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northwest hydraulic consultants

NHC Ref. No. 03000133

26 November 2014

MID VANCOUVER ISLAND HABITAT ENHANCEMENT SOCIETY
PO Box 935
Parksville, BC
V9P 2G9

Attention: **Ms. Faye Smith**
Project Coordinator

Via email: fcsmith@telus.net

Re: **Shelly Creek Geomorphic Overview and Conceptual Level Habitat Enhancement Program Development**

Dear Ms. Smith,

Northwest Hydraulic Consultants (NHC) has been commissioned to assess the condition of the lower reaches of Shelly Creek from Wildgreen Way to the mouth, to review the results of the Urban Salmon Habitat Program (USHP) data collection program, and to assist in the development of a habitat enhancement program. This report is not a biological assessment of Shelly Creek though it is intended to support the Mid Vancouver Island Habitat Enhancement Society (MVIHES) in their quest to develop fish habitat enhancement project concepts for the enhancement of Shelly Creek in Parksville, BC, and to provide a basis for developing a long term capital program.

1 BACKGROUND

Shelly creek is a small stream channel that historically was home to a thriving population of coastal cutthroat trout. The lower 1.02 km is used by anadromous fish though a barrier prevents upstream access for salmonids and Cutthroat trout[1]. At its headwaters Shelly Creek drains from Little Mountain, a steeply sloped bedrock outcrop that protrudes about 140 m above the surrounding landscape. It has a maximum elevation of 240 m and a total channel length of almost 6.5 km from its headwaters to the junction with the lower reach of the Englishman River. Portions of the channel flow through forested areas though most of the area has been developed for residential and rural uses, which has had a

[1] Clough DR, 2012. *Shelly Creek Smolt Trap 2012*. Prepared by DR Clough for Mid Vancouver Island Habitat Enhancement Society (MVIHES).

negative impact on the fish habitat in the lower reaches Shelly creek[2]. For this study eight channel reaches have been defined to represent different morphological channel sections (Error! Reference source not found.).

The channel alignment has been mapped based on Regional District of Nanaimo (RDN)[3] mapping, Provincial flood mapping[4], photo interpretation and field data and its position is considered accurate to +/- 10 to 20 m. The local road network[5] is included to provide reference points and surficial geology mapping data has been included to provide an overview of the type of surface sediments that influence present day fluvial processes[6]. Surficial geology at specific locations along the channel will vary according to site conditions.

