SLIAMMON FIRST NATION

MASTER DRAINAGE PLAN

Feasibility Report

David Nairne + Associates Ltd.

July 2008

DNA
David Nairne + Associates

MASTER DRAINAGE PLAN

Feasibility Report

for

Sliammon First Nation

Client: Sliammon First Nation
RR #2, Sliammon Road
Powell River, BC
V8A 4Z3
Tel: 604-483-9646
Fax: 604-483-9769

Prepared by: David Nairne + Associates Ltd
Suite 250 – 171 W. Esplanade
North Vancouver, BC
V7M 3J9
Tel: 604-984-3503
Fax: 604-984-0627

Project Engineer: ……
……..
Giorgio Caon, P. Eng. Brad Gilmore, EIT

Date issued: July, 2008

DNA Project No.: 4392

INAC CPMS No.: 7133

EXECUTIVE SUMMARY

This report presents the findings and recommendations for improving the Sliammon First Nation Master Drainage Plan. The Sliammon First Nation community have identified concerns with their existing drainage system, which has been causing flooding in and around houses and on roads. They have requested this study be done to identify areas where there are problems, and to recommend improvements.

The two main factors that were identified as contributing to drainage related problems in the community included inadequate drainage control features to direct surface water away from lots, as well as a lack of adequate drainage control on the lots to keep water away from houses.

The recommended approach to improving the drainage system in Sliammon is upgrading the existing drainage and culverts along roads and outfalls as well as improving drainage at the individual houses. This is felt to be the most cost effective way to adequately address the concerns with the existing drainage system. A Class D cost estimate for the proposed drainage works is $572,000. The environmental implications of this project are believed to be minimal.

A discussion is presented regarding new housing developments in the Sliammon community and recommendations are made to avoid similar drainage problems in the future. It is also proposed that the upgrading of drainage works be combined with the proposed new subdivision project to reduce costs and coordinate activities.

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1.0 INTRODUCTION

This report presents the findings and recommendations for improving the Sliammon First Nation Master Drainage Plan. The Sliammon First Nation community have identified concerns with their existing drainage system, which has been causing flooding in and around houses and on roads. In the past several years, considerable sums of money have been spent to address drainage issues at individual homes, however not at the community level. The community has requested that a study be done of the existing drainage system, to identify areas where there are problems and to recommend improvements that will benefit the community as a whole.

1.1. Report Objectives

The purpose of this study is to review Sliammon's existing stormwater drainage system and to make recommendations for improvements. The scope of this study includes:

- reviewing previous reports;
- consulting with Sliammon First Nation community members;
- carrying out households surveys;
- mapping and evaluating the existing drainage works;
- developing conceptual designs for drainage rehabilitation and upgrading; and
- making recommendations to address the drainage issues.

2.0 COMMUNITY CONTEXT

The Sliammon community is located on Sliammon IR No. 1 near the town of Powell River, approximately 150 kilometers northwest of Vancouver. The existing community is located on the southern end of the reserve, on the fringe of land bordered between Highway 101 and the ocean, as show in Figure 1. The community is bisected by Sliammon Creek, flowing from north to south, with newer residential areas located to the east of the creek.

The existing development is made up of a First Nation settlement with a population of approximately 770 individuals residing in roughly 180 houses, in addition to the Klahanie Development comprising of about 110 leased lots, which are located along the shore on the western side of the community and the Southview Development located in the northwest corner of the reserve.

SLIAMMON FIRST NATION
IR 1 LOCATION MAP

I:\PROJECT\4392\C-Cadd\4392FIG1

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FIGURE 1

The analysis of the drainage system focused on the First Nation's development of the community around Sliammon Creek and did not include the Klahanie Development or the Southview Development, as these developments are on leased lands and do not fall under the scope of INAC funded projects.

2.1. Precipitation

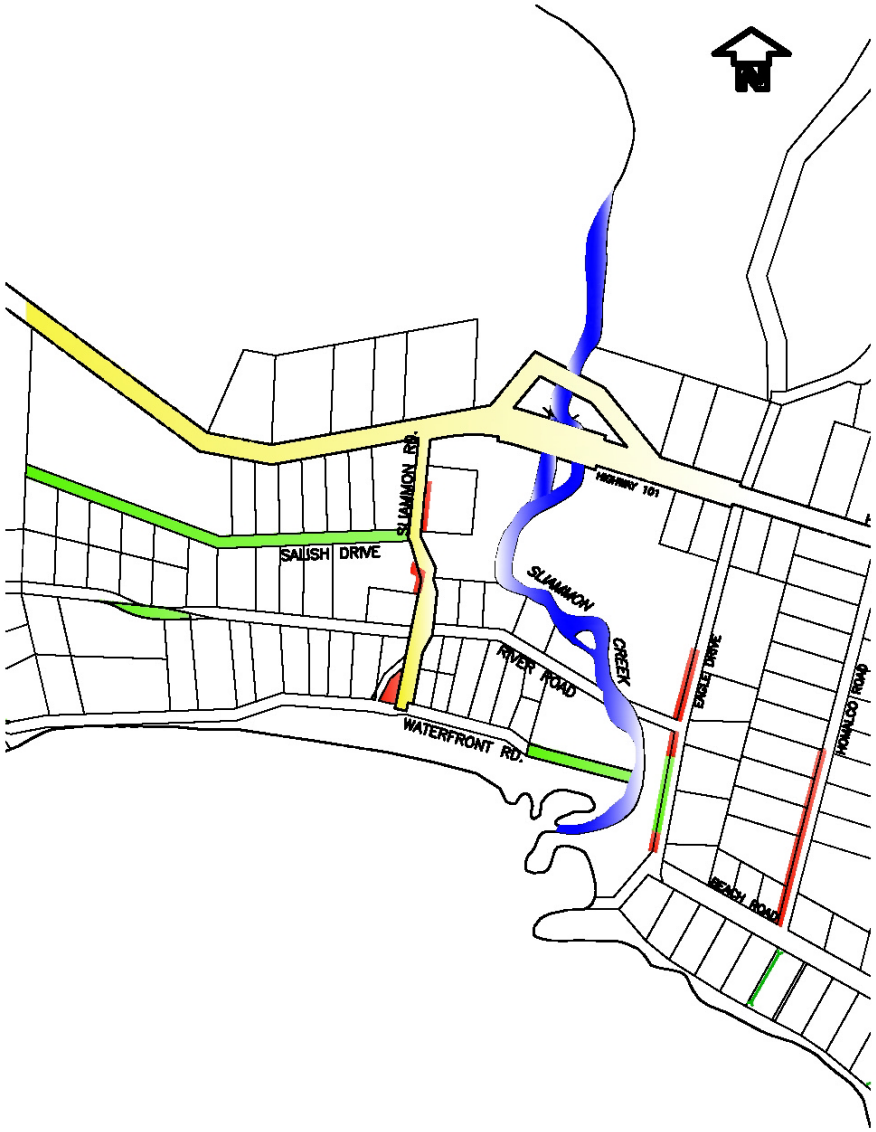
Sliammon is within a relatively mild climate which has warm dry summers and mild wet winters. The average annual precipitation for the neighboring community of Powell River is 1072.1mm, with average monthly temperatures ranging between 4ºC in the winter and 18.3ºC in the summer (Canadian Climate Normals, years 1971 – 2000).

