March 2017

Environmental Impact Statement for the Resort Centre Area Structure Plan Amendment

Submitted to:
Town of Canmore
902 - 7th Avenue
Canmore, AB

REPORT

Report Number: 1539221

Golder Associates

Executive Summary

Introduction

On behalf of the current Three Sisters Mountain Village owners, Three Sisters Mountain Village Properties Ltd. (TSMVPL), QuantumPlace Developments Ltd. (QPD) is working to amend the existing 2004 Area Structure Plan (ASP) for the Resort Centre (the Project). The Project focuses on providing alternative development options for the area within the Resort Centre where a golf course was approved in 2004, was partially constructed, but was not completed. Golder Associates Ltd. (Golder) prepared the Environmental Impact Statement (EIS) for the Project. This executive summary provides an overview of the key elements contained within Golder's EIS.

Background

In 1992, the Natural Resource Conservation Board (NRCB) approved a recreational and tourism project that proposed a variety of housing units, golf courses and a range of commercial services on 1,036 hectares (ha) of Three Sisters Mountain Village (TSMV) land, within the eastern boundaries of the Town of Canmore (the Town). The NRCB had jurisdiction to determine whether the proposed development was in the public interest and grant approval for the development. The NRCB elected not to act as an ongoing regulator of detailed plans and operations. Instead, the Town has the responsibility to determine how the approved TSMV infrastructure is developed and operated through the regulatory process and statutory and non-statutory planning documents including the Town's Municipal Development Plan, ASPs, land use bylaw, and subdivision plans.

The Province of Alberta (the Province) is responsible for approving wildlife corridors and wildlife aversive conditioning plans proposed by the developer on or adjacent to TSMV lands. These requirements are defined in Clause 14 of Appendix C of the NRCB decision, which states:

> "*Three Sisters shall incorporate into its detailed design, provision for wildlife movement corridors in as undeveloped a state as possible, and prepare a wildlife aversive conditioning plan, both satisfactory to Alberta Forestry, Lands and Wildlife*" (currently known as Alberta Environment and Parks [AEP]).

Although there are other municipal, federal and provincial regulations affecting the development of TSMV, such as the Alberta Wetlands Policy, the Alberta Historical Resources Act, and the Federal Migratory Bird Convention Act (and these are identified in the EIS), the 1992 NRCB decision and especially provisions related to wildlife are of primary concern to stakeholders in the Bow Valley.

Wildlife corridors adjacent to the Project Boundary, which incorporated provincial lands and 152 ha of TSMV lands, were approved by the Province in 2004. The approved Along Valley Corridor is immediately south of the area zoned as golf course in the approved 2004 ASP. The golf course is not part of the approved Along Valley Corridor. The approved Tipple Across Valley Corridor is immediately west of the Project Boundary.

Through the 1998 Settlement Agreement and the Town's master zoning bylaw Direct Control District (DC) 1-98 within Land Use Bylaw 22-2010, and following general terms of the NRCB decision, the Town has approved a total of 5,457 residential, resort accommodation and timeshare units and up to 306 ha of developable area across TSMV lands. Currently, there are 4,104 units and 206.86 ha that remain to be developed in TSMV. These units are currently allocated to the approved Resort Center ASP, the approved Stewart Creek ASP, and an area to the east of the Resort Center known as the Smith Creek ASP, which has been submitted to the Town for consideration but has not yet received an ASP approval.

The Resort Centre is located at the western edge of TSMV property. An ASP for the Resort Centre was approved by the Town in 2004. The approved ASP boundary includes 303 ha of land. In addition to the golf course, 1,330 to 2,525 resort accommodation units and a possible range of 90,000 to 150,000 sq. ft. of gross floor area of medical, health and wellness commercial uses and an additional 25,000 sq. ft. of commercial retail space were approved in the area known as the "Resort Core". These previous approvals translate into a potential population of 3,192 to 6,060[1], including visitors and residents.

Proposed Resort Centre ASP Amendment

Because current market conditions do not support additional golf course development in the region, the Project proposes to amend the ASP by redistributing and adding resort accommodation and recreational amenities into areas currently approved for a golf course. The ASP also proposes that a portion of the additional units be permanent residential units. The proposed amendment would result in an increase from the approved 1,330 to 2,525 units for the Resort Centre to 1,600 to 3,000 units. However, if the higher number of units in the range are developed in the Resort Centre, fewer units will be developed on other TSMV lands so that the total number of units approved for TSMV lands does not exceed the total unit cap identified in DC 1-98.

As required by the Town's EIS policy, alternatives and modifications to the Project Boundary and other design elements were considered to limit or remove impacts, prior to QPD developing the final Project design proposed in the ASP. The alternatives analysis and consultation about alternatives with stakeholders, including the Town, local residents, local environmental organizations, recreational enthusiasts, and community services representatives, was led by QPD and considered a wide range of factors including environmental, social, legal, and economic.

Golder's input into the alternatives considered by QPD included using quantitative models developed using data from animals collared in the Bow Valley, to evaluate three conceptual development scenarios (Figure 1). Two species were chosen for the alternatives analysis. Grizzly bears are a species of concern in terms of both movement and negative human wildlife interactions in the Bow Valley, whereas wolves are a species for which sensory disturbance from human development creates a strong zone of influence. High density development scenarios create a negative zone of influence that extends into wildlife corridors for wolves, but lower density developments with open space adjacent to wildlife corridors maintains probability of selection in wildlife corridors similar to existing conditions for wolves (Figure 2). Conversely, lower density developments and open spaces were selected by grizzly bears in the low density development scenarios, resulting in an increased risk of negative human-bear interactions (Figure 3).

Based on the scenario analysis, Golder provided the following recommendations and observations:

- To the extent possible, select development footprint alternatives that avoid impacts to wetlands and riparian areas (Environmentally Sensitive Areas).

[1] Calculated using an average of 2.4 people per household.

- Concentrating higher density development closer to downtown Canmore in the Resort Centre will benefit species like grizzly bears that exhibit higher potential for negative interactions with people in lower density developments, and species like wolves for which the zone of influence from high-density development can extend into adjacent wildlife corridors.
- The benefits of low density development for reducing sensory disturbance in wildlife corridors are outweighed by the higher potential for negative human-wildlife interactions in developed areas for grizzly bears. Therefore, unless a physical barrier is created between people and wildlife, higher density developments are recommended to reduce this risk.
- If low density developments are included adjacent to the wildlife corridor, scenario modelling and existing conflict data support the use of a physical barrier separating wildlife and people to mitigate potential increases in negative human-wildlife interactions. By incorporating a wildlife fence, the advantages of reduced sensory disturbance associated with lower density development can be achieved for species like wolves without increasing the risk of negative human-wildlife interactions for species like grizzly bears.
- Recreational activities such as off-leash dog use, terrain parks, zip-lines and/or rope courses, or trails for hiking, cross country skiing, and mountain biking were identified as options to occur within open spaces or recreation zones in the Resort Centre. Because animals like grizzly bears show strong selection for open areas within and adjacent to developments, these areas are predicted to become hotspots for negative human-wildlife interactions. Moreover, human recreational activities could spill over into the wildlife corridor. If the development footprint includes recreational activities in open spaces adjacent to the wildlife corridor, the quantitative scenario modelling and available conflict data support using a physical barrier to mitigate predicted increases in negative human-wildlife interactions and the adverse impacts to wildlife associated with it, such as hazing or mortality.

The Project Boundary selected by QPD and assessed in the EIS avoids ESAs, such as wetlands and riparian areas, identifies higher density development closer to the Three Sisters Parkway, and transitions to lower density development in the golf course area. Open spaces and recreational zones are identified adjacent to the wildlife corridor. The Project includes a proposed wildlife fence along the northern boundary of the 35 m Conservation Easement adjacent to approved wildlife corridors. The fence separates open space, recreational areas, and development from the wildlife corridors.

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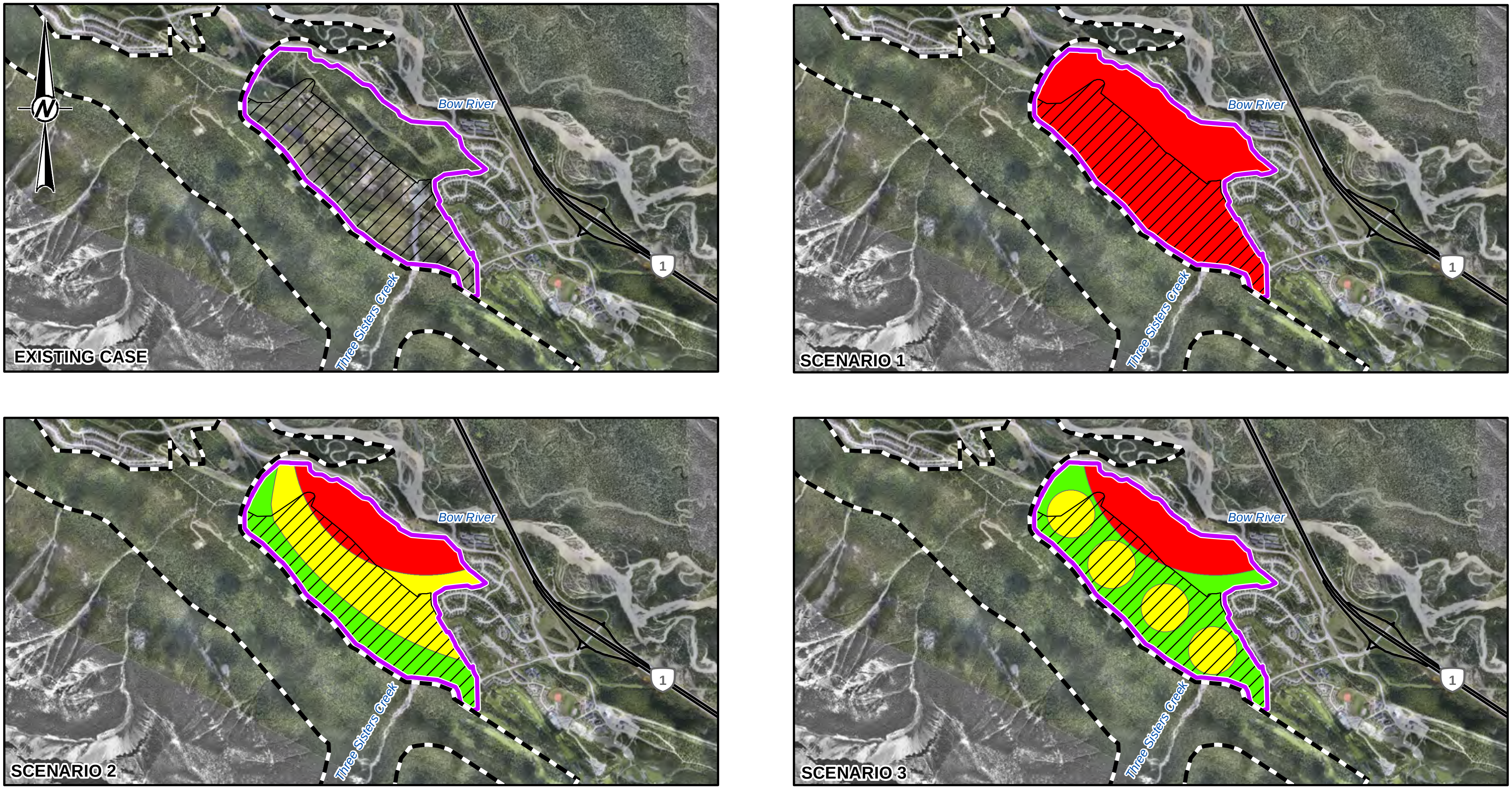

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROJECT FOOTPRINT DENSITY

- HIGH
- LOW
- NONE

0 1,000 2,000

1:45,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
CONCEPTUAL DEVELOPMENT ALTERNATIVES

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	1

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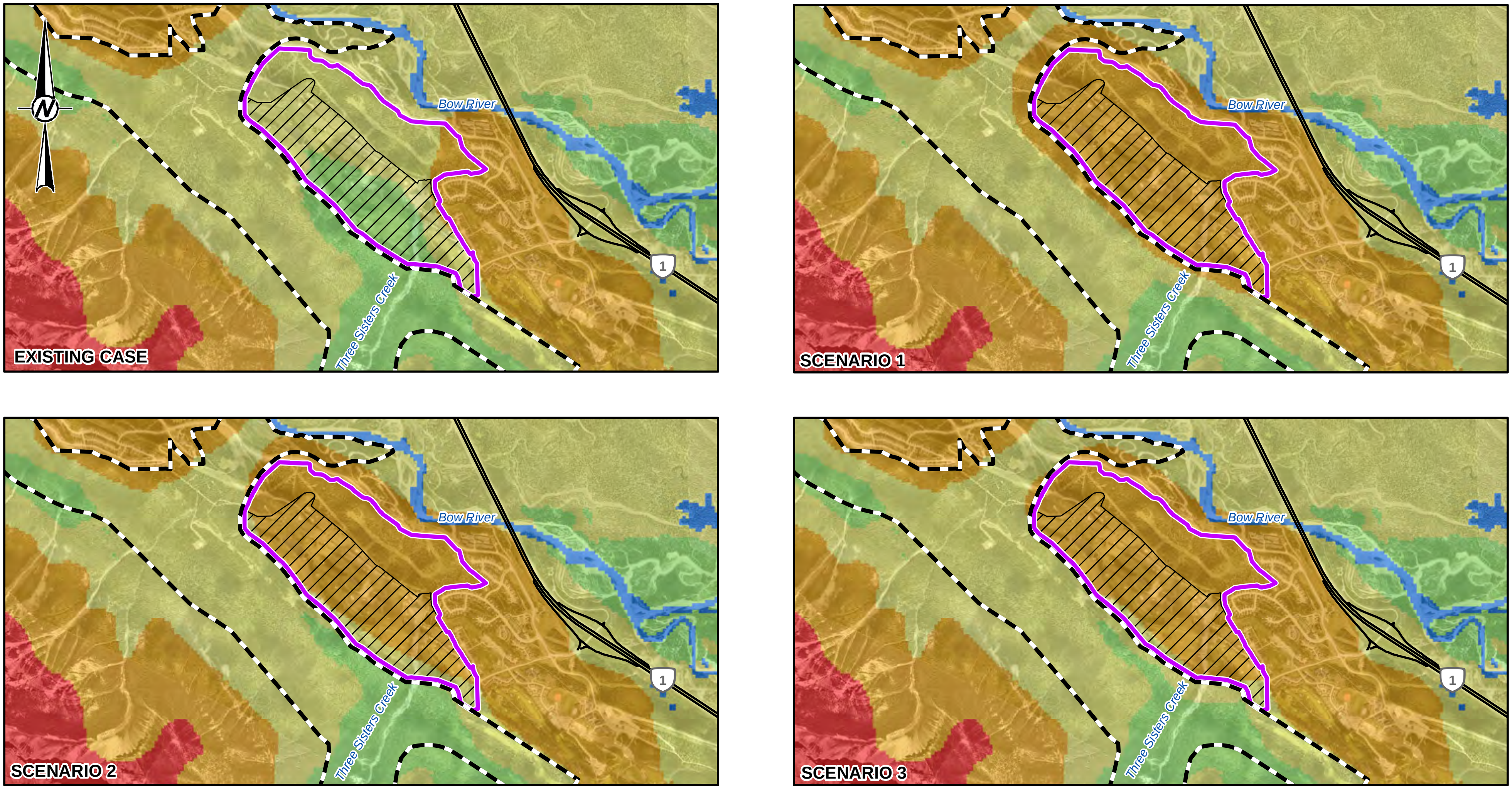

LEGEND

—	PRIMARY HIGHWAY
▭ (dashed)	APPROVED WILDLIFE CORRIDOR
▭ (magenta)	PROJECT BOUNDARY
▨	RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 1,000 2,000

1:45,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

WINTER WOLF RESOURCE SELECTION UNDER DIFFERENT DEVELOPMENT SCENARIOS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	2

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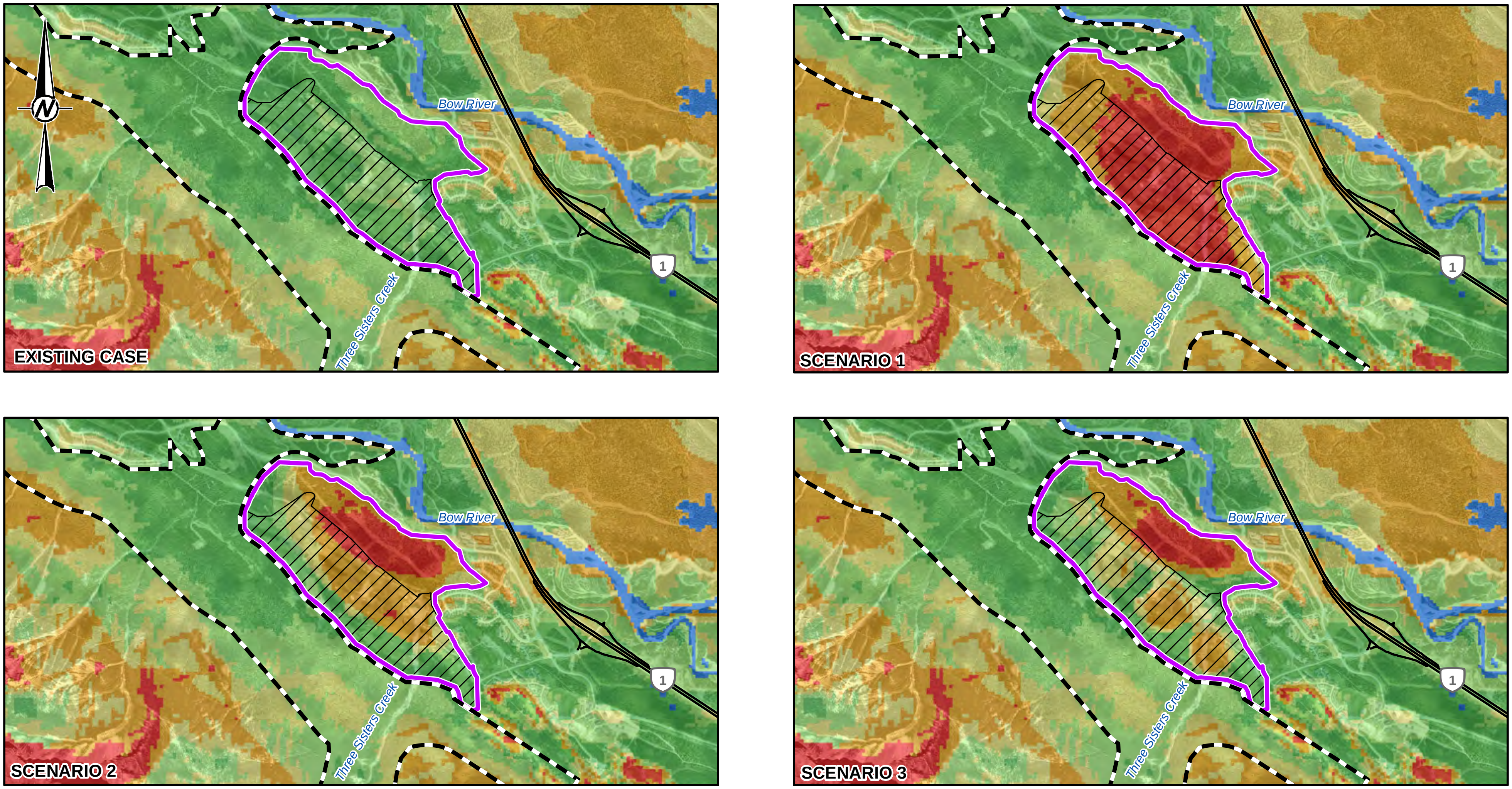

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 1,000 2,000

1:45,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

SUMMER GRIZZLY BEAR RESOURCE SELECTION UNDER DIFFERENT DEVELOPMENT SCENARIOS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	3

Purpose and Scope of the Environmental Impact Statement

The purpose of this EIS is to provide sufficient information about the potential environmental impacts of the Resort Centre ASP amendment for Council to make an informed decision about the Project. The EIS was prepared to meet a Terms of Reference (TOR) issued by the Town after being reviewed by the Town's independent third party reviewer. Following the TOR, valued environmental components (VECs) assessed in the EIS were wildlife, fish, vegetation, terrain, bedrock, and soils, surface and groundwater, air, visual resources, and historical resources.

Because stakeholders were especially concerned about Project impacts on wildlife, particularly wildlife movement and negative human-wildlife interactions, the level of assessment for wildlife was greater than for other VECs. The EIS assessed the potential effects of the Project on grizzly bears, wolves, cougars, and elk.

The TOR states that "the scope of the EIS will not include the functionality of the wildlife corridors as this is under the authority of the Province under the direction of the NRCB Decision". Consequently, the physical characteristics of the existing wildlife corridors, such as width, length, elevation, slope, or whether the regional network of wildlife corridors and habitat patches is appropriate was outside the EIS scope, as was evaluation of whether additional lands might be required to improve existing corridor function.

However, the TOR also states that "the environmental review will need to consider development proposed adjacent to wildlife corridors and habitat patches" (Appendix A, Page 4). Therefore, the potential for the Project to affect wildlife use of habitats inside the boundaries of existing corridors was part of the scope of the EIS and these potential effects were evaluated.

Assessment Methods

Golder evaluated the potential effects of the proposed Project on wildlife and other VECs by:

- outlining existing conditions, including identifying significant natural and ecological features;
- determining the nature and scale of the environmental risks associated with the proposed project;
- providing recommendations to avoid or mitigate those risks, including identifying legal requirements and good practice guidelines for specific mitigation actions;
- describing residual impacts that remain after mitigation and defining their significance; and
- recommending further studies or monitoring, if necessary.

Cumulative effects are the sum of all natural and human-induced influences on a valued environmental component. The EIS considered cumulative effects for three assessment cases within a 23,878 ha regional study area (RSA) located between the east boundary of Banff National Park and Exshaw. The Existing Conditions Case considered the cumulative effects of previous and existing developments, setting the stage for evaluating Project effects. The Project Effects Case considered the predicted contribution of the Project, after incorporating mitigation, to the effects identified under existing conditions. The Cumulative Effects Case added the combined effects of the Project and other reasonably foreseeable developments in the Bow Valley, such as the Smith Creek ASP, Dead Man's Flats ASP, Silvertip Resort Expansion, and industrial expansion at Baymag and Lafarge plants to the effects identified under existing conditions.

The significance of effects was evaluated using an environmental consequence rating of positive, negligible, low, or high. A high environmental consequence was associated with a serious risk, which is equivalent to a significant adverse effect. Using wildlife as an example, a serious risk would be any factor that puts the viability of a population inhabiting the RSA at risk. For instance, the loss of connectivity among habitat patches in the RSA or creation of a population sink for a particular wildlife species in the RSA through increased negative human wildlife interactions would constitute a serious risk. Weight of available evidence and professional judgement were used to determine environmental consequence using logical reasoning. A precautionary approach was applied, such that adverse effects were overestimated where uncertainty was present.

Quantitative data, including data from remote cameras, telemetry data from collared wildlife, empirical models of wildlife habitat selection including the influence of human use, and records of negative human wildlife interactions were combined with a review of literature, opinion of local wildlife experts, and information provided by the Town and Province to provide the foundation for the wildlife effects assessment.

Although the EIS considered the entire Project so that effects of the Resort Centre as a whole could be predicted and appropriate mitigation identified, the EIS recognized that much of what is being proposed has already been approved as part of the existing 2004 Resort Centre ASP and subsequent land use approvals, and therefore could be developed. Where appropriate, differences between approved and proposed developments were considered in the EIS, including differences between developing the approved 2004 ASP using the mitigation identified in 2004 and developing the Project using updated approaches to mitigate potential adverse environmental effects.

Human Use

An analysis of human use impacts on wildlife populations and habitats was required by the TOR and was central to evaluating the effects of the Project and cumulative effects to wildlife. Human use on recreational trails in the Bow Valley is high and has been increasing at a rate of approximately 6% per year. Negative human-wildlife interactions have also increased over time in the Bow Valley and are highest in places where wildlife habitat occurs adjacent to human development. Undesignated trails are more common than designated trails in wildlife corridors in the RSA (i.e., 57.7 km of designated trail and 83.9 km of undesignated trail)[2]. Illegal trail use in wildlife corridors adjacent to the Project is common, including off leash dog use, undesignated trail use, and use during seasonal closures. People and off-leash dogs were recorded on remote cameras twice as often as wildlife.

Remote camera data show that human use is higher closer to existing developments; consequently, a key risk associated with the Project is that human use would increase in wildlife corridors adjacent to the Resort Centre, including increased illegal trail proliferation, increased use of undesignated trails, and increased off-leash dog use. Mitigation to address this risk includes: fencing to delineate boundaries between wildlife corridors and open space and recreational areas, educational signs to inform people about legal obligations in wildlife corridors, a trail system inside the Project Boundary to provide users with an enjoyable and effective alternative to using trails in wildlife corridors, defining access points to designated trails in wildlife corridors and incorporating off-leash dog areas inside the Project Boundary.

[2] Undesignated trails may be under-represented because not all of them have been mapped and new trails are created each year, often by individuals who do not know they are building trails in wildlife corridors (Derworiz 2015).

Mitigation is predicted to limit illegal off-leash dog use and undesignated trail use within wildlife corridors. This could result in a positive outcome compared to existing conditions and is predicted to result in a strongly positive outcome relative to developing the Resort Centre according to the approved 2004 ASP. Although uncertainty exists about how people will respond to the proposed mitigation, previous education campaigns in Canmore's Benchlands area and surveys undertaken in 2014 as part of the Town's Human Use Management Review program indicate that the mitigation including educational signs and clear demarcation of wildlife corridor boundaries will likely prove successful. Thoughtful trail construction has also proven successful elsewhere in the Bow Valley. For example, the "Long Road to Ruin" Trail in the Canmore Nordic Center has resulted in the abandonment of almost all non-sanctioned trails in the immediate vicinity.

The combined effect of future developments in the RSA and growth of the City of Calgary could result in doubling the number of people residing in the RSA and more than tripling the number recreating in the RSA by 2037. Estimates from the Town's Utility Plan indicate that the Town could have a population of 34,000 at full build out. Without careful application of appropriate mitigation throughout Canmore, this increase is predicted to contribute to at least a doubling of both legal and illegal human use in wildlife corridors and habitat patches relative to existing conditions. Project mitigation will result in a substantially improved outcome for the adjacent Along Valley and Tipple wildlife corridors relative to developing the Resort Centre according to the approved 2004 ASP.

Grizzly bears

Grizzly bears have adapted to existing developments in Canmore. Some of the most strongly selected habitats in the RSA occur adjacent to residential areas during summer. The result of substantial bear use in the vicinity of development is a large number of negative human-bear interactions. Peaks of Grassi, the Homesteads, Rundleview, Cougar Creek, and Silvertip where housing developments occur adjacent to wildlife corridors or habitat patches are hotspots for negative human-bear interactions. Grizzly bears are typically hazed, translocated, or killed if they spend time near residential developments, or are involved in aggressive interactions with people. Grizzly bears in the Bow Valley also suffer substantial mortality associated with vehicle strikes on highways and railways. When these mortality sources are considered together, the Bow Valley is one of the places with the highest mortality risk for grizzly bears in Alberta. Attractive habitat combined with high mortality risk mean that the RSA represents an ecological trap and a population sink for grizzly bears. Consequently, a serious risk was identified for grizzly bears under existing conditions.

Because grizzly bears in the Bow Valley have adapted to people, the greatest risk of the Project is that it will create another hotspot for negative human-bear interactions, similar to or greater than those observed in existing communities in Canmore. This risk is substantially increased by the incorporation of open spaces and recreation areas integrated throughout the Project Boundary, especially those proposed adjacent to wildlife corridors. Mitigation recommended to limit potential risks is multi-faceted, but the most important components are a wildlife fence to prevent bears from entering development and careful application of attractant management within the development.

The Project is not expected to contribute adversely to the serious risk and high environmental consequence identified for grizzly bears under existing conditions. Although the habitats that will be lost as a result of the Project are selected by bears, the Project Boundary also has a high level of negative human-bear interactions, and is an ecological trap under existing conditions. Preventing grizzly bears from accessing the Project Boundary using a wildlife fence is predicted to result in a positive outcome relative to existing conditions. Empirical habitat modelling showed that the zone of influence around development is weak for grizzly bears and that grizzly bear selection within wildlife corridors adjacent to the Project is predicted to change little with development of the Project. The Project is beneficial for grizzly bears when compared to developing the approved 2004 Resort Centre ASP without a fence, which would result in a strong adverse contribution to the serious risk identified under existing conditions for this species.

Empirical habitat models predict that habitats with a high probability of selection by grizzly bears will remain abundant in wildlife corridors and habitat patches in the RSA after the Project and other reasonably foreseeable developments have been developed. Sufficient habitat to preserve connectivity and provide adequate forage for grizzly bears will be preserved. However, human use and the potential for negative human-bear interactions is predicted to increase substantially, intensifying the effect of the ecological trap identified under existing conditions in the RSA. The contribution of the Project to the cumulative increase in risk of negative human-bear interactions is predicted to be neutral or positive because fencing is predicted to result in a positive outcome by reducing negative human-bear interactions from the high levels identified under existing conditions. Conversely, developing the approved 2004 Resort Centre ASP would result in a large and negative contribution to the serious risk identified for grizzly bears as a result of cumulative effects.

Cougars

Cougars are ecosystem generalists, and are capable of occupying diverse habitats, provided sufficient prey and cover are present. Cougars adapt well to human development and are commonly found close to development in habitat patches and movement corridors in the Bow Valley. Strong selection by cougars for areas adjacent to residential developments in the Bow Valley likely reflects selection by prey species such as deer and elk for urban development in the Bow Valley. Available data suggest that the cougar population in the RSA is healthy under existing conditions and habitat connectivity, including across the Trans-Canada highway, is well maintained for this species.

Like grizzly bears, cougars are not affected by a negative zone of influence around development. In fact, probability of habitat selection increases near development, most likely as a result of increased ungulate densities within and adjacent to urban areas in Canmore. The greatest risk to cougars associated with the Project is therefore an increased risk of negative human-cougar interactions. Negative interactions can result in low tolerance for cougars, with potential adverse implication for cougar conservation. The most important components of mitigation identified to address this risk are a wildlife fence to prevent cougars from entering development and careful application of attractant management within the development. In the case of cougars, attractant management means reducing the number of ungulates and other potential prey within developed areas, which is also facilitated by fencing.

The Project is predicted to have small adverse effects on cougars, primarily in the form of a loss of 140 ha of habitat that is selected or used as available, which represents less than 2% of this habitat in the RSA. Habitat selection within approved wildlife corridors adjacent to the Project changes little for cougars as a result of the Project and fencing is predicted to result in a neutral or positive outcome with respect to negative human-cougar interactions. The addition of the Project is not predicted to change the healthy population status of cougars in the RSA under existing conditions and is predicted to be beneficial relative to developing the 2004 Resort Centre ASP without a fence.

Empirical habitat models predict that habitats with a high probability of selection by cougars will remain abundant in wildlife corridors and habitat patches in the RSA after the Project and other reasonably foreseeable developments have been developed. The risk of negative human-cougar interactions is predicted to increase substantially as a result of increases in human use expected in the RSA associated with reasonably foreseeable development. This may pose a risk to cougars, depending on how people respond to the real or perceived threat to human safety presented by cougars. Whether changes in negative human-cougar interactions as a result of increased human use will pose a serious risk to cougars in the RSA is uncertain. However, fencing associated with the Project means that the Project is not predicted to contribute to this risk.

Wolves

Wolves using the RSA are members of packs that use Kananaskis Country to the south, Banff National Park to the west and potentially provincial lands such as Don Getty Wildland Park to the north, as well as lone wolves that are not affiliated with packs. Corridors and habitat patches in the Bow Valley may only be partially effective for wolves under existing conditions. Decreasing trends in amount of wolf use have been reported over time in high quality habitats north of Canmore. Similarly, remote camera data indicate that wolf use of the approved Along Valley Corridor, Tipple Across Valley Corridor and Stewart Creek Across Valley Corridor is rare, although increased use was noted in 2016. No wolves were documented using the G8 or Stewart Creek wildlife underpasses during 2007 to 2012. Although the stability of the regional wolf population is not known, wolf packs overlapping the Bow Valley are subjected to a variety of mortality sources, including being hit on highways and by trains, and, more recently, being killed in response to negative human-wolf interactions. To be precautionary, a serious risk was identified for wolves under existing conditions in the RSA because of uncertainty about pack stability and very low levels of use reported in wildlife corridors and habitat patches.

Wolf habitat in the Resort Centre amendment boundary and in adjacent wildlife corridors is primarily avoided under existing conditions, consistent with lower probability of selection south of the Bow River on north facing slopes for this species during winter. Wolves experience a relatively strong negative zone of influence from development and associated with human use of trails. The most important risk associated with the Project for wolves is reduced probability of selection in wildlife corridors adjacent to the Project Boundary as a result of development adjacent to the corridor and as a function of increased human use of the corridor. Other risks include habitat loss and habituation due to greater contact with people and anthropogenic food sources. The most important components of mitigation identified to address these risks include wildlife fencing, attractant management, assigning open space and recreational zones adjacent to the wildlife corridor, lot and dwelling design along the corridor edge that minimizes effects of sensory disturbance in the corridor, and the suite of mitigation identified to manage human use, such as fencing, signage, education, and creating recreational opportunities within the Project Boundary.

The Project is not predicted to contribute adversely to the serious risk and high environmental consequence identified for wolves under existing conditions. The Project will result in small reductions to habitat quantity and quality for wolves which are not predicted to affect existing connectivity or the ability of the RSA to support wolves. Within the Project Boundary, 41 ha of habitat that is used as available will be lost, representing 1.2% of this habitat class in the RSA. Probability of wolf selection in wildlife corridors adjacent to the Project declines slightly, with an increase of up to 6% of avoided habitat. Construction of the fence could increase access to prey, such as elk, that use the Project Boundary as a refuge from predation under existing conditions and this would benefit wolves. Compared to developing the approved 2004 Resort Centre ASP without a fence, the Project will benefit wolves because of the lower level of dispersed human use in in wildlife corridors adjacent to the Project Boundary resulting from application of the suite of mitigation designed to minimize illegal human activities in wildlife corridors.

The cumulative effects of reasonably foreseeable developments and activities, and especially a large predicted increase in human use in the RSA, are predicted to contribute substantially and adversely to the serious risk already present under existing conditions for wolves. Habitats that are selected or used as available by wolves will be further reduced, especially within wildlife corridors on the north side of the Bow River. Using precautionary assumptions, a reduction of up to 50% in habitats that are selected and used as available in wildlife corridors is predicted. Under these conditions, pack use in the RSA may decline to near zero. Dispersing wolves are likely to continue to travel through the RSA because dispersing wolves take greater risks and use habitats that are otherwise not preferred. The contribution of the Resort Centre ASP Amendment and Smith Creek ASP to the prediction of low pack use of the RSA is small because most of the change from cumulative effects is predicted on the north side of the Bow Valley and because fencing is predicted to lead to small reductions in probability of selection in wildlife corridors adjacent to TSMV (i.e., a 3% increase in avoided habitat).

Elk

The elk population in the RSA is considered stable under existing conditions, with a population of between 300 and 400 animals. Elk inhabiting the RSA spend much of their time within urban development or in close proximity to it, and these habitats are the most strongly selected in the RSA. Elk in the Bow Valley are so habituated to people that they only respond by moving away if people approach within 20 to 50 m and do not move far without strong provocation. Habituated elk can pose a human safety risk when they concentrate in urban areas, including school yards, as elk are known to do in Canmore. Although elk may be self-sustaining in the RSA under existing conditions, their natural ecological interactions have been diminished. Elk living in Canmore are substantially less available to predators such as wolves and cougars than they would be under natural conditions, and parasite loads in elk are higher because elk are concentrated in small areas of intense use. Consequently, a serious risk was identified for elk in the RSA under existing conditions because elk do not function in their natural ecological role.

Habitat within the Project Boundary is selected by elk under existing conditions, and the unfinished golf course is heavily used. Primary risks associated with the Project for elk are related to habitat loss and the potential for increased negative human-elk interactions. Movement and habitat connectivity is not a concern for this species given the high level of habituation to human activity in the Bow Valley. Fencing is a central mitigation to minimize negative human-elk interactions, but it will also restrict access by elk to selected habitat. FireSmart measures implemented by the Town, the Municipal District of Bighorn, and the Province that reduce forest cover and increase early seral habitats in the wildlife corridors and south of the wildlife corridors constitute habitat enhancements that would help to compensate for the loss of selected habitats in anthropogenic grasslands, such as the unfinished golf course.

Development of the Project will not affect the attractiveness of habitat in the Project Boundary for elk, but fencing will block elk from accessing it, resulting in the loss of 163 ha of selected habitat, which represents 3% of habitat selected by elk in the RSA. Changes in use of the wildlife corridors and negative human-wildlife interactions are predicted to be neutral for elk as a result of the Project. Substantial uncertainty was identified for predictions about how elk will respond to the Project. The proposed wildlife fence contains a gap along the Bow River, and elk may enter through this gap and through high density development in the Resort Core to access open spaces and recreational zones in the southern portion of the Project. If habitat improvements are constructed in wildlife corridors, a positive outcome is possible for elk. In this case, an improvement from the serious risk and high environmental consequence identified for the ecological function of the elk population under existing conditions is possible because elk would be more exposed to their predators. On the other hand, elk may also simply move to other parts of Canmore to avoid predators.

Changes to elk connectivity are not expected as a result of cumulative effects of the Project and other reasonably foreseeable developments in the Bow Valley, and negative human-elk interactions may decline with implementation of habitat enhancements in wildlife corridors and habitat patches. The primarily adverse effect to elk in the RSA when the cumulative effects of existing and reasonably foreseeable projects and activities are combined is habitat loss associated with fencing for the Resort Centre ASP Amendment and the Smith Creek ASP, resulting in a 9% decrease in selected habitat in the RSA. This loss of selected habitat may have a detrimental effect on elk carrying capacity, but is not expected to alter the self-sustaining status of elk in the Bow Valley. Fencing is a key mitigation required to prevent what would otherwise be substantial adverse contributions from new development to the high environmental consequences present in the Bow Valley for grizzly bears and to reduce negative human-wildlife interactions more broadly. Possible outcomes of cumulative effects include maintaining the high environmental consequence identified for elk under existing conditions if elk continue to concentrate their use in anthropogenic habitats in Canmore, or reducing the environmental consequence to low if elk redistribute themselves outside of Canmore and improve their contribution to ecosystem function.

Other Valued Environmental Components

Effects of the Project to all other VECs are predicted to have either a negligible adverse effect, or a low magnitude adverse effect. Environmental risks of the Project were substantially less for VECs other than wildlife. Key mitigation identified for other VECs includes avoiding disturbing ESAs such as wetlands or compensating for them where disturbance cannot be avoided, complying with legal requirements and good practice guidelines such as the *Alberta Water Act*, the Federal *Fisheries Act*, and the Town's policies related to architectural and landscaping controls. In no case was a potential for a serious risk identified, either because of the Project or because of the cumulative interaction of the Project with other previous, existing, and reasonably foreseeable developments.

Uncertainty, Monitoring, and Adaptive Management

Uncertainty for wildlife was reduced by using site-specific empirical data, empirically derived habitat models, and scientific literature from similar ecosystems and conditions to those found near Canmore. When combined with precautionary assumptions that are likely to overestimate potential adverse effects, the available evidence indicates that the effects caused by the Project are unlikely to be worse than predicted in this EIS, provided the recommended mitigation is fully applied. Importantly, a situation where the proposed Project would result in a worse outcome in terms of negative human-wildlife interactions and human use in wildlife corridors than developing the approved 2004 Resort Centre ASP is difficult to imagine because the approved 2004 Resort Centre ASP lacks key mitigation identified in this EIS, such as fencing.

Although the available data provides substantial support for the predictions made in this assessment, some uncertainty was identified, especially with respect to ecological thresholds that may exist but have not been detected, and the response of current and future citizens of Canmore to education, signs, fencing, and enforcement. Uncertainty about how elk will redistribute themselves on the landscape after fencing is constructed is also present, and elk may enter the Resort Centre through the gap in the wildlife fence, move into more natural habitats and improve ecological function of the large carnivore predator-prey system in the RSA, or move into other parts of Town with an associated increase in the potential for negative human-elk interactions in these places.

The response of wolves to reductions in dispersed human use in wildlife corridors and the potential for wolves to habituate to higher human use is also uncertain.

To address these uncertainties, a monitoring program is recommended in conjunction with a phased approach to developing the Project to facilitate adaptive management. Adaptive management is a tool for decision making in the face of uncertainty that is comprised of four iterative steps: act, measure, evaluate, and adapt. In the case of the Project, actions represent the phased development, measurement and evaluation are undertaken through monitoring, and adaptations may be undertaken if monitoring indicates that they are required.

Phased development of the Project should be undertaken by constructing the wildlife fence prior to developing other Project components. Early construction of the fence will permit evaluation of the efficacy of the fence for 1) excluding large mammals from the Project Boundary, and 2) improving compliance with existing regulations in wildlife corridors. An education and enforcement campaign undertaken by the Town and the Province over the first 5 years that the fence is in place is recommended to maximize efficacy of fencing and education in achieving compliance with trail use, off-leash dog use, and seasonal closure regulations within wildlife corridors. This is especially important for existing residents, who may be using wildlife corridors inappropriately because they are unaware of legal requirements or the location of corridor boundaries.

Within the amendment area, development should occur from north to south. This approach to development will permit monitoring to occur in the wildlife corridor as development proceeds, providing opportunities for adaptive management as development progresses closer to the wildlife fence and wildlife corridor.

A monitoring program developed and directed by a stakeholder committee comprised of a Government of Alberta representative (e.g., an AEP biologist), a representative of the Town, and a representative of TSMV is recommended to provide the information necessary to inform adaptive management. The committee may seek advice from external experts, as required.

Provisions must be in place so that the Project can be adjusted, if required. Adaptation is not always necessary, and if monitoring indicates that the predictions of this EIS are met, no adaptation would be required. On the other hand, if monitoring identifies important deviations from the predictions of the EIS, then adaptation should be explored if the Project was identified as the cause of the deviation.

Conclusion

Through the application of mitigation, the Project is not predicted to contribute to any of the serious risks identified for wildlife under existing conditions, nor is it predicted to create or contribute to the serious risks for other VECs. Uncertainty will be addressed using a phased approach to development, monitoring, and adaptive management, providing further assurance that the Project will not contribute to significant adverse environmental effects. The suite of mitigation proposed for the Project, including wildlife fencing, education, and off-leash dog parks is predicted to have positive effects for some wildlife species, especially in comparison to developing the approved 2004 Resort Centre ASP without similar mitigation. For these conclusions to be maintained, mitigation and adaptive management strategies identified in the EIS, including phased development and monitoring, must be fully and effectively implemented.

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1.0 INTRODUCTION

Three Sisters Mountain Village (TSMV) is located within the eastern boundary of the Town of Canmore (the Town). Development approval for TSMV was granted by the Natural Resources Conservation Board (NRCB) in 1992 (NRCB 1992). The approval included developments such as golf courses, residential neighbourhoods and supporting commercial infrastructure. Through the Settlement Agreement and the Town's master zoning bylaw Direct Control District (DC)1-98 within Land Use Bylaw 22-2010, the Town has provided for a total of 5,457 residential, resort accommodation and timeshare units and up to 306 ha of developable area across TSMV lands. Currently, there are 4,104 units and 206.86 ha that remain to be developed in TSMV[3]. Development of TSMV properties thus far has generally progressed in stages from west to east and several residential and limited commercial areas have been developed.

The area of TSMV properties known as DC 1-98 Sites 1 and 3, and more recently as the Resort Centre, (Figure 1) is located at the western edge of TSMV property. An Area Structure Plan (ASP) for the Resort Centre was approved by the Town in 2004. The approved ASP permits development of 95 ha of land for a Resort Core and resort accommodation units, and includes approval for a total unit density of 1,339 to 2,525 and a potential population of 3,214 to 6,060[4], including visitors and residents. In addition, 110 ha of land was allocated for the development of a golf course.

On behalf of the current TSMV owners, Three Sisters Mountain Village Properties Ltd., QuantumPlace Developments Ltd. (QPD) is working to amend the existing ASP for the Resort Centre to match current market conditions in the Town. Specifically, the amendment proposes to change the type of development permitted on the golf course lands, which were partially developed and then abandoned. The general plans for the development of resort accommodation, and commercial space north of the golf course is consistent with the previously approved ASP.

The Town's Municipal Development Plan requires that an Environmental Impact Statement (EIS) be prepared and submitted as part of an application to amend an ASP. Golder Associates Ltd. (Golder) was retained by QPD to prepare an EIS for the Resort Centre ASP Amendment (the Project).

This introduction intends to familiarize the reader with the existing Resort Centre ASP, the Project, and Golder's scope of work:

- provides background information about the existing Resort Centre ASP;
- identifies the objectives of the Project;
- defines the purpose and scope of the EIS;
- describes the role of stakeholder engagement undertaken to inform the design of the Project and the mitigation identified in this EIS; and
- outlines the structure of the EIS.

[3] This total includes units for which sub-division approval has been provided in Stewart Creek Phase 3, but which have not yet been constructed. Total units available will be updated annually for all TSMV property and development will not exceed the maximum provided by DC 1-98.

[4] Calculated using an average of 2.4 people per household.

1.1 Existing Resort Centre ASP and Current Land status

The Resort Centre (Figure 1) has an existing ASP, which was approved in 2004. The approved ASP boundary includes 303 ha of land, 1,339 to 2,525 resort accommodation units, and a possible range of 90,000 to 150,000 sq. ft. of gross floor area of medical, health and wellness commercial uses and an additional 25,000 sq. ft. of commercial retail space in the area known as the "Resort Core". Predominant planned commercial uses within the existing ASP are in the form of health/medical wellness and spa facilities within a 25 to 30 ha area.

Following the approval of the ASP, land use approval was granted by Canmore Town Council for the Three Sisters Resort Golf Course, one of the "Resort Accommodation Areas" and the "Resort Core" (land use districts GRD, TS-RA1, and TS-RC). Other lands within the original DC 1-98 land use district required rezoning prior to development.

During the preparation of the 2004 Resort Centre ASP, adjacent wildlife corridors were reviewed and approved by the Province of Alberta (the Province) in their current location. The designation of wildlife corridors is a requirement of Clause 14 of Appendix C of the NRCB decision, which states:

> "*Three Sisters shall incorporate into its detailed design, provision for wildlife movement corridors in as undeveloped a state as possible, and prepare a wildlife aversive conditioning plan, both satisfactory to Alberta Forestry, Lands and Wildlife*" (currently known as Alberta Environment and Parks [AEP]).

The approved Along Valley Corridor is south of, and immediately adjacent to, the abandoned golf course development in the Project Boundary. The golf course is not part of the approved Along Valley Corridor. The approved Tipple Across Valley Corridor is west of, and immediately adjacent to, the Project Boundary (Figure 2). The approved corridors incorporated 152 ha of TSMV lands, totalling approximately 40% of the original 2004 Resort Centre ASP area (Golder 2002).

Three Sisters Mountain Village lands designated as wildlife corridor are subject to the provisions of a conservation easement with the Province. The corridors are also subject to the regulations of the Wildlands Conservation District incorporated in the Town's Land Use Bylaw. Adjacent to the corridors, a 35 m conservation easement is held by the Town. The primary purpose of these buffer lands is to widen the effective width of the wildlife corridors and provide for transition lands between development and the wildlife corridor, while allowing for vegetation removal and thinning for wildfire protection.

Some development has occurred on the Resort Centre in accordance with the existing 2004 Resort Centre ASP. Approximately 15 of 18 holes of the Three Sisters Resort Golf Course were partially constructed. However, in February 2009, the property was placed into court-ordered receivership. PricewaterhouseCoopers Inc. was appointed the Receiver and Receiver Manager (the "Receiver"). Work on the Resort Centre was halted indefinitely. The incomplete golf course is the only existing development within the Resort Centre ASP lands.

In accordance with the Framework Agreement between the Receiver and the Town dated November 20, 2012, the Receiver offered new options for development in the Resort Centre as part of an early 2013 ASP proposal for TSMV lands. However, before the review of the 2013 ASP was completed, the Receiver withdrew the ASP application. The TSMV properties were subsequently put up for sale. In 2013, Three Sisters Mountain Village Properties Ltd. purchased the properties.

1.2 Resort Centre Amendment Objectives

QPD, on behalf of Three Sisters Mountain Village Properties Ltd., is seeking to amend the approved Resort Centre ASP to match current market conditions in the Town. Specifically, the Resort Centre Amendment focuses on changing the development concept for that portion of the Resort Centre that was identified as a golf course in the approved 2004 ASP. The general plans for the development of resort accommodation and commercial space in the Resort Centre lands north of the golf course are consistent with the previously approved ASP.

A study by the National Allied Golf Associations found that the number of rounds played on the average Canadian course has dropped 10 percent over the past five years (Sorensen 2014). Consequently, there has been a decline in the market viability of golf courses. Furthermore, the waning market for golf in Canmore is served by the Stewart Creek Golf and Country Club, Silvertip Golf Resort, and Canmore Golf and Curling Club in Canmore, and also by the nearby Kananaskis Country Golf Course, Banff Springs Golf Course, and Brewster's Kananaskis Ranch Golf Course. Therefore, the objective of the 2016 Project is to provide direction for a viable and sustainable development, including resort accommodation, recreation, and residential developments in area previously approved for a golf course.

The area of the Resort Centre for which an ASP amendment is being sought was altered by the partially constructed and then abandoned golf course, and this area consists primarily of greens, fairways, pathways, materials stockpiles, and anthropogenic water features (Figure 1). Those portions of the Resort Centre occurring north of the ASP amendment area depicted in Figure 1 will contain developments similar to those already approved in the 2004 Resort Centre ASP.

By updating the land use concept for the amendment area, the Project proposes to adjust the total number of units in the Resort Centre from a range of 1,339 to 2,525 units to a range of 1,600 to 3,000. Therefore, the amendment seeks the addition of up to 465 units and the ability to redistribute resort accommodation and residential units into areas currently approved for golf course development. Any additional units built as part of the Resort Centre Amendment will count towards the total number of units provided for TSMV in DC 1-98 and Section 3.9 of the Towns Land Use Bylaw 22-2010. The boundaries of wildlife corridors adjacent to the Resort Centre, which were approved by the Province in 2004, will remain unchanged.

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LEGEND

PROJECT BOUNDARY

RESORT CENTRE ASP AMENDMENT AREA

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-06
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

PROJECT BOUNDARY

PROJECT NO.	CONTROL	REV.	FIGURE
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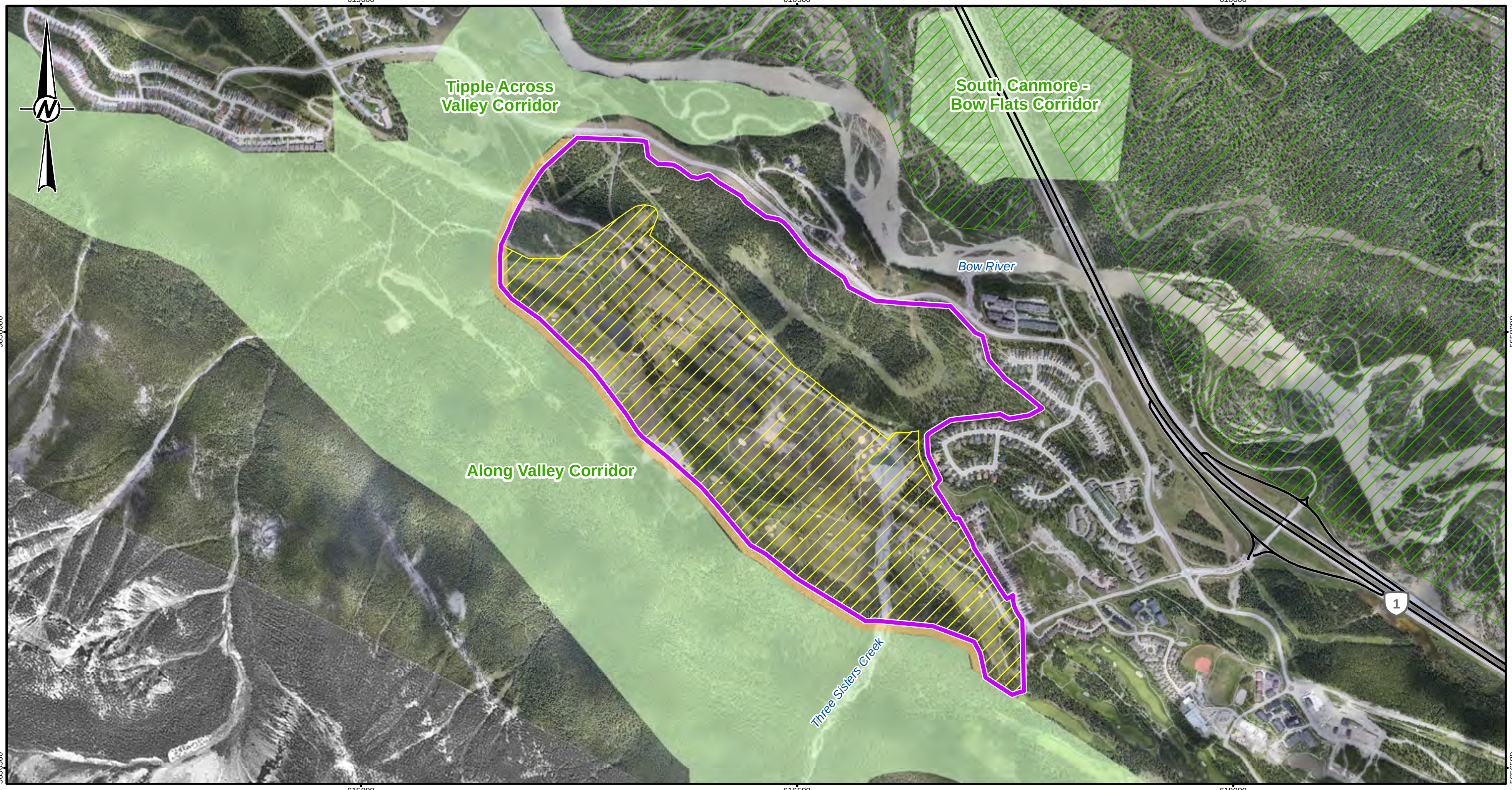

LEGEND

- PRIMARY HIGHWAY
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
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DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

TITLE

APPROVED WILDLIFE CORRIDORS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	2

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25mm

1.3 Purpose and Scope of the Resort Centre EIS

The Town approved an updated Municipal Development Plan (MDP) in 2016, which is the principal long-range planning document used by the Town to guide development. The associated EIS policy was also approved by Council in 2016. Based on these policies, a terms of reference (TOR) entitled *Environmental Impact Statement (EIS) for an Application to Amend the Resort Centre ASP in Three Sisters Mountain Village* was prepared by Town administration in November 2016 (Appendix A). Before issuing the TOR, the Town also sought input about the contents of the TOR from Fiera Biological Consulting Ltd. (Fiera), the firm hired to be the independent third party reviewer. This EIS was prepared to meet the requirements outlined in the TOR.

The purpose of this EIS is to provide sufficient information, as required in the TOR, to Council in order to make an informed decision on the application to amend the Resort Centre ASP. Specifically, the goal of the EIS is to identify the potential environmental impacts of the proposed developments and to identify mitigation that can be used to avoid or minimize negative impacts or build on positive impacts.

As defined in the Town's EIS policy, Golder's role is to evaluate the proposed Project by:

- outlining existing conditions;
- identifying significant natural and ecological features;
- determining the nature and scale of the potential impacts generated by the proposed project;
- providing recommendations for how best to avoid or mitigate those impacts;
- identifying residual impacts and their significance; and
- recommending further studies or monitoring, if necessary.

Because of the importance of environmentally sensitive areas (ESAs) in the Town's MDP, potential effects to ESAs are an important focus in this EIS.

Planning Context

As noted in the TOR, a component of planning context that affects the scope of the EIS is that the Project being evaluated is an amendment to an existing ASP for the Resort Centre that was approved by the Town in 2004. Although the EIS considers the entire Project comprehensively so that effects of the Resort Centre as a whole can be predicted and appropriate mitigation can be identified, this EIS recognizes that much of what is being proposed has already been approved and could be constructed (Section 1.1). Where appropriate, differences between approved and proposed developments are considered in this EIS, including differences between developing the approved ASP using approved mitigation and developing the ASP amendment using updated approaches to mitigate potential adverse environmental effects.

Another important component of the planning context that affects the scope of the EIS is that the detail for the development being proposed is provided at the ASP level only. The details about a proposed development included at the ASP stage are high-level policy statements that include development concepts within broad spatial boundaries, often associated with ranges of unit density and building type. Precise development footprints, including final unit numbers for each development area, road locations, trail locations, and the exact location of green space are typically undefined at the ASP stage.

Constraints associated with the level of development detail are recognized in the TOR, which states that: “The scope of the EIS will generally be limited to the level of detail provided within an Area Structure Plan” (Appendix A, page 4). These constraints are addressed in this EIS by making precautionary assumptions that overestimate potential effects. For example, to address uncertainty about the Project footprint size or location, the potential Project Boundary was overestimated and any pods that were zoned for development were considered completely developed, even though the proposed ASP policy may require larger amounts of undeveloped space within a policy area. Overestimation of the Project Boundary and potential impacts of the Project at the ASP stage permits flexibility at the land use and subdivision stages, where decisions by developers or the Town within the assessed Project Boundary can reduce predicted effects, but will not increase them.

As required in the TOR, this EIS also addresses constraints associated with the level of development detail by identifying issues for which further detailed work is required or anticipated at later planning stages. For instance, follow up at the land use and/or subdivision stage may be required to confirm that the more detailed design submitted to the Town for approval appropriately integrates mitigation identified in this EIS.

Valued Environmental Components

As directed by the TOR, the EIS identifies potential impacts caused by the amendment to the Resort Centre ASP and identifies mitigation for the following valued environmental components (VECs):

- wildlife;
- vegetation;
- fish;
- soils and terrain;
- surface and groundwater;
- air;
- visual resources; and
- historical resources.

For each VEC, the EIS:

- describes existing conditions, including important natural and ecological features;
- identifies potential environmental risks associated with the Project during both construction (i.e., building the development) and operations (i.e., functioning communities present) and defines these according to impact criteria;
- presents mitigation strategies to address identified risks;
- describes residual effects of the Project on valued components of the environment after mitigation has been applied;
- identifies uncertainty and, where appropriate, monitoring programs to address uncertainty; and
- analyzes the contribution of the Project to cumulative impacts.

Although all of the VECs listed above are considered in the EIS, the amount of detail applied to the assessment of each varied. An independent third party review conducted by Management and Solutions in Environmental Science (MSES) in 2013 identified wildlife habitat loss, potential changes in wildlife movement, and negative human-wildlife interactions as the primary issues to be addressed by environmental assessments for development projects in the South Canmore region. The language in the TOR developed for this EIS also focuses on wildlife (Appendix A). A focus on wildlife is consistent with the Town's EIS policy, which states that the "EIS is intended to have a scope limited to those issues relevant to the proposal" (Town of Canmore 2016, pg. 2). This EIS therefore provides substantially more detail and analysis for wildlife than for other VECs.

Alternatives and Modifications to Limit or Remove Impacts

The TOR requires that alternatives and modifications to the proposal to limit or remove impacts are analysed and incorporated into the EIS. This EIS incorporated alternatives and modifications in two ways.

1) An iterative process was undertaken between Golder and QPD during Project design to limit or remove potential impacts. Different abstract concepts for development and mitigation were presented by QPD and Golder made recommendations for options that would minimize impacts to wildlife. Recommended modifications were based on similar modifications that were identified during meetings between Golder, the Town, other stakeholders and QPD concerning development options for TSMV, and included modelling to predict potential effects of different conceptual scenarios. Details of how alternatives and modifications were evaluated and incorporated into the ASP design are presented in Section 2.

2) Because of the constraints associated with the level of development detail presented in an ASP, such as lack of precise development footprint locations, additional mitigation was presented to address this uncertainty in the mitigation strategies section for each VEC. Additional mitigation includes modifications to limit or remove impacts that should be undertaken at later planning stages, such as avoiding ESAs at the subdivision planning stage, or complying with the Federal *Fisheries Act* when undertaking construction near creeks.

As noted in the Town's EIS policy, mitigation identified in the EIS to address potential effects that cannot be fully defined at the ASP stage because development detail is at the conceptual level, "shall be incorporated as conditions of approval for subdivisions and development permits" (Town of Canmore 2016, Page 4). If more analysis is required to precisely define mitigation at a later stage, this was identified in the EIS.

Wildlife Corridors

The TOR states that "the scope of the EIS will not include the functionality of the wildlife corridors as this is under the authority of the Province under the direction of the NRCB Decision" (Appendix A, page 4). Similarly Section 4.2.5 of the Town's MDP states that "pursuant to the 1992 NRCB decision, wildlife corridor identification for Three Sisters lands is under the exclusive jurisdiction of the Province". Consequently, any discussion of the effect of the physical characteristics of wildlife corridors already approved by the Province on their function, such as width, length, elevation, slope, or whether the alignment of regional networks of wildlife corridors have been appropriately selected and will function to maintain movement, are outside the scope of this EIS. In other words, analyses of whether or not additional lands may be required to improve function of approved wildlife corridors or whether wildlife corridors should be placed elsewhere was outside the scope of this EIS. For this reason, connectivity analyses using approaches such as least cost paths (Chetkiewicz and Boyce 2009) or circuit theory (Koen et al. 2014), which are designed to identify optimal movement routes or linkages with high functional connectivity for wildlife, were not applied to this assessment.

However, both the TOR and the MDP point to the importance of wildlife corridors as a municipal planning issue, and wildlife corridors are defined as ESAs in the Town's MDP. The TOR indicates that "the environmental review will need to consider development proposed adjacent to wildlife corridors and habitat patches" (Appendix A, Page 4). Therefore, the potential for the Project to change how wildlife use habitats inside the boundaries of the corridors approved by the Province is part of the scope of the EIS, and appropriate mitigation for these potential changes should be identified. Changes to wildlife use of the approved corridors considered in this EIS include changes caused by sensory disturbance such as light and noise, adjacent habitat alteration, and changes in human use in the corridor. The EIS considers these potential adverse changes and identifies mitigation that can address them.

Scientific Approach and Information Sources

Large and complex developments, such as those anticipated for the Project, require substantial study to support an assessment of environmental effects. The TOR indicates that a science-based analysis of impacts should be completed based on these studies and also acknowledges that extensive studies have already been undertaken with respect to TSMV lands to support such an assessment.

In the case of development on TSMV lands and surrounding areas, substantial effort has already been undertaken to define existing conditions and understand important natural and ecological features. These studies go back to the 1980s when applications for development were first being prepared for the NRCB.

Most recently, Golder (2013) prepared a detailed EIS for the proposed 2013 ASP submitted and subsequently withdrawn by PricewaterhouseCoopers Inc. MSES provided a third party review of Golder's 2013 EIS for the Town. As part of that review, MSES (2013, p. 5) made the following conclusions about the data used in that EIS:

- "The EIS is based on the best compilation of available data regarding corridor functionality around the TSMV lands produced to date."
- "We concur that Golder has access to the best available raw data."

The TOR states that these "accumulated data, along with recent scientific thought will form the basis of the EIS" (Appendix A, p 2). The only data collection required for this EIS was a reconnaissance survey to ground truth existing information (Appendix A, p 2). Consequently, this EIS relied on existing data and models, updating them where necessary in alignment with the results of the reconnaissance survey, new science, or other relevant information. Where appropriate, this EIS integrated information directly from Golder's 2013 EIS.

The science-based approach used in this EIS was to draw conclusions about the potential effects of the Project based on evidence in the form of available data, models, and scientific literature. This evidence was considered together to predict the most likely outcomes of implementing the Project and associated mitigation. Conclusions were drawn based on a logical evaluation of the available evidence, similar to the approach normally undertaken in a scientific review article. Conclusions drawn from site-specific and context-specific data and associated models were prioritized when predicting effects.

The intended audience for this EIS is broad, including Town Administration, Town Council, members of the public, scientific subject matter experts, and environmental assessment practitioners conducting external third party review. This EIS has been prepared to accommodate this diversity. Technical concepts and approaches were presented and discussed and uncertainties associated with those concepts were identified, but detailed technical discussions were frequently excluded. Documents containing technical details were referenced for interested readers.

As with any scientific process, disclosure of uncertainty is paramount. This EIS identifies uncertainty in individual sections for each valued environmental component, according to good environmental assessment practice (Lees et al. 2016).

Third Party Review

The Town hired an independent third party reviewer for this EIS pursuant to the requirements of the Town's EIS Policy. As outlined on page 4 of the Town's EIS policy, one of the roles of a third party reviewer is to "identify and make recommendations on how to reduce, mitigate, or avoid impacts of the proposal including raising concerns if the negative impacts cannot be satisfactorily reduced, mitigated or avoided". The third party reviewer assisted the Town in preparing the TOR for this EIS and reviewed and provided additional recommendations into the components informing this EIS, including:

- the data and literature used;
- the evaluation criteria used to assess the Project;
- the evaluation of impacts included in the EIS, such as cumulative impacts and alternative development options;
- the proposed mitigation strategies; and
- monitoring or further study requirements.

1.4 Stakeholder Engagement

Stakeholder engagement for the Project was led by QPD. This engagement built on issues being discussed as part of engagement for the Smith Creek ASP project, recognizing that certain issues differ between the two projects. In addition to five meetings with the Resort Centre community advisors, QPD also held eight "community conversations" with a variety of stakeholders. These stakeholders included Hubman Landing residents, representatives from local environmental groups, recreational enthusiasts, and community services representatives. The purpose of the meetings was to share information and obtain feedback on the ASP concepts and mitigation proposed in the EIS.

QPD hosted two online community conversations. The first online community conversation was held on September 14, 2016 and focused on wildlife mitigation. The second online community conversation was held on October 5, 2016 and focused on undermining. The online community conversation webcasts were open to the general public and allowed community members to ask QPD and technical experts questions using instant messaging. The videos of the sessions and question and answer documents summarizing responses to all of the questions that were asked during the webcast were posted to the 2016 Project website (http://www.resortcentrecanmore.ca).

Furthermore, on October 18, 2016, QPD hosted two community-wide information sessions to share information about the Project and answer questions about the proposed land use concept, recreation, transportation, servicing, and wildlife mitigation strategy.

Wildlife Fencing

Wildlife fencing was one of several key mitigations identified by Golder during initial discussions with QPD and the Town about alternatives and modifications to the Project to limit or remove impacts. Fencing was also discussed in community conversations and stakeholder specific conversations led by QPD to address concerns about negative human-wildlife interactions, in developed areas and in wildlife corridors. Stakeholder engagement regarding wildlife fencing was substantial. The reasons for including wildlife fencing as a mitigation and the engagement undertaken to address it is therefore summarized here.

Negative human wildlife interactions represent interactions between people and wildlife that span a continuum ranging from mild interactions (e.g., observing wildlife in a place where they are not welcome) to severe interactions (e.g., an attack on a person or a pet). From the perspective of wildlife populations, the problem with negative human wildlife interactions at any point in the continuum arises when wildlife managers need to apply aversive conditioning or remove wildlife to protect people. Wildlife fencing can be a part of the solution to this problem.

Wildlife fencing strategies are not new; for example, the approved 2004 Resort Centre ASP and approved Stewart Creek ASP recommended forms of fencing, or review of fencing, as potentially effective mitigation to mitigate effects on wildlife use of corridors. Parks Canada Agency has long recognized the need to separate wildlife and people in the mountain parks and has used a variety of fencing types to provide necessary separation. Examples include the Sulphur Mountain wildlife corridor fence, Trans-Canada Highway fencing, permanent and temporary electric fencing at the Lake Louise campground and the lodges at the Lake Louise Ski Hill. A variety of forms of fencing were considered as possible solutions, including different types of fencing and partial fencing; these are discussed in Section 5.5.4.

Ultimately, a 2.5 m high page wire fence with a buried apron similar to those found on the Trans-Canada Highway was identified as part of the solution to mitigate the likely effects of the Project on wildlife. Although fencing in the form proposed in this EIS has not previously been applied to residential developments in the Bow Valley, it is commonly used to reduce wildlife mortality on highways, and has been applied to residential developments elsewhere. For example, in Jackson, Wyoming, wildlife fencing and supplemental feeding are used as mitigation to reduce human wildlife conflict associated with bison and elk.

Given the importance of wildlife fencing as a mitigation strategy to address human-wildlife conflict and concerns raised by some Canmore residents as part of previous ASP processes, specific engagement with external wildlife managers was sought regarding wildlife fencing. The Town convened a meeting of wildlife managers from Banff National Park and the Province in April 2016 to discuss the efficacy of wildlife fencing as a mitigation strategy for the Smith Creek ASP. Attendees were:

- David Gummer and Eric Knight from Parks Canada;
- Jay Honeyman from AB Fish & Wildlife;
- Brett Boukall from AEP;
- Tracy Woitenko, Alaric Fish, Lisa Guest, and Lori Rissling-Wynn from the Town;
- Martin Jalkotzy and Cornel Yarmoloy from Golder; and
- Jessica Karpat, Kent MacDougall, and Jenn Giesbrecht from QPD.

The focus of the meeting was to discuss negative human-wildlife interactions in the Bow Valley, determine whether wildlife fencing is a viable mitigation option for future development at TSMV, and, if so, to discuss potential challenges and configuration options. Fence construction, fence ends, swing gates, jump-outs, and electromats were discussed.

Permeable fencing was not considered effective due to the high level of enforcement that is required to manage human crossing and because permeable fencing does not prevent wildlife from accessing developed areas. On the other hand, wildlife exclusion fence similar to the fencing used on the Trans-Canada Highway was identified as a potentially effective mitigation tool if the fence fully enclosed development.

As an outcome of the meeting, QPD and the Town are working to develop an understanding of the issues, strategies, and obligations that will need to be implemented to ensure the long-term success of wildlife fencing for the Project, including phasing of long-term developments.

Information regarding fencing was presented as part of the community conversations to address some of the long standing concerns within the community about wildlife fencing. The latest design features and suggestions on conceptual alignment recommended by some attendees have been incorporated into this EIS.

1.5 Document Structure

Following these introductory materials, this EIS is structured as follows:

- Section 2 provides an evaluation of conceptual design alternatives and lists design recommendations provided by Golder to QPD to limit impacts on VECs.
- Section 3 presents the details of the Project that is being proposed by QPD.
- Section 4 outlines the assessment methods.
- Section 5 presents the impact statement for wildlife.
- Section 6 presents the impact statements for all other VECs.
- Section 7 summarizes impacts and presents overall conclusions.
- Section 8 provides closure and a signature page.
- Section 9 lists the information referred to during the development of this EIS.

2.0 ALTERNATIVES AND MODIFICATIONS

2.1 Approach

Alternatives and modifications to the conceptual design for the Project were presented to QPD prior to finalizing the proposed Project design described in Section 3. The alternatives analysis and consultation about alternatives was led by QPD and considered a wide range of factors including environmental, social, legal, and economic. Golder provided input into the environmental component of the alternatives considered by QPD and this section describes that input. Input was iterative, and Golder provided feedback on various conceptual options by making recommendations that would help reduce the potential impact of the Project on VECs.

A fundamental consideration of the alternatives analysis was that the NRCB had already approved development of TSMV lands in 1992. Separately, through the Settlement Agreement and the Town's master zoning bylaw DC 1-98 within Land Use Bylaw 22-2010, the Town has provided for a total of 5,457 residential, resort accommodation and timeshare units and up to 306 ha of developable area across TSMV lands. Currently, there are 4,104 units and 206.86 ha that remain to be developed in TSMV. The question being evaluated when considering alternatives and modifications is how the approved units and development areas would be conceptualized and distributed as part of the Project, not whether the total number of units, gross developable area, or number of people added to Canmore would change as a result of different development options for TSMV.

Like other aspects of this EIS, exploring alternatives and modifications focused on wildlife, especially on identifying design principles that could reduce negative wildlife-human interactions and minimize sensory disturbance in approved wildlife corridors. Alternative designs to avoid or minimize potential impacts to other VECs or ESAs, such as wetlands, were also identified.

This section focuses on describing the potential outcomes of some conceptual alternative scenarios for the distribution of unit densities and development areas. These concepts were developed and analyzed by Golder and then presented to QPD. The purpose of the conceptual scenarios was to help QPD to understand the implications of different design alternatives for wildlife as they developed their proposal. Additional mitigation was recommended based on Golder's assessment of the final design proposed by QPD, and this mitigation is presented in sections addressing each VEC (Sections 5 and 6).

Available information about how wildlife respond to existing developments and mitigation in the Bow Valley, along with available scientific literature, formed the basis of the alternatives analysis. The information used to inform this analysis is the same as was used to inform the impact assessment for wildlife presented in Section 5 and Appendix B. General concepts are summarised here, and readers interested in more detail about the literature and data supporting these concepts will find it in Section 5 and Appendix B.

2.2 Analysis

The Project proposes to add resort accommodation, residential development, and recreational amenities to the area designated as a golf course in the approved 2004 ASP. The amount, density, and spatial arrangement of the proposed development has the potential to affect wildlife use in the adjacent Along Valley Wildlife Corridor (Figure 2). Human use within wildlife corridors also has the potential to affect wildlife use of the corridor, but the amount of human use in the corridor is expected to be driven more by the number of people in the development, and less as a function of different development footprint designs. Because the number of people associated with new development within TSMV is a function of the number of units granted under DC 1-98 [5], the analysis did not evaluate the potential effects of variation in the number of people associated with the development on wildlife corridors or the amount of negative human-wildlife interactions, but instead evaluated the spatial configuration and density of different conceptual development footprint options.

Because no development will occur in the approved wildlife corridors adjacent to the Project Boundary, sensory disturbance is the mechanism by which variation in the Project Boundary could alter wildlife habitat selection within the approved wildlife corridors. The degree to which sensory disturbance from development might change the probability of wildlife selection within the approved wildlife corridors is a function of many variables including:

- amount of sensory disturbance entering the corridor, that is, how noisy, how much light, how many strong smells;
- how far the nearest human structures are from the edge of the corridor;
- species of wildlife, because different species react to human developments to varying degrees; and
- the degree of habituation that individuals of a species exhibit as a result of prior experience.

A number of different mitigation measures can be used to reduce sensory disturbance, including changing development footprint design and reducing development density. However, one of the challenges of looking for ways to reduce sensory disturbance is that these approaches can increase the risk of negative wildlife-human interactions. For example, both Golder (2002) and BCEAG (2012) recommended that development areas adjacent to corridors should include as much open space as possible. That is, golf courses and recreation areas are preferred over acreage lots, which in turn are preferred over high-density housing. The intention of this "soft edge" approach was to increase the effective width of the adjacent wildlife corridor by reducing the effects of sensory disturbance on wildlife travelling within corridors, thereby increasing the probability that the corridor would be used. This approach was based on the assumption that wildlife would strongly avoid all forms of human development and that human development would exert a large zone of influence that adversely affects probability of selection; assumptions that have since proven false for species like cougars, grizzly bears, and elk (Appendix B). An unintended side-effect of applying soft edges is increased negative interactions between humans and wildlife that select areas near or within developed parts of Canmore. Negative human-wildlife interactions have increased substantially in and immediately adjacent to residential developments in Canmore during the last decade (Town of Canmore 2015).

The analysis undertaken in this section uses three different conceptual development scenarios for the abandoned golf course to investigate trade-offs between sensory disturbance and negative human-wildlife interactions adjacent to the Along Valley Corridor. Three conceptual scenarios are presented in Figure 3, and were developed as follows:

- **Scenario 1** – Full buildout of the Project Boundary with no restrictions on the locations of development, and assuming high density developments similar to downtown Canmore.

[5] Approval of the Resort Centre ASP amendment is required to build up to 3,000 units. The 2004 Resort Centre ASP approved 2,525 units. If unit density applied to the Resort Centre ASP amendment declines, unit density in the Smith Creek ASP would increase, up to the total unit density provided by DC 1-98.

- **Scenario 2** – Graduated buildout within the Project Boundary with high density developments closer to Town, low density development on the northern part of the abandoned golf course, and open space or recreational zones on the land immediately adjacent to the Along Valley Corridor boundary.
- **Scenario 3** – High density development in the northern part of the Project Boundary, and low density development (i.e., 2 to 8 units per acre) occurring only within four pods located on the abandoned golf course and otherwise maintaining recreational zones on the abandoned golf course lands.

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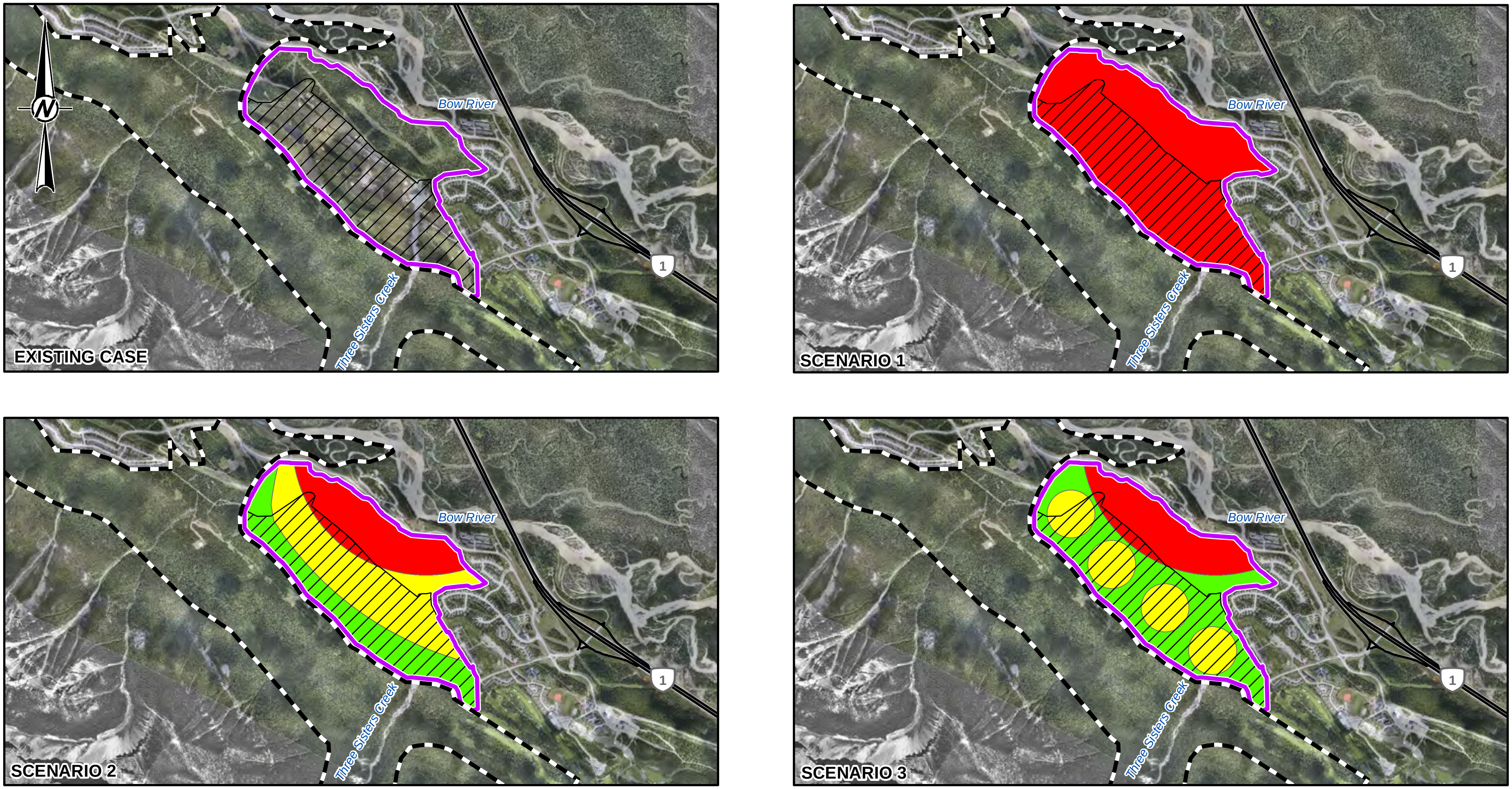

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROJECT FOOTPRINT DENSITY

- HIGH
- LOW
- NONE

0 1,000 2,000

1:45,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
CONCEPTUAL DEVELOPMENT ALTERNATIVES

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	3

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Trade-offs between sensory disturbance in the wildlife corridor (i.e., reduced probability of selection) and negative human-wildlife interactions (i.e., whether or not developed areas are selected) for the different scenarios were then evaluated for grizzly bears and wolves using resource selection function (RSF) models derived from empirical data collected in the Bow Valley (Section 5.1.3, Appendix B). Grizzly bears are a species of concern in terms of both movement and negative human wildlife interactions in the Bow Valley (Section 5.2.3). Wolves are a species for which sensory disturbance from human development creates a strong zone of influence (Appendix B).

The RSF models provide a spatially explicit quantification of the responses of grizzly bears and wolves inhabiting the Bow Valley to a number of environmental variables including human development (Appendix B). Because the zones of influence estimated from the RSF models were derived from responses exhibited by animals collared in the Bow Valley, they will more accurately represent site-specific responses to residential developments than literature values obtained from places with less development (Knopff et al. 2014). Integrating the conceptual development scenarios into the models results in a quantitative prediction of how grizzly bears and wolves will respond to different scenarios. This permits a quantitative evaluation of the change in the probability of grizzly bear and wolf selection in the Project Boundary and adjacent Along Valley Corridor as a result of each conceptual development scenario.

