Fish Habitat Management System for Yukon Placer Mining

Aquatic Health Report (2015)

Prepared by

The Yukon Placer Secretariat

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Contents

1 Introduction

The Fish Habitat Management System for Yukon Placer Mining (FHMS) is intended to balance the objectives of a sustainable Yukon placer mining industry with the conservation and protection of fish and fish habitat supporting fisheries. Within the FHMS there are three effects-monitoring programs and associated protocols including Aquatic Health, Water Quality Objectives and Economic Health. All three programs help to verify the effectiveness of the FHMS in meeting its objectives.

The Aquatic Health Monitoring program was designed to assess how effective the FHMS is at maintaining aquatic health for fish and fish habitat, information that will then be used to make changes to the program, if necessary, through adaptive management. The annual AHM program is jointly delivered by Fisheries and Oceans Canada (DFO) and the Yukon Government Department of Environment (YG). The Yukon Placer Secretariat was established to coordinate the implementation of the Fish Habitat Management System for Yukon Placer Mining and as such is responsible for producing this report. This report provides cursory background information to the AHM program and presents the results of 2015 monitoring efforts.

2 Methods

2.1 Aquatic Health Monitoring Protocol

The Aquatic Health Monitoring (AHM) program is governed by the Aquatic Health Monitoring Protocol (http://www.yukonplacersecretariat.ca/infocentre.html). The AHM Protocol describes the objectives and key questions to be addressed in monitoring, and guides sampling design (locations, timing, frequency and methods employed), as well as the methods used to analyze data.

2.2 CABIN

Data gathered under the AHM program is housed, managed, and analyzed online through the Canadian Aquatic Biomonitoring Network (CABIN), a website administered and maintained by Environment and Climate Change Canada (ECCC) to support the collection, assessment, reporting and distribution of biological monitoring information across Canada. CABIN is an aquatic biomonitoring network for assessing the health of freshwater ecosystems in Canada. CABIN is based on the network of networks approach that promotes inter-agency collaboration and data-sharing to achieve consistent and comparable reporting on freshwater quality and aquatic ecosystem conditions in Canada. CABIN allows for a formalized scientific assessment using nationally comparable standards overseen by a National Science Team.

A training program for the application of CABIN protocols is provided by Environment Canada in partnership with the Canadian Rivers Institute (CRI) at the University of New Brunswick (UNB). Training ensures that practitioners of CABIN fieldwork, laboratory analysis and data entry and interpretation are operating under a nationally standardized methodology. Certified personnel can then reduce the work required in building their own biomonitoring program, benefit from the collective research efforts by practitioners across Canada and contribute consistent data to the national database. In turn, this data can be shared for building more accurate and up-to-date assessment models.

2.3 Reference Condition Approach

Under the AHM program and CABIN, the Reference Condition Approach (RCA) is used to assess the health of freshwater aquatic ecosystems. The RCA uses the condition of the benthic invertebrate community assemblage as a surrogate for stream health. A Yukon and placer mining specific RCA empirical model has been developed to assist in this assessment. This model uses the habitat characteristics found at a site to predict the benthic macroinvertebrate community (at the family level) that should be expected at that site.

2.3.1 RCA Model

The development of the Yukon placer mining RCA model involved the collection of environmental descriptors and biological data from a wide variety of stream sites throughout the Yukon Territory that were considered to be “In Reference”, or unaffected by stressors that may impact the aquatic health of the stream. These Reference Sites were put through two steps. The first was to classify the sites based on their biological characteristics (the benthic macroinvertebrate community present). This requires defining a number of community types based on the taxonomic composition. The second step was to determine a subset of habitat attributes that are associated with those community types. After these

steps are completed the process can be reversed to predict the number and type of organisms expected to occur at any given site based on the habitat attributes of the site.

RCA Model Versions

An RCA model was first adopted for assessing watershed health under the FHMS for Yukon placer mining in 2007. In January 2008, this model was re-calibrated incorporating data collected in 2007. Further development of the model was undertaken in 2010 using new data collected in 2008 and 2009. In 2013, site data collected in 2010-2012 was incorporated into the model and additional data collected in 2007 and 2008 resulted in the expansion of the geographic range of the model. Current analyses and this report rely on a recalibrated 2013 Yukon model developed from a suite of 286 Reference Sites gathered from across the Yukon Territory by Fisheries and Oceans Canada, the Yukon Government and the University of Western Ontario from 2006 to 2012 (https://www.researchgate.net/publication/281067514_Revision_of_the_Yukon_CABIN_Invertebrate_Bioassessment_Model_using_2004-12_Reference_Site_Data).

The 286 Reference Sites are separated into five Reference Groups based on their benthic invertebrate communities. Table 1 shows the 14 habitat variables that statistically best define each Group.

Table 1. Habitat variables used in determining Reference Groups as well as placing Test Sites into Reference Groups. Standard deviations are given for each metric.

Model Group	1		2		3		4		5	
	Average	SD	Average	SD	Average	SD	Average	SD	Average	SD
Longitude	-138.27	2.10	-136.93	2.75	-135.66	3.18	-137.45	2.65	-137.47	2.24
Altitude (ft)	1973.87	1104.18	2134.49	899.68	2756.11	719.61	2296.81	838.01	2727.00	914.30
Depth Avg (cm)	36.46	24.31	31.44	19.67	32.11	15.81	29.80	14.62	24.00	13.45
Velocity Avg (m/s)	0.42	0.29	0.43	0.26	0.58	0.29	0.52	0.32	0.69	0.41
Precip. February (mm)	27.74	9.11	28.51	7.47	36.14	23.93	29.34	11.79	23.65	9.87
Precip. March (mm)	25.55	9.72	26.48	7.73	33.13	21.04	27.46	11.91	21.43	10.29
Precip. June (mm)	49.78	15.10	57.14	13.59	64.67	18.69	53.49	18.49	42.71	20.01
Precip. July (mm)	63.45	19.77	73.01	17.74	78.30	20.81	65.85	22.37	53.48	23.83
Rainfall June (mm)	45.78	13.48	49.32	11.37	52.72	13.46	48.44	16.06	39.59	18.11
April Max Temp (°C)	-0.26	3.57	0.93	4.20	1.38	3.74	-0.98	3.38	-1.99	4.49
Broadleaf Open (%)	0.20	0.41	0.14	0.34	0.68	1.62	0.38	1.31	0.11	0.31
Bryoids (%)	0.17	0.42	0.31	0.61	0.37	0.84	0.54	1.04	1.01	2.53
Mixed Wood Open (%)	2.46	5.01	0.75	1.44	0.96	1.72	0.77	2.87	0.14	0.32
Wetland herbaceous (%)	0.22	0.64	0.11	0.31	0.03	0.10	0.14	0.46	0.03	0.08

The five main Reference Groups are discrete, and represent a gradient of increasing benthic invertebrate abundance (total number of individuals) and family richness (number of different families). The invertebrate families characteristic of each group are given in Table 2.

Table. 2. Invertebrate families characteristic of Reference Groups 1 through 5.

Group 1	Group 2	Group 3	Group 4	Group 5
Chironomidae	Chironomidae	Chironomidae	Chironomidae	Chironomidae
Naididae	Heptageniidae	Heptageniidae	Heptageniidae	Baetidae
Lumbriculidae	Baetidae	Baetidae	Baetidae	Simuliidae
	Nemouridae	Nemouridae	Nemouridae	
	Chloroperlidae	Chloroperlidae	Simuliidae	
	Simuliidae	Simuliidae		

The following is a summary of the general characteristics of each Reference Group:

Group 1. Sites have very low abundance and richness, with a community dominated by Chironomids which represent over a third of the community with Naidid worms as the other main characteristic family. However this is a quite variable community. These sites tend to be the lowest altitude and have larger drainage basins. The channels are deeper, velocity slower and have the finest substrate.

