

## **APPENDIX 10**

**Date:** September 9, 2014  
**From:** John Wilcockson  
**To:** David Harpley, Canadian Zinc Corp  
**Subject:** Habitat Assessment of Sundog Creek Channels for Realignment- DRAFT

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HCP Ref No.: CZN6788

Canadian Zinc Corp (CZN), owner of the Prairie Creek Mine, is proposing to build an all-season road generally along the existing winter-road right of way. Along km 30-40, the road traverses the lower Sundog Creek floodplain. The current winter road alignment is located in the central part of the floodplain, and would result in multiple creek crossings in summer. For the all season road, CZN plans to maintain the alignment on the south edge of the floodplain, thereby largely avoiding contact with active creek channels. However, between km 37 and km 39, there are three locations approximately 1 km to 2 km west of Cat Camp where the active channel is currently on the south side of the floodplain and up against north-facing bedrock cliffs.

In order to maintain the all-season road on the south side and avoid creek crossings, these parts of the active channel will need to be moved further north. Sundog Creek has a large floodplain and the location of the active channels change from year to year. It is possible that natural changes to flow over time would remove the current active channel along the cliff face.

## Habitat Characterization

The habitat that would be removed as a result of stream re-alignment consists primarily of pools, as well as some slow moving run and riffle habitat. The wetted width of the channel at site 1 and 2 was typically less than 15 m, and the deepest water (approximately 1.5m) occurred in the downstream pool, site 1. However, water depth was generally less than 40 cm. Maximum flow velocity was 1.2 m/s, in riffle habitat. Substrate consisted primarily of cobble and boulder, and there was some gravel and sand in the pool at site 1. Periphyton was observed on rocks in the upstream riffle habitat in site 1, but nowhere else in either of the sites. A low density of macrophytes were only observed within the side channel located immediately upstream of the rock face at site 1. This site also had a small amount of woody debris and boulders providing some cover to fish. Upstream and downstream of the study sites, Sundog Creek surface flows consisted primarily of riffle and run habitat. Pool habitat is less common.

## Habitat Use

Electrofishing conducted by CZN and Parks staff while at the site indicated that fish were not using the pool/riffle habitat along the rock walls at the time. However, fish were found upstream and downstream of the largest cliff-bordered pool. Two slimy sculpin were caught downstream of the rock face, in riffle habitat. The remainder of fish, two slimy sculpin and four Arctic grayling, were caught in a small side channel upstream of the rock face at site 1. No fish were found in the pool or run habitat along the rock face.

## Habitat Loss and Compensation

The re-direction of the channels away from the cliffs will result in the loss of some pool habitat; the largest pool at the time of the habitat assessment may be deep enough to provide overwintering habitat. However, creek levels are known to recede into the floodplain gravels as flows drop, so it is likely that, even if a pool exists in early winter, it will be shallower and will freeze to the bottom by the end of winter. In fact, at the time of the survey, there was no surface flow visible in sections of Sundog Creek upstream and downstream of the study area.

The preliminary conclusion based on the observations above are that the cliff faces at the two locations studied do not provide critical habitat. Pool and some run habitat would be lost along with cover provided by rough vertical rock faces. One option to re-create this habitat is to place several large boulders down the centre of the flood plain, and train the active channel to flow along the new alignment. This will serve two purposes: it will recreate pool habitat; and, it will keep flows away from the road and reduce armour requirements.