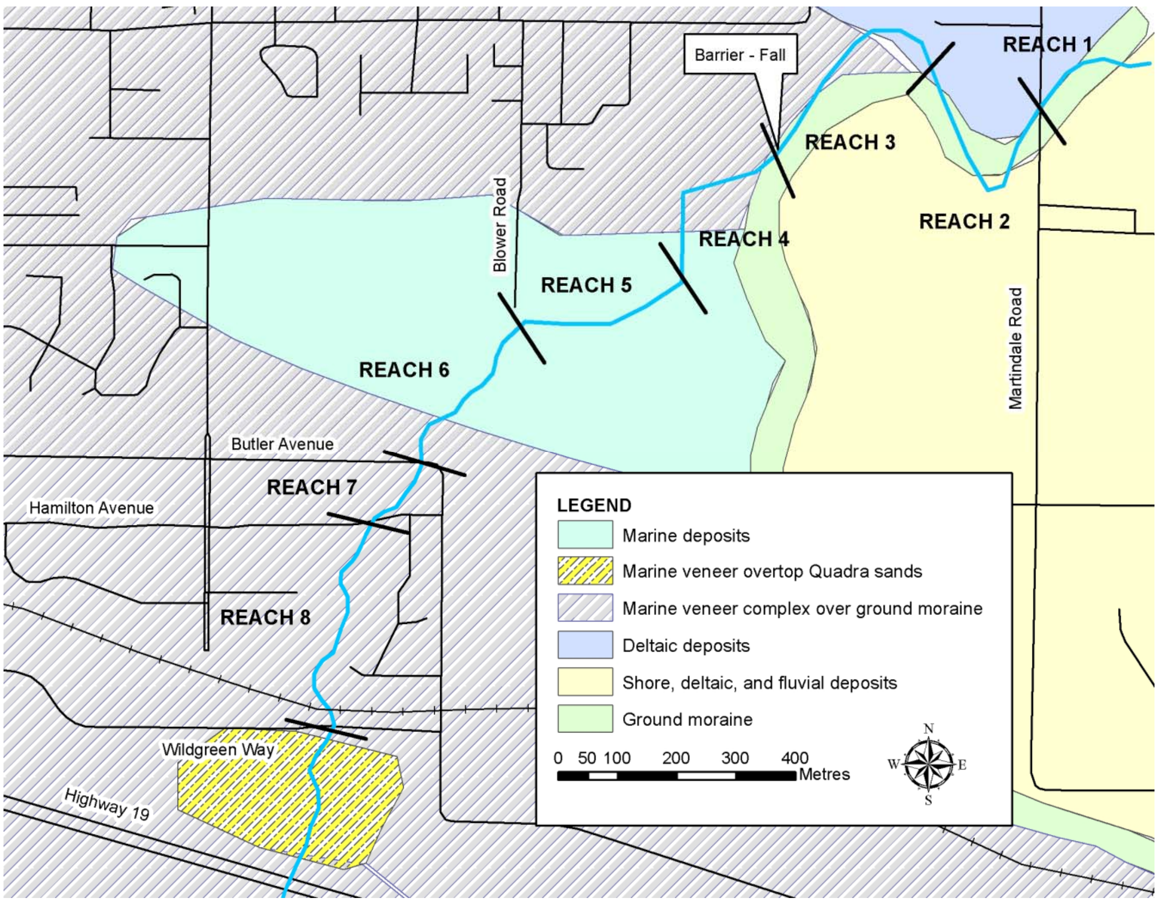

Figure 1. Shelly Creek channel alignment, surficial geology, and channel reaches

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[2] Clough DR, 2011. *Shelly Creek Smolt Trap 2011*. Prepared by DR Clough for Mid Vancouver Island Habitat Enhancement Society (MVIHES).

[3] RDN (2013). *Regional District of Nanaimo online mapping service*, https://rdnweb.com.

[4] Province of British Columbia (1980). *Englishman River Floodplain Mapping.* Ministry of Environment, Water Management Branch.

[5] Government of Canada (2005). *National Road Network*. https://data.gc.ca.

[6] Geological Survey of Canada (1964). *Surficial Geology Map No. 1112A (Parksville)*. Survey and Mapping Branch.

Urbanization over the past several decades has resulted in the draining of wetlands in the upper watershed, covering of natural ground surfaces with impervious materials, and installation of drainage systems that convey storm water directly into the stream (Bud Shelly 20 August, 2014 personal communication). Agricultural practices such as the clearing of riparian areas, realignment of the channel into linear ditches, and withdrawal of water for irrigation purposes have also impacted the channel. A water license was issued in 1955 for irrigation purposes and permits a maximum withdrawal of 18,500 m^3/year[7] though the actual rate, volume, and timing of withdrawal is uncertain and the BC Provincial government does not normally verify water usage. According to the Englishman River Water Allocation Plan (ERWAP), extractive water demands in the ERWAP area are only to be allowed during the period of November to April inclusive when mean monthly flow is greater than 60% of MAD[8].

2 PHYSIOGRAPHY

Repeated glaciation during the Pleistocene epoch, which ended about 10,000 years ago, is the dominating force that created the local physiography. At its maximum, the watershed was submerged by the sea up to a height of 145 m above present day mean sea level[9]. Shelly Creek flows within a marine and glacio-marine veneer complex typically less than 1.5 m thick with varied stony gravel, gravel, sand, silt, clay, stony loam, and discontinuous bedrock. Generally this layer is found overtop ground moraine deposits comprised of till, and lenses of gravel, sand, and silt.

A thick exposure of ground moraine near the downstream end of Reach 4 marks the shoreward limit of the younger Salish sediments (yellow polygon) which are comprised of varying amounts of gravel, sand, silt, clay and peat and fluctuating sea levels resulted in alternating periods of channel incision and deposition of marine sediment, glacio-fluvial, and fluvial material. The ground moraine is expressed on the landscape as a steep terrace that is typically more than 5 m high and forms the boundary of the Englishman River floodplain.

3 CHANNEL CONDITION ASSESSMENT

The channel assessment was conducted on 20 August and 3 September, 2014 extending approximately 2.5 km from Wildgreen Way to the mouth on the left bank of the Englishman River.

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[7] Government of BC. 2014. Online water licences query http://a100.gov.bc.ca/pub/wtrwhse/water_licences.input).

[8] Bryden G, 1994. *Englishman River Water Allocation Plan. Prepared by Regional Water Management – Vancouver Island Region, Nanaimo, BC* , for the Province of British Columbia, Ministry of Environment, Lands and Parks, Vancouver Island Region. November, 1994.

[9] Day JH, L Farstad and DG Laird. 1959. *Soil Survey southeast of Vancouver Island and gulf islands, British Columbia Report No. 6*, British Columbia Soil Survey, Canada. Department of Agriculture, Research Branch.

3.1 Reach Overview

An overview of the channel assessment by reach is presented in **Table 1** and each reach is described in greater detail in Sections 3.2 to 3.9. Channel reaches have been evaluated according to several categories for two main purposes:

1) to summarize the observed 2014 channel condition, and

2) to relate the channel morphology to the susceptibility to erosion and sedimentation.

