5.4 km of sewermains (gravity and forcemain) to service Phase 1 to convey the sewage to the City's treatment plant site. This sewermain would be sized to handle flow from the ultimate development. A major lift station and a bridge crossing are also required.

An upgraded or new treatment plant will be required. To facilitate a direct comparison to Option 2 only the cost of providing treatment for the resort will be calculated (obviously if this option were chosen a plant sufficient to handle growth in the City and the resort would be built). A mechanical type plant would be required (one similar to Option 2 is assumed). Given the low dilution ratio (58:1) by comparison to Option 2 (7,448:1) a higher level of treatment is assumed required. In terms of cost, a 15% premium is applied to the cost of building the Option 2 sewage treatment plant in order to provide a cost estimate for Option 1. A new outfall will also be required to handle the resort flows. A 200 m long, 250 mm diameter pipe is assumed.

The estimated off-site sewer system costs to service the build-out horizon, including engineering and construction contingencies are:

Trunk Sewers	
• 5440 m @ 375 mm Ø gravity/forcemain @ $325/m	$1,770,000
1130 m @ 250 mm Ø gravity @ $275/m	$ 310,000
1600 m @ 150 mm Ø forcemain @ $200/m	$ 320,000
Bridge Crossing	$ 200,000
Major Lift Station	$ 500,000
Smaller Lift Stations (x2)	$ 300,000
Treatment Plant [(1)]	$7,500,000
Outfall – 200 m	$ 80,000
Total	$10,980,000

(1) A 15% premium over Option 2 is included in the cost of treatment for Option 1 because of the much lower dilution ratio and the assumption this would entail a higher level of treatment.


PHASE 1
PHASE 4
Resort Boundary
PHASE 3
4280m OF TRUNKMAIN
800m OF FORCEMAIN
LIFT STATION
EXISTING CITY LAGOONS
EXISTING OUTFALL
800m OF FORCEMAIN
1130m OF TRUNKMAIN
PHASE 2
LIFT STATION
NEW MECHANICAL TREATMENT PLANT
MAJOR LIFT STATION
1160m OF FORCEMAIN
BRIDGE CROSSING
Mt. Mackenzie Resorts Ltd.
Wastewater Servicing
Option 1:
Connect to Expanded City Plant
URBAN SYSTEMS.
Figure 13
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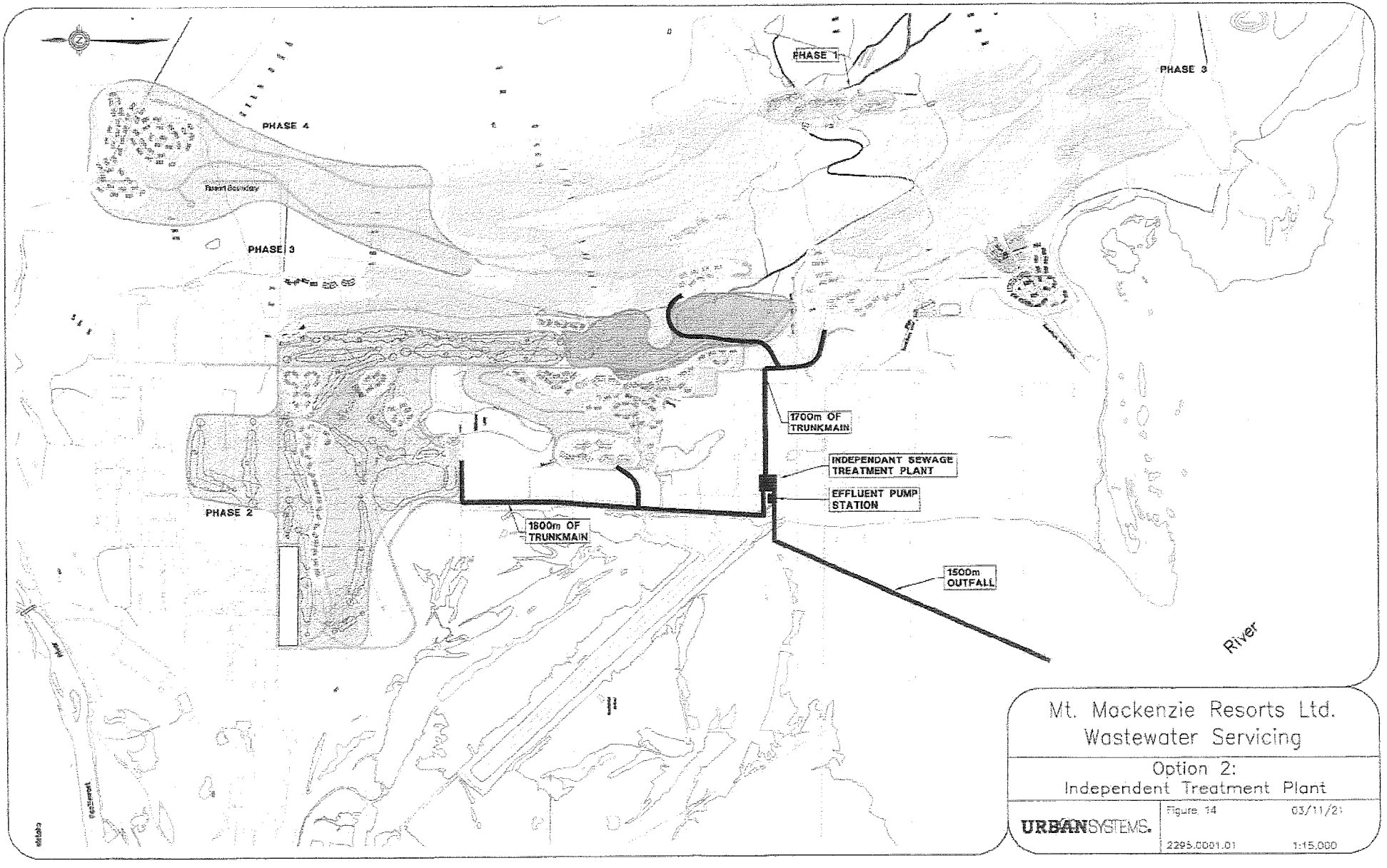
5.5.3 Option 2 – Construct an Independent Plant

In this option all of the wastewater would be directed to a newly constructed plant in close proximity to the resort. Discharge would be to the Columbia River. Figure 14 conceptually illustrates this option. To accommodate Phase 1 development, 1.7 km of trunk sewer at 300 mm diameter are required (utilizing road right-of-ways and legal easements).

The required effluent criteria, which determines the level of treatment, is established by the nature of the discharge or reuse. As noted, the discharge for Option 2 is to the Columbia River. The MSR requires the dilution ratio to be based on the "2 year return period, 7 day low flow". For the Columbia River downstream of the Revelstoke Dam this was calculated using a Weibull analysis on 11 years of available data. The conclusion is that the low flow period equates to 335 m^3/s. Therefore, based on a maximum effluent flow from the resort of 3,886 m^3/d (0.045 m^3/s) the minimum dilution ration would be 7,448:1. The MSR requires more stringent environmental impact studies if the minimum dilution ratio is less then 100:1. At 7,448:1 this means there will be negligible impact on the environment. Indeed, it is probable that the discharge of nitrogen and phosphorus into the Upper Arrow Lakes would be a benefit. Nutrient concentrations in the Arrow Lakes were altered with the construction of the Keenleyside, Mica and Revelstoke Dams. These upstream dams retained nutrients, thus decreasing what was available in the Arrow Lakes, resulting in smaller Kokanee populations. As a consequence, a partnership between BC Hydro, Ministry of Water, Land and Air Protection, Ministry of Transportation, Columbia Power/Columbia Basin Trust and the University of BC initiated a fertilization program in the Lakes. This experimental program began in 1999 and is to finish in 2003. Interim analyses indicate that adding fertilizer into the lake has increased the fish population. Therefore, it is probable that the MSR will require a secondary level of effluent to be achieved (i.e. no nitrogen or phosphorus removal).

There are no registered water licences drawing water from the Columbia River downstream to Greenslide Creek (approximately 10 km from where the resort outfall would go). This means that, strictly speaking, disinfection of the treated effluent will not be required. However, the Proponents of MMR are of the opinion that if potential pathogens are being collected, then they should be killed prior to discharge back into the environment. Consequently, ultraviolet light will be used (i.e. not chlorine or chloramines).

One other point needs to be made with respect to the discharge. The installation of the Hugh Keenleyside dam in 1968 flooded low lying lands surrounding the current Revelstoke airport runway, effectively widening the Columbia River. However, the resort outfall will need to be extended to the thalweg (the deep channel). This means an outfall of approximately 1,500 m will need to be built. Based on the anticipated peak flow rate at design, and allowing for a reasonable head loss, a 250 mm diameter pipe is selected.



Mt. Mackenzie Resorts Ltd.
Wastewater Servicing

Option 2:
Independent Treatment Plant

URBANSYSTEMS.

Figure 14 03/11/21

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There are many different methods of treating wastewater. Each method is appropriate under certain circumstances and for different effluent concentrations. Common methods include:

- aerated lagoons
- rotating biological contactors
- trickling filters
- activated sludge
- sequencing batch reactors
- biological nutrient removal, and
- membrane bioreactors.

It is not necessary, nor would it be appropriate, at this time to select a given method. This should be done during the detailed phase of the project since new technologies are evolving continuously. Having said that, aerated lagoons will not be considered because of relatively large land requirements. For the sake of generating cost estimates, the sequencing batch reactor (SBR) has been selected to provide the necessary treatment for discharge to the Columbia River.

Whatever treatment method is selected, the following components will be included:

- an equalization basin (if not provided within the secondary unit process)
- maceration and screening of non-biodegradable products
- grit removal
- fine bubble diffusers (this is a source of significant power savings)
- secondary process units
- ultraviolet light disinfection, and
- sludge digestion and dewatering.

The plant will be classified by the BC Environmental Operators Certification Program under the BC Water and Wastewater Association. An operator will then be hired with the appropriate classification.

The site selected for the treatment plant is the old City of Revelstoke gravel pit, which is 100 m wide and 200 m long. It has been excavated to approximately 3 m below the elevation of Airport Way. This is advantageous in that buildings and tankage can more easily be visually screened. Extensive landscaping is planned to improve the appearance of the lot and to screen the plant from the road and from neighbouring residential properties. In addition, it will assist in noise attenuation. Noise will be further attenuated by incorporating acoustic panels within the blower room, placing pumps in the water and

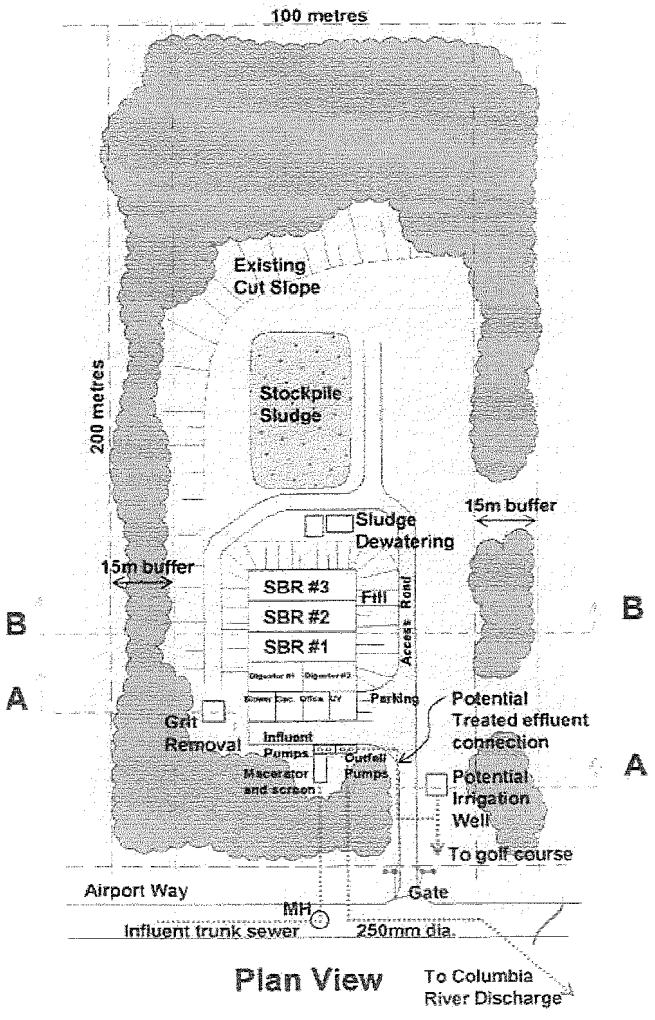
submerging the aeration diffusers. Odours will either be prevented from occurring or will be oxidized using new technology (such as Solair – an ultraviolet light based process which has proven itself in many sewage systems). Prevention will be achieved by maintaining aerobic conditions (dissolved oxygen levels above 2.0 mg/L) in the wastewater. To ensure this happens there will be one back up blower and standby power (diesel or gas generator). Figure 15 illustrates one possible layout of the site using sequencing batch reactors for the secondary process.

The plant and site design will be undertaken in such a way as to prevent leakage or leachate of any kind entering the ground. This is necessary to protect the integrity of the groundwater in the area, which is used for potable purposes by local residents.

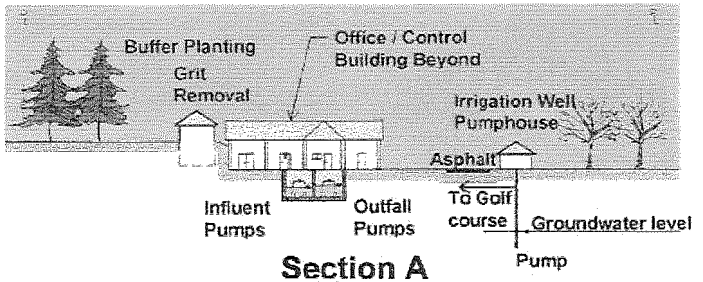
The solids, or sludge, generated by the treatment process will be aerobically digested to meet either Class A or Class B criteria under the *BC Organic Matter Recycling Regulation.* In this way, the solids may be reused on the ski hill, on agricultural land or for silviculture as a soil amendment. After aerobic digestion the solids will be dewatered using either a centrifuge or belt filter press to achieve a concentration that is truckable. Water from this process will be conveyed back to the influent pump station. Depending on the season and/or the reuse locations the dewatered sludge will either be stockpiled (at the plant site – on an impermeable surface) or it will be hauled to its final destination.

The treatment plant will be constructed in phases in proportion to the flows generated by the resort. Initially it is expected that one grit removal tank, one SBR, one aerobic digestor and a proportional number of UV lamps for disinfection will be required. As flows increase additional components will be added.

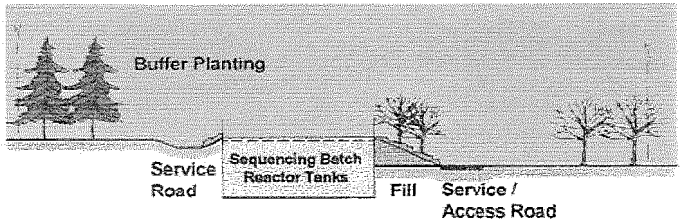
An influent pump station is required to lift the sewage 4 to 5 m to allow gravity flow through the plant. An effluent pump station is also required (though perhaps not in the early years, and possibly not during low river flows). By installing an effluent pump, the size of the outfall pipe can be reduced significantly by comparison to a gravity outfall pipe.



