Hamlet of Igloolik
Master Drainage Plan and Geotechnical Investigation



PRESENTED TO

Department of Community and Government Services (CGS)
Government of Nunavut

MARCH 31, 2020
ISSUED FOR USE
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ACRONYMS & ABBREVIATIONS

Acronyms/Abbreviations	Definition
DEM	Digital Elevation Model
GIS	Geographic Information System
GPS	Global Positioning System
SWMM	Stormwater Management Model
AES	Atmospheric Environmental Service

LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of Government of Nunavut and their agents. Tetra Tech Canada Inc. (Tetra Tech) does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any Party other than Government of Nunavut, or for any Project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. Use of this document is subject to the Limitations on the Use of this Document attached in the Appendix or Contractual Terms and Conditions executed by both parties.

1.0 INTRODUCTION

Tetra Tech Canada Inc. (Tetra Tech) was retained by the Department of Community and Government Services (CGS), Government of Nunavut to develop a Master Drainage Plan for the Hamlet of Igloolik (Igloolik). CGS and Igloolik require that a drainage study be conducted for both the existing town site and planned subdivisions identified in the Community Plan. As part of the deliverables, CGS has also requested that a geotechnical investigation be completed to confirm the geology characteristics of the Hamlet and provide guidance as to the location of future subdivisions.

The Terms of Reference (ToR) developed by CGS confirmed that Igloolik has in action a Community Plan (By-law No. 197, 2017) and Zoning By-law (By-law No. 198, 2017). To ensure the community plans are developed in harmony with the local site drainage limitations, it was recommended that a complete review of the local drainage system be completed. In addition to a detailed review of the community plans and its impacts on the existing stormwater system, CGS identified the need to review and evaluate the conditions of the existing drainage system and undertake a geotechnical investigation to assist in the siting of future community expansions.

The 2017 Community Plan estimates the population of Igloolik to be 1,985 people. The Igloolik Community Plan aims to prepare for a population of 2,915 people by 2037. Its is estimated an additional 336 housing units will be required over this period to meet the estimated population growth – an average of 17 new dwellings per year. This means Proposed subdivisions will need to be constructed away from the community's core and on existing open plots of land at its boundary. In order to ensure that the Hamlet of Igloolik has sufficient and suitable developable land to accommodate population growth forecast in the Community Plan, it is necessary for a qualified team of professionals to conduct a drainage and geotechnical study for these subdivisions.

The study conducted by Tetra Tech encompassed the following tasks:

- A review of all available background material;
- A site visit to Igloolik by a team of hydrotechnical engineers to identify, assess, and document all drainage infrastructure and known drainage issues;
- A site visit to Igloolik by a geologist to identify, assess, and document the geology of the Hamlet and its surrounding areas;
- Inventory of existing drainage issues;
- Development of inputs to a hydrologic model;
- Assess the drainage system for existing and proposed development conditions;
- Assess geotechnical conditions and terrain suitability for the proposed development plans; and
- Completion of the Igloolik Master Drainage Plan.

Figure 1-1 on the following page shows a Field Map outlining the extent of the study area.

Q:\Edmonton\GIS\TRANSPORTATION\WTRM\WTRM03184-01\Maps\WTRM03184-01_FieldMap.mxd modified 8/18/2019 by megan.verburg

LEGEND

Study Area

NOTES
Base data source: Imagery provided by GoogleEarth; DigitalGlobe (2006)

STATUS
FOR INTERNAL USE ONLY

GEOTECHNICAL INVESTIGATION AND DRAINAGE PLANNING IGLOOLIK, NUNAVUT

Field Map

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Government of Nunavut

Scale: 1:12,000

200 100 0 200

Metres

TETRA TECH

FILE NO.
WTRM03184-01_FieldMap.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-EDM	MRV	XXX	VER	0

DATE	PROJECT NO.
August 18, 2019	TRN.WTRM03184-01

Figure 1-1

2.0 REVIEW OF BACKGROUND INFORMATION

Tetra Tech collected, compiled and processed all information related to the drainage system of Igloolik made available by officials from the Government of Nunavut, the Hamlet, and from publicly available reports and data.

The initial background review process provided Tetra Tech with an understanding of the terrain, climate, long-term land-use plans, and known drainage issues in Igloolik.

Reviewed background data has included the following:

- 2018 Satellite Imagery (.tif);
- 2018 Digital Elevation Models (Bare earth and surface models available in .tif and .asc formats);
- 2018 Building footprint, infrastructure, and transportation vector datasets (AutoCAD .dwg and ESRI File Geodatabase or Shapefile formats);
- 2018 Hydrology (water bodies and watercourses) vector datasets (AutoCAD .dwg and ESRI File Geodatabase and Shapefile formats);
- 2018 Contours vector datasets (AutoCAD .dwg and ESRI File Geodatabase and Shapefile formats);
- 2017 Community Plan and Community Plan By-law;
- National Topographic Survey (NTS) 1:50,000 Topography Map of Igloolik;
- Google Earth 2019 Satellite Imagery; and
- Historical climate data for Igloolik, monitored and made available by Environment Canada.

Additional anecdotal background information was collected through informal discussions with Hamlet staff and local residents during the 2019 field visit.

2.1 Geology Background Data Review

The following background information was collected from a variety of sources and referenced while mapping:

- Google Earth Pro™ historical imagery (starting from August 31, 2010);
- 1965 B&W air photos (1:12,000 scale);
- 1975 B&W air photos (1:23,900 scale);
- 1987 B&W air photos;
- 1989 B&W air photos (1:5,000 scale);
- 1995 B&W air photos (1:5,000 scale);
- 1995 colour air photos (1:8,000 scale).
- 1996 B&W air photos (1:15,000 scale);
- Regional surficial geology and permafrost maps (refer to the REFERENCES list of this report);

- Geotechnical site investigation reports by various consultants (refer to the REFERENCES list of this report), and
- Literature on surficial geology and permafrost in the area (Heginbottom et al. 1995; and Dredge 1988).

2.2 Community Plan, Population and Expansion Plans (Land Use)

The Government of Nunavut CGS division maintain and regularly update community plan maps for each community within the Territory. The purpose of these community plans is to outline Council's policies for managing the physical development of each Hamlet for the next 20 years.

The community plan includes existing land parcels as well as proposed parcels of land allocated for future community growth. This combination of existing and proposed development forms the scope of our Master Drainage Plan, which aims to improve the existing drainage system and provide design of drainage features in future areas of development. It is recommended that the results of this community drainage study be incorporated within future community plan updates.

In undertaking this work Tetra Tech has also identified sections of the community plan where development should not proceed and has instead recommended alternative areas less prone to drainage issues. For recognition of this, Appendix B includes a revised community plan.

2.3 Terrain

The Hamlet of Igloolik, hereafter referred to as the study area, is located on Igloolik Island, in the north-western part of Foxe Basin, just east of the northern end of the Melville Peninsula. Igloolik Island which is 18 km long, consists of prominent, rocky buttes, i.e. flat-topped hills, joined by lowland plains where a low bedrock outcrop is partly covered by old, raised beaches. (Dredge 1992).

Based on records available from Environment Canada (1977 to 2007, with select data to the present) from two weather stations in Igloolik, the mean annual air temperature has averaged -13.3°C. While the data is incomplete the average mean annual air temperature indicates a warming trend. Linear interpolation of the mean annual air temperature suggests an average rate of warming of about 0.08°C/year, over the period of record. Climate normals have also been compiled by Environment Canada for Igloolik for various periods, the most recent being 1981-2010. During the period of 1981-2010, the average temperature in Igloolik was -13.3°C and daily averages by month ranged from 7.4°C in July to -31.9°C in February. Mean annual total precipitation was 222.4 mm, 86.9 mm being rainfall (Tetra Tech 2017).

Shallow or partially exposed bedrock is found throughout the study area, but raised beach material, and scree (rock rubble on slopes) cover the bedrock in many places. Bedrock is primarily composed of dolomite. Limestone is also common and is found primarily on top of the dolomite, particularly on the top of the buttes. A churned-up layer and pebbly zone are found between these two rock units. The main dolomite unit was deposited in a lagoon or shallow sea. Later, the island emerged from the sea, and the pebble and sandy churned-up layers were deposited as a result of erosion of the land during that time. The overlying, younger limestone was deposited in an open deep sea, later, when the sea covered most of the northeastern Canada, including all of Melville Peninsula and Igloolik Island (Dredge 1992).

Based on a surficial geology map of the Northern Melville Peninsula (Dredge and Nixon 1993) there are also isolated marine deposits (silt and sand) in flat-lying areas. These beach deposits are generally 1 m thick (Dredge 1992). The community is situated on an area of reworked marine sediments.

2.3.1 Surficial Geology

The surficial materials and permafrost terrain features within the study area were mapped using the regional (1:200,000 scale) surficial geology map (Dredge 1988) as a baseline. Marine littoral deposits mapped by Dredge (1988) as raised beaches composed of gravel and shingle are the most widespread surficial materials within the study area. They are described as 2.0 m to 6.0 m thick occurring as flights of emerged beach ridges, derived from shattered limestone.

Tetra Tech reviewed results of the recent geotechnical investigations completed by several geotechnical consultants and summarized surficial geology of the study area in the following sections. Figure 2-1 shows locations of the previous geotechnical investigation sites.

Organic Soils

A thin layer of topsoil was encountered on surface at the proposed community center (Trow 2010) and the new high school (Tetra Tech EBA 2014). These sites were underdeveloped at the time of the investigations. The topsoil was found to be organic rich, containing roots, rootlets and other organic matter.

Sand and Gravel

The prevalent native soils encountered at the new high school site (Tetra Tech EBA 2014) and at the powerhouse site (EBA 2005) was sand and gravel with variable amounts of silt (generally increasing with depth) and trace of clay. This layer was encountered beneath the topsoil layers. The thickness of this layer ranged from approximately 3.5 m to 6.5 m at the powerhouse, and about 3.2 m to 4.5 m at the new high school site.

The moisture content of the sand and gravel averaged 10% at the Powerhouse site (EBA 2005), and 9% at the new high school site (Tetra Tech EBA 2014).

Silt or Silty Sand

The predominant surficial material encountered during Trow's site investigation (Trow 2010) was silty sand (till like) underlying the topsoil. The thickness of this layer ranged from about 2.0 m to 3.5 m. The silty sand was described as slightly cohesive and containing trace to some gravel and occasional cobbles. The natural moisture content ranged from 6% to 20%.

A layer of silt encountered at the Community Learning Centre site (EBA 1994), underlying the gravel fill. The thickness of this layer ranged from about 2.4 m to 2.7 m. The silt generally contained a trace to some gravel to a depth of about 2.0 m below grade, with no gravel observed below that depth. The average moisture content was about 16%.

Bedrock

Bedrock has been found at depths ranging from 1.2 m to 7.4 m below ground surface in previous site investigations throughout the community. Weathered or weaker bedrock with a thickness of 2.0 m to 3.0 m is expected to overly more competent bedrock at depth.

The moisture content averaged about 3% (EBA 1994) and 4% (EBA 1992) in slightly weathered bedrock and 9% in highly weathered bedrock (EBA 1992). Highly weathered bedrock was characterized by the relative ease of drilling (EBA 1992, Tetra Tech EBA 2014). In some instances, it was difficult to differentiate the native soils from weathered bedrock due to the drilling method used (EBA 2005).

Frost shattered bedrock outcrops were observed about 400 m southwest of the school site during Tetra Tech EBA's 2013 investigation (Tetra Tech EBA 2014).

When encountered, bedrock was described as limestone (EBA 1992, EBA 1994), siltstone (Trow 2010), or dolomite (EBA 2005, Tetra Tech EBA 2014).

The unconfined compressive strength of rock core samples collected at depths from 5.4 m to 6.3 m at the community center site ranged from 94 MPa to 118 MPa (Trow 2010).

2.3.2 Permafrost

According to the Canada Permafrost Map (Heginbottom et al. 1995), the study area is located within the zone of continuous permafrost. Ground temperature cables installed in the study area in the fall of 2013 indicated an average temperature of -5.5°C at a depth ranging between 4 m and 8 m in depth (Tetra Tech EBA 2014). This temperature was recorded one day after thermistor installation. In general, the ground temperature will take more than one day to stabilize, and is anticipated to drop further, so this value is considered inaccurate.

As per Tetra Tech's summary description of the subsurface conditions in the Igloolik area (Tetra Tech 2017), the ground temperatures at depths below 6 m have been reported to average -8.1°C at the Powerhouse site (EBA 2005) and -6.6°C at the Community Centre site (Trow 2010). Based on the records from these two past investigations and the probable effects of the climate change since then, a mean annual ground temperature in the range of -7.0°C is estimated for the study area.

The thickness of the active layer (ALT) is expected to be in the range of 1.5 m to 2.0 m.

Visible ice crystals, generally less than 5% by volume of visible ice, were observed in boreholes completed in a layer of silt 2.4 to 2.7 m thick underlying the gravel fill at the Community Learning Centre site. The perennially frozen, well-bonded silt was not considered to be ice-rich, except possibly near one borehole where the moisture content averaged 21% (EBA 1994 – Figure 1).

Individual crystals and inclusions of ground ice (Vx 2% by volume of visible ice) were observed in poorly-bonded to friable perennially frozen soils at a depth ranging from 2.0 to 3.0 m in boreholes completed around the perimeter of the existing Municipal Garage (Tetra Tech 2019).

0 — 50 m

Scale: 1: 1000
(Approximate)

CLIENT

Nunavut

TETRA TECH

GEOTECHNICAL INVESTIGATION AND DRAINAGE PLANNING IGLOOLIK, NU

PREVIOUS GEOTECHNICAL INVESTIGATION SITE LOCATION PLAN

PROJECT NO.	DWN	CKD	REV
TRN.WTRM03184-01.001	DBD	JS	0

OFFICE	DATE
EDM	November 2019

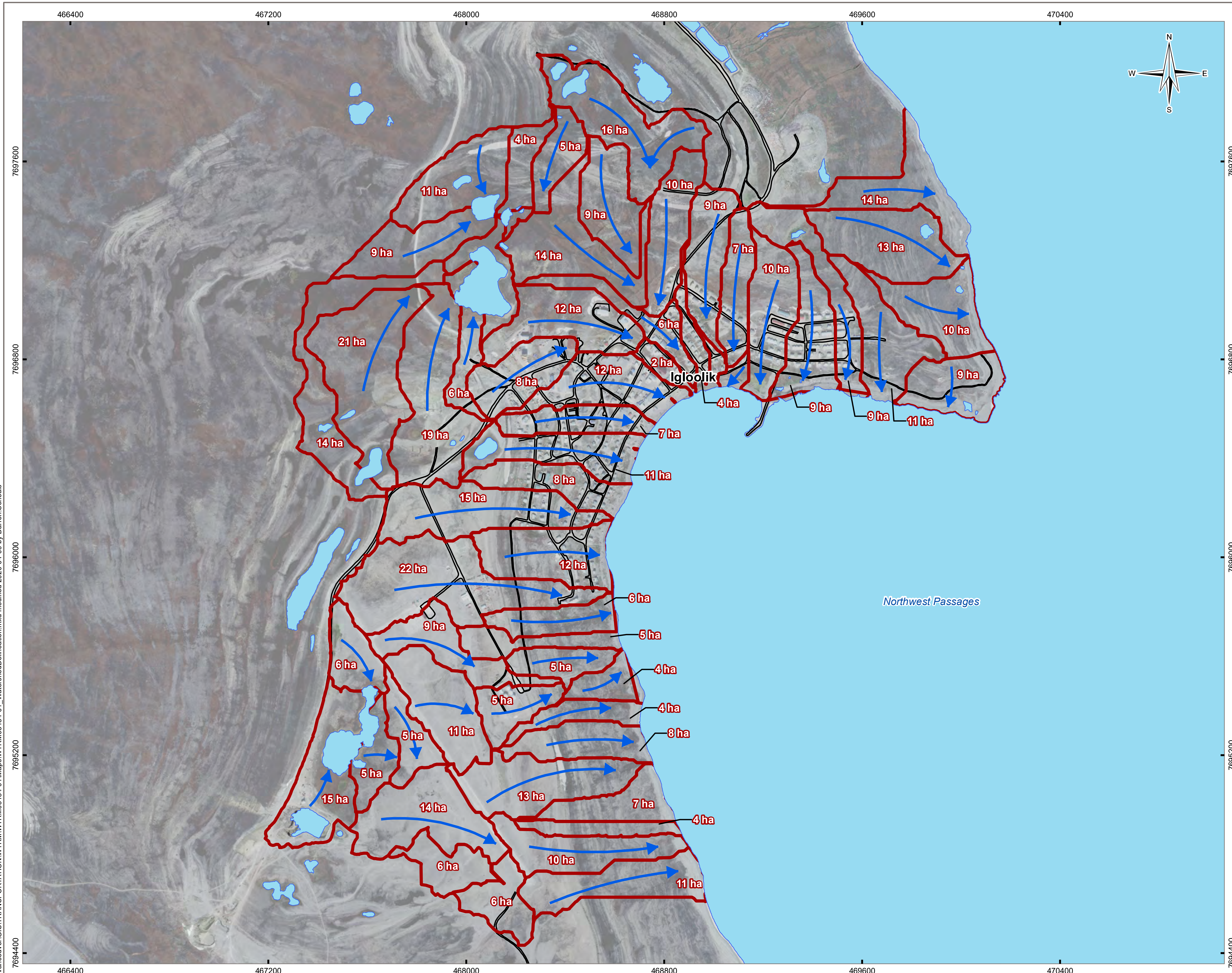
Figure 2-1

Q:\Edmonton\Drafting\PROJECTS\704-TRN.WTRM\TRN.WTRM03184-TRN.WTRM03184-01\02_Acad\TRN.WTRMC03184-01_001 Figure 1.dwg [FIGURE 1] November 19, 2019 - 4:42:09 pm (BY: DAS, DEBASHIS)

2.3.3 Topography and Watershed Delineation

A Digital Elevation Model (DEM) of the Igloolik region was developed to represent the topography of the project area. The DEM was derived from aerial photographs used to extract elevation information through a technique called photogrammetry. The use of measurements from photographs is of sufficient accuracy for use within a drainage planning exercise.

Tetra Tech has reviewed this DEM in conjunction with NTS 1:50,000 topography maps of the area and has performed a watershed delineation analysis to identify drainage patterns in the Igloolik area. The existing drainage patterns are presented in Figure 2-2 and were confirmed during the August 2019 field visit. Note that several paths are impacted by the presence of other surficial obstructions such as buildings and conveyance systems such as culverts and ditches.



LEGEND

- Flow Direction
- Watershed

Base Data

- Gravel Road
- Waterbody

NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Watershed Delineation

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:15,000

300 150 0 300

Metres

TETRA TECH

FILE NO.
WTRM03184-01_WatershedDelineation.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE
April 6, 2020

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Figure 2-2

2.4 Climate

2.4.1 Recorded Data

Climate data for Igloolik are based on records collected at from , from 1984 to present. Data is collected and published by Environment and Climate Change Canada (ECCC). Figure 2-3, Table 2-1, and Table 2-2 present the climate normals determined by ECCC for the period of 1981 to 2010.

The daily average, maximum and minimum temperatures in February, the coldest month of the year, are -31.8°C, -28.5°C, and -35.1°C respectively. The same temperatures in July, the warmest month of the year, are 7.4°C, 11.2°C, and 3.6°C respectively. The annual mean daily temperature is -13.3°C. Extreme maximum and minimum recorded temperatures are 24.5°C and -47.0°C respectively. The average annual precipitation for the climate normal period is 222.4 mm, with 89.6 mm (40%) of rain and the remainder as snow. Precipitation amounts are elevated throughout the summer but highest in the months of August and October, with a maximum recorded daily rainfall of 28.0 mm which occurred on September 11, 1994.

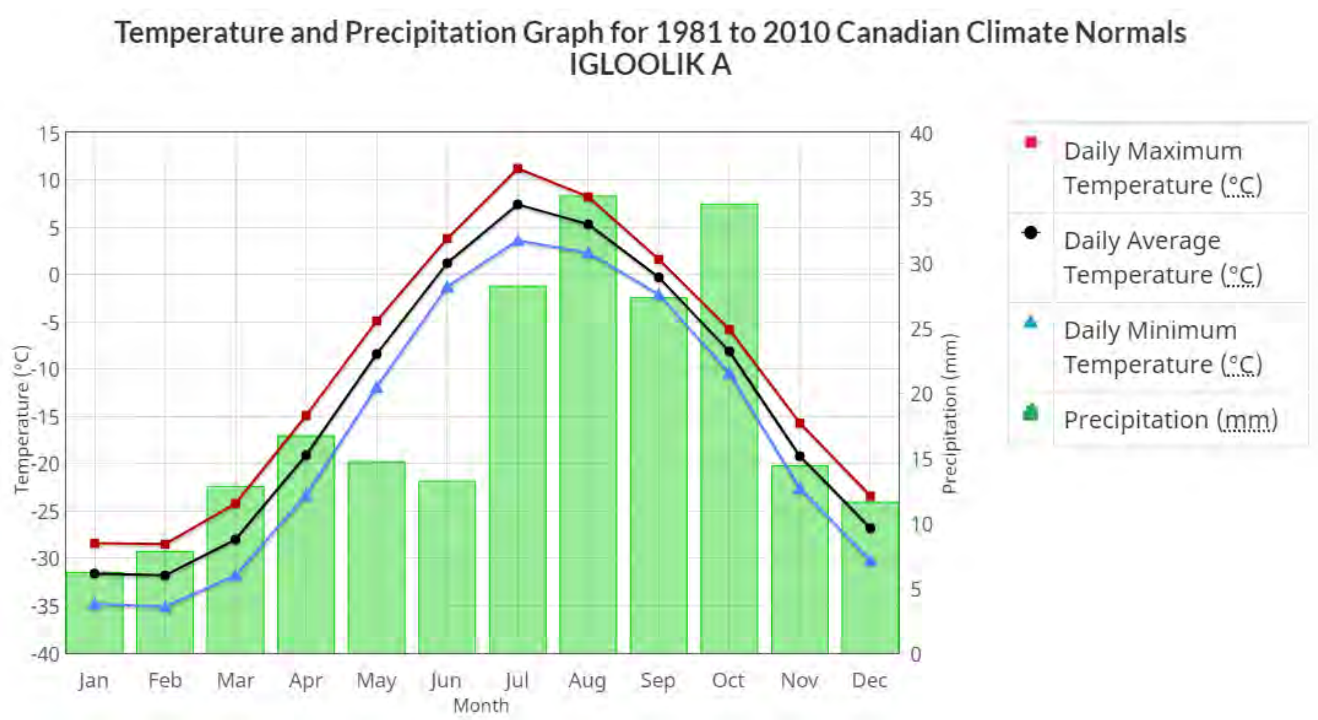


Figure 2 3: Temperature and Precipitation (1981-2010). Igloolik A

Table 2-1: Temperature Climate Normals 1981-2010. Igloolik A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	-31.6	-31.8	-28	-19.1	-8.4	1.2	7.4	5.3	-0.3	-8.1	-19.2	-26.8	-13.3
Standard Deviation	2.8	3.2	2.6	2.3	2.2	1.4	1.5	1.2	1.3	2.8	3.5	3.7	3.6
Daily Maximum (°C)	-28.4	-28.5	-24.2	-14.9	-4.9	3.8	11.2	8.2	1.6	-5.8	-15.7	-23.4	-10.1
Daily Minimum (°C)	-34.8	-35.1	-31.8	-23.3	-11.9	-1.3	3.6	2.3	-2.1	-10.4	-22.6	-30.2	-16.5
Extreme Maximum (°C)	-1	-1	-3	1.5	7	16.5	**24.5**	21.5	11.5	2	-1	-1.5	
Date (yyyy/dd)	1986/29	2006/27	2005/11	1995/26	1993/30	1991/18	2001/28	1991/05	2000/06	1986/02	1985/03	1998/03	
Extreme Minimum (°C)	-47	**-47**	-47	-40.5	-28	-13.5	-1	-5.5	-11	-30.5	-37	-42.5	
Date (yyyy/dd)	1987/05	1988/16	1993/16	1985/09	1999/01	1986/02	1994/30	1996/31	1984/29	1986/24	1986/23	1991/08	

Table 2-2: Precipitation Climate Normals 1981-2010. Igloolik A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	0	0	0	0.1	0.2	8.9	28.2	32.7	15.9	1.1	0	0	**86.9**
Snowfall (cm)	6.2	7.9	13.4	17.1	14.8	4.5	0	2.4	11.1	32.8	14.5	11.5	**136.2**
Precipitation (mm)	6.2	7.8	12.8	16.7	14.7	13.2	28.2	35.1	27.3	34.5	14.4	11.6	**222.4**
Snow Depth at Month-end (cm)	39	40	42	44	35	1	0	0	4	19	26	32	**24**
Extreme Daily Rainfall (mm)	0	0	0	0.8	2.6	13	24.8	25	**28**	7	0	0	
Date (yyyy/dd)	1985/01	1986/01	1985/01	1995/26	2006/11	1998/21	1990/29	1990/22	1994/11	2006/16	1984/01	1984/01	

In absence of Environment and Climate Change Canada (ECCC) data availability, short duration rainfall characteristics in the form of Intensity Duration Frequency (IDF) data for Igloolik were obtained from Western University's IDF_CC Tool and are presented in Table 2-3. This data was compared to both daily rainfall data from the Igloolik Airport station and Environment Canada IDF tables for the nearby Hamlet of Hall Beach to ensure the consistency and accuracy of the tool. The IDF_CC tool uses as Gumbel Extreme Value distribution (GEV) while ECCC statistical distributions are normally computed with a standard Gumbel distribution.

Table 2-3: Return Period Rainfall Amounts for Igloolik (mm)

T (years)	2	5	10	25	50	100
5 min	1.14	2.09	3.07	4.85	6.56	8.80
10 min	1.45	2.53	3.74	6.07	8.53	11.78
15 min	1.89	3.21	4.54	6.85	9.03	11.98
30 min	2.70	4.44	6.08	8.72	11.02	13.29
1 h	4.29	6.38	8.04	9.74	10.24	13.29
2 h	6.19	8.79	10.74	13.15	14.66	16.08
6 h	11.59	17.19	21.91	28.55	33.51	38.77
12 h	14.34	21.36	27.31	35.75	42.11	48.90
24 h	18.16	27.01	34.00	43.23	49.59	55.93

2.4.2 Climate Change Predictions

2.4.2.1 Igloolik Regional Climate Projections

Atlas Canada (The Prairie Climate Centre, 2019) climate change projections were retrieved for the Region of Igloolik. Tetra Tech analysed projected changes between the 30-year time periods of 1976-2005 and 2021-2050 for the RCP8.5 climate change scenario. Between these two time periods, the annual mean temperature is expected to increase by 3.2 °C from -13.2 °C to -10.0 °C. Annual precipitation is expected to increase by 14 percent from 224 mm to 255 mm. The maximum 1-day precipitation is expected to increase by 16 percent from 13 mm to 15 mm between the same time periods. Seasonal mean temperature and precipitation projections are shown in Tables 2-4 and 2-5 below.

Table 2-4: Atlas Canada RCP8.5 Climate Change Temperature Projections Summary

		1976-2005	2021-2050		2051-2080	
Variable	Period	Mean (°C)	Mean (°C)	Increase (°C)	Mean (°C)	Increase (°C)
Mean Temperature (°C)	Annual	-13.2	-10	3.2	-6.5	6.7
Mean Temperature (°C)	Spring	-18.4	-15.8	2.6	-12.9	5.5
Mean Temperature (°C)	Summer	4.6	6.5	1.9	8.7	4.1
Mean Temperature (°C)	Fall	-9.8	-5.8	4.0	-2.2	7.6
Mean Temperature (°C)	Winter	-29.4	-25.1	4.3	-20	9.4

Table 2-5: Atlas Canada RCP8.5 Climate Change Precipitation Projections Summary

		1976-2005	2021-2050		2051-2080	
Variable	**Period**	**Mean (mm)**	**Mean (mm)**	**Increase (mm)**	**Mean (mm)**	**Increase (mm)**
Precipitation	Annual	224	255	14%	292	30%
Precipitation	Spring	41	46	12%	52	27%
Precipitation	Summer	83	91	10%	100	20%
Precipitation	Fall	72	83	15%	98	36%
Precipitation	Winter	28	35	25%	43	54%
Max 1-Day Precipitation		13	15	16%	17	31%

As a result of the projected increase in spring temperatures for the 2021-2050 time period, the timing of the spring snowmelt event is expected to occur approximately 6 days earlier in the spring season. The timing of the start of snowfall in the fall season is expected to be delayed by approximately 11 days compared to the 1976-2005 time period due to the projected increase in fall temperatures.

As a result of the projected change in spring melt and fall freeze dates, the duration of winter (taken to be the period when precipitation falls as snow) is expected to decrease for the 2021-2050 time period by approximately 17 days. Due to the expected shorter winter duration, a reduction in total snow accumulation period is expected; conversely, as a result of the projected monthly precipitation increases, snowfall in the Igloolik region is expected to increase. The combined net effect of a shorter winter and increased precipitation is an increase in snow accumulation during the winter months. It is estimated that the increase will be 4%.

In the spring, despite the timing of the freshet being expected earlier, the 2021-2050 warming rate is projected to be very similar to the average warming rate on record in the 1976-2005 time period. As climate change is projected to translate into an increase of 0.07 mm per day during the spring snowmelt period, it is expected that over the freshet period, lasting approximately 15 days, the total increase in precipitation in May and June is estimated to be 1 mm. Overall Tetra Tech estimates the springtime snowmelt runoff rates for the 2021-2050 will increase by a marginal amount.

During the part of the year when temperatures in Igloolik are above-freezing, rainfall is projected to increase by approximately 27%, from 89 mm to 113 mm, for the 2021-2050 time period. Due to the projected increase in rainfall, larger and more severe summer precipitation events are expected for the Igloolik region in the 2021-2050 time period. Figures 2-4 and 2-5 below show the Atlas Canada temperature and precipitation projections discussed in this section.

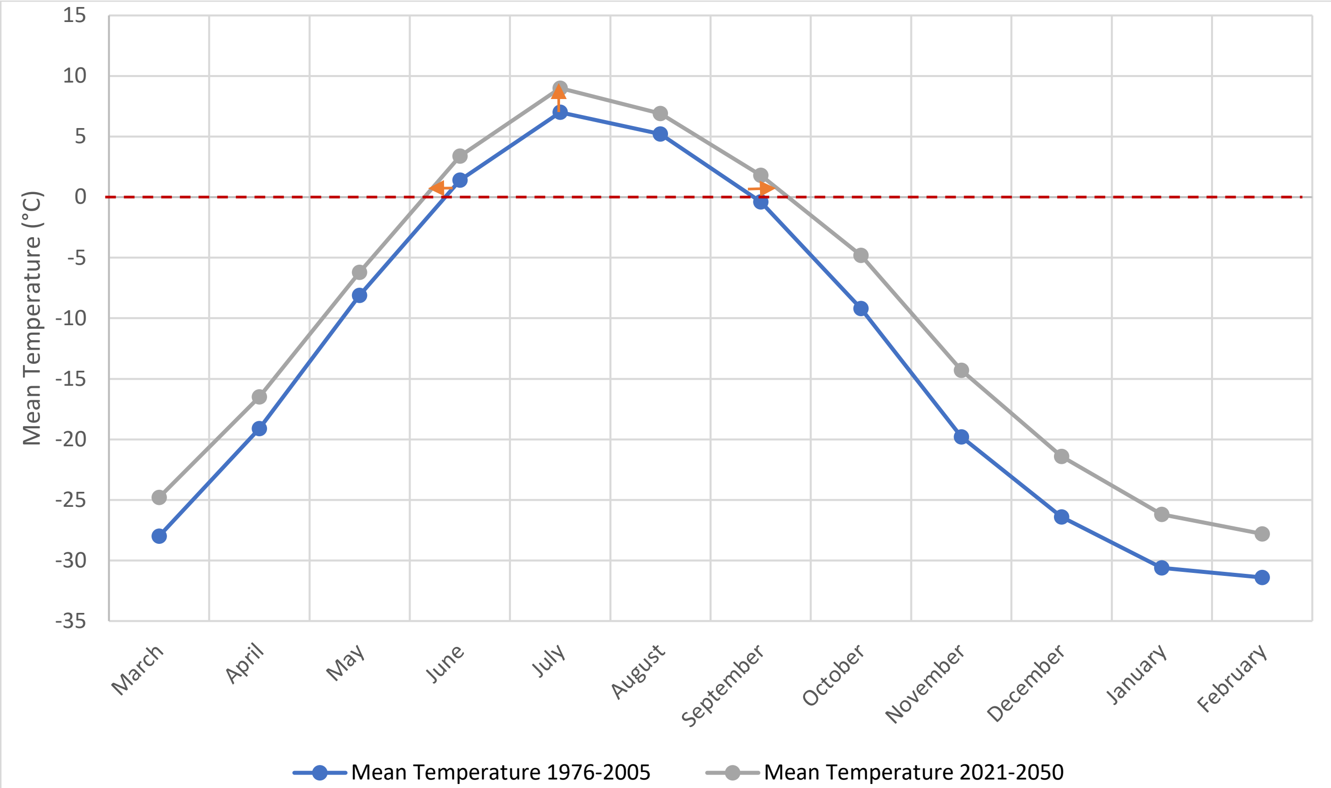


Figure 2-4: Atlas Canada Projected Monthly Mean Temperature

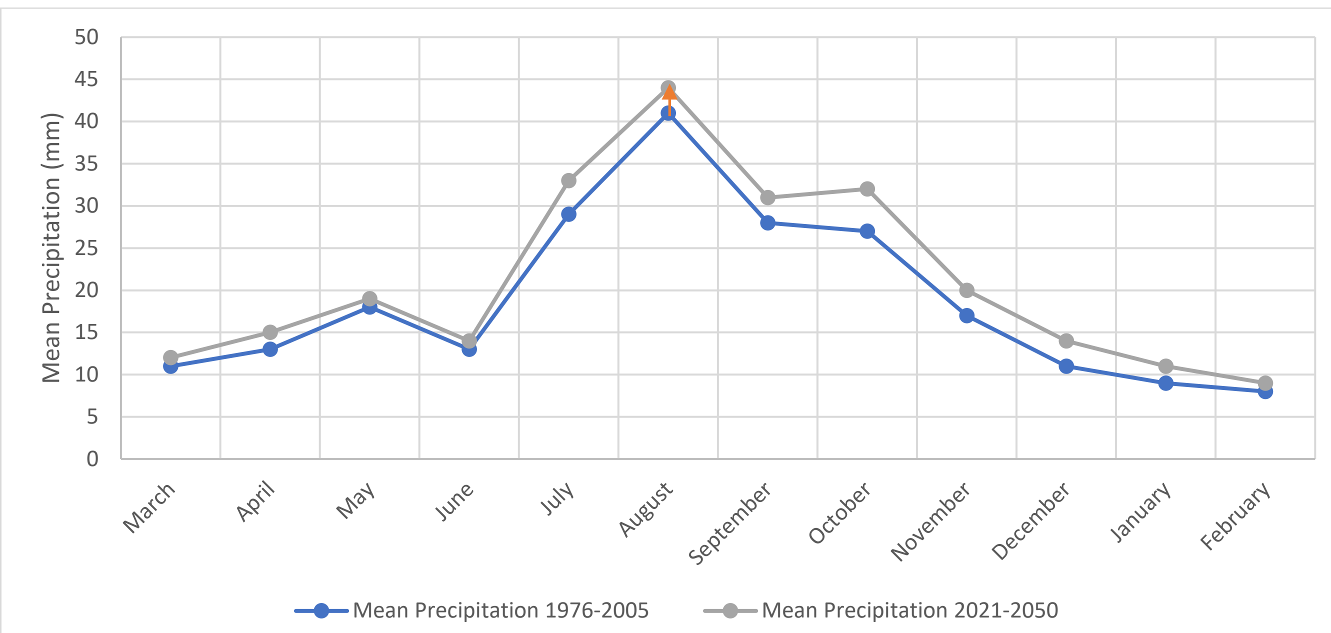


Figure 2-5: Atlas Canada Projected Monthly Mean Precipitation

2.4.2.2 Short Duration Rainfall Events

Climate change effects on short duration rainfall events are available through the IDF_CC Online Tool v4.0 developed by Western University (Simonovic, Schardong, Gaur, & Sandink, 2018). The tool provides rainfall intensity-duration-frequency (IDF) data from historic observations and climate change scenarios from 24 Global Circulation Models (GCMs).

Projected IDF data for the RCP 8.5 scenario and the time period of 2021 to 2050 is listed in Table 2-6. Detailed hydrological modelling of Igloolik was conducted based on these climate change adjusted rainfall depths.

Table 2-6: Projected IDF at Igloolik (mm) (2021 to 2050)

T (years)	2	5	10	25	50	100
5 min	1.1	2.1	3.1	4.8	6.5	8.8
10 min	1.5	2.5	3.7	6.1	8.5	11.7
15 min	1.9	3.2	4.5	6.9	9.0	11.7
30 min	2.7	4.5	6.1	8.7	11.0	13.2
1 h	4.3	6.4	8.0	10.2	11.7	13.2
2 h	6.2	8.9	10.7	13.2	14.6	16.0
6 h	11.7	17.3	21.8	28.6	33.4	38.6
12 h	14.5	21.5	27.2	35.8	41.9	48.7
24 h	18.3	27.2	33.8	43.2	49.4	55.7

2.4.3 Climate Change Implications

Due to limited climate change research available for the Hamlet of Igloolik, relevant findings from Lewis and Miller's "*Climate Change Adaptation Action Plan for Iqaluit*" (2010) was utilized for this section of the report. Lewis and Miller (2010) presented a summary of perceived sensitivities to climate change in Iqaluit, including the following:

Infrastructure

1. *Damage to infrastructure is expected to increase due to increases in climate variability and extreme events.*
2. *A decrease in the permafrost layer was identified as the most significant climate-related concern for infrastructure.*
3. *The following may be particularly at risk: buildings with shallow foundations; buildings, roads and buried pipes along steep south facing slopes and/or in areas of high snow accumulation; any building or road in areas of poor drainage where water may pool.*
4. *The following infrastructure may be vulnerable to other climate change impacts: buildings or piping in poor condition due to age, absence of regular maintenance, outdated design or over-extended use; infrastructure located along the coast which may be susceptible to damage from flooding or storm surges; the drainage system which may be impacted by changes in precipitation; and the City's water supply.*
5. *All new municipal infrastructure shall be designed and constructed to specifications that withstand projected changes in climate over their expected design life and meet sustainable development standards.*

6. *City outfalls should be designed to fall outside the range in tidal variability.*

Buildings

7. *With an increase of the active layer of permafrost, many existing building foundations could experience structural damage.*

8. *With a change in weather patterns such as extreme storm events, more extreme temperature variations, increased humidity in snow and more rain, buildings will be more susceptible to weathering and moisture damage.*

9. *Some waterfront buildings are vulnerable to flooding at extreme high tides or under storm surge conditions and minimum foundation levels may need to be established.*

Water Supply System

10. *Changes in permafrost will have implications for both existing and new underground piping.*

11. *Warmer air temperatures could cause surface evaporation of the City's water supply and could eventually reach temperatures that allow algae and other micro-organisms to grow, thereby compromising water quality.*

12. *Increased rainfall could potentially put the municipal water supply at risk by washing contaminants and soil into the reservoir.*

Wastewater Treatment System

13. *Increased precipitation, in the form of heavy rainfall, could overwhelm the system and cause failure or overflow, which could contaminate adjacent water bodies.*

Waste Disposal System

14. *Increase in the active layer of permafrost could lead to changes the freeze-thaw cycle, drainage and water flow around the landfill. Design and operation of the landfill needs to take this into consideration.*

3.0 EXISTING DRAINAGE SYSTEM AND ISSUES

A critical task in the development of a Drainage Master Plan is to identify, assess, and log all critical drainage infrastructure and known deficiencies. For Tetra Tech process included documenting the geometric locations, descriptions and conditions of the physical assets that the Igloolik drainage system is composed of. Using field and desktop data, this information was used to build a georeferenced map of the drainage infrastructure. The inventory also includes the location and description of existing issues such as ponding and damaged culverts. The following sections describe the activities conducted during the site visit, and the development of the georeferenced map detailing the drainage system.

3.1 Site Visit

A site visit was conducted from August 29th - 30th, 2019 by Tetra Tech engineering staff Mark Aylward-Nally and Josh Weidner. The purpose of the site visit was to:

- Discuss ongoing drainage issues and maintenance practices with the Igloolik foreman, Mr. Joasai Kublu;
- Conduct a walkthrough inspection of the drainage system of the Hamlet;
- Conduct informal interviews with local residents regarding known drainage issues; and
- Document and develop a photo inventory of all drainage infrastructure and discernible issues.

3.1.1 Walkthrough Inspection

A walkthrough of Igloolik was conducted from August 29th to August 30th, 2019 with the following objectives:

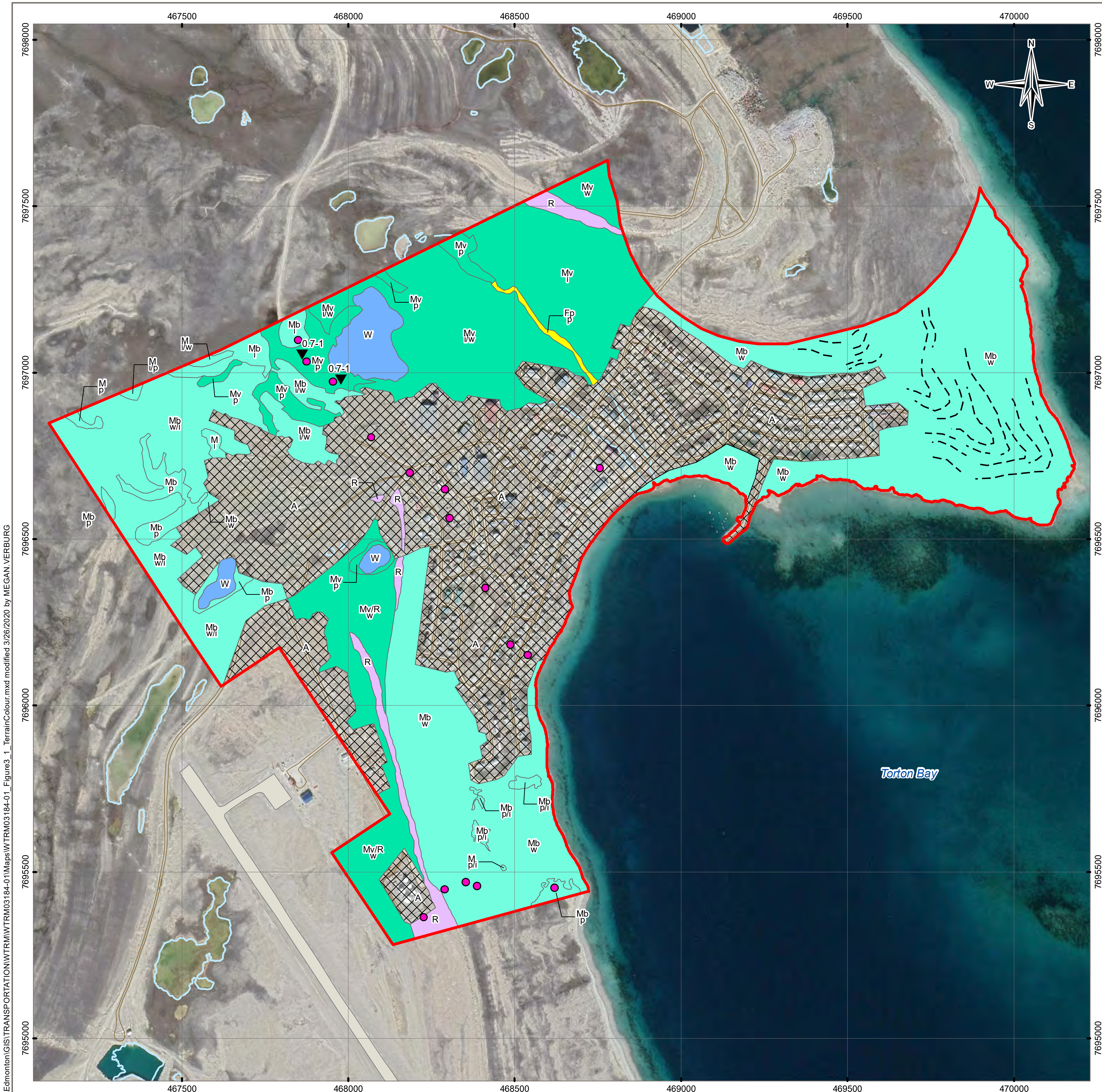
- Develop an understanding of the drainage patterns through the Hamlet;
- Identify main drainage routes and infrastructure assets;
- Get GPS points of key infrastructure locations, including upstream and downstream culvert ends;
- Measure culvert dimensions and document culvert conditions;
- Identify areas of ponding and undesirable flow;
- Record a photo inventory of key elements of the drainage infrastructure;
- Record a "photosphere" inventory of the Hamlet for use as geolocated 360-degree point of view references (in total 275 Photosphere locations were recorded throughout the community);
- Identify drainage outlet locations; and
- Conduct Informal Interviews with Hamlet residents.

A complete inventory of all existing Culverts documented and photographed within the Hamlet during this field visit is included in Appendix E.

3.2 Geology Field Reconnaissance

The site visit was conducted by Dr. Roujanski of Tetra Tech's Edmonton office on September 12, 2019. The purpose of the field reconnaissance was to confirm the findings of the background data review and preliminary terrain mapping, as well as to collect additional data relevant to potential terrain-related development constraints.

The fieldwork focused on the proposed community expansion areas. A series of foot traverses were conducted across the study area with stops at selected observation sites shown on Figures 3-1 and 3-2. The collected information includes types of surficial materials, surface expression, soil drainage conditions, and permafrost-related processes and phenomena. Numerous GPS-linked photographs of the terrain features were taken. Measuring active layer thickness (ALT) with the permafrost probe within the study area was found ineffective due to the high clast content of the surficial materials and very shallow top of bedrock. Few ALT measurements taken are shown on Figures 3-1 and 3-2.



LEGEND

- Field Observation Site Location
- Active Layer Thickness (m, measured)
- Raised Beach Ridge
- Study Area
- Runway
- Gravel Road
- Watercourse
- Waterbody

NOTES
Terrain Classification based on data provided by Carleton.
Hydrology and transportation base data provided by Government of Nunavut, August 2016
Imagery provided by Google Earth (August 10, 2019)

SURFICIAL MATERIAL

F — **Fluvial (Alluvium) Deposit:** sand and gravel less than 5 m thick.

M — **Marine (Littoral) Deposit:** sediments (coarse sand, gravel, and shingles with variable amounts of silt) derived from shattered limestone, related to marine inundation during periods of higher sea level.

Mv — **Marine Veneer (Mv) Deposit:** up to 1 m thick; commonly includes patches of exposed bedrock and marine blanket.

Mb — **Marine Blanket (Mb) Deposit:** greater than 1 m thick (generally 2-8 m); may include patches of marine veneer and exposed bedrock.

R — **Bedrock:** exposed sedimentary (carbonate) rocks: dolomite, limestone.

W — **Water:** water bodies such as lakes and ponds.

A — **Anthropogenic Material:** human-made or modified geological material whose original properties have been changed.

SURFICIAL EXPRESSION

v — **Veneer:** deposit less than 1 m thick (less than 0.3 m for organic deposits); surface mimics form of the underlying unit (generally bedrock).

b — **Blanket:** deposit greater than 1 m thick (generally 1 to 5 m thick; more than 0.3 m for organic deposits); minor irregularities of the underlying unit (generally bedrock) are masked.

p — **Plain:** flat or relatively level landscape element; bedrock topography is masked.

DRAINAGE CLASS

w — Well Drained Surface

i — Imperfectly Drained Surface

p — Poorly Drained Surface

DELIMITERS

/ — First component more common than second (e.g. i/w means that 60-75% of the polygon area is imperfectly drained, with the remainder being well drained).

TERRAIN CODE

Upper case letter = Surficial Material
Lower case letter = Surficial Expression

Ov//Fp
p/i

Delimiter
Second unit
Secondary Drainage
First unit
Primary Drainage
Drainage Delimiter

STATUS
ISSUED FOR USE

GEOTECHNICAL INVESTIGATION AND DRAINAGE PLANNING IGLOOLIK, NUNAVUT

Terrain Map

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:12,500
200 100 0 200
Metres

TETRA TECH

FILE NO.
WTRM03184-01_Figure3_1_TerrainColour.mxd

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Tt-EDM	MRV	SL	VER	0

DATE
March 26, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 3-1

LEGEND

- Field Observation Site Location
- Active Layer Thickness (m, measured)
- Raised Beach Ridge
- Study Area
- Runway
- Gravel Road
- Watercourse
- Waterbody

NOTES
Terrain Classification based on data provided by Carleton.
Hydrology and transportation base data provided by Government of Nunavut, August 2016
Imagery provided by Google Earth (August 10, 2019)

SURFICIAL MATERIAL

F — **Fluvial (Alluvium) Deposit:** sand and gravel less than 5 m thick.

M — **Marine (Littoral) Deposit:** sediments (coarse sand, gravel, and shingles with variable amounts of silt) derived from shattered limestone, related to marine inundation during periods of higher sea level.

Mv — **Marine Veneer (Mv) Deposit:** up to 1 m thick; commonly includes patches of exposed bedrock and marine blanket.

Mb — **Marine Blanket (Mb) Deposit:** greater than 1 m thick (generally 2-8 m); may include patches of marine veneer and exposed bedrock.

R — **Bedrock:** exposed sedimentary (carbonate) rocks: dolomite, limestone.

W — **Water:** water bodies such as lakes and ponds.

A — **Anthropogenic Material:** human-made or modified geological material whose original properties have been changed.

SURFICIAL EXPRESSION

v **Veneer:** deposit less than 1 m thick (less than 0.3 m for organic deposits); surface mimics form of the underlying unit (generally bedrock).

b **Blanket:** deposit greater than 1 m thick (generally 1 to 5 m thick; more than 0.3 m for organic deposits); minor irregularities of the underlying unit (generally bedrock) are masked.

p **Plain:** flat or relatively level landscape element; bedrock topography is masked.

DRAINAGE CLASS

w Well Drained Surface

i Imperfectly Drained Surface

p Poorly Drained Surface

DELIMITERS

/ First component more common than second (e.g. i/w means that 60-75% of the polygon area is imperfectly drained, with the remainder being well drained).

TERRAIN CODE

Upper case letter = Surficial Material
Lower case letter = Surficial Expression

Ov//Fp ← Second unit
p/i ← Secondary Drainage
Delimiter
First unit
Primary Drainage
Drainage Delimiter

STATUS
ISSUED FOR USE

GEOTECHNICAL INVESTIGATION AND DRAINAGE PLANNING IGLOOLIK, NUNAVUT

Terrain Map

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:12,500
200 100 0 200
Metres

FILE NO.
WTRM03184-01_Figure3_2_TerrainHollow.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-EDM	MRV	SL	VER	0

DATE: March 26, 2020
PROJECT NO.: TRN.WTRM03184-01

Figure 3-2

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3.3 Geology Terrain Mapping

3.3.1 Surficial Geology and Permafrost

Surficial geology and permafrost feature mapping of the proposed Igloolik community expansion areas was carried out by Mr. Vladislav E. Roujanski, Ph.D., P.Geol. and Ms. Jennifer Stirling, P.Geo., with GIS support provided by Ms. Megan Verburg.

The existing surficial geology map of the region (Dredge 1988) was reviewed and modified to create a detailed terrain map of the study area. The B&W air photos (stereopairs) listed in Section 2.1 were interpreted using a Sokkia MS27 stereoscope. Surficial geology polygons were delineated on Google Earth Pro™ historical imagery of the study area using Google Earth Pro™ mapping tools.

The resultant terrain map shows spatial distribution of surficial materials. Surficial geology polygons were delineated in areas where terrain and subsurface data was available. This information was then extrapolated to unknown areas using appearance (texture, colour, hue etc.) on the air photos.

All terrain polygons were assigned a drainage class, except for “the Anthropogenic Material” map unit, drainage of which was modified during the land development. The following three drainage classes are used to characterize drainage conditions across the study area:

- well drained (**w**);
- imperfectly drained (**i**); and
- poorly drained (**p**).

These drainage classes are relative and qualitative.

The terrain map is presented at a scale of 1:12,000 and should be considered accurate to that scale (Figures 3-1 and 3-2).

3.3.2 Development Suitability Ranking

Development suitability within the study area is based on the presence of terrain constraints and potential geohazards.

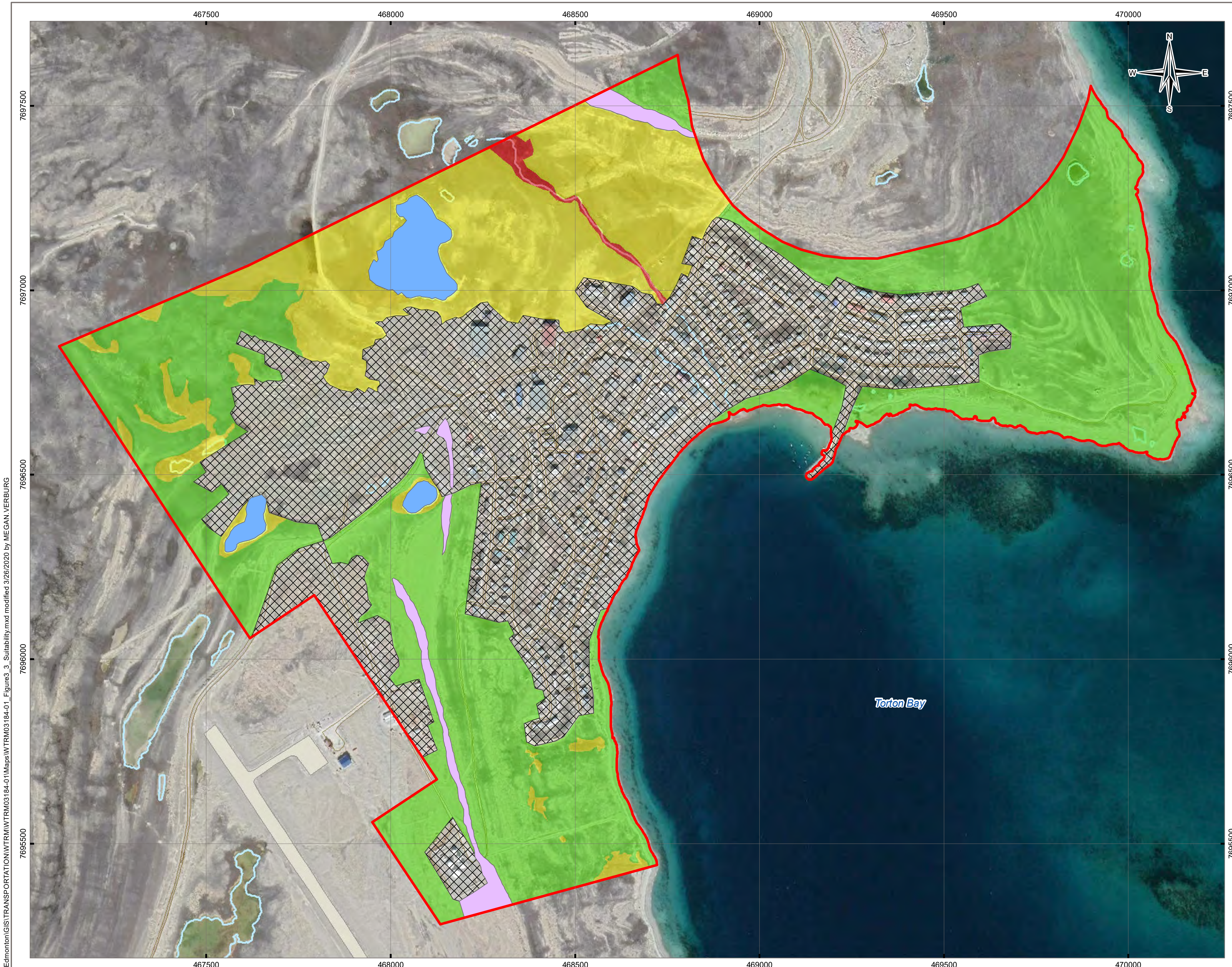
Terrain constraints in the study area include surficial material type, permafrost conditions (thermal state and ice content, especially occurrence of massive ice bodies), permafrost-related geomorphic processes and landforms, drainage conditions, flooding of areas of low-lying ground adjacent to major stream channels, terrain stability and its ruggedness, particularly slope steepness. These naturally occurring features affect the design, construction techniques and maintenance of the community infrastructure, housing and facilities.

Geohazards in the study area include thermal erosion, permafrost degradation in the form of thermokarst, ground differential settlement and subsidence, permafrost-related mass wasting such as thaw flow slides and other hazardous geomorphic processes and phenomena, such as flooding of areas of low-lying ground adjacent to major stream channels. These processes may damage or adversely affect existing or potential infrastructure, housing and facilities.

These permafrost terrain features were identified through background data review, desktop terrain analysis and mapping, and field observations during a recent site visit. Development Suitability Map of the study area was produced at a scale of 1:12,000 (Figure 3-3).

The development suitability classes for the project area were established as follows:

- **Suitable for Development:** Permafrost appears to be predominantly ice-poor with ground ice content generally less than 10% by volume of visible ice; permafrost terrain is generally stable; the ground surface is well- to imperfectly-drained; gently sloping, and permafrost processes are inactive to limited.
- **Conditionally Suitable for Development (Provided Tetra Tech's Drainage Improvement Plan is Implemented):** Permafrost appears to be of medium to, locally, high ice content, i.e. 10 to more than 20% by volume of visible ice, and may contain significant accumulations of ground ice; permafrost terrain is relatively stable to potentially unstable and sensitive to human-induced disturbance; ground surface is imperfectly to poorly-drained with pools of standing water; and there is evidence of active hazardous permafrost processes, such as thermokarst, differential settlement and subsidence.
- **Unsuitable for Development:** Unsuitable for development category consists of floodplain, i.e. area of low-lying ground adjacent to the major stream channel in the study area (Figures 3-1, 3-2 and 3-3). The floodplain is subject to seasonal flooding. Permafrost appears to be predominantly ice-rich with ground ice content commonly exceeding 20% by volume of visible excess ice and may contain significant accumulations of ground ice; such permafrost condition is unstable and sensitive to human-induced disturbance; ground surface is poorly-drained with pools of standing water.



LEGEND

Study Area

Construction Suitability

- Suitable for Development
- Conditionally Suitable for Development Provided the Drainage Improvement Plan is Implemented
- Unsuitable for Development

Terrain Not Assessed for Development Suitability

- Anthropogenic
- Bedrock
- Water

Base Features

- Runway
- Gravel Road
- Watercourse
- Waterbody

NOTES

Base data source:
Terrain Classification based on data provided by Carleton.
Hydrology and transportation base data provided by Government of Nunavut, August 2016
Imagery provided by Google Earth (August 10, 2019)

STATUS
ISSUED FOR USE

GEOTECHNICAL INVESTIGATION AND DRAINAGE PLANNING IGLOOLIK, NUNAVUT

Development Suitability

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:10,000

200 100 0 200

Metres

TETRA TECH

FILE NO.
WTRM03184-01_Figure3_3_Suitability.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-EDM	SL	MRV	VER	0

DATE
March 26, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 3-3

3.4 Development of Georeferenced Mapping

Using the GPS points, field notes and photographs obtained during the site visit, the topology of the drainage network was put together in a GIS shapefile. The shapefile includes locations of open channels (ditches and swales) or culverts. A naming convention was developed, and every asset was named in the shapefile. Connectivity of the drainage system was developed using data from the site visit and supplemented by mapping data provided by CGS. A separate shapefile was created to mark areas with drainage issues identified during the site visit. The drainage issues identified included ponding areas, damaged culverts, uncontrolled overland flow and erosion issues. Figures 3-4 to 3-9 in Section 3.6 highlight the documented issues.

3.5 Drainage

Igloolik's drainage patterns follow the natural relief, however the construction of fill pads for buildings and road embankments have modified the native streams and lead to an increase in surface runoff and peak flows. A large portion of the runoff passing through the community is confined to two watercourses, with their headwaters located within the highlands upstream of the community. Snowmelt and storm runoff collects in sub-catchments directly northwest of the Hamlet before flowing southeast through the community and into Turton Bay. We estimate the larger of these two catchments to have a watershed area of approximately 158 hectares at its confluence with the bay.

Tetra Tech has completed a delineation of the existing subcatchments within the Igloolik region using the 2017 Aerial Photograph derived DEM as well as from observations and photographs collected during the site visit. Drainage areas and flow paths are presented on Figure 2-2 in Section 2.3.3.

Based on the 2017 Community Plan, land allocated for future expansion is located around the community's perimeter. The development of proposed drainage channels and drainage infrastructure for these future expansion areas is included within the scope of Tetra Tech's Master Drainage Plan and Geotechnical Investigation.

3.6 Drainage Infrastructure

During the 2019 site visit, existing culverts, ditches, swales, and natural streams were observed. A total of 77 culverts were assessed as part of this visit. The diameter of the culverts ranged from 100 mm to 1050 mm, with the majority having a diameter of 300 mm or 600 mm. The bulk of these culverts were damaged and/or partially/fully buried. As such the existing functionality of each culvert varies significantly. An Inventory of Existing Culverts is included in Appendix E.

3.7 Drainage Issues

Developing and maintaining a well-functioning drainage system is an ongoing concern for northern communities which experience harsh climates and rely on semi-permanent infrastructure. During Tetra Tech's 2019 site visit, several categories of drainage issues in Igloolik were identified. Of the existing culverts, many were damaged, buried, and/or blocked with sediment, rocks, and debris. Through interviews with local residents and the Hamlet foreman, culverts especially susceptible to ice blockages were also noted. The lack of formalized swales is a separate issue which results in ponding and water egress across roadways leading to washouts and erosion during larger rain or snowmelt events.

Location specific drainage issues noted during the field investigation through observation and discussions with the Hamlet foreman and local residents are as follows:

- The region surrounding the Hamlet's RCMP detachment (near the intersection of Road R18 and Sivingayaaq) was highlighted by the Hamlet's foreman as particularly susceptible to flooding during the spring melt period. Water egress from related ponding also flows down to Road R12 affecting the "Northern Store" and surrounding lots. During its site inspection, Tetra Tech determined that a principle cause for this flooding was water leakage from the unformalized swale running down the northeast side of Road R18 as pictured in Figure 3-12 and highlighted in Figure 3-5.
- Systemic poor drainage was observed in Igloolik's eastern subdivision with substantial undesirable overland flow being reported by residents and witnessed during the site visit. Roads affected by water egress include Roads R22 – R27 as shown in Figure 3-4.
- Ponding was observed on the southwest side of the Igloolik firehall facility (Lot 54). Although ponding did not appear to directly affect vehicle access, conditions could worsen during the yearly freshet period. This in turn could promote water egress through the building envelope and/or restrict vehicle access. As the firehall is an essential building, Tetra Tech is recommending improving grading along the building's southwestern side to improve access and allow for additional storage area on the lot.
- The children's playground on the north east side of town is subject to flooding yearly due to poor grading and unformalized overland flow. This area is shown on Figure 3-4.

A summary of the most common drainage issues observed throughout the community of Igloolik are detailed in Table 3-1 below.

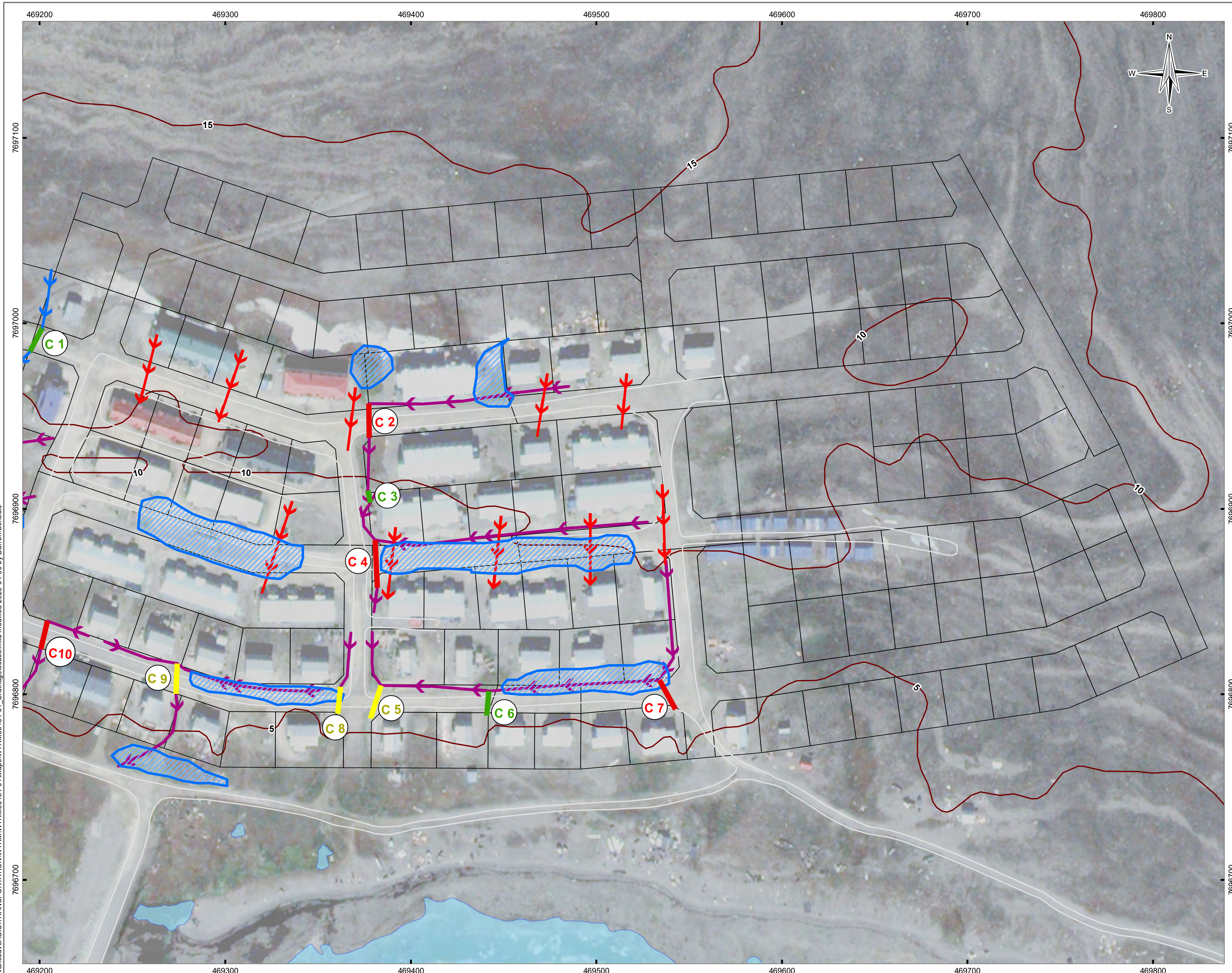
Table 3-1: Most Common Igloolik Drainage Issues

Issue	Cause
Spring Flooding	Yearly extreme runoff volumes. Culverts blocked by ice/snow.
Damaged Culvert Inlet/Outlet	Damage caused by snow removal and/or spring de-icing activities
Undesirable Flows which Cross Roadways and Traverse Residential Properties	Lack of formalized Ditches/Swales and blocked Culverts
Buried or Blocked Culvert Inlet/Outlet	Culvert inlet and/or outlet blocked due to sediment, rock, and debris deposition, and/or ice blockage.
Ponding	Blocked culverts, poor grading, vegetation overgrowth, lack of outlet.
Erosion	Velocity threshold for erosion is exceeded

Figures 3-4 to 3-9 identifies Igloolik's existing drainage infrastructure, locates the typical issues described above and specifies an existing condition for all culverts within the community. Tables 3-1 and 3-2 below provides guidance as to each of the 4 condition categories, how the conditions assigned are defined and the potential remedying actions available to the Hamlet. Appendix E includes a summary of the existing culverts identified within the community and their condition. Tetra Tech's recommended action for each culvert is provided in Section 6.0 - Drainage Master Plan.

