Englishman River Storage Feasibility: Shelton Lake Option

Englishman River
Vancouver Island

Stream Flow Sustainability for a Community of Fish & People

Prepared for:

Natural Resources Canada Ressources naturelles Canada

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1.0 Introduction

Recent declines in snowpack and snow water equivalents in the Pacific Northwest have been well documented and are predicted to have a profound effect on water availability and use (Mote et al 2005). In the Georgia Basin, water supply characteristics (i.e., stream discharge, lake levels, temperature regimes) are already being affected by climate change (Whitfield *et al.* 2002; Quilty *et al.* 2004). In a brief summary of Pacific Northwest regional literature, Bakke (2008) identified a change in balance between snow and rain resulting in reduced summer base flows and a loss of headwater perennial habitats. Potential physical impacts from quantitative/temporal changes in annual precipitation include deceased summer precipitation and base flow. Land and natural resource management changes were predicted, including strategies to address increased demand for surface water storage reservoirs and, paradoxically, for groundwater withdrawals in response to declining surface water resources (Bakke 2008). Groundwater itself has recently been proven to supply 25% of summer stream flows in the Englishman River (GW Solutions Inc. 2012). The quality of Vancouver Island stream habitat is predicted to decrease as a result of stream flow and temperature changes (Murdock and Werner 2010).

In a December 2009 Statement of Expectations on reform of the BC Water Act, 29 largely BC-based NGOs advocated a fundamental re-thinking of how water is stored, delivered, and used to generate power, protect ecosystems and ecosystem resilience, and support agriculture (http://www.watershed-watch.org/publications/files/NGO_SoE-WaterActReform-Jan2010.pdf, accessed December 20, 2011). After protection of habitat, Bakke (2009) recommended that improving (or at least maintaining) stream connectivity be the highest priority, and that all interventions be analyzed in relation to sustainability, resiliency and threats from climate change.

The Province of BC, through its Living Water Smart Plan (http://livingwatersmart.ca/), has a renewed focus on water security for both people and ecosystems. The protection of stream health and aquatic environments is among the Plan's key initiatives, as is Water Act modernization and an examination of current water governance and potential ground water regulation. Stream function and instream flow requirements have been highlighted as critical considerations, and adaptive management approaches are being encouraged to solve supply/demand problems. With increased drought risk often cited, water conservation and protection has also become a priority for a number of Vancouver Island's regional and municipal governments, with many using innovative planning and public education programs that advocate wise consumption to lower impacts to fish and aquatic habitats.

> ***In considering our natural resources, 49% of Canadians believe fresh water is most important, and 83% of Canadians are either somewhat or very concerned about fresh water availability***
>
> *(2010 Canadian Water Attitudes Study, commissioned by RBC and Unilever Canada).*

In 2006, as part of its mission to promote and assist in the conservation of BC's fish and wildlife resources, the British Columbia Conservation Foundation (BCCF) initiated a multi-year program to identify potential stream flow improvement projects in the Georgia Basin, primarily on east coast Vancouver Island (ECVI). Once built, these projects are intended to increase (or at least maintain in the face of climate change) the quality and quantity of freshwater fish rearing habitat and, in turn, wild smolt production for anadromous species (i.e., smolts/spawner). Though numerous terrestrial and aquatic species benefit from healthy stream flows, augmentation projects target native keystone stream-rearing species including Coho (*Oncorhynchus kisutch*) and Chinook Salmon (*O. tshawytscha*), and Steelhead (*O. mykiss*) and Coastal Cutthroat Trout (*O. clarki clarki*). Projects are designed to be as effective, and at the same time as environmentally benign, as possible. Provincial and federal fisheries agencies have been advocates for the program since its inception, regularly providing advice and in-kind support, where possible.

Since 2006, annual financial support from the provincial Living Rivers Trust, the Habitat Conservation Trust Foundation and the Pacific Salmon Commission Southern Fund has been complemented with assistance from local First Nations, municipal governments, regional districts, the private sector, community stream stewards and other interested ENGOs. In support of climate change adaptation since 2009, Natural Resources Canada has funded six Regional Adaptation Collaboratives across the country; one such initiative in BC has assisted BCCF's storage feasibility work in two ECVI watersheds: the Englishman River near the City of Parksville, and the Cowichan River flowing through the City of Duncan. This report summarizes storage feasibility work to date in the former, the Englishman River.

1.1 Background

Draining an area of 324 km^2, the Englishman River flows east from Mount Arrowsmith (1,820 m) in the Vancouver Island Range to the Strait of Georgia at the City of Parksville, BC (Figure 1). The watershed is part of BC's Coastal Western Hemlock biogeoclimatic zone and receives an average of 964 mm of precipitation annually at Parksville (Boom and Bryden 1994). The 19th largest watershed on Vancouver Island, the Englishman has a mean annual discharge of 13.5 m^3·s^{-1} based on 41 years of records (www.wateroffice.ec.gc.ca). The watershed lies within traditional lands of the Snaw-Naw-As (Nanoose), Qualicum and Snuneymuxw (Nanaimo) First Nations, and is over 70% privately held forest lands, with logging as the primary industrial activity. The remainder is a blend of agricultural, rural residential, urban, commercial and park land.

The Englishman River is an important ECVI salmon and trout producer (for escapements, see DFO's Mapster website at http://pacgis01.dfo-mpo.gc.ca/Mapster30/#/SilverMapster). In rough order of abundance, the river supports stocks of Chum (*O. keta*), Coho, Pink (*O. gorbuscha*) and Chinook Salmon, as well as winter run Steelhead and anadromous Cutthroat Trout. Resident Cutthroat and Rainbow Trout also occur (mainly above barriers), and there are references to Dolly Varden Char (*Salvelinus malma*) in headwater streams (Ostapowich and Pollard 2002). Sockeye Salmon (*O. nerka*) are occasionally observed during fall snorkel counts. The Community Fisheries Development Centre (CFDC) and Fisheries and Oceans Canada (DFO) continue to partner in Chinook and Pink stocking programs[1] initiated in 1987 and 1993, respectively (Bocking and Gaboury 2001). Due to wild stock conservation concerns and high cost/benefit, the Province of BC discontinued the Englishman's hatchery programs for Steelhead and Cutthroat[2] in 1997 and 2008, respectively. Non-salmonids in

[1] The CFDC hatchery typically receives ~1,000,000 Quinsam River Pink eggs and ~250,000 Big or Little Qualicum River Chinook fry annually for release into the Englishman.

[2] From 3-23,000 Steelhead smolts and 2-9,000 Cutthroat smolts had been stocked annually since 1988 and 1991, respectively.

the system include Threespine Stickleback (*Gasterosteus aculeatus*), Lamprey (*Lampetra spp.*), and Sculpin (*Cottus spp.*).

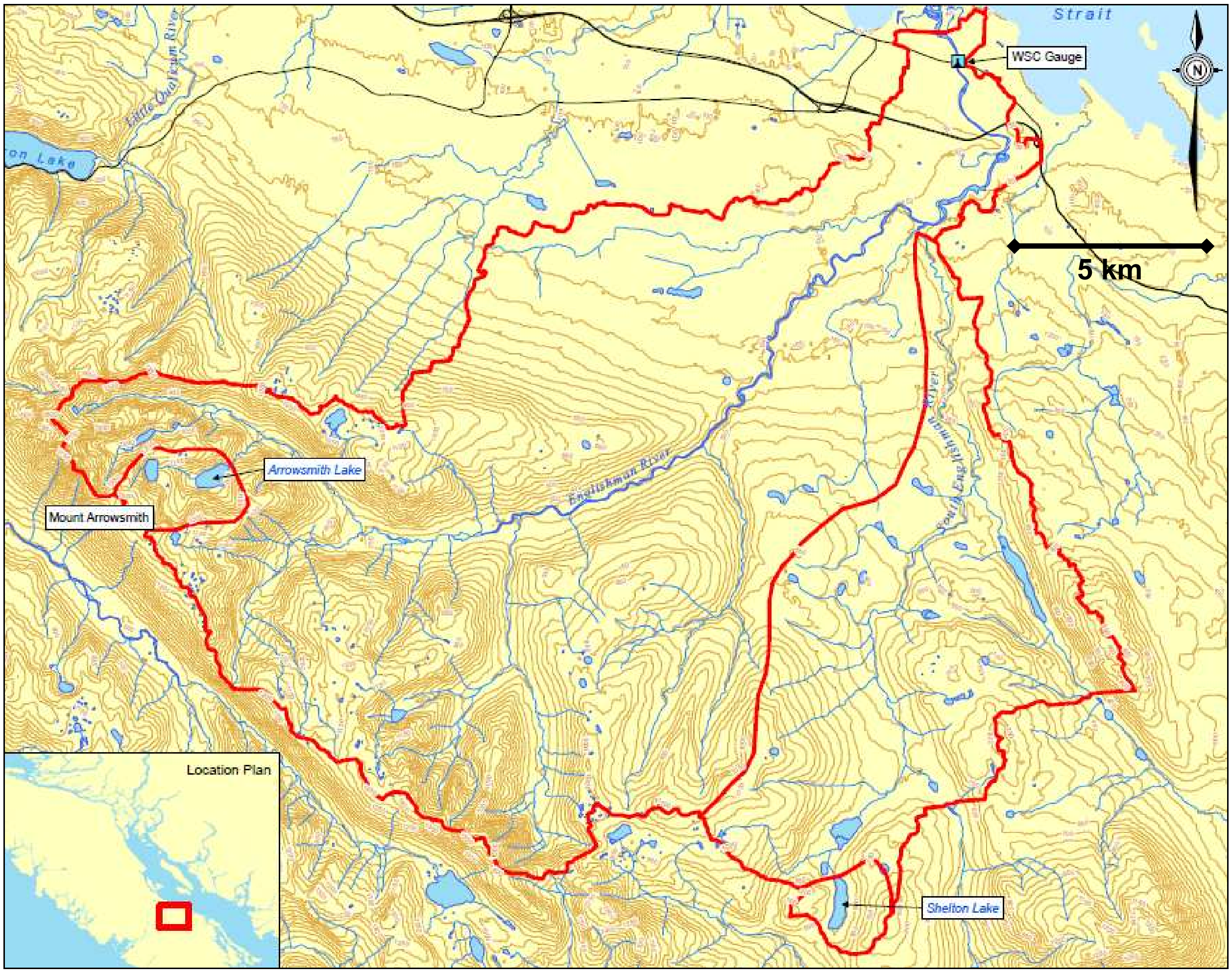

Figure 1. Englishman River watershed, with South Englishman sub-basin (excluding Centre Creek) and Shelton Lake basin apportioned (adapted from KWL 2010).

From the late 1990s on, the frequency and/or precision of abundance estimates of key fish stocks improved. Previously, federal fishery officers had, since 1953, conducted stream walks to estimate salmon run sizes each year. Since 1982, provincial biologists had typically conducted an annual snorkel count of steelhead adults. Starting in 1998 with the Vancouver Island Steelhead Recovery Plan (Wightman *et al.* 1998), replicate steelhead snorkel counts occurred each winter/spring. Similarly, DFO began to support adult snorkel programs and downstream smolt enumeration, the latter to evaluate constructed side-channel Coho contributions to total production. Because the river generally affords reasonable snorkel conditions in spring, the Ministry of Forests, Lands and Natural Resource Operations (MNRO) currently uses Englishman as its indicator stream for wild east coast Vancouver Island steelhead abundance.

To address mainstem habitat impacts from historical logging (e.g., channel widening, sediment aggradation, loss of stable instream LWD; Ostapowich and Pollard 2002), fish habitat restoration – primarily side-channel construction for coho rearing – commenced in the late 1980s, led by DFO.

Restoration activities continued and peaked in the mid-2000s, largely guided by the Englishman River Watershed Recovery Plan (Bocking and Gaboury 2001), completed for the Pacific Salmon Endowment Fund. Focusing on Coho and Steelhead, species most affected by freshwater habitat impairment, the Plan laid out long term objectives and strategies that focused on maintaining low exploitation rates, providing adequate summer flows, and rehabilitating/protecting Coho and Steelhead rearing and spawning habitat.

Licensed water extractions from the Englishman River or its tributaries occur for waterworks, domestic, agricultural, industrial and conservation purposes. Withdrawals for municipal waterworks are by far the largest, with local government[3] licensed to withdraw, from a point 500 m above tide water, up to 0.621 $m^3 \cdot s^{-1}$ during summer[4] provided existing or seasonally established minimum fisheries flows are maintained immediately upstream of that point. This extraction (plus groundwater wells) meets the water requirements of 11,500 residents of Parksville, a portion of Nanoose Bay demand, plus peak tourist demand that comes close to doubling the area's population in July and August (M. Squire, Program Manager, Arrowsmith Water Service, pers. comm.). On a volume basis, waterworks represent 99.8% of licensed summer withdrawals from the mainstem Englishman River.

On March 10, 2000 under the provincial Fish Protection Act, fifteen BC rivers including the Englishman were designated *Sensitive Streams*. According to the provincial MoE website (http://www.env.gov.bc.ca/habitat/fish_protection_act/sensitive_streams/sensitive.html, accessed January 13, 2012), *Sensitive Stream* status means:

- *the sustainability of fish will receive the highest priority;*
- *recovery plans may be required on Sensitive Streams that are unable to rehabilitate naturally;*
- *water managers must consider the needs of fish before issuing a water license;*
- *water license applicants may be required to provide water flow and fish habitat information, or find a reasonable alternate source of water; and,*
- *water license applicants may be required to develop mitigation or compensation measures.*

[3] Waterworks licenses are in the name of either the City of Parksville or Arrowsmith Water Service, a partnership of the City, the Regional District of Nanaimo, and the Town of Qualicum Beach.
[4] This figure is the aggregate maximum daily volume specified in four current water licenses (C022058, C023297, C026692, C110050), and assumes that the rate of extraction is even during each 24 hour period. Current peak extractions are in the order of 0.250 $m^3 \cdot s^{-1}$.

2.0 Methods

2.1 Project Identification

One of 20 ECVI watersheds slated for storage feasibility assessment in 2006, the Englishman River was initially ranked on BCCF's priority candidate list ("Identification Stage") against a number of criteria:

- number and status of fish stocks;
- fish habitat status;
- fish agency priorities;
- landowner, First Nation, stakeholder and partner support;
- water-centric initiatives underway locally, regionally;
- existing water licenses, facility status or new applications; and
- potential water license proponents.

These criteria were part of a larger decision framework created to identify new or existing projects with the best overall potential, and to minimize resources spent on those with high cost/benefit ratios. With existing storage facilities, focus was placed on the potential to update or modify infrastructure, amend water licenses, or to improve operations to benefit fish.

2.2 Consultation

Acknowledging that water storage projects require the support of landowners, First Nations and a broad range of agencies and local stakeholders, consultation commenced early and continued annually as projects developed.

BCCF communicated and worked regularly with fish agency staff and water regulators to provide updates, confirm project direction, identify challenges and ensure appropriate studies were planned and conducted.

Consultations with Snaw-Naw-As First Nation occurred in the field during site reconnaissance and data collection, and at band administration offices to confirm project support.

The Regional District of Nanaimo (RDN) and local governments received presentations and provided feedback as to project support or concerns, and how storage feasibility could align with local initiatives.

Similarly, progress reports were circulated or presentations made at least semi-annually to the Steering Committee of the Englishman River Watershed Recovery Plan (ERWRP), consisting of local stewards and conservationists, federal and provincial fish agencies, the RDN, agricultural interests, landowners, the private sector and other ENGOs.

2.3 Stream Discharge, Lake Level and Temperature Monitoring

Stream flow and stream or lake stage data were collected and used to develop discharge records following BC RISC standards (Province of BC 2009).

Discharge measurements were conducted to document instantaneous flows in key reaches during critical summer fish rearing periods, to build stage/discharge relationships for new hydrometric stations, and to help City of Parksville water utility operators meet licensed minimum fisheries flows. For discharge measurements, technicians used regularly calibrated Swoffer (model 2100 or 3000) velocimeters or SonTek/YSI (model FlowTracker) acoustic Doppler velocimeters. Mean velocities were measured (0.6 depth, mid-section method) across hydraulically suitable transects at a minimum of 20 verticals spaced to ensure no subsection exceeded 10% of total flow.

River stage and lake level data were collected hourly using Solinst (model 3001) self-powered water level dataloggers. Barologgers were installed on nearby trees to allow for barometric compensation. Dataloggers also collected air and water temperatures. River stage loggers were positioned in vented steel tubes installed firmly in stable pool locations, and surveyed for their elevation relative to permanent benchmarks above the stream bank. A staff gauge was also installed and benchmarked near the river station as an additional reference. Data were downloaded and station elevations checked at least quarterly. KWL converted river stage data to discharge using a rating curve. The rating curve was developed by synthesizing discharges measured by BCCF during low to moderate flows with discharges estimated by KWL for moderate to high flows. Estimated discharges were generated from a calibrated hydraulic model of the stream channel in the vicinity of the river station. Using the latest season's low-moderate flow measurements, BCCF annually modified the KWL curve to maximize its ability to generate that season's hydrograph accurately.

Lake level loggers were housed in vented, benchmarked steel tubes pounded into shoreline substrates. Care was taken to position loggers to be accessible, remain wetted year round, and avoid damage or disturbance by ice accumulations, shifting shoreline LWD, or lake recreationalists.

2.4 Hydrology Assessment

Preliminary and in-depth hydrological assessments of the Englishman and potential storage sites in the watershed were completed under contract by Kerr Wood Leidal Associates Ltd. (KWL; Victoria, BC). Because discharge records were only available for the lower mainstem, initial hydrological assessment of sub-basin tributaries was performed using existing regional runoff mapping and curves, and a hydrological GIS tool developed for the province by KWL. Detailed methodology is outlined in the associated technical memorandum (KWL 2008; Appendix A).

Subsequently, and with two years of detailed discharge data collected by BCCF, a more focused water balance assessment of the South Englishman River was completed. The assessment refined estimates of mean annual discharge, identified preliminary conservation flows based on a provincially modified Tennant Method, characterized storage requirements, and developed initial storage concept designs for consideration (KWL 2012; Appendix B). This assessment included conceptual designs prepared by Trow Associates Ltd. (Burnaby, BC). Detailed methodology may be found in the KWL technical memorandum (KWL 2012; Appendix B).

2.5 Estimating Fish Habitat & Fish Production Benefits/Impacts

Analysis of fish habitat and fish production benefits focused on anadromous reaches, though non-anadromous stream habitats were also examined to understand the potential effects of spring storage activities and summer flow augmentation. The degree to which lake habitats and stocks were assessed was dependent on the level of information in provincial files and date collected, as well as current Fisheries management objectives for the lake.

2.5.1 Fish Habitat

South Englishman River habitat typing was conducted to identify mesohabitat unit composition in anadromous reaches and predict improvements in the quantity and quality of summer fish habitat resulting from base flow augmentation.

Quantity – Reach Scale: During low flow stages, technicians walked the stream from its confluence with the mainstem Englishman upstream to the anadromous barrier. Habitat unit types and their boundaries were identified visually following guidelines in Johnston and Slaney (1996). Crews used a hip chain to track distance from the mouth, locate tributaries, and measure thalweg length of each mesohabitat to the nearest metre. Unit gradients were measured with a Suunto clinometer and survey rod, and dominant and sub-dominate substrates were recorded by unit. A survey rod was used to find and measure maximum depths which, given extremely low flows, were essentially equal to residual pool depths. Bankfull channel and representative wetted widths were measured with a range finder or 50-m tape to the nearest metre or tenth of a metre, respectively. Each unit was photographed from its downstream end.

Quantity – Unit Scale: Fish habitat area available over a range of summer discharge scenarios was modelled based on wetted width measurements across transects established in each of the South Englishman's four anadromous reaches[5]. Transects were located across representative riffles and glides (mesohabitats known to be most flow sensitive); pool habitats were not studied. At each transect end, 60 cm-long rebar was pounded into the streambank at locations high enough to be protected from heavy flows and scour. Rebar tops were painted, flagged with orange tape and labelled. With a 50-m tape strung tightly between rebar, net wetted widths of each transect were collected by summing the widths of open water sections immediately beneath the tape (dry *and embedded* boulders beneath the tape were excluded).

Digital photos (35 mm focal length) looking upstream, downstream, and cross-stream from each bank were taken during each measured flow stage for comparison. Cross-stream photos were largely taken from rebar locations, while an orange "P" painted on in-stream boulders or stable LWD generally identified locations from which up and downstream photos were taken.

Quality – Unit Scale: In riffle habitats, fish habitat *quality* over a range of flows was modelled by comparing field collected depth/velocity transect data to habitat suitability index (HSI) curves

[5] Reaches as defined by Lough and Morley (2002).

(Appendix C) developed by BC Hydro and the Province of BC for water use planning processes. Once again, riffles were selected because of their sensitivity to incremental flow changes. Depth/velocity transects (DVT) were established across representative riffles using procedures similar to that described above for net wetted widths. A measurement interval that would yield at least 20 DV stations/transect was established. Mean water column velocities were measured (mid-section method, 0.6 depth, 20 second sample time) using a calibrated Swoffer velocimeter (model 2100 or 3000). If significant dry sections (i.e., >10% of the overall wetted width) were apparent along a particular transect, measurement intervals were adjusted to retain at least 20 DV stations/transect. However, as base flows dropped and habitats contracted, station spacing was maintained at no less than 25 cm to minimize redundant data collection. During data entry and for HSI calculations, dry sections of transects were essentially removed and replaced with a single station with a depth value of 0.0 m. This resulted in an accurate net wetted width for the respective mesohabitat and, from the HSI perspective, captured that fact that there was one (or more) dry point(s) along the particular transect during that flow stage. Comments on the overall quality of each transect or issues encountered were noted to enhance repeatability.

Non-anadromous reaches immediately downstream of target lakes were surveyed to document fish habitat features (e.g., spawning gravel, over-summering pools, side channels/connectivity) that may be influenced by changes in flow regime. Point stream flows were measured and key habitats photographed.

Lake habitats, including tributary mouths and outlet configurations, were synoptically surveyed and opportunistically photographed at various water levels from boats or shoreline accesses. Provincial files were reviewed for historic lake surveys, relevant information and any history of habitat impacts or restoration.

Where a lake was situated downstream of a potential storage site, and thus subject to additional "flow through" from summer releases upstream, changes in typical flushing rates were calculated and considered by provincial government and private sector scientists specializing in limnology and lake productivity[6]. Sampled using a handheld YSI meter (model Pro Plus), dissolved oxygen and temperature profiles of subject lakes were collected to better inform this analysis.

2.5.2 Fish Populations

<u>Stream-based:</u> Existing inventories and reports describing past fish sampling were reviewed. To update data and document current stock status, juvenile standing stock densities were evaluated in anadromous reaches near the end of the growing season using closed-site electrofishing techniques. Habitats sampled were primarily riffles and, to enable comparisons with historic data, included sites sampled during Vancouver Island Steelhead Recovery Plan stock monitoring (1998-2006). Approximately 100 m^2 of suitable Steelhead fry habitat (typically cobble/gravel riffles, 5-25 cm in depth, and 7-20 cm/sec in velocity) were enclosed with two 15.24 m by 1.52 m stopnets (1/2" stretch knotless mesh). Fish were captured by a two or three person crew using a Smith-Root backpack

[6] Applying its catchment area (7.56 km^2) to an estimate of its annual runoff (47.6 $L \cdot s^{-1} \cdot km^{-2}$), Healy Lake's MAD was estimated at 0.356 $m^3 \cdot s^{-1}$. Mean monthly flows from Healy were then estimated by using ratios of Englishman River mean monthly to annual flow. Mean monthly discharges converted to volume allowed a comparison to lake volumes corrected for summer, shoulder, and winter periods.

electrofisher (model LR-24). Crews employed a standard two-pass removal method whereby a population estimate (N) is derived by entering the number of fish caught in pass one (P1) and pass two (P2) in the formula $N= (P1)^2 /(P1-P2)$ (deLeeuw 1981). Lengths were recorded for all species captured and juveniles from each age class were weighed using Ohaus top loading scales (model CS 200) accurate to 0.1 g. Habitat parameters were documented consistent with current Ministry of Environment techniques (methodology by R. Ptolemy, Rivers Biologist, MoE, Victoria), and each site was photographed. Upon removal of the stopnets, a depth/velocity profile across a representative transect within the site was recorded using a Swoffer velocimeter (model 2100). The usability of habitat sampled for each species and age class was later calculated using HSI curves described above (2.5.1). To standardize the data set, population estimates were adjusted based on each site's depth-velocity profile.

Non-anadromous stream reaches downstream of target lakes were sampled to confirm fish presence and relative abundance. Spot shocking with a backpack electrofisher allowed capture and confirmation of species and age classes.

<u>Lake-based:</u> Existing biophysical inventories of lakes considered for storage were reviewed in consultation with the MNRO Small Lakes Biologist. As conducted by provincial staff or their contractors, these assessments typically list static physical parameters (e.g., area, maximum depth, etc.) already on file, and describe transparency, dissolved oxygen and temperature profiles, and fish sampling methodology and results collected during the inventory. Fish data typically includes species, CPUE, length, weight, age, stomach contents, and photographs. A new fish inventory was only completed if there were no records on file or if the last inventory was significantly out-dated or incomplete.

2.6 Environmental impact assessments

Following initial scoping of the lakes, an archaeological search was conducted on line via the provincial MNRO website. Following on-site reconnaissance, the presence of culturally modified trees (CMT) was suspected on the shorelines of both Healy and Shelton lakes – formal surveys for CMTs by Snaw-Naw-As First Nation representatives were scheduled.

Environmental impact assessments related to potential storage site development were generally conducted under contract by experienced local biologists specializing in plants or non-fish vertebrate groups possibly affected. These studies were modelled on previous examinations of other potential storage sites on Vancouver Island, conducted for DFO and/or BCCF. Field studies generally occurred between spring and fall, with contractors in place prior to critical periods associated with migration, breeding or foraging by the target species or taxonomic class.

Study parameters and scope were based on a range of potential storage scenarios supplied by BCCF. Consistent with BCCF's preference for developing storage with minimal environmental impact – a strategy supported by funders of the regional initiative – the amount of storage considered was generally within or close to the natural range of water elevation fluctuations occurring at a given site, from the lows of late summer to the highs of rain-on-snow type flood events. Site specific physical and temporal changes in lake level regime expected from storage scenarios were described to contractors, as were likely footprints associated with storage-related infrastructure and its construction. Contractors used this information to plan their assessments and consider the range of possible impacts. Specific methods used by contractors are detailed in appendicized reports (Wind 2008).

2.7 Shelton Lake Weir – Conceptual Designs

Under sub-contract to KWL, Trow Associates Ltd. (Burnaby, BC) developed conceptual designs for a small storage dam at the outlet of Shelton Lake. Designs were based on Trow's on-site reconnaissance in late 2008 and overlaid on detailed topographic site plans developed by Bazett Land Surveying Inc. (Courtenay, BC) in 2009.

3.0 Results

3.1 Project Identification

In 2006, Englishman River was highly ranked against criteria established during BCCF's storage feasibility project Identification Stage. It supported all species of salmon and trout native to south coast BC watersheds, including blue-listed Cutthroat and a winter Steelhead stock confirmed to be at low abundance and a conservation concern (Wightman *et al.* 1998; Lill 2002; BC Conservation Foundation 2007). As a result of poor historic logging practices, degraded fish habitat had been well documented in recent bio-physical studies (Bocking and Gaboury 2001; Lough and Morley 2002; nhc 2002). Pursuant to those studies, addressing low summer flows was identified as the highest of three priority restoration activities. Both fisheries agencies had a strong interest in Englishman stocks under their jurisdiction – use by provincial biologists of Englishman Steelhead as an ECVI indicator was growing, and DFO was initiating further investments in habitat restoration targeting stream-rearing Coho Salmon. The ERWRP Steering Committee was actively supporting and coordinating partners in a range of watershed assessment and restoration initiatives, from headwater projects to estuary inventories. Being a community water supply, water issues were commonly at the forefront of regional and municipal government agendas, in the local media and in discussions amongst community environmental stewards. With recent construction (1998) and commissioning (2000) of Arrowsmith Dam in the Englishman's headwaters, dam operations were still being fine-tuned, particularly the integration of deviation-adjusted Water Survey of Canada discharge data from the lower river hydrometric station (08HB002) in the daily maintenance of minimum fisheries flows. With sufficient benefits to fish and the ecosystem, potential water license holders for a new storage project included the province, DFO and, provided those benefits included additional mainstem flow to help meet downstream fisheries requirements, Arrowsmith Water Service (AWS)[7].

In considering the watershed as a whole, two primary strategies to improve base flows for fish presented themselves:

1. examine the potential to improve capacity or operation of the existing storage facility, Arrowsmith Dam, in the mainstem's headwaters; and,
2. explore the feasibility of new storage sites.

As suspected and recently confirmed, natural inflows to Arrowsmith Reservoir are inadequate to fill the lake under drought scenarios (Associated Engineering 2011), making increased capacity at the reservoir of questionable value, particularly in light of potential climate change effects.

