TABLE OF CONTENTS

A.10 – FISH AND AQUATIC RESOURCES A.10-1

A.10.1 INTRODUCTION A.10-1
A.10.2 FISHERIES ACT – FISHERIES PROTECTION PROVISIONS A.10-6
A.10.2.1.1 R273 ..... A.10-6
A.10.3 CHARGE WEIGHTS A.10-7
A.10.3.1.1 R274 ..... A.10-7
A.10.4 BASELINE DATA A.10-7
A.10.4.1.1 R275 ..... A.10-7
A.10.4.1.2 R276 ..... A.10-8
A.10.4.1.3 R277 ..... A.10-21
A.10.4.1.4 R278 ..... A.10-24
A.10.4.1.5 R279 ..... A.10-24
A.10.4.1.6 R280 ..... A.10-25
A.10.4.2 Missing Appendices Documenting Baseline Data A.10-25
A.10.4.2.1 R281 ..... A.10-25
A.10.5 HABITAT LOSS, ALTERATION AND COMPENSATION A.10-26
A.10.5.1 Flow and Wetted Area Reduction A.10-26
A.10.5.1.1 R282 ..... A.10-26
A.10.5.1.2 R283 ..... A.10-26
A.10.5.1.3 R284 ..... A.10-26
A.10.5.1.4 R285 ..... A.10-26
A.10.5.2 Tailings Management Facility Fish Barrier A.10-30
A.10.5.2.1 R286 ..... A.10-30
A.10.5.2.2 R287 ..... A.10-31
A.10.5.3 Airstrip Diversion Channel A.10-32
A.10.5.3.1 R288 ..... A.10-32
A.10.5.3.2 R289 ..... A.10-32
A.10.5.4 Fisheries Protection Provisions of the Fisheries Act A.10-33
A.10.5.4.1 R290 ..... A.10-33
A.10.5.5 Physical Habitat Simulation Model and Habitat Evaluation Procedure A.10-33
A.10.5.5.1 R291 ..... A.10-33
A.10.5.5.2 R292 ..... A.10-34
A.10.5.6 Habitat Loss Calculations – Airstrip Diversion Channel A.10-34
A.10.5.6.1 R293 ..... A.10-34
A.10.5.6.2 R294 ..... A.10-34

A.10.5.7 Habitat Evaluation Procedure Analysis A.10-34
A.10.5.7.1 R295 ..... A.10-34
A.10.5.8 Ford Rehabilitation A.10-35
A.10.5.8.1 R296 ..... A.10-35
A.10.6 WATERCOURSE CROSSINGS A.10-35
A.10.6.1 Embedded Culverts on Fish Bearing Streams A.10-35
A.10.6.1.1 R297 ..... A.10-35
A.10.6.2 Existing Stream Crossings A.10-35
A.10.6.2.1 R298 ..... A.10-35
A.10.6.3 Nordenskiold River Bridge A.10-36
A.10.6.3.1 R299 ..... A.10-36
A.10.6.3.2 R300 ..... A.10-36
A.10.6.3.3 R301 ..... A.10-37
A.10.6.4 Classification of Crossings A.10-38
A.10.6.4.1 R302 ..... A.10-38
A.10.6.5 Erosion A.10-39
A.10.6.5.1 R303 ..... A.10-39
A.10.6.5.2 R304 ..... A.10-39
A.10.6.5.3 R305 ..... A.10-115
A.10.7 AQUATIC MONITORING PLAN A.10-116
A.10.7.1.1 R306 ..... A.10-116
A.10.8 CLARIFICATION A.10-117
A.10.8.1.1 R307 ..... A.10-117

LIST OF TABLES

Table A.10.1-1 Requests for Supplementary Information Related to Fish and Aquatic Resources A.10-2
Table A.10.4-1 Fish Sampling Effort above an Identified Barrier (2008-2010) A.10-21
Table A.10.4-2 Rationale for Non-Fish-Bearing Status along the proposed Freegold Upgrade, Extension, and Airstrip and Airstrip Road A.10-23
Table A.10.4-3 Fisheries Baseline Information Locater A.10-25
Table A.10.5-1 Fish Habitat Sites and Habitat Quality Assessment A.10-27
Table A.10.5-2 Habitat Index values (m^2/s per 1000 m stream) versus flow for all life stages of Arctic grayling in Casino Creek including adult and juvenile winter values A.10-28
Table A.10.5-3 Results of the March 2013 Pool Investigations in Casino Creek A.10-29

LIST OF FIGURES

Figure A.10.4-1 Overview Map of the Casino Mine Roads and Watersheds A.10-13
Figure A.10.4-2 Freegold Road Upgrade Fish Presence/Absence (Map 1) A.10-14
Figure A.10.4-3 Freegold Road Upgrade Fish Presence/Absence (Map 2) A.10-15
Figure A.10.4-4 Freegold Road Upgrade Fish Presence/Absence (Map 3) A.10-16
Figure A.10.4-5 Freegold Road Extension Fish Presence/Absence (Map 1) A.10-17
Figure A.10.4-6 Freegold Road Extension Fish Presence/Absence (Map 2) A.10-18
Figure A.10.4-7 Freegold Road Extension Fish Presence/Absence (Map 3) A.10-19
Figure A.10.4-8 Airstrip and Airstrip Access Road Fish Presence/Absence A.10-20
Figure A.10.4-9 Casino Creek Fish and Aquatic Resources Baseline Summary Map A.10-22
Figure A.10.5-1 Proposed drop fish barrier structure downstream of the TMF on Casino Creek A.10-30
Figure A.10.5-2 Average winter water surface elevations (WSE) at Casino Creek low gradient riffle 182 during baseline, construction, operation, closure, and post-closure conditions A.10-32
Figure A.10.6-1 Freegold Road Extension Map 1 Erosion Potential A.10-40
Figure A.10.6-2 Freegold Road Extension Map 2 Potential Ecological Consequences A.10-65
Figure A.10.6-3 Freegold Road Extension Map 3 Overall Erosion and Sedimentation Risk A.10-90

APPENDICES

Appendix A.10A Updated Fish Habitat Offsetting Plan
Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study

A.10 – FISH AND AQUATIC RESOURCES

A.10.1 INTRODUCTION

Potential effects of the Project on fish and aquatic resources were evaluated in Section 10 of the Proposal. The assessment concluded that no significant habitat loss and alteration, lethal effects, sub-lethal effects, or cumulative effects on fish and aquatic organisms are predicted to occur due to the Casino Project. All residual effects were considered non-significant due to the low geographical extent, and low to medium magnitude of the anticipated impacts. The assessment of significance is contingent on the complete implementation of mitigation measures, including proposed compensation works.

While habitat loss and alteration in Casino Creek will be notable, the reduction in available habitat will be offset with new higher quality habitat in lower Britannia Creek. For example, flow reductions during winter may decrease or eliminate the low amount of overwintering habitat currently available in lower Casino Creek, however, the proposed compensation pond will more than offset this loss. Overall, the net habitat gain will ensure that there is no impact on the productive capacity of habitat on a regional scale.

Impacts from mine effluent discharge are not anticipated to be significant based on the application of alternative water quality guidelines which take into account site-specific water chemistry including high water hardness, and elevated baseline metal concentrations. The designation of non-significance is directly formulated on results from the water quality model.

Sub-lethal effects on fish and local aquatic biota are difficult to predict owing to the number of factors involved (e.g., lowered flows, temperature increases, altered channel morphology) and the uncertainty surrounding their potential interactions. Thus, monitoring of water quality and aquatic communities at near-field sites in Casino, Dip, Canadian and Britannia Creeks is required to identify and potentially mitigate/compensate any future impacts on the fitness of local fish species. Despite the uncertainty involved, potential project impacts are not predicted to yield far-reaching effects on regional productivity or diversity.

On January 27, 2015, the Executive Committee requested that Casino Mining Corporation (CMC) provide supplementary information to the proposed Casino Project (YESAB Project No. 2014-0002) to enable completion of a Draft Screening Report. The Executive Committee considered received comments from various First Nations, Decision Bodies and regulators on the adequacy of the Project Proposal in the preparation of the Adequacy Review Report (ARR). Casino Mining Corporation is providing this Supplementary Information Report (SIR) as an addendum to the Project Proposal to assist the Executive Committee in preparation of the Draft Screening Report.

The Executive Committee has 34 requests related to information presented in Section 10 Fish and Aquatic Resources of the Project Proposal submitted on January 3, 2014. These requests are outlined in Table A.10.1-1. Some responses require detailed technical information, data, and figures. Where necessary, this additional supporting information is provided as appendices to the SIR.

Table A.10.1-1 Requests for Supplementary Information Related to Fish and Aquatic Resources

Request #	Request for Supplementary Information	Response
R273	An updated Section 10 of the proposal which reflects the current *Fisheries Act* (Fisheries Protection Provisions). This updated section should include the identification of project components likely requiring a paragraph 35(2)(b) *Fisheries Act* authorization.	Section A.10.2.1.1 Appendix A.10A Updated Fish Habitat Offsetting Plan
R274	Proposed charge weights to be used for different project activities including the operation of the mine pit, and construction of infrastructure site pads and access roads. Indicate setback distances from fish-bearing waters for each activity and an analysis of potential effects based on this information.	Section A.10.3.1.1 Appendix A.10A Updated Fish Habitat Offsetting Plan Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R275	Baseline data for the creek intersected by the proposed airstrip, Taylor Creek, and other Casino Creek tributaries lacking baseline data including a. the existing condition, including quality and relative abundance, of the fish habitat; and b. the species and life stages of fish present.	Section A.10.4.1.1
R276	A discussion of fish populations, densities, and diversity in downstream watercourses including lower Dip Creek and the Klotassin River.	Section A.10.4.1.2
R277	Maps demonstrating fish presence, assumed absence, or observed absence by stream segment. Include the stream channel intersected by the proposed airstrip, Casino Creek tributaries such as Taylor Creek, and the Freegold Road. Where fish are assumed as absent, provide rationale.	Section A.10.4.1.3
R278	Maps demonstrating fish habitat quality and fish distribution by species for watercourses including Casino Creek and its tributaries, Dip Creek downstream of its confluence with Casino Creek, and Britannia Creek and its tributaries. Include any seasonal barriers to movement.	Section A.10.4.1.4
R279	A table or other tool identifying the location in the proposal of supporting baseline information for each of the potentially impacted watercourses.	Section A.10.4.1.5
R280	Information on the time of year each of the water bodies potentially affected by the Project are likely to be used by the various life stages of each fish species.	Section A.10.4.1.6
R281	Appendices A through E for Appendix 10 A – Casino Project Fish and Aquatic Resources Baseline Report, November 12, 2013, by Palmer Environmental Consulting Group Inc.	Section A.10.4.2.1

Request #	Request for Supplementary Information	Response
R282	A description of the detailed methods used to calculate the estimated reductions in flow and wetted area from baseline conditions in all watercourses affected. (EcoMetrix)	Section A.10.5.1.1 Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R283	An indication of and rationale for the selected minimum in-stream flow threshold. (EcoMetrix)	Section A.10.5.1.2 Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R284	The full documents cited as KPL 2013 and Normandeau, November 2013. (EcoMetrix)	Section A.10.5.1.3 Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R285	A discussion of the extent to which the identified overwintering and spawning habitat in the affected portion of Casino Creek is actively used by Arctic grayling for these stages, and the potential effects of the Project to this habitat.	Section A.10.5.1.4 Appendix A.10A Updated Fish Habitat Offsetting Plan Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R286	A discussion of the potential fish barrier proposed to be installed above the Casino- Brynelson Creek confluence. This discussion should include: a. description of the barrier proposed, and details regarding its installation; and b. identification of alternative mitigations to the physical fish barrier in this location to prevent winter kill and fish stranding.	Section A.10.5.2.1
R287	The degree of risk for fish stranding to actually occur in Casino Creek due to low water flow attributed to the operation of the tailings management facility.	Section A.10.5.2.2 Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R288	A discussion of and rationale for the diversion of this drainage around the airstrip. This discussion should consider alternatives, such as allowing the drainage to pass underneath the airstrip.	Section A.10.5.3.1 Appendix A.10A Updated Fish Habitat Offsetting Plan Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R289	A discussion of the potential for seasonal stranding of fish in the lower portion of the dewatered channel.	Section A.10.5.3.2

Request #	Request for Supplementary Information	Response
R290	An updated Fish Habitat Compensation Plan to align with the new requirements of the *Fisheries Protection Provisions* of the new *Fisheries Act*.	Section A.10.5.4.1 Appendix A.10A Updated Fish Habitat Offsetting Plan
R291	A detailed description of the physical habitat simulation model. Details should include: a. data used in the model (habitat and hydrological) and methods for field data collection; b. locations of all transects (of each mesohabitat type - riffle, pool and glide) on each watercourse; c. habitat suitability indices (HSI) curves for Arctic grayling in all life stages which consider site specific conditions; d. species and life stage periodicity chart highlighting the seasonal use of the study area by different life stages of the target species, and a discussion of whether migration patterns were considered in the model; e. discussion of whether seasonal use by life stage requirements of target species was considered in the model; f. target flow velocities for low, mid and high flows, with a comparison to the baseline and projected flows for construction, operation and closure phases, indicating and providing rationale for the selected minimum in-stream threshold; g. discussion of impacts to Britannia Creek from reduced flows in Canadian Creek as flow is redirected to the pit; and h. a comparison of percent reduction in flow for areas affected by reduced stream flows considering natural variability observed in stream.	Section A.10.5.5.1 Appendix A.10B Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study
R292	A detailed description of the habitat evaluation procedure. Details should include: a. methods and assumptions for the calculation of habitat lost; b. summary of HSI values for each variable; c. identification of and rationale for habitat types included; and d. data and methods used to calculate habitat gains, including from all proposed compensation options.	Section A.10.5.5.2 Appendix A.10B
R293	Clarification of whether the estimated habitat loss in Dip Creek was accounted for in the total habitat loss calculation for the proposed airstrip tributary diversion channel.	Section A.10.5.6.1

Request #	Request for Supplementary Information	Response
R294	Clarification of, and rationale for, the methods used to calculate the figures in Table 4-5: in-stream habitat impacts and in-stream habitat gains. This clarification should include the calculation of 4753 m² as identified in Table 4-5, based on the proposed airstrip diversion channel width of 2.5 m and length of 1 509 m.	Section A.10.5.6.2 Appendix A.10A Updated Fish Habitat Offsetting Plan
R295	Clarification of whether the assumed fish bearing streams (those of less than 20 percent gradient) were included in the habitat evaluation procedure analysis for habitat loss and compensation.	Section A.10.5.7.1
R296	Identification and rationale for the type(s) of habitat created by ford restoration.	Section A.10.5.8.1 Appendix A.10A Updated Fish Habitat Offsetting Plan
R297	Clarification of whether clear-span bridges are proposed for all fish-bearing watercourses. If culverts will be installed on some fish-bearing creeks, please provide rationale, mitigations, and incorporate habitat losses into the habitat compensation plan.	Section A.10.6.1.1
R298	Details on existing crossing structures no longer used for portions of the Freegold Road upgrade once the road is re-aligned.	Section A.10.6.2.1
R299	Details on when and how the Nordenskiold River bridge pier will be constructed.	Section A.10.6.3.1
R300	The quality and type of fish habitat (e.g. highly suitable spawning and/or rearing habitat, confirmed spawning habitat, and migratory channel) potentially affected by the Nordenskiold River bridge. Discussion should include identification of potential effects of the bridge and the pier, focusing on potential long-term morphological changes to the river in contrast to natural morphological changes.	Section A.10.6.3.2
R301	The fish species (and their life stages) present in the area potentially affected by the Nordenskiold River bridge. Discussion should include identification of potential effects of the bridge and the pier.	Section A.10.6.3.3
R302	A list of stream crossings for the Freegold Road including stream name, kilometre marker, crossing properties and the type of crossing, considering DFO's definition of clear-span crossing.	Section A.10.6.4.1

Request #	Request for Supplementary Information	Response
R303	An assessment of the overall erosion and sedimentation risk that will form the basis for designing and ultimately preparing an erosion and sediment control plan for the Freegold Road Upgrade, Airstrip Access Road and Casino Mine site.	Section A.10.6.5.1
R304	Identification of fish-bearing and non fish-bearing reaches of affected watercourses in the Map Series 3 (overall erosion and sedimentation risk) of the Erosion and Sedimentation Risk Assessment Report.	Section A.10.6.5.2
R305	Discussion on the methods of monitoring for erosion and sedimentation during all phases of the Project.	Section A.10.6.5.3 Appendix A.10A Updated Fish Habitat Offsetting Plan Appendix A.22C Sediment and Erosion Control Management Plan
R306	Discussion of and rationale for the exclusion of W16 or other downstream locations from monitoring throughout the life of the Project.	Section A.10.7.1.1
R307	The information related in Section 7.4.5.1 and 7.4.5.2.	Section A.10.8.1.1

Notes:

1. Request # refers to the assigned identification number in the YESAB Adequacy Review Report January 27, 2015 Prepared by Executive Committee Yukon Environmental and Socio-economic Assessment Board.
2. Response refers to the location of CMC's response to the YESAB request for supplementary information.

A.10.2 FISHERIES ACT – FISHERIES PROTECTION PROVISIONS

A.10.2.1.1 R273

R273. An updated Section 10 of the proposal which reflects the current Fisheries Act (Fisheries Protection Provisions). This updated section should include the identification of project components likely requiring a paragraph 35(2)(b) Fisheries Act authorization.

On November 25, 2013 new fisheries protection provisions were enacted under Section 35 of the *Fisheries Act*, to support the Department of Fisheries and Oceans Canada's (DFO) new focus on avoiding "serious harm to fish", and the framework for offsetting any residual harm to fish. The new *Fisheries Act* provisions alter the legislative focus from "no net loss" of habitat to the "sustainability and ongoing productivity of commercial, recreational and Aboriginal (CRA) fisheries". The Proposal was submitted during the time of transition for the *Fisheries Act* legislation, and hence was consistent with the older version of the *Fisheries Act*. Based on CMC's interpretation of the new provisions, fish and aquatic resources within the Casino project area are still protected by the updated *Fisheries Act* legislation. Further, the new *Fisheries Act* provisions do not modify the size, number or nature of potential project effects on fisheries identified in the Fish and Aquatic Resources section of the Proposal. Section 35 of the *Fisheries Act* still includes a reference to protecting fish habitat, in that the definition of serious harm to fish incorporates any destruction or permanent alteration of fish habitat. Additionally, the new provisions still allow for habitat-based approaches, commonly used under the old provisions, during the assessment of potential

effects, and the development of mitigation and offsetting plans. Based on the similarities of the two Act versions, and the presence of CRA or CRA supporting species in the Casino project area, CMC has concluded that the previous Fish and Aquatic Resources effects assessment remains valid with minor terminology substitutions to the text. For clarification, the following substitutions may be made, although the intent of the text remains valid:

- ***Habitat loss*** can replace all references to Harmful Alteration, Disruption, or Destruction of Fish Habitat (***HADD***); and
- ***Sustainability and ongoing productivity of CRA fisheries*** can replace ***productive capacity of habitat***.

The Fish Habitat Compensation Plan previously submitted in the Proposal will require updating to reflect the changes in the *Fisheries Act*, as well as the finalized design of the proposed offsetting options. The initial plan submitted in the Proposal was to support DFOs review of the Proposal, with the understanding that a final detailed design for fish habitat offsetting was to be provided to DFO in association with CMC's subsequent request for *Fisheries Act* authorization. To reflect the changes to the *Fisheries Act*, as well as to update the plan with more detailed design and site selection techniques, CMC has provided the Fish Habitat Offsetting Plan (Appendix A.10A), which reflects the change in terminology of the new fisheries protection provisions.

A.10.3 CHARGE WEIGHTS

A.10.3.1.1 R274

R274. Proposed charge weights to be used for different project activities including the operation of the mine pit, and construction of infrastructure site pads and access roads. Indicate setback distances from fish-bearing waters for each activity and an analysis of potential effects based on this information.

While specific charge weights and associated setback distances are not currently available, DFO standard mitigation to prevent serious harm to fish by blasting will be considered for all blasting activities (Wright and Hopky 1998; DFO 2013). Where required, site-specific mitigation will be incorporated depending on proximity to fish habitat and sensitivity of known fish species. For example, if there is the potential for blasting activities to adversely affect fish, charge weights may be subdivided into a series of smaller charges (e.g., "decking") in blast holes with a delay between charge detonations. Examples of maximum charge weights per delay used during other open pit mining operations ranged from 630-750 kg per delay (e.g., Ekati Diamond Mine, New Prosperity). Thus, based on what has been observed as typical maximum detonation charges at other major mines, and the noted 1.2 km distance to the closest fish-bearing habitat in upper Canadian Creek, blasting activities in the Casino open pit area are not expected to have any influence on fish health (See Project Proposal Section 10, p. 10-30 for more details).

A.10.4 BASELINE DATA

A.10.4.1.1 R275

R275. Baseline data for the creek intersected by the proposed airstrip, Taylor Creek, and other Casino Creek tributaries lacking baseline data including:
a. the existing condition, including quality and relative abundance, of the fish habitat; and
b. the species and life stages of fish present.

Taylor Creek

Taylor Creek was assessed as part of the Upper Casino Creek Habitat Evaluation Procedure (HEP) study (Appendix A.10B). During this assessment, a fish barrier was identified on Taylor Creek approximately 275 m upstream of its confluence with Casino Creek. The barrier consisted of multiple vertical drops (0.35 - 0.8 m to estimated bankfull) with insufficient bankfull pool depths for Arctic grayling passage, as Arctic grayling require a minimum pool depth of 1.25x the vertical drop in order to surmount vertical barriers (Parker 2000). Fish sampling was conducted above the barrier in summer 2014 to further document and verify an absence of fish in Taylor Creek. No fish were caught using two sampling methods (overnight minnow trap sets and 587s of electrofishing) during late July 2014.

Casino Creek Unnamed Tributaries

The three unnamed Casino Creek tributaries were inferred as non-fish bearing based on undocumented field assessments during the baseline program. HEP assessments were completed during the 2014 field program to assess the habitat quality of these tributaries, and the Fish Habitat Offsetting Plan (Appendix A.10A) was modified according to results. All of the tributaries were small low quality streams that likely do not directly support fish, however, modelled habitat loss values were conservatively included in the overall habitat budget.

Dip Creek Tributary at the proposed Airstrip

Fish habitat information for the Dip Creek tributary (Crossing Site 10+330) that will be intersected by the airstrip was provided in Appendix 10B, in the following locations:

- Table 9 page 52;
- Table 10 page 53; and
- Site card in Appendix D.

In addition, fish and fish habitat assessments were completed in July 2014 on the lowermost section of the airstrip stream. Habitat was surveyed using a Habitat Evaluation Procedure (HEP) on a 750 m stretch extending upstream from Dip Creek. HEP methods applied were the same as used in other areas of the project and included documenting channel dimensions, substrate, and habitat type (Appendix A.10B). Overall, the habitat assessed was marginal shallow seasonal rearing habitat and there was evidence of major instability due to permafrost melting. Evidence of this instability included dead and unstable riparian areas, lots of woody debris, lateral stream movement, multiple shallow stream channels that were poorly defined and often flowing through flooded shrubs and trees, and turbid water. In addition, during the 2014 field program the stream outflow was providing a noticeable plume of turbid water into Dip Creek, which was noted to run several hundreds of metres downstream from its confluence.

Fish sampling in July 2014 consisted of minnow trapping (overnight set of two traps) and electrofishing (493s) in the lowermost 250 m adjacent to Dip Creek. No fish were caught and water levels were very low despite a recent rainfall event.

A.10.4.1.2 R276

R276. A discussion of fish populations, densities, and diversity in downstream watercourses including lower Dip Creek and the Klotassin River.

Fish species documented within the Yukon River Basin near the study area include Chinook and chum salmon, longnose sucker, Arctic grayling, slimy sculpin, inconnu, round whitefish, least cisco, northern pike, Arctic Lamprey, and burbot (Walker 1976). Of these species, Arctic grayling and slimy sculpin are the most widely distributed and are present throughout the majority of the RSA. There are no known stocked or enhanced

fisheries within the project area, with the exception of rainbow trout stocking in Gloria Lake II (Appendix 19A, p.23). Specific information regarding species life history, distribution within the project area, and a discussion of the species contribution to CRA fisheries is provided below. In addition, Figure A.10.4-9 depicts fish species presence/absence directly adjacent to the mine site, and Figure A.10.4-1 through Figure A.10.4-8 show the Chinook salmon distribution throughout the RSA along the road routes.

Chinook Salmon

Life history

Chinook spawning occurs between late July and September, within the Yukon River Basin near the study area (Yukon River Panel 2008). Chinook salmon prefer to spawn in groundwater fed gravel beds within small tributaries or larger river systems (de Graff 2009). The young salmon hatch as fry in the spring and migrate to small non-natal streams where productivity is high and to escape predators. Fry spend their first winter in freshwater before migrating down the Yukon River to the Bering Sea to complete the marine stage of their lifecycle. As a result, overwintering habitat within smaller stream systems is critical for the success of Chinook salmon.

Distribution

Overview: The areas of known adult Chinook salmon utilization and the areas of known Chinook salmon presence at other live stages (i.e., fry and juvenile) are presented in Figure A.10.4-1. The areas shown are based on numerous historical studies conducted on Chinook habitat, presence, and spawning in the area (i.e., DFO 1985; DFO 1994; Yukon River Panel 2008a; EDI 2011). Big Creek, Selwyn River, Nordenskiold River, Klotassin River, Donjek River, and the White River are known to be utilized by adult Chinook salmon for spawning habitat (DFO 1985; Yukon River Panel 2008a), and the tributaries of Seymour Creek, Bow Creek, Stoddart Creek, Hayes Creek, and Dip Creek have all been shown to contain fry and juvenile Chinook (DFO 1994; von Finster 1998). Juvenile Chinook salmon have also been documented in the lower reaches of Britannia Creek, Isaac Creek, Mascot Creek, Crossing Creek and Murray Creek, near the confluence with the Yukon River (DFO 1994; EDI 2011). No Chinook salmon have been captured either recently or historically within Casino Creek.

Dip Creek and the Klotassin River: Within the 2008-2013 sampling program, no juvenile Chinook salmon were captured in Dip Creek. Similarly, historical sampling by Knight Piésold in 1994 yielded no Chinook salmon during 2,807s of electrofishing effort at site F14 (HKP, 1997). In contrast, Summit Environmental (2012) captured a single juvenile Chinook in Dip Creek near its confluence with Casino Creek in July 2011. Historically, there is some evidence of juvenile Chinook salmon rearing in lower Dip Creek from studies conducted by DFO in 1994 and 1998 (DFO, 1994; Otto, 1998). In DFO (1994), minnow trapping was carried out on the Klotassin River adjacent to its confluence with Dip Creek, as well as at two sites on Dip Creek located approximately 10 and 27km upstream of the Dip Creek outlet. A total of 38 young-of-the-year Chinook salmon were captured at the Dip-Klotassin site, and 25 more were captured at the intermediate Dip Creek station which is located approximately 18 linear kilometers downstream from the Casino Creek confluence. No salmon were captured at the furthest upstream site on Dip Creek. In Otto (1998), two minnow traps were set 100m upstream of the Dip-Klotassin confluence on Dip Creek, with one young-of-the-year Chinook salmon captured. No sites further upstream were assessed. Three minnow traps set on the Klotassin River within 1km downstream of Dip Creek did not capture any juvenile Chinook salmon, however juveniles were observed in the stream during trap deployment (Otto, 1998).

The first record of adult Chinook salmon spawning in the Klotassin River was during field studies conducted by DFO in 1994, where a single adult was observed approximately 8km upstream of the Klotassin-Dip confluence (DFO, 1994). Additional adult Chinook salmon were observed spawning in the summer of 1998, when two adults

were observed in the lowest reaches of the Klotassin River on July 14 during a boat survey, and four adults were observed during a short aerial survey completed on the lowest 5km of the river in August (Otto, 1998).

Contribution to CRA Fisheries

The Canadian Yukon River Chinook salmon fishery has been heavily regulated in recent years due to historically low escapement counts. Commercial, domestic, and recreational fisheries have been closed or had very low captures since 1997 (JTC 2013; Yukon Salmon Sub-Committee 2014). The aboriginal fishery has also declined over the period from 1961-2011 (JTC 2013), with complete closures announced in summer 2014 (Whitehorse Daily Star 2014).

Chum Salmon

Life history

Chum salmon spawning occurs later in the season in comparison to Chinook, with migration runs into the Yukon beginning in late August, and with peak spawning occurring during late September to early October (de Graff 2009). Chum salmon tend to spawn in slow moving side channels where groundwater inputs are present (de Graff 2009). Chum salmon juveniles hatch as fry in the spring and immediately migrate downstream to estuaries (de Graff 2009).

Distribution

Adult chum salmon have been documented within the Nordenskiold River, and in Big Creek approximately 13.7 km upstream of the Yukon River confluence (DFO 1985).

Contribution to CRA Fisheries

Yukon River fall chum salmon support both commercial and aboriginal fisheries, with 63% and 37% of the catch occurring in the commercial and aboriginal fisheries, respectively (Yukon River Panel 2008). As described in the Casino Project Land Use and Tenure Baseline Report (Appendix 19A), commercial fishing accounts for less than 5% of the fish harvested in the Yukon Territory (Environment Yukon 2010). A small fishery is located in the Minto area, on the periphery of the RSA and the Canadian Commercial fishery is located in the Dawson area (Appendix 19A, p.23). These fisheries harvest summer and fall chum (Yukon Salmon Sub-Committee 2014).

Arctic Grayling

Life history

Arctic grayling typically spend the spring and summer in smaller tributary streams and migrate to the lower reaches of large river systems to overwinter (McPhail 2007). Arctic grayling spawn around the same time as ice break-up in clear, fast-flowing tributaries with temperatures between 4-16°C (Stewart et al. 2007). Adult Arctic grayling have been documented residing in water with temperatures between 0.3 - 16.7 °C, whereas juveniles have been associated with warmer waters (5-17°C; Stewart et al. 2007). Arctic grayling are opportunistic visual feeders, with varying rates of piscivory noted in fish greater than 150mm (Stewart et al. 2007). They are sensitive to changes in turbidity, which may reduce feeding success or cause habitat avoidance. Populations of Arctic grayling are particularly vulnerable to changes in habitat and water conditions, which may lead to habitat fragmentation (Stewart et al. 2007).

Distribution

Arctic grayling have been documented within the majority of waterbodies in the RSA, including Casino Creek, Dip Creek, Britannia Creek, as well as in all of the major watersheds crossing the proposed Casino roads. Larger Arctic grayling tend to distribute more widely than small juveniles and young-of-the-year (YOY), and are often the

only fish species documented in upper headwater reaches. In and around the Casino mine site, young-of-the-year Arctic grayling juveniles have been captured in Dip Creek, and in lower Britannia Creek. While less fish sampling has been conducted at proposed crossing sites along the Freegold Road, it is expected that YOYs would be present in all major rivers and creeks, as well as in tributaries directly adjacent to the Yukon River of sufficient size and quality.

Contribution to CRA Fisheries

Arctic grayling is the most popular sport fish in the Yukon (Environment Yukon 2010). Arctic grayling support both recreational and Aboriginal fisheries along the Yukon River and in accessible tributaries, however, the remoteness and inaccessibility of the project area watersheds likely limits fishing activities.

Slimy Sculpin

Life history

The slimy sculpin is a bottom-dwelling species, residing under cobble or other in-stream habitat cover features. Slimy sculpins demonstrate very high site fidelity, generally remaining within a 50 m-radius home range throughout their lives (Gray et al. 2002). Thus, all life history stages, including overwintering and spawning, must be carried out within this limited home range. As a result, the presence of over wintering habitat (either in groundwater fed pools or river systems) and a lack of movement barriers is key to success of this species. In the study area, they were generally found in lower to middle reaches of watercourses, and were often associated with shallow riffle and run sections providing large substrate cover, as well as in channel edges providing cover from undercut banks, woody debris and overhanging vegetation. Spawning takes place in the spring when temperatures approach 5 to 10°C, in nests on the underside of rocks, submerged rocks or other available in-stream habitat (Roberge et al. 2002). Slimy sculpin may provide a food source for larger predatory fish such as burbot, northern pike, and Arctic grayling (McPhail and Paragamian 2000; Stewart et al. 2007).

Distribution

Slimy sculpin is one of the most widely distributed species in the RSA, with reported captures in lower Casino Creek, lower Brynelson Creek, Dip Creek, lower Britannia Creek, Isaac Creek, Selwyn River, Hayes Creek, Big Creek, Murray Creek, and the Nordenskiold River.

Contribution to CRA Fisheries

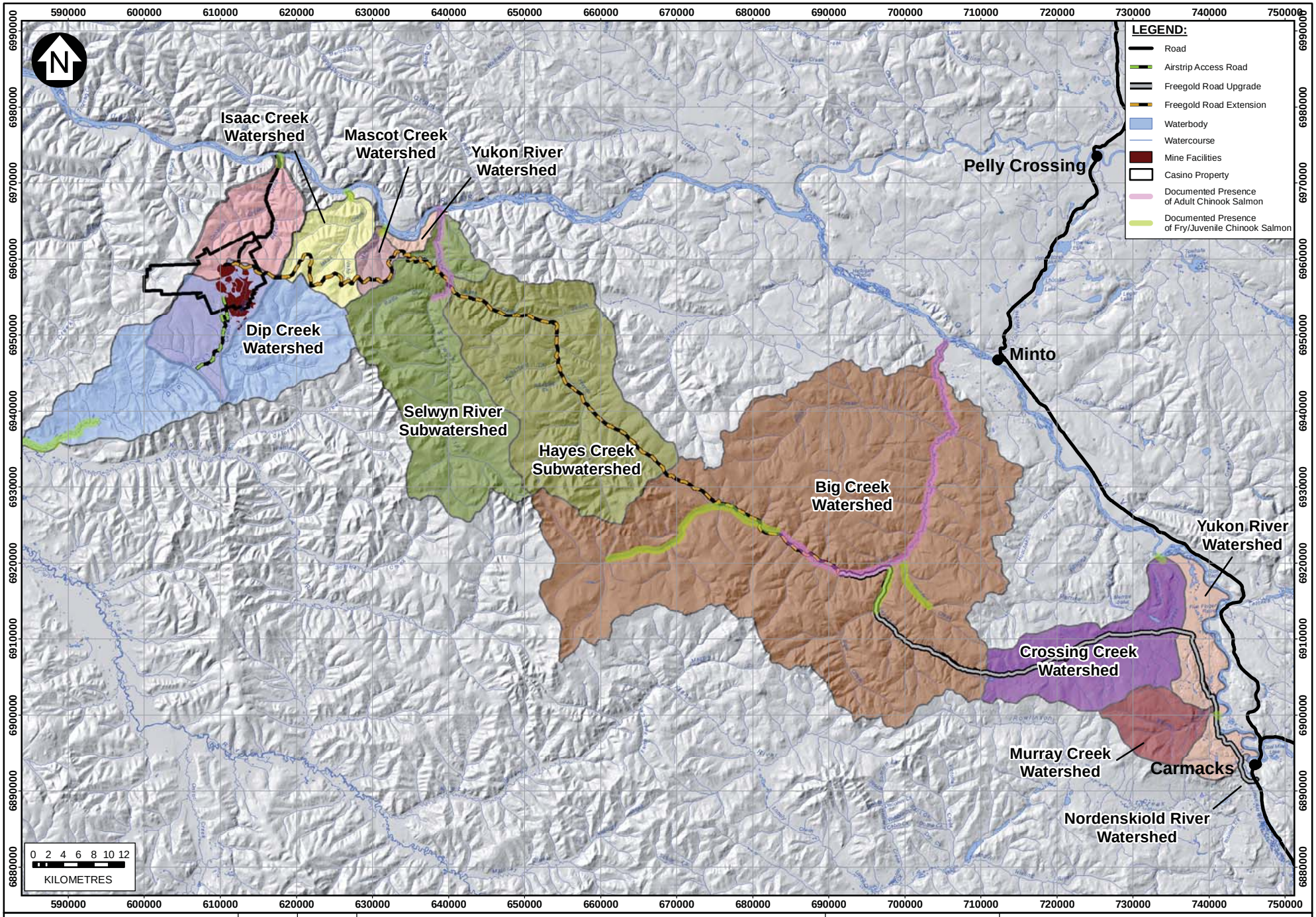
There are no known slimy sculpin fisheries within the RSA. However, as slimy sculpin is sometimes a prey fish for larger predatory fish species, it may be considered a species which supports a CRA fishery and would thus be protected under the *Fisheries Act*. In and around the proposed Casino mine site, both Arctic grayling and burbot may rely on slimy sculpin as a food source. Adult burbot have been captured in low densities in Dip Creek, where they subsequently may feed on low numbers of slimy sculpin. Arctic grayling may rely on slimy sculpin as a prey source in areas where they overlap, including lower Casino Creek, lower Brynelson Creek, Dip Creek, and in lower Britannia Creek. Along the proposed Freegold Road, slimy sculpin may be a prey food for northern pike, burbot, and Arctic grayling. It is not expected that salmon species would rely on slimy sculpin as a prey source. Adult Chinook salmon generally cease feeding upon their return to freshwater (Behnke 2010). Before migrating to sea, juvenile Chinook salmon feed primarily on insects, and some plankton (Healey 1991).

Unfortunately, the lack of site-specific diet information for Arctic grayling in the LSA makes it difficult to predict the contribution of slimy sculpin to their diet. However, inferences can be made from studies of Arctic grayling diet in Yukon and NWT streams and lakes which have demonstrated that sculpins and other fish generally contributed a low percentage of energy intake relative to benthic invertebrates (Bishop 1967; de Bruyn and McCart 1974; Tripp

and McCart 1974; Chang-Kue and Cameron 1980; Mathers 1981; Birtwell et al. 1984; Jessop et al. 1993). Fish made up less than 4% of stomach content volume in fluvial and adfluvial Arctic grayling from various NWT streams and lakes (Bishop 1967). Occurrence of fish in Arctic grayling stomachs was generally low for the majority of studies, with occurrence of piscivory ranging from 0-2% (deBruyn and McCart 1974; Tripp and McCart 1974; Chang-Kue and Cameron 1980; Birtwell et al. 1984; Jessop et al. 1993). Higher incidences of piscivory were documented in a few select lakes in NWT, including Great Bear Lake where 10.8% of Arctic grayling stomachs had fish (Miller 1946), and in two lakes studied by deBruyn and McCart (1974) where 12.8 - 20.9% of stomachs had fish. Based on evidence for the low Arctic grayling piscivory rates in similar waterbodies elsewhere, it is likely that the contribution of slimy sculpin to the Arctic grayling fishery within the RSA is similarly low.

Other Fish Species

- Northern pike is one of the top three most targeted fish species by anglers in the Yukon (Environment Yukon 2010). The distribution of northern pike in the project area is restricted to the Nordenskiold River.
- Burbot is most commonly caught by anglers in lakes during the winter through ice (Environment Yukon 2010). In the project area, burbot has been captured in stream habitats such as lower Casino Creek, Dip Creek, Isaac Creek, and the Nordenskiold River, where fishing is less common and/or unlikely to occur due to remoteness.
- Round whitefish have been captured in Dip Creek, Murray Creek, Big Creek, and within the Nordenskiold River. Little is known about round whitefish populations in the Yukon, and they are not recognized as a popular angling species (Environment Yukon 2010). While other species of whitefish are commercially harvested in the Yukon, round whitefish are not specifically targeted due to their smaller size. However, First Nations may harvest round whitefish for subsistence (Environment Yukon 2014).
- Longnose sucker have been captured in Isaac Creek and the Nordenskiold River. Longnose sucker is not recognized as a popular angling species (Environment Yukon 2010).



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

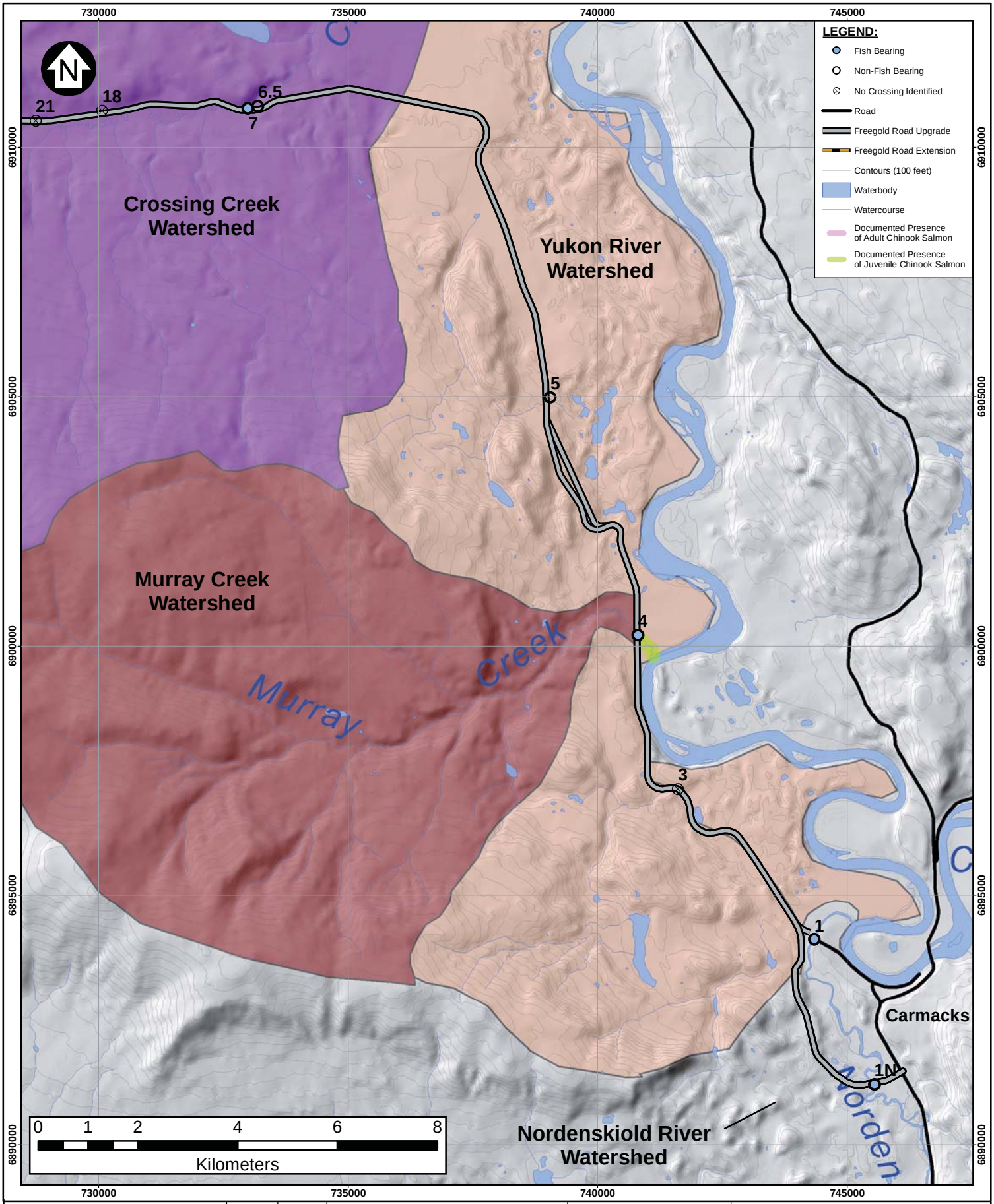
1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 7N
3. COORDINATE GRID: METRES
4. SCALE: 1:650,000
5. Documentation on the presence of adult and fry/juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Overview Map of the Casino Mine Roads and Watersheds

FIGURE A.10.4-1



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

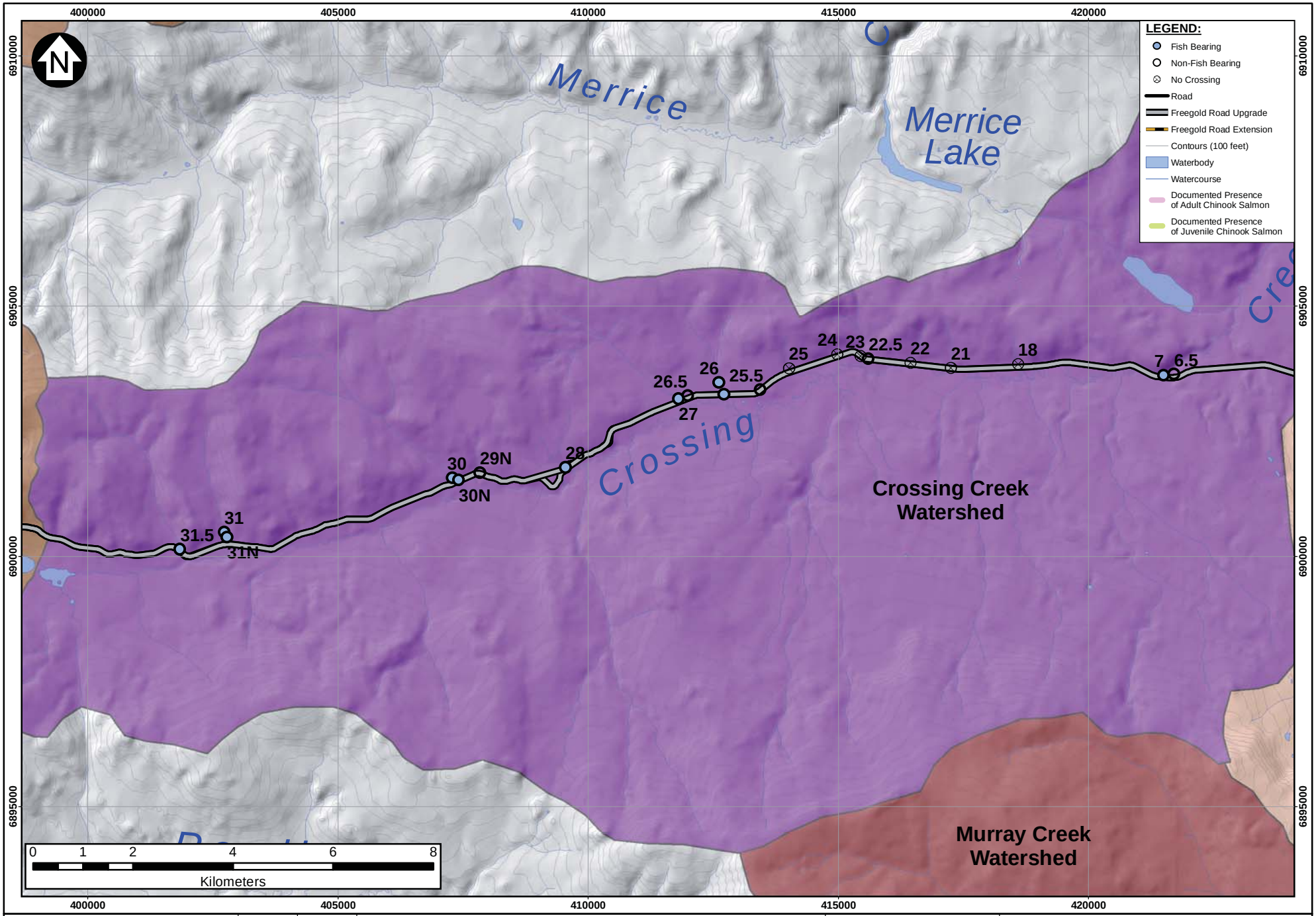
1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 7N
3. COORDINATE GRID: METRES
4. SCALE: 1:100,000
5. Documentation of presence of adult and juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Freegold Road Upgrade Fish Presence / Absence (Map 1)

FIGURE A.10.4-2



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

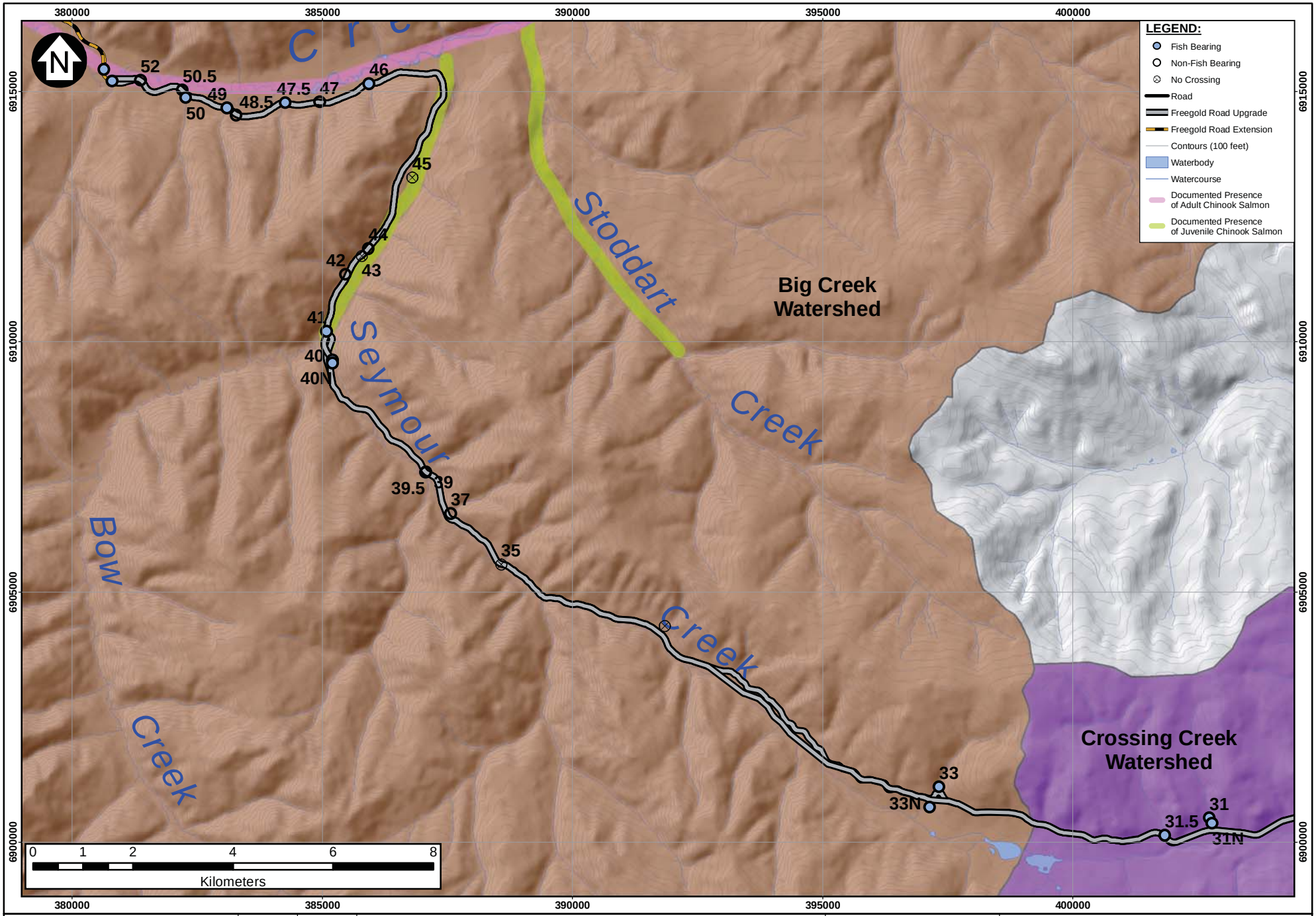
1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 8N
3. COORDINATE GRID: METRES
4. SCALE: 1:100,000
5. Documentation of presence of adult and juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Freegold Road Upgrade
Fish Presence / Absence
(Map 2)

FIGURE A.10.4-3



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

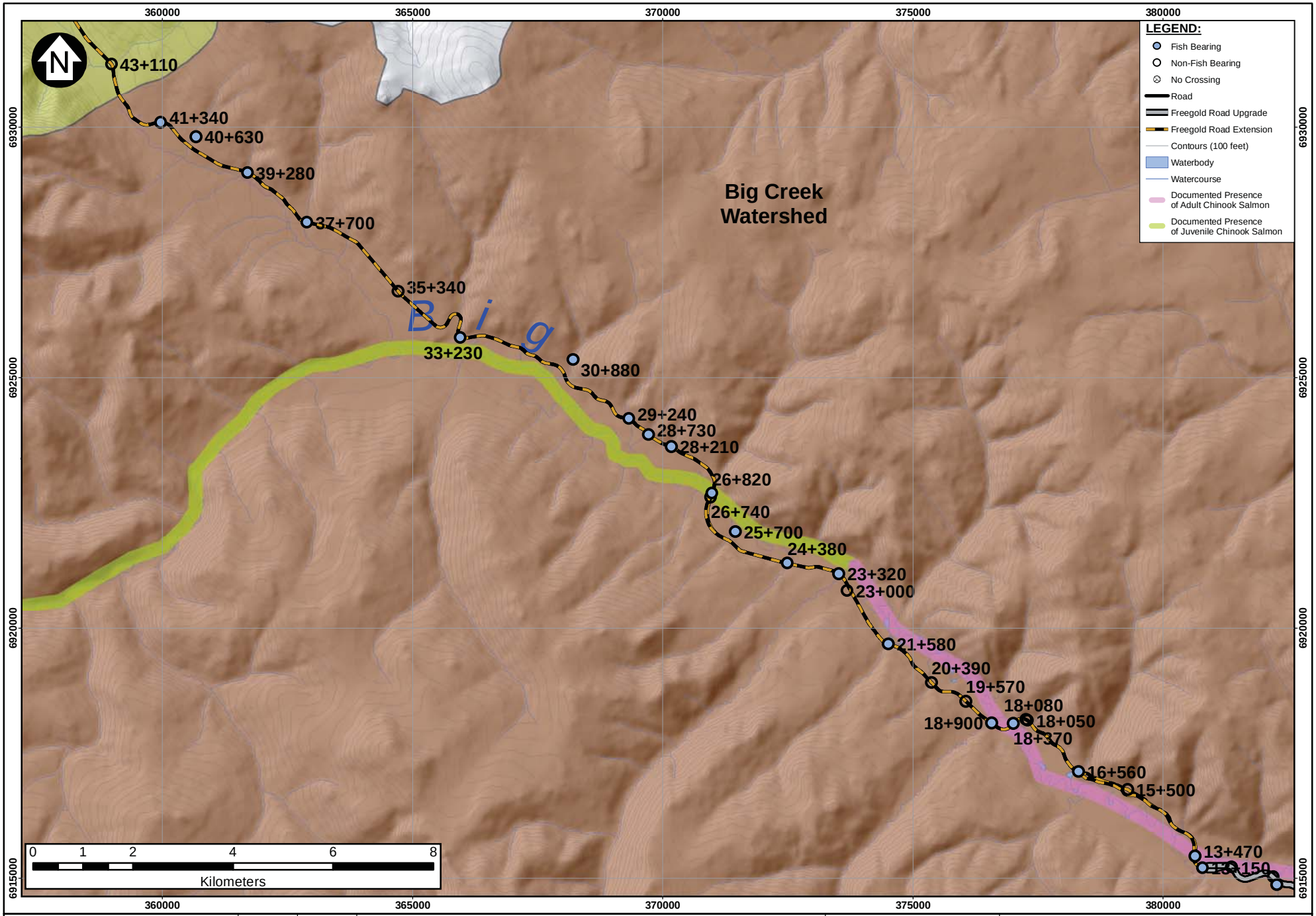
1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 8N
3. COORDINATE GRID: METRES
4. SCALE: 1:100,000
5. Documentation of presence of adult and juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Freegold Road Upgrade
Fish Presence / Absence
(Map 3)