Plan View



Section A



Section B

Mt. Mackenzie Resorts Ltd.
Wastewater Servicing

Conceptual Illustration of
Independent Sewage Treatment Plant

URBAN SYSTEMS

Figure 15 03/11/07

2295.0001.01 Scale: N.T.S.

The estimated off-site sewer system costs to satisfy the build-out horizon, including engineering and construction contingency but not including a sewermain to service the elevated mountain restaurants and small number of cabins, are:

Trunk Sewers- 3,500 m @ 300 mm Ø @ $300/m	$ 1,020,000
Treatment Plant (3,886 m^3/d)	$6,500,000 (1)
Influent/Effluent Pump Stations	$ 400,000
Outfall 1,500 m @ 250 mm Ø @ $400/m	$ 600,000
Total	$8,520,000

(1) does not include the cost of land

5.5.4 Evaluation of Treatment/Disposal Options

The advantages and disadvantages of each option are summarized in Table 10.

Table 10. Advantages/Disadvantages of Treatment/Disposal Options

Advantages	Disadvantages
Option 1: Connect to Expanded City Plant • no new site is required • long trunk main would make sewering of Arrow Heights easier.	• capital cost of off-site works is $2.5 M higher • less opportunity to phase construction • minimum dilution ratio in the Illecillewaet River is below 100:1 therefore requiring special environmental assessment studies
Option 2: Construct an Independent Plant • capital cost of off-site works is $2.3 M lower • phasing of trunk sewers to service later Phase development pods	• a new site is required • trunk sewer requires easements

• minimum dilution ratio in the Columbia River is 7,448:1 • could connect Arrow Heights with relative ease	

Based on the lower capital cost and the much higher minimum dilution ratio in the Columbia River, Option 2 is preferred.

5.6 Recommendations

Based on this assessment, the following are recommended:

1. Conclude who will own and operate the wastewater system.
2. Commit to an aggressive water conservation program that requires all homes and buildings to use ultra low flush (or dual flush) toilets, low flow showerheads and faucets. All services would have water meters and charges would be based on metered use.
3. Utilize a community sewer system as opposed to individual on-site systems. The only exception may be remote mountain restaurants/cabins.
4. Define the service area boundary prior to the commencement of detailed design.
5. Select the conventional collection method for services and pipes in the public right-of-way.
6. Construct an independent treatment plant in close proximity to the resort. Incorporate aesthetic landscaping, noise attenuation, odour control and leachate prevention into the facility.
7. Select discharge of the treated effluent to the thalweg of the Columbia River, with future potential reuse of some of the effluent for golf course irrigation.
8. Fulfill all terms of the *BC Municipal Sewage Regulation* once the Master Plan is approved (conduct environmental impact study, prepare an operating plan and submit the MSR registration application).
9. Digest the sludge to meet Class A or B criteria in the *BC Organic Matter Recycling Regulation.* Identify and conclude reuse opportunities. Dewater and reuse sludge in the resort vicinity as a soil amendment.

5.7 Water Conservation/Demand Management

The MMR water and wastewater systems would be designed, built and operated from the beginning with a strong water conservation philosophy. The principles underpinning this philosophy will include:

- Mandatory use of water conserving plumbing fixtures in all buildings:
  - toilets - 6 L/flush maximum; and
  - low flow taps and showerheads.
- Mandatory use of waterless urinals in all public washrooms.
- All building water services to be metered.
- User rates for water and sanitary sewer to be volume-based on water meter readings.
- Ongoing education program that highlights the economic and environmental benefits of water use conservation.
- No extraneous connections to the sanitary sewer system from buildings or any other drainage works permitted (i.e., roof gutters, foundation drains). The only drainage exception would be floor drains in underground parkades, which should be equipped with oil/water separators. Infiltration/Inflow (I/I) ongoing management program to ensure I/I does not develop over time.

This chapter presents a summary of the options considered and the preferred option for handling domestic wastewater. Section 6.0 describes stormwater management.

6.0 STORMWATER MANAGEMENT PLAN

6.1 Introduction

This section of the report addresses stormwater management within the Base Lands of the Mount Mackenzie Resort. Sanitary sewer systems are addressed in Section 5. Stormwater was not addressed at the Concept Stage.

Mount Mackenzie lies south of the Illecillewaet River and east of the Columbia River (Upper Arrow Lake). Development in the order of 16,400 bed units is proposed at the base of the mountain and on the generally west facing slopes up to approximately 800m in elevation. The plans incorporate development of an 18-hole golf course, which will have a number of water features, within the Base Lands. The soils in the area range from outcroppings of bedrock at the high elevations to permeable sand and gravel alluvial deposits near the Valley floor.

The objective of the stormwater management plan is to provide a general overview of stormwater management for the resort village including the roads but excluding the ski hill and golf course areas. The study area for the stormwater plan is shown in Figure 16. This plan will identify general requirements and could be used as the basis for preparing a Storm Drainage Master Plan at a later date.

6.2 Context

6.2.1 Watershed(s)

Figure 17 is a map of the watershed/drainage areas considered for the stormwater plan.

6.2.2 Topography

The topography in the Revelstoke area is typical of the Selkirk and Monashee Mountain Ranges. Mt. Mackenzie bottoms at the valley floor (Upper Arrow Lake) at an elevation of approximately 440 m and peaks as high as 2350m. The study area is of the proposed development area and ranges from 440 m to 800 m. Western portions of the Base Lands can be essentially flat while slopes of 40% or more are not uncommon on the mountain to the east.

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Mount Mackenzie Resorts Ltd.
MASTER PLAN

STORMWATER PLAN
STUDY AREA

URBANSYSTEMS.
Prepared for: Revelstoke Alpine Village Inc.

Figure 16 NOV. 2003

2295.0001.01 1:15,000

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Mount Mackenzie
MASTER PLAN

KEY
WATERSHEDS

URBANSYSTEMS.

Figure 17 DEC 2003

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6.2.3 Precipitation

Two data sets collected by Environment Canada in Revelstoke provide the following information. The first data set was collected from 1898 to 1969. The average annual precipitation from 1898-1969 is 1040 mm. The second data set was collected from 1969 to 1999. The average annual precipitation during this period is 935.4 mm. Table 11 presents the average precipitation data in tabular format.

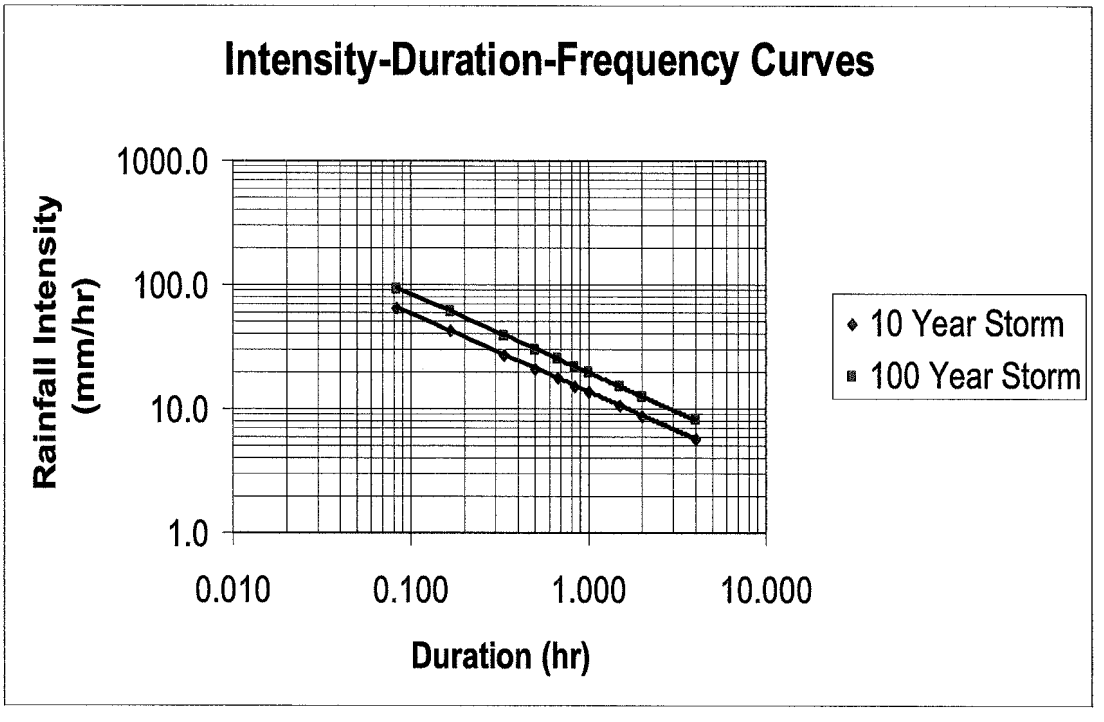
Table 11. Recorded Precipitation

	1898 – 1969 Average Value	1969 – 1999 Average Value
Rainfall (mm)	655.4	605.4
Snowfall (mm)	3968	4290
Precipitation (mm)	1040	935.4

IDF (Intensity Duration Frequency)

The IDF curve for the District of Revelstoke, Figure 18 presents both the 10-year and 100-year storm events and their associated intensity (mm precipitation per hour) and duration (hours).

Figure 18. Intensity Duration Frequency Curves



24-hour design storms (2-, 5-, 10-, 25-, and 100-yr)

Statistical analysis of available rainfall data shows that the 100-year recurrence storm event is roughly 55 mm in 24 hours, while the 25-year, 10-year, 5-year, and 2-year recurrence storm events are approximately 46.6 mm, 40.9 mm, 36.4 mm and 29.7 mm in 24 hours respectively. Figures 20 and 21 show the distribution of rainfall events compared to the MAR. From 1898 to 1999, 11,259 of the 11,940 rainfall events produced less than the MAR amount of 33 mm in 24 hours. These 11,259 events produce nearly 95% of all rainfall events in Revelstoke.

MAR

Recent work in the stormwater field has stressed the "Mean Annual Rainfall" (MAR) as being an important parameter for stormwater control. MAR is the 24-hour rainfall event with a return period of 2.33 years and is expressed as the accumulated precipitation over 24 hours. The MAR for Revelstoke is about 33 mm in 24 hours. See Figure 19.

Figure 19. Mean Annual Rainfall

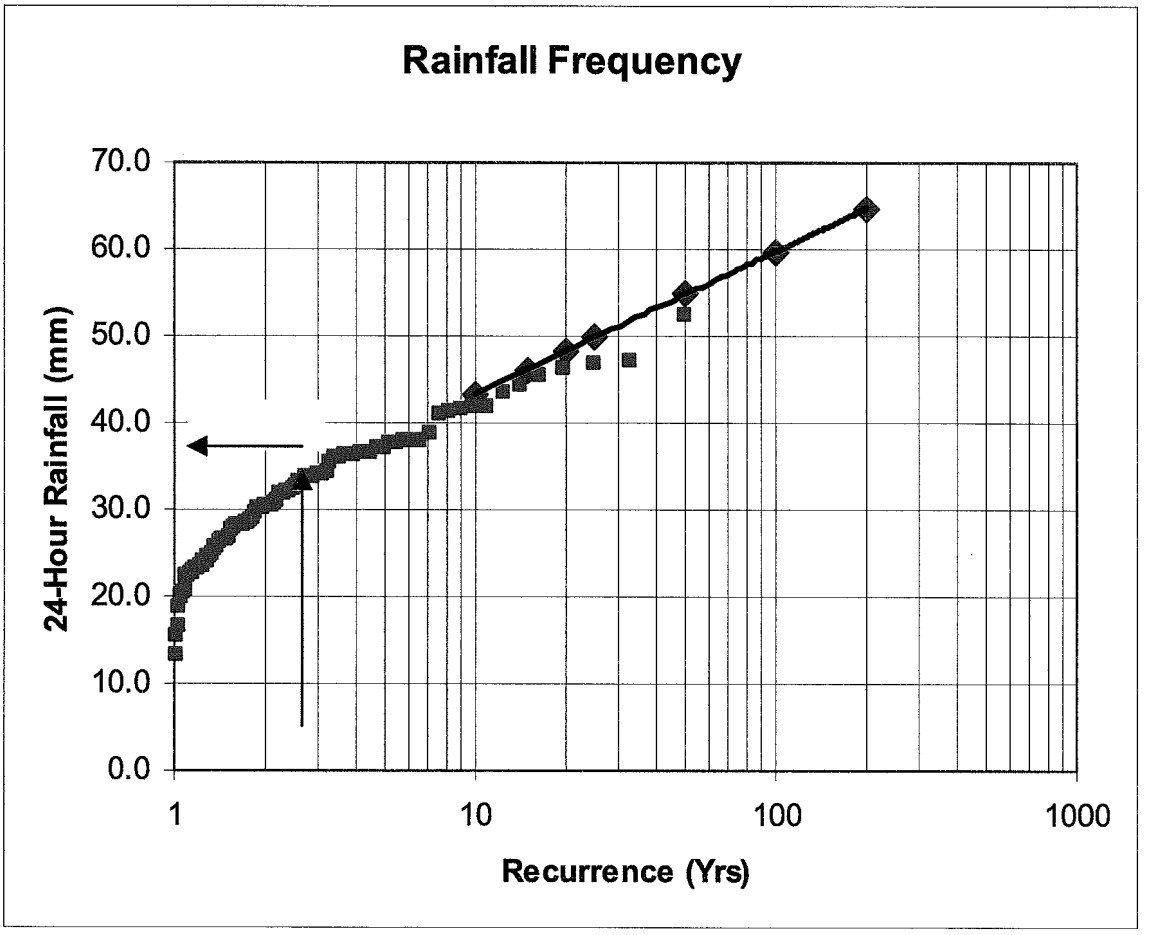


Figure 20. Rainfall Data Distribution

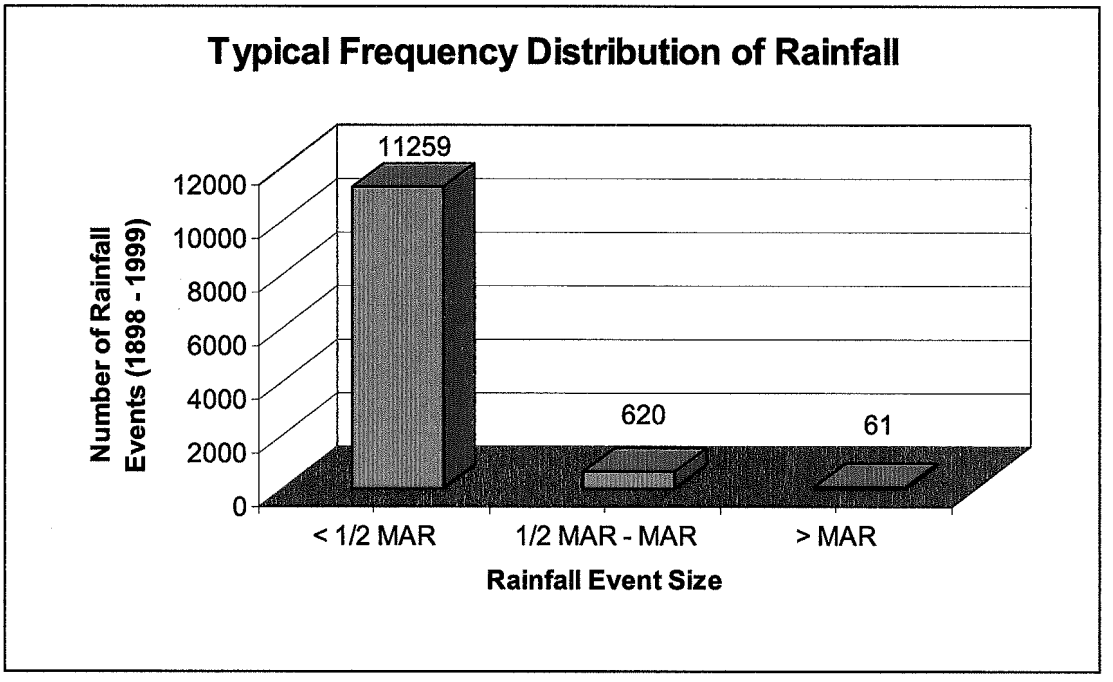
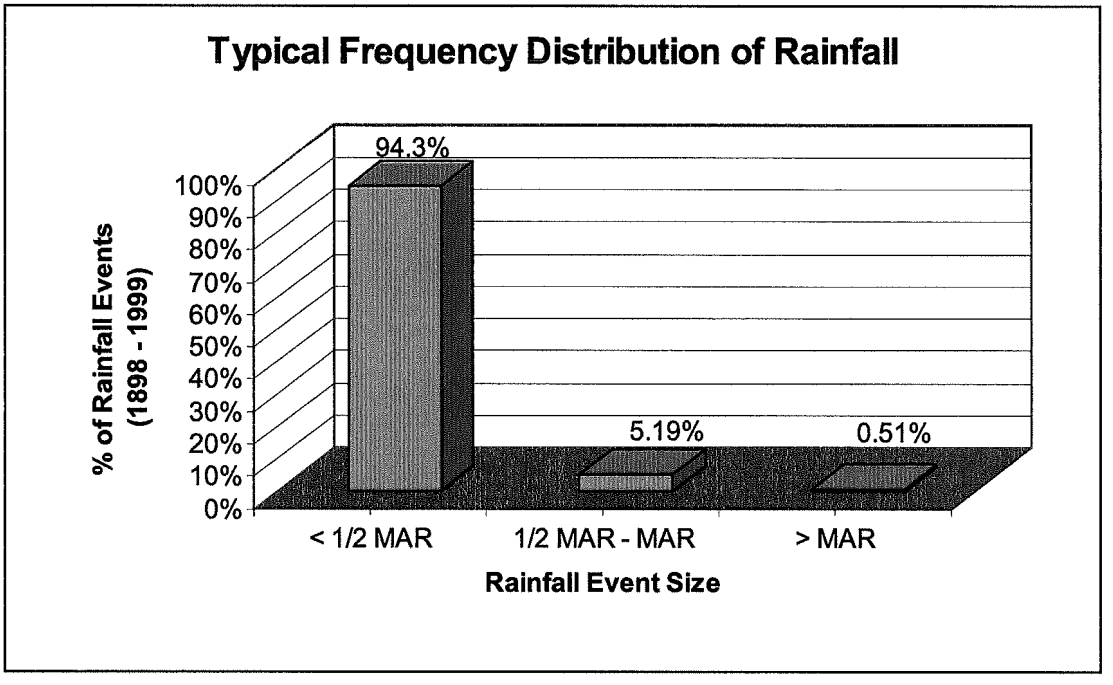


