Hamlet of Cape Dorset Master Drainage Plan



PRESENTED TO

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

NOVEMBER 4, 2020
ISSUED FOR REVIEW
FILE: 704-ENG.WTRI03002-01

This "Issued for Review" document is provided solely for the purpose of client review and presents our interim findings and recommendations to date. Our usable findings and recommendations are provided only through an "Issued for Use" document, which will be issued subsequent to this review. Final design should not be undertaken based on the interim recommendations made herein. Once our report is issued for use, the "Issued for Review" document should be either returned to Tetra Tech Canada Inc. (Tetra Tech) or destroyed.

Tetra Tech Canada Inc.
Suite 1000 – 10th Floor, 885 Dunsmuir Street
Vancouver, BC V6C 1N5 CANADA
Tel 604.685.0275 Fax 604.684.6241

TABLE OF CONTENTS

LIST OF TABLES IN TEXT

LIST OF FIGURES IN TEXT

APPENDIX SECTIONS

APPENDICES

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 Hamlet of Cape Dorset (Cape Dorset) to develop a Master Drainage Plan for the community. Cape Dorset requires that a drainage study be completed for both the existing town site and planned subdivisions identified in the Community Plan.

The Terms of Reference (ToR) developed by Cape Dorset confirmed that the Hamlet has in action a Community Plan (By-law No. 168, 2013) and Zoning By-law (By-law No. 169, 2013). 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 carried out. In addition to a detailed review of the community plans and its impacts on the existing stormwater system, Cape Dorset identified the need to review and evaluate the conditions of the existing drainage system and undertake an investigation to assist in the siting of future community expansions.

The 2013 Community Plan estimated the population of Cape Dorset to be 1,397 people. The Cape Dorset Community Plan aims to prepare for a population of 1,791 people by 2033. It estimated an additional 240 housing units will be required over this period to meet the estimated population growth – an average of 12 new dwellings per year. In order to ensure that the Hamlet of Cape Dorset 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 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 Cape Dorset by a team of hydrotechnical engineers to identify, assess, and document all drainage infrastructure and known drainage issues;
- Development of an inventory covering existing drainage issues;
- Development of inputs to a hydrologic model;
- Assess the drainage system for existing and proposed development conditions; and
- Completion of the Cape Dorset Master Drainage Plan.

2.0 REVIEW OF BACKGROUND INFORMATION

Tetra Tech collected, compiled and processed all information related to the drainage system of Cape Dorset 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 Cape Dorset.

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);
- 2013 Community Plan and Community Plan By-law;
- National Topographic Survey (NTS) 1:50,000 Topography Map of Cape Dorset;
- Google Earth 2019 Satellite Imagery; and
- Historical climate data for Cape Dorset, 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. This was also supported by field observations provided by Ms. Alecia Boddie covering the 2020 freshet.

2.1 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.

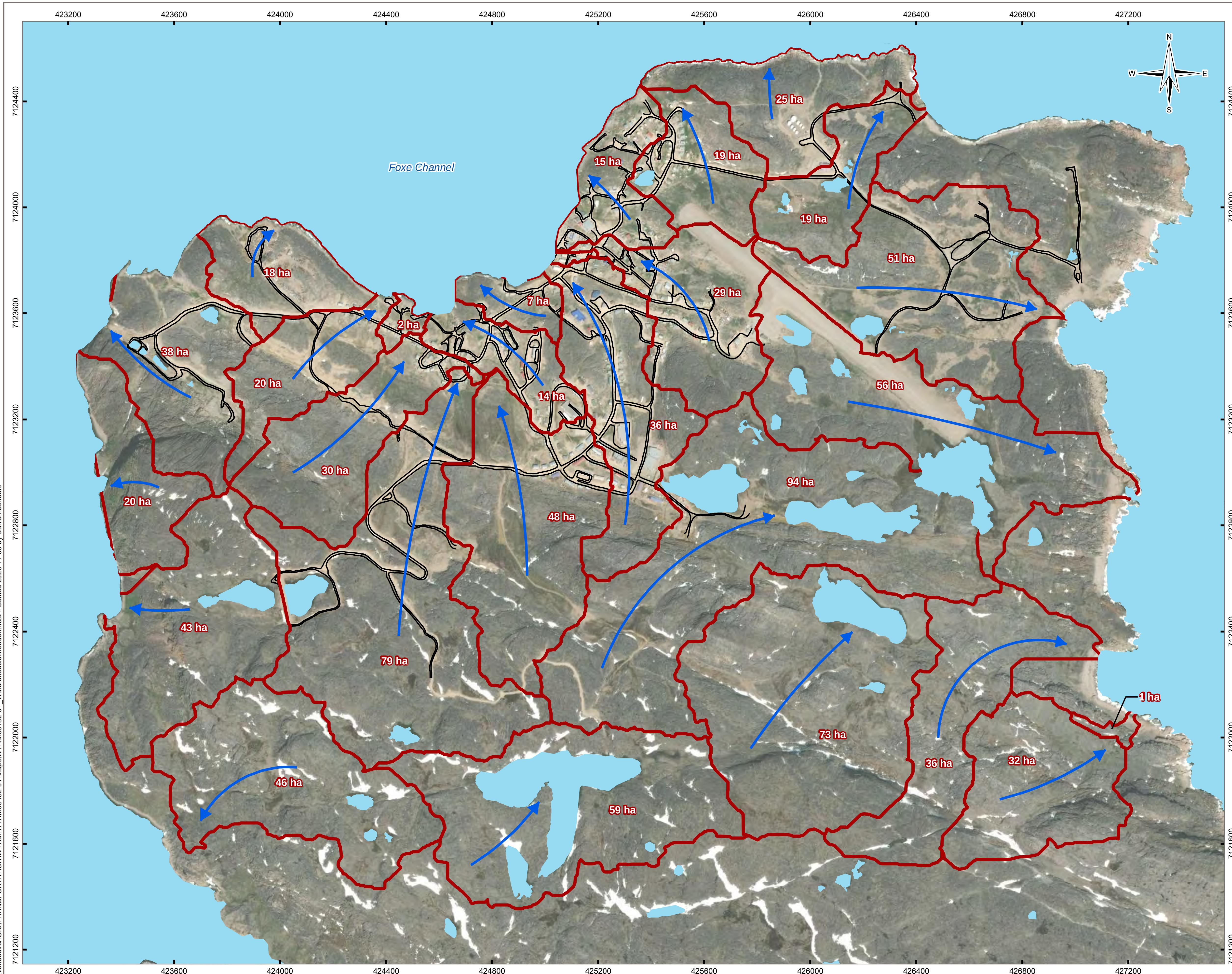
2.2 Terrain

The Hamlet of Cape Dorset, hereafter referred to as the study area, is located on Dorset Island, a small island approximately 7 km in length, south of Baffin Island. 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. The community itself is situated on the shores of Tellik Inlet, set in a valley beneath bedrock ridges rising over 100 metres in elevation to the south.

2.2.1 Topography and Watershed Delineation

A Digital Elevation Model (DEM) of the Cape Dorset 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 Cape Dorset area. The existing drainage patterns are presented in Figure 2-1 and were confirmed during the September 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.



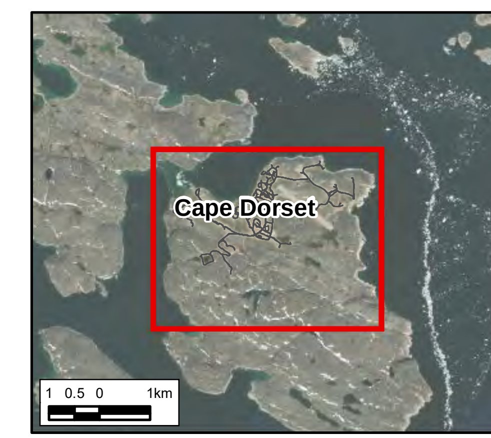
Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01_WatershedDelineation.mxd modified 2020-11-05 by Darren.Schouls

LEGEND

- Flow Direction
- Watershed

Base Data

- Gravel Road
- Waterbody



NOTES
Base data source:
Imagery provided by ESRI; Maxar (2015)
Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET MASTER DRAINAGE PLAN

Watershed Delineation

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:14,000
200 100 0 200
Metres

TETRA TECH

FILE NO.				
WTRM03182-01_WatershedDelineation.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0
DATE	PROJECT NO.			
November 5, 2020	TRN.WTRI03002-01			

Figure 2-1

2.3 Climate

2.3.1 Recorded Data

Climate data for Cape Dorset is based on records collected from 1981 to 2007. Data is collected and published by Environment and Climate Change Canada (ECCC). Figure 2-2, 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 -25.4°C, -22.2°C, and -28.7°C respectively. The same temperatures in July, the warmest month of the year, are 7.8°C, 11.8°C, and 3.7°C respectively. The annual mean daily temperature is -8.9°C. Extreme maximum and minimum recorded temperatures are 25.0°C and -42.2°C respectively. The average annual precipitation for the climate normal period is 418.5 mm, with 158 mm (38%) of rain and the remainder as snow. Precipitation amounts are elevated throughout the summer but highest in the months of July and August, with a maximum recorded daily rainfall of 41.2 mm which occurred on August 20, 1986.

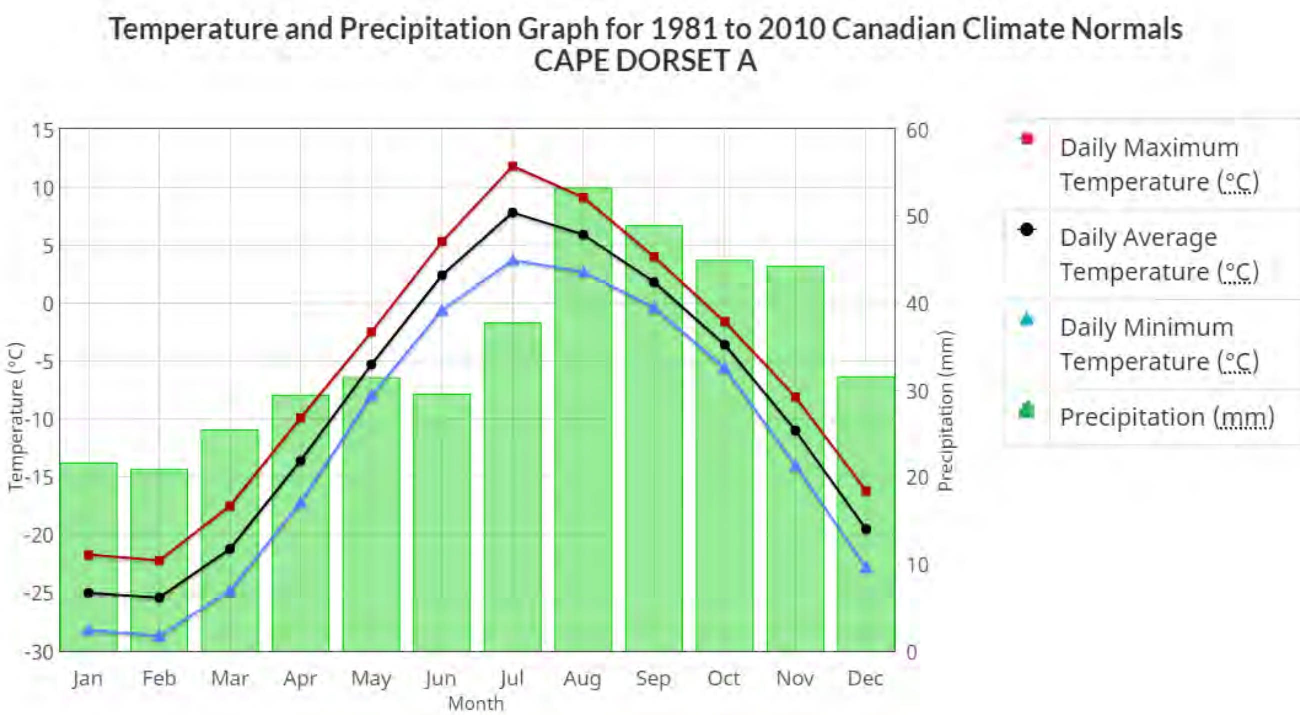


Figure 2-2: Temperature and Precipitation (1981-2010). Cape Dorset A

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Average (°C)	-25	-25.4	-21.2	-13.6	-5.3	2.4	7.8	5.9	1.8	-3.6	-11	-19.5	-8.9
Standard Deviation	3.2	2.8	3.3	2.1	1.9	1.4	1.2	1.1	1.2	1.8	3	4	4.3
Daily Maximum (°C)	-21.7	-22.2	-17.5	-9.9	-2.5	5.3	11.8	9.1	4	-1.6	-8.1	-16.2	-5.8
Daily Minimum (°C)	-28.2	-28.7	-24.8	-17.2	-8	-0.6	3.7	2.7	-0.4	-5.6	-14	-22.8	-12
Extreme Maximum (°C)	-1.4	2.8	1.6	5.6	10.9	17.9	25	21.9	18.1	7.2	3.4	-0.8	
Date (yyyy/dd)	1985/ 18	2006/ 27	2005/ 10	1975/ 29	1993/ 31	1985/ 15	1984/ 15	1991/ 09	1989/ 10	1998/ 02	1985/ 02	1998/ 05	
Extreme Minimum (°C)	-38.9	-40.6	-42.2	-32.8	-19.6	-9.3	-3.4	-4.6	-8.3	-23.9	-30.6	-42.8	
Date (yyyy/dd)	1964/ 14	1964/ 26	1964/ 11	1963/ 01	1983/ 15	2000/ 04	1983/ 11	1983/ 23	1963/ 30	1986/ 25	1963/ 28	1971/ 30	

Table 2-2: Precipitation Climate Normals 1981-2010. Cape Dorset A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Rainfall (mm)	0	0	0	0.3	4	20.9	37.8	52.1	35.7	7.2	0	0	158
Snowfall (cm)	24.2	24.2	28.3	32.8	29.7	8.5	0.2	1.2	13.2	40.1	50.6	37.6	290.7
Precipitation (mm)	21.6	20.9	25.4	29.4	31.4	29.5	37.7	53.2	48.9	44.9	44.2	31.5	418.5
Snow Depth at Month-end (cm)	46	51	58	61	36	1	0	0	1	11	28	41	28
Extreme Daily Rainfall (mm)	0	0	0	1.8	24.2	35.2	32.8	41.2	32	18.6	0.6	0.2	
Date (yyyy/dd)	1964/01	1963/01	1963/01	2006/02	2006/31	2001/17	2004/30	1986/20	1998/10	2005/11	1985/02	1998/04	
Extreme Daily Precipitation (mm)	31.2	23.2	53.8	28.2	42	35.2	32.8	41.2	32	20.2	30.4	15.7	
Date (yyyy/dd)	2003/31	2005/03	2005/31	1995/09	2006/31	2001/17	2004/30	1986/20	1998/10	1999/31	2005/27	1971/05	

Computed short duration rainfall characteristics in the form of Intensity Duration Frequency (IDF) data for Cape Dorset were obtained from Environment and Climate Change Canada (ECCC) and are presented in Table 2-3. The ECCC data was computed with a Gumbel frequency distribution using precipitation data from 1971 to 2017.

Table 2-3: Return Period Rainfall Amounts for Cape Dorsett (1971 to 2017) (mm)

T (years)	2	5	10	25	50	100
5 min	1.2	1.7	2.0	2.5	2.8	3.1
10 min	1.9	2.6	3.0	3.6	4.0	4.4
15 min	2.4	3.2	3.7	4.4	4.9	5.4
30 min	3.8	5.1	6.0	7.1	7.9	8.7
1 h	5.9	7.7	8.9	10.5	11.6	12.8
2 h	8.6	10.8	12.3	14.1	15.5	16.9
6 h	15.4	20.4	23.7	27.9	31.0	34.1
12 h	18.6	25.2	29.6	35.2	39.3	43.4
24 h	20.7	28.4	33.6	40.1	44.9	49.6

2.3.2 Climate Change Predictions

2.3.2.1 Cape Dorset Regional Climate Projections

Atlas Canada (The Prairie Climate Centre, 2019) climate change projections were retrieved for the Region of Cape Dorset. Tetra Tech analysed projected changes between the 30-year time periods of 1976-2005 and 2021-2050 for the Representative Concentration Pathway (RCP) 8.5 climate change scenario. Between these two time periods, the annual mean temperature is expected to increase by 3.1 °C from -9.7 °C to -6.6 °C. Annual precipitation is expected to increase by 14 percent from 342 mm to 389 mm. The maximum 1-day precipitation is expected to increase by 10 percent from 20 mm to 22 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	-9.7	-6.6	3.1	-3.3	6.4
Mean Temperature (°C)	Spring	-14.2	-11.8	2.4	-8.9	5.3
Mean Temperature (°C)	Summer	5.1	6.9	1.8	9.1	4.0
Mean Temperature (°C)	Fall	-5.5	-2.6	2.9	-0.3	5.2
Mean Temperature (°C)	Winter	-24.4	-19.2	5.2	-13.4	11.0

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	342	389	14%	442	29%
Precipitation	Spring	62	68	10%	76	23%
Precipitation	Summer	110	121	10%	129	17%
Precipitation	Fall	116	130	12%	148	28%
Precipitation	Winter	55	70	27%	88	60%
Max 1-Day Precipitation		20	22	10%	26	30%

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 10 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 16 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 Cape Dorset 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 similar to the average warming rate on record in the 1976-2005 time period. As climate change is projected to cause a precipitation increase of approximately 0.1 mm per day during the spring snowmelt period, it is expected that over the freshet period, lasting approximately 20 days, precipitation is expected to increase by approximately 2 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 Cape Dorset are above-freezing, rainfall is projected to increase by approximately 26% for the 2021-2050 time period. Due to the projected increase in rainfall, larger and more severe summer precipitation events are expected for the Cape Dorset region in the 2021-2050 time period. Figures 2-3 and 2-4 below show the Atlas Canada temperature and precipitation projections discussed in this section.

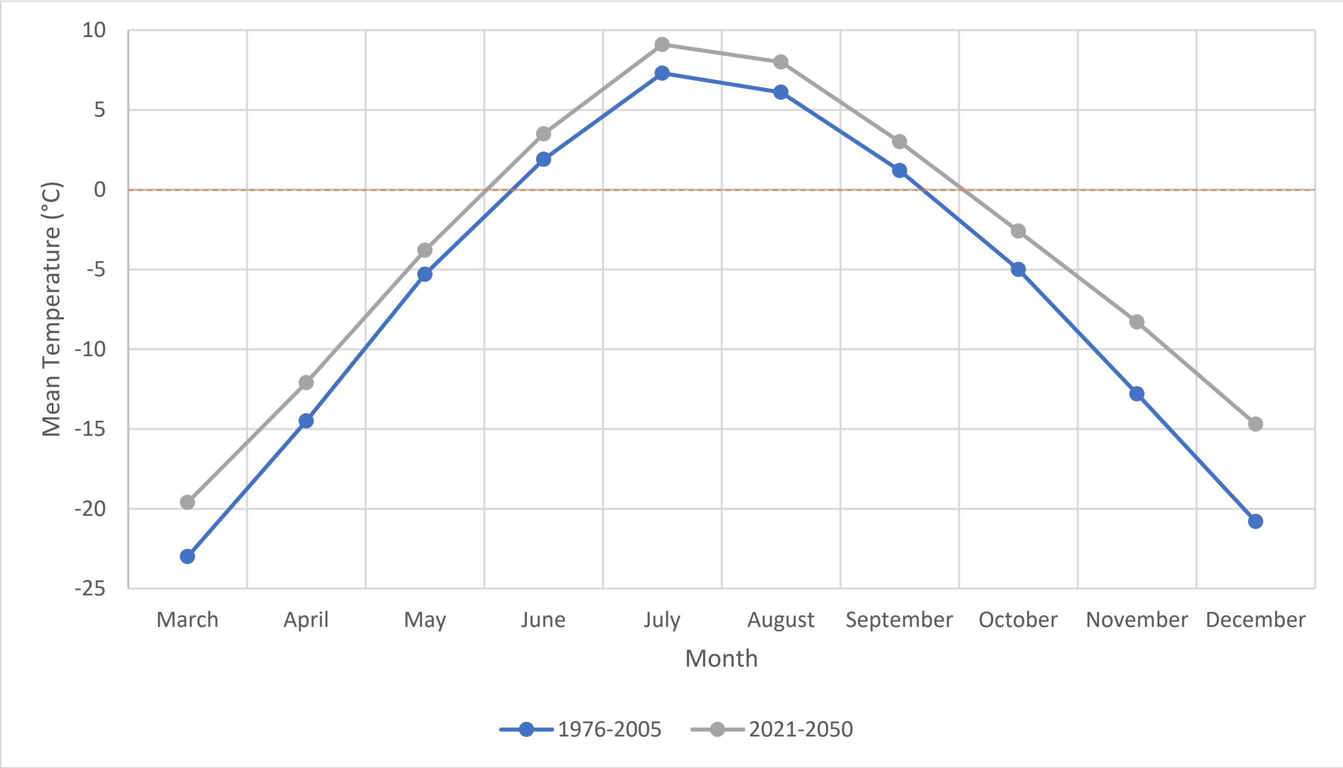


Figure 2-3: Atlas Canada Projected Monthly Mean Temperature

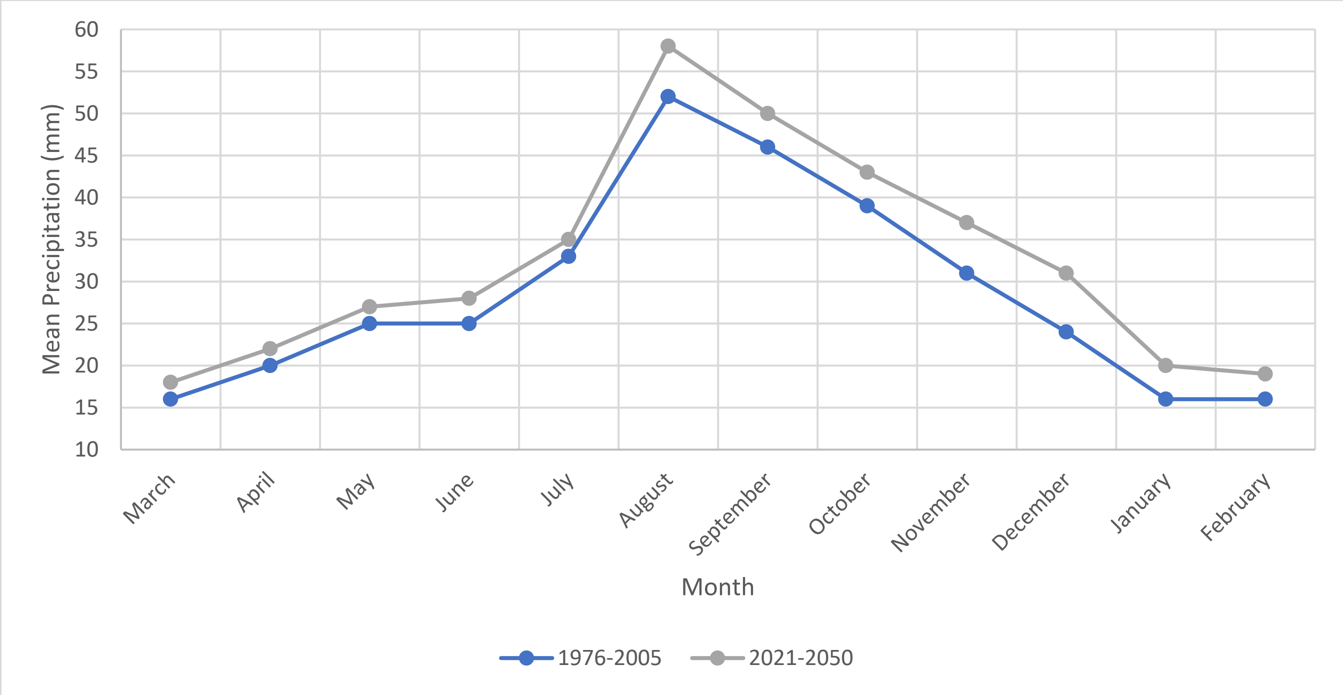


Figure 2-4: Atlas Canada Projected Monthly Mean Precipitation

2.3.2.2 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 Cape Dorset was conducted based on these climate change adjusted rainfall depths.

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

T (years)	2	5	10	25	50	100
5 min	1.32	1.86	2.24	2.78	3.21	3.78
10 min	2.01	2.79	3.32	4.07	4.63	5.37
15 min	2.57	3.52	4.14	4.98	5.58	6.36
30 min	4.08	5.56	6.59	8.05	9.18	10.81
1 h	6.43	8.63	10.03	11.90	13.22	14.86
2 h	9.58	12.26	13.79	15.80	17.12	18.72
6 h	17.07	22.97	26.87	31.00	34.13	37.74
12 h	20.59	28.47	33.83	39.30	43.60	48.45
24 h	22.28	30.97	36.90	45.15	51.32	59.50

2.3.3 Climate Change Implications

Due to limited climate change research available for the Hamlet of Cape Dorset, 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, the process included documenting the geometric locations, descriptions, and conditions of the physical assets that form the Cape Dorset drainage system. 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 September 30th – October 1st, 2019 by Tetra Tech engineering staff Mark Aylward-Nally and Eric Rothfels. The purpose of the site visit was to:

- Discuss ongoing drainage issues and maintenance practices with the Cape Dorset foreman, Mr. Steven Pootoogook;
- 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 Cape Dorset was conducted from September 30th to October 1st, 2019 with the following objectives:

- Develop an understanding of the drainage patterns through the Hamlet;
- Identify main drainage routes and infrastructure assets;
- Document GPS points of key infrastructure locations, including upstream and downstream culvert ends;
- Measure culvert dimensions and document culvert conditions;
- Identify ponding areas and uncontrolled overland 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;
- 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 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 3-1 to 3-6 in Section 3.6 highlight the documented issues.

3.3 Drainage

Cape Dorset's drainage patterns follow the natural relief, however the construction of fill pads for buildings and road embankments have modified the natural streams and lead to an increase in surface runoff and peak flows. A large portion of the runoff in Cape Dorset flows through the lower portion of the community in the northwest, with the headwaters of the watercourses located within the highlands upstream of the community. Snowmelt and storm runoff collects in sub-catchments directly south of the Hamlet before flowing north through the community and into Cape Dorset Harbour. We estimate the total catchment area of the lower portion of the community to have a watershed area of approximately 169 hectares.

Tetra Tech has completed a delineation of the existing subcatchments within the Cape Dorset 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 2.2.2.

Based on the 2013 Community Plan, land allocated for future expansion is located primarily in two locations: adjacent to the water truck fill station southwest of the community, and north of the airport runway adjacent to the tank farm. 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.

3.4 Drainage Infrastructure

During the 2019 site visit, existing culverts, ditches, swales, and natural streams were observed. A total of 76 culverts were assessed as part of this site visit. The diameter of the culverts ranged from 100 mm to 1000 mm, with the majority having a diameter of 450 mm, 600 mm, or 800 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.

3.5 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 Cape Dorset 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, Tetra Tech documented both areas susceptible to flooding and culverts susceptible to ice blockages. The lack of formalized swales is a separate issue which promotes the ponding of water and 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:

- Flooding was highlighted by the Hamlet's foreman surrounding Lot 526 between the Arctic College and the Fire Hall. During the site inspection, Tetra Tech determined that a principle cause for this flooding is uncontained flow from the unformalized ditch between culverts C53 and C55 as shown in Figure 3-11 and highlighted in Figure 3-4.
- The northwest region of the community (near the intersection of Road R1 and R2) was highlighted by the Hamlet's foreman as particularly susceptible to flooding during the spring melt period. Tetra Tech determined that the cause for this flooding is a combination of inadequate culvert sizing, culvert damage, and blockages due to ice and debris. Culverts C6 and C9 are key drainage components serving this area of the Hamlet, and springtime maintenance of these culverts is crucial to ensure their proper functioning.
- Due to poor grading, snow accumulation in front of the multi-residential building along Road R8 (numbers 3035, 3033, 3019, 3029) often translates into ponding issues during spring freshet. This was noted by Mr. Pootoogook. This area is shown on Figure 3-4.
- Flooding across Road R8 was noted by Mr. Pootoogook at culvert C49. Ice and debris blockages likely prevent flow from being conveyed through culvert C49 which results in flooding across the road and erosion of the C49 inlet area. Monitoring and maintenance particularly with a culvert steamer truck is important to reinstate capacity before spring freshet.
- Flooding across Road R9 was noted by Mr. Pootoogook by the heated garage (Lot 12) and the Coop Store. Blockages due to ice and debris in culvert C59 is likely the cause for water overtopping the road in this area. Monitoring and maintenance particularly with a culvert steamer truck is important to reinstate capacity before spring freshet.
- A similar flooding issue was noted by Mr. Pootoogook across Road R14 at culvert crossing C60 behind the northern store. Blockages in culvert C60 due to ice and debris are also likely the cause of the flooding.

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

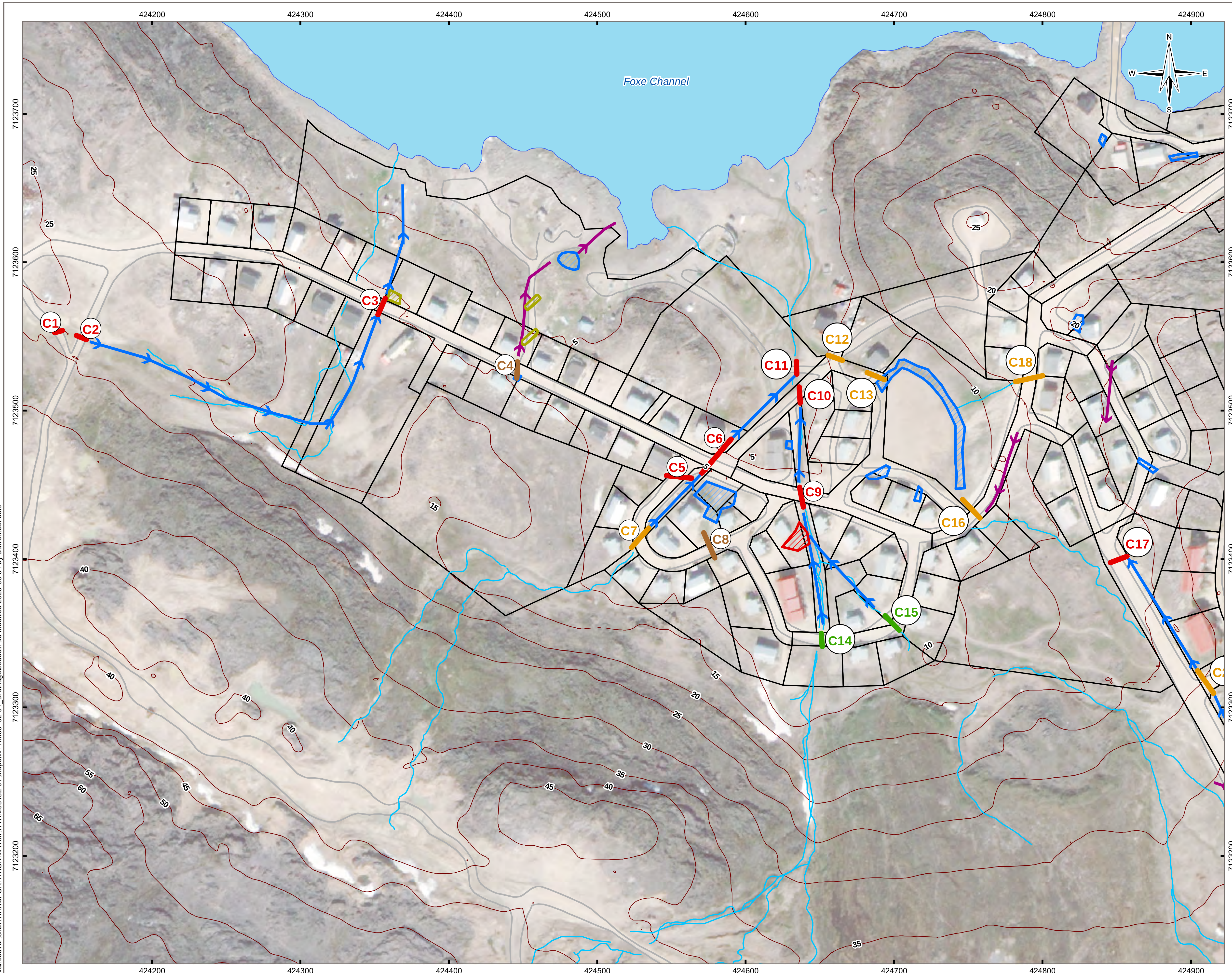
Table 3-1: Most Common Cape Dorset Drainage Issues

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 3-1 to 3-6 identify Cape Dorset'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 provide guidance as to each of the condition categories, how the conditions assigned are defined and the potential remediation 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 5.0 - 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, Relocate
Damaged	Non-superficial Damage Observed. Damage is the primary concern.	Repair, Replace, Abandon
Blocked	Inlet or outlet is completely blocked or buried. Blockage is the primary concern.	Remove Debris, Replace, Abandon
Partially Blocked And Damaged	Capacity Restricted (30-70%) due to Sediment Build Up and Damage.	Remove Debris, Repair, Replace, Abandon
Partially Blocked	Capacity Restricted (30-70%) due to Sediment Build Up	Remove Debris, Replace, Abandon
Undersized	Capacity is inadequate for conveying observed flows.	Replace, Abandon



LEGEND

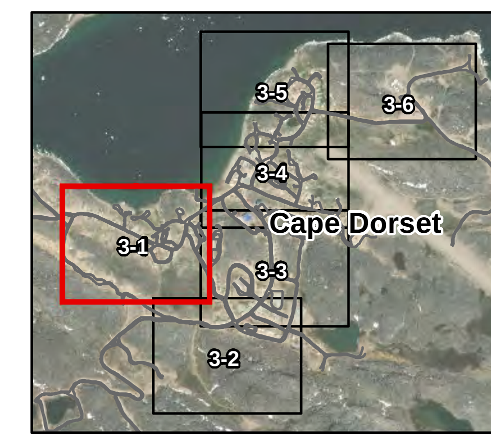
Culverts
- Blocked
- Partially Blocked and Damaged
- Damaged
- Functioning as Intended

C## Culvert Number

Open Channels
- Well-Defined Flow
- Overland Flow

Issues
- Erosion
- Anecdotal Flooding
- Ponding

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Drainage Issues Based on Sept. 30 - Oct. 1 Field Visit Observations

PROJECTION: UTM Zone 18
DATUM: NAD83
CLIENT: Nunavut

Scale: 1:2,500
50 25 0 50
Meters

TETRA TECH

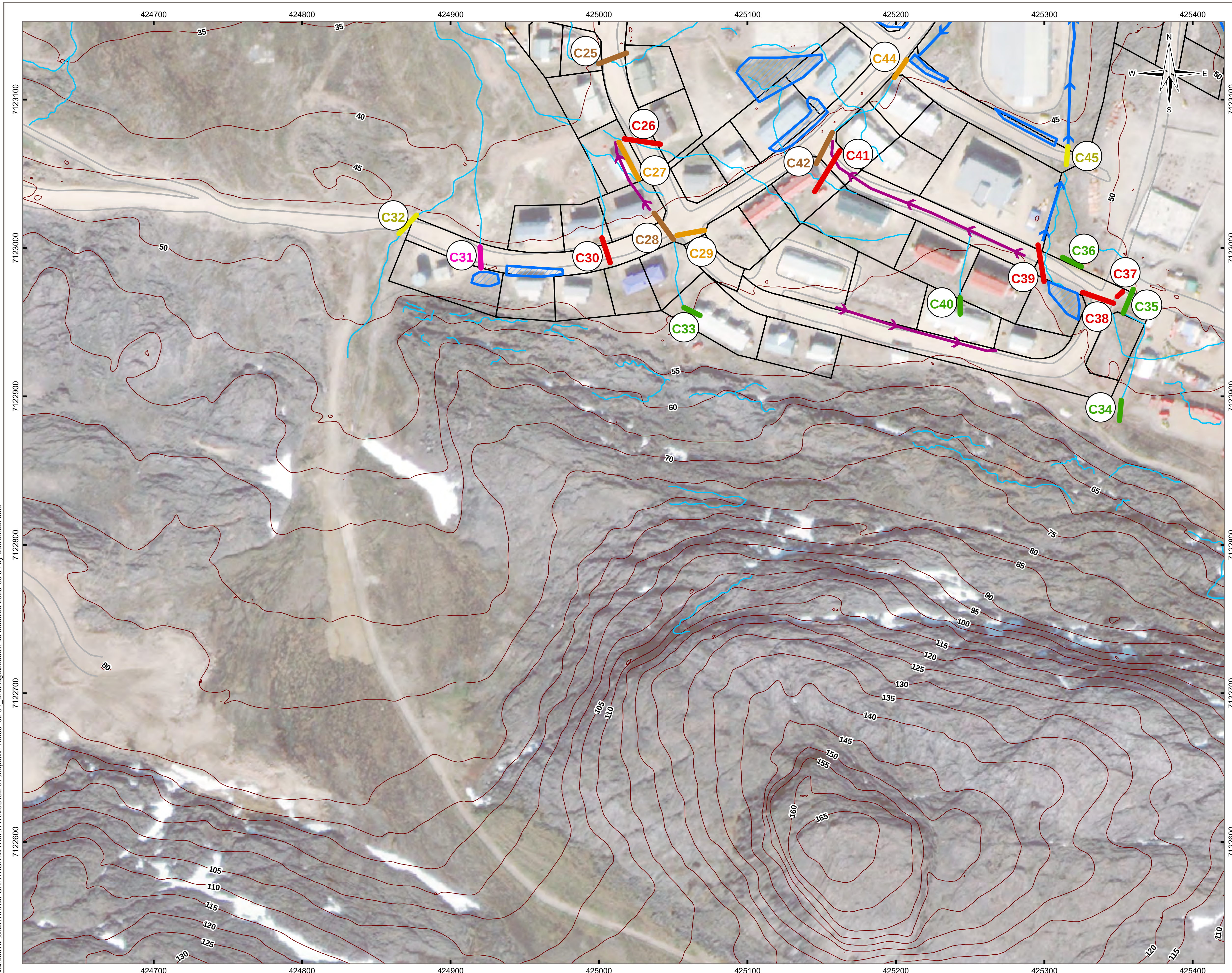
FILE NO.: WTRM03182-01_DrainageIssues.mxd

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

DATE: September 1, 2020
PROJECT NO.: TRN.WTRI03002-01

Figure 3-1

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_DrainageIssues.mxd modified 2020-09-01 by Darren.Schouls



LEGEND

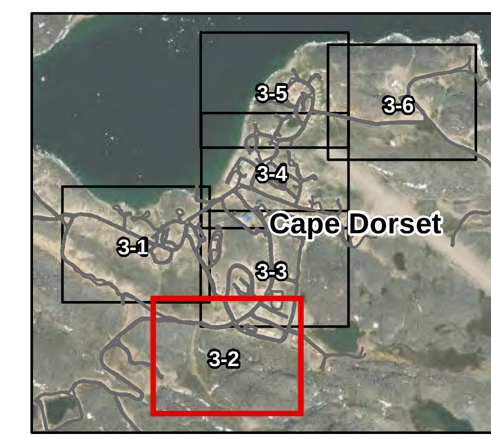
Culverts
- Blocked
- Partially Blocked
- Partially Blocked and Damaged
- Damaged
- Undersized
- Functioning as Intended

C## Culvert Number

Open Channels
- Well-Defined Flow
- Overland Flow

Issues
- Ponding

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Drainage Issues Based on Sept. 30 - Oct. 1 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.
WTRM03182-01_DrainageIssues.mxd

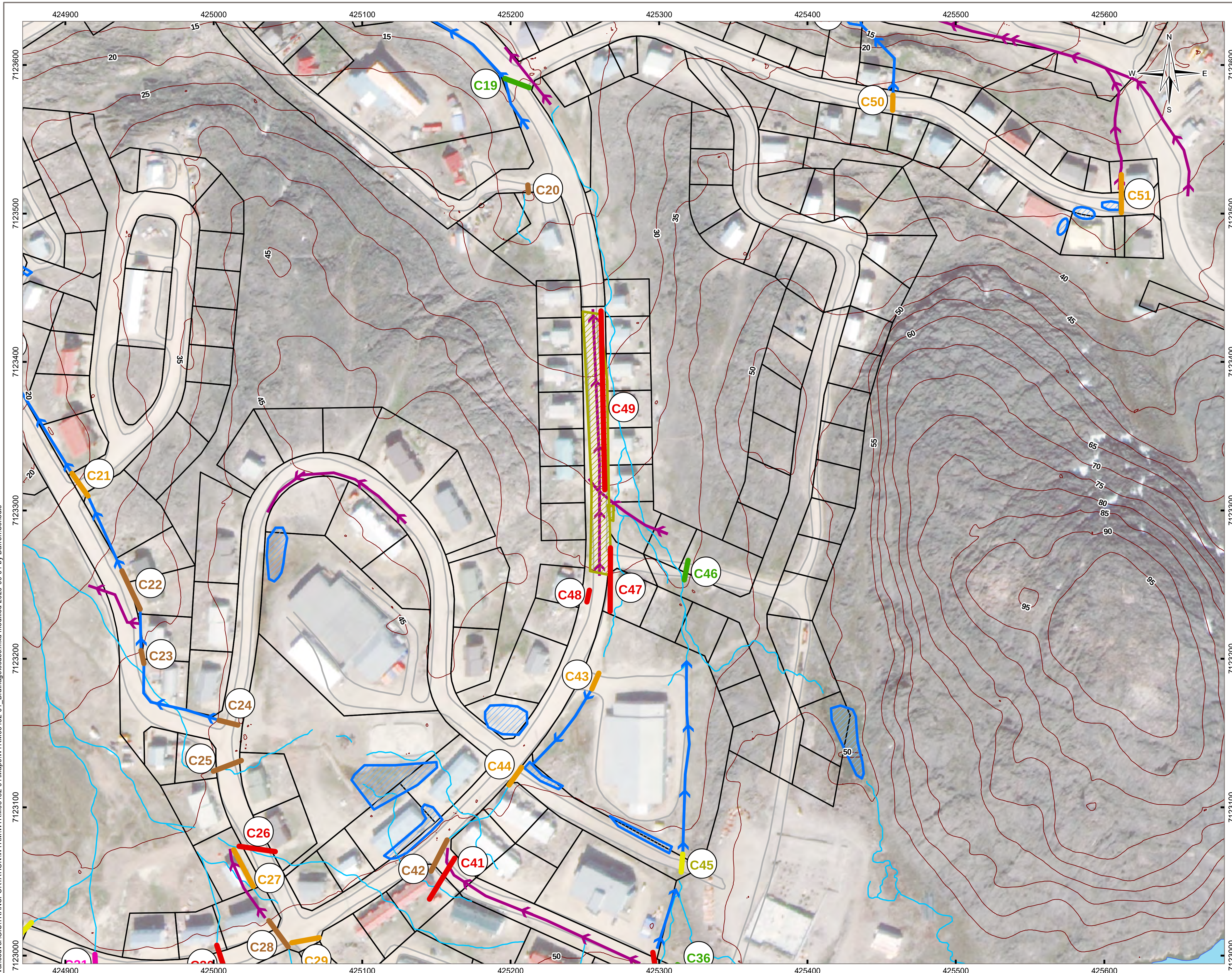
TETRA TECH

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

DATE	PROJECT NO.
September 1, 2020	TRN.WTRI03002-01

Figure 3-2

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_DrainageIssues.mxd modified 2020-09-01 by Darren.Schouls



LEGEND

Culverts

- Blocked
- Partially Blocked
- Partially Blocked and Damaged
- Damaged
- Undersized
- Functioning as Intended

C## Culvert Number

Open Channels

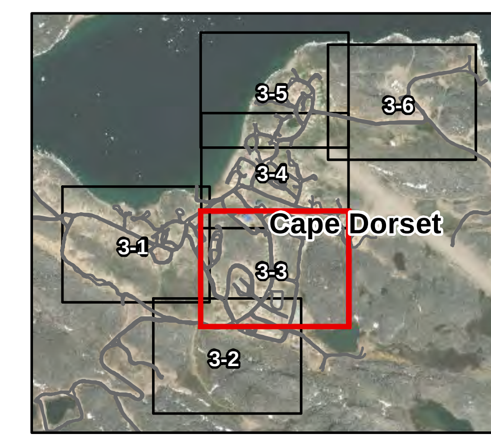
- Well-Defined Flow
- Overland Flow

Issues

- Erosion
- Ponding

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Drainage Issues Based on Sept. 30 - Oct. 1 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.
WTRM03182-01_DrainageIssues.mxd

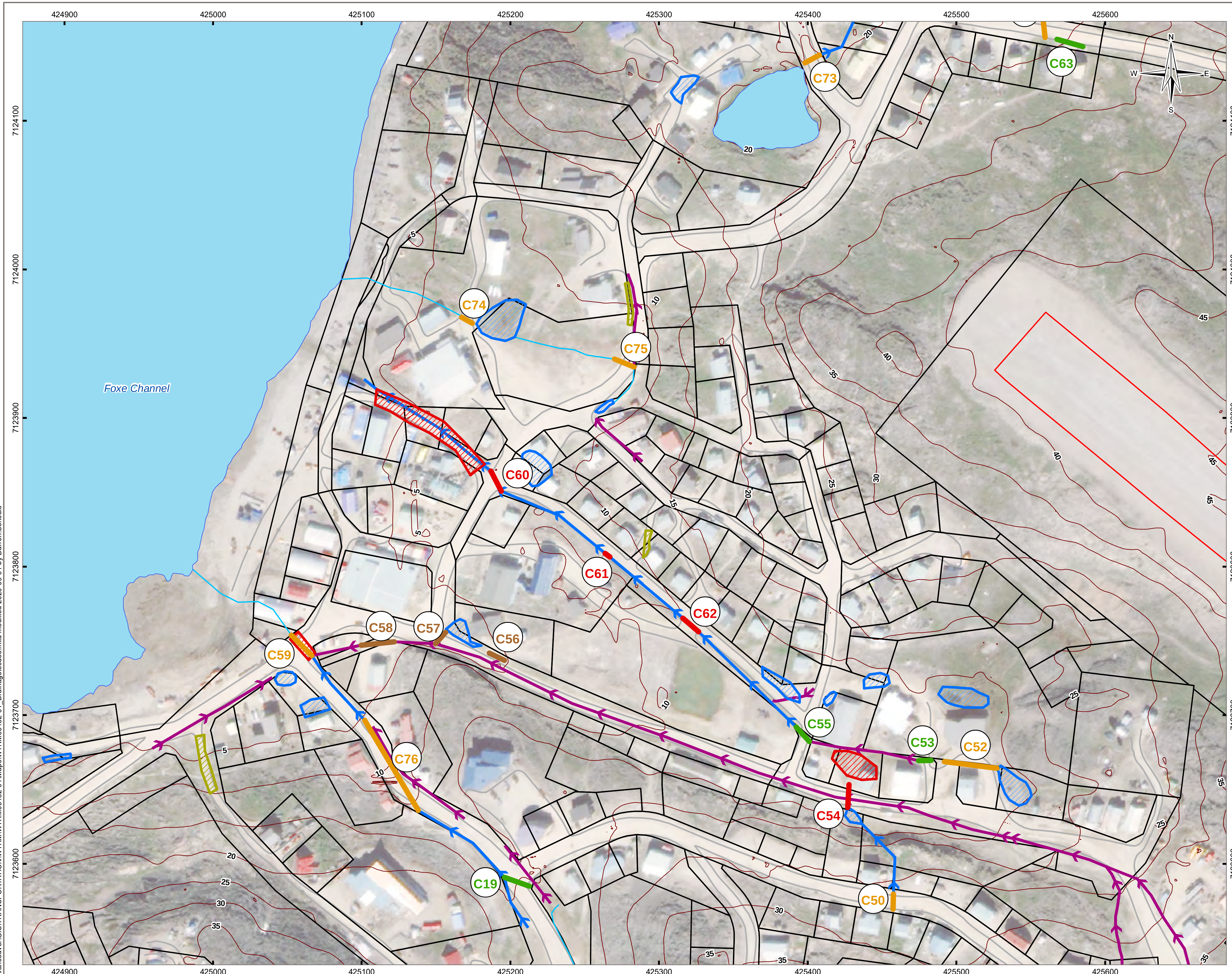
TETRA TECH

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

DATE	PROJECT NO.
September 1, 2020	TRN.WTRI03002-01

Figure 3-3

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_DrainageIssues.mxd modified 2020-09-01 by Darren.Schouls



LEGEND

C## Culvert Number

Culverts
- Blocked
- Partially Blocked and Damaged
- Damaged
- Functioning as Intended

Open Channels
- Well-Defined Flow
- Overland Flow

Issues
- Erosion
- Anecdotal Flooding
- Ponding

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

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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Drainage Issues Based on Sept. 30 - Oct. 1 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

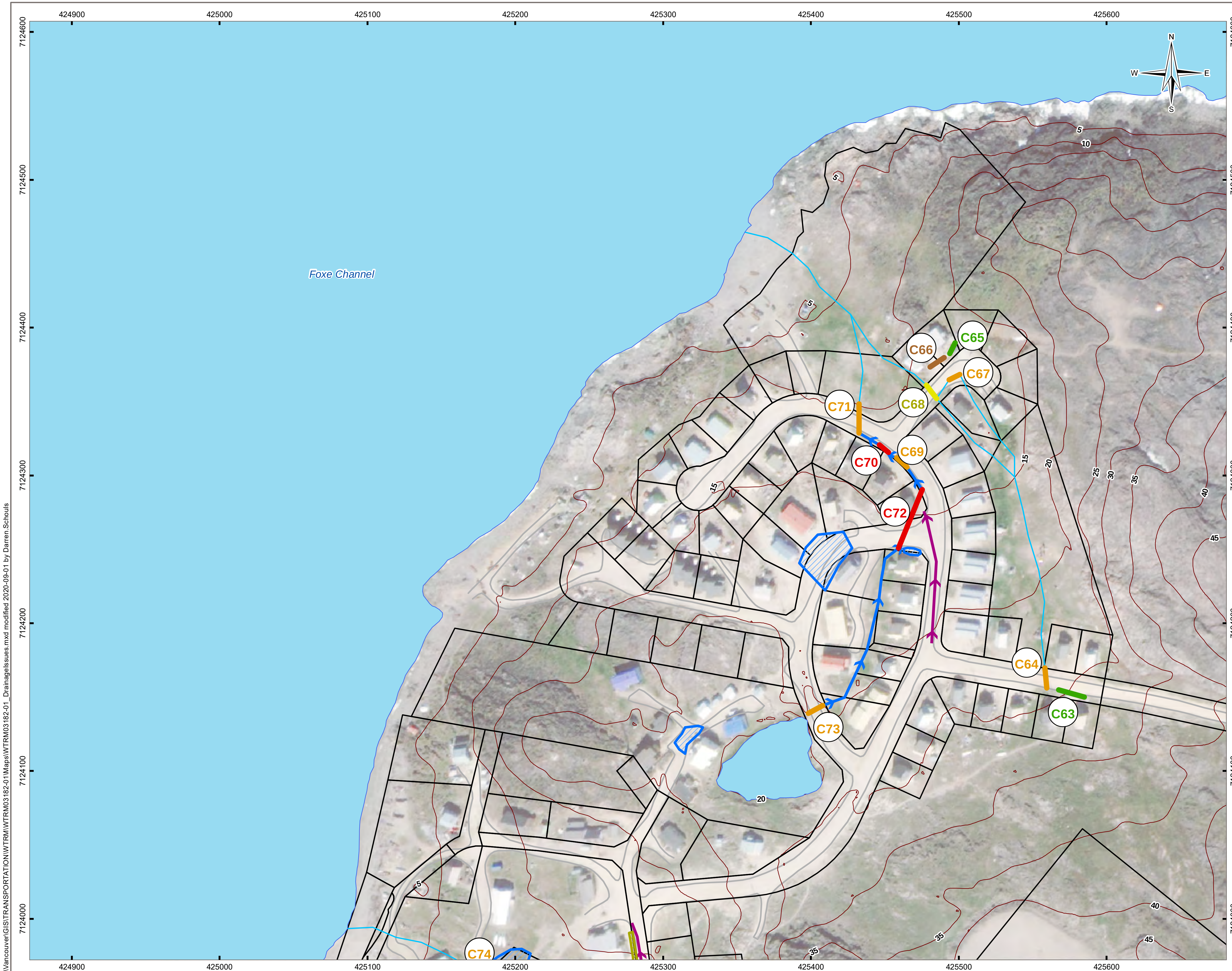
Scale: 1:2,500
50 25 0 50
Meters

TETRA TECH

FILE NO.				
WTRM03182-01_DrainageIssues.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0
DATE	PROJECT NO.			
September 1, 2020	TRN.WTRI03002-01			

Figure 3-4

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_DrainageIssues.mxd modified 2020-09-01 by Darren.Schouls



LEGEND

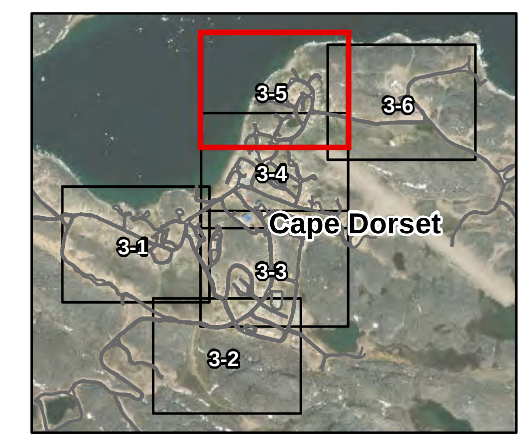
C## Culvert Number

Culverts
- Blocked
- Partially Blocked
- Partially Blocked and Damaged
- Damaged
- Functioning as Intended

Open Channels
- Well-Defined Flow
- Overland Flow

Issues
- Erosion
- Ponding

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Drainage Issues Based on Sept. 30 - Oct. 1 Field Visit Observations

PROJECTION: UTM Zone 18
DATUM: NAD83
CLIENT: Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.: WTRM03182-01_DrainageIssues.mxd

TETRA TECH

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

DATE: September 1, 2020
PROJECT NO.: TRN.WTRI03002-01

Figure 3-5

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_DrainageIssues.mxd modified 2020-09-01 by Darren.Schouls

LEGEND

Culverts

Functioning as Intended

C## Culvert Number

Base Data

Current Parcel

Runway

Topographic Contour (5 m)

Road

Watercourse

Waterbody

NOTES

Base data source:

1. Cape Dorset base data from Government of Nunavut

STATUS

ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Drainage Issues Based on Sept. 30 - Oct. 1 Field Visit Observations

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50

Meters

TETRA TECH

FILE NO.				
WTRM03182-01_DrainageIssues.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	DS	SL	ER	0
DATE	**PROJECT NO.**			
September 1, 2020	TRN.WTRI03002-01			

Figure 3-6

3.6 Example Photos

Figures 3-7 to 3-16 depict examples of the typical drainage system deficiencies identified during Tetra Tech's Sept. 30 – Oct. 1, 2019 site visit.

Figure No.	Description	Image
3-7	Buried culvert inlet (Culvert C28)	
3-8	Damaged culvert outlet. Insufficient cover. (Culvert C73)	

Figure No.	Description	Image
3-9	Water egress from unformalized swale on Road R20.	
3-10	Ponding and undesirable flow crossing roadway (Near building 5012, 5014)	
3-11	Anecdotal Flooding due to unformalized ditch (Near building 526)	

Figure No.	Description	Image
3-12	Undesirable Flow across roadway due to lack of road crown and formalized swales	
3-13	Partially Blocked and Damaged Culvert Inlet (Culvert C51)	

Figure No.	Description	Image
3-14	Repairable Damage on Inlet of Culvert C76	
3-15	Damaged Culvert inlet due to lack of cover and/or snow clearing activities. (Culvert C61)	

Figure No.	Description	Image
3-16	Erosion across road due to unformalized flow path	

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 Cape Dorset 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:
   a. Minimizing the number of different culvert diameters specified;
   b. Minimizing the number of new culverts, which would not only need to be barged to Cape Dorset for installation, but also need to be maintained once installed;
   c. Minimizing the number of different ditch and swale dimensions specified;
   d. 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 providing access to residences.

4.2 Design Criteria

As per the guidelines set by the Community Drainage System Planning, Design, and Maintenance in Northern Communities (CSA-S503-15), the culvert design capacity should be based on the following:

- *Size culverts to accept design flows 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 24-hour storm event. The 10-year 24-hour storm event was selected as the critical event following a review of freshet snowmelt events and a number of rainstorm durations ranging from 1 hour to 24 hours. The goal is to develop 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 24-hour storm event.

3. Swales were sized to maintain at least 50 mm of freeboard during the 10-year 24-hour storm 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, hourly historical data extracted from the Iqaluit A weather station was used to develop a synthetic hyetograph representing 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 2.3.2.2 of this report.

The resulting peak flow rates for each design storm along the Hamlet's largest watercourse are summarized in Table 4-1 (located in the northwest area of the community, at the west corner of lot 1109).

As stated in Section 4-2, the 10-year 24-hour storm event was selected as the critical 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 Cape Dorset between 1980 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: Cape Dorset Design Storm Events

Design Storm Events	Peak Flow Rate (m^3/s) *
10-year 1-hour	0.03
10-year 24-hour	**1.55**
10-year Snowmelt	1.19
100-year 1-hour	1.45
100-year 24-hour	**2.84**
100-year Snowmelt	1.60

* Peak Flow Rate measured through conduit C110 in the PCSWMM model.

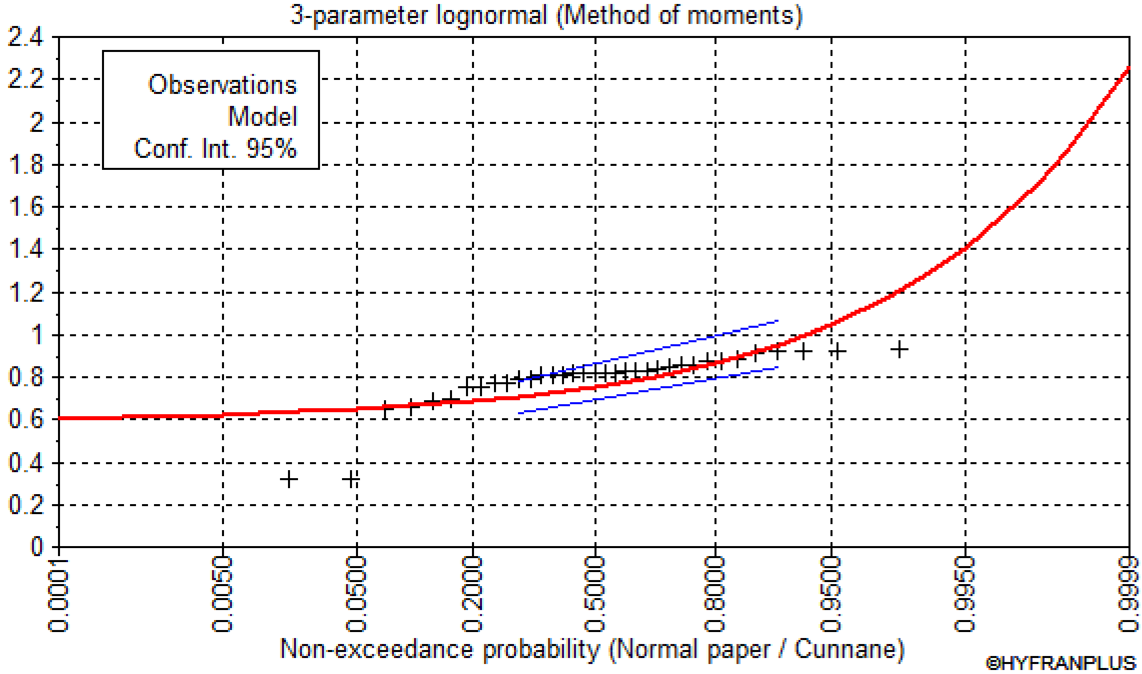
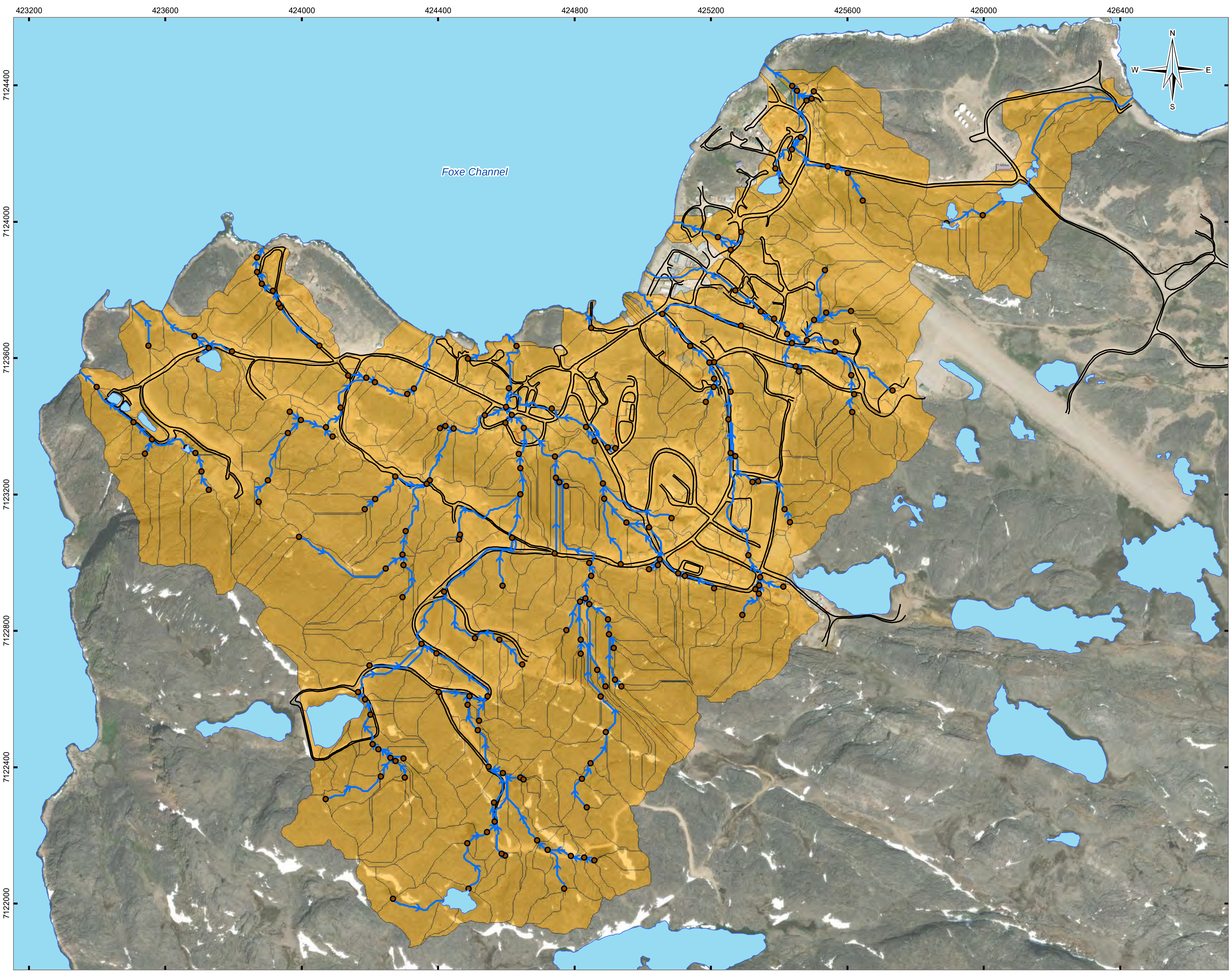


Figure 4-1: Statistical Analysis of watercourse C110 Peak Annual Flow (m^3/s)

4.4 Modelling of System

A systems analysis approach was adopted to design the proposed drainage system for the Hamlet of Cape Dorset. PCSWMM, a professional hydrologic/hydraulic 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 hydrologic units used to calculate flows. Flows generated by a subcatchment area are assigned to a junction, and then hydraulically routed through the drainage network. Through this approach, flows are aggregated through the system until discharged through an outfall point. Figure 4-2 shows the sub-catchments, junctions and conduits representing the model. Input parameters for the subcatchments, junctions and conduits are presented in Appendix H.