2.2.1 Grizzly Bears

Results of the scenario analysis for grizzly bears are summarized as changes in habitat selection classes both within the Resort Centre ASP boundary (Table 1, Figure 4) and within the adjacent Along Valley Corridor (Table 2, Figure 4).

Under existing conditions, the vast majority of the Resort Centre ASP is predicted to be selected or used as available by grizzly bears during summer (Table 1, Figure 4). Similarly, the adjacent Along Valley Corridor consists primarily of land that is either selected or used as available with 4% of the corridor consisting of habitat that is strongly avoided or rarely used (Table 2). Under existing conditions, negative bear-human interactions occur throughout the Resort Centre ASP as well as in some parts of the adjacent Along Valley Corridor. Based on AEP data, negative bear human interactions are currently rated as high in the Resort Centre ASP boundary (Section 5.2.3).

None of the three scenarios result in substantial changes in the probability of habitat selection in the approved Along Valley or Tipple Across Valley Corridors adjacent to the Resort Centre (Table 2, Figure 4). This reflects the adaptability of grizzly bears in the Bow Valley, which commonly select habitat immediately adjacent to development, including high density developments (Appendix B). In other words, the zone of influence is small because grizzly bears in the Bow Valley are habituated to anthropogenic disturbance (Donelon 2004). Although the type of development within the Resort Centre Project Boundary makes little difference in the likelihood that grizzly bears will use the corridor, the different scenarios have very different implications for human-bear conflict.

Scenario 1, which assumes full buildout of the Resort Centre Project Boundary with no restrictions on the locations of development, and high density developments throughout, results in the majority of the Resort Centre ASP classified as habitat that is avoided or rarely used by grizzly bears during summer (Table 1). Negative bear-human interactions are expected along the full length of the development adjacent to the Along Valley Corridor, a distance of over 2 km, but are unlikely within the development area because bears strongly avoid or would rarely use most of it (Table 1, Figure 4).

Table 1: Change in habitat classes for grizzly bears in the Project Boundary as a result of different conceptual development scenarios

Habitat Class	Existing Conditions ha	Scenario 1 ha (change [(a)])	Scenario 2 ha (change [(a)])	Scenario 3 ha (change [(a)])
Selected	115	<1 (-114)	41 (-73)	45 (-69)
Used as available	48	3 (-45)	12 (-35)	27 (-21)
Somewhat avoided	<1	11 (11)	22 (22)	28 (27)
Strongly avoided	0	53 (53)	56 (56)	43 (42)
Rarely used	0	95 (95)	30 (30)	20 (20)

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] change calculated by subtracting the existing conditions value from the scenario value.

Table 2: Change in habitat classes for grizzly bears in approved wildlife corridors adjacent to the Project as a result of different conceptual development scenarios

Habitat Class	Existing Conditions ha	Scenario 1 ha (change [(a)])	Scenario 2 ha (change [(a)])	Scenario 3 ha (change [(a)])
Selected	151	147 (-7)	151 (-2)	151 (-3)
Used as available	142	142 (<1)	143 (-1)	142 (-1)
Somewhat avoided	68	70.0 (6)	67 (3)	68 (4)
Strongly avoided	14	15 (1)	14 (<1)	14 (<1)
Rarely used	1	1 (0)	1 (<1)	1 (<1)

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] change calculated by subtracting the existing conditions value from the scenario value.

Scenario 2, which assumes graduated buildout within the Project Boundary (Figure 3), results in more selected habitat for grizzly bears within the Project Boundary than Scenario 1 (Table 1, Figure 4). As a result of the reduced development density on the south side of the Resort Centre ASP and the land dedicated to open space or private recreation immediately adjacent to the Along Valley Corridor, a strip of land approximately 100 to 150 m wide adjacent to the corridor remains selected or used as available habitat for grizzly bears in summer (Figure 4). This represents an increase in the probability of negative bear human interactions relative to Scenario 1.

The extent of negative wildlife human interactions under Scenario 2, without additional mitigation, would likely be similar to that currently being experienced in the adjacent Peaks of Grassi subdivision located in the upper right-hand side of Figure 4. The Peaks of Grassi currently has a very high rating for negative human bear interaction by AEP.

Scenario 2 has similar outcomes to those that would be expected from development of the approved 2004 Resort Centre ASP. Golder (2002) indicated that the golf course associated with the approved 2004 ASP would increase the effective width of the wildlife corridor. As indicated in the modeling results, open space could increase functional width for grizzly bear movement (Figure 4; Scenario 2), although bears are so commonly removed from golf courses in the Bow Valley that the golf courses may not have increased effective width (Appendix B). Although the golf course may increase opportunities for movement, the expected human-bear conflict levels associated with developing the 2004 Resort Centre ASP been as approved would be similar to those currently recorded for the

Stewart Creek Golf Course and surrounding development. Currently, human-bear conflict rankings provided by AEP for Stewart Creek Golf Course and adjacent Three Sisters Creek neighborhood are very high (Section 5.2.3). Therefore, the result of the modeling and observations of conditions at developments similar to those proposed for the 2004 Resort Centre ASP indicates that the benefits of open space or golf courses adjacent to corridors are small for grizzly bears in terms of use of designated wildlife corridors and movement, but the costs are large in terms of negative human-bear interactions.

Scenario 3, which assumes high density development in the northern part of the Resort Centre ASP, and low density development (i.e., 2 to 8 units per acre) only within four pods located on the abandoned golf course, further increases the area selected or used as available by grizzly bears in the Project Boundary relative to Scenarios 1 or 2 (Table 1). In particular, the undeveloped space between the low density development pods will be strongly selected by bears, and the portion of the development pod located furthest west beside the Along Valley Corridor will not be avoided by bears (Figure 4).

Development consistent with Scenario 3 would result in negative bear-human interactions along the full length of the interface between the development pods and grizzly bear habitat, an interface that is more than 4 km long. Negative interactions are predicted to be highest in the most westerly pod that is bordered by wildlife corridor on two sides (Figure 4).

Negative human-bear interactions under Scenario 3 are even higher than under Scenario 2 because of the increased probability of grizzly bear selection within and adjacent to development. The extent of negative wildlife human interactions in this scenario is predicted to be greater than the very high rates currently identified in the adjacent Peaks of Grassi subdivision because of the larger size of the Resort Centre development and the increase in the amount of interface between habitat used by bears and human development. Selected habitat between the development pods will draw bears into habitat where the probability of negative bear human interactions will be very high.

In summary, the effects of the three development scenarios changed the predicted extent of selected and used as available habitat for grizzly bears within the Resort Centre ASP, but the development scenarios did not change habitat selection patterns in the adjacent Along Valley Corridor. Scenarios with low density development (i.e., 2 and 3) resulted in patterns of habitat selection within the Resort Centre ASP that increased the likelihood of negative human bear interactions. Scenarios 2 and 3 have outcomes that are also similar to the likely outcomes if the 2004 Resort Centre ASP is built out as currently approved.

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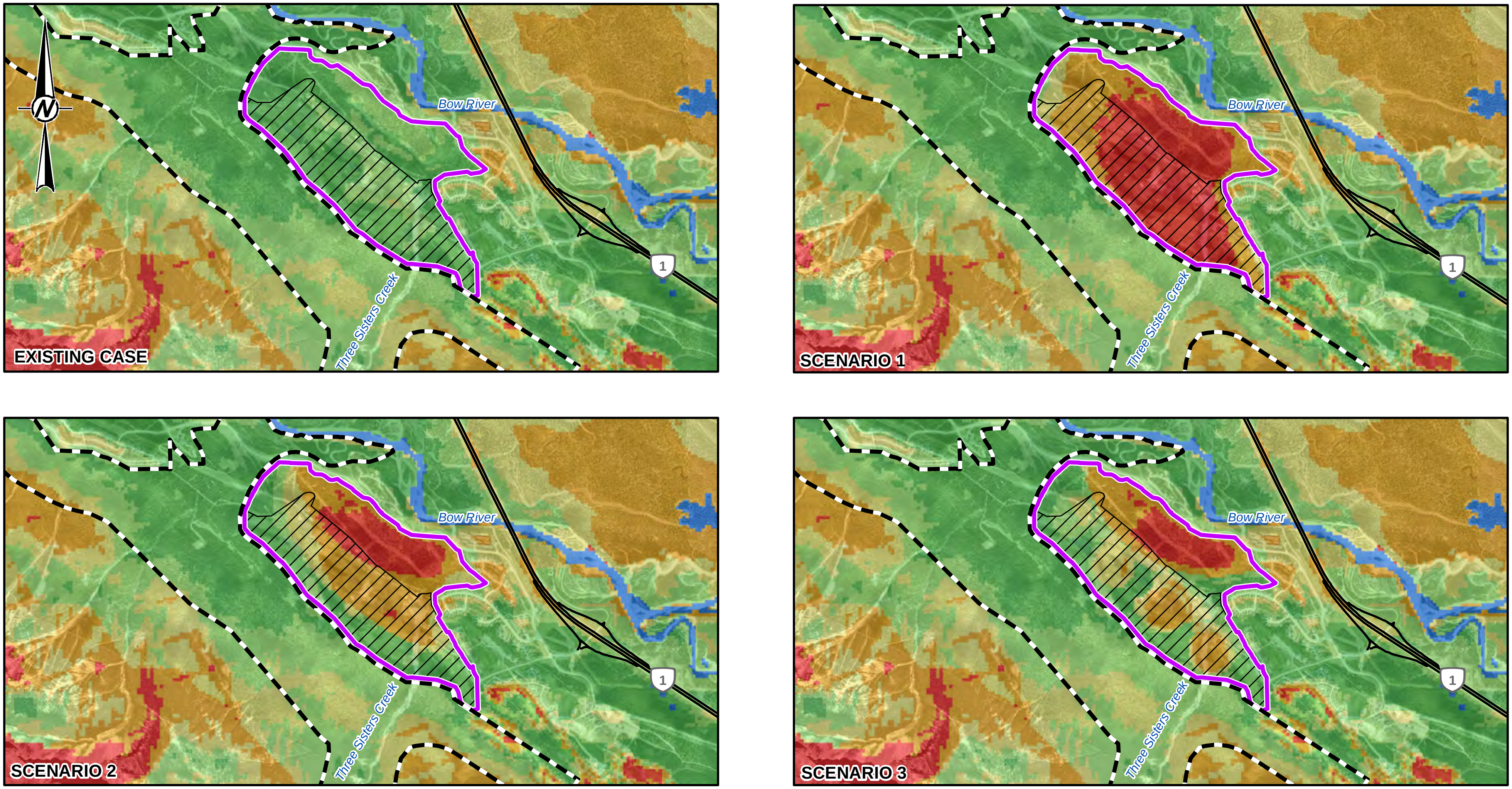

LEGEND

PRIMARY HIGHWAY
APPROVED WILDLIFE CORRIDOR
PROJECT BOUNDARY
RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

SELECTED
USED AS AVAILABLE
SOMEWHAT AVOIDED
STRONGLY AVOIDED
RARELY USED
WATERBODY

0 1,000 2,000
1:45,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
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PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
SUMMER GRIZZLY BEAR RESOURCE SELECTION UNDER DIFFERENT DEVELOPMENT SCENARIOS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	4

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2.2.2 Wolves

Results of the scenario analysis for wolves were quantified as changes to habitat selection both within the Project Boundary (Table 3, Figure 5) and within the adjacent Along Valley Corridor (Table 4, Figure 5).

Wolf habitat on the south side of the Bow Valley generally has a lower probability of selection during winter when compared to habitat on south facing slopes at moderate elevations on the north side of the Bow Valley (e.g., Benchlands; Appendix B). In this context, under existing conditions, wolf habitat in the entire Resort Centre ASP (123 ha of 163 ha) as well as the adjoining Along Valley Corridor (261 ha of 377 ha) is primarily comprised of habitats avoided by wolves during winter (Tables 3 and 4, Figure 5).

Scenario 1, which assumes full buildout of the Resort Centre ASP with no restrictions on the locations of development, and high density developments throughout, results in all of the Resort Centre ASP classified as habitat that is strongly avoided by wolves in the winter (163 ha). At full build out, the zone of influence extends south from the development into the adjacent Along Valley Corridor and west into the Tipple Across Valley Corridor, with the result that strongly avoided wolf habitat in the adjacent wildlife corridors increases substantially (Table 4; Figure 5). Habitat that is strongly avoided occurs in a band approximately 75 m to 100 m wide along the length of the interface between ASP and the corridor. This reflects the avoidance Bow Valley wolves exhibit to high density development (Appendix B).

Scenarios 2 and 3 which assume graduated buildout of the Project Boundary with high density developments closer to existing developments in Canmore, and two scenarios of low density development on the abandoned golf course adjacent to the Along Valley Corridor, result in very similar predicted patterns of selection by wolves. In both cases, and similar to Scenario 1, the Resort Centre ASP shifts to habitat that is strongly avoided by wolves in winter (Table 3). However, by reducing development intensity adjacent to wildlife corridors in both scenarios, conditions within the approved Along Valley and Tipple Across Valley Corridors are improved relative to Scenario 1 (Table 4, Figure 5). Scenario 2 is most similar to the likely outcome of development if the 2004 Resort Centre ASP had been built as planned. Contrary to the prediction of Golder (2002), the golf course associated with the 2004 Resort Centre ASP would have done little to improve the effective width of the wildlife corridor for wolves, and this effect would be compounded by adding a golf course instead of open space, because wolves avoid golf courses (Appendix B).

In summary, the three development scenarios differed little in their effects on predicted wolf use within the Resort Centre ASP; the entire area becomes uniformly avoided. Although Scenario 1 had a relatively strong negative impact on corridor selection by wolves as a result of high density development immediately abutting the corridor, Scenarios 2 and 3 resulted in patterns of selection within the corridor that were similar to existing conditions.

Table 3: Change in habitat classes for wolves in the Project Boundary as a result of different conceptual development scenarios

Habitat Class	Existing Conditions ha	Scenario 1 ha (change [a])	Scenario 2 ha (change [a])	Scenario 3 ha (change [a])
Selected	0	0 (0)	0 (0)	0 (0)
Used as available	41	0 (-41)	<1 (-41)	0 (-41)
Somewhat avoided	111	0 (-111)	18 (-94)	10 (-102)
Strongly avoided	12	163 (152)	145 (134)	154 (142)
Rarely used	0	0 (0)	0 (0)	0 (0)

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

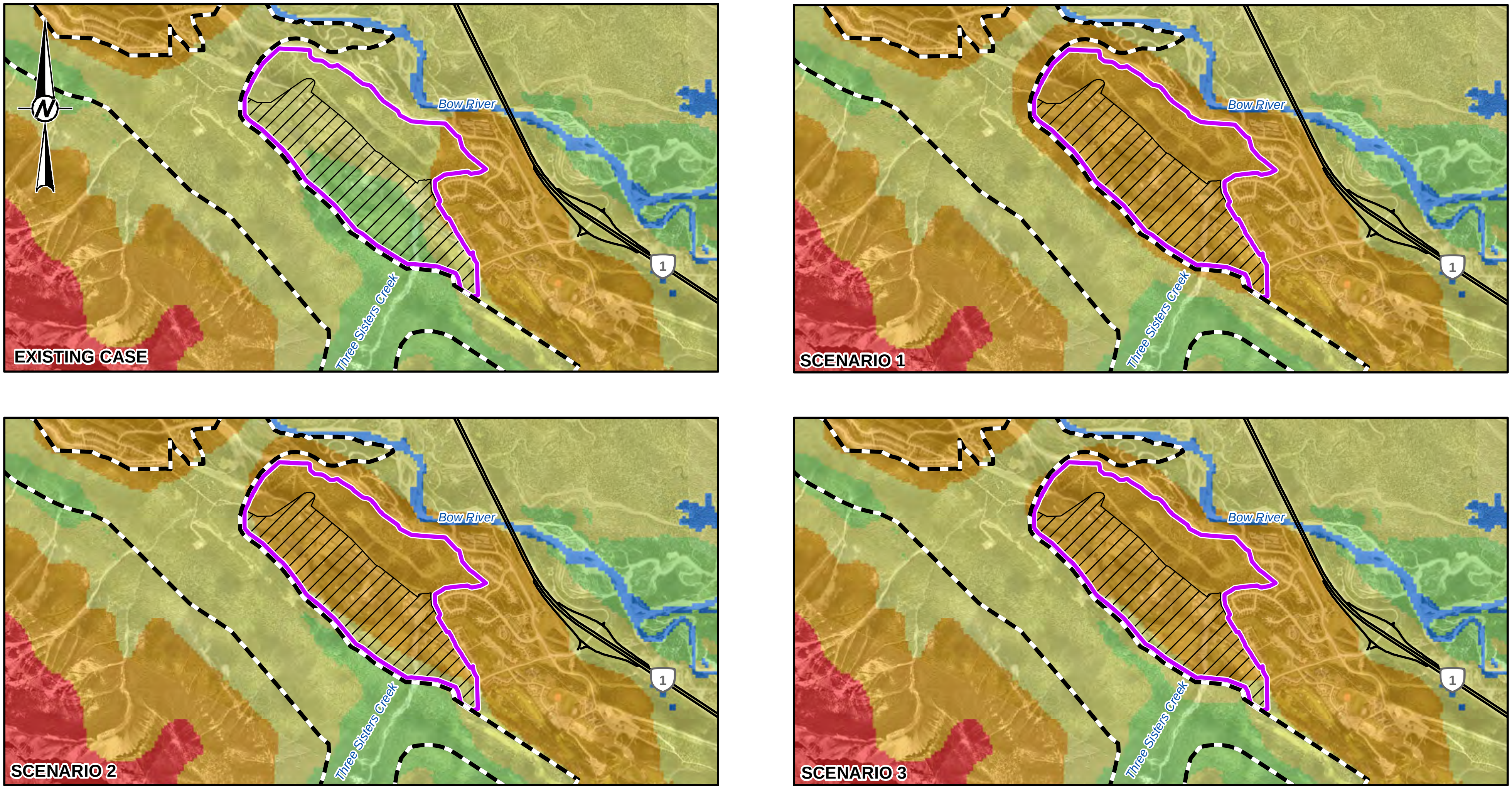
[a] change calculated by subtracting the existing conditions value from the scenario value

Table 4: Change in habitat classes for wolves in approved wildlife corridors adjacent to the Project as a result of different conceptual development scenarios

Habitat Class	Existing Conditions ha	Scenario 1 ha (change [(a)])	Scenario 2 ha (change [(a)])	Scenario 3 ha (change [(a)])
Selected	8	8 (0)	8 (0)	8 (0)
Used as available	107	77 (-30)	104 (-3)	92 (-15)
Somewhat avoided	233	223 (-10)	226 (-7)	242 (9)
Strongly avoided	28	68 (40)	37 (10)	34 (6)
Rarely used	0	0 (0)	0 (0)	0 (0)

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] change calculated by subtracting the existing conditions value from the scenario value.



LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 1,000 2,000

1:45,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

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CONSULTANT
Golder Associates

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PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
WINTER WOLF RESOURCE SELECTION UNDER DIFFERENT DEVELOPMENT SCENARIOS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	5

2.3 Recommendations

Based on the concepts presented in Section 2.2 and using information about ESAs provided in the existing conditions section for vegetation (Section 6.1.1.1), Golder provided QPD with recommendations for development footprint designs that would minimize effects on the environment, especially for wildlife. The relative importance of these recommendations for determining the likely conclusions of the EIS was discussed with QPD, so that they could consider these potential outcomes along with other factors affecting development, such as physical constraints (e.g., undermining, steep creek hazards), achieving a sustainable community design, and economic feasibility. All of these factors were integrated by QPD when making decisions about the final conceptual design to propose to the Town in the ASP amendment and submit to Golder for assessment in this EIS.

Golder's recommendations were as follows:

- To the extent possible, select development footprint alternatives that avoid impacts to ESAs, such as wetlands and riparian areas.
- Given that the Town has provided for a total of 5,457 residential, resort accommodation and timeshare units and up to 306 ha of developable area across TSMV lands in Land Use Bylaw 22-2010, concentrating this development closer to Canmore in the Resort Centre will result in better outcomes for wildlife than distributing development evenly across TSMV lands. Concentrating development closer to existing disturbances in Canmore will benefit both species like grizzly bears that exhibit higher potential for negative interactions with people in lower density developments, and species like wolves for which the zone of influence from high-density development can extend into adjacent wildlife corridors.
- The modelling results indicate that the benefits of low density development for reducing sensory disturbance in wildlife corridors are outweighed by the higher potential for negative human-wildlife interactions in developed areas for grizzly bears. Therefore, unless a physical barrier is created between people and wildlife, higher density developments are recommended to reduce this risk, even where development is planned adjacent to wildlife corridors.
- If a physical barrier is put in place between people and wildlife, low density development can be used next to wildlife corridors. In this case, the advantages of reduced sensory disturbance associated with lower density development can be achieved for species like wolves without increasing the risk of negative human-wildlife interactions for species like grizzly bears. Maximum advantage can be achieved by maintaining developments farther away from the corridor edge. However, the advantage of reduced sensory disturbance associated with developing further from the corridor edge will be small for many species for which human developments create a weak zone of influence, such as grizzly bears. If low density developments are included adjacent to the wildlife corridor, the RSF-based scenario modelling and existing conflict data support the use of a physical barrier separating wildlife and people to mitigate potential increases in negative human-wildlife interactions.
- Recreational activities such as off leash dog use, terrain parks, zip-lines and/or rope courses, or trails for hiking, cross country skiing, and mountain biking have been proposed by QPD to occur within open spaces or recreation zones in the Resort Centre. Because animals like grizzly bears show strong selection for open areas within developments, these areas could become hotspots for negative human-wildlife interactions. Human recreational activities could also spill over into the wildlife corridor. If the development footprint includes recreational activities in open spaces adjacent to the wildlife corridor, the RSF scenario modelling

and current conflict data support the use of a physical barrier to mitigate potential impacts to wildlife. To the extent possible, a physical barrier should separate open spaces designated for recreation from wildlife movement corridors.

3.0 PROJECT DESCRIPTION

The 2004 Resort Centre ASP approved a range of 1,330 to 2,525 Resort Core and resort accommodation units and a potential population of 3,214 to 6,060 visitors and residents. Ninety five ha of land were approved for development of a Resort Core and 110 ha of land for a golf course. Under existing regulatory approvals, (DC 1-98), a maximum of 4,104 units and 206.86 ha of developable land remain to be developed across all TSMV lands. DC 1-98 permits the transfer of units from one TSMV plan area to another. The actual number of resort accommodation and residential units built in the Project Boundary will be determined in conjunction with planning for the Smith Creek and the Stewart Creek areas to ensure that the total number of resort accommodation and residential units between the three ASPs does not exceed 5,457 units within the Three Sisters lands per the Master Zoning Bylaw (DC 1-98).

After considering regulatory requirements, existing approvals, market conditions, stakeholder input and recommendations provided by Golder to reduce potential impacts on VECs, QPD prepared a Project design to meet the requirements of an ASP. The Project design focuses on alternate forms of development on the lands previously identified as golf course and also on transferring some of the units from other TSMV lands to the east to increase unit numbers within the Resort Centre ASP. Although this transfer will increase density closer to existing developments in Canmore, the total number of developable units and associated population approved for TSMV lands will not increase over previous approvals.

This section presents details of the Project that are relevant to this EIS. As noted in Section 1.3, the details of the Project at the ASP stage are conceptual and the precise location of development footprints, roads, and trails will not be defined until later planning stages (e.g., land use and subdivision). The planning rationale for the development concept described in this section and assessed as part of this EIS is presented in the ASP and is not repeated in detail here.

Proposed densities within the ASP would increase from 1,330 to 2,525 units to 1,600 to 3,000 units and a population of 3,192 to 6,060 visitors and residents, to 3,840 to 7,200 visitors and residents[6]. Therefore, the amendment seeks the addition of up to 475 units and 1,140 visitors and residents and the ability to redistribute resort accommodation, residential units, and recreational amenities into areas currently approved for golf course development.

The ASP amendment proposes to remove all references to the golf course and associated facilities from the approved 2004 ASP and replace them with references to uses related to resort accommodation, permanent residences, and comprehensive public and private recreation and open space amenities. When compared to the existing 2004 ASP, the amendment proposes to use unfinished golf course lands for the expansion of the Resort Core and Resort Expansion Area, and include some resort accommodation and/or residential developments along with recreational use. The objective of the Project is to provide for the development and sustainable growth of major year-round resort facilities and land uses to support an overall tourism 'base camp' focus for the Resort Centre Plan.

[6] Calculated using an average of 2.4 people per household.

3.1 Policy Areas and Development Concept

A general schematic of the different Project policy areas and a proposed development concept within them is provided (Figure 6). The proposed development area and unit density ranges for each policy area is outlined in Table 5. Descriptions of the intended purpose and development types within each development area displayed in Figure 6 are presented below. The proposed development is conceptual at the ASP stage, including ranges of development types and unit densities. The final design of each policy area will be determined through the land use, subdivision and development application processes:

- **Resort Core and Expansion Area** – The purpose of the Resort Core area is to provide for development of a comprehensively planned resort acting as a base camp to the recreational amenities available in the Bow Valley. The Resort Centre is envisioned as the heart of the TSMV area, and will function as a destination attraction for visitors and residents of the Bow Valley. The Resort Core and Expansion Area will house commercial and residential units and hotels with 300,000 to 525,000 sq. ft. of commercial gross floor area.
- **Area A** – The purpose of this area is to provide a range of medium to high-density resort accommodation uses. The location of higher density accommodation development closer to the Resort Core is encouraged to facilitate walking and cycling. A broad range of medium and possibly higher density building forms are encouraged.
- **Area B** – The purpose of this area is to provide a range of low to medium density resort accommodation uses. A range of low to medium density building forms is encouraged.
- **Area C** – The purpose of this area is to provide a range of medium to high-density resort accommodation uses. The location of higher density accommodation development closer to the Resort Expansion Area is also encouraged to facilitate walking and cycling. A broad range of medium and high density building forms are encouraged.
- **Area D - Signature Site** – The purpose of this area is to provide for resort accommodation uses in the form of comprehensively designed signature hotel developments. Hotels are envisioned to have between 50 and 250 rooms, including the potential for separate buildings providing visitor accommodation units separate from a primary hotel building. Area D may also be used for signature tourism features such as a spa, health-oriented services or medical facilities.
- **Area E** – The purpose of this area is to provide a range of resort accommodation uses, including short term stays and permanent residences. Area E may also include private recreational opportunities within a recreational zone that encourages year round use of the area. Private recreational opportunities may include terrain parks, zip-lines and/ or rope courses, hiking, cross country skiing, and mountain biking trails. Building forms will transition from mixed use buildings within the Resort Core and Resort Expansion Area to lower intensity uses and/or building forms moving southward away from the Resort Core area. Unit densities and associated building forms within Area E shall be graduated, such that higher densities are located in closer proximity to the Resort Core and Resort Expansion Areas. Open spaces and recreational zones will be located closer to the corridor and away from the Resort Core.

- **Area F** – The primary but not exclusive focus of Area F is public or private recreation opportunities within recreational zones and open space; however, resort accommodation and residential uses may also be accommodated in Area F. Recreational opportunities in Area F may include public and private recreational opportunities that encourage all-season uses of the area such as off-leash dog parks, a trailhead, hiking, cross-country skiing, and mountain biking trails as well as sports fields or other passive recreational amenities. The Resort Centre land use concept provides for regulation sized sports fields in Policy Area F within the Three Sisters Creek steep creek hazard zone (Figure 12). Should residential development be pursued, the layout and design of development in Area F will encourage a range of low density ground oriented building forms.

Table 5: Development summary within each distinct development area included in the 2017 Resort Centre Area Structure Plan

Policy Area	Policy Area Size	Unit Range
Resort Core & Expansion Area	43.5	800-1,425
Resort Accommodation Area A	14.6	150-250
Resort Accommodation Area B	2.9	25-75
Resort Accommodation Area C	7.4	115-175
Resort Accommodation Area D	4.8	115-350
Resort Accommodation Area E	58.6	335-625
Resort Accommodation Area F	19.9	60-100
Total	**151.7**	**1,600–3,000**

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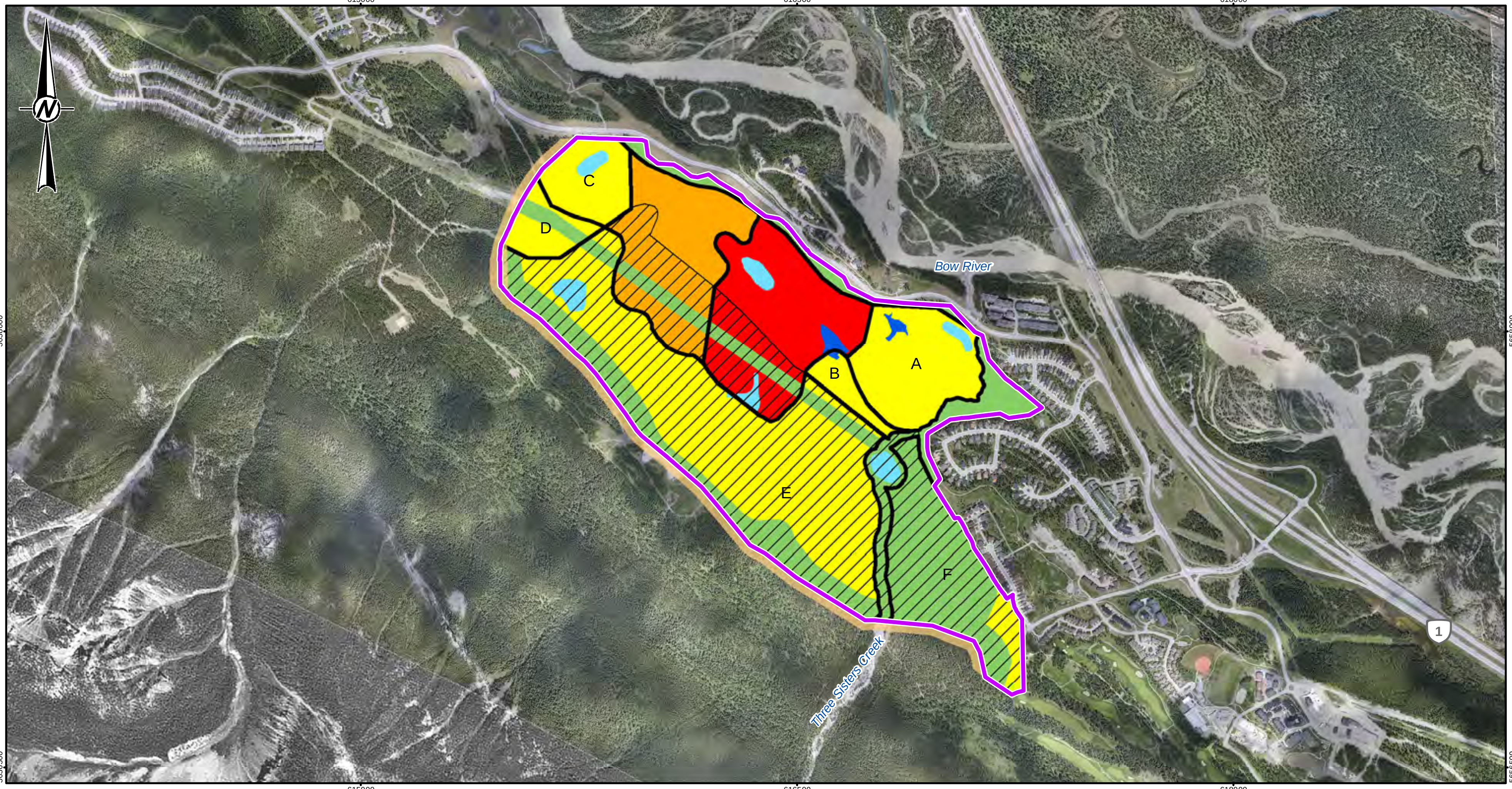

LEGEND

- 35 m CONSERVATION EASEMENT
- POLICY AREAS
- OPEN SPACE
- RESORT ACCOMMODATION
- RESORT CORE
- RESORT EXPANSION
- STORM WATER POND
- WETLAND
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

0 500 1,000

1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
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CONSULTANT

Golder Associates

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DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
RESORT CENTRE ASP AMENDMENT

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	6

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3.2 Open Space and Trails

The Resort Centre land use concept incorporates open spaces that will be integrated with the Town and Bow Valley open space networks. The amount of open space and recreational zones varies by policy area, with more open and recreational zones defined in Areas E and F. Development areas will be strategically linked to the open space network through a hierarchy of trails. The Resort Core is envisioned as the hub of the open space system and trail network, acting as both a destination and embarkation point for commuter cycling, short walks and longer hikes. Specific cross-sections and alignment of local pathways and connectors will be determined at the subdivision application stage.

The open space system and trail network will be complementary to existing and future water features (Figure 6). A central open space amenity / water feature within or adjacent to the Resort Core will provide a focal point for the open space and trails system (Figure 6). Off leash dog areas will be included within the open spaces incorporated into the Project. Other amenities within the recreation zone may include terrain parks, zip-lines and/ or rope courses, as well as trails for hiking, cross country skiing, and recreation/mountain biking.

Open space areas will consist of municipal reserve lands dedicated pursuant to the *Municipal Government Act* and private open space areas that may accommodate various forms of recreation like trails, rope courses, and indoor/outdoor recreation facilities centrally located within Area F. Restriction of development on environmentally sensitive areas pursuant to the *Municipal Government Act*, are provided through the designation of such areas as Environmental Reserve or creditable Municipal Reserve. Conservation easements on TSMV property set aside for the approved Resort Centre ASP, including a 35 m low human use conservation easement agreed to by the Town and TSMVPL in 2007, will remain in place as open space and part of the existing corridors. The conservation easements are outside the Project Boundary (Figure 6).

3.3 Utility Services and Transportation

The developments in the Resort Centre ASP area will be serviced with municipal water, sanitary sewer, and stormwater utilities. Domestic potable water for the development will be drawn from the Town municipal supply through an extension of the water mains generally located beneath the Three Sisters Parkway and running through the Resort Centre area near existing buried powerlines. The developed area will be serviced with a gravity and pumped sanitary sewer collection system and the sanitary sewer servicing will generally follow the storm sewer servicing catchment areas. Sanitary mains will connect development areas to the existing mains located within the Three Sisters Parkway. Site-specific lift stations may also be required in low-lying areas.

A stormwater conveyance system will be designed to accommodate the range of differing densities proposed for the Project. The conveyance system is proposed to consist of curb/gutters with curb cuts discharging to piped systems, ponds or bioswales and bioretention areas. Ponds, bioswales and bioretention ponds associated with storm water management are presented in Figure 6 and are landscape elements designed to remove silt and pollutants from surface runoff water before ultimate discharge to the Bow River via existing and new outfalls. Effort will be taken to achieve consistency in the hydrologic regime under pre- and post-development conditions.

The road system design will be integrated with the trail design to provide a diversity of options for modes of transportation and recreation including vehicles, bikes and pedestrian. The transportation network proposed follows the direction of the Town's Integrated Transportation Plan, which focuses on "creating a multi-modal transportation network through Complete Streets that prioritize pedestrians and cyclists wherever possible, complemented by a trail network" (Town of Canmore 2014b, p.43). The Resort Centre transportation network will include the street classification Livable Urban Boulevard, identified in the Integrated Transportation Plan, which prioritizes active transportation modes and transit. To further promote multiple modes of transportation, two-lane cross section streets are proposed, rather than wider four-lane streets, which also prioritizes active modes of transportation by allocating more space to walking and cycling.

Road design standards will generally minimize street widths, taking into account emergency vehicle requirements, provide drainage and utility corridors and maximize future transit effectiveness. The road network will build upon the existing system within and adjacent to the Project Boundary for the purpose of adequately servicing local transportation and circulation demands. Three road types are proposed: collector roads, collector roads with curbs, and local roads. Specific road cross-sections and alignment details shall be determined at the subdivision application stage.

3.4 Wildlife Fencing

Golder's recommendation to use wildlife fencing as a key component of a broader mitigation strategy for wildlife was accepted by QPD, and QPD therefore proposes to incorporate wildlife fencing into the Project, as outlined in Section 5.5.4. Recreational trails within the developed area will provide access into wildlife corridors through gated entry points on designated trails that will direct recreational users through the wildlife corridor to designated trails above it, such as the Highline Trail.

4.0 ASSESSMENT METHODS

This section:

- presents the spatial and temporal boundaries applied in this EIS (Section 4.1);
- describes the impact assessment methods used to define existing conditions (Section 4.2);
- predicts and characterize residual effects (Section 4.3);
- identifies uncertainty and monitoring requirements (Section 4.4); and
- considers the cumulative effects of existing conditions, the addition of the Project, and the addition of other reasonably foreseeable developments to the Bow Valley in the vicinity of Canmore (Section 4.5).

Specific methods used to quantify or describe impacts for each VEC are presented in their respective sections.

4.1 Spatial and Temporal Boundaries

Assessment boundaries were used to set the spatial and temporal limits of the EIS. The boundaries were defined to capture the areas and times in which the Project is expected to interact with VECs. Spatial and temporal boundaries are also intended to capture past, present, and reasonably foreseeable effects that might interact cumulatively with the incremental effects of the Project.

The assessment considered two primary spatial scales:

- The Project, which encompasses the 163 ha where development will occur. This 163 ha area includes both the area for which the ASP amendments are being sought and other areas associated with the ASP that were approved in 2004 (Figure 6).

- A regional study area (RSA) that encompasses 23,878 ha within the Bow River watershed between the east boundary of Banff National Park and Exshaw (Figure 7).

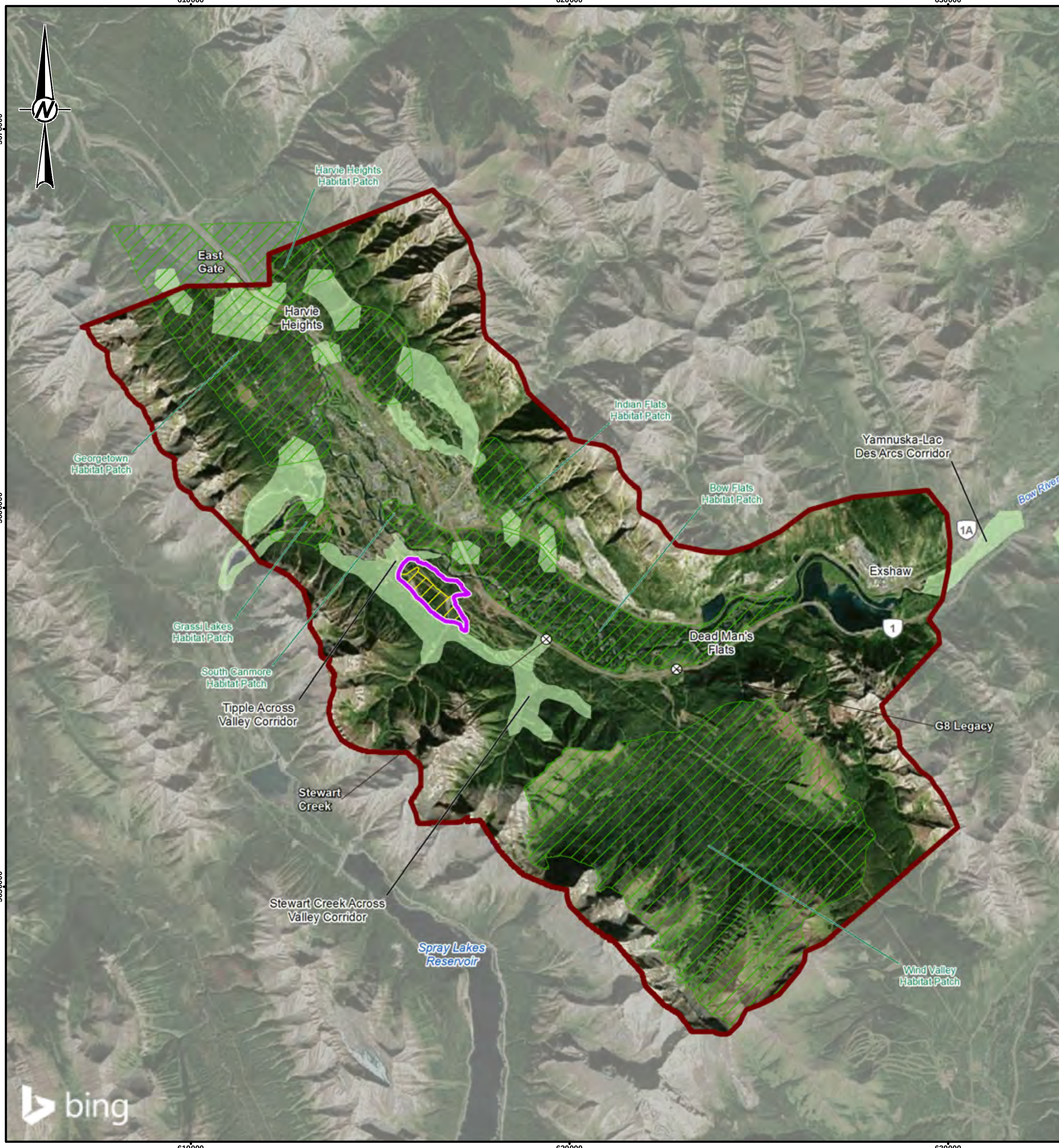
Within these two primary spatial boundaries, the assessment considered various scales, as appropriate to the VEC and potential issue of concern. For example, the wildlife assessment considered the boundaries of wildlife corridors adjacent to the Project boundaries, and throughout the RSA.

For most VECs, the assessment focused spatially on effects inside the Project Boundary. Although the Project does not propose substantial changes north of the Golf Course from what was approved in 2004, the entire Resort Centre was considered in the spatial boundaries set for this assessment. Differences between impacts within the amendment area and those that were previously approved in 2004 (Figure 6) were identified in the residual effects assessment, as appropriate. However, the assessment also considered the Resort Centre as a cohesive whole, including total unit numbers and additional inhabitants, so that mitigation can be identified and applied in an integrated manner to the entire Project.

Some indirect effects of the Project, such as those associated with FireSmart activities, noise associated with construction or operations, or human use outside of developed areas, may extend beyond the Project Boundary. These effects were considered according to their likely spatial extent and interaction with VECs.

The RSA boundaries were selected using political and ecological boundaries and for consistency with past studies (e.g., JWA 2005, Golder 2013). The Banff National Park boundary constitutes the western edge of the RSA, and the heights of land paralleling the Bow River were used for the north and south boundaries (Figure 7). The east boundary includes Exshaw (Figure 7). The RSA includes major developments, landscape boundaries, wildlife corridors and wildlife habitat patches at a scale relevant to assessing the effects of the Project and, where appropriate, the cumulative effects of the interaction of the Project with other developments. Specifically, development and human use present environmental challenges within the RSA not faced to the same degree outside of its boundaries, and unique management solutions may be required within the RSA.

The temporal boundaries of the assessment are broad and cumulative effects extending back in time as far as the late 1800s and as far forward as 2037 were considered to provide context to help define the importance of the incremental effects from the Project to VECs. The residual effects assessment focuses on changes caused by the Project between current conditions (i.e., 2015/2016) through to full build out of the development, which is predicted to be 5 to 20 years into the future (i.e., 2012 to 2037). The assessment identifies potential environmental effects associated with both construction and operations of the Project. Construction includes short term effects associated with equipment and workers on site, whereas operations extend over the life of the Project, which is considered permanent.



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LEGEND

- HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. UPDATED STEWART CREEK ACROSS VALLEY CORRIDOR DATA LAYER FROM QPD IN OCTOBER 2016.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

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TITLE
REGIONAL STUDY AREA

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Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

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4.2 Existing Conditions

Existing conditions (i.e., 2015/2016) were described for each VEC to provide an assessment baseline against which residual effects of the Project could be measured. Existing conditions are the outcome of past and present developments, human activities, and natural factors. Therefore, the description of existing conditions provides information about the cumulative effects affecting each VEC prior to the addition of the Project or other reasonably foreseeable developments. Existing conditions were described within the spatial boundaries defined for the EIS.

Resort Centre Project Boundary

Existing conditions were presented for each VEC within the Project Boundary. Particularly sensitive natural features, hazards, or constraints within or adjacent to the Project Boundary were identified for each VEC.

The Resort Centre is located in an area that was previously affected by open pit and underground mining. In 2016, the existing conditions at the Resort Centre consisted of the unfinished golf course on the southern two thirds, and forested and wetland areas in the northern third where the existing 2004 Resort Centre ASP permits development of the resort core and other resort accommodation. A powerline right-of-way bisects the Resort Centre along the northern edge of the abandoned golf course. The Three Sisters Creek flows through the Resort Centre. The banks of the creek were heavily affected during the floods of 2013.

Additional information about existing conditions in the Project Boundary relevant to each VEC were obtained primarily using extensive available information from previous and ongoing studies. Information also was collected during reconnaissance surveys undertaken in 2015 and 2016 by Golder, including confirming the location of wetlands, riparian areas, and other ESAs. A survey through wildlife corridors and adjacent habitats was conducted to investigate trails and movement routes within wildlife corridors and evaluate possible locations for a wildlife fence.

Regional Study Area

The level of detail used to describe existing conditions in the RSA varied among VECs. More detail was provided for VECs for which past and present developments and activities have had strong adverse cumulative effects under existing conditions. Consequently, substantially more information was presented to describe existing conditions for wildlife at the RSA scale than for other VECs. General information about existing conditions in the RSA that was used to inform the existing conditions assessment for all VECs is presented below.

The RSA is a wide, low-elevation valley that is part of the Bow River watershed, which supplies water to much of southern Alberta, including the City of Calgary. Topographically diverse conditions produce a diverse assemblage of wildlife and vegetation. At lower elevations, coniferous forests are dominant, with some grasslands and mixedwood forests on south- and west-facing aspects and in valley bottoms. At moderate elevations, the montane subregion features differing aspects, slope positions and wind exposures which result in highly variable micro-climates, and changes in soil and vegetation assemblages at small spatial scales (Natural Regions Committee 2006).

In recognition of its ecological importance and natural beauty, substantial portions of the RSA have been designated as protected areas. These include Bow Valley Wildland Provincial Park, Don Getty Wildland Provincial Park, Canmore Nordic Centre Provincial Park, Bow Valley Provincial Park and Spray Valley Provincial Park. The total area in the RSA that is protected is 17,326 ha, or 73%.

Approximately a third of the lands outside of protected areas in the RSA have been developed. Major developments in the RSA include the Trans-Canada Highway, which is fenced in places to reduce vehicle-wildlife collisions, the Canadian Pacific Railway, several cement plants and quarries, the Town, and the communities of Exshaw, Deadman's Flats, Lac Des Arcs, and Harvie Heights.

After many decades as a coal mining town, Canmore has more recently maintained a strong economic focus on tourism and recreation. Residential, commercial and resort development in Canmore has continued to grow since the 1988 Olympics. In addition to construction of new golf courses, hotels and other infrastructure, Canmore's population more than doubled between 1993 and 2014, increasing from 6,621 to 13,077 permanent residents. The population count increases to over 17,000 when non-permanent second home owners are included (Town of Canmore 2014a).

Overall, human development in the RSA has been substantial along the valley bottom, particularly in the Town. Human development can negatively affect the ecological function of landscapes, and development interests are not always compatible with maintaining viable ecosystems (Hilty et al. 2006). For example, roads and buildings reduce habitat quality for many wildlife species and can impede movement (Fahrig and Merriam 1985; Huck et al. 2010). Negative environmental effects often increase when effects from a number of different sources act cumulatively.

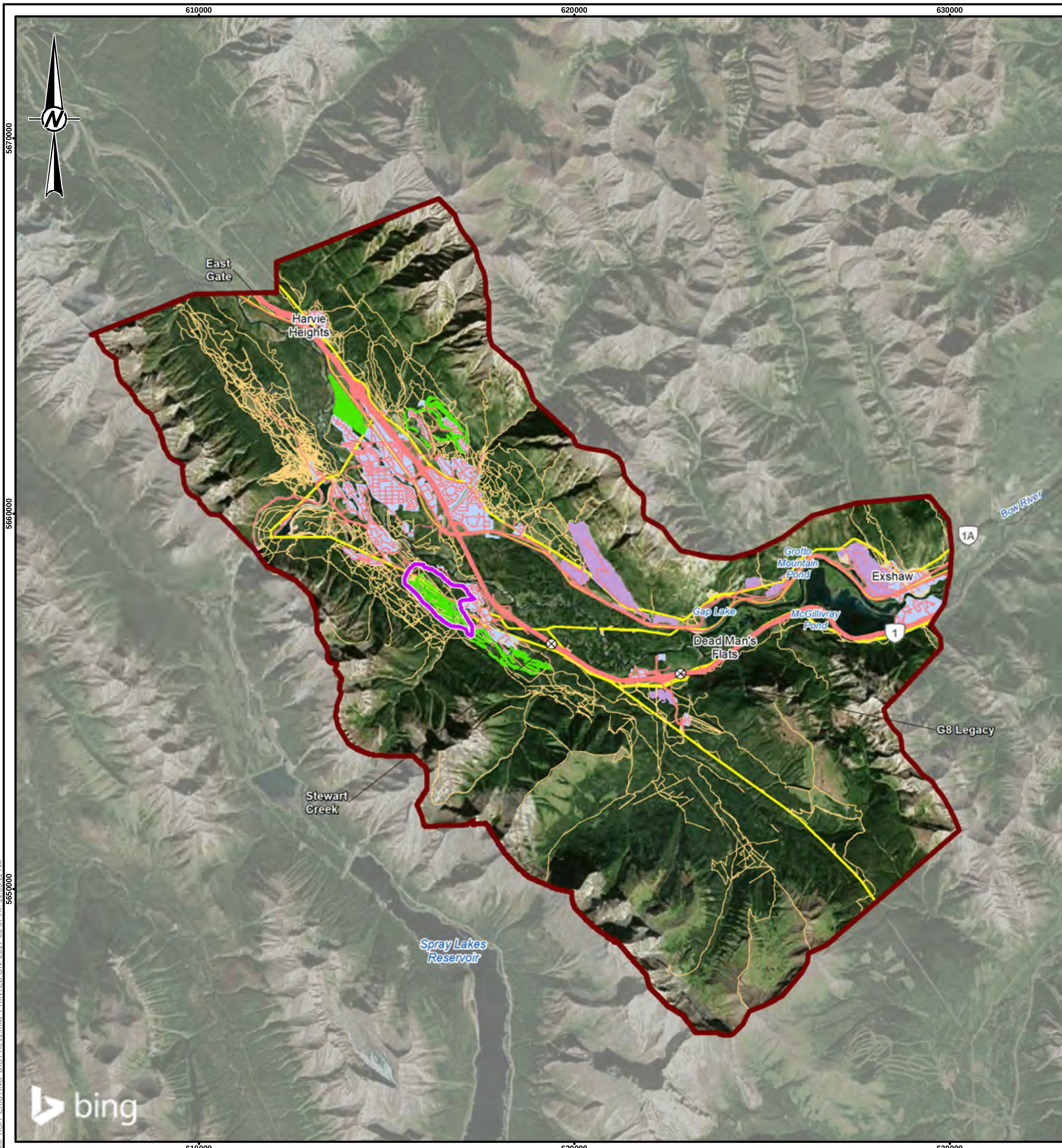
To provide a better understanding of the cumulative effects of development in the Bow Valley, existing disturbance areas within the RSA were calculated using disturbance layers developed by Golder (2013) and updated in 2016 (Table 6). Disturbance area associated with linear features was defined using average widths for each linear feature in the study area as estimated from available imagery. This approach likely overestimated the actual extent of linear disturbance in many cases. Disturbance data indicate that approximately 11% of the RSA has been altered by development (Table 6). Development within the RSA is not evenly distributed, but is generally concentrated in the valley bottom (Figures 8 and 9). Urban development is the single greatest form of disturbance, followed by transportation infrastructure, including highways, rail lines, and roads within urban developments, and pipelines and transmission lines (Table 6).

Table 6: Amount of anthropogenic disturbance in the Regional Study Area by disturbance type in 2016

Disturbance type	Area [ha]	Percent of RSA
Golf Course[a]	214	1
Industrial	281	1
Other Trails	374	2
Pipeline/Transmission Line	303	1
Transportation	658	3
Urban Development	686	3
Non vegetated	57	<1
Total disturbance	**2,573**	**11**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] includes anthropogenic grasslands associated with the Resort Centre that are not an active golf course



LEGEND

- ⊗ HIGHWAY WILDLIFE UNDERPASS
- PROJECT BOUNDARY
- REGIONAL STUDY AREA

DISTURBANCES

- GOLF COURSE
- INDUSTRIAL
- NON VEGETATED
- OTHER TRAIL
- PIPELINE / TRANSMISSION LINE
- TRANSPORTATION
- URBAN DEVELOPMENT

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
EXISTING DISTURBANCE IN THE REGIONAL STUDY AREA

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-02-06
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	8

Figure 9: Aerial Image of the Bow Valley (2012)

Note: The image depicts some existing development in the Bow Valley in 2012. The existing Stewart Creek Golf Course and TSMV developments are prominent at the lower left and the Trans-Canada Highway bisects the Bow Valley including core portions of the Town of Canmore at the upper right.

4.3 Project Effects

Residual effects of the Project are the incremental effects that the Project adds to existing cumulative effects, after mitigation has been applied. Residual effects were predicted for each VEC using five sequential steps:

- identify environmental risks;
- summarize relevant legislation that is in place to constrain potential impacts;
- present mitigation measures; and
- predict and characterize residual effects.

Details each step are described in the following sections.

Environmental Risks

The effect assessment considers the potential interactions between the Project, as described in the Project description (Section 3) and each VEC. Potential interactions were identified based on literature review and documented evidence from previous similar developments in Canmore. Importantly, this step identified key risks prior to identifying mitigation. Relevant legislation and mitigation identified in the next steps of the assessment can minimize or eliminate potential environmental risks.

Relevant Legislation

Relevant federal or provincial requirements or restrictions that are defined in existing legislation and will result in a reduction in residual effects were identified for each VEC.

Mitigation

Mitigation was identified for each VEC, as required and appropriate, to eliminate or reduce environmental risks associated with the Project. Mitigation was discussed extensively as part of the consultation undertaken for the proposed Smith Creek ASP and Resort Centre ASP Amendments and outcomes from all consultations were also applied to this EIS.

Mitigation began with the design concept phase using an iterative approach between Golder, QPD, and stakeholders, including the Town. This iterative process continued throughout the planning, consultation, and engagement activities for both the Smith Creek ASP and Resort Centre ASP Amendments, including incorporating the information presented in Section 2. Additional mitigation was identified based on the environmental risks and federal or provincial requirements or restrictions identified as part of this EIS. Where mitigation was used to meet federal or provincial legislative requirements, this is stated.

At this conceptual stage of development planning (i.e., ASP amendment), detailed design for some mitigation remains unavailable. Assumptions about the type of mitigation used were made for the purposes of this EIS. Failure of the final design to meet these assumptions would require re-assessment of the conclusions provided in this EIS. Mitigation for which uncertainty was present and for which assumptions must be met in the final design is described in the uncertainty and monitoring section for each VEC.

Predict and Characterize Residual Effects

Residual effects of the Project are those that are predicted to persist after successful implementation of all recommended mitigation. Residual effects, where identified, were characterized using the following assessment criteria based on *Canadian Environmental Assessment Act* principles (CEAA 2012):

- direction (positive, neutral, or negative effect);
- geographic extent (spatial scale where effect occurs);
- duration/reversibility (how long does the effect last);
- magnitude (measure of effect size, e.g., ha of habitat lost);
- probability (likelihood of effect); and
- frequency (number of events).

These assessment criteria were considered together to obtain an environmental consequence for each VEC (Table 7). A key term in Table 7 is “serious risk”, because this creates the distinction between a low or high environmental consequence. The precise definition of serious risk depends on the VEC being evaluated and is described in each residual effects section for which an environmental consequence greater than negligible was identified.

Using wildlife as an example, a serious risk would be any factor that put the viability of the portion of a population inhabiting the RSA at risk. For instance, the loss of connectivity among habitat patches in the RSA or creation of a population sink for a particular wildlife species in the RSA through increased negative human wildlife interactions would constitute a serious risk. Weight of available evidence and professional judgement were used to determine environmental consequence using logical reasoning for each VEC.

Table 7: Environmental consequence rating for residual effects

Environmental Consequence	Definition
Positive	The Project results in a net benefit relative to existing conditions
Negligible	No detectable adverse change is expected relative to existing conditions
Low	Detectable adverse effect, but the effect is not expected to result in serious risk to the resource or population, nor is it expected to contribute to a serious risk already present under existing conditions.
High	Effect is expected to pose a serious risk to the resource or population, or will contribute to a serious risk already present under existing conditions.

4.4 Uncertainty and Monitoring

Scientific inference is associated with uncertainty, and prediction confidence depends on the level of uncertainty and the manner in which it is addressed. Primary factors affecting confidence in the predictions made in the EIS include:

- availability and accuracy of data to describe existing conditions;
- accuracy of ecosystem maps;
- accuracy of models;
- level of understanding of population viability and ecological resilience;
- level of understanding of the strength of Project-environment interactions in terms of the effects they are likely to have on each VEC;
- level of certainty associated with the effectiveness of proposed mitigation; and
- level of understanding of the cumulative drivers of environmental change and associated effects on VECs.

Uncertainty in the EIS was managed by:

- incorporating historical data and relevant studies conducted in the Project Boundary and the RSA;
- using relevant published literature to help make predictions;
- overestimating rather than underestimating potential effects where uncertainty was high (i.e., a precautionary assessment);
- Specifying assumptions about mitigation for which final designs were not available and recommending follow up actions to confirm consistency of final design with this EIS; and

- recommending monitoring and adaptive management where substantial uncertainty remained or where the consequences of being wrong about a predicted residual effect were substantial (e.g., potential for a high environmental consequence).

The precautionary approach to this assessment means that many predicted effects will be greater than they are likely to be when the Project is built. For example, the development footprints used to define developed areas for the Project overestimated likely total disturbance to address uncertainty about which parts of each development pod will be built up and which will remain green space. In all cases, policy presented in the ASP requires smaller total development footprint than was assumed for this assessment. Similarly, where a range of units or populations was presented, this assessment evaluated the maximum value.

4.5 Cumulative Effects

Cumulative effects are defined for the purposes of this EIS as the sum of all natural and human-induced influences on each VEC in the RSA from a condition prior to development of the Town (i.e., 1800s) until full build out of the Project, which is expected to take 5 to 20 years (i.e., complete development by 2012 to 2037). A cumulative effects assessment was only completed for VECs for which Project related residual effects were predicted to have an environmental consequence greater than negligible (Table 7). Cumulative effects may be important for VECs for which the Project has positive or negligible effects, but the Project will not make them worse, and therefore they are not considered in this EIS.

Cumulative effects were assessed at the RSA scale. Both quantitative and qualitative approaches were used to conduct the cumulative effects assessment, depending on the availability of data for each VEC.

Cumulative effects were primarily generated by the interactions of previous and existing developments and activities, and the largest portion of the cumulative effect was described in the existing conditions section for each VEC. Existing disturbance and activates associated with human development in the RSA that were considered in cumulative effects assessment are presented in Figure 5 and include:

- Trans-Canada Highway and other secondary highways and roads in the RSA and associated existing traffic;
- Canadian Pacific Railway;
- residential and industrial disturbance in the RSA including:
  - urban developments: Canmore, Harvey Heights, Deadman's Flats, Banff Gate Mountain Resort, Lac des Arcs, Exshaw; and
  - industrial developments: Baymag, Lafarge, Thunderstone Quarry, Graymont.
- designated and undesignated trails and patterns of human use on these trails in the RSA.

A comprehensive cumulative effects assessment was achieved by adding the Project and other reasonably foreseeable developments to the existing condition to predict a future outcome for VECs in the RSA, assuming all of the expected future changes happened together. In addition to the Project, other reasonably foreseeable developments that were included quantitatively in the cumulative effects assessment were:

- Smith Creek ASP; and
- Dead Man's Flats ASP.

Future projects or activities that were considered qualitatively or using projections include:

- traffic increases on Trans-Canada Highway and other secondary highways and roads in the RSA;
- increases in human use of natural landscapes including wildlife habitat patches and movement corridors in the RSA;
- increased proliferation of undesignated trails in the RSA;
- industrial expansion at Baymag and Lafarge plants;
- Silvertip Resort expansion;
- Alpine Club of Canada facility upgrades;
- extension of the existing Highline Trail east, and
- population growth within the RSA.

The existing disturbance in the RSA, the Project Boundary, and footprints of reasonably foreseeable developments for which data were available are presented in Table 8. Urban development will increase in the RSA by 332 ha or 48%. If all reasonably foreseeable developments are built, this will mean that the proportion of the RSA affected by disturbance will increase from 11% in 2016 to approximately 12% in 2037. Additional expansions are also possible at Silvertip Resort, Alpine Club of Canada, the Baymag and Lafarge plants, but footprints were not defined. Given that 73% of the RSA is park or protected area and, with the addition of 152 ha of land to complete the proposed corridor adjacent to the Smith Creek ASP, TSMVPL will have designated 644 ha of their private lands as wildlife corridors, opportunities for additional development in the Bow Valley beyond those defined for the cumulative effects assessment are limited.

Table 8: Existing and future anthropogenic disturbance in the Regional Study Area by disturbance type

Disturbance Type	Disturbance Amount (ha)			
	Existing Disturbance (2016)	Resort Centre ASP Amendment	Reasonably Foreseeable Developments	Total Future Disturbance (2037)
Golf Course[a]	214	-43	0	172
Industrial	281	0	-9	272
Other Trails	374	-5	-3	366
Pipeline/Transmission Line	303	-1	-4	298
Transportation	658	-1	0	656
Urban Development	686	114	121	921
Non vegetated	57	0	0	57
Total Disturbance	**2,573**	**64**	**105**	**2,743**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

(a) includes anthropogenic grasslands associated with the Resort Centre that are not an active golf course

5.0 WILDLIFE

The wildlife valued environmental component is a primary focus of this EIS. To identify appropriate mitigation for wildlife, the wildlife section identifies existing conditions and potential Project effects for a range of wildlife species and important habitat features in the Project Boundary. For example, considering potential effects of the Project to migratory birds permitted identification of important mitigation, such as clearing vegetation outside of the breeding period or conducting nesting surveys to avoid mortality and comply with the *Migratory Birds Convention Act*.

Residual and cumulative effects assessments were undertaken for grizzly bears, cougars, wolves, and elk, which were selected as indicator species based on their varied responses to development and, in the case of grizzly bears, their provincially Threatened status (Section 5.2.1). Using these indicator species permits evaluation of the key issues of habitat loss, potential changes in wildlife use of provincially approved corridors, and potential negative human-wildlife interactions. Information about black bears was also included in the grizzly bear section because of similarities of the environmental risks faced by both species and in the mitigation used to address environmental risks. Human recreational use of natural areas was also a major focus of the wildlife impact assessment because of the potential for human use to influence wildlife habitat use or result in negative human-wildlife interactions.

5.1 Methods

The wildlife impact assessment follows the assessment methods outlined in Section 4. This section presents additional details about specific analyses and approaches used to complete the wildlife assessment.

5.1.1 Camera Data

Remote cameras were deployed on TSMV lands and in adjacent wildlife corridors by Chinook Co. Environmental Ltd. (Chinook) during 2009-2014, and Corvidae Environmental Consulting Inc. during 2015-2016. Cameras recorded use by wildlife and people.

The camera deployment area consists of portions of TSMV slated for future development, the Stewart Creek and Three Sisters Golf Courses, the proposed and designated wildlife corridor system adjacent to TSMV property, TSMV conservation easements, and Provincial Lands on Wind Ridge. The deployment area extends from the Trans-Canada, at its northern boundary, to the southern edge of the designated and proposed Along Valley Corridor, except east of Stewart Creek where the deployment area extends south past the Along Valley Corridor to include Wind Ridge. The deployment area is bounded to the west by the Peaks of Grassi subdivision and extends east to the Wind Valley.

The deployment area was stratified into grid cells to achieve representative coverage of the camera deployment area. Each cell was 300 m x 300 m. Monitoring occurred throughout the grid during 2009-2016, but more cameras were deployed east of Stewart Creek from 2010 to 2012 and 2015 to 2016, resulting in higher sampling intensity in grid cells near Smith Creek compared to the Resort Centre.

Random sampling locations were generated within each 300 m x 300 m grid cell. Cameras were deployed on the nearest trail to the random location, including faint game trails, heavily used game trails, designated and undesignated human recreation trails, and active and inactive access / mine roads. Cameras were relocated to a new random site approximately every three to four weeks. Initially, the program generated new random locations that were restricted from occurring within 50m of a previous sampling location in each grid cell, but over the years this rule had to be relaxed because of the high number of sampling locations within each grid cell. Camera equipment included Reconyx PC 85 (colour), PC 75 (monochrome), and Reconyx HC600 (colour) models.

Cameras were not deployed at random locations in open habitat without a suitable tree to attach the camera to. Where trees were present, cameras were attached to a suitable tree with a minimum 6-inch diameter to prevent false image triggers due to wind shaking the tree. Cameras were mounted at approximately chest height and tilted slightly down, at a 45˚ angle to the trail, to maximize the amount of time a subject could be detected. Cameras were locked to the tree to deter theft. A GPS unit was used to record the location of the camera.

Cameras targeted detections of mammals coyote sized or larger. Smaller animals could have passed undetected. Cameras were deployed to achieve a similar field of view at each deployment location to minimize variation in detection probability among sites. Camera sensors were set on high and the cameras took three pictures if the sensor was triggered.

Reconyx cameras use compact flash and microSD memory cards that can be changed in the field. Memory cards were downloaded onto a computer, and the images were reviewed by researchers and data associated with each image was recorded on data sheets (Table 9). Image information was then entered and stored in a Microsoft Excel database.

Table 9: Summary of information collected from mages

Heading	Description
Observer	The researcher who transcribed the images from memory card to database.
Sample Site	The UTM NAD 83 coordinates for the sample site.
Date	The date the camera was deployed.
Time	The time the camera was deployed.
Days Operating	The number of days the camera was deployed.
Event	The type of event: options were human (including dogs) or wildlife.
Species	Either the wildlife species or the type of human recreation use.
Young	Whether there is a young-of-year or yearling in the image.
Number	Number of humans or wildlife in the image.

When reviewing images the following protocols were used:

- If a subject was in a series of images continuously, without a break, no matter how long, this was entered as one event.
- If a subject enters and exits the frame a series of times, and it can be determined that it is the same subject, then it is entered as one event. This rule resets every two hours.

During 2009-2016, 1,336 locations were monitored by Chinook and Corvidae in the deployment area. Camera data from an additional 26 locations monitored by the Town and AEP as part of a Human Use Management Review (HUMR) program were also incorporated into the analyses. Sampling at these 1,362 locations totaled 42,558 camera monitoring days (Table 10).

The study area was divided into deployment area units for analyses relevant to the Project and the Smith Creek ASP (Table 10). Most deployment area units presented in Table 10 were primarily forested. Exceptions were the Stewart Creek Golf Course and the anthropogenic grasslands on the abandoned golf course in the southern part of the Project Boundary. These areas were sampled by deploying cameras in patches of forested habitat, but open areas were not sampled.

Table 10: Camera analysis categories and sample sizes

Trail type	Deployment Area Unit[(a)]					Total
	Project Boundary (163 ha)	Resort Centre Approved Wildlife Corridor[(b)] (376 ha)	Smith Creek ASP Boundary (157 ha)	Smith Creek Approved and Proposed Wildlife Corridor[(c)] (561 ha)	Other (undefined)	
Designated	0/0	9 / 542	0/0	2 / 360	8 / 826	19 / 1,728
Undesignated	0/0	47 / 1,801	20 / 607	97 / 3,461	34 / 1,213	198 / 7,082
Other	62 / 1,781	201 / 5,563	150 / 4,819	382 / 11,604	350 / 9,980	1,145 / 33,748
Total	**62 / 1,781**	**257 / 7,906**	**170 / 5,426**	**481 / 15,425**	**392 / 11,317**	**1,362 / 42,558**

Note: Numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

(a) Results presented as number of camera locations / number of camera days.

(b) Approved Along Valley Corridor and Tipple Across Valley Corridor adjacent to the Project Boundary.

(c) Approved Along Valley Corridor and 2017 corridor proposal adjacent to Smith Creek.

Camera data were analyzed using the number of photographs of individuals from a category of interest, such as humans, off leash dogs, or grizzly bears, divided by the number of days monitored for each camera deployment. This yields a detection rate expressed as photos/camera/day. Comparisons were made using these data among various spatial categories such as deployment area unit and trail type. The distance between each camera location and the nearest urban development was also calculated in a Global Information System (GIS) to permit investigation of the influence proximity to urban development had on detection rates. Temporal and seasonal patterns of detection over a 24 hour period were investigated using the time-stamp on photographs from all cameras for carnivores, and from HUMR cameras for humans. Because random locations sampled different locations with variable numbers of cameras deployed on designated, undesignated, and other trail types among years, inter-annual comparisons were not undertaken.

Variation in detectability among species and locations can affect the interpretation of comparisons using detection rates from camera data (Burton et al. 2015). Variation in detectability was not explicitly tested in this study, but constant detectability was considered a reasonable assumption for the following reasons:

- the random design of the study incorporated a variety of habitats, including faint game trails through the forested matrix, thereby avoiding bias associated with deploying cameras on a single trial type (Harmsen et al. 2010);
- the relatively small size of the study area (i.e., within the home range of target species like elk, cougars, wolves, and grizzly bears), meant that behavioral and ecological processes were similar throughout the sampled area, avoiding bias associated with behavioral or ecological variation among sites (Burton et al. 2015);

- camera locations were not baited and were moved regularly, avoiding potential problems associated with increasing visitation rates to camera locations over time (Sollmann et al. 2013); and
- consistent deployment methods, camera specifications, camera settings, and consistent large body size of target species (e.g., people, elk, grizzly bears), avoids several potential sources of inconsistent detection (Wellington et al. 2014; Burton et. al. 2015).

A key exception to this assumption was present for open habitats. Species selecting open habitats, such as elk and grizzly bears (Appendix B), may be underrepresented by camera data in places with substantial open areas, like the unfinished golf course in the Resort Centre. Comparisons among deployment area units must therefore consider this potential bias.

5.1.2 Resource Selection Functions

Changes in habitat selection from existing conditions as a result of the Project and the Project plus other reasonably foreseeable developments were estimated using RSFs developed for grizzly bears, cougars, wolves, and elk using telemetry data collected from animals collared in the Bow Valley (Appendix B). The Foothills Research Institute has also developed RSFs for grizzly bears that could be applied using their GBTools program. These models were considered, but models derived from bears in the Bow Valley were selected because:

1) bears in the Bow Valley may respond differently to disturbance variables than bears occupying habitats with less disturbance and human use[7]; and
2) models available in GBTools did not include a variable for urban development; therefore, responses of grizzly bears to the addition of the Project could not be evaluated, except through changes in landcover and the addition of roads.

The RSA was divided into raster cells of 25 m x 25 m and the RSF for each species outputs a value that indicates the relative probability of selection for each cell. Models were validated using five discrete habitat selection categories and validation indicated that all models interpreted at the category level have excellent predictive abilities (Appendix B). Model categories for each species should be interpreted as follows:

- **Selected** – observed proportion of independent telemetry locations in this category were greater than the proportion that would be expected if habitats were used as available.
- **Used as available** – observed proportion of independent telemetry locations in this category were at or near the proportion that would be expected if habitats were used as available.
- **Somewhat avoided** – observed proportion of independent telemetry locations in this category were below the proportion that would be expected if habitats were used as available.
- **Strongly avoided** – observed proportion of independent telemetry locations in this category were much less than the proportion that would be expected if habitats were used as available.
- **Rarely Used** – observed proportion of independent telemetry locations in this category were near zero.

[7] This phenomenon is known as a functional response in habitat selection. Some animals decrease avoidance of anthropogenic features as those features become more prevalent on a landscape. As noted by Knopff et al. 2014 "failure to account for potential functional responses could lead to overestimation of negative impacts of development for adaptable large carnivores".

Three spatially explicit model outputs were created using the RSFs for each species at the RSA scale[8]:

- **Existing Conditions** – The models used to describe existing conditions were run using habitat and human disturbance layers representing the conditions present in the Bow Valley in 2016.
- **Project Effects** – The models developed to inform the Project effects assessment incorporated habitat and human disturbance layers representing existing conditions with the proposed Resort Centre ASP Amendment development footprints stamped in.
- **Cumulative Effects** – The models developed to inform the cumulative effects assessment incorporated habitat and human disturbance layers representing existing conditions with the proposed Resort Centre ASP Amendment, the Smith Creek ASP, and the Dead Man's Flats development footprints stamped in.

Comparing the existing conditions model outputs to the Project effects or cumulative effects model outputs permits quantification of changes in animal selection and habitat conditions. Residual effects were evaluated within the Project Boundary and the adjacent Along Valley and Tipple Across Valley wildlife corridors. The portion of the Along Valley corridor considered adjacent to the Project Boundary extended east to approximately the midway point of the Stewart Creek Golf Course. Cumulative effects were evaluated at the RSA scale and included an evaluation of cumulative changes in grizzly bear, cougar, wolf, and elk selection within the entire wildlife corridor network around Canmore.

The RSFs can be interpreted as representing habitat quality, which is a traditional interpretation of this kind of model (Manly et al. 2002). Using this interpretation, habitat quality and the contribution to the number of animals the landscape can support is proportionally highest in selected habitats and habitats used as available. Avoided habitats contribute less, and rarely used habitats may contribute little or nothing to the number of animals the landscape can support. Because wildlife occurrence is proportional to the probability of selection (Lele et al. 2013), the potential for encountering animals also increases as habitat quality increases, and risk of negative interactions between people and wildlife increases in higher quality habitats (Takahata et al. 2014).

More recently, RSFs have been used for corridor identification and movement modelling. In these cases, RSFs are interpreted as a resistance layer (Chetkiewicz et al. 2006, Chetkiewicz and Boyce 2009, Abrahms et al. 2016). The assumption typically made when using RSFs in this way is that the poorest quality habitat on the landscape will inhibit wildlife movement (i.e., high resistance), whereas the highest quality habitat facilitates movement (i.e., low resistance) (Chetkiewicz and Boyce 2009; Abrahams et al. 2016). Therefore, increases in probability of selection can also be interpreted as reducing resistance and increasing the likelihood of movement through a given area on the landscape.

When applying RSFs to corridor definition with the goal of achieving connectivity for dispersing animals or during long-distance movements, behavioral state can be considered in model development (Elliot et al. 2014; Zeller et al. 2014; Abrahams et al. 2016). Behavior during long-distance dispersal is frequently different from behavior during other behavioral states such as foraging or resting. Dispersers or animals moving long distances sometimes take greater risks than animals involved in other behaviors and animals sometimes display opposite selection patterns during movement. For example, cougars normally avoid grassland habitats, but individuals moving long distances will sometimes select them (Zeller et al. 2014). Similarly, wild dogs strongly avoid roads

[8] RSF models were run at scales larger than the RSA to account for edge effects (Appendix B) and subsequently clipped to the RSA for analysis.

when all behavioral states are considered together, but select for them during movement (Abrahams et al. 2016), and avoidance of roads and human development by lions declines dramatically during dispersal (Elliot et al. 2014).

Although resistance surfaces derived using RSF developed using data from dispersing individuals[9] or from long-distance movements of resident animals may be useful for defining the location of corridors for protection (Abrahams et al. 2016), defining the location or function of movement corridors was not part of the scope of this EIS (Section 1.3, Appendix A). Instead, the task outlined for this EIS in the TOR was to consider changes in animal behavior and selection for habitats already designated for protection as movement corridors by the Province (Section 1.3).

The RSF models used in this EIS incorporate multiple behavioral states, which is appropriate for answering questions about how the Project could affect wildlife use in approved wildlife corridors. The models consider the breadth of behavioral states exhibited by grizzly bears, cougars, wolves, and elk in the Bow Valley, acknowledging that corridors in the Bow Valley may be used both for occasional dispersal by animals traveling to other destinations, for short inter-patch movement for resident animals, and as important habitat that contributes to population viability. Using probability of selection for all behavioral states combined also provides a better understanding of where animals are most likely to occur on the landscape and permits an improved understanding of potential habitat loss as a result of the Project and the potential for negative human-wildlife conflict.

Human use of trails could reduce wildlife use of high quality habitats and increase landscape resistance for movement (Ladle et al. 2016). Trail density was considered during RSF development and model selection (Appendix B) and appeared in the top models for grizzly bears (positively associated with trail density), cougars (negatively associated with trail density), and wolves (negatively associated with trail density). Trail density was considered for elk during model selection, but was not included in the top model (Appendix B). Because data about the intensity of human use on trails were not available concurrent with the telemetry data collected for the grizzly bears, cougars, wolves and elk in the Bow Valley, intensity of human use could not be included as a candidate variable in the RSF models.

Human use of recreational trails in the Bow Valley has increased substantially since the RSFs were estimated (J. Herrero, unpublished data), and is predicted to increase further as a result of the Project and other reasonably foreseeable developments and activities in the RSA (Section 5.8.1). Noting that site-specific data were not available to parameterize the strength of the response of wildlife to increased human use of trails in the Bow Valley[10], spatially explicit scenarios were run based on literature-based assumptions about potential reductions in probability of selection as a function of increased human use (Section 5.1.2, Appendix B).

Scenarios were run for grizzly bears, cougars, and wolves, both to describe existing conditions and to predict residual and cumulative effects. Trail use scenarios were not evaluated for elk because increased human use on trails was not anticipated to change probability of selection by elk in wildlife corridors. Elk in the Bow Valley are habituated to people, spend much of their time near and within development (Appendix B), and need to be aggressively chased in order to achieve displacement (Kloppers et al. 2005).

[9] Telemetry data from dispersing animals was not available for this EIS; only resident animals were collared.

[10] Human use data on trails and GPS collar data were not collected at the same time. Therefore RSFs could not be developed using amount of use on trails as a predictor variable in candidate sets (Appendix B).

5.1.3 Environmental Consequence

The TOR for the EIS requires that the residual impacts of the Project are identified, along with their significance (Appendix A). As described in Section 4.3, residual effects for each VEC were assigned an environmental consequence. A high environmental consequence, which can be considered a significant effect, was assigned if serious risk was identified. The definition of a serious risk varies among VECs and this section provides the methods used to identify whether or not a serious risk was present for wildlife under existing conditions or would be expected as a result of the Project, or the Project plus other reasonably foreseeable developments.

Defining a serious risk for wildlife was accomplished using the concept of self-sustaining and ecologically effective populations. Self-sustaining wildlife populations are populations that will be maintained into the future with a low risk of extirpation. Self-sustaining populations are healthy and viable populations, which are by definition robust and capable of withstanding environmental change and accommodating stochastic population processes (Reed et al. 2003). Maintaining viable populations is a conservation target frequently applied by conservation biologists and resource managers (Fahrig 2001; Nicholson et al. 2006; Ruggiero et al. 1994; With and Crist 1995).

Achieving viable populations may not be sufficient to meet conservation objectives for assemblages of wildlife species that might interact with the species being assessed (Soulé et al. 2005). For highly interactive wildlife species that have strong effects on ecosystem structure and function, such as grizzly bears (Gailus 2010), cougars (Ripple and Beschta 2006, 2008), or wolves and elk (Hebblewhite et al. 2005b), the concept of ecologically effective populations was also applied. An ecologically effective population differs from a self-sustaining population if the number of individuals needed to maintain ecological function is greater than the number required to maintain a viable population, or if the behavior of animals in a viable population of a highly interactive species is altered so that they no longer perform important ecological functions.

The potential for a serious risk was evaluated for grizzly bears, cougars, wolves, and elk by considering the cumulative effects of previous and existing disturbance on a) the amount habitat in the RSA, b) habitat connectivity, and c) mortality, and combining this with the predicted residual effects of the Project and the effects of the Project and other reasonably foreseeable developments. Although residual effects of the Project were characterized, the significance of the Project in isolation was not evaluated for wildlife because effects of a single project infrequently cause serious risk on their own (McCold and Saulsbury 1996).