FIGURE A.10.4-4



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

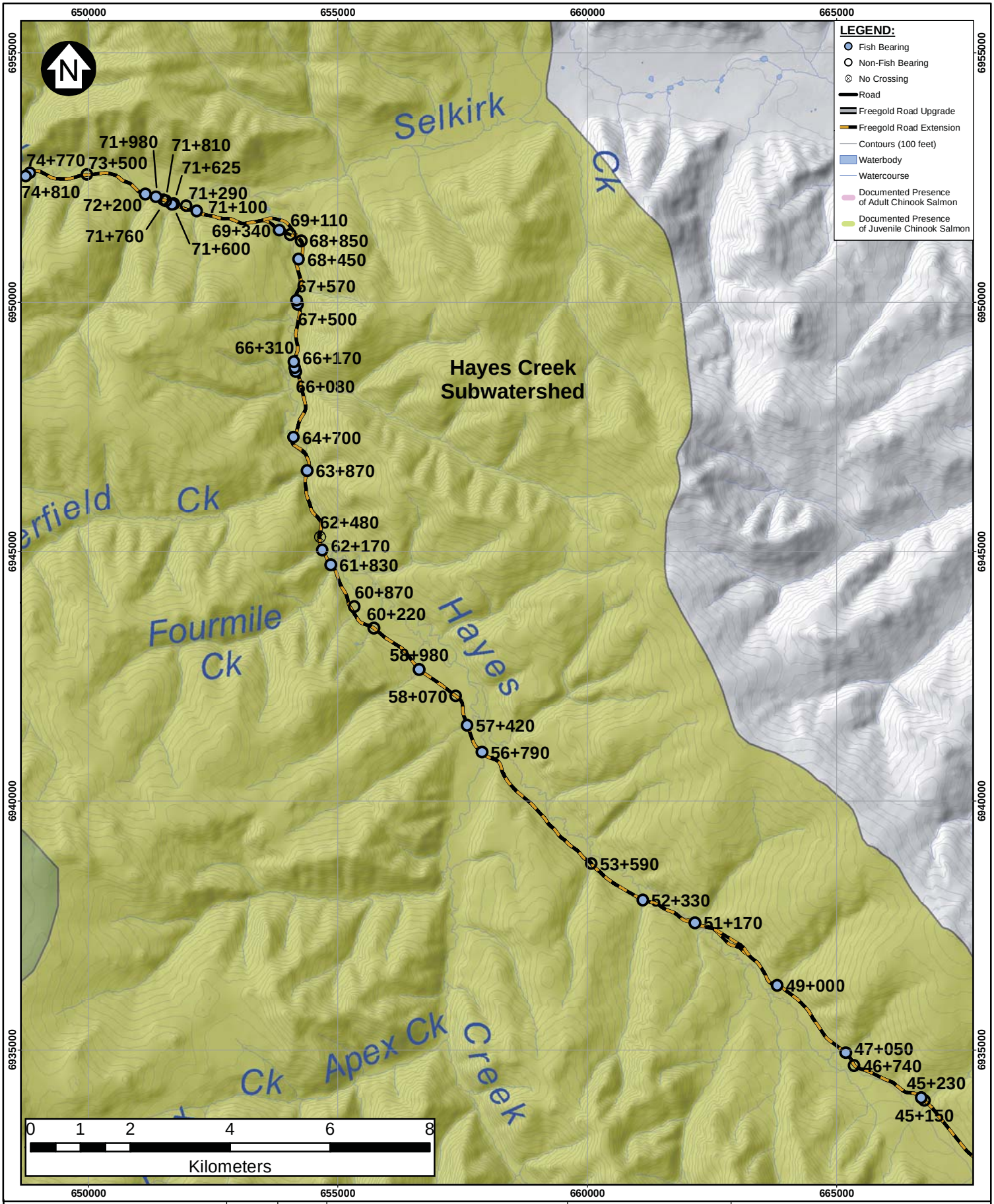
1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 8N
3. COORDINATE GRID: METRES
4. SCALE: 1:100,000
5. Documentation on the presence of adult and fry/juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Freegold Road Extension
Fish Presence / Absence
(Map 1)

FIGURE A.10.4-5



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

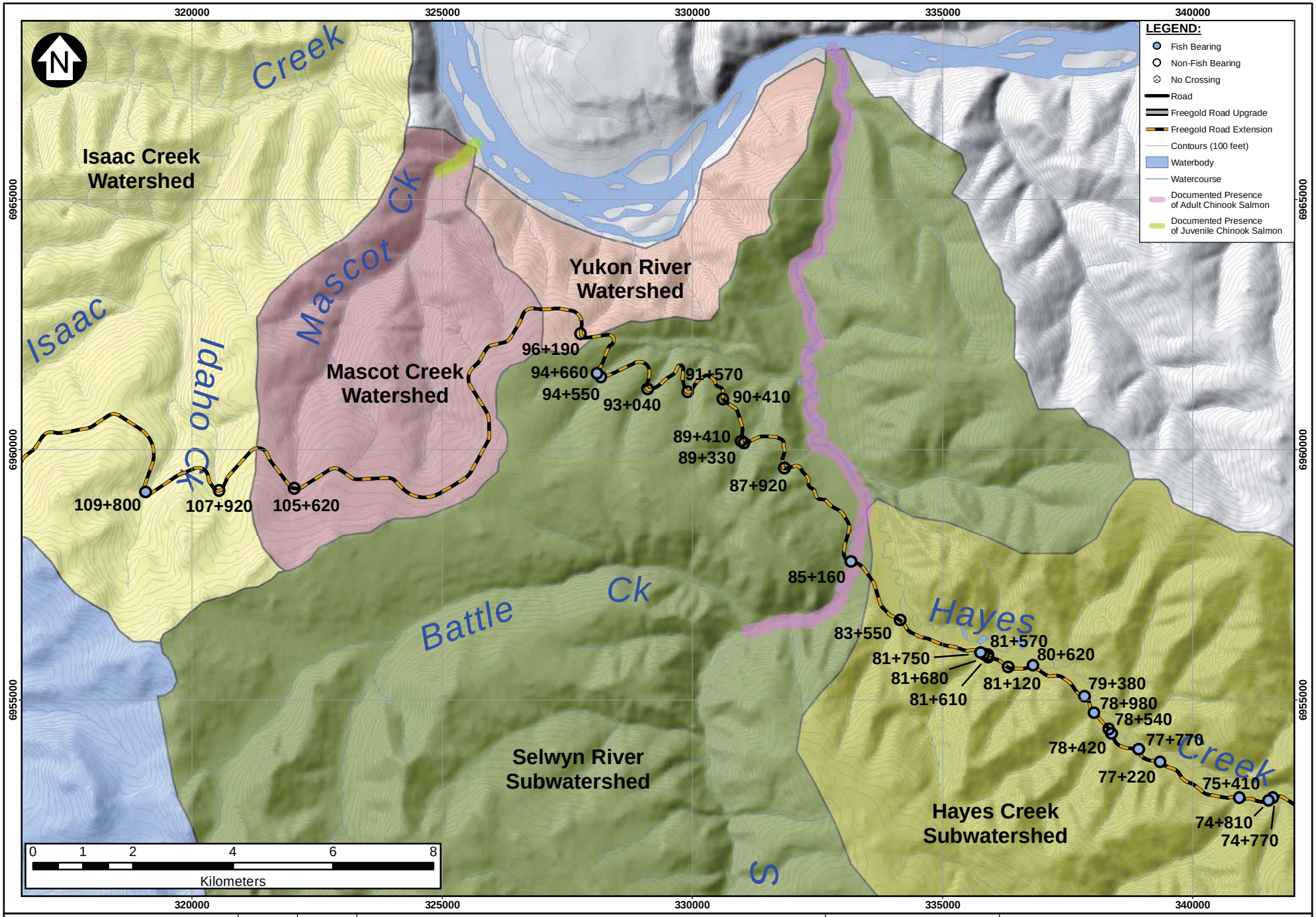
1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 7N
3. COORDINATE GRID: METRES
4. SCALE: 1:100,000
5. Documentation on the presence of adult and fry/juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Freegold Road Extension Fish Presence / Absence (Map 2)

FIGURE A.10.4-6



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

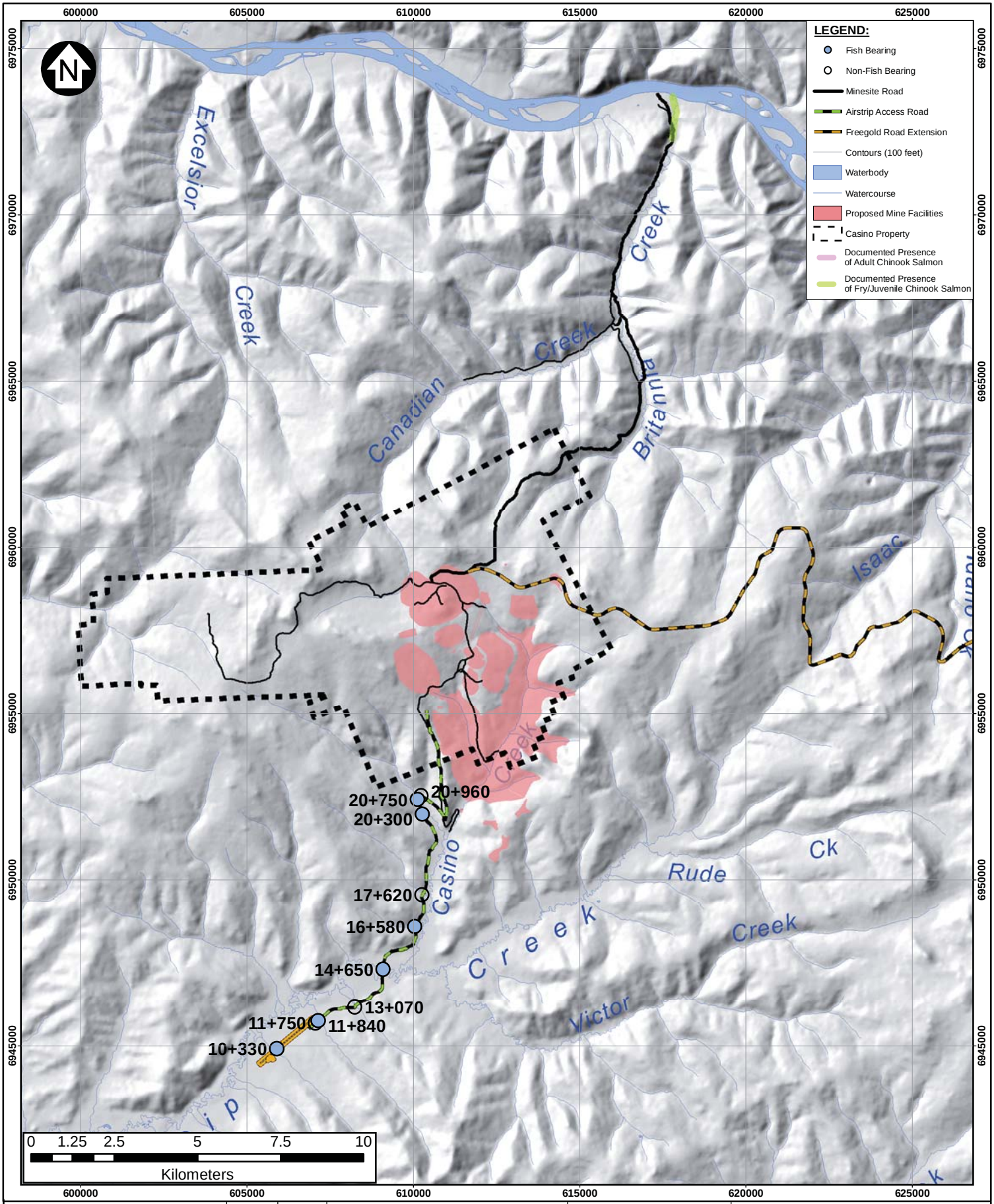
1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 8N
3. COORDINATE GRID: METRES
4. SCALE: 1:100,000
5. Documentation on the presence of adult and fry/juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Freegold Road Extension
Fish Presence / Absence
(Map 3)

FIGURE A.10.4-7



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	J. Cole
APP'D	J. Cole
REV	R. Palmer
DATE	28Oct'14

NOTES:

1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 7N
3. COORDINATE GRID: METRES
4. SCALE: 1:150,000
5. Documentation of the presence of adult and fry/juvenile chinook salmon provided by DFO (1985), DFO (1994), Summit (2011) and EDI (2011)

CASINO

CASINO PROJECT

Airstrip and Airstrip Access Road Fish Presence / Absence

FIGURE A.10.4-8

A.10.4.1.3 R277

R277. Maps demonstrating fish presence, assumed absence, or observed absence by stream segment. Include the stream channel intersected by the proposed airstrip, Casino Creek tributaries such as Taylor Creek, and the Freegold Road. Where fish are assumed as absent, provide rationale.

Fish species presence/absence, fish bearing designations, habitat information, and identified barriers or seasonal impediments in watercourses directly adjacent to the mine site are provided in Figure A.10.4-9. Fish bearing designations for each watercourse crossing along the proposed road routes and the Chinook salmon distribution are provided in Figure A.10.4-2 through Figure A.10.4-8. Detailed fisheries information for each watershed near the mine site was summarized in Appendix 10A, with annual data reports provided as appendices A1 – A5 of the Water and Sediment Quality Baseline Report (Appendix 7A), which correspond to appendices A through F of the Fish and Aquatic Resources Baseline Report (Appendix 10A).

Fish bearing status was determined for all watercourses around the Project study area. In upper Canadian Creek fish bearing status was assessed following the identification of a high gradient cascade which was deemed a probable barrier to fish migration (Appendix 10A, p.13). The noted barrier was a stream segment greater than 20% gradient, with no upstream perennial habitat, and no fish were captured in upstream areas over multiple seasons and years of sampling using two fishing methods (Table A.10.4-1). Assessment methods followed the standards established by the BC Ministry of Forests (BC MoF 1998). Habitat upstream of the barrier was assessed for deep pools or other habitat with potential to support overwintering fish. As the Casino project is situated in an un-glaciated area of the Yukon, no lakes are present.

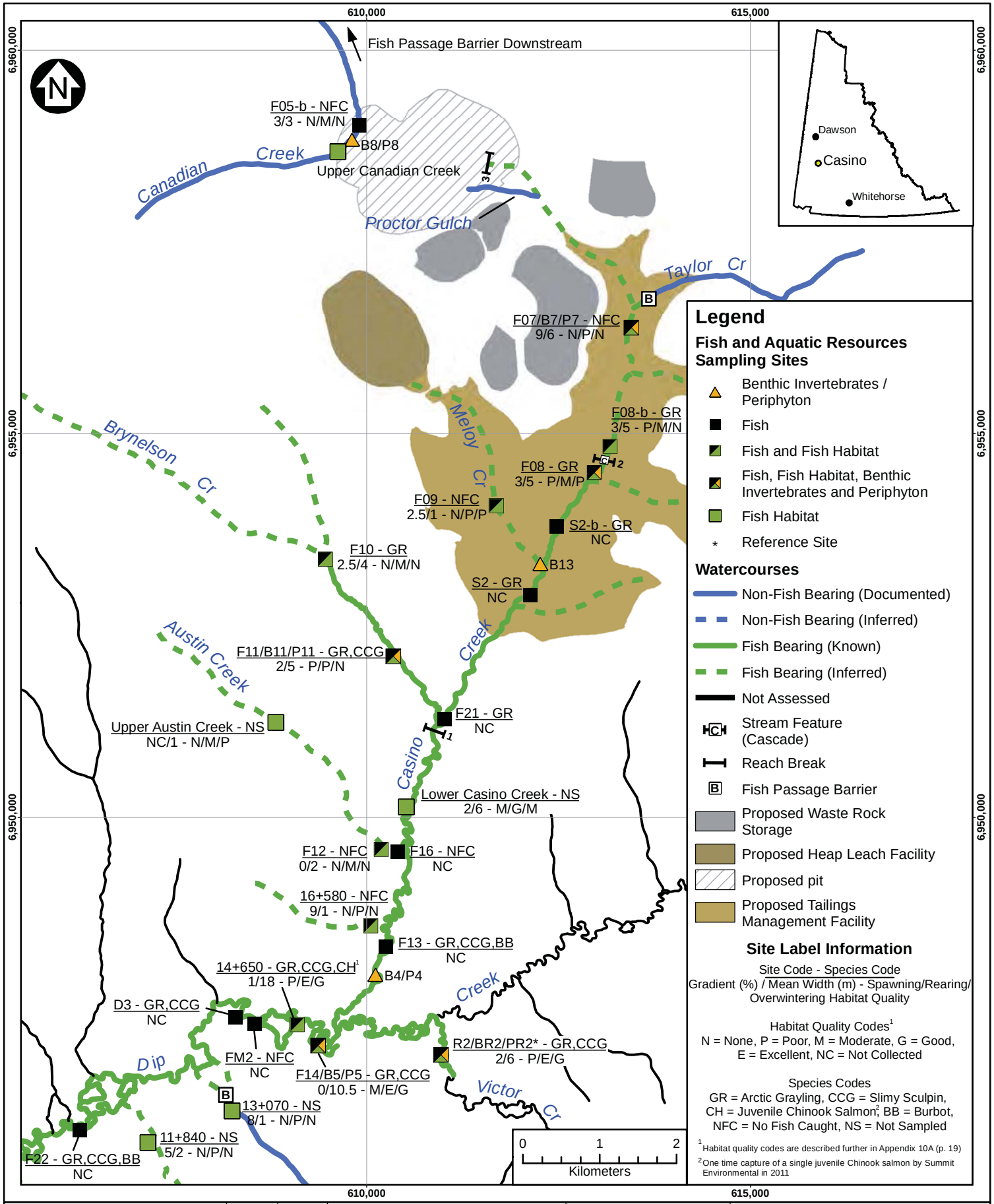
Table A.10.4-1 Fish Sampling Effort above an Identified Barrier (2008-2010)

Location	Barrier Location	Site	Reach	Date	Method	Electrofishing				Minnow Trapping	
						Section Length (m)	# Passes	Voltage (V)	Effort (s)	# Traps	Effort (h)
Canadian Creek, Britannia Creek Watershed	609,391 6,960,354	F05	3	9-Jul-08	EF	226	1	5505	577	-	-
				11-Jul-08	MT	-	-	-	-	3	72
		F05-b		12-Aug-10	EF	250	1	270-437	1278	-	-
				10-Aug-10	MT	-	-	-	-	2	83
								TOTAL	**1855**		**155**

Notes:

1. Method: EF – electrofishing; MT – minnow trapping

As stated in the response for R275, Taylor Creek was assessed as part of the Upper Casino Creek Habitat Evaluation Procedure (HEP) study (Appendix A.10B). During this assessment, a fish barrier was identified on Taylor Creek approximately 275 m upstream of its confluence with Casino Creek. The barrier consisted of multiple vertical drops (0.35-0.8 m to estimated bankfull) with insufficient bankfull pool depths for Arctic grayling passage, as Arctic grayling require a minimum pool depth of 1.25x the vertical drop in order to surmount vertical barriers (Parker 2000). Fish sampling was conducted above the barrier in summer 2014 to further document and verify an absence of fish in Taylor Creek. No fish were caught using two sampling methods (overnight minnow trap sets and 587s of electrofishing) during late July 2014.



PREPARED BY:

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

DESIGNED	D. Turner
DRAWN	D. Turner
CHK'D	A. Murdoch
APP'D	M. Quach
REV	R. Palmer
DATE	19Feb'15

NOTES:

1. BASE MAP: Digital Elevation Model and 1:250,000 and 1:50,000 Topographic Spatial Data provided by Geomatics - Yukon Government via online source (www.geomaticsyukon.ca)
2. PROJECTION: NAD 1983 UTM Zone 7N
3. COORDINATE GRID: METRES
4. SCALE: 1:65,000

CASINO

CASINO PROJECT

Casino Creek Fish and Aquatic Resources Baseline Summary Map

FIGURE A.10.4-9

For the Freegold Road Baseline Report (Appendix 10B), a wider variety of fish barrier definitions was used, including:

- Stream gradients over 20% with no perennial fish habitats available upstream (BC MoF 1998);
- Dry ephemeral stream sections only providing short-term run off during high precipitation or melt events;
- Underground flows noted preventing fish passage;
- Artificial barriers such as perched culverts or metal grates preventing fish access; and
- Vertical drops noted with insufficient pool depth to allow fish surmounting to upstream areas. Arctic grayling require a minimum pool depth of 1.25x the vertical drop (Parker 2000).

Following this assessment, crossings determined to be non-fish-bearing were identified, and are summarized in Table A.10.4-2 along with rationale for the determination. Crossing locations are provided in Figure A.10.4-2 through Figure A.10.4-8.

Table A.10.4-2 Rationale for Non-Fish-Bearing Status along the proposed Freegold Upgrade, Extension, and Airstrip and Airstrip Road

Crossing #	Rationale for Non Fish Bearing Status
Freegold Upgrade Section:	
29N	Creek flows underground downstream of crossing due to major channel disturbance
39	Dry ephemeral
39.5	Stream is not permanent and contains a series of ponds and intermittent short connector channels which originate from groundwater pool 20m above crossing
47	Dry ephemeral channel with perched culvert
48.5	Dry ephemeral channel with perched culvert
50.5	Bog habitat separated from Big Creek side channel with metal grate
Freegold Extension Section:	
15+500	dry ephemeral
19+570	disconnected shallow oxbow marsh
20+390	very small turbid runoff, channel not well defined
22+960	dry intermittent, no connection to Big Creek downstream
23+000	dry intermittent, no connection to Big Creek downstream
26+740	no visible channel, standing pools of water without connector streams
35+340	dry ephemeral
43+110	stream is not permanent: flow goes underground and dries up in several areas downstream of crossing
45+150	dry ephemeral
53+590	underground flow, small poorly defined channel, muddy flow
58+070	dry ephemeral upstream, flow goes underground downstream
60+220	stream not permanent, low flow barriers noted both upstream and downstream of crossing
60+870	dry ephemeral
69+110	dry ephemeral
71+290	no defined channel, very low flow grass swale
73+500	high gradient low flow channel (18% at crossing), 1m vertical drop noted with bankfull depth <0.4m
81+120	dry ephemeral

Crossing #	Rationale for Non Fish Bearing Status
81+570	small shallow muddy poorly defined channel, no direct fish habitat
81+680	small shallow poorly defined intermittent channel over shallow permafrost; goes underground upstream
81+610	small shallow poorly defined channel not providing direct fish habitat
83+550	gradient >20%, vertical 1m drop downstream of crossing
87+920	gradient >30% at crossing
89+330	gradient 21% at crossing
89+410	gradient 23% at crossing
90+410	gradient 50% at crossing
91+570	gradient 25% at crossing
93+040	gradient 35% at crossing
96+190	gradient 20% at crossing
107+920	downstream gradient barrier 28%
Airstrip Section:	
11+750	intermittent flow; stagnant disconnected puddles
13+070	29% gradient drop downstream of crossing
17+620	small shallow muddy flow, goes underground downstream of crossing
20+960	no surface flow downstream of crossing

A.10.4.1.4 R278

R278. Maps demonstrating fish habitat quality and fish distribution by species for watercourses including Casino Creek and its tributaries, Dip Creek downstream of its confluence with Casino Creek, and Britannia Creek and its tributaries. Include any seasonal barriers to movement.

See response to R277 above, specifically Figure A.10.4-9. No similar figures have been made for the Britannia Creek watershed, however, fisheries information for this watershed is provided in detail in Appendix 10A (P.29-30, 37-38), and in all of the annual reports which are provided as sub-appendices. In addition, the Yukon Placer Secretariat has fish habitat suitability maps available for the entire RSA found at http://www.yukonplacersecretariat.ca/.

A.10.4.1.5 R279

R279. A table or other tool identifying the location in the proposal of supporting baseline information for each of the potentially impacted watercourses.

The Fish and Aquatic Resources Baseline Reports for the mine site and road routes were provided as Proposal Appendices 10A and 10B, respectively. The Baseline Reports were generally presented in comprehensive sections (e.g., benthic invertebrates and periphyton, fish community composition, or fish habitat) and not by watercourse; however watershed specific details and summaries are provided in Table A.10.4-3.

Table A.10.4-3 Fisheries Baseline Information Locater

Watershed	Creek	Proposal Document	Pages
Casino	Casino and tributaries (Austin, Brynelson, Meloy, Taylor, Proctor Gulch)	Appendix 10A	Fish community: 28-29; watershed summary: 36-37
Dip	Dip	Appendix 10A	Fish community: 29; spawning survey: 30, watershed summary: 37
Victor	Dip	Appendix 10A	Fish community: 30; site summary: 38
Britannia	Britannia	Appendix 10A	Fish community: 29; spawning survey: 30; watershed summary: 37-38
Britannia	Canadian	Appendix 10A	Fish community: 29; barrier assessment: 30; watershed summary: 37-38
Coffee	Coffee	Appendix 10A	Fish community: 30; site summary: 38
Isaac	Isaac	Appendix 10B	30, 36
Mascot	Mascot	Appendix 10B	30, 36
Selwyn	Selwyn	Appendix 10B	28-29,35-36
Hayes	Selwyn	Appendix 10B	26-28, 35
Big	Big and tributaries (Seymour, Bow)	Appendix 10B	21-26, 34-35
Crossing	Crossing	Appendix 10B	20-21, 34
Murray	Murray	Appendix 10B	19, 34
Nordenskiold	Nordenskiold	Appendix 10B	18-19, 34
Dip	Dip, Casino Creek unnamed tributaries, and unnamed tributaries associated with the airstrip and road	Appendix 10B	30-32, 36, 52, 53

A.10.4.1.6 R280

R280. Information on the time of year each of the water bodies potentially affected by the Project are likely to be used by the various life stages of each fish species.

See response R276 for the life stages and distribution of the various fish species present in the Project area.

A.10.4.2 Missing Appendices Documenting Baseline Data

A.10.4.2.1 R281

R281. Appendices A through E for Appendix 10 A – Casino Project Fish and Aquatic Resources Baseline Report, November 12, 2013, by Palmer Environmental Consulting Group Inc.

Appendices A through F of the Fish and Aquatic Resources Baseline Report (Appendix 10A) were provided as Appendix A1 – A5 of the Water and Sediment Quality Baseline Report (Appendix 7A) and are not provided herein, but can be found in the Proposal.

A.10.5 HABITAT LOSS, ALTERATION AND COMPENSATION

A.10.5.1 Flow and Wetted Area Reduction

A.10.5.1.1 R282

R282. A description of the detailed methods used to calculate the estimated reductions in flow and wetted area from baseline conditions in all watercourses affected. (EcoMetrix)

The fish habitat evaluation procedures are summarized in the *Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study* provided in Appendix A.10B. Predictions of reductions in wetted widths and flows and associated error measurements are a product of the PHABSIM analysis, in conjunction with hydrological data obtained at site, and through long term projections provided by Knight Piésold (Appendix A.10B Section 3.1, p. 12-25) and Appendix 7H.

A.10.5.1.2 R283

R283. An indication of and rationale for the selected minimum in-stream flow threshold. (EcoMetrix)

Results produced do not recommend a single minimum in-stream threshold to avoid possible disturbance to fish and aquatic organisms, but rather generate a total area of habitat which is useable to the species and life stage modelled, at each modelled discharge. Information pertaining to potential low-flow risks in Casino Creek, such as fish stranding and effects on overwintering habitat are addressed in subsequent sections under R285 and R287.

A.10.5.1.3 R284

R284. The full documents cited as KPL 2013 and Normandeau, November 2013. (EcoMetrix)

The documents cited as KPL 2013 and Normandeau, November 2013 have been consolidated into the *Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study* provided in Appendix A.10B.

A.10.5.1.4 R285

R285. A discussion of the extent to which the identified overwintering and spawning habitat in the affected portion of Casino Creek is actively used by Arctic grayling for these stages, and the potential effects of the Project to this habitat.

Direct assessments of Arctic grayling overwintering and spawning habitat in Casino Creek have not been conducted; however, habitat assessments and summer sampling provide some information regarding the extent that these habitats support spawning and overwintering activities.

As stated in the Fish and Aquatic Resources Baseline Report (Appendix 10A, p.19), spawning and overwintering habitat potential was evaluated and rated using field-collected habitat data. Habitat ratings from highest to lowest were excellent, good, moderate, poor and none (Table A.10.5-1). For example, a site with no deep pools (>1 m) was considered to have no overwintering habitat. Spawning habitat potential was based on channel morphology, flow, depth, and substrate. For example, sites with 10 - 20% of preferred small gravel substrate were generally classified as moderate, whereas sites with <10% of small gravel were considered poor. Sites which were lacking small gravel substrate or low gradient riffle habitat, or were heavily dominated by fines or boulder substrate (>70% of total area) were generally considered to have no spawning potential. More detailed habitat assessments were completed in reaches 1 and 2 of Casino Creek as part of the in-stream flow and habitat evaluation studies (Appendix A.10B). Data recorded on suitable substrate, flow and depths were used to determine spawning habitat

availability in these reaches. Habitat assessment results in Casino Creek indicated that 16% of reach 1 provided potential spawning habitat, whereas reaches 2 and 3 had virtually none (Appendix 10A, p.34). Furthermore, no young-of-the-year Arctic grayling have been captured in Casino Creek, suggesting that any spawning activities which do occur may be minimal.

Table A.10.5-1 Fish Habitat Sites and Habitat Quality Assessment

Watershed	Creek	Reach	Site	Description	Fish Species Caught	Habitat Quality		
						Spawning	Rearing	Over-wintering
Britannia	Canadian	3	Upper Reach of Canadian Creek	Above cascade barrier (>20% gradient)	NFC	N	M	N
		2	F04		GR	N	M	N
		1	Placer Mine on Canadian Creek	Downstream end of placer mining area	GR	P	M	N
		1	Lower Reach of Canadian Creek	Downstream of placer mining activity	GR	M	M	P
		1	F03	Just upstream of confluence with Britannia Creek	GR	M	M	N
	Britannia	1	Lower Reach of Britannia Creek	Upstream of F01	GR, CCG, CH	M	G	M
Casino	Casino	3	F07	In proposed TMF	NFC	N	P	N
		3	(F08-b) Upper Reach of Casino Creek	In proposed TMF	GR	P	M	N
		2	F08	In proposed TMF	GR	P	M	P
	Meloy	n/a	F09	In proposed TMF	NFC	N	P	P
	Brynelson	2	(F10) Upper Reach of Brynelson Creek		GR	N	M	N
		1	(F11) Lower Reach of Brynelson Creek		GR, CCG	P	P	N
	Casino	1	Lower Reach of Casino Creek	Upstream of site F16	GR, CCG, BB	M	G	M
	Austin	2	Upper Reach of Austin Creek		NFC	N	M	P
		1	(F12) Lower Reach of Austin Creek		NFC	N	M	N
Dip	Victor	n/a	R2*	Reference site	GR, CCG	P	E	G
	Dip	n/a	F14		GR, CCG, RW	M	E	G
Coffee	Coffee	n/a	F19*	Reference site	GR,RW	P	G	P

Notes:

1. n/a = not applicable; *Reference site; Parentheses indicate proximate fish sampling site; NFC=No fish caught; GR=Arctic Grayling; CCG=slimy sculpin; CH=juvenile Chinook salmon; BB=burbot; N=None; P=Poor; M=Moderate; G=Good; E=Excellent

Overwintering habitat quantity and quality will vary from year to year and is difficult to measure based on summer conditions alone. In addition to water depth, it will depend on various factors including air temperatures, groundwater, and the timing and nature of ice and snow cover. It is apparent from habitat and fish surveys that reaches 2 and 3 of Casino Creek provide little to no overwintering based on the lack of deep pools (>1 m), the observation of anchor ice during winter, and the absence of resident fish species such as slimy sculpin. However, some deep pools have been noted in Casino Creek reach 1, and were estimated to make up approximately 20% of the total area at the lower Casino Creek fish habitat site. The presence of slimy sculpins in lower Casino Creek further indicates that there is sufficient water within this reach to maintain fish populations year-round. Thus, it is likely that depending on the year, there remains sufficient pool depths to also harbour Arctic grayling overwinter.

PHABSIM analysis provides additional insight into the potential for fish overwintering in Casino Creek. Analysis results of the winter Arctic Grayling habitat indicated that high flows would be required to create depths necessary for significant suitable habitat (pages 52-54, Appendix A.10B). Since those flows do not occur in the wintertime, the PHABSIM analysis indicates that there is only minimal winter habitat in Casino Creek (Table A.10.5-2). In order to further investigate the potential for isolated pockets of suitable habitat not captured by the PHABSIM transects and visually observe fish presence/absence, field observations were conducted in March 2013. Water was located beneath the ice cover at multiple locations in Casino Creek; however, no fish were observed using the underwater video camera. Table A.10.5-3 presents the observations from the March pool investigation in Casino Creek.

Multi-year baseline sampling in Casino Creek suggests that the primary use of the creek is by adult and sub-adult Arctic grayling for summer rearing activities. Further, Arctic grayling densities in Casino Creek are generally low, particularly in the upper watershed where habitat losses are expected. While it is difficult to predict how an increase in rearing habitat will offset any potential decreases in spawning and overwintering habitat, it is important to note that the potential and evidence for Arctic grayling spawning and overwintering in Casino Creek is low to moderate, as well as generally restricted to reach 1. Finally, the decrease in potential spawning habitat is included in the offsetting habitat budget which will contribute to provide a greater overall benefit to fisheries productivity in the local study area (Appendix A.10A). Based on our findings, effects to the limited spawning and overwintering habitat for Arctic grayling are anticipated to be minor or negligible.

Table A.10.5-2 Habitat Index values (m^2/s per 1000 m stream) versus flow for all life stages of Arctic grayling in Casino Creek including adult and juvenile winter values

Flow (m^3/s)	Adult Summer	Juvenile Summer	Fry	Spawning	Adult Winter	Juvenile Winter
0.1	2443	2404	1775	15	0.0	0.0
0.2	2693	2603	1190	156	0.0	0.0
0.3	2758	2590	835	433	0.0	0.0
0.4	2668	2460	662	667	0.0	0.0
0.5	2487	2273	546	818	0.0	0.0
0.6	2286	2079	455	922	0.0	0.0
0.7	2096	1899	401	999	0.0	0.0
0.8	1910	1726	358	1060	0.0	0.0
0.9	1742	1571	329	1111	0.0	0.0
1.0	1583	1430	304	1152	0.0	0.0
1.1	1446	1311	288	1182	0.0	0.0
1.2	1333	1206	280	1203	0.0	0.0
1.3	1235	1121	271	1214	0.0	0.0
1.4	1153	1047	256	1216	0.0	0.0

Flow (m^3/s)	Adult Summer	Juvenile Summer	Fry	Spawning	Adult Winter	Juvenile Winter
1.5	1078	979	240	1208	0.0	0.0
1.6	1011	919	222	1192	0.2	0.2
1.7	952	868	205	1164	0.9	0.8
1.8	897	819	193	1127	1.5	1.2
1.9	850	776	187	1082	1.9	1.6
2.0	803	734	183	1028	2.3	2.0
2.1	758	695	180	973	2.7	2.3
2.2	723	661	178	911	2.9	2.5
2.3	693	633	173	850	3.0	2.6
2.4	667	609	168	789	3.0	2.6
2.5	642	587	166	737	2.9	2.5
2.6	619	564	162	690	2.9	2.4
2.7	603	546	162	647	2.7	2.3
2.8	589	532	163	605	2.5	2.2
2.9	578	521	165	568	2.3	2.0
3.0	566	510	164	538	2.0	1.7

Table A.10.5-3 Results of the March 2013 Pool Investigations in Casino Creek

Site #	Coordinates	Total Depth (m)	Ice Thickness (m)	Cover	Dissolved Oxygen (mg/L)	Temp. (^oC)	Fish Present?
1	7V 609835 947576	1.14	0.53	LWD	9.84	-0.10	N
2	7V 609854 6947610	1.13	0.27	None	9.85	-0.12	N
3	7V 609856 6947651	0.83	0.18	LWD	10.20	-0.11	N
4	7V 609977 6947745	1.12	0.78	None	9.36	-0.12	N
5	7V 609958 6947779	1.24	0.73	NA	10.40	-0.14	N
6	7V 610078 6947889	0.82	0.82	NA	NA	NA	NA
7	7V 610211 6948518	0.69	0.41	None	11.15	-0.13	N
8	7V 610213 6948496	1.09	0.71	None	11.20	-0.12	N

Notes:

1. NA – Not Available due to shallow depth
2. WD – Woody Debris – mix of large and small sized debris
3. LWD – Large Woody Debris

A.10.5.2 Tailings Management Facility Fish Barrier

A.10.5.2.1 R286

R286. A discussion of the potential fish barrier proposed to be installed above the Casino- Brynelson Creek confluence. This discussion should include:

a. a description of the barrier proposed, and details regarding its installation; and

b. identification of alternative mitigations to the physical fish barrier in this location to prevent winter kill and fish stranding.

A drop fish barrier is proposed on Casino Creek, just upstream of its confluence with Brynelson Creek to prevent fish from becoming stranded in the low-flow TMF discharge channel. A basic design for a drop barrier consists of a vertical concrete wall that rises 2 m above a concrete apron on the channel bottom (Figure A.10.5-1). The crest wall typically follows the configuration of the channel bottom so that a 2 m drop extends across the entire channel bottom. The apron is designed to produce uniform water velocities that exceed fish swimming abilities, thereby precluding upstream passage. The vertical height of the barrier exceeds the leaping abilities of fishes when combined with the shallow, fast-flowing water over the apron. At high discharges, effectiveness of the vertical barrier will be lost in the center of the channel as water depths increase, but the vertical drop will be maintained at the edges of the floodwaters where current velocities are lowest. Upstream movements of fishes during floods are not expected in mid-channel because of high current velocities and sediment loads, but potential movements along the edges of floodwaters will be prevented by the maintained vertical drop.

Drop fish barriers have been used extensively by the US Department of Interior, Bureau of Reclamation as a method to protect native fish species from non-native species. Typical lifespan of such structures in the U.S. is approximately 100 years, with regular maintenance.

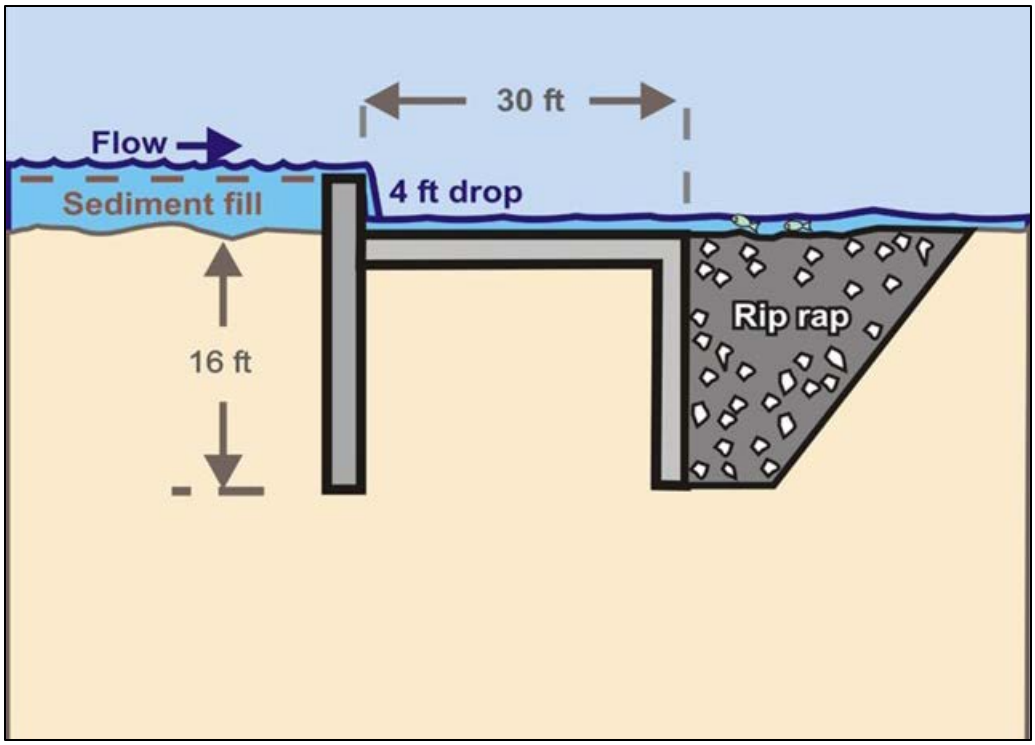


Figure A.10.5-1 Proposed drop fish barrier structure downstream of the TMF on Casino Creek

Additional mitigation measures may be considered if concerns arise surrounding the proposed physical barrier. CMC will develop and implement an adaptive monitoring plan that evaluates the effectiveness of the barrier, with the inclusion of triggers for implementing further mitigation measures to protect resident fishes. Other mitigation that may be considered may include other physical deterrents or flow management strategies.

A.10.5.2.2 R287

R287. The degree of risk for fish stranding to actually occur in Casino Creek due to low water flow attributed to the operation of the tailings management facility.

Fish passage capability can be determined by plots of riffle water surface elevations (Appendix A.10B) and depths at low flow levels. Figure A.10.5-2 depicts the average summer flow and winter flow water surface elevations for baseline, construction, operation, closure, and post-closure conditions at low gradient riffle 182 in Casino Creek Reach 1. LGR182 is the shallowest riffle transect in Casino Creek. Although fish migration was not specifically evaluated, Figure A.10.5-2 and Appendix A.10B indicates that sufficient flow will be maintained in Casino Creek to allow for fish passage in both seasons with projected riffle depths of 18 cm and 9 cm in summer and winter, respectively. In Appendix A.10B, riffle plots in Casino Creek are shown for the month of September, which is typically the month of seasonal low flow during the ice-free season. The highest flow alteration occurs in the summer season and the lowest flows occur in the winter season. The stream will be ice covered in the winter season with little fish movement; however, the winter season graph represents the lowest flow period. Very little off-channel habitat exists in Casino Creek and it was not evaluated due the paucity of this type of habitat.

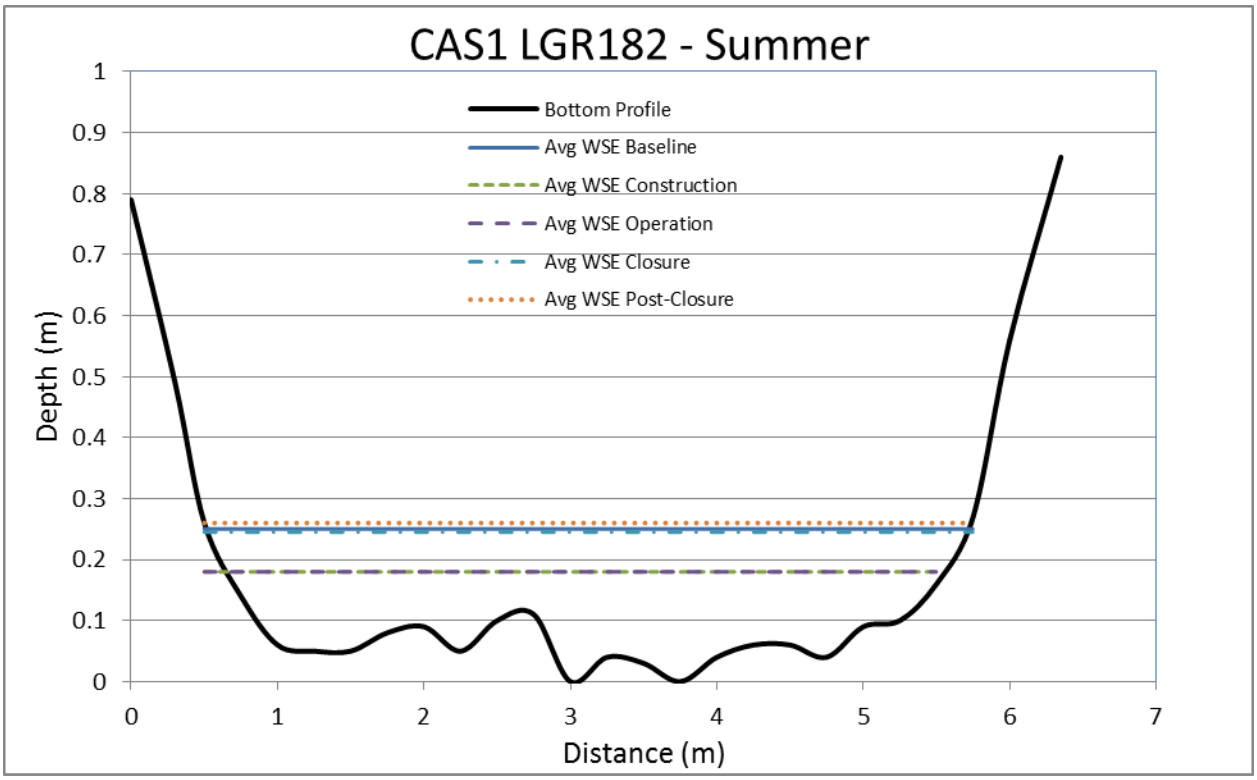


Figure A.10.5-2a Average summer water surface elevations (WSE) at Casino Creek low gradient riffle 182 during baseline, construction, operation, closure, and post-closure conditions

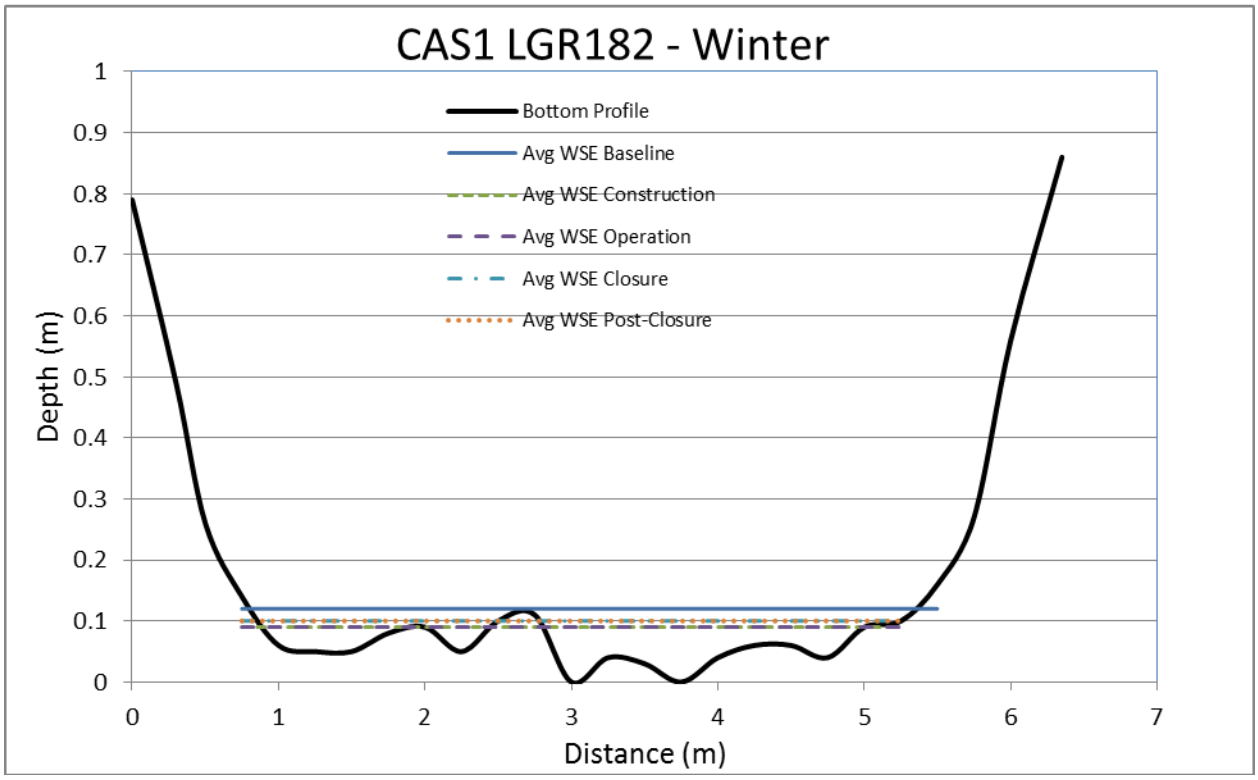


Figure A.10.5-2b Average winter water surface elevations (WSE) at Casino Creek low gradient riffle 182 during baseline, construction, operation, closure, and post-closure conditions

A.10.5.3 Airstrip Diversion Channel

A.10.5.3.1 R288

R288. A discussion of and rationale for the diversion of this drainage around the airstrip. This discussion should consider alternatives, such as allowing the drainage to pass underneath the airstrip.

The engineers are opposed to passing the tributary through a culvert beneath the airstrip because the underlying, ice-rich permafrost is susceptible to thawing while water flows across it. This could result in differential settlement and potentially blockages within the culvert. Additional maintenance would be required to ensure the airstrip surface is intact. In addition, it is likely that the culvert would become blocked with ice build-up in the winter, while cold air is able to penetrate and flow through the culvert. During the spring melt, ice blockages within the culvert could cause flooding upstream of the airstrip.

A.10.5.3.2 R289

R289. A discussion of the potential for seasonal stranding of fish in the lower portion of the dewatered channel.

The airstrip tributary is a very small channel, even at its mouth with Dip Creek. The HEP assessment carried out in July 2014 identified that under bankfull conditions, the lowermost 100m upstream from Dip Creek was on average 1.3m wide and 0.32m deep. Following the airstrip construction, all surface runoff within the creek and

overland that reaches the airstrip will be diverted elsewhere, and thus the only source of water for the tributary downstream will be localized runoff from the floodplain and adjacent embankments. The small downstream tributary will receive negligible or minor flow along its approximately 500m length, reducing the drainage substantially from its already small size and likely precluding access to fish from Dip Creek. In addition, fish and fish habitat surveys completed in 2014 confirmed that the tributary had marginal fish habitat potential, and no fish were captured during a survey when conditions were most amenable to fish passage (See R275 for more detail).

A.10.5.4 Fisheries Protection Provisions of the Fisheries Act

A.10.5.4.1 R290

R290. An updated Fish Habitat Compensation Plan to align with the new requirements of the Fisheries Protection Provisions of the new Fisheries Act.

The initial plan submitted in the Proposal was to support DFOs review of the Proposal, with the understanding that a final detailed design for fish habitat offsetting was to be provided to DFO in association with CMC's subsequent request for *Fisheries Act* authorization. To reflect the changes to the *Fisheries Act*, as well as to update the plan with more detailed design and site selection techniques, CMC has provided the Fish Habitat Offsetting Plan (Appendix A.10A), which reflects the change in terminology of the new fisheries protection provisions.

A.10.5.5 Physical Habitat Simulation Model and Habitat Evaluation Procedure

A.10.5.5.1 R291

R291. A detailed description of the physical habitat simulation model. Details should include:

- **a. data used in the model (habitat and hydrological) and methods for field data collection;**
- **b. locations of all transects (of each mesohabitat type - riffle, pool and glide) on each watercourse;**
- **c. habitat suitability indices (HSI) curves for Arctic grayling in all life stages which consider site specific conditions;**
- **d. species and life stage periodicity chart highlighting the seasonal use of the study area by different life stages of the target species, and a discussion of whether migration patterns were considered in the model;**
- **e. discussion of whether seasonal use by life stage requirements of target species was considered in the model;**
- **f. target flow velocities for low, mid and high flows, with a comparison to the baseline and projected flows for construction, operation and closure phases, indicating and providing rationale for the selected minimum in-stream threshold;**
- **g. discussion of impacts to Britannia Creek from reduced flows in Canadian Creek as flow is redirected to the pit; and**
- **h. a comparison of percent reduction in flow for areas affected by reduced stream flows considering natural variability observed in stream.**

See Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study provided in Appendix A.10B.

A.10.5.5.2 R292

R292. A detailed description of the habitat evaluation procedure. Details should include:
- **a. methods and assumptions for the calculation of habitat lost;**
- **b. summary of HSI values for each variable;**
- **c. identification of and rationale for habitat types included; and**
- **d. data and methods used to calculate habitat gains, including from all proposed compensation options.**

See Fish Habitat Evaluation: Instream Flow and Habitat Evaluation Procedure Study provided in Appendix A.10B.

A.10.5.6 Habitat Loss Calculations – Airstrip Diversion Channel

A.10.5.6.1 R293

R293. Clarification of whether the estimated habitat loss in Dip Creek was accounted for in the total habitat loss calculation for the proposed airstrip tributary diversion channel.

The proposed diversion of the small tributary around the Airstrip shifts its confluence with Dip Creek approximately 3.8 km downstream. This shift is unlikely to result in any measureable or significant loss in habitat along this short section of Dip Creek, because the tributary contributes so little water to Dip Creek relative to its flow from upstream. The tributary's 10 km^2 drainage area is only 3% of the 334 km^2 drainage area of Dip Creek at the confluence with the tributary. The localized loss of flow along this short section of Dip Creek from 3% of its watershed would be unmeasurable and would have a negligible effect on available habitat. Flow conditions downstream of the new confluence would be unaffected.

Wetted habitat loss in Dip Creek due to construction of the TMF in Casino Creek is included in the total habitat loss calculation (Appendix A.10A).

A.10.5.6.2 R294

R294. Clarification of, and rationale for, the methods used to calculate the figures in Table 4-5: in-stream habitat impacts and in-stream habitat gains. This clarification should include the calculation of 4753 m² as identified in Table 4-5, based on the proposed airstrip diversion channel width of 2.5 m and length of 1 509 m.

