Digitizing and spatially analyzing historic placer exploration data from Dominion Creek: A pilot project

***Sydney van Loon*[1]**
Yukon Geological Survey

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Abstract

Compilation of historic geologic data can help identify deposits of unmined gold-bearing gravel and promote further exploration on under-explored ground. Archival documents of the Yukon Consolidated Gold Corporation (YCGC) contain detailed, accurate prospecting data, and can be used to identify dredge localities and production values. With dredge inefficiency and crude mining techniques, areas heavily worked in the past may contain both technogenic and remnant *in situ* gold-bearing gravel. These types of placer deposits have been the target for many miners on previously worked ground, but with the aid of historic data, these deposits can be identified and evaluated for their potential prior to any ground work. Although there are some limitations and challenges associated with the historic documents, the data contained within them can significantly support placer exploration in both mined and unmined areas of Yukon.

[1]*sydney.vanloon@gov.yk.ca*

INTRODUCTION

Higher gold prices, more economical and efficient mining methods, and growth in the placer industry have resulted in new targets being explored and historic creeks analyzed for their missed potential. Uncovering remnants of untouched gravels on previously mined creeks has been a target for many miners, but these remnants are primarily found by coincidence and anecdotal evidence. Using historic geological data, targets can be identified in previously explored creeks that can lead to discoveries of virgin gravel. An extensive and detailed resource of historic placer geology data exist in the Yukon Consolidated Gold Corporation (YCGC) archival files; YCGC was a prominent company in the Klondike while in operation from 1923 to 1966 (Green, 1977). Geological data obtained from the collection consist of surficial material depth, depth to bedrock, gold grade, ground condition (permafrost), bedrock and surface elevation, as well as historic activity localities such as dredge limits, drilling and shafting locations. Documents from the collection can be used to piece together new and missed potential that exists in the Klondike. The archival files of the YCGC include data primarily from the Klondike mining district, as well as a small amount of reconnaissance exploration data from other placer districts.

While a small number of YCGC documents handed down from the previous generation still circulate in the Klondike, the bulk of the YCGC archival collection is housed at the Canadian National Archives in Ottawa. Identified by the Yukon placer mining industry as a valuable resource, Yukon Geological Survey (YGS) has undertaken a project to identify, scan and make available documents of geological interest pertaining to Yukon. This repatriation project has involved scanning more than 1000 documents and maps. In order to evaluate the potential of the historic geologic data to modern placer exploration, YGS completed a digital compilation for Dominion Creek.

The objective of this project is to demonstrate how to incorporate YCGC data into a geographic information system (GIS) in order to assess its potential for placer exploration. This process highlights the challenges, limitations and accuracy of bringing historic data into a modern analytical environment.

A pilot project was completed on a section of the Dominion Creek drainage where sufficient YCGC data have been recovered. Data includes drilling information on gold grades, material thickness, presence of permafrost and depth to bedrock. In addition, data on areas dredged (dredge limits) and gold produced are also captured. Through analyses of this information two important economic questions are addressed: (1) what are the pay channel characteristics; and (2) where are the exploration targets?

STUDY AREA: DOMINION CREEK

Dominion Creek, a tributary of the Indian River, is a significant placer gold-bearing stream which has been actively mined since the early 1900s. A total of 2.73 million ounces of placer gold has been produced from Dominion Creek; hand mining produced 1,000,000 ounces, dredging produced 775,000 ounces, and mechanized mining produced 621,000 ounces (YGS, 2010). Twenty five historic documents on drilling, shafting and dredging are present for the middle reaches of Dominion Creek; for this reason the pilot project was chosen in this area (Fig. 1). The section investigated is approximately 9 km long, extending from the mouth of Nevada Creek downstream to the mouth of Arkansas Creek, and includes claims 76 to 177. Three historic drilling maps from 1936 were used in this project, YCGC Map numbers 1103 to 1105 (Fig. 2).

METHODS

Bringing historic geological maps into modern Geographical Information Systems (GIS) provides opportunities for advanced analysis and the creation of new maps that can be significantly more intuitive and easier to use than the original maps. For the Dominion Creek pilot project, the following steps were taken to incorporate the historic data into a modern mapping system.

GEOREFERENCING

In order to digitize data contained on the historic maps, scanned maps were imported into ESRI ArcGIS, and stable control points (stream junctions and valley orientation) were used to initially place the dataset to known positions. The dataset was then georeferenced by matching the vertices of historic placer claims with the Yukon Government's placer claim dataset. Quality of georeferencing was assessed by comparing actual known historic claim locations, which were located and recorded in the field.