Figure 21. Rainfall Distribution as Percentage Rainfall Distribution



Snow is a major component of the annual precipitation in Revelstoke. As indicated above, Revelstoke receives on average between 397 cm and 429 cm per year. Even the lowest snowfall recorded, 149.7 cm in 1941, far exceeds the Cold Climate definition (91.5 cm/year). The highest snowfall, 717.9 cm was recorded in 1971.

6.2.4 Hydrology

Numerous ephemeral streams are present in the study area. Most of them originate at springs generally day-lighting higher up the mountain. Most of these streams do not make it overland to Upper Arrow Lake, as they are absorbed by the sandy soils of the Airport Bench, or discharge into either Williamson Lake or an unnamed lake before they reach Upper Arrow Lake.

The most significant watercourse in the study area is Montana Creek located at the south end of the study area and discharging into a wetland adjacent to the lake.

The major run-off events typically occur during spring freshet due to the large amount of snowfall that accumulates in the Revelstoke area. Streams generally see their highest flows in May and June and their lowest flows in late winter (January to March). Many of the small streams are spring fed thereby maintaining a nominal base flow throughout the year.

6.2.5 Hydrogeology

The base area below 440 m is underlain by an unconfined or semi-confined alluvial/floodplain aquifer. For the mountainside development (above 440 m) a shallow perched surficial groundwater and a deeper fractured bedrock aquifer are the primary groundwater occurrences.

The airport bench area north of Montana Creek is spotted with numerous small stream courses generally originating at seeps and springs located at 605 - 770 m. Kala Groundwater visited five springs in the study area in September 2003 and recorded flows from less than 0.5 L/s to as high as 60 L/s.

6.2.6 Soils

Testing has not been performed on the soils of the Airport Bench to confirm percolation rates and the suitability of using infiltration to manage stormwater. A review of well logs from the area show alternating layers of sand and gravel with varying degrees of clay. Sand and gravel soils are generally porous and desirable when proposing infiltration.

6.3 Regulatory

6.3.1 Regulatory Background

In British Columbia, the responsibility for local drainage has been vested with municipalities and regional districts through the *Local Government Act.* In addition, there are federal and provincial provisions and guidelines that work alongside of or can enhance the City's or regional District's ability to address stormwater issues.

The federal provisions and guidelines that are in place to assist the local government's ability to address stormwater issues include:

- Canadian Environmental Quality Guidelines – establish target conditions in water bodies, including bottom sediments
- Federal *Fisheries Act* – provides for protection of fish habitat

The City of Revelstoke currently has a draft bylaw pertaining to stormwater drainage and management. The primary purpose of the bylaw is to limit the effect of peak flows and volumes of runoff on property, receiving streams, and watercourses through an overall stormwater management strategy.

6.3.2 Current City Drainage Design Guidelines

Design criteria for the City of Revelstoke cover multiple topics including: system sizing, design grades, roughness coefficients, minimum pipe sizes, culverts, location of storm mains, alignment of storm mains, depth of cover, manholes, catchbasins, catchbasin leads, service connections, pipe class and bedding class, major flow routing, and drainage drywells.

6.3.3 Provincial Stormwater Guidelines

At present there are no requirements to manage urban drainage in any particular manner. It is up to the local government to determine how to best balance community development, environmental protection and stakeholder desires. Until a development project or action impinges on fish habitat or seriously impairs water quality, there are not specific rules requiring stormwater management. However, authority is available to address stormwater through any number of planning, regulation, development approval and servicing provisions of the *Local Government Act.* Provincial guidelines are generally to retain runoff for events up to 50% of MAR, detain events up to 100% MAR, and to prevent flooding and erosion for events > MAR.

6.3.4 Fisheries and Oceans Canada and Ministry of Water, Land, and Air Protection (MWLAP) perspectives

A "Preliminary Environmental Assessment: Mount Mackenzie Resort Expansion" report was submitted, by ENKON Environmental Limited: March, 2000, as part of the Mount Mackenzie Resort Expansion Final Concept Report. This preliminary environmental

assessment stated that the "Scott, Montana and the Unnamed Creek, Williamson Lake and a portion of Lake No. 1 are located within the proposed base area lands." The report further indicates, "none of the proposed mountain or base area lands is located within fish bearing sections of Scott and Montana Creeks." The report continues "a number of the mountain facilities (i.e. lifts, ski runs, road building) could potentially impact non-fish bearing sections (>600 m asl) of Scott and Montana Creeks and some of the ephemeral streams that drain into these streams."

6.4 Stormwater Management Approach

6.4.1 Stormwater Management Objectives

At the watershed level, the stormwater management systems shall be developed to meet four primary objectives:

- Flood Protection
- Erosion protection
- Aquatic habitat protection
- Water quality protection

6.4.2 Stormwater Management Strategies

The integrated stormwater management approach is to incorporate three strategies:

- Control total impervious area (TIA) through zoning and road design standards
- Reduce effective impervious area by limiting portion of TIA that is directly connected to drainage systems
- Maximize retention of rainfall from frequent events (<50% MAR) for slow release to local watercourses through appropriate landscaping and incorporating BMPs (biofiltration; infiltration; etc.)

For purposes of stormwater management, the City of Revelstoke should be considered a "cold weather region." This means that the normal maximum January temperature is less than 1.7°C, the growing season is less than 150 days and the mean snowfall (snow depth) is greater than 915 mm. Revelstoke meets all three criteria

6.4.3 Stormwater Management Measures

Typical stormwater management measures (dependent on site specific feasibility) for urban areas include:

- Maximize rainfall retention at the local level for small frequent storm events (<50% MAR).
- Provide stormwater detention, where necessary, to attenuate post development flows (up to 100% MAR).

- In lieu of the above, local stormwater conveyance systems to the 1:10 year level in accordance with the City of Revelstoke bylaws. This will be accomplished in most areas using underground piping. Where space limitations allow (primarily along SF development) open ditches and swales may be implemented.
- Provide adequate major flow paths for the protection of public safety, infrastructure and property to a return period of 1:100 years.
- Where soils conditions permit, utilize infiltration to manage stormwater from small frequent events (<50% MAR).
- Implement a snow management strategy.

A list of approaches used to achieve the management measures include:

Design Standards

Presuming the Resort will be incorporated into the City Boundary the applicable design standards are the current City standards.

The City of Revelstoke bylaw requires:

1. The minor system to convey a 10-year return period flow for residential, industrial, commercial and institutional and high density residential area.
2. The major system to convey a 100-year return period flow.

Potential Flow Paths for Major Storms

Flow paths for the major storm system include:

1. Surface flood paths,
2. Roadways, and
3. Watercourses

Protection of Existing Water Courses, Including Buffer Zone

Along with the main streams (Montana and Scott) there are a number of ephemeral streams that are licensed for use as either domestic or irrigation water. These watercourses can be protected by implementing buffer zones and by minimizing discharging stormwater to these water courses. Ensuring the quality of water in these streams is maintained using one or more BMPs should be explored during pre-design.

Best Management Practices

One of the key elements of most stormwater control programs today is the application of "best management practices" to mitigate the potential affects of land development on watersheds. BMPs may serve to reduce the peak rate of stormwater runoff, reduce the total volume of stormwater runoff, improve the water quality of the stormwater runoff or,

typically, meet more than one of these objectives. Where possible one or more of the following BMPS should be implemented into the Resort design.

BMP's are typically divided into three broad categories:

- Non-structural / land use-oriented
- Structural
- Operation and maintenance (O&M)

Non-structural / land use-oriented BMPs practices include:

- Preventative actions that involve management and source controls
  - Policies and ordinances that provide requirements and standards to direct growth in specific areas
  - Protection of wetlands and riparian zones
  - Maintain and/or increase open space (buffer around developed areas)
  - Minimize disturbance of soils and vegetation
- Education programs for developers, and the public
- Minimization of impervious area after development and minimization of directly connected impervious areas.

Structural BMPs are probably the most well-known type of stormwater treatment practices and include:

- Storage practices
  - Wet ponds
  - Extended-detention outlet structures
- Filtration practices
  - Grassed swales
  - Sand filters and filter strips
- Infiltration Practices
  - Infiltration basins
  - Infiltration trenches

O&M BMPs focus both on maintaining the long-term usefulness of structural BMPs as well as reducing the likelihood of stormwater causing problems. O&M BMPs include:

- Street cleaning
- Detection of contaminant spills
- Maintenance of vegetation in swales and catch basin cleaning

Snow

Snow management in an area with such an abundance of snow is both a challenge and a requirement such that its' melting does not adversely affect the surrounding aquatic

environments. Snow management practices that can be used to avoid adverse environmental effects include:

- not plowing snow directly into watersheds (lakes, streams or wetlands) or storing snow outside direct drainage into surface waters
- piling snow away from vegetated areas to avoid damage to vegetation by sediment and/or salt damage
- positive actions include;
    - monitoring snow piles for windblown debris
    - containing sediments from snow melt and removing sediments from storage areas every spring

It is important that any snow removal program store the snow in locations where snow can slowly infiltrate into the ground without running directly/indirectly into surface waters. Sediment/salt damage must also be avoided by choosing a location where vegetation will not be harmed, and sediment removal is simple during the spring.

Culverts

Existing culverts throughout the study area, which may or may not have adequate capacity should be assessed at the watershed level. This should be done at pre-design or during the preparation of a Storm Drainage Master Plan for the Resort.

6.5 Conclusions and Recommendations

We recommend the use of multiple BMPs and that a Master Stormwater Drainage Plan (MSDP) be developed early in the development process such that the techniques available are best applied to specific site requirements. Preliminary on-site cost estimates, with an allowance for stormwater conveyance, have been provided to Lynnpeaks Consulting for inclusion in the economic analysis. Further analysis, as part of the MSDP, is required to identify and define the major stormwater works required.

The development plans include an 18-hole golf course, which will have a number of water features. One or more of these golf-course ponds may prove suitable to use as component of stormwater management. The utilization of golf course lands in this manner should be reviewed in a stormwater management plan and at the predesign phase of the golf course.

The major components of the MSDP for the resort should include considerations for cold climate conditions. Such components include, but are not limited to, extended duration wet ponds, extended duration wetlands, underground sand filters and to some extent wet/dry ponds, infiltration trenches and basins, bioretention and submerged gravel wetland filtration systems as well as open channel systems, which can double as snow storage areas. Snow management will be an important component of the stormwater management plan.

7.0 VEGETATION MANAGEMENT PLAN

7.1 Introduction

The following section describes the guiding principles, proposed mitigation measures and best management practices to reduce potential impacts to vegetation resources in the proposed development area and includes the following recommendations:

- Revegetation of areas as soon as possible following the end of construction in order to limit the area of exposed soil;
- Salvage of all merchantable tree volumes;
- Use of seed mixtures that will not increase the frequency or distribution of any weed species or introduction of non-native species;
- Use of seed mixtures that will include species that are adapted to the climate and soil conditions of the region and will be obtained from local native sources wherever possible;
- Measures to address both the short term and long term impacts and how the ski runs will be managed; and
- Measures to preserve the maximum biodiversity within the project boundaries (e.g. allow forests to mature and wind firmness of trees at the edge of ski runs).

7.2 Tree Protection Plan

All trees that are to be retained will be protected from mechanical damage to the trunk and root system. This protection can be achieved through:

1. Marking trees or flagging areas that are to be protected during the construction phase of the project;
2. Installing 'Tree Protection' signs;
3. Taking all measures necessary to prevent the activities such as storage of materials or equipment, stockpiling of soil or excavated materials, burning, excavation or trenching or cutting of roots or branches within the tree protection areas;
4. Restricting vehicle traffic to designated access routes and travel lanes to avoid soil compaction and vegetation disturbances; and,
5. Avoiding alterations to existing hydrological patterns to minimize impact on vegetation.

Clearing (of ski runs, in particular) will be done in a manner to minimize the potential for windthrow and other damage to newly exposed inner forest areas. The following practices will be implemented

1. Trees will be cut to achieve a "soft edge," keeping smaller trees near the edge and progressing toward larger trees in the middle. Unit edges will be feathercut to reduce the strong contrast between the ski trails and undisturbed areas.
2. When cutting, the integrity of naturally occurring tree clumps will be maintained.

7.3 Sensitive Ecosystem Protection Plan

All Sensitive Ecosystems (i.e. riparian zones) will be protected from mechanical damage during construction. This protection can be achieved through:

1. Limit clearing to the minimum area required for construction boundaries Snow fence areas that are to be protected during the construction phase of the project;
2. Install 'Sensitive Ecosystem Protection' signs;
3. Remove the minimum amount of vegetation possible from environmentally sensitive areas or areas where rare or endangered plants or plant communities are identified by the environmental monitor; and
4. Take all measures necessary to prevent the activities such as storage of materials or equipment, stockpiling of soil or excavated materials, burning, excavation or trenching or cutting of roots or branches within the sensitive ecosystem protection areas.

Due to the close proximity of the development to sensitive ecosystems the following guidelines as outlined in the SEI Conservation Manual (McPhee *et al.*, 2000) should be followed after the completion of construction, where possible:

1. Where residential or other developments are adjacent to sensitive ecosystems establish conservation covenants;
2. Restrict recreational access;
3. Control the introduction or spread of invasive species;
4. Prevent wildlife disturbance (especially nesting or breeding areas);
5. Locate developments away from sensitive core areas;
6. Establish a buffer zone between the core sensitive areas and the development area; and
7. Maintain hydrologic regime.