The length of 1,509 m for the proposed Airstrip diversion channel is a typographical error, reflecting a former iteration of preliminary design configuration. The correct proposed length is approximately 1,901 m. The 4,753 m^2 of habitat indicated in Table 4-5 is correctly determined as the product of 2.5 m and 1,901 m. The updated Fish Habitat Offsetting Plan (Appendix A.10A) includes a fully updated impacts/gains table, including the application of a 'reverse' Habitat Evaluation Procedure (HEP) to habitat gains, where possible.

A.10.5.7 Habitat Evaluation Procedure Analysis

A.10.5.7.1 R295

R295. Clarification of whether the assumed fish bearing streams (those of less than 20 percent gradient) were included in the habitat evaluation procedure analysis for habitat loss and compensation.

All assumed fish bearing stream crossings were included in the total habitat loss calculations. Habitat losses were modelled using habitat evaluation procedure for all crossings containing suitable data for running the model.

A.10.5.8 Ford Rehabilitation

A.10.5.8.1 R296

R296. Identification and rationale for the type(s) of habitat created by ford restoration.

Details on the ford restoration in Britannia Creek is provided in Appendix A.10A. The abandoned fords were originally sited (by prospectors and placer miners) at naturally wide sections of the creeks, typically riffles, where flow depths are locally at a minimum. This eased periodic crossing by vehicles. Creation and persistence of habitat-benefiting deep pools at these natural widenings, where sediment deposition and accumulation predominate, would be inconsistent and incompatible with the natural morphology of the creeks. The intention of the preliminary design drawings is to emphasize the restoration of pre-existing channel form and function. This will generally involve localized removal of any fine sediments that have accumulated as a result of ford disturbance, returning the channel to its naturally wide, riffle morphology. Detailed design drawings will include site-specific guidance for sediment removal and preservation at each ford site.

A.10.6 WATERCOURSE CROSSINGS

A.10.6.1 Embedded Culverts on Fish Bearing Streams

A.10.6.1.1 R297

R297. Clarification of whether clear-span bridges are proposed for all fish-bearing watercourses. If culverts will be installed on some fish-bearing creeks, please provide rationale, mitigations, and incorporate habitat losses into the habitat compensation plan.

The Freegold extension section including the airstrip road is at feasibility level design and clear span bridges will be the preferred design at all fish bearing crossings. However, there will be some crossings not suitable for bridges (high fills, on sharp corners etc.) which will require another solution such as embedded culverts to be determined during detailed design. Any fish-bearing crossings requiring culverts will be designed to ensure fish passage and habitat losses will be assessed and offset accordingly. Currently, the Freegold Road Upgrade section is at the conceptual design stage. The Yukon Government will be providing the feasibility level design in the future which will clarify the location and type of crossing structures.

A.10.6.2 Existing Stream Crossings

A.10.6.2.1 R298

R298. Details on existing crossing structures no longer used for portions of the Freegold Road upgrade once the road is re-aligned.

As discussed in Section 4, the Freegold Road upgrade will be the responsibility of the Yukon Government (YG), pending an agreement with CMC and the First Nations on whose settlement land the Freegold Road crosses. CMC cannot comment on the work to be done by YG. Section A.4 outlines the discussions with YG on assessment of the Freegold Road upgrade through the YESAB process.

A.10.6.3 Nordenskiold River Bridge

A.10.6.3.1 R299

R299. Details on when and how the Nordenskiold River bridge pier will be constructed.

As discussed in Section 4, the Freegold Road upgrade, and the Carmacks bypass including construction of the Nordenskiold Bridge, will be the responsibility of the Yukon Government (YG), pending an agreement with CMC and the First Nations on whose settlement land the Freegold Road crosses. CMC cannot comment on the work to be done by YG, however, Section A.4 outlines the incorporation of the Freegold Road upgrade in the Proposal.

A.10.6.3.2 R300

R300. The quality and type of fish habitat (e.g. highly suitable spawning and/or rearing habitat, confirmed spawning habitat, and migratory channel) potentially affected by the Nordenskiold River bridge. Discussion should include identification of potential effects of the bridge and the pier, focusing on potential long-term morphological changes to the river in contrast to natural morphological changes.

The proposed Nordenskiold River Bridge is crossing number 1N on Figure A.10.4-2. As described in Appendix 10B (p.18-19), the proposed Nordenskiold River crossing has a wetted width of 53 m, an average depth of 1 m and a cobble dominated substrate. In-stream cover was low (<20%) and the channel gradient was low (2%) typical of large watercourses within the study area. The mean temperature as measured on August 9, 2013 was 15.9°C, which is warm for the Yukon River Basin but not uncommon in large watercourses.

In response to comments received during the adequacy review, a geomorphological impact assessment of the proposed Nordenskiold bridge pier was conducted using the following reference materials:

1. Historical photos of the Nordenskiold crossing;
2. Fluvial Geomorphology Hazard Assessment for Proposed Access Roads (Appendix 6E);
3. On-site field photos from 2013;
4. Google Earth imagery; and
5. Proposed bridge/pier design from *Casino Project Access Overview for Submission to YESAB* (Appendix 4B).

The proposed Nordenskiold River bridge crossing is immediately downstream of a tortuous meander that was cut-off (naturally) sometime between 1994 and 2008. A large, side- to mid-channel gravel bar formed in association with this cut-off as a result of localized erosion of the former meander 'neck'. This gravel bar has migrated and extended downstream slightly since the cut-off event, now forming a very thin bar along the channel centreline immediately upstream of the proposed crossing location. However, the bar has also shrunk appreciably as flows continue to erode its head and flanks. It is expected that continued erosion of the bar, with its current mid-channel position and full exposure to erosive flows, will remove it entirely within the next several years. The bar is thus a short-lived feature formed in direct response to the meander cut-off. Placement of the pier along the downstream limit of this thin, remnant bar is not recommended, from a fluvial geomorphological perspective, as the pier would likely be positioned in the thalweg in several years and be exposed to direct and regular impacts from rafted ice and large woody debris.

The currently proposed pier position is close to the west bank of the river, in a small 'alcove' between the main bank and a small side-channel bar (depositional area) immediately downstream, at a transition between the thalweg (on the east) and slackwater and possible back-eddy flow (on the west). The thalweg is expected to align

itself closer to the channel centreline, over time, in response to continued erosion and removal of the mid-channel bar immediately upstream. Currently, the focus of erosion along the west bank, as a result of the meander cut-off and new meander pattern, is approximately 110 m upstream of the proposed pier position. The gradual alignment of the thalweg into the middle of the channel is expected to moderate and ultimately eliminate this western bank erosion, thus posing no risk to the pier position in the long-term.

The pier is anticipated to cause localized scour around and immediately downstream of its base, where flow velocities are concentrated and capable of eroding the gravelly to cobbly bed material. The pier will be constructed to withstand such scour. The head of the small side-channel bar immediately downstream may be 'trimmed' slightly by this localized scour, although the propensity for continued deposition in this point bar-like position is expected to maintain the bar and its role in protecting the west bank from significant erosion. Relatively little scour may occur around the west side of the pier, given how close it is to the west bank and its sheltering from the thalweg by the bar immediately downstream. A deep, yet small pool is expected to be formed and maintained on the east and downstream side of the pier, which may be attractive to fish species seeking deep water refuge. Ultimately, the pier is expected to cause very localized and minor changes in morphology, with no adverse effects on fish habitat or fisheries productivity.

The noted gravel bar is upstream from the currently proposed bridge alignment by 10 m. The bridge designers have chosen the proposed pier location to be as close to the normal high water mark as possible, essentially creating a clear span of the main river channel. This reduces the likelihood of debris accumulation and scour around the pier and also improves constructability by allowing easy access for pile driving equipment working from the shore. The pier is designed to take loads and impacts from ice and debris and is complete with a steel diaphragm connecting the 4 piles together that will distribute horizontal loads and prevent debris from catching between the pier piles.

The geomorphological assessment conducted also provided insight into the creation and stability of the noted gravel bar. Based on this assessment, it was not recommended to place the bridge pier on the eroding gravel bar as the pier would likely be positioned in the thalweg in several years and be exposed to direct and regular impacts from rafted ice and large woody debris.

It is expected that the proposed bridge site may support spawning and rearing habitat for any of the documented fish species in the river, including Chinook and Chum salmon. As depths are generally less than 1 m, it is unlikely that any overwintering habitat will be lost. As the total footprint of the bridge pier is small (6 m^2) relative to the estimated area of the river mainstem (estimated 1.43 km^2), it is anticipated that any potential impacts on fisheries productivity will be minor.

A.10.6.3.3 R301

R301. The fish species (and their life stages) present in the area potentially affected by the Nordenskiold River bridge. Discussion should include identification of potential effects of the bridge and the pier.

Fisheries baseline data on the area around the Nordenskiold Bridge is provided in Appendix 10B, pages 18-19 and 34.

As detailed in Section A.10.4.1.2:

- Big Creek, Selwyn River, Nordenskiold River, Klotassin River, Donjek River, and the White River are known to be utilized by adult Chinook salmon for spawning habitat (DFO 1985; Yukon River Panel

2008a), and the tributaries of Seymour Creek, Bow Creek, Stoddart Creek, Hayes Creek, and Dip Creek have all been shown to contain fry and juvenile Chinook (DFO 1994; von Finster 1998).

- Adult chum salmon have been documented within the Nordenskiold River, and in Big Creek approximately 13.7 km upstream of the Yukon River confluence (DFO 1985).
- Slimy sculpin is one of the most widely distributed species in the RSA, with reported captures in lower Casino Creek, lower Brynelson Creek, Dip Creek, lower Britannia Creek, Isaac Creek, Selwyn River, Hayes Creek, Big Creek, Murray Creek, and the Nordenskiold River.
- Northern pike is one of the top three most targeted fish species by anglers in the Yukon (Environment Yukon 2010). The distribution of northern pike in the project area is restricted to the Nordenskiold River.
- Burbot is most commonly caught by anglers in lakes during the winter through ice (Environment Yukon 2010). In the project area, burbot has been captured in stream habitats such as lower Casino Creek, Dip Creek, Isaac Creek, and the Nordenskiold River, where fishing is less common and/or unlikely to occur due to remoteness.
- Round whitefish have been captured in Dip Creek, Murray Creek, Big Creek, and within the Nordenskiold River. Little is known about round whitefish populations in the Yukon, and they are not recognized as a popular angling species (Environment Yukon 2010). While other species of whitefish are commercially harvested in the Yukon, round whitefish are not specifically targeted due to their smaller size. However, First Nations may harvest round whitefish for subsistence (Environment Yukon 2014).
- Longnose sucker have been captured in Isaac Creek and the Nordenskiold River. Longnose sucker is not recognized as a popular angling species (Environment Yukon 2010).

While no fish sampling was conducted along the Nordenskiold River, crossing 1N (Figure A.10.4-2) is considered to be fish bearing. It is known that the Nordenskiold River hosts eleven species of fish (Chinook salmon, chum salmon, lake trout (*Salvelinus namaycush*), Arctic grayling, round whitefish, lake whitefish (*Coregonus clupeaformis*), longnose sucker, burbot, northern pike, Arctic lamprey and slimy sculpin), all of which are common to the Yukon River Basin (Nordenskiold Sterring Committee 2010). Both Chinook salmon and chum salmon utilize the river for spawning and rearing habitat and the river provides suitable conditions for overwintering habitat. No barriers to fish movement were identified as part of this study, however frequent log jams within the Nordenskiold River may restrict salmon movement (Nordenskiold Sterring Committee 2010).

As stated above, it is expected that the proposed bridge site may support spawning and rearing habitat for any of the documented fish species in the river, including Chinook and Chum salmon. As depths are generally less than 1 m, it is unlikely that any overwintering habitat will be lost. As the total footprint of the bridge pier is small (6 m^2) relative to the estimated area of the river mainstem (estimated 1.43 km^2), it is anticipated that any potential impacts on fisheries productivity will be minor.

A.10.6.4 Classification of Crossings

A.10.6.4.1 R302

R302. A list of stream crossings for the Freegold Road including stream name, kilometre marker, crossing properties and the type of crossing, considering DFO's definition of clear-span crossing.

All stream crossing data is provided in the *Fish and Aquatic Resources Baseline Report: Freegold Road Extension, Freegold Road Upgrade, and Casino Airstrip and Airstrip Access Road*, provided in Appendix 10B.

Proposed clear-span bridges will have abutments above the high water mark, similar to DFO's description of clear-span bridges. However, rip rap will be placed within the high water mark where necessary to reduce slope failure in potentially unstable permafrost laden areas. If abutments were set well back from the active channel, the die-off of riparian vegetation would destabilize the banks and promote long-term bank collapses and slumping. This would have a far greater and more long-term impact than a small patch of rip-rap on the bank. Thus, the usage of rip rap is essential to minimize siltation below bridges where vegetation is unable to grow due to insufficient light. Further, rip rap will be placed flush with the stream bank to avoid changes in channel volume or flows.

The response to R297 addresses the placement of crossing structures in areas which may be more unstable and thus not suitable for a clear-span bridge.

A.10.6.5 Erosion

A.10.6.5.1 R303

R303. An assessment of the overall erosion and sedimentation risk that will form the basis for designing and ultimately preparing an erosion and sediment control plan for the Freegold Road Upgrade, Airstrip Access Road and Casino Mine site.

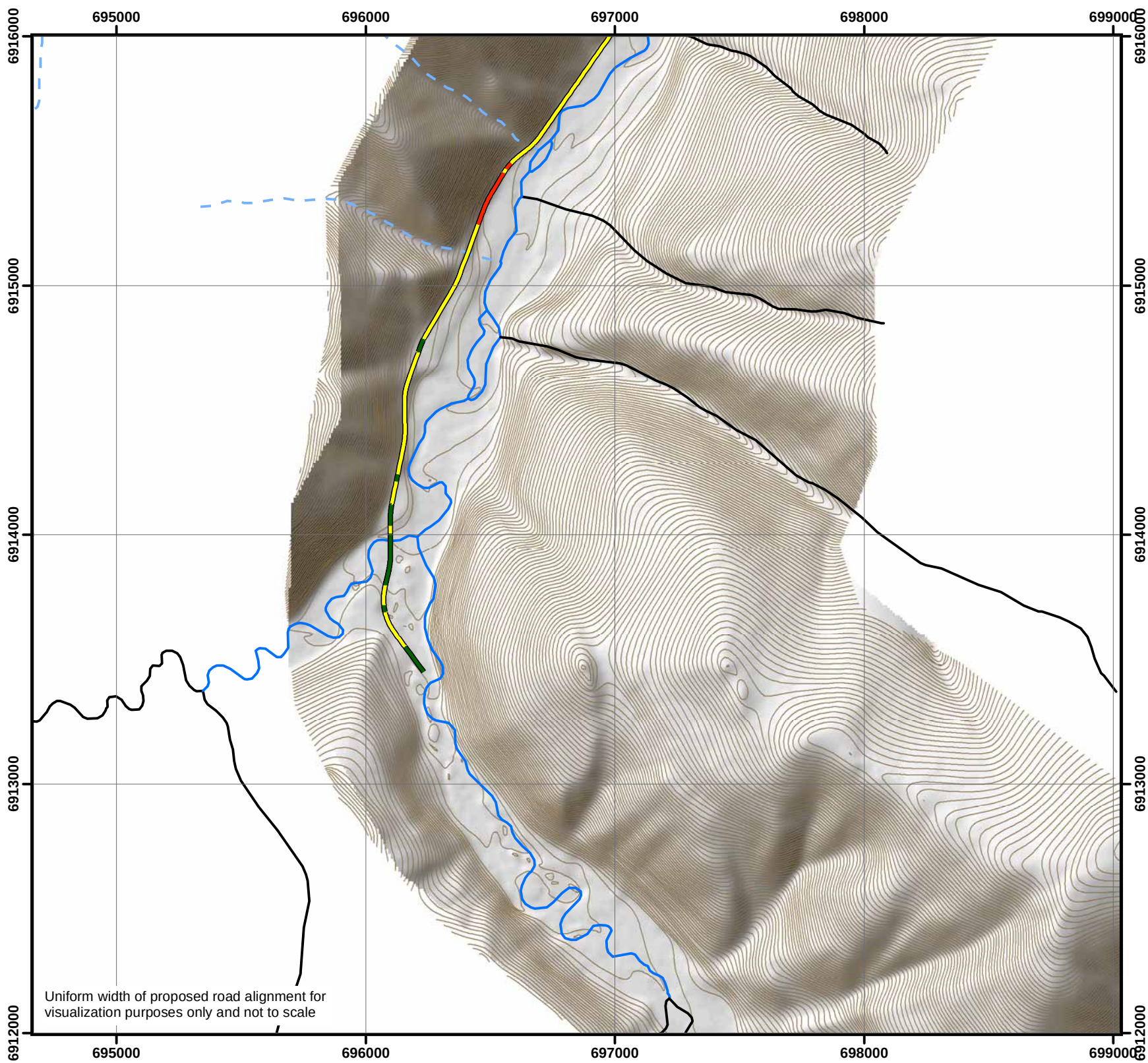
The risk assessment was completed initially along the Freegold Road Extension because its construction necessitates numerous new stream crossings and encroachments, some associated with major fish-bearing streams, and extensive linear disturbance to vegetation and soil.

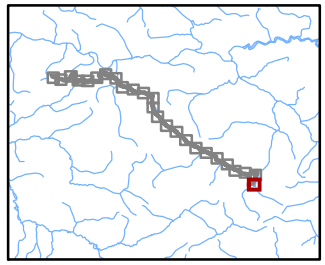
In writing the Erosion and Sediment Control Plan (for the Quartz Mining Licence application), the same overall erosion and sedimentation risk assessment will be conducted for the Freegold Road Upgrade, Airstrip Access Road and Casino Mine Site. Corresponding mitigation measures will be applied at the areas identified in the risk assessment.

A.10.6.5.2 R304

R304. Identification of fish-bearing and non fish-bearing reaches of affected watercourses in the Map Series 3 (overall erosion and sedimentation risk) of the Erosion and Sedimentation Risk Assessment Report.

The classification of relevant watercourses as fish bearing or non-fish bearing is provided in Figure A.10.4-1 through Figure A.10.4-8, and this classification has now also been added for clarity to all three map series comprising the erosion and sedimentation risk assessment. Freegold road extension erosion potential, potential ecological consequences, and overall erosion and sedimentation risk are provided in Figure A.10.6-1, Figure A.10.6-2, and Figure A.10.6-3, respectively. The presence/absence of a direct downstream connection to fish bearing watercourses has also been included in the updated map symbology, as it relates to potential downstream effects from non-fish-bearing crossings. The overall erosion and sedimentation risk (Figure A.10.6-3) may be low for non-fish-bearing crossings in gentle (low erosion potential) terrain where there is no obvious direct connection to downstream fish bearing watercourses.





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

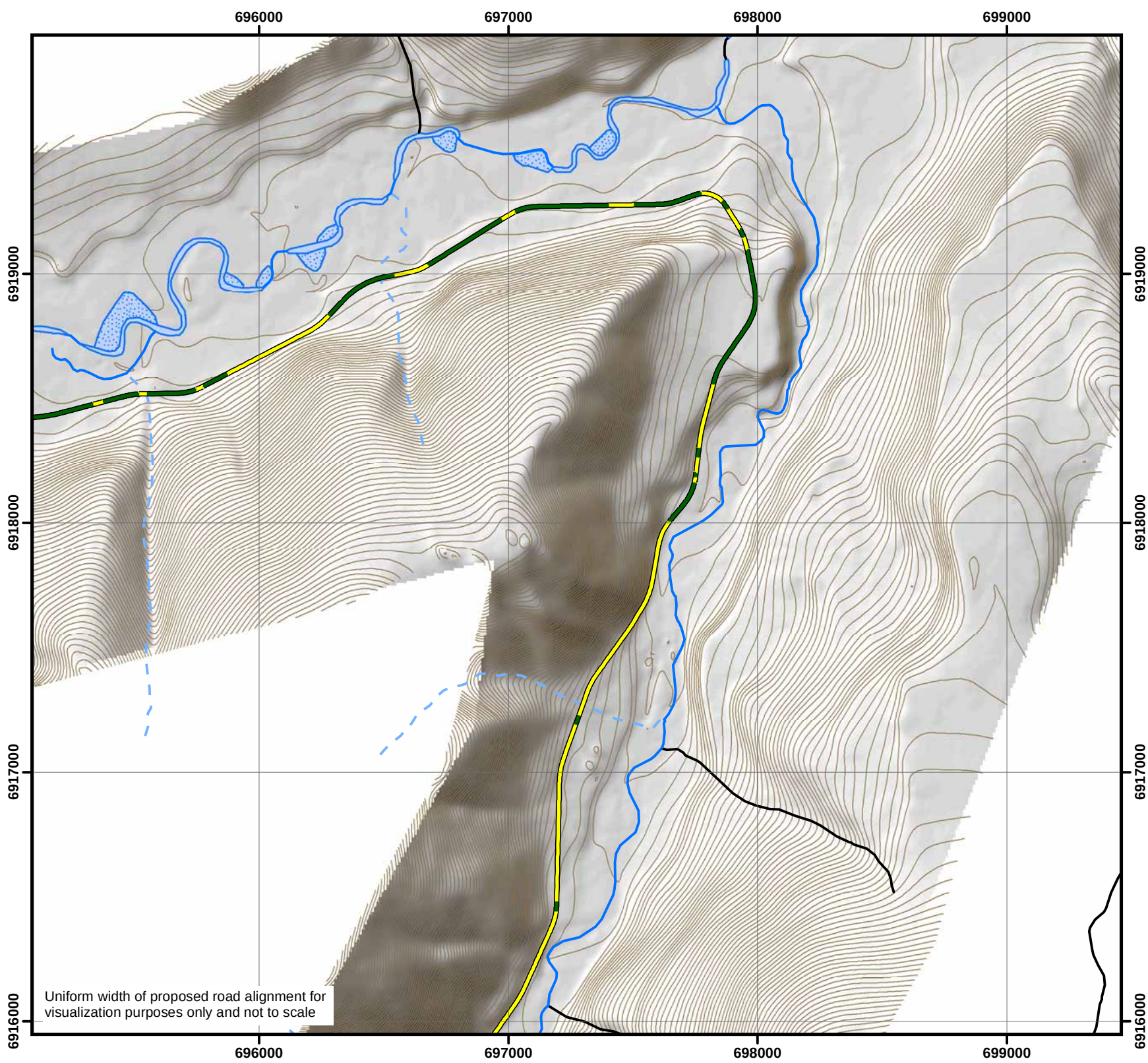
Map 1

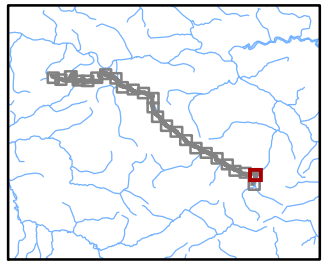
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 1 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

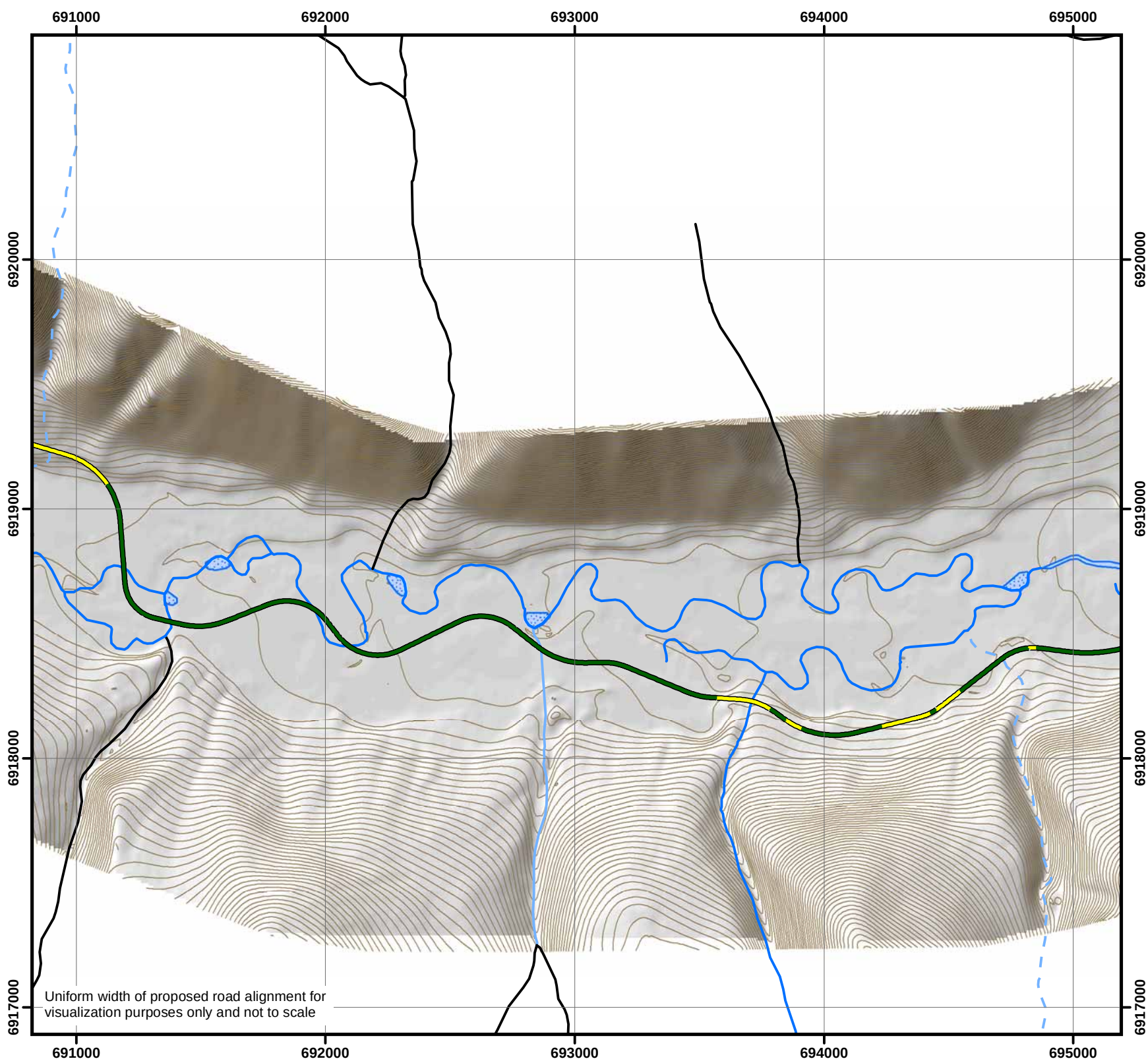
Map 1

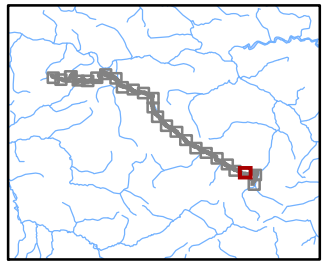
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 2 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

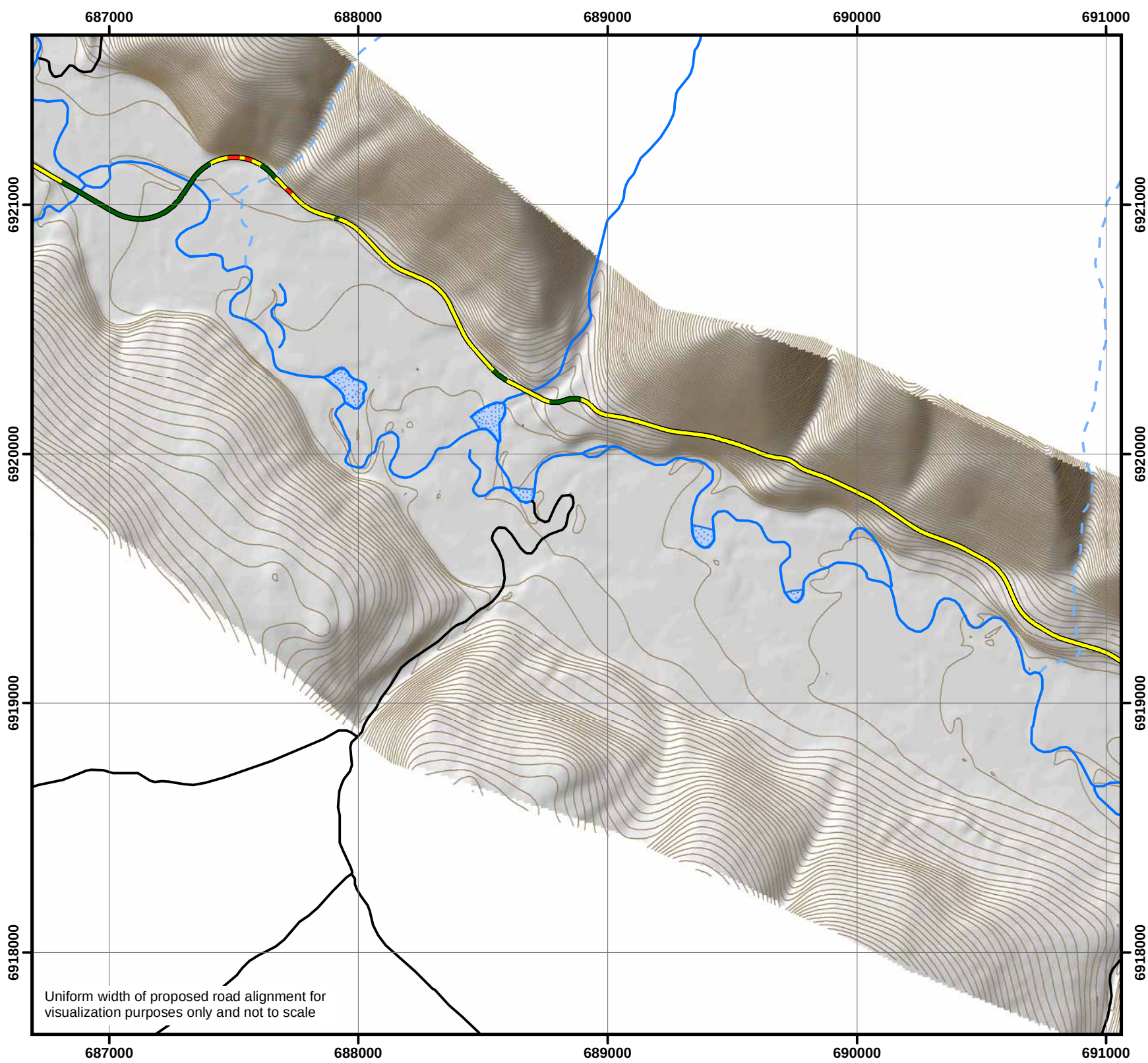
Freegold Road Extension

Map 1

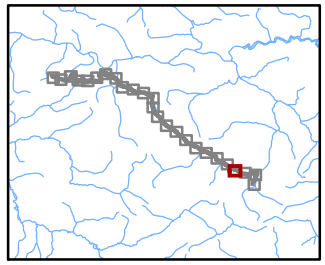
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

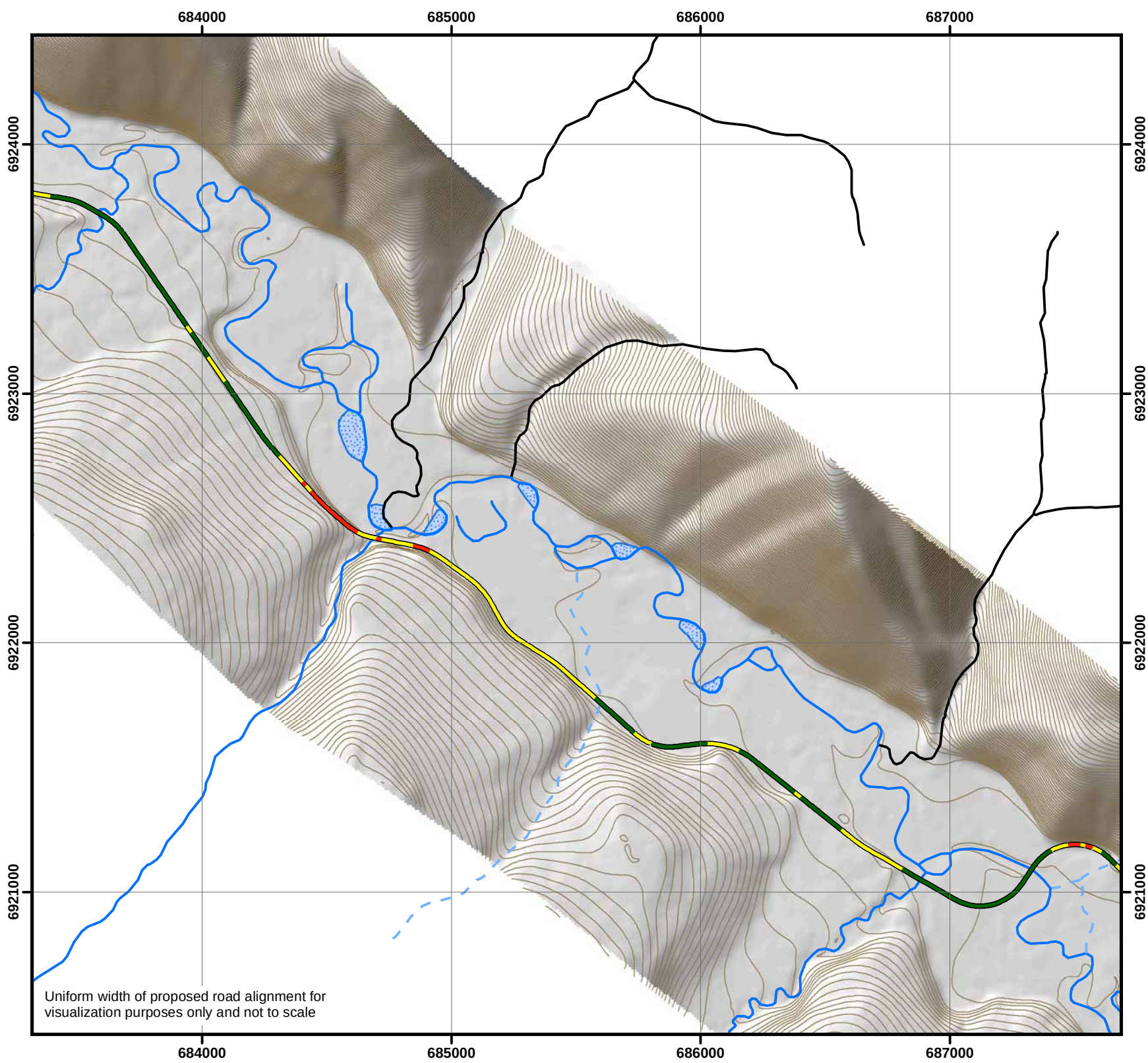
Map 1

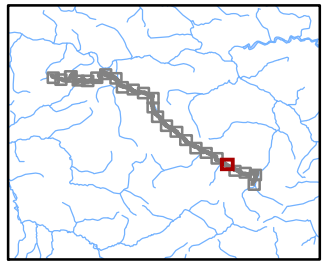
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 4 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

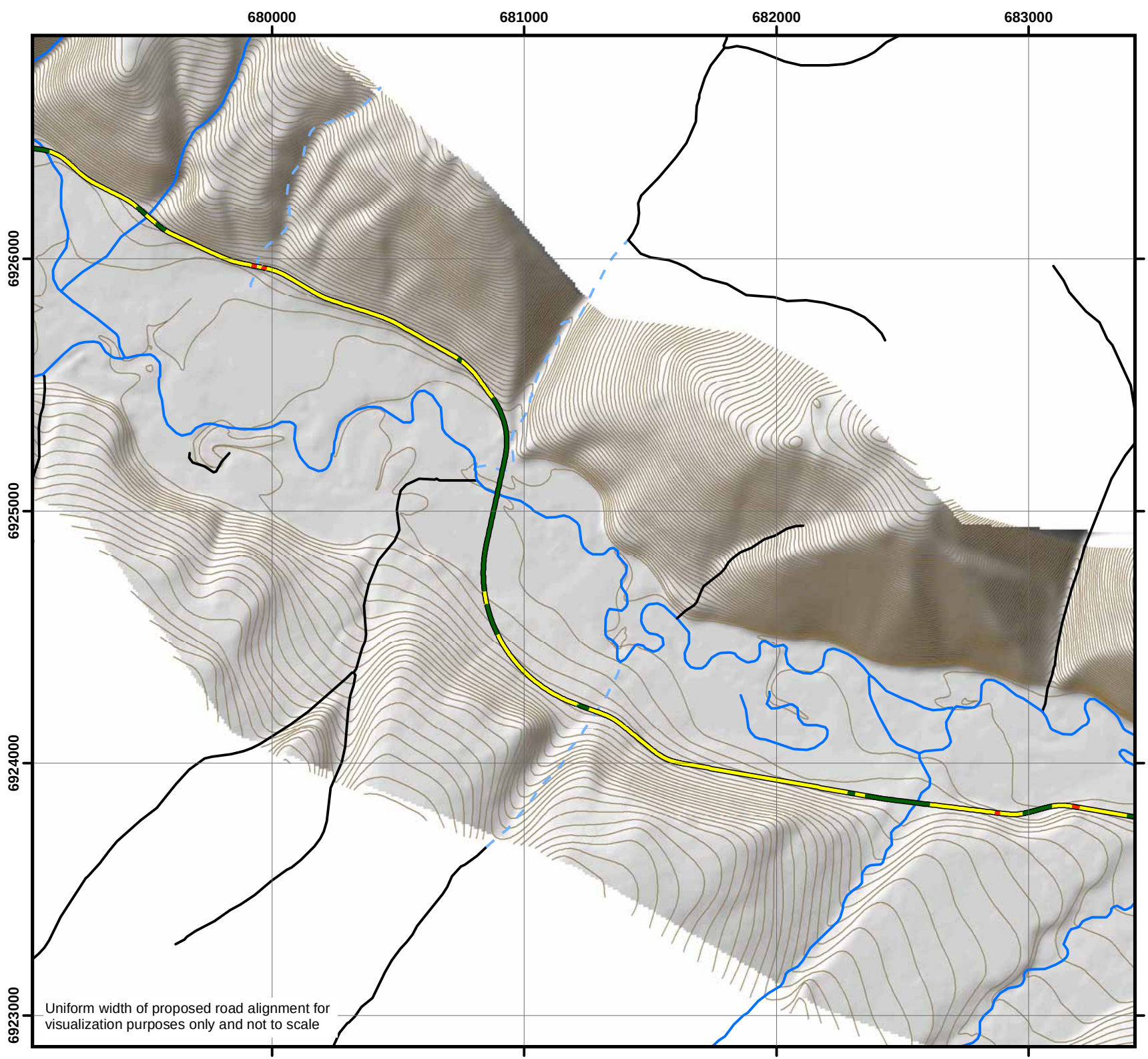
Map 1

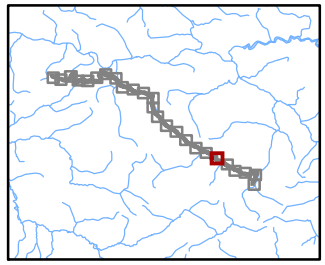
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 5 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

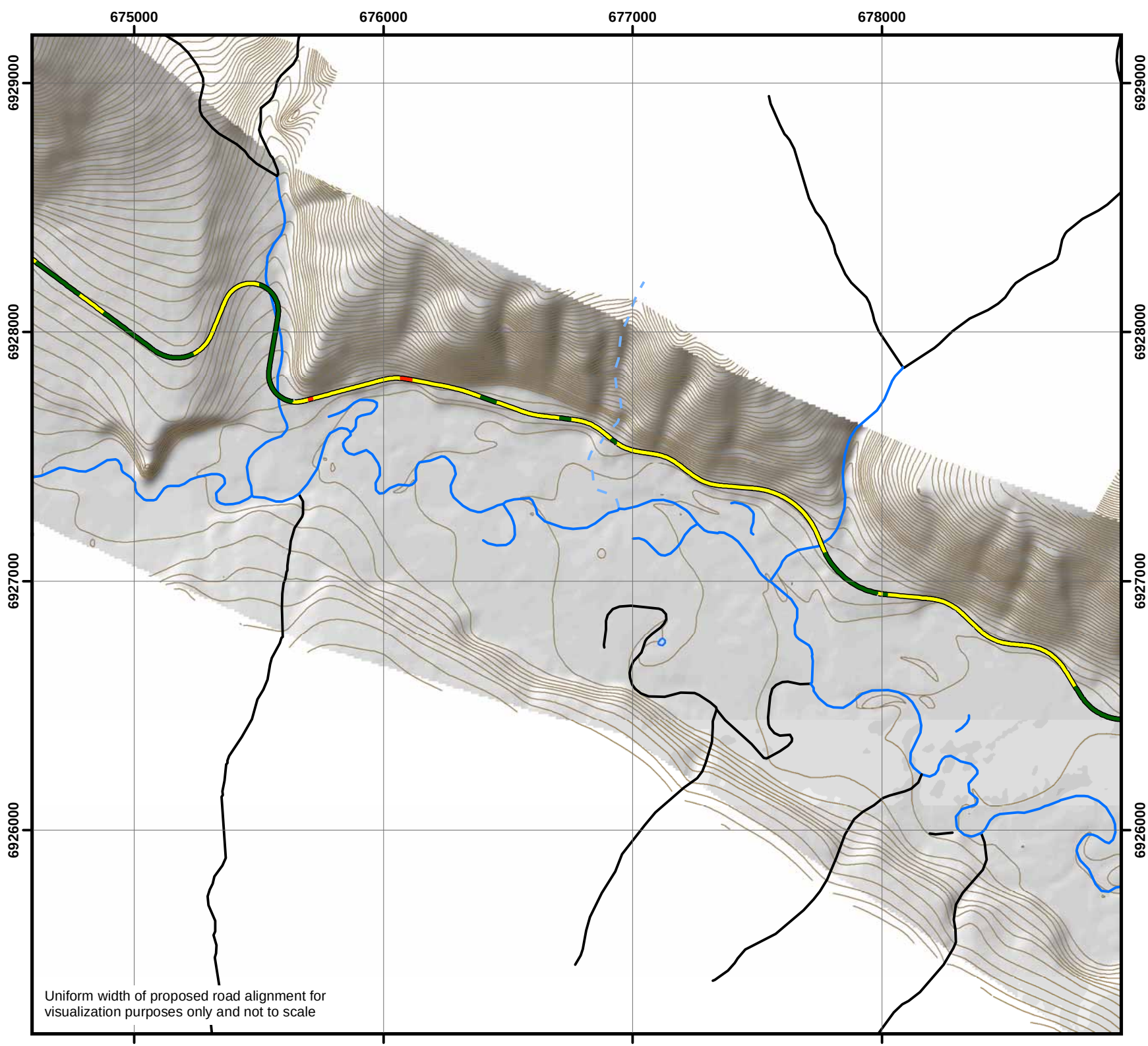
Freegold Road Extension

Map 1

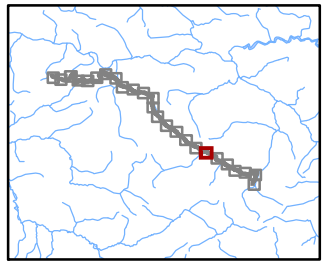
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

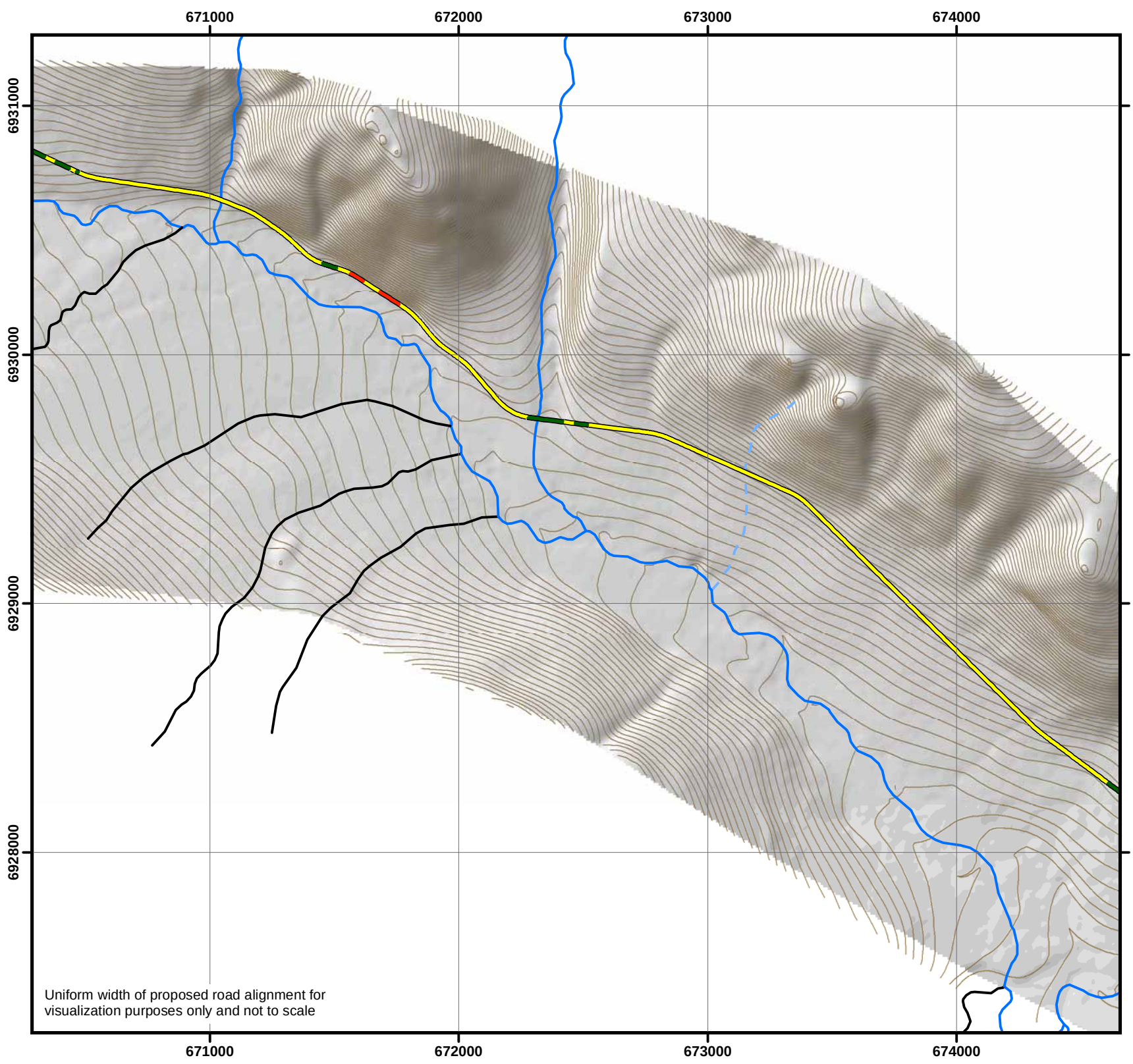
Map 1

Erosion Potential

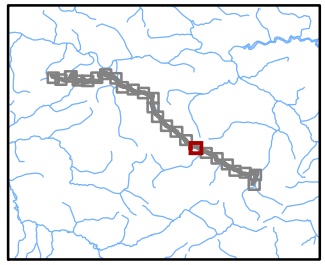
CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 7 of 25



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

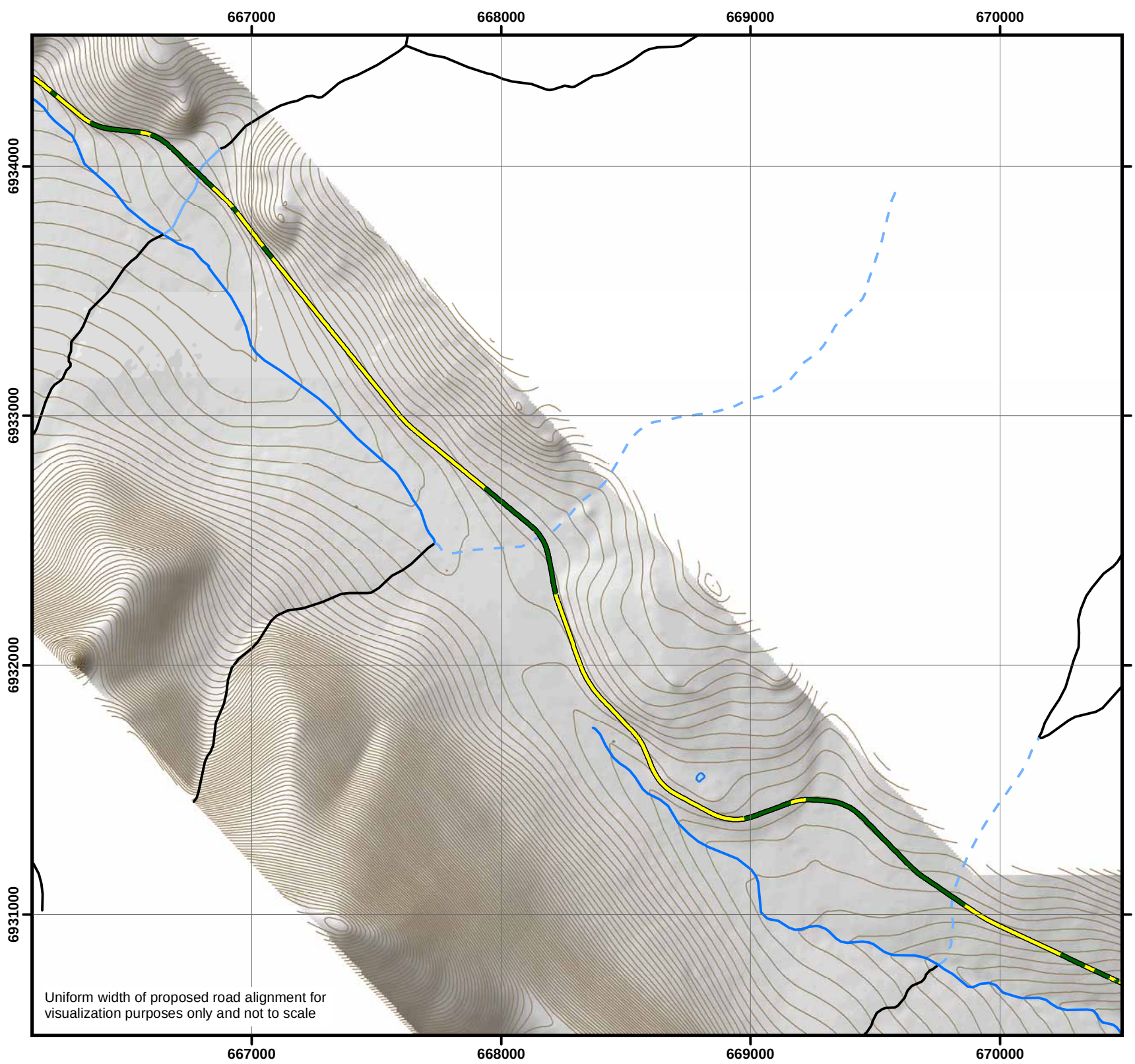
Map 1

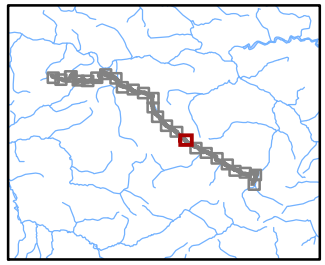
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 8 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

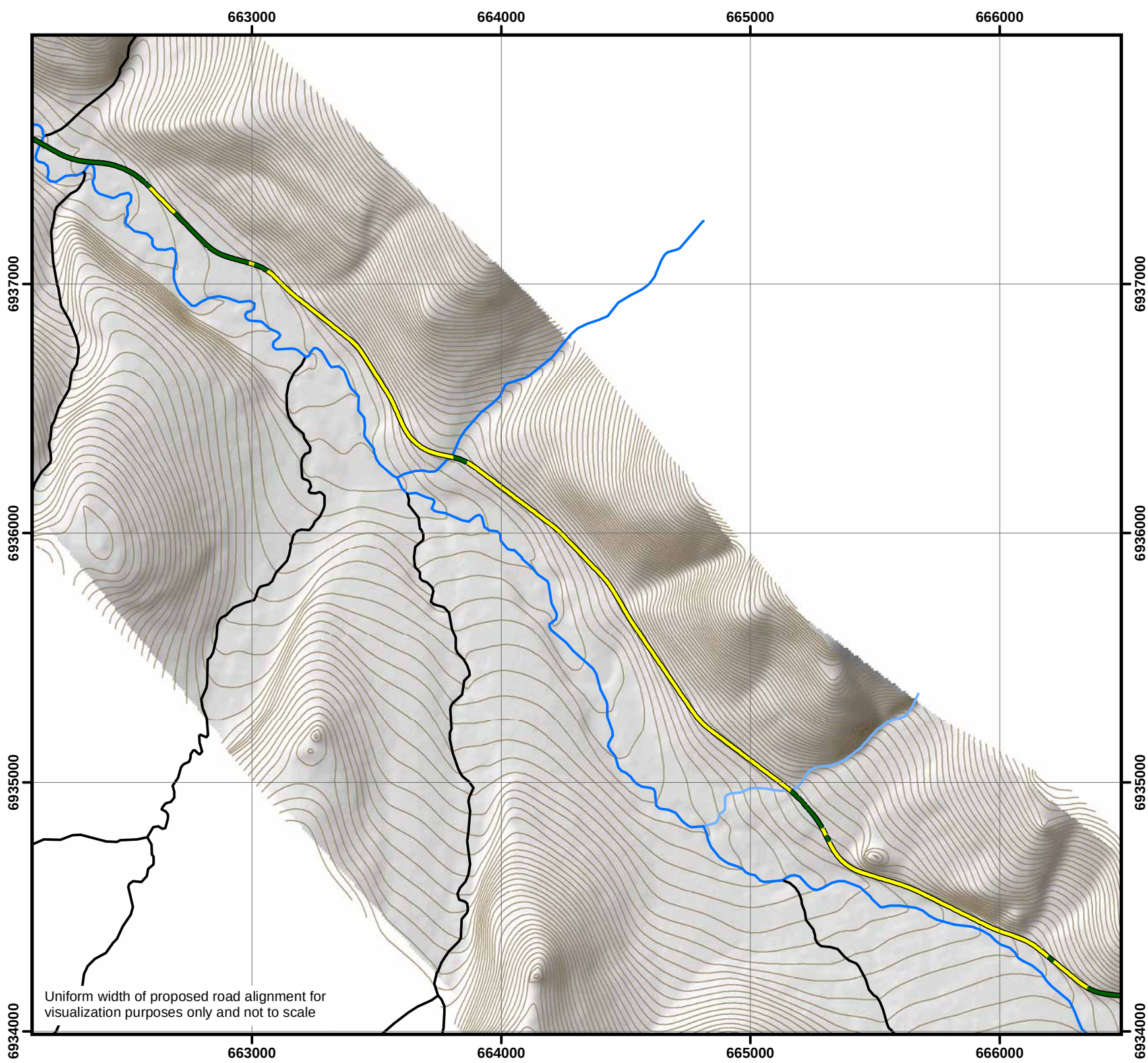
Map 1

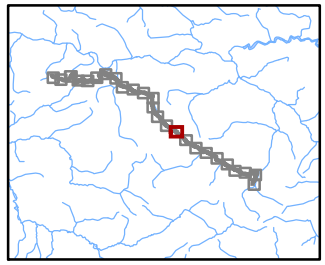
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 9 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