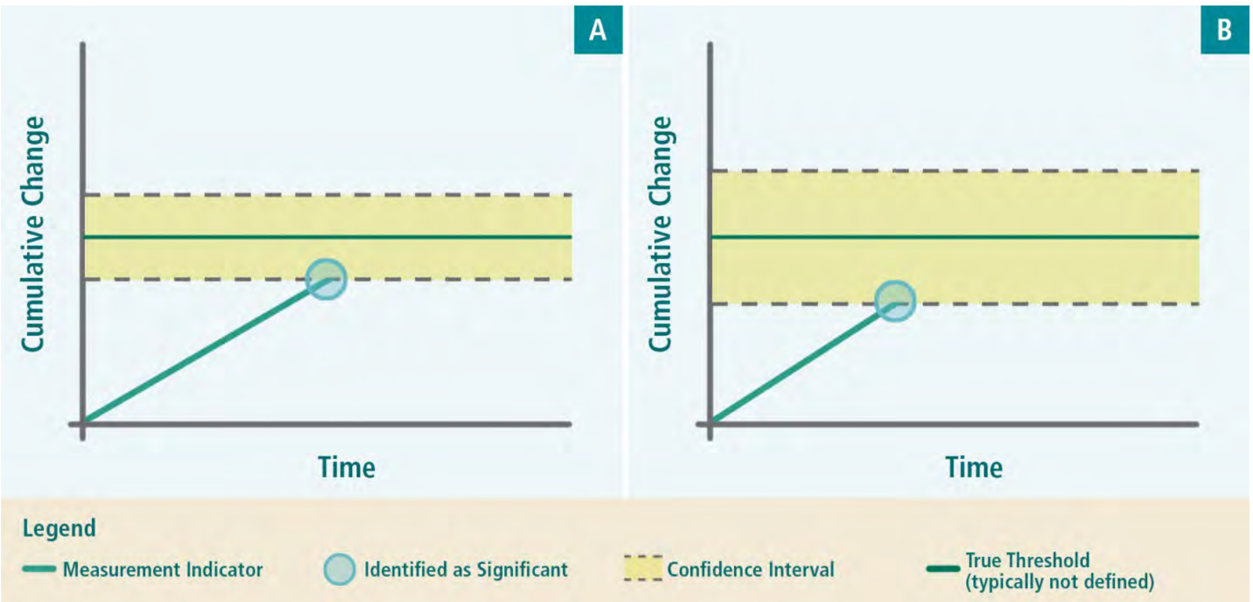
A serious risk was identified for grizzly bears, cougars, wolves, or elk if the evidence indicated that:

- the abundance of the species in the RSA, whether an open or closed population, is on a declining trajectory that is not predicted to recover or stabilize, or a population sink is present at the scale of the RSA;
- connectivity through the RSA for the species declines to a level at which population viability for the species in the RSA or in surrounding areas be adversely affected; or
- the species has lost important ecological function in the RSA, regardless of their self-sustaining status, such that the loss in function might trigger ecological changes that result in degraded or simplified ecosystems (Soulé et al. 2003).

Determining whether a wildlife population is self-sustaining and ecologically effective cannot be accomplished without a cumulative effects assessment and all aspects of the wildlife assessment consider cumulative effects (including the description of existing conditions). The potential contribution of the Project to the cumulative effect was described using the residual effects characterization.

Uncertainty about whether or not a serious risk was present was identified and discussed. Where uncertainty was high, the assessment applied a precautionary approach and identified a serious risk (equivalent to a high environmental consequence or significant effect) earlier on a continuum of cumulative change (Figure 10b) than where confidence was higher (Figure 10a). Serious risks identified because of high uncertainty were clearly recognized as such, and additional follow-up actions to reduce uncertainty were recommended.

Figure 10: Conceptual Schematic Showing Effect of Uncertainty on Significance Determination



Note: Where confidence was higher, a serious risk was identified closer to the unknown true threshold (A), but serious risk was identified farther from the unknown true threshold when confidence was lower (B).

5.2 Existing Conditions

5.2.1 Species Present, Habitat Features, and ESAs

Wildlife surveys do not always capture all species present; therefore both species that have been confirmed within the Project Boundary and those that are present in the Bow Valley and may occasionally overlap with the Project were identified so that appropriate mitigation could be considered in this assessment. Species of mammals, birds, amphibians, and reptiles that have been confirmed or are potentially present within or near the Project Boundary are provided in Appendix C. Mammals known to be present or potentially present include at least 16 species of carnivores, six species of ungulates, six bat species, and 29 species of small mammals. More than 180 species of birds were identified, along with six species of amphibians and two species of reptiles. Many of these species only occasionally use land within the Project Boundary.

Of the species identified, 41 are provincially-listed as Sensitive and eight are listed provincially as May Be At Risk or At Risk (Appendix C). Thirteen species are federally-listed under COSEWIC, and seven of these are also federally-listed under the Species at Risk Act (Appendix C). Of the federally-listed species or species listed provincially as May Be At Risk or higher, only two are known to use the Project area with some frequency:

- Grizzly bears regularly occur near the Project and a number of studies have recorded their presence in and around TSMV land (UMA 1991b; JWA 2005; Leeson and Kamenka 2008; Golder 2013). The northwest population of grizzly bears, including those in the Canmore region, are federally-listed as species of Special Concern (COSEWIC 2012). This status designation indicates that the population has the biological characteristics that make it particularly sensitive to human activities. The species is provincially-listed as Threatened (ASRD 2010) and is addressed in detail as one of indicator species selected for this assessment.

- Western toads have been observed in the Project Boundary and have been known to breed in some of the wetlands near the Project. Western toads are federally-listed as a species of Special Concern (COSEWIC 2002) and provincially-listed as Sensitive (ASRD 2010). Mitigation to avoid impacts to breeding habitat for western toads is presented in Section 5.5.

Wildlife habitat present in the Project Boundary has been substantially modified by human activity, especially in the area of the unfinished golf course where the amendment is being sought. The Project was previously affected by open pit and underground mining and in 2016 was largely comprised of modified grasslands associated with the unfinished golf course. Under existing conditions, other areas within the Project Boundary are influenced by utility corridors, roads, and a large number of designated and undesignated hiking and biking trails that are subject to high levels of human use (Section 5.2.2). Nevertheless, important habitat features and ESAs for wildlife are still present within or adjacent to the Project Boundary, as follows:

- The Tipple Across Valley Corridor (Figure 2).
- The Along Valley Corridor (Figure 2).
- Breeding habitat for western toads in wetlands and riparian habitats, particularly long-toed salamander habitat at a wetland, commonly known as “Railbed Pond”, in the Project Boundary (Figure 53, wetlands 2N; JWA 2005, 2008; Golder 2013).
- Nesting habitat for birds associated with forested habitat, meadows, and wetlands. Larger grassy areas surrounding artificial ponds in the Project area can also be used as nesting habitat for some species of waterfowl.
- Portions of the Project area and surrounding areas are used as elk calving grounds in spring (Wildlife & Company 1998a,b; Delta 1991a).

The Tipple Across Valley and Along Valley Corridors are part of a broader network of wildlife corridors and habitat patches, which are ESAs designed to maintain viable wildlife populations in the RSA. In the 1990’s a number of habitat patches were identified and set aside to provide for the needs of a variety of wildlife species (BCEAG 1999a). These habitat patches are linked to one another with designated wildlife movement corridors (BCEAG 2012).

Movement corridors are especially important for large mammals, for which many habitat patches in the Bow Valley are too small to meet all of an individual animal’s requirements and population viability depends on connectivity among patches (Weaver et al. 1996; BCEAG 1999a). Connectivity across the Trans-Canada Highway is also important for large mammals (Merrill 2005), but has been strongly constrained by cumulative effects of development in the valley bottom (Golder 2013). The network of corridors and highway crossing structures in the Bow Valley was established to help mitigate adverse cumulative effects on wildlife connectivity.

5.2.2 Human Use

Negative human-wildlife interactions have been increasing under existing conditions in the Bow Valley, predominantly in places where wildlife habitat occurs adjacent to human development (Town of Canmore 2015a). Increasing negative interactions between people and animals in all of its forms relates, at least in part, to increasing development and human use in the Bow Valley. Based on 10 years of monitoring of trails in the Bow Valley, using trail counters deployed during 2003-2012, J. Herrero (unpublished data) estimates that human use is increasing near Canmore at a rate of approximately 6% per year. Human use is common on trails throughout the RSA, including on designated and undesignated trails in wildlife corridors, as indicated by data collected by Strava[11] (Figure 11).

Much of the human use within existing corridors that increases potential for negative human-wildlife interactions is contrary to existing regulations. For example, human use in wildlife corridors is only permitted on designated trails (Government of Alberta 2002). However, undesignated trails are more common than designated trails in wildlife corridors in the RSA (i.e., 57.7 km of designated trail and 83.9 km of undesignated trail)[12], and trails often radiate out from the backyards of residences adjacent to corridors.

The Bow Valley Protected Areas Management Plan applies special designation to some wildlife corridors in the RSA. For example, the Along Valley Corridor is designated a P-4 wildlife corridor, which means that most trails are closed during December 1 to June 15 (Government of Alberta 2002). Analysis of remote camera data showed that this corridor was used by people year round, with use increasing rapidly during April and May, remaining relatively high until August and then declining during winter. The period of higher use during April and May overlaps with the closure period.

Similarly, off-leash dog use is not permitted in wildlife corridors, but commonly occurs in wildlife corridors and habitat patches in the RSA (Golder 2013 pg. 58). Such use could be one of the most important factors adversely affecting wildlife use of corridors and habitat patches in the Bow Valley (Young et al 2011).

On TSMV property and in adjacent wildlife corridors, human use and off-leash dog use are highest in the Project Boundary, followed by the wildlife corridors adjacent to it (Figure 12). Human use is much less common in the Smith Creek ASP boundary and in the adjacent approved and proposed corridors (Figure 12).

Greater human use in the corridors adjacent to the Resort Centre ASP Amendment boundary is linked to how far away corridors are from urban developments. Most people accessing wildlife corridors, do so from adjacent development where they live or park their cars, as evidenced by a strong relationship between the amount of human use detected at a camera locations and the distance of the camera from the nearest urban development (Figure 13).

Cameras detected humans more frequently than wildlife in some wildlife corridors. Cameras deployed within the Tipple Across Valley and Along Valley Corridors adjacent to the Project Boundary detected humans twice as often as wildlife (66% vs. 34%, respectively), whereas cameras deployed in the approved and proposed wildlife corridors adjacent to Smith Creek recorded approximately half as many people as wildlife (40% vs. 60%, respectively).

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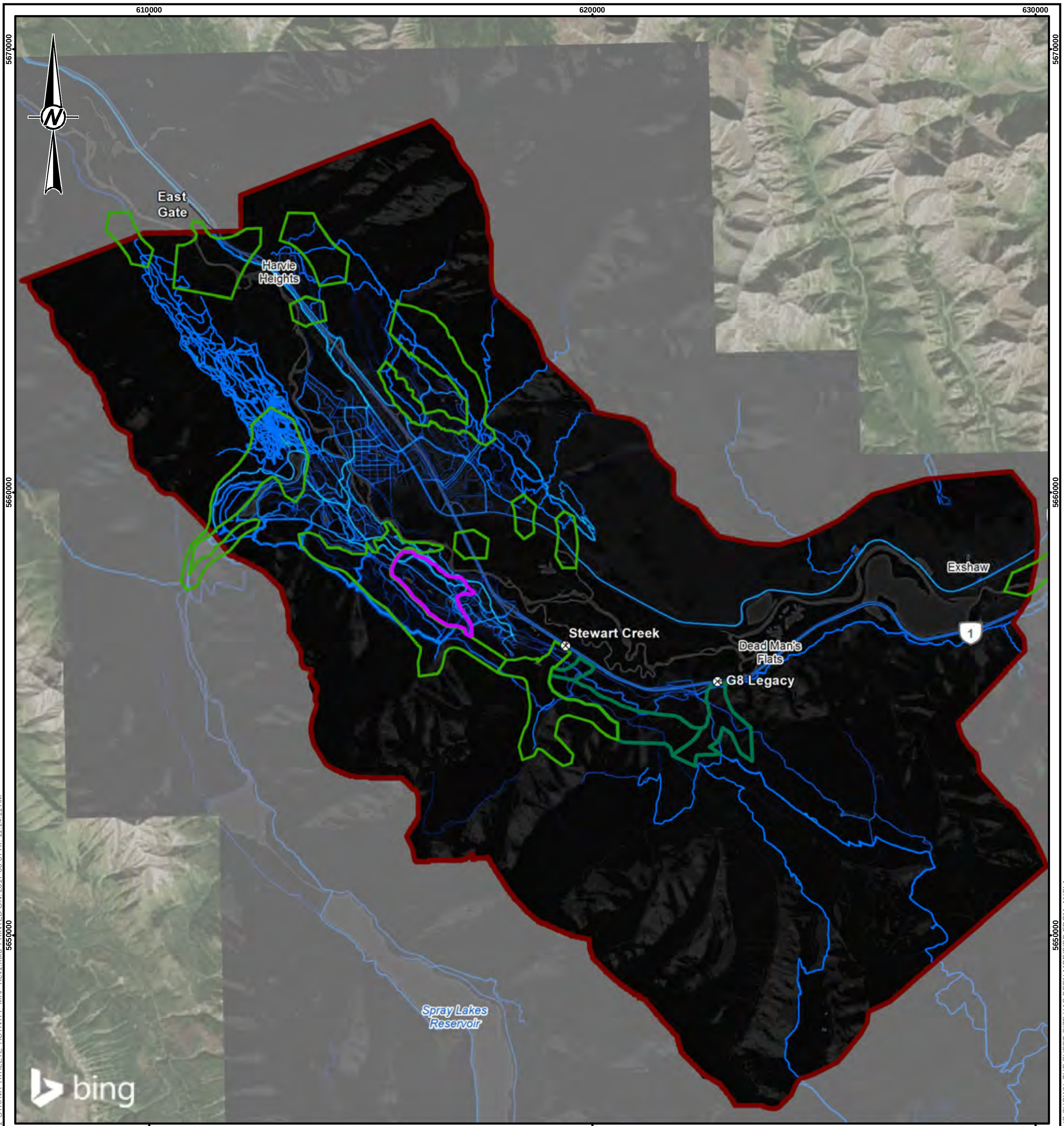
[11] Strava is a social network for athletes where members can upload spatial data associated with their workouts online. The data are therefore biased to the sub-portion of the population that uses Strava, mostly runners and cyclists. Strava's website can be accessed at https://www.strava.com.

[12] Undesignated trails may be under-represented because not all of them have been mapped and new trails are created each year, often by individuals who do not know they are building trails in wildlife corridors (Derworiz 2015).



LEGEND

- ⊗ HIGHWAY WILDLIFE UNDERPASS
- STRAVA IDENTIFIED TRAILS
- 2016 WILDLIFE CORRIDOR PROPOSAL
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- REGIONAL STUDY AREA

0 2,000 4,000

1:125,000 METRES

REFERENCE(S)

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.
2. STRAVA IDENTIFIED TRAILS OBTAINED JANUARY 2017 FROM STRAVA HEAT MAP.
3. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
4. UPDATED STEWART CREEK ACROSS VALLEY CORRIDOR DATA LAYER FROM QPD IN OCTOBER 2016.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

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PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
STRAVA ATHLETE ACTIVITY MAP

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	11

Figure 12: Use of TSMV and Adjacent Approved and Proposed Wildlife Corridors by Hikers, Bikers, and Off Leash Dogs

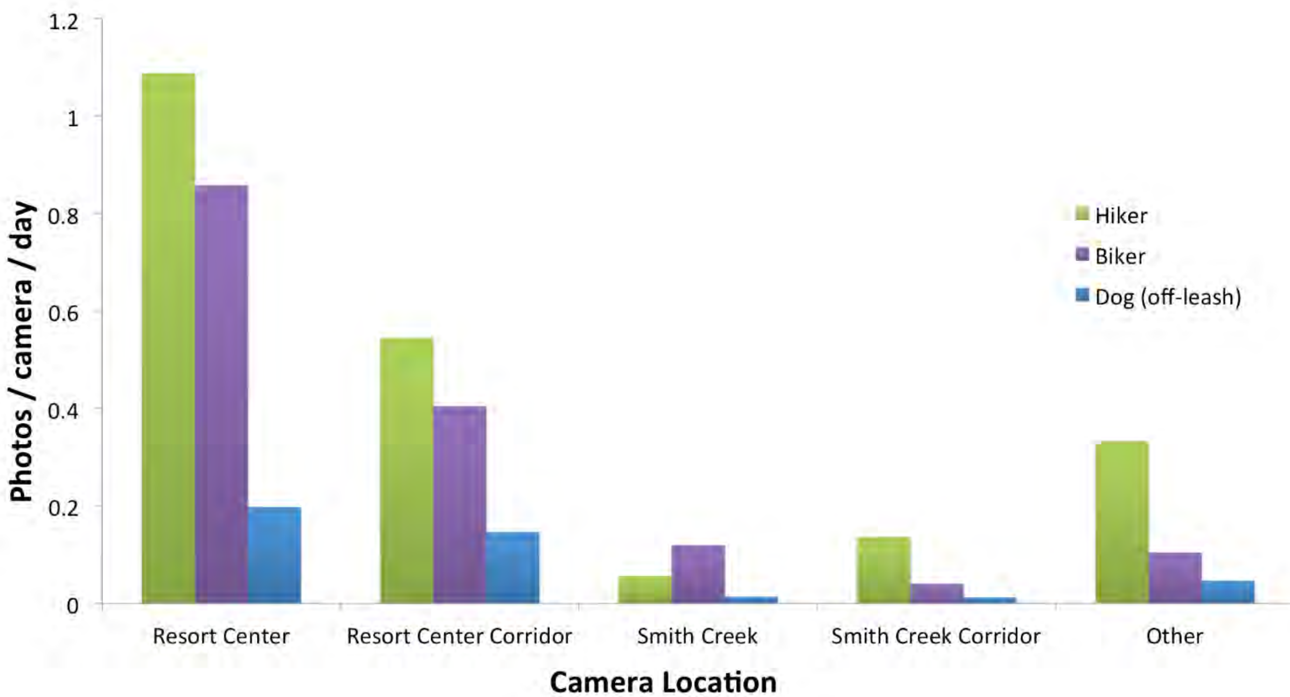
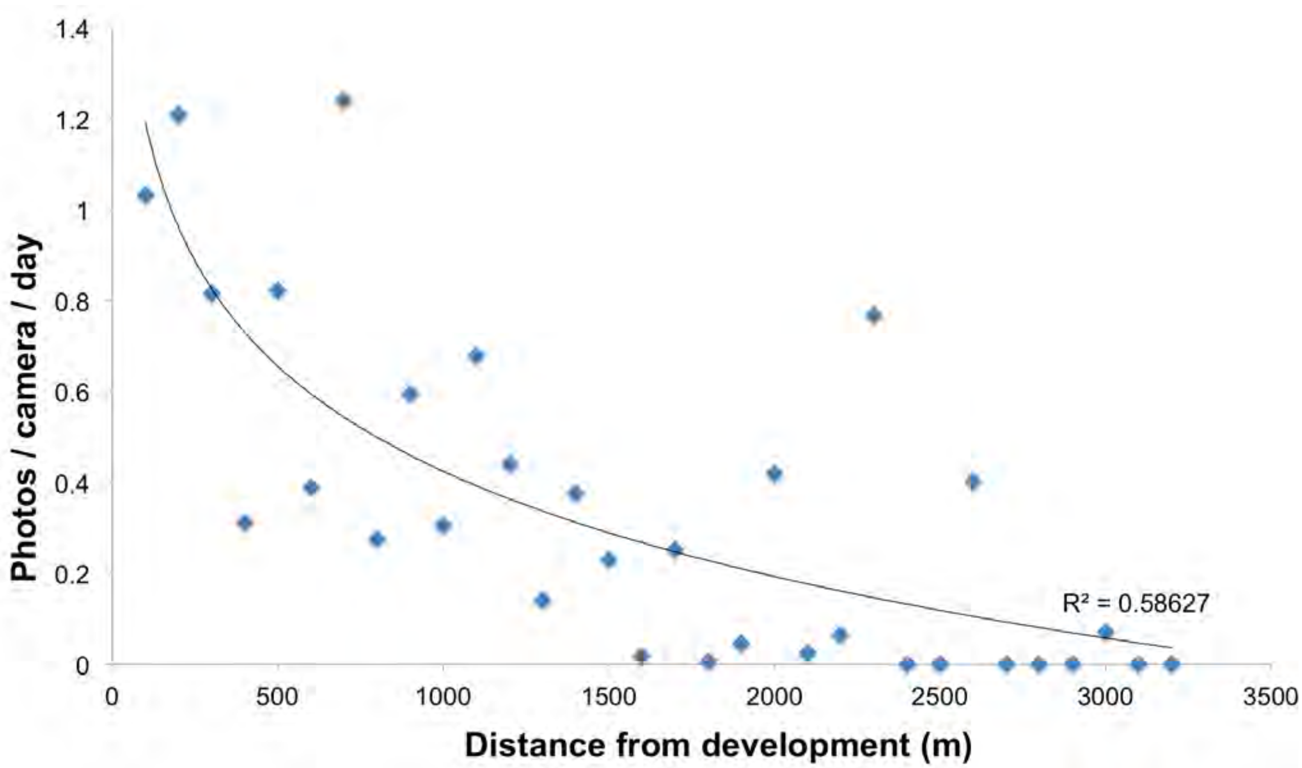
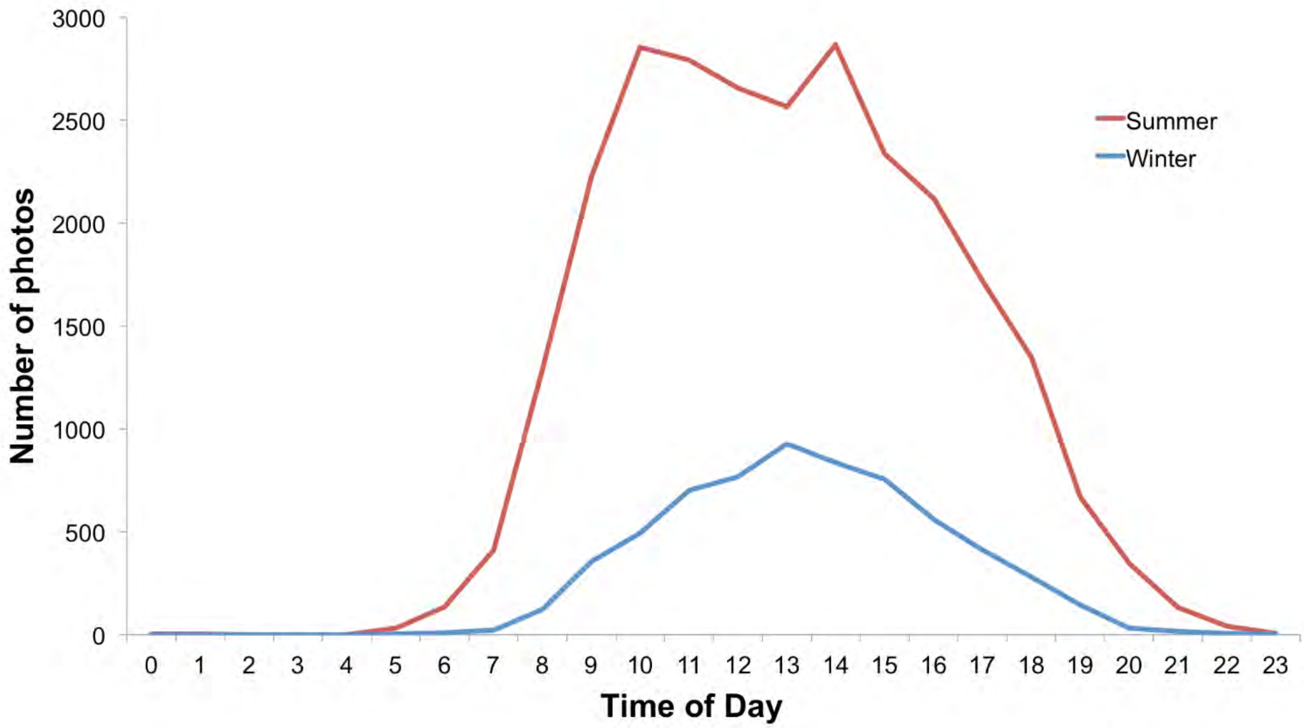


Figure 13: Relationship Between Intensity of Human Use at Camera Locations and Distance to Urban Development



Human use varies substantially by season and time of day (Figure 14). The lack of human use of natural habitats at night means that the potential for negative wildlife-human interactions in wildlife corridors is restricted to daylight hours. Human use is lowest in winter, which is the same period that wildlife are most restricted to the valley bottom (Appendix B) and is therefore the period during which use of low elevation wildlife corridors is most important.

Figure 14: Temporal and Seasonal Patterns of Human Activity



Rates of human use at camera locations on designated trails within wildlife corridors exceeds rates of human use on undesignated trails (Table 11). However, the linear distance of designated trails in wildlife corridors is small (Table 11), and the diffused nature of human use on a larger linear network of undesignated trails and use of areas where neither designated nor undesignated trails are defined, means that the majority of all human use in wildlife corridors under existing conditions occurs away from designated trails (Table 11, Figures 15 and 16).

Table 11: Human use of designated and undesignated trails in wildlife corridors

Trail Type	Resort Centre Wildlife Corridor[(a)]		Smith Creek Wildlife Corridor[(b)]	
	photos/camera/day	Linear distance (km)	photos/camera/day	Linear distance (km)
Designated	10.85	4.4	0.61	1.8
Undesignated	1.48	26.8	0.33	25.0
Other	0.38	undefined	0.20	undefined

[(a)] Approved Along Valley Corridor and Tipple Across Valley Corridor adjacent to the Project Boundary.

[(b)] Approved Along Valley Corridor and 2017 corridor proposal adjacent to Smith Creek.

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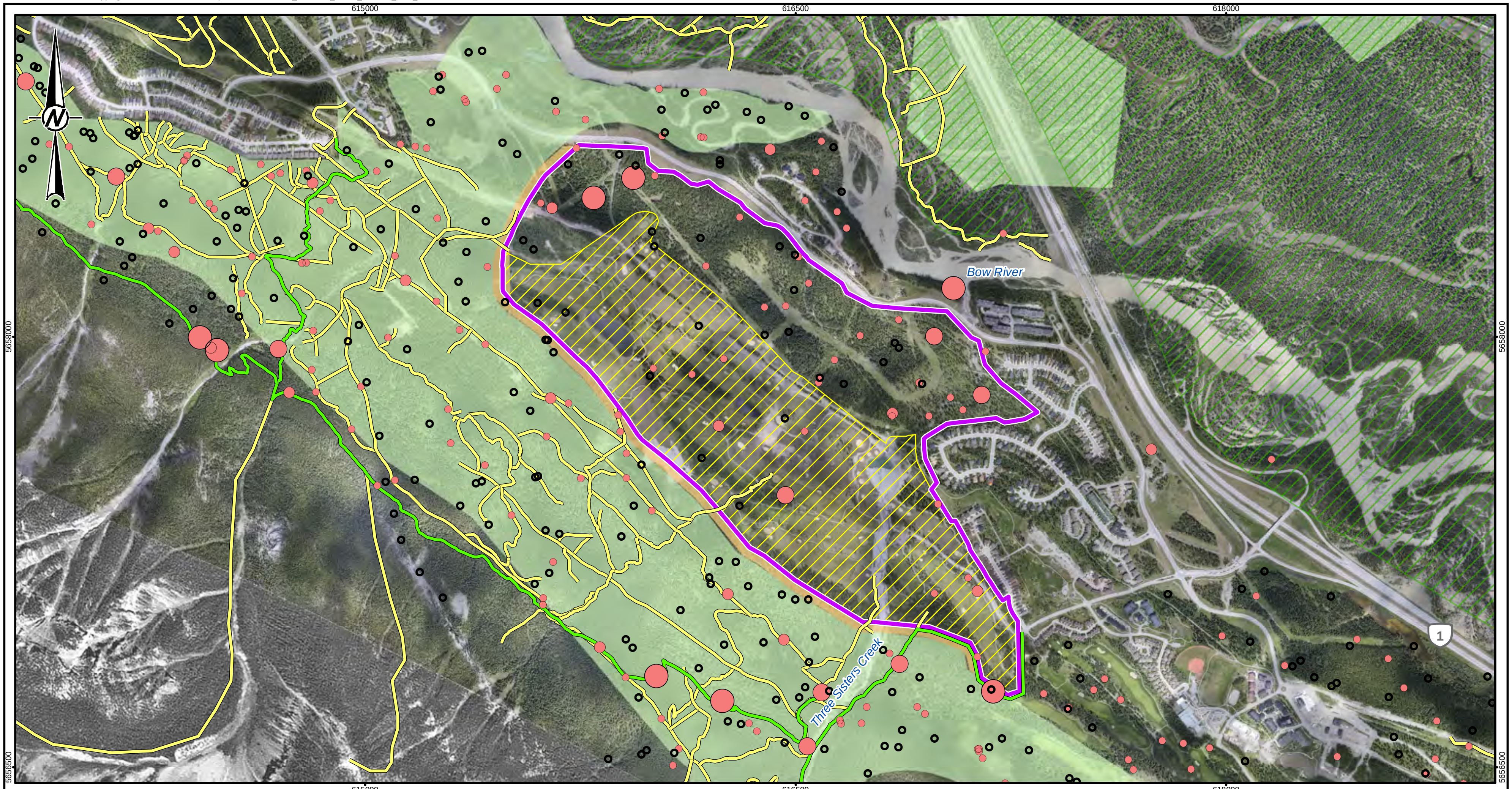

LEGEND

- DESIGNATED TRAIL
- UNDESIGNATED TRAIL
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

MEAN NUMBER OF INDIVIDUALS PHOTOGRAPHED PER DAY*

- 0.000
- 0.011 - 2.817
- 2.817 - 6.742
- 6.742 - 13.786
- 13.786 - 33.581

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. REMOTE CAMERA DATA (2013 - 2016) OBTAINED FROM AEP, AUGUST 2016. USED UNDER LICENCE.
3. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
4. TRAILS OBTAINED FROM ALBERTA PARKS AND PROTECTED AREAS, 2011. ADDITIONAL TRAILS DIGITIZED 2016.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
HUMAN USE RECORDED ON REMOTE CAMERAS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	15

NOTE
*DATA INTERVALS CATEGORIZED USING JENKS METHOD FOR NATURAL BREAKS

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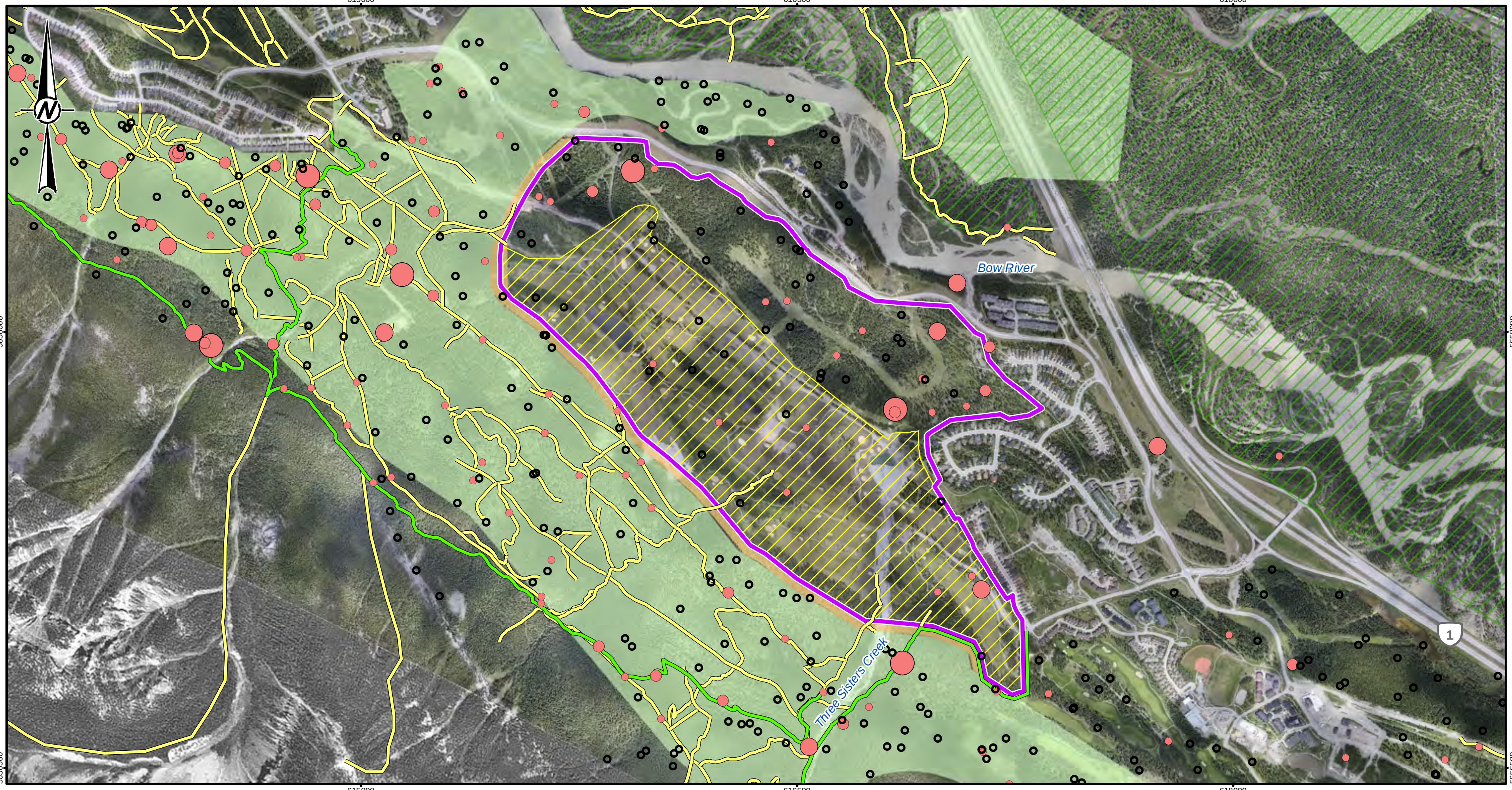

LEGEND

- DESIGNATED TRAIL
- UNDESIGNATED TRAIL
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

MEAN NUMBER OF INDIVIDUALS PHOTOGRAPHED PER DAY*

- 0.000
- 0.005 - 0.458
- 0.458 - 1.006
- 1.006 - 1.878
- 1.878 - 3.362

NOTE
*DATA INTERVALS CATEGORIZED USING JENKS METHOD FOR NATURAL BREAKS

0 500 1,000
1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. REMOTE CAMERA DATA (2013 - 2016) OBTAINED FROM AEP, AUGUST 2016. USED UNDER LICENCE.
3. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
4. TRAILS OBTAINED FROM ALBERTA PARKS AND PROTECTED AREAS, 2011. ADDITIONAL TRAILS DIGITIZED 2016.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
OFF-LEASH DOG USE RECORDED ON REMOTE CAMERAS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	16

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5.2.3 Grizzly Bears

The Bow Valley, including the towns of Canmore, Banff and Lake Louise, represents one of the most intensely developed and heavily accessed landscapes in North America where a grizzly bear population still persists (Chruszcz et al. 2003). Habitat quality in the Bow Valley around Canmore is high for grizzly bears during summer (Chetkiewicz and Boyce 2009), and grizzly bears commonly access it (Gibeau et al. 2002b, Chruszcz et al. 2003, Appendix B, Figure B-2).

Under existing conditions, grizzly bears use a wide variety of habitats throughout the RSA at virtually all elevations, slopes, and aspects to meet their life requisites (Chetkiewicz and Boyce 2009). Grizzly bears make use of the RSA on both sides of the Trans-Canada Highway based on radio telemetry data, and use wildlife corridors and other undeveloped or less developed portions of the landscape to move between habitat patches. During summer (June 16 to August 10), grizzly bears spend most of their time at lower elevations (Appendix B); this is when movement is potentially affected by development at the valley bottom. During the non-summer season (August 11 to November, and April to June 15) bears spend most of their time at higher elevations (Chetkiewicz and Boyce 2009).

Highways and towns, like those present in the RSA, can isolate grizzly bear populations in some cases (Mace et al. 1999, Proctor et al. 2005). Least cost path analysis conducted for grizzly bears and cougars near Canmore indicates that preferred movement routes occur upslope from currently designated wildlife corridors and away from development, indicating that substantial space is available for east-west movement through the Bow Valley for grizzly bears under existing conditions (Chetkiewicz and Boyce 2009). The Trans-Canada highway and associated fencing reduce north-south connectivity in the RSA, but wildlife crossing structures help to mitigate this risk (Clevenger et al. 2009). Collared bears from which telemetry data were collected near Canmore all crossed the Trans-Canada Highway (Appendix B, Figure B2). With the exception of underpasses, most of the areas designated as wildlife corridors in the Bow Valley function as extensions of habitat patches and are intensely used by grizzly bears (Appendix B, Figure B-5).

Although high quality habitat is abundant and movement and habitat connectivity has been maintained in the Bow Valley under existing conditions, a serious risk is present for grizzly bears because of mortality. One of the consequences of habitats with a high probability of grizzly bear selection near towns, roads, and other places where human use is high is that an ecological trap can occur. An ecological trap is present when attractive habitats cause animals to come to an area, but mortality risk in that area means that the use of the habitat results in a net loss for the population. Because grizzly bears can adapt to human presence and frequently use habitats near development (Roever et al. 2008, Roever et al. 2010; Stewart et al. 2012; Elfstrom et al. 2012; Labree et al. 2014; McKay et al. 2014), ecological traps for this species are increasingly reported in the literature (Lamb et al. 2016), including near Canmore, which has been identified as one of the places with the highest mortality risk for grizzly bears in western Alberta (Nielsen et al. 2004).

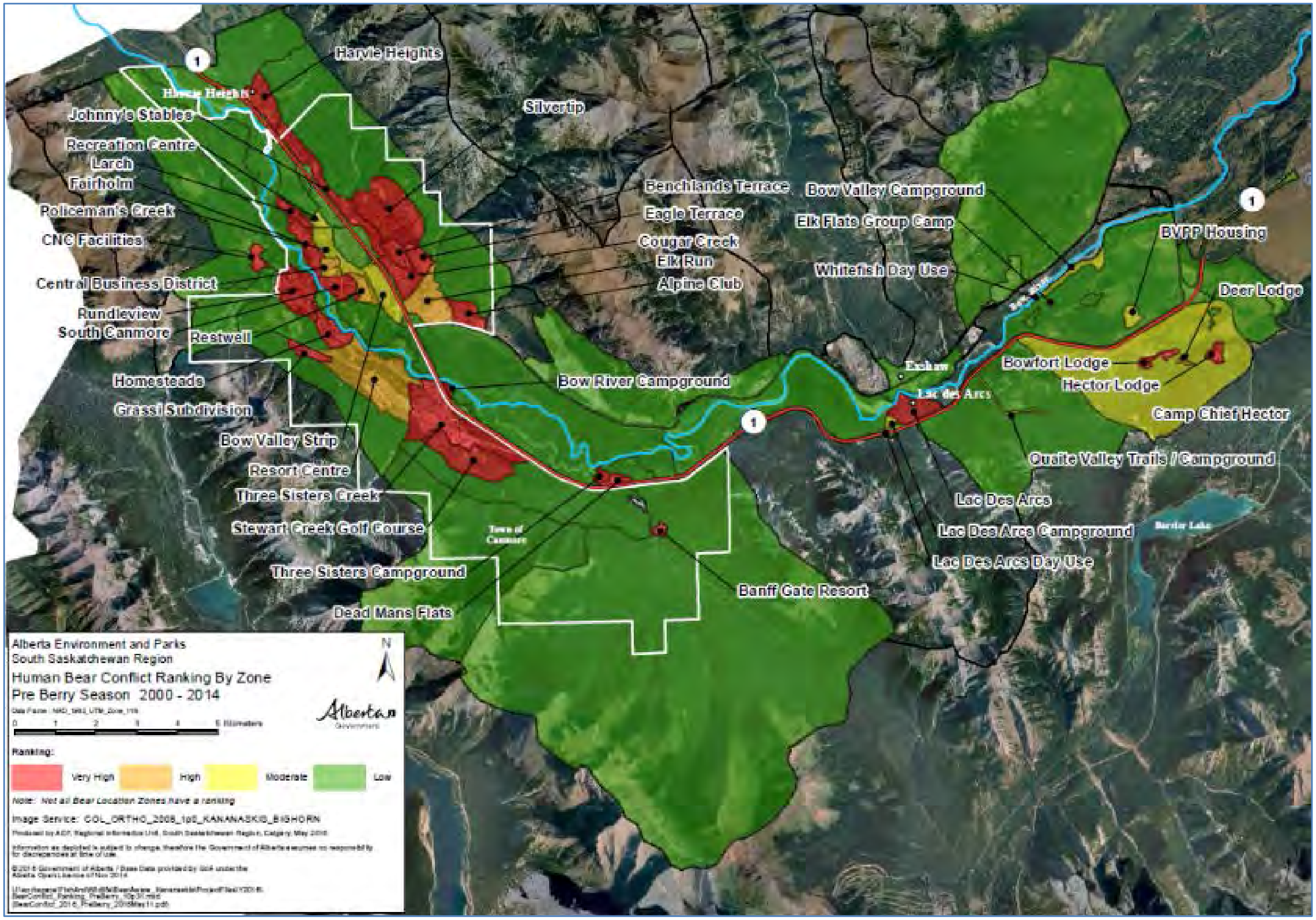
Garbage management and many other aspects of minimising negative human-wildlife interactions are better in Canmore than some other places in North America where people and bears co-exist, but fruit trees and other attractants, which have not been explicitly addressed in the Town's bylaws, remain a problem (Figure 17). Because habitats within or adjacent to development are attractive to bears, places like Peaks of Grassi, the Homesteads, Rundleview, Cougar Creek, and Silvertip where housing developments occur adjacent to wildlife corridors or habitat patches are hotspots for negative human-bear interactions (Figure 18).

Figure 17: A Black Bear Eats Apples in a Back Yard in Cougar Creek (photo courtesy Jay Honeyman)

Tolerance for negative interactions between bears and people in the Bow Valley is low (Jorgenson 2012, pers. comm.) and bears in Canmore are often hazed, translocated, or killed if they spend time near residential developments, or are involved in aggressive interactions with people. Most grizzly bear mortality in the Bow Valley is human-caused, with bears dying as a result of vehicle or train strikes, or removed as problem animals (Nielsen et al. 2004; Garshelis et al. 2005). During 1997-2015, 17 grizzly bears, 158 black bears, and 4 bears of unknown species were killed or translocated in the immediate vicinity of Canmore (from the Banff East Gate to the Kananaskis River), averaging more than nine bears per year (AEP, unpublished data). Bears that are relocated do not always survive, and those that do may return over distances of hundreds of kilometers to the original location of the negative interaction or may cause additional negative interactions elsewhere (Linnell et al. 1997).

Delayed age of first reproduction, long inter-birth intervals, and small litter sizes mean that grizzly bears have a limited capacity to compensate for human-caused mortality, especially mortality of adult females (ASRD and ACA 2010). Consequently, where human-caused mortality of bears occurs, it presents a significant conservation challenge for grizzlies in Alberta (Nielsen et al. 2004). High mortality rates near Canmore have led scientists and government wildlife managers to conclude that the Bow Valley represent an ecological trap for grizzly bears (Benn and Herrero 2002; Hebblewhite et al. 2003; Nielsen et al., 2004; Nielsen et al. 2006; Sawaya et al. 2012; Webb 2013, pers. comm.; Boukall 2016, pers. comm.). Sawaya et al. (2012, pg. 11) succinctly conclude that, although additional confirmatory analyses would be helpful, their results “show concordance with previous research suggesting that the Bow Valley may act as an attractive sink for grizzly bears in the Central Canadian Rocky Mountains”.

Figure 18: Spatial Depiction of Negative Human Bear Interaction Data in the Bow Valley



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Within the Project Boundary, summer grizzly bear habitat under existing conditions consists primarily of those that are selected or used as available (Table 12, Figures 18 and 19). However, these habitats are also heavily used by people under existing conditions (Section 5.2.2) and the Project Boundary is in an area identified by AEP as having high human bear conflicts (Figure 18).

Although habitat conditions in the Project Boundary are selected by grizzly bears during summer, the probability that winter dens are present is near zero. Studies of grizzly bear denning habitat in the Central Rockies ecosystem around Banff and Canmore show that grizzly bears den in upper subalpine habitat, where they excavate dens on steep slopes, most often choosing slopes between 30° and 38° (Vroom et al. 1980). Grizzlies also select locations where heavy snowfall will provide good insulating cover for the den (Vroom et al. 1980). More recent work in the northern Rocky Mountains of Alberta yielded similar findings (Pigeon et al. 2014), with bears selecting high elevation habitats with steep slopes and consistent snowpack for denning. Because the Project Boundary consists of flat low elevation habitat where deep snow does not accumulate during winter, denning habitat for grizzly bears is not present.

Table 12: Grizzly bear habitat in the Project Boundary under existing conditions with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha)	With Estimated Effects of Increased Human Use on Trails (ha)
Selected	115	114
Used as available	48	49
Somewhat avoided	0	0
Strongly avoided	0	0
Rarely used	0	0
Total	**163**	**163**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

Wildlife corridors adjacent to the Project Boundary consist primarily of habitat that is selected or used as available by grizzly bears during summer (Table 13). High human use does not strongly affect grizzly bear selection in the Bow Valley, and bears sometimes select habitats, such as the Canmore Nordic Centre, that have high trail density (Appendix B) and are subject to very high levels of human use (Figure 11). In both the RSF without estimated effects of increased human use on trails and the RSF with the estimated effects of increased human use on trails, therefore, habitats that are strongly avoided or rarely used and may create higher resistance to grizzly bear movement are uncommon in the approved wildlife corridor, i.e., up to 4.5% of the corridor (Table 13). Grizzly bears can adapt to temporal patterns of human use (Boyce et al. 2010), and therefore reductions in probability of selection associated with human use of trails identified in Table 13 are likely present only during the day when human use on trails occurs (Section 5.2.2).

Habitat that is used as available or selected by grizzly bears extends upslope from the approved Along Valley Corridor (Figures 19 and 20). Habitats south of the approved Along Valley Corridor adjacent to the Project Boundary were identified by Chetkiewicz and Boyce (2009) as a multi-season movement route for grizzly bears and cougars.

Table 13: Grizzly bear habitat in wildlife corridors adjacent to the Project amendment boundary under existing conditions with and without estimated effects of human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha)	With Estimated Effects of Increased Human Use on Trails (ha)
Selected	154	138
Used as available	144	137
Somewhat avoided	64	84
Strongly avoided	14	16
Rarely used	1	1
Total	**377**	**377**

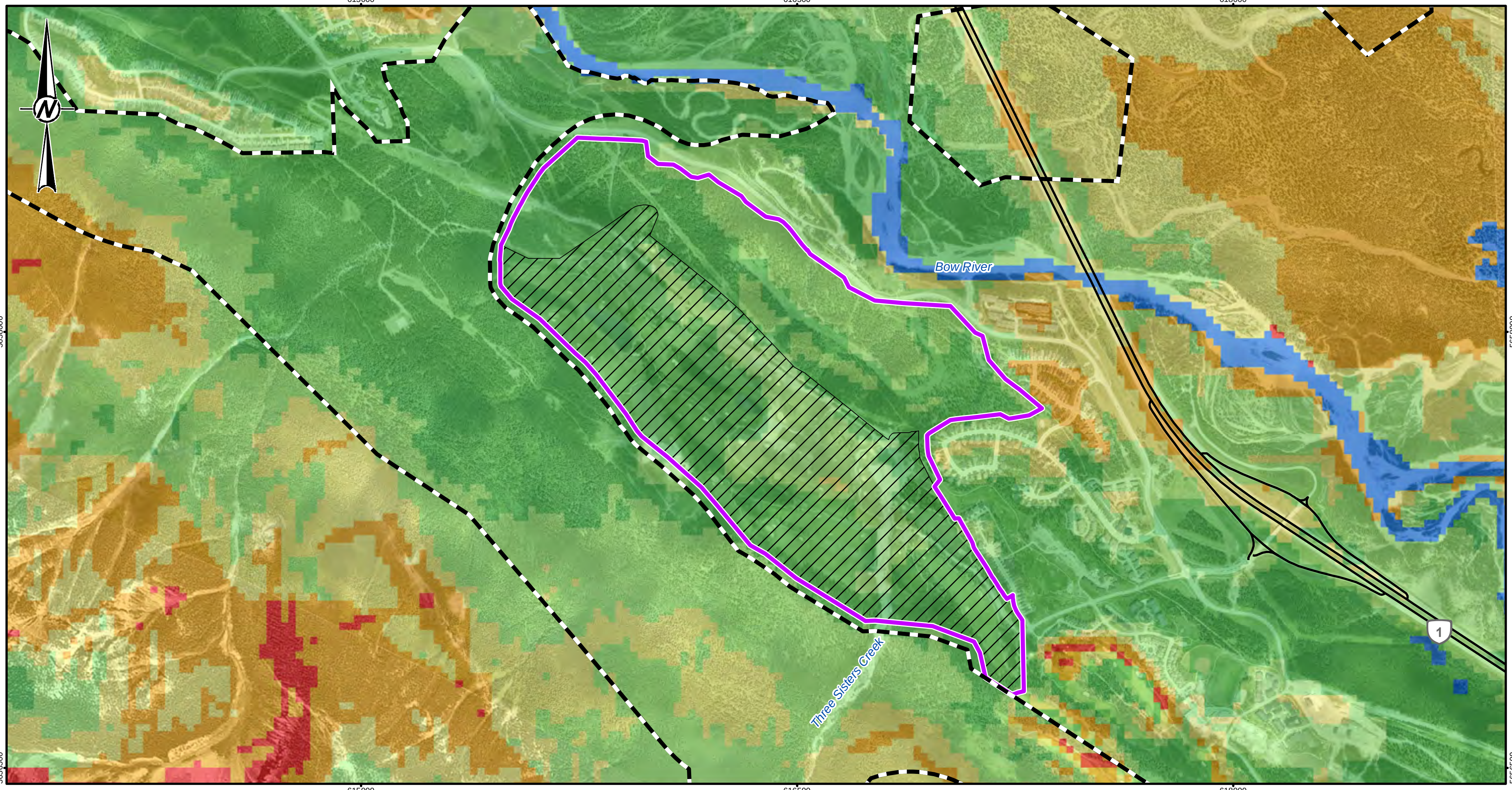
Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

Although grizzly bears were rarely detected by remote cameras in the vicinity of the Project (Figure 21), they were detected by cameras placed in approved or proposed wildlife corridors (0.0011 detections/camera/day near the Project Boundary and 0.0013 detections/camera/day near Smith Creek) more frequently than at cameras placed elsewhere in the deployment area (0 – 0.0005 detections/camera/day). However, camera data may underestimate grizzly bear use of the Project Boundary because cameras were not deployed in open habitats (Section 5.1.1).

Grizzly bears were detected most frequently at cameras deployed on designated trails (0.0053 detections/camera/day), followed by undesignated trails (0.0019 detections/camera/day), and were less commonly detected at cameras deployed on other trails (0.0006 detections/camera/day). However, because designated trails are not common in the wildlife corridors, most grizzly bear occurrences were recorded on undesignated or other trail types (Figure 21). Cameras were not placed south of the approved Along Valley Corridor where Chetkiewicz and Boyce (2009) identified a multi-season movement route for grizzly bears and cougars.

Grizzly bears were detected by cameras throughout the day and night, with peaks at 7:00am and 6:00pm. Peak grizzly bear detections were at the margins of where human use was highest, but grizzly bears and people showed overlap in patterns of temporal use. Black bears showed even greater overlap with people, with most detections recorded between 1:00pm and 8:00pm.

PATH: I:\2015\1539221\Mapping\MXD\ResortCentre\Rev1\QUANTUM-RESORT_CENTRE_FIG19_GRIZZLY_EXISTING-Rev1.mxd PRINTED ON: 2017-03-07 AT: 11:17:31 AM



LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

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PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
SUMMER GRIZZLY BEAR RESOURCE SELECTION – EXISTING CONDITIONS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	19

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm

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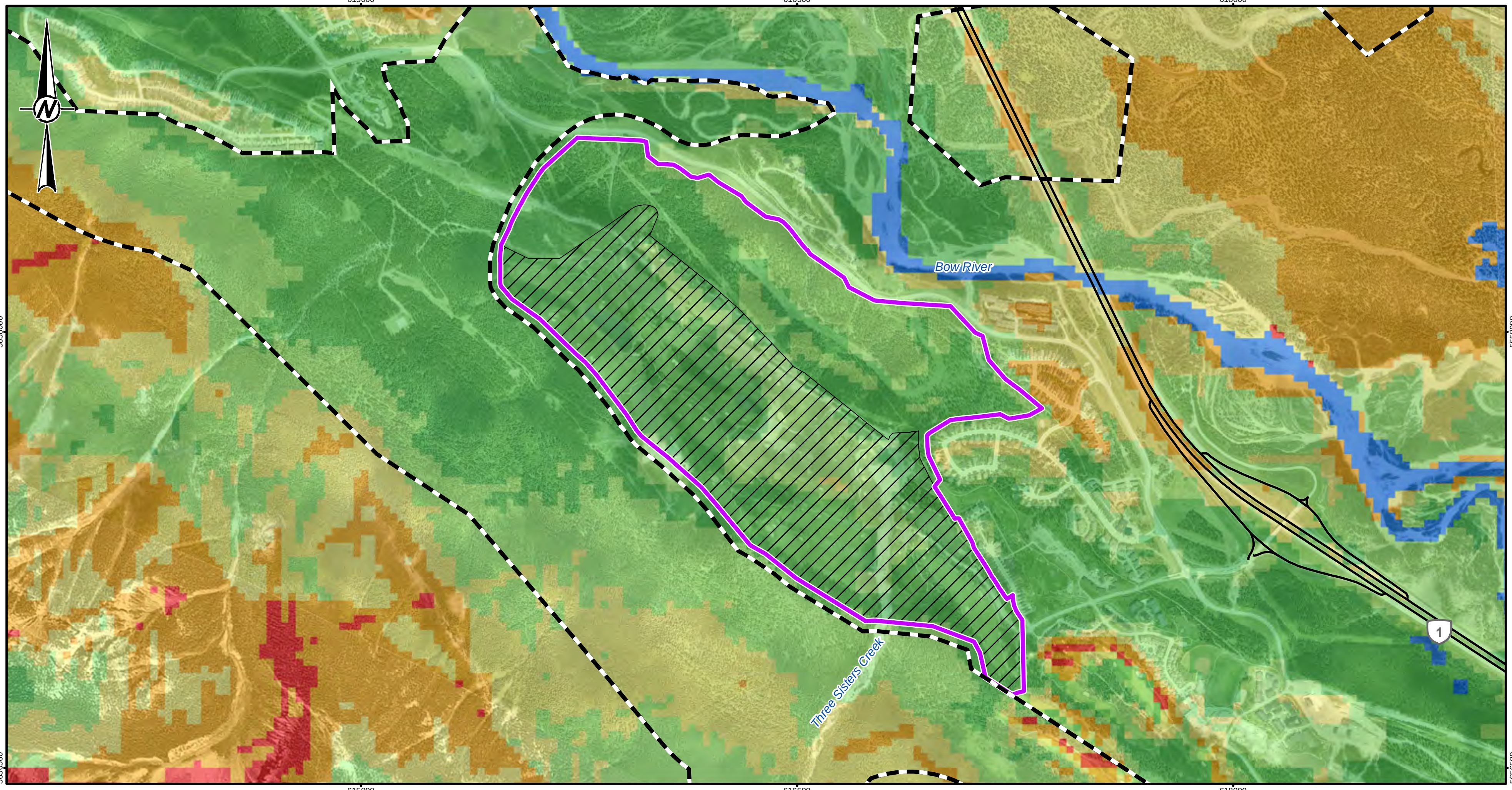
PATH: I:\2015\1539221\Mapping\MXD\ResortCentre\Rev1\QUANTUM-RESORT_CENTRE_FIG20_GRIZZLY_EXISTING_TRAIL-Rev1.mxd PRINTED ON: 2017-03-07 AT: 1:48:17 PM



LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
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Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
SUMMER GRIZZLY BEAR RESOURCE SELECTION – EXISTING CONDITIONS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	20

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm

PATH: I:\2015\1539221\Mapping\MXD\ResortCentre\Rev1\QUANTUM-RESORT_CENTRE_FIG21_GRIZZLY_CAM-Rev1.mxd PRINTED ON: 2017-03-02 AT: 1:29:04 PM

LEGEND

- DESIGNATED TRAIL
- UNDESIGNATED TRAIL
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

MEAN NUMBER OF INDIVIDUALS PHOTOGRAPHED PER DAY*

- 0.000
- 0.003 - 0.034
- 0.034 - 0.053
- 0.053 - 0.071
- 0.071 - 0.100

NOTE
*DATA INTERVALS CATEGORIZED USING JENKS METHOD FOR NATURAL BREAKS

0 500 1,000
1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. REMOTE CAMERA DATA (2013 - 2016) OBTAINED FROM AEP, AUGUST 2016. USED UNDER LICENCE.
3. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
4. TRAILS OBTAINED FROM ALBERTA PARKS AND PROTECTED AREAS, 2011. ADDITIONAL TRAILS DIGITIZED 2016.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

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YYYY-MM-DD	2017-03-02
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
GRIZZLY BEARS RECORDED ON REMOTE CAMERAS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	21

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
25mm 0

5.2.4 Cougars

Cougars are ecosystem generalists capable of occupying diverse habitats provided sufficient prey and cover are present. Deer, elk and bighorn sheep, all important prey for cougars, are present in suitable habitats throughout the RSA. Cougars using the RSA are part of a broader regional population occupying the eastern slopes of the Rocky Mountains from the U.S. border to northwestern Alberta.

Although the size and trend of the cougar population in the RSA have not been rigorously measured, cougars are common. Cougars were the most frequently tracked carnivore during winter backtracking studies undertaken by the Province in 2002 (Regional Wildlife Corridor Study 2002). Detections in the vicinity of TSMV were obtained at a rate of 0.005/camera/day, including photos of females with kittens. At broader regional scales, cougar populations have been increasing and expanding their range since the late 1970s (Ross and Jalkotzy 1992; Knopff et al. 2013). Human caused mortality, especially from hunting and trapping, is the most important mortality source for cougar populations in Alberta (Knopff et al. 2010). Because cougar harvest is managed to achieve stable populations in the RSA and cougar densities in the vicinity of the RSA are among the highest in the Province (Alberta Environment & Sustainable Resource Development 2012), self-sustaining and ecologically effective populations are likely present.

Connectivity between habitat patches for cougars either through corridors or in otherwise undeveloped land, does not appear to be constrained in the RSA. Both the G8 and the Stewart Creek Underpasses are used regularly by cougars; between 2008 and 2012, cougars were recorded using the Stewart Creek Underpass 134 times and the G8 Underpass 49 times. Cougars have also been recorded regularly on winter snow tracking transects and during remote camera surveys on both sides of the valley (Lee et al. 2010; Golder 2013).

Least cost path analysis conducted for grizzly bears and cougars near Canmore indicates that preferred movement routes occur upslope from currently designated wildlife corridors and away from development, indicating that substantial space is available for east-west movement through the Bow Valley for cougars under existing conditions (Chetkiewicz and Boyce 2009). With the exception of underpasses, most of the areas designated as wildlife corridors in the Bow Valley function as extensions of habitat patches and are heavily used by cougars (Appendix B, Figure B-5).

Carnivores that are tolerant of human activity, such as cougars, are also commonly found close to development in habitat patches and movement corridors in the Bow Valley. Cougars can adapt to anthropogenic landscape change (Knopff et al. 2014). Although probability of cougar selection declines within developed areas in the Bow Valley, it increases immediately adjacent to them (Appendix B). Cougar habitat selection is closely linked to prey availability, and selection for places closer to development is likely a result of strong selection by some prey species for urban development in the Bow Valley (Section 5.2.6).

Although cougars are able to make use of natural prey in close proximity to humans, cougar proximity to human development represents a safety risk for humans and their pets. Cougar attacks on people are rare but do occur, often with tragic outcomes (Beier 1991; Conrad 1992). In 2001, a cross-country skier was killed by an adult male cougar on a heavily used ski trail in Banff national Park. More frequently, pets, particularly dogs, are killed and consumed by cougars that use the interface between wildlife habitat and residential areas. This kind of conflict can result in low tolerance for cougars, with potential adverse implications for cougar conservation (Knopff et al. 2016).

Within the Project Boundary, RSF modelling identifies winter cougar habitat under existing conditions that consists primarily of habitats that are selected or used as available (Table 14, Figures 22 and 23). The incomplete golf course represents selected habitat because of the large amount of forest edge in an otherwise cleared area with habitats that support high prey density (Appendix B). These habitats are also frequently used by people (Section 5.2.2), creating a high potential for negative human-cougar interactions.

Table 14: Cougar habitat in the Project Boundary under existing conditions with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha)	With Estimated Effects of Increased Human Use on Trails (ha)
Selected	102	102
Used as available	38	38
Somewhat avoided	23	23
Strongly avoided	0	0
Rarely used	0	0
Total	**163**	**163**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

Wildlife corridors adjacent to the Project Boundary consist primarily of habitat that is used as available by cougars (Table 15, Figures 22 and 23). High human use on trails may decrease probability of selection somewhat for cougars, primarily by transforming selected habitat into habitat used as available, with some increase in the amount of habitat that is somewhat avoided (Table 15).

Substantial habitat that is used as available by cougars during winter extends upslope from the approved Along Valley Corridor (Figures 22 and 23). Habitats south of the approved Along Valley Corridor adjacent to the Project Boundary were identified by Chetkiewicz and Boyce (2009) as a multi-season movement route for cougars and grizzly bears.

Table 15: Cougar habitat in wildlife corridors adjacent to the Project Boundary under existing conditions with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha)	With Estimated Effects of Increased Human Use on Trails (ha)
Selected	63	42
Used as available	237	233
Somewhat avoided	62	87
Strongly avoided	14	14
Rarely used	0	0
Total	**377**	**377**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

As depicted in Figure 24, cougars were detected by remote cameras within the Project Boundary (0.0006 detections/camera/day) and, especially, in adjacent wildlife corridors (0.0038 detections/camera/day). Throughout the camera deployment area, cougars were detected most frequently at cameras deployed on designated trails (0.0069 detections/camera/day), followed closely by undesignated trails (0.0057 detections/camera/day) and other deployment areas (0.0048 detections/camera/day). Cameras were not placed south of the approved Along Valley Corridor where Chetkiewicz and Boyce (2009) identified a multi-season movement route for cougars and grizzly bears.

Cougars were detected by cameras throughout the day and night, with peaks in the late afternoon and overnight and the lowest number of detections between 6:00am and 3:00pm. Cougar detections overlapped substantially with periods of high human use in the afternoon and early evening, especially during summer.

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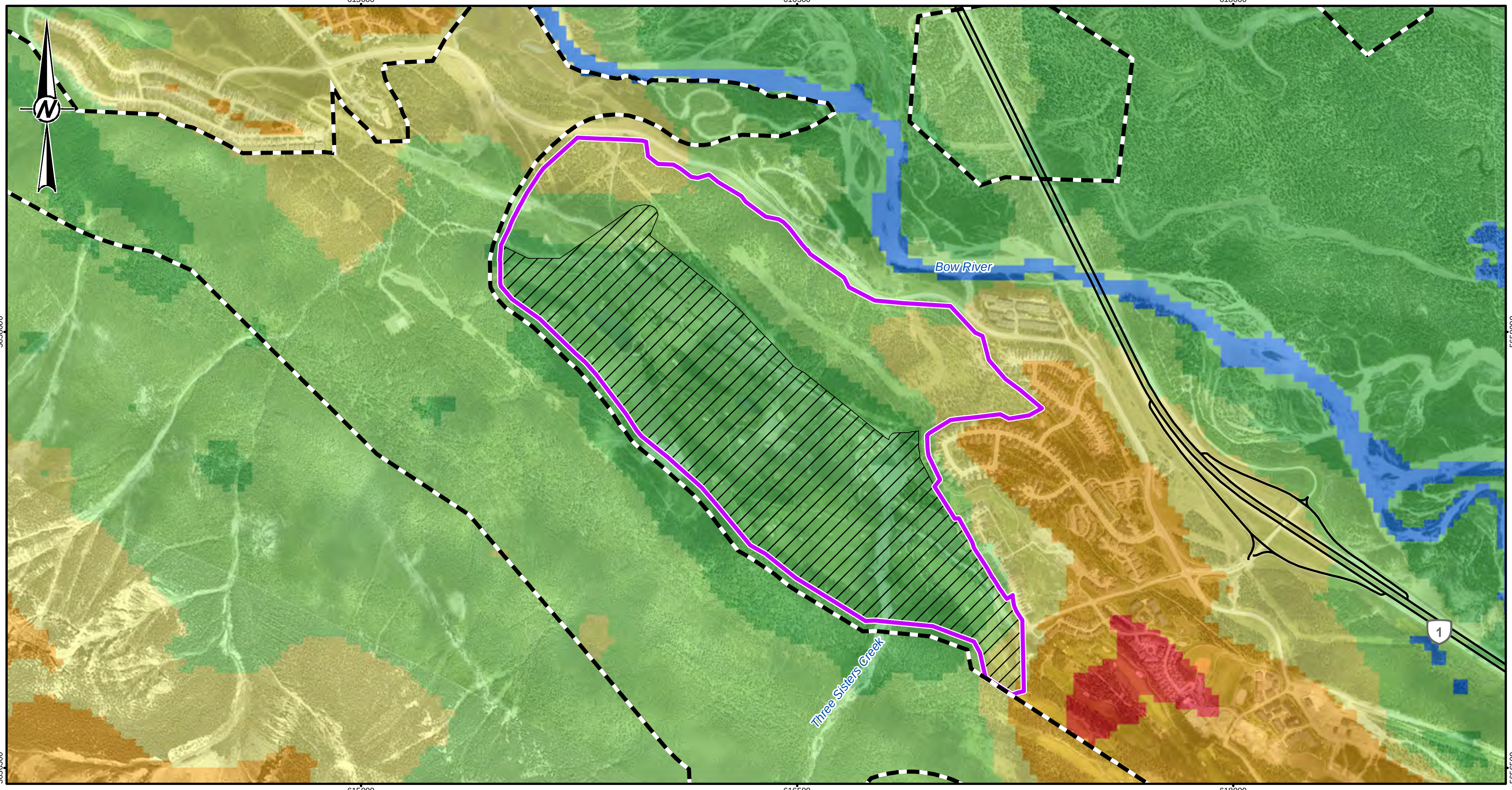

LEGEND

PRIMARY HIGHWAY
APPROVED WILDLIFE CORRIDOR
PROJECT BOUNDARY
RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

SELECTED
USED AS AVAILABLE
SOMEWHAT AVOIDED
STRONGLY AVOIDED
RARELY USED
WATERBODY

0 500 1,000
1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

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PROJECT
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CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
WINTER COUGAR RESOURCE SELECTION – EXISTING CONDITIONS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	22

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm

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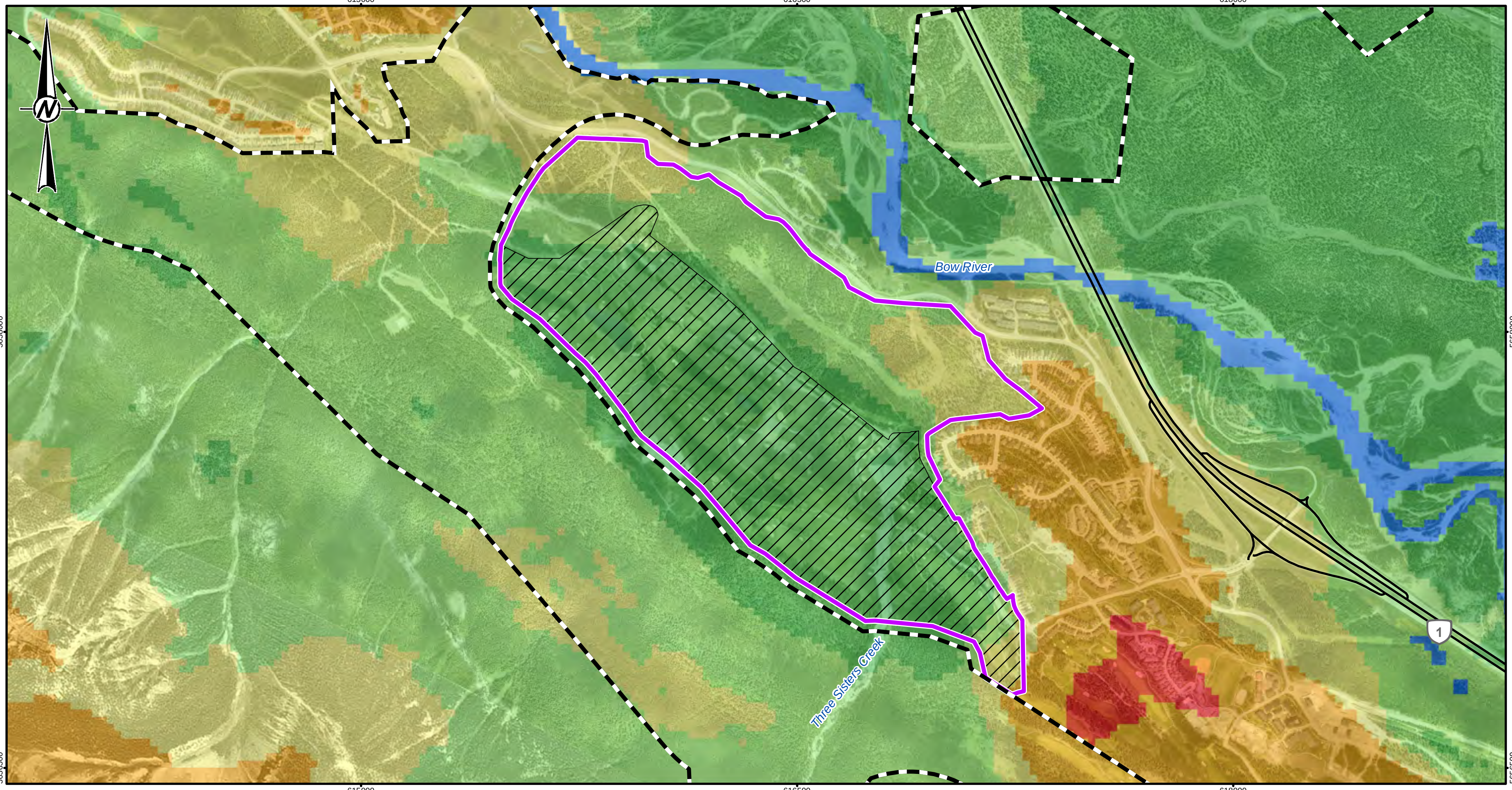

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

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RESORT CENTRE ASP AMENDMENT EIS

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YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

WINTER COUGAR RESOURCE SELECTION – EXISTING CONDITIONS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	23

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm

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LEGEND

- DESIGNATED TRAIL
- UNDESIGNATED TRAIL
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

MEAN NUMBER OF INDIVIDUALS PHOTOGRAPHED PER DAY*

- 0.000
- 0.003 - 0.055
- 0.055 - 0.105
- 0.105 - 0.214
- 0.214 - 0.789

NOTE
*DATA INTERVALS CATEGORIZED USING JENKS METHOD FOR NATURAL BREAKS

0 500 1,000
1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. REMOTE CAMERA DATA (2013 - 2016) OBTAINED FROM AEP, AUGUST 2016. USED UNDER LICENCE.
3. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
4. TRAILS OBTAINED FROM ALBERTA PARKS AND PROTECTED AREAS, 2011. ADDITIONAL TRAILS DIGITIZED 2016.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

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PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
COUGARS RECORDED ON REMOTE CAMERAS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	24

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
25mm
0

5.2.5 Wolves

Wolves maintain an important ecological role as top predators and are capable of structuring ecosystems through trophic cascades (Fortin et al. 2005, Hebblewhite et al. 2005a). In addition to their ecological value, wolves have substantial consumptive value within Alberta's hunting and trapping communities (Webb 2009). Although wolf conservation is often controversial, wolves are frequently used as flagship species for conservation efforts (Musiani et al. 2005). Large home ranges, sensitivity to human development, and substantial political and ecological importance make wolves a prime candidate for use as an indicator species, particularly in the Bow Valley (Callaghan 2002).

Wolves are ecosystem generalists capable of occupying almost any habitat where sufficient prey are available and humans are willing to tolerate wolf presence (Paquet and Carbyn 2003, Oakleaf et al. 2006). Habitat use is strongly affected by abundance and distribution of primary prey, typically ungulates, and wolf occupancy in the northern Rocky Mountains of the U.S. correlated positively with elk density (Oakleaf et al. 2006). Wolves often select conifer or mixed forest (Mladenoff et al. 1995, Paquet and Carbyn 2003), but also select cut blocks and natural openings under certain circumstances (Hebblewhite and Merrill 2008, Houle et al. 2010). Areas closer to edges between forest and clearcuts or natural meadows and areas with higher ungulate forage biomass might provide the best opportunity to find prey where sufficient cover also is available to facilitate hunting (Hebblewhite and Merrill 2008, Houle et al. 2010).

In mountainous areas, wolf home range placement, habitat selection and travel routes are influenced by topographic complexity, especially during winter when wolves tend to select low elevations, flat or shallow slopes and south aspects, presumably because those areas accumulate less snow and maintain the highest prey abundance (Alexander 2001, Duke 2001, Callaghan 2002; Paquet and Carbyn 2003, Whittington et al. 2005). When travelling between valleys in mountainous terrain, wolves are most likely to use low-elevation mountain passes (Callaghan 2002). Wolves in Banff National Park were mainly found at elevations below 1850m, but during summer, wolves tracked the vertical migration of elk to high elevations and open areas (Paquet 1993). However, even in summer, wolves tend to avoid steeper slopes (Hebblewhite and Merrill 2008).

Despite a strong preference for low elevation and shallow slopes where such habitats are available, wolves can and do use steep slopes when gentle terrain is unavailable. For example, in the Kicking Horse Valley west of Lake Louise around the town of Field, wolves selected for steeper slopes when traveling (Duke 2001), presumably because the valley is narrow and shallow slopes were unusable due to high levels of human development (i.e., the town of Field and the Trans-Canada Highway). Similarly, in Jasper National Park, wolves successfully used higher elevations and steeper slopes to move around places of high human activity to access fragmented habitat patches in the valley bottom (Shepherd and Whittington 2006). When a corridor was implemented on the valley bottom, wolves used the mountainside less frequently, indicating that lower elevations were preferred, if available, but that alternate routes are possible (Shepherd and Whittington 2006).

Wolves are sensitive to human disturbance in many places. In North America[13], wolves are typically absent from areas with dense human populations or intense agriculture and are prone to extirpation in areas with high livestock density (Alberta Forestry, Lands, and Wildlife 1991, Oakleaf et al. 2006, Mladenoff et al. 1995, Paquet and Carbyn 2003). Human development can have a profound effect on wolf habitat selection and may be one of the most important determinants of wolf travel routes (Duke 2001, Hebblewhite and Merrill 2008).

[13] But see Chapron et al. 2015 for new information from Europe that indicates wolves may be more adaptable to human presence than previously believed.

In the Bow Valley, for instance, wolves might have been excluded from prime habitat east of the town of Banff by the town itself (Paquet 1993), creating an artificial predator-free zone. The effect of anthropogenic linear features (e.g., roads) on wolves has been well-studied, and linear features are thought to have an especially important influence on movement and habitat selection. Wolves near Jasper, Alberta selected areas with lower road and trail density (i.e., <1 km/km^2) and both kinds of linear features fragmented habitat and degraded habitat quality (Whittington et al. 2005). Ninety percent of wolf locations occurred where road density was less than 1.3 km/km^2 and trail density was less than 2.9 km/km^2 (Whittington et al. 2005). In the Rocky Mountains, wolves are thought to persist only at road densities below 0.6-0.70 km/km^2 (Paquet and Carbyn 2003).

However, the physical presence of roads does not necessarily reduce wolf habitat quality. Rather, human-caused mortality and disturbance near roads might be the primary influence of roads on wolves. Thus, human activity that accompanies development must be considered when evaluating habitat suitability for wolves. Indeed, wolves frequently used anthropogenic linear features at night in Banff and Yoho National Parks when human activity is low, presumably to take advantage of an easy travel route (Callaghan 2002), and wolves might regularly exploit linear features to facilitate travel and hunting efficiency where human use of such features is low (James and Stewart-Smith 2000).

As is typical in mountainous regions, low elevation montane habitats like those found at low elevation in the RSA, are used primarily by wolves in winter when their ungulate prey congregates on low elevation winter range (Section 5.2.6). The winter RSF developed for wolves indicates that wolves select intermediate elevations, especially on south facing slopes (Appendix B). Wolves avoided non-vegetated habitats, built up areas, areas with high trail densities and golf courses. In addition to a strong preference for south facing slopes, wolves selected for forest edge, herbaceous vegetation and areas with more shrubs. Habitats on the south side of the Bow Valley tend to be less strongly selected than the south facing slopes on the north side. Most of the selected habitat for wolves during winter in the RSA occurs in wildlife corridors and habitat patches on the north side of the river.

Corridors and habitat patches in the Bow Valley may only be partially effective for wolves under existing conditions. Lee et al. (2010) noted a decreasing trend in wolf use over time in high quality habitats north of Canmore, with minimal use of the Benchlands area after 2002-2003, except in the far west end next to Banff National Park. Similarly, Golder (2013) concluded that rare use by wolves of the approved Along Valley Corridor, Tipple Across Valley Corridor and Stewart Creek Across Valley Corridor (Golder 2013; Figure 37) was most likely a result of high human use. No wolves were documented using the G8 or Stewart Creek wildlife underpasses during 2007 to 2012, but wolves were known to cross the Trans-Canada Highway using the Stewart Creek Underpass prior to 2007 (Clevenger et al. 2002, 2007).

The stability of the regional wolf population is not known, but wolf packs overlapping the Bow Valley are subjected to a variety of mortality sources, including being hit on highways and by trains, and, more recently, being killed in response to negative human-wolf interactions (Small, 2016). To be precautionary, a serious risk was identified for wolves under existing conditions in the RSA because of uncertainty about pack stability and very low levels of use reported in wildlife corridors and habitat patches (Lee et al. 2010, Golder 2013).

Wolf habitat in the Resort Centre amendment boundary and in adjacent wildlife corridors is primarily avoided under existing conditions (Tables 16 and 17, Figures 25 and 26). This is not surprising in the context of generally reduced probability of selection south of the Bow River. Taking into account human use on designated and undesignated trails reduced the probability of selection (Tables 16 and 17), but habitats that are strongly avoided or rarely used and may create higher resistance to wolf movement are not predicted to be common in the wildlife corridors adjacent to the Project Boundary, even with added effects of human use (i.e., up to 12.7% of the corridor, Table 17).

Table 16: Wolf habitat in the Project Boundary with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha)	With Estimated Effects of Increased Human Use on Trails (ha)
Selected	0	0
Used as available	41	14
Somewhat avoided	111	132
Strongly avoided	11	17
Rarely used	0	0
Total	**163**	**163**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

Table 17: Wolf habitat in wildlife corridors adjacent to the Project Boundary under existing conditions with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha)	With Estimated Effects of Increased Human Use on Trails (ha)
Selected	8	0
Used as available	107	22
Somewhat avoided	233	306
Strongly avoided	28	48
Rarely used	0	0
Total	**377**	**377**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

Wolves can adapt to temporal patterns of human use (Hebblewhite and Merrill 2008), and therefore reductions in probability of selection associated with human use of trails identified in Tables 16 and 17 are likely present only during the day when human use on trails occurs (Section 5.2.2). Remote camera data indicate that wolves are primarily active during the crepuscular periods in the early morning and later in the evening, a temporal pattern opposite to human use on the trails (Figure 14). In addition, 94% of photographs of wolves collected at remote cameras were obtained in winter (i.e., 15 November to 15 April) when human use is at its lowest (Figure 14).

Although wolf use has declined in wildlife corridors in the Bow Valley over time (Lee et al. 2010, Golder 2013), the most recent available data suggest that wolf use of wildlife corridors on the south side of the Bow Valley may have increased since the Golder (2013) review was completed (i.e., during 2013-2016). This includes documentation of wolf packs using the Along Valley Corridor and adjacent TSMV lands a number of times in 2016, including near the project Boundary (Figure 27). Wolves were not detected by remote cameras in the Project Boundary during

2009 to 2016[14], but were detected in wildlife corridors adjacent to the Project (0.00015 detections/camera/day) and Smith Creek (0.0019 detections/camera/day).

Increased use of wildlife corridors by wolves in the vicinity of TSMV in 2015 and 2016 coincided with Parks Canada having to kill two wolves from the Bow Valley Pack in the summer of 2016 because the animals exhibited bold behaviors around people (Fletcher 2016, Small 2016). Although the wolves observed in the vicinity of TSMV in 2015 and 2016 were not likely members of the Bow Valley Pack, other packs in Kananaskis Country and the Bow Valley are frequently in contact with humans and associated infrastructure, and therefore also have the potential to habituate to people.

Large carnivores, including wolves, can be highly adaptable in human dominated landscapes (Chapron et al. 2015). Habituation of wolves to people in the Bow Valley may be increasing in response to higher levels of human use or to greater contact with human food sources. In January 2017, wolf activity was reported between Stewart Creek and the Nordic Centre, including wolves in the Peaks of Grassi and Larch neighborhoods, close to and around houses (Ellis 2017). Jay Honeyman, a wildlife conflict specialist with AEP, indicated that wolves were probably following elk into the Town, and that this posed a risk to wolves and could create a public safety hazard (Ellis 2017). Habituation is a double edged sword. Although it may eliminate the serious risk identified for Bow Valley wolves under existing conditions because of low levels of movement and limited use of available habitat, it also exposes wolves to higher levels of negative interactions with people and possibly to higher mortality.