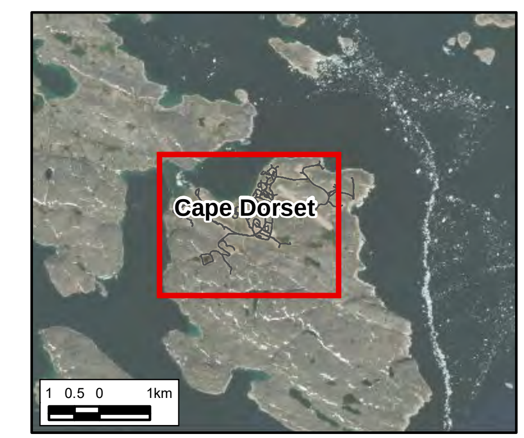


LEGEND

- Junction
- Natural Drainage Path
- Subcatchment

Base Data

- Gravel Road
- Waterbody



NOTES

Base data source:
Imagery provided by ESRI; Maxar (2015)
Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET MASTER DRAINAGE PLAN

PCSWMM Model of Natural Drainage Paths

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:11,000
200 100 0 200
Metres

FILE NO.
WTRM03182-01_Subcatchments.mxd

TETRA TECH

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

DATE	PROJECT NO.
November 5, 2020	TRN.WTRI03002-01

Figure 4-2

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_Subcatchments.mxd modified 2020-11-05 by Darren.Schouls

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 towards 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 45 of the existing culvert crossings be replaced (which totals 51 pipes due to crossings with multiple pipes in parallel) and that 19 new culverts be added to the existing system (see Table 4-2). 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 D presents the modelled results at each of the proposed culverts for the 10-year 24-hour design flow.

Tetra Tech is recommending that the proposed new culverts range in size between 450 mm and 1200 mm. Further to this, all culverts being replaced will be 450 mm in diameter or larger. The minimum diameter of 450 mm is based on the recommendations provided by CSA-S503-15.

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 4-2: Summary of Recommended Culvert Actions

Recommended Culvert Action	Number of Culverts	Total Length (m)
EXISTING CULVERTS		
No Action Required	12	166
Abandon	11	337
Relocate	1	14
Remove Debris	4	52
Repair	4	107
Replace	45	795
Total Existing Culverts	**77**	**1475**
NEW CULVERTS		
Within Existing Community	19	266
Servicing Future Community Expansion	6	142
Total New Culverts	**25**	**408**

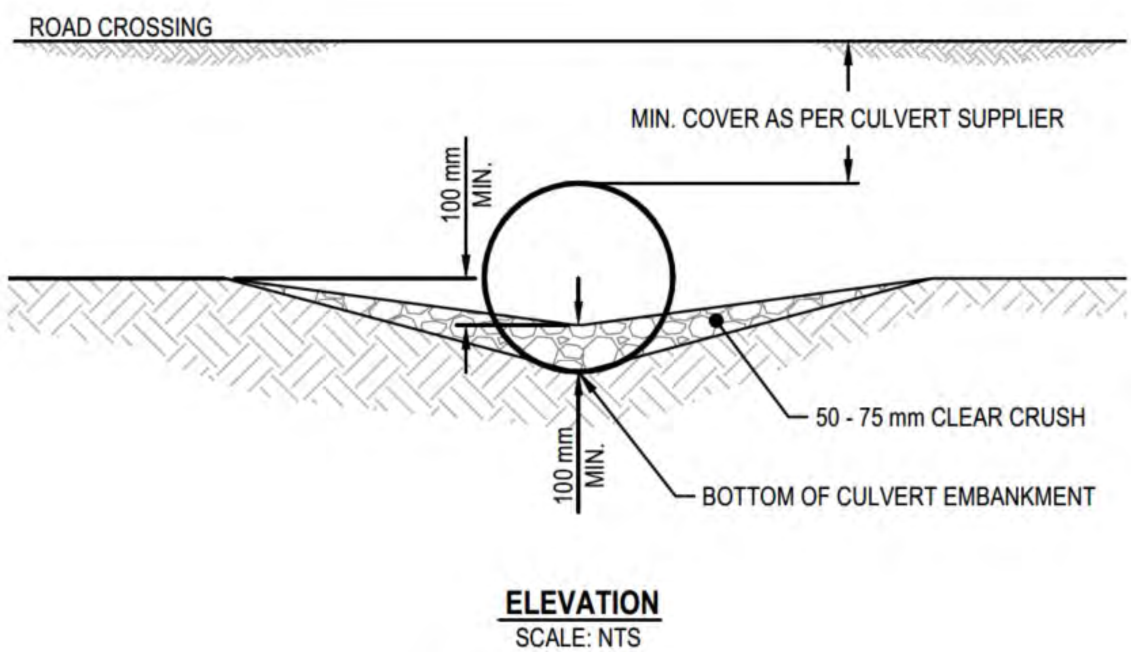


Figure 4-3: Typical Embedded Culvert Details

4.5 Drainage Recommendations

This section summarizes the recommended actions needed to improve the Level of Service provided by Cape Dorset's Drainage System. Currently, there are several system deficiencies (identified in Section 3.0). Tetra Tech has developed the following series of recommendations intended to 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 D provides a full inventory of Cape Dorset's existing culverts including recommended improvements. Tetra Tech's overarching culvert recommendations are provided below.

1. The minimum culvert size should be 450 mm.
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 mm to 12 mm will ensure an extended service life. As detailed in Appendix E, the majority of corrugated steel pipes in Cape Dorset 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 B. 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/deicing 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. Recommended maintenance activities are 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 end-wall side slopes are to be 1.5H:1V to 2H:1V. Side slopes of 2H:1V are preferred where space allows.

9. Riprap headwalls and end-walls are recommended for erosion protection and slope stability. Where space does not allow for riprap protection, culvert inlets and outlets should include a concrete headwall. Figure 4-5 shows typical riprap headwall and end-wall details.

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.

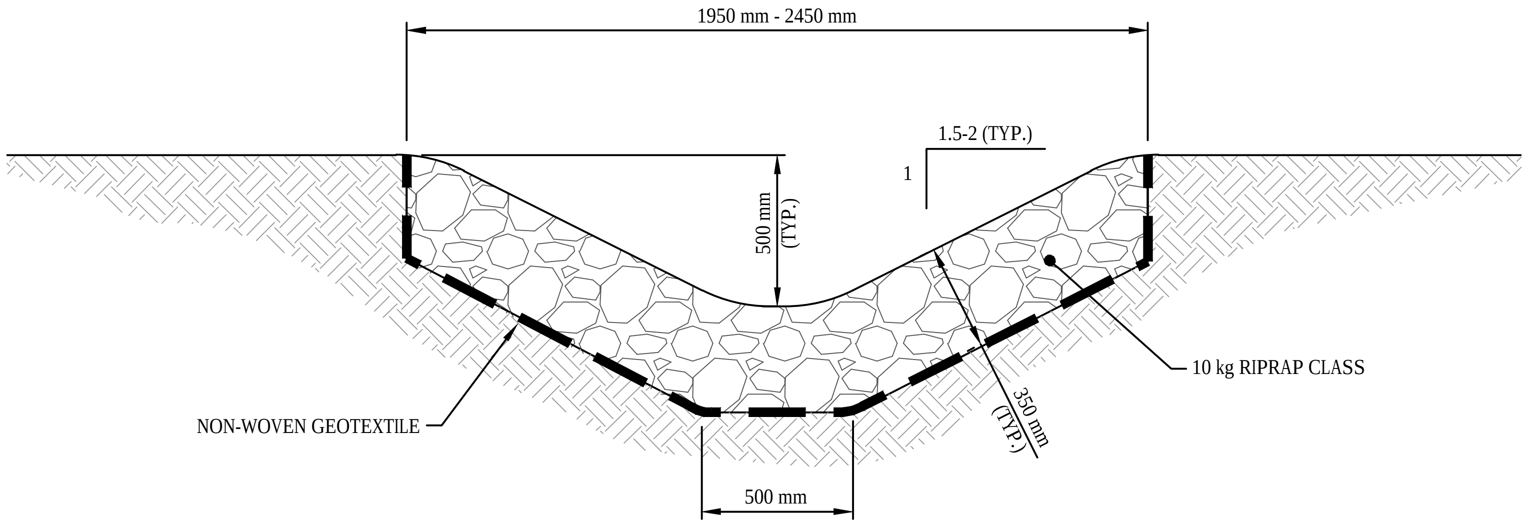
5. Ditches are to be lined with a non-woven geotextile between the existing soil and the specified riprap layer.

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.

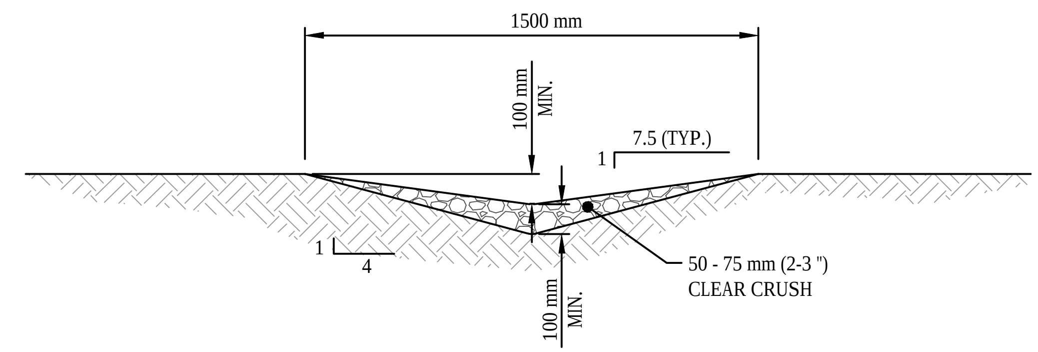
7. Figure 4-4 includes typical cross section details for the proposed ditches and swales.

8. The community of Cape Dorset 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.

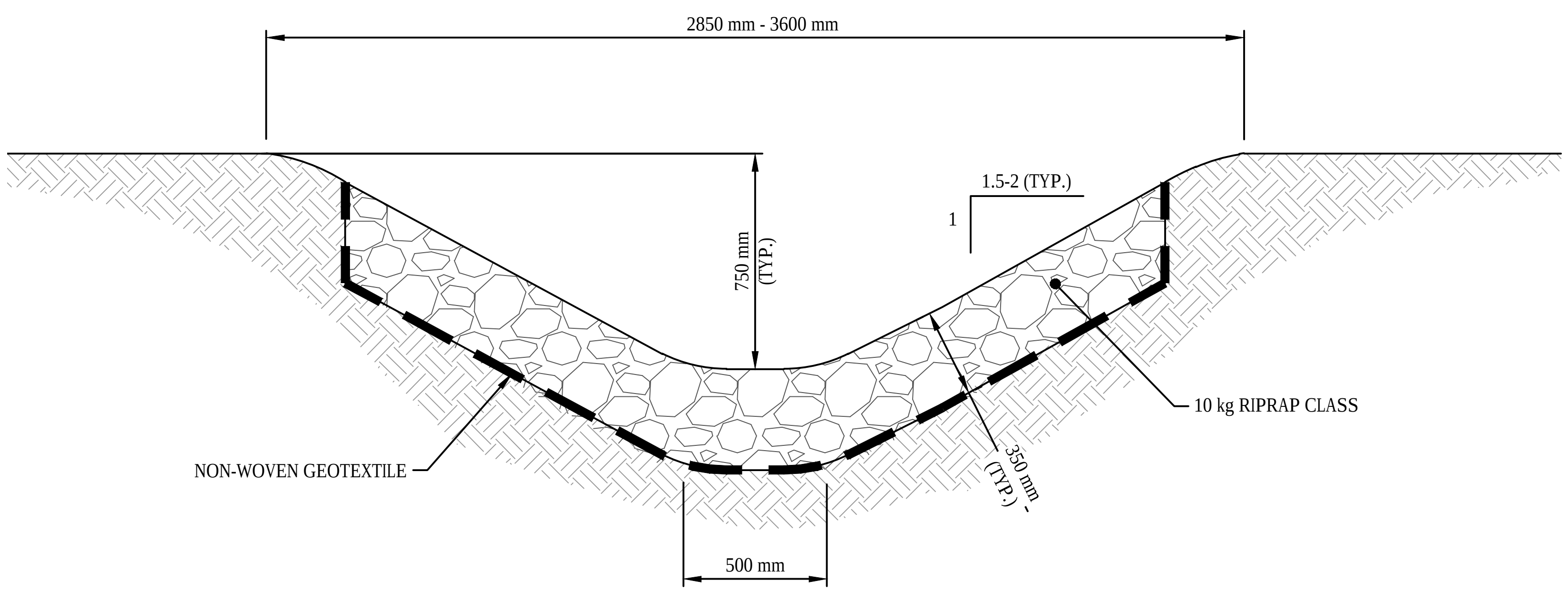
9. To the extent possible, ponding water nearby and underneath buildings should be eliminated. Grading practices underneath buildings should promote the movement of water away from their footprints/foundations.



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
SCALE:NTS

LEGEND

NOTES

NUM	DATE	DWN	CKD	APR	DESCRIPTION
A	03/11/20	MJK	ER	DNM	ISSUED FOR REVIEW

REVISIONS

PROFESSIONAL SEAL

CLIENT

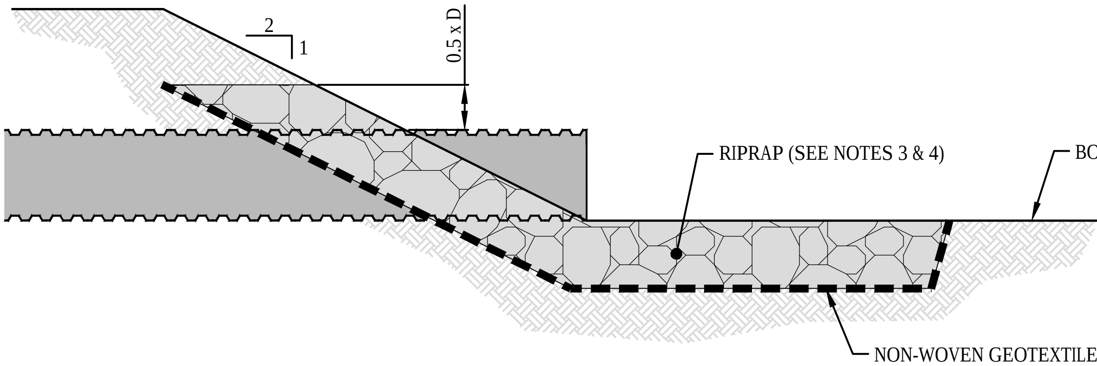
Nunavut

TETRA TECH

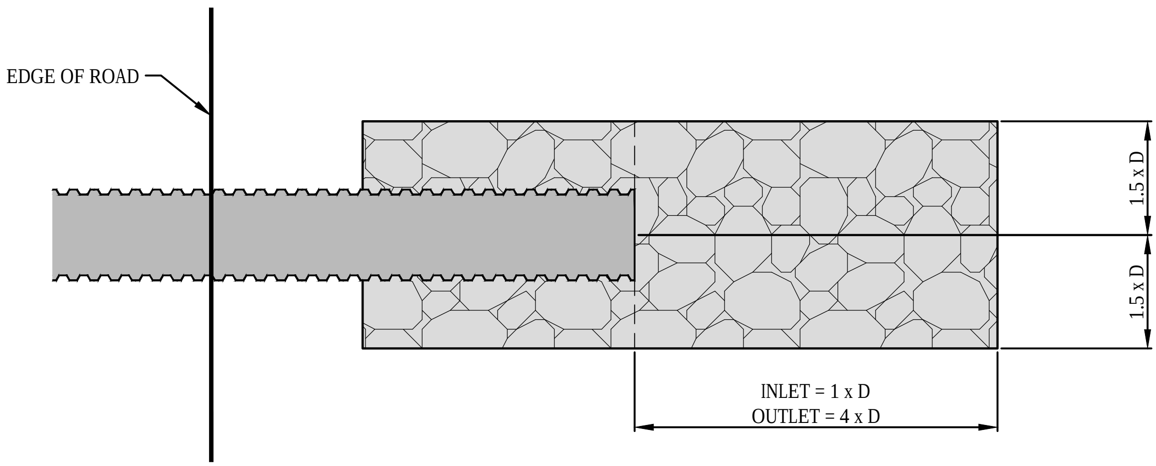
CAPE DORSET MASTER DRAINAGE PLAN

TYPICAL DITCHES AND SWALE DIAGRAMS

PROJECT NO.	OFFICE	DES	CKD	REV	DRAWING
WTRI03002-01	VANC	ER	ER	A	FIG.4-4
DATE	SHEET No.	DWN	APP	STATUS	
Sept. 30, 2020	- of -	MJK	DNM	IFC	



SECTION



PLAN

1 / - CULVERT APRON DETAIL
SCALE: 1:50

NOTES:

1. D = Pipe Diameter
2. Riprap shall be 10 kg class or larger.
3. 10 kg class riprap layer shall be a minimum thickness of 350 mm.
4. 25 kg class riprap layer shall be a minimum thickness of 450 mm.
5. Riprap shall be placed in a controlled manner (no end dumping) to specified design slope.

ISSUED FOR REVIEW

SCALE 1:50

500 0 500 1000 2000mm

CLIENT

Nunavut

TETRA TECH

DRAINAGE PLANNING
CAPE DORSET, NU

TYPICAL CULVERT
RIPRAP PROTECTION DETAIL

PROJECT NO.	DWN	CKD	REV
ENG.WTRI03002	JDM	ER	A

OFFICE	DATE
VANC	September 8, 2020

Figure 4-5

5.0 MASTER DRAINAGE PLAN

Based on our 2019 field investigation, background data review, and modeling work, Tetra Tech has developed the following drainage system upgrades for both the existing community and the planned community expansion areas.

The Master Drainage Plan (MDP) developed for the Hamlet of Cape Dorset is presented as a conceptual drainage plan including general grading recommendations. As part of the MDP, Tetra Tech has also included a series of phasing plans to assist in budgeting the proposed upgrades. Finally, Tetra Tech has developed a maintenance program including recommendations for training and equipment requirements.

The proposed upgrades, in combination with the outlined maintenance program, are designed to convey the expected peak flows identified in Section 4.3 of this report.

5.1 Conceptual Drainage Plan

Tetra Tech has compiled all the existing and the proposed drainage infrastructure into a single conceptual drainage plan complete with recommended upgrades for existing infrastructure, flow routing 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 5-4 to 5-9. Action categories have been created for both culverts and open channels. Tables 5-1 and 5-2 below outline and explain each action category.

Table 5-1: Culvert Action Categories and Descriptions

Action Category	Description
ABANDON	Culvert not functioning as intended and/or not necessary to the functioning of the drainage system. Complete removal of culvert is preferred. Reuse of culvert may be possible if its structural integrity remains intact.
FUNCTIONING AS INTENDED	Culvert retains full capacity with no observed damage. No action required.
NOT ASSESSED	Culvert was not assessed by Tetra Tech staff during the 2019 site visit due to one of the following: • Culvert was completely buried; • Culvert was not found; and • Culvert was outside of the core community area and therefore outside of the project scope.
RELOCATE	Culvert functioning as intended, but to be moved to a different location.
REMOVE DEBRIS	Culvert is blocked or partly blocked with sediments or debris. No damage observed. Sediments and/or debris to be cleared.
REPAIR	Culverts with damage where repair will restore full or near full capacity. Repair culvert as per Section 5.6.1 and clean out sediments as required.
REPLACE	Culverts damaged beyond repair to restore full capacity or culvert does not have enough capacity to convey the design flows. In some cases, the culvert was fully buried and assumed damaged beyond repair. This assessment can be revisited and revised as appropriate. In some cases, repairs could still be completed to restore a reduced capacity if funding for replacement is not immediately available. Such culverts are noted as “Repair Possible” in Appendix D.

Table 5-2: 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.
FORMALIZE TYPICAL LARGE DITCH	Install typical large ditch as per Figure 4-4. This action applies to both existing and newly created overland flow paths.
NATURAL DRAINAGE PATH	Stable stream or creek. No Action Required.

Comments in regard to the conceptual drainage design include the following:

1. As stated in Section 4.5.1, Appendix D Culvert Summary Table details the recommended actions for each culvert. Several culverts could either be replaced or repaired. Many of the culverts identified in the 2019 site visit have damaged ends. There were a number that were completely buried, and we were not able to assess their conditions. We recommend replacement in these cases; however, if the existing culvert is in good shape, unblocking it and repairing the damaged ends may be all that is required. Where Tetra Tech indicated "Repair Possible," the culvert had sustained visible damage and/or was buried, however the measured culvert size was determined to be adequate. In this case, repair may be a viable cost-effective alternative to the replacement of the entire culvert. A sleeve can be installed at the ends in these culverts as shown in Figure 5-17. Replacement and upgrade to a SWSP is still the recommended option for a longer service life.

2. A few culverts in the Hamlet were recognized as key components to the proper functioning of the drainage system. Tetra Tech is proposing that a second culvert be added to these crossings for redundancy. This will help protect the community in the event that one of the culverts becomes blocked with ice and/or debris. We recommend that one of the culverts be installed slightly above the other. This offset will prevent debris from entering the second culvert and force all the debris through the main culvert barrel. This will reduce the frequency of icing and debris blockages.

3. Tetra Tech recommends installing a ditch behind the residential buildings north of the Community Arena instead of installing a new 128 m long culvert (C49). If excavating a new ditch is not feasible due to the presence of a shallow bedrock layer, an above grade embankment could be constructed to promote the movement of water around the perimeter of the buildings. This technique can be utilized in other areas of the community where ditching is not possible due to the presence of a shallow bedrock layer and/or shallow permafrost layer. Finally, if neither a ditch or an embankment behind the buildings is desired, Tetra Tech would advise upgrading culvert C49 to 0.9 m diameter to meet the 10-year design storm event.

4. Culvert headwalls and end-walls should be armored with riprap. All riprap installations should include the installation of a non-woven geotextile to act as a filter layer between the riprap and the in-situ soils. Headwalls protect road embankments from erosion and improve the stability of the slope. These should be installed on all culvert crossings in the community. However, recognizing budgetary constraints as well as the need to prioritize the most in-need crossings, Tetra Tech has noted in Figures 5-4 to 5-9 major crossings

where headwall and end-wall protection is most critical. A typical riprap headwall detail is shown in Figure 4-5 in Section 4.5.

5.2 Grading Plans

To aid in directing flows and reducing ponding, Tetra Tech has identified community areas where poor drainage conditions could be improved via regrading. Recommended regrading sites are shown in Figures 5-1 to 5-3 and are detailed below. Regrading plans are intended to direct surface water towards the proposed drainage infrastructure where it is then conveyed through the community.

- Raising the road profile and adding a crown is recommended for all roadways in the Hamlet. However, recognizing budgetary constraints as well as the need to prioritize certain critical areas, a phased approach is recommended. Tetra Tech has included in Figures 5-1 to 5-3 specific sections of roadways where raising the profile of road embankment is most critical. These road sections were identified during the 2019 site visit as promoting surface ponding and/or overland flow. Crowning the road is a technique that can be used in combination with swales along the shoulders to prevent ponding and overland flow across roadways.
- During the field visit Mr. Pootoogook identified the region around Lot 526 between the Fire Hall and the Arctic College as a primary area of flooding within the community. To address this issue, it is recommended that the Hamlet formalize a typical large ditch between Culverts C53 and C55. Raising the road profiles and lot frontages surrounding this area is also recommended. Lowering culvert C62 and regrading the ditch between culverts C55 and C62 will improve the downstream flow conditions, which is very important in relieving the flooding issues noted between the Fire Hall and the Arctic College. Additionally, proper grading along Road R11 will help to constrain flow within adjacent conveyance channels. As the Fire Hall provides an essential service to the community, it is important that clear access to the facility be maintained.
- For the areas highlighted as “Regrade to Protect from Ponding,” slope the grading areas in the direction indicated using cut and fill techniques to minimize the amount of fill material needed to be procured or hauled away. Grading the areas in the direction shown will move the surface water away from the site. Regrading these areas will reduce ponding in the community, improve access to buildings, and improve the drainage system performance following rainfall events and during the spring freshet. The highlighted areas were identified during the 2019 site visit. Through anecdotal discussions with the Hamlet representatives, Tetra Tech was able to identify areas promoting significant ponding. These areas were found to be a nuisance restricting access to buildings.
- Regrading is recommended in front of the multi-residential building along Road R8 (numbers 3035, 3033, 3019, 3029). Snow builds up in front of this building due to the lot frontage being lower than the Road R8 profile. We recommended raising the grade of the lot frontage up to the level of the road and sloping the grades towards the outside corners of the building. This will allow surface runoff to be collected by the proposed swales around the perimeter of the building and conveyed north through the community.
- Raise the profile of the land by the northeast corner of the new school by adding fill material to block water from the lake flowing North around the new school building. This will force the lake to drain to the east, away from the community, preventing flow from the lake from entering the Hamlet’s drainage system.

5.2.1 Gravel Road Construction Techniques

5.2.1.1 Current Hamlet Maintenance Practices and Issues

Tetra Tech identified some issues with the Hamlet's gravel road network and maintenance practices during the site visit, including a lack of surface drainage and ditches, and the presence of surface defects, such as potholes and rutting. The Hamlet's current gravel road maintenance practices and snow ploughing operations appear to have reduced the thickness of the gravel road structure, removed gravel fines from the road surface, and reduced the roadway crown in numerous locations.

5.2.1.2 Design Criteria

To achieve sufficient roadway drainage, crowning of the centre of the road should be completed to provide crossfall of 3-4%. This will facilitate drainage of water off the road surface and into adjacent ditches. Flat areas on the road surface can lead to ponding of water or sheet flow of water along the roadway. These issues can allow water to penetrate and weaken the road structure and subgrade (native soils below the road), and accelerate the loss of surface fines, resulting in development of surface failures (e.g. potholes, rutting, corrugation, etc.). These concerns can reduce the road's service life and increase regular maintenance requirements. Conversely, crossfalls greater than 4% can lead to safety concerns for vehicles, particularly for large vehicles and during winter / frozen conditions.

One-way crossfall (superelevation) up to 4%, can be incorporated into the road cross section at curves by raising the outside edge of the roadway. In addition to providing surface drainage, superelevation provides better road geometry for vehicles manoeuvring through the curve. Vehicle speeds and the curvature of the roadway need to be considered with designing maximum superelevation values. The transition between regular two-way crossfall and superelevation should be gradual and graded to ensure continuous surface drainage is achieved.

Ditches should be provided along the length of the roadway to ensure continuous drainage is achieved. Ditches should be constructed to a depth a minimum of 300 mm below the bottom of the granular road structure and graded (minimum 0.5%) to eliminate low spots and prevent ponding of water. Ponding water has the potential to saturate the road structure and subgrade, which may result in road failures requiring significant maintenance or reconstruction.

Gravel roads should be surfaced with a minimum 100 mm thick layer of a Crushed Surfacing Gravel. A Crushed Surfacing Gravel has a higher percentage of fines (material finer than 0.075 mm) compared to a Crushed Base Gravel, and therefore performs better in gravel road surfacing applications. The higher fines content helps bind the granular material together and will better seal the road surface to limit material loss and ingress of water through the surface. Where the road needs to be raised to address geometric or drainage issues, or to increase ditch capacities, the Hamlet can utilize Crushed Base Gravel and/or a Pit Run material. The Crushed Base Gravel and Pit Run material should be placed and compacted in 150-200 mm thick layers prior to the placement of the Crushed Surfacing Gravel.

Sample gradation and specifications for Crushed Surfacing Gravel, Crushed Base Gravel and Pit Run material is included below for the Hamlet's reference.

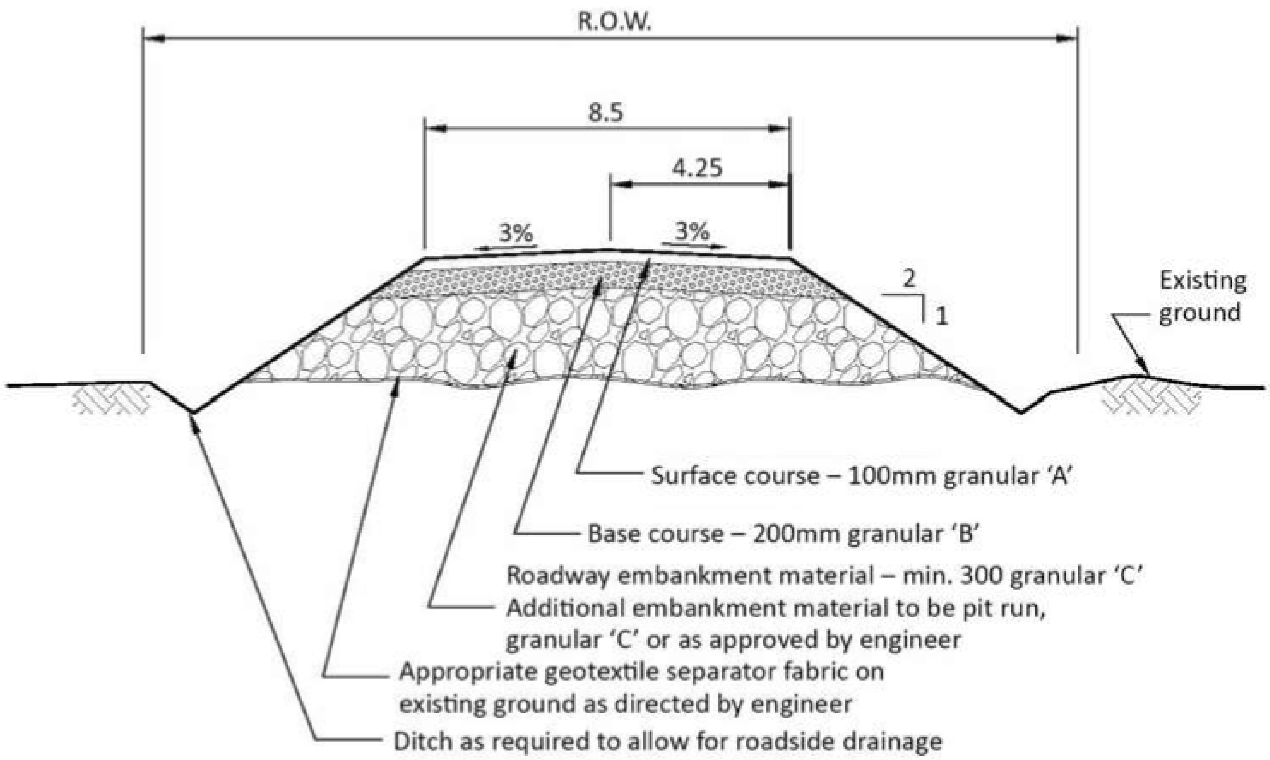


Figure 5-1: Typical Embankment Construction, NISI Northern Design Standard (CAN/CSA-S503-15)

5.2.1.3 Equipment

It is understood the Hamlet's current maintenance practices involve dragging weighted tractor tires over the gravel roads to infill potholes and flatten other surface imperfections. However, this approach does not allow operators to control the crossfall, and over time has the potential to remove surface fines, reduce the overall road structure and flatten the road crown.

To make the roadway maintenance more effective and efficient, the following equipment is presented for consideration by the Hamlet:

- **Grader**: to reshape the gravel roads and evenly spread additional granular material. The angle of the grader's blade can be set during grading operations to ensure a consistent crossfall is achieved along the length of road. The grader can also be utilized to mix and dry granular stockpiles prior to placement onto the roads. Grader operators will require training so as not to damage the road or waste granular.
  - Alternatively, the Hamlet could utilize a bobcat (skid steer loader) to complete regrading of the gravel roads. Granular material can be placed along the centreline of the road and shaped by the bobcat to ensure minimum crossfall requirements are achieved. Bobcats have advantages over a grader in that they require less operator training, can be utilized in a variety of functions by the Hamlet, and have a lower capital cost. Additionally, bobcats can be equipped with tracks to enable its use in the winter i.e. for snow clearing operations.

- **Compactor**: necessary to achieve compaction of the granular road structure during placement. The Hamlet could consider use of a standalone rubber tire or steel drum roller machine, or utilize a roller towed behind the grader.
  - Conversely, compaction of the granular material can be achieved by wheel rolling the moisture conditioned material with construction equipment or other community vehicles during road maintenance or construction activities. The lift thickness of material placed may need to be reduced to ensure required density is achieved.
- **Gravel truck(s)**: for hauling of granular from the quarry / stockpile site to town.
- **Wheel loader**: to load granular material into trucks at the quarry / stockpile site.
- **Water truck**: used to moisture condition granular material to ensure it is placed and compacted at the optimum moisture content.
- **Gravel crusher and screen**: to manufacture and sort granular material. The Hamlet could consider purchasing their own gravel crusher unit, or hire a contractor to complete blasting, crushing and stockpiling of the various material types (e.g. crushed surfacing gravel, crushed base gravel, pit run, riprap, etc.) in a sufficient for the Hamlet's requirements for multiple years.

5.2.1.4 Construction / Maintenance Methodology

Gravel road construction should be completed in the summer after spring thaw to ensure granular materials do not contain ice and/or frozen lumps, or are placed on snow, ice or frozen ground. Granular materials should be placed and compacted to the thicknesses and grades in accordance with the Design Criteria noted above. Each layer of granular material placed should be sufficiently compacted prior to placing subsequent granular layers of gravel such that there is no (or very limited) movement observable in the surface of the layer when trafficked by a loaded gravel truck. At culvert inlets and outlets, riprap erosion protection should be installed to ensure drainage flows do not erode the roadway granular structure.

The Hamlet should complete gravel road maintenance on a bi-annual or more frequent basis, with the associated maintenance costs included in the Hamlet's annual budget. Similar to road construction activities, gravel road maintenance should be completed in the summer months. Typically, gravel road maintenance should be completed at the following times:

- In spring shortly after freshet when road conditions are likely to be at their worst due to increase flows from snow melt. Resurfacing of gravel roads and addressing erosion issues may be required, in addition to regrading of roadways.
- Prior to the onset of winter to ensure roads are left in a suitable driving condition for the winter months. In addition, completing ditch and culvert maintenance will aid with drainage during spring thaw in the following year.

Hamlet personnel should assess the exact maintenance activities year-by-year as the requirements may vary by location, due to traffic volumes, nearby drainage features or other factors. In some locations, reworking / regrading of the existing gravels to re-establish drainage and crossfall may be satisfactory. In other areas, the Hamlet may need to import additional Crushed Surfacing Gravel to ensure a minimum thickness of 100 mm is maintained. When grading roadways, the grader or bobcat's operating speed should be limited to 5-10 km/h ensure a consistent grade is achieved.

When importing additional granular material, Hamlet personnel should mark spread distances for granular material unloaded from trucks to aid with even spreading of material by the grader or bobcat. The spread distance is the length a truckload of gravel will cover at the given road width and specified thickness.

Depending on the characteristics of the available granular material, the Hamlet may consider implementing a Dust Control program, should this be identified as an issue by Hamlet personnel, or the community's residents. There are numerous products and methods available for dust control, which are typically completed on an annual basis. Chloride products, such as Calcium Chloride, are common and typically involve applying the product to the road surface or intermixing into gravel to be incorporated into the road surface. The benefits of completing dust control extend beyond improving air quality for residents, and includes reduced loss of fines in the gravel surface and reduced maintenance / blading requirements.

Further guidance on gravel road construction and maintenance practices are detailed in the U.S. Department of Transportation, Federal Highway Administration Gravel Roads Construction & Maintenance Guide (August 2015) provides further guidance and information.

5.2.1.5 Granular Material Specifications

The following material sample material specifications are provided for the Hamlet's reference:

- Crushed Surfacing Gravel shall be manufactured to conform to the following requirements:
  - Consist of hard durable particles free from clay lumps, frozen material, organic matter, and other deleterious materials. Cohesion of this aggregate is achieved by plastic fines.
  - When tested in accordance to ASTM C136, the material shall have a gradation conforming to the following gradation limits:

Gradation Limits: Crushed Surfacing Gravel	
Sieve Designation (mm)	**Percent Passing by Weight**
25	100
19	85 – 100
9.5	60 – 85
4.75	40 – 70
1.18	20 – 50
0.300	10 – 30
0.075	7 – 15

  - Liquid limit when tested in accordance to ASTM D4318, maximum 25.
  - Plasticity index when tested in accordance to ASTM D4318, maximum 6.
  - Los Angeles degradation when tested in accordance to ASTM C131/C131M, maximum percent loss by weight 25.
  - Fracture, at least 80% of particles by mass retained on 4.75 mm sieve to have at least one freshly fractured face.

- Pit Run material shall conform to the following requirements:
  - The material shall be well graded, granular material free from clay lumps, organic matter and other extraneous material, screened to remove all stones in excess of maximum 100 mm diameter.
  - When tested in accordance to ASTM C136/C136M, the material shall have a gradation conforming to the following gradation limits:

Gradation Limits: Pit Run	
Sieve Designation (mm)	**Percent Passing by Weight**
100	100
75	85 – 100
50	70 – 100
25	50 – 100
4.75	25 – 100
2.00	10 – 80
0.075	2 – 8

- Crushed Base Gravel shall be manufactured to conform with the following requirements:
  - The material shall consist of hard durable particles free from clay lumps, frozen material, organic matter, and other deleterious materials.
  - When tested in accordance to ASTM C136/C136M, the material shall have a gradation conforming to the following gradation limits:

Gradation Limits: Crushed Base Gravel	
Sieve Designation (mm)	**Percent Passing by Weight**
50	100
37.5	60 – 100
25	40 – 75
12.5	15 – 40
2.36	10 – 25
0.300	5 – 15
0.075	0 – 5

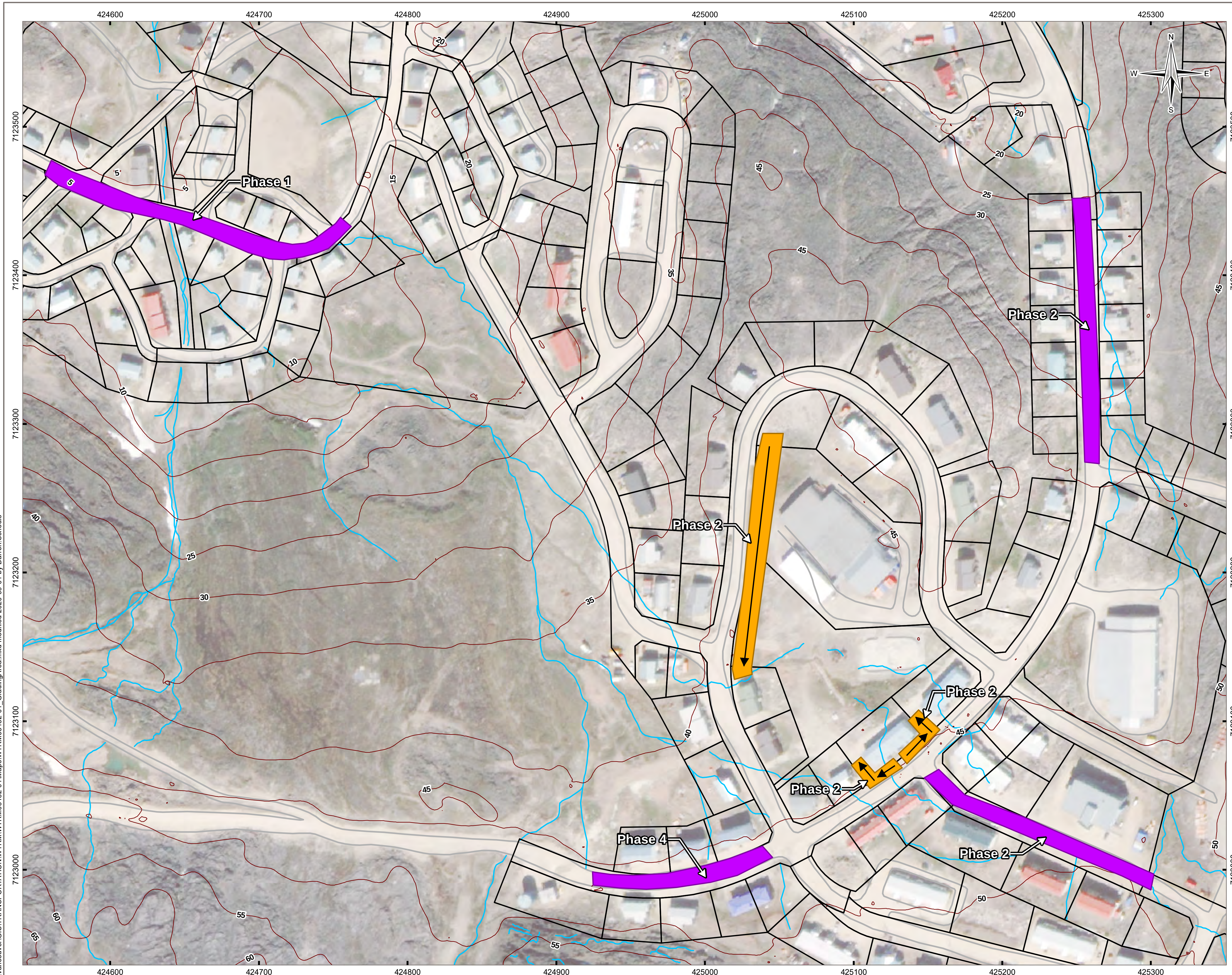
  - Liquid limit when tested in accordance to ASTM D4318, maximum 25.
  - Plasticity index when tested in accordance to ASTM D4318, maximum 6.
  - Los Angeles degradation when tested in accordance to ASTM C131/C131M, maximum percent loss by weight 35.

- Fracture, at least 60% of particles by mass retained on 4.75 mm sieve to have at least one freshly fractured face.

5.2.1.6 Quarry / Pit Development

Tetra Tech understands the Hamlet does not currently have access to a permanent source for granular materials. The development of a quarry will secure a long-term source of granular materials for the Hamlet. The steps for quarry development would likely include preparation of a Pit Development Plan, covering the following phases:

- Desktop assessment, including rock classification (i.e. material hardness, abrasion, and acid rock potential);
- Review of permitting requirements, including potential environmental and Land Use Permit applications;
- Site Reconnaissance, including review of topography to assess potential quarry sites;
- Lab testing of surface samples collected during the site reconnaissance to determine rock properties and quality;
- LiDAR / topographic survey of potential quarry site, to aid with estimation of available rock volume;
- Geotechnical drilling program to confirm test results of surface sample (if required);
- Development of a drainage / sediment control plan to implement during pit operation; and
- Development of a Pit Closure Plan to guide the Hamlet through the decommissioning requirements to be implemented at the end of the pit's service life.



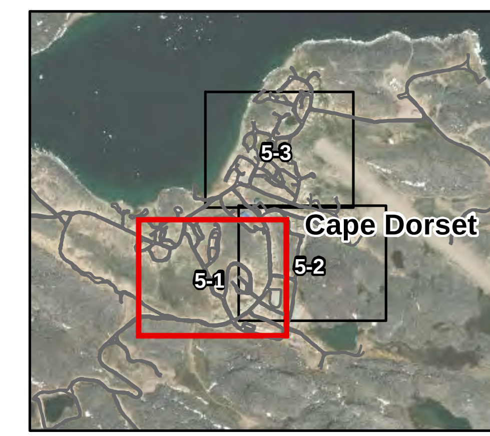
LEGEND

Grading Type

- Raise Profile of Road and Add Crown
- Regrade to Protect from Ponding
- Grading Direction

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Proposed Grading Plan

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50

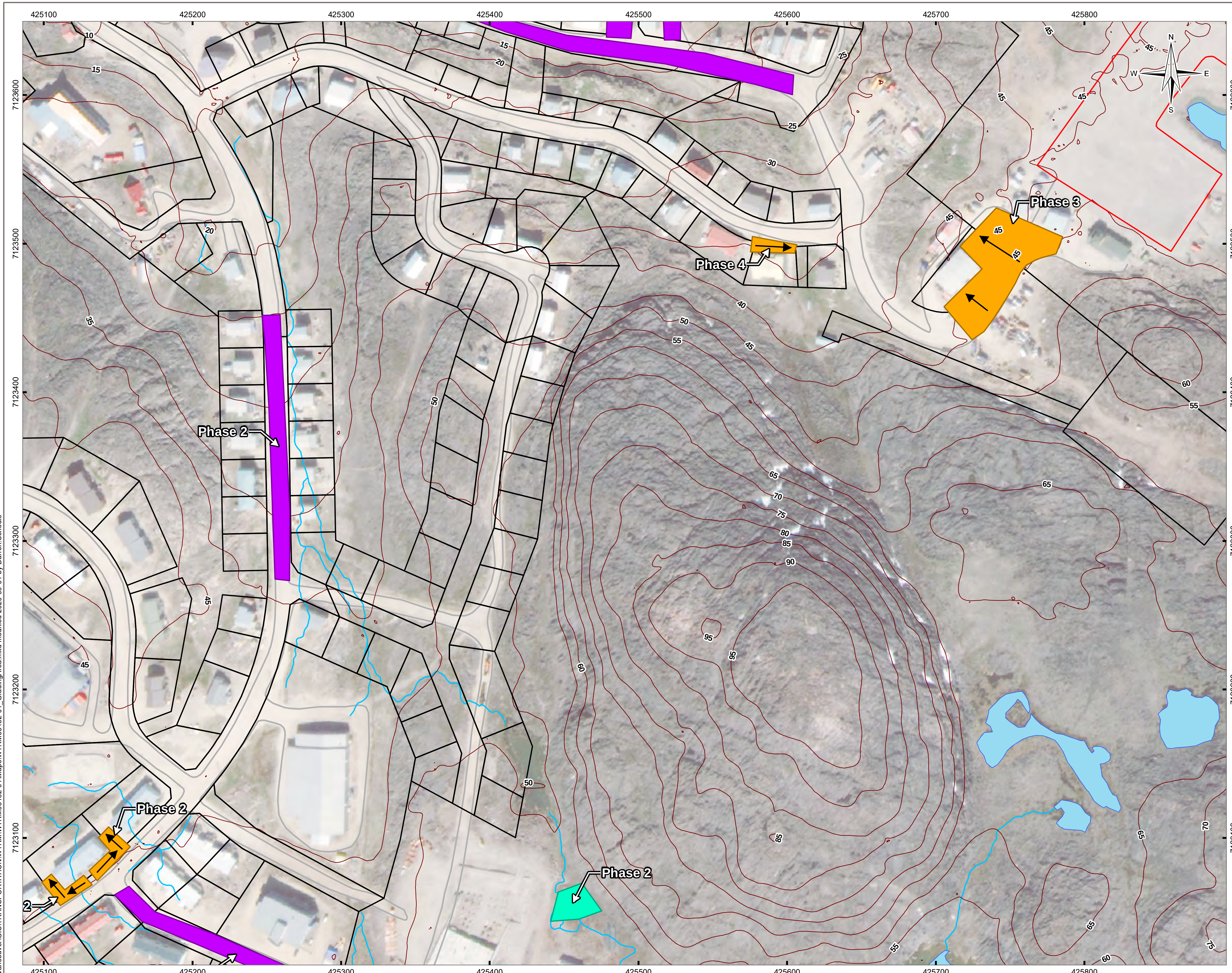
Meters

TETRA TECH

FILE NO.				
WTRM03182-01_GradingArea.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	DS	SL	ER	0
DATE	**PROJECT NO.**			
September 1, 2020	TRN.WTRI03002-01			

Figure 5-1

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_GradingArea.mxd modified 2020-09-01 by Darren.Schouls



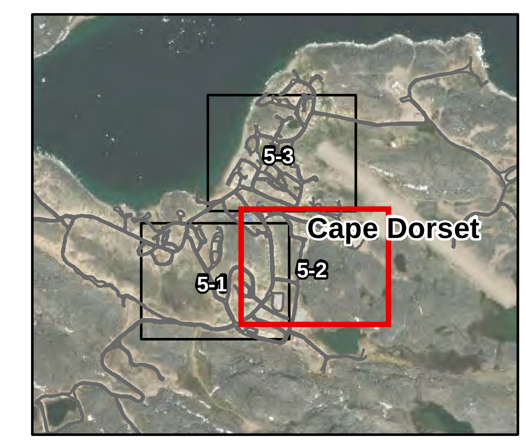
LEGEND

Grading Type

- Raise Profile of Road and Add Crown
- Raise Profile to block water from the lake flowing North around the new school
- Regrade to Protect from Ponding
- Grading Direction

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Proposed Grading Plan

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50

Meters

FILE NO.
WTRM03182-01_GradingArea.mxd

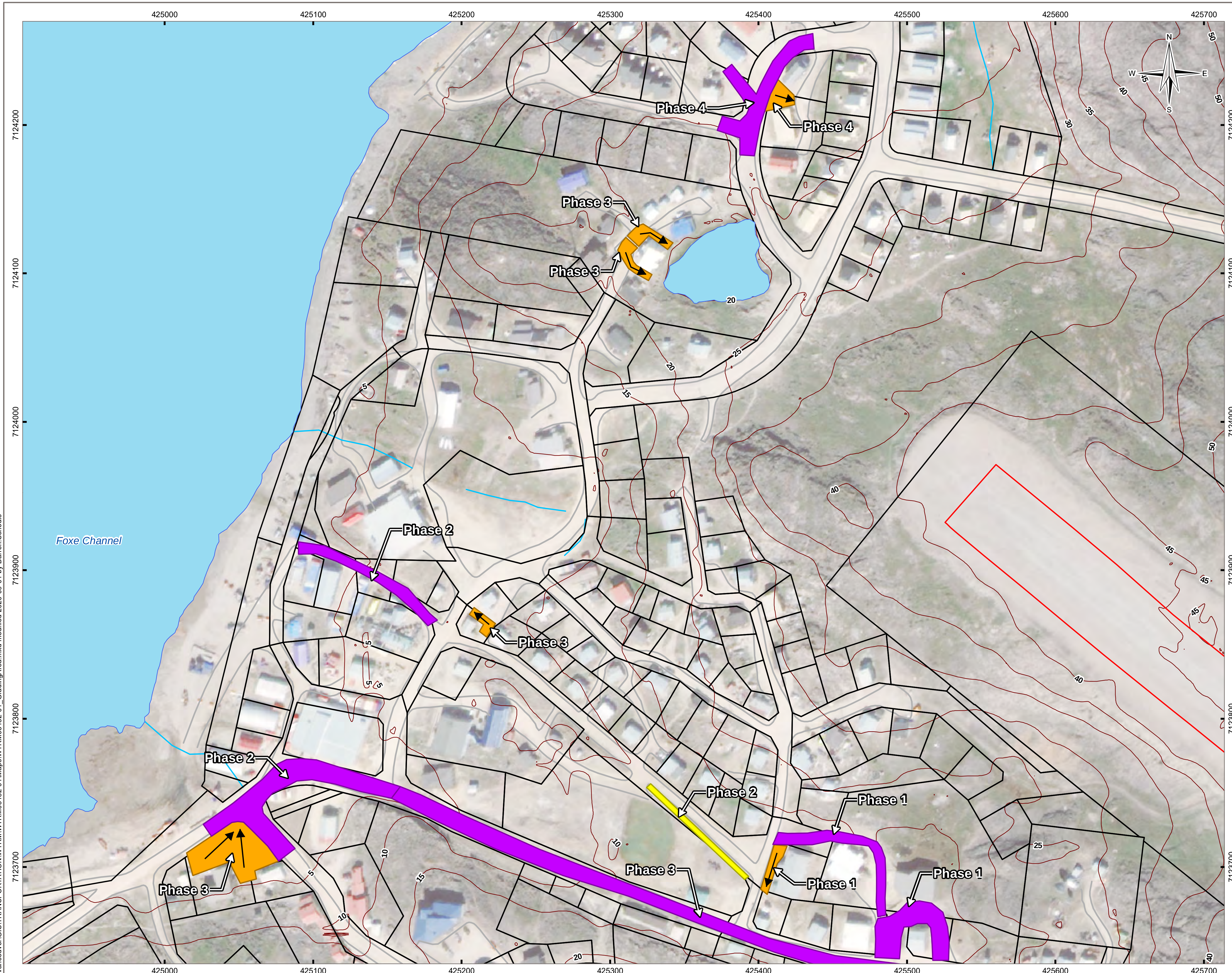
TETRA TECH

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

DATE	PROJECT NO.
September 1, 2020	TRN.WTRI03002-01

Figure 5-2

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_GradingArea.mxd modified 2020-09-01 by Darren.Schouls



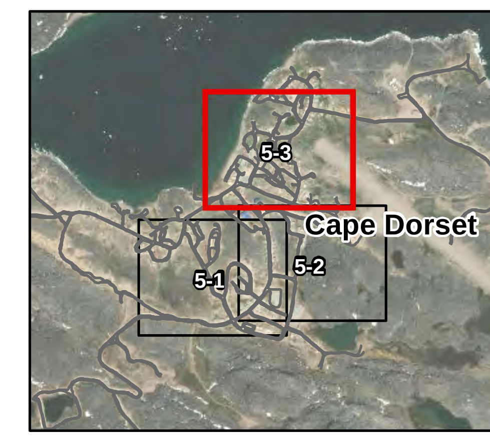
LEGEND

Grading Type

- Lower C62 and Regrade Ditch
- Raise Profile of Road and Add Crown
- Regrade to Protect from Ponding
- Grading Direction

Base Data

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



NOTES

Base data source:
1. Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Proposed Grading Plan

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50
Meters

FILE NO.
WTRM03182-01_GradingArea.mxd

TETRA TECH

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

DATE	PROJECT NO.
September 1, 2020	TRN.WTRI03002-01

Figure 5-3

5.3 Community Plan & Proposed Development Areas

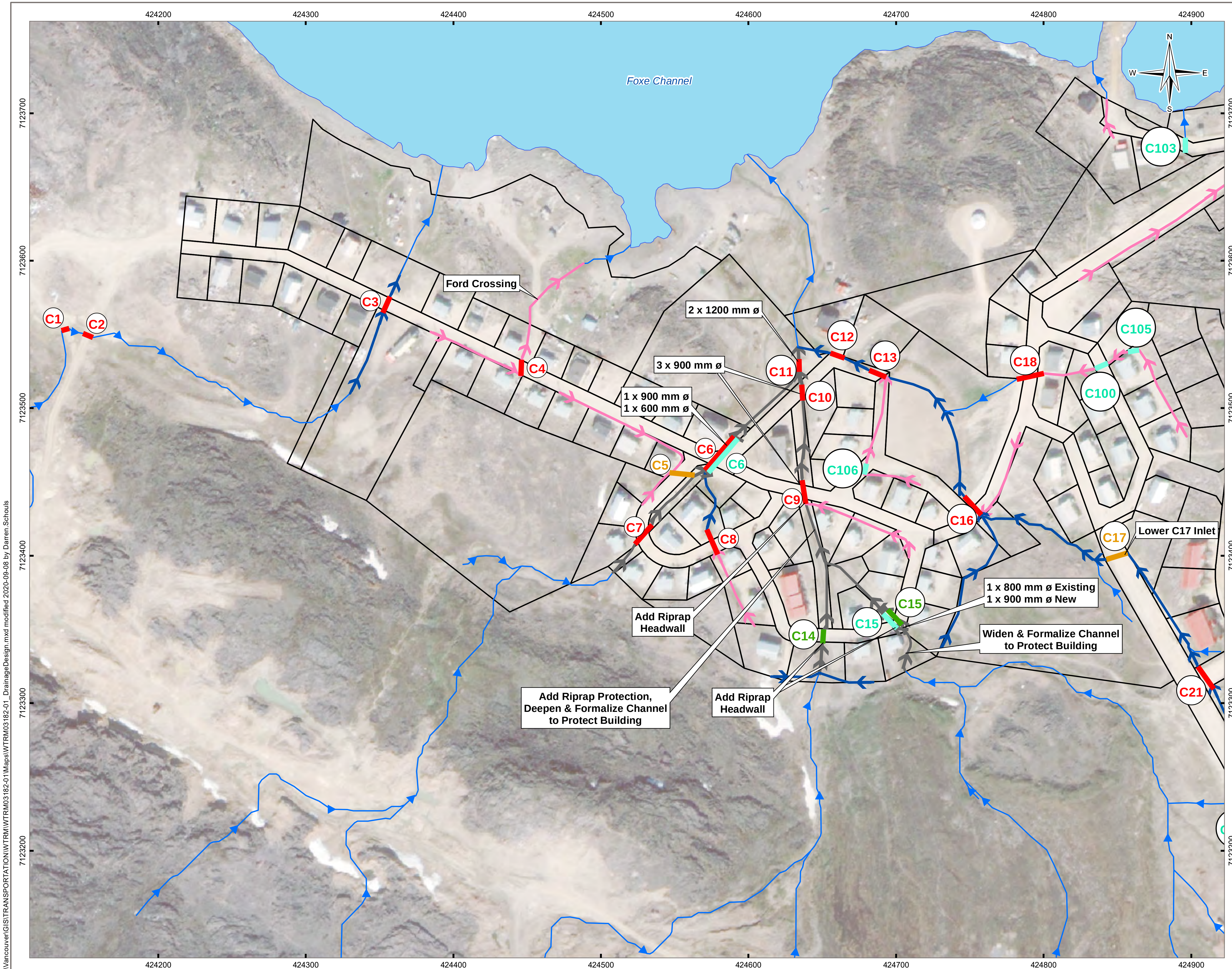
The 2013 Cape Dorset Community Plan included in Appendix F outlines proposed development areas to allow for future community growth. Existing topography and drainage conditions were reviewed and a preliminary design of required drainage infrastructure for the proposed expansion areas was developed (see Figures B-1 to B-2).

At this stage we have provided drainage improvement recommendations based on the 2013 Cape Dorset Community Plan. Amendments to the 2013 Community Plan would likely carry revisions to the proposed drainage improvements.

Appendix F includes a Revised Community Planning Map for the Hamlet to consider. The slope percentage of the underlying topography has been overlaid for reference and highlights the development suitability of each region based on the nature of the local terrain. Illustrated within these maps are the following remarks:

- Tetra Tech recommends relocating an 8-lot portion of the proposed subdivision. The area proposed for development is currently located on steep bedrock terrain with a slope angle that is predominantly greater than 20 percent. Development of these lots would require substantial fill material, adding capital costs to their development. These 8 lots are outlined in turquois in the Revised Community Planning Maps.
- Tetra Tech has proposed a relocation option for the aforementioned group of lots to the north, adjacent to other proposed lots part of this subdivision. The proposed relocation considers the site's terrain and is intended to lower construction cost and risk. The area chosen appears to be suitable for construction, however a subsequent geotechnical investigation should be undertaken to confirm suitability. This relocation option is outlined in purple in the Revised Community Planning Maps shown on Figure F-2 in Appendix F.