Group 2. Also has low abundance but higher taxonomic richness, this is again a community where Chironomids are dominant (39.7%) but Baetid and Heptaegiid mayflies also have high relative abundance (20%). Six families representing the Diptera, Ephemeroptera and Plecoptera characterise this community type. These are streams in the eastern Yukon but tend to be intermediate with regard to their habitat characteristics.

Group 3. These sites have reasonable abundance and have the highest family richness (> 15 families per site). The dominant families are mayflies (Heptageniidae) and stoneflies (Nemouridae) which together comprise almost 50% of the community, Chironomids are less abundant (15%) but occur at all sites. The same six families as Community 2 characterise this assemblage. These are higher altitude sites in the eastern portion of the study area and with smaller drainage areas, with the highest spring precipitation and also warmer spring temperatures and the largest substrate.

Group 4. This is a more abundant community with 10 times more organisms per sample than communities 1 and 2. The community also has the high taxonomic richness. Chironomids are again the most common family (44%), however the Baetidae are also common (11% relative abundance) and found at more than 80% of the sites. This is the most frequently occurring assemblage (38% of Reference Sites) and also the most variable in terms of habitat attributes.

Group 5. This is a small community representing less than 5% of the Reference Sites. This community has the greatest number of organisms and is again dominated by Chironomids (56%) but also Baetid mayflies (22%) and Dimulids (black flies) are also abundant (8%). These are shallow streams with high stream velocity. They also have the coolest spring and summer temperatures and the least amount of spring precipitation. These sites are located in the northern part of the study area.

2.4 CABIN Outputs

2.4.1 Group Assignment

Site assessment is conducted by comparing a Test Site (a site known to have been exposed to placer mining) to the groups of Reference Sites (sites not exposed to placer mining or other known stressors) to determine which Group it is most similar to. The RCA model uses the habitat predictors (Table 1) of a

Test Site to develop a probability of assignment to each group of Reference Sites. This Test site is compared with the Reference Group to which it has the highest probability of assignment.

There are certain circumstances where a Test Site is found to have a similar probability of belonging to two Reference Groups. When this occurs further analysis is required in order to determine which Reference Group is most representative of the Test Site. This analysis is based on similarity of the predictor variables to a particular Reference Group.

2.4.2 Ordination

The same environmental and biological data collected at Reference Sites are collected at Test Sites known to be exposed to placer mining. By comparing the results from a Test Site to its assigned Reference Group averages, a statistical determination is made as to whether the Test Site falls inside or outside of the expected natural range of variability for that group. The normal range of variability for a particular Reference Group is established by constructing probability ellipses around the Reference Sites in ordination space, a three dimensional representation of the cloud of Reference Sites (Figure 1). CABIN uses three ellipses to provide 4 Bands describing how far a Test Site is from reference condition. Three graphs are generated during the analysis, one for each two dimensional axis. It is important to note that it is the maximum distance from the reference community in any one direction that dictates the result of the assessment, not an average over three graphs or the number of graphs indicating stress. The overall assessment is based on the most severe rating where the Test Site is most different from reference.

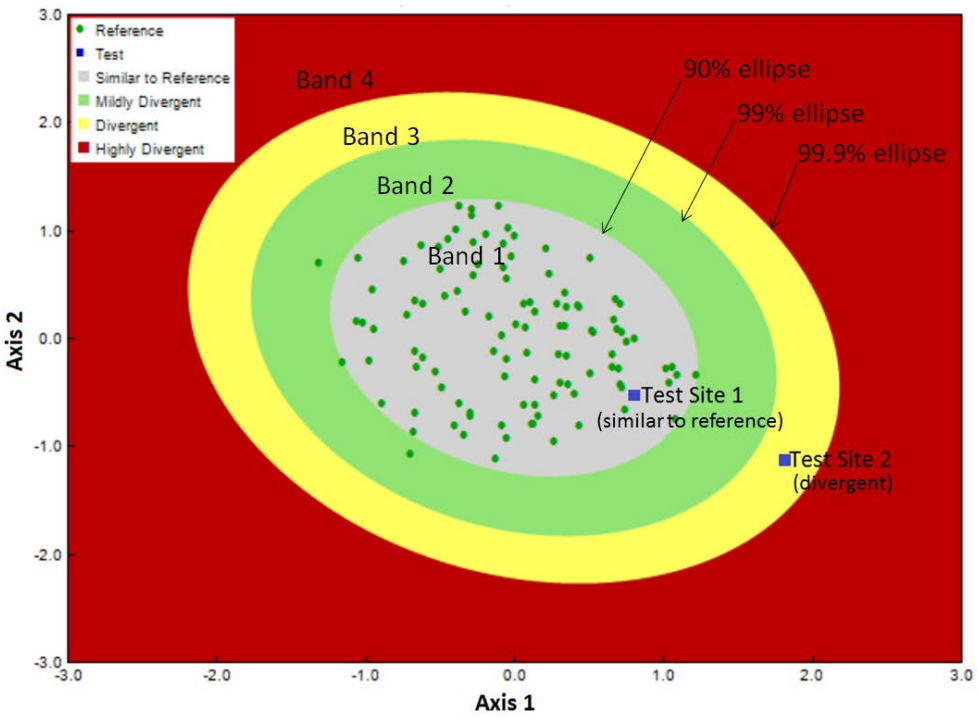

Figure 1. This example figure displays site assessment graphs which show Test Sites relative to the group of R eference Sites to which they are compared on two of the three axes.

If a site is inside the 90% probability ellipse it is deemed in Band 1 and similar to reference condition, if it is outside the 90% ellipse but inside the 99% ellipse it is deemed mildly divergent from reference condition (Band 2), if it is outside the 99% ellipse but inside the 99.9% ellipse it is deemed divergent from reference condition (Band 3), and finally if it is outside the 99.9% ellipse it is considered highly divergent from reference condition (Band 4).

Applying a precautionary approach, for Test Sites initially identified to be in Band 1, an additional 0-75% probability band is constructed to ensure the site is indeed in reference condition. This additional step is taken in order to balance Type 1 and Type 2 errors. A Type 1 error is the likelihood of a Reference Site being assessed as out of reference condition when it is in reference. A Type 2 error is failing to detect a disturbed Test Site as being out of reference. Sites inside the 75% ellipse (Band 0) are deemed to be in reference condition and those in the 75% to 90% ellipse (Band 1) are deemed to be similar to reference (Table 3). Although the ability to construct the 75% ellipses is not currently built into CABIN, programming is being developed to integrate this function. For now 75% ellipses are drawn manually for each site using SYSTAT 13 (a statistics and statistical graphics software program).

Table 3. Potential Assessment Results

Band 0	Band 1	Band 2	Band 3	Band 4
In Reference Condition	Similar to Reference Condition	Mildly Divergent from Reference Condition	Divergent from Reference Condition	Highly Divergent from Reference Condition

2.4.3 RIVPACS

As part of the RCA model interpretation, River Invertebrate Prediction and Classification Software (RIVPACS) are used to analyse benthic invertebrate family presence and absence information. RIVPACAS uses the probability of a Test Site belonging to each Reference Group, and the frequency of taxa occurrence in each Reference Group, to predict the benthic invertebrate families expected to be observed at the Test Site. Probabilities of occurrence are given as a percentage, and can be summed to indicate the number of families predicted (Table 7 to 14). RIVPACS observed vs expected ratios (O:E) are calculated and represent the observed taxa divided by the number of taxa expected by the model in a single value. RIVPACS probability of occurrence predictions can be used to assess which families expected to occur are missing or which families occur in lower or higher numbers than predicted. RIVPACS are presented for P>0.50, more likely to be present than not, and P>0.70 for each site (Appendix 1).

