REPORT

Master Drainage Plan Update

2021 Drainage Report

Sayward, BC

Presented to:

Ann MacDonald, RPP, MCIP

Chief Administrative Officer

Village of Sayward

652 H'Kusam Way, PO Box 29
Sayward, BC V0P 1R0

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Your Contact: S. Masterman, PEng., CCA.
Civil Engineer

#104-950 Alder Street, Campbell River, BC V9W 2P8 Phone (250) 287-2825 Fax (250) 287-3980
Email: smasterman@highland-eng.ca Web Page: www.highland-eng.ca
Permit to Practice No. 1000844

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Revision	Date	Description	Contributors		Reviewer	
			FirstName LastName	Position	FirstName LastName	Position
A		For Internal Information/Discussion	Stuart Masterman	Eng	Richard Stephens	Snr Eng
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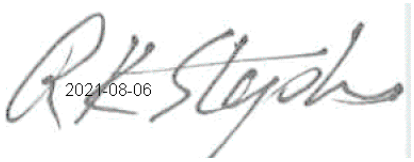
Signed and Sealed

S. Masterman, P. Eng.

Reviewed by



Richard Stephens, P. Eng.

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1. INTRODUCTION & SCOPE OF REPORT

This report follows on from the Village of Sayward Master Drainage Plan (Highland Engineering / Ludvigson Land Surveying, 2000). For ease of comparison, we have mirrored the format of this earlier report and have kept the same creek naming conventions used previously.

1.1 Scope of Report

The objective of this report is to identify measures to mitigate flood risk for residential properties in the Village centre area. Therefore, this report focuses on catchment 3 which contains Creeks 3A, 3B and 3C that flow through the Village centre.

Review of catchments 1, 2 (Newcastle Creek), 4 and 5 is excluded from the scope of this report. See sheet 1 & 2 of 4 in **APPENDIX A** for a plan that outlines the locations of these catchments.

1.2 Background

The Village of Sayward (the Village) has requested that Highland Engineering Services Ltd (Highland) review drainage challenges within the Village centre area.

The primary issue is localized flooding around the northern portion of MacMillan Drive where existing pipes are backing up and causing flooding on the roadway and into some properties. We understand that there has been at least one crawlspace flooded and regular sandbagging required since 2000.

Secondly, we understand that water is flowing down slope through private properties on MacMillan Drive. The Village has told us that during high flows, water is overflowing from the ditch running along the trail above MacMillan Drive and some homeowners have started to install a ditch along their rear property line to divert this surface flow away from their homes.

1.3 Other Reports Currently Underway

We understand that the Village has other consultants currently working on a Flood Hazard Mapping study as well as a review of the Official Community Plan. The Village intends to use these reports together to come up with a comprehensive strategy for how to deal with drainage.

1.4 Methodology

Highland conducted two site visits in January and March 2021 to review the Village drainage infrastructure. The Public Works Manager accompanied Highland staff on one site visit and outlined areas of concern and what maintenance work the Village has been doing on the storm infrastructure. During a second site visit, Highland staff spoke with residents on MacMillan Drive, and walked the length of Creek #3C from M-Branch down to the 1200 mm diameter storm inlet at Dyer Drive trail.

Highland also conducted a topographic survey, using a combination of GPS and total station, to collect elevations/locations of critical drainage infrastructure within the Village.

Drainage flows were calculated as outlined in **Section 3** and our recommendations in **Section 7** are based on these calculations.

2. STUDY AREA

All photos referenced in this section are found in **APPENDIX C.**

2.1 Topography & Drainage

The Village is situated west of the Salmon River estuary and is partially built up the base of Newcastle Ridge which rises to ~1300m. The catchments included in this report extend to ~600m elevation and have slopes ranging from 25% to 45%.

Creek 3C below M-Branch consists of a gully between 2m and 15m deep with continuous gravel and cobbles in the creek bed. There are many areas of bank sloughing and / or undercutting, where gravelly till is exposed up to ~3m height. The side slopes of the gullies are wet and loose, and any fallen trees expose the gravelly subsoils. See photos **Photo 3** and **Photo 4**.

2.2 Soils and Vegetation

Soil classifications vary by elevation within the catchment. Ranier soils are located above ~300m elevation, Quatsino soils are between 300m and 80m elevation and Honeymoon soils are below 80m[1]. All these soils are described as well drained with gravelly/very gravelly sandy loam in the

[1] iMap BC Soil Polygons Parent Material layer https://maps.gov.bc.ca/ess/hm/imap4m/ [accessed 2021-04-19]

surface layer and gravelly/very gravelly sand and cobbles in the subsoils[2]. Bedrock is typically found ~1m below the surface. These soil descriptions match Highland's observations along the lower half of Creek 3C which are described in **Section 2.1**.

Vegetation is typically mature second growth fir and cedar trees with mixed understorey shrubs. Logging is active in the catchment area and surrounding watersheds above the Village boundary.

The bottom portion of the catchment is the Village area. This contains extensively modified soils and no significant vegetation other than grass / landscaping in yards / park areas.

2.3 Land Use & Land Ownership

Land use in the upper portion of the catchment is commercial logging operations. We understand that Western Forest Products and Mosaic Forest Management operate in this area. The harvest rotation has not been confirmed, but historic air photo[3] shows ~80Ha was harvested around 1985 and ~90Ha was harvested between 2016 & 2019.

Land use in the lower portion of the catchment is residential, commercial and public space within the Village centre. Roadways and park spaces are owned by the Village of Sayward (except Ministry of Transportation & Infrastructure owns and maintains Sayward Road). Individual lots are privately owned.

The large 21 Ha remainder lot (PID 009-679-065 – see **Figure 1** below) west of MacMillan Drive is owned by Island Timberlands Gp Ltd. (now managed under Mosaic Forest Management (Mosaic)). This large undeveloped lot extends to the western Village boundary. The lot contains the lower portions of Creeks #3A & 3B as well as the Dyer Drive access trail and ditches that divert Creeks #3A & 3B to the headwall on MacMillan Drive (HW 1). It also contains the lower portions of Creek #3C and the culvert inlet at the Dyer Drive access trail. There are no statutory right of way (SRW) or other legal charges registered in favour of the Village of Sayward which would allow legal access by the Village to maintain drainage infrastructure within this lot.

[2] Soils of Southern Vancouver Island, MOE Technical Report No. 44, BC Soil Survey, 1985 http://www.env.gov.bc.ca/esd/distdata/ecosystems/Soils_Reports/bc44_report.pdf [accessed 2021-04-19]
[3] Google Earth Pro – historical imagery tool [accessed 2021-04-19]

Figure 1 – 21 Ha remainder lot (PID 009-679-065) owned by Island Timberlands Gp Ltd. (now managed under Mosaic Forest Management)

2.4 Existing Drainage Infrastructure

Refer to sheet 1 & 2 in **APPENDIX A** for a plan showing the existing drainage infrastructure discussed below.

2.4.1 M-Branch Creek Crossings

Creek 3A, 3B and 3C cross M-Branch in steel culverts which appear to be clear and in good condition (**Photo 1** & **Photo 2**). Gravels were observed being easily transported through culvert 3C without any blockages.