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 5-10 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

C## Culvert Number

Open Channels

- Formalize Typical Ditch
- Formalize Large Ditch
- Formalize Typical Swale
- Natural Drainage Path

Base Data

- Current Parcel
- Waterbody

5-8 5-9 5-7 Cape Dorset 5-4 5-6 5-5

NOTES

Where ditch is not possible consider an embankment to protect buildings

Base data source:
1. Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50 Meters

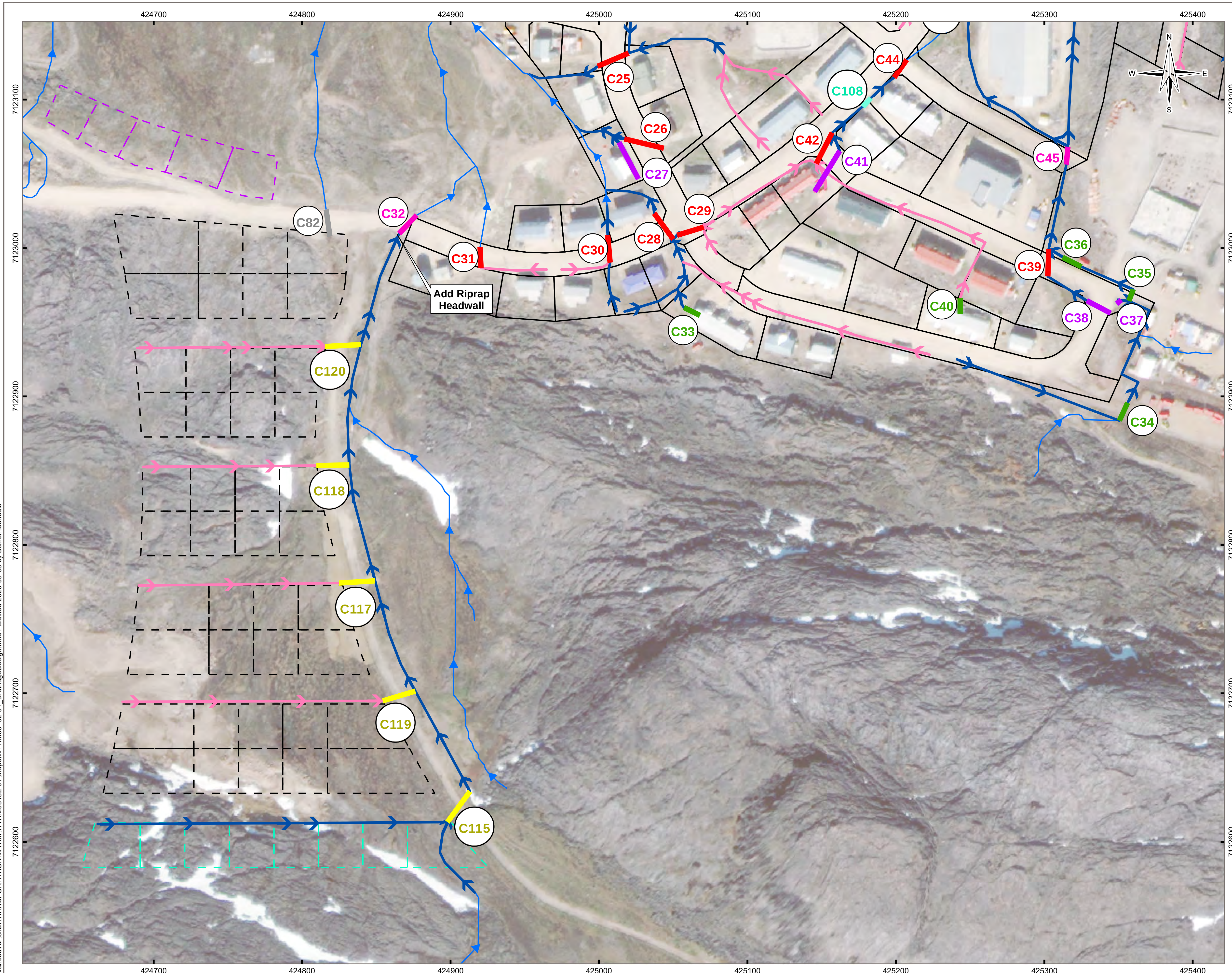
FILE NO.
WTRM03182-01_DrainageDesign.mxd

TETRA TECH

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure 5-4



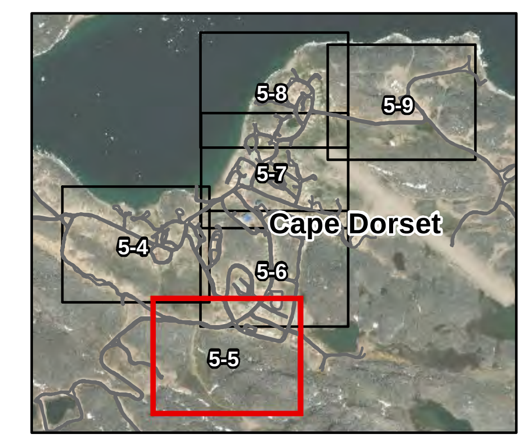
LEGEND

Culverts
- Functioning as Intended
- Remove Debris
- Abandon
- Replace
- Not Assessed
- New - Existing Community
- New - Future Community Expansion

C## Culvert Number

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

Base Data
- Current Parcel
- GN Proposed Parcel
- Relocate GN Proposed Parcel
- Tetra Tech Relocated Parcel



NOTES
Where ditch is not possible consider an embankment to protect buildings

Base data source:
1. Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.
WTRM03182-01_DrainageDesign.mxd

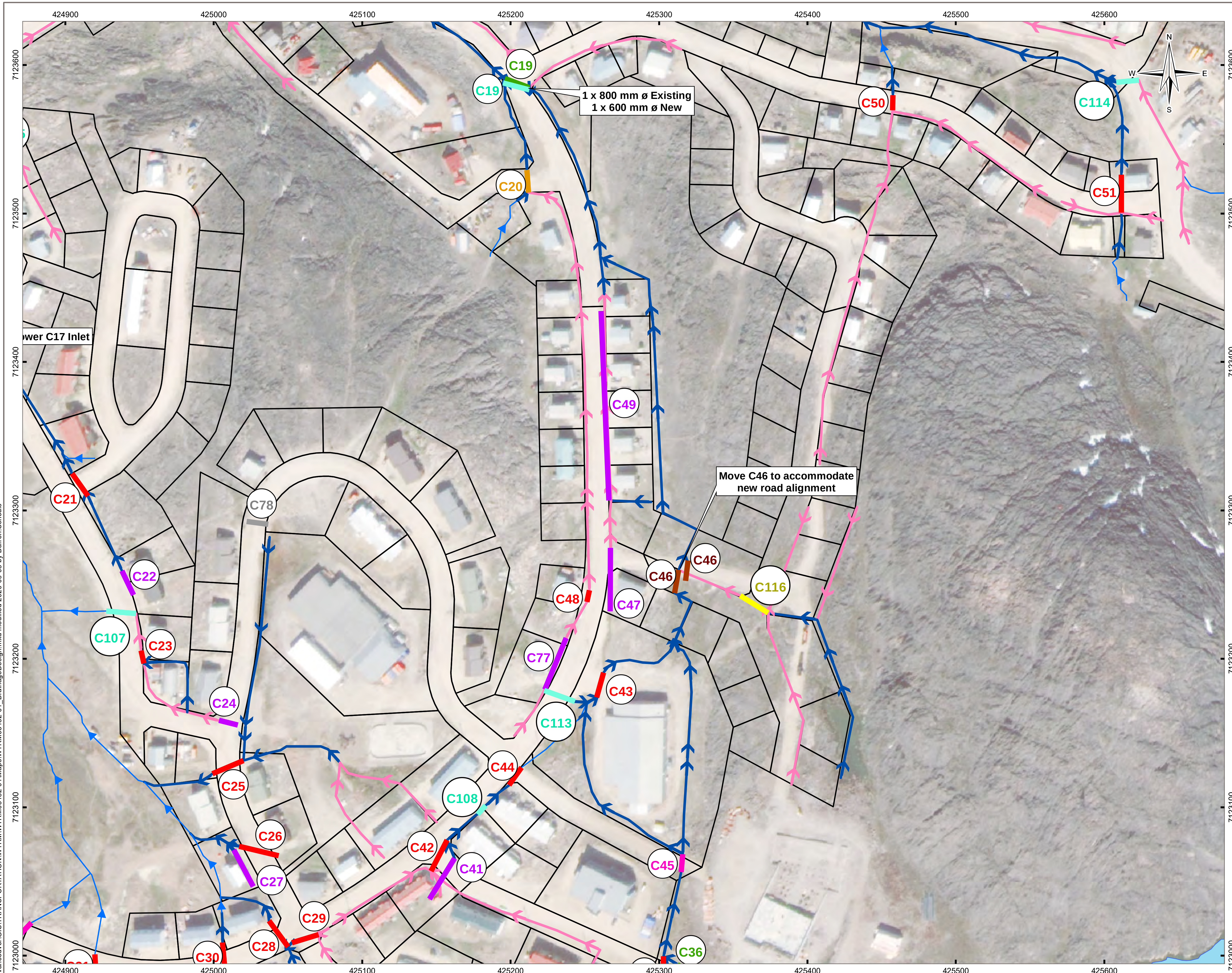
TETRA TECH

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure 5-5

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_DrainageDesign.mxd modified 2020-09-08 by Darren Schouls



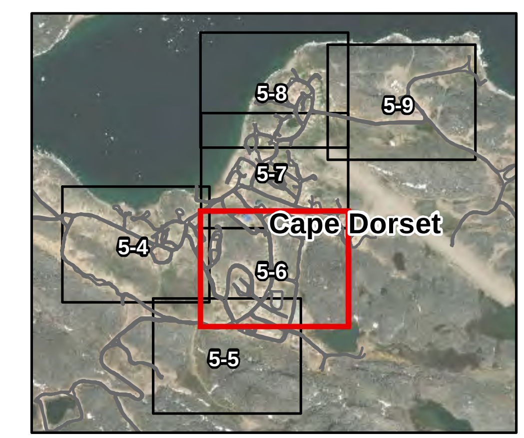
LEGEND

Culverts
- Functioning as Intended
- Remove Debris
- Relocate
- Abandon
- Repair
- Replace
- Not Assessed
- New - Existing Community
- New - Future Community Expansion

C## Culvert Number

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

Base Data
- Current Parcel
- Waterbody



NOTES
Where ditch is not possible consider an embankment to protect buildings

Base data source:
1. Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

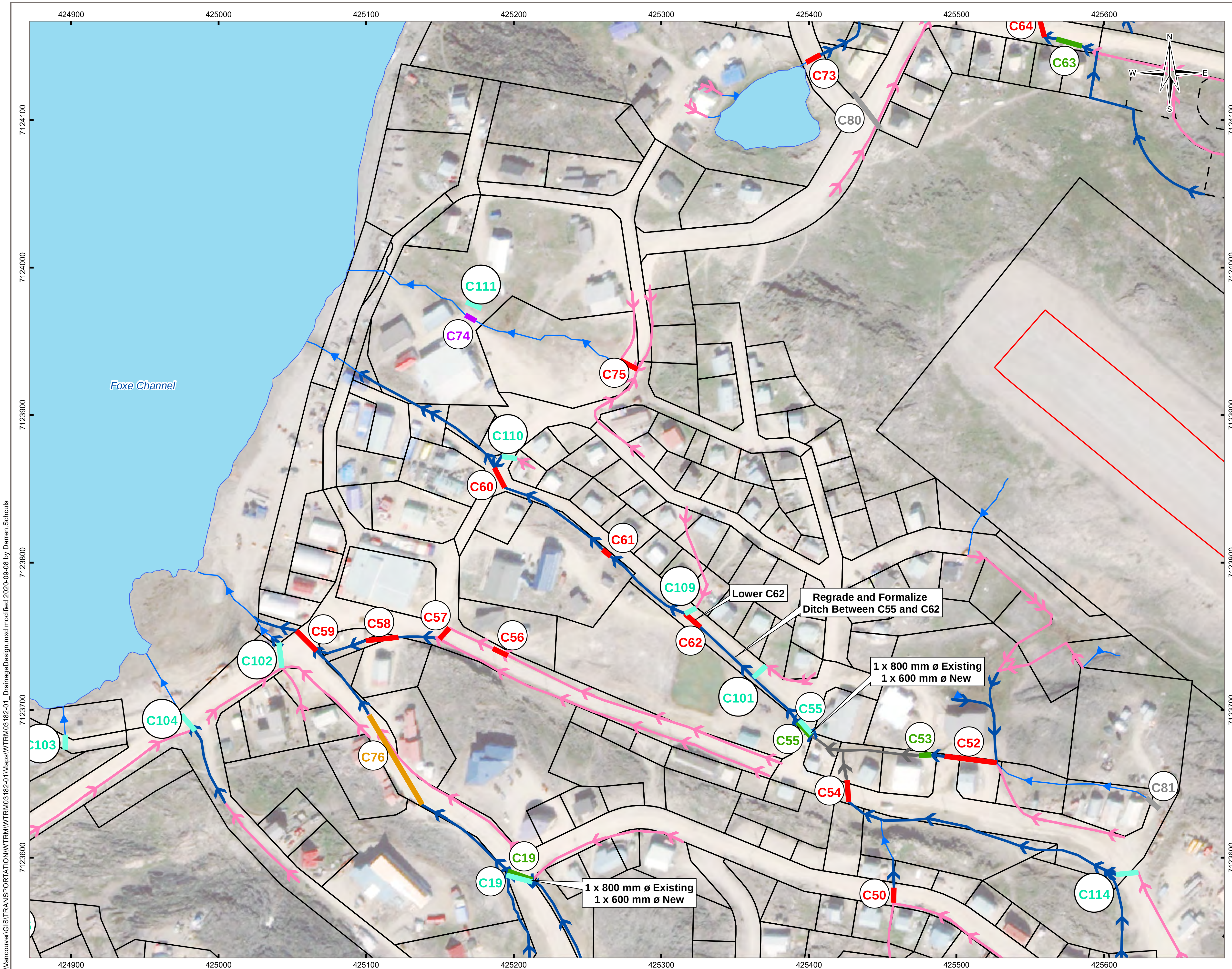
TETRA TECH

FILE NO.				
WTRM03182-01_DrainageDesign.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure 5-6

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_DrainageDesign.mxd modified 2020-09-08 by Darren Schouls



LEGEND

Culverts

- Functioning as Intended
- Abandon
- Repair
- Replace
- Not Assessed
- New - Existing Community

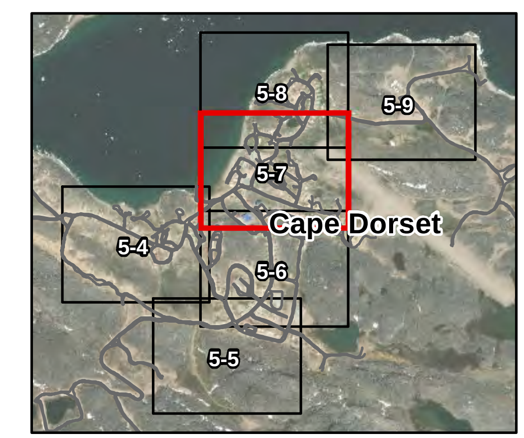
C## Culvert Number

Open Channels

- Formalize Typical Ditch
- Formalize Large Ditch
- Formalize Typical Swale
- Natural Drainage Path

Base Data

- Current Parcel
- GN Proposed Parcel
- Runway
- Waterbody



NOTES
Where ditch is not possible consider an embankment to protect buildings

Base data source:
1. Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Conceptual Drainage Design

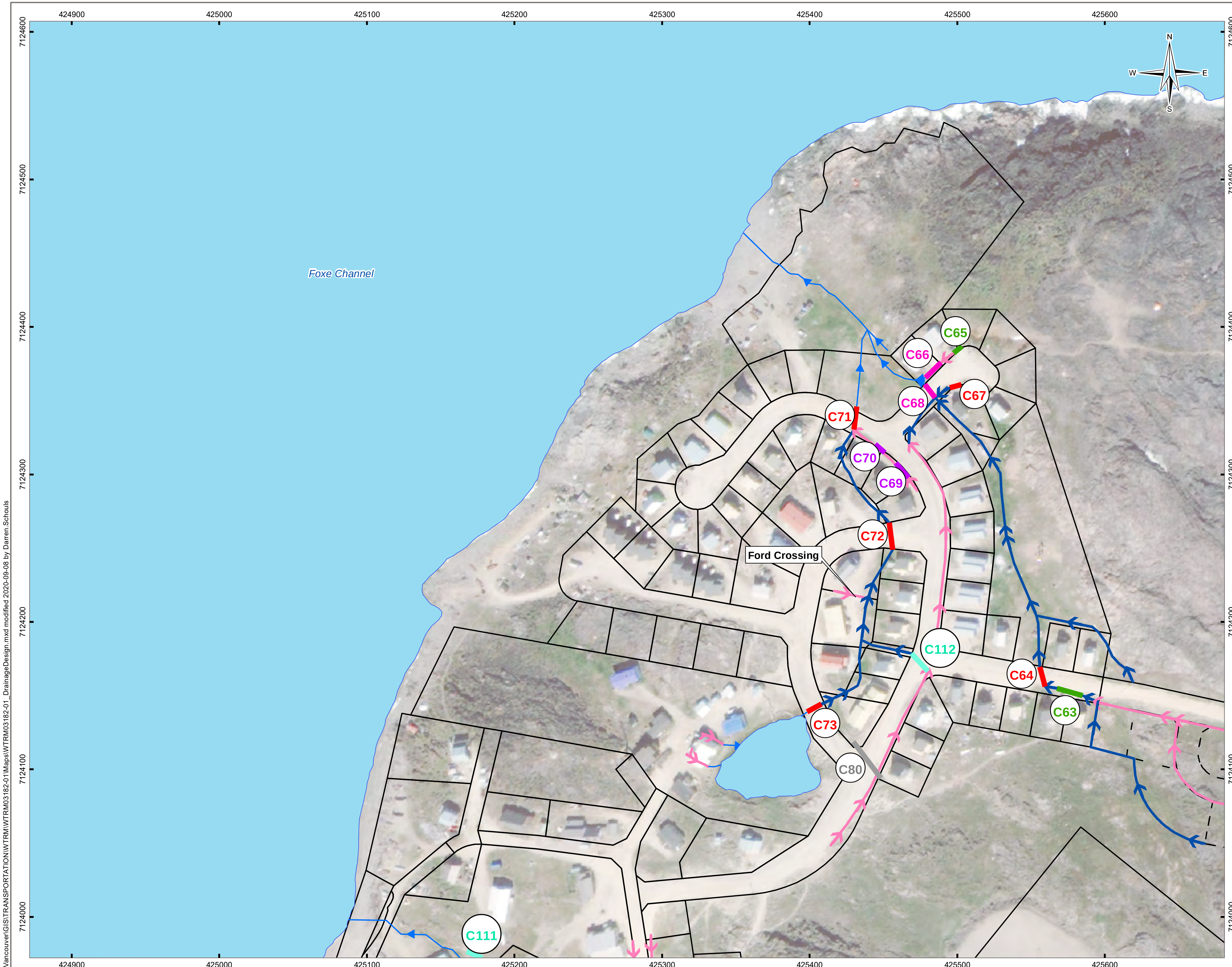
PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

TETRA TECH

FILE NO.				
WTRM03182-01_DrainageDesign.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0
DATE	PROJECT NO.			
September 8, 2020	TRN.WTRI03002-01			

Figure 5-7



LEGEND

Culverts

- Functioning as Intended
- Remove Debris
- Abandon
- Replace
- Not Assessed
- New - Existing Community

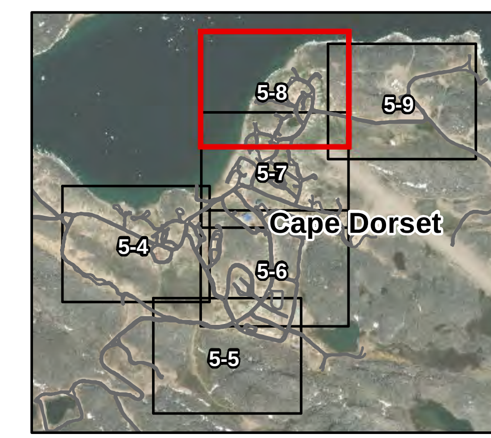
C## Culvert Number

Open Channels

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

Base Data

- Current Parcel
- GN Proposed Parcel
- Waterbody



NOTES

Where ditch is not possible consider an embankment to protect buildings

Base data source:
1. Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50
Meters

TETRA TECH

FILE NO.				
WTRM03182-01_DrainageDesign.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0
DATE	PROJECT NO.			
September 8, 2020	TRN.WTRI03002-01			

Figure 5-8

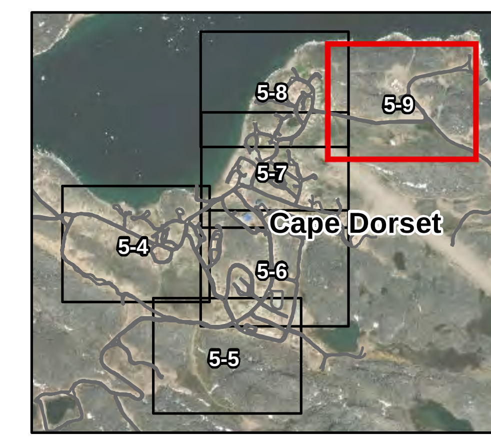
LEGEND

Culverts
- Functioning as Intended
- Not Assessed

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

Base Data
- Current Parcel
- GN Proposed Parcel
- Runway
- Waterbody

C## Culvert Number



NOTES
Where ditch is not possible consider an embankment to protect buildings

Base data source:
1. Cape Dorset base data from Government of Nunavut

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Conceptual Drainage Design

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

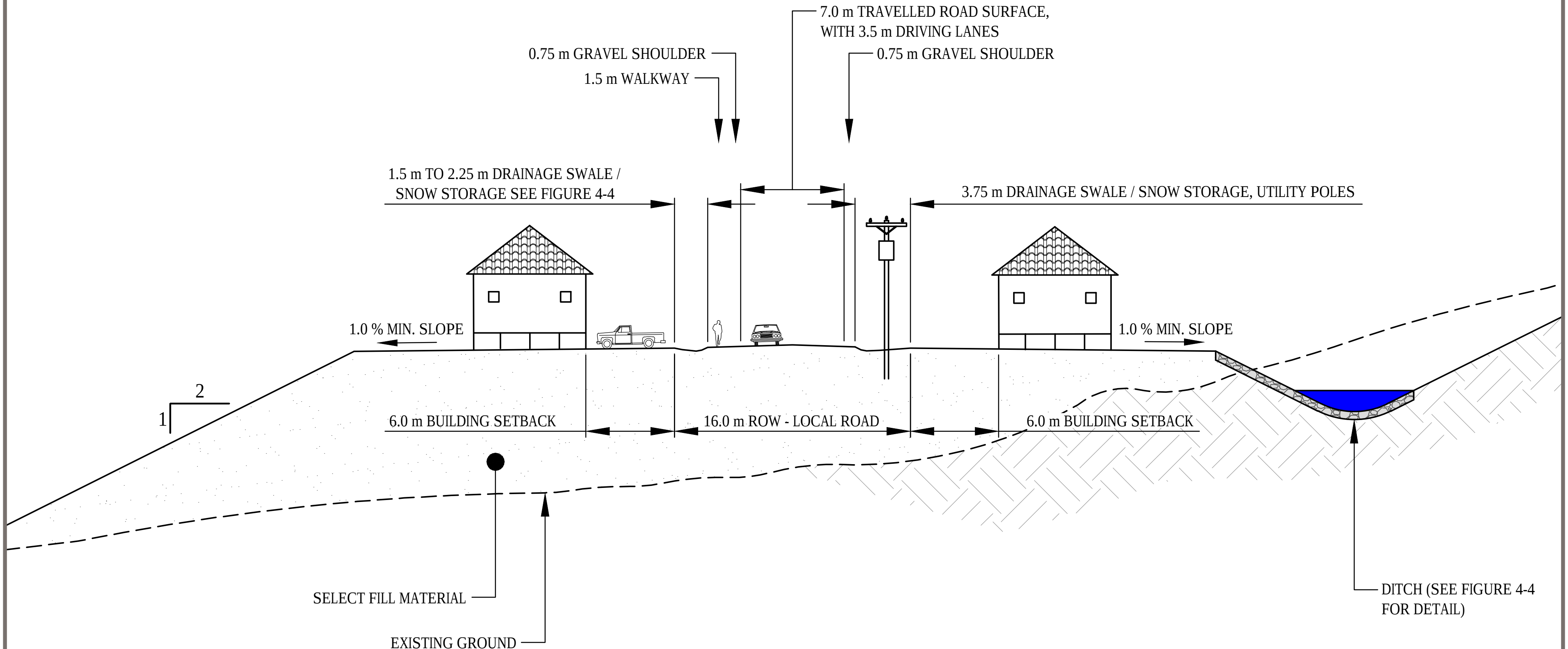
FILE NO.
WTRM03182-01_DrainageDesign.mxd

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

TETRA TECH

Figure 5-9



LEGEND

-

NOTES

-

0 20

Scale: 1: 400 (metres)

ISSUED FOR REVIEW

CLIENT

Nunavut

TETRA TECH

CAPE DORSET MASTER DRAINAGE PLAN

ABOVE GRADE DEVELOPMENT DETAIL

PROJECT NO.	DWN	CKD	REV
WTRI03002-01	AD	ER	0

OFFICE	DATE
VANC	Sept. 30, 2020

Fig. 5-10

5.4 Project Phasing

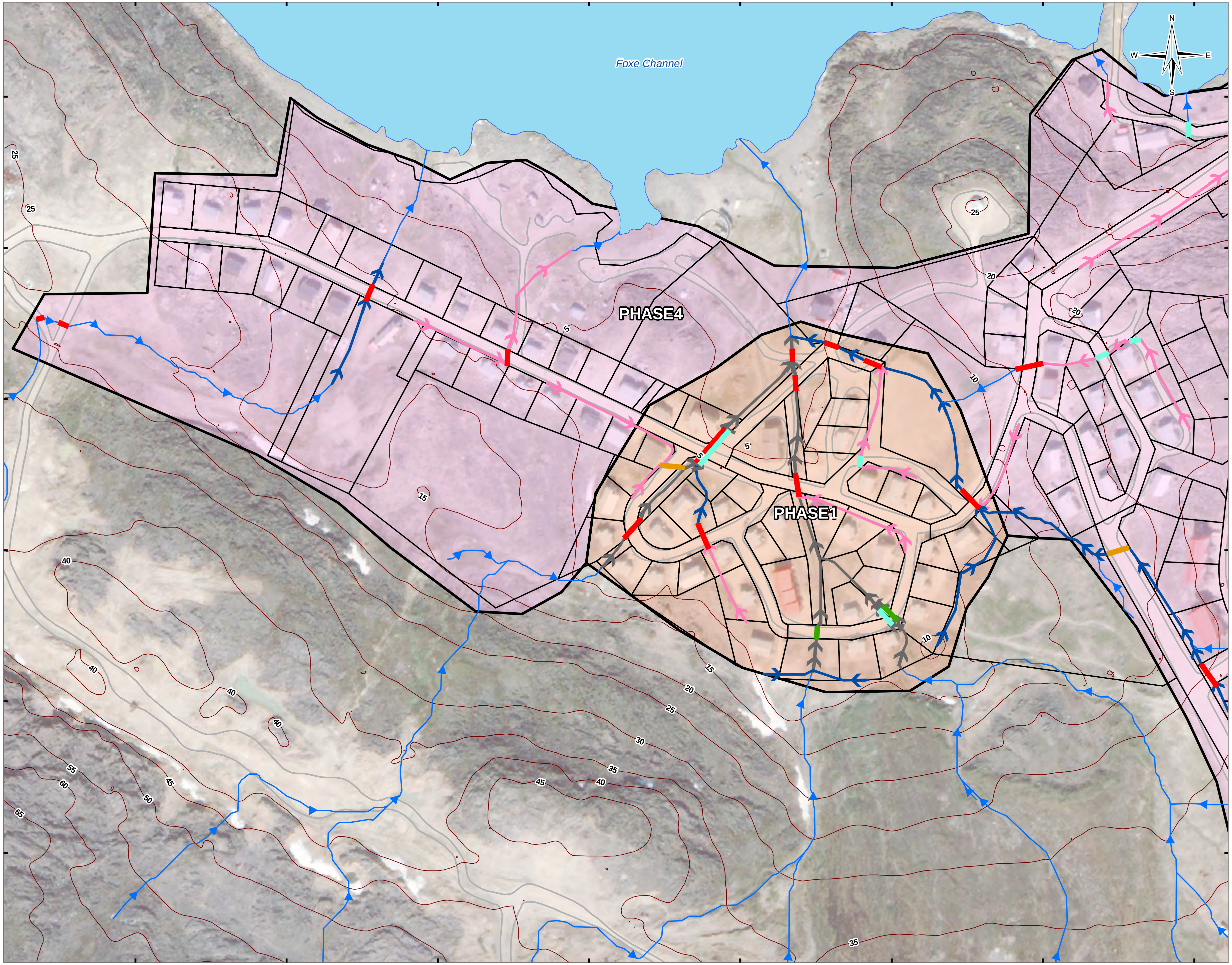
Tetra Tech has developed a phasing plan allowing CGS and the Hamlet to focus on the most critical elements of the proposed drainage plan first; and consider postponing some of the less critical aspects until funding is available in future construction seasons.

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 5.5).

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 address the flooding noted by Mr. Pootoogook around essential infrastructure including around building number 526 near the firehall and in the northwest region of the community near the intersection of Road R1 and R2.
- Phase 2: Address Essential Service Areas
  - This phase is aimed at upgrading existing infrastructure around essential service areas including the Hamlet's Health Centre 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 to ensure long term capacity in the central watercourses running through Cape Dorset's developed area.
  - Common Public Use facilities protected under this phase includes the Northern Store, Dorset Suites Housing Buildings, Dorset Suites Restaurant, the RCMP building, and the Airport Terminal Building.
- 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 Hamlet's core area.
- 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 if desired. As discussed in Section 5.5, it is expected the Hamlet would also benefit from the efficiencies of scale. If a number of phases are combined, the Hamlet would likely benefit from lower unit rates derived from bulk material orders.



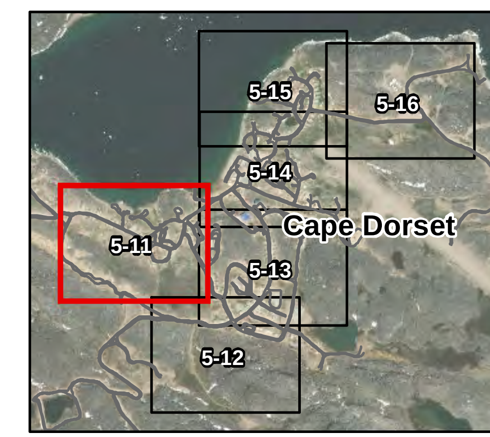
LEGEND

Culverts
- Functioning as Intended
- Repair
- Replace
- New - Existing Community

Open Channels
- Formalize Typical Ditch
- Formalize Large Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing
- Phase 1 - Address Existing Flooding
- Phase 4 - Address Remaining Upgrades

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.
WTRM03182-01_Phasing.mxd

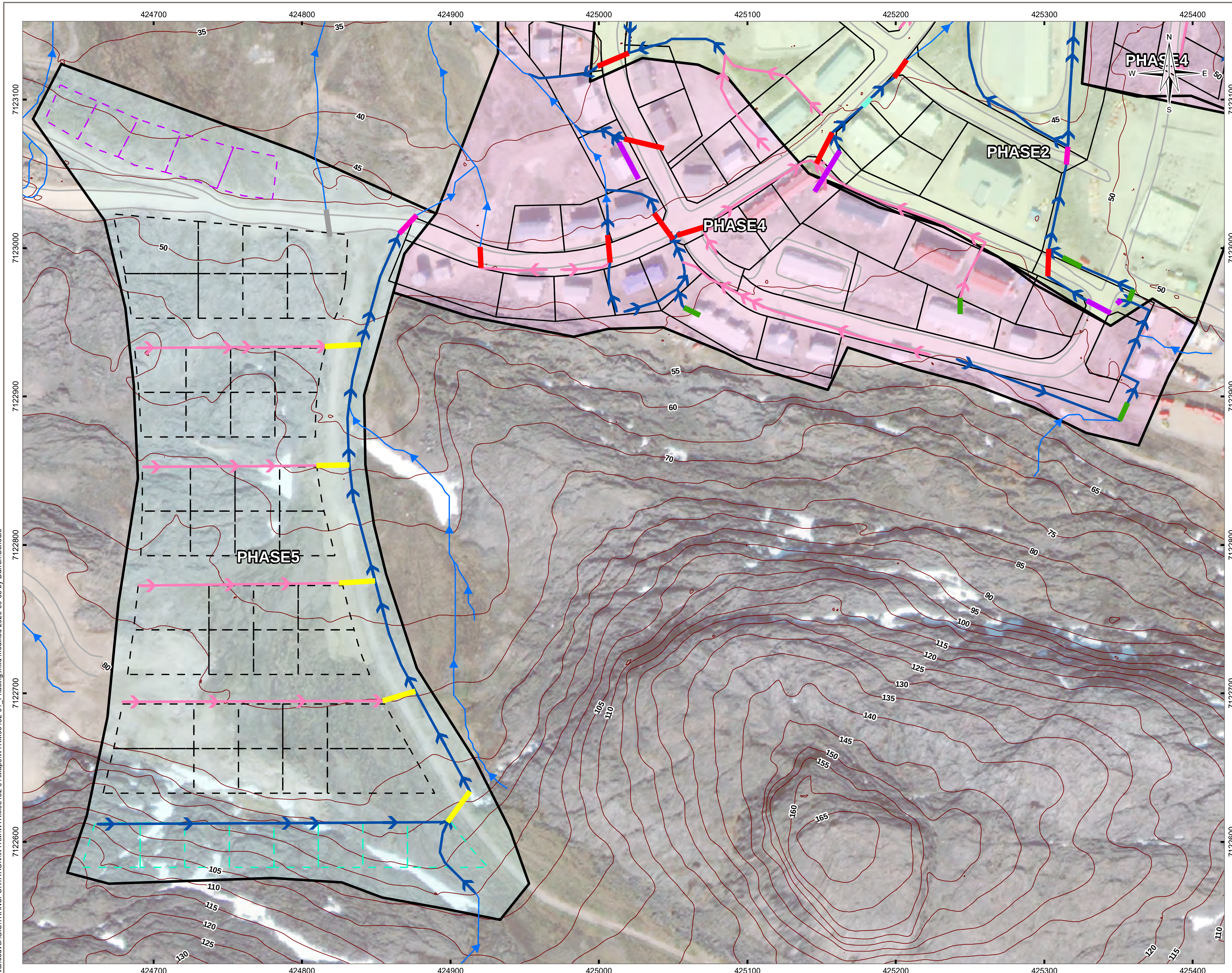
TETRA TECH

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

DATE: September 8, 2020
PROJECT NO.: TRN.WTRI03002-01

Figure 5-11

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_Phasing.mxd modified 2020-09-08 by Darren.Schouls



LEGEND

Culverts

- Functioning as Intended
- Remove Debris
- Abandon
- Replace
- Not Assessed
- New - Existing Community
- New - Future Community Expansion

Open Channels

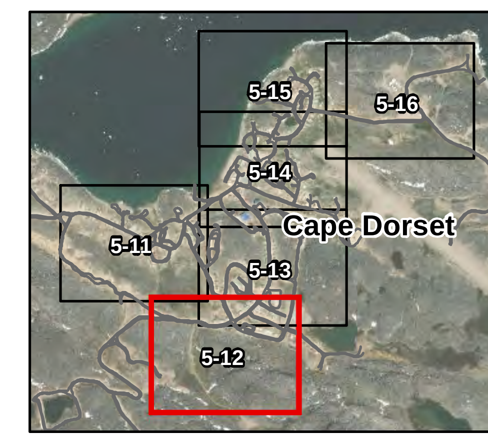
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing

- Phase 2 - Essential Service Areas
- Phase 4 - Address Remaining Upgrades
- Phase 5 - Future Community Expansion Infrastructure

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.
WTRM03182-01_Phasing.mxd

TETRA TECH

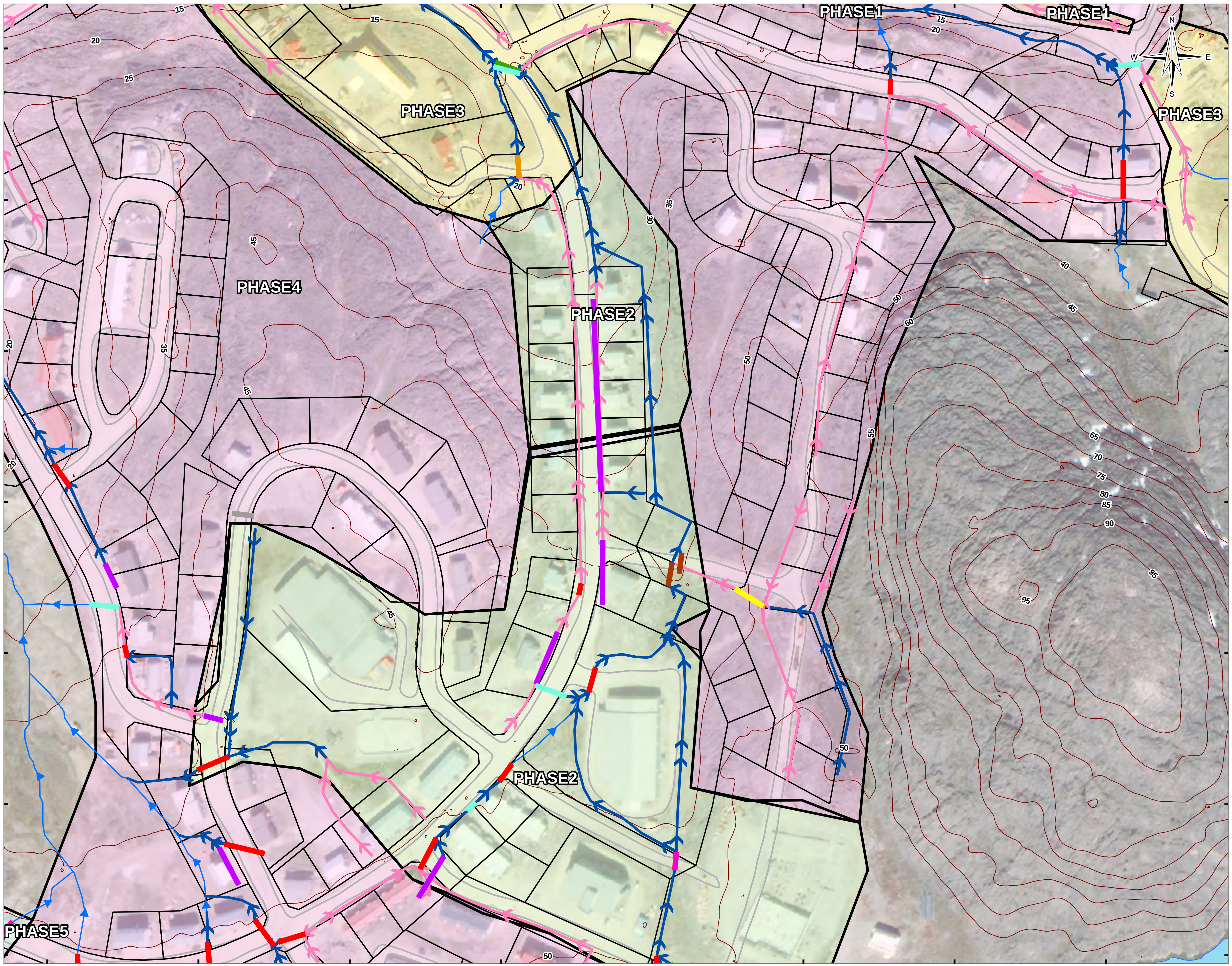
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0

DATE
September 8, 2020

PROJECT NO.
TRN.WTRI03002-01

Figure 5-12

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_Phasing.mxd modified 2020-09-08 by Darren.Schouls



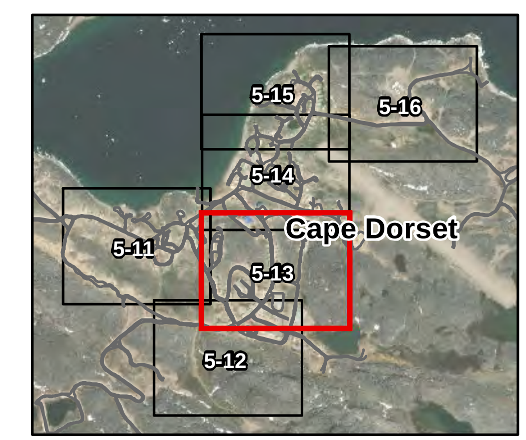
LEGEND

Culverts
- Functioning as Intended
- Remove Debris
- Relocate
- Abandon
- Repair
- Replace
- Not Assessed
- New - Existing Community
- New - Future Community Expansion

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

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

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

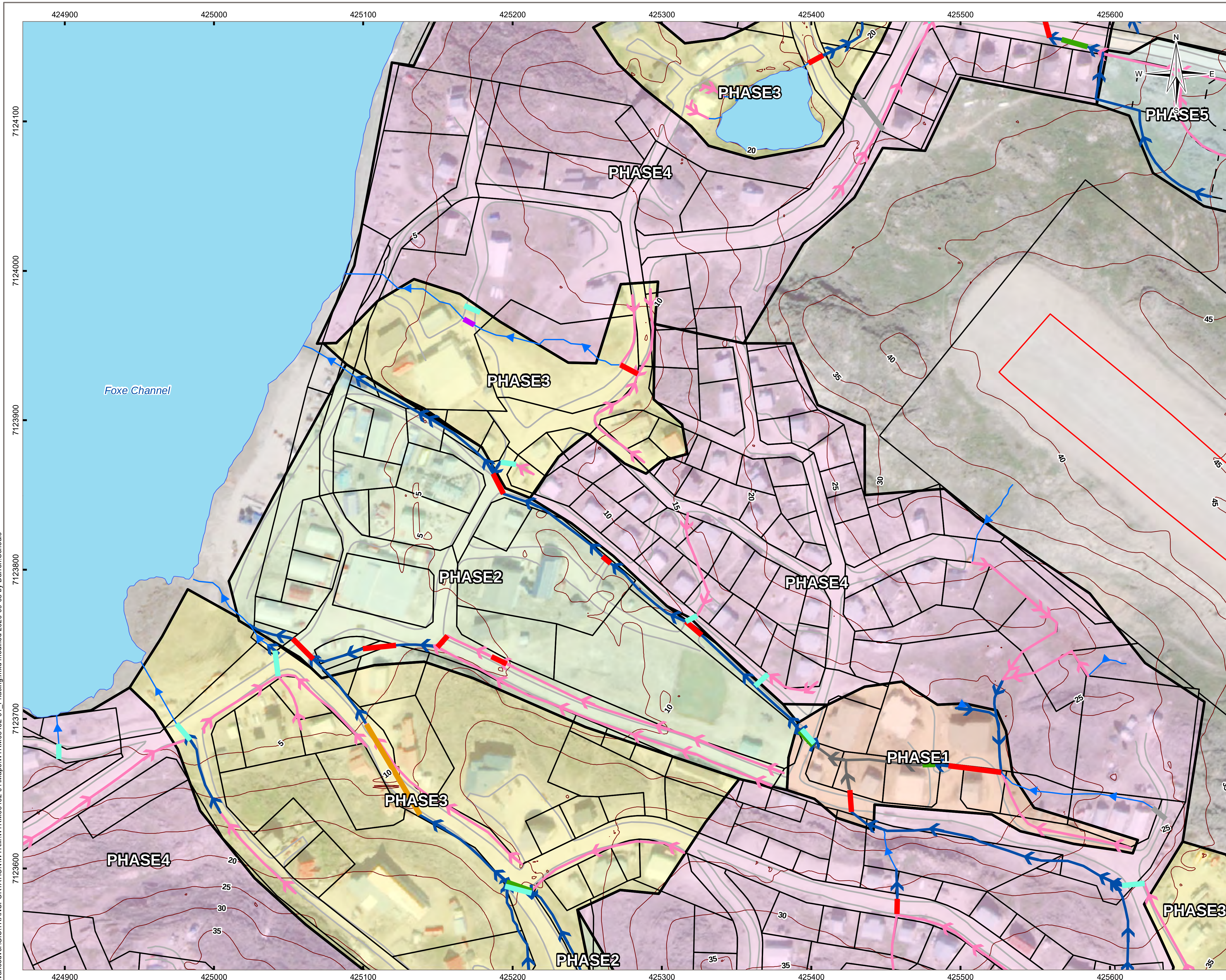
Scale: 1:2,500
50 25 0 50
Meters

TETRA TECH

FILE NO.				
WTRM03182-01_Phasing.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0
DATE	PROJECT NO.			
September 8, 2020	TRN.WTRI03002-01			

Figure 5-13

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_Phasing.mxd modified 2020-09-08 by Darren.Schouls



Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_Phasing.mxd modified 2020-09-08 by Darren.Schouls

LEGEND

Culverts

- Functioning as Intended
- Abandon
- Repair
- Replace
- Not Assessed
- New - Existing Community

Open Channels

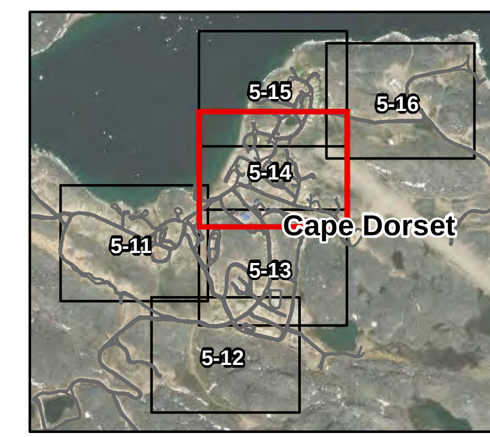
- Formalize Typical Ditch
- Formalize Large Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing

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

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

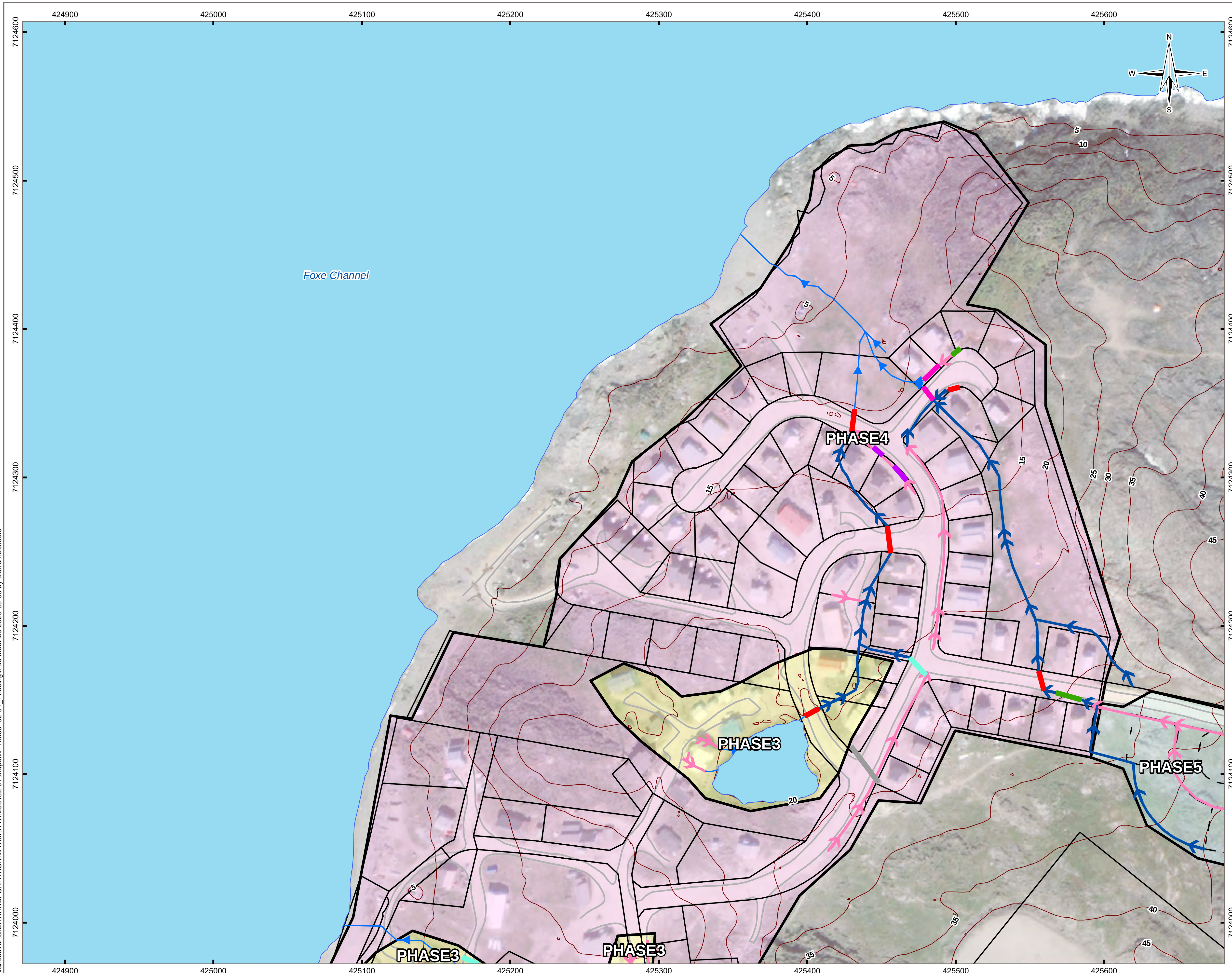
FILE NO.
WTRM03182-01_Phasing.mxd

TETRA TECH

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure 5-14



LEGEND

Culverts

- Functioning as Intended
- Remove Debris
- Abandon
- Replace
- Not Assessed
- New - Existing Community

Open Channels

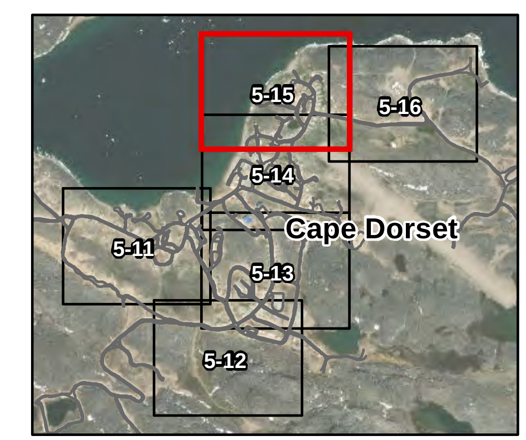
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing

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

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.
WTRM03182-01_Phasing.mxd

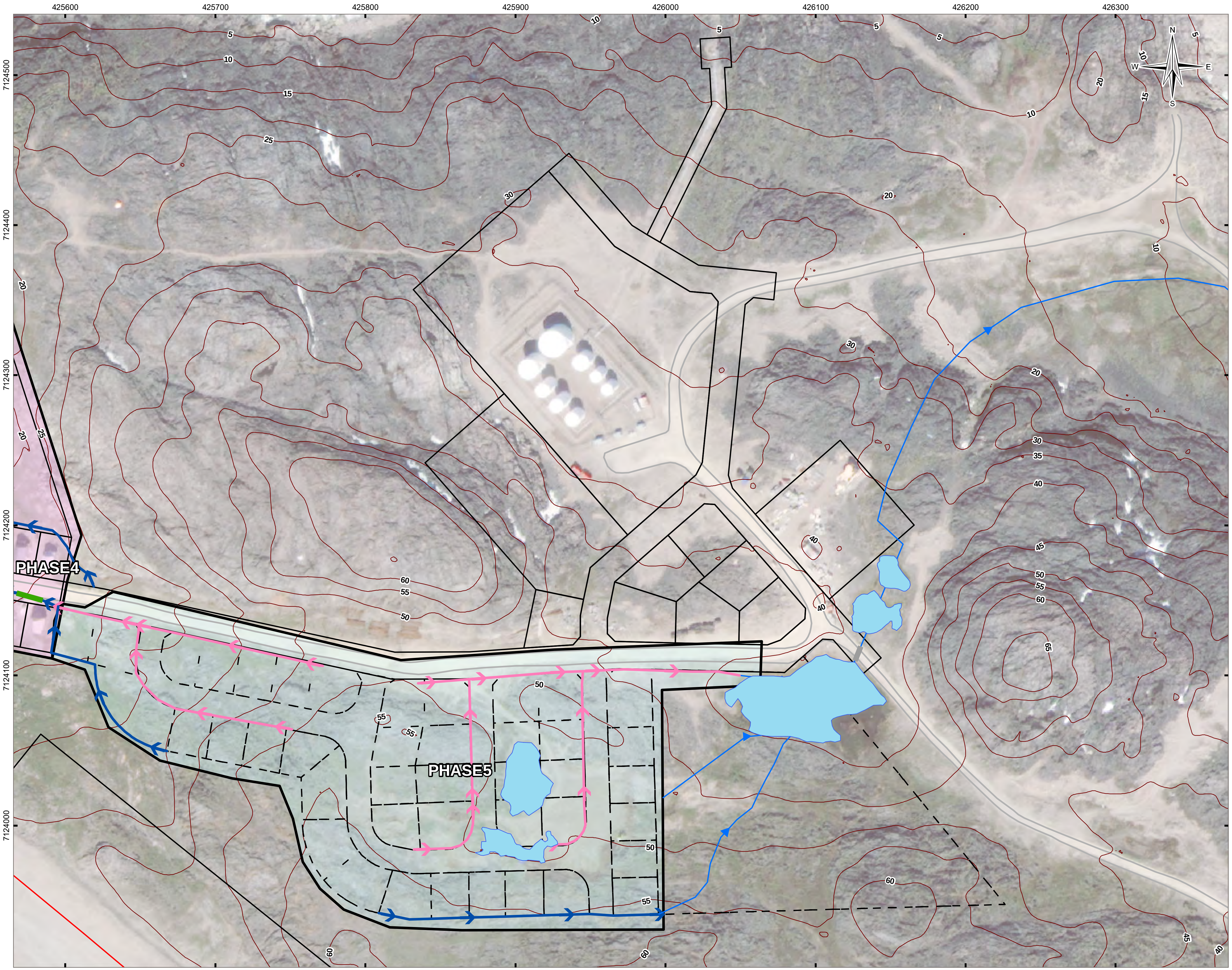
TETRA TECH

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure 5-15

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_Phasing.mxd modified 2020-09-08 by Darren.Schouls



LEGEND

Culverts

- Functioning as Intended
- Not Assessed

Open Channels

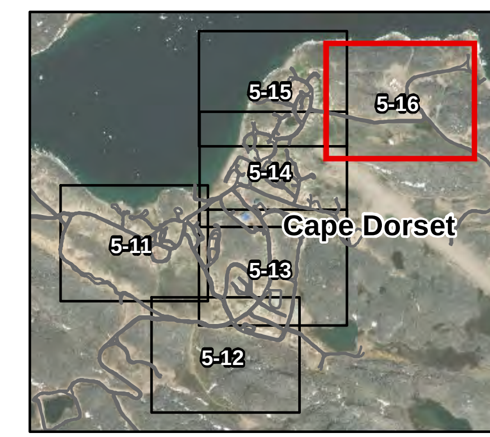
- Formalize Typical Ditch
- Formalize Typical Swale
- Natural Drainage Path

Project Phasing

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

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Cape Dorset Project Phasing

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

TETRA TECH

FILE NO.
WTRM03182-01_Phasing.mxd

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

DATE: September 8, 2020
PROJECT NO.: TRN.WTRI03002-01

Figure 5-16

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_Phasing.mxd modified 2020-09-08 by Darren.Schouls

5.5 Construction Cost Estimate

Construction of the Cape Dorset 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 covering the future community expansion areas.

A Class "D" cost estimate was developed for each phase. The cost estimates are included in Appendix C. A summary of the cost estimates is shown in Table 5-3 below.

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.

Table 5-3: Summary of Phased Cost Estimate

	Phase					
	1	**2**	**3**	**4**	**5**	**Total**
Preliminaries	$88,875	$94,912	$53,450	$103,736	$58,823	$399,795
Civil Works	$609,753	$670,118	$255,498	$758,357	$309,226	$2,602,952
Miscellaneous	$15,000	$15,000	$15,000	$15,000	$15,000	$75,000
Sub-total	**$713,628**	**$780,030**	**$323,948**	**$877,093**	**$383,049**	**$3,077,747**
Project Contingencies: (40%)	$285,451	$312,012	$129,579	$350,837	$153,219	$1,231,099
Total Estimated Construction Cost	**$999,080**	**$1,092,042**	**$453,527**	**$1,227,930**	**$536,268**	**$4,308,846**

5.6 Ongoing System Maintenance

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

5.6.1 Culvert Repairs and Maintenance Schedule

As per the guidelines for community drainage system planning, design, and maintenance in northern communities (CSA-S503-15), 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 5-17 provides a sketch covering the proposed repairs.
- After rain events and/or during spring freshet, the inlets and outlets of the drainage system closest to the discharge location should be inspected for blockages including sediment and debris. If blockages exist they should be removed to allow for the conveyance of flows to the full capacity of identified culverts.
- De-icing the culverts every spring is important. Proper de-icing equipment should be made available to the Hamlet to facilitate the de-icing of the culverts. Steaming is a typical process used to clear a culvert from ice.
- Ditches and swales should be reinstated every summer/autumn to maintain the hydraulic capacity of the system. Blocked ditches and swales will promote flooding.
- Roads should be re-nourished with gravel. The roads should be regularly raised and crowned to prevent surface ponding and to prevent surface runoff from flowing across the road. Excess surface runoff across a road will impact the integrity of the road and increase road maintenance costs.

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 above. 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.

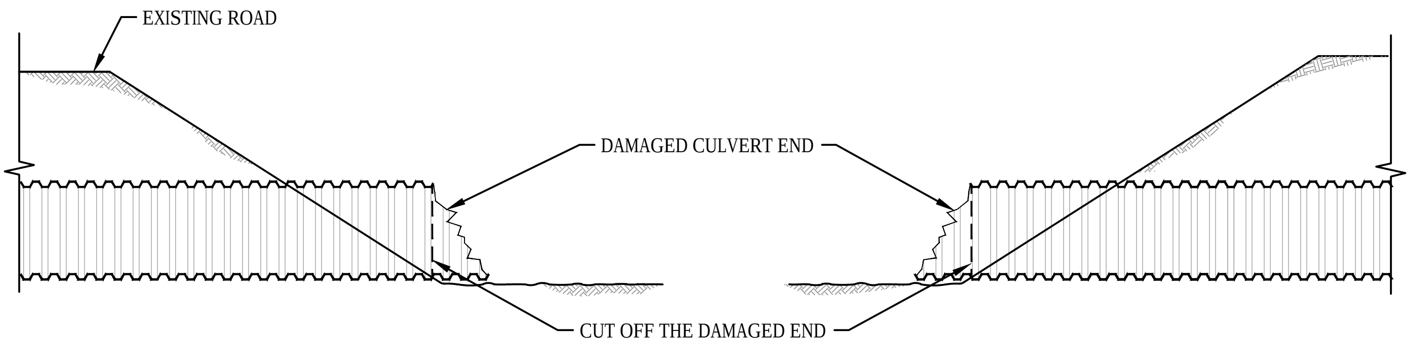
Fall:

- 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.

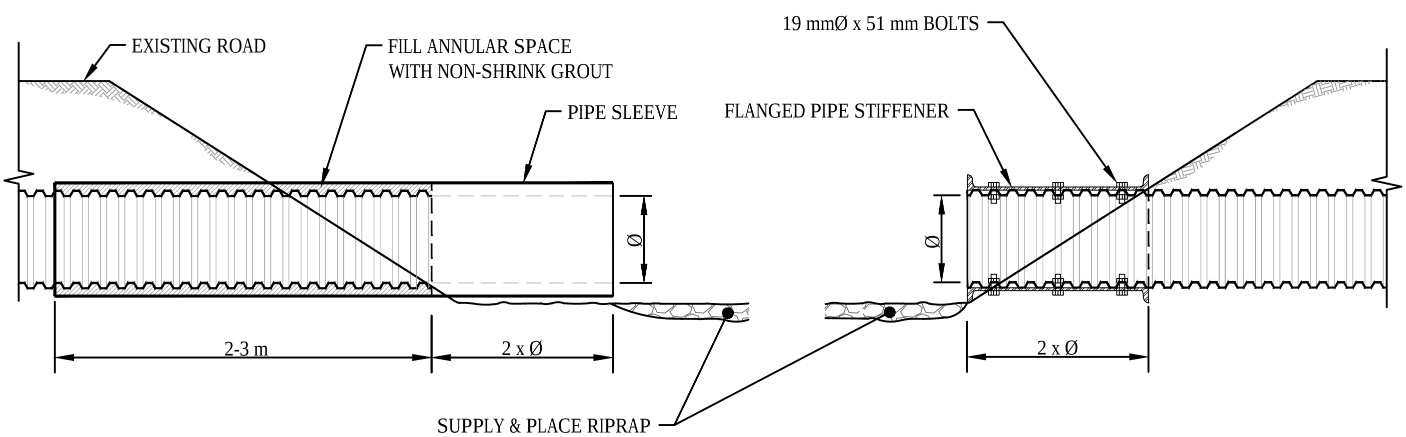
Winter:

- Monitor culverts and culvert marking posts.

Implement the snow removal management plan as detailed in Section 5.6.2.