2.4.4 Additional Metrics

Bray-Curtis Dissimilarity

Displayed as a value from 0 to 1, Bray-Curtis dissimilarity compares the proportion of taxon in a Test Site benthic invertebrate community to the proportion of taxon in the median community. A community with exactly the same benthic invertebrate community structure as the median community will have a Bray-Curtis dissimilarity measure of 0 while a value of 1 indicates a totally different community.

2.5 Annual Aquatic Health Monitoring

2.5.1 Study Area

The Fish Habitat Management System for Yukon Placer governs Yukon placer mining in 16 watersheds within the Yukon River Basin including: Big Creek, Big Salmon River, Fortymile River, Indian River, Klondike River, Mayo River, McQuesten River, Nisutlin River, Nordenskiold River, Pelly River, Sixty Mile River, Southern Lakes, Stewart River, White River, Yukon River North and Yukon River South. Placer mining occurs at different intensities among these watersheds and as such sampling is not carried out equally in each.

2.5.2 Site Selection

Approximately 40 sites are sampled each year by Fisheries and Oceans Canada and Yukon Government. The selection of priority Reference and Test Sites for sampling/re-sampling is based on several factors outlined in the Aquatic Health Monitoring Protocol and the Adaptive Management Framework (http://www.yukonplacersecretariat.ca/infocentre.html). Several of these factors are summarized in Table 4 below.

Table 4. Summary of site selection criteria and conditions used in the selection of sample sites for annual monitoring.

Site Selection Criteria	Condition
Watershed Sensitivity Category	Equal representation of A and B.
Habitat Suitability	Higher priority on high habitat suitability types if found to be out of reference during previous site visits. Otherwise equal representation of habitat suitability types.
New placer operations on reference/un-impacted streams	If new operations are active on previously un-impacted streams, these sites are considered a high priority for sampling.
Chronic compliance issues	These sites may not be sampled until issues are addressed because the sample results may not reflect the FHMS.
Sites with improving/declining trends in site assessment results	Re-sample in order to track improvement/decline over time in order to pinpoint reasons for change.
Site has shown declining trend in assessment result over multiple samples	1st sample: high priority to resample (intensify monitoring) 2nd sample: medium priority to resample (continue monitoring) 3rd+ sample: low priority to resample until change to standard or determine other cause of decline.
Habitat suitability	1: High to Moderate-High and out of reference: resample at site level 2: Low to Moderate and out of reference: determine at watershed level
Known natural disturbance with influence on site (forest fire, landslide etc)	If significant and can be tied to site/watershed may not re-sample. It may not be possible to differentiate natural impacts from placer impacts.
Long term trend sites	Some sites are sampled each year regardless of previous site assessment results in order to monitor long term trends and maintain continuity of sample years.
Reference sites	1 in 5 annual site visits are done on repeat Reference Sites to monitor natural variation.
Points of Interest	Sites of interest to First Nations, industry, government agencies, non-governmental organizations may be a priority.

2.5.3 Field Sampling

Annual sampling is carried out over a 3-week period beginning no earlier than the second week of July and extending no later than the start of the second week of August of each year. Repeat site visits are sampled at the same location each visit while new site locations are chosen based on ease of access as well as representation of the sample stream. Data collected during site visits includes a 3 minute travelling 500um kick net (benthic macro invertebrate samples collected for laboratory identification and counting), basic water chemistry (YSI Probe: pH, temperature, conductivity, dissolved oxygen), detailed water chemistry (laboratory analysis: nutrients, physical and chemical properties and metals), environmental variables (stream width, depth and velocity, riparian vegetation and site characteristics) and electrofishing (fish species, length, weight and count). All information is recorded on a standard field form and several standardized photos are taken of each site while on the ground and from the air, when possible. More information regarding field sampling procedures can be found in the CABIN field sampling protocol (http://www.ec.gc.ca/rcba-cabin/default.asp?lang=en&n=74876ADD-1) as well as in the AHM Protocol (http://www.yukonplacersecretariat.ca/infocentre.html).

2.5.4 Invertebrate Classification

All benthic macroinvertebrate samples are classified by a certified consulting company and each organization and laboratory participating in the CABIN program is required to implement stringent quality assurance and quality control procedures. For more information regarding laboratory methods

see documentation on the CABIN website (http://www.ec.gc.ca/rcba-cabin/default.asp?lang=en&n=74876ADD-1).

2.5.5 Placer Mining Activity Assessment

In order to assess the influence of current and historic placer mining activity on a Test Site, these activities need to be quantified for each stream. Information related to placer mining activity provided in this report is limited to direct observations made while conducting site visits or through conversation with knowledgeable personnel. A formalized placer mining activity assessment process is currently under development; please see Next Steps in this report for more information.

3 Results – 2015 Aquatic Health Monitoring

3.1 Study Area

Watersheds sampled in 2015 included: Fortymile, Sixty Mile, Klondike, Mayo, Stewart, White, Big Creek and Yukon River South drainages. All sites were located within the Yukon River Basin (Figure 2).

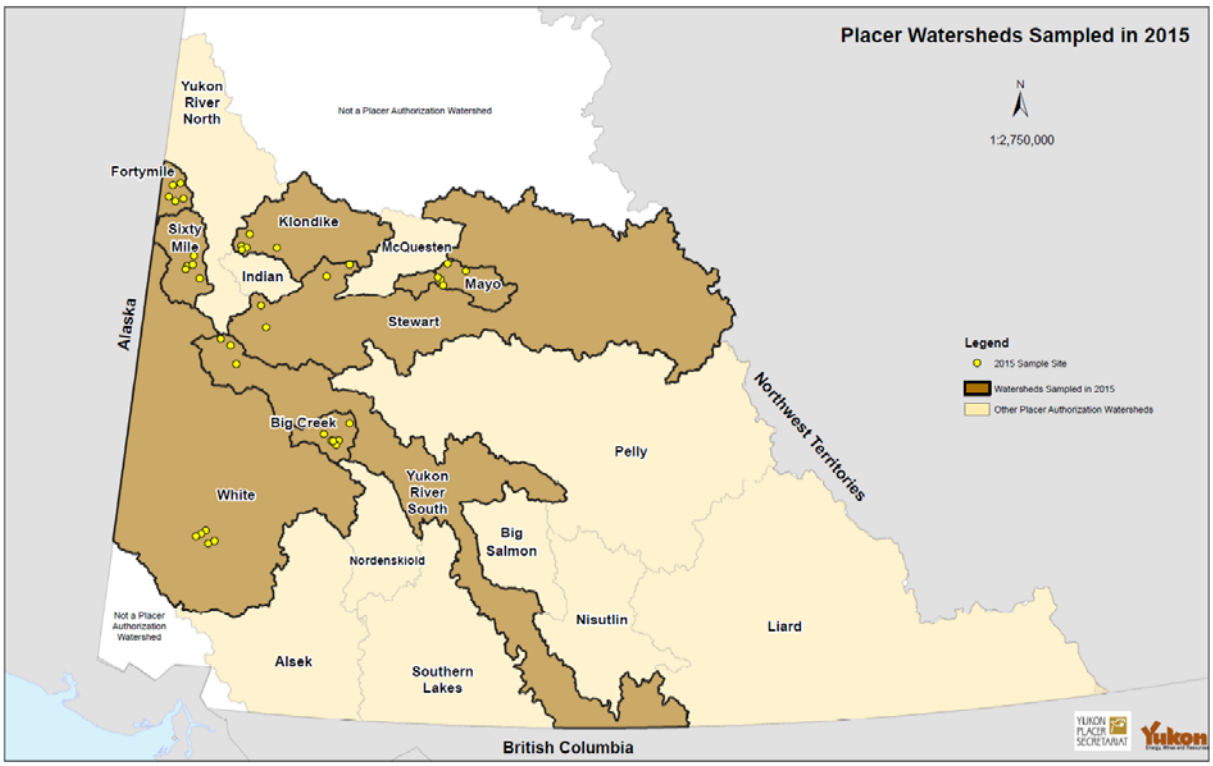

Figure 2. Placer watersheds and general Test Site locations for 2015 Aquatic Health Monitoring.