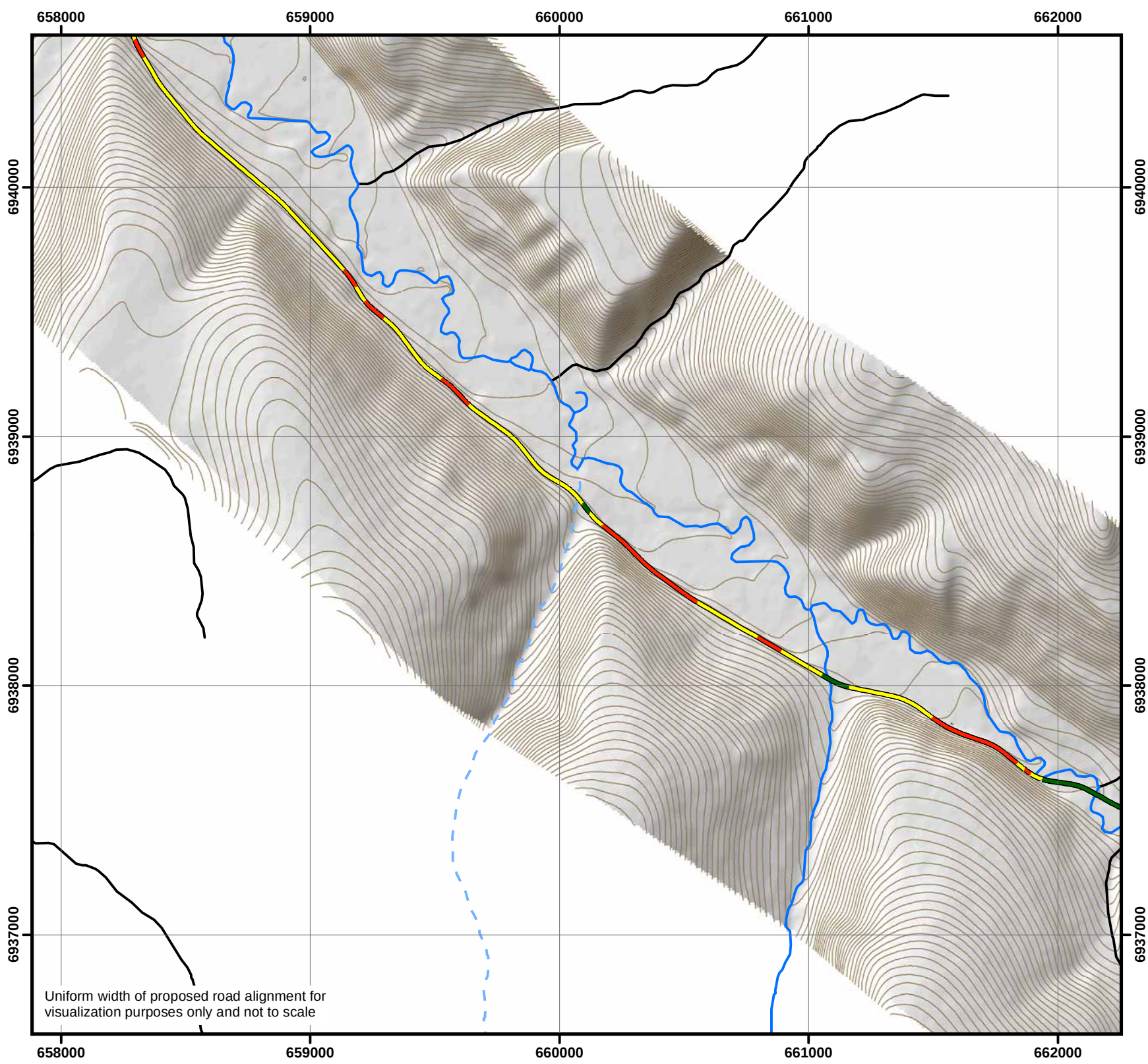
Map 1

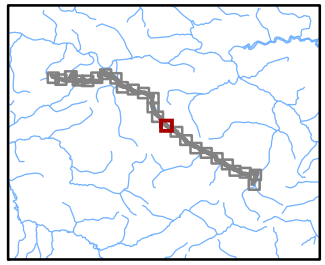
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 10 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

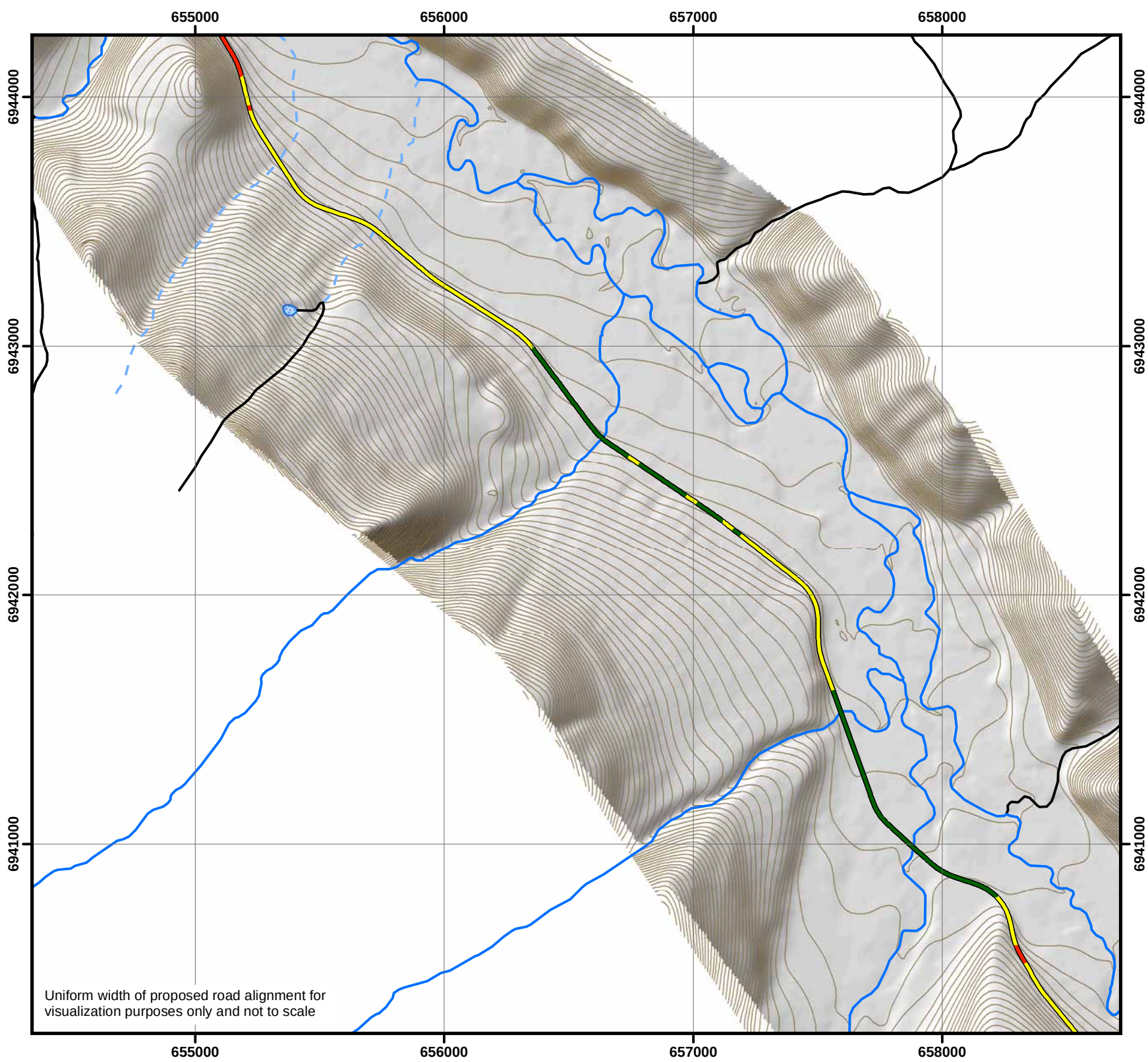
Map 1

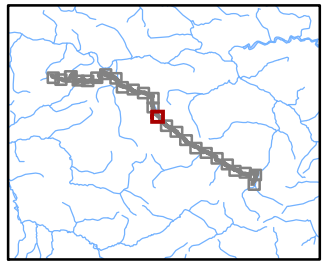
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 11 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

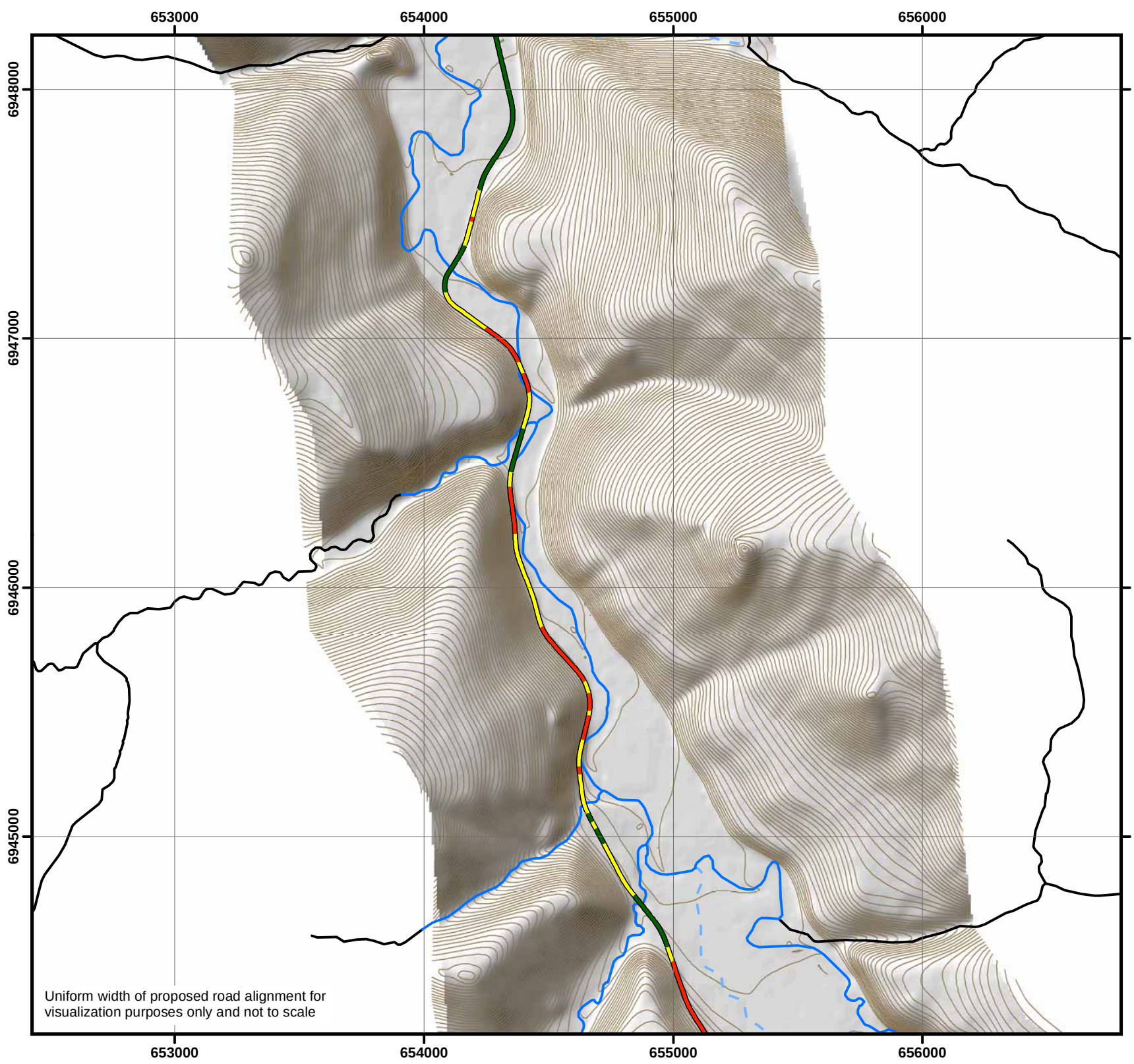
Map 1

Erosion Potential

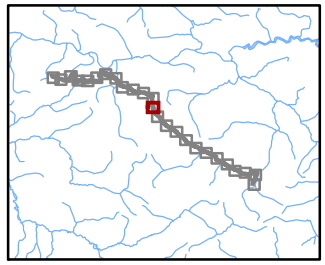
CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 12 of 25



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

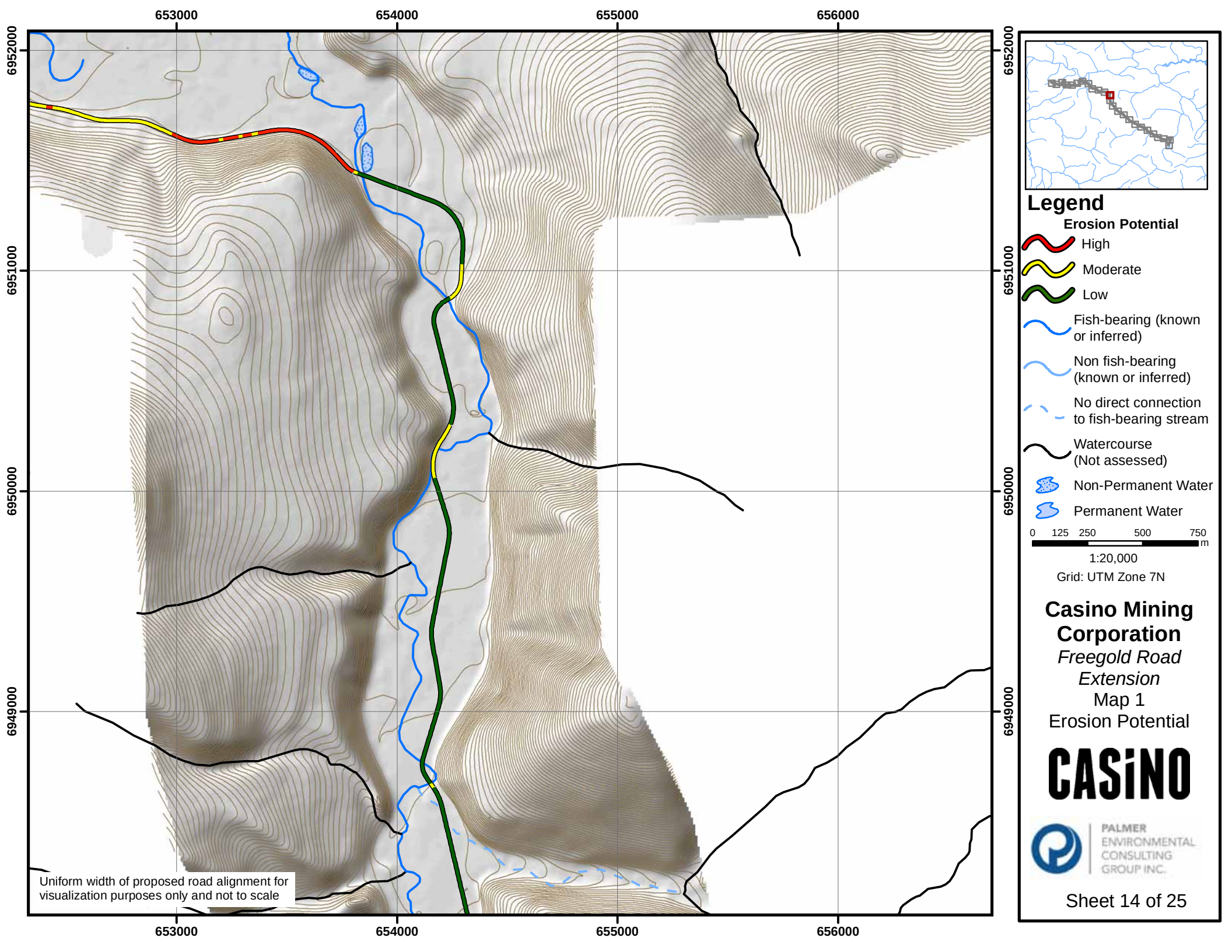
Map 1

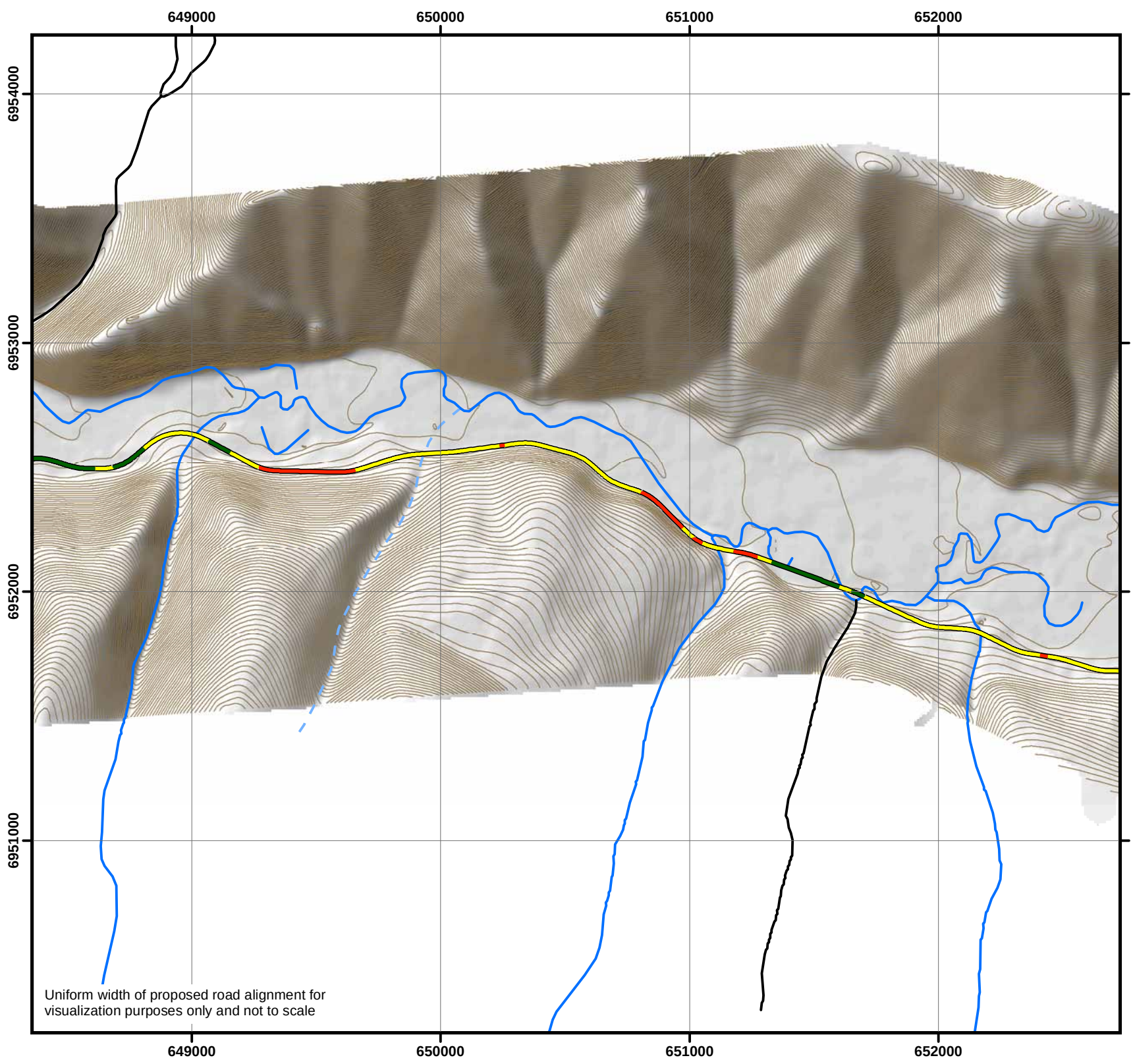
Erosion Potential

CASINO

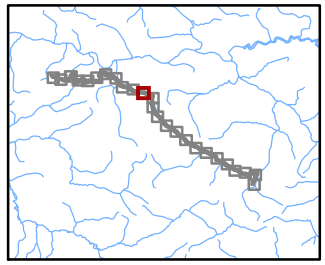
PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 13 of 25


653000
654000
655000
656000
6952000
6951000
6950000
6949000
Uniform width of proposed road alignment for visualization purposes only and not to scale
Legend
Erosion Potential
High
Moderate
Low
Fish-bearing (known or inferred)
Non fish-bearing (known or inferred)
No direct connection to fish-bearing stream
Watercourse (Not assessed)
Non-Permanent Water
Permanent Water
0 125 250 500 750 m
1:20,000
Grid: UTM Zone 7N
Casino Mining Corporation
Freegold Road Extension
Map 1
Erosion Potential
CASINO
PALMER ENVIRONMENTAL CONSULTING GROUP INC.
Sheet 14 of 25



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

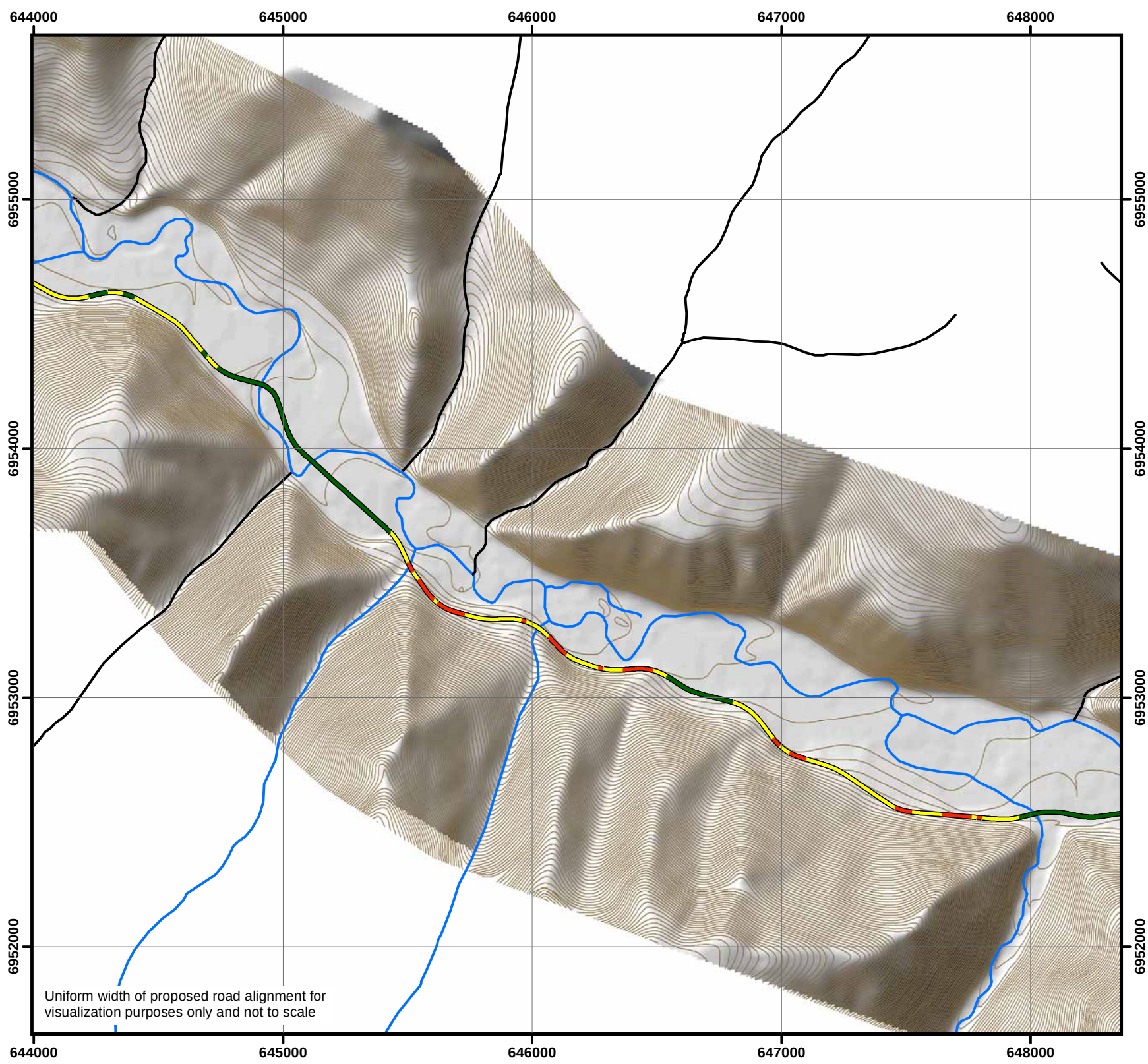
Map 1

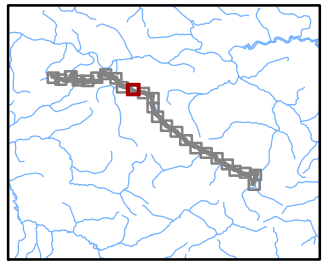
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 15 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

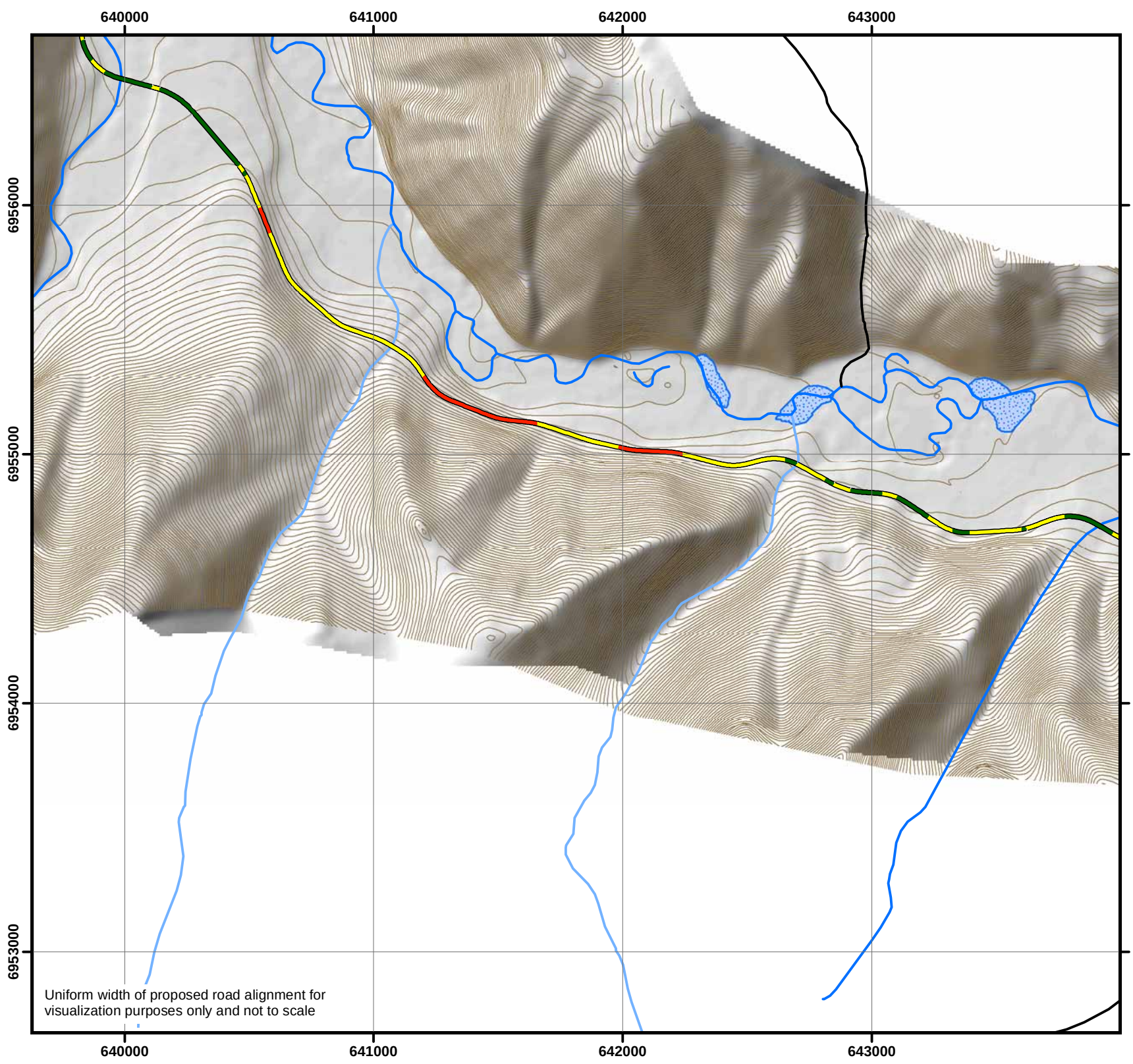
Freegold Road Extension

Map 1

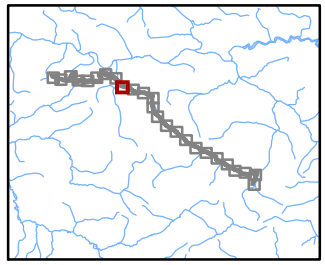
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

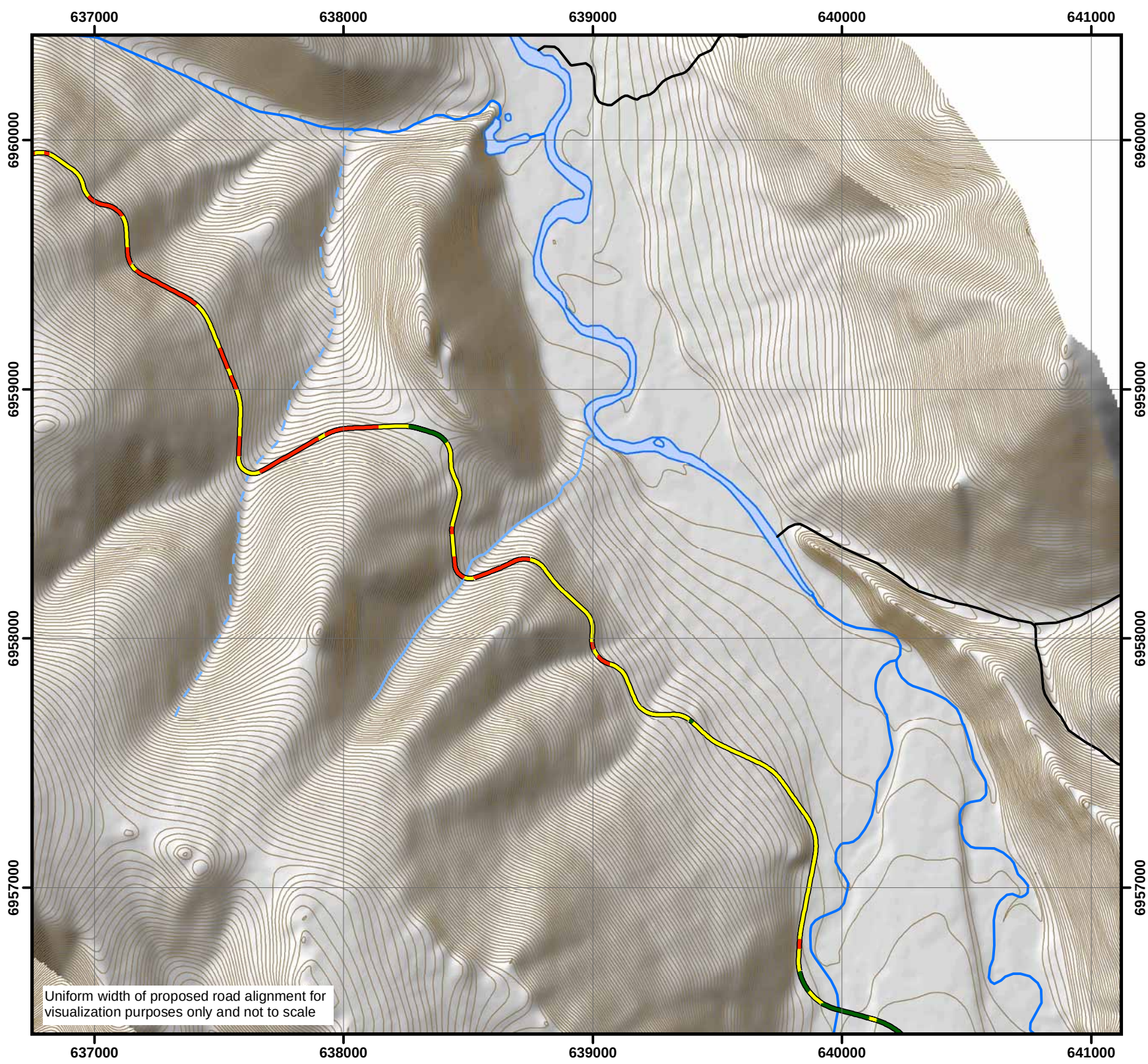
Freegold Road Extension

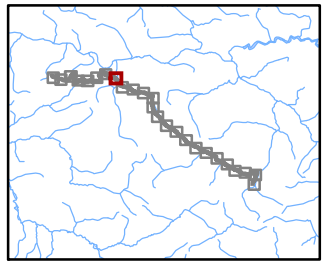
Map 1

Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

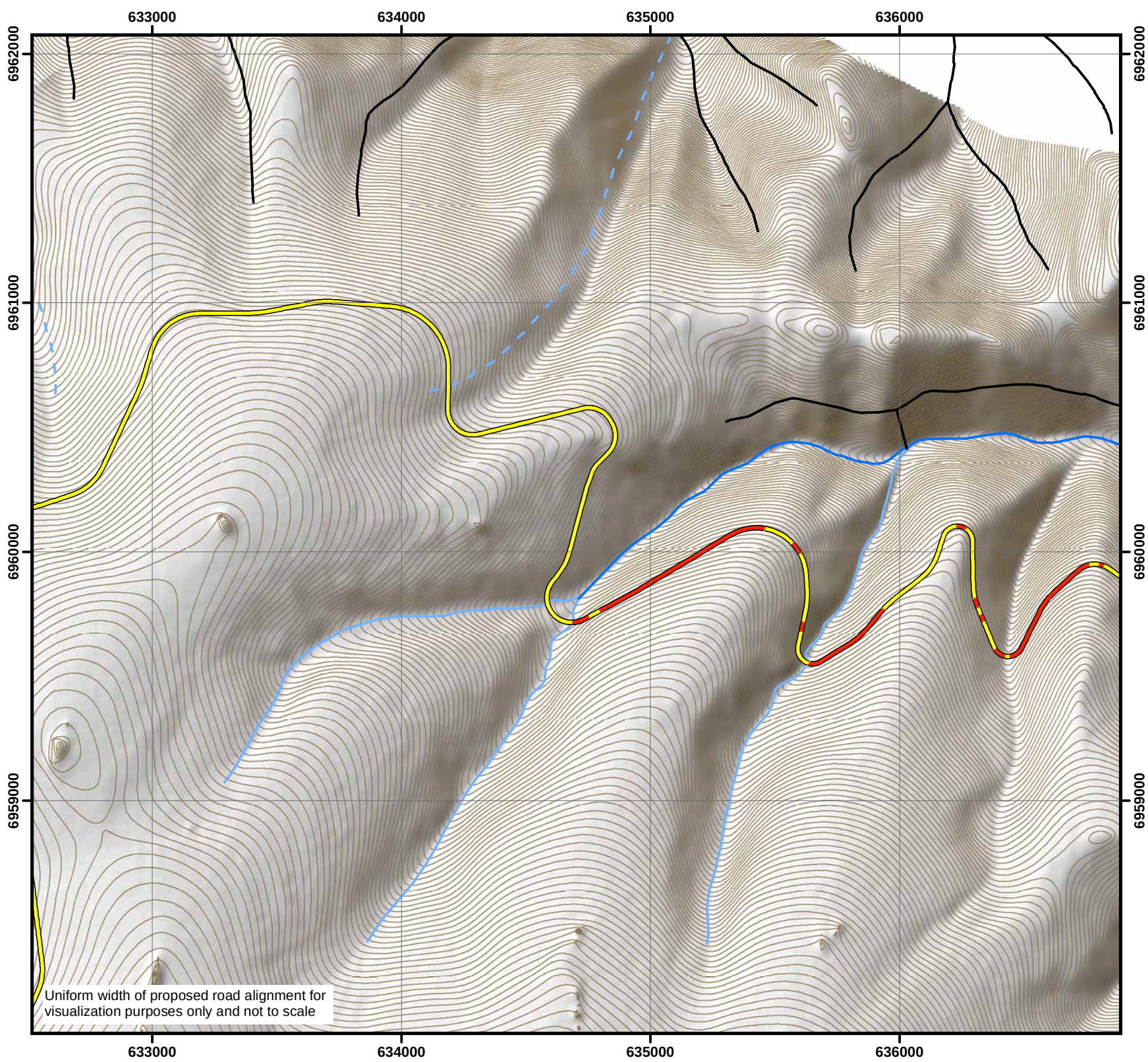
Map 1

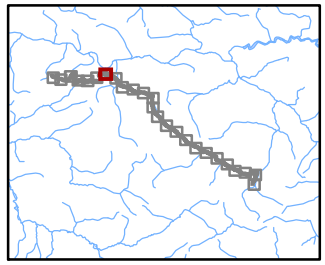
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 18 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

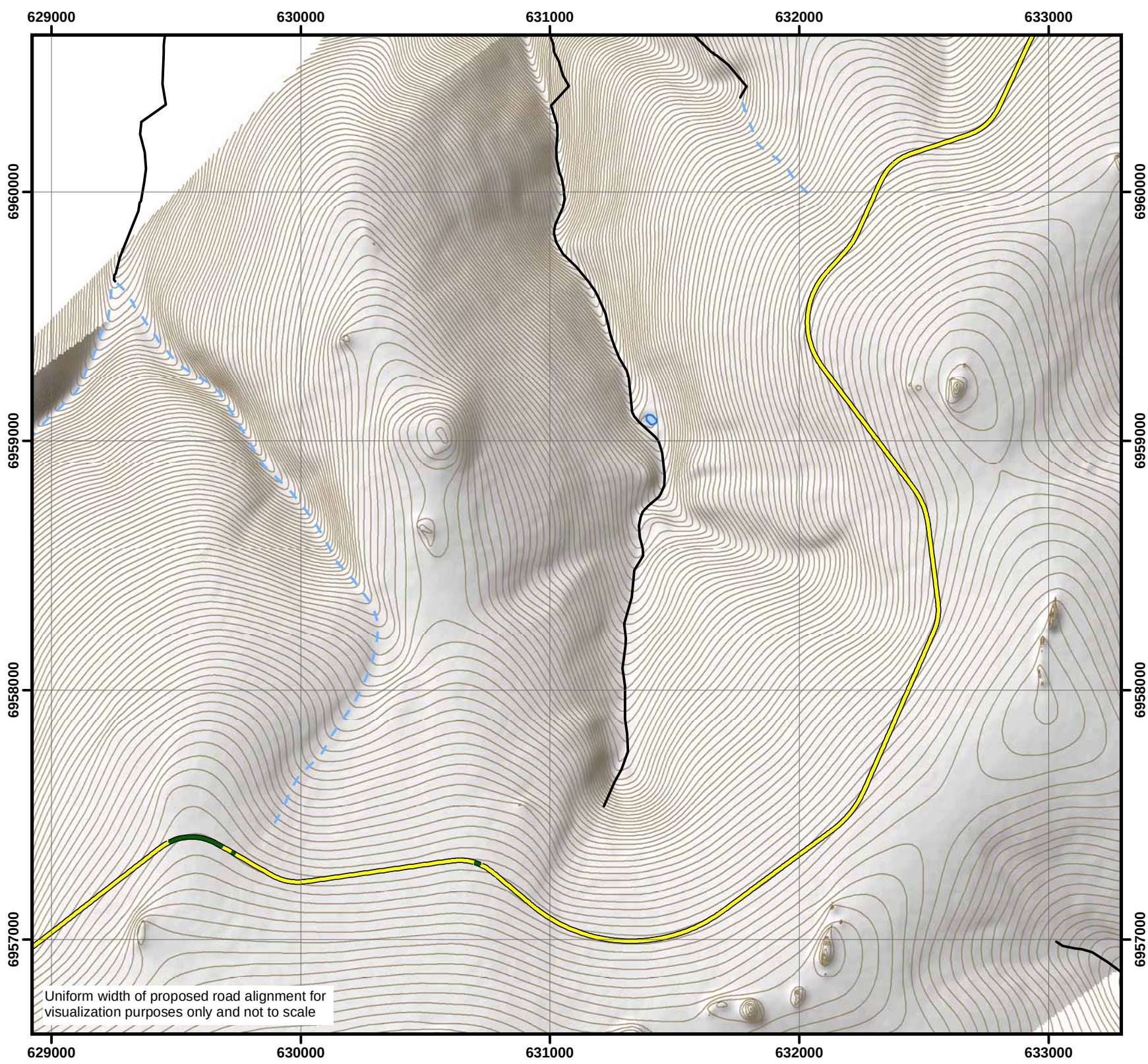
Freegold Road Extension

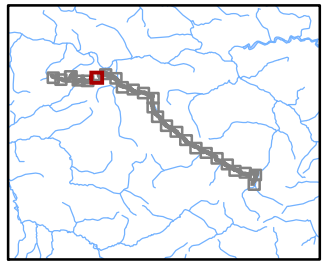
Map 1

Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

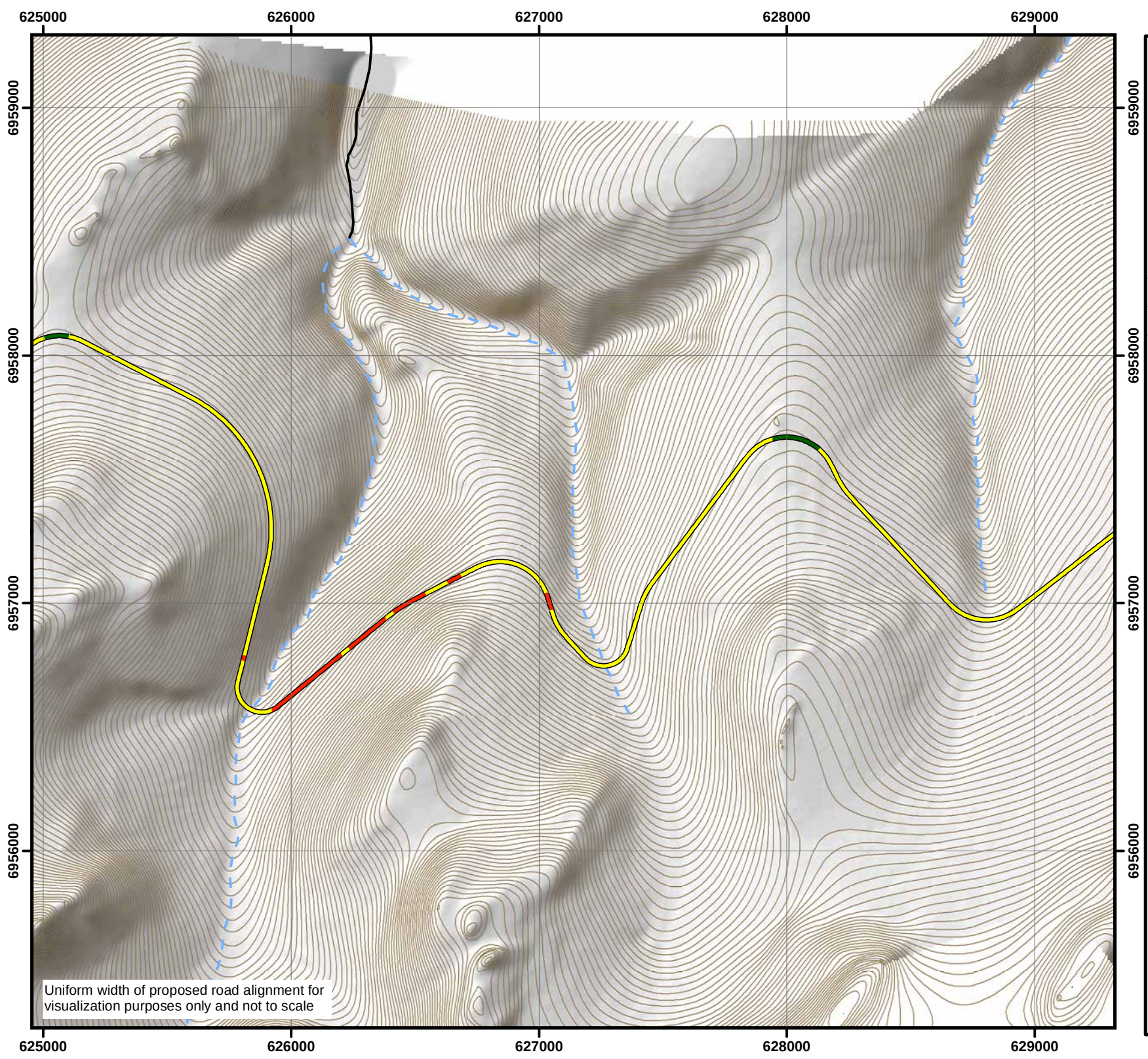
Map 1

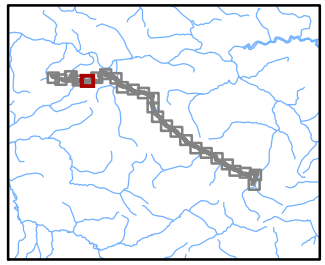
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 20 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

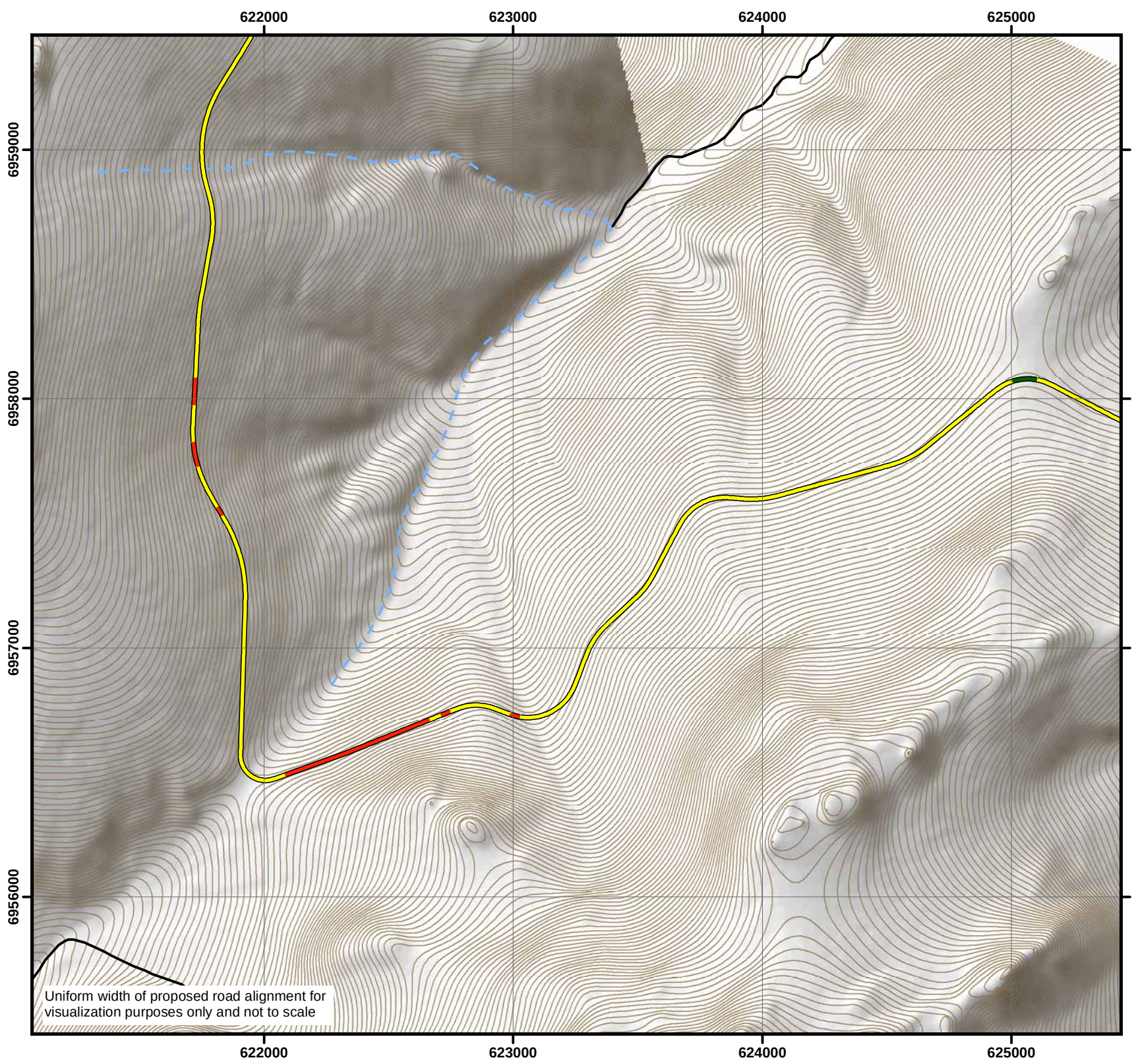
Freegold Road Extension

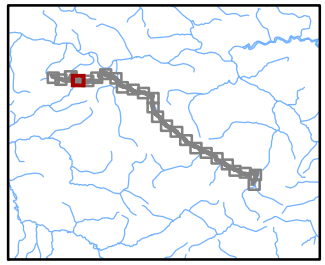
Map 1

Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

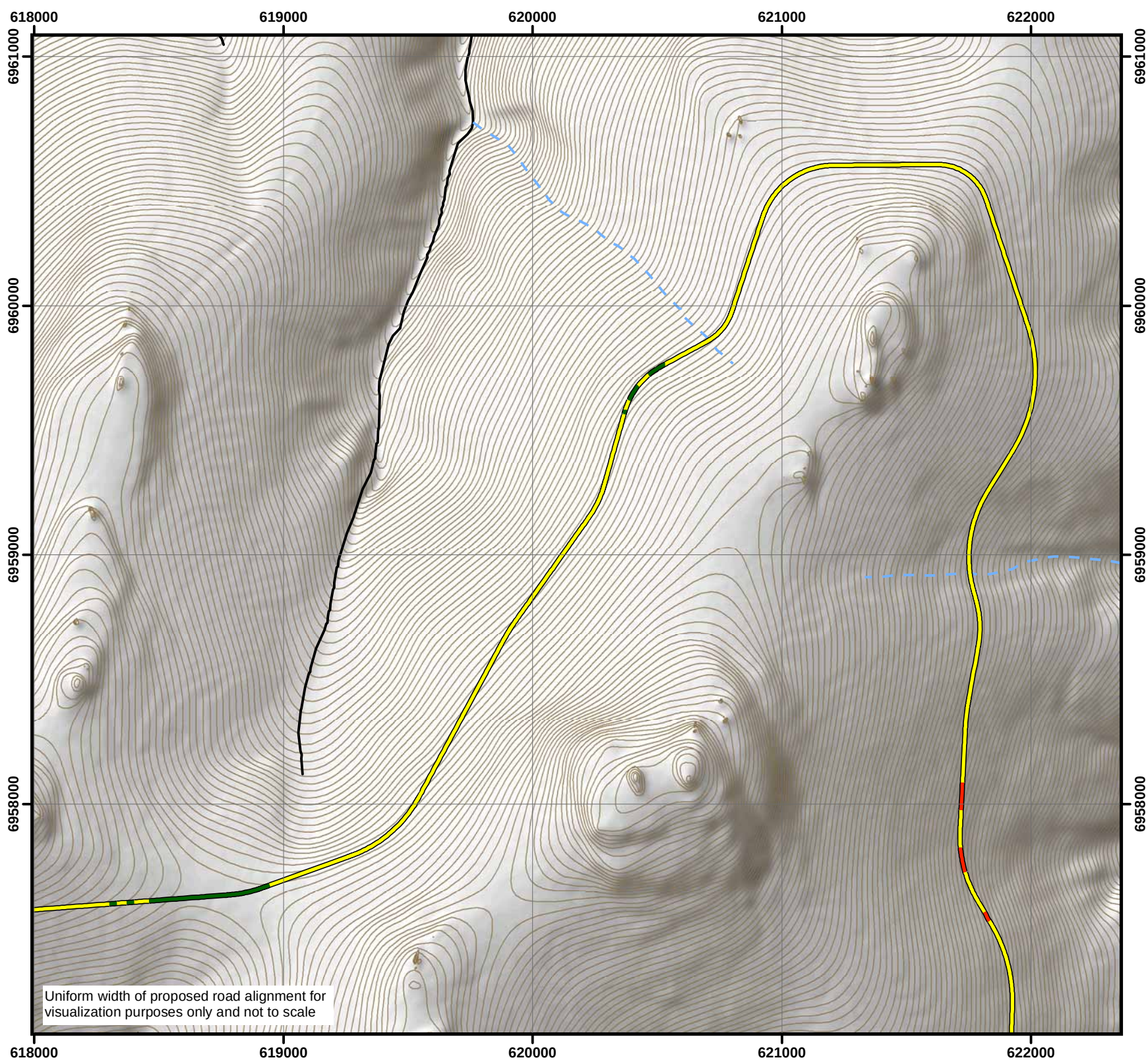
Freegold Road Extension

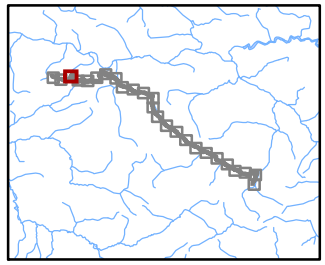
Map 1

Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

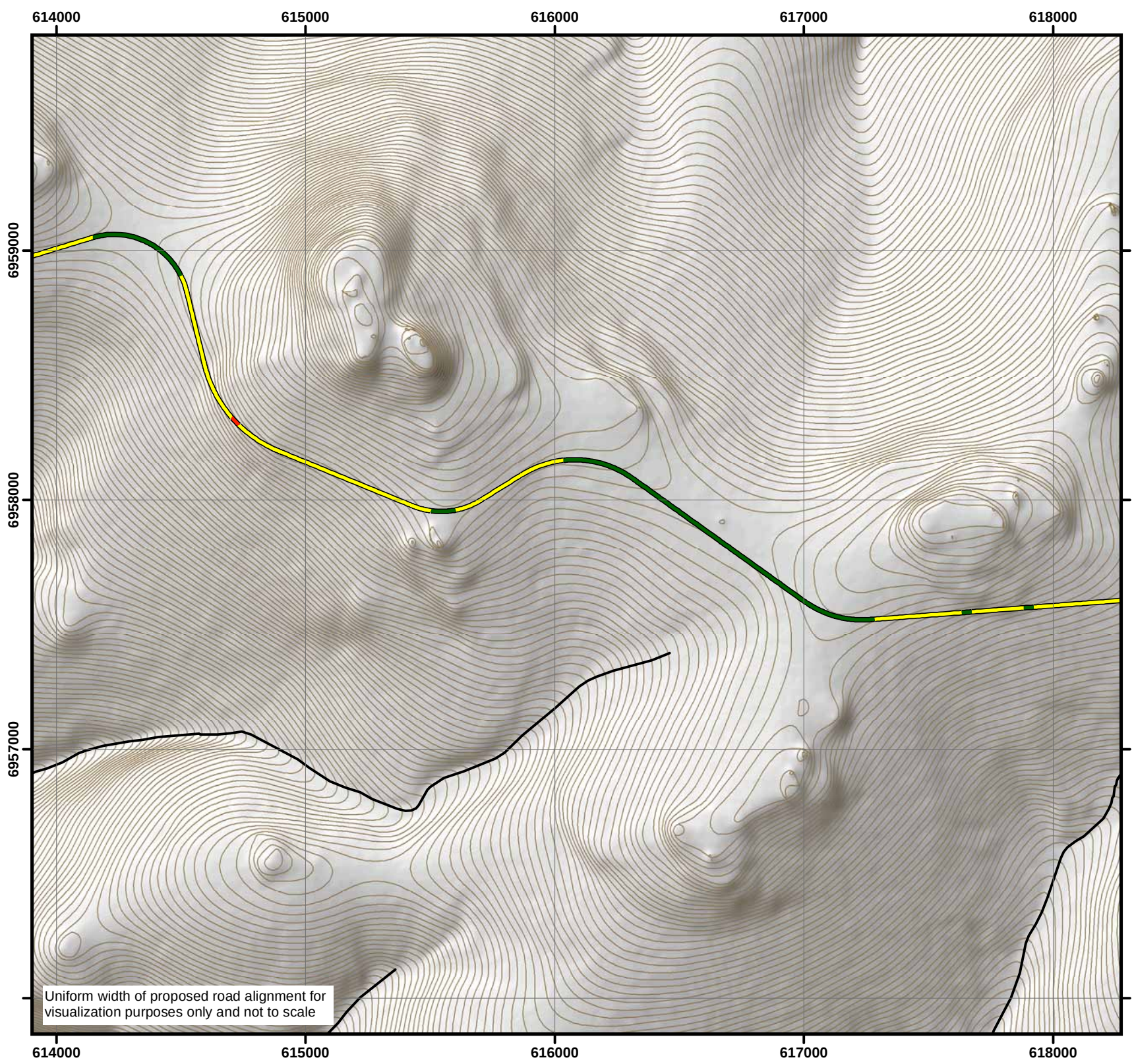
Freegold Road Extension

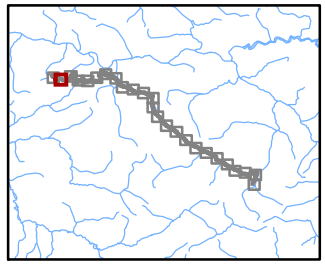
Map 1

Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

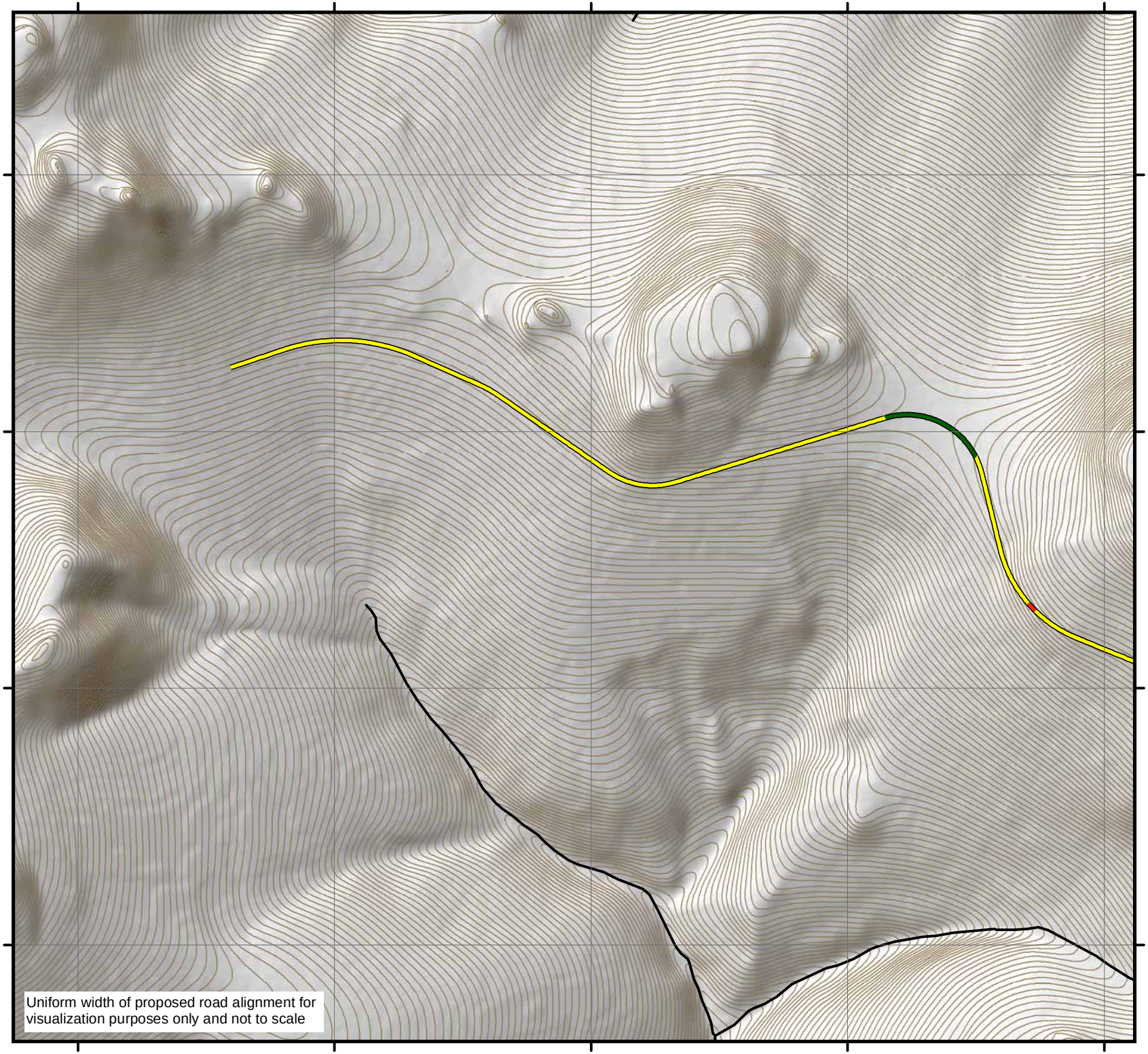
Map 1

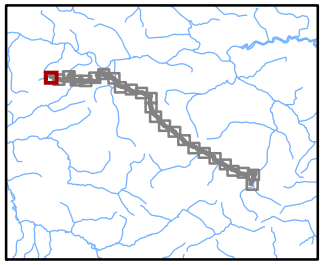
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 24 of 25