7.4 Revegetation Plan

7.4.1 Ski Runs

The proposed development plan for the ski runs indicates that there will be very little requirement for tree clearing in subalpine and alpine parklands. Ski run routes will be designed to travel between the sparse stands of trees present in these areas. Where it is not possible to align the routes around existing stands of trees, the trees will be flush-cut so that the roots will remain to stabilize the soil. Areas that will require revegetation should be re-seeded with the appropriate seed mix.

The revegetation plan for the slopes will follow *Ski Area BMPs* (Sibbernsen *et al.* 2001), which contains the following recommendations:

- Finish the project during one summer construction season and reclaim the area permanently before winder snows cover the ground.
- Have a contingency plan for erosion control if there is any possibility that finishing the run could be delayed by an early snowfall.
- Strip and stockpile as much topsoil as possible for later reapplication. Limit topsoil losses to either two inches (5 cm) or half the thickness of the original topsoil, whichever is less.
- Protect reapplied topsoil layers from erosion using caterpillar track surface roughening, cross slope waterbars and surface mulch blankets.
- Apply seed in late autumn to take advantage of snowmelt and rainfall the following spring.
- Test soil to determine fertilizer requirements and, if necessary, apply fertilizer with the seeds.
- To establish successful vegetation at a density of 40 plants per square foot, apply seeds at a rate of at least 100 per square foot.
- For improved seed germination, consider using a snow cat to track in and cover the seed with soil.
- Monitor seedling establishment to fine tune seed mixes and determine if supplemental seeding is needed.
- Enhance seedling establishment and growth with supplemental fertilizer application during the spring following initial seeding.
- Cover freshly seeded areas with mulch to create a cool, moist environment for fragile seedling survival.
- Restrict vehicle access to reclaimed areas so that multiple trails do not form. Delay entering previously disturbed areas with new construction until vegetation has completely recovered.

The success of revegetation will be monitored, and reseeding will occur, if necessary. Monitoring will consist of the following:

1. revegetation success;
2. sheet and rill erosion, gullies, slumping and subsidence;
3. soundness and effectiveness of erosion control measures;
4. noxious and undesirable weed invasion;
5. degree of herbivory by rodents on seeds and seedlings; and
6. evidence of excessive wildlife grazing.

Monitoring will include the establishment of a reference transect to establish baseline conditions. The reference transects will be used to compare the revegetation success against the following performance standards:

1. Percent cover: The reclaimed area contains 75% of the total vegetal cover measured for the reference transect.
2. Dominant species: 90% of the revegetation consists of species contained in the applied seed mix and/or that occur in the reference transect.
3. Seedling density: The density and abundance of seedlings is at least 10 to 12 seedlings per meter.
4. Erosion condition: The erosion condition of the reclaimed area is equal to or in better than that measured for the reference transect.

7.4.2 Development Areas

Following construction residential and commercial development areas should be revegetated using a mix of indigenous tree, shrub and groundcover species. Trees should be planted at an average density of one plant per 4 m^2 and shrubs should be planted at a density of approximately one plant per 1 m^2. Berry producing species are not recommended for development areas as they may attract bears. Bioswales should be replanted using a mix of sedges and rushes. Stormwater ponds should be planted with a mix of emergent and submergent native plants.

7.4.3 Roadways and Transmission Lines

Following the completion of roadways adjacent slopes should be reseeded with a mix of indigenous grass seed. A specialized mix designed for linear developments should be used which contains numerous species tolerant of varied elevation and soil nutrient and moisture regimes.

Reseeding of disturbed areas can be accomplished in two ways. On steep slopes hydroseeding is recommended. On gentle slopes and flat areas seed can be hand-broadcasted. To further protect seeded areas and stabilize exposed soil areas the application of mulch is recommended. Loose mulch can be applied on gentle slopes and

flat areas, and cocoa-mats should be used on steep cut-slopes (greater than 2:1) immediately uphill of streams.

7.5 Trail Management Plan

Off-trail use has the potential to damage sensitive vegetation, particularly in alpine areas. To minimize damage, the following management plan for hiking and mountain bike trails will be implemented:

1. Trails will be clearly marked, including fencing in particularly sensitive areas, to avoid off-trail use by bikers and equestrians. Off-trail use by hikers will be strongly discouraged.
2. Signs will be posted to inform trail users of the sensitive nature of alpine ecosystems and potential for damage from off-trail activities.
3. Picking wildflowers will be prohibited.
4. All interpretative staff guiding visitors on trails will inform hikers of the potential damaged caused by off trail activities and picking wildflowers.
5. Visitor information centre staff members will hand out information on trail etiquette and the protection of alpine and other sensitive ecosystems. Trained staff will be available to answer visitor questions.
6. Resort staff will regularly patrol trails to look for signs of vegetation damage (trampling, corner-cutting, unauthorized new trails). Trails may be closed temporarily if the damage appears to be significant. In cases of severe damage, reseeding with an appropriate seed mixture may be necessary.
7. If there is an ongoing issue with damage to sensitive plant communities, access to some backcountry areas may be restricted using a permit system.

8.0 GRIZZLY BEAR MANAGEMENT PLAN

8.1.1 Resort Management Objectives

The Proponent, MMRL understands that the potential impacts to grizzly bears in the area could be substantially addressed through a number of mitigation measures and provided that a comprehensive mitigation package was implemented may result in "no net impact" to the population. Therefore, MMRL is committed to the following management objectives to ensure the "no net impact" scenario occurs:

1. Preparation of a comprehensive "Bear Management Plan" (contained herein) to reduce bear-human conflicts to be approved by the Ministry of Water, Land and Air Protection and implemented by MMRL. The management plan will include measures for managing any recreational use outside the project area, which originates directly from the resort (i.e. people hiking, biking, riding horses, or driving motorised vehicles from the resort into neighbouring drainage's);
2. Contribute towards efforts to reduce bear-human conflicts in the surrounding valleys through visitor education and improvements in infrastructure (i.e. provision of bear-proof garbage cans, fencing of portions of the access road as required and extension of bridge structures);
3. Commit to mitigate the impact of habitat loss and habitat deterioration through off-site habitat enhancement such as access management;
4. Commit to increasing habitat effectiveness through measures (i.e. not allowing overnight parking for non-guests; not operating lifts or building trails for summer sightseeing that would a provide access into surrounding valleys; prohibiting the use of motorised vehicles and restricting helicopter use) to minimise the movement of;
5. Apply an adaptive management approach consisting of monitoring as well as feedback mechanisms that will allow the results of the monitoring to influence the implementation of any mitigation measures adopted; and
6. Support the government initiatives for controlling access into surrounding valleys through review of applications for commercial recreation.

While the objectives of the *Grizzly Bear Management Plan* are addressed based on the experience and proven techniques developed from other resort and park developments throughout the Pacific Northwest, the ultimate success of the mitigation measures will be achieved through an adaptive management approach by monitoring and effective feedback mechanisms. Undoubtedly, the implementation of the proposed mitigation measures will be adjusted and evolve over time.

Many of the recommendations in the Grizzly Bear Management Plan are also applicable to the management of other wildlife, such as Black Bear, Wolverine, Cougar and other predators.

8.1.2 Historical Bear Management Plans/Programs

Since the early 1960's, comprehensive grizzly bear management plans have been prepared to address grizzly bear-human conflicts in the National Parks throughout the Pacific Northwest.

In 1960, the National Parks Service implemented a bear management program in Yellowstone National Park designed to reduce the number of bear-caused human injuries and property damages occurring within Yellowstone National Park and to re-establish bears in a natural state (Gunther, 1994). During the 1960's, the National Parks of Canada were also developing and implementing bear management programs (Canadian Wildlife Service, 1971). Similar to the US plans, the early National Parks programs were focused on bear-human conflicts and reporting of bear movements.

In 1970, a new more intensive bear management program (Leopold et al., 1969) was initiated in Yellowstone National Park with the objective of restoring the grizzly and black bear populations to subsistence on natural forage and reducing bear-caused injuries to humans (Cole 1976, Meagher and Phillips 1983).

In 1983, the park implemented a modified grizzly bear management program with greater emphasis on habitat protection in backcountry areas. This plan restricted recreational use in areas with seasonal concentrations of grizzly bears.

Since 1983, bear-caused human injuries declined to an average of one per year. During the first years of these programs, most bear-human conflicts involved food-conditioned bears that aggressively sought human foods. In more recent years, management problems have involved habituated (but not food-conditioned) bears seeking natural foods within developed areas along roadsides.

In 1998, a bear-human conflict management plan was prepared by Parks Canada and was a synthesis of five bear management plans including Banff, Jasper, Yoho, Kootenay and Waterton National Parks. The plan concentrated on mitigation measures such as bear monitoring systems, bear-human conflict management, facility management, public information/education and training of park personnel.

In summary, grizzly bear management plans/programs have evolved over the years to reduce the cause of bear-human conflicts through such mitigation measures as backcountry access restrictions, food and garbage management, public information/education, training of park personnel and monitoring systems.

The following proposed "Bear Management Plan" is intended to reduce the potential impacts to grizzly bears from the MMR. For clarification, it is assumed that the

proponent, MMRL is responsible for implementing or funding each proposed mitigation measure unless otherwise noted.

8.2 Garbage Management

8.2.1 Background and Problem Description

Schullery (1980) chronicled the history of the grizzly bear/garbage situation in Yellowstone National Park. Both black and grizzly bears were feeding at hotel dumps as early as the 1890's and nuisance bears had emerged by the early 1900's. The number of grizzly bears feeding at dumps rose drastically from 40 bears in 1920 to 260 bears in 1930. Grizzlies were often closely associated with garbage in many preserves, therefore leading to human/bear problems, and as a result "nuisance bears" or habituated bears (GBIT 1987). Craighead (1980) reported that 56-77% of the total grizzly bear population of Yellowstone Park congregated at the dumps. These nuisance bears become habituated to people and obtain non-natural foods, are "repeat-offenders" in relocation programs and express offensive aggressive behaviour towards humans, becoming a threat to human safety (MELP 1996). In 1932, the Research and Education Branch suggested that dumps were unhealthy for bears and were no longer necessary in Yellowstone National Park. The last of the Yellowstone Park dumps were closed in 1970.

Open-pit garbage dumps and poorly designed incinerators still enabled grizzly bears to obtain garbage in several Canadian National Parks throughout the 1960's. The landfills in Banff and Jasper National Parks were fenced in 1970 but habitual garbage bears still managed to obtain garbage by digging under, or breaking through the enclosures (Kaye, 1982). The Banff landfill was closed in 1980 and an electric fence was placed around the Jasper landfill in 1981 to discourage bear activity. Kootenay and Yoho National Parks have hauled all refuse to nearby communities since 1973 and 1974, respectively.

Beginning in 1980, all refuse from Denali National Park was hauled to the public landfill at Nenana, Alaska. Singer (1982) felt that closure of the park dump, bear proofing of most garbage cans and increased visitor awareness were the primary factors in minimising grizzly bear incidents in Denali Park.

Herrero (1970, 1976, 1978, 1982 and 1985) concluded that bears which habitually fed on human food and garbage often lost their natural wariness of people. Such food conditioned bears were more likely to show aggressive tendencies than non-food conditioned bears. Although there is some uncertainty as to the degree of habituation/conditioning related solely to feeding at remote garbage dumps, there is general agreement that acquisition of garbage or other human foods in campgrounds or developed areas can have serious consequences for humans and bears. Within North American National Parks, habituated food-conditioned grizzly bears accounted for approximately 2/3's of all bear-inflicted human injuries up to 1970. Ninety percent of these injuries occurred in developed campgrounds in Yellowstone National Park where grizzlies had a long history of feeding on human refuse. Since 1970, improperly stored food and garbage was the second most common circumstance following surprise encounters associated with grizzly bear inflicted injuries.

Garbage feeding bears are generally more often predisposed to control actions and resultant re-location or mortality. Every year about 950 black bears and 50 grizzly bears are destroyed in BC to protect the public (MELP 1996, CWS 1971). Between 1986 and 1996, the Conservation Officer Service relocated 107 grizzly bears and 54 black bears and destroyed 15 grizzly bears and 266 black bears within or near the City of Revelstoke (Robinson 1997).

In Yellowstone National Park, the average size of grizzly bear litters before dump closure was 2.1 cubs whereas the average litter size after dump closure was 1.9 cubs. Knight and Eberhardt (1984 and 1985) reported that 70% of the females reproduced at age 5 prior to the dump closure while 60% of the females reproduced at age 6 after dump closure.

Knight et al. (1981) found that three adult males weighed less in 1980 after the Cook City dump closed. The mean weight of male bears five years and older was significantly less after dump closure. Russell et al. (1979) observed that the only grizzly bear in Jasper National Park that used a landfill was exceptionally large for its age. Their observations suggest that grizzly bears that used garbage to supplement their natural diet did attain greater weights than bears that did not supplement their diet with garbage.

8.2.2 Bear Aware Program

The availability of human food and garbage sources to bears is recognised as a major source of people-bear conflicts within Yellowstone National Park (1996) and in BC (MELP 1986). As a result, several communities that historically have extensive problems with human/bear conflicts associated with attraction to non-natural food sources have implemented "Bear Aware Programs" (Robinson 1998). Since 1996, the City of Revelstoke initiated a "Bear Aware Program" to develop long-term strategies to reduce the number of bear/human conflicts and thereby reduce the number of bears having to be destroyed or relocated. While the program is still in its' infant stages, the number of bears destroyed or relocated has dropped dramatically in the Revelstoke area.

Therefore, the MMR development will adopt its' own "Bear Aware Program" to reduce bear/human conflicts associated with non-natural food attractants. The program will have the following objectives:

1. Reduce or eliminate bear deaths and relocations as a result of their being attracted into urban areas by garbage, fruit, compost, and other human-generated attractants. Ultimately the reduction/elimination of bear deaths would ensure that births exceed deaths;
2. Increase the public understanding of the negative implications to bears and humans when bears forage in urban areas; and
3. Build public support for the objectives of these programs (Robinson 1998).

This component of the "Bear Aware Program" will implement the following mitigation measures to reduce or eliminate non-natural food attractants to bears within the resort base area, along the access road and along any developed trail systems associated with

the resort base area. In addition, the details of the program outlined below should form part of the resort architectural design guidelines and bylaws.

8.2.2.1 Resort Base Area

1. All outdoor trashcans and dumpsters will be of a bear resistant design and all trashcans will have plastic removable liners to contain odours as much as possible. Plastic can liners will be changed at every pickup to eliminate any odour. Maintenance personnel will ensure that the bear-proof garbage cans are available where needed;
2. Areas of concentrated visitor use will be maintained as litter-free as possible within the limits of available staff and budgets;
3. Garbage pick-up will be carefully scheduled (preferably later in the day) to prevent overflow of cans and to assure leaving as little garbage as possible emanating odour overnight;
4. All bear proof containers will be picked up as quickly as possible to minimise the build up of any odours or spillage;
5. Drive-through inspections for garbage will be performed in the residential areas on a regular basis to determine whether there are any open containers and/or garbage in the facilities;
6. When loaded, trash collection vehicles will proceed directly to the appropriate transfer station, except if late evening pick-ups area necessary, the trash may be stored on the collection vehicle inside a closed utility building or within a secured, fenced utility area;
7. Mishandling of garbage by resort residents/recreational visitors will be reported to resort officials. Repetition of mishandling garbage or any case of deliberate feeding of bears will result in a citation and may be grounds for loss of in- resort privileges;
8. Avoid planting of fruit trees, compost and other bear attractants;
9. A trained bear official employed by the resort will patrol all grounds and roads into and within the site during active hours to assure that food and garbage are stored properly and to talk with visitors about bears in the country;
10. Facility personnel will identify and correct operational and maintenance deficiencies regularly on an on going basis. Inspections will be conducted all year round and comply with regional standards;
11. All commercial operators will be given food and garbage management guidelines for the area as part of their business license conditions;
12. Garbage transfer or detainment areas will be fenced with bear resistant fencing or electric fencing. These fences will be repaired and maintained as needed within the limits of available staff and budgets for the resort;

13. All enclosures for refuse will be cleaned and disinfected (steam cleaned) both inside and out at least once per year;
14. If garbage is to be burned on-site all combustible garbage will be burned in enclosed incinerators. No garbage is to be buried, including empty cans or other food containers; and
15. Odour control from sewage facilities will require a demanding management approach. Septic tank sewage control systems will be recommended for containment of liquid and water waste. If not applicable, sewage ponds will be fenced with bear resistant fencing or electric fencing. These fences will be repaired and maintained as needed.