3.2 Sample Sites

Site visits were carried out between July 16 and July 30, 2015. A total of 40 sites were sampled, with mostly even distribution among the 8 sampled watersheds (Table 5).

Table 5. Number of 2015 sample sites by watershed.

Watershed	Total Number of Sites Visited
Big Creek	7
Forty Mile	5
Klondike	5
Mayo River	5
Sixty Mile	5
Stewart River	5
White River	5
Yukon River South	3

Nine of the 40 sites sampled in 2015 were visited for the first time, while 18 sites were visited for the second time. Only 2 sites visited in 2015 have been sampled 5 or more times (Table 6).

Table 6. Total number of site visits for site sampled in 2015.

Watershed	Stream	Site	Number of times site has been sampled
Big Creek	Big Creek	YPS-172	3*
	Big Creek	YPS-201	3*
	Mechanic Creek	YPS-411	3
	Big Creek	YPS-412	3
	Seymour Creek	YPS-414	3
	Seymour Creek	YPS-576	1
	Big Creek	YPS-577	2*
Forty Mile	Browns Creek	YPS-540	2*
	Bruin Creek	YPS-541	2
	Unnamed Trib to Bruin Creek	YPS-542	2
	Maiden Creek	Yps-375	3
	Bruin Creek	YPS-379	3*
Klondike	Eldorado Creek at Little Eldorado	YPS-082	2
	Bonanza Creek u/s Grand Forks	YPS-084	3
	Bonanza Creek-Park's Site	YPS-108	2
	Hunker Creek	YPS-544	4*
	Allgold Creek	YPS-569	3*
Mayo River	Duncan Creek	YPS-147	2
	Duncan Creek	YPS-149	2
	Davidson Creek	YPS-573	1
	Granite Creek	YPS-574	1*
	Davidson Creek	YPS-575	1
Sixty Mile	20-Mile Creek at 60-Mile River	YPS-086	2
	Matson Creek	YPS-114	3
	Matson Creek at 60-Mile Rive	YPS-115	2*
	60-Mile River at 50-Mile Creek	YPS-118	2
	Matson Creek	YPS-538	2
Stewart River	Black Hills Creek	YPS-428	4
	Black Hills Creek (Upper)	YPS-429	4
	Clear Creek	YPS-347	2
	Clear Creek	YPS-348	2
	No Name	YPS-578	1
White River	Burwash Creek	YPS-506	2
	Quill Creek	YPS-508	2
	Tatamagouche Creek	YPS-568	3*
	Maple Creek	YPS-571	1
	Quill Creek	YPS-572	1
Yukon River South	Sparkling Creek	YPS-119	2
	Thistle Creek	YPS-164	6*
	Donahue Creek	YPS-579	1

*Site sampled in 2016

3.3 2015 Site Assessments

All data collected in 2015 were entered into the Canadian Aquatic Biomonitoring Network (CABIN) online database. Each site was run through the RCA assessment process and classified and compared using the 2013 Yukon model.

CABIN summary reports for 2015 Test Sites were generated and selected metrics were compiled for each site. Site description, map location, site photo, CABIN assessment results, ordination results,

community structure, frequency and probability of taxa occurrence and RIVPACS ratios are provided for each site in Appendix 1.

Of the 40 sites assessed in 2015, 12 were initially identified as Similar to Reference and as such 75% ellipses were constructed for these sites in SYSTAT 13 (Appendix 2). After analysis, 7 of the 12 sites were found to be In Reference Condition (Band 0) while 5 remained as Similar to Reference Condition (Band 1). The purpose of completing the 75% ellipse analysis is to ensure a precautionary approach is applied and the potential to fail to identify a disturbance when it exists is reduced. The 5 sites that did not fall within the 75% ellipse are still considered in good overall condition however these sites will be afforded slightly higher consideration during future site selection processes as compared to sites that fall within the 75% ellipse (Band 0).

3.4 Site Assessment Results and Trend Discussion

Multiple characteristics of the benthic invertebrate community are used by CABIN to generate the site assessment results (e.g., abundance, richness, characteristic families etc.). The abundance (total number of individual organisms) and richness (total number of families) for each site have been summarized in Tables 7 through 14. These basic metrics may provide initial insight into the model results; however, other characteristics may have also influenced the results. Appendix 1 provides a full description of the benthic invertebrate community observed at each site.

A wide range of factors can influence site assessment results including natural disturbances such as forest fires, rain events and landslides. Environmental factors that influence sampling efficacy as well as those that can have a direct impact on benthic invertebrate abundance at the site level are discussed where possible. Information for current year as well as past years site visits was analysed to determine the validity of the site assessment result. Information for sites with known placer activity is also summarized. Where sites visits were conducted in previous years, trend information is provided.

3.4.1 Big Creek Watershed

Table 7. Site assessment results for Big Creek Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	Year	Stream	Habitat Suitability	Group	Group Prob.	Site Assessment Result	Abundance	Richness	Depth (cm)	Velocity (m/s)	Abundance (SD)	Depth in cm (SD)	Velocity in m/s (SD)	RIVPACS Expected Richness
YPS-172	2015	Big Creek	Mod-High	4	0.37	In Reference Condition	3027	15	73.6	0.48	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.21
YPS-172	2007	Big Creek		4	0.47	Mildly Divergent	2338	14	43.6	0.50	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.74
YPS-201	2015	Big Creek	High	4	0.48	Mildly Divergent	491	17	39.8	0.74	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.89
YPS-201	2007	Big Creek		4	0.48	Divergent	76	5	41.6	0.82	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.22
YPS-411	2015	Mechanic Cr		4	0.48	Mildly Divergent	281	14	7.90	0.10	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.72
YPS-411	2014	Mechanic Cr	Mod-Mod	4	0.48	Mildly Divergent	254	12	7.30	0.13	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.76
YPS-411	2009	Mechanic Cr		4	0.46	In Reference Condition	827	13	11.0	0.12	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.64
YPS-412	2015	Big Creek		4	0.51	Mildly Divergent	1260	12	37.0	0.48	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.66
YPS-412	2014	Big Creek	Mod-Mod	4	0.39	Highly Divergent	47	11	82.8	0.66	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.02
YPS-412	2009	Big Creek		4	0.35	Mildly Divergent	4975	11	62.2	0.07	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.72
YPS-414	2015	Seymour Cr		4	0.50	Mildly Divergent	1580	17	15.4	0.48	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.32
YPS-414	2014	Seymour Cr	Mod-High	4	0.48	Mildly Divergent	476	15	23.9	0.76	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.49
YPS-414	2009	Seymour Cr		4	0.49	Similar to Reference	2300	18	21.6	0.44	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.30
YPS-576	2015	Seymour Cr	Mod-Mod	4	0.48	Similar to Reference	837	14	26.2	0.68	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.47
YPS-577	2015	Big Creek	Mod-Low	4	0.52	In Reference Condition	1574	14	35.2	0.44	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.63

3.4.1.1 Big Creek Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-172

This site is located on the main channel of Big Creek in the lower third of the drainage and two years of reliable sample data are reported here. In 2015, benthic invertebrate abundance was within the normal range and family richness was higher than expected. Given the habitat suitability of Big Creek in this location, the site assessment results and the distance to known placer mining activity upstream, the site is considered a high priority for re-sampling. Based on this priority this site was re-sampled in 2016.

YPS-201
This site is located on the main channel of Big Creek in the lower part of the drainage and has two years of reliable sample data. In 2015, benthic invertebrate abundance was low but within the normal range and family richness was much higher than expected. Given the habitat suitability of Big Creek in this location as well as the site assessment results and the distance to known placer mining activity upstream, the site is considered a high priority for re-sampling. Based on this priority this site was re-sampled in 2016.