With respect to Arrowsmith Reservoir operations, BCCF worked with City of Parksville engineering staff to clarify the error in Englishman River discharge data supplied daily to the City each summer by Water Survey of Canada (WSC). This issue is further discussed in section 3.3, *Stream Discharge, Lake Level and Temperature Monitoring*.

[7] AWS is a joint venture between City of Parksville (63.9% ownership), Regional District of Nanaimo (22.4%) and Town of Qualicum Beach (13.7%) which owns and operates Arrowsmith Dam in the Englishman's headwaters (http://www.arrowsmithwaterservice.ca/governance.asp, accessed March 7, 2012).

In considering new storage sites in the watershed, the mainstem and each sub-basin were examined, including all sites previously considered during historical bulk water supply investigations (e.g., Chatwin 1986).

Following construction and annual releases from Arrowsmith Reservoir, rearing conditions in the 15.5 anadromous kilometres of Englishman mainstem improved significantly. Average August and September mean monthly flows for the ten years following dam completion were 57 and 44% greater, respectively, than those in the preceding decade (WSC data). A metric of fish habitat "bottlenecking," 7-day average low flows improved as well, varying from 5% to 12% of mean annual discharge (MAD) during the post-dam era (Figure 2). Despite increased base flows in the post-dam period, mainstem habitats were occasionally unsatisfactory and, according to Provincial Water Allocation Plan criteria (Boom and Bryden 1994), classified as offering "poor spawning and rearing" conditions for fish.

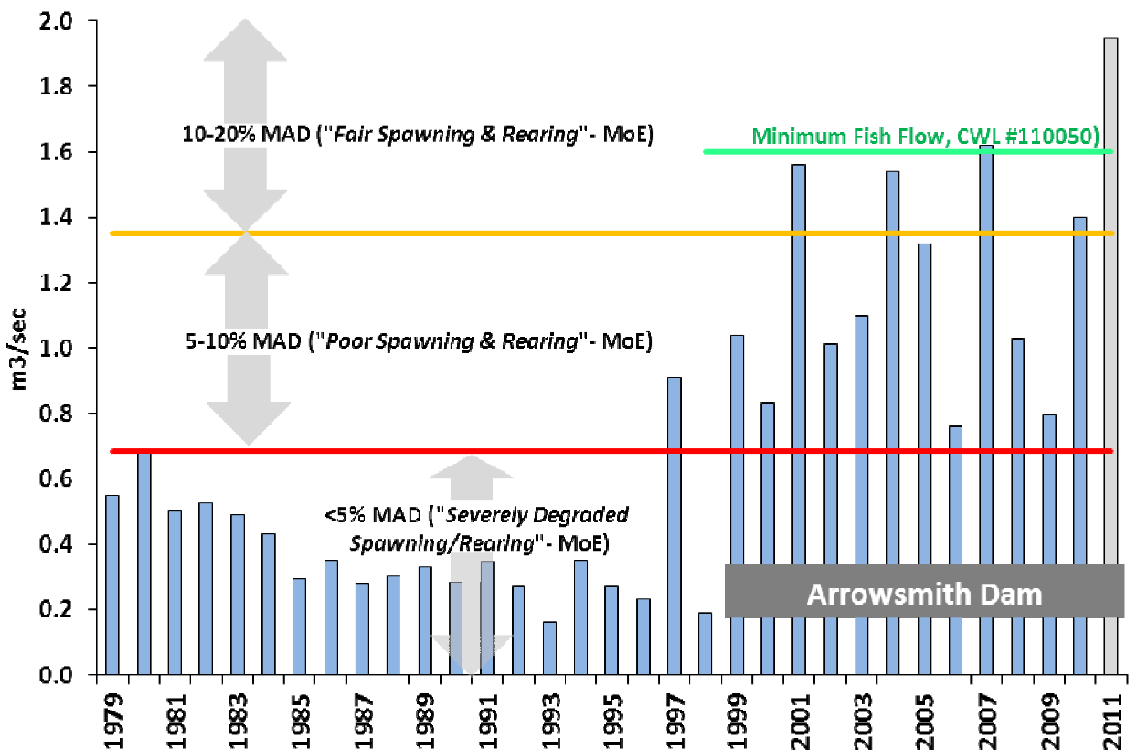

Figure 2. Seven-day average low flow, by year, for Englishman River at Hwy 19a (WSC 08HB002; 2011 is preliminary data).

Given Arrowsmith Dam-related improvements to base flow through the length of the Englishman mainstem, potential storage and flow augmentation in its sub-basin tributaries had significant merit and made sense on a cost efficiency basis. This is because a smaller channel that is already flow-challenged requires less additional water to generate substantial habitat benefits to fish. Acknowledging recent *mainstem* flow improvements, Lough and Morley (2002) and nhc (2002) singled out the mainstem's anadromous tributaries (Table 1) as the best locations for further flow improvements in the watershed.

Table 1. Englishman River anadromous sub-basins.

Sub-basin	Enters mainstem at river km	Area (km^2)	Anadromous Length (km)
Shelley Creek	1.0	2.4	1.0
South Englishman River (excluding Centre Creek)	7.5	78	4.5
Centre Creek	7.9	22	5.2
Morison Creek	8.6	38	2.1

Notes: 1. Centre Creek enters the South Englishman River at a point ~380 m above the river's confluence with the mainstem. 2. Areas as reported on DFO's Mapster V3.1 web site (http://www.pac.dfo-mpo.gc.ca/gis-sig/maps-cartes-eng.htm), using 1:20,000 or 1:50,000 BC Watershed themes.

A case can be made for the need for flow improvements in each of the four tributaries, although lakes are present in the South Englishman only. The following summarizes key points.

Shelley Creek, though small and offering only 1.0 km of anadromous length downstream of a 5-m falls (Clough 2011), may support significant coho production, as indicated by results of a spring 2011 fence operation near its confluence with the Englishman. Between April 22 and June 4, stream stewards caught 2,881 fish (2,638 Coho smolts, 37 trout) at the fence. The origin of these fish remains unclear – a good portion were thought to be from the Englishman mainstem, having sought the protected habitats of lower Shelley Creek in which to over-winter (Clough 2011). However, no potential storage sites were identified during recent reconnaissance of the rural and forested areas of the upper drainage.

Morison Creek drains actively managed forest lands between 150 and 800 m elevation and a patchwork of rural residential and farm lands at elevations between 60 and 150 m. A set of bedrock falls limits anadromous fish to the lower 2.1 km of stream length. Near its confluence with the Englishman, BCCF point flow measurements during summer 2010 and 2011 were commonly between 0.008 and 0.017 $m^3 \cdot s^{-1}$, or 0.5 to 1.0% MAD (assumes MAD=1.75 $m^3 \cdot s^{-1}$; Sutherland 2010), suggesting severely degraded rearing conditions for fish. Though no lakes exist in the drainage, small marshes and beaver impoundments are located in the middle reaches and continue to be investigated in a parallel project working with agricultural landowners (Stenhouse 2012).

Centre Creek is technically a tributary of the north-flowing South Englishman River, entering it from the west at a point 380 m upstream of its confluence with the Englishman mainstem. Starting in 2001, four years of DFO-sponsored spring fence operations on Centre Creek produced Coho smolt counts ranging from 3,295 (in 2003; Schick and Decker 2004) to 6,549 (in 2004; Taylor 2004) fish. During the summer and between 2008 and 2011, BCCF documented instantaneous flows in Centre Creek of 0.002-0.014 $m^3 \cdot s^{-1}$ (n=13), representing 4-20% of total discharge from the South Englishman River on those days. Assuming Centre Creek unit runoff was similar to that of Morison Creek, its mean annual discharge was estimated at ~1.0 $m^3 \cdot s^{-1}$. Base flows therefore correspond to 0.2 to 1.4% MAD, and can be described as severely limiting to fish production. In recognition of Centre Creek's potential if it were to receive additional water, nhc (2002) recommended examining the feasibility of improving its base flow with diversions from the South Englishman. However, it was established early in the study that landscape elevations between the two drainages prohibit cost effective connection.

Having the greatest quantity of anadromous stream habitat, as well as the largest and 3rd largest lakes in the Englishman watershed (Arrowsmith Lake is 2nd), it was – and remains – apparent that the South Englishman River offered the greatest potential for storage-related habitat and fish production improvements. Headwater lake storage would benefit the entire 4.5 km of stream length downstream of the barrier falls situated beneath Island Timberland's 155 Mainline bridge (Table 2). Resident Rainbow and Cutthroat stocks in 16.8 km of stream length between the falls and the sub-basin's headwater lakes would also benefit.

Table 2. South Englishman River reach characteristics.

Reach	Channel Type	Length (m)	Channel Slope (%)	Channel Width (m)	Substrate (Dominant/Sub)
SE1	Unconfined, alluvial fan	378	0.6	31.8	Cobble/Gravel
SE2	Mostly confined	1,051	0.8	17.2	Cobble/Gravel
SE3	Some widening, jams	1,372	1.3	23.8	Cobble/Boulder
SE4	Confined, stable	1,777	4.3	18.5	Boulder/Cobble

Notes: 1. Reach slopes from Lough and Morley 2002.

During preliminary reconnaissance on July 13, 2007, crews documented flows of 0.058-0.068 $m^3 \cdot s^{-1}$ in the South Englishman's lowest reach, equating to 2.5% MAD. Discharges later that summer likely dropped by 60-70%, based on comparative records from nearby gauged watersheds (Chemainus, Tsolum, WSC data; French, Stenhouse 2012). Given the abundance of riffle habitats and general stream size relative to other tributaries, the South Englishman holds the most potential to support significant Steelhead and Coho production.

3.2 Consultation

In 2006, BCCF met initially with federal and provincial fisheries agency staff to conceptualize ECVI storage feasibility work, including work in the Englishman watershed. Since then, discussions and updates occurred regularly at dedicated meetings or during BCCF project reviews at ERWRP Steering Committee meetings (Appendix D). Following identification of Shelton and/or Healy lakes as candidates for storage feasibility in the upper South Englishman, both agencies were asked to clarify concerns and the potential for their involvement as water license proponents. Both agencies supported flow augmentation conceptually, provided a biological case was made and impacts were minimal. Neither agency had particular concerns with the sites, although a provincial staff perception of unique attributes and a better-than-usual sport fishery at Healy Lake was noted. Though neither agency wholly rejected the notion of becoming water licence applicants in the early years of storage feasibility work, recent economic challenges have pushed both toward more risk-adverse policies with respect to infrastructure and operational costs, severely limiting the potential for their involvement in conservation storage projects in the Englishman or elsewhere.

Landowners affected by storage work in the South Englishman include TimberWest Forest Corp. and Island Timberlands Limited Partnership. Shelton and Healy lakes are owned by TimberWest, as are most of the forest lands draining to them and the road network that accesses them from the Nanaimo watershed. Island Timberlands owns most of the sub-basin downstream of the lakes, including roads accessing the lower South Englishman.

TimberWest was originally approached in March 2007 regarding potential storage projects in the South Englishman and other ECVI TW lands. They were, and continue to be, generally supportive of the initiative, acknowledging the potential for improving habitats for stream rearing fish species. Feasibility results such as environmental impact assessments have been forwarded to the company and reviewed by them. Providing other key stakeholders were aligned, adequate licensing and road use agreements established, and the scope of proposed storage was close to the lake's natural range of fluctuation, the company would remain supportive. On the other hand, should project scale exceed natural high water marks and potentially impact TW's working forest base, compensation would need to be examined.

Island Timberlands are also supportive of the work, seeing little if any potential impact to their operations or lands in the lower South Englishman.

The concept of small scale storage feasibility was originally presented to the ERWRP Steering Committee in mid-December 2006. The Committee was generally supportive of exploring the potential for further base flow improvements. Some members suggested a cautionary approach, advising that, without strategic licensing, new storage could be used by growth advocates to justify new urban development. The Committee has since been updated semi-annually on various aspects of feasibility work, receiving environmental impact assessment reports as well as presentations by BCCF's hydrological and engineering consultant, KWL Associates Ltd.

Snaw-Naw-As First Nation fisheries staff were first contacted directly regarding storage feasibility in June 2008[8], with a follow up field reconnaissance of Healy Lake in November. Having been involved with small storage projects in neighbouring watersheds in the past, their staff were quite supportive conceptually. In December 2008, BCCF presented the project and preliminary results to band administration and received tentative support. Since then, Snaw-Naw-As Fisheries staff have assisted in Shelton lake level and stream flow data collection with BCCF crews. In April 2012, we updated Band Administration on project progress and related water issues in the Englishman. A survey for culturally modified trees near the Shelton Lake outlet and adjacent shorelines is planned for summer 2012.

In April 2008 at a meeting of the ERWRP Steering Committee, Arrowsmith Water Service gave a presentation on their history, current and forecasted water demand issues in the community, and longer term plans around Englishman River bulk water supply and treatment options. For AWS

[8] Prior to 2008, invitations were made to attend ERWRP meetings, but the band had opted not to participate in that process.

officials, this was also an opportunity to receive updates on various Committee member projects, including BCCF's storage feasibility work in the South Englishman sub-basin. In February 2009, BCCF further apprised AWS engineering staff on potential base flow improvements and environmental impact assessment results. New storage-related contributions to Englishman mainstem summer flows were of particular interest to AWS staff, who indicated conceptual support and a willingness to consider sponsoring a new storage license provided taxpayer benefits were realized, and design and construction funding was found outside of AWS budgets (Appendix D). Presentations and updates were also given to the Management Board of AWS in 2010 and 2011. Board members acknowledged the potential value of the Shelton Lake project, and requested their staff to report on what role it could play in AWS community water planning.

Following a presentation to the Mid-Island Castaways Fly Fishing Club in April 2012, members expressed unanimous support for building a weir on the outlet of Shelton Lake to improve low summer discharge rates in the South Englishman River.

3.3 Stream Discharge, Lake Level and Temperature Monitoring

Preliminary stream flow measurements in the South Englishman River occurred in 2007 as part of project identification. Through the summer, instantaneous discharges were taken in the reaches SE1 and SE2 and lower Centre Creek to assess relative flows and, in consultation with KWL, determine the best site for longer term flow monitoring. Discharges were also taken in relation to HSI transect analysis (see section 3.5).

On July 11, 2008, a semi-permanent hydrometric station was installed in reach SE 2 (Figure 3, 4), approximately 120 m upstream of the reach break (i.e., Centre Creek confluence). A station located in reach SE1 was not an option due to channel instability and evidence of surface flow losses in the aggraded channel. With the exception of a data logger malfunction between April 25 and August 6, 2009, the *South Englishman River above Centre Creek* station operated continuously, downloaded and re-surveyed three or four times/year. A set of low to moderate flow measurements collected

Figure 3. Location of semi-permanent hydrometric station in lower reach SE2, South Englishman River.

annually allowed the bottom end of the stage/discharge relationship to be updated following each high water season. Refer to Appendix E for complete hydrometric records.

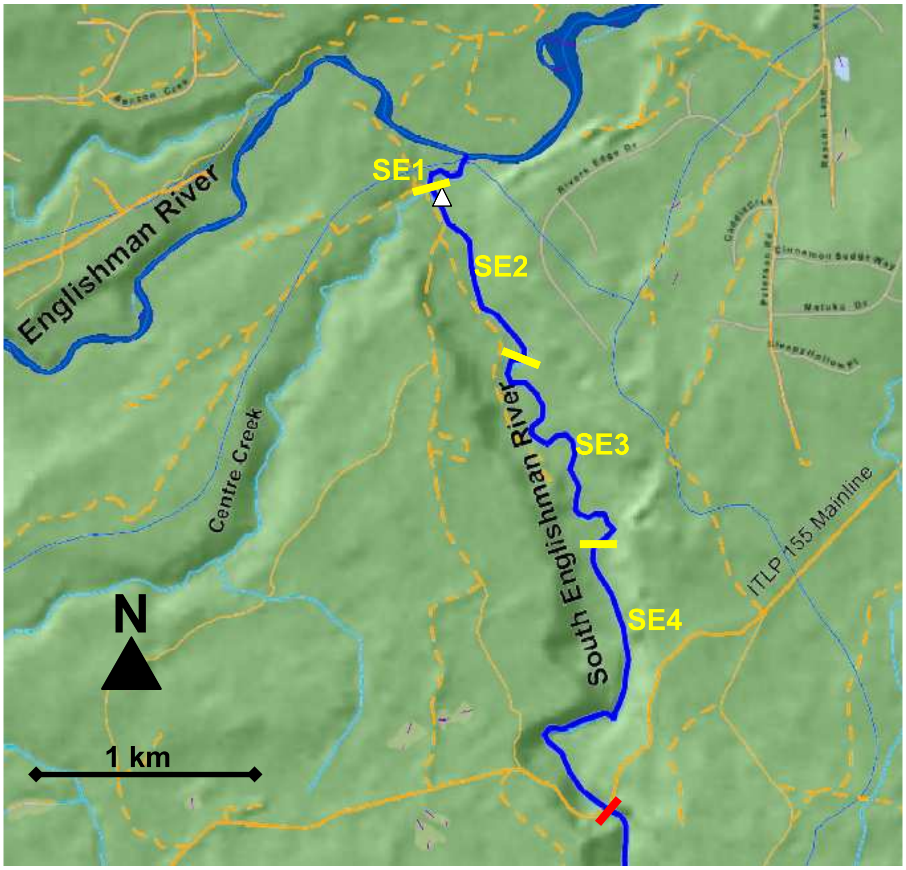

Figure 4. Lower South Englishman River, showing watershed boundaries, road infrastructure, Centre Creek, *South Englishman above Centre Creek* hydrometric station (white triangle), approximate reach breaks (yellow), and anadromous barrier (red).

Between 2008 and 2012, mean monthly discharges in the South Englishman River above Centre Creek ranged from a low of 0.016 $m^3 \cdot s^{-1}$ in August 2009 to a high of 11.2 $m^3 \cdot s^{-1}$ in November 2009 (Table 3). Seven-day low flows occurred in August for 2008, 2009 and 2010 (0.014, 0.014, and 0.027 $m^3 \cdot s^{-1}$, respectively), and in September for 2011 (0.034 $m^3 \cdot s^{-1}$).

Table 3. Mean monthly flows ($m^3 \cdot s^{-1}$) for South Englishman River above Centre Creek.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2008							*0.038*	0.035	0.029	0.338	3.18	1.34
2009	2.89	0.938	1.81	*0.771*	-	-	-	*0.016*	0.026	0.574	11.2	2.63
2010	8.06	3.47	3.03	3.49	1.80	0.876	0.074	0.034	0.279	1.36	3.15	8.93
2011	4.81	3.60	6.41	2.40	2.50	1.44	0.321	0.077	0.485	1.30	4.14	2.50
2012	5.74	*2.98*										
Mean	**5.37**	**2.75**	**3.75**	**2.22**	**2.15**	**1.16**	**0.144**	**0.040**	**0.205**	**0.892**	**5.42**	**3.85**

Values in italics were derived from an incomplete monthly record (see Appendix E).

Uncertainties related to flood plain modelling meant that KWL's final hydraulic model for the station was limited to rating peak flow stage heights up to 1.50 m over the data logger. For dates where river stage exceeded this height, mean daily discharges were estimated by reducing the WSC-reported mean daily discharge for Englishman River near Parksville (stn 08HB002) on the day in question by the ratio of KWL's MAD estimate (KWL 2010) for *South Englishman River above Centre Creek* to Englishman River MAD.

From 2008 to 2011, mean monthly water temperatures in the South Englishman River were highest in July and August, ranging from 14.7 to 16.9°C (Appendix F). Highest mean daily temperatures in those months ranged from 16.4 to 21.0°C over the period of record. In 2008, 2010 and 2011, the highest hourly temperatures occurred in the month of August at 20.4, 20.6 and 18.4°C, respectively. The highest water temperature recorded during the study was 23.1°C, occurring at 1900h on July 28, 2009 amidst a week-long heat wave (the highest recorded air temperature during the study, 32.5°C, occurred two hours prior).

At Shelton Lake, water level monitoring commenced September 23, 2008. Station benchmarks were tied into an elevational survey conducted July 21, 2009 by Bazett Land Surveying Inc. (Courtenay, BC), leading to a conversion of the data to metres geodetic (Appendix G). Survey results determined that Shelton Lake's outlet invert was at an elevation of 549.00 m.

Choked with LWD that shifts slightly each winter, Shelton Lake's outlet was a 50 m-long, low gradient channel averaging 10 m in width. Where LWD was missing, hardhack, grasses and aquatic vegetation dominated the channel (minor beaver activity was noted in subsequent years). Because substrates were mainly small wood and organic debris over loamy till, the invert's elevation of 549.00 m should be considered approximate. Over four years of monitoring, annual lake level fluctuation between summer and winter averaged 0.96 m (hourly data; Table 4).

Table 4. Observed Shelton Lake water elevations, 2008-2011 (hourly data).

Year	Lowest		Highest		Fluctuation (m)
	Elevation (m geodetic), Date		Elevation (m geodetic), Date		
2008	549.24	Sep 23	549.97	Nov 8	0.73
2009	549.10	Sep 05	550.22	Nov 16	1.12
2010	549.12	Sep 11	550.19	Jan 12	1.07
2011	549.18	Sep 21	550.09	Jan 1	0.91

Mean daily data (Figure 5) revealed that Shelton Lake levels remained elevated above 549.60 m for most of the late fall, winter and early spring each year. This was likely due to wet season "charging" of the sub-basin, as well as the coarse "sieve" effect of log jams, debris and snow/ice accumulations in the outlet channel. During the three years with late spring data, water levels started to decline below 549.60 m between May 20 and June 7, and continued down to summer lows. Annual low levels during the four years of record were reached between September 5 and 23, and were within 10 to 18 cm of the estimated invert elevation[9]. As a result of the drought in 2009, lake levels stayed chronically low into mid-October before fall rains began to recharge the watershed.

[9] The lowest lake level documented in 2008 was on the day the lake station was installed, September 23. Based on the September discharge record from the *South Englishman River above Centre Creek* station, actual lowest levels likely occurred between September 12 and 20.

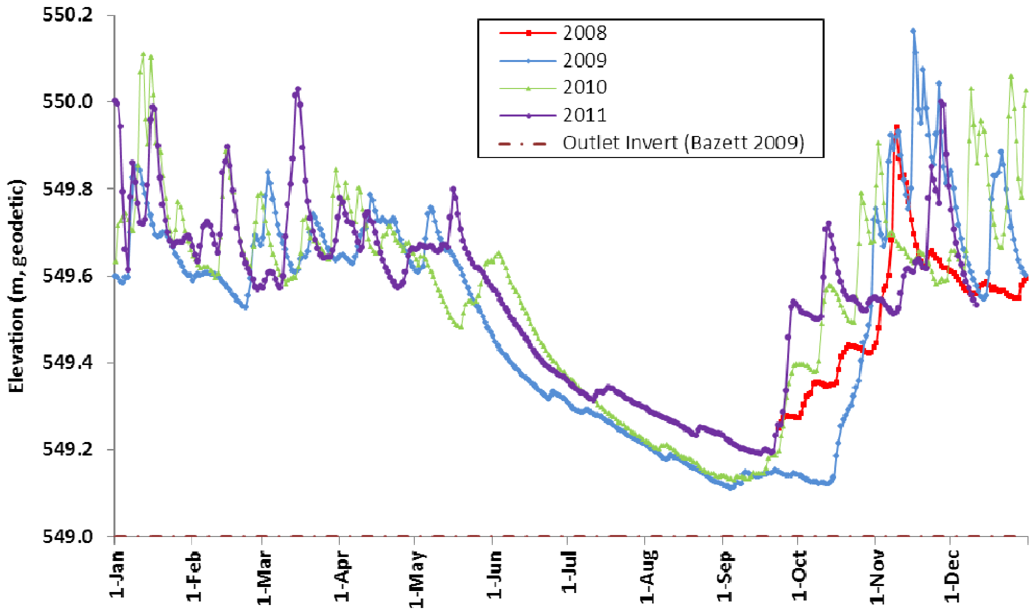

Figure 5. Shelton Lake mean daily water levels, September 2008 to December 2011.

Shelton Lake water temperatures (Appendix H) were recorded at the static elevation of the datalogger in its housing: 548.84 m geodetic. As a result, water depths at which temperatures were recorded varied seasonally, from lows during late summer approaching 0.26 m in depth, to highs in November of 1.39 m in depth. Mean monthly water temperatures were highest in August (3-year range: 19.4 to 21.1°C), when water depths at which temperatures were logged ranged from 0.28 to 0.45 m. Over the three summers fully documented, maximum water temperatures occurred in July or August and ranged from 21.1 to 25.5°C (recorded at depths of 0.40 and 0.38 m, respectively).

Annual air temperature extremes at Shelton Lake station temporally mirrored those of *South Englishman River above Centre Creek* station, but were 2.3 to 3.0 degrees higher in each case (Appendix H). The onset of mean daily air temperatures below 0.0°C at Shelton Lake station suggested surface icing commenced between mid-November and mid-December during the years documented (Appendix H).

Englishman Mainstem Flow Monitoring: Under conditional water license C110050, AWS is obliged to release from Arrowsmith Dam sufficient water during summer and early fall to maintain a minimum fisheries flow of 1.6 $m^3 \cdot s^{-1}$ at WSC station *Englishman River near Parksville* (08HB002). Following recommendations by Lough and Morley (2002), BCCF conducted summer flow monitoring to help clarify in-season error associated with preliminary WSC discharge data supplied daily to City of Parksville dam operators. In the early years of reservoir operation, the error (i.e., stage/Q curve-generated discharge versus actual measured discharge) inherent in discharge reported by email or website between station maintenance visits (every 6-8 weeks) was not identified by WSC. Since 2007/08, WSC has supplied a deviation factor that allows hydrometric station clients and/or general public using the website to correct real-time preliminary discharge to values closer to reality. Prior to 2007/08, BCCF in-season measurements were circulated to WSC, City of Parksville and fish agency staff to identify error in discharges reported to and used by city staff maintaining minimum fish flows. After 2008, BCCF assisted city staff to use reported deviations to more accurately meet the 1.6 $m^3 \cdot s^{-1}$ target on the lower river.

In 2009, AWS, the water regulators and fisheries agencies agreed to a revised Provisional Operational Rule for Arrowsmith reservoir releases. This was in response to the reservoir's inability to consistently meet the licensed minimum flows (1.6 $m^3 \cdot s^{-1}$) throughout the low flow period each year since construction (see Appendix A), as well as an expectation of a particularly dry summer ahead (low snow pack; reservoir not expected to fully recharge). The revised rule allowed for reduced flow targets during the augmentation period, as dictated by remaining storage. BCCF continued to monitor mainstem flows at the *Englishman River near Parksville* station, providing updated discharge data to dam operators and fish agency staff.

In 2011 following training by WSC personnel and acquisition of WSC-endorsed metering technology, BCCF supplied in-season discharge data directly to WSC to augment their scheduled maintenance trips during the summer. As a result, revised deviation factors were more frequently published (e.g., six from July 1 to August 31), leading to improved data reliability and storage management by reservoir operators. In late August 2011, BCCF identified an opportunity for improved base flows in the lower river. With full storage still remaining behind Arrowsmith Dam (good spring snow pack; wet summer), BCCF recommended to fish agency staff that AWS increase releases to a level over and above the licensed minimum. Subsequently, a healthy 2.0 $m^3 \cdot s^{-1}$ (15% MAD) was maintained throughout the lower river for the remainder of the season.

3.4 Hydrology Assessment

Preliminary and detailed results of the South Englishman hydrological assessment were laid out in two technical memoranda by KWL Associates (Appendix A, B).

Completed in 2008, the preliminary assessment examined potential base flow improvements from storage at both headwater lakes in the South Englishman: Shelton and Healy. It indicated:

- Mean annual discharge for South Englishman River above Centre Creek was estimated at 2.72 $m^3 \cdot s^{-1}$.
- 10% MAD could be sustained for a 10-year low flow condition with 2.7 m of top storage constructed on both lakes.
- 5% MAD could be sustained for up to a 10-year low flow condition with 0.6 to 0.7 m of top storage constructed on both lakes, or ~1.0 m of top storage on Shelton Lake only.
- More streamflow data, particularly during the low flow period, were needed for a detailed assessment of storage potential.
- Field assessments were required to assess engineering feasibility of constructing weirs at the lake outlets.
- Preferred minimum flows in Englishman River had not been achieved since construction of the AWS reservoir. Alternative reservoir management strategies should be reviewed to achieve these flows.

The subsequent detailed assessment (KWL 2012; Appendix B) used hydrometric data collected by BCCF since 2008 to refine earlier estimates of MAD and storage needed to meet various minimum conservation flows. It completed a water balance analysis and considered projected climate change impacts and associated implications on water storage strategies for the South Englishman. Lastly, and in light of environmental studies at Healy Lake that identified unique characteristics and sensitivities that make it less appropriate as a storage site, the assessment focused on conceptual designs for outlet structures at Shelton Lake only. For this latter task, KWL arranged on-site surveys and sub-contracted Trow Associates Ltd. to develop designs and Level-D cost estimates (see Section 3.7; Appendix B). From a hydrological perspective, the assessment concluded:

- Mean annual discharge for South Englishman River above Centre Creek was revised to an estimated 2.75 $m^3 \cdot s^{-1}$.
- 0.7 to 1.4 m of top storage at Shelton Lake would be adequate to provide 5% MAD in the South Englishman River during 5-year return period and 10-year return period droughts, respectively.
- Under average conditions, it is feasible to develop storage at Shelton Lake sufficient to maintain 10% MAD in the South Englishman under average flow conditions. However, maintaining that flow during 10-year return drought periods would require up to 5.0 m of storage, a volume unlikely to be consistently re-filled each winter given the lake's small contributing watershed area of 3.5 km^2.

