

**Date:** November 3, 2016

HCP Ref No.: CZN7932

**From:** John Wilcockson

**To:** David Harpley, Canadian Zinc Corp

**Subject:** **Prairie Creek Mine, all season road undertaking 7 IR replies – PCA IRs**

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This memo responds to PCA IR#2, 3, 8 and 10 from the proposed all season road undertaking 7 information requests.

## PCA #2 – ASSESSMENT OF RIPARIAN HABITAT

**Comment:** During the Technical sessions, there were three other short realignments where small portions the channel of Sundog Creek is On page 3 of a Hatfield Memo, dated September 6th, 2016, the proponent describes how the width of the riparian zone was determined and the criteria used to rank its level of importance (High, Medium, and Low). Tables later in the document contain estimates (m<sup>2</sup>) of the riparian habitat that will be lost for this project both permanently and temporarily. Lastly, the Memo states, on pg. 3, that the proponent believes “the loss of riparian vegetation will result in negligible loss of ecological function” and that the proponent does “not intend to directly offset these losses”. While we appreciated the work presented in the document, Parks Canada disagrees with the proponent regarding the ecological significance and the need to offset or restore impacted riparian habitat. The proponent’s statement regarding the loss of riparian habitat and resulting “negligible loss of ecological function” lacks scientifically based supporting references. The same can be said with regards to how the width and ranking of riparian habitat were determined. In addition, the ranking presented focusses solely on the significance of the riparian habitat for fish and gives no consideration to the other ecological functions it serves. Parks Canada is required to maintain ecological integrity and as such is compelled to consider all of the ecological structures and functions of riparian zones (see Gregory et al., 1991; Naiman and Décamps 1997; Pusey and Arthington 2003).

**Recommendation:** 1) Provide scientific literature which supports the conclusion “the loss of riparian vegetation will result in negligible loss of ecological function”; 2) Provide scientific literature that supports the method used to determine width of riparian zone; 3) Provide scientific literature to support the methodology used for ranking riparian habitat and which considers all of the ecological functions of the habitat; and 4) If the above results in a new riparian habitat categorization or ranking system, recalculate the amount of riparian habitat that will be lost, both temporarily and permanently, in each category/rank.

### Response

#### 1) Support for Our Opinion

It is our opinion that there will be negligible loss of aquatic ecological function. We considered the services that riparian vegetation provides to fish and fish habitat for each location, including: stream bank

stabilization, water regulation, soil retention, nutrient regulation, waste treatment, cover from solar radiation (temperature regulation), cover from predators, nursery functions in flooded areas, refuge during high flows, and food production (Pusey and Arthington 2003, Naiman and Decamps 1997, Hauer et al. 2016).

At crossing locations, throughout the entire all season road, the anticipated loss of riparian vegetation is generally very small compared to the remaining available riparian vegetation in a given watershed, thus we believe that detecting any measureable fisheries-specific effects would be unlikely.

The proposed all season road paralleling Sundog Creek is constrained by both the floodplain and cliffs and/or tallus slopes, thus the road alignment is often positioned within the riparian zone. In Sundog Creek, vegetation generally only becomes dense and mature outside of the anticipated Q100 flood zone. Therefore, it is unlikely that aquatic organisms derive much function from the riparian area.

A potential construction/operation-related risk, related to the loss of riparian vegetation, is erosional processes and subsequent sediment inputs to watercourses at these crossing sites. However, erosion and sediment concerns are anticipated to be mitigated by applying best management practices, thus is considered a low risk issue. The natural scarcity of vegetation and resulting poor soil stability in many Nahanni drainages result in naturally high TSS levels during those seasons that experience snowmelt (during freshet) and/or heavy rainfall events.

The portion of Sundog Creek paralleled by the all season road is approximately 23 km in length. Of this linear distance, approximately half is within the assigned 50 m riparian area (see map in Attachment 2). Approximately 40% of this follows the old winter road alignment, while approximately 60% follows a proposed new alignment. The proposed road runs through habitat that do not appear to be unique in the area; satellite imagery of Sundog Creek indicates six tributaries having a similar appearance to the branch paralleling the all season road. Based on satellite imagery, the riparian zone downstream of the road alignment, becomes denser and the gradient lower (as per Google Earth). These observations suggest more diverse habitat opportunities to fish downstream of the all season road. We feel it is highly unlikely that the removal of vegetation from the road prism will have any measureable impact on the aquatic ecology of Sundog Creek.

## **2) Determining Riparian Zones and Buffer Widths**

In the absence of a formal riparian protection statute specific to the Northwest Territories, Hatfield used a riparian area framework that adopts criteria from: the British Columbia Provincial Forest Planning and Practices Regulation of BC (FPPR), the Land Development Guidelines for the Protection of Aquatic Habitat (DFO 1993), as well as the riparian function in the context of fish and fish habitat. Under these regulations and guidelines the most conservative riparian management zone width (i.e., largest) of 50 m was selected for Sundog Creek, Poljie Creek, Tetcela River and the Liard River. Under the regulations, the 50m zone was intended to be applied to watercourses supporting fish, and having a channel width >20 m and a flood plain >100 m. Other documentation that supports the method used to determine the width of riparian buffers includes Northern Land Use Guidelines Northern Territories Seismic Operations (AANDC 1998) and Operational Statement for the Maintenance of Riparian Vegetation in Existing Right-of-Ways (DFO 2007).

### 3) Ranking Riparian Habitat

Use of a modest habitat ranking system (e.g., low, moderate and high) is a commonly used method to categorize potential effects of a Project on various habitats types; however, ranking systems are often dependent on the specific habitat type (e.g., riparian, wetland forest etc.), species presence, and objectives of the Project (Sloan and Lacroix 2011; Rossi and Kuitunen 1996; DFO 2006). For the purpose of this reply, riparian habitat was ranked with respect to how it contributes to the overall value and productivity of fish habitat.

In Attachment 1, we provide some examples of how riparian vegetation was ranked. Locations were chosen based on availability of field photos that could be matched to attributes on ortho photographs. We feel that our ranking of riparian zones along the all season road is reasonable given the reasons provide above.

### 4) Argument for a New Ranking System

Our opinion is that our existing ranking system is adequate for the reasons provided above.

## PCA #3 – RIPARIAN HABITAT

**Comment:** On pages 1 and 2 of a Hatfield Memo, dated September 6th 2016, the proponent describes three categories (A-C) of aquatic habitat and the criteria used to rank the importance of its ecological function with respect to fish. Tables in the back of the document contain estimates (m<sup>2</sup>) of aquatic habitat in each category that will be impacted by this project and their rank. Parks Canada recognizes this work, but requires additional information to properly determine the potential impacts on aquatic habitat from this project. The categories and ranks provided in this Memo lack scientifically based references to justify their use. In addition, the ranking presented focusses solely on the significance of the aquatic habitat for fish and gives no consideration to the other ecological functions it serves. Parks Canada is required to maintain ecological integrity and as such is compelled to consider all of the ecological structures and functions this habitat provides. Also, in IR Round 2 PCA#10, Parks Canada requests that the impacts to the floodplain be assessed using Q20 flow projections and would ask that fish habitat be evaluated using the same flow projection.

**Recommendation:** 1) Provide scientific literature which supports how the categories were applied to the riparian habitat; 2) Provide scientific literature which supports the ranking of riparian habitat that considers all the ecological functions it provides; and 3) Recalculate the amount of fish habitat that will be lost, both temporarily and permanently, for each category and rank using the Q20 flow projections (See IR Round 2 PCA#10).