[14] Although not displayed on Figure 27, which includes data up to December 2016, wolves were detected by remote cameras deployed in the Project Boundary in January 2017

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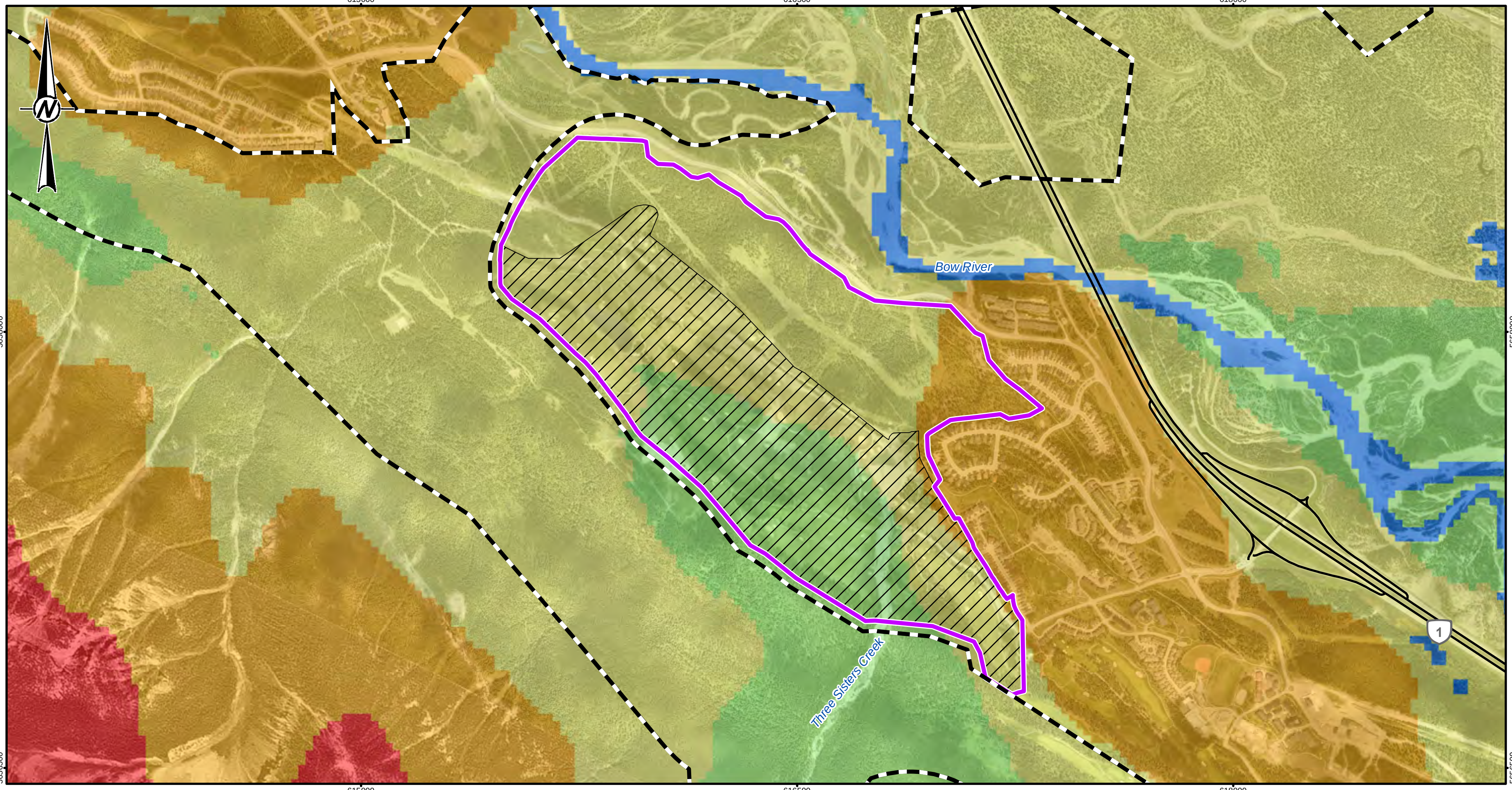

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

WINTER WOLF RESOURCE SELECTION – EXISTING CONDITIONS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	25

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm

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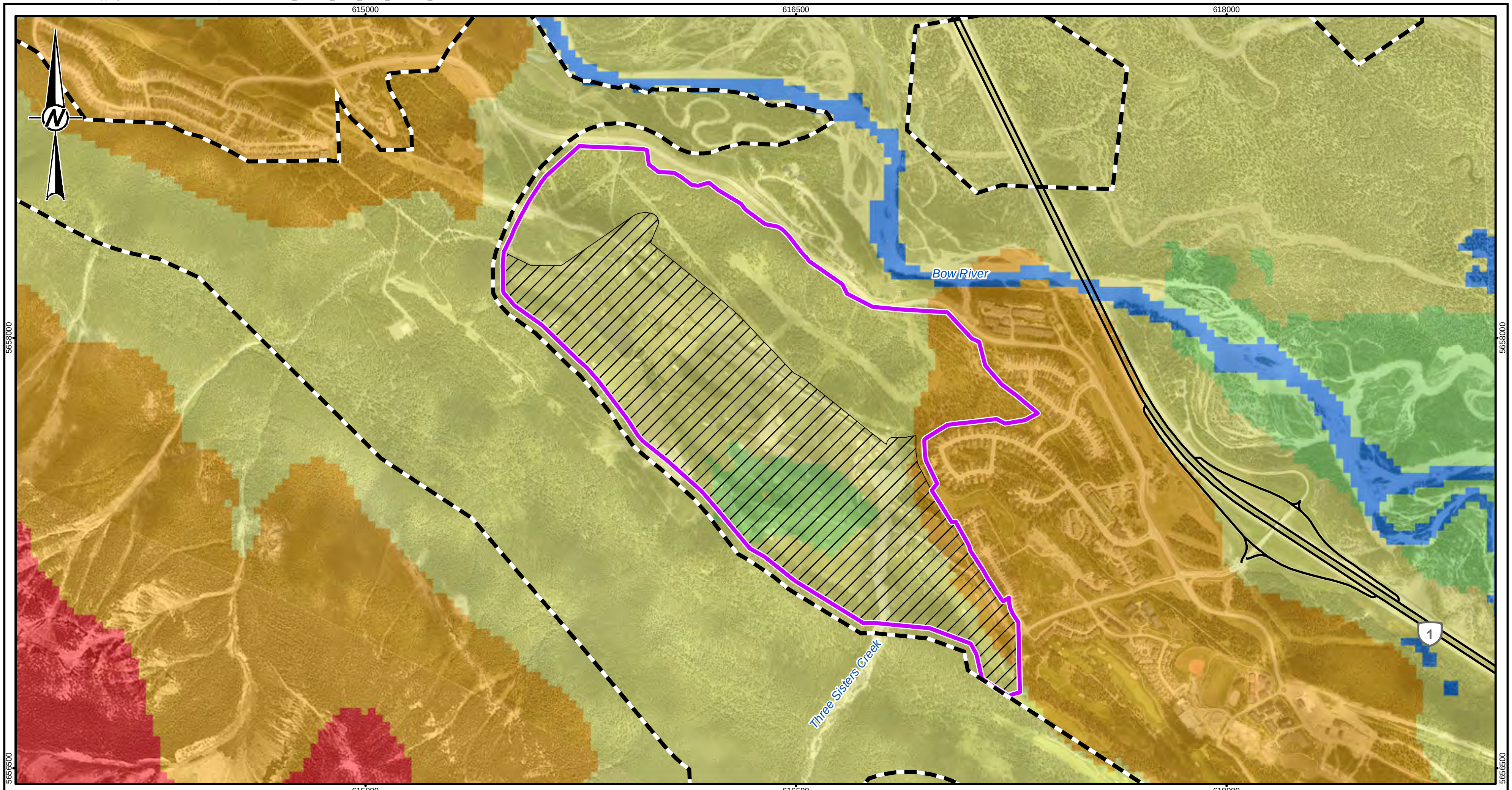

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

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PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

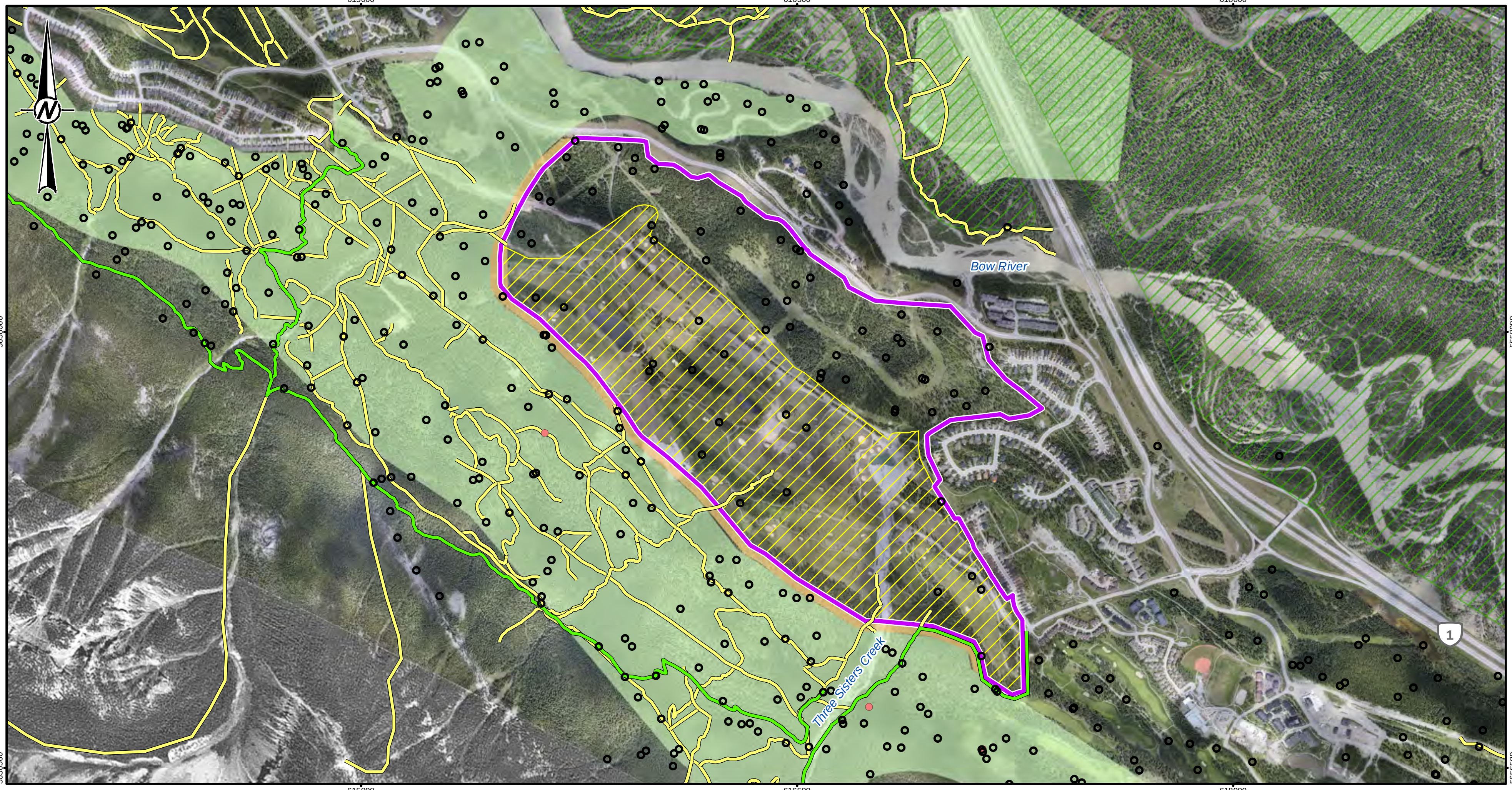
YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

WINTER WOLF RESOURCE SELECTION – EXISTING CONDITIONS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	26

PATH: I:\2015\1539221\Mapping\MXD\ResortCentre\Rev1\QUANTUM-RESORT_CENTRE_FIG27_WOLF_CAM-Rev1.mxd PRINTED ON: 2017-03-07 AT: 1:52:54 PM



LEGEND

- DESIGNATED TRAIL
- UNDESIGNATED TRAIL
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

MEAN NUMBER OF INDIVIDUALS PHOTOGRAPHED PER DAY*

- 0.000
- 0.003 - 0.020
- 0.020 - 0.048
- 0.048 - 0.103
- 0.103 - 0.201

NOTE
*DATA INTERVALS CATEGORIZED USING JENKS METHOD FOR NATURAL BREAKS

0 500 1,000
1:20,000 METRES

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Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. REMOTE CAMERA DATA (2013 - 2016) OBTAINED FROM AEP, AUGUST 2016. USED UNDER LICENCE.
3. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
4. TRAILS OBTAINED FROM ALBERTA PARKS AND PROTECTED AREAS, 2011. ADDITIONAL TRAILS DIGITIZED 2016.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
WOLVES RECORDED ON REMOTE CAMERAS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	27

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

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5.2.6 Elk

Elk occur in a range of habitats throughout the RSA in different seasons. Elevation, slope, and aspect are linked to precipitation, snow accumulation and plant phylogeny, and thus have a substantial influence on elk habitat selection (Hohler 2004; Hebblewhite et al. 2008). Higher elevations can be used year-round, though lower elevations often are preferred, especially during winter (Boyce 1991; Skovlin et al. 2002; Boyce et al. 2003; Serrouya et al. 2000). Elk move upslope during summer, influenced primarily by forage availability as plant growth initiates at progressively higher elevations through the spring and summer (Hebblewhite et al. 2008).

Elk generally prefer gentle slopes (Johnson et al. 2000), although preference for slope can vary with season, year and among sexes (Hohler 2004). In less human-affected ecosystems where wolves are present, elk may select higher elevations and steeper slopes (Mao et al. 2005), presumably because elk encounter wolves more frequently in valley bottoms, i.e., places with gentle slopes and low elevation (Hebblewhite et al. 2005a). However, in the RSA, elk tend to be concentrated in the valley bottom in and around the Town (Appendix B, Figure B4), where forage is present and the risk of predation is lower (Appendix B, Sections 2.2.2 and 2.2.3; Edwards 2013).

Anthropogenic grasslands are not a natural habitat feature, but are nevertheless identified as important for elk in the Bow Valley because they provide optimal conditions for elk where forage quality is high and predation risk is low (Frair et al. 2005). Another reason that anthropogenic grasslands, like those on the unfinished golf course within the Project boundary, are important for elk in the Bow Valley is because grassland habitats are not common in other parts of the Bow Valley. Forest cover and the availability of grassland habitat in the Bow Valley has varied historically based on fire occurrence. There have been no recent large fires in the RSA, and vegetation in the area is currently dominated by forest cover. As illustrated in Figure 28, in 1890 the valley had much less tree cover and more grassland area due to the effects of fire. Forest encroachment and reduction of open habitats in similar ecosystems has been well documented in Alberta (e.g., Rhemtulla et al. 2002, Widenmaier and Strong 2010). The concentration of elk activity within and immediately adjacent to Canmore (Appendix B, Edwards 2013) is consistent with the findings of previous studies of elk habitat selection use near the town of Banff (McKenzie 2001; Hebblewhite et al. 2005a, 2005b; Kloppers et al. 2005).

The habituation of elk to human activity and developments in the Bow Valley, as well as clear evidence of elk use throughout wildlife corridors and developed areas (Edwards 2013), means that landscape connectivity for elk in the RSA remains high under existing conditions.

Elk in the Bow Valley are so habituated to people that they only respond by moving away if people approach within 20 to 50 m and do not move far without strong provocation including starter pistols, screamers, cracker shells, and actively chasing the elk by running after them (Kloppers et al. 2005). Habituated elk can pose a human safety risk when they concentrate in urban areas, including school yards, as elk are known to do in Canmore (Figure 31). Fire suppression, and the increasingly forested landscape that results (Rhemtulla 1999), may have intensified negative human-elk interactions in the Bow Valley under existing conditions because grassland habitats are concentrated near development, and are less abundant elsewhere than they were historically.

The concentration of elk in areas where wolves are scarce, such as in close proximity to Canmore, results in an overall reduction in mortality risk and an increased rate of calf recruitment (Hebblewhite et al. 2005b). This effect is so strong that elk in Canmore do not exhibit seasonal shifts in habitat use; instead they remain in Canmore and access anthropogenic landscapes year-round and maintain unusually small home ranges and high population density (Edwards 2013).

Another detrimental effect of the high concentrations of elk in and around Canmore is higher rates and intensities of parasitic infections among the resident elk population because of frequent and repeated use of small numbers of foraging sites and day beds (Edwards 2013).

The elk population in the RSA is considered stable under existing conditions, and minimum aerial survey population counts in 2015 and 2016 were 240 and 243 elk, respectively (Chapman 2017, pers. comm.). When correcting for visibility and other factors affecting minimum counts, the population of elk is probably between 300 and 400 animals (Chapman 2017, pers. comm.).

Figure 28: Photographs Demonstrating Substantial Increase in the Amount of Forested Habitat in the Bow Valley between 1890 and 2008

Source: Mountain Legacy, School of Environmental Studies 2013.

Although elk may be self-sustaining in the RSA under existing conditions, their natural ecological interactions have been substantially diminished, predation risk is near zero for elk living in Canmore, and parasite loads in elk are higher because elk are concentrated in small areas of intense use (Edwards 2013). Consequently, a serious risk was identified for elk in the RSA under existing conditions because they do not function in their natural ecological role and are not considered ecologically effective.

The concentration of elk activity in proximity to golf courses (e.g., the Project) and other human developments occurs during all seasons and is apparent from remote camera data (Figure 29) as well as elk telemetry data (Appendix B, Figure B4). Elk were much more commonly detected by remote cameras in the Project Boundary (0.489 detections/camera/day) than in the Smith Creek ASP boundary (0.093 detections/camera/day), or in wildlife corridors (0.143 detections/camera/day in the Resort Centre Corridor and 0.099 detections/camera/day in the Smith Creek Corridor). The relative concentration of elk activity in the Project Boundary may be greater than the data suggest because cameras were not deployed in open habitats (Section 5.1.1), where elk are known to congregate (Golder 2013, Figure 49). Remote camera data shows that elk were detected at cameras deployed on designated trails (0.182 detections/camera/day) more often than undesignated trails (0.110 detections/camera/day) or other areas (0.139 detections/camera/day).

Patterns of elk habitat selection in the Project Boundary and adjacent wildlife corridors are clearly expressed through the numerical and graphical output of the RSF model built using elk telemetry collar data (Appendix B). The RSF model expresses the preference of elk for built-up areas (i.e., elk in the Bow Valley near Canmore prefer to be closer to human developments; Figures 30 and 31), as well as forest edge, herbaceous vegetation, and golf courses, while avoiding dense conifer and shrub habitats (Appendix B). All habitat within the Project Boundary is predicted by RSF modelling to be selected by elk (Table 18; Figure 30). Habitat in wildlife corridors adjacent to the Project Boundary is approximately evenly split between selected (52%) and used as available by elk (48%; Figure 30), and elk use wildlife corridors regularly (Figure 29).

Table 18: Elk habitat in the Project Boundary and adjacent wildlife corridor under existing conditions

Habitat Class	Area in the Project Boundary (ha)	Area in Wildlife Corridor Adjacent to the Project Boundary (ha)
Selected	163	195
Used as available	0	181
Somewhat avoided	0	0
Strongly avoided	0	0
Rarely used	0	0
Total	**163**	**377**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

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LEGEND

- DESIGNATED TRAIL
- UNDESIGNATED TRAIL
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

MEAN NUMBER OF INDIVIDUALS PHOTOGRAPHED PER DAY*

- 0.000
- 0.005 - 0.367
- 0.367 - 0.732
- 0.732 - 1.345
- 1.345 - 3.633

NOTE
*DATA INTERVALS CATEGORIZED USING JENKS METHOD FOR NATURAL BREAKS

0 500 1,000
1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. REMOTE CAMERA DATA (2013 - 2016) OBTAINED FROM AEP, AUGUST 2016. USED UNDER LICENCE.
3. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
4. TRAILS OBTAINED FROM ALBERTA PARKS AND PROTECTED AREAS, 2011. ADDITIONAL TRAILS DIGITIZED 2016.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

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Golder Associates

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APPROVED	MJ

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
ELK RECORDED ON REMOTE CAMERAS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	29

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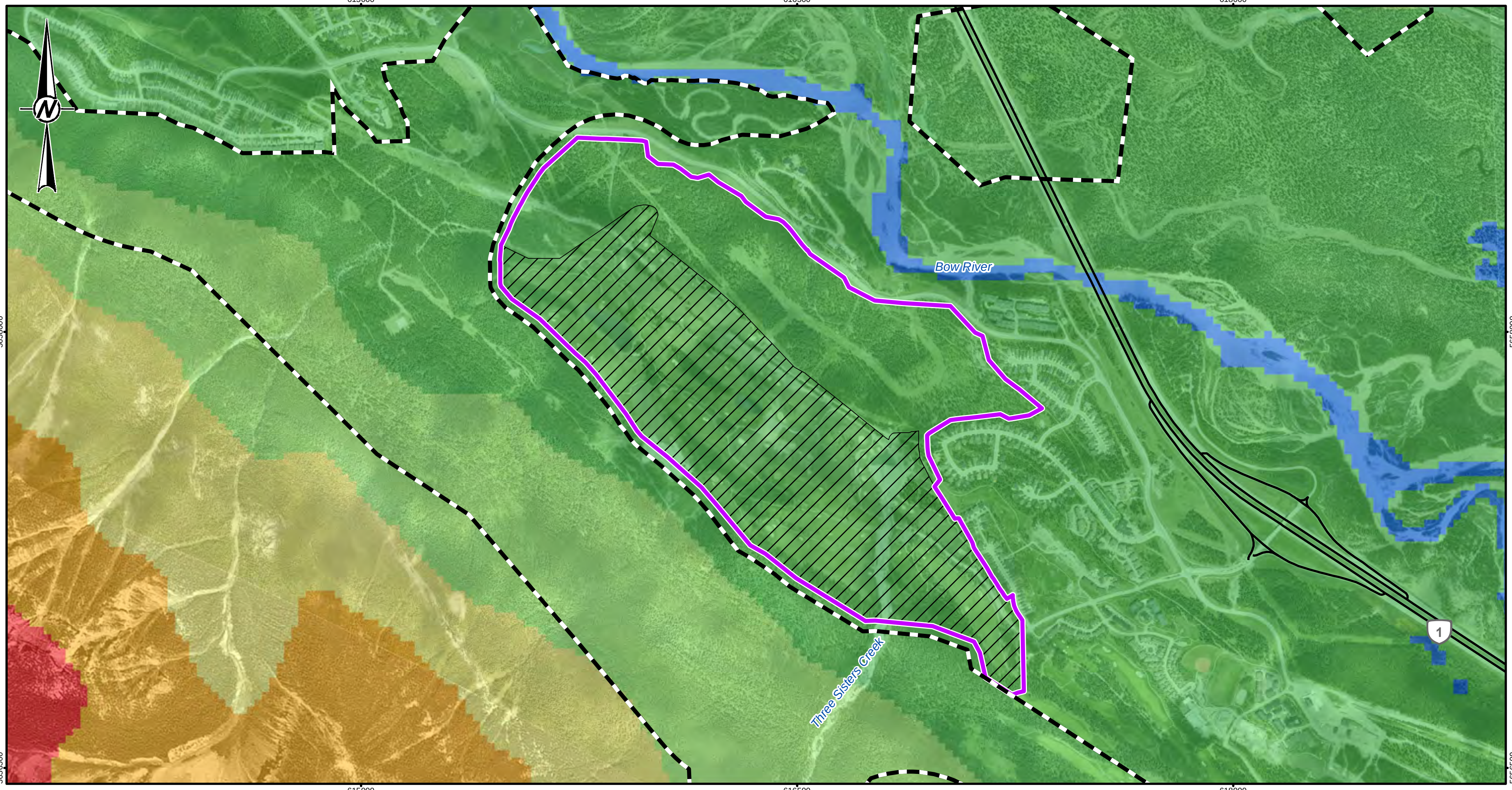

LEGEND

PRIMARY HIGHWAY
APPROVED WILDLIFE CORRIDOR
PROJECT BOUNDARY
RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

SELECTED
USED AS AVAILABLE
SOMEWHAT AVOIDED
STRONGLY AVOIDED
RARELY USED
WATERBODY

0 500 1,000
1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

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PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
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PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
WINTER ELK RESOURCE SELECTION – EXISTING CONDITIONS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	30

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A
25mm
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Figure 31: Elk in a School Yard in Canmore (Photo Courtesy Jay Honeyman)

5.3 Environmental Risks

The following categories of environmental risks for wildlife were identified for the Project:

- wildlife mortality caused by site clearing and construction activities;
- reduced quantity and quality of wildlife habitat within the Project Boundary caused by construction and operations;
- reduction in wildlife use of approved wildlife corridors adjacent to the Project Boundary; and
- increased negative human-wildlife interactions.

Specific risks associated with each risk category are discussed in the following sections.

5.3.1 Wildlife Mortality Caused by Site Clearing and Construction

Construction activities, particularly site clearing and vehicle activity, have the potential to cause direct mortality to wildlife. Wildlife most at risk of mortality during construction include those with limited mobility or those that remain still in response to danger, such as young animals, small mammals, birds, and amphibians. In some cases, in addition to potential adverse effects to local individuals and populations, such mortality contravenes federal or provincial legislation (Section 3.2.2.3). Adult large mammals are generally expected to avoid construction activities, except in rare circumstances where mobility might be limited, such as the case of black bears that are in their dens.

5.3.2 Reduced Quantity and Quality of Wildlife Habitat within the Project Boundary

Habitats that provide value for wildlife under existing conditions will be removed and replaced with buildings, roads, recreation areas, and other components of the Project. Habitats that will be removed within the Project Boundary have already been modified by humans, such as the unfinished golf course, or are part of developments already approved under the existing 2004 Resort Centre ASP, such as the Resort Core and resort accommodations approved in areas containing forested and wetland habitat north of the unfinished golf course.

Noise associated with construction may exceed that associated with the completed Project and may result in greater disturbance and displacement of wildlife that use habitat near active construction sites. This type of disturbance may also extend beyond the Project Boundary where construction occurs near the boundary. For species such as elk that select habitats near developed areas, active construction may temporarily decrease probability of selection below values expected once construction is complete (i.e., during operations).

Areas of natural habitat or anthropogenic open spaces within the Project Boundary will retain some value for wildlife, particularly those that adapt well to people, but overall reductions in habitat quality and biodiversity in these habitats are likely because of high levels of human use.

An important mitigation to reduce the effect of the Project on negative wildlife human interactions and human use of adjacent wildlife corridors is wildlife fencing, which will provide a hard edge that physically separates wildlife habitat from human development (Section 2). Application of fencing as a mitigation will exclude large mammals from areas of natural habitat or anthropogenic open spaces within the Project Boundary, resulting in a complete loss of access to habitat that otherwise might be used. Other species of wildlife, such as birds, amphibians, and small mammals will continue to be able to access habitats inside the fence.

5.3.3 Reduction in Wildlife Use of Approved Corridors

The Project has the potential to change patterns of wildlife use within approved wildlife corridors adjacent to the Resort Centre ASP Amendment boundaries. If the Project described in Section 3 is completed without mitigation, these changes could adversely affect wildlife use in corridors adjacent to the Project Boundary.

Sensory disturbance may result in a zone of influence that will extend away from development and into wildlife corridors, reducing probability of selection for wildlife that tend to avoid human disturbance. Because the amendment seeks to add resort accommodation and residential developments to portions of the area that was approved in 2004 for use as a golf course, impacts to the wildlife corridor associated with sensory disturbance constitute the most important difference between the existing 2004 Resort Centre ASP and the Resort Centre ASP Amendment.

The risk from sensory disturbance associated with the development footprint is different from the risk from sensory disturbance associated with human use. Human use is currently not restricted to developed areas, and commonly occurs within wildlife corridors under existing conditions. Therefore the risk from sensory disturbance associated with increased use by recreating humans and their pets is diffused throughout the landscape and will be most strongly associated with designated and undesignated trails. Recreational use of wildlife habitat, wildlife corridors, and wildlife crossing structures is already very high near the Project Boundary (Section 5.2.2) and studies show that this kind of use can reduce the probability of use for many wildlife species (Banks and Bryant 2007; Clevenger and Waltho 2000; George and Crooks 2006; Gibeau et al. 2002b; Reed and Merenlender 2008; Rogala et al. 2011; Roloff et al. 2001; Whittington et al. 2005).

If the Project is approved, development of the Project is expected to introduce between 3,840 to 7,200 new residents and visitors to Canmore (Section 3). However the Project adds a maximum of 475 units and 1,140 new residents and visitors to the number that was already approved in the 2004 Resort Centre ASP. Taken as a whole and without application of appropriate mitigation, substantial increases in human use, off-leash dog use, and associated unsanctioned trail proliferation in wildlife corridors adjacent to the Project Boundary is expected. The incremental contribution of the ASP amendment to this risk is up to 16% of the total potential effect.

5.3.4 Increased Negative Human-Wildlife Interactions

As outlined in Section 5.2, negative wildlife-human interactions have been increasing in the Bow Valley and have contributed to a population sink for grizzly bears. Soft edges associated with existing human developments leave wildlife free to move into areas used by humans, and animals regularly do so under existing conditions. Humans also are frequently found in wildlife corridors. The resulting mix of wildlife and people, especially along or in the interface between wildlife habitat and human development, has driven increasing negative human-wildlife interactions (Section 5.2.2).

If the Project developments described in Section 3 are completed without mitigation, similar levels of negative interactions can reasonably be expected adjacent to wildlife corridors. The Project will result in a combined development area several times the size of Peaks of Grassi and the Homesteads and will increase the number of residents and visitors in the area by 3,840 to 7,200 at build out. The incremental contribution of the amendment to the existing 2004 ASP approval is up to 475 units and 1,140 new residents and visitors.

Without adequate mitigation, wildlife are expected to enter Project developments and high levels of negative interactions similar to what is observed under existing conditions in other Canmore neighborhoods adjacent to wildlife corridors and habitat patches are predicted. Wildlife entry into human developments would be especially likely in green spaces left between development pods (Section 2).

New Canmore residents and visitors present within and adjacent to the Project, will want to walk, mountain bike, run their dogs, and otherwise use natural habitats in the vicinity of the Project. Without the application of appropriate mitigation, available data suggests that these residents will use areas adjacent to development, including wildlife corridors, for these activities. Activity will likely occur both on and off designated trails within wildlife corridors and additional illegal trail building should be expected without adequate mitigation. Such use is likely to substantially increase negative wildlife-human interactions in and around the Project and would pose a serious risk without adequate mitigation. The Tipple Across Valley Corridor will also have development on both sides, which has potential to exacerbate negative human-wildlife interactions (Golder 2013).

5.4 Relevant Legislation

Federal legislation and guidelines intended to protect wildlife and that are relevant to the Project include:

- the Migratory Birds Convention Act (MBCA), which prohibits mortality of migratory birds or damaging their nests or eggs; and
- the Species at Risk Act (SARA), which prohibits killing, harming, or harassing species listed on Schedule 1, damaging or destroying the residence (e.g., nest or den) of individuals of a species listed as endangered or threatened, and damaging critical habitat as defined in a recovery plan.

Provincial legislation and guidelines intended to protect wildlife and that are relevant to the Project include:

- the Wildlife Act, under which protective measures for wildlife may be established;
- the Alberta Wetland Policy, which promotes the conservation, restoration and protection of Alberta's wetlands to sustain the benefits they provide to the environment, society and economy;
- the Alberta Wetland Mitigation Directive, which provides guidelines to minimize adverse effects to wetlands and details wetland replacement requirements when permanent disturbance cannot be avoided; and
- the 1992 NRCB Three Sisters decision, which has specific requirements for wildlife associated with development on TSMV property (e.g., wildlife corridors).

5.5 Mitigation

Mitigation measures to avoid or reduce effects associated with each category of environmental risk identified for the Project are recommended in this section.

5.5.1 Wildlife Mortality Caused by Site Clearing and Construction

Mitigation measures to avoid or reduce direct mortality during site clearing and construction include:

- avoiding clearing during potential mortality periods, such as the migratory bird nesting period, where possible (the Project is within Environment and Climate Change Canada's migratory bird nesting zone A4, but is close to zone A3, which, to be precautionary, suggests a restricted activity period of April 14 to August 19 [ECCC 2016a]);
- conducting a pre-construction survey to identify the location of any sensitive wildlife features (e.g., active nest sites, dens) if site clearing occurs within critical time periods and implement appropriate measures to reduce potential effects (e.g., delay construction until migratory bird nesting is complete);
- keeping all construction equipment out of wetlands and riparian areas (Section 6.1) - follow up work to confirm that wetlands have been appropriately avoided in compliance with the Alberta Wetland Policy should occur at the subdivision stage;
- implementing erosion and siltation control measures as stated in Section 6.1.1 in the vicinity of wetlands and riparian areas;

- traffic control measures (e.g., speed limits below 50 km/h) to reduce the risk of vehicle collisions with wildlife; and
- continued implementation of TSMV Construction Management Guidelines (March 20, 2015 Version 2.5).

Some small mammal mortality may occur during construction, but large mammals are generally expected to avoid construction activities and lower vehicular speed limits can reduce mortality rates for these animals (Found and Boyce 2011; Neumann et al. 2012). Mortality of particularly susceptible wildlife such as nesting birds and denning bears will be avoided by clearing at appropriate times or by conducting pre-clearing surveys, and subsequently avoiding active nests and dens.

Amphibian mortality will be predominantly avoided by not developing on wetlands or riparian areas, and keeping construction equipment out of these areas. Western toads have a terrestrial life phase in which they will be vulnerable to impacts by construction activities outside of wetlands (ECCC 2016), and some mortality may be unavoidable. Silt fencing may be used to discourage or prevent toad dispersal from breeding ponds into active construction areas. Should development occur in wetlands, the requirements of SARA and the Alberta Wetland Policy must be met and losses compensated for.

The mitigation measures identified in this section, with a strong focus on avoidance, represent application of due diligence to meet requirements of the MBCA, SARA and the Alberta Wildlife Act.

Because of uncertainty about development footprint location at the ASP stage, follow up work to confirm that wetlands have been appropriately avoided or compensated for in compliance with the Alberta Wetland Policy should occur at the subdivision stage. Similarly, follow up work in the form of pre-clearing surveys will be required for any vegetation clearing activities that are proposed during the migratory bird nesting window; clearing must be delayed if nesting birds are detected.

5.5.2 Quantity and Quality of Wildlife Habitat within the Project Boundary

The 1992 NRCB approval accepted that wildlife habitat loss would occur as the result of the development of TSMV. The NRCB also recognized that there were opportunities to avoid developing on particularly sensitive wildlife habitats and to minimize other kinds of impacts to ESAs. Mitigation measures to avoid or minimize adverse effects of the Project on wildlife habitat quantity and quality include:

- restricting construction schedule to daylight hours to facilitate wildlife use of adjacent habitats, especially adjacent to wildlife corridors or habitat patches at dawn, dusk and overnight;
- delineating the designated construction zone boundary and instructing construction personnel to stay within the boundary;
- training for employees and contractors to ensure personal awareness of key issues for wildlife and stewardship responsibility while working in the area (e.g., identify opportunities to minimize noise and other forms of sensory disturbance);
- avoiding wetlands and riparian areas within the ASP, where possible, through the creation of green space designations and compensating for wetland loss where avoidance is not possible (Section 3.2.4); and
- continued implementation of TSMV Construction Management Guidelines (March 20, 2015 Version 2.5).

Although outside the scope of the developer's direct influence, a mitigation measure that could be considered by the Town, the MD of Bighorn, and the Province is off-site wildlife habitat improvements. Habitat improvements can also be associated with wildfire control efforts (e.g., clearing forested areas to create fire breaks) in wildlife corridors and other habitats adjacent to the Project Boundary.

Clearing that creates early seral habitats would help compensate for adverse effects of habitat loss to these habitats within the Project Boundary(e.g., disturbed grasslands on the unfinished golf course that are heavily used by elk), and simultaneously meet FireSmart objectives. Modelling that simulated habitat enhancements consistent with these objectives in the Along Valley Corridor identified increased habitat suitability for grizzly bears, wolves, cougars, and elk (Golder 2012, pp. 88-94).

5.5.3 Wildlife Use of Approved Corridors and Negative Human Wildlife Interactions

Mitigation measures to avoid or minimize adverse effects of the Project on the efficacy of wildlife corridors adjacent to the Project Boundary and on the potential for increased negative human-wildlife interactions overlap substantially and include:

- erecting wildlife fencing along the perimeter of the Project Boundary and around other Three Sisters developments with access points only at designated trails through the wildlife corridors[15] to minimize the potential for ungulates and carnivores to enter developed areas and reduce trail proliferation and off-leash dog use in wildlife corridors;
- using gates with signs at the entrance to wildlife corridors informing users of their legal obligations in wildlife corridors and presenting maps of designated trails through the corridors;
- designing residential lots immediately adjacent to the wildlife corridors to incorporate outdoor spaces with minimal exterior lighting to reduce sensory disturbance in the corridors (only effective with a fence, otherwise could encourage wildlife to enter development);
- maintaining native vegetation for residential lots along the wildlife corridor interface, within the constraints of FireSmart regulations, to reduce sensory disturbance within the corridor;
- locating dwellings on lots immediately adjacent to the wildlife corridor at the furthest position possible from the edge of the corridor (e.g., within standard low density lots) to reduce sensory disturbance within the corridor (only effective with a fence, otherwise could encourage wildlife to enter development);
- continuing to implement TSMV's Wildlife Human Interaction Plan (WHIP) plan[16], as mandated by the NRCB (1992), with a particular focus on attractant management to minimize potential negative human-wildlife interactions, including:
  - animal attractants such as berry-producing shrubs (e.g., buffaloberry), and understory and/or overstorey vegetation will be cleared in certain areas to reduce potential for bear-human interaction, where possible, as part of the Construction Management Guidelines (TSMV 2008), and FireSmart activities;

---

[15] Designated trails through wildlife corridors have been identified by the Province to connect with areas outside of the wildlife corridor boundaries.

[16] Clearer town-wide bylaws would help improve the efficacy of this mitigation.

   - on-site landscaping will be completed using only non-palatable plant species as per the Flowering Landscapes of TSMV (Stantec 2004a) and Woody Plants of TSMV (Stantec 2004b) guidance documents;
   - no fruit trees, gardens, or outside composting;
   - all garbage collection containers must be bear-proof;
   - barbeques be stored in a secure location when not in use; and
   - no bird feeders.
- planning a trail system inside the Project Boundary that will provide users with an enjoyable and effective alternative to use of trails in the corridor while connecting to existing designated trails through the corridor; and
- designating off-leash areas inside the Project Boundary to provide an opportunity for safe off-leash dog recreation and reducing the need for people to find inappropriate places to run their dogs (i.e., outside of the fence in wildlife corridors and habitat patches).

The separation between people and ungulates and carnivores in developed areas is important for wildlife conservation. Attractant management is central for achieving this separation. Wildlife will not enter developed areas unless there is a benefit for them in doing so, such as food acquisition or predator avoidance. However, there have been many approaches tried in Canmore to achieve this separation, including but not limited to attractant management, education, enforcement, and aversive conditioning; none has worked sufficiently well to prevent negative human-wildlife interactions from contributing to the population sink identified for grizzly bears (Section 5.2.3). For this reason, wildlife fencing was proposed as an additional mitigation and is discussed in more detail in the following section.

5.5.4 Wildlife Fencing

One of the most important mitigation actions proposed to reduce the risk of negative human-wildlife interactions and the risk of reduced use of approved corridors by wildlife is wildlife fencing. Fencing to separate wildlife and people has been used for centuries and is increasingly used around the world (Hayward and Kerley 2009). As outlined in Somers and Hayward (2012), fencing allows fragmented habitats to be used by wildlife when they may not be used otherwise, and fences can conserve wildlife in an otherwise human-dominated landscape.

Many conservation biologists agree that appropriately designed and well-maintained fences can be a fundamental conservation tool (Pfeifer et al. 2014, Woodroof et al. 2014a, Woodroof et al. 2014b). Even within remote wilderness of National Parks, wildlife fences can play an important role in separating wildlife from places where they might come into conflict with people. For example, bison holding fences are proposed as part of Parks Canada's Banff National Park Bison reintroduction program. The purpose of the fences is to keep introduced bison inside the more remote bison reintroduction zone and away from places where they might come into conflict with people (Parks Canada 2016).

The importance of fencing as part of a conservation strategy for large carnivores has been strongly advocated by some. Packer et al. (2013) surveyed contrasting management practices with African lion densities and population trajectories at 42 sites in 11 countries. They found that lion populations in fenced reserves were on average at 80% of their potential densities while lions in unfenced reserves were only at 50% of their potential densities. In addition, the unfenced reserves required management budgets that were four times the budgets of fenced reserves, yet almost half of the lion populations in unfenced reserves were predicted to disappear within 20 to 40 years. Higher lion mortality on unfenced reserves is related to conflict with people in surrounding communities. In the opinion of the Packer et al. (2013), human development in larger wildlife dominated ecosystems may need to be fenced as enclaves to conserve large carnivores. Similarly, a recent global survey of negative human-bear interactions conducted by Can et al. (2014, pg. 501) concluded that, within the toolbox of available mitigation, "*the peer-reviewed literature indicates a heavy reliance on education and physical barriers for conflict mitigation*".

But there is debate about the efficacy of large-scale wildlife fencing, and this type of fencing clearly fails to meet conservation objectives in some cases (Woodroffe et al. 2014a). Many of the failures are due to major changes in landscape connectivity caused by long fences or heavily fenced landscapes, where wildlife populations can become isolated (Woodroffe et al. 2014a). Connectivity problems associated with large scale fencing in North America have been mitigated in many places, including in the Bow Valley, by using crossing structures (Clevenger et al. 2009).

By contrast, fencing used to enclose relatively small areas of intense conflict, such as human settlements, may achieve important conservation benefits while avoiding the potential negative ramifications of large-scale wildlife fencing (Woodroffe et al. 2014a). In this context, fencing is frequently recommended as part of a broader suite of tools used to minimize negative interactions with people and achieve conservation objectives, especially for carnivores (Treves and Karanth 2003, Can et al. 2014, Takahata et al. 2014, Knopff et al. 2016).

In North America, fencing is sometimes used in this way to separate residential developments from areas intended for wildlife. For example, in Jackson, Wyoming, an approximately 3 km page wire fence between the town and National Elk Refuge has helped to contribute to low levels of negative human wildlife interactions (Figure 32). The fence was a mitigation put in place several decades ago (Figures 33 and 34). Without the wildlife fence, refuge staff feel there would be a significant increase in negative interactions (Dippel 2016, pers. comm.). In a recent email to Y2Y, Alyson Courtemanch, a wildlife biologist with the Wyoming Department of Game and Fish living in Jackson, stated that '*without the fence we could have thousands of elk on the highway or in downtown Jackson during the winter creating enormous human safety (and elk safety) issues*".

Closer to Canmore, the tenting area in Parks Canada's Lake Louise campground is also entirely fenced, in this case using electric fencing, to separate campers from grizzly bears (Parks Canada 2013). The base and Whitehorn lodges at the Lake Louise Ski Resort are similarly fenced during the summer months. Fencing is also used to separate wildlife from vehicles on the Trans-Canada Highway and Highway 93S in Kootenay National Park. Fencing on highways is considered a major benefit to wildlife populations because, in combination with crossing structures, wildlife suffer substantially lower mortality rates on fenced highways (Clevenger et al. 2009; Jarvie 2017).

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LEGEND

WILDLIFE FENCE LINE

0 250 500

1:12,000 METRES

REFERENCES
IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-02
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
LOCATION OF A WILDLIFE FENCE BETWEEN THE TOWN AND THE NATIONAL ELK WILDLIFE REFUGE IN JACKSON, WYOMING

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	32

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Figure 33: Jackson Hole Wildlife Fence along Edge of Residential Neighborhood

Figure 34: Jackson Hole Wildlife Fence along Edge of Residential Neighborhood

Wildlife fencing can take several forms and different types of fencing were initially considered for the Project. The first type is a standard fence that does not restrict wildlife movement but is a boundary that marks the edge of a wildlife corridor. An example of this type is the chain link fence used to demarcate the edge of the Sulphur Corridor from the Middle Springs subdivision in Banff (Bow Valley Naturalists 2010). The corridor is closed to people and signage on the fence indicates that trespassers were subject to prosecution. The purpose of the fence was to reduce human intrusion in the wildlife corridor without constraining wildlife movement. Heavy fines enforced by Parks Canada ensure that humans respect the boundary between the community and wildlife corridors.

The second type of wildlife fence is similar, but in this case the fence was designed to restrict the movement of elk but not that of carnivores. This type of fencing has been erected on either side of the wildlife corridor on the golf course on the Jasper Park Lodge lease in Jasper National Park (Shepherd and Whittington 2006). Although deer move back and forth across the barrier, elk for the most part cannot. Wolves could travel back and forth across the fence but to a great degree have not, possibly because prey (e.g., elk) are less available inside the fence. Voluntary trail closures have reduced human use in the corridor, resulting in a corridor that is used by wolves and elk.

Both wildlife fence types could achieve the goal of reducing human use in a wildlife corridor, one of the two key issues that currently exists in the wildlife corridors around the TSMV development. However, neither fully addresses negative wildlife-human interactions within the Project Boundary, which is another major risk for large mammals, particularly bears. Given the serious risk identified for grizzly bears in the Bow Valley (Section 5.2.3), the reduction in negative wildlife-human interactions was of paramount importance when considering mitigation for the potential effects of the proposed Projects on wildlife. Therefore, the first two fencing options discussed above were not considered any further.

A third wildlife fence option that was considered and ultimately selected as a recommended mitigation measure for the Resort Centre ASP Amendment is a page wire fence, approximately 2.5 m high, with a buried apron similar to those found on the Trans-Canada highway and in Jackson, Wyoming. A high tension wire at the top will be used to address potential tree fall.

This type of wildlife fence was chosen because it can address both primary wildlife issues that currently exist in the Bow Valley, i.e., wildlife incursion into developed areas and inappropriate human use in wildlife corridors. The fence will substantially reduce or eliminate the ability of mammals larger than a coyote to enter the development from the wildlife corridor. Although fencing will keep most wildlife from entering developed areas, reducing attractants within human development area remains important so that wildlife are less likely to attempt to breach the barrier.

The wildlife fence will easily accommodate human access to wildlife corridors on designated trails using walk-through swing gates. The design allows human and bike access but does not permit wildlife passage. Examples of successful deployment of such access points can be found in numerous places along the Trans-Canada Highway in the Bow Valley (e.g., Redearth Trail head access point) and on the enclosed portion of the Lake Louise Ski Hill to allow access to the Pipestone Trail system in the summer. Larger locked swing gates will also be incorporated into the fence at intervals to permit wildlife to be removed from the developed area should they get in. Experience in Banff National Park and from AEP employees suggest swing gates are more effective than jump-outs for this purpose (Honeyman, Gummer, Boukall 2016, pers. comm.). Jump outs may also be included, depending on the final design.

To achieve greatest overall efficacy, the wildlife fence should encompass developments in the TSMV area as a whole, not just the Project Boundary. In the proposed design, the fence would travel through the Stewart Creek Golf Course and the west side of the Stewart Creek Across Valley Corridor, abutting the Trans-Canada Highway fence west of the Stewart Creek Underpass. A single transportation access point through the Stewart Creek Across Valley Corridor linking vehicles, pedestrians, and cyclists to developments in the Smith Creek ASP area will be constructed and a wildlife crossing structure will be constructed under this access route.

The fence would be aligned between the Project and wildlife corridors, habitat patches and other undeveloped lands, as delineated in Figure 35. Fence ends should be limited to the extent possible and where breaks in the fence are required, such as at road crossings, cattle guards or electro-mats should be applied. In the case of the Resort Centre ASP, a single fence enclosing the Project, a portion of the Stewart Creek Golf Course and the most westerly development of the Smith Creek ASP which is proposed to be west of the Stewart Creek Across Valley Corridor is proposed to minimize fence ends. Fencing will require upkeep to maintain integrity over time.

The conceptual wildlife fence alignment is not complete; a large opening is present along the north boundary adjacent to the Bow River (Figure 35). Wildlife could enter development through this opening and will need to be removed, or be permitted to exit of their own accord through the opening or over jump-outs or other one-way exits. The overall benefits of the fence are expected to outweigh costs associated with managing these incursions, but the opening does increase uncertainty about the effectiveness of the fence and amount of effort required to address incursions relative to a complete enclosure scenario.

Final design of the fence, including design at creek crossings, fence ends, and other aspects will be undertaken after ASP approval and should include the design principles outlined here. A qualified professional should evaluate the final design of the wildlife fence to confirm that it is consistent with the fence described in this section.

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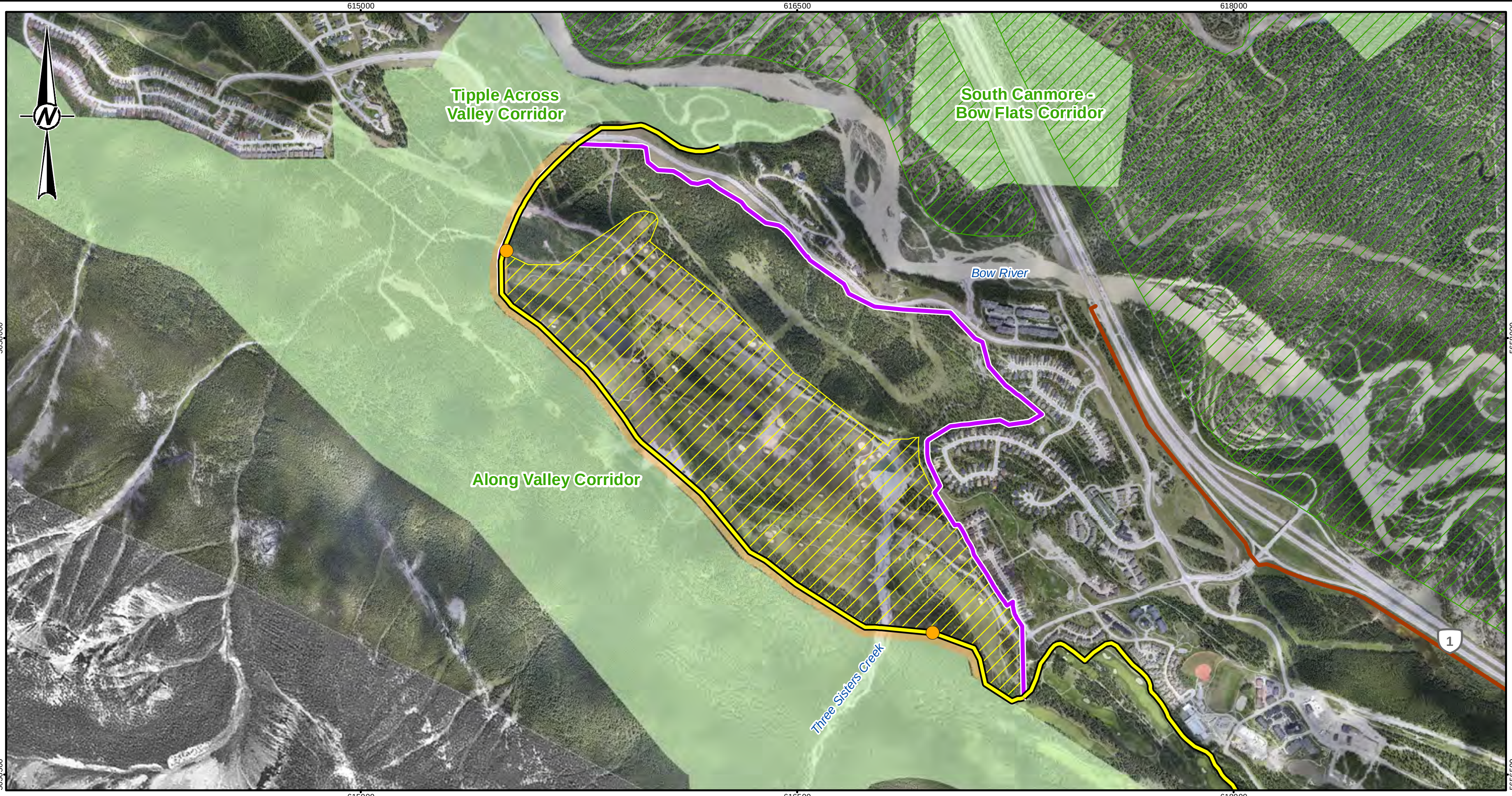

LEGEND

- PROPOSED SWING GATE
- EXISTING FENCE
- PROPOSED FENCE
- 35 m CONSERVATION EASEMENT
- APPROVED WILDLIFE CORRIDOR
- HABITAT PATCH
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

NOTE

FINAL FENCE ALIGNMENT ALONG STEWART CREEK GOLF COURSE MAY BE ADJUSTED SLIGHTLY TO OPTIMIZE USER EXPERIENCE OF GOLF COURSE AND MINIMIZE NUMBER OF GATES. WILDLIFE CONSERVATION FENCE ON WEST SIDE OF THE STEWART CREEK CROSS VALLEY CORRIDOR WILL BE DETERMINED IN CONSULTATION WITH ALBERTA ENVIRONMENT AND PARKS.

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-01
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

TITLE

PROPOSED LOCATION OF WILDLIFE FENCE FOR THE PROJECT

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	35

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm

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5.6 Predicted Project Effects

This section predicts residual effects of the Project for grizzly bears, cougars, wolves, and elk, assuming the mitigation measures recommended in Section 5.5 are implemented. Based on the mitigation identified in Section 5.5.1 and the fact that the probability of grizzly bear dens occurring in the Project Boundary is near zero (Section 5.2.3), construction of the Project is not expected to cause mortality for grizzly bears, cougars, wolves or elk. Therefore, the Project effects assessment focuses on evaluating the importance of the residual effect of the Project for habitat quantity and quality, use of wildlife corridors adjacent to the Project, and negative wildlife human interactions. Because of the importance of human use in influencing all of these, predicted changes in human use are presented prior to assessing effects of the Project on each wildlife species.

5.6.1 Human Use

Mitigation identified to address the potential for human use to increase in wildlife corridors includes:

- a wildlife fence;
- a trail network inside the Project Boundary that permits access only through signed gates onto designated trails through wildlife corridors;
- education; and
- opportunities for off-leash dog use inside the human development area within the Project Boundary.

From the perspective of human use in wildlife corridors, the intent of the proposed mitigation is to manage human use in wildlife corridors by providing people with an opportunity to recreate and run their dogs inside the fence and to help them follow existing regulations within wildlife corridors, such as using only designated trails. The efficacy of this mitigation will depend on how people respond to its implementation and is therefore uncertain. However, available evidence suggests that this suite of mitigation will most likely be successful, as described in the following paragraphs.

The efficacy of a wildlife fence for directing human access can be seen along the fenced portions of the Trans-Canada Highway, where people rarely go over the fence to access trails and vehicles tend to pull out at designated trailheads. Compare this with Highway 40, which is unfenced, where people park vehicles at a large number of locations in the ditch or on the side of the road to access various trails. East of Canmore along the Trans-Canada Highway, people park vehicles at a variety of locations on the side of the highway, like Heart Creek or McGillvray Pond.

Human use in wildlife corridors has been successfully limited in some parts of the RSA using education programs. For example, trail closures in the Benchlands were reinforced by education campaigns and resulted in more than 10-fold reductions in human use (Lee et al. 2010). By combining the fencing mitigation with education, similar or better success is expected within the corridors near the Resort Centre ASP area. This expectation is further supported by a survey undertaken in 2014 as part of the Town's Human Use Management Review program. When residents of Canmore were asked "what would it take for you to not recreate in wildlife corridors or habitat patches?", they consistently answered that more signage, alternative trails for recreation, and better education would be most effective (Town of Canmore 2015b).

During their review of Golder (2013), MSES (2013, pg. 6) concurred with Golder "*that the fencing could indeed reduce wildlife – human interactions in the corridor*". In MSES's view, this reduction could be achieved not only through the physical separation between wildlife and people, but also as a result of the increased awareness of people who enter the wildlife corridor through designated gates equipped with educational signs.

By combining wildlife fencing with alternative options for recreation, especially off-leash dog parks and designated trails that are fun to use, the potential effects of increased human use in the wildlife corridor are predicted to be substantially reduced relative to building the Project without recommended mitigation. Developing the Project with a wildlife fence and educational signs is predicted to result in a substantial reduction in human use of undesignated trails in adjacent wildlife corridors relative to developing the Resort Centre according to the approved 2004 ASP.

With the application of wildlife fencing, a trail network that connects to designated trails and is fun to use, and off-leash dog opportunities included in the Project Boundary, effects of the Project on human use in wildlife corridors may result in positive outcomes for wildlife when compared to existing conditions. The corridors adjacent to the Project experience high human use under existing conditions, including high use by off-leash dogs and substantial use of undesignated trails (Section 5.2.1). Fencing and provision of off-leash dog areas inside the fence is predicted to reduce the amount of off-leash dog use in corridors relative to existing conditions by providing alternatives and direction.

Education and developing trails that are fun to use within the Project Boundary are predicted to reduce use of undesignated trails in the corridors. Thoughtful trail construction has proven successful elsewhere in the Bow Valley. For example, the "Long Road to Ruin" Trail in the Canmore Nordic Center has resulted in the abandonment of almost all non-sanctioned trails in the immediate vicinity of the constructed trail (Dickison 2017, pers. comm.).

Because the number of new people likely to occur in the Project Boundary as a result of the Project and increased concentration of existing users on designated trails because of the fence and improved education, use of designated trails in wildlife corridors adjacent to the Resort Centre could more than double from existing conditions, although the amount of increase is uncertain.

As pointed out by MSES (2013), there is uncertainty about whether or not a fence will result in a reduction of off-leash dog use and undesignated trail use relative to existing conditions because the benefit will depend on whether people are accessing the corridor through the Resort Centre, or if they are coming from elsewhere. If people are accessing through the Resort Centre, they will be exposed to the fence and associated educational signs about uses that are permitted in the wildlife corridor. Camera data indicate that many recreational activities do begin in the Resort Centre under existing conditions; the Project Boundary has the highest level of human use of any area investigated within the camera deployment area.

Addressing human use within wildlife corridors is a problem that is broader than this Project (Town of Canmore 2015 b). The Province and the Town will need to provide enforcement and will likely need to work together with agencies like WildSmart and other local organizations to help with developing educational materials for people entering corridors from outside of the Resort Centre.

5.6.2 Grizzly Bears

5.6.2.1 Habitat Quantity and Quality

Habitat quality declines substantially for grizzly bears within the Project Boundary with implementation of the Project because grizzly bears tend to avoid higher density developments like those in the Resort Core, but some areas predicted to be selected or used as available remain, especially in areas designated for recreation or low density development in Policy Areas E and F (Table 19, Figures 36 and 37). Development of the Project with a wildlife fence surrounding the developments will virtually eliminate any future grizzly bear use of the area. Because the unfenced portion of the Project Boundary consists of strongly avoided or rarely used habitats associated with higher density developments, grizzly bears are not expected to enter through the gap in the fence to access areas of selected habitat within the Project Boundary.

Relative to existing conditions, fencing will result in a loss of 115 ha of selected habitat, i.e., 3% of this habitat class in the RSA, and 48 ha of used as available habitat, i.e., 1% of this habitat class in the RSA. Because the Project Boundary represents an ecological trap where grizzly bear selection and negative human interactions are both high under existing conditions (Figures 18 and 19), loss of access to the area will be beneficial or neutral for the grizzly bear population overlapping the RSA (Lamb et al. 2016).

FireSmart measures implemented by the Town, the MD of Bighorn, and the Province that reduce forest cover and increase early seral habitats in wildlife corridors adjacent to the Project Boundary and the Smith Creek ASP boundary would provide high quality habitat for grizzly bears away from zones of higher negative human-bear interactions. Well planned implementation of FireSmart could result in a net benefit to grizzly bears (Golder 2012, pg. 88-94).

Table 19: Predicted grizzly bear habitat in the Project Boundary with the addition of the Project with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [a])	With Estimated Effects of Increased Human Use on Trails (ha) (change [a])
Selected	27 (-87)	26 (-88)
Used as available	25 (-23)	27 (-22)
Somewhat avoided	25 (25)	25 (25)
Strongly avoided	69 (69)	69 (69)
Rarely used	16 (16)	16 (16)
Total	**163**	**163**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[a] Change calculated by subtracting the existing conditions value (with or without estimated effects of increased human use on trails) from the Project effects value.

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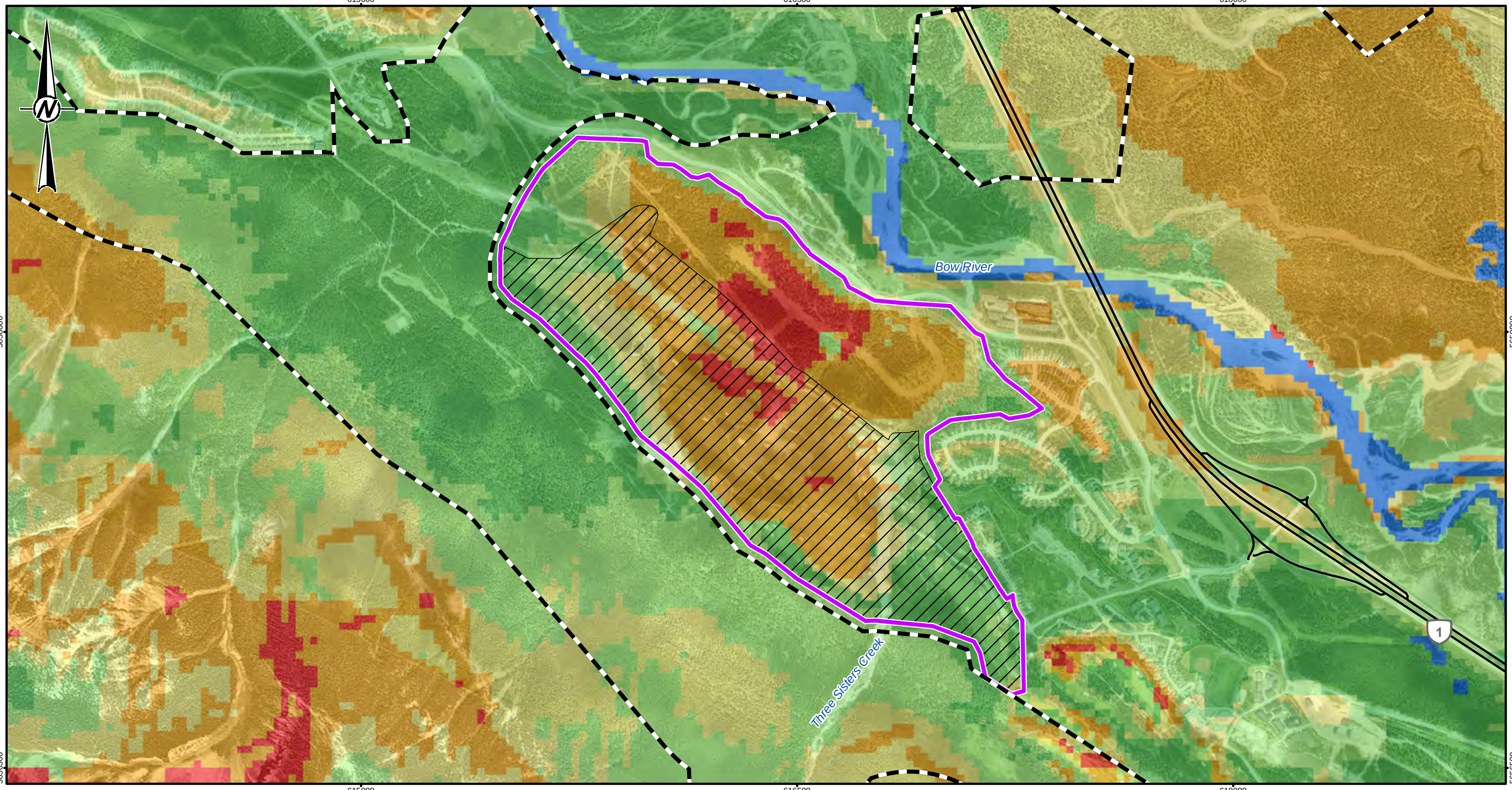

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	JE

TITLE

PREDICTED SUMMER GRIZZLY BEAR RESOURCE SELECTION – PROJECT EFFECTS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	36

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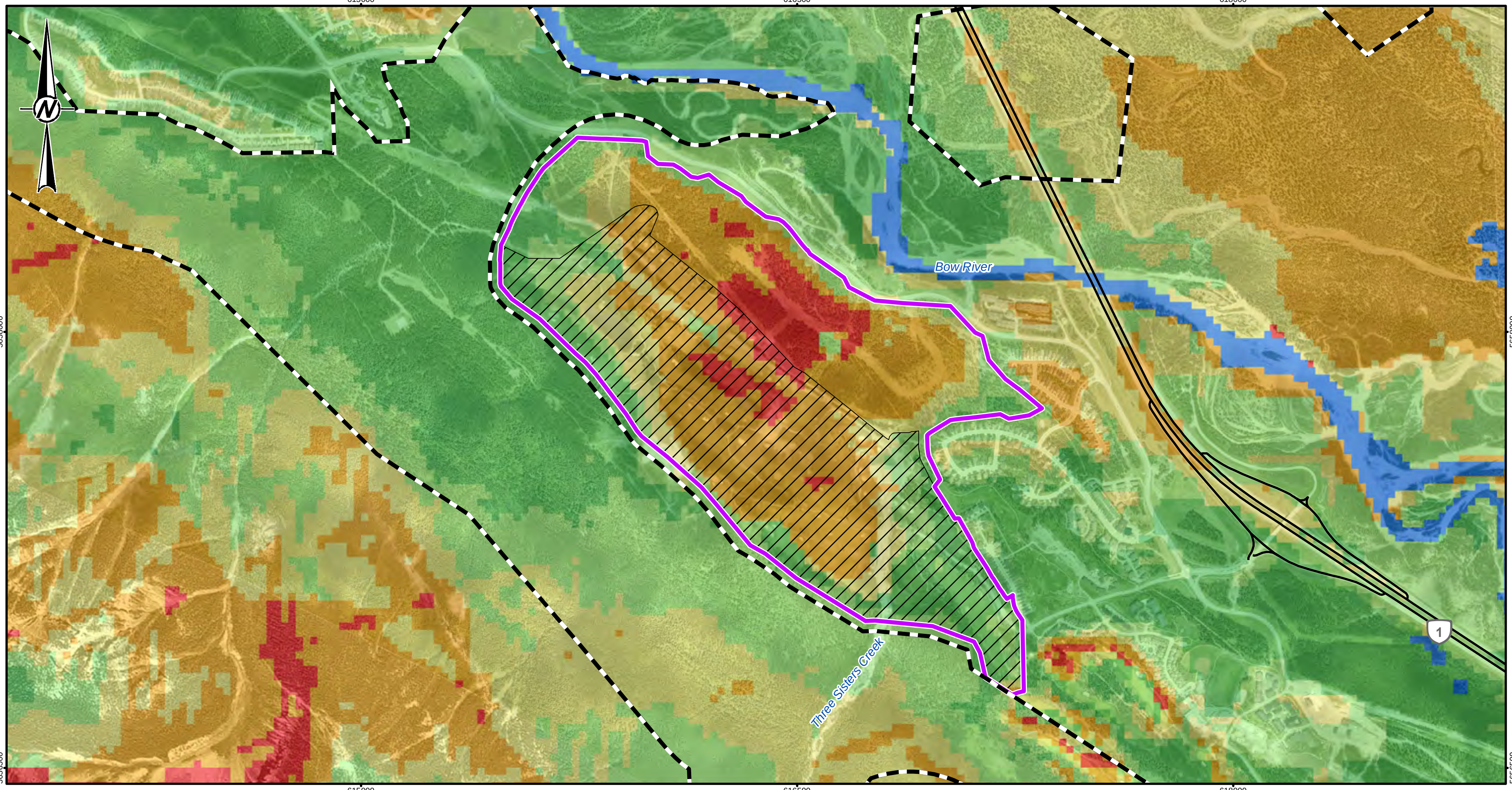

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

PREDICTED SUMMER GRIZZLY BEAR RESOURCE SELECTION – PROJECT EFFECTS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	37

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

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5.6.2.2 Use of Approved Corridors

Under existing conditions, grizzly bears in the RSA retain a high probability of selection for some places where human use and trail density are also high, such as the Canmore Nordic Centre and in the vicinity of the Resort Centre ASP Amendment. Probability of grizzly bear selection is therefore expected to remain relatively high in wildlife corridors adjacent to the Resort Centre, even if human use in the corridor increases (Gibeau et al. 2002a). Probability of grizzly bear selection predicted by RSF output in approved corridors changes little as a result of the Project (Table 20, Figures 36 and 37).

Because human use on undesignated trails is expected to decline in wildlife corridors adjacent to the Project as a result of fencing, education, and alternative recreation opportunities inside the fence (Section 5.6.1), the disturbance coefficient for these trails was removed (Appendix B). Consequently, the model with estimated effects of increased human use on trails results in 5 ha increase of selected habitat relative to existing conditions as a result of the Project (Table 20).

There is some uncertainty about whether the small predicted benefit for bears in approved corridors will be achieved because it would depend on how people access the wildlife corridor and on the good behavior of people in wildlife corridors (Section 5.6.1). Consequently, to be precautionary, the residual effects of the Project are predicted to be neutral relative to existing conditions. However, relative to developing the approved 2004 Resort Centre ASP, which does not have a fence, the effects of the Project are predicted to be positive.

Table 20: Predicted grizzly bear habitat in wildlife corridors adjacent to the Project Boundary with the addition of the Project with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	150 (-4)	143 (5)
Used as available	143 (-1)	134 (-3)
Somewhat avoided	68 (4)	81 (-4)
Strongly avoided	15 (1)	17 (1)
Rarely used	1 (0)	1 (0)
Total	**377**	**377**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without estimated effects of increased human use on trails) from the Project effects value.

5.6.2.3 Negative Human-Wildlife Interactions

Under current conditions, the Project Boundary is heavily used by people (Section 5.6.1) and the grizzly bear RSF identifies a high probability of selection (Section 5.2.3). Negative human-bear interactions are high in the Resort Centre during the pre-berry season (Figure 18), indicating the likely presence of an ecological trap. Fencing the Project Boundary, as identified in Section 5.5.4, is predicted to substantially reduce the number of negative human-bear interactions inside the Resort Centre. Although grizzly bears can swim the Bow River, large areas of strongly avoided and rarely used habitat associated with the Resort Core are predicted to result in a very low probability of grizzly bears entering development through the gap in the fence by the Bow River. Therefore, effects of the Project are predicted to have a positive outcome by reducing negative bear-human interactions within the Resort Centre.

In wildlife corridors adjacent to the Resort Centre, the number of negative human-bear interactions is also predicted to decrease from existing conditions if people use recreational amenities envisioned for the Resort Centre ASP Amendment, such as the off leash dog park and trail system, and stay on designated trails when traveling through the wildlife corridor. There is some uncertainty about whether this benefit will be achieved because it would depend on how people access the wildlife corridor and on the good behavior of people in wildlife corridors (Section 5.6.1). An increase in negative human-bear interactions is possible in wildlife corridors adjacent to the Project Boundary if the new residents and visitors associated with the Project do not respect regulations in wildlife corridors, including ignoring direction provided on signs at entry points.

To be precautionary, the overall residual effects of the Project in terms of changes to negative human-bear interactions are predicted to be neutral relative to existing conditions because of uncertainty about the level of negative interaction in adjacent wildlife corridors after development. However, relative to developing the approved 2004 Resort Centre ASP, which does not have a fence and would see increased negative interaction in the Project Boundary (Section 2), the effects of the Project are predicted to be overwhelmingly positive.

5.6.2.4 Environmental Consequence

The impacts described in Sections 5.6.2.1 to 5.6.2.4 according to the impact criteria used to inform the determination of environmental consequence are summarized in Table 21. Residual changes in habitat quantity and quality, use of approved wildlife corridors adjacent to the Project Boundary, and negative human-wildlife interactions associated with the Project are all predicted to have either positive or neutral outcomes for grizzly bears (Table 21). Consequently, the Project is not expected to contribute adversely to the serious risk and high environmental consequence identified for grizzly bears identified under existing conditions (Section 5.2.3). The Project is beneficial for grizzly bears when compared to developing the approved 2004 Resort Centre ASP without a fence, which would result in a strong adverse contribution to the high environmental consequence identified under existing conditions.

Table 21: Residual effects summary for grizzly bears

Effect Category	Impact Criterion	Residual Effect Summary	Prediction Confidence
Habitat Quantity and Quality	Direction	Positive	High - the direction of change is expected to be positive for grizzly bears because the Resort Centre represents an ecological trap under existing conditions.
	Geographic extent	Primarily within the Project Boundary, with minor changes in adjacent wildlife corridors	High – RSF models, scientific literature, camera data, and conflict data the Bow Valley all indicate that the zone of influence from development is small for grizzly bears.
	Duration	Permanent	High – development will be present for many decades.
	Magnitude	Loss of 114 ha of selected habitat, i.e., 3% of this habitat class in the RSA, and 48 ha of used as available habitat, i.e., 1% of this habitat class in the RSA	High – development will reduce habitat quality and fencing will exclude access to remaining selected habitats. These habitats represent a relatively small portion of available habitat at the RSA scale.
	Probability	High	High – if development proceeds with a fence, bears will be excluded from primary sink habitats that act as an ecological trap.
	Frequency	Change will occur once, when the wildlife fence is constructed.	High – construction of the fence will immediately eliminate access by grizzly bears to selected habitats in the Resort Centre.
Use of Approved Wildlife Corridor	Direction	Neutral	Moderate – the outcome of the Project has a potential to be positive relative to existing conditions and is predicted to be positive relative to developing the approved 2004 ASP
	Geographic extent	Immediately adjacent to the Project Boundary	High – human use is highest close to development and zone of influence from development is small for grizzly bears.
	Duration	Permanent	High – development will be present for many decades
	Magnitude	Changes of less than 4% of selected or used as available habitat	High – RSF models validate well, available evidence suggests grizzly bears respond weakly to human use.
	Probability	High	High – Changes in the corridor are likely, will be small, and will most likely be neutral or positive.
	Frequency	Change will occur incrementally over time as the Project is built	Moderate – Changes within wildlife corridors will occur over time as people are added, but the largest positive change will be associated with application of the fence and this change will occur rapidly with fence construction.
Negative Human Wildlife Interactions	Direction	Neutral	Moderate – the outcome of the Project has a potential to be positive relative to existing conditions and is predicted to be strongly positive relative to developing the approved 2004 ASP.
	Geographic extent	Within the Project Boundary and adjacent wildlife corridors	High – the primary benefit will be within the fenced Project Boundary.
	Duration	Permanent	High – development will be present for many decades.
	Magnitude	No change from existing conditions	Moderate – outcome could be positive.
	Probability	High	High – A neutral of better outcome is expected based on available evidence.
	Frequency	The largest change will occur once, when the wildlife fence is constructed	High – construction of the fence will eliminate access by grizzly bears to selected habitats that are also heavily used by people in the Resort Centre.

5.6.3 Cougars

5.6.3.1 Habitat Quantity and Quality

Habitat quality for cougars within the Project Boundary is predicted to shift from habitats consisting primarily of those that are selected or used as available to habitats that are primarily avoided as a result of the Project, but some areas of habitat that is selected or used as available are predicted to remain, especially in areas designated for recreation in Policy Areas E and F (Table 22, Figures 38 and 39). Development of the Project with a wildlife fence surrounding the developments will virtually eliminate any future cougar use of the area. Because the unfenced portion of the Project Boundary consists of strongly avoided habitats associated with higher density developments, cougars are not expected to enter through the gap in the fence to access the areas of selected habitat within the Project Boundary.

Relative to existing conditions, fencing will result in a loss of 102 ha of selected habitat, i.e., 2% of this habitat class in the RSA, and 38 ha of used as available habitat, i.e., 1% of this habitat class in the RSA. This will result in a small adverse effect on cougar habitat availability in the RSA. However, this may be offset somewhat by an increase in the amount of selected habitat that is predicted in adjacent wildlife corridors, especially under the model with estimated effects of increased human use on trails (Table 23, Figures 38 and 39). An increase in probability of selection is predicted because a) cougars select habitats on the edges of developed areas where prey are abundant (Appendix B) and b) human use of undesignated trails is predicted to decline with the Project (Section 5.6.1). Whether or not prey will increase on the edge of development with a fence is uncertain, so the model may overestimate the positive change in cougar selection in the wildlife corridor. Overall, the outcome of changes in habitat quantity and quality are predicted to negatively affect cougars.

FireSmart measures implemented by the Town, the MD of Bighorn, and the Province that reduce forest cover and increase early seral habitats in wildlife corridors adjacent to the Project Boundary and the Smith Creek ASP boundary would improve habitat conditions for cougars in the wildlife corridors. Well planned implementation of FireSmart could result in a net benefit to cougars (Golder 2012, pg. 88-94).

Table 22: Predicted cougar habitat in the Project Boundary with the addition of the Project with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	21 (-81)	21 (-81)
Used as available	20 (-18)	20 (-18)
Somewhat avoided	83 (60)	83 (60)
Strongly avoided	39 (38)	39 (38)
Rarely used	0 (0)	0 (0)
Total	**163**	**163**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without estimated effects of increased human use on trails) from the Project effects value.

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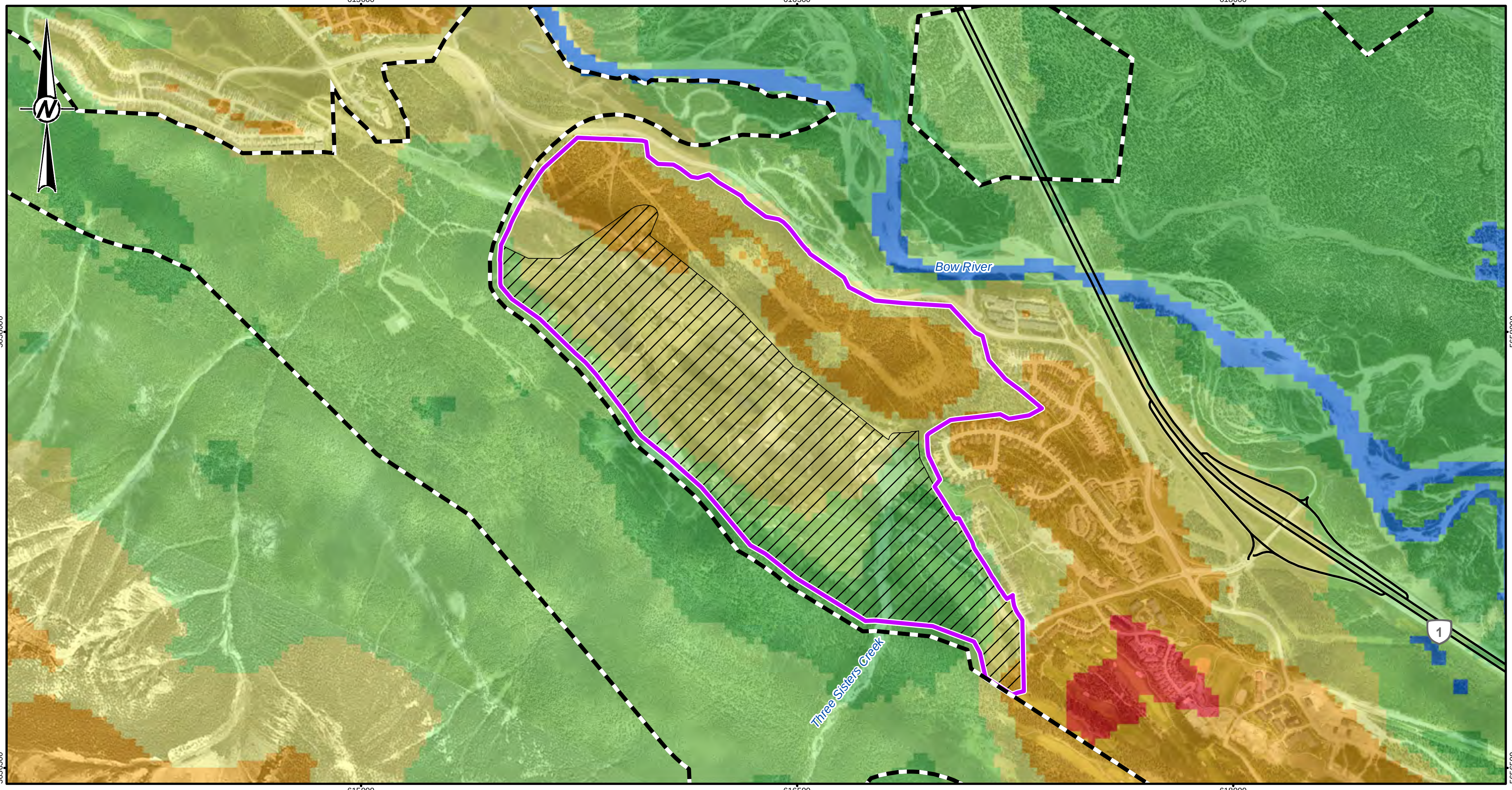

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

PREDICTED WINTER COUGAR RESOURCE SELECTION – PROJECT EFFECTS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	38

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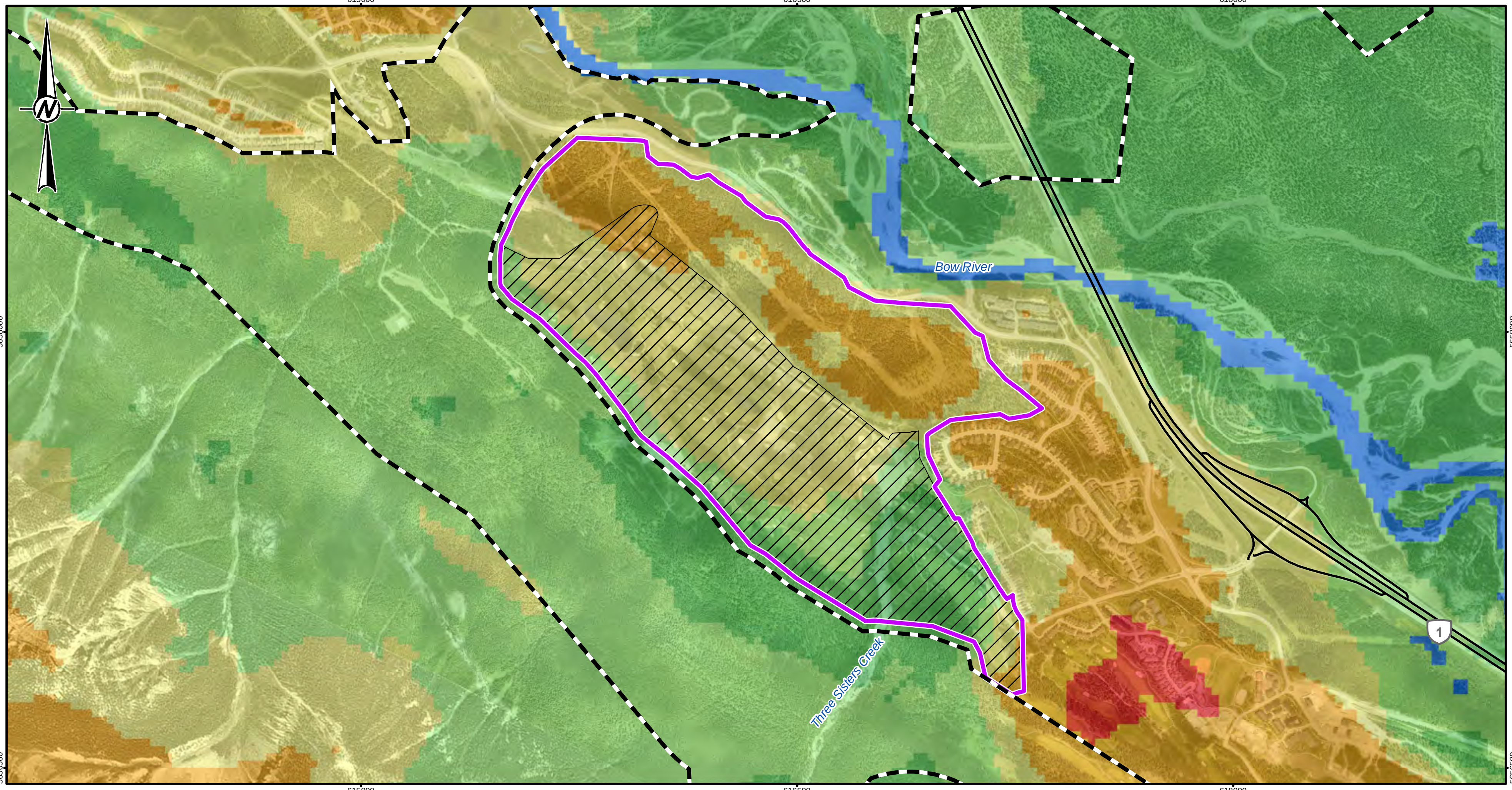

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

PREDICTED WINTER COUGAR RESOURCE SELECTION – PROJECT EFFECTS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	39

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm 0

5.6.3.2 Use of Approved Corridors

Zones of influence vary by species and disturbance type and also by the amount of exposure animals have to people (Rogala et al. 2011). For example, cougars tend to avoid human activity in landscapes where such activity is rare, but avoid it substantially less or not at all in places where human disturbance is prevalent (Knopff et al. 2014). Cougars are also capable of adjusting their behavior temporally to use landscapes closer to human development during times when people are less active (Knopff et al. 2014).