2.4.2 Creek 3A & 3B Catchment

Creek 3A and 3B are intercepted by a ditch along the Dyer Drive access trail at elevation ~70m and 55m respectively. The historic creek gullies are still located below the interceptor ditch and extend down to the rear property lines of 400 and 360 MacMillan Drive respectively.

The interceptor ditch runs across slope, on the uphill side of an existing trail (Dyer Drive access trail), to a wooden log diversion structure at elevation ~27m (**Photo 5**). Flows are directed downslope into a drainage channel that is eroded (up to 2m deep) by water flow, has substantial amounts of exposed gravelly subsoils in the banks and continues to be eroded by water flow (**Photo 6**).

This channel runs down along the property line of 290/300 MacMillan Drive (channel is riprap lined at this point - **Photo 7**) to a recently installed 600 mm diameter concrete headwall in the MacMillan Drive right of way. The 600 mm pipe extends to a catch basin structure that has been overbuilt on 600 mm CSP culvert pipe running parallel with the roadway. This is the location where flooding described in **Section 2.5.1** is originating.

From here, underground pipes take the flow northwest on MacMillan Drive and then south-east down through the west side of a vacant lot (301 MacMillan Drive) to outlet in a ditch in H'Kusum Park (**Photo 8**) at elevation ~3.9 m. No easement or SRWs are registered over the pipe route through 301 MacMillan Drive to allow the Village legal access for maintenance or replacement of the pipe. There is a bend in the pipe at the H'Kusum Park property line, however Highland did not locate any manhole structure here and no manhole is shown on the utility mapping. We did note bubbling of water up through the ground at the entrance to H'Kusum Park. This indicates that the existing 900 mm CSP pipe is being surcharged and water is flowing out of failed joints or corroded areas of pipe.

The ditch in H'Kusum Park is mostly filled with gravels and flows south into a 600 mm CSP pipe inlet at a sandbag headwall which discharges into a manhole-type structure (DMH 2 - **Photo 9**) and out to a 1200 mm diameter piped crossing under Kelsey Way that drains to the large pond between Kelsey Way and Sayward Highway. The pond outlets to the Salmon River estuary at elevation ~1.0 m via a 1050 mm MoTI culvert under Sayward Highway and Salmon River Mainline service road. We understand that a flap gate used to be installed on the outlet pipe to minimize increased water levels in the pond under large tides, however this has corroded and is no longer in place. Creek 3C also discharges to the pond and estuary as described in the next section.

2.4.3 Creek 3C Catchment

For description of Creek 3C, refer to **Section 2.1** above.

Creek 3C terminates in a pool at the west end of Dyer Drive at elevation ~25 m. Water is piped from here to H'Kusum Park via a 1200 mm diameter pipe (**Photo 11** and **Photo 13**) which runs along the rear property lines of many properties on Ambleside Drive, Sayward Heights and MacMillan Drive. No easement or SRWs are registered over the pipe route to allow the Village legal access for maintenance or replacement of the pipe. The outlet pipe in H'Kusum Park is at elevation ~4.3 m

There are bends shown in the pipe, however Highland could not locate any manholes structures at these locations and no manholes are shown on the Village's utility mapping.

A ditch runs from this outlet to a twinned 900 mm CSP pipe arch culvert crossing under Kelsey Way (**Photo 14**) and into the pond described in **Section 2.4.2** above. The outlets of the pipe arch culvert are ~50% buried and the drainage channel into the pond was mostly filled with soils.

2.5 Historic Drainage Issues

2.5.1 Flooding of Residences - Major Overflows on MacMillan Drive

At least 3 residences on MacMillan Drive (#311, 321 & 331) have experienced flooding in the last 5 years. At the time of Highland's site visits there were stockpiles of sandbags stacked outside these residences for quick placement in the event of a flood. All these residences have driveways that drain down to garage/houses which have finished floor elevations below the road elevation.

Feedback from the Village of Sayward Public Works Manager and residents of these properties confirmed that flooding is being caused by water backing up at the 600 mm headwall at 290 MacMillan Drive and overtopping onto the roadway as well as surcharging at CB 1 and spilling out of the CB grate. This water is sufficiently deep to overtop the rollover curb on the south side of MacMillan Drive and flow down driveways toward and into the buildings. Surface flow along MacMillan Drive was not considered to be a major contributor to the total volume of water.

2.5.2 Water Issues at Rear of Lots on MacMillan Drive

We understand that lots along the west side of MacMillan Drive are having issues with water coming downslope onto the lots. Some property owners have dug ditches at the rear of their lots to direct surface water away from their lots.

Highland did not look specifically at the rear of these lots during our site visit, however we reviewed the land below Dyer Drive access trail which has the historic creek gullies of Creek 3A and 3B. We would expect that #360, 370, 390 & 400 MacMillan Drive would experience the most concentrated flows in the old creek gullies. Other lots will experience less concentrated surface flow from the slopes above the lots and below Dyer Drive access trail.

2.5.3 Gravel Build Up

During the January site visit, Highland observed gravel in the Creek 3A / 3B outlet pipe in H'Kusum Park almost up to the top of pipe, and gravel to the same elevation in the ditch. **Photo 8**, taken in

March 2021, shows that Village crews have since dredged this channel to remove gravel down to approximately halfway up the pipe.

Creek 3C is considered by the Village Public Works Manager to be the major gravel source and requires regular maintenance to remove accumulated gravels. **Photo 12** and **Photo 13** show piles of gravel that were removed from the inlet and outlet of the 1200 mm pipe between January and March 2021.

Gravel is expected to accumulate where the water slows down at pipe bends and where the pipe grade gets flatter.

3. FLOW ASSESSMENT

Highland completed the drainage flow assessment for catchments 3-C and 3-D. We used several technical references for this work including:

- US Soil Conservation Service TR-55 Urban Hydrology for Small Watersheds (1986)
- BC Ministry of Transportation & Infrastructure TAC Supplement (2019)
- MMCD Design Guidelines (2014)

This section outlines the data used for the drainage calculations, shows the results and describes the capacity of each system.

3.1 Drainage System Performance Targets

Minor drainage systems (pipes, catch basins, gutters etc) are typically designed to accommodate 5-year or 10-year return period[4] flows. Major drainage systems (roadways, culverts, watercourses etc) are designed to convey larger flows, typically up to 100-year return period.

The current land use in the lower portion of the catchment is primarily residential and public open space. Many private properties are situated in the old creek alignments which would typically be used to convey the major flows. Creek 3A and 3B historic drainage courses have been diverted to a piped system so any major flows from these creeks now overflows at Macmillan Drive without a safe overland flow route.

[4] 10-year return period storm has a 1 in 10 chance (10%) of being exceeded in any given year. A 100-year storm has a 1 in 100 chance (1%) of being exceeded in any given year.

Given this and the annual frequency of flooding events experienced around HW 1, the degree of risk warrants design of the drainage system to convey at a minimum the 100-year flows past the private properties and down to H'Kusum Park where some flooding would be acceptable as there is minimal risk to people and property in this public space.