BEFORE REPAIR



AFTER REPAIR

PIPE SLEEVE OPTION
SCALE: NTS

PIPE STIFFENER OPTION
SCALE: NTS

NOTE:

CLIENT

Nunavut

TETRA TECH

CAPE DORSET MASTER DRAINAGE PLAN

DAMAGED CULVERT END REPAIR DETAILS

PROJECT NO.	DWN	CKD	REV
WTRI03002-01	MJK	ER	A
OFFICE	DATE		
VANC	Sept. 30, 2020		

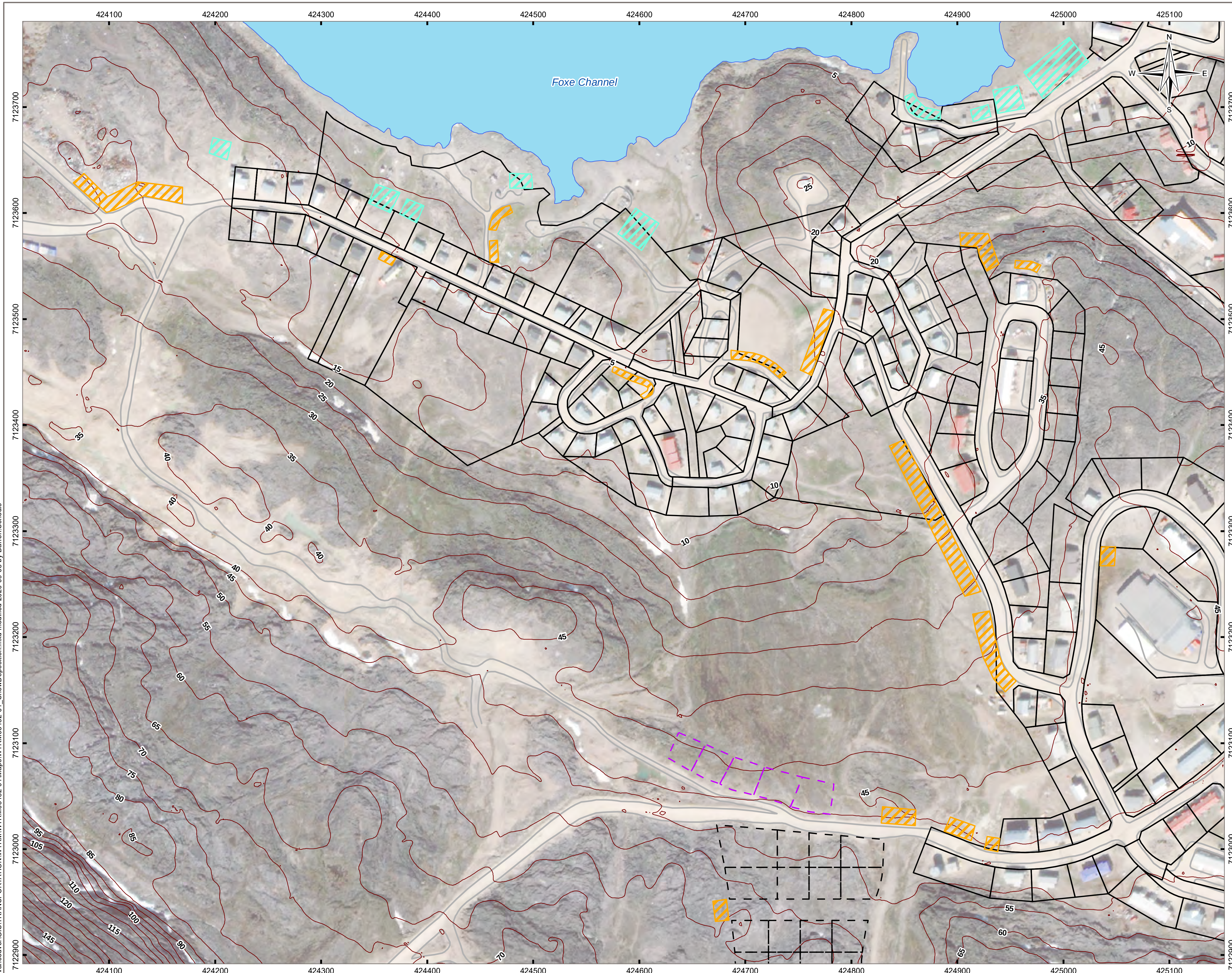
FIG.5-17

5.6.2 Snow Removal Management Plan

As per the guidelines for Community Drainage System Planning, Design, and Maintenance in Northern Communities (CSA-S503-15), runoff from stockpiled snow should be prevented from re-entering the Hamlet's 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 Storage Areas" as shown in Figures 5-18 to 5-22. Further details are outlined below.

- The preferred Snow Storage Areas are specifically identified to minimize water egress back into the hamlet.
- Limited storage has been allotted in the higher elevation portions of the community where snow melt from storage zones would re-enter the Hamlet's drainage system, adding to the springtime melt flows passing through the system. Temporary Push Out Zones have been designated for the higher elevation areas. Culverts downstream of the proposed storage areas have sufficient capacity to accept the additional flows. These areas should be used sparingly, however the preference remains for snow to be placed on the north side of the community's boundary adjacent to the harbour.
- Snow removed from the airport runway can be safely deposited in one of the "Runway Storage Zones."
- A Push Out Zone for the airport runway has been designated for temporary storage. Snow in this zone should be moved to the Runway Storage Zone at a later time.
- Snow removed from the airport runway shall not be deposited in the "Runway No Storage Zones." Snow in these areas would re-enter the Hamlet's drainage system during spring freshet and could overwhelm the system.



Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_SnowDeposition.mxd modified 2020-09-08 by Darren.Schouls

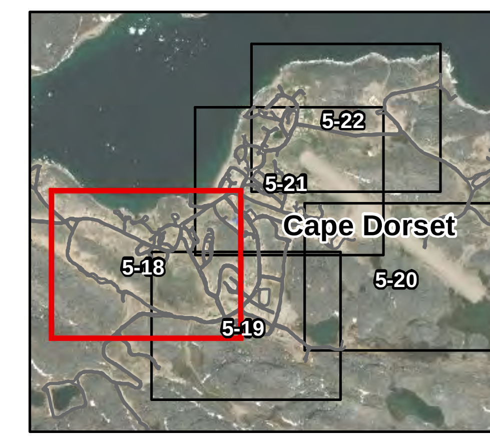
LEGEND

Snow Deposition

- Push Out Zone
- Storage Zone

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:3,500

60 30 0 60

Meters

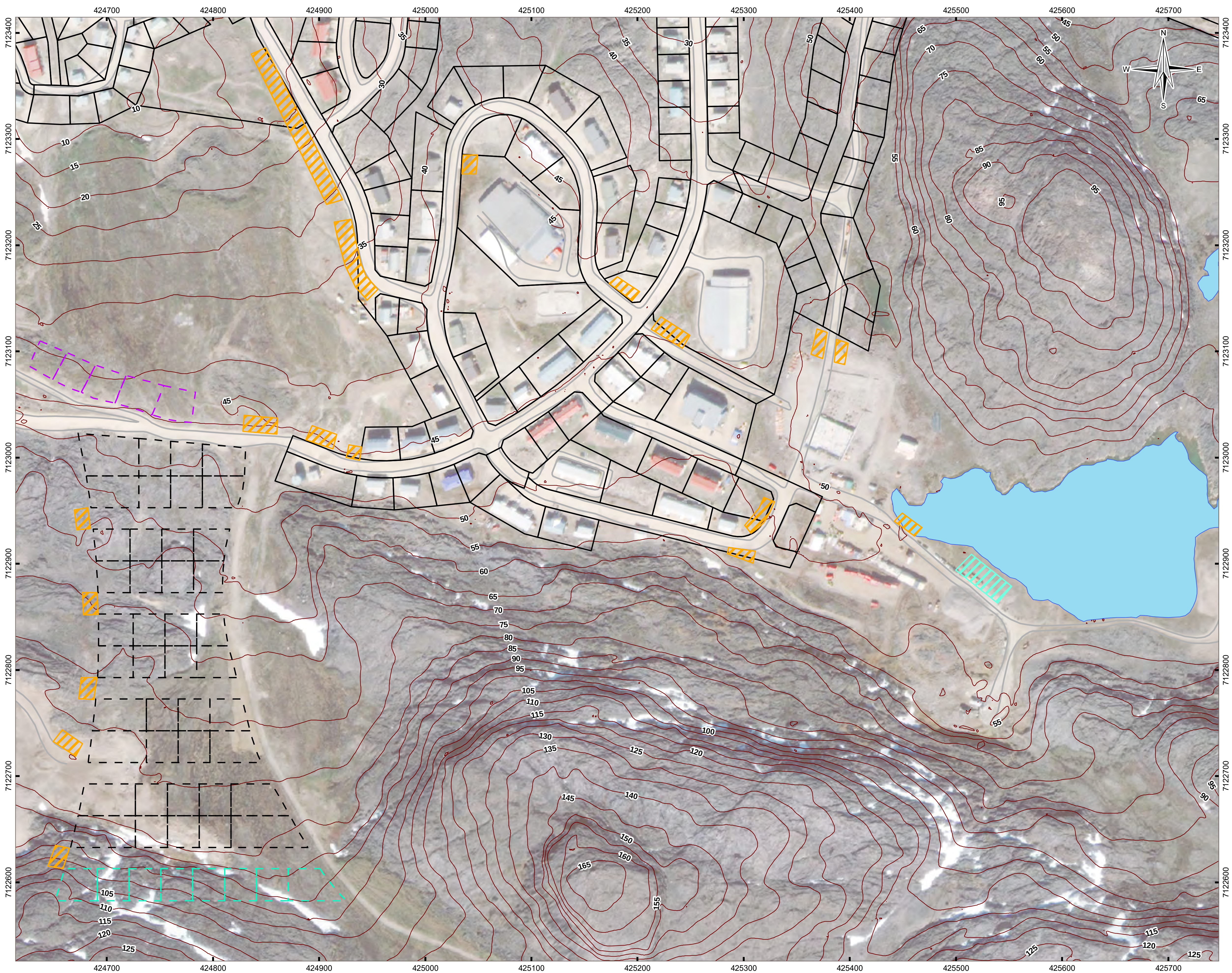
FILE NO.
WTRM03182-01_SnowDeposition.mxd

TETRA TECH

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure 5-18



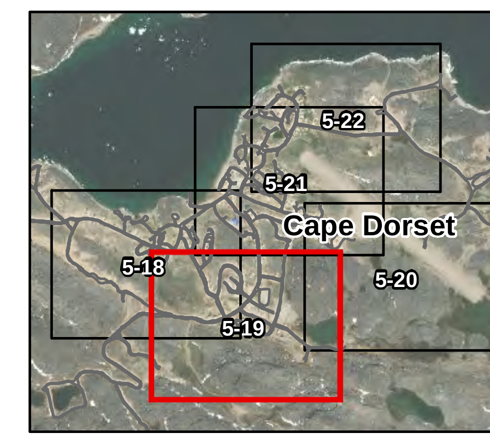
LEGEND

Snow Deposition

- Push Out Zone
- Storage Zone

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:3,500
60 30 0 60
Meters

FILE NO.
WTRM03182-01_SnowDeposition.mxd

TETRA TECH

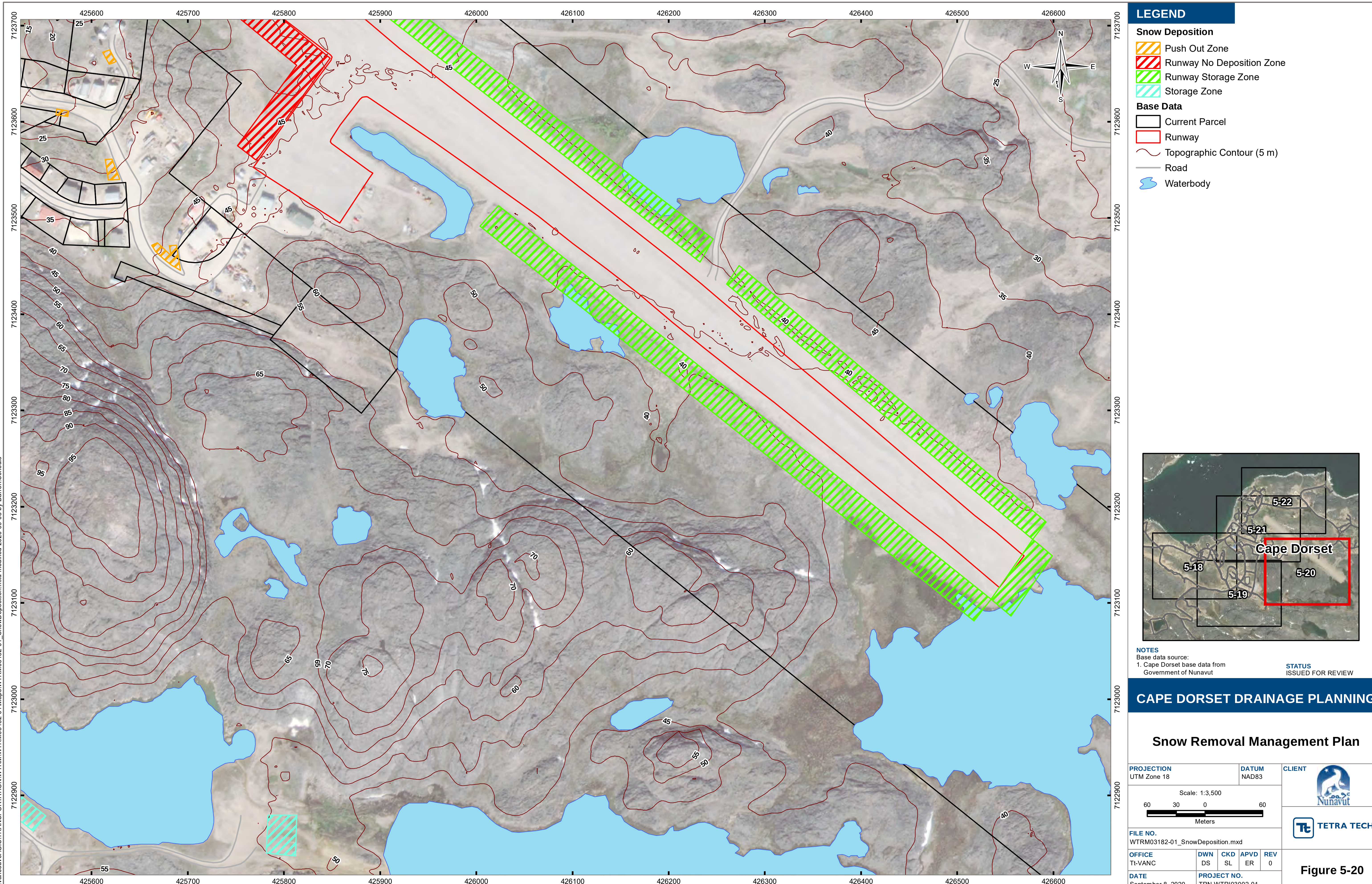
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0

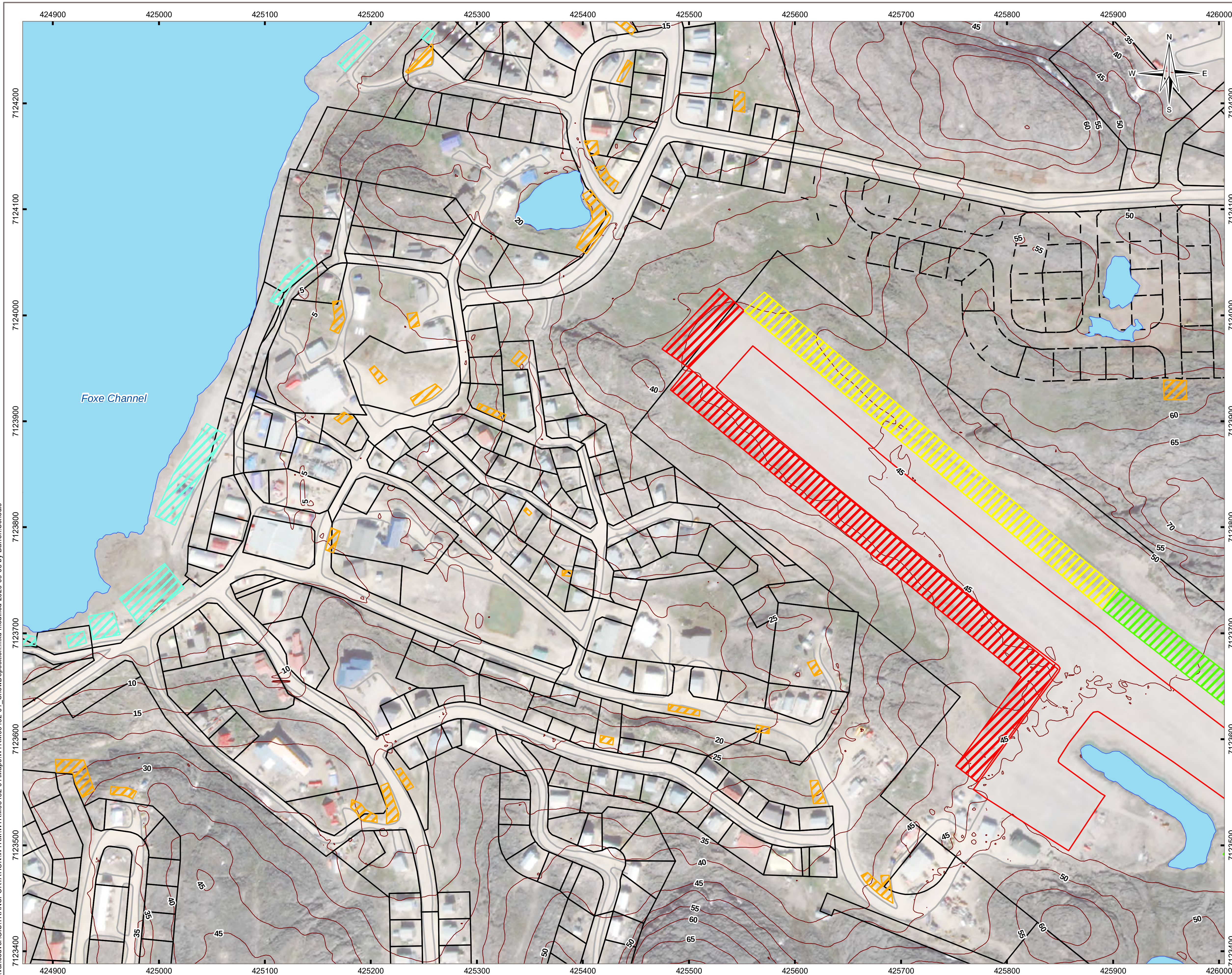
DATE
September 8, 2020

PROJECT NO.
TRN.WTRI03002-01

Figure 5-19

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_SnowDeposition.mxd modified 2020-09-08 by Darren.Schouls


LEGEND
Snow Deposition
Push Out Zone
Runway No Deposition Zone
Runway Storage Zone
Storage Zone
Base Data
Current Parcel
Runway
Topographic Contour (5 m)
Road
Waterbody
Cape Dorset
5-18
5-19
5-20
5-21
5-22
NOTES
Base data source:
1. Cape Dorset base data from Government of Nunavut
STATUS
ISSUED FOR REVIEW
CAPE DORSET DRAINAGE PLANNING
Snow Removal Management Plan
PROJECTION UTM Zone 18
DATUM NAD83
CLIENT
Nunavut
Scale: 1:3,500
60 30 0 60
Meters
FILE NO. WTRM03182-01_SnowDeposition.mxd
TETRA TECH
OFFICE Tt-VANC
DWN DS
CKD SL
APVD ER
REV 0
DATE September 8, 2020
PROJECT NO. TRN.WTRI03002-01
Figure 5-20
Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_SnowDeposition.mxd modified 2020-09-08 by Darren.Schouls



Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_SnowDeposition.mxd modified 2020-09-08 by Darren.Schouls

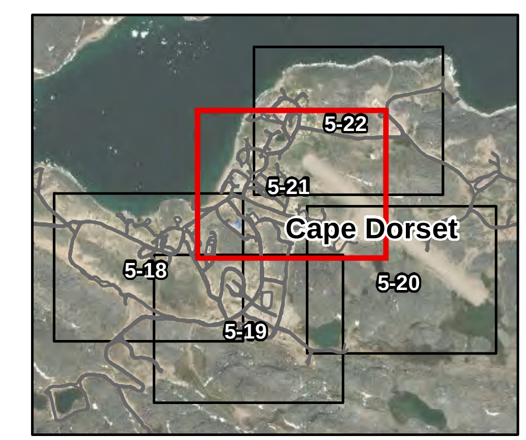
LEGEND

Snow Deposition

- Push Out Zone
- Runway No Deposition Zone
- Runway Push-Out Zone (Temporary
- Runway Storage Zone
- Storage Zone

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Snow Removal Management Plan

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:3,500

60 30 0 60

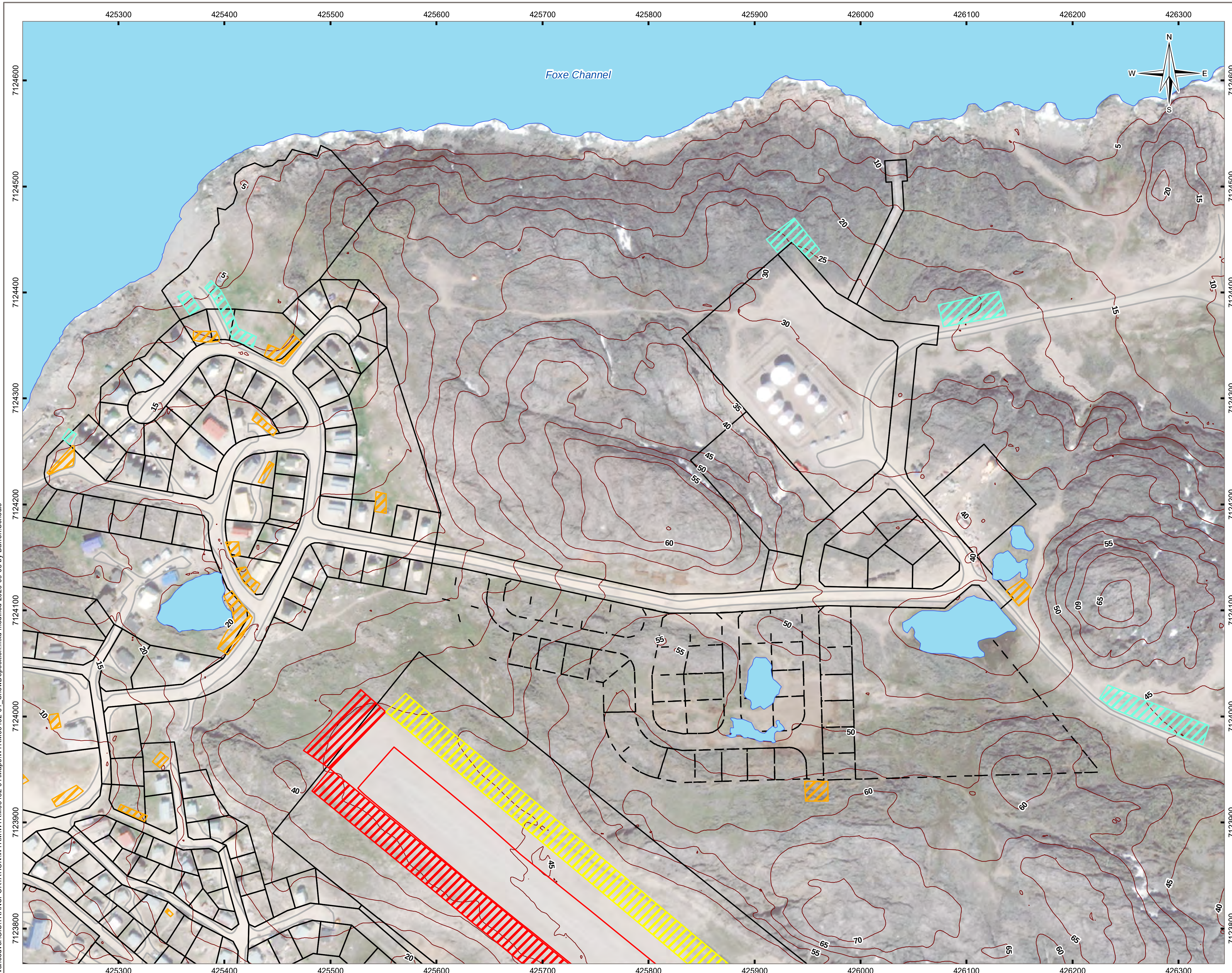
Meters

TETRA TECH

FILE NO.				
WTRM03182-01_SnowDeposition.mxd				
OFFICE	**DWN**	**CKD**	**APVD**	**REV**
Tt-VANC	DS	SL	ER	0

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure 5-21



Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_SnowDeposition.mxd modified 2020-09-08 by Darren.Schouls

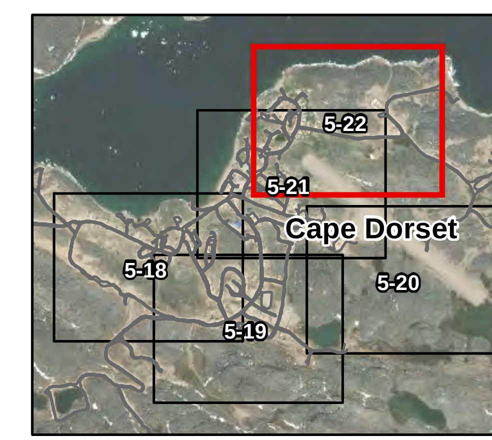
LEGEND

Snow Deposition

- Push Out Zone
- Runway No Deposition Zone
- Runway Push-Out Zone (Temporary Storage)
- Storage Zone

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Snow Removal Management Plan

PROJECTION: UTM Zone 18	DATUM: NAD83	CLIENT: Nunavut
Scale: 1:3,500 (60 30 0 60 Meters)		TETRA TECH
FILE NO.: WTRM03182-01_SnowDeposition.mxd		
OFFICE: Tt-VANC	DWN: DS; CKD: SL; APVD: ER; REV: 0	Figure 5-22
DATE: September 8, 2020	PROJECT NO.: TRN.WTRI03002-01	

5.6.3 Culvert Thawing

Cape Dorset's annual maintenance program should incorporate a culvert thawing strategy. Some options for thawing culverts are presented in Appendix G for consideration. Figure 5-23 below shows the proposed method for thawing ice inside culverts.

As per the project phasing diagrams shown in Figures 5-11 to 5-16, higher priority culverts should be thawed first. For example, culverts in Phase 1 zones should be thawed before culverts in Phase 2 zones. Within these phased zones thawing efforts should begin at the end of the drainage system and work upstream.

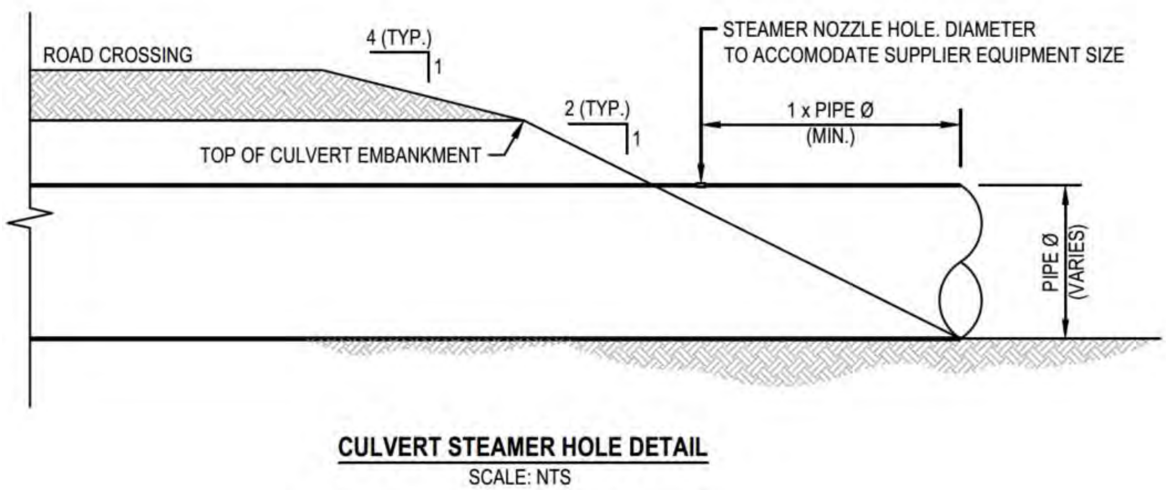


Figure 5-23: Culvert Thawing Detail

5.6.4 Inspection & Replacement Procedures

The climate and environment in Cape Dorset can lead to asset degradation at a faster pace than typical of southern environments. Yearly freeze-thaw cycles along with de-icing maintenance may reduce the service life of the culverts.

It is recommended that the Hamlet not follow a predetermined replacement schedule but rather ensure culverts and ditches are assessed on a yearly basis to determine if replacement or repair is necessary. This approach takes into account the following considerations:

- Unlike with municipal infrastructure and utilities in other Canadian cities, where the drainage system is often out of sight (underground), Cape Dorset's culverts and road structures are accessible and can be easily inspected as necessary. Ongoing degradation and/or damage can be observed on a monthly or yearly basis allowing replacements to occur only if and when necessary.
- The possibility of a culvert failure without observable signs of damage or deterioration is unlikely. In addition, the consequence of such a failure is low. Given this, pre-emptive asset replacement is financially inefficient. Culverts and ditches should be retained while they remain fully serviceable to maximize cost savings.
- Damage occurring from maintenance and snow clearing activities is the largest source of asset deterioration. Any predetermined replacement schedules would be unable to predict yearly damages caused by maintenance equipment.

As an alternative to a set replacement schedule, Tetra Tech recommends that at a minimum once per year and in the Spring, the community foreman inspect and take inventory of all culverts within the hamlet. During this inspection, the foremen is to assess damages and look for signs of degradation. This information should be logged in a culvert inventory form. As much of the culvert damages occurs over the spring, during de-icing and snow removal activities, this inspection should occur only once all snow and ice has melted. In some cases, damage will be repairable by installing a SWSP sleeve over the damaged end as detailed in Section 5.6.1. In some cases, the damage will be irreparable and will necessitate a full replacement.

This decision should be made by the Hamlet foreman who has the best knowledge on the probability of success in repair versus replacement. Culverts of special concern are those with minimal cover. As a guideline, Tetra Tech recommends that culverts displaying the following issues be prioritize for replacement:

- Pipe deformation has occurred to the point where vertical deformation exceeds 20% of the original pipe diameter.
- Pipe deformation is such that the culvert has holes or splits throughout its length allowing for leakage
- Corrosion is observed in the body of the pipe to the extent that small holes in the pipe wall are beginning to form.
- Damage to the pipe end is to the extent that installing a SWSP over the damaged pipe is not feasible.

Culverts which require replacement or repair should be flagged for service work to be completed during the summer of that year. Replacement should be in keeping with manufacturer's specifications. Tetra Tech has included in Appendix J a complete inventory of all culverts and "large ditches" within the community. It is recommended that the Hamlet's foremen work through this list in a sequential order when the yearly spring asset inspection is completed.

Critical Spares

Spare couplers, SWSP and repair clamps should be held within Cape Dorset's reserve inventory at all times. As per CSA-S503-15 guidelines, at least 5% of culvert materials used throughout a community's drainage system should be kept on hand in case critical, time-sensitive repair or replacements are required.

Repairing a Washout

Following a culvert washout, exposed saturated ground should be covered with drain rock or pea sized gravel. This will help to minimize the amount of fines that are washed out from the roadway structure and moved into the downstream system. Once the culvert is replaced, riprap shall be used to armor the inlet and the outlet embankments to prevent future washouts. Nonwoven filter fabric should be installed under the riprap.

5.7 Staff Training Requirements

From our site visit and communication with Hamlet staff including the Hamlet foreman, Mr. Pootoogook, Tetra Tech developed an understanding of current workers skill/experience levels and shortcomings. From this knowledge base we have developed the forgoing recommendations regarding initial and ongoing training for using equipment and maintaining the drainage infrastructure including, culverts, ditches, swales and roads. These recommendations include documentation practices, heavy and light equipment training, and safety protocols, among other aspects. We have also provided a plan to develop an in-house training program that will enable the transfer of knowledge and skills onto new staff.

5.7.1 Toromont CAT Equipment Training

Tetra Tech engaged Toromont CAT who is the official Caterpillar supplier for Nunavut and has sold and delivered much of the heavy equipment that Cape Dorset currently uses in their day to day operations. Toromont CAT is able to provide training and maintenance recommendations to Cape Dorset to ensure the equipment is used safely and efficiently and required ongoing maintenance is undertaken. Appendix I provides a quotation for a training representative from Toromont to visit Cape Dorset and educate the Hamlet's equipment users. Depending on the how many pieces of equipment require instruction and the number of individuals to receive the training, it is expected the training representative will require 1-3 days in Cape Dorset.

Tetra Tech recommends that all Hamlet workers who are put through training with Toromont receive a certificate of training and Cape Dorset tracks staff which have been put through formal supplier training and staff which have receive internal training from other experienced staff as per Section 5.7.3 below.

Tetra Tech's contact with Toromont CAT is Tim as below. Mr. Chandler welcomes enquiries from the Hamlet when they are ready to consider a new equipment purchase and subsequent training.

- Tim Chandler – Operator Training Supervisor - Toromont CAT- 416.917.4527-TChandler@toromont.com

5.7.2 Brandt Steamer Truck Training

Tetra Tech engaged Brandt Truck Rigging and Trailers as one of Canada's largest steamer truck providers regarding potential training for new steamer trucks which Cape Dorset may consider purchasing.

Brandt confirmed their capacity to provide in person training and maintenance recommendations to Cape Dorset to ensure the new steamer trucks are used safely. Brandt confirm they will provide maintenance training. Appendix I *(with IFU submission)* provides a quotation for a training representative from Brandt to visit Cape Dorset and educate the Hamlet's potential steamer struck operators. Depending on the number of individuals to receive the training, it is expect only one day of in person training will be required.

Tetra Tech recommends that all the Hamlet operators who are put through training with Brandt receive a certificate of training and we recommend that Cape Dorset tracks staff training which have been put through formal supplier training and staff which have receive internal training from other experienced staff.

Tetra Tech's contact with Brandt was Dan McCartney as below. Mr. McCartney welcomes enquiries from the Hamlet when they are ready to consider a steamer truck purchase and subsequent training.

- Dan McCartney - Brandt Truck and Trailer – 604.880.3662 – dmccartney@brandt.ca

5.7.3 Staff Training & Experience Checklist

Tetra Tech has developed a Staff Training & Experience Checklist which should be used by Cape Dorset Administrators to assess the experience and competency of field staff including foreman and labour. In order to receive a check mark in the "training" category, staff should have undergone either formal trasining from the equipment/machinery suppliers or formal Peer to Peer training from other Hamlet staff who are experienced with the applicable equipment.

In order to receive a check mark in the "experience" category, staff must have gone through one season where they were hands on operating equipment under the supervision of another "experienced" staff member and they feel confident at operating the equipment and completing maintenance without oversight. Appendix J provides the Staff Trainings and Experience checklist which can be used by Cape Dorset administrators to assess and track the capabilities of their existing labour force. It is recommended that the Hamlet keep the checklist outcomes in a master spreadsheet tracking all staff's various competency levels with different equipment.

Tetra Tech intends this checklist to be a living document. Cape Dorset administrative staff are encouraged to add fields and adapt the structure to the Hamlet's changing needs and preferences. As always, safety training is key to the development of any training programs.

5.7.4 Annual Staff Training Plan

Cape Dorset requested that Tetra Tech prepare and annual staff training plan for the Hamlet of Cape Dorset to follow. Appendix J provides a chart directing staff training decisions on an ongoing basis as equipment inventories regenerate and new machinery is brought into the Hamlet.

This chart presents chronological considerations and actions based on the seasons. The considerations column is intended as questions and environmental influences which the Hamlet should be aware of as they will dictate which actions the Hamlet should be undertaking. The actions column is intended as the steps and procedures Hamlet administrative staff should be following given factors and conditions the Hamlet is experiencing that year.

Tetra Tech intends this plan to be a living document. Cape Dorset administrative staff are encouraged to add considerations and adapt the structure to the Hamlet's changing needs and preferences.

5.8 Equipment Requirements

From our site visit and correspondence with Hamlet staff, Tetra Tech has developed a full equipment inventory of machinery and heavy vehicles the Hamlet has on hand. Based on this inventory of equipment along with comments and suggestions from the Hamlet foreman, Mr. Pootoogook, we have developed the forgoing recommendations regarding initial and ongoing training for using equipment and maintaining the drainage infrastructure including, culverts, ditches, swales and roads. These recommendations include documentation practices, heavy and light equipment training, and safety protocols, among other aspects. We have also provided a plan to develop an in-house training program that will enable the transfer of knowledge and skills onto new staff.

5.8.1 Heavy Equipment Requirements

Based on our communications with the GN, Tetra Tech understands that the Hamlet currently possesses the equipment listed in Table 5-4 below which is used to undertake infrastructure improvements and repairs throughout the community including road building, grading improvements, ditch and culvert installations and the supply of consumables to the Hamlet's residents.

Table 5-4: Cape Dorset Current Equipment List

Truck #	Vehicle Type	Year	Make
031-594	Screener	2017	Mobile Screen
031-950G	950G CAT Loader	2000	CATERPILLAR
031-966H	966H CAT Loader	2008	CATERPILLAR
031-950M	950M CAT Loader	2020	CATERPILLAR
031-420F2	420F2 CAT Backhoe	2020	CATERPILLAR
031-904	Dump Truck	2019	WESTERN STAR
031-140M	Grader 140M	2016	CATERPILLAR
031-203	Snowblower	2008	RPM TECH
031-D8T	Crawler Dozer	2012	CATERPILLAR

Upon reviewing this equipment list, and in consultation with equipment supplier Tormont CAT, we recommend that the Hamlet prioritize procurement of the equipment listed in Table 5-5 below with upcoming capital fund allocations.

Table 5-5: Cape Dorset Recommended Equipment List

Equipment Make	Equipment Type	Model	Intended Used
Peterbuilt or Equivalent	Single Axle Steam Truck***	Peterbilt 248	For use in spring de-icing activities***
Caterpillar or Equivalent**	Jaw Crusher and Cone Crusher*	N/A	For use in the production of aggregate and riprap for the construction of road structure, ditches and culverts. Complemented by the existing screener
Caterpillar or Equivalent**	Large Excavator	CAT 349	For use during the loading of transport/tandem trucks with material from aggregate stock piles.
Caterpillar or Equivalent**	Medium Excavator	CAT 336	For use in building roads, digging ditches and insalling culverts within the community area

** A reduced setup could include only a cone crusher and screener, however given the local material availability, Toromont CAT is of the opinion that a Jaw Crusher is required to breakdown the regions available material who's average diameter is often above 20 cm in size.*
*** For the purposes of this report, Tetra Tech has sepcified equipment predominartly from Caterpillar as we understand they are currently the largest supplier of heavy equipment to Cape Dorset and Canada's Arctic communities. Other manufacturarers do produce equivalent equipment however and should be contacted intermittently to ensure prices and limitations quoted by Catapillar suppliers remain competitive.*
**** See Section 5.8.2 below for further information regarding steam truck procurement.*

All together, the equipment listed above is expected to provide the most cost effective and versatile equipment solutions to allow the Hamlet to:

- Build and repair road structures;
- Remove and install culverts;
- Dig ditches and swales and place revetment;
- Snow removal and management;
- Miscellaneous tasks including supply and material transport, drive over/bucket material compaction, etc.

5.8.2 Steamer Truck Pilot Project

After talking to Cape Dorset's foremen and in discussions with Brandt, Tetra Tech recommends the community of Cape Dorset purchase a full-size steamer truck. The purchase and trial could be considered a pilot project for other Nunavut communities. Currently the majority of Nunavut communities complete de-icing activites with pickup truck mounted steamer equipment. This less robust small-scale system often is not able to fully de-ice culverts and other infrastructure leading to damage during snow removal activities and flooding when ice blockages in culverts are unable to removed in time before the spring freshet.

It is recommended the Hamlet consult with Brandt equipment to determine the best model and price point for their needs. A contact with Brandt has been provided below for reference.

- Dan McCartney - Brandt Truck and Trailer – 604.880.3662 – dmccartney@brandt.ca

6.0 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.

Prepared by:
Eric Rothfels, B.Sc., E.I.T.
Civil/Water Resources Engineer-in-Training
Direct Line: 604.356.6483
Eric.Rothfels@tetratech.com

Reviewed by:
David Moschini, P.Eng.
Manager - Water Resources and Infrastructure
Direct Line: 604.608.8612
David.Moschini@tetratech.com

ER/DM/cy

REFERENCES

Beckstead, G. & L.B. Smith (1985, September). Geotechnical and hydrological evaluation – Proposed residential subdivisions – Coppermine, N.W.T.. Thurber Consultants ltd. & Hydrocon Engineering (Continental) Ltd.

Bostock, H.S. 1970. Physiographic Subdivisions of Canada. In: R.J.W. Douglas, ed. *Geology and Minerals of Canada.* GSC Economic Geology Report No. 1, 9-30.

CSA Group. (2015, January). Community drainage system planning, design, and maintenance in northern communities. CAN/CSA-S503-15. National Standard of Canada

Ecoregions Working Group, 1989. Ecoclimatic Regions of Canada, Ecological Land Classification Series, No 23, Environment Canada, Ottawa, 119 pp.

Environment Canada, 2017. National Climate Data and Information Archive, Cape Dorset, NU. Retrieved from: http://www.climate.weatheroffice.gc.ca/climateData/canada_e.html.

Google Earth, 2017. Imagery for Cape Dorset, NU. Imagery dated August 3, 2019. Access date: August 2020.

Heginbottom, J.A., Dubreuil, M.A., and Harker, P.T. 1995. Canada Permafrost; In: National Atlas of Canada, 5th Edition. National Atlas Information Service, Natural Resources of Canada, Ottawa. (MCR 4177), Scale 1:7,500,000.

Keen, M.J. and Williams, G.L. 1990. Geology of the Continental Margin of Eastern Canada

Klassen, R.A. 1993. Surficial Geology: Bylot Island and Adjacent Areas, District Franklin, Northwest Territories, GSC, Map 1686A, Scale 1:250,000

Lewis, J., & Miller, K. (2010). Climate Change Adaptation Action Plan for Iqaluit. Retrieved from Canadian Institute of Planners: https://www.cip-icu.ca/Files/Resources/IQALUIT_REPORT_E

McCuaig, S.J. 1994. Glacial Chronology of the South Bylot and Salmon River Lowlands, N.W.T., Using Erratic Dispersal Patterns, Cosmic Dating, Radiocarbon Dating and Lichenometry. A Master of Science Thesis, Department of Earth Sciences, Carleton University, Ottawa, Ontario, May 1994, 140 pp.

Simonovic, S., Schardong, A., Gaur, A., & Sandink, D. (2018). IDF curves for ungauged locations - Canada. Retrieved from Computerized IDF CC Tool for the Development of Intensity-Duration-Frequency Curves under a Changing Climate: www.idf-cc-uwo.ca/idfgrid

NU. Report submitted to the Nunavut Housing Corporation, October 19, 2015 (Tetra Tech EBA file: Y14103362-01).

The Prairie Climate Centre. (2019, July 10). Find & Display Local Data. Retrieved from The Climate Atlas of Canada: https://climateatlas.ca/

U.S. Department of Transportation Federal Highway Administration. (2015, August). Gravel Roads Construction & Maintenance Guide.

APPENDIX A

TETRA TECH'S LIMITATIONS ON THE USE OF THIS DOCUMENT

LIMITATIONS ON USE OF THIS DOCUMENT

HYDROTECHNICAL

1.1 USE OF DOCUMENT AND OWNERSHIP

This document pertains to a specific site, a specific development, and a specific scope of work. The document may include plans, drawings, profiles and other supporting documents that collectively constitute the document (the "Professional Document").

The Professional Document is intended for the sole use of TETRA TECH's Client (the "Client") as specifically identified in the TETRA TECH Services Agreement or other Contractual Agreement entered into with the Client (either of which is termed the "Contract" herein). TETRA TECH does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Professional Document when it is used or relied upon by any party other than the Client, unless authorized in writing by TETRA TECH.

Any unauthorized use of the Professional Document is at the sole risk of the user. TETRA TECH accepts no responsibility whatsoever for any loss or damage where such loss or damage is alleged to be or, is in fact, caused by the unauthorized use of the Professional Document.

Where TETRA TECH has expressly authorized the use of the Professional Document by a third party (an "Authorized Party"), consideration for such authorization is the Authorized Party's acceptance of these Limitations on Use of this Document as well as any limitations on liability contained in the Contract with the Client (all of which is collectively termed the "Limitations on Liability"). The Authorized Party should carefully review both these Limitations on Use of this Document and the Contract prior to making any use of the Professional Document. Any use made of the Professional Document by an Authorized Party constitutes the Authorized Party's express acceptance of, and agreement to, the Limitations on Liability.

The Professional Document and any other form or type of data or documents generated by TETRA TECH during the performance of the work are TETRA TECH's professional work product and shall remain the copyright property of TETRA TECH.

The Professional Document is subject to copyright and shall not be reproduced either wholly or in part without the prior, written permission of TETRA TECH. Additional copies of the Document, if required, may be obtained upon request.

1.2 ALTERNATIVE DOCUMENT FORMAT

Where TETRA TECH submits electronic file and/or hard copy versions of the Professional Document or any drawings or other project-related documents and deliverables (collectively termed TETRA TECH's "Instruments of Professional Service"), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed electronic file and/or hard copy version archived by TETRA TECH shall be deemed to be the original. TETRA TECH will archive a protected digital copy of the original signed and/or sealed version for a period of 10 years.

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.

Electronic files submitted by TETRA TECH have been prepared and submitted using specific software and hardware systems. TETRA TECH makes no representation about the compatibility of these files with the Client's current or future software and hardware systems.

1.3 STANDARD OF CARE

Services performed by TETRA TECH for the Professional Document have been conducted in accordance with the Contract, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Professional Document. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Professional Document.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of TETRA TECH.

1.4 DISCLOSURE OF INFORMATION BY CLIENT

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

During the performance of the work and the preparation of this Professional Document, TETRA TECH may have relied on information provided by third parties other than the Client.

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

EXAMPLE CULVERT END STIFFENER

Photo 1: Example Culvert End Stiffener

APPENDIX C

PHASED COST ESTIMATES

Community and Government Services - Government of Nunavut

Class 'D' Cost Estimate - All Phases

Tetra Tech Project ENG.WTRI03002-01 - Cape Dorset Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$399,795
Civil Works		$2,602,952
Miscellaneous		$75,000
	Sub-total	**$3,077,747**
Project Contingencies	40.0%	$1,231,099
	Total Estimated Construction Cost	**$4,308,846**

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	$279,795.20	$279,795
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	**$399,795**

Civil Works			Unit	Est Quantity	Est. Unit Price	Est. Total
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	11,959	$30.00	$358,770
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	565	$527.00	$297,755
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	351	$707.00	$248,157
33 42 13	1-4	Supply and Install 900 mm Steel Casing Culvert	m	273	$1,068.00	$291,564
33 42 13	1-5	Supply and Install 1200 mm Steel Casing Culvert	m	18	$1,770.00	$31,860
33 42 13	1-6	Supply and Install 450 mm Steel Casing Sleeve	m	4	$527.00	$2,108
33 42 13	1-7	Supply and Install 500 mm Steel Casing Sleeve	m	4	$604.00	$2,416
33 42 13	1-8	Supply and Install 600 mm Steel Casing Sleeve	m	4	$707.00	$2,828
33 42 13	1-9	Supply and Install 800 mm Steel Casing Sleeve	m	4	$921.00	$3,684
31 37 10	1-10	Supply and Place 10 kg Class Riprap	cu. m	6,017	$100.00	$601,700
31 37 10	1-11	Supply and Place 50 - 75 mm Clear Crush (Swales)	cu. m	663	$100.00	$66,300
31 37 10	1-12	Supply and Place 19 mm Minus Crush (Road Grading)	cu. m	1,657	$90.00	$149,130
31 32 21	1-13	Supply and Place Non-Woven Geotextile	sq. m	21,134	$20.00	$422,680
02 41 13	1-14	Culvert Removal and Off-Site Disposal	each	62	$2,000.00	$124,000
					Sub-total Site Services	**$2,602,952**

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 ENG.WTRI03002-01 - Cape Dorset Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$88,875
Civil Works		$609,753
Miscellaneous		$15,000
	Sub-total	**$713,628**
Project Contingencies	40.0%	$285,451
	Total Estimated Construction Cost	**$999,080**

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	$64,875.30	$64,875
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	**$88,875**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	2,235	$30.00	$67,050
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	26	$527.00	$13,702
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	133	$707.00	$94,031
33 42 13	1-4	Supply and Install 900 mm Steel Casing Culvert	m	143	$1,068.00	$152,724
33 42 13	1-5	Supply and Install 1200 mm Steel Casing Culvert	m	18	$1,770.00	$31,860
33 42 13	1-6	Supply and Install 500 mm Steel Casing Sleeve	m	4	$604.00	$2,416
31 37 10	1-7	Supply and Place 10 kg Class Riprap	cu. m	1,103	$100.00	$110,300
31 37 10	1-8	Supply and Place 50 - 75 mm Clear Crush (Swales)	cu. m	45	$100.00	$4,500
31 37 10	1-9	Supply and Place 19 mm Minus Crush (Road Grading)	cu. m	293	$90.00	$26,370
31 32 21	1-10	Supply and Place Non-Woven Geotextile	sq. m	3,740	$20.00	$74,800
02 41 13	1-11	Culvert Removal and Off-Site Disposal	each	16	$2,000.00	$32,000
					Sub-total Site Services	**$609,753**
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 ENG.WTRI03002-01 - Cape Dorset Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$94,912
Civil Works		$670,118
Miscellaneous		$15,000
	Sub-total	**$780,030**
Project Contingencies	40.0%	$312,012
	Total Estimated Construction Cost	**$1,092,042**

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	$70,911.80	$70,912
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	**$94,912**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	2,993	$30.00	$89,790
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	156	$527.00	$82,212
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	20	$707.00	$14,140
33 42 13	1-4	Supply and Install 900 mm Steel Casing Culvert	m	92	$1,068.00	$98,256
31 37 10	1-5	Supply and Place 10 kg Class Riprap	cu. m	1,614	$100.00	$161,400
31 37 10	1-6	Supply and Place 50 - 75 mm Clear Crush (Swales)	cu. m	120	$100.00	$12,000
31 37 10	1-7	Supply and Place 19 mm Minus Crush (Road Grading)	cu. m	648	$90.00	$58,320
31 32 21	1-8	Supply and Place Non-Woven Geotextile	sq. m	5,700	$20.00	$114,000
02 41 13	1-9	Culvert Removal and Off-Site Disposal	each	20	$2,000.00	$40,000
					Sub-total Site Services	**$670,118**
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 ENG.WTRI03002-01 - Cape Dorset Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$53,450
Civil Works		$255,498
Miscellaneous		$15,000
	Sub-total	**$323,948**
Project Contingencies	40.0%	$129,579
	Total Estimated Construction Cost	**$453,527**

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	$29,449.80	$29,450
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	**$53,450**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	1,257	$30.00	$37,710
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	58	$527.00	$30,566
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	30	$707.00	$21,210
33 42 13	1-4	Supply and Install 450 mm Steel Casing Sleeve	m	4	$527.00	$2,108
33 42 13	1-5	Supply and Install 800 mm Steel Casing Sleeve	m	4	$921.00	$3,684
31 37 10	1-6	Supply and Place 10 kg Class Riprap	cu. m	592	$100.00	$59,200
31 37 10	1-7	Supply and Place 50 - 75 mm Clear Crush (Swales)	cu. m	110	$100.00	$11,000
31 37 10	1-8	Supply and Place 19 mm Minus Crush (Road Grading)	cu. m	446	$90.00	$40,140
31 32 21	1-9	Supply and Place Non-Woven Geotextile	sq. m	2,094	$20.00	$41,880
02 41 13	1-10	Culvert Removal and Off-Site Disposal	each	4	$2,000.00	$8,000
					Sub-total Site Services	**$255,498**
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 ENG.WTRI03002-01 - Cape Dorset Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$103,736
Civil Works		$758,357
Miscellaneous		$15,000
	Sub-total	**$877,093**
Project Contingencies	40.0%	$350,837
	Total Estimated Construction Cost	**$1,227,930**

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	$79,735.70	$79,736
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	**$103,736**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	3,472	$30.00	$104,160
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	233	$527.00	$122,791
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	142	$707.00	$100,394
33 42 13	1-4	Supply and Install 900 mm Steel Casing Culvert	m	38	$1,068.00	$40,584
33 42 13	1-5	Supply and Install 600 mm Steel Casing Sleeve	m	4	$707.00	$2,828
31 37 10	1-6	Supply and Place 10 kg Class Riprap	cu. m	1,720	$100.00	$172,000
31 37 10	1-7	Supply and Place 50 - 75 mm Clear Crush (Swales)	cu. m	250	$100.00	$25,000
31 37 10	1-8	Supply and Place 19 mm Minus Crush (Road Grading)	cu. m	270	$90.00	$24,300
31 32 21	1-9	Supply and Place Non-Woven Geotextile	sq. m	6,115	$20.00	$122,300
02 41 13	1-10	Culvert Removal and Off-Site Disposal	each	22	$2,000.00	$44,000
					Sub-total Site Services	**$758,357**
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 ENG.WTRI03002-01 - Cape Dorset Master Drainage Plan

Preliminary Estimate of Probable Costs		Total
Preliminaries		$58,823
Civil Works		$309,226
Miscellaneous		$15,000
	Sub-total	**$383,049**
Project Contingencies	40.0%	$153,219
	Total Estimated Construction Cost	**$536,268**

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	$34,822.60	$34,823
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	**$58,823**
Civil Works			**Unit**	**Est Quantity**	**Est. Unit Price**	**Est. Total**
31 14 11	1-1	Excavation and Off-Site Disposal	cu.m	2,002	$30.00	$60,060
33 42 13	1-2	Supply and Install 450 mm Steel Casing Culvert	m	92	$527.00	$48,484
33 42 13	1-3	Supply and Install 600 mm Steel Casing Culvert	m	26	$707.00	$18,382
31 37 10	1-4	Supply and Place 10 kg Class Riprap	cu. m	988	$100.00	$98,800
31 37 10	1-5	Supply and Place 50 - 75 mm Clear Crush (Swales)	cu. m	138	$100.00	$13,800
31 32 21	1-6	Supply and Place Non-Woven Geotextile	sq. m	3,485	$20.00	$69,700
					Sub-total Site Services	**$309,226**
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 D

SUMMARY OF EXISTING AND PROPOSED CULVERTS

Table D-1: Existing and Proposed Culverts Summary Table

Name	Condition	Proposed Culvert Action	Comments	Design Diameter (mm)	Length (m)	Phase	Material	Max. Flow (m³/s)	Max. Velocity (m/s)	Max/Full Flow	Max/Full Depth
C1	Damaged	Replace		450	6	4	SWSP	0.112	1.69	0.72	0.48
C2	Damaged	Replace		450	7	4	SWSP	0.112	1.84	0.46	0.47
C3	Damaged	Replace		600	12	4	SWSP	0.163	1.71	0.29	0.42
C4	Blocked	Replace		450	11	4	SWSP	0.006	0.50	0.02	0.14
C5	Damaged	Repair		500	17	1	CSP	0.011	0.73	0.03	0.29
C6 A		New - Existing Community		900	31	1	SWSP	0.109	1.09	0.21	0.40
C6 B	Damaged	Replace	Repair Possible	900	30	1	SWSP	0.173	1.46	0.04	0.27
C7	Partially Blocked and Damaged	Replace		900	18	1	SWSP	0.251	1.67	0.13	0.29
C8	Blocked	Replace		450	18	1	SWSP	0.015	1.00	0.07	0.16
C9	Damaged	Replace	2 x 1200 mm	900	16	1	SWSP	1.284	1.30	0.47	0.52
C10	Damaged	Replace	2 x 1200 mm	900	11	1	SWSP	1.235	1.50	0.16	0.46
C11	Damaged	Replace	2 x 1200 mm	1200	9	1	SWSP	1.502	1.87	0.15	0.39
C12	Partially Blocked and Damaged	Replace		600	10	1	SWSP	0.082	1.67	0.08	0.25
C13	Partially Blocked and Damaged	Replace	Repair Possible	600	12	1	SWSP	0.081	1.13	0.17	0.33
C14		Functioning as Intended		800	10	1	CSP	0.736	1.44	0.17	0.38
C15 A		Functioning as Intended		900	14	1	SWSP	0.249	1.82	0.16	0.33
C15 B		New - Existing Community		900	14	1	CSP	0.216	1.66	0.10	0.27
C16	Partially Blocked and Damaged	Replace		600	17	1	SWSP	0.060	1.20	0.06	0.25
C17	Damaged	Repair	Lower Inlet	600	15	4	CSP	0.040	1.40	0.08	0.16
C18	Partially Blocked and Damaged	Replace		450	19	4	SWSP	0.012	1.30	0.03	0.12
C19 A		Functioning as Intended		800	18	3	CSP	0.158	1.38	0.10	0.29
C19 B		New - Existing Community		800	18	3	SWSP	0.076	0.66	0.09	0.44
C20	Partially Blocked	Repair		450	5	3	CSP	0.039	1.03	0.14	0.29

Name	Condition	Proposed Culvert Action	Comments	Design Diameter (mm)	Length (m)	Phase	Material	Max. Flow (m^3/s)	Max. Velocity (m/s)	Max/Full Flow	Max/Full Depth
C21	Partially Blocked and Damaged	Replace	Repair Possible	600	19	4	SWSP	0.008	1.07	0.01	0.07
C22	Blocked	Abandon	Repair Possible	450	18	4	SWSP	0.010	1.13	0.03	0.12
C23	Blocked	Replace		450	9	4	SWSP	0.000	0.00	0.00	0.00
C24		Replace	Repair Possible	450	13	2	SWSP	0.000	0.00	0.00	0.00
C25	Blocked	Replace	Repair Possible	450	23	2	SWSP	0.035	1.26	0.13	0.23
C26	Damaged	Replace	Repair Possible	600	27	4	SWSP	0.005	0.18	0.01	0.25
C27	Partially Blocked and Damaged	Abandon	Repair Possible	450	28	4	SWSP	0.000	0.00	0.00	0.26
C28	Blocked	Replace	Repair Possible	600	22	4	SWSP	0.041	1.08	0.05	0.21
C29	Partially Blocked and Damaged	Replace	Repair Possible	450	19	4	SWSP	0.001	0.31	0.01	0.16
C30	Damaged	Replace	Repair Possible	450	19	4	SWSP	0.011	0.40	0.13	0.23
C31	Undersized	Replace		450	14	4	SWSP	0.010	1.21	0.04	0.10
C32	Partially Blocked	Remove Debris		900	17	5	CSP	0.259	2.03	0.19	0.26
C33		Functioning as Intended		500	12	4	CSP	0.000	0.00	0.00	0.00
C34		Functioning as Intended		500	13	4	HDPE	0.059	1.31	0.20	0.30
C35		Functioning as Intended		800	8	2	CSP	0.076	1.18	0.07	0.20
C36		Functioning as Intended		700	14	2	HDPE	0.076	1.31	0.09	0.21
C37		Abandon		450	4	2	CSP	0.002	0.06	0.02	0.87
C38		Abandon		600	18	2	CSP	0.000	0.00	0.00	0.00
C39	Damaged	Replace	Repair Possible	600	19	2	SWSP	0.004	0.42	0.02	0.14
C40		Functioning as Intended		450	11	4	CSP	0.000	0.00	0.00	0.00
C41	Damaged	Abandon	Repair Possible	450	32	3	SWSP	0.004	0.80	0.01	0.07
C42	Blocked	Replace		450	23	2	SWSP	0.011	0.79	0.07	0.15
C43	Partially Blocked and Damaged	Replace	Repair Possible	900	17	2	SWSP	0.084	1.42	0.08	0.16
C44	Partially Blocked and Damaged	Replace		450	15	2	SWSP	0.018	1.36	0.06	0.14

Name	Condition	Proposed Culvert Action	Comments	Design Diameter (mm)	Length (m)	Phase	Material	Max. Flow (m^3/s)	Max. Velocity (m/s)	Max/Full Flow	Max/Full Depth
C45	Partially Blocked	Remove Debris		600	12	2	CSP	0.094	1.64	0.20	0.27
C46		Relocate		800	14	2	CSP	0.139	1.35	0.11	0.26
C47	Damaged	Abandon		900	43	2	SWSP	0.002	0.35	0.00	0.03
C48	Damaged	Replace		450	8	2	SWSP	0.000	0.00	0.00	0.00
C49	Damaged	Abandon		900	128	2	SWSP	0.000	0.00	0.00	0.00
C50	Partially Blocked and Damaged	Replace	Repair Possible	600	10	4	SWSP	0.033	1.45	0.04	0.14
C51	Partially Blocked and Damaged	Replace		900	26	4	SWSP	0.066	1.58	0.02	0.13
C52	Partially Blocked and Damaged	Replace		600	36	1	SWSP	0.094	1.34	0.26	0.31
C53		Functioning as Intended		800	8	1	CSP	0.100	1.26	0.09	0.22
C54	Damaged	Replace		600	15	1	SWSP	0.131	1.05	0.73	0.45
C55 A		Functioning as Intended		800	13	1	CSP	0.142	1.07	0.12	0.32
C55 B		New - Existing Community		800	12	1	SWSP	0.134	1.25	0.28	0.42
C56	Blocked	Replace		450	11	2	SWSP	0.011	0.66	0.04	0.16
C57	Partially Blocked	Replace		450	10	2	SWSP	0.015	0.80	0.08	0.20
C58	Blocked	Replace	Repair Possible	450	22	2	SWSP	0.037	1.08	0.15	0.27
C59	Partially Blocked and Damaged	Replace	Repair Possible	900	19	2	SWSP	0.330	1.14	0.08	0.28
C60	Damaged	Replace	Repair Possible	900	15	2	SWSP	0.264	1.70	0.29	0.30
C61	Damaged	Replace		900	7	2	SWSP	0.279	1.52	0.10	0.33
C62	Damaged	Replace		900	14	2	SWSP	0.258	1.56	0.29	0.32
C63		Functioning as Intended		600	18	4	CSP	0.035	1.43	0.03	0.15
C64	Partially Blocked and Damaged	Replace	Repair Possible	600	14	4	SWSP	0.049	1.37	0.06	0.19
C65		Functioning as Intended		400	7	4	CSP	0.015	0.69	0.06	0.23
C66	Partially Blocked	Remove Debris		450	11	4	Steel	0.016	1.50	0.04	0.12
C67	Partially Blocked and Damaged	Replace		450	8	4	SWSP	0.024	0.92	0.08	0.25