**Figure 1** Lower realignment location, site 1, facing downstream, Sundog Creek, July 27, 2014.





**Figure 2** Lower realignment location, site 1, facing upstream, Sundog Creek, July 27, 2014.

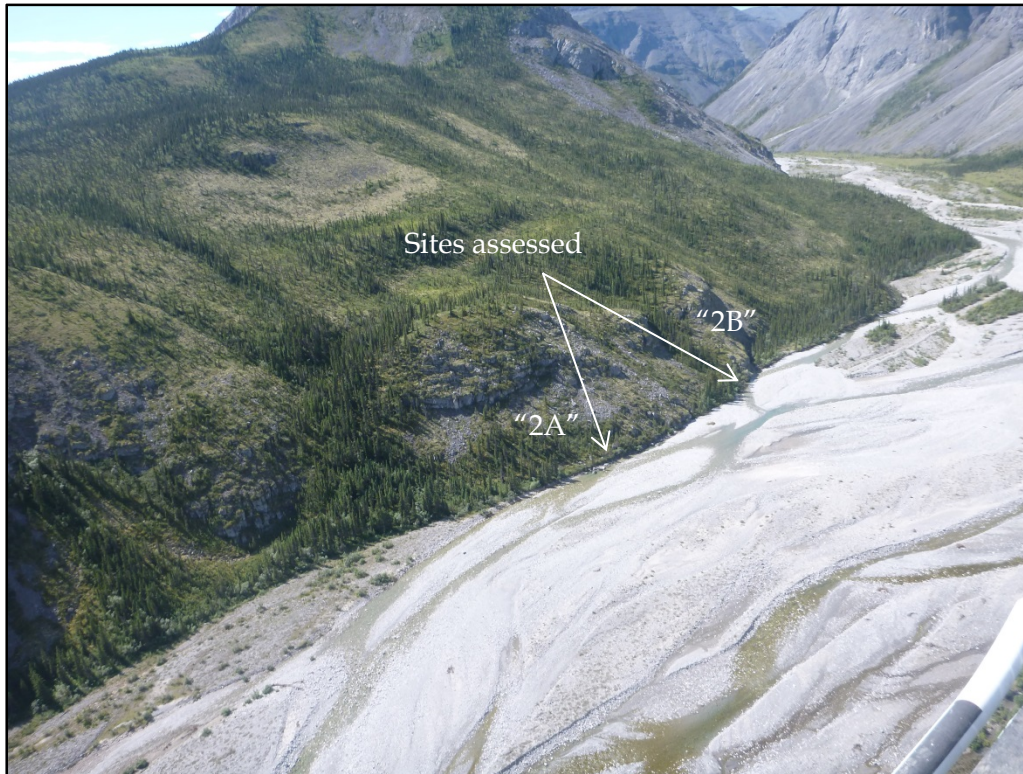


**Figure 3** Lower realignment location, site 1, facing upstream, Sundog Creek, July 27, 2014.





**Figure 4** Upper realignment location, sites 2A and 2B, facing upstream, Sundog Creek, July 27, 2014.



**Figure 5** Upper realignment location, site 2B, facing upstream, Sundog Creek, July 27, 2014.





**Figure 6** Upper realignment location, site 2A, facing downstream, Sundog Creek, July 27, 2014.



**Figure 6** Upper realignment location, site 2A, facing downstream, Sundog Creek, July 27, 2014.





**Figure 7** Upper realignment location, site 2A, facing downstream, Sundog Creek, July 27, 2014.**Table 1** GPS Coordinates.

Description	Coordinates (UTMs)
Lower Sundog Realignment (Site 1)	10 V 427079 6829372 (down-stream) 10 V 427032 6829328 (up-stream)
Upper Sundog Realignment (Site 2A)	10 V 426417 6829265 (down-stream) 10 V 426356 6829278 (up-stream)
Upper Sundog Realignment (Site 2B)	10 V 426324 6829305 (down-stream) 10 V 426255 6829318 (up-stream)

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# Attachment 1

Field Notes

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⑥ CZN 6788 27 July '14

Purpose: First day of  
Road assessment - Sundog  
to cat camp + Polge (Bubbling  
Springs) Ck. Electrofishing  
Sundog + net/trap mosquito

Crew: John, Dave, Garry + Jon

Electrofishing settings used in past  
last year 425V  $\pm$  25V 30 Hz

Duty cycle 12% (Neel)

US: sculpin - 400V 50 Hz 20 DC  
Trout - 40 Hz

Km 44 look at potential migration barrier  
prefer culvert over bridge.

Km 35-38 - possible re-alignment, shocking  
here.

Trib to Polge (Bubbling Springs)

Km 24 - falls

up 10 drop of electrofishing  
gear. ~ Km 36

Tetsela

44 Fish migration barrier 47-49 - alignment JN

CZN 6788 27 July 14 ⑦

WP 11 Catcamp

Km 43 Crossing WP 012  
431569  
6829953

WP 13 Trib to Sundog  
long chute ~ 75m S  
Photo + Photo north  
~ 150m long against  
black coloured cliff 10° slope  
~ 12° further upstream in  
chute

WP 14 Down stream pool,  
Dave saw fish ~ 10cm  
upstream of pool ~ 10°  
Farthest D/S point  
0431295  
6830730