There may be some flooding with 200-yr storms as these flows may not be accommodated in the drainage design.

3.2 Input Data

Historic and 100-yr rainfall data was generated[5] for an ungauged location at the head of catchment area above the Village of Sayward (Lat 50.38477°, Lon -125.99185°). 200-yr rainfall amounts were calculated by increasing the 100-yr rainfall amount by 10% [6]. Values are shown in **Table 1** below.

Table 1 - 24-Hr Rainfall Design Values

Return Period	Historical 24-Hr Rainfall	Future 24-Hr Rainfall (RCP 8.5 Climate Change Model)
100-Yr	198mm (7.8")	234mm (9.2")
200-Yr	218mm (8.6")	257mm (10.1")

Land use in the catchments above the Village is assumed to be fully forested under present conditions[7], and with ~40% clear cut under developed conditions. We have not accounted for any further development within the Village boundary as the catchment limits did not cover much developable land. Localized development in the Island Timberlands lot above MacMillan Drive will increase runoff rates, but is not expected to have a meaningful impact on the 100- and 200-year flows calculated below as these areas are part of a different sub-catchment that drains to H'Kusum Park via a 900 mm and unknown sized culverts from southern sections of MacMillan Drive.

[5] Data from IDF_CC Tool 4.5 available from https://www.idf-cc-uwo.ca/home [accessed April 16, 2021]

[6] This 10% increase over the 100-Year return period to the 200-Year return period is in keeping with the IDF curves prepared for Metro Vancouver which range from approximately 6.7%-10.7% increases. BGC Engineering Inc.'s report: Regional IDF Curves, Metro Vancouver Climate Stations: Phase 1 (Dec. 23, 2009).

[7] M-Branch road was excluded from vegetation cover calculations as it is an insignificant percentage of overall area. M-Branch ditches were included in the time of concentration calculations used to confirm how long it takes water to migrate from the top to the bottom of the watershed.

3.3 Results

Calculated flows for Creeks 3A / 3B (catchment D3-A) and Creek 3C (catchment D4-A) are shown in **Table 2** below. **Sections 3.3.1** and **3.3.2** outline how the existing drainage infrastructure would be expected to handle these flows, and confirms if the system capacity is adequate.

For simplicity, we have not included flows from local catchments within the Village, as these should not significantly increase the major flows.

Table 2: Design Flows for 100-yr and 200-yr Return Periods

			Design Flows (cu.m./sec)							
			Present Land Use [1]				Developed Land Use [2]			
			100-yr Return Period		200-yr Return Period		100-yr Return Period		200-yr Return Period	
Catchment	Creek	Discharge Point	Historic	RCP 8.5	Historic	RCP 8.5	Historic	RCP 8.5	Historic	RCP 8.5
D3-A	3A & 3B	Wooden crossing on Dyer Dr trail	1.3	2.0	1.7	2.4	1.7	2.5	2.2	3.0
D4-A	3C	1200 CSP pipe inlet	1.6	2.3	2.0	2.9	2.1	3.0	2.6	3.7

Notes
[1] Assumes forest in good hydrological condition
[2] Assumes ~40% of catchment area has been clear cut

3.3.1 Creek 3A & 3B

Existing 100-yr flows are expected to be 1.3 cu.m./sec and future 100-yr flows are 2.5 cu.m./sec. Peak future 200-yr flows are expected to be ~3.0 cu.m./sec.

The existing 600 mm headwall at MacMillan Drive has a maximum inlet capacity of 0.6 cu.m./sec therefore 0.7 to 1.9 cu.m./sec could be expected to overflow at the headwall and flood onto MacMillan Drive. The rest of the underground piped system down to H'Kusum Park is also unable to pass the maximum flow rate whether it is clear of debris or not.

The existing 600 mm CSP inlet at Headwall 2 in H'Kusum Park is also undersized with an inlet capacity of 0.4 cu.m./sec therefore between 0.9 and 2.1 cu.m./sec are expected to flood into H'Kusum Park and flow overland to the pond.

The system is undersized to handle existing peak flows and expected future peak flows.

3.3.2 Creek 3C

Existing 100-yr and 200-yr flows based on present land use within this catchment are expected to be between 1.6 and 2.0 cu.m./sec respectively. Peak 200-yr flows of ~3.7 cu.m./sec are expected based on higher yr-2100 rainfall rates due to climate change and assuming ~40% of the catchment is clear cut.

The existing 1200mm pipe inlet at Dyer Drive trail has sufficient capacity to pass the existing flows. The pipe flows at ~25% capacity which provides a significant buffer to allow for gravel filling part of the pipe. Under future flows, the pipe inlet does not have enough capacity to prevent overtopping of the trail and therefore some overland flow is expected.

The Kelsey Way twin 900 mm pipe-arch culvert crossing has a capacity of 2.8 cu.m./sec which will be able to pass all flows up to the future 100-year flow under developed land use.

The system is sized adequately for existing conditions. Under future flows, some overland flow is expected from the CSP pipe inlet if the system is not upgraded to accommodate 200-yr flows. Overland flow routes have not been confirmed and there may be flooding risk for properties downhill of the 1200 mm pipe inlet on Dyer Drive trail.

4. OTHER CONSIDERATIONS

4.1 Gravel Transport

As discussed in Sections **2.2** and **2.5.2**, gravel is being generated from soils within the creek catchments and is migrating into the piped systems. The gravel is accumulating at the outlets and is expected to also be accumulating within the pipe at bends and changes in grade. This reduces the capacity of the system and is a factor that is contributing to drainage issues. Gravel management is an ongoing and costly issue for the Village.

Once gravel is inside a piped system, it is challenging and costly to remove. The best option is to minimise the amount of gravel entering the piped system in the first place by means of a sump or some other gravel storage / diversion facility. Secondly, the piped system should be designed so that any gravel that does enter the system can be removed via manholes at bends and changes in grade. Lastly, smooth pipes such as HDPE or PVC pipes allow gravel to move through the system easily.

Alternately, removing a closed pipe system and replacing with an open ditch system allows for much easier inspection and access for gravel maintenance.

Both existing piped systems reviewed have bends and grade changes without manholes, and these are key locations where gravel is expected to build up.

4.2 Sea Level Rise

We understand that the Village has engaged McElhanney to perform a flood hazard mapping study of the Salmon and White Rivers which will review the effects of sea level rise and establish flood construction levels (FCL) for the Village. This section provides a brief overview of sea level rise related to drainage, and is not intended to supersede any information that will be published in the flood hazard mapping study.

Sea levels in BC are predicted to rise 1 m by the year 2100 (see **Figure 2**).