2.2. Right of Way Issues

There are problems related to the location of roads relative to the legal road rights of way in the Sliammon community. These problems have the potential to impede drainage system development and approvals; therefore, they must be considered within the scope of this feasibility study. Issues related to rights of way include both the land available next to roads for easements and also the jurisdiction under which the operation and maintenance of the road falls. The areas of the community where rights of way issues are a concern are primarily in the western portion of the community with River Road and Waterfront Road having some sections built outside of the right of way, while all of Salish Drive has been built outside of the right of way. In addition, Sliammon Road, Eagle Drive and Homalco Road have sections where the edge of the road pavement is up to the outer limit of the rights of way. The following figure (Figure 2) shows the general areas with rights of way issues, where roads have been built outside of easements (highlighted in green) and where roads are built up to the edge of the easement (highlighted in red).

In addition to the isolated areas with rights of way issues, it was identified that Sliammon Road is part of the highway right of way and is maintained by the Ministry of Transportation under a previous agreement with the Band. The highways right of way is highlighted in yellow in Figure 2. Sliammon Road runs parallel to Sliammon Creek and is one of the main travel routes for both cars and pedestrians and also serves as the access point to several of the main community facilities including the Band Office, Firehall and School. Therefore, any upgrades to drainage along this road need prior approval from the Ministry of Transportation and it would not be eligible for

funding under an INAC project. Therefore, recommendations to improving drainage along Sliammon Road will not be considered under the scope of this project.



SLIAMMON FIRST NATION
IR 1 ROADS WITH
RIGHTS OF WAY ISSUES

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FIGURE 2

1PROJECT\4392\C-Cadd\4392FIG1

3.0 EXISTING DRAINAGE SYSTEM

3.1. Overall topography and catchment area

The Sliammon Community is located on land, which generally slopes down towards the ocean, with Sliammon Creek flowing through the centre of the community. The overall drainage regime of the catchment area directs surface water either into Sliammon Creek or along man made features to the ocean (Refer to Appendix 1- Figure 1.1).

3.2. Existing drainage within the community

As part of this investigation, a field reconnaissance was completed to prepare an "as Found" map of the existing drainage system in Sliammon and to identify areas of concern. The fieldwork included inspecting and examining the existing conditions of the drainage system, and mapping out the location of the drainage features.

The existing stormwater drainage system within the community comprises of roadside ditches and culverts under driveways and road crossings. The drainage system was developed gradually over the years, with drainage features added whenever new construction took place. As a result of the staggered construction, some parts of the drainage system do not link together very well. No maps of the drainage system were available, partially due to this staggered construction. The "As Found" drainage system is presented in Appendix 1 – Figure 1.2.

3.2.1. Drainage Characteristics

During the site investigations, the following observations with respect to the existing drainage were recorded:

1. The major surface runoff flow direction is from north to south.
2. Runoff intercepted in ditches along Highway 101 is primarily directed to flow away from the residential areas, by ditches discharging either into Sliammon Creek or into channels located on the outskirts of the community. The majority of the water which is collected from the water catchment to the north of Highway 101 does not enter into the Sliammon community drainage system, with the exception of one drainage channel located in the western portion of the community.

3. In general, the drainage system within the developed roads directs flow either into Sliammon Creek or into ditches that discharge to the shore. West of Sliammon Creek, stormwater is directed to two culverts under Waterfront road, with one near lot 4902 and the other at the end of Sliammon Road. East of Sliammon Creek, stormwater is directed down the roads and discharges through three ditches along Beach Rd. Refer to Appendix 1 – Figure 1.2, Reference Points A, B, C, D & E.
4. Several of the existing culverts and ditches and fully or partially blocked by soil and/or vegetation.
5. The old portions of the community, and in particular areas west of Sliammon Creek, have less consistent drainage works where ditches are often not present along the roadways or behind lots or the ditches do not connect to one another.
6. The newer developments east of the creek appear to have a more continuous network of roadside ditches along both sides of the roads and in most cases connect to each other, but there are no rear yard interceptor ditches or swales located at the back of these lots.
7. The roads in the eastern part of the community are primarily oriented perpendicular to the slope, and interceptor ditches between properties were not constructed and graded, therefore runoff from lots drains to the neighbours lot below. Some homeowners have constructed ditches on the high side of their lots, between the properties, to attempt to intercept runoff from the lot above.

The existing drainage characteristics of the sub-catchment areas in Sliammon community are summarized in the following table and figure.

Table 3-1: Sliammon First Nation Existing Drainage Characteristics

Catchment Area	Area ID	Area (ha)	Sub-Catchment Area Description and Flow	Existing Characteristics Description of Flow to Outfall
Ocean Outfall (A)	A1	17.0	Sub-catchment area includes a portion of land north of Highway 101 to the west of lot #4826 (the western most occupied lot north of Highway 101). This runoff is directed to two culverts under the highway (18"CMP[1] and 24"CMP). Overland flow to ditch on Highway 101.	Surface flow from the sub-catchments is collected in roadside ditches and directed in an existing ditch running towards Ocean Outfall (A). Ocean Outfall (A) clogs during heavy rains, and causes flooding of Waterfront Road.
	A2	2.7	Sub-catchment area extending from the ditches on Highway 101 to Salish Drive, from the western highway culvert at the west end of the community to the ditch running from the highway around the salish centre.	
	A3	1.2	Sub-catchment area extending from the ditches on Highway 101 to Salish Drive, from the existing ditch east of the Salish Centre to a high point which divides runoff catchments between Outfalls A & B (near lot #4926).	
	A4	1.7	Sub-catchment area extends north of River Road to Salish Dr. The western limit of the sub-catchment is along a high point near Lot 4280, and it extends to the existing ditch on the east side at Lot 4898.	
	A5	1.0	Sub-catchment area extends between Salish Drive and River Road, between the ditches at the western edge of the sub-catchment to high point which divides runoff catchments between Outfalls A & B (near lot #4926).	
	A6	3.2	Sub-catchment area extends between River Road and Waterfront Road, and extends from the western edge of lot #4818 to the existing ditches at the east of this area.	
	A7	2.1	Sub-catchment area extends between River Road and Waterfront Road, between the existing ditches at the west of this area to the high point which divides runoff catchments between Outfalls A & B.	
Ocean Outfall (B)	B1	2.7	Sub-catchment area extends from Highway 101 to Salish Drive, between the high point which divides runoff catchments between Outfalls A & B and Sliammon Road.	Ditches and culverts along the south side of Salish Drive and the north side of Waterfront Road direct runoff from the sub-catchment areas to roadside ditches along the west side of Sliammon Road. An existing 24" culvert under Waterfront Road drains area B to the Ocean at Outfall (B). Runoff collected on River Road flows onto lots on Waterfront Road as there is no complete ditch to intercept the flow.
	B2	3.0	Sub-catchment area extends from Salish Drive to Waterfront Road, between the high point which divides runoff catchments between Outfalls A & B and Sliammon Road. There is only a partial ditch on River Road.	
Ocean Outfall (C)	C1	3.8	Sub-catchment area extends from Highway 101 to Beach Road, between Eagle Drive and Homalco Drive.	Homalco Road has ditches and culverts installed on both sides of the road. Ditches and culverts along Homalco Road and Beach Road direct runoff from catchment area through ditches, between lots #5129 and #5137, to Ocean Outfall (C).