Additional detail and conclusions may be found in the memoranda (Appendix A, B).

3.5 Fish Habitat and Fish Production Benefits/Impacts

The following section identifies potential improvements in the quantity and quality of South Englishman River fish habitat resulting from increased summer base flow. Though the focus is on anadromous reaches (and salmon and trout species supported there), similar physical habitat improvements can be expected above barriers for resident trout. Improvements to the quantity of rearing habitat made available from flow augmentation are directly translated to additional number of fish, by species and age class, supported by the habitat. The status of, and potential impacts and benefits to, non-target fish above barriers and in affected lakes are also discussed.

The well-being of the South Englishman's aquatic ecosystems aside, healthy stream flows provide many direct and indirect benefits to riparian and terrestrial wildlife, and the watershed ecosystem as a whole. The successful interaction of species between aquatic and terrestrial habitats is often dependant on adequate discharge regimes (e.g., birds or amphibians reliant upon aquatic insect hatches, the abundance of which depends on healthy stream flows). Though these benefits are real and numerous, they were not part of this project's scope and are not discussed here-in.

3.5.1 Fish Habitat

Habitat Quantity: Habitat typing in South Englishman River's anadromous reaches occurred on August 20 and 21, 2009 during very low flows of 0.015-0.016 $m^3 \cdot s^{-1}$ (Appendix E). A total of 143 unique mesohabitats were identified over 4,569 m of stream length between the confluence with the mainstem Englishman and the anadromous barrier beneath Island Timberland's 155 ML bridge crossing (Appendix I). From the reach scale perspective, overall mesohabitat composition by thalweg length was 49% riffle, 19% pool, 31% glide, and less than 1% cascade (Table 5).

Table 5. Mesohabitat composition by reach, South Englishman River, 2009 versus 2002.

Reach	Proportion of Thalweg Length					
	Riffle		Pool		Glide	
	2009	***2002***	**2009**	***2002***	**2009**	***2002***
SE1	0.36	*0.52*	0.12	*0.11*	0.52	*0.37*
SE2	0.38	*0.48*	0.19	*0.13*	0.43	*0.39*
SE3	0.49	*0.52*	0.21	*0.10*	0.30	*0.38*
SE4	0.60	*0.52*	0.11	*0.09*	0.29	*0.37*
Aggregate	0.49	*0.51*	0.19	*0.11*	0.31	*0.38*

Notes: 2002 data from Lough and Morley (2002). ~1% of habitat in 2009 was classified as cascade.

Table 5 indicates mesohabitat typing results from BCCF's survey varied somewhat from that of a previous study (Lough and Morley 2002). Authors of the earlier study used a sub-sampling approach rather than sampling each unit in each reach as was done in 2009. Also, morphology has likely changed in SE1 where 2005 channel restoration activities included construction of lateral LWD jams to increase pool and glide cover and depths (McCulloch 2006). Lastly, evaluations in 2002 may have been conducted at a higher discharge than that present during the 2009 study, leading to differing interpretations of mesohabitat composition.

Bankfull channel width measurements across all four reaches averaged 20.7 m. The outlier, Reach 1 averaged 31.8 m, while average bankfull width in Reaches 2, 3 and 4 ranged from 17 to 21 m. Over the anadromous length, riffle, pool and glide wetted widths averaged 6.2, 8.6 and 7.5 m, respectively. While pool depths were substantial (mean=2.18 m; n=9) in the confined, often bedrock-controlled Reach 4, they were less significant (mean=0.77 m; n=7) in the alluvial Reach 1 that contained constructed lateral debris jams.

Multiplying mesohabitat lengths by their respective average wetted widths generated an aggregate 35,055 m^2 of anadromous fish habitat available in the South Englishman River under the base flow condition documented (~0.016 $m^3 \cdot s^{-1}$). Reaches 1 through 4 held 9, 25, 29 and 37% of this aggregate, respectively (Figure 6). From the unit scale perspective, riffle habitats dominated with 44% of total wetted area, followed by glides (33%), pools (22%) and cascades (<<1%).

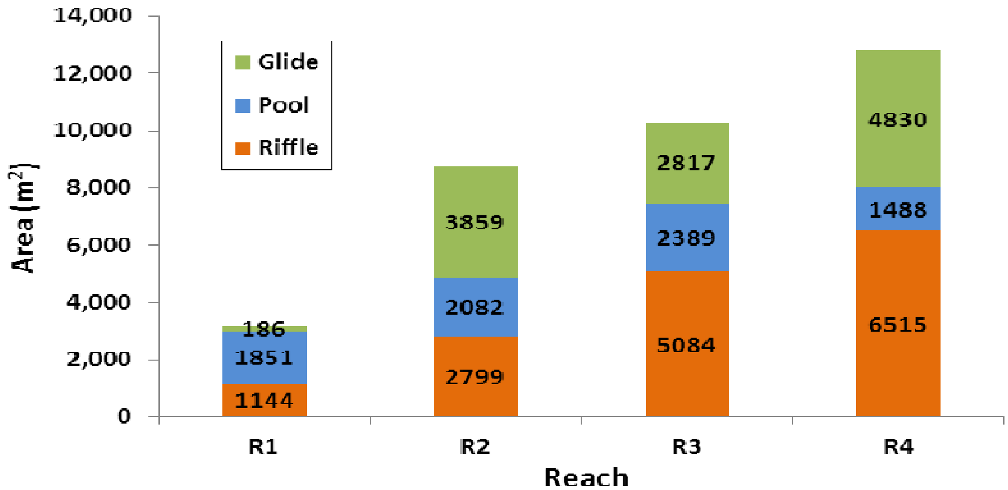

Figure 6. Fish habitat available in the South Englishman River by anadromous reach and mesohabitat type, during a base flow condition survey (~0.016 $m^3 \cdot s^{-1}$, August 20 and 21, 2009).

To examine how wetted widths and area changed with flow in the South Englishman River, seven riffle and five glide transects were established and measured over a range of five low to moderate flows between July and November 2008. Wetted widths of pools were not surveyed due to their relative insensitivity to incremental changes in flow. At least one riffle and one glide site were established in each of the four reaches; sites were selected to be as representative as possible. Combining relationships established from 2008 transect data (Figure 7) with mesohabitat typing data from 2009, we calculated wetted area available over a range of low flows (Table 6).

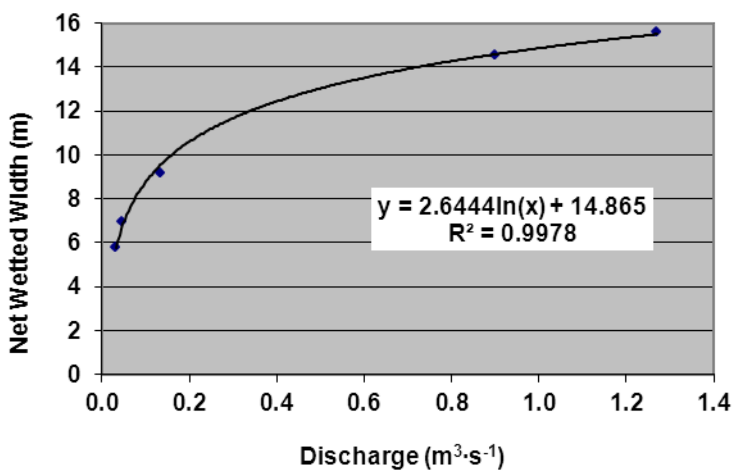

Figure 7. Example relationship of mean wetted width from riffle mesohabitat transects (n=7) in the South Englishman River to discharge over a range of low flows.

Results showed that as flows increased, riffle habitat area increased at a higher rate than did glide habitat area, as expected. A change of flow in the South Englishman from 1.0 to 2.5%MAD increased available riffle and glide habitats by 5,460 and 1,970 m^2, respectively (increases of 45 and 20%, respectively). Similarly, a change of flow from 1.0 to 5.0%MAD increased available riffle and glide habitats by 9,590 and 3,460 m^2, respectively (increases of 79 and 36%). With an increase of 1.0 to 10.0%MAD, modelling showed a combined gain in riffle and glide habitat of more than 18,660 m^2, an 86% increase over that available under a base flow condition of 1.0%MAD (Table 6).

Table 6. South Englishman River available wetted area, by reach and mesohabitat type, over a range of low flows.

Flow		Wetted Area (m^2)							
		R1		R2		R3		R4	
$m^3 \cdot s^{-1}$	%MAD	Glide	Riffle	Glide	Riffle	Glide	Riffle	Glide	Riffle
0.028	1	299	740	3,082	2,123	2,746	3,591	3,472	5,631
0.069	2.5	360	1,074	3,714	3,082	3,309	5,213	4,184	8,175
0.138	5	407	1,327	4,192	3,808	3,735	6,440	4,723	10,100
0.275	10	453	1,580	4,669	4,533	4,161	7,668	5,261	12,025
0.550	20	500	1,833	5,147	5,259	4,587	8,895	5,800	13,950

Habitat Quality (hydraulic): Riffles are known to be the most sensitive mesohabitat with respect to changes in flow. Though stream rearing juveniles are commonly found in pools, growth rates and densities of steelhead and coho are likely correlated with invertebrate production in riffles (Hartman *et al*. 1996). Reiser and Bjornn (1979) described good fish food production areas for juvenile salmonids as "mostly riffles with water depths of 0.15-0.91 m and water velocities of 0.30-0.46 m/s". Both depth and velocity in a riffle must meet species specific threshold values before the habitat functions optimally for a given species. In most BC streams, optimum threshold levels for fish rearing and insect production in most mesohabitats often occur when streams are at or near 20%MAD (Ptolemy and Lewis 2002).

For these reasons, flow-related changes in riffle habitat quality were examined at representative sites in Reaches 1 and 3 in 2008. Results over a range of flows (0.016 to 0.508 $m^3 \cdot s^{-1}$) were assessed against habitat suitability index (HSI) curves (Appendix C) for Steelhead fry and parr, and generic aquatic insects.

Steelhead parr prefer depths greater than 34 cm and velocities from 25-55 $cm \cdot s^{-1}$ (Appendix C). For Steelhead parr, study results confirmed that low base flows significantly compromised riffle suitability and that flows closer to 20%MAD created the preferred conditions. Mean suitability was highest (35%) during the highest discharge documented (0.508 $m^3 \cdot s^{-1}$), declining to just 3 to 4% usable under flows of less than 0.026 $m^3 \cdot s^{-1}$.

HSI results for Steelhead fry showed a weaker relationship over the range of flows documented than for parr. Steelhead fry find mean depths of 5-25 cm and mean velocities of 7-20 $cm \cdot s^{-1}$ most preferable (i.e., 100% suitable). During the study, HSI results for Steelhead fry generally improved as flows increased to 5%MAD, then declined slightly as flows approached the highest flow documented (18.5%MAD).

Suitability consistently improved for generic aquatic insects as flows increased, varying from less than 2% during the lowest three flows documented to as high as 36% during a flow of 0.508 $m^3 \cdot s^{-1}$ or

18.5%MAD. Generic insects prefer depths of 15-70 cm and velocities of approximately 1.0 $m \cdot s^{-1}$ (velocities of 35-152 $cm \cdot s^{-1}$ are at least 50% suitable; Appendix C).

Compared to Steelhead/Rainbow Trout, Coho fry prefer habitats with much lower velocities. Provided temperature and food supply are not issues, Coho fry find pools or glides with velocities of 0.0 to 12 $cm \cdot s^{-1}$ 100% suitable (Appendix C). As velocities increase from 13 to 44 $cm \cdot s^{-1}$, suitability for Coho fry steadily decreases from 100 to 0%. With respect to water column depths, any values in excess of 25 cm are 100% suitable for Coho fry. As depths decrease from 25 cm, usability also steadily decreases, eventually to zero as habitat dries.

Because riffle mesohabitats are inherently fast, they are generally not suitable for, or preferred by, Coho fry. Exceptions include riffle margins at each stream edge where velocities are slowest. As summer flows decline, riffle margin habitat with velocities preferred by Coho generally remains constant or increases, until water depth becomes limiting and shrinks available habitat. Competition with Steelhead fry in riffles is also a consideration.

Non-anadromous stream habitat: Non-anadromous stream lengths connecting Shelton and Healy lakes were assessed and photographed May 14, 2009. Shelton Lake, its catchment and its outlet stream are tributary to the South Englishman River proper, which starts from higher slopes to the west of Healy Lake. Not gazetted, Shelton Lake's outlet stream (hereafter referred to as *Shelton Creek*) flows north from the lake for 650 m, where it joins the South Englishman River approximately 400 m upstream of Healy Lake (Figure 8).

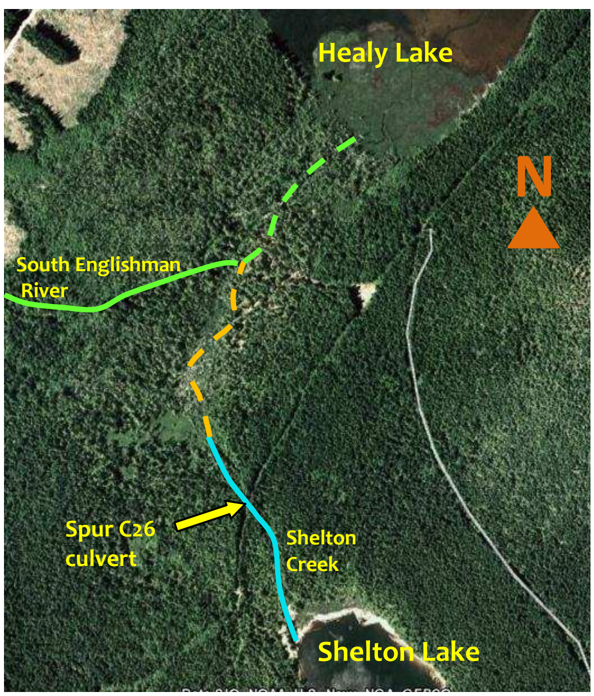

Figure 8. Satellite image of Shelton Creek flowing north to its confluence with South Englishman River, relative to Shelton and Healy Lakes.

On the day of survey, the area had 1 cm of fresh snow on the ground and Shelton Creek discharge was 0.162 $m^3 \cdot s^{-1}$ at the wooden box culvert beneath spur C26. From the Shelton Lake outlet to 100 m downstream of the Spur C26 culvert, the channel morphology was riffle-pool, single thread and stable (solid blue line, Figure 7). Riparian and instream cover appeared good to excellent. Constructed to enhance lake outlet spawning and rearing in 1989, a series of gabions, cross-stream LWD structures and spawning gravel placements in this reach (Tripp 1990) appeared to be mostly functional, with only a couple of displaced log sills apparent. Gradient averaged 3% and substrates were dominantly boulder-cobble, with gravel sub-dominant. Staging/spawning Rainbow Trout (estimated fork length: 150-300 mm) were regularly noted through this reach, using small to medium-sized gravel patches where they occurred.

The remainder of Shelton Creek to its confluence with the South Englishman (dashed orange line, Figure 7) was a stable but irregular channel, braiding often through flat, semi-open cedar and hemlock forest with abundant hardhack and old windfall LWD. The latter provided good instream cover for fish. Substrates were mainly sand, small woody debris and other organics. Spawners were noted but much less abundant than upstream of Spur C26.

The South Englishman downstream of Shelton Creek had similar characteristics to those of lower Shelton Creek. However, the primary channel was slightly larger and forest/LWD cover was greater, with significant jams that made survey progress difficult. Likely offspring of native Cutthroat, trout fry with fork lengths of 45-55 mm were noted in very low densities.

We surveyed the first kilometre of the South Englishman River downstream of Healy Lake synoptically on September 18, 2007 and again on July 25, 2008. On both occasions, beaver activity was evident at the lake outlet. In 2007, a beaver dam controlled 51 cm of head and allowed an estimated 0.002-0.003 $m^3 \cdot s^{-1}$ to feed the South Englishman River. This boulder and cobble dominated stream channel averaged 2% gradient and appeared highly stable. The only sign of disturbance was at the historical Branch C bridge crossing, where ATV/motorbike traffic had prevented abutment banks from stabilizing. Riparian forest was mixed conifer/deciduous and provided >80% canopy cover on average. Trout fry, parr and adults to 20 cm fork length were observed in moderate abundance in pool and deeper glide habitats on both occasions.

Non-anadromous reaches of the South Englishman River between the 155 ML bridge and the historical Branch C crossing 1 km downstream of Healy Lake, about 15 km in total, were not inspected on the ground. These middle reaches are situated between 100 and 520 m elevation and have an average gradient of 2.8%. From aerial photography, the channel appeared generally stable and in some cases incised, with little evidence of recent disturbance. Riparian corridors appeared mixed, with mature deciduous stands dominating in the upper half, and mature conifers in the lower. Access to these reaches appeared difficult - no road crossings were evident though recent forest harvesting upstream of 155 ML bridge may offer some rough road access.

Shelton Lake Habitat: The most recent provincial survey (Andrews 2006) described Shelton Lake (*aka* Echo Lake) as having an area 37.7 ha and a shoreline of 3,200 m. Mean and maximum depths were 10.8 and 19.5 m, respectively. (Andrews 2006). Total dissolved solids were sampled at 14.8 ppm. On a north-south axis, its rectangular shape is 1,300 m in length and 300 m in width.

Synoptic surveys by BCCF since 2007 have documented well-established shoreline vegetation (primarily salal, bracken, baldhip rose, buckbean, hardhack, alder) backed by mature second growth coniferous forest. Nearshore forest communities were classified by Wind (2008; Appendix J) as CWHxm2-05 Western redcedar/sword fern Very Dry Maritime. Natural and historical logging-related LWD was commonplace on all shorelines and functioned as fish habitat subject to lake level elevations (which have been shown to vary 1.12 m over the period of record; Table 4). Significant accumulations of LWD occurred at the north shore and outlet area, presumably a result of dominant winds from the southwest. Aquatic vegetation included yellow pond-lily, marsh cinquefoil, sedges, and, in deeper waters, pondweed (*Potamogeton sp.*). Shoreline substrates were generally sandy with moderate to high gravel content, capped with varying depths of organic silts, detritus and small woody debris. Shoreline plant communities are described in detail by Wind (2008; Appendix J). These plant communities and substrates are seasonally inundated to varying degrees. Development was limited to two accesses: the south end via Branch G off Nanaimo River Road, and the northwest corner via C-26 and Branch C off Nanaimo River Road. A small campsite has been developed at the northwest access, including a rough boat launch situated 20 m from the outlet's log jams.

In response to a lake fertilization proposal in the mid-1990s from TimberWest, the province assessed water chemistry, phytoplankton and zooplankton data collected by the company in the fall of 1995 and the spring of 1996. Four classes and 12 species of phytoplankton were documented; *Melosira granulata* and *Aphanocapsa sp*. were most abundant. In 18-m vertical tows sampling 1.29 m^3 of water, seven species of zooplankton were identified, with Daphnia and Cyclopoid copepods dominant on an individual/m^3 basis. From the water chemistry perspective, the preliminary conclusion was that Shelton was a moderately productive coastal lake, with spring and fall orthophosphate concentrations that already met typical fertilization targets. Nitrogen concentrations were relatively low but normal for coastal lakes (Johnston 1996). It was recommended that the fertilization proposal be delayed until stronger data and a rationale supporting it was available.

Three 1st order tributaries enter Shelton Lake: one through a small wetland at the southern end (Wind 2008), and one along each of the east and west shorelines, halfway up the lake. Shoreline reconnaissance by boat during the summer 2008 did not locate these tributaries.

Healy Lake Flushing Rates: Using 1970s bathymetry (Appendix K), modelling as described in Section 2.5.1 showed that current Healy Lake flushing rates by month ranged from 0.19 in August to 3.43 in December. Assuming a storage period (acquisition through release) of April 1 to September 30, monthly flushing rates were calculated to vary from 75 to 327% (Table 7). Collected on August 26, 2008, dissolved oxygen and temperature profiles on Healy indicated the lake was largely isothermal and offered good oxygen levels in all but the lowest metre of depth (Appendix K).

Table 7. Healy Lake discharge and flushing rates under natural and flow-augmented scenarios.

	Apr	May	Jun	Jul	Aug	Sep
Mean monthly discharge (natural; $m^3 \bullet s^{-1}$)	0.365	0.299	0.190	0.082	0.033	0.038
Complete flushes/month (natural)	1.77	1.50	0.92	0.46	0.19	0.21
Discharge lost/gained due to storage ($m^3 \bullet s^{-1}$)	-0.090	-0.060	-0.030	0.030	0.075	0.075
Complete flushes/month (Augmented)	1.33	1.21	0.78	0.64	0.61	0.62
Change from natural state	75%	81%	84%	137%	327%	298%

Assumes 1.25 m of storage built at Shelton Lake, and target augmentation of 0.075 $m^3 \cdot s^{-1}$ in August and September.

Reviewers concluded effects on Healy Lake's ecology from storage-related changes in flushing rates were difficult to predict but generally anticipated to be low. Productivity losses stemming from decreased water residence time (in-lake) may be offset by increased dissolved and particulate nutrient loading from Shelton Lake inflows. Changes in stream flows during Rainbow Trout spawning and rearing periods have the potential to affect spawning success and recruitment in various ways, both positively (e.g., improved July migration flows for recruiting fry) and negatively (e.g., reduced egg-fry survival if storage acquisition in May is too aggressive). Detailed comments from each reviewer are included in Appendix K.

3.5.2 Fish Populations

Stream Populations: Few inventories or reports describing South Englishman River fish stocks were located. In the 1980s, DFO engaged in a Coho colonization program, stocking and evaluating smolt production from wetlands in the South Englishman above the anadromous barrier (D. Clough, biologist, Lantzille, BC, pers. comm.). But no stock assessment above the barrier was likely completed in advance. In 2001, an Englishman River watershed assessment was completed for Weyerhaeuser Company Ltd. (Ostapowich and Pollard 2002). Given the relative wealth of information on streams downstream of barriers, the assessment's fish module focused on sampling fish in non-anadromous reaches. However, no sampling was conducted in the South Englishman.

Between October 9 and November 2, 2001, Lough and Morley (2002) sampled anadromous reaches of the Englishman and its tributaries. In the South Englishman, they captured Coho, Steelhead, Chinook, Stickleback, Lamprey and Sculpin. In light of a strong brood year that likely lead to full seeding, the authors concluded that high juvenile Coho densities they sampled in the South Englishman (15-68 fry/100m^2) probably reflected high capacity juvenile rearing areas. Centre Creek sampling and one site in Morison Creek also showed strong densities. With respect to Steelhead, the authors believed low seeding during spring 2001 lead to the low relative abundance of South Englishman juveniles sampled in that fall (5-15 fry/100m^2).

In 2008 and 2009, we sampled juvenile abundance at the same South Englishman River site sampled annually from 1998 to 2006 under the provincial Vancouver Island Steelhead Recovery Plan. This site, located 60 m upstream of the Centre Creek confluence, was a riffle habitat originally selected based on its suitability for Steelhead fry (mean depths of 5-25 cm, mean velocities of 7-20 cm·s^{-1}). Two additional riffle sites were also sampled each year, located 85 m downstream and 600 m upstream of the Centre Creek confluence, respectively (Appendix L).

2008: Observed densities at the historical site for Steelhead and Coho fry were 31.6 and 9.5 fish per unit (FPU; unit=100m^2), respectively (Appendix L). Weighting results based on site suitability, depth-velocity (D/V) adjusted density was 71.2 FPU for Steelhead. Poor site suitability for Coho fry confounds comparisons of D/V adjusted results for that species. In 2008, D/V adjusted Steelhead fry densities were 190% of the 1998-2006 mean (36 FPU, range 11-136 FPU).

Averaging observed Steelhead fry densities across the three sites sampled in 2008 yielded a mean of 20 FPU (range 11-36). D/V adjusted densities for the three sites averaged 39 FPU (range 13-71). Observed Coho densities for the three sites averaged 23 FPU (range 9.5-39). The mean weights of Steelhead and Coho fry sampled were 2.4 g (SD=0.91) and 2.4 g (SD=0.95), respectively. Steelhead and Coho fry condition factors were 1.12 and 1.08, respectively.

2009: Observed densities at the historical site for Steelhead and Coho fry were 10.7 and 41.2 fish per unit (FPU; unit=100m^2), respectively (Appendix L). Weighting results based on site suitability, depth-velocity (D/V) adjusted density was 22 FPU for Steelhead. Poor site suitability for Coho fry once again confounded comparisons of D/V adjusted results for that species. In 2009, D/V adjusted Steelhead fry densities were 61% of the 1998-2006 mean.

Averaging observed Steelhead fry densities across the three sites sampled in 2009 yielded a mean of 11 FPU (range 5-25). D/V adjusted densities for the three sites averaged 28 FPU (range 10-51).

Observed Coho densities for the three sites averaged 88 FPU (range 41-137). The mean weights of Steelhead and Coho fry sampled were 2.4 g (SD=0.84) and 1.7 g (SD=0.86), respectively. Steelhead and Coho fry condition factors were 1.09 for both cohorts.

Because riffle habitats sampled contained velocities preferred by Steelhead fry, they were also less appropriate for Steelhead parr. As expected, few parr were caught – from one to five were captured at sites sampled in 2008; zero to three parr at the sites in 2009 (Appendix L).

To estimate additional juvenile fish potentially supported by flow augmentation, average sampled densities of Coho and Steelhead fry from riffles in 2008 and 2009 were applied to additional wetted habitat areas (riffles and glides only; Section 3.5.1; Table 6) generated by flow augmentation over the base flow condition of 1%MAD. Assuming a storage-related flow increase to 10%MAD in normal years, additional wetted area could support over 7,500 and 2,700 additional Coho fry in riffle and glide habitats, respectively. Similarly, additional wetted area could support over 2,100 and 760 additional Steelhead fry in riffle and glide habitats, respectively. Using Keogh River (Vancouver Island) observed Steelhead parr densities in improved habitats (9 FPU; Koning and Keeley 1997), additional wetted area in the South Englishman would support a minimum of 1,230 additional Steelhead parr in riffle habitats alone. These numbers should be considered conservative – the *quality* of *existing* riffle habitats would increase significantly for Steelhead parr, improving overall capacity. Additionally, depth-velocity characteristics (i.e., *quality*) of other mesohabitat types will improve – particularly pool entry points favoured by parr – generating additional rearing capacity in each unit. This is particularly well demonstrated by suitability results for generic aquatic insects in riffles, where order of magnitude increases in HSI scores were documented between base and enhanced flows (Section 3.5.1). Lastly, minor gains in suitability (both quality and quantity) of *pool habitats* in the South Englishman would also be realized, though these were not considered during this assessment.

Inspections of non-anadromous stream populations in Shelton Creek and South Englishman River in the vicinity of Healy Lake occurred in spring 2007 and 2009. On May 4, 2007, Rainbow Trout preparing to spawn were observed and videoed from 50-150 m downstream of Shelton Lake, in many cases adjacent to gravel platforms installed in the late 1980s (see 3.5.1). One to two dozen fish were noted in each significant pool, with estimated fork lengths of 18-28 cm. Small parr, likely one year-olds, were also occasionally noted. Discharge was estimated at 0.050-0.100 $m^3 \cdot s^{-1}$. On May 14, 2009, similar observations of spawning Rainbow Trout were made in the same reach below Shelton Lake. Up to 25 moderate to darkly coloured fish (15-30 cm estimated fork length) were counted in main pools near historic machine access points. Fish were generally holding over or spawning in small gravel (1-2 cm B-diameter) accumulations between larger cobble and boulder.

On September 21, 2009 with zero effective discharge in Shelton Creek, Rainbow fry were sampled from isolated pools within 100 m of the lake. These remaining pools were 2-8 m^2 in size and spaced at roughly 35 m intervals. It was assumed that other shallower pools had recently de-watered, and that fish there had been scavenged or perished. Spot electrofishing yielded an aggregate of 10 Rainbow fry (45-58 mm, 1.0-2.6 g) from three remaining pools offering a total of 14.5 m^2 of wetted habitat. One parr-sized fish was noted but not captured.

<u>Lake Populations</u>: According to provincial records, Healy Lake has never been stocked.

Provincial records indicate that, with the exception of 1989, Shelton Lake was stocked annually between 1988 and 2006, typically with 2,000 26-gram yearling diploid Rainbow Trout from the

Vancouver Island Trout Hatchery in Duncan, BC. The most recent stocking rate was 53.1 fish/ha annually (2006). Brood sources varied year to year, alternating between Blackwater, Tzenzaicut, Pennask, Badger and Tunkwa strains. In 2000 and 2001 during a provincial catchability study in ECVI lakes, both Blackwater and Tzenzaicut strains were stocked.