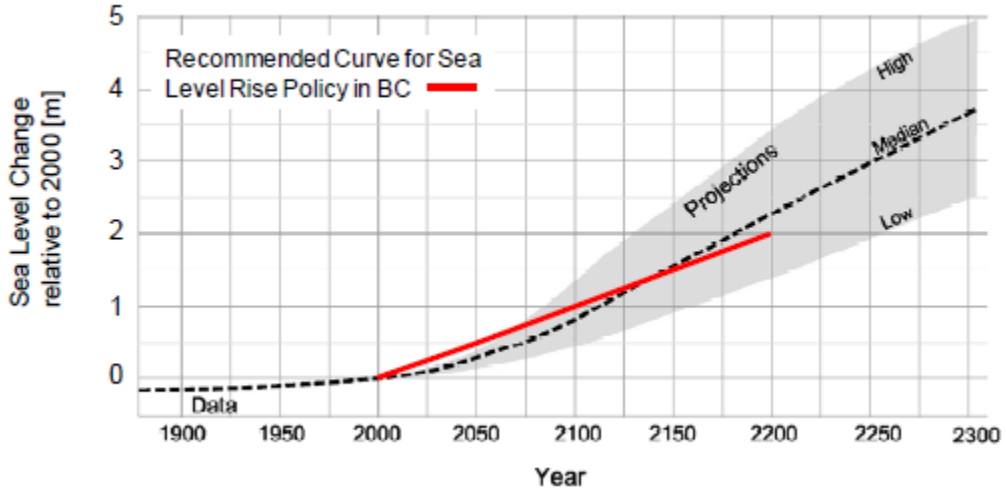

Figure 2 – Recommended Global Sea Level Rise Curve for Planning and Design in BC (from Ausenco Sandwell Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use, 2017 amendment)

The entire drainage catchment above the Village centre outlets to Salmon Bay at the downstream end of the Salmon River estuary. Predicted rise in sea levels will impact how quickly the H'Kusum Park pond can drain during high tides, particularly in the event of high river flows coupled with a high tide and storm surge event. Detailed analysis of the interaction between sea level rise and Salmon River discharges is beyond the scope of this report.

Detailed studies in Campbell River have shown that water levels at the mouth of the Campbell River are strongly influenced by tides in the bottom section ~2.5 km upstream from the river mouth[8].

[8] City of Campbell River Sea Level Rise Study, Phase 2 – Estuary Assessment, North West Hydraulic Consultants, 2018

Therefore, we have assumed that high flows from the Salmon River under a 200-yr storm will not significantly impact water elevations in Salmon Bay under a high tide.

Highland has followed the Province of BC guidelines for sea level rise to the year 2100. The calculated year 2100 flood reference plane for Sayward is 4.3-4.8 m, which includes 1.0 m global sea level rise, 0.4 m regional uplift and a 1.3 m storm surge allowance. We note again that this elevation may be superseded by the detailed Flood Hazard Mapping study that is currently underway.

The H'Kusum Park pond outlet is at 1.15 m elevation, therefore H'Kusum pond will have high tide waters backflow into the pond and raise the water level during high tides. This is expected to contribute to flooding in H'Kusum Park, however the Flood Hazard Mapping study should provide much more detail on this item.

4.3 Environmental & Archaeological Permitting

Assessment of ditches in relation to the Riparian Area Protection Act (RAPR) is beyond the scope of this report, however we recommend that a qualified environmental professional is engaged to assess each open watercourse and provide guidance on permitting requirements for any work that may be required as part of upgrades and/or ongoing regular maintenance.

Archaeological review and permitting may also be necessary as part of the design process for any upgrade works.

5. DRAINAGE UPGRADES

Refer to sheet 3 & 4 in **APPENDIX A** for plans showing the proposed drainage upgrades discussed below.

5.1 Short-Term Upgrades

The following short-term upgrades should be implemented as soon as possible to address the immediate risk of flooding homes at #311, 321 & 331 MacMillan Drive. All work is within Village of Sayward property.

1. Upgrade HW1 to 1200 mm with trash rack (to prevent large cobbles / boulders / debris entering the piped system).

2. Upgrade section of pipe on MacMillan Drive from HW1 to CBMH1 from 600 mm to 900 mm pipe.

3. Replace / upgrade section of pipe from CBMH1 to ditch outlet from 900 mm to 1200 mm including new manhole at the bend in pipe alignment.

4. Remove gravel from H'Kusum Park ditch and maintain bottom width of 1.0 m, minimum clear depth of 1.0 m and 2:1 side slopes to provide a flow capacity of ~0.7 cu.m./sec which will transport all minor storms and provide additional volume for sediment capture at the pipe outlet. Note the ditch is still expected to overflow into H'Kusum Park during major flows.

5. Line channel above 1200 mm inlet headwall with riprap to reduce gravel generation. This may not be necessary if item **11** is planned to be implemented in the medium term provided proper gravel removal maintenance work is carried out on the new piped system.

The next short-term upgrade addresses the risk of pipe failure in private property and potential property damage as a result:

6. If warranted (based on CCTV condition inspection) repair / replace some / all of the existing 1200 mm CSP culvert for Creek 3C. Note that this pipe trespasses through multiple private properties, so access agreements should be secured. Also refer to upgrade item **10** which recommends long term removal / abandonment of this section of pipe.

5.2 Medium-Term Upgrades

To minimize the short/medium term risk of flooding in H'Kusum Park, the following upgrade should be completed:

7. Clean outlets of the twin 900 mm CSP pipe arch culverts at Kelsey Way / Ambleside Drive and deepen the outlet ditch to the pond.

8. Upgrade DMH 2 inlet pipes to 1200 mm with new headwalls and replace DMH 2.

To protect Macmillan Drive homes from upslope surface water:

9. Install interceptor ditches upslope of existing residential lots and connect to existing piped system to H'Kusum Park. Note that the upslope property is owned by Island Timberlands (Mosaic), so coordination will be required and approval given for this work. SRWs should be registered. Ditch and pipe sizing is to be confirmed.

5.3 Long-Term Upgrades

Long term upgrades work towards re-establishing natural, open flow paths in the historic creek alignments. This will better serve to keep major flows away from private property, minimize the risk of capacity constraints from gravel build up in pipes and allow for much simpler gravel removal tasks by the Village.

10. Reinstate full overland flow of Creek 3C down the historical creek bed to H'Kusum Park. This will require acquisition of a portion of the Island Timberlands (Mosaic) lot and 280 / 301 MacMillan Drive. A road culvert crossing will need to be constructed to allow flow to safely pass under MacMillan Drive. The existing 1200 mm CSP culvert should be removed or abandoned.

11. Creek 3A and 3B have two options. Either:

    a. Preferred option: Plan to reinstate Creek 3A & 3B original creek channels down to MacMillan Drive and install new pipe/headwalls to direct flow under MacMillan Drive to H'Kusum Park (size TBC); or

    b. If upgrade 11a is not an option the Village wishes to consider: Redirect Creek 3A & 3B flows into Creek 3C by widening/deepening the ditch on the Dyer Drive access trail and abandoning the wooden diversion which currently directs flow to Headwall 1. Update COP and any other relevant planning documents to reflect this drainage pattern that must be maintained and only changed after a full drainage assessment.

Other long-term upgrades which will help increase the outlet capacity from the H'Kusum Park pond to the Salmon River estuary:

12. Upgrade H'Kusum Park pond outlet culverts under Sayward Rd and Salmon River Main to ~1600 mm (size TBC based on Flood Hazard Mapping study currently underway) to increase capacity to ~6cu.m/sec. Add a backflow flap on the outlet to minimize tidal water backups into the pond. Will require authorization from MoTI and Island Timberlands (Mosaic) as the culverts are under their jurisdiction.