Name	Condition	Proposed Culvert Action	Comments	Design Diameter (mm)	Length (m)	Phase	Material	Max. Flow (m^3/s)	Max. Velocity (m/s)	Max/Full Flow	Max/Full Depth
C68	Partially Blocked	Remove Debris	Remove debris	800	12	4	CSP	0.102	1.80	0.12	0.17
C69	Partially Blocked and Damaged	Abandon		450	13	4	SWSP	0.000	0.00	0.00	0.00
C70	Damaged	Abandon		450	8	4	SWSP	0.000	0.00	0.00	0.00
C71	Partially Blocked and Damaged	Replace	Repair Possible	600	20	4	SWSP	0.059	1.70	0.08	0.18
C72	Damaged	Replace	Repair Possible	600	18	4	SWSP	0.049	1.30	0.14	0.19
C73	Partially Blocked and Damaged	Replace	Repair Possible	600	11	3	SWSP	0.009	1.03	0.01	0.10
C74	Partially Blocked and Damaged	Abandon		900	8	3	SWSP	0.061	1.65	0.06	0.11
C75	Partially Blocked and Damaged	Replace		450	13	3	SWSP	0.034	1.47	0.14	0.20
C76	Partially Blocked and Damaged	Repair		800	70	3	CSP	0.295	1.60	0.12	0.40
C77	Blocked	Abandon	Completely Buried	0	37	2		0.000	0.00	0.00	0.00
C78		Not Assessed			15			0.000	0.00	0.00	0.00
C79		Not Assessed			10			0.109	1.96	0.02	0.13
C80		Not Assessed			31			0.000	0.00	0.00	0.00
C81		Not Assessed			12			0.013	0.31	0.00	0.10
C82		Not Assessed			18			0.003	0.99	0.00	0.02
C83		Not Assessed			7			0.000	0.00	0.00	0.00
C84		Not Assessed			17			0.000	0.00	0.00	0.00
C100		New - Existing Community		450	9	4	SWSP	0.008	0.42	0.00	0.06
C101		New - Existing Community		450	12	4	SWSP	0.005	0.37	0.01	0.34
C102		New - Existing Community		450	17	3	SWSP	0.018	1.24	0.03	0.16
C103		New - Existing Community		450	10	4	SWSP	0.001	0.99	0.00	0.03
C104		New - Existing Community		450	14	3	SWSP	0.021	0.43	0.04	0.34
C105		New - Existing Community		450	8	4	SWSP	0.007	0.51	0.00	0.06
C106		New - Existing Community		450	8	1	SWSP	0.000	0.00	0.00	0.00

Name	Condition	Proposed Culvert Action	Comments	Design Diameter (mm)	Length (m)	Phase	Material	Max. Flow (m^3/s)	Max. Velocity (m/s)	Max/Full Flow	Max/Full Depth
C107		New - Existing Community		450	20	4	SWSP	0.000	0.00	0.00	0.00
C108		New - Existing Community		450	8	2	SWSP	0.018	0.82	0.15	0.19
C109		New - Existing Community		450	9	4	SWSP	0.000	0.00	0.00	0.10
C110		New - Existing Community		450	10	3	SWSP	0.000	0.00	0.00	0.00
C111		New - Existing Community		900	12	4	SWSP	0.000	0.00	0.00	0.00
C112		New - Existing Community		450	16	4	SWSP	0.028	1.37	0.09	0.18
C113		New - Existing Community		450	22	2	SWSP	0.003	0.73	0.00	0.02
C114		New - Existing Community		450	15	4	SWSP	0.029	1.37	0.06	0.19
C115		New - Future Community Expansion		600	26	5	SWSP	0.103	1.76	0.03	0.28
C116		New - Future Community Expansion		450	22	4	SWSP	0.042	1.17	0.04	0.28
C117		New - Future Community Expansion		450	24	5	SWSP	0.012	0.94	0.01	0.20
C118		New - Future Community Expansion		450	22	5	SWSP	0.012	0.78	0.01	0.20
C119		New - Future Community Expansion		450	23	5	SWSP	0.030	1.20	0.05	0.26
C120		New - Future Community Expansion		450	25	5	SWSP	0.016	0.63	0.01	0.29

APPENDIX E

INVENTORY OF EXISTING CULVERTS

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C1	Inlet	2019 / 09 / 30	-76.5640437629476	64.2297636612956

Diameter (mm):	Material:	Condition:
0.3	Steel	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C1

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5639612280605

Latitude: 64.2298091784276

Diameter (mm): 0.3

Material: Steel

Condition: Damaged

Recommended Action: Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C2	Inlet	2019 / 09 / 30	-76.56372297045	64.2298022399211

Diameter (mm):	Material:	Condition:
0.4	Cast Iron	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C2	Outlet	2019 / 09 / 30	-76.5635924722422	64.2297713542048

Diameter (mm):	Material:	Condition:
0.4	Cast Iron	Damaged

Recommended Action:
Replace

Notes:

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C3	Inlet	2019 / 09 / 30	-76.5595498134761	64.2299447802764

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C3	Outlet	2019 / 09 / 30	-76.5594542003879	64.2300400150536

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C4	Inlet	2019 / 09 / 30	-76.5576043149208	64.2295762587223

Diameter (mm):	Material:	Condition:
0.15	Cast Iron	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C4	Outlet	2019 / 09 / 30	-76.5576034351352	64.2296769253272

Diameter (mm):	Material:	Condition:
0.15	Cast Iron	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C5	Inlet	2019 / 09 / 30	-76.5554750005186	64.2290036121177

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Repair

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C5	Outlet	2019 / 09 / 30	-76.5552366451046	64.2289947616996

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Repair

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C6	Inlet	2019 / 09 / 30	-76.5550007431839	64.2290295661015

Diameter (mm):	Material:	Condition:
0.9	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C7	Inlet	2019 / 09 / 30	-76.5559562701633	64.2285682381844

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C7	Outlet	2019 / 09 / 30	-76.5557192572686	64.2286904861609

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C8	Inlet	2019 / 09 / 30	-76.5547933816064	64.2285237456743

Diameter (mm):	Material:	Condition:
0.2	Cast Iron	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C8	Outlet	2019 / 09 / 30	-76.5549521256428	64.2286692387112

Diameter (mm):	Material:	Condition:
0.2	Cast Iron	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C9	Inlet	2019 / 09 / 30	-76.5535776220541	64.2288431299458

Diameter (mm):	Material:	Condition:
0.9	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C9	Outlet	2019 / 09 / 30	-76.5536416753797	64.2289595521654

Diameter (mm):	Material:	Condition:
0.9	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C10	Inlet	2019 / 09 / 30	-76.5537011435887	64.2294745481322

Diameter (mm):	Material:	Condition:
0.75	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C10	Outlet	2019 / 09 / 30	-76.5537173772347	64.2295693345174

Diameter (mm):	Material:	Condition:
0.75	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C11

Culvert End: Inlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5537531327633

Latitude: 64.2296620135102

Diameter (mm): 1

Material: CSP

Condition: Damaged

Recommended Action: Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C11	Outlet	2019 / 09 / 30	-76.5537677679103	64.2297283290842

Diameter (mm):	Material:	Condition:
1	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C12	Inlet	2019 / 09 / 30	-76.5531057762145	64.2297534301001

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C12	Outlet	2019 / 09 / 30	-76.5532041846864	64.2297571289516

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C13	Inlet	2019 / 09 / 30	-76.5525082000013	64.2296271009279

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C13	Outlet	2019 / 09 / 30	-76.5527411818065	64.2296728024878

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C14	Inlet	2019 / 09 / 30	-76.5532650382236	64.2279976130671

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C14	Outlet	2019 / 09 / 30	-76.5532933820481	64.2280809763147

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C15	Inlet	2019 / 09 / 30	-76.5522105549306	64.2281106759994

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C15

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.55240943861

Latitude: 64.2281940203172

Diameter (mm): 0.8

Material: CSP

Condition: Functioning as Intended

Recommended Action: Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C16	Inlet	2019 / 09 / 30	-76.5511238168899	64.2287946363318

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C16	Outlet	2019 / 09 / 30	-76.5513652344096	64.2289138066815

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C17

Culvert End: Inlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5490701320356

Latitude: 64.2285942867756

Diameter (mm): 0.6

Material: CSP

Condition: Damaged

Recommended Action: Repair

Notes: Lower Inlet

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C17	Outlet	2019 / 09 / 30	-76.5493028643832	64.2285530148464

Diameter (mm):	Material:	Condition:
0.6	CSP	Damaged

Recommended Action:
Repair

Notes:
Lower Inlet

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C18	Inlet	2019 / 09 / 30	-76.5503009323637	64.2296636555197

Diameter (mm):	Material:	Condition:
0.3	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C18	Outlet	2019 / 09 / 30	-76.5506786592153	64.2296282988816

Diameter (mm):	Material:	Condition:
0.3	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C19	Inlet	2019 / 09 / 30	-76.5418285452505	64.2303119275795

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C19	Outlet	2019 / 09 / 30	-76.5421781263784	64.2303585558443

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C20

Culvert End: Inlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5418063572482

Latitude: 64.2296787847021

Diameter (mm): 0.45

Material: CSP

Condition: Partially Blocked

Recommended Action: Repair

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C20	Outlet	2019 / 09 / 30	-76.5418198003685	64.2297242228357

Diameter (mm):	Material:	Condition:
0.45	CSP	Partially Blocked

Recommended Action:
Repair

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C21	Inlet	2019 / 09 / 30	-76.5478189216653	64.2277766154014

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C21	Outlet	2019 / 09 / 30	-76.5480511347996	64.2279099398695

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C22	Inlet	2019 / 09 / 30	-76.5470585609851	64.2270952873197

Diameter (mm):	Material:	Condition:
0.45	CSP	Blocked or Buried

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C22	Outlet	2019 / 09 / 30	-76.5473271855059	64.2273336310751

Diameter (mm):	Material:	Condition:
0.45	CSP	Blocked or Buried

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C23

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5470274267072

Latitude: 64.2268506228195

Diameter (mm): 0.3

Material: Steel

Condition: Blocked or Buried

Recommended Action: Replace

Notes:

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C24	Inlet	2019 / 09 / 30	-76.5456383694435	64.2262804182995

Diameter (mm):	Material:	Condition:
0.45		Blocked or Buried

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C24	Outlet	2019 / 09 / 30	-76.5456081962044	64.226365252248

Diameter (mm):	Material:	Condition:
0.45		Blocked or Buried

Recommended Action:
Replace

Notes:
Repair Possible

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C25	Inlet	2019 / 09 / 30	-76.5457135339943	64.226219796372

Diameter (mm):	Material:	Condition:
0.45	CSP	Blocked or Buried

Recommended Action:	Notes:
Replace	Repair Possible

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C25

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5460056508313

Latitude: 64.2261369305849

Diameter (mm): 0.45

Material: CSP

Condition: Blocked or Buried

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C26

Culvert End: Inlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5450990464078

Latitude: 64.2256580970341

Diameter (mm): 0.6

Material: CSP

Condition: Damaged

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C26

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5456739978291

Latitude: 64.2256589793405

Diameter (mm): 0.6

Material: CSP

Condition: Damaged

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C27	Inlet	2019 / 09 / 30	-76.545391748349	64.2254408634147

Diameter (mm):	Material:	Condition:
0.4	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C27	Outlet	2019 / 09 / 30	-76.5456739978291	64.2256589793405

Diameter (mm):	Material:	Condition:
0.4	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C28	Inlet	2019 / 09 / 30	-76.5448929435122	64.2250795771142

Diameter (mm):	Material:	Condition:
0.6	CSP	Blocked or Buried

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C28

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5451692031292

Latitude: 64.2252384060561

Diameter (mm): 0.6

Material: CSP

Condition: Blocked or Buried

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C29	Inlet	2019 / 09 / 30	-76.5444555163053	64.225147057605

Diameter (mm):	Material:	Condition:
0.45	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C29	Outlet	2019 / 09 / 30	-76.5448384486838	64.2251092484073

Diameter (mm):	Material:	Condition:
0.45	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C30	Inlet	2019 / 09 / 30	-76.5457644736232	64.2249330093422

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C30

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5458798765925

Latitude: 64.22508423523

Diameter (mm): 0.5

Material: CSP

Condition: Damaged

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C31

Culvert End: Inlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5475502309843

Latitude: 64.2248779731544

Diameter (mm): 0.15

Material: Cast Iron

Condition: Undersized

Recommended Action: Replace

Notes: Lower Inlet

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C31	Outlet	2019 / 09 / 30	-76.5475734177304	64.2250057383904

Diameter (mm):	Material:	Condition:
0.15	Cast Iron	Undersized

Recommended Action:
Replace

Notes:
Lower Inlet

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C32	Inlet	2019 / 09 / 30	-76.5486948055838	64.225071790948

Diameter (mm):	Material:	Condition:
0.9	CSP	Partially Blocked

Recommended Action:
Remove Debris

Notes:


2019 Assessment Photo


2019 Assessment Photo


2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C32	Outlet	2019 / 09 / 30	-76.5484635424976	64.2251917868162

Diameter (mm):	Material:	Condition:
0.9	CSP	Partially Blocked

Recommended Action:
Remove Debris

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C33	Inlet	2019 / 09 / 30	-76.5444973071251	64.2246241324195

Diameter (mm):	Material:	Condition:
0.5	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C33	Outlet	2019 / 09 / 30	-76.5447199393153	64.2246706311878

Diameter (mm):	Material:	Condition:
0.5	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C34	Inlet	2019 / 09 / 30	-76.5386377632058	64.224053810978

Diameter (mm):	Material:	Condition:
0.5	HDPE	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C34

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5386218690836

Latitude: 64.2241750035742

Diameter (mm): 0.5

Material: HDPE

Condition: Functioning as Intended

Recommended Action: Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C35	Inlet	2019 / 09 / 30	-76.5386206758816	64.2247014719517

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C35	Outlet	2019 / 09 / 30	-76.5384903091825	64.2248428636046

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C36	Inlet	2019 / 09 / 30	-76.5392141987061	64.2249772301601

Diameter (mm):	Material:	Condition:
0.7	HDPE	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C36	Outlet	2019 / 09 / 30	-76.5394787183413	64.2250257127317

Diameter (mm):	Material:	Condition:
0.7	HDPE	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C37	Inlet	2019 / 09 / 30	-76.5386357863337	64.2248278194433

Diameter (mm):	Material:	Condition:
0.45	CSP	Not Functioning as Intended

Recommended Action:
Abandon

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C37	Outlet	2019 / 09 / 30	-76.5387099922113	64.2248020624482

Diameter (mm):	Material:	Condition:
0.45	CSP	Not Functioning as Intended

Recommended Action:
Abandon

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C38	Inlet	2019 / 09 / 30	-76.5387571851301	64.2247595630417

Diameter (mm):	Material:	Condition:
0.6	CSP	Not Functioning as Intended

Recommended Action:
Abandon

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C38	Outlet	2019 / 09 / 30	-76.5391936773988	64.2248230623213

Diameter (mm):	Material:	Condition:
0.6	CSP	Not Functioning as Intended

Recommended Action:
Abandon

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C39	Inlet	2019 / 09 / 30	-76.5397236316525	64.2248787583516

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C39	Outlet	2019 / 09 / 30	-76.5398231255599	64.2250971216862

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C40	Inlet	2019 / 09 / 30	-76.5408829722822	64.2246678470077

Diameter (mm):	Material:	Condition:
0.45	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C40

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5408911373425

Latitude: 64.2247676551304

Diameter (mm): 0.45

Material: CSP

Condition: Functioning as Intended

Recommended Action: Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C41	Inlet	2019 / 09 / 30	-76.5429444900063	64.2253884153788

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C41	Outlet	2019 / 09 / 30	-76.5426065602273	64.2256428649068

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C42	Inlet	2019 / 09 / 30	-76.542933441951	64.225564481527

Diameter (mm):	Material:	Condition:
0.1	Cast Iron	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C42	Outlet	2019 / 09 / 30	-76.5427198870863	64.2257574501182

Diameter (mm):	Material:	Condition:
0.1	Cast Iron	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C43	Inlet	2019 / 09 / 30	-76.5407591440864	64.2266827434687

Diameter (mm):	Material:	Condition:
0.9	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C43	Outlet	2019 / 09 / 30	-76.5406685778042	64.2267832332295

Diameter (mm):	Material:	Condition:
0.9	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C44	Inlet	2019 / 09 / 30	-76.5418774191477	64.2260895558922

Diameter (mm):	Material:	Condition:
0.3	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C44	Outlet	2019 / 09 / 30	-76.5417120401728	64.2261998862281

Diameter (mm):	Material:	Condition:
0.3	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C45	Inlet	2019 / 09 / 30	-76.5394627115929	64.2255940103529

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked

Recommended Action:
Remove Debris

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C45

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5393703912738

Latitude: 64.2257980159152

Diameter (mm): 0.6

Material: CSP

Condition: Partially Blocked

Recommended Action: Remove Debris

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C46	Inlet	2019 / 09 / 30	-76.5396336232532	64.2273002465995

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Relocate

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C46	Outlet	2019 / 09 / 30	-76.5396395900283	64.2274074873719

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Relocate

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C47	Inlet	2019 / 09 / 30	-76.5405337103428	64.2271546470356

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C47	Outlet	2019 / 09 / 30	-76.540622969206	64.2275477660259

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C48	Inlet	2019 / 09 / 30	-76.5408645256712	64.2272090158123

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C48	Outlet	2019 / 09 / 30	-76.5408287821584	64.2272777097824

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C49	Inlet	2019 / 09 / 30	-76.5406514219989	64.2278899820989

Diameter (mm):	Material:	Condition:
0.6	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C49	Outlet	2019 / 09 / 30	-76.5407588085589	64.2289746775105

Diameter (mm):	Material:	Condition:
0.6	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C50	Inlet	2019 / 09 / 30	-76.5367833433579	64.2302219254001

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C50

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5367816407262

Latitude: 64.2303135908816

Diameter (mm): 0.6

Material: CSP

Condition: Partially Blocked and Damaged

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C51	Inlet	2019 / 09 / 30	-76.5335726634146	64.2296365473393

Diameter (mm):	Material:	Condition:
0.75	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C51	Outlet	2019 / 09 / 30	-76.5335837380045	64.2298757273103

Diameter (mm):	Material:	Condition:
0.75	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C52	Inlet	2019 / 09 / 30	-76.5353846500491	64.231082801222

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C53	Inlet	2019 / 09 / 30	-76.5361283121296	64.231095730565

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C53	Outlet	2019 / 09 / 30	-76.5360547565031	64.2310680184112

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C53

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5364504885925

Latitude: 64.2311597541026

Diameter (mm): 0.8

Material: CSP

Condition: Functioning as Intended

Recommended Action: Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C54	Inlet	2019 / 09 / 30	-76.537434491496	64.2308309471523

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C54	Outlet	2019 / 09 / 30	-76.5374306710921	64.2309689915187

Diameter (mm):	Material:	Condition:
0.45	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C55	Inlet	2019 / 09 / 30	-76.5379918166786	64.231225281847

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C55	Outlet	2019 / 09 / 30	-76.5381829720495	64.2313114495687

Diameter (mm):	Material:	Condition:
0.8	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C56	Inlet	2019 / 09 / 30	-76.5422486302305	64.2316625485645

Diameter (mm):	Material:	Condition:
0.1	CSP	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C56	Outlet	2019 / 09 / 30	-76.5424610843419	64.2317153757618

Diameter (mm):	Material:	Condition:
0.1	CSP	Blocked or Buried

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C57	Inlet	2019 / 09 / 30	-76.5430763337111	64.2318294589256

Diameter (mm):	Material:	Condition:
0.15	Cast Iron	Partially Blocked

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C57	Outlet	2019 / 09 / 30	-76.5432140826548	64.2317558309365

Diameter (mm):	Material:	Condition:
0.15	Cast Iron	Partially Blocked

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C58	Inlet	2019 / 09 / 30	-76.5437864848644	64.2317668594457

Diameter (mm):	Material:	Condition:
0.45	CSP	Blocked or Buried

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C58

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5442412760572

Latitude: 64.2317430478511

Diameter (mm): 0.45

Material: CSP

Condition: Blocked or Buried

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C59

Culvert End: Inlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5449224851019

Latitude: 64.231670304057

Diameter (mm): 0.8

Material: CSP

Condition: Partially Blocked and Damaged

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C59	Outlet	2019 / 09 / 30	-76.545212918027	64.2317906710493

Diameter (mm):	Material:	Condition:
0.8	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C60	Inlet	2019 / 09 / 30	-76.5423503005811	64.2326873317021

Diameter (mm):	Material:	Condition:
0.8	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C60	Outlet	2019 / 09 / 30	-76.5424998403821	64.2328099299468

Diameter (mm):	Material:	Condition:
0.8	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C61	Inlet	2019 / 09 / 30	-76.5408238687631	64.232307904639

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C61	Outlet	2019 / 09 / 30	-76.5408941596051	64.232330195324

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C62	Inlet	2019 / 09 / 30	-76.5395658477686	64.2318705458612

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Replace

Notes:


2019 Assessment Photo


2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C62	Outlet	2019 / 09 / 30	-76.5397889403811	64.2319503083619

Diameter (mm):	Material:	Condition:
0.5	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C63	Inlet	2019 / 09 / 30	-76.5344365392842	64.2354550809694

Diameter (mm):	Material:	Condition:
0.6	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C63

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5347970234363

Latitude: 64.2354977445595

Diameter (mm): 0.6

Material: CSP

Condition: Functioning as Intended

Recommended Action: Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C64	Inlet	2019 / 09 / 30	-76.5349679673092	64.2355131059737

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C64

Culvert End: Outlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5350024872659

Latitude: 64.2356238442465

Diameter (mm): 0.6

Material: CSP

Condition: Partially Blocked and Damaged

Recommended Action: Replace

Notes: Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C65	Inlet	2019 / 09 / 30	-76.5363600537086	64.2375875309028

Diameter (mm):	Material:	Condition:
0.4	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C65	Outlet	2019 / 09 / 30	-76.5364330347334	64.2375259876839

Diameter (mm):	Material:	Condition:
0.4	CSP	Functioning as Intended

Recommended Action:
Functioning as Intended

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C66	Inlet	2019 / 09 / 30	-76.5365039192628	64.2375052988748

Diameter (mm):	Material:	Condition:
0.4	Steel	Partially Blocked

Recommended Action:
Remove Debris

Notes:

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C66	Outlet	2019 / 09 / 30	-76.5366968854627	64.2374424902699

Diameter (mm):	Material:	Condition:
0.4	Steel	Partially Blocked

Recommended Action:
Remove Debris

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C67	Inlet	2019 / 09 / 30	-76.5362818298527	64.2373974881943

Diameter (mm):	Material:	Condition:
0.4	Steel	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C67	Outlet	2019 / 09 / 30	-76.5364307756363	64.2373674300833

Diameter (mm):	Material:	Condition:
0.4	Steel	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C68	Inlet	2019 / 09 / 30	-76.5366011019274	64.2372507337182

Diameter (mm):	Material:	Condition:
0.8	CSP	Partially Blocked

Recommended Action:
Repair

Notes:
Remove debris if repair not necessary

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C68	Outlet	2019 / 09 / 30	-76.5367473840739	64.237329906151

Diameter (mm):	Material:	Condition:
0.8	CSP	Partially Blocked

Recommended Action:
Repair

Notes:
Remove debris if repair not necessary

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C69	Inlet	2019 / 09 / 30	-76.5369839816645	64.2368345737483

Diameter (mm):	Material:	Condition:
0.4	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C69	Outlet	2019 / 09 / 30	-76.5371417168348	64.236884187696

Diameter (mm):	Material:	Condition:
0.4	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert: C70

Culvert End: Inlet

Date Assessed: 2019 / 09 / 30

Longitude: -76.5372527440494

Latitude: 64.236918151226

Diameter (mm): 0.4

Material: CSP

Condition: Damaged

Recommended Action: Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C70	Outlet	2019 / 09 / 30	-76.5373863252078	64.2369651709682

Diameter (mm):	Material:	Condition:
0.4	CSP	Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C71	Inlet	2019 / 09 / 30	-76.5376695166155	64.237033402024

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C71	Outlet	2019 / 09 / 30	-76.5376835873545	64.2372079780496

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C72	Inlet	2019 / 09 / 30	-76.5370790795008	64.2363332458419

Diameter (mm):	Material:	Condition:
0.6	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C72	Outlet	2019 / 09 / 30	-76.5367700689214	64.2366950045037

Diameter (mm):	Material:	Condition:
0.6	CSP	Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C73	Inlet	2019 / 09 / 30	-76.5382805884701	64.2353177245503

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C73	Outlet	2019 / 09 / 30	-76.5380886184246	64.2353688710901

Diameter (mm):	Material:	Condition:
0.6	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:
Repair Possible

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C74	Inlet	2019 / 10 / 01	-76.5428098562878	64.2337039262407

Diameter (mm):	Material:	Condition:
0.7	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C74	Outlet	2019 / 10 / 01	-76.542957610808	64.2337314790165

Diameter (mm):	Material:	Condition:
0.7	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C75	Inlet	2019 / 10 / 01	-76.5405502231128	64.2334562527827

Diameter (mm):	Material:	Condition:
0.3	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C75	Outlet	2019 / 10 / 01	-76.5408278101263	64.2335026961848

Diameter (mm):	Material:	Condition:
0.3	CSP	Partially Blocked and Damaged

Recommended Action:
Replace

Notes:

2019 Assessment Photo

2019 Assessment Photo

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C76	Inlet	2019 / 10 / 01	-76.5433980439732	64.2307501634724

Diameter (mm):	Material:	Condition:
0.8	CSP	Partially Blocked and Damaged

Recommended Action:
Repair

Notes:

2019 Assessment Photo

2019 Assessment Photo

2019 Assessment Photo

TETRA TECH

Inventory of Existing Culverts

Cape Dorset Master Drainage Plan

Culvert:	Culvert End:	Date Assessed:	Longitude:	Latitude:
C76	Outlet	2019 / 10 / 01	-76.5443321679053	64.2313774410059

Diameter (mm):	Material:	Condition:
0.8	CSP	Partially Blocked and Damaged

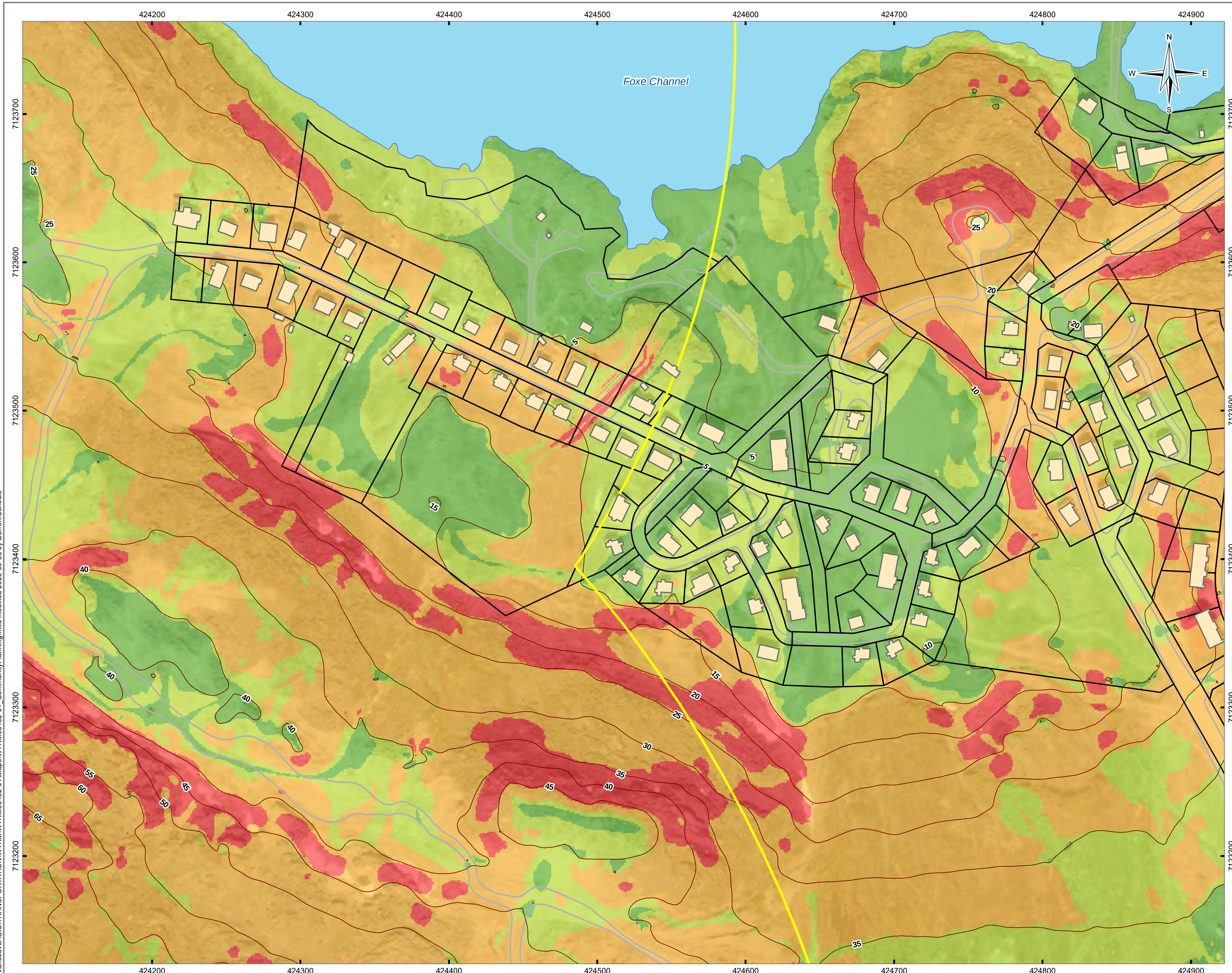
Recommended Action:
Repair

Notes:

2019 Assessment Photo

APPENDIX F

COMMUNITY PLANS AND BYLAW NO. 168

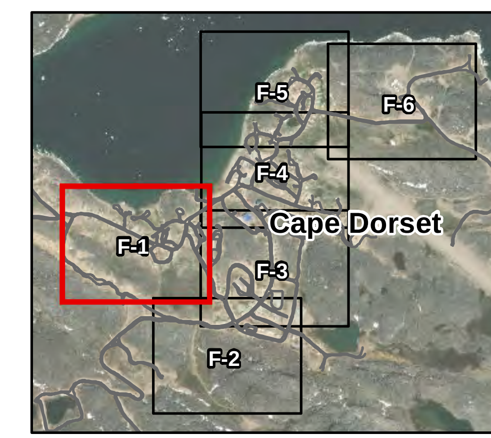


LEGEND

Percent Slope
- 0% - 5%
- 5% - 10%
- 10% - 25%
- 25%+

Site Feature
- Waste and Sewage 450 m Setback

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50

Meters

FILE NO.
WTRM03182-01_CommunityPlanning.mxd

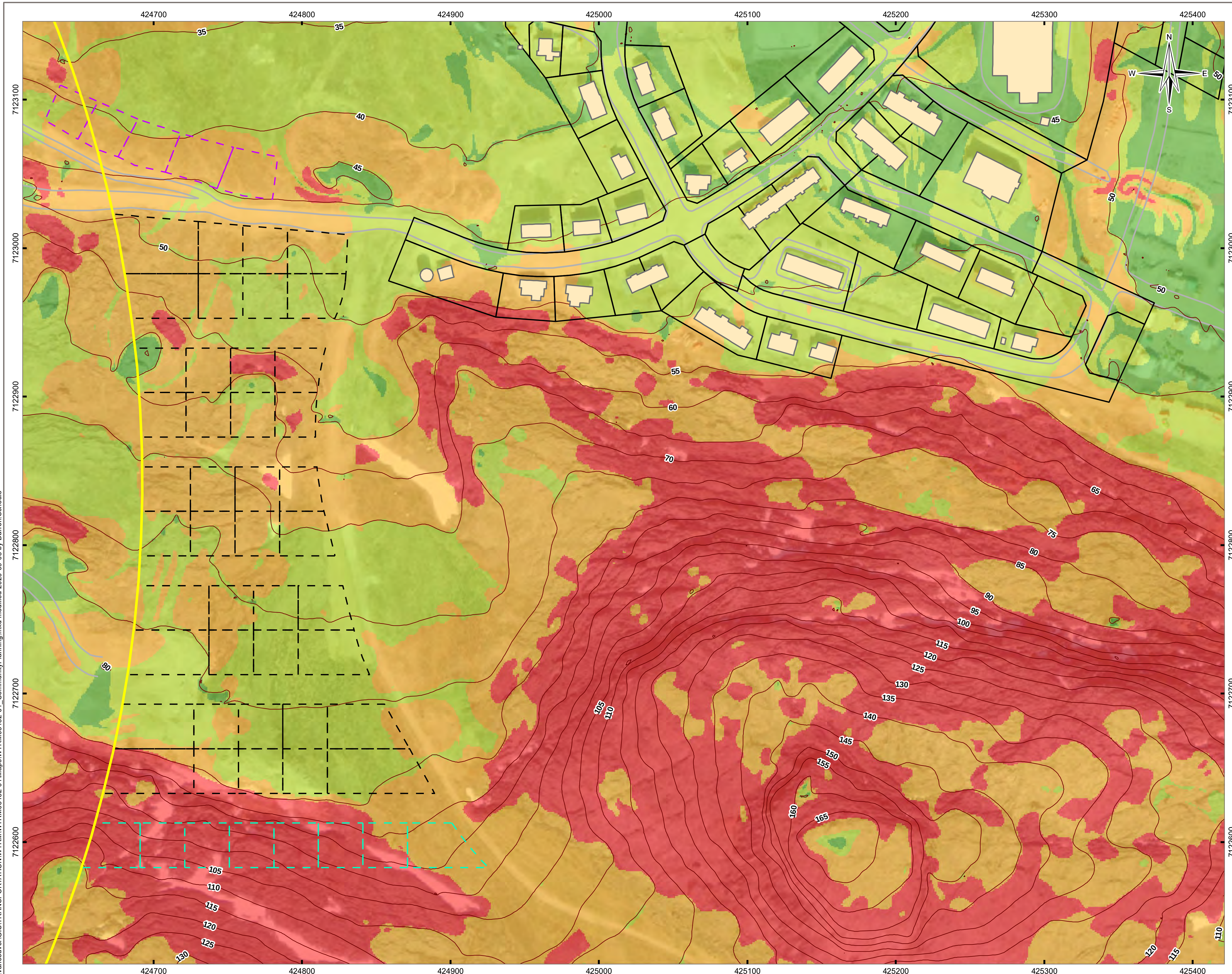
TETRA TECH

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure F-1

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_CommunityPlanning.mxd modified 2020-09-08 by Darren.Schouls



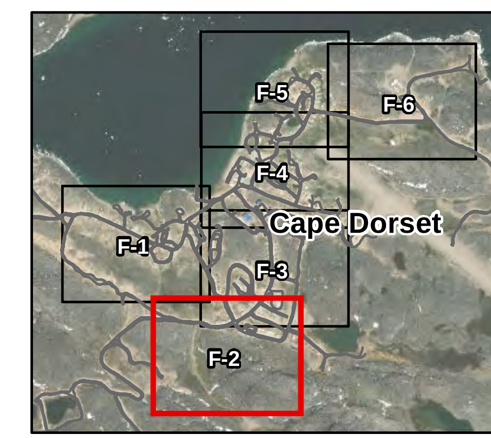
Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_CommunityPlanning.mxd modified 2020-09-08 by Darren.Schouls

LEGEND

Percent Slope
- 0% - 5%
- 5% - 10%
- 10% - 25%
- 25%+

Site Feature
- Waste and Sewage 450 m Setback

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

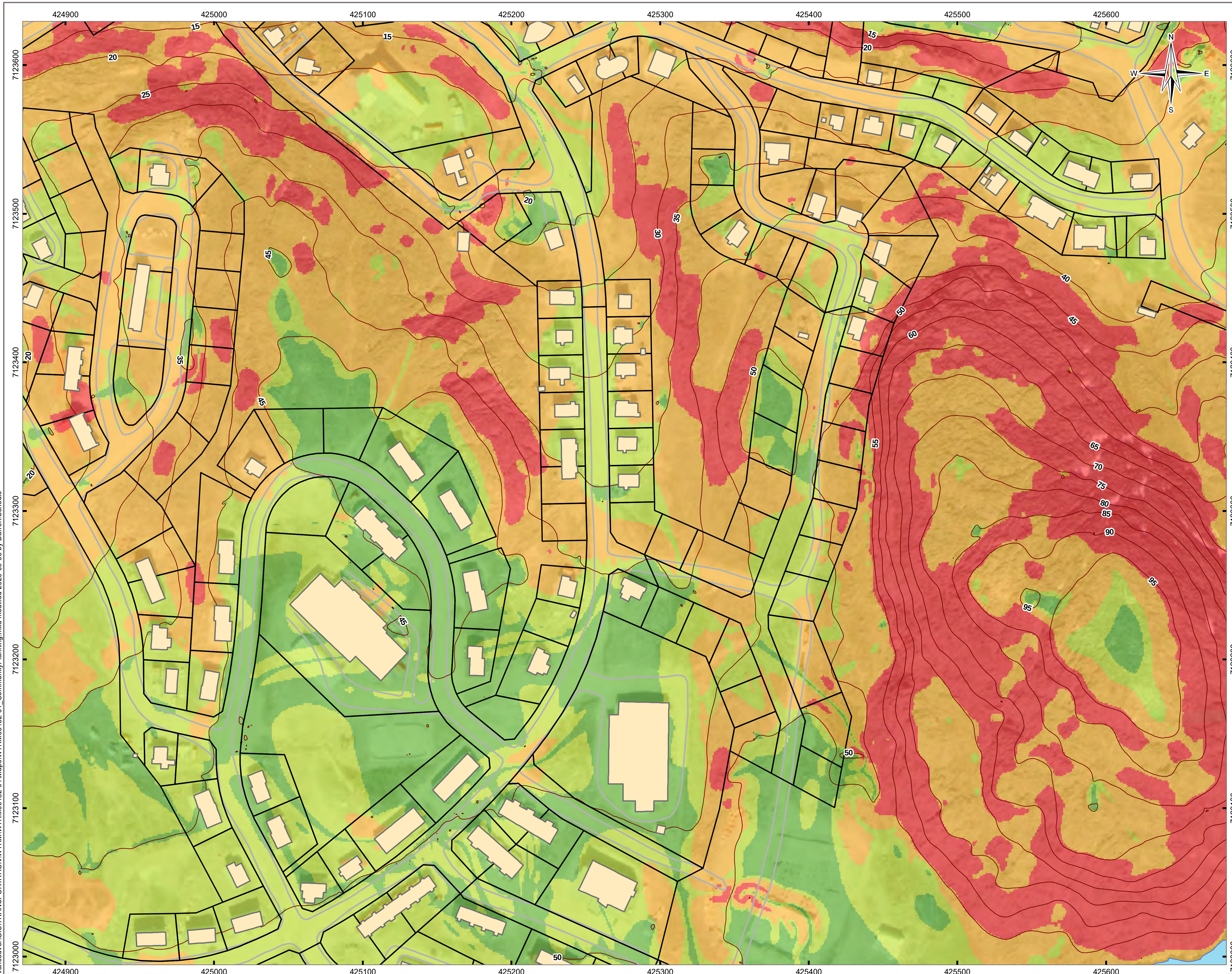
FILE NO.
WTRM03182-01_CommunityPlanning.mxd

TETRA TECH

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

DATE	PROJECT NO.
September 8, 2020	TRN.WTRI03002-01

Figure F-2



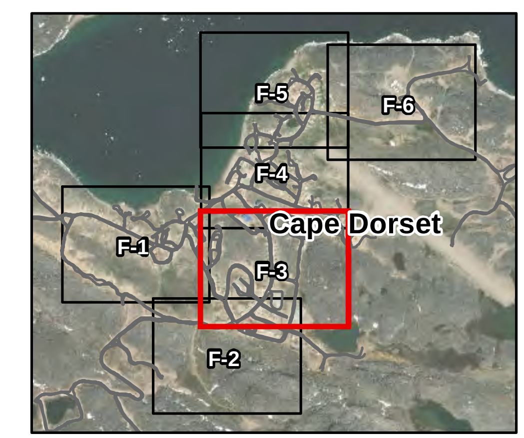
LEGEND

Percent Slope

- 0% - 5%
- 5% - 10%
- 10% - 25%
- 25%+

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50

Meters

FILE NO.
WTRM03182-01_CommunityPlanning.mxd

TETRA TECH

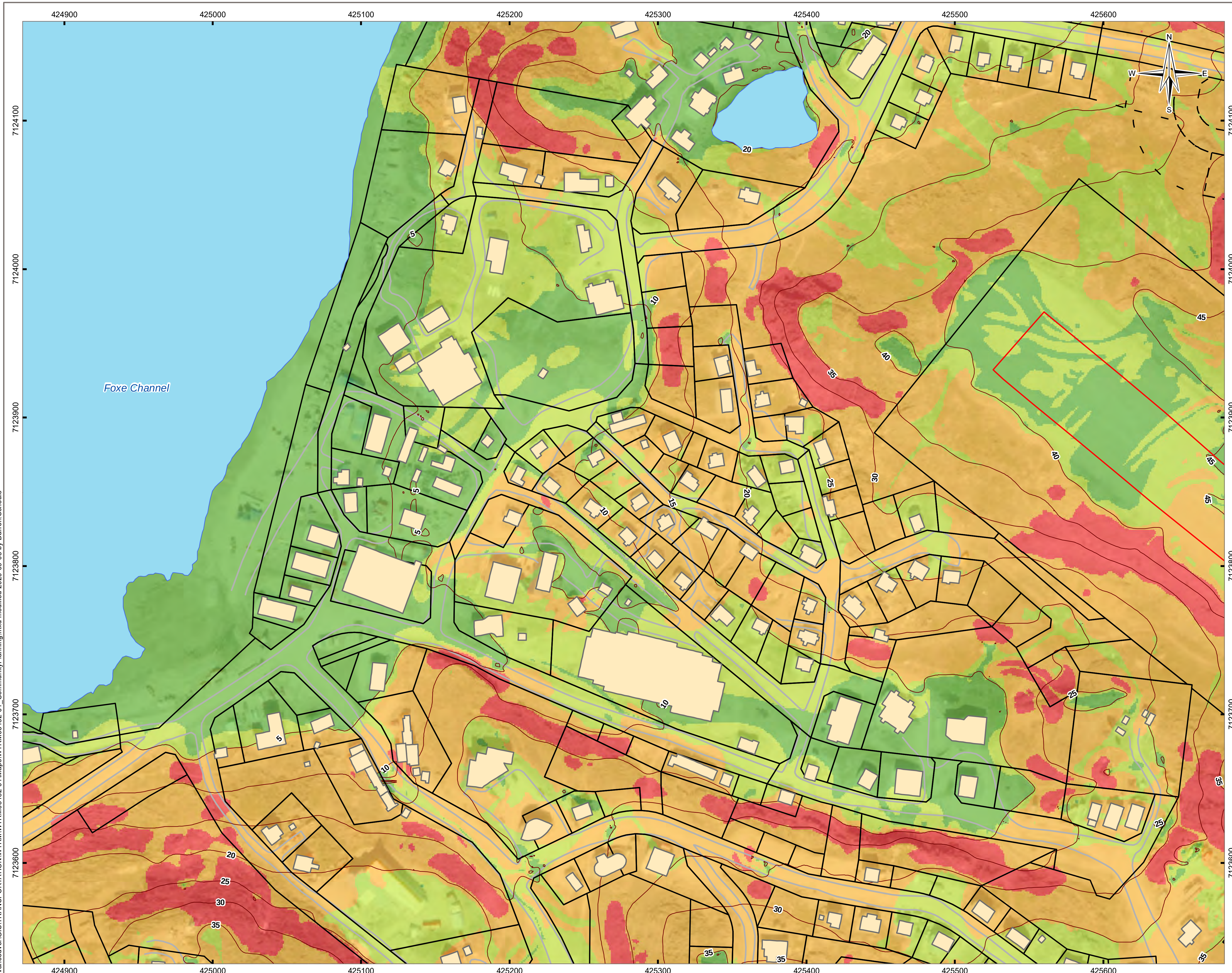
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0

DATE
September 8, 2020

PROJECT NO.
TRN.WTRI03002-01

Figure F-3

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_CommunityPlanning.mxd modified 2020-09-08 by Darren.Schouls



LEGEND

Percent Slope

- 0% - 5%
- 5% - 10%
- 10% - 25%
- 25%+

Base Data

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

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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500
50 25 0 50
Meters

FILE NO.
WTRM03182-01_CommunityPlanning.mxd

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

DATE: September 8, 2020
PROJECT NO.: TRN.WTRI03002-01

TETRA TECH

Figure F-4

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_CommunityPlanning.mxd modified 2020-09-08 by Darren.Schouls

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_CommunityPlanning.mxd modified 2020-09-08 by Darren.Schouls

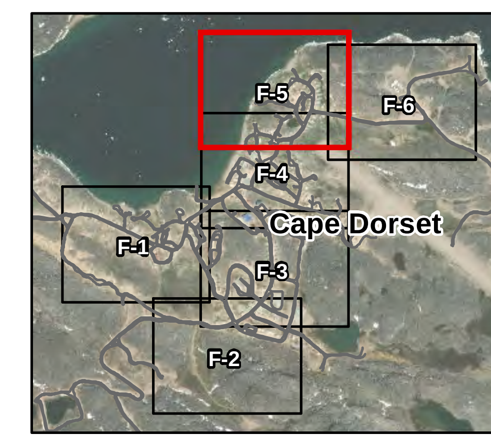
LEGEND

Percent Slope

- 0% - 5%
- 5% - 10%
- 10% - 25%
- 25%+

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

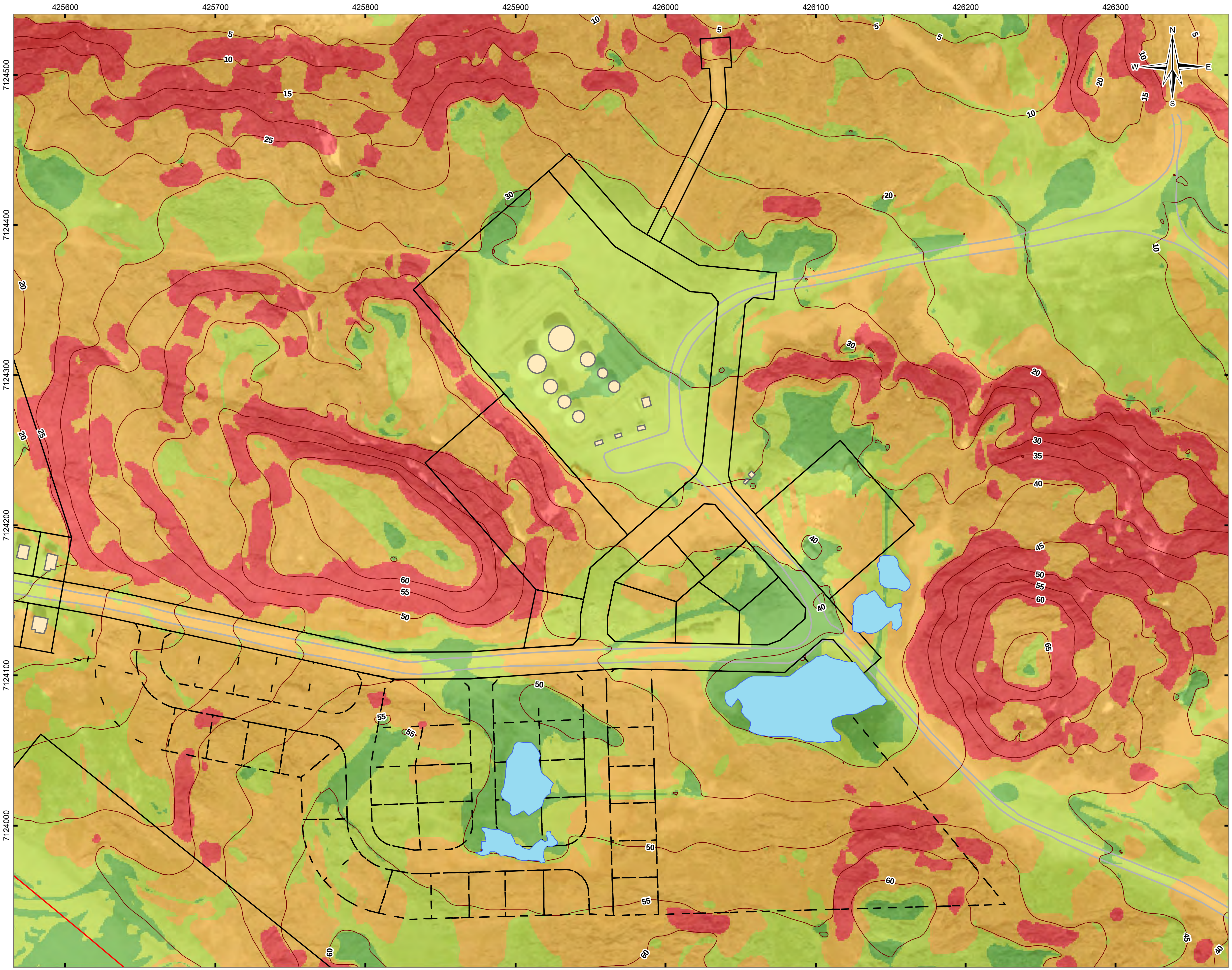
Scale: 1:2,500

50 25 0 50
Meters

TETRA TECH

FILE NO.				
WTRM03182-01_CommunityPlanning.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0
DATE	PROJECT NO.			
September 8, 2020	TRN.WTRI03002-01			

Figure F-5



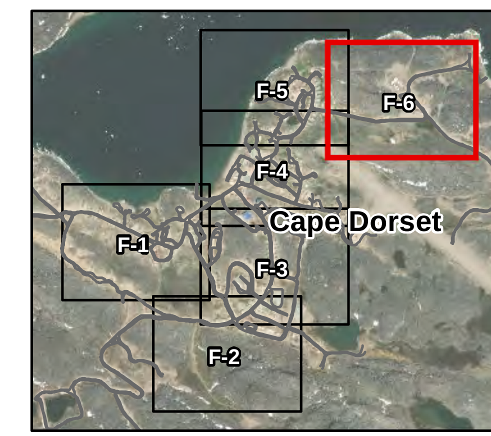
LEGEND

Percent Slope

- 0% - 5%
- 5% - 10%
- 10% - 25%
- 25%+

Base Data

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



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

STATUS
ISSUED FOR REVIEW

CAPE DORSET DRAINAGE PLANNING

Revised Community Planning Map

PROJECTION	DATUM	CLIENT
UTM Zone 18	NAD83	Nunavut

Scale: 1:2,500

50 25 0 50

Meters

FILE NO.				
WTRM03182-01_CommunityPlanning.mxd				
OFFICE	DWN	CKD	APVD	REV
Tt-VANC	DS	SL	ER	0
DATE	PROJECT NO.			
September 8, 2020	TRN.WTRI03002-01			

TETRA TECH

Figure F-6

Q:\Vancouver\GIS\TRANSPORTATION\WTRM\WTRM03182-01\Maps\WTRM03182-01_CommunityPlanning.mxd modified 2020-09-08 by Darren.Schouls

CAPE DORSET COMMUNITY PLAN AND ZONING BY-LAW

SCHEDULE 1 - COMMUNITY PLAN

SECTION 1. INTRODUCTION

1.1 Purpose of the Plan

The purpose of the Cape Dorset Community Plan is to outline Council's policies for managing the physical development of the Hamlet for the next 20 years - to 2033. The Community Plan was created through a community consultation process and reflects the needs and desires of the Community. The Community Plan builds on previous plans, while incorporating new challenges, issues and needs identified by the Community.

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 established for this Community Plan are:

1. To develop in an orderly fashion creating a safe, healthy, functional, and attractive community that reflects community values and culture.
2. To promote the Plan as a tool for making effective and consistent decisions regarding land use and development in the community.
3. To ensure an adequate supply of land for all types of uses to support the growth and change of the community.
4. To build upon community values of participation and unity to support community projects and local economic development.
5. To protect the natural beauty of "Nuna", protect viewpoints to the water, and retain waterfront and lakeshore areas for public uses and traditional activities.

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-laws 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 is also being enacted for the purpose of implementing detailed policies based on the Community Plan. All development must follow the intent of the Community Plan and Zoning By-law. The Community Plan includes Schedule 1 (Plan Policy Text), Schedule 2 (Community Plan and Zoning Map) and Schedule 3 (General Land Use Map).

SECTION 2. COMMUNITY GROWTH AND PHASING POLICIES

At the time of preparation of this Plan, the population of Cape Dorset was approximately 1,397 people. This Plan is based on a future population of 1,791 people by 2033. It is estimated that an additional 240 dwelling units will be required to meet the projected population growth, representing the need for approximately 13 hectares of land for residential development. In addition, an appropriate mix and range of industrial, commercial, and community uses has been proposed to meet long-term needs . The policies of Council are:

a) Plan for a 2033 population of 1,791.
b) Identify sufficient land on the Community Plan to meet the needs of the projected 2033 population.
c) Review the Community Plan in 5 years, in 2018, to re-assess actual rates of growth and community needs.
d) Council will generally phase new land development as follows:
   i.) 2013 - 2018:
   - Build on existing vacant lots within the built-up area.
   - Develop Phase 1 and 2, residential subdivision.
   - Develop lots in the industrial west subdivision.

   ii.) 2018 - 2023
   - Develop Phase 3 residential subdivision.
   - Develop new barge landing, dock and sealift area.

   iii.) 2023 - 2033
   - Develop Phase 4 area.

e) Council may change the phasing of development without amendment to this Plan.

SECTION 3. GENERAL POLICIES

The following policies of Council apply to all development in the Hamlet regardless of land use designation:

a) The development of lots shall be subject to the following lot development policies:
   i.) All service connections to buildings shall be easily accessed from the front yard on all lots and grouped together, where possible.
   ii.) Access to new buildings will avoid, where possible, main entrances on the south-southeast side to reduce problems associated with snow drifting.
   iii.) Buildings shall be sited to respect setbacks identified on the Zoning Chart.
   iv.) Any building over 500 m2 in gross floor area shall consider potential wind impacts on surrounding development. A wind study may be required by the Development Officer.
   v.) Culverts are required and shall be installed at the access points to lots.
   vi.) On any portion of a lot where fill is introduced, drainage shall be directed towards the public road. Exceptions may be made by the Development Officer. Where possible, drainage troughs shall not be located in Utility Rights-of-Way or Easements.
   vii.) 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) Utilities or communication facilities shall be permitted in any land use designation. Other than designated Rights-of-Way or Easements for Utility or Communication lines, Easements alongside roadways, marked between the edge of the roadway and lot lines, will be used for distribution lines, with a minimum clearance, as specified in the Utility Corporation's Joint Use Agreement.
c) The Hamlet will pile snow in locations to minimize downwind snow drifting and where spring melt run-off can be properly channeled to drainage ditches or waterbodies.
d) The Hamlet will avoid piling snow within at least 30.5 metres (100 feet) of any watercourse.
e) A minimum setback distance of 30.5 metres (100 feet) shall be maintained, except subject to terms and conditions of the Hamlet Council.
f) The Hamlet shall protect any cemeteries and sites of archaeological, ethnographical or historical significance from disturbance.
g) The Hamlet shall encourage development that minimizes emissions from fossil fuels, that are energy efficient and that consider alternative energy supply technology.
h) The Hamlet shall work with the Nunavut Planning Commission to ensure that the Cape Dorset Community Plan and the future Baffin Regional Land Use Plan are compatible.

SECTION 4. LAND USE DESIGNATION

4.1 Residential

The Residential designation provides land for primarily residential uses, but also permits other small-scale conditional uses subject to the approval of Council. The policies of Council are intended to maintain an adequate supply of land for residential development, to build safe and livable neighbourhoods and to protect residential areas from incompatible development. The policies of Council are:

a) The Residential designation will be used primarily for housing with all types of dwelling types permitted. Other related residential uses such as a group home, a home occupation, or bed and breakfast will also be permitted.
b) Residential development will be phased so that a target minimum of 2 hectares of vacant surveyed land is available at any given time.

4.2 Community Core

The Community Core designation defines the core area of the community which provides a focal point for community amenities, cultural activities, and tourism. Given the important role the Community Core plays in defining community and cultural identity, specific policies are adopted for this area. Policies are aimed at maintaining the community uses and a mix of service commercial and tourism related uses, allowing limited types of residential uses, improving the character of development, increasing pedestrian safety and beautifying the streetscape. The policies of Council are:

a) The Community Core designation will permit all uses permitted in the Community Use designation and retail commercial and tourism or visitor-related uses. Residential uses will be conditionally permitted by Council and only multi-unit dwellings or dwelling units in non-residential buildings above the ground floor will be permitted.
b) Council may adopt a Downtown Beautification Plan which provides more details on the character of development in the Community Core and provides an action and phasing plan for improvements such as walkways, street lighting, paving, road widenings, signage, public art, as outlined in the Plan.
c) Council will support development of the proposed Arts & Heritage Centre.
d) Council shall seek opportunities and encourage the relocation of industrial uses (i.e. garages, power plant, etc.) and low density residential uses outside the Community Core over time by considering land swaps and/or other incentives.
e) Front yard parking will not be permitted for any new development of a significant size in the Community Core. Parking will be provided at the side or rear of the building. Parking spaces that require vehicles to back-out onto the municipal road will also not be permitted.
f) Give priority for the development of a defined walkway as shown on the Community Land Use Map. Monetary contributions for the construction of the walkway may be requested as a condition of development approval.
g) Council will ensure that as part of the relocation of the power plant that appropriate site remediation is completed in order for the area to be re-developed with a new community hall.
h) Council will consider re-locating the Hamlet office either in a new community hall or elsewhere in the Core to provide lands for an expansion to the Health Centre.

4.3 Community Use

The Community Use designation is intended to maintain an adequate supply of land for community uses, to provide easy access to public facilities and services, and to reserve significant and important locations for community uses. The policies of Council are:

a) The Community Use designation will be used primarily for public uses (i.e. social, cultural, religious, or educational) and government services.
b) Community facilities will be centrally located to ensure safe and convenient access by residents.

4.4 Commercial

The Commercial designation is intended to support local economic development by maintaining an adequate supply of land for commercial uses in a central location with good access from the community. The policies of Council are:

a) The Commercial designation will be used for commercial uses such as hotels, restaurants, retail, personal and business services, and offices.
b) Residential uses shall be permitted when located above a ground floor commercial use.
c) Commercial facilities will be located along main roads, where possible, to provide safe and convenient access by residents.
d) Council will encourage the re-use or redevelopment of existing commercial sites within the existing townsite.

4.5 Open Space

The Open Space designation is intended to protect shoreline environments, maintain access to the sea and to reserve open spaces within the built up area for recreational uses and cultural events. The policies of Council are:

a) The Open Space designation will be used primarily for parks, walking trails, traditional and recreational uses such as beach shacks, harbour uses, boat storage, dog teams, community docks, temporary storage of sealift materials and equipment during sealift operations, and municipal infrastructure such as a water pump house. All uses are conditional and at the discretion of Council.
b) Owners of development will be required to maintain the development and keep the surrounding area tidy.
c) A playground should be located within 300 metre walking distance from any residence in the community.
d) Unless otherwise noted, all Commissioner's Land forming part of the 100-foot strip (30.5 m) along the seashore measured from the ordinary high water mark will be designated Open Space.
e) No development is generally permitted within 30 metres from the normal high water mark of any river or major creek. Council may consider the filling of a waterbody where it is needed for future development provided that the appropriate approvals are obtained.
f) Council will support development of a new community dock adjacent the Core area.
g) Open Space corridors will be protected for trail connections and drainage channels.

4.6 Industrial

The Industrial designation is intended to reduce the negative effects and dangers associated with industrial uses such as noise, dust, odours, truck travel and the storage of potentially hazardous substances by concentrating these uses on the periphery of the townsite. The policies of Council are:

a) Permitted uses in the Industrial designation will include all forms of manufacturing, processing, warehousing and storage uses. Permitted uses will also include garages, power generation plants, and fuel storage.
b) Council will develop a new industrial subdivision near the old landfill site to minimize land use conflicts and to reserve land closer to the townsite for residential and community uses. Council will work with local businesses and government operations to identify opportunities to relocate over time non-conforming industrial uses (eg. garages, warehouses, power plant) to industrial areas.
c) Council will support the development of a new power plant near the tank farm.

4.7 Transportation

The Transportation designation is intended to protect and ensure the safe operation of airport and related activities such as the NavCanada communications site. The policies of Council are:

a) Permitted uses in the Transportation designation includes all activities related to air traffic and uses accessory to these activities such as related commercial activities and communications sites.
b) All development within the 4km boundary of the airport, as shown on Schedule 3, shall comply with the Cape Dorset Airport Zoning Regulations. 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.
c) All development within the Transportation Influence Zone of the communications facility is subject to the approval of NavCanada.
d) Council will discourage the use of travelled pathways that are not identified as public right-of-ways.

4.8 Hinterland

The Hinterland 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 - 'Nuna' - while providing access for traditional, recreational and tourism activities, as well as quarrying. The policies of Council are:

a) The Hinterland designation generally permits traditional, tourism and passive recreational uses. Permitted uses also include dog teams, quarrying, and infrastructure projects for local economic development.
b) Council shall ensure that development does not negatively impact wildlife, wildlife habitat and harvesting and is consistent with the guiding principles of Inuit Qaujimajatuqangit.

4.9 Waste Disposal

The Waste Disposal designation is intended to identify existing or former waste disposal sites and ensure required development setbacks. The policies of Council are:

a) The Waste Disposal designation permits no development except those uses accessory to the operation or remediation of a waste disposal site.
b) 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, pursuant to the *General Sanitation Regulations* of the Public Health Act.
c) The Hamlet shall prohibit the development of any public road allowance or cemetery within a 90 metre setback from a waste disposal ground, pursuant to the General Sanitation Regulation of the *Public Health Act*.
d) The Hamlet will work with appropriate levels of government to resolve issues with the new sewage lagoon in order for it to be approvable.
e) The Hamlet will evaluate all possible options for an integrated waste management system, including:
   a. the suitability of the existing landfill site for long-term use;
   b. the use of an incinerator;
   c. metal recovery projects; and
   d. complementary strategies, such as source reduction, reuse, and recycling of waste materials.