**Response:** The comment associated with this IR (above) focuses on aquatic habitat. There also appears to be overlap with PCA IR#2, regarding the classification and ranking of riparian habitat. Therefore, we have assumed that the purpose of this IR is aquatic habitat.

### 3-1 and 3-2

Our habitat categorization and ranking scheme was created to address the uniqueness of the Sundog Creek system adjacent to the road, both in terms of physical habitat, as well as the aquatic biota inhabiting

the system. Flow (and water level) and habitat to Arctic grayling are our primary determinants for reasons discussed below.

The habitat ranking framework was decided first, the classification framework (i.e., A, B, C) was created as a convenient means to group habitat with a similar level of aquatic function.

Our habitat ranking approach primarily considered value to Arctic grayling. Our rationale for this approach is that i) grayling are the only principal game fish in the system ii) habitat critical to Arctic grayling is more limiting than for the other fish species in the system (primarily slimy sculpin), and iii) Arctic grayling, being an insectivore species, are similar to slimy sculpin in that they are both dependent upon lower trophic assemblages for food. Fish habitat in Sundog Creek appears to be more limiting for grayling than sculpin; thus evaluating the potential temporary and permanent aquatic effects to Arctic grayling should also address any potential effects to slimy sculpin.

Arctic grayling life history information was compiled from scientific literature (e.g., Larocque et al 2014 and Hubert et al 1985). Life-history information suggests that Sundog Creek in the areas of proposed road encroachments and proposed channel relocation is likely used primarily as migration habitat. The habitat offering these services is not limiting in Sundog Creek in the area of consideration. Nor is the type of habitat needed for benthic invertebrate assemblages or slimy sculpin. Please refer to Hatfield memo, April 22, 2016, section 3 for a discussion of slimy sculpin habitat requirements, and Hatfield memo, September 6, 2016 for a description of aquatic habitat features. The types of aquatic habitat that are currently limiting in Sundog Creek adjacent to the all season road, for Arctic grayling, are overwinter habitat, and rearing habitat for the juvenile life stage. Boulders capable of creating back eddies during higher flows are also not common and may provide refuge for migrating fish). Deep pools suitable for overwintering are absent from the area of interest. However, side channels and back eddies (behind instream boulders) are present, and in some cases will be lost during the construction by the proposed all season road. Since these fish habitat features are uncommon and possibly important to Arctic grayling, our ranking approach has scored reaches of Sundog Creek containing these habitat features as “high”. Other habitat, used by Arctic grayling, but not uncommon, such as shallow run or riffle morphology in the thalweg or braids, were assigned a “moderate” habitat rating.

The criteria used to generate our aquatic habitat categories (i.e., A, B, C) were based primarily on the periodicity of inundation, since the duration of inundation as well as time of year when inundation occurs will determine the extent to which aquatic life likely utilize a given area. This approach also acknowledges the uniqueness of the Sundog Creek system, which generally has low flows, but can experience short periods of intense flows. Based on our observations of Sundog Creek and other similar drainages in the local area, as well as hydrographs the Prairie Creek drainage to the west, higher flows are associated with freshet as well as periods of intense precipitation.

A key factor we considered was the value of flooding to the aquatic ecosystem of upper Sundog Creek. Flooding here does not appear to be as beneficial as would be expected in other stream systems (Brown 2002; Zeug 2007). Due to the gradient, there are no ephemeral wetlands and associated benefits to fish. Furthermore, there is limited interaction with riparian vegetation since the stream-side vegetation tends to small and distant from the active channel. Stream-side vegetation is often sandwiched between the unstable alluvial flood plain of Sundog Creek and unstable talus slopes. Periodic high flows will typically scour away vegetation and recovery is believed to be slow based on field observations, and due to low nutrients, unsuitably coarse growing substrates, harsh climatic conditions and short growing seasons. The

recovery of the former winter road (>30 year old) stands testament to the slow recovery of plant assemblages in Sundog Creek.

Flooding may increase access to new habitat that could be used for rearing; however this habitat would be short lived and the short period of inundation would limit autochthonous production, as well as colonization by benthic invertebrates<sup>1</sup>. The primary benefit of the flooded areas is anticipated to be the provision of refuge from high flows, possible refuge from suspended sediments and access of adult Arctic grayling to side channels and tributaries where they are most likely to spawn.

The 1:2 year return period was selected for HWM, based on DFO operational statements (DFO 2007). Ephemeral aquatic habitat above the 1:2 year return period has still been captured, and loss quantified. We chose the upper limit of ephemeral aquatic habitat as the 1:100 year return level, omitting areas that have established vegetation (that is vegetation visible from ortho photographs of Sundog Creek). This is likely similar to the 1:20 year return level. We feel that this approach is conservative since we have not omitted any habitat that fish may use; or that provides any meaningful benefit to other aquatic organisms.

### 3-3

As discussed above, it is our opinion that the approach developed and applied is an appropriate way of identifying aquatic habitat of value as well as temporary and permanent alterations. We have assumed the 1:2 year flood level as an indicator of HWM, as per DFO operational statements (DFO 2007). In Sundog Creek, adjacent to the all season road, habitat between the 1:2 and 1:20-year flood levels is not considered to be high value fish habitat, and therefore offsetting should not be required. Therefore, we see no value in modelling the 1:20 year flood level.

We have calculated the area of the existing aquatic habitat downstream of the proposed diversion berm that will be altered as a result of diversion. Similar to portions of Sundog Creek within the road prism, the current channel was divided into categories A, B and C. In addition, at the suggestion of DFO (conference call on October 20, 2016), we have calculated the area of a smaller altered area, for an alternative option where flows return to the current channel at km 36.5 instead of at km 37. Area calculations were done using GIS and divided into the following categories: normally wetted main channel, normally wetted side channels, 1:2 flood level and 1:100 flood level minus mature vegetation. The calculated areas are provided in Table 1 and the maps used for the calculations are provided in Attachment 3.

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<sup>1</sup> The only possible exception is increased access to small side channels which may provide habitat to benthic invertebrates but were inaccessible to fish due to low water levels. However, we consider side channels as having high ecological value.

**Table 1** Estimates of the aquatic habitat altered in the existing Sundog Creek channel after diversion

a) Raw data from maps in Attachment 3.

	Area (m <sup>2</sup> )	
	Diversion (as proposed)	Alternate diversion (early return)
Normally wetted main channel	21,312	14,566
Normally wetted side channels	3,214	3,214
1:2 year flood level	45,556	27,131
1:100 year flood level minus areas having mature vegetation	68,346	38,440
1:100 year flood level	73,097	41,027

Areas include sub-areas (e.g., 1:100 year flood area includes 1:2 flood area and wetted channel areas)

b) Areas of habitat classes (as per offsetting tables).

Aquatic habitat classification	Area (m <sup>2</sup> )	
	Diversion (as proposed)	Alternate diversion (early return)
A	24,526	17,780
B	21,030	9,351
C	22,790	11,309

A = normally wetted channels; B= area within 1:2 but not including normally wetted channels; C= area within 1:100, but not including areas of mature vegetation, 1:2 or normally wetted channels.