WP 15 S , WP 16 S  
N 16 N w pool

WP 17 S WP 18 S (not recorded)  
N N

1215 @ Sundog Ck re-alignment  
location #1

PH 9.51 7.6°C 221  $\mu$ S (AJ)

JN PH 8.60 8.58°C 260  $\mu$ S (AJ)

⑧ CZN6788 27 July '14

up stream riffle flows / depths

Top 25 22cm 0.29

Mid 50 46cm 0.75

bottom 75 26cm 0.61

Mid 25 32cm 0.59

50 46cm 0.97

75 22 0.27

Bottom 25 28 0.92

50 32 1.20

75 42cm 1.06

DO on meter 11.20 mg/L  
94.8%

DO titration 10.8 mg/L

WP22 Sundog goes to  
ground.

Second sundog <sup>realign</sup> site (Location ~~72A~~ 72A)

Top WP023 426356 6829278

Bottom WP024 426418

6829265

Cond 268  $\mu$ S / 9.1°C / 7.40 (AK) *SW*

CZN6788 27 July '14 ⑨

DO meter

99.4% 11.83 mg/L

pH 8.63 7.4°C 233  $\mu$ S (AJ)

DO titration 10.2 mg/L

second sundog realign site  
Location B

Top Wpt 025 426255  
6829318

Bottom Wpt 026 426323  
6829305

End ~ 1635

Pilot late picking us up -  
decided to send just Gary  
+ Dave to sundog trib to  
electrofish 1730-1815  
back @ camp about 1835

For the sundog alignment  
locations, Jon and I did  
habitat sheets, while  
Gary + Dave electrofished

A sundog 1, ~~site A~~ 1348sec

ARGR FL (mm): 190, 183, 181, 192

SLSC FL (mm): 81, 92, 93, ?

*SW* Rite in the Rain



(10) CZN6788

27 July '14

Settings for sites A+B 1 + 2  
500v, freq. 50

For the Sundog Alignment, site

<sup>2</sup>  
d/s location ("A") - no fish 327 sec  
v/s " ("B") - no fish 188 sec

For trib to Sundog (visited earlier  
in day)

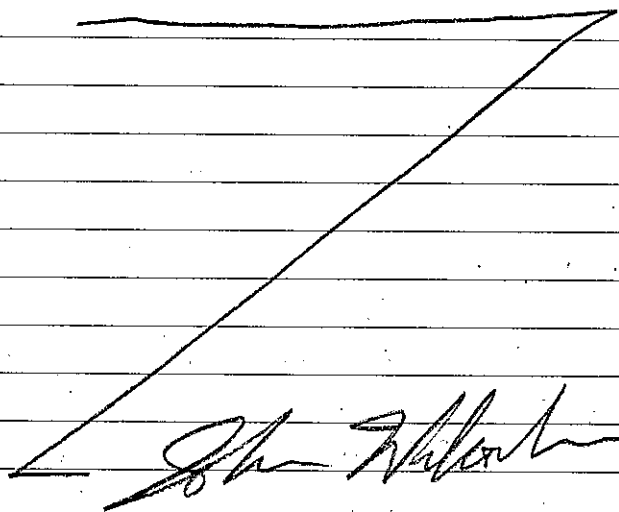
724 sec

wp 27 (431594 / 6829949)

to wp 28 (431514 / 6829743)

assume sinusosity of 2.0

assume wetted width 2.5m



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## Attachment 2

### Habitat Sheets

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Stream Habitat Information		
Data Collectors John W / Jon T	Date 27 July '14	Time (24 H) 1330
Site Pool	Station Sundog 1 (200m u/s of KM 37)	Project CZN - all season road
UTM NAD	Upstream Northing 0427064	Upstream Easting 6829319
Access	Downstream Northing 0427078	Downstream Easting 6829372

Stream Morphology Types (%)		Length (m)				Velocity (60% depth or surface)			
Run	Riffle	Depth Transect (m)		@ 25% width	50%	75%	25%	50%	75%
Fall	Other:	1	44cm	1200cm	1400cm	0	0	0.32	
Depth/Pool (m)		2	18 cm	42cm	72 cm	0.14	0.41	0.24	
Channel Slope (°)		3	24cm	20cm	46 cm	0.24	0.25	0.24	
Wetted Width		Channel Width (m)		Unstable Banks (5%)					
Meander Frequency		Regular / Irregular meanders		Bank slope (5°)		L R			