Table 3-1 (continued): Sliammon First Nation Existing Drainage Characteristics

Catchment Area	Area ID	Area	Sub-Catchment Area Description and Flow	Existing Characteristics Description of Flow to Outfall

[1] CMP – Corrugated Metal Pipe

		(ha)		
Ocean Outfall (D)	D1	3.9	Overland flow from properties on the west side of Harwood Drive, through ditches and culverts on Harwood Drive and Beach Road.	Harwood Drive has ditches and culverts installed on both sides of the road. Ditches and culverts along Harwood Drive and Beach Road direct runoff from catchment area through ditches, between lots #5169 and #5177, to Ocean Outfall (D).
	D2	4.3	Overland flow from properties on the east side of Harwood Drive, through ditches and culverts on Harwood Drive and Beach Road.	
Ocean Outfall (E)	E1	6.1	Overland flow from properties on the northeast side of Beach Road, through ditches and culverts on Beach Road.	Ditches and culverts along Beach Road direct runoff from catchment area to Ocean Outfall (E). The existing interceptor ditch northeast of the developed lots, collects runoff and directs it to Ocean Outfall (E).
	E2	38	Overland flow on undeveloped land north east of Beach Road. Runoff flows through existing interceptor ditch in the eastern portion of the community.	
Sliammon Creek	S1	2.0	Sub-catchment area extends from Highway 101 to River Road, west of Sliammon Creek to Sliammon Road. Ditches along River Road direct runoff to Sliammon Creek. Runoff also flows directly from the sub-catchment area into Sliammon Creek.	There are no ditches along the east side of Sliammon Road. Runoff is directed into Sliammon Creek, through ditches or directly from the catchment area. Sliammon Creek discharges into the Ocean.
	S2	0.3	Sub-catchment area in a small portion of land west of Sliammon Creek, between River Road and the Ocean. Overland flow is directed to Sliammon Creek.	
	S3	3.9	Sub-catchment area extends from Highway 101 to River Road, east of Sliammon Creek to Eagle Drive. Ditches along Eagle Drive and River Road direct runoff to Sliammon Creek. Runoff also flows directly from the sub-catchment area into Sliammon Creek.	
	S4	0.5	Sub-catchment area in a small portion of land east of Sliammon Creek, between River Road and the Ocean. Overland flow is directed to Sliammon Creek.	
	S5	6.1	Sub-catchment area extends from Highway 101 to Beach Road, between Eagle Drive and Homalco Drive. Ditches along Eagle Drive, Homalco Drive and Beach Road direct runoff from catchment area to Sliammon Creek.	
Ocean (over beach)	O1	1.8	Sub-catchment area extends between Waterfront Road and Ocean, between the limit of to the Klahanie Development and Ocean Outfall (B).	Overland flow through some lots towards the ocean. Runoff flows through lots and does not flow to man-made discharge point. Most of the runoff collected north of Waterfront Road and Beach Road is collected into ditches and culverts and directed to Outfalls A,B,C,D, and E. Runoff flowing through lots is generally restricted to the catchment area of each individual lot.
	O2	2.9	Sub-catchment area extends between Waterfront Road and Ocean, between Ocean Outfall (B) and S2.	
	O3	2.1	Sub-catchment area extends between Waterfront Road and Ocean, between Eagle Drive and Ocean Outfall (C).	
	O4	1.4	Sub-catchment area extends between Waterfront Road and Ocean, between Ocean Outfall (C) and Ocean Outfall (D).	
	O5	3.2	Sub-catchment area extends between Waterfront Road and Ocean, between Ocean Outfall (D) and Ocean Outfall (E).	

SLIAMMON FIRST NATION
IR 1 TOPOGRAPHY
DRAINAGE CATCHMENT AREAS

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FIGURE 3

1PROJECT\4392\C-Cadd\4392FIG3

4.0 DRAINAGE ISSUES

In order to identify problem drainage areas within the community, a survey of residents was conducted related to flooding basements, observations were made during the site investigation, discussions were carried out with band members, and concerns with the existing drainage system were discussed with the Band's Capital Manager.

4.1. Subsurface Conditions

The original proposal to complete the feasibility level study of the drainage system, prepared by Urban Systems Ltd. in June 2003, included carrying out investigations of the subsurface hydrology. The subsurface investigation was proposed, as it was believed that there was an elevated groundwater table and that the high groundwater was causing the drainage issues related to flooded basements and mould problems. However, subsequent to this proposal being submitted, the level of understanding of the subsurface conditions has improved and investigations into the subsurface hydrology are no longer required.

After the original drainage proposal was submitted by Urban Systems Ltd., a sanitary sewer repairs project was undertaken in the Sliammon community. The repair program included completing excavations throughout the community. During this work it was discovered that there was not an issue of high groundwater, but instead a perched groundwater table, caused by the soil conditions.

The soil conditions in the community, observed through the sanitary repairs, generally consist of a relatively thin surface permeable layer of organic and granular soils overlying a much thicker layer of impermeable till like soils. This soil stratification causes groundwater to collect and flow only in the top layer of the soil. This soil and groundwater condition was also confirmed through a geotechnical investigation for a proposed new subdivision. Therefore, it was identified that the perched groundwater table gave the false impression that there is a high groundwater table in the area. This indicated that the drainage issues are limited to the surface flow and flow within the top layer of soil, and not the result of high groundwater levels, as originally believed. Therefore, proposed solutions for drainage problems in Sliammon should focus on creating or improving surface drainage features in order to effectively direct runoff away from roads and buildings.

4.2. House Survey Results

To assist in identifying the primary locations of drainage related issues within the community, a survey of the residents was completed in November 2007. The survey was used to identify which houses had basements, and of those, which ones had identified that they had a problem of water entering into the basements or lower floors. A total of 153, of the roughly 180 homes in Sliammon, were surveyed for this project. The remaining houses were either not occupied, or did not participate in the survey. A copy of the survey and a summary of the findings are included in Appendix 2.

Of the surveyed homes, 79 (52% of respondents) reported that they have basements and 74 (48% of the respondents) indicated that they have crawlspaces. There were 14 households who indicated that they have had issues of water entering and flooding their basements, which represents 18% of respondents who have houses with basements. However, two of the respondents indicated that the water in their basement might be related to plumbing issues and not drainage issues. The suspected cause of basement flooding in the other 12 houses, included water entering through cracks in floors or basements walls, as well as flooding through entryways. A map showing the location of these households is included in Appendix 1 – Figure 1.2.

Eleven of the fourteen houses who identified basement flooding are located to the west of Sliammon Creek. As discussed in Section 3.2.1, the area west of Sliammon Creek is the older portion of the community and the drainage systems are less developed. Also, it is possible that these older homes were constructed without adequate perimeter drains or grading around the houses.

It is important to note that the survey only addressed leaking basements, and did not have a question specifically related to drainage issues on lots. However, eight respondents volunteered additional information indicating that while they did not have flooding of their houses they did have drainage issues on their lots. A map showing the location of these eight households is included in Appendix 1 – Figure 1.2. Again, five of the eight households are located to the west of Sliammon Creek along River Road and Waterfront Road. Given that there was no specific question on the survey related to lot drainage, it is not possible to conclude that these are the only properties in

the community who are experiencing flooding on their lots and it is felt that the problems associated with lot flooding are much more widespread throughout the community.

This survey was designed to get an indication of the drainage issues within the community and was not designed to be a comprehensive study. Also, this survey was carried out by a community member who had limited training and supervision from DNA staff. DNA staff tried, where possible, to verify the results of this survey through observations in the field and discussions with community members. However, more detailed site visits and surveys will be required to identify the exact number, location and extent to which households are affected by flooding and standing water. Selection criteria will also need to be developed to assist in prioritizing which drainage improvements should be addressed first.