## PCA #8 – SHORT TERM FISH HABITAT LOSS-SUNDOG CREEK

**Comment:** In Parks Canada's original IR 25 we indicated that the realignments of the river channel from existing stream channels to new areas within floodplain that were recently dry will result in short term losses in the quality of fish habitats. We outlined that these reductions in habitat quality for fish arise primarily from two factors. Firstly, lower habitat quality as new stream channels initially support lower abundances of benthic macroinvertebrates that serve as important food sources for fish. Secondly, areas of the floodplain that receive new flow will be more physically unstable for a period of time until the stream channel stabilizes. Taken together, reduced food availability for fish and unstable stream channels will likely persist for up to three years as the stream channels are colonized by benthic macroinvertebrates from upstream non-disturbed areas and as the channel stabilizes and more closely approximates upstream, non-disturbed areas that have received water for extended periods. In the response to IR 25, CanZinc indicates the following "Given that this stretch was (and continues to be) naturally depopulated from periods of bedload movement and periods where the channel is completely dry, it is expected to provide poor benthic invertebrate habitat relative to areas of Sundog Creek upstream of the stretch under consideration.

Therefore, the relative impact on the creek from diverting the creek in this stretch compared to other stretches will be smaller." CanZinc concludes that a poor macroinvertebrate community similar to that described for the existing alignment would be established within one season. PCA continues to hold the opinion that the realignment of a section of Sundog Creek will affect benthic macroinvertebrates. Macroinvertebrate communities are complex structures. The variation of flow in the current channel may actually provide a diverse habitat with greater variability and possibly higher densities of benthic macroinvertebrates. The assertion that recolonization will match the current state of the existing channel within one season is unsubstantiated as there has been no data collected to describe the structure and abundance of the existing macroinvertebrate community. Benthic macroinvertebrates, such as insects, worms and crustaceans, which live on the bottom of streams and rivers are an important food for many northern stream fish species. Benthic macroinvertebrates are with certainty an important food source for fish species in the Sundog Creek drainage. Rerouting and training of the stream channel in Sundog Creek will result in flow being moved from an area that may support natural and high densities of benthic macroinvertebrates to an area(s) of the stream where macroinvertebrates are less abundant. Lower abundances of benthic macroinvertebrates communities in areas that have recently received flow will reduce the quality of habitat for fish in Sundog Creek until the stream channel is able to fully colonize. Many peer-reviewed scientific studies have quantified the rate at which recently created reaches of stream are colonized by benthic macroinvertebrates. A prominent review was completed by Mackay in 1988. The full reference is Mackay, R.J. 1988. Colonization of lotic macroinvertebrates: a review of processes and patterns, Canadian Journal of Fisheries and Aquatic Sciences, 49: 617-628. Colonization of benthic macroinvertebrates in new reaches of streams is highly variable and can take from months to years.

**Recommendation:** 1) Provide a qualitative and quantitative description of the existing macroinvertebrate community for the existing and realignment sections of Sundog Creek; 2) Ensure that fish habitat compensation plans take into account the short term reduction in the quality of fish habitat due to low densities of benthic macroinvertebrates; and 3) Commit to monitoring the difference in benthic macroinvertebrate communities in the realigned channel for a minimum of three years following the realignment. The design could comprise 2 sites upstream of the alignment, 2 sites in the realigned stream channel and 2 sites located downstream of the realignment. The existing reference condition approach model for stream in the South Nahanni Watershed could be used to assess similarity in the structure of the benthic macroinvertebrate communities. Results from this monitoring program will then be used to support an adaptive management plan.

**Response:** Hatfield maintains the belief that the benthic invertebrate assemblages should return to similar species diversity and densities within a short timeframe post-diversion. In our IR2 reply to MVEIRB IR#7 we provide our arguments and cite the work by Fowler 2004, Stanley et al 1994 and Casselman et al. 2016. Our opinion is based partially on the fact that there will be downstream drift of benthic invertebrates, which will colonize the new channel. Even under the low water conditions of July 2014, there was flowing water further upstream. We did account for a temporary decrease in benthic invertebrate biomass in our offsetting table, and therefore already consider this temporary loss. CZN may consider conducting a study to assess potential effects on benthic invertebrate assemblages in Sundog Creek, with the study counting towards offset of potential losses.

## PCA #10 – FOOTPRINT OF ROAD IN FLOODPLAIN

**Comment:** In an Allnorth Report dated Aug. 17th, 2016, the portions of the road that would occupy different components of the floodplain were identified using the Q2 and Q100 HWM flow projections provided by Tetra Tech EBA. Parks Canada also notes that in a Hatfield Memo dated Sept. 6th, 2016, estimates of the amount of aquatic habitat that would be impacted by the proposed all season road were performed using the Q2 HWM flow projections. As stated during the initial round of Information Requests, because of the ecological significance of the floodplains in these systems (see Bornette et al. 1998; Naiman and Décamps 1997; Hauer et al. 2016) Parks Canada is interested quantifying the road footprint in the floodplain to understand impacts to all components of the floodplain (biotic and abiotic). Parks Canada recognizes that the proponent has provided data regarding the road footprint at different flow projections, but that these are two ends of the spectrum. An estimate based on Q20 HWM flow projection would provide more suitable information to assess the environmental impacts of the project

**Recommendation:** Calculated footprint of proposed road in the active floodplain (in m<sup>2</sup>) using Q 20 HWM flow projections.

**Response:** As noted in our reply to IR#3, habitat between 1:2 and 1:20 in Sundog Creek is not considered to be high quality fish habitat, and is not an important factor in terms of habitat offset. Therefore, we see no value in modelling the 1:20 year flood level. However, the Q100 area, minus established vegetation (visible in ortho photographs), is thought to be a good surrogate for Q20. The slope of the right bank of Sundog Creek is typically steep. As a result, the area of the road prism that would be covered by the Q100 is only about 45% more than the Q2. Subtracting areas of mature vegetation, the additional area is only 32% more than the Q2. Therefore, we do not agree that our estimates are at “two ends of the spectrum”. Further, a more accurate estimate of Q20 is unwarranted given the small area of road encroachment on the alluvial floodplain, and the marginal value to fish and fish habitat.

In addition, the difference between the Q20 and Q100 for the existing channel (i.e., the alteration) of the diversion is considered to be inconsequential given that critical processes occurring in the hyporehic zone in the floodplain, as a whole, should not be influenced by the diversion. With respect to the ecological benefits of flooding, we have not observed ephemeral wetlands proximal to Sundog, and established plant material is small and generally only found outside of the 1:100. Therefore, in our opinion, the ecological benefits of flooding to Sundog Creek adjacent to the all season road are minimal.

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**Attachment 1**

**Examples of Riparian Ranking**

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## A1.0 RIPARIAN AREA RANKING – EXAMPLES

The following is a description of assessed riparian area losses, as presented in the Offsetting table that was distributed on September 6, 2016.

For the tributary at Km 25.3, we assigned a proportion riparian coverage of 50% based on the ortho photo (Figure 1), and a riparian area of 30m on either side of the tributary. We classified the riparian area habitat as having low value, since the vegetation is small and set back from a deeply incised creek. In addition, this tributary is inferred to be non-fish-bearing due to its channel morphology and steep stream gradient (i.e., presence of a very steep incised rock chute).

**Figure 1** Tributary to Sundog Creek, crossing at Km 25.3 – ortho photo showing road (red) and 50 m riparian area (green).