8.2.2.2 Roadside Corridors

The availability of human food and garbage sources to bears along roadsides is also recognised as a major potential cause of bear management problems and related public safety hazards. The following mitigation measures will be implemented along the access road corridor to the resort:

1. All outdoor trashcans will be of bear-resistant design and equipped with plastic removable liners. Plastic can liners will be changed at every pickup to eliminate any odour;
2. Roadsides and all other areas of concentrated visitor use (i.e. pull-outs) will be maintained as litter-free as possible;
3. Garbage pick-up will be carefully scheduled (preferably later in the day) to prevent overflow of cans and to assure leaving as little garbage as possible overnight to allow for odour to emanate. Public use levels will dictate the schedule for garbage pickup at roadside pullouts. Overflow of cans will be prevented; and

Management of bears frequenting roadside areas will include:

a) Prompt follow-up of bear reports (sightings, incidents, etc.) by resort staff to learn bear behaviour patterns;

b) Investigation of any indications or possible evidence of deliberate feeding and initiate appropriate measures to curtail this activity; and

c) Double-check the garbage/food security situation at pullouts and along the roadside corridor.

8.2.2.3 Recreational Trails

The availability of human food and garbage to bears in recreational trails is also considered a major potential cause of bear management problems and related public safety hazards. The following mitigation measures will be implemented along the access road corridor to the resort:

1. Resort staff will be responsible for routine monitoring of trail areas and any deficiencies in garbage collection units. These will be brought to the attention of the commercial operators immediately;
2. The "Pack in-Pack out" policy will be enforced on recreational trails;
3. Overnight camping along trails will not be allowed; and
4. Bear warning signs will be posted at all entry points to trails or trailheads.

8.3 Outdoor Recreational Management

8.3.1 Background and Problem Description

Many studies have been conducted addressing impacts of recreational activities and related noise on grizzly bears due to urban presence (GBIT 1987, Gibeau 2000, Haroldson and Mattson 1985). Recreational areas are associated with prime grizzly bear habitat due to the human favoured panoramic views. Reactions of grizzly bears to human recreational use have primarily been documented as negative, resulting in bear displacements or human/bear conflicts (Gunther 1990, Schleyer et. al. 1984, Hemmera 1999, GBIT 1987, Herrero 1997). Many of these studies conclude that human recreational use in alpine and sub alpine areas can displace grizzly bears during foraging seasons, but most of these displacements can be avoided with seasonal trail closures (GBIT 1987).

The consequences of superimposing high recreational activity on productive grizzly bear habitat include both direct mortality and reduced habitat effectiveness. There is considerable evidence that grizzly bears avoid human facilities especially when they are occupied and active (Mattson, 1993).

8.3.1.1 Mortality

Mattson et al. (1992) indicated that the mortality risk was nearly five times greater for adult female grizzly bears in the inner zone (0-3 km) adjacent to a development, and only marginally greater for adult male grizzly bears. Conversely, subadults suffered greatest mortality risk in zones furthest from developments. Mattson et al. (1992) suggested that subadults were either displaced by adult bears into the less secure zones adjacent to developments (within 0-3 km) or stood an increased mortality risk by co-occupying the more remote zones (3-9 km) with adult bears. High adult female mortality risk close to developments was believed to be a consequence of habituation to predictable high-density human presence. Subadult and adult grizzly bear males occupying the inner zone (0-3 km) were presumably indifferent to human presence or developments rather than habituated bears. Thus these classes of bears were less predisposed toward conflict situations than were the habituated adult bears.

8.3.1.2 Habitat Displacement and/or Reduced Habitat Effectiveness

Mattson et al. (1992) found that in zones beyond the conceivable influence of human development, grizzly bears occupied habitat that was more productive than the average

for that zone. However, in zones proximal to roads and developments, grizzly bears occupied habitat that was close to, or below the average for that zone. Thus, it appeared that grizzly bear foraging strategies directed towards habitat optimization were disrupted by human developments. This reduction in habitat effectiveness was evident out to 3.5 km in spring and summer but less in the fall (Mattson et al., 1992).

Mattson also evaluated the displacement effects of human developments. They found that adult bears showed a bimodal distribution with neutral/habituated grizzly bears occupying the 0-3 km zone around developments and a group of more wary adult grizzly bears occupying the 9-15 km zone. All of the young adults occupied the 9-15 km zone, while subadults were more often occupants of the 0-3 km and 3-9 km zones.

8.3.1.3 Impacts on Grizzly Bear Habituation

Indications of grizzly bear habituation defined as a long-term decrease in the frequency or magnitude of a response because of repeated stimuli, have been noted for a number of areas.

Factors which contributed to bear habituation were consistent context for encounters (i.e. trails), frequent irregularly spaced encounters, easily recognised stimuli (hikers with bear bells), and innocuous habituation of grizzly bears' fear surprise encounters with adult and subadult grizzly bears. Jope (1985) theorized that by reducing the occurrence of full charges, habituation of grizzly bears' fear response actually reduced the rate of injury to hikers from surprise encounters with adult and subadult grizzly bears. Jope (1985) noted that no recorded hiker injuries had involved a grizzly bear that appeared to be habituated. Hornocker (1962) and Egbert and Stokes (1976) observed habituation by subadults and lone adults, but female grizzly bears with young remained intolerant of other bears.

The following mitigation measures are intended to reduce/eliminate bear/human conflicts and associated bear mortality from recreational trail hiking:

1. Trail development will avoid moderate-high value feeding and security habitat. These habitats are generally associated with the lower elevations;
2. Trail development will be restricted in the upper alpine areas and located in areas with natural barriers (rock outcroppings, vertical slopes, etc.) to nearby drainage's. Many studies conclude that human recreational use in alpine and sub alpine areas can displace grizzly bears during foraging seasons, but most of these displacements can be avoided with seasonal trail closures (GBIT 1987);
3. Trails will be clearly marked/fenced to avoid off-trail use by hikers. Signs will be posted to warn hikers of the potential danger of grizzly bear encounters off-trail. Off-trail use by hikers will be discouraged;
4. "Bear Warning" signs will be provided at the entrance to trails and at trailheads identifying grizzly bear habitat and recommending appropriate human conduct (creation of noise, staying on trails, proper food and garbage handling, etc.);

5. "Hikers with Packs" will be prevented from using the lifts/gondolas to prevent hikers from gaining access into nearby drainages;
6. Recreational hikers will be encouraged to travel in groups of four or more as most grizzly bears avoid large and noisier groups (USFS, 1985);
7. Trails with a documented increase in grizzly bear use (i.e. spring or fall feeding periods) will be temporarily closed. Resort staff will regularly patrol trails during visitor use to identify problem areas;
8. Pets will not be allowed on to trails;
9. Hikers will not be allowed on trails between one hour before sunset and one hour after sunrise;
10. Motorised vehicles (all terrain vehicles) will not be allowed on trails; and
11. If grizzly bear tolerance levels have been exceeded, the backcountry areas will be restricted through the use of permit systems or the re-evaluation of commercial uses (subject to MWLAP).

8.4 Access Road Management

8.4.1 Background and Problem Description

The most direct form of road-related mortality involves bears killed by vehicles (Knight et al., 1981, 1988; Greer 1985; Palmiscano 1986; Burns 1986). However, most researchers have concluded that the effects of increased human access into bear habitat, particularly increased vulnerability to legal and illegal harvest, constitute the most critical impacts of road activity on grizzly bears (Nagy and Russell 1978; Ruediger and Mealy 1978; Smith 1978; Schallenberger 1980; Zager 1980; McLellan and Mace 1985). In Banff National Park, between 1971 and 1995 of the 118 grizzly bear mortalities, only 11 were not man-caused. Over 80% of the man-caused mortalities occurred within 500 m of a road while only 14% of these mortalities were due to highway or railway collisions. Most were management actions toward problem grizzly bears.

Mattson (1987) suggested that adult female grizzly bears use roadside habitat in order to avoid close contact with adult male grizzly bears that pose a mortality risk, especially to cubs. Conversely, Gibeau (2000) found that female grizzly bears avoided the Trans Canada Highway regardless of habitat quality or time of day, while males and especially subadult males were found closer to the Trans Canada Highway when within or adjacent to high quality habitat and during the human inactive period. However, regardless of the sex of grizzly bear using roadside habitats, between 1975-1990 habituated bears were killed 3.1 times more often than wary bears in the Greater Yellowstone Ecosystem (Mattson et al., 1992). The authors concluded that road environments cause grizzly bears to make difficult choices with little opportunity to learn successful behaviours if they die in the process. Mattson et al. (1992) suggested that adult female grizzly bears that are thought to operate under considerable energetic duress in the Yellowstone area might have higher mortality and lower productivity rates from avoidance of developments and roads.

While a number of different management strategies have been attempted to reduce mortality and impacts from road development, some mitigation measure may be detrimental to grizzly bear populations. For example, between 1983-1987 a 27-km section of the Trans Canada Highway in Banff National Park was upgraded from a 2-lane highway to a 4-lane divided highway. At the same time a 2.4 metre high woven-wire fence was installed on both sides of the highway to prevent vehicle-wildlife collisions (Gibeau and Heuer, 1996). Although highway overpasses/underpasses were constructed to allow wildlife movement across the highway, for the first 5-10 years since the installation of the highway fences in 1987, only two unconfirmed and one confirmed use of the wildlife underpasses by grizzly bears has been recorded (Gibeau and Heuer, 1996). The implications of fencing and associated mitigation could have profound effects on grizzly bear passage across the Bow River Valley and ultimately movement throughout the Central Canadian Rocky Mountains (Gibeau and Heuer, 1996).

8.4.1.1 Avoidance/Displacement

Much of the literature on road impacts concerns avoidance/displacement of grizzly bears from roads. Lloyd and Flect (1977) found that in southeastern BC grizzly bears avoided areas within 0.5 miles from roads. Zager (1980 and 1983) concluded that in northeastern Montana there was no overall avoidance of roads by grizzly bears. However, females and females with cubs avoided habitat within 200 m of roads whereas male grizzly bears appeared to prefer habitat adjacent to roads.

McLellan and Mace (1985) found that grizzly bears used the area within 100 m of a road an average of 40% of the expected value in spring and 50% of the expected value in summer/fall. Beyond 100 m the displacement effect was minimal and there was no difference between the effects of primary, secondary and tertiary roads. McLellan and Mace (1985) calculated that 8.5% of the area within 100 m of a road was lost to bears because of road avoidance. McLellan and Mace (1985) also concluded that bears were found directly on roads more frequently at night than during the day.

Brannon (1984) found that in Yellowstone National Park grizzly bears avoided areas within 50 m of a road and used the area between 3 and 4.5 km from a road more than expected. Mattson et al. (1992) found that primary roads and developments were within the most productive grizzly bear habitat in Yellowstone Park.

Puchlerz and Servheen (1994) summarised studies regarding the influence of roads on grizzly bear habitat use, documenting a range of distances between 100-914 m wherein bears appear to show avoidance. Given this range in the zones of less than expected use Purchlerz and Servheen (1994) recommended 500 m as a standard buffer for grizzly bear/motorized access management.

In the Bow River Valley, high road densities contribute significantly toward habitat alienation for grizzly bears along the valley bottom habitats. This avoidance behaviour is strongest in the adult segment of the population where male grizzly bears select high quality habitats and an absence of humans. Adult female grizzly bears select areas with a high degree of security habitat for raising cubs, which in some cases means avoiding

adult male grizzly bears. With the safest and most habitats taken up by adult males and resident females, subordinate bears and other adult female grizzly bears are forced to utilise sub-optimal habitats including those with high human density. In this way roadside vegetation and other anthropogenic foods become important resources in sub-optimal habitats. Unable to successfully compete elsewhere, some bears are relegated to utilising habitats close to people and communities. While in proximity of humans a bear may become habituated to people, and although the bears have successfully adapted to use habitats near busy transportation corridors, they are most likely to die at the hands of humans (Mattson et al., 1992).

8.4.1.2 Factors Affecting Grizzly Bear Responses to Roads

A number of factors affect grizzly bear response to roads including age, sex, type of area, individual habituation to road related stimuli, nature of the stimuli and character of the habitat adjacent to the road (Grizzly Bear Compendium (National Wildlife Federation, 1987).

Zager (1980), Miller and Ballard (1982) found that females with cubs avoided roads and roads interfered with movement. In Denali National Park, some family groups appeared to be thoroughly habituated to tour bus travel along the major park roads while single bears seemed to be under-represented in areas adjacent to roads (Tracy, 1977).

Bear populations in different areas show pronounced differences in their reactions and degree of habituation to road stimuli. Smith (1978) found that all grizzly bears displayed a strong escape reaction. McLellan and Mace (1985) noted that local bears reacted less strongly to road activity than remote bears. McLellan and Mace (1985) also found that bears in direct view of vehicles generally fled but bears close to roads in some protective cover were not affected. Loud noises were found to increase the degree of flight response (Tracy, 1977; Stemlock 1981).

In Denali National Park, snow removal, road dust and modified drainage patterns along roads caused roadside vegetation to green-up before other areas. Hastened green-up of some roadside forage species attracted grizzly bears to roads in late spring (Tracy, 1977).