Table 3-2: Existing Culvert Condition Categories, Descriptions and Potential Actions

Culvert Condition	Description	Potential Actions
Functioning as Intended	Full Conveyance Capacity (80-100%) No Damage	No Action Required, Upsize
Unblocked Damaged	Full Conveyance Capacity (80-100%) Non-superficial Damage Observed	Repair, Replace, No Action
Partly Blocked (with & without damage)	Capacity Restricted (30-70%) due to Sediment Build Up and/or Damage	Clean, Repair, Replace
Blocked (with & without damage)	Capacity Blocked (0-20% remaining) due to Sediment Build Up and/or Damage	Clean, Repair, Replace



LEGEND

Culverts

- Functioning as Intended
- Partly Blocked (with & without damage)
- Blocked (with & without damage)

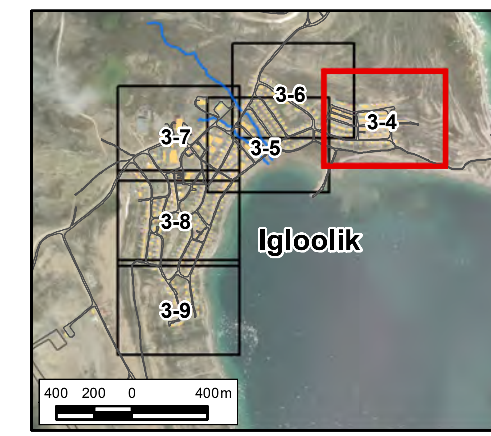
C## Culvert Number

Open Channels

- Well Defined Flow Path
- Overland Flow Path
- Undesirable Overland Flow Path
- Ponding

Base Data

- Current Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Drainage Issues Based on August 29-30 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000
40 20 0 40
Meters

TETRA TECH

FILE NO.
WTRM03184-01_DrainageIssues.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
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Figure 3-4

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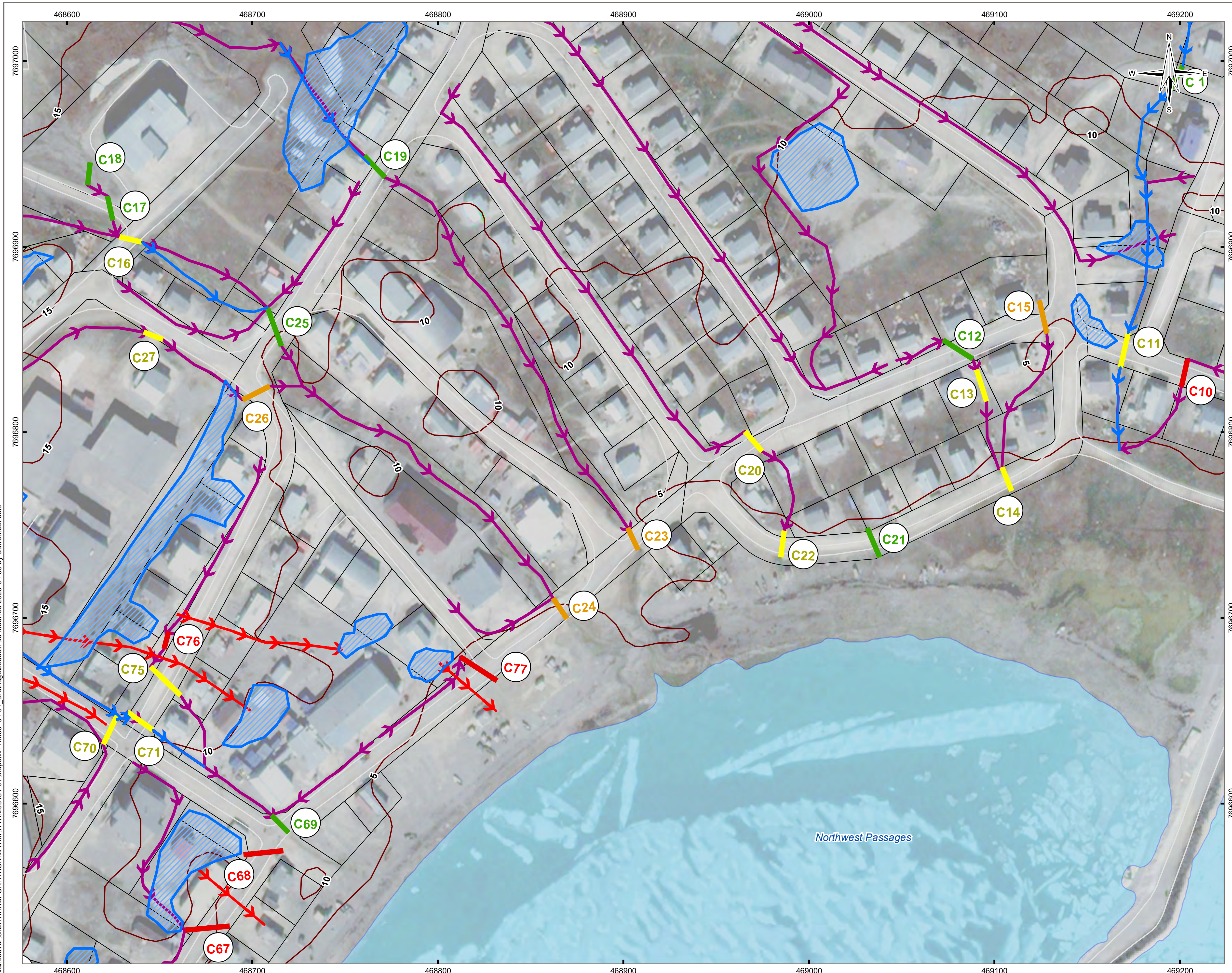


LEGEND

C## Culvert Number

Culverts

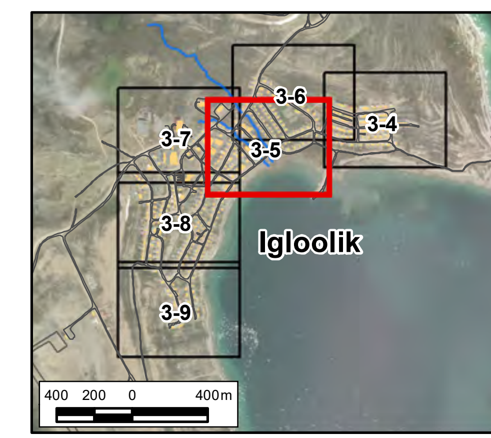
- Functioning as Intended
- Partly Blocked (with & without damage)
- Unblocked Damaged
- Blocked (with & without damage)

Open Channels

- Well Defined Flow Path
- Overland Flow Path
- Undesirable Overland Flow Path
- Ponding

Base Data

- Current Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Drainage Issues Based on August 29-30 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000

40 20 0 40
Meters

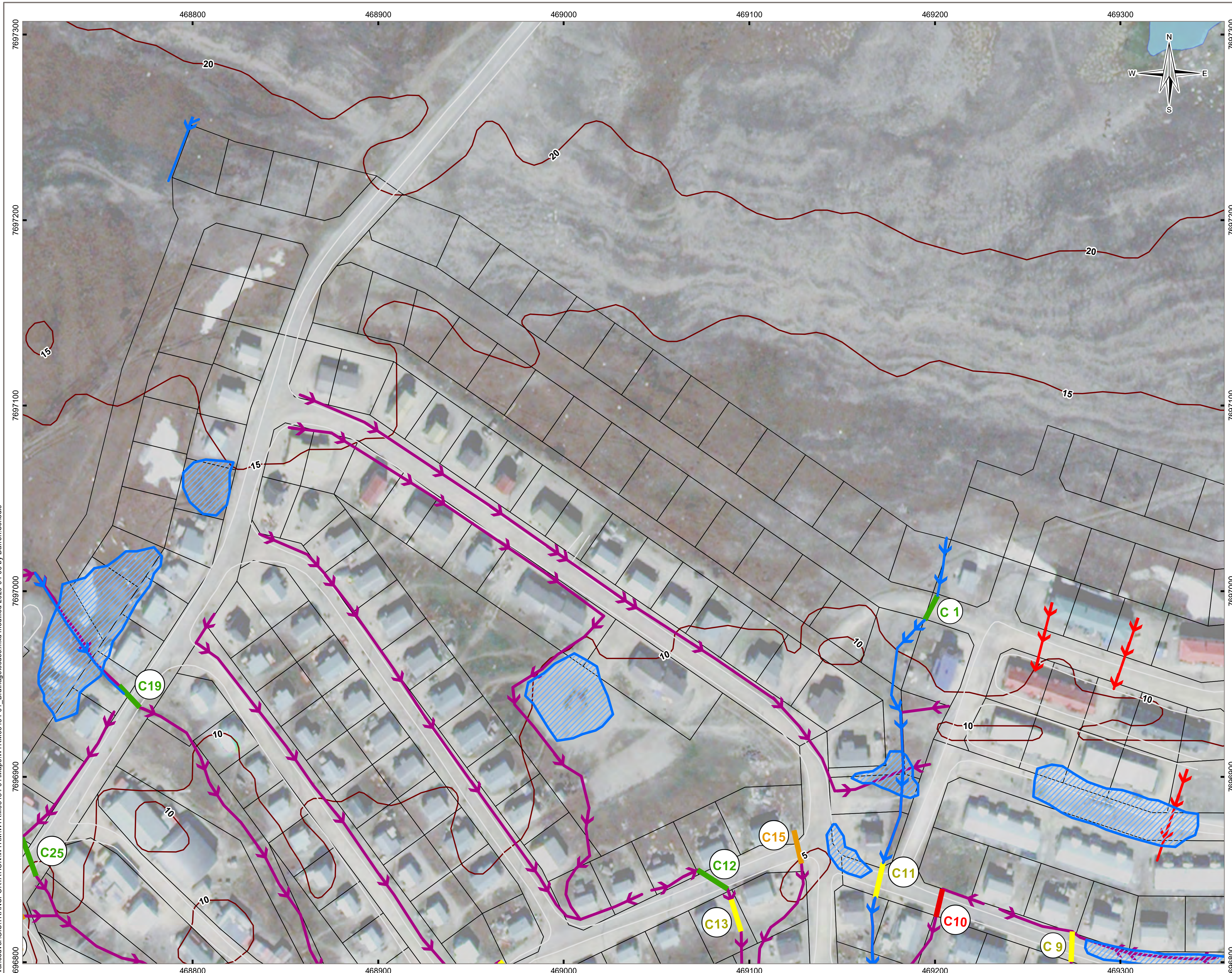
FILE NO.
WTRM03184-01_DrainageIssues.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure 3-5



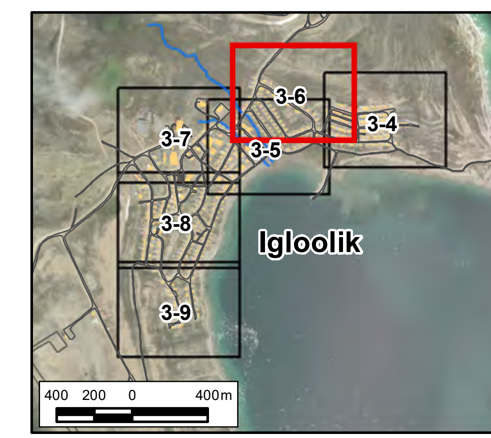
LEGEND

(C##) Culvert Number

Culverts
- Functioning as Intended
- Partly Blocked (with & without damage)
- Unblocked Damaged
- Blocked (with & without damage)

Open Channels
- Well Defined Flow Path
- Overland Flow Path
- Undesirable Overland Flow Path
- Ponding

Base Data
- Current Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Drainage Issues Based on August 29-30 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000
40 20 0 40
Meters

FILE NO.
WTRM03184-01_DrainageIssues.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE: April 6, 2020
PROJECT NO.: TRN.WTRM03184-01

TETRA TECH

Figure 3-6

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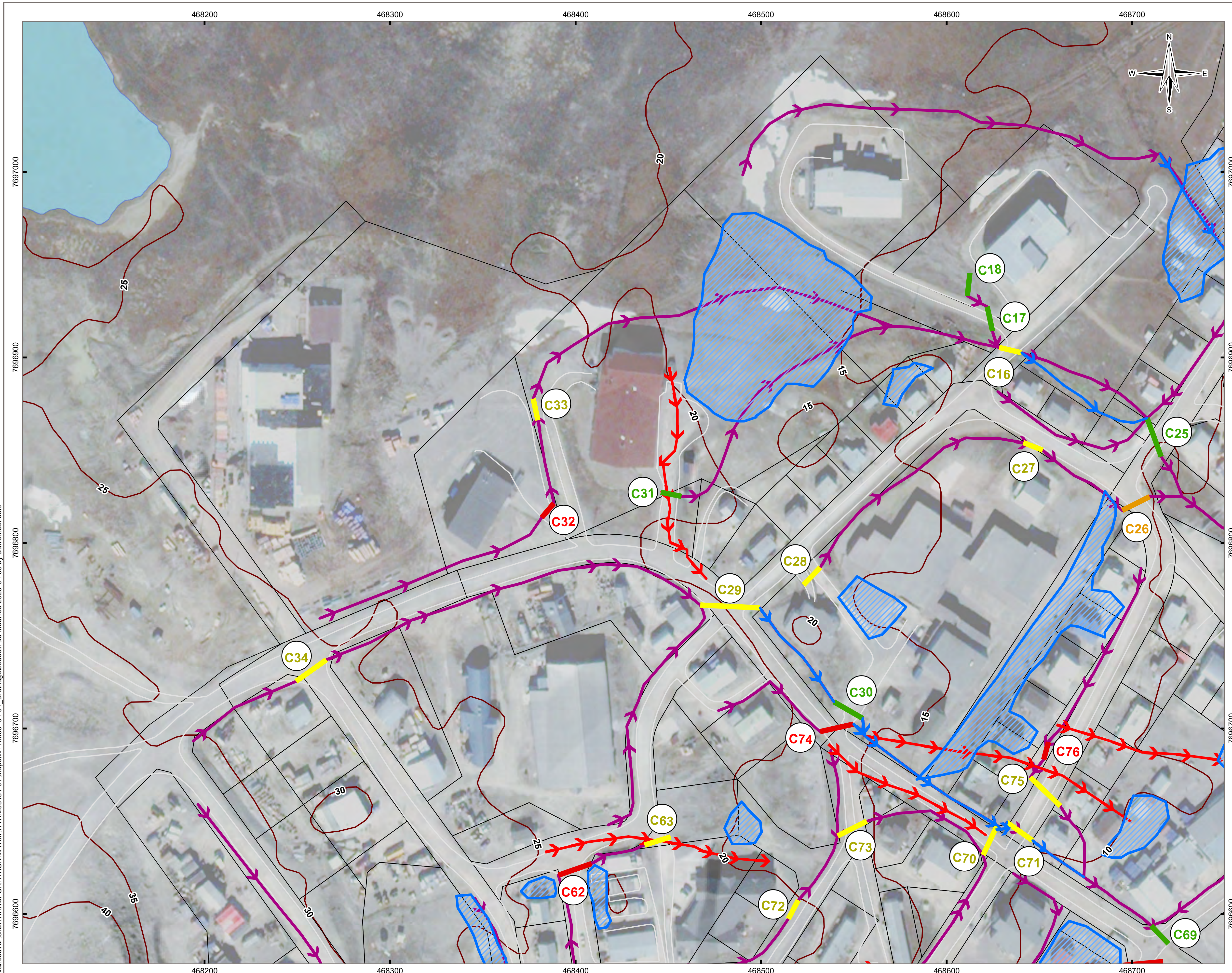


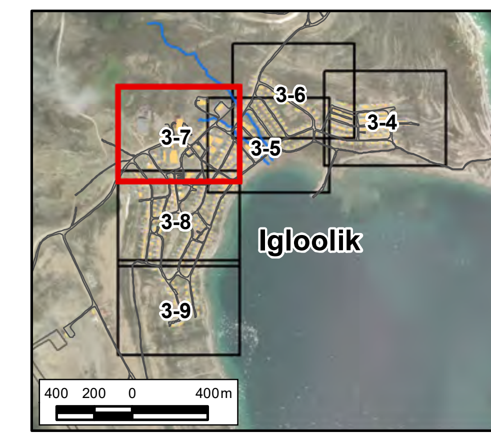
LEGEND

Culverts
- Functioning as Intended
- Partly Blocked (with & without damage)
- Unblocked Damaged
- Blocked (with & without damage)

C## Culvert Number

Open Channels
- Well Defined Flow Path
- Overland Flow Path
- Undesirable Overland Flow Path
- Ponding

Base Data
- Current Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Drainage Issues Based on August 29-30 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

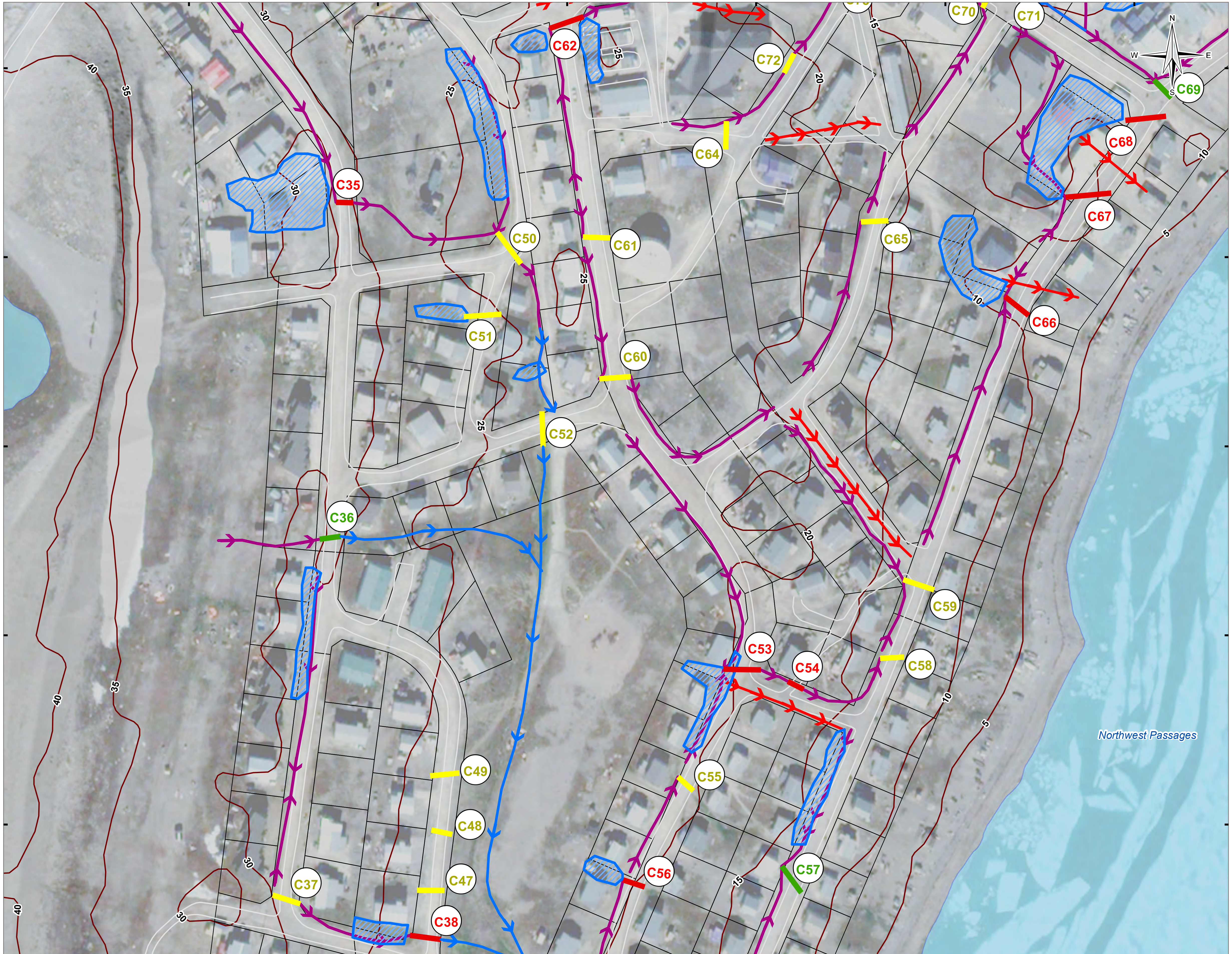
Scale: 1:2,000
40 20 0 40
Meters

TETRA TECH

FILE NO.				
WTRM03184-01_DrainageIssues.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure 3-7



LEGEND

Culvert Number

Culverts

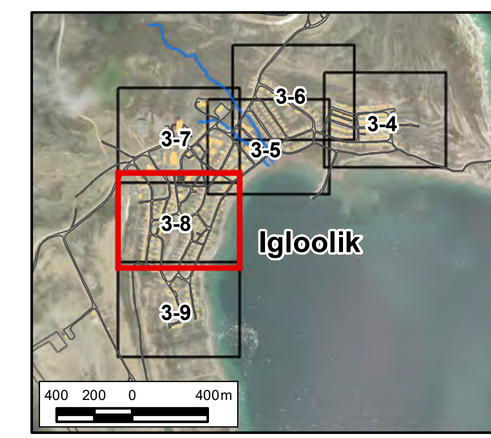
- Functioning as Intended
- Partly Blocked (with & without damage)
- Blocked (with & without damage)

Open Channels

- Well Defined Flow Path
- Overland Flow Path
- Undesirable Overland Flow Path
- Ponding

Base Data

- Current Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Drainage Issues Based on August 29-30 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000
40 20 0 40
Meters

FILE NO.
WTRM03184-01_DrainageIssues.mxd

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DATE
April 6, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 3-8

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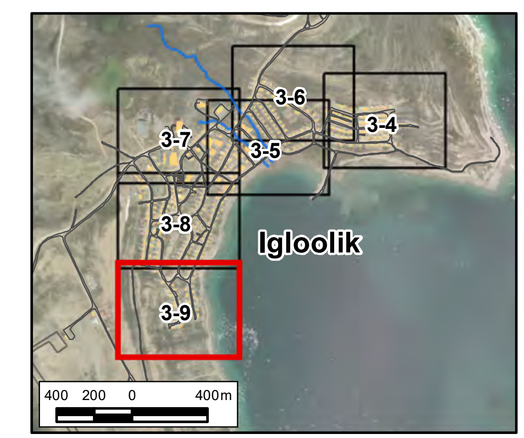
LEGEND

C## Culvert Number

Culverts
- Functioning as Intended
- Partly Blocked (with & without damage)
- Unblocked Damaged
- Blocked (with & without damage)

Open Channels
- Well Defined Flow Path
- Overland Flow Path
- Ponding

Base Data
- Current Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Drainage Issues Based on August 29-30 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000
40 20 0 40
Meters

FILE NO.
WTRM03184-01_DrainageIssues.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE
April 6, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 3-9

3.8 Example Photos

Figures 3-10 to 3-17 depict examples of the typical drainage issues identified during Tetra Tech's site visit.

Figures 3-10 to 3-17: Example Photos of Igloolik Drainage Issues from August 29 – 30 Site Visit

Figure No.	Description	Image
3-10	Buried culvert inlet (Culvert C66)	
3-11	Damaged culvert outlet (Culvert C73)	

Figure No.	Description	Image
3-12	Water egress from unformalized swale on Road R18. (Contributor to flooding around RCMP Detachment)	
3-13	Ponding and undesirable flow crossing roadway	

Figure No.	Description	Image
3-14	Ponding water adjacent to Hamlet Firehall	
3-15	Undesirable Flow across roadway due to lack of formalized swale	

Figure No.	Description	Image
3-16	Partly Blocked and Damaged Culvert Inlet (Culvert C22)	
3-15	Repairable Damage on Inlet of Culvert C41	

Figure No.	Description	Image
3-16	Damage on Culvert outlet due to lack of cover and/or snow clearing activities. (Culvert C2)	
3-17	Erosion due to unchannelized flow down steep grades	

4.0 ANALYSIS OF DRAINAGE SYSTEM

The Drainage Principles, Design Criteria, Design Scenarios and Modelling Results used to develop the proposed conveyance system for the Hamlet of Igloolik are described in this section of the report. Overarching recommendations for improvements are also provided at the end of this section.

4.1 Drainage Principles

According to the guidelines for Community Drainage System Planning, Design, and Maintenance in Northern Communities (CSA Group, 2015), the drainage system should be designed in accordance with the level of risk that is established during the planning process. The CSA Group also noted that:

- *"It is recognized that the capacity of any drainage system might be exceeded at some point";*
- *"The design will be impacted by physical constraints present within communities";*
- *"The desired acceptable level of risk might not be achievable in any given community due to physical (spatial) limitations, resources, subsurface conditions, and topography, among other factors";*
- *The acceptable level of risk established might be impacted by the changing the climate, for example, due to the changing climate, what was previously considered to be a 1-in-10 year event might occur on average every five years in the future".*

In addition to the CSA Group's design principles, the development of the proposed upgrades was based on Tetra Tech's own best practice principles as follows:

1. Effectively capture and route water around populated areas to protect buildings and communities.
    a. Where possible, minimize the imposition of waterways through populated areas and by forcing water towards the edges of the more populated areas;
2. Utilize shallow swales for driveway crossings and roadside drainage.
3. Minimize complexity for drainage system construction, maintenance, and management by:
    b. Minimizing the number of different culvert diameters specified;
    c. Minimizing the number of new culverts, which would not only need to be barged to Igloolik for installation, but also need to be maintained once installed;
    d. Minimizing the number of different ditch and swale dimensions specified;
    e. Keeping the design simple such that the Hamlet foreman and crew can not only construct but also maintain the new drainage systems with ease.
4. Capture and immediately convey water towards the nearest major watercourse/waterbody (i.e. ocean, lake, river, or stream).
5. Use multiple outlets to add redundancy at critical locations throughout the system.
6. Design using projected precipitation trends to account for future climate change.

7. Select culvert sizes based on available roadway embankment cover.

8. Provide drainage swales through driveways to comfortably accommodate the tires and undercarriage of vehicles.

9. Develop plans recognizing the land use limitations, for example remove nuisance ponding from community amenity areas and from the foot of exterior staircases leading to residences.

4.2 Design Criteria

As per the guidelines for community drainage system planning, design, and maintenance in northern communities (CSA Group, 2015), the culvert design capacity prescribed by the CSA Group is:

- *Size culverts to accept design flow at 80% capacity under free flow condition (1:10 year event).*
- *Size culverts to accept 1:100 design flow at 80% of available head at entrance.*

In addition to the above requirements the proposed drainage system was developed to meet the following general criteria:

1. Ditches and swales were sized to convey the 10-year snowmelt event. The 10-year snowmelt event was selected as the critical 10-year event following a review of freshet snowmelt events and a number of rainstorm durations ranging from 1 hour to 24 hours. The goal was to provide sufficient capacity to handle the critical event. Tetra Tech has further upsized the culverts to add additional capacity to compensate for debris deposition blocking the culverts and limiting their capacity. Buried culverts and significant deposition was noted in the majority of culverts identified in the field visit described in Section 3.1.

2. Ditches were sized to maintain at least 100 mm of freeboard during the 10-year snowmelt event.

3. Swales were sized to maintain at least 50 mm of freeboard during the 10-year snowmelt event.

4.3 Design Scenarios

The model was run under six design storm scenarios as follows:

- 10-Year 1-Hour Rainfall;
- 10-Year 24-Hour Rainfall;
- 10-Year Snowmelt;
- 100-Year 1-Hour Rainfall;
- 100-Year 24-Hour Rainfall; and
- 100-Year Snowmelt.

To develop the 24-Hour storm distribution, historical data extracted from the Igloolik A weather station was used to develop a synthetic hyetograph which represented the intensity pattern likely to develop over the course of a 24-hour rainfall event.

The 1-hr storm intensities were developed using the Northern Quebec AES distribution. Climate change adjusted precipitation volumes for each of the scenarios were obtained using the IDF_CC Tool v4.0 developed by Western University as described in Section 2.4.1 of this report.

The resulting peak flow rates for each design storm in the Hamlet's largest watercourse – existing between the Co-op Store and St. Stephens Catholic Church - are summarized in Table 4-1.

These flows are lower when compared to other master drainage plans Tetra Tech has developed for Communities in Nunavut. Igloolik, unlike other communities, has a relatively even spread of runoff and a small total catchment area. The Hamlet's topography has allowed for several primary drainage channels to exist throughout the community and thus the peak flow in any one of them is reduced compared to a single centralized channel layout, such as is true for the Hamlet of Pond Inlet.

As stated in Section 4-2, the 10-year snowmelt event was selected as the critical 10-year design event following a review of freshet snowmelt events and a number of rainstorm event durations ranging from 1 hour to 24 hours. The snowmelt events were estimated by running a continuous model of Igloolik between 1990 and 2014. Annual peak freshet flow rates in the community's largest watercourse were generated over this time span. A statistical analysis was carried out on the annual flow rates to produce 10-year and 100-year snowmelt-driven return events (Figure 4-1). The results of the statistical analysis are shown in Table 4-2.

Table 4-1: Igloolik Design Storm Events

Design Storm Events	Peak Flow Rate (m^3/s) *
10-year 1-hour	0.26
10-year 24-hour	0.31
10-year Snowmelt	0.75
100-year 1-hour	0.71
100-year 24-hour	1.11
100-year Snowmelt	1.08

* Peak Flow Rate measured through conduit C124 in the PCSWMM model.

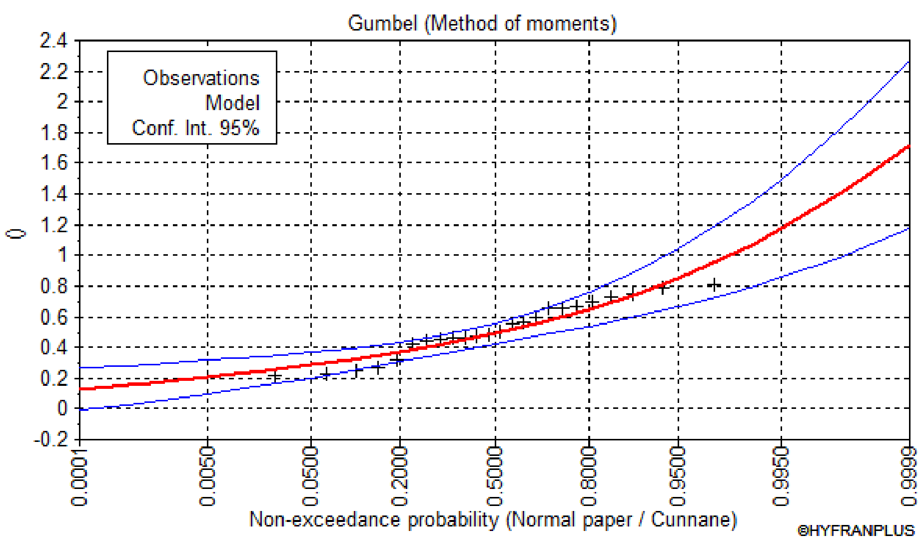


Figure 4-1: Statistical Analysis of culvert C124 Peak Annual Flow (m^3/s)

Table 4-2: Igloolik Snowmelt Design Storm Events

Return Period (years)	Max. Flow (m^3/s)
200	1.18
100	1.08
50	0.98
20	0.85
10	0.75
5	0.65
2	0.49

4.4 Modelling of System

A systems analysis approach was adopted to design the proposed drainage system for the Hamlet of Igloolik. PCSWMM, a professional stormwater modelling program was used to develop the model of the drainage system. The model uses a node-link arrangement where links represent conduits, such as ditches and culverts; and junctions represent a point where two or more links are joined, according to how the drainage network operates.

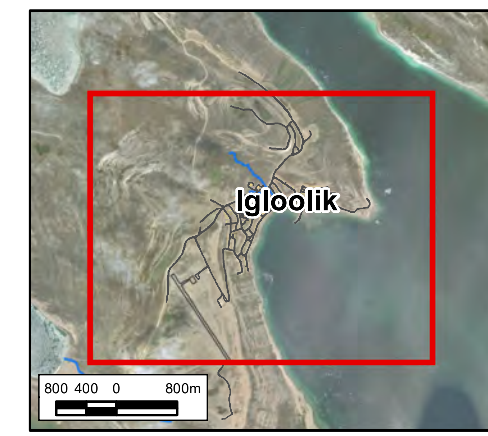
In addition, the drainage area is split into subareas or subcatchments, which are the hydrological units used to calculate flows. Flows calculated from a subcatchment area assigned to a junction, and then hydraulically routed through the drainage network. Through this approach, flows are aggregated through the system until discharged to an outfall point. Figure 4-2 shows the sub-catchments, junctions and conduits represented in the model. Input parameters for the subcatchments, junctions and conduits are presented in Appendix G.

LEGEND

- Junction
- Natural Drainage Path
- Subcatchment

Base Data

- Gravel Road
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

PCSWMM Model of Natural Drainage Paths

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:14,000
250 125 0 250
Metres

TETRA TECH

FILE NO.
WTRM03184-01_Subcatchments.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure 4-2

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Although the typical process followed in developing a stormwater management plan includes the development of a hydrologic/hydraulic model of the existing system, the absence of a proper drainage system within the community led Tetra Tech to move directly to modelling the proposed system and using these results to size and identify the infrastructure upgrades required to convey the estimated flows.

After modelling the scenarios described in Section 4.3, Tetra Tech proposes that 37 of the existing culverts be replaced and that 13 new culverts be added to the existing system (see Table 4-3). In addition, Tetra Tech is recommending that a formal system of swales and ditches be integrated into the community allowing for the systematic and effective conveyance of runoff. Table 1 in Appendix F shows the specifications and modelled performance of the proposed culverts for the 10-year snowmelt design scenario.

Tetra Tech is recommending that the proposed new culverts range in size between 450 mm to 900 mm. Further to this, all culverts being replaced will be 450 mm in diameter or larger. This sizing approach upholds the CSA recommended 450 mm minimum criteria.

It should be noted that in certain cases swale profiles and site limitations will force the embedment of some culverts so as to meet the minimum depth of cover requirements set by the supplier. The minimum cover requirements must be met to ensure the structural integrity of the culvert. Figure 4-3 provides a schematic representation of the typical installation details where the integration of the minimum depth of cover requires culvert embedment.

Table 4-3: Summary of Recommended Culvert Actions

Recommended Culvert Action	Number of Culverts	Total Length (m)
EXISTING CULVERTS		
No Action Required	12	186
Clean Out	5	83
Repair	18	269
Replace	37	503
Upsize	5	67
Total Existing Culverts	**77**	**1225**
NEW CULVERTS		
Within Existing Community	13	205
Servicing Future Community Expansion	33	570
Total New Culverts	**46**	**775**

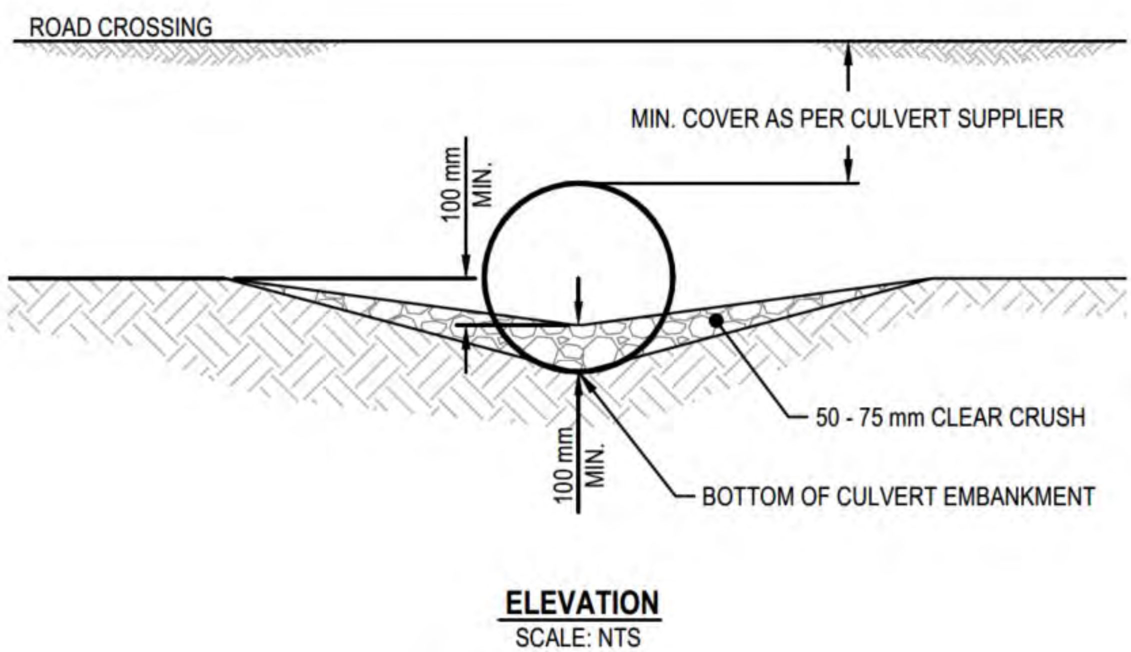


Figure 4-3: Typical Embedded Culvert Details

4.5 Drainage Recommendations

This section summarizes the recommended actions needed to upgrade the Level of Service provided by Igloolik's Drainage System. Currently, there are a number of deficiencies as identified in Section 3.0. Tetra Tech has developed the following series of recommendations which if implemented will remedy the previous issues identified throughout the community. The proposed improvements include the upgrading of culverts, ditches and swales.

4.5.1 Culverts

Table 1 in Appendix F provides a full inventory of Igloolik's existing culverts including recommended actions for each culvert. Tetra Tech's overarching culvert recommendations are provided below.

1. The minimum culvert size should be 450 mm as per the culvert size recommendations from CSA Group (2015) for de-icing purposes.

2. Cover over culverts shall meet the structural requirement set by the supplier. Tetra Tech recommends a minimum cover of 300 mm where vehicular traffic is likely to be present.

3. All newly installed culverts are to be Smooth Wall Steel Pipe (SWSP). The use of SWSP with a gauge of 10 to 12 mm will ensure the long-term durability. As detailed in Appendix E, the majority of corrugated steel pipes in Igloolik have failed to retain their structural integrity and are often damaged by maintenance equipment and road traffic.

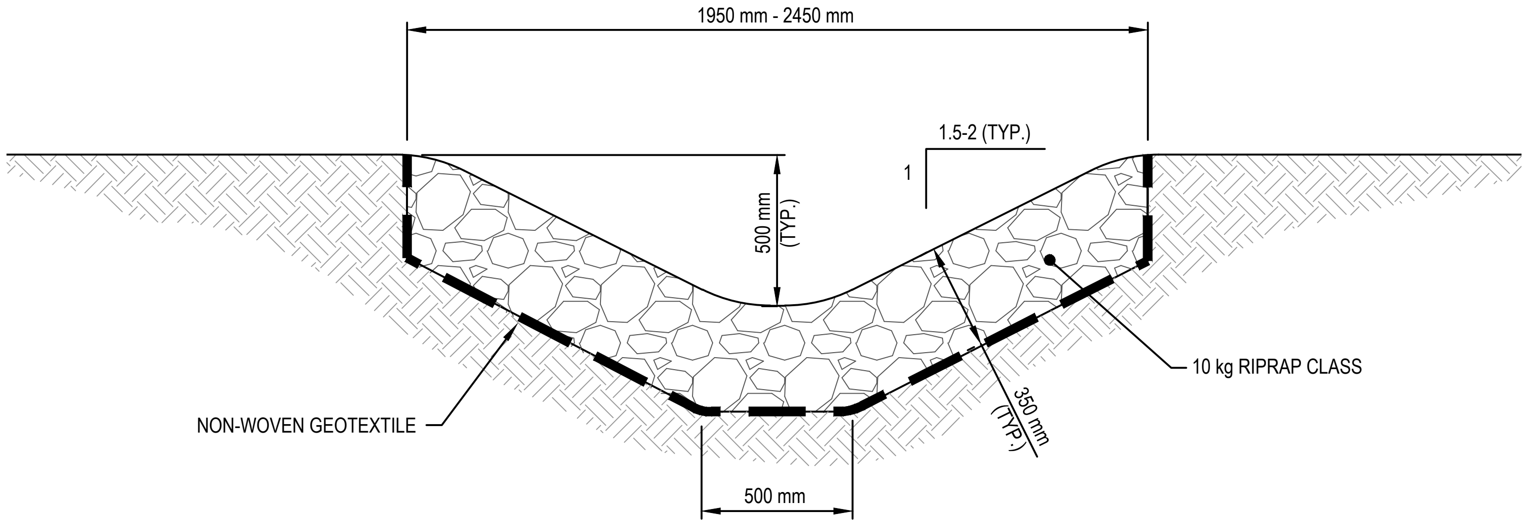
   If CSP culverts are preferred, Tetra Tech recommends the use of a culvert end steel stiffener/sleeve to better protect the structural integrity of the culverts. A sample photo of a culvert end stiffener is included in

Appendix H. Note that Tetra Tech recommends a stiffener length equal to 2 times the culvert diameter. Details of a culvert end stiffener/sleeve are included in Figure 6-15 in Section 6.4.1.

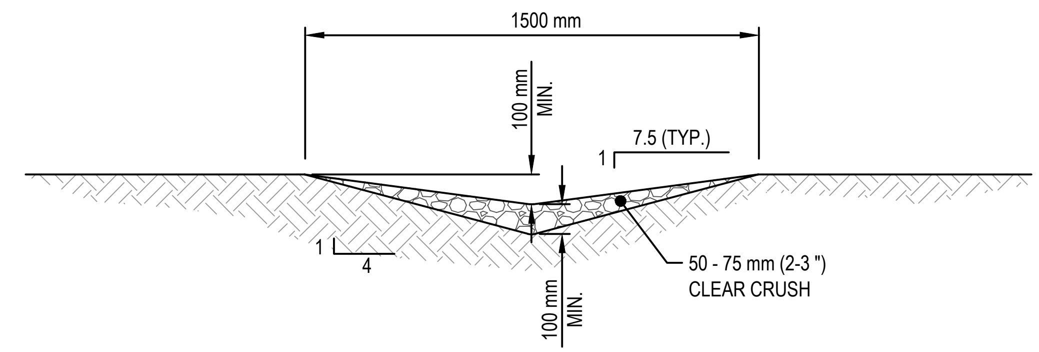
4. Culverts should be provided with high visibility marker poles to prevent damage during spring cleaning activities.
5. An annual maintenance program should be implemented to prepare the system for the spring freshet. This may include the steaming of specific culverts and/or the removal of debris limiting the capacity of the culvert crossings. Maintenance is further detailed in Section 6.7.4.
6. Based on the areas of erosion noted during our site visit and on water velocities modelled using PCSWMM, Tetra Tech recommends the use of riprap aprons for culvert inlets and outlets. Appendix E includes riprap recommendation for all culvert aprons.
7. Culverts are to extend a minimum of one diameter past the embankment as shown in Figure 6-22 in Section 6.4.3.
8. Headwall and endwall side slopes are to be 1.5H:1V to 2H:1V. Side slopes of 2H:1V are preferred where space allows.
9. Where space does not allow for riprap protection, culvert inlets and outlets should include a concrete headwall alternative.

4.5.2 Ditches and Swales

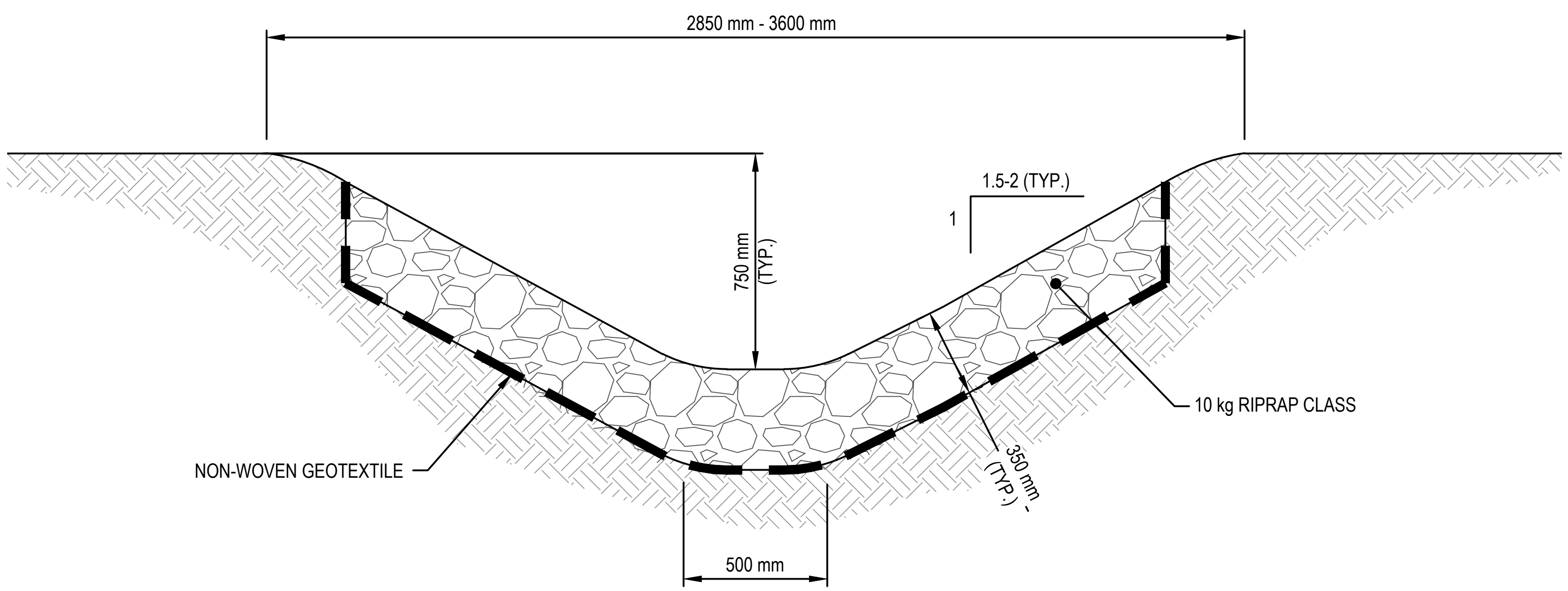
1. Open channels must include a revetment system for erosion protection, particularly in areas where permafrost can be impacted. Failure to do so may lead to hydraulic erosion, which in turn may lead to thermal degradation of the permafrost layer.
2. The slope of ditches and swales should be as gradual as possible with a minimum slope of 0.5% being maintained.
3. Ditches are to have a minimum bottom width of 500 mm, a minimum depth of 500 mm and side slopes ranging between 1.5H:1V to 2H:1V. Flatter side slopes should be considered near schools and children's playgrounds.
4. Ditches are to be lined with a 10 kg class riprap layer having a minimum thickness of 350 mm. See Figure 4-4 for riprap gradation.
5. Ditches are to be lined with a non-woven geotextile between the existing soil and the specified riprap layer.
6. Swales are to have a minimum depth of 100 mm. Swale side slopes are to be a 7.5H:1V minimum to allow for vehicular traffic to safely cross without damage. Swales are to be lined with a 50-75 mm (2-3") clear crush layer having a minimum thickness of 100 mm in the centre of the swale.
7. Figure 4-4 includes typical cross section details for the proposed ditches and swales.
8. The community of Igloolik may wish to increase the active depth of the existing swales throughout the community by raising the road profiles. This may be necessary to fully formalize the proposed swale sections detailed in Figure 4-4.
9. To the extent possible, ponding water nearby and underneath of buildings should be eliminated. Grading practices underneath buildings should promote the movement of water away from their footprints.



1 FIG.1 **TYPICAL DITCH**
SCALE: 1:25



2 FIG.1 **TYPICAL SWALE**
SCALE: 1:25



3 FIG.1 **TYPICAL LARGE DITCH**
SCALE: 1:25

10 kg RIPRAP CLASS			
ROCK GRADATION PERCENTAGE (kg)			
15 %	50 %	85 %	
1	10	30	
APPROXIMATE AVERAGE DIMENSIONS (mm)			
15 %	50 %	85 %	100 %
90	195	280	330

TYPICAL 50-75 mm (2-3") CLEAR CRUSH GRADATION

LEGEND

NOTES

NUM	DATE	DWN	CKD	APR	DESCRIPTION
A	12/9/19	MJK	ER	DNM	ISSUED FOR USE

REVISIONS

PROFESSIONAL SEAL

CLIENT
Nunavut

TETRA TECH

IGLOOLIK DRAINAGE PLAN

TYPICAL DITCHES AND SWALE DIAGRAMS

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRM03184-01	VANC	ER	ER	A	FIG.4-4
DATE	SHEET No.	DWN	APP	STATUS	
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5.0 SURFICIAL GEOLOGY AND PERMAFROST RESULTS

Most of the study area is underlain by glacial deposits (till) composed of unsorted glacial debris (diamicton) deposited directly by glacier ice by lodgement or by melt out during ablation. The local till generally consists of a sand or sand and gravel matrix with variable amounts of silt, cobbles and boulders disseminated throughout.

Surficial geology units and permafrost-related terrain features, such as ice-wedge polygons, thermokarst, thermal erosion etc.), which may pose a challenge for the proposed community expansion, are shown on the detailed terrain and permafrost feature map (Figures 3-1 and 3-2) and are summarized below.

Organic deposits (**O**) represent peaty organic soils observed as thin veneers (less than 0.3 m thick) overlying till or fluvial deposits.

Fluvial (alluvial) deposits (**F**) consist of stratified silt, sand and gravel, commonly cobbly and bouldery, transported, deposited or modified by small modern streams.

Colluvial deposits (**C**) consist of poorly sorted, commonly poorly compacted material (coarse sand, gravel, cobbles, boulders) deposited by mass wasting, including creep, debris slides and thaw slumping.

Marine (nearshore) deposits (**M**) are related to marine inundation during periods of higher sea level. They consist of stratified coarse sand, gravel, cobbles and boulders and were identified along the Eclipse Sound coastline. Large bodies of massive ice were encountered by Thurber (1981) within stratified silty sand, gravelly sand and gravelly sediments at the Land Assembly site as defined by Thurber (see Section 1.2.2). Ground ice formations ranged from ice lenses 1 or 2 mm thick to massive ice beds more than 3 m in thickness. A particularly large “ice wedge” was encountered in one of the testholes (14.6 m of ice). The approximate locations of these ground ice formations are shown on the terrain and permafrost feature map (Figures 3-1 and 3-2).

Glaciofluvial deposits (**GF**) consist predominantly of stratified well sorted sand deposited by meltwater in front of retreating glaciers, forming isolated mounds (kames) or short ridges, and may contain buried glacier ice. Active thermokarst, ongoing formation of thaw ponds and saturated sand observed by Dr. Roujanski in a sand pit developed in a glaciofluvial deposit located in the southeast corner of the study area indicate presence of shallow massive ice.

Ice contact drift (**I**) is a mixture of stratified glaciofluvial material and massive till deposited against glacier ice. It is commonly deformed and faulted, and may contain buried glacier ice.

Till veneer (**Tv**) forms deposits up to 1 m thick. Its surface reflects the topography of the underlying bedrock and commonly includes patches of exposed bedrock (**R**), till blanket (**Tb**), glaciofluvial material (**GF**) and felsenmeer. Permafrost within the unit is generally ice-poor.

Till blanket (**Tb**) is generally 1 to 5 m thick. It masks irregularities of the underlying bedrock surface and may include patches of till veneer, hummocky till (5 to 15 m thick), exposed bedrock, and felsenmeer. Hummocky till forms moderately to steeply sloped hills and ridges, and may contain significant accumulations of massive ice.

Bedrock (**R**) in the study area consists of crystalline igneous and metamorphic rocks (granite, gneiss and schist) of Pre-Cambrian age.

Anthropogenic material (**A**) consists of human-made or modified geological material whose original properties have been changed.

6.0 DRAINAGE MASTER PLAN

Based on our 2019 field investigation, background data review, and modeling work, Tetra Tech has developed the proposed upgrades for the existing drainage system and the planned community expansion areas. Features of the Master Drainage Plan include and complete Conceptual Drainage Design (Figures 6-2 to 6-7), Perimeter Collector Ditch (Section 6.2), Grading Plan (Figure 6-1), Revised Community Plan (B-1 to B-6), Construction Phasing (Figures 6-9 to 6-14) and ongoing system maintenance approach (Section 6.7).

The proposed upgrades in combination with the outlined maintenance program, have been designed to convey the expected peak flows identified in Section 4.3 of this report as per CSA Northern Community Drainage Guidelines.

6.1 Conceptual Drainage Design

Tetra Tech has compiled all existing and proposed drainage infrastructure into a single conceptual drainage plan complete with recommended upgrades for existing infrastructure, flow routing improvements within the current community and preliminary drainage recommendations for the future Hamlet expansion. The recommended system is comprised of ditches, swales and culverts and is laid out in Figures 6-2 to 6-7. Action categories have been created for both culverts and open channels. Tables 6-1 and 6-2 below outline and explain each action category.

Table 6-1: Culvert Action Categories and Descriptions

Action Category	Description
FUNCTIONING AS INTENDED	Culverts retains full capacity with no observed damage. No action required.
CLEAN	Culverts is blocked or partly blocked with sediment or debris. No damage observed. Sediment and/or debris to be cleared.
REPAIR	Culverts with damage where repair will restore full or near full capacity. Repair culvert as per Section 6.4.1 and clean out sediments as required. Note that some culverts labelled Repair are smaller than the recommended 450 mm diameter minimum. As funding allows these culverts should be replaced with 450 mm SWSP.
REPLACE	Culverts damaged beyond repair to restore full capacity. In some cases, the culvert has been fully buried out of sight and assumed damaged beyond repair. This assessment can be revisited and revised as appropriate upon the culvert's excavation. **In some cases, repairs could still be completed to restore a reduced capacity if funding for replacement is not immediately available.**
UPSIZE*	Culverts functioning as intended but which modelling suggests do not have sufficient capacity to convey the design flow events to CSA guidelines Replacement is recommended but should be a lower priority than replace or repair culverts within the same phase.

*For simplicity "UPSIZE" is displayed within Figures 6-2 to 6-7 as "REPLACE". This recommendation category however remains within Appendix F: Culvert Summary Tables and Appendix E: Inventory of Existing Culverts.

Table 6-2: Open Channel Action Categories and Descriptions

Action Category	Description
FORMALIZE TYPICAL DITCH	Install typical ditch as per Figure 4-4. This action applies to both existing and newly created overland flow paths.
FORMALIZE TYPICAL SWALE	Install typical swale as per Figure 4-4. This action applies to both existing and newly created overland flow paths.
PARIMETER COLLECTOR DITCH	Install typical ditch as per Figure 4-4 running parallel to the perimeter of the community's upper regions to intercept flows before these egress into the developed areas. Further detailed in Section 6.2. below.
NATURAL DRAINAGE PATH	Stable stream or creek. No Action Required.

6.2 Perimeter Collector Ditch

Tetra Tech is proposing the installation of a perimeter collector ditch which would run parallel to the Hamlet's highest properties and intercept upper catchment flows before these egress into the Hamlet's inhabited areas. This is expected to be particularly effective to protect the community's proposed expansion areas from spring runoff and flooding.

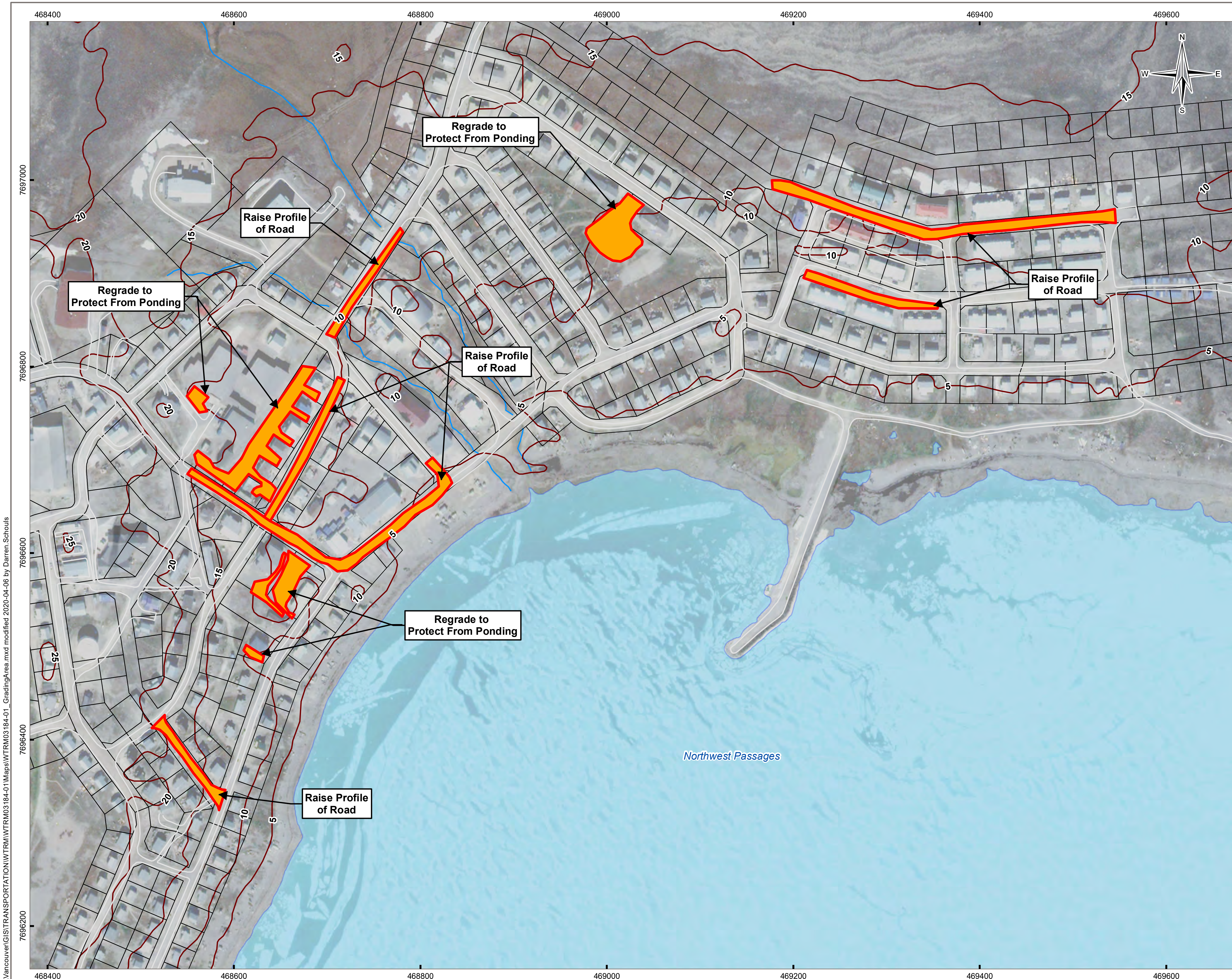
The geometry and composition is to follow Tetra Tech's Typical Ditch Diagrams as provided in Figure 4-4. The proposed alignment and location is shown in Figures 6-2 to 6-7. As described in Section 6.5, it is proposed that the implementation occurs across Project Phases 4 and 5.

6.3 Grading Plan

To aid in directing flows and reducing ponding, Tetra Tech has identified community areas where poor drainage conditions could be improved via regrading. Regrading locations are shown in Figure 6-1 and are detailed below.

- During the field visit Mr. Joasai Kublu identified the region surrounding the RCMP detachment as a primary area of flooding within the community. To address this issue it is recommended that the Hamlet raise the road profile and lot frontages surrounding the detachment. Proper grading along Sivingayaaq and Road R18 will help to constrain flow within adjacent conveyance channels. As the RCMP provide an essential service to the community, it is important that clear access to the facility be maintained.
- The Igloolik firehall facility (Lot 54) experiences flooding along its south side as highlighted in Section 3.6. As the firehall provides an essential service, Tetra Tech is recommending improved grading along the buildings southern exterior to improve access and allow for additional storage area within the lot.
- Grading is recommended on adjacent lots 339, 338 and 337 to allow for the formalization of a swale connecting Road R18 and Main Road. This swale follows the natural preferred direction of water in the area – elevating the ground around it will protect the lowland building areas from flooding.
- Roads R15, R22 and R23 on the eastern edge of the Hamlet were noted to flood during the freshet period. It is recommended that these road profiles are raised to promote containment within roadside swales.
- Road R5 was noted during the site visit have flow travelling down its center. Tetra Tech recommends the raising of the road profile to encourage flow collection along the west side swale and limiting water flow across the road.

- Erosion and flooding was evident at the children's playground on the Hamlet's eastside. It is recommended that the sand and gravel pad upon which the playground sits be elevated. This will promote flow collection in the proposed adjacent swale, thus prevent flooding of this area and allowing for the use of the playground during freshet season.



LEGEND

Grading Area

Base Data

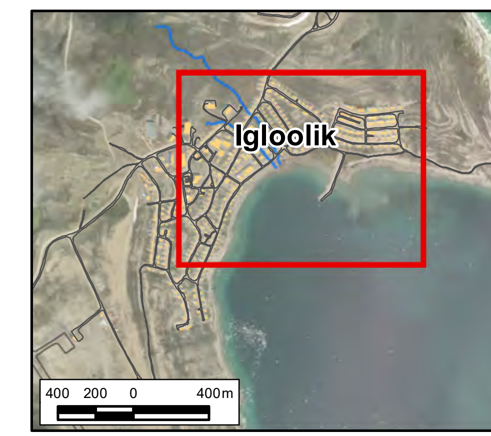
Current Parcel

Road

Watercourse

Topographic Contour (5 m)

Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Proposed Grading Plan

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:4,000
80 40 0 80
Meters

FILE NO.
WTRM03184-01_GradingArea.mxd

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DATE
April 6, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 6-1

6.4 Community Plan & Proposed Development Areas

The 2017 Igloolik Community Plan included in Appendix B outlines proposed development areas to allow for future community growth. Existing topography and drainage conditions were reviewed and a preliminary design of drainage infrastructure for the proposed expansion areas was developed and is shown in Figures B-1 to B-6.

At this stage we have provided drainage improvement recommendations based on the 2017 Igloolik Community Plan. Amendments to the 2017 Community Plan would likely carry revisions to the proposed drainage improvements.

Appendix B includes a Revised Community Planning Map for CGS to consider. The Construction Suitability Map presented in Section 3.3.2 has been overlaid for reference and highlights the development suitability of each region based on the nature of the local geology. Illustrated within these maps are the following remarks:

- Tetra Tech recommends relocating a 35-lot portion of the proposed subdivision. The area proposed for development is currently affected by poor drainage conditions and could be potentially bisected by a natural watercourse. Development of these lots would require additional drainage infrastructure adding capital costs to their development. These 35 lots are outlined in turquois in the Revised Community Planning Maps.
- Tetra Tech has proposed a relocation option for the above lot group to the south, adjacent to other proposed lots part of this subdivision. The proposed relocation considers the sites geology and is intended to protect future lots from potential drainage issues. The area chosen appears to be better draining and more readily suitable for construction. This relocation option is outlined in purple in the Revised Community Planning Maps.
- Some subdivisions are proposed within areas which are “Conditionally Suitable for Development”. These subdivisions should only move forward provided Tetra Tech’s Drainage Improvement Plan is implemented in the region.

Specific to the new development grading, the use of gravel pads should be considered which include a 1% minimum slope directing water away from building footprints. Figure 6-8 provides details as to the recommended grades which may be considered at the time of development.