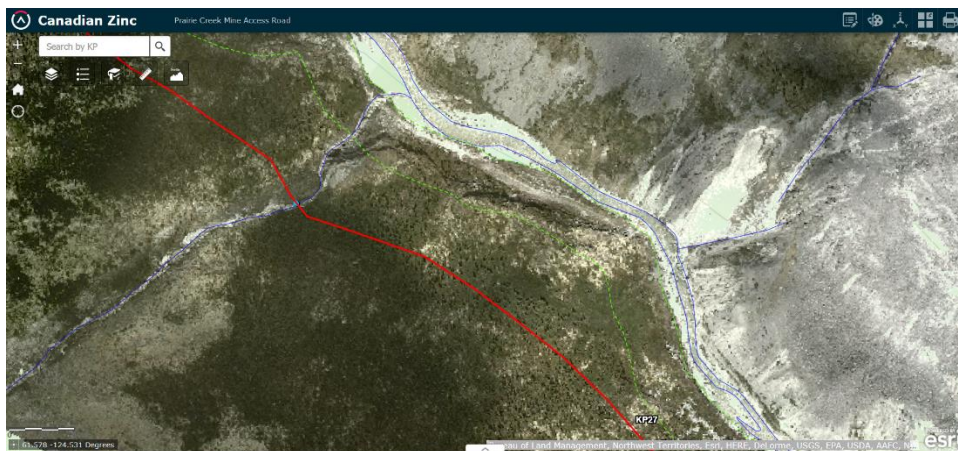


**Figure 2 Tributary to Sundog Creek, crossing at Km 25.3 – oblique air-photo showing approximate crossing location and riparian vegetation.**



For the tributary at Km 26.7, we assigned a proportion riparian coverage of 70% based on the ortho photo (Figure 3), and a riparian area of 30m on either side of the tributary. We classified the riparian habitat as having low value, since the tributary at the crossing is inferred to be non-fish-bearing due to the presence of a downstream waterfall and an absence of upstream overwinter habitat.

**Figure 3 Tributary to Sundog Creek, crossing at Km 26.6 – ortho photo showing road (red) and 50 m riparian area (green).**

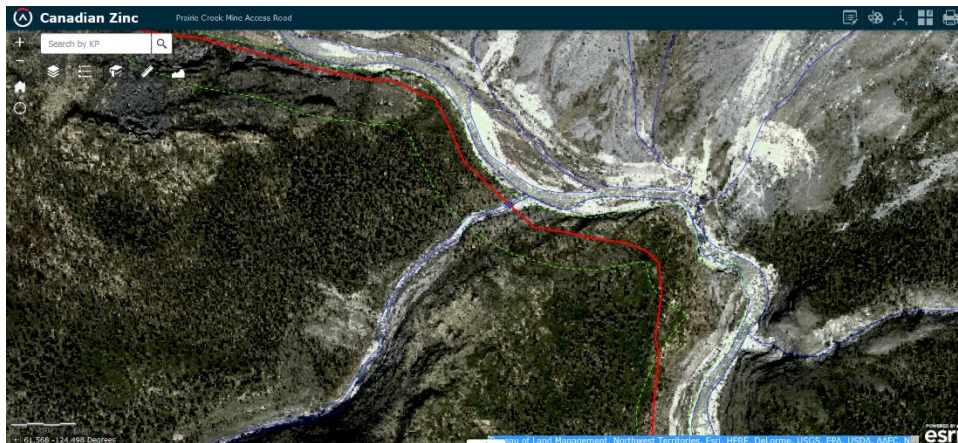


**Figure 4** Tributary to Sundog Creek, crossing at Km 26.7 – oblique air-photo showing approximate crossing location and riparian vegetation.



For the tributary at Km 28.7, we assigned a proportion riparian coverage of 60%, based on the ortho photo (Figure 5), and a riparian area of 30 m on either side of the tributary. We classified the riparian habitat as having moderate value, since there are mature conifer forests on both sides (late successional stage for the area). There are also shrubs overhanging the stream providing some cover. In addition, Arctic grayling and sculpin are believed to inhabit adjacent Sundog Creek (for some life history stages) and could also utilize this tributary.

**Figure 5** Tributary to Sundog Creek, crossing at Km 28.7 – ortho photo showing road (red) and 50 m riparian area (green).



**Figure 6 Tributary to Sundog Creek, crossing at Km 28.7 – oblique air-photo showing approximate crossing location and riparian vegetation.**



The all season road at km 31.7 parallels Sundog Creek and will use the historical winter road alignment, which is still clearly visible. It is within the 50 m riparian area (following our approach, based on BC forest practices, a larger area is created around larger streams). The riparian vegetation in this area consists of early successional stage plants. Thus, despite the likely presence of fish at this site, the riparian habitat provides limited fish and fish habitat benefits to Sundog Creek. We assumed 60% riparian coverage, based on the orthophoto (Figure 7), in this area and assigned this section a low riparian value. The 60% coverage is likely an over estimation because the vegetation on and adjacent to the road appears negligible in Figure 8. Approximately 2.5m of additional riparian vegetation will need to be removed on either side of the existing winter right of way.

**Figure 7 Sundog Creek at Km 31.7 – ortho photo showing road (red) and 50 m riparian area (green).**



**Figure 8 Sundog Creek at Km 31.7 – oblique air-photo showing location of proposed road, using historical right of way.**



The all season road at km 34.7 parallels Sundog Creek through undisturbed riparian vegetation. It is also within the assigned 50 m riparian area (following our approach, based on BC forest practices, a larger area is created around larger streams), but is set back almost 100 m from the current wetted channel, and approximately 30m from the flood plain. The vegetation in this area consists of mature conifers; We assumed 80% riparian coverage in this area, based on the orthophoto (Figure 9). Due to the distance of

the riparian area from the active channel and infrequent wetting of the riparian margin, we have assigned this section a low riparian value.

**Figure 9 Sundog Creek at Km 34.7 – ortho photo showing road (red) and 50 m riparian area (green).**



**Figure 10 Sundog Creek at Km 34.7 – oblique air-photo showing location of proposed road.**



The all season road between 35.3 and 35.5 parallels Sundog Creek through undisturbed riparian vegetation. It is aligned within the designated 50 m riparian area, and is set back between 0 and 20 m from the flood channel. The vegetation in this area consists of a mix of mature conifers and shrubs. The riparian vegetation provides the greatest benefit to aquatic resources downstream of a large boulder demarked with a white

arrow. For 90 m, a side channel hugs the right bank, and shrubs and trees will provide some shading of the side channel. There is also a higher probability of organic material input into the side channel, which is also likely fish bearing. We assumed 100% riparian coverage in this area, based on the ortho photo (Figure 11). The portion adjacent to the side channel would provide moderate value, but generally, the value to fish and fish habitat in this area is low due to the distance of the riparian area to frequently wetted channels.