Legend

Erosion Potential

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

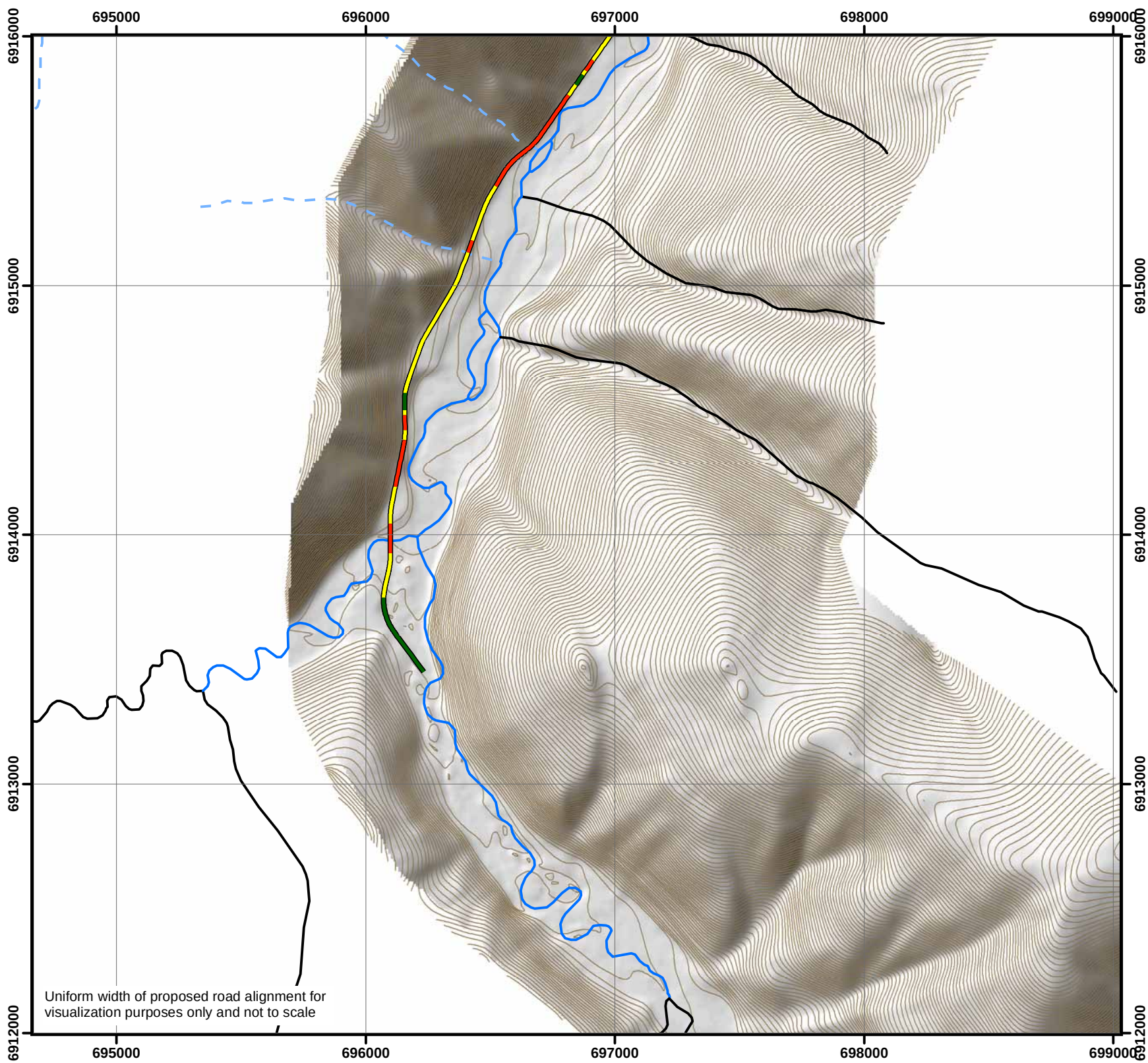
Map 1

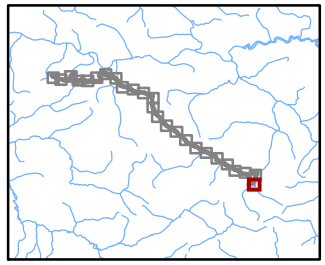
Erosion Potential

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 25 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

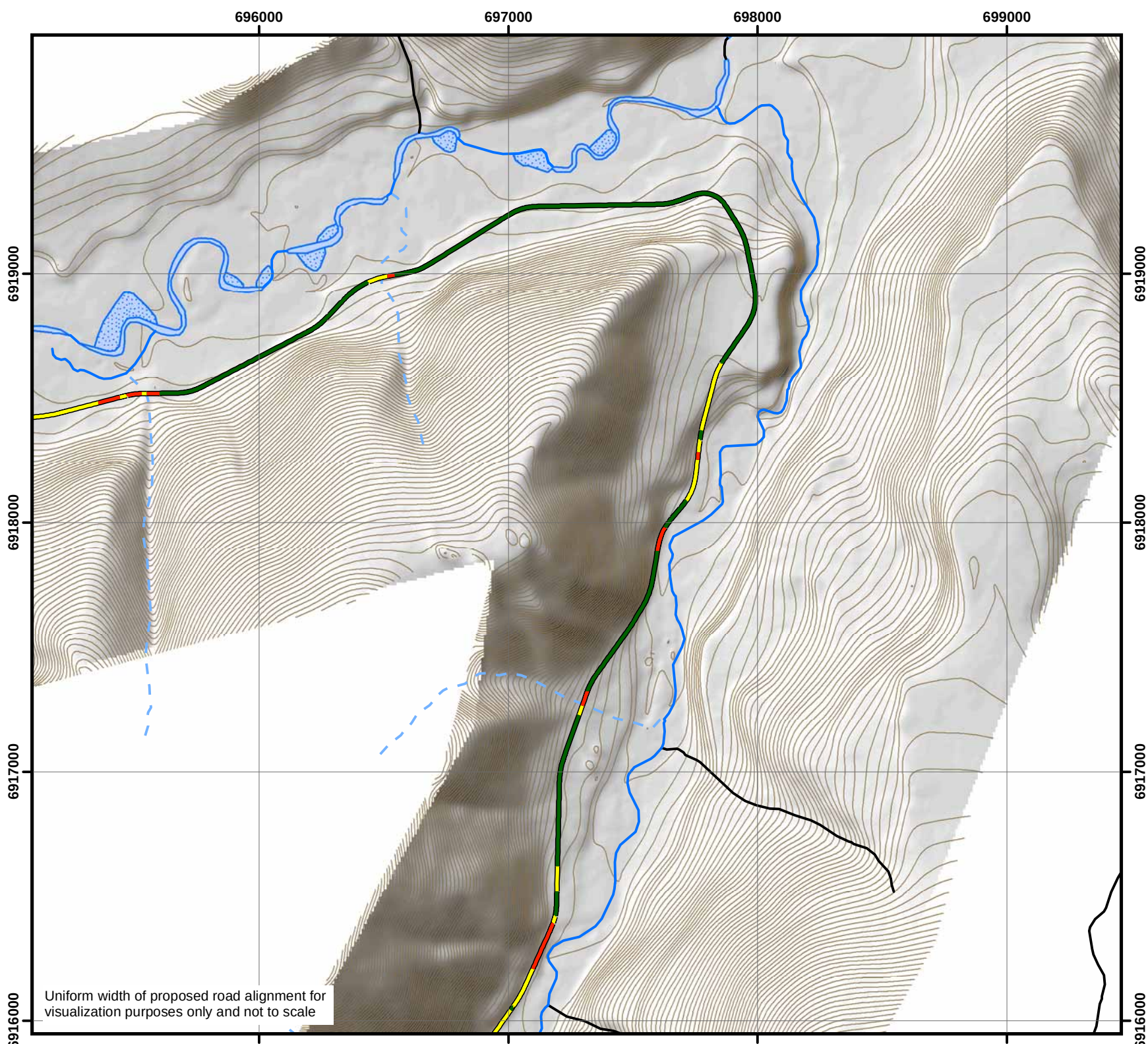
Map 2

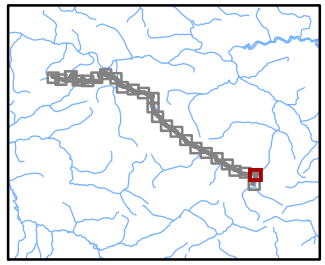
Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 1 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

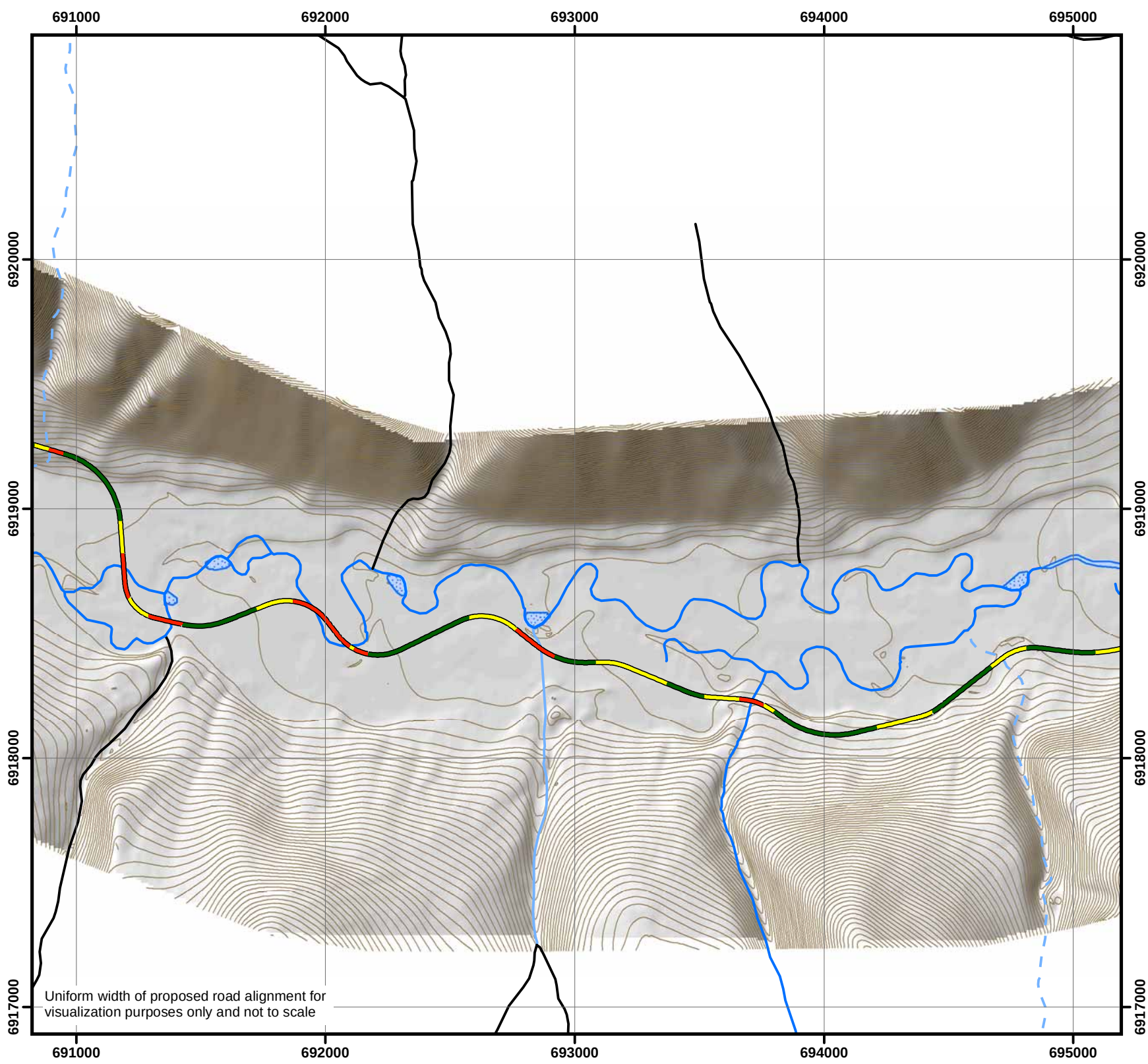
Freegold Road Extension

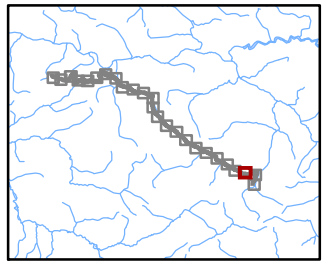
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

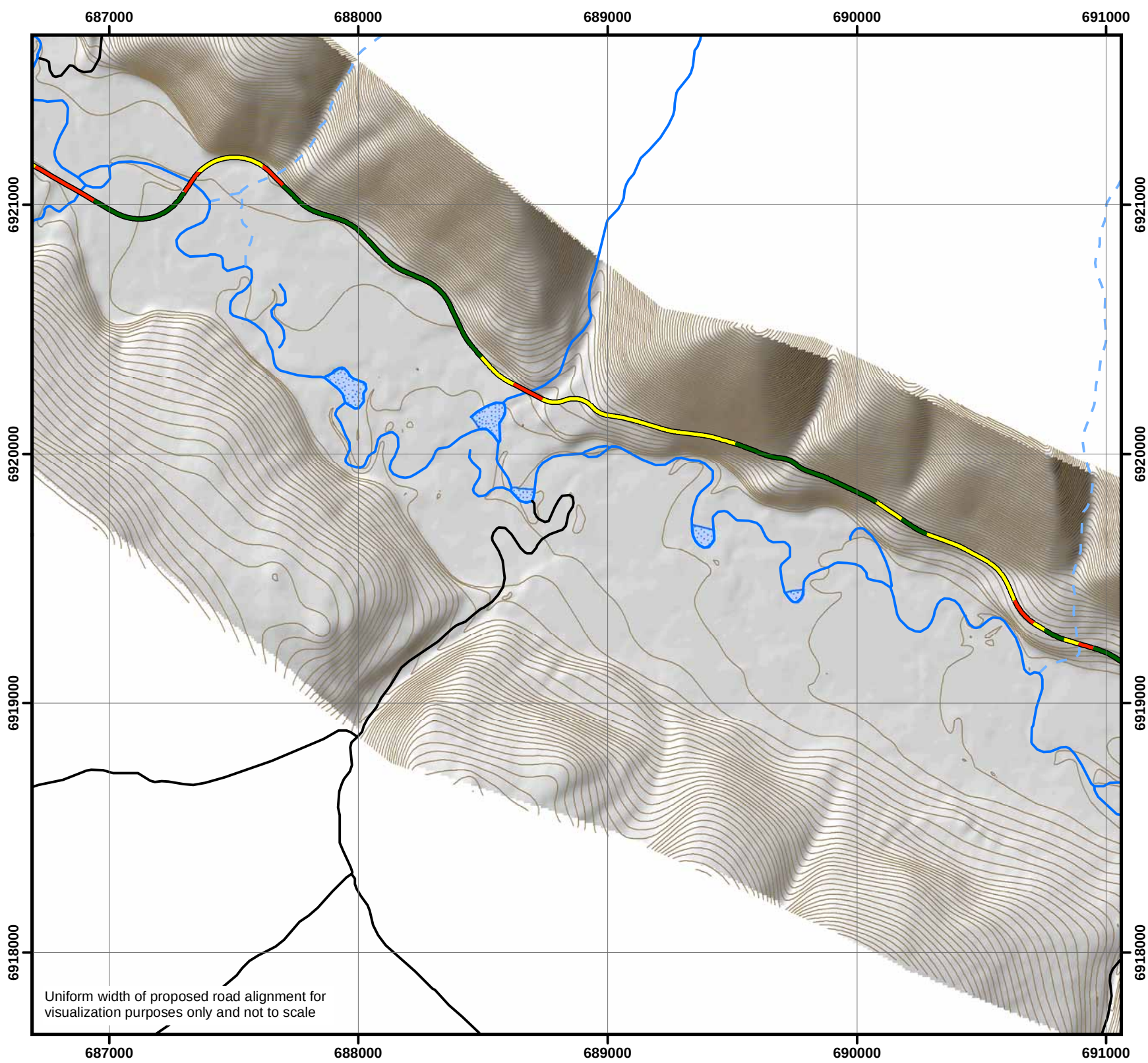
Freegold Road Extension

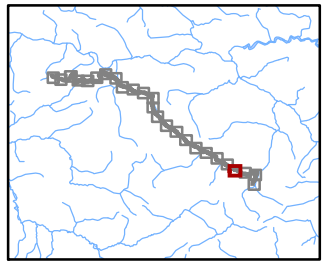
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

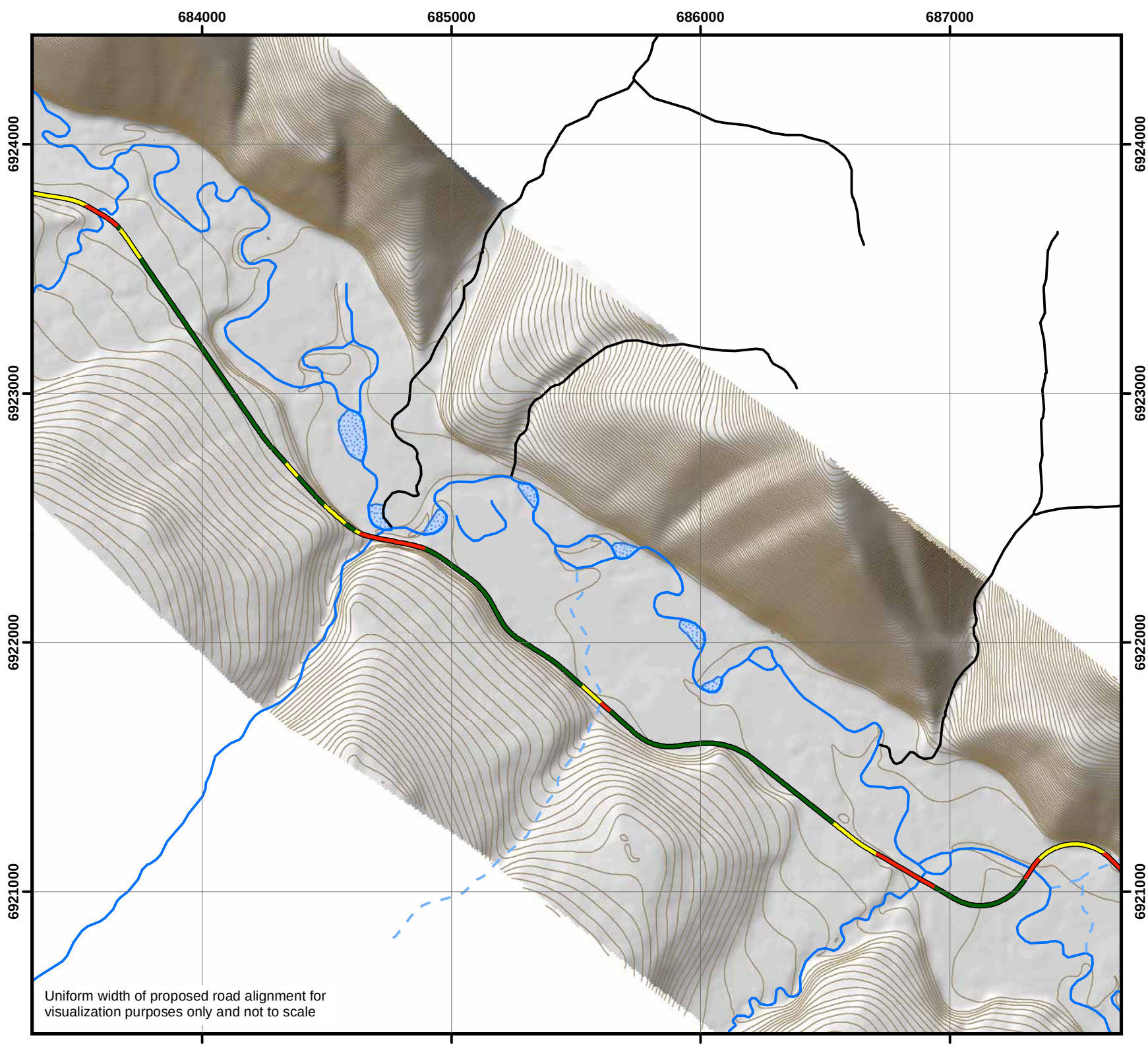
Map 2

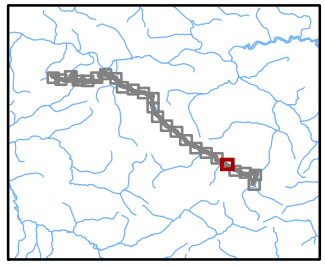
Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 4 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

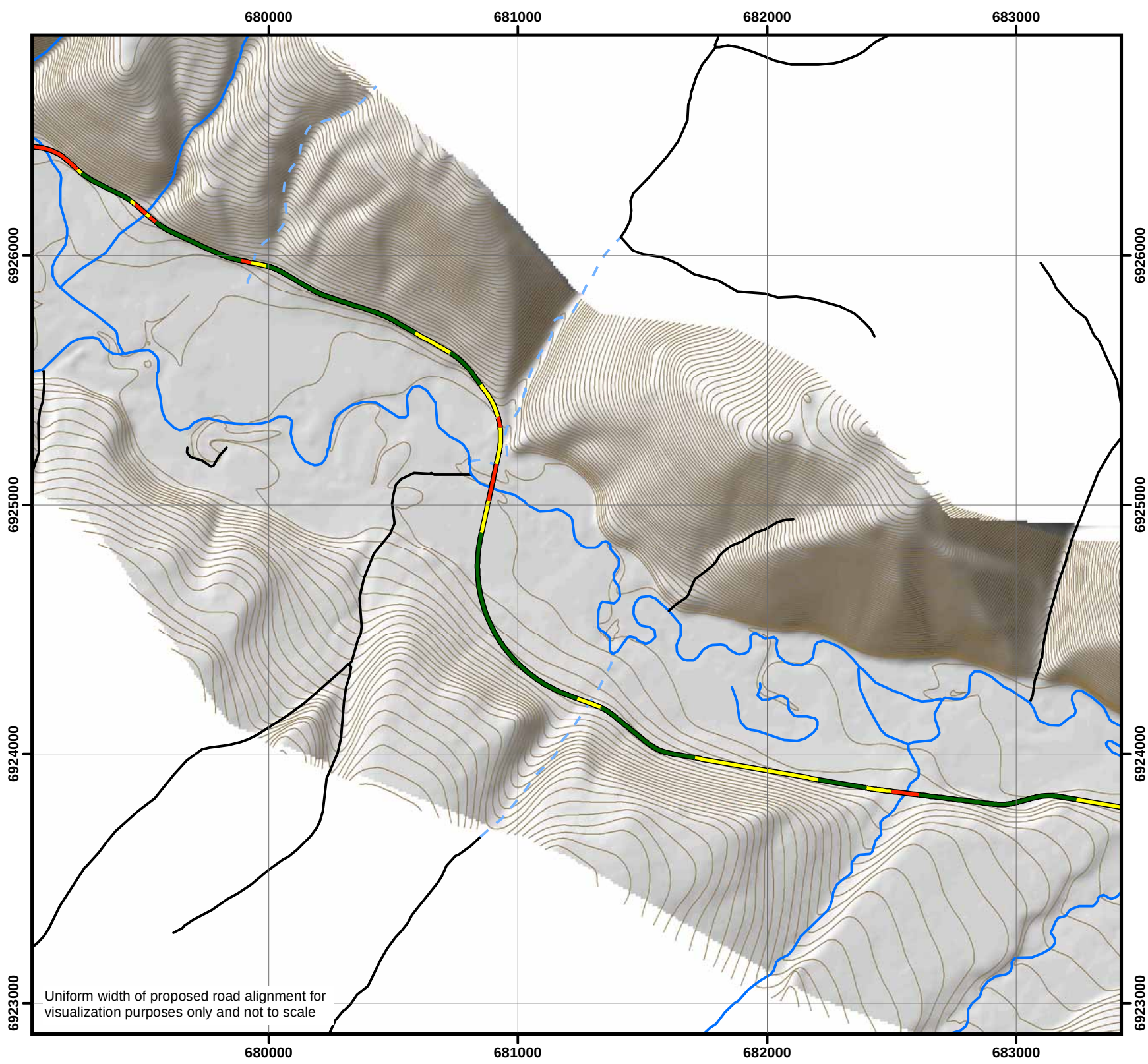
Map 2

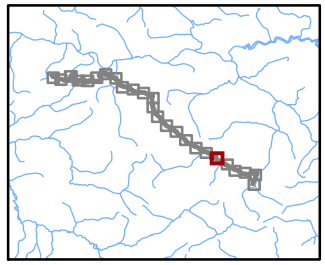
Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 5 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

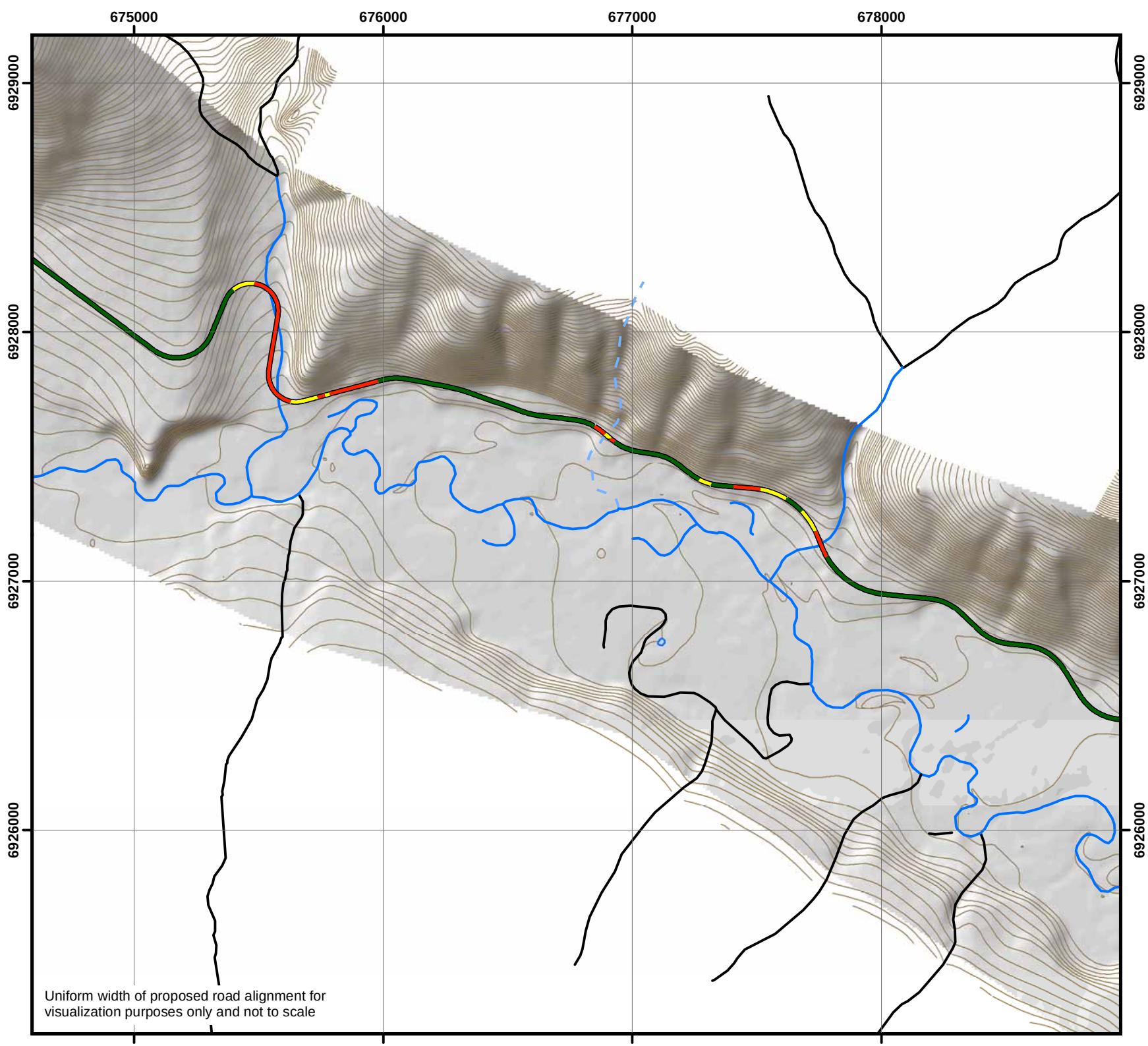
Map 2

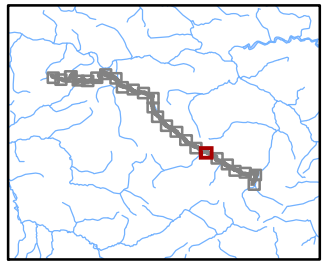
Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 6 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

Map 2

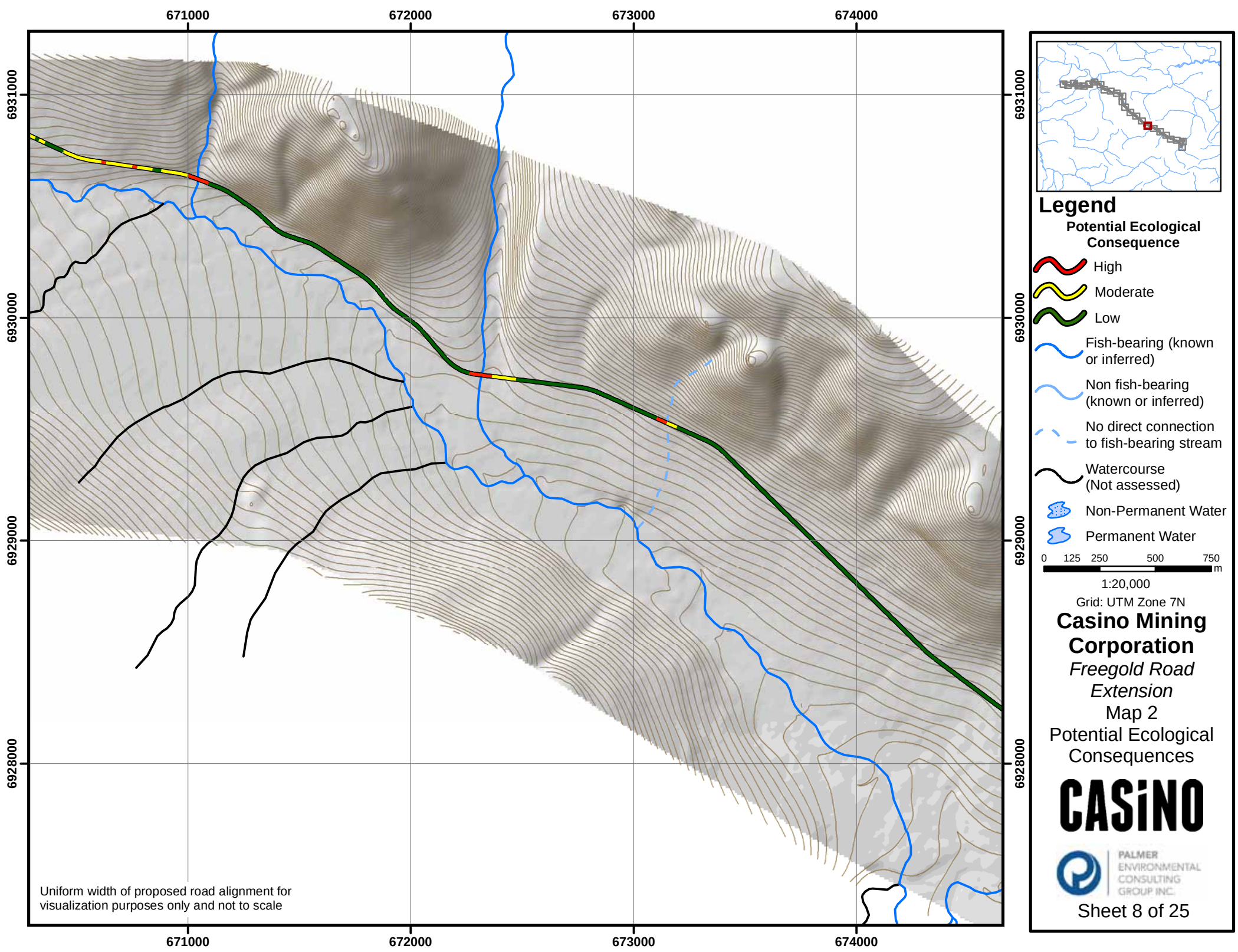
Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 7 of 25

Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

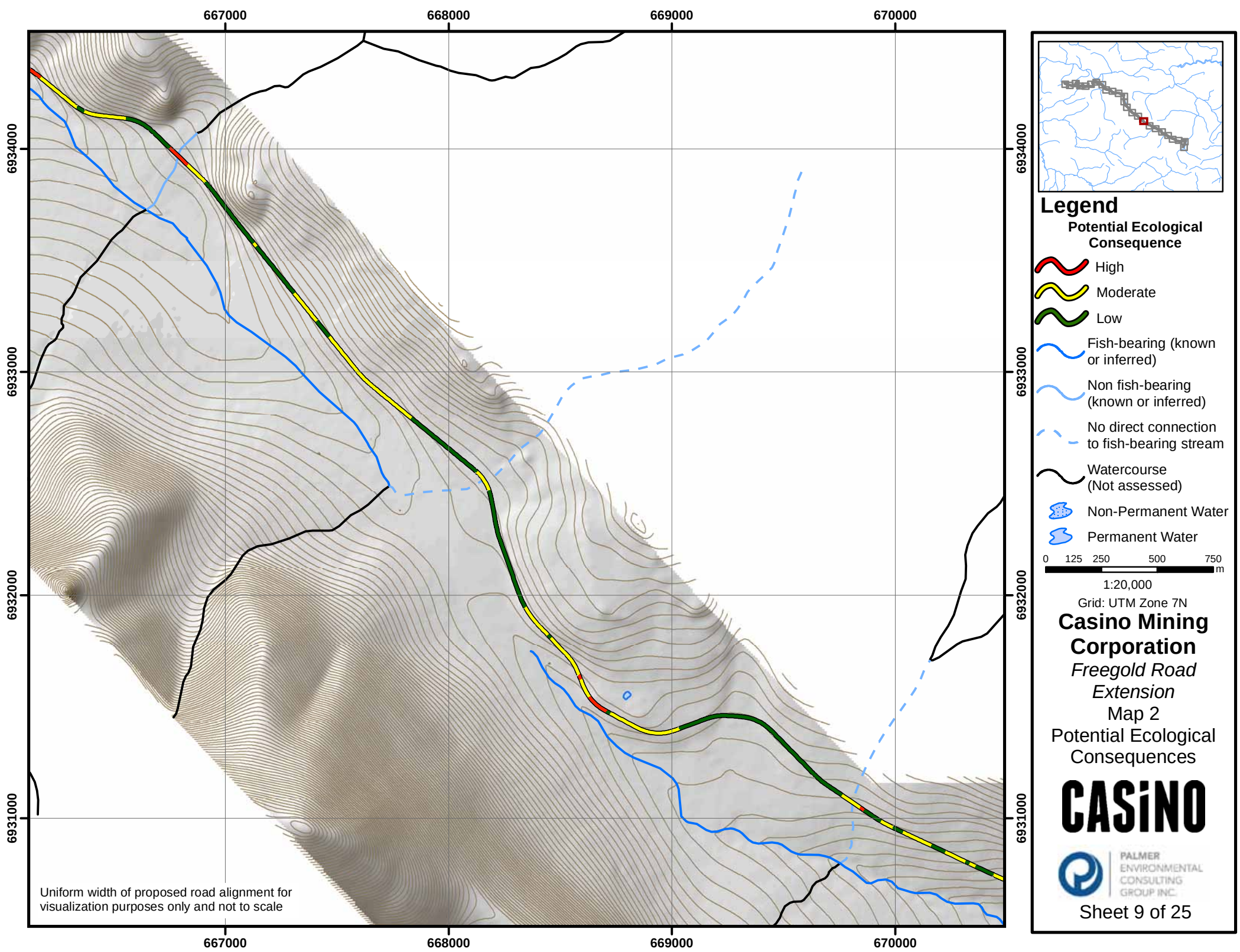
Freegold Road Extension

Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

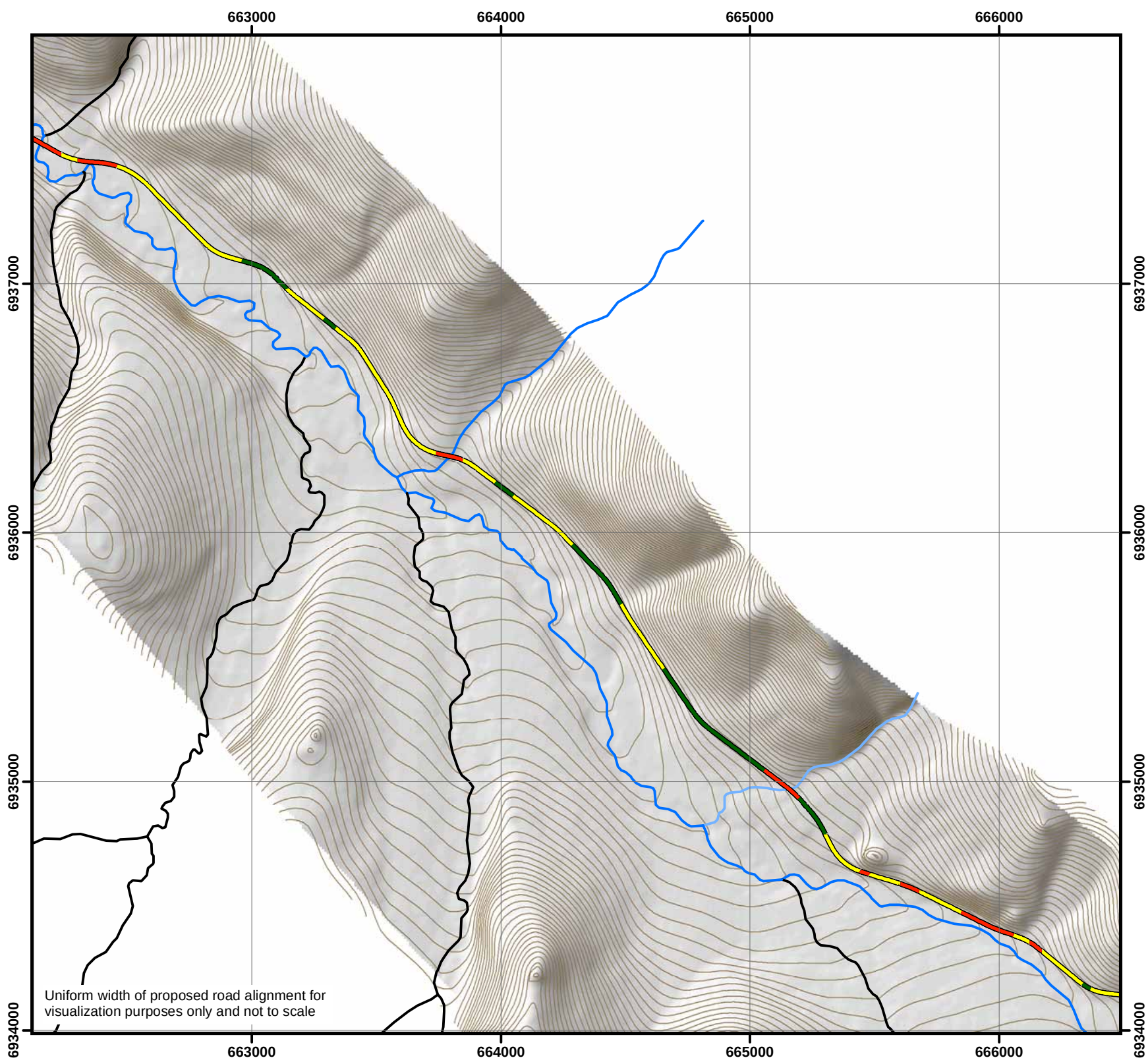
Freegold Road Extension

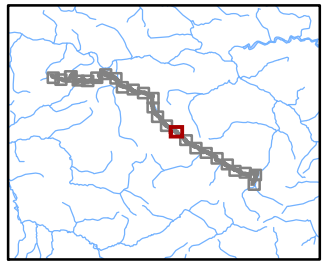
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

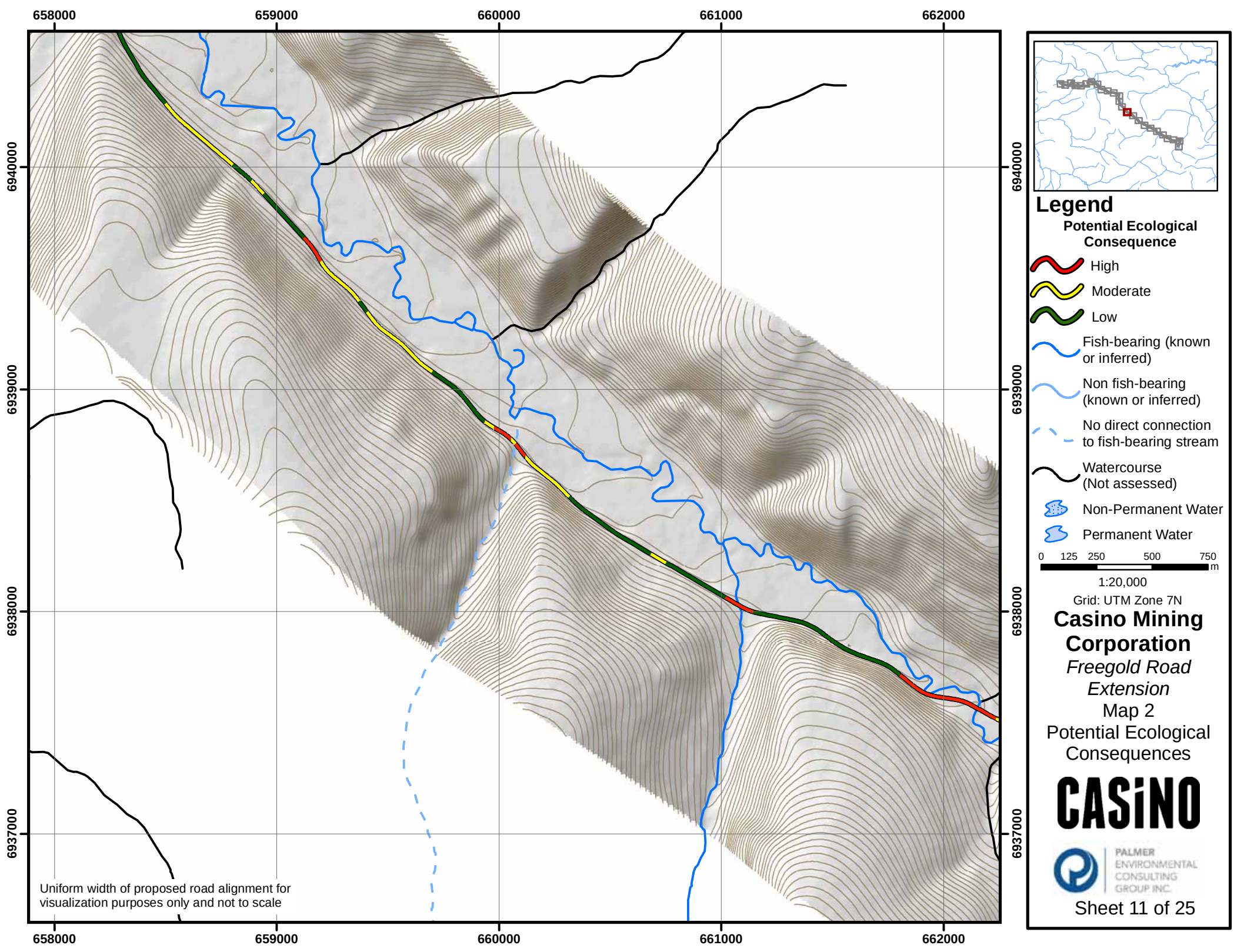
Freegold Road Extension

Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

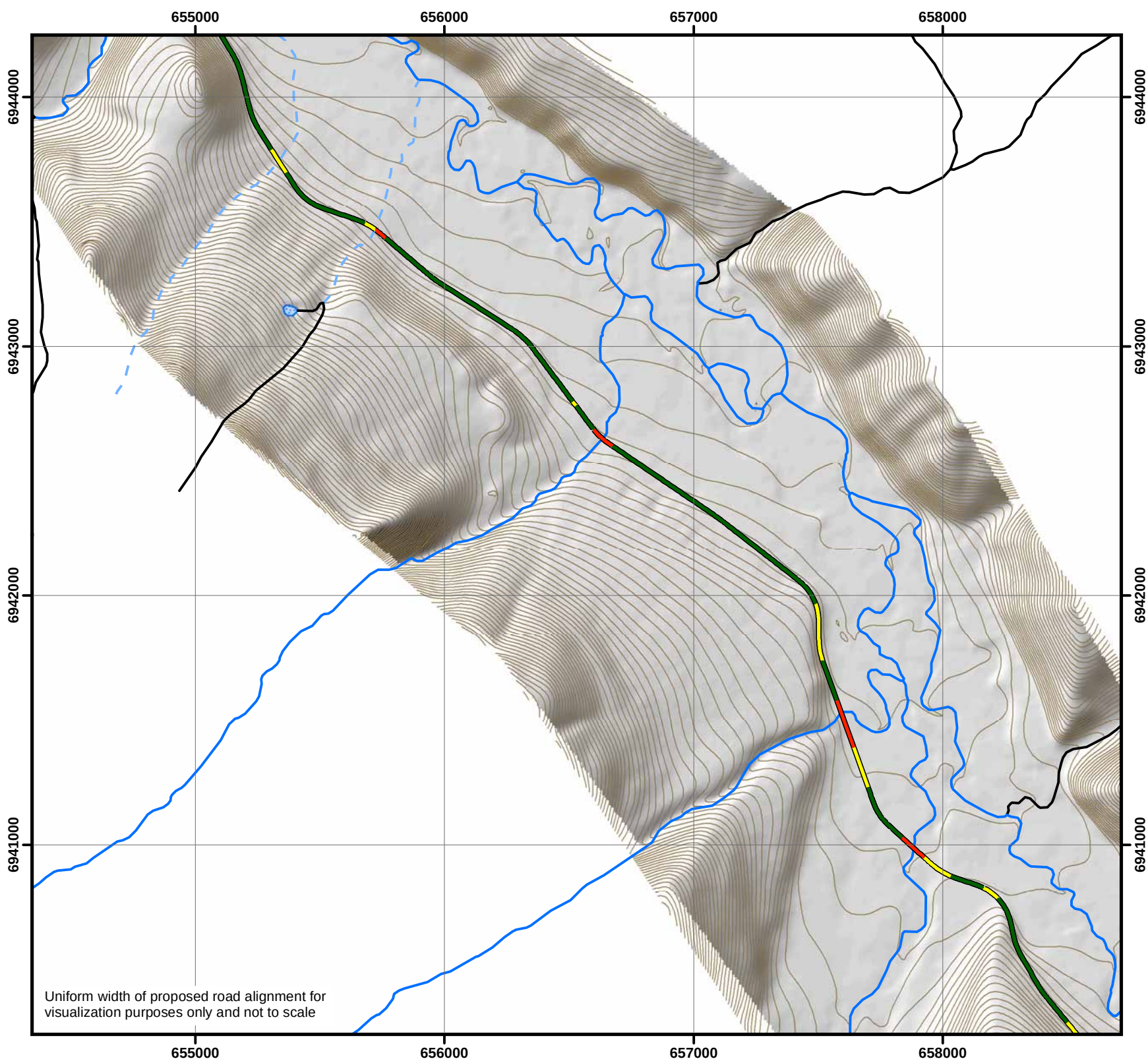
Freegold Road Extension

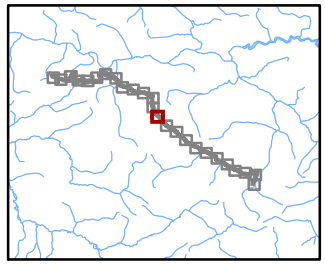
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