YPS-411
This site is located at the mouth of Mechanic Creek and has three years of reliable sample data. In 2015, benthic invertebrate abundance was below the normal range and family richness was slightly higher than expected. The site is influenced by historical as well as active placer mining activity upstream, however given the site assessment results for this site it is considered a low priority for re-sample at this time.

YPS-412
This site is located on the main channel of Big Creek and is in close proximity to upstream placer mining activity. In 2015, benthic invertebrate abundance was within the normal range and family richness was as expected. Sampling results for 2009 and 2014 may not be representative of the normal conditions for this site as very low and very high water velocities were recorded during these years respectively. When circumstances such as rain events and low water years are accounted for the 2015 site assessment result is considered most appropriate for this site, however in order to confirm these results and continue to monitor this site the priority for re-sample is considered High.

YPS-414
This site is located near the mouth of Seymour Creek and has three years of reliable data. In 2015, benthic invertebrate abundance was within the normal range and family richness was much higher than expected. The site is located downstream of active placer mining and is therefore influenced by this activity, however given the site assessment results over multiple sample years this site is considered a low priority for re-sample.

YPS-576
This site is located in the lower third of the Seymour Creek drainage just downstream of a tributary with known active placer mining. In 2015, benthic invertebrate abundance within the normal range and family richness was as expected. This is the first year of sample data for this site and given the site assessment result it is considered a low priority for re-sample.

YPS-577
This site is located on the main channel of Big Creek in the upper third of the drainage and is above all known placer activity in this watershed. In 2015, benthic invertebrate abundance was within the normal range and family richness was slightly higher than expected. This was the first year of sample data for this site and the site assessment result appears as expected however this site was sample again in 2016 in order to confirm results and to capture any change over time.

3.4.2 Forty Mile River Watershed

Table 8. Site assessment results for Forty Mile River Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	Year	Stream	Habitat Suitability	Group	Group Prob.	Site Assessment Result	Abundance	Richness	Depth (cm)	Velocity (m/s)	Abundance (SD)	Depth in cm (SD)	Velocity in m/s (SD)	RIVPACS Expected Richness
YPS-375	2015	Maiden Cr	ASC	2	0.33	Similar to Reference	117	12	48.2	0.74	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	10.60
YPS-375	2014	Maiden Cr		2	0.43	Similar to Reference	79	9	14.7	0.37	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	11.22
YPS-375	2009	Maiden Cr		2	0.49	Similar to Reference	336	14	10.2	0.18	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	11.09
YPS-379	2015	Bruin Creek	Mod-Mod	4	0.31	Highly Divergent	75	16	35.0	0.84	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.14
YPS-379	2014	Bruin Creek		2	0.33	Mildly Divergent	213	12	22.7	0.66	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	11.15
YPS-379	2009	Bruin Creek		2	0.45	Mildly Divergent	1372	20	20.0	0.12	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	10.59
YPS-540	2015	Browns Cr	Mod-Low	1	0.34	Mildly Divergent	217	15	43.0	0.78	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	10.74
YPS-540	2012	Browns Cr		4	0.34	Mildly Divergent	174	13	17.8	0.54	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.27
YPS-541	2015	Bruin Creek	Mod-Mod	4	0.40	Mildly Divergent	980	13	25.4	0.56	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.73
YPS-541	2012	Bruin Creek		4	0.40	Similar to Reference	2659	16	18.7	0.43	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.71
YPS-542	2015	Trib Bruin Cr	Mod-Mod	4	0.39	Similar to Reference	439	13	29.4	0.86	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.84
YPS-542	2012	Trib Bruin Cr		4	0.37	Divergent	165	14	21.0	0.52	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.56

3.4.2.1 Forty Mile Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-375

This site is located near the mouth of Maiden Creek and just downstream of active placer mining. In 2015, benthic invertebrate abundance was within the normal range and family richness was slightly higher than expected. The site has three years of reliable data with a consistent site assessment results. Given the monitoring results thus far there is a low priority for re-sampling this site.

YPS-379

This site is located at the mouth of Bruin Creek with no known active placer mining upstream and only minimal historic activity. In 2015, benthic invertebrate abundance was well below the normal range but family richness was much higher than expected. Although there are three years of sample data for this site, a high water event that occurred just before the 2015 sample date

may have influenced the results of the site assessment and as such the 2015 result may not be accurate. Given the 2009 and 2014 site assessment results, and the potentially unreliable 2015 data combined with minimal placer activity within the drainage, this site is considered a moderate priority for re-sample. This site was re-sampled in 2016.

YPS-540

This site is located in the middle portion of the Browns Creek drainage within historic placer workings and downstream of new active placer mining. In 2015, benthic invertebrate abundance was within the normal range but family richness was much higher than expected. There are 2 years of reliable sample data. Given the assessment results and the presence of new placer mining upstream, this site is considered to have a moderate priority for re-sample. This site was re-sampled in 2016.

YPS-541

This site is located in the upper portion of the Bruin Creek drainage within historic placer workings with no known active placer mining upstream. In 2015, benthic invertebrate abundance was low but within the normal range and family richness was slightly higher than expected. Given the 2 years of reliable sample data as well as the site assessment results, this site is considered to have a low priority for re-sample.

YPS-542

This site is located on a tributary to Bruin Creek with no known placer activity upstream. In 2015, benthic invertebrate abundance was just outside the normal range and family richness was slightly higher than expected. There are 2 years of reliable sample data. Given the assessment results, this site is considered to have a low priority for re-sample.

3.4.3 Klondike River Watershed

Table 9. Site assessment results for Klondike River Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	**Year**	**Stream**	**Habitat Suitability**	**Group**	**Group Prob.**	**Site Assessment Result**	**Abundance**	**Richness**	**Depth (cm)**	**Velocity (m/s)**	**Abundance (SD)**	**Depth in cm (SD)**	**Velocity in m/s (SD)**	**RIVPACS Expected Richness**
YPS-082	2015	Eldorado Cr	Mod-Low	4	0.46	Similar to Reference	581	16	17.0	0.33	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.29
YPS-082	2006	Eldorado Cr		4	0.48	Mildly Divergent	381	10	13.3	0.49	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.49
YPS-084	2015	Bonanza Cr	Mod-Low	4	0.45	Highly Divergent	76	9	31.2	0.70	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.52
YPS-084	2010	Bonanza Cr		2	0.41	Highly Divergent	2567	16	18.0	0.05	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	12.00
YPS-084	2006	Bonanza Cr		4	0.42	Divergent	132	7	28.9	0.43	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.23
YPS-108	2015	Bonanza Cr	Mod-Low	4	0.50	Mildly Divergent	240	9	15.0	0.63	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.56
YPS-108	2006	Bonanza Cr		4	0.47	Divergent	1564	9	22.8	0.52	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.38
YPS-544	2015	Hunker Cr	Mod-High	4	0.35	Divergent	143	12	38.2	0.62	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.71
YPS-544	2014	Hunker Cr		2	0.43	Divergent	45	4	24.8	0.30	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	11.62
YPS-544	2013	Hunker Cr		2	0.39	Mildly Divergent	39	6	19.0	0.42	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	11.92
YPS-544(077)*	2006	Hunker Cr		2	0.36	Mildly Divergent	240	15	29.5	0.55	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	11.83
YPS-569	2015	Allgold Cr	Mod-High	4	0.50	Divergent	99	4	20.4	0.98	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.96
YPS-569	2013	Allgold Cr		4	0.43	Divergent	108	7	17.3	0.23	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.24
YPS-569(214)*	2007	Allgold Cr		4	0.45	Divergent	125	11	10.6	0.23	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.37

* These sites were combined due to their close proximity to one another as well as high similarity; old site number is given in brackets.

3.4.3.1 Klondike River Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-082

This site is located in the middle of the Eldorado Creek drainage within historic workings with historic as well as active placer mining upstream and in close proximity to the site. In 2015, benthic invertebrate abundance was low but within the normal range and family richness was higher than expected. The site has 2 years of reliable sample data and, given the assessment results, it is considered to have a low priority for re-sample.