8.4.2 New Roads or Upgrading of the Existing Access Road

Jonkel (1982) suggest that new roads have the greatest impact on grizzly bears because bears eventually avoid the surrounding area and a block of habitat is lost. The following mitigation measures should be considered during the upgrading and/or re-aligning of the access road into the proposed resort development:

1. Maximise the use of the existing alignments and minimise the construction of new roads to avoid impacting undisturbed grizzly bear habitat. Minimise the width of road clearing for upgrades during later phases of development and avoid impacting moderate-high value feeding/security habitat;
2. Road densities that are a broad index of the ecological effects of roads in a landscape should be limited to a threshold density of <0.6 km per km^2;

3. Maintain and/or restore high quality security habitat adjacent to roads especially if associated with forage/feeding areas. Maintenance/restoration of these areas is important for adult female and sub-adult grizzly bears because these bears are more likely to interact with humans resulting in greater chances of mortality;
4. Any new, temporary roads to be constructed to access ski runs for clearing and lift placement should be done so as to facilitate their eventual closure/obliteration and actively re-vegetated with indigenous vegetation or left for natural conifer regeneration. Closure and re-vegetation should occur within one season after use;
5. Minimise clearing widths, low cuts and fills of new roads and maximise diversity in a horizontal and vertical alignment through indigenous re-vegetation;
6. Maintain existing drainage patterns along roads and prevent the introduction of drainage that promotes roadside vegetative growth. As mentioned earlier, snow removal, road dust and modified drainage patterns along roads in Denali National Park caused roadside vegetation to green-up before other areas. Hastened green-up of some roadside forage species attracted grizzly bears to roads in late spring (Tracy, 1977).
7. Refrain from the creation of >0.6 m paved road shoulders;
8. Store any topsoil removed from road construction and re-use the topsoil to re-vegetate areas along roadsides. Re-vegetation of roadside areas should discourage the use of plants that will attract grizzly bears;
9. Where possible, allow >100 m between important grizzly bear feeding/security habitat and any new roads in order to provide cover. Create/leave buffer strips especially in areas with steep slopes, rugged terrain and/or open habitats;
10. Do not create new roads or re-vegetate existing roads so that blind corners and surprise encounters would occur between motorists and bears;
11. Avoid road construction/maintenance (where possible) during key grizzly bear periods (spring-early summer and late fall);

In order to reduce the risk of vehicle/bear collisions, ENKON recommends the following:

A "Bear Information Centre" should be established within the resort base area to inform and remind visitors of the potential dangers of bears and the potential for bear encounters while at the resort. The "Centre" would only need to operate through the active bear season from April-November.

a) As a component of the grizzly bear monitoring program, grizzly bear/human conflict areas along the resort access road should be patrolled/monitored to identify high risk areas which would then be incorporated into the information pamphlet hand-outs;

b) Wildlife Warning Signs should be placed at the entrance to the resort and at strategic locations along the access roads (i.e. high-risk areas for bear crossings), and within the resort base area. Wildlife "Warning Signs" will be posted and display the following warning "Resort Regulations Prohibit the Feeding of Bears – Warning, Bears are Dangerous – For Your Safety Do Not Feed Bears – View from a Safe Distance". " No Stopping" signs will be displayed in areas of expected high use by grizzly bears to prevent bear-jams (public stopping and watching grizzly bears along roadsides).

c) Roadside reflectors should be erected that reflect light and create a barrier image such as the "Streiter-Lite Wildlife Warning Reflector". Headlights from passing vehicles strike rows of staggered reflectors, which are mounted on posts at headlight height along each side of the highway, with each reflector in turn directing flashes of low intensity reflected light across the road. Entering light from vehicle headlights is reflected at approximately 90 degrees. Drivers do not see and are not bothered by the light (http://www.strieter-lite.com/).

d) The access road should be designed for low speed limits (50-60 km/hr.) and the speed limits should be enforced by resort staff in combination with the RCMP; and

As part of a recommended education program for residents and village personnel a committee or persons (as part of interpretative and regulating staff) should be allocated to monitor traffic and regulate any interactions of tourists/visitors with grizzly bears. The following are mitigation plans to help reduce bear mortality as a result of human/bear interactions, and "bear-jams" resulting from visitors stopping to view and interact with bears along roadsides and trails:

a) In the unlikely event that bear jams occur, a "bear-sitting program" will be implemented at bear jams when there are safety concerns or significant traffic congestion. Resource, interpretative and bear management staff will be dispatched to the bear jam for managing visitors and traffic. Bear-sitting will involve a combination of traffic control, answering visitor questions and ensuring that the public does not approach, feed or behave inappropriately around bears;

b) Erect signs along the road to identify "no-stopping zones". This method is intended to keep traffic moving and prevent people from stopping and interacting with the observed bears:

c) Erect temporary closures (regular/seasonal) in zones of potential, historical and identified bear crossing areas. These temporary area closures would allow people to stop to view bears from the roadside, but keep people from leaving the safety of the roadside and approaching the bears too closely;

d) Along areas of high frequency defined or potential bear crossings or constructed crossings for bears, provide vegetation screening to reduce the chance of poaching and hunting. Vegetation screening involves the planting of indigenous vegetation screens in order to screen high quality habitat from the road corridor, primarily to reduce any bear-jams and roadside stopping;

e) Wildlife carcasses within 100 m of the access road which could pose a hazard to bears from vehicle collisions will be removed to areas away from visitor activity; and

f) If interpretative and/or regulatory staff for the development is not available to control problems with visitors and bears, it may be necessary to bait bears out of identified human/bear confrontational areas. If the potential for interaction between bears and humans has escalated beyond controllable limits, bait such as ungulate carcasses may be placed in areas where it will lure the unwanted bears and reduce the need for bear mortality. This methodology, if implemented, would have to be approved and performed by MWLAP.

8.5 Aircraft Access Management

Aircraft such as helicopters and small planes have not been documented very intensely (GBIT 1987). Grizzly bears are very affected by aircraft but have been known to habituate to their presence (Harding and Nagy 1980).

8.5.1 Background and Problem Description

In Yellowstone National Park, Graham (1978) and Peacock (1978) observed grizzly bears, which fled into timber as research tracking planes approached. Conversely, Schleyer (1980) found that research planes did not disturb grizzly bears. Campbell (1985) observed that 54.5% of the grizzly bears seen from small planes showed no response while only 29% showed a severe response. McLellan and Mace (1985) found that 15-20 grizzly bears observed from the air showed no reaction to the aircraft, while the remaining five bears ran to cover.

Grizzly bears may be more sensitive to helicopters than to fixed-wing aircraft. Quimby (1974) found that 90% of the grizzly bears in the Caning River study reacted moderately or strongly to helicopters while only 21% reacted strongly to fixed-wing aircraft. Harding and Nagy (1980), Eebhart (1983) and Spreadbury (1984) found that grizzly bears that had previously been captured or re-located using helicopters were particularly sensitive to helicopter disturbance. McLellan and Mace (1984) found that individual bears in several areas demonstrated significantly different tolerances to helicopter disturbance.

8.5.2 Factors Influencing Grizzly Bear Reactions to Aircraft

Factors such as degree of habituation to aircraft, availability of cover, altitude, noise level and behaviour of the aircraft may influence grizzly bear reactions to aircraft. McCourt (1974) found that there was no consistent trend in grizzly bear reaction to fixed-wing aircraft at different altitudes. Campbell (1985) indicated a relationship between age/sex class of grizzly bears and reactions to aircraft. Lone or paired adults seldom reacted severely while females with cubs were more susceptible to disturbance. Quimby (1974) and Rutton (1974) found that grizzly bears may be more reluctant to flee form aircraft when feeding on carcasses or while at feeding sites (McLellan and Mace 1985).

Reynolds et al. (1984) found that mid-winter flights caused no significant increase in the heart rates of grizzly bears; however, during the period just after emergence the heart rates of two different females increased by up to 10% or became erratic when planes flew overhead. Although no bears abandoned dens from aircraft disturbance, Quimby (1974) reported that five bears abandoned den construction due to helicopter disturbance.

8.5.3 Helicopter Access Management

The proposed development is anticipated to create noise and problems with aircraft use, primarily during the construction phases of the development, causing bear displacement problems. The following plans may be used to mitigate impact of aircraft noise and its presence:

1. Restrict helicopter activity during construction to a minimum;
2. If possible, prohibit helicopter access for the sole purpose of transporting guests to/from the resort once construction is completed (except for emergencies and any necessary maintenance);
3. Minimise air traffic during the denning period, particularly during the den entry period (October-mid-November) and emergence (April-May);
4. Schedule helicopter flights between one hour after sunrise and one hour before sunset from mid April to mid October;
5. Maintain minimum helicopter altitudes of 300 m;
6. Establish flight patterns of less than half a mile wide along travel routes and landing zones, except where flight safety precludes this;
7. Designate landing zones with adequate visual of topographic barriers; and
8. If possible, allow only one access to the developed area; by use of the primary road and restrict flight access into areas elsewhere except for emergencies.

8.6 Education Program

In order for the recommendations of the "Bear Management Plan" to be successful, the public and resort staff within and surrounding the MMR must be committed to making it

work. Education, awareness and involvement of the public and staff of the resort are critical to the future success of the program.

Members of the public must learn how to avoid creating situations where bears can gain access to non-natural foods and appreciate the consequences of habituating or conditioning bears. The public must also recognise that responsible handling and storage of garbage can reduce the potential for bear-human conflicts.

Educational communication tools such as newsletters, posters, signs, mailouts, pamphlets, videos, and public presentations/training seminars in combination with involvement of community groups/organisations and co-operation with stakeholder groups (i.e. hunters, backcountry hikers) may provide the winning formula. However, there is also a need for continued research, new resort/regional district bylaws and provincial regulations/legislation.

8.6.1 Goals

The goals of the education program include:

1. Reduce or eliminate bear-human conflicts through understanding of bear ecology, becoming bear aware (safety) and reducing the potential for bear–human interaction, and responsible disposal, transfer and storage of human-generated waste;
2. Increase public understanding of the negative implications to bears and humans when bears forage in areas of urban centres; and
3. Build public and visitor support for the program.

8.6.2 Communication Tools and Dissemination of Bear Safety Information

The following communication tools will be used to disseminate the educational information and warning literature to the public and resort staff:

1. Visitors checking into resort hotels will receive a brochure that contains bear safety-warning articles such as "Bears are Dangerous" and "Hiking and Camping in Bear Country". Resort hotels will also be asked to provide this brochure as part of any information packages sent by mail or through the internet to potential visitors;
2. Residents living or vacationing (time share) at the resort will be provided bear safety information (i.e. "Living in Bear Country") through door-to-door delivery services;
3. Wildlife warning signs depicting "Regulations Prohibiting Feeding or Molesting of Animals - Warning Bears and Other Large Animals are Dangerous - For Your Safety Do Not Feed Wildlife - View from a Safe Distance" will be displayed at strategic locations to the entrance of the resort and along the access road;

4. The local "Resort" and "Revelstoke" newspapers/newsletters will be given quarterly (or as required) articles to publish regarding bear safety and warnings;
5. The local Revelstoke radio station will also be given quarterly (or as required) articles to publish regarding bear safety and warnings;
6. Trailhead information boards will be displayed at all trailheads accessed from the resort and/or lifts. Signs will state "Danger Entering Bear Country – a Risk" and "No Overnight Camping" with supporting information bulletins containing information about avoiding bear/human encounters, reacting to a bear if encountered and proper food storage and removal;
7. All interpretative staff guiding visitors on trails will be trained and knowledgeable of and able to answer questions concerning bear safety recommendations for hiking in bear country;
8. The visitor information centre in the base area will be staffed with trained and knowledgeable staff on bear safety. These staff members will handout information on bear safety and be available to answer visitor questions;
9. The resort will sponsor monthly seminars that invite guest speakers to discuss bear safety issues;
10. The resort will also sponsor workshops (Clarkson, 1986) in order to train people with a variety of backgrounds and experience in the art and science of coping with potential bear-people conflicts. Three types of workshops will be considered:
    a) One day workshop for staff/volunteers who perform duties relating to distribution of information about bear-people conflicts;
    b) Two-day workshop for staff responsible for dealing with bear-human conflicts;
    c) Four day workshop to train "Safety in Bear Country" Instructors
11. Resort book stores will be required to stock bear safety books/pamphlets such as:
    a) Bear Attacks-Their Causes and Avoidance (Herrero, 1985)
    b) Safety in Bear Country: a Reference Manual (Bromley, 1985)
    c) Bears and Menstruating Women
    d) Bear-Inflicted Human Injuries in Yellowstone, 1970-1994
    e) Beyond Road's End
    f) Bear Us in Mind, Grizzly Country
12. Develop activities and contests for local residents and visitors to the watershed that reinforce bear-proofing messages.

8.7 Problem Bear Management: Action Plan

The Ministry of Environment, Lands and Parks will be responsible for performing all direct actions such as aversive conditioning, trapping, relocation/translocation and destruction unless there is immediate threat to life or property. In these exceptional

cases, properly trained resort employees through agreement with MWLAP may carry out these emergency actions.

8.7.1 Decision Flow Chart

Decisions regarding area closures, aversive conditioning, hazing, capture, relocation/translocation and destruction of bears will be made by the Ministry of Water, Land and Air Protection. Decisions and emergency response action protocols regarding bear attacks will be pre-determined with input and prior approval from the Ministry of Water, Land and Air Protection.

8.7.2 Habituated Bear Management Techniques

Over the years numerous methods and techniques have been experimented with, with varying degrees of success. On the results of a workshop held in the spring of 1997 leading experts in the field of bear-human conflict developed a matrix of current bear management techniques (Parks Canada, 1998). This matrix will be used throughout as a template for decision making when managing habituated bears. Preventative actions will continue to be the primary management strategy for bears.

8.7.2.1 Aversive Conditioning

The process of aversive conditioning makes use of an animal's ability to negatively associate events and is a specialized form of learning imposed on an animal by punishing it for behaviour that is deemed undesirable with a painful experience.

When managing the symptoms of bear-human conflict are of concern, aversive conditioning offers an advantage over more traditional methods of bear relocation and destruction. The technique avoids the removal of breeding animals limits individual bear displacement and offers the potential to have avoidance, rather than nuisance behaviour passed from generation to generation. However, the technique fails to address the source of human-bear conflicts such as human use in good bear habitat and poor storage of human food and garbage.

The goals for using aversive conditioning techniques are:

1. Reduce the number of bears that must be removed from the ecosystem;
2. Reduce the number of nuisance bears that must be trapped and relocated to backcountry areas. Relocation of a bear from a conflict area does not prevent the problem from recurring by the same bear in a new location or by the bear returning and causing the same problem in the same location. Most bears have an innate ability to return to their original home range and become repeat offenders at the same or different site that requires removal or destruction. Aversive conditioning offers the potential to modify nuisance behaviour whereas relocation is often a temporary solution or moves the problem to a new area;

3. Reduce the rate of bear-caused human injuries and property damages by discouraging bears from frequenting developed areas, campgrounds and backcountry campsites;
4. Establish a fear of humans that might otherwise become dangerous due to their habituation to humans; and
5. Evaluate the effectiveness of various aversive conditioning agents in keeping bears away from sites of human activity and/or food sources.

Guidelines for determining when to use aversive conditioning will be as follows:

1. As an additional management technique to prevent removal of some bears from the ecosystem. Under some conditions free-ranging bears may be conditioned to avoid people and specific sites within their home ranges;
2. Most effective if it is used on bears when they first encounter humans or situations offering a potential food reward;
3. The highest priority candidate bears for aversive conditioning are:
   - Grizzly bears as compared to black bears;
   - Degree of aggression or threat the bear poses to public safety;
   - Yearling through subadult bears for their initial exposure to humans or human foods;
   - Both problem bears and bears that endanger their own lives along roadsides;
   - Female bears as compared to male bears;
   - Bears already subjected to aversive conditioning as compared to new candidates;
   - For new candidates, those bears with no history of food reward and little tolerance of human presence as compared to those bears that exhibit food conditioning or habituation towards humans and high human use; and
   - Bears frequenting areas where attractants have been properly stored and/or removed as compared to bears frequenting areas where food reward remains likely.
4. Adult bears that have been repeatedly food rewarded and have lost their fear of humans are not good candidates for aversive conditioning;
5. Not to be used when food attractants cannot be removed. Aversive conditioning has proven ineffective at open sewage lagoons and trout spawning streams;
6. Not be attempted on sick or injured bears;
7. Not be used on aggressive bears;
8. Focus on roadside bears (i.e. to avoid cars on the access road) and campground/townsite/resort bears (i.e. to render human developments less attractive to bears that have learned to associate them with food rewards);

9. Only equipment approved by the Ministry of Water, Land and Air Protection for hazing/use of deterrents should be used, for example:
   - Cracker shells and sling shots to be used to move bears away from roadsides, developed areas, backcountry campsites or in other situations when there is a bear-related human safety or crowd control problem;
   - Bear deterrent rounds (i.e. rubber slugs) should only be used by trained personnel from a minimum distance of 40 metres for rump shots only;
   - Screamers, bangers and sirens should be used simultaneously when a clear line of fire and a safe backstop exist. Screamers and bangers not to be used during periods of extreme fire hazard rating; and
   - Trained personnel should only conduct photography and video taping of bear management operations for training purposes.

   Hazing/use of deterrents will only be used when the situation demands immediate attention due to an immediate threat to bear(s) or people (i.e. roadside bear causing a traffic jam with potential for a traffic accident or bear/vehicle collision).
10. Shot placement (i.e. rump) is critical to insure the target animal is not severely injured; and
11. Consistent and thorough documentation is necessary to assess the long term effectiveness, impacts and financial cost of aversive conditioning. Location, behavioural data and bears that have been fired at should be recorded. A database should be developed for all bears that have been aversive conditioned.