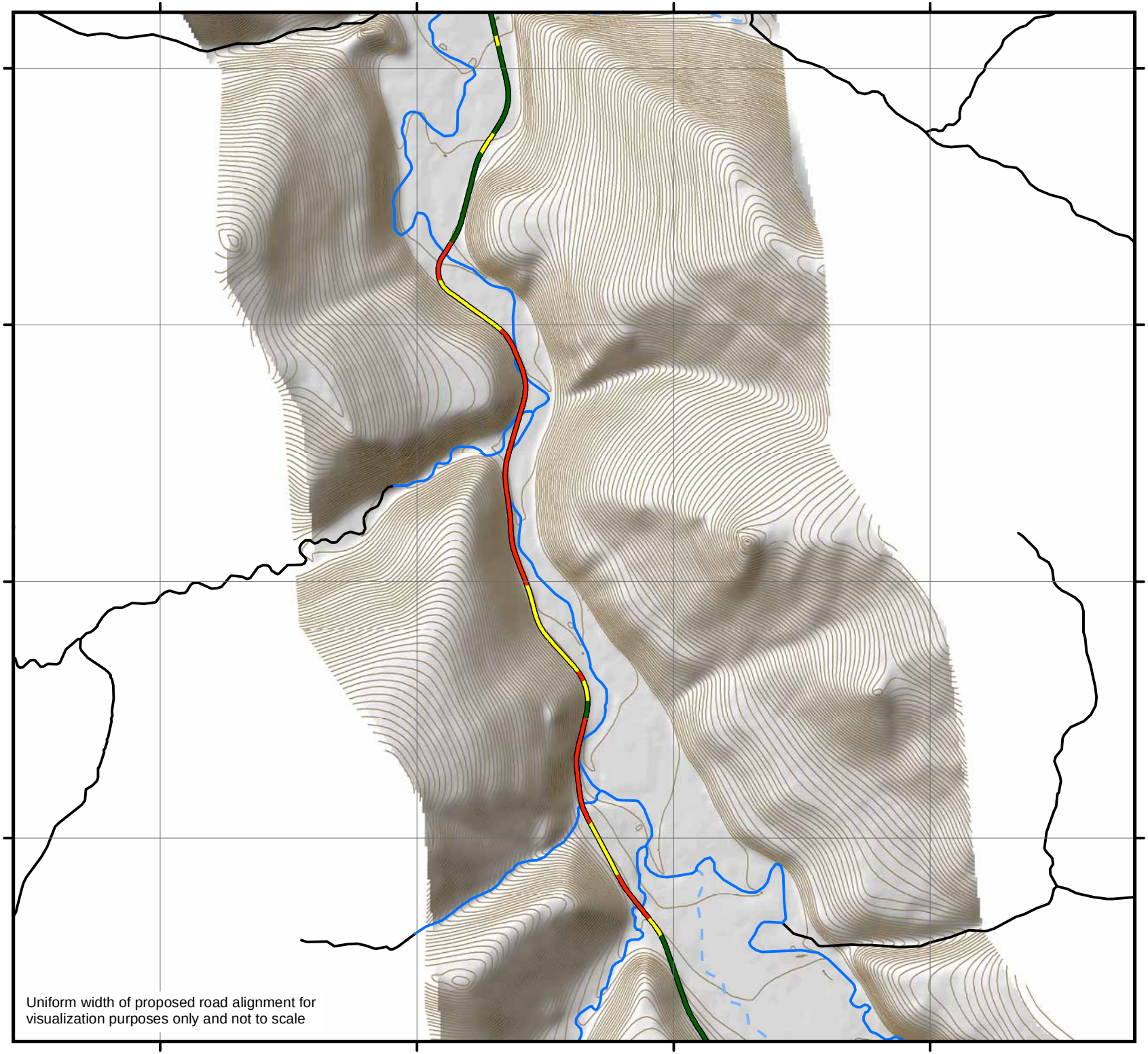
Map 2

Potential Ecological Consequences

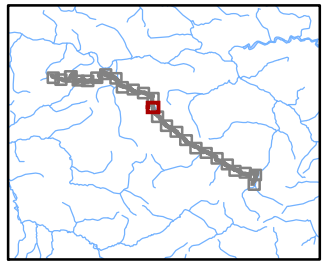
CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 12 of 25



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

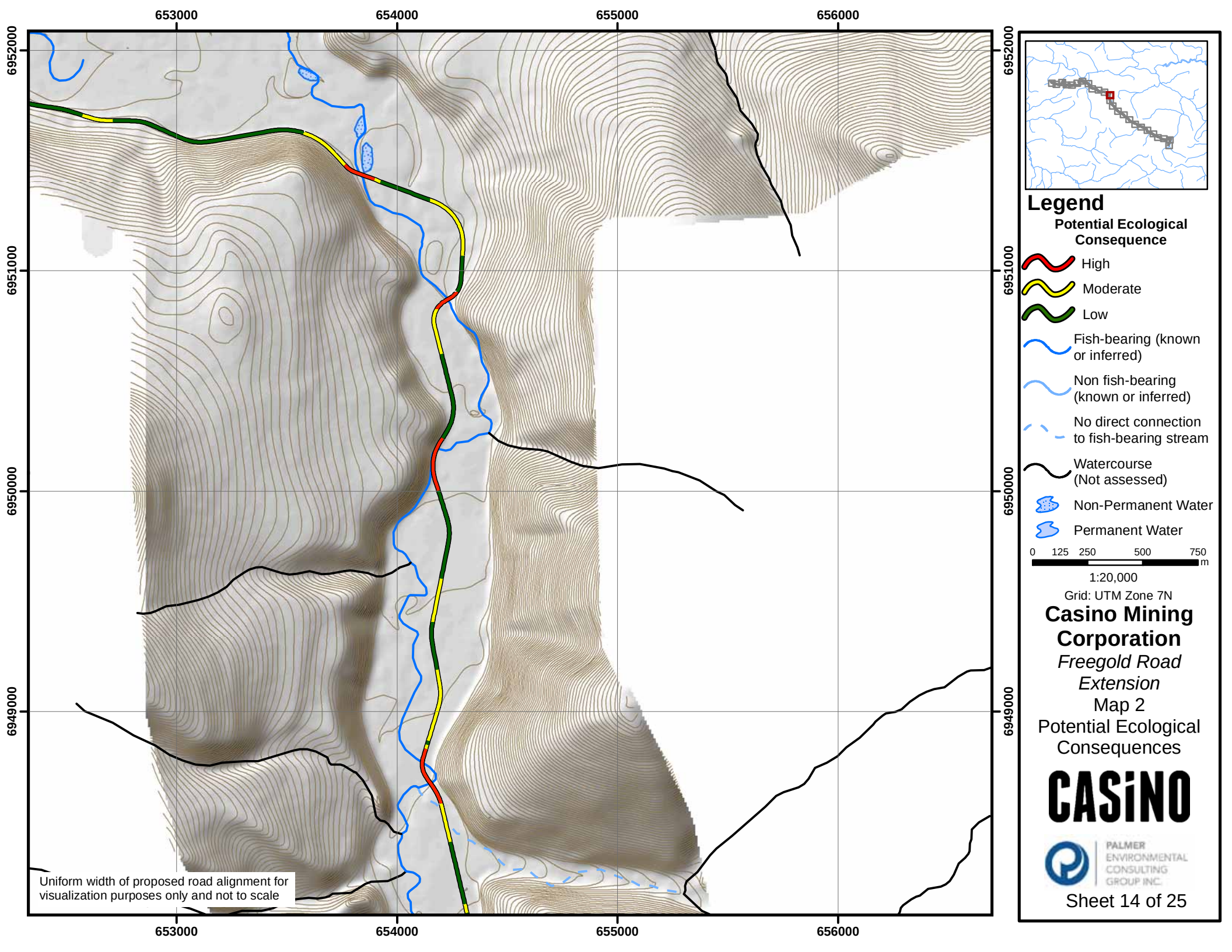
Map 2

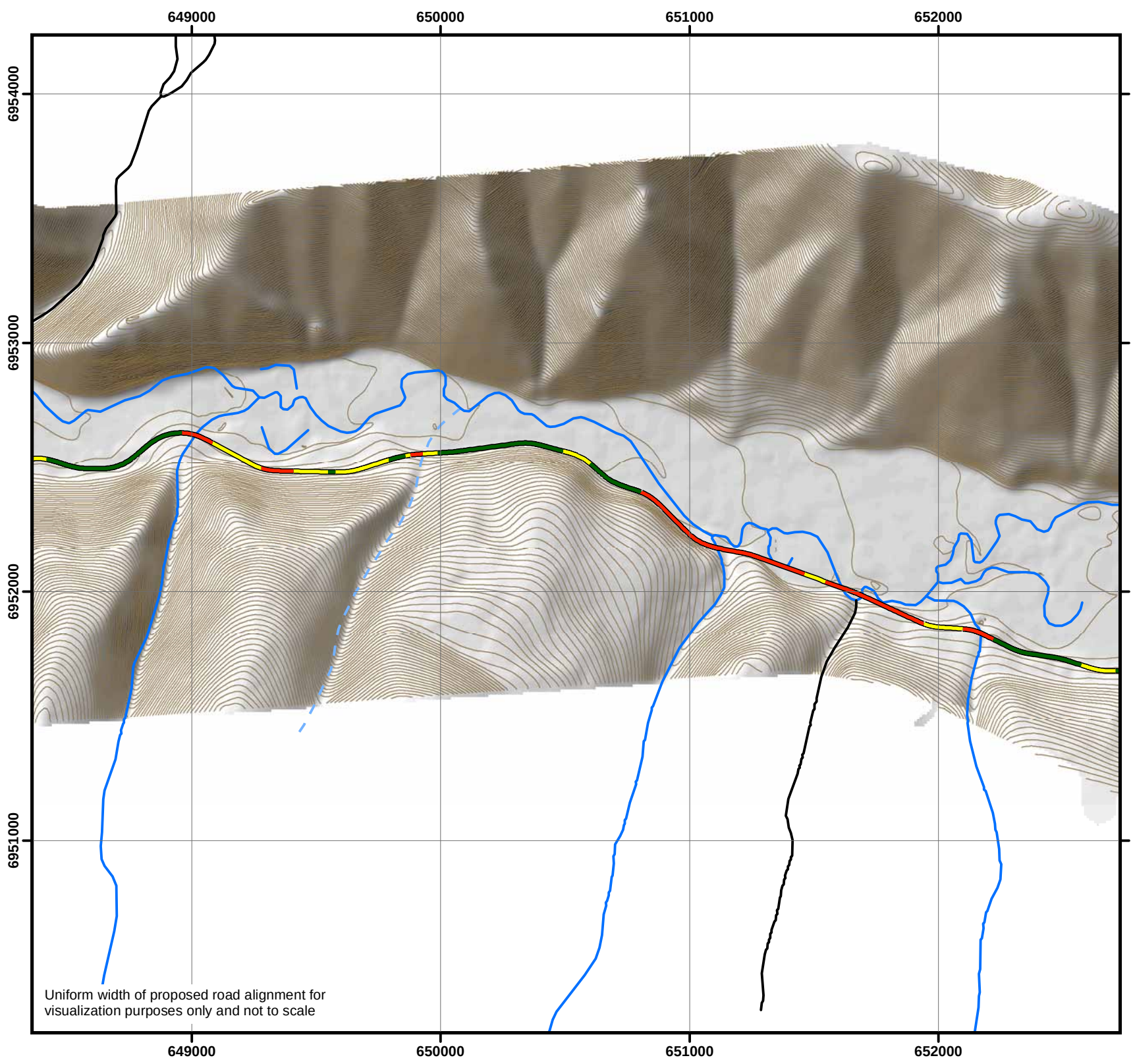
Potential Ecological Consequences

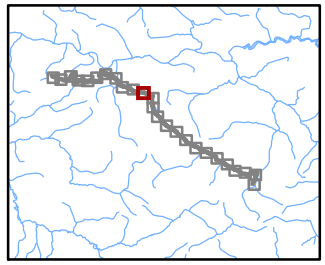
CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 13 of 25


653000
654000
655000
656000
6952000
6951000
6950000
6949000
Uniform width of proposed road alignment for visualization purposes only and not to scale
Legend
Potential Ecological Consequence
High
Moderate
Low
Fish-bearing (known or inferred)
Non fish-bearing (known or inferred)
No direct connection to fish-bearing stream
Watercourse (Not assessed)
Non-Permanent Water
Permanent Water
0 125 250 500 750 m
1:20,000
Grid: UTM Zone 7N
Casino Mining Corporation
Freegold Road Extension
Map 2
Potential Ecological Consequences
CASINO
PALMER ENVIRONMENTAL CONSULTING GROUP INC.
Sheet 14 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

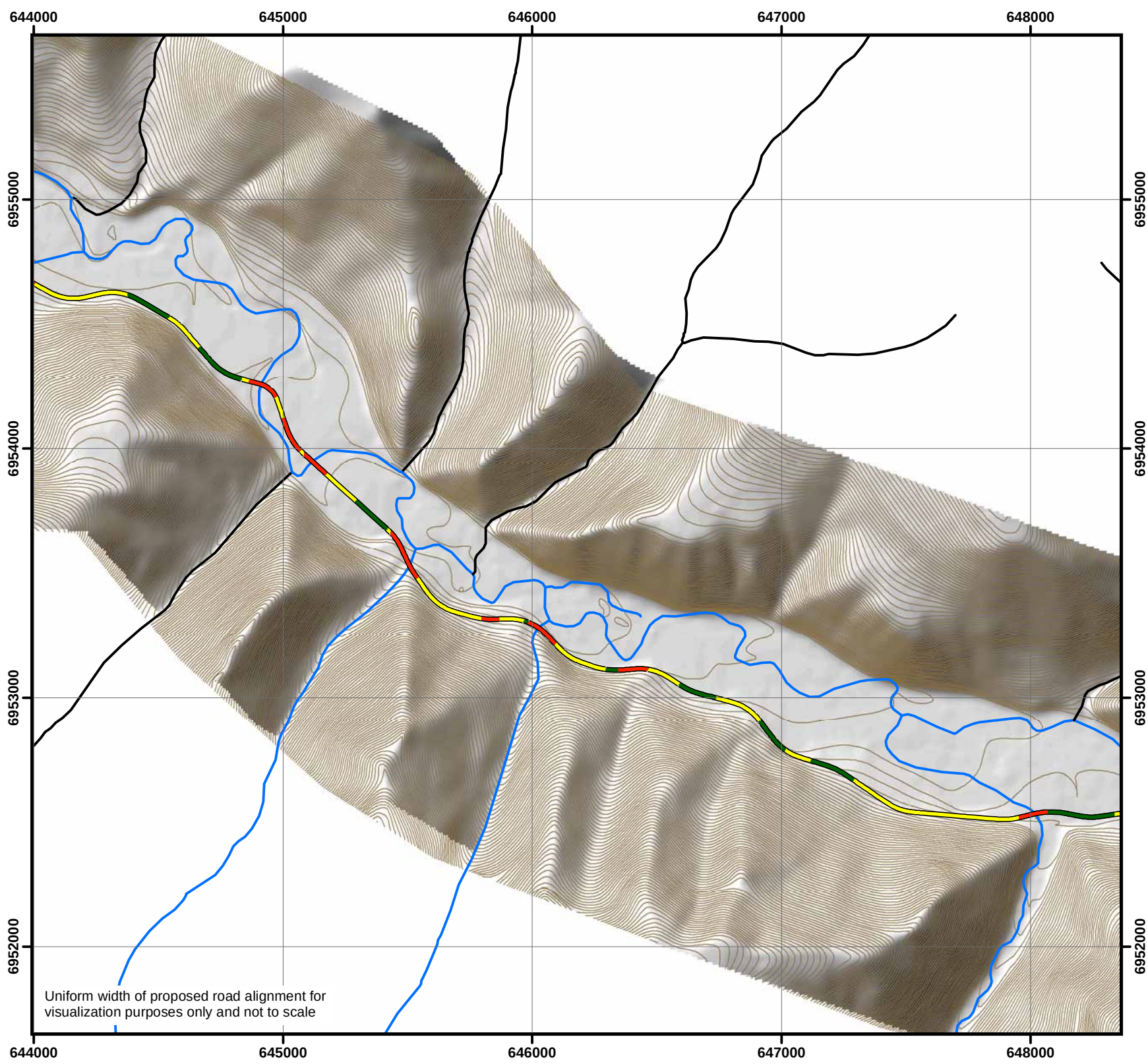
Map 2

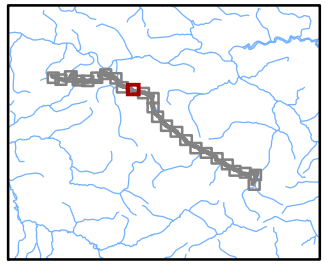
Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 15 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

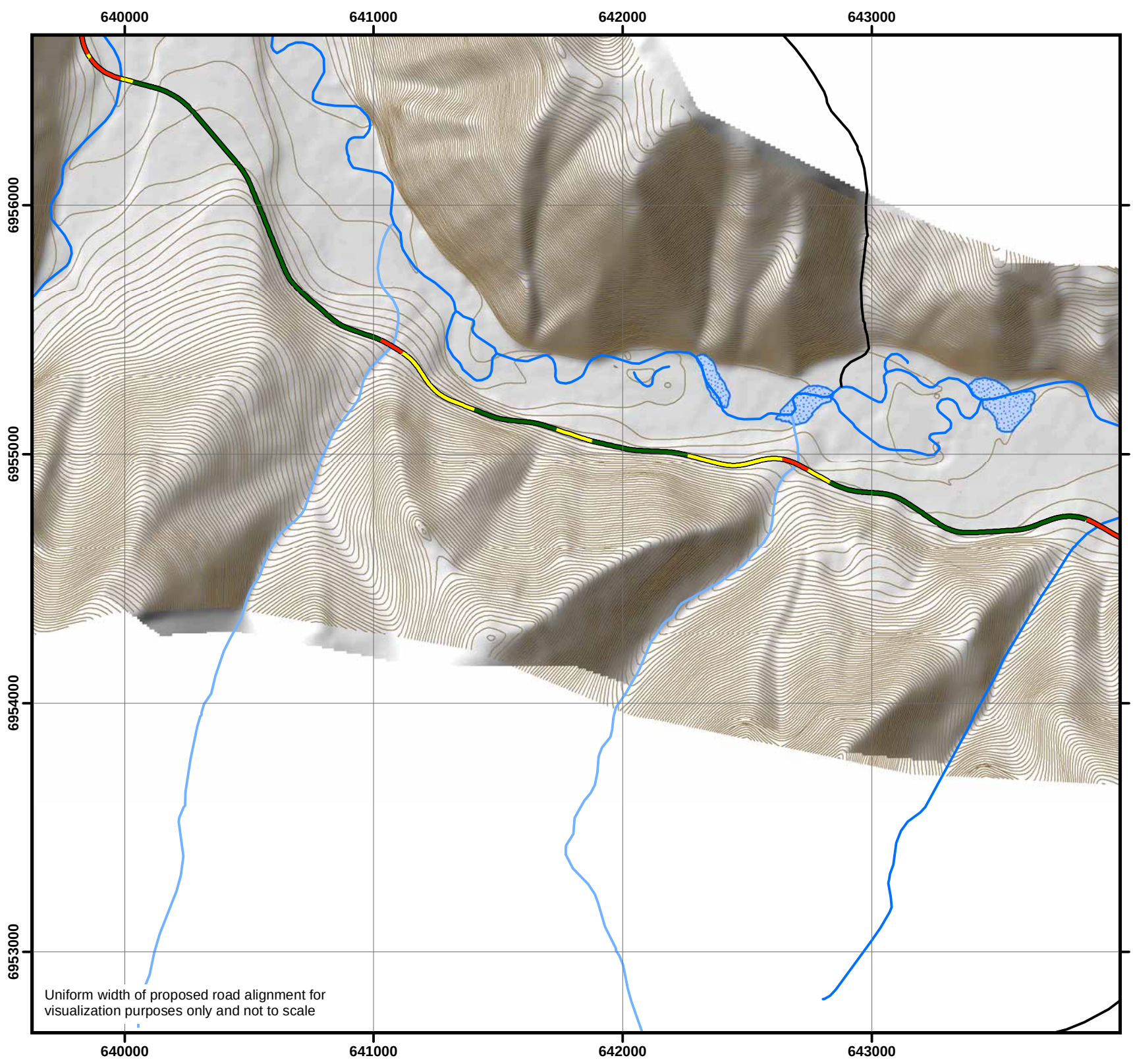
Map 2

Potential Ecological Consequences

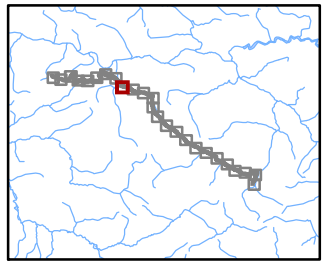
CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 16 of 25



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

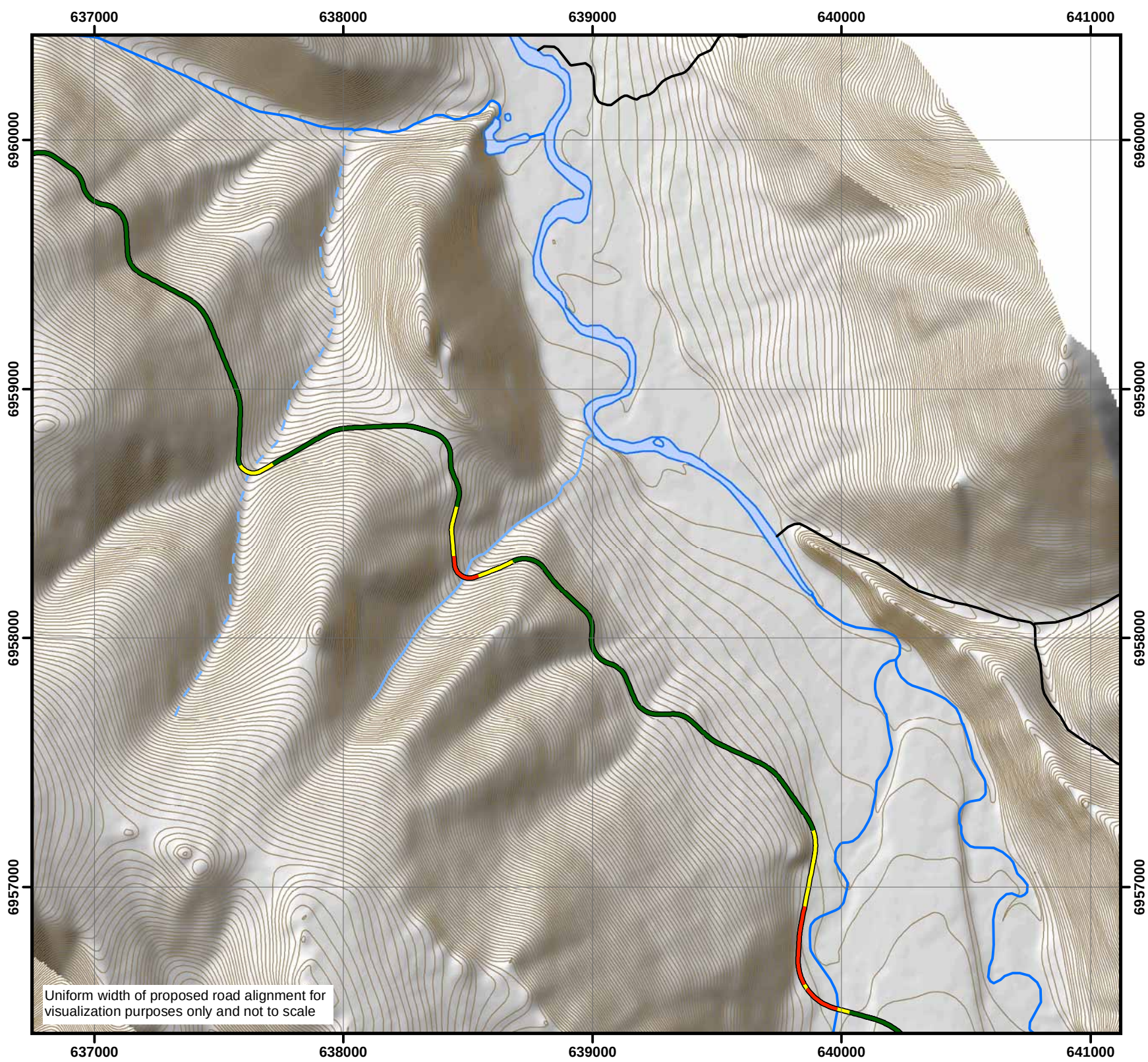
Map 2

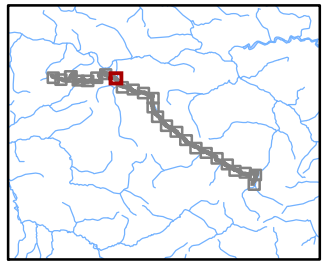
Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 17 of 25





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

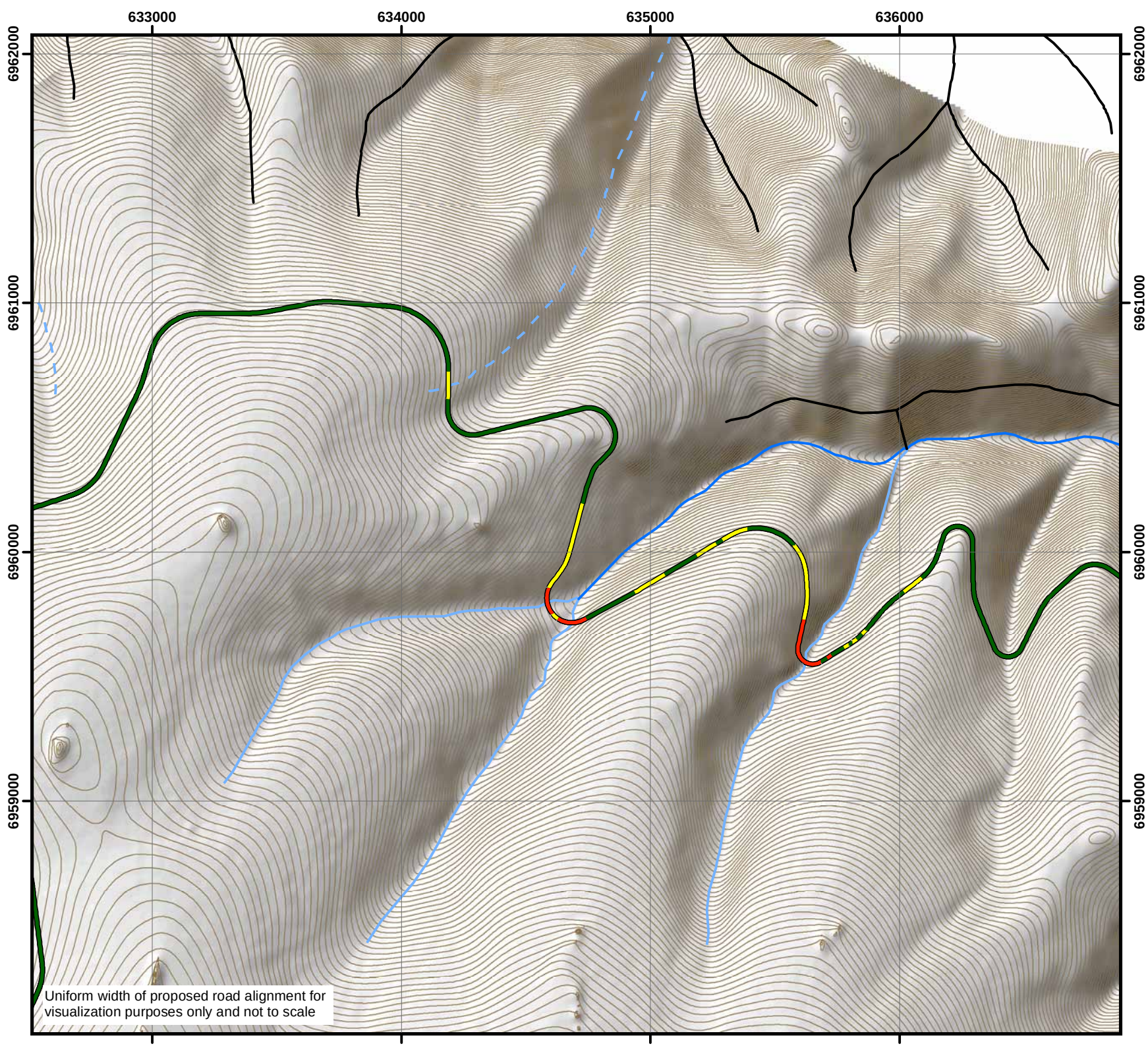
Freegold Road Extension

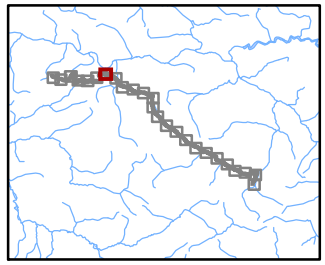
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

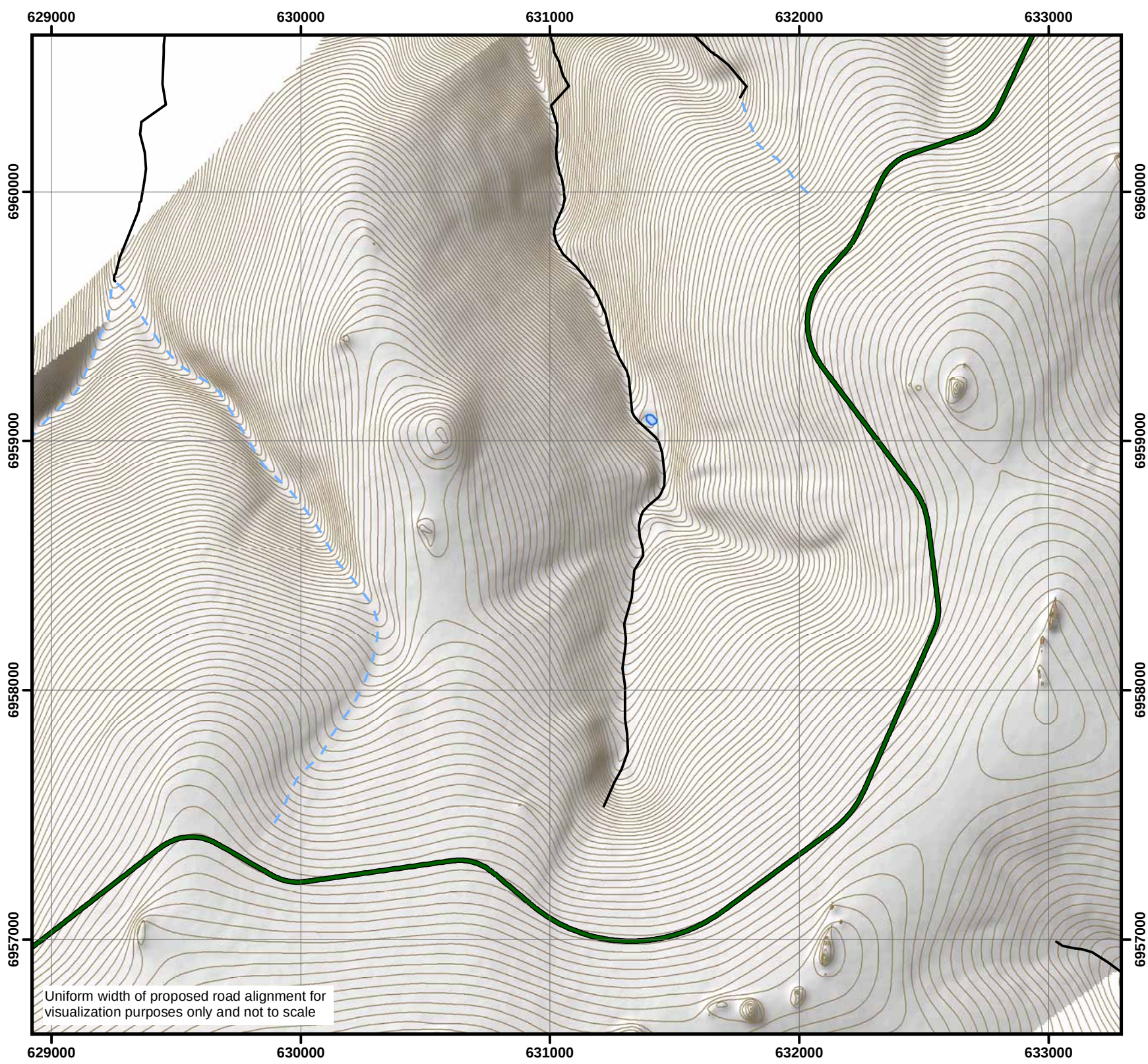
Freegold Road Extension

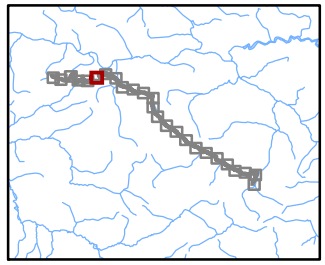
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

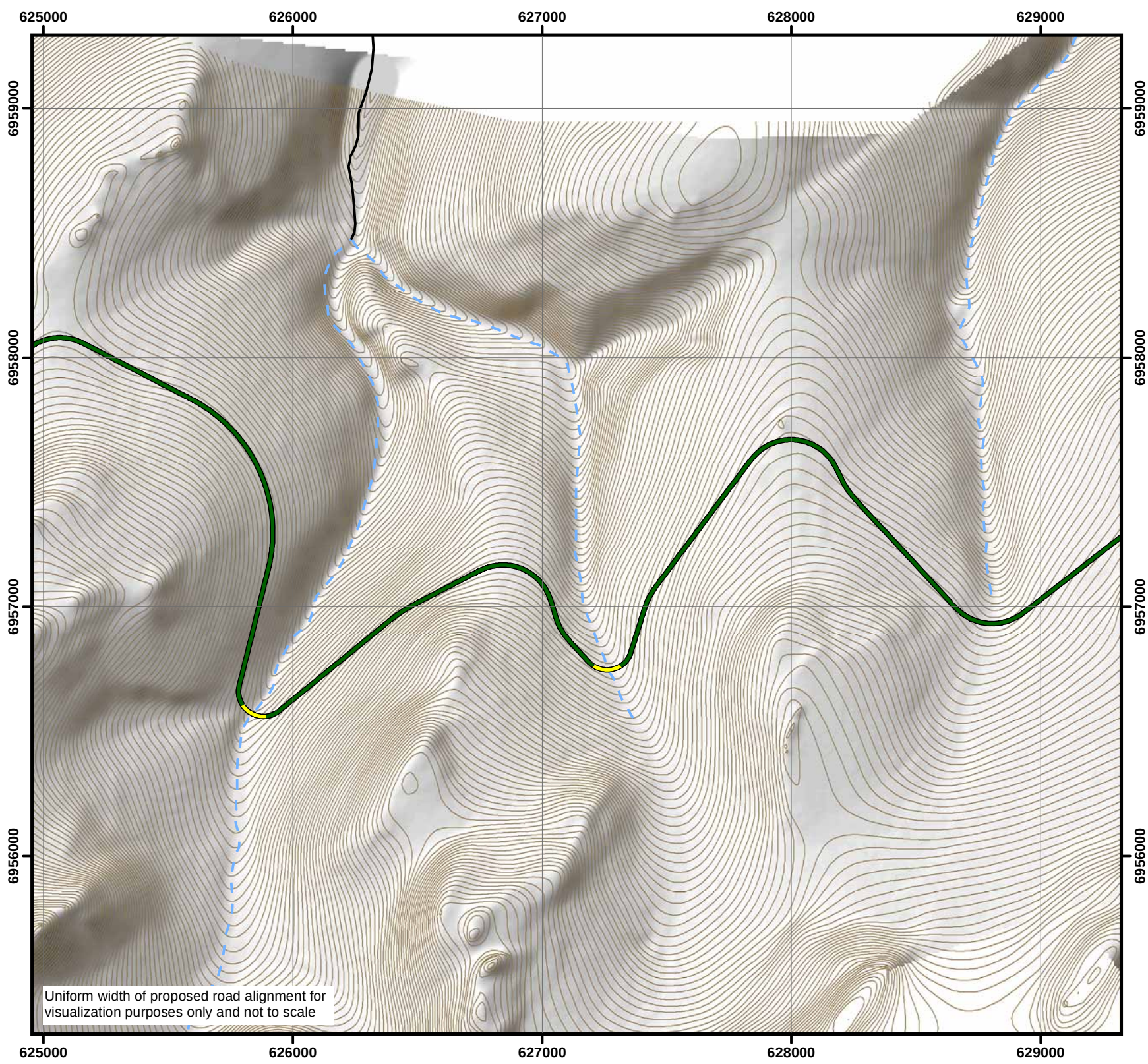
Freegold Road Extension

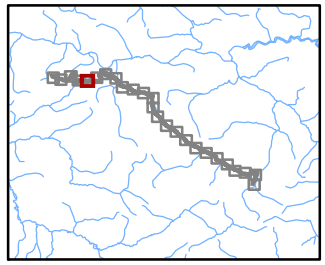
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

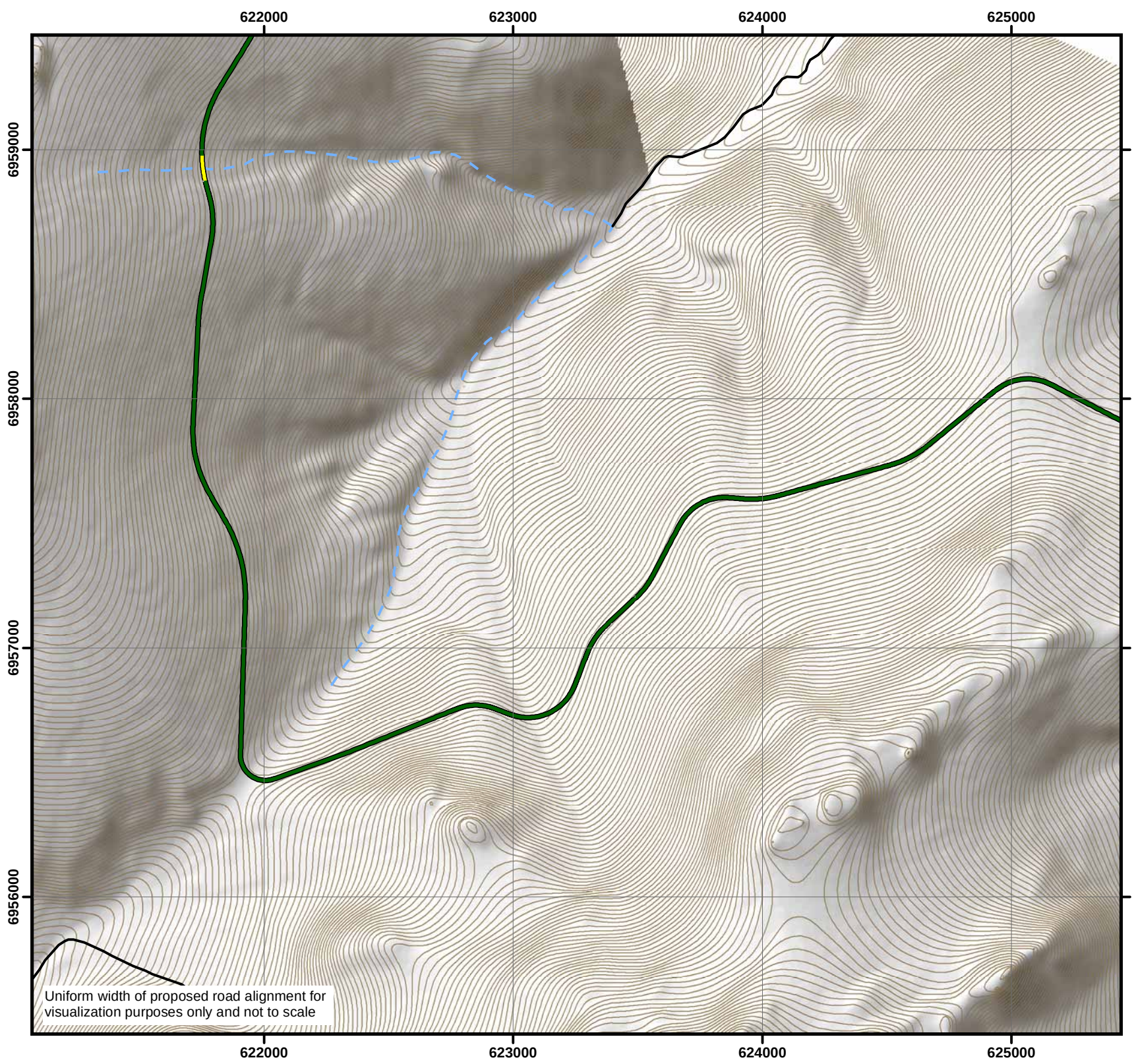
Freegold Road Extension

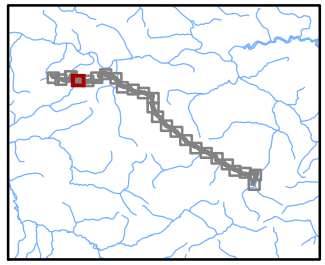
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

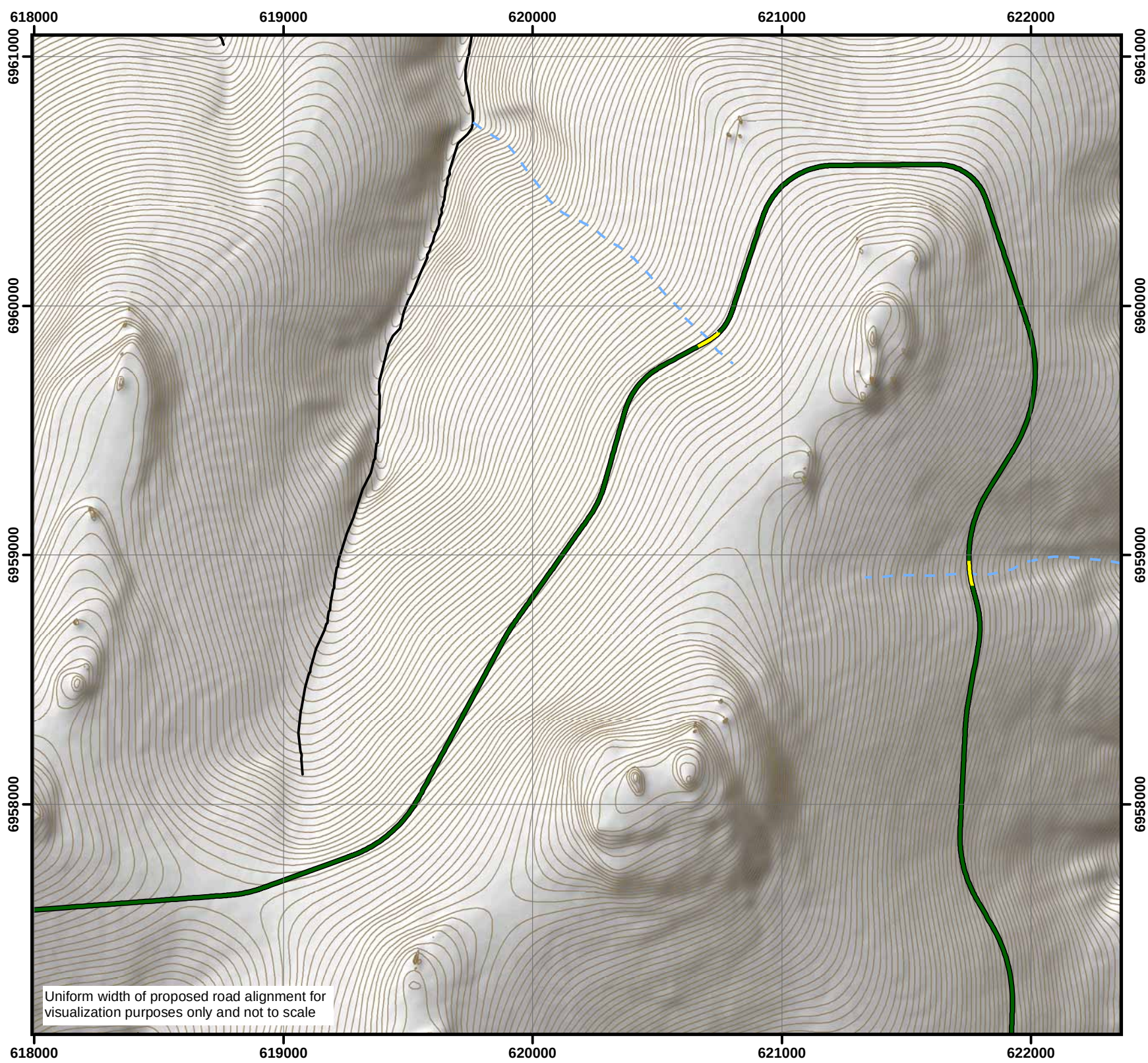
Freegold Road Extension

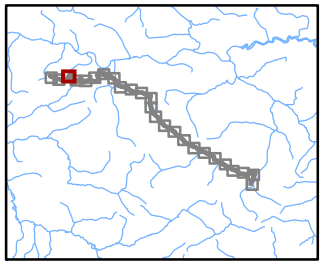
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

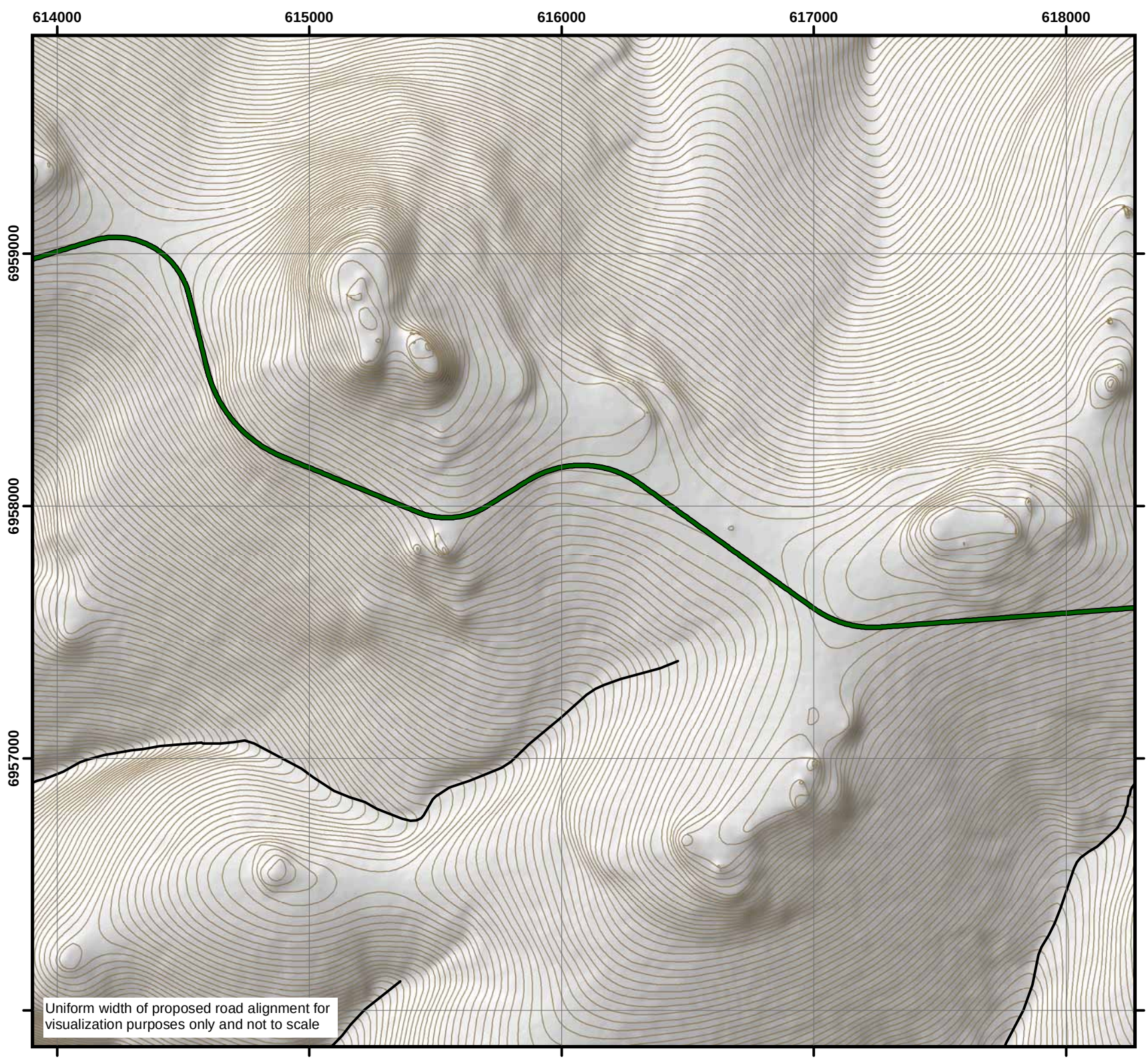
Freegold Road Extension

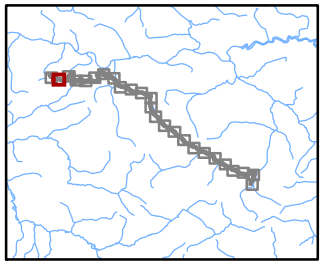
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

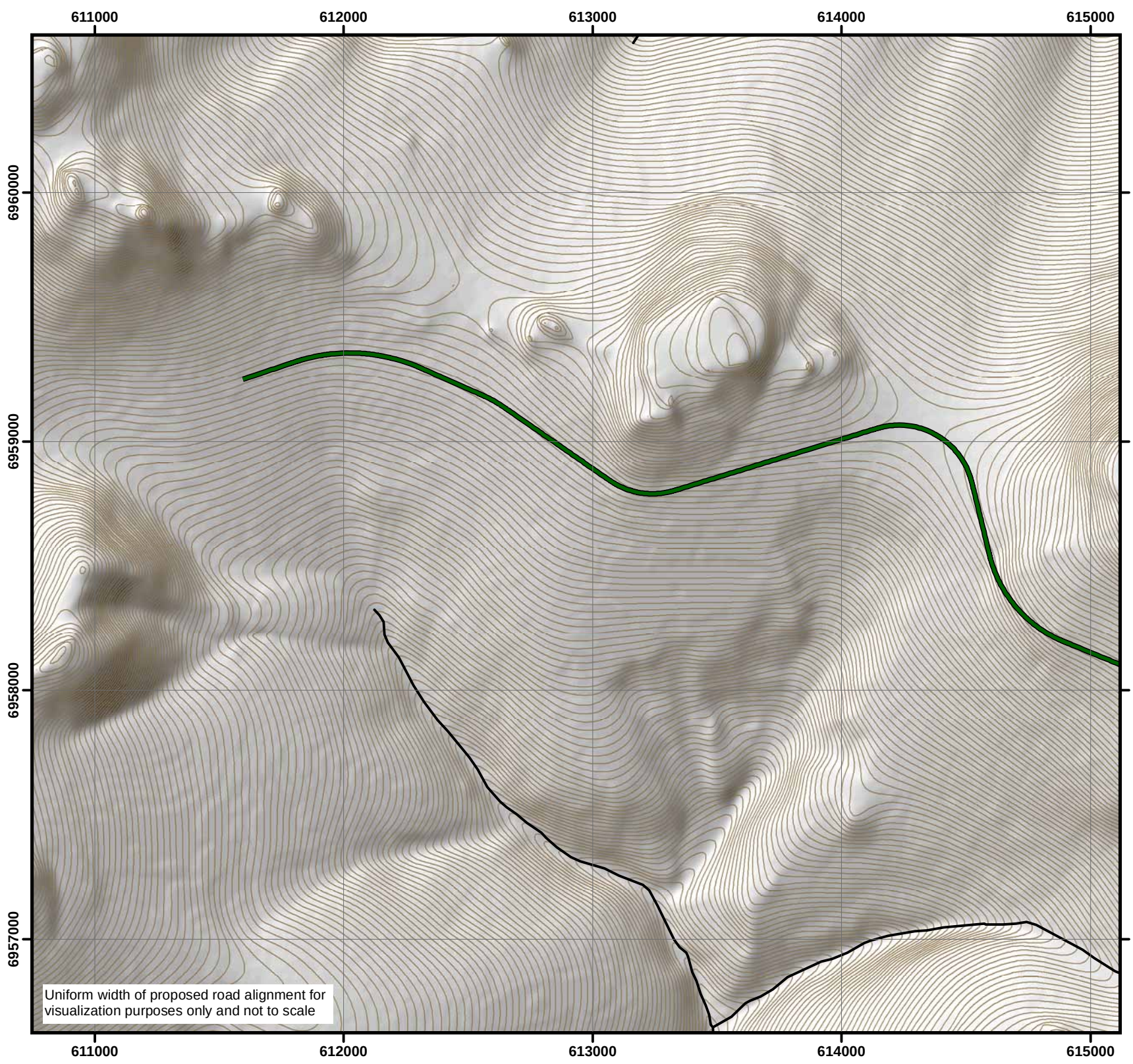
Freegold Road Extension

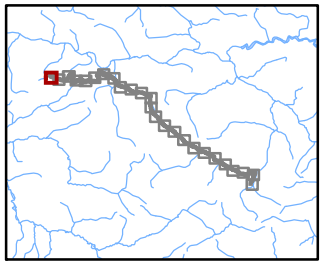
Map 2

Potential Ecological Consequences

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Potential Ecological Consequence