Instream Cover (Detritus)	<input type="text" value="0"/> %	Instream Cover (Twigs/Sticks <sup>†</sup> etc)	<input type="text" value="0"/> %	Substrate (as cover)	<input type="text" value="0"/> %
Instream Cover (logs, etc)	<input type="text" value="0"/> %	Instream vegetation	<input type="text" value="0"/> %	Undercut Bank	<input type="text" value="5"/> %
Woody Debris Description (log jams, fallen trees, beaver activity, etc)			cliff all one side		

	Embed. (%)			
% Organics		-	Rooted Emergent	0 %
% Clay		-	Rooted Submergent	0 %
% Silt		-	Rooted Floating	0 %
% Sand	15	-	Free-floating	0 %
% Gravel	40	0	Floating Algae	0 %
% Cobble	40	50	Attached Algae	< 1 %
% Boulder	5	50	Periphyton	%
% Bedrock	—	-	Filamentous	0 %
			Aquatic Moss	25 %
			Flooded Terrestrial Plants	0 %

Rooted Emergent	0	%
Rooted Submergent	0	%
Rooted Floating	0	%
Free-floating	0	%
Floating Algae	0	%
Attached Algae	< 1	%
Periphyton		%
Filamentous	0	%
Aquatic Moss	45	%
Flooded Terrestrial Plants	0	%

Mixed Forest	Coniferous Forest
Grasses	Deciduous Forest
Re-growth forest	Shrubs
Flooded	Sedges
Roads	Cutlines

s Forest

Back Pull - 20 18 23

Overhead Litter <150 mm	0 %	Overhead Litter >150 mm (%)	0 %
Overhead Undercut Banks	5 %	Overhanging Trees	0 %
Overhanging Grasses	0 %	Overhanging Shrubs	0 %

High water mark	1.5	m	previous 24 H cloudy dry
Flood Evidence (Debris on plants, etc)		m	
Air Temperature	21	°C	
Cloud Cover (5%)	810		
Wind Direction + speed (km/h)	NE 5		

Sample Depth (m)	0			
Dissolved Oxygen (%)	94.8			
Dissolved Oxygen (mg/L)	11.2			
Secchi Depth (m)	—			
Temperature (°C)	8.6			
pH	8.60			
Turbidity (TCU)	—			
Conductivity (uS/cm)	260			

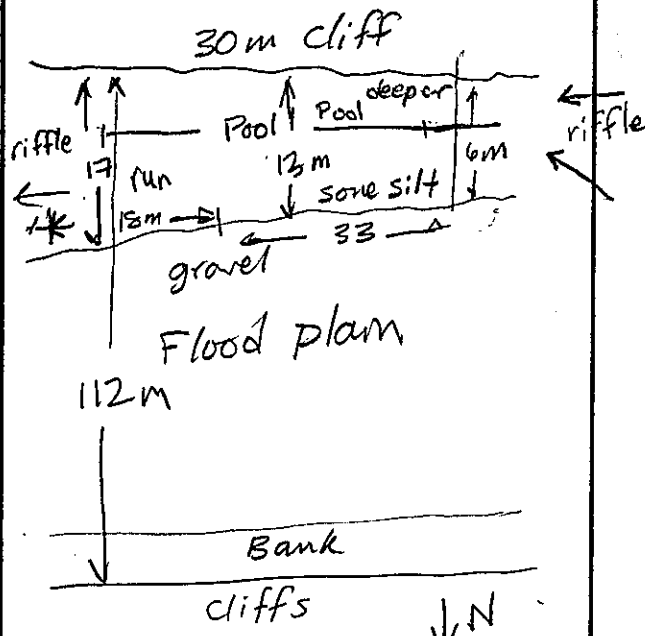
Mixed Forest	Coniferous Forest	Roads	Surface Debris	Culvert
Grasses	Deciduous Forest	Cutlines	Beaver Dam	Weir
Re-growth forest	Shrubs	Hills	Collapsed Bank	

Surface Debris	Culvert
Beaver Dam	Weir
Collapsed Bank	

Notes	Quantity	Unit	Dimensions
		Islands	
		Bars	

Islands		
Bars		

100



## Stream Habitat Information

Data Collectors <i>John W</i>	Date <i>27 July '14</i>	Time (24 H) <i>0416</i>
Site <i>Riffle (US of Pool)</i>	Station <i>Sundog 1 (200 m US of KM 37)</i>	Project <i>C2N6788</i>
UTM NAD <i>WP 20</i>	Upstream Northing <i>427033</i>	Upstream Easting <i>6829328</i>
Access <i>WP 21</i>	Downstream Northing <i>427055</i>	Downstream Easting <i>6829344</i>