4.3. Site Observations and Discussions with Band Members

Findings from site observations and discussions with band members were also used to identify drainage concerns within the Sliammon community. From the analysis of these findings, it was identified that many of the drainage concerns in the community are related to the condition of the drainage system, or lack there of, in some areas. The components of the drainage system that were identified to be causing the majority of the problems, in no particular order, were:

(a) ditches and culverts;
(b) drainage outfalls (outlets to the shore); and
(c) lack of adequate lot grading.

4.3.1. Ditches and Culverts

There are many areas of the community where ditches are not present along the roadways and behind lots, or the ditches do not connect to one another. In addition, many of the ditches and culverts that do exist are in poor condition, with driveway culverts partially blocked by soil and/or vegetation. As a result, there are several areas where runoff flows onto occupied properties or onto roadways. This causes problems for homeowners and community members.

Appendix 1 – Figure 1.2 shows the “As Found” drawings for the Sliammon drainage system. As illustrated in this drawing, there is a ditch built on at least one side of the road in most of the community and in several areas there are ditches on both sides of the roads. The two localized

areas in the community where there is a lack of ditching, which is causing flooding, are on the south side River Road and the east side of Sliammon Road.

4.3.2. Discharge Outfalls

The community has also experienced problems and complaints related to three drainage outfalls located along the shore. The culvert that runs under Waterfront Road beside lot 4902 regularly backs up in large storms and causes flooding of the road (Labelled as outfall 'A' on the "As Found" drawing in Appendix 1 – Figure 1.2). The two discharge ditches, on Beach Road near lots 5129 and 5169, collect drainage from all of the lots located to the north, and channel stormwater through these individual lots (Labelled as outfalls 'C' and 'D' on the "As Found" drawing in Appendix 1 – Figure 1.2). These two lot owners have concerns with the safety of the channels in their yards as well as the damage that could result if these channels overflow.

4.3.3. Lot Grading and Drainage

In addition to deficiencies with surface water cut-offs at roads, there is a general problem with insufficient drainage control on lots. In many cases, the houses have been constructed in low-flat locations and the ground has not been graded to direct water away from the houses. In addition, many houses have been constructed with basements however, adequate perimeter drains have not been installed or are not functioning as intended. The result of these problems includes surface water staying adjacent to houses, creating the potential for ingress and flooding which contributes to flooding basements and mould problems. Roughly half of the community surveyed have basements, which causes an increased risk for infiltration.

4.4. Observation / Experience

In addition to the survey data collected and site investigations, input regarding other noted drainage problems around the community was provided by Sliammon's Capital Manager, Eugene Louie. Based on his personal experience as well as feedback that he has received from residents, Mr. Louie identified areas where there have been drainage problems in the past. Mr. Louie identified that there have been drainage concerns with houses along Eagle Drive, Homalco Road and Harwood Drive, which are roads located to the east of Sliammon Creek.

The primary concern that Mr. Louie identified in these areas is that surface water is pooling at the back of the lots. These roads are generally built perpendicular to the slope, which often results in surface water from each lot draining onto the lot of the lower neighbour, which contributes to the surface drainage problems. Also, there are no interceptor ditches located at the rear of these properties, therefore water that collects at the back of the houses is not easily drained away.

The drainage issues that were highlighted by Mr. Louie were not identified in the survey as there were no specific questions related to drainage issues on lots and in some cases drainage problems were identified after the survey was completed.

5.0 IMPROVEMENT OPTIONS

The two main factors that were identified as contributing to drainage related problems in the community, were inadequate drainage control features to direct surface water away from lots and lack of adequate drainage control on the lots to keep water away from houses. Both issues are related to surface water flow or water flow in the top organic layer of soil and both contribute to leaking basements in various locations of the community.

Collecting surface drainage and directing it away from lots is the aim of the drainage system. However, there are some gaps in the Sliammon system that are contributing to drainage problems. Improvements to the system are presented in this section under the following types of activities: improving the existing system, installing storm sewers and improving drainage at the individual houses. These improvements do not have to be made in isolation of each other, and can be instead considered together in order to provide a more integrated solution.

5.1. Improve Existing System

The recommended improvements to the existing system, include upgrades or improvements to:

- Roadside Ditches;
- Rear Yard Interceptor Ditches; and
- Drainage Outfalls.

5.1.1. Roadside Ditches

While having ditches on both sides of the road is the general convention, there are several areas in Sliammon where there is only a ditch on one side of the road and it does not appear to be causing adverse conditions. Adding a second ditch to these areas will not be greatly improving the drainage conditions and is therefore not recommended. There are however, two localized areas where the lack of ditching along the roadway is contributing to adverse conditions for adjacent lots.

The two localized areas in the community where the lack of roadside ditches is contributing to significant flooding, are along the south side River Road and the east side of Sliammon Road. However, improvements on Sliammon Road are not considered as part of the recommended improvements in this feasibility report (Refer to Section 2.2). Construction of new ditches on River Road should be considered to improve the surface drainage control and inhibit water from flowing on properties adjacent to these ditches. The proposed roadside ditches on River Road are along sections of road that are within the established rights of way, therefore rights of way issues should not be a problem.

5.1.2. Rear Yard Interceptor Ditches

There is a need for rear yard interceptor ditches at the back of lots along Eagle Drive, Homalco Road and Harwood Drive, which are located to the east of Sliammon Creek, and extend from Highway 101 to Beach Road. Ditches constructed at the back of the lots would help to direct water away from the lots and reduce the amount of water pooling around houses.

Rear yard interceptor ditches would also be helpful in solving the problem outlined in section 4.4, where roads have been built perpendicular to the slope. In these areas, some of the homeowners have constructed ditches on the high side of their lots, between the properties. However, water simply collects in these ditches without a proper rear yard discharge point. If these rear yard interceptor ditches are in place, it would be possible to grade the ditches between properties to direct surface flow into the rear yard interceptor ditches.

Rights of way issues for rear yard ditches will need to be secured as part of the design phase, as explained in Section 2.2.

5.1.3. Drainage Outfalls

It is recommended that the discharge culvert on Waterfront Road beside lot 4902 should either be replaced with a larger culvert or have a second culvert added to help to manage the high surface water flows. Also, the existing culvert should be cleared of brush and graded so that surface water is able to flow more effectively towards the ocean (Refer to Appendix 1 – Figure 1.2, Outfall 'A').

To address the concerns related to the ditches through lots 5129 and 5169 on Beach Road, it is recommended that a culvert be installed which extends through the lots. This will allow the system to transport stormwater to the ocean and minimise the risk of water overflowing the ditches and flooding the houses (Refer to Appendix 1 – Figure 1.2, Outfalls 'C', and 'D').

5.2. Storm Sewer System Installation

Another option to address some of the surface runoff issues within the community would be to introduce a storm sewer system which would include a storm main running under the roadways and have catchbasins either within the roadway or in swales located along the side of the roads. A storm sewer system could be installed throughout the entire community or in localized areas where the most significant drainage issues have been observed.

However, a complete drainage overhaul of the system would be very expensive and would require significant roadwork and utilities installation along roads that would fall outside of the rights of way and there could be significant land encumbrance issues. For these reasons, a storm sewer upgrade for the entire community is not likely a feasible option.

Storm sewers were considered for specific areas of the community where the drainage infrastructure along the road is lacking, such as along the south side of River Rd. However, as there is already a partial ditch on River Rd., it makes economic sense to simply add more ditching to complete the system. As well, a storm sewer on River Rd. would have no other system to tie into further justifying the construction of a ditch.

A storm sewer could be considered along Sliammon Road, however as explained in Section 2.2, will not be considered under the scope of this project.