Table 1. Channel Assessment Summary

		Reach 1	Reach 2	Reach 3	Reach 4	Reach 5	Reach 6	Reach 7	Reach 8
Reach Length (m)		220	400	400	310	340	280	140	400
Average Gradient (%)		< 0.5	< 0.5	0.5 (excluding the vertical drop at the upstream end)	< 0.5	0.5 to 1 (excluding the vertical drop at the upstream end)	3	3	4
Typical Width (m)		45 to 50	15 to 20	7 to 10	2	2 to 4	2 to 4 (w/ some unconfined sections)	2	2 to 4 (w/ some unconfined sections)
Storm Water sources		Surface runoff	Surface runoff	Stanford Avenue culvert/storm drain	Field runoff/Blower Road storm drain	Surface runoff	Surface runoff	Hamilton Avenue storm drain/Corfield Glades subdivision	Surface runoff/ unidentified sources from upstream
LWD		None	None	None	None	Some small wood	Large and small wood	Large and small wood	Large and small wood
Erosion Potential	Upstream end	Marginal	Marginal	Significant	Marginal	Significant	Significant	Marginal	Significant
	Downstream end	Marginal	Marginal	Marginal	Significant	Moderate	Moderate	Significant	Significant
Sedimentation	Fines	Significant	Significant	Moderate to significant	Moderate	Marginal	Significant	Significant	Significant
	Coarse	None	None	Marginal	Moderate	Significant	Moderate	Moderate to significant	Moderate to significant
Avulsion Potential		Marginal	Marginal	Moderate	Moderate	High (at downstream end)	Moderate	Marginal	Moderate to significant

3.2 Reach 1

Reach 1 is a low gradient marshland that extends 220 m between Martindale Road and the Englishman River (**Photo 1**). Typically this reach is about 45 to 50 m wide. The downstream end is partially impounded by moraine deposits comprised of lenses of gravel sand and silt which forms a 1 to 2 m high berm. The channel drains through the berm and into the Englishman River in a steeply incised channel that is only a few metres (**Photo 2**).

This reach is characterised by a network of small channels that are entrenched into deposits of fine sediments that are densely covered with grasses, and bushes and trees in elevated locations. The groundwater table is high and this area regularly floods due to backwatering during high flow events on the Englishman River.

Photo 1. View of Reach 1 marshland

Photo 2. Upstream view of Shelly Creek at the confluence with the Englishman River

3.3 Reach 2

Reach 2 extends upstream of Martindale Road for a distance of about 400 m. Immediately upstream of Martindale Road is a pool that is roughly 30 m wide by 50 m long. Fine sediment deposition has partially filled in the pool and has facilitated the colonization of vegetation (**Photo 3**). Upstream of the pond the channel is typically 15 to 20 m wide with a poorly defined and densely vegetated right bank and a left channel edge that is confined by a steep terrace.

Photo 3. View of pond upstream of Martindale Road

3.4 Reach 3

The downstream end of Reach 3 was defined based on differences in the active channel width and condition of the riparian zone (**Figure 2**). Reach 3 is about 400 m long with an active channel width that ranges between 7 to 10 m. Riparian habitat along the right channel edge is relatively sparse and the left bank is confined by a steep terrace. A culvert drains into the reach about 150 m upstream of the reach break and conveys storm drainage from Stanford Avenue.

The channel is occasionally incised into the adjacent field and the bed is covered with fine sediment (**Photo 4**). The upper end of the reach is defined by a steep terrace that is up to 5 m high and forms a barrier to fish passage. The channel was likely aligned differently prior to settlement by man and the steep drop may be a direct result of channel realignment for farming and settlement purposes. The terrace is severely eroded and a steep gully has formed at the downstream end of a culvert that drains from Reach 4.

Figure 2. Google Earth™ image of portion of Reach 3 (21 May, 2007)

Photo 4. View of Shelly Creek downstream of the falls (20 August, 2014)

3.5 Reach 4

Reach 4 is a 310 m long low gradient ditch that skirts around a field on the Shelly property. The downstream 125 m long portion runs approximately east-west and the upper portion runs north-south. Along this entrenched reach, the channel is about 2 m wide and is heavily treed along the right bank and bare or grass covered along the left bank (**Photo 5**). A ditch drains into the channel at the bend in the creek and conveys surface and intercepted ground water from the western field and surface runoff from Blower Road. The channel bed is mostly covered with gravel deposits and the channel has cut through the upper soil layer and exposed the marine clay veneer in places.

Photo 5. Downstream view of Shelly Creek

3.6 Reach 5

Reach 5 extends approximately 340 m downstream from Blower Road and is characterised by relatively straight channel that is between 2 to 4 m wide. Low growing ferns and bushes cover the riparian zone and Cedar trees grow alongside the channel toward the upper end of the reach while the lower end is covered with alder trees that have introduced small woody debris into the channel.

Downstream progressing head cutting is evident, starting at the outlet of the culvert that crosses Blower Road and the channel is steeply incised into easily erodible fine grained marine sediment by more than 2 m at the upstream end (**Photo 6**). Exposures of relatively resistant marine clay on the channel bed toward the downstream end of the reach have limited the extent of channel incision. The banks are typically less than 0.5 m (**Photo 7**) and overbank flooding occurs regularly (Bud Shelly 20 August, 2014 personal communication). The gradient decreases near the lower end of this reach and the bed is covered with a thick layer of gravel deposits.