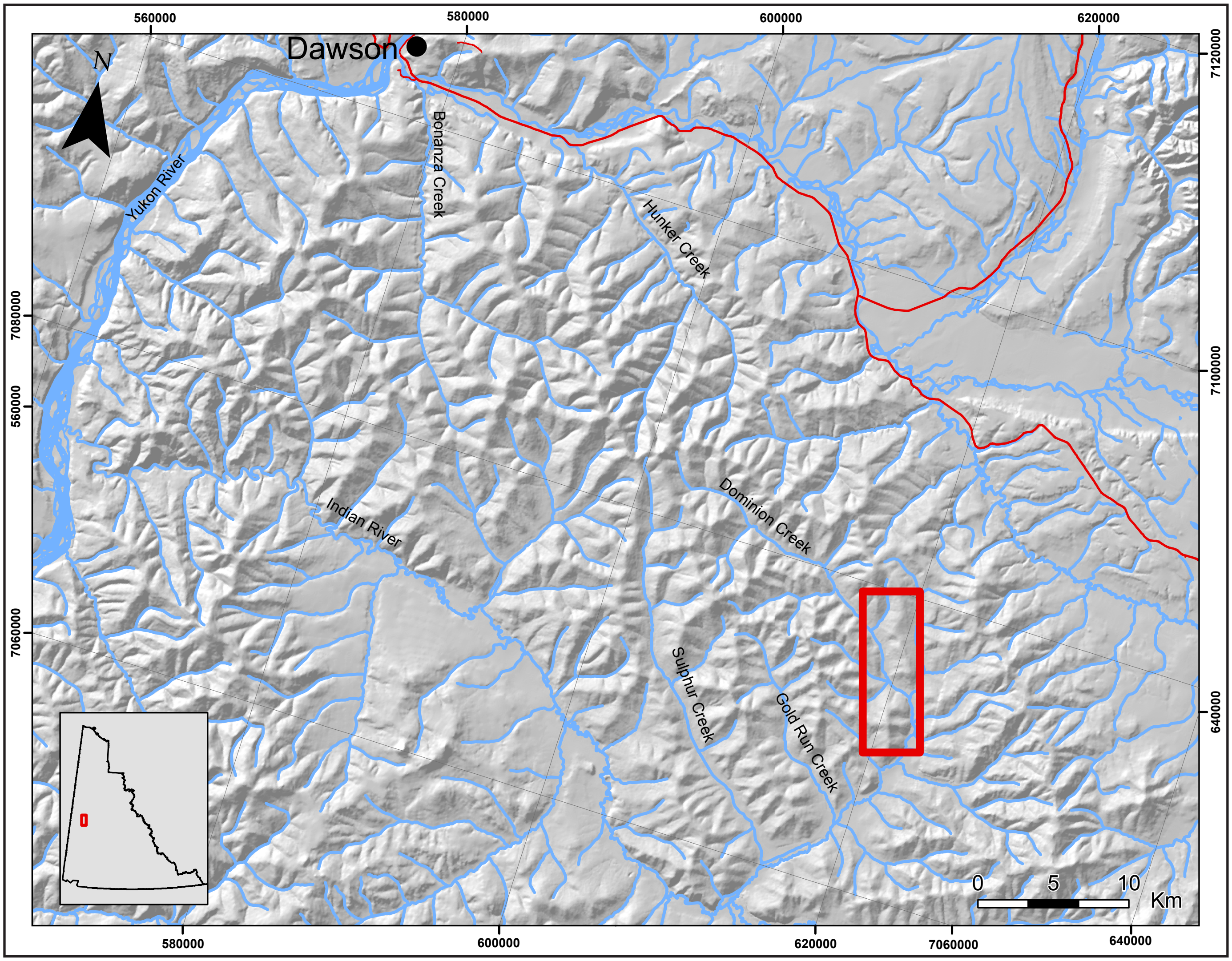

Figure 1. *Study area (outlined in red) south of Dawson City on mid-Dominion Creek.*

DIGITIZING

The 450 drill hole collars within the study area were manually digitized inside a point feature class, and attributed with their associated geological data (Appendix 1). The geological data include drill hole number, ground condition (frozen, partial or thawed), surface elevation, bedrock elevation, depth of overburden, depth of dredge section (pay gravel plus bedrock), and grade measured in dollars per cubic yard (gold at CDN $20.67). Dredge limits, both original and revised, were also digitized from the maps. Satellite imagery from July 2009 was used to compare georeferenced dredge limit locations with actual dredge limits by identifying dredge piles and undisturbed ground. The resulting digitized drill hole dataset and dredge limits formed the basis of the analysis (Appendix 2).

CONVERSIONS

Calculations were performed to convert measurements from imperial to metric. Depth in feet for overburden and dredge section were converted to metres. Within the attribute table of the drill hole data layer, a new column labeled 'total section depth' was generated from the sum of overburden plus dredge section. This was completed using the Field Calculator function in ArcGIS. The value of gravel in cents per cubic yard, was converted from the historic price of CDN $20.67 to today's price of CDN $1400.00. This was completed by converting cents to dollars, dollars to number of fine ounces, and multiplying the ounces by CAD $1400 to determine modern grade.

CORRECTIONS

Drill holes labeled with TR (trace) grades were digitized as 0.1 cents per cubic yard to show that gold was present, despite the low quantity. Several bedrock elevation values were too faintly transcribed to be reliable and were removed from the dataset. Drill hole 134-8 produced an historic grade of 2132.7 cents per cubic yards (gold at CDN $20.67), which was 527% higher than the next highest value in the dataset (404.8 cents per cubic yard). We considered this value to be the result of the nugget affect, and therefore, assigned a value that averaged its neighbouring drill holes to reduce the emphasis of the location.

SPATIAL ANALYSIS

Once the raw data were reviewed and corrected, spatial analyses were performed to create a series of raster datasets; each dataset highlights the various measurements associated with the drill hole data. In order to create the raster surfaces, the ArcGIS Spatial Analyst tool 'Inverse Distance Weighting' (IDW) algorithm was used to interpolate each attribute associated with the drill hole points. Contours at various intervals were then derived, using ArcGIS Spatial Analyst 'Surface' tool, from each of the resulting raster datasets to determine which interval gives the best representation of the data. For example, larger contour intervals of bedrock topography highlighted

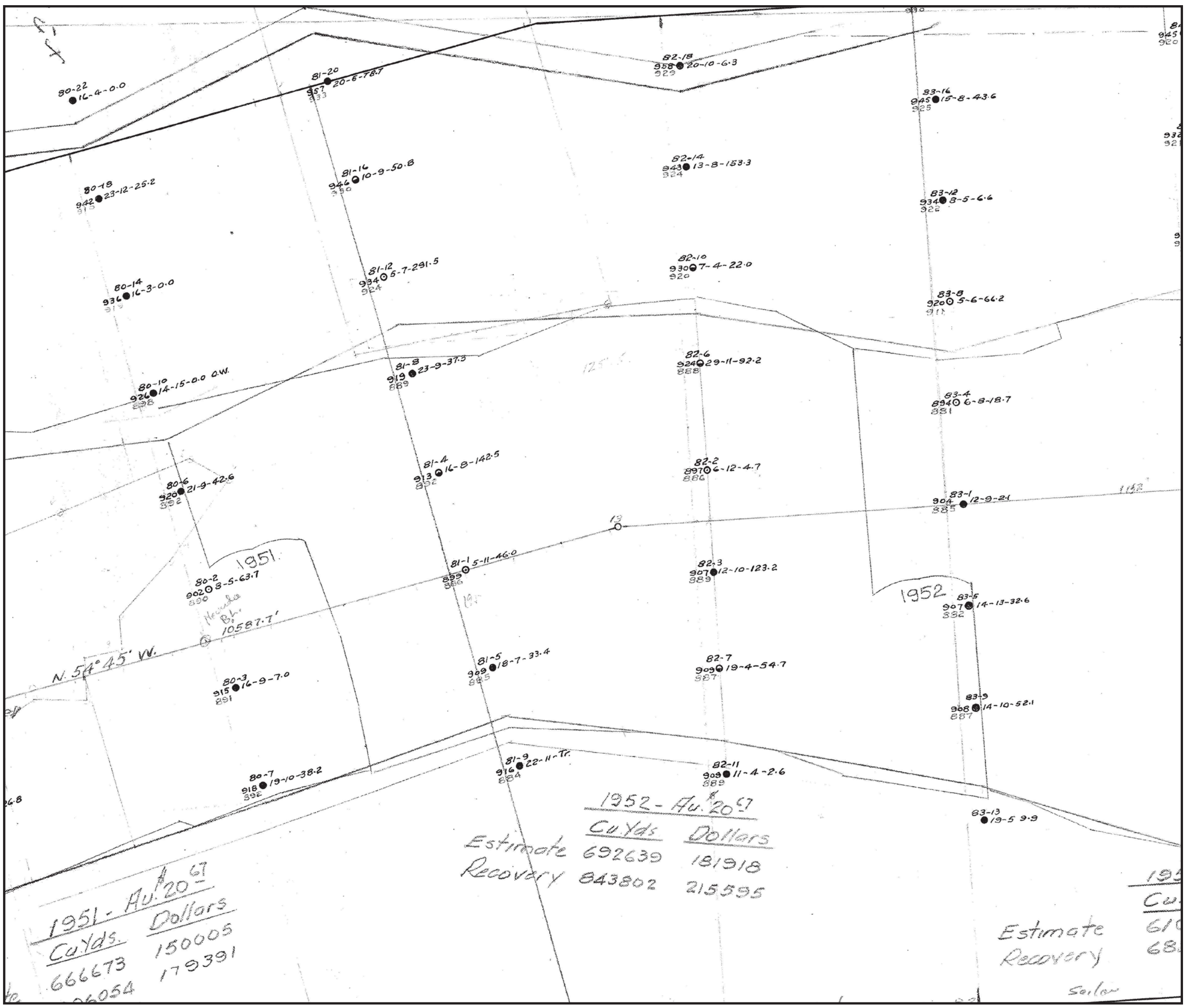

Figure 2. *Clip of drill map no. 1103, September 1936 (YCGC, 1936).*

bench features and small intervals highlighted undulations. The pay channel location was accentuated when grade contours were presented at coarser intervals (10 m), whereas detailed channel morphological features were highlighted under finer (2 m) contours.