5.3. Individual House Options

The primary cause of basement flooding is due to the lack of adequate drainage control on individual lots. Since lots are poorly graded, houses are constructed on low-flat areas, and many houses are constructed without adequate perimeter drains, surface water collects around the houses and creates the potential for ingress and flooding.

While the ideal situation would be to have houses constructed with slab, on-grade, with the surrounding ground graded away from the house, this is not possible in the already fully populated community. Instead, it is recommended that a reliable and adequately sized perimeter drain be constructed around houses to direct surface water away to an appropriate location. It is also recommended that drainage systems for these houses be installed to include a drain tile system around the house as well as shallow swales in the yard to further direct surface water away from the house. This work should be viewed as a preventative measure to minimize potential negative health impacts and high repair costs associated with flooding and mould damage.

Priority should be given to houses that have identified flooding issues due to poor drainage in their basements. Selection criteria will need to be further developed to identify which houses will receive improved drainage around the house. Additional minor drainage work is also recommended for lots where there are surface drainage concerns but no basement flooding. Work on these lots should include some minor grading and swale building to eliminate low areas and ensure that surface water flows off the lot and rear yard interceptor ditches could also be considered. However the survey data should be verified and it may be necessary to consider other houses who were not identified in the original survey.

6.0 PROPOSED IMPROVEMENTS

As mentioned in Section 5.0, the recommended approach to improving the Sliammon Master Drainage Plan could use a combined approach of upgrades. This will be the most cost effective way to adequately address most of the concerns with the existing drainage system. Drainage improvements include replacing and installing culverts, constructing additional ditching,

constructing swales, grading lots and installing perimeter drains around houses with leaking basements. Proposed drainage upgrading is summarised in the following table, and shown on Figure 1.3 in Appendix 1.

Table 6-1: Proposed Drainage Upgrades

No.	Location	Description
1	River Road	Construct additional ditching along the south side of River Road to the west of Sliammon Road
2	Eagle Drive	Install rear yard interceptor ditches behind houses
3	Homalco Road	Install rear yard interceptor ditches behind houses
4	Harwood Drive	Install rear yard interceptor ditches behind houses
5	Outfall (A)	Install new 600mm culvert
6	Outfall (B)	Install new 600mm culvert
7	Outfall (C)	Install new 600mm culvert
8	Household Level	Installing perimeter drains and yard drainage swales for houses with leaking basements
9	Household Level	Improving lot grading and building swales on lots with drainage issues and those backing onto the new rear yard interceptor ditches

The location of these proposed improvements are shown in Appendix 1 – Figure 1.3.

7.0 ENVIRONMENTAL ASSESSMENT REQUIREMENTS

An Environmental Scoping Report has been prepared for this project and is included in Appendix 3. The environmental implications of this project are believed to be minimal due to the fact that most of the work will be completed in and around previously developed areas.

8.0 COST ESTIMATE

A Class D cost estimate for the proposed drainage works has been prepared. The costs for this work includes completing all of the new ditch and culvert work described in Section 6.0 and allows for perimeter drains to be installed around fifteen houses in the community. While only twelve houses were identified to have flooding in their basements due to poor drainage, it is believed that there may be additional houses that were not identified in the original survey or have developed problems since the survey was completed. The preliminary Class D cost estimate for the work is presented in the following table.

Table 8-1 Preliminary Class D Cost Estimate

Item	Quantity	Unit	Unit Cost	Cost
Culverts	155	m	300	$46,500
Ditch	1725	m	20	$34,500
Clearing and Restoration for Ditch	1.6	ha	40,000	$64,000
Perimeter drain installation	15	ea	15,000	$225,000
Grading of flooding lots to swales	1	ls	30,000	$30,000
Sub Total				**$400,000**
Contingency (10%)				$40,000
Total Construction				**$440,000**
Enigneering Design & Construction (30%)				$132,000
Total Project Cost				**$572,000**

9.0 DISCUSSION – FUTURE DEVELOPMENTS

Many of the drainage problems observed in Sliammon are the result of the layout, location of house construction and design. Many of the homes are located in low-flat locations on the lot and the surrounding ground has not been adequately graded to direct surface water away from the houses. This condition coupled with the fact that roughly half of the homes have below ground basements, creates an opportunity for water to collect near houses, and in some cases eventually leak into houses that do not have adequate perimeter drains. Also contributing to the problem is the layout of lots in certain areas, particularly east of Sliammon Creek. In these eastern areas, the roads were built perpendicular to the slope, which results in surface water from the higher lots draining into their lower neighbours, eventually causing flooding of some of the houses.

The proposed improvements of this project include adding more ditches to help direct water away from lots and grading lots towards discharge locations. As well, improved perimeter drains are proposed to address problems with houses that have flooding issues. While these improvements are designed to help address the current drainage issues, there are measures, which should be taken into consideration for new developments to ensure that similar drainage problems are avoided in the future.

Recommendations for future subdivisions are summarised as follows:

1. Prepare new developments with proper lot drainage plans to direct surface flow away from houses.

2. Basement construction is not recommended in new houses, due to the soil conditions. Instead, it is recommended to build houses on slabs, with the surround lot graded away to ensure there is no opportunity for water collection adjacent to the house.

3. If basements are required, there should be adequately sized perimeter drains installed, which could outlet to a location that will not adversely effect a neighbouring lot.

4. Adequate drainage control in the form of ditches of storm sewers should be built to direct water away from lots, either at the roads or behind the houses. Newly developed drainage works should be designed to connect to one another and the existing system.

10.0 RECOMMENDATIONS

To adequately address the drainage concerns in Sliammon, it is recommended that the Band considers implementing the design and construction of the proposed improvements described in Section 6.0. These improvements are important to address the existing flooding problems and also improve drainage in some areas, which have the possibility of developing into more serious flooding problems.

To move this project forward, it is proposed that the construction of the drainage works be combined with the existing proposed subdivision project (CPMS No. 5008). Combining the two projects will simplify the process by only having one capital project, and will facilitate linking the drainage features of the new subdivision into an improved Master Drainage Plan. As the drainage work required is small in scale relative to the subdivision construction, the improvements would be adequately handled by the same contractor. Having only one contractor to complete both

projects will also reduce the overhead, bonding and mobilization costs associated with having two different projects.

It is also recommended that the Band pursue upgrading Sliammon Road with the Ministry of Transportation. Consideration should be made to constructing a storm sewer and curb and gutter roadway.

It is recommended that all future houses should be designed to direct surface water flow away from the houses. This includes grading the lots away from the houses and providing adequate drainage features by way of interceptor ditches or storm sewers to prevent water from flowing into lots and also ensuring that surface water flow is directed away from the houses.