**Figure 11 Sundog Creek at Km 35.3 – ortho photo showing road (red) and 50 m riparian area (green).**

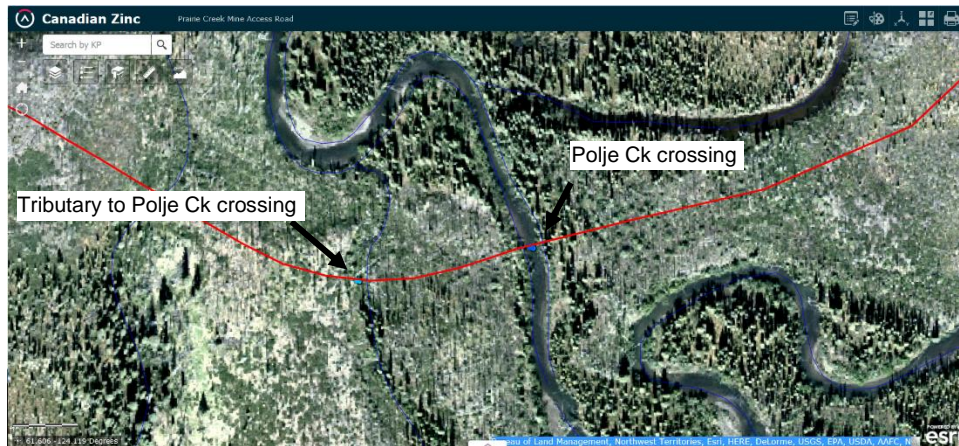


**Figure 12 Sundog Creek at Km 35.3 – oblique air-photo showing of a large boulder next to proposed road.**



The crossing of Polje Creek (km 54.5) and a tributary of Polje Creek (km 53.55), will result in the removal of some second growth riparian (old burn) habitat consisting of trees and shrubs. The riparian habitat here provides cover for fish (solar as well as protection from predators), often consisting of woody debris, overhanging banks and overhanging vegetation. The riparian vegetation will also contribute local inputs (e.g., nutrients as well as terrestrial insects). For both, we assumed that there is 100% coverage of vegetation in the riparian area at the crossing, based on the ortho photo (Figure 11). Due to the presumed fish presence and mature riparian quality at the site, we gave the tributary riparian area a high value rating, while the Polje Creek riparian area a medium to high value. The Polje Creek riparian habitat was rated at lower value relative to the tributary riparian, due to the lesser coverage of overhanging vegetation and woody debris.

**Figure 13 Tributary to Polje Creek and Polje Creek crossings at km 53.5 and 53.55 respectively – red line is the all season road.**



**Figure 14 Tributary to Polje Creek at km 53.5.**



**Figure 15 Polje Creek at crossing location, km 53.55.**



The crossing of Tetcela River (km 89.7) and a tributary of Tetcela River (km 87.4), will result in the removal of some mature riparian habitat consisting of trees and shrubs. The riparian habitat here provides cover for fish (solar as well as protection from predators), often consisting of woody debris and overhanging vegetation. The riparian vegetation will also contribute local inputs (e.g., nutrients as well as terrestrial insects). For both, we assumed that there is 100% coverage of vegetation in the riparian area at the crossing, based on the ortho photo (Figure 16 & Figure 18). Due to the presumed fish presence and mature riparian quality that the riparian area provides to the aquatic environment here, we gave both the Tetcela River and Tetcela tributary riparian areas a medium importance.

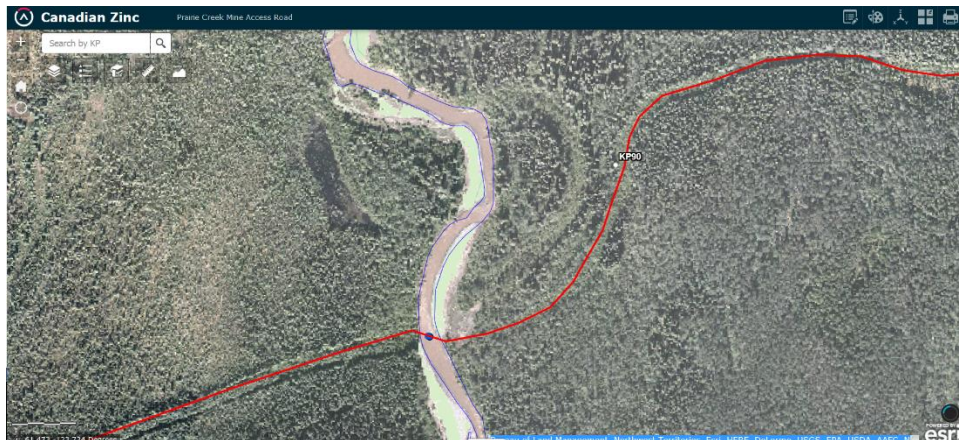
**Figure 16 Tetcela Tributary, proposed crossing location, km 87.4. – red line is the all season road.**



Figure 17 Tributary to Tetcela River at crossing location, km 87.4.



Figure 18 Tetcela River, proposed crossing location, km 89.7. – red line is the all season road.



**Figure 19 Tetcela River at crossing location, km 89.7.**



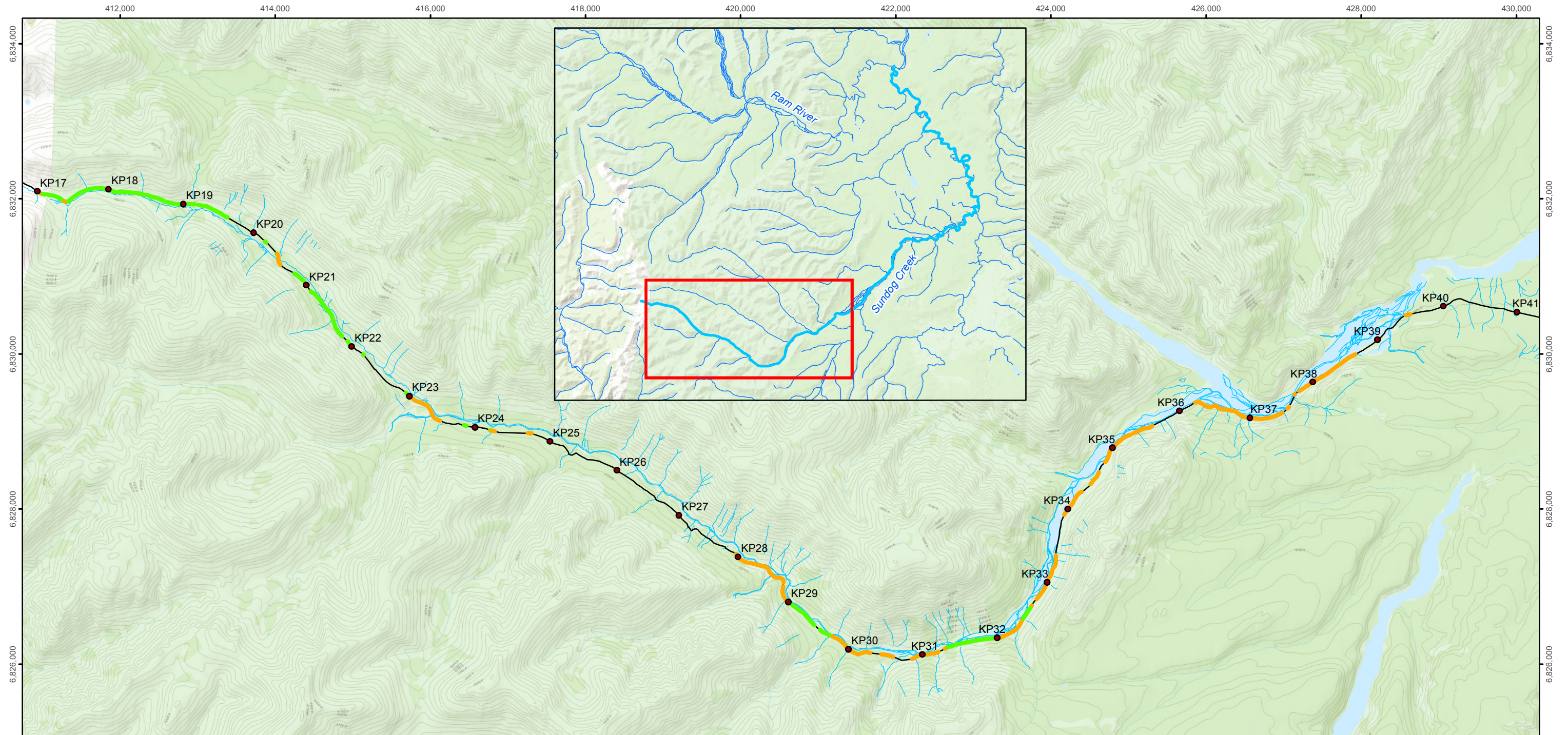
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**Attachment 2**