Of particular value was the development of a bedrock topography map. In order to illustrate the bedrock topography, a digital elevation model (DEM) was visually represented with a hillshade image produced from the Spatial Analyst tool 'Hillshade' algorithm.

INTERPRETATIONS

The resulting points, rasters, and contours were then used to produce a series of maps (Appendices 3 to 7). A bedrock-low channel was digitized by following the contours (Appendix 8). Similarly, the pay channel was reconstructed and digitized by connecting the zones of the highest grade. Pay channel patterns and characteristics were derived from viewing single and multiple layer raster data. Likewise, exploration targets were generated by overlaying multiple sets of raster data and using the dredge limit polygon to further subdivide target types.

DATA LIMITATIONS

Several limitations exist within the dataset and must be taken into consideration when working with and interpreting the data. The main challenge associated with the historic map documents is their lack of geographical reference. Most maps have no grid reference, and at best, have base lines and claim blocks. To orient a map, several maps may be required to correlate references such as claim block numbers, old cabins, or contour lines. Incomplete legends add a significant limitation and legends from other YCGC maps were relied upon to interpret symbology. Data must be critically analyzed; highs and lows are removed from the dataset as a precaution and to not skew extrapolated raster data. Once raster data are generated, interpretation must consider the extent of the data, as in our case the data do not cover the entire width of the valley. The margins of the raster dataset are represented by an extrapolation from the nearest data point and therefore are zones of reduced data confidence. The radius of extrapolation on the margin measured 200 m.

Drilling accuracy can be affected by variables such as inconsistent recovery from varied ground conditions, nugget effect and sampling procedures. The reliability of the drill data was determined by comparing it to the dredge production data. Dredge estimate and actual production data are labeled on the maps for ten annual blocks. Six dredge blocks underestimated their production by an average 23%, while four overestimated their production by an average 14%. This speaks directly to drilling accuracy, as the drill data on average underestimated recovery by 8%.

RESULTS: MAPPING THE PAY CHANNEL

The paleo-channel and its associated patterns were reconstructed using raster data of gold grade (Appendix 9). The reconstructed high-grade channel width is ~45 m as defined by a grade greater than $150 per cubic yard. The channel width is approximately the same on the bench as it is in the valley bottom, indicating that as the stream incised, the reworking process did not greatly affect the lateral distribution of gold grains. The position of the pay channel in the valley bottom is offset towards the left limit and does not follow the bedrock low on the right limit (Appendix 8). This disconnection between bedrock topography and gold distribution could be attributed to the resilience of gold to move laterally during the reworking process. Therefore, the enriched channel is a reflection of an earlier channel thalweg and primarily moved vertically during reworking.

The gold grade data also provide us with an opportunity to assess grade continuity within the channel and interpret patterns. A common pattern is the accumulation of gold immediately upstream from the mouths of left limit tributaries. This could be the result of stream hydraulics or resulting dilution from the tributaries. If the tributaries were major gold contributors, you might expect to see more consistent grade throughout the channel rather than sporadic spikes. Bedrock undulations also appear to affect the grades. The pay channel appears to become more dispersed when the bedrock topography is more undulatory. Grade also increases where locally steep gradients in bedrock exist, which could reflect a more channelized flow and limited lateral gold movement.

Across the valley from the mouth of Hunter Creek (Fig. 3), a canyon and irregular bedrock surface is visible from modern elevation contours and bedrock contours. Also at this location, the reconstructed pay channel follows the bedrock low through a section measuring approximately 230 m wide. Grade is affected as a result of a change in channel hydraulics from the canyon, with a hotspot present both upstream and downstream from it.

At the downstream end of the study area the channel appears to dissipate after Arkansas Creek, which could be a function of the valley widening causing both stream flow and gold transport to decrease (Appendix 9). In addition, a dissipating channel could reflect changes in bedrock and a decrease in gold sources.

RESULTS: IDENTIFYING EXPLORATION PROSPECTS

The second objective of the pilot project was to identify exploration prospects. This was completed by analyzing single and multiple layer raster data for both dredged and unmined areas.

Targets inside the dredge limits can be identified by:

- A total section depth that exceeds the dredge maximum digging depth of 9.1 m (30 ft). These areas can be field verified by looking for rounded clasts on tailings piles indicating that the dredge did not reach bedrock and left behind *in situ* gold-bearing gravel and gold-enriched bedrock; and
- Bedrock undulations observed in the bedrock topography raster. Uneven bedrock surfaces would have been difficult to clean using dredge buckets, providing potential for *in situ* gravel to remain.

Four targets with a total section depth exceeding 9.1 m were identified, with the largest target measuring 650 m long by 105 m wide (Appendix 10). Undulations are evident throughout the length of the study area and accentuated at the mouth of Sullivan Creek, approximately 1 km downstream from Nevada Creek and Hunter Creek. The presence of bedrock undulations warrants large parts of the dredged area to be re-examined, with approximately ⅓ of the study area having prospective undulatory bedrock topography. These areas may yield increased grade due to channelized flow resulting in lag concentrations, particularly for coarser gold. In addition, channel irregularities, similar to the canyon near Hunter Creek, could cause an increased concentration of gold due to changes in gradients or stream velocity. Other prospects inside the dredge limits include technogenic deposits such as tailing piles, cat push, and historic settling ponds that offer a potential mineable resource due to poor gold recovery techniques in the past.

Targets outside the limits of both dredging and modern excavations include:

- High grade areas derived from extrapolated grade data from the nearest drilling location;
- Areas identified with shallow overburden and a thick gravel package; and
- Favourable ground conditions, such as selecting thawed areas that would be less expensive to mine.

Significant areas of extrapolated high grade include a 2-km-long left limit zone at the mouth of Nevada Creek, a 0.5-km-long left limit section between Jensen and Kentucky creeks, and a 1 km-long section, on both limits of Dominion Creek, near the mouth of Arkansas Creek Appendix 3). Additional extrapolated high grade zones also extend approximately 1 km up and down-stream from Hunter Creek on both limits of Dominion Creek. A significant prospect of a thawed, thick gravel package exists on the left limit of Dominion Creek, across from Hunter Creek. Appendix 4 and Appendix 7 display the gravel depth and thawed conditions of this target, which is approximately 1 km in length and 0.5 km in width, with thawed gravels ranging from 6 to 10 m thick.