Photo 6. Upstream view of steeply incised channel downstream of Blower Road

Photo 7. Downstream view of channel near downstream end of Reach 5

3.7 Reach 6

With an average gradient of about 3%, Reach 6 is significantly steeper than the Reaches 1 to 5, which have an average gradient of 0.5% or less. The Reach 6 bed is vertically controlled at three locations by culverts: at the upstream end at Butler Avenue, approximately mid reach, and at the downstream end at Blower Road. Large woody debris also functions to maintain the channel gradient and structure (**Photo 8** and **Photo 9**).

Photo 8. Downstream view of Shelly Creek near Blower Road

Photo 9. Downstream view of Shelly Creek near Butler Avenue

Immediately downstream of Butler Avenue the channel is relatively unconfined and the banks are poorly defined and low. Water hoses and sumps buried into the channel bed suggest that some unlicensed water withdrawal is occurring (**Photo 10**). Approximately 80 m downstream of Butler Avenue, the channel gradient increases and becomes incised by up to 2 m at the left bank. Locations such as this are significant point sources of fine material to the system.

Photo 10. Downstream view of Shelly Creek just downstream of Butler Avenue

Channel bed material typically ranges from fine gravel to small cobbles. Fine sediment deposits are commonly found upstream of channel blockages that are created by dense accumulations of small woody and large debris, vegetation, and mobile bed material (**Photo 11**). Large accumulations of fine gravel immediately upstream of the mid reach culvert and the Blower Road culvert indicate that they are undersized.

Photo 11. Deposits of fine sediment upstream of channel blockages (view looking downstream)

Typically during floods undersize culverts cause water to back up at the inlet, reducing the velocity and promoting the settling of material. Upstream of the mid reach culvert a large mid-channel bar has formed which has redirected the flow towards the banks, causing erosion and entrainment of fine material into the system. A pool has formed immediately downstream of the mid reach culvert and is partially full of fine grained sediment. During higher flows this fine material will likely be entrained and mobilized further downstream.

3.8 Reach 7

Reach 7 extends 140 m between Butler Avenue and Hamilton Avenue along an entrenched channel with bank heights of 1 to 2 m and a gradient of about 3%. The channel banks are sparsely vegetated, and banks are typically unstable and undercut, and the channel is devoid of any large woody debris. Grade is controlled at the downstream end by an undersized culvert that is causing gravel to accumulate at the inlet (**Photo 12**). A storm drain, roughly 850 mm diameter, drains from the Corfield Glades subdivision directly into Shelly Creek approximately 100 m upstream of Butler Avenue and the right bank is severely eroded immediately downstream of the outlet.

Photo 12. Downstream view of Shelly Creek at Butler Avenue

From the upstream end of this reach, at Hamilton Avenue, to the Corfield Glades storm drain the channel is confined by riprap bank protection along the left side and the base of Hamilton Road along the right. The riparian area is sparsely vegetated with low growing vegetation and young alders (**Photo 13**) and is absent of large woody debris. The creek crossing at Hamilton Road was replaced in 1999 (Faye Smith, 20 August, 2014 personal communication) with a large double box culvert that conveys is tied into the Hamilton Avenue storm water system. Immediately downstream of the outlet the channel widens to 4 to 6 m and the bed is covered with fine sediments.

Photo 13. Downstream view of Shelly Creek between storm drain and Hamilton Avenue

3.9 Reach 8

Reach 8 is about 400 m long and extends from Hamilton Road to Wildgreen Way. Most of it flows within a natural riparian setting and even though the average channel gradient is 4% the channel is heavily influenced by logs, boulders, and tree roots that have formed a step-pool channel morphology (**Photo 14**).

Photo 14. Upstream view of Shelly Creek

Eroding banks at several locations along this reach supply a significant volume of fine and coarse sediment (**Photo 15**), some of which is transported through the system to lower reaches and some of which is accumulating upstream of channel blockages and filling in valuable pool habitat. Deposits of material at the culverts passing under the railway (**Photo 16**) and Wildgreen Way (**Photo 17**) indicate that the steeper gradient upstream reaches are capable of conveying large cobbles and other coarse grained material in significant volumes.

Photo 15. View of 3 m high eroding right bank

Photo 16. Upstream view towards culverts crossing under the railway

Photo 17. Downstream view from inside the Wildgreen Way culvert

This coarse material will eventually be transported further downstream and will deposit behind large woody debris and other blockages. In places it has almost completely filled the channel and has buried channel habitat features (**Photo 18**).

Photo 18. Downstream view of sediment deposition

Immediately downstream of the railway crossing the channel the channel gradient increases and has incised by as much as 2 to 3 m. Downstream progressing channel incision is limited by tree roots, boulders and large wood y debris that has created a step-pool transition (**Photo 19**).