8.7.2.2 Capture and Relocation

The decision to capture and relocate a bear will be made by the Ministry of Water, Land and Air Protection. In general, relocation refers to moving a bear within its estimated home range where as translocation means moving a bear out of its home range. Recent research in the Rocky Mountains indicates that 300 km^2 for a female grizzly and 1500 km^2 for a male grizzly bear could be used as a guideline (Strom et al. 1999, Parks Canada, 1998).

Decision Criteria

The decision to relocate a bear will be based on the following criteria:

1. Degree of aggression displayed by the bear;
2. Degree of habituation to humans and conditioning to human foods;
3. Bears past history and disposition;
4. Age, sex, and physical condition of the bear;
5. Effectiveness of previous relocation if applicable;
6. Alternate visitor management actions;

7. Area (i.e. backcountry, roadside, developed areas) that the bear is considered a problem in; and
8. Human safety considerations.

Non-problem bears captured unintentionally will not be marked and generally not be relocated.

Training

Thorough training in capture/trapping techniques, immobilization agents, use of firearms and handling wildlife will be mandatory before resort employees are allowed to handle bears or other wildlife. Use of immobilizing drugs will be restricted to those qualified through additional training and only under supervision of MWLAP's instructors.

The following minimum qualifications are required for resort employees handling or immobilizing bears:

1. Successful completion of an immobilisation and handling class covering the following topics:
   - Bear monitoring systems
   - Traps
   - Drug pharmacology
   - Wildlife reactions to drugs
   - Human and wildlife safety
   - Wildlife handling ethics
   - Handling and Monitoring immobilized wildlife
   - Relocation and translocation
   - Destruction
   - Necropsy
   - Bear/human emergency plan
2. Current Cardio-Pulmonary Resuscitation (CPR) qualification;
3. Successful completion of a refresher training course every year; and
4. Successful qualification semi-annually with immobilisation rifles, pistols and blowguns. A minimum of 80% proficiency is required on a course specifically designed for capture weapons. Use of firearms for bear management purposes are for the protection of the visitor in case of animal attack or for the disposal of animals. Secondarily the firearm is available for trained personnel protection in case of animal attack during management actions and patrolling of areas closed due to bear problems.

Trapping Techniques and Equipment

Trapping will normally be used prior to application of other capture techniques. The Ministry of Water, Land and Air Protection will approve all traps including culvert traps,

aluminium traps, barrel traps and foot snares. Parks Canada prefers culvert traps baited with natural food and uses foot snaring or free-range immobilization techniques only if culvert traps prove ineffective and all human safety concerns are addressed. To prevent bears from becoming conditioned to human foods, only road-killed wildlife or wildlife blood will be used as bear bait.

Conspicuous warning signs will identify baited traps and set traps shall not be left unattended in public use areas during busy, daylight hours. Area closed signs will be used to close the area in the immediate vicinity around all baited traps.

The Ministry of Water, Land and Air Protection will approve wildlife immobilization drugs (i.e. telazol, ketaset, rompun, M-99).

While in captivity, bears that are to be relocated will be isolated from human activity and kept in a cool, shaded area and given water and natural foods as needed. No bear will be kept for more than 24 hours. Bears handled for management or research purposes will be marked by ear-tag, paint mark, tattoo, radio collar, backpack radio or radio implant. The Ministry of Water, Land and Air Protection must approve other methods of marking bears.

Relocation and Translocation of Nuisance Bears

Except in emergencies involving an immediate threat to human safety, grizzly bears will be relocated as a free-roaming individual within their own home range. Bear relocations into home ranges occupied by other bear(s) generally result in displacement. A high priority release site would be one where the niche is known to be available. Problem bears will not be relocated to a national park unless prior arrangements have been made with Parks Canada. Wherever possible, release sites should be remote from visitor use areas and provide as many of the bear's ecological requirements as possible. Distance from the capture site and geographic barriers will be considered when choosing the relocation/translocation site.

As determined by the Ministry of Water, Land and Air Protection, some nuisance bears may be translocated to remote sections of the Central Purcell Population Unit or to a threatened unit such as the Yahk, South Selkirk, Kettle-Granby or North Cascades.

8.7.3 Emergency Response to Bear Attacks

Bear related emergencies should be infrequent occurrences but require an immediate effective response in order to ensure public safety and resolution of the problem. A bear-human conflict emergency plan will be developed and will be based on the following principles:

1. Ensure safety of response team and the public;
2. Immediate, safe evacuation and treatment of the victim(s);
3. Safe removal and exclusion of other people from the area;

4. Investigation and evaluation of the attack circumstances and possible capture/destruction of the bear;
5. Preservation, collection and documentation of evidence and response actions;
6. Disposition of the bear (continue/discontinue capture efforts, relocate, destroy, etc.); and
7. Post trauma victim support.

8.7.4 Destruction of Bears

Except in life threatening situations, the decision to destroy a bear will only be made by the Ministry of Water, Land and Air Protection. The decision will be based on the following criteria:

1. Threat to public safety and/or property;
2. Effectiveness of alternate visitor management procedures;
3. Thorough evaluation of causal factors, bear behaviour and human provocation;
4. Past history of the bear;
5. Degree of habituation/conditioning shown by the bear;
6. Species, sex, age, presence of cubs and general health; and
7. Additional criteria relevant to the particular incident.

All bears will be destroyed in a humane and discrete manner and thoroughly documented. Any bear destroyed because of contact with a human will be independently necropsied and any saleable parts (i.e. teeth, skull, claws, gall bladder, coat) will be disposed of in such a way to render them unsaleable.

9.0 AIR QUALITY PROTECTION PLAN

9.1 Introduction

Construction and operational activities at the MMR could result in localized air quality impacts. Construction-related impacts are generally short-term in duration, but may still cause adverse air quality impacts. The project most common construction activities will include site preparation, earthmoving and general construction. General construction includes roadways, infrastructures and facilities. Earthmoving includes cut and fill operations, trenching, soil compaction and grading. Activities associated with site preparation include blasting, general land clearing and grubbing. Emissions generated from the sources include:

- Combustion emissions from mobile heavy-duty diesel and gasoline powered vehicles and equipment;
- Combustion emissions from worker commute trips;
- Combustion emissions for open burning of wood and organic debris; and
- Fugitive dust from blasting, soil disturbance and land clearing.

Operational activities that may impact air quality at the MMR include the use of wood burning appliances, traffic to and from the resort by employees and visitors, and energy use. Emissions generated from these sources include:

- Combustion emissions from wood burning appliances; and
- Combustion emissions from worker and visitor vehicular traffic.

To minimize potentially significant construction and operational emissions, the following mitigation measures will be implemented at the MMR.

9.2 Construction Activities

9.2.1 Air Emissions Mitigation Plan

9.2.1.1 Heavy Construction Vehicles and Equipment

The contractor will implement the following mitigation measures to minimize release of air pollutants from construction-related heavy-duty vehicle and equipment.

1. On unpaved roads traffic speeds shall be limited to 20 kmh.
2. Equipment producing excessive exhaust pollution, as determined by the Project Manager, shall be repaired or replaced at the Contractor's cost.

3. All on-road dump trucks used on the Project shall be model year 1994 or newer.
4. All dump trucks will be subject to visual inspection by the Project Manager. Vehicles shall have better than 10% opacity (i.e. 10% or lower). The Project Manager will remove any vehicles deemed to have excessive emissions from the Work Site.
5. All off-road dump trucks shall be equipped with a catalyzed particulate trap fitted on the exhaust system. At no time shall any off-road truck be operated without a fully operational catalyzed particulate trap, maintained as recommended by the manufacturer. Catalyzed particulate traps shall remove a minimum of 85% of particulate matter and shall oxidize 90% of unburned hydrocarbons from equipment emissions.
6. All off-road dump trucks shall utilize ultra-low sulphur diesel fuel. At a minimum, the fuel must match the catalytic particulate trap manufacturer's and vehicle manufacturer's requirements. Fuel shall have sulphur content less than 50 ppm.

9.2.1.2 Emissions from Worker Commuter Trips

To decrease emissions of air contaminants resulting from worker commuter trips during construction, the contractor will:

1. Educate workers on air quality issues related to vehicle exhaust;
2. Encourage carpooling;
3. Explore the use of low-pollution shuttle buses to transport workers to and (if necessary) around the project site during construction.

9.2.1.3 Open Burning Plan

Land clearing for construction of the MMR will result in the removal of timber, vegetation and organic debris from the landscape. Potential impacts to air quality from the disposal of wood, wood residue or debris that is cleared would only occur during disposal by burning. Smoke produced from the prescribed burning of timber harvest residue and natural fuels can have an adverse effect on air quality. To minimize potential air quality impacts, the contractor will implement the following:

1. Determine the wind direction and speed for the day of the open burn. The burn may be rescheduled if the wind direction allows smoke to impact environmentally sensitive areas, such as upland nesting habitats.
2. To the extent possible, conduct open burning in the spring and early summer. Daytime heating and general windflows help smoke to rise above ridgetops and into the free air winds where it is diluted and dispersed.

3. Conduct open burning when the ventilation index[1] on the day of the burn is good and the ventilation index on the following day is good or fair.
4. Prohibit or restrict open burns at times and places where stagnant weather conditions result in poor smoke dispersion.
5. Minimize the amount of dirt in the material being burned to reduce smouldering.
6. Prohibit the burning of oils, rubber, tires, pesticide containers, and any other material creating unreasonable amounts of smoke or air pollutants.
7. Extinguish open burns completely to ensure that smouldering of material does not persist.
8. Notify the CSRD Fire Commissioner' Office about when and where the open burn will occur.
9. Closely monitor the open burn to assess smoke dispersal and direction.
10. For major burns, conduct a test burn to determine if smoke dispersal will be adequate.
11. For major burns, a Burn Plan will be prepared for approval that includes:
    - location, duration and inclusive dates for the planned burn;
    - location of all sensitive features that may be impacted by smoke;
    - weather forecasts and how they will be used to prevent smoke impacts;
    - how weather changes will be monitored and what will be done to reduce or mitigate smoke impacts if unfavourable weather should occur after ignition;
    - coordination with air quality authorities;
    - how public will be informed prior to, during and after burning; and
    - what will be done to enhance active fire phase and reduce smouldering phase.

9.2.1.4 Fugitive Dust Control Plan

Emissions during construction can be associated with drilling and blasting, land clearing, excavation, earth moving, material storage and handling. The extent of these impacts would depend on the existing air quality, the size of the affected area and the level of construction and demolition activities associated. Typical dust-producing sources are:

Demolition of existing structures and other obstacles – mechanical wrecking and dismemberment of structures and obstacles; drilling and blasting of structures and rocks,

[1] Ventilation Index outlines whether wind and weather conditions are favourable for burning and is prepared using Environment Canada data and approved by a manager or a forest official.

if required; debris and land clearing, stockpiling of debris and soil; loading of debris and soil into trucks; loaded truck transport; and unloading of trucks.

Site preparation – excavation by bulldozers; scraping and removal of topsoil and subsoil; loading of excavated material into trucks; dumping, storage and moving of fill material, aggregates and other materials; compacting; and grading.

General construction – vehicle movements; material storage and handling; portable crushing and screening, and other operations.

To minimize potential impacts from fugitive dust, the contractor will implement a Fugitive Dust Control Plan. Elements of this plan will include:

1. Use only environmentally acceptable dust suppressants or water as necessary to control dust on access roads, laydown, work and disposal areas. Use water in preference to chemical dust suppressants whenever practical.
2. Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary and permanent roads.
3. Water any temporary storage soil piles to reduce the potential for fugitive dust.
4. Avoid potential dust-generating activities during periods when wind direction may carry dust into environmentally sensitive areas (e.g., riparian zones or nesting areas).
5. Implement onsite cement and concrete batching in enclosed areas, with suitable water dowsing and wind shielding.
6. Conduct a visual inspection of the site perimeter to check for dust deposition on vegetation, cars and other objects. Take remedial action if necessary.
7. Replant vegetation in disturbed areas as quickly as possible.

Table 11 shows estimated fugitive dust emissions reductions for a variety of particulate matter (PM) control measures. These measures are expressed as a percentage of total fugitive dust PM from project construction.

Table 11. Estimated Fugitive Dust Emissions Reductions for Particulate Matter Control Measures

Source	Mitigation Measure	Control Efficiency
Soil Piles	Enclosing, covering or watering twice daily all soil piles	16%
Exposed Surface/Grading	Watering all exposed soil twice daily	37%
	Watering exposed soil with adequate frequency to keep soil moist at all times	75%
Truck Hauling Road	Watering all haul roads twice daily	3%
Truck Hauling Load	Covering load of all haul/dump trucks securely	2%

Source: SCAQMD, weighted for percentage contribution of PM emissions.

9.3 Resort Operation Activities

9.3.1 Wood-Burning Appliances

Wood-burning appliances installed at the MMR residences are a potential source of common air contaminants such as particulates and greenhouse gases including CO_2, CH_4 and N_2O. To minimize potential air quality impacts from these emissions, MMRL will ensure that all installed wood burning devices will adhere to BC's *Waste Management Act Solid Fuel Burning Domestic Appliance Regulation* that specifies emission, labelling, testing and record keeping requirements for new solid fuel burning devices. This includes stoves, pellet stoves, fireplace inserts and factory built fireplaces that have air-fuel ratios of less than 35 to 1 and minimum burn rates of less than 5 kg/hr but does not include cook stoves, central heating systems, masonry heaters or site-built fireplaces. The regulation also contains specifications for residential pellet fuels.

MMRL will employ Best Available Control Technology measures such as:

1. Use of new technology wood stoves;
2. Ensuring that the stove/fireplace is of proper size for its location and use.
3. Ensuring that the stove/fireplace is properly installed and regularly inspected.

4. Improvements in wood burning performance (e.g., control of wood moisture content, weatherization of residences);
5. Ensuring good draft and proper chimney size (liner).
6. Installing a sealed, double-wall flue pipe from the stove to the chimney.
7. Use of internal baffles, catalytic converters, and adequate air supply to promote the burning of vaporized unused fuels.

MMRL will also explore a public education program to make resort residents and visitors to the resort aware of the potential air quality impacts of improperly operated wood-burning appliances. Among some of the more education points that will be included in this program are:

1. Avoid smouldering fires by using proper burning techniques.
2. Avoid smouldering, overnight burns.
3. Avoid the burning of trash or garbage in a wood-burning stove as these emit toxic fumes when burned.
4. Avoid the burning of coal in a wood-burning appliance as coal emits oxides of nitrogen and sulphur along with carbon monoxide.
5. In fireplaces, make small hot fires because with these types of fires combustion is more complete and pollution is less.
6. Avoid the use of lighter fluids (these are not regulatory remember, but BACM) or other flammable liquids to start fires.
7. Start fires with strips of newspaper and kindling placed loosely on top. As the wood begins to burn, add larger pieces until the fire is stable. Too much fuel will cause the fire to smoulder and smoke.
8. Remove ashes frequently, leaving a light "bed" to catch the coals. Too many ashes obstruct the flow of oxygen and smother the fire. (Use a metal bucket to remove the hot ashes and store them until cooled).

In addition, MMRL will investigate the use of a voluntary and/or mandatory program for curtailment of wood burning during periods of stagnant meteorological conditions. Voluntary curtailment programs have been demonstrated to be effective in reducing peak period PM_{10} emissions by 16-50% in a variety of instances. Mandatory curtailment programs have reported peak period PM_{10} reduction rates as high as 90% when combined with a public awareness program and stringent enforcement.

9.3.2 Emissions from Worker, Resident and Visitor Vehicles

To reduce emissions of common air contaminants and greenhouse gases from exhaust emissions from worker, resident and visitor vehicles, MMRL will:

1. Design the resort to promote the use of walkways and bike paths around the resort;

2. Require overnight visitors to leave their cars parked during their stay;
3. Promote the use of busses as modes of transportation to and from the resort; and
4. If necessary, consider using low-pollution shuttle buses to transport visitors around the resort area.