4.10 Granular Resources

The Granular Resources designation is intended to protect aggregate deposits for future extraction. The policies of Council are:

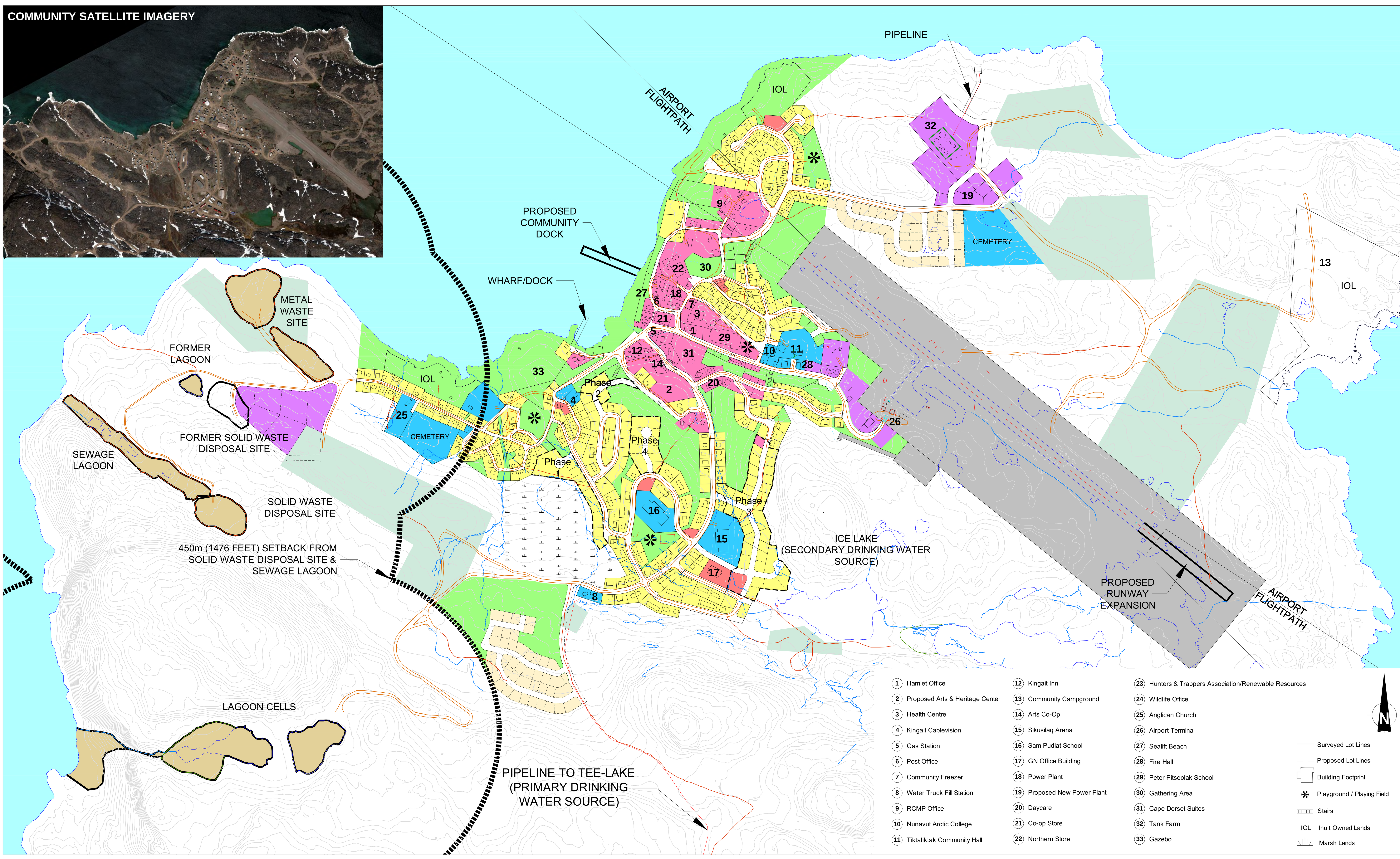
a) The Granular Resources designation does not permit any development except uses accessory to the operation or remediation of a quarry or gravel pit.
b) Council shall ensure that lands subject to Quarry Permit No. QB10-002 are designated for quarry purposes only.

4.11 Municipal Reserve

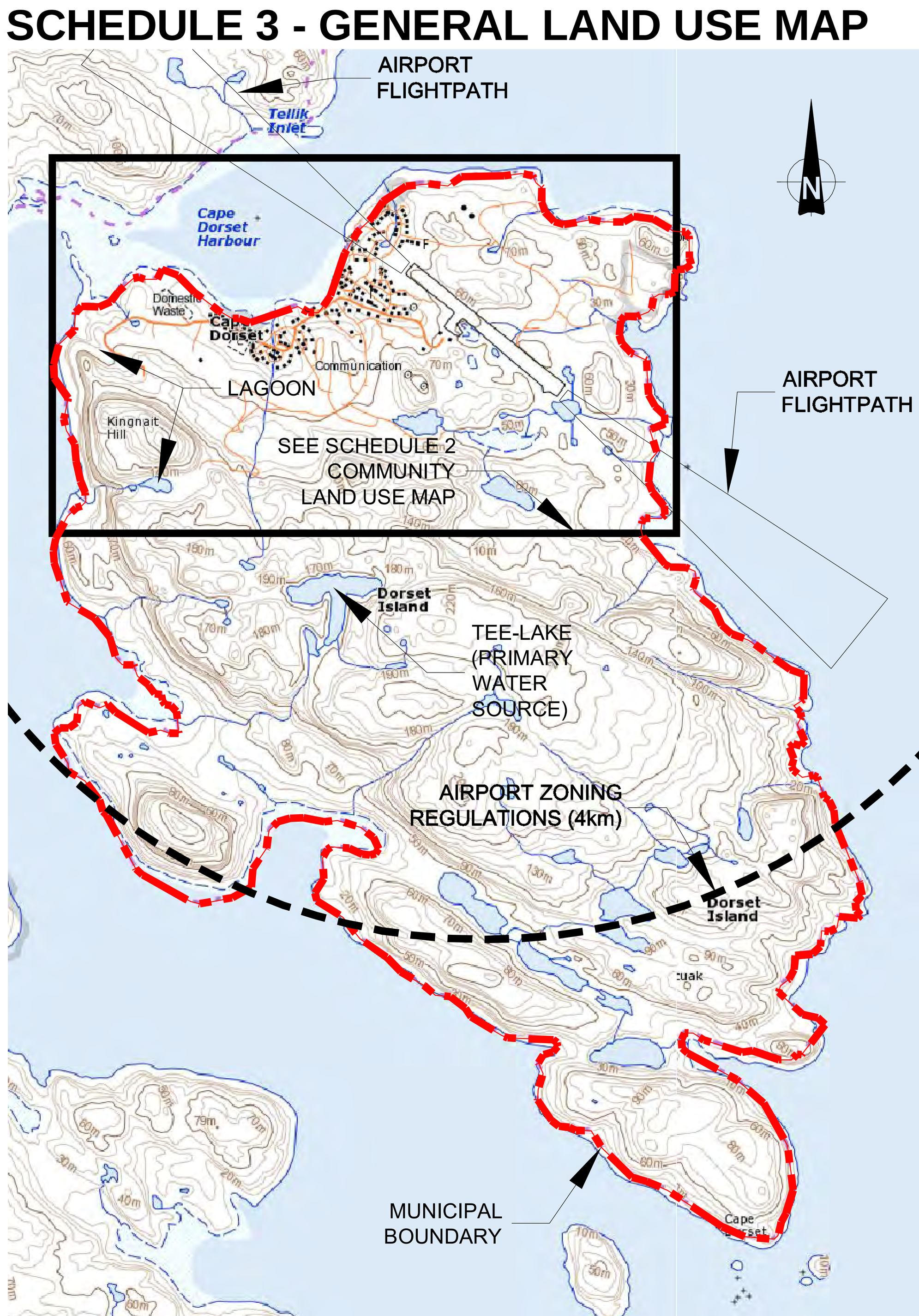
The Municipal Reserve designation is intended to reserve land for the future growth of the community. The policies of Council are:

a) The Municipal Reserve designation does not permit any development except temporary uses approved by Council.
b) Municipal Reserve lands shall be redesignated by amendment to this Plan prior to being used for community expansion.
c) A conceptual road network is shown on some of the Municipal Reserve lands which considers connections with existing road network, future land uses, prevailing wind direction, solar orientation, drainage and topography. The concept may need to be changed according to community needs during the detailed subdivision design process.

SCHEDULE 2 - COMMUNITY PLAN MAP



SCHEDULE 3 - GENERAL LAND USE MAP



SCHEDULE 4 - ZONE REGULATIONS

	Permitted Uses	Conditional Uses	Zone Requirements
Residential	Dwelling, single-unit Dwelling, semi-detached or duplex Dwelling, rowhouse Park or playground Any accessory building, structure or use, subject to Section 5.1	Bed and breakfast Craft studio Day care centre Dwelling, multi-unit Dwelling, mini home Elders facility Group home Home occupation Secondary suite	(a) Setbacks (minimum) Front = 6 metres Rear = 6 metres Rear, backing onto an OS Zone = 2.5 metres Side (Exterior) = 4 metres Side (Interior) = 6 metres, or as required by the Fire Marshal Building Height (maximum) 8.5 metres (28 feet) (b) Despite the provisions of Section 6.3(a), for semi-detached dwellings or rowhouse dwellings located on separate, adjacent lots, the side yard where units are attached may be reduced to zero. (c) Parking or storage of a commercial vehicle having a gross vehicle weight of 2,000 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 60m² of gross floor area, whichever is less.
Commercial	Bank Broadcasting studio Commercial recreation Communications facility Convenience store Craft studio Day care centre Hotel Office Parking lot Personal service Restaurant Retail store Service and repair shop Any accessory building, utility, structure or use, subject to Section 5.1	Automotive gas bar Automotive repair, sales, or rental shop Dwelling unit(s) in a non-residential building provided that the dwelling unit(s) are above the ground floor. Contractor's shop Home occupation Uses similar in character and purpose to those listed for this zone	(a) Setbacks (minimum) Front = 6 metres Rear = 6 metres Side (Exterior) = 4 metres Side (Interior) = 6 metres, or as required by the Fire Marshal Building Height (maximum) 3 storeys, not to exceed 13 metres
Community Use	Broadcasting studio Communications facility Community freezer Community hall or centre Day care centre Educational facility Elders facility Emergency and protective services Place of Worship Government office Group home Health care facility Park or Playground Parking lot Post office Any accessory building, utility, structure or use, subject to Section 5.1	Cemetery Uses similar in character and purpose to those listed for this zone	(a) Setbacks (minimum) Front = 6 metres Rear = 6 metres Side (Exterior) = 6 metres Side (Interior) = 6 metres, or as required by the Fire Marshal Building Height (maximum) 13 metres (42.65 feet)
Community Core	Bank Commercial recreation Convenience store Craft studio Day care centre Hotel Office Park or playground Parking lot Personal service Restaurant Retail store Uses permitted in the Community Use Zone (CU)	Automotive gas bar Contractor's shop Dwelling, multi-unit Dwelling unit(s) in a non-residential building provided that the dwelling unit(s) are above the ground floor Home occupation Warehouse, accessory Uses similar in character and purpose to those listed for this zone	(a) Setbacks (minimum) Front = 6 metres Rear = 6 metres Side (Exterior) = 4 metres Side (Interior) = 6 metres, or as required by the Fire Marshal Building Height (maximum) 10.7 metres (35 feet)
Open Space	Archaeological site Beach shacks Boat storage Dock Monument, cairn, or statue Park or playground Shed to store equipment for traditional, cultural, and recreational activities taking place in the Zone. Snow fence Sports field Temporary outdoor storage of sealift equipment during sealift Washroom facility	Communications facility Dog teams Temporary tenting or camping Uses similar in character and purpose to those listed for this zone	(a) The following provisions applies to all development in the Open Space Zone: Gross Floor Area (maximum) 25 sq.m. Building Height (maximum) 3.1 metres (10 feet) (b) No building or structure shall be located closer than 10m to any side or rear lot line. (c) Dog teams may not be located closer than 30.5 m to a water body.
Industrial	Automotive gas bar Automotive repair, sales or facility Building supply or contractors shop Caretaker unit Heavy equipment and vehicle yard Outdoor storage Rental shop Warehouse Communications facility Any accessory building, structure or use, subject to Section 5.1	Community freezer Barge staging and landing site with associated warehousing Fuel storage facility Hazardous goods storage Manufacturing plant Power generation facility Uses similar in character and purpose to those listed for this zone	(a) Setbacks (minimum) Front = 6 metres Rear = 8 metres Side (Exterior) = 6 metres Side (Interior) = 8 metres, or as required by the Fire Marshal Building Height (maximum) 10.7 metres (35 feet) (b) Only 1 caretaker unit is permitted on a lot. (c) Hazardous goods storage or tank farm uses shall not be permitted within 30.5 metres of any water course. (d) No commercial development involving food storage, handling or preparation shall be permitted within 450m of a waste handling facility.
Granular Resources		Quarry	
Waste Disposal		Waste disposal site Sewage treatment system	(a) No residential development or commercial development involving food storage, handling or preparation shall be permitted within 450 metres of a waste disposal site.
Hinterland	Archaeological site Dog team Temporary tenting or camping	Beach shack Cabin Quarry Cemetery Commercial harvesting Communications facility Permanent hunting and fishing cabins or camps Resource exploration and development Snow fence Tourist facilities Wind turbine Any accessory building, structure or use, subject to Section 5.1 Uses similar in character and purpose to those listed for this zone	(a) Any development within the Transportation Influence Zone as indicated on the Land Use Map shall be subject to the approval of NAV Canada. (b) No development is permitted within 150 metres downwind of any snow fence without the approval of council. (c) No development is permitted within 200 metres of a wind turbine. (d) No development is permitted within 100 metres of an Archaeological Site or Paleontological Site.
Transportation	Airport and related uses Communications facility Service shop Sea lift facility		(a) Any development within a 4000m radius of the airport reference point, as indicated on the Land Use Map, is subject to the Baker Lake Airport Zoning Regulations and shall be subject to the approval of NAV Canada and Nunavut Airports. (b) No development shall occur within 150m of the Non-Directional Beacon (NDB) Site.
Municipal Reserve			(a) The Municipal Reserve Zone identifies lands that may be interesting for future redevelopment. No development is permitted in the MR Zone unless of temporary nature, subject to Council approval.

CAPE DORSET COMMUNITY PLAN
BY-LAW No. 168

A By-law of the Hamlet of Cape Dorset 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 Cape Dorset has prepared a General Plan, referred to as the "Cape Dorset Community Plan", in accordance with the *Planning Act*;

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

1. Schedules 1, 2, 3 of this By-law form part of this By-law.
2. This By-law may be cited as the "Cape Dorset Community Plan".
3. This By-law shall come into full force and effect on the date of its Third Reading.
4. By-laws No. 53 of the Hamlet of Cape Dorset, and all amendments thereto, is hereby repealed.

READ a first time this 26th day of March, 2013 A.D.

______________________ ______________________
Mayor Senior Administrative Officer

After due notice and a Public Hearing, READ a second time this 7th day of May, 2013 A.D.

______________________ ______________________
Mayor Senior Administrative Officer

APPROVED by the Minister of Community and Government Services this __ day of __________________, 2013 A.D.

____
Minister

READ a third time this __ day of __________________, 2013 A.D.

______________________ ______________________
Mayor Senior Administrative Officer

Cape Dorset ZONING BY-LAW
BY-LAW No. 169

A By-law of the Hamlet of Cape Dorset 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 Cape Dorset 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 Cape Dorset, duly assembled, enacts as follows:

1. Schedules 2, 3 and 4 of this By-law are declared to form part of this By-law.
2. This By-law may be cited as the "Cape Dorset 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. 54 and all amendments thereto, of the Hamlet of Cape Dorset is hereby repealed.

READ a first time this 26th day of March, 2013

______________________ ______________________
Mayor Senior Administrative Officer

After due notice and a Public Hearing, READ a second time this 7th day of May, 2013

______________________ ______________________
Mayor Senior Administrative Officer

APPROVED by the Minister of Community and Government Services this __ day of __________________, 2013

____
Minister

READ a third time this __ day of __________________, 2013

______________________ ______________________
Mayor Senior Administrative Officer

CAPE DORSET COMMUNITY PLAN

SCHEDULE 1

BY-LAW NO. 168

May 2013

CAPE DORSET COMMUNITY PLAN
BY-LAW No. 168

A By-law of the Hamlet of Cape Dorset 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 Cape Dorset has prepared a General Plan, referred to as the "Cape Dorset Community Plan", in accordance with the *Planning Act*;

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

1. Schedules 1, 2, 3 of this By-law form part of this By-law.
2. This By-law may be cited as the "Cape Dorset Community Plan".
3. This By-law shall come into full force and effect on the date of its Third Reading.
4. By-laws No.53 of the Hamlet of Cape Dorset, and all amendments thereto, is hereby repealed.

READ a first time this 26th day of March, 2013 A.D.

________________________ ________________________
Mayor Senior Administrative Officer

After due notice and a Public Hearing, READ a second time this 7th day of May, 2013 A.D.

________________________ ________________________
Mayor Senior Administrative Officer

APPROVED by the Minister of Community and Government Services this __ day of ___________________, 2013 A.D.

____
Minister

READ a third time this __ day of ____________________, 2013 A.D.

________________________ ________________________
Mayor Senior Administrative Officer

SECTION 1. INTRODUCTION

1.1 Purpose of the Plan

The purpose of the Cape Dorset Community Plan is to outline Council's policies for managing the physical development of the Hamlet for the next 20 years – to 2033. The Community Plan was created through a community consultation process and reflects the needs and desires of the Community. The Community Plan builds on previous plans, while incorporating new challenges, issues and needs identified by the Community.

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 established for this Community Plan are:

1. To develop in an orderly fashion creating a safe, healthy, functional, and attractive community that reflects community values and culture.
2. To promote the Plan as a tool for making effective and consistent decisions regarding land use and development in the community.
3. To ensure an adequate supply of land for all types of uses to support the growth and change of the community.
4. To build upon community values of participation and unity to support community projects and local economic development.
5. To protect the natural beauty of "Nuna", protect viewpoints to the water, and retain waterfront and lakeshore areas for public uses and traditional activities.

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-laws 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 is also being enacted for the purpose of implementing detailed policies based on the Community Plan. All development must follow the intent of the Community Plan and Zoning By-law. The Community Plan includes Schedule 1 (Plan Policy Text), Schedule 2 (Community Plan and Zoning Map) and Schedule 3 (General Land Use Map).

SECTION 2. COMMUNITY GROWTH AND PHASING POLICIES

At the time of preparation of this Plan, the population of Cape Dorset was approximately 1,397 people. This Plan is based on a future population of 1,791 people by 2033. It is estimated that an additional 240 dwelling units will be required to meet the projected population growth, representing the need for approximately 13 hectares of land for residential development. In addition, an appropriate mix and range of industrial, commercial, and community uses has been proposed to meet long-term needs. The policies of Council are:

a) Plan for a 2033 population of 1,791.

b) Identify sufficient land on the Community Plan to meet the needs of the projected 2033 population.

c) Review the Community Plan in 5 years, in 2018, to re-assess actual rates of growth and community needs.

d) Council will generally phase new land development as follows:

   i.) 2013 - 2018:
   - Build on existing vacant lots within the built-up area.
   - Develop Phase 1 and 2, residential subdivision.
   - Develop lots in the industrial west subdivision.

   ii.) 2018 – 2023
   - Develop Phase 3 residential subdivision.
   - Develop new barge landing, dock and sealift area.

   iii.) 2023 – 2033
   - Develop Phase 4 area.

e) Council may change the phasing of development without amendment to this Plan.

SECTION 3. GENERAL POLICIES

The following policies of Council apply to all development in the Hamlet regardless of land use designation:

a) The development of lots shall be subject to the following lot development policies:
   - i.) All service connections to buildings shall be easily accessed from the front yard on all lots and grouped together, where possible.
   - ii.) Access to new buildings will avoid, where possible, main entrances on the south-southeast side to reduce problems associated with snow drifting.
   - iii.) Buildings shall be sited to respect setbacks identified on the Zoning Chart.
   - iv.) Any building over 500 m^2 in gross floor area shall consider potential wind impacts on surrounding development. A wind study may be required by the Development Officer.
   - v.) Culverts are required and shall be installed at the access points to lots.
   - vi.) On any portion of a lot where fill is introduced, drainage shall be directed towards the public road. Exceptions may be made by the Development Officer. Where possible, drainage troughs shall not be located in Utility Rights-of-Way or Easements.
   - vii.) 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) Utilities or communication facilities shall be permitted in any land use designation. Other than designated Rights-of-Way or Easements for Utility or Communication lines, Easements alongside roadways, marked between the edge of the roadway and lot lines, will be used for distribution lines, with a minimum clearance, as specified in the Utility Corporation's Joint Use Agreement.

c) The Hamlet will pile snow in locations to minimize downwind snow drifting and where spring melt run-off can be properly channeled to drainage ditches or waterbodies.

d) The Hamlet will avoid piling snow within at least 30.5 metres (100 feet) of any watercourse.

e) The Hamlet shall protect any cemeteries and sites of archaeological, ethnographical or historical significance from disturbance.

f) The Hamlet shall encourage development that minimizes emissions from fossil fuels, that are energy efficient and that consider alternative energy supply technology.

g) The Hamlet shall work with the Nunavut Planning Commission to ensure that the Cape Dorset Community Plan and the future Baffin Regional Land Use Plan are compatible.

SECTION 4. LAND USE DESIGNATION

4.1 Residential

The Residential designation provides land for primarily residential uses, but also permits other small-scale conditional uses subject to the approval of Council. The policies of Council are intended to maintain an adequate supply of land for residential development, to build safe and livable neighbourhoods and to protect residential areas from incompatible development. The policies of Council are:

a) The Residential designation will be used primarily for housing with all types of dwelling types permitted. Other related residential uses such as a group home, a home occupation, or bed and breakfast will also be permitted.

b) Residential development will be phased so that a target minimum of 2 hectares of vacant surveyed land is available at any given time.

4.2 Community Core

The Community Core designation defines the core area of the community which provides a focal point for community amenities, cultural activities, and tourism. Given the important role the Community Core plays in defining community and cultural identity, specific policies are adopted for this area. Policies are aimed at maintaining the community uses and a mix of service commercial and tourism related uses, allowing limited types of residential uses, improving the character of development, increasing pedestrian safety and beautifying the streetscape. The policies of Council are:

a) The Community Core designation will permit all uses permitted in the Community Use designation and retail commercial and tourism or visitor-related uses. Residential uses will be conditionally permitted by Council and only multi-unit dwellings or dwelling units in non-residential buildings above the ground floor will be permitted.

b) Council may adopt a Downtown Beautification Plan which provides more details on the character of development in the Community Core and provides an action and phasing plan for improvements such as walkways, street lighting, paving, road widenings, signage, public art, as outlined in the Plan.

c) Council will support development of the proposed Arts & Heritage Centre.

d) Council shall seek opportunities and encourage the relocation of industrial uses (i.e. garages, power plant, etc.) and low density residential uses outside the Community Core over time by considering land swaps and/or other incentives.

e) Front yard parking will not be permitted for any new development of a significant size in the Community Core. Parking will be provided at the side or rear of the building. Parking spaces that require vehicles to back-out onto the municipal road will also not be permitted.

f) Give priority for the development of a defined walkway as shown on the Community Land Use Map. Monetary contributions for the construction of the walkway may be requested as a condition of development approval.

g) Council will ensure that as part of the relocation of the power plant that appropriate site remediation is completed in order for the area to be re-developed with a new community hall.

h) Council will consider re-locating the Hamlet office either in a new community hall or elsewhere in the Core to provide lands for an expansion to the Health Centre.

4.3 Community Use

The Community Use designation is intended to maintain an adequate supply of land for community uses, to provide easy access to public facilities and services, and to reserve significant and important locations for community uses. The policies of Council are:

a) The Community Use designation will be used primarily for public uses (i.e. social, cultural, religious, or educational) and government services.

b) Community facilities will be centrally located to ensure safe and convenient access by residents.

4.4 Commercial

The Commercial designation is intended to support local economic development by maintaining an adequate supply of land for commercial uses in a central location with good access from the community. The policies of Council are:

a) The Commercial designation will be used for commercial uses such as hotels, restaurants, retail, personal and business services, and offices.

b) Residential uses shall be permitted when located above a ground floor commercial use.

c) Commercial facilities will be located along main roads, where possible, to provide safe and convenient access by residents.

d) Council will encourage the re-use or redevelopment of existing commercial sites within the existing townsite.

4.5 Open Space

The Open Space designation is intended to protect shoreline environments, maintain access to the sea and to reserve open spaces within the built up area for recreational uses and cultural events. The policies of Council are:

a) The Open Space designation will be used primarily for parks, walking trails, traditional and recreational uses such as beach shacks, harbour uses, boat storage, dog teams, community docks, temporary storage of sealift materials and equipment during sealift operations, and municipal infrastructure such as a water pump house. All uses are conditional and at the discretion of Council.

b) Owners of development will be required to maintain the development and keep the surrounding area tidy.

c) A playground should be located within 300 metre walking distance from any residence in the community.

d) Unless otherwise noted, all Commissioner's Land forming part of the 100-foot strip (30.5 m) along the seashore measured from the ordinary high water mark will be designated Open Space.

e) No development is generally permitted within 30 metres from the normal high water mark of any river or major creek. Council may consider the filling of a waterbody where it is needed for future development provided that the appropriate approvals are obtained.

f) Council will support development of a new community dock adjacent the Core area.

g) Open Space corridors will be protected for trail connections and drainage channels.

4.6 Industrial

The Industrial designation is intended to reduce the negative effects and dangers associated with industrial uses such as noise, dust, odours, truck travel and the storage of potentially hazardous substances by concentrating these uses on the periphery of the townsite. The policies of Council are:

a) Permitted uses in the Industrial designation will include all forms of manufacturing, processing, warehousing and storage uses. Permitted uses will also include garages, power generation plants, and fuel storage.

b) Council will develop a new industrial subdivision near the old landfill site to minimize land use conflicts and to reserve land closer to the townsite for residential and community uses. Council will work with local businesses and government operations to identify opportunities to relocate over time non-conforming industrial uses (eg. garages, warehouses, power plant) to industrial areas.

c) Council will support the development of a new power plant near the tank farm.

4.7 Transportation

The Transportation designation is intended to protect and ensure the safe operation of airport and related activities such as the NavCanada communications site. The policies of Council are:

a) Permitted uses in the Transportation designation includes all activities related to air traffic and uses accessory to these activities such as related commercial activities and communications sites.

b) All development within the 4km boundary of the airport, as shown on Schedule 3, shall comply with the Cape Dorset Airport Zoning Regulations. 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.

c) All development within the Transportation Influence Zone of the communications facility is subject to the approval of NavCanada.

d) Council will discourage the use of travelled pathways that are not identified as public right-of-ways.

4.8 Hinterland

The Hinterland 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 – 'Nuna' – while providing access for traditional, recreational and tourism activities, as well as quarrying. The policies of Council are:

a) The Hinterland designation generally permits traditional, tourism and passive recreational uses. Permitted uses also include dog teams, quarrying, and infrastructure projects for local economic development.

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

4.9 Waste Disposal

The Waste Disposal designation is intended to identify existing or former waste disposal sites and ensure required development setbacks. The policies of Council are:

a) The Waste Disposal designation permits no development except those uses accessory to the operation or remediation of a waste disposal site.

b) 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, pursuant to the *General Sanitation Regulations* of the Public Health Act.

c) The Hamlet shall prohibit the development of any public road allowance or cemetery within a 90 metre setback from a waste disposal ground, pursuant to the General Sanitation Regulation of the *Public Health Act*.

d) The Hamlet will work with appropriate levels of government to resolve issues with the new sewage lagoon in order for it to be approvable.

e) The Hamlet will evaluate all possible options for an integrated waste management system, including:

    a. the suitability of the existing landfill site for long-term use;

    b. the use of an incinerator;

    c. metal recovery projects; and

    d. complementary strategies, such as source reduction, reuse, and recycling of waste materials.

4.10 Granular Resources

The Granular Resources designation is intended to protect aggregate deposits for future extraction. The policies of Council are:

a) The Granular Resources designation does not permit any development except uses accessory to the operation or remediation of a quarry or gravel pit.

b) Council shall ensure that lands subject to Quarry Permit No. QB10-002 are designated for quarry purposes only.

4.11 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 redesignated by amendment to this Plan prior to being used for community expansion.

c) A conceptual road network is shown on some of the Municipal Reserve lands which considers connections with existing road network, future land uses, prevailing wind direction, solar orientation, drainage and topography. The concept may need to be changed according to community needs during the detailed subdivision design process.

APPENDIX G

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

[56] **References Cited**

U.S. PATENT DOCUMENTS

596,062	12/1897	Firey	138/28
678,118	7/1901	Kruschke .	
926,092	6/1909	Bright	138/28
2,029,630	2/1936	McMichael	138/28
2,676,607	4/1954	Carr et al.	138/32 X

FOREIGN PATENT DOCUMENTS

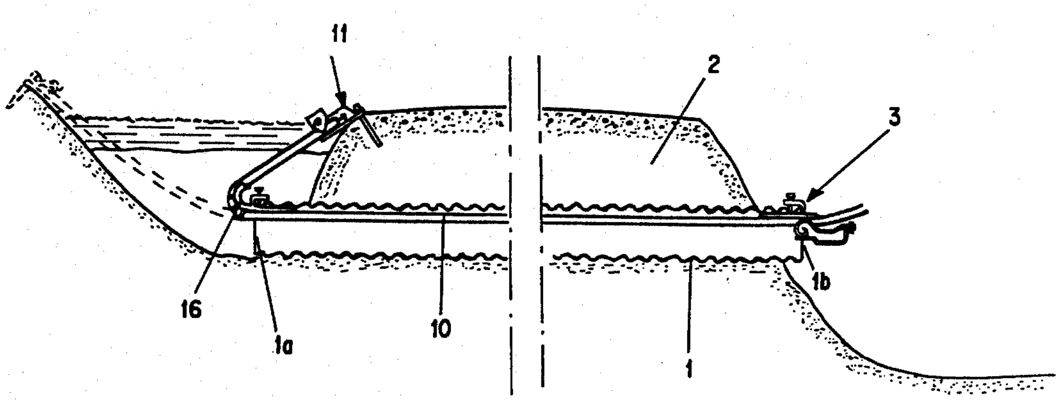
1122877	5/1982	Canada	138/32
1219487	5/1960	France	138/28
2478161	9/1981	France .	
80034861	11/1981	Sweden .	
1345	1/1891	United Kingdom	138/28
15138	7/1892	United Kingdom	138/28
1288677	9/1972	United Kingdom .	
836271	6/1981	U.S.S.R. .	
901427	1/1982	U.S.S.R. .	

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



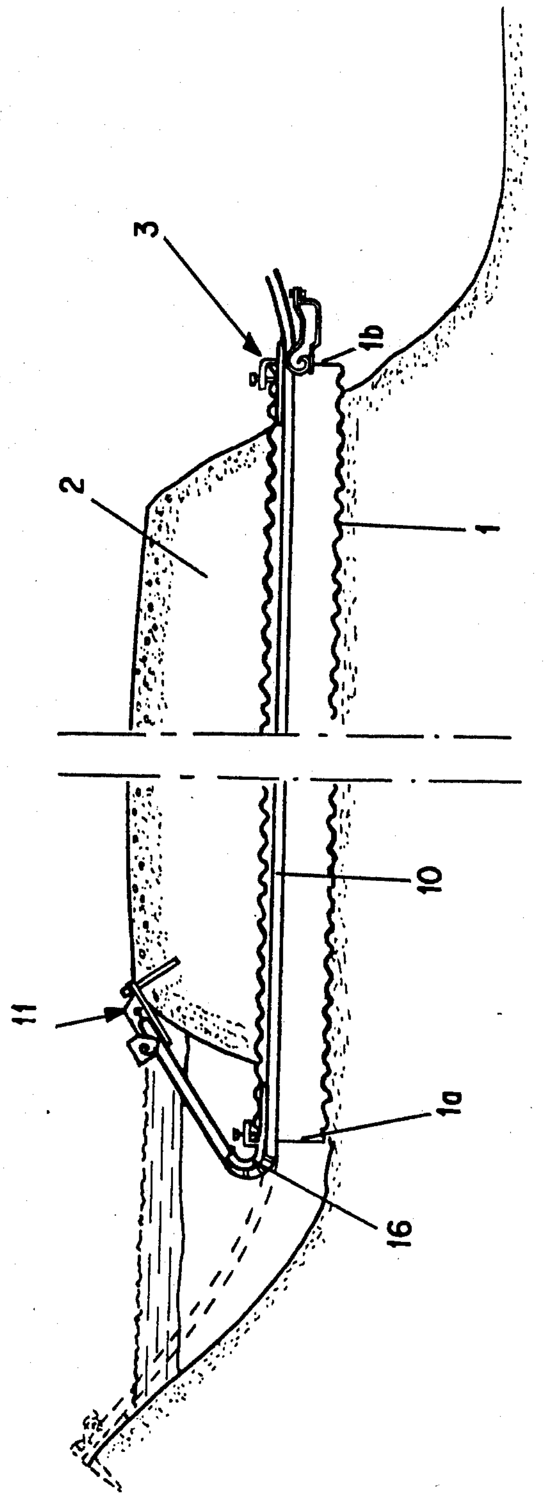


Fig. 1

Fig. 5

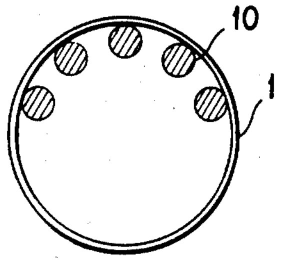
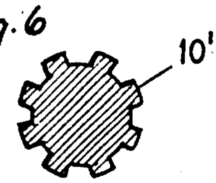


Fig. 6



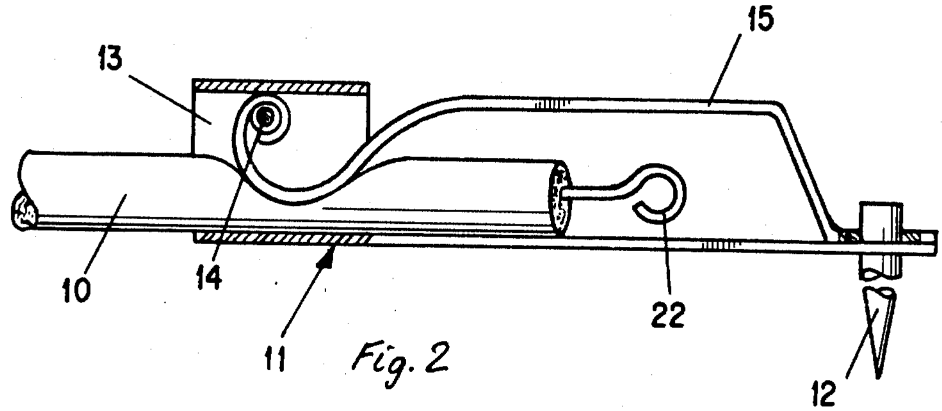


Fig. 2

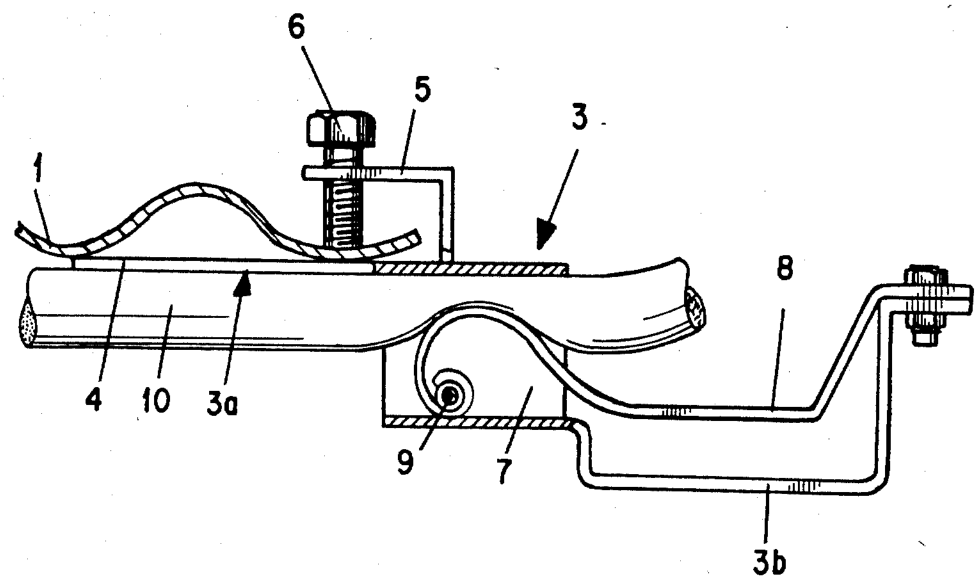
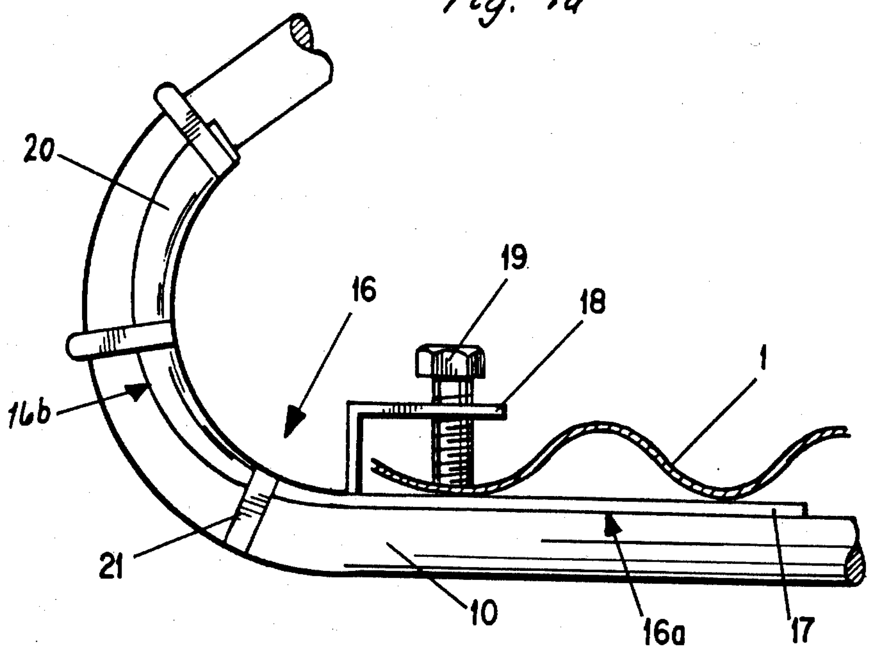


Fig. 3

Fig. 4a



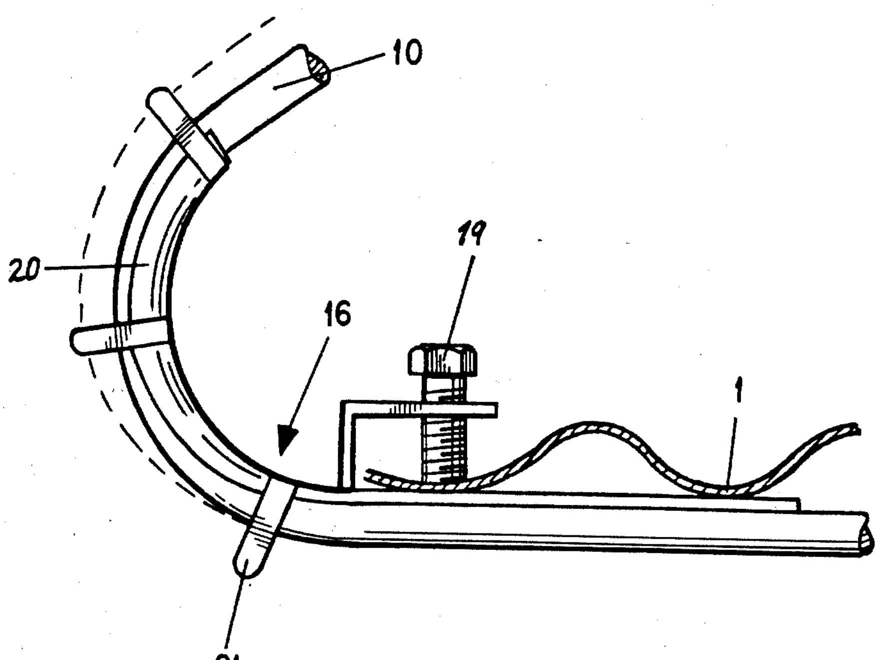


Fig. 4b

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.

* * * * *

US005986237A

United States Patent [19]
Sterling et al.

[11] **Patent Number: 5,986,237**
[45] **Date of Patent: Nov. 16, 1999**

[54] **METHOD FOR THAWING FROZEN ROAD CULVERTS**

[75] Inventors: **Robert Laurel Sterling**, Grande Prairie; **Rudiger Schmidt**, Wainwright, both of Canada

[73] Assignee: **Iceworm International Inc.**, Alberta, Canada

[21] Appl. No.: **08/936,825**

[22] Filed: **Sep. 25, 1997**

[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**

U.S. PATENT DOCUMENTS

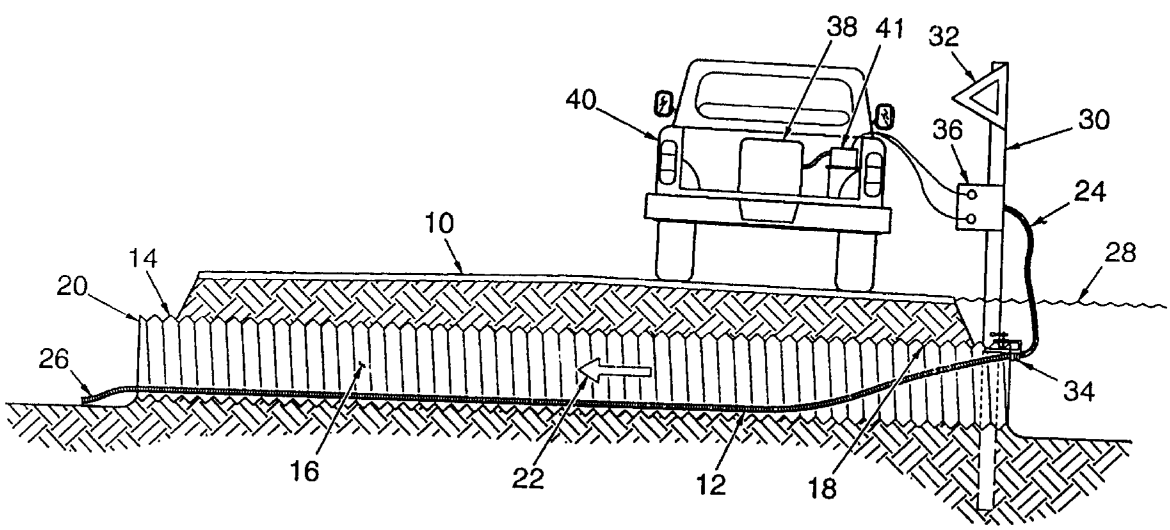
1,349,136 8/1920 Lillard .
3,823,304 7/1974 Siemianowski 219/213

Primary Examiner—Teresa Walberg
Assistant Examiner—Thor S. Campbell
Attorney, Agent, or Firm—Davis and Bujold

[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



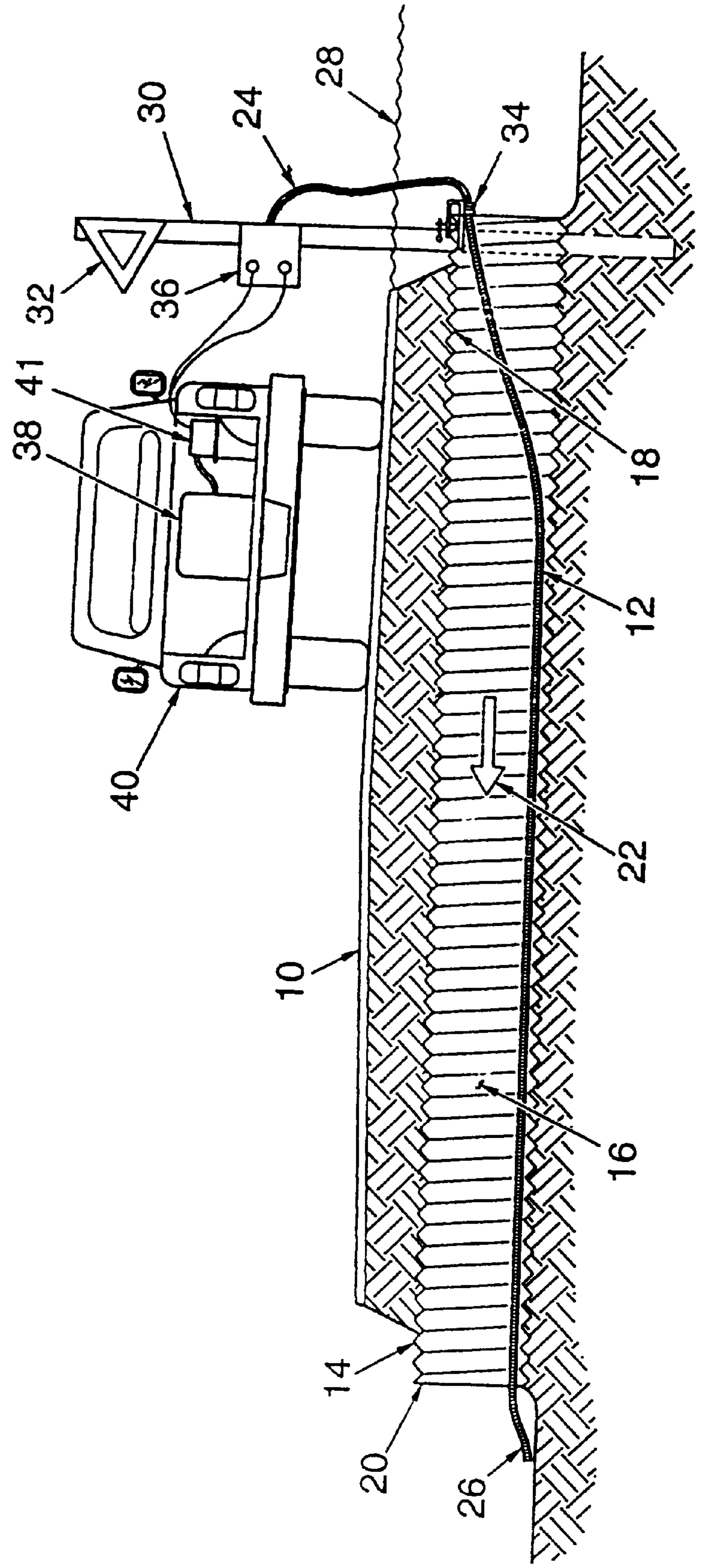


FIGURE 1

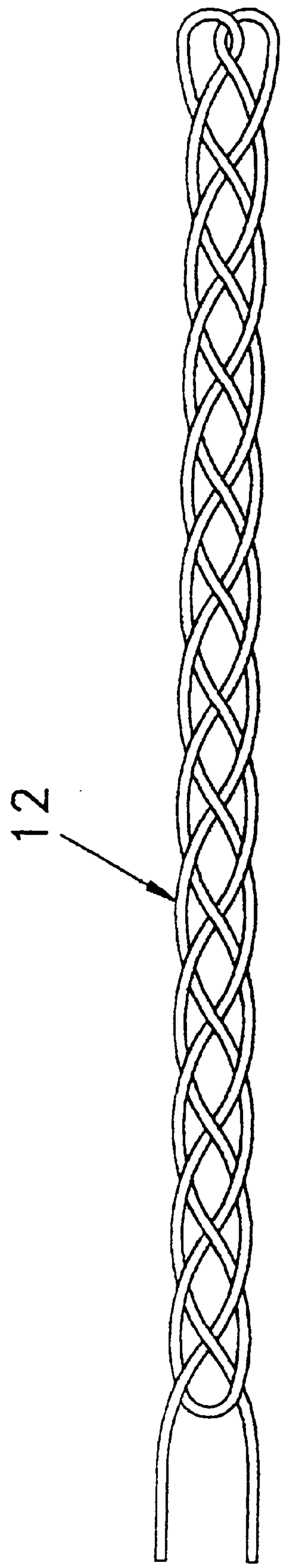


FIGURE 2

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 H

PCSWMM MODEL PARAMETERS

Table H-1: Conduits PCSWMM Parameters

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C1	C1i	C1o	5.511	0.023	CIRCULAR	0.45	0	1	0.00925
C2	C2i	C2o	7.223	0.023	CIRCULAR	0.45	0	1	0.02285
C3	C3i	C3o	12.04	0.023	CIRCULAR	0.6	0	1	0.02609
C4	C4i	C4o	11.05	0.023	CIRCULAR	0.45	0	1	0.02363
C5	C5i	C5o	17.049	0.023	CIRCULAR	0.5	0	1	0.0341
C7	C7i	C7o	17.54	0.023	CIRCULAR	0.9	0	1	0.03588
C8	C8i	C8o	18.433	0.023	CIRCULAR	0.45	0	1	0.0178
C9	C9i	C9o	16.35	0.023	CIRCULAR	0.9	0	3	0.00783
C10	C10i	C10o	10.798	0.023	CIRCULAR	0.9	0	3	0.05947
C11	C11i	C11o	8.677	0.023	CIRCULAR	1.2	0	2	0.05344
C13	C13i	C13o	12.368	0.023	CIRCULAR	0.6	0	1	0.01917
C14	C14i	C14o	9.561	0.023	CIRCULAR	0.8	0	3	0.03684
C15	C15i	C15o	13.575	0.023	CIRCULAR	0.8	0	1	0.04188
C16	C16i	C16o	17.089	0.023	CIRCULAR	0.6	0	1	0.07677
C17	C17i	C17o	15.159	0.023	CIRCULAR	0.6	0	1	0.0225
C18	C18i	C18o	18.975	0.023	CIRCULAR	0.45	0	1	0.05161
C19	C19i	C19o	17.657	0.023	CIRCULAR	0.8	0	1	0.04655
C20	C20i	C20o	4.998	0.023	CIRCULAR	0.45	0	1	0.03203
C21	C21i	C21o	18.677	0.023	CIRCULAR	0.6	0	1	0.16101
C22	C22i	C22o	18.103	0.023	CIRCULAR	0.45	0	1	0.06321
C24	C24i	C24o	13.108	0.023	CIRCULAR	0.45	0	1	0.10315
C25	C25i	C25o	22.723	0.023	CIRCULAR	0.45	0	1	0.02809
C26	C26i	J2	27.284	0.023	CIRCULAR	0.6	0	1	0.06649
C27	C27i	C27o	28.153	0.023	CIRCULAR	0.45	0	1	0.06947
C28	C28i	C28o	21.858	0.023	CIRCULAR	0.6	0	1	0.05898
C29	C29i	C29o	18.922	0.023	CIRCULAR	0.45	0	1	0.01142
C30	C30i	C30o	18.71	0.023	CIRCULAR	0.45	0	1	-0.00294
C31	C31i	C31o	14.082	0.023	CIRCULAR	0.45	0	1	0.02344
C32	C32i	C32o	17.332	0.023	CIRCULAR	0.9	0	1	0.01847
C33	C33i	C33o	12.051	0.023	CIRCULAR	0.5	0	1	0.5868
C34	C34i	C34o	13.283	0.023	CIRCULAR	0.5	0	1	0.01845

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C35	C35i	C35o	8.436	0.023	CIRCULAR	0.8	0	1	0.02371
C36	C36i	C36o	14.213	0.023	CIRCULAR	0.7	0	1	0.02456
C38	C38i	C38o	18.15	0.023	CIRCULAR	0.6	0	1	0.01923
C39	C39i	C39o	18.632	0.023	CIRCULAR	0.6	0	1	0.0051
C40	C40i	C40o	11.141	0.023	CIRCULAR	0.45	0	1	0.4593
C41	C41i	C41o	32.281	0.023	CIRCULAR	0.45	0	1	0.02246
C42	C42i	C42o	23.498	0.023	CIRCULAR	0.45	0	1	0.0103
C43	C43i	C43o	17.4	0.023	CIRCULAR	0.9	0	1	0.01138
C44	C44i	C44o	14.772	0.023	CIRCULAR	0.45	0	1	0.0336
C45	C45i	C45o	12.102	0.023	CIRCULAR	0.6	0	1	0.01942
C46	C46i	C46o	13.842	0.023	CIRCULAR	0.8	0	1	0.01459
C47	C47i	C47o	42.785	0.023	CIRCULAR	0.9	0	1	0.07941
C48	C48i	C48o	7.929	0.023	CIRCULAR	0.45	0	1	0.12765
C49	C49i	C49o	127.849	0.023	CIRCULAR	0.9	0	1	0.06762
C50	C50i	C50o	10.202	0.023	CIRCULAR	0.6	0	1	0.04445
C51	C51i	C51o	25.642	0.023	CIRCULAR	0.9	0	1	0.06884
C53	C53i	C53o	8.414	0.023	CIRCULAR	0.8	0	1	0.02164
C54	C54i	C54o	14.691	0.023	CIRCULAR	0.6	0	1	-0.00265
C55	C55i	C55o	13.31	0.023	CIRCULAR	0.8	0	1	0.0239
C56	C56i	C56o	11.121	0.023	CIRCULAR	0.45	0	1	0.03383
C57	C57i	C57o	10.177	0.023	CIRCULAR	0.45	0	1	0.01346
C58	C58i	C58o	22.261	0.023	CIRCULAR	0.45	0	1	0.02256
C59	C59i	C59o	19.411	0.023	CIRCULAR	0.9	0	2	0.04218
C60	C60i	C60o	15.221	0.023	CIRCULAR	0.9	0	1	0.00815
C61	C61i	C61o	7.077	0.023	CIRCULAR	0.9	0	1	0.06955
C62	C62i	C62o	14.054	0.023	CIRCULAR	0.9	0	1	0.00761
C63	C63i	C63o	18.026	0.023	CIRCULAR	0.6	0	1	0.08608
C64	C64i	C64o	13.747	0.023	CIRCULAR	0.6	0	1	0.05449
C65	C65i	C65o	7.459	0.023	CIRCULAR	0.4	0	1	0.04657
C66	C66i	C66o	11.395	0.023	CIRCULAR	0.45	0	1	0.06393
C67	C67i	C67o	7.994	0.023	CIRCULAR	0.45	0	1	0.03743

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C68	C68i	C68o	11.504	0.023	CIRCULAR	0.8	0	1	0.01287
C69	C69i	C69o	13.257	0.023	CIRCULAR	0.45	0	1	0.0419
C70	C70i	C70o	8	0.023	CIRCULAR	0.45	0	1	0.05132
C71	C71i	C71o	19.563	0.023	CIRCULAR	0.6	0	1	0.0438
C72	C72i	J217	18.453	0.023	CIRCULAR	0.6	0	1	0.01084
C73	C73i	C73o	11.119	0.023	CIRCULAR	0.6	0	1	0.03897
C74	C74i	C74o	8.207	0.023	CIRCULAR	0.9	0	1	0.0117
C75	C75i	C75o	13.238	0.023	CIRCULAR	0.45	0	1	0.02191
C76	C76i	C76o	70.414	0.023	CIRCULAR	0.8	0	1	0.1008
C6	C6i	C6o	30.183	0.01	CIRCULAR	0.9	0	1	0.03727
C12	J36	J37	10.22	0.023	CIRCULAR	0.6	0	1	0.08089
C23	J7	C23o	9.014	0.023	CIRCULAR	0.45	0	1	0.07868
C52	C52i	J8	35.824	0.023	CIRCULAR	0.6	0	1	0.01052
C77	J315	J1518	53.309	0.04	TRAPEZOIDAL	1	2	1	0
C79	C6o	C11i	62.352	0.03	TRAPEZOIDAL	0.75	1	1	0.01487
C85	J501	J416	46.489	0.04	TRAPEZOIDAL	1	2	1	0.05226
C87	J1440	J501	79.812	0.04	TRAPEZOIDAL	1	2	1	0.18382
C88	J1351	J1440	141.985	0.04	TRAPEZOIDAL	1	2	1	0.12135
C89	J1459	J1351	284.742	0.04	TRAPEZOIDAL	1	2	1	0.08293
C91	J1475	J1459	199.601	0.04	TRAPEZOIDAL	1	2	1	0.06696
C92	J1401	J1490	65.585	0.04	TRAPEZOIDAL	1	2	1	0.17209
C94	J542	J1401	16.54	0.04	TRAPEZOIDAL	1	2	1	0.16596
C86	J1421	J705	204.825	0.04	TRAPEZOIDAL	1	2	1	0.06028
C95	J1409	J1421	58.663	0.04	TRAPEZOIDAL	1	2	1	0.0801
C100	J824	J1409	33.37	0.04	TRAPEZOIDAL	1	2	1	0.21595
C108	J869	J824	84.826	0.04	TRAPEZOIDAL	1	2	1	0.10432
C116	J344	J350	25.713	0.04	TRAPEZOIDAL	1	2	1	0.01968
C125	J1489	J869	118.331	0.04	TRAPEZOIDAL	1	2	1	0.10233
C133	J357	J344	107.964	0.04	TRAPEZOIDAL	1	2	1	0.06937
C141	J1367	J357	29.36	0.04	TRAPEZOIDAL	1	2	1	0.04425
C147	J902	J1489	131.132	0.04	TRAPEZOIDAL	1	2	1	0.03308

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C149	J452	J1395	178.979	0.04	TRAPEZOIDAL	1	2	1	0.12523
C153	J1463	J452	13.901	0.04	TRAPEZOIDAL	1	2	1	0.03152
C159	J740	J1475	278.087	0.04	TRAPEZOIDAL	1	2	1	0.13737
C165	J830	J740	30.018	0.04	TRAPEZOIDAL	1	2	1	0.03744
C169	J944	J902	59.14	0.04	TRAPEZOIDAL	1	2	1	0.0807
C176	J1356	J360	74.368	0.04	TRAPEZOIDAL	1	2	1	0.13672
C177	J946	J944	40.267	0.04	TRAPEZOIDAL	1	2	1	0.23229
C179	J779	J830	47.582	0.04	TRAPEZOIDAL	1	2	1	0.01534
C180	J395	C1i	112.745	0.04	TRAPEZOIDAL	1	2	1	0.05105
C184	J1428	J1490	201.091	0.04	TRAPEZOIDAL	1	2	1	0.0925
C187	J1382	J1489	50.643	0.04	TRAPEZOIDAL	1	2	1	0.04229
C194	J1350	C16i	86.972	0.03	TRAPEZOIDAL	0.5	0.5	1	0.09901
C195	J969	J946	70.725	0.04	TRAPEZOIDAL	1	2	1	0.10423
C197	J1377	J1482	19.806	0.04	TRAPEZOIDAL	1	2	1	-0.00419
C198	J1339	J1428	45.874	0.04	TRAPEZOIDAL	1	2	1	0.09026
C201	J263	J238	132.696	0.04	TRAPEZOIDAL	1	2	1	0
C203	J1410	J395	82.247	0.04	TRAPEZOIDAL	1	2	1	0.05373
C206	J1437	J137	21.714	0.04	TRAPEZOIDAL	1	2	1	-999
C211	J532	J1463	184.842	0.04	TRAPEZOIDAL	1	2	1	0.12517
C213	J812	J779	106.852	0.04	TRAPEZOIDAL	1	2	1	0.07678
C214	J405	J1350	51.562	0.04	TRAPEZOIDAL	1	2	1	0.03952
C220	J456	J1356	126.385	0.04	TRAPEZOIDAL	1	2	1	0.04486
C226	J1415	J812	21.939	0.04	TRAPEZOIDAL	1	2	1	0.14913
C229	J174	J209	34.176	0.04	TRAPEZOIDAL	1	2	1	0
C235	J1365	J456	31.562	0.04	TRAPEZOIDAL	1	2	1	0.1566
C236	J644	J1437	72.75	0.04	TRAPEZOIDAL	1	2	1	0.11948
C240	J1398	J1339	97.289	0.04	TRAPEZOIDAL	1	2	1	0.06611
C241	J1408	J1415	45.671	0.04	TRAPEZOIDAL	1	2	1	0.0522
C245	J1362	J1410	79.91	0.04	TRAPEZOIDAL	1	2	1	0.01985
C248	J567	J532	71.171	0.04	TRAPEZOIDAL	1	2	1	0.09224
C250	J211	J174	45.402	0.04	TRAPEZOIDAL	1	2	1	0.0944

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C255	J650	J1475	178.876	0.04	TRAPEZOIDAL	1	2	1	0.2001
C270	J1363	J644	44.814	0.04	TRAPEZOIDAL	1	2	1	0.11589
C271	J470	J1365	60.17	0.04	TRAPEZOIDAL	1	2	1	0.1934
C276	J196	J211	41.007	0.04	TRAPEZOIDAL	1	2	1	0.00124
C278	J374	J1362	56.082	0.04	TRAPEZOIDAL	1	2	1	0.37464
C281	J896	J1408	65.914	0.04	TRAPEZOIDAL	1	2	1	0.07905
C284	J1023	J969	173.115	0.04	TRAPEZOIDAL	1	2	1	0.04609
C285	J575	J567	65.185	0.04	TRAPEZOIDAL	1	2	1	0.10464
C289	J661	J1459	189.926	0.04	TRAPEZOIDAL	1	2	1	0.04126
C303	J207	J196	38.564	0.04	TRAPEZOIDAL	1	2	1	0.02397
C307	J993	J1382	237.429	0.04	TRAPEZOIDAL	1	2	1	0.09257
C309	J1050	J1023	46.685	0.04	TRAPEZOIDAL	1	2	1	-0.00054
C310	J472	J470	60.929	0.04	TRAPEZOIDAL	1	2	1	0.17877
C313	J845	J814	107.393	0.04	TRAPEZOIDAL	1	2	1	0.32312
C332	J234	J207	43.621	0.04	TRAPEZOIDAL	1	2	1	0.08385
C335	J529	J1440	283.494	0.04	TRAPEZOIDAL	1	2	1	0.08454
C340	J1360	J232	132.327	0.04	TRAPEZOIDAL	1	2	1	0
C342	J1374	J993	42.507	0.04	TRAPEZOIDAL	1	2	1	0.01678
C347	J219	J234	12.807	0.04	TRAPEZOIDAL	1	2	1	0.12576
C351	J590	J529	14.968	0.04	TRAPEZOIDAL	1	2	1	0.06434
C356	J864	J845	55.697	0.04	TRAPEZOIDAL	1	2	1	0.06497
C357	J475	J458	95.145	0.04	TRAPEZOIDAL	1	2	1	0.16951
C362	J579	J567	31.973	0.04	TRAPEZOIDAL	1	2	1	0.04709
C366	J756	J661	92.271	0.04	TRAPEZOIDAL	1	2	1	0.009
C381	J596	J134	52.99	0.04	TRAPEZOIDAL	1	2	1	0.01047
C384	J730	J1363	138.228	0.04	TRAPEZOIDAL	1	2	1	0.08723
C389	J494	J475	43.687	0.04	TRAPEZOIDAL	1	2	1	0.13545
C398	J774	J1421	83.686	0.04	TRAPEZOIDAL	1	2	1	0.23229
C403	J462	J374	163.028	0.04	TRAPEZOIDAL	1	2	1	0.14476
C410	J769	J730	28.179	0.04	TRAPEZOIDAL	1	2	1	0.23475
C412	J995	J1374	73.471	0.04	TRAPEZOIDAL	1	2	1	0.02475