LEGEND

Culverts

- Functioning as Intended
- Repair
- Replace
- New - Existing Community
- New - Future Community Expansion

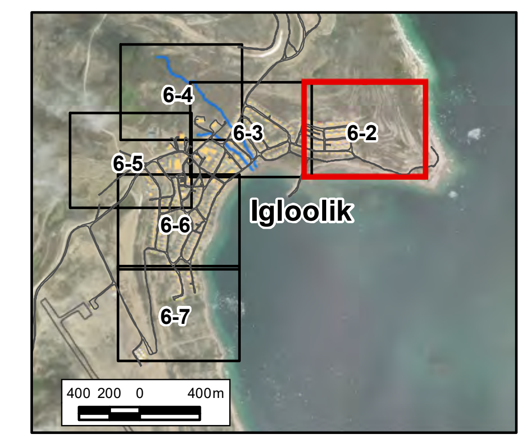
C## Culvert Number

Open Channels

- Perimeter Collector Ditch
- Formalize Typical Swale
- Natural Drainage Path

Base Data

- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
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Meters

TETRA TECH

FILE NO.				
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DATE	PROJECT NO.			
April 7, 2020	TRN.WTRM03184-01			

Figure 6-2

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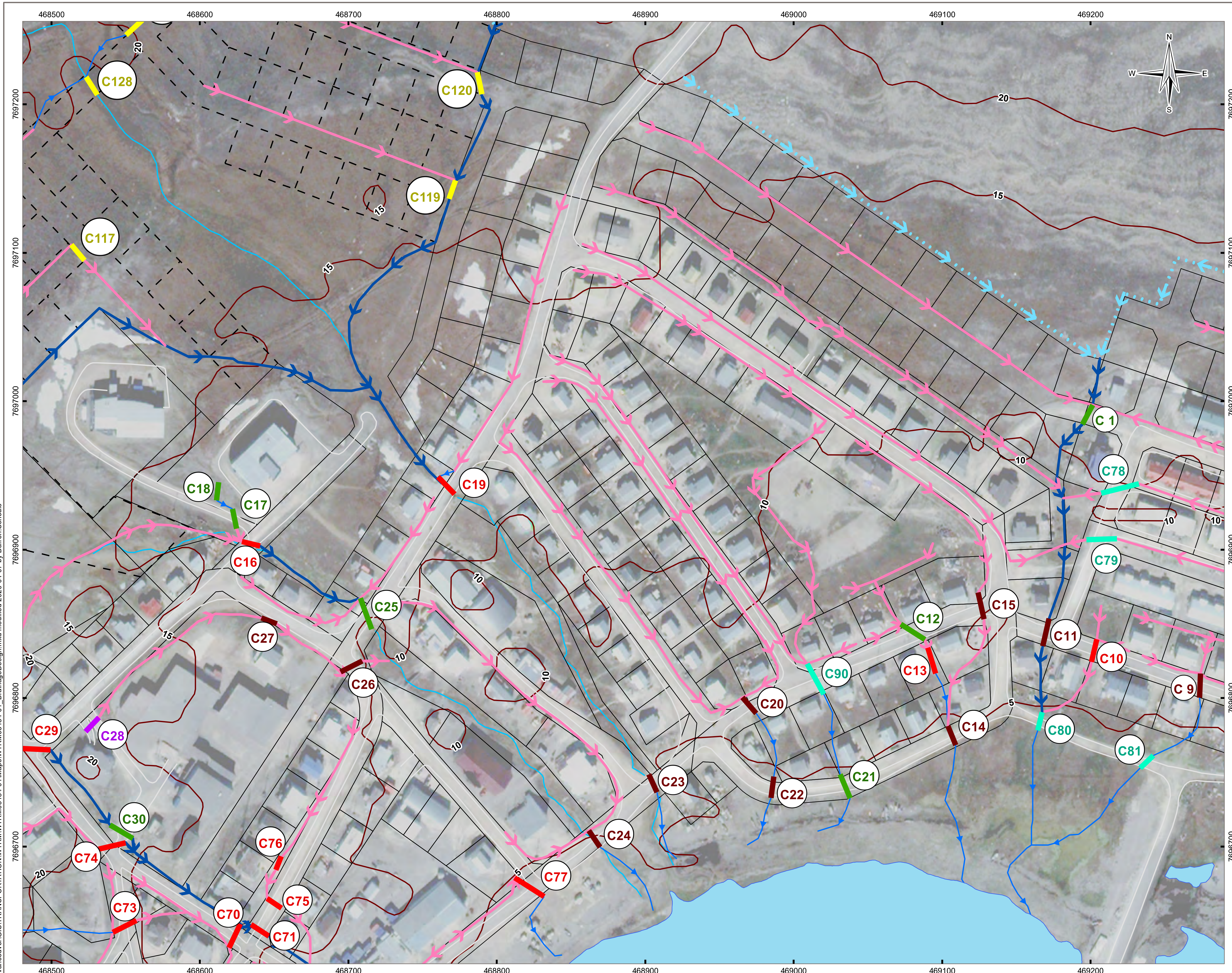


LEGEND

Culverts

- Functioning as Intended
- Clean
- Repair
- Replace
- New - Existing Community
- New - Future Community Expansion

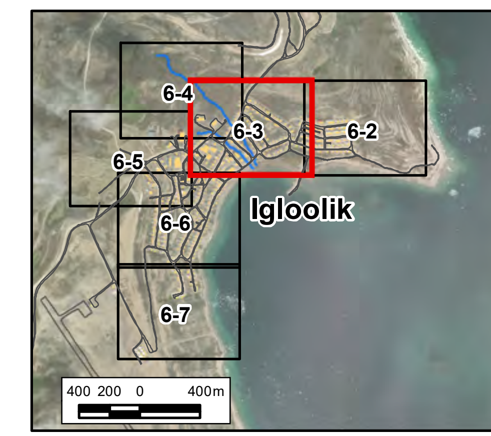
C## Culvert Number

Open Channels

- Perimeter Collector Ditch
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Base Data

- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Watercourse
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

TETRA TECH

FILE NO.				
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DATE	PROJECT NO.			
April 7, 2020	TRN.WTRM03184-01			

Figure 6-3

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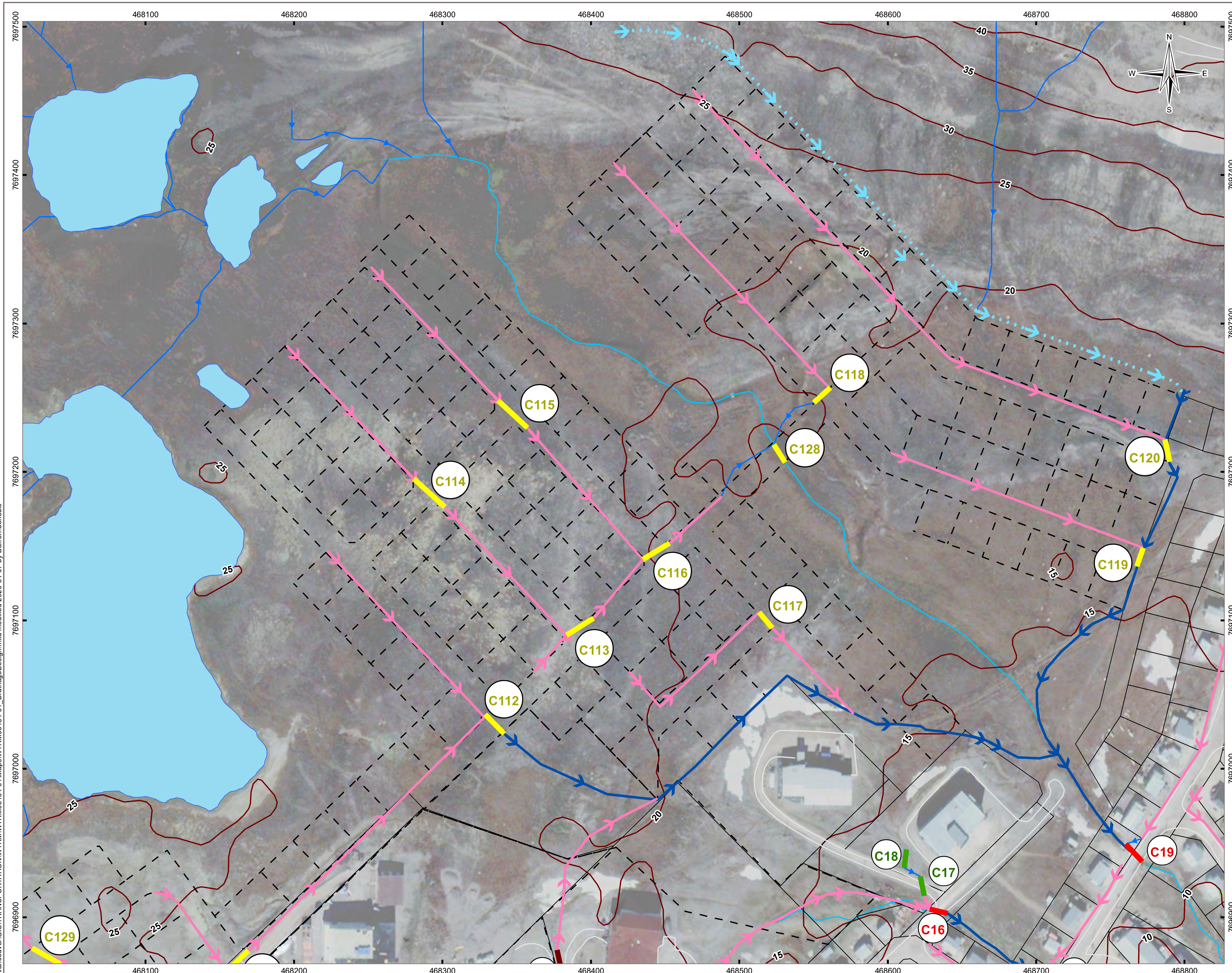


LEGEND

Culverts

- Functioning as Intended
- Repair
- Replace
- New - Future Community Expansion

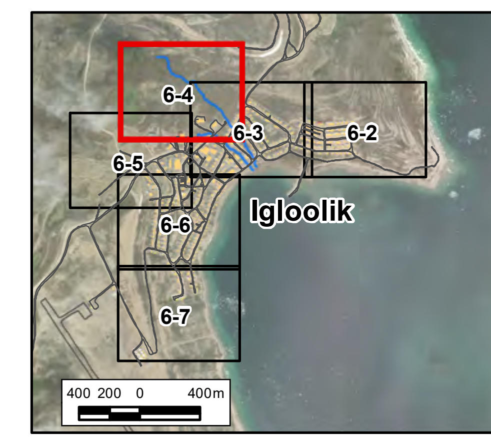
C## Culvert Number

Open Channels

- Perimeter Collector Ditch
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Base Data

- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Watercourse
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

TETRA TECH

FILE NO.
WTRM03184-01_DrainageDesign.mxd

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DATE
April 7, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 6-4

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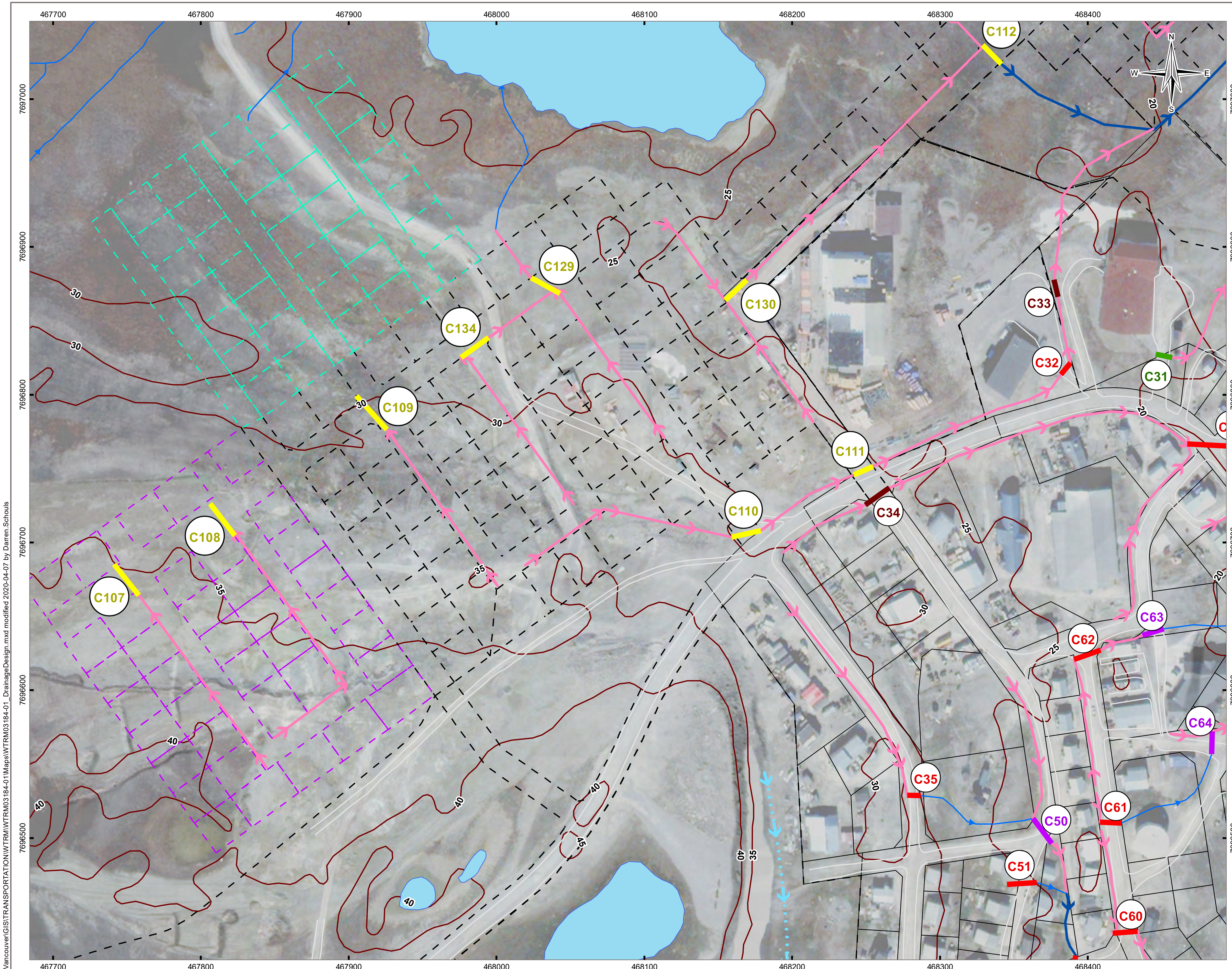


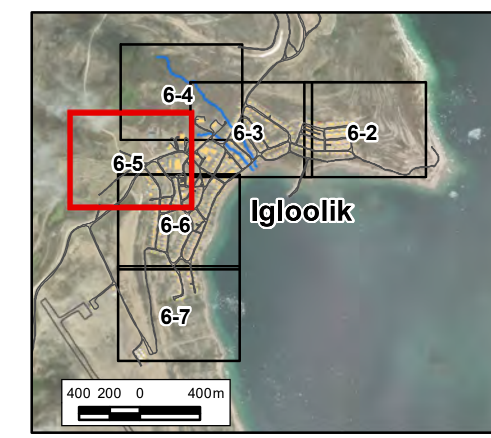
LEGEND

C## Culvert Number

Culverts
- Functioning as Intended
- Clean
- Repair
- Replace
- New - Future Community Expansion

Open Channels
- Perimeter Collector Ditch
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Base Data
- Current Parcel
- GN Proposed Parcel
- Relocate GN Proposed Parcel
- Tetra Tech Relocated Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

FILE NO.
WTRM03184-01_DrainageDesign.mxd

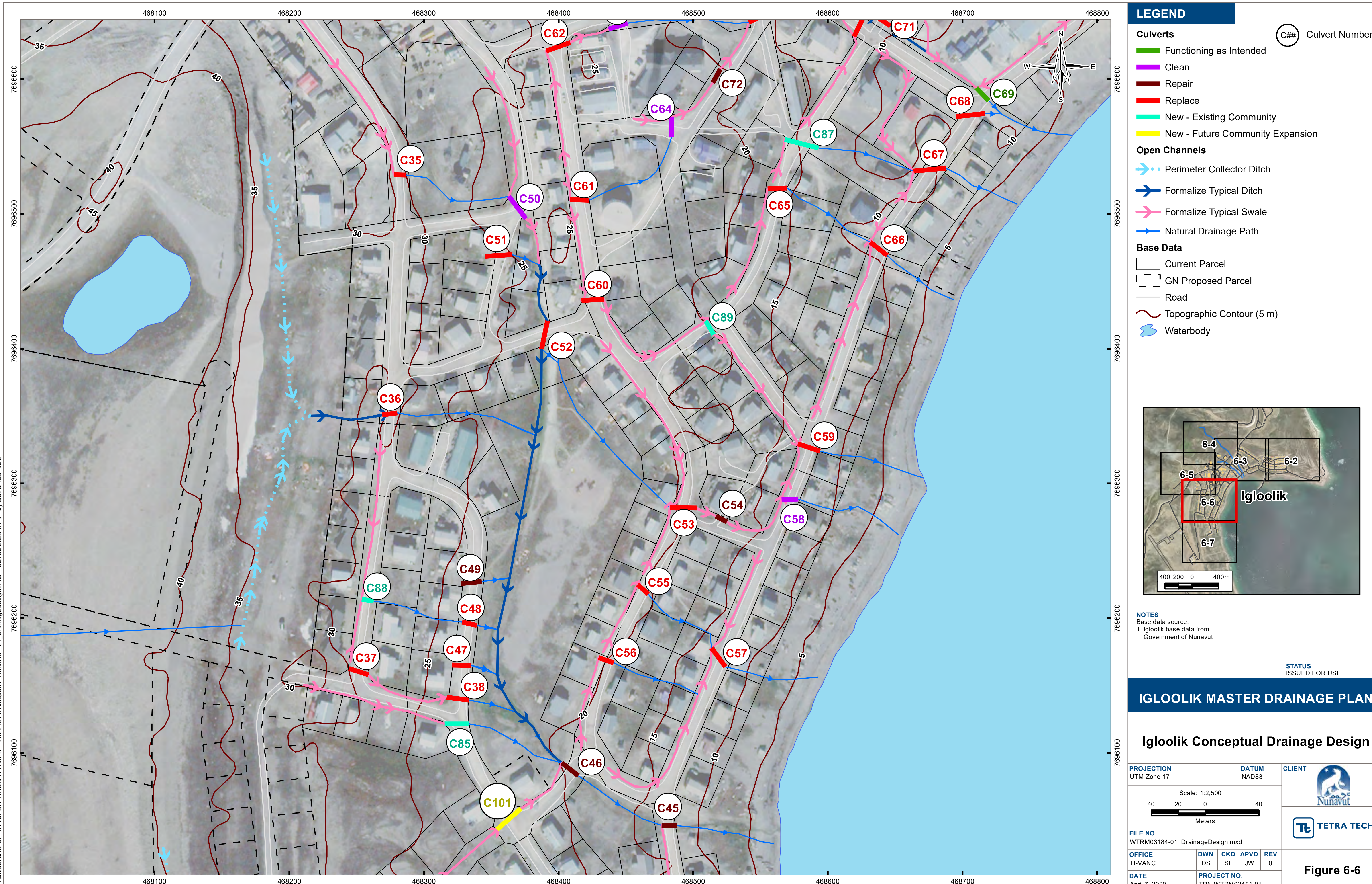
TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE
April 7, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 6-5



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LEGEND

C## Culvert Number

Culverts

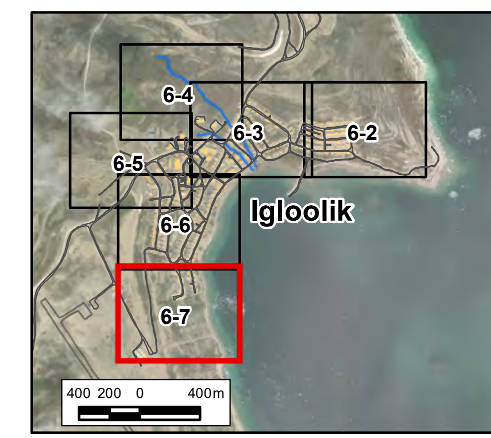
- Functioning as Intended
- Repair
- Replace
- New - Future Community Expansion

Open Channels

- Perimeter Collector Ditch
- Formalize Typical Swale
- Natural Drainage Path

Base Data

- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

TETRA TECH

FILE NO.
WTRM03184-01_DrainageDesign.mxd

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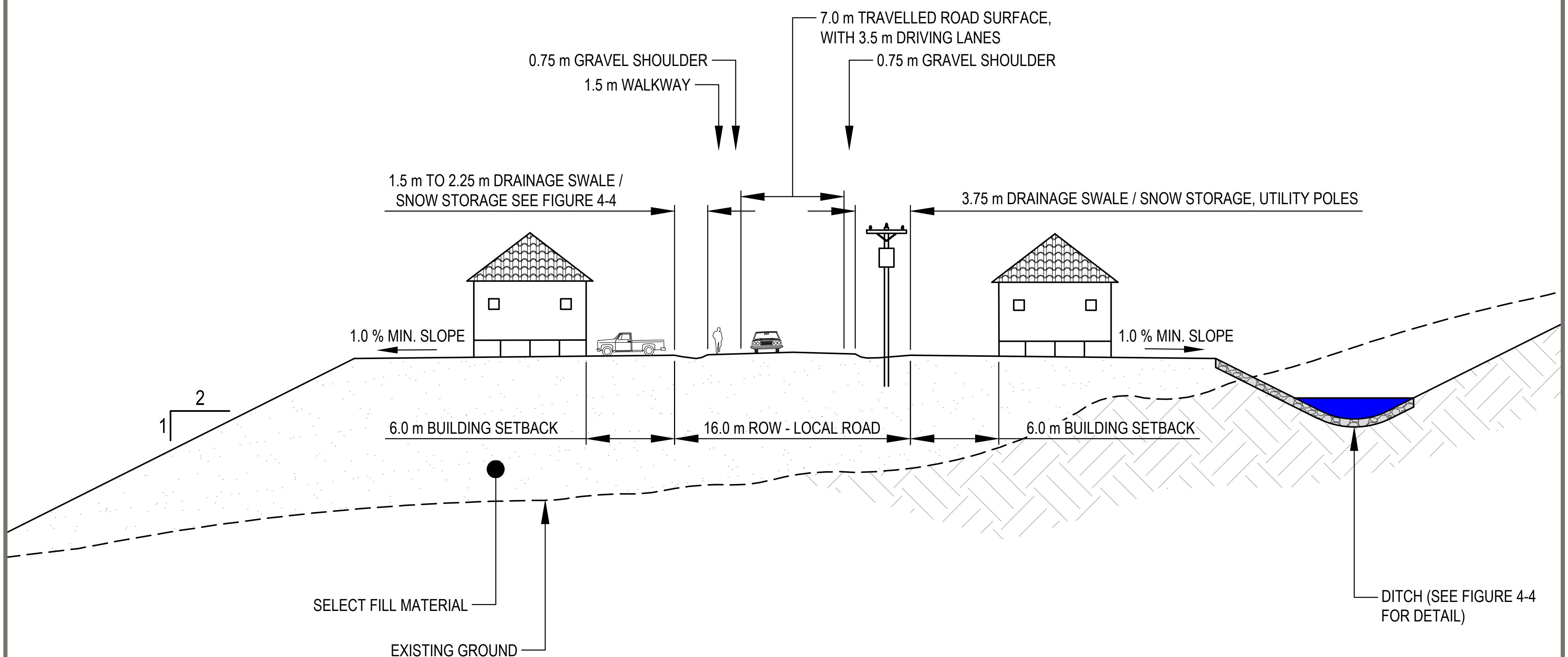
Tt-VANC	DS	SL	JW	0

DATE: April 7, 2020
PROJECT NO.: TRN.WTRM03184-01

Figure 6-7



LEGEND

-

NOTES

-

Dimensions as per CAN/CSA-S503-15 Figure 5

0 20

Scale: 1: 400 (metres)

ISSUED FOR USE

CLIENT

Nunavut

TETRA TECH

IGLOOLIK MASTER DRAINAGE PLAN

ABOVE GRADE DEVELOPMENT DETAIL

PROJECT NO.	DWN	CKD	REV
TRN.WTRM03184	AD	ER	0

OFFICE	DATE
VANC	March 30, 2020

Fig. 6-8

6.5 Project Phasing

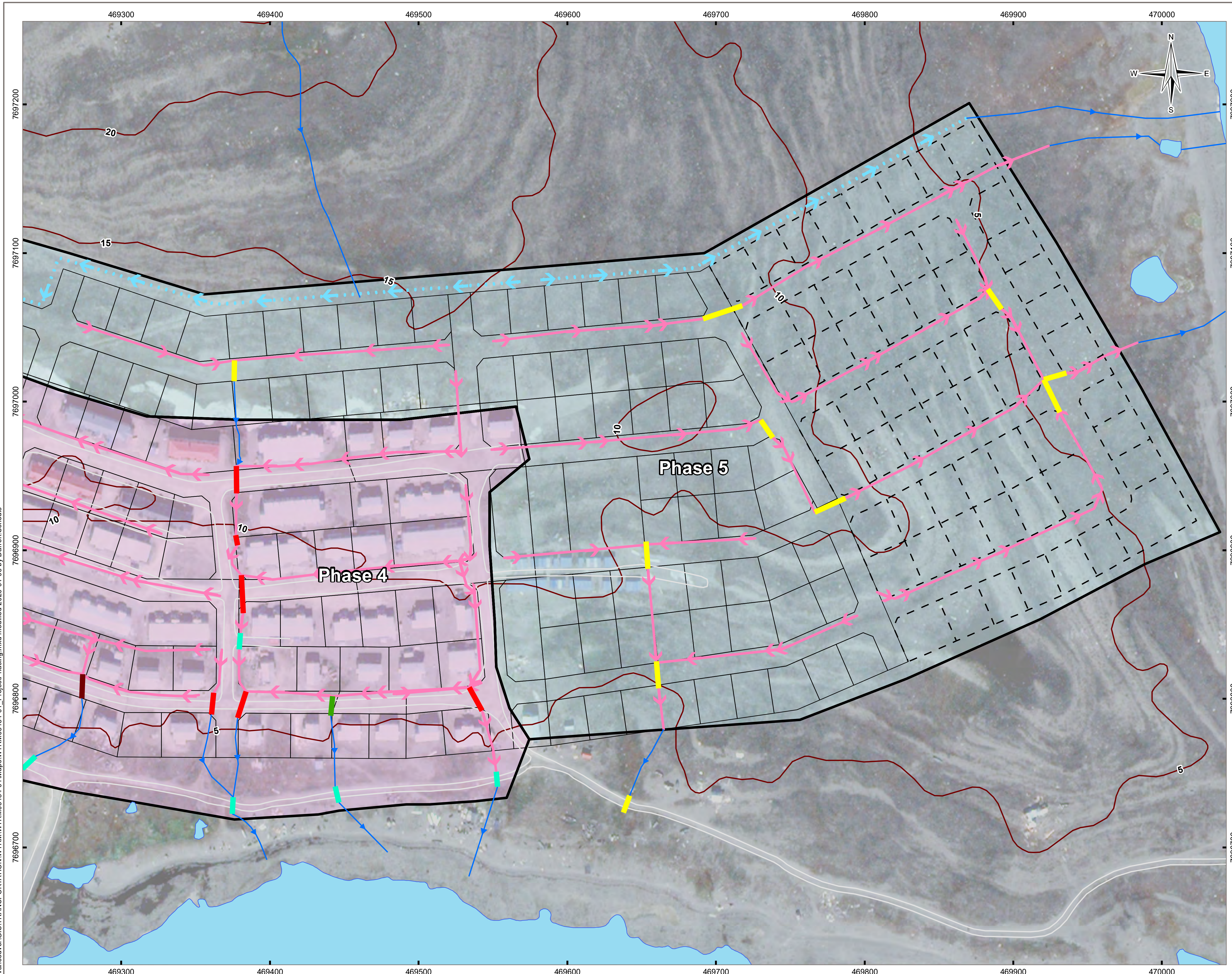
Tetra Tech has developed a phasing plan allowing CGS and the Hamlet to focus on the most critical elements of the proposed drainage plan first and consider postponing some of the less critical aspects until funding is available in future construction seasons.

Tetra Tech has broken the work into 5 phases, with Phase 1 having the highest priority, Phase 4 having the lowest priority, and Phase 5 subject to future community expansion. For each Phase we have developed a Class "D" cost estimate to assist with future budgeting (see Section 6.3).

The phasing was developed based on the following criteria:

- Phase 1: Address Existing Flooding
  - This phase will address the most prominent areas of flooding concern as observed during the field investigation and discussed with the Hamlet foreman.
  - It includes upgrades which will simultaneously address flooding around essential services including the RCMP detachment and the Firehall as well as non-essential community services including the Hamlet Office and Co-op Hotel & Restaurant.
- Phase 2: Address Essential Service Areas
  - This phase is aimed at upgrading existing infrastructure around essential service areas including the Hamlet's Health and Education Centres.
- Phase 3: Address Community Service Areas and Main Watercourses
  - This phase is aimed at upgrading drainage infrastructure around common public use amenities and ensuring long term capacity in the four central watercourses running through Igloolik's developed area.
  - Common Public Use facilities protected under this phase includes the Kips Gak Arena, Co-op and Northern Stores, Elders Residence and Government of Nunavut Office.
- Phase 4: Remaining Existing Infrastructure
  - This phase is aimed at upgrading the remaining existing infrastructure not addressed under phases 1-3. It predominately covers the remaining residential areas outside of the Hamlets core.
- Phase 5: Future community expansion infrastructure
  - This Phase is to be completed in conjunction with future community expansions and can be completed as required by the advancement of development.

Tetra Tech notes that the potential exists to combine Phases 2 and 3 as their expected capital cost is reduced relative to the other Phases. As discussed in Section 6.6, it is expected the Hamlet would also benefit from efficiencies of scale with their merging due to bulk material orders and reduced travel costs for skilled labour.



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LEGEND

Culverts

- Functioning as Intended
- Repair
- Replace
- New - Existing Community
- New - Future Community Expansion

Open Channels

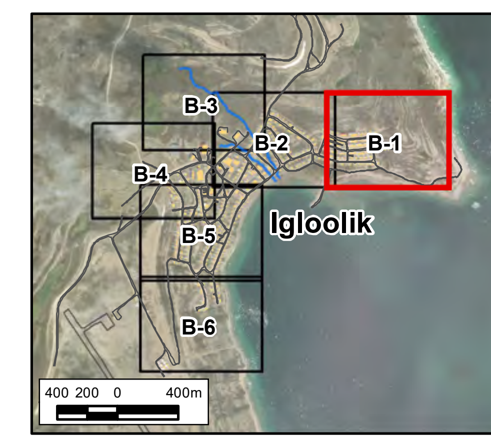
- Perimeter Collector Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing

- Phase 4 - Address Remaining
- Phase 5 - Future Community Expansion Infrastructure

Base Data

- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

TETRA TECH

FILE NO.
WTRM03184-01_ProjectPhasing.mxd

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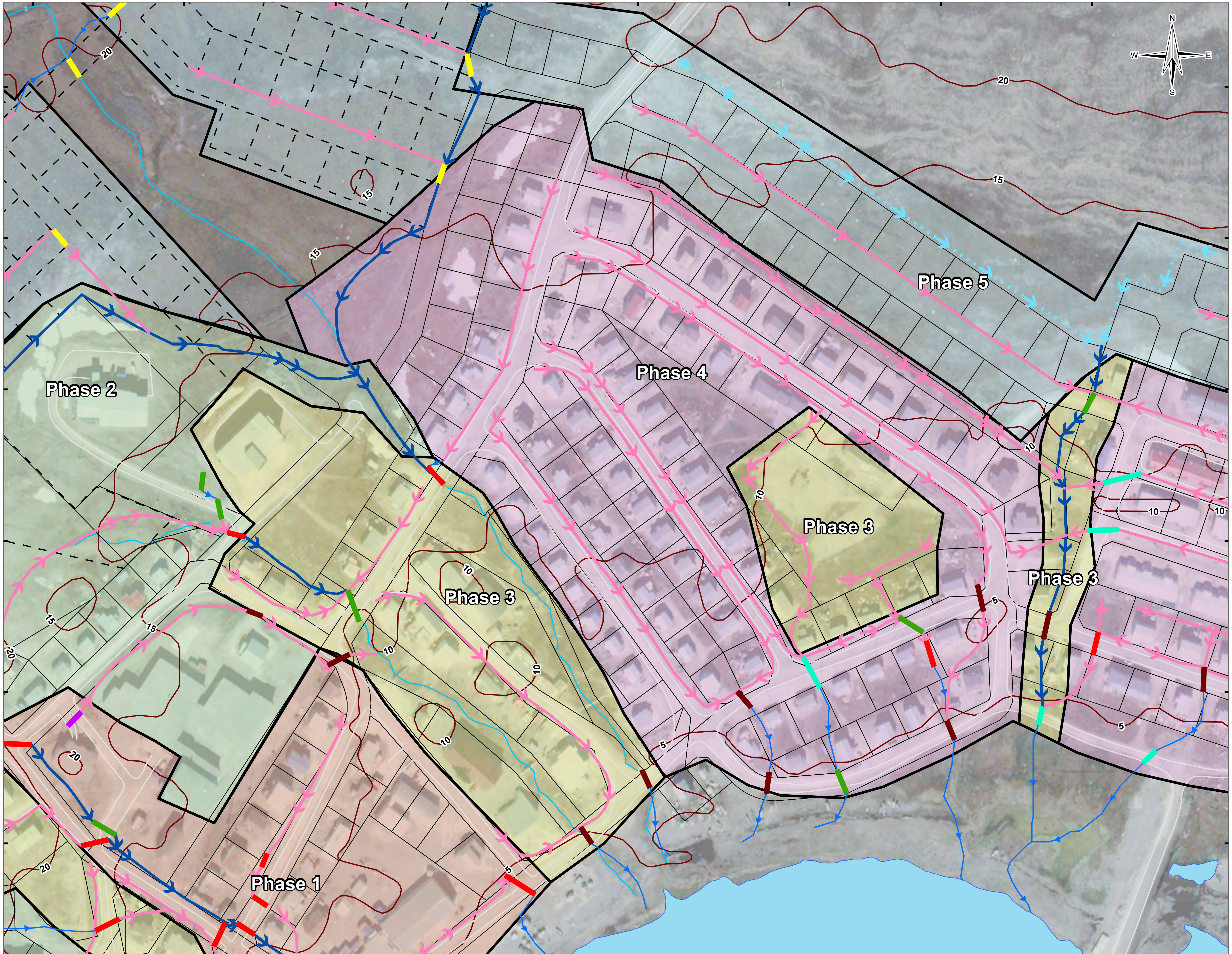
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure 6-9



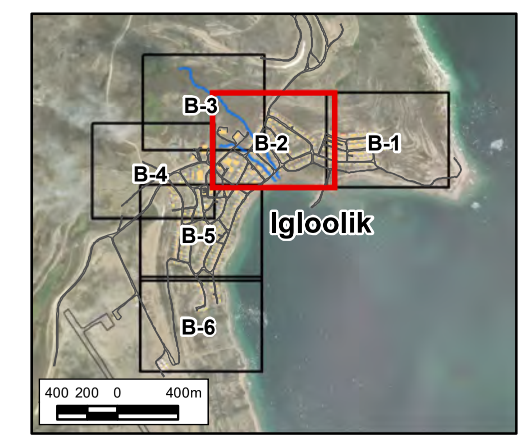
LEGEND

Culverts
- Functioning as Intended
- Clean
- Repair
- Replace
- New - Existing Community
- New - Future Community Expansion

Open Channels
- Perimeter Collector Ditch
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing
- Phase 1 - Address Existing
- Phase 2 - Essential Service
- Phase 3 - Community Service Areas and Central Watercourses
- Phase 4 - Address Remaining
- Phase 5 - Future Community Expansion Infrastructure

Base Data
- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Watercourse
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Project Phasing

PROJECTION: UTM Zone 17
DATUM: NAD83
CLIENT: Nunavut

Scale: 1:2,500
40 20 0 40
Meters

TETRA TECH

FILE NO.
WTRM03184-01_ProjectPhasing.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE: April 6, 2020
PROJECT NO.: TRN.WTRM03184-01

Figure 6-10

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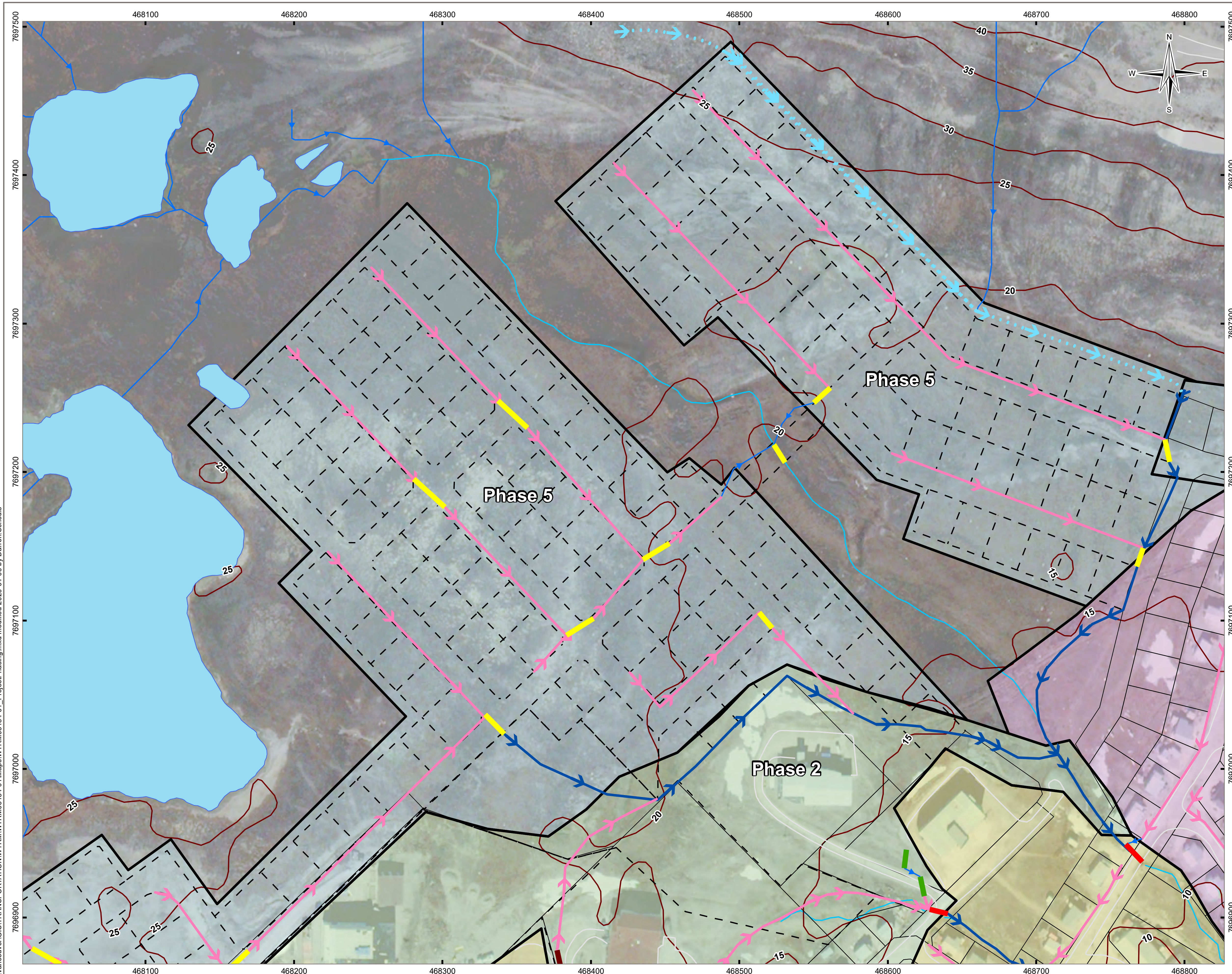


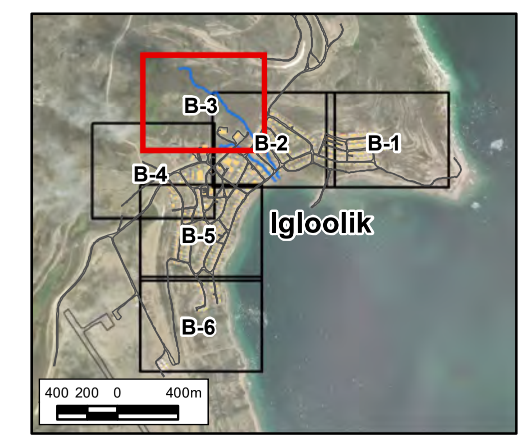
LEGEND

Culverts
- Functioning as Intended
- Repair
- Replace
- New - Future Community Expansion

Open Channels
- Perimeter Collector Ditch
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing
- Phase 2 - Essential Service
- Phase 3 - Community Service Areas and Central Watercourses
- Phase 4 - Address Remaining
- Phase 5 - Future Community Expansion Infrastructure

Base Data
- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Watercourse
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

FILE NO.
WTRM03184-01_ProjectPhasing.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure 6-11

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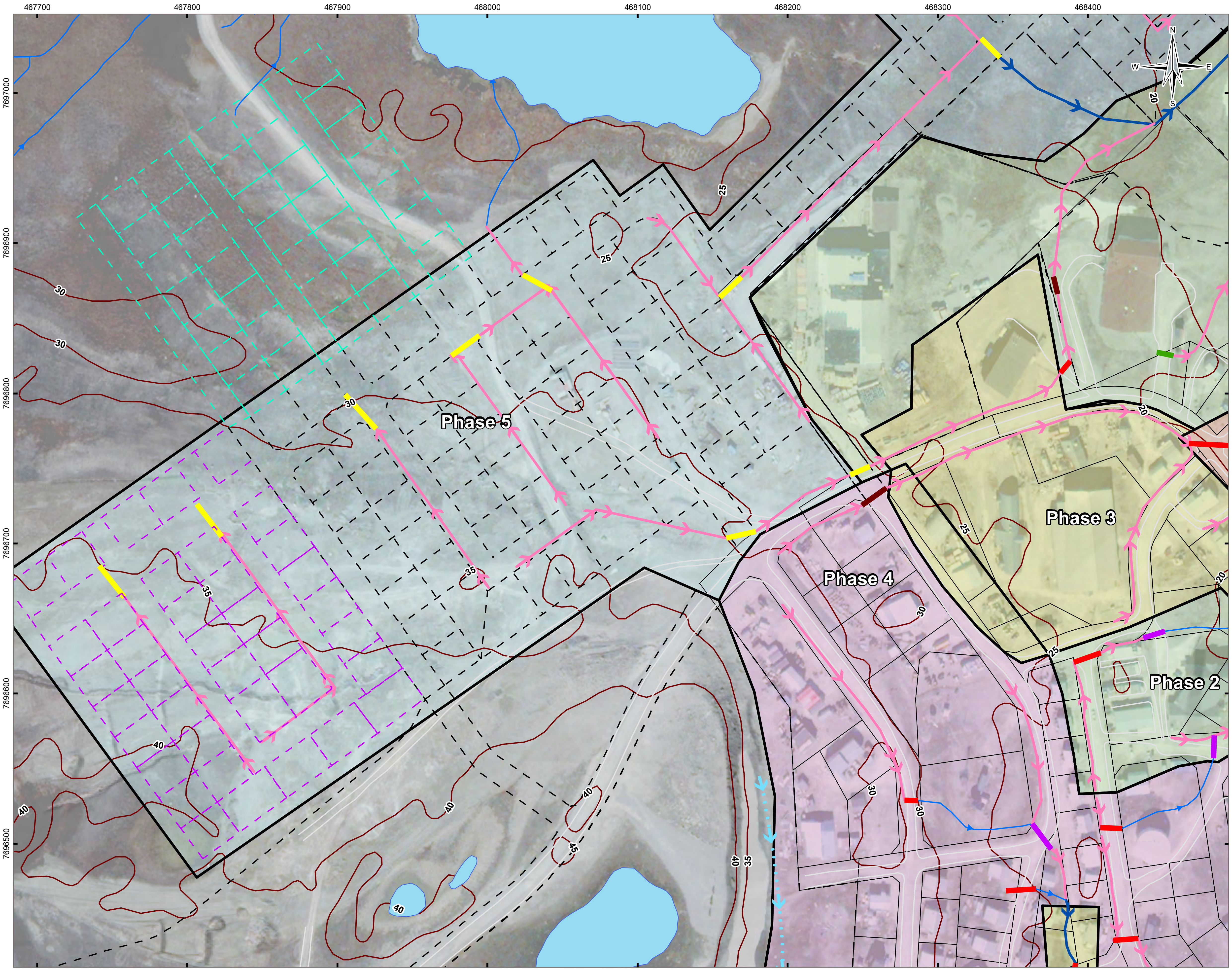


LEGEND

Culverts

- Functioning as Intended
- Clean
- Repair
- Replace
- New - Future Community Expansion

Open Channels

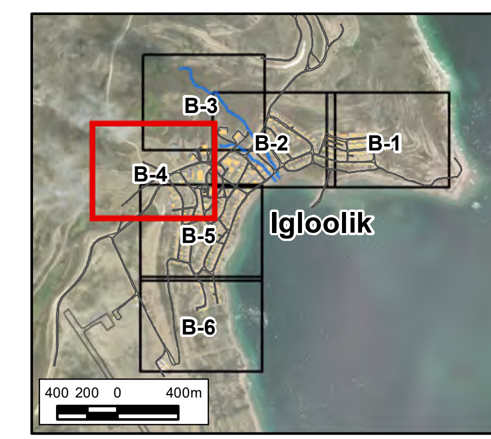
- Perimeter Collector Ditch
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing

- Phase 1 - Address Existing
- Phase 2 - Essential Service
- Phase 3 - Community Service Areas and Central Watercourses
- Phase 4 - Address Remaining
- Phase 5 - Future Community Expansion Infrastructure

Base Data

- Current Parcel
- GN Proposed Parcel
- Relocate GN Proposed Parcel
- Tetra Tech Relocated Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

TETRA TECH

FILE NO.
WTRM03184-01_ProjectPhasing.mxd

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Tt-VANC	DS	SL	JW	0

DATE: April 6, 2020
PROJECT NO.: TRN.WTRM03184-01

Figure 6-12

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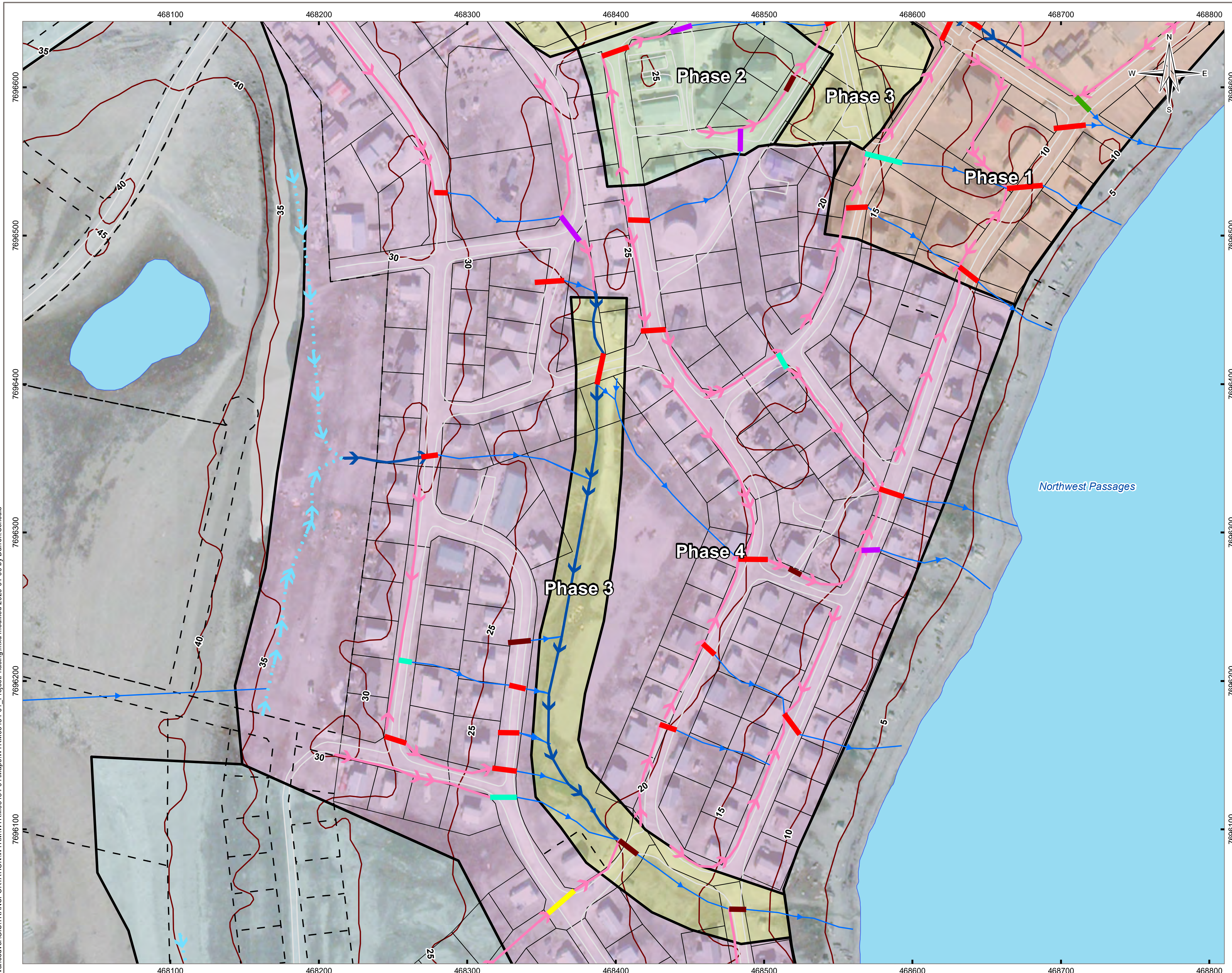


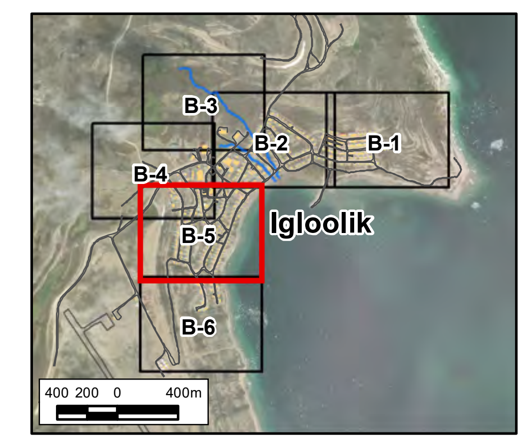
LEGEND

Culverts
- Functioning as Intended
- Clean
- Repair
- Replace
- New - Existing Community
- New - Future Community Expansion

Open Channels
- Perimeter Collector Ditch
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing
- Phase 1 - Address Existing
- Phase 2 - Essential Service
- Phase 3 - Community Service Areas and Central Watercourses
- Phase 4 - Address Remaining
- Phase 5 - Future Community Expansion Infrastructure

Base Data
- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
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Meters

TETRA TECH

FILE NO.
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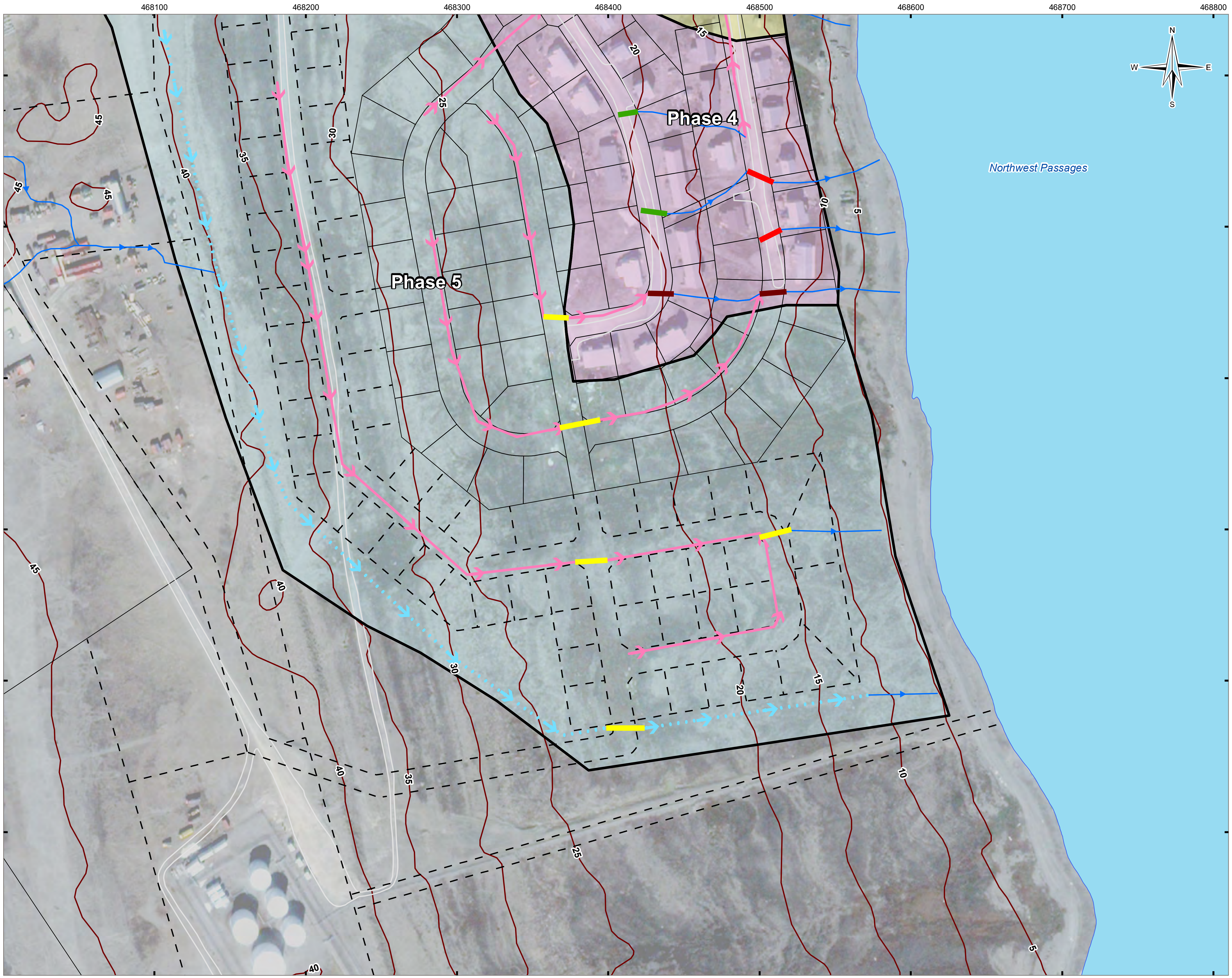
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE: April 6, 2020
PROJECT NO.: TRN.WTRM03184-01

Figure 6-13



LEGEND

Culverts

- Functioning as Intended
- Repair
- Replace
- New - Future Community Expansion

Open Channels

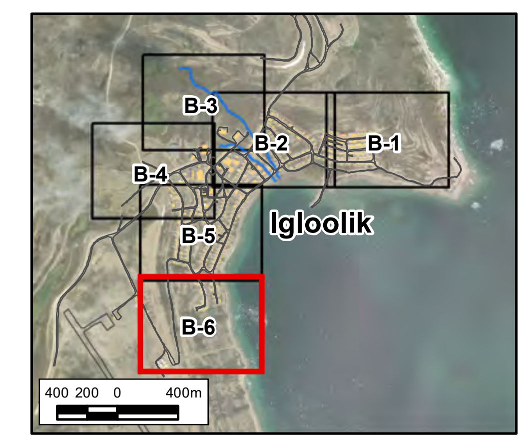
- Perimeter Collector Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing

- Phase 3 - Community Service Areas and Central Watercourses
- Phase 4 - Address Remaining
- Phase 5 - Future Community Expansion Infrastructure

Base Data

- Current Parcel
- GN Proposed Parcel
- Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
40 20 0 40
Meters

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FILE NO.
WTRM03184-01_ProjectPhasing.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE: April 6, 2020
PROJECT NO.: TRN.WTRM03184-01

Figure 6-14

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6.6 Construction Cost Estimate

Construction of the Igloolik Master Drainage Plan has been broken into five phases, with Phase 1 having the highest priority, Phase 4 having the lowest priority, and Phase 5 denoting future community expansion.

A Class "D" cost estimate was developed for each phase. The cost estimates are included in Appendix D. A summary of the cost estimates is shown in Table 6-3 below. Additionally, a summary of the drainage materials required are presented in Table 6-4.

Phasing has been broken down to distribute the cost over a longer period of time to accommodate the availability of annual budgets. Combining phases will translate into greater savings as it will allow the Hamlet to take advantage of economies of scale due to bulk material orders and reduced travel for skilled labour.

Tetra Tech notes specifically that the potential exists to combined Phases 2 and 3 as their expected capital cost is reduced relative to the other Phases.

Table 6-3: Summary of Phased Cost Estimate

	Phase					
	1	**2**	**3**	**4**	**5**	**Total**
Preliminaries	$48,575	$39,113	$49,075	$82,597	$127,965	$347,324
Civil Works	$206,745	$112,126	$211,750	$546,971	$1,000,650	$2,078,242
Miscellaneous	$15,000	$15,000	$15,000	$15,000	$15,000	$75,000
Sub-total	**$270,320**	**$166,239**	**$275,825**	**$644,568**	**$1,14,615**	**$2,500,566**
Project Contingencies: (40%)	$108,128	$66,495	$110,330	$257,827	$457,446	$1,000,226
Total Estimated Construction Cost	**$378,447**	**$232,734**	**$386,155**	**$902,395**	**$1,601,061**	**$3,500,793**

Table 6-4: Summary of Required Drainage Materials

	Phase 1		Phase 2		Phase 3		Phase 4		Phase 5		Total	
Item	**Est Quantity**	**Count**	**Est Quantity**	**Count**	**Est Quantity**	**Count**	**Est Quantity**	**Count**	**Est. Quantity**	**Count**	**Est Quantity**	**Count**
450 mm Culvert	187 m	11	19 m	1	30 m	2	421 m	26	495 m	29	1,152 m	69
600 mm Culvert	50 m	2	10 m	1	24 m	1	128 m	7	55 m	3	270 m	14
900 mm Culvert	0 m	0	13 m	1	30 m	2	0 m	0	20 m	1	67 m	4
1050 mm Culvert	0 m	0	0 m	0	4 m (casing)	0	0 m	0	0 m	0	4 m	0
Total Culverts	237 m	13	42 m	3	58 m	5	549 m	33	570 m	33	1489 m	87
50-75 mm Clear Crush	105 cu.m	-	91 cu.m	-	174 cu.m	-	867 cu.m	-	867 cu.m	-	2,104 cu.m	-
10 kg Class Riprap	162 cu.m		76 cu.m	-	460 cu.m	-	254 cu.m	-	2,429cu. m	-	3,381 cu.m	-
Non-Woven Geotextile	591 sq.m	-	269 sq.m	-	1,705 sq.m	-	909 sq.m	-	8,881 sq.m	-	12,355 sq.m	-
Culvert Removal	-	11	-	3	-	4	-	24	-	0	-	42

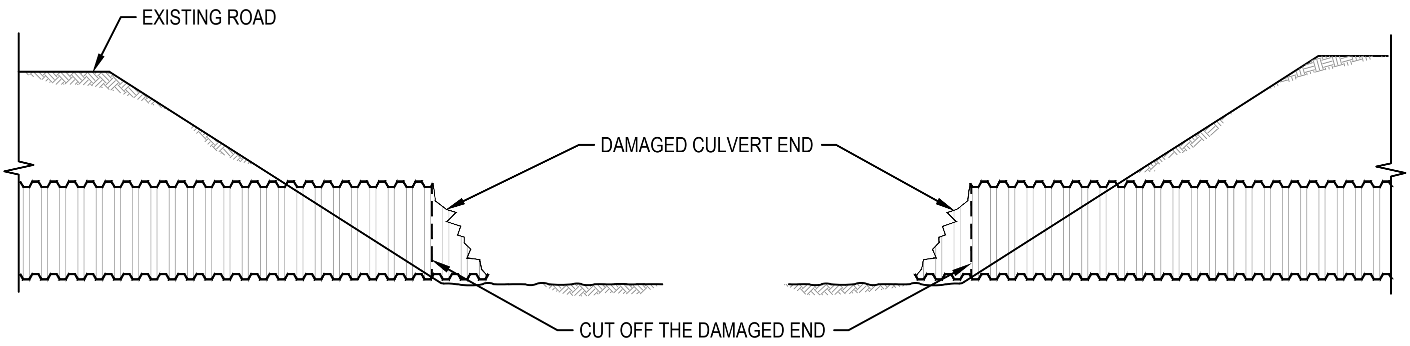
6.7 Ongoing System Maintenance

A properly maintained and monitored community drainage system is important in promoting the ongoing safety and well-being of a community. To ensure proper functioning of the drainage system, a program to maintain and monitor the system should be implemented.

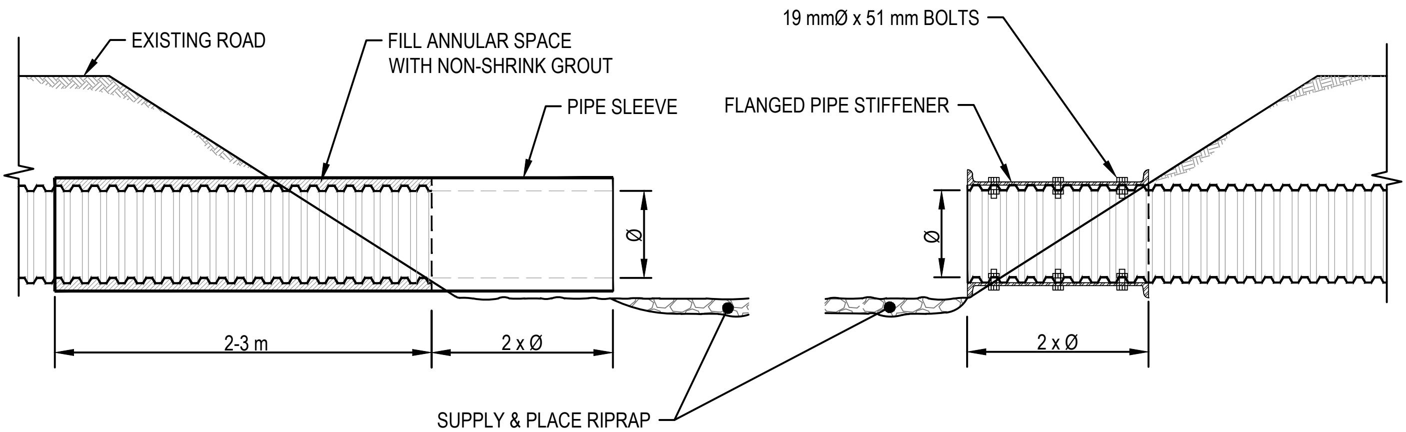
6.7.1 Culvert Maintenance and Repair

As per the guidelines for community drainage system planning, design, and maintenance in northern communities (CSA Group, 2015), culvert maintenance and repair guidelines are as follows:

- Culvert ends should be marked with a brightly painted posts installed vertically at the outlet and inlet. When lost or damaged, culvert marking posts shall be replaced.
- Spare culverts of each size shall be kept on hand to facilitate the timely repair and replacement of all culverts.
- Where culverts have suffered end damage but are otherwise in good condition, a SWSP sleeve should be added to reinstate the original length of the culvert. The annular space between the existing pipe and the SWSP sleeve should be grouted and sealed. Figure 6-15 provides a sketch covering the proposed repairs.



BEFORE REPAIR



AFTER REPAIR

PIPE SLEEVE OPTION
SCALE: NTS

PIPE STIFFENER OPTION
SCALE: NTS

NOTE:

CLIENT

Nunavut

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IGLOOLIK MASTER DRAINAGE PLAN

DAMAGED CULVERT END REPAIR DETAILS

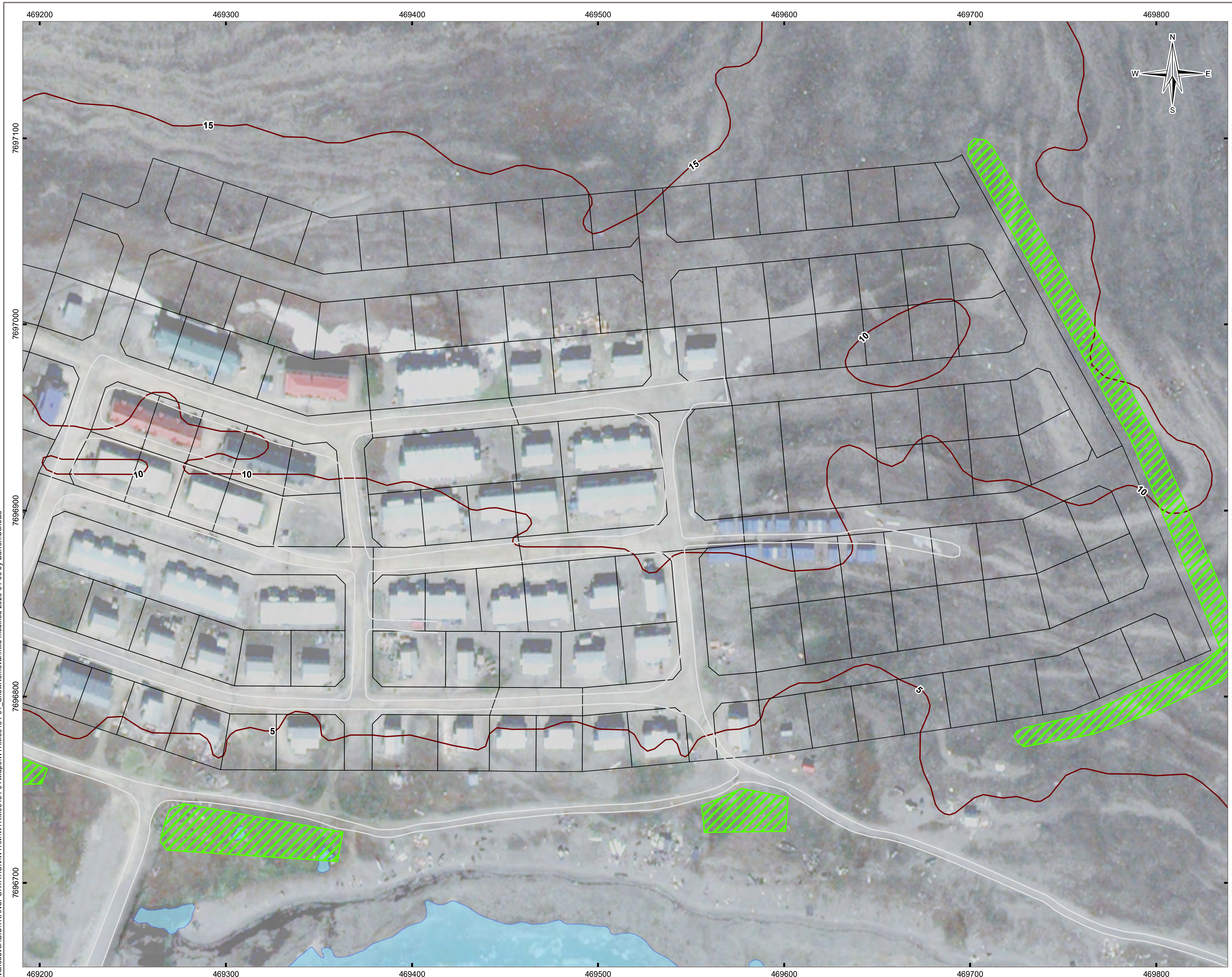
PROJECT NO.	DWN	CKD	REV	
WTRM03184-01	MJK	ER	A	**FIG.6-15**
OFFICE	DATE			
VANC	March 27, 2020			

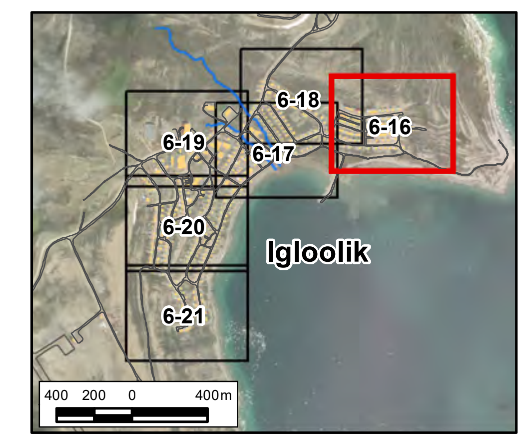
6.7.2 Snow Removal Management Plan

As per the guidelines for Community Drainage System Planning, Design, and Maintenance in Northern Communities (CSA Group, 2015), runoff from stockpiled snow should be prevented from re-entering the drainage system. Runoff from stockpile areas can overwhelm formalized and natural channels causing flooding.

To that end, Tetra Tech recommends that removed snow from roadways and driveways be safely deposited in one of the designated "Snow Deposition Areas" as shown in Figures 6-16 to 6-21. Further details are outlined below.

- The preferred Snow Deposition Areas exist on boundary of the community to minimize water egress back into the drainage system.
- Limited storage has been allowed for adjacent to one of the main community watercourses as its outlet culvert has sufficient capacity to accept additional flow. These areas should be used sparingly however, and the preference remains for snow to be placed on the southeast side of the community's boundary adjacent to Turton Bay.