**Sundog Creek – Map Showing  
Riparian Zone Intersected by All-  
Season Road**

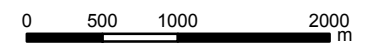
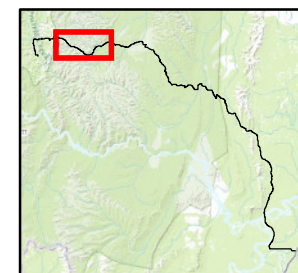
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**Attachment 2 Sections of the proposed all season road alignment within the Sundog Creek Riparian Area.**



**Legend**

- KP (Kilometre Point; distance from mine using all season road plan 161026)
- All season road within riparian area, but following historical winter road (4.97 km)
- All season road within riparian area, new alignment (7.47 km)
- All season road outside riparian area, either > 50 m from edge of flood zone or within flood zone (24 km)
- Water Features



Scale: 1:50,000  
 Projection: NAD 1983 UTM Zone 10N  
 Data Sources:  
 ESRI World Topographic Map  
 All North

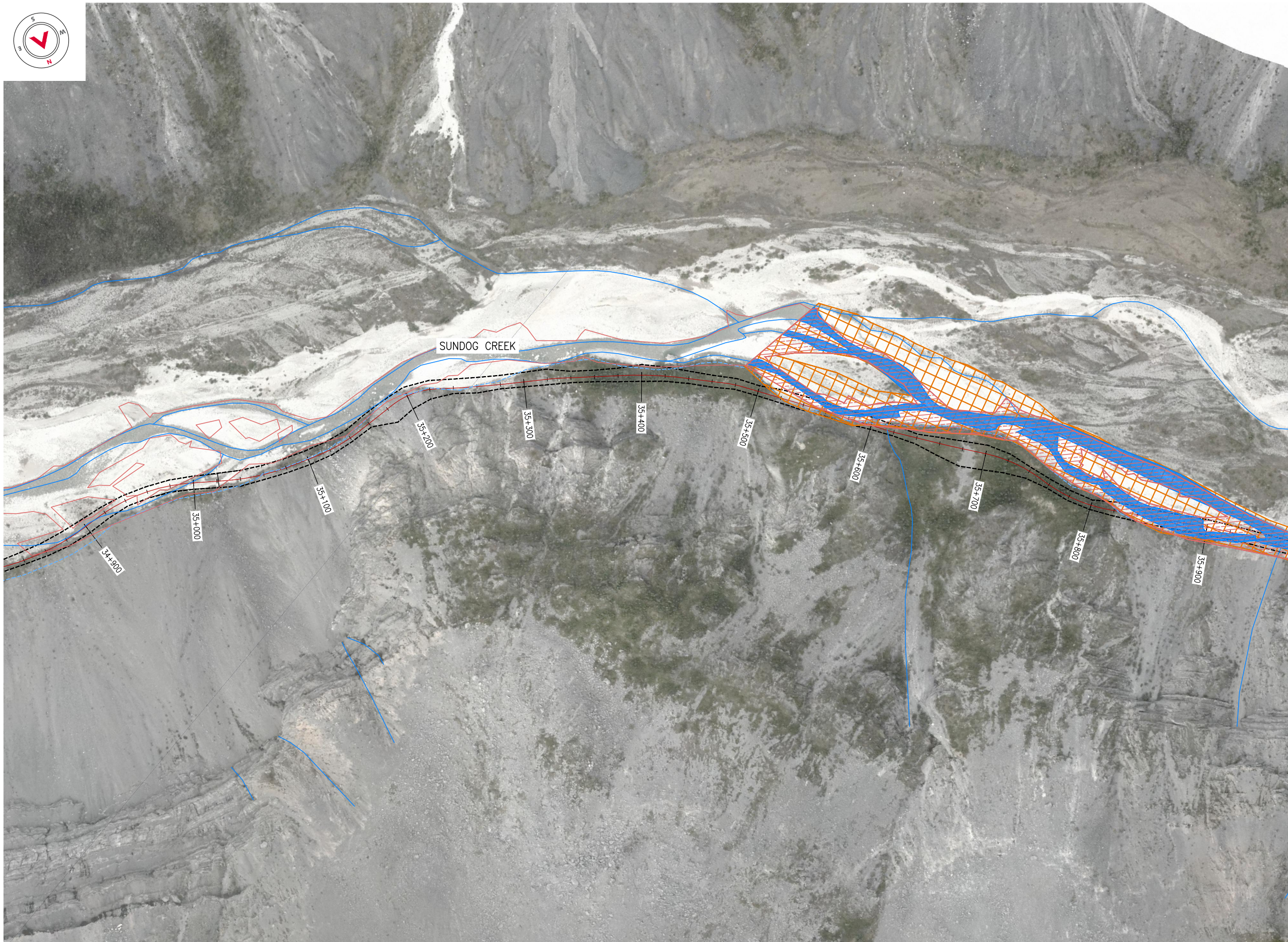


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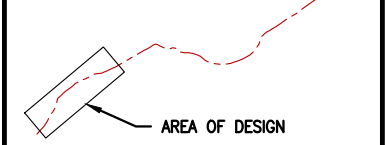
**Attachment 3**

**Sundog Creek – Maps showing areas  
altered after diversion**

---



**KEY PLAN**



**LEGEND**

- 8+000 PROPOSED DESIGN CL
- PROPOSED CUT/FILL LINES
- WATERCOURSES
- SUNDOG Q2 HEC-RAS
- SUNDOG Q100 OPTION #1
- SUNDOG Q100 OPTION #2
- WETTED CHANNELS

MAIN CHANNEL AREA  
OPTION#1 = 21312.26m<sup>2</sup>

SIDE CHANNEL AREAS  
OPTION#1 = 3213.68m<sup>2</sup>

SUNDOG Q2 HED-RAS AREA  
OPTION#1 = 45555.82m<sup>2</sup>

SUNDOG Q100 AREA  
OPTION#1 = 73096.56m<sup>2</sup>

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2	2016/11/03	GENERAL REVISIONS	TMM	WBM
1	2016/11/02	GENERAL REVISIONS	TMM	WBM
0	2016/11/01	ISSUED FOR REVIEW	TMM	WBM