Additional prospects could be identified by adding supplementary data that may exist, such as shafting results, modern geology maps, and additional dredge and modern production data. In dredge blocks where production was less than anticipated, potential for economic gravel deposits could remain due to dredge inefficiencies. In these areas, exploration targets may include reworking tailing piles that were inadequately processed or assessing the bedrock interface for missed pay gravel.

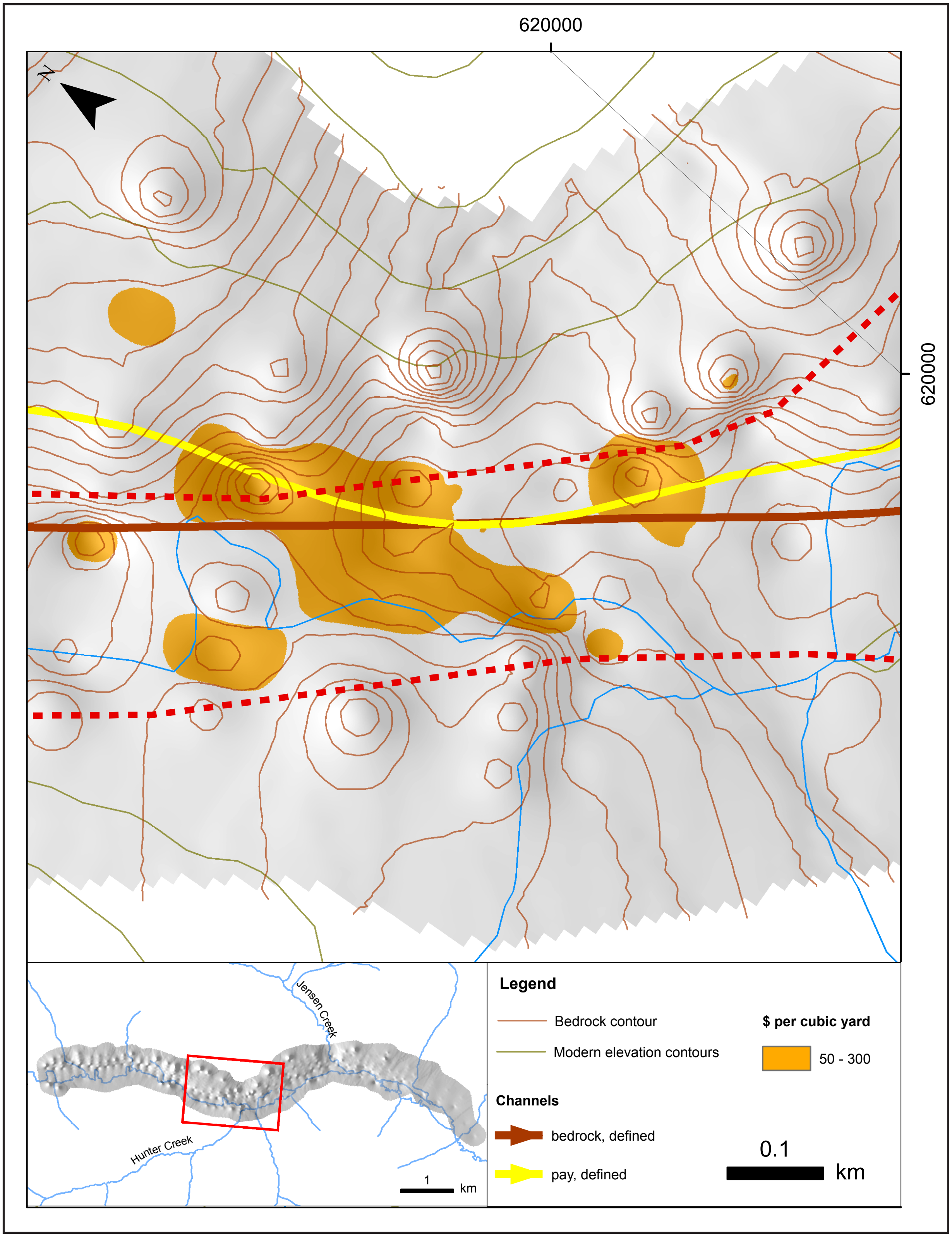

Figure 3. *Canyon at the mouth of Hunter Creek, causing a channel irregularity to affect gold grade. A bedrock contour map with gold grade near the mouth of Hunter Creek. The yellow line defines the approximate center of the pay channel and the brown line defines the bedrock topographic low. The distribution of gold (orange shade) appears irregular and may be attributed to the uneven bedrock surface.*

CONCLUSION

The Dominion Creek YCGC pilot project has shown that bringing historic map data into modern GIS mapping systems can provide new and encouraging ways to view and interpret archival data. With the ability to characterize the pay channel in terms of width, distribution and grade, we can hypothesis about drainage evolution and the mechanics of gold transport and deposition. An understanding of the gold deposition system, when used with thaw, overburden depth and bedrock depths allows prospectors to make informed decisions when identifying potential targets. Compilations larger than the one presented here would likely result in a greater ability to interpret channel dynamics and have an increased understanding of gold transport within the creek system. This could also lead to exploration of tributaries and nearby creeks with similar valley morphologies.

YCGC data are available for most major tributaries in the Klondike goldfields. Archival data include drilling results, shafting locations and dredge reserves, all of which could assist miners and prospectors in the placer mining industry to locate pockets of unmined areas in historic placer regions. While there are some challenges to using the data, the substantial wealth of exploration knowledge contained in the YCGC archives makes it a worthwhile tool for investigating placer potential.

ACKNOWLEDGMENTS

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We thank the miners for all their contributions and the industry for supporting the acquisition of the YCGC data collection.

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APPENDICES

Appendix 1. Attribute table; from historic drill maps.

Note: Appendices 2 through 10 are oversized maps.

Appendix 2. Satellite imagery of Dominion Creek study area with YCGC drilling data, dredge limits, and 2015 placer operation locations.

Appendix 3. Dredge limits and gold grade, gold at $1,400.

Appendix 4. Dredge section thickness, pay gravel plus bedrock.

Appendix 5. Overburden depth.

Appendix 6. Total section depth, overburden plus dredge section.

Appendix 7. Bedrock topography and ground condition.

Appendix 8. Bedrock topography with bedrock low and pay channel highlighted.

Appendix 9. Pay channel reconstruction using modern grade raster information.

Appendix 10. Total section depth with dredge limit and high grade zones.