LEGEND

Snow Deposition Area

Base Data

Current Parcel

Road

Topographic Contour (5 m)

Waterbody

NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik
Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000
40 20 0 40
Meters

FILE NO.
WTRM03184-01_SnowRemoval.mxd

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OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure 6-16

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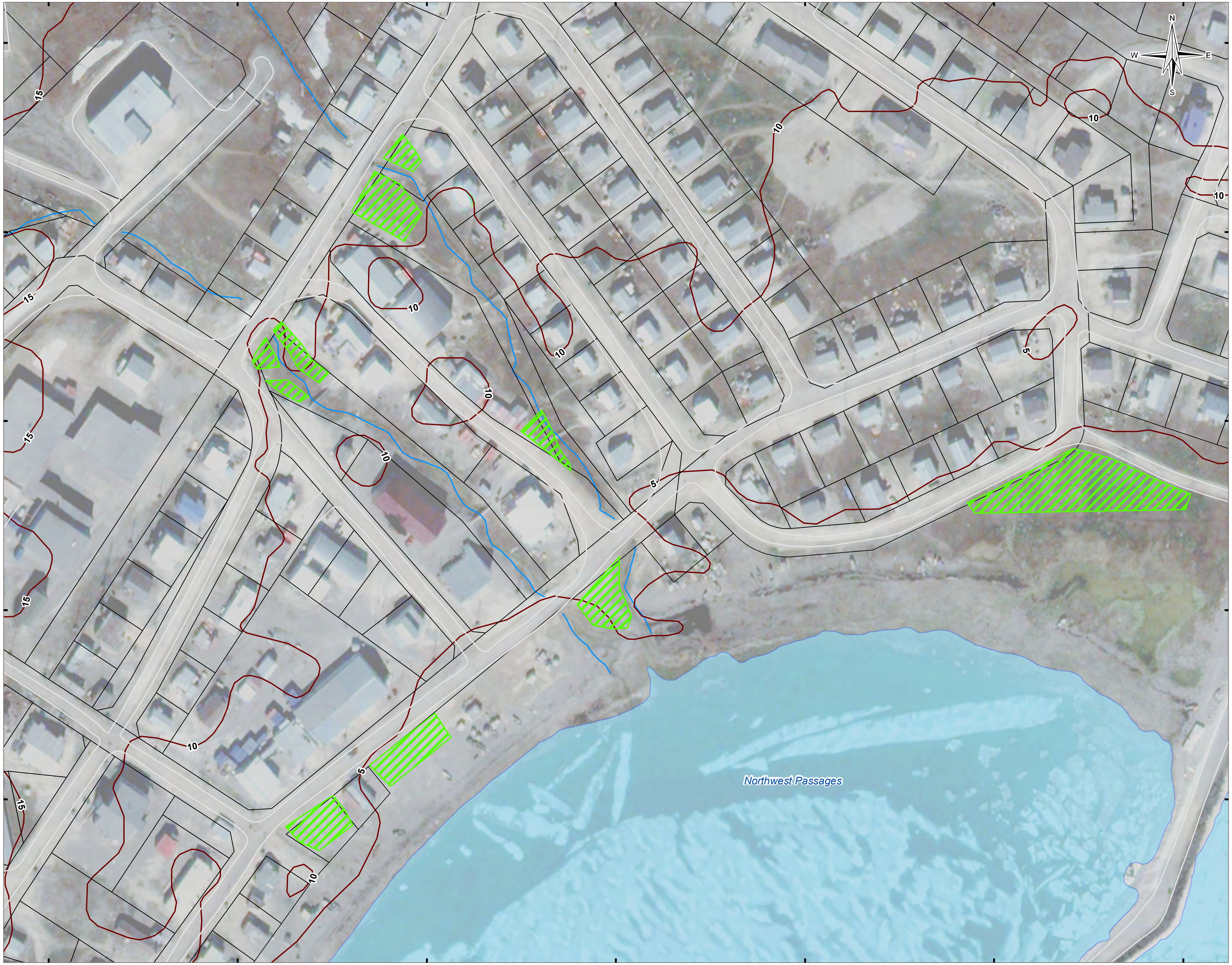

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LEGEND

Snow Deposition Area

Base Data

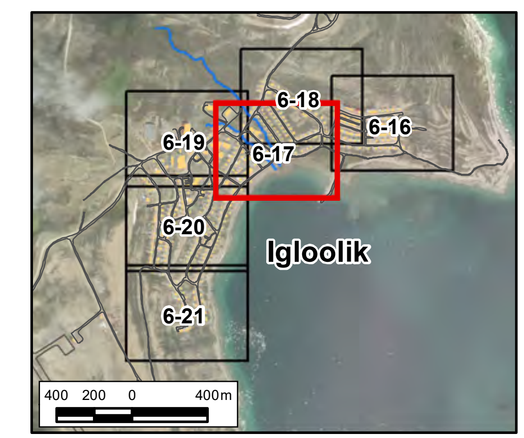
Current Parcel

Road

Watercourse

Topographic Contour (5 m)

Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik
Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000

40 20 0 40

Meters

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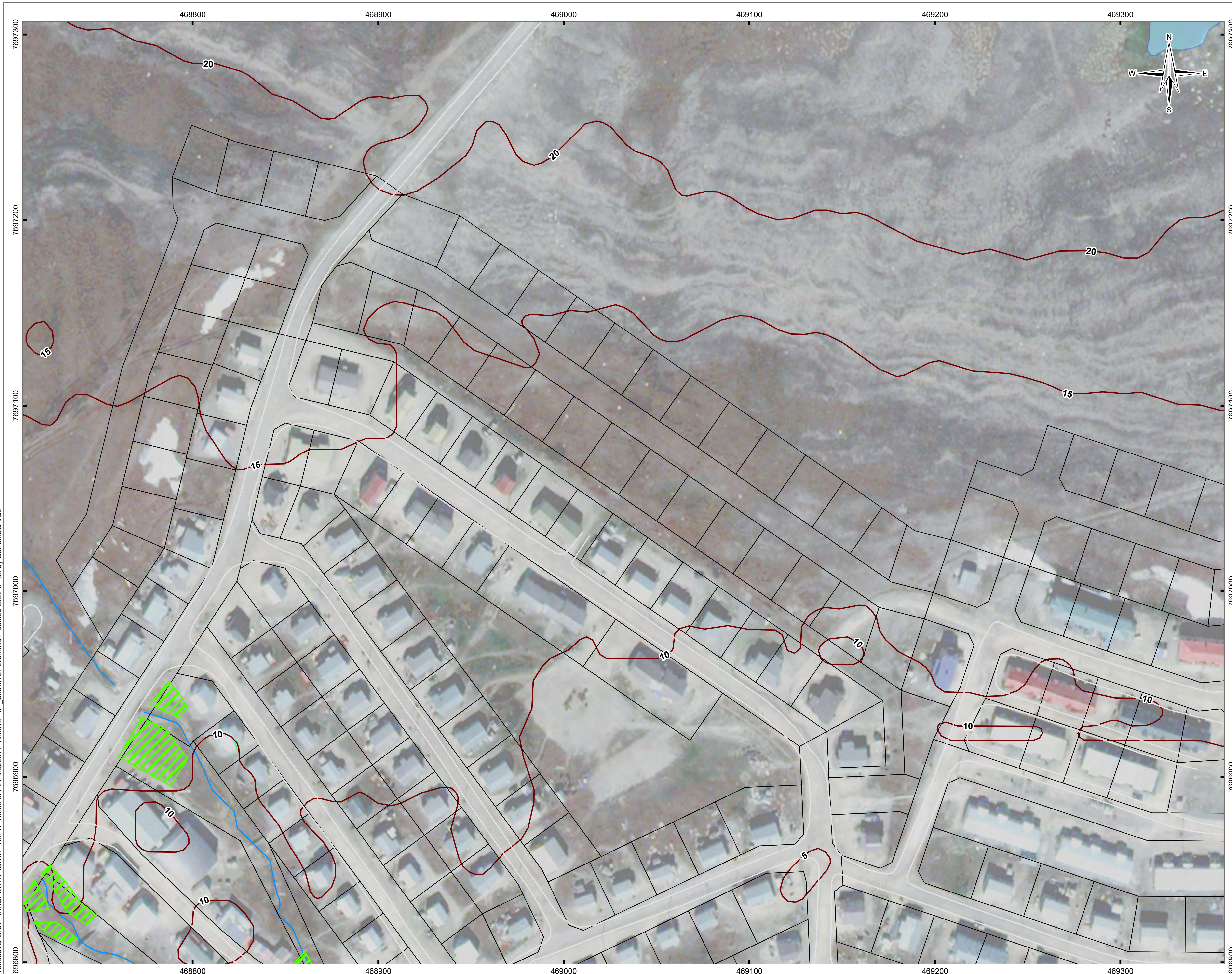
FILE NO.
WTRM03184-01_SnowRemoval.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure 6-17



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LEGEND

Snow Deposition Area

Base Data

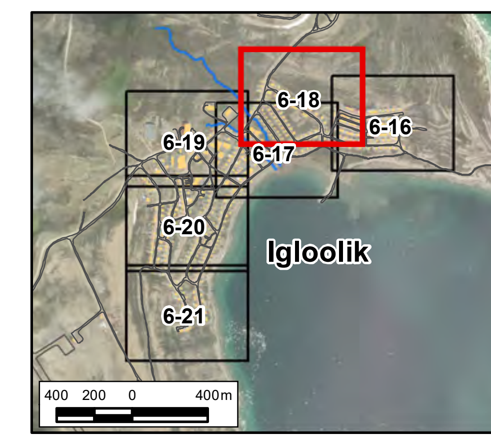
Current Parcel

Road

Watercourse

Topographic Contour (5 m)

Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik
Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000
40 20 0 40
Meters

FILE NO.
WTRM03184-01_SnowRemoval.mxd

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OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE: April 6, 2020

PROJECT NO.: TRN.WTRM03184-01

Figure 6-18

LEGEND

Snow Deposition Area

Base Data

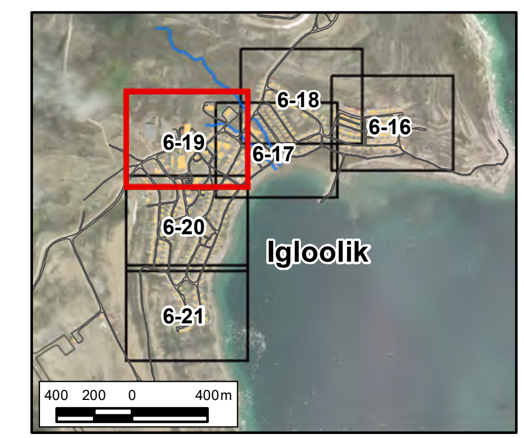
Current Parcel

Road

Watercourse

Topographic Contour (5 m)

Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik
Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000

40 20 0 40
Meters

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FILE NO.
WTRM03184-01_SnowRemoval.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE
April 6, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure 6-19

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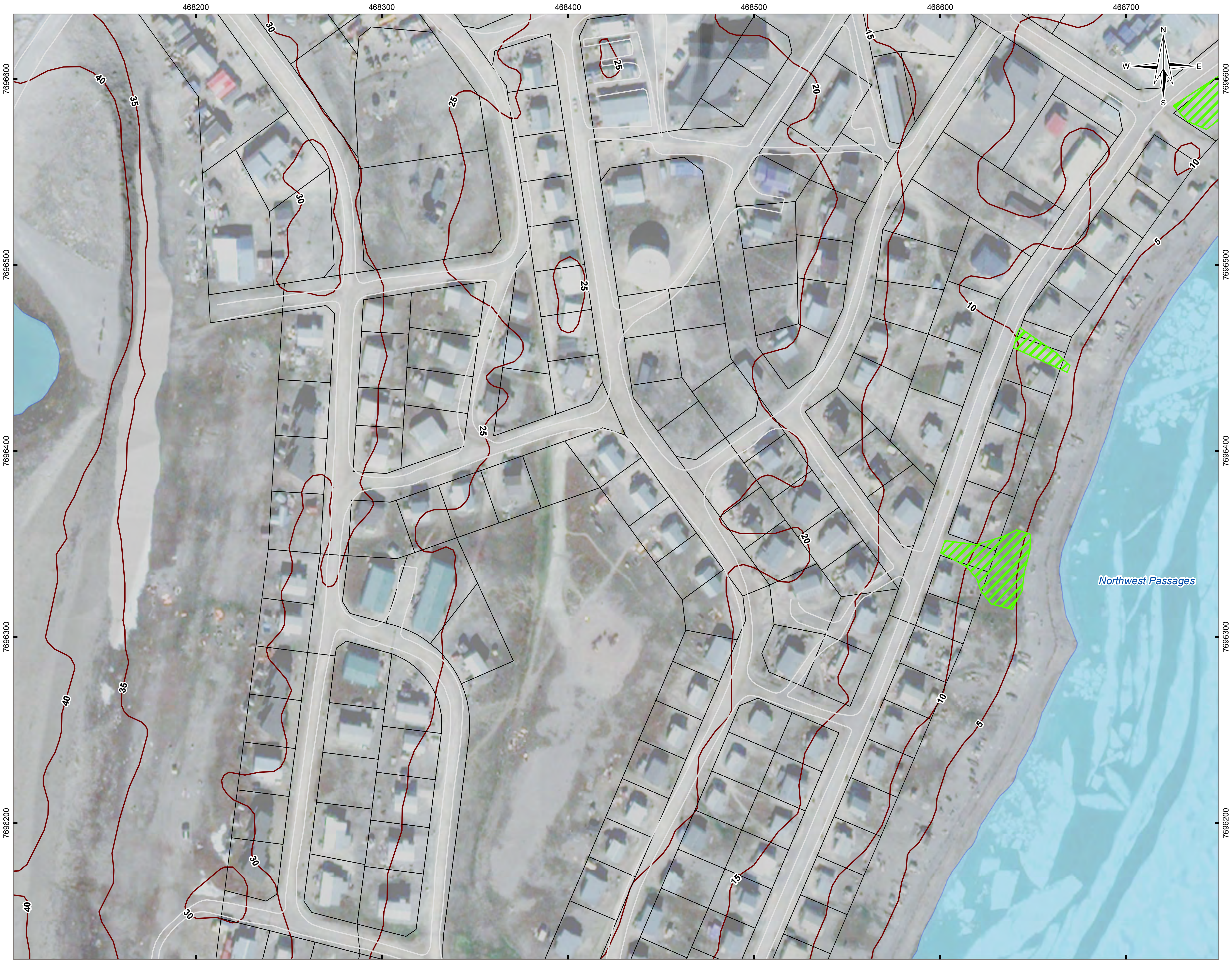


LEGEND

Snow Deposition Area

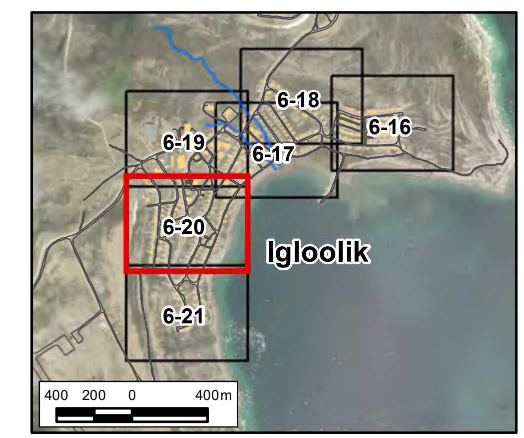
Base Data

Current Parcel

Road

Topographic Contour (5 m)

Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik
Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000

40 20 0 40
Meters

FILE NO.
WTRM03184-01_SnowRemoval.mxd

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

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Figure 6-20

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LEGEND

Snow Deposition Area

Base Data

Current Parcel

Road

Topographic Contour (5 m)

Waterbody

NOTES

Base data source:

1. Igloolik base data from Government of Nunavut

STATUS

ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Igloolik
Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,000

40 20 0 40

Meters

FILE NO.

WTRM03184-01_SnowRemoval.mxd

TETRA TECH

OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	JW	0

DATE: April 6, 2020

PROJECT NO.: TRN.WTRM03184-01

Figure 6-21

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6.7.3 Culvert Thawing

Igloolik's annual maintenance program should incorporate a culvert thawing strategy. Some options for thawing culverts are presented in Appendix C for consideration. Figure 6-22 below shows the proposed method for thawing ice inside culverts.

As per the project phasing diagrams shown in Figures 6-9 to 6-14, higher priority culverts should be thawed first. For example, culverts in Phase 1 zones should be thawed before culverts in Phase 2 zones.

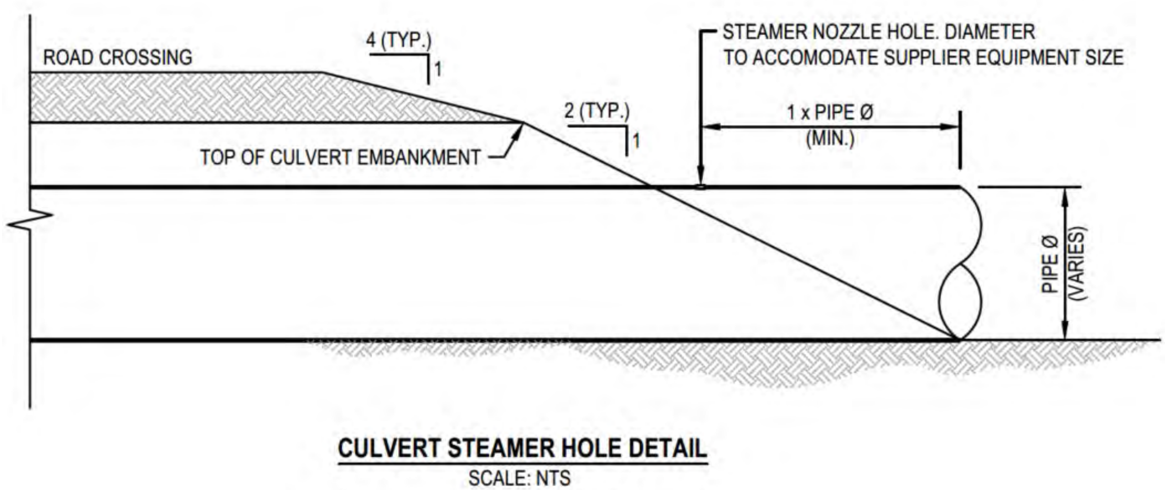

Figure 6-22: Culvert Thawing Detail

6.7.4 Maintenance Schedule

A recommended seasonal maintenance schedule as per the Guidelines for Community Drainage System Planning, Design, and Maintenance in Northern Communities (CSA Group, 2015), is presented as follows:

Spring:

- Visually inspect and thaw frozen culverts in order of their priority level, as discussed in Section 6.7.2. Note any damages to culverts.
- Remove debris from blocked or partially blocked culverts.
- Collect and dispose of litter if present.
- Following the spring freshet, inspect the drainage system to identify deficiencies for repair.

Summer:

- Repair washed out ditches, swales and riprap aprons as necessary. Ponding in ditches and swales should be identified and fixed with re-sloping and grading.
- A water pump can be used to flush blocked culverts free of sediment, rocks, and debris. Discharge of sediments into natural streams should be avoided and appropriate sediment and erosion control measures should be incorporated to protect the receiving water bodies.

- Repair damaged culvert ends. Replace or re-install culverts that have been shifted or damaged. Repair culverts in order of their priority level and the level of damage observed.

Fall:

- Complete repairs to the drainage system.
- Replace missing or damaged culvert marking posts.
- Create an inventory of materials required for the next year's maintenance program.

Winter:

- Monitor culverts and culvert marking posts.
- Implement the snow removal management plan as detailed in Section 6.7.2.

7.0 CLOSURE

We trust this document meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

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APPENDIX A

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LIMITATIONS ON USE OF THIS DOCUMENT

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Both electronic file and/or hard copy versions of TETRA TECH's Instruments of Professional Service shall not, under any circumstances, be altered by any party except TETRA TECH. TETRA TECH's Instruments of Professional Service will be used only and exactly as submitted by TETRA TECH.

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The Client acknowledges that it has fully cooperated with TETRA TECH with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for TETRA TECH to properly provide the services contracted for in the Contract, TETRA TECH has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

1.5 INFORMATION PROVIDED TO TETRA TECH BY OTHERS

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While TETRA TECH endeavours to verify the accuracy of such information, TETRA TECH accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

1.6 GENERAL LIMITATIONS OF DOCUMENT

This Professional Document is based solely on the conditions presented and the data available to TETRA TECH at the time the data were collected in the field or gathered from available databases.

The Client, and any Authorized Party, acknowledges that the Professional Document is based on limited data and that the conclusions, opinions, and recommendations contained in the Professional Document are the result of the application of professional judgment to such limited data.

The Professional Document is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present, or variation in assumed conditions which might form the basis of design or recommendations as outlined in this report, at or on the development proposed as of the date of the Professional Document requires a supplementary exploration, investigation, and assessment.

TETRA TECH is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

1.7 ENVIRONMENTAL AND REGULATORY ISSUES

Unless expressly agreed to in the Services Agreement, TETRA TECH was not retained to investigate, address or consider, and has not investigated, addressed or considered any environmental or regulatory issues associated with the project.

1.8 LEVEL OF RISK

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design, in consideration of the level of the hydrotechnical information that was reasonably acquired to facilitate completion of the design.

APPENDIX B

COMMUNITY PLANS AND BYLAW NO. 197

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LEGEND

Suitability

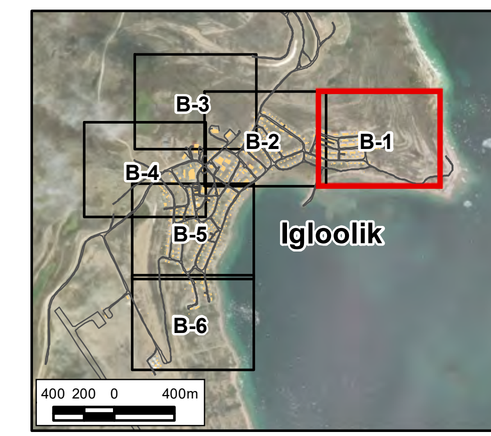
- Anthropogenic
- Suitable for Development

Site Features

- Waste and Sewage 450 m Setback

Base Data

- Current Parcel
- GN Proposed Parcel
- Building Footprint
- Gravel Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
ISSUED FOR USE

IGLOOLIK MASTER DRAINAGE PLAN

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50

Meters

FILE NO.
WTRM03184-01_CommunityPlan.mxd

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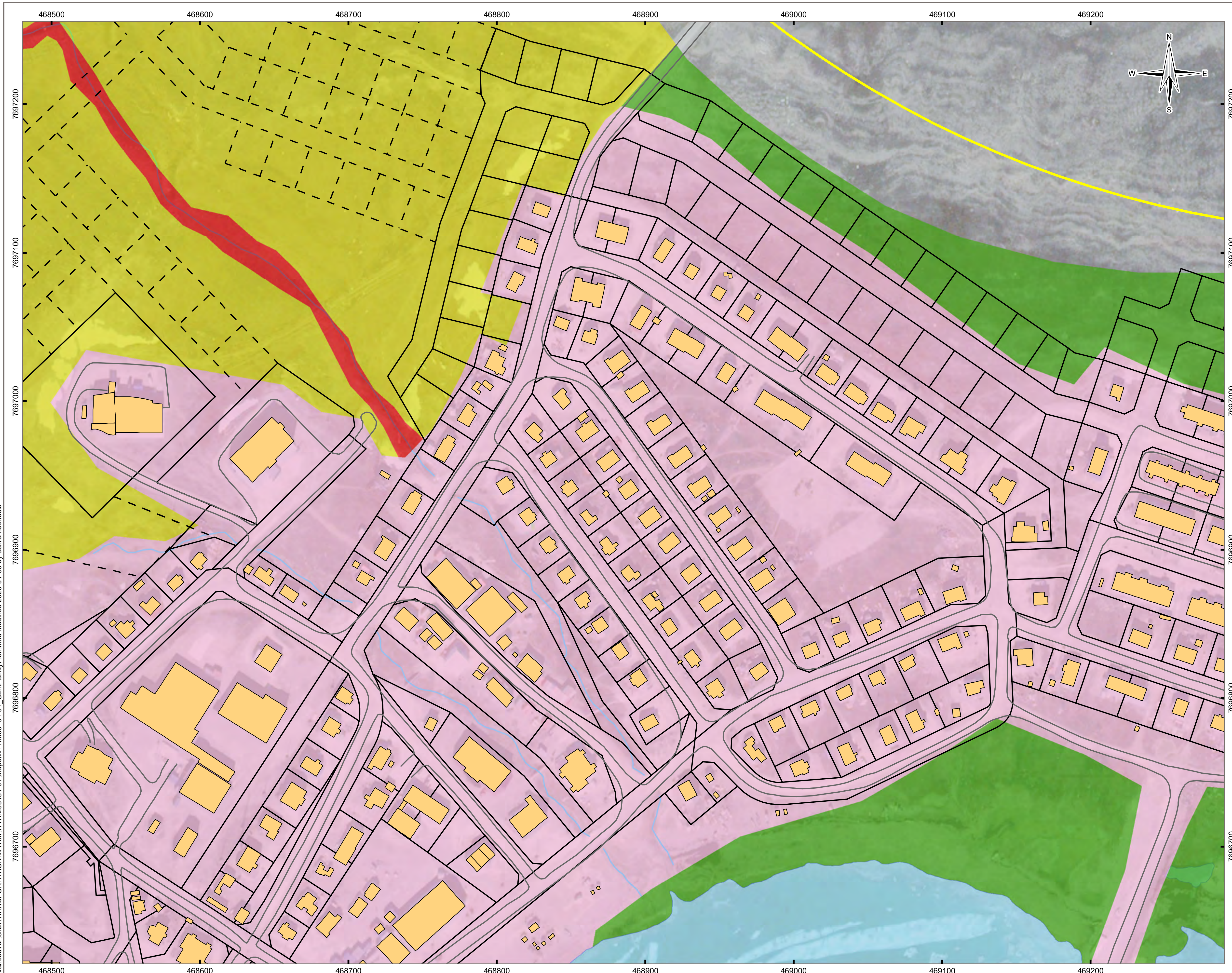
DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure B-1



LEGEND

Suitability

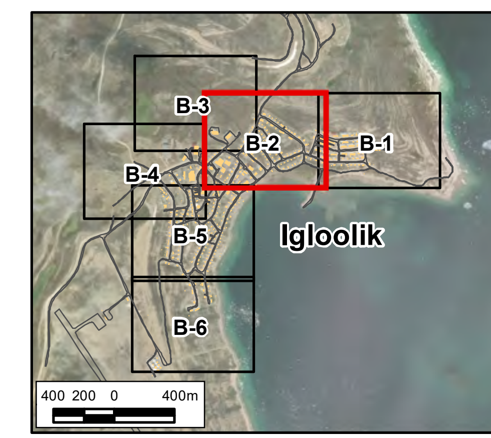
- Anthropogenic
- Suitable for Development
- Conditionally Suitable for Development Provided the Drainage Improvement Plan is Implemented
- Unsuitable for Development

Site Features

- Waste and Sewage 450 m Setback

Base Data

- Current Parcel
- GN Proposed Parcel
- Building Footprint
- Gravel Road
- Topographic Contour (5 m)
- Watercourse
- Waterbody



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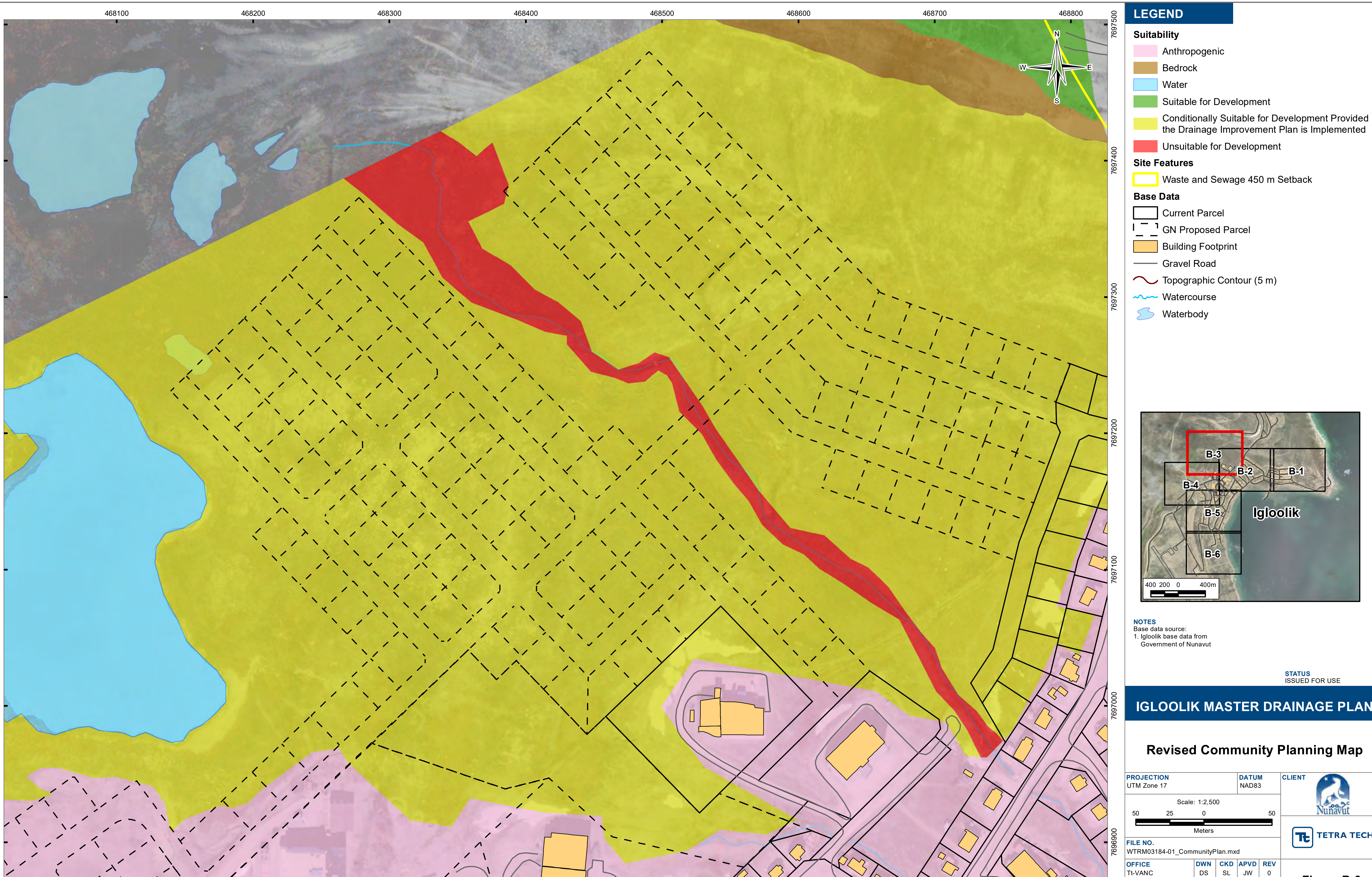
DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure B-2



NOTES
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DATE: April 6, 2020
PROJECT NO.: TRN.WTRM03184-01

TETRA TECH

Figure B-3

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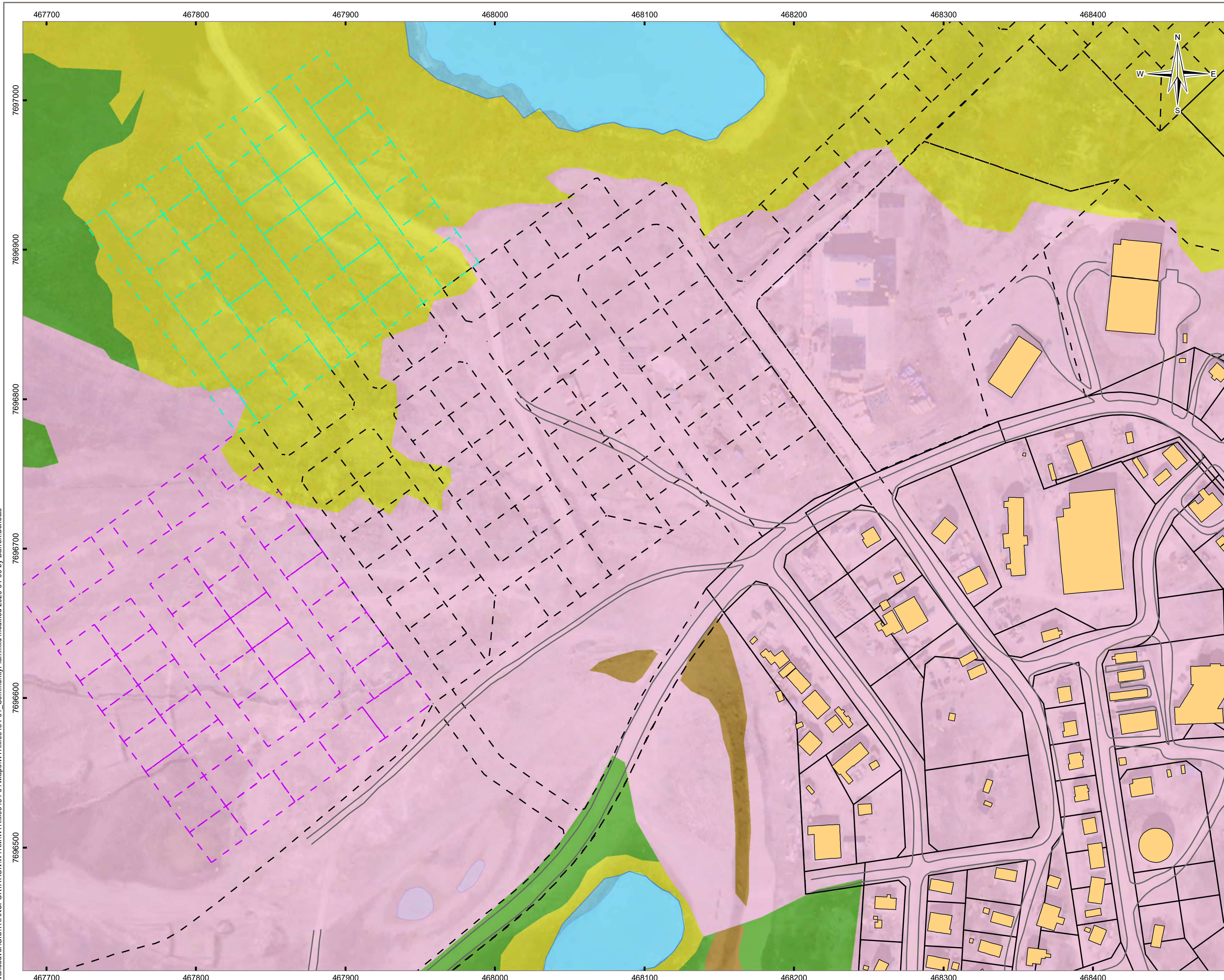


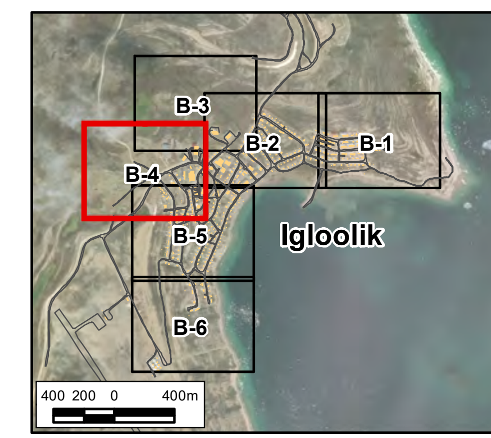
LEGEND

Suitability

- Anthropogenic
- Bedrock
- Water
- Suitable for Development
- Conditionally Suitable for Development Provided the Drainage Improvement Plan is Implemented

Base Data

- Current Parcel
- GN Proposed Parcel
- Relocate GN Proposed Parcel
- Tetra Tech Relocated Parcel
- Building Footprint
- Gravel Road
- Topographic Contour (5 m)
- Waterbody



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Base data source:
1. Igloolik base data from Government of Nunavut

STATUS
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IGLOOLIK MASTER DRAINAGE PLAN

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
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DATE
April 6, 2020

PROJECT NO.
TRN.WTRM03184-01

Figure B-4

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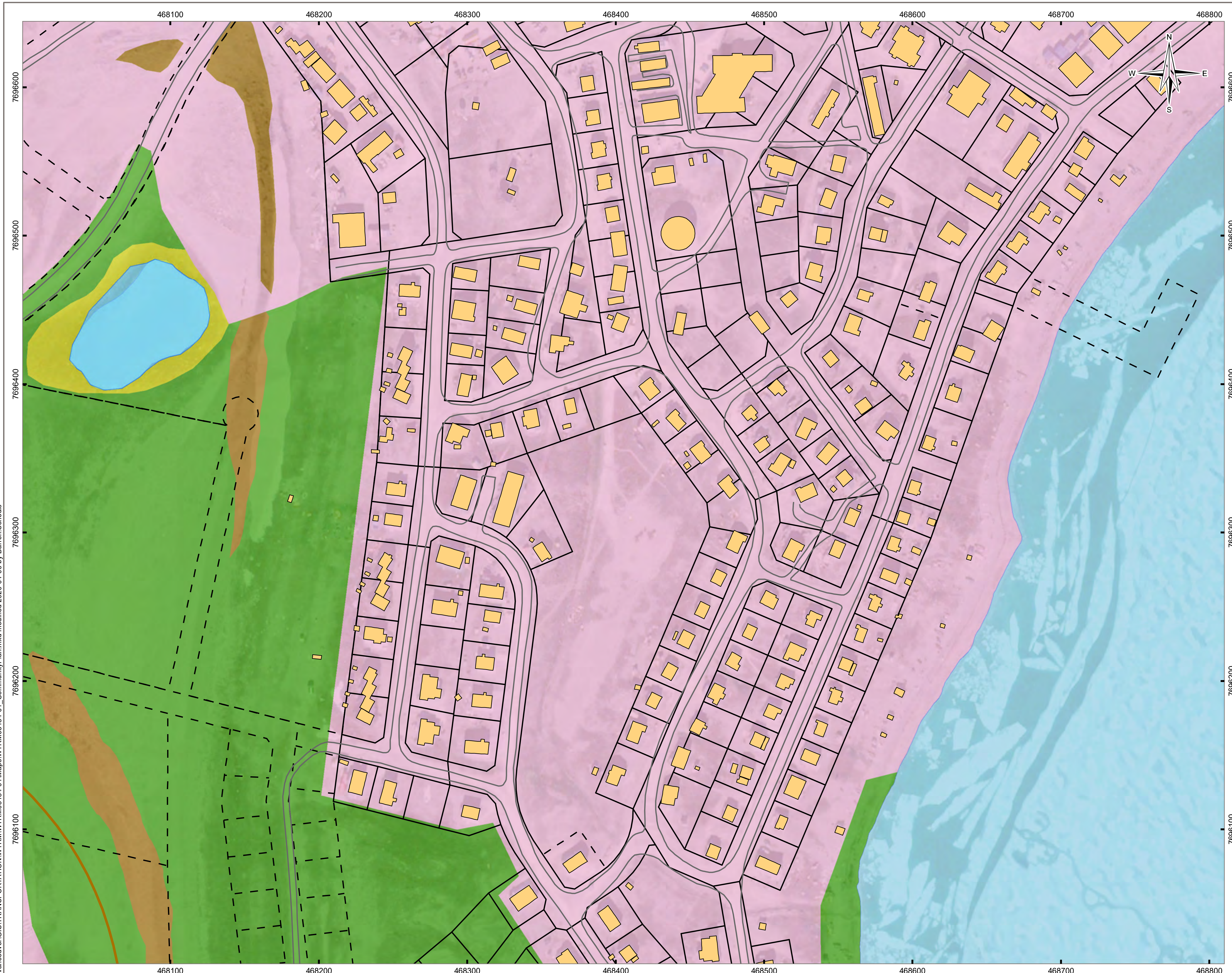
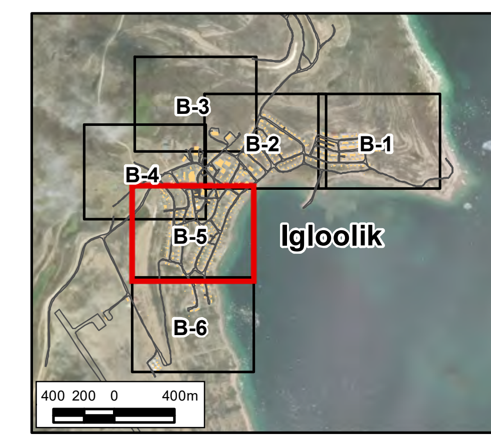


LEGEND

Suitability
- Anthropogenic
- Bedrock
- Water
- Suitable for Development
- Conditionally Suitable for Development Provided the Drainage Improvement Plan is Implemented

Site Features
- Non-Directional Beacon 200 m Setback

Base Data
- Current Parcel
- GN Proposed Parcel
- Building Footprint
- Gravel Road
- Topographic Contour (5 m)
- Waterbody



NOTES
Base data source:
1. Igloolik base data from Government of Nunavut

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IGLOOLIK MASTER DRAINAGE PLAN

Revised Community Planning Map

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UTM Zone 17	NAD83	Nunavut

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DATE	PROJECT NO.
April 6, 2020	TRN.WTRM03184-01

Figure B-5

LEGEND

Suitability

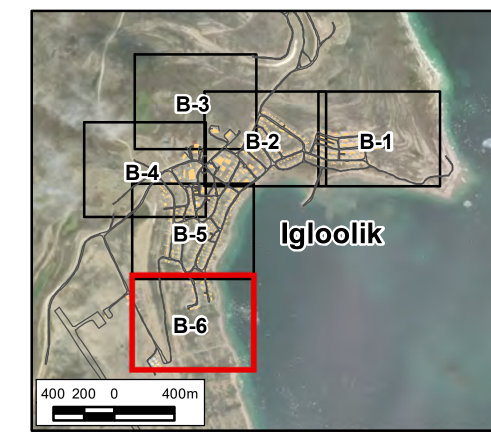
- Anthropogenic
- Bedrock
- Suitable for Development
- Conditionally Suitable for Development Provided the Drainage Improvement Plan is Implemented

Site Features

- Airport Property Boundary
- Non-Directional Beacon 200 m Setback

Base Data

- Current Parcel
- GN Proposed Parcel
- Building Footprint
- Gravel Road
- Topographic Contour (5 m)
- Waterbody



NOTES
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1. Igloolik base data from Government of Nunavut

STATUS
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IGLOOLIK MASTER DRAINAGE PLAN

Revised Community Planning Map

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UTM Zone 17	NAD83	Nunavut

Scale: 1:2,500
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DATE	PROJECT NO.			
April 6, 2020	TRN.WTRM03184-01			

TETRA TECH

Figure B-6

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IGLOOLIK COMMUNITY MAP 2037

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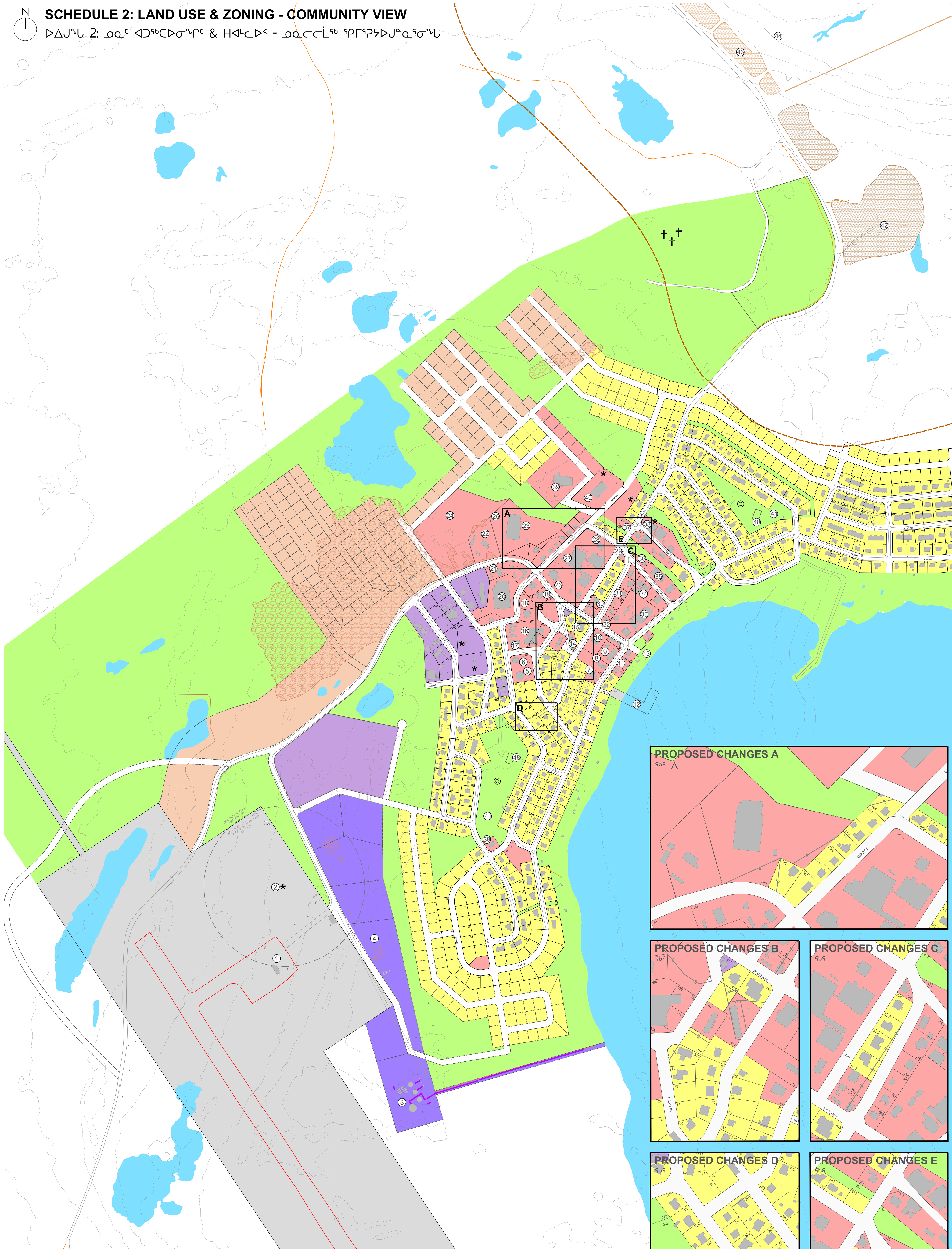
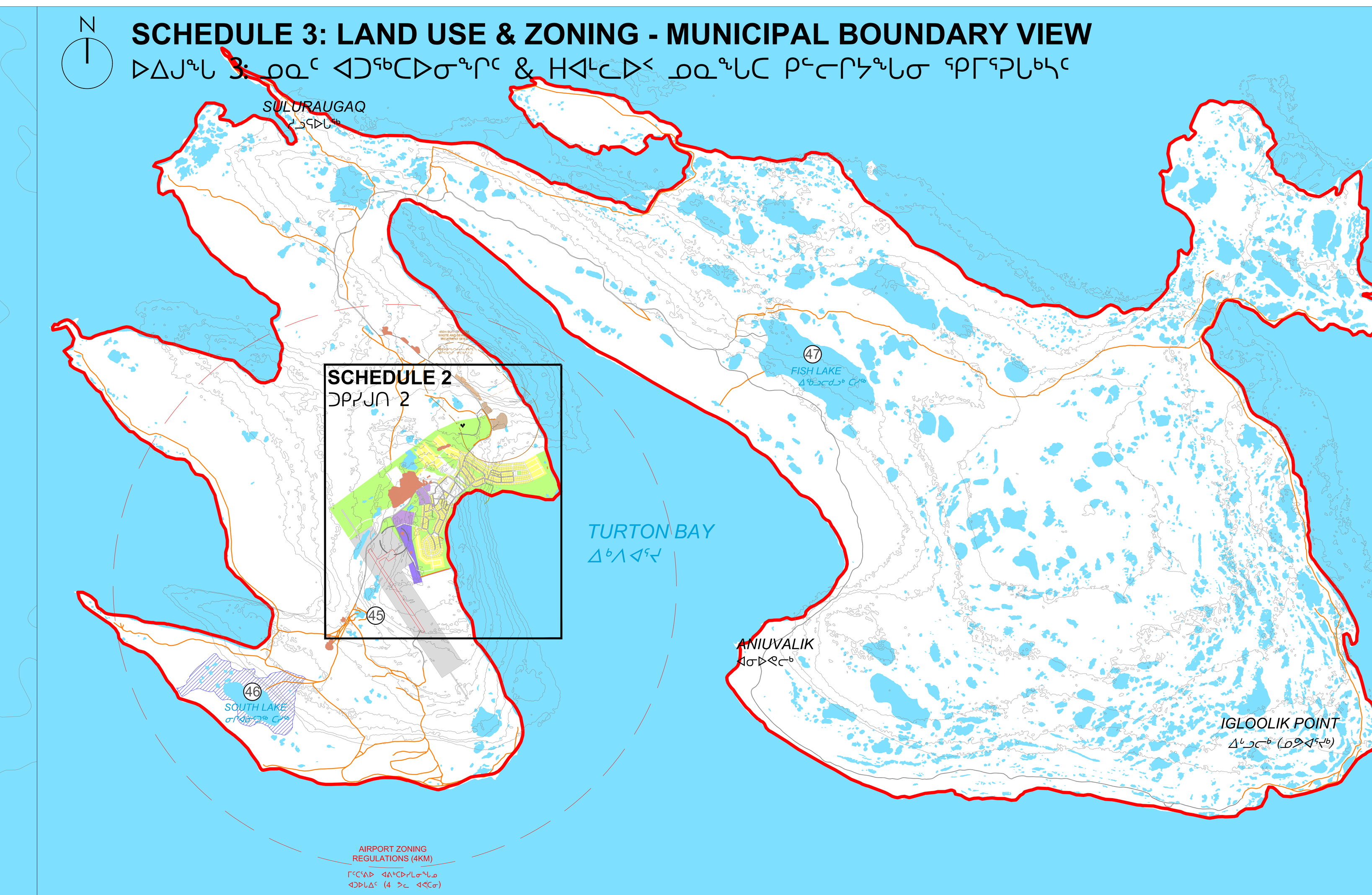




Airport	1	Community Freezer	31
NBD Tower	2	Hunters & Trappers	32
Tank Farm	3	Northern Store	33
Future Power Plant	4	Co-op Hotel	34
Research Centre	5	St. Stephen's Catholic Church	35
Daycare	6	Radio Station	36
Fire Hall	7	Studio	37
Anglican Church	8	Co-op Store	38
Old Hamlet Office	9	Continuing Care	39
Hamlet Office	10	GN Office	40
Youth Centre	11	Volleyball Court	41
Proposed Breakwater	12	Solid Waste Disposal Site	42
Docking Area	13	Sewage Lagoon	43
Igloolik Inn Hotel	14	Wetland Treatment Area	44
Elders Residence	15	Reservoir	45
Health Centre	16	Primary Drinking Water Source	46
Housing Association	17	Secondary Drinking Water Source	47
Basketball Court	18	Future Ice Rink	48
Wildlife Office	19	Municipal Boundary	
Kips Gak Arena	20	Existing Lot	
Power Plant	21	Proposed Lot	
Community Hall	22	Existing Road	
Ataguttaaluk High School	23	Trail	
New School Site	24	ATV Trail	
Future Baseball Diamond	25	Pipeline	
Arctic College	26	Communication Site	*
Primary School	27	Playground	
Igloolik Headstart	28	Cemetery	
Savik Enterprises	29	Quarry	
RCMP	30	Waste Disposal Site	
		Watershed Overlay	

COMMUNITY (C)

PERMITTED USES

- Automotive sevices & sales
- Commercial recreation & entertainment
- Commercial uses
- Communication facility
- Community centre
- Craft studio
- Daycare centre
- Educational facility
- Elders facility
- Government service
- Health care facility
- Hotel
- Place of worship
- Restaurant
- Retail store
- Service and repair shop

CONDITIONAL USES

- Dwelling units, provided that the units are above the ground floor.
- Home occupation

RESIDENTIAL (R)

PERMITTED USES

- Dwelling, single-unit
- Dwelling, semi-detached
- Dwelling, multi-unit

CONDITIONAL USES

- Bed and breakfast
- Craft studio
- Daycare centre
- Dwelling, secondary suite
- Elders facility
- Group home
- Home occupation

OPEN SPACE (OS)

PERMITTED USES

- Camp
- Cemetery
- Park
- Snow fence

CONDITIONAL USES

- Beach Shack
- Cabin
- Campground
- Communications facility
- Dog teams
- Outdoor storage

LIGHT INDUSTRIAL (M1)

PERMITTED USES

- Automotive service & sales
- Building supply & contractor's shop
- Communications facility
- Contractor's yard
- Craft studio
- Greenhouse
- Industrial use
- Outdoor storage
- Service & repair shop

CONDITIONAL USES

- Heavy industrial uses
- Caretaker units

TRANSPORTATION (T)

PERMITTED USES

- Airport and related use
- Communications facility
- Sealift facility

CONDITIONAL USES

- Outdoor storage
- Warehouse

NUNA (N)

PERMITTED USES

- Camp
- Dog team

CONDITIONAL USES

- Beach shack
- Cabin
- Campground
- Communications facility
- Mineral exploration
- Quarry
- Snow fence

HEAVY INDUSTRIAL (M2)

PERMITTED USES

- Hazardous goods storage
- Light industrial uses
- Power generation facility
- Tank farm
- Utility installation

MUNICIPAL RESERVE (MR)

The Municipal Reserve identifies lands that may be interesting for future development. No development is permitted in the MR zone unless of temporary nature, subject to Council approval.

READ a third time this ____________ day of ____________________ , 2017 A.D.

Mayor ____________________ Senior Administrative Officer ____________________

IGLOOLIK COMMUNITY PLAN

BY-LAW 197

MARCH 2017

Nunavut

FOTENN Planning + Design

exp.

IGLOOLIK COMMUNITY PLAN
BY-LAW No. 197

A By-law of the Hamlet of Igloolik in Nunavut Territory to adopt a General Plan pursuant to the provisions of the Planning Act, RSNWT, 1988, c. P-7, s.4.

WHEREAS the Council of the Hamlet of Igloolik has prepared a General Plan, referred to as the "Igloolik Community Plan", in accordance with the Planning Act;

NOW THEREFORE, the Council of the Hamlet of Igloolik, duly assembled, enacts as follows:

1. Schedules 1, 2 and 3 of this By-law form part of this By-law.
2. This By-law may be cited as the "Igloolik Community Plan".
3. This By-law shall come into full force and effect on the date of its Third Reading.
4. By-law No. 154 of the Hamlet of Igloolik is hereby repealed

READ a first time this 8th day of February 2017 A.D.

Mayor

Senior Administrative Officer

After due notice and a Public Hearing, READ a second time this 20 day of 07 2017 A.D.

Mayor

Senior Administrative Officer

APPROVED by the Minister of Community and Government Services this 17 day of January, 2019 A.D.

Minister

READ a third time this 7 day of March, 2019 ~~2017~~ A.D.

Mayor

Senior Administrative Officer

SCHEDULE 1: COMMUNITY PLAN

1. Introduction

1.1 Purpose of the Plan

The purpose of the Igloolik Community Plan is to outline Council's policies for managing the physical development of the Hamlet to 2037 and reflect the needs and desires of the Community. The Plan was created through a community consultation process. The Community Plan builds on previous plans, while addressing new challenges, issues and needs identified by the community.

This Plan designates residential and commercial land to accommodate future growth. To conserve land, Council will support higher-density forms of housing including multi-storey units and redevelopment when opportunities arise.

1.2 Goals of the Community Plan

Community Plan policies emerge from the values of a community and its vision of how it would like to grow. The goals of this Community Plan are:

1. To create a healthy, safe, functional, and attractive community that reflects community values and culture.
2. To promote the Community Plan as a tool for making effective and consistent decisions about land use and development in the community.
3. To ensure an adequate supply of land for all types of uses to support the community's future growth.
4. To support community values of participation and unity to encourage community projects and local economic development.
5. To protect the natural beauty and accessibility of Nuna by protecting views of the water, retaining waterfront and lakeshore areas for public uses and traditional activities, and identifying important access routes on the Plan to protect them from development.

1.3 Administration of the Plan

The Community Plan is enacted by By-law. Changes to the Plan can be made by amending the By-law in accordance with the *Nunavut Planning Act*. The Community Plan should be reviewed and updated every five years as required by the *Nunavut Planning Act*. A Zoning By-law will be being enacted to implement detailed policies based on the Community Plan. All development must follow the intent of the Community Plan policies. The Community Plan includes Schedule 1 (Plan Policy Text), Schedule 2 (Land Use and Zoning Map – Community View), and Schedule 3 (Land Use and Zoning Map – Municipal Boundary).

2. Community Growth and Phasing Policies

At the time of preparation of this Plan, the population of Igloolik was approximately 1,985 people. This Plan is based on a potential population of 2,915 people in Igloolik in 2037. It is estimated that an additional 336 dwelling units will be required to meet the projected population growth and to reduce current overcrowding. Meeting this need over the planning period will require the construction of approximately 17 new dwellings every year.

The projected amount of new housing land required assumes most new housing will be provided by the Nunavut Housing Corporation (NHC), but that some private dwellings and staff housing will continue to be built at an average density of approximately 25 dwelling units per net hectare. Providing 336 dwellings at a density of 25 units per hectare represents a need for approximately 13.44 hectares of residential land, or approximately 0.672 hectares per year.

At the time of preparation of this Plan, Igloolik has approximately 14.8 hectares of existing surveyed lots available for lease and development. Some existing lots are vacant and are available for development or redevelopment. Approximately 26.2 hectares of additional land is available to be surveyed north, south, and east of the Townsite. The available land is sufficient to accommodate projected needs.

These land and housing requirements may increase or decrease depending on several factors including economic development activity in the community or the wider region, changes to the natural rate of population growth, and migration between communities.

Over the next 20 years, Igloolik will also require additional community, commercial and industrial lands. This Plan identifies vacant lands for future development of community, commercial, and industrial uses.

The policies of Council about Community Growth and Phasing are:

a) Plan for a 2037 population of 2,915 people and address the current overcrowding situation.

b) Council will phase the development of new Residential and Community land as follows, in order of priority:
   i. Infill: Council will encourage the development of existing lots within the Townsite.
   ii. Surveyed Lots: Continue to develop existing lots within the new residential subdivisions.
   iii. Expansion Areas: After existing surveyed lots are developed, new lots may be surveyed in designated areas.

c) Council will encourage and facilitate the consolidation, intensification and redevelopment of existing lots within the community to conserve land supplies as follows:
   i. Where appropriate, Council will support infill in the form of multi-storey residential units.

ii. Where appropriate, Council will support infill in the form of new multi-family unit construction to replace existing single-family dwellings if existing dwellings must be demolished or relocated.

3. General Policies

The following policies of Council apply to **all development** in the Hamlet:

a) The development of lots shall be subject to the following lot development policies:
   i. Buildings shall be sited to respect setbacks identified in the Zoning By-law.
   ii. All service connections to buildings with trucked services shall be easily accessed from the front yard on all lots, and shall be grouped together where possible.
   iii. Wherever possible, building foundations should achieve an unobstructed gap of at least 0.8 metres between the ground and the underside of the building to reduce snow drifting.
   iv. Any building over 500 square metres in gross floor area shall consider potential wind impacts on surrounding development. A wind study may be required by the Development Officer.
   v. To reduce the amount of fill and ground alterations, pile foundations shall be used where appropriate.
   vi. Where culverts are required, they shall be installed across driveways or access points to lots.
   vii. On any portion of a lot where fill is introduced, the lot shall be graded so that drainage is directed towards the public road. Exceptions may be made by the Development Officer. Where possible, drainage ditches shall not be located in utility rights-of-way or easements.
   viii. Road widenings may be obtained, as required, at the time of development or redevelopment of a lot in situations where the road right-of-way is less than 16 metres wide.

b) No development is permitted within 30.5 metres (100 feet) of the normal high water mark of any river, major creek or water body, except subject to terms and conditions of the Hamlet Council.

c) Utilities or communications facilities shall be permitted in any land use designation.

d) As much as possible, development shall be designed to maintain views to Turton Bay from the beachfront and adjacent access roads.

e) Other than designated rights-of-way or easements for utility or communication lines, easements along roads will be used for distribution lines with a minimum clearance as specified in the *Utility Corporations Joint Use Agreement.*

f) Hydro poles and other utility infrastructure should be located to not interfere with snow plowing or other maintenance services.

g) The Hamlet shall pile snow in locations that minimize downwind snow drifting and where spring melt runoff can be properly channeled to drainage ditches or water bodies.

h) The Hamlet shall avoid piling snow within at least 30.5 metres (100 feet) of any watercourse or water body.

i) The Hamlet shall protect cemeteries and sites of archaeological, ethnographical, paleontological or historical significance from disturbance. Any development in or near such sites shall follow the *Nunavut Archaeological and Paleontological Regulations, 2001 of the Nunavut Act (Canada)*

j) The Hamlet shall work with the Nunavut Planning Commission to ensure the Igloolik Community Plan is compatible with the future Nunavut Land Use Plan.

4. Community Development Policies

The following policies shall guide Council's decision-making on development and land use issues:

a) Adequate housing is fundamental to public health and the social well being of the community. In addition to identifying new residential development areas, Council will encourage and pursue the development of new homes in the community, particularly homes with 3 and 4 bedrooms.

b) The Hamlet will use new development and public spaces to celebrate Inuit culture and language.

c) Council will actively pursue property standards with lease holders and property owners in the Hamlet to ensure that all building stock, particularly housing, is being maintained and used fully and efficiently.

d) The following community facilities shall be a priority for Council:
   i. New 8-bay municipal garage
   ii. Storage and office space for Housing Authority
   iii. Extension of community access roads

e) Council shall consider developing a Drainage Plan for the entire community.

f) Council shall consider adopting a snow piling by-law.

g) The Hamlet shall encourage development that minimizes fossil fuel emissions, that is energy efficient, and that considers alternative energy supply technology.

h) The Hamlet shall consider strategies for climate change adaptation, such as locating development away from low lying coastal areas and protecting existing areas against erosion.

i) Council shall consider new infrastructure solutions, such as tank reservoir systems, incinerators, and recycling facilities, in consultation with the Government of Nunavut and where feasible.

5. Land Use Designations

5.1 Residential

The Residential designation is intended to provide and maintain an adequate supply of land for residential uses. It also permits other small conditional uses subject to the approval of Council. The policies of Council are intended to maintain an adequate supply of residential land, and to protect residential areas from incompatible development. The policies of Council for Residential areas are:

a) The Residential designation will be used for housing with all types of dwellings permitted. Other related residential uses, such as group homes, home businesses or bed and breakfasts are also permitted.

b) Residential development will be phased so that a minimum of a 3-year supply of vacant surveyed land or approximately 5.4 hectares is available at any given time.

c) Council will look for new residential opportunities on infill lots within the existing downtown and uptown areas of the community. Priority locations for future surveys for infill lots are identified on the Plan.

d) Council will work with Nunavut Housing Corporation to identify where existing lots in the downtown area could be consolidated and redeveloped with attached housing forms (i.e., 5-plexes).

5.2 Community

The Community designation is intended to maintain an adequate supply of land for commercial and community uses, preferably in central and accessible locations so that residents may enjoy easy access to public facilities and community services. The policies of Council for Community areas are:

a) The Community designation will be used for:

   i. Commercial uses, such as hotels, restaurants, retail stores, personal and business services and offices;

   ii. Public uses, such as community centres, places of worship, medical clinics, schools, and other institutional or community uses; and

   iii. Government services.

b) Commercial and Community facilities will be centrally located along main roads wherever possible to ensure safe and convenient access by residents.

c) Residential uses will be permitted when located above a ground floor commercial or community use.

d) Council will encourage the re-use or redevelopment of existing unused or underused sites within the community.

e) Council shall seek opportunities and encourage the relocation of light and heavy industrial uses outside the community core over time by considering land swaps and/or other incentives.

f) Lands in residential expansion areas shall also be reserved for Community uses to ensure all residents have convenient access to commercial and community services.

g) Council shall encourage adaptive re-use of the old Hamlet Office building.

5.3 Open Space

The Open Space designation is intended to protect the shoreline, maintain access to the sea, and to reserve land within the community for recreation and cultural events. The policies of Council for the Open Space area are:

a) The Open Space designation will be used for parks, walking trails, traditional and recreational uses such as beach shacks, boat and snow machine storage, community docks, and temporary storage of sealift deliveries and equipment. All uses are conditional and at the discretion of Council.

b) A playground or sports field should be located within walking distance of every residence in the community (approximately 300 metres from each residence).

c) Council shall set aside a space for a playground in new residential areas.

d) Commissioner's Land forming part of the "100-foot strip" (30.5 metres) along the shore measured from the ordinary high water mark shall be designated Open Space.

5.4 Light Industrial

The Light Industrial designation is intended for light industrial developments which are compatible with surrounding uses. These uses should not be apparent outside an enclosed building, and should operate in a manner that creates no nuisance to adjacent properties. Limited outdoor activities that are necessary to a principal use such as loading, service and storage may occur, but should not dominate the use of the site. The policies of Council for Light Industrial areas are:

a) Permitted uses in the Light Industrial designation will include all forms of manufacturing, processing, warehousing and storage uses.

b) Garages are also permitted in the Light Industrial designation provided they do not generate excessive noise, fumes and odours.

c) The storage of dangerous or hazardous materials is not permitted in the Light Industrial designation.

d) Council shall ensure compatibility between uses and minimize the negative impact of light industrial uses on adjacent non-industrial areas.

e) When additional Industrial land is required, Council will redesignate the Municipal Reserve lands north of the Heavy Industrial area beside the airport.

5.5 Heavy Industrial

The Heavy Industrial designation is intended to reduce the negative effects and dangers associated with industrial uses, such as excessive noise, dust, truck travel and the storage of potentially hazardous substances. Industrial uses shall be directed to industrial subdivisions away from the centre of the Hamlet. The policies of Council for Heavy Industrial areas are:

a) Permitted uses in the Heavy Industrial designation will include the power generation plant, fuel storage and other uses likely to generate excessive noise, fumes, traffic, odours or are hazardous or obnoxious.

b) When additional Industrial land is required, Council will redesignate the Municipal Reserve lands north of the Heavy Industrial area beside the airport.

c) The location of the future power plant is indicated on Schedule 2 (Land Use and Zoning Map – Community View)

d) The uses permitted in the Light Industrial designation are also permitted in the Heavy Industrial designation.

5.6 Transportation

The Transportation designation is intended to identify major transportation and communication facilities such as airports, marinas, and communication installations, and to ensure their safe and efficient operation. The policies of Council for Transportation areas are:

a) The Transportation designation shall be used for all activities related to air traffic and uses accessory to these activities such as communications sites, storage and warehousing that is needed close to the Airport.

b) All development within the areas affected by the *Igloolik Airport Zoning Regulations*, as shown on Schedule 3 (Land Use and Zoning Map – Municipal Boundary), shall comply with those regulations.

c) Development applications shall be referred to Nunavut Airports for review and approval where development is proposed adjacent to the airport and/or where development has the potential to interfere with airport operations.

d) All development within the 200 metre Influence Zone of the Non-Directional Beacon (NDB) Communications Facility is subject to the approval of NavCanada.