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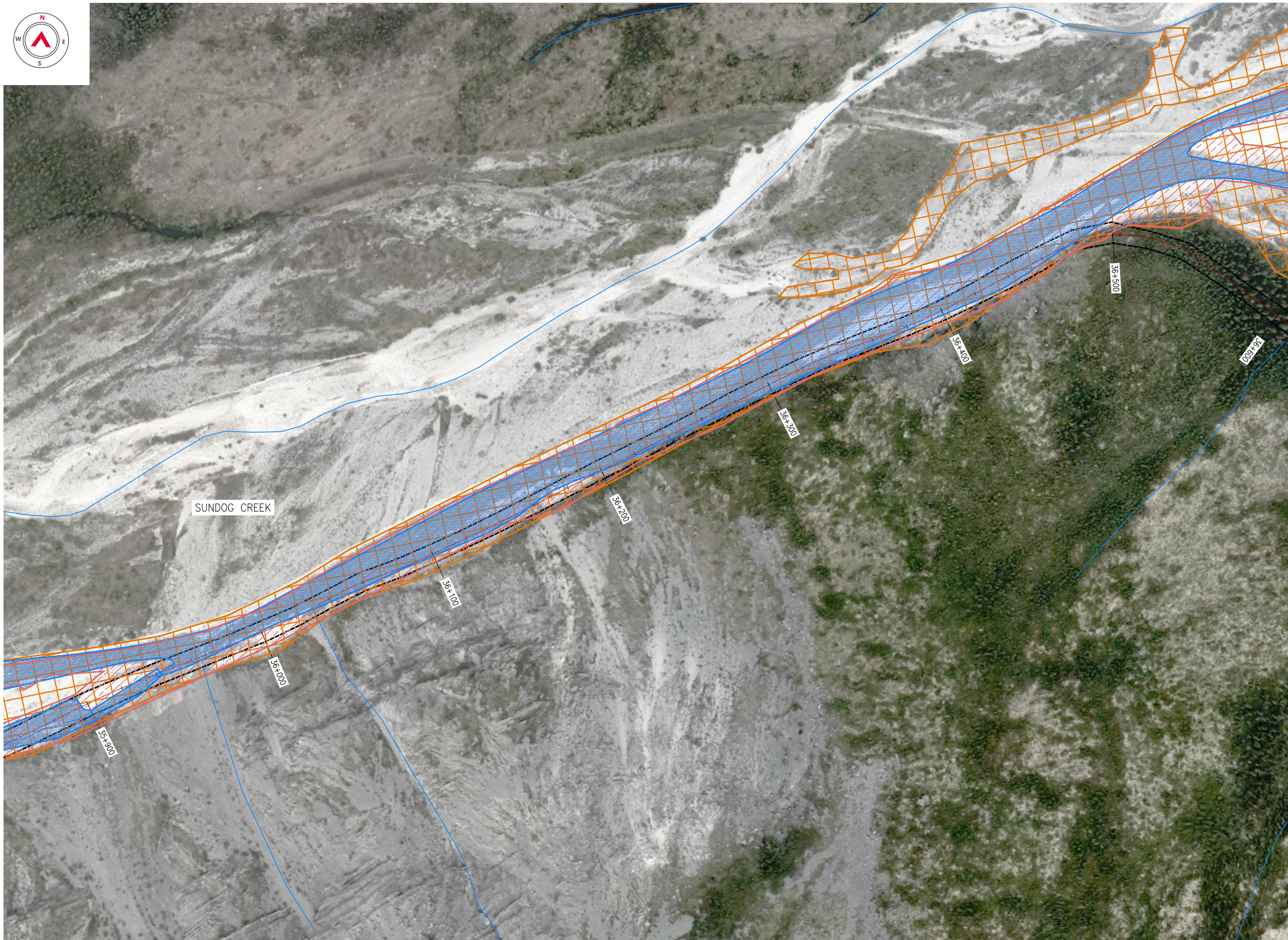


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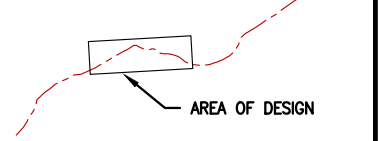
**SUNDOG CREEK  
FLOODPLAIN ANALYSIS  
OPTION #1**

TITLE:  
**PLAN VIEW WITH  
AREA CALCULATIONS  
km 34+800 to km 35+800**

DWG NO:	16GP0041-325-1920-005	REV:	2
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**KEY PLAN**



**LEGEND**

- PROPOSED DESIGN CL
- PROPOSED CUT/FILL LINES
- WATERCOURSES
- SUNDOG Q2 HED-RAS
- SUNDOG Q100 OPTION #1
- SUNDOG Q100 OPTION #2
- WETTED CHANNELS

**MAIN CHANNEL AREA**  
 OPTION#1 = 21312.26m<sup>2</sup>  
**SIDE CHANNEL AREAS**  
 OPTION#1 = 3213.68m<sup>2</sup>  
**SUNDOG Q2 HED-RAS AREA**  
 OPTION#1 = 45555.82m<sup>2</sup>  
**SUNDOG Q100 AREA**  
 OPTION#1 = 73096.56m<sup>2</sup>

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0	2016/11/01	ISSUED FOR REVIEW	TMM	WBM

CLIENT:



CLIENT NO:	DRWN: TMM	DATE: 16/11/01
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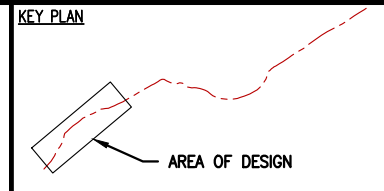
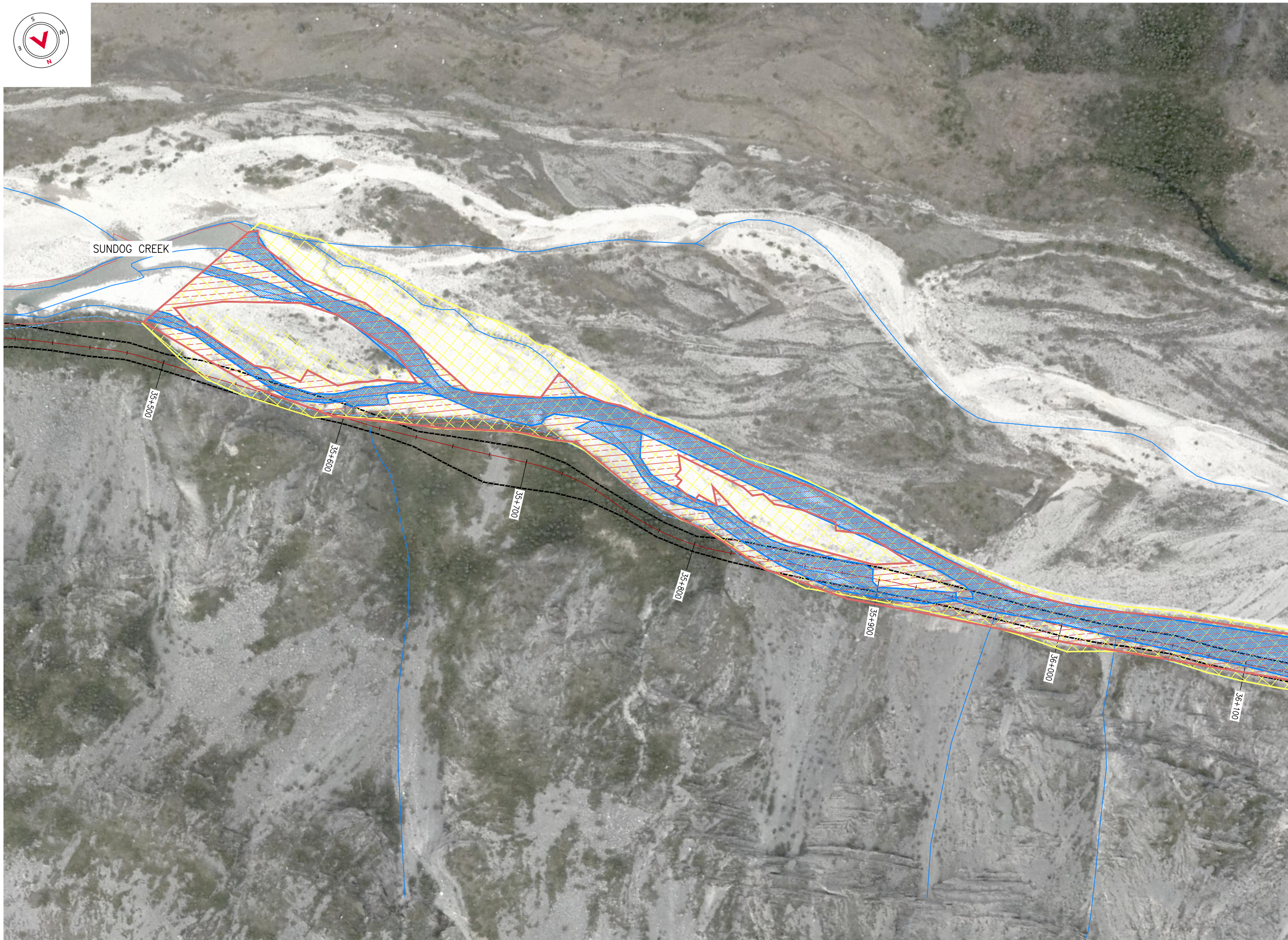
**SUNDOG CREEK  
FLOODPLAIN ANALYSIS  
OPTION #1**