In the RSA, cougars select habitats that are closer to development, presumably because prey density is highest there (Section 5.2.6). As a result of this selection pattern, probability of selection is predicted to be higher for cougars in wildlife corridors adjacent to the Project after the development occurs (Table 23, Figures 38 and 39). As identified in Section 5.6.3.1, whether prey density will increase near development after a fence is constructed is uncertain. Therefore, an increase in probability of selection, and associated increased potential for movement, may not occur in the wildlife corridors adjacent to the Project. Moreover, the potential improvement in probably of selection within wildlife corridors as a result of lower human use of undesignated trails is small (Table 23). Consequently, to be precautionary, the Project is predicted to have a neutral effect on cougar use of the wildlife corridors.

Table 23: Predicted cougar habitat in wildlife corridors adjacent to the Project Boundary with the addition of the Project with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [a])	With Estimated Effects of Increased Human Use on Trails (ha) (change [a])
Selected	85 (22)	80 (38)
Used as available	216 (-20)	219 (-14)
Somewhat avoided	62 (-1)	63 (-24)
Strongly avoided	13 (0)	14 (0)
Rarely used	0 (0)	0 (0)
Total	**377**	**377**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[a] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use on trails) from the Project effects value.

5.6.3.3 Negative Human-Wildlife Interactions

Under current conditions, the area within the Project Boundary is heavily used by people (Section 5.6.1) and the cougar RSF modelling predicts a high probability of selection (Section 5.2.4). The potential for negative human-cougar interactions is therefore high in the Resort Centre under existing conditions. After the Project is developed, habitat selected by cougars will be present in areas designated for recreation (Figure 38), resulting in a high potential for negative human-cougar interactions unless adequate mitigation is applied.

Fencing the Project Boundary, as identified in Section 5.5.4, is predicted to reduce the potential for negative human-cougar interactions inside the Project Boundary. Although cougars can swim the Bow River, large areas of strongly avoided habitat associated with the Resort Core are predicted to result in a low probability of cougars entering development through the gap in the fence, although this is uncertain and may depend on the number of prey animals that enter the Project Boundary after development (Section 5.6.5). If cougars do not enter through the gap in the fence, then the risk of negative human-cougar interactions within the Project Boundary will decline relative to existing conditions as a result of the Project.

In wildlife corridors adjacent to the Project Boundary, the risk of negative human-cougar interactions is also predicted to decrease from existing conditions if people use recreational amenities envisioned for the Project, such as the off leash dog park and trail system, and stay on designated trails when traveling through the wildlife corridor. The risk of dogs being attacked by cougars is predicted to decline with the use of off leash dog parks inside the fence. There is some uncertainty about whether this benefit will be achieved because it would depend on how people access the wildlife corridor and on the good behavior of people in wildlife corridors (Section 5.6.1).

To be precautionary, the overall residual effects of the Project in terms of changes to negative human-cougar interactions are predicted to be neutral relative to existing conditions because of uncertainty about the level of interaction both within the Project Boundary and adjacent wildlife corridors after development. However, relative to developing the approved 2004 Resort Centre ASP, which does not have a fence and would result in increased negative interaction in the Project Boundary, the effects of the Project are predicted to be positive.

5.6.3.4 Environmental Consequence

The impacts described in Sections 5.6.3.1 to 5.6.3.4 according to the impact criteria used to inform the determination of environmental consequence are summarized in Table 24. Residual changes in the use of approved wildlife corridors adjacent to the Project Boundary, and negative human-wildlife interactions associated with the Project are predicted to have neutral outcomes for cougars. Residual changes in habitat quantity and quality are predicted to have small adverse effects. Consequently, the Project is not expected to change the self-sustaining and ecologically effective status of the cougar population identified in the RSA under existing conditions, and the environmental consequence is predicted to remain low.

Table 24: Residual effects summary for cougars

Effect Category	Impact Criterion	Residual Effect Summary	Prediction Confidence
Habitat Quantity and Quality	Direction	Negative	High - the direction of change is expected to be negative for cougars because of an overall loss of selected habitat.
	Geographic extent	Primarily within the Project Boundary, with minor changes in adjacent wildlife corridors	High – RSF models, scientific literature, camera data, and conflict data the Bow Valley all indicate that the zone of influence from development is small for cougars. If changes in selection occur in habitats adjunct to development, the change is generally positive (Appendix B).
	Duration	Permanent	High – development will be present for many decades.
	Magnitude	Loss of 102 ha of selected habitat, i.e., 2% of this habitat class in the RSA, and 38 ha of used as available habitat, i.e., 1% of this habitat class in the RSA	High – development will reduce habitat quality and fencing will exclude access to remaining selected habitats. These habitats represent a relatively small portion of available habitat at the RSA scale.
	Probability	Moderate	Moderate – if development proceeds with a fence, cougars should be excluded from remaining selected habitat within the Project Boundary, but some uncertainty is present.
	Frequency	Change will occur once, when the wildlife fence is constructed.	High – construction of the fence will immediately restrict access by cougars to selected habitats in the Project Boundary.
Use of Approved Wildlife Corridor	Direction	Neutral	Moderate – the outcome of the Project has a potential to be positive relative to existing conditions and is predicted to be positive relative to developing the approved 2004 ASP.
	Geographic extent	Immediately adjacent to the Project Boundary	High – human use is highest close to development and zone of influence from development is small for cougars.
	Duration	Permanent	High – development will be present for many decades.
	Magnitude	The RSF predicts and increase in selected habitat within the wildlife corridors	Low – RSF models validate well, but do not consider potential effects of a fence on prey abundance adjacent to development.
	Probability	High	High – Neutral or positive effects are expected, based on available evidence.
	Frequency	Change will occur incrementally over time as the Project is built	Moderate – Changes within wildlife corridors will occur over time as people are added, but the largest change will be associated with application of the fence and this change will occur rapidly with fence construction.
Negative Human Wildlife Interactions	Direction	Neutral	Moderate – the outcome of the Project has a potential to be positive relative to existing conditions and is predicted to be strongly positive relative to developing the approved 2004 ASP.
	Geographic extent	Within the Project Boundary and adjacent wildlife corridors	High – the primary benefit will be within the fenced Project Boundary.
	Duration	Permanent	High – development will be present for many decades.
	Magnitude	No change from existing conditions	Moderate – outcome could be positive.
	Probability	High	High – A neutral of better outcome is expected based on available evidence.
	Frequency	The largest change will occur once, when the wildlife fence is constructed	High – construction of the fence will restrict access by cougars to selected habitats that are also heavily used by people in the Project Boundary.

5.6.4 Wolves

5.6.4.1 Habitat Quantity and Quality

Habitat quality declines for wolves within the Project Boundary with implementation of the Project, and the majority of the area is predicted to be strongly avoided by wolves with or without taking into account the effects of trail use by humans (Table 25, Figures 40 and 41). Development of the Project with a wildlife fence surrounding the development is intended to eliminate any future wolf use of the area. Because the unfenced portion of the Project Boundary consists of strongly avoided habitat associated with higher density developments (Figure 40), wolves are not expected to enter through the gap in the fence adjacent to the Bow River to access the small areas of remaining selected habitat. This prediction depends on whether elk and deer will use the unfenced portion of the Project Boundary to gain access to forage resources inside (Section 5.6.5). If elk and deer enter through the fence, then habituated wolves[17] may take advantage of the opening to access prey.

Fencing will not result in a loss of any selected habitat for wolves, but 41 ha of used as available habitat will be lost, i.e., 1.2% of this habitat class in the RSA (Table 35). The loss of access to the Resort Centre ASP area will be neutral for the wolf population overlapping the RSA. Although some wolf habitat will be lost, deer and elk will also be excluded from the area. Elk and deer will likely be displaced elsewhere in the Bow Valley, potentially increasing the value of those habitats for wolves.

FireSmart measures implemented by the Town, the MD of Bighorn, and the Province that reduce forest cover and increase early seral habitats in wildlife corridors adjacent to the Project Boundary and the Smith Creek ASP boundary would improve habitat conditions for wolves in wildlife corridors (Golder 2012, pg. 88-94). Improvement for wolves is likely strongly linked to increased use of early seral habitats by ungulate prey (Section 5.6.5).

Table 25: Predicted wolf habitat in the Project Boundary with the addition of the Project with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails ha (change [(a)])	With Estimated Effects of Increased Human Use on Trails ha (change [(a)])
Selected	0 (0)	0 (0)
Used as available	0 (-41)	0 (-14)
Somewhat avoided	9 (-102)	1 (-131)
Strongly avoided	154 (143)	162 (145)
Rarely used	0 (0)	0 (0)
Total	**163**	**163**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without estimated effects of increased human use on trails) from the Project effects value.

[17] Habituated wolves have not been present in the Bow Valley until recently. Wolves that are not habituated strongly avoid people and are not expected to use the Project Boundary, even if elk and deer enter through the gap in the fence.

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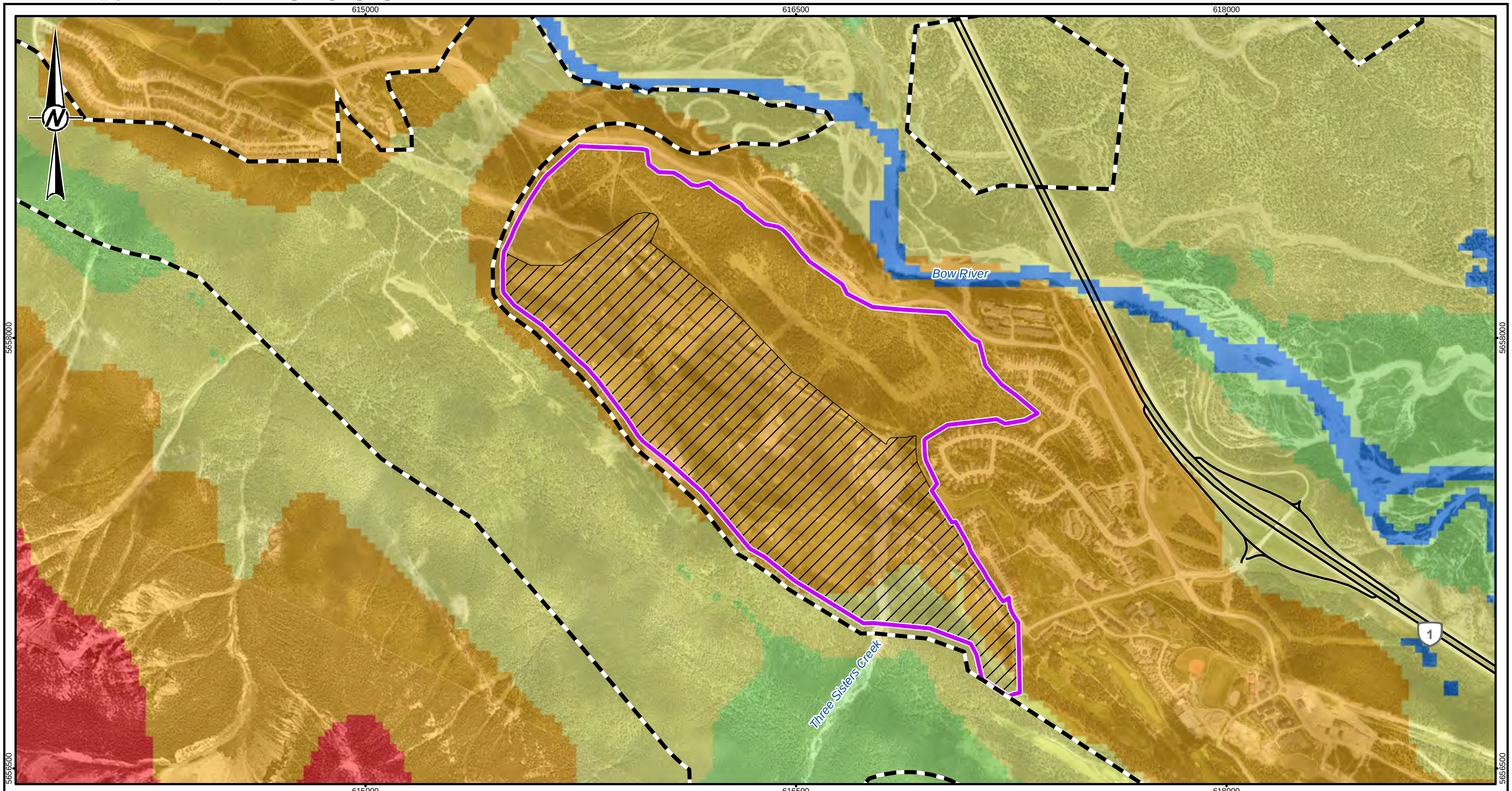

LEGEND

PRIMARY HIGHWAY
APPROVED WILDLIFE CORRIDOR
PROJECT BOUNDARY
RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

USED AS AVAILABLE
SOMEWHAT AVOIDED
STRONGLY AVOIDED
RARELY USED
WATERBODY

0 500 1,000
1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
PREDICTED WINTER WOLF RESOURCE SELECTION – PROJECT EFFECTS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	40

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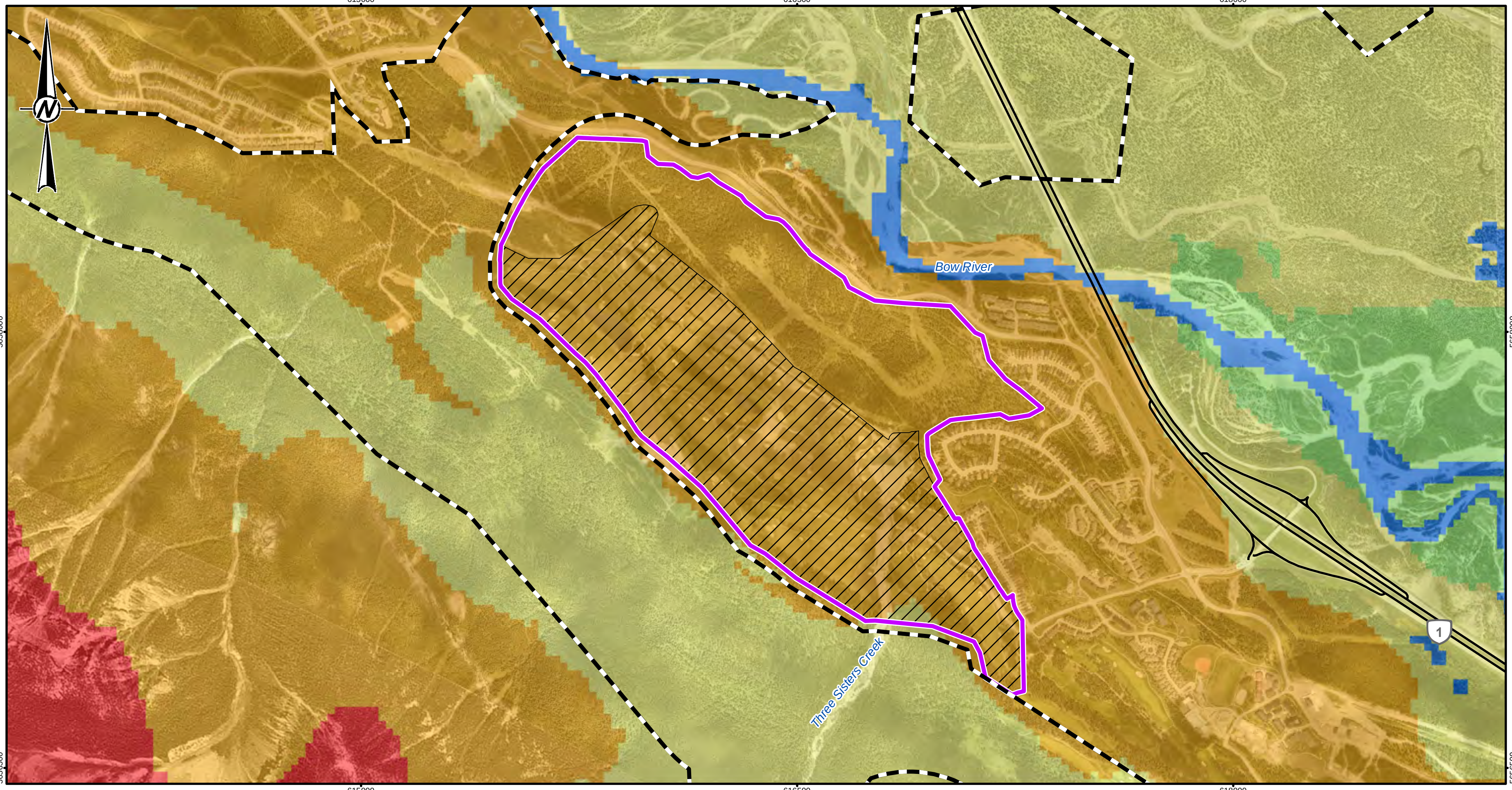

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

PREDICTED WINTER WOLF RESOURCE SELECTION – PROJECT EFFECTS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	41

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

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5.6.4.2 Use of Approved Corridors

Under existing conditions, wolves in the RSA are predicted to retain a high probability of selection on the north side of the Bow Valley. On the south side of the valley where a greater amount of avoided habitat for wolves is present under existing conditions, most of the Along Valley Corridor remains habitat that is somewhat avoided by wolves in winter (Table 26, Figures 40 and 41). This is the result of the designation of open space within the Project Boundary immediately adjacent to the Along Valley Corridor, which reduced the effects of development on wolf habitat selection patterns in the adjacent Along Valley Corridor (Section 2).

In contrast, as a result of development immediately adjacent to the Tipple Across Valley Corridor, wolf habitat within a strip about 100 m wide changes from somewhat avoided to strongly avoided as a result of the Project (Figure 40 and 41). Under existing conditions, the Tipple Across Valley Corridor currently sustains a very high level of human use (Golder 2013; Section 5.4.2.2) and wolves were not recorded using this corridor by remote cameras deployed during 2009-2016. Therefore, the increase in strongly avoided habitat may not substantially alter the number of wolves traveling though this corridor relative to existing conditions.

Predicted changes in habitat selection do not account for the effects of fencing on wildlife use of adjacent corridors because fenced developments were not present in the Bow Valley when models were developed and responses to such developments could not be measured. As described in Section 5.6.1, by combining wildlife fencing with alternative options for recreation, especially off-leash dog parks, the potential effects of increased human use in the wildlife corridor are predicted to be reduced relative to building the Project without a fence. Benefits would be even greater if the Province and the Town simultaneously worked to address human access to the Tipple Across Valley Corridor from the west side and could improve potential for wolf use relative to existing conditions.

With the application of wildlife fencing, an effective trail network that connects to designated trails and is fun to use, and off-leash dog opportunities included in the Project Boundary, effects of the Project on the probability of wolf selection in wildlife corridors will be much improved relative to a condition without a fence, but large potential zones of influence around designated trails (Appendix B) mean that wolf probability of selection is still predicted to decline slightly using the model with estimated effects of increased human use on trails, even in if people remain on designated trails (Table 26). The decline is small, however, with an increase in up to 6% of avoided habitat in wildlife corridors adjacent to the Project.

Table 26: Predicted wolf habitat in wildlife corridors adjacent to the Project Boundary with the addition of the Project with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	8 (0)	2 (2)
Used as available	86 (-22)	7 (-14)
Somewhat avoided	234 (1)	261 (-45)
Strongly avoided	49 (21)	106 (57)
Rarely used	0 (0)	0 (0)
Total	**377**	**377**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use on trails) from the Project effects value.

5.6.4.3 Negative Human-Wildlife Interactions

Based on the radio telemetry data and the winter RSF modelling of the RSA, wolves demonstrate the most avoidance of human infrastructure (e.g., built up areas, areas with high trail densities and golf courses) of the four species for which RSF modelling was completed. Given this avoidance of urban development and areas of high human use, negative wolf-human interactions have not been a substantial concern in the Bow Valley. However, as described in Section 5.2.5, this may be changing. Wolves in the Bow Valley are being observed more often by people in and around development and negative wolf human interactions are occurring in neighboring Banff National Park. Two wolves were destroyed there in 2016 as a result of food habituation. In January 2017, wolves were observed in and around developments in the south side of Canmore, contrary to the predictions of the RSF model.

Habituation of wolves, although novel in the Bow Valley, has occurred elsewhere and negative human-wolf interactions are a result. Wolves become habituated when they use human food sources (e.g., garbage, livestock) and lose their fear of humans (Linnell et al. 2002). Some wolves without access to human food may also become increasingly bold because of repeated interactions with humans that do not result in negative experiences for wolves (McNay 2002; Smith and Stahler 2003). Even though negative human-wolf interactions have been increasing in recent years in North America, there are only two recorded fatalities attributed to wolves behaving in a predatory manner in North America since 1950 (Linnell and Alleau 2016). One of those fatalities occurred in northern Saskatchewan in 2005. This incident appears to have been a predatory attack by a healthy but food-conditioned and habituated wolf (Giest 2007). Another similar attack occurred in the same area of northern Saskatchewan in 2016, although in that case the human that was attacked survived. However, seven habituated wolves in the area were destroyed after the attack. Where predatory attacks by wolves on humans do occur, the majority of these attacks are from wolves that have been habituated (Linnell et al. 2002). Problems resulting from habituated and food-conditioned wolves have been increasing in recent years in North America (Fritz et al 2002; Linnell and Alleau 2016). Given the recent trends in the Bow Valley, the issue of wolf habituation and potential wolf-human conflict need to be considered for the Project.

Wildlife fencing is predicted to have a positive effect on reducing the potential for wolf habituation. Development of the Project with a wildlife fence surrounding developments will eliminate or substantially reduce future wolf use of the area, limiting potential for habituation. Similarly, the potential for human-wolf encounters In wildlife corridors adjacent to the fenced Project is predicted to decrease from existing conditions if people use recreational amenities envisioned for the Project, such as the off leash dog park and trail system, and stay on designated trails when traveling through the wildlife corridor. There is some uncertainty about whether this benefit will be achieved because it would depend on how people access the wildlife corridor and on the good behavior of people in wildlife corridors (Section 5.6.1). An increase in the number of encounters between wolves and people is possible in wildlife corridors adjacent to the Project Boundary if the new residents and visitors associated with the Project do not respect regulations in wildlife corridors, including ignoring direction provided on signs at entry points.

The residual effects of the Project in terms of changes to negative human-wolf interactions are predicted to be neutral relative to existing conditions. As is the case for grizzly bears, relative to developing the approved 2004 Resort Centre ASP, which does not have a fence, the effects of the Project are predicted to be positive.

5.6.4.4 Environmental Consequence

Table 27 summarizes the impacts described in Sections 5.6.4.1 to 5.6.4.4 according to the impact criteria used to inform the determination of environmental consequence. Residual changes in habitat quantity and quality and use of approved wildlife corridors adjacent to the Project Boundary are predicted to result in small negative changes for wolves, and human-wolf interactions are predicted to have a neutral outcome, relative to existing conditions with the addition of the Project (Table 27). Although the effects of the Project on wildlife corridors are predicted to be small and negative to be precautionary, there is substantial uncertainty in this prediction. Effects could also be positive with the application of wildlife fencing, an effective trail network that connects to designated trails and is fun to use, and off-leash dog opportunities included in the Project Boundary. Overall, the small adverse effects of the Project are not predicted to change how wolf populations use or move through the RSA and are not predicted contribute adversely to the serious risk and high environmental consequence identified for the wolf population under existing conditions (Section 5.2.3). When compared to developing the approved 2004 Resort Centre ASP without a fence, the Project will benefit wolves because of the lower level of dispersed human use in wildlife corridors adjacent to the Project Boundary. This is a result of the application of mitigations designed to minimize illegal human activities in wildlife corridors.

Table 27: Residual effects summary for wolves

Effect Category	Impact Criterion	Residual Effect Summary	Prediction Confidence
Habitat Quantity and Quality	Direction	Negative	High – Habitat lost within the Resort Centre ASP area was primarily avoided under existing conditions.
	Geographic extent	Primarily within the Project Boundary, with some changes in the adjacent Along Valley Corridor and more substantial changes in the Tipple Across Valley Corridor	High – RSF modelling indicate that the zone of influence from housing development at the edge of the Project will change habitat class over approximately100 m into the corridor.
	Duration	Permanent	High – development will be present for many decades.
	Magnitude	No loss of selected habitat, and 41 ha of used as available habitat will be lost, i.e., 1.2% of this habitat class in the RSA	High –habitat quality is low relative to the north side of the Bow valley; fencing will exclude access to habitat that was used as available or somewhat avoided.
	Probability	High	Moderate – with development proceeding with a fence, wolves will be excluded from within the Project Boundary, although there is potential that wolves may exploit the northwest fence end along the Bow River to gain access to the area.
	Frequency	Change will occur once, when the wildlife fence is constructed.	High – construction of the fence will immediately eliminate access by wolves to habitat in the Project Boundary.
Use of Approved Wildlife Corridor	Direction	Negative	Moderate – the outcome of the Project has a potential to be neutral or even positive relative to existing conditions with predicted reductions in dispersed human use and is predicted to be positive relative to developing the approved 2004 ASP.
	Geographic extent	Immediately adjacent to the Project Boundary in the case of the Along valley Corridor, and about 100 m into the Tipple Across Valley Corridor	High – human use is highest close to development and zone of influence from housing development is about 100 m for wolves.
	Duration	Permanent	High – development will be present for many decades
	Magnitude	Up to a 6% increase in avoided habitat within wildlife corridors adjacent to the Project Boundary	Moderate - Evidence from the Benchlands study and the HUMR report suggests that with education and signage, people will respect the changes to trail use in the wildlife corridors (Section 5.6.1). Evidence from fencing in Banff National Park demonstrates fencing is effective in managing human access
	Probability	High	High – Changes in the corridor are likely, will be small, and will most likely be neutral or positive.
	Frequency	Change will occur incrementally over time as the Project is built	Moderate – Changes within wildlife corridors will occur over time as development proceeds and the population grows, but the largest positive change will be associated with application of the fence and this change will occur rapidly with fence construction.
Negative Human Wildlife Interactions	Direction	Neutral	Moderate – the outcome of the Project has a potential to be positive relative to existing conditions and is predicted to be positive relative to developing the approved 2004 ASP
	Geographic extent	Within the Project Boundary and adjacent wildlife corridors	High – the primary benefit will be within the fenced Project Boundary, greater predictability of human use on designated trails will reduce the likelihood of encounters elsewhere in wildlife corridors.
	Duration	Permanent	High – development will be present for many decades
	Magnitude	No change from existing conditions	Moderate – outcome could be positive.
	Probability	High	High – A neutral or better outcome is expected based on available evidence.
	Frequency	The largest change will occur once, when the wildlife fence is constructed	High – construction of the fence will eliminate access by wolves to habitats that are also heavily used by people in the Project Boundary.

5.6.5 Elk

5.6.5.1 Habitat Quantity and Quality

The probability of habitat selection by elk within the Project Boundary is predicted to not change with implementation of the Project (Table 28; Figure 42). As under existing conditions (Section 5.2.6), habitat within the Project Boundary is predicted by RSF modelling to be selected by elk after Project implementation. Although probability of selection remains high because anthropogenic landscapes have low predation risk, forage quantity will decline, especially because landscaping will be undertaken using plants that are not palatable for wildlife, including elk (Section 5.5.3).

Table 28: Predicted elk habitat in the Project Boundary with the addition of the Project

Habitat Class	Area (ha) (change [(a)])
Selected	163 (0)
Used as available	0 (0)
Somewhat avoided	0 (0)
Strongly avoided	0 (0)
Rarely used	0 (0)
Total	**163**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value from the Project effects value.

Fencing will make habitat in the Project Boundary more difficult for elk to access, resulting in the potential loss of 163 ha of habitat that was selected under existing conditions. This loss represents about 3% of selected habitat available in the RSA under existing conditions. Access inside the Project Boundary should no longer be possible for elk from the west or south sides of the development (i.e., the Tipple Across Valley and Along Valley Corridors). Elk have potential to access the Project area by crossing the Bow River and / or side channels through the gap in the fence. However, to be precautionary with respect to the potential loss of habitat, this assessment assumed that elk will no longer be able to access the Project Boundary, which is the intended outcome of the wildlife fence. Effects of the Project on elk habitat quantity and quality are therefore considered negative, with a loss of all 163 ha of selected habitat within the Project Boundary.

FireSmart measures implemented by the Town, the MD of Bighorn, and the Province that reduce forest cover and increase early seral habitats in the wildlife corridors and south of the wildlife corridors, would help to compensate for the loss of anthropogenic grasslands, such as the unfinished golf course on the 2016 Resort Centre (Golder 2012, pg. 88-94). Increasing early seral habitats will bring conditions in the corridors closer to historical conditions that were likely more prevalent prior to active fire suppression (Figure 28).

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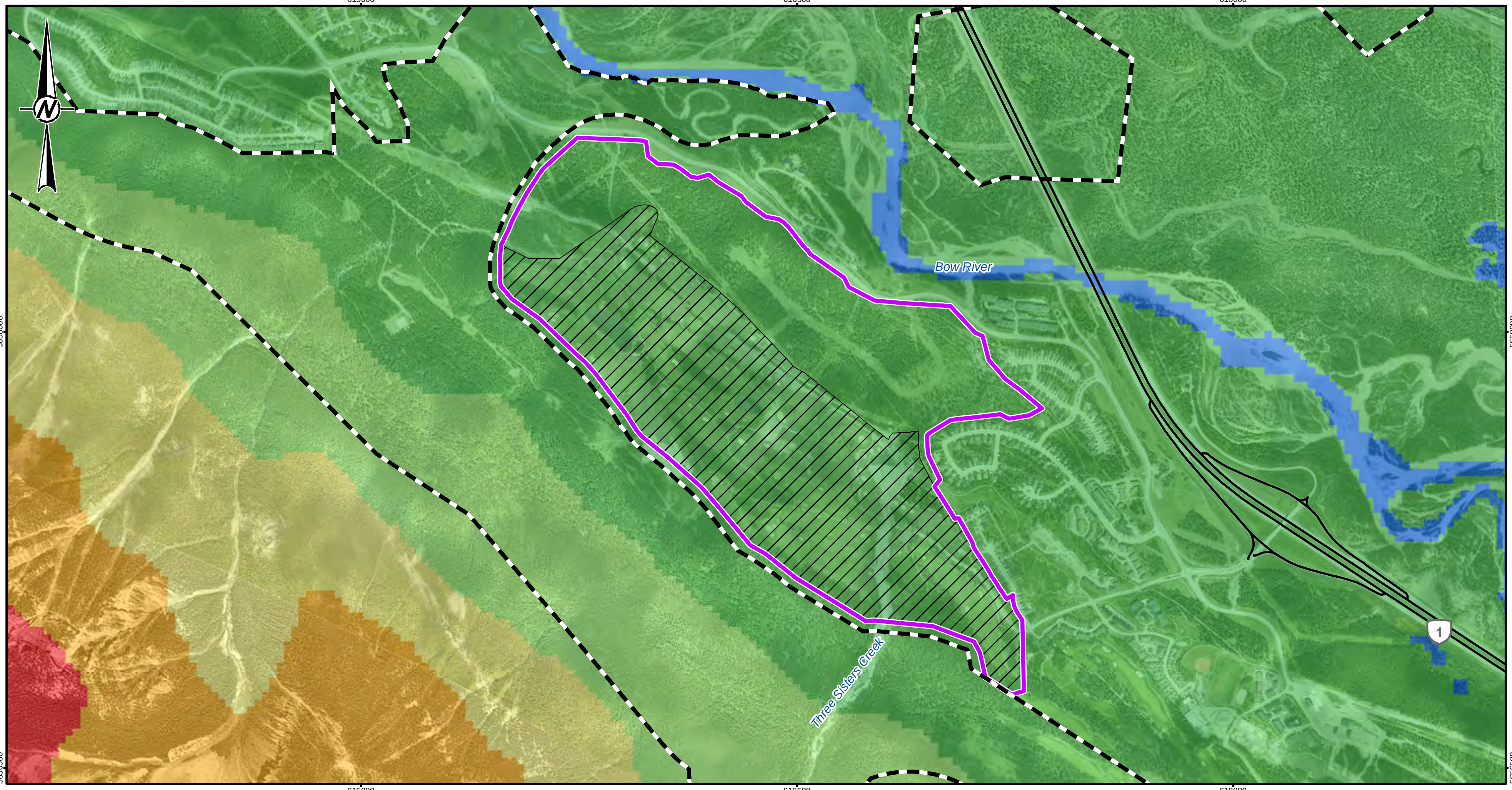

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
PREDICTED WINTER ELK RESOURCE SELECTION – PROJECT EFFECTS WITHOUT ESTIMATED EFFECTS OF

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	42

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5.6.5.2 Use of Approved Corridors

Habitat in the wildlife corridor adjacent to the Project Boundary is approximately evenly split between selected and used as available by elk under existing conditions (52%:48%; Section 5.2.6). After implementation of the Project, and prior to construction of the wildlife fence, the proportion of habitat in the corridor that is selected will increase relative to habitat used as available due to the increased proximity of human residences (57%:43%; Table 29). The predicted decrease of human use on undesignated trails and increased human use on designated trails in the wildlife corridors adjacent to the Project (Section 5.6.1) will likely not affect elk, which are habituated to people.

Table 29: Predicted elk habitat in wildlife corridors adjacent to the Project Boundary with the addition of the Project

Habitat Class	Area ha (change [(a)])
Selected	215 (20)
Used as available	162 (-20)
Somewhat avoided	0 (0)
Strongly avoided	0 (0)
Rarely used	0 (0)
Total	**377**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value from the Project effects value.

The wildlife fence is predicted to eliminate access by elk to the Project Boundary, which could increase elk use of adjacent wildlife corridors when combined with the predicted increase in probability of selection. The fence also has potential to increase the risk of predation on elk by preventing escape from the wildlife corridor into urban areas that create a refuge from predators (Edwards 2013, Appendix B). Therefore, the increase in probability of selection predicted within the corridors by the RSF may not occur.

Habituation of elk to human activity and developments in the Bow Valley, large areas of selected and used as available habitat predicted in the wildlife corridors after the Project even if increases in probability of selection do not occur, and camera and telemetry data demonstrating elk use within wildlife corridors and developed areas under existing conditions, means that elk use of the wildlife corridors adjacent to the Project is not predicted to change. The effect of the Project on elk use of wildlife corridors is therefore considered neutral.

5.6.5.3 Negative Human-Wildlife Interactions

Implementation of the Project is predicted to not result in a change in negative interactions between people and elk. The potential for negative human-elk interactions within the Project Boundary will be reduced, but elk may concentrate elsewhere in Canmore, potentially increasing the potential for negative interactions between people and elk in these areas.

Negative interactions with elk are already an issue of concern under existing conditions, both within TSMV and in other Canmore neighborhoods. Jay Honeyman, a wildlife conflict specialist with AEP, has indicated that elk in Canmore are problematic for public safety, and therefore elk are often herded away from playfields and playgrounds (Ellis 2017). According to Honeyman, keeping elk in wildlife corridors and habitat patches, and away from Canmore, is the most desirable outcome (Ellis 2017). The wildlife fence will be effective at reducing or eliminating negative human-elk interactions within the Project Boundary, but will not address similar problems elsewhere in Canmore, and could exacerbate them. In this context, habitat improvements in wildlife corridors and habitat patches are important mitigation. Reducing forest cover associated with FireSmart measures implemented by the Town, the MD of Bighorn, and the Province will increase early seral habitats in the wildlife corridors and increase the likelihood that elk use these areas. Larger cleared areas will result in greater benefits for elk (Golder 2012, pg. 88-94) and could help to reduce negative human-elk interactions by providing elk with alternative habitats.

Changes in negative human-elk interactions are predicted to be neutral as a result of the Project because the benefits of wildlife fencing around the Project Boundary could be offset by increased risk of negative human-elk interactions elsewhere in Canmore. However, there is substantial uncertainty regarding how elk distribution in Canmore may change due to the wildlife fence, and the degree to which elk shift to other parts of Canmore may depend substantially on whether or not the habitat improvements recommended as part of the suite of mitigation identified in this EIS are implemented in wildlife corridors and habitat patches (Section 5.5.2).

5.6.5.4 Environmental Consequence

Table 30 summarizes the impacts described in Sections 5.6.5.1 to 5.6.2.3 according to the impact criteria used to inform the determination of environmental consequence. Development of the Project will not affect the attractiveness of habitat in the Project Boundary for elk, but fencing will block elk from accessing it, resulting in the loss of 163 ha of selected habitat. This loss represents about 3% of selected habitat in the RSA relative to what is available under existing conditions. Changes in use of the wildlife corridors and negative human-wildlife interactions are predicted to be neutral for elk as a result of the Project.

The addition of the Project to existing cumulative effects is not predicted to affect the self-sustaining status identified for the elk population in the RSA under existing conditions because a 3% reduction in selected habitat is not expected to affect population stability. However, there is uncertainty in this prediction because of the intense use by elk of anthropogenic habitats within TSMV. Uncertainty is also present with respect to potential construction of habitat enhancements in habitat patches and wildlife corridors. If these are constructed in association with the Project, a positive outcome is possible for elk. In this case, an improvement from the serious risk and high environmental consequence identified for the ecological function of the elk population under existing conditions is possible because elk would be more exposed to their predators.

Table 30: Residual effects summary for elk

Effect Category	Impact Criterion	Residual Effect Summary	Prediction Confidence
Habitat Quantity and Quality	Direction	Negative	Moderate – forage quality will be reduced; fencing will make selected habitat in the Project Boundary unavailable to elk, but there is some uncertainty about whether elk might enter through the gap in the fence.
	Geographic extent	Within the Project Boundary, with minor changes in adjacent wildlife corridors	High – RSF modelling predicts small changes in habitat quality in wildlife corridors. The loss of selected habitat due to the fence will be localized in the Project Boundary.
	Duration	Permanent	High – development will be present for many decades.
	Magnitude	Loss of 163 ha of selected habitat, which represents about 3% of selected habitat in the RSA	Low – To be precautionary the assessment assumes that fencing will exclude access to selected habitats in the Project Boundary. Because elk are habituated in the Bow Valley, they may continue to access selected habitats through the gap in the fence.
	Probability	Moderate	Low – substantial uncertainty is present about whether elk will enter the Project Boundary through the gap in the fence.
	Frequency	Change will occur once, when the wildlife fence is constructed.	High – construction of the fence will immediately alter access by elk to selected habitats in the Project Boundary.
Use of Approved Wildlife Corridor	Direction	Neutral	Moderate – uncertainty is present about how the fence will alter predation risk in the wildlife corridor.
	Geographic extent	Immediately adjacent to the Project Boundary	Moderate – RSF modelling predicts small changes in habitat quality in wildlife corridors.
	Duration	Permanent	High – development will be present for many decades
	Magnitude	Predicted increase of 20 ha of selected habitat in wildlife corridors,	Low – RSF models validate well, available evidence demonstrate elk in the Bow Valley respond positively to human development, but elk response to potential changes in predation risk associated with the fence are uncertain.
	Probability	Moderate	Moderate – Changes in the corridor are likely to be small, but could be neutral instead of positive.
	Frequency	Change will occur once, when the wildlife fence is constructed.	High – construction of the fence will immediately alter access by elk to selected habitats in the Project Boundary and may change how elk use adjacent wildlife corridors.
Negative Human Wildlife Interactions	Direction	Neutral	Low – the outcome of the Project is predicted to be positive within the Project Boundary, but there is uncertainty about how elk distribution will change in Canmore as a result of the fence and uncertainty about whether elk may enter the Project Boundary through the gap in the fence.
	Geographic extent	Within Canmore	Moderate – negative human-elk interactions could change throughout Canmore. There is uncertainty about how elk distribution will change in Canmore as a result of the fence.
	Duration	Permanent	High – development will be present for many decades
	Magnitude	Positive in the Project Boundary, but redistribution of negative interactions to other parts of Canmore is possible.	Low – the outcome of the Project is predicted to be positive within the Project Boundary, but there is uncertainty about how elk distribution will change in Canmore as a result of the fence and uncertainty about whether elk may enter the Project Boundary through the gap in the fence.
	Probability	Moderate	Moderate – available evidence supports the conclusion, but uncertainty is present.
	Frequency	The largest change will occur once, when the wildlife fence is constructed	High – change in elk behaviour will be primarily associated with construction of the fence, which will occur only once.

5.7 Uncertainty and Monitoring

Site-specific empirical data, empirically derived RSF models, and scientific literature were used understand existing conditions and to predict the potential effects of the Project on wildlife. When combined with precautionary assumptions that are likely to overestimate potential adverse effects, the available evidence indicates that the effects caused by the Project will not be worse than predicted in this assessment. Factors increasing certainty in the conclusions of the wildlife assessment include:

- Conceptual development footprints identified for the ASP overestimate the total area that will ultimately be developed and the highest end of the range of unit densities and population associated with the Project was used to predict effects.
- RSF models used for the assessment validate extremely well (Appendix B), indicating that they have an excellent ability to predict spatial patterns of selection by wildlife and changes in probability of selection as a result of zones of influence associated with the Project.
- Models incorporating intensity of trail use by people and zones of influence based on flight initiation distance were evaluated. The models quantified the potential effects on wildlife use of corridors under scenarios that explored changes in human use on designated and undesignated trails.
- Ten years of camera data, including 1,362 locations and 42,558 camera monitoring days, were available and analyzed to provide an understanding of seasonal, diel and spatial patterns of wildlife and human use in wildlife corridors and TSMV lands.
- Mitigation such as speed limits and clearing outside of the migratory bird nesting window are effective for limiting or avoiding wildlife mortality.
- The type of wildlife fencing proposed to maintain separation between wildlife and people and limit negative human wildlife interactions within the Project Boundary has proven to be highly effective for controlling wildlife entry (Clevenger et al. 2009).
- Information collected as part to the Human Use Management Review (Town of Canmore 2015b) indicates that better delineation of wildlife corridor boundaries and education would result in people changing their behaviour to recreate less in wildlife corridors.
- Wildlife conflict data were available from AEP and used in the analysis.
- Expert opinion of wildlife managers in the Bow Valley was used to inform predictions and analysis.

Although the available data provides substantial support for the predictions made in this assessment, some uncertainty remains. Residual uncertainty is associated with the following:

- Ecological thresholds may exist beyond which changes are non-linear or exhibit surprising outcomes that cannot easily be predicted from existing data (Kelly et al. 2014).
- Human behavior is challenging to predict and predictions about future human use of wildlife corridors depend on current and future citizens of Canmore responding positively to education, signs, fencing, and enforcement such that they comply with existing regulations in wildlife corridors.

- Potential changes in negative human-wildlife interactions elsewhere in the Bow Valley as a result of the Project remain uncertain, especially for elk.
- The amount of wildlife incursion into the Project Boundary through the gap in the fence along the Bow River remains uncertain, especially for elk.

The consequences of being wrong about the potential effects of the Project or the efficacy of mitigation could be substantial for wildlife in the Bow Valley. If the Project were to proceed without the proposed mitigation, or if proposed mitigation is less effective than predicted, the Project has the potential to contribute to a high environmental consequence for wildlife.

For example, if mitigation proves unsuccessful, the increase in residents and visitors associated with the Project would exacerbate the serious risk already present for grizzly bears under existing conditions. Levels of negative human-bear interactions higher than those currently observed in Peaks of Grassi are predicted in the Project Boundary without fencing and associated mitigation. However, a situation where the proposed Project would result in a worse outcome in terms of negative human-wildlife interactions than developing the approved 2004 Resort Centre ASP is difficult to imagine because the approved 2004 Resort Centre ASP lacks key mitigation identified in this EIS, such as fencing (Section 2).

Similarly, if fencing and associated mitigation proves ineffective for achieving human behavior that follows existing regulations in wildlife corridors, the currently high levels of undesignated trail and off-leash dog use in wildlife corridors adjacent to the Project could increase dramatically as a result of the Project, similar to the effect predicted if the 2004 Resort Centre ASP proceeded as currently approved. This increase could contribute to the serious risk to wolf movement already present in the RSA under existing conditions.

Where consequences associated with uncertainty are potentially high for wildlife, as they are in the case of new developments in the Bow Valley, monitoring and adaptive management should be applied (MSES 2013, Foley et al. 2015). Consequently, a monitoring program is recommended in conjunction with a phased approach to developing the Project to facilitate adaptive management.

Adaptive management is a tool for decision making in the face of uncertainty (Williams 2011) and is comprised of four iterative steps: act, measure, evaluate, and adapt. In the case of the Project, actions represent the phased development, measurement and evaluation are undertaken through monitoring, and adaptations may be undertaken if monitoring indicates that they are required. These concepts are discussed in turn in the following sections.

Phased development

Phased development of the Project should be undertaken in a manner that facilitates adaptive management in response to monitoring. Development should begin by constructing the wildlife fence, as proposed in Section 5.5.4, prior to developing the Project. Early construction of the fence will permit evaluation of the efficacy of the fence for 1) excluding large mammals from the Project Boundary, and 2) improving compliance with existing regulations in wildlife corridors. An education and enforcement campaign undertaken by the Town and the Province over the first 5 years that the fence is in place is recommended to maximize efficacy of fencing and education in achieving compliance with trail use, off-leash dog use, and seasonal closure regulations within wildlife corridors. This is especially important for existing residents, who may be using wildlife corridors inappropriately because they are unaware of legal requirements or the location of corridor boundaries (Town of Canmore 2015b, Derworiz 2015).

Within the Project Boundary, development should occur from north to south, beginning with policy Areas A, B, C, D and the Resort Core and Resort Expansion, as approved in the existing 2004 Resort Centre ASP, and followed by Areas , E and F (Figure 6). This approach to development will permit monitoring to occur in the wildlife corridor as development moves from north to south, providing opportunities for adaptive management.

Monitoring

The primary issues of concern with respect to uncertainty relate to changes in human and wildlife use of wildlife corridors and negative human-wildlife interactions within the Project Boundary because of the gap in the fence along the Bow River. Consequently a monitoring program will be developed to measure change in:

- use of wildlife corridors by people and off-leash dogs;
- use of wildlife corridors by large mammals; and
- changes in negative human-wildlife interactions[18].

Because of the high environmental consequences already present in the RSA for some species under existing conditions and because of broader regional implications of changes in human use and negative human-wildlife interactions in the future (Section 5.8), considerable collaboration among stakeholders, including financial collaboration and sharing resources, will be required to manage human use in wildlife corridors and minimize negative human-wildlife interactions in the Bow Valley. Consequently, monitoring for the Project should be integrated with broader regional monitoring programs, where these are being undertaken. This section recommends an approach to developing the monitoring program and identifies some of the key considerations that should be taken into account. Details of the monitoring program should be developed in consultation between the developer, the Town, and the Province.

The monitoring program should be developed and directed by a stakeholder committee comprised of a Government of Alberta representative (e.g., an AEP biologist), a representative of the Town, and a representative of TSMVPL. The committee may seek advice from external experts, as required.

The committee and experts consulted by the committee should consider the following when developing the monitoring program:

- A before after control impact (BACI) design may be appropriate to more clearly isolate the effects of the Project.
- Remote cameras may be the appropriate data collection tool to monitor use of wildlife corridors by people, off-leash dogs, and large mammals. The reasons for using remote cameras are a) substantial remote camera data are available for TSMV between 2009 and 2016, and b) data collected by the Town and the Province for the Human Use Management Review is currently being collected using remote cameras to monitor human and wildlife use of wildlife corridors and habitat patches in the RSA. Integration with the Human Use Management Review study should be considered.
- Fixed camera locations should be considered to facilitate detecting trends in use over time. The potential need to collect additional baseline data from fixed locations should be evaluated.

[18] Monitoring negative human-wildlife interactions is a responsibility of the Province, to which negative interactions are reported

- Statistical power should be considered when defining sampling effort.
- AEP currently collects information about negative human wildlife interactions. The adequacy of this information to test predictions of this EIS should be considered, and additional data collection approaches identified, if required.

Results of monitoring should be compiled annually in a report prepared by the committee and be provided to the Town, Province and the Developer.

Adaptation

As indicated by the name "adaptive management", provisions need to be in place so that the Project can be adjusted, if required. Adaptation is not always necessary, and if monitoring indicates that the predictions of this EIS are met, no adaptation would be required. On the other hand, if monitoring identifies important deviations[19] from the predictions of the EIS, then adaptation should be explored if the Project was identified as the cause of the deviation.

The adaptation applied would depend on the type and cause of the deviation from EIS predictions and may need to be applied by the developer, the Town, or the Province, depending on the situation. Potential adaptations include:

- updating educational materials;
- implementing or increasing habitat improvements within wildlife corridors or habitat patches;
- increasing enforcement;
- closing trails within wildlife corridors;
- adjusting the configuration of resort accommodation development in Areas E and F; and
- adjusting fence design, or closing the fence end on the north west side of the Project Boundary.

After each adaptation is applied, monitoring needs to continue to evaluate success and the potential need for additional adjustments. Monitoring should cease when uncertainty about the effects of the Project and associated mitigation has been resolved. The decision to stop monitoring could be made by the stakeholder committee at any time, and would continue for a maximum of five years beyond full buildout of the Project. The Town and the Province may choose to continue monitoring at their discretion, but the developer's responsibility would end after the Project is completed and the developer has incorporated any adaptations that may be required.

[19] Important deviations would be findings contrary to the predictions of this EIS. An example could be if human use on undesignated trails increased after implementation of the fence, enforcement, and education, which would be contrary to the prediction of this EIS.

5.8 Cumulative Effects

5.8.1 Human Use

Human use on trails in the RSA has been rising at a rate of about 6% annually (J. Herrero, unpublished data). With or without the Project or other reasonably foreseeable developments, human use on designated and undesignated trails in the RSA, including those in wildlife corridors is predicted to increase. A 6% annual increase translates into a doubling of human use every 12 years. Whether such a high rate of increase would continue is uncertain. However, the combined effect of the Resort Centre ASP Amendment, the Smith Creek ASP, a new subdivision at Dead Man's Flats, the Silvertip resort expansion, the Alpine Club of Canada facility upgrades, population growth in other towns in the RSA, and growth of the City of Calgary could result in doubling the number of people residing in the RSA and more than tripling the number recreating in the RSA by 2037. Estimates from the Town's Utility Plan indicate that the Town could achieve a population of 34,000 at full build out (Foubert 2017). This increase in population and human use in the RSA is predicted to lead to decreased habitat effectiveness for many wildlife species and increased negative human-wildlife interactions over time. Both legal and illegal use of wildlife corridors would likely more than double, unless something is done to change patterns of human use relative to those observed under existing conditions. Temporal and seasonal patterns of human use are not expected to change dramatically and most use in 2037 will likely continue to be during the day and in summer. However, new cold weather activities, such as fat biking, may contribute to increasing human use during winter relative to existing conditions.

5.8.2 Grizzly Bears

5.8.2.1 Habitat Quantity and Quality

During summer, substantial habitat that is selected or used as available remain in the RSA for grizzly bears after cumulative effects have been accounted for (Table 31, Figures 43 and 44). Using the model without estimated effects of increased human use on trails, total reductions represent 6% of the selected habitat in the RSA under existing conditions. The model with estimated effects of increased human use on trails predicts an 8% decline in selected habitat at the RSA scale (Table 32).

Fencing associated with the Resort Centre ASP Amendment and Smith Creek ASP, means that 448 ha of habitat that is selected or used as available will become unavailable to grizzly bears. In the case of the Resort Centre ASP Amendment, these habitats represent an ecological trap and their removal is predicted to benefit grizzly bears relative to existing conditions. In the case of Smith Creek, habitat quality is high and conflicts are low, indicating that this may be source habitat and effects of habitat loss will be negative, relative to existing conditions.

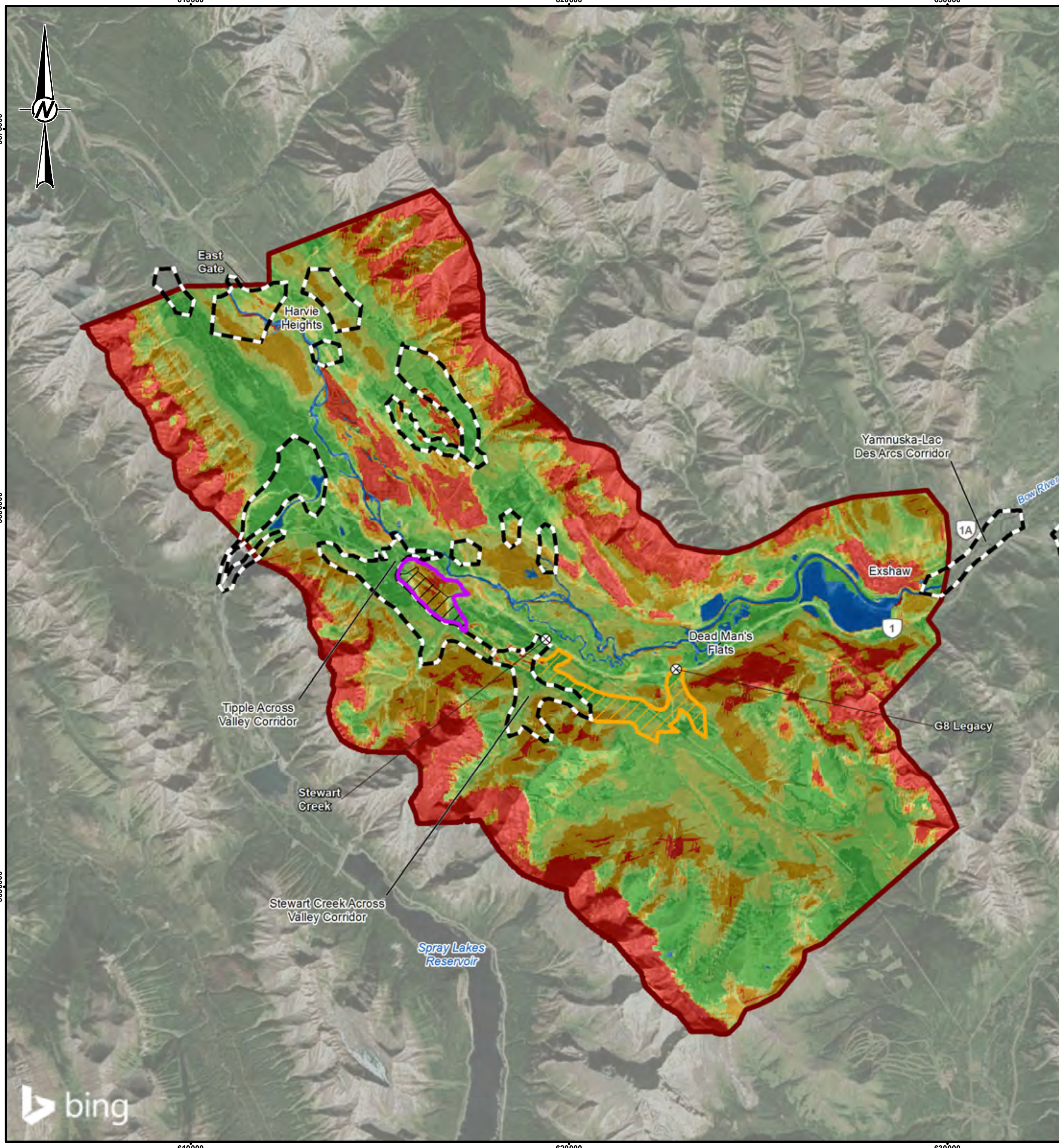
Overall, effects to grizzly bear habitat quantity and quality will be negative if all reasonably foreseeable developments described in Section 4.5 are undertaken. The negative effects summarized in Table 32 and presented in Figures 43 and 44 will underestimate this effect because spatial footprints for some developments were unavailable, including the Silvertip Resort Expansion and expansions at the Baymag and Lafarge plants.

Table 31: Predicted grizzly bear habitat in the RSA with the addition of the Project and other reasonably foreseeable developments with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	3,719 (-254)	3,404 (-306)
Used as available	4,910 (-15)	4,827 (-48)
Somewhat avoided	4,743 (104)	4,881 (110)
Strongly avoided	4,849 (132)	5,054 (188)
Rarely used	5,042 (34)	5,096 (56)
Water	616 (0)	616 (0)
Total	**23,878**	**23,878**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use on trails) from the cumulative effects value.



LEGEND

- HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- 2016 WILDLIFE CORRIDOR PROPOSAL
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. UPDATED STEWART CREEK ACROSS VALLEY CORRIDOR DATA LAYER FROM QPD IN OCTOBER 2016.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

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PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
PREDICTED SUMMER GRIZZLY BEAR RESOURCE SELECTION – CUMULATIVE EFFECTS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	43

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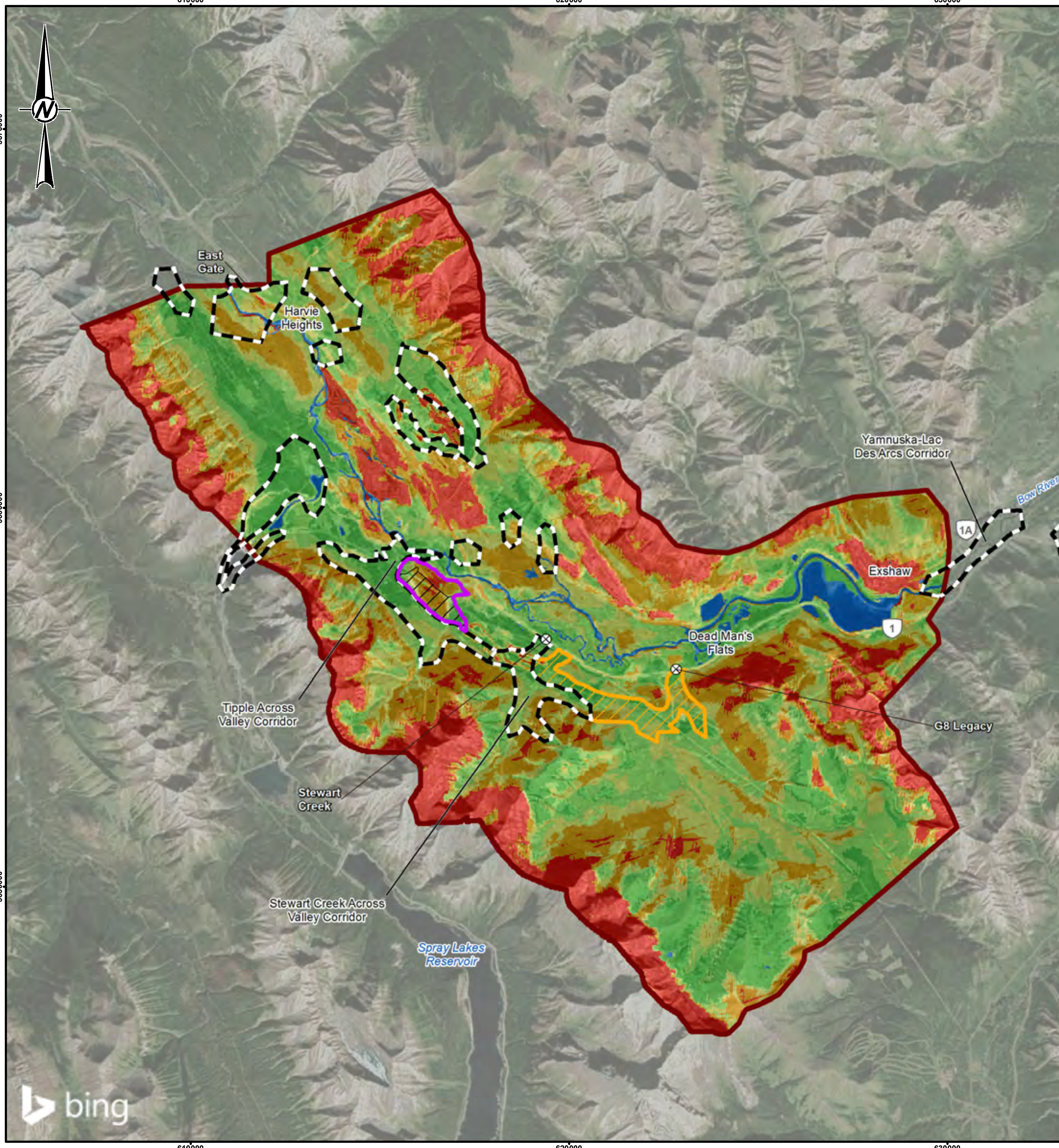
25mm 0



LEGEND

- ⊗ HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- 2016 WILDLIFE CORRIDOR PROPOSAL
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

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DATUM: NAD 83 PROJECTION: UTM ZONE 11

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PROJECT
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PREDICTED SUMMER GRIZZLY BEAR RESOURCE SELECTION – CUMULATIVE EFFECTS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	44

25mm
0

5.8.2.2 Use of approved corridors

Although grizzlies are using wildlife corridors and other undeveloped lands to move between habitat patches under current conditions, the Trans-Canada Highway and associated fencing limits across valley movement. During six years of monitoring between 1999-2002 and 2004-2007, no grizzly bears were documented using either the Stewart Creek Underpass or the G8 Legacy Underpass across the Trans-Canada Highway (Clevenger et al. 2002, 2007). However, grizzly bears were documented using both corridors in 2009 and 2012 (ESRD, unpublished data). Moreover, collared bears are known to cross the Trans-Canada Highway at underpasses linked by existing and proposed wildlife corridors, although across valley movement through underpasses was much less common than along valley movement (Golder 2013, Figure 31).

Habitat classes in the wildlife corridors consist primarily of habitats that are selected or used as available by grizzly bears, and this changes little when all reasonably foreseeable developments are added using models with or without estimated effects of increased human use on trails (Table 32). Therefore, grizzly bear movements through the RSA are expected to be maintained.

Table 32: Predicted grizzly bear habitat in wildlife corridors in the RSA with the addition of the Project and other reasonably foreseeable developments with and without the estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	707 (-25)	633 (-22)
Used as available	706 (8)	715 (6)
Somewhat avoided	463 (8)	491 (2)
Strongly avoided	220 (9)	253 (11)
Rarely used	25 (2)	30 (3)
Water	34 (0)	34 (0)
Total	**2,156**	**2,156**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use trails) from the cumulative effects value.

5.8.2.3 Negative human-wildlife interactions

Because habitats that are selected by grizzly bears continue to be present in the RSA and human use is predicted to more than double (Section 5.8.1), negative human-bear interactions are predicted to increase. The degree to which negative human-bear interactions will increase is uncertain, but assuming negative interactions increases linearly with the amount of human use, they could more than double. If bears adjust their behavior to use wildlife corridors mostly at night because of substantially higher human use (e.g., Boyce et al. 2010), negative human-wildlife interactions may not increase linearly with the amount of human use.

5.8.2.4 Environmental Consequence

Grizzly bears using the RSA are part of a broader regional population that use Kananaskis Country to the south as well as Banff National Park to the west and provincial lands such as Don Getty Wildland Park to the North. At this landscape scale extending beyond the RSA, the population may be stable under existing conditions (Garshelis et al. 2005). Grizzly bear populations in Southwestern Alberta appear to be doing well (Morehouse and Boyce

2016). However, a serious risk and associated high environmental consequence was identified under existing conditions for grizzly bears in the RSA because habitats in the vicinity of Canmore represent an ecological trap (Section 5.2.3).

The combined effects of the Project and other reasonably foreseeable developments and activities are predicted to contribute adversely to the serious risk present under existing conditions. Habitats with a high probability of selection remain after the Project and other reasonably foreseeable developments have been added to the effect already present under existing conditions. At the same time, human use and the potential for negative human-bear interactions is predicted to increase, likely intensifying the effect of the ecological trap.

The contribution of the Resort Centre ASP Amendment and Smith Creek ASP to the cumulative increase in risk of negative human-bear interactions is predicted to be neutral or positive. In the Resort Centre ASP Amendment boundary, fencing is predicted to result in a positive outcome by reducing negative human-bear interactions from the high levels identified under existing conditions (Figure 18). In the Smith Creek ASP boundary, where negative human-bear interactions are low under existing conditions, the outcome with a fence is expected to be neutral. Fencing associated with both the Smith Creek ASP and Resort Centre ASP Amendment will also encompass the Three Sisters Creek development, which has a very high human-bear conflict rank under existing conditions (Figure 18), and fencing this development is predicted to have a positive outcome.

Grizzly bear movement is expected to be maintained at the regional scale. The contribution of the Resort Centre ASP Amendment and Smith Creek ASP will likely result in a positive outcome for wildlife corridors adjacent to these developments relative to a future conditions without fences and educational signs. This conclusion is uncertain because it depends on whether people are exposed to signs and fencing as they access the corridor through the Resort Centre and Smith Creek and on the good behavior of people once they are inside the corridor. The former is likely for many users given the spatial configuration of the two developments (Figure 43), and the latter is also likely based on the feedback from Canmore residents on surveys undertaken as part of the HUMR program (Town of Canmore 2015b). Other factors that may affect the outcomes include the level of enforcement that may be applied by the Province, and the effectiveness of education programs beyond signage.

5.8.3 Cougars

5.8.3.1 Habitat Quantity and Quality

The RSF modelling predicts that the amount of selected habitat in the RSA will increase for cougars as a consequence of the Project and other reasonably foreseeable developments, using models with or without estimated effects of increased human use on trails (Table 33). Habitat value declines within developed areas but increases adjacent to them (Figures 45 and 46). This increase is a function of prey selection for developed areas and selection by cougars for places where prey are abundant. With the wildlife fencing proposed for the Resort Centre ASP Amendment and Smith Creek ASP, increases in selection may not happen as predicted by the RSF models because prey density may not increase when the ASP boundaries are fenced.

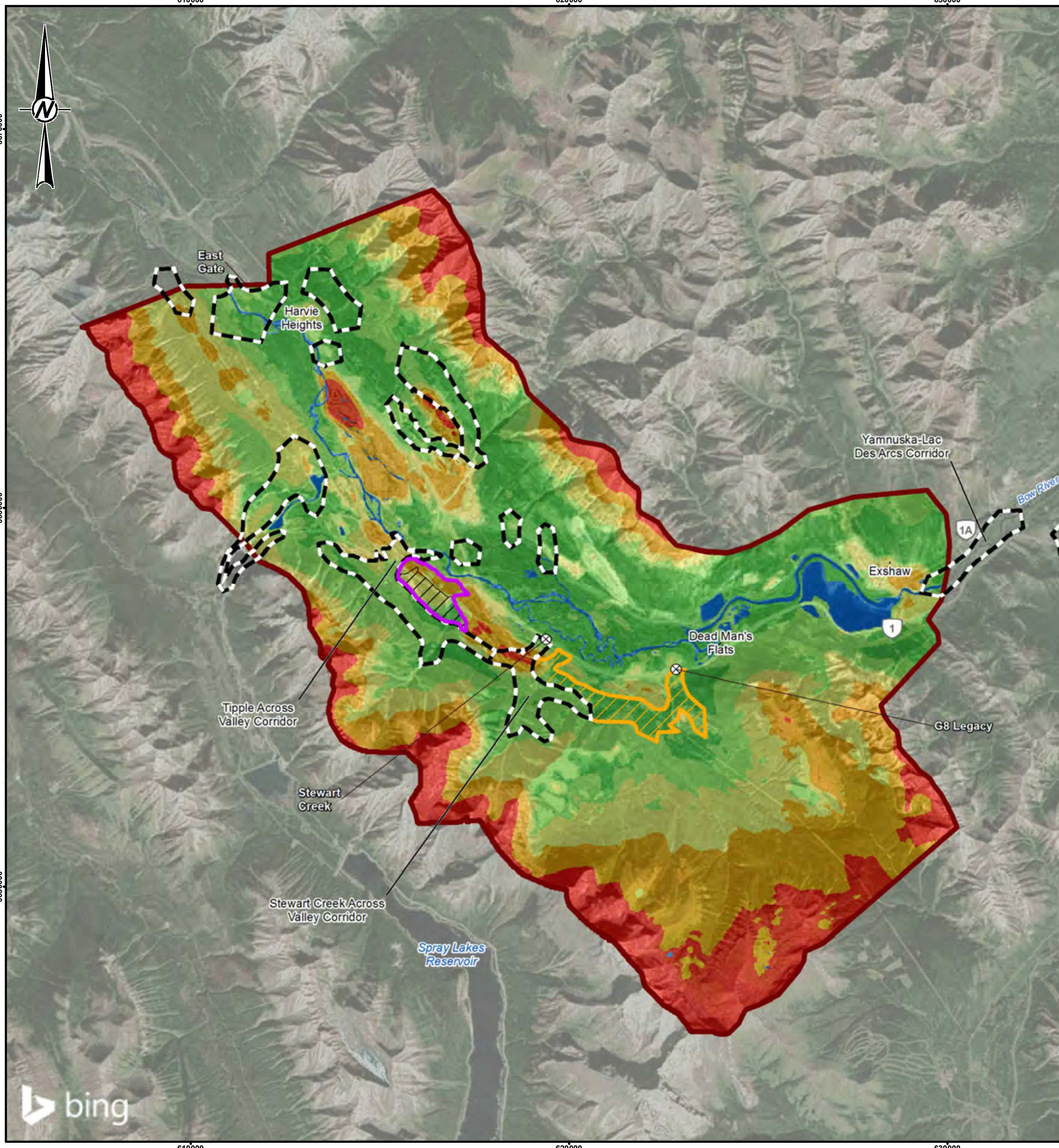
Fencing, combined with other developments for which footprints were unavailable, such as the Baymag and Lafarge industrial expansions, may therefore result in a neutral or small negative effect on cougar habitat quantity and quality.

Table 33: Predicted cougar habitat in the RSA with the addition of the Project and other reasonably foreseeable developments with and without the estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	5,323 (241)	5,051 (216)
Used as available	5,221 (-83)	5279 (-62)
Somewhat avoided	4,612 (-123)	4,715 (-146)
Strongly avoided	4,918 (-2)	5,006 (21)
Rarely used	3,188 (-33)	3,211 (-29)
Water	616 (0)	616 (0)
Total	**23,878**	**23,878**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use on trails) from the cumulative effects value.



LEGEND

- ⊗ HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- 2016 WILDLIFE CORRIDOR PROPOSAL
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. UPDATED STEWART CREEK ACROSS VALLEY CORRIDOR DATA LAYER FROM QPD IN OCTOBER 2016.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

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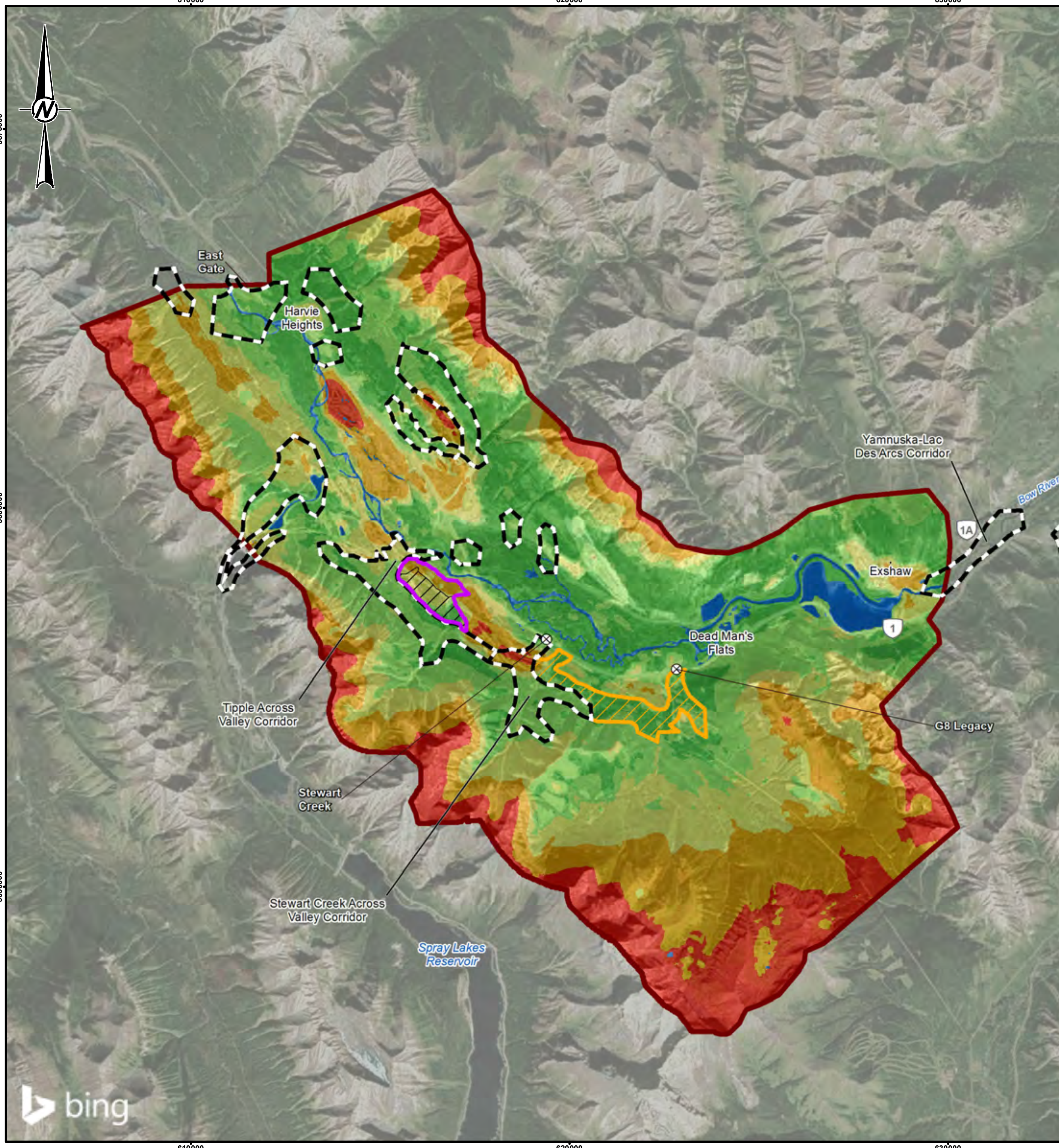
PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
PREDICTED WINTER COUGAR RESOURCE SELECTION – CUMULATIVE EFFECTS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	45



LEGEND

- HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- 2016 WILDLIFE CORRIDOR PROPOSAL
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

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- SOMEWHAT AVOIDED
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- RARELY USED
- WATERBODY

0 2,500 5,000

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TITLE
PREDICTED WINTER COUGAR RESOURCE SELECTION – CUMULATIVE EFFECTS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	46

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5.8.3.2 Use of approved corridors

Habitat selected by cougars in wildlife corridors in the RSA is predicted to increase substantially with the addition of the Project and other reasonably foreseeable developments for the same reasons described in Section 5.8.3.1 (Table 34). Increases in probability of selection within wildlife corridors are more pronounced than for the RSA as a whole because wildlife corridors tend to be located closer to developments, which may harbour prey.

Table 34: Predicted cougar habitat in wildlife corridors in the RSA with the addition of the Project and other reasonably foreseeable developments with and without the estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	866 (135)	801 (151)
Used as available	853 (-45)	872 (-29)
Somewhat avoided	305 (-87)	334 (-124)
Strongly avoided	77 (-1)	95 (4)
Rarely used	20 (-1)	20 (-1)
Water	34 (0)	34 (0)
Total	**2,156**	**2,156**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use on trails) from the cumulative effects value.

5.8.3.3 Negative Human-Wildlife Interactions

Because habitats that are selected by cougars continue to be present and may increase in the RSA and, at the same time, human use is predicted to more than double (Section 5.8.1), risk of negative human-cougar interactions is predicted to increase substantially. If cougars adjust their behavior to use wildlife corridors and other habitats near human development mostly at night because of substantially higher human use (e.g., Knopff et al. 2014), negative human-wildlife interactions may not increase linearly with the amount of human use.

5.8.3.4 Environmental Consequence

Available evidence suggests that the cougar population in the RSA is self-sustaining and ecologically effective under existing conditions (Section 5.2.4). Habitat quantity and quality and habitat connectivity for cougars in the RSA are expected to be similar to existing conditions with development of the Project and other reasonably foreseeable developments. Consequently, changes in habitat quality, quantity, or connectivity are not predicted to alter the self-sustaining ecologically effective status of cougars in the RSA.

The risk of negative human-cougar interactions is predicted to increase substantially as a result of increases in human use expected in the RSA by 2037. This may pose a risk to cougars, depending on how people respond to the real or perceived risk presented by cougars (Knopff et al. 2016). Whether or not changes in negative human-cougar interactions as a result of increased human use will pose a serious risk to cougars in the RSA is uncertain. However, fencing associated with the Resort Centre ASP Amendment and the Smith Creek ASP mean that risk of negative human-cougar interactions will be reduced from existing conditions because areas that currently are used by both cougars and people such as the Resort Centre ASP boundary, Three Sisters Creek development, and the Smith Creek ASP boundary will be fenced.

5.8.4 Wolves

5.8.4.1 Habitat Quantity and Quality

During winter, areas that are selected or used as available are reduced by up to 1.9% in the RSA relative to the existing case for wolves after cumulative effects have been accounted for using the model without estimated effects of increased human use on trails (Table 35, Figure 47). However, the effects of increased trail human use on wolf habitat selection is particularly evident for wolves. During winter, areas that are selected or used as available are reduced by up to 17% in the RSA relative to the existing case for wolves after cumulative effects have been accounted for using the model with estimated effects of increased human use on trails (Table 35, Figure 48). There is a predicted 15.6% increase in the amount of strongly avoided habitat with the addition of the Project and other reasonably foreseeable developments and activities. As described in the Section 5.2.5, under existing conditions, most habitat selected by wolves is on the north side of the RSA on the mid-elevation south-facing benches, and the effects of increased trail use on wolf habitat selection are particularly evident on that side of the valley (Figure 48).