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

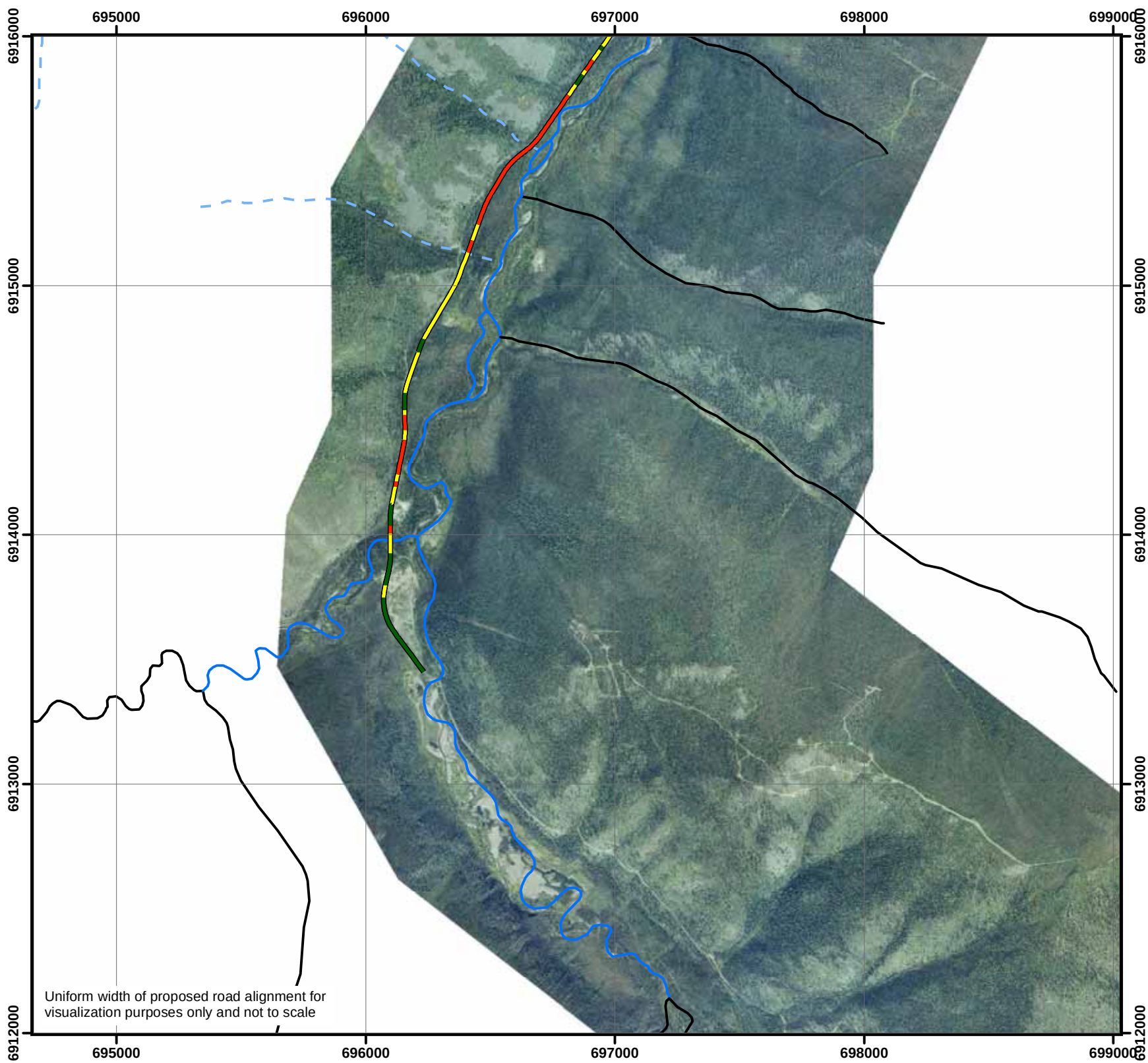
Map 2

Potential Ecological Consequences

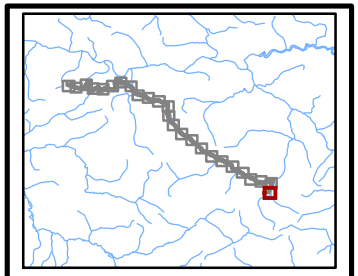
CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 25 of 25



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

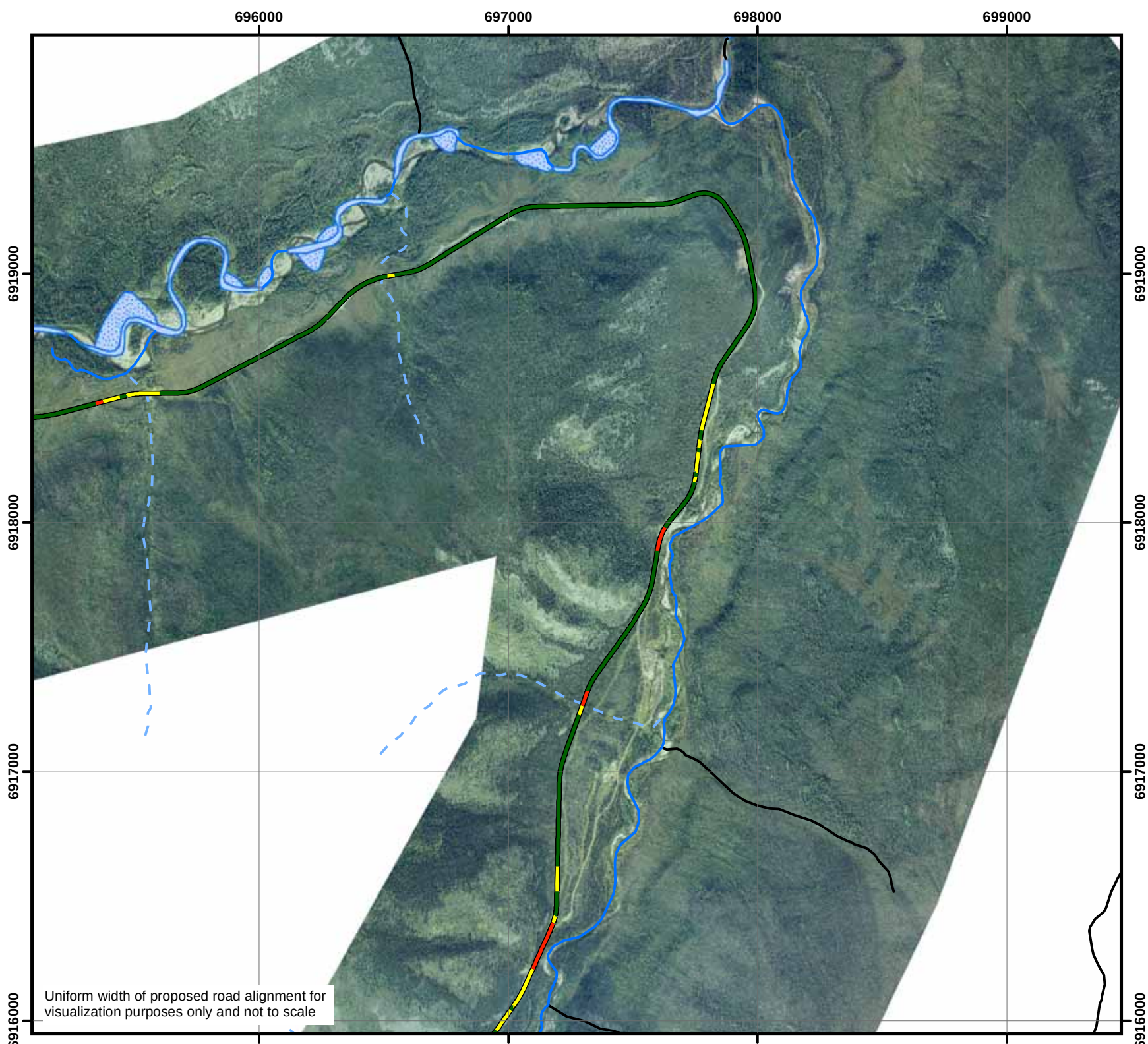
Map 3

Overall Erosion and Sedimentation Risk

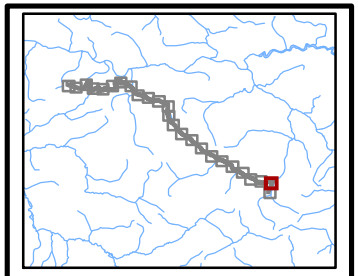
CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 1 of 25



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

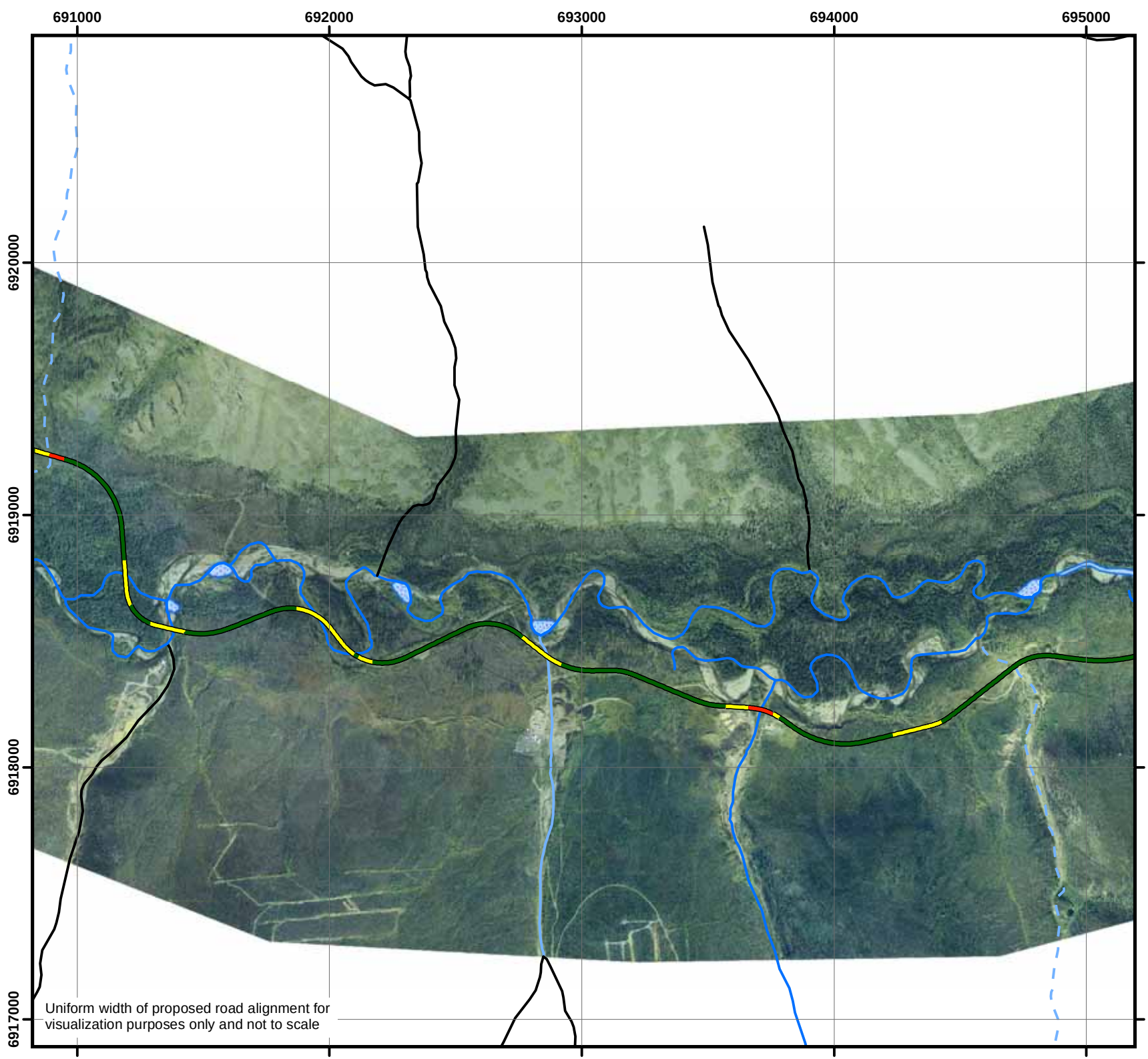
Freegold Road Extension

Map 3

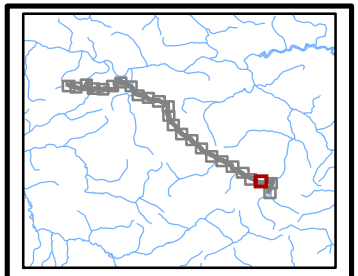
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

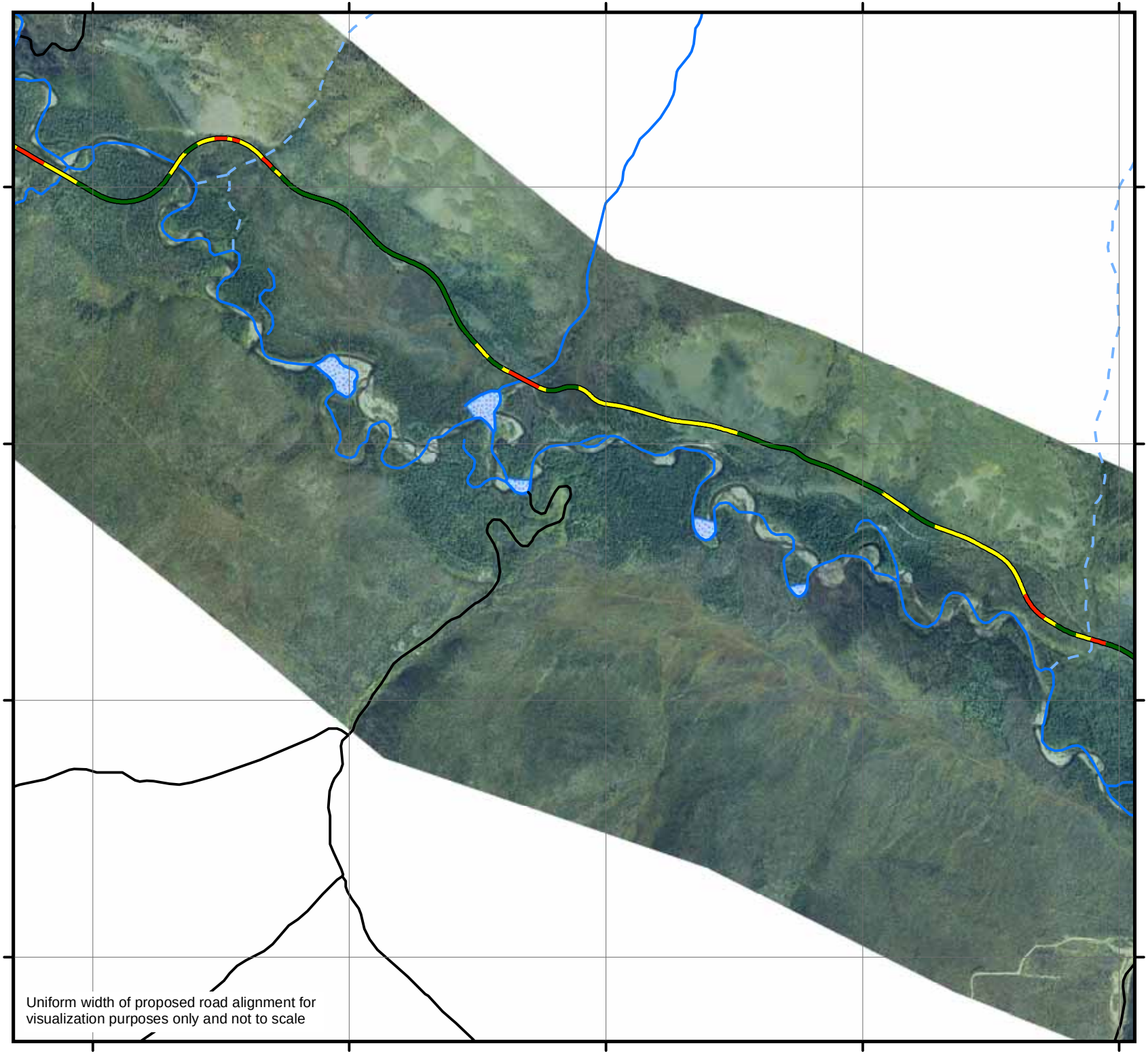
Map 3

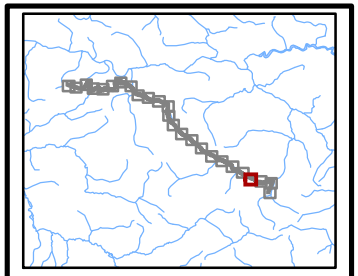
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 3 of 25





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

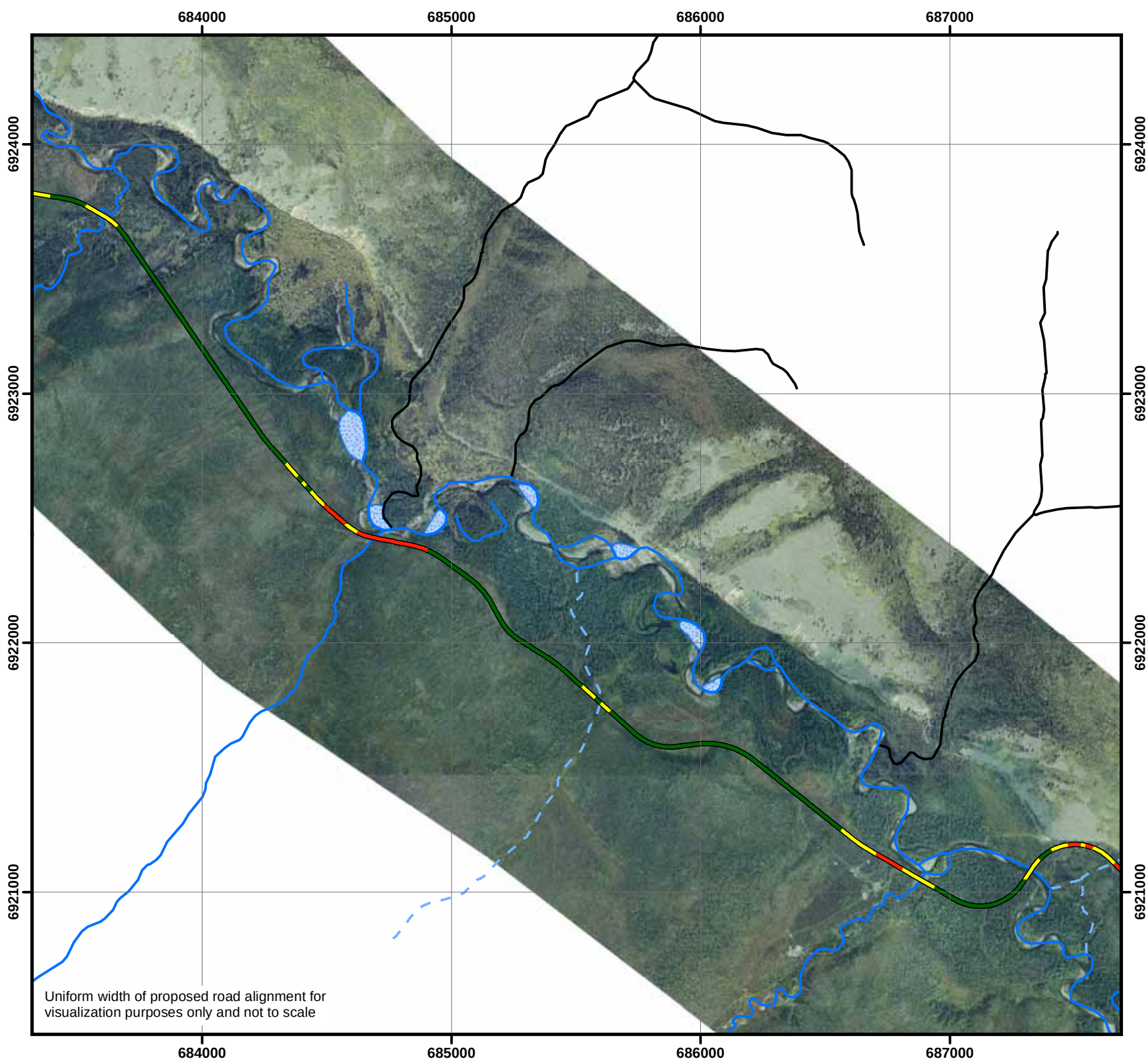
Map 3

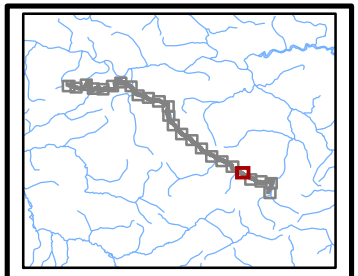
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Uniform width of proposed road alignment for visualization purposes only and not to scale





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

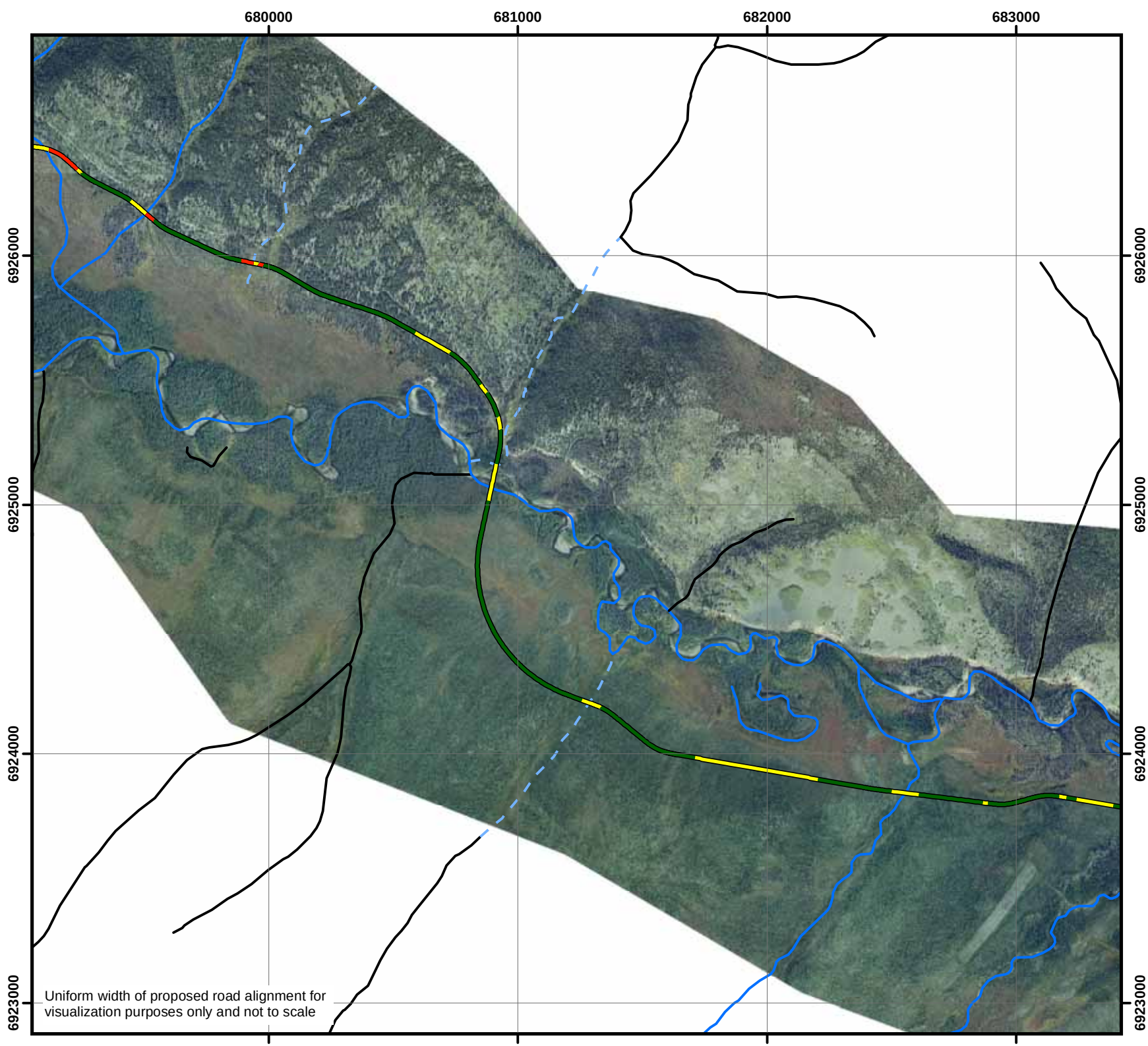
Map 3

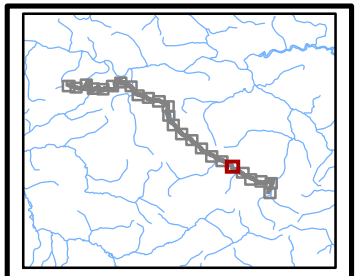
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 5 of 25





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

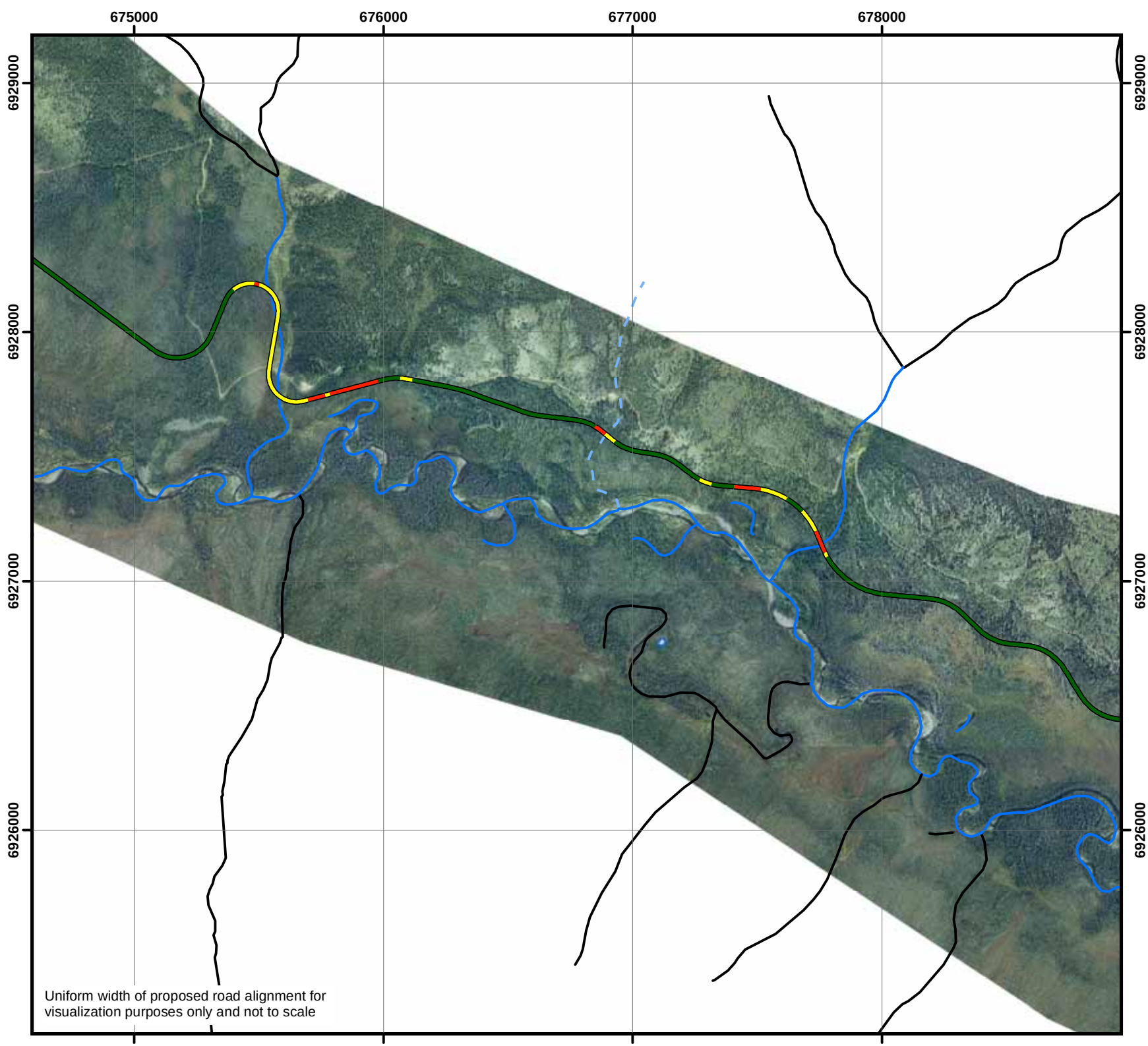
Map 3

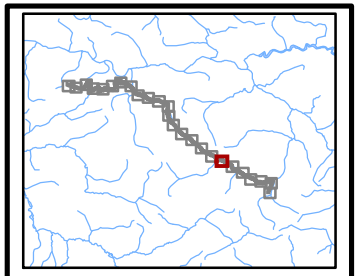
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 6 of 25





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

Map 3

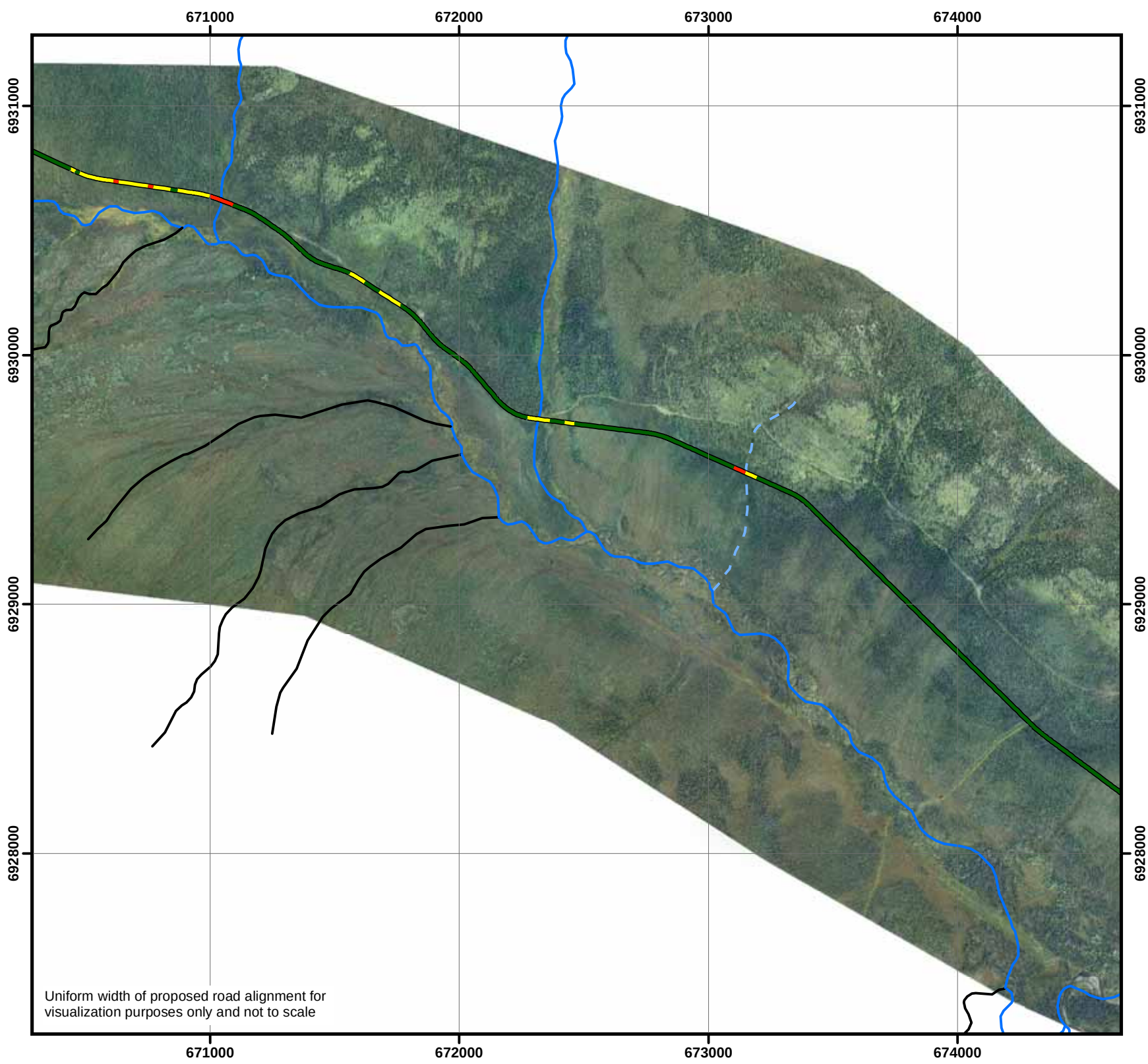
Overall Erosion and Sedimentation Risk

CASINO

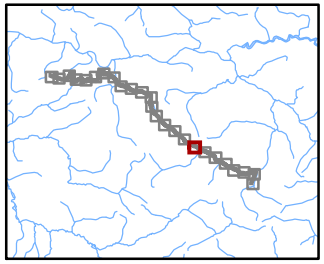
PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 7 of 25

Uniform width of proposed road alignment for visualization purposes only and not to scale



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

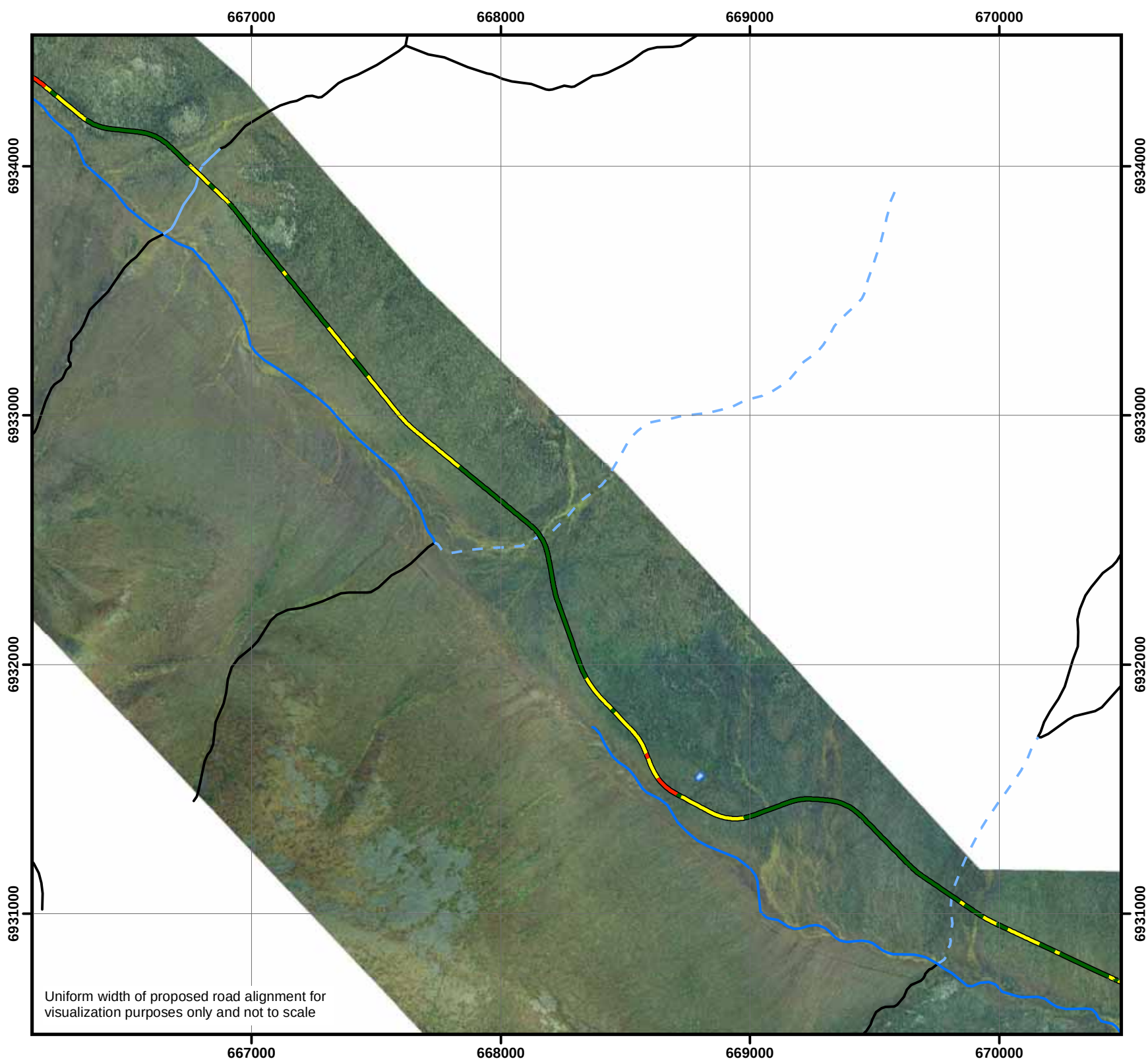
Freegold Road Extension

Map 3

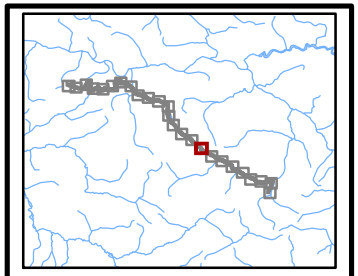
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

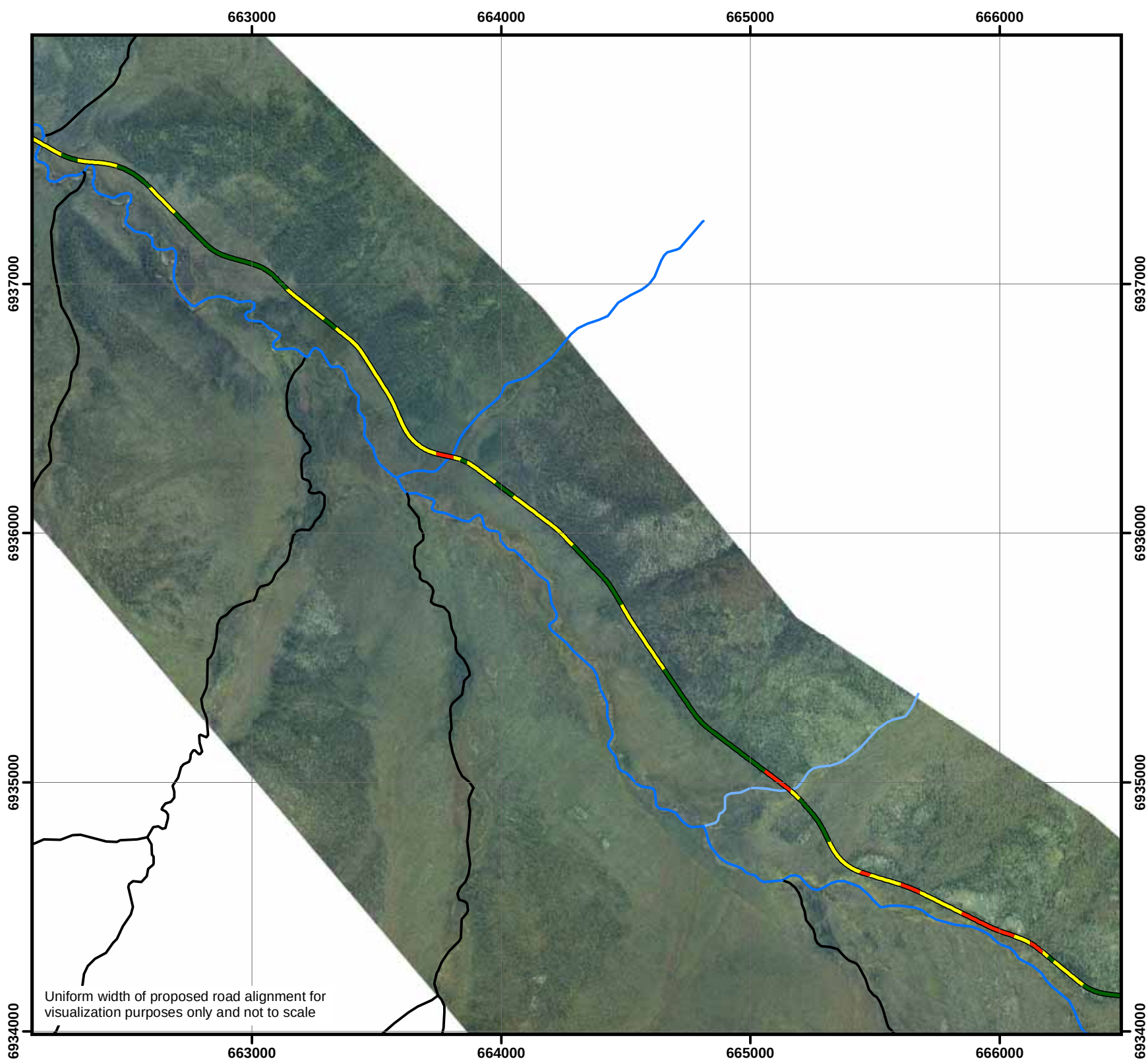
Freegold Road Extension

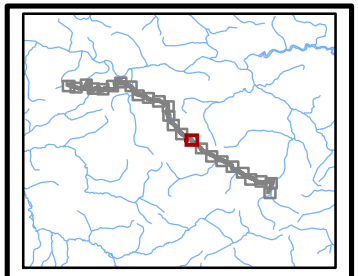
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

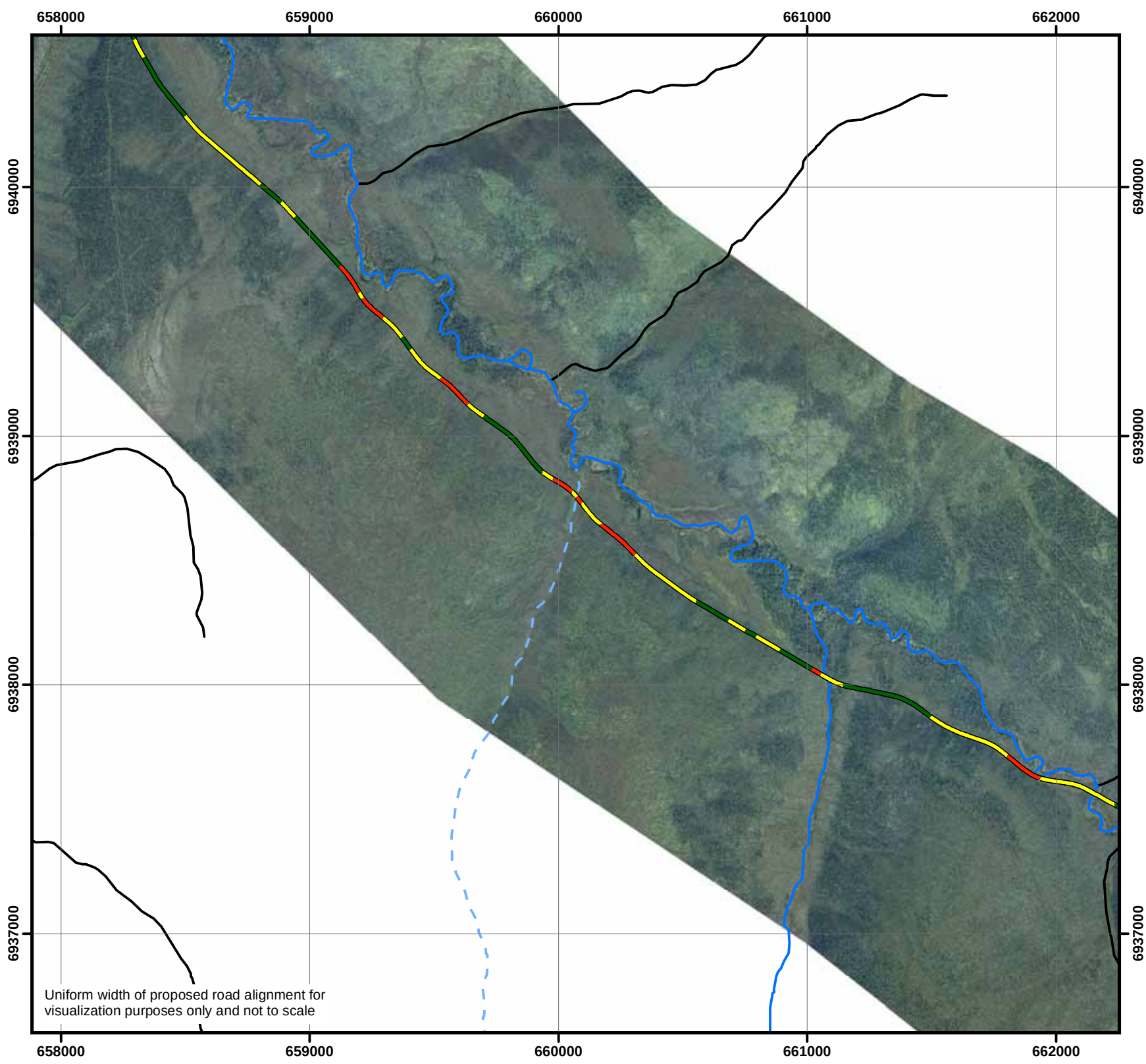
Freegold Road Extension

Map 3

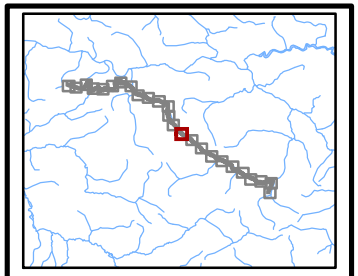
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

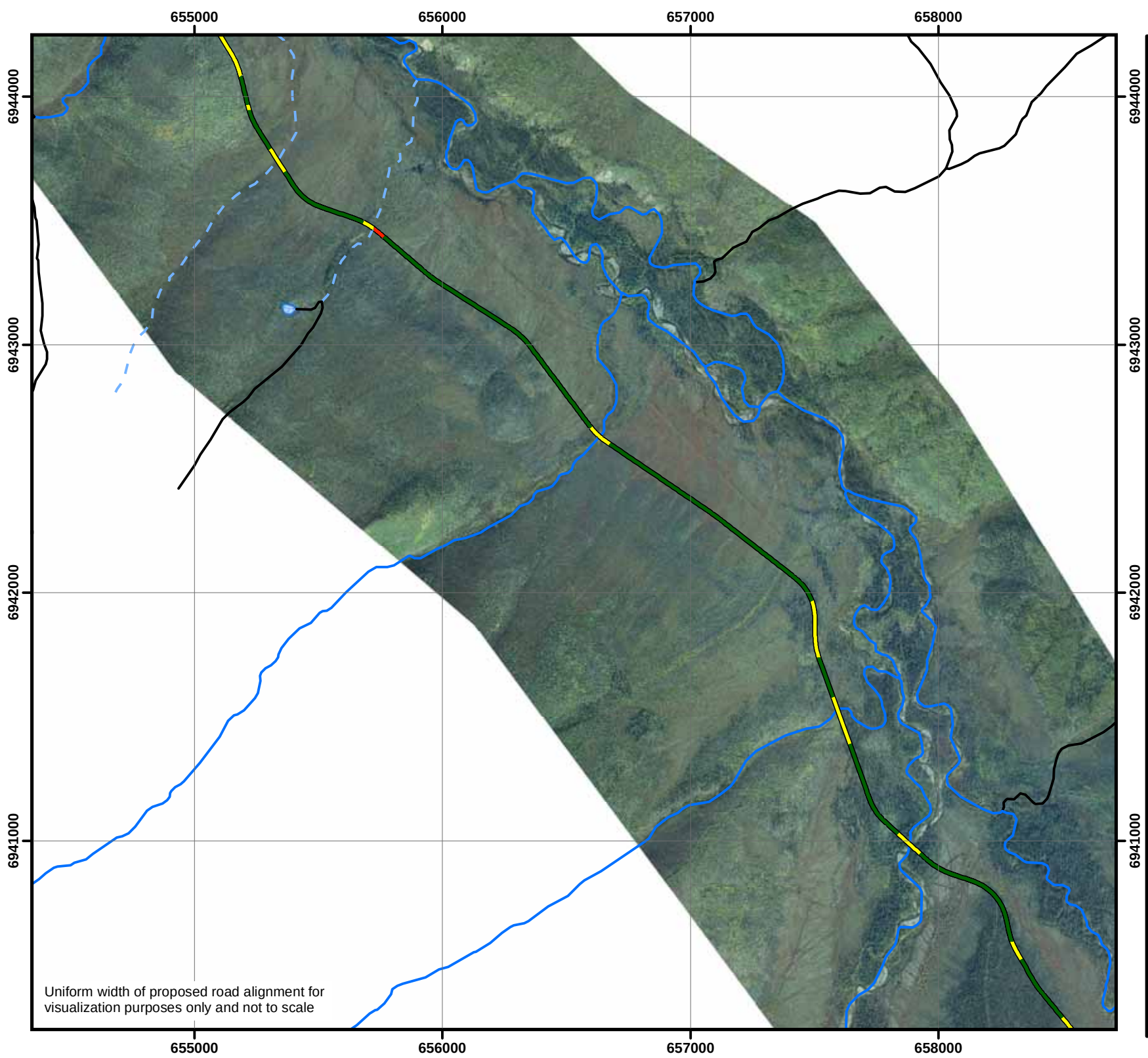
Freegold Road Extension

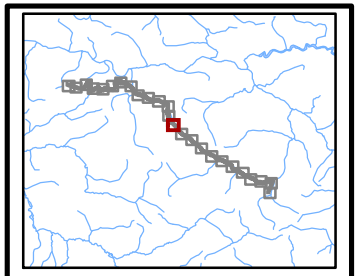
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

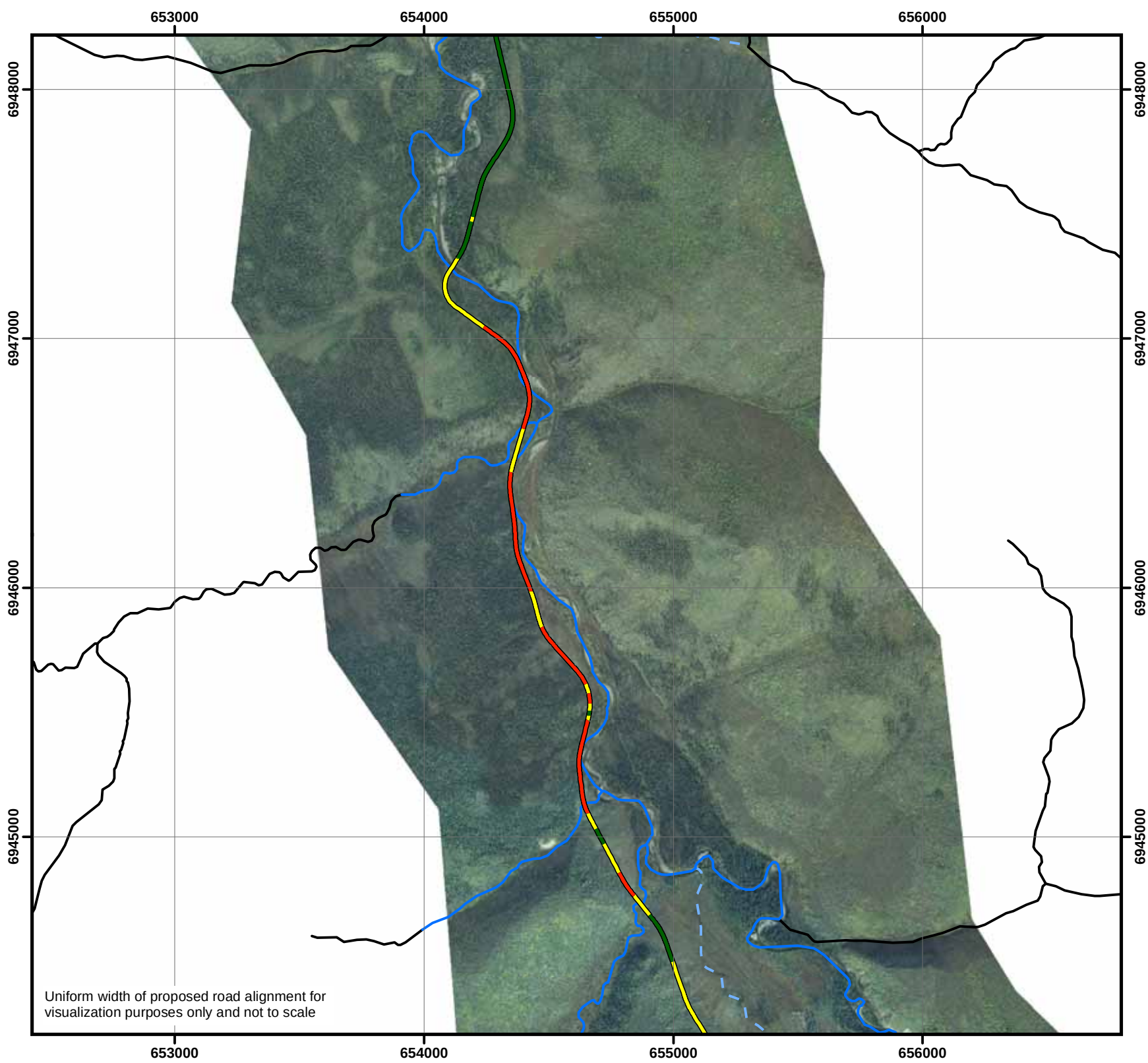
Freegold Road Extension

Map 3

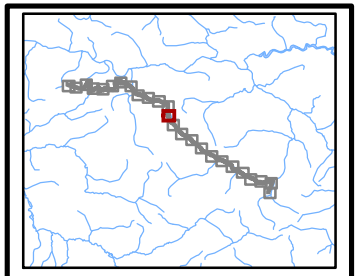
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

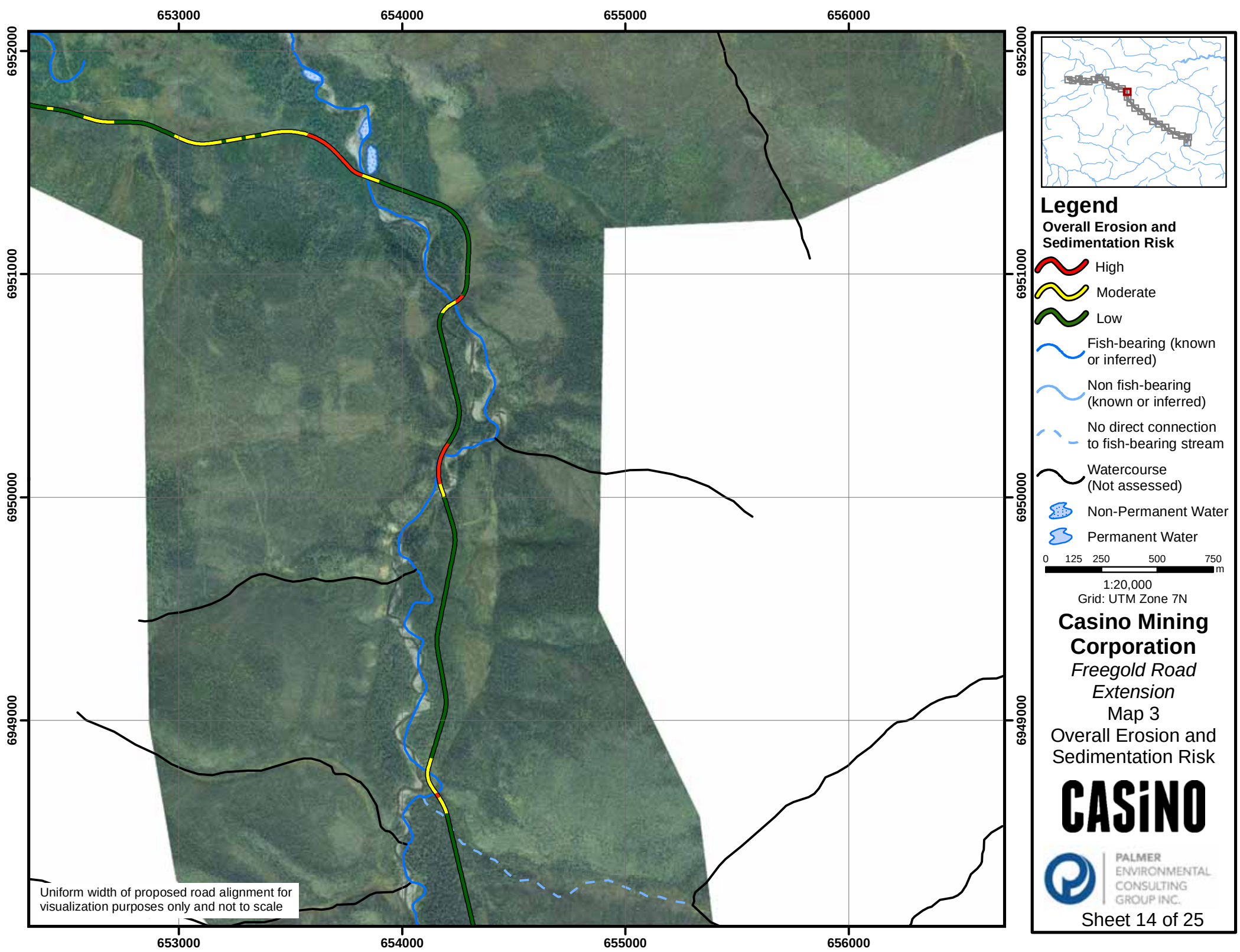
Freegold Road Extension

Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

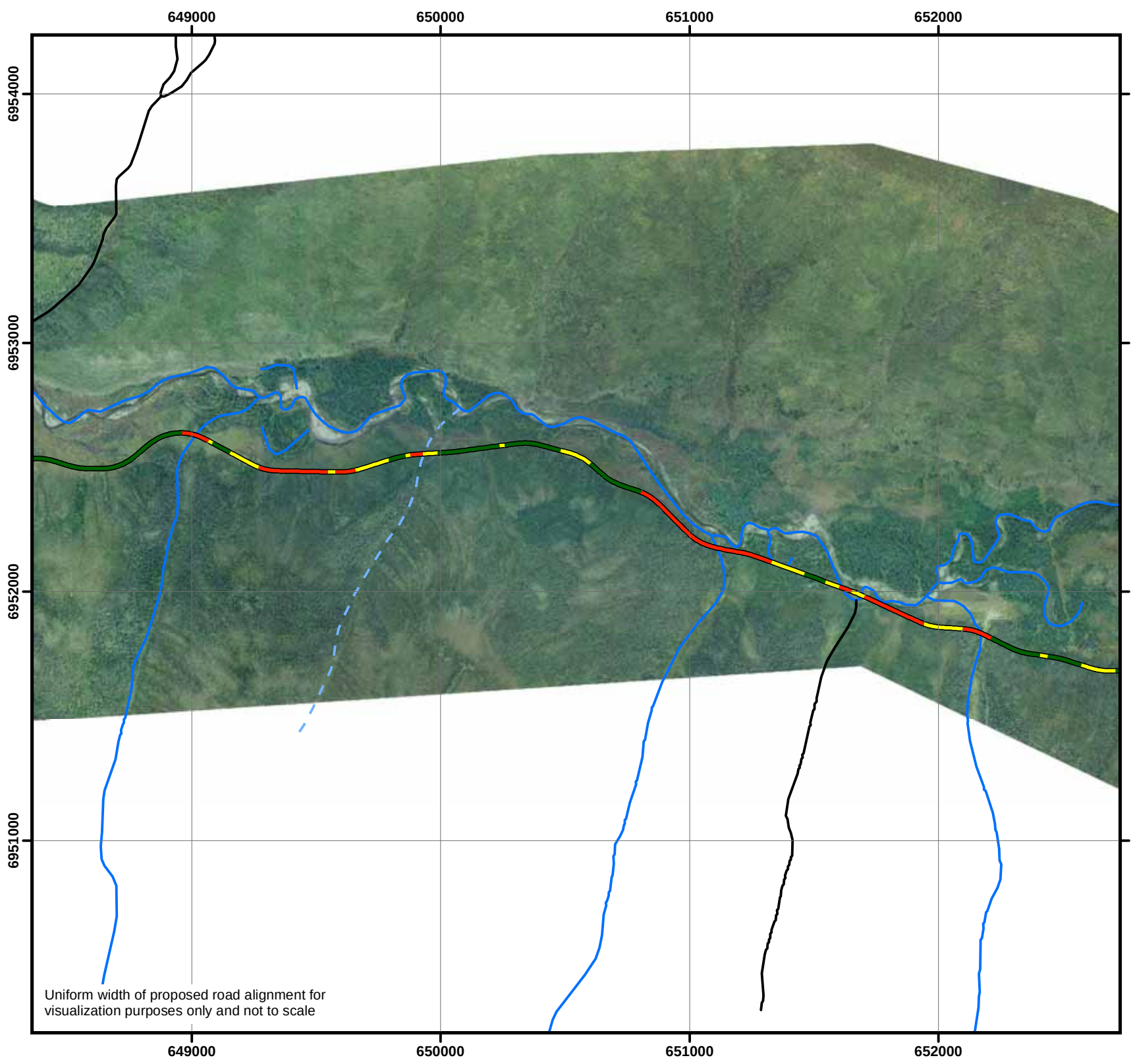
Freegold Road Extension

Map 3

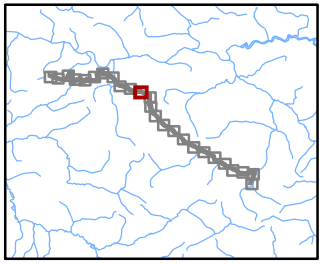
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.