The last provincial lake assessments that included Shelton occurred October 5, 2006 (Appendix M). Gillnet sampling employed "standard experimental" 90-m nets, one floating and two sinking. A total of 57 Rainbow Trout were caught in the three nets, averaging 239 mm in length (range 180-320, SD 28.8) and 141 g in weight (range 64-307, SD 47.1). The lake's stock was subsequently described as a "high density stunted RB population." This, combined with recent access issues[10], led the provincial small lakes biologist to cancel further stocking. Consistent observations we made of Rainbow Trout spawning in the outlet stream in 2007 and 2009 suggest some level of natural recruitment continues to occur at Shelton Lake.

Previous sampling occurred in 1996, 1987, 1979 and 1970. Comparing results to 2006 suggests that the population's mean length may have dropped slightly (Table 8), likely a product of stocking. As CPUE data were only available for 2006, no trend in catch rate could be assessed. Though all surveys identified Rainbow Trout, three Cutthroat Trout were also sampled in the 1996 survey.

Table 8. Gillnet sampling results for Shelton Lake, 1970-2006.

Date	Auth	# Caught		Length (mm)		Comment
		RB	CT	Mean	Range	
Oct 5, 06	Prov	57	-	239	180-320	CPUE=4.41 RB/net hr
Apr 20, 96	TW	33	-	246	150-325	~half were aged: 2-5 yr-olds
			3	316	300-330	2 aged: both 5 yr-olds
Aug 24, 87	Prov	9	-	254	180-380	
Jul 31, 79	Prov	2	-	283	210-360	
May 2, 70	Prov	8	-	-	-	

Typically, the province's regional Fish and Wildlife staff conduct the Vancouver Island Lakes Questionnaire every four years. A mail-out survey to anglers who purchase freshwater licenses, it allows managers to estimate catch and effort on the region's lakes in relation to stocking, regulations and other management actions. The 2006 questionnaire results were representative of 8.8% of the target angler cohort. Just two respondents fished Shelton Lake, for a combined seven days of effort and catch of 43 fish (6.1 fish/day). Expanded results suggested a total of 23 anglers fished Shelton Lake during that licence year, devoting 80 angler-days of effort.

[10] Situated on private land, Shelton Lake access is controlled by TimberWest. Security, fire and/or road safety concerns have, in some cases, left TimberWest with no alternative but to close gates on mainlines and spurs leading to Shelton Lake.

3.6 Environmental Impact Assessments

Following data requests to the Archaeology Branch, MNRO, Victoria, there were no known archaeological sites recorded around or in close proximity to Shelton Lake (H. Bond, Archaeological Site Inventory Information and Data Administrator, pers. comm.). Though planned for June 2011, scheduling conflicts prevented a CMT survey by Snaw-Naw-As First Nations staff from being completed. This has been re-scheduled for 2012.

Potential environmental impacts of 1-2 m of storage on flora and non-fish fauna were assessed at Shelton and Healy lakes between May 28 and September 14, 2008. The following sections (3.6.1 to 3.6.4) are based on detailed results by Wind (2008) – further information is found in Appendix J.

3.6.1 Plants

Wind (2008) found that plant communities and shoreline morphology at Healy Lake were more diverse and subject to impacts of increased water levels than at Shelton Lake. At both sites, increased water levels would stress shoreline trees, create more snag habitat and lead to higher inputs of LWD as shoreline trees experience the effects of seasonal inundation. Providing substrates are suitable, wetland plants may re-colonize upslope under annual storage scenarios. Bogs and fens sensitive to disturbance are commonly found at Healy but mostly absent at Shelton. Two provincially Blue-listed riparian communities were recorded at Shelton Lake: black cottonwood – red alder/salmonberry (*Populus balsamifera ssp. Tricocarpa – Alnus rubra/Rubus spectabilis*) and western redcedar/sword fern Very Dry Montane (*Thuja plicata/Polystichum munitum Very Dry Montane*). With storage, wetland inflow and outflow areas at Shelton Lake would increase in size, and plant community structure would slowly be altered.

Further description, detailed results and discussion of potential impacts to plants may be found in Appendix J (Wind 2008).

3.6.2 Amphibians

At Shelton and Healy lakes, two and three species of amphibians were confirmed breeding, respectively, including Red-legged Frog (*Rana aurora*). The other amphibian at Shelton Lake was the Northwest Salamander (*Ambystoma gracile*). Shelton was thought to be generally less suitable for breeding than Healy due to its relative lack of shallow water areas and lower shoreline habitat complexity. Though storage may reduce shallow water available for amphibians at Shelton Lake, flooding into riparian areas may compensate for the lost habitat. Breeding areas may shift spatially, but may not be as suitable until canopy cover is reduced through die off (stand thinning in advance was recommended). Over the long-term, increased water levels were not predicted to have negative effects on amphibian species or populations in the area (Wind 2008). See Appendix J for further details.

3.6.3 Birds

While a number of potential impacts were predicted with storage development on Healy Lake, no impacts to birds were expected from proposed water storage at Shelton Lake (Wind 2008; Appendix J). This was mainly due to the topography of the surrounding uplands, forest condition, and lack of rare or special bird habitat at Shelton.

3.6.4 Small Mammals

Focus was placed on potential impacts of storage on the Vancouver Island water shrew (*Sorex palustris brooksi*), a provincially red-listed subspecies of the American water shrew, found only on Vancouver Island. During field investigations, there were no sightings or evidence of the shrew at Healy or Shelton lakes, however, the habitat there is quite suitable and records indicate that *S. p. brooksi* has been documented as close as 2.5 km from Healy Lake (Wind 2008).

At Shelton Lake, the best potential habitats for the shrew were located at creek mouths and in the outlet channel. At the former, higher summer water levels may improve transportation corridors for the shrew through the water-forest interface. In the latter, additional flow during the summer time from storage releases might be a net benefit to the habitat quality for the shrew, providing increased foraging opportunities. Minimizing the footprint of any dam facility was deemed critical to reducing the potential for lost shrew habitat (Wind 2008, Appendix J).

3.7 Shelton Lake Weir – Conceptual Designs

On July 21, 2009, Bazett Land Surveying Inc. conducted a topographic survey of Shelton Lake outlet using both GPS and traditional instruments. Results were georeferenced and overlaid on aerial photography (Appendix N). Shelton Lake's natural invert was surveyed at 549.00 m geodetic.

As part of their monthly water balance modelling, KWL examined Shelton Lake's catchment area from the perspective of its potential to re-fill a reservoir each spring. While releasing minimum conservations flows of at least 10%MAD, the watershed would consistently re-fill 2 m of top storage during the re-fill period. Accordingly, and to investigate the upper bookend of storage potential at Shelton, KWL instructed Trow Associates Ltd. to produce conceptual designs and Class D cost estimates for 2 m of top storage.

In their memorandum (Appendix B), Trow stressed that discussions and proposed designs must be considered preliminary due to the limited site-specific information (e.g., no geotechnical test pits – dense glacial soils or bedrock was assumed to be at reasonable depth[11]) and the fact that drawings were based on relatively coarse-scale GPS/instrument surveys (Appendix N). Also, fish passage was not considered in designs, an oversight that must be included in future designs. According to Trow

[11] During 1980s feasibility investigations for the Arrowsmith Lake Dam and Reservoir, a 15 m-deep bore hole was drilled at Healy Lake outlet on June 4 and 5, 1986. Analysis confirmed earlier assumptions that seepage would not be a problem and that stable soils existed at Healy Lake outlet (Chatwin 1986).

and based on height and volume stored, the dam would likely be classified as LOW consequence under Canadian Dam Safety Guidelines and BC Dam Safety Guidelines. However, to be conservative, it was assumed the dam would be classified as HIGH consequence (mid-point of five ratings from LOW to EXTREME). Probable maximum floods and inflow design floods were based on Englishman and Jump Creek (Nanaimo River) data, and estimated to be 51 and 32 $m^3 \cdot s^{-1}$, respectively.

Two concepts were presented:

1. A dam built to 551.50 m across the outlet. A low level outlet at the base of the dam. A spillway comprised of a free overflow structure located within a separate excavated channel (invert = 550.00 m) in the right bank abutment.
2. A spillway comprised of a free overflow central concrete gravity structure, flashboards (to 550.50 m) and low level outlet, located within or near the existing river channel. An excavated inlet channel to 548.50 m. Adjoining embankments to 551.50 m would provide retainment on each side of this structure.

Further details and design drawings for the two concepts are included in Appendix B. Trow emphasised the "order of magnitude" cost estimates included in their memorandum (Table 9), which contain 30% contingency. Construction and material costs and availability will vary over time and strongly influence estimates, as will ultimate classification of dam consequence, inclusion of fish passage infrastructure, and completion of further environmental assessments, if required.

Table 9. Trow Associates Ltd. storage and estimated construction costs for Dam Options 1 and 2 at Shelton Lake (Appendix B).

Option	#1 (Zoned Earthfill Embankment with Separate Spillway)		#2 (Zoned Earthfill Embankment w Central Concrete Gravity Spillway	
Crest Elevation (m geodetic)	550.50	551.50	550.50	551.50
Storage (m^3)*	191,000	573,000	382,000	764,000
Est. Construction Cost (2010 $)**	1,520,000	1,680,000	1,310,000	1,570,000

*For Option 1, volumes are storage that would be provided to the invert level of the outlet channel. For Option 2, volumes are storage that would be provided with optional flashboards installed.
**Conceptual level, class D estimate. Assumes HIGH consequence dam rating. Includes 30% contingency.

Using future monthly temperature and precipitation forecasts for the 2041 to 2070 Normal Period (2050s), climate change impacts were modelled by KWL to estimate storage needed under future climate conditions. Results suggested future runoffs would increase in winter (higher precipitation and temperatures) and decrease in summer (lower precipitation, higher temperatures). Accordingly, storage requirements to sustain conservation flows in the face of modelled climate change may be up to 15% higher than under conditions at present (KWL 2010; Appendix B).

4.0 Discussion/Summary

Following examinations since 2007 of the Englishman River and its tributaries, the South Englishman River offered the greatest potential for storage-related fish habitat improvements. Hydrographic records and modelling since 2008 have indicated mean annual discharge (MAD) in the South Englishman above Centre Creek is 2.75 $m^3 \cdot s^{-1}$, and that low flows in summer often drop to less than 0.027 $m^3 \cdot s^{-1}$. Small scale storage at Shelton Lake (e.g., 1.4 m) has the potential to increase base lows in the lower South Englishman by close to an order of magnitude in normal years, from near 1%MAD (*severely degraded spawning and rearing habitat*) to 10%MAD (*fair spawning and rearing habitat*; Boom and Bryden 1994). Under a 1:10-year low flow condition (i.e., 10-year drought), 5%MAD could be maintained with this same volume of storage (KWL 2012, Appendix B). These improvements to base flow represent significant insurance against more frequent and severe droughts predicted with climate change.

Consultation around potential storage feasibility commenced in 2006 and has occurred regularly with provincial and federal fisheries agencies; landowners; Snaw-Naw-As First Nation; local streamkeepers, environmental stewards and anglers; as well as local governments and their water utility partnerships, the AWS and the Englishman River Water Service (ERWS). Stakeholders have been generally supportive, though the outcomes of feasibility work presented here have yet to be fully considered by some. Consultation has led to a good working relationship between BCCF and AWS operators, and greater success in using preliminary, in-season WSC data to manage Arrowsmith Reservoir releases and supply minimum fisheries flows in the lower Englishman.

Given current plans of the ERWS to "expand the joint venture drinking water supply system with a new surface water intake and water treatment plant along the Englishman River" (http://www.arrowsmithwaterservice.ca/future_plans.asp, accessed May 2012), water regulators and/or fisheries agencies may require compensation for impacts to Englishman mainstem habitat related to moving the intake upstream of its current location at Turner Road, 500 m above tidewater[12]. Such a move requires a license amendment and would potentially transfer the extraction of over 0.6 $m^3 \cdot s^{-1}$ (see Section 1.1) from mainstem summer flows to a point 2.7 km further upstream, and during periods when minimum fisheries flows of 1.6 $m^3 \cdot s^{-1}$ are already difficult to maintain with existing storage. Accordingly, building or annually operating streamflow augmentation infrastructure such as Shelton Lake storage is presumably one of a number of potential options ERWS could consider as compensation for the intake move, assuming it is required to undertake it.

From the perspective of local environmental impacts, proposed storage at Shelton Lake was predicted to have minimal long term consequences to plant communities, amphibian populations, birds or small mammals. No red-listed species or communities were identified at Shelton Lake, and forecasted impacts to other less common or sensitive species were thought to be easily mitigated. Surveys for culturally modified trees are still required. Should a construction project proceed, potential construction-related impacts would have to be identified and mitigated appropriately.

[12] As of spring 2012 and to our knowledge, impacts associated with moving the intake have yet to be identified.

Shelton Lake water levels were shown to reach their low point in September each year, at elevations of 10-24 cm above the suspected natural invert (elevation: 549.00 m geodetic). The maximum documented water level fluctuation occurred in 2009 and equalled 1.12 m.

Based on the most recent provincial evaluation in 2006, Shelton Lake's fish population was a monoculture of small (mean=24 cm) Rainbow Trout, mostly a product of annual stocking of hatchery produced fish since 1990. Following the 2006 evaluation, the province believed the stock to be at high density and "stunted", and cancelled further stocking. Observations during our study confirmed an abundance of small Rainbow spawning in May in the outlet, Shelton Creek. Accordingly, fish passage to accommodate adult and juvenile-size trout would be a pre-requisite in any further weir designs.

As discussed above, KWL's hydrological analysis indicates average year base flow in the South Englishman River above Centre Creek could be increased to 10% MAD (i.e., 0.275 $m^3 \cdot s^{-1}$) with 1.4 m of storage at Shelton Lake. Amounting to an increase of at least 0.200 $m^3 \cdot s^{-1}$ over normal base flows, this additional water would enter the mainstem Englishman River and contribute to meeting target minimum fish flows in the lower river (currently 1.6 $m^3 \cdot s^{-1}$ at WSC Stn 08HB002). This operational benefit and the associated fish habitat improvements in the mainstem are over and above improvements in fish habitat quantity and quality identified in the South Englishman River.

Though 10% MAD is achievable in South Englishman River in normal years with 1.4 m of storage on Shelton Lake, KWL's analysis indicated that closer to 5.0 m of storage would be required to maintain this target flow during a 1:10-year drought. Amounting to four times the lake's natural fluctuation, such flooding would be significantly more than what was conceptualized at the outset, have larger (and unstudied) environmental impacts, be well outside project scope as defined to funders of BCCF's storage feasibility work, and likely involve substantial compensation to landowner TimberWest for the associated loss of working forest land base. Most importantly, the relatively small catchment of Shelton Lake can only guarantee re-filling 2.0 metres of storage annually while maintaining minimum fish flows downstream during storage acquisition.

At the conceptual level, preliminary cost estimates range from $1.3 to $1.7 million for a 2-m dam storing up to 764,000 m^3 of water at Shelton Lake. Given the estimate's 30% contingencies and that design criteria for High consequence dams were used[13], future costings would be reduced once a Low consequence classification is confirmed and design criteria altered accordingly.

Annual operation requirements would be subject to dam classification and level of automation. BC Dam Safety Regulations require site surveillance for dams classified Significant or Low Consequence to occur monthly or quarterly, respectively, during the dam operation period (http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/10_44_2000, accessed May 2, 2012). Given any dam on Shelton Lake would not be operated from late fall through to early spring (i.e., no active storage; inflows=outflows), annual operation would potentially require a two-person crew to commence storage acquisition mid-April, visit the site every two weeks until full storage is achieved (likely mid-June), and then monthly through September. Using dataloggers, hydrometric records would be required to document releases from Shelton Lake. A hydrometric station on lower

[13] Design criteria for HIGH consequence dams include 1) Inflow Design Flood 1:3,000-yr return period event, 2) minimum freeboard such that no overtopping occurs for 95% of waves generated by the 2-yr wind event at the maximum water level during the IDF, and 3) Maximum Design Earthquake is the 1:2,500-yr return period event.

South Englishman River operated spring through fall would enable managers to monitor conditions and maintain flow targets based on available storage and climate conditions.

Hydrological advantages of a low-head structure at Shelton Lake are further discussed in KWL's 2012 memorandum (Appendix B).

From the anadromous fish habitat perspective, surveys documented an aggregate 35,055 m^2 of fish habitat available in the South Englishman River under a base flow condition (0.6%MAD). Flow transect-based modelling showed that an increase in flow from 1.0%MAD (typical base condition) to 5.0%MAD – the minimum discharge maintained with 1.4 m of Shelton Lake storage even in a 1:10-yr return period drought – increased available riffle and glide habitats by 9,590 and 3,460 m^2, respectively. An increase of 1.0 to 10.0%MAD – achievable in normal years – resulted in a gain of more than 18,000 m^2 of high quality riffle and glide habitats. Analysis of depth/velocity conditions relative to HSI curves confirmed that current base flows are highly unsuitable for stream rearing salmonids and generic aquatic insects, and that order-of-magnitude increases in habitat suitability occur with flow augmentation to 10%MAD. Similar habitat benefits from flow augmentation would no doubt be realized by resident trout stocks occupying the South Englishman's 15 km of stream length above the barrier.

In 2001, 2008 and 2009, results of juvenile standing stock density sampling in the South Englishman's anadromous reaches varied but suggested that Coho were close to, or at, habitat capacity. Results were similar for Steelhead fry, despite the fact that brood year peak adult abundances appeared relatively low during provincial/BCCF snorkel surveys. These observations tend to support the conclusion that, in the South Englishman River, the amount of summer rearing habitat is the most significant limiting factor to fish production.

Using the most recent observed densities of Coho and Steelhead fry in the South Englishman (2008, 2009 cohorts), we estimated that additional wetted riffle and glide habitats (Section 3.5.1; Table 6) created through base flow changes from 1.0 to 10.0%MAD would support over 13,000 additional wild fry (10,200 Coho, 2,860 Steelhead) through the summer rearing period. An estimated 1,320 Steelhead parr would also be supported in the additional riffle habitats resulting from the same flow augmentation.

The capacity of existing habitats to support fish rearing under base flow conditions would improve substantially under an augmented flow regime. Better hydraulic characteristics (water depths, velocities) would increase cover, generate greater aquatic invertebrate production and increase dissolved oxygen levels. There are unlikely to be any significant stream temperature benefits from flow augmentation – the mid-summer documented 3-4°C drop in water temperature between Shelton Lake and *South Englishman above Centre Creek* stations was more likely influenced by stream canopy and channel aspect and morphology, and largely unaffected by discharge.

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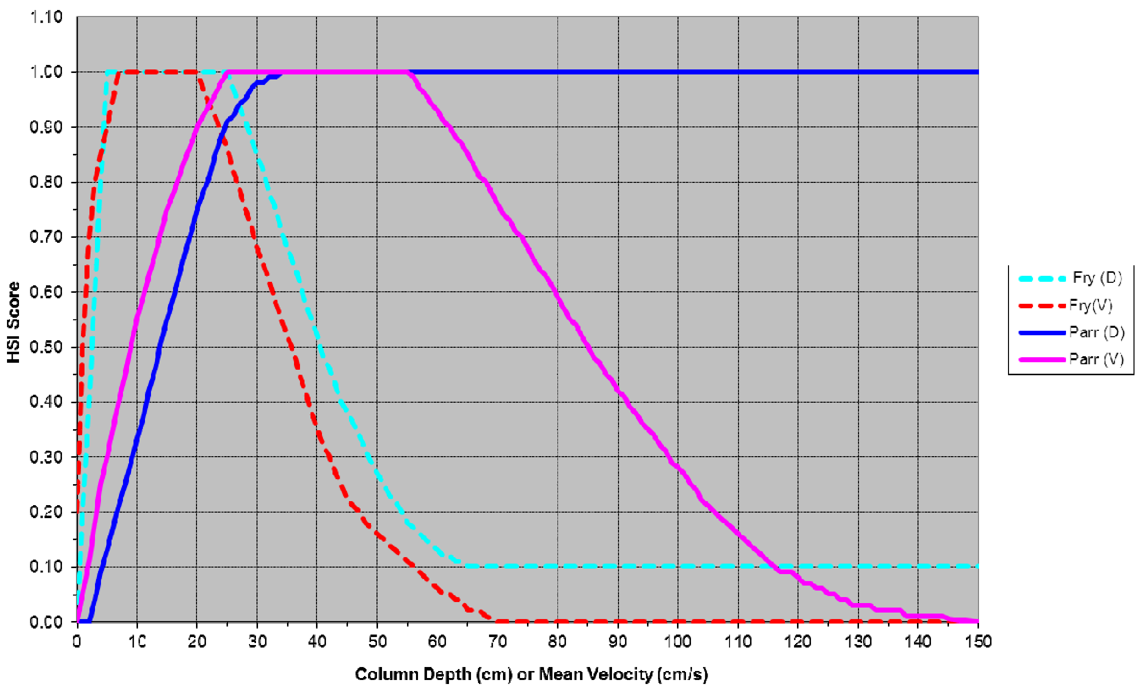
Appendix A – (Under separate cover) Technical Memorandum, July 17, 2008 – Englishman River Water Balance – Preliminary Regional Hydrological Assessment (file 0673.010). Prepared by C. Sutherland, P.Eng., Kerr Wood Leidal Associates, Victoria, BC.

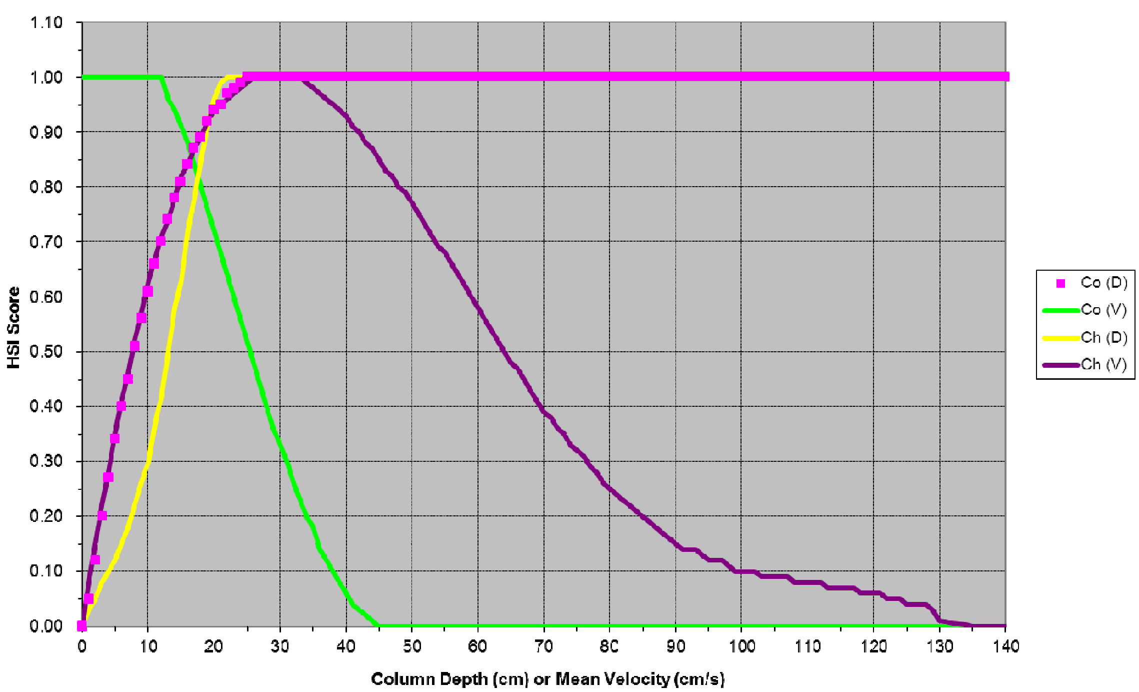
Appendix B – (Under separate cover) Technical Memorandum, May 22, 2012 – South Englishman River Water Balance and Hydrological Assessment, Shelton Lake Storage Feasibility and Rationale (file 0673.010). Prepared by C. Sutherland, P.Eng., Kerr Wood Leidal Associates, Victoria, BC.

Appendix C – Habitat suitability index (HSI) curves for target fish species and age classes.

Univariate HSI Curves for Juvenile Steelhead Rearing. WUP Delphi Derived.



Univariate HSI Curves for Juvenile Salmon Rearing. WUP Delphi Derived.



Appendix D – Project consultation records.

2006	Oct	MoE Fisheries/DFO – supportive of ECVI storage concept
2006	Dec	ERWRP SC – Storage concept introduced (Healy/Shelton)
2007	Mar	TimberWest – introduced ECVI-wide project – support received.
2007	May	ERWRP SC – Project update, plans to start feasibility work
2007	May	Island Timberlands – introduced ECVI-wide project – support received.
2007	Oct	MoE Fisheries – supportive of ECVI storage concepts
2007	Nov	ERWRP SC – update on feasibility
2007	Nov	Nanoose FN – contacted by ERWRP for input (no attendance)
2008	Apr	AWS & ERWRP – update on feasibility (AWS presenting as well)
2008	Apr	MoE Fisheries – written support for S. Eman storage subject to feasibility results
2008	May	ERWRP SC – KWL presentation: "Water Balance"
2008	Jun	Nanoose FN – introduced project – supportive conceptually.
2008	Aug	ERWRP SC – ToR for "non-fish" flora/fauna impact assessments circulated
2008	Sep	DFO - potential ECVI storage site reviews, request for engineering, partnering support
2008	Nov	Nanoose FN – Healy Tour with Nanoose FN Fisheries
2008	Dec	AWS - informal discussions with RDN member regarding storage strategy.
2008	Dec	Nanoose FN – Presentation to Band Administration; supportive conceptually, written support requested
2009	Feb	AWS – project update at Engineers' meeting
2009	Jul	Nanoose FN – field measurements with FN fisheries staff
2009	Aug	Local Community – "Low Flow" articles in PQB News and Arrowsmith Star to get storage concept out
2009	Dec	ERWRP SC – update on storage feasibility
2010	May	ERWRP SC – update on storage feasibility
2010	Sep	DFO – storage update, proponent and funding discussions
2010	Sep	Nanoose FN – Arrange field recon to Shelton Lake.
2010	Nov	ERWRP SC – update on storage feasibility in relation to proposed watershed management planning
2010	Dec	AWS Management Committee - presentation of project results to date
2010	Dec	TimberWest – update on storage feasibility results
2011	Jan	AWS Management Committee - summary of project results to date, with questions
2011	May	DFO - storage as a mitigation option for AWS re-location of domestic intake
2011	May	ERWRP SC – update on storage feasibility and AWS proposal implications
2011	May	MoE Fisheries - storage as a mitigation option for AWS re-location of domestic intake
2011	May	Nanoose FN – Arrangements for CMT survey for Shelton Lake
2011	Jun	Nanoose FN – Arrangements for CMT survey for Shelton Lake.
2011	Nov	ERWRP SC – update on storage feasibility and AWS proposal implications
2012	Feb	Nanoose FN - project update, discuss related fish flow issues, plan CMT survey
2012	Apr	Local Anglers - MI Castaways FF Club
		* ERWRP Steering Committee meetings typically have RDN, ITLP, TW, DFO, & MoE Fisheries representation

Appendix D – Project consultation records.

City of PARKSVILLE   REGIONAL DISTRICT OF NANAIMO   Town of Qualicum Beach

March 18, 2009 File: 5620-01-AWS

James Craig
BC Conservation Foundation
3-1200 Princess Royal Avenue
Nanaimo, BC V9S 3Z7

Dear James:

Re: Englishman River Watershed Water Storage Opportunities

Thanks for meeting with AWS staff representatives on February 13, 2009 and for your presentation on the Englishman River watershed and some of the activities of the BC Conservation Foundation.

We acknowledge BCCF's goal to establish additional (low-level) storage in the watershed to support river flows. As you are aware, AWS has already, through the Arrowsmith Lake Dam and Reservoir, contributed significantly to supplementing flow in the river during low flow periods. The Operation Rule associated with the AWS Conditional Water Licence specifies reservoir release and river flow requirements that exceed what AWS originally proposed the dam and reservoir were capable of maintaining. This has placed expectations on the AWS facility to maintain flow requirements that are sometimes beyond the capacity of the Arrowsmith Lake catchment area, which is less than 5% of the Englishman River watershed.

Nonetheless, over the past several years, AWS has operated the reservoir to meet the requirements of the Operation Rule on as a continuous basis as precipitation and river hydrology will allow. Occasional adjustments to the Operation Rule have been authorized by the Ministry of Environment, in consultation with fisheries agencies, to insure sufficient storage can be maintained in the reservoir to support a level of fall release.

Watershed activities and the unknowns of climate change will continue to put pressure on the river flows. Additional storage in the watershed can provide better management of the river regime and compliment operation of the AWS system. For AWS to participate financially in any BCCF capital initiatives, water service benefits would need to be established to reflect AWS costs. Support from our elected officials and taxpayers would also be required. Considering the status and timing of the AWS capital plan review, it is unlikely that the Joint Venture could support funding for any non-AWS capital works at this time.