## Morphology

Stream Morphology Types (%)	Length (m)	Velocity (60% depth or surface)
Run <i>(Riffle)</i> Pool	Depth Transect (m) @ 25% width 50% 75%	25% 50% 75%
Fall Other:	1 22 40 26	.29 .75 .61
Depth/Pool (m) <i>NA</i>	2 32 46 22	.59 .97 .27
Channel Slope (°) <i>20</i>	3 28 32 42	.92 1.20 1.06
Wetted Width <i>110 19 11</i> m	Channel Width (m) <i>23 28 29 1</i> *	Unstable Banks (5%)
Meander Frequency <i>1 1 1 1</i> m	Regular / Irregular meanders	Bank slope (5°) L R

## Instream Cover

Instream Cover (Detritus)	<i>0</i> %	Instream Cover (Twigs/Sticks, etc)	<i>0</i> %	Substrate (as cover)	<i>0</i> %
Instream Cover (logs, etc)	<i>0</i> %	Instream vegetation	<i>0</i> %	Undercut Bank	<i>0</i> %
Woody Debris Description (log jams, fallen trees, beaver activity, etc)					

Substrate Composition (Sum 100%)	Instream Vegetation (Sum 100%)	Riparian Zone (25 m Buffer)	circle
% Organics <i>1</i>	Rooted Emergent <i>0</i> %	Mixed Forest <i>0</i> %	<i>Coniferous Forest</i>
% Clay <i>1</i>	Rooted Submergent <i>0</i> %	Grasses <i>0</i> %	Deciduous Forest
% Silt <i>1</i>	Rooted Floating <i>0</i> %	Re-growth forest <i>0</i> %	<i>Shrubs</i>
% Sand <i>20</i>	Free-floating <i>0</i> %	Flooded <i>0</i> %	Sedges
% Gravel <i>20</i>	Floating Algae <i>0</i> %	Roads <i>0</i> %	Cutlines
% Cobble <i>20</i>	Attached Algae <i>&lt;1</i> %		
% Boulder <i>20</i>	Periphyton <i>0</i> %		
% Bedrock <i>20</i>	Filamentous <i>0</i> %		
	Aquatic Moss <i>0</i> %		
	Flooded Terrestrial Plants <i>0</i> %		

## Overhead Cover

Overhead Litter <150 mm	<i>0</i> %	Overhead Litter >150 mm (%)	<i>0</i> %
Overhead Undercut Banks	<i>0</i> %	Overhanging Trees	<i>0</i> %
Overhanging Grasses	<i>0</i> %	Overhanging Shrubs	<i>0</i> %

## Miscellaneous

High water mark	<i>1.3</i> m	Weather	previous 24 H
Flood Evidence (Debris on plants, etc)			
Air Temperature	<i>23</i> °C		<i>cloudy</i>
Cloud Cover (5%)	<i>5</i>		<i>dry getting sunny</i>
Wind Direction + speed (km/h)	<i>NE 5</i>		

## In situ Water Parameters

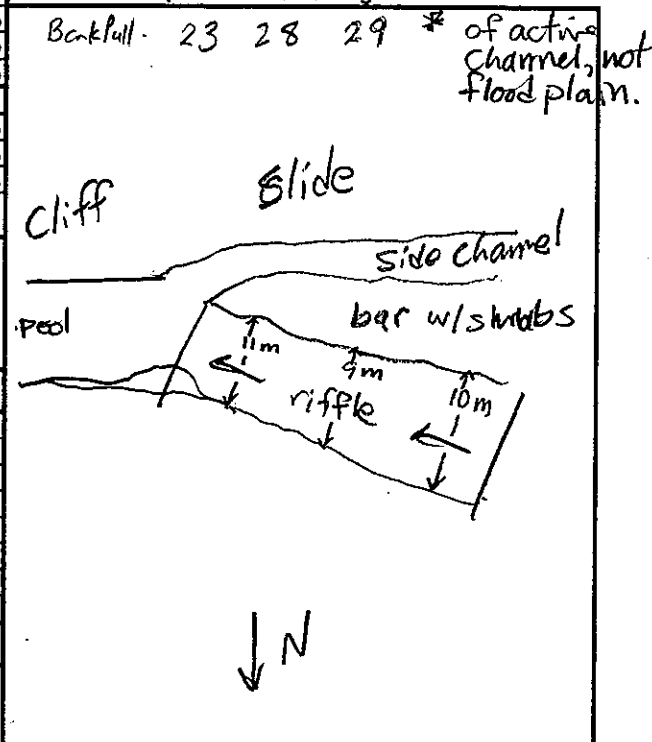
Sample Depth (m)			
Dissolved Oxygen (%)			
Dissolved Oxygen (mg/L)			
Secchi Depth (m)	<i>see ponded site</i>		
Temperature (°C)			
pH			
Turbidity (TCU)			
Conductivity (uS/cm)			