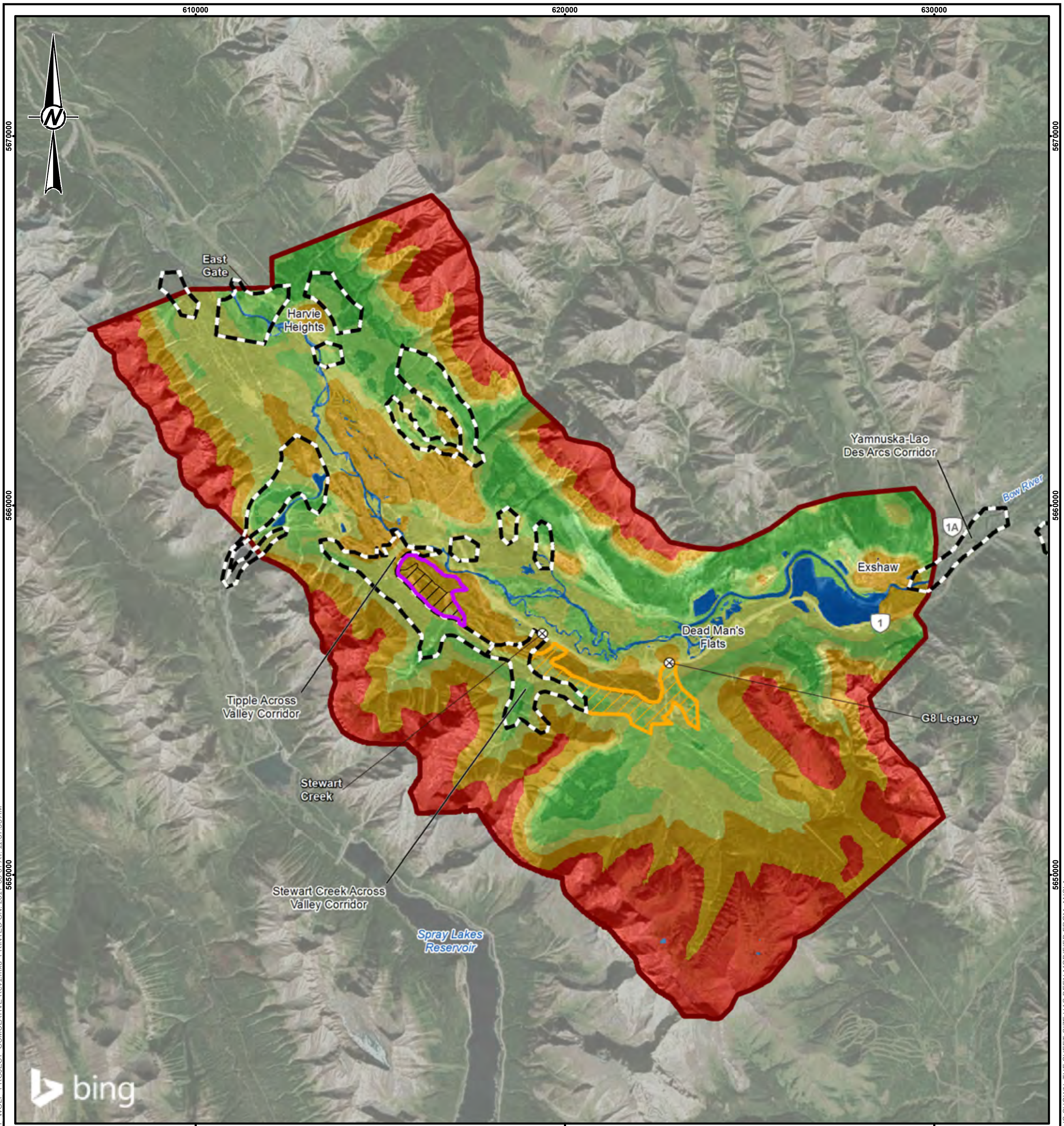
Table 35: Predicted wolf habitat in the RSA with the addition of the Project and other reasonably foreseeable developments with and without estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	2,446 (0)	1,050 (-380)
Used as available	3,423 (-116)	2,539 (-353)
Somewhat avoided	5,714 (-342)	6,857 (-288)
Strongly avoided	6,121 (459)	7,110 (960)
Rarely used	5,560 (0)	5,706 (62)
Water	616 (0)	616 (0)
Total	**23,878**	**23,878**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use on trails) from the cumulative effects value.

Effects to wolf habitat quantity and quality will be negative if all reasonably foreseeable developments described in Section 4.5 are undertaken. In particular, if precautionary assumptions about the effects of human trail use on wolf habitat selection are realized, the effects will be strongest on the north side of the RSA where existing habitat is better for wolves. The negative effects are underestimated because disturbance footprints for some developments were unavailable, including the Silvertip Resort Expansion and expansions at the Baymag and Lafarge plants, all located on the north side of the RSA.



LEGEND

- ⊗ HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- 2016 WILDLIFE CORRIDOR PROPOSAL
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.
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3. UPDATED STEWART CREEK ACROSS VALLEY CORRIDOR DATA LAYER FROM QPD IN OCTOBER 2016.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

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TITLE

PREDICTED WINTER WOLF RESOURCE SELECTION – CUMULATIVE EFFECTS WITHOUT ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	47

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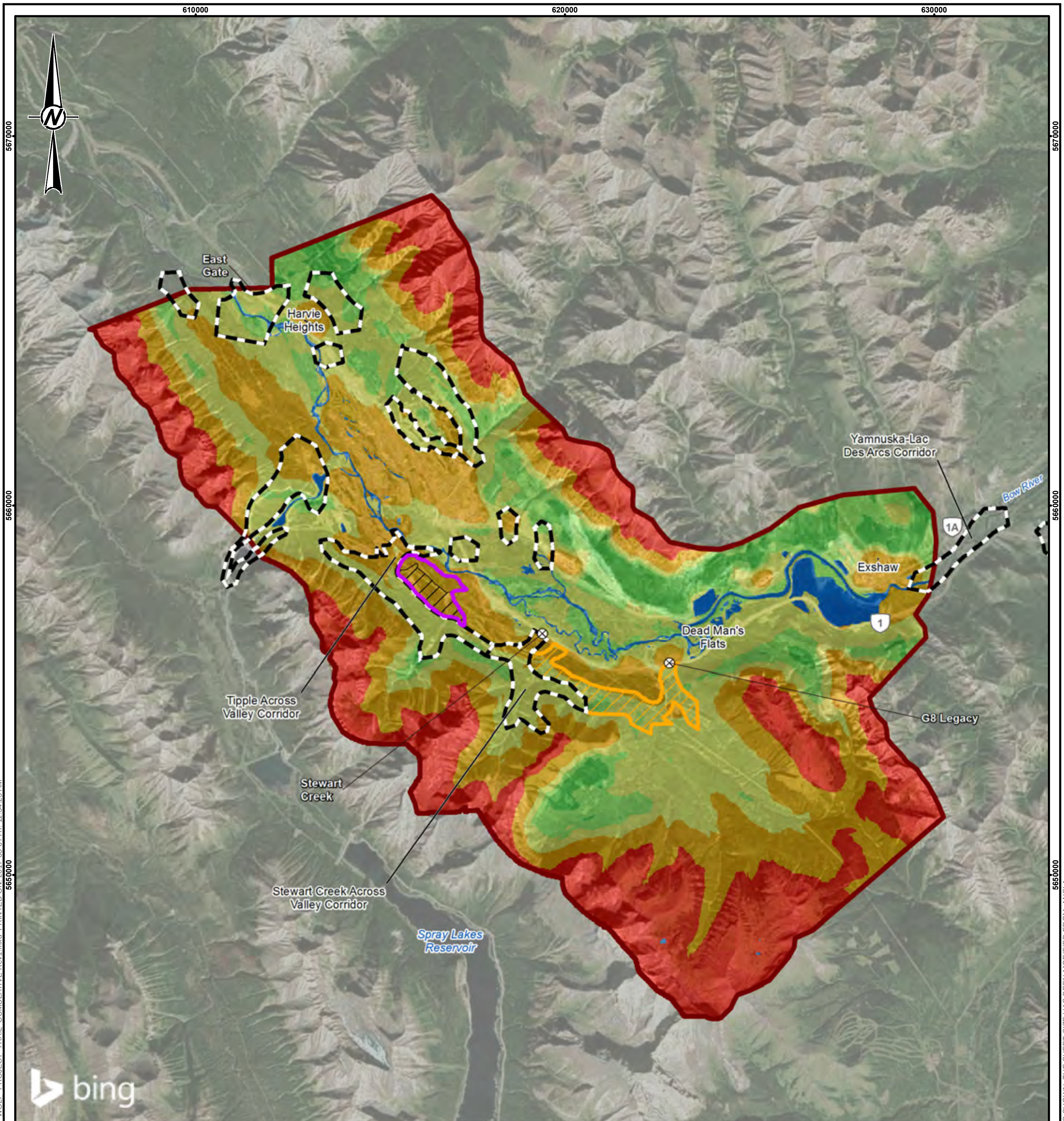

LEGEND

- HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- 2016 WILDLIFE CORRIDOR PROPOSAL
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

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DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
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PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
PREDICTED WINTER WOLF RESOURCE SELECTION – CUMULATIVE EFFECTS WITH ESTIMATED EFFECTS OF INCREASED HUMAN USE ON TRAILS

CONSULTANT
Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
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5.8.4.2 Use of approved corridors

Wolf habitat quality within wildlife corridors in the RSA is predicted to decline in the cumulative effects case. As was the case with overall habitat quality, the effects of trail use is particularly evident. Using conservative assumptions regarding the effects of increased human use of trails, selected and used as available habitat within corridors declines to 273 ha, a 49.7% reduction relative to the existing conditions (Table 36, Figure 48). This represents 12.7% of all corridor land in the RSA. If wolves do not avoid trails to the degree modelled (Appendix B), then selected and used as available habitat represents 45.4% of corridor land in the RSA (Table 36). As discussed in the Section 5.8.4.1, these effects are most evident on the north side of the valley because, under existing conditions, the benches north of the Bow River represent the best habitat for wolves in the RSA during winter. Under existing conditions in relatively poorer habitat on the south side of the valley, the approved Along Valley Corridor, Tipple Across Valley Corridor and Stewart Creek Across Valley Corridor were used only rarely by wolves (Section 5.2.5).

Overall, the cumulative effects to wolf corridor use is predicted to be negative if all reasonably foreseeable developments described in Section 4.5 are undertaken. The negative effects are underestimated because disturbance footprints for some developments were unavailable, including the Silvertip Resort Expansion and expansions at the Baymag and Lafarge plants, all located on the north side of the RSA.

Table 36: Predicted wolf habitat in wildlife corridors in the RSA with the addition of the Project and other reasonably foreseeable developments with and without the estimated effects of increased human use on trails

Habitat Class	Without Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])	With Estimated Effects of Increased Human Use on Trails (ha) (change [(a)])
Selected	296 (0)	19 (-42)
Used as available	683 (-58)	254 (-228)
Somewhat avoided	905 (-13)	1,427 (100)
Strongly avoided	237 (71)	422 (171)
Rarely used	0 (0)	34 (34)
Water	34 (0)	34 (0)
Total	**2,156**	**2,156**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value (with or without the estimated effects of increased human use on trails) from the cumulative effects value.

5.8.4.3 Negative Human-Wildlife Interactions

Because wolves have shown a strong avoidance of urban development and areas of high human use in the Bow Valley in the past, negative wolf human interactions have not been an issue in the Bow Valley until recently. However, wolves in the Bow Valley are being seen more often in and around development and negative wolf human interactions may become more common place. The cumulative effects of increased trail use in the RSA could increase the likelihood that wolves become more habituated to humans with the potential to increase the likelihood of negative wolf human encounters. However, fencing associated with the Resort Centre ASP and Smith Creek ASP should reduce the likelihood of wolf habituation adjacent to those developments because dispersed human use within adjacent corridors should decrease. If wolves adjust their behavior to use wildlife corridors and other habitats near human development mostly at night because of substantially higher human use (e.g., Hebblewhite and Merrill 2008), the likelihood of habituation and associated human wolf interactions may not increase at the same rate as the amount of human use.

5.8.4.4 Environmental Consequence

Wolves using the RSA are members of packs that use Kananaskis Country to the south, Banff National Park to the west and potentially provincial lands such as Don Getty Wildland Park to the north, as well as lone wolves that are not affiliated with packs. The stability of the population at this landscape scale is not known under existing conditions. To be precautionary, given the extent of development and associated human use in the RSA, low wolf use of the RSA was identified as a serious risk under existing conditions (Section 5.2.3).

The combined effects of the Project and other reasonably foreseeable developments and activities are predicted to contribute adversely to the serious risk already present under existing conditions. Habitats that are selected or used as available by wolves in the RSA, particularly on the north side of the RSA, will be further reduced. This is especially true if wolves continue to avoid trails in the future as modelled (Appendix B). Under these conditions, Pack use in the RSA may decline to near zero. However, dispersing wolves are likely to continue to travel through the RSA because dispersing wolves take greater risks and use habitats that are otherwise not preferred (e.g., Hinton et al. 2016).

The contribution of the Resort Centre ASP Amendment and Smith Creek ASP to the prediction of low pack use of the RSA is small because most of the change from cumulative effects is predicted on the north side of the Bow Valley and because fencing is predicted to lead to small reductions in probability of selection in wildlife corridors adjacent to TSMV (i.e., a 3% increase in avoided habitat). This conclusion depends on whether people are exposed to signs and fencing as they access the corridor through the Resort Centre and Smith Creek and on the good behavior of people once they are inside the corridor. The former is likely for many users given the spatial configuration of the two developments, and the latter is also likely based on the feedback from Canmore residents on surveys undertaken as part of the HUMR program (Town of Canmore 2015).

The very low use of the RSA predicted for wolves from RSF models is highly uncertain. Wolf habituation, which until recently has not been an issue in the RSA, appears to be increasing. Habituation has the potential to increase connectivity for wolves in the RSA and also increase the amount of time wolves spend in suitable habitats. However, increased habituation also has the potential to affect human safety in and around Canmore and ultimately, wolves could be removed, similar to the removal of 2 wolves from the Bow Valley pack in Banff National Park in 2016. Removal of wolves in the RSA as a result of human safety concerns could put additional pressure on the regional wolf population. The contribution of the Resort Centre ASP Amendment and Smith Creek ASP projects to the cumulative increase in risk of increasing wolf habituation and associated human wolf interactions is predicted to be neutral because of fencing.

5.8.5 Elk

5.8.5.1 Habitat Quantity and Quality

With the addition of the Project and other reasonably foreseeable developments the elk RSF model predicts a 116 ha (2%) increase in selected habitat relative to existing conditions (Table 37; Figure 49). However, with the addition of wildlife fences proposed for the Resort Centre ASP amendment and the Smith Creek ASP, a total of 532 ha (9% of selected habitat in the RSA) would become unavailable for elk, including selected habitat associated with the Stewart Creek developments. Whether elk are completely excluded from the Resort Centre ASP

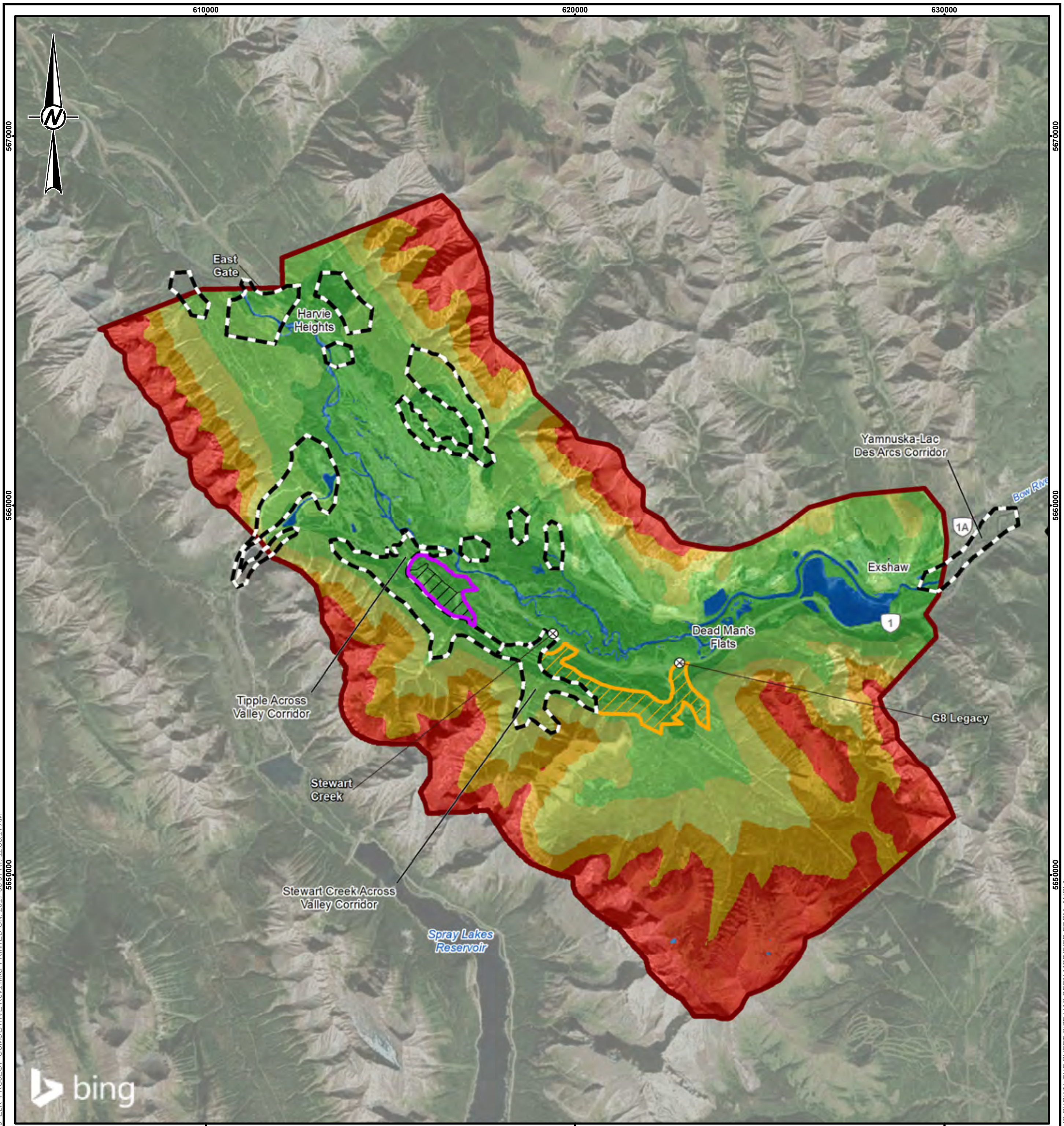
Amendment area and Stewart Creek developments would depend on whether elk enter through the gap at the Bow River in the fence (Section 5.6.5).

Table 37: Predicted elk habitat in the RSA with the addition of the Project and other reasonably foreseeable developments

Habitat Class	Area (ha) (change [(a)])
Selected	6,049 (116)
Used as available	4,616 (-34)
Somewhat avoided	3,721 (-21)
Strongly avoided	3,864 (-45)
Rarely used	5,013 (-15)
Water	616 (0)
Total	**23,878**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value from the cumulative effects value.



LEGEND

- HIGHWAY WILDLIFE UNDERPASS
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- 2016 WILDLIFE CORRIDOR PROPOSAL
- REGIONAL STUDY AREA
- RESORT CENTRE ASP AMENDMENT AREA

PROBABILITY OF SELECTION

- SELECTED
- USED AS AVAILABLE
- SOMEWHAT AVOIDED
- STRONGLY AVOIDED
- RARELY USED
- WATERBODY

0 2,500 5,000

1:150,000 METRES

REFERENCE(S)

1. IMAGERY OBTAINED FROM BING MAPS FOR ARCGIS PUBLISHED BY MICROSOFT CORPORATION, REDMOND, WA, JANUARY 2017.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. UPDATED STEWART CREEK ACROSS VALLEY CORRIDOR DATA LAYER FROM QPD IN OCTOBER 2016.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

TITLE
PREDICTED WINTER ELK RESOURCE SELECTION – CUMULATIVE EFFECTS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	49

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5.8.5.2 Use of Approved Corridors

The addition of the Project and other reasonably foreseeable developments are predicted to increase probability of selection for elk in wildlife corridors in the RSA because increased proximity of developments will reduce predation risk (Section 5.6.5). The RSF model predicts a 102 ha (9%) increase in selected elk habitat in wildlife corridors in the RSA due to the Project and other reasonably foreseeable developments (Table 38).

Table 38: Predicted elk habitat in wildlife corridors in the RSA with the addition of the Project and other reasonably foreseeable developments

Habitat Class	Area (ha) (change [(a)])
Selected	1,190 (102)
Used as available	852 (-92)
Somewhat avoided	77 (-7)
Strongly avoided	3 (-2)
Rarely used	0 (0)
Water	34 (0)
Total	**2,156**

Note: Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

[(a)] Change calculated by subtracting the existing conditions value from the cumulative effects value.

Although the RSF model predicts an increase in probably of elk selections adjacent to development because of reduced predation risk, the implementation of wildlife fencing has the potential to eliminate this benefit by preventing elk from escaping from wildlife corridors into the adjacent development. This change only applies to corridors where fencing is proposed. Probability of selection for elk in other corridors in the RSA where development will expand, such those adjacent to Silvertip, is predicted to increase.

Habituation of elk to human activity and developments in the Bow Valley, telemetry and camera data showing elk use throughout wildlife corridors and developed areas, and a potential net increase in probably of selection in the regional corridor network for elk means that landscape connectivity for elk in the Bow Valley is likely to remain high after addition of the Project and other reasonably foreseeable developments.

5.8.5.3 Negative Human-Wildlife Interactions

As discussed in Section 5.6.5.3, implementation of the wildlife fence associated with the Resort Centre ASP Amendment and Smith Creek ASP has the potential to shift negative human-wildlife interactions with elk into other parts of Canmore. If this occurs, elk are particularly likely to concentrate in other developed areas where forage is abundant, such as golf courses, the edges of roads, and schoolyards. Other reasonably foreseeable developments will likely attract elk, which could result in additional negative interactions with people near these developments. If habitat enhancements are implemented in wildlife corridors and habitat patches, a decline in negative human-elk interactions may result because elk will have high-quality forage resources available outside of Canmore.

5.8.5.4 Environmental Consequence

Changes to elk connectivity are not expected as a result of cumulative effects in the Bow Valley, and negative elk-human interactions may decline with implementation of habitat enhancements in wildlife corridors and habitat patches. The primarily adverse effect to elk in the RSA when the cumulative effects of existing and reasonably foreseeable projects and activities are combined is habitat loss associated with fencing for the Resort Centre ASP Amendment and the Smith Creek ASP. Although fencing may adversely affect elk, it is a key mitigation required to prevent substantial contributions from the Project to high environmental consequences present in the Bow Valley for grizzly bears under existing conditions and to reduce negative human-wildlife interactions more broadly.

Edwards (2013, pg 44) concluded that "propositions to construct wildlife exclusion fencing around the perimeter of the Three Sisters development could have catastrophic effects on the local elk by eliminating a significant portion of the core home range area and restricting lateral movement between the Bow River and heavily grazed terrain at Three Sisters". This assessment identified a loss of up to 9% of selected habitat in the RSA for elk, including the anthropogenic grasslands that were created in the Resort Centre as part of the unfinished golf course. Loss of this habitat may have a detrimental effect on elk carrying capacity in the RSA. However, because 92% of habitat selected by elk in the RSA will be present after reasonably foreseeable developments are built, and this does not include high-quality winter range in the west Wind Valley discussed below, this change is not expected to be large enough to undermine the self-sustaining status of elk in the Bow Valley identified under existing conditions.

Elk habituation and use of anthropogenic landscapes within TSMV was one of the greatest concerns raised by the NRCB (1992). The high density of elk and deer taking advantage high quality anthropogenic foraging opportunities and reduced predation risk could also attract habituated predators into areas used heavily by people. Elk habituation and intense use of anthropogenic habitats to obtain forage and avoid predation also means that areas identified as high-quality winter range, such as the West Wind Valley (Alberta Parks 2015), are less frequently used by elk than they were in the 1980s (NRCB 1992), and were not selected by GPS collared elk during winter (Appendix B). Fencing at TSMV could increase elk use of naturally occurring high-quality habitats in the West Wind Valley where elk are exposed to their natural predators without putting people at risk (Ellis 2017). If, on the other hand, elk congregate in other parts of Town as a result of fencing, the likelihood of negative interactions between elk and people and between people and predators that are attracted to elk could increase in these areas (Section 5.8.4.4).

Edwards (2013) identified another important consequence of the concentrations of elk in Canmore. Higher rates and intensities of parasitic infections were identified in urban elk because of heavy repeated use of a relatively small amount of habitat in and around Canmore. Removing artificial refuges from predation could improve ecological function of elk at the local scale of TSMV by making them less prone to parasitic infection and more available to their predators (Hebblewhite et al. 2005b).

Overall, the addition of the Project and other reasonably foreseeable developments are not expected to contribute adversely to the diminished ecological efficacy of elk in the Bow Valley identified under existing conditions. Wildlife fences at TSMV combined with habitat enhancements in wildlife corridors and habitat patches have the potential to increase use of habitat patches and wildlife corridors by elk, as recommended by J. Honeyman (Ellis et al. 2017), but there is uncertainty about how elk will redistribute themselves after fencing is applied. Possible environmental consequences as a result of cumulative effects include maintaining the high environmental consequence identified under existing conditions if elk continue to concentrate their use in anthropogenic habitats in Canmore, or reducing the environmental consequence to low if elk redistribute themselves outside of Canmore and improve their contribution to ecosystem function.

6.0 OTHER VALUED ENVIRONMENTAL COMPONENTS

6.1 Vegetation

6.1.1 Existing Conditions

The description of existing conditions for vegetation identifies the following within the Project Boundary:

- vegetation communities;
- ESAs;
- rare plants;
- tracked and watched plant communities; and
- weeds.

A vegetation community map was developed by Golder using methods developed for the environmental impact assessment in support of the NRCB application (Delta 1991b,c). This map was developed using 1995 AVI data obtained from Alberta Sustainable Resource Development (ASRD, now AEP) and then verified using air photo interpretation and field data collected during the summer of 2008.

A total of 153 vegetation surveys were conducted within Three Sisters Mountain Village properties between July 2 and August 7, 2008. These surveys included rare plant and ecosystem surveys where site characteristics were documented (e.g., moisture and nutrient regimes, slope, aspect, species, strata and percent cover). Additional surveys were conducted on September 4 and 5, 2008 to delineate wetland and riparian ESA boundaries. Detailed methods are provided in Appendix B of Golder (2013).

Maps were updated in 2016 using high-resolution imagery to define new disturbance boundaries and confirm land cover type classification. Additional data collected in 2012 and 2015 were used to update ESA boundaries within the Project area. Methods used to update ESA information are described in the ESA specific subsections below.

Although other methodologies are available for developing vegetation community maps (e.g., remote-sensed classification), the approach used here relies heavily on site-specific detail (i.e., field survey data and field delineated polygons). Consequently, there is a high degree of confidence in the vegetation community mapping presented here.

Land Cover Types

Eleven land cover types occur within the Project Boundary (Table 39, Figure 50). Vegetation communities in the Project Boundary are part of the montane ecoregion of the Rocky Mountain Natural Region (Archibald et al. 1996). The Project Boundary contains native vegetation including treed and wetland areas. Treed areas account for 71.9 ha of the Project, most of which is closed pine forest (Figure 51). Wetlands are another native vegetation community that occurs within the Project Boundary and is also an ESA; wetlands are described in more detail in section devoted to ESAs below.

Although native vegetation is present, large areas of disturbance and anthropogenic land cover types are also found throughout the Project Boundary, where most of the habitat has previously been heavily disturbed by historic mining activity, and subsequent construction of the unfinished golf course. Non-native grasslands are the most common cover type in the Resort Centre ASP Amendment area (i.e., 44.3%) and are associated primarily with the unfinished golf course. These areas were seeded with non-native grass, although some native species also are present, and weeds have invaded some areas. Three anthropogenic water impoundments have been created in the incomplete golf course, accounting for 2.5 ha of the Project area (Table 39, Figure 50). These water impoundments have begun to re-establish native riparian and aquatic vegetation (Figure 52). Disturbances total 12.9 ha of the Project area overall, including trails, pipelines/ transmission lines, and roadways (Table 39).

Table 39: Land cover types within the Project area

Land Cover Types	Area [ha]	
Treed		
Closed Pine	48.9	
Closed Spruce	6.6	
Deciduous	3.0	
Mixedwood	1.0	
Open Pine	4.6	
Open Spruce	7.8	
treed subtotal		*71.9*
Non-Native Vegetation		
Non-Native Grassland	72.3	
non-native vegetation subtotal		*72.3*
Wetlands		
Wetland	0.9	
wetlands subtotal		*0.9*
Anthropogenic Water Impoundments		
Anthropogenic Water Impoundments	2.5	
anthropogenic water impoundments subtotal		*2.5*
Rock		
Rock	2.6	
rock subtotal		*2.6*
Disturbance		
Disturbance	12.9	
disturbance subtotal		*12.9*
Total	**163.1**	

Note: Non-native grasslands are associated primarily with former development areas cleared and contoured within Project.

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values

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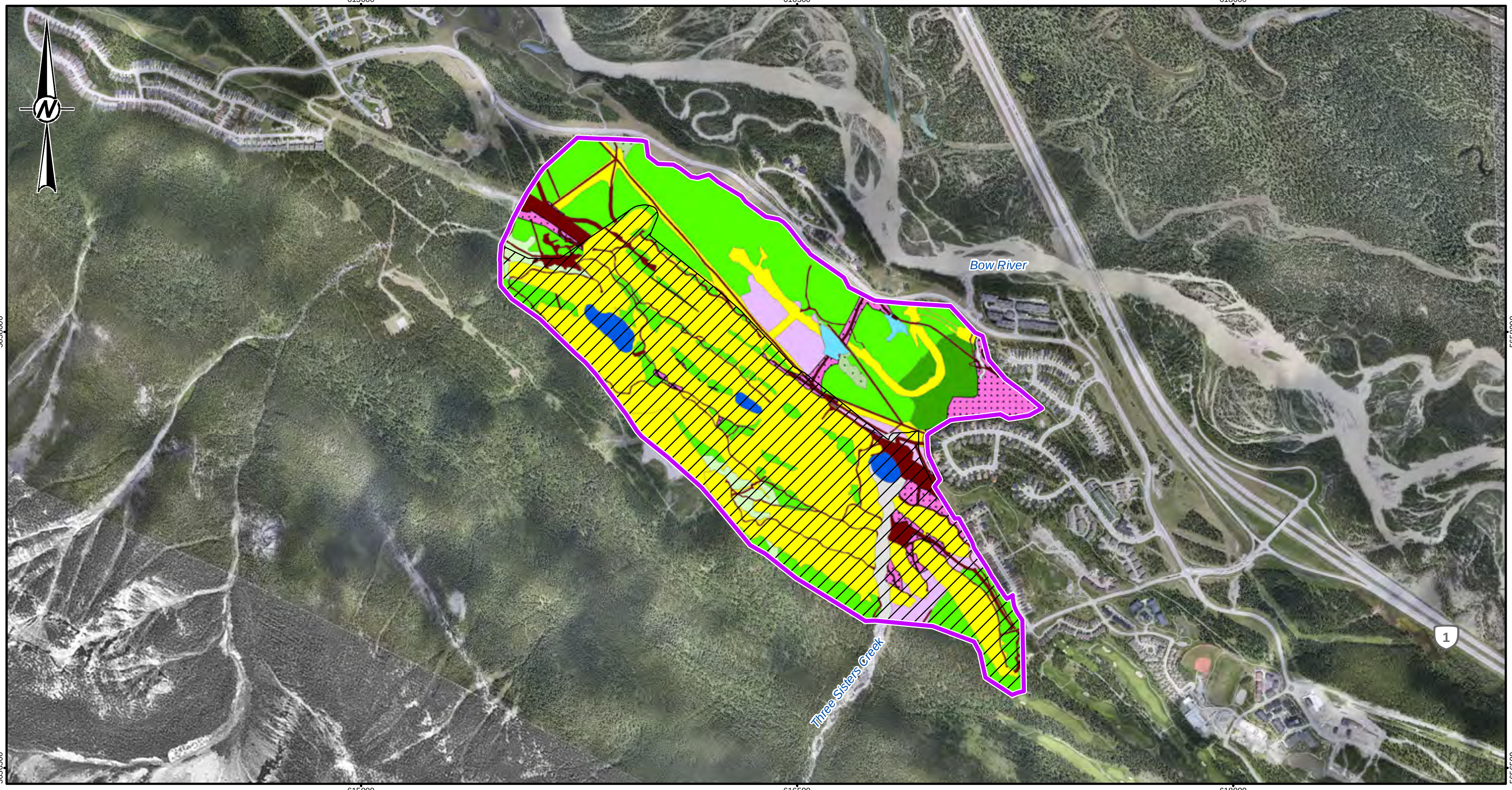

LEGEND

- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

LAND COVER TYPE

- CLOSED PINE
- CLOSED SPRUCE
- DECIDUOUS
- DISTURBANCE
- MIXEDWOOD
- NON-NATIVE GRASSLAND
- OPEN PINE
- OPEN SPRUCE
- ROCK
- WETLAND
- ANTHROPOGENIC WATER IMPOUNDMENT

0 500 1,000

1:20,000 METRES

REFERENCES
1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT
QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT
RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE
LAND COVER TYPES WITHIN THE PROJECT BOUNDARY

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	50

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Figure 51: Spruce (foreground) and Pine (background) Stands Typical of Area

Figure 52: Non-native Grassland Meadow with Anthropogenic Water Impoundment within the Project Area

Environmentally Sensitive Areas

Environmentally Sensitive Areas (ESA) are areas of land established for the protection of sensitive natural features and ecologic functions and diversity, primarily for the protection of wildlife and waterbodies (Town of Canmore 2016). The Town's MDP requires that lands identified as ESAs should be conserved or protected. The NRCB (1992) also required that ESAs be considered in the development of the Project. The NRCB included old growth stands of Douglas fir (*Pseudotsuga menziesii*) and subalpine fir (*Abies lasiocarpa*), wetlands and riparian areas as ESAs. As part of the Canmore MDP, the Town has also identified riparian and wetlands as ESAs within the municipality. Vegetation ESAs are illustrated in Figure 53. Based on field surveys conducted in 2008, 2012 and 2015, Alberta Vegetation Inventory (AVI) data and a review of air-photo imagery, Douglas fir and subalpine and fir were not identified within the Project Area and are not anticipated to be affected by the Project.

Wetlands

Wetlands are ecosystems containing soils that are saturated with moisture either permanently or seasonally (Aber et al. 2012; National Wetlands Working Group 1988), and are further characterized by the presence of water-adapted vegetation. The areas within and surrounding the Project area are typical of mountain landscapes with steep elevational gradients, varied bedrock type and groundwater chemistry across relatively short distances (Lemly and Cooper 2011). In continental climate regions, deep winter snow cover accumulates at high elevation. During the spring and summer, snowmelt recharges groundwater aquifers and contribute to the formation of array of wetlands and riparian areas (Cooper 1990; Cooper and Andrus 1994; Clausen et al. 2006; Winter et al. 1998).

Peatlands are wetlands where there is an accumulation of organic matter that is at least 40 cm thick and include bogs and fens. Peatlands form in mountain valleys, in basins, or on slopes and are typically supported by groundwater input (Lemly and Cooper 2011). Because of the variation in chemical content and landform, the diversity of plants within Rocky Mountain wetlands is highly variable. These areas are of particular importance within the region, because they contribute substantially to regional biodiversity of both plants and animals (Chadde et al. 1998). Additionally, fens function as regionally important habitat islands for rare plant and animal species that are otherwise limited to colder environments in boreal and arctic regions (Cooper 1996).

On 4 and 5 September 2008, surveys were conducted to document wetlands areas within the ASP boundaries. Natural wetlands were characterized and delineated according to the Stewart and Kantrud (1971) wetland classification, the Canadian Wetland Classification System, Second Edition (National Wetlands Working Group 1997), and the United States Army Corps of Engineers Wetland Delineation Manual (US ACE 1987). During the field survey of the Project, each potential wetland site was searched for water-adapted vegetation, wet soils, and primary or strong secondary indicators of wetland hydrology. The presence and persistence of wetlands within the Project area were verified on September 13 and 14, 2012. Based on these field surveys and vegetation community mapping, there are two natural wetlands present in the Project Boundary (1N and 2N in Figure 53) accounting for 0.9 ha of the Project area (Table 39).

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LEGEND

PROJECT BOUNDARY

RESORT CENTRE ASP AMENDMENT AREA

ENVIRONMENTALLY SENSITIVE AREAS

RIPARIAN AREA

WETLAND

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

CONSULTANT

YYYY-MM-DD	2017-03-02
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

TITLE

VEGETATION ENVIRONMENTALLY SENSITIVE AREAS

PROJECT NO.	CONTROL	REV.	FIGURE
1539221	9400	1	53

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Figure 54: Fen in the Project area; Looking Southwest from Clearing

Riparian Areas

Riparian habitat is a transition zone between aquatic and terrestrial ecosystems (Austin et al. 2008). Riparian habitat is defined as areas adjacent to rivers and lakes, or ephemeral, intermittent, or perennial streams that differ from surrounding uplands in plant and animal diversity and productivity (Environment Canada 2013). Generally, riparian ecosystems are found in areas where watercourses at least occasionally cause flooding beyond their channel allowing for the establishment and growth of diverse and flood-tolerant vegetation (Bradley and Smith 1986). These areas are structurally complex, transitioning from zones of higher to lower moisture (Mitsch and Gosselink 1993). Riparian areas were surveyed in conjunction with wetlands surveys on September 4 and 5, 2008.

Watercourse drainages were mapped using Altalis (2015) and field-verified data. The datasets were merged, and a 10 m buffer was applied to map the riparian areas. The 10 m buffer was applied to provide a rough estimate of the areal extent of riparian area within the ASP. The actual boundary of riparian habitat adjacent to Three Sisters Creek will be determined at the land use and subdivision application stage using methods described in ‘Stepping Back from the Water” (AEP 2012). Within the Project area, 2.5 ha of riparian areas are associated with Three Sisters Creek. This riparian buffer was heavily scoured during the 2013 flood event and the banks were reinforced to channelize the creek after the flood.

Rare Plants

A rare plant is defined as any native vascular or non-vascular (i.e., lichens and bryophytes) plant species that, because of its biological characteristics, exists in low numbers or in very restricted areas (ANPC 2012). Plant rarity is determined by three factors: geographic range, habitat specificity and local population size (Drury 1974; Rabinowitz 1981). For example, some rare plant species may have a widely dispersed distribution but are usually only found in small numbers. Other rare plant species require specific habitat conditions that are geographically uncommon. Thus, the range of some rare species is restricted to so few localities that they are considered rare even though they occur in large numbers at each locality.

Rare plants in Alberta are represented by those species listed on the Alberta Conservation Information Management System (ACIMS) tracking and watch lists (ACIMS 2016a). The tracking lists include species of high priority because they are rare or there is a conservation concern (Kemper 2009). Species on the watch lists are taxa that are not currently considered as having high conservation concern, but there is some information that they may become rare should there be significant alterations to habitat or population (ACIMS 2016b).

The ACIMS tracking and watch lists denote nine ranks of rarity for rare plants where the species are evaluated and ranked on their status both globally and provincially (Golder 2013 Appendix D). Ranking is generally based on the number of known population occurrences in the province. In some cases, species have not been assessed at a provincial level, or global level, and have been classified as “unranked” for the purposes of reporting. These species are different than those ranked “SNR” or “GNR” which are formally recognized by ranking bodies, such as ACIMS, but have not yet been ranked or are under review.

Also at the provincial level, rare plant species are assessed by AEP and categorized in the *General Status of Alberta Wild Species* (GSOAWS) (ASRD 2010). Species listed as “At Risk” of extinction, “May Be At Risk” of extinction and those considered “Sensitive” to human activities or natural events are listed in below. Species listed as “At Risk” are those known to be at risk after a formal detailed status assessment and legal designation Because ACIMS and AEP use different methodologies for ranking rarity, species may be listed according to one organization, but not the other.

At the national level, rare plant species are assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and then legally listed pursuant to the *Species at Risk Act* (SARA) and denoted by five rarity definitions or classes (COSEWIC 2010):

- Special Concern: a species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats;
- Threatened: a species likely to become endangered if limiting factors are not reversed;
- Endangered: a species facing imminent extirpation or extinction;
- Extirpated: a species that is no longer existing in the wild in Canada, but occurring elsewhere; and
- Extinct: any species that no longer exists.

For the purposes of this report, the term "listed" will be used to reference rare plants that appear on:

- Tracked and Watched Elements (ACIMS 2016a);
- General Status of Alberta Wild Species (ASRD 2010); or
- Canadian Wildlife Species at Risk (COSEWIC 2010).

Listed plant species have not been documented within the Resort Centre ASP Amendment boundary.

There are no known occurrences of provincially or federally-listed plants within the Project area that would require avoidance measures. Within the RSA, there are four reported occurrences of whitebark pine (*Pinus albicaulis)* (ACIMS 2016a). Whitebark pine is listed federally as *Endangered* under Schedule 1 of SARA and is listed as "Endangered" provincially under the *Alberta Wildlife Act*. This tree species was not observed during field programs in the Project area and is unlikely to occur because whitebark pine is largely restricted to higher elevations (approximately 1,950 to 2,250 metres above sea level [masl]).

There are no known occurrences of federally-listed non-vascular plants within the Project area that would require avoidance measures. Within the RSA, there is one reported occurrences of Porsild's Bryum (*Bryum porsildii)* (ACIMS 2016a). Porsild's Bryum is listed federally as *Endangered* by the COSEWIC, is listed in Schedule 1 of SARA and is listed as At Risk provincially (ASRD 2010). This bryophyte species has not been reported from within the ASP. Porsild's Bryum is associated with western mountain ranges, preferring sites that are constantly moist with seepage or splash during the growing season, along with complete desiccation (i.e., drying out due to water freezing) during the winter season. This moss grows in cracks and cliffs of calcareous conglomerate rock, limestone, basalt, sandstone, and shale and is very unlikely to occur in the ASP.

Tracked and Watched Plant Communities

ACIMS develops tracking lists of plant community elements that are considered high priority because they are rare or special in some way. ACIMS database (2016a) was queried and there are no documented tracked or watched communities within the Project Boundary.

Weed Species

The definition of a weed is limited to those plants listed in the Alberta *Weed Control Act* (Government of Alberta 2010). Weeds listed in the Alberta *Weed Control Act* are invasive, aggressive and difficult to manage (Government of Alberta 2010). They may displace native plants or change native plant communities and may also cause economic damage to private and public lands.

The Town has a comprehensive weed control program and monitors locations and spread of invasive plant species. Some of these species are only found, or were originally found, within the TSMV area (e.g., blueweed). It is believed that these species were brought in during movement of spoils and equipment (Guest 2013, pers. comm.). The noxious weed species documented within the town boundaries are listed in Table 40.

Table 40: Invasive plant species documented within the Town of Canmore

Scientific Name	Common Name
Arctium lappa	great burdock
Campanula rapunculoides	garden bluebell
Chrysanthemum leucanthemum	ox-eye daisy
Cirsium arvense	Canada thistle
Clematis tangutica	yellow clematis
Echium vulgare	blueweed
Hieracium aurantiacum	orange hawkweed
Hieracium caespitosum	meadow hawkweed
Linaria vulgaris	common toadflax
Matricaria perforata	scentless chamomile
Ranunculus acris	tall buttercup
Silene latifolia	bladder campion
Sonchus arvensis	perennial sow-thistle
Tanacetum vulgare	common tansy
Verbascum Thapsus	common mullein

Note: data provided by the Town of Canmore.

6.1.2 Environmental Risks

Four primary environmental risks have been identified for Vegetation:

1) Construction and operation of the Project may result in the disturbance and removal of native vegetation and ESAs because of clearing.

2) Operation of the Project may increase accidental damage of native vegetation and ESAs associated with recreational use of the area.

3) Construction and operations of the Project may result in a reduction of vegetation habitat quality through changes to hydrology, dust deposition and the introduction of contaminants (e.g., spills):

   a. Project activities that alter wetlands or riparian areas, may alter local water flows and drainage patterns. Changes in drainage patterns can strongly influence plant species composition, community structure, and biological diversity (Vale et al. 2015). These changes in water levels will affect soil moisture, and may result in localized effects to vegetation habitat quality.

   b. Accidental spills or leaks of hydrocarbons (e.g., gasoline and diesel fuel) could occur during equipment operation, maintenance, fueling, or fuel storage during clearing, construction, and operation, resulting in local contamination of vegetation and soil.

   c. Dust will be generated as a result of clearing and construction activities, which may result in changes to vegetation. Dust that falls directly on plants can have a physical effect by smothering plant leaves or blocking stomata openings (Farmer 1993). Crusts forming on leaves can reduce net photosynthesis (Brandt and Rhoades 1973). After many cycles of crusting, the annual growth rate of plants can be reduced or cease and crusting can even lead to death.

4) Construction and operations of the Project may result in the introduction of weed species, which can out-compete native plant species and reduce biodiversity within native plant communities and ESAs. Project activities including the movement of machinery or equipment from and to the site, ground disturbance and vegetation clearing could introduce invasive plants to or add to existing infestations within the study area. Bare soil, where reclamation has not been initiated or is unsuccessful, is susceptible to encroachment by invasive plant species.

6.1.3 Relevant Legislation

Federal legislation and guidelines intended to protect vegetation include:

- Species at Risk Act, prohibits killing or harming species listed on Schedule 1, or damaging critical habitat as defined in a recovery plan.

Provincial legislation and guidelines intended to protect vegetation include:

- Alberta Wetland Policy, promotes the conservation, restoration and protection of Alberta's wetlands to sustain the benefits they provide to the environment, society and economy.
- Alberta Wetland Mitigation Directive, provides guidelines to minimize adverse effects to wetlands and details wetland replacement requirements when permanent disturbance cannot be avoided.
- Water Act, promotes the conservation and management of water resources within Alberta.
- Stepping Back from the Water, provides guidelines for determining appropriate setbacks and riparian buffer areas for developments near wetlands, waterbodies, and water courses.
- Alberta Weed Act, identifies and regulates weeds through control measures.
- Wildlife Act, under which protective measures for wildlife and plants may be established.

6.1.4 Mitigation

Mitigation measures to avoid or reduce effects associated with each category of environmental risk identified for the Projects are recommended in this section. No old growth Douglas fir or subalpine fir are known to occur in the Project Boundary and as such, no mitigation for these ESAs is proposed.

Disturbance and Removal of Native Vegetation

The following mitigation measures will be implemented to reduce the potential damage or loss of native vegetation and ESAs (i.e., wetlands and riparian areas) during construction and operations of the Projects:

- damage and/or disturbance to ESAs will be avoided, where possible, through the creation of green space designations;
- wetlands will be avoided, to the extent possible, during subdivision design;
- where loss to wetlands cannot be avoided, they will be compensated for according to the requirements of the Alberta Wetland Policy;
- site-specific Construction Management Plan will be prepared to include environmental protection measures including, but not limited to vegetation and ESA protection, and monitoring measures, and reclamation and revegetation plans;

- prior to construction, all on-site contractors will be briefed on the proper procedures and activities to minimize environmental effects, as per the Construction Management Guidelines (TSMV 2008);
- work limits will be marked to ensure operations will remain within the clearing boundaries to minimize damage to vegetation and soil;
- boundaries for wetlands and riparian areas will be clearly delineated and avoided during construction so that no clearing will take place beyond the development footprint, unless approved for wildlife and vegetation habitat improvement, or wildfire control purposes;
- workers and vehicles will be restricted to the designated work area of the development site and will not be permitted to access other parts of the property without written authorization from TSMVPL; and
- areas that are temporarily disturbed during construction will be progressively reclaimed with native species. Flowering Landscapes of TSMV (Stantec 2004a) and the Woody Plants of TSMV (Stantec 2004b) will be used as a guide for post-construction planting.

Accidental Damage of Native Vegetation Associated with Recreational Users

- Canmore residents and visitors will want to walk, mountain bike, run their dogs and otherwise use natural habitats within and adjacent to the ASP as a result of the Project. Although all of these activities have the potential of damaging vegetation and increasing soil erosion, mountain biking may have the highest potential to effect native vegetation, rare plants, and ESAs (i.e., wetlands and riparian areas). The following mitigation measures will be implemented to reduce the likelihood of native vegetation being impacted through increased human use of green spaces areas within and adjacent to the Project Boundary:
  - planning a trail system inside the Project Boundary that will provide users with an enjoyable and effective link between different components of the Projects and minimize trail proliferation and potential damage to native vegetation; and
  - guidelines in the TSMV Vegetation Management Handbook (Stantec 2005) will be applied, specifically maintenance standards for residual and planted vegetation such as plant health care programs and tree protection plans.

Reduction of Vegetation Habitat Quality

The following mitigation measures will be implemented to minimize the potential for reduced vegetation habitat quality, including rare plant habitat, and ESAs (i.e., wetlands and riparian areas) during construction and operations of the Project:

- maintaining established drainage patterns, and vegetation habitat quality, through the implementation of the Master Drainage Plan;
- a site-specific Construction Management Plan will be prepared to include environmental protection measures including, but not limited to erosion control, vegetation protection, pesticide environmental mitigation and monitoring measures, hazardous material handling and storage, and reclamation and revegetation plans; and
- dust control measures will be implemented during construction.

Introduction of Weed Species

Mitigation measures to reduce the potential establishment of weed species including those recommended by the Town are as follows:

- Guideline in the TSMV Vegetation Management Handbook (Stantec 2005).
- A site-specific Construction Management Plan will be prepared to include environmental protection measures including pesticide and herbicide control.
- All equipment will be steam or pressure washed to remove dirt and vegetative debris before entering the work site.
- Introduced soils and seed mixtures must be certified as being free from noxious weeds.
- Native soil stockpiles must be sprayed regularly to kill any weed growth.
- Disturbed soil must be seeded or planted within three days to prevent invasive plants from establishing. Over-seeding with approved seed mixtures should be conducted in seed areas that have not germinated.
- If herbicide application is required, spot application techniques will be used in lieu of broad-scale herbicide application.
- Turf establishment and maintenance shall follow the Town's Construction and Landscaping Standards, including preparing the site for the Construction Completion Certificate (CCC) followed by the 24-month warranty/maintenance period leading up to the Final Acceptance Certificate (FAC).
- Disturbed areas should be monitored after development and sprayed as required when new weed infestations are disturbed areas should be monitored for up to five years after development and sprayed as required when new weed infestations are documented, and afterwards on public spaces by the Town, until inspection and acceptance of the FAC.

6.1.5 Predicted Project Effects

This section predicts the residual effects for the environmental risks of the Project (i.e., removal of native vegetation, accidental damage associated with recreational use of the area, reduction in vegetation habitat quality and the introduction of weeds) identified in Section 3.2.4.2 assuming the mitigation measures recommended in Section 3.2.4.4 are implemented. There are no known occurrences of provincially or federally-listed plants with legal protection (i.e., avoidance requirements) or tracked and watched plant communities within the Project area and therefore rare plants and tracked and watched plant communities are not anticipated. The following VECs were assessed:

- native vegetation communities; and
- ESAs.

Native Vegetation Communities

Vegetation removal due to site clearing for the Project will result in the loss of a maximum of 12.1 ha of native vegetation within the amendment area, all of which is in the treed land cover type (Table 41). Up to an additional 52.9 ha of treed vegetation will be removed within the areas for which approvals are already in place form the 2004 ASP (Table 41). The Project Boundary presented in this EIS is conceptual and overestimates the actual amount of vegetation disturbance. Design of final development pods within the Project Boundary will occur at the subdivision application stage. During construction, vegetation will be cleared to accommodate houses, roads, pedestrian trails and associated infrastructure.

Table 41: Change in land cover types within the Project area

Land Cover Type	Project Area (Amendment Area) [ha]	Unaffected - open space [ha]
Treed		
Closed Pine	39.4 (9.4)	9.5
Closed Spruce	3.9 (0.2)	2.7
Deciduous	2.4 (1.9)	0.6
Mixedwood	0.8 (0.0)	0.1
Open Pine	4.3 (0.0)	0.3
Open Spruce	1.9 (0.6)	5.9
treed subtotal	*52.9 (12.1)*	*19.0*
Non-Native Vegetation		
Non-Native Grassland	51.4 (43.9)	20.9
non-native vegetation subtotal	*51.4 (43.9)*	*20.9*
Wetlands		
Wetland	0.0 (0.0)	0.9
wetland subtotal	0.0 (0.0)	*0.9*
Anthropogenic Water Impoundments		
Anthropogenic Water Impoundment	2.4 (2.4)	<0.1
anthropogenic water impoundment subtotal	*2.4 (2.4)*	*<0.1*
Rock		
Rock	0.1 (<0.1)	2.4
rock subtotal	*0.1 (<0.1)*	*2.4*
Disturbance		
Disturbance	7.5 (4.0)	5.4
disturbance subtotal	*7.5 (4.0)*	*5.4*
Total	**114.4 (62.4)**	**48.7**

Notes: Land cover types identified within the Project Boundary including the amendment area are proposed to be developed into resort accommodation, core developments and expansion areas or storm water ponds (anthropogenic water impoundments).

Some numbers are rounded for presentation purposes. Therefore, it may appear that the totals do not equal the sum of the individual values.

Most vegetation clearing will be associated with closed pine stands, but will also include closed spruce, deciduous and open spruce. Although deciduous stands are relatively uncommon both at the local and regional scale, tree species that make up this vegetation community type are found across the RSA and will not be disproportionally affected by the Project (Golder 2013). Non-native grassland meadow associated with previously cleared golf course will be reduced by about 43.9 ha within the Amendment Area (Table 41).

The design of the Project will include designation of parks and trails for recreationalists, which aim to reduce the dispersed use of green space and conservation areas within and outside the Project Boundary. With the implementation of mitigation measures, expected effects to native terrestrial vegetation from recreational use will not increase from baseline conditions.

With the application of mitigation measures specified in Section 3.2.4.4, changes to terrestrial vegetation because of alteration in hydrology, dust and the introduction of contaminants are not anticipated.

Because of the invasive nature of weeds, even when mitigation measures have been implemented, weeds have been a consistent problem in past developments within the Town. Therefore, even once mitigation measures have been effectively implemented, the development of the Project is anticipated to increase potential for weed species within the Project Boundary.

With the application of the mitigation outlined in Section 3.2.4.4, predicted effects of the Project on native vegetation, excluding ESAs, are:

- negative;
- restricted primarily to development areas within the Project Boundary; however, weeds have the potential to proliferate elsewhere within open areas within the Project Boundary;
- permanent;
- expected to result in the removal of a maximum 12.1 ha of treed vegetation communities within the Amendment Area; weeds are expected to increase within the ASP boundaries;
- certain for most terrestrial vegetation communities within the Project Boundary; probable increase in weed species; and
- clearing is expected to occur only once; however, weed proliferation could occur continually.

Although the effects of tree clearing and the introduction of weed species associated with the Project on native vegetation communities are anticipated to be permanent, they do not pose a risk to terrestrial vegetation communities regionally; therefore, the environmental consequence of the Project on terrestrial vegetation communities is rated as low.

Potential changes are also possible for ESAs (Table 41), and these are specifically discussed in the following section.

Environmentally Sensitive Areas

Environmentally sensitive areas could be affected by clearing and disturbance associated with development, a reduction in habitat quality through changes to hydrology, dust deposition and the introduction of contaminants (i.e., spills) and reduced biodiversity through the introduction of weed species. Residual effects for each of the ESAs (i.e., wetlands and riparian areas) are assessed individually below.

Wetlands are present within the Resort Centre Project Boundary. Placement of development areas has considered and avoided wetlands and it is anticipated that wetlands will not be directly affected by the Project (Table 41).

However, if at the subdivision stage it is determined that a wetland cannot be avoided, then under the Alberta *Water Act*, an approval must be obtained before undertaking any construction activity in a wetland. A construction activity includes, but is not limited to, disturbing, altering, infilling or draining a wetland. The Wetland Mitigation Directive (under the Alberta Wetlands Policy) (AEP 2015) outlines the wetland mitigation process that AEP follows when making approval decisions for developments that may affect wetlands. Where wetlands cannot be avoided, an application to AEP will be required for approval to cause permanent adverse effects. There will be a requirement to provide compensation to a Wetland Replacement Agent (e.g., Southern Alberta Land Trust, Ducks Unlimited Canada) for permanent adverse effects to any wetland.

There are approximately 0.2 ha of riparian area that have the potential to be directly affected based on the conceptual design of the Amendment Area footprint. This riparian buffer was heavily scoured during the 2013 flood event and the creek was subsequently channelized as part of preliminary steps towards steep creek hazard mitigation. The extent of effects to riparian ecosystems will be more accurately determined during subdivision planning using methods described in Stepping Back From the Water (AEP 2012) and riparian areas will be avoided during subdivision planning to the extent practicable.

Changes in drainage patterns due to grading and contouring could locally alter hydrology and result in additional changes to the vegetation community composition and structure of wetlands and riparian areas; however, the development and implementation of a Master Drainage Plan including a stormwater management plan is predicted to minimize these effects. With the application of mitigation measures specified in those plans, wetlands and riparian areas are not anticipated to be impacted by dust and the introduction of contaminants.

Wetlands and riparian areas can be particularly sensitive to invasive species, and changes in species composition can affect local wetland community composition and structure (Zedler and Kercher 2004). Species such as common toadflax *(Linaria vulgaris),* Canada thistle *(Cirsium arvense)* and perennial sow-thistle (*Sonchus arvensis*) have been reported within wetland ecosystems, are known within the Town, and may affect wetlands and riparian areas that are retained within Project Boundary.

The design of the Project will include designation of parks and trails for recreationists, which aim to reduce the dispersed use of green space and conservation areas outside the Project Boundary. With the implementation of mitigation measures, expected effects to wetlands and riparian areas from recreational use will not increase from baseline conditions.

With the application of the mitigation outlined in Section 3.2.4.4, including avoidance of natural wetlands and riparian areas and compensation for any affected wetlands, predicted effects of the Project on wetlands and riparian areas are primarily associated with the introduction of weeds within the 2016 Resort Centre ASP and are:

- negative;
- restricted to the Project Boundary;
- permanent;
- a maximum 0.2 ha of riparian areas may be affected by the Amendment area footprint; changes to wetland and riparian community composition and structure may occur;
- probable within the Project Boundary; and
- weed proliferation could occur continually.

Although the increase in weed species may result in changes to wetland and riparian community composition, implementation of weed control measures is predicted to minimize these effects. Moreover, these ESAs are distributed along the Bow River, both locally and regionally, and therefore, the environmental consequence is rated as low.

6.1.6 Uncertainty and Monitoring

There is substantial certainty associated with vegetation community mapping. Vegetation surveys conducted within the Resort Centre ASP were used to map and characterize the vegetation within the Project areas (Section 7.1.1.1), and subsequent field programs were completed to delineate, characterize and verify wetland and riparian areas.

A monitoring program has been proposed to identify proliferation of weeds within the Town. Weeds are currently an important issue for the Town and the Town has a weed control program that involves locating, spraying and monitoring infestations. Because the *Alberta Weed Act* requires that provincially listed weeds are controlled, the Town must address this issue. Similar monitoring approaches as have been used elsewhere in the Town should be applied for the Project.

6.1.7 Cumulative Effects

The environmental consequence of the Project on native vegetation communities is rated as low. The construction of the Smith Creek ASP on TSMV lands will add to these predicted effects in the RSA. Similar mitigation as described for the Project will be applied to the Smith Creek ASP. Taking into account existing conditions described in Section 3.2.4.1 and future projects or activities, the cumulative effects caused by site clearing and the introduction of weed species are expected to pose a low risk to terrestrial vegetation communities within the RSA.

The environmental consequence on ESAs, specifically wetlands and riparian areas, as a result of site clearing and construction for the Project is rated as low. The construction of the Smith Creek ASP on TSMV lands will add to these predicted effects in the RSA. Taking into account existing conditions described in Section 3.2.4.1 and future projects or activities, the cumulative effects caused by site clearing and construction are not expected to alter the overall distribution and condition of wetland and riparian ESAs within the RSA. Therefore, the cumulative effects are expected to result in a low environmental consequence.

6.2 Fish

6.2.1 Existing Conditions

The Bow River is the main watercourse in the RSA. Mountain whitefish (*Prosopium williamsoni*) are the most abundant sportfish in the Bow River in this region, comprising approximately 80% of the sport fish population. Brown trout (*Salmo trutta*) are the next most abundant sport fish species in the RSA, based on angler creel and recorded inventory data (Thompson 1977; R.L. & L. 1995). Additional sport fish species that may be present include brook trout (*Salvelinus fontinalis*), cutthroat trout (*Oncorhynchus clarki*), bull trout (*Salvelinus confluentus*), lake trout (*Salvelinus namaycush*), burbot (*Lota lota*) and rainbow trout (*Oncorhynchus mykiss*) (UMA 1991b).

Additional fish species found in the Bow River in this region include white sucker (*Catostomus commersoni*), longnose sucker (*Catostomus catostomus*), mountain sucker (*Catostomus platyrhynchus)*, lake chub *(*http://www.fishbase.org/Summary/SpeciesSummary) longnose dace (*Rhinichthys cataractae*) and brook stickleback (*Culaea inconstans*) (Nelson and Paetz 1992).

The Three Sisters Creek flows through the 2016 Resort Centre ASP, draining into the Bow River (UMA 1991b). The upper and lower portions of Three Sisters Creek are ephemeral. Channel characteristics consisted mainly of riffles and runs with minor pools. Substrate was dominated by boulder and rock with minor gravel. Cover was provided by boulder and minor undercut banks. Riparian vegetation consisted of grass and shrubs. No instream vegetation was present. Visual assessment of fish habitat at Three Sisters Creek was conducted on three occasions (UMA 1991c). Habitat consisted primarily of high gradient channels with a lack of pools for adult fish and substrate dominated by rock and boulder.

After the site inspection conducted on Three Sisters Creek, it was determined that there is limited fish habitat potential due to the following habitat attributes:

- frequent high gradients;
- low pool to riffle ratio;
- lack of spawning substrate;
- low winter flows, lack of overwintering pools;
- lack of pools of sufficient size and depth for adult fish; and
- ephemeral flows.

Electrofishing surveys were conducted in Three Sisters Creek 300 m above and 200 m below Chinaman's Dam (October – November 1990); no fish were captured. Electrofishing surveys were also conducted in 500 m of Stewart Creek in August 1991, no fish were captured (UMA 1991e).

6.2.2 Environmental Risks

It is unlikely that Three Sisters Creek has suitable fish habitat for spawning or over-wintering due to seasonal and intermittent flows, steep gradients and lack of suitable habitat (UMA 1991d). However, downstream effects on the Bow River could occur. The use and operation of equipment and vehicles during in-stream activities and storm water runoff from the proposed development can result in sedimentation of water courses during construction which can affect surface water quality, and riparian habitat. The introduction of fine sediment downstream to the Bow River can have sub-lethal (e.g., irritation of gill tissue) and lethal (e.g., suffocation of developing embryos) effects on fish (CCME 2008).

6.2.3 Relevant Legislation

Federal legislation and guidelines intended to protect aquatic life and water quality include:

- *Fisheries Act*;
- Fisheries and Oceans Canada's Measures to Avoid Causing Harm to Fish and Fish Habitat (http://www.dfo-mpo.gc.ca/pnw-ppe/measures-mesures/index-eng.html);
- *Species at Risk Act*; and
- Canadian Environmental Quality Guidelines.

Provincial legislation and guidelines intended to protect aquatic life and water quality include:

- *Water Act*; promotes the conservation and management of water resources within Alberta.
- *Environmental Protection and Enhancement Act;*
- Surface Water Quality Guidelines for Use in Alberta (AENV 1999);
- Code of Practice for Watercourse Crossings;
- Code of Practice for Outfall Structure on Water Bodies; and
- Code of Practice for Pesticides.

6.2.4 Mitigation

The potential effects and mitigation measures outlined in this section are related to those outlined in the Surface and Groundwater Section (Section 3.2.6) and are addressed in the Stormwater Management Strategies document that has been developed for the site (MMM Group Limited 2016).

To mitigate effects, management practices presented in the Construction Management Guidelines (TSMV 2015) will be applied to all construction activities, and development activities will adhere to federal and provincial legislation and guidelines. Mitigation measures to reduce effects from the operation of equipment and vehicles and sedimentation to watercourses and riparian areas include:

- clearly delineating the designated boundary for construction;
- maintaining or restoring riparian vegetation within a buffer developed following the Stepping Back from the Water management practices guide (GOA 2012);
- locating staging areas at least 20 m away from all permanent watercourse streambanks (Town of Canmore 2012);
- avoiding permanent footprints or placement of fill below the normal high water mark at watercourse crossing locations;
- complying with regulatory timing windows for working in or near rivers or streams that have the potential to connect with viable fish bearing waterbodies (i.e., Bow River). The Bow River is a Class C waterbody with a Restricted Activity Period (RAP) is September 1 to April 30 (AEP 2006);
- isolating the streambed as much as possible during in-stream activities;
- minimizing the time and extent of equipment and vehicles operating in the riparian zones and/or on watercourse banks;
- implementing an erosion and sediment control plan, with particular attention to the stabilization of watercourse streambanks and prevention of siltation;
- scheduling work during the driest times of the year to minimize erosion and sedimentation;
- suspending all construction activities during wet conditions (e.g., heavy rainfall and run-off events), when necessary to minimize erosion and sedimentation; and

- maintaining and monitoring all sediment and erosion controls.

Mitigation measures to reduce effects to the aquatic environment through contamination will include:

- restricting residential use of fertilizers and chemicals, and washing of vehicles;
- integrating all chemical use (i.e., pesticides, herbicides) into an approved Integrated Pest Management Plan; and
- AEP monitoring runoff at established monitoring stations on the Bow River.

6.2.5 Predicted Project Effects

Generally, effects to surface water quality and riparian habitat are predicted to be negative because of increased sedimentation and contamination, and result in a negative effect on downstream fish habitat quality. With the application of mitigation measures, infrequent, low-magnitude, short-term effects are predicted because of sedimentation and contamination. Effects are predicted to be unlikely, extend downstream into the Bow River and will be reversible within the short-term.

With the application of the mitigation outlined in Section 3.2.3.4, predicted effects to fish associated with the Resort Centre ASP Amendment are:

- negative;
- may extend beyond the ASP boundaries;
- long-term during operations due to potential surface water contamination;
- expected to result in small adverse changes and to cause no serious harm to fish during construction because any watercourse crossings will follow standard best management practices and will comply with Alberta Code of Practice and Fisheries and Ocean's Canada's measures to avoid harm to fish and fish habitat, but with the potential for larger adverse effects from run-off during operations if residents do not follow guidelines;
- unlikely; and
- expected to occur rarely.

The environmental consequence of this effect is predicted to be low.

6.2.6 Uncertainty and Monitoring

Although uncertainty exists around the precise footprint location and footprint area within the Project Boundary, appropriate setbacks from watercourses will be implemented during final subdivision planning. Mitigation and best practices identified for surface water are standard for construction activities and are expected to have a high probability of success.

Water quality monitoring on the Bow River is conducted by AEP downstream of TSMV.

6.2.7 Cumulative Effects

The environmental consequence to surface water quality and riparian habitat caused by site clearing and construction for the Project is rated as low. The construction of the Smith Creek ASP on TSMV lands will add to these predicted effects in the RSA. Similar mitigations as described for Resort Centre ASP will be applied to that project when it is developed. Taking into account existing conditions described in Section 3.2.3.1 and future projects or activities, the cumulative effects caused by site clearing and construction may result in a detectable adverse effect in water quality, but the effect is not predicted to result in serious risk to fish populations within the RSA. For example, there may be short term increases in sediment loads due to high precipitation events but these are not predicted to have long term effects on fish populations in the RSA.

6.3 Soils and Terrain

6.3.1 Existing Conditions

The Project is located in the front ranges of the southern Rocky Mountains physiographic region on the southwest side of the Bow River (Pettapiece 1986, *in* Paquet and Carbyn 2003). The general topography of the area consists of broad-terraced, fluvial deposits along the Bow River surrounded by steep ridged and gullied bedrock-dominated mountains (UMA 1991a). Elevations within the Project Boundary range between 1,300 to 1,550 masl.

Bedrock geology in the region is dominated by siltstones, limestone, shales, sandstones and coal, which were deposited during the Lower Mesozoic-Lower Cretaceous periods (Hamilton et al. 1999). Specifically, the ASP area is underlain by the Kootenay Formation, the Fernie Group and the Sulphur Mountain Formation (Alberta Geological Survey Map 232A).

Topographic relief varies within the Project with approximately 55% of the area consisting of gentle slopes (0% to 11%) and 41% consisting of moderate slopes (12% to 44%) (Figure 55). Strong and steep slopes (over 45%) occupy approximately 4% and are predominantly associated with rock outcrops and colluvial deposits. Aspects within the Project are predominantly North-Easterly (23 - 68°) accounting for 33%, with an additional 22% for North (338-23°) and 14% for East (68-113°) Southerly (113 - 248°) facing slopes cover 16% of the MDA while Westerly (248 – 293°) facing slopes account for 5%. Flat areas where aspect was not assigned, including water bodies, accounts for <1% of the Project.

Surficial materials within the Project Boundary are predominantly glacial tills, flood plain deposits, alluvial fans and cones, and weathered bedrock (NRCB 1992). Gently undulating to moderately inclined glacial till deposits are present on lower slopes and colluvial deposits of variable thickness are present on the steeper topography (O'Leary 1988). Drainage sources from the mountains have transported extensive quantities of materials that have been deposited in the form of alluvial fans and cones over bedrock (UMA 1991a).

Soils in the Resort Centre ASP are Orthic Eutric Brunisols and Orthic Gray Luvisols (ASIC 2013). Soils across the ASP are poor to rapidly drained (NRCB 1992).

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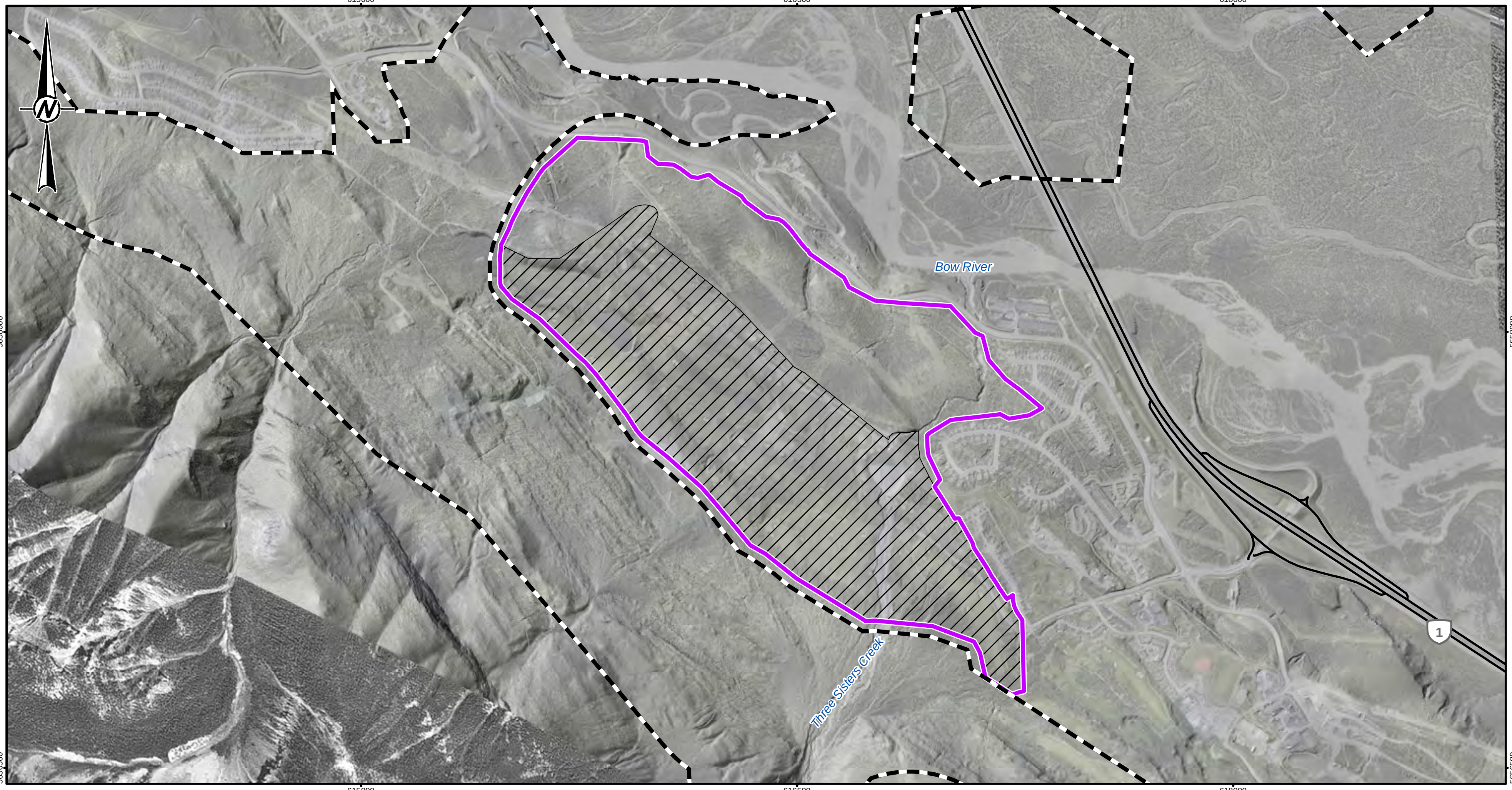

LEGEND

- PRIMARY HIGHWAY
- APPROVED WILDLIFE CORRIDOR
- PROJECT BOUNDARY
- RESORT CENTRE ASP AMENDMENT AREA

0 500 1,000

1:20,000 METRES

REFERENCES

1. IMAGERY CAPTURED IN 2013. SPATIAL RESOLUTION OF 0.1 m.
2. WILDLIFE CORRIDOR OBTAINED FROM ASRD, MARCH 2010.
3. HIGHWAY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

DATUM: NAD 83 PROJECTION: UTM ZONE 11

CLIENT

QUANTUMPLACE DEVELOPMENTS LTD.

CONSULTANT

Golder Associates

YYYY-MM-DD	2017-03-07
DESIGNED	KK
PREPARED	SG
REVIEWED	MG
APPROVED	MJ

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

TITLE

HILL SHADED TERRAIN MODEL OF THE PROJECT AREA

PROJECT NO.	PHASE	REV.	FIGURE
1539221	9400	1	55

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM: ANSI A

25mm

A large portion of the northern half of the Project was mined using underground and surface excavations to extract coal. The mining took place from the 1890s through to 1979 (ERCB 2013). Of particular relevance to this EIS, the western half of the Resort Centre ASP area was mined during the early half of the 20th Century. The mining was performed in coal seams that comprised the No. 2 Mine. These were, stratigraphically from youngest to oldest, the Stewart Seam, the Morris and Sedlock Seams, and the Carey Seam. There also was a small open pit mine operated along the western edge of Resort Centre ASP area.

6.3.2 Environmental Risks

Three potential environmental risks have been identified for soils and terrain:

- Ground disturbance during vegetation clearing, construction, and contouring and grading may result in increased erosion and/or loss of soil, soil compaction, soil admixing or mass movement.
- Human use during operations may result in soil compaction and erosion, particularly though creation of new undesignated trails.
- Terrain stability over old mine workings areas of low strength of coal seams, and a variation in the amount of coal removed and the number of seams mined (NRCB 1992).

6.3.3 Relevant Legislation

- Canmore Undermining Review Regulation, Alta Reg 114/1997.
- Canmore Undermining Indemnity Regulation, Alta Reg 112/1997.

6.3.4 Mitigation

Measures to mitigate the potential environmental impact on soils and terrain include:

- prior to construction, all on-site contractors will be briefed by TSMVPL on the proper procedures and activities to minimize environmental impacts, as described in the Construction Management Guidelines (TSMV 2015);
- a site-specific Construction Management Plan will be prepared to include environmental protection measures including erosion control, vegetation protection and environmental mitigation and monitoring measures;
- salvaging and storing surface soil for post-construction site reclamation;
- use of stored soils salvaged from other areas in Canmore to improve reclamation success, whenever feasible;
- protecting topsoil stockpiles by prompt revegetation by either seeding with native grasses for long-term storage applying herbicides for weeks;
- restricting construction activities and heavy machinery to designated work spaces;
- clearly delineating areas designated for terrain modification by survey stakes and flagging;
- developing and implementing erosion and sediment control plans that will include, but not be limited to installing silt fencing around the perimeter of cleared areas, promptly revegetating or covering areas of exposed mineral soils and suspending all earthwork activities during and following heavy rainfall, including short events and high storm runoff; and

- conducting environmental monitoring and inspection of all construction activities to ensure compliance with the Construction Management Guidelines (TSMV 2015) and a site-specific Construction Management Plan (listed above).

Mitigation measures to address surface stability related to undermining can vary and must be identified on a case-by-case basis. Development of land within the Three Sisters property is governed by the "Canmore Undermining Review Regulation AR114/97 (the Regulation). The Regulation requires that the developer retain an Undermining Engineer to produce an Undermining Report for each development, and that development, with the exception of site grading and utility installation, cannot proceed until the report has been submitted to the Minister and that recommended mitigation has been implemented. The Undermining Report also is required to be reviewed by a second engineer that is independent of the Undermining Engineer (and the Undermining Engineer's firm). Both the Undermining Engineer and the Review Engineer are required to sign certificates that identify the land as suitable for the intended use.

The regulation also provides an exemption to the Town with respect to their duties under the Municipal Governance Act. Section 3 of the Regulation states:

> *3**(1)** Part 17 of the Act and the Subdivision and Development Regulation (AR 43/2002) do not apply with respect to undermining and related conditions in designated land.*
>
> ***(2)** Canmore and Canmore's agents have no responsibility, duty or obligation to consider undermining and related conditions in designated land with respect to the subdivision, development or any other land use planning function of Canmore under Part 17 of the Act and the Subdivision and Development Regulation (AR 43/2002), including, without restricting the generality of the foregoing, with respect to enforcement, maintenance or inspection of undermining and related conditions in designated land.*

6.3.5 Predicted Project Effects

There will be a maximum of 104.3 ha permanent loss of native soil within the ASP boundaries. With the exception of buildings and infrastructure, disturbed areas will be reclaimed.

Predicted effects to terrain, bedrock geology, and soils as a result of soil erosion, loss of topsoil and soil compaction are anticipated to be:

- Negative;
- Confined to the Project area;
- Greatest potential impacts will be short term during construction;
- Detectable impacts long term are predicted be less than or similar to other developments in Canmore;
- Impact duration short term for construction, long term for operations;
- A maximum of 104.3 ha of native soils will be disturbed within the Resort Centre ASP area;
- Probability of negative effects is certain;

- Impacts during construction will be frequent due to construction: and
- Impacts will be infrequent during operations as construction will be complete.

The adverse impacts are expected to occur within the ASP boundaries, and resulting environmental consequences are considered to be low after mitigation has been applied.

6.3.6 Uncertainty and Monitoring

Uncertainty exists around the precise footprint location and footprint area. However, the assessment was conservative because it overestimated disturbance. Mitigation and best practices defined are standard for this type of project and are expected to have a high probability of success. During construction, monitoring will be conducted by TSMV site engineers to ensure compliance with the TSMV Construction Management Guidelines (2015).

6.3.7 Cumulative Effects

The environmental consequence to soils and terrain as a result of soil erosion, loss of topsoil and soil compaction caused by site clearing and construction for the Project is rated as low. The construction of the Smith Creek ASP on TSMV lands will add to these predicted effects in the RSA. Similar mitigation as described for the Project will be applied to the Smith Creek ASP when it is developed. Taking into account existing conditions described in Section 3.2.5.1 and future projects or activities, the cumulative effects to soils and terrain are expected to equal to or less than that experienced in similar developments in the RSA and are expected to result in a low environmental consequence.

6.4 Surface and Groundwater

6.4.1 Existing Conditions

Canmore is located within the third reach of the Bow River watershed, which has a catchment area of about 26,000 km^2 from the Rocky Mountains to the South Saskatchewan River. The Project is drained by Three Sisters Creek which is ephemeral (UMA 1991b). The Bow River parallels the Resort Centre's north property edge for approximately 3 km. However, it is mostly separated from the Project by the Trans-Canada Highway (Figure 1).

The Project area and its upstream catchment is north-east facing with slopes ranging from 2% to 40%. The area inside the Project Boundary have high infiltration capacity as well as high groundwater flows (Stantec 2005).

There are large upslope off-site natural subcatchments that affect the development of the downstream areas. The Three Sisters Creek catchment has its origin in the high mountainous region south of the Project (UMA 1991b,c).

The groundwater conditions are mainly influenced by the Benchlands Aquifer system. These aquifers are mainly comprised of poorly sorted glacial deposits of sand, gravel and clay. As such, permeability is high in the region. Most of the aquifers of significance are surficial and unconfined. This means that there is a lot of interaction between the surface and groundwater systems. As such, the groundwater chemistry of the region is often similar to that of the Bow River. Typically, the groundwater is a calcium-magnesium-bicarbonate-sulphate type and the water quality mostly falls within Drinking Water Guidelines (Government of Alberta 2006).