Appendix 1 Figures

SLIAMMON FIRST NATION
IR 1 TOPOGRAPHY
& CATCHMENT AREA

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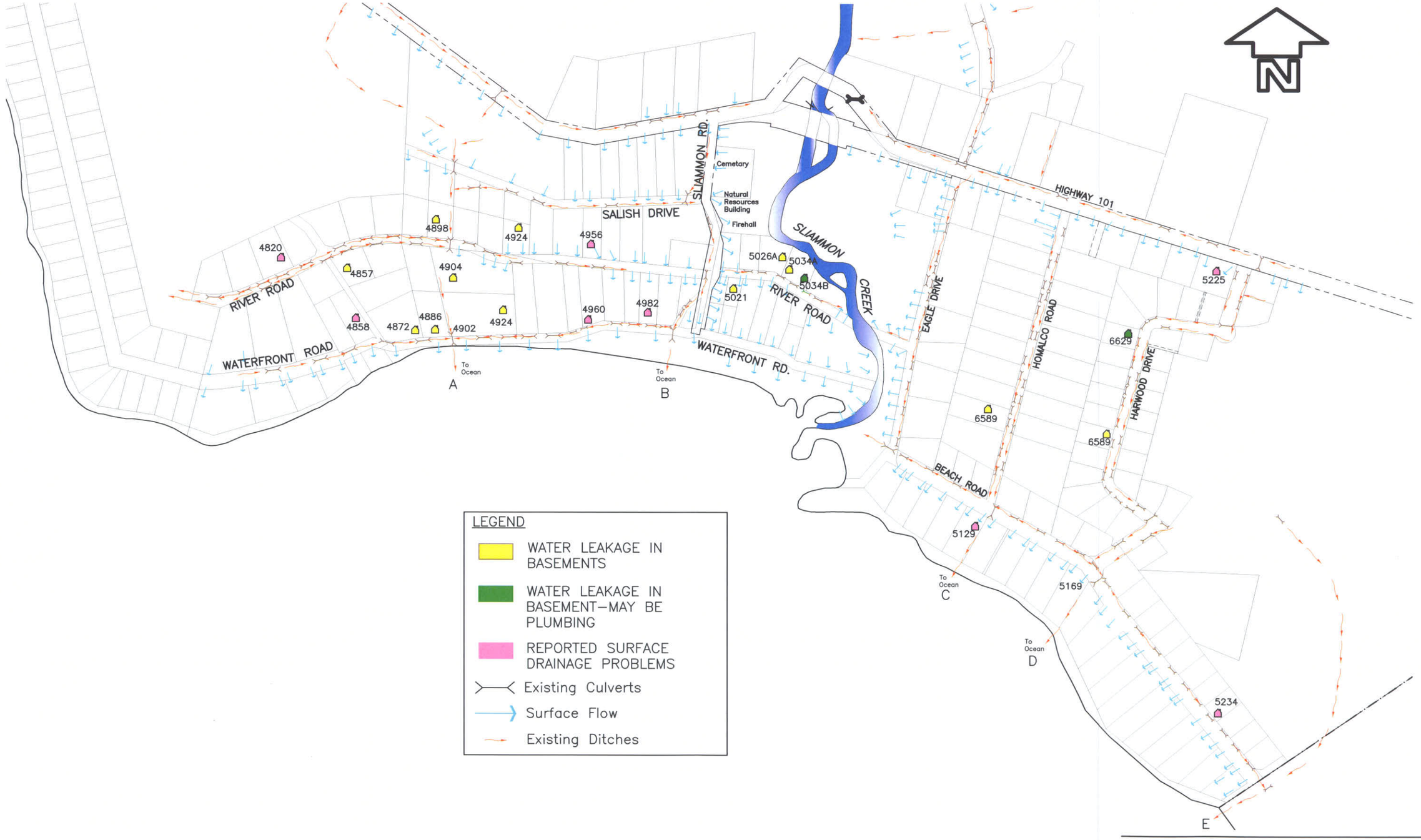
JULY, 2008
FIGURE 1.1

\PROJECT\4392\C-Cadd\4392FIG1_1



LEGEND

- WATER LEAKAGE IN BASEMENTS
- WATER LEAKAGE IN BASEMENT—MAY BE PLUMBING
- REPORTED SURFACE DRAINAGE PROBLEMS
- Existing Culverts
- Surface Flow
- Existing Ditches

SLIAMMON FIRST NATION
IR 1 "AS FOUND" DRAINAGE SYSTEM

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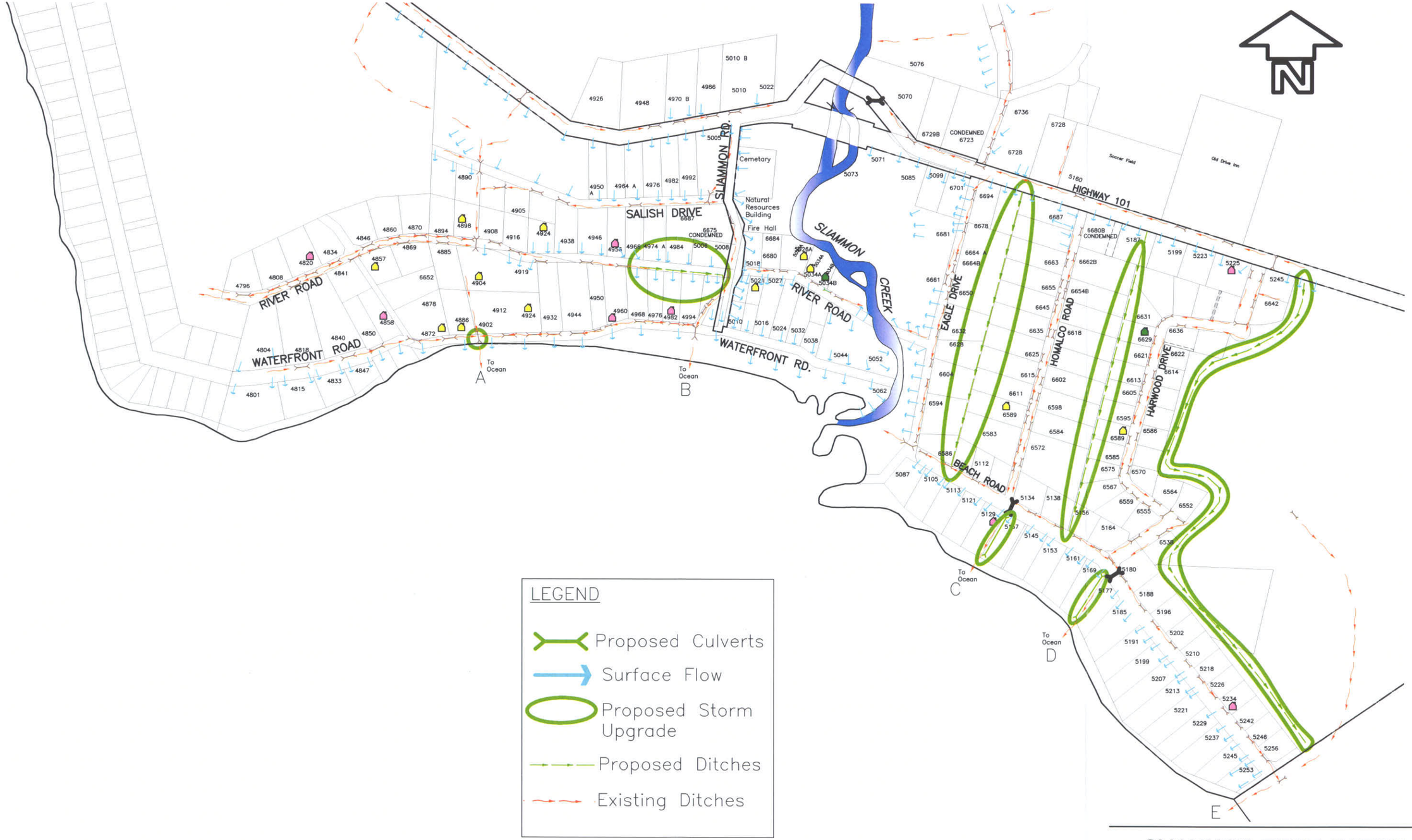
JULY, 2008
FIGURE 1.2

1PROJECT\4392\C-Cadd\4392FIG1_2



LEGEND

- Proposed Culverts
- Surface Flow
- Proposed Storm Upgrade
- Proposed Ditches
- Existing Ditches