## Landscape (Beyond 25 m Buffer)

Mixed Forest	<i>Coniferous Forest</i>	circle	Visible Disturbance circle
Grasses	Deciduous Forest	Roads	Surface Debris
Re-growth forest	Shrubs	Cutlines	Culvert
		<i>Hills</i>	Weir
			Collapsed Bank

Photos	Channel Features	#	Dimensions
	Islands		
	Bars		

Notes	<i>some fairly thick brown algae growing on some boulders.</i>
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## Stream Habitat Information

Data Collectors John W / Jon T	Date 27 July - 2014	Time (24 H) 15:26
Site 1 (lower) Sundog 2	Station Sundog 2 A	Project CZN 6788
UTM NAD	Upstream Northing 426356	Upstream Easting 6829278
Access	Downstream Northing 426418	Downstream Easting 6829265

## Morphology

Stream Morphology Types (%)	Length (m)	Velocity (60% depth or surface)
Run Riffle (Pool) close to wall	Depth Transect (m)	25% 50% 75%
Fall Other:	1 8 11 10	0.13 0.34 0.26
Depth/Pool (m)	2 6 14 15	0.36 0.40 0.52
Channel Slope (°) 3°	3 11 22 44	0.08 0.27 0.31
Wetted Width 1 27 1 5 1 9 m	Channel Width (m) 1 1 1	Unstable Banks (5%)
Meander Frequency 1 1 1 1	Regular / Irregular meanders	Bank slope (5°) L R

## Instream Cover

Instream Cover (Detritus)	0 %	Instream Cover (Twigs/Sticks, etc)	0 %	Substrate (as cover)	2 %
Instream Cover (logs, etc)	0 %	Instream vegetation	0 %	Undercut Bank	0 %
Woody Debris Description (log jams, fallen trees, beaver activity, etc)					

Substrate Composition (Sum 100%)	Instream Vegetation (Sum 100%)	Riparian Zone (25 m Buffer)
% Organics 1	Rooted Emergent 0 %	Mixed Forest 0 %
% Clay 1	Rooted Submergent 0 %	Grasses 0 %
% Silt 1	Rooted Floating 0 %	Re-growth forest 0 %
% Sand 1	Free-floating 0 %	Flooded 0 %
% Gravel 20	Floating Algae 0 %	Roads 0 %
% Cobble 55	Attached Algae 0 %	
% Boulder 20	Periphyton 0 %	
% Bedrock 5	Filamentous 0 %	
	Aquatic Moss 0 %	
	Flooded Terrestrial Plants 0 %	

## Overhead Cover

Overhead Litter <150 mm	0 %	Overhead Litter >150 mm (%)	0 %
Overhead Undercut Banks	0 %	Overhanging Trees	0 %
Overhanging Grasses	0 %	Overhanging Shrubs	0 %

## Miscellaneous

High water mark	1.4 m	Weather
Flood Evidence (Debris on plants, etc)	22 m	previous 24 H
Air Temperature	22 °C	Cloudy
Cloud Cover (5%)	5	Dry
Wind Direction + speed (km/h)	NE 5	

## In situ Water Parameters

Sample Depth (m)	0
Dissolved Oxygen (%)	121.7
Dissolved Oxygen (mg/L)	12.19
Secchi Depth (m)	—
Temperature (°C)	7.4
pH	8.63
Turbidity (TCU)	—
Conductivity (uS/cm)	283

## Landscape (Beyond 25 m Buffer)

Mixed Forest	Coniferous Forest	Roads	Surface Debris	Culvert
Grasses	Deciduous Forest	Cutlines	Beaver Dam	Weir
Re-growth forest	Shrubs	Hills	Collapsed Bank	