TITLE:  
**PLAN VIEW WITH  
AREA CALCULATIONS  
km 35+800 to km 36+400**

DWG NO: <b>14GP0128-325-1920-006</b>	REV: <b>2</b>
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**LEGEND**

	PROPOSED DESIGN CL
	PROPOSED CUT/FILL LINES
	WATERCOURSES
	SUNDOG Q2 HEC-RAS
	SUNDOG Q100 OPTION #1
	SUNDOG Q100 OPTION #2
	WETTED CHANNELS

MAIN CHANNEL AREA  
OPTION#2 = 14566.29m<sup>2</sup>

SIDE CHANNEL AREAS  
OPTION#2 = 3213.68m<sup>2</sup>

SUNDOG Q2 HED-RAS AREA  
OPTION#2 = 27130.78m<sup>2</sup>

SUNDOG Q100 AREA  
OPTION#2 = 41026.92m<sup>2</sup>

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0	2016/11/01	ISSUED FOR REVIEW	TMM	WBM

CLIENT:

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PROJECT NO:	14-GP-0128	DSGN:	TMM	DATE:	16/02/25
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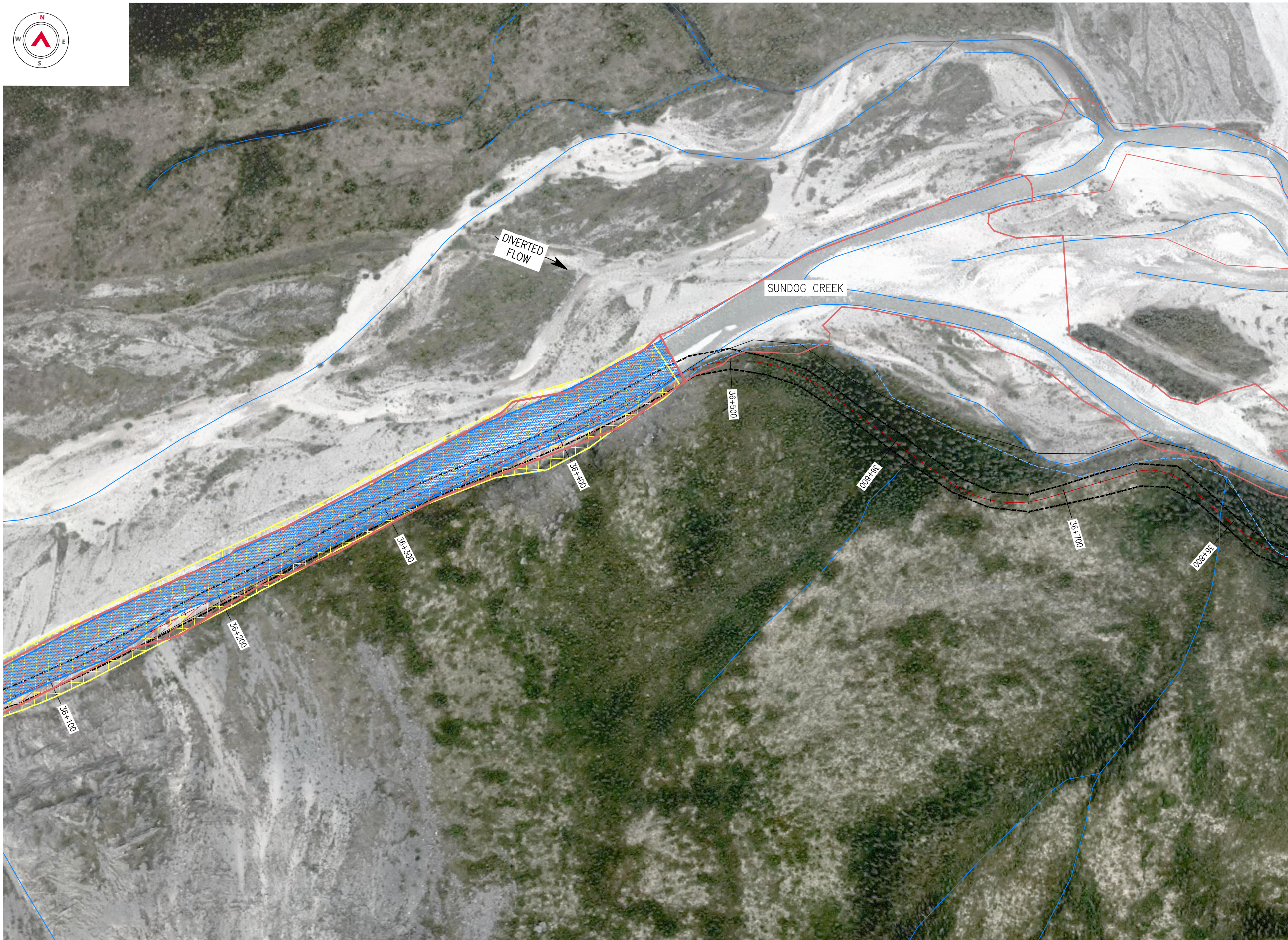
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FLOODPLAIN ANALYSIS  
OPTION #2**

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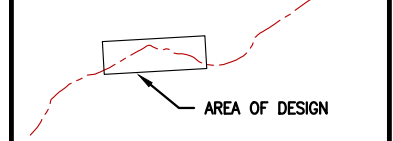
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km 34+800 to km 35+800**

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**KEY PLAN**



**LEGEND**

- PROPOSED DESIGN CL
- PROPOSED CUT/FILL LINES
- WATERCOURSES
- SUNDOG Q2 HEC-RAS
- SUNDOG Q100 OPTION #1
- SUNDOG Q100 OPTION #2
- WETTED CHANNELS

MAIN CHANNEL AREA  
OPTION#2 = 14566.29m<sup>2</sup>

SIDE CHANNEL AREAS  
OPTION#2 = 3213.68m<sup>2</sup>

SUNDOG Q2 HED-RAS AREA  
OPTION#2 = 27130.78m<sup>2</sup>

SUNDOG Q100 AREA  
OPTION#2 = 41026.92m<sup>2</sup>

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**SUNDOG CREEK  
FLOODPLAIN ANALYSIS  
OPTION #2**

TITLE:  
**PLAN VIEW WITH  
AREA CALCULATIONS  
km 35+800 to km 36+400**

DWG NO:	14GP0128-325-1920-006	REV:	1
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