5.7 Nuna

The Nuna designation applies to all unsurveyed land within the Municipal Boundary not designated by another land use and is intended to protect the natural beauty and cultural resources of the land while providing access for traditional, recreational and tourism activities, as well as allowing for quarrying, mining exploration and local infrastructure. The policies of Council for the Nuna are:

a) The Nuna designation shall permit traditional, tourism and recreational uses. These include dog teams, quarrying, mining exploration, and local infrastructure projects.

b) Council shall ensure that development does not negatively impact wildlife, wildlife habitat and harvesting and is consistent with the guiding principles of Inuit Qaujimajautqangit (IQ).

c) Council will continue to maintain the existing community access road to the east island. Council will consider the possibility of extending the access road toward Igloolik Point.

5.8 Development Constraints

The Development Constraint overlays are intended to protect the water supply, granular resources, environmentally sensitive areas and hazard areas. The Policies of council for Development Constraint areas are:

a) The Hamlet shall prohibit the development of residential uses and uses involving food storage or food preparation within the 450 metre setback from any existing or former waste disposal site, in accordance with the *General Sanitation Regulations* of the *Public Health Act*.

b) No development is permitted in the Watershed Overlay as shown on the Plan, unless it can be demonstrated that the development will have no negative impact on the Hamlet's water source.

i. Notwithstanding Policy 5.8 b) above, uses accessory to the supply of water such as a pipeline, a pumping or monitoring station or access road are permitted within the Watershed Overlay.

ii. Notwithstanding Policy 5.8 b) above, uses related to traditional activities such as seasonal hunting cabins are permitted within the Watershed Overlay but must be set back 30 metres from any watercourse or water body.

5.9 Municipal Reserve

The Municipal Reserve designation is intended to reserve land for the future growth of the community. The policies of Council are:

a) The Municipal Reserve designation does not permit any development except temporary uses approved by Council.

b) Municipal Reserve lands shall be re-designated by amendment to this Plan prior to being used for community expansion. Re-designations shall include residential, community, and light industrial land to facilitate the development of a mixed-use neighbourhood.

c) Notwithstanding the policies of this section, gravel extraction is permitted in the area north of the Townsite, as shown on Schedule 2 (Land Use and Zoning Map – Community View), until the resource is exhausted and future development can take place.

IGLOOLIK
ZONING BY-LAW

BY-LAW 198

MARCH 2017

Nunavut

FOTENN Planning + Design

exp.

IGLOOLIK ZONING BY-LAW
BY-LAW No. 198

A By-law of the Hamlet of Igloolik in Nunavut Territory to adopt a Zoning By-law pursuant to the provisions of the Planning Act, RSNWT, 1988, c. P-7, s.13.

WHEREAS the Council of the Hamlet of Igloolik has prepared a General Plan, and

WHEREAS it is deemed desirable to regulate certain uses of land and development within the Municipality,

NOW THEREFORE, the Council of the Hamlet of Igloolik, duly assembled, enacts as follows:

1. That the Zoning By-law of the Hamlet of Igloolik hereto annexed and marked as Appendix "A" to this By-law, shall hereby constitute the Zoning By-law of the Hamlet of Igloolik.
2. This By-law may be cited as the "Igloolik Zoning By-law".
3. This By-law shall come into full force and effect on the date of its Third Reading.
4. By-law No.155 of the Hamlet of Igloolik is hereby repealed.

READ a first time this 8th day of February, 2017

Mayor

Senior Administrative Officer

After due notice and a Public Hearing, READ a second time this 20 day of

07, 2017

Mayor

Senior Administrative Officer

APPROVED by the Minister of Community and Government Services this 17 day of

January, 2019

Minister

READ a third time this 7 day of March, ~~2017~~ 2019

Mayor

Senior Administrative Officer

Table of Contents

APPENDIX A: ZONING BY-LAW

SECTION 1: INTRODUCTION & INTERPRETATION

PURPOSE

1.1 This By-law

(a) Divides the Municipality into zones of permitted land use classes, and

(b) Specifies the purposes for which buildings and land may be used.

(c) Regulates or prohibits the use of land or buildings referred to in clause (b) for any other purpose.

DEFINED AREA

1.2 This By-law applies to all lands within the Municipal Boundaries of the Hamlet of Igloolik ("the Hamlet").

SCOPE

1.3 No land shall be used and no development shall take place within the Hamlet except in conformity with the provisions of this By-law.

VALIDITY

1.4 Should any section, clause or provision of this By-law be held by a court of competent jurisdiction to be invalid, the validity of the remainder of the By-law shall not be affected.

ESTABLISHMENT OF ZONES

1.5 For the purpose of this By-law, the Hamlet is divided into zones. The extent and boundaries of all zones are delineated on Schedules 2 and 3; entitled "Land Use and Zoning Map – Community View" and "Land Use and Zoning Map – Municipal Boundary View," which specify the zoning provisions applying to particular lands.

INTERPRETATION OF ZONING BOUNDARIES

1.6 If there is any uncertainty as to the location of the boundary of a zone, the Development Officer or the regional Community Planner shall interpret the Land Use Map to determine the boundary line based on the centerline of a public road, a surveyed lot line, or an unsurveyed lease sketch.

SECTION 2 – DEFINITIONS

INTERPRETATION

2.1 Typical uses listed in the definitions as examples are not intended to be exclusive or restrictive. Reference should be made to the Community Plan and the intent or the definition of the use in determining whether or not a use is included within a particular definition.

DEFINITIONS

2.2 In this By-law:

"ABUT" means a lot line that has any point in common with another lot line.

"ACCESSORY BUILDING" means a building that is separated from the principal building or structure on the lot and is secondary to, and normally associated with the main use and located on the same lot and includes garages, workshops, sheds, and shipping containers. Accessory uses cannot be used for human habitation. See section 3.6.

"ACCESSORY USE" means the use of a building or a lot which is normally subordinate and incidental to the main use of the building and located on the same lot with such main use or lot.

"ACT" means the Planning Act. RSNWT, 1988 c.P-7 as amended.

"AIRPORT" means an area of land, water (including the frozen surface thereof) used for or intended to be used for the arrival and departure, movement or servicing or aircraft. It includes any building, installation or equipment in connection therewith, and for which an airport license has been issued.

"ARCHAEOLOGICAL ARTIFACT" means any tangible evidence of human activity that is more than 50 years old and in respect of which an unbroken chain of possession or regular pattern of usage cannot be demonstrated, and includes a Denesuline archaeological specimen referred to in section 40.4.9 of the Nunavut Land Claims Agreement.

"ARCHAEOLOGICAL SITE" means a site where an archaeological artifact is found.

"AUTOMOTIVE SERVICE & SALES" means any building, structure or premises where, vehicles are fuelled, serviced, repaired, or stored for rental, sale or display.

"BEACH SHACKS" means a building that is in or within close proximity to beach areas and is used for harvesting purposes or other purposes related to the owners' participation in the land-based economy.

"BED & BREAKFAST" means a dwelling in which the resident owner or resident manager, whose primary residence is the dwelling, that provides overnight accommodation and meals for the traveling public.

"BUILDING" means any structure, erection, stockpile, sign or fixture built or placed on land.

"BUILDING SUPPLY AND CONTRACTORS SHOP" means an establishment engaged in the selling of building supplies such as lumber, millwork, siding, roofing, plumbing, electrical, heating, air conditioning or home improvements and/or for persons employed in building trades such as painting, plumbing, electrical work, masonry, metal working and carpentry or truck, bulldozer, loader and backhoe operating.

"CABIN" means a building that is located in the Nuna and is used for recreation and land-based harvesting purposes. Cabins are not intended for long-term human habitation. Cabins shall not exceed 18 m^2 in gross floor area.

"CAMPGROUND" shall mean a site, comprising land used for seasonal recreational activity as grounds for the camping or parking of tents.

"CAMP" shall mean using land as a temporary camp for recreational and cultural purposes including hunting and hiking.

"***CARETAKER UNIT***" means a dwelling used for the accommodation of a person employed as a caretaker, janitor, manager, watchman, security guard or superintendent by an industrial or commercial use operating on the site.

"CEMETERY" means land primarily used for interment of human remains.

"COMMERCIAL RECREATION AND ENTERTAINMENT" means any building, structure or premises with athletic or entertainment facilities for commercial purposes including gyms, cinemas, billiards halls, bowling alleys, and dance studios.

"COMMERCIAL USE" means a building from which business may be transacted, a service performed or a consultation given such as a bank, office, hair salon, tailor, dry cleaning, laundry, or veterinary clinic.

"COMMUNICATIONS FACILITY" means an installation which transmits, receives and/or relays communications such as a microwave or satellite relay tower, cellular telephone tower, aircraft communications tower, radio or television broadcast tower or similar facility. A communications facility includes the antennae or transmit/receive equipment, a support structure or tower, and a small building to shelter equipment.

"COMMUNITY CENTRE" means any building, structure or premises where facilities are provided for athletic, civic, educational, political, religious or social events and are controlled by the Municipality of the Government of Nunavut, or other organization. This definition includes an arena, gymnasium, swimming pool, theatre, library, or similar uses.

"CONDITIONAL USE" means a conditional use listed in a specific zone that may be permitted by Council or the Development Officer, where delegated, after consideration of the impact of that use upon neighbouring land and other criteria listed in the specific zone or other sections of this By-law.

"CONTRACTOR'S YARD" means premises used by any building trade or other construction or service contractor for the purpose of: a) storing equipment, vehicles, or materials and may include construction and heavy equipment and commercial motor vehicles but not including derelict motor vehicles; or b) performing shop work or assembly work; or c) the base of operations for persons who are employed by or associated with the business, including the assembly or rally of such persons for transportation to a work site off the premises.

"COMMERCIAL VEHICLE" means any vehicle, which is licensed as a commercial carrier as determined by the Registrar of Motor Vehicles.

"CRAFT STUDIO" means the workplace of an artist or craftsman, including a carver, painter, or photographer, where small personal goods such as jewelry or fine art such as portraits or carvings are produced in small quantity or to special order, for sale at retail from the premises.

"DAY CARE CENTRE" means an establishment for the care and supervision of children during the day.

"DEVELOPMENT" means the carrying out of any construction, excavation, or any operation in, on, over, or under land, or the making of any changes in the use or in the intensity of use of any land or building.

"DEVELOPMENT AGREEMENT" means a binding contract between the Hamlet of Igloolik and the proponent of a development. Development Agreements may only be used where the *Planning Act* permits a Council, an approving authority or Development Appeal Board to impose limitations or requirements as a condition of issuing a permit. The agreement requires observance of limitations or requirements on the development of the land and is considered a covenant running with the land.

"DEVELOPMENT OFFICER" means an official of the municipality, appointed by Council to assist Council to administer this By-law.

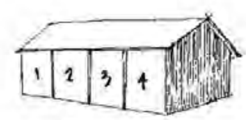
"DEVELOPMENT PERMIT" means a certificate of document permitting a development. It includes plan(s) or drawing(s) specifications and may contain relevant documents.

"DOG TEAM" means three or more dogs trained to be harnessed together and used for recreational or commercial purposes or in the maintenance of a subsistence lifestyle.

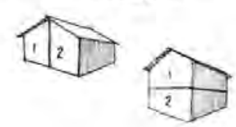
"DWELLING UNIT" means a separate set of living quarters designed or used as a housekeeping unit for one or more people and usually containing cooking, sleeping, and sanitary facilities.

"DWELLING, SINGLE-UNIT" means a separate detached building consisting of one dwelling.

"DWELLING, MULTI-UNIT" means a building that contains 3 or more dwelling units divided either vertically or horizontally and which may have independent or combined entranceways.



"DWELLING, SEMI-DETACHED" means a building that is divided either vertically or horizontally into 2 dwelling units.



"EDUCATIONAL FACILITY" means a place of instruction, including classrooms, seminar rooms and similar installations, and may include residences.

"ELDERS FACILITY" means a building or part of a building, which is used or intended to be used to provide housing and care for three or more elderly persons who are provided living and sleeping facilities, meal preparation, personal care, supervision, or assistance essential for sustaining the activities of daily living.

"ERECT" means to build, construct, reconstruct, alter, locate, or relocate and without limiting the generality of the foregoing, shall be taken to include any preliminary physical operation such as excavating, grading, piling, cribbing, filling and structurally altering any existing building or structure by an addition, deletion, enlargement or extension.

"EXISTING," means in existence on the effective date of this By-law.

"FENCE" shall mean a wall (other than the wall of a building), gate or other barrier constructed of wood, masonry, metal or combination thereof, which is continuous throughout its entire length, save and except for access points.

"GENERAL PLAN" means the General Plan of the Hamlet of Igloolik, known as the Igloolik Community Plan.

"GOVERNMENT SERVICE" means any buildings or lands from which government services are offered, including fire and police protection, municipal services, government offices, and correctional facilities, but excludes outside storage or the servicing of machinery and equipment.

"GRADE" means with reference to a building, the average elevation of the finished surface of the ground where it meets the exterior of such building and when used with reference to a structure, shall mean the average elevation of the finished grade of the ground immediately surrounding such structures.

"GREENHOUSE" means a building used for the growing of flowers, fruits, vegetables, plants, shrubs, trees and similar vegetation.

"GROSS FLOOR AREA" means the sum of the area of each floor of a building as measured from the outermost perimeter of the building, and excludes mechanical space.

"GROUP HOME" means a residence where persons live under supervision and who, by reason of their emotional, mental, social or physical condition or legal status, require a group living arrangement for their well being. The home is licensed and/or approved under Territorial Statutes and in compliance with Municipal By-laws.

"HAZARDOUS GOODS STORAGE" means any of the following:

- explosives and pyrotechnics
- gases (either compressed, deeply refrigerated, liquefied, or dissolved under pressure)
- flammable and combustible liquids
- flammable solids
- oxidizing substances and organic peroxides
- poisonous and infectious substances
- corrosives and
- other miscellaneous substances of similar nature

"HEALTH CARE FACILITY" means an establishment used by qualified medical practitioners and staff for the provision of medical and health care on an outpatient basis. This term refers to such uses as medical or dental offices, occupational health and safety offices, physiotherapy services, counseling services, chiropractic services and ancillary clinic counseling services, but does not include veterinary services.

"HOME OCCUPATION" means any occupation, trade, profession, personal service, day care or craft carried on by an occupant of a residential building as a secondary use to the residential use of the building.

"HOTEL" means a commercial building or buildings providing temporary accommodations for travelers or transients on a year-round basis, and may have a public dining room.

"INDUSTRIAL USE" means an establishment primarily engaged in the fabricating, processing, finishing, refinishing or assembly or similar production of various articles and commodities such as custom workshops, factories, mills, industrial shops and production facilities, or other similar uses.

"LOADING SPACE" means an area of land providing and maintained upon the same lot or lots upon which the main use is located and which has adequate access to permit ingress and egress by means of driveways, aisles or manoeuvring areas and which is used for the temporary parking of a commercial motor vehicle while merchandise of materials are being loaded or unloaded from the vehicles.

"LOT" or "PARCEL" means an area of land, which is described on a registered plan, or described on a certificate of title, or described by a lease agreement.

"LOT, CORNER" means a lot situated at the intersection of, and abutting on, two or more streets.

"LOT, INTERIOR" means a lot other than a corner or through lot.

"LOT, THROUGH" means a lot bounded on two opposite sides by streets that are parallel or approximately parallel.

"LOT AREA" means the total horizontal area within the lot lines of a lot.

"LOT LINE" means a common line between a lot and an abutting lot, lane, street, parcel of land or body of water.

"LOT LINE, FRONT" means the line dividing the lot from the street or other means of access, and

i) in the case of a corner or through lot – the shorter lot line abutting the street shall be the front lot line, and where such lot lines are of equal length, the lot line where the principal access to the lot is provided shall be the front lot line.

ii) in the case of a lot, which has one of its boundaries the shoreline of a lake or the bank of a river – the lot facing the access road shall be deemed to be the front lot line.

"LOT LINE, SIDE" means a lot line other than a front or rear lot line.

"LOT LINE, INTERIOR SIDE" means a side lot line that does not abut a street.

"LOT LINE, EXTERIOR SIDE" means a side lot line that abuts a street.

"LOT LINE, REAR" means the lot line farthest from or opposite to the front lot line.

"MAIN BUILDING" means the building in which is carried on the principal purpose or purposes for which the lot is used.

"MAIN WALL" means the exterior front, side or rear wall of a building.

"MINERAL EXPLORATION" means the use of land to locate commercially viable concentrations of mineral ores to mine.

"MUNICIPALITY" means the Hamlet of Igloolik.

"NON-CONFORMING" means a use, building, or structure that was lawfully constructed, or under construction, on the effective date of this By-law, and which now does not conform to the uses and/or provisions of this By-law.

"OUTDOOR STORAGE" means the storage of merchandise, goods, inventory, materials or equipment or other items, which are not intended for immediate sale, by locating them on the lot exterior to the building.

"PARK" means a park, playground or playfield and may include athletic fields, swimming pools, public gardens, bandstand, outdoor skating rinks, camping areas, fairgrounds, golf courses, or similar uses.

"PARKING LOT" means any parking area other than a parking area that is accessory to a permitted use and located on the same lot. A parking lot does not include the storage of motor vehicles.

"PARKING SPACE" means an area for the temporary parking or storage of a motor vehicle.

"PERMITTED USE" means a use permitted by this By-law.

"PERSON" includes an individual, association, firm, partnership, corporation, trust, incorporated company, organization, trustee or agent, and the heirs, executors or other legal representatives of a person to whom the context can apply according to law.

"PLACE OF WORSHIP" shall mean a building or structure designed, used or intended for religious worship and may include a church, mosque, synagogue or temple.

"POWER GENERATION FACILITY" means a building, structure or lot used to produce energy by combustion, such as gas, coal, or fuel burning plants. It does not include small-scale renewable energy facilities (e.g. wind turbine, solar photovoltaic arrays, tidal and ocean current power systems) that have a power rating of 15 kW or less. These small-scale facilities fall under the definition of ***"UTILITY INSTALLATION"***.

"PUBLIC STREET" means a road which affords the principal means of access to abutting lots and is open and maintained on a regular, year-round basis by the Corporation.

"QUARRY" means the excavation, processing, and stockpiling of gravel, stone, sand, earth, clay fill, or other similar substances.

"RESTAURANT" means a building or part of a building where foods and beverages are offered for sale to the public, for consumption within the premises or off the site. This includes licensed restaurants, cafes, lunchrooms, and take-out restaurants.

"RESIDENTIAL USE" means a building, converted or purpose-built, comprised solely of a dwelling unit or dwelling units, and includes a single unit, multi-unit and/or semi-detached dwelling unit.

"RETAIL STORE" means a building or part of a building in which goods, wares, merchandise, substances, articles or things are offered for sale directly to the public at retail value and shall include minor food processing and packaging in connection with the sale of food products.

"SECONDARY SUITE" means a self-contained dwelling unit created by either interior renovation within the existing home, or as an exterior addition to the house, provided that all one entire face of the addition is attached to the principal dwelling and is architecturally consistent with the principal dwelling, and shall not be considered a second dwelling on the lot for the purposes of this By-law.

"SERVICE AND REPAIR SHOP" means a building or part of a building used for the sale and repair of household articles and shall include all replacement shops, radio, television and appliance repair shops but shall not include industrial uses or manufacturing or vehicle repair shops.

"SETBACK" means the right-angled distance from a lot line or street boundary to the nearest part of a main building on the lot.

"SIGN" means any object or device intended for the purpose of advertising or calling attention to any person, matter, thing, or event and includes posters, notices, panels, boarding and banners.

"SNOW FENCE" means a fence erected by the Hamlet or Territorial Government to prevent hazardous snowdrifts from occurring in a specific area.

"STREET OR ROAD" means the whole and entire right-of-way of every road allowance in the Hamlet.

"STREET LINE" means the boundary line of a street.

"STRUCTURE" means anything that is erected or constructed, either temporary or permanent, the use of which requires location on the ground or attachment to something on or in the ground.

"TEMPORARY" means such time limit as may be set by the Council for a specific use. In a case where no time limit is set, "temporary" shall mean no more than 60 consecutive days, unless otherwise indicated.

"UTILITY" means any component of electrical power, cable television, or telecommunication systems.

"UTILITY INSTALLATION" means the actual building plant, works, utility line, tower, transmitter, relay, receiver, pedestal or other equipment used to make or deliver a utility product, commodity or service but does not include a power generation facility as defined in this By-law. The definition of utility installation includes renewable energy generation systems with a power rating of 15 kW or less.

"WAREHOUSE" means a building used primarily for the storage of goods and materials. It also includes a centre for distribution of wholesale goods and commodities to retailers, professional users or other wholesalers.

"WASTE DISPOSAL SITE" means a place where ashes, garbage, refuse, domestic waste, industrial waste, municipal refuse, and sewage is disposed of or dumped.

"WATERCOURSES" means any lake, river, stream, ocean, or other body of water.

"YARD" means part of a lot upon which no structure is erected above grade.

"YARD, FRONT" means the area extending across the full width of a lot from the front lot line to the nearest wall of any main building or structure on the lot.

"YARD, REAR" means the area extending across the full width of a lot from the rear lot line to the nearest wall of any main building or structure on the lot.

"YARD, INTERIOR SIDE" means the area extending across the full length of a lot between an interior side yard to the nearest main wall of any building on the lot.

"YARD, EXTERIOR SIDE" means the area extending across the full length of a lot between an exterior side yard to the nearest main wall of any building on the lot.

"ZONE" means a land use category as defined and regulated in this By-law and as shown on its Schedules.

SECTION 3 – ADMINISTRATION

POWERS OF COUNCIL

3.1 All development must be approved by Council, unless otherwise stated in this By-law.

3.2 No building may be erected in the municipality in respect of which, in the opinion of the Council, satisfactory arrangements have not been made for the supply of electric power, streets or other services or facilities

DEVELOPMENT OFFICER AND DUTIES

3.3 The Hamlet Council shall appoint a Development Officer as an authorized Officer of Council. This appointment shall be enacted by Council resolution.

3.4 The Council will authorize the Development Officer to perform the following duties:

(a) Exercise, on behalf of Council, the powers of Council under section 20 (Unauthorized Construction) of the *Planning Act*;

(b) Keep and maintain for inspection by the public during normal office hours the following official records:

(i) A copy of this By-law and all the amendments thereto;

(ii) A register of all applications for development, home occupations, and amendments and all decisions made regarding all applications.

(c) Carry out other duties as may be prescribed in this By-law;

(d) Receive and review applications for Development Permits, amendments and variances to this By-law;

(e) Prepare a report to Council regarding applications for Development Permits, amendments and variances to this By-law;

(f) Approve, approve with conditions, or refuse Development Permit applications, subject to the authority provided by Council, for sheds and shacks, or other similar types of accessory buildings.

(g) Issue Notice of Decisions subject to the provisions of this By-law;

(h) Request Council to revoke or suspend a Development Permit where the permit holder is in breach of this By-law or of conditions of a Development Permit;

(i) Carry out any inspection on lands or premises necessary to enforce this By-law.

DEVELOPMENT PERMIT

3.5 No person or agency shall undertake development without a Development Permit.

3.6 No Development Permit shall be issued for development that is in contravention of this By-law.

3.7 The approval of a Development Permit shall not relieve the permit holder from constructing in accordance with the National Building Code, the National Fire Code, and all Federal and Territorial Regulations.

3.8 The approval of a Development Permit shall not exempt any person or agency from complying with the requirements of any other by-law in force within the Municipality or to obtain any license, permission, or permit required by municipal, territorial and federal legislation.

3.9 All development requires a Development Permit except for the following:

- (a) For grading or landscaping where the cutting or filling is less than 1 metre and provided that the drainage of the surrounding area is not affected;
- (b) Traditional and cultural activities including the establishment of a trap line, non-commercial tent camps and cabins in the Nuna;
- (c) Minor repairs, painting, decorating, or landscaping, provided that no person's health or safety is endangered or completion of a development approved for or under construction on the effective date of this by-law;
- (d) Minor repairs or renovations that do not increase the floor space of the building, but does not exempt anyone from informing the Fire Marshal's Office of their plans;
- (e) A temporary building or structure associated with construction, unless such building or structure is used for human habitation.
- (f) The installation, maintenance and repair of public works, services and utilities carried out by the Hamlet on land which is publicly owned or controlled;
- (g) Temporary election campaign signs and signs not exceeding 1 square metre in size.
- (h) Decks or porches in the Residential Zone that meet all provisions of this By-law.

DEVELOPMENT PERMIT SUBMISSION REQUIREMENTS

3.10 A complete application form for a Development Permit must be submitted to the Development Officer.

3.11 Every application shall be accompanied by:

- (a) The required application fee calculated as follows:
  - (i) Residential projects: $10 application fee plus $20 for the first $10,000 of project value, PLUS $10 for every $10,000 of project value thereafter to a maximum permit fee of $250.

(ii) Non-residential projects: $10 application fee plus $20 for the first $10,000 of project value, PLUS $10 for every $10,000 of value thereafter to a maximum permit fee of $500.
(iii) All accessory uses: $25
(iv) Fees are exempt for Hamlet projects or projects that will be transferred Hamlet ownership.

(b) A site plan drawn to scale in metric units and showing:
(i) The location of existing buildings;
(ii) All legal dimensions of the lot(s);
(iii) The location and dimensions of surrounding lots and buildings;
(iv) Plans of the proposed buildings showing dimensions;
(v) Proposed front, rear, and side yard setbacks;
(vi) Access points to property;
(vii) Exterior materials;
(viii) The location of outdoor fuel storage facilities,
(ix) The location of water and sewer connections; and,
(x) The location of water and sewage storage tanks.

(c) The Development Officer may require additional information.
(d) A letter of Consent from the appropriate Landlord is also required.

NOTICE OF DECISION

3.12 Each application shall be considered by Council or the Development Officer as required, and shall be either approved with or without conditions, or refused, with written reasons provided for the refusal.

3.13 A decision on an application for a Development Permit shall be made by the Development Officer or Council within 40 days of receipt of the application in its complete and final form. If a decision is not made within 40 days, the application for Development Permit shall be deemed to be refused.

3.14 When an application is approved, the Development Officer will within 3 business days of the date of decision post a Notice of Decision conspicuously on the lot for which the application has been approved and in the Hamlet Office.

3.15 When a Variance has been granted, the Development Officer will within 3 business days of the date of decision send a Notice of Decision to adjacent property owners.

3.16 The Development Permit does not become effective until 14 days after the Notice has been posted or mailed, and where no appeal of the decision has been filed, and where the relevant conditions of development approval have been met.

EXPIRY OF DEVELOPMENT PERMIT

3.17 A Development Permit shall become void if:

- (a) The development is not completed within 2 years of the date of Notice of Decision or within any period of extension granted by the Development Officer; or
- (b) The development has not been commenced after 1 year of the date of Notice of Decision or within any period of extension granted by the Development Officer; or
- (c) If there has been any violation of this By-law or of any conditions in the permit.

ENFORCEMENT

3.18 Anyone violating any provision of this By-law or conditions of a Development Permit is liable to a fine of $500 plus $100 for every day the offence continues, as specified in Section 34 of the Planning Act and Sections 105,106,107 and 108 of the Hamlets Act.

DEVELOPMENT AGREEMENTS

3.19 The Development Officer may recommend that a Development Agreement be required as a condition of approval for a Development Permit. The Development Agreement may contain contractual arrangements as to the following:

- (a) Design, including exterior materials and signage of any proposed building or structure;
- (b) The provision of site grading, landscaping, fencing, screening materials, location of garbage receptacles, and lighting;
- (c) The replacement or construction of roads, sidewalks and street lighting associated with the development;
- (d) The provision of municipal services;
- (e) The provision of on-site amenities;
- (f) The provision of parking;
- (g) The moving of buildings; and,
- (h) Financial security for the implementation of the above-noted matters.

DEVELOPMENT APPEAL BOARD

3.20 In accordance with Sections 21 and 22 of the Planning Act, Council shall establish a Development Appeal Board and by resolution appoint one Council member and two community residents as members of the Development Appeal Board. Members will be appointed for a 3 year consecutive term. The Development Appeal Board will not include employees of the Hamlet.

3.21 Anyone claiming to be affected by a decision made by Council under this By-law may appeal in writing to the Appeal Board within 14 days of the mailing or posting of a Notice of Decision.

3.22 Upon receiving in writing an appeal, the Development Appeal Board shall:
- (a) Hold a hearing with a minimum of 3 Board members within 30 days from the receipt of the appeal, upon determining that the appeal is based on planning grounds;
- (b) Ensure that reasonable notice of the hearing is given to the applicant and all persons who, in the opinion of the Board, may be affected;
- (c) Allow the Development Officer and every person concerned with the opportunity to be heard, to submit evidence and to hear the evidence of others;
- (d) Consider the circumstances and merits of each case and consider the purpose and scope and intent of the Community Plan and the provisions of this By-law;
- (e) Confirm, reject or vary the decision appealed and impose such conditions as it considers necessary under the circumstances; and
- (f) Take minutes of the hearing and render its decision in writing to the parties involved within 60 days of the hearing date.

3.23 Where a member of the Development Appeal Board has an interest in an application for a Development Permit that is being appealed, they shall be subject to the provisions of the Conflict of Interest Act.

ZONING BY-LAW AMENDMENTS

3.24 A person who seeks to have this By-law amended shall submit an application in the prescribed form to Council with the following:
- (a) A copy of their lease of their certificate of leasehold title;
- (b) A fee of two hundred and fifty dollars $250.00;
- (c) Any information as may be required by Council.

RULES OF INTERPRETATION

3.25 Typical uses listed in the definitions as examples are not intended to be exclusive or restrictive. Reference should be made to the intent, impact and definition of the use in determining whether or not the type of use proposed is consistent with the examples listed.

3.26 Where a specific use does not conform to the wording of any use definition or generally conforms to the wording of two or more definitions, a Development Officer may use their discretion to determine which definition of use type is most similar in terms of character and purpose.

INSPECTION OF PREMISES

3.27 The Development Officer, or his or her delegate, may enter and inspect a property if there is reason to believe that the land, building or structure has been erected, altered, enlarged or used in violation of any of the provisions of this By-law.

VIOLATIONS AND PENALTIES

3.28 In the case of any lot being used, any building or structure being erected, altered, reconstructed, demolished, extended or part thereof in contravention of any provision of this By-law, or a permit issued under this By-law, the Development Officer, by written notice, may require the cessation of such contravention.

3.29 Where a person has been served written notice and fails to comply with its requirements, the Development Officer or designated officials may enter the property and carry out the work required by the notice and recover the resulting expense from the owner by action.

3.30 Any person who undertakes or permits development on land without a Development Permit or without complying with conditions of a Development Permit is guilty of an offence and liable on summary conviction to a fine. Each day of violation shall constitute an offence.

SECTION 4 - COMPLIANCE WITH OTHER REGULATIONS

4.1 Nothing in this By-law shall exempt any person from complying with the requirements of any other by-law in force within the Municipality or to obtain any license, permission, or permit. Authority or approval required by any other by-law of the Municipality or statute and regulations of the Government of Nunavut or the Government of Canada.

4.2 Where the provisions in this by-law conflict with those of any other municipal, federal or provisional regulations, by-laws or codes, the higher or more stringent requirement shall prevail.

REVIEW BY FIRE MARSHAL'S OFFICE

4.3 The Hamlet Council shall seek the comments of the Fire Marshal's Office before approving a development application for the following type of uses:

a) Residential uses:
   i. All semi-detached, or multi-unit dwellings; and
   ii. Single units that do not meet the required setbacks; and

b) All non-residential uses.

Applications for development permits must include proof that the development has been approved by the Fire Marshal's Office.

NUNAVUT IMPACT REVIEW BOARD

4.4 Industrial development which is subject to screening must be approved by the Nunavut Impact Review Board (NIRB) before a Development Permit can be issued. The screening criteria are identified in the NIRB "Guide to Project Proposals Exempt from Screening" document.

NUNAVUT WATER BOARD AND CROWN-INDIGENOUS RELATIONS AND NORTHERN AFFAIRS CANADA

4.5 The Nunavut Water Board (NWB) must approve all projects proposing to use, or dispose of waste into water, including proposals to partially or fully fill a waterbody. Once approved, Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC) enforce the licenses. If a waterbody is deemed "navigable," Transport Canada must also approve these activities, pursuant to the Navigable Waters Protection Act (NWPA). If applicable, the project will also be circulated to the Department of Fisheries and Oceans Canada (DFO) for review and approval.

LEGAL LAND TENURE

4.6 Before a Development Permit can be issued on a lot, the applicant of the proposed improvements must be the leaseholder of the lot, have a land use permit/license to use the lot or have fee simple title to the lot.

NUNAVUT PLANNING COMMISSION

4.7 Information on any development occurring close to the Municipal Boundary or any development with potential impacts outside the Municipal Boundary should be submitted to the Nunavut Planning Commission for review and comment.

AIRPORT ZONING REGULATIONS

4.8 Any land use should be compliant with Obstacle Limitation Surface for the Igloolik Airport as listed in table 4-1 of the TP312E Aerodrome Standards and recommended practices. Before any structure is built, plans should be submitted to Operations and Standards at Nunavut Airports.

SCIENTIFIC INSTALLATIONS

4.9 Notwithstanding the regulations in Section 6, no use or development shall be permitted which will interfere with the operation of atmospheric monitoring or other scientific installations (e.g. Telecommunications, radar. EMR magnetic observatory, meteorological station). All development proposals which could potentially interfere with such installations require review and approval by the appropriate Territorial and Federal Departments.

ARCHAEOLOGICAL SITES

4.10 Whenever archaeological specimens are found during construction, they should be reported immediately to the Development Officer, who must immediately report them to the Chief Archaeologist at the Department of Culture and Heritage. All development must comply with the Nunavut Lands Claim Agreement, Section 33 and 34, and the Nunavut Archaeological and Palaeontological Sites Regulations.

GRANULAR RESOURCES

4.11 Except where provided for within this By-law, no person shall strip, excavate or otherwise remove granular material for sale or for use from a lot or other parcel of land without approval from the Hamlet.

4.12 Where, in connection with the construction of a building or structure, there is an excess of granular material other than that required for grading and landscaping on a lot, such excess may be removed for sale or use.

A Quarry Permit is required to remove any granular material. The Nunavut Impact Review Board must review the development of a new quarry prior to the Hamlet issuing any Quarry Permits for these areas.

UTILITY CORPORATION

4.13 The Customer shall ensure that all required permits, licenses, and authorizations are provided to the Corporation prior to: commencement of Service, or; any change of service requirements at any point of delivery, or; commencement of construction of new service extensions.

GENERAL SANITARY REGULATIONS

4.14 Any land use must be compliant with the General Sanitation Regulations of the Public Health Act. All development proposals for residential uses and uses involving food storage or food preparation proposed within 450 m of a waste disposal site, require review and approval from the Environmental Health Officer prior to the issuance of a development permit.

SECTION 5 - GENERAL PROVISIONS

ACCESSORY BUILDING

5.1 Accessory uses, buildings, and structures shall be permitted in any zone but shall:

- (a) For the total gross floor area of all accessory buildings on the lot, not exceed 50% of the gross floor area of the main building. This total includes both permitted and non-conforming accessory uses;
- (b) Not be used for habitation except where a dwelling is a permitted accessory use;
- (c) Not be used for the keeping of animals other than household pets;
- (d) Not be built closer to the front or exterior side lot line than the minimum distance required for the main building;
- (e) Not be located closer than 1 metre to any interior side or rear lot line;
- (f) Not exceed one-half the height of the main building or exceed a height of 5.0 m in a residential zone; and
- (g) Not exceed 40 m^2 in any Residential Zone.

BED AND BREAKFAST

5.2 Where permitted, bed and breakfasts shall conform to the following requirements:

- (a) The bed and breakfast lodging forms part of a single unit dwelling;
- (b) The number of bedrooms devoted to the use shall not exceed 4 in number;
- (c) No sign in connection with the use shall exceed 0.75 m^2 in area nor exceed one in number;
- (d) On-street parking shall be prohibited; and
- (e) The use should conform to all Building and Fire Codes.

BUILDING TO BE MOVED

5.3 No building, residential or otherwise, shall be relocated without obtaining a Development Permit.

DAY CARE FACILITIES

5.4 Where Day Cares are permitted under this By-law, all day care centers or home day cares must comply with Fire Protection Regulations, the Child Day Care Act, and the Child Standards Regulations, as amended.

DISTANCE FROM WATERCOURSES

5.5 No development shall be permitted within 30.5 metres of a navigable waterbody except subject to terms and conditions of the Hamlet Council and the Territorial Government.

FENCES

5.6 No fences are permitted in residential zones. Fences may be permitted in industrial, airport and community use zones but would be subject to terms and conditions set out by the Council.

FRONTAGE ON A STREET

5.7 No Development Permit shall be issued except where the lot has frontage on a street or road. Exceptions are made where specifically provided for in this By-law. Where a lot has frontage on more than one street, the Development Officer may require any building, structure, or accessory building on the lot to maintain a front yard on each street so as to present a consistent street appearance on each street.

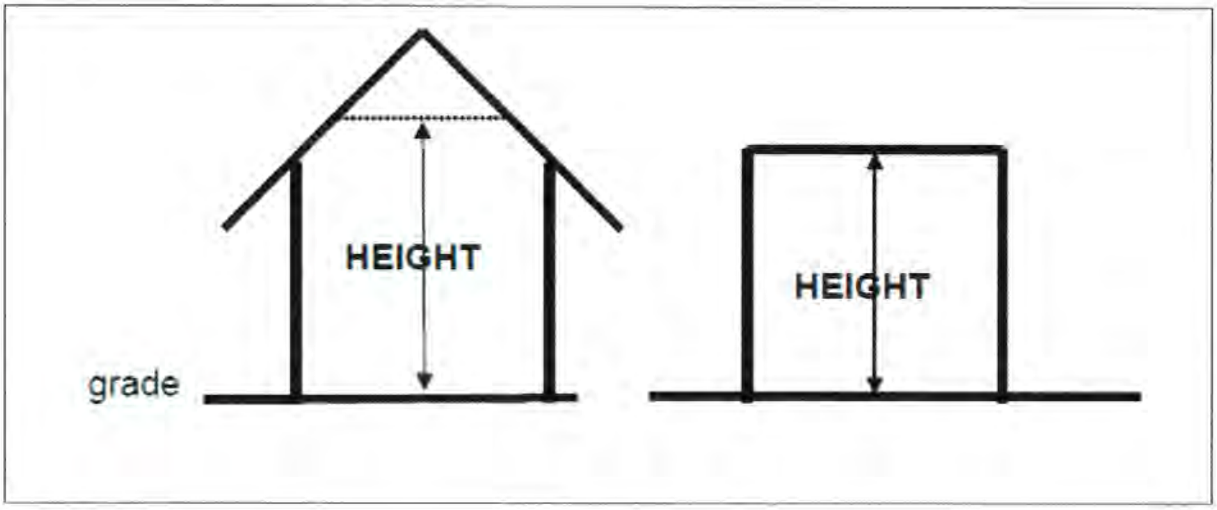
FRONTAGE ON CURVES

5.8 Where the front lot line of any lot is a curved line or when the sidelines of a lot are not parallel, the minimum front lot line shall be a minimum of 10 m.

HEIGHT

5.9 When used with reference to a building or structure, is the vertical distance between the average finished grade and a horizontal plane through either:

- (a) the highest point of the roof in the case of a building with a flat roof;
- (b) the average level of a sloped roof, provided that such a roof has a slope of less than 20°, or;
- (c) the average level between eaves and ridges in the case of a pitched gambrel mansard or hipped roof.



5.10 The height of buildings and structures in the vicinity of airports are regulated by Airport Zoning Regulations. Refer to section 4.8.

5.11 Where height limitations are set forth in this By-law, such limitations shall not apply to artworks and cultural structures (i.e. Inukshuks), aids to navigation or aviation, antennae, bulk storage tanks, chimneys, church steeples, clock towers, communication facilities, electrical supply facilities, fire towers, flagpoles, lighting standards, lightning rods, mechanical equipment penthouses, skylights, solar panels, stacks, water tanks, or windmills. Notwithstanding the foregoing, limitations prescribed by a Federal Ministry or other Authority with respect to height limitations and appropriate lighting in the vicinity of airfields shall prevail.

5.12 The height of buildings and structures in the vicinity of airports are regulated by Airport Zoning Regulations. Refer to the Airport Zoning Regulations (Section 4.8) of this By-law.

HOME OCCUPATION

5.13 Where a home occupation is permitted under this By-law, a home occupation is subject to the following requirements:

- (a) Does not change the residential character of the lot by creating problems with noise, traffic, outdoor storage, or other nuisance;
- (b) Does not employ more than 2 people who do not live in the dwelling;
- (c) Does not show any evidence that there is a business in the dwelling unit except for a sign no bigger than 0.3 m^2;
- (d) No more than 25% of the gross floor area of the dwelling shall be used for a home occupation.

LOADING SPACE REQUIREMENTS

5.14 Every building or structure in a non-Residential zone involving the frequent receiving, loading or unloading of goods, merchandise and raw materials shall provide off-street space for such vehicles to stand and for loading and unloading.

MINOR VARIANCE

5.15 Where a development does not conform with the site regulations, Council may vary the regulations of development in accordance with the following:

	DEGREE OF RELAXATION	
	Residential Zones	**Other Zones**
Front Yard	25%	Discretion of Council
Side Yard	25% with prior authorization of the Fire Marshal	15% with prior authorization of the Fire Marshal
Rear Yard	25%	15%
Rear Yard abutting N or OS Zone	50%	20%

NON-CONFORMING BUILDING OR USE

5.16 This By-law cannot be used to prevent the use and development of land that had been lawfully established or has a valid Development Permit or was under construction at the time that this by-law was enacted. Non-conforming uses are subject to the following regulations:

(a) The non-conforming use may be transferred to a new owner or occupant;
(b) The non-conforming building may be enlarged up to 20% of the gross floor area of the building, as it existed on the date this By-law came into effect, as long as the enlargement does not increase the extent to which the building is non-conforming;
(c) If a non-conforming building or use of land is discontinued for twelve consecutive months, the future use shall conform with this By-law;
(d) If more than 50% of a non-conforming building or use is accidentally destroyed, any new use or building must conform to this By-law.

PARKING REQUIREMENTS

5.17 Parking shall be required for any use, building or structure in accordance with the following standards and such parking shall be accessory to a permitted use and located on the same lot as the use:

(a) Residential – 1 parking space per dwelling unit
(b) Residential in a non-Residential building – 1 parking space per 2 dwelling units
(c) Commercial / Community Use – 1 space per 75 m^2 of gross floor area
(d) Industrial – 1 space for every 3 people working on site
(e) School – 1 space for every 3 people working on site
(f) Open Space – Discretion of Development Officer or Council.

5.18 Each required parking space shall be 6.0m in length and 2.7m wide.

5.19 For a required parking area of more than 6 spaces, at least one space for every 25 spaces must be a designated space for persons with disabilities. A space for persons with disabilities shall be 6.0 m in length and 3.7 m wide.

PERMITTED PROJECTIONS INTO YARDS

5.20 Despite any other provision to the contrary, the following features and other similar features are permitted to project from a principal building into a required yard in accordance with the following table.

Object	Permitted projection into any required yard	Minimum distance from lot line
Canopies or awnings	1.5 m	3 m
Solar panels, heat pump or similar equipment	1 m	3 m
Unenclosed balconies or stairways, including a fire escape	1.5 m	3 m
Unenclosed porches, decks and steps	3 m	3 m

RESTORATION TO A SAFE CONDITION

5.21 Nothing in this By-law shall prevent the strengthening or restoring to a safe condition of any building or structure.

SATELLITE DISHES

5.22 Satellite dishes shall not be permitted between the building and the street line. Poles must be located at the side or rear and positioned so as to avoid obstructing parking and / or service delivery. Ground-mounted satellite dishes shall not be permitted in the Residential Zone.

TEMPORARY CONSTRUCTION USES PERMITTED

5.23 Nothing in this By-law shall prevent the use of land or the use or erection of a temporary building or structure, which is accessory to construction in progress, such as a mobile home, tool or maintenance shed, trailer, sea container or scaffold, provided that a Development Permit for the main use has been issued, the temporary use is occurring on the same lot as the construction, or an adjacent lot, and the temporary use is discontinued and removed within 30 days following completion of construction.

UTILITIES

5.24 Structures or buildings required by the Hamlet or any public utility corporation to provide utility services may be permitted in any zone, provided that such structures or buildings comply with all applicable statutes, regulations, standards, codes and agreements. Structures such as utility poles, utility lines and pipelines are exempt from the minimum yard setback and maximum building height provisions of this by-law.

WATERSHED OVERLAY

5.25 Notwithstanding the permitted and conditional uses of the underlying Zone, on lands subject to the Watershed Overlay, no commercial or industrial development which uses or stores hazardous materials are permitted.

Despite Section 5.22, uses accessory to the supply of water such as a pipeline, a pumping or monitoring station or a road are permitted.

YARD REGULATIONS

5.26 No person shall keep or permit in any part of the yard in any residential zone:

(a) Any more than two dismantled vehicles for more than six months and such vehicles shall be stored out of public view;

(b) Any object or chattel which, in the opinion of the Development Officer is unsightly or tends to adversely affect the amenities of the district;

(c) Any excavation, storage, or piling up of materials required during the construction stage unless all necessary safety measures are undertaken.

5.27 No person shall keep or permit on any site any buildings, or structures or portions thereof, rubbish or other things that may constitute, in the opinion of the Development Officer, a fire hazard, or hazard to safety or health.

SECTION 6 - ZONE REGULATIONS

RESIDENTIAL (R)

6.1 Permitted Uses

Dwelling, Multi-unit
Dwelling, Semi-detached
Dwelling, Single-unit

6.2 Conditional Uses

Bed and Breakfast
Craft Studio
Day Care Centre
Dwelling, Secondary Suite
Elders Facility
Greenhouse
Group Home
Home Occupation

6.3 Zone Requirements

(a) The following provisions applies to all development in the Residential Zone:

Setbacks (minimum)
Front= 6 m
Rear= 6 m
Rear, backing onto an OS Zone = 2.5 m
Side (Exterior) = 4 m
Side (Interior) = 6 m, or as required by the Fire Marshal

Building Height (maximum) = 10.5 m

(b) Despite the provisions of Section 6.3(a), for semi-detached dwellings or multi-unit dwellings located on separate, adjacent lots, the side yard where units are attached may be reduced to 0 m.

(c) Parking or storage of a commercial vehicle having a gross vehicle weight of 4,500 kg or construction equipment including bulldozers, backhoes, high hoes, and pay loaders is not permitted.

(d) The following provisions will apply to Secondary Suites:
   (i) The suite forms part of a single unit or semi-detached dwelling;
   (ii) The suite is structurally attached or located within the principal dwelling;
   (iii) The suite does not exceed a floor area of 25% of the principal dwelling, or 60 m^2 of gross floor area, whichever is less; and,

COMMUNITY (C)

6.4 Permitted Uses

Automotive Service & Sales
Commercial Recreation & Entertainment
Commercial Use
Communication Facility
Community Centre
Craft Studio
Day Care Centre
Educational Facility
Elders' Facility
Government Service
Greenhouse
Health Care Facility
Hotel
Place of Worship
Restaurant
Retail Store
Service and Repair Shop

6.5 Conditional Uses

Dwelling units, provided that the units are above the ground floor.
Home Occupation

6.6 Zone Requirements

(a) The following provisions applies to all development in the Commercial Zone:

<u>Setbacks (minimum)</u>
Front = 6 m
Rear = 6 m
Side (Exterior) = 4 m
Side (Interior) = 6 m, or as required by the Fire Marshal

<u>Building Height (maximum)</u> = 10.7 m

(b) A covered or screened area for garbage and trade waste is required.

OPEN SPACE (OS)

6.7 Permitted Uses

Camp
Cemetery
Park
Snow Fence

6.8 Conditional Uses

Beach Shack
Cabin
Campground
Communications Facility
Dog Teams
Greenhouse
Outdoor Storage

6.9 Zone Requirements

(a) The following provisions applies to all buildings located within 30.5 metres from the high water mark in the Open Space Zone::

<u>Gross Floor Area (maximum)</u>
25 m²

<u>Building Height (maximum)</u>
3.1 m

(b) No building or structure shall be located closer than 10 m to any lot line.

LIGHT INDUSTRIAL (M1)

6.10 Permitted Uses

Automotive Service & Sales
Building Supply and Contractor's Shop
Communications Facility
Contractor's Yard
Craft Studio
Greenhouse
Outdoor Storage
Service and Repair Shop
Warehouse

6.11 Conditional Uses

Heavy Industrial Use
Caretaker Unit

6.12 Zone Requirements

(a) The following provisions applies to all development in the Industrial Zone:

Setbacks (minimum)

Front = 8 m
Rear = 8 m
Side (Exterior) = 6 m
Side (Interior) = 8 m, or as required by the Fire Marshal

HEAVY INDUSTRIAL (M2)

6.13 Permitted Uses

Light Industrial Use
Hazardous Goods Storage
Power Generation Facility
Tank Farm
Utility Installation

6.14 Conditional Uses

6.15 Zone Provisions

(a) The following provisions applies to all development in the Industrial Zone:

Setbacks (minimum)

Front = 8 m
Rear = 8 m
Side (Exterior) = 6 m
Side (Interior) = 8 m, or as required by the Fire Marshal

NUNA (N)

6.16 Permitted Uses

Camp
Dog Team
Beach Shack
Cabin
Campground
Communications Facility
Mineral Exploration
Quarry
Snow fence

6.17 Conditional Uses

Waste Disposal Site

6.18 Zone Requirements

(a) No development is permitted within 200 m downwind of any snow fence without the approval of council.

TRANSPORTATION (T)

6.19 Permitted Uses

Airport and related use
Communications Facility
Sealift Facility

6.20 Conditional Uses

Outdoor Storage
Warehouse

6.21 Zone Requirements

(a) Any development within the Transportation Influence Zone as indicated on the Land Use Map shall be subject to the approval of NAV Canada.

MUNICIPAL RESERVE (MR)

6.22 Zone Requirements

(a) The Municipal Reserve Zone identifies lands that may be interesting for future development. No development is permitted in the MR Zone unless of temporary nature, subject to Council approval.

SECTION 7 – FORMS

Form A	Application for Development Permit;
Form B	Application for Home Occupation;
Form C	Development Permit and Notice of Approval;
Form D	Permit - Notice of Refusal;
Form E	Notice of Appeal Hearing;
Form F	Notice of Appeal Decision;
Form G	Stop Work Notice
Form H	Use of Land is in Violation of the Zoning By-law Notice.
Form I	Application for Amendment to the Zoning By-law

FORM A – Application for Development Permit

APPLICATION FOR DEVELOPMENT PERMIT

Permit No.: ____________________ **Date:** ____________________

Application Fee: ______________
(see Section 3.11a)

I hereby make application under the provisions of the Zoning By-law for a Development Permit, in accordance with the plans and supporting information submitted herewith and which form part of this application.

Applicant: ____

P.O. Box No.: ____

Telephone Number: ______________________________________

Legal Description of Lot:

Lot No: __________ Plan No. ____________________________

Lessee or Private Land Owner: ____

P.O. Box No.: ______________________________

Telephone number: ____

Lease Number: ____

Letter of Permission to Occupy File No.: ____

Describe the proposed development:

Current Use and Zoning:

Current use of the lot: ______________________________

Current Zoning: ______________________________

Cost and Completion time:

Date of Completion: ______________________________

Estimated cost of the project: ______________________________

Date of Commencement: ______________________________

ZONING REGULATIONS:

Proposed Setbacks:

Front Yard:
Interior Side Yard(s):
Rear Yard:
Exterior Side Yard:

Height of Proposed Building:

Number of Parking Spaces proposed:

Fire Separation distance from adjacent buildings:

North side: South side: East side: West side:

I hereby give my consent to allow all authorized person(s) the right to enter the above land and/or buildings, with respect to this application only.

Date: ________________ **Signature of Applicant:** ________________

Development Permit Applications shall be accompanied by the following information:

- ☐ 1) Site Plan. See Section No 3.11
- ☐ 2) A letter from the Fire Marshal's Office approving the project, for all development other than Single Family Dwellings.
- ☐ 3) Certificate from Nunavut Impact Review Board approving a proposed industrial development.
- ☐ 4) Approval from the Water Board if the project requires filling or altering a water body.
- ☐ 5) Letter from Nunavut Airports approving the project, if the project is near an airport.
- ☐ 6) A letter requesting a Variance, if the proposed project does not meet the exact zoning regulations.
- ☐ 7) If a Variance or Terms and Conditions are required by the Hamlet Council, a letter from the Applicant will be required stating the adjacent land owners and lessees have been notified of the proposed development.

I certify that I will abide by the above conditions after I have received a Development Permit, knowing that failure to do so will result in cancellation of the Development Permit and possible further action taken by the Hamlet.

______________________ ______________________

Signature of Applicant **Date**

If the applicant is not the Registered Owner or Lessee of the Property, please submit a letter from the Registered Owner or Lessee granting you permission to use the property for the proposed business.

______________________ ______________________

Signature of Lessee or Private Land Owner **Date**

(not required if the lessee or landowner is the applicant)

FORM B – Application for Home Occupation

APPLICATION FOR HOME OCCUPATION

I/We hereby make application under the provisions of the Zoning By-law No.244 for a Development Permit to operate a Home Occupation.

PLEASE PRINT:

Applicant's Name: ______________________________.

Business Name: ______________________________.

Mailing Address: ______________________________.

Phone Number: ______________________________.

Lot No.: _______________ . **Plan No.:**_______________.

Zoning: _______________.

Details:

How many people will you employ? Are these people residents of the Home?

How many and what kind of vehicles and/or equipment you expect to use in conjunction with the business (indicate number, type and size)?

Where will the above vehicles and/or equipment be parked?

Lessee of the Property:____.

(* If the applicant is not the Registered Owner or Lessee of the Property, please submit a letter from the Registered Owner or Lessee granting you permission to use the

property for the proposed business)
HOME OCCUPATION: Requirements, Refer to Section 5.13

Where a home occupation is permitted under this By-law, a home occupation is subject to the following requirements:

i) Does not change the residential character of the lot by creating problems with noise, traffic, outdoor storage, or other nuisance;

ii) Does not employ 2 people who do not live in the dwelling; and

iii) Does not show any evidence that there is a business in the dwelling unit except for a sign no bigger than 0.3 m^2

iv) The home business does not take up more than 25% of the dwelling

I certify that I will abide by the above conditions after I have received a Development Permit for my Home Occupation, knowing that failure to do so will result in cancellation of the Development Permit and possible further action taken by the Hamlet.

________________________ ________________________

Signature of Applicant **Date**

Permit No.:________________ **Date:**________________

FORM C – Development Permit & Notice of Approval

DEVELOPMENT PERMIT – NOTICE OF APPROVAL

POSTED ON SITE, IN THE HAMLET OFFICE

Development involving:____

as further described in Application No.: ________ has been:

APPROVED: ☐

APPROVED - subject to conditions (state reasons): ☐

Shall comply with:
(1) Hamlet Zoning By-law;
(2) Building Code Act, most current;
(3) Fire Prevention Act, most current; and
(4) All Federal and Territorial Regulations

The applicant is hereby authorized to proceed with the specified development provided that any stated conditions are complied with, that development is in accordance with any approved plans and applications. **Should an appeal be made against this decision to the Development Appeal Board, or the Development Officer this Development Permit shall be null and void.**

Date of decision: __________________Date of issue of Development Permit: ________

Motion Number if Council Approval is required: _______________.

Signature of Development Officer: __________________________.

NOTE:

1. The issuance of a Development Permit, in accordance with the Notice of Decision, is subject to the condition that it does not become effective until 15 days after the date the order, decision or Development Permit is issued;
2. Any person claiming to be affected by a decision of Council may appeal to the Development Appeal Board by submitting a written notice of appeal to Development Officer within 14 days after notice of the decision is given; and
3. A permit shall become void after two years or if the development has not commenced within 6 months from the date that the permit was issued.

Permit No.:__________________ **Date:**__________________

FORM D – Notice of Development Permit Refusal

DEVELOPMENT PERMIT – NOTICE OF REFUSAL

POSTED ON SITE, IN THE HAMLET OFFICE

Development Permit No.:___________

Development involving:____

as further described in Application No.: ________ has been:

has been **REFUSED** for the following reasons:

You are further notified that you may appeal this decision to the Development Appeal Board in accordance with the provisions of *Section 3 of this By-law*. Such an appeal shall be made in writing and shall be delivered either personally or by mail so as to reach the Secretary of the Development Appeal Board (Development Officer) not later than fourteen (14) days following the date of issue of this notice. The notice of appeal shall contain a statement of the grounds of the appeal.

Date of Decision: ________________________________

Date of Notice of Decision: ___________________________

Signature of Development Officer: ______________________

FORM F – Notice of Appeal Decision

NOTICE OF APPEAL DECISION

Date: ______________________

This is to notify you than an appeal against the:

APPROVAL: ☐

APPROVAL - with conditions: ☐

REFUSAL: ☐

of a Development Permit with regard to the following:

____

____

was considered by the DEVELOPMENT APPEAL BOARD on ______________20___ and the decision of the DEVELOPMENT APPEAL BOARD with regard to the appeal is as follows and for the following reasons:

__________ ______________________________

Date Secretary, Development Appeal Board

NOTE:

1. A decision of the Development Appeal Board is final and binding on all parties and persons subject only to an appeal upon a question of jurisdiction or law pursuant to Section 51 of the Planning Act. An application for leave to appeal to the Supreme Court shall be made:

   (a) to a judge of the Supreme Court; and
   (b) within 30 days after the issue of the order, decision, permit or approval sought to be appealed.

FORM G – Stop Work Notice

STOP WORK NOTICE

POSTED ON SITE AND AT THE HAMLET OFFICE

Date: ____________

You are hereby notified that your development is in contravention of the Igloolik Zoning By-law, No.198 Development Permit by reason of:

____

____

You are requested to take remedial action to conform to the By-law/Permit as follows:

Failure to comply with this request within 30 days of receipt of this notice may result in action being taken through the courts to seek remedy under the provisions of the ***Planning Act and Hamlets Act.***

______________________ ______________________

Date of Notice Signature of Development Officer

FORM H – Use of Land in Violation of Zoning By-law Notice

USE OF LAND IS IN VIOLATION OF THE IGLOOLIK ZONING BY-LAW NOTICE

POSTED ON SITE AND AT THE HAMLET OFFICE

Date: ____________________

You are hereby notified that your development is in contravention of the Igloolik Zoning By-law, No. 198 by reason of:

____

____

You are requested to take remedial action to conform to the By-law as follows:

Failure to comply with this request within 30 days of receipt of this notice may result in action being taken through the courts to seek remedy under the provisions of the ***Planning Act and Hamlets Act.***

________________________	________________________
Date of Notice	Signature of Development Officer

FORM I – Application for Amendment to Zoning By-law

APPLICATION FOR AMENDMENT TO THE ZONING BY-LAW

Fee: $250

Date: ____________________

Zoning Amendments are subject to the provisions of the Planning Act Section 29 and Section 3.24 of this By-law.

I/We hereby make application to amend the Zoning By-law.

Applicant: ________________________________ Telephone: ______________

Address: ________________________________

Owner of Land or Lessee: ______________________ Telephone: ______________

Address: ____

Land Description: Lot: __________ Plan: _______________

Civic Address: ____

Amendment Proposed:

From: ________________________ To: ________________________

Reasons in support of Application for Amendment:

____________________ ____________________

Signature of Applicant Date

FORM J – Request for Variance

Fee: $75

REQUEST FOR VARIANCE

I / We hereby make a request to vary one or more provisions of the Zoning By-law.

PLEASE PRINT:

Applicant's Name: ______________________________

Business Name: ______________________________

Mailing Address: ______________________________

Phone Number: ______________________________

Lot No.: ________________ **Plan No.:** ________________

Zoning: ________________

Lessee of the Property: ____.

(* If the applicant is not the Registered Owner or Lessee of the Property, please submit a letter from the Registered Owner or Lessee granting you permission to request a variance)

Describe the variance(s) being requested:

I certify that I will abide by the above conditions after I have received a Development Permit, knowing that failure to do so will result in cancellation of the Development Permit and possible further action taken by the Hamlet.

______________________ ______________________

Signature of Applicant **Date**

FORM E – Notice of Appeal Hearing

NOTICE OF APPEAL HEARING

Date: ____________________

This is to notify you that an appeal has been made to the DEVELOPMENT APPEAL BOARD against a decision in respect of Application No.: ___________ which involves development described as follows:

This decision was:

APPROVED: ☐

APPROVED - with conditions: ☐

REFUSED: ☐

Reasons for this decision is as follows:

Place of Hearing: ____

Time of Hearing: ____________________________ Date of Hearing: _____________

Any persons affected by the proposed development have the right to present a written brief prior to the hearing and to be present and be heard at the hearing. Persons requiring to be heard at the meeting shall submit the written briefs to the Secretary of the Development Appeal Board (Development Officer) not later than:_____________.

________________ ____

Date

Secretary of the Development Appeal Board
(Development Officer)

APPENDIX C

CULVERT THAWING METHODS

Culvert Thawing

Culverts are subject to freezing during winter and spring. During winter, ground water can continuously feed streams which either flow through culverts or over roadways causing icing. During spring breakup, daytime melting must be carried through culverts.

When a culvert freezes it can no longer do the job it was designed to do and trapped water will begin to cause problems and ultimately, money.

What's the Solution?

To thaw culverts, a combination of hot water/steam and high pressure water in a mobile environment is the effective method.

Mobile Pressure Washers

To thaw culverts quickly, a skid style hot water pressure washer/steamer, also known as a truck mounted pressure washer is the equipment of choice.

Self-contained and designed to hold up under the toughest of conditions, skid mounted pressure washers/steamers can be bolted onto the back of a truck, on an open deck trailer or in an enclosed trailer.

Enclosed Trailer Mounted Pressure Washer

Open Deck Mounted Pressure Washer

Skid Mounted Presure Washer

Culvert Nozzles

Culvert nozzles are required to dig effectively through ice. The reverse jets on the fixed and rotary nozzles pull the hose through the tube or sewer line and blast debris from the line or tube wall.

Backward ports drive the nozzle forward and flush debris
Forward ports blast into pipe and break up clogs & debris
Physically small for cornering ability up to 4200 PSI
Corrosion resistant stainless steel construction
A wide range of orifice sizes are available for various pressure and flow applications

Rotating style adds extra agitation and surface cleaning

United States Patent [19]

Olsson

[11] Patent Number: 4,770,211

[45] Date of Patent: Sep. 13, 1988

[54] **METHOD FOR THAWING OUT ROAD CULVERTS CHOKED WITH ICE**

[76] Inventor: **Lars-Uno Olsson**, Heden 4084, S-780 53 Nås, Sweden

[21] Appl. No.: **931,722**

[22] PCT Filed: **Feb. 24, 1986**

[86] PCT No.: **PCT/SE86/00080**

§ 371 Date: **Oct. 24, 1986**

§ 102(e) Date: **Oct. 24, 1986**

[87] PCT Pub. No.: **WO86/04939**

PCT Pub. Date: **Aug. 28, 1986**

[30] **Foreign Application Priority Data**

Feb. 25, 1985 [SE] Sweden 8500914

[51] **Int. Cl.**[4] **E03B 7/10**; F16L 53/00

[52] **U.S. Cl.** **138/32**; 138/28; 138/35

[58] **Field of Search** .... 138/26, 28, 32, 35; 254/262, 263, DIG. 14; 405/124, 130, 131; 137/301

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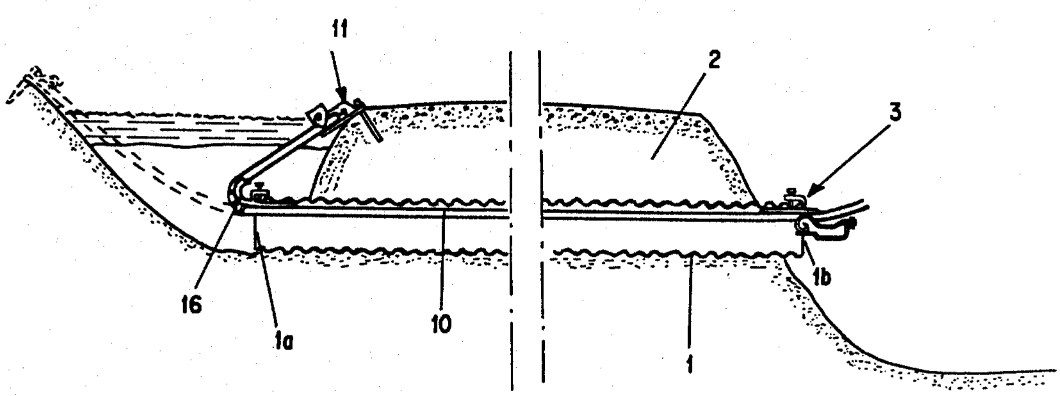
Primary Examiner—James E. Bryant, III
Attorney, Agent, or Firm—Witherspoon & Hargest

[57] **ABSTRACT**

Method for clearing a road culvert or the like which is choked with ice, wherein a substantially homogeneous rope of a material having at least a certain reversible extensibility is extended through the culvert from its inlet side to its outlet side and wherein the rope in its unloaded condition is clamped in connection with the outlet side and the inlet side respectively of the culvert so that the rope extends through the culvert.