SLIAMMON FIRST NATION
IR 1 PROPOSED DRAINAGE WORKS

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JULY, 2008
FIGURE 1.3

1PROJECT\4392\C-Cadd\4392FIG1

Appendix 2 Drainage Survey and Results

Sliammon Master Drainage Plan

Survey of homes with Water infiltration

Resident's names: _____

Street Address: _____

Type of construction (check):

Basement: _____

Crawlspace: _____

Slab on grade: _____

Questions:

1. Do you have water coming into your basement?

2. If so: where does it come from?

3. Do you have a sump pump?

4. If so: where does it pump to?

Sliammon First Nation
Drainage Survey Results
DNA 4392

Houses with Water Leakage into Basements

	Address	Comment
1	4872 Waterfront	Comes from the back of the lot
2	4886 Waterfront	Enters from the side of the house from a slope
3	6589 Homalco	Floods driveway and carport from road
4	4904 Waterfront	Water enters crack in foundation
5	5034B River	Water comes from the shower and into the basement
6	5026A River	Enters through the foundation
7	4898 River	Water enters through the door frames
8	5034A River	unknown
9	5021 River	water coming through concrete floor
10	4924 Waterfront	Enters through foundation
11	4857 River	Poor drainage around house, crack in foundation
12	4924 River	No drainage around house, foundation cracked
13	6629 Harwood	Water from gutters and shower
14	6589 Harwood	Flood in winter, need weather stripping on doors

Houses with other reported drainage problems

	Address	Comment
1	4956 River	Poor Drainage in backyard
2	4858 Waterfront	Low Drainage problem at back of house
3	4960 Waterfront	Drainage problem at back of house
4	5234 Beach	Poor drainage in yard
5	4982 Waterfront	Concern related to road drainage from River Rd.
6	4820 River	Poor drainage
7	5129 Beach	Low drainage causing floods
8	5225 Highway	Concerns related to road drainage

Appendix 3 Environmental Scoping

SLIAMMON FIRST NATION

MASTER DRAINAGE PLAN

Environmental Scoping

David Nairne + Associates Ltd.

July 2008

DNA
David Nairne + Associates

MASTER DRAINAGE PLAN
Environmental Scoping

for

Sliammon First Nation

Client: Sliammon First Nation
RR #2, Sliammon Road
Powell River, BC
V8A 4Z3
Tel: 604-483-9646
Fax: 604-483-9769

Prepared by: David Nairne + Associates Ltd
Suite 250 – 171 W. Esplanade
North Vancouver, BC
V7M 3J9
Tel: 604-984-3503
Fax: 604-984-0627

Project Engineer: .....
Giorgio Caon, P. Eng.

Date issued: July, 2008

DNA Project No.: 4392

INAC CPMS No.: 7133

TABLE OF CONTENTS

1. INTRODUCTION

1.1. Background

David Nairne & Associates (DNA) was retained by the Sliammon First Nation to prepare the following Environmental Scoping Report for a master drainage plan for the Sliammon community. The Sliammon community is located on Sliammon IR No. 1 near the town of Powell River, approximately 150 kilometers northwest of Vancouver. The existing community is located on the southern end of the reserve, on the fringe of land bordered between Highway 101 and the ocean, as show in Appendix 1- Figure 1.

This report is part of the feasibility design of the drainage project and is intended to satisfy requirements of the Indian and Northern Affairs Canada – BC Region (INAC) as outlined in the document *INAC General Terms of Reference for Environmental Assessments*, dated June 21, 2005.

The existing drainage system in Sliammon has been developed over several years with drainage features added whenever new construction takes place. This haphazard design of the drainage system has resulted in poor drainage, causing persistent flooding in and around houses, which the community would like to resolve. The existing drainage system includes a series of roadside ditches and culverts under driveways and road crossings. However, there are many areas of the community where ditches are not present along the roadways or behind lots, or they are not designed to connect to one another. In addition, many of the ditches and culverts that do exist are in poor condition and are overgrown or partially blocked by soil and/or vegetation.

The feasibility study presents a Master Drainage Plan for the Sliammon community which includes mapping the existing drainage works, identifying problem areas, and recommending solutions to address drainage issues within the community. A combined approach of adding new drainage, in addition to upgrading and rehabilitating existing drainage, has been recommended for the Master Drainage Plan.

1.2. Project Description

The proposed approach to improving the drainage system on Sliammon I.R.No1, to protect the properties and houses in Sliammon, will use a combined approach of upgrading and adding ditches, installing some new culverts and also improving drainage on some of the lots. This combined approach will be the most cost effective way to adequately address the primary concerns with the existing drainage plan.

Construction activities will include limited clearing and grubbing of some areas where the additional ditches will be installed, installing three new culverts at the discharges in the southern portion of the community, installing perimeter drains and yard drainage swales for houses with leaking basements as well as minor grading and swale building on the lots with drainage issues and on the lots where new ditches are being installed at the rear of the property. The proposed improvements are show in Appendix 1- Figure 1.3.

1.3. Contact Information

OWNER: Sliammon First Nation
RR #2, Sliammon Road
Powell River, BC
V8A 4Z3
Contact: Eugene Louie, Capital Manager
Tel: 604-483-9646
Fax: 604-483-9769

CONSULTANT: David Nairne + Associates Ltd
Suite 250 – 171 W. Esplanade
North Vancouver, BC
V7M 3J9
Contact: Giorgio Caon, P.Eng
Tel: 604-984-3503
Fax: 604-984-0627

2. ENVIRONMENTAL SETTING

Sliammon IR No.1 is situated near the town of Powell River, approximately 150 kilometers northwest of Vancouver. The existing community is located on the southern end of the reserve, on the fringe of land in between the highway and the ocean. The main portion of the community is bisected by Sliammon Creek, which traverses the reserve from north to south, and flows into the Straight of Georgia. Houses are built on both sides of Sliammon Creek, between Highway 101 and the ocean. The existing development is made up of a First Nations settlement with a population of about 770 people residing in roughly 180 occupied houses, plus a non-First Nations (Klahanie) development comprising of about 110 leased lots, which are located along the shore on the western side of the community.

The Sliammon area is within a relatively mild climate which has warm dry summers and mild wet winters. The average annual precipitation for the region is roughly 1100mm per year.

The main natural resources on the site include Sliammon Creek, the Georgia Straight and the undeveloped land located outside of the houses on the reserve. The creek and the straight are

valued ecosystems and may be a habitat to mammals, fish and other species. The areas to be cleared to install ditches and swales behind houses may also be the habitat of other species.

A search for the possibility of species at risk residing in the area, showed that the site was within the range of twelve species listed as being either threatened or of special concern. A list of the identified species in the *Species at Risk Act* (SARA) database, their preferred habitat, along with information regarding their likelihood of being impacted by the project is presented in the following table:

Species	SARA Status	Habitat	Likely impacted by the project
Marbled Murrelet	Threatened	Prefer inshore, marine environment. Require old growth forests for their nests	No, the site does not include old growth forest
Short-tailed Albatross	Threatened	Seabird live in habitat along and inshore of the shelf break. Typically nest on isolated offshore islands with restricted human access.	No, there is likely no suitable habitat in limited areas to be cleared
Western Screech-Owl kennicottii subspecies	Special Concern	Live in varied habitat including semi open woodland and treed suburban areas	Possible, there may be suitable habitat but only a limited area will be cleared
Coast Tailed Frog	Special Concern	Live within cool permanent streams adjacent to mature or coastal old growth forests, with very few or no fish species.	No, there is likely no suitable habitat in limited areas to be cleared
Western Toad	Special Concern	Lives in forested areas near shallow lakes or ponds.	No, there is likely no suitable habitat in limited areas to be cleared
Northern Abalone	Threatened	Live in a marine environment	No, the project is inland
Grey Whale (Eastern North Pacific population)	Special Concern	Live in a marine environment	No, the project is inland
Harbour Porpoise (Pacific Ocean population)	Special Concern	Live in a marine environment	No, the project is inland
Humpback Whale (North Pacific population)	Threatened	Live in a marine environment	No, the project is inland
Killer Whale (Northeast Pacific northern resident population)	Threatened	Live in a marine environment	No, the project is inland
Killer Whale (Northeast Pacific transient population)	Threatened	Live in a marine environment	No, the project is inland
Steller Sea Lion	Special Concern	Live in a marine environment	No, the project is inland

The information in the above table was obtained from the Environment Canada, Canadian Wildlife Service. 2004. Species at Risk Web Mapping Application (http://www.sis.ec.gc.ca/ec_species/ec_species_e.phtml), accessed on July 9, 2008.