Appendix D – Project consultation records.

File: 5620-01-AWS
Date: 18/03/2009
Page: 2

However, to administratively facilitate your program, AWS may be receptive to being a potential water licensee for additional storage and release of water to the river during low flow periods. As noted, a benefit to AWS would need to be established.

We understand that you plan another year of feasibility analysis to confirm the logistics of the initiative and if supported, a project could get underway around 2010 or 2011. We suggest you maintain communications with us and that we meet periodically to keep apprised of your progress. At an appropriate time, it would be beneficial for you to attend an AWS Management Committee meeting to discuss your project with the committee members.

Sincerely, on behalf of the Arrowsmith Water Service,

John O. Finnie, P. Eng
General Manager of Water & Wastewater Services
Regional District of Nanaimo

cc Bob Weir, Town of Qualicum Beach
Mike Squire, City of Parksville
AWS Management Committee

Appendix E – Hydrometric record (mean daily discharge in m^3·s^{-1}) for the *South Englishman River above Centre Creek* station, Jul 2008 to Feb 2012.

2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1								0.051	0.051	0.032	0.481	1.59
2								0.073	0.046	0.030	0.928	1.45
3								0.067	0.042	0.042	2.03	1.34
4								0.052	0.039	0.112	1.41	1.24
5								0.042	0.032	0.254	0.983	1.14
6								0.033	0.027	0.201	1.22	1.06
7								0.027	0.025	0.503	3.37	1.02
8								0.023	0.024	0.756	16.8	0.974
9								0.020	0.023	0.548	10.7	0.949
10								0.022	0.024	0.405	6.17	1.27
11							0.075	0.022	0.022	0.321	5.07	1.31
12							0.059	0.021	0.019	0.255	6.08	1.38
13							0.045	0.020	0.020	0.217	4.86	1.43
14							0.045	0.017	0.019	0.209	3.42	1.28
15							0.034	0.015	0.018	0.190	2.62	1.13
16							0.038	0.013	0.019	0.190	2.07	1.13
17							0.039	0.010	0.020	0.448	1.72	1.09
18							0.038	0.010	0.020	0.973	1.46	1.21
19							0.036	0.013	0.018	0.766	1.30	1.33
20							0.036	0.018	0.018	0.616	1.17	1.63
21							0.033	0.026	0.018	0.564	1.39	2.52
22							0.031	0.041	0.020	0.463	3.87	3.06
23							0.030	0.034	0.022	0.381	3.29	2.51
24							0.031	0.033	0.026	0.326	2.48	1.45
25							0.031	0.049	0.032	0.290	2.03	0.833
26							0.030	0.053	0.042	0.271	1.88	0.754
27							0.030	0.044	0.048	0.248	1.64	0.762
28							0.032	0.055	0.044	0.225	1.50	0.822
29							0.037	0.057	0.041	0.198	1.74	1.18
30							0.037	0.056	0.037	0.195	1.75	1.26
31							0.042	0.053		0.248		1.41
Mean							**0.038**	**0.035**	**0.029**	**0.338**	**3.18**	**1.34**
Max							**0.075**	**0.073**	**0.051**	**0.973**	**16.77**	**3.06**
Min							**0.030**	**0.010**	**0.018**	**0.030**	**0.481**	**0.754**
Total							**0.808**	**1.070**	**0.857**	**10.476**	**95.353**	**41.542**
Total Dam^3							**69.8**	**92.4**	**74.0**	**905**	**8240**	**3590**

E: estimated value derived by reducing the WSC reported mean daily discharge for Englishman River by the ratio of KWL (2010) MAD estimate for "South Englishman River above Centre Creek" to Englishman River MAD.

Appendix E – Hydrometric record (mean daily discharge in $m^3 \cdot s^{-1}$) for the *South Englishman River above Centre Creek* station, Jul 2008 to Feb 2012.

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	1.31	0.629	1.83	0.696					0.015	0.026	3.70	3.43
2	1.15	0.635	7.97	0.665					0.014	0.028	2.19	2.42
3	1.05	0.914	6.84	0.640					0.014	0.028	1.52	1.85
4	0.999	0.934	3.86	0.542					0.013	0.027	1.15	1.52
5	1.05	0.938	2.57	0.390					0.015	0.026	2.53	1.26
6	1.13	0.967	2.05	0.373					0.019	0.024	12.0	1.07
7	4.88	1.10	1.55	0.610				0.014	0.021	0.024	11.1	0.939
8	9.21	1.01	1.28	0.860				0.013	0.025	0.024	6.81	0.899
9	7.41	0.931	1.07	0.917				0.013	0.046	0.024	14.7	1.02
10	6.02	0.903	0.948	0.934				0.014	0.064	0.023	10.7	0.851
11	6.20	0.800	0.834	0.757				0.014	0.050	0.022	6.10	0.685
12	5.06	0.712	0.709	1.37				0.014	0.036	0.021	4.01	0.620
13	4.48	0.659	0.578	2.23				0.016	0.031	0.022	3.62	0.585
14	3.96	0.627	0.508	1.38				0.026	0.030	0.032	3.11	0.537
15	3.40	0.579	0.591	0.826				0.021	0.025	0.036	8.80	0.621
16	2.91	0.577	0.792	0.590				0.019	0.026	0.148	61.7 E	3.10
17	2.56	0.532	0.849	0.592				0.018	0.025	0.510	27.5	10.5
18	2.43	0.497	0.742	0.863				0.017	0.024	1.29	10.4	7.61
19	2.72	0.441	1.57	0.560				0.016	0.027	0.821	23.0	5.40
20	3.04	0.420	3.83	0.426				0.016	0.025	0.511	36.5 E	6.06
21		0.402	4.95	0.560				0.015	0.023	0.374	10.8	9.27
22		0.369	2.53	0.564				0.014	0.024	0.359	9.24	5.99
23		0.800	1.62	0.375				0.014	0.024	0.413	6.39	3.57
24		1.74	1.17					0.013	0.023	0.632	6.36	2.54
25		2.86	0.975					0.015	0.022	0.516	18.5	1.96
26	0.782	2.43	0.851					0.015	0.022	0.998	17.7	1.60
27	0.752	1.63	0.671					0.016	0.019	1.22	6.61	1.37
28	0.691	1.22	0.694					0.019	0.021	0.838	3.81	1.16
29	0.609		0.636					0.017	0.028	0.851	2.91	1.04
30	0.584		0.515					0.015	0.028	1.29	3.73	0.995
31	0.657		0.468					0.015		6.62		0.961
Mean	**2.89**	**0.938**	**1.81**	**0.771**				**0.016**	**0.026**	**0.574**	**11.2**	**2.63**
Max	**9.21**	**2.86**	**7.97**	**2.23**				**0.026**	**0.064**	**6.62**	**61.7**	**10.52**
Min	**0.584**	**0.369**	**0.468**	**0.373**				**0.013**	**0.013**	**0.021**	**1.15**	**0.537**
Total	**75.059**	**26.258**	**56.041**	**17.729**				**0.399**	**0.779**	**17.781**	**337.249**	**81.484**
Total Dam^3	**6490**	**2270**	**4840**	**1530**				**34.5**	**67.3**	**1540**	**29100**	**7040**

E: estimated value derived by reducing the WSC reported mean daily discharge for Englishman River by the ratio of KWL (2010) MAD estimate for "South Englishman River above Centre Creek" to Englishman River MAD.

Appendix E – Hydrometric record (mean daily discharge in $m^3 \cdot s^{-1}$) for the *South Englishman River above Centre Creek* station, Jul 2008 to Feb 2012.

2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.54	1.83	3.98	3.98	1.71	2.39	0.174	0.034	0.036	0.463	9.76	6.71
2	7.16	1.76	3.15	5.47	1.49	2.65	0.171	0.033	0.031	0.335	10.2	4.11
3	4.22	1.65	2.71	9.39	2.74	2.69	0.147	0.033	0.031	0.286	4.96	3.06
4	3.72	1.52	2.26	5.15	2.53	2.26	0.134	0.030	0.032	0.260	3.16	2.44
5	4.06	1.77	1.93	3.99	2.13	1.81	0.127	0.030	0.030	0.225	2.42	2.03
6	3.24	1.99	1.57	3.46	1.77	1.47	0.113	0.031	0.031	0.188	2.05	1.74
7	2.48	1.89	1.44	3.64	1.50	1.27	0.099	0.044	0.034	0.179	3.58	4.78
8	2.38	1.67	1.33	9.54	1.36	1.04	0.092	0.057	0.036	0.159	3.21	30.3
9	7.88	1.46	1.12	6.05	1.25	1.03	0.084	0.062	0.037	0.314	2.66	26.5
10	10.1	1.33	1.05	4.01	1.19	0.967	0.078	0.053	0.037	2.62	2.88	10.8
11	35.0	1.47	1.26	2.99	1.13	0.952	0.072	0.048	0.035	2.04	2.68	5.74
12	25.6	4.36	1.50	2.43	1.15	0.833	0.073	0.037	0.038	1.64	2.82	13.8
13	8.87	7.66	1.83	2.14	1.06	0.760	0.068	0.041	0.045	1.23	2.42	11.2
14	8.14	14.4	2.00	1.97	1.04	0.666	0.063	0.037	0.052	0.952	2.32	10.4
15	40.9 E	7.54	2.78	1.97	1.04	0.604	0.062	0.034	0.051	0.741	2.09	7.11
16	13.6	6.01	4.17	2.04	1.02	0.552	0.063	0.032	0.046	0.596	2.02	4.63
17	7.16	4.79	7.04	2.30	0.964	0.500	0.058	0.030	0.042	0.508	2.40	3.36
18	10.2	3.56	4.63	3.03	1.14	0.454	0.056	0.030	0.047	0.450	3.02	2.72
19	9.33	2.78	3.28	2.89	1.15	0.426	0.053	0.029	0.079	0.410	2.48	2.35
20	5.65	2.30	2.52	3.92	2.18	0.380	0.050	0.027	0.098	0.371	2.23	2.10
21	4.03	1.95	2.38	3.53	2.50	0.356	0.048	0.028	0.079	0.343	1.82	2.33
22	3.17	1.61	2.59	2.78	2.13	0.335	0.049	0.029	0.066	0.338	1.56	4.08
23	2.62	1.38	2.25	2.31	1.70	0.305	0.045	0.027	0.063	0.358	1.38	8.17
24	2.14	1.47	1.93	2.11	1.42	0.280	0.043	0.025	0.085	2.19	1.25	39.5 E
25	3.56	3.02	1.86	1.92	1.48	0.259	0.040	0.026	0.523	5.56	0.970	28.9
26	7.15	4.03	1.88	1.64	1.94	0.236	0.039	0.028	2.45	6.46	1.71	14.1
27	4.61	6.21	1.53	2.80	2.66	0.220	0.039	0.027	1.54	3.72	2.74	8.57
28	3.32	5.63	1.94	2.82	3.00	0.203	0.038	0.027	1.22	2.67	2.50	5.67
29	2.65		9.51	2.37	3.66	0.189	0.037	0.027	0.868	2.22	2.16	4.09
30	2.34		10.5	1.98	3.03	0.174	0.035	0.027	0.609	1.83	9.14	3.08
31	2.09		5.98		2.74		0.035	0.030		2.47		2.40
Mean	**8.06**	**3.47**	**3.03**	**3.49**	**1.80**	**0.88**	**0.074**	**0.034**	**0.279**	**1.36**	**3.15**	**8.93**
Max	**40.9**	**14.4**	**10.5**	**9.54**	**3.66**	**2.69**	**0.174**	**0.062**	**2.45**	**6.46**	**10.2**	**39.5**
Min	**2.09**	**1.33**	**1.05**	**1.64**	**0.964**	**0.174**	**0.035**	**0.025**	**0.030**	**0.159**	**0.970**	**1.74**
Total	**249.950**	**97.089**	**93.905**	**104.614**	**55.774**	**26.271**	**2.286**	**1.054**	**8.365**	**42.143**	**94.587**	**276.860**
Total Dam^3	**21600**	**8390**	**8110**	**9040**	**4820**	**2270**	**198**	**91.0**	**723**	**3640**	**8170**	**23900**

E: estimated value derived by reducing the WSC reported mean daily discharge for Englishman River by the ratio of KWL (2010) MAD estimate for "South Englishman River above Centre Creek" to Englishman River MAD.

Appendix E – Hydrometric record (mean daily discharge in $m^3 \cdot s^{-1}$) for the *South Englishman River above Centre Creek* station, Jul 2008 to Feb 2012.

2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	2.01	2.06	0.981	4.50	2.12	2.17	0.528	0.136	0.046	0.832	1.24	2.90
2	1.66	1.77	1.84	3.73	2.02	2.22	0.472	0.129	0.045	0.643	1.08	2.36
3	1.43	1.63	2.90	2.93	2.16	2.10	0.451	0.124	0.041	0.670	1.30	2.17
4	1.27	2.82	2.40	2.55	2.21	2.14	0.406	0.117	0.041	0.744	1.15	1.81
5	1.23	3.61	2.19	2.68	2.22	2.13	0.365	0.113	0.041	0.837	1.03	1.53
6	2.08	2.90	1.98	2.66	2.04	2.29	0.304	0.107	0.040	0.927	0.923	1.36
7	10.6	2.88	1.79	2.32	2.12	2.26	0.289	0.102	0.037	0.831	0.811	1.23
8	9.07	2.57	1.73	2.23	2.05	2.20	0.281	0.096	0.036	0.723	0.767	1.12
9	5.02	2.16	3.71	2.02	2.14	2.21	0.251	0.092	0.034	0.892	0.762	1.00
10	3.38	1.81	13.1	2.11	2.20	1.84	0.234	0.089	0.033	0.921	1.19	0.942
11	2.58	1.56	10.4	4.66	2.16	1.73	0.230	0.090	0.033	3.81	1.74	0.900
12	2.57	5.01	10.3	3.59	2.25	1.68	0.287	0.074	0.034	4.52	2.08	0.822
13	3.73	12.6	14.6	2.81	2.20	1.63	0.505	0.072	0.033	2.97	2.04	0.775
14	9.90	10.8	35.2	2.55	2.07	1.56	0.485	0.068	0.033	2.09	1.73	0.740
15	18.9	14.0	27.1	2.28	5.26	1.38	0.383	0.068	0.035	1.73	1.44	0.746
16	16.0	7.84	18.1	2.07	6.38	1.29	0.389	0.062	0.036	1.34	1.19	0.697
17	13.5	5.06	8.03	2.09	4.25	1.21	0.550	0.060	0.041	1.06	2.11	0.702
18	7.42	3.68	4.89	1.90	3.16	1.17	0.482	0.056	0.044	0.865	2.04	0.897
19	4.78	2.77	4.02	1.74	2.57	1.14	0.405	0.053	0.049	0.769	1.82	0.937
20	3.46	2.29	3.45	1.65	2.42	1.07	0.330	0.049	0.043	0.716	1.43	0.924
21	2.95	1.95	3.09	1.67	2.44	1.00	0.294	0.049	0.044	0.693	1.35	0.918
22	2.66	1.71	2.88	1.52	2.27	1.01	0.280	0.052	0.095	0.971	15.0	0.830
23	2.44	1.47	2.55	1.45	2.09	0.978	0.263	0.069	0.308	1.12	9.50	0.816
24	2.42	1.38	2.37	1.52	2.01	0.860	0.230	0.076	0.526	0.987	5.90	1.13
25	2.79	1.23	2.29	1.72	2.16	0.826	0.216	0.064	0.714	0.843	6.04	2.03
26	2.71	1.10	2.30	1.96	2.15	0.741	0.198	0.060	1.98	0.760	4.43	2.08
27	2.55	1.03	2.33	2.23	2.04	0.614	0.191	0.056	4.59	0.736	30.0	2.53
28	2.45	1.12	2.25	2.47	2.15	0.619	0.175	0.051	2.66	0.988	13.9	14.6
29	2.59		2.63	2.30	2.03	0.629	0.163	0.051	1.72	1.99	6.08	15.2
30	2.69		3.05	2.08	2.25	0.606	0.154	0.048	1.13	1.67	4.05	7.96
31	2.40		4.10		1.99		0.149	0.047		1.53		4.92
Mean	**4.81**	**3.60**	**6.41**	**2.40**	**2.50**	**1.44**	**0.321**	**0.077**	**0.485**	**1.30**	**4.14**	**2.50**
Max	**18.9**	**14.0**	**35.2**	**4.66**	**6.38**	**2.29**	**0.550**	**0.136**	**4.59**	**4.52**	**30.0**	**15.2**
Min	**1.23**	**1.03**	**0.981**	**1.45**	**1.99**	**0.606**	**0.149**	**0.047**	**0.033**	**0.643**	**0.762**	**0.697**
Total	**149.137**	**100.776**	**198.575**	**71.992**	**77.588**	**43.310**	**9.942**	**2.380**	**14.540**	**40.199**	**124.079**	**77.575**
Total Dam^3	**12900**	**8710**	**17200**	**6220**	**6700**	**3740**	**859**	**206**	**1260**	**3470**	**10700**	**6700**

E: estimated value derived by reducing the WSC reported mean daily discharge for Englishman River by the ratio of KWL (2010) MAD estimate for "South Englishman River above Centre Creek" to Englishman River MAD.

Appendix E – Hydrometric record (mean daily discharge in $m^3 \cdot s^{-1}$) for the *South Englishman River above Centre Creek* station, Jul 2008 to Feb 2012.

2012	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.28	4.96										
2	2.46	3.67										
3	3.57	2.80										
4	46.2 E	2.30										
5	26.0	2.22										
6	9.08	1.91										
7	4.79											
8	3.37											
9	3.55											
10	3.08											
11	2.37											
12	2.18											
13	1.82											
14	1.63											
15	1.41											
16	1.19											
17	1.11											
18	1.04											
19	1.09											
20	0.967											
21	2.58											
22	2.84											
23	3.86											
24	4.75											
25	10.9											
26	5.99											
27	3.62											
28	2.56											
29	7.62											
30	7.83											
31	5.18											
Mean	**5.74**	**2.98**										
Max	**46.2**	**4.96**										
Min	**0.967**	**1.91**										
Total	**177.877**	**17.860**										
Total Dam^3	**15400**	**1540**										

E: estimated value derived by reducing the WSC reported (prelim) mean daily discharge for Englishman River by the ratio of KWL (2010) MAD estimate for "South Englishman River above Centre Creek" to Englishman River MAD.

Appendix F – Temperature record for *South Englishman River above Centre Creek* station, Jul 2008 to Dec 2011.

	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
DATE	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Jan							0.4	0.6	0.1	-0.1	0.9	-1.3	2.9	3.3	2.5	5.0	6.7	3.5	0.1	0.4	-0.2	-3.0	-0.4	-4.9
2-Jan							0.3	0.5	-0.1	-2.5	-0.7	-4.8	3.4	3.8	3.1	4.0	6.6	1.8	0.1	0.3	-0.1	-2.7	-0.5	-4.3
3-Jan							0.1	0.5	-0.2	-2.2	0.6	-5.4	3.3	3.6	3.0	2.2	4.4	0.3	0.0	0.3	-0.2	-3.0	-0.7	-4.9
4-Jan							0.5	0.9	-0.2	0.1	1.3	-0.8	3.7	3.9	3.6	4.2	4.9	3.6	0.5	1.0	0.2	-0.9	-0.1	-1.9
5-Jan							0.5	0.8	-0.1	0.3	1.3	-0.1	4.0	4.2	3.9	4.8	5.4	4.3	1.6	2.0	1.1	1.3	2.8	-0.1
6-Jan							0.9	1.2	0.6	0.8	2.6	-0.1	3.7	4.2	3.4	2.5	4.4	0.4	2.0	2.2	1.9	1.7	2.7	0.9
7-Jan							0.1	0.7	-0.1	0.9	2.2	0.5	3.1	3.4	2.8	0.6	2.8	-0.9	2.4	2.6	2.1	3.0	4.8	-0.3
8-Jan							1.6	2.0	0.9	0.7	1.9	-0.5	3.8	4.3	3.4	4.6	6.3	3.0	1.8	2.0	1.6	-0.8	0.1	-1.9
9-Jan							1.9	2.1	1.7	0.2	1.8	-0.8	4.5	4.7	4.3	6.9	8.4	5.7	1.2	1.9	0.8	-0.6	0.0	-2.4
10-Jan							2.3	2.5	2.1	1.7	2.7	0.4	4.8	5.1	4.6	6.2	7.4	5.0	0.7	1.1	0.3	-2.7	-0.8	-4.9
11-Jan							2.5	2.7	2.4	1.2	2.2	0.5	5.4	5.7	5.1	8.2	8.7	7.3	1.0	1.3	0.5	-1.0	-0.1	-1.8
12-Jan							2.7	2.9	2.6	1.6	2.9	1.0	5.6	5.9	5.4	7.8	8.9	6.2	0.1	0.7	-0.1	0.1	1.2	-0.4
13-Jan							2.6	2.7	2.4	1.2	2.7	0.2	5.7	5.9	5.5	6.2	8.4	4.6	1.5	1.9	0.7	0.5	1.8	-0.1
14-Jan							2.7	2.8	2.6	1.4	2.3	1.1	5.6	5.8	5.5	6.1	6.8	5.2	2.2	2.6	1.8	1.7	3.5	0.3
15-Jan							2.3	2.6	2.1	1.2	2.1	0.0	5.6	5.7	5.1	6.1	7.6	2.7	2.8	3.0	2.6	1.9	3.2	0.9
16-Jan							1.6	2.0	1.3	-0.5	1.0	-1.8	4.6	4.9	4.3	2.1	4.8	0.4	3.4	3.7	3.0	3.7	6.0	2.1
17-Jan							1.2	1.4	1.0	-1.4	0.6	-3.2	4.8	5.2	4.5	5.4	7.5	3.2	3.6	3.8	3.4	4.0	5.2	3.0
18-Jan							1.0	1.1	0.8	-1.7	0.6	-3.4	5.3	5.4	5.0	6.2	7.7	2.8	3.1	3.6	2.7	1.5	3.2	-0.5
19-Jan							1.0	1.1	0.8	-1.9	0.6	-3.8	5.0	5.3	4.8	4.6	7.3	2.5	2.2	2.6	1.9	-0.6	0.4	-1.8
20-Jan							0.9	1.1	0.7	-3.0	-1.1	-4.0	5.2	5.3	5.0	5.4	7.8	4.1	2.7	2.9	2.4	1.6	2.9	-0.1
21-Jan													5.1	5.3	4.9	5.1	7.3	3.8	3.2	3.4	2.9	3.7	5.1	2.9
22-Jan													4.5	5.1	4.1	2.6	5.8	0.8	3.0	3.3	2.7	2.4	5.3	0.2
23-Jan													3.9	4.3	3.6	1.9	5.4	-0.3	3.4	3.8	3.1	3.7	5.9	1.4
24-Jan													4.4	4.6	4.1	4.1	5.8	2.4	4.0	4.4	3.8	5.7	7.2	4.8
25-Jan													4.7	5.0	4.4	5.6	7.4	3.5	4.0	4.3	3.9	5.8	7.2	4.7
26-Jan							-0.2	-0.2	-0.3	-0.2	0.5	-0.7	4.5	4.8	4.1	3.6	6.3	0.6	4.3	4.5	4.1	6.0	8.4	3.7
27-Jan							0.1	0.5	-0.2	0.3	1.8	-0.4	4.5	4.7	4.2	4.2	6.3	2.7	4.0	4.2	3.7	3.7	6.1	1.5
28-Jan							0.3	0.7	0.0	-0.3	2.1	-2.0	4.8	4.9	4.6	4.8	6.2	4.0	4.1	4.3	3.7	4.8	6.6	2.7
29-Jan							1.1	1.8	0.6	1.3	4.7	-0.4	5.0	5.3	4.8	5.8	7.3	4.6	4.2	4.3	4.2	5.3	5.7	4.5
30-Jan							1.5	2.1	1.2	1.3	4.7	-0.6	5.4	5.6	5.3	6.4	7.5	5.6	3.7	4.1	3.0	2.8	4.2	-0.1
31-Jan							1.0	1.3	0.7	-0.2	3.1	-1.8	5.6	5.7	5.4	6.3	7.8	4.9	2.6	2.9	2.4	-0.1	1.6	-0.9
1-Feb							1.2	1.5	0.9	0.6	2.0	-0.8	5.2	5.4	4.9	4.7	6.6	3.2	2.1	2.4	2.0	-0.3	1.4	-1.2
2-Feb							1.9	2.4	1.5	2.4	4.6	0.9	5.5	5.8	5.3	5.9	7.4	4.9	2.1	2.6	1.7	0.2	2.3	-1.5
3-Feb							1.7	2.0	1.3	0.7	4.5	-1.2	5.5	5.7	5.3	5.6	6.8	4.6	2.9	3.3	2.6	2.7	4.6	1.3
4-Feb							1.6	2.0	1.3	0.6	4.2	-1.0	5.7	6.0	5.4	6.2	8.5	4.6	3.9	4.5	3.4	5.4	8.6	3.0
5-Feb							1.7	2.2	1.4	0.7	3.0	-0.8	5.9	6.3	5.7	7.0	9.1	5.3	4.1	4.3	3.9	4.9	6.1	3.8
6-Feb							2.3	2.8	2.0	2.1	5.0	-0.8	5.9	6.1	5.7	6.1	8.4	4.4	4.3	4.6	4.1	4.8	6.0	3.7
7-Feb							1.6	1.9	1.1	0.3	3.6	-1.9	5.7	6.1	5.4	5.5	7.5	3.7	4.0	4.4	3.7	3.6	6.0	2.3
8-Feb							2.1	2.4	1.8	1.6	4.0	0.3	5.0	5.4	4.7	3.7	7.3	0.8	3.3	3.6	2.8	2.2	4.7	-0.4
9-Feb							1.8	2.3	1.3	0.4	2.8	-1.5	4.4	4.7	4.1	3.5	6.4	0.8	2.1	2.7	1.8	-0.4	2.2	-2.2
10-Feb							1.0	1.2	0.8	-0.4	0.6	-2.2	4.3	4.7	3.9	3.6	6.2	1.1	1.9	2.1	1.5	-0.1	2.4	-1.8
11-Feb							1.3	1.8	0.9	0.8	3.3	-0.2	5.2	5.8	4.7	6.4	8.0	5.0	2.5	3.2	2.0	1.9	5.0	-0.4
12-Feb							1.6	2.3	1.3	1.0	4.1	-0.6	5.5	5.8	5.2	6.1	7.4	4.5	3.5	3.8	3.2	5.2	6.2	3.4
13-Feb							1.7	2.2	1.3	1.0	4.1	-1.1	5.5	5.7	5.3	6.4	7.4	5.4	3.7	4.1	3.4	4.5	7.4	2.6
14-Feb							1.4	1.8	1.0	0.2	3.9	-1.7	5.6	5.9	5.4	6.0	8.0	2.7	4.0	4.2	3.9	5.2	6.5	4.0
15-Feb							1.4	2.0	0.9	0.8	4.6	-1.4	5.0	5.4	4.5	3.7	6.4	0.6	3.7	3.9	3.4	3.0	4.6	1.1
16-Feb							0.6	1.0	0.1	-0.6	3.4	-3.5	5.5	5.6	5.2	5.9	7.8	2.3	3.2	3.4	2.9	2.4	6.0	0.6
17-Feb							0.7	1.6	0.2	0.7	5.5	-1.8	4.3	5.0	3.9	2.0	6.3	-0.4	2.6	3.0	2.2	0.5	2.6	-1.3
18-Feb							0.7	1.6	0.1	0.5	5.7	-2.6	3.8	4.1	3.4	1.3	6.4	-1.3	2.4	2.7	2.2	0.6	4.0	-1.0
19-Feb							0.7	1.7	0.2	0.9	6.0	-1.9	3.5	3.8	3.1	1.5	7.1	-1.3	1.5	2.1	1.2	-0.8	2.0	-2.6
20-Feb							0.7	1.6	0.2	0.6	5.9	-2.4	3.5	3.9	3.0	1.9	7.5	-1.2	1.1	1.7	0.6	-0.8	2.8	-3.7
21-Feb							0.7	1.7	0.1	0.7	5.8	-2.5	3.4	3.9	2.9	1.6	6.4	-1.2	2.0	2.5	1.7	0.6	3.5	-0.4
22-Feb							1.7	2.7	1.0	3.6	7.6	0.9	3.3	3.8	2.7	1.4	6.0	-1.5	1.8	2.3	1.5	-0.3	1.1	-1.3
23-Feb							2.4	2.5	2.3	4.5	5.8	3.6	4.0	4.4	3.5	3.3	5.2	0.8	0.4	1.4	-0.2	-2.0	-1.1	-3.0
24-Feb							2.6	3.0	2.2	4.6	7.2	2.6	4.8	5.5	4.4	6.0	8.4	4.6	0.0	0.5	-0.2	-3.0	-1.3	-5.0
25-Feb							2.4	2.9	1.7	1.9	3.8	-0.5	4.8	5.1	4.3	6.1	10.8	2.1	-0.1	0.4	-0.2	-4.0	-1.2	-6.5
26-Feb							1.5	1.7	1.2	-0.2	1.2	-1.3	5.3	5.6	5.1	7.1	8.0	6.2	0.1	0.7	-0.2	-2.5	0.7	-6.3
27-Feb							1.9	2.4	1.6	1.3	4.7	-0.1	5.6	5.9	5.5	7.0	8.1	6.1	0.4	0.9	0.2	0.1	1.7	-1.3
28-Feb							2.1	2.5	1.6	2.1	5.0	-0.3	5.9	6.2	5.5	7.1	9.0	5.0	0.7	1.4	0.3	0.3	3.0	-1.0
1-Mar							2.9	3.5	2.4	5.6	8.5	2.7	6.1	6.3	5.8	7.1	9.5	5.5	1.0	1.5	0.5	0.3	2.3	-1.4
2-Mar							3.2	3.5	3.0	6.9	9.1	4.4	6.5	6.9	6.2	8.4	11.1	5.9	1.3	1.6	1.0	1.6	3.5	0.2
3-Mar							2.8	3.1	2.4	2.9	6.1	0.5	5.8	6.3	5.4	5.8	9.8	3.0	1.3	1.7	1.0	1.0	4.1	-0.2
4-Mar							2.9	3.4	2.4	4.4	8.0	1.3	5.2	5.6	4.8	5.0	8.7	1.6	1.5	1.8	1.3	0.6	2.3	-0.6
5-Mar							3.0	3.4	2.6	3.3	6.8	-0.4	5.6	6.1	5.2	5.7	10.0	2.8	1.6	2.1	1.1	1.0	4.3	-1.0
6-Mar							2.0	2.4	1.4	1.0	5.4	-2.5	4.9	5.4	4.3	3.9	9.4	0.0	2.3	2.9	1.7	1.2	4.2	-0.5
7-Mar							2.2	2.5	1.7	1.2	4.0	-0.8	4.8	5.2	4.5	2.9	7.7	1.0	2.1	2.4	1.8	1.2	4.0	-1.1
8-Mar							1.5	1.9	1.1	0.1	3.3	-1.7	3.8	4.4	3.2	1.4	5.8	-1.1	2.7	3.4	2.3	3.3	6.4	1.7
9-Mar							1.3	1.7	0.8	-0.4	1.8	-2.4	3.2	3.6	2.7	1.5	4.9	-1.9	2.9	3.3	2.5	4.6	7.3	2.1
10-Mar							0.3	0.9	-0.2	-1.3	1.8	-3.2	4.0	4.6	3.6	4.3	7.8	2.1	2.8	3.2	2.4	4.9	7.5	2.7
11-Mar							0.0	0.9	-0.4	-1.2	3.3	-4.7	4.2	4.9	3.7	4.5	8.5	2.6	2.8	3.4	2.4	3.7	6.9	1.3
12-Mar							0.3	1.5	-0.4	0.0	5.9	-4.0	3.4	4.0	3.0	2.3	4.9	1.1	3.1	3.4	2.8	5.5	8.2	3.8
13-Mar							1.4	2.6	0.5	2.9	8.2	-1.4	3.6	4.3	2.9	4.2	8.0	0.8	3.1	3.6	2.8	5.3	7.7	3.3
14-Mar							2.5	3.3	2.0	3.5	7.7	1.0	4.2	4.4	4.0	4.8	6.0	3.9	3.1	3.3	2.9	5.5	7.4	4.5
15-Mar							1.9	2.4	1.4	1.1	3.5	-0.3	4.6	5.0	4.2	6.3	8.9	4.5	3.4	3.7	3.1	6.1	7.9	4.6
16-Mar							1.4	2.2	0.9	2.1	5.9	0.2	5.2	5.7	4.9	7.4	10.6	5.9	3.3	3.8	2.9	4.9	7.5	2.9
17-Mar							1.5	2.3	0.8	2.2	6.2	-0.3	4.7	5.2	4.1	5.2	9.4	2.0	3.2	3.9	2.6	3.8	7.2	0.1
18-Mar							2.7	3.9	1.8	5.2	10.4	1.5	4.2	4.6	3.5	3.0	8.2	-0.6	3.4	3.6	3.0	4.5	6.8	1.8
19-Mar							3.2	3.8	2.6	6.8	10.1	4.2	4.4	4.9	3.7	4.1	9.9	-0.3	3.7	4.1	3.3	5.0	7.4	1.9
20-Mar							2.9	3.2	2.4	4.6	7.1	0.5	4.6	5.5	3.7	5.2	12.2	-0.8	3.7	4.2	3.3	4.3	8.0	0.7
21-Mar							2.4	3.2	1.7	2.6	7.7	-1.5	6.0	6.7	5.5	8.9	11.8	5.9	4.1	4.5	3.7	5.3	7.5	3.6
22-Mar							2.8	3.5	2.1	3.4	7.7	-0.1	5.5	6.0	4.9	6.1	10.5	1.4	3.7	4.2	3.2	3.8	7.3	0.7
23-Mar							2.9	3.2	2.5	3.3	5.2	1.4	5.6	6.1	5.0	5.8	9.9	1.5	4.1	4.7	3.5	4.3	8.8	1.2
24-Mar							3.3	3.9	2.8	5.5	9.1	3.2	5.7	6.3	4.9	6.0	10.6	1.4	4.1	4.6	3.4	4.7	9.7	0.9
25-Mar							3.4	4.0	2.9	4.1	7.4	0.6	6.5	7.0	6.0	6.7	9.3	4.3	4.6	5.0	4.3	5.8	7.8	3.7
26-Mar							3.1	3.7	2.4	3.7	8.3	-0.6	6.3	6.8	5.6	6.6	11.0	1.6	4.4	4.9	3.9	5.7	8.7	3.0
27-Mar							3.6	4.0	3.3	5.5	7.4	2.7	6.8	7.5	6.2	8.1	11.8	5.4	4.4	4.8	3.8	5.3	8.7	1.3
28-Mar							3.3	3.6	2.8	3.7	6.7	1.3	6.8	7.2	6.3	7.3	11.2	4.1	4.5	4.9	3.8	5.6	9.3	0.9
29-Mar							3.1	3.9	2.3	5.3	9.3	2.1	5.6	6.5	4.9	5.4	6.6	3.5	4.8	5.1	4.4	6.5	8.4	4.8
30-Mar							3.6	4.3	2.9	5.0	8.6	2.3	5.0	5.5	4.5	4.2	7.9	0.9	5.0	5.5	4.6	8.0	10.7	5.9
31-Mar							4.0	4.5	3.4	5.0	7.6	1.1	4.7	5.2	4.0	3.6	7.8	-0.2	5.4	5.9	4.9	8.8	12.3	6.5