4 Claims, 3 Drawing Sheets



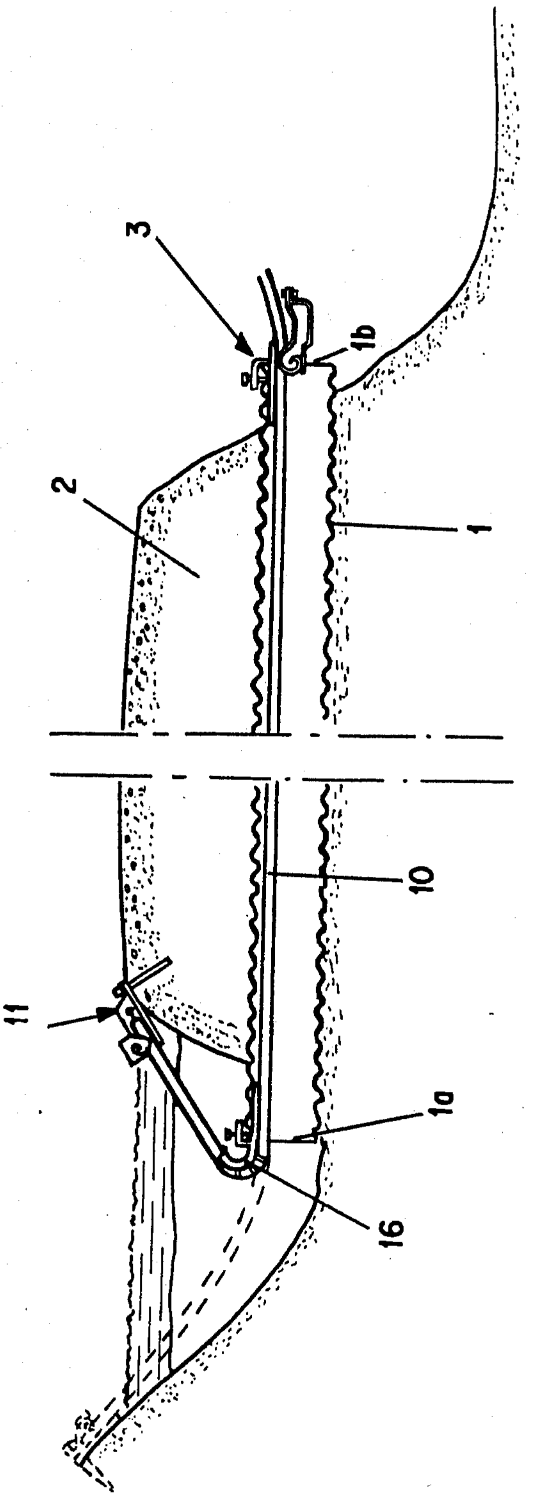


Fig. 1

Fig. 5

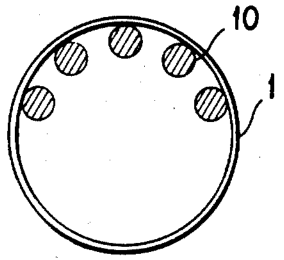
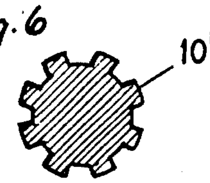


Fig. 6



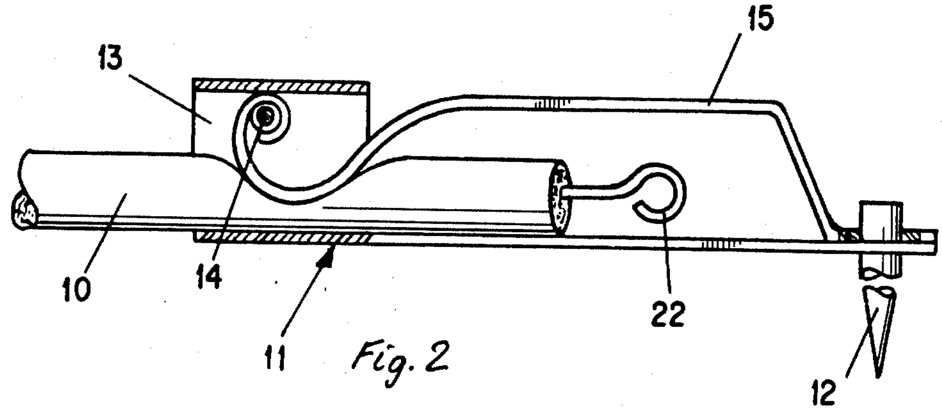


Fig. 2

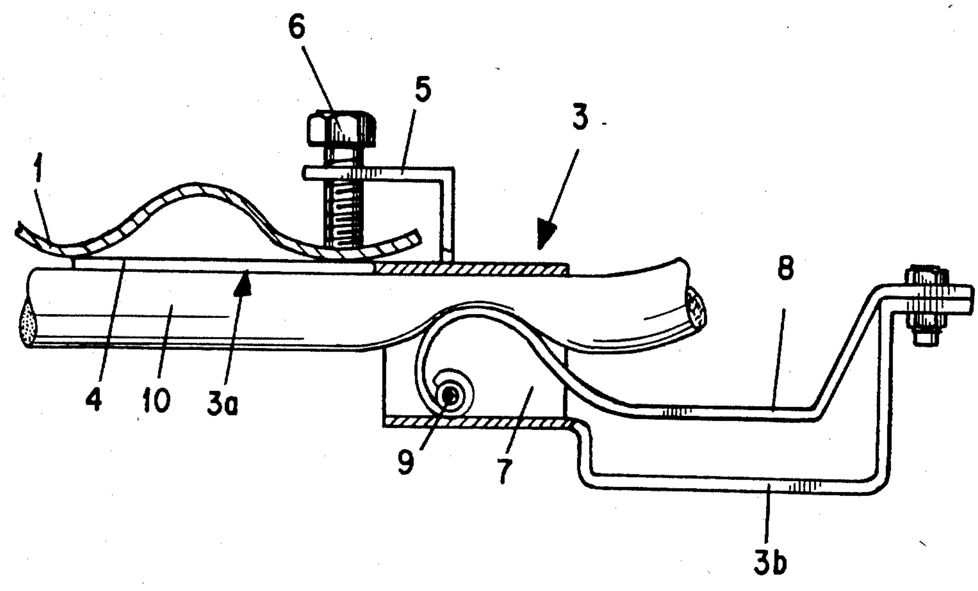
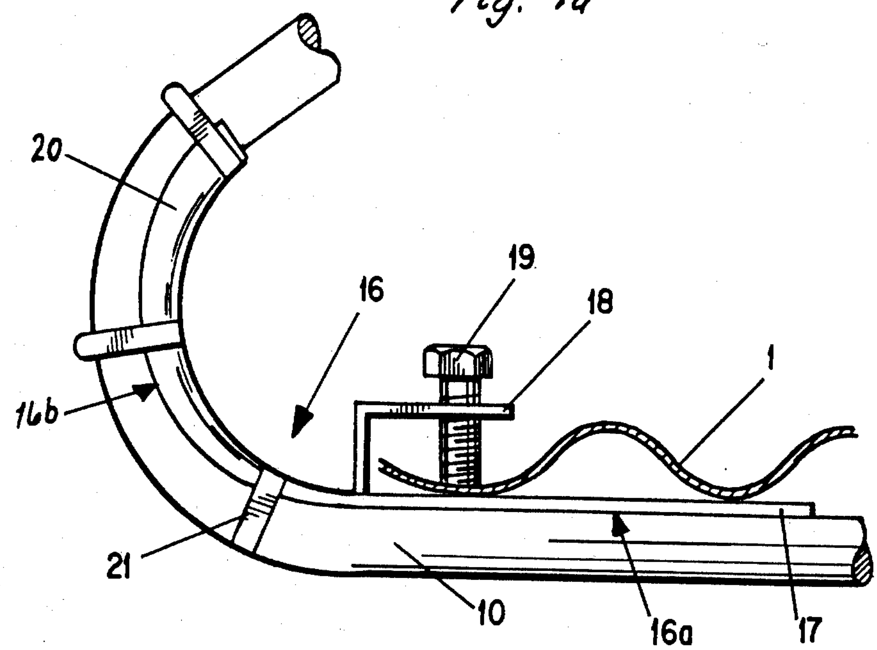


Fig. 3

Fig. 4a



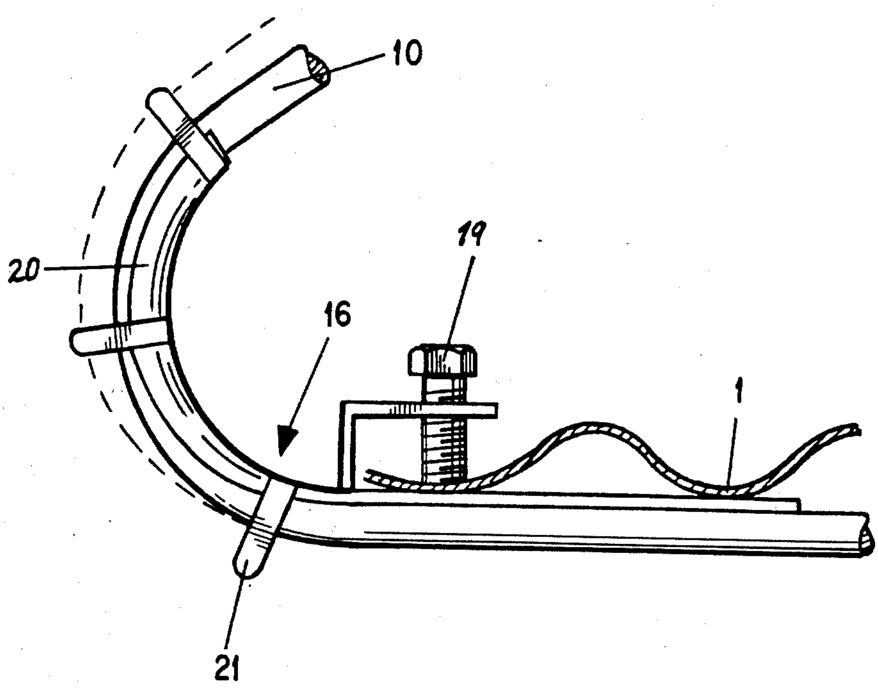


Fig. 4b

METHOD FOR THAWING OUT ROAD CULVERTS CHOKED WITH ICE

BACKGROUND OF THE INVENTION

The present invention relates to a method for thawing out road culverts choked with ice and also relates to an apparatus for carrying out said method.

A common problem in connection with winter maintenance is that road culverts become completely choked with ice, which makes it impossible to drain melted ice through the road culverts in warm weather, and especially by the spring flood. If such a road culvert that is completely choked with ice is not thawed out before the spring flood this may cause serious flooding and also a danger of parts of the road way being washed away.

In order to prevent the above mentioned, serious consequences of a road culvert choked with ice it is presently common practice to continously inspect road culverts which by experience are known to cause problems. When a road culvert choked with ice is found during such a periodical inspection, the procedure is presently to send out a clearing partrol, usually two persons, by car for thawing out the road culvert in question. Today steam generators are mostly used for thawing out road culverts in this manner, although attempts have also been made to use conventional building dryers. Already from the above it is clear that the thawing out of a road culvert in the conventional manner brings about relatively high costs which apart from transport costs also include wage costs for two persons and the cost for the steam generator.

Apart from the fact that the conventional clearing method discussed above is relatively expensive it also suffers from a number of more or less serious disadvantages that are clear from the following general description of the presently employed method using steam thawing. As indicated above a steam generator is transported out to the working place on a lorry or the like, and when the ends of the road culvert have been exposed the steam generator is started and is connected through hoses to steam pipes used for the thawing. In certain cases it is only necessary to thaw out a smaller passage through the culvert, whereupon the flow of water through this smaller passage continues to widen the passage in the ice until the culvert is completely cleared. In such a case it is, for obtaining the best result, absolutely necessary that the first thawing out of the smaller passage is carried out relatively close to the upper portion of the road culvert since the water will eat its way down through the ice towards the bottom of the culvert. Since road culverts may have a length of up to 15–20 meters, depending upon the width of the road, such a thawing out of a first small passage through the entire length of the road culvert is very difficult to achieve with a satisfactory result by means of a steam pipe. The reason for this is that if the steam pipe has such a length that it may reach through the entire length of the road culvert it will not be possible to keep it close to the upper portion of the road culvert throughout the entire length thereof and accordingly the steam pipe will deflect such that in the worst case it will leave the culvert close to its bottom. Accordingly it may also happen that the steam pipe will be stopped and cannot be brought through the entire length of the road culvert in case stones have fallen into the road culvert and remained therein on the bottom of the culvert.

In other cases it is not sufficient to thaw out only a smaller passage in the road culvert in order to avoid flooding, and therefore it will be necessary to clear the whole culvert in order to avoid the risk that a smaller passage is frozen again. It will also be realized that in the above discussed case where it proves impossible even to thaw out a first small passage in the road culvert by means of a steam pipe, it may become necessary to clear the whole culvert. In such a case when the whole culvert is to be cleared the procedure is such that a number of unperforated steam pipes, being upon in the outer end and having a length of approximately 3 meters are successively introduced from the outlet side of the culvert. When these unperforated pipes have been inserted to their full length they are withdrawn and are exchanged for perforated steam pipes which are fixed in position. Then steam is turned on to perform its thawing action until this length of the culvert may be cleared. This procedure is repeated until the culvert has been cleared throughout its length. The last portion of the length of the culvert is usually cleared from its inlet side, but it will be realized that if the culvert has a length of 10–15 meters and possibly even 20 meters it will be necessary for the persons performing the clearing to crawl into the culvert in order to be able to carry out a great deal of the work. Even if this work is not extremely risky it is cold and damp and generally unpleasant. Naturally such a clearing of a complete culvert is very time consuming, and especially so by larger culvert diameters and lengths.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a method and an apparatus by means of which the above discussed disadvantages in connection with conventional methods may be eliminated as far as possible.

This object is achieved by means of a method and an apparatus of the kind indicated in the enclosed patent claims. From the patent claims the characteristic features of the invention are also clear.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplifying embodiments of the invention are described more closely below in connection with the enclosed drawings, on which:

FIG. 1 is a schematic illustration of the principles of the present invention in connection with a road embankment with a road culvert, both in cross section,

FIG. 2 illustrates a ground attachment of the apparatus according to the invention.

FIG. 3 illustrates a culvert attachment of the apparatus according to the invention.

FIG. 4*a* illustrates an edge cover in combination with the rope in its unloaded condition.

FIG. 4*b* illustrates the edge cover according to FIG. 4*a*, but with the rope in its loaded condition.

FIG. 5 illustrates a modified embodiment with several apparatuses according to the invention positioned in a road culvert, and

FIG. 6 illustrates another embodiment of the rope having an alternative cross-sectional shape.

Although the invention is described herein with reference only to the clearing of a road culvert, it should be obvious that the invention with the same advantage may be used for thawing out other types of culverts for draining off melted ice and/or rain-water. An example of this may be culverts used in fields by farmers in order to prevent flooding of the fields.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

FIG. 1 schematically illustrates the use of the invention by a road culvert 1 extended through a road embankment 2 in order to conduct melted ice and/or rainwater from an inlet side 1*a* to an outlet side 1*b*. Mostly the outlet side 1*b* of the culvert is relatively freely accessible from the outside even if the road culvert 1 is completely choked with ice, and thus, for reasons which will be explained below, a culvert attachment 3 is positioned in connection with the outlet and 1*b* of the culvert. An embodiment of the culvert attachment 3 is illustrated in greater detail in FIG. 3 from which it is clear that the culvert attachment has a first portion 3*a* intended to be clamped to the culvert. In the illustrated embodiment the first portion 3*a* comprises an inner leg 4 and an outer leg 5 between which the culvert 1 is introduced and clamped by means of a bolt 6 engaging a threaded bore in the outer leg 5. The other portion 3*b* of the culvert attachment is formed integral with the first portion 3*a* and is at its outer end releasably connected to a clamping means 8, for instance by means of a screw-nut connection 8*a*. In the illustrated embodiment the clamping means 8 consists of a flat bar being bent into a helical shape in its free end for a pivotal mounting on a pin 9 being firmly connected to a plate secured to the culvert attachment substantially midway between its ends. Through the pivotal mounting of the clamping means 8 on the pin 9 a rope 10 that will be more closely described below may be released and clamped between the helical end of the clamping means 8 and a portion of the culvert attachment close to the middle thereof by swinging the clamping means 8 upwardly and downwardly respectively about the pin 9.

In connection with the inlet side 1*a* of the road culvert 1 and at a distance therefrom a ground attachment 11 is anchored in the road embarkment 2 or at some other suitable place in accordance with what will be discussed below. In FIG. 2 a suitable embodiment of the ground attachment 11 is illustrated which in one of its ends is provided with a peg 12 which is pointed in one of its ends and which is intended to be forced down into the ground for anchoring the ground attachment. In its other end the ground attachment 11 is provided with a plate 13 which essentially corresponds to the plate 7 on the culvert attachment of FIG. 3 and which accordingly is provided with a pin 14 for pivotal mounting of one end of a clamping means 15 which in turn corresponds to the clamping means 8 of FIG. 3. Thus, the clamping means 15 has a helically shaped end for mounting on the pin 14, and in its opposite end it is releasably attached to the ground attachment 11, preferably by means of a nut 15*a* screwed into a threaded upper portion of the anchoring peg 12. It will now be realized that in accordance with what has been described in connection with FIG. 3 the clamping means 15 is intended for releasably clamping the rope 10 between its helical end a portion of the ground attachment 11.

In the case illustrated in FIG. 1 where the ground attachment is anchored in connection with the road embankment 2 it also becomes necessary to provide an edge cover 16 at the inlet end 1*a* of the culvert, and this partly for guiding the rope 10 around the relatively sharp bend and at the same time also for protecting the rope. As is clear from FIGS. 4*a* and 4*b* the edge cover 16 in a suitable embodiment consists of a first portion 16*a* which to a great extent corresponds to the first portion 3*a* of the culvert attachment 3 and thus comprises an inner leg 17 and an outer leg 18 between which the culvert 1 is clamped by means of a bolt 19 screwed into a threaded bore in the outer leg 18. The other portion 16*b* of the edge cover provides the guiding proper for the rope 10 and for this purpose includes an upwardly bent guide rail 20 having a smooth curvature for deflecting the rope 10 between 90° and 180°, in the illustrated embodiment approximately 135°. For providing the best guiding the guide rail 20 has an inner, longitudinal groove having a shape essentially corresponding to that of the rope 10. For additionally securing and guiding the rope 10 in the guide rail 20 the latter is also provided with a number of guide loops 21 evenly distributed along the length of the guide rail, and through these loops the rope is threaded.

For reasons of clarity it should be mentioned that although the elongated means, which according to the invention is intended to be extended through a road culvert, herein is referred to as a rope this term is not intended to delimit the invention regarding the cross-sectional shape or surface of the elongated means. Although the rope in the illustrated embodiments has a substantially circular cross-sectional shape it is obvious that the term rope should also cover rectangular, triangular or other suitable cross-section shapes.

As mentioned above the rope 10 is intended to be extended through the road culvert 1 and to be clamped at the culvert attachment 3 as well as at the ground attachment 11. The rope is substantially solid or homogeneous (possibly with air bubbles contained in the material) and in the illustrated embodiments it has a basically circular sectional area. The rope is cut into a suitable length corresponding to the length of the road culvert to which it is to be attached. Characteristic of the rope is that it is manufactured from a material which at least to a certain degree may be reversibly extended, i.e. a material which when it is subject to a tension load undergoes a certain, not permanent, reduction in cross section. Thus, when the tension load is removed the rope shall resume its original shape. By an embodiment of the invention where a free passage is established through ice in the road culvert by simply pulling the rope out from the culvert, it is sufficient if the rope has a relatively low reversible extensibility sufficient for reducing the cross-sectional area of the rope to such a degree that it without problem is released from the surrounding ice. By another embodiment where the passage through the ice is established with the rope remaining in the culvert by extending the rope to such an extent that its cross-sectional area is greatly reduced, it must on the other hand be possible to subject the material to such a tension load that its cross-sectional area is substantially reduced to half without any danger of the material rupturing or breaking. A material that has been found suitable for the later embodiment and that complies with the requirements thereof is a synthetic rubber EPDM (SIS 1626-70).

In either or both of its ends the rope is provided with a hook 22 the function of which will be described below. In certain cases it may also be preferable to provide the free ends of the rope with a not shown web or stocking intended to protect the rope from external damage through for instance gravel and rocks.

According to an emboidment of the invention the clearing or thawing out of a road culvert is carried out in the following manner:

In good time before the winter, when the culvert is open, the above described equipment is installed, and when installed it can remain there year after year and it will not be necessary to dismount it unless some portion thereof is damaged. The assembly is carried out such that a culvert attachment **3** of the kind described above is clamped to the outlet side **1***b* of the culvert **1**. The ground attachment **11** may be secured by forcing the anchoring peg **12** into the ground by means of any suitable tool so that it is firmly anchored, and the anchoring may be carried out in alternative places depending upon the surrounding terrain. Hereby it is determining that the ground attachment shall be anchored at a spot where there is little danger that it will become covered by ice during winter. The reason for this is naturally that it must be easy to get hold of the end of the rope **10** being positioned in connecton therewith without having to expose said end by chopping off ice. Of importance for the positioning is also that the anchoring position must be as close as possible to the inlet end **1***a* of the culvert so that the length of the rope may be reduced. In view of this the positioning illustrated with full lines in FIG. **1** seems to be preferable in most cases, but it is also possible to position the ground attachment as illustrated with broken lines in FIG. **1**, in which case the rope will be extended obliquely upwardly in FIG. **1**.

As mentioned above the positioning of the ground attachment **11** illustrated with full lines in FIG. **1** also necessitates the mounting of an edge cover **16** at the inlet end **1***a* of the culvert for deflecting and guiding the rope **10**. By the alternative positioning illustrated with broken lines it would be possible to manage without any edge cover or with an edge cover of a simpler design. When the culvert attachment, the ground attachment and possibly an edge cover have been installed the rope **10** is extended through the culvert and, where appropriate, the rope is then threaded through the edge cover, and its ends are clamped to the culvert attachment and to the ground attachment respectively. The clamping is carried out in such a way that the clamping means **8** and **15** respectively is disengaged and is swung about the pin **9** and **14** respectively, whereupon the rope is installed in the respective attachment and is clamped in position by means of the clamping means which are secured by the nut **8***a* and **15***a* respectively. The rope **10** is clamped to the attachments in its substantially unloaded condition, i.e. without being subject to any essential tension load. However, especially in connection with longer road culverts it may be necessary to clamp the rope **10** when the same is subject to a certain, low tension load in order to make sure that the rope does not hang down towards the middle but runs close to the upper edge of the culvert **1** throughout its extension, and as discussed in the introduction this is essentially in order to make it possible for the water flowing through an opened passage to eat its way down in the ice so that the ice may be efficiently cleared away. The rope remains in the above described position and when it is discovered, during a routine inspection discussed above, that the culvert is completely choked with ice so that melted ice cannot be drained therethrough it will, by employing the invention, no longer be necessary to send out any special patrol for clearing the culvert, but in most cases the person carrying out the inspection may carry out the clearing by himself. By one embodiment the procedure is such that the rope is released at the culvert attachment **3** by the outlet side **1***b* of the culvert, possibly subsequent to exposing this side by removing snow, through disengaging the clamping means **8** and swinging the same about the pin **9**. The rope which in this embodiment should have a high reversible extensibility is then stretched or tensioned by hand from the outlet side **1***b* while remaining clamped at the ground attachment **11**, and through this tension load and due to the tensibility of the material the rope **10** is immediately released from the ice as its cross-sectional area is greatly reduced. Hereby a free passage for the melted ice is established around the circumference of rope and when this has been achieved the rope is clamped to the culvert attachment **3** again in its loaded condition so that the water may continue to flow in the passage in such a way that it wears its way through the ice and finally clears the whole culvert. When the culvert has been cleared the rope is released from the culvert attachment **3** again and is unloaded so that it resumes its original shape and finally it is clamped again so that the procedure may be repeated if the culvert should become choked with ice once more. As has been mentioned above it is obvious that the rope **10** by this embodiment should have as high a reversible extensibility as possible in order to establish the largest possible passage for the melted ice when it is stretched or tensioned. In this embodiment it may also be suitable if the rope has a rectangular cross-sectional shape in order to leave as wide a passage as possible for the melted ice to thereby ensure a positive clearing of the complete culvert.

When the ground attachment is positioned as illustrated with broken lines in FIG. **1** there is a danger that the reduction of the cross section of the rope at the end closest to the ground attachment, due to the great distance from the place where the tension load is applied, goes on so slowly that the water beginning to flow in freezes before sufficient flow has been established in order to keep the passage open. For that reason it may be preferable in all cases to use the variant illustrated with full lines in FIG. **1**, having an edge cover **16**. The reason for this is that when the rope is stretched about the edge cover the passage may be opened up more quickly by performing the tensioning or stretching in two different steps. In FIG. **4***a* the rope is illustrated guided about the edge cover in its unloaded condition, but in FIG. **4***b* the broken lines illustrate how the extension of the rope is blocked by the guide rail **20** of the edge cover so that the reduction of the cross-sectional area of the rope, when the rope is normally tensioned, has been fully established up to the guide rail and possibly a distance around the same, while the remaining portion of the rope still maintains its full cross-sectional dimension so that no melted ice or snow enters from above. At this state the rope is clamped at the culvert attachment **3** when in its loaded condition and the person moves to the ground attachment **11** and exposes the same when necessary. Then the rope is released at the ground attachment and since only a relatively short portion of the rope from the edge cover **16** and up to the ground attachment is unloaded this portion of the rope may quickly be stretched or tensioned so that a full flow through the established passage is immediately obtained and so that the above mentioned danger of freezing is elminated.

By certain road culverts which by experience are known to cause serious problems, or by road culverts having a large diameter it may suitable to provide several ropes **10** at a distance from each other in connection with the upper portion of the culvert, and for instance in the way schematicaly illustrated in FIG. **5**. Another alternative that may be considered in connection with larger road culverts is to employ thicker ropes therein, but in such a case it may be necessary to provide some kind of not shown auxiliary device having a gear mechanism for tensioning or stretching the rope.

In FIG. 6 a rope 10' is illustrated having an alternative cross-sectional shape with longitudinal grooves or channels. This rope is intended to be twisted in connection with the streching or tensioning thereof so that the grooves assume a screw line shape around the rope. Apart from the fact that this configuration establishes a somewhat larger passage for the melted ice it also gives the ice a non-uniform surface so that the melted ice more efficiently wears off the ice. This is even further emphasized if the grooves or channels initially are helically shaped in the rope.

In extremely difficult situations where the above described method is not sufficient or in cases where it is desirable to open up a culvert in spite of the fact that there is no water such as melted ice or snow present that can wear down through the ice during its flow through the culvert, it is in accordance with another embodiment also possible to use the invention together with a conventional steam unit or possibly together with a hot-air unit, such as a building dryer. For this purpose a hook **22** is provided in one or possibly both ends of the rope. By connecting a particular steam pipe (possibly a flexible steam hose), which is closed in one end and in said end is provided with a loop for engaging the hook **22** and which is perforated along a portion of its length, to the steam unit the complete culvert may be cleared from one side without the necessity for crawling into the culvert. This is achieved by hooking-up the loop of the steam pipe to the hook **22** of the rope, whereupon the steam pipe, through withdrawal of the rope, is pulled stepwise through the culvert as this is thawed out. Due to the fact that the steam pipe is pulled in through the passage established by the rope it will not be necessary to take up separate holes for the perforated steam pipe and moreover the complete culvert may be thawed out in one operation independent of the length of the culvert. This work is naturally speeded up even further if several ropes are installed in the culvert in accordance with FIG. **5**, whereby a corresponding number of steam pipes may be used. It should be realized that by this embodiment it is, as mentioned, sufficient if the rope only has a certain reversible extensibility, since it is intended to establish a passage through the ice by being completely withdrawn from the culvert. Thus, the reduction of the cross-sectional area need only be sufficient to ensure that the rope is released from the ice.

Although preferred embodiments of the invention have been described and illustrated herein it should be obvious to those skilled in the art that a great number of changes and modifications may be carried out without departing from the scope of the invention. For instance it is possible to employ alternative designs for the culvert attachment, the ground attachment and the edge cover, both regarding their preferred clamping to the culvert, anchoring in the ground and clamping of the rope respectively. Thus, the scope of the invention should only be restricted by the enclosed patent claims.

I claim:

1. A method for clearing road culverts or the like having become choked with ice, comprising the steps of: extending a substantially homogenous rope of a material having at least a certain reversible extensibility through the culvert from its inlet side to its outlet side before it becomes choked with ice; clamping the rope in its unloaded condition in connection to the outlet side and inlet side of the culvert so that the rope extends through the culvert; and, once the culvert has become choked with ice, releasing the rope from its clamping in connection with the outlet side of the culvert; applying a tension load to the rope from the released end for reducing the cross-sectional area of the rope and thereby forming a free passage through the culvert around the circumference of the rope; clamping the rope again in connection with the outlet side of the culvert, in the loaded extended condition of the rope; and allowing a continuous flow of melted ice or snow in the passage formed around the circumference of the rope, thereby clearing the road culvert.

2. A method as described in claim **1**, wherein a rope having a high reversible extensibility is used and wherein the rope is clamped close to the upper portion of the culvert.

3. A method as described in claim **2**, wherein the rope in connection with the inlet side of the culvert is deflected from its extension within the culvert through an edge cover; the corresponding end of the rope is clamped at a distance from the inlet side of the culvert and both ends of the rope, one after the other, are released from the clamping, are tensioned or extended and clamped again.

4. A method for clearing road culverts or the like having become choked with ice, comprising the steps of: extending a substantially homogeneous rope of a material having at least a certain reversible extensibility through the culvert from its inlet side to its outlet side before it becomes choked with ice; clamping the rope in its unloaded condition in connection to the outlet side and the inlet side of the culvert so that the rope extends through the culvert; and, once the culvert has become choked with ice, releasing both ends of the rope at their respective clamping positions; connecting a steam pipe perforated along a portion of its length to one end of the rope; connecting the steam pipe to a steam unit; applying a tension load to the end of the rope not connected to the steam pipe, for reducing the cross-sectional area of the rope so that it is released from the ice; successively pulling the rope out from the culvert for forming a free passage through the culvert and successively pulling the steam pipe into the passage in the ice established by withdrawing the rope; thereby successively clearing the culvert by means of steam supplied from the steam unit.

* * * * *

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United States Patent [19]

Sterling et al.

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[45] **Date of Patent: Nov. 16, 1999**

[54] **METHOD FOR THAWING FROZEN ROAD CULVERTS**

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[51] **Int. Cl.**[6] **H05B 1/00**; H01C 3/06

[52] **U.S. Cl.** **219/213**; 219/549; 338/214

[58] **Field of Search** 219/213, 528, 219/544, 538, 546; 404/77, 79; 405/131, 128; 338/214

[56] **References Cited**

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Primary Examiner—Teresa Walberg

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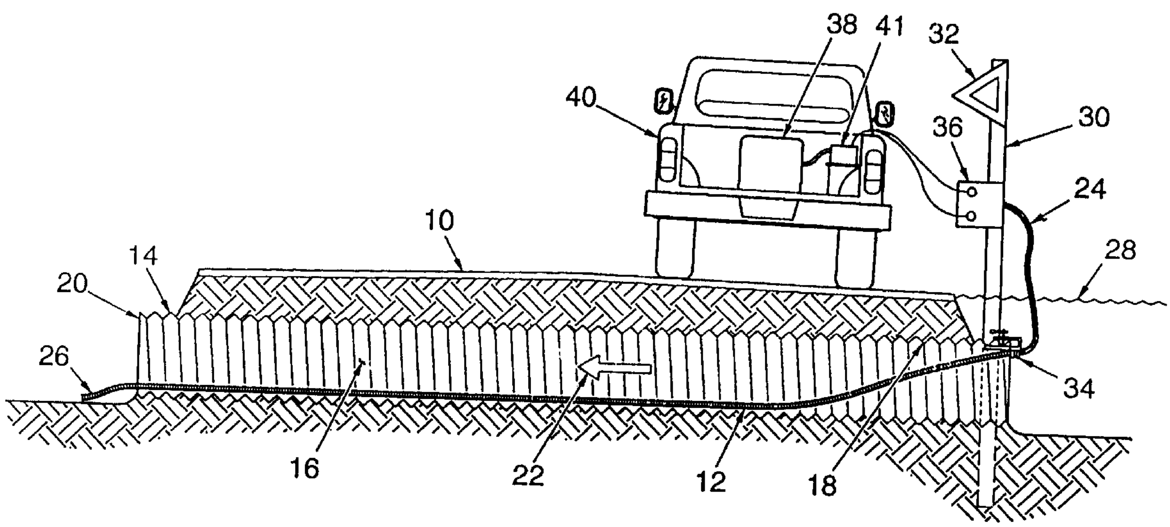
[57] **ABSTRACT**

A method for thawing frozen road culverts. The first step involves positioning an electrically conductive cable in a road culvert prior to an ice blockage occurring. A connection end of the electrically conductive cable is anchored in an accessible location. The second step involves connecting a power source to the connection end of the electrically conductive cable after an ice blockage of the road culvert has occurred and supplying power to the electrically conductive cable, such that energy generated by power flowing through the electrically conductive cable causes a flow path to be created through the ice blockage in the road culvert.

7 Claims, 2 Drawing Sheets



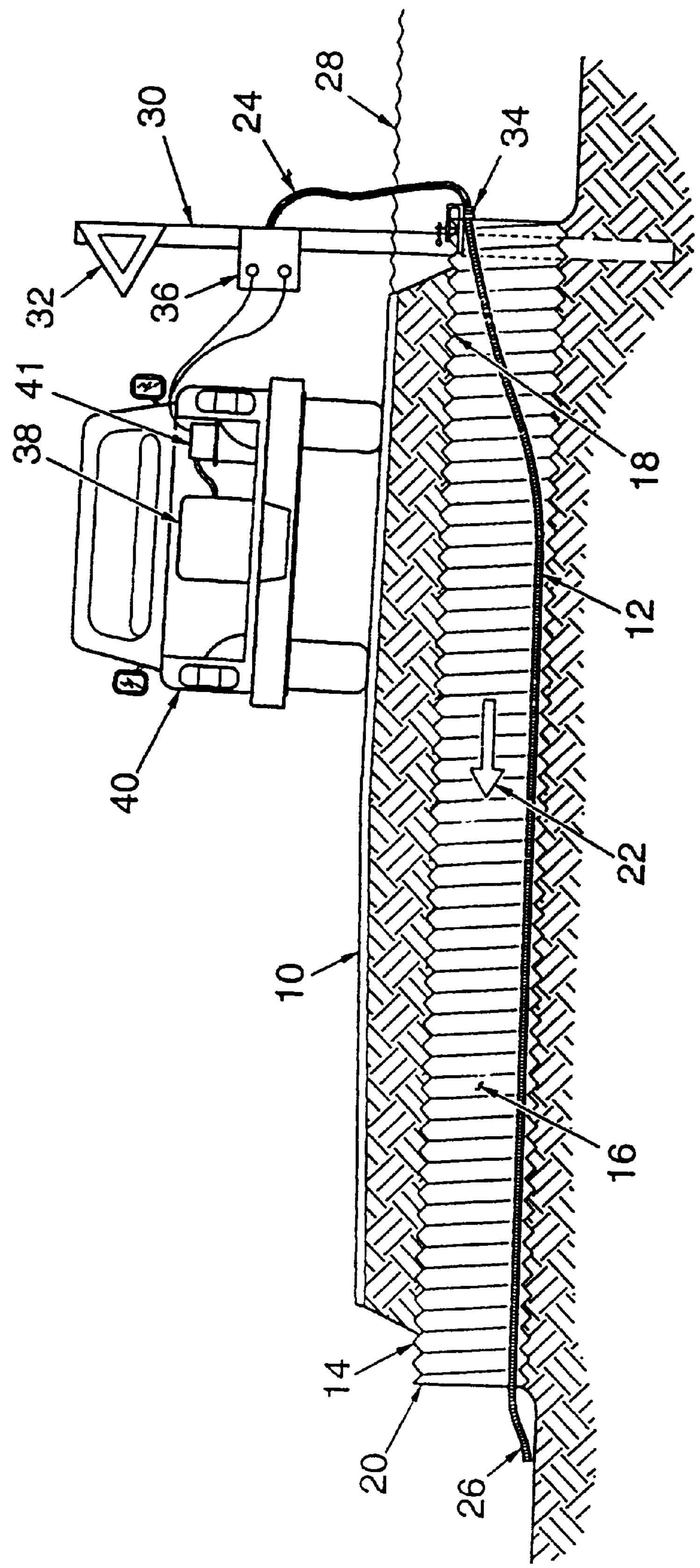


FIGURE 1

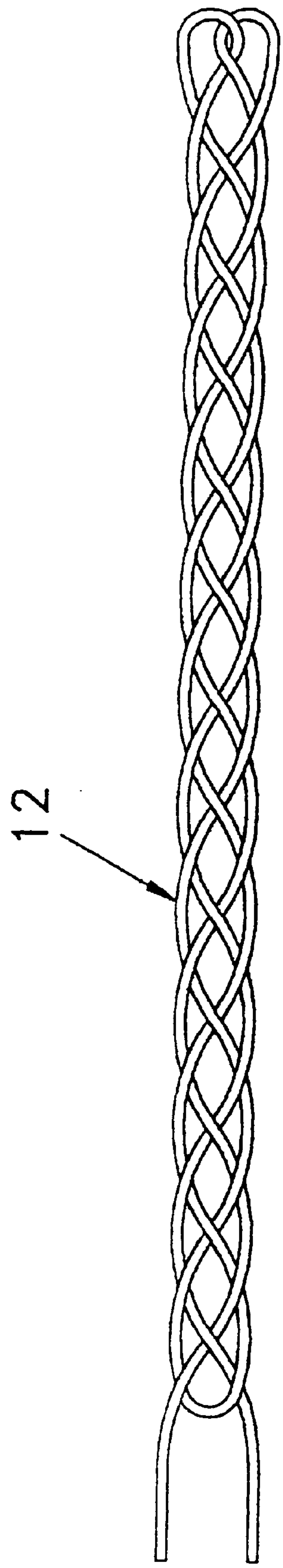


FIGURE 2

METHOD FOR THAWING FROZEN ROAD CULVERTS

FIELD OF THE INVENTION

The present invention relates to a method for thawing frozen road culverts.

BACKGROUND OF THE INVENTION

With the coming of spring every year there is a daily cycle of melting and freezing. The heat of the sun during the day causes snow to melt. As the sun goes down the temperature falls and water resulting from melting of the snow freezes.

Culverts are strategically placed under roads which are in a path followed by a flow of water from the melting snow. The culverts divert the flow of water so the road does not wash out. Unfortunately, the daily cycle of melting and freezing sometimes results in a culvert becoming blocked by an ice plug. If the ice plug is not removed in a timely fashion, the flow of water seeks an alternative path which often results in a washing out of portions of the road.

At the present time, steam truck crews are dispatched whenever it is noted that a culvert is plugged by ice. Removal of an ice plug from a culvert is generally a slow process. High pressure steam is injected into the ice plug, usually from a downstream side of the culvert, until a flow of water is restored. An ice plug that extends part way into a culvert generally can be removed by high pressure steam within three hours. Ice plugs that extend completely through a culvert can take considerably longer to remove.

The problem of road culverts plugging with ice has become so prevalent, that oversize culverts are frequently used for the express purpose of reducing the frequency of the problem.

SUMMARY OF THE INVENTION

What is required is a more time efficient method of thawing frozen road culverts.

According to one aspect of the present invention there is provided a method for thawing frozen road culverts. The first step involves positioning an electrically conductive cable in a road culvert prior to an ice blockage occurring. A connection end of the electrically conductive cable is anchored in an accessible location. The second step involves connecting a power source to the connection end of the electrically conductive cable after an ice blockage of the road culvert has occurred and supplying power to the electrically conductive cable, such that energy generated by power flowing through the electrically conductive cable causes a flow path to be created through the ice blockage in the road culvert.

According to another aspect of the present invention, there provided, a combination including a road culvert and an electrically conductive cable. The road culvert has an interior bore with an upstream end and a downstream end relative to normal water flow. The electrically conductive cable is positioned in the interior bore and extends substantially the length of the road culvert from the upstream end toward the downstream end. A connection end of the electrically conductive cable is anchored in an accessible location, such that a power source connectable to the connection end of the electrically conductive cable to supply power to energize the electrically conductive cable.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features of the invention will become more apparent from the following description in which reference is made to the appended drawings, wherein:

FIG. **1** is a front elevation view, in section, of a culvert that has been equipped with an electrically conductive cable in accordance with the teachings of the present method.

FIG. **2** is a detailed top plan view of a electrically conductive cable illustrated in FIG. **1**.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred method for thawing frozen road culverts will now be described with reference to FIG. **1**.

The teachings of the preferred method, as will hereafter be further described, require that an electrically conductive cable **12** be positioned in a road culvert **14**. Road is generally indicated by reference numeral **10**. Road culvert **14** has an interior bore **16** with an upstream end **18** and a downstream end **20** relative to a direction of normal water flow as indicated by arrow **22**. Electrically conductive cable **12** has a connection end **24** and a remote end **26**. Beneficial results have been obtained using electrically conductive cable **12** made from #10 insulated copper wire, although in applications requiring higher temperatures wire made from alloys that can withstand higher temperatures may be used. Electrically conductive cable **12** is positioned in interior bore **16** of road culvert **14** and, preferably, extends substantially the length of road culvert **14** from upstream end **18** toward downstream end **20**. It is essential that electrically conductive cable **12** is positioned at upstream end **18**, for it is at upstream end **18** that a lockage by ice is most likely to occur. It is not always ssential that electrically conductive cable **12** reach all the ay to downstream end **20**. Each installation must be made having regard to surface topography and other conditions prevailing. Some road culverts become blocked at both ends, others are prone only to upstream blockage. Connection end **24** of electrically conductive cable **12** is anchored in an accessible location. When choosing an accessible location must bear in mind the conditions that will prevail when an ice blockage condition is encountered. There is likely to be an accumulation of water upstream of road culvert **14**, so the accessible location ispeferably above a high water mark generally indicated by reference numeral **28**. There is also likely to be an accumulation of snow on the ground, so connection end **24** is preferably a sufficient height to be above any accumulation of snow. In order to achieve this objective, it is preferred that connection end **24** be mounted onto a post **30**. Post **30** can be marked with a sign **32** or otherwise marked so as to be readily identified by work crews. In order to ensure that electrically conductive cable **12** does not shift after installation, it is preferred that electrically conductive cable **12** be clamped by means of clamp **34** to upstream end **18** of road culvert **14**. Connection end **24** of electrically conductive cable **12** is preferably is connected to a junction box **36**. A power source **38** is used to supply power to electrically conductive cable **12**. For safety reasons, a low voltage direct current power source which generates six to forty volts is preferred. It will be appreciated that the power required will vary with the gauge and length of electrically conductive cable **12** used. It is not viewed as being cost effective to have a power source at every installation. It is viewed as being more practical to take power source **38** to the particular road culvert that is blocked, it is, therefore, preferred that power source **38** be mounted on a truck **40**. For reasons of safety, it is preferred that power source **38** have a control box **41** which include features that control current and provide overcurrent protection with a breaker trip mechanism.

The use and operation of the above described combination in accordance with the teachings of the preferred method will now be described. The first step involves positioning electrically conductive cable **12** in road culvert **14** prior to an ice blockage occurring. Of course, after an ice blockage has occurred it is too late to insert electrically conductive cable **12**. Historical data can be used to select those of road culverts **14** that are most prone to ice blockage. Connection end **24** of electrically conductive cable **24** is anchored in an accessible location, such as post **30**. It is preferred that cable be secured to road culvert **14** at upstream end **18** by means of clamp **34**. Cable **24** is then laid through road culvert **14**.

The second step involves connecting power source **38** to connection end **24** of electrically conductive cable **12** after an ice blockage (not shown) of road culvert **14** has occurred. As low voltage power source **38** is truck mounted, truck **40** can be dispatched. The connection of power source **38** to connection end **24** of electrically conductive cable **12** is made through junction box **36**. Power source **38** provides power to electrically conductive cable **12**. Tests have shown that energy generated by electrically conductive cable **12** causes a flow path to be created through the ice blockage in the immediate vicinity of electrically conductive cable **12**. The resulting flow of water then tends to accelerate the process of removing the blockage by rapidly washing away the ice. A trickle of water through road culvert **14** generally occurs in as little as two minutes and normal flow through road culvert **14** is generally restored within ten minutes. The rapid clearing of the blockage is believed to be due to more than just the heat generated by power passing through electrically conductive cable **12**.

Referring to FIG. **2**, in addition to thermal energy, there is believed to be an eddy current induced. In order to enhance this effect cable **12** is looped lengthwise back and forth in boustrophedonic fashion. The loops are then twisted together in order to make cable **12** more compact and easier to handle. Regardless of what forces are at work, the energy generated can be objectively shown to clear an ice blockage in a remarkably short time.

It will be apparent to one skilled in the art that modifications may be made to the illustrated embodiment without departing from the spirit and scope of the invention as hereinafter defined in the Claims.

The embodiments of the invention in which an exclusine property or privilege is claimed are defined as follows:

1. A method for thawing frozen road culverts, comprising the steps of:

positioning an electrically conductive cable in a road culvert prior to an ice blockage occurring, with a connection end of the electrically conductive cable anchored in an accessible location;

dispatching a mobile low voltage power source to the road culvert when a blockage occurs; and

connecting the power source to the connection end of the electrically conductive cable and supplying power to the electrically conductive cable, such that energy generated by power flowing through the electrically conductive cable causes a flow path to be created through an ice blockage in the road culvert.

2. In combination:

a road culvert having an interior bore;

an electrically conductive cable positioned in the interior bore and extending substantially the length of the road culvert;

a connection end of the electrically conductive cable being anchored in an accessible location, such that a power source is connectable to the connection end of the electrically conductive cable to supply power to energize the electrically conductive cable; and

a mobile low voltage power source for supplying power to the electrically conductive cable.

3. The combination as defined in claim **2**, wherein the road culvert has with an upstream end and a downstream end relative to normal water flow, the cable extending from the upstream end toward the downstream end.

4. The combination as defined in claim **2**, wherein the cable is looped lengthwise back and forth in boustrophedonic fashion.

5. The combination as defined in claim **4**, wherein the cable is twisted.

6. A method for thawing frozen road culverts, comprising the steps of:

positioning an electrically conductive cable in a road culvert prior to an ice blockage occurring, with a connection end of the electrically conductive cable anchored in an accessible location outside the road culvert and an opposite end of the cable being unattended and extending completely through the road culvert and projecting out through the opposite end thereof;

dispatching a mobile low voltage power source to the road culvert when a blockage occurs in the road culvert; and

connecting the power source to the connection end of the electrically conductive cable and supplying electrical power to the electrically conductive cable, such that energy generated by the electrical power flowing through the electrically conductive cable causes a flow path to be created through the ice blockage in the road culvert thereby assisting with thawing of the road culvert.

7. The combination of claim **2** wherein the accessible location of the connection end of the cable is located outside the road culvert so as to be accessible.

* * * * *

APPENDIX D

PHASED COST ESTIMATES

Community and Government Services - Government of Nunavut
Class 'D' Cost Estimate - All Phases
Tetra Tech Project WTRM03184-01 - Igloolik Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$347,324
Civil Works		$2,078,242
Miscellaneous		$75,000
	Sub-total	**$2,500,566**
Project Contingencies	40.0%	$1,000,226
	Total Estimated Construction Cost	**$3,500,793**

NMS Specs						
Preliminaries			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 25 01	0-1	Mob / Demob, Temporary Facilities, Security, Quality Control, etc.	lump sum	1	$227,324.20	$227,324
01 35 14	0-2	Traffic Control, Barricades, and Temporary Signage	lump sum	1	$20,000.00	$20,000
01 71 00	0-3	Construction Surveys	lump sum	1	$100,000.00	$100,000
					Sub-total Preliminaries	**$347,324**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	10,718	$30.00	$321,540
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	1,152	$527.00	$607,104
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	242	$707.00	$171,094
33 42 13	1-5	Supply and Install 900 mm Steel Casing Culvert	m	63	$1,068.00	$67,284
33 42 13	1-4	Supply and Install 300 mm Steel Casing Sleeve	m	6	$346.00	$2,076
33 42 13	1-3	Supply and Install 600 mm Steel Casing Sleeve	m	28	$707.00	$19,796
33 42 13	1-5	Supply and Install 900 mm Steel Casing Sleeve	m	4	$1,068.00	$4,272
33 42 13	1-6	Supply and Install 1050 mm Steel Casing Sleeve	m	4	$1,370.00	$5,480
31 37 10	1-7	Supply and Place 10 kg Class Riprap	cu. m	3,381	$100.00	$338,100
31 37 10	1-8	Supply and Place 50 - 75 mm Clear Crush	cu. m	2,104	$100.00	$210,400
31 32 21	1-9	Supply and Place Non-Woven Geotextile	sq. m	12,355	$20.00	$247,096
02 41 13	1-10	Culvert Removal and Off-Site Disposal	each	42	$2,000.00	$84,000
					Sub-total Site Services	**$2,078,242**
Miscellaneous			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 35 43	2-1	Dewatering	lump sum	1	$25,000.00	$25,000
01 35 43	2-2	Sediments and Erosion Control Measures	lump sum	1	$50,000.00	$50,000
					Sub-total Miscellaneous	**$75,000**

Notes:

1 Quantities shown on this table are estimates and provided for reference only.

2 Estimated quantities do not account for spare culverts and materials.

Community and Government Services - Government of Nunavut

Class 'D' Cost Estimate - Phase 1

Tetra Tech Project WTRM03184-01 - Igloolik Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$48,575
Civil Works		$206,745
Miscellaneous		$15,000
	Sub-total	**$270,320**
Project Contingencies	40.0%	$108,128
	Total Estimated Construction Cost	**$378,447**

NMS Specs						
Preliminaries			Unit	Est Quantity	Est. Unit Price	Est. Total
01 25 01	0-1	Mob / Demob, Temporary Facilities, Security, Quality Control, etc.	lump sum	1	$24,574.50	$24,575
01 35 14	0-2	Traffic Control, Barricades, and Temporary Signage	lump sum	1	$4,000.00	$4,000
01 71 00	0-3	Construction Surveys	lump sum	1	$20,000.00	$20,000
					Sub-total Preliminaries	**$48,575**
Civil Works			Unit	Est Quantity	Est. Unit Price	Est. Total
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	411	$30.00	$12,330
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	187	$527.00	$98,549
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	44	$707.00	$31,108
33 42 13	1-3	Supply and Install 600 mm Steel Casing Sleeve	m	6	$707.00	$4,242
31 37 10	1-5	Supply and Place 10 kg Class Riprap	cu. m	162	$100.00	$16,200
31 37 10	1-6	Supply and Place 50 - 75 mm Clear Crush	cu. m	105	$100.00	$10,500
31 32 21	1-7	Supply and Place Non-Woven Geotextile	sq. m	591	$20.00	$11,816
02 41 13	1-8	Culvert Removal and Off-Site Disposal	each	11	$2,000.00	$22,000
					Sub-total Site Services	**$206,745**
Miscellaneous			Unit	Est Quantity	Est. Unit Price	Est. Total
01 35 43	2-1	Dewatering	lump sum	1	$5,000.00	$5,000
01 35 43	2-2	Sediments and Erosion Control Measures	lump sum	1	$10,000.00	$10,000
					Sub-total Miscellaneous	**$15,000**

Notes:

1 Quantities shown on this table are estimates and provided for reference only.

2 Estimated quantities do not account for spare culverts and materials.

Community and Government Services - Government of Nunavut
Class 'D' Cost Estimate - Phase 2
Tetra Tech Project WTRM03184-01 - Igloolik Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$39,113
Civil Works		$112,126
Miscellaneous		$15,000
	Sub-total	**$166,239**
Project Contingencies	40.0%	$66,495
	Total Estimated Construction Cost	**$232,734**

NMS Specs

Preliminaries			Unit	Est Quantity	Est. Unit Price	Est. Total
01 25 01	0-1	Mob / Demob, Temporary Facilities, Security, Quality Control, etc.	lump sum	1	$15,112.60	$15,113
01 35 14	0-2	Traffic Control, Barricades, and Temporary Signage	lump sum	1	$4,000.00	$4,000
01 71 00	0-3	Construction Surveys	lump sum	1	$20,000.00	$20,000
					Sub-total Preliminaries	**$39,113**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	1,664	$30.00	$49,920
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	19	$527.00	$10,013
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	10	$707.00	$7,070
33 42 13	1-5	Supply and Install 900 mm Steel Casing Culvert	m	13	$1,068.00	$13,884
33 42 13	1-4	Supply and Install 300 mm Steel Casing Sleeve	m	3	$346.00	$1,038
33 42 13	1-4	Supply and Install 600 mm Steel Casing Sleeve	m	3	$707.00	$2,121
31 37 10	1-6	Supply and Place 10 kg Class Riprap	cu. m	76	$100.00	$7,600
31 37 10	1-7	Supply and Place 50 - 75 mm Clear Crush	cu. m	91	$100.00	$9,100
31 32 21	1-8	Supply and Place Non-Woven Geotextile	sq. m	269	$20.00	$5,380
02 41 13	1-9	Culvert Removal and Off-Site Disposal	each	3	$2,000.00	$6,000
					Sub-total Site Services	**$112,126**
Miscellaneous			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 35 43	3-1	Dewatering	lump sum	1	$5,000.00	$5,000
01 35 43	3-2	Sediments and Erosion Control Measures	lump sum	1	$10,000.00	$10,000
					Sub-total Miscellaneous	**$15,000**

Notes:

1 Quantities shown on this table are estimates and provided for reference only.

2 Estimated quantities do not account for spare culverts and materials.

Community and Government Services - Government of Nunavut

Class 'D' Cost Estimate - Phase 3

Tetra Tech Project WTRM03184-01 - Igloolik Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$49,075
Civil Works		$211,750
Miscellaneous		$15,000
	Sub-total	**$275,825**
Project Contingencies	40.0%	$110,330
	Total Estimated Construction Cost	**$386,155**

NMS Specs						
Preliminaries			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 25 01	0-1	Mob / Demob, Temporary Facilities, Security, Quality Control, etc.	lump sum	1	$25,075.00	$25,075
01 35 14	0-2	Traffic Control, Barricades, and Temporary Signage	lump sum	1	$4,000.00	$4,000
01 71 00	0-3	Construction Surveys	lump sum	1	$20,000.00	$20,000
					Sub-total Preliminaries	**$49,075**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	1,056	$30.00	$31,680
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	30	$527.00	$15,810
33 42 13	1-2	Supply and Install 600 mm Steel Casing Culvert	m	21	$707.00	$14,847
33 42 13	1-3	Supply and Install 900 mm Steel Casing Culvert	m	30	$1,068.00	$32,040
33 42 13	1-2	Supply and Install 600 mm Steel Casing Sleeve	m	3	$707.00	$2,121
33 42 13	1-3	Supply and Install 900 mm Steel Casing Sleeve	m	4	$1,068.00	$4,272
33 42 13	1-3	Supply and Install 1050 mm Steel Casing Sleeve	m	4	$1,370.00	$5,480
31 37 10	1-4	Supply and Place 10 kg Class Riprap	cu. m	460	$100.00	$46,000
31 37 10	1-5	Supply and Place 50 - 75 mm Clear Crush	cu. m	174	$100.00	$17,400
31 32 21	1-6	Supply and Place Non-Woven Geotextile	sq. m	1,705	$20.00	$34,100
02 41 13	1-7	Culvert Removal and Off-Site Disposal	each	4	$2,000.00	$8,000
					Sub-total Site Services	**$211,750**
Miscellaneous			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 35 43	2-1	Dewatering	lump sum	1	$5,000.00	$5,000
01 35 43	2-2	Sediments and Erosion Control Measures	lump sum	1	$10,000.00	$10,000
					Sub-total Miscellaneous	**$15,000**

Notes:

1 Quantities shown on this table are estimates and provided for reference only.

2 Estimated quantities do not account for spare culverts and materials.

Community and Government Services - Government of Nunavut

Class 'D' Cost Estimate - Phase 4

Tetra Tech Project WTRM03184-01 - Igloolik Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$82,597
Civil Works		$546,971
Miscellaneous		$15,000
	Sub-total	**$644,568**
Project Contingencies	40.0%	$257,827
	Total Estimated Construction Cost	**$902,395**

NMS Specs						
Preliminaries			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 25 01	0-1	Mob / Demob, Temporary Facilities, Security, Quality Control, etc.	lump sum	1	$58,597.10	$58,597
01 35 14	0-2	Traffic Control, Barricades, and Temporary Signage	lump sum	1	$4,000.00	$4,000
01 71 00	0-3	Construction Surveys	lump sum	1	$20,000.00	$20,000
					Sub-total Preliminaries	**$82,597**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	1,843	$30.00	$55,290
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	421	$527.00	$221,867
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	112	$707.00	$79,184
33 42 13	1-2	Supply and Install 300 mm Steel Casing Sleeve	m	3	$346.00	$1,038
33 42 13	1-3	Supply and Install 600 mm Steel Casing Sleeve	m	16	$707.00	$11,312
31 37 10	1-5	Supply and Place 10 kg Class Riprap	cu. m	254	$100.00	$25,400
31 37 10	1-6	Supply and Place 50 - 75 mm Clear Crush	cu. m	867	$100.00	$86,700
31 32 21	1-7	Supply and Place Non-Woven Geotextile	sq. m	909	$20.00	$18,180
02 41 13	1-7	Culvert Removal and Off-Site Disposal	each	24	$2,000.00	$48,000
					Sub-total Site Services	**$546,971**
Miscellaneous			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 35 43	2-1	Dewatering	lump sum	1	$5,000.00	$5,000
01 35 43	2-2	Sediments and Erosion Control Measures	lump sum	1	$10,000.00	$10,000
					Sub-total Miscellaneous	**$15,000**

Notes:

1 Quantities shown on this table are estimates and provided for reference only.

2 Estimated quantities do not account for spare culverts and materials.

Community and Government Services - Government of Nunavut

Class 'D' Cost Estimate - Phase 5

Tetra Tech Project WTRM03184-01 - Igloolik Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$127,965
Civil Works		$1,000,650
Miscellaneous		$15,000
	Sub-total	**$1,143,615**
Project Contingencies	40.0%	$457,446
	Total Estimated Construction Cost	**$1,601,061**

NMS Specs						
Preliminaries			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 25 01	0-1	Mob / Demob, Temporary Facilities, Security, Quality Control, etc.	lump sum	1	$103,965.00	$103,965
01 35 14	0-2	Traffic Control, Barricades, and Temporary Signage	lump sum	1	$4,000.00	$4,000
01 71 00	0-3	Construction Surveys	lump sum	1	$20,000.00	$20,000
					Sub-total Preliminaries	**$127,965**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	5,744	$30.00	$172,320
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	495	$527.00	$260,865
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	55	$707.00	$38,885
33 42 13	1-4	Supply and Install 900 mm Steel Casing Culvert	m	20	$1,068.00	$21,360
31 37 10	1-5	Supply and Place 10 kg Class Riprap	cu. m	2,429	$100.00	$242,900
31 37 10	1-6	Supply and Place 50 - 75 mm Clear Crush	cu. m	867	$100.00	$86,700
31 32 21	1-7	Supply and Place Non-Woven Geotextile	sq. m	8,881	$20.00	$177,620
					Sub-total Site Services	**$1,000,650**
Miscellaneous			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
01 35 43	2-1	Dewatering	lump sum	1	$5,000.00	$5,000
01 35 43	2-2	Sediments and Erosion Control Measures	lump sum	1	$10,000.00	$10,000
					Sub-total Miscellaneous	**$15,000**

Notes:

1 Quantities shown on this table are estimates and provided for reference only.

2 Estimated quantities do not account for spare culverts and materials.

APPENDIX E

INVENTORY OF EXISTING CULVERTS

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C1	INLET	2019 / 08 / 29	-81.783658273	69.38058905

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 3

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C1	OUTLET	2019 / 08 / 29	-81.783830607	69.380469818

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 3

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C2	INLET	2019 / 08 / 29	-81.77917104	69.380242616

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C2	OUTLET	2019 / 08 / 29	-81.779158738	9.3800774906

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C3	INLET	2019 / 08 / 29	-81.779166828	69.379823821

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
UPSIZE	PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C3	OUTLET	2019 / 08 / 29	-81.779130175	69.379763232

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
UPSIZE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C4	INLET	2019 / 08 / 29	-81.779059098	69.379584333

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C4	OUTLET	2019 / 08 / 29	-81.779020624	69.379353651

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 4

2019 Assessment Photo

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C5	INLET	2019 / 08 / 29	-81.778951911	69.378881619

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C5	OUTLET	2019 / 08 / 29	-81.779092626	69.378721524

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C6	INLET	2019 / 08 / 29	-81.777473382	69.378860829

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C6	OUTLET	2019 / 08 / 29	-81.777499275	69.37874225

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C7	INLET	2019 / 08 / 29	-81.7756200	69.3789222

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C7	OUTLET	2019 / 08 / 29	-81.7756028	69.3788278

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C8	INLET	2019 / 08 / 29	-81.779508994	69.378872376

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C8	OUTLET	2019 / 08 / 29	-81.779543156	69.378740973

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C9	INLET	2019 / 08 / 29	-81.781752211	69.378974072

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & REPAIRABLE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C9	OUTLET	2019 / 08 / 29	-81.781763569	69.378827098

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C10	INLET	2019 / 08 / 29	-81.78353991	69.379171693

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C10	OUTLET	2019 / 08 / 29	-81.783624201	69.379036097

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C11	INLET	2019 / 08 / 29	-81.784360589	69.379293817

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 3

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C11	OUTLET	2019 / 08 / 29	-81.784461571	69.3791267

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 3

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C12	INLET	2019 / 08 / 29	-81.786901353	69.379248671

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C12	OUTLET	2019 / 08 / 29	-81.786484436	69.379157893

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C13	INLET	2019 / 08 / 29	-81.786435227	69.379107993

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C13	OUTLET	2019 / 08 / 29	-81.786291744	69.378953721

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C14	INLET	2019 / 08 / 29	-81.786069124	69.378637294

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C14	OUTLET	2019 / 08 / 29	-81.78593139	69.378522484

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C15	INLET	2019 / 08 / 29	-81.785585819	9.3794459226

Diameter (mm):	Material:	Condition:
600	CSP	REPAIRABLE DAMAGE &

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C15	OUTLET	2019 / 08 / 29	-81.785476582	69.379285421

Diameter (mm):	Material:	Condition:
600	CSP	REPAIRABLE DAMAGE &

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C16	INLET	2019 / 08 / 29	-81.798210403	69.37969581

Diameter (mm):	Material:	Condition:
800	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 2

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C16	OUTLET	2019 / 08 / 29	-81.797899285	69.379671404

Diameter (mm):	Material:	Condition:
800	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 2

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C17	INLET	2019 / 08 / 29	-81.798381394	69.379892473

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 2

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C17	OUTLET	2019 / 08 / 29	-81.798303785	69.379774362

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 2

2019 Assessment Photo

2019 Assessment Photo

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C18	INLET	2019 / 08 / 29	-81.798624332	69.380053878

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C18	OUTLET	2019 / 08 / 29	-81.798654699	69.379942869

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C19	INLET	2019 / 08 / 29	-81.794868392	69.38010324

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
UPSIZE

Proposed Phase:
PHASE 3

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C19	OUTLET	2019 / 08 / 29	-81.794576506	69.379999331

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
UPSIZE

Proposed Phase:
PHASE 3

2019 Assessment Photo

2019 Assessment Photo

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C20	INLET	2019 / 08 / 29	-81.789599108	69.378794605

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C20	OUTLET	2019 / 08 / 29	-81.789358636	69.378698484

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C21	INLET	2019 / 08 / 29	-81.787906425	69.378335942

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C21	OUTLET	2019 / 08 / 29	-81.787728919	69.378193973

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C22	INLET	2019 / 08 / 29	-81.78904313	69.378317171

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C22	OUTLET	2019 / 08 / 29	-81.789085802	69.378187884

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C23	INLET	2019 / 08 / 29	-81.791188809	69.37832119

Diameter (mm):	Material:	Condition:
800	CSP	REPAIRABLE DAMAGE &

Recommended Action:
REPLACE & UPSIZE

Proposed Phase:
PHASE 3

2019 Assessment Photo

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C23	OUTLET	2019 / 08 / 29	-81.791042713	69.378214016

Diameter (mm):	Material:	Condition:
800	CSP	REPAIRABLE DAMAGE &

Recommended Action:
REPLACE & UPSIZE

Proposed Phase:
PHASE 3

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert: C24

Culvert End: INLET

Date Assessed: 2019 / 08 / 29

Longitude: -81.792201548

Latitude: 69.377976422

Diameter (mm): 1200

Material: CSP

Condition: REPAIRABLE DAMAGE &

Recommended Action: REPAIR

Proposed Phase: PHASE 3

2019 Assessment Photo

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TETRA TECH

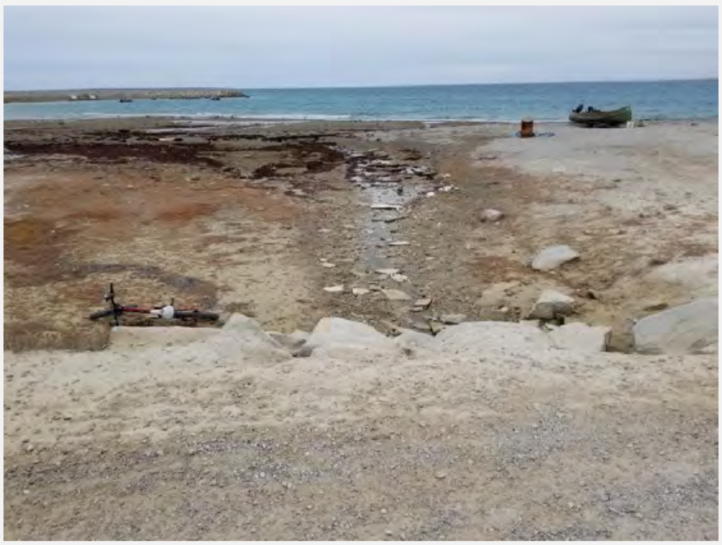
Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C24	OUTLET	2019 / 08 / 29	-81.792004038	69.377877073

Diameter (mm):	Material:	Condition:
1200	CSP	REPAIRABLE DAMAGE &

Recommended Action:	Proposed Phase:
REPAIR	PHASE 3



2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C25	INLET	2019 / 08 / 29	-81.796168817	69.379363351

Diameter (mm):	Material:	Condition:
	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 3

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C25	OUTLET	2019 / 08 / 29	-81.795968088	9.3791774512

Diameter (mm):	Material:	Condition:
	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 3

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C26	INLET	2019 / 08 / 29	-81.79649268	69.378915363

Diameter (mm):	Material:	Condition:
600	CSP	REPAIRABLE DAMAGE &

Recommended Action: REPAIR

Proposed Phase: PHASE 1

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C26	OUTLET	2019 / 08 / 29	-81.796120371	69.378983877

Diameter (mm):	Material:	Condition:
600	CSP	REPAIRABLE DAMAGE &

Recommended Action:
REPAIR

Proposed Phase:
PHASE 1

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C27	INLET	2019 / 08 / 29	-81.797861713	9.3792372058

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 1

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C27	OUTLET	2019 / 08 / 29	-81.797593287	69.379201974

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 1

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C28	INLET	2019 / 08 / 29	-81.800851657	69.378535596

Diameter (mm):	Material:	Condition:
	CSP	PARTLY BLOCKED &

Recommended Action:
CLEAN OUT CULVERT

Proposed Phase:
PHASE 1

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C28	OUTLET	2019 / 08 / 29	-81.800622196	69.378621693

Diameter (mm):	Material:	Condition:
	CSP	PARTLY BLOCKED &

Recommended Action:
CLEAN OUT CULVERT

Proposed Phase:
PHASE 1

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C29	INLET	2019 / 08 / 29	-81.802260949	69.378431963

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C29	OUTLET	2019 / 08 / 29	-81.801441999	69.378422033

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C30	INLET	2019 / 08 / 29	-81.800410395	69.377973485

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 1

2019 Assessment Photo

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C30	OUTLET	2019 / 08 / 29	-81.800014483	69.3778938

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 1

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C31	INLET	2019 / 08 / 29	-81.802822708	69.378974972

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 2

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C31	OUTLET	2019 / 08 / 29	-81.802538823	69.378955896

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 2

2019 Assessment Photo

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2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C32	INLET	2019 / 08 / 29	-81.804451645	9.3788443716

Diameter (mm):	Material:	Condition:
500	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 2

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C32	OUTLET	2019 / 08 / 29	-81.804286597	69.378914783

Diameter (mm):	Material:	Condition:
500	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 2

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C33	INLET	2019 / 08 / 29	-81.80451954	69.379314521

Diameter (mm):	Material:	Condition:
500	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 2

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C33	OUTLET	2019 / 08 / 29	-81.804589729	69.379419146

Diameter (mm):	Material:	Condition:
500	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 2

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C34	INLET	2019 / 08 / 29	-81.807789747	9.3780379985

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C34	OUTLET	2019 / 08 / 29	-81.807375702	69.378143919

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C35	INLET	2019 / 08 / 29	-81.807000394	9.3762797316