Photo 19. Upstream view of Shelly Creek

Near the midpoint of this reach the channel transitions to a flat bench and opens into a broad floodplain with low banks, relatively sparse streamside vegetation, and signs of overbank flooding (**Photo 20**). This low gradient, unconfined location creates optimal conditions for deposition of suspended sediment, which has covered the creek bed with fine grained material.

Photo 20. Upstream view from unconfined channel section

4 CHANNEL PROCESSES

4.1 1999 to 2014 Habitat Survey

In 2014 MVIHES recently completed an assessment of the creek under the Urban Salmon Habitat Program (USHP) to repeat the survey that was originally conducted in 1999. Repeated habitat surveys provide a means to compare reaches against measurable channel attributes. Consistent survey methods were used so that the channel habitat could be compared over time. **Table 2** presents the results of the UHSP fish habitat assessment and incorporates the corresponding NHC stream reaches for reference.

Table 2. Shelly Creek Habitat Comparisons August 1999 to July 2014[10]

USHP Stream Reach	Blower Rd. to Butler Rd.		Butler Rd. to Corfield Glades storm		Corfield Glades storm to Hamilton Rd.		Hamilton Rd. to E and N Culvert	
Corresponding NHC Stream Reach	Reach 6		Reach 7				Reach 8[11]	
Reach Length	280 m		98 m		44 m		338 m	
Habitat / Year	1999	2014	1999	2014	1999	2014	1999	2014
% Pool Area	81.1	40.0	100	54.5	100	28.6	61.56	72.13
Debris/Bankfull Channel Width	0.34	0.47	0.1	0.31	0	0	0.72	0.78
% Cover in Pools	42	44	20	23	5	0	45	37
Average % Boulder Cover	0	0	0	0	3	0	0	4
Average % Fines	20	43.3	5	30	55	0	46.3	72.5
Average % Gravel	80	39.3	75	45	5	0	30	14.3
% of Reach Eroded	0	45.6	29	75	0	0	0	87
# of Obstructions	1	11	0	0	1	1	6	16
% of Reach Altered	0	11.1	64	42	64	92	0	1
% Wetted Area	100	58.8	62.0	49.3	42.8	42.8	32.76	48.3
Stream Temp	14.0	14.9	13.0	15.3	10.8	20	10.4	23
Dissolved Oxygen	6.4	6.2	7.9	7.7	8.7	6.4	8.3	6.4
PH	7.8	7.25	7.8	6.4	7.9	7.7	7.8	7.7

[10] Table provided by MVIHES and is based on surveys carried out using Urban Salmon Habitat – Stream Habitat Assessment Methodology developed by BC Ministry of Environment.
[11] Reach 8 extends another 60 m beyond the E and N railway culvert to Wildgreen Way.

4.2 1999 to 2014 Habitat Survey Summary

One of the most significant changes over the 15 year period is the increase in percent of erosion. Eroding stream banks were a commonly observed feature during the 2014 channel assessment conducted by NHC. Banks are typically comprised of an easily erodible matrix of fine sediment with some embedded coarser material. Storm drains also deliver fine sediment into the creek and are believed to drastically increase peak flows during rainfall events.

Percentage pool area has decreased by 50% or more in Reaches 6 and 7 which is likely a result of deposition of sediment that has been entrained from further upstream or from locally eroding stream banks. Percentage pool area in Reach 8 has increased by less than 20% which is attributed to localized scour and erosion where the channel steepens and where root structure from mature conifers have strengthened the banks. Percentage of wetted width follows similar trends as percentage pool area.

Significant decreases in average percent gravels and increases in average percent fines have occurred at most of the compared reaches. This suggests a trend of ongoing erosion, transport, and deposition of fine sediments. Coarse material transport is restricted where the channel is significantly blocked with large and small debris. Undersized culverts are incapable of conveying flood flows which causes localized deposition zones. Measured reductions in the average percent gravels are also a function of fine grained sediment deposition overtop immobile gravel.

Except for Reach 7, the percentage of obstructions to fish passage has increased significantly over the study period. Large woody debris plays an important role in defining the channel structure and creating habitat features. However, significant accumulations of small woody debris amongst the large woody debris can become highly efficient screens that can collect coarse and fine grained material and start to function as a barrier to sediment transport. Reach 7 has chronically been devoid of significant amounts of any small or large woody debris.

5 HABITAT ENHANCEMENT CONCEPTS

5.1 Long term approach

To be effective, fish habitat enhancement in Shelly Creek must be comprehensive and focus on long term planning and protection strategies as well as localized restoration efforts. Seven components of a long term approach are presented below[12]:

1) Planning initiatives that involve local governments and citizens.

2) Development restrictions focussed on long-term protection and attention to impervious area.

[12] Reid GE, TA Michalski, and T Reid. (1999). *Status of Fish Habitat in East Coast Vancouver Island Watersheds*. Proc. Biology and Management of Species and Habitats at Risk, Kamloops, BC, 15-19 Feb, 1999.

3) New legislation that restricts water extraction when flow are critical.