Appendix F – Temperature record for *South Englishman River above Centre Creek* station, Jul 2008 to Dec 2011.

	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
DATE	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Apr							2.8	3.2	2.2	2.0	4.3	-0.2	4.9	5.4	4.3	3.9	7.2	0.4	5.3	5.7	5.0	6.1	7.6	4.1
2-Apr							3.2	4.1	2.5	3.9	8.2	0.8	4.8	5.1	4.5	4.8	5.7	3.6	4.8	5.4	4.2	5.7	9.8	2.0
3-Apr							3.2	4.1	2.6	4.1	8.7	1.0	4.7	5.1	4.2	5.6	7.8	3.1	4.4	4.8	3.9	4.1	8.1	0.1
4-Apr							3.2	4.2	2.1	4.2	11.0	-1.5	5.0	5.6	4.4	6.3	11.0	2.3	4.6	5.1	4.3	5.3	7.4	3.8
5-Apr							4.0	4.9	3.0	5.6	11.6	-0.1	5.4	5.8	5.0	6.1	8.1	4.4	4.4	5.0	3.8	5.5	9.2	2.7
6-Apr							4.6	5.6	3.6	7.0	14.4	0.6	5.5	6.0	4.7	5.5	8.5	1.1	3.8	4.3	3.3	4.2	7.0	0.5
7-Apr							4.6	5.3	3.4	7.5	15.8	0.9	5.9	6.4	5.5	7.1	9.2	5.3	4.2	5.3	3.3	4.3	9.7	0.0
8-Apr							4.7	5.5	3.8	7.1	11.7	2.3	4.9	5.7	4.2	4.3	8.5	0.8	4.4	5.3	3.2	5.1	10.4	-0.5
9-Apr							4.9	5.2	4.4	7.3	10.4	4.3	4.4	5.0	3.7	3.1	7.4	-0.8	5.6	6.0	5.0	7.3	10.0	4.6
10-Apr							4.6	5.4	3.8	7.4	11.7	2.7	4.5	5.2	3.6	3.3	9.0	-1.3	6.1	6.6	5.6	7.7	9.6	6.2
11-Apr							5.4	6.2	4.7	9.3	13.5	5.9	5.0	5.8	4.0	5.0	11.2	-0.3	4.9	5.7	4.1	5.7	9.6	2.0
12-Apr							5.2	5.8	4.6	8.2	11.9	6.2	5.8	6.7	4.8	7.7	14.3	1.1	5.0	5.4	4.5	5.7	8.7	3.1
13-Apr							3.9	4.4	3.4	5.5	9.1	2.0	7.0	7.9	6.2	9.0	13.5	5.1	5.4	5.9	4.9	6.4	9.7	3.8
14-Apr							3.8	4.8	2.6	4.7	11.3	-0.8	7.5	8.4	6.7	9.3	13.9	6.3	4.4	5.3	3.9	3.2	5.5	0.9
15-Apr							4.4	5.4	3.3	5.6	12.0	-0.5	7.4	8.0	6.6	9.1	13.9	4.3	3.6	4.1	2.9	2.7	6.6	-1.1
16-Apr							5.0	5.7	4.2	6.7	10.7	2.0	7.7	8.4	6.8	9.7	15.6	4.8	3.8	4.5	3.1	3.3	7.8	-0.3
17-Apr							5.8	6.7	5.2	8.7	13.3	5.4	8.2	8.7	7.6	9.3	12.8	5.7	4.2	5.5	3.0	4.2	9.2	-0.6
18-Apr							5.4	6.3	4.4	7.6	12.5	2.5	8.3	9.2	7.3	11.0	16.0	6.9	4.9	6.3	3.8	5.2	10.5	0.0
19-Apr							6.0	6.3	5.7	9.3	12.6	6.5	9.3	10.1	8.4	12.2	16.1	8.4	5.0	6.0	4.0	5.1	9.8	0.7
20-Apr							6.7	7.5	6.0	11.3	16.5	7.5	8.7	9.8	8.2	10.1	11.7	8.7	4.6	5.0	4.1	3.1	6.1	0.2
21-Apr							6.8	8.0	5.5	10.7	17.4	3.9	7.8	8.3	6.9	8.8	12.9	5.3	4.9	6.4	3.8	5.2	9.8	1.2
22-Apr							6.6	7.7	5.7	7.9	11.3	2.8	7.8	8.5	6.8	8.6	13.1	4.6	5.6	6.9	4.7	5.9	10.7	0.8
23-Apr							6.0	6.8	5.1	7.5	13.3	2.4	7.1	7.9	6.5	6.4	10.3	1.7	5.7	7.2	4.4	6.0	12.4	-0.2
24-Apr							5.8	6.8	4.4	6.5	13.5	-0.3	7.0	7.6	6.3	7.2	10.5	3.1	6.4	7.0	5.9	7.0	10.3	3.4
25-Apr							6.7	7.8	5.6	8.4	13.7	3.6	7.3	7.9	6.5	8.1	11.9	3.8	6.5	6.9	6.1	6.5	8.8	3.8
26-Apr							6.5	7.5	5.3	7.3	13.9	0.7	8.0	8.6	7.2	9.7	15.7	5.9	6.3	6.8	5.4	7.1	11.2	2.5
27-Apr							6.8	8.0	5.7	9.0	16.0	2.6	8.2	8.5	7.8	9.4	11.4	7.1	6.3	6.7	5.7	5.9	7.4	4.2
28-Apr							7.0	8.0	6.0	9.4	16.0	2.6	7.6	8.2	7.0	8.0	11.2	5.1	5.5	6.4	4.6	6.2	10.5	2.7
29-Apr							7.1	8.6	6.0	9.6	16.7	3.4	7.8	8.8	6.7	8.4	13.3	3.5	6.0	7.0	4.9	7.1	12.2	2.1
30-Apr							7.6	9.1	6.4	10.0	17.0	3.1	8.0	8.7	7.2	8.3	13.1	4.7	6.7	7.7	5.5	7.9	12.5	3.0
1-May							7.8	8.9	6.6	9.4	17.0	1.8	8.1	8.9	7.2	8.7	13.0	4.4	6.8	7.8	5.6	8.3	14.2	1.7
2-May							7.9	8.3	7.5	9.1	12.7	4.1	8.4	8.8	8.0	8.6	9.9	6.5	7.5	7.9	7.2	8.3	10.0	6.3
3-May							8.0	8.6	7.2	8.4	12.4	4.1	7.3	7.9	6.9	7.2	10.0	5.4	7.1	8.0	6.2	8.2	12.6	4.4
4-May							8.1	8.4	7.5	9.1	12.2	6.2	6.4	7.2	5.6	5.2	9.3	1.5	7.1	8.1	5.8	8.7	14.4	2.6
5-May							7.4	8.3	6.7	9.0	11.9	7.3	6.4	7.5	5.0	6.1	13.0	0.1	8.4	9.2	7.7	9.8	12.9	7.4
6-May							6.8	7.3	6.2	8.0	10.0	5.2	7.0	7.8	6.1	7.4	12.3	2.0	8.0	8.5	7.5	8.9	11.7	6.6
7-May							7.0	7.6	6.4	9.1	13.1	5.4	7.8	9.2	6.6	8.9	14.8	3.9	7.8	8.1	7.3	8.3	10.2	6.8
8-May							7.0	7.8	6.3	9.4	12.9	6.4	8.1	9.4	6.8	9.0	16.3	2.0	7.6	8.3	6.8	9.0	13.8	4.9
9-May							7.3	8.5	6.0	9.4	15.8	3.7	8.4	9.3	7.3	9.9	16.0	3.1	8.6	9.7	7.8	11.1	14.9	7.9
10-May							7.9	8.5	6.9	9.6	15.8	3.8	9.5	11.0	8.6	11.4	16.8	7.2	8.7	9.1	8.3	10.7	13.1	8.4
11-May							8.4	8.7	8.0	9.2	11.6	6.5	9.7	11.1	8.6	10.8	17.3	4.4	8.2	8.6	7.6	9.6	10.6	5.8
12-May							8.1	9.1	7.0	8.4	13.2	4.2	9.7	10.2	9.0	10.2	14.2	5.6	7.0	7.5	6.2	7.1	11.3	3.5
13-May							7.2	8.1	6.7	7.3	9.9	4.5	9.9	11.5	8.6	11.0	17.7	4.5	7.6	8.7	6.3	8.8	14.0	3.2
14-May							7.2	8.6	5.9	8.5	13.9	4.2	10.9	12.4	9.7	12.6	18.9	6.7	8.5	8.9	8.0	10.6	14.0	7.9
15-May							8.4	9.2	7.2	10.3	15.2	5.6	11.2	12.2	10.3	12.7	17.1	7.3	8.1	8.9	7.5	10.5	11.5	8.9
16-May							9.7	10.9	8.7	13.3	18.8	9.1	11.6	12.3	10.9	13.1	16.5	9.1	7.8	8.5	7.4	9.8	12.8	7.8
17-May							10.8	12.1	9.7	15.1	20.4	10.9	11.6	12.5	10.7	12.9	17.9	8.0	7.6	8.7	6.4	8.5	13.4	3.5
18-May							10.8	11.7	10.1	11.7	13.8	8.5	11.9	12.7	11.4	13.1	15.4	11.2	8.0	9.1	6.8	9.3	15.0	4.0
19-May							9.2	9.9	8.4	8.6	12.1	4.8	11.1	11.5	10.6	11.8	15.0	9.4	8.5	9.6	7.1	10.5	17.5	4.0
20-May							8.9	9.7	8.0	9.0	14.2	3.5	9.3	10.4	8.6	8.3	10.6	6.7	9.4	10.8	7.9	12.0	18.8	5.3
21-May							9.2	10.8	7.9	10.1	16.7	3.9	8.2	9.0	7.6	7.8	10.2	5.7	10.0	10.7	9.7	12.0	13.6	10.1
22-May							9.7	11.4	8.4	11.1	18.6	4.0	7.9	8.5	7.0	7.6	11.4	3.2	9.1	9.8	8.7	10.8	12.7	7.6
23-May							10.4	12.1	9.1	12.0	18.6	5.4	8.5	9.3	7.9	9.4	11.8	6.9	9.3	10.2	8.8	11.2	15.2	8.8
24-May							10.9	12.6	9.7	12.6	19.2	5.9	9.2	9.6	8.6	10.0	13.1	7.2	8.9	9.4	8.3	10.9	13.9	6.9
25-May							11.2	12.1	10.3	12.6	17.5	7.0	9.7	10.3	9.1	11.1	13.8	8.8	9.2	9.5	8.9	10.5	12.2	8.3
26-May							11.9	12.9	11.3	14.8	17.7	11.1	9.7	10.0	9.5	10.8	11.7	9.7	8.8	9.2	8.4	9.7	11.9	7.1
27-May							11.4	12.6	10.4	11.6	16.5	6.4	10.0	10.8	9.2	12.6	15.6	10.4	8.9	9.4	8.4	9.2	10.6	7.7
28-May							11.5	13.5	10.0	12.8	20.3	6.2	10.2	10.5	9.9	12.1	12.8	11.5	9.1	10.1	8.1	9.5	13.8	6.0
29-May							12.6	15.1	10.8	15.4	24.1	7.7	9.8	10.0	9.6	11.5	12.0	10.8	9.6	10.7	8.3	11.3	16.5	6.1
30-May							13.3	15.4	11.9	15.2	21.4	10.3	9.5	9.8	9.1	10.1	11.8	8.1	9.5	10.1	9.2	11.6	13.8	10.0
31-May							13.4	15.4	11.6	15.4	22.3	8.3	9.8	10.4	9.4	11.4	13.5	9.6	9.6	10.5	8.6	11.9	16.5	6.5
1-Jun							13.7	15.7	12.0	16.6	24.4	9.1	10.3	10.7	9.7	11.6	13.8	9.7	10.1	10.4	9.7	12.4	14.0	10.6
2-Jun							14.7	17.1	12.8	18.2	26.1	11.7	10.9	12.2	10.2	12.8	17.0	10.1	9.7	10.0	9.4	11.0	12.1	9.8
3-Jun							15.4	18.0	13.3	19.2	28.0	11.4	10.0	10.6	9.3	10.3	13.4	7.0	9.8	10.9	8.9	12.1	16.0	9.4
4-Jun							15.9	18.4	13.8	19.9	29.4	11.6	10.4	11.2	9.6	11.6	15.4	8.4	10.2	11.4	8.8	12.9	19.0	7.3
5-Jun							16.1	17.9	14.3	18.2	24.0	12.0	10.3	11.2	9.5	11.5	15.6	7.4	11.1	12.2	9.7	14.6	20.0	9.1
6-Jun							15.8	17.1	14.5	16.4	20.8	12.0	10.4	11.0	9.8	11.2	13.8	7.8	11.8	12.9	10.4	15.3	20.9	10.0
7-Jun							16.0	17.7	14.4	16.6	21.2	12.9	11.1	12.0	10.5	12.9	15.8	10.4	11.5	12.5	10.4	13.3	17.5	10.1
8-Jun							15.8	17.1	14.5	16.5	20.8	12.8	11.7	12.8	10.7	13.1	16.9	8.5	11.7	12.8	10.3	13.6	19.2	8.0
9-Jun							15.8	17.8	13.8	16.5	22.5	10.9	12.1	12.4	11.7	12.6	15.1	11.5	11.4	12.5	10.8	12.8	15.4	8.9
10-Jun							16.3	18.3	14.4	17.7	23.7	12.4	11.6	12.1	11.2	11.6	14.2	8.0	11.7	12.0	11.5	13.9	15.7	12.1
11-Jun							16.6	18.4	14.8	17.4	22.9	12.1	12.2	13.1	11.5	13.9	16.8	11.5	11.7	12.7	11.1	13.3	16.1	11.5
12-Jun							16.7	18.3	14.9	17.1	22.4	12.2	12.8	14.7	11.4	14.4	19.8	8.9	11.0	11.7	10.4	12.3	15.3	8.5
13-Jun							16.8	18.6	14.8	17.6	23.7	11.7	13.9	15.6	13.1	14.6	17.4	11.6	11.6	12.4	10.9	13.7	17.4	11.3
14-Jun							16.7	18.0	15.0	16.1	20.6	11.2	12.8	14.2	11.6	11.7	16.2	6.9	11.2	12.0	10.9	12.5	14.1	11.1
15-Jun							16.0	17.0	14.8	15.7	20.6	11.3	12.2	13.4	11.4	12.2	16.5	9.1	11.1	12.5	9.9	12.1	16.3	8.2
16-Jun							15.2	16.2	14.3	14.8	18.4	11.1	12.3	14.5	10.7	12.2	17.2	6.8	11.3	12.4	10.0	12.2	17.4	6.7
17-Jun							15.7	17.2	14.4	16.5	20.7	13.0	13.1	14.6	12.1	13.8	17.1	11.6	12.1	13.4	11.0	13.6	17.7	8.8
18-Jun							16.2	17.4	15.0	16.6	19.8	13.5	12.6	13.7	11.9	13.0	17.4	9.8	12.5	13.0	12.0	14.2	16.3	12.6
19-Jun							15.6	16.5	14.8	15.8	18.9	12.7	13.2	15.4	11.4	14.4	19.3	9.2	12.3	12.6	12.0	13.9	15.6	11.9
20-Jun							14.5	15.5	13.2	13.6	17.7	9.1	13.7	15.0	12.7	14.6	17.7	12.0	12.4	12.8	11.9	14.5	16.2	12.4
21-Jun							14.6	16.3	13.1	14.5	19.2	10.1	14.1	15.6	13.1	15.0	18.2	12.7	13.0	14.1	12.0	15.8	20.0	12.0
22-Jun							14.5	15.6	13.3	14.1	18.9	9.6	14.4	16.1	12.8	14.9	19.1	10.0	13.5	15.2	12.5	15.3	19.9	11.2
23-Jun							14.1	15.3	12.6	14.3	19.3	8.1	15.1	16.6	13.7	16.8	20.7	12.7	12.6	13.1	12.0	13.6	16.6	10.3
24-Jun							14.2	14.8	13.6	14.1	16.1	12.6	15.5	16.8	14.4	16.9	20.5	14.0	11.8	12.7	11.1	11.9	15.2	8.5
25-Jun							13.8	14.5	13.1	14.0	17.5	11.1	15.7	17.4	14.2	16.2	20.1	12.6	11.7	12.6	11.0	12.4	15.6	9.3
26-Jun							14.0	15.5	12.3	13.7	18.5	8.5	14.8	15.4	14.1	14.5	17.0	11.4	12.3	14.2	10.9	13.5	18.5	8.4
27-Jun							13.5	14.7	12.6	12.3	16.3	8.2	14.9	15.9	14.1	15.3	18.1	13.2	12.8	13.4	12.3	14.4	15.9	12.6
28-Jun							13.5	15.2	11.7	12.5	17.7	7.4	14.1	15.5	12.8	13.1	17.5	8.2	13.3	14.3	12.6	15.9	18.3	13.8
29-Jun							13.6	15.2	11.9	12.7	18.5	7.0	13.2	14.0	12.4	12.3	15.3	8.3	13.7	15.1	13.0	15.8	19.3	13.5
30-Jun							13.9	15.9	12.1	13.7	20.1	7.5	12.4	13.5	11.2	11.5	16.0	6.4	12.7	13.8	11.9	13.7	17.0	10.6

Appendix F – Temperature record for *South Englishman River above Centre Creek* station, Jul 2008 to Dec 2011.