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C35	OUTLET	2019 / 08 / 29	-81.806768959	69.376278954

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C36	INLET	2019 / 08 / 29	-81.807161618	69.374680917

Diameter (mm):	Material:	Condition:
100	STEEL	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
UPSIZE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C36	OUTLET	2019 / 08 / 29	-81.806877876	69.374695889

Diameter (mm):	Material:	Condition:
100	STEEL	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
UPSIZE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C37	INLET	2019 / 08 / 29	-81.807732676	69.372990464

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C37	OUTLET	2019 / 08 / 29	-81.807356559	69.372950479

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C38	INLET	2019 / 08 / 29	-81.805877066	9.37280809

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C38	OUTLET	2019 / 08 / 29	-81.805458603	69.372790266

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action: REPLACE

Proposed Phase: PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C39	INLET	2019 / 08 / 29	-81.803542171	69.371316366

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 4

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C39	OUTLET	2019 / 08 / 29	-81.803212084	69.371338096

Diameter (mm):	Material:	Condition:
600	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C40	INLET	2019 / 08 / 29	-81.803138401	69.370752305

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C40	OUTLET	2019 / 08 / 29	-81.802698886	69.37073433

Diameter (mm):	Material:	Condition:
300	CSP	FUNCTIONING AS INTENDED

Recommended Action:
NO ACTION REQUIRED

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C41	INLET	2019 / 08 / 29	-81.803004359	69.370262113

Diameter (mm):	Material:	Condition:
600	CSP	REPAIRABLE DAMAGE &

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C41	OUTLET	2019 / 08 / 29	-81.802569287	9.3702595456

Diameter (mm):	Material:	Condition:
600	CSP	REPAIRABLE DAMAGE &

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C42	INLET	2019 / 08 / 29	-81.801126844	69.370267651

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C42	OUTLET	2019 / 08 / 29	-81.800670861	69.370281881

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C43	INLET	2019 / 08 / 29	-81.801138546	69.370583503

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C43	OUTLET	2019 / 08 / 29	-81.800770645	9.3706504884

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C44	INLET	2019 / 08 / 29	-81.80135618	69.370994098

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C44	OUTLET	2019 / 08 / 29	-81.800918788	69.370929267

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action: REPLACE

Proposed Phase: PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C45	INLET	2019 / 08 / 29	-81.801788718	69.371973252

Diameter (mm):	Material:	Condition:
800	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 3

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C45	OUTLET	2019 / 08 / 29	-81.801495832	9.3719730707

Diameter (mm):	Material:	Condition:
800	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 3

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C46	INLET	2019 / 08 / 29	-81.80368604	69.372380724

Diameter (mm):	Material:	Condition:
1050	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 3

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C46	OUTLET	2019 / 08 / 29	-81.80337282	9.3722971056

Diameter (mm):	Material:	Condition:
1050	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 3

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C47	INLET	2019 / 08 / 29	-81.805790303	69.373022636

Diameter (mm):	Material:	Condition:
100	STEEL	PARTLY BLOCKED &

Recommended Action: UPSIZE

Proposed Phase: PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C47	OUTLET	2019 / 08 / 29	-81.805419887	69.373022816

Diameter (mm):	Material:	Condition:
100	STEEL	PARTLY BLOCKED &

Recommended Action:	Proposed Phase:
UPSIZE	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C48	INLET	2019 / 08 / 29	-81.805607148	69.373309006

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C48	OUTLET	2019 / 08 / 29	-81.805326429	69.373289031

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C49	INLET	2019 / 08 / 29	-81.805633937	69.373565556

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

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Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C49	OUTLET	2019 / 08 / 29	-81.805242543	69.37358102

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:	Proposed Phase:
REPAIR	PHASE 4

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TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert: C50

Culvert End: INLET

Date Assessed: 2019 / 08 / 29

Longitude: -81.804828773

Latitude: 69.376147838

Diameter (mm): 600

Material: CSP

Condition: PARTLY BLOCKED &

Recommended Action: CLEAN OUT CULVERT

Proposed Phase: PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C50	OUTLET	2019 / 08 / 29	-81.804501671	69.375999124

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED &

Recommended Action:
CLEAN OUT CULVERT

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C51	INLET	2019 / 08 / 29	-81.80526073	69.375745517

Diameter (mm):	Material:	Condition:
150	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C51	OUTLET	2019 / 08 / 29	-81.804753431	69.375759319

Diameter (mm):	Material:	Condition:
150	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C52	INLET	2019 / 08 / 29	-81.804193073	69.375301919

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 3

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C52	OUTLET	2019 / 08 / 29	-81.804169454	69.375133687

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 3

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C53	INLET	2019 / 08 / 29	-81.801706183	9.3740893413

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C53	OUTLET	2019 / 08 / 29	-81.801205017	9.3740891396

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C54	INLET	2019 / 08 / 29	-81.800858651	9.3740757867

Diameter (mm):	Material:	Condition:
600	CSP	BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C54	OUTLET	2019 / 08 / 29	-81.800590349	69.374039697

Diameter (mm):	Material:	Condition:
600	CSP	BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C55	INLET	2019 / 08 / 29	-81.802300439	69.373576261

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4


2019 Assessment Photo


2019 Assessment Photo


2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C55	OUTLET	2019 / 08 / 29	-81.802091241	69.37351039

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C56	INLET	2019 / 08 / 29	-81.803018711	9.3730839321

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C56	OUTLET	2019 / 08 / 29	-81.802728933	69.373051844

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C57	INLET	2019 / 08 / 29	-81.800888112	69.373159386

Diameter (mm):	Material:	Condition:
	CSP	FUNCTIONING AS INTENDED

Recommended Action:
UPSIZE

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C57	OUTLET	2019 / 08 / 29	-81.800620158	69.373034143

Diameter (mm):	Material:	Condition:
	CSP	FUNCTIONING AS INTENDED

Recommended Action:
UPSIZE

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C58	INLET	2019 / 08 / 29	-81.799759057	69.374157392

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED &

Recommended Action:
CLEAN OUT CULVERT

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C58	OUTLET	2019 / 08 / 29	-81.799280952	69.37415805

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED &

Recommended Action:
CLEAN OUT CULVERT

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C59	INLET	2019 / 08 / 29	-81.799307459	9.3745254728

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C59	OUTLET	2019 / 08 / 29	-81.798887901	69.374478781

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C60	INLET	2019 / 08 / 29	-81.803430013	69.375458934

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C60	OUTLET	2019 / 08 / 29	-81.803004014	69.375471514

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C61	INLET	2019 / 08 / 29	-81.803674679	69.376130632

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C61	OUTLET	2019 / 08 / 29	-81.803304096	69.376127771

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 4

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C62	INLET	2019 / 08 / 29	-81.804160329	69.377116773

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C62	OUTLET	2019 / 08 / 29	-81.803704908	69.377175411

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C63	INLET	2019 / 08 / 29	-81.802984602	69.377268313

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED &

Recommended Action:	Proposed Phase:
CLEAN OUT CULVERT	PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C63	OUTLET	2019 / 08 / 29	-81.802624249	69.377309448

Diameter (mm):	Material:	Condition:
600	CSP	PARTLY BLOCKED &

Recommended Action:
CLEAN OUT CULVERT

Proposed Phase:
PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C64	INLET	2019 / 08 / 29	-81.801769009	69.376553455

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED &

Recommended Action:	Proposed Phase:
CLEAN OUT CULVERT	PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C64	OUTLET	2019 / 08 / 29	-81.801765427	9.3766899655

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED &

Recommended Action:
CLEAN OUT CULVERT

Proposed Phase:
PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C65	INLET	2019 / 08 / 29	-81.799940377	69.376219816

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C65	OUTLET	2019 / 08 / 29	-81.799568235	69.376227617

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C66	INLET	2019 / 08 / 29	-81.797987438	69.375874071

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C66	OUTLET	2019 / 08 / 29	-81.797665407	9.3757859262

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C67	INLET	2019 / 08 / 29	-81.797189174	69.37634894

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C67	OUTLET	2019 / 08 / 29	-81.796575446	69.37637079

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert: C68

Culvert End: INLET

Date Assessed: 2019 / 08 / 29

Longitude: -81.796398739

Latitude: 69.376716607

Diameter (mm): 300

Material: CSP

Condition: BLOCKED & DAMAGED

Recommended Action: REPLACE

Proposed Phase: PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C68	OUTLET	2019 / 08 / 29	-81.795852444	69.376738827

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C69	INLET	2019 / 08 / 29	-81.796022439	69.376909678

Diameter (mm):	Material:	Condition:
800	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C69	OUTLET	2019 / 08 / 29	-81.795782406	69.376825714

Diameter (mm):	Material:	Condition:
800	CSP	FUNCTIONING AS INTENDED

Recommended Action:	Proposed Phase:
NO ACTION REQUIRED	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C70	INLET	2019 / 08 / 29	-81.798339462	69.377240886

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C70	OUTLET	2019 / 08 / 29	-81.798150957	69.377386026

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C71	INLET	2019 / 08 / 29	-81.798017933	69.3774003

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C71	OUTLET	2019 / 08 / 29	-81.797661476	69.37731383

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C72	INLET	2019 / 08 / 29	-81.800999818969.	3.7692022322e+11

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C72	OUTLET	2019 / 08 / 29	-81.800862922	69.377013352

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & REPAIRABLE DAMAGE

Recommended Action:
REPAIR

Proposed Phase:
PHASE 2

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C73	INLET	2019 / 08 / 29	-81.800337494	9.3773255298

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 3

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C73	OUTLET	2019 / 08 / 29	-81.799937439	69.377398344

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 3

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C74	INLET	2019 / 08 / 29	-81.800597157	9.3778273498

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C74	OUTLET	2019 / 08 / 29	-81.800138472	69.37786667

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C75	INLET	2019 / 08 / 29	-81.797707255	69.377620414

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C75	OUTLET	2019 / 08 / 29	-81.797287189	69.37748288

Diameter (mm):	Material:	Condition:
300	CSP	PARTLY BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C76	INLET	2019 / 08 / 29	-81.797463698	69.377791623

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C76	OUTLET	2019 / 08 / 29	-81.797525172	9.3777062922

Diameter (mm):	Material:	Condition:
300	CSP	BLOCKED & DAMAGED

Recommended Action:
REPLACE

Proposed Phase:
PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C77	INLET	2019 / 08 / 29	-81.793460807	69.377687535

Diameter (mm):	Material:	Condition:
100	STEEL	BLOCKED & DAMAGED

Recommended Action:	Proposed Phase:
REPLACE & UPSIZE	PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Igloolik Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C77	OUTLET	2019 / 08 / 29	-81.792952781	69.37757474

Diameter (mm):	Material:	Condition:
100	STEEL	BLOCKED & DAMAGED

Recommended Action: REPLACE & UPSIZE

Proposed Phase: PHASE 1

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

APPENDIX F

SUMMARY OF EXISTING AND PROPOSED CULVERTS

Table F-1: All Culverts Summary Table

Name	Proposed Culvert Action	Phase	Material	Wall Thickness (mm)	Length (m)	Diameter (mm)	Max Flow (m^3/s)	Max. Velocity (m/s)	Max/ Full Flow (%)	Max/ Full Depth (%)
C01	RETAIN	Phase 4	CSP	N/A	15	600	0.039	1.2	0.07	0.17
C02	REPLACE AND UPSIZE	Phase 4	CSP	N/A	18	450	0.063	1.34	0.22	0.34
C03	UPSIZE	Phase 4	CSP	N/A	7	450	0.065	1.5	0.26	0.32
C04	REPLACE AND UPSIZE	Phase 4	CSP	N/A	26	450	0.066	2.12	0.22	0.25
C05	REPLACE	Phase 4	CSP	N/A	19	450	0.07	1.48	0.26	0.34
C06	EXISTING	Phase 4	CSP	N/A	13	450	0.002	0.72	0.01	0.05
C07	REPLACE	Phase 4	CSP	N/A	9	1000	0	0	0	0
C08	REPLACE	Phase 4	CSP	N/A	15	450	0.002	0.41	0.02	0.07
C09	REPAIR OR REPLACE	Phase 4	CSP	N/A	16	450	0.005	0.49	0.04	0.12
C10	REPLACE	Phase 4	CSP	N/A	15	450	0.002	0.44	0.01	0.07
C11	REPAIR OR REPLACE	Phase 4	CSP	N/A	19	450	0.107	1.82	0.39	0.4
C12	EXISTING	Phase 4	CSP	N/A	19	600	0.008	0.74	0.01	0.08
C13	REPLACE	Phase 4	CSP	N/A	18	450	0.008	0.57	0.04	0.14
C14	REPAIR OR REPLACE	Phase 4	CSP	N/A	14	450	0.014	1.07	0.04	0.19
C15	REPAIR OR REPLACE	Phase 4	CSP	N/A	18	450	0.002	0.42	0.01	0.07
C16	REPLACE	Phase 2	CSP	N/A	13	450	0.079	1.69	0.23	0.33
C17	EXISTING	Phase 2	CSP	N/A	14	600	0.021	0.87	0.03	0.14
C18	EXISTING	Phase 2	CSP	N/A	12	450	0.021	1.11	0.08	0.18
C19	UPSIZE	Phase 3	CSP	N/A	16	1050	0.738	2.24	0.69	0.43
C20	REPAIR OR REPLACE	Phase 4	CSP	N/A	14	450	0.013	1.01	0.04	0.14
C21	EXISTING	Phase 4	CSP	N/A	17	600	0.02	0.93	0.02	0.15
C22	REPAIR OR REPLACE	Phase 4	CSP	N/A	15	450	0.018	0.94	0.04	0.19
C23	REPAIR OR REPLACE	Phase 3	CSP	N/A	13	900	0.753	3.23	0.98	0.41
C24	REPAIR OR REPLACE	Phase 3	CSP	N/A	14	450	0.106	1.08	0.46	0.59

Table F-1: All Culverts Summary Table

Name	Proposed Culvert Action	Phase	Material	Wall Thickness (mm)	Length (m)	Diameter (mm)	Max Flow (m^3/s)	Max. Velocity (m/s)	Max/ Full Flow (%)	Max/ Full Depth (%)
C25	EXISTING	Phase 3	CSP	N/A	22	800	0.087	1.72	0.05	0.16
C26	REPAIR OR REPLACE	Phase 1	CSP	N/A	17	450	0.008	0.98	0.02	0.1
C27	REPAIR OR REPLACE	Phase 1	CSP	N/A	11	450	0.006	0.51	0.02	0.12
C28	CLEAN	Phase 1	CSP	N/A	13	450	0.003	0.51	0.01	0.08
C29	REPLACE	Phase 1	CSP	N/A	32	450	0.03	1.96	0.07	0.15
C30	EXISTING	Phase 1	CSP	N/A	18	600	0.035	1.43	0.06	0.14
C31	EXISTING	Phase 2	CSP	N/A	11	600	0	0	0	0
C32	REPLACE	Phase 2	CSP	N/A	10	450	0.02	0.86	0.09	0.21
C33	REPAIR OR REPLACE	Phase 2	CSP	N/A	12	450	0.02	1.01	0.09	0.18
C34	REPAIR OR REPLACE	Phase 4	CSP	N/A	20	450	0.011	0.84	0.04	0.14
C35	REPLACE	Phase 4	CSP	N/A	9	450	0.015	1.18	0.03	0.13
C36	UPSIZE	Phase 4	CSP	N/A	11	450	0.025	1.51	0.06	0.16
C37	REPLACE	Phase 4	CSP	N/A	15	450	0.052	1.59	0.16	0.26
C38	REPLACE	Phase 4	CSP	N/A	17	450	0.053	1.74	0.16	0.25
C39	EXISTING	Phase 4	CSP	N/A	13	600	0.019	1.51	0.02	0.09
C40	EXISTING	Phase 4	CSP	N/A	17	450	0.012	1.51	0.02	0.1
C41	REPAIR OR REPLACE	Phase 4	CSP	N/A	17	450	0.015	0.66	0.03	0.26
C42	REPAIR OR REPLACE	Phase 4	CSP	N/A	18	450	0.025	1.18	0.05	0.2
C43	REPLACE	Phase 4	CSP	N/A	16	450	0.002	0.73	0.01	0.05
C44	REPLACE	Phase 4	CSP	N/A	19	450	0.013	1.11	0.03	0.13
C45	REPAIR OR REPLACE	Phase 4	CSP	N/A	12	500	0.185	4.15	0.2	0.28
C46	REPAIR OR REPLACE	Phase 4	CSP	N/A	15	500	0.16	3.21	0.24	0.3
C47	CLEAN	Phase 4	CSP	N/A	15	450	0.007	0.33	0.05	0.33
C48	REPLACE	Phase 4	CSP	N/A	11	450	0.018	1.62	0.04	0.12
C49	REPAIR OR REPLACE	Phase 4	CSP	N/A	15	450	0.005	0.82	0.01	0.08

Table F-1: All Culverts Summary Table

Name	Proposed Culvert Action	Phase	Material	Wall Thickness (mm)	Length (m)	Diameter (mm)	Max Flow (m^3/s)	Max. Velocity (m/s)	Max/ Full Flow (%)	Max/ Full Depth (%)
C50	CLEAN	Phase 4	CSP	N/A	21	450	0.024	0.77	0.14	0.25
C51	REPLACE AND UPSIZE	Phase 4	CSP	N/A	20	450	0.005	0.61	0.03	0.1
C52	REPLACE	Phase 4	CSP	N/A	21	450	0.035	0.89	0.21	0.3
C53	REPLACE	Phase 4	CSP	N/A	20	450	0.012	1.24	0.05	0.11
C54	REPAIR OR REPLACE	Phase 4	CSP	N/A	9	450	0.014	0.74	0.02	0.18
C55	REPLACE	Phase 4	CSP	N/A	11	450	0.001	0.96	0	0.03
C56	REPLACE	Phase 4	CSP	N/A	12	450	0.004	1.1	0.01	0.06
C57	EXISTING	Phase 4	CSP	N/A	18	200	0.014	1.21	0.33	0.39
C58	CLEAN	Phase 4	CSP	N/A	19	450	0.014	1.03	0.04	0.15
C59	REPLACE	Phase 4	CSP	N/A	17	450	0.008	0.86	0.02	0.11
C60	REPLACE	Phase 4	CSP	N/A	17	450	0	0	0	0
C61	REPLACE	Phase 4	CSP	N/A	15	450	0.002	0.62	0.01	0.05
C62	REPLACE	Phase 2	CSP	N/A	19	450	0	0	0	0.03
C63	CLEAN	Phase 2	CSP	N/A	15	450	0.002	0.86	0	0.04
C64	CLEAN	Phase 2	CSP	N/A	15	450	0.005	0.57	0.02	0.1
C65	REPLACE	Phase 1	CSP	N/A	15	450	0.008	1.35	0.01	0.08
C66	REPLACE	Phase 1	CSP	N/A	16	450	0.017	0.87	0.06	0.18
C67	REPLACE	Phase 1	CSP	N/A	24	450	0.01	0.85	0.03	0.14
C68	REPLACE	Phase 1	CSP	N/A	22	450	0	0	0	0
C69	EXISTING	Phase 1	CSP	N/A	13	800	0.073	1.41	0.05	0.16
C70	REPLACE	Phase 1	CSP	N/A	18	450	0.02	1.31	0.08	0.16
C71	REPLACE AND UPSIZE	Phase 1	CSP	N/A	17	450	0.066	1.62	0.39	0.3
C72	REPAIR OR REPLACE	Phase 2	CSP	N/A	12	450	0.008	0.84	0.02	0.11
C73	REPLACE	Phase 3	CSP	N/A	18	450	0.014	1.06	0.04	0.14
C74	REPLACE	Phase 1	CSP	N/A	19	450	0.001	0.88	0	0.03
C75	REPLACE	Phase 1	CSP	N/A	12	1000	0	0	0	0
C76	REPLACE	Phase 1	CSP	N/A	10	450	0.012	0.47	0.08	0.21

Table F-1: All Culverts Summary Table

Name	Proposed Culvert Action	Phase	Material	Wall Thickness (mm)	Length (m)	Diameter (mm)	Max Flow (m^3/s)	Max. Velocity (m/s)	Max/ Full Flow (%)	Max/ Full Depth (%)
C77	REPLACE AND UPSIZE	Phase 1	CSP	N/A	24	450	0.007	0.61	0.03	0.13
C78 NEW	New- Existing Community	Phase 4	SWSP	10-12	21	450	0.004	0.47	1%	9%
C79 NEW	New- Existing Community	Phase 4	SWSP	10-12	21	450	0.003	0.41	2%	9%
C80 NEW	New- Existing Community	Phase 4	SWSP	10-12	13	450	0.108	0.68	37%	100%
C81 NEW	New- Existing Community	Phase 4	SWSP	10-12	12	450	0.012	0.83	4%	100%
C82 NEW	New- Existing Community	Phase 4	SWSP	10-12	12	450	0.074	1.09	24%	44%
C83 NEW	New- Existing Community	Phase 3	SWSP	10-12	12	450	0.003	0.63	1%	7%
C85 NEW	New- Existing Community	Phase 4	SWSP	10-12	18	450	0.005	0.99	1%	7%
C86 NEW	New- Existing Community	Phase 4	SWSP	10-12	18	450	0.027	1.21	4%	20%
C87 NEW	New- Existing Community	Phase 1	SWSP	10-12	12	450	0.003	1.01	1%	5%
C88 NEW	New- Existing Community	Phase 4	SWSP	10-12	22	450	0.017	1.2	4%	14%
C89 NEW	New- Existing Community	Phase 1	SWSP	10-12	12	450	0.002	0.4	1%	8%
C90 NEW	New- Existing Community	Phase 4	SWSP	10-12	12	450	0.016	0.92	5%	17%
C91N EW	New- Existing Community	Phase 4	SWSP	10-12	21	450	0.065	2.21	18%	24%
C101 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.009	0.83	3%	100%
C102 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.009	1.12	1%	10%
C103 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.113	3.75	16%	24%
C104 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.113	8.05	9%	14%

Table F-1: All Culverts Summary Table

Name	Proposed Culvert Action	Phase	Material	Wall Thickness (mm)	Length (m)	Diameter (mm)	Max Flow (m^3/s)	Max. Velocity (m/s)	Max/ Full Flow (%)	Max/ Full Depth (%)
C105 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.113	3.75	16%	24%
C106 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.005	1.65	16%	5%
C107 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.05	2.52	10%	18%
C108 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.022	2.09	4%	12%
C109 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.05	1.95	18%	25%
C110 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.015	0.95	5%	15%
C111 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.017	1.2	4%	14%
C112 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.029	1.48	7%	18%
C113 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.089	2.72	16%	26%
C114 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.06	1.95	18%	25%
C115 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.011	1.15	3%	11%
C116 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.1	3.1	16%	26%
C118 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.044	2.69	1%	5%
C119 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.072	3.97	1%	6%
C120 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.086	1.29	3%	14%

Table F-1: All Culverts Summary Table

Name	Proposed Culvert Action	Phase	Material	Wall Thickness (mm)	Length (m)	Diameter (mm)	Max Flow (m³/s)	Max. Velocity (m/s)	Max/ Full Flow (%)	Max/ Full Depth (%)
C121 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.05	1.55	4%	26%
C122 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.01	1.12	3%	11%
C123 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.011	1.08	3%	12%
C124 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.015	0.95	5%	15%
C125 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.012	1.07	2%	13%
C126 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.045	2.34	7%	18%
C127 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.03	1.72	6%	17%
C128 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	900	0.599	1.91	14%	57%
C129 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.05	1.95	18%	25%
C130 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.011	1.15	3%	11%
C131 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.01	1.11	2%	11%
C132 NEW	New - Community Expansion	Phase 5	SWSP	10-12	20	450	0.011	1.08	3%	12%
C133 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.015	1.05	5%	14%
C134 NEW	New - Community Expansion	Phase 5	SWSP	10-12	15	450	0.05	1.95	18%	25%

Table F-2: New Culvert Apron Riprap Volumes - Including Inlet & Outlet Protection

					Inlet			Outlet			Total
Name	Proposed Phase	Diameter (mm)	Riprap Class (kg)	Riprap Thickness (mm)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Total Riprap Volume (m3)
C02	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C03	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C04	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C05	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C07	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C08	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C10	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C13	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C16	Phase 2	900	10	350	4.2	2.7	3.2	6.9	2.7	4.9	8.1
C19	Phase 3	900	10	350	4.2	2.7	3.2	6.9	2.7	4.9	8.1
C23	Phase 3	900	10	350	4.2	2.7	3.2	6.9	2.7	4.9	8.1
C29	Phase 1	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C32	Phase 2	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C35	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C36	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C37	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C38	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C43	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C44	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C47	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C48	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C51	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C52	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C53	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C55	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C56	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C57	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0

Table F-2: New Culvert Apron Riprap Volumes - Including Inlet & Outlet Protection

					Inlet			Outlet			Total
Name	Proposed Phase	Diameter (mm)	Riprap Class (kg)	Riprap Thickness (mm)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Total Riprap Volume (m3)
C59	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C60	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C61	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C62	Phase 2	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C65	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C66	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C67	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C68	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C70	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C71	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C73	Phase 3	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C74	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C75	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C76	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C77	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C78	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C79	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C80	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C81	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C82	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C83	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C86	Phase 4	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C87	Phase 1	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C88	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C89	Phase 1	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C90	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C91	Phase 4	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0

Table F-2: New Culvert Apron Riprap Volumes - Including Inlet & Outlet Protection

					Inlet			Outlet			Total
Name	Proposed Phase	Diameter (mm)	Riprap Class (kg)	Riprap Thickness (mm)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Total Riprap Volume (m3)
C101	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C102	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C103	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C104	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C105	Phase 5	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C106	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C107	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C108	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C109	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C110	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C111	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C112	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C113	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C114	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C115	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C116	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C118	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C119	Phase 5	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C120	Phase 5	600	10	350	2.8	1.8	1.4	4.6	1.8	2.2	3.6
C121	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C122	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C123	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C124	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C125	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C126	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C127	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C128	Phase 5	900	10	350	4.2	2.7	3.2	6.9	2.7	4.9	8.1

Table F-2: New Culvert Apron Riprap Volumes - Including Inlet & Outlet Protection

					Inlet			Outlet			Total
Name	Proposed Phase	Diameter (mm)	Riprap Class (kg)	Riprap Thickness (mm)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Riprap Length (m)	Riprap Width (m)	Riprap Volume (m3)	Total Riprap Volume (m3)
C129	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C130	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C131	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C132	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C133	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
C134	Phase 5	450	10	350	2.1	1.1	0.8	3.5	1.1	1.2	2.0
	Total Volume Riprap for Culvert Aprons (m^3):										**220.8**

Table F-3: New Culverts Apron Geotextile Quantities (Including Inlet and Outlet Protection)

			Inlet			Outlet			
Name	Phase	Diameter (mm)	Riprap Length (m)	Riprap Width (m)	Geotextile Area (m2)	Riprap Length (m)	Riprap Width (m)	Geotextile Area (m2)	Total Geotextile Area (m2)
C02	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C03	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C04	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C05	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C07	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C08	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C10	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C13	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C16	Phase 2	900	2.7	4.2	11.6	2.7	6.9	17.8	20.5
C19	Phase 3	900	2.7	4.2	11.6	2.7	6.9	17.8	20.5
C23	Phase 3	900	2.7	4.2	11.6	2.7	6.9	17.8	20.5
C29	Phase 1	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C32	Phase 2	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C35	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C36	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C37	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C38	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C43	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C44	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C47	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C48	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C51	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C52	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C53	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C55	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C56	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C57	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C59	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8

Table F-3: New Culverts Apron Geotextile Quantities (Including Inlet and Outlet Protection)

			Inlet			Outlet			
Name	Phase	Diameter (mm)	Riprap Length (m)	Riprap Width (m)	Geotextile Area (m2)	Riprap Length (m)	Riprap Width (m)	Geotextile Area (m2)	Total Geotextile Area (m2)
C60	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C61	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C62	Phase 2	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C65	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C66	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C67	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C68	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C70	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C71	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C73	Phase 3	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C74	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C75	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C76	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C77	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C78	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C79	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C80	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C81	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C82	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C83	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C86	Phase 4	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C87	Phase 1	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C88	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C89	Phase 1	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C90	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C91	Phase 4	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C101	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C102	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8

Table F-3: New Culverts Apron Geotextile Quantities (Including Inlet and Outlet Protection)

			Inlet			Outlet			
Name	Phase	Diameter (mm)	Riprap Length (m)	Riprap Width (m)	Geotextile Area (m2)	Riprap Length (m)	Riprap Width (m)	Geotextile Area (m2)	Total Geotextile Area (m2)
C103	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C104	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C105	Phase 5	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C106	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C107	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C108	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C109	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C110	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C111	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C112	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C113	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C114	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C115	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C116	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C118	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C119	Phase 5	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C120	Phase 5	600	1.8	2.8	5.7	1.8	4.6	8.7	10.5
C121	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C122	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C123	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C124	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C125	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C126	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C127	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C128	Phase 5	900	2.7	4.2	11.6	2.7	6.9	17.8	20.5
C129	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C130	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C131	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8

Table F-3: New Culverts Apron Geotextile Quantities (Including Inlet and Outlet Protection)

			Inlet			Outlet			
Name	**Phase**	**Diameter (mm)**	**Riprap Length (m)**	**Riprap Width (m)**	**Geotextile Area (m2)**	**Riprap Length (m)**	**Riprap Width (m)**	**Geotextile Area (m2)**	**Total Geotextile Area (m2)**
C132	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C133	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
C134	Phase 5	450	1.4	2.1	3.5	1.4	3.5	5.4	6.8
	Total Geotextile Area for Culvert Aprons (m2):								**698**

APPENDIX G

PCSWMM MODEL PARAMETERS

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S1	J115	1.7	56.0	296.9	3.1	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S2	c39in	0.5	21.4	223.0	8.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S3	J108	1.4	83.8	171.8	5.7	10	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S4	J1454	0.4	13.7	258.9	5.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S5	J147	0.4	22.5	181.9	6.2	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S6	J116	1.9	124.5	155.8	3.4	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S7	J209	0.2	6.4	244.1	8.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S8	J1731	0.4	17.6	236.1	9.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S9	J1684	0.2	8.6	227.3	8.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S10	J191	0.1	2.0	373.4	12.9	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S11	c15in	0.3	21.5	147.1	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S12	J144	0.9	35.4	244.0	6.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S13	c18in	1.7	104.0	166.3	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S14	J82	1.5	90.8	166.3	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S15	J86	0.4	26.0	166.3	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S16	c18in	1.3	77.8	166.3	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S17	J1383	1.0	45.2	227.1	4.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S18	c22in	0.7	68.8	102.1	4.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S19	J1383	0.4	41.8	104.9	4.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S20	c13out	0.3	30.0	114.5	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S21	J2852	0.5	65.0	80.4	3.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S22	c40in	0.2	20.7	97.5	9.2	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S23	J25	0.2	11.9	196.8	4.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S24	J29	0.4	30.7	123.9	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S25	J285	0.5	41.6	122.2	3.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S26	J30	0.2	11.3	206.1	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S27	J3	0.4	47.5	78.0	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S28	J23	0.3	17.2	195.0	4.7	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S29	J156	1.9	78.4	242.1	7.2	20	0.01	0.35	0.05	2	0.1	0.01	4	6
S30	J121	2.6	108.1	242.1	7.2	20	0.01	0.35	0.05	2	0.1	0.01	4	6
S31	J155	3.3	135.6	242.1	7.2	20	0.01	0.35	0.05	2	0.1	0.01	4	6
S32	J1216	1.1	86.9	126.0	3.5	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S33	J61	1.3	55.0	244.9	5.4	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S34	J66	0.8	55.8	152.2	4.6	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S35	S22	0.3	12.7	234.6	8.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S36	main_drainage_line	1.4	134.3	101.2	4.2	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S37	J64	0.8	64.6	124.4	4.1	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S38	J12	0.5	48.2	94.2	4.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S39	J90	0.8	32.0	241.9	5.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S40	J70	0.2	18.5	116.0	4.2	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S41	J117	0.2	19.0	116.0	4.2	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S42	J11	0.4	52.9	79.1	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S43	J188	0.3	21.9	156.1	10.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S44	J126	0.9	59.3	156.1	10.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S45	c20in	1.9	74.8	258.1	4.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S46	c19in	0.7	62.1	118.8	5.3	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S47	J164	0.3	11.5	238.6	9.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S48	c64in	0.5	19.4	238.6	9.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S49	c51in	0.5	17.1	275.2	8.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S50	J38	0.5	51.2	93.2	4.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S51	J130	0.8	41.3	198.6	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S52	J1304	2.6	110.5	236.4	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S53	J119	0.6	33.9	177.4	3.6	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S54	J120	2.7	112.1	239.7	3.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S55	J1111	1.4	141.8	95.7	5.8	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S56	J85	0.7	32.1	226.2	3.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S57	J122	1.2	70.9	174.2	4.5	10	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S58	J129	0.7	21.5	334.4	3.3	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S59	J106	0.4	31.4	139.1	4.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S60	c66in	0.2	110.0	22.2	6.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S61	J198	1.1	29.1	372.0	9.8	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S62	J134	0.7	22.8	325.1	6.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S63	c73in	0.4	18.4	210.7	6.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S64	J223	0.5	29.2	165.3	26.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S65	c53in	0.4	21.5	165.3	26.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S66	J173	0.5	35.2	154.8	15.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S67	J174	0.5	21.0	216.5	17.4	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S68	J344	1.6	113.0	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S69	S8	0.7	52.0	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S70	1013_2	1.0	73.7	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S71	S97	1.7	123.0	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S72	965_3	1.6	115.1	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S73	J1721	17.8	1262.2	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S74	S97	1.1	75.8	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S75	J362	0.9	66.3	141.4	7.0	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S76	J153	0.5	41.3	117.3	8.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S77	c65in	0.6	31.2	200.6	8.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S78	J1104	7.2	446.7	162.2	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S79	J1093	10.6	650.8	162.2	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S80	J1039	19.4	1197.6	162.2	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S81	J2910	21.7	1335.3	162.2	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S82	J895	9.2	569.4	162.2	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S83	J2962	22.9	1414.0	162.2	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S84	J1400	17.3	1064.7	162.2	3.4	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S85	J1362	1.0	40.8	238.6	5.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S86	S3_5	1.4	138.2	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S87	J244	1.9	193.3	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S88	J246	3.4	345.0	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S89	OF8	5.3	534.2	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S90	J20	2.7	265.3	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S91	S25_8	2.0	197.2	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S92	J963	1.2	120.0	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S93	J903	17.9	1358.0	132.1	9.2	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S94	S64	1.0	104.7	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S95	S60	2.4	243.5	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S96	S19	1.8	181.1	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S97	S59	1.5	154.6	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S98	J963	1.9	189.3	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S99	S69_2	1.4	139.9	100.0	0.5	25	0.01	0.35	0.05	2	0.1	0.01	4	6
S100	J1037	7.6	571.5	132.1	9.2	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S101	OF7	1.7	175.0	100.0	0.5	10	0.01	0.1	0.05	2	0.1	0.01	4	7
S102	J70	1.1	65.5	166.0	4.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S103	potential_culvert	0.5	31.4	167.2	20.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S104	J9999	0.6	30.5	197.7	5.2	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S105	S54_1	7.4	351.5	210.3	9.7	0	0.01	0.35	0.05	2	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S106	J145	0.3	11.0	240.2	6.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S107	c46in	0.4	22.5	186.7	8.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S108	c42in	0.7	66.4	107.3	16.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S109	J6	1.3	94.0	138.3	4.1	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S110	J3178	0.7	70.4	93.9	18.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S111	J207	0.4	20.2	180.4	29.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S112	OF5	0.5	34.2	133.2	6.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S113	J190	0.3	9.4	319.6	12.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S114	J187	0.6	50.6	126.9	29.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S115	J211	0.5	56.2	97.1	17.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S116	J203	0.1	3.1	395.8	11.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S117	J203	0.2	5.6	299.4	15.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S118	OF7	2.1	211.3	100.0	0.5	25	0.01	0.1	0.05	2	0.1	0.01	4	7
S119	OF7	2.3	226.4	100.0	0.5	10	0.01	0.1	0.05	2	0.1	0.01	4	7
S120	c37in	2.1	131.8	160.3	12.7	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S121	J192	0.5	28.6	160.3	12.7	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S122	J183	2.7	171.4	160.3	12.7	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S123	potential_ culvert	1.2	72.0	160.3	12.7	0	0.01	0.35	0.05	2	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S124	potential_ culvert	0.9	46.2	199.3	9.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S125	c37in	6.9	427.8	160.3	12.7	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S126	J162	1.4	71.6	199.3	9.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S127	swale_	1.3	63.9	199.3	9.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S128	OF7	2.0	196.4	100.0	0.5	10	0.01	0.1	0.05	2	0.1	0.01	4	7
S129	J183	1.5	95.7	160.3	12.7	0	0.01	0.35	0.05	2	0.1	0.01	4	6
S130	J201	0.1	4.2	309.3	8.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S131	S22	0.3	7.3	379.7	7.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S132	S11	0.1	3.9	331.0	14.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S133	J205	0.2	19.8	112.9	9.4	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S134	J205	0.3	30.3	112.9	9.4	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S135	c49in	0.3	13.7	239.8	6.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S136	S28	0.2	7.8	239.8	6.6	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S137	950_3	0.3	10.6	239.8	6.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S138	c54in	0.3	12.3	276.0	14.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S139	J3139	0.4	14.4	276.0	14.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S140	J223	0.4	14.7	276.0	14.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S141	J215	0.4	16.0	276.0	14.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S142	J167	0.6	43.3	127.1	6.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S143	c51in	0.4	12.8	283.6	8.7	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S144	J218	0.4	17.0	214.4	6.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S145	c72in	0.5	22.4	214.4	6.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S146	c70in	0.3	12.9	241.0	6.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S147	c62out	0.3	12.1	241.0	6.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S148	c76out	0.2	7.9	314.5	7.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S149	J160	0.4	11.7	314.5	7.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S150	J217	0.3	15.2	178.7	6.6	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S151	J3121	0.3	18.0	162.2	3.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S152	J4	0.9	55.1	162.2	3.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S153	J5666	0.2	9.9	224.3	4.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S154	J36	0.2	9.4	224.3	4.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S155	J133	0.5	23.5	197.3	3.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S156	J51	0.2	11.6	153.0	3.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S157	J38	0.3	19.6	153.0	3.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S158	c30in	0.8	23.0	329.6	6.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S159	J159	0.2	6.2	329.6	6.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S160	c77in	0.1	3.8	329.6	6.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S161	J1454	0.3	8.2	329.6	6.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S162	J1	0.2	19.2	95.9	4.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S163	c28in	0.4	14.6	288.4	5.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S164	J133	0.5	17.2	288.4	5.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S165	J53	0.3	13.5	231.6	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S166	J1358	0.4	16.8	231.6	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S167	J36	0.5	20.8	231.6	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S168	J4	1.0	34.6	280.5	3.5	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S169	J3161	0.4	13.9	323.4	3.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S170	J4	0.7	29.0	228.6	11.0	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S171	S54_1	0.5	25.4	197.9	4.0	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S172	J3228	0.3	56.5	44.3	1.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S173	OF6	0.4	145.7	29.6	3.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S174	c14in	0.2	22.7	106.8	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S175	J3157	1.2	112.7	106.8	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S176	J212	0.7	47.4	138.8	11.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S177	J1578	1.3	94.9	138.8	11.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S178	J3161	0.2	13.5	139.9	6.2	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S179	J210	0.2	34.2	72.0	9.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S180	J2909	0.7	94.2	72.0	9.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S181	S51	0.3	62.7	55.3	4.8	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S182	c45in	0.3	16.9	183.9	9.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S183	J1700	0.3	16.0	183.9	9.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S184	c45in	0.3	11.1	253.5	8.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S185	J1715	0.3	10.8	253.5	8.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S186	J201	0.2	16.5	138.1	9.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S187	J200	0.1	7.0	210.2	8.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S188	J1756	0.2	9.1	210.2	8.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S189	c43in	0.4	40.0	88.7	9.2	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S190	OF3	0.7	77.7	88.7	9.2	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S191	J3195	0.6	125.0	47.8	10.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S192	J3195	0.3	27.8	98.9	16.8	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S193	c55in	0.2	22.8	87.5	17.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S194	J125	1.0	76.0	132.1	6.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S195	J3161	0.1	9.2	132.1	6.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S196	J1250	0.2	25.7	83.1	4.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S197	J193	0.1	9.0	99.5	24.3	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S198	c47in	0.2	21.0	99.5	24.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S199	J185	0.2	21.6	99.5	24.3	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S200	c48in	0.2	22.5	99.5	24.3	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S201	c49in	0.4	35.2	99.5	24.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S202	J224	0.3	29.8	99.5	24.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S203	c38in	0.1	13.3	99.5	24.3	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S204	c56in	0.3	28.4	99.5	24.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S205	c21in	0.2	15.5	120.3	3.4	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S206	J3121	0.2	11.8	145.9	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S207	J10	0.6	41.6	145.9	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S208	J4	0.6	38.5	145.9	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S209	J3121	0.3	46.4	56.3	3.6	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S210	J132	0.4	30.5	138.0	5.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S211	c27out	0.4	27.9	138.0	5.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S212	J170	0.1	5.3	163.4	17.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S213	J1576	0.3	20.6	163.4	17.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S214	OF1	0.2	17.2	92.6	6.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S215	c53in	0.2	13.4	178.5	30.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S216	J81	0.5	35.4	146.6	4.9	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S217	J2963	0.5	51.6	91.7	4.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S218	J34	0.2	25.5	91.7	4.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S219	J2	0.1	11.5	90.9	5.1	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S220	1684_5	0.7	28.6	234.0	5.5	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S221	J42	0.1	15.0	72.7	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S222	J1358	0.5	65.9	72.7	3.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S223	J69	0.1	7.2	142.8	3.9	0	0.01	0.095	0.05	1	0.1	0.01	4	6
S224	J175	0.2	9.4	247.6	9.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S225	J150	0.5	20.5	247.6	9.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S226	J149	0.6	23.7	247.6	9.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S227	OF6	0.4	16.3	247.6	9.7	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S228	J213	0.3	15.6	163.4	9.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S229	J167	0.4	25.1	163.4	9.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S230	c3in	0.4	35.3	111.8	4.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S231	c8in	0.3	26.9	111.8	4.1	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-1: Subcatchment PCSWMM Model Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Max. Infil. Rate (mm/hr)	Min. Infil. Rate (mm/hr)	Decay Constant (1/hr)	Drying Time (days)
S232	J169	0.4	19.3	201.6	23.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S233	J3118	0.3	15.6	201.6	23.3	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S234	c32in	0.2	19.5	122.4	7.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S235	J45	0.3	29.1	110.2	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S236	J26	0.3	23.6	110.2	4.0	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S237	c44in	0.2	3.0	524.2	9.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S238	c44in	0.1	2.6	524.3	9.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6
S239	c40in	0.1	1.7	524.1	9.5	20	0.01	0.025	0.05	0.5	0.1	0.01	4	6

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
c10in	469204.1	7696840	3.89	5.89
c10out	469200.6	7696824	3.546	5.546
c11in	469172	7696854	3.556	5.556
c11out	469167.8	7696835	3.059	5.059
c12in	469072.1	7696850	3.6	5.6
c12out	469088.4	7696839	3	5
c13in	469090.2	7696834	2.6	4.6
c13out	469095.7	7696817	2.309	4.309
c14in	469104	7696781	1.906	3.906
c14out	469109.2	7696768	1.397	3.397
c15in	469124.1	7696871	4.166	6.166
c15out	469128.2	7696853	3.787	5.787
c16in	468628.3	7696905	10.654	12.654
c16out	468640.5	7696903	10.137	12.137
c17in	468621.9	7696927	11.195	13.195
c17out	468624.8	7696914	10.83	12.83
c18in	468612.6	7696946	11.965	13.965
c18out	468611.2	7696933	11.651	13.651
c19in	468760.2	7696949	7.374	9.374
c19out	468771.6	7696937	7.161	9.161
c1in	469201.5	7696998	8.562	10.562
c1out	469194.6	7696984	8.243	10.243
c20in	468965.4	7696801	2.948	4.948
c20out	468974.8	7696790	2.349	4.349
c21in	469031.3	7696749	1.482	3.482
c21out	469038.1	7696733	0.505	2.505
c22in	468986.6	7696747	1.326	3.326
c22out	468984.7	7696733	0.532	2.532
c23in	468902.3	7696749	0.558	2.558
c23out	468907.9	7696737	0.358	2.358
c24in	468862	7696711	1.247	3.247

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
c24out	468869.6	7696699	1	3
c25in	468708.1	7696867	8.005	10.005
c25out	468715.7	7696846	6.648	8.648
c26in	468694.7	7696818	7.975	9.975
c26out	468709.4	7696825	6.868	8.868
c27in	468641.4	7696854	9.648	11.648
c27out	468651.8	7696850	9.4	11.4
c28in	468522.8	7696777	13.952	15.952
c28out	468532	7696787	13.369	15.369
c29in	468467.3	7696767	17.911	19.911
c29out	468499.4	7696765	15.643	17.643
c2in	469377.3	7696957	8.897	10.897
c2out	469377.6	7696938	8.378	10.378
c30in	468539.3	7696714	13.236	15.236
c30out	468554.8	7696705	12.79	14.79
c31in	468446	7696827	17.517	19.517
c31out	468457.1	7696825	17.107	19.107
c32in	468381.8	7696814	20.18	22.18
c32out	468388.4	7696821	20	22
c33in	468379.8	7696866	19.33	21.33
c33out	468377.2	7696878	19.1	21.1
c34in	468249.4	7696725	26.981	28.981
c34out	468265.8	7696737	26.355	28.355
c35in	468277.8	7696529	30.895	32.895
c35out	468286.9	7696529	30.198	32.198
c36in	468269.2	7696351	31.1	33.1
c36out	468280.3	7696352	30.388	32.388
c37in	468244.2	7696163	27.95	29.95
c37out	468258.9	7696158	27.392	29.392
c38in	468316.9	7696141	24.715	26.715
c38out	468333.3	7696139	24.043	26.043

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
c39in	468406.5	7695974	18.016	20.016
c39out	468419.5	7695976	16.733	18.733
c3in	469376.9	7696910	7.918	9.918
c3out	469378.3	7696903	7.765	9.765
c40in	468421.6	7695911	17.019	19.019
c40out	468438.8	7695908	15.162	17.162
c41in	468426.1	7695856	11.659	13.659
c41out	468443.2	7695855	10.292	12.292
c42in	468499.9	7695856	5.818	7.818
c42out	468517.9	7695857	4.373	6.373
c43in	468499.9	7695891	8.474	10.474
c43out	468514.5	7695898	7.47	9.47
c44in	468492	7695937	9.72	11.72
c44out	468509.1	7695929	8.408	10.408
c45in	468476.4	7696046	11.139	13.139
c45out	468487.9	7696046	9.14	11.14
c46in	468402.4	7696093	18.691	20.691
c46out	468414.6	7696083	17.321	19.321
c47in	468320.6	7696165	21.579	23.579
c47out	468335.2	7696165	21.45	23.45
c48in	468328.2	7696197	25	27
c48out	468339.3	7696195	24	26
c49in	468327.6	7696226	24.79	26.79
c49out	468343	7696227	23.969	25.969
c4in	469380.8	7696883	6.729	8.729
c4out_-_runs_over_road_due_to_blocked_inlet	469382	7696858	5.867	7.867
c50in	468363	7696513	25.523	27.523
c50out	468375.6	7696496	25.31	27.31
c51in	468345.4	7696469	25.647	27.647
c51out	468365.4	7696470	25.399	27.399
c52out	468387.4	7696400	24.453	26.453

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
c53in	468482.7	7696282	13.577	15.577
c53out	468502.4	7696282	13.119	15.119
c54in	468516.7	7696276	12.148	14.148
c54out	468525	7696271	10.908	12.908
c55in	468458.6	7696225	16.172	18.172
c55out	468466.8	7696218	15.076	17.076
c56in	468429.7	7696171	12.956	14.956
c56out	468441	7696167	11.05	13.05
c57in	468513.5	7696178	5	7
c57out	468523.9	7696164	4.2	6.2
c58in	468565.5	7696288	8.965	10.965
c58out	468578.2	7696288	7.862	9.862
c59in	468577.7	7696329	8.7	10.7
c59out	468594.1	7696324	7.953	9.953
c5in	469384	7696805	3.284	5.284
c5out	469378.3	7696787	2.797	4.797
c60in	468417	7696436	21.228	23.228
c60out	468433.7	7696437	21.05	23.05
c61in	468408.3	7696511	23.8	25.8
c61out	468422.9	7696510	23.5	25.5
c62in	468390.7	7696621	24.038	26.038
c62out	468408.7	7696627	23.58	25.58
c63in	468437.1	7696637	21.627	23.627
c63out	468451.4	7696642	20.759	22.759
c64in	468483.9	7696557	18.872	20.872
c64out	468484.2	7696572	18.6	20.6
c65in	468555.3	7696519	13.25	15.25
c65out	468569.9	7696519	11.859	13.859
c66in	468631.5	7696479	5.1	7.1
c66out	468644.1	7696469	4.708	6.708
c67in	468663.6	7696532	3.955	5.955

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
c67out	468687.7	7696534	2.892	4.892
c68in	468695.2	7696572	4.036	6.036
c68out	468716.7	7696574	3.219	5.219
c69in	468710.3	7696594	2.862	4.862
c69out	468719.6	7696584	2.395	4.395
c6in	469442.1	7696802	4.2	6.2
c6out	469440.9	7696789	3.576	5.576
c70in	468619.7	7696632	8.846	10.846
c70out	468627.3	7696648	8.418	10.418
c71in	468634.5	7696648	7.5	9.5
c71out	468646.4	7696640	7.282	9.282
c72in	468514.6	7696597	16.866	18.866
c72out	468520.2	7696608	16.421	18.421
c73in	468541.3	7696642	13.5	15.5
c73out	468557.1	7696650	12.836	14.836
c74in	468531.8	7696698	14.077	16.077
c74out	468549.9	7696702	12.839	14.839
c76in	468654.9	7696693	7.708	9.708
c76out	468655.6	7696683	7.642	9.642
c77in	468812.1	7696679	1.8	3.8
c77out	468831.9	7696666	1.34	3.34
c8in	469362.1	7696804	3.304	5.304
c8out	469360.6	7696789	3.242	5.242
c9in	469274.1	7696817	3.54	5.54
c9out	469273.4	7696800	3.407	5.407
J1	469402	7696880	6.922	8.922
J10	469534	7696808	4.552	6.552
J100	468989.1	7696813	3.304	5.304
J1007	468029.6	7697494	24	26
J1009	468328.2	7697399	22.139	24.139
J101	468811.6	7696988	10.493	12.493

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J102	468801.8	7696972	9.862	11.862
J103	468850.5	7696916	7.416	9.416
J1034	468298.3	7697433	22.848	24.848
J1037	468464.1	7697261	19.078	21.078
J1039	467816.5	7697389	26.349	28.349
J104	468899.7	7696848	4.884	6.884
J1045	469009.8	7697054	10.825	12.825
J105	468944.2	7696790	3.4	5.4
J106	468808.8	7696897	6.742	8.742
J1063	468779.1	7697225	16.35	18.35
J107	468846.4	7696842	3.666	5.666
J108	468875.1	7696784	1.734	3.734
J1081	469393.8	7697293	20.225	22.225
J109	468252.1	7697338	23.723	25.723
J1093	468435.3	7697263	19.2	21.2
J1099	467763	7697275	26.787	28.787
J11	469472.7	7696804	4.4	6.4
J110	468337.3	7697243	22.666	24.666
J1104	468108.9	7697275	23.5	25.5
J111	468348.7	7697232	22.305	24.305
J1111	468696.8	7697079	11.735	13.735
J1113	467932.8	7697274	25.086	27.086
J1117	468792.5	7697239	16.953	18.953
J1119	467906.1	7697247	25.375	27.375
J112	468740.5	7697124	12.743	14.743
J113	468737.8	7697098	12.682	14.682
J1137	467803.1	7697212	26.054	28.054
J114	468719.7	7697050	11	13
J1140	468477.5	7697209	18.309	20.309
J1146	467846.4	7697201	25.704	27.704
J115	468534.3	7697070	15.694	17.694

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J1150	467824.7	7697190	25.776	27.776
J1155	468582.5	7697139	15.55	17.55
J116	468666.4	7697019	12.089	14.089
J1165	468514.5	7697168	17.299	19.299
J117	468715.1	7697010	10.41	12.41
J1170	467906.1	7697146	24.968	26.968
J118	468171.7	7696085	35.079	37.079
J119	468289.9	7696957	22.166	24.166
J1199	467418.1	7697056	30.407	32.407
J12	469411.5	7696804	3.782	5.782
J120	468463	7696930	18	20
J121	468249.2	7696758	26.364	28.364
J1212	467822.7	7697044	26.188	28.188
J1216	469375.9	7697013	9.784	11.784
J122	468498.9	7696882	14.799	16.799
J123	468559.3	7696915	12.837	14.837
J1230	469207.4	7697001	8.689	10.689
J124	468727.1	7696825	5.355	7.355
J1240	469380.4	7696961	8.991	10.991
J125	468789.5	7696784	3.247	5.247
J1252	469188.9	7696979	8.003	10.003
J126	468843.1	7696735	1.9	3.9
J1264	469510.1	7696962	9.245	11.245
J127	468757.5	7696935	9	11
J1274	467619.8	7696950	29.18	31.18
J128	468748.9	7696918	8.813	10.813
J1283	467575.6	7696980	28.978	30.978
J129	468722.9	7696881	8.533	10.533
J13	469683.4	7697095	10.73	12.73
J130	468627.7	7696882	10.396	12.396
J1304	468381.7	7696915	18.8	20.8

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J131	468684.5	7696851	9	11
J1314	467940	7697032	25.5	27.5
J1316	467946.2	7696908	26.602	28.602
J132	468598.7	7696851	10.955	12.955
J1321	469104.5	7696823	2.348	4.348
J1325	469064.3	7696846	4	6
J133	468704.9	7696786	8.5	10.5
J1338	467636.3	7696970	28.882	30.882
J134	468679.3	7696730	8	10
J1340	467886.5	7696845	28.117	30.117
J135	468584.4	7696675	10.831	12.831
J1358	469192	7696708	0.157	2.157
J136	468555.8	7696696	12.526	14.526
J1360	467622.9	7696818	31.289	33.289
J1362	468810	7696668	1.917	3.917
J137	468726.8	7696860	8.202	10.202
J138	468749.3	7696863	7.695	9.695
J1388	467369.7	7696742	32.305	34.305
J139	468818	7696803	4.839	6.839
J14	469584.9	7697081	12.332	14.332
J140	468880.7	7696740	1.937	3.937
J1400	467377.9	7696775	32.111	34.111
J1408	467989.5	7696852	27.538	29.538
J141	468805.6	7696710	3.374	5.374
J142	468833.9	7696693	2.151	4.151
J1424	467371.7	7696708	32.605	34.605
J143	468768.4	7696636	2.352	4.352
J1434	467547.8	7696653	34.152	36.152
J144	468764.9	7696633	3.044	5.044
J145	468674	7696620	5.469	7.469
J146	468636	7696622	7.862	9.862

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J1462	468728.7	7696574	1.675	3.675
J1467	467504.5	7696584	35.039	37.039
J1469	467929.7	7696576	37.537	39.537
J147	468657.8	7696608	6.315	8.315
J148	468641.2	7696556	5.706	7.706
J149	468650	7696509	4.961	6.961
J1497	467409.8	7696530	35.021	37.021
J15	469530.2	7697076	13.5	15.5
J150	468568	7696555	11.605	13.605
J1505	467822.7	7696497	39.03	41.03
J151	468593	7696549	9.255	11.255
J152	468559.2	7696524	12.792	14.792
J153	468524.8	7696438	14.52	16.52
J154	468311.6	7696758	24.633	26.633
J155	468415.8	7696789	19.664	21.664
J156	468193.9	7696693	30.733	32.733
J1568	467851.5	7696513	38.603	40.603
J157	468417.6	7696648	22.878	24.878
J1570	467640.4	7696426	42.603	44.603
J158	468427.7	7696701	22.253	24.253
J1580	467888.6	7696554	37.527	39.527
J159	468477.1	7696710	17.855	19.855
J16	469460.6	7697070	13.316	15.316
J160	468537.5	7696688	14.5	16.5
J1602	468195.4	7696309	35	37
J1604	467558.1	7696308	42.186	44.186
J161	468504.9	7696725	15.849	17.849
J162	468345.7	7696609	26.435	28.435
J1627	467963.7	7696187	35.8	37.8
J163	468405.1	7696536	25	27
J164	468405.8	7696530	24.3	26.3

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J165	468409	7696505	24.458	26.458
J1657	467838.1	7696152	41.869	43.869
J166	468385.7	7696462	25	27
J167	468391.9	7696421	24.666	26.666
J168	468400.9	7696404	23.336	25.336
J1680	467877.2	7696006	45.293	47.293
J169	468509.3	7696421	16.839	18.839
J17	469361.4	7697066	12.542	14.542
J170	468515.2	7696411	16.71	18.71
J1706	467972	7696002	44	46
J171	468462.2	7696394	19.261	21.261
J1713	467986.4	7695965	43.416	45.416
J1717	467751.6	7696006	47.666	49.666
J172	468545.7	7696377	13.422	15.422
J1721	467835	7696002	46.535	48.535
J1724	467714.6	7695973	47.715	49.715
J173	468588.5	7696348	8.951	10.951
J1735	467708.4	7695959	47.765	49.765
J1737	467935.9	7696006	44.836	46.836
J174	468616.5	7696424	6.536	8.536
J175	468642.7	7696497	5.21	7.21
J176	468195.5	7696333	34.524	36.524
J177	468199.2	7696398	34.315	36.315
J1772	467626	7695906	48.422	50.422
J178	468160.8	7696191	35.5	37.5
J179	468178.2	7696267	35.187	37.187
J1797	467698.1	7695873	47.998	49.998
J1799	467850.5	7695854	46.264	48.264
J18	469262.4	7697091	11.965	13.965
J180	468202.5	7696457	36	38
J181	468174	7696232	35.3	37.3

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J182	468200.3	7696372	34	36
J183	468215.6	7696350	33.696	35.696
J184	468399.7	7696390	23.052	25.052
J185	468368.2	7696130	21	23
J186	468262.6	7696213	27.551	29.551
J1868	467712.5	7695811	48.937	50.937
J187	468245.3	7696168	28.853	30.853
J188	468268	7696331	30.879	32.879
J189	468163.9	7696141	35.8	37.8
J19	469235.8	7697022	9.279	11.279
J190	468315.5	7696121	24.998	26.998
J191	468333.5	7696121	24.003	26.003
J192	468211.1	7696150	30.669	32.669
J193	468266.8	7696135	28.23	30.23
J194	468400.3	7695680	23.284	25.284
J195	468168.5	7695836	40.5	42.5
J196	468188.1	7695718	40.227	42.227
J197	468416.4	7695848	14.582	16.582
J198	468384.7	7695770	21.898	23.898
J199	468470.9	7695801	13.891	15.891
J2	469440.4	7696885	7.066	9.066
J20	469204.2	7697012	9.092	11.092
J200	468490.7	7695959	10.5	12.5
J201	468483.4	7695998	10.2	12.2
J202	468416.8	7696103	16.474	18.474
J203	468419	7696137	15.798	17.798
J204	468433.2	7696175	17	19
J205	468462.7	7696233	16.092	18.092
J206	468550.2	7696250	7.304	9.304
J207	468530.4	7696202	6	8
J208	468436.9	7696089	14.038	16.038

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J209	468465.6	7696075	11.213	13.213
J21	469358.7	7696951	9.036	11.036
J210	468489.6	7696111	9.157	11.157
J211	468503.8	7696143	8.8	10.8
J212	468566.5	7696292	9.082	11.082
J213	468431.4	7696406	21.109	23.109
J214	468457.5	7696373	20.646	22.646
J215	468486.9	7696327	13.697	15.697
J216	468554.5	7696680	12.739	14.739
J217	468591.6	7696656	10.39	12.39
J218	468606.4	7696601	9.639	11.639
J219	468579.1	7696564	11.093	13.093
J22	469340	7696951	8.849	10.849
J220	468455.8	7696571	21.03	23.03
J221	469549.1	7696968	10.257	12.257
J222	469804.8	7696660	1.753	3.753
J223	468383	7696336	24.257	26.257
J224	468363.8	7696230	23.548	25.548
J225	468355.1	7696191	22.5	24.5
J226	468354.6	7696158	21.3	23.3
J227	469616.2	7696973	9.87	11.87
J228	469717.6	7697046	10.024	12.024
J229	469714.1	7696982	9.276	11.276
J23	469239	7696986	8.709	10.709
J230	469730.1	7696988	9.425	11.425
J231	469738.4	7696976	9.416	11.416
J232	469745.7	7696969	9.358	11.358
J233	469751.1	7697000	9.225	11.225
J234	469800.9	7697026	7.972	9.972
J235	469876.7	7697069	4.464	6.464
J236	469571.3	7696808	4.833	6.833

Table G-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J237	469641.1	7696819	4.711	6.711
J238	469744.4	7696833	6.816	8.816
J239	469795.1	7696856	7.98	9.98
J24	469366.4	7696869	6.5	8.5
J240	469820.1	7696867	7.748	9.748
J241	469887	7696897	7.154	9.154
J242	469954.4	7696928	4.207	6.207
J243	469376	7697028	11.479	13.479
J244	469427.1	7697032	12.539	14.539
J245	469475.8	7697035	12.936	14.936
J246	469520.5	7697038	14	16
J247	469550.1	7697041	12.489	14.489
J248	469597.9	7697047	11.692	13.692
J249	469656.2	7697051	10.086	12.086
J25	469309.9	7696879	6.2	8.2
J250	469693.9	7697063	10.343	12.343
J251	469709.4	7697067	10.067	12.067
J252	469760.8	7697091	9.214	11.214
J253	469807.1	7697115	7.202	9.202
J254	469857.4	7697142	4.193	6.193
J255	469889.3	7697159	3.125	5.125
J256	469968.3	7696949	3.571	5.571

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
1640STREAM	J1604	J2848	WDT	365.993	0.35	TRAPEZOIDAL	2	3	0.02011
1674STREAM	J1462	OF1	WDT	55.546	0.35	TRAPEZOIDAL	2	3	0.04821
1686STREAM	J1099	J1137	WDT	76.526	0.35	TRAPEZOIDAL	2	3	0.00958
1688STREAM	J1467	J2868	WDT	32.158	0.35	TRAPEZOIDAL	2	3	0.01735
1689STREAM	J1799	J2869	WDT	211.091	0.35	TRAPEZOIDAL	2	3	0.0202
1699STREAM	J800	J842	WDT	145.779	0.35	TRAPEZOIDAL	2	3	0.0022
1700STREAM	J1039	J2875	WDT	255.362	0.35	TRAPEZOIDAL	2	3	0.00998
1714STREAM	J887	J927	WDT	16.192	0.35	TRAPEZOIDAL	2	3	0.01365
1722STREAM	J1216	J1240	WDT	52.195	0.35	TRAPEZOIDAL	2	3	0.01519
1734STREAM	J1497	J2848	WDT	17.362	0.35	TRAPEZOIDAL	2	3	0.01117
1747STREAM	J927	J909	WDT	46.915	0.35	TRAPEZOIDAL	2	3	0.01518
1748STREAM	J1570	J2868	WDT	258.202	0.35	TRAPEZOIDAL	2	3	0.03147
1812STREAM	J961	J1007	WDT	27.091	0.35	TRAPEZOIDAL	2	3	0.00923
1815_1STREAM	J1240	C2IN	WDT	5.597	0.35	TRAPEZOIDAL	2	3	0.0168
1816STREAM	J1469	J2910	WDT	35.502	0.35	TRAPEZOIDAL	2	3	0.02028
1832STREAM	J991	J1007	WDT	65.547	0.35	TRAPEZOIDAL	2	3	0.00305
1834STREAM	J1772	J2917	WDT	91.113	0.35	TRAPEZOIDAL	2	3	0.00574
1835STREAM	J1868	J1797	WDT	73.51	0.35	TRAPEZOIDAL	2	3	0.01277
1855STREAM	J1137	J1150	WDT	30.589	0.35	TRAPEZOIDAL	2	3	0.00909
1863STREAM	J909	J2925	WDT	317.958	0.35	TRAPEZOIDAL	2	3	0.05387
1896STREAM	J1360	J2936	WDT	341.824	0.35	TRAPEZOIDAL	2	3	0.01509
1917STREAM	J978	J3074	WDT	92.108	0.35	TRAPEZOIDAL	2	3	0.00869
1925STREAM	J1358	J2946	WDT	33.59	0.35	TRAPEZOIDAL	2	3	0.09821
1948STREAM	J1657	J1627	WDT	181.736	0.35	TRAPEZOIDAL	2	3	0.03341
1955STREAM	J1007	J2875	WDT	57.337	0.35	TRAPEZOIDAL	2	3	0.00349
1963STREAM	J1434	J2962	WDT	101.688	0.35	TRAPEZOIDAL	2	3	0.01007
1990STREAM	J842	J850	WDT	36.365	0.35	TRAPEZOIDAL	2	3	0.0366
2000STREAM	J895	J1034	WDT	151.302	0.35	TRAPEZOIDAL	2	3	0.04277
2001STREAM	J1505	J1568	WDT	33.378	0.35	TRAPEZOIDAL	2	3	0.01279

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
2012STREAM	J1797	J2917	WDT	47.366	0.35	TRAPEZOIDAL	2	3	0.00209
2024STREAM	J958	J956	WDT	21.779	0.35	TRAPEZOIDAL	2	3	0.01143
2034STREAM	J1408	J2988	WDT	280.09	0.35	TRAPEZOIDAL	2	3	0.01063
2058STREAM	J1037	J2998	WDT	18.445	0.35	TRAPEZOIDAL	2	3	0.01263
2062STREAM	J850	J810	WDT	124.004	0.35	TRAPEZOIDAL	2	3	0.03769
2065_1STREAM	J1081	J16	WDT	239.155	0.35	TRAPEZOIDAL	2	3	0.0289
2077STREAM	J1568	J1580	WDT	58.838	0.35	TRAPEZOIDAL	2	3	0.01829
2085STREAM	J956	J967	WDT	45.958	0.35	TRAPEZOIDAL	2	3	0.01123
2116STREAM	J1150	J1146	WDT	25.429	0.35	TRAPEZOIDAL	2	3	0.00283
2122STREAM	J2917	J1735	WDT	43.244	0.35	TRAPEZOIDAL	2	3	0.0031
2147STREAM	J1146	J1119	WDT	76.297	0.35	TRAPEZOIDAL	2	3	0.00431
2171STREAM	J967	J3035	WDT	31.509	0.35	TRAPEZOIDAL	2	3	0.01536
2182STREAM	J1580	J2910	WDT	28.879	0.35	TRAPEZOIDAL	2	3	0.02459
2199_2STREAM	J41	J2946	WDT	78.011	0.35	TRAPEZOIDAL	2	3	0.02915
2204STREAM	J1735	J1724	WDT	15.982	0.35	TRAPEZOIDAL	2	3	0.00313
2229STREAM	J1724	J1717	WDT	49.85	0.35	TRAPEZOIDAL	2	3	0.00098
2230STREAM	J2910	J1340	WDT	275.681	0.35	TRAPEZOIDAL	2	3	0.03157
2233STREAM	J1274	J1338	WDT	25.853	0.35	TRAPEZOIDAL	2	3	0.01153
2245STREAM	j37	J2963	WDT	40.206	0.35	TRAPEZOIDAL	2	3	0.03796
2249STREAM	J2868	J2962	WDT	96.231	0.35	TRAPEZOIDAL	2	3	0.01406
2256STREAM	J1119	J1113	WDT	38.671	0.35	TRAPEZOIDAL	2	3	0.00747
2261STREAM	J2875	J3074	WDT	99.049	0.35	TRAPEZOIDAL	2	3	0.00606
2265STREAM	J1338	J3066	WDT	84.108	0.35	TRAPEZOIDAL	2	3	0.01557
2267STREAM	J810	J903	WDT	56.257	0.35	TRAPEZOIDAL	2	3	0.03833
2268STREAM	c77out	J1454	WDT	53.858	0.35	TRAPEZOIDAL	2	3	0.04421
2284STREAM	J1717	J1721	WDT	84.387	0.35	TRAPEZOIDAL	2	3	0.0134
2292STREAM	J1627	J178	WDT	197.347	0.35	TRAPEZOIDAL	2	3	0.00152
2297STREAM	J1113	J3074	WDT	238.092	0.35	TRAPEZOIDAL	2	3	0.00792
2299STREAM	J1034	J1009	WDT	46.464	0.35	TRAPEZOIDAL	2	3	0.01526