3. ENVIRONMENTAL EFFECTS

The primary environmental concern associated with this project includes potential impacts on the watercourses located close to the site. Potential concerns include the disturbance of soil and sediment transport into the watercourses. However, no work will be carried out in Sliammon creek itself. Also, the installation of new culverts at the discharges will be limited to construction activities on the lots adjacent to the shore.

Other potential effects of the project include the clearing and grubbing behind the houses. The clearing of the land could disturb habitat and possible species on the site. However, much of the area to be cleared is not heavily treed and will not likely contain significant habitat value.

During the design phase of the project, an environmental assessment will be prepared to identify mitigation measures to limit any environmental effects on Valued Ecosystem Components (VEC's). Primary mitigation measures would likely include conventional sedimentation control measures around excavations and limiting clearing to only the necessary areas.

It is believed that the cumulative effects of the project will be minimal because much of the development will be completed on previously cleared and developed areas.

4. STUDIES / INVESTIGATIONS

As part of the design phase of this project an environmental assessment of the final design will be completed to expand upon this environmental scoping. The Environmental Assessment Report will be completed in accordance with the INAC document INAC *General Terms of Reference for Environmental Assessments*, dated June 21, 2005, and will address the requirements of the INAC Environmental Screening Process for Lands and Trust Services as required by the Canadian Environmental Assessment Act (CEAA). The environmental assessment will further address mitigation measures associated with the construction of the project addressed during design.

5. PUBLIC CONSULTATION

Consultation with the Sliammon First Nation community has been and will continue to be included in the design process of the project. At this time, the project is well supported by the residents because the current drainage system is not functioning well. However, any concerns that do arise will be directed to the Sliammon First Nation administration and will be incorporated into the final design of the project.

6. ACCESSORY ACTIVITIES

Accessory activities that are planned during the design phase of this project may include some minor clearing for access to parts of the site. This concern will be mitigated by limiting clearing as much as possible to areas where it is necessary.

7. CONCLUSIONS

The project is expected to have minimal adverse environmental impacts based on the construction techniques that will be observed and due to the fact that the majority of the site has been previously developed. The amount of necessary clearing and grubbing will be minimal and contained to a small portion of the reserve. The continued impacts of the project are also expected to be minimal, as the majority of the site will be returned to its original condition. An environmental assessment of the final design will be completed to expand upon this environmental scoping to address the necessary mitigation measures during construction.

Appendix 1 Figures

SLIAMMON FIRST NATION
IR 1 LOCATION MAP

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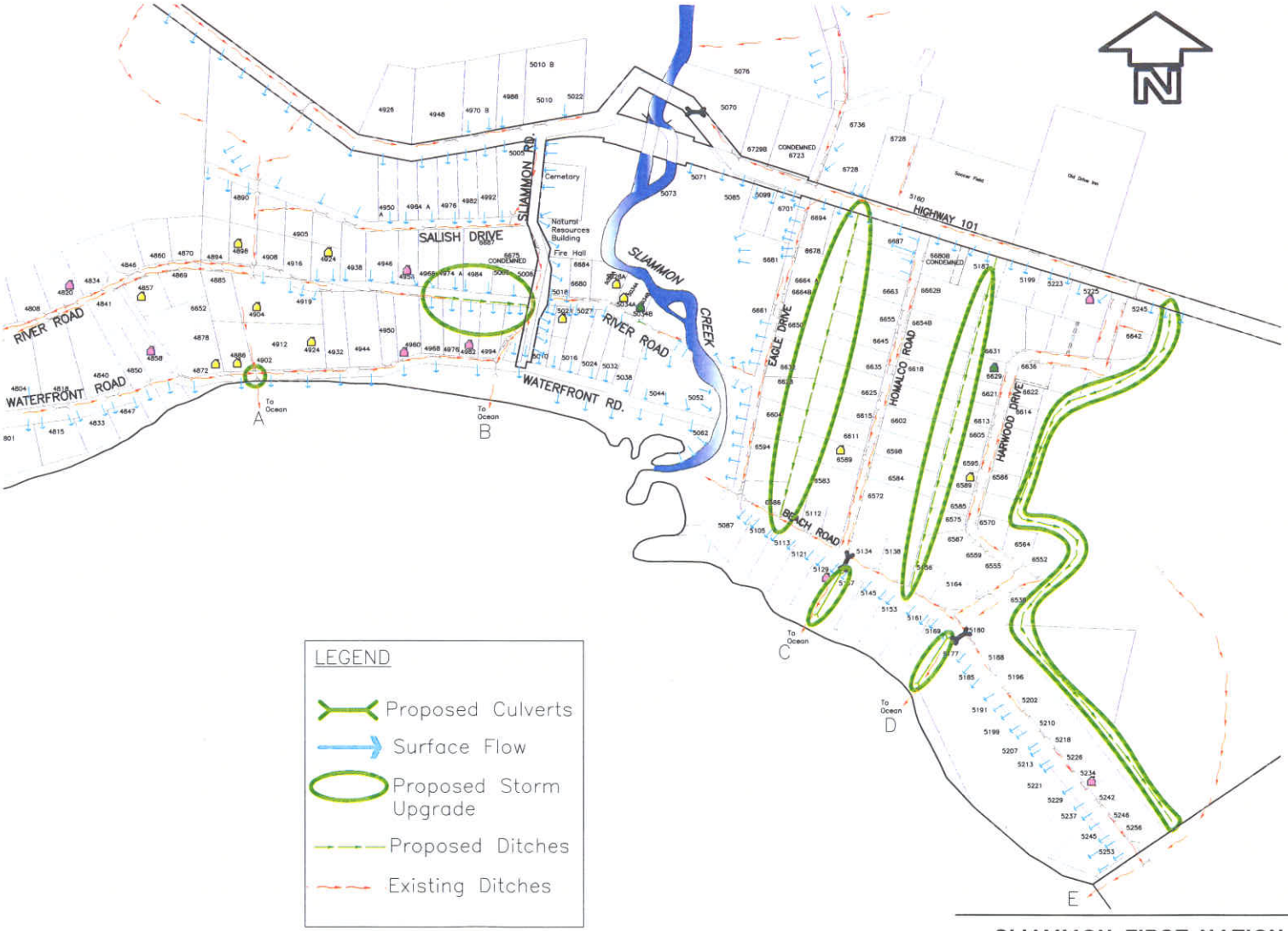
JULY, 2008
FIGURE 1



SLIAMMON FIRST NATION
IR 1 PROPOSED DRAINAGE WORKS

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FIGURE 1.3