YPS-084
This site is located in the middle of the Bonanza Creek drainage within historic workings with historic and active placer mining upstream and in close proximity. In 2015, benthic invertebrate abundance was well below the normal range and family richness was much lower than expected. Given the results of three years of monitoring this site is considered a high priority for re-sampling in order to continue to observe trends over time.

YPS-108
This site is located in the middle of the Upper Bonanza Creek drainage within historic workings with historic and active placer mining upstream and in close proximity to the site. In 2015, benthic invertebrate abundance was below the normal range and family richness was much lower than expected. This site has two years of reliable sample data and this combined with the site assessment results it is considered a low priority for re-sample.

YPS-544
This site is located near the mouth of Hunker Creek and has four years of reliable and comparable sample data. There is active and historical placer mining upstream and in close proximity to this site. In 2015, benthic invertebrate abundance was well below the normal range and family richness was as expected. Given the results of monitoring, this site it is considered a high priority for re-sampling in order to continue to observe trends in site assessment results over time. This site was re-sampled in 2016.

YPS-569
This site is located in the lower reaches of Allgold Creek, has three years of sample data and is located within historic placer workings and downstream of active placer mining. In 2015, benthic invertebrate abundance was well below the normal range and family richness was very much lower than expected. The consistent site assessment results between years is likely appropriate for this site therefore this site is considered a moderate priority for re-sample. This site was re-sampled in 2016.

3.4.4 Mayo River Watershed

Table 10. Site assessment results for May River Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	**Year**	**Stream**	**Habitat Suitability**	**Group**	**Group Prob.**	**Site Assessment Result**	**Abundance**	**Richness**	**Depth (cm)**	**Velocity (m/s)**	**Abundance (SD)**	**Depth in cm (SD)**	**Velocity in m/s (SD)**	**RIVPACS Expected Richness**
YPS-147	2015	Duncan Cr	Low	4	0.42	Mildly Divergent	388	17	32.8	0.80	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.72
YPS-147	2006	Duncan Cr		4	0.41	Similar to Reference	716	15	39.1	0.86	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.69
YPS-149	2015	Duncan Cr	Low	4	0.47	In Reference Condition	2668	14	32.4	0.84	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.12
YPS-573	2015	Davidson Cr	Low	4	0.40	Divergent	150	19	25.2	0.68	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.39
YPS-574	2015	Granite Cr	Mod-Mod	4	0.49	In Reference Condition	2147	16	37.0	0.72	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.05
YPS-575	2015	Davidson Cr	Low	4	0.45	Mildly Divergent	680	19	26.0	0.94	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	13.20

3.4.4.1 Mayo River Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-147

This site is located in the lower reach of the Duncan Creek drainage and has two years of reliable sample data. There is historical placer mining upstream and in close proximity to this site. In 2015, benthic invertebrate abundance was below the normal range but family richness was much higher than expected. Given the site assessment results, this site is considered a low priority for re-sample at this time.

YPS-149

This site is located in the upper part of the Duncan Creek drainage and there is one year of data available for this site. The site is located downstream of extensive hard rock mining activity and as such the site assessment results are not considered reflective of placer mining influences alone. Additional sampling at this location will not be undertaken.

YPS-573

This site is located at the mouth of Davidson Creek and 2015 was the first sample at this location. There is active placer activity upstream of the site. In 2015, benthic invertebrate abundance was well below the normal range but family richness was much higher than expected. Given the site assessment result this site is a high priority for re-sample.

YPS-574

This site is located in the upper reaches of Granite Creek and 2015 was the first sample at this location. There is recently developed active placer activity upstream of the site. In 2015, benthic invertebrate abundance within the normal range with family richness higher than expected. Given that all placer activity on Granite Creek is recent, this site is a high priority for re-sample. This site was resampled in 2016.

YPS-575

This site is located mid-way up the Davidson Creek drainage above all placer activity and 2015 is the first sample at this location. In 2015, benthic invertebrate abundance was low, but within the normal range, and family richness was much higher than expected. Given the site assessment result, this site is considered a low priority for re-sample.

3.4.5 Sixty Mile River Watershed

Table 11. Site assessment results for Sixty Mile River Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	**Year**	**Stream**	**Habitat Suitability**	**Group**	**Group Prob.**	**Site Assessment Result**	**Abundance**	**Richness**	**Depth (cm)**	**Velocity (m/s)**	**Abundance (SD)**	**Depth in cm (SD)**	**Velocity in m/s (SD)**	**RIVPACS Expected Richness**
YPS-086	2015	20-Mile Cr at 60-Mile R.	Mod-Mod	4	0.39	Similar to Reference	430	12	35.8	0.78	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.25
YPS-086	2006	20-Mile Cr at 60-Mile R.		1	0.46	Mildly Divergent	520	10	61.5	0.67	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	9.91
YPS-114	2015	Matson Cr	ASC	4	0.39	In Reference Condition	1627	15	44.8	0.72	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.37
YPS-114	2012	Matson Cr		4	0.33	Mildly Divergent	648	20	47.2	0.49	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	10.90
YPS-114	2006	Matson Cr		4	0.33	In Reference Condition	1431	16	48.1	0.52	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	10.92
YPS-115	2015	Matson Cr	ASC	4	0.47	Mildly Divergent	556	22	42.2	1.38	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.44
YPS-115	2006	Matson Cr		1	0.33	Divergent	1192	15	60.0	0.81	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	10.89
YPS-118	2015	60-Mile R. at 50-Mile R.	Mod-Low	1	0.46	In Reference Condition	63	15	103.0	1.10	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	10.03
YPS-538	2015	Matson Cr	Mod-Low	4	0.38	Similar to Reference	770	19	46.4	0.60	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.29
YPS-538	2012	Matson Cr		4	0.35	Mildly Divergent	186	18	50.4	0.55	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.02

3.4.5.1 Sixty Mile River Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-086

This site is located at the mouth of 20-Mile Creek. Information related to the level and extent of placer activity on this drainage is not available at this time. There are two years of reliable sample data for this site. In 2015, benthic invertebrate abundance was below the normal range but family richness was as expected. Given the site assessment result this location is considered a low priority for re-sample.

YPS-114

This site is located in the lower reaches of the Matson Creek drainage and is well downstream of both historic and active placer mining. The site has three years of reliable data. In 2015, benthic invertebrate abundance was within the normal range and family richness was higher than expected. Given the site assessment results it is considered a low priority for re-sample.

YPS-115
This site is located at the mouth of Matson Creek and is well downstream of both historic and active placer mining. The site has two years of sample data. In 2015, benthic invertebrate abundance was low but within the normal range but family richness was way higher than expected. This site is considered a moderate priority for re-sample. This site was resampled in 2016.

YPS-118
This site is located on the 60 Mile River with historic and active placer occurring upstream. The stream channel at this location is wide and deep and as such the sample methods intended for wadeable streams that were used in 2015 may not have been appropriate for this location. In 2015, benthic invertebrate abundance was within the normal range and family richness was much higher than expected. This single year site assessment is considered potentially unreliable and combined with an unusable previous visit in 2006, indicates that no further sampling should be undertaken at this location with our current methodology.

YPS-538
This site is located in the lower-mid reaches of the Matson Creek drainage and is downstream of both historic and active placer mining. The site has two years of reliable data. In 2015, benthic invertebrate abundance was low but within the normal range while family richness was much higher than expected. Given the site assessment results it is considered a low priority for re-sample.