4) Local government responsibility for fish habitat protection.

5) Long-term riparian and in-stream restoration plans.

6) Public awareness and landowner contact programs.

Local and senior governments play a crucial role for improving fish habitat by ensuring that development in headwaters and near streams are carefully planned. Alterations to natural stream flow rates should be controlled by developing and implementing strategies at site, catchment, and watershed scales to minimize rainfall runoff, to delay timing of runoff into the creek system, and to reduce the impacts of flood flows.

It is recommended that a water balance model be developed for Shelly Creek to quantify and evaluate the potential effect of land development on stream health from the perspective of surface and groundwater hydrologists, aquatic biologists, and geomorphologists. A watershed analysis should be conducted to quantify the hydrology inputs and hydrograph and evaluate the extent and duration of storm flow and low flow conditions under current conditions and with future climate change. Effects of existing urban and rural development on the water balance should be identified and documented and targets should be established for the governance of land use planning, development approvals, and creation/revision of subdivision and building standards.

5.2 Restoration concepts

Several restoration concepts are provided for consideration. Capital cost estimates (in 2014 dollars) have been estimated where possible to provide a general sense of the level of funding that will be required. These estimates are based on lump sum costs from other projects and are considered to be in the order of +/- 50% including construction, labour, equipment rental, and materials but excluding project management, design, construction supervision, permitting, environmental, land acquisition, reporting costs, and applicable taxes. The specific design approach adopted for each rehabilitation project will depend on several factors such as the computed design flow, site specific channel geometry, site accessibility, budgetary constraints, availability of materials, and subject to degree of pairing with other restoration program components. Capital and maintenance cost will vary significantly depending on the approaches taken.

5.2.1 Bank protection and Riparian Planting

Eroding banks are a significant source of fine sediment, particularly in Reaches 3 to 8. These point sources range from less than one metre to tens of metres in length and less than a half metre to three or more metres in height. Banks stabilization takes three general forms: rock armour, vegetation, and integrated methods that use multiple materials including rock, vegetation, wood, and fabrics such as coir mesh or geotextiles[13].

Vegetation has a secondary benefit of providing shade, cover, and nutrients to the stream. Vegetation growing along channel margins will also help reduce stream velocity and roots will strengthen the banks[14]. Planting can often be conducted relatively inexpensively using live cuttings, rooted stock, and transplants. Reaches 3, 4, and 7 and portions of reaches 6 and 8 would significantly benefit from riparian planting, however riparian planting alone will not appreciably improve habitat quality and should be paired with other rehabilitation measures.

Rock

- Rock armouring using a hydraulic machine could cost in the order of $50 to $70 or more per m^2 of bank armouring, depending on the site conditions and availability of material.

Vegetation

- Where it can be freely collected, and planted using volunteer efforts the costs for bank protection measures that use vegetation are expected to be low.

- Biodegradable geotextiles such as jute, coconut fibre or coir mesh can be applied to bare surfaces to provide protection while vegetation is becoming established. Application of these products typically ranges from$3 to $6 per m^2 but could be less if volunteer labour is used[15].

- Turf reinforcement mats (TRMs) are typically constructed of synthetic woven material and are intended to provide long term erosion protection. Application of TRMs cost from $10 to $20 per m^2 depending on the channel slope and hydraulic design requirements[16].

- Hydraulic Mulch (HM) is a mixture of seed, shredded wood and fibre with a stabilizing emulsion that is applied to bare surfaces to create a nutrient rich growing medium that promotes the growth of vegetation and protects against erosion. Application of HM costs from $2 to $3 per m^2.

- Hydro Seeding (HS) is similar to Hydraulic Mulch in that is applied directly to bare earth surfaces, though it only contains the stabilizing emulsion without the benefit of erosion protection. Application of HS costs $0.75 to $1.50 per m^2.

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[13] Slaney PA and D Zaldokas (1997). *Fish Habitat Rehabilitation Procedures,* Ministry of Environment, Lands and Parks and Ministry of Forests, WRP - Technical Circular No. 9.
[14] Donat, M (1995). *Bioengineering Techniques for Streambank Restoration: A Review of Central European Practices*. Watershed Restoration Project No. 2. Watershed Restoration Program. Ministry of Environment, Lands and Parks and Ministry of Forests.
[15] Informal quote from Nilex, 2014
[16] http://www.geotextile.com/downloads/Landlok%20TRM%20Products%20Brochure.pdf

Integrated Methods

- Log brush barriers (LBBs) are sometimes used for larger bank failures and use a combination of branches, small trees, wooden stakes, rocks, and live plantings to push the flow away from the eroding bank and create roughness that will slow down the stream velocity and provide shade and cover. Application of LBBs cost about 25 to 50% of the cost of rock protection.

- Branch packing (BP) uses layers of wooden stakes, live branches, soil, and rocks to create a sandwich of vegetation and soil/gravel. Application of BPs cost about 25 to 50% of the cost of rock protection.