APPENDIX 1. *Attribute table of geological information obtained from historic drill maps.*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
99-9	Frozen	859	839	5.49	1.52	170
99-5	Frozen	860	837	5.18	2.13	4.9
99-4	Frozen	868	846	1.83	5.18	0
99-21	Partial	879	862	1.52	3.96	5.2
99-17	Frozen	872	863	1.22	2.13	10.4
99-13	Partial	864	861	0.3	0.91	20.1
99-1	Frozen	861	836	5.79	3.66	51.9
98-7	Frozen	863	842	5.49	1.83	78.1
98-6	Partial	882	875	0.91	1.22	0
98-3	Frozen	863	837	5.79	3.35	99.6
98-2	Frozen	869	844	6.71	1.22	29.9
98-19	Frozen	881	870	2.74	0.91	0.1
98-15	Frozen	868	857	1.83	1.83	2.7
98-11	Frozen	863	849	3.66	1.22	178.4
97-9	Frozen	866	854	3.05	1.52	1.6
97-5	Frozen	866	840	6.1	3.05	314.6
97-4	Frozen	890	874	1.83	3.35	4
97-21	Frozen	883	859	5.18	2.44	0
97-17	Frozen	869	850	5.49	1.52	181.6
97-13	Frozen	865	860	0.91	1.22	18.4
97-1	Frozen	873	866	1.22	1.22	10.3
96-7	Frozen	875	864	2.74	0.91	0
96-6	Frozen	912	877	8.53	3.05	102.5
96-3	Frozen	886	875	1.52	2.44	33.6
96-23	Frozen	884	858	7.62	0.61	9.6
96-2	Frozen	899	876	4.57	3.35	65.8
96-19	Frozen	870	845	4.88	3.66	13.1
96-15	Frozen	869	847	5.79	1.83	54.8
96-14	Frozen	947	895	14.94	1.22	0
96-14	Frozen	947	895	14.94	1.22	0
96-11	Frozen	870	840	7.01	2.74	94.4
96-10	Frozen	928	880	13.11	2.13	45.3
95-9	Frozen	877	851	5.49	3.05	120.2
95-8	Frozen	922	880	10.67	2.44	18.7
95-5	Frozen	886	870	3.35	1.83	9.1
95-4	Frozen	909	879	7.32	2.44	82.6
95-23	Frozen	880	861	5.18	0.91	0
95-21	Frozen	870	850	4.88	1.52	13.2
95-17	Frozen	872	848	6.1	2.13	19.8
95-13	Frozen	872	841	5.49	4.27	5.7
95-12	Frozen	934	882	14.33	2.13	10.1

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
95-1	Frozen	896	879	4.27	1.83	57.8
94-7	Frozen	881	870	2.13	1.52	30.5
94-6	Frozen	907	885	5.49	2.13	122
94-3	Frozen	888	873	3.66	1.83	171.3
94-21	Frozen	<Null>	<Null>	<Null>	<Null>	0
94-2	Frozen	897	880	4.57	1.52	74
94-19	Frozen	875	843	7.32	3.05	28.6
94-18	Frozen	955	915	10.97	1.52	0
94-15	Frozen	873	852	5.49	1.52	18.9
94-14	Frozen	937	893	11.89	1.83	73.8
94-11	Frozen	875	852	5.49	1.83	40.4
94-10	Frozen	922	889	7.92	3.05	36.6
93-9	Frozen	877	854	6.1	2.13	12.5
93-8	Frozen	917	889	6.4	3.35	145.7
93-5	Frozen	883	876	1.83	1.83	178.3
93-4	Frozen	904	884	5.18	1.52	157.8
93-20	Frozen	963	929	9.14	1.52	0
93-19	Frozen	<Null>	<Null>	<Null>	<Null>	0
93-17	Frozen	876	863	5.49	1.83	72.4
93-16	Frozen	946	889	15.24	2.44	10.9
93-13	Frozen	878	855	5.49	2.44	30.4
93-12	Thawed	931	889	10.67	3.05	39.7
93-1	Frozen	893	880	2.74	2.44	404.8
92-7	Frozen	881	856	5.79	2.44	27.4
92-6	Frozen	902	889	1.83	2.74	68.2
92-3	Partial	876	871	0.91	0.91	0.1
92-2	Frozen	888	880	1.22	1.83	16.3
92-14	Frozen	930	887	8.23	2.13	4.2
92-11	Frozen	880	856	6.4	1.22	5.9
92-10	Frozen	916	893	3.35	4.88	75
91-9	Frozen	887	861	6.71	1.52	8.8
91-8	Partial	895	892	0.61	0.61	0
91-5	Frozen	883	857	5.79	3.35	15.4
91-4	Frozen	893	875	4.57	1.22	3.5
91-16	Frozen	958	917	8.84	3.66	0
91-12	Frozen	928	894	7.62	3.05	13.7
91-1	Frozen	884	860	6.1	1.52	52.6
90-9	Frozen	890	873	1.22	4.27	0
90-7	Frozen	886	860	6.4	2.74	25.1
90-6	Partial	905	900	1.52	0.61	0.1

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
90-3	Frozen	884	861	4.88	2.74	28.2
90-2	Frozen	890	870	2.44	4.88	75.1
90-14	Frozen	953	946	0.91	1.22	0
90-11	Frozen	902	894	0.61	2.13	0
90-10	Partial	932	920	0.91	3.05	6.2
89-9	Frozen	889	861	6.4	2.74	60.6
89-5	Frozen	889	865	5.79	2.44	69
89-4	Partial	891	883	0.91	1.22	3.5
89-16	Frozen	962	929	3.96	6.4	0
89-12	Frozen	938	915	5.49	2.13	51.3
89-11	Frozen	899	887	2.74	1.22	7.3
89-1	Frozen	880	865	5.79	1.52	18.4
88-7	Frozen	891	867	5.49	2.44	12
88-6	Frozen	908	885	7.32	0.91	20.3
88-3	Frozen	886	863	1.52	4.27	1.3
88-2	Frozen	894	872	7.01	1.22	8.6
88-18	Frozen	963	940	6.4	0.91	0
88-14	Frozen	941	910	7.62	2.13	3.7
88-11	Frozen	898	870	7.92	0.91	16.9
88-10	Frozen	923	904	5.18	1.22	74.8
87B-8	Frozen	899	875	6.71	2.44	274
87B-7	Frozen	<Null>	<Null>	<Null>	<Null>	0
87B-5	Frozen	895	867	6.1	3.05	35.2
87B-20	Frozen	951	913	9.45	2.44	2
87B-16	Frozen	936	911	6.1	1.83	18.4
87B-12	Thawed	908	908	0	0.61	8.3
87B-1	Frozen	891	872	4.27	2.13	3.9
87A-6	Frozen	894	873	4.88	2.13	29.9
87A-3	Frozen	898	872	4.57	3.66	1.5
87A-2	Frozen	895	874	5.79	1.52	43.7
87A-18	Frozen	940	914	5.79	2.74	5.1
87A-16	Frozen	929	914	2.44	2.74	21.8
87A-14	Frozen	918	911	0.91	1.52	25.3
87A-10	Frozen	901	874	7.01	1.83	36.7
878-4	Frozen	891	870	5.18	1.83	133.4
87-8	Frozen	888	876	2.44	1.52	5.7
87-5	Frozen	894	874	3.35	3.05	0.1
87-4	Frozen	896	874	5.18	2.44	17.4
87-24	Frozen	954	929	5.18	2.74	0
87-20	Frozen	933	915	5.49	2.44	43.4