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
2315STREAM	J2848	J1424	WDT	175.434	0.35	TRAPEZOIDAL	2	3	0.01267
2325STREAM	J903	J2925	WDT	332.646	0.35	TRAPEZOIDAL	2	3	0.04271
2340STREAM	J1009	J3087	WDT	10.67	0.35	TRAPEZOIDAL	2	3	0.01556
2341STREAM	J1212	J2856	WDT	54.108	0.35	TRAPEZOIDAL	2	3	0.01545
2352STREAM	J2946	J3092	WDT	95.865	0.35	TRAPEZOIDAL	2	3	0.0464
2368STREAM	J2962	J1283	WDT	342.807	0.35	TRAPEZOIDAL	2	3	0.01211
2391STREAM	J963	J1117	WDT	23.527	0.025	TRAPEZOIDAL	2	3	0.03228
2396STREAM	J1721	J1680	WDT	42.941	0.35	TRAPEZOIDAL	2	3	0.02894
2417STREAM	J1117	J1063	WDT	20.46	0.025	TRAPEZOIDAL	2	3	0.02948
2446STREAM	J1680	J1737	WDT	59.903	0.35	TRAPEZOIDAL	2	3	0.00763
2512STREAM	J1737	J1706	WDT	37.06	0.35	TRAPEZOIDAL	2	3	0.02256
2540STREAM	J1424	J1388	WDT	34.618	0.35	TRAPEZOIDAL	2	3	0.00867
2558STREAM	J3074	J3141	WDT	49.372	0.35	TRAPEZOIDAL	2	3	0.00608
2559STREAM	J1706	J1713	WDT	42.648	0.35	TRAPEZOIDAL	2	3	0.01369
2566STREAM	J1340	J1316	WDT	87.084	0.35	TRAPEZOIDAL	2	3	0.0174
2567STREAM	J1388	J1400	WDT	36.684	0.35	TRAPEZOIDAL	2	3	0.00529
2590STREAM	J1713	J2869	WDT	117.07	0.35	TRAPEZOIDAL	2	3	0.0121
2596STREAM	J1400	J1199	WDT	342.665	0.35	TRAPEZOIDAL	2	3	0.00497
2620STREAM	J1316	J1314	WDT	131.202	0.35	TRAPEZOIDAL	2	3	0.0084
2649STREAM	J2925	J1155	WDT	324.718	0.35	TRAPEZOIDAL	2	3	0.02987
2656STREAM	J1283	J3066	WDT	135.769	0.35	TRAPEZOIDAL	2	3	0.01035
2665STREAM	J2869	J348	WDT	114.51	0.35	TRAPEZOIDAL	2	3	0.00873
2690STREAM	J1314	J3167	WDT	38.164	0.35	TRAPEZOIDAL	2	3	0.0131
2726STREAM	J3066	J2936	WDT	139.381	0.35	TRAPEZOIDAL	2	3	0.01035
2766STREAM	J1199	J1170	WDT	549.845	0.35	TRAPEZOIDAL	2	3	0.00989
2785STREAM	J2936	J2856	WDT	65.242	0.35	TRAPEZOIDAL	2	3	0.01193
2811STREAM	J2856	J3167	WDT	88.923	0.35	TRAPEZOIDAL	2	3	0.00396
2853STREAM	J3167	J2988	WDT	34.331	0.35	TRAPEZOIDAL	2	3	0.01279
2872STREAM	J2988	J3198	WDT	138.758	0.35	TRAPEZOIDAL	2	3	0.00404

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
2947STREAM	J1170	J3198	WDT	144.851	0.35	TRAPEZOIDAL	2	3	0.00668
2981STREAM	J3198	J1104	WDT	106.332	0.35	TRAPEZOIDAL	2	3	0.0047
3005STREAM	J1104	J3141	WDT	99.576	0.35	TRAPEZOIDAL	2	3	0.00603
3022STREAM	J3141	J3035	WDT	144.175	0.35	TRAPEZOIDAL	2	3	0.00277
3042STREAM	J3035	J3087	WDT	69.289	0.35	TRAPEZOIDAL	2	3	0.00761
3052STREAM	J3087	J1093	WDT	169.882	0.35	TRAPEZOIDAL	2	3	0.01633
3073STREAM	J1093	J2998	WDT	24.045	0.35	TRAPEZOIDAL	2	3	0.01477
3075STREAM	J2998	J1140	WDT	46.22	0.35	TRAPEZOIDAL	2	3	0.0116
3081STREAM	J1140	J1165	WDT	58.98	0.35	TRAPEZOIDAL	2	3	0.01713
3085STREAM	J1165	J378	WDT	50.307	0.35	TRAPEZOIDAL	2	0.5	0.01787
C105STREAM	J83	c21in	WDT	56.158	0.35	TRAPEZOIDAL	2	3	0.02339
C106STREAM	c20out	c22in	WDT	46.357	0.35	TRAPEZOIDAL	2	3	0.02207
C107STREAM	c13out	c14in	WDT	36.954	0.35	TRAPEZOIDAL	2	3	0.01091
C111STREAM	c21out	J3157	WDT	34.524	0.35	TRAPEZOIDAL	2	3	0.04427
C112STREAM	c22out	J1250	WDT	37.456	0.35	TRAPEZOIDAL	2	3	0.0415
C113STREAM	c23out	J3161	WDT	48.355	0.035	TRAPEZOIDAL	2	3	0.0283
C129	c14out	J3228	WDT	132.805	0.35	TRAPEZOIDAL	2	3	0.01809
C159STREAM	c24out	J1426	WDT	58.01	0.35	TRAPEZOIDAL	2	3	0.03453
C176	J316	J1155	WDT	76.745	0.01	TRAPEZOIDAL	1	1.5	0.20691
C188STREAM	c69out	J1462	WDT	13.43	0.35	TRAPEZOIDAL	2	3	0.05369
C189STREAM	c68out	J1462	WDT	12.008	0.35	TRAPEZOIDAL	2	3	0.12966
C193	J339	OF12	WDT	62.843	0.01	TRAPEZOIDAL	1	1.5	0
C198STREAM	J151	c67in	WDT	73.283	0.35	TRAPEZOIDAL	2	3	0.07251
C2	J373	J378	wdt	88.975	0.01	TRAPEZOIDAL	1	1	0.02625
C212	J360	OF13	WDT	45.738	0.01	TRAPEZOIDAL	1	1	0
C214STREAM	c63out	c73in	WDT	90.539	0.35	TRAPEZOIDAL	2	3	0.08043
C229STREAM	c59out	OF2	WDT	85.688	0.35	TRAPEZOIDAL	2	3	0.09322
C242STREAM	c36out	J223	WDT	106.161	0.35	TRAPEZOIDAL	2	3	0.29874
C243STREAM	J168	J184	WDT	14.444	0.35	TRAPEZOIDAL	2	3	0.01967

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C245STREAM	J184	c53in	WDT	138.362	0.35	TRAPEZOIDAL	2	3	0.06864
C246STREAM	c49out	J224	WDT	20.97	0.35	TRAPEZOIDAL	2	3	0.0001
C248STREAM	c48out	J225	WDT	16.255	0.35	TRAPEZOIDAL	2	3	0.09267
C249STREAM	c47out	J226	WDT	21.066	0.35	TRAPEZOIDAL	2	3	0.00712
C250STREAM	c38out	J185	WDT	36.184	0.35	TRAPEZOIDAL	2	3	0.0844
C256STREAM	J186	c48in	WDT	68.005	0.35	TRAPEZOIDAL	2	3	0.03754
C261STREAM	J191	c46in	WDT	75.987	0.35	TRAPEZOIDAL	2	3	0.08003
C271STREAM	c39out	J200	WDT	74.749	0.35	TRAPEZOIDAL	2	3	0.08368
C272STREAM	c40out	c44in	WDT	62.642	0.35	TRAPEZOIDAL	2	3	0.0872
C273STREAM	c41out	c42in	WDT	58.12	0.35	TRAPEZOIDAL	0.5	0.5	0.07721
C274STREAM	c44out	J1756	WDT	72.967	0.35	TRAPEZOIDAL	2	3	0.13085
C275STREAM	c42out	J3195	WDT	75.161	0.35	TRAPEZOIDAL	2	3	0.07196
C276STREAM	c43out	OF3	WDT	75.914	0.35	TRAPEZOIDAL	2	3	0.09888
C277STREAM	c45out	J1700	WDT	73.53	0.035	TRAPEZOIDAL	0.75	0.5	0.13968
C279STREAM	c57out	J3178	WDT	70.233	0.35	TRAPEZOIDAL	2	3	0.0749
C280STREAM	c58out	OF4	WDT	82.616	0.35	TRAPEZOIDAL	2	3	0.0956
C303STREAM	c55out	c57in	WDT	66.585	0.35	TRAPEZOIDAL	2	3	0.15309
C304STREAM	c56out	J211	WDT	67.505	0.35	TRAPEZOIDAL	2	3	0.03335
C306STREAM	c61out	c64in	WDT	82.915	0.35	TRAPEZOIDAL	2	3	0.0559
C307STREAM	c51out	J166	WDT	21.68	0.35	TRAPEZOIDAL	2	3	0.01841
C308STREAM	c65out	c66in	WDT	74.312	0.35	TRAPEZOIDAL	2	3	0.09133
C309STREAM	c66out	OF5	WDT	60.13	0.35	TRAPEZOIDAL	2	3	0.07854
C310STREAM	c67out	OF6	WDT	59.706	0.35	TRAPEZOIDAL	2	3	0.04849
C312STREAM	c18out	c17in	WDT	12.129	0.35	TRAPEZOIDAL	2	3	0.03762
C313STREAM	J1155	J116	WDT	146.898	0.35	TRAPEZOIDAL	2	3	0.02357
C314STREAM	J1111	J114	WDT	38.553	0.35	TRAPEZOIDAL	2	3	0.01907
C4	J355	J1340	wdt	51.707	0.035	TRAPEZOIDAL	1	1	0.04885
C5	J354	J1360	wdt	163.591	0.035	TRAPEZOIDAL	1	1	0.03098
C6	J353	J1360	wdt	193.382	0.035	TRAPEZOIDAL	1	1	0.02295

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C63STREAM	J39	J1358	WDT	61.529	0.35	TRAPEZOIDAL	2	3	0.02017
C65STREAM	c5out	J38	WDT	53.862	0.35	TRAPEZOIDAL	2	3	0.03573
C66STREAM	c8out	J38	WDT	64.153	0.35	TRAPEZOIDAL	2	3	0.03694
C67STREAM	c6out	J34	WDT	47.804	0.35	TRAPEZOIDAL	2	3	0.0303
C7	J222	OF7	WDT	28.714	0.01	TRAPEZOIDAL	2	3	0
C82STREAM	J35	J1379	WDT	46.821	0.35	TRAPEZOIDAL	2	3	0.05542
C83STREAM	J286	J3121	WDT	63.342	0.35	TRAPEZOIDAL	2	3	0.01653
C03	c3in	c3out	UPSIZE	6.911	0.022	CIRCULAR	0.45	0	0.02214
C19	c19in	c19out	UPSIZE	16.312	0.035	CIRCULAR	1.05	0	0.01306
C36	c36in	c36out	UPSIZE	11.283	0.022	CIRCULAR	0.45	0	0.06323
C100	J241	J242	SWALE	74.498	0.01	TRIANGULAR	0.2	1.5	0
C100STREAM	J87	J1325	SWALE	18.772	0.025	TRIANGULAR	0.2	1.5	0.05335
C101	J242	J279	SWALE	13.724	0.01	TRIANGULAR	0.2	1.5	0
C101STREAM	J1325	c12in	SWALE	8.621	0.025	TRIANGULAR	0.2	1.5	0.04645
C102STREAM	J88	J998	SWALE	35.738	0.025	TRIANGULAR	0.2	1.5	0.02522
C103	J256	J257	SWALE	31.083	0.01	TRIANGULAR	0.2	1.5	0
C103STREAM	J2999	J998	SWALE	41.346	0.025	TRIANGULAR	0.2	1.5	0.01296
C104	J257	J258	SWALE	17.937	0.01	TRIANGULAR	0.2	1.5	0
C105	J258	J259	SWALE	17.19	0.01	TRIANGULAR	0.2	1.5	0
C106	J259	J260	SWALE	27.764	0.01	TRIANGULAR	0.2	1.5	0
C107	J260	OF10	SWALE	23.616	0.01	TRIANGULAR	0.2	1.5	0
C108	J278	OF9	SWALE	23.981	0.01	TRIANGULAR	0.2	1.5	0
C108STREAM	c12out	c13in	SWALE	5.893	0.025	TRIANGULAR	0.2	1.5	0.06803
C109	J246	J245	SWALE	44.831	0.01	TRIANGULAR	0.2	1.5	0.02374
C109STREAM	c15out	J89	SWALE	41.329	0.025	TRIANGULAR	0.2	1.5	0.03159
C110	J244	J243	SWALE	51.261	0.01	TRIANGULAR	0.2	1.5	0
C110STREAM	J89	c14in	SWALE	39.104	0.025	TRIANGULAR	0.2	1.5	0.01473
C111	J245	J244	SWALE	48.815	0.01	TRIANGULAR	0.2	1.5	0
C112	J281	J282	SWALE	89.513	0.01	TRIANGULAR	0.2	1.5	0

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C113	J282	J243	SWALE	20.898	0.01	TRIANGULAR	0.2	1.5	0
C114STREAM	J90	J91	SWALE	28.078	0.025	TRIANGULAR	0.2	1.5	0.01674
C115	J239	J238	SWALE	55.574	0.01	TRIANGULAR	0.2	1.5	0
C115STREAM	J91	J92	SWALE	13.337	0.025	TRIANGULAR	0.2	1.5	0.03331
C116	J238	J237	SWALE	104.25	0.01	TRIANGULAR	0.2	1.5	0.00975
C116STREAM	J92	J93	SWALE	20.73	0.025	TRIANGULAR	0.2	1.5	0.0207
C117	J237	J236	SWALE	70.657	0.01	TRIANGULAR	0.2	1.5	0.00849
C117STREAM	J93	J94	SWALE	72.837	0.025	TRIANGULAR	0.2	1.5	0.03096
C118STREAM	J94	J95	SWALE	107.763	0.025	TRIANGULAR	0.2	1.5	0.0325
C119	J263	J262	SWALE	64.679	0.01	TRIANGULAR	0.2	1.5	0.00405
C119STREAM	J95	J998	SWALE	33.242	0.025	TRIANGULAR	0.2	1.5	0.02091
C120	J262	J261	SWALE	45.933	0.01	TRIANGULAR	0.2	1.5	0.0039
C120STREAM	J96	J97	SWALE	30.039	0.025	TRIANGULAR	0.2	1.5	0.01155
C121	J261	J294	SWALE	6.387	0.01	TRIANGULAR	0.2	1.5	0
C121STREAM	J97	J98	SWALE	97.81	0.025	TRIANGULAR	0.2	1.5	0.0299
C122STREAM	J98	J99	SWALE	108.308	0.025	TRIANGULAR	0.2	1.5	0.03118
C123	J295	J4	SWALE	7.343	0.01	TRIANGULAR	0.2	1.5	0.02725
C123STREAM	J99	J100	SWALE	28.902	0.025	TRIANGULAR	0.2	1.5	0.03372
C124	J4	J293	SWALE	17.404	0.01	TRIANGULAR	0.2	1.5	0.01149
C124STREAM	J100	c20in	SWALE	27.099	0.025	TRIANGULAR	0.2	1.5	0.01314
C125	J293	J46	SWALE	6.808	0.01	TRIANGULAR	0.2	1.5	0.03115
C125STREAM	J101	J102	SWALE	18.146	0.025	TRIANGULAR	0.2	1.5	0.03479
C126	J296	J3	SWALE	18.37	0.01	TRIANGULAR	0.2	1.5	0.08
C126STREAM	J102	J103	SWALE	74.795	0.025	TRIANGULAR	0.2	1.5	0.03272
C127	J3	J4	SWALE	39.242	0.01	TRIANGULAR	0.2	1.5	-0.0037
C127STREAM	J103	J104	SWALE	83.765	0.025	TRIANGULAR	0.2	1.5	0.03024
C128	J264	J263	SWALE	57.739	0.01	TRIANGULAR	0.2	1.5	0
C128STREAM	J104	J105	SWALE	73.691	0.025	TRIANGULAR	0.2	1.5	0.02014
C130	J236	J288	SWALE	11.56	0.01	TRIANGULAR	0.2	1.5	0.02735

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C130STREAM	J105	c20in	SWALE	23.859	0.025	TRIANGULAR	0.2	1.5	0.01895
C134	J283	J284	SWALE	8.928	0.01	TRIANGULAR	0.2	1.5	0
C135	J284	J285	SWALE	20.687	0.01	TRIANGULAR	0.2	1.5	0
C136	J285	J32	SWALE	15.515	0.01	TRIANGULAR	0.2	1.5	0
C137	J290	J2	SWALE	18.609	0.01	TRIANGULAR	0.2	1.5	0.02408
C138	J287	J10	SWALE	50.971	0.01	TRIANGULAR	0.2	1.5	0.01857
C139	J221	J227	SWALE	67.275	0.01	TRIANGULAR	0.2	1.5	0
C140	J227	J229	SWALE	98.364	0.01	TRIANGULAR	0.2	1.5	0.00071
C141	J229	J230	SWALE	17.121	0.01	TRIANGULAR	0.2	1.5	0.01168
C143	J231	J232	SWALE	9.775	0.01	TRIANGULAR	0.2	1.5	0.00512
C144	J233	J234	SWALE	56.501	0.01	TRIANGULAR	0.2	1.5	0
C145	J234	J235	SWALE	87.147	0.01	TRIANGULAR	0.2	1.5	0
C146	J235	J271	SWALE	8.819	0.01	TRIANGULAR	0.2	1.5	0
C147	J266	J267	SWALE	47.614	0.01	TRIANGULAR	0.2	1.5	0
C147STREAM	J121	c32in	SWALE	133.22	0.025	TRIANGULAR	0.2	1.5	0.04647
C148	J267	J268	SWALE	41.004	0.01	TRIANGULAR	0.2	1.5	0
C148STREAM	c32out	c33in	SWALE	45.539	0.025	TRIANGULAR	0.2	1.5	0.01471
C149	J268	J269	SWALE	40.744	0.01	TRIANGULAR	0.2	1.5	0
C150	J269	J275	SWALE	26.971	0.01	TRIANGULAR	0.2	1.5	0
C151	J228	J299	SWALE	46.027	0.01	TRIANGULAR	0.2	1.5	0
C151STREAM	c31out	J122	SWALE	75.391	0.025	TRIANGULAR	0.2	1.5	0.03063
C152	J299	J233	SWALE	12.205	0.01	TRIANGULAR	0.2	1.5	0
C152STREAM	J122	J123	SWALE	69.541	0.025	TRIANGULAR	0.2	1.5	0.02822
C153	J232	J265	SWALE	48.393	0.01	TRIANGULAR	0.2	1.5	0.00107
C154	J280	J297	SWALE	36.303	0.01	TRAPEZOIDAL	1	1	0
C155	J297	J300	SWALE	300.058	0.01	TRIANGULAR	0.2	1.5	0
C156	J298	J240	SWALE	12.666	0.01	TRIANGULAR	0.2	1.5	0
C157	J300	c1in	SWALE	25.069	0.01	TRIANGULAR	0.2	1.5	0.006339
C158	J301	J302	SWALE	250.078	0.01	TRIANGULAR	0.2	1.5	0

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C160	J109	J110	SWALE	123.606	0.01	TRIANGULAR	0.2	1.5	0
C160STREAM	J127	J128	SWALE	19.026	0.025	TRIANGULAR	0.2	1.5	0.00983
C161STREAM	J128	J129	SWALE	45.429	0.025	TRIANGULAR	0.2	1.5	0.00616
C162	J111	J303	SWALE	117.991	0.01	TRIANGULAR	0.2	1.5	0
C162STREAM	J129	c25in	SWALE	20.091	0.025	TRIANGULAR	0.2	1.5	0.02629
C163STREAM	J130	J131	SWALE	65.691	0.025	TRIANGULAR	0.2	1.5	0.02126
C164	J304	J1165	SWALE	81.303	0.01	TRIANGULAR	0.2	1.5	0.002178
C164STREAM	J131	c25in	SWALE	29.687	0.025	TRIANGULAR	0.2	1.5	0.03354
C165	J305	J306	SWALE	126.586	0.01	TRIANGULAR	0.2	1.5	0.00511
C165STREAM	c28out	J132	SWALE	94.279	0.025	TRIANGULAR	0.2	1.5	0.02561
C166STREAM	J132	c27in	SWALE	43.962	0.025	TRIANGULAR	0.2	1.5	0.02974
C167	J307	J308	SWALE	119.233	0.01	TRIANGULAR	0.2	1.5	0
C167STREAM	c27out	c26in	SWALE	54.126	0.025	TRIANGULAR	0.2	1.5	0.02634
C168STREAM	c26out	J124	SWALE	17.65	0.025	TRIANGULAR	0.2	1.5	0.08604
C169	J309	J303	SWALE	51.736	0.01	TRIANGULAR	0.2	1.5	0
C169STREAM	J133	J134	SWALE	62.532	0.025	TRIANGULAR	0.2	1.5	0.008
C170	J310	J311	SWALE	153.694	0.01	TRIANGULAR	0.2	1.5	0
C170STREAM	J134	c76in	SWALE	44.65	0.025	TRIANGULAR	0.2	1.5	0.00654
C171STREAM	c76out	c71in	SWALE	39.251	0.025	TRIANGULAR	0.2	1.5	0.00362
C172	J312	J308	SWALE	59.995	0.01	TRIANGULAR	0.2	1.5	0
C173	J313	J314	SWALE	55.231	0.01	TRIANGULAR	0.2	1.5	0
C174	J314	J315	SWALE	40.521	0.01	TRIANGULAR	0.2	1.5	0
C175	J315	J316	SWALE	51.777	0.01	TRIANGULAR	0.2	1.5	0
C177	J318	J319	SWALE	129.707	0.01	TRIANGULAR	0.2	1.5	0
C178	J322	J323	SWALE	65.306	0.01	TRIANGULAR	0.2	1.5	0.03319
C179	J325	J323	SWALE	48.796	0.01	TRIANGULAR	0.2	1.5	0.06269
C179STREAM	J137	J138	SWALE	23.428	0.025	TRIANGULAR	0.2	1.5	0.02165
C180	J323	J324	SWALE	76.739	0.01	TRIANGULAR	0.2	1.5	0.00973
C180STREAM	J138	J139	SWALE	92.896	0.025	TRIANGULAR	0.2	1.5	0.03076

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C181STREAM	J139	J140	SWALE	90.192	0.025	TRIANGULAR	0.2	1.5	0.03219
C182	J320	J321	SWALE	53.506	0.01	TRIANGULAR	0.2	1.5	0
C182STREAM	J140	c24in	SWALE	37.98	0.025	TRIANGULAR	0.2	1.5	0.01817
C183	J321	J326	SWALE	128.36	0.01	TRIANGULAR	0.2	1.5	0
C183STREAM	J141	J142	SWALE	36.115	0.025	TRIANGULAR	0.2	1.5	0.03388
C184	J327	J328	SWALE	138.682	0.01	TRIANGULAR	0.2	1.5	0
C184STREAM	J142	c24in	SWALE	32.922	0.025	TRIANGULAR	0.2	1.5	0.02747
C185	J317	J311	SWALE	225.159	0.01	TRIANGULAR	0.2	1.5	0
C185STREAM	J143	J1362	SWALE	52.645	0.025	TRIANGULAR	0.2	1.5	0.00826
C186	J337	J338	SWALE	97.559	0.01	TRIANGULAR	0.2	1.5	0
C186STREAM	J1362	c77in	SWALE	11.271	0.025	TRIANGULAR	0.2	1.5	0.01038
C187STREAM	J144	c69in	SWALE	67.84	0.025	TRIANGULAR	0.2	1.5	0.00268
C188	J347	J333	SWALE	107.685	0.01	TRIANGULAR	0.2	1.5	0.00618
C189	J334	J335	SWALE	72.087	0.01	TRIANGULAR	0.2	1.5	0
C191	J194	J336	SWALE	101.369	0.01	TRIANGULAR	0.2	1.5	0.08212
C192	J336	J338	SWALE	65.779	0.01	TRIANGULAR	0.2	1.5	0
C193STREAM	J146	J147	SWALE	25.861	0.025	TRIANGULAR	0.2	1.5	0.05993
C194	J341	J340	SWALE	57.146	0.01	TRIANGULAR	0.2	1.5	0.03975
C194STREAM	J147	J148	SWALE	57.578	0.025	TRIANGULAR	0.2	1.5	0.01058
C195STREAM	J148	c67in	SWALE	32.926	0.025	TRIANGULAR	0.2	1.5	0.05326
C196STREAM	J149	c67in	SWALE	28.004	0.025	TRIANGULAR	0.2	1.5	0.03595
C198	J342	J343	SWALE	28.98	0.01	TRIANGULAR	0.2	1.5	0.02071
C199	J343	J344	SWALE	92.748	0.01	TRIANGULAR	0.2	1.5	0.01078
C199STREAM	J152	J150	SWALE	32.653	0.025	TRIANGULAR	0.2	1.5	0.03638
C200STREAM	c60out	J171	SWALE	53.153	0.025	TRIANGULAR	0.2	1.5	0.03368
C201	J330	J331	SWALE	50.93	0.01	TRIANGULAR	0.2	1.5	0.00982
C201STREAM	J153	c65in	SWALE	87.651	0.025	TRIANGULAR	0.2	1.5	0.01449
C202	J331	J332	SWALE	63.389	0.01	TRIANGULAR	0.2	1.5	0.00473
C202STREAM	c34out	J154	SWALE	50.66	0.025	TRIANGULAR	0.2	1.5	0.03401

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C203	J332	J347	SWALE	33.922	0.01	TRIANGULAR	0.2	1.5	0.0059
C203STREAM	J154	J155	SWALE	108.869	0.025	TRIANGULAR	0.2	1.5	0.04569
C204	J333	J334	SWALE	110.125	0.01	TRIANGULAR	0.2	1.5	0
C204STREAM	J155	c29in	SWALE	57.692	0.025	TRIANGULAR	0.2	1.5	0.0304
C205	J349	J350	SWALE	43.237	0.01	TRIANGULAR	0.2	1.5	0
C205STREAM	J156	c34in	SWALE	64.825	0.025	TRIANGULAR	0.2	1.5	0.05798
C206	J350	J351	SWALE	59.726	0.01	TRIANGULAR	0.2	1.5	0
C206STREAM	J157	J158	SWALE	61.267	0.025	TRIANGULAR	0.2	1.5	0.0102
C207STREAM	J158	c29in	SWALE	80.389	0.025	TRIANGULAR	0.2	1.5	0.05409
C208	J352	c46in	SWALE	47.541	0.01	TRIANGULAR	0.2	1.5	0.042759
C208STREAM	J159	J161	SWALE	32.14	0.025	TRIANGULAR	0.2	1.5	0.06254
C209STREAM	J161	c74in	SWALE	38.12	0.025	TRIANGULAR	0.2	1.5	0.04654
C20STREAM	J30	J29	SWALE	100.138	0.025	TRIANGULAR	0.2	1.5	0.00075
C210STREAM	J160	c73in	SWALE	46.496	0.025	TRIANGULAR	0.2	1.5	0.02151
C211STREAM	c64out	c72in	SWALE	41.193	0.025	TRIANGULAR	0.2	1.5	0.04213
C212STREAM	c72out	c73in	SWALE	41.072	0.025	TRIANGULAR	0.2	1.5	0.0713
C213	J344	J362	SWALE	22.126	0.01	TRIANGULAR	0.2	1.5	0.02052
C213STREAM	c62out	c63in	SWALE	30.585	0.025	TRIANGULAR	0.2	1.5	0.06399
C215	J361	J197	SWALE	43.771	0.01	TRIANGULAR	0.2	1.5	0
C215STREAM	J997	J995	SWALE	125.413	0.025	TRIANGULAR	0.2	1.5	0.00741
C216STREAM	J995	c35in	SWALE	30.205	0.025	TRIANGULAR	0.2	1.5	0.02152
C217	J363	J364	SWALE	79.621	0.01	TRIANGULAR	0.2	1.5	0.00432
C217STREAM	c35out	c50in	SWALE	83.048	0.025	TRIANGULAR	0.2	1.5	0.05638
C218	J364	J341	SWALE	50.648	0.01	TRIANGULAR	0.2	1.5	0.01295
C218STREAM	J162	c50in	SWALE	101.168	0.025	TRIANGULAR	0.2	1.5	0.00902
C219	J291	J292	SWALE	43.339	0.01	TRIANGULAR	0.2	1.5	-0.19071
C219STREAM	J164	c61in	SWALE	19.793	0.025	TRIANGULAR	0.2	1.5	0.02527
C220	J292	J295	SWALE	6.272	0.01	TRIANGULAR	0.2	1.5	0.08303
C220STREAM	J163	c62in	SWALE	86.861	0.025	TRIANGULAR	0.2	1.5	0.01108

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C221	J357	J5	SWALE	54.279	0.01	TRIANGULAR	0.2	1.5	0.18308
C221STREAM	J165	c60in	SWALE	71.436	0.025	TRIANGULAR	0.2	1.5	0.04526
C223STREAM	c50out	J166	SWALE	37.11	0.025	TRIANGULAR	0.2	1.5	0.00835
C224STREAM	J166	J167	SWALE	43.563	0.025	TRIANGULAR	0.2	1.5	0.00767
C225STREAM	J171	J169	SWALE	54.801	0.025	TRIANGULAR	0.2	1.5	0.04424
C227STREAM	J170	J172	SWALE	46.48	0.025	TRIANGULAR	0.2	1.5	0.07092
C228STREAM	J172	c59in	SWALE	57.553	0.025	TRIANGULAR	0.2	1.5	0.08232
C22STREAM	J24	J25	SWALE	57.39	0.025	TRIANGULAR	0.2	1.5	0.00523
C230STREAM	J173	J174	SWALE	81.121	0.025	TRIANGULAR	0.2	1.5	0.02978
C231STREAM	J174	c66in	SWALE	57.647	0.025	TRIANGULAR	0.2	1.5	0.02492
C232STREAM	J175	c66in	SWALE	21.037	0.025	TRIANGULAR	0.2	1.5	0.00523
C23STREAM	J25	J26	SWALE	43.504	0.025	TRIANGULAR	0.2	1.5	0.0069
C24STREAM	J26	J27	SWALE	52.852	0.025	TRIANGULAR	0.2	1.5	0.00568
C252STREAM	c37out	c38in	SWALE	63.969	0.025	TRIANGULAR	0.2	1.5	0.04189
C253STREAM	J188	J996	SWALE	118.221	0.025	TRIANGULAR	0.2	1.5	0.02407
C254STREAM	J187	J996	SWALE	47.09	0.025	TRIANGULAR	0.2	1.5	0.01739
C258STREAM	J192	J193	SWALE	58.08	0.025	TRIANGULAR	0.2	1.5	0.04203
C259STREAM	J193	J190	SWALE	50.586	0.025	TRIANGULAR	0.2	1.5	0.06402
C267STREAM	J198	J199	SWALE	92.678	0.025	TRIANGULAR	0.2	1.5	0.08672
C268STREAM	J199	c42in	SWALE	62.732	0.025	TRIANGULAR	0.2	1.5	0.12977
C269STREAM	J200	J201	SWALE	39.835	0.025	TRIANGULAR	0.2	1.5	0.00753
C270STREAM	J201	c45in	SWALE	48.507	0.025	TRIANGULAR	0.2	1.5	0.00412
C27STREAM	J11	c6in	SWALE	30.649	0.025	TRIANGULAR	0.2	1.5	0.00653
C281STREAM	J202	J203	SWALE	35.061	0.025	TRIANGULAR	0.2	1.5	0.01928
C282STREAM	J203	c56in	SWALE	35.019	0.025	TRIANGULAR	0.2	1.5	0.08142
C283STREAM	J204	c55in	SWALE	56.343	0.025	TRIANGULAR	0.2	1.5	0.0147
C284STREAM	J205	c53in	SWALE	53.628	0.025	TRIANGULAR	0.2	1.5	0.04695
C285STREAM	J208	J209	SWALE	32.975	0.025	TRIANGULAR	0.2	1.5	0.08599
C286STREAM	J209	J210	SWALE	45.398	0.025	TRIANGULAR	0.2	1.5	0.04533

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C287STREAM	J210	J211	SWALE	35.713	0.025	TRIANGULAR	0.2	1.5	0.01
C288STREAM	J211	c57in	SWALE	36.529	0.025	TRIANGULAR	0.2	1.5	0.10459
C289STREAM	J206	J207	SWALE	51.801	0.025	TRIANGULAR	0.2	1.5	0.02518
C28STREAM	c6in	J12	SWALE	30.681	0.025	TRIANGULAR	0.2	1.5	0.01363
C290STREAM	J207	c57in	SWALE	30.353	0.025	TRIANGULAR	0.2	1.5	0.03296
C292STREAM	c54out	c58in	SWALE	57.589	0.025	TRIANGULAR	0.5	1.5	0.03376
C293STREAM	J212	c59in	SWALE	39.972	0.025	TRIANGULAR	0.2	1.5	0.00956
C294STREAM	J213	J214	SWALE	42.298	0.025	TRIANGULAR	0.2	1.5	0.01095
C295STREAM	J214	J215	SWALE	54.905	0.025	TRIANGULAR	0.2	1.5	0.12759
C296STREAM	J215	c53in	SWALE	49.085	0.025	TRIANGULAR	0.2	1.5	0.00244
C297STREAM	J219	J218	SWALE	46.138	0.025	TRIANGULAR	0.2	1.5	0.03153
C298STREAM	J218	c70in	SWALE	35.365	0.025	TRIANGULAR	0.2	1.5	0.02243
C299STREAM	J216	J217	SWALE	44.225	0.025	TRIANGULAR	0.2	1.5	0.05319
C29STREAM	J12	c5in	SWALE	27.525	0.025	TRIANGULAR	0.2	1.5	0.0181
C3	J370	J371	SWALE	74.49	0.01	TRAPEZOIDAL	1	1	0
C300STREAM	J217	c70in	SWALE	37.795	0.025	TRIANGULAR	0.2	1.5	0.04089
C301STREAM	c73out	J217	SWALE	35.05	0.025	TRIANGULAR	0.2	1.5	0.06996
C302STREAM	J220	c64out	SWALE	29.079	0.025	TRIANGULAR	0.2	1.5	0.08386
C311STREAM	c17out	c16in	SWALE	9.534	0.025	TRIANGULAR	0.2	1.5	0.01846
C35STREAM	J42	J43	SWALE	53.389	0.025	TRIANGULAR	0.2	1.5	0.00493
C36STREAM	J43	c9in	SWALE	24.87	0.025	TRIANGULAR	0.2	1.5	0.01983
C37STREAM	J44	J43	SWALE	80.385	0.025	TRIANGULAR	0.2	1.5	0.00141
C38STREAM	J45	c10in	SWALE	22.721	0.025	TRIANGULAR	0.2	1.5	0.00995
C39STREAM	J21	J22	SWALE	18.71	0.025	TRIANGULAR	0.2	1.5	0.01
C3STREAM	J2	J1	SWALE	38.674	0.025	TRIANGULAR	0.2	1.5	0.02271
C40STREAM	J9999	J23	SWALE	44.987	0.025	TRIANGULAR	0.2	1.5	0.00202
C41STREAM	J22	J9999	SWALE	61.757	0.025	TRIANGULAR	0.2	1.5	0.00079
C42STREAM	J23	c1in	SWALE	39.368	0.025	TRIANGULAR	0.2	1.5	0.00373
C43STREAM	J46	J47	SWALE	52.4	0.025	TRIANGULAR	0.2	1.5	0.01409

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C44STREAM	J47	J10	SWALE	13.966	0.025	TRIANGULAR	0.2	1.5	0.03582
C4STREAM	J1	c4in	SWALE	21.469	0.025	TRIANGULAR	0.2	1.5	0.00899
C50STREAM	J28	J49	SWALE	25.983	0.025	TRIANGULAR	0.2	1.5	0.01678
C51STREAM	J31	J48	SWALE	14.577	0.025	TRIANGULAR	0.2	1.5	0.09997
C52STREAM	J50	c8in	SWALE	30.192	0.025	TRIANGULAR	0.2	1.5	0.03311
C53STREAM	J51	J5666	SWALE	46.918	0.025	TRIANGULAR	0.2	1.5	0.00126
C54STREAM	J5666	c9in	SWALE	33.866	0.025	TRIANGULAR	0.2	1.5	0.00177
C55STREAM	J53	c9in	SWALE	41.112	0.025	TRIANGULAR	0.2	1.5	0.0125
C56STREAM	J52	c10in	SWALE	23.372	0.025	TRIANGULAR	0.2	1.5	0.00702
C5STREAM	J5	J6	SWALE	43.56	0.025	TRIANGULAR	0.2	1.5	0.00184
C60STREAM	c10out	J40	SWALE	51.358	0.025	TRIANGULAR	0.2	1.5	0.0388
C64STREAM	c9out	J36	SWALE	55.693	0.025	TRIANGULAR	0.2	1.5	0.03146
C6STREAM	J6	J7	SWALE	26.29	0.025	TRIANGULAR	0.2	1.5	0.00323
C72STREAM	J60	J61	SWALE	44.4	0.025	TRAPEZOIDAL	0.2	0.5	0.01115
C73STREAM	J61	J62	SWALE	47.433	0.025	TRAPEZOIDAL	0.2	0.5	0.01636
C74STREAM	J63	J1045	SWALE	35.015	0.025	TRAPEZOIDAL	0.2	0.5	0.03363
C75	J247	J248	SWALE	48.335	0.01	TRIANGULAR	0.2	1.5	0
C75STREAM	J62	J63	SWALE	42.098	0.025	TRAPEZOIDAL	0.2	0.5	0.02402
C76STREAM	J1045	J64	SWALE	15.508	0.025	TRAPEZOIDAL	0.2	0.5	0.01451
C77STREAM	J64	J65	SWALE	68.409	0.025	TRAPEZOIDAL	0.2	0.5	0.01189
C78STREAM	J65	J66	SWALE	62.253	0.025	TRAPEZOIDAL	0.2	0.5	0.02613
C78swale	J69	J70	SWALE	88.559	0.025	TRIANGULAR	0.2	1.5	0.02362
C79STREAM	J66	J999	SWALE	54.811	0.025	TRAPEZOIDAL	0.2	0.5	0.02542
C7STREAM	J8	J9	SWALE	21.441	0.025	TRIANGULAR	0.2	1.5	0.00485
C8	J382	J381	swale	127.839	0.01	CIRCULAR	1	0	0.01622
C80STREAM	J67	J68	SWALE	37.619	0.025	TRIANGULAR	0.2	1.5	0.0063
C81STREAM	J68	J69	SWALE	80.381	0.025	TRIANGULAR	0.2	1.5	0.01695
C83	J248	J249	SWALE	58.429	0.01	TRIANGULAR	0.2	1.5	0.01184
C84	J249	J250	SWALE	39.414	0.01	TRIANGULAR	0.2	1.5	0.01667

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C84STREAM	J70	J71	SWALE	117.745	0.025	TRIANGULAR	0.2	1.5	0.03061
C85STREAM	J71	J72	SWALE	40.056	0.025	TRIANGULAR	0.2	1.5	0.03027
C86	J251	J252	SWALE	50.535	0.01	TRIANGULAR	0.2	1.5	0
C86STREAM	J72	J48	SWALE	39.031	0.025	TRIANGULAR	0.2	1.5	0.02412
C87	J252	J253	SWALE	52.143	0.01	TRIANGULAR	0.2	1.5	0
C87STREAM	J76	J77	SWALE	23.098	0.025	TRIANGULAR	0.2	1.5	0.01165
C88	J253	J254	SWALE	57.166	0.01	TRIANGULAR	0.2	1.5	0
C88STREAM	J78	J79	SWALE	73.998	0.025	TRIANGULAR	0.2	1.5	0.02119
C89	J254	J255	SWALE	36.075	0.01	TRIANGULAR	0.2	1.5	0
C89STREAM	J77	J78	SWALE	63.393	0.025	TRIANGULAR	0.2	1.5	0.01041
C8STREAM	J7	J8	SWALE	31.488	0.025	TRIANGULAR	0.2	1.5	0.00349
C9	J381	J380	swale	58.225	0.01	CIRCULAR	1	0	-0.01012
C90	J255	OF8	SWALE	36.93	0.01	TRIANGULAR	0.2	1.5	0
C90STREAM	J79	J80	SWALE	39.668	0.025	TRIANGULAR	0.2	1.5	0.02746
C91	J270	J272	SWALE	43.847	0.01	TRIANGULAR	0.2	1.5	0
C91STREAM	J80	J81	SWALE	62.826	0.025	TRIANGULAR	0.2	1.5	0.03195
C92	J272	J271	SWALE	7.76	0.01	TRIANGULAR	0.2	1.5	0
C92STREAM	J73	J74	SWALE	50.865	0.025	TRIANGULAR	0.2	1.5	0.03206
C93STREAM	J74	J75	SWALE	63.104	0.025	TRIANGULAR	0.2	1.5	0.03293
C94	J273	J274	SWALE	8.552	0.01	TRIANGULAR	0.2	1.5	0
C94STREAM	J75	c15in	SWALE	32.899	0.025	TRIANGULAR	0.2	1.5	0.02822
C95	J274	J275	SWALE	47.425	0.01	TRIANGULAR	0.2	1.5	0
C95STREAM	J81	J82	SWALE	80.314	0.025	TRIANGULAR	0.2	1.5	0.03435
C96STREAM	J82	J2999	SWALE	25.989	0.025	TRIANGULAR	0.2	1.5	0.02252
C97	J276	J277	SWALE	7.224	0.01	TRIANGULAR	0.2	1.5	0
C97STREAM	J84	J85	SWALE	48.64	0.025	TRIANGULAR	0.2	1.5	0.01528
C98	J277	J278	SWALE	22.053	0.01	TRIANGULAR	0.2	1.5	0
C98STREAM	J86	J85	SWALE	22.655	0.025	TRIANGULAR	0.2	1.5	0.00825
C99	J240	J241	SWALE	72.969	0.01	TRIANGULAR	0.2	1.5	0

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C99STREAM	J85	c12in	SWALE	34.284	0.025	TRIANGULAR	0.2	1.5	0.01412
C9STREAM	J9	c2in	SWALE	29.073	0.025	TRIANGULAR	0.2	1.5	0.01717
J369	J324	J369	SWALE	11.476	0.01	TRIANGULAR	0.2	1.5	-999
C10STREAM	c2out	c3in	SMALL DITCH	28.3	0.025	TRAPEZOIDAL	0.5	0.1	0.01626
C11STREAM	c3out	c4in	SMALL DITCH	23.568	0.025	TRAPEZOIDAL	0.5	0.1	0.044
C172STREAM	c30out	J136	SMALL DITCH	9.237	0.025	TRAPEZOIDAL	0.5	0.5	0.02859
C173STREAM	J136	J135	SMALL DITCH	35.732	0.025	TRAPEZOIDAL	0.5	0.5	0.04749
C174STREAM	J135	c70out	SMALL DITCH	50.741	0.025	TRAPEZOIDAL	0.5	0.5	0.04761
C175STREAM	c74out	J136	SMALL DITCH	8.593	0.025	TRAPEZOIDAL	0.5	0.5	0.03645
C176STREAM	c70out	c71in	SMALL DITCH	8.41	0.025	TRAPEZOIDAL	0.5	0.5	0.10981
C177STREAM	c29out	c30in	SMALL DITCH	64.645	0.025	TRAPEZOIDAL	0.5	0.5	0.03726
C190STREAM	c71out	J145	SMALL DITCH	33.865	0.025	TRAPEZOIDAL	0.5	0.5	0.05361
C191STREAM	J145	c69in	SMALL DITCH	44.88	0.025	TRAPEZOIDAL	0.5	0.5	0.05819
C19STREAM	J20	c1in	SMALL DITCH	15.06	0.05	TRAPEZOIDAL	0.5	0.5	0.03521
C291STREAM	c53out	c54in	SMALL DITCH	15.568	0.025	TRAPEZOIDAL	0.5	0.5	0.06249
C46STREAM	J1252	J999	SMALL DITCH	38.82	0.05	TRAPEZOIDAL	0.5	0.5	0.03183
C47STREAM	J999	J49	SMALL DITCH	10.572	0.05	TRAPEZOIDAL	0.5	0.5	0.03578
C48STREAM	J49	J48	SMALL DITCH	31.03	0.05	TRAPEZOIDAL	0.5	0.5	0.07725
C49STREAM	J48	c11in	SMALL DITCH	51.723	0.05	TRAPEZOIDAL	0.5	0.5	0.00858
C57STREAM	c4out	J54	SMALL DITCH	13.297	0.025	TRAPEZOIDAL	0.5	0.5	0.063

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C59STREAM	J55	c5in	SMALL DITCH	29.94	0.025	TRAPEZOIDAL	0.5	0.5	0.04159
C61STREAM	c11out	J2852	SMALL DITCH	28.225	0.05	TRAPEZOIDAL	0.5	0.5	0.03513
C62STREAM	J2852	J40	SMALL DITCH	16.454	0.05	TRAPEZOIDAL	0.5	0.5	0.03119
C02	c2in	c2out	REPLACE	18.427	0.022	CIRCULAR	0.45	0	0.02818
C04	c4in	c4out	REPLACE	25.778	0.022	CIRCULAR	0.45	0	0.03346
C05	c5in	c5out	REPLACE	18.697	0.022	CIRCULAR	0.45	0	0.02606
C08	c8in	c8out	REPLACE	14.72	0.022	CIRCULAR	0.45	0	0.00421
C10	c10in	c10out	REPLACE	15.485	0.022	CIRCULAR	0.45	0	0.02222
C13	c13in	c13out	REPLACE	18.11	0.022	CIRCULAR	0.45	0	0.01607
C16	c16in	c16out	REPLACE	12.532	0.022	CIRCULAR	0.45	0	0.04129
C29	c29in	c29out	REPLACE	32.222	0.022	CIRCULAR	0.45	0	0.07056
C32	c32in	c32out	REPLACE	10.189	0.022	CIRCULAR	0.45	0	0.01767
C35	c35in	c35out	REPLACE	9.102	0.022	CIRCULAR	0.45	0	0.0768
C37	c37in	c37out	REPLACE	15.451	0.022	CIRCULAR	0.45	0	0.03614
C38	c38in	c38out	REPLACE	16.579	0.022	CIRCULAR	0.45	0	0.04057
C43	c43in	c43out	REPLACE	16.287	0.022	CIRCULAR	0.45	0	0.06176
C44	c44in	c44out	REPLACE	18.663	0.022	CIRCULAR	0.45	0	0.07047
C48	c48in	c48out	REPLACE	11.264	0.022	CIRCULAR	0.45	0	0.08913
C51	c51in	c51out	REPLACE	20.01	0.022	CIRCULAR	0.45	0	0.01239
C52NEW	J167	c52out	REPLACE	21.358	0.022	CIRCULAR	0.45	0	0.00997
C53	c53in	c53out	REPLACE	19.711	0.022	CIRCULAR	0.45	0	0.02324
C55	c55in	c55out	REPLACE	11.032	0.022	CIRCULAR	0.45	0	0.09984
C56	c56in	c56out	REPLACE	11.946	0.022	CIRCULAR	0.45	0	0.16162
C59	c59in	c59out	REPLACE	17.304	0.022	CIRCULAR	0.45	0	0.04321
C60	c60in	c60out	REPLACE	16.812	0.022	CIRCULAR	0.45	0	0.01059
C61	c61in	c61out	REPLACE	14.577	0.022	CIRCULAR	0.45	0	0.02058
C62	c62in	c62out	REPLACE	19.067	0.022	CIRCULAR	0.45	0	0.02403
C65	c65in	c65out	REPLACE	14.66	0.022	CIRCULAR	0.45	0	0.09531

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C66	c66in	c66out	REPLACE	16.033	0.022	CIRCULAR	0.45	0	0.02446
C67	c67in	c67out	REPLACE	24.258	0.022	CIRCULAR	0.45	0	0.04386
C68	c68in	c68out	REPLACE	21.626	0.022	CIRCULAR	0.45	0	0.03781
C70	c70in	c70out	REPLACE	17.807	0.022	CIRCULAR	0.45	0	0.02404
C71	c71in	c71out	REPLACE	17.016	0.025	CIRCULAR	0.45	0	0.01281
C73	c73in	c73out	REPLACE	17.705	0.022	CIRCULAR	0.45	0	0.03753
C74	c74in	c74out	REPLACE	18.563	0.022	CIRCULAR	0.45	0	0.06684
C75NEW	J365	J366	REPLACE	11.717	0.01	CIRCULAR	1	0	0
C76	c76in	c76out	REPLACE	9.821	0.022	CIRCULAR	0.45	0	0.00672
C77	c77in	c77out	REPLACE	23.61	0.022	CIRCULAR	0.45	0	0.01949
C09	c9in	c9out	REPAIR/ REPLACE	16.402	0.022	CIRCULAR	0.45	0	0.00811
C11	c11in	c11out	REPAIR/ REPLACE	19.061	0.022	CIRCULAR	0.45	0	0.02608
C14	c14in	c14out	REPAIR/ REPLACE	13.905	0.022	CIRCULAR	0.45	0	0.03663
C15	c15in	c15out	REPAIR/ REPLACE	18.413	0.022	CIRCULAR	0.45	0	0.02059
C20	c20in	c20out	REPAIR/ REPLACE	14.296	0.022	CIRCULAR	0.45	0	0.04194
C22	c22in	c22out	REPAIR/ REPLACE	14.52	0.022	CIRCULAR	0.45	0	0.05477
C23	c23in	c23out	REPAIR/ REPLACE	13.264	0.035	CIRCULAR	0.9	0	0.01508
C24	c24in	c24out	REPAIR/ REPLACE	13.533	0.022	CIRCULAR	0.45	0	0.01825
C26	c26in	c26out	REPAIR/ REPLACE	16.515	0.022	CIRCULAR	0.45	0	0.06718
C27	c27in	c27out	REPAIR/ REPLACE	11.263	0.022	CIRCULAR	0.45	0	0.02202
C33	c33in	c33out	REPAIR/ REPLACE	11.993	0.022	CIRCULAR	0.45	0	0.01918
C34	c34in	c34out	REPAIR/ REPLACE	20.117	0.022	CIRCULAR	0.45	0	0.03113
C41	c41in	c41out	REPAIR/ REPLACE	17.117	0.022	CIRCULAR	0.45	0	0.08012

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C42	c42in	c42out	REPAIR/ REPLACE	18.007	0.022	CIRCULAR	0.45	0	0.08051
C45	c45in	c45out	REPAIR/ REPLACE	11.52	0.022	CIRCULAR	0.5	0	0.07486
C46	c46in	c46out	REPAIR/ REPLACE	15.453	0.022	CIRCULAR	0.5	0	0.08901
C49	c49in	c49out	REPAIR/ REPLACE	15.49	0.022	CIRCULAR	0.45	0	0.05308
C54	c54in	c54out	REPAIR/ REPLACE	9.405	0.022	CIRCULAR	0.45	0	0.13301
C72	c72in	c72out	REPAIR/ REPLACE	11.701	0.022	CIRCULAR	0.45	0	0.03806
C1	J367	J377	NEW DITCH	377.332	0.01	CIRCULAR	1	0	0
C12STREAM	J13	J14	NEW DITCH	99.454	0.05	TRAPEZOIDAL	0.75	0.5	0.01006
C138STREAM	J112	J113	NEW DITCH	26.904	0.025	TRAPEZOIDAL	0.75	0.5	0.00227
C139STREAM	J113	J114	NEW DITCH	51.69	0.025	TRAPEZOIDAL	0.75	0.5	0.03256
C13STREAM	J14	J15	NEW DITCH	54.987	0.05	TRAPEZOIDAL	0.75	0.5	0.00909
C145STREAM	J119	J120	NEW DITCH	175.875	0.05	TRAPEZOIDAL	0.75	0.5	0.02369
C14STREAM	J15	J16	NEW DITCH	69.856	0.05	TRAPEZOIDAL	0.75	0.5	0.00263
C15STREAM	J16	J17	NEW DITCH	81.588	0.05	TRAPEZOIDAL	0.75	0.5	0.00949
C16STREAM	J17	J18	NEW DITCH	69.958	0.05	TRAPEZOIDAL	0.75	0.5	0.01897
C17STREAM	J18	J19	NEW DITCH	74.515	0.05	TRAPEZOIDAL	0.75	0.5	0.03607
C18STREAM	J19	J20	NEW DITCH	32.905	0.05	TRAPEZOIDAL	0.75	0.5	0.00568
C233STREAM	J180	J177	NEW DITCH	59.603	0.05	TRAPEZOIDAL	0.75	0.5	0.02828
C234STREAM	J177	J182	NEW DITCH	25.91	0.05	TRAPEZOIDAL	0.75	0.5	0.01216

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C235STREAM	J176	J183	NEW DITCH	28.507	0.05	TRAPEZOIDAL	0.75	0.5	0.02906
C236STREAM	J178	J181	NEW DITCH	42.676	0.05	TRAPEZOIDAL	0.75	0.5	0.00469
C237STREAM	J179	J1602	NEW DITCH	44.735	0.05	TRAPEZOIDAL	0.75	0.5	0.00418
C238STREAM	J181	J179	NEW DITCH	36.093	0.05	TRAPEZOIDAL	0.75	0.5	0.00313
C239STREAM	J1602	J176	NEW DITCH	24.25	0.05	TRAPEZOIDAL	0.75	0.5	0.01963
C240STREAM	J183	c36in	NEW DITCH	54.145	0.05	TRAPEZOIDAL	0.75	0.5	0.048
C257STREAM	J189	J178	NEW DITCH	50.937	0.05	TRAPEZOIDAL	0.75	0.5	0.00589
C68STREAM	J56	J57	NEW DITCH	96.57	0.05	TRAPEZOIDAL	0.75	0.5	0.02624
C69STREAM	J57	J58	NEW DITCH	76.979	0.05	TRAPEZOIDAL	0.75	0.5	0.04351
C70STREAM	J58	J59	NEW DITCH	69.599	0.05	TRAPEZOIDAL	0.75	0.5	0.00496
C71STREAM	J59	J20	NEW DITCH	107.558	0.05	TRAPEZOIDAL	0.75	0.5	0.02654
C01	c1in	c1out	EXISTING	14.928	0.022	CIRCULAR	0.6	0	0.02137
C06	c6in	c6out	EXISTING	13.268	0.022	CIRCULAR	0.45	0	0.04708
C12	c12in	c12out	EXISTING	19.269	0.022	CIRCULAR	0.6	0	0.03115
C17	c17in	c17out	EXISTING	13.525	0.022	CIRCULAR	0.6	0	0.027
C18	c18in	c18out	EXISTING	12.441	0.022	CIRCULAR	0.45	0	0.02525
C21	c21in	c21out	EXISTING	17.307	0.022	CIRCULAR	0.6	0	0.05654
C25	c25in	c25out	EXISTING	22.189	0.022	CIRCULAR	0.8	0	0.06127
C30	c30in	c30out	EXISTING	17.927	0.022	CIRCULAR	0.6	0	0.02489
C31	c31in	c31out	EXISTING	11.364	0.022	CIRCULAR	0.6	0	0.0361
C39	c39in	c39out	EXISTING	13.208	0.022	CIRCULAR	0.6	0	0.0976
C40	c40in	c40out	EXISTING	17.405	0.022	CIRCULAR	0.45	0	0.10731
C57	c57in	c57out	EXISTING	17.501	0.022	CIRCULAR	0.2	0	0.04576
C69	c69in	c69out	EXISTING	13.298	0.022	CIRCULAR	0.8	0	0.03514

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
2431STREAM	J376	J374	DITCH	56.382	0.025	TRAPEZOIDAL	2	3	0
C140STREAM	J114	J117	DITCH	42.665	0.025	TRAPEZOIDAL	0.75	0.5	0.01383
C141STREAM	J117	c19in	DITCH	76.183	0.035	TRAPEZOIDAL	0.75	0.5	0.03988
C142STREAM	J120	J123	DITCH	97.523	0.05	TRAPEZOIDAL	0.75	0.5	0.05302
C143STREAM	J116	J117	DITCH	51.962	0.035	TRAPEZOIDAL	0.75	0.5	0.03233
C146STREAM	J115	J116	DITCH	144.576	0.05	TRAPEZOIDAL	0.75	0.5	0.02494
C149STREAM	c33out	J1304	DITCH	37.535	0.025	TRAPEZOIDAL	0.75	0.1	0.00799
C150STREAM	J1304	J120	DITCH	83.659	0.025	TRAPEZOIDAL	0.75	0.1	0.00956
C153STREAM	J123	c16in	DITCH	70.391	0.025	TRAPEZOIDAL	0.75	0.1	0.03103
C154STREAM	c16out	c25in	DITCH	77.259	0.05	TRAPEZOIDAL	0.75	0.5	0.02761
C155STREAM	c25out	J124	DITCH	24.436	0.05	TRAPEZOIDAL	0.75	0.5	0.05299
C159	J302	J1063	DITCH	146.782	0.01	TRAPEZOIDAL	0.75	0.5	0.011209
C196	J348	J195	DITCH	33.93	0.01	TRAPEZOIDAL	0.75	0.5	0.01474
C197	J195	J196	DITCH	119.627	0.01	TRAPEZOIDAL	0.75	0.5	0.00228
C200	J196	J346	DITCH	149.534	0.01	TRAPEZOIDAL	0.75	0.5	0.05999
C207	J346	J356	DITCH	89.556	0.01	TRAPEZOIDAL	0.75	0.5	0
C209	J356	J358	DITCH	29.099	0.01	TRAPEZOIDAL	0.75	0.5	0
C211	J359	J360	DITCH	149.52	0.01	TRAPEZOIDAL	0.75	0.5	0
C241STREAM	J182	J183	DITCH	27.353	0.05	TRAPEZOIDAL	0.75	0.5	0.01111
C251STREAM	J185	c46in	DITCH	51.513	0.35	TRAPEZOIDAL	0.5	0.5	0.04487
C305STREAM	c46out	c45in	DITCH	72.493	0.035	TRAPEZOIDAL	0.5	0.5	0.09102
C45STREAM	c1out	J1252	DITCH	7.871	0.05	TRAPEZOIDAL	0.75	0.5	0.03051
C78	c52out	J223	DITCH	64.337	0.03	TRAPEZOIDAL	0.5	0.5	0.39629
C79	J223	J224	DITCH	107.721	0.03	TRAPEZOIDAL	0.5	0.5	0.002
C80	J224	J225	DITCH	39.503	0.03	TRAPEZOIDAL	0.5	0.5	0.02654
C81	J225	J226	DITCH	33.725	0.03	TRAPEZOIDAL	0.5	0.5	0.0356
C82	J226	J185	DITCH	30.895	0.01	TRAPEZOIDAL	0.5	0.5	0.00971
C101NEW	J351	J352	CULVERT_ NEW	23.683	0.01	CIRCULAR	0.45	0	0.002

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C102NEW	J340	J198	CULVERT_NEW	17.177	0.01	CIRCULAR	0.45	0	0.10727
C103NEW	J335	J194	CULVERT_NEW	19.21	0.01	CIRCULAR	0.45	0	0.03495
C104NEW	J338	J339	CULVERT_NEW	21.676	0.01	CIRCULAR	0.45	0	0.002
C105NEW	J358	J359	CULVERT_NEW	25.402	0.01	CIRCULAR	0.45	0	0.002
C106NEW	J362	J361	CULVERT_NEW	16.769	0.01	CIRCULAR	0.45	0	0.002
C107NEW	J328	J354	CULVERT_NEW	26.68	0.01	CIRCULAR	0.45	0	0.002
C108NEW	J326	J353	CULVERT_NEW	27.362	0.01	CIRCULAR	0.45	0	0.002
C109NEW	J319	J355	CULVERT_NEW	22.923	0.01	CIRCULAR	0.45	0	0.03405
C110NEW	J369	J370	CULVERT_NEW	15.552	0.01	CIRCULAR	1	0	0.002
C111NEW	J371	J121	CULVERT_NEW	13.186	0.01	CIRCULAR	1	0	0.011
C112NEW	J311	J312	CULVERT_NEW	18.226	0.01	CIRCULAR	0.45	0	0.002
C113NEW	J308	J309	CULVERT_NEW	21.407	0.01	CIRCULAR	0.45	0	0.002
C114NEW	J306	J307	CULVERT_NEW	18.219	0.01	CIRCULAR	0.45	0	0.00829
C115NEW	J110	J111	CULVERT_NEW	27.261	0.01	CIRCULAR	0.45	0	0.01324
C116NEW	J303	J304	CULVERT_NEW	21.004	0.01	CIRCULAR	0.45	0	0.002
C118NEW	J372	J373	CULVERT_NEW	18.636	0.01	CIRCULAR	1	0	0.002
C119NEW	J374	J375	CULVERT_NEW	18.636	0.01	CIRCULAR	1	0	0.002
C120NEW	J1063	J376	CULVERT_NEW	15.789	0.01	CIRCULAR	1	0	0.002
C121NEW	J243	J1216	CULVERT_NEW	14.851	0.01	CIRCULAR	0.45	0	0.11488

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C122NEW	J294	J295	CULVERT_NEW	18.333	0.01	CIRCULAR	0.45	0	0.01582
C123NEW	J288	J289	CULVERT_NEW	18.285	0.01	CIRCULAR	0.45	0	0.002
C124NEW	J230	J231	CULVERT_NEW	14.446	0.01	CIRCULAR	0.45	0	0.00692
C125NEW	J279	J256	CULVERT_NEW	11.78	0.01	CIRCULAR	0.45	0	0.002
C126NEW	J275	J276	CULVERT_NEW	15.826	0.01	CIRCULAR	0.45	0	0.002
C127NEW	J271	J273	CULVERT_NEW	16.155	0.01	CIRCULAR	0.45	0	0.002
C128NEW	J378	J1155	CULVERT_NEW	25.51	0.01	CIRCULAR	0.9	0	0.03334
C129NEW	J380	J1408	CULVERT_NEW	16.457	0.01	CIRCULAR	0.45	0	0.0717
C131NEW	J250	J251	CULVERT_NEW	16.256	0.01	CIRCULAR	0.45	0	0.01698
C133NEW	J265	J266	CULVERT_NEW	22.866	0.01	CIRCULAR	0.45	0	0.00595
C78NEW	J29	J28	CULVERT_NEW	26.135	0.022	CIRCULAR	0.45	0	0.02296
C79NEW	J27	J31	CULVERT_NEW	20.61	0.022	CIRCULAR	0.45	0	0.00728
C80NEW	J40	J41	CULVERT_NEW	12.649	0.022	CIRCULAR	0.45	0	0.03069
C81NEW	J36	J39	CULVERT_NEW	12.296	0.022	CIRCULAR	0.45	0	0.03377
C82NEW	J38	J37	CULVERT_NEW	11.111	0.022	CIRCULAR	0.45	5	0.0335
C83NEW	J34	J35	CULVERT_NEW	11.07	0.022	CIRCULAR	0.45	0	0.05129
C85NEW	J190	J191	CULVERT_NEW	18.035	0.022	CIRCULAR	0.45	0	0.05525
C86NEW	J32	J286	CULVERT_NEW	10.266	0.01	CIRCULAR	0.45	0	0.05525
C87NEW	J150	J151	CULVERT_NEW	25.896	0.022	CIRCULAR	0.45	0	0.09112

Table G-3: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Tag	Length (m)	Rough-ness	Cross-Section	Geom1 (m)	Geom 2 (m)	Slope (m/m)
C88NEW	J996	J186	CULVERT_NEW	9.01	0.022	CIRCULAR	0.45	0	0.05368
C89NEW	J169	J170	CULVERT_NEW	11.658	0.022	CIRCULAR	0.45	0	0.01107
C90NEW	J998	J83	CULVERT_NEW	23.338	0.022	CIRCULAR	0.45	0	0.03447
C91NEW	J54	J55	CULVERT_NEW	11.049	0.022	CIRCULAR	0.45	0	0.04557
C131STREAM	c19out	J106	CREEK	57.99	0.035	TRAPEZOIDAL	2	2	0.00723
C132STREAM	J106	J107	CREEK	66.77	0.035	TRAPEZOIDAL	2	2	0.04612
C133STREAM	J107	J108	CREEK	65.708	0.035	TRAPEZOIDAL	2	2	0.02942
C134STREAM	J108	c23in	CREEK	44.795	0.035	TRAPEZOIDAL	2	2	0.02626
C156STREAM	J124	J125	CREEK	77.402	0.05	TRAPEZOIDAL	2	2	0.02724
C157STREAM	J125	J126	CREEK	72.905	0.05	TRAPEZOIDAL	2	2	0.01848
C158STREAM	J126	c24in	CREEK	31.282	0.05	TRAPEZOIDAL	2	2	0.02088
C28	c28in	c28out	CLEAN	13.178	0.022	CIRCULAR	0.45	0	0.04428
C47	c47in	c47out	CLEAN	14.569	0.022	CIRCULAR	0.45	0	0.00885
C50	c50in	c50out	CLEAN	20.993	0.022	CIRCULAR	0.45	0	0.01015
C58	c58in	c58out	CLEAN	18.804	0.022	CIRCULAR	0.45	0	0.05876
C63	c63in	c63out	CLEAN	14.895	0.022	CIRCULAR	0.45	0	0.05837
C64	c64in	c64out	CLEAN	15.229	0.022	CIRCULAR	0.45	0	0.01786

APPENDIX H

EXAMPLE CULVERT END STIFFENER

Photo 1: Example Culvert End Stiffener