5.2.2 In-stream Placement of Large Woody Debris and Boulders

Large woody debris and boulders serve an important function to maintain the channel structure, control the gradient, and create pooled habitat. Step-pool features are a major morphological feature found in many of the assessed reaches. In particular, Reaches 5, 7, and the upstream end of Reach 6 would greatly benefit by incorporating large wood and boulders into the channel. In-stream placement of large woody debris and boulders is estimated to cost in the range of $1,000 to $5,000 per each channel spanning structure depending on the use of hand labour or machine and availability locally sourced material.

5.2.3 Removal of obstructions

- Accumulations of small and large woody debris, vegetation and sediment have created obstructions for fish and sediment transport in several locations. In particular Reaches 6 and 8 would benefit from installation of weirs or other low structures to reduce the height of these barriers. Costs for this work would be comparable to those identified in Section 5.2.2.

- Several culverts create obstructions that are affecting sedimentation patterns and fish passage. In particular all of the culverts between Butler Avenue and Blower Road should be replaced with larger sized structures that are capable of conveying the flood flows. Culverts should be replaced with bridges where feasible or the culvert should be designed to have open bottoms or be large enough and set low enough to adequately pass mobile bed material. Costs to replace any of these culverts will vary significantly and could be in the order of anywhere from $50,000 to $250,000 per crossing. Construction of crossings for single lane roads with gravel surfaces and no subsurface infrastructure such as pipelines and transmission cables may be less costly.

5.2.4 Channel realignment

Once of the major factors that limits amount of usable salmonid habitat in Shelly Creek is the 6 m high vertical drop and the upstream end of Reach 3 which prevents fish passage. In order to remove the fish barrier, it is necessary to lengthen the channel and create a series of step-pools that can be navigated by fish (**Figure 3**).

The realignment of Reaches 4 and 5 would significantly increase the channel length so the channel could transition the 8 to 9 m elevation difference between the upstream end of Reach 5 and the upstream end of Reach 3 with no fish barriers. Construction of a new channel would also alleviate much of the existing sedimentation and flooding issues on the farm and would utilize non- productive farmland. It is estimated that it would cost in the range of $30 to $70 per m^2 to realign Shelly Creek and install habitat features.