10.0 SPILL CONTINGENCY PLAN

10.1 Introduction

Prior to the start of site development work, MMRL will prepare a Spill Prevention Plan for the construction phase and a general Spill Contingency Plan. The Spill Contingency Plan will be consistent with the requirements of Canada Standards Association Standard Practice CAN/CSA-Z731-M91: Emergency Planning for Industry. It will include details of the amounts and types of fuels and other dangerous goods, such as bulk oils, antifreeze, solvents, etc., and the locations where they will be stored on-site. This section outlines the general contents of the Spill Prevention and Spill Contingency plans.

10.2 Spill Contingency Plan Outline

A "Spill Contingency Plan" will be developed and submitted for approval by the Regional Waste Manager. The table of contents for the plan as recommended in the BC Guidelines for Industry Emergency Response Plans will be as follows:

1. Policy Statement
2. Purpose and Scope

3. Pre-Emergency Planning
   - 3.1 Hazard Identification
   - 3.2 Risk Analysis
   - 3.3 Legislation and Industry Standards
   - 3.4 Emergency Organization and Responsibilities
   - 3.5 Resources
   - 3.6 Internal Alerting
   - 3.7 External Alerting
   - 3.8 Communications
   - 3.9 Public Affairs

4. Emergency Response
   - 4.1 Response Action Decision
   - 4.2 Plan Activation and Response Mobilization
   - 4.3 Response Action/Containment/Cleanup
   - 4.4 Emergency Operations Centre
   - 4.5 Evacuation
   - 4.6 Disposal of Spilled Contaminants and Debris
   - 4.7 Site Restoration and Remediation
   - 4.8 Post-Incident Evaluation

5. Training and Practice
   - 5.1 Training
   - 5.2 Practice Drills

6. Plan Evaluation
7. Plan Updates

The overall Spill Contingency Plan will include both spill prevention plans and spill response plans.

10.3 Spill Prevention Plans

Spill Prevention Plans will be site and/or activity specific. The Spill Prevention Plan for the construction phase based on the following guidelines:

- The construction staging area should be located at least 30 m away from streams or any ephemeral drainage channels;
- Activities that carry a risk of materials spills should take place within a bermed staging area. These activities include mixing concrete or other materials and any vehicle fuelling and other maintenance that is done on site;
- Any areas where vehicle fuels or other potentially deleterious substances are stored should be equipped with impervious containment berms. If fuel tanks larger than 250 l are present within a berm, the bermed area should have a holding capacity equal to 125% of the capacity of the largest tank;
- Storage and maintenance facilities should have spill clean up and disposal equipment;
- Any equipment that will work in streams and/or wetlands should be maintained and used in a manner that will prevent deleterious substances such as fuel, oil, grease or other chemicals from entering the watercourse. This may necessitate cleaning the equipment prior to use; and
- Mobile construction equipment should be fuelled, lubricated and serviced only at approved locations (i.e. within the bermed staging area; at least 30 m from all watercourses). Field servicing of equipment, particularly near streams should not be permitted. In addition, equipment and machinery should not be washed near watercourses.

10.4 Spill Response Plans

The Spill Contingency Plan will contain separate spill response plans for the various project phases and activities. Each plan will be in writing and kept in a binder at the appropriate location (e.g., construction office/staging area, golf course maintenance building, wastewater treatment plant and other location(s) where potentially deleterious materials are stored or used). All pages of the spill response plan(s) will be numbered and dated for referencing and updating. At a minimum, each binder will contain:

- A copy of the *Spill Reporting Regulation* (which includes a list of substances and spill volumes that must be reported);
- The 24-hour toll-free telephone number of MWLAP's Environmental Emergency Program: 1-800-663-3456 prominently displayed;

- A list of the information that should be provided when reporting a spill to Environmental Emergency Program:
  - Reporter's name and telephone number;
  - Name and telephone number of person who caused the spill;
  - Location and time of the spill;
  - Type and quantity of the substance spilled;
  - Cause and effect of the spill;
  - Details of action taken or proposed;
  - Description of the spill location and surrounding area;
  - Names of agencies on the scene; and
  - Names of other persons or agencies advised concerning the spill.
- A list of 24-hour emergency contacts for the project (e.g. site engineer, construction supervisor, environmental monitor): names, positions and telephone numbers;
- A list of other relevant 24-hour emergency contacts and a description of the circumstances under which they should be contacted;
- A list of the substances most likely to be involved in a spill or incident;
- The *Material Safety Data Sheets* (MSDS) for all potentially deleterious substances stored on site and clean-up instructions for each substance or class of substances;
- A list of the spill response equipment on site along with a map of where it is stored;
- A description of potential environmental impacts should a spill occur;
- A detailed site map that identifies areas of particular concern with respect to environmental impacts, such as probable flow pathways to watercourses; and
- Detailed instructions for preventing/mitigating environmental impacts, such as containment measures for spills that have entered watercourses.

11.0 TERMS OF REFERENCE FOR ENVIRONMENTAL MONITORING

11.1 Responsibilities of the Environmental Monitor

The environmental management plan includes provision for environmental monitoring during construction. Some environmental monitoring also will take place during operation. This section provides draft terms of reference for the Environmental Monitor for the construction phase.

The objectives of the environmental monitoring program are to:

- ensure proper development and implementation of the environmental management plan and other mitigation measures;
- assess the performance of environmental controls and mitigation measures;
- ensure that the contractor corrects any mitigation measures that are not functioning acceptably; and
- ensure that water quality, fish and wildlife in the MMR area are protected throughout the construction program.

The Environmental Monitor will be an independent third party who will have the authority to stop construction activities temporarily if unacceptable environmental events occur or appear likely to occur. The Environmental Monitor will be on site full time when stream crossing work is done. He/she will make periodic inspections during other construction activities to ensure that the construction contractor is following all aspects of the Environmental Management Plan. The Environmental Monitor will report immediately to the appropriate agencies any significant environmental events or construction deviations. He/she also will make regular (monthly) reports on progress with construction, any other (minor) environmental events or impacts that occurred and actions taken to address these events or impacts.

The Environmental Monitor's specific responsibilities will include the following:

1. meeting periodically with the contract project manager to discuss work requirements, compliance issues, and other environmental matters;
2. conducting inspections of all sediment/silt control works;
3. inspecting other aspects of the work area and equipment for general housekeeping, dust control and compliance with the spill prevention plan;
4. monitoring all instream works;
5. conducting fish salvages; and

6. monitoring receiving water quality during activities that could cause increased total suspended solids (TSS) or turbidity in watercourses.

The following sections provide a more detailed description of the responsibilities and tasks of the Environmental Monitor.

11.1.1 Meeting and Communication

The Environmental Monitor will meet with the contractor for the site to establish appropriate lines of communication. The monitor will also meet with subcontractors, other field staff, environmental agency representatives, key stakeholders and other engineering staff associated with the project where required.

The monitor will be available by pager 24 hours a day. The phone number will be provided to a number of individuals such as the contractor and a Columbia Shuswap Regional District designate and will be posted at the site.

11.1.2 Monitoring Prior to and During Site Preparation

The monitor will be responsible for the following activities before and during site preparation:

- marking environmentally sensitive areas and identifying these areas to the construction foreman and/or crew;
- reviewing vehicle access points to the site and the sediment control structures at these points prior to start of clearing;
- ensuring that the site designated for clearing is clearly marked and that any environmentally sensitive features are not enclosed within this area; and
- reviewing the sediment control structures proposed during site construction.

11.1.3 Drainage and Sediment Control

The Environmental Monitor will review the sedimentation control system (SCS) proposed for the site with the contractor before construction activities. It is understood that the contractor will be responsible for the day-to-day maintenance of the SCS and ensuring that it is working adequately to control all discharges from the site.

The Environmental Monitor will inspect the SCS weekly to:

- make recommendations to the contractor on improving the SCS, if required;
- review placement of sand, gravel and materials specified to control erosion in exposed areas;
- require that works be stopped in the event of malfunction of the SCS;

- ensure that runoff is diverted from cleared areas by use of swales, water bars or low berms and that runoff is routed to the appropriate sedimentation control structures;
- ensure that runoff does not reach streams or any storm drains that have been connected to receiving waters;
- review stockpiling methods of excavated materials to ensure that they are placed in appropriate locations away from watercourses and stored properly (e.g., covered with tarps); and
- recommend mitigation measures and ensure expeditious implementation if activities are found to have the potential for environmental impact.

11.1.4 Stream Crossings

The Environmental Monitor will be onsite during all instream construction activities to ensure that operators and crew comply with the Environmental Management Plan and all applicable regulations. The Environmental Monitor will:

- arrange for and/or participate in fish salvage operations, as required;
- measure turbidity upstream and downstream of the work site periodically (at least four times per day or as deemed necessary depending upon the types of instream activities);
- measure pH upstream and downstream of the work site periodically during any concrete works; and
- collect total suspended solids samples from sedimentation ponds and upstream and downstream locations on receiving waters during periods of runoff and major storm events.

11.1.5 Control of Deleterious Substances on the Site

The Environmental Monitor will review housekeeping practices on site (e.g., daily cleanup, use of disposal bins) and ensure proper use, storage and disposal of deleterious substances and associated containers. The monitor will need to be aware of all such substances used on the site. The monitor will review the contractors spill contingency plans for the site and will ensure that an inventory of all hazardous materials is maintained. The monitor will respond to and review any spillage of fuels, lubricants, hydraulic oils or other hazardous substances to determine if additional remedial measures are required and if necessary, implemented expeditiously.

11.1.6 Air Quality Management

11.1.6.1 Fugitive Dust Control

The Environmental Monitor will review the fugitive dust control plan with the contractor to ensure that proper dust control techniques are used and that the plan is implemented during periods when dust problems are most likely to occur. During his/her regular

inspections, the monitor will ensure that the dust control plan is implemented and functioning adequately.

11.1.6.2 Smoke Control

The Environmental Monitor will ensure that the Burn Plan is properly implemented. The Burn Plan prepared for MMR will include:

- location, duration and inclusive dates for the planned burn;
- location of all sensitive features that may be impacted by smoke;
- weather forecasts and how they will be used to prevent smoke impacts;
- how weather changes will be monitored and what will be done to reduce or mitigate smoke impacts if unfavourable weather should occur after ignition;
- coordination with air quality authorities;
- how the public will be informed prior to, during and after burning; and
- what will be done to enhance active fire phase and reduce smouldering phase.

11.1.7 Management Plans for Vegetation and Wildlife

The Environmental Monitor will review the management plans for vegetation and wildlife with the contractor prior to site preparation. The environmental monitor will inspect the construction site to ensure that:

- vegetation to be protected is clearly marked using appropriate fencing or tape;
- fencing is placed at an adequate distance from vegetation to be protected;
- recommendations for the bird and wildlife management made in the environmental assessment report and supplementary reports are adopted; and
- construction stops if unacceptable impacts to vegetation or wildlife are occurring or appear likely.

11.1.8 Waste Management

The Environmental Monitor will ensure that adequate, bear-proof garbage disposal facilities are on site. The Monitor will observe general housekeeping practices and ensure that all food and other odiferous waste is properly disposed in bear proof containers and removed from the site regularly.

11.1.9 Fire Prevention

The Environmental Monitor will review the Fire Prevention Plan with the contractor and ensure that the plan is implemented adequately. The Environmental Monitor will be onsite during all phases of burning of woody debris, slash, etc. If measures to prevent accidental fire or fire suppression equipment are inadequate, the Environmental Monitor

will identify these deficiencies and provide recommendations to upgrade fire prevention measures/equipment.

11.2 Frequency of Site Inspection

The Environmental Monitor will visit the site on a pre-established schedule during the lifespan of the project to ensure that all environmental management measures are in place and these measures have demonstrated effective site control. The Environmental Monitor will be onsite during all stream crossing work.

11.3 Reporting

The monitor will prepare monthly monitoring reports and a summary report at the end of the construction phase. Additional reports may be prepared at the conclusion of specific instream works. The reports will outline major construction activities in relation to environmental issues, significant concerns encountered during the project and mitigation measures used to deal with those concerns.

12.0 WILDLIFE MONITORING

12.1 Wildlife Monitoring

12.1.1 Field Surveys

Wildlife and vegetation (habitat) inventory and documentation studies will be conducted during all phases of construction and during the operational phase of the resort. Field studies will be conducted on a regular basis during each season, with a special emphasis being placed on locating the following sites (if present): ungulate mineral licks; Grizzly and Black Bear dens; large carnivore den sites (e.g., Wolverine); and raptor nests. Data will be compared to data collected during the previous years.

12.1.2 Management Approach

To evaluate the success of the mitigation/compensation measures it is recommended that an adaptive management approach through an effective monitoring program be implemented after project certification. The monitoring program should have feedback mechanisms that will allow the results of the monitoring to influence the implementation of any further mitigation measures. Adaptive management requires that identified problems are addressed, particularly when actual or potential conflicts persist in particular areas and/or times, including the issue of people moving from the resort directly out of the valley into adjacent drainages. In addition, it is recognized that there may be some residual impact on habitat effectiveness and at least a slightly increased mortality risk to ungulates from the presence of the resort that cannot be completely mitigated. These residual impacts may need to be compensated by habitat enhancement or restrictions of human activities outside of the drainage.

Monitoring involves regular data gathering on ungulate occurrence, significant ungulate-human conflicts (esp. during rutting), human recreational uses in the area, and other factors of interest to ungulate security that may be identified. Due to the research nature of some of the proposed mitigation measures and their relevance to conservation and management, it is recommended that both government and the proponent share the responsibility and cost of on-going monitoring.

The monitoring should be undertaken before construction of the project begins, during initial construction of the project (i.e. prior to commercial-scale resort operations), and during commercial-scale operations.

Since these monitoring activities include collecting information on species conservation and management, and are not directly related to the impacts of the project, it is recommended that the Ministry of Sustainable Resource Management (MSRM) take responsibility for this component of the monitoring program. If the proponent undertakes

this component, it should be considered as partial/complete compensation for some of the project impacts (with the caveat that mitigation is strongly preferred over compensation).

12.1.3 Performance Indicators

Methods to achieve the management plan outlined in this report will be implemented, and evaluated each year to identify their effectiveness and that of all management implementations relating to the human activities in and around the resort facilities. This will involve the monitoring of several criteria to evaluate the performance and effectiveness of the management plan. The following criteria have been identified as important indicators of performance in the management plan surrounding the proposed resort development activities, and each will be assessed annually qualitatively and quantitatively for implementation effectiveness:

1. Number of property damage incidents due to wildlife;
2. Number of threat encounters;
3. Number of no contact charge encounters (base and back country);
4. Number of annual wildlife relocations/translocations (by species) at the resort assessed as necessary by a conservation officer;
5. Number of animals destroyed (by species) in and around the project area;
6. Total known mortality (by species). This should be separated into human and natural causes;
7. Total number of observations (by species) reported in the project area;
8. Total annual resort visitations;
9. Total human injuries, deaths caused by ungulates (e.g., Moose and Elk) in and around the project area; and
10. The education program should be reviewed and analysed annually before the start of a new season comparing records of data.

All identified characteristics should be divided into front and backcountry occurrences for annual analysis of the program success. Annual analysis, because of observer bias, will be based on multi year trends to evaluate ungulate/human conflicts. The program is to be implemented immediately upon phase construction and by all staff associated with the final development. Roles and duties may be formulated at that time.

Finally, if the management program objectives are not being met, at an acceptable level according to the Wildlife Management committee, contingency measures will have to be implemented by the provincial government including but not limited to the following:

1. Increased enforcement (patrol frequency);
2. Area design and delivery of the bear/human conflict awareness and education programs;
3. Additional spot closures to human access;

4. Hunter harvest restrictions and closures as recommended by affiliated agencies in the Purcell Mountain Range or by MSRM; and
5. Perform on-going monitoring and research involving the monitoring of ungulate security habitats and how effective this habitat is relative to the impacts of the proposed development and human presence in the project area and surrounding valleys.

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