Photos	Channel Features	#	Dimensions
	Islands		
	Bars		

## Notes

Slope = total slope of reach - slopes of individual channels will be lower.  
Slope = 3% . Slightly more periphyton than Prairie.

circle

Mixed Forest 0 %

Grasses 0 %

Re-growth forest 0 %

Flooded 0 %

Roads 0 %

Coniferous Forest

Deciduous Forest

Shrubs

Sedges

Cutlines

Channel Description/Notes/Drawing

Bank full width. 62 58 72 62

depth 72

velocity 0

Cliff

24cm

0 velocity

STN

IS

Lower elevation

\* ~2m wide small gravel bar incl. in measurement

## Stream Habitat Information

Data Collectors <b>JW, GS</b>	Date <b>27 July '14</b>	Time (24 H) <b>1610 h</b>
Site <b>Sundog realign 2</b>	Station <b>B</b>	Project <b>C2N6788</b>
UTM NAD	Upstream Northing <b>426255</b>	Upstream Easting <b>6829318</b>
Access	Downstream Northing <b>426323</b>	Downstream Easting <b>6829305</b>

## Morphology

Stream Morphology Types (%)			Length (m)				Velocity (60% depth or surface)		
Run	Riffle	Pool	Depth Transect (m)	@ 25% width	50%	75%	25%	50%	75%
Fall	Other:		1	15	18	14	0.27	0.79	0.1
Depth/Pool (m)			2	20	76	68	0.12	0.14	0.05
Channel Slope (°) <b>3°</b>			3	9	18	18	0.29	0.25	0.06
Wetted Width <b>3   4   5   1</b>	m	Channel Width (m) <b>163   75   79</b>	Unstable Banks (5%)						
Meander Frequency <b>1   1   1   1</b>	m	Regular / Irregular meanders	Bank slope (5°)			L R			

## Instream Cover

Instream Cover (Detritus)	— %	Instream Cover (Twigs/Sticks, etc)	— %	Substrate (as cover)	— %
Instream Cover (logs, etc)	<b>2</b> %	Instream vegetation	— %	Undercut Bank	<b>2</b> %
Woody Debris Description (log jams, fallen trees, beaver activity, etc) <b>Tree + cliff face</b>					

Substrate Composition (Sum 100%)			Instream Vegetation (Sum 100%)			Riparian Zone (25 m Buffer)		
	Embed. (%)							circle
% Organics	—		Rooted Emergent	0	%	Mixed Forest		Coniferous Forest
% Clay	—		Rooted Submergent	0	%	Grasses		Deciduous Forest
% Silt	—		Rooted Floating	0	%	Re-growth forest		Shrubs
% Sand	—		Free-floating	0	%	Flooded		Sedges
% Gravel	<b>60</b>	<b>60</b>	Floating Algae	0	%	Roads		Cutlines
% Cobble	<b>25</b>	<b>25</b>	Attached Algae	0	%			
% Boulder	<b>15</b>	<b>25</b>	Periphyton	0	%	Channel Description/Notes/Drawing		
% Bedrock	—		Filamentous	0	%			
			Aquatic Moss	0	%			
			Flooded Terrestrial Plants	0	%			

## Overhead Cover

Overhead Litter <150 mm	— %	Overhead Litter >150 mm (%)	— %
Overhead Undercut Banks	— %	Overhanging Trees	— %
Overhanging Grasses	— %	Overhanging Shrubs	— %

## Miscellaneous

High water mark	1.2 m	Weather	previous 24 H
Flood Evidence (Debris on plants, etc)	— m		
Air Temperature	22 °C		
Cloud Cover (5%)	5		
Wind Direction + speed (km/h)	WS		

## In situ Water Parameters

Sample Depth (m)			
Dissolved Oxygen (%)			
Dissolved Oxygen (mg/L)			
Secchi Depth (m)			
Temperature (°C)			
pH			
Turbidity (TCU)			
Conductivity (uS/cm)			

*see site A*

## Landscape (Beyond 25 m Buffer)

Mixed Forest	Coniferous Forest	Roads	Surface Debris	Culvert
Grasses	Deciduous Forest	Cutlines	Beaver Dam	Weir
Re-growth forest	Shrubs	Hills	Collapsed Bank	

## Photos

		Channel Features	#	Dimensions
		Islands		
		Bars		

## Notes

<b>3° slope</b>
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