6. OPINION OF PROBABLE COSTS

We have prepared an opinion of probable cost for the short-, medium- and long-term upgrade options presented in **Section 5**. Costs are summarized below and a detailed breakdown is included in **APPENDIX B**.

	Short-Term Upgrades	Medium-Term Upgrades	Long-Term Upgrades
Class of Estimate	Class C	Class D	Class D
Construction & Property Acquisition Value	$528,000	$485,000	$1,520,000
General Contingency	$105,600	$121,250	$380,000
Engineering. Legal etc. Allowance	$52,800	$48,500	$152,000
Inflation Contingency	$26,400	$48,500	$380,000
TOTAL (rounded)	**$713,000**	**$703,000**	**$2,432,000**

CLASS C ESTIMATE: This estimate is based on the preliminary design that provides a recommended scope of work for the specific project. It includes estimates for consultant design fees where a proposal has not been received. This category is prepared with limited site information and is based on probable conditions affecting the project and past experiences with similar projects.

CLASS D ESTIMATE: This estimate is based on little or no site specific detailed engineering but provides order of magnitude or 'ball park' estimates and is derived from lump sum or unit costs from comparable projects of similar magnitude. This category is used in developing long term capital plans and for comparing conceptual options.

7. RECOMMENDATIONS

The following recommendations include additional investigation work that is required to complete a full assessment of the drainage system condition, as well as short, medium and long term recommendations based on the upgrade items outlined in **Section 5**.

Short term:

A. Conduct CCTV condition inspection of existing drainage pipes to confirm size, condition, location and identify any blockages. This is particularly important for Creek 3C 1200 mm CSP pipe as any failure of this pipe may cause severe localized flood damage on private property along the pipe route. Revise drainage report recommendations, if required, based on pipe conditions that are found (see **upgrade item 6**).

B. Engage a Qualified Environmental Professional to review all watercourses, provide guidance on permitting requirements for upgrades and/or ongoing maintenance activities, and submit permit applications on behalf of the Village.

C. Confirm ownership of all land containing Village drainage infrastructure.

D. Implement **upgrade items 1** to **4** to deal with the immediate risk of flooding on MacMillan Drive.

E. Set up a regular maintenance schedule to remove sediment from ditches in September of each year (or other date as recommended by QEP) in preparation for wet season, and ongoing through fall / winter / spring as required to maintain channel capacity.

Medium / long term:

F. Implement **upgrade items 7** and **8** to deal with drainage constraints in H'Kusum Park.

G. Implement **upgrade item 9** to protect Macmillan Drive properties from upslope surface drainage.

H. Confirm if reinstatement of existing creek channels (**upgrade items 10** & **11**) is feasible based on Village planning objectives:

   - If so, start land acquisition process and update Village planning documents (OCP etc).

   - If not, review options for rehabilitation/replacement of existing pipes

I. Based on results of Flood Hazard Mapping study, start consultation process with MoTI and Island Timberlands (Mosaic) if upgrades to Sayward Road culverts are required as outlined in long-term **upgrade item 12**.

J. Register SRW/easements where all existing and proposed Village infrastructure runs through private property.

APPENDIX A
Drainage Plans

D4–A
AREA 52.3ha

D3–A
AREA 51.4ha

NEWCASTLE CREEK

CREEK 3A

CREEK 3B

CREEK 3C

CREEK 4A

CREEK 4B

CREEK 4C

EXISTING INTERCEPTOR DITCH

DYER DRIVE ACCESS TRAIL

INTERCEPTOR DITCH DIVERSION
(WOODEN BRIDGE)

D3
AREA 25.6ha

D4
AREA 7.3ha

MacMILLAN RD

H'KUSAM
PARK

SEAVIEW ST.

D2
AREA 6.5ha

POND

KELSEY WAY

SAYWARD ROAD

SALMON RIVER
MAIN LINE

D5
AREA 2.2ha

D1
AREA 3.6ha

SALMON BAY

3

4

5

0 100 200m
1:5000 @ A1 METRIC

BC 1 CALL
CALL BEFORE YOU DIG!
1-800-474-6886
or by CELLULAR *6886
[CALL AT LEAST 3 FULL WORKING DAYS BEFORE YOU PLAN TO DIG...]

NO.	ISSUE	BY	YY/MM/DD
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–	–	–	–
–	–	–	–
–	–	–	–
2	FOR FINAL REPORT	SM	21/07/27
1	FOR REPORT	HT	21/05/26

EXISTING	LEGEND	DESIGN
T	U/G TELEPHONE	T
H	U/G HYDRO	H
G	NATURAL GAS	G
	PERMEABLE PAVING	

EXISTING	LEGEND	DESIGN
S	SANITARY SEWER	S
D	STORM DRAIN	D
W	WATER MAIN	W
P	PAVEMENT	P
C	CURB & GUTTER	C
	SIDEWALK	
	INFILTRATION SWALE	

EXISTING	LEGEND	DESIGN
O.D.	OPEN DITCH	O.D.
S	SANITARY MANHOLE	S
D	STORM MANHOLE	D
SIDE INLET / TOP INLET	CATCH BASIN	SIDE INLET / TOP INLET
HYD.	FIRE HYDRANT	HYD.
W.V.	WATER VALVE	W.V.
U.P.	UTILITY POLE	U.P.

DESIGNED: –
DRAWN: –
CHECKED: –
APPROVED: –
SCALE: AS SHOWN
DATE: FEB 2021
DATE: –
DATE: –

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#104-950 Alder Street,
Campbell River, B.C.
V9W 2P8
(250) 287-2825
highland@highland-eng.ca
www.highland-eng.ca