	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
DATE	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Jul							14.2	16.3	12.4	14.7	21.9	7.7	12.3	12.7	12.0	11.5	12.6	10.4	12.1	13.1	11.4	13.3	16.1	11.1
2-Jul							14.9	18.5	12.6	16.1	24.1	8.3	13.1	15.0	11.5	13.1	17.1	9.2	12.8	14.9	11.2	14.4	19.9	9.3
3-Jul							15.7	18.2	13.4	17.6	25.8	9.7	14.2	15.9	12.4	14.2	19.1	9.4	14.2	16.3	12.8	15.6	18.9	12.8
4-Jul							16.5	18.7	14.5	18.7	25.9	11.7	14.1	14.8	13.2	14.0	17.3	10.9	13.9	15.9	12.3	14.4	19.8	9.0
5-Jul							16.4	17.7	15.0	17.8	23.3	12.3	14.6	16.2	13.1	15.0	19.8	11.5	14.4	16.8	12.4	16.0	22.3	9.8
6-Jul							15.5	16.6	14.8	14.9	16.7	12.4	14.9	16.8	12.8	15.6	22.9	8.9	15.3	17.5	13.4	17.3	22.6	12.1
7-Jul							13.5	14.5	13.1	12.0	13.4	9.6	16.3	18.3	14.0	18.9	26.7	11.9	15.3	16.3	14.3	15.5	18.5	13.1
8-Jul							13.7	14.6	12.9	13.8	15.9	11.6	17.5	19.6	15.3	20.8	29.0	13.8	14.8	16.3	13.5	13.9	17.0	11.4
9-Jul							14.9	16.8	13.7	15.9	19.9	13.2	18.0	19.6	16.3	20.2	26.1	14.8	14.5	16.3	12.7	14.0	18.9	8.9
10-Jul							15.6	18.0	13.6	16.6	23.0	10.8	18.0	19.9	16.1	19.7	25.7	13.7	14.6	15.6	13.5	15.4	18.1	12.0
11-Jul							16.6	19.1	14.4	18.3	25.7	11.6	18.4	19.8	17.0	19.7	24.1	15.5	14.8	15.5	14.2	16.0	18.0	14.3
12-Jul	16.4	18.6	14.4	16.9	24.8	9.8	17.3	19.4	15.5	18.3	23.7	13.5	17.4	18.7	16.3	16.3	19.4	13.8	14.8	15.7	14.1	15.2	17.2	13.8
13-Jul	17.1	19.1	15.2	17.2	23.4	10.9	16.4	17.3	15.8	16.0	18.6	14.0	16.0	17.8	14.3	14.5	20.5	8.8	14.4	14.9	13.9	14.5	15.3	13.7
14-Jul							16.3	18.1	15.0	16.7	21.0	13.6	15.9	18.1	14.0	15.3	21.7	9.3	14.0	14.6	13.3	14.1	15.7	12.5
15-Jul							16.5	18.6	14.5	16.9	22.5	11.1	16.5	18.5	14.8	16.6	23.1	11.2	13.6	14.0	13.1	13.8	15.1	11.7
16-Jul	16.7	18.8	14.7	16.1	23.0	9.9	17.3	19.6	15.3	18.7	24.8	12.7	16.3	18.3	14.6	15.6	21.1	10.3	13.8	14.4	13.4	14.7	15.8	13.8
17-Jul	16.5	18.1	14.9	15.5	20.9	9.8	18.0	20.4	15.9	19.5	26.0	13.3	16.2	18.3	14.3	15.6	21.2	9.9	14.2	15.2	13.3	14.5	16.7	12.0
18-Jul	16.2	18.2	14.4	15.2	20.5	9.4	17.8	19.7	16.0	18.6	24.2	13.2	16.3	18.4	14.5	15.8	21.3	10.3	14.7	16.3	13.7	15.6	18.3	13.7
19-Jul	16.4	18.5	14.5	15.9	21.8	10.2	17.3	19.2	15.5	17.6	22.8	12.5	16.2	18.3	14.2	15.3	20.8	9.5	15.0	16.6	13.7	15.4	18.7	12.1
20-Jul	16.8	19.0	14.8	16.8	22.8	10.6	17.1	19.2	15.0	18.1	24.8	11.3	16.8	18.8	15.2	16.8	22.1	12.6	15.0	16.2	14.0	15.4	18.6	13.1
21-Jul	17.2	19.1	15.4	17.0	22.7	11.6	17.5	19.8	15.3	18.9	25.9	12.1	17.2	19.4	15.2	18.0	24.1	11.8	14.7	15.8	13.6	14.3	17.0	11.9
22-Jul	17.4	19.2	15.9	16.8	21.3	12.8	17.9	19.8	16.0	18.8	24.3	13.3	17.5	19.3	16.1	17.7	21.4	14.3	14.1	15.4	12.7	13.2	16.8	9.1
23-Jul	17.4	18.9	16.2	16.5	20.6	13.2	17.7	19.4	15.8	17.7	22.6	12.7	17.0	19.0	15.1	16.7	22.7	10.7	14.3	15.9	12.6	14.3	18.6	9.6
24-Jul	16.7	18.8	14.7	15.5	22.2	9.2	17.6	19.7	15.5	18.3	25.0	11.9	17.3	19.5	15.4	17.7	23.2	12.5	15.1	17.1	13.1	16.2	22.3	10.7
25-Jul	16.3	17.9	14.5	15.9	22.0	9.1	18.6	20.7	16.5	20.7	27.1	14.7	17.0	19.3	14.9	17.1	24.0	10.4	16.0	17.4	14.6	17.5	21.2	14.0
26-Jul	17.0	17.6	16.4	17.1	19.0	14.9	20.0	21.8	18.2	22.8	27.8	18.0	17.1	19.5	14.9	17.3	24.0	10.8	15.4	16.1	14.8	15.7	17.1	14.3
27-Jul	17.0	18.2	16.1	16.9	20.4	13.9	20.4	22.5	18.4	23.5	30.4	17.1	17.7	20.0	15.6	18.4	24.8	12.6	15.6	17.0	14.4	16.0	19.4	13.5
28-Jul	15.8	16.9	14.4	14.7	19.5	9.8	21.0	23.1	18.9	24.7	32.5	17.7	17.8	19.9	15.8	17.8	23.0	12.5	15.7	17.3	13.9	15.8	20.7	10.8
29-Jul	15.5	16.1	15.1	14.1	16.2	12.6				24.4	31.7	18.3	17.6	19.7	15.7	17.3	22.6	12.1	16.4	17.9	14.9	16.9	20.8	13.6
30-Jul	14.7	15.5	13.7	13.0	16.6	9.5				24.8	31.9	18.6	17.3	19.3	15.2	16.8	22.9	10.9	16.2	17.2	14.8	16.7	20.7	12.2
31-Jul	13.9	14.5	13.3	11.8	13.9	9.7				23.3	27.8	18.7	17.2	19.2	15.2	16.8	22.2	11.2	16.1	17.3	14.9	16.0	19.0	12.8
1-Aug	13.6	14.0	13.2	12.4	13.6	11.1				22.3	28.1	16.4	17.4	19.2	15.8	17.1	21.3	12.8	15.5	16.9	13.8	14.8	20.0	9.7
2-Aug	14.4	16.0	13.3	14.0	17.4	11.7				21.4	27.6	15.0	17.9	19.5	16.7	18.2	22.1	14.9	16.1	17.5	14.6	16.3	20.8	12.5
3-Aug	14.8	16.5	13.2	14.4	20.7	8.9				19.6	26.1	13.2	18.0	19.9	16.2	18.3	23.8	13.5	16.8	18.0	15.6	17.5	21.1	14.1
4-Aug	15.4	17.4	13.6	15.8	23.0	9.6				13.9	16.6	12.2	18.4	20.4	16.5	20.1	27.1	14.1	16.8	18.4	15.1	17.3	22.6	12.6
5-Aug	15.9	18.1	14.0	16.7	24.8	9.8							18.2	19.4	17.0	19.3	23.8	15.3	16.8	17.7	15.4	16.9	20.4	12.9
6-Aug	16.8	18.9	14.8	18.6	26.4	11.8							18.4	20.2	16.7	18.9	23.8	14.6	16.9	18.3	15.8	16.9	20.1	14.0
7-Aug	17.5	19.2	15.9	18.3	23.6	13.5	17.6	18.6	16.0	18.4	21.4	12.5	17.7	18.5	17.2	16.7	18.0	15.7	16.1	17.6	14.5	15.3	20.2	10.4
8-Aug	17.3	19.1	15.5	17.0	22.7	12.0	17.2	17.9	16.6	16.7	19.3	14.4	17.3	18.2	16.7	16.6	18.7	15.5	16.1	17.7	14.5	15.6	20.5	11.0
9-Aug	16.9	17.7	16.3	16.2	18.8	14.2	17.1	18.3	16.0	17.3	22.9	13.1	16.7	17.9	15.9	15.7	18.9	13.5	16.5	17.7	15.5	16.3	19.6	13.3
10-Aug	15.5	16.5	14.5	14.6	18.4	10.9	16.9	17.3	16.4	16.0	17.6	14.2	16.7	18.5	15.5	15.9	20.4	12.2	16.3	17.5	15.5	16.0	19.0	13.6
11-Aug	15.1	17.2	13.2	14.4	20.4	8.4	16.3	17.2	14.9	15.2	19.4	10.1	16.7	18.6	15.0	16.0	20.9	11.5	16.3	17.3	15.5	16.4	19.9	13.7
12-Aug	15.3	16.2	14.3	15.1	18.5	10.8	16.2	17.3	15.1	15.7	19.9	12.1	16.9	20.4	15.1	16.5	24.9	11.7	16.2	18.0	15.0	16.3	20.6	13.4
13-Aug	16.1	18.2	14.4	17.1	23.2	11.4	15.8	16.6	15.2	14.8	16.7	13.0	17.1	19.5	15.1	18.1	25.9	11.7	15.7	16.9	14.4	14.8	18.7	10.4
14-Aug	17.0	19.2	15.1	19.0	26.4	12.7	15.5	17.0	14.4	14.6	18.7	11.5	17.6	20.0	15.5	19.6	27.4	13.0	15.6	16.9	14.5	15.1	18.5	12.2
15-Aug	17.6	18.8	16.5	19.5	25.2	14.9	16.4	18.0	15.3	16.2	19.9	13.6	18.1	20.4	16.1	20.4	28.1	14.0	14.9	16.7	13.4	13.7	18.6	9.2
16-Aug	18.1	20.2	16.4	20.6	27.6	14.8	16.6	18.2	14.9	16.7	21.8	11.0	18.5	20.6	16.6	20.7	27.8	14.7	14.8	16.8	13.1	14.1	19.7	8.9
17-Aug	18.7	20.4	17.1	20.3	26.4	15.0	17.0	18.6	15.4	17.4	22.6	12.4	18.1	20.1	16.2	19.2	25.6	13.0	14.9	16.8	13.3	14.4	19.4	9.7
18-Aug	19.0	19.6	18.5	20.0	22.2	17.5	17.5	19.4	15.5	18.7	24.9	12.6	17.4	19.0	15.8	16.9	21.4	12.1	15.1	16.9	13.6	14.8	19.4	10.6
19-Aug	17.2	18.4	16.8	16.4	18.6	14.2	18.4	20.1	16.8	20.0	26.1	14.4	17.3	18.5	16.4	16.9	20.0	15.0	15.0	17.1	13.2	15.0	21.1	9.4
20-Aug	16.0	16.7	15.6	14.2	15.3	12.8	18.6	20.3	16.7	20.1	27.2	13.9	16.6	17.7	15.6	15.5	18.0	13.3	15.2	17.3	13.4	16.2	22.1	10.8
21-Aug	15.3	16.3	14.5	13.8	16.9	11.7	18.2	18.9	17.4	18.3	21.7	14.6	15.5	16.9	13.9	14.5	19.3	9.2	15.9	17.2	14.8	17.5	21.9	13.5
22-Aug	15.2	16.3	14.1	14.8	19.0	10.7	16.3	17.4	14.7	14.6	20.2	9.1	15.2	16.6	13.8	14.4	18.7	10.3	16.8	17.7	16.3	18.6	20.3	17.3
23-Aug	16.1	16.8	15.5	16.9	19.8	15.1	15.8	17.2	14.5	15.2	20.7	11.2	15.3	17.0	13.6	15.0	19.9	10.1	16.1	16.9	15.2	16.5	19.8	13.4
24-Aug	16.0	16.4	15.4	15.6	17.2	12.5	15.1	16.4	13.3	14.7	20.7	8.3	15.6	17.4	13.7	15.8	22.2	9.7	15.6	17.0	14.2	15.5	20.0	11.1
25-Aug	14.5	15.2	13.6	12.3	16.2	8.9	15.7	16.4	15.1	15.5	17.0	14.0	16.1	18.0	14.2	17.1	23.6	11.4	15.9	17.7	14.5	16.4	21.4	12.2
26-Aug	13.3	14.2	12.3	11.1	15.4	6.9	15.5	16.6	14.3	14.8	18.9	11.0	15.8	16.4	15.0	15.7	18.3	13.1	16.1	17.6	14.8	16.7	21.6	12.7
27-Aug	13.8	15.2	12.8	14.0	18.7	10.5	15.2	17.1	13.0	15.1	23.0	7.6	14.7	15.5	13.7	13.4	16.5	10.0	16.3	18.1	14.9	17.1	22.0	12.8
28-Aug	14.6	15.2	14.0	14.6	17.4	12.8	15.4	16.6	13.9	15.9	22.3	9.8	13.8	15.5	12.1	12.5	18.1	7.5	16.2	18.1	14.6	16.7	22.3	11.7
29-Aug	14.8	15.8	14.0	15.7	20.9	12.7	16.5	18.1	14.9	17.9	23.2	13.7	13.4	15.0	11.8	12.3	17.6	6.9	16.1	17.3	14.9	16.0	19.0	12.9
30-Aug	13.8	14.8	12.7	11.9	16.4	7.5	16.5	17.9	15.0	17.2	22.9	12.1	13.5	15.2	11.7	13.2	18.5	7.0	15.7	16.6	14.9	15.3	18.1	12.9
31-Aug	13.2	14.3	12.0	11.5	17.0	6.7	16.3	17.6	14.8	16.5	21.9	11.3	14.1	14.7	13.5	13.4	15.4	12.1	14.4	16.0	12.9	13.0	18.1	8.3
1-Sep	12.8	13.8	11.6	11.3	16.3	6.2	16.1	17.4	14.7	16.1	20.9	11.2	14.4	15.7	13.3	13.9	17.1	10.7	13.7	14.6	12.6	12.6	16.1	8.8
2-Sep	13.2	14.2	12.3	12.5	15.9	9.3	16.2	17.6	14.7	16.1	20.9	10.8	13.9	15.5	12.3	13.2	18.9	8.1	13.8	15.3	12.5	13.3	17.4	9.0
3-Sep	13.7	14.8	12.7	13.5	17.3	9.7	16.1	16.8	15.2	16.6	21.2	12.8	14.5	16.4	12.7	15.3	22.3	9.4	13.2	15.2	11.4	12.7	19.1	7.2
4-Sep	13.5	14.8	12.2	13.1	18.3	8.2	15.9	16.7	15.0	16.3	20.0	12.8	14.5	15.4	13.4	14.3	17.7	9.8	13.5	15.5	11.7	13.9	20.5	7.9
5-Sep	13.8	15.1	12.7	14.4	18.8	10.0	15.6	16.0	15.1	14.7	16.5	13.3	13.3	14.6	11.7	12.4	17.1	7.0	14.0	15.8	12.3	14.8	21.0	9.1
6-Sep	14.5	15.9	13.6	15.5	20.0	11.8	14.6	15.2	14.0	12.5	13.6	11.0	13.5	14.0	13.0	12.3	13.5	11.3	14.4	16.1	12.8	15.3	20.6	10.3
7-Sep	14.4	16.0	13.0	14.6	20.9	9.5	13.7	14.4	12.6	11.8	14.7	8.1	13.9	14.7	13.2	13.3	15.2	12.1	14.7	16.6	13.0	15.9	22.6	10.4
8-Sep	14.1	15.5	12.8	14.1	19.6	9.1	13.3	14.4	12.0	11.9	16.3	7.6	13.8	15.4	12.4	13.3	18.2	9.1	15.0	16.9	13.2	17.0	24.0	11.4
9-Sep	13.8	15.0	12.6	13.3	18.1	8.4	14.0	14.9	13.2	13.1	15.5	11.3	13.2	14.6	11.8	12.1	16.3	7.3	15.6	17.2	14.1	17.5	23.3	12.6
10-Sep	13.0	14.5	11.4	12.0	18.2	6.5	14.1	15.4	13.1	13.6	19.5	10.3	13.3	14.0	12.6	12.2	14.1	10.4	15.6	17.2	14.0	17.0	22.9	11.9
11-Sep	13.0	14.7	11.4	13.2	20.2	7.1	14.2	15.7	12.7	13.8	19.9	8.8	12.2	12.8	11.2	10.4	13.6	6.9	15.3	17.0	13.7	16.4	22.8	11.0
12-Sep	13.9	15.3	12.8	14.7	20.1	11.3	14.6	16.3	12.9	15.5	22.1	9.6	12.8	13.2	12.3	12.5	13.6	11.5	15.1	16.7	13.6	15.8	21.2	11.1
13-Sep	13.0	14.5	11.5	12.3	19.0	6.5	15.7	16.6	14.9	16.8	19.8	14.4	13.2	13.8	12.8	13.4	14.8	12.6	14.7	15.2	14.0	14.6	16.9	11.9
14-Sep	13.0	14.5	11.5	13.1	20.4	7.4	15.9	16.8	15.0	16.5	20.0	13.7	13.6	14.6	12.8	13.9	16.6	11.4	15.0	15.6	14.6	15.7	17.8	14.1
15-Sep	12.9	14.4	11.3	13.1	20.7	7.0	15.9	17.3	14.8	16.7	21.5	12.7	13.4	13.9	12.8	13.3	15.5	11.1	14.6	15.3	13.9	14.4	16.7	12.6
16-Sep	12.9	14.4	11.4	13.4	20.8	7.3	15.4	15.9	15.0	15.1	17.3	13.6	13.9	14.6	13.3	14.7	16.7	13.1	13.6	14.2	12.9	12.4	14.9	10.2
17-Sep	13.1	14.2	11.9	13.6	19.7	9.1	14.3	15.4	12.8	13.3	17.9	7.9	14.6	15.5	13.8	15.5	17.8	13.8	13.3	14.0	12.6	12.3	14.2	10.6
18-Sep	13.0	14.1	11.9	12.6	16.8	8.5	15.0	15.7	14.3	15.2	18.5	13.1	15.1	15.8	14.5	15.5	17.2	14.4	13.4	14.1	12.8	13.3	16.1	11.4
19-Sep	13.6	14.3	13.1	14.2	16.5	12.3	14.9	15.4	14.1	14.8	18.6	11.0	14.9	15.5	14.5	15.0	16.6	13.5	12.8	14.0	11.7	12.0	15.7	8.4
20-Sep	13.2	13.8	12.6	12.9	15.5	10.1	13.2	14.3	11.9	11.5	16.5	6.8	14.3	14.6	14.0	13.5	14.4	12.3	12.2	13.6	10.6	11.5	17.2	6.1
21-Sep	13.4	14.0	12.8	13.1	15.9	11.2	12.5	13.9	11.1	11.4	17.7	6.5	13.2	13.9	12.4	11.2	13.1	9.2	13.2	13.5	12.9	14.0	15.7	13.0
22-Sep	12.4	13.2	11.4	10.6	14.6	6.1	12.7	14.2	11.2	12.7	19.8	7.2	11.8	12.7	10.7	9.5	13.3	5.3	13.9	14.7	13.2	15.5	17.8	13.9
23-Sep	11.6	12.3	10.8	10.5	13.8	6.5	13.0	14.6	11.4	13.7	21.7	7.5	12.5	13.3	11.8	11.6	14.2	9.6	14.8	15.7	14.0	17.5	20.6	14.8
24-Sep	11.5	12.0	11.2	10.2	11.3	8.7	13.3	14.2	12.4	13.4	17.5	9.4	12.4	12.7	11.9	11.7	13.1	9.6	14.9	15.6	14.3	16.1	19.5	13.0
25-Sep	11.6	12.3	10.9	11.2	13.4	8.2	12.1	13.4	10.7	11.2	17.5	6.0	12.9	13.5	12.4	14.7	17.6	12.7	13.7	14.4	12.5	13.1	15.2	9.1
26-Sep	12.6	13.3	12.1	13.4	15.9	12.0	11.9	12.7	11.0	11.4	16.2	7.3	12.8	13.4	12.2	14.1	15.5	11.9	11.9	12.4	11.6	11.0	12.9	8.9
27-Sep	12.4	13.1	11.7	11.9	15.7	9.1	10.6	11.7	9.3	8.7	14.7	3.7	13.5	14.1	12.8	15.1	18.0	11.5	11.5	11.9	11.1	10.5	12.8	8.5
28-Sep	11.6	12.6	10.6	10.2	15.8	5.9	9.9	10.8	8.8	8.2	14.5	4.0	14.0	14.5	13.3	15.3	17.5	11.7	10.5	11.3	10.0	8.7	12.2	5.4
29-Sep	11.0	12.1	9.7	9.9	16.8	4.1	10.0	10.7	9.5	7.8	9.8	6.3	12.2	13.1	11.4	11.2	15.5	7.8	10.1	10.6	9.4	9.4	14.7	4.6
30-Sep	11.2	12.3	10.2	11.6	17.4	7.0	9.2	10.3	7.8	6.8	11.0	2.1	11.0	11.9	10.2	10.2	15.7	5.7	10.7	11.0	10.5	10.4	11.4	9.6

Appendix F – Temperature record for *South Englishman River above Centre Creek* station, Jul 2008 to Dec 2011.

	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
DATE	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Oct	11.8	12.7	10.8	12.4	16.8	7.6	10.3	11.1	9.7	9.9	12.6	7.9	10.9	12.1	10.1	11.2	16.9	6.8	10.5	11.0	10.1	10.0	12.8	8.3
2-Oct	12.6	13.3	12.2	13.8	15.9	12.0	10.1	10.8	9.4	8.3	11.2	5.3	11.6	12.4	11.0	12.3	15.4	10.6	9.7	10.1	9.2	8.8	11.5	5.8
3-Oct	13.0	13.2	12.8	13.6	14.1	13.1	9.5	10.5	8.8	8.1	12.3	4.2	11.6	12.3	10.9	11.1	14.0	8.3	10.3	11.1	9.8	11.2	13.1	9.5
4-Oct	12.9	13.3	12.6	13.1	14.6	10.3	9.1	10.3	7.9	8.0	14.5	3.1	11.5	12.0	10.7	10.8	13.5	7.5	10.2	10.5	9.8	9.8	12.0	8.2
5-Oct	11.5	12.5	10.9	9.1	11.8	5.9	8.5	9.6	7.2	7.0	13.8	2.1	9.9	10.7	8.9	7.5	12.4	3.3	10.1	10.2	10.0	10.2	11.0	9.3
6-Oct	10.9	11.3	10.7	9.6	10.5	8.5	8.3	9.6	6.9	7.5	13.4	2.1	9.5	10.4	8.6	8.5	13.8	4.5	10.0	10.4	9.7	9.8	11.1	8.2
7-Oct	10.2	10.8	9.3	10.4	14.1	5.8	9.7	10.7	9.1	10.1	13.8	7.4	9.6	10.5	8.6	9.6	14.7	5.1	10.2	10.9	9.8	10.3	12.3	8.2
8-Oct	8.5	9.2	7.9	5.8	10.6	1.9	8.9	9.7	7.9	7.7	12.9	3.7	10.8	11.3	10.4	12.6	13.7	11.9	9.4	9.7	8.9	8.4	11.1	5.0
9-Oct	7.6	7.9	7.4	5.0	7.6	3.0	9.5	10.4	8.7	9.6	12.9	6.9	11.3	11.6	11.0	12.9	13.5	12.0	9.1	9.6	8.8	8.3	10.9	5.4
10-Oct	7.3	8.0	6.7	5.2	9.5	1.6	10.1	10.6	8.8	9.6	13.0	4.1	11.1	11.7	10.2	11.2	13.6	6.9	9.2	9.6	8.9	9.0	10.7	7.2
11-Oct	6.4	7.2	5.6	4.1	8.8	-0.2	7.7	8.6	6.7	5.1	11.1	1.1	9.8	10.2	9.1	7.9	11.6	4.0	9.7	10.0	9.4	10.7	12.8	9.0
12-Oct	7.3	8.2	6.7	8.2	11.7	5.0	7.1	7.8	6.1	4.9	9.3	0.7	10.4	10.9	10.0	10.5	12.9	8.9	9.4	9.6	9.1	9.0	10.8	7.5
13-Oct	8.2	8.5	8.0	9.8	10.8	9.0	7.6	7.9	7.2	6.2	7.9	4.8	9.8	10.4	9.4	8.0	12.2	4.6	8.5	9.0	8.1	7.0	9.8	4.0
14-Oct	7.8	8.5	7.2	5.7	8.7	2.3	8.7	9.8	7.9	9.2	12.4	6.6	9.8	10.4	9.3	9.1	12.4	6.3	7.8	8.4	7.5	6.4	9.9	4.3
15-Oct	6.7	7.2	5.9	4.2	8.8	0.5	9.5	10.3	8.6	9.8	13.2	6.7	8.5	9.4	7.5	5.6	9.7	2.3	6.7	7.4	6.2	4.4	8.4	1.2
16-Oct	7.1	7.7	6.8	7.1	9.3	5.1	10.6	11.3	10.2	12.6	15.5	10.9	6.9	7.6	6.4	4.3	9.5	0.7	6.0	6.3	5.5	3.9	8.3	0.5
17-Oct	8.0	8.3	7.7	10.3	12.4	8.3	10.8	11.2	10.4	12.7	13.8	11.9	6.3	7.1	5.6	4.6	9.4	0.5	6.7	7.3	6.1	6.6	10.3	3.9
18-Oct	7.6	8.2	6.9	5.7	8.6	2.6	10.6	10.8	10.1	10.7	12.1	7.9	7.1	7.8	6.4	8.1	10.8	5.9	7.1	7.6	6.7	6.8	10.5	3.2
19-Oct	6.4	6.8	5.9	4.1	8.0	0.4	10.1	10.5	9.7	8.9	11.0	7.4	8.0	8.9	7.4	8.6	12.4	5.4	7.7	8.3	7.1	8.3	11.1	5.6
20-Oct	6.8	7.4	6.4	6.7	9.2	3.6	9.9	10.4	9.6	9.3	11.9	6.7	8.1	8.8	7.4	7.0	10.8	3.8	8.6	9.1	8.1	9.2	10.0	8.2
21-Oct	6.4	6.9	5.8	4.5	8.6	0.6	10.2	10.8	9.8	10.3	12.4	7.6	7.9	8.5	7.1	6.8	10.2	2.8	8.9	9.6	8.5	9.8	12.8	7.7
22-Oct	7.0	7.7	6.6	8.3	11.9	5.6	9.2	9.6	8.7	7.2	10.2	3.9	8.7	9.3	8.2	10.3	13.2	8.4	9.0	9.4	8.8	9.1	10.9	8.0
23-Oct	7.0	7.4	6.5	6.3	9.6	2.7	9.5	9.9	9.1	9.5	10.7	7.0	8.9	9.4	8.5	9.6	11.6	8.0	8.0	8.8	7.4	6.2	9.2	3.0
24-Oct	6.7	7.2	6.3	6.4	9.1	3.4	8.1	8.9	7.3	5.0	8.5	1.9	9.0	9.3	8.5	9.0	10.2	7.0	6.8	7.3	6.3	5.0	8.1	1.9
25-Oct	7.0	7.4	6.4	6.7	9.3	2.3	7.1	7.3	6.8	4.8	7.0	1.6	8.8	9.2	8.4	8.9	11.1	7.0	6.2	6.8	5.8	4.7	8.0	2.7
26-Oct	5.7	6.3	5.1	2.9	8.0	-0.4	7.5	7.8	7.2	7.0	8.4	4.5	8.7	8.9	8.6	8.7	9.9	7.6	6.0	6.5	5.7	4.5	7.8	1.5
27-Oct	5.1	5.8	4.5	3.2	8.7	-0.5	6.6	7.3	6.1	3.8	7.5	1.3	8.5	8.7	8.3	8.0	9.6	6.9	5.6	6.0	5.2	3.7	6.9	0.7
28-Oct	5.1	5.9	4.5	4.8	9.6	0.7	6.0	6.2	5.6	3.8	6.4	1.7	8.3	8.7	8.0	7.8	9.8	6.5	6.0	6.5	5.5	6.3	8.3	4.4
29-Oct	6.3	6.9	5.9	8.5	10.8	7.2	6.3	6.7	6.0	5.8	7.2	4.3	8.1	8.4	7.7	7.2	10.3	4.0	6.0	6.6	5.5	5.0	8.4	1.7
30-Oct	6.9	7.2	6.7	7.9	9.8	6.7	8.3	10.3	6.8	9.6	14.5	6.5	8.3	8.5	8.0	8.2	9.5	6.9	7.0	7.5	6.6	7.7	10.0	5.3
31-Oct	7.8	8.5	7.2	10.9	12.8	9.9	8.5	9.6	7.2	7.0	13.8	2.1	7.7	8.5	7.3	6.7	8.9	3.1	6.1	6.8	5.5	3.9	6.9	1.3
1-Nov	8.5	8.8	8.2	10.6	11.5	9.8	8.3	9.6	6.9	7.5	13.4	2.1	8.2	8.7	7.7	9.0	11.3	7.1	4.9	5.4	4.5	2.6	6.2	-0.1
2-Nov	8.8	9.3	8.4	9.6	12.0	5.9	9.7	10.7	9.1	10.1	13.8	7.4	8.2	8.4	7.8	6.9	10.2	4.4	5.0	5.3	4.7	4.3	6.2	2.8
3-Nov	7.4	8.2	7.1	6.2	8.8	4.5	8.9	9.7	7.9	7.7	12.9	3.7	8.0	8.3	7.7	6.7	9.5	4.7	4.6	5.0	4.3	2.8	5.3	1.0
4-Nov	7.0	7.2	6.4	5.4	8.3	2.4	9.5	10.4	8.7	9.6	12.9	6.9	8.2	9.0	7.7	7.6	11.8	3.8	4.5	4.9	4.2	2.7	5.4	0.7
5-Nov	5.5	6.2	5.1	3.1	7.1	-0.4	10.1	10.6	8.8	9.6	13.0	4.1	8.8	9.0	7.9	8.1	9.7	3.7	4.1	4.5	3.7	1.9	5.7	-0.3
6-Nov	6.1	6.9	5.5	6.6	8.5	5.0	7.7	8.6	6.7	5.1	11.1	1.1	7.1	7.7	6.5	4.7	8.0	1.3	3.7	4.0	3.3	1.5	5.1	-0.7
7-Nov	7.3	8.0	6.9	8.8	10.9	7.3	7.1	7.8	6.1	4.9	9.3	0.7	7.4	7.6	7.1	6.3	8.5	3.7	4.2	4.7	3.8	4.1	7.0	2.2
8-Nov	8.4	8.8	8.0	10.7	12.2	9.2	7.6	7.9	7.2	6.2	7.9	4.8	6.4	7.3	5.9	3.2	5.9	0.7	5.0	5.3	4.5	5.5	6.9	3.5
9-Nov	8.6	8.7	8.5	9.2	9.8	8.9	8.7	9.8	7.9	9.2	12.4	6.6	5.8	6.2	5.4	3.5	5.1	0.8	5.9	6.4	5.3	7.5	9.2	6.0
10-Nov	8.0	8.6	7.7	7.3	9.2	5.1	9.5	10.3	8.6	9.8	13.2	6.7	6.3	6.6	6.0	4.7	6.4	1.4	6.6	7.0	6.4	7.4	9.9	5.2
11-Nov	7.7	8.0	7.5	7.8	9.5	6.4	10.6	11.3	10.2	12.6	15.5	10.9	5.9	6.3	5.6	3.6	6.7	0.8	6.4	6.9	5.3	5.6	8.7	2.1
12-Nov	8.3	8.5	8.0	9.8	11.4	8.3	10.8	11.2	10.4	12.7	13.8	11.9	5.4	6.0	4.9	3.0	6.5	0.2	4.6	5.0	4.4	2.3	4.2	0.7
13-Nov	7.5	8.2	6.7	5.8	7.6	3.1	10.6	10.8	10.1	10.7	12.1	7.9	6.4	6.6	6.0	6.4	7.1	5.5	4.6	4.9	4.3	2.9	5.6	0.4
14-Nov	6.6	6.8	6.3	5.2	7.5	3.2	10.1	10.5	9.7	8.9	11.0	7.4	6.8	7.0	6.6	7.1	7.9	6.6	4.3	4.6	3.7	2.3	4.2	0.5
15-Nov	7.0	7.3	6.7	7.3	8.7	6.3	9.9	10.4	9.6	9.3	11.9	6.7	7.2	7.4	7.0	7.7	9.0	7.0	3.0	3.6	2.5	-0.2	1.5	-1.6
16-Nov	7.5	7.8	7.3	8.5	11.1	7.2	10.2	10.8	9.8	10.3	12.4	7.6	6.8	7.2	6.4	5.6	7.7	3.3	2.8	3.1	2.5	1.2	3.4	-1.2
17-Nov	7.6	7.7	7.4	7.2	10.1	4.9	9.2	9.6	8.7	7.2	10.2	3.9	6.2	6.7	5.3	4.7	6.5	1.4	2.9	3.1	2.7	1.3	2.8	0.2
18-Nov	7.5	7.8	6.6	6.2	8.2	1.6	9.5	9.9	9.1	9.5	10.7	7.0	4.9	5.2	4.7	1.9	3.2	0.2	2.7	2.9	2.5	0.4	1.2	-0.5
19-Nov	5.2	6.4	4.5	1.6	5.0	-1.0	8.1	8.9	7.3	5.0	8.5	1.9	4.6	4.8	3.8	2.1	3.1	0.7	2.1	2.4	1.8	-0.8	0.4	-1.7
20-Nov	4.6	5.2	4.1	3.1	7.9	-0.3	7.1	7.3	6.8	4.8	7.0	1.6	3.1	3.7	2.9	0.1	0.6	-0.9	1.4	1.7	1.0	-1.4	0.1	-3.2
21-Nov	5.2	5.4	4.9	4.1	6.7	1.4	6.4	7.8	4.9	6.0	8.4	3.9	2.7	2.9	2.2	-1.0	-0.7	-2.1	1.9	2.3	1.7	1.5	3.8	0.0
22-Nov	5.1	5.3	4.9	2.5	5.7	0.4	5.0	5.3	4.8	4.4	5.5	3.3	1.2	2.1	-0.1	-3.7	-2.4	-6.8	3.7	4.2	2.4	4.8	5.9	2.6
23-Nov	4.5	4.9	4.3	1.6	5.0	-0.2	5.2	5.3	5.0	4.8	6.5	2.7	-0.1	0.0	-0.2	-5.4	-3.1	-7.1	4.0	4.3	3.8	3.0	4.6	0.6
24-Nov	4.3	4.7	4.0	2.3	7.0	-0.2	5.6	5.9	5.3	6.4	7.4	5.5	0.0	0.1	-0.1	-3.6	-1.8	-5.9	3.7	3.9	3.6	2.1	3.8	0.2
25-Nov	5.0	5.4	4.6	4.7	7.3	2.0	5.9	6.0	5.7	8.1	8.8	7.1	0.3	0.8	0.0	-1.0	0.2	-2.2	3.6	4.0	3.3	1.4	3.0	-0.7
26-Nov	4.2	5.0	3.7	0.9	4.0	-0.4	5.7	6.0	5.3	5.9	7.6	3.5	1.3	2.1	0.7	0.8	2.2	-0.2	4.3	4.8	4.0	5.2	7.8	3.3
27-Nov	3.7	4.2	3.3	2.2	5.7	-0.5	4.8	5.3	4.5	2.4	4.1	0.4	2.5	3.0	2.2	0.2	1.6	-0.8	5.1	5.3	4.8	7.5	9.1	4.5
28-Nov	4.9	5.5	4.3	5.8	7.8	3.7	5.3	5.8	4.9	5.4	7.4	3.2	2.9	3.1	2.7	0.4	1.9	-0.5	4.4	4.7	4.2	2.2	4.2	0.9
29-Nov	5.9	6.2	5.6	7.6	8.4	7.0	6.1	6.5	5.8	7.8	10.4	6.2	2.9	3.3	2.6	1.2	2.6	-0.7	4.4	4.5	4.3	3.4	4.7	2.1
30-Nov	6.4	6.6	6.2	8.0	9.5	6.9	6.2	6.6	5.0	5.6	8.9	1.1	3.8	4.3	3.3	3.4	5.4	1.8	4.4	4.7	3.9	3.9	6.1	0.8
1-Dec	6.8	7.0	6.6	8.0	9.3	7.1	4.3	4.9	3.8	0.8	2.9	-0.4	4.2	4.4	4.0	2.1	4.5	0.9	3.6	3.8	3.5	1.7	3.9	0.2
2-Dec	7.1	7.5	7.0	7.6	9.8	6.4	3.2	3.8	2.9	-0.3	1.0	-1.1	4.1	4.3	3.8	2.4	5.0	1.0	3.5	3.7	3.2	2.0	4.3	0.4
3-Dec	6.5	6.9	5.9	5.2	7.0	1.5	2.8	3.1	2.6	-0.4	1.0	-1.7	3.8	4.0	3.6	1.9	3.7	0.4	3.5	4.0	3.1	3.0	4.9	0.6
4-Dec	5.3	5.8	5.0	2.4	5.1	0.2	2.8	3.1	2.4	0.0	2.4	-1.1	3.1	3.8	2.4	0.3	2.0	-1.3	3.9	4.2	3.3	3.3	5.1	0.0
5-Dec	4.8	5.0	4.5	3.4	4.8	1.2	1.9	2.4	1.7	-1.1	1.7	-2.5	2.4	2.7	2.1	-0.4	1.5	-1.9	3.1	3.4	2.9	1.4	3.0	-0.6
6-Dec	5.3	5.7	4.9	5.6	7.1	4.7	1.0	1.6	0.4	-2.3	-0.1	-4.2	2.7	3.1	2.5	0.9	4.3	-0.7	3.5	3.8	3.3	3.2	4.2	2.2
7-Dec	5.6	5.9	5.4	5.2	6.8	2.5	0.0	0.3	-0.1	-4.3	-1.0	-6.7	3.9	4.6	3.2	6.1	7.0	4.1	3.8	4.0	3.4	3.3	4.2	1.2
8-Dec	4.8	5.3	4.5	2.4	5.4	0.5	-0.1	0.0	-0.1	-5.2	-2.0	-7.5	4.7	4.8	4.6	6.0	6.8	5.0	2.4	3.3	1.7	-0.4	1.1	-1.3
9-Dec	4.9	5.2	4.6	4.7	6.4	2.8	-0.1	0.0	-0.1	-4.7	-1.3	-7.3	4.6	4.8	4.3	4.5	6.5	1.8	1.6	1.8	1.3	-0.6	0.9	-2.1
10-Dec	5.4	5.7	5.0	5.7	7.5	2.4	0.1	0.3	-0.1	-3.2	-1.0	-6.5	4.3	4.5	4.0	2.1	4.4	0.4	1.8	2.1	1.5	0.8	2.4	-0.4
11-Dec	4.8	5.1	4.2	3.6	6.0	0.6	0.4	0.6	0.2	-1.2	0.0	-2.0	4.3	4.4	4.1	2.7	4.6	1.1	2.2	2.5	1.8	1.2	2.8	-0.7
12-Dec	3.4	4.2	2.4	1.3	2.6	0.3	0.5	0.8	0.4	-0.5	0.4	-1.1	4.6	4.9	4.4	5.1	7.7	2.7	1.2	1.7	0.9	-1.1	0.1	-2.4
13-Dec	2.1	2.4	1.5	-0.4	0.4	-2.3	0.9	1.3	0.5	-0.5	0.6	-1.7	4.5	4.9	4.2	4.2	6.9	2.0	1.3	1.6	0.9	-0.1	0.9	-0.7
14-Dec	1.0	1.4	0.7	-2.1	-1.6	-2.4	1.3	1.6	0.8	-0.2	0.5	-0.6	4.3	5.0	4.0	3.3	6.8	1.8	1.5	1.8	1.2	-0.2	0.9	-1.2
15-Dec	0.0	0.7	-0.1	-4.9	-2.6	-6.9	1.1	1.4	0.7	0.9	2.5	-0.1	4.0	4.2	3.7	2.3	4.5	0.6	2.2	2.5	1.8	1.8	3.8	0.6
16-Dec	-0.1	-0.1	-0.1	-4.6	-1.7	-6.8	1.5	2.7	0.7	3.0	4.6	1.2	3.6	3.8	3.3	1.1	3.3	-0.5	2.9	3.3	2.5	4.3	6.2	2.4
17-Dec	-0.1	0.0	-0.2	-2.0	1.4	-3.8	2.8	3.1	2.6	2.6	5.6	0.0	3.5	3.8	3.2	1.5	3.9	-0.2	3.6	3.9	3.3	4.9	6.9	2.8
18-Dec	-0.1	-0.1	-0.2	-5.0	-3.0	-7.2	3.5	3.7	3.1	5.4	6.8	4.2	3.1	3.2	2.9	0.9	2.7	-0.7	4.0	4.2	3.7	4.8	5.8	2.5
19-Dec	-0.1	-0.1	-0.2	-6.3	-4.6	-8.5	3.4	3.6	3.1	3.0	4.7	0.5	3.2	3.4	3.1	2.5	3.6	1.0	3.3	3.8	3.1	3.0	4.5	1.0
20-Dec	-0.2	-0.2	-0.2	-10.0	-6.2	-13.9	3.8	4.1	3.4	4.0	5.1	2.9	3.1	3.2	3.0	2.0	3.2	0.9	3.5	3.9	3.2	3.9	6.0	1.2
21-Dec	-0.2	-0.2	-0.2	-3.1	-1.5	-6.0	3.8	4.1	3.3	3.1	4.5	1.0	3.5	3.8	3.2	4.3	5.3	3.2	2.2	3.1	1.5	0.1	1.5	-1.0
22-Dec	-0.2	-0.2	-0.2	-2.7	-1.6	-6.3	2.9	3.3	2.8	0.2	1.1	-0.6	3.9	4.1	3.8	3.9	5.8	2.7	1.2	1.5	0.9	-0.9	0.4	-2.4
23-Dec	-0.2	-0.2	-0.2	-5.2	-2.5	-8.0	2.9	3.1	2.8	0.6	2.2	-0.5	4.1	4.5	3.9	5.0	5.9	3.8	1.8	2.4	1.2	1.6	3.8	0.0
24-Dec	-0.2	-0.1	-0.2	-1.1	0.3	-2.7	2.7	3.0	2.3	0.0	1.0	-1.0	4.8	5.0	4.6	6.3	6.8	6.0	3.1	3.6	2.4	5.6	7.8	3.9
25-Dec	-0.1	0.0	-0.2	-0.5	0.1	-1.7	1.9	2.2	1.8	-0.5	0.6	-1.6	4.8	5.0	4.7	6.4	7.6	5.3	3.3	3.5	3.1	4.4	6.5	1.5
26-Dec	0.0	0.1	-0.1	-0.6	0.4	-1.9	1.7	2.1	1.5	0.2	1.1	-0.2	4.5	4.7	4.0	4.3	5.7	2.9	3.1	3.4	2.7	2.4	4.4	0.4
27-Dec	0.1	0.2	0.0	0.4	1.1	-0.1	1.2	1.7	1.0	0.1	1.0	-0.5	3.8	4.1	3.6	2.5	4.3	0.9	3.4	3.9	3.2	4.3	5.7	2.9
28-Dec	0.0	0.2	-0.1	-0.2	0.6	-1.5	1.2	1.5	0.9	0.5	1.9	-0.4	3.5	3.8	3.2	1.2	3.3	-0.2	4.4	4.8	3.9	5.7	7.8	4.0
29-Dec	-0.1	0.0	-0.2	0.0	0.2	-0.5	1.9	2.2	1.6	1.5	3.6	0.5	2.8	3.2	2.6	0.3	1.8	-0.6	4.1	4.5	3.9	3.0	5.5	1.2
30-Dec	0.0	0.1	-0.2	-0.2	0.9	-1.0	2.3	2.7	2.0	2.0	4.1	0.5	2.0	2.6	1.4	-1.1	0.2	-2.6	3.8	4.0	3.2	2.8	5.3	-0.1
31-Dec	0.0	0.1	-0.1	0.2	1.0	-0.8	2.2	2.5	1.9	1.3	3.4	-0.5	0.7	1.3	0.4	-3.0	-0.7	-4.4	2.7	3.1	2.5	-0.6	0.5	-1.8