Uniform width of proposed road alignment for visualization purposes only and not to scale



Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

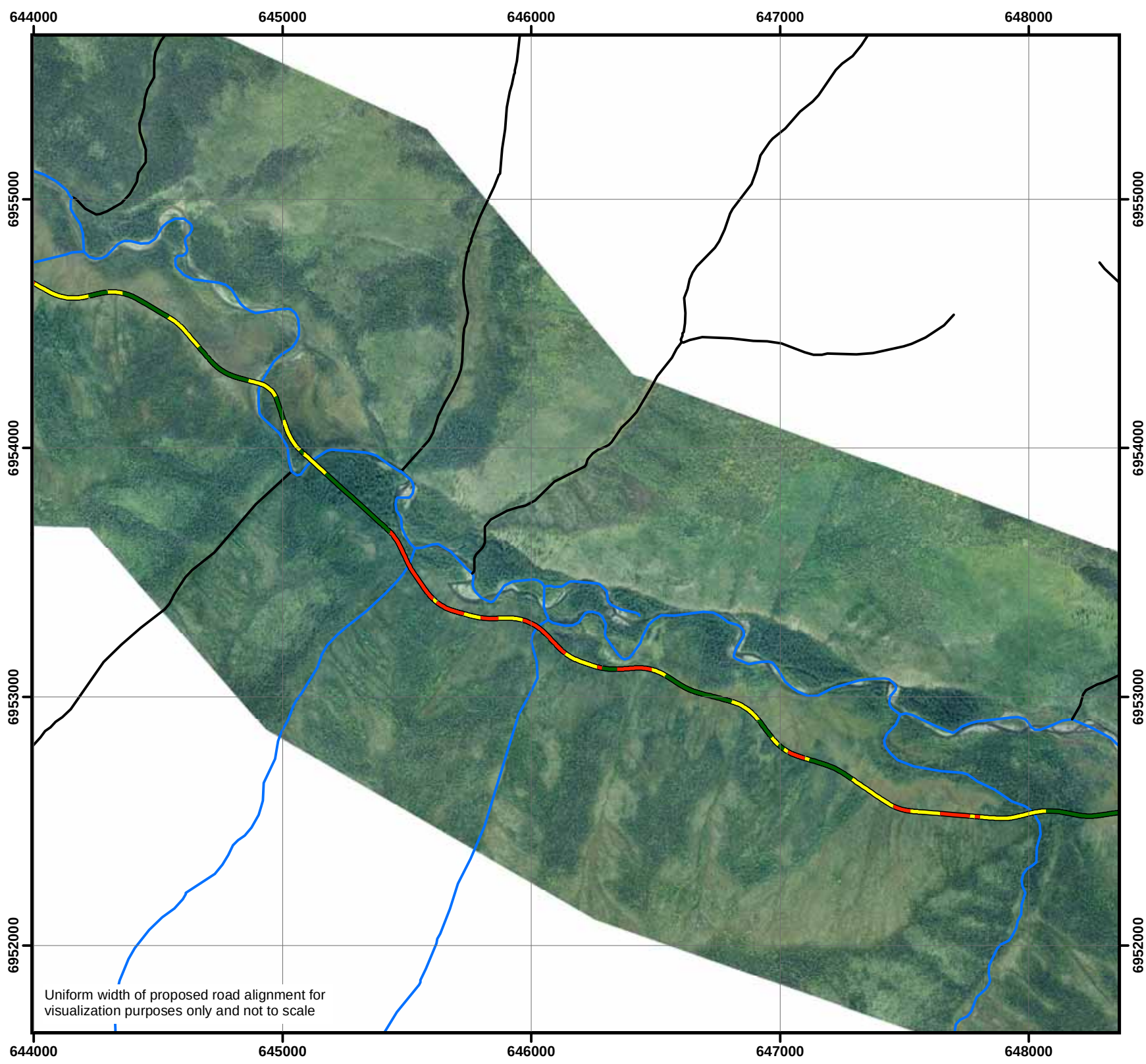
Map 3

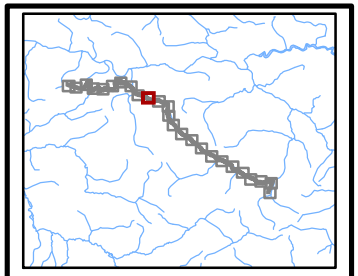
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 15 of 25





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

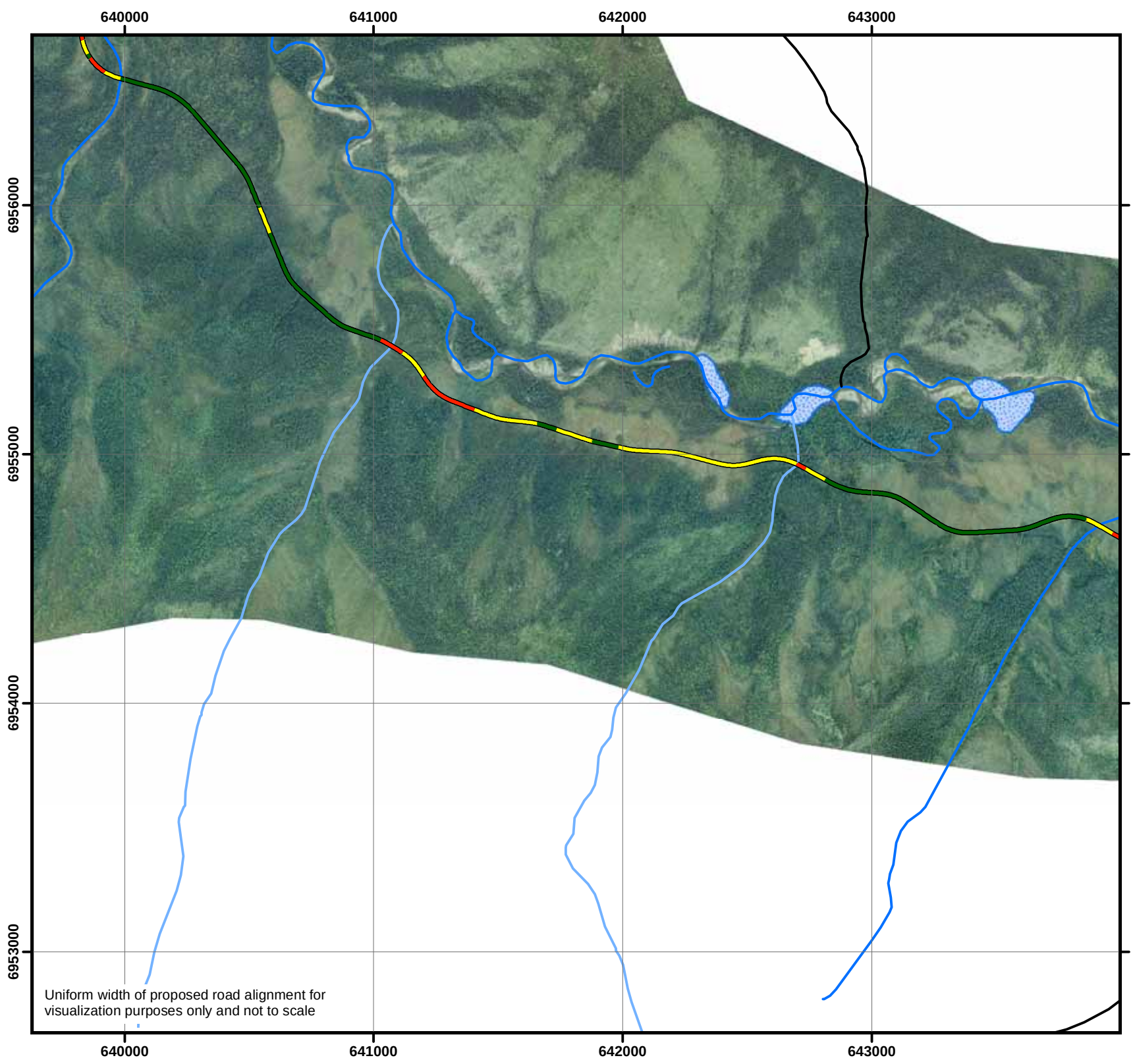
Freegold Road Extension

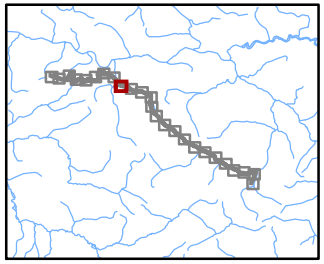
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

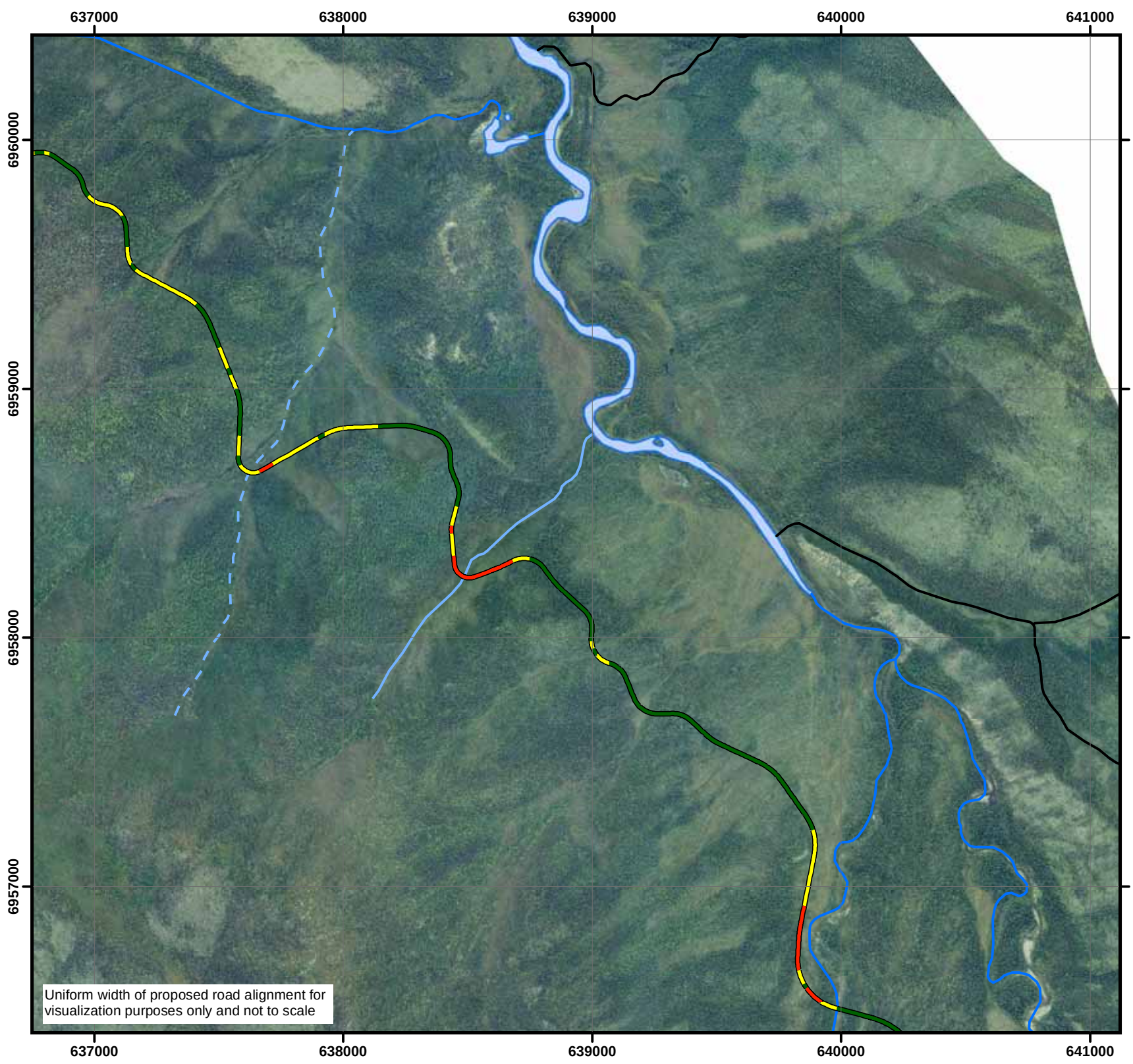
Freegold Road Extension

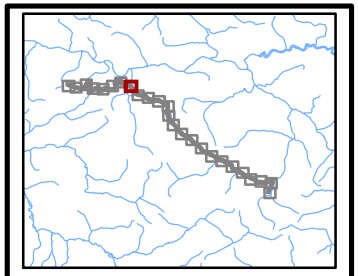
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

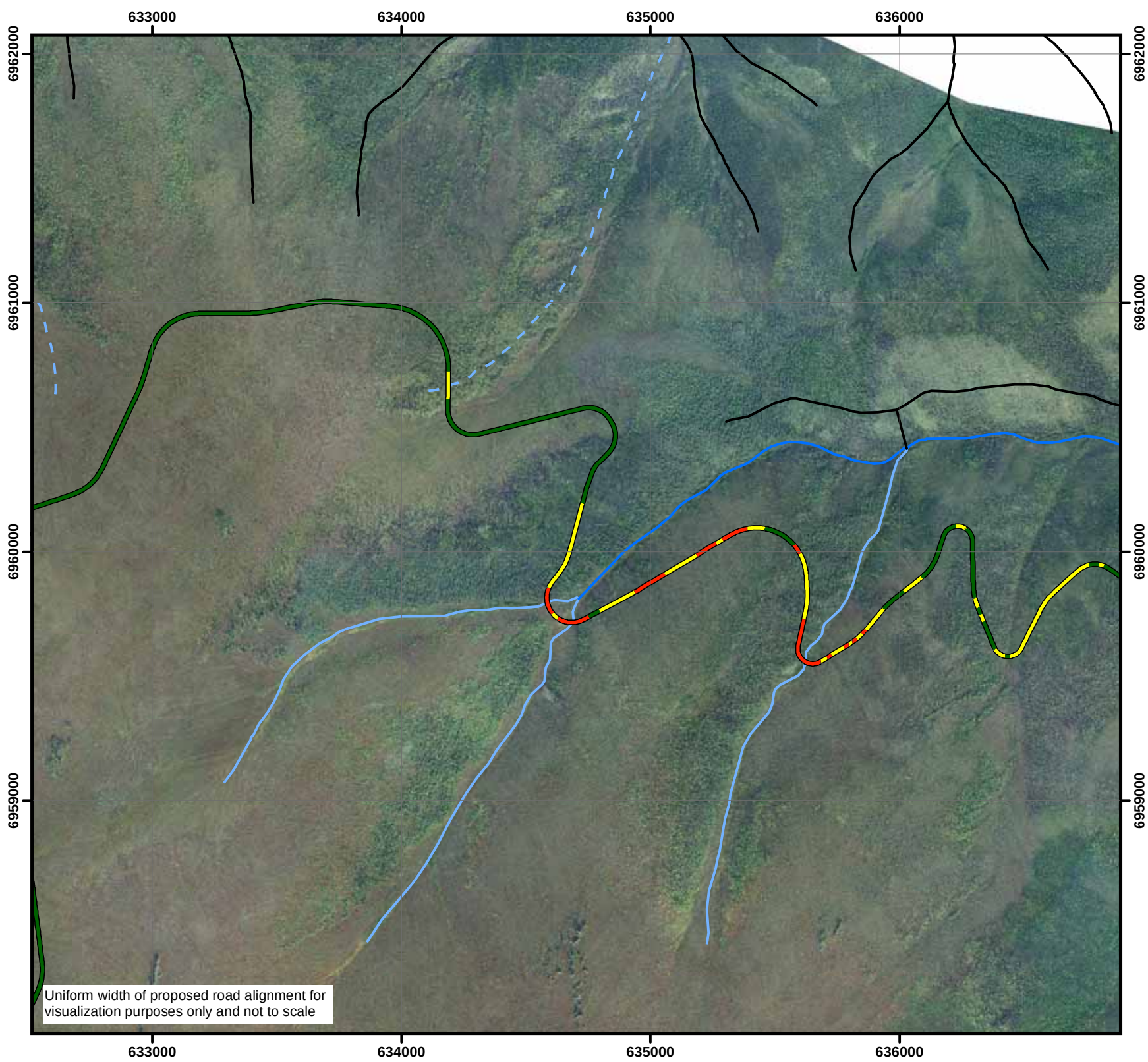
Map 3

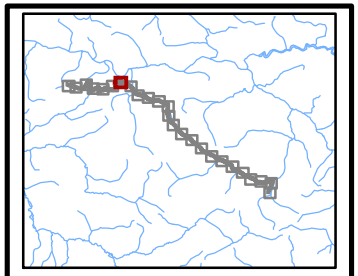
Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 18 of 25





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

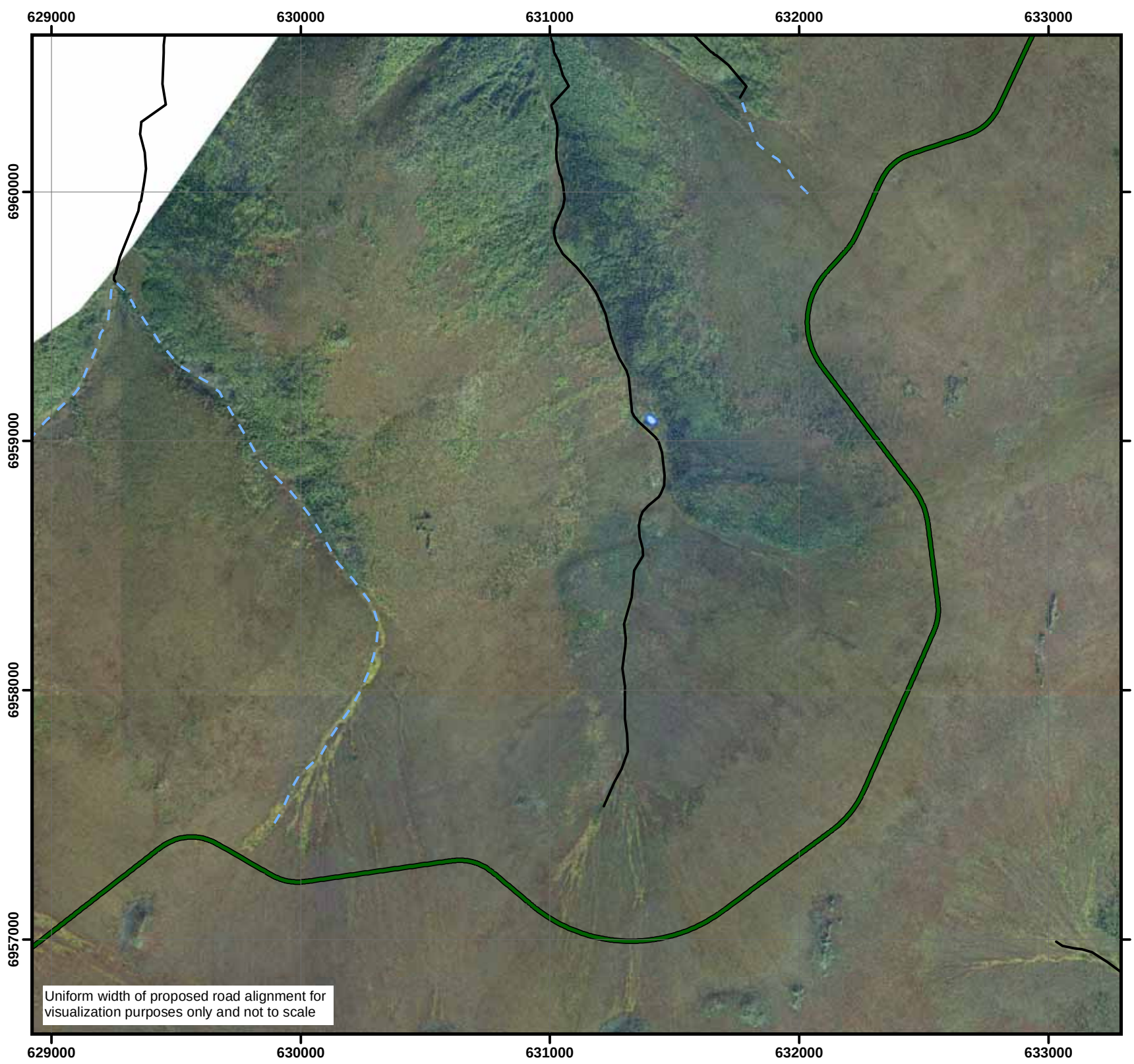
Freegold Road Extension

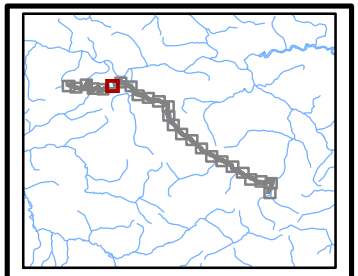
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

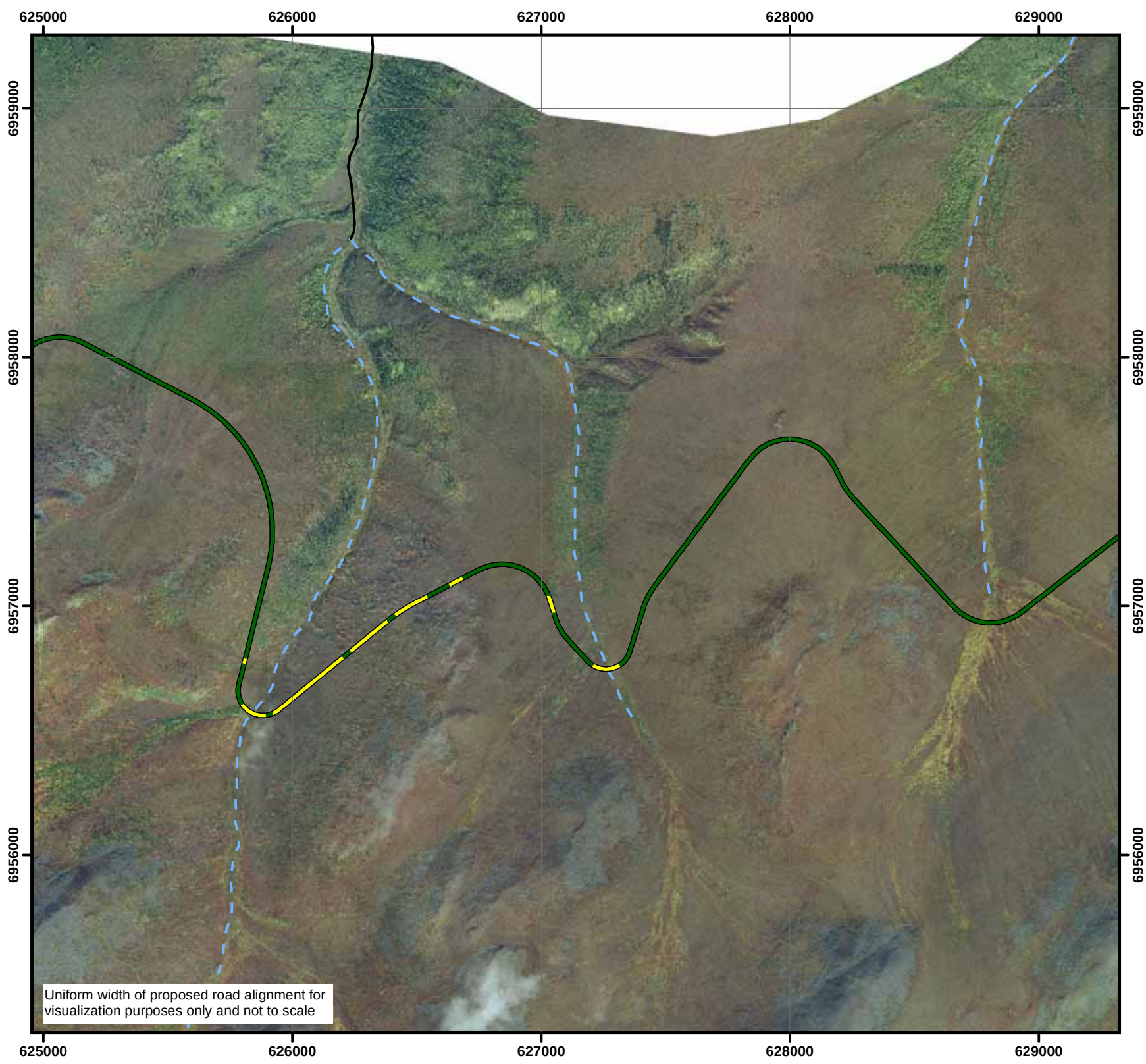
Freegold Road Extension

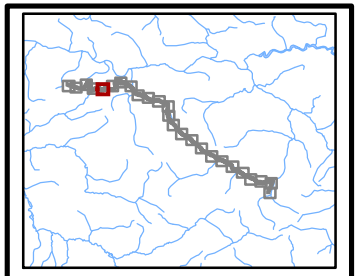
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

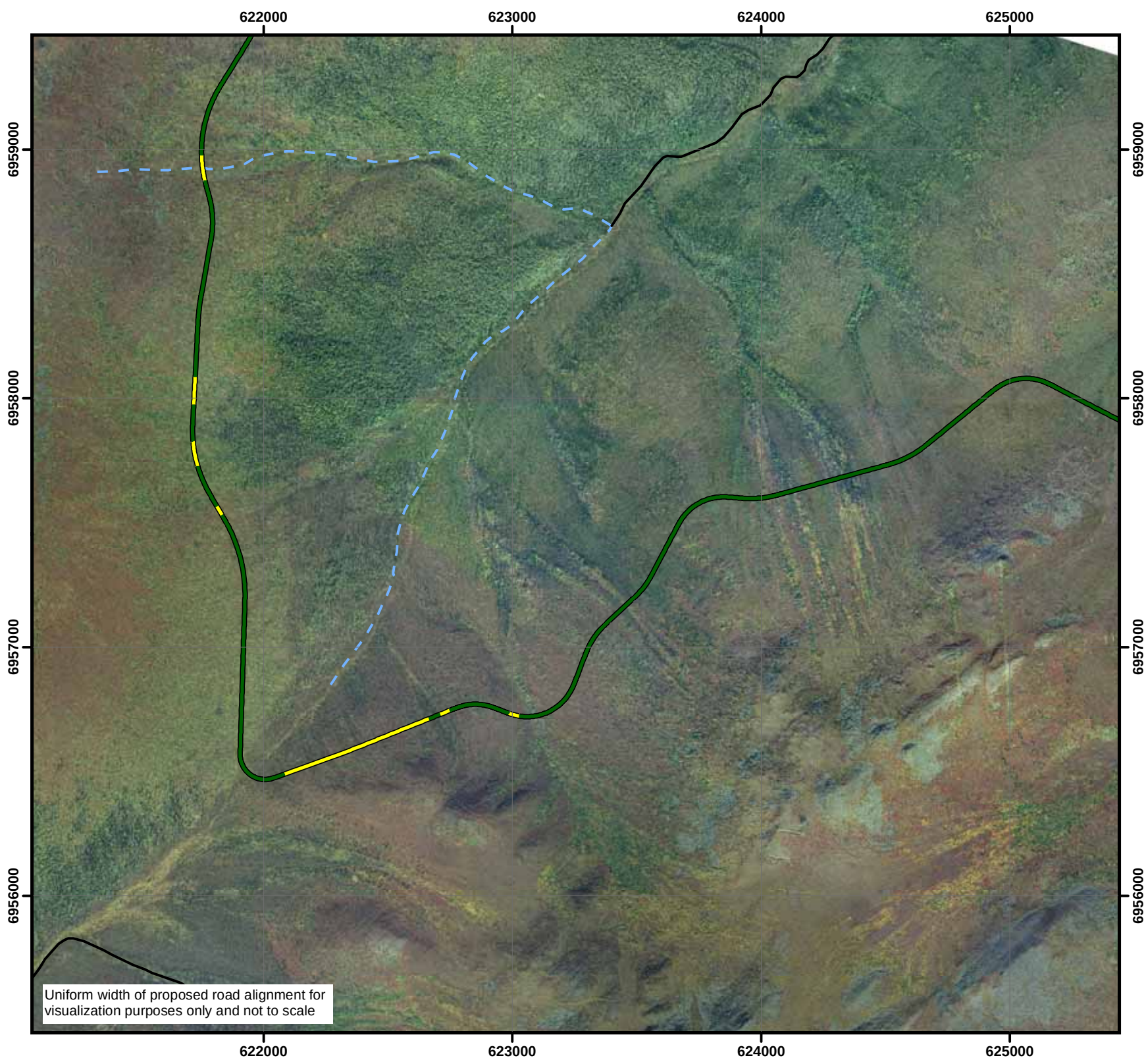
Freegold Road Extension

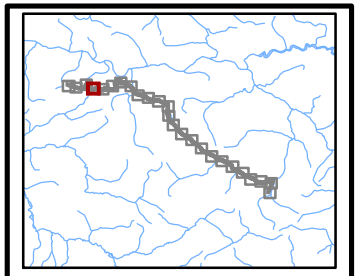
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

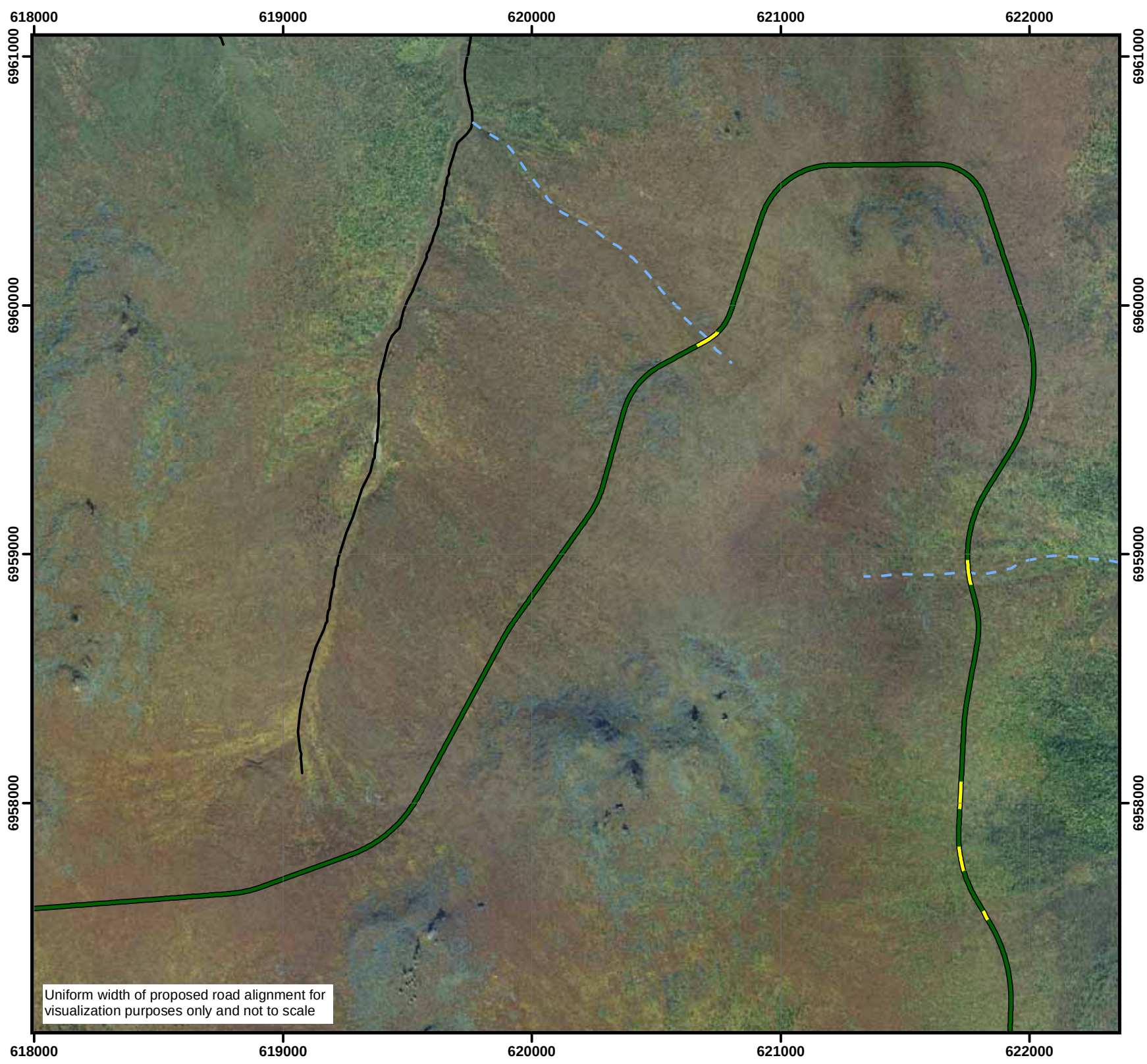
Freegold Road Extension

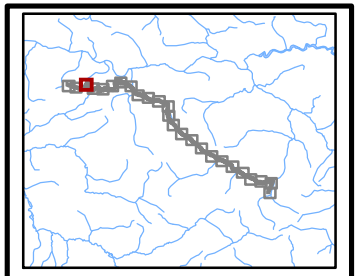
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

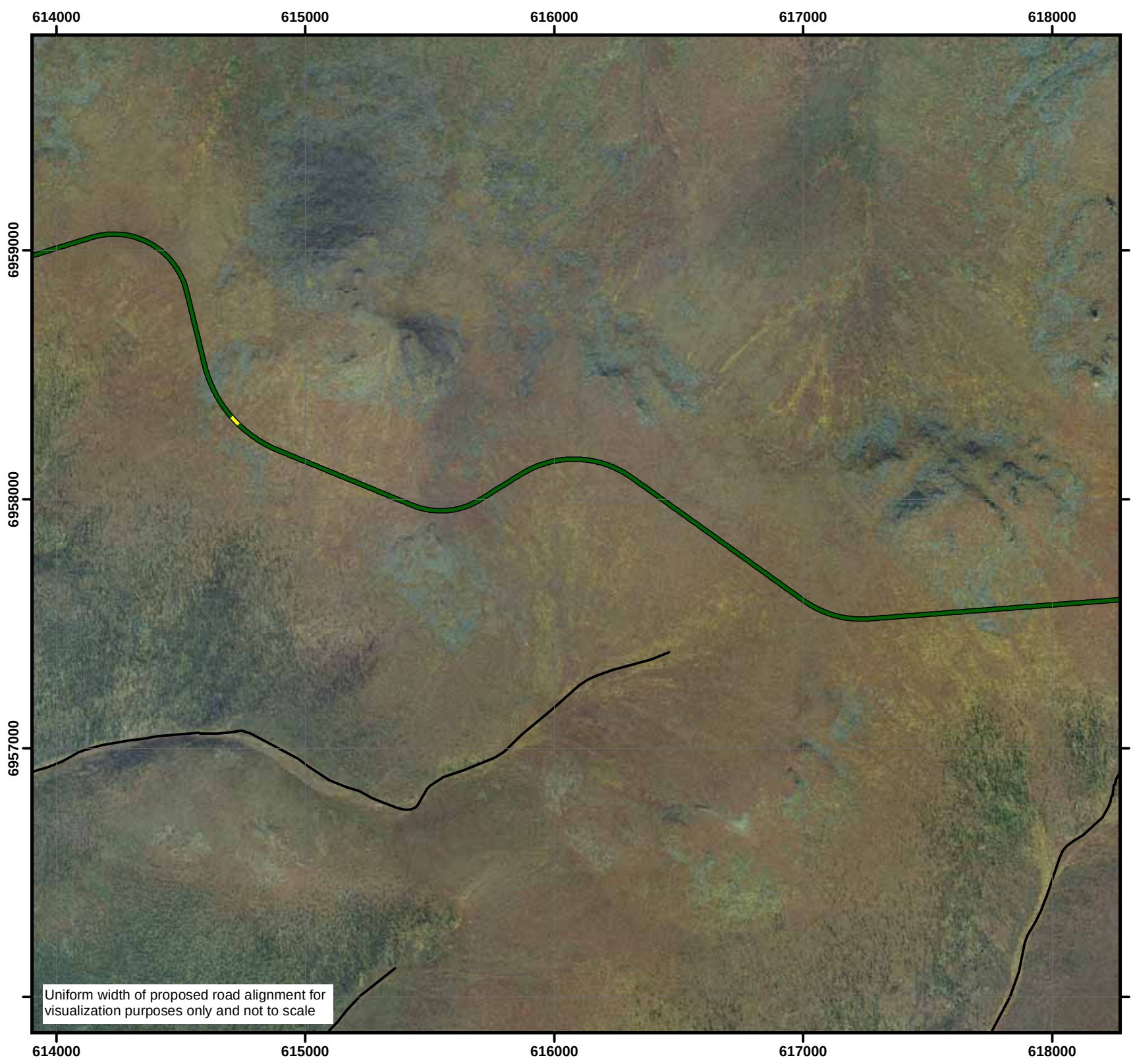
Freegold Road Extension

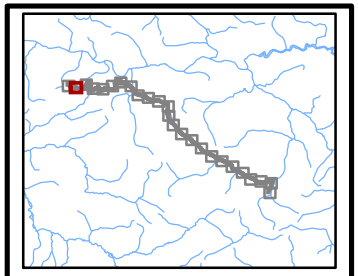
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

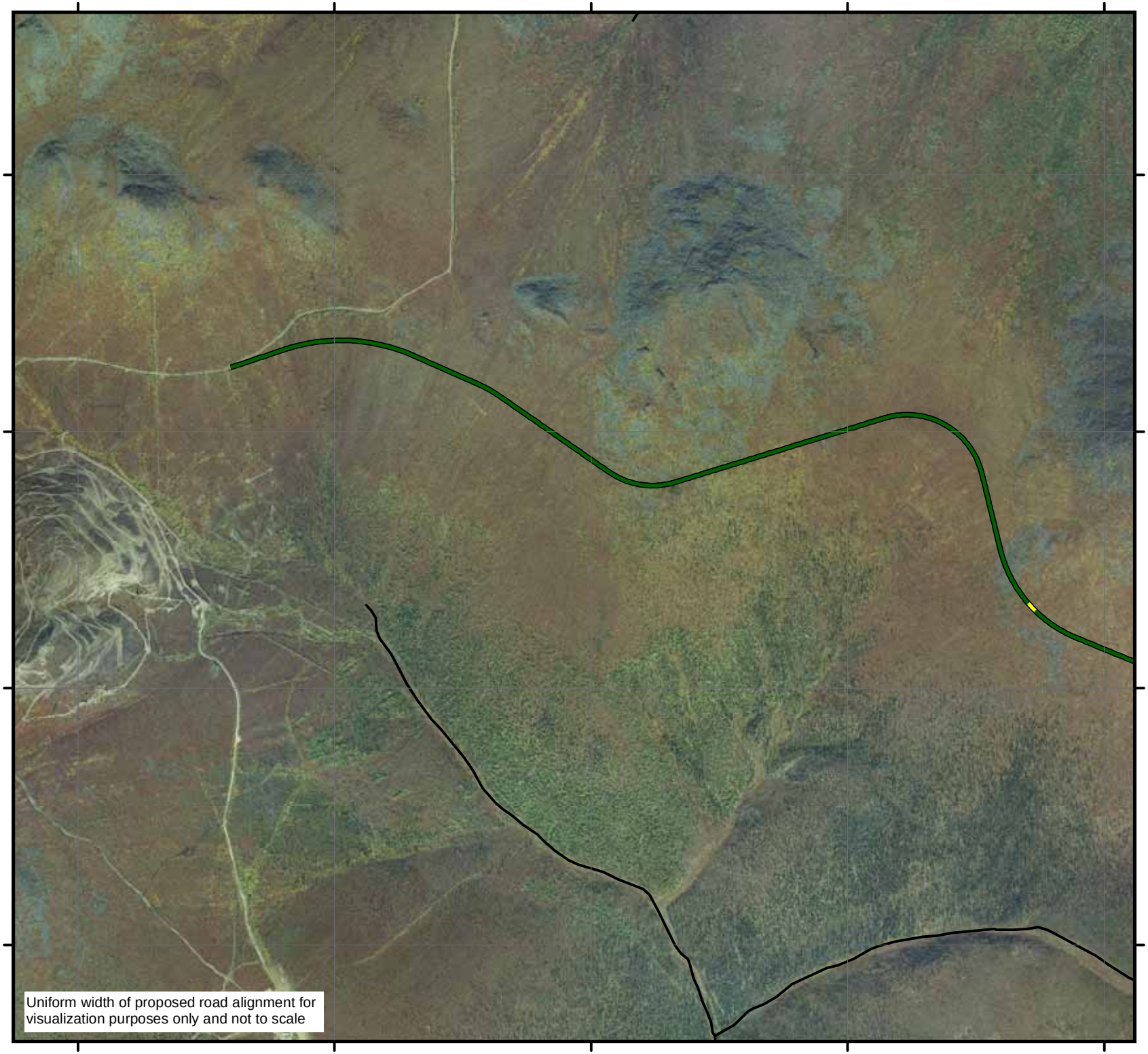
Freegold Road Extension

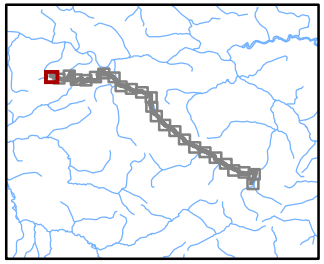
Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.





Legend

Overall Erosion and Sedimentation Risk

- High
- Moderate
- Low
- Fish-bearing (known or inferred)
- Non fish-bearing (known or inferred)
- No direct connection to fish-bearing stream
- Watercourse (Not assessed)
- Non-Permanent Water
- Permanent Water

0 125 250 500 750 m

1:20,000

Grid: UTM Zone 7N

Casino Mining Corporation

Freegold Road Extension

Map 3

Overall Erosion and Sedimentation Risk

CASINO

PALMER ENVIRONMENTAL CONSULTING GROUP INC.

Sheet 25 of 25

A.10.6.5.3 R305

R305. Discussion on the methods of monitoring for erosion and sedimentation during all phases of the Project.

A preliminary Sediment and Erosion Control Management Plan is provided in Appendix A.22C. The objective of the Sediment and Erosion Control Management Plan is to control run-off, minimize erosion on exposed slopes and substrates, and prevent inputs of silt or sediment into watercourses during all phases of the Project. Erosion control measures are those designed to prevent exposed soil particles from becoming detached and transported by water or wind. Sediment is comprised of soil particles resulting from erosion; sedimentation is the deposition of the transported sediment. Best management practices will be the primary tool used to mitigate erosion and sedimentation risks. The Sediment and Erosion Control Management Plan will provide specific details on what types of erosion and sedimentation control measures will be used and where and when they will be applied. It will describe the requirements for inspection, cleaning, repair and ultimately removal of the erosion and sediment control measures.

The final Sediment and Erosion Control Management Plan will describe the measures to be undertaken to manage erosion and sedimentation during all phases of the Project. To achieve these objectives, CMC will:

- Comply with applicable federal and territorial legislation, Project permits, licences and approvals;
- Understand the potential for erosion to occur by identifying all potential erosion and sediment sources prior to undertaking any activities that will disturb ground;
- Adopt a multi-barrier approach for erosion and sedimentation control measures; and
- Inspect and maintain sedimentation control equipment and infrastructure, and remove once work is complete.

The protection of the natural environment and management of environmental risk from erosion and sedimentation in the Yukon is governed by the *Quartz Mining Act*, *Waters Act*, *Lands Act and Territorial Lands Act,* and the *Environment Act*. Additionally, sediment and sediment laden water can be considered a deleterious substance under Section 36 of the federal *Fisheries Act*.

Guidance documents relevant to the topic include:

- Environmental Code of Practice for Metal Mines (Environment Canada 2009);
- Canadian Environmental Quality Guidelines. Canadian Council of Ministers of the Environment (Guidelines for Canadian Drinking Water Quality, Recreational Water Quality, Protection of Aquatic Life, Agricultural Water Uses, as applicable); and
- Best Management Practices for Works Affecting Water in Yukon (Yukon Environment 2011).

Potential adverse effects from erosion and sedimentation can be minimized through project planning, following BMPs, and providing site specific controls that are commensurate with the potential risks to the natural environment. The Plan will provide a detailed description of the methods of sedimentation and erosion prevention and control that will be used, the specific situations that they will be used in, and the implementation procedures that will be followed. The Plan will include details regarding:

- The appropriate location of control measures;
- The timing of installation, inspection and maintenance of control measures; and

- The responsible parties for implementation, operation, modification, inspection and maintenance control measures.

The Sediment and Erosion Control Management Plan provided in Appendix A.22C is a preliminary draft, which will be updated as the project is refined, and has been derived from Plan Requirement Guidance for Quartz Mining Projects (Government of Yukon 2013). The final Plan will provide an overview of the project, described the areas where erosion may be a concern, and provide specific monitoring and management strategies for addressing the areas of concern. The final Plan will include a table of proponent commitments made during the environmental assessment process relevant to erosion and sedimentation management, and indicate how the Plan addresses the commitments. Terms and conditions of any applicable licences, permits and approvals required for the Project operations will also be included, once acquired.

Monitoring of relevant water quality and sediment parameters in any receiving environment is included as a component of the Casino Environmental Monitoring, Surveillance and Reporting Plan. The frequency of erosion and sedimentation control monitoring and receiving environment monitoring will be established following Project permitting in consultation with regulatory agencies.

Monitoring will generally comprise of regular monitoring of key areas identified to be at high risk for erosion or sedimentation and follow up monitoring of installed mitigation measures. Periods of high flows (e.g., during spring melt/freshet periods, or high precipitation events) will also require monitoring of implemented best management practices. Frequent and proper maintenance will allow for prolonged use instead of allowing the measures to be destroyed and in need of full replacement.

Silt fences, sediment traps/basins, ditches, culverts, exfiltration areas, and water management ponds will be visually inspected for the following:

- Excess sediment build-up;
- Structural/physical integrity; and
- Anticipated wear and tear.

Sediment removal and proper disposal shall be conducted as required.

A.10.7 AQUATIC MONITORING PLAN

A.10.7.1.1 R306

R306. Discussion of and rationale for the exclusion of W16 or other downstream locations from monitoring throughout the life of the Project.

As discussed in Section 7 and Section A.7, the water quality modeling conducted by CMC indicates that water quality at station W5 is at or below the water quality objectives. Therefore, monitoring of stations downstream of W5 will not materially affect the understanding of Project effects. However, CMC will comply with the requirements of the Environmental Effects Monitoring Program as detailed in the Metal Mine Effluent Regulations (Environment Canada 2002), which may require monitoring further downstream, depending on the results of initial monitoring studies.

A.10.8 CLARIFICATION

A.10.8.1.1 R307

R307. The information related in Section 7.4.5.1 and 7.4.5.2.

For Section 7.4.5.1, please refer to Section 7.4.1.4.1 Blasting Residues.

For Section 7.4.5.2, please refer to Section 7.4.1.4.2 Dust and Emissions.