TITLE:
VILLAGE OF SAYWARD
MASTER DRAINAGE PLAN
CATCHMENT PLAN

CITY DWG #: –
PROJECT: 4313
SHEET 1 OF 4
ISSUE 2

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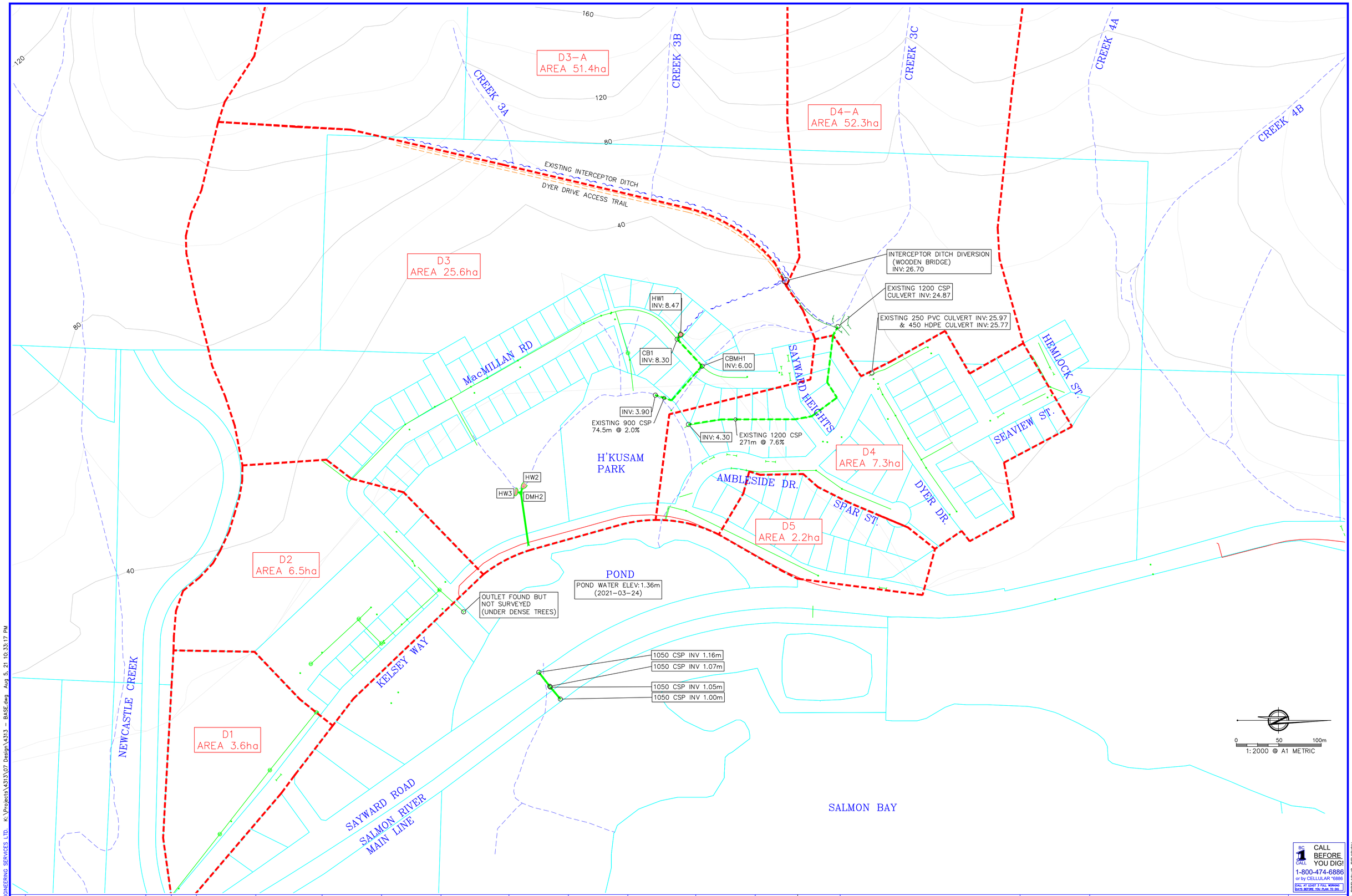
2021

DESTROY PRINTS OF PREVIOUS REVISION



NO.	ISSUE	BY	YY/MM/DD
2	FOR FINAL REPORT	SM	21/07/27
1	FOR REPORT	HT	21/05/26

EXISTING	LEGEND	DESIGN
T	U/G TELEPHONE	T
H	U/G HYDRO	H
G	NATURAL GAS	G
	PERMEABLE PAVING	
	CURB & GUTTER	C
	SIDEWALK	
	INFILTRATION SWALE	

EXISTING	LEGEND	DESIGN
S	SANITARY SEWER	S
D	STORM DRAIN	D
W	WATER MAIN	W
P	PAVEMENT	P
C	CURB & GUTTER	C
	SIDEWALK	
	INFILTRATION SWALE	

EXISTING	LEGEND	DESIGN
O.D.	OPEN DITCH	O.D.
S	SANITARY MANHOLE	S
D	STORM MANHOLE	D
SIDE INLET / TOP INLET	CATCH BASIN	SIDE INLET / TOP INLET
HYD.	FIRE HYDRANT	HYD.
W.V.	WATER VALVE	W.V.
U.P.	UTILITY POLE	U.P.

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APPROVED: –
SCALE: AS SHOWN
DATE: FEB 2021
DATE: –
DATE: –

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TITLE:
VILLAGE OF SAYWARD
MASTER DRAINAGE PLAN
CATCHMENT PLAN

CITY DWG #: –
PROJECT: 4313
SHEET 2 OF 4
ISSUE 2

BC 1 CALL — CALL BEFORE YOU DIG! 1-800-474-6886 or by CELLULAR *6886 (CALL AT LEAST 3 FULL WORKING DAYS BEFORE YOU PLAN TO DIG)

DESTROY PRINTS OF PREVIOUS REVISION

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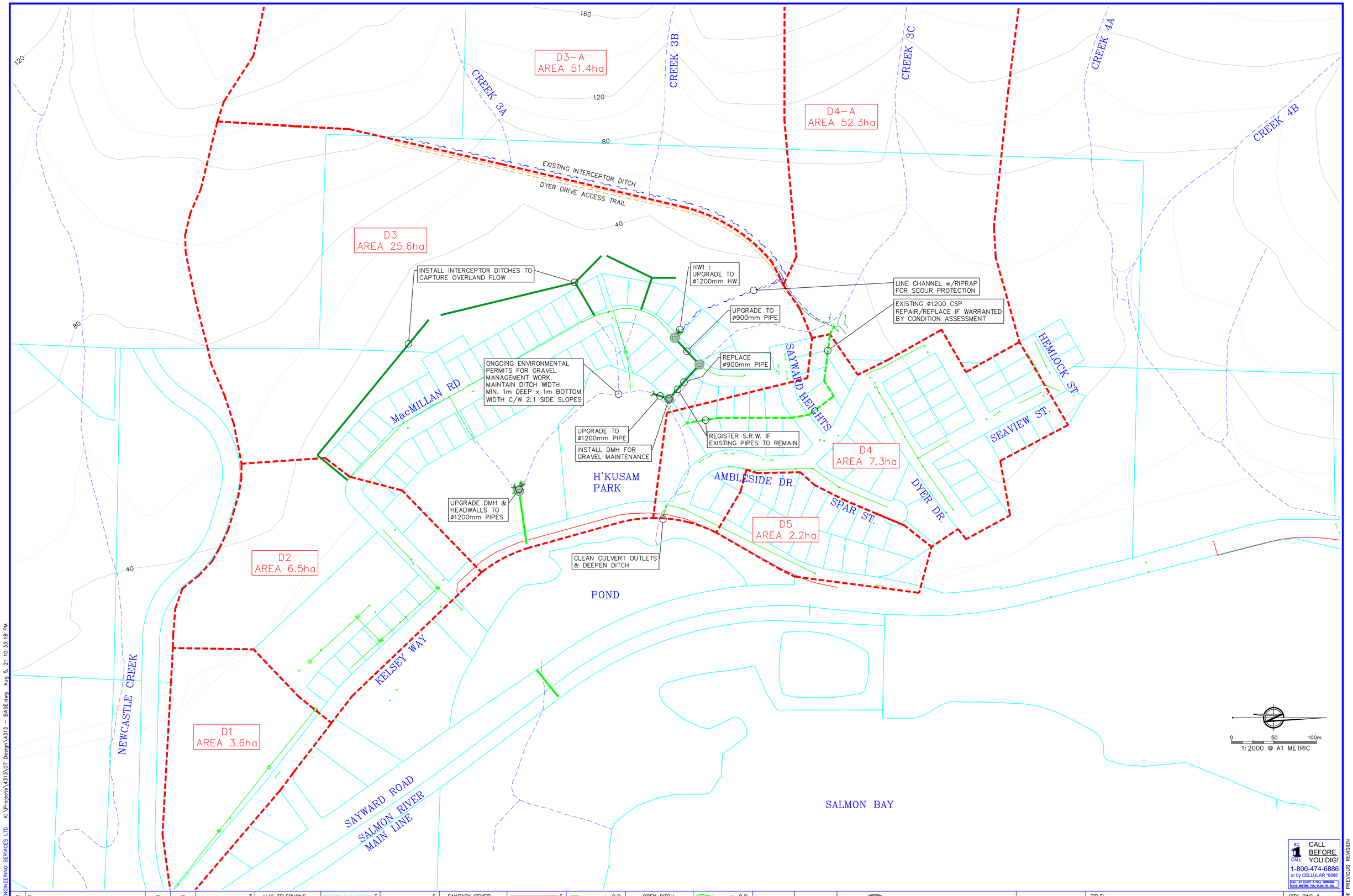