Ground water flows in the Project Boundary have been extensively affected by undermining. Ground water can flow between and along mines relatively easily, and the surface deposits are largely gravel, which is well drained. Due to the lateral extent of the mines and the interconnections between them, there is very little opportunity for perched water tables. Ground water flows south to north towards the river, but the exact flow paths have not been mapped in detail. Surficial gravels provide a high level of drainage without taking into account the additional potential drainage conduits through the mines.

Although more detailed hydrological data are available from the Province, this more detailed scale of mapping is not required for impact assessment at the ASP stage. Undermining and associated potential issues are not within the scope of the EIS as outlined in Section 6.3.1.4. Any area that is proposed for development that is affected by undermining will be mitigated in accordance with The Town Policies and Provincial Regulations.

6.4.2 Environmental Risks

Four potential project environmental risks include:

1) Increased stormwater runoff from proposed development areas potentially resulting in changes to watercourse geomorphology as a result of potential increase in erosion and sedimentation;
2) High groundwater flow episodes potentially affecting structures in susceptible zones;
3) Potential contamination of groundwater through spills during construction activity; and
4) Grout or mortar (i.e., paste) material used to mitigate undermined areas may locally impede ground water flow.

6.4.3 Relevant Legislation and Guidelines

- Water Act;
- Public Lands Act;
- *Fisheries Act*;
- Construction Management Guidelines (TSMV 2015);
- Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems – Alberta 2012;
- Code of Practice for Watercourse Crossings Alberta – 2013;
- Stormwater Management Guidelines for the Province of Alberta (CH2M Gore & Storie Ltd. 1999);
- Canmore Stormwater Master Plan (2005); and
- Engineering Design and Construction Guidelines for the Town.

6.4.4 Mitigation

Erosion and Sedimentation

During construction, vegetation removal and grading of the site will occur, exposing the subsoil to weathering. As a result, the potential for erosion and sedimentation (e.g., suspended sediment) increases during storm events which may affect surface water quality. The Storm Water Management Strategies Report (MMM 2016) predicts potential stormwater discharge and preliminary estimates of runoff that must be stored on site. The number and type of storage facilities, such as ponds and wetlands, would be determined by the development site plans after approval of the ASP. Details of the ponds and wetlands design and water management will be provided after approval of the ASP.

Erosion and sediment control plans will be prepared, implemented and enforced to minimize sediment input into the creeks, wetlands, storm ponds, bio-swales, and bio-retention areas during the construction phases of the Project as detailed in the Construction Management Guidelines (TSMV 2015). The Town Engineering, Design and Construction Guidelines (Town of Canmore 2010) will also be incorporated. The following plans will be produced prior to construction:

- a site-specific Construction Management Plan will be developed following ASP approval and will include environmental protection measures including, but not limited to erosion and sediment control, vegetation protection, pesticide and herbicide control, environmental mitigation and monitoring measures, and reclamation and revegetation plans including but not limited to:
  - maintaining native vegetation as much as possible;
  - maintaining buffer strips of existing native vegetation around all natural aquatic systems; and
  - implementing erosion and sediment control plans.
- Construction Management Guidelines (TSMV 2015) including but not limited to:
  - prior to construction, all on-site contractors will be briefed by TSMVPL on the proper procedures and activities to minimize environmental impacts;
  - reclaiming disturbed areas as soon as construction works permit, following ground disturbance;
  - applying temporary erosion protection measures if the reclamation of a disturbed area is to be delayed by more than a week;
  - applying hydroseed to any topsoil stockpiled for more than six months, and straw crimping, mulch, netting or hydroseeding to any topsoil stockpiled for thirty days or more or during wet conditions;
  - applying erosion controls immediately after clearing an area in wet conditions and within 72 hours of work completion during dry conditions;
  - applying dust control measures using water only, if required;
  - ensuring that no direct discharge of sumps and equipment rinse water is released to surface water;
  - conducting all in-stream work in accordance with the *Water Act, Public Lands Act and Fisheries Act*, during the time periods approved by Alberta Forestry, Lands and Wildlife; and

- conducting environmental monitoring and inspection of all construction activities to ensure compliance with the Construction Management Guidelines (TSMV 2015) and a site-specific Construction Management Plan.

Groundwater Quality and Quantity

During construction, the main groundwater quality concern is the increased possibility of contaminant spills such as gasoline or motor oil occurring in the Project Boundary. Such spills can have a negative impact if the contaminant seeps into the groundwater. The following mitigation measures will be implemented in order to reduce the potential for contaminant spills:

- prior to construction, all on-site contractors will be briefed by TSMVPL on the proper procedures and activities to minimize environmental impacts, as per the Construction Management Guidelines (TSMV 2015); and
- a site-specific Construction Management Plan will be prepared to include environmental protection measures including, but not limited to erosion control, vegetation protection, pesticide and herbicide control, environmental mitigation and monitoring measures, and reclamation and revegetation plans.

Regionally and locally, most of the aquifers of significance are surficial and unconfined; therefore groundwater quantity can be affected by surface water systems. The groundwater levels in the valleys in the RSA tend to be fairly close to surface (Toop and de la Cruz 2002). Groundwater associated with the Project tends to be more influenced by bedrock elevation beneath the glacial overburden.

Groundwater quantity and flow patterns may be altered at a local scale due to the removal and/or modification of native vegetation and the construction of buildings and infrastructure including the use of cement-based grout or mortar (i.e., paste) to mitigate localized undermined areas. Given the well-drained gravels that generally sit on top of the sedimentary rock in the Project area the lateral extent of the mines and the interconnections between them and the small area of the features being filled with paste relative to the watershed, local perched water are an unlikely outcome of paste injection. Any area that is proposed for development that is affected by undermining will be mitigated in accordance with The Town Policies and Provincial Regulations.

Paste injection is done in areas with voids at shallow depths above typical groundwater elevations in TSMV. Paste also rarely goes all the way to the top of the void so there is still room for water flow above the paste infill, where such flows occur. The catchment area which drains water in and out of the Three Sisters Creek aquifer zone is much larger than the Project area, and no effects to regional groundwater patterns are anticipated.

Master Drainage Plan and Storm Water Management Plan

A 2016 Master Drainage Plan has been prepared for the Project area that provides for a network of stormwater facilities to manage storm drainage and direct it into the Bow River basin. Following ASP approval, a Storm Water Management Plan will be developed consistent with The Town Engineering, Design and Construction Guidelines (Canmore 2010).The stormwater management plan for the Project, will utilize concepts of BMPs and low impact development (LID) to minimize effects of the proposed development on receiving watercourses, where feasible, under The Town’s engineering requirements. Mitigating measures to meet or exceed the above noted criteria in the current guidelines will be described in the stormwater management plan. All applicable Provincial and Municipal guidelines for stormwater treatment and discharge will be met.

6.4.5 Predicted Project Effects

Predicted effects during operations due to increased stormwater runoff as a result of proposed development are anticipated to be:

- Negative in direction.
- Confined to the Project area, with an end point for some flows at the Bow River.
- The majority of impacts will be short term during construction.
- Long term impacts are predicted be similar or less than other developments in Canmore.
- A maximum of 104.3 ha of native soils will be disturbed within the Project Boundary (Section 6.1.1.5; Table 41).
- Probability of negative effects is predicted to be unlikely.
- Frequency of impacts during construction will be frequent due to construction activities.
- Frequency of impacts during operations will be infrequent as construction will be complete.
- The environmental consequence with increased stormwater runoff are expected to be negligible with mitigation measures in place.

Predicted adverse effects to groundwater quality as a result of Project construction activities are anticipated to be:

- Negative in direction.
- Confined largely to the Project areas with an end point at the Bow River as aquifer flow is toward the Bow River.
- The majority of potential impacts are anticipated to be short term during construction.
- Long term impacts are predicted to be similar or less than other developments in Canmore.
- A maximum of 104.3 ha of native soils will be disturbed within the Project Boundary.
- Probability of negative effects is predicted to be unlikely.
- Frequency of impacts during construction will be frequent due to construction activities.
- Frequency of impacts during operations will be infrequent as construction will be complete.

The contribution of the Project to environmental consequences associated with erosion, sedimentation, non-permeable surfaces, and spills are expected to be negligible after mitigation has been applied.

6.4.6 Uncertainty and Monitoring

Storm events may increase erosion impacts. To address this TSMVPL will conduct environmental monitoring and inspection of all construction activities to ensure compliance with the Construction Management Guidelines (TSMV 2015), The Town's guidelines and a site-specific Construction Management Plan.

Water quality monitoring on the Bow River is conducted by AEP downstream of the Project.

6.4.7 Cumulative Effects

The environmental consequence to surface and groundwater caused by construction activities and operations is rated as low. The development of Smith Creek lands will add to environmental effects in the RSA. Similar mitigation as described for the Project will be applied to the Smith Creek ASP when it is developed. Taking into account existing conditions described in Section 3.2.5.1 and future projects or activities, the cumulative effects to surface and groundwater are expected to be equal to or less than that experienced in similar developments in the RSA and are expected to result in a low environmental consequence.

6.5 Air

6.5.1 Existing Conditions

The Bow Valley's ambient air quality levels are generally below Alberta's Ambient Air Quality Objectives (ESRD 2013a). Concentrations of small respirable particulate levels are generally low and below the 24-hour Canadian Ambient Air Quality Standards. Ambient air quality in the Bow Valley is influenced primarily by forest fires, industrial activity (e.g., Lafarge, Graymont, Baymag), natural wind-blown dust, vehicle exhaust and smoke from recreational fires.

While the existing and proposed developments are for the most part non-industrial, air quality at TSMV is also influenced by local and regional emission sources (UMA 1991d), including:

- natural gas combustion emissions from residential and commercial heating;
- residential wood combustion from fireplaces and wood stoves;
- vehicular emissions from local and highway traffic; and
- fugitive dust emissions from local and highway traffic.

The most representative ambient air quality monitoring data in the Project area is undertaken near the Lafarge Exshaw site. The Lafarge currently operates an air quality monitoring program as a condition of the approval and to monitor the long term air quality in the airshed and measure against the Alberta Air Quality objectives (AAAQOs, AEP 2016). There are four continuous monitoring stations on the site. The Lagoon station is designed to carry out the monitoring program objectives and can thus be considered representative of the ambient concentrations from natural sources, nearby sources and unidentified, possibly distant sources. The remaining three stations are designed to assess the effectiveness of the fugitive dust control procedures in place at the Project. Data are available in the form of annual reports (WSP 2017)

The ambient concentrations for each of the compounds monitored at the Lagoon Station over the most recently year of publically available monitoring data (November 2015 to October 2016) are presented in Table 42.

Table 42: Ambient concentration of criteria air compounds from the lagoon station

Compound	Alberta Ambient Air Quality Objective (AAAQO, CAAQS[1] ($\mu g/m^3$)	Annual Average Concentration ($\mu g/m^3$)
Nitrogen Dioxide, NO_2	45	10.8
Sulphur Dioxide, SO_2	20	1.8
Particulate Matter with a mean aerodynamic diameter less than 2.5 microns (µm), $PM_{2.5}$	10[1]	2.7
Particulate Matter with a mean aerodynamic diameter less than 10 microns (µm), PM_{10}	50[2]	18.9
Total Suspended Particulate, TSP	60	25.7

[1] CAAQS – Canadian Ambient Air Quality Standards

6.5.2 Environmental Risks

The Project will result in an temporary reduction in air quality during construction due to vehicles and construction activity and subsequent incremental increases in local emissions with natural gas combustion emissions from residential and commercial heating, residential wood combustion from fireplaces and vehicular emissions from local traffic during Project operations.

6.5.3 Relevant Legislation

- Alberta Ambient Air Quality Objectives and Guidelines – ESRD 2013a.
- Environmental Protection and Enhancement Act – ESRD 2013b.

6.5.4 Mitigation

During construction TSMVPL will:

- check machinery and exhaust systems to ensure that they are in good working condition and functioning properly prior to use on site;
- allow vehicles and machinery to run only when in use;
- provide fugitive dust control during construction – early paving and sweeping combined with watering or chemical suppressants on site roadways will be considered; and
- produce concrete and asphalt off-site.

During operations TSMVPL will design residential and recreational elements to encourage residents to use non-vehicular transportation and the trail network within the Project Boundary to access other portions of TSMV and Canmore.

6.5.5 Predicted Project Effects

Predicted adverse impacts to air quality during Project construction activities are anticipated to be:

- negative;
- regional;

- duration of detectable impacts are long term and predicted be similar to other developments in Canmore;
- new residential and commercial buildings and vehicles are anticipated to produce emissions;
- probability of negative effects is predicted to be likely; and
- emissions will occur throughout construction and operations stages.

The adverse environmental consequences are expected to be low and similar to other urban zones in the Canmore area after mitigation has been applied.

6.5.6 Uncertainty and Monitoring

There are no public air quality monitoring stations present in Canmore, but intermittent monitoring programs, the most recent from September and October of 2012, indicate that particulate concentrations in the Bow Valley near the site are consistently low and well within the Alberta Ambient Air Quality Objectives and Guidelines. A single, temporary excursion above the relevant guidance for 24-hr $PM_{2.5}$ was observed during this monitoring campaign. The proposed residential development does not warrant additional monitoring in the area because the changes to air quality are predicted to be local, and low level, and typical of residential developments elsewhere in Alberta.

6.5.7 Cumulative Effects

At the RSA scale, ambient air quality levels are generally below Alberta's Ambient Air Quality Objectives (AENV 2001). Concentrations of small respirable particulate levels are generally low and below the 24-hour Canada-wide standard. Because the emissions from the Project are small and not expected to contribute to exceeding Alberta's Ambient Air Quality Objectives, the environmental consequence of adding the Project to other regional emissions sources affecting ambient air quality is expected to be low.

6.6 Visual Resources

6.6.1 Existing Conditions

The visual resources of the Bow Valley are considered an important factor for both the tourism industry and those that reside in the area. The Bow Valley is a key destination for people seeking the opportunity to experience the mountain vistas of the region and large areas of native vegetation communities that extend the length of the valley at lower elevations.

Within the Resort Centre ASP, high quality visual resources include Three Sisters Creek, mature forest stands, and views of surrounding mountain peaks, including the Three Sisters. Low quality visual resources in the area include mining scars, old haul roads, power line infrastructure and municipal development (UMA 1991a).

6.6.2 Environmental Risks

Section 10.1.11 of the Town's MDP indicates that architectural and landscaping controls will be required so that buildings achieve harmony of form and materials with the surrounding environment, especially to limit adverse effects to the view shed from the Trans-Canada Highway. If buildings associated with the Project are constructed in a manner that is inconsistent with the Town's MDP, there is a risk that visual resources could be adversely affected.

6.6.3 Relevant Legislation

- Canmore Municipal Development Plan (Town of Canmore 2016);
- Construction Management Plan (TSMV 2015); and
- TSMV Flowering Landscape (Stantec 2004a).

6.6.4 Mitigation

To reduce potential adverse impacts on visual resources from the Trans-Canada Highway during site planning and construction:

- architectural and landscaping controls will be implemented to ensure that buildings achieve a harmony of form and materials with the surrounding environment and are framed by natural landscaping (Town of Canmore 2016);
- retain native vegetation where possible surrounding the wetlands and the riparian areas, and limit the amount of vegetation removal required;
- complete landscaping within the development using natural vegetation features and native plant species, in keeping with the TSMV Flowering Landscape (Stantec 2004a) and Woody Plants of TSMV (Stantec 2004b);
- dispose of debris and slash as per the Construction Management Plan (TSMV 2015) to maintain aesthetic quality of the site;
- rehabilitate existing disturbances during reclamation of Project related disturbances, where possible; and
- rehabilitate and utilize existing tracks, haul roads and trail alignments within the proposed development area for paths and access roads, where practicable.

During operations, TSMVPL will:

- apply architectural standards and designs;
- avoid obstruction of key viewsheds where possible; and
- apply appropriate downcast exterior lighting.

6.6.5 Predicted Project Effects

The Project will not impede views of high quality visual resources such as mountain peaks and vistas. The new development within Resort Centre ASP will be visible to recreational area users from higher elevations on the surrounding mountains and from portions of the Smith Dorrien / Spray Trail, Three Sisters Parkway and George Biggy Sr. Road. Parts of the development will also be visible from the Trans-Canada Highway.

The Project adds development of lower intensity uses, such as recreational amenities, and building forms such as single detached dwellings, duplexes, and townhomes to Areas E and F. From a viewpoint on the Trans-Canada highway, these developments will be behind the more prominent buildings, up to six stories high, already identified for the Resort Core as part of the approved 2004 Resort Centre ASP. Consequently, the amendment will have little effect on visual resources. Development of iconic buildings within the Resort Core may be viewed by some as a positive visual outcome.

Predicted effects to visual resources are:

- negative[20] for the development as a whole, but neutral for the amendment;
- regional;
- long term;
- the Project area is 104.3 ha, which represents 4.1% of the total disturbed area within the RSA and 0.4% of the RSA overall; and
- once buildup is complete the development footprint in the ASP will not increase without additional regulatory amendment.

Environmental consequences are expected to be low after mitigation has been applied.

6.6.6 Uncertainty and Monitoring

Uncertainty exists about the specific footprint and structure design within the development areas at the ASP stage, but building type and height within different policy areas is defined. Controls and restrictions with respect to architectural standards will be developed at the subdivision phase. Because the largest contribution to effects to visual resources is from the Resort Core, where buildings up to six stories high have been approved as part of the 2004 Resort Centre ASP, certainty is high that the amendment in Areas E and F will result in small additional changes to visual resources. No additional monitoring or study is recommended.

6.6.7 Cumulative Effects

The development will contribute to cumulative effects on visual resources together with existing and future, anticipated urban, industrial and infrastructure development as well as population growth in the RSA. The cumulative effects on visual resources, both present and future, are anticipated to be detectable and adverse due to the increase in development in the RSA. However, the changes are not predicted to change the overall visual character or general existing visual conditions in the RSA, with mitigation and by following direction in the MDP. Environmental consequence is therefore predicted to be low.

6.7 Historic Resources

The following is a summary of the historic resource concerns associated with the Resort Centre ASP. The background information used for this summary includes a search of the historic resource inventory files maintained by the Historic Resources Management Branch of Alberta Culture and Tourism (ACT), discussion with Barry Newton (Regional Regulator at ACT), and a review of the 1990 HRIA conducted by Fedirchuk McCullough & Associates Ltd. (FMA 1991).

6.7.1 Existing Conditions

In 1990, on behalf of TSMVPL, FMA conducted a Historic Resource Impact Assessment (HRIA) of the entire TSMV property. The results of the HRIA indicated that the area was rich in historic resources. Some historic resources may already have been mitigated during previous development at the Resort Centre (e.g., the unfinished

[20] Relative to a natural state.

golf course). Other resources on TSMV properties, such as the Canmore Mines Lamphouse, have been identified for permanent protection.

Existing conditions for historical resources is based on a search of the historic resource inventory files maintained by the Historic Resources Management Branch of ACT, discussion with Barry Newton (Regional Regulator at ACT), and a review of the 1990 HRIA conducted by FMA (FMA 1991). The field investigations undertaken to inform the HRIA already done on the entire TSMV property provided useful information for describing existing conditions.

The HRIA conducted in 1990 considered the potential impacts to palaeontological and archaeological sites as well as historic features situated within the TSMV property boundary. No palaeontological sites were identified within the TSMV property (FMA 1991). However, the HRIA did identify 10 previously unknown prehistoric archaeological sites and 122 historic period features associated with a single historic period site; Canmore Mine No. 2. The types of historic period features recorded include building/building remains, mine entrances, subsidence features, airshafts, sawmills, middens, transportation features, water diversions and cairns.

Based on a comparison of the historic period features map (FMA 1991 and the Resort Area ASP area), some historic features are present within, or immediately adjacent to, the Project Boundary (Table 43). All of these features are related to mining.

Table 43: Historic Period Features identified in or immediately adjacent to the Project Boundary

Type of Feature	Relationship of Feature to Boundaries of the Project[(a)]	*Historical Resource Act* Requirements (Alberta Culture and Multiculturalism 1992)
A06 The Shop	within boundary Resort Centre	Avoidance
A07 Coal Analysis Building	in close proximity to the north boundary of Resort Centre	detailed recording and documentation
B03 Mine Entrance	in close proximity to west boundary of Resort Centre	detailed recording and documentation
B05 Mine Entrance	within boundary Resort Centre	detailed recording and documentation
B06 Mine Entrance	within boundary Resort Centre	detailed recording and documentation
B29 Mine Entrance	within boundary Resort Centre	detailed recording and documentation
B30 Mine Entrance	within boundary Resort Centre	detailed recording and documentation
B32 Mine Entrance	within boundary Resort Centre	detailed recording and documentation
B33 Mine Entrance	within boundary Resort Centre	detailed recording and documentation
B34 Mine Entrance	in close proximity to west boundary of Resort Centre	detailed recording and documentation
B35 Mine Entrance	in close proximity to west boundary of Resort Centre	detailed recording and documentation
B36 Mine Entrance	within boundary Resort Centre	detailed recording and documentation
B37 Mine Entrance	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C01 Subsidence	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C02 Subsidence	within boundary Resort Centre	detailed recording and documentation
C03 Subsidence	within boundary Resort Centre	detailed recording and documentation
C04 Subsidence	within boundary Resort Centre	detailed recording and documentation
C05 Subsidence	within boundary Resort Centre	detailed recording and documentation
C06 Subsidence	within boundary Resort Centre	detailed recording and documentation
C07 Subsidence	within boundary Resort Centre	detailed recording and documentation
C24 Subsidence	within boundary Resort Centre	detailed recording and documentation
C25 Subsidence	within boundary Resort Centre	detailed recording and documentation
C26 Subsidence	within boundary Resort Centre	detailed recording and documentation
C27 Subsidence	within boundary Resort Centre	detailed recording and documentation
C28 Subsidence	within boundary Resort Centre	detailed recording and documentation

Table 43: Historic Period Features identified in or immediately adjacent to the Project Boundary

Type of Feature	Relationship of Feature to Boundaries of the Project[(a)]	*Historical Resource Act* Requirements (Alberta Culture and Multiculturalism 1992)
C29 Subsidence	within boundary Resort Centre	detailed recording and documentation
C30 Subsidence	within boundary Resort Centre	detailed recording and documentation
C31 Subsidence	within boundary Resort Centre	detailed recording and documentation
C32 Subsidence	within boundary Resort Centre	detailed recording and documentation
C33 Subsidence	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C34 Subsidence	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C35 Subsidence	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C36 Subsidence	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C37 Subsidence	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C38 Subsidence	in close proximity to west boundary of Resort Centre	detailed recording and documentation
C39 Subsidence	within boundary Resort Centre	detailed recording and documentation
F01 Midden	within boundary Resort Centre	2 square meters of excavation
H01 Pipe	within boundary Resort Centre	detailed recording and documentation
H03 Pipe Support	within boundary Resort Centre	detailed recording and documentation
H10 Pipe Support	in close proximity to east boundary of Resort Centre	detailed recording and documentation

(a) Based on the quality of the historic feature map from the 1990 HRIA report, historic features were included here if they appeared to be close to or within the boundaries of Project Boundary.

6.7.2 Environmental Risks

Historic resources (i.e., palaeontological, prehistoric and archaeological sites and historic period features) are non-renewable resources, which are highly vulnerable to alteration, destruction or damage due to development activity. Potential impacts may occur whenever the ground surface is disturbed, because these features tend to be located either at or directly below the ground surface.

With regard to the Project, there are no concerns for impacts to palaeontological sites or for prehistoric archaeological sites. However, there are two historic period features that may be situated within the Project Boundary that have *Historical Resources Act* requirements associated with them (Table 44).

Table 44: Potential Historical Resources Act requirements for historic features within the Project Development Area

Type of Feature	Relationship of Feature to PDA[(a)]	*Historical Resource Act* Requirements (Alberta Culture and Multiculturalism 1992)
A06 The Shop	within boundary Resort Centre	Avoidance
F01 Midden	within boundary Resort Centre	2 square metres of excavation

(a) Locations are approximated based on results of 1990 HRIA (FMA 1991: 92)

6.7.3 Relevant Legislation

- 1992 *Historical Resources Act*
- Alberta Culture and Multiculturalism 1992; Files 90-065, 90-CR013 (2), 50-THR-9054, and 6392-002-00-02

6.7.4 Mitigation

The Project area and other TSMV properties are considered rich in historic resources, prompting Alberta Culture and Multiculturalism (now Alberta Culture and Tourism [ACT]) to issue a letter outlining the *Historical Resource Act* requirements associated with the proposed development area (Alberta Culture and Multiculturalism 1992; Files 90-065, 90-CR013 (2), 50-THR-9054, and 6392-002-00-02). This letter, issued in 1992, is considered here as an appropriate guideline for mitigation measures that may be required for the development of the ASP, if there is potential overlap between the Project Boundary and historic resources.

Anticipated mitigation measures include:

- avoidance of historic period feature A06 (shop);
- conducting detailed recording and documentation of all historic period features related to the mining complex; and
- excavation at the identified historic period midden.

TSMVPL will submit a Statement of Justification and Historic Resource Application to ACT in order to obtain updated *Historical Resources Act* requirements for any features that have the potential to be affected by the Project. This will be done at future planning stages (i.e., subdivision stage) once final development footprints are known. Such planning is not required at ASP stage when detailed development footprints have not been finalized. Three Sisters Mountain Village will comply with the requirements of the *Historical Resources Act*.

6.7.5 Predicted Project Effects

Predicted adverse residual impacts to historic resources are expected during both Project construction and operations. During construction, some historic features may be removed or otherwise affected. However, because mitigation defined by ACT will be applied, no significant loss of historic resources is anticipated. During operations, the addition of new residences in the area may result in greater use of the areas beyond the Project Boundary, which may result in an increase in unofficial trail development, and therefore potential damage to historic resources. Such impacts are expected to be of low magnitude and local in extent and fencing as a mitigation for wildlife is expected to reduce proliferation of undesignated trails. With the implementation of mitigation measures and the granting of *Historical Resources Act* approval for the Resort Centre ASP area, the predicted adverse environmental consequences to historic resources as a result of Project are expected to be negligible overall.

6.7.6 Uncertainty and Monitoring

Once Project footprints have been defined (i.e., subdivision stage), TSMVPL will follow any requirements defined by ACT.

6.7.7 Cumulative Effects

A cumulative effects assessment was not completed for Historic Resources because the Project related residual effects were predicted to be negligible. Cumulative effects may be important for VECs for which the Project has positive or negligible effects, but the Project will not make them worse; therefore cumulative effects on Historic Resources are not considered in this EIS.

7.0 IMPACT SUMMARY AND CONCLUSION

The NRCB granted approval for the development of TSMV properties in 1992. Among other considerations, the NRCB approval was based on an impact assessment that identified a number of adverse effects to VECs. To mitigate some of these potential impacts, the NRCB imposed conditions for development of TSMV properties. All NRCB conditions that relate to the Resort Centre, such as wildlife corridor designation by the Province, have been met. Approval of an ASP for the Resort Centre was provided by Town council in 2004.

This EIS provides additional information about the anticipated environmental impacts associated with the Resort Centre ASP Amendment, which is being submitted for consideration to the Town. The EIS included assessments of the following VECs: wildlife, fish, vegetation, terrain and soils, surface and groundwater, air, visual, and historic resources.

Although all of the VECs listed above are considered in the EIS, the amount of detail applied to the assessment of each varied, and the EIS focused on wildlife, specifically on grizzly bears, wolves, cougars, and elk. The EIS was undertaken according to six sequential steps for each VEC including: describing existing conditions, identifying environmental risks, summarizing relevant legislation, presenting mitigation measures, predicting effects, discussing uncertainty and identifying recommended monitoring. Cumulative effects were also considered for each VEC.

Under existing conditions, the efficacy of the corridor and habitat patch network in the RSA has clearly been diminished by habitat alteration and high levels of human use. However, the RSA still supports most of the species that were assessed because these species have adapted to higher levels of human use. The exception was wolves, because this species rarely used wildlife corridors and habitat patches for more than a decade, although increased use was observed in 2016. Wildlife in the Bow Valley live in proximity to people and use the same landscapes frequented by large numbers of people. This has led to increased negative interactions between people and wildlife including in wildlife corridors and developed areas, sometimes resulting in negative consequences for wildlife, people, or both (Chetkiewicz et al. 2006).

Through the application of mitigation, the Project is not predicted to contribute to any of the serious risks identified for wildlife under existing conditions, nor is it predicted to create or contribute to the serious risks for other VECs. Table 45 and Table 46 summarize the existing conditions, risks, recommended mitigation and predicted effects after implementation of mitigation for wildlife and all other VECs, respectively.

For EIS predictions to hold, mitigation identified in this EIS must be fully and effectively implemented. Uncertainty about whether or not a serious risk was present was identified and discussed in the EIS. Cases where there was some uncertainty about the efficacy of mitigation such that the Project could contribute to a serious risk if mitigation was unsuccessful were recognized as such, and additional follow-up actions to reduce uncertainty were recommended. Following recommended approaches to address uncertainty using adaptive management will improve the ability to adjust planning and development, if necessary, to achieve desired outcomes for VECs.

Table 45: Summary of Existing Conditions, Environmental Risks Associated with the Project, Mitigation and Predicted Effects of the Project after Mitigation for Wildlife Valued Environmental Components.

Valued Environmental Component	Existing Conditions	Environmental Risks Associated with the Project	Mitigation	Predicted Effects of the Project after Mitigation	EIS Section Reference
Grizzly bear	▪ habituated bear population ▪ high mortality risk ▪ habitat with high probability of selection in the Project Boundary is also associated with high human-bear conflict, representing an ecological trap ▪ RSA is an attractive sink and a serious risk is present	▪ increased negative bear-human interactions	▪ wildlife fencing ▪ education and enforcement ▪ recreational amenities inside wildlife fencing including off-leash dog parks, trail system ▪ habitat enhancement in corridors ▪ attractant management ▪ low intensity development adjacent to corridor ▪ manage human access to wildlife corridors	▪ neutral to positive ▪ not expected to contribute adversely to the serious risk and high environmental consequence identified for grizzly bears identified under existing conditions ▪ beneficial for grizzly bears when compared to developing the approved 2004 Resort Centre ASP without a fence	Section 5.6.2 Table 21
Cougars	▪ self-sustaining and ecologically effective populations are likely present ▪ connectivity between habitat patches does not appear to be constrained ▪ commonly found close to development in habitat patches and movement corridors	▪ increased negative cougar-human interactions ▪ habitat loss	▪ wildlife fencing ▪ education and enforcement ▪ recreational amenities inside wildlife fencing including off-leash dog parks, trail system ▪ low intensity development adjacent to corridor ▪ manage human access to wildlife corridors	▪ neutral ▪ no increase in negative cougar human interactions expected ▪ loss of 102 ha of selected habitat, i.e., 2% of this habitat class in the RSA ▪ not expected to change the self-sustaining and ecologically effective status of the population identified under existing conditions ▪ beneficial for cougars when compared to developing the approved 2004 Resort Centre ASP without a fence	Section 5.6.3 Table 24

Table 45: Summary of Existing Conditions, Environmental Risks Associated with the Project, Mitigation and Predicted Effects of the Project after Mitigation for Wildlife Valued Environmental Components.

Valued Environmental Component	Existing Conditions	Environmental Risks Associated with the Project	Mitigation	Predicted Effects of the Project after Mitigation	EIS Section Reference
Wolves	▪ stability of the regional wolf population is uncertain, but wolf packs overlapping the Bow Valley are subjected to a variety of mortality sources; ▪ development area and Along Valley Corridor is habitat that is somewhat avoided based on RSF modelling, very low levels of use reported in wildlife corridors and habitat patches ▪ low wolf use of the RSA was identified as a serious risk (precautionary assessment)	▪ reductions in corridor use ▪ habitat loss ▪ habituation increasing in response to higher levels of human use or to greater contact with human food sources.	▪ wildlife fencing ▪ attractant management ▪ education and enforcement ▪ recreational amenities inside wildlife fencing including dog parks, trail system ▪ low intensity development adjacent to corridor ▪ manage human access to wildlife corridors	▪ neutral to negative ▪ 41 ha of used as available wolf habitat will be lost, but deer and elk will also be excluded from the area; will likely be displaced elsewhere in the Bow Valley, potentially increasing the value of corridor habitats for wolves ▪ Small decline in habitat selection within approved corridors adjacent to the Project ▪ wildlife fence could benefit wolves by making prey, such as elk, more available ▪ not expected to contribute adversely to the serious risk and high environmental consequence identified for wolves under existing conditions ▪ beneficial for wolves when compared to developing the approved 2004 Resort Centre ASP without a fence	Section 5.6.4 Table 27

Table 45: Summary of Existing Conditions, Environmental Risks Associated with the Project, Mitigation and Predicted Effects of the Project after Mitigation for Wildlife Valued Environmental Components.

Valued Environmental Component	Existing Conditions	Environmental Risks Associated with the Project	Mitigation	Predicted Effects of the Project after Mitigation	EIS Section Reference
Elk	▪ population of 300-400 elk in the RSA is considered stable under existing conditions ▪ elk are habituated, occur at high population density, do not exhibit natural seasonal shifts in habitat use ▪ elk use urban areas to avoid predation risk; ▪ serious risk identified for elk because they have lost important ecological function in the RSA	▪ habitat low ▪ human conflicts in other developed areas of Canmore	▪ wildlife fencing ▪ education and enforcement ▪ recreational amenities inside wildlife fencing including dog parks, trail system ▪ habitat enhancement in corridors ▪ attractant management	▪ neutral ▪ not predicted to affect the self-sustaining status identified for the elk population or contribute adversely to serious risk related to reduced ecological function ▪ loss of 163 ha of selected habitat, i.e., 3% of this habitat class ▪ elk use of the wildlife corridors adjacent to the Project is not predicted to change ▪ improvement in ecological function possible for elk because fencing may cause them to increase use of natural habitats, which would result in greater exposure to their predators.	Section 5.6.5 Table 30

Table 46: Summary of Existing Conditions, Risks, Mitigation and Predicted Effects of the Project after Mitigation for Other Valued Environmental Components

Valued Environmental Component	Existing Conditions	Environmental Risks	Mitigation	Predicted Effects of the Project after Mitigation	EIS Section Reference
Vegetation ▪ Native vegetation ▪ ESAs	▪ 97.7 ha of 163.1 ha non-native cover types ▪ two natural wetlands - 0.9 ha ▪ 2.5 ha of riparian areas on Three Sisters Creek, scoured and banks reinforced as a result of 2013 flood ▪ no known occurrences of federally-listed plants ▪ weed species present	▪ disturbance and removal of native vegetation and ESAs ▪ accidental damage of native vegetation and ESAs associated with recreational use ▪ reduction of vegetation habitat quality through changes to hydrology, dust deposition and the introduction of contaminants ▪ introduction of weed species	▪ wetland avoidance or compensation, and maintaining established drainage patterns ▪ site-specific construction management environmental protection measures ▪ reclamation ▪ trail system inside the Project Boundary ▪ guidelines for maintenance standards for residual and planted vegetation	▪ Negative, low magnitude ▪ Maximum 12.1 ha of native treed cover lost ▪ Maximum 0.2 ha of riparian areas affected ▪ wetland and riparian community composition and structure may be affected	Section 6.1.5
Fish	▪ upper and lower portions of Three Sisters Creek are ephemeral ▪ Unlikely to be fish-bearing	▪ sedimentation effects could occur downstream on the Bow River	▪ site-specific construction management environmental protection measures ▪ development of approved Integrated Pest Management Plan to restrict chemical uses	▪ negative, low	Section 6.2.5
Soils and Terrain	▪ Soils are Orthic Eutric Brunisols and Orthic Gray Luvisols, poor to rapidly drained ▪ Topographic relief varies within the Project with approximately 55% of the area consisting of gentle slopes (0% to 11%) and 41% consisting of moderate slopes (12% to 44%)	▪ increased erosion and/or loss of soil, soil compaction, soil admixing or mass movement ▪ terrain stability over old mine workings areas	▪ site-specific construction management environmental protection measures including erosion and sediment control plan ▪ reclamation, use of stored soils salvaged from other areas in Canmore to improve reclamation success ▪ Canmore Undermining Review Regulation AR114/97	▪ Negative, low ▪ maximum of 104.3 ha permanent loss of native soil	Section 6.3.5

Table 46: Summary of Existing Conditions, Risks, Mitigation and Predicted Effects of the Project after Mitigation for Other Valued Environmental Components

Valued Environmental Component	Existing Conditions	Environmental Risks	Mitigation	Predicted Effects of the Project after Mitigation	EIS Section Reference
Surface and Groundwater	▪ drained by Three Sisters Creek which is ephemeral ▪ influenced by the Benchlands Aquifer system, high infiltration capacity as well as high groundwater flows , extensively affected by undermining	▪ Increased stormwater runoff ▪ High groundwater flow episodes ▪ groundwater contamination ▪ grout or mortar (i.e., paste) material may locally impede ground water flow.	▪ site-specific construction management environmental protection measures including erosion and sediment control plan ▪ development and implementation of a site-specific stormwater management plan ▪ paste also rarely goes all the way to the top of the void so there is still room for water flow above the paste infill	▪ Negative, negligible	Section 6.4.5
Air	▪ Bow Valley's ambient air quality levels are good, generally below Alberta's Ambient Air Quality Objectives	▪ temporary reduction in air quality during construction	▪ site-specific construction management environmental protection measures including dust control ▪ produce concrete and asphalt off-site	▪ negative, low during construction only	Section 6.5.5
Visual Resources	▪ high quality visual resources include Three Sisters Creek, mature forest stands, and views of surrounding mountain peaks, including the Three Sisters.	▪ If buildings associated with the Project are constructed in a manner that is inconsistent with the Town's MDP, there is a risk that visual resources could be adversely affected.	▪ reclamation ▪ apply architectural standards and designs ▪ avoid obstruction of key viewsheds where possible ▪ apply appropriate downcast exterior lighting	▪ negative for the development as a whole relative to a natural state, but neutral for the amendment ▪ low magnitude effect	Section 6.6.5

Table 46: Summary of Existing Conditions, Risks, Mitigation and Predicted Effects of the Project after Mitigation for Other Valued Environmental Components

Valued Environmental Component	Existing Conditions	Environmental Risks	Mitigation	Predicted Effects of the Project after Mitigation	EIS Section Reference
Historic Resources	▪ rich in historic resources; some historic resources may already have been mitigated	▪ Historic resources (i.e., palaeontological, prehistoric and archaeological sites and historic period features) are non-renewable resources, which are highly vulnerable to alteration, destruction or damage due to development activity	▪ 1992 letter outlining the Historical Resource Act requirements is considered an appropriate guideline for mitigation measures including: ▪ avoidance of historic period feature A06 ▪ conducting detailed recording and documentation of all historic period features ▪ excavation at the identified historic period midden	▪ negative, negligible	Section 6.7.5

8.0 CLOSURE

We trust that the information included in this report meets your present requirements. If you have any questions or require additional details, please contact the undersigned.

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APPENDIX A

Terms of Reference: Environmental Impact Statement (EIS) for an Application to Amend the Resort Centre ASP in Three Sisters Mountain Village

Terms of Reference

Environmental Impact Statement (EIS) for an Application to Amend the Resort Centre ASP in Three Sisters Mountain Village

1.0 Introduction

1.1 Planning Context

The Resort Centre Area Structure Plan (ASP) was approved by the Town of Canmore in 2004. It encompasses an area of approximately 303 ha (750 acres) of land in the Three Sisters Mountain Village area. The only development that has commenced in the Resort Centre ASP area is the golf course. By 2007, 15 of the 18 holes of the golf course had been partially constructed. Construction on the golf course was then halted and the lands went into receivership in 2009. No further development has taken place on the lands since. The current landowners of the Resort Centre lands are proposing to amend the ASP by redeveloping the unfinished golf course into additional resort core, resort accommodation, residential and recreational uses.

1.2 Requirement for EIS

The Town of Canmore's Municipal Development Plan requires that an Environmental Impact Statement (EIS) be prepared for an application to amend an ASP and that an independent third party review of the EIS be conducted by the Town. The preparation of an EIS is outlined in the Town's Environmental Impact Statement Policy. Prior to preparing the EIS, the Town must prepare a Terms of Reference and obtain input from a qualified third party reviewer.

1.3 Approval Authority

Under the *NRCB Act*, Three Sister's Golf Resorts Inc. applied for approval to develop a recreational and tourism project within the town of Canmore. An Environmental Impact Assessment (EIA) was prepared and submitted to the NRCB, and in 1992 the NRCB released a Decision Report #9103. The approval permitted Three Sisters Golf Resorts to develop golf courses, residential neighbourhoods and supporting commercial infrastructure. The approval was subject to the owner of the Three Sisters lands incorporating provision for wildlife movement corridors into its detailed design. Condition #14 of the Decision requires Three Sisters to "incorporate into its detailed design, provision for wildlife movement corridors in as undeveloped state as possible, and prepare a wildlife aversion conditioning plan, both satisfactory to Alberta Forestry, Lands and Wildlife". Since 1992, development has proceeded in stages and the Three Sisters Golf Resorts property has changed ownership several times.

As outlined in Condition #4 of the NRCB Decision, the Town of Canmore has planning authority regarding the "detailed timing and the specific land uses and population densities" of the Three Sisters lands. While the wildlife corridor designation is under the jurisdiction of the Province, development adjacent to the corridors is within the scope of approval by the Town of Canmore.

2.0 Purpose of the EIS

The purpose of the EIS is to provide sufficient information to Council in order to make an informed decision on the application to amend the Resort Centre ASP. The EIS will outline existing conditions, identify significant natural and ecological features, determine the nature and scale of the potential impacts generated by the proposal, provide recommendations for how to best avoid or mitigate those impacts, identify residual impacts and their significance, and recommend further studies or monitoring to be undertaken through the course of implementation.

3.0 Scope

Extensive bodies of literature and studies exist for the Three Sisters Lands, some of which are as a result of previous approvals or proposals. The applicability of these reports will be evaluated during the preparation of the EIS. Biophysical information was originally compiled in support of the NRCB Decision Report Application #9103 for the property. Since that time, a number of studies and monitoring programs have been conducted, including those by Chinook Co., Golder Associates Ltd. (Golder), university researchers, and Alberta Environment and Sustainable Resource Development (ESRD) and its predecessors. The accumulated data along with most recent scientific thought will form the basis of the EIS. In addition to existing information, additional site-specific data will be gathered during a reconnaissance level survey to ground truth existing information.

The EIS will be based on an understanding of available information on environmental resources from the ASP area, surrounding environments and identified linkages to the proposed development.

The EIS for the application to amend the Resort Centre ASP will contain, at a minimum:

1) Proposal Overview
    a. A description of the proposal.
    b. Mapping of the proposal (regional and site-specific within the project boundary).
    c. Overview of the municipal planning policy context.
    d. Identification of Federal or Provincial legislative requirements/approvals.

2) Existing Site Conditions
    a. Identification of previous relevant literature/studies.
    b. A description and mapping of existing environmental conditions, including:
        i. Soils, landforms and surficial geology,
        ii. Hydrological or hydrogeological resources, including wetlands,
        iii. A biophysical inventory and analysis of terrestrial and aquatic communities and the relationship to the local and regional ecosystem, and
        iv. A summary of the natural features and components, and the proposed criteria to be applied for evaluation of their significance.
    c. Examination of similar proposals in similar site conditions, and environmental impact studies undertaken and mitigations therein.

3) <u>Valued Environmental Components</u>

   a. Science-based analysis of the impacts of the proposal on the following Valued Environmental Components:
      i. Fish and associated aquatic habitat,
      ii. Wildlife and associated terrestrial habitat,
      iii. Terrestrial and aquatic vegetation,
      iv. Soils and terrain,
      v. Groundwater,
      vi. Surface water,
      vii. Air quality,
      viii. Historical resources, and
      ix. Visual resources.

4) <u>Impact Criteria</u>

   a. Impact criteria to be considered for each Valued Environmental Component.
      i. Nature,
      ii. Duration,
      iii. Magnitude,
      iv. Direction,
      v. Spatial extent,
      vi. Reversibility, and
      vii. Likelihood.

5) <u>Specific Analyses to be Considered</u>

   a. Human-use impacts on wildlife populations and habitat.
   b. Alternatives and modifications to the proposal to limit or remove impacts.
   c. An evaluation of whether the form of the development/proposal can be accommodated given any identified ecological sensitivities or constraints, including land use type and intensity of the proposed development.
   d. Analysis of the cumulative impacts of the proposal considering the impacts of adjacent development.
   e. Environmental impacts due to undermining, including on ground and surface water.

6) <u>Mitigations, Recommendations & Conclusions</u>

   a. Provide recommendations for how to reduce, avoid or mitigate negative impacts or build on positive impacts.
   b. Specific recommendations on how to mitigate long term human use impacts resulting from the proposal.
   c. Identification of residual impacts and criteria proposed to evaluate their significance.
   d. Identify monitoring requirements, and whether more extensive environmental work is required.

The scope of the EIS will generally be limited to the level of detail provided within an Area Structure Plan. The EIS must identify where further detailed work is required or anticipated at later planning stages.

The scope of the EIS will not include an assessment of the wildlife corridor dedication as this is under the authority of the Province under the direction of the NRCB decision; however, wildlife corridors are a valid municipal planning issue and the environmental review will need to consider the impact that development proposed adjacent to wildlife corridors will have on the functionality of the wildlife corridor.

4.0 EIS Report

The report will contain all information required by this Terms of Reference. The format of the report will include mapping, tables and supporting text.

5.0 Review of EIS

The EIS Policy requires that this EIS Terms of Reference and the resulting EIS are reviewed by an independent qualified third party that reports directly to the Town. The EIS Policy also requires that the third party reviewer be involved from the beginning of the process, however, the Town acknowledges that the EIS for the Resort Centre ASP amendment application was in a near complete state when the new EIS policy was adopted. Therefore, the Town and its third party reviewer will work with the applicant’s consultant to update and revise the EIS as may be necessary through the review process. As questions arise or incremental work is produced by the Town or its consultant, it will be provided to the applicant and their consultant for consideration. Where significant changes are proposed to the EIS, the project or recommended mitigation strategies through the EIS review process, the applicant’s consultant will produce an updated EIS that reflects these changes.

The EIS must be submitted and reviewed by the Town’s third party reviewer prior to First Reading of the ASP by Council.

The Town may also refer the EIS to other agencies or committees for comment, including but not limited to the Province of Alberta and Canmore’s Environmental Advisory Review Committee (EARC).

APPENDIX B

Modeling Methods

1.0 INTRODUCTION

This appendix presents the methods employed to develop the resource selection functions (RSFs) that were used to help describe existing conditions and predict effects of the Resort Center ASP amendment, Smith Creek ASP, and other reasonably foreseeable developments on grizzly bears, wolves, elk and cougars. This appendix first presents the methods and results of RSF development from telemetry data (Section 2), and then describes how human use of recreational trails was incorporate into these models (Section 3).

The application of the models differs from previous applications because models were run using landscape variables updated to reflect conditions in 2016 (e.g., to incorporate new development and new trails) and were run using footprints provided for the Resort Centre ASP amendment and Smith Creek ASPs to predict future conditions. In addition, because the unfinished golf course on the Resort Centre is not managed or used like other golf courses in Canmore, the designation was changed from one of "golf course greens, tees, and fairways" (Golder 2012) to "herbaceous grassland" for application of the models to all analyses undertaken for the Resort Centre ASP amendment and Smith Creek ASP. This change was made to more accurately reflect the ecological conditions and types of human use that occur on the abandoned golf course.

2.0 RESOURCE SELECTION FUNCTIONS

An RSF uses empirical data to provide an unbiased estimate of relative probability of selection by an organism (Manly et al. 2002). Key benefits of RSFs are that they use spatial data collected from wildlife to provide quantitative (as opposed to qualitative) habitat models, they are easily implemented using standard statistical techniques, and information theory can be used for model selection or inference (Manly et al. 2002, Burnham and Anderson 2002). For these reasons, RSFs are increasingly used to assess wildlife habitat relationships (Johnson et al. 2004; Lemaitre and Villard 2005; Psyllakis and Gillingham 2009; Richardson et al. 2005; Sawyer et al. 2006).

Models were developed for four large mammals: grizzly bears, wolves, elk, and cougars. These species were chosen because:

- discussions with the Town of Canmore and Fiera Biological Consulting Ltd. indicated that these species would adequately address the primary concerns associated with the proposed development, which include changes in the way wildlife use approved wildlife corridors and changes in negative human-wildlife interactions;
- as charismatic megafauna, these species maintain a significant socio-political profile and are among the species for which the greatest concern is voiced by the conservation community in the Bow Valley;
- these species are among those most prevalently considered by previous researchers in the Bow Valley (NRCB 1992, BCEAG 1999a, Herrero and Jevons 2000, Jacques Whitford AXYS 2008, Chetkiewicz and Boyce 2009, Alberta Tourism Parks and Recreation 2010, Golder 2012, Golder 2013), ensuring that the results of this study will be comparable to previous work; and
- telemetry data were available in the Bow Valley for these four species to permit developing empirical models of habitat selection.

2.1 Methods

2.1.1 Modelling Approach

The used available approach described by Manly et al. (2002) was employed to develop the RSFs used for this EIS. In this design, used sites are compared to random samples of available locations generated in a Geographical Information System [GIS] environment using logistic regression. Because available samples are not the same as unused locations, predictive output yields a relative as opposed to absolute probability of selection (Manly et al. 2002). Thus, although the model cannot indicate the actual probability that a particular landscape will be selected by an animal, it does describe how much more or less likely a particular habitat patch may be selected than a neighbouring patch, or one across the valley (Pearce and Boyce 2006).

Although sample contamination (i.e., the potential for randomly generated available points also to be used points) has been raised as a potential problem in used-available designs and some authors discourage their application as a result (Keating and Cherry 2004), recent analyses confirm that contamination is generally insufficient to significantly bias RSF output for used-available designs (Johnson et al. 2006). More importantly, Johnson et al. (2006) show how to avoid the contamination issue completely by using the logistic regression model to estimate coefficients for the exponential discriminant function. From this function, the selection ratio for any particular values of predictor covariates is obtained, reinforcing the validity of applying a used-available approach to RSF estimation.

To develop a used-available RSF model depicting relative probability of selection across a landscape, coefficients estimated for each habitat variable using logistic regression are inserted into the following log-linear selection model proposed by Manly et al. (2002):

$$w(x) = \exp(\beta_1 x_1 + \ldots \beta_n x_n)$$

where *w(**x**)* represents the relative probability of selection of a habitat by a species, β_n represent regression coefficients estimated from the logistic regression model and x_n represent values for the n^{th} habitat variable in a given patch. RSF values were generated for each pixel in a raster landscape using this equation (Manly et al. 2002, Nielsen et al. 2004, Chetkiewicz and Boyce 2009).

2.1.2 Season

To produce conservative estimates selection within wildlife corridors, RSF models were developed for each indicator species during the season when that species has been shown to be most restricted to low elevation habitat and shallow slopes. Wildlife movements are more likely to be impeded by development in the valley bottom during these periods. For grizzly bears in the Bow Valley, this occurs during summer (16 June to 10 August), after bears leave denning habitat at high elevation and move down to the valley bottom and before they move back upslope to access berry crops and alpine vegetation in fall (Chetkiewicz and Boyce 2009). Bears are presumably attracted to lower elevations during summer to forage on abundant green vegetation and also to prey on ungulate young. Habitat suitability models for bears were therefore developed for summer using cut-off dates (16 June to 10 August) defined by Chetkiewicz and Boyce 2009.

Habitat use by elk, wolves, and cougars, on the other hand, is most restricted to valley bottoms during winter when snow and ice at higher elevations cause these animals to congregate at lower elevations and on south facing slopes where snow depth is lower (Alexander 2001, Duke 2001, Callaghan 2002, Paquet and Carbyn 2003, Hohler

2004, Whittington et al. 2005, Alexander et al. 2006, Chetkiewicz and Boyce 2009). Thus, habitat suitability models for these species were developed for winter. For the purposes of this study, winter was defined as 15 November to 15 April, again following Chetkiewicz and Boyce (2009).

2.1.3 Spatial Data

Three types of spatial data are required to estimate an RSF:

- locations used by wildlife;
- a random sample of locations across the landscape; and
- spatially explicit depictions of habitat features that can be linked to the used and available location data.

Scale is an important consideration for RSF model development (Boyce 2006), and the scale of interest in this study was the Bow Valley. The area over which spatial data were obtained for RSF modelling was that part of the Bow Valley beginning near the Town of Banff and stretching south-east to where the Bow River flows out of the Rocky Mountains approximately 20 km east of Canmore (Figure B-1).

2.1.3.1 Telemetry Data

Use locations for grizzly bears, wolves, elk, cougars, were generated using either VHF or GPS wildlife telemetry collars deployed on a sample of animals from each species in the Bow Valley. Use and availability data were drawn from the polygons shown in Figures B-2 to B-5 to ensure that this scale was reflected in RSF models. Although individual animals used to estimate the RSFs for this study often traveled out of the Bow Valley, these data were not used in RSF modeling, ensuring that habitat suitability models reflect wildlife habitat use patterns only when animals are present in the Bow Valley.

Grizzly bear data came from five individuals (three males and two females) collared during 2000-2008 with Televilt-Simplex collars programmed to acquire a fix either every 1 or 2 hours, yielding 2,913 locations (Figure B-2). The number of locations for each bear were 30, 590, 405, 1264, and 624. A total of 797 wolf use locations were obtained during winter from 22 VHF collared wolves during 1988-2003 (Figure B-3). Number of locations for individual wolves varied between 1 and 142. Elk locations were obtained during winter from 11 animals collared with VHF collars during 2000-2003 (189 locations) and 4 GPS collared animals wearing Telonics (Messa, Arizona) collars during 2009 (9,874 locations; Figure B-4). GPS collared elk yielded 1385, 3381, 3583, and 1525 locations each. Cougar location data were derived from 5 individuals collared with Televilt-Simplex GPS radiocollars (Lindesberg, Sweden) programmed to obtain a fix either every 1 or 4 hours during 2000-2004. A total of 2,285 cougar locations were obtained during winter (Figure B-5) and these were distributed fairly evenly among individuals (536, 640, 720, 194 and 195 locations each).

Telemetry data for individual animals were pooled to develop population-level models. This is the simplest approach to RSF estimation and was chosen because it suited the available data and could be easily applied and interpreted. Alternate approaches include mixed-effects models, and models estimated for each individual animal in the sample and subsequently taking the mean coefficient value to obtain a population model (Gillies et al. 2006, Fieberg et al. 2010). Pooling data from different animals means that individuals contributing more location data to the model will have greater influence on population level coefficient values.

Although random effects models can account for this potential problem and might improve model fit (Gillies et al. 2006), problems with specifying correlation structure (Fieberg et al. 2010) and challenges associated with interpreting the output of random effects models were deemed to outweigh the potential benefits of their application. In addition, small sample sizes for some animals meant that they would have more influence on the models than the amount of data (i.e., <30 locations) could justify (Fieberg et al. 2010). Combining coefficients from models developed for each individual animal to obtain population-level coefficients for RSFs has recently been advocated as an alternative, but this approach also was not appropriate because of small numbers of locations obtained for some collared animals (Fieberg et al. 2010).

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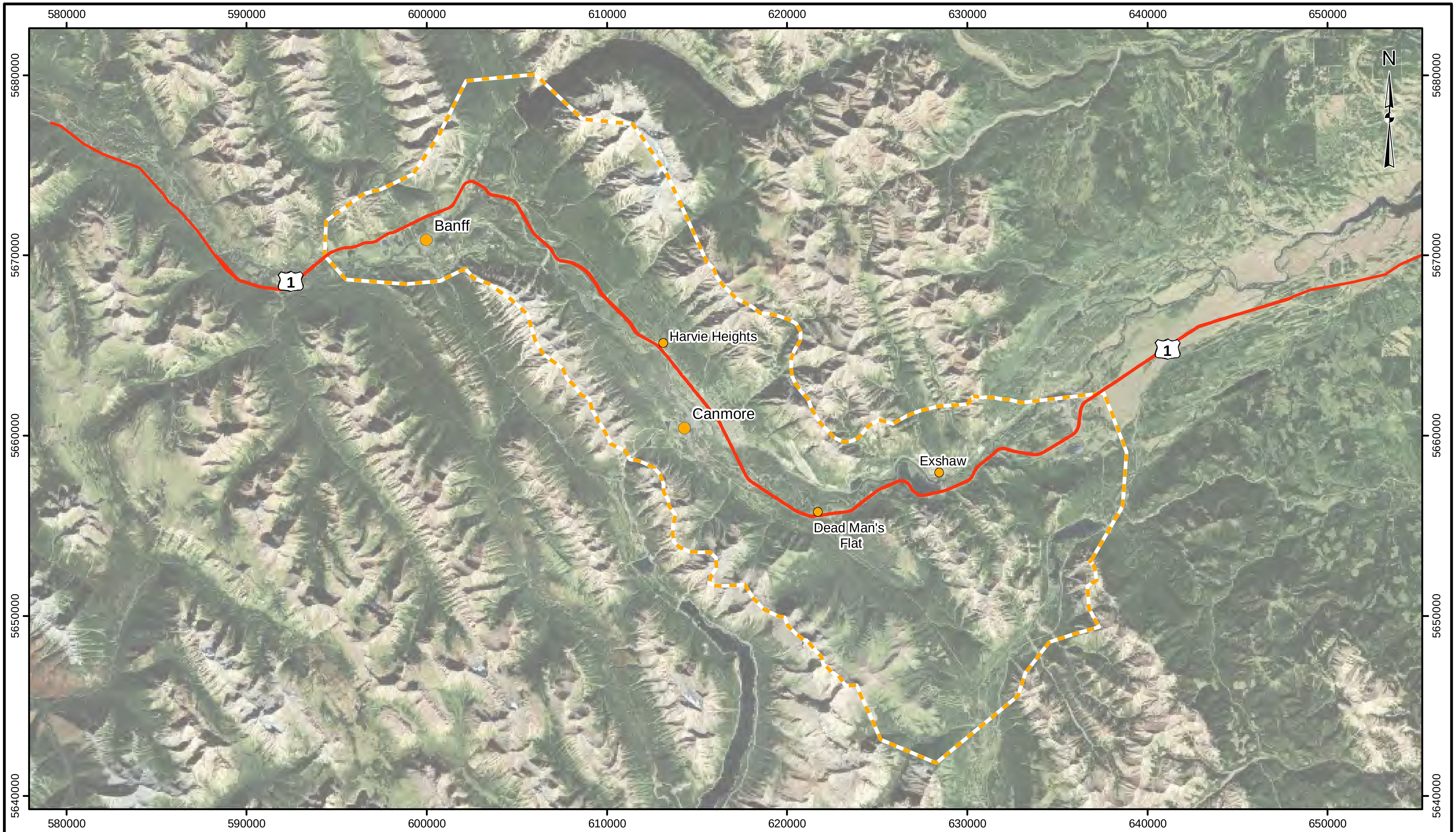

LEGEND

- TOWNS AND HAMLETS
- RSF MODELING EXTENT

REFERENCE

Imagery obtained from Bing Maps, May 2010.
Projection: UTM Zone 11 Datum: NAD 83

10 0 10
SCALE 1:300,000 KILOMETRES

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

QUANTUMPLACE DEVELOPMENTS LTD.

TITLE

RSF MODELLING EXTENT

Golder Associates
Calgary, Alberta

PROJECT NO.1539221			SCALE AS SHOWN	REV. 2
DESIGN	KK	14 May 2010	FIGURE: B-1	
GIS	GM	18 Jan. 2011		
CHECK	MG	07 Mar. 2017		
REVIEW	MGJ	07 Mar. 2017		

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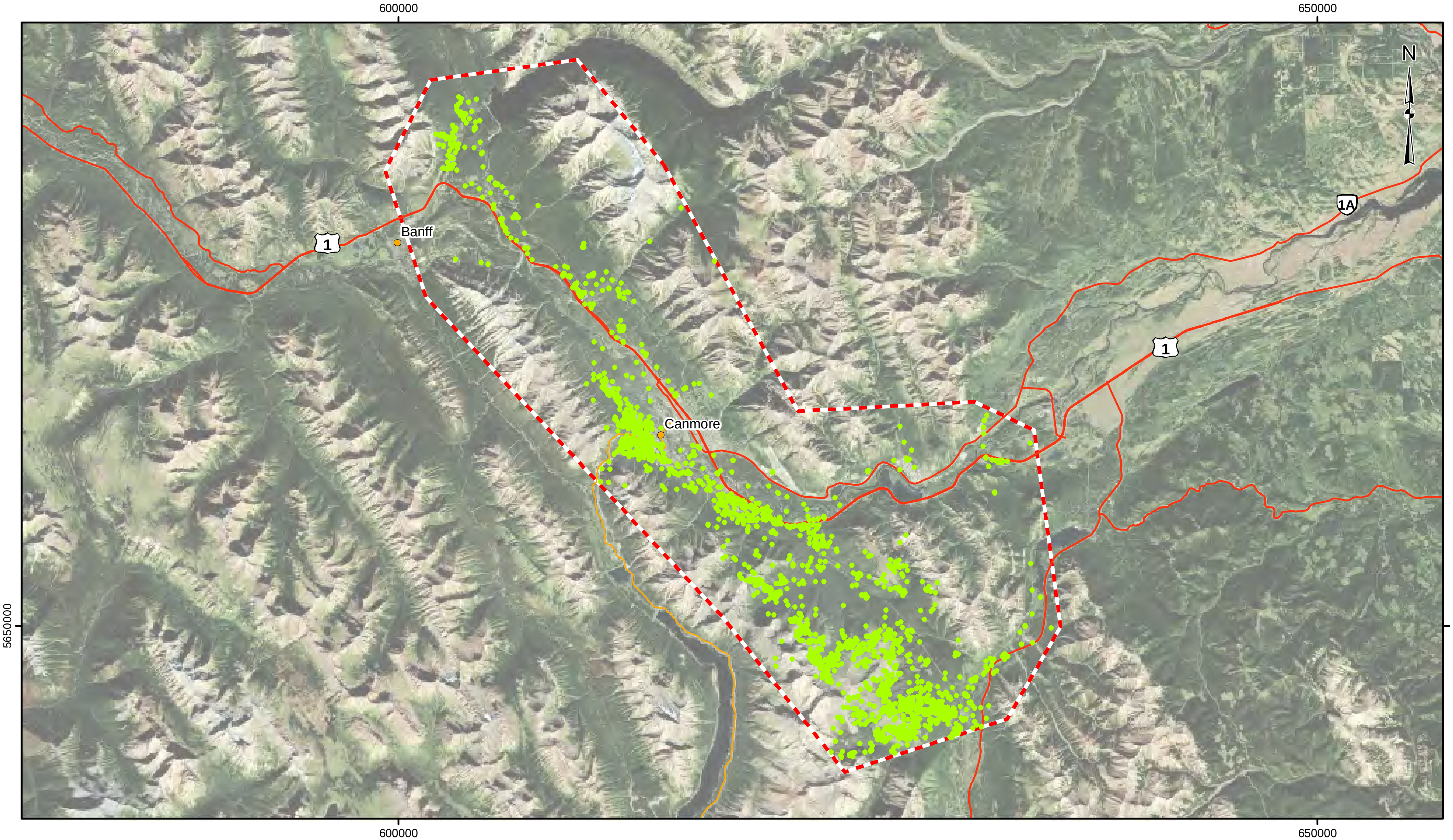

LEGEND

- TOWNS AND HAMLETS
- TELEMETRY LOCATION
- AVAILABILITY EXTENT

TRANSPORTATION FEATURES

- PRIMARY HIGHWAY
- SECONDARY HIGHWAY

10 0 10

SCALE 1:300,000 KILOMETRES

REFERENCE

Imagery obtained from Bing Maps, May 2010. Alberta digitial data obtained from DMTI Spatial Inc., June 2008. Used under license.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

QUANTUMPLACE DEVELOPMENTS LTD.

TITLE

GRIZZLY BEAR TELEMETRY LOCATION DATA

Golder Associates
Calgary, Alberta

PROJECT NO. 1539221			SCALE AS SHOWN	REV. 2
DESIGN	KK	14 May 2010	FIGURE: B-2	
GIS	GM	20 Jan. 2011		
CHECK	MG	07 Mar. 2017		
REVIEW	MGJ	07 Mar. 2017		

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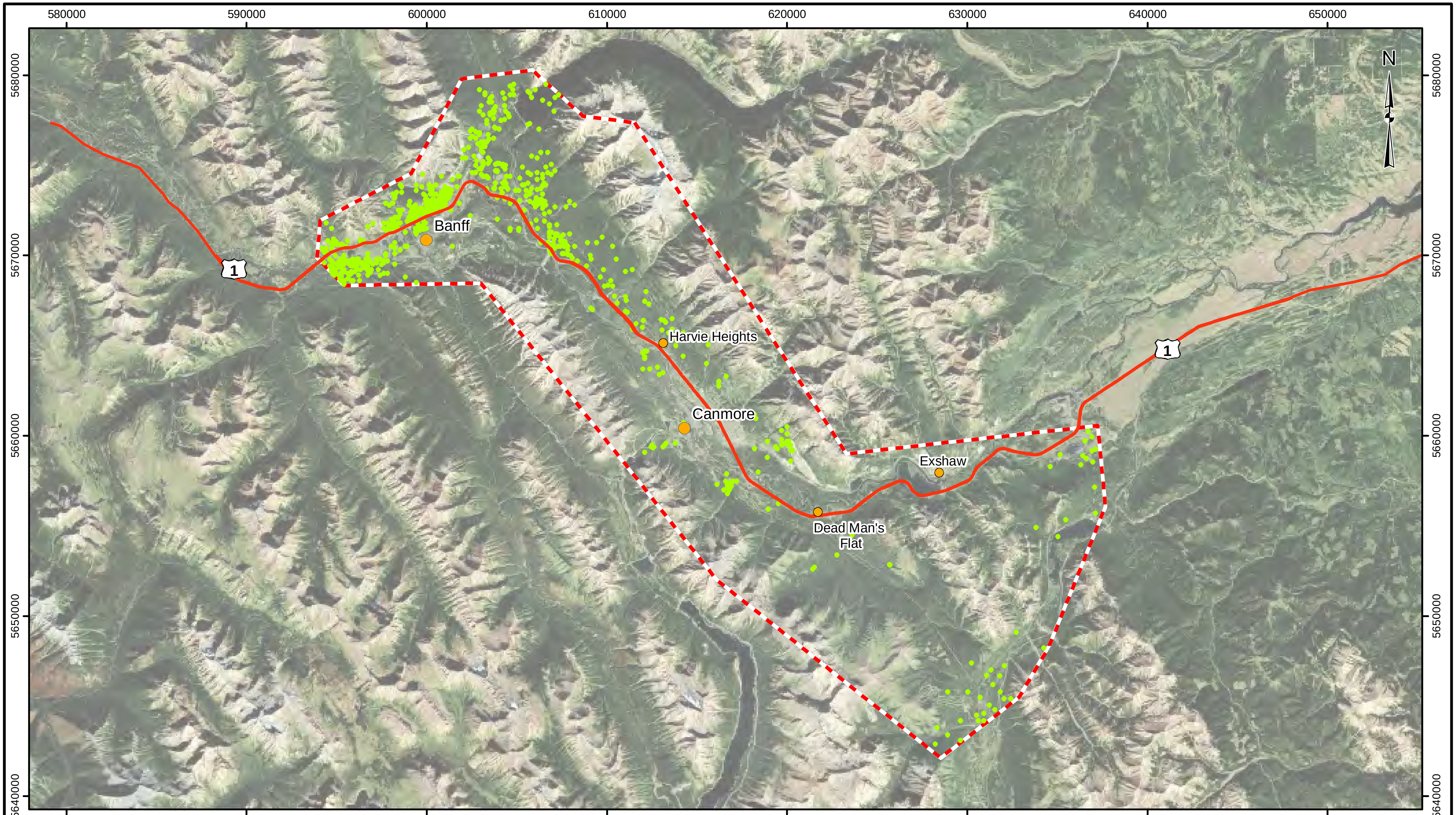

LEGEND

- TOWNS AND HAMLETS
- TELEMETRY LOCATION
- AVAILABILITY EXTENT

REFERENCE

Imagery obtained from Bing Maps, May 2010.
Projection: UTM Zone 11 Datum: NAD 83

10 0 10

SCALE 1:300,000 KILOMETRES

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

QUANTUMPLACE DEVELOPMENTS LTD.

TITLE

WOLF TELEMETRY LOCATION DATA

Golder Associates
Calgary, Alberta

PROJECT NO. 1539221			SCALE AS SHOWN	REV. 2
DESIGN	KK	14 May 2010	FIGURE: B-3	
GIS	GM	20 Jan. 2011		
CHECK	MG	07 Mar. 2017		
REVIEW	MGJ	07 Mar. 2017		

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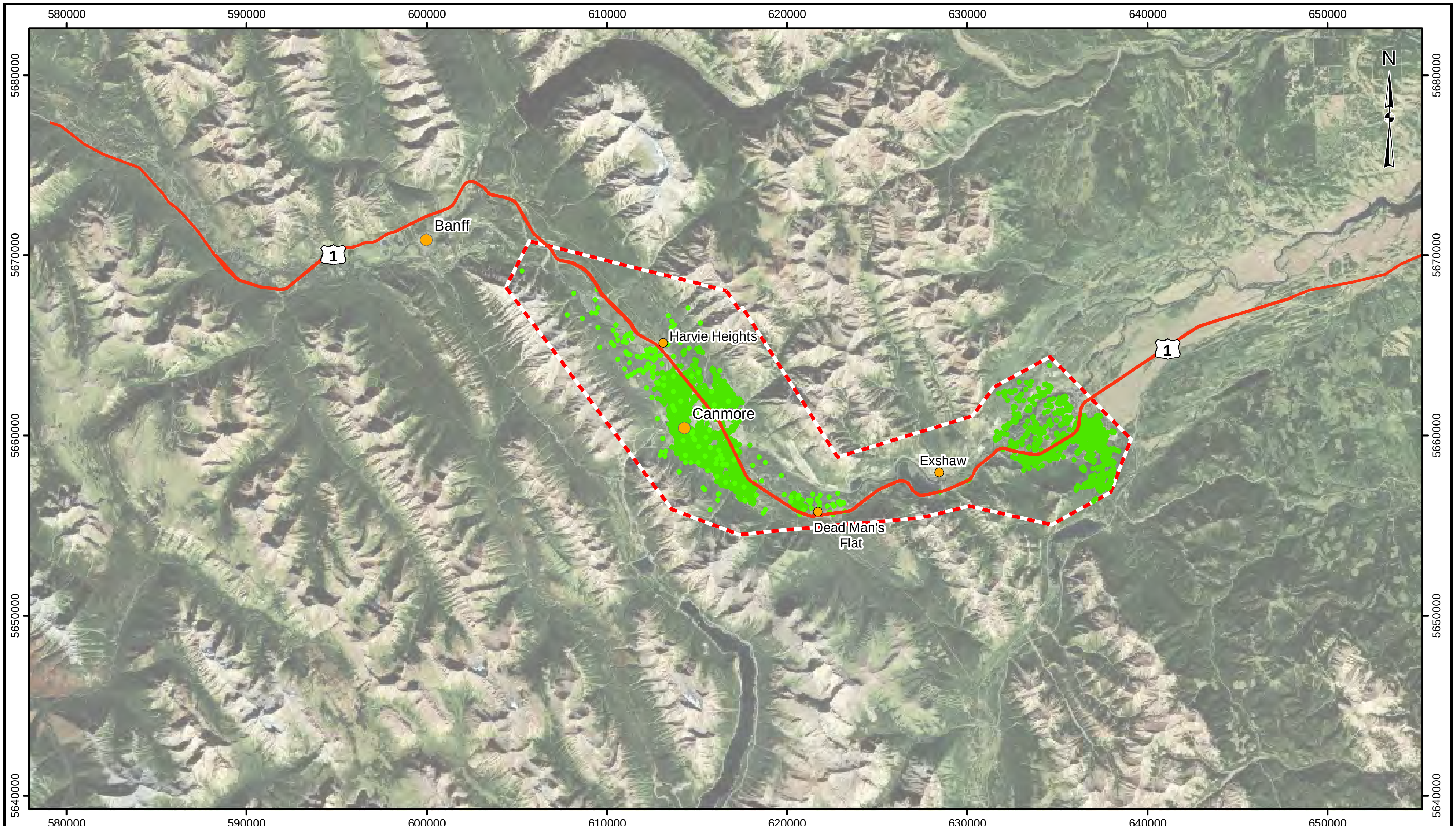

LEGEND

- TOWNS AND HAMLETS
- TELEMETRY LOCATION
- AVAILABILITY EXTENT

10 0 10

SCALE 1:300,000 KILOMETRES

REFERENCE

Imagery obtained from Bing Maps, May 2010.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

QUANTUMPLACE DEVELOPMENTS LTD.

TITLE

ELK TELEMETRY LOCATION DATA

Golder Associates
Calgary, Alberta

PROJECT NO. 1539221			SCALE AS SHOWN	REV. 2
DESIGN	KK	21 May 2010	FIGURE:B-4	
GIS	GM	20 Jan. 2011		
CHECK	MG	07 Mar. 2017		
REVIEW	MGJ	07 Mar. 2017		

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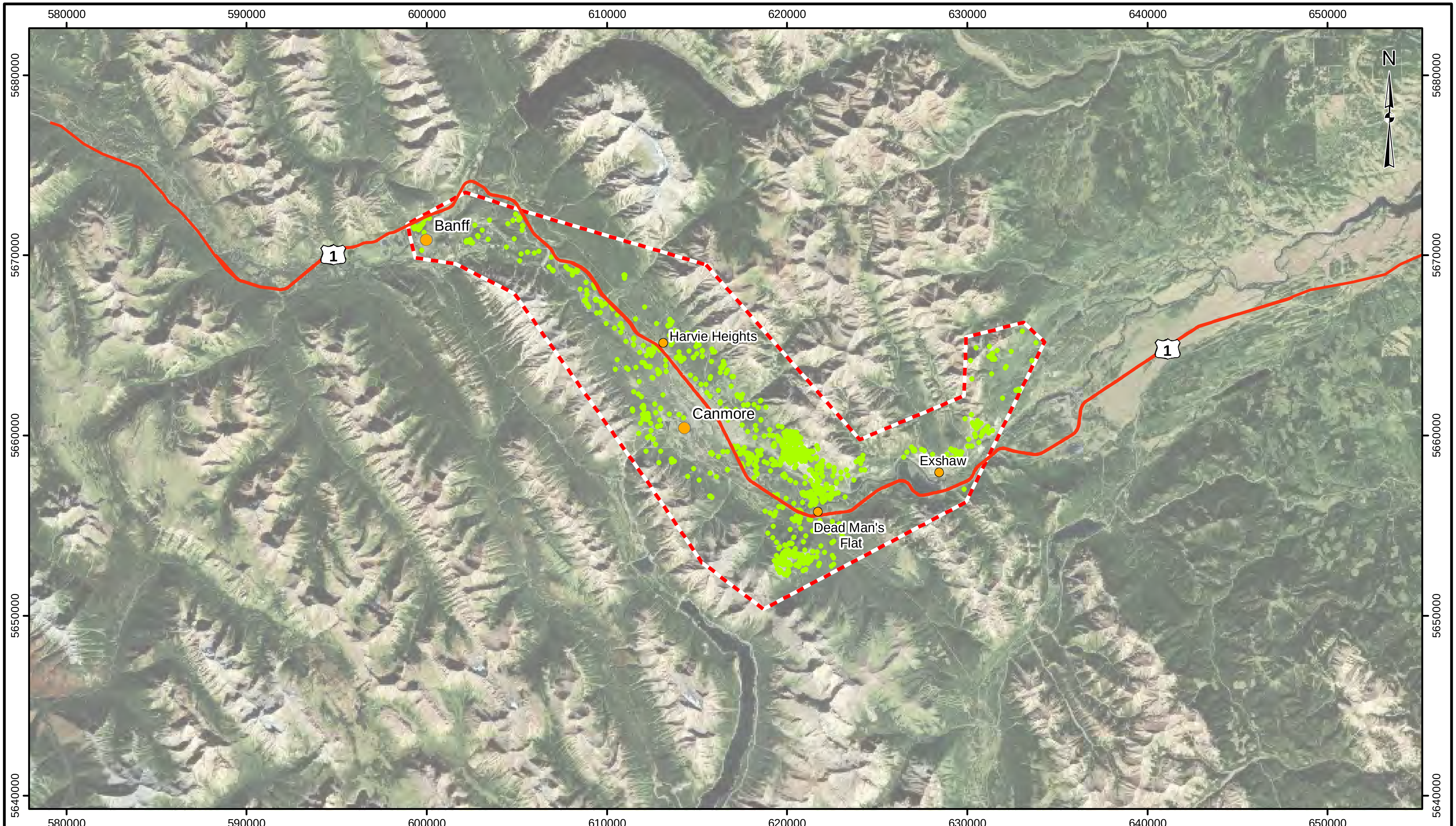

LEGEND

- TOWNS AND HAMLETS
- TELEMETRY LOCATION
- AVAILABILITY EXTENT

10 0 10

SCALE 1:300,000 KILOMETRES

REFERENCE

Imagery obtained from Bing Maps, May 2010.
Projection: UTM Zone 11 Datum: NAD 83

PROJECT

RESORT CENTRE ASP AMENDMENT EIS

QUANTUMPLACE DEVELOPMENTS LTD.

TITLE

COUGAR TELEMETRY LOCATION DATA

Golder Associates
Calgary, Alberta

PROJECT NO. 1539221			SCALE AS SHOWN	REV. 2
DESIGN	KK	14 May 2010	FIGURE: B-5	
GIS	GM	20 Jan. 2011		
CHECK	MG	07 Mar. 2017		
REVIEW	MGJ	07 Mar. 2017		

2.1.3.2 Availability Data

Availability data were sampled to characterize the landscape using a random point generator in ArcGIS (version 9.3.1). Points were generated at a sampling intensity of five random locations per square kilometre (km^2) following Nielsen et al. (2004) and Chetkiewicz and Boyce (2009). For all species, random locations to characterize the available landscape were generated only within the polygons delineating use locations within the Bow Valley (Figures B-2 to B-5).

All grizzly bears used in this analysis crossed the Trans-Canada Highway, suggesting that the preponderance of grizzly bear locations on the south side of the Bow Valley is driven by high-quality landscape characteristics and not because bears were unable to move across the valley, justifying incorporating the less-frequently used north side of the valley as habitat available to bears (Figure B-2).

2.1.3.3 Habitat Layers

Used and available locations were intersected with habitat layers developed in a GIS environment to accommodate RSF estimation. All spatial analyses were conducted using ArcGIS version 9.3.1 and the pixel size for all vegetation, terrain, and human use layers was 25 m x 25 m.

Vegetation classification was derived from the Canadian Forest Service's Earth Observation for Sustainable Development of Forest (EOSD) land cover classification (SAFORAH, website). Some EOSD classes were collapsed into ecologically similar categories prior to analysis (Table 1). Where EOSD classified habitat as Shadow, Cloud, or No Data, visual interpretation of high resolution satellite imagery was used to reclassify pixels to the appropriate habitat class. Most unclassified habitat occurred high on the mountains surrounding the Bow Valley where satellite imagery indicated it could be reclassified as rock/rubble or dense conifer. Edges between forests and other habitat types also can be important habitats for some wildlife species and a forest edge layer was created using a buffer 1 pixel wide on either side of the coniferous, broadleaf and mixed wood forest types (total width = 50 m). The landscape also was divided into alpine, subalpine, or montane vegetation communities using the provincial natural regions and sub-regions data; each generalized vegetation community category encompassed several habitat types.

Human development (e.g., buildings, golf courses, mines) also were digitized based on visual interpretation of high-resolution satellite imagery, and linear disturbance (e.g., roads, trails, and railways) were obtained from the Government of Alberta and Banff National Park. Polygons of built-up areas and golf courses were stamped onto the EOSD classification as distinct habitat types (Table B-1).

In addition to data on vegetation cover and human use, GIS layers depicting terrain features also were obtained. Elevation, slope, and a terrain ruggedness index (TRI) were calculated using a Digital Elevation Model (DEM). The TRI was obtained from the DEM using the TRI.aml script in ArcGIS, which conforms to the approach described by Riley et al. (1999). Each pixel in the GIS also was assigned a binary value identifying it as south facing (157.5° – 202.5°) or not, again using the DEM. Greeness was calculated using a tasseled cap transformation from thematic imagery (Franklin 2001).

Although snow might be an important determinant of wildlife habitat suitability during winter, snow depth can vary dramatically both spatially and temporally during winter and these fine-scale data were unavailable. However, south-facing slopes and elevation may account for some of the variation in snow depth.