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
87-16	Frozen	925	915	1.83	2.74	30.9
87-12	Frozen	912	889	6.71	1.22	152.6
87-1	Frozen	896	874	3.66	3.66	14.3
86-7	Frozen	900	878	5.49	1.52	19.5
86-6	Frozen	897	881	2.74	3.05	7.8
86-3	Frozen	899	878	4.88	2.74	39
86-22	Frozen	947	923	6.71	1.22	19.5
86-2	Frozen	896	880	4.88	0.91	8.2
86-18	Frozen	930	916	2.44	3.05	117.5
86-14	Frozen	918	900	3.66	2.74	76.8
86-10	Frozen	906	882	6.71	1.22	43.8
85-9	Frozen	899	880	3.66	2.74	26.7
85-8	Frozen	907	885	5.18	2.74	136.6
85-5	Frozen	900	878	5.18	2.13	8.7
85-4	Frozen	893	883	1.52	1.83	2.7
85-16	Thawed	931	922	1.22	1.83	3.9
85-13	Frozen	903	881	5.18	1.83	4.2
85-12	Frozen	917	903	3.05	1.22	170.4
85-1	Frozen	900	881	5.18	0.91	5.5
84-7	Frozen	905	879	5.49	3.05	47.1
84-6	Partial	894	884	2.44	0.91	6.2
84-3	Frozen	903	880	4.57	3.05	72.1
84-26	Thawed	960	926	12.8	1.22	0
84-22	Frozen	960	926	7.92	3.35	91
84-2	Frozen	902	882	4.57	1.83	7.6
84-18	Partial	945	920	5.49	2.44	46.6
84-15	Thawed	916	882	9.14	2.13	83.9
84-14	Partial	932	921	1.83	3.05	189.4
84-11	Frozen	905	881	5.18	2.44	0.1
84-10	Frozen	919	910	2.13	1.22	61.6
83-9	Frozen	908	887	4.27	3.05	52.1
83-8	Thawed	920	911	1.52	1.83	66.2
83-5	Frozen	907	882	4.27	3.96	32.6
83-4	Thawed	894	881	1.83	2.44	18.7
83-20	Frozen	957	930	6.71	1.83	6.6
83-16	Frozen	945	925	4.57	2.44	43.6
83-13	Frozen	910	886	5.79	1.52	9.9
83-12	Frozen	934	922	2.44	1.52	6.6
83-1	Frozen	904	885	3.66	2.74	2.1
82-7	Partial	909	887	5.79	1.22	54.7
82-6	Partial	924	888	8.84	3.35	92.2

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
82-3	Frozen	907	889	3.66	3.05	123.2
82-2	Thawed	897	886	1.83	3.66	4.7
82-18	Frozen	958	929	6.1	3.05	6.3
82-14	Frozen	943	924	3.96	2.44	153.3
82-11	Frozen	909	889	3.35	1.22	2.6
82-10	Partial	930	920	2.13	1.22	22
81-9	Frozen	916	884	6.71	3.35	0.1
81-8	Frozen	919	889	7.01	2.74	37.3
81-5	Frozen	909	885	5.49	2.13	33.4
81-4	Partial	913	892	4.88	2.44	142.5
81-24	Frozen	967	937	7.92	1.52	0
81-20	Frozen	957	933	6.1	1.83	78.7
81-16	Partial	946	930	3.05	2.74	50.8
81-12	Thawed	934	924	1.52	2.13	291.5
81-1	Thawed	899	886	1.52	3.35	46
80-7	Frozen	918	892	5.79	3.05	38.2
80-6	Frozen	920	892	6.4	2.74	42.6
80-3	Frozen	915	891	4.88	2.74	7
80-22	Frozen	<Null>	<Null>	<Null>	<Null>	0
80-2	Thawed	902	890	2.44	1.52	63.7
80-18	Frozen	942	910	7.01	3.66	25.2
80-14	Frozen	936	919	4.88	0.91	0
80-10	Frozen	926	898	4.27	4.57	0
78-8	Partial	918	895	4.57	3.05	57
78-5	Frozen	919	893	6.1	3.05	26.8
78-4	Partial	915	895	1.22	5.18	6.1
78-24	Frozen	957	934	0.91	6.4	3.2
78-20	Partial	948	928	2.74	2.13	22
78-16	Partial	936	930	0.91	1.83	42.5
78-12	Partial	924	920	0.61	0.91	99.9
78-1	Frozen	916	893	3.96	4.57	88.7
77-7	Frozen	930	895	8.84	3.05	46.3
77-6	Partial	918	894	5.49	2.44	64.4
77-3	Frozen	918	893	5.49	2.74	26.3
77-22	Partial	956	938	3.35	2.44	59.8
77-2	Frozen	920	895	4.57	3.96	71.1
77-18	Partial	940	933	1.22	1.22	3.4
77-15	Frozen	970	921	13.72	1.83	6.1
77-14	Frozen	930	910	5.49	0.91	4.8
77-11	Frozen	948	910	9.45	3.35	19
77-10	Thawed	923	891	7.32	2.74	11.9

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
151-18	Frozen	795	769	4.57	4.88	22.3
151-14	Frozen	792	766	4.57	4.88	5.4
149-6	Partial	793	774	4.27	2.13	30.9
149-14	Frozen	798	772	4.88	3.66	58.7
149-10	Frozen	795	774	4.27	2.74	50.7
147-30	Frozen	823	789	8.84	2.44	6.9
147-26	Frozen	814	787	5.49	3.35	15.2
147-22	Frozen	807	786	5.49	1.52	40.4
147-18	Frozen	801	785	3.05	2.13	3.7
147-14	Frozen	798	779	5.18	1.52	101.8
145-6	Frozen	805	783	4.27	2.74	26.6
145-30	Frozen	837	793	10.36	3.96	10.9
145-26	Frozen	828	794	5.49	5.18	5.1
145-22	Frozen	819	792	4.27	4.57	23.9
145-18	Frozen	812	791	3.66	3.05	0.6
145-14	Frozen	808	791	3.05	3.05	24.8
145-10	Frozen	807	788	3.66	3.96	48.8
143-6	Frozen	814	798	2.44	3.35	11.2
143-26	Frozen	<Null>	<Null>	4.27	5.79	1.7
143-22	Frozen	828	800	6.1	3.05	23.5
143-2	Frozen	808	788	3.35	3.66	22.6
143-18	Frozen	823	800	4.27	3.05	1.7
143-14	Frozen	819	799	3.35	3.35	10.3
143-10	Frozen	817	798	3.05	3.66	53
142-7	Frozen	<Null>	<Null>	4.27	3.96	10.3
142-6	Frozen	<Null>	<Null>	3.96	3.05	9.5
142-5	Frozen	<Null>	<Null>	3.96	4.57	3.3
142-4	Frozen	<Null>	<Null>	4.88	3.35	3.6
142-3	Frozen	<Null>	<Null>	5.18	4.88	6.9
142-2	Frozen	<Null>	<Null>	4.57	6.4	1.2
142-1	Thawed	<Null>	<Null>	3.66	8.23	1.7
141-b	Frozen	<Null>	<Null>	6.1	3.05	6.9
141-a	Frozen	<Null>	<Null>	4.57	3.35	4.7
141-6	Frozen	821	804	3.05	2.74	2
141-18	Frozen	836	815	4.57	2.74	1.9
141-14	Frozen	831	809	5.18	2.13	61.3
141-10	Partial	825	809	3.05	2.74	161.8
140-8	Frozen	828	812	3.35	1.83	119
140-5	Frozen	814	794	4.57	1.83	2.9
140-4	Frozen	825	794	7.92	2.13	28.1
140-28	Frozen	848	<Null>	7.32	1.52	10.6