NO.	ISSUE	BY	YY/MM/DD	EXISTING	LEGEND	DESIGN	EXISTING	LEGEND	DESIGN	EXISTING	LEGEND	DESIGN
–	–	–	–	T	U/G TELEPHONE	T	S	SANITARY SEWER	S	O.D.	OPEN DITCH	O.D.
–	–	–	–	H	U/G HYDRO	H	D	STORM DRAIN	D	S SMH	SANITARY MANHOLE	S SMH
–	–	–	–	G	NATURAL GAS	G	W	WATER MAIN	W	D DMH	STORM MANHOLE	D DMH
–	–	–	–		PERMEABLE PAVING		P	PAVEMENT	P	SIDE INLET / TOP INLET	CATCH BASIN	SIDE INLET / TOP INLET
–	–	–	–				C	CURB & GUTTER	C	HYD.	FIRE HYDRANT	HYD.
2	FOR FINAL REPORT	SM	21/07/27					SIDEWALK		W.V.	WATER VALVE	W.V.
1	FOR REPORT	HT	21/05/26					INFILTRATION SWALE		U.P.	UTILITY POLE	U.P.

DESIGNED: – | SCALE: AS SHOWN
DRAWN: – | DATE: FEB 2021
CHECKED: – | DATE: –
APPROVED: – | DATE: –

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TITLE:
VILLAGE OF SAYWARD
MASTER DRAINAGE PLAN
UPGRADE PLAN – SHORT/MEDIUM TERM

CITY DWG #: –
PROJECT: 4313
SHEET 3 OF 4
ISSUE 2

D3–A
AREA 51.4ha

D4–A
AREA 52.3ha

D3
AREA 25.6ha

D4
AREA 7.3ha

D5
AREA 2.2ha

D2
AREA 6.5ha

D1
AREA 3.6ha

CREEK 3A

CREEK 3B

CREEK 3C

CREEK 4A

CREEK 4B

160

120

80

40

EXISTING INTERCEPTOR DITCH

DYER DRIVE ACCESS TRAIL

CREEK 3A/3B ALTERNATE OPTION:
DEEPEN DITCH FOR 200yr
FLOWS & DIVERT CREEK
3A/3B TO 3C

CREEK 3A/3B PREFERRED OPTION:
REINSTATE ORIGINAL CREEK
CHANNELS FOR CREEK 3A & 3B

EXTEND DYER DR. ACCESS
TRAIL DITCH TO CREEK 3C

REINSTATE CREEK 3C FLOW ROUTE &
INSTALL ROAD CROSSING AT MacMILLAN DR.
& AT DYER ACCESS TRAIL (BOTH DESIGNED
FOR 200yr FLOWS)

UPGRADE TO ø1600 CULVERT
c/w BACKWATER FLAP VALVE

MacMILLAN RD

SAYWARD HEIGHTS

HEMLOCK ST.

SEAVIEW ST.

AMBLESIDE DR.

SPAR ST.

DYER DR.

H'KUSAM
PARK

POND

KELSEY WAY

NEWCASTLE CREEK

SAYWARD ROAD

SALMON RIVER
MAIN LINE

SALMON BAY

0 50 100m
1:2000 @ A1 METRIC

BC 1 CALL
CALL BEFORE YOU DIG!
1-800-474-6886
or by CELLULAR *6886
CALL AT LEAST 3 FULL WORKING DAYS BEFORE YOU PLAN TO DIG

NO.	ISSUE	BY	YY/MM/DD
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2	FOR FINAL REPORT	SM	21/07/27
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EXISTING	LEGEND	DESIGN
T	U/G TELEPHONE	T
H	U/G HYDRO	H
G	NATURAL GAS	G
	PERMEABLE PAVING	
S	SANITARY SEWER	S
D	STORM DRAIN	D
W	WATER MAIN	W
P	PAVEMENT	P
C	CURB & GUTTER	C
	SIDEWALK	
	INFILTRATION SWALE	

EXISTING	LEGEND	DESIGN
O.D.	OPEN DITCH	O.D.
SMH	SANITARY MANHOLE	SMH
DMH	STORM MANHOLE	DMH
SIDE INLET TOP INLET	CATCH BASIN	SIDE INLET TOP INLET
HYD.	FIRE HYDRANT	HYD.
W.V.	WATER VALVE	W.V.
U.P.	UTILITY POLE	U.P.

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TITLE:
VILLAGE OF SAYWARD
MASTER DRAINAGE PLAN
UPGRADE PLAN – LONG TERM

CITY DWG #: –
PROJECT: 4313
SHEET 4 OF 4
ISSUE 2

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DESTROY PRINTS OF PREVIOUS REVISION

APPENDIX B
Opinion of Probable Cost

#104-950 Alder Street
Campbell River, BC V9W 2P8
Tel. 250.287.2825 Fax. 250.287.3980

HIGHLAND

Project:	**Sayward Master Drainage Plan Update**	Prepared By:	S. Masterman	2021-07-27
Owner:	**Village of Sayward**	Reviewed by:	R. K. Stephens	2021-07-27
Contractor:	**n/a**	Highand File #:	4313	