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C414	J879	J1415	91.769	0.04	TRAPEZOIDAL	1	2	1	0.04197
C423	J397	J1410	37.656	0.04	TRAPEZOIDAL	1	2	1	0.01009
C424	J767	J1409	95.699	0.04	TRAPEZOIDAL	1	2	1	0.05499
C425	J907	J1408	18.036	0.04	TRAPEZOIDAL	1	2	1	0.04874
C427	J230	J180	30.518	0.04	TRAPEZOIDAL	1	2	1	0.05316
C440	J536	J1401	222.164	0.04	TRAPEZOIDAL	1	2	1	0.11704
C451	J366	J1395	27.568	0.04	TRAPEZOIDAL	1	2	1	0.03361
C452	J920	J864	107.164	0.04	TRAPEZOIDAL	1	2	1	0.05798
C461	J977	J995	41.781	0.04	TRAPEZOIDAL	1	2	1	0.11778
C462	J898	J896	201.597	0.04	TRAPEZOIDAL	1	2	1	0.07774
C466	J276	J1360	125.798	0.04	TRAPEZOIDAL	1	2	1	0.06579
C473	J368	J366	18.01	0.04	TRAPEZOIDAL	1	2	1	0.07315
C477	J857	J1382	55.574	0.04	TRAPEZOIDAL	1	2	1	0.0245
C479	J985	J1382	263.792	0.04	TRAPEZOIDAL	1	2	1	0.06744
C481	J625	J579	115.501	0.04	TRAPEZOIDAL	1	2	1	0.05725
C491	J885	J857	10.455	0.04	TRAPEZOIDAL	1	2	1	-0.00497
C492	J464	J1401	38.948	0.04	TRAPEZOIDAL	1	2	1	0.14151
C493	J487	J462	81.569	0.04	TRAPEZOIDAL	1	2	1	0.063
C495	J274	J219	161.799	0.04	TRAPEZOIDAL	1	2	1	0.07523
C496	J983	J985	11.893	0.04	TRAPEZOIDAL	1	2	1	0.02506
C500	J981	J977	34.3	0.04	TRAPEZOIDAL	1	2	1	-0.00029
C506	J707	J756	107.32	0.04	TRAPEZOIDAL	1	2	1	0.02466
C516	J696	J1363	44.044	0.04	TRAPEZOIDAL	1	2	1	0.05539
C517	J346	J1362	40.424	0.04	TRAPEZOIDAL	1	2	1	0.01061
C520	J283	J1360	58.097	0.04	TRAPEZOIDAL	1	2	1	0.11677
C530	J422	J1356	49.317	0.04	TRAPEZOIDAL	1	2	1	0.35099
C533	J875	J907	59.223	0.04	TRAPEZOIDAL	1	2	1	0.05335
C536	J1017	J1050	213.59	0.04	TRAPEZOIDAL	1	2	1	0.0265
C542	J620	J1351	185.336	0.04	TRAPEZOIDAL	1	2	1	0.10269
C552	J171	J179	60.991	0.04	TRAPEZOIDAL	1	2	1	0.15249
C559	J399	J411	22.97	0.04	TRAPEZOIDAL	1	2	1	0.16385

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C564	J525	J575	305.633	0.04	TRAPEZOIDAL	1	2	1	0.06098
C571	J705	J1475	54.42	0.04	TRAPEZOIDAL	1	2	1	0.02474
C580	J360	J336	156.559	0.04	TRAPEZOIDAL	1	2	1	0.18778
C594	J458	J1463	100.723	0.04	TRAPEZOIDAL	1	2	1	0.02846
C597	C20o	C19o	74.665	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05323
C614	J1033	J1374	136.725	0.04	TRAPEZOIDAL	1	2	1	0.06665
C615	J411	C17i	76.33	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04687
C617	J280	J283	43.562	0.04	TRAPEZOIDAL	1	2	1	-0.00989
C1_3	J3	J4	139.949	0.04	TRAPEZOIDAL	1	2	1	0.04591
C525_1	J278	J5	39.358	0.04	TRAPEZOIDAL	1	2	1	0
C164_1	J1482	J11	109.576	0.04	TRAPEZOIDAL	1	2	1	0
C123_1	J336	J12	71.077	0.04	TRAPEZOIDAL	1	2	1	0
C509_1	C1o	C2i	10.199	0.04	TRAPEZOIDAL	1	2	1	0.0424
C509_2	C2o	J1367	37.979	0.04	TRAPEZOIDAL	1	2	1	0.07003
C113_2	J350	C3i	59.109	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0385
C96	C4o	J278	83.416	0.03	TRIANGULAR	0.2	1.5	1	0.08364
C97	C5o	C6i	7.722	0.03	TRAPEZOIDAL	0.75	1	1	0.01386
C98	C7o	C5o	45.004	0.03	TRAPEZOIDAL	0.75	1	1	0.01536
C99	C8o	C6i	43.206	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01391
C80	P17	C8i	54.807	0.03	TRIANGULAR	0.2	1.5	1	0.029
C84_2	C14o	J1515	45.728	0.03	TRAPEZOIDAL	0.75	1	1	0.04516
C82	J1515	C9i	42.147	0.03	TRAPEZOIDAL	0.75	1	1	0.01737
C104	C10o	C11i	8.783	0.03	TRAPEZOIDAL	0.75	1	1	0.02927
C105	C13o	J36	18.568	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00598
C106	C11o	J13	8.176	0.03	TRAPEZOIDAL	0.75	1	1	0.04371
C109	J37	J13	22.293	0.03	TRAPEZOIDAL	0.5	0.5	1	0.09121
C110	J13	J315	101.077	0.04	TRAPEZOIDAL	1	2	1	0.01478
C78	P37	C16i	62.302	0.03	TRIANGULAR	0.2	1.5	1	0.08295
C111	C22o	C21i	55.178	0.03	TRAPEZOIDAL	0.5	0.5	1	0.10839
C113	C17o	J1350	7.321	0.03	TRAPEZOIDAL	0.5	0.5	1	0.13129
C101_1	C16o	J14	60.385	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00894

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C101_2	J14	C13i	48.368	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00895
C101	C18o	J14	54.312	0.04	TRAPEZOIDAL	1	2	1	0.19742
C115	C21o	J411	14.647	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0918
C563_1	C31o	J15	56.393	0.04	TRAPEZOIDAL	1	2	1	0.06938
C563_2	J15	J1339	141.671	0.04	TRAPEZOIDAL	1	2	1	0.06936
C119	C32o	J15	54.452	0.04	TRAPEZOIDAL	1	2	1	0.05844
C120	C29o	C28i	3.722	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0094
C122	C25o	J1398	48.238	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04316
C128	C28o	J175	41.167	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01134
C121_2	J16	J1398	46.655	0.04	TRAPEZOIDAL	1	2	1	0.06157
C121_3	C27o	J17	4.028	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.00571
C121_4	J17	J16	29.234	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.00571
C121	J2	J17	6.498	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.00693
C121_5	C30o	J18	19.93	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06158
C129	J20	C42i	126.52	0.03	TRIANGULAR	0.2	1.5	1	0.02724
C130_1	J21	J22	122.632	0.03	TRIANGULAR	0.2	1.5	1	0.04467
C130	J23	C31i	44.411	0.03	TRIANGULAR	0.2	1.5	1	0.01049
C131	J24	C30i	33.765	0.03	TRIANGULAR	0.2	1.5	1	0.01327
C132_2	J26	C28i	16.597	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02513
C132_3	J25	J27	39.028	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01871
C132_4	J27	J26	19.582	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02518
C132	C33o	J27	13.462	0.03	TRAPEZOIDAL	0.5	0.5	1	0.10721
C134	J29	C30i	33.56	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04316
C130_3	J22	J30	15.274	0.03	TRIANGULAR	0.2	1.5	1	0.05127
C130_4	J30	J26	41.335	0.03	TRIANGULAR	0.2	1.5	1	0.05128
C426_1	J637	C34i	87.2	0.04	TRAPEZOIDAL	1	2	1	0.18687
C135_2	J31	C19i	101.597	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06563
C135_4	J32	J235	27.016	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06461
C139	C71o	J1482	50.789	0.04	TRAPEZOIDAL	1	2	1	0.04837
C79	J33	J34	10.132	0.01	CIRCULAR	1	0	1	0.01974
C144	C63o	C64i	8.107	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06738

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C80	J41	J42	30.679	0.01	CIRCULAR	1	0	1	0
C148_1	C73o	J43	9.048	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04858
C144_4	J44	C63i	11.86	0.03	TRAPEZOIDAL	0.5	0.5	1	0.08615
C135_5	C64o	J45	34.87	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06033
C135	J46	J45	85.902	0.03	TRAPEZOIDAL	0.5	0.5	1	0.07731
C599_2	C75o	J1361	56.581	0.04	TRAPEZOIDAL	1	2	1	0.02422
C341_2	J1361	C74i	50.458	0.04	TRAPEZOIDAL	1	2	1	-0.00059
C341_3	C74o	J10	90.54	0.04	TRAPEZOIDAL	1	2	1	0.11909
C148_3	C60o	J49	54.374	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06465
C148	C61o	C60i	79.466	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0182
C154	C76o	C59i	56.539	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01619
C155	C58o	C59i	34.757	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01502
C156_1	C59o	J50	30.584	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0319
C156_2	J50	O8	51.605	0.04	TRAPEZOIDAL	1	2	1	0.09507
C102	J51	J52	17.314	0.01	CIRCULAR	0.45	0	1	0.03595
C158	P1	J51	78.819	0.03	TRIANGULAR	0.2	1.5	1	0.04492
C160	P60	J51	39.505	0.03	TRIANGULAR	0.2	1.5	1	0.00691
C161_1	J52	J53	3.673	0.03	TRAPEZOIDAL	0.5	0.5	1	0.07179
C161_2	J53	J50	20.998	0.04	TRAPEZOIDAL	1	2	1	0.03961
C161_3	J54	J55	100.075	0.03	TRIANGULAR	0.2	1.5	1	0.10353
C162	C56o	C57i	32.738	0.03	TRIANGULAR	0.2	1.5	1	0.02081
C166	C57o	C58i	28.006	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01218
C167	C54o	J1467	20.464	0.03	TRAPEZOIDAL	0.75	0.5	1	0.01603
C168	J1467	C55i	24.682	0.03	TRAPEZOIDAL	0.75	1	1	-0.00235
C170	C53o	J1467	51.481	0.03	TRAPEZOIDAL	0.75	0.5	1	0.02028
C171	J8	C53i	8.904	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02708
C164_2	J57	J58	87.609	0.03	TRIANGULAR	0.2	1.5	1	0.03465
C164_4	J58	J59	98.814	0.03	TRIANGULAR	0.2	1.5	1	0.03465
C164_5	J59	C57o	56.127	0.03	TRIANGULAR	0.2	1.5	1	0.03464
C161_5	J56	J60	80.076	0.03	TRIANGULAR	0.2	1.5	1	0.03715
C161_6	J60	C56i	119.59	0.03	TRIANGULAR	0.2	1.5	1	0.03716

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C161	P73	C76o	141.988	0.03	TRIANGULAR	0.2	1.5	1	0.08004
C81	C19o	C76i	73.891	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04804
C161_8	J61	J51	23.826	0.03	TRIANGULAR	0.2	1.5	1	0.00042
C78	J62	J63	14.759	0.01	CIRCULAR	1	0	1	0
C164	J64	J244	127.364	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00314
C173	C38o	C39i	25.948	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01634
C175	C35o	C36i	38.049	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01043
C178	C36o	C39o	11.046	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02626
C182	C34o	J65	43.204	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01859
C185	P21	C42i	77.525	0.03	TRIANGULAR	0.2	1.5	1	0.00774
C186	J67	C29i	6.902	0.03	TRIANGULAR	0.2	1.5	1	0.00869
C188	J66	C29i	20.246	0.03	TRIANGULAR	0.2	1.5	1	0.05928
C172_1	C42o	J68	26.838	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01088
C172	J69	C51i	41.565	0.03	TRIANGULAR	0.2	1.5	1	0.0186
C190_1	J70	J71	77.489	0.03	TRIANGULAR	0.2	1.5	1	0.06463
C190_2	J71	C50i	42.865	0.03	TRIANGULAR	0.2	1.5	1	0.06464
C603_1	J370	J72	33.166	0.04	TRAPEZOIDAL	1	2	1	0.04346
C190	J72	C51i	30.942	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06305
C191	J73	C51i	28.498	0.03	TRIANGULAR	0.2	1.5	1	0.06569
C192	C51o	J338	22.813	0.03	TRAPEZOIDAL	0.5	0.5	1	0.14959
C193	J338	P25	39.021	0.03	TRAPEZOIDAL	0.5	0.5	1	0.14005
C196	C50o	J74	19.634	0.03	TRAPEZOIDAL	0.5	0.5	1	0.20127
C199	J74	J75	28.26	0.04	TRAPEZOIDAL	1	2	1	0.32193
C163_2	J75	C54i	24.849	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05675
C448_1	J313	J77	89.335	0.04	TRAPEZOIDAL	1	2	1	0.12171
C163_3	P24	J77	15.08	0.03	TRIANGULAR	0.2	1.5	1	0.09593
C163_6	J79	C52i	109.419	0.03	TRIANGULAR	0.2	1.5	1	0.07597
C81	J76	J78	11.727	0.01	CIRCULAR	1	0	1	0
C200_1	J78	J80	57.069	0.04	TRAPEZOIDAL	1	2	1	0.09082
C200_2	J80	C52i	49.895	0.04	TRAPEZOIDAL	1	2	1	0.07184
C316_1	J1407	J82	7.172	0.04	TRAPEZOIDAL	1	2	1	-0.00502

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C200_3	J82	J83	35.838	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00396
C200_4	J83	C52i	29.559	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00396
C152_1	C62o	J6	52.202	0.03	TRAPEZOIDAL	0.5	0.5	1	0.03074
C152_2	J6	C61i	12.938	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04588
C143_1	C55o	J87	50.981	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01212
C143_2	J87	C62i	40.767	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01214
C101	P13	J87	11.899	0.023	CIRCULAR	0.45	0	1	0.03658
C152_3	P30	J88	26.371	0.03	TRIANGULAR	0.2	1.5	1	0.02549
C152_4	J88	P13	11.554	0.03	TRIANGULAR	0.2	1.5	1	0.04549
C152_5	J89	J90	21.175	0.03	TRIANGULAR	0.2	1.5	1	0.00557
C152_6	J90	C75i	17.068	0.03	TRIANGULAR	0.2	1.5	1	0.00557
C152	P29	J89	50.387	0.03	TRIANGULAR	0.2	1.5	1	0.08437
C157_1	J91	J92	27.052	0.03	TRIANGULAR	0.2	1.5	1	0.03003
C151	C65o	C66i	10.59	0.03	TRIANGULAR	0.2	1.5	1	0.01473
C157	C67o	C68i	12.067	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00936
C174_1	C68o	J38	7.982	0.04	TRAPEZOIDAL	1	2	1	0.05773
C174_2	J38	J1482	49.683	0.04	TRAPEZOIDAL	1	2	1	0.05766
C174	C66o	J38	8.15	0.04	TRAPEZOIDAL	1	2	1	0.05653
C135_7	J45	J28	54.072	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06034
C135_6	J28	J81	48.131	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06036
C135_9	J81	C68i	66.685	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06035
C200	P40	J84	23.51	0.03	TRIANGULAR	0.2	1.5	1	0.0767
C268_1	J86	J84	5.31	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00791
C268_2	J84	C72i	36.986	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01503
C157_3	J92	J93	51.252	0.03	TRIANGULAR	0.2	1.5	1	0.03862
C157_2	J93	J95	57.433	0.03	TRIANGULAR	0.2	1.5	1	0.03561
C202_1	J94	J96	127.92	0.03	TRIANGULAR	0.2	1.5	1	0.05018
C202_2	J96	C68i	36.476	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06693
C202_4	J98	J4	61.42	0.04	TRAPEZOIDAL	1	2	1	0.03508
C202_6	J100	J98	104.591	0.03	TRIANGULAR	0.2	1.5	1	0.03877
C202	J99	J100	88.093	0.03	TRIANGULAR	0.2	1.5	1	0.0391

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C202_3	J35	J102	34.026	0.03	TRIANGULAR	0.2	1.5	1	0.06864
C202_7	J102	J100	76.175	0.03	TRIANGULAR	0.2	1.5	1	0.03623
C204	J101	J102	84.22	0.03	TRIANGULAR	0.2	1.5	1	0.02415
C205	J103	J101	60.726	0.03	TRIANGULAR	0.2	1.5	1	0.03609
C207	J104	J99	50.284	0.03	TRIANGULAR	0.2	1.5	1	0.0218
C208	J1	J105	147.39	0.03	TRIANGULAR	0.2	1.5	1	0.11468
C146_1	J97	J105	125.674	0.03	TRIANGULAR	0.2	1.5	1	0.1163
C146_2	J105	J44	54.346	0.03	TRIANGULAR	0.2	1.5	1	0.10507
C82	J115	J116	18.318	0.01	CIRCULAR	1	0	1	0
C219_1	C3o	J118	15.686	0.03	TRAPEZOIDAL	0.5	0.5	1	0.13949
C219_2	J118	O6	83.544	0.04	TRAPEZOIDAL	1	2	1	0.13946
C219	J119	C4i	68.352	0.03	TRIANGULAR	0.2	1.5	1	0.03137
C221	J19	C5i	108.849	0.03	TRIANGULAR	0.2	1.5	1	0.01665
C222	J120	C5i	28.435	0.03	TRIANGULAR	0.2	1.5	1	-0.00179
C90_3	J1490	J121	40.731	0.04	TRAPEZOIDAL	1	2	1	0.01495
C84_3	J416	J122	7.924	0.04	TRAPEZOIDAL	1	2	1	0.02563
C84_4	J122	C14i	12.069	0.03	TRAPEZOIDAL	0.75	1	1	0.01235
C84_1	C9o	J125	13.515	0.03	TRAPEZOIDAL	0.75	1	1	0.01036
C84_5	J125	C10i	40.649	0.03	TRAPEZOIDAL	0.75	1	1	0.01333
C444_1	J348	J128	44.248	0.04	TRAPEZOIDAL	1	2	1	0.03725
C444_2	J128	C20i	9.02	0.03	TRAPEZOIDAL	0.5	0.5	1	0.03728
C93_1	J129	J130	152.331	0.03	TRIANGULAR	0.2	1.5	1	0.07933
C93_2	J130	C20i	75.033	0.03	TRIANGULAR	0.2	1.5	1	0.06904
C77	J131	J132	37.463	0.01	CIRCULAR	0.45	0	1	0
C103	J132	C48i	28.221	0.03	TRIANGULAR	0.2	1.5	1	-999
C117	C48o	J129	57.729	0.03	TRIANGULAR	0.2	1.5	1	0.07541
C374_1	J523	C25i	71.145	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01487
C228	C41o	C42o	13.374	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02558
C181_1	J65	J134	13.342	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00757
C181_2	J134	C35i	33.563	0.03	TRAPEZOIDAL	0.5	0.5	1	0.00474
C37	C37o	C37i	3.969	0.023	CIRCULAR	0.45	0	1	0.00554

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C181	C37i	C35i	5.095	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.04361
C230	J135	C34i	117.121	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02694
C231	C40o	J20	41.127	0.03	TRIANGULAR	0.2	1.5	1	0.0609
C112_1	C24o	J136	22.029	0.03	TRIANGULAR	0.2	1.5	1	0.05725
C112_2	J136	J7	48.333	0.03	TRIANGULAR	0.2	1.5	1	0.05726
C112	J136	J7	61.309	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04511
C102	J116	J464	233.263	0.04	TRAPEZOIDAL	1	2	1	-0.12882
C115	J109	J113	25.73	0.01	CIRCULAR	0.6	0	1	0.13986
C140	J113	J114	33.24	0.03	TRAPEZOIDAL	0.5	0.5	1	0.10775
C588_1	J814	J141	75.384	0.04	TRAPEZOIDAL	1	2	1	0.12131
C588_2	J141	J109	57.358	0.03	TRAPEZOIDAL	0.5	0.5	1	0.13409
C215_1	J112	J142	112.128	0.03	TRIANGULAR	0.2	1.5	1	0.02029
C215_2	J142	J140	63.149	0.03	TRIANGULAR	0.2	1.5	1	0.00443
C114_1	J111	J143	90.762	0.03	TRIANGULAR	0.2	1.5	1	-0.33421
C114_2	J143	J139	44.191	0.03	TRIANGULAR	0.2	1.5	1	-0.3342
C107_1	J108	J144	77.397	0.03	TRIANGULAR	0.2	1.5	1	-0.18714
C107_2	J144	J138	39.091	0.03	TRIANGULAR	0.2	1.5	1	-0.18715
C218_1	J106	J145	65.754	0.03	TRIANGULAR	0.2	1.5	1	0
C218_2	J145	J107	60.905	0.03	TRIANGULAR	0.2	1.5	1	0
C120	J107	J203	24.506	0.01	CIRCULAR	0.45	0	1	0.08452
C118	J138	J204	22.417	0.01	CIRCULAR	0.45	0	1	0.10115
C117	J139	J147	24.338	0.01	CIRCULAR	0.45	0	1	0.0921
C119	J140	J148	22.98	0.01	CIRCULAR	0.45	0	1	0.03196
C146_6	J150	C32i	66.989	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.13606
C148_5	J49	J85	56.187	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06465
C148_6	J85	J9	47.773	0.04	TRAPEZOIDAL	1	2	1	0.06465
C1_1	J4	J33	23.4	0.04	TRAPEZOIDAL	1	2	1	0
C1_2	J34	O2	497.337	0.04	TRAPEZOIDAL	1	2	1	0.08638
C146	J153	C73i	42.262	0.04	TRAPEZOIDAL	1	2	1	-0.68292
C107_3	J151	J154	18.102	0.03	TRIANGULAR	0.2	1.5	1	0
C107_4	J154	J153	21.55	0.04	TRAPEZOIDAL	1	2	1	0

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C114_3	J152	J155	19.31	0.03	TRIANGULAR	0.2	1.5	1	0
C114_4	J155	J153	35.339	0.04	TRAPEZOIDAL	1	2	1	0
C161_4	J55	J159	89.344	0.03	TRIANGULAR	0.2	1.5	1	0.14103
C161_9	J156	J61	40.414	0.03	TRIANGULAR	0.2	1.5	1	0.00069
C107	J48	P69	74.126	0.03	TRIANGULAR	0.2	1.5	1	0.12596
C114	P69	J159	53.158	0.03	TRAPEZOIDAL	0.5	0.5	1	0.30983
C540_2	J247	J161	27.479	0.03	TRIANGULAR	0.2	1.5	1	0.1035
C540_3	J161	O7	31.587	0.04	TRAPEZOIDAL	1	2	1	0.10347
C103	J157	J158	10.262	0.01	CIRCULAR	0.45	0	1	0
C104	J159	J160	14.431	0.01	CIRCULAR	0.45	0	1	0
C210	J160	OF2	51.205	0.04	TRAPEZOIDAL	1	2	1	0
C215	J158	OF3	22.115	0.04	TRAPEZOIDAL	1	2	1	0
C126_2	J162	J205	29.459	0.03	TRAPEZOIDAL	0.5	0.5	1	0.07691
C126	J168	J163	80.547	0.03	TRIANGULAR	0.2	1.5	1	0
C217	J163	J164	33.193	0.03	TRAPEZOIDAL	0.5	0.5	1	0
C116	J164	J165	22.227	0.01	CIRCULAR	0.45	0	1	0
C239	C44o	C43i	72.839	0.04	TRAPEZOIDAL	1	2	1	0.0286
C123_2	C47o	J166	9.941	0.03	TRIANGULAR	0.2	1.5	1	0.0904
C123_3	J166	J235	22.153	0.03	TRIANGULAR	0.2	1.5	1	0.09838
C216_1	J169	J170	79.395	0.03	TRAPEZOIDAL	0.5	0.5	1	0
C216_2	J170	J163	32.244	0.03	TRAPEZOIDAL	0.5	0.5	1	0
C216	J173	J164	120.731	0.03	TRIANGULAR	0.2	1.5	1	0.52067
C238	J178	J164	76.281	0.03	TRIANGULAR	0.2	1.5	1	1.00339
C243	J167	C50i	245.511	0.03	TRIANGULAR	0.2	1.5	1	0.09635
C127_1	C39o	J177	24.963	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02934
C127_2	J177	C45i	32.957	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02932
C242	J180	J181	70.678	0.03	TRIANGULAR	0.2	1.5	1	0.08044
C246	J181	J83	34.165	0.03	TRAPEZOIDAL	0.5	0.5	1	0.03303
C127_3	J179	J182	54.331	0.03	TRIANGULAR	0.2	1.5	1	0.09429
C127_4	J182	J181	71.776	0.03	TRIANGULAR	0.2	1.5	1	0.09429
C115_2	J1395	J183	68.898	0.04	TRAPEZOIDAL	1	2	1	0.0617

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C115_3	J183	C7i	24.469	0.03	TRAPEZOIDAL	0.75	1	1	0.0287
C224_1	J123	J185	12.183	0.03	TRIANGULAR	0.2	1.5	1	0.02299
C224_2	J185	C9i	72.562	0.03	TRIANGULAR	0.2	1.5	1	0.03354
C126_3	C45o	J188	63.436	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02668
C126_4	J188	J162	79.79	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02669
C232	C46o	OF4	1.845	0.01	TRAPEZOIDAL	1	2	1	-999
C90_1	C15o	J192	2.815	0.03	TRAPEZOIDAL	0.75	1	1	0.03697
C90_4	J192	J1515	51.813	0.03	TRAPEZOIDAL	0.75	1	1	0.037
C223_1	J121	J193	30.604	0.03	TRAPEZOIDAL	0.75	1	1	0.01399
C223_2	J193	C15i	2.329	0.03	TRAPEZOIDAL	0.75	1	1	0.01589
C223	J193	J191	4.192	0.03	TRAPEZOIDAL	0.75	0.5	1	0.00048
C15	J191	J190	13.807	0.023	CIRCULAR	0.9	0	1	0.04372
C249	J190	J192	1.848	0.03	TRAPEZOIDAL	0.75	0.5	1	0.05637
C227_1	J124	J194	38.995	0.03	TRIANGULAR	0.2	1.5	1	0.006
C106	J194	J195	7.624	0.03	CIRCULAR	0.45	0	1	0.00603
C227_4	J195	C13i	60.428	0.03	TRIANGULAR	0.2	1.5	1	0.00601
C105	J186	J187	7.772	0.01	CIRCULAR	1	0	1	0.02793
C127_6	J187	J198	15.965	0.03	TRIANGULAR	0.2	1.5	1	0.03817
C100	J198	J199	9.286	0.01	CIRCULAR	1	0	1	0.01249
C127_10	J199	C18i	35.335	0.03	TRIANGULAR	0.2	1.5	1	-0.15975
C107	J233	J200	20.21	0.01	CIRCULAR	0.45	0	1	0.06446
C127	J244	C25i	24.391	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.00832
C225_1	J133	J201	37.098	0.03	TRIANGULAR	0.2	1.5	1	0.03377
C225_2	J201	J523	43.407	0.03	TRIANGULAR	0.2	1.5	1	0.03377
C224	J202	J523	75.612	0.03	TRIANGULAR	0.2	1.5	1	0.03466
C146_4	J137	J203	41.424	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05221
C146_7	J203	J150	12.168	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05217
C146_8	J204	J137	40.662	0.03	TRAPEZOIDAL	0.5	0.5	1	0.1092
C146_9	J147	J204	80.322	0.03	TRAPEZOIDAL	0.5	0.5	1	0.1092
C146_5	J114	J148	43.693	0.03	TRAPEZOIDAL	0.5	0.5	1	0.1092
C146_10	J148	J147	79.435	0.03	TRAPEZOIDAL	0.5	0.5	1	0.10921

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C135_8	J146	J31	28.748	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06802
C247_3	J205	J206	29.328	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06163
C232_1	J165	J208	57.608	0.03	TRIANGULAR	0.2	1.5	1	0.09274
C121_1	J18	J175	10.493	0.04	TRAPEZOIDAL	1	2	1	0.06159
C121_7	J175	J16	49.189	0.04	TRAPEZOIDAL	1	2	1	0.06157
C247	C41i	C42i	22.625	0.03	TRIANGULAR	0.2	1.5	1	0.03649
C108	J68	J189	8.145	0.03	CIRCULAR	0.45	0	1	0.00921
C172_4	J189	C44i	20.788	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01054
C252_1	P39	J210	72.979	0.03	TRIANGULAR	0.2	1.5	1	0.06467
C109	J210	C62o	8.517	0.01	CIRCULAR	1	0	1	0.06471
C252	J212	J213	13.385	0.03	TRIANGULAR	0.2	1.5	1	0
C110	J213	J214	10.492	0.01	CIRCULAR	0.45	0	1	0
C254	J214	C60o	9.05	0.03	TRAPEZOIDAL	0.5	0.5	1	-999
C111	J215	J216	11.687	0.01	CIRCULAR	1	0	1	0
C257	P27	C75o	49.088	0.03	TRIANGULAR	0.2	1.5	1	0.03896
C183	J220	C75i	59.134	0.03	TRIANGULAR	0.2	1.5	1	0.05109
C112	J95	J221	16.429	0.03	CIRCULAR	0.45	0	1	0.06778
C157_6	J110	J94	16.751	0.03	TRIANGULAR	0.2	1.5	1	0.04751
C148_4	J43	J222	49.923	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04855
C148_7	J222	J86	23.572	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04855
C260	J221	J222	35.185	0.03	TRAPEZOIDAL	0.5	0.5	1	0.10193
C251	J217	C71i	77.086	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05313
C136	C72o	C71i	59.769	0.03	TRIANGULAR	0.2	1.5	1	0.04995
C113	J225	J223	22.01	0.01	CIRCULAR	1	0	1	0.03551
C124_1	C45o	J224	137.096	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02903
C124_2	J224	C43i	7.279	0.03	TRAPEZOIDAL	0.5	0.5	1	0.029
C124	J223	J224	8.142	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05943
C145_1	J39	J225	36.626	0.03	TRIANGULAR	0.2	1.5	1	0.00653
C138	C43o	J205	57.639	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02939
C46	J149	J208	15.998	0.01	CIRCULAR	0.8	0	1	-0.00569
C145	J206	J149	12.893	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.00636

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C227_2	J197	J226	50.571	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02407
C227_5	J226	C16i	57.117	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02408
C127_9	J184	J227	47.548	0.03	TRIANGULAR	0.2	1.5	1	0.43177
C127_11	J227	J186	19.511	0.03	TRIANGULAR	0.2	1.5	1	0.03005
C227	J235	J127	78.74	0.03	TRIANGULAR	0.2	1.5	1	0.06364
C234	J127	J228	60.465	0.03	TRIANGULAR	0.2	1.5	1	0.0899
C258	J228	J146	24.795	0.03	TRAPEZOIDAL	0.5	0.5	1	0.02578
C247_1	J208	J229	117.512	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06032
C247_4	J229	J231	66.44	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06033
C247_5	J231	J146	65.055	0.03	TRAPEZOIDAL	0.5	0.5	1	0.06032
C90_2	C23o	J233	25.137	0.03	TRIANGULAR	0.2	1.5	1	0.0567
C90	J200	J1428	43.464	0.04	TRAPEZOIDAL	1	2	1	0.09608
C259	J236	P24	31.199	0.01	TRIANGULAR	0.2	1.5	1	0.09102
C163_4	J77	J237	71.796	0.03	TRIANGULAR	0.2	1.5	1	0.12752
C114	J237	J239	15.167	0.023	CIRCULAR	0.45	0	1	0.08883
C163_5	P25	J240	3.895	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05683
C163_7	J240	J75	161.41	0.03	TRAPEZOIDAL	0.5	0.5	1	0.05677
C262	J239	J240	5.775	0.03	TRAPEZOIDAL	0.5	0.5	1	0.08166
C225_3	J117	J241	137.866	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0742
C225_4	J241	J109	97.89	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0742
C225	J242	J416	33.359	0.03	TRAPEZOIDAL	0.5	0.5	1	0.01055
C263	J243	J416	35.558	0.03	TRAPEZOIDAL	0.5	0.5	1	0.0236
C19	J245	J246	18.447	0.023	CIRCULAR	0.6	0	1	0.05625
C265	C19i	J245	1.617	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.04891
C266	J246	C19o	3.063	0.03	TRAPEZOIDAL	0.5	0.5	1	-0.04444
C267	C55i	J248	1.685	0.03	TRAPEZOIDAL	0.5	0.5	1	-999
C55	J248	J249	12.322	0.023	CIRCULAR	0.6	0	1	0
C269	J249	C55o	1.862	0.03	TRAPEZOIDAL	0.5	0.5	1	-999
C272	C6i	J250	2.789	0.03	TRAPEZOIDAL	0.75	0.5	1	-0.00825
C6	J250	J251	30.642	0.03	CIRCULAR	0.6	0	1	0.03743
C274	J251	C6o	3.084	0.03	TRAPEZOIDAL	0.75	0.5	1	0.00032

Name	Inlet Node	Outlet Node	Length (m)	Roughness	Cross-Section	Geom1 (m)	Geom2 (m)	Barrels	Slope (m/m)
C83	J252	J253	7.314	0.01	CIRCULAR	1	0	1	0
C84	J254	J255	16.628	0.01	CIRCULAR	1	0	1	0
C244_2	J256	C19i	115.24	0.03	TRIANGULAR	0.2	1.5	1	0.08767
C123	J40	J44	138.176	0.03	TRAPEZOIDAL	0.5	0.5	1	0.09572
C233_1	J172	J176	194.796	0.03	TRAPEZOIDAL	0.5	0.5	1	0.04607
C233_2	J176	J4	198.481	0.03	TRAPEZOIDAL	1	2	1	0.05159

Table H-2: Junctions PCSWMM Parameters

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
C10i	424636.6	7123505	8.018	9.218
C10o	424636.1	7123516	7.377	7.377
C11i	424634.3	7123525	7.12	8.32
C11o	424634.1	7123533	6.657	7.657
C13i	424693.2	7123521	9.497	10.097
C13o	424681.7	7123526	9.26	9.86
C14i	424650.2	7123340	11.975	11.975
C14o	424650.8	7123350	11.623	11.623
C15i	424703.9	7123353	12.148	12.948
C15o	424694.3	7123363	11.58	12.38
C16i	424757.8	7123428	11.778	12.378
C16o	424746.2	7123440	10.47	11.07
C17i	424856.9	7123402	21.641	22.241
C17o	424842.4	7123397	21.3	21.9
C18i	424800.2	7123524	21.427	21.727
C18o	424781.6	7123520	20.449	20.749
C19i	425212.7	7123585	19.021	19.821
C19o	425196.1	7123591	18.2	19
C1i	424134.4	7123553	28.87	29.17
C1o	424139.7	7123554	28.819	29.119
C20i	425212	7123514	22.329	22.779
C20o	425211.6	7123519	22.169	22.619
C21i	424915.3	7123310	29.523	30.123
C21o	424904.5	7123325	26.554	27.154
C22i	424945.9	7123243	36.611	37.061
C22o	424938.1	7123259	35.469	35.919
C23o	424951.1	7123206	38.623	38.923
C24i	425016.2	7123155	44.697	45.147
C24o	425003.5	7123158	43.352	43.802
C25i	425020.1	7123131	45.003	45.453
C25o	424999.2	7123123	44.365	44.815

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
C26i	425043.7	7123067	46.75	47.35
C26o	425013.4	7123071	44.962	45.562
C27i	425026.6	7123047	46.913	47.313
C27o	425013.4	7123071	44.962	45.362
C28i	425050.1	7123006	49.929	50.529
C28o	425037.2	7123023	48.642	49.242
C29i	425070.7	7123014	50.18	50.63
C29o	425052.6	7123009	49.964	50.414
C2i	424149.1	7123551	28.387	28.787
C2o	424155.7	7123548	28.222	28.622
C30i	425007.5	7122990	49.99	50.49
C30o	425005.8	7123009	50.045	50.545
C31i	424920.6	7122987	49.903	49.903
C31o	424919.9	7123001	49.573	49.573
C32i	424865.3	7123010	49.167	50.067
C32o	424877.3	7123022	48.847	49.747
C33i	425068.1	7122955	58.373	58.873
C33o	425057.3	7122960	52.274	52.774
C34i	425350.8	7122884	54.808	55.308
C34o	425356.1	7122896	54.563	55.063
C35i	425357	7122964	53.5	54.3
C35o	425360	7122972	53.3	54.1
C36i	425325.1	7122988	52.903	53.603
C36o	425312.4	7122994	52.554	53.254
C37i	425351.9	7122965	53.278	53.728
C37o	425348.8	7122963	53.3	53.75
C38i	425344.7	7122956	53.132	53.732
C38o	425328.6	7122965	52.783	53.383
C39i	425302.4	7122981	52.359	52.859
C39o	425303	7123000	52.264	52.764
C3i	424352.3	7123565	14.02	14.47
C3o	424357.1	7123576	13.706	14.156

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
C40i	425243.3	7122955	60.143	60.593
C40o	425243.3	7122967	55.493	55.943
C41i	425145.3	7123038	50.373	50.823
C41o	425162.3	7123066	49.648	50.098
C42i	425146.5	7123057	49.548	49.648
C42o	425157.2	7123078	49.306	49.406
C43i	425258	7123174	46.142	47.042
C43o	425262.7	7123191	45.944	46.844
C44i	425198.9	7123115	48.72	49.02
C44o	425207.4	7123127	48.224	48.524
C45i	425314.9	7123056	50.566	51.166
C45o	425316	7123068	50.331	50.931
C46i	425318	7123252	43.338	44.138
C46o	425319.5	7123266	43.136	43.936
C47i	425267	7123232	45.131	45.581
C47o	425267.3	7123275	41.744	42.194
C48i	425251.4	7123238	44.888	45.338
C48o	425253	7123246	43.884	44.334
C49i	425266.2	7123307	38.7	39.3
C49o	425261	7123434	30.075	30.675
C4i	424445.9	7123522	11.819	11.969
C4o	424446.2	7123533	11.558	11.708
C50i	425457.4	7123569	30.637	31.237
C50o	425457.6	7123580	30.184	30.784
C51i	425611.5	7123501	37.567	38.317
C51o	425611.4	7123526	35.806	36.556
C52i	425527.4	7123664	17.797	18.397
C53i	425483	7123669	17.179	17.979
C53o	425474.5	7123669	16.997	17.797
C54i	425427	7123638	16.242	16.692
C54o	425425.8	7123652	16.281	16.731
C55i	425401.2	7123682	16.011	16.811

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
C55o	425392.2	7123692	15.693	16.493
C56i	425196	7123737	9.236	9.336
C56o	425185.9	7123742	8.86	8.96
C57i	425156.4	7123756	8.179	8.329
C57o	425149.7	7123748	8.042	8.192
C58i	425121.8	7123749	7.701	8.151
C58o	425099.7	7123747	7.199	7.649
C59i	425066.5	7123740	6.677	6.677
C59o	425052.8	7123754	5.859	5.859
C5i	424546.6	7123456	9.859	10.359
C5o	424563.6	7123454	9.278	9.778
C60i	425193.9	7123851	10.339	11.139
C60o	425187	7123864	10.215	11.015
C61i	425265.6	7123804	12.276	12.776
C61o	425260.1	7123809	11.785	12.285
C62i	425326.7	7123756	14.58	15.08
C62o	425316.1	7123765	14.473	14.973
C63i	425584.9	7124150	29.781	30.381
C63o	425567.6	7124155	28.235	28.835
C64i	425559.6	7124156	27.69	28.29
C64o	425556	7124169	26.942	27.542
C65i	425503.3	7124387	15.75	16.15
C65o	425497.6	7124382	15.403	15.803
C66i	425489.1	7124376	15.247	15.647
C66o	425478.6	7124366	14.52	14.92
C67i	425502.8	7124361	15.08	15.48
C67o	425495	7124359	14.781	15.181
C68i	425485	7124352	14.668	15.468
C68o	425478	7124361	14.52	15.32
C69i	425467.1	7124298	16.356	16.756
C69o	425458.3	7124308	15.801	16.201
C6i	424570.5	7123458	9.171	10.071

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
C70i	425450.9	7124315	15.436	15.836
C70o	425444.3	7124320	15.026	15.426
C71i	425430	7124330	14.51	15.11
C71o	425432	7124346	13.654	14.254
C72i	425456.2	7124249	18.8	19.4
C72o	425472.8	7124289	17.492	18.092
C73i	425398.2	7124139	23.834	24.434
C73o	425407.9	7124144	23.401	24.001
C74i	425174.3	7123964	10.803	11.503
C74o	425167.2	7123968	10.707	11.407
C75i	425283.8	7123931	12.433	12.733
C75o	425272.2	7123937	12.143	12.443
C76i	425137.9	7123636	14.654	15.454
C76o	425102	7123696	7.592	8.392
C7i	424523	7123408	10.598	11.198
C7o	424534.7	7123421	9.969	10.569
C8i	424579.1	7123401	10.1	10.1
C8o	424571.7	7123418	9.772	9.772
C9i	424638.9	7123435	8.828	10.028
C9o	424636.3	7123451	8.7	8.7
J1017	424268.1	7122013	168.539	168.539
J1023	424490.1	7122043	162.905	162.905
J1033	424770.1	7122043	163.23	163.23
J1050	424457.1	7122010	162.88	162.88
J1339	424888.1	7123187	35.867	35.867
J1350	424835.1	7123397	20.347	20.347
J1351	424618.1	7123072	46.286	46.286
J1356	423561.1	7123361	51.706	51.706
J1360	423686.1	7123664	22.929	22.929
J1361	425221.1	7123954	10.773	10.773
J1362	423998.1	7123418	40.617	40.617
J1363	424902.1	7122789	71.632	71.632

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J1365	423689.1	7123321	62.253	62.253
J1367	424190.1	7123542	25.569	25.569
J1374	424722.1	7122157	154.137	154.137
J1377	425453.1	7124384	11.117	11.117
J1382	424591.1	7122382	131.539	131.539
J1395	424446.1	7123393	15.543	15.543
J1398	424953.1	7123117	42.285	42.285
J1401	424746.1	7123248	24.345	24.345
J1407	425503.1	7123711	18.02	18.02
J1408	424261.1	7122427	136.65	136.65
J1409	424493.1	7122608	101.508	101.508
J1410	424072.1	7123396	39.031	39.031
J1415	424225.1	7122452	134.269	134.269
J1421	424546.1	7122608	96.824	96.824
J1428	424884.1	7123232	31.743	31.743
J1437	424844.1	7122878	57.842	57.842
J1440	424642.1	7123200	29.182	29.182
J1459	424418.1	7122914	69.818	69.818
J1463	424367.1	7123231	38.221	38.221
J1467	425423.3	7123673	15.953	15.953
J1475	424352.1	7122761	83.154	83.154
J1482	425439.1	7124398	11.2	11.2
J1489	424549.1	7122401	129.399	129.399
J1490	424743.1	7123311	13.222	13.222
J1515	424652.1	7123395	9.56	9.56
J171	425535.1	7123857	40.074	40.074
J174	423870.1	7123895	4.755	4.755
J196	423884.1	7123817	9.073	9.073
J2	425017.2	7123074	44.94	45.54
J207	423916.1	7123797	9.997	9.997
J211	423870.1	7123852	9.022	9.022
J219	423939.1	7123748	15.24	15.24

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J230	425611.1	7123737	26.329	26.329
J234	423933.1	7123759	13.642	13.642
C6o	424590.1	7123481	8.047	8.047
J247	424847.3	7123683	6.08	6.08
J263	423551.1	7123636	20.304	20.304
J274	424052.1	7123636	27.378	27.378
J276	423796.1	7123619	31.187	31.187
J278	424488.1	7123598	4.605	4.605
J280	423699.1	7123596	29.236	29.236
J283	423728.1	7123628	29.667	29.667
J3	425998.1	7124018	49.418	49.418
J313	425733.1	7123504	48.485	48.485
J315	424631.1	7123635	4.806	4.806
J336	423399.1	7123515	12.739	12.739
J338	425612.1	7123549	32.431	32.431
J344	424310.1	7123494	16.8	16.8
J346	423966.1	7123442	41.046	41.046
J348	425186.1	7123471	24.312	24.312
J350	424330.1	7123510	16.294	16.294
J357	424215.1	7123529	24.271	24.271
J36	424665.1	7123534	9.149	9.749
J360	423507.1	7123411	41.632	41.632
J366	424422.1	7123400	16.469	16.469
J368	424406.1	7123394	17.783	17.783
J37	424655.5	7123537	8.325	8.925
J370	425615.1	7123441	40.954	40.954
J374	423960.1	7123380	60.292	60.292
J395	424115.1	7123454	34.618	34.618
J397	424091.1	7123369	39.411	39.411
J399	424920.1	7123335	28.929	28.929
J4	426110.3	7124093	43	43
J405	424860.1	7123355	22.383	22.383

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J411	424898.1	7123338	25.215	25.215
J416	424648	7123321	12.313	12.313
J422	423541.1	7123319	68.039	68.039
J452	424376.1	7123241	37.783	37.783
J456	423663.1	7123337	57.37	57.37
J458	424275.1	7123252	41.086	41.086
J462	423901.1	7123241	83.649	83.649
J464	424776.1	7123224	29.802	29.802
J470	423707.1	7123267	73.678	73.678
J472	423728.1	7123213	84.4	84.4
J475	424216.1	7123186	56.987	56.987
J487	423874.1	7123178	88.778	88.778
J494	424185.1	7123156	62.851	62.851
J501	424642.1	7123276	14.753	14.753
J523	425085.1	7123130	46.061	46.061
J525	423993.1	7123075	93.102	93.102
J529	424465.1	7123082	53.064	53.064
J532	424306.1	7123092	61.178	61.178
J536	424742.1	7123027	50.17	50.17
J542	424756.1	7123235	27.053	27.053
J567	424296.1	7123023	67.715	67.715
J575	424247.1	7122982	74.499	74.499
J579	424299.1	7122992	69.219	69.219
J590	424462.1	7123068	54.025	54.025
J596	425413.1	7122929	54.214	54.214
J620	424590.1	7122932	65.219	65.219
J625	424296.1	7122898	75.821	75.821
J637	425293.1	7122846	70.826	70.826
J644	424899.1	7122833	66.473	66.473
J650	424199.1	7122698	118.252	118.252
J661	424509.1	7122778	77.647	77.647
J696	424916.1	7122749	74.068	74.068

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J7	424953	7123197	39.33	39.63
J705	424396.1	7122733	84.5	84.5
J707	424647.1	7122701	81.123	81.123
J730	424919.1	7122656	83.644	83.644
J740	424166.1	7122620	121	121
J756	424580.1	7122773	78.477	78.477
J767	424402.1	7122620	106.763	106.763
J769	424938.1	7122636	90.084	90.084
J774	424521.1	7122536	115.759	115.759
J779	424202.1	7122554	122.853	122.853
J8	425491.8	7123669	17.42	18.02
J812	424209.1	7122467	131.033	131.033
J814	424892.1	7122502	111.49	111.49
J824	424487.1	7122582	108.552	108.552
J830	424186.1	7122598	122.123	122.123
J845	424848.1	7122411	144.51	144.51
J857	424642.1	7122369	132.9	132.9
J86	425438.1	7124211	19.398	19.398
J864	424822.1	7122365	148.121	148.121
J869	424517.1	7122508	117.353	117.353
J875	424303.1	7122369	140.683	140.683
J879	424299.1	7122425	138.117	138.117
J885	424651.1	7122364	132.848	132.848
J896	424233.1	7122372	141.844	141.844
J898	424071.1	7122306	157.47	157.47
J902	424564.1	7122296	133.735	133.735
J907	424276.1	7122418	137.528	137.528
J920	424836.1	7122282	154.324	154.324
J944	424566.1	7122240	138.492	138.492
J946	424544.1	7122209	147.603	147.603
J969	424486.1	7122176	154.935	154.935
J977	424829.1	7122134	160.842	160.842

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J981	424859.1	7122126	160.832	160.832
J983	424597.1	7122140	149.587	149.587
J985	424587.1	7122146	149.289	149.289
J993	424691.1	7122185	153.424	153.424
J995	424790.1	7122139	155.955	155.955
P1	425102.3	7123682	10.137	10.137
P12	424800.8	7123408	19.218	19.218
P13	425371.1	7123730	15.51	15.51
P17	424604.2	7123352	11.689	11.689
P2	425432.6	7123670	16.115	16.115
P21	425080.3	7123021	50.148	50.148
P22	425030	7123245	44.68	44.68
P24	425652.3	7123510	39.132	39.132
P25	425605.3	7123587	27.019	27.019
P26	425490.3	7124267	18.521	18.521
P27	425280.2	7123984	14.054	14.054
P28	425267.7	7123914	12.368	12.368
P29	425288.2	7123872	16.882	16.882
P3	423850.2	7123886	5.15	5.15
P30	425404	7123725	16.707	16.707
P31	425138.3	7123651	13.661	13.661
P32	425318.9	7123680	15.019	15.019
P35	424876.9	7123365	24.157	24.157
P37	424784	7123483	16.928	16.928
P39	425317.3	7123838	19.733	19.733
P40	425416.8	7124221	21.154	21.154
P43	425769.4	7123490	49.009	49.009
P44	424929.3	7123353	31.426	31.426
P45	424810.4	7123485	21.076	21.076
P46	424862.9	7123470	25.197	25.197
P49	425058.2	7123309	48.12	48.12
P54	425174	7124037	11.174	11.174

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
P58	425431	7123721	16.432	16.432
P59	425220.4	7123862	11.075	11.075
P6	425184	7123100	49.02	49.02
P60	425058.4	7123693	6.873	6.873
P69	425004.3	7123637	15.732	15.732
P70	425332.1	7122983	53.016	53.016
P72	426301.7	7123669	41.489	41.489
P73	425206.3	7123603	18.92	18.92
P74	425205.6	7123572	18.959	18.959
P75	425417	7123707	16.068	16.068
P76	425190.6	7123956	10.416	10.416
P77	425027.2	7123041	46.926	46.926
J13	424633.6	7123541	6.3	6.3
J14	424732.9	7123498	9.93	10.53
J15	424917	7123055	45.67	45.67
J16	424984.3	7123082	45.152	45.337
J17	425010.7	7123074	44.985	45.359
J18	425005.4	7123029	48.82	49.241
J20	425260.3	7123004	52.993	52.993
J21	425222.9	7122928	58.718	58.718
J22	425105.5	7122963	53.245	53.583
J23	424964.9	7122986	50.369	50.369
J24	424974.7	7122986	50.438	50.438
J25	425017.4	7122957	51.569	51.569
J26	425056.6	7122991	50.346	50.793
J27	425052.9	7122973	50.839	51.106
J29	425012	7122958	51.437	51.437
J30	425092.1	7122970	52.463	52.83
J31	425256.2	7123499	25.675	26.355
J32	425294.6	7123306	40.422	41.102
J33	426126.4	7124110	43	43
J34	426130.1	7124119	42.8	42.8

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J41	425448.3	7124094	28.183	28.183
J42	425429.7	7124119	26.395	26.395
J43	425416.1	7124148	22.962	23.496
J44	425595.8	7124145	30.799	31.342
J45	425553.5	7124204	24.842	25.476
J46	425619	7124159	31.463	31.463
J47	425281.1	7123939	13.02	13.02
J49	425146.9	7123900	6.707	7.507
J50	425024	7123763	4.884	5.107
J51	425043	7123729	6.6	6.6
J52	425041	7123746	5.978	5.978
J53	425038.1	7123748	5.715	5.748
J54	424824.1	7123587	22.783	22.783
J55	424908.2	7123641	12.477	12.477
J56	425381.4	7123664	16.65	16.65
J57	425373.1	7123655	16.441	16.441
J58	425291.2	7123686	13.407	13.461
J59	425199.1	7123722	9.985	10.1
J60	425306.6	7123692	13.677	13.717
J61	425022.7	7123716	6.61	6.61
J62	425036.9	7123291	45.317	45.317
J63	425022.3	7123293	46.431	46.431
J64	425037.7	7123282	45.2	45.2
J65	425358.2	7122929	53.76	53.76
J66	425079.3	7122996	51.378	51.378
J67	425076.6	7123018	50.24	50.24
J68	425177.7	7123095	49.014	49.214
J69	425571.3	7123508	38.34	38.34
J70	425561.3	7123512	38.4	38.4
J71	425497.7	7123556	33.402	33.788
J72	425608.6	7123470	39.514	39.514
J73	425639.4	7123495	39.435	39.435

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J74	425457	7123599	26.31	26.31
J75	425448.5	7123626	17.65	18.041
J77	425653.1	7123525	37.692	37.733
J76	425637.5	7123633	26.39	26.39
J78	425628.6	7123641	26.534	26.534
J79	425613.5	7123614	26.086	26.351
J80	425573.1	7123650	21.372	21.692
J82	425497.1	7123707	18.056	18.056
J83	425525.5	7123694	17.914	18.243
J6	425275.4	7123797	12.869	13.369
J87	425362.4	7123722	15.075	15.708
J88	425380.3	7123723	16.035	16.035
J89	425257.9	7123905	12.646	12.646
J90	425275.9	7123916	12.528	12.694
J91	425414.3	7124048	30.054	30.054
J92	425430.3	7124070	29.242	29.242
J38	425470.6	7124364	14.06	14.749
J28	425534.3	7124255	21.585	22.272
J81	425528.5	7124302	18.685	19.419
J84	425439.7	7124216	19.356	19.426
J93	425454.3	7124115	27.264	27.264
J94	425487.5	7124201	23.515	23.515
J95	425480.2	7124167	25.22	25.22
J96	425467.2	7124321	17.104	17.684
J97	425771.5	7124106	50.996	50.996
J35	425835.2	7124095	54.293	54.293
J98	426049.3	7124100	45.153	45.153
J99	425945.8	7124015	52.647	52.647
J100	425945	7124103	49.205	49.205
J101	425871.6	7124013	53.996	53.996
J102	425869.1	7124097	51.963	51.963
J103	425832.3	7123984	56.186	56.186

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J104	425917.2	7123987	53.743	53.743
J1	425751.1	7124064	53.271	53.271
J105	425648.9	7124134	36.478	36.857
J106	424688.7	7122933	64.948	64.948
J107	424815.3	7122934	56.133	56.133
J108	424693.1	7122853	69.972	69.972
J111	424690.1	7122773	77.773	77.773
J112	424679.1	7122694	81.275	81.275
J114	424897.4	7122663	82.729	82.729
J115	424818.8	7123008	50.098	50.098
J116	424816.2	7123026	49.05	49.05
J118	424363.6	7123590	11.539	11.989
J119	424384.7	7123552	13.962	13.962
J19	424472	7123511	11.671	11.671
J120	424528.1	7123435	9.808	9.808
J121	424706	7123322	12.613	13.067
J122	424649.1	7123328	12.124	12.124
J123	424708.7	7123399	11.54	11.54
J124	424716.2	7123448	10.14	10.14
J125	424636.3	7123465	8.56	8.56
J126	425266.5	7123330	37.697	37.697
J127	425264.2	7123385	33.679	33.995
J128	425204.7	7123509	22.665	23.039
J129	425251.5	7123304	39.543	39.543
J130	425245.6	7123456	27.497	27.798
J131	425223	7123179	47.612	47.612
J132	425237.4	7123214	46.715	46.715
J133	425150.3	7123090	48.778	48.778
J134	425363.6	7122941	53.659	53.903
J135	425241.2	7122925	57.962	57.962
J136	424982.2	7123164	42.093	42.496
J137	424831.8	7122895	56.229	56.831

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J109	424898	7122613	89.854	89.854
J138	424809.6	7122853	62.899	62.899
J139	424825	7122774	71.594	71.594
J140	424854.3	7122695	78.72	78.72
J113	424913.1	7122634	86.29	86.29
J141	424916.3	7122566	97.745	97.745
J142	424791.2	7122695	79	79
J143	424780.8	7122774	72.948	72.948
J144	424770.5	7122853	66.145	66.145
J145	424754.4	7122933	58.93	58.93
J150	424843.2	7122947	53.435	54.169
J85	425097.8	7123927	3.082	3.882
J151	425325.9	7124121	24.254	24.254
J152	425320.3	7124114	24.391	24.391
J153	425363	7124116	23.62	23.62
J154	425341.5	7124117	23.855	23.855
J155	425331.5	7124102	24.018	24.018
J48	425054.7	7123583	24.996	24.996
J156	424993.4	7123691	6.638	6.638
J157	424896.1	7123673	7.292	7.292
J158	424896.1	7123683	6.356	6.356
J159	424984.1	7123686	6.694	6.694
J160	424974.8	7123697	6.922	6.922
J161	424842.8	7123710	3.251	3.251
J162	425312	7123207	46.51	47
J163	425406.5	7123226	52.929	52.929
J164	425373.6	7123231	49.535	49.535
J165	425354.8	7123243	47.94	47.94
J167	425408.2	7123331	54.182	54.182
J168	425433.5	7123302	56.188	56.188
J169	425422.5	7123120	53.834	53.834
J166	425267.1	7123285	40.849	41.343

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J170	425417.6	7123196	53.717	53.717
J173	425389.1	7123115	55.756	55.756
J178	425400.7	7123302	54.03	54.03
J177	425308.1	7123024	51.532	52.075
J179	425507.7	7123805	30.88	30.88
J180	425585.6	7123729	24.709	24.709
J181	425528.3	7123726	19.042	19.042
J182	425551.7	7123775	25.78	25.78
J183	424508.1	7123389	11.3	11.75
J185	424706.7	7123410	11.26	11.26
J39	425202.5	7123148	47.856	47.856
J188	425319.1	7123132	48.639	49.19
J190	424691.1	7123361	11.58	11.58
J191	424700.7	7123351	12.183	12.183
J192	424691.3	7123363	11.476	12.235
J193	424704.8	7123350	12.185	12.961
J194	424678.4	7123455	9.906	10.125
J195	424679.8	7123463	9.86	10.122
J197	424730.2	7123337	14.37	14.37
J184	424896.9	7123481	26.35	26.35
J186	424864.7	7123539	24.626	24.774
J187	424857	7123538	24.409	24.575
J198	424843.5	7123530	23.8	24.001
J199	424834.9	7123527	23.684	23.906
J200	424927.5	7123232	35.9	35.9
J201	425124.4	7123116	47.526	47.526
J202	425114.6	7123066	48.68	48.68
J203	424839.8	7122935	54.069	54.773
J204	424832	7122854	60.643	61.145
J147	424849.2	7122776	69.362	69.666
J148	424876.3	7122702	77.986	78.094
J117	424662.4	7122612	107.3	107.3

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J146	425260.6	7123470	27.626	28.271
J205	425310.4	7123211	44.251	44.875
J206	425321.9	7123238	42.447	43.073
J208	425313.2	7123260	42.62	42.909
J175	425004.7	7123039	48.175	48.555
J189	425183.3	7123101	48.939	49.165
J210	425323.6	7123769	15.023	15.471
J212	425214	7123864	10.928	10.928
J213	425202.3	7123870	10.747	10.747
J214	425191.9	7123872	10.477	10.477
J215	425178.3	7123972	0	0
J216	425167.6	7123977	0	0
J217	425454	7124267	18.6	18.6
J218	425777.7	7124124	0	0
J220	425292.4	7123988	15.45	15.45
J110	425484.9	7124185	24.31	24.31
J221	425469	7124179	24.109	24.109
J222	425435.1	7124188	20.541	20.712
J223	425243.4	7123171	46.836	46.836
J224	425251.5	7123171	46.353	47.238
J225	425222.7	7123179	47.617	47.617
J149	425310.5	7123244	42.529	42.995
J226	424745.7	7123384	13.153	13.435
J227	424874.1	7123522	25.212	25.317
J228	425263.2	7123446	28.265	28.265
J229	425299.4	7123360	35.544	36.001
J231	425295.8	7123426	31.543	32.095
J233	424947.7	7123230	37.2	37.6
J235	425267.6	7123307	38.68	38.68
J236	425657	7123480	41.96	41.96
J237	425623.3	7123590	28.61	28.626
J239	425608.2	7123589	27.268	27.268

Name	X-Coordinate	Y-Coordinate	Invert Elev. (m)	Rim Elev. (m)
J240	425602.5	7123590	26.798	26.807
J241	424800.2	7122613	97.098	97.098
J242	424615.3	7123318	12.665	12.665
J243	424684.6	7123314	13.152	13.152
J244	425021.6	7123156	44.8	44.8
J245	425212.8	7123583	19.1	19.1
J246	425195	7123588	18.064	18.064
J248	425401.9	7123684	15.988	15.988
J249	425393.8	7123693	15.744	15.744
J250	424572.7	7123456	9.194	9.194
J251	424592.8	7123479	8.048	8.048
J252	424598.1	7123085	0	0
J253	424600.5	7123092	0	0
J254	424586.4	7123033	0	0
J255	424584.5	7123049	0	0
J256	425316.5	7123609	29.086	29.636
J40	425663	7124050	43.965	43.965
J172	425816.7	7123938	62.192	62.192
J176	426011.2	7123941	53.227	53.227