Table B-1: Land Cover, Development, and Terrain Classifications used for RSF Modelling

Classification for Modelling	EOSD Classification	Description
N/A (reclassified)	no data	No data – unknown reason
N/A (reclassified)	cloud	No data – image obscured by cloud cover
N/A (reclassified)	shadow	No data – image obscured by shadow
water	water	Lakes, reservoirs, rivers, or streams
nonveg	snow/ice	includes glacier, snow, or ice
nonveg	rock/rubble	Bedrock, rubble, talus, blockfield, rubbley mine spoils, or lava beds
nonveg	exposed land	River sediments, exposed soils, pond or lake sediments, reservoir margins, beaches, landings, burned areas, road surfaces, mudflat sediments, cutbanks, moraines, gravel pits, tailings, or other non-vegetated surfaces
shrub	shrub tall	At least 20% ground cover which is at least one-third shrub; average shrub height greater than or equal to 2 m
wet_shrub	wetland-shrub	Land with a water table near/at/above soil surface for enough time to promote wetland or aquatic processes; the majority of vegetation is tall, low, or a mixture of tall and low shrub
herb	herb	Vascular plant without woody stem (grasses, crops, forbs, gramminoids); minimum of 20% ground cover or one-third of total vegetation must be herb
conif_dens	coniferous dense	Greater than 60% crown closure; coniferous trees are 75% or more of total basal area
conif_open	coniferous open	26-60% crown closure; coniferous trees are 75% or more of total basal area
br_leaf	broadleaf dense	Greater than 60% crown closure; broadleaf trees are 75% or more of total basal area
mixwood	mixed wood dense	Greater than 60% crown closure; neither coniferous nor broadleaf tree account for 75% or more of total basal area
montane	N/A	Occurring in the Montane subregion of the Rocky Mountain Natural Region (NRC 2006)
forest_edge	N/A	50m edge adjacent to coniferous, broadleaf and mixed wood forest polygons
greeness	N/A	Greenness calculated using tasseled cap transformation from thematic images
builtup	N/A	Buildings, parking lots, or other anthropogenic structures
dist_builtup	N/A	Distance to nearest building, parking lot, or other anthropogenic structure
golf	N/A	Golf course greens, tees, and fairways
dens_roads	N/A	Density of roads (km/km^2)
dens_trails	N/A	Density of trails (km/km^2)
dens_tchwy	N/A	Density of Trans-Canada Highway (km/km^2)
dist_trails	N/A	Distance to nearest trail
slope_perc	N/A	Slope (percent) calculated for each pixel using a DEM
slope2	N/A	Squared value of slope (percent) calculated for each pixel using a DEM
elev	N/A	Elevation in meters calculated using a DEM
elev2	N/A	Squared value of elevation in meters calculated using a DEM
TRI	N/A	Terrain ruggedness index was obtained from the DEM using the TRI.aml script in ArcGIS
cti	N/A	Compound topographic index calculated using ArcGIS
south_slope	N/A	South facing (157.5° – 202.5°) calculated from DEM
elevnonveg	N/A	Interaction multiplying elev x nonveg

Note: _150, _300, or _600 were applied to each classification variable where a moving window was used to calculate a proportion or density.

Animals can select for landscape features at different spatial scales (i.e., moving window sizes; Gaucherel et al. 2010). Proportions of each EOSD habitat classification, linear classification, habitat classifications stamped into the EOSD, or classifications derived from these were calculated within three moving windows classes: 150 m, 300 m, and 600 m to test for responses at different spatial scales. Similarly, 300 m and 600 m moving windows were used to calculate density of linear features (km/km^2). Larger moving windows will tend to smooth RSF probability surfaces because adjacent cells necessarily have similar properties.

For species where location data were obtained primarily or exclusively using GPS collars (e.g., grizzly bears, elk, and cougars), the scale of moving window used in model development was selected based on the best performing univariate model, or was assigned based on biological expectation. For VHF collared wolves, on the other hand, only the 600 m diameter size was used in RSF model development because of location bias associated with VHF telemetry (see next section for additional information). Surfaces depicting the shortest straight-line distance from a pixel to the nearest built-up habitat or to roads or trails also were calculated and evaluated as potential drivers of wildlife habitat selection.

Because wildlife telemetry data were obtained over long periods of time (i.e., 1988-2009, depending on species) it was important to account for landscape changes caused by human development during that period. Wildlife location data were therefore applied integrated with land cover layers depicting development prior to and after 2004, depending on the date associated with the telemetry location. Data were unavailable to make finer temporal divisions. This may not account well for wolf data collected in the late 1980s and early 1990s, but because most wolf locations occur west of Canmore where new development over the last two decades has been less pronounced, the introduced bias was expected to be minimal. All RSF surfaces used to predict probability of selection for the purpose of preparing environmental impact statements were estimated by applying models estimated from appropriate temporal information to more up-to-date development and land cover surfaces (e.g., 2016).

2.1.3.4 Wildlife Telemetry Collar Bias

Wildlife location data collected using VHF telemetry is often associated with uncertainty regarding the precise location of an animal because of triangulation error (White and Garrott 1990, Gilsdorf et al. 2008). Data on wolf habitat use were exclusively obtained using VHF telemetry and were subject to this form of error. To account for location uncertainty, wolf points were intersected only with GIS layers calculated using a moving window 600 m in diameter. Although some elk data also were derived using VHF collars, the vast majority (>95%) were generated using GPS telemetry, and a similar restriction to the 600 m moving window size for elk RSF development was deemed unnecessary.

Another bias associated with VHF telemetry locations is that these data are generally collected during daylight hours and so do not represent habitat selection throughout the diel cycle. The only species this form of bias substantially affects is wolves, but considering this potential bias is important since wolves have demonstrated a tendency to reduce avoidance of anthropogenic features at night (Hebblewhite and Merrill 2008). Consequently, any avoidance of anthropogenic features by wolves might be over-emphasised using daytime VHF telemetry.

Location data obtained using GPS collars are generally much more accurate than those obtained from VHF telemetry and precision after the United States government stopped scrambling GPS signals in 2000 has increased dramatically. Moreover, GPS collars collect data throughout the diel cycle, avoiding temporal bias. GPS telemetry is not perfect, however, and bias can be introduced where vegetation or terrain interfere with fix acquisition, causing fix locations to occur less frequently in some habitats than others. This bias has important implications for habitat models, including RSFs, because it can cause selection coefficients to be underestimated in habitats where the probability of successfully obtaining a fix is lower (D'Eon et al. 2002, Frair et al. 2004). For GPS collars with high fix success, this form of bias is not a concern (Frair et al. 2004, Hebblewhite et al. 2007). However, for collars with low fix success such as the Televilt Simplex collars used on grizzly bears and cougars in this study (see Chetkiewicz and Boyce 2009 for additional detail on collar performance), correction for habitat bias is necessary (Hebblewhite et al. 2007). Correction was accomplished by using the inverse of the probability of fix as a sample weight for used locations in the logistic regression model applied to estimate grizzly bear and cougar RSFs (available locations all received a sample weight of 1; Frair et al. 2004). To identify the probability of obtaining a fix where each cougar or grizzly bear location was recorded, a P_{FIX} layer developed by Hebblewhite et al. (2007) for Televilt Simplex collars in the region around the Bow Corridor was applied to the landscape at the pixel level in the GIS and intersected with cougar and grizzly bear GPS data.

2.1.4 Model Selection

A critical step towards developing effective RSF models is to identify variables that might drive habitat selection for a particular species. Well-informed model construction is an integral part of using information theory for model selection (Burnham and Anderson 2002). Identifying appropriate habitat drivers for a species improves predictive capacity, serving to reduce the incidence of spurious relationships in models (Anderson et al. 2001). Spurious relationships are those which are biologically irrelevant and arise due to chance; their inclusion in habitat models can impede conservation when land-management decisions are made based on false wildlife-habitat relationships.

A review of the scientific literature was performed to identify variables that should be tested as possible drivers of selection for grizzly bears, cougars, wolves and elk (Golder 2012 pg. 25-33). Particular attention was paid to reviewing the literature regarding the influence of slope, elevation and human development on habitat use by each indicator species because steep slopes, high elevation and areas with substantial development are all features that have been prominently identified as potential barriers to wildlife movement in the Bow Valley. Variable identification and the structure of candidate models was based on this review.

In some cases, studies may contradict each other in terms of the strength or direction of a particular wildlife-habitat relationship. Where this occurs, it highlights the complexity and scale-, site- and season-specific nature of wildlife-habitat relationships (Nielsen et al. 2004, Boyce 2006, Ciarniello et al. 2007*a*, 2007*b*), and does not preclude incorporating such variables into candidate models.

Candidate models were developed for grizzly bears (Table B-2) in summer, and elk (Table B-3), wolves (Table B-4), and cougars (Table B-5) during winter. Candidate models incorporated different combinations of variables thought to drive the habitat-selection patterns of the particular species for which the model was developed. Each model represents a hypothesis about the drivers of habitat selection for each species in the Bow Valley.

Because shallow slopes, substantial hiding cover (e.g., forest), and low anthropogenic development have been proposed as important characteristics of functional corridors in the Bow Valley (BCEAG 1999a), a model including this combination of variables was considered in the candidate set for each species. To avoid multicollinearity, variables correlated at $|r| > 0.7$ were not used in the same model (Tabachnick and Fidell 2001, Chetkiewicz and

Boyce 2009, Webb et al. 2008). Importantly, slope and elevation were always highly and positively correlated (r >0.7) in the Bow Valley. These two variables were therefore always considered in separate candidate models.

Each candidate model was fit using logistic regression and ranked using the small sample size correction for Akaike's Information Criterion (AIC_c; Akaike 1973, Burnham and Anderson 2002). Model selection criteria from the AIC family were used because of their comparative advantage when ranking models that describe complex systems, such as ecosystems (Hurvich and Tsai 1989). The small sample corrected form of AIC (AIC_c) converges on AIC as sample size becomes large. Consequently, it provides an improved model selection criterion for small sample sizes and is comparable to AIC for larger sample sizes, indicating that AIC_c can be universally applied for model selection regardless of sample size.

Table B-2: Candidate Models Tested for Grizzly Bears

Model	Variables
1	greenness elev tri builtup_150 elevnonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dist_builtup montane
2	greenness elev builtup_150 elevnonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dist_builtup montane
3	slope_perc slope2 greenness builtup_300 elevnonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dens_roads_600 dist_builtup
4	greenness elev elev2 builtup_300 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dens_roads_600 dist_builtup
5	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 elev elev2 shrub_150 conif_dens_600 nonveg_300 herb_600 golf_600
6	greenness cti elev elev2 builtup_600 nonveg_600 south_slope_600 dens_trails_600 herb_600 shrub_600
7	elev elev2 builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_600 shrub_600
8	slope_perc slope2 builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_600 shrub_600
9	conif_dens_300 conif_open_150 golf_600 herb_300 nonveg_150 shrub_150 forest_edge_300 greenness
10	elev elev2 greenness forest_edge_300 south_slope_600 elevnonveg_150
11	slope_perc nonveg_600 conif_open_600 builtup_600 conif_dens_600 dens_trails_600 dens_tchwy_600 dens_roads_600
12	conif_dens_300 herb_600 nonveg_300 shrub_150 wet_shrub_300 forest_edge_300
13	elev elev2 greenness forest_edge_300 south_slope_600
14	conif_dens_300 herb_600 nonveg_300 shrub_150 forest_edge_300
15	elev elev2 greenness forest_edge_300
16	herb_600 nonveg_300 shrub_150 forest_edge_300 montane subalpine
17	herb_600 nonveg_300 shrub_150 forest_edge_300
18	cti greenness dens_roads_300 conif_dens_600 herb_150 shrub_300 nonveg_150 elev
19	dens_roads_600 dens_rail_600 dens_tchwy_600 dens_trails_300 dist_trails builtup_600 golf_300
20	dens_tchwy_600 dens_trails_300 dist_trails builtup_600 golf_300

Note: Variables are defined Table B-1.

Table B-3: Candidate Models Tested for Wolves

Model	Variables
1	elev elev2 builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_600 shrub_600
2	elev elev2 builtup_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 shrub_600
3	slope_perc slope2 builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 elev herb_600 golf_600 shrub_600
4	builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 elev herb_600 golf_600 shrub_600
5	builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 elev
6	elev elev2
7	nonveg_600 south_slope_600 forest_edge_600 elev herb_600 golf_600 shrub_600
8	builtup_600 conif_dens_600 golf_600 herb_600 nonveg_600 south_slope_600 dens_tchwy_600 dens_roads_600 dens_trails_600 forest_edge_600 slope_perc
9	builtup_600 nonveg_600 south_slope_600 dens_tchwy_600 dens_trails_600 forest_edge_600 slope_perc
10	slope_perc nonveg_600 conif_open_600 builtup_600 conif_dens_600 dens_trails_600 dens_tchwy_600 dens_roads_600
11	builtup_600 south_slope_600 slope_perc
12	builtup_600 nonveg_600 south_slope_600 dens_tchwy_600 dens_trails_600 forest_edge_600
13	nonveg_600 dens_tchwy_600 dens_trails_600 forest_edge_600 slope_perc
14	elev
15	conif_dens_600 conif_open_600 herb_600 shrub_600 nonveg_600 wet_shrub_600 forest_edge_600
16	conif_open_600 herb_600 shrub_600 nonveg_600 forest_edge_600
17	slope_perc slope2
18	slope_perc
19	herb_600 nonveg_600 forest_edge_600
20	builtup_600 golf_600 dens_roads_600 dens_trails_600 dens_tchwy_600 dens_rail_600
21	builtup_600 dens_roads_600 dens_tchwy_600
22	builtup_600 dens_tchwy_600

Note: Variables are defined Table B-1.

Table B-4: Candidate Models Tested for Elk

Model	Variables
1	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev elev2 dist_builtup south_slope_600
2	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev dist_builtup south_slope_600
3	golf_600 herb_150 elev dist_builtup south_slope_600
4	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev elev2 dist_builtup
5	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev dist_builtup
6	shrub_600 forest_edge_600 golf_600 herb_150 elev elev2 dist_builtup
7	slope_perc nonveg_600 conif_open_600 builtup_600 conif_dens_600 dens_trails_600 dens_tchwy_600 dens_roads_600
8	conif_dens_600 shrub_600 forest_edge_600 herb_150 elev elev2 south_slope_600
9	herb_150 elev elev2 south_slope_600
10	builtup_600 golf_600 dens_roads_600 dens_trails_600 dens_tchwy_600 dens_rail_600
11	elev elev2
12	elev
13	slope_perc slope2
14	builtup_150 golf_600 dist_builtup
15	slope_perc
16	builtup_600 dens_roads_600 dens_tchwy_600
17	conif_dens_600 conif_open_600 herb_150 shrub_600 nonveg_600 wet_shrub_300 forest_edge_600
18	builtup_600 dens_tchwy_600
19	conif_open_600 herb_150 shrub_600 nonveg_600 forest_edge_600
20	herb_150 nonveg_600 forest_edge_600

Note: Variables are defined Table B-1.

Table B-5: Candidate Models Tested for Cougars

Model	Variables
1	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 elev elev2 shrub_150 conif_dens_600 nonveg_300 herb_600 golf_600
2	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 elev elev2 nonveg_300 herb_600 golf_600
3	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 slope_perc slope2 shrub_150 conif_dens_600 nonveg_300 herb_600 golf_600
4	builtup_150 conif_dens_300 conif_open_600 golf_600 herb_600 shrub_150 wet_shrub_300 elev elev2 south_slope_600 dens_trails_300 dens_tchwy_600 forest_edge_300
5	builtup_150 conif_dens_300 golf_600 herb_600 nonveg_150 shrub_150 wet_shrub_300 elev elev2 south_slope_600 dens_trails_300 forest_edge_300
6	builtup_150 forest_edge_300 dens_trails_300 south_slope_600 elev elev2 shrub_150 conif_dens_600 nonveg_300 herb_600 golf_600
7	forest_edge_300 dens_trails_300 south_slope_600 elev elev2 shrub_150 nonveg_300 herb_600
8	builtup_150 nonveg_300 elev elev2 south_slope_600
9	elev elev2 south_slope_600
10	elev elev2
11	conif_dens_300 herb_600 nonveg_300 shrub_150 wet_shrub_300 forest_edge_300
12	conif_dens_300 herb_600 nonveg_300 shrub_150 forest_edge_300
13	elev
14	herb_600 nonveg_300 shrub_150 forest_edge_300
15	slope_perc nonveg_150 conif_open_300 conif_dens_300 builtup_150 dens_roads_600 dens_tchwy_600 dens_trails_600
16	slope_perc slope2
17	slope_perc
18	builtup_150 golf_600 dens_tchwy_600 dens_trails_600

Note: Variables are defined Table B-1.

2.1.5 Model Validation

Prior to application, models were evaluated for predictive reliability in a process referred to as model validation (Marcot et al. 1983). Validation was conducted on the best RSF model (identified from the candidate set using AICc) for each indicator species to evaluate model reliability. When employing a used-available sampling scheme, as in this study, traditional logistic regression diagnostic approaches such as Receiver Operating Characteristics (ROC) curves or goodness-of-fit tests are inappropriate (Boyce et al. 2002, Johnson et al. 2006). Therefore, a cross-validation approach using *k*-fold partitioning (as recommended by Boyce et al. 2002) was applied to RSF models for each indicator species. This approach iteratively withholds a partition of the used data (the number of partitions = *k*), parameterizes the model using the remaining data, and predicts probability of selection for the withheld data (Fielding and Bell 1997, Boyce et al. 2002, Johnson et al. 2006). All models developed in this study were evaluated using $k = 5$. A good model is one where the withheld used locations fall more often in habitat patches that are predicted to be high suitability by a model parameterized with the remaining data.

To assess model fit, the RSF probability surface for each species was predicted at the appropriate availability extent (Figures B-2 to B-5) and binned into 5 equal-area RSF score categories for each of the 5 validation sets. The average number of withheld locations in each bin (across all 5 validations) was then correlated with bin rank using a Spearman Rank Correlation (Boyce et al. 2002) and observed number of locations in each bin were compared to expected values derived from a utilization function (Johnson et al. 2006) to quantify predictive ability. Models that predict well will have a high positive Spearman Rank Correlation score (R_S; Boyce et al. 2002), and, when used locations are compared with expected, a model that is proportional to the probability of use will exhibit a regression slope “different from 0, but not different from 1, and intercept of 0, and a high R^2 value with nonsignificant χ^2 goodness-of-fit value” (Johnson et al. 2006 pp. 352).

2.2 Results

2.2.1 Grizzly Bears

The most parsimonious model for predicting relative probability of grizzly bear selection in the Bow Valley during summer contained variables for terrain features, anthropogenic landscape features, and vegetation (Table B-6). Grizzly bears selected locations with high greenness, higher elevations, areas with high trail density, forest edge, herbaceous vegetation, and montane vegetation communities (Table B-7). Grizzly bears avoided rugged terrain, developed areas, non-vegetated areas at high elevation, south slopes, golf courses, and habitats dominated by shrubs (Table B-7).

Slope was tested as a candidate variable, but was not included in the most parsimonious model. Although grizzly bears tended to avoid areas consisting of the steepest slopes (e.g., mountain tops) telemetry data indicate that bears used areas with slopes up to 34.5˚ during summer. The BCEAG guidelines model which included slope, hiding cover, and anthropogenic development variables ranked 9th of 17 candidate models ($w_i = 0.00$).

Although alpine meadows provided highly selected habitat, especially at the head of Wind Valley, most of the best grizzly bear habitat during summer was in the valley bottom, a result also reported by Chetkiewicz and Boyce (2009). Presumably, grizzly bear selection for greenness and a preference for habitats closer to trails reflect selection for the food resources with which these variables were correlated (e.g., Roever et al. 2008). In the case of trails, edge habitats may contain higher volumes of bear foods like *Shepherdia*, which may be attractive enough to override negative zone of influence from people using the trail networks in places where trail density is high (e.g., the Canmore Nordic Centre Provincial Park).

Model validation indicated that the most parsimonious summer grizzly bear RSF provided an extremely good fit to the data and exhibited excellent predictive capacity (R_s = 1, R^2 = 0.99, Slope = 0.94, Intercept = 0.01, $P(\chi^2)$ >0.1; Figure B-6).

The poorest habitats for grizzly bears in the Bow Valley during summer consisted primarily of exposed rock at high elevation. Strong avoidance of golf courses by grizzly bears may be related to ongoing aversive conditioning programs implemented by the Province in the Bow Valley, and not necessarily because golf courses represent inherently poor habitat for bears. Grizzly bears that entered areas of high human use, such as golf courses, were hazed using rubber bullets, bangers and aggressive dogs. Aversive conditioning of collared bears such as those used for RSF development was perhaps more consistently applied than aversive conditioning of other bears because collared animals were easily monitored (Honeyman 2008). Of the bears monitored by the Province and used in model development, two received no aversive conditioning and two received extensive aversive conditioning (J. Jorgensen, ESRD, personal communication). The fifth bear used for model development was collared in Banff National Park, and it was unclear whether it was subjected to aversive conditioning (J. Jorgensen ESRD, personal communication).

Table B-6: Top-ranked Logistic Regression Models for Relative Probability of Grizzly Bear Habitat Use in the Bow Valley during Winter

Rank	Variables [(a)]	LL	K	AIC_c	ΔAIC_c	w_i
1	greenness elev tri builtup_150 elevnonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dist_builtup montane	-3051	13	6127	0.0	1.0
2	greenness elev builtup_150 elevnonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dist_builtup montane	-3121	12	6267	139.9	0.0
3	slope_perc slope2 greenness builtup_300 elevnonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dens_roads_600 dist_builtup	-3129	13	6283	156.1	0.0
4	greenness elev elev2 builtup_300 dens_trails_600 forest_edge_600 herb_600 golf_150 shrub_600 dens_roads_600 dist_builtup	-3137	11	6296	168.6	0.0
5	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 elev elev2 shrub_150 conif_dens_600 nonveg_300 herb_600 golf_600	-3207	12	6437	310.0	0.0

[(a)] Numbers following variable names indicate the moving window size used.

Note: Models are shown in order of decreasing rank. Log-likelihood (LL), number of estimated parameters (*K*), small sample size corrected Akaike's Information Criterion (AIC_c), AIC difference (ΔAIC_c), and AIC weight (w_i) are displayed for each of the top 5 models considered in the candidate set. Variables are defined in Table B-1.

Table B-7: Coefficients for the Highest Ranked Logistic Regression Model used to Predict Relative Probability of grizzly Bear Habitat Use in the Bow Valley during Summer

Variable	Coefficient
Greenness	0.0598720
elev	0.0029652
TRI	-0.0312045
builtup_150	-0.9917101
elev*nonveg_600	-0.0006170
south_slope_600	-0.6676020
dens_trails_600	0.2813665
forest_edge_600	2.5757000
herb_600	1.9769270
golf_150	-6.5657650
shrub_600	-1.8038040
dist_builtup	0.0000848
montane	0.8545787

Note: Variables are defined Table B-1.

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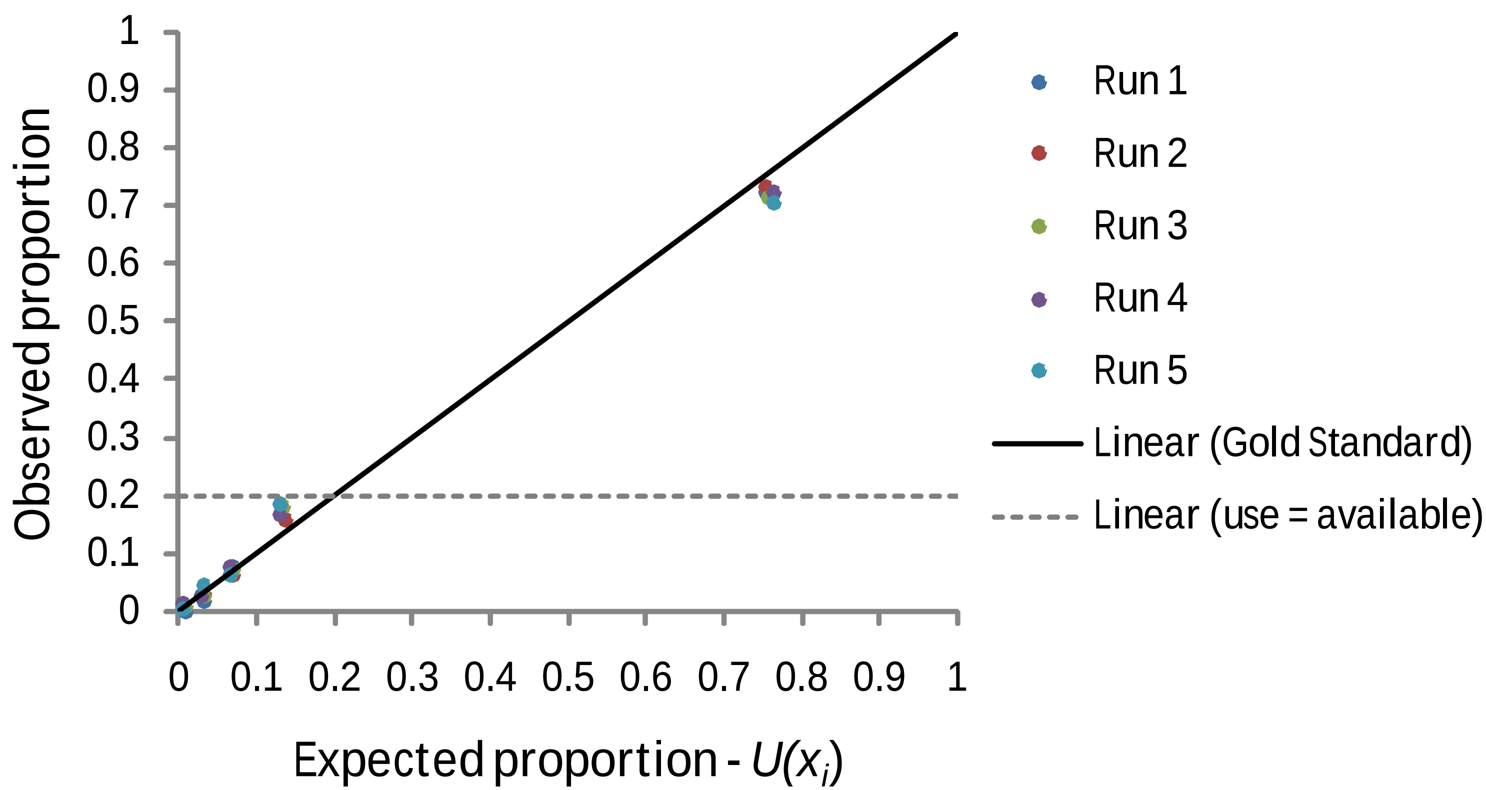

PROJECT	RESORT CENTRE ASP AMENDMENT EIS			QUANTUMPLACE
TITLE	**GRIZZLY BEAR K-FOLD CROSS-VALIDATION**			
Golder Associates Calgary, Alberta	PROJECT 1539221			
	DESIGN	KK	21/01/11	SCALE AS SHOWN REV. 0
	CADD	KJM	24/01/11	**FIGURE:** B-6
	CHECK	MG	07/03/17	
	REVIEW	MGJ	07/03/17	

2.2.2 Wolves

The most parsimonious model for predicting relative probability of wolf selection in the Bow Valley during winter contained variables for terrain features, anthropogenic landscape features, and vegetation (Table B-8). Wolves exhibited a non-linear (quadratic) response to elevation (i.e., a squared term was included in the model). This indicates that wolves generally avoided valley bottoms and selected intermediate elevations, especially on south facing slopes (Table B-9). Wolves avoided non-vegetated habitats, built up areas, areas with high trail density, and golf courses (Table B-9). In addition to a strong preference for south facing slopes, wolves selected for forest edge, herbaceous vegetation, and areas with more shrubs (Table B-9). Models including slope as a covariate explained less of the overall variation in habitat use than did models including elevation. Although wolves tended to remain in valley bottoms where slopes are gentle, telemetry data indicate that wolves used areas with slopes up to 32.5˚. These results are generally consistent with previous findings regarding wolf habitat selection in the Alberta Rockies (Alexander 2001, Duke 2001, Callaghan 2002, Paquet and Carbyn 2003, Whittington et al. 2005). A primary difference is that a non-linear relationship with elevation was tested during model selection and that it proved important (i.e., it was retained in the top model). The BCEAG guidelines model which included slope, hiding cover, and anthropogenic development variables ranked 10th of 22 candidate models (w_i = 0.00).

The poorest quality habitat for wolves in the Bow Valley during winter consisted primarily of exposed rock at high elevation, while the best habitat included south facing slopes at moderate elevations; these were especially prominent on the north side of the Bow Valley (e.g., the benches north of Canmore and west of the town of Banff). Model validation indicated that the top wolf RSF generated in this analysis provided an extremely good fit to the data and exhibited excellent predictive capacity (R_s = 1, R^2 = 0.95, Slope = 0.97, Intercept = 0.01, $P(\chi^2)$ >0.1; Figure B-9).

Table B-8: Top-ranked Logistic Regression Models for Relative Probability of Wolf Habitat use in the Bow Valley during Winter

Rank	Variables [(a)]	LL	K	AIC_c	ΔAIC_c	w_i
1	elev elev2 builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 golf_600 shrub_600	-1433	10	2886	0.0	0.7
2	elev elev2 builtup_600 south_slope_600 dens_trails_600 forest_edge_600 herb_600 shrub_600	-1436	8	2888	1.8	0.3
3	slope slope2 builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 elev herb_600 golf_600 shrub_600	-1506	10	3033	147.1	0.0
4	builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 elev herb_600 golf_600 shrub_600	-1518	9	3053	167.2	0.0
5	builtup_600 nonveg_600 south_slope_600 dens_trails_600 forest_edge_600 elev	-1543	6	3098	211.5	0.0

[(a)] Numbers following variable names indicate the moving window size used.

Note: Models are shown in order of decreasing rank. Log-likelihood (LL), number of estimated parameters (K), small sample size corrected Akaike's Information Criterion (AIC_c), AIC difference (ΔAIC_c), and AIC weight (w_i) are displayed for each of the top 5 models considered in the candidate set. Variables are defined in Table B-1.

Table 9: Coefficients for the Highest Ranked Logistic Regression Model used to Predict Relative Probability of Wolf Habitat Use in the Bow Valley during Winter

Variable	Coefficient
elev	0.088387
elev2	-0.000030
builtup_600	-7.021987
nonveg_600	-0.146696
south_slope_600	1.538460
dens_trails_600	-0.200368
forest_edge_600	0.670858
herb_600	1.033150
golf_600	-4.090004
shrub_600	1.32248

Note: Variables are defined in Table B-1.

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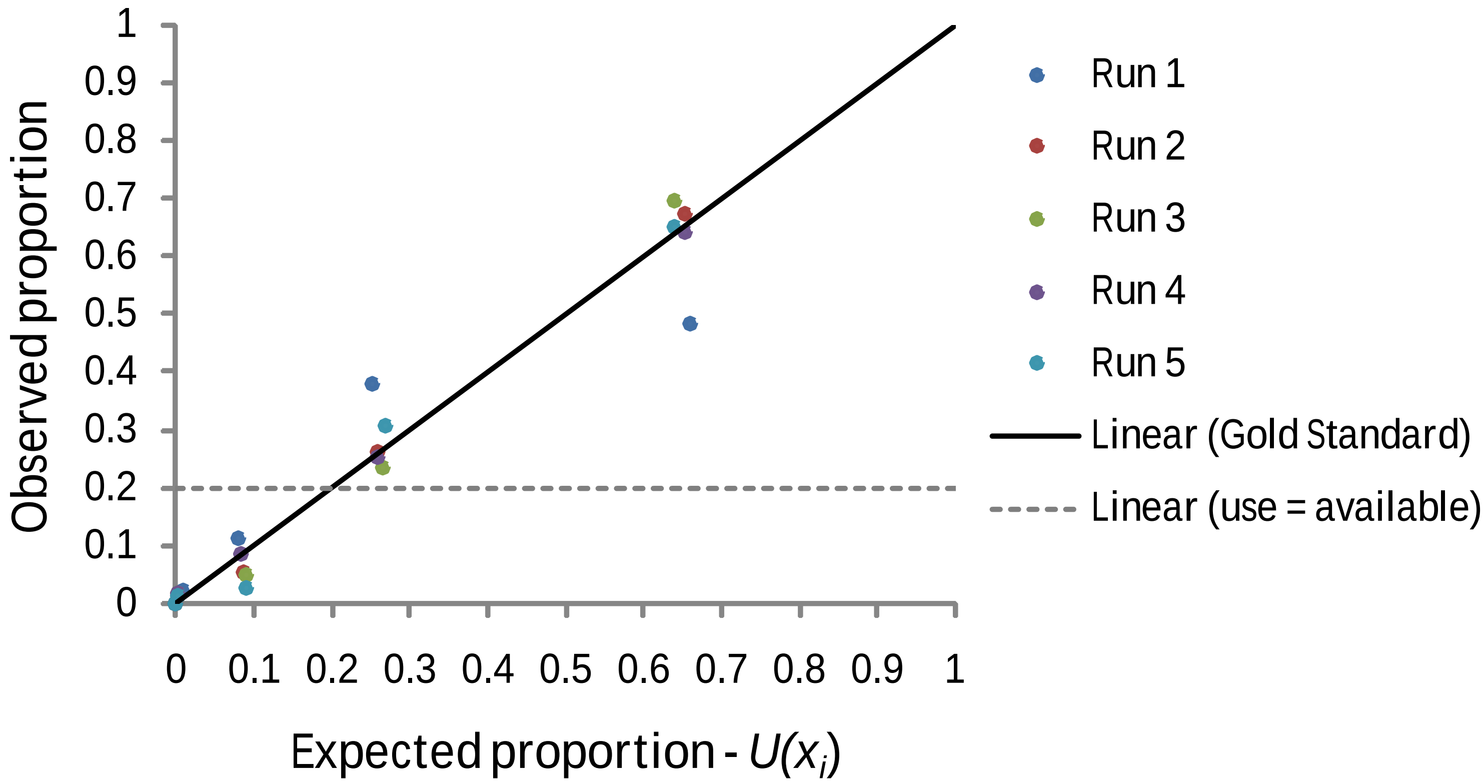

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SCALE KILOMETRES

PROJECT RESORT CENTRE ASP AMENDMENT EIS		QUANTUMPLACE DEVELOPMENTS LTD.	
TITLE **WOLF K-FOLD CROSS-VALIDATION**			

Golder Associates
Calgary, Alberta

PROJECT	1539221			
DESIGN	KK	21/01/11	SCALE AS SHOWN	REV. 0
CADD	KJM	24/01/11	**FIGURE:** B-7	
CHECK	MG	MG		
REVIEW	07/03/11	1539221		

2.2.3 Elk

The most parsimonious model for predicting relative probability of elk selection in the Bow Valley during winter contained variables for terrain features, anthropogenic landscape features, and vegetation (Table B-10). Like wolves, elk exhibited a non-linear (quadratic) response to elevation. In addition to a preference for built-up areas (i.e., elk in the Bow Valley near Canmore prefer to be closer to human developments), elk selected for forest edge, herbaceous vegetation, and golf courses (Table B-11). Surprisingly, elk avoided south facing slopes, but this appears to be a function of the extensive use of built up areas in the Town of Canmore, especially on the south side of town (i.e., north aspect). Elk also avoided dense conifer and shrub habitats. These results, particularly selection for built-up areas and golf courses, are consistent with previous studies of elk habitat use near the town of Banff, and may be a function of built-up areas providing protection from predation in addition to good quality forage (McKenzie 2001, Kloppers et al. 2005).

Models including slope as a covariate explained less of the overall variation in habitat use than did models including elevation. Although elk tended to remain in the valley bottoms during winter, telemetry data indicate that elk used areas with slopes up to 34.5˚. The BCEAG guidelines model which included slope, hiding cover, and anthropogenic development variables ranked 7th of 20 candidate models (w_i = 0.00).

The poorest quality habitat for elk in the Bow Valley during winter included snow covered mountaintops consisting of broken rock and little vegetative cover. The best habitat for elk was found on the valley floor, especially around developed areas and golf courses, the same places avoided by wolves and cougars, which are important predators of elk. Model validation indicated that the top elk RSF generated in this analysis provided an extremely good fit to the data and exhibited excellent predictive capacity (R_s = 1, R^2 = 0.99, Slope = 0.94, Intercept = 0.01, $P(\chi^2)$ >0.1; Figure B-8).

Table B-10: Top-ranked Logistic Regression Models for Relative Probability of Elk Habitat Use in the Bow Valley during Winter

Rank	Variables [(a)]	LL	K	AIC_c	ΔAIC_c	w_i
1	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev elev2 dist_builtup south_slope_600	-2895	9	5808	0.0	1.0
2	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev dist_builtup south_slope_600	-2915	8	5845	37.7	0.0
3	golf_600 herb_150 elev dist_builtup south_slope_600	-2964	5	5937	129.7	0.0
4	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev elev2 dist_builtup	-2991	8	5998	190.3	0.0
5	conif_dens_600 shrub_600 forest_edge_600 golf_600 herb_150 elev dist_builtup	-2998	7	6010	202.8	0.0

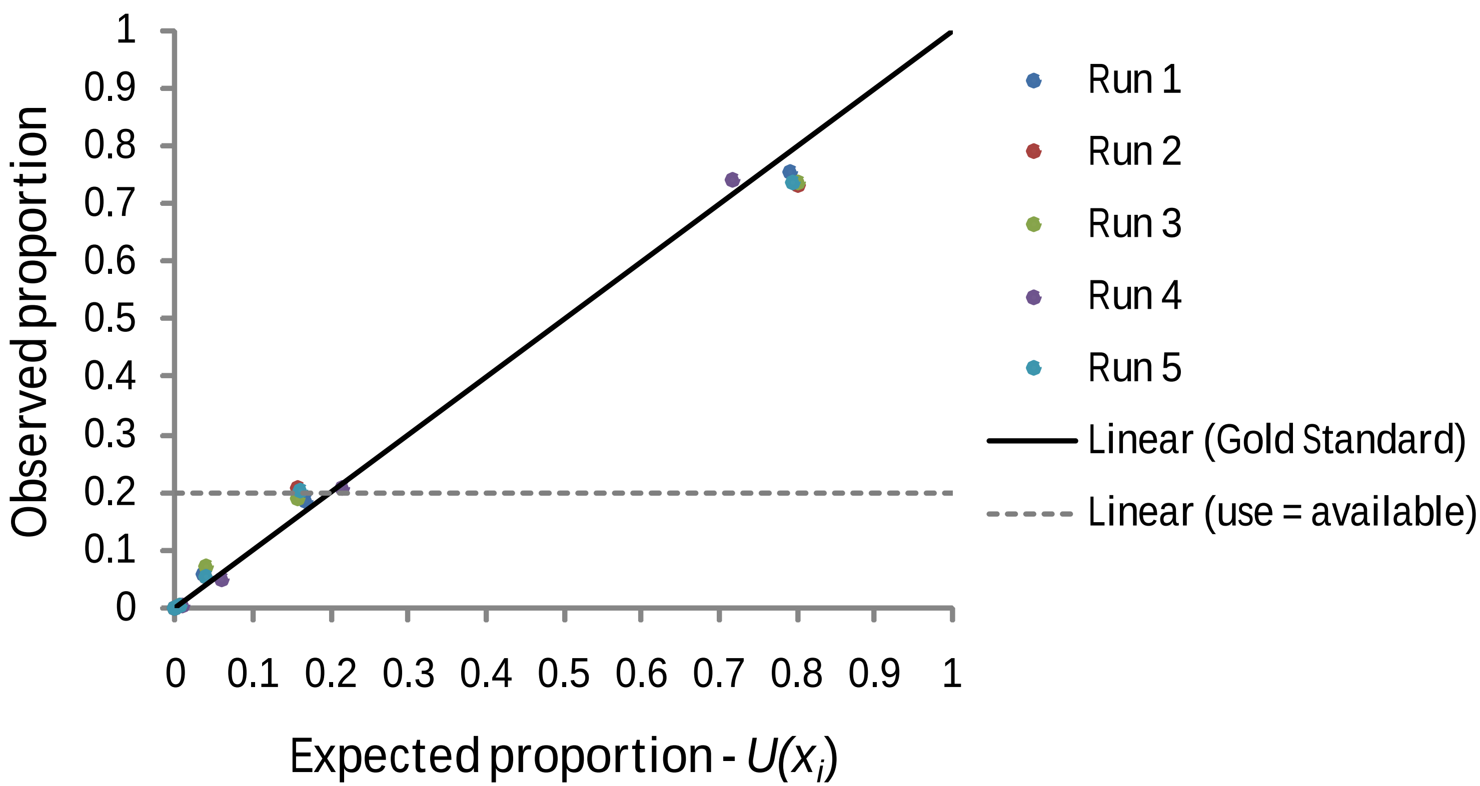
(a) Numbers following variable names indicate the moving window size used.

Note: Models are shown in order of decreasing rank. Log-likelihood (LL), number of estimated parameters (K), small sample size corrected Akaike's Information Criterion (AIC_c), AIC difference (ΔAIC_c), and AIC weight (w_i) are displayed for each of the top 5 models considered in the candidate set. Variables are defined Table B-1.

Table B-11: Coefficients for the Highest Ranked Logistic Regression Model used to Predict Relative Probability of Elk Habitat use in the Bow Valley during Winter

Variable	Coefficient
conif_dense_600	-1.176067
shrub_600	-2.687693
forest_edge_600	1.73134
golf_600	4.113394
herb_150	1.041379
elev	0.0550596
elev2	-0.0000215
dist_builtup	-0.0008968
south_slope_600	-4.455782

Note: Variables are defined in Table B-1.



PROJECT

RESORT CENTRE ASP
AMENDMENT EIS

QUANTUMPLACE

TITLE

ELK K-FOLD CROSS-VALIDATION

Golder Associates
Calgary, Alberta

PROJECT	1539221		
DESIGN	KK	21/01/11	SCALE AS SHOWN / REV. 0
CADD	KJM	24/01/11	
CHECK	MG	07/03/2017	**FIGURE:** B-8
REVIEW	MGJ	07/03/2017	

2.2.4 Cougars

The most parsimonious model for predicting relative probability of cougar selection in the Bow Valley during winter contained variables for terrain features, anthropogenic landscape features, and vegetation (Table B-12). As with wolves and elk, cougars exhibited a non-linear (quadratic) response to elevation during winter. Like wolves, cougars showed a particular affinity for intermediate elevation south facing slopes. Cougars avoided non-vegetated habitats, built up areas, areas with high trail density, areas with high road density, and golf courses (Table B-13).

Presumably because prey species (e.g., elk) selected built-up areas, cougars preferred to be closer to these areas, even though the coefficient for built-up areas was negative. This indicates that, all else being equal, cougars are more likely to use the areas around urban developments, but are less likely to enter them. Cougars also selected forest edge, herbaceous vegetation, dense conifer forest, and areas with more shrubs (Table B-13).

Models including slope as a covariate explained less of the overall variation in habitat use than did models including elevation. Like wolves and elk, cougars during winter tended to avoid higher elevations that correlated with steep slopes. However, telemetry data indicate that cougar used areas with slopes up to 32˚. The BCEAG guidelines model which included slope, hiding cover, and anthropogenic development variables ranked 15^{th} of 18 candidate models (w_i = 0.00).

The Bow Valley contains habitat with a relatively high probability of selection by cougars within a regional context, especially during winter (Chetkiewicz and Boyce 2009). The habitat with the lowest probability of selection by cougars in the Bow Valley during winter consisted of rocky peaks at high elevation, intensely developed areas (i.e., the core of the town of Canmore), and golf courses. Preferred cougar habitat extended to higher elevations than for either wolves or elk. Like wolves, the best winter habitats for cougars were found on the south-facing benches on the north side of the Bow Valley, likely because snow depth is lower and more prey are available in these habitats during winter.

Residential developments outside of Canmore's core did not necessarily cause probability of cougar selection to decline to low levels. In fact, RSF scores indicated that some smaller residential developments surrounded by forest (e.g., developments on Lawrence Grassi Ridge and Wilson Way on the south side of Canmore) consisted of habitat with moderate to high probability of selection by cougars. Model validation indicated that the top cougar RSF generated in this analysis provided an extremely good fit to the data and exhibited excellent predictive capacity (R_s = 1, R^2 = 0.99, Slope = 1, Intercept = 0, $P(\chi^2)$ >0.1; Figure B-9.

Table B-12: Top-ranked Logistic Regression Models for Relative Probability of Cougar Habitat Use in the Bow Valley during Winter

Rank	Variables [(a)]	LL	K	AIC_c	ΔAIC_c	w_i
1	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 elev elev2 shrub_150 conif_dens_600 nonveg_300 herb_600 golf_600	-1902	13	3830	0.0	1.0
2	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 elev elev2 nonveg_300 herb_600 golf_600	-1908	11	3839	9.2	0.0
3	builtup_150 forest_edge_300 dens_trails_300 dens_roads_600 dist_builtup south_slope_600 slope_perc slope2 shrub_150 conif_dens_600 nonveg_300 herb_600 golf_600	-1928	13	3882	52.0	0.0
4	builtup_150 conif_dens_300 conif_open_600 golf_600 herb_600 shrub_150 wet_shrub_300 elev elev2 south_slope_600 dens_trails_300 dens_tchwy_600 forest_edge_300	-2015	13	4056	226.2	0.0
5	builtup_150 conif_dens_300 golf_600 herb_600 nonveg_150 shrub_150 wet_shrub_300 elev elev2 south_slope_600 dens_trails_300 forest_edge_300	-2026	12	4077	247.3	0.0

[(a)] Numbers following variable names indicate the moving window size used.

Note: Models are shown in order of decreasing rank. Log-likelihood (LL), number of estimated parameters (*K*), small sample size corrected Akaike's Information Criterion (AIC_c), AIC difference (ΔAIC_c), and AIC weight (w_i) are displayed for each of the top 5 models considered in the candidate set. Variables are defined in Table B-1.

Table B-13: Coefficients for the Highest Ranked Logistic Regression Model used to Predict Relative Probability of Cougar Habitat use in the Bow Valley during Winter

Variable	Coefficient
builtup_150	-1.281421
forest_edge_300	0.2907269
dens_trails_300	-0.1273898
dens_roads_600	-0.1737865
dist_builtup	-0.0006896
south_slope_600	1.394376
elev	0.0077137
elev2	-2.90E-06
shrub_150	0.8890654
conif_dense_600	0.9852458
nonveg_300	-0.3634998
herb_600	4.427354
golf_600	-12.5119

Note: Variables are defined Table B-1.

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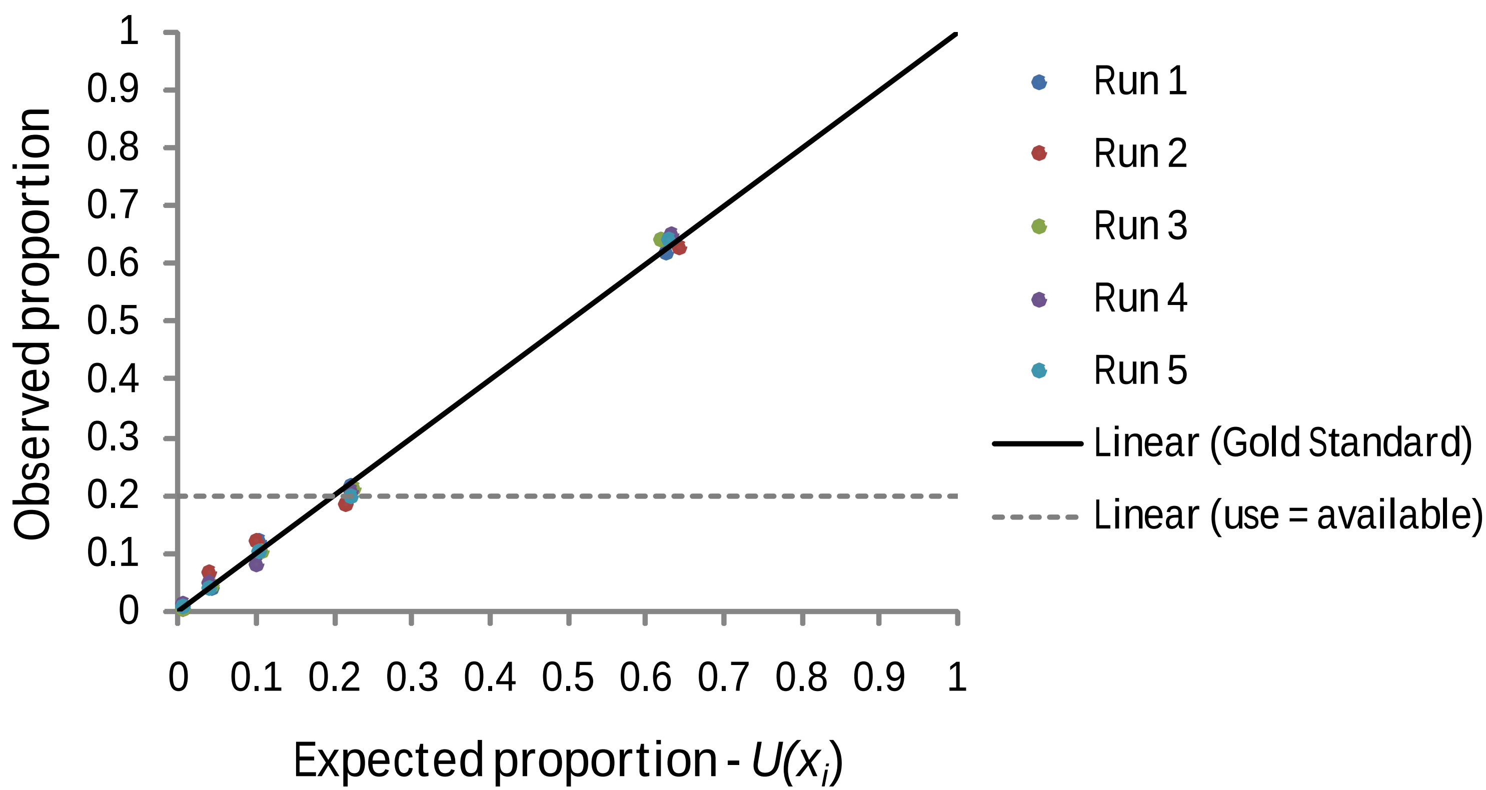

PROJECT
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TITLE

COUGAR K-FOLD CROSS-VALIDATION

Golder Associates
Calgary, Alberta

PROJECT	1539221			
DESIGN	KK	21/01/11	SCALE AS SHOWN	REV. 0
CADD	KJM	24/01/11		
CHECK	MG	MG	**FIGURE:** B-9	
REVIEW	07/03/1	1539221		

3.0 HUMAN USE OF RECREATIONAL TRAILS

One factor that could both reduce access of animals to high quality habitats and increase landscape resistance for movement is human use on trails. Trail density was considered during model selection and appeared in the top RSF models for grizzly bears (positively associated with trail density), cougars (negatively associated with trail density), and wolves (negatively associated with trail density). Trails were not retained in the top model for elk.

Human use of recreational trails in the Bow Valley has increased substantially since the RSFs were estimated, and is predicted to increase further as a result of the Project and other reasonably foreseeable developments and activities in the RSA. Animals may respond differently to trails with more or less human use, and human use may therefore influence probability of selection (Ladle et al. 2016). Because data about the intensity of human use on trails were not available concurrent with the telemetry data collected for the grizzly bears, cougars, wolves and elk in the Bow Valley, intensity of use could not be included as a candidate variable in the RSF models.

During initial consultation about the Resort Centre ASP amendment EIS, Fiera recommended undertaking spatially explicit analyses to investigate the potential ramifications of changes in human use of recreational trails for wildlife. Because data were not available to parameterize the zone of influence or strength of the response of wildlife to increased human use of trails in the Bow Valley, spatially explicit scenarios were created using assumptions about potential derived from and inferences from available data about how animals respond to human disturbance in the Bow Valley.

Assumptions about the zone of influence of human use of trails relied on information about flight initiation distance (FID). In their review of Golder (2013), MSES (2013) identified the concept of flight initiation distance (FID), which is a metric that informs the distance within which wildlife may respond by moving away. This concept was applied by MSES to an evaluation of changes in effective corridor width using the simplified assumption that people will remain within the developed area and not in the corridor. However, human use is currently not restricted to developed areas, and commonly occurs within wildlife corridors under existing conditions. Trails were therefore used as the origin for the FID, and the total zone of influence was obtained by applying the FID to either side of the trail.

The FID used to define the zone of influence and the disturbance coefficient applied to each model for grizzly bears, wolves, and cougars under existing and future scenarios are presented in Table B-14. Disturbance coefficients associated with trails were not applied to elk because increased human use of trails was not anticipated to change the probability of selection by elk in wildlife corridors. Elk in the Bow Valley are habituated to people, spend much of their time near and within development (Appendix B), and need to be aggressively chased in order to achieve displacement (Kloppers et al. 2005).

Different disturbance coefficients were applied under existing and future scenarios (Table B-14) to represent changes in intensity of human use (i.e., potential doubling). Disturbance coefficients were applied within the zone of influence identified from the literature. Disturbance coefficients most likely decline with distance away from the disturbance, but evidence to describe the shape of this relationship to was not identified for grizzly bears, wolves, and cougars. Consequently, a precautionary assumption that the coefficient applied evenly to the entire zone of influence was used.

Table B-14: Grizzly bear, wolf, and cougar flight initiation distance and disturbance coefficient for designated and undesignated trails

Species	Flight Initiation Distance (m)	Disturbance Coefficient			
		Existing Conditions		Future Conditions	
		Designated Trails	Undesignated Trails	Designated Trails	Undesignated Trails
Grizzly bear	100	0.85	0.9	0.8	0.85
Wolf	400	0.6	0.75	0.4	0.65
Cougar	50	0.8	0.85	0.75	0.8

Although FID can be estimated directly from the literature, the disturbance coefficient is an interpretation or "best guess" based on an understanding of how the RSF for each species works and on the evidence for stronger or weaker responses by different species. Evidence and rationale used to select the FID and disturbance coefficient information presented in Table B-14 is described in the following sections. Because the application of fencing and signage is expected to reduce human use on undesignated trails in wildlife corridors adjacent to the Resort Centre ASP amendment boundary and Smith Creek ASP boundary (EIS for the 2017 Resort Centre ASP Amendment, Section 5.6.1), the undesignated trail disturbance coefficient was not applied to undesignated trails in these corridors for future conditions (i.e., residual effects assessment and cumulative effects assessment).

Grizzly bears

Grizzly bears in the Bow Valley avoid high density development (e.g., downtown Canmore), but select areas near lower density urban developments with adjacent natural habitats (e.g., near Peaks of Grassi or Silvertip). The RSF model showed that grizzly bears in the Bow Valley tend to select areas with high trail density and areas close to forest edges (Section 2.2.1). This is likely due to grizzly bear selection for the high quality forage that is often available in early successional habitat, such as the edges of trails (e.g., Roever et al. 2008). The attraction of the available forage in edge habitat is sufficient to override the negative zone of influence that arises from people using the trail networks in places where trail density and human use is high (e.g., the Canmore Nordic Centre Provincial Park). However, to be precautionary, a zone of influence was applied to represent human presence as aversive stimulus.

A review of the literature undertaken by Fortin et al. (2016) found that brown bears fled at distances from 100 m to 400 m when directly approached by hikers, but bears that were not approached directly tolerated distances <100 m. Grizzly bears in the Bow Valley are selecting areas where human use is high, and in general people will not be directly approaching grizzly bears; therefore, a FID of <100 m may be appropriate. However, to be precautionary, a FID of 100 m was selected (Table B-14). Disturbance coefficients applied for grizzly bears were relatively weak because grizzly bears in the Bow Valley do not exhibit strong responses to high levels of human use.

Wolves

Habitat suitability modelling shows that wolves avoid anthropogenic developments and trails in the Bow Valley (Section 2.2.2). This avoidance appears to be influenced by the intensity of human use. For example, Rogala et al. (2011) found that trails with high human use were more strongly avoided by wolves than roads in the National Parks. In some cases, wolves may be able to adapt to human disturbance, and as a general rule wolves will be more active near people when humans occupy habitats that are attractive to wolves (Paquet and Carbyn 2003; Hebblewhite and Merrill 2008). Flexibility in wolf habitat selection may permit wolves to access areas with greater human development than is sometimes considered possible (Mech 2006). In Banff and Yoho National Parks, wolves frequently used anthropogenic linear features at night when human activity is low, presumably to take advantage of an easy travel route (Callaghan 2002). Wolves may regularly exploit linear features to facilitate travel and hunting efficiency where human use of such features is low (James and Stewart-Smith 2000). Nevertheless, where human use is extremely high, wolves will stop using otherwise suitable habitat. In the Bow Valley, wolves changed their habitat use patterns when human activity in an area exceeded 100 people/month and stopped using areas entirely when human visitation exceeded 10,000 people/month, regardless of habitat suitability (Paquet and Carbyn 2003).

Little research has been done on FIDs for wolves. However, in Scandinavia, Karlsson et al. (2007) found that wolves moved away when humans approached between 17 and 310 m away, and at an average distance of 106 m over 34 encounters. To be precautionary given the paucity of available information and the known sensitivity of wolves to human activity, a FID of 400 m was assigned (Table B-14). Higher disturbance coefficients were also applied for wolves than were applied for either grizzly bears or cougars because wolves responded more strongly to trails than either of the other species (Section 2.1.4).

Cougars

Cougars are tolerant of human activity, adaptable to anthropogenic landscape change (Knopff et al. 2014), and are commonly found in habitat patches and movement corridors in the Bow Valley, including near developed areas (Golder 2013). Presumably because prey species (e.g., elk) select built-up areas, RSF modelling showed that cougars are likely to use the areas around urban developments, but are less likely to enter them because of the associated risk (Section 2.2.4).

Cougars do not always move away from people and can have short flight initiation distances in developed landscapes. In one study in New Mexico, cougars moved away from researchers 66% of the time when approached within 2 to 50 m, but remained where they were (25%) or exhibited an aggressive response (9%) on other occasions (Sweanor et al. 2005). Therefore, a FID of 50 m was selected for cougars and disturbance coefficients were weaker than for wolves (Table B-14).

4.0 LITERATURE CITED

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APPENDIX C

Wildlife Species List

Table C-1 Mammal Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status[1]	Federal Status Under the Species at Risk Act (SARA)[2] and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[3]
Carnivores			
American Marten	*Martes americana*	Secure	Not listed
American Mink	*Mustela vison*	Secure	Not listed
Black bear	*Ursus americanus*	Secure	Not listed
Cougar	*Puma concolor*	Secure	Not listed
Coyote	*Canis latrans*	Secure	Not listed
Fisher	*Martes pennanti*	Sensitive	Not listed
Gray Wolf	*Canis lupus*	Secure	Not listed
Grizzly bear	*Ursus americanus*	**At Risk**	**COSEWIC: Special Concern**
Least Weasel	*Mustela nivalis*	Secure	Not listed
Long-tailed Weasel	*Mustela frenata*	**May Be At Risk**	Not listed
Northern River Otter	*Lutra canadensis*	Secure	Not listed
Red fox	*Vulpes vulpes*	Secure	Not listed
Short-tailed Weasel	*Mustela erminea*	Secure	Not listed
Striped Skunk	*Mephitis mephitis*	Secure	Not listed
Wolverine	*Gulo gulo*	**May Be At Risk**	**COSEWIC: Special Concern**
Ungulates			
Bighorn sheep	*Ovis canadensis*	Secure	Not listed
Elk	*Cervus elaphus*	Secure	Not listed
Moose	*Alces alces*	Secure	Not listed
Mountain goat	*Oreamnos americanus*	Secure	Not listed
Mule deer	*Odocoileus hemionus*	Secure	Not listed
White-tailed deer	*Odocoileus virginianus*	Secure	Not listed
Bats			
Big brown bat	*Eptesicus fuscus*	Secure	Not listed
Hoary bat	*Lasiurus cinereus*	**Sensitive**	Not listed
Little brown Myotis	*Myotis lucifugus*	Secure	**COSEWIC: Endangered; SARA: Schedule 1 Endangered**
Long-legged Myotis	*Myotis volans*	Undetermined	Not listed
Northern long-eared Myotis	*Myotis septentrionalis*	**May Be At Risk**	**COSEWIC: Endangered; SARA: Schedule 1 Endangered**
Silver-haired bat	*Lasionycteris noctivagans*	**Sensitive**	Not listed
Western long-eared Myotis	*Myotis evotis*	Secure	Not listed
Hares and Rodents			
American beaver	*Castor canadensis*	Secure	Not listed
American pika	*Ochotona princeps*	Secure	Not listed
Bushy-tailed Woodrat	*Neotoma cinerea*	Secure	Not listed
Columbian ground squirrel	*Spermophilus columbianus*	Secure	Not listed
Common muskrat	*Ondatra zibethicus*	Secure	Not listed
Common porcupine	*Erethizon dorsatum*	Secure	Not listed
Deer mouse	*Peromyscus maniculatus*	Secure	Not listed

[1] ESRD 2010

2 Government of Canada Species at Risk Registry

3 Government of Canada Committee on the Status of Endangered Wildlife in Canada

Table C-1 Mammal Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status[1]	Federal Status Under the Species at Risk Act (SARA)[2] and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[3]
Dusky shrew	*Sorex monticolus*	Secure	Not listed
Golden-mantled ground-squirrel	*Spermophilus lateralis*	Secure	Not listed
Heather vole	*Phenacomys intermedius*	Secure	Not listed
Hoary marmot	*Marmota caligata*	Secure	Not listed
House mouse	*Mus musculus*	Exotic	Not listed
Least chipmunk	*Eutamias minimus*	Secure	Not listed
Long-tailed vole	*Microtus longicaudus*	Secure	Not listed
Northern bog lemming	*Synaptomys borealis*	Secure	Not listed
Northern flying squirrel	*Glaucomys sabrinus*	Secure	Not listed
Northern water shrew	*Sorex palustris*	Secure	Not listed
Masked shrew	*Sorex cinereus*	Secure	Not listed
Meadow vole	*Microtus pennsylvanicus*	Secure	Not listed
Muskrat	*Ondatra zibethicus*	Secure	Not listed
Pygmy shrew	*Sorex hoyi*	Secure	Not listed
Red squirrel	*Tamiasciurus hudsonicus*	Secure	Not listed
Richardson's ground squirrel	*Spermophilus richardsonii*	Secure	Not listed
Snowshoe hare	*Lepus americanus*	Secure	Not listed
Southern red-backed vole	*Myodes gapperi*	Secure	Not listed
Wandering shrew /vagrant shrew	*Sorex vagrans*	**May Be At Risk**	Not listed
Water vole	*Microtus richardsoni*	**Sensitive**	Not listed
Western jumping mouse	*Zapus princeps*	Secure	Not listed
Yellow pine chipmunk	*Neotamias minimus*	Secure	Not listed

Table C-2 Bird Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status	Federal Status Under the Species at Risk Act and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Seasonal distribution
Ducks, Geese and Swans				
American wigeon	*Anas americana*	Secure	Not Listed	Uncommon breeder, spring and fall migrant
Barrow's goldeneye	*Bucephala islandica*	Secure	Not Listed	Common breeder
Blue-winged teal	*Anas discors*	Secure	Not Listed	Uncommon breeder
Bufflehead	*Bucephala albeola*	Secure	Not Listed	Common breeder
Canada goose	*Branta canadensis*	Secure	Not Listed	Common breeder
Common goldeneye	*Bucephala clangula*	Secure	Not Listed	Common breeder
Common merganser	*Mergus merganser*	Secure	Not Listed	Common breeder
Harlequin duck	*Histrionicus histrionicus*	**Sensitive**	Not Listed	Uncommon breeder
Hooded merganser	*Lophodytes cucullatus*	Secure	Not Listed	Uncommon breeder
Lesser scaup	*Aythya affinis*	**Sensitive**	Not Listed	Uncommon breeder, spring and fall migrant

Table C-2 Bird Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status	Federal Status Under the Species at Risk Act and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Seasonal distribution
Mallard	*Anas platyrhynchos*	Secure	Not Listed	Common breeder
Northern shoveler	*Anas clypeata*	Secure	Not Listed	Uncommon breeder, spring and fall migrant
Redhead	*Aythya americana*	Secure	Not Listed	Uncommon breeder, spring and fall migrant
Ring-necked duck	*Aythya collaris*	Secure	Not Listed	Uncommon breeder, spring and fall migrant
Ruddy duck	*Oxyura jamaicensis*	Secure	Not Listed	Uncommon breeder, spring and fall migrant
Trumpeter swan	*Cygnus buccinator*	**At Risk**	COSEWIC: Not At Risk	Uncommon breeder and spring and fall migrant
Tundra swan	*Cygnus columbianus*	Secure	COSEWIC: Not At Risk	spring and fall migrant
Grouse				
Ruffed grouse	*Bonasa umbellus*	Secure	Not Listed	Uncommon year round
Spruce grouse	*Falicpennis canadensis*	Secure	Not Listed	Uncommon year round
White-tailed ptarmigan	*Lagopus leucura*	Secure	Not Listed	Uncommon year round
Loons and Grebes				
Common loon	*Gavia immer*	Secure	COSEWIC: Not At Risk	Common breeder
Horned grebe	*Podiceps auritus*	**Sensitive**	**COSEWIC: Special Concern**	Uncommon breeder, spring and fall migrant
Pacific loon	*Gavia pacifica*	Secure	Not Listed	Uncommon migrant
Pied-billed grebe	*Podilymbus podiceps*	**Sensitive**	Not Listed	Uncommon breeder
Red-necked grebe	*Podiceps grisegena*	Secure	COSEWIC: Not At Risk	Uncommon breeder, spring and fall migrant
Western grebe	*Aechmophorus occidentalis*	**Sensitive**	**COSEWIC: Special Concern**	Uncommon breeder, spring and fall migrant
Herons				
Great blue heron	*Ardea herodias*	**Sensitive**	Not Listed	Common breeder
Hawks and Eagles				
Bald eagle	*Haliaeetus leucocephalus*	**Sensitive**	COSEWIC: Not At Risk	common breeder
Cooper's hawk	*Accipiter cooperii*	Secure	COSEWIC: Not At Risk	uncommon breeder
Golden eagle	*Aquila chrysaetos*	**Sensitive**	COSEWIC: Not At Risk	Uncommon year round, common spring and fall migrant
Northern goshawk	*Accipiter gentilis*	**Sensitive**	COSEWIC: Not At Risk	uncommon year round
Northern harrier	*Circus cyaneus*	**Sensitive**	COSEWIC: Not At Risk	Uncommon breeder
Osprey	*Pandion haliaetus*	**Sensitive**	Not Listed	common breeder
Red-tailed hawk	*Buteo jamaicensis*	Secure	COSEWIC: Not At Risk	common breeder
Rough-legged Hawk	*Buteo lagopus*	Secure	COSEWIC: Not At Risk	Spring and fall migrant
Sharp-shinned hawk	*Accipiter striatus*	Secure	COSEWIC: Not At Risk	Uncommon breeder
Swainson's hawk	*Buteo swainsoni*	**Sensitive**	Not Listed	Uncommon breeder
Cranes, Rails and Coots				
American coot	*Fulica americana*	Secure	COSEWIC: Not At Risk	common breeder
Sandhill crane	*Grus canadensis*	**Sensitive**	Not Listed	uncommon breeder
Virginia rail	*Rallus limicola*	Undetermined	Not Listed	uncommon breeder

Table C-2 Bird Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status	Federal Status Under the Species at Risk Act and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Seasonal distribution
Shorebirds				
Barid's sandpiper	*Calidris bairdii*	Secure	Not Listed	Spring and fall migrant
Greater yellowlegs	*tringa melanoleuca*	Secure	Not Listed	Spring and fall migrant
Killdeer	*Charadrius vociferus*	Secure	Not Listed	Common breeder
Lesser yellowlegs	*tringa flavipes*	Secure	Not Listed	Spring and fall migrant
Pectoral sandpiper	*Calidris melanotos*	Secure	Not Listed	Spring and fall migrant
Solitary sandpiper	*tringa solitaria*	Secure	Not Listed	Uncommon breeder
Spotted sandpiper	*Actitis macularia*	Secure	Not Listed	Common breeder
Wilson's snipe	*Gallinago delicata*	Secure	Not Listed	Common breeder
Dippers				
American dipper	*Cinclus mexicanus*	Secure	Not Listed	Common year-round
Gulls and Terns				
Black tern	*Chlidonias niger*	**Sensitive**	Not Listed	uncommon breeder, spring and fall migrant
Bonaparte's gull	*Chroicocephalus philadelphia*	Secure	Not Listed	**spring and fall migrant**
California gull	*Larus californicus*	Secure	Not Listed	**spring and fall migrant**
Herring gull	*Larus argentatus*	Secure	Not Listed	**spring and fall migrant**
Ring-billed gull	*Larus delawarensis*	Secure	Not Listed	uncommon breeder, spring and fall migrant
Doves and Pigeons				
Mourning dove	*Zenaida macroura*	Secure	Not Listed	uncommon breeder
Rock pigeon	*Columba livia*	Exotic	Not Listed	common year round
Owls				
Barred owl	*Strix varia*	**Sensitive**	Not Listed	uncommon year round
Boreal owl	*Aegolius funereus*	Secure	COSEWIC: Not At Risk	uncommon year round
Great gray owl	*Strix nebulosa*	**Sensitive**	COSEWIC: Not At Risk	uncommon year round
Great horned owl	*Bubo virginianus*	Secure	Not Listed	common year round
Long-eared owl	*Asio otus*	Secure	Not Listed	uncommon breeder
Northern hawk owl	*Surnia ulula*	Secure	COSEWIC: Not At Risk	uncommon year round
Northern pygmy-owl	*Glaucidium gnoma*	**Sensitive**	Not Listed	uncommon year round
Northern saw-whet owl	*Aegolius acadicus*	Secure	Not Listed	common breeder
Nightjars				
Common nighthawk	*Chordeiles minor*	**Sensitive**	**SARA: Schedule 1 Threatened**	**uncommon breeder**
Swifts				
Black swift	*Cypseloides niger*	Undetermined	**COSEWIC: Endangered**	**uncommon breeder**
Hummingbirds				
Calliope hummingbird	*Stellula calliope*	Secure	Not Listed	common breeder
Rufous hummingbird	*Selasphorus rufus*	Secure	Not Listed	common breeder
Kingfishers				
Belted kingfisher	*Megaceryle alcyon*	Secure	Not Listed	common breeder
Woodpeckers and Allies				
American three-toed woodpecker	*Picoides dorsalis*	Secure	Not Listed	common year round
Black-backed woodpecker	*Picoides arcticus*	**Sensitive**	Not Listed	uncommon year round

Table C-2 Bird Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status	Federal Status Under the Species at Risk Act and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Seasonal distribution
Downy woodpecker	*Picoides pubescens*	Secure	Not Listed	common year round
Hairy woodpecker	*Picoides villosus*	Secure	Not Listed	common year round
Northern flicker	*Colaptes auratus*	Secure	Not Listed	common breeder
Pileated woodpecker	*Dryocopus pileatus*	**Sensitive**	Not Listed	common year round
Red-naped sapsucker	*Sphyrapicus nuchalis*	Undetermined	Not Listed	common breeder
Falcons				
American kestrel	*Falco sparverius*	**Sensitive**	Not Listed	uncommon breeder
Merlin	*Falco columbaris*	Secure	COSEWIC: Not At Risk	uncommon year round
Peregrine falcon	*Falco peregrinus anatum*	**At Risk**	**SARA: Schedule 1 Special Concern**	uncommon breeder, spring and fall migrant
Prairie falcon	*Falco mexicanus*	**Sensitive**	COSEWIC: Not At Risk	uncommon year round
Flycatchers				
Alder flycatcher	*Empidonax alnorum*	Secure	Not Listed	common breeder
Dusky flycatcher	*Empidonax oberholseri*	Secure	Not Listed	common breeder
Eastern kingbird	*Tyrannus tyrannus*	Secure	Not Listed	common breeder
Eastern phoebe	*Sayornis phoebe*	**Sensitive**	Not Listed	uncommon breeder
Hammond's flycatcher	*Empidonax hammondii*	Secure	Not Listed	uncommon breeder
Least flycatcher	*Empidonax minimus*	**Sensitive**	Not Listed	common breeder
Olive-sided flycatcher	*Contopus cooperi*	**May Be At Risk**	**SARA: Schedule 1 Threatened**	**uncommon breeder**
Pacific-slope flycatcher	*Empidonax difficilis*	Undetermined	Not Listed	uncommon breeder
Western wood-pewee	*Contopus sordidulus*	**Sensitive**	Not Listed	common breeder
Willow flycatcher	*Empidonax traillii*	Secure	Not Listed	common breeder
Shrikes and Vireos				
Cassin's vireo	*Vireo cassinii*	Undetermined	Not Listed	common breeder
Northern shrike	*Lanius excubitor*	Secure	Not Listed	spring and fall migrant
Red-eyed vireo	*Vireo olivaceus*	Secure	Not Listed	common breeder
Warbling vireo	*Vireo gilvus*	Secure	Not Listed	common breeder
Jays and Crows				
American crow	*Corvus brachyrhynchos*	Secure	Not Listed	common breeder
Black-billed magpie	*Pica hudsonia*	Secure	Not Listed	common year round
Blue jay	*Cyanocitta cristata*	Secure	Not Listed	uncommon year round
Clark's nutcracker	*Nucifraga columbiana*	**Sensitive**	Not Listed	common year round
Common raven	*Corvus corax*	Secure	Not Listed	common year round
Gray jay	*Perisoreus canadensis*	Secure	Not Listed	common year round
Steller's jay	*Cyanocitta stelleri*	Secure	Not Listed	uncommon year round
Larks and pipits				
American pipit	*Anthus rubescens*	Secure	Not Listed	**common breeder**
Horned lark	*Eremophila alpestris*	Secure	Not Listed	**common breeder**
Swallows				
Bank swallow	*Riparia riparia*	Secure	Not Listed	common breeder
Barn swallow	*Hirundo rustica*	**Sensitive**	**COSEWIC: Threatened**	common breeder
Cliff Swallow	*Petrochelidon pyrrhonota*	Secure	Not Listed	common breeder

Table C-2 Bird Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status	Federal Status Under the Species at Risk Act and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Seasonal distribution
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Secure	Not Listed	common breeder
Tree swallow	*Tachycineta bicolor*	Secure	Not Listed	common breeder
Violet-green swallow	*Tachycineta thalassina*	Secure	Not Listed	common breeder
Chickadees, Nuthatches and Creepers				
Black-capped chickadee	*Poecile atricapillus*	Secure	Not Listed	common year round
Boreal chickadee	*Poecile hudsonicus*	Secure	Not Listed	common year round
Brown creeper	*Certhia americana*	**Sensitive**	Not Listed	common breeder
Mountain chickadee	*Poecile gambeli*	Secure	Not Listed	common year round
Red-breasted nuthatch	*Sitta canadensis*	Secure	Not Listed	common year round
White-breasted nuthatch	*Sitta carolinensis*	Secure	Not Listed	uncommon year round
Wrens and Kinglets				
Golden-crowned kinglet	*Regulus satrapa*	Secure	Not Listed	common breeder
House wren	*Troglodytes aedon*	Secure	Not Listed	common breeder
Marsh wren	*Cistothorus palustris*	Secure	Not Listed	uncommon breeder
Rock wren	*Salpinctes obsoletus*	Secure	Not Listed	uncommon breeder
Ruby-crowned kinglet	*Regulus calendula*	Secure	Not Listed	common breeder
Winter wren	*Troglodytes troglodytes*	Secure	Not Listed	common breeder
Thrushes				
American robin	*Turdus migratorius*	Secure	Not Listed	common breeder
Hermit thrush	*Catharus guttatus*	Secure	Not Listed	common breeder
Mountain bluebird	*Sialia currucoides*	Secure	Not Listed	uncommon breeder
Swainson's thrush	*Catharus ustulatus*	Secure	Not Listed	common breeder
Townsend's solitaire	*Myadestes townsendi*	Secure	Not Listed	common breeder
Varied thrush	*Ixoreus naevius*	Secure	Not Listed	common breeder
Veery	*Catharus fuscescens*	Secure	Not Listed	uncommon breeder
Waxwings and Starling				
Bohemian waxwing	*Bombycilla garrulus*	Secure	Not Listed	uncommon breeder, spring and fall migrant
Cedar waxwing	*Bombycilla cedrorum*	Secure	Not Listed	common breeder
European starling	*Sturnus vulgaris*	Exotic	Not Listed	common breeder
Wood-warblers				
American redstart	*Setophaga ruticilla*	Secure	Not Listed	common breeder
Blackpoll warbler	*Dendroica striata*	Secure	Not Listed	uncommon breeder
Common yellowthroat	*Geothlypis trichas*	**Sensitive**	Not Listed	common breeder
Macgillivray's warbler	*Oporornis tolmiei*	Secure	Not Listed	common breeder
Nashville warbler	*Vermivora ruficapilla*	Secure	Not Listed	uncommon breeder
Northern waterthrush	*Seiurus noveboracensis*	Secure	Not Listed	common breeder
Orange-crowned warbler	*Vermivora celata*	Secure	Not Listed	common breeder
Ovenbird	*Seiurus aurocapilla*		Not Listed	common breeder
Tennessee warbler	*Oreothlypis peregrina*	Secure	Not Listed	common breeder
Townsend's warbler	*Dendroica townsendi*	Secure	Not Listed	common breeder

Table C-2 Bird Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status	Federal Status Under the Species at Risk Act and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Seasonal distribution
Wilson's warbler	*Wilsonia pusilla*	Secure	Not Listed	common breeder
Yellow warbler	*Dendroica petechia*	Secure	Not Listed	common breeder
Yellow-rumped warbler	*Dendroica coronata*	Secure	Not Listed	common breeder
Towees, Sparrows, Juncos and Longspurs				
American tree sparrow	*Spizella arborea*	Secure	Not Listed	spring and fall migrant
Brewer's sparrow	*Spizella breweri*	**Sensitive**	Not Listed	common breeder
Chipping sparrow	*Spizella passerina*	Secure	Not Listed	common breeder
Clay-colored sparrow	*Spizella pallida*	Secure	Not Listed	common breeder
Dark-eyed junco	*Junco hyemalis*	Secure	Not Listed	common breeder
Fox sparrow	*Passerella iliaca*	Secure	Not Listed	common breeder
Golden-crowned sparrow	*Zonotrichia atricapilla*	Secure	Not Listed	common breeder
Lapland longspur	*Calcarius lapponicus*	Secure	Not Listed	spring and fall migrant
Lincoln's sparrow	*Melospiza lincolnii*	Secure	Not Listed	common breeder
Savannah sparrow	*Passerculus sandwichensis*	Secure	Not Listed	common breeder
Song sparrow	*Melospiza melodia*	Secure	Not Listed	common breeder
Vesper sparrow	*Pooecetes gramineus*	Secure	Not Listed	common breeder
White-crowned sparrow	*Zonotrichia leucophrys*	Secure	Not Listed	common breeder
White-throated sparrow	*Zonotrichia albicollis*	Secure	Not Listed	common breeder
Tanagers, Grosbeaks, Buntings				
Black-headed grosbeak	*Pheucticus melanocephalus*	Secure	Not Listed	uncommon breeder
Lazuli bunting	*Passerina amoena*	Secure	Not Listed	common breeder
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Secure	Not Listed	spring and fall migrant
Snow bunting	*Plectrophenax nivalis*	Secure	Not Listed	spring and fall migrant
Western tanager	*Piranga ludoviciana*	**Sensitive**	Not Listed	common breeder
Blackbirds				
Baltimore oriole	*Icterus galbula*	**Sensitive**	Not Listed	uncommon breeder
Brewer's blackbird	*Euphagus cyanocephalus*	Secure	Not Listed	common breeder
Brown-headed cowbird	*Molothrus ater*	Secure	Not Listed	common breeder
Common grackle	*Quiscalus quiscula*	Secure	Not Listed	uncommon breeder
Red-winged blackbird	*Agelaius phoeniceus*	Secure	Not Listed	common breeder
Rusty blackbird	*Euphagus carolinus*	**Sensitive**	**SARA: Schedule 1 Special Concern**	spring and fall migrant
Finches and Relatives				
American goldfinch	*Spinus tristis*	Secure	Not Listed	not listed
Common redpoll	*Acanthis flammea*	Secure	Not Listed	spring and fall migrant
Evening grosbeak	*Coccothraustes vespertinus*	Secure	Not Listed	uncommon breeder
Gray-crowned rosy-finch	*Leucosticte tephrocotis*	Secure	Not Listed	common breeder
House sparrow	*Passer domesticus*	Exotic	Not Listed	common breeder
Pine grosbeak	*Pinicola enucleator*	Secure	Not Listed	uncommon breeder

Table C-2 Bird Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status	Federal Status Under the Species at Risk Act and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Seasonal distribution
Pine siskin	*Spinus pinus*	Secure	Not Listed	common breeder
Purple finch	*Carpodacus purpureus*	Secure	Not Listed	uncommon breeder, spring and fall migrant
Red crossbill	*Loxia curvirostra*	Secure	Not Listed	common breeder
White-winged crossbill	*Loxia leucoptera*	Secure	Not Listed	common breeder

Table C-3 Amphibian and Reptiles Species that May Occur within the Canmore Region

Common Name	Latin Name	General Provincial Status[2]	Federal Status Under the Species at Risk Act (SARA)[2] and the Committee on the Status of Endangered Wildlife in Canada (COSEWIC)[3]
Frogs			
Boreal chorus frog	*Pseudacris maculata*	Secure	Not listed
Columbia spotted frog	*Rana luteiventris*	**Sensitive**	COSEWIC: Not at Risk
Wood frog	*Lithobates sylvatica*	Secure	Not listed
Toads			
Western toad	*Anaxyrus boreas*	**Sensitive**	**SARA: Schedule 1 Special Concern**
Salamanders			
Long-toed salamander	*Ambystoma macrodactylum*	**Sensitive**	COSEWIC: Not at Risk
Tiger salamander	*Ambystoma mavortium*	Secure	COSEWIC: Not at Risk
Snakes			
Red-sided garter snake	*Thamnophis sirtalis*	**Sensitive**	Not listed
Wandering garter snake	*Thamnophis elegans*	**Sensitive**	Not listed

[2] ESRD 2010.

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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