3.4.6 Stewart River Watershed

Table 12. Site assessment results for Stewart River Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	Year	Stream	Habitat Suitability	Group	Group Prob.	Site Assessment Result	Abundance	Richness	Depth (cm)	Velocity (m/s)	Abundance (SD)	Depth in cm (SD)	Velocity in m/s (SD)	RIVPACS Expected Richness
YPS-347	2015	Clear Creek	Low	4	0.37	Mildly Divergent	942	15	25.8	0.57	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.86
YPS-347	2008	Clear Creek		4	0.36	Mildly Divergent	1689	17	17.8	0.57	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.69
YPS-348	2015	Clear Creek	Low	4	0.42	Mildly Divergent	383	18	35.0	0.56	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.87
YPS-348	2008	Clear Creek		2	0.36	Mildly Divergent	720	21	47.6	0.38	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	12.39
YPS-428	2015	Black Hills Cr	Mod-High	4	0.38	Highly Divergent	26	6	37.4	0.36	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.72
YPS-428	2014	Black Hills Cr		2	0.38	Similar to Reference	72	8	61.2	0.38	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	10.90
YPS-428	2013	Black Hills Cr		2	0.41	Divergent	13	2	69.8	0.18	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	10.31
YPS-428	2010	Black Hills Cr		2	0.38	Highly Divergent	11	2	74.4	0.28	265.38 (160.60)	31.44 (19.67)	0.43 (0.26)	10.32
YPS-429	2015	Black Hills Cr	Mod-Low	4	0.50	Mildly Divergent	269	8	13.7	0.52	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.61
YPS-429	2013	Black Hills Cr		4	0.49	Divergent	297	11	38.4	0.64	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.54
YPS-429	2011	Black Hills Cr		4	0.46	Highly Divergent	71	9	24.6	0.58	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.41
YPS-429	2010	Black Hills Cr		4	0.50	Mildly Divergent	543	14	13.4	0.64	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.70
YPS-578	2015	No Name	Low	4	0.45	In Reference Condition	815	8	10.0	0.20	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.74

3.4.6.1 Stewart River Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-347

This site is located in the upper part of the Clear Creek drainage and is downstream of both historic and active placer mining. In 2015, benthic invertebrate abundance was low but within the normal range and family richness was slightly higher than expected. The site has two years of reliable data and given the site assessment results it is considered a low priority for re-sample.

YPS-348

This site is located mid-way up the Clear Creek drainage and is downstream of both historic and active placer mining. In 2015, benthic invertebrate abundance was below the normal range and family richness was much higher than expected. The site has two years of reliable data and given the site assessment results it is considered a low priority for re-sample.YPS-428

YPS-428
This site is located at the mouth of Black Hills Creek and is downstream of both historic and active placer mining. In 2015, benthic invertebrate abundance was well below the normal range and family richness was much lower than expected. There are four years of reliable site assessment results for this location; however no consistent trend is apparent. In order to continue to track trends in monitoring results over time this site is considered a moderate priority for re-sampling.

YPS-429
This site is located in the upper Black Hill Creek Drainage with both historic and active placer mining upstream of the site. In 2015, benthic invertebrate abundance was below the normal range and family richness was much lower than expected. Over the four years of reliable site assessment results there may be a trend emerging; however additional information may be required to make a determination. At this time this site is considered a low priority for re-sample given other priorities in this drainage.

YPS-578
This site is located at the mouth of a tributary to Clear Creek and is situated downstream of both historic and active placer activity. In 2015, benthic invertebrate abundance was low but within the normal range and family richness was much lower than expected. 2015 was the first sample year for this site and given the site assessment result no further sampling is planned on this stream unless placer related activity changes. This site is a low priority for re-sample.

3.4.7 White River Watershed

Table 13. Site assessment results for White River Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	Year	Stream	Habitat Suitability	Group	Group Prob.	Site Assessment Result	Abundance	Richness	Depth (cm)	Velocity (m/s)	Abundance (SD)	Depth in cm (SD)	Velocity in m/s (SD)	RIVPACS Expected Richness
YPS-506	2015	Burwash Cr	Mod-Mod	4	0.28	Highly Divergent	16	6	26.1	0.70	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.19
YPS-506	2011	Burwash Cr		3	0.36	Highly Divergent	32	6	44.8	1.07	567.00 (737.13)	32.11 (15.81)	0.58 (0.29)	12.33
YPS-508	2015	Quill Creek	Low	4	0.32	Mildly Divergent	319	12	19.5	0.73	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	12.56
YPS-508	2011	Quill Creek		3	0.40	Mildly Divergent	235	15	33.2	1.56	567.00 (737.13)	32.11 (15.81)	0.58 (0.29)	12.98
YPS-568	2015	Tatamagouche Cr	Low	5	0.33	Highly Divergent	571	13	22.5	0.52	12539.4 (5669.59)	24.00 (13.45)	0.69 (0.41)	12.43
YPS-568	2013	Tatamagouche Cr		5	0.53	Highly Divergent	129	7	27.4	1.21	12539.4 (5669.59)	24.00 (13.45)	0.69 (0.41)	12.37
YPS-571	2015	Maple Cr	Low	5	0.97	Divergent	780	9	15.0	0.53	12539.4 (5669.59)	24.00 (13.45)	0.69 (0.41)	11.04
YPS-572	2015	Quill Cr	Mod-Mod	4	0.31	Mildly Divergent	470	13	24.0	0.62	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.89

3.4.7.1 White River Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-506

This site is located in the lower part of the Burwash Creek drainage upstream of the highway and downstream of historic and active placer mining. In 2015, benthic invertebrate abundance was well below the normal range and family richness was much lower than expected. There are two years of sample data for this site however given the difference in flow conditions between the two samples, results may not be comparable. Given the potential data issues further sampling may be required; therefore this site is considered a moderate priority for re-sample.

YPS-508

This site is located in the middle portion of the Quill Creek drainage near historic placer mining, no active placer mining upstream from site. In 2015, benthic invertebrate abundance was below the normal range and family richness was as expected. Two years of reliable sample data combined with the site assessment results make this site a low priority for re-sample.

YPS-568
This site is located mid-way up the Tatamagouche Creek drainage with only historic placer mining as well as roads and fords located upstream. In 2015, benthic invertebrate abundance was well below the normal range and family richness was as expected. There are two years of sample data for this site however given the results of site assessments this site is considered a moderate priority for re-sample. Based on its priority assignment this site was re-sampled in 2016.

YPS-571
This site is located in the lower portion of the Maple Creek drainage and downstream of historic placer mining as well as a road running up the drainage. In 2015, benthic invertebrate abundance was well below the normal range and family richness was slightly lower than expected. Site assessment results for this site may not be accurate and as such further investigation into this result is required. Given the potential issues with this site no additional site visits are planned at this time.

YPS-572
This site is located in the lower part of the Quill Creek drainage and downstream of historic placer mining. In 2015, benthic invertebrate abundance was just below the normal range and family richness was slightly higher than expected. This is the first year of sample data for this site and given the site assessment result it is considered a low priority for re-sample.

3.4.8 Yukon River South Watershed

Table 14. Site assessment results for Yukon River South Watershed sample sites including invertebrate community metrics and habitat variables. Reference group averages as well as RIVPACS expected richness are provided for comparison. Standard deviation (SD) is given where appropriate.