Table H-3: Subcatchments PCSWMM Parameters

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S24	C65i	0.90	79.03	113.63	16.0	0	0.018	0.04	1.5	2	7	91
S29	C65i	0.56	41.67	134.88	16.2	0	0.018	0.04	1.5	2	7	91
S41	C67i	1.09	50.96	212.93	21.2	0.7	0.018	0.04	1.5	2	7	91
S42	C67i	1.40	120.93	115.85	21.3	0.8	0.018	0.04	1.5	2	7	91
S59	C73i	0.75	116.41	64.52	10.3	1.6	0.018	0.04	1.5	2	7	91
S64	C64i	1.61	51.83	310.80	14.0	0.5	0.018	0.04	1.5	2	7	91
S66	J105	1.17	65.19	179.01	12.8	0	0.018	0.04	1.5	2	7	91
S73	J91	0.63	48.40	130.58	7.6	0	0.018	0.04	1.5	2	7	91
S116	J90	1.95	139.29	139.71	20.2	0.5	0.018	0.04	1.5	2	7	91
S119	J209	1.72	69.14	249.05	12.9	0	0.018	0.04	1.5	2	7	91
S121	J171	0.83	53.91	154.70	5.3	0	0.018	0.04	1.5	2	7	91
S125	J174	0.47	71.56	65.96	21.6	0	0.018	0.04	1.5	2	7	91
S129	J180	1.11	71.18	155.37	14.1	0	0.018	0.04	1.5	2	7	91
S133	J181	1.20	92.97	129.51	15.0	0	0.018	0.04	1.5	2	7	91
S137	J211	1.07	67.02	159.51	17.8	0	0.018	0.04	1.5	2	7	91
S143	J6	1.59	221.25	72.00	13.3	16.4	0.018	0.04	1.5	2	7	91
S146	J1407	0.87	130.91	66.38	14.2	0.3	0.018	0.04	1.5	2	7	91
S151	J230	0.81	68.67	117.67	10.5	0	0.018	0.04	1.5	2	7	91
S153	J196	1.52	90.22	168.70	10.4	0	0.018	0.04	1.5	2	7	91
S158	C55i	1.04	68.16	152.58	22.4	3.2	0.018	0.04	1.5	2	7	91
S161	J207	0.79	39.35	199.77	12.5	0	0.018	0.04	1.5	2	7	91
S165	J230	1.12	82.05	136.74	6.3	0	0.018	0.04	1.5	2	7	91
S173	J234	0.84	88.35	94.63	13.5	0	0.018	0.04	1.5	2	7	91
S175	J238	1.32	80.00	164.87	20.0	0	0.018	0.04	1.5	2	7	91
S176	J232	1.20	167.56	71.62	18.8	0	0.018	0.04	1.5	2	7	91
S177	J219	1.70	133.97	126.90	13.1	0	0.018	0.04	1.5	2	7	91
S182	C76o	0.58	66.96	86.62	23.4	4.5	0.018	0.04	1.5	2	7	91
S185	P1	0.82	81.80	100.74	22.4	1.3	0.018	0.04	1.5	2	7	91
S189	J1360	0.71	116.53	60.84	12.5	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S190	J58	0.70	44.47	157.85	18.2	3	0.018	0.04	1.5	2	7	91
S195	J1467	0.18	28.24	63.74	19.0	12.2	0.018	0.04	1.5	2	7	91
S201	J274	1.05	60.11	175.35	13.5	0	0.018	0.04	1.5	2	7	91
S202	J75	1.75	119.58	146.43	23.7	1	0.018	0.04	1.5	2	7	91
S204	J263	2.67	81.10	329.21	17.3	0	0.018	0.04	1.5	2	7	91
S205	J263	1.04	101.82	101.65	18.0	0	0.018	0.04	1.5	2	7	91
S206	J315	0.78	83.62	93.64	7.4	0	0.018	0.04	1.5	2	7	91
S207	C76i	0.94	73.70	127.81	22.7	1.8	0.018	0.04	1.5	2	7	91
S210	J283	1.67	76.06	220.09	21.8	0	0.018	0.04	1.5	2	7	91
S211	J276	0.56	66.70	83.65	12.2	0	0.018	0.04	1.5	2	7	91
S212	C19i	0.54	61.07	88.75	20.6	3.9	0.018	0.04	1.5	2	7	91
S213	J276	1.18	94.21	125.04	22.1	0	0.018	0.04	1.5	2	7	91
S218	J280	1.30	44.20	294.58	23.3	0	0.018	0.04	1.5	2	7	91
S220	C1i	0.71	59.51	119.82	10.8	0	0.018	0.04	1.5	2	7	91
S221	C19i	1.06	146.57	72.25	16.8	1.4	0.018	0.04	1.5	2	7	91
S222	C19o	0.22	80.52	27.45	13.7	1.2	0.018	0.04	1.5	2	7	91
S227	C1i	0.78	51.35	152.47	12.7	0	0.018	0.04	1.5	2	7	91
S230	J344	1.99	167.23	118.88	18.0	0	0.018	0.04	1.5	2	7	91
S231	C50i	0.73	37.52	193.24	33.1	1.7	0.018	0.04	1.5	2	7	91
S232	C50i	1.34	100.31	133.19	20.5	1	0.018	0.04	1.5	2	7	91
S235	J236	0.60	34.91	171.03	15.6	4.7	0.018	0.04	1.5	2	7	91
S238	C20o	0.59	29.58	200.47	15.2	2.7	0.018	0.04	1.5	2	7	91
S239	J130	0.75	39.18	190.43	24.9	2.6	0.018	0.04	1.5	2	7	91
S241	J357	0.97	43.20	224.98	13.3	0	0.018	0.04	1.5	2	7	91
S245	J336	1.12	94.06	118.86	77.4	0	0.018	0.04	1.5	2	7	91
S246	J336	0.67	74.09	90.17	25.5	0	0.018	0.04	1.5	2	7	91
S247	C20i	0.98	78.65	124.60	22.7	1.2	0.018	0.04	1.5	2	7	91
S248	J350	0.77	58.90	130.73	14.1	0	0.018	0.04	1.5	2	7	91
S250	J313	1.81	90.32	200.28	12.7	0.8	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S255	J346	1.49	85.52	173.99	23.1	0	0.018	0.04	1.5	2	7	91
S256	J411	1.46	69.56	209.16	16.9	2.3	0.018	0.04	1.5	2	7	91
S257	J72	0.52	137.38	37.93	25.4	0.9	0.018	0.04	1.5	2	7	91
S258	J73	1.07	77.05	138.75	19.3	1.1	0.018	0.04	1.5	2	7	91
S259	C5i	0.55	72.89	74.91	14.1	2.5	0.018	0.04	1.5	2	7	91
S260	J348	0.74	104.30	70.57	20.8	0	0.018	0.04	1.5	2	7	91
S261	J348	0.62	51.38	119.90	13.4	4.6	0.018	0.04	1.5	2	7	91
S263	J1362	0.44	80.58	54.60	25.5	0	0.018	0.04	1.5	2	7	91
S265	J366	0.65	78.76	81.90	14.0	0	0.018	0.04	1.5	2	7	91
S267	J1410	1.74	193.40	89.97	25.2	0	0.018	0.04	1.5	2	7	91
S269	J395	0.99	50.93	194.77	13.2	0	0.018	0.04	1.5	2	7	91
S271	J370	0.71	52.93	134.32	25.3	0.7	0.018	0.04	1.5	2	7	91
S272	J370	0.53	40.30	131.77	25.1	0	0.018	0.04	1.5	2	7	91
S273	J370	1.94	122.88	157.96	33.0	0.2	0.018	0.04	1.5	2	7	91
S274	C7i	1.22	120.61	101.40	22.3	0.8	0.018	0.04	1.5	2	7	91
S279	J360	0.58	69.17	83.71	70.7	0	0.018	0.04	1.5	2	7	91
S280	J360	0.88	65.04	134.68	32.2	0	0.018	0.04	1.5	2	7	91
S282	C8i	0.60	53.33	111.76	24.1	2	0.018	0.04	1.5	2	7	91
S284	J1395	1.03	107.83	95.71	19.0	0	0.018	0.04	1.5	2	7	91
S286	J368	0.90	47.18	190.56	19.0	0	0.018	0.04	1.5	2	7	91
S289	J1490	1.95	196.86	99.16	14.0	0	0.018	0.04	1.5	2	7	91
S291	J1356	1.06	119.12	89.15	35.9	0	0.018	0.04	1.5	2	7	91
S294	J374	1.23	117.04	104.92	22.2	0	0.018	0.04	1.5	2	7	91
S295	J399	0.68	51.84	130.99	17.1	1.6	0.018	0.04	1.5	2	7	91
S296	J397	1.36	76.13	177.99	31.0	0	0.018	0.04	1.5	2	7	91
S297	J397	0.57	56.46	100.60	33.1	0	0.018	0.04	1.5	2	7	91
S301	J456	0.55	144.95	37.60	30.1	0	0.018	0.04	1.5	2	7	91
S304	J411	0.53	51.08	104.35	20.7	5.2	0.018	0.04	1.5	2	7	91
S305	J456	2.02	95.51	211.60	39.3	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S308	J1365	0.00	0.00	0.00	33.5	0	0.018	0.04	1.5	2	7	91
S311	J422	1.47	187.63	78.08	41.1	0	0.018	0.04	1.5	2	7	91
S312	J422	1.14	70.19	161.84	33.5	0	0.018	0.04	1.5	2	7	91
S313	J1365	1.08	57.81	186.84	31.3	0	0.018	0.04	1.5	2	7	91
S314	J1365	1.28	53.03	242.11	31.0	0	0.018	0.04	1.5	2	7	91
S315	J416	1.01	181.18	55.52	23.2	0	0.018	0.04	1.5	2	7	91
S318	J1490	1.00	164.74	60.70	18.2	0	0.018	0.04	1.5	2	7	91
S322	J458	1.47	119.81	122.94	22.6	0	0.018	0.04	1.5	2	7	91
S328	J1463	0.78	128.09	60.82	16.6	0	0.018	0.04	1.5	2	7	91
S329	J501	0.65	155.35	41.52	19.2	0	0.018	0.04	1.5	2	7	91
S330	J501	0.59	50.87	115.79	14.8	0	0.018	0.04	1.5	2	7	91
S333	J470	0.82	51.02	161.31	49.0	0	0.018	0.04	1.5	2	7	91
S337	J452	1.34	124.56	107.90	16.2	0	0.018	0.04	1.5	2	7	91
S339	J458	1.17	72.94	160.83	15.9	0	0.018	0.04	1.5	2	7	91
S343	J1401	0.59	98.83	59.40	10.6	0	0.018	0.04	1.5	2	7	91
S346	J462	1.05	119.63	87.60	28.9	0	0.018	0.04	1.5	2	7	91
S351	J169	0.64	60.84	105.53	28.7	0	0.018	0.04	1.5	2	7	91
S353	J1440	2.62	181.55	144.20	13.5	0	0.018	0.04	1.5	2	7	91
S355	J1463	1.13	126.69	88.88	17.5	0	0.018	0.04	1.5	2	7	91
S360	J464	0.58	53.97	106.55	9.4	0	0.018	0.04	1.5	2	7	91
S361	J464	0.75	48.97	152.15	10.3	0	0.018	0.04	1.5	2	7	91
S362	J169	0.82	62.89	131.01	27.7	0	0.018	0.04	1.5	2	7	91
S364	J472	2.71	100.57	269.36	49.8	0	0.018	0.04	1.5	2	7	91
S366	J475	1.38	63.10	218.37	20.4	0	0.018	0.04	1.5	2	7	91
S368	J1440	1.00	109.34	91.28	16.1	0	0.018	0.04	1.5	2	7	91
S370	J494	0.66	48.99	134.11	18.3	0	0.018	0.04	1.5	2	7	91
S371	J1339	1.52	113.94	133.23	9.1	1.1	0.018	0.04	1.5	2	7	91
S372	J487	1.18	45.91	257.87	53.5	0	0.018	0.04	1.5	2	7	91
S375	J494	1.69	180.74	93.23	17.8	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S387	J169	0.78	85.86	90.49	19.5	0	0.018	0.04	1.5	2	7	91
S389	J525	0.77	57.80	132.87	50.0	0	0.018	0.04	1.5	2	7	91
S390	J1398	0.98	88.49	111.20	16.1	2.1	0.018	0.04	1.5	2	7	91
S401	J532	0.99	61.29	161.20	13.0	0	0.018	0.04	1.5	2	7	91
S403	J575	4.36	172.27	253.33	53.4	0	0.018	0.04	1.5	2	7	91
S404	J529	0.47	43.27	108.62	14.1	0	0.018	0.04	1.5	2	7	91
S405	J525	0.59	39.84	147.36	59.8	0	0.018	0.04	1.5	2	7	91
S406	J590	1.07	42.62	249.87	19.4	0	0.018	0.04	1.5	2	7	91
S407	J1351	1.30	70.45	184.52	14.4	0	0.018	0.04	1.5	2	7	91
S408	J1351	1.40	140.33	99.62	14.8	0	0.018	0.04	1.5	2	7	91
S409	J590	0.94	84.80	111.20	13.8	0	0.018	0.04	1.5	2	7	91
S417	J536	1.07	79.47	135.14	14.7	0	0.018	0.04	1.5	2	7	91
S421	J567	0.89	23.94	372.68	31.0	0	0.018	0.04	1.5	2	7	91
S425	J579	0.88	171.69	51.32	20.7	0	0.018	0.04	1.5	2	7	91
S428	C31i	0.98	35.00	280.33	25.2	1.6	0.018	0.04	1.5	2	7	91
S430	J579	1.35	75.25	179.41	36.0	0	0.018	0.04	1.5	2	7	91
S433	C30i	1.18	102.19	115.38	25.7	2	0.018	0.04	1.5	2	7	91
S435	J575	0.65	49.29	132.09	50.0	0	0.018	0.04	1.5	2	7	91
S438	J22	0.89	73.93	120.66	36.4	2.4	0.018	0.04	1.5	2	7	91
S439	J21	0.88	69.22	126.84	25.5	1.9	0.018	0.04	1.5	2	7	91
S449	J620	1.08	88.24	122.29	10.5	0	0.018	0.04	1.5	2	7	91
S450	J596	1.48	61.72	239.79	26.4	0	0.018	0.04	1.5	2	7	91
S452	J21	0.74	37.79	196.06	39.7	0	0.018	0.04	1.5	2	7	91
S456	J1459	1.54	145.03	106.25	8.6	0	0.018	0.04	1.5	2	7	91
S457	J1459	1.15	120.37	95.62	12.5	0	0.018	0.04	1.5	2	7	91
S458	C34i	0.75	55.91	134.85	32.5	0	0.018	0.04	1.5	2	7	91
S459	C34i	2.40	106.44	225.29	35.8	0	0.018	0.04	1.5	2	7	91
S462	J137	0.19	62.78	30.59	14.4	0	0.018	0.04	1.5	2	7	91
S463	J625	1.05	89.73	117.46	45.5	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S464	J625	0.76	54.83	138.06	23.2	0	0.018	0.04	1.5	2	7	91
S470	J1437	0.96	184.05	52.38	14.9	0	0.018	0.04	1.5	2	7	91
S479	J650	2.33	97.83	237.77	30.7	0	0.018	0.04	1.5	2	7	91
S485	J637	1.72	73.99	231.94	39.1	0	0.018	0.04	1.5	2	7	91
S486	J644	1.25	61.32	203.20	29.9	0	0.018	0.04	1.5	2	7	91
S488	J644	0.56	109.28	50.79	39.6	0	0.018	0.04	1.5	2	7	91
S497	J661	1.28	169.04	75.72	16.6	0	0.018	0.04	1.5	2	7	91
S502	J650	1.11	84.02	132.00	39.8	0	0.018	0.04	1.5	2	7	91
S503	J1363	0.62	82.95	74.26	18.1	0	0.018	0.04	1.5	2	7	91
S504	J1363	0.53	120.81	44.12	34.7	0	0.018	0.04	1.5	2	7	91
S509	J661	0.57	82.11	69.90	14.8	0	0.018	0.04	1.5	2	7	91
S510	J756	0.61	108.71	55.75	11.5	0	0.018	0.04	1.5	2	7	91
S513	J756	0.62	40.88	152.40	27.9	0	0.018	0.04	1.5	2	7	91
S518	J740	1.61	98.92	162.75	31.7	0	0.018	0.04	1.5	2	7	91
S519	J1475	2.01	69.47	289.91	27.3	0	0.018	0.04	1.5	2	7	91
S521	J696	0.97	34.86	278.56	33.2	0	0.018	0.04	1.5	2	7	91
S527	J705	0.81	59.30	136.93	29.0	0	0.018	0.04	1.5	2	7	91
S528	J705	1.02	26.97	378.54	34.9	0	0.018	0.04	1.5	2	7	91
S540	J707	0.52	48.74	105.87	36.8	0	0.018	0.04	1.5	2	7	91
S541	J140	0.56	22.40	250.41	29.0	0	0.018	0.04	1.5	2	7	91
S548	J730	0.67	20.69	323.86	16.5	0	0.018	0.04	1.5	2	7	91
S551	J769	1.69	100.61	168.27	42.1	0	0.018	0.04	1.5	2	7	91
S555	J1409	0.78	115.63	67.29	21.4	0	0.018	0.04	1.5	2	7	91
S558	J140	0.93	25.47	364.69	23.4	0	0.018	0.04	1.5	2	7	91
S559	J769	0.59	61.36	96.15	23.4	0	0.018	0.04	1.5	2	7	91
S560	J740	1.47	89.95	163.77	19.7	0	0.018	0.04	1.5	2	7	91
S561	J740	0.77	108.54	70.85	15.1	0	0.018	0.04	1.5	2	7	91
S562	J767	0.80	69.84	114.26	23.6	0	0.018	0.04	1.5	2	7	91
S563	J767	1.96	132.38	148.21	27.3	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S566	J1421	0.25	44.52	56.60	28.3	0	0.018	0.04	1.5	2	7	91
S568	J141	0.62	85.97	72.24	25.9	0	0.018	0.04	1.5	2	7	91
S569	J141	0.91	61.06	149.35	27.6	0	0.018	0.04	1.5	2	7	91
S573	J830	0.86	59.51	145.19	37.3	0	0.018	0.04	1.5	2	7	91
S574	J830	0.80	185.88	43.09	24.1	0	0.018	0.04	1.5	2	7	91
S581	J824	1.39	73.16	189.44	18.4	0	0.018	0.04	1.5	2	7	91
S584	J779	0.59	54.70	106.95	23.0	0	0.018	0.04	1.5	2	7	91
S586	J779	0.71	125.21	56.39	20.1	0	0.018	0.04	1.5	2	7	91
S588	J774	1.58	103.30	152.86	17.9	0	0.018	0.04	1.5	2	7	91
S601	J869	0.91	58.63	155.55	19.3	0	0.018	0.04	1.5	2	7	91
S603	J814	1.24	63.91	193.23	28.9	0	0.018	0.04	1.5	2	7	91
S604	J814	1.32	70.43	186.86	25.6	0	0.018	0.04	1.5	2	7	91
S617	J812	0.50	73.19	68.72	21.6	0	0.018	0.04	1.5	2	7	91
S624	J1415	0.88	74.90	116.95	12.7	0	0.018	0.04	1.5	2	7	91
S628	J857	0.86	87.37	98.20	20.7	0	0.018	0.04	1.5	2	7	91
S632	J1408	0.39	50.77	77.61	11.5	0	0.018	0.04	1.5	2	7	91
S633	J879	0.56	54.94	101.57	16.0	0	0.018	0.04	1.5	2	7	91
S634	J879	1.25	88.20	141.28	11.6	0	0.018	0.04	1.5	2	7	91
S637	J907	1.43	87.65	163.50	15.1	0	0.018	0.04	1.5	2	7	91
S642	J845	0.50	43.17	114.90	19.6	0	0.018	0.04	1.5	2	7	91
S645	J1489	0.78	47.40	164.34	6.6	0	0.018	0.04	1.5	2	7	91
S646	J864	0.68	84.40	80.10	13.2	0	0.018	0.04	1.5	2	7	91
S648	J896	1.00	107.69	92.67	15.0	0	0.018	0.04	1.5	2	7	91
S650	J1382	0.95	66.59	142.06	18.6	0	0.018	0.04	1.5	2	7	91
S651	J1382	1.63	104.16	156.20	16.5	0	0.018	0.04	1.5	2	7	91
S652	J885	0.63	43.34	145.36	26.0	0	0.018	0.04	1.5	2	7	91
S658	J896	1.04	74.69	139.24	30.9	0	0.018	0.04	1.5	2	7	91
S659	J875	1.32	101.35	130.14	20.5	0	0.018	0.04	1.5	2	7	91
S660	J875	1.03	64.84	158.54	18.3	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S665	J864	1.09	187.59	58.21	15.8	0	0.018	0.04	1.5	2	7	91
S666	J885	0.59	54.69	107.34	29.1	0	0.018	0.04	1.5	2	7	91
S678	J898	2.14	129.91	164.65	18.9	0	0.018	0.04	1.5	2	7	91
S682	J902	0.77	77.25	99.29	25.4	0	0.018	0.04	1.5	2	7	91
S686	J920	1.59	100.09	158.86	14.2	0	0.018	0.04	1.5	2	7	91
S698	J944	0.42	60.77	68.29	18.7	0	0.018	0.04	1.5	2	7	91
S700	J946	1.71	85.10	201.30	10.4	0	0.018	0.04	1.5	2	7	91
S703	J993	0.65	186.50	34.69	19.6	0	0.018	0.04	1.5	2	7	91
S708	J977	1.10	105.17	104.49	10.9	0	0.018	0.04	1.5	2	7	91
S723	J993	1.16	81.20	143.35	18.5	0	0.018	0.04	1.5	2	7	91
S727	J969	1.38	86.97	158.32	13.3	0	0.018	0.04	1.5	2	7	91
S731	J981	0.57	45.94	123.22	16.4	0	0.018	0.04	1.5	2	7	91
S734	J1374	1.08	127.68	84.90	16.7	0	0.018	0.04	1.5	2	7	91
S735	J985	0.44	46.62	93.51	13.4	0	0.018	0.04	1.5	2	7	91
S736	J981	1.03	95.02	108.30	17.3	0	0.018	0.04	1.5	2	7	91
S738	J983	1.34	98.03	136.99	35.7	0	0.018	0.04	1.5	2	7	91
S739	J995	0.65	63.52	102.48	14.1	0	0.018	0.04	1.5	2	7	91
S741	J1017	0.77	110.51	69.68	14.3	0	0.018	0.04	1.5	2	7	91
S745	J1017	0.68	108.79	62.60	15.4	0	0.018	0.04	1.5	2	7	91
S750	J1023	0.58	85.87	67.66	13.0	0	0.018	0.04	1.5	2	7	91
S760	J1050	1.94	167.33	115.64	17.7	0	0.018	0.04	1.5	2	7	91
S767	J1033	1.37	79.85	171.46	15.5	0	0.018	0.04	1.5	2	7	91
S768	J1023	0.90	85.38	105.07	14.2	0	0.018	0.04	1.5	2	7	91
S769	J1033	0.58	50.82	114.14	25.1	0	0.018	0.04	1.5	2	7	91
S776	J1050	0.58	89.34	64.36	19.5	0	0.018	0.04	1.5	2	7	91
S31	O2	0.94	41.94	224.11	12.5	0	0.018	0.04	1.5	2	7	91
S33	O2	0.96	99.52	96.26	9.6	0	0.018	0.04	1.5	2	7	91
S44	O2	1.39	72.02	192.86	24.3	0	0.018	0.04	1.5	2	7	91
S46	O2	1.08	58.62	184.06	13.7	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S47	O2	1.24	80.40	154.35	25.7	0	0.018	0.04	1.5	2	7	91
S60	O2	0.92	116.85	78.73	16.5	0	0.018	0.04	1.5	2	7	91
S77	J4	1.67	134.45	124.21	19.7	0	0.018	0.04	1.5	2	7	91
S83	J4	2.06	221.63	92.81	13.0	0	0.018	0.04	1.5	2	7	91
S85	J4	0.54	63.08	85.44	9.3	0	0.018	0.04	1.5	2	7	91
S99	J4	1.65	80.51	204.32	14.0	0	0.018	0.04	1.5	2	7	91
S103	J101	0.52	75.94	68.35	11.5	0	0.018	0.04	1.5	2	7	91
S105	J3	0.83	63.42	130.72	12.3	0	0.018	0.04	1.5	2	7	91
S108	J104	0.57	56.96	100.25	12.6	0	0.018	0.04	1.5	2	7	91
S109	J99	1.09	91.46	118.85	8.8	0	0.018	0.04	1.5	2	7	91
S166_2	O6	0.83	120.80	68.46	14.0	1.6	0.018	0.04	1.5	2	7	91
S178_2	O6	0.95	54.66	173.08	11.7	1.3	0.018	0.04	1.5	2	7	91
S181_2	J1518	0.30	61.98	49.05	6.9	0	0.018	0.04	1.5	2	7	91
S162_2	O7	0.69	80.09	86.15	18.1	1.3	0.018	0.04	1.5	2	7	91
S147_2	OF1	0.10	64.83	15.43	3.7	0	0.018	0.04	1.5	2	7	91
S147_3	OF1	0.05	65.66	7.77	3.7	0	0.018	0.04	1.5	2	7	91
S124_2	J9	1.27	65.55	193.76	12.9	0.8	0.018	0.04	1.5	2	7	91
S96_2	J10	0.20	42.41	45.98	18.7	46.6	0.018	0.04	1.5	2	7	91
S21_2	J11	0.49	49.20	98.79	12.1	0	0.018	0.04	1.5	2	7	91
S224_2	J12	1.05	170.92	61.67	38.7	0	0.018	0.04	1.5	2	7	91
S163_2	J238	1.21	204.63	58.98	18.9	0	0.018	0.04	1.5	2	7	91
S27_2	O2	0.57	109.33	52.32	12.4	0	0.018	0.04	1.5	2	7	91
S236_1	J1367	0.50	120.34	41.48	11.9	0	0.018	0.04	1.5	2	7	91
S236_2	C1i	0.49	120.34	40.80	11.9	0	0.018	0.04	1.5	2	7	91
S179_1	C3i	1.30	174.29	74.46	11.1	0.8	0.018	0.04	1.5	2	7	91
S179_3	O6	0.68	174.29	39.19	11.1	0	0.018	0.04	1.5	2	7	91
S217_1	J278	0.80	65.13	122.35	13.3	0.9	0.018	0.04	1.5	2	7	91
S217_2	C4i	0.35	65.13	53.10	13.3	2.8	0.018	0.04	1.5	2	7	91
S242_1	C6i	0.68	58.30	117.42	11.7	1.7	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S242_2	C5i	0.44	58.30	75.84	11.7	2.5	0.018	0.04	1.5	2	7	91
S180_1	J5	0.91	126.63	71.58	10.9	1	0.018	0.04	1.5	2	7	91
S180_3	C4i	0.23	126.63	18.43	10.9	3.6	0.018	0.04	1.5	2	7	91
S283_2	C8i	0.74	72.68	102.31	22.8	1.3	0.018	0.04	1.5	2	7	91
S287_1	J1515	0.17	134.82	12.83	14.5	13.1	0.018	0.04	1.5	2	7	91
S287_2	C14i	0.49	134.82	36.71	14.5	1.7	0.018	0.04	1.5	2	7	91
S288_1	J1515	0.14	147.84	9.79	12.3	14.9	0.018	0.04	1.5	2	7	91
S288_2	C15i	1.16	147.84	78.73	12.3	0.7	0.018	0.04	1.5	2	7	91
S243_1	C6o	0.32	117.71	27.58	12.0	3.4	0.018	0.04	1.5	2	7	91
S299_1	J405	0.29	100.16	29.18	17.9	0	0.018	0.04	1.5	2	7	91
S299_3	C22i	0.88	100.16	88.33	17.9	2.4	0.018	0.04	1.5	2	7	91
S299_4	J244	1.73	100.16	172.33	17.9	12.7	0.018	0.04	1.5	2	7	91
S354_1	J1428	0.61	73.04	83.73	9.9	2.3	0.018	0.04	1.5	2	7	91
S354_2	C25i	0.62	73.04	84.70	9.9	19.8	0.018	0.04	1.5	2	7	91
S402_2	C39i	0.39	90.28	43.62	8.9	6.1	0.018	0.04	1.5	2	7	91
S383_2	J523	0.27	68.70	39.71	16.5	14	0.018	0.04	1.5	2	7	91
S398_1	C29i	0.13	61.41	21.12	21.7	1	0.018	0.04	1.5	2	7	91
S383_3	C41i	0.79	68.70	115.69	16.5	5.3	0.018	0.04	1.5	2	7	91
S383_4	C42i	0.20	68.70	29.46	16.5	28.2	0.018	0.04	1.5	2	7	91
S2	J20	0.42	111.44	37.96	16.0	7.5	0.018	0.04	1.5	2	7	91
S398_3	J22	0.35	61.41	56.73	21.7	12.7	0.018	0.04	1.5	2	7	91
S398_4	C26i	0.51	61.41	82.28	21.7	3.7	0.018	0.04	1.5	2	7	91
S431_1	C28i	0.11	49.34	21.61	31.2	25.6	0.018	0.04	1.5	2	7	91
S431_2	J27	0.75	49.34	151.27	31.2	0	0.018	0.04	1.5	2	7	91
S424_1	J30	0.24	30.98	78.97	25.0	18.2	0.018	0.04	1.5	2	7	91
S424_2	J26	0.22	30.98	70.99	25.0	20.2	0.018	0.04	1.5	2	7	91
S317_3	J32	0.18	88.48	20.50	11.8	0	0.018	0.04	1.5	2	7	91
S317_4	C46o	0.35	88.48	40.02	11.8	0	0.018	0.04	1.5	2	7	91
S25_1	J11	0.38	70.29	54.59	15.5	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S25_3	C71i	0.87	70.29	124.40	15.5	1.4	0.018	0.04	1.5	2	7	91
S54_1	C72i	0.47	80.80	57.69	12.5	2.2	0.018	0.04	1.5	2	7	91
S54_2	J95	0.69	80.80	85.89	12.5	1.1	0.018	0.04	1.5	2	7	91
S57_1	J86	0.78	95.66	81.75	14.5	3.1	0.018	0.04	1.5	2	7	91
S57_2	J93	1.17	95.66	122.24	14.5	0.7	0.018	0.04	1.5	2	7	91
S43_1	J46	1.87	97.08	192.55	21.6	0	0.018	0.04	1.5	2	7	91
S94_1	C75i	0.25	142.50	17.40	17.8	3.8	0.018	0.04	1.5	2	7	91
S94_2	J1361	0.83	142.50	57.94	17.8	3.5	0.018	0.04	1.5	2	7	91
S79_1	J10	0.62	82.58	75.02	10.1	3.5	0.018	0.04	1.5	2	7	91
S79_3	C74i	0.85	82.58	103.03	10.1	2.2	0.018	0.04	1.5	2	7	91
S3	J49	0.63	500.00	12.59	0.5	15.5	0.018	0.04	1.5	2	7	91
S4	O8	0.82	500.00	16.34	0.5	10.6	0.018	0.04	1.5	2	7	91
S5	J9	0.92	500.00	18.50	0.5	1.9	0.018	0.04	1.5	2	7	91
S167_1	OF1	0.06	68.87	9.22	23.7	0	0.018	0.04	1.5	2	7	91
S168_1	OF1	0.19	76.36	25.26	19.4	0	0.018	0.04	1.5	2	7	91
S140_1	O8	0.62	82.85	75.12	11.7	15.7	0.018	0.04	1.5	2	7	91
S140_3	J51	0.27	82.85	32.74	11.7	4.1	0.018	0.04	1.5	2	7	91
S191_2	J247	1.02	75.98	134.02	21.4	1.4	0.018	0.04	1.5	2	7	91
S187_1	J57	0.84	60.58	138.80	19.7	2	0.018	0.04	1.5	2	7	91
S187_2	J60	0.14	60.58	23.56	19.7	5.6	0.018	0.04	1.5	2	7	91
S154_3	C57i	0.46	202.82	22.68	18.7	7.7	0.018	0.04	1.5	2	7	91
S154_4	C56i	0.52	202.82	25.76	18.7	69.8	0.018	0.04	1.5	2	7	91
S154_1	J59	0.76	202.82	37.35	18.7	4.7	0.018	0.04	1.5	2	7	91
S154_6	C57o	0.15	202.82	7.46	18.7	0	0.018	0.04	1.5	2	7	91
S154_2	C58o	0.44	202.82	21.52	18.7	26.1	0.018	0.04	1.5	2	7	91
S154_7	C56i	0.16	202.82	8.06	18.7	0	0.018	0.04	1.5	2	7	91
S194_1	C76i	0.31	124.98	24.94	25.7	0	0.018	0.04	1.5	2	7	91
S194_2	P73	0.26	124.98	20.63	25.7	14	0.018	0.04	1.5	2	7	91
S442_2	J65	0.36	57.89	61.99	7.0	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S453_1	C34i	0.19	107.24	17.77	26.7	0	0.018	0.04	1.5	2	7	91
S453_2	C34i	0.90	107.24	84.33	26.7	0	0.018	0.04	1.5	2	7	91
S357_1	J523	0.94	105.10	89.73	15.4	3.8	0.018	0.04	1.5	2	7	91
S357_3	J68	0.40	105.10	38.35	15.4	12.3	0.018	0.04	1.5	2	7	91
S310_3	C45i	0.45	128.88	35.07	17.7	0	0.018	0.04	1.5	2	7	91
S310_4	C43i	1.26	128.88	97.91	17.7	13.1	0.018	0.04	1.5	2	7	91
S310_1	C47i	0.20	128.88	15.48	17.7	6.4	0.018	0.04	1.5	2	7	91
S310_5	J129	0.12	128.88	8.92	17.7	15.1	0.018	0.04	1.5	2	7	91
S229_1	J71	0.70	75.73	92.89	23.2	1.6	0.018	0.04	1.5	2	7	91
S229_2	C50i	0.33	75.73	43.35	23.2	3.5	0.018	0.04	1.5	2	7	91
S234_1	J338	0.20	139.80	14.20	24.3	8.4	0.018	0.04	1.5	2	7	91
S234_3	C51i	0.40	139.80	28.39	24.3	7.5	0.018	0.04	1.5	2	7	91
S234_4	J69	0.14	139.80	9.74	24.3	22	0.018	0.04	1.5	2	7	91
S196_1	J80	0.72	156.93	46.17	18.4	1.6	0.018	0.04	1.5	2	7	91
S196_2	J76	1.35	156.93	85.86	18.4	0.4	0.018	0.04	1.5	2	7	91
S214_1	J77	0.64	95.77	67.30	17.1	4.6	0.018	0.04	1.5	2	7	91
S186_2	C52i	0.30	123.61	23.89	18.2	0	0.018	0.04	1.5	2	7	91
S186_3	C53i	0.67	123.61	54.03	18.2	5.1	0.018	0.04	1.5	2	7	91
S186_4	J83	0.16	123.61	12.85	18.2	0	0.018	0.04	1.5	2	7	91
S214_3	P25	0.22	95.77	22.60	17.1	0	0.018	0.04	1.5	2	7	91
S214_4	P25	0.15	95.77	15.66	17.1	0	0.018	0.04	1.5	2	7	91
S130_1	J88	0.48	25.89	185.75	12.5	1.8	0.018	0.04	1.5	2	7	91
S130_2	J87	0.21	25.89	79.31	12.5	3.7	0.018	0.04	1.5	2	7	91
S7	J220	1.38	68.87	200.99	19.0	0.8	0.018	0.04	1.5	2	7	91
S74_1	C73i	0.29	61.40	46.66	11.1	0	0.018	0.04	1.5	2	7	91
S74_2	J92	0.43	61.40	70.44	11.1	0	0.018	0.04	1.5	2	7	91
S32_1	J1377	0.31	52.41	58.21	13.6	3.8	0.018	0.04	1.5	2	7	91
S32_2	C65i	0.09	52.41	16.81	13.6	0	0.018	0.04	1.5	2	7	91
S43_3	C67o	0.36	97.08	36.92	21.6	3.2	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S43_4	J28	0.30	97.08	31.28	21.6	2.3	0.018	0.04	1.5	2	7	91
S28_2	J96	0.42	84.17	50.14	12.5	2.7	0.018	0.04	1.5	2	7	91
S67_1	J4	0.86	93.63	91.54	9.5	0	0.018	0.04	1.5	2	7	91
S87_1	J3	0.31	151.95	20.35	8.1	0	0.018	0.04	1.5	2	7	91
S67_3	J102	0.24	93.63	26.10	9.5	0	0.018	0.04	1.5	2	7	91
S67_4	J100	0.36	93.63	38.59	9.5	0	0.018	0.04	1.5	2	7	91
S87_3	J101	0.33	151.95	21.46	8.1	0	0.018	0.04	1.5	2	7	91
S87_4	J99	0.50	151.95	32.58	8.1	0	0.018	0.04	1.5	2	7	91
S203_3	J14	1.08	111.87	96.18	16.2	0.8	0.018	0.04	1.5	2	7	91
S203_4	J315	1.20	111.87	107.40	16.2	0.7	0.018	0.04	1.5	2	7	91
S203_1	C18i	0.26	111.87	22.93	16.2	3.8	0.018	0.04	1.5	2	7	91
S268_1	J1350	0.17	85.16	19.51	25.5	0	0.018	0.04	1.5	2	7	91
S268_2	C17i	0.62	85.16	72.28	25.5	3.9	0.018	0.04	1.5	2	7	91
S9	J134	0.20	56.34	35.45	7.3	0	0.018	0.04	1.5	2	7	91
S526_1	J707	0.43	81.26	52.31	21.3	0	0.018	0.04	1.5	2	7	91
S526_2	J112	0.26	81.26	31.80	21.3	0	0.018	0.04	1.5	2	7	91
S465_2	J142	0.12	203.92	5.81	13.4	0	0.018	0.04	1.5	2	7	91
S477_1	J1437	0.40	69.29	58.08	13.1	0	0.018	0.04	1.5	2	7	91
S514_2	J142	0.19	99.63	19.36	10.8	0	0.018	0.04	1.5	2	7	91
S514_3	J142	0.03	99.63	3.46	10.8	0	0.018	0.04	1.5	2	7	91
S477_3	J140	0.14	69.29	20.19	13.1	0	0.018	0.04	1.5	2	7	91
S477_4	J109	0.19	69.29	28.09	13.1	0	0.018	0.04	1.5	2	7	91
S10	J139	0.29	95.05	30.25	16.0	0	0.018	0.04	1.5	2	7	91
S493_2	J143	0.29	85.64	33.35	11.5	0	0.018	0.04	1.5	2	7	91
S465_4	J143	0.33	203.92	16.12	13.4	0	0.018	0.04	1.5	2	7	91
S498_4	J143	0.20	89.42	22.66	27.1	0	0.018	0.04	1.5	2	7	91
S418_1	J108	0.18	95.10	18.90	15.4	0	0.018	0.04	1.5	2	7	91
S440_1	J150	0.65	51.22	127.82	21.0	0	0.018	0.04	1.5	2	7	91
S440_2	J107	0.04	51.22	8.43	21.0	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S423_4	J107	0.08	66.80	11.83	15.8	0	0.018	0.04	1.5	2	7	91
S349_1	J542	0.58	41.65	138.84	13.2	0	0.018	0.04	1.5	2	7	91
S349_2	J145	0.21	41.65	50.75	13.2	0	0.018	0.04	1.5	2	7	91
S418_2	J536	0.11	95.10	11.60	15.4	0	0.018	0.04	1.5	2	7	91
S418_3	J145	1.08	95.10	113.80	15.4	0	0.018	0.04	1.5	2	7	91
S423_1	J115	0.37	66.80	55.00	15.8	0	0.018	0.04	1.5	2	7	91
S350_1	J542	0.46	40.62	113.81	11.2	0	0.018	0.04	1.5	2	7	91
S11	C32i	0.20	54.08	37.22	13.6	2.9	0.018	0.04	1.5	2	7	91
S13	J44	2.52	141.17	178.50	13.5	0	0.018	0.04	1.5	2	7	91
S8	J137	0.33	203.50	16.20	13.4	0	0.018	0.04	1.5	2	7	91
S12	J144	1.04	159.41	65.54	12.8	0	0.018	0.04	1.5	2	7	91
S14	J10	1.55	500.00	30.98	0.5	1	0.018	0.04	1.5	2	7	91
S167_2	J61	0.59	68.87	84.96	23.7	3.8	0.018	0.04	1.5	2	7	91
S167_4	J48	0.57	68.87	82.10	23.7	0	0.018	0.04	1.5	2	7	91
S6_2	J55	1.47	76.35	191.93	19.5	0.9	0.018	0.04	1.5	2	7	91
S6_3	J156	0.10	76.35	12.86	19.5	5.2	0.018	0.04	1.5	2	7	91
S6_4	P69	0.16	76.35	21.59	19.5	0	0.018	0.04	1.5	2	7	91
S6_5	J156	0.12	76.35	15.34	19.5	0	0.018	0.04	1.5	2	7	91
S148_1	O7	0.36	500.00	7.29	10.8	0.4	0.018	0.04	1.5	2	7	91
S148_3	J157	0.15	500.00	2.93	10.8	14.5	0.018	0.04	1.5	2	7	91
S348_2	J162	0.28	108.18	26.14	13.8	55	0.018	0.04	1.5	2	7	91
S317_2	J149	0.17	88.48	19.60	11.8	10	0.018	0.04	1.5	2	7	91
S317_5	J162	0.11	88.48	12.69	11.8	13.9	0.018	0.04	1.5	2	7	91
S402_3	J177	1.11	90.28	122.54	8.9	0	0.018	0.04	1.5	2	7	91
S402_4	C35i	0.11	90.28	12.35	8.9	0	0.018	0.04	1.5	2	7	91
S316_1	J168	0.74	62.15	119.27	32.4	0	0.018	0.04	1.5	2	7	91
S316_2	J164	0.22	62.15	35.16	32.4	0	0.018	0.04	1.5	2	7	91
S344_1	J170	0.52	130.63	39.78	21.0	0	0.018	0.04	1.5	2	7	91
S344_4	J170	0.33	130.63	25.47	21.0	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S132_1	J182	0.59	110.30	53.62	13.6	0	0.018	0.04	1.5	2	7	91
S132_2	J1407	0.11	110.30	10.12	13.6	0	0.018	0.04	1.5	2	7	91
S262_1	C16i	0.65	106.13	61.18	17.6	1.9	0.018	0.04	1.5	2	7	91
S262_2	C16o	0.06	106.13	5.42	17.6	0	0.018	0.04	1.5	2	7	91
S237_1	C16o	0.02	96.97	2.56	17.6	0	0.018	0.04	1.5	2	7	91
S131_1	J1407	0.44	76.70	56.92	15.8	1.2	0.018	0.04	1.5	2	7	91
S131_2	J179	0.35	76.70	45.15	15.8	1.2	0.018	0.04	1.5	2	7	91
S6_1	J164	0.43	110.67	38.68	14.6	0	0.018	0.04	1.5	2	7	91
S6_8	J188	0.25	110.67	22.68	14.6	0	0.018	0.04	1.5	2	7	91
S6_6	J162	0.15	110.67	13.46	14.6	0	0.018	0.04	1.5	2	7	91
S6_9	J206	0.36	110.67	32.45	14.6	0	0.018	0.04	1.5	2	7	91
S28_4	C72o	0.18	84.17	21.90	12.5	1.4	0.018	0.04	1.5	2	7	91
S28_1	J1482	0.29	84.17	34.84	12.5	1.4	0.018	0.04	1.5	2	7	91
S28_5	J96	0.10	84.17	11.36	12.5	1.4	0.018	0.04	1.5	2	7	91
S309_1	J129	0.95	79.33	120.11	13.0	2.1	0.018	0.04	1.5	2	7	91
S309_2	J39	0.32	79.33	40.58	13.0	2.1	0.018	0.04	1.5	2	7	91
S1_4	J226	0.12	115.85	10.55	13.3	2.9	0.018	0.04	1.5	2	7	91
S243_5	J226	0.09	117.71	7.54	12.0	6.2	0.018	0.04	1.5	2	7	91
S1	J1515	0.70	115.85	60.65	13.3	3.297	0.018	0.04	1.5	2	7	91
S243	C10i	1.10	117.71	93.50	12.0	1.802	0.018	0.04	1.5	2	7	91
S203_2	J198	0.13	111.87	11.59	16.2	4.2	0.018	0.04	1.5	2	7	91
S203_6	J227	0.14	111.87	12.92	16.2	4.2	0.018	0.04	1.5	2	7	91
S237_3	P37	0.86	96.97	89.17	17.6	1.3	0.018	0.04	1.5	2	7	91
S237_4	J184	0.54	96.97	56.19	17.6	1.3	0.018	0.04	1.5	2	7	91
S253_1	J146	0.75	63.08	119.07	23.5	1.1	0.018	0.04	1.5	2	7	91
S253_2	J231	0.24	63.08	37.62	23.5	1.1	0.018	0.04	1.5	2	7	91
S278_1	J127	0.62	141.99	43.89	18.3	1	0.018	0.04	1.5	2	7	91
S278_2	J229	1.00	141.99	70.58	18.3	1	0.018	0.04	1.5	2	7	91
S498_1	J142	0.49	89.42	54.82	27.1	0	0.018	0.04	1.5	2	7	91

Name	Outlet	Area (ha)	Width (m)	Flow Length (m)	Slope (%)	Imperv. (%)	N Imperv	N Perv	Dstore Imperv (mm)	Dstore Perv (mm)	Drying Time (days)	Curve Number
S498_3	J117	0.81	89.42	90.06	27.1	0	0.018	0.04	1.5	2	7	91
S531_1	J142	0.34	79.72	43.00	33.2	0	0.018	0.04	1.5	2	7	91
S531_3	J241	0.90	79.72	113.41	33.2	0	0.018	0.04	1.5	2	7	91
S532_1	J142	0.15	83.83	17.46	29.2	0	0.018	0.04	1.5	2	7	91
S532_3	J241	1.03	83.83	123.21	29.2	0	0.018	0.04	1.5	2	7	91

APPENDIX I

SUPPLIER TRAINING QUOTATIONS

Sales Quote

Camex Equipment Sales & Rentals Inc.

1511 Sparrow Drive, Nisku, Alberta, T9E 8H9
Phone (780) 955-2770   Fax (780) 955-3735

DATE: 10/1/2020

CUSTOMER NAME Teta Tech c/o Josh Weidner
ADDRESS
PHONE 778 230 6787 **FAX** **CELL**

ID NUMBER	YEAR	MAKE	MODEL	COLOR

SERIAL NUMBER	TANK S/N	MILEAGE

SALE PRICE TO INCLUDE:	AMOUNT
	$ -
Steam truck traning in Cape Dorset	**$ 7,000.00**
As per our conversation, to go to Cape Dorset and provide a day of training on	
a Brandt provided Steam truck	

TRADE DETAILS			
YEAR	MAKE	MODEL	COLOR
SERIAL NUMBER		ENGINE S/N	MILEAGE
TRADE ALLOWANCE		$ -	
CUST. GST#		$ -	
SUBTOTAL		$ -	
LESS LIENS			
NET TRADE		$ -	

SALE PRICE (Subject to Change)	**$ 7,000.00**
GST # 13351 1311 RT 0001	**$ 350.00**
TOTAL SALE PRICE	**$ 7,350.00**
LESS: NET TRADE	**$ -**
DEPOSIT RECEIVED	**$ -**
NET DOWN PAYMENT REQUIRED	**$ -**
BALANCE DUE	**$ 7,350.00**

LIENS OWING TO:

Balance due when equipment is ready for delivery

CUSTOMER ACCEPTANCE

DATE: **Sept 25 2020**

Camex Equipment Sales & Rentals Inc.

Tom Huyghe

SALESMAN

ALL SALES ARE SUBJECT TO MANAGEMENT APPROVAL

Training Quote

TOROMONT CAT

September 1, 2020

Toromont Contact:	Tim Chandler	**Branch Address:**	3131 Hwy 7
Position:	Operator Trainer Supervisor		Concord, Ontario
Branch:	Concord		L4K 5E1
Cell	416 917 4527	**General Line:**	tchandler@toromont.com

Billing information

Customer Name:	Tetra Tech
Address:	Suite 1000-10th Floor
	Dunsmuir St Vancouver BC. V
Contact:	Josh Weidner
Telephone:	778 230 6787

Training Location

Address:	Same
Contact:	Same
Telephone:	

Contract Information

Training Date:	
Travel Days:	
# of Training Days:	1
Airfare:	N/A
Rental Vehicle:	N/A
Total Mileage:	N/A
Lodging Required:	4
Meals:	4
Shipping:	N/A
MAX # of Participants:	8

Contract Pricing

Travel Days	
Training Costs	$2,700.00
Airfare	$0.00
Rental Vehicle	$0.00
Mileage Charges	$0.00
Lodging	$350.00
Meals	$200.00
Shipping Costs	$0.00
Additional Expenses	$0.00
	$3,250.00

PRE-TAX CONTRACT PRICE	**$**	**3,250.00**
Tax HST	$	487.50
TOTAL CONTRACT PRICE	**$**	**3,737.50**

Delays are not included.

Additional Notes

Please review and send a copy of the signed quote complete with purchase order number to my attention.

This quote is for one day of training and lodging in Cape Dorset without Covid 19 restrictions

If restrictive or applicable Covid conditions apply, example self quarantine prior to exit or entry etc.

Additional costs for travel and expenses may apply

Signature ______________________ **PO# :** ________

The signature is an authorization to proceed with preparation for the training as described within the quote. Subject to the cancellation policy, the above signed herby acknowledges itself indebted to Toromont Industries Ltd. in the amount of this quote.

Please provide an email address if payment will be made by credit card. A credit card link will be sent to the email address provided to process your payment.

Deadline Date: N/A

$ -

This quotation is valid for 30 days, until October 1, 2020

Questions? Please contact - Tim Chandler 416 917 4527

Training Quote

TOROMONT CAT

September 1, 2020

Toromont Contact:	Tim Chandler	**Branch Address:**	3131 Highway 7
Position:	Operator Trainer Supervisor		Concord Ontario
Branch:	Concord		L4K 5E1
Cell	416 917 4527	**General Line:**	tchandler@toromont.com

Billing information

Customer Name:	Tetra Tech
Address:	Suite 1000-10th Floor
	Dunsmuir St Vancouver BC. V
Contact:	Josh Weidner
Telephone:	778 230 6787

Training Location

Address:	Same
Contact:	Same
Telephone:	

Contract Information

Training Date:	
Travel Days:	4
# of Training Days:	
Airfare:	N/A
Rental Vehicle:	N/A
Total Mileage:	N/A
Lodging Required:	4
Meals:	4
Shipping:	N/A
MAX # of Participants:	8

Contract Pricing

Travel Days	$4,000.00
Training Costs	$6,000.00
Airfare	$0.00
Rental Vehicle	$0.00
Mileage Charges	$0.00
Lodging	$1,000.00
Meals	$600.00
Shipping Costs	$0.00
Additional Expenses	$0.00
	$11,600.00

PRE-TAX CONTRACT PRICE	**$**	**11,600.00**
Tax HST	$	1,750.00
TOTAL CONTRACT PRICE	**$**	**13,350.00**

Delays are not included.

Additional Notes

Please review and send a copy of the signed quote complete with purchase order number to my attention.

This quote is for Travel and lodging to and from Cape Dorset without Covid 19 restrictions

If restrictive or applicable Covid conditions apply, example self quarantine prior to exit or entry etc.

Additional costs for travel and expenses may apply

Signature ______________________ **PO# :** ________

The signature is an authorization to proceed with preparation for the training as described within the quote. Subject to the cancellation policy, the above signed herby acknowledges itself indebted to Toromont Industries Ltd. in the amount of this quote.

Please provide an email address if payment will be made by credit card. A credit card link will be sent to the email address provided to process your payment.

Deadline Date:	N/A
$	-

This quotation is valid for 30 days, until October 1, 2020

Questions? Please contact - Tim Chandler 416 917 4527

APPENDIX J

EQUIPMENT & TRAINING CHECKLISTS

CAPE DORSET – ADDITIONAL EQUIPMENT REQUIRED CHECKLIST

(TO BE COMPLETED ONCE MUNICIPALITY TAKES INVENTORY OF EXISTING EQUIPMENT)

Staff Member:			**Date:**	

Priority	Equipment Make & Model	Type	Supplier	Contact	Target Procurement Date	Notes

Completed by: ________________________ Reviewed by: ________________________

Recommended Actions:

____
____
____
____
____
____

ANNUAL STAFF TRAINING PLAN

`

SEASON	CONSIDERATIONS	ACTIONS
Winter	• Will the Hamlet be acquiring new equipment this year? • Which existing staff members are the most experienced to provide training on existing equipment? • Which staff members should be enrolled in training?	• Schedule Formal Training with Equipment Supplier for any new equipment • Schedule Staff for Training Day(s)
Spring	• Are any drainage emergency's occurring which take priority over training?	• Untrained staff receive training from experienced staff on how to use steamer equipment • Inexperienced staff use steamer equipment under supervision of experienced staff to increase competence • Supplier specific training occurs for steamer equipment
Summer		• Untrained staff receive training from experienced staff on how to use earth moving equipment • Inexperienced staff use equipment under supervision of experienced staff to increase competence • Supplier specific training occurs for earth moving equipment
Fall	• Evaluate if any new equipment/equipment upgrades are required for the following year	• Apply for funding and/or order new equipment

CAPE DORSET – CULVERT INVENTORY – ANNUAL INSPECTION SHEET

Name of Inspector:			**Date:**	
Position:			**Weather During Inspection:**	
Supervisor:			**Ground Conditions: (Snow/Ice/Saturated etc.)**	

Culvert ID	Details			Condition						Notes
	Location	Diameter (mm)	Material	Culvert Shifting?	Internal Damage?	Culvert End Damage?	Plugging of Culvert Ends?	Rock Blockage?	Silting and Sediment Building Up?	
1		300	CSP	☐	☐	☐	☐	☐	☐	
2		400	CSP	☐	☐	☐	☐	☐	☐	
3		450	CSP	☐	☐	☐	☐	☐	☐	
4		150	CSP	☐	☐	☐	☐	☐	☐	
5		500	CSP	☐	☐	☐	☐	☐	☐	
6		900	CSP	☐	☐	☐	☐	☐	☐	
7		600	CSP	☐	☐	☐	☐	☐	☐	
8		2x150	CSP	☐	☐	☐	☐	☐	☐	
9		2x900	CSP	☐	☐	☐	☐	☐	☐	
10		2x750	CSP	☐	☐	☐	☐	☐	☐	
11		2x450, 1x1000	CSP	☐	☐	☐	☐	☐	☐	
12		600	CSP	☐	☐	☐	☐	☐	☐	
13		600	CSP	☐	☐	☐	☐	☐	☐	
14		3x800	CSP	☐	☐	☐	☐	☐	☐	
15		800	CSP	☐	☐	☐	☐	☐	☐	
16		600	CSP	☐	☐	☐	☐	☐	☐	
17		600	CSP	☐	☐	☐	☐	☐	☐	
18		300	CSP	☐	☐	☐	☐	☐	☐	

Culvert ID	Location	Diameter (mm)	Material	Culvert Shifting?	Internal Damage?	Culvert End Damage?	Plugging of Culvert Ends?	Rock Blockage?	Silting and Sediment Building Up?	Notes
19		800	CSP	☐	☐	☐	☐	☐	☐	
20		450	CSP	☐	☐	☐	☐	☐	☐	
21		600	CSP	☐	☐	☐	☐	☐	☐	
22		450	CSP	☐	☐	☐	☐	☐	☐	
23		300	CSP	☐	☐	☐	☐	☐	☐	
24		450	CSP	☐	☐	☐	☐	☐	☐	
25		450	CSP	☐	☐	☐	☐	☐	☐	
26		600	CSP	☐	☐	☐	☐	☐	☐	
27		400	CSP	☐	☐	☐	☐	☐	☐	
28		600	CSP	☐	☐	☐	☐	☐	☐	
29		450	CSP	☐	☐	☐	☐	☐	☐	
30		500	CSP	☐	☐	☐	☐	☐	☐	
31		2x150	CSP	☐	☐	☐	☐	☐	☐	
32		900	CSP	☐	☐	☐	☐	☐	☐	
33		500	CSP	☐	☐	☐	☐	☐	☐	
34		500	CSP	☐	☐	☐	☐	☐	☐	
35		800	CSP	☐	☐	☐	☐	☐	☐	
36		700	CSP	☐	☐	☐	☐	☐	☐	
37		450	CSP	☐	☐	☐	☐	☐	☐	
38		600	CSP	☐	☐	☐	☐	☐	☐	
39		500	CSP	☐	☐	☐	☐	☐	☐	
40		450	CSP	☐	☐	☐	☐	☐	☐	
41		450	CSP	☐	☐	☐	☐	☐	☐	
42		100	SWSP	☐	☐	☐	☐	☐	☐	
43		900	CSP	☐	☐	☐	☐	☐	☐	
44		300	CSP	☐	☐	☐	☐	☐	☐	

Culvert ID	Location	Diameter (mm)	Material	Culvert Shifting?	Internal Damage?	Culvert End Damage?	Plugging of Culvert Ends?	Rock Blockage?	Silting and Sediment Building Up?	Notes
45		600	CSP	☐	☐	☐	☐	☐	☐	
46		800	CSP	☐	☐	☐	☐	☐	☐	
47		450	CSP	☐	☐	☐	☐	☐	☐	
48		450	CSP	☐	☐	☐	☐	☐	☐	
49		600	CSP	☐	☐	☐	☐	☐	☐	
50		600	CSP	☐	☐	☐	☐	☐	☐	
51		750	CSP	☐	☐	☐	☐	☐	☐	
52		600	CSP	☐	☐	☐	☐	☐	☐	
53		800	CSP	☐	☐	☐	☐	☐	☐	
54		450	CSP	☐	☐	☐	☐	☐	☐	
55		800	CSP	☐	☐	☐	☐	☐	☐	
56		100	SWSP	☐	☐	☐	☐	☐	☐	
57		150	CSP	☐	☐	☐	☐	☐	☐	
58		450	CSP	☐	☐	☐	☐	☐	☐	
59		2x800	CSP	☐	☐	☐	☐	☐	☐	
60		800	CSP	☐	☐	☐	☐	☐	☐	
61		500	CSP	☐	☐	☐	☐	☐	☐	
62		500	CSP	☐	☐	☐	☐	☐	☐	
63		600	CSP	☐	☐	☐	☐	☐	☐	
64		600	CSP	☐	☐	☐	☐	☐	☐	
65		400	CSP	☐	☐	☐	☐	☐	☐	
66		400	CSP	☐	☐	☐	☐	☐	☐	
67		400	CSP	☐	☐	☐	☐	☐	☐	
68		800	CSP	☐	☐	☐	☐	☐	☐	
69		400	CSP	☐	☐	☐	☐	☐	☐	
70		400	CSP	☐	☐	☐	☐	☐	☐	
71		600	CSP	☐	☐	☐	☐	☐	☐	

Culvert ID	Location	Diameter (mm)	Material	Culvert Shifting?	Internal Damage?	Culvert End Damage?	Plugging of Culvert Ends?	Rock Blockage?	Silting and Sediment Building Up?	Notes
72		600	CSP	☐	☐	☐	☐	☐	☐	
73		600	CSP	☐	☐	☐	☐	☐	☐	
74		700	CSP	☐	☐	☐	☐	☐	☐	
75		300	CSP	☐	☐	☐	☐	☐	☐	
76		800	CSP	☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	

Culvert ID	Location	Diameter (mm)	Material	Culvert Shifting?	Internal Damage?	Culvert End Damage?	Plugging of Culvert Ends?	Rock Blockage?	Silting and Sediment Building Up?	Notes
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	☐	

Reviewed by: ____

Recommended Actions:

____

____

____

____

__

CAPE DORSET – DITCH INVENTORY – ANNUAL INSPECTION SHEET

Name of Inspector:			**Date:**	
Position:			**Weather During Inspection:**	
Supervisor:			**Ground Conditions: (Snow /Dry/Saturated etc.)**	

Ditch ID	Details			Condition					Notes
	Location	Approximate Length	Size	Damming (leading to Ponding)?	Presence of Standing Water?	Erosion?	Soil Settlement?	Excess Vegetation/ Overgrowth?	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	

				☐	☐	☐	☐	☐	
Ditch ID	Location	Approximate Length	Size	Damming (leading to Ponding)?	Presence of Standing Water?	Erosion?	Soil Settlement?	Excess Vegetation/ Overgrowth?	Notes
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	

				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
Ditch ID	*Location*	*Approximate Length*	*Size*	*Damming (leading to Ponding)?*	*Presence of Standing Water?*	*Erosion?*	*Soil Settlement?*	*Excess Vegetation/ Overgrowth?*	*Notes*
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	

				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
Ditch ID	*Location*	*Approximate Length*	*Size*	*Damming (leading to Ponding)?*	*Presence of Standing Water?*	*Erosion?*	*Soil Settlement?*	*Excess Vegetation/ Overgrowth?*	*Notes*
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	
				☐	☐	☐	☐	☐	

Reviewed by: ____

Recommended Actions:

____

____

____

____

__

CAPE DORSET – TRAINING AND EXPERIENCE CHECKLIST

Staff Member:			**Date:**	
Project:			**Proposal No:**	

Training Checklist	**Yes**	**No**
Has the staff member received formal training from either the equipment supplier or a experienced worker the following equipment?		
1. CAT D12 Dozer	☐	☐
2. Water Truck	☐	☐
3. Steamer Truck	☐	☐
4.	☐	☐
5.	☐	☐
6.	☐	☐
If the answer to any question is "No", then the staff member should undergo formal training from either the equipment supplier or a Cape Dorset Staff member who is considered competent before attempting to operate the equipment		

Experience Checklist	**Yes**	**No**
Has the staff member completed one season operating the below equipment under supervision of an experienced staff member?		
7. CAT D12 Dozer	☐	☐
8. Water Truck	☐	☐
9. Steamer Truck	☐	☐
10.	☐	☐
11.	☐	☐
If the answer to any question is "No", then this staff member should not be permitted to operate equipment without the supervision of a more experienced staff member. *If the staff member receives a "Yes" in both the training and skills checklist for a certain piece of equipment, then this staff member is deemed as competent and can operate this equipment without supervision – if and only if permitted by separate safety regulations and guidelines, and train new or unexperienced staff members n this piece of equipment.*		

Completed by: ______________________ Reviewed by: ______________________

Recommended Actions:

____
____
____
____
____
____