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
140-24	Frozen	844	820	6.1	1.83	17.5
140-20	Frozen	838	818	4.57	3.66	43.3
140-16	Frozen	835	815	4.27	2.13	41
140-12	Frozen	831	814	3.66	1.83	28.7
140-1	Frozen	821	796	6.1	1.83	5.5
139-b	Frozen	<Null>	<Null>	6.4	1.22	35.7
139-a	Frozen	<Null>	<Null>	3.05	2.74	10.5
139-7	Frozen	818	795	5.18	2.13	24.9
139-6	Frozen	823	812	1.22	2.74	21
139-3	Frozen	819	796	3.66	3.66	1.5
139-2	Frozen	820	799	3.96	2.74	4.3
139-18	Frozen	835	818	1.83	3.66	2.9
139-15	Frozen	817	793	3.96	3.66	3.4
139-14	Frozen	832	818	1.52	3.66	41.6
139-11	Frozen	818	795	5.79	1.52	16.1
139-10	Frozen	827	813	2.13	2.74	43.7
138-b	Frozen	<Null>	<Null>	5.18	2.74	1.8
138-a	Frozen	<Null>	<Null>	3.05	3.96	72.8
138-9	Frozen	820	798	5.18	1.83	4.3
138-8	Frozen	827	813	2.74	2.13	40.7
138-5	Frozen	821	803	3.66	2.44	4.3
138-4	Frozen	822	808	2.44	1.83	4.2
138-20	Frozen	844	824	4.57	1.83	7.2
138-16	Frozen	838	823	2.13	3.35	66.4
138-12	Frozen	832	822	1.52	2.74	70.1
138-1	Frozen	821	804	4.27	1.52	8.4
137-7	Frozen	823	796	4.57	3.96	0
137-6	Frozen	829	820	1.52	1.83	28.7
137-30	Frozen	877	844	3.05	7.32	5
137-3	Frozen	822	805	4.27	2.13	2.5
137-28	Frozen	872	835	2.44	9.14	3
137-26	Frozen	868	836	6.1	4.27	15.1
137-22	Frozen	858	850	3.66	5.18	5
137-2	Frozen	824	817	1.22	1.22	7.3
137-15	Frozen	849	835	3.35	1.83	8
137-14	Partial	842	827	4.57	0.91	6.5
137-10	Frozen	836	826	1.22	2.13	2.7
137-1	Frozen	815	782	6.4	3.66	1.5
136-9	Frozen	826	799	5.18	3.66	14.5
136-8	Frozen	837	828	2.44	1.22	37.8
136-5	Frozen	826	800	5.79	2.44	3.1

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
136-4	Frozen	829	821	1.22	1.52	11
136-26	Frozen	877	838	8.84	3.35	8.5
136-24	Frozen	871	838	7.92	2.74	34.3
136-22	Frozen	866	835	7.32	2.44	5
136-20	Frozen	861	835	6.71	2.13	6.5
136-16	Frozen	852	833	3.66	1.83	2.1
136-12	Frozen	845	832	1.83	2.44	8.2
136-1	Frozen	824	802	4.88	2.13	11.2
135-9	Frozen	829	804	3.96	4.27	3.2
135-7	Frozen	828	799	5.49	3.66	7.5
135-6	Partial	837	825	2.13	1.83	75.3
135-3	Frozen	827	805	6.1	1.22	30.4
135-22	Partial	869	835	6.1	5.18	4.4
135-2	Frozen	827	808	4.57	1.83	45.9
135-18	Frozen	860	837	5.18	3.35	41.3
135-14	Frozen	851	834	1.22	4.88	173.7
135-11	Frozen	822	795	7.92	1.22	31.4
135-10	Thawed	844	832	1.22	2.74	5.2
134-9	Frozen	828	807	4.57	2.44	17.1
134-8	Frozen	849	837	3.35	1.22	237
134-5	Partial	829	820	0.91	2.13	0.1
134-4	Frozen	841	829	2.44	2.44	368.7
134-16	Frozen	867	840	5.18	3.35	2.9
134-15	Frozen	<Null>	<Null>	<Null>	<Null>	0
134-13	Frozen	831	805	6.1	2.13	4.8
134-12	Partial	857	838	4.57	1.83	105.3
134-1	Thawed	835	829	0.61	1.52	90.9
133-7	Thawed	830	811	4.57	1.52	7.5
133-6	Thawed	841	835	0.91	2.13	11.8
133-3	Thawed	838	828	1.22	2.13	11.8
133-2	Thawed	840	830	0	3.66	75.6
133-18	Partial	882	865	1.52	4.57	9.1
133-17	Frozen	<Null>	<Null>	<Null>	<Null>	2.4
133-15	Frozen	833	806	6.4	2.13	18.4
133-14	Partial	870	848	4.88	4.27	21.7
133-11	Frozen	831	808	5.49	1.83	2.7
133-10	Partial	861	836	4.88	2.74	28.7
132-9	Frozen	832	810	6.1	1.52	43.3
132-8	Thawed	849	838	0.61	3.05	3.3
132-5	Partial	834	820	3.66	0.91	4.5
132-4	Thawed	841	839	0.61	0.91	6.2