Test Site Assessment Results											Reference Group Averages			
Site	**Year**	**Stream**	**Habitat Suitability**	**Group**	**Group Prob.**	**Site Assessment Result**	**Abundance**	**Richness**	**Depth (cm)**	**Velocity (m/s)**	**Abundance (SD)**	**Depth in cm (SD)**	**Velocity in m/s (SD)**	**RIVPACS Expected Richness**
YPS-119	2015	Sparkling Cr	Mod-High	1	0.59	Mildly Divergent	520	11	10.4	0.37	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	9.23
YPS-119	2006	Sparkling Cr		1	0.57	Similar to Reference	96	11	11.6	0.49	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	9.39
YPS-164	2015	Thistle Creek	Mod-High	4	0.45	Divergent	303	11	18.7	0.84	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.61
YPS-164	2014	Thistle Creek		1	0.39	Mildly Divergent	517	15	29.8	0.48	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	10.43
YPS-164	2013	Thistle Creek		4	0.36	Highly Divergent	55	6	16.2	0.31	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	10.75
YPS-164	2012	Thistle Creek		4	0.41	Divergent	136	13	18.2	0.61	2059.40 (1572.90)	29.80 (14.62)	0.52 (0.32)	11.21
YPS-579	2015	Donahue Cr	Mod-High	1	0.42	Divergent	1448	13	12.5	0.37	192.18 (127.13)	36.46 (24.31)	0.42 (0.29)	10.21

3.4.8.1 Yukon River South Test Site Discussion

A description of the site assessment results, placer mining activity, as well as the priority for re-sampling the site is provided below. At this time the intensity and proximity of all historic and active placer mining cannot be provided for each sample site. Information provided is based on observations made during field sampling as well as through conversation with knowledgeable personnel and should therefore not be considered exhaustive.

YPS-119

This site is located very near the mouth of Sparkling Creek which is downstream of historic placer activity. In 2015, benthic invertebrate abundance was well above the normal range and family richness was slightly higher than expected. There are two years of reliable sample data for this site and given the site assessment results combined with no known active placer on this drainage there is a low priority for re-sampling this site.

YPS-164

This site is located at the mouth of Thistle Creek and downstream of both historic and active placer mining. In 2015, benthic invertebrate abundance was below the normal range and family richness was as expected. Over the four years of sample data no trend in site assessment results is apparent; however additional information may be required to make a determination. Given the variable site assessment results at this location the site is considered a high priority for re-sample and as such was re-visited in 2016.

YPS-579

This site is located at the mouth of Donahue Creek with no known historic or active placer mining in the drainage. In 2015, benthic invertebrate abundance was well above the normal range and family richness was higher than expected. This is the first year of sample data for this site and given the site assessment result it is considered a moderate priority for re-sample.

4 Next Steps

4.2 Additional Tasks and Future Monitoring

Aquatic health monitoring is being carried out to obtain data to inform sound adaptive management decisions. To achieve this, the following initiatives will be undertaken:

- Develop secondary assessment methodology to corroborate RCA and assist in determining reasons for site assessment results;
- Analyse all past site assessments with the 2013 Yukon RCA model and publish the site assessment reports on the Yukon Placer Secretariat website;
- Better integrate water quality objective monitoring and aquatic health monitoring;
- Focus aquatic health monitoring on sites with downward trends in site assessments, on those historically mined sites that are not showing signs of improvement over time and on Test Sites where there is new (post 2008) placer development.
- Continue working toward compiling information related to placer mining activity on monitored watercourses. The following is a proposed methodology to facilitate this exercise.

Placer Mining Activity Assessment

In order to assess the effects of placer mining activity on the aquatic health of Yukon streams it is vital that data on the intensity and variety of placer activity at or upstream of sampling locations be collected. Several descriptors can be used to identify this information at, and upstream of, Test Sites. When possible streams can be flown and photographs can be taken along with detailed notes about placer activity. Existing sources of information can also be accessed including Yukon Government databases and mining inspection reports as well as information gained through discussion with relevant personnel.

A set of proposed placer related metrics that can be collected during annual site visits, as well as through consultation with Yukon Government Energy Mines and Resources staff, is provided in the table below. This information is provided for discussion purposes and does not necessarily include all potential options. Further discussion is required in order to establish the feasibility of collecting this information as well as to determine a scoring system in order to accurately quantify placer related impacts at the site and watershed level.

The flowing table outlines the proposed metrics used to determine the scale of placer related impacts at each Test Site.

Placer Related Impacts	**Metric**	**Score**
Active Placer Mining	Present	
Active Sluicing	Present	
Historic Placer	Pre-2008 Post-2008	
Total Recirculation	Present	
Roads with impacts on stream (% of upstream drainage)	1-25 % 26-50 % 51-75 % 76-100 %	
Instream Works	Diversion Instream Settling Instream Reservoir Stream as Conduit Small works (dugout/wing dams/etc) Ford(s)	
Channel Substrate Impacted	Compacted High Silt Load	
Significant Bank Erosion	Intensity/Score: 1 2 3 4 5 6 7 8 9 10 (0 = Isolated Areas to 10 = Entire Channel Bank(s))	
Natural Impacts	**Metric**	
Active Landslide(s)	Small (1) Medium (2) Large (3)	
Recent Forest Fire(s) with Influence on Site	Intensity/score: 1 2 3 4 5 6 7 8 9 10 (0 = Isolated Areas to 10 = entire drainage)	
Recent Storm/Rain Event	Intensity/Score: Low (1) Med (2) High (3) Very High (4)	
Proximity of Upstream Placer Activity	<1km 1-2km 2-4km 4-6km 6-8km 8-10km >10km	

Appendix 1 - CABIN Summary Reports for 2015 Test Site Assessments

(Sites listed in numerical order)

Appendix 1 Legend

Habitat variables are provided for each sample site in either absolute values, binary values (0,1) or by category (0-9); definitions are provided below.

			Range							
Habitat Variable	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
CH-Macrophyte (PercentRange)	None	1-25	26-50	51-75	76-100					
CH-Reach-%CanopyCoverage (PercentRange)	None	1-25	26-50	51-75	76-100					
CH-Reach-Pools (Binary)	Absent	Present								
CH-Reach-Rapids (Binary)	Absent	Present								
CH-Reach-Riffles (Binary)	Absent	Present								
CH-Reach-StraightRun (Binary)	Absent	Present								
CH-Veg-Coniferous (Binary)	Absent	Present								
CH-Veg-Deciduous (Binary)	Absent	Present								
CH-Veg-GrassesFerns (Binary)	Absent	Present								
CH-Veg-Shrubs (Binary)	Absent	Present								
SU-Dominant-1st (Category(0-9))	Organic Cover	<0.1 cm (silt)	0.1 – 0.2 cm (sand)	0.2 – 1.6 cm (gravel)	1.6 – 3.2 cm (pebble)	3.2 – 6.4 cm (pebble)	6.4 – 12.8 cm (cobble)	12.8 – 25.6 cm (cobble)	> 25.6 cm (boulder)	Bedrock
SU-Dominant-2nd (Category(0-9))	Organic Cover	<0.1 cm (silt)	0.1 – 0.2 cm (sand)	0.2 – 1.6 cm (gravel)	1.6 – 3.2 cm (pebble)	3.2 – 6.4 cm (pebble)	6.4 – 12.8 cm (cobble)	12.8 – 25.6 cm (cobble)	> 25.6 cm (boulder)	Bedrock
SU-SurroundingMaterial (Category(0-9))	Organic Cover	<0.1 cm (silt)	0.1 – 0.2 cm (sand)	0.2 – 1.6 cm (gravel)	1.6 – 3.2 cm (pebble)	3.2 – 6.4 cm (pebble)	6.4 – 12.8 cm (cobble)	12.8 – 25.6 cm (cobble)	> 25.6 cm (boulder)	Bedrock
Habitat Variable	**0**	**1**	**2**		**3**		**4**		**5**	
SU-Embeddedness (Category(1-5))	N/A	Completely embedded	3/4 embedded		1/2 embedded		1/4 embedded		unembedded	
SU-PeriphytonCoverage (Category(1-5))	N/A	Thin layer, no colour	Yellow-brown to light green		Patches of thicker green to brown		Numerous large clumps of green to dark brown		Rocks are mostly obscured, extensive green, brown to black mass may have long strands (≥ 20mm thick)	

Appendix 2 - 75% Ellipse Plots for 2015 Test Sites Assessed in Band One in CABIN Online Assessment

(Sites listed in numerical order)

Appendix 3 - CABIN Raw Site Data Outputs, 2015 Sample Sites

(All measurements reflect conditions at the site on the sample date)