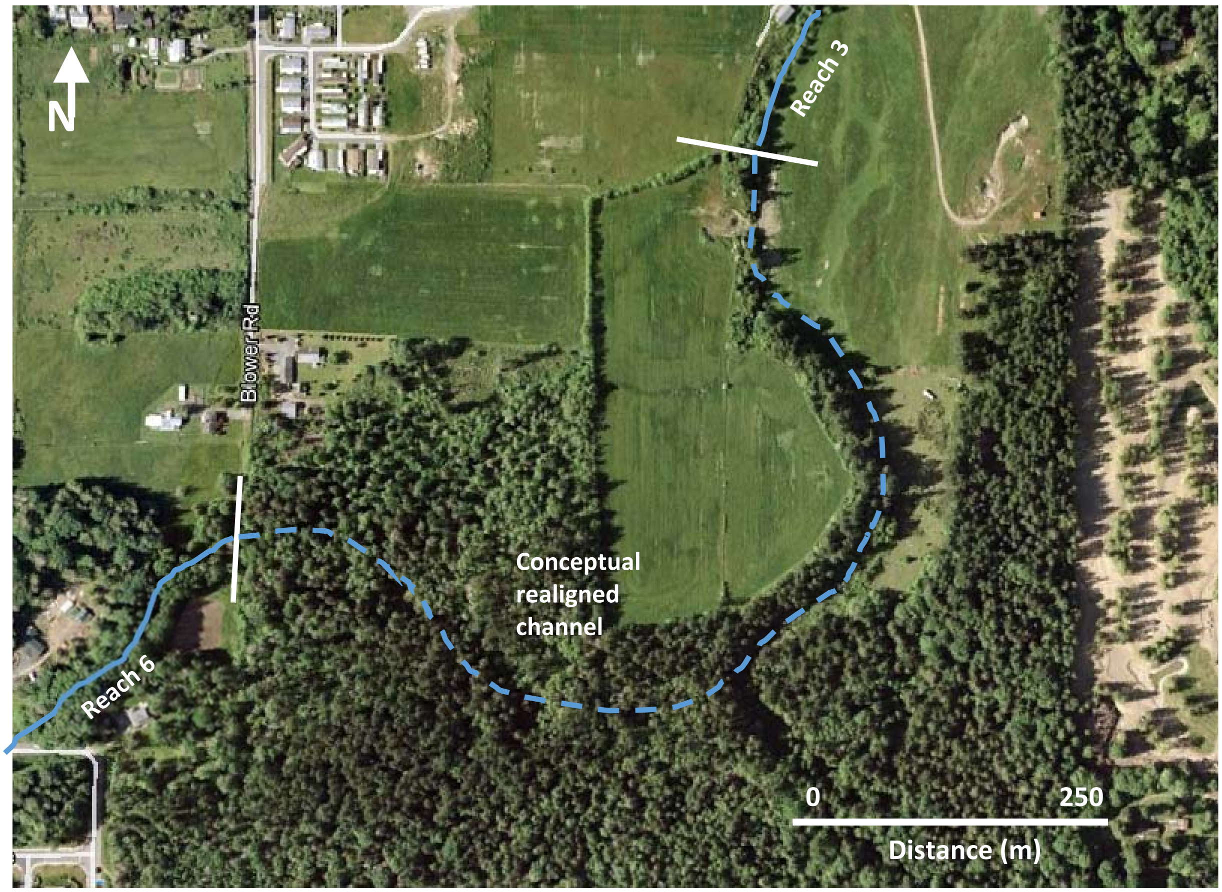

Figure 3. Conceptual channel realignment

5.2.5 Pond construction

A major limiting factor for salmonid and trout in Shelly Creek is the lack of refuge habitat during low flow conditions. During the 2014 site visit in late August and early September many parts of the channel were completely dry except where there were pools that were below the groundwater table. The reconstruction of in-filled pools and construction of new pools to below the low flow groundwater table would significantly increase the amount of usable habitat. Pool construction would be beneficial in all the reaches though the construction of pools downstream of the fish barrier, in Reach 3 and at the upstream end of Reach 2, would specifically target salmonid habitat areas.

Excavation of pools is expected to cost in the order of $10 to $20 per m^2 of pool area but could be more if handling and disposal of spoil material is required.

5.2.6 Sediment basins

Regardless of any bank protection measures that are implemented, sediment will continue to be supplied from reaches upstream of Wildgreen Way and sediment that is already in the lower reaches will continue to work its way through the system. Construction of sediment basins with a downstream weir or a piped outlet would create localized areas of low velocity to promote the settling of fines. These basins could be placed in key areas along the channel in areas that are easily accessible for regular maintenance, such as upstream of Wildgreen Way or downstream of Butler Avenue. The lower end of Reach 5 is a deposition zone for gravel and, in lieu of channel realignment as discussed in Section 5.2.4, constructing a basin or designating an excavation site at this location would provide a means to routinely maintain the channel and reduce flooding of the adjacent land. However, the use of in-stream sediment basins must be carefully considered and a sedimentation assessment should be conducted to weigh the benefits of sediment removal versus the potential for trapping gravel and increasing erosion further downstream.

Sediment traps also serve to improve water quality by reducing total suspended sediments and by trapping pollutants and could also be placed at key points where storm water systems drain into the creek such as along Reach 3 to capture storm runoff from Stanford Avenue.

Sediment basins should generally be constructed long and narrow to provide adequate length for the suspended sediment to settle out of the water column. Therefore these basins do require significant area in order to store the expected average annual sediment load. Maintenance and disposal of material is ongoing though they are relatively cost efficient because of their ease of construction. Estimated initial construction costs[17] for a basin ranges from \$10 to \$25 per m^3 and annual maintenance could range from \$10 to 15\$ per m^3.

5.3 Next Steps: Restoration concept development

Developing a long term relatively detailed restoration plan is recommended. The plan will form the roadmap for future restoration work. It should be flexible to take advantage of opportunities as they arise (eg. culvert replacements during road upgrades), and to incorporate 'lessons learned'. There are several approaches in developing a restoration plan such as: starting at the upstream end of the watershed (sediment stabilisation); starting at the downstream end first (fish-centric approach because there are generally more species diversity and abundance); starting with 'easy projects'; or starting with a 'show-case project'. This plan should be developed by a multi-disciplinary group that includes stream-keepers, biologists, fisheries engineers, and other stakeholders (eg. local government, property owners), possibly facilitated through the establishment of a working group or round table committee.

It is recommended that a hydrologic analysis be conducted and included in the long-term restoration plan. The hydrologic analysis should include estimates of low flow and floods. Design thresholds should be recommended (ie. LWD should be designed to withstand 20-year flood events, etc).

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[17] BMP Handbook. Management Practices for Protecting Water Quality
http://www.sjdeltawatershed.org/files/46087387.pdf

Detailed project planning should be completed for each of the projects identified on the restoration roadmap. Detailed planning should generally take place 1 to 2 years before the project is implemented. Detailed planning will include assembling the project team, developing the designs and detailed cost estimates, fundraising, obtaining approval and permits, and assembling the construction team.

Projects should be checked off the detailed restoration plan as they are completed. Long term monitoring should be undertaken to confirm the biological performance and physical functionality of each project. The monitoring should be documented to ensure that long term performance can be tracked.

6 CLOSURE

I trust this letter report meets your requirements.

If you have any questions, please do not hesitate to contact me at 250.754.6425.

Sincerely,

Northwest Hydraulic Consultants Ltd.

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This document represents an electronic version of the original hard copy document, sealed, signed and dated by Wil Hilsen, P. Geo and retained on file. The content of the electronically transmitted document can be confirmed by referring to the original hard copy and filed.

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