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
132-13	Frozen	834	811	3.35	4.27	27
132-12	Partial	866	849	3.35	2.13	0
132-1	Thawed	843	839	1.22	0.3	0
131-7	Frozen	834	817	3.35	2.13	0
131-6	Frozen	842	810	6.1	1.52	0
131-3	Frozen	836	811	5.18	3.35	51.6
131-2	Frozen	839	819	4.88	1.52	0
131-19	Frozen	832	807	3.66	4.27	6.9
131-15	Frozen	834	811	6.71	0.91	113.5
131-11	Frozen	833	811	5.49	1.52	9.3
131-10	Frozen	845	820	7.32	1.22	0.1
130-9	Frozen	833	805	5.79	3.35	18.2
130-8	Frozen	841	823	2.74	1.52	0.1
130-5	Frozen	832	806	4.57	3.66	17.5
130-4	Frozen	838	824	3.35	1.22	1.3
130-11	Thawed	836	807	7.32	2.13	6.7
130-1	Frozen	837	816	4.27	1.83	100.9
129-7	Frozen	837	819	4.57	1.52	36.5
129-6	Frozen	842	825	2.44	2.44	73.7
129-3	Frozen	835	816	3.66	2.74	32.7
129-2	Partial	839	831	0.61	2.13	26
129-18	Partial	867	856	0.91	4.57	4.9
129-14	Partial	858	848	1.22	2.13	42.7
129-11	Frozen	838	808	7.01	2.44	16.9
129-10	Frozen	849	842	1.52	0.91	5.7
128-9	Frozen	840	812	5.18	3.66	5.3
128-8	Thawed	845	834	2.13	1.52	8.2
128-5	Frozen	839	817	5.79	1.22	5.9
128-4	Thawed	842	835	1.83	1.83	275.3
128-24	Frozen	898	854	2.74	1.22	0
128-20	Frozen	885	855	5.49	2.74	0
128-16	Frozen	873	849	3.35	4.27	7.9
128-13	Thawed	862	805	13.41	3.66	27.2
128-12	Frozen	860	845	2.13	2.74	105.2
128-1	Frozen	839	814	4.88	0.91	16.7
127-7	Frozen	841	817	4.88	3.05	5
127-6	Partial	846	838	1.52	1.22	3.5
127-3	Frozen	841	820	5.49	1.83	105.2
127-2	Partial	848	834	3.05	1.52	13.1
127-18	Partial	896	855	11.58	1.22	7.6
127-14	Frozen	878	850	6.71	2.74	24.4

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
127-11	Frozen	857	830	6.4	2.13	1.7
127-10	Frozen	865	842	6.1	1.83	49.3
126-9	Frozen	845	821	5.18	2.44	5.4
126-8	Partial	850	844	0.91	1.22	29.7
126-5	Frozen	843	823	5.49	0.91	22.2
126-4	Partial	855	848	1.52	0.91	7.8
126-28	Frozen	938	890	9.14	5.79	0
126-24	Partial	924	856	18.59	2.74	41.1
126-20	Frozen	910	858	14.63	1.83	9.3
126-16	Frozen	894	858	9.14	2.13	42.3
126-12	Partial	875	845	7.92	1.83	88.6
126-1	Partial	843	825	2.13	3.96	58.9
125-7	Frozen	846	824	5.18	2.44	14.2
125-6	Thawed	852	844	1.22	1.83	105.2
125-3	Frozen	845	822	5.79	1.52	19.3
125-26	Partial	948	867	21.34	4.27	3.5
125-22	Thawed	929	861	18.29	2.74	19.5
125-2	Frozen	850	826	6.4	1.22	0
125-18	Partial	911	852	14.63	3.66	1.3
125-15	Frozen	854	822	8.84	1.22	18.4
125-14	Frozen	894	850	11.28	3.05	46.4
125-11	Frozen	847	824	5.79	1.83	51.4
125-10	Thawed	870	839	7.32	2.44	12.6
124-9	Frozen	847	828	4.88	1.52	20.9
124-8	Frozen	880	849	7.92	2.13	59.7
124-5	Partial	847	831	4.57	0.91	5
124-4	Frozen	867	847	4.27	3.35	99.8
124-20	Frozen	926	866	13.11	5.49	0
124-17	Frozen	851	820	7.32	3.05	13.9
124-16	Frozen	910	863	9.14	5.49	0.8
124-13	Frozen	848	828	4.88	1.52	20.9
124-12	Frozen	893	851	11.89	1.83	65.5
124-1	Partial	847	842	1.22	0.61	0.1
123-7	Frozen	850	826	5.49	2.44	29.3
123-6	Frozen	876	851	6.4	2.13	117.3
123-3	Frozen	852	831	4.88	1.83	10.1
123-22	Frozen	940	908	8.53	1.52	0
123-2	Frozen	862	840	6.4	0.91	206.7
123-19	Frozen	872	821	13.72	2.13	0
123-18	Frozen	921	865	14.63	1.83	62.2
123-15	Frozen	850	820	5.18	5.18	41.9

Appendix 1. *continued*

DRILL HOLE ID	GROUND CONDITION	SURFACE ELEVATION	BEDROCK ELEVATION	OVERBURDEN (M)	DREDGE SECTION (M)	CENTS PER CUBIC YARD
123-14	Partial	904	857	11.28	3.66	24.3
123-11	Frozen	850	830	5.18	1.52	22.6
123-10	Frozen	890	852	7.62	4.27	8
122-8	Partial	880	857	7.01	1.22	56.2
122-5	Frozen	852	833	5.18	0.91	29.9
122-4	Frozen	867	842	7.01	1.22	46.7
122-2	Frozen	898	859	4.88	7.32	0
122-17	Frozen	858	825	7.62	1.83	6.6
122-13	Frozen	852	825	5.79	3.66	36.3
122-1	Frozen	855	834	5.79	1.22	78.2
121-7	Frozen	847	823	5.79	2.13	10.6
121-6	Partial	878	856	4.88	3.05	47.6
121-3	Frozen	855	841	3.66	0.91	16.4
121-2	Partial	865	855	1.22	2.13	14
121-15	Frozen	859	832	6.1	2.44	4.3
121-14	Frozen	909	878	4.27	5.49	0
121-11	Frozen	854	827	5.79	3.05	57.4
121-10	Frozen	892	860	4.57	5.18	9.2
120-9	Frozen	855	833	5.18	1.83	23.9
120-8	Frozen	881	866	3.35	2.13	80.8
120-5	Frozen	855	829	5.49	3.05	50.7
120-4	Frozen	865	837	7.32	1.83	35
120-17	Frozen	860	838	6.1	1.22	8.6
120-14	Partial	<Null>	<Null>	<Null>	<Null>	0
120-13	Frozen	859	837	5.18	2.13	66.1
120-10	Frozen	<Null>	<Null>	<Null>	<Null>	15.6
120-1	Frozen	856	834	4.57	2.44	10.9
100-7	Frozen	858	844	3.35	1.52	0.1
100-6	Partial	866	860	0.61	1.52	0
100-3	Frozen	860	837	5.18	3.35	58.7
100-2	Frozen	858	832	6.1	3.05	308
100-19	Frozen	871	851	4.88	1.52	0
100-15	Partial	867	847	4.88	1.52	9.6
100-11	Frozen	862	840	4.88	2.44	88

APPENDIX 2. Satellite imagery of Dominion Creek study area with YCGC drilling data, dredge limits, and 2015 placer operation locations.

APPENDIX 3. *Dredge limits and gold grade raster (gold at $1,400 CAD) with dark red indicating the richest ground.*

APPENDIX 4. Dredge section thickness raster (pay gravel plus bedrock) with darker colours representing the thickest areas.

APPENDIX 5. Overburden depth raster with light green indicating shallow and dark green indicating thick.

APPENDIX 6. *Total section depth raster (overburden plus dredge section) with depth increasing as brown lightens to blue.*

APPENDIX 7. *Bedrock topography and ground condition raster with light blue indicating thaw and dark blue indicating frozen conditions.*

APPENDIX 8. Bedrock topography raster with bedrock low and pay channel highlighted.

APPENDIX 9. Pay channel reconstruction using modern grade raster information.

APPENDIX 10. *Total section depth with dredge limit and high grade zones.*