Item #	Description of Work	Estimated Quantity	Unit	Unit Price, $	Estimated Amount
	Short-Term Upgrades				
1.00	Mob/Demob; Traffic Control; Safety Etc [1]	1	LS	$ 50 000.00	$ 50 000.00
1.01	CCTV pipeline inspection - 2 day allowance	1	LS	$ 11 000.00	$ 11 000.00
1.02	Concrete Headwall 1200mm w. Trash Rack	1	Ea	$ 12 000.00	$ 12 000.00
1.03	Storm Pipe 1200mm Concrete	20	Lin. M.	$ 1 750.00	$ 35 000.00
1.04	Storm Pipe 900mm Ribbed PVC	96	Lin. M.	$ 1 250.00	$ 120 000.00
1.05	Manhole base, lid, slab, cover, frame and risers 1800mm diameter	3	ea	$ 15 000.00	$ 45 000.00
1.06	Misc. Concrete / Asphalt / Landscaping Surface Restoration	1	Allowance	$ 20 000.00	$ 20 000.00
1.07	Riprap Lining of Channel above 1200mm Inlet Headwall (~150m length)	1	Allowance	$ 85 000.00	$ 85 000.00
1.08	Ex. 1200mm CSP Pipe (Creek 3C) Repair Allowance	1	Allowance	$ 150 000.00	$ 150 000.00
	[Scope TBC Based on CCTV Inspection]				
				Sub-Total	**$ 528,000.00**
			General Contingency Allowance	20%	$ 105,600.00
			Allowance for Engineering, Legal and Administrative Costs	10%	$ 52,800.00
			Contingency Allowance for Inflation	5%	$ 26,400.00
			CLASS C OPINION OF PROBABLE COST	**Total**	**$ 713,000.00**
	Medium-Term Upgrades				
2.00	Mob/Demob; Traffic Control; Safety Etc [1]	1	LS	$ 100 000.00	$ 100 000.00
2.01	Clean 900mm Pipe Arch Culverts & Deepen Ditch to H'Kusum Pond	1	LS	$ 5 000.00	$ 5 000.00
2.02	Concrete Headwall 1200mm	2	Ea	$ 12 000.00	$ 24 000.00
2.03	Storm Pipe 1200mm Concrete	15	Lin. M.	$ 1 750.00	$ 26 250.00
2.04	Manhole - 5m x 3m custom box & lid	1	LS	$ 15 000.00	$ 15 000.00
2.05	Interceptor Ditches Above MacMillan Rd Properties (Clear & Grub; Shape & Finish Ditch)	650	Lin. M.	$ 100.00	$ 65 000.00
2.06	3 headwalls and ~150m pipework - sizes TBD	1	Allowance	$ 250 000.00	$ 250 000.00
				Sub-Total	**$ 485,000.00**
			General Contingency Allowance	25%	$ 121,250.00
			Allowance for Engineering, Legal and Administrative Costs	10%	$ 48,500.00
			Contingency Allowance for Inflation	10%	$ 48,500.00
			CLASS D OPINION OF PROBABLE COST	**Total**	**$ 703,000.00**
	Long-Term Upgrades				
3.00	Mob/Demob; Traffic Control; Safety Etc [1]	1	LS	$ 200 000.00	$ 200 000.00
3.01	Property Acquisition - 280 MacMillan Drive	1	Ea	$ 70 000.00	$ 70 000.00
3.02	Property Acquisition - 301 MacMillan Drive	1	Ea	$ 75 000.00	$ 75 000.00
3.03	Creek Crossings at MacMillan Drive / Dyer Drive (Assume Pipe Arch Culvert [3])	1	LS	$ 375 000.00	$ 375 000.00
3.04	Creek 3C Reinstatement Bank Work / Environmental Work	1	Allowance	$ 250 000.00	$ 250 000.00
3.05	Creek 3A & 3B Realignment to Original Creek Beds [2]	1	Allowance	$ 250 000.00	$ 250 000.00
3.06	Property Acquisition for Creeek 3A & 3B Realignment	1	Allowance	$ 300 000.00	$ 300 000.00
				Sub-Total	**$ 1,520,000.00**
			General Contingency Allowance	25%	$ 380,000.00
			Allowance for Engineering, Legal and Administrative Costs	10%	$ 152,000.00
			Contingency Allowance for Inflation	25%	$ 380,000.00
			CLASS D OPINION OF PROBABLE COST	**Total**	**$ 2,432,000.00**

Notes

[1] Assumes all work is performed under a single contract with one mobilisation / demobilisation

[2] Assumes that headwalls and piping on MacMillan Drive (item 2.06) have already been installed

[3] Creek crossing design scope TBC during preliminary design stage with environmental input

Definitions

CLASS C ESTIMATE: This estimate is based on the preliminary design that provides a recommended scope of work for the specific project. It includes estimates for consultant design fees where a proposal has not been received. This category is prepared with limited site information and is based on probable conditions affecting the project and past experiences with similar projects.

CLASS D ESTIMATE: This estimate is based on little or no site specific detailed engineering but provides order of magnitude or 'ball park' estimates and is derived from lump sum or unit costs from comparable projects of similar magnitude. This category is used in developing long term capital plans and for comparing conceptual options.

APPENDIX C
Photographs

Photo 1 - Culvert inlet at Creek 3C crossing of M-Branch

Photo 2 - Culvert outlet at Creek 3C crossing of M-Branch

Photo 3 - Creek 3C gully just below M-Branch road crossing. Note gravel and cobbles in creek bed.

Photo 4 - Undercut bank in mid-section of Creek 3C with exposed gravelly subsoils

Photo 5 - Wooden log diversion structure for Creek 3A & 3B flows (water flows left to right under the trail)

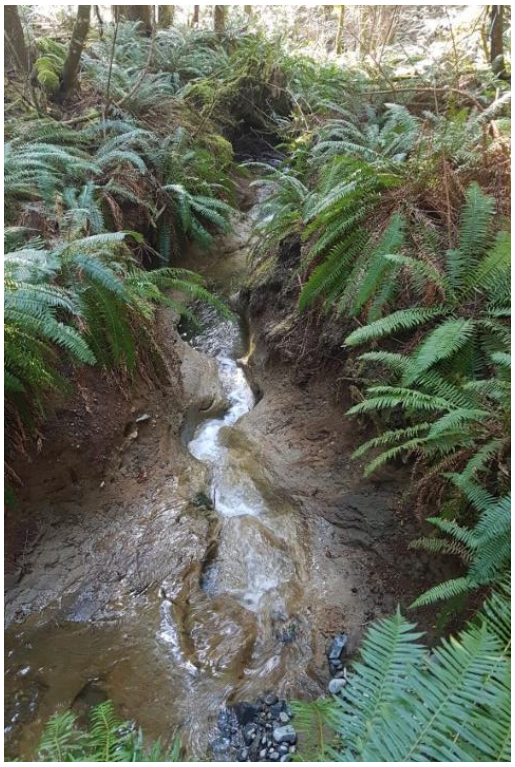

Photo 6 - Creek 3A & 3B drainage channel below wooden log diversion structure.
Note exposed gravels in walls and continued erosion in bottom of channel

Photo 7 - Drainage ditch upstream of Headwall 1

Photo 8 - Creek 3A & 3B outlet in H'Kusum Park. Note gravel depth in pipe and ditch, and pile of dredged material next to ditch.

Photo 9 - 600mm CSP pipe inlet to DMH 2

Photo 10 - 1050mm culvert outlet from storage pond to Salmon River estuary

Photo 11 - Creek 3C inlet pipe/trashrack

Photo 12 - Pile of dredged material from pool at Creek 3C inlet pipe

Photo 13 - Creek 3C outlet pipe at H'Kusum Park. Note pile of dredged gravels on left side of ditch.

Photo 14 - Double 900mm CSP Pipe Arch Crossing of Kelsey Way