Appendix G – Lake level record for Shelton Lake, Sep 2008-Dec 2011 (mean daily; metres geodetic).

2008	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1										549.27	549.45	549.61
2										549.28	549.48	549.61
3										549.30	549.54	549.60
4										549.32	549.57	549.59
5										549.33	549.58	549.58
6										549.33	549.60	549.57
7										549.35	549.68	549.57
8										549.35	549.91	549.56
9										549.35	549.94	549.56
10										549.35	549.87	549.56
11										549.35	549.83	549.56
12										549.34	549.83	549.57
13										549.35	549.81	549.58
14										549.35	549.77	549.58
15										549.35	549.73	549.59
16										549.36	549.70	549.58
17										549.38	549.67	549.57
18										549.42	549.65	549.57
19										549.42	549.63	549.57
20										549.43	549.62	549.56
21										549.44	549.62	549.57
22										549.44	549.65	549.57
23									549.25	549.44	549.66	549.56
24									549.26	549.44	549.65	549.56
25									549.27	549.43	549.64	549.55
26									549.28	549.43	549.64	549.55
27									549.28	549.43	549.62	549.55
28									549.28	549.42	549.62	549.55
29									549.28	549.42	549.62	549.58
30									549.27	549.42	549.61	549.59
31										549.44		549.60

2009	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	549.60	548.84	549.68	549.64	549.61	549.46	549.30	549.21	549.12	549.14	549.75	549.84
2	549.59	549.60	549.78	549.65	549.61	549.45	549.30	549.21	549.11	549.14	549.72	549.80
3	549.58	549.60	549.84	549.64	549.61	549.44	549.29	549.20	549.11	549.13	549.69	549.75
4	549.58	549.60	549.81	549.64	549.62	549.43	549.29	549.20	549.11	549.13	549.66	549.71
5	549.59	549.60	549.77	549.63	549.68	549.42	549.29	549.19	549.11	549.13	549.68	549.68
6	549.59	549.60	549.74	549.63	549.74	549.41	549.28	549.19	549.12	549.12	549.86	549.66
7	549.70	549.60	549.72	549.64	549.75	549.41	549.28	549.18	549.12	549.12	549.92	549.64
8	549.82	549.60	549.69	549.67	549.74	549.40	549.29	549.18	549.12	549.12	549.89	549.62
9	549.85	549.60	549.67	549.69	549.72	549.39	549.29	549.17	549.14	549.12	549.92	549.61
10	549.85	549.60	549.66	549.70	549.70	549.39	549.28	549.18	549.15	549.12	549.93	549.59
11	549.84	549.60	549.64	549.71	549.68	549.38	549.28	549.18	549.14	549.12	549.87	549.57
12	549.81	549.59	549.62	549.74	549.67	549.37	549.28	549.18	549.14	549.12	549.82	549.56
13	549.79	549.58	549.61	549.78	549.66	549.37	549.28	549.18	549.14	549.12	549.78	549.55
14	549.76	549.58	549.61	549.77	549.66	549.36	549.27	549.18	549.14	549.12	549.75	549.54
15	549.74	549.57	549.61	549.75	549.65	549.36	549.27	549.17	549.14	549.13	549.80	549.55
16	549.72	549.56	549.64	549.72	549.64	549.35	549.27	549.17	549.14	549.18	550.16	549.60
17	549.69	549.55	549.64	549.72	549.63	549.35	549.26	549.17	549.14	549.21	550.11	549.77
18	549.69	549.55	549.64	549.73	549.62	549.34	549.26	549.16	549.14	549.25	549.98	549.83
19	549.69	549.54	549.65	549.72	549.61	549.34	549.26	549.16	549.14	549.27	549.95	549.83
20	549.70	549.53	549.70	549.72	549.60	549.33	549.25	549.16	549.14	549.28	550.07	549.84
21	549.70	549.53	549.74	549.72	549.58	549.32	549.24	549.15	549.15	549.29	549.98	549.88
22	549.69	549.53	549.73	549.73	549.57	549.32	549.24	549.15	549.15	549.30	549.92	549.85
23	549.68	549.55	549.72	549.72	549.55	549.31	549.24	549.15	549.15	549.32	549.87	549.79
24	549.66	549.59	549.70	549.70	549.54	549.32	549.24	549.14	549.14	549.34	549.85	549.75
25	549.65	549.67	549.69	549.68	549.53	549.33	549.23	549.14	549.14	549.35	549.92	549.71
26	549.64	549.69	549.67	549.67	549.52	549.32	549.23	549.14	549.14	549.40	550.04	549.68
27	549.63	549.68	549.66	549.65	549.52	549.32	549.22	549.13	549.14	549.44	549.93	549.66
28	549.62	549.67	549.65	549.64	549.50	549.32	549.22	549.13	549.14	549.46	549.85	549.63
29	549.61		549.64	549.63	549.49	549.32	549.22	549.12	549.14	549.48	549.81	549.62
30	549.60		549.63	549.62	549.48	549.31	549.22	549.12	549.14	549.53	549.83	549.60
31	549.60		549.64		549.47		549.21	549.12		549.73		549.60

Appendix G – Lake level record for Shelton Lake (mean daily; metres geodetic).

2010	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	549.63	549.64	549.76	549.76	549.63	549.63	549.37	549.22	549.14	549.39	549.81	549.66
2	549.71	549.63	549.73	549.77	549.62	549.64	549.36	549.21	549.14	549.39	549.91	549.66
3	549.72	549.62	549.70	549.81	549.64	549.65	549.35	549.21	549.13	549.39	549.84	549.65
4	549.73	549.62	549.67	549.78	549.64	549.64	549.35	549.21	549.13	549.39	549.77	549.64
5	549.74	549.62	549.65	549.75	549.64	549.63	549.34	549.20	549.13	549.39	549.72	549.62
6	549.73	549.62	549.63	549.72	549.62	549.62	549.34	549.20	549.14	549.38	549.69	549.61
7	549.71	549.62	549.61	549.72	549.61	549.60	549.33	549.21	549.14	549.38	549.70	549.65
8	549.70	549.61	549.60	549.80	549.60	549.58	549.32	549.21	549.14	549.38	549.69	549.91
9	549.78	549.60	549.59	549.79	549.58	549.57	549.32	549.21	549.13	549.40	549.68	550.03
10	549.85	549.60	549.58	549.75	549.57	549.56	549.32	549.21	549.13	549.49	549.67	549.95
11	550.07	549.60	549.59	549.71	549.55	549.55	549.31	549.20	549.13	549.54	549.66	549.86
12	550.11	549.69	549.59	549.68	549.54	549.54	549.31	549.20	549.14	549.57	549.66	549.93
13	549.96	549.78	549.60	549.66	549.53	549.52	549.30	549.19	549.15	549.58	549.65	549.96
14	549.90	549.89	549.59	549.65	549.51	549.51	549.30	549.19	549.14	549.57	549.64	549.93
15	550.10	549.86	549.62	549.65	549.50	549.50	549.29	549.18	549.14	549.57	549.63	549.88
16	550.01	549.83	549.65	549.65	549.49	549.49	549.29	549.18	549.14	549.56	549.63	549.81
17	549.90	549.79	549.73	549.66	549.48	549.48	549.28	549.18	549.14	549.54	549.64	549.75
18	549.89	549.75	549.73	549.69	549.48	549.47	549.28	549.18	549.15	549.53	549.66	549.72
19	549.88	549.71	549.71	549.69	549.48	549.45	549.27	549.17	549.18	549.52	549.65	549.69
20	549.83	549.68	549.68	549.71	549.51	549.44	549.27	549.17	549.19	549.51	549.65	549.67
21	549.78	549.66	549.68	549.71	549.53	549.44	549.26	549.17	549.19	549.50	549.63	549.66
22	549.74	549.64	549.68	549.70	549.54	549.43	549.26	549.16	549.19	549.49	549.63	549.70
23	549.70	549.62	549.67	549.68	549.54	549.42	549.26	549.16	549.19	549.49	549.61	549.76
24	549.67	549.62	549.66	549.67	549.54	549.41	549.25	549.15	549.23	549.55	549.59	549.96
25	549.71	549.67	549.65	549.67	549.54	549.40	549.25	549.15	549.25	549.67	549.58	550.06
26	549.77	549.72	549.65	549.66	549.55	549.40	549.24	549.14	549.32	549.79	549.58	549.98
27	549.76	549.78	549.64	549.67	549.58	549.39	549.24	549.14	549.35	549.77	549.59	549.91
28	549.73	549.79	549.65	549.68	549.60	549.38	549.23	549.14	549.38	549.73	549.59	549.82
29	549.70		549.78	549.67	549.63	549.38	549.23	549.14	549.39	549.70	549.59	549.78
30	549.68		549.84	549.65	549.63	549.37	549.23	549.14	549.40	549.68	549.64	549.99
31	549.66		549.80		549.63		549.22	549.14		549.68		550.02

2011	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	550.00	549.67	549.57	549.78	549.66	549.57	549.36	549.30	549.23	549.53	549.55	549.75
2	549.99	549.65	549.59	549.77	549.66	549.57	549.35	549.29	549.22	549.52	549.54	549.71
3	549.94	549.63	549.61	549.74	549.67	549.56	549.35	549.29	549.22	549.51	549.54	549.67
4	549.79	549.67	549.61	549.72	549.67	549.55	549.34	549.28	549.22	549.51	549.54	549.65
5	549.66	549.71	549.61	549.72	549.66	549.53	549.34	549.28	549.21	549.51	549.53	549.62
6	549.61	549.72	549.59	549.72	549.66	549.52	549.33	549.28	549.21	549.51	549.53	549.60
7	549.78	549.73	549.58	549.70	549.67	549.52	549.33	549.28	549.21	549.50	549.52	549.59
8	549.86	549.71	549.57	549.68	549.67	549.51	549.33	549.27	549.20	549.50	549.51	549.57
9	549.82	549.70	549.60	549.66	549.66	549.50	549.32	549.27	549.20	549.50	549.52	549.56
10	549.77	549.67	549.69	549.67	549.66	549.49	549.32	549.27	549.20	549.51	549.53	549.54
11	549.72	549.65	549.76	549.74	549.66	549.48	549.31	549.27	549.20	549.60	549.56	549.53
12	549.72	549.70	549.81	549.75	549.67	549.47	549.32	549.26	549.19	549.71	549.60	
13	549.73	549.84	549.87	549.73	549.67	549.47	549.33	549.26	549.20	549.72	549.61	
14	549.81	549.86	550.01	549.72	549.66	549.46	549.33	549.26	549.19	549.69	549.62	
15	549.96	549.90	550.03	549.70	549.74	549.45	549.33	549.25	549.19	549.66	549.61	
16	549.99	549.85	549.99	549.68	549.80	549.44	549.34	549.25	549.19	549.63	549.61	
17	549.98	549.80	549.89	549.65	549.78	549.43	549.34	549.25	549.20	549.61	549.63	
18	549.90	549.75	549.82	549.63	549.74	549.42	549.34	549.24	549.20	549.59	549.64	
19	549.82	549.71	549.77	549.62	549.71	549.42	549.34	549.24	549.20	549.57	549.63	
20	549.76	549.68	549.73	549.61	549.68	549.41	549.33	549.24	549.19	549.55	549.62	
21	549.73	549.65	549.70	549.60	549.66	549.40	549.33	549.23	549.19	549.55	549.62	
22	549.70	549.63	549.68	549.59	549.65	549.40	549.33	549.25	549.23	549.55	549.78	
23	549.68	549.62	549.66	549.58	549.64	549.39	549.32	549.25	549.26	549.55	549.85	
24	549.67	549.61	549.65	549.57	549.63	549.38	549.32	549.25	549.26	549.54	549.82	
25	549.67	549.59	549.64	549.58	549.62	549.38	549.32	549.25	549.29	549.53	549.80	
26	549.68	549.57	549.64	549.58	549.62	549.38	549.31	549.24	549.34	549.53	549.77	
27	549.68	549.57	549.64	549.61	549.61	549.37	549.31	549.24	549.46	549.52	550.00	
28	549.68	549.58	549.64	549.64	549.61	549.37	549.31	549.24	549.53	549.52	549.99	
29	549.69		549.66	549.66	549.60	549.37	549.30	549.24	549.54	549.54	549.88	
30	549.69		549.68	549.66	549.59	549.36	549.30	549.24	549.53	549.55	549.81	
31	549.68		549.74		549.58		549.30	549.23		549.55		

Appendix H – Water and air temperature records for Shelton Lake, Sep 2008 to Dec 2011.

	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Jan							2.2	2.2	2.1	-2.6	-0.8	-6.9	2.9	3.3	2.4	1.8	3.6	-0.1	1.9	2.2	1.8	-6.8	-3.8	-9.2
2-Jan							2.2	2.2	2.1	-8.7	-4.9	-12.0	3.2	3.5	2.7	1.8	3.6	0.8	2.0	2.3	1.9	-6.4	-4.0	-8.5
3-Jan							2.1	2.1	2.0	-5.0	-2.6	-11.6	3.3	3.4	3.2	0.9	2.6	-0.5	2.1	2.4	2.0	-5.5	-3.0	-7.8
4-Jan							2.0	2.0	1.9	-1.7	-1.1	-2.8	3.3	3.3	3.2	0.7	2.0	0.0	2.0	2.1	2.0	-2.4	-1.3	-3.8
5-Jan							1.9	1.9	1.9	-1.0	0.8	-2.4	3.3	3.4	3.3	2.1	3.4	0.9	2.0	2.0	2.0	-0.5	0.0	-1.5
6-Jan							1.9	1.9	1.8	1.6	3.7	0.0	3.3	3.4	3.2	0.5	2.2	-1.3	2.0	2.1	2.0	0.3	1.5	-0.1
7-Jan							2.0	2.3	1.8	3.1	4.2	0.8	3.4	3.5	3.3	-0.3	1.5	-2.0	1.8	2.1	1.6	1.8	3.7	-1.1
8-Jan							2.5	2.6	2.3	0.9	2.3	-2.2	3.4	3.6	3.3	2.2	4.4	0.3	2.1	2.4	2.1	-1.7	0.4	-3.5
9-Jan							2.6	2.6	2.5	-0.4	0.7	-2.3	3.3	3.4	3.2	4.5	5.4	2.9	2.1	2.1	2.1	-3.4	-1.1	-8.2
10-Jan							2.5	2.6	2.4	0.6	1.2	0.1	3.5	3.6	3.4	4.8	6.6	3.8	2.1	2.1	2.1	-7.1	-4.4	-11.7
11-Jan							2.6	2.7	2.5	0.6	2.0	0.1	3.5	4.0	3.3	7.1	7.9	5.8	2.0	2.1	2.0	-3.8	-2.5	-4.6
12-Jan							2.6	2.7	2.5	1.3	3.6	0.3	4.0	4.1	3.7	6.3	7.7	5.0	1.9	2.0	1.9	-1.1	0.5	-3.5
13-Jan							2.5	2.6	2.5	0.6	1.6	-0.1	3.9	4.1	3.8	5.3	6.6	4.4	1.9	1.9	1.9	1.2	3.2	-0.2
14-Jan							2.6	2.7	2.5	-0.5	2.1	-2.0	3.8	4.0	3.8	3.7	5.4	2.9	1.8	2.0	1.7	3.6	4.9	1.8
15-Jan							2.7	2.8	2.6	-0.1	3.3	-1.5	3.9	4.1	3.8	3.4	5.6	-0.4	1.9	2.1	1.7	2.5	4.6	1.0
16-Jan							2.7	2.8	2.7	-0.8	3.3	-2.2	3.8	4.1	3.5	-0.2	1.7	-1.7	2.1	2.2	1.9	4.5	5.6	3.1
17-Jan							2.8	2.8	2.7	-1.4	1.2	-3.2	3.6	3.8	3.5	3.0	4.8	0.8	2.1	2.2	2.0	2.6	3.8	0.1
18-Jan							2.8	2.9	2.7	-0.3	4.5	-2.2	3.8	4.0	3.7	3.6	4.8	1.3	2.1	2.1	2.1	-1.1	0.1	-4.1
19-Jan							2.8	2.9	2.8	-0.7	3.8	-2.2	3.8	3.9	3.8	3.6	4.9	1.3	2.1	2.2	2.1	-2.6	0.1	-5.3
20-Jan							2.9	3.0	2.8	-1.6	1.2	-3.6	3.9	4.0	3.8	3.5	5.9	2.3	2.1	2.2	2.1	0.1	1.0	-0.7
21-Jan							3.0	3.0	2.9	-2.3	0.8	-4.4	3.9	4.0	3.8	3.3	5.3	1.8	2.2	2.3	2.1	1.0	2.4	-0.1
22-Jan							3.0	3.1	2.9	-2.5	0.3	-5.0	3.9	4.0	3.8	0.9	4.1	-0.5	2.2	2.4	2.2	0.3	1.8	-0.9
23-Jan							3.0	3.1	3.0	-3.9	0.0	-5.9	3.8	4.1	3.4	2.5	5.2	-0.1	2.3	2.5	2.2	1.5	2.8	0.5
24-Jan							3.0	3.1	3.0	-4.3	-0.6	-7.0	3.7	4.0	3.5	2.0	2.7	0.9	2.3	2.5	2.3	2.0	4.0	1.2
25-Jan							3.0	3.0	2.9	-3.9	-1.5	-7.9	3.5	3.6	3.4	2.3	3.2	1.6	2.4	2.4	2.3	1.6	3.1	0.0
26-Jan							2.9	3.0	2.9	-6.2	-1.6	-10.9	3.7	4.0	3.5	1.8	5.0	-0.3	2.4	2.6	2.3	2.0	4.0	0.6
27-Jan							2.8	2.9	2.8	-1.8	0.0	-3.4	3.5	3.7	3.3	1.6	3.5	-0.3	2.5	2.7	2.4	1.2	3.5	-0.3
28-Jan							2.7	2.8	2.7	-1.1	1.3	-3.6	3.4	3.5	3.3	2.4	3.6	1.8	2.5	2.5	2.4	1.3	2.9	-0.6
29-Jan							2.6	2.7	2.5	1.3	3.6	0.0	3.7	3.9	3.5	3.6	5.2	2.2	2.5	2.6	2.4	1.7	3.0	0.7
30-Jan							2.5	2.6	2.1	0.9	3.4	-0.3	4.0	4.3	3.8	4.7	6.2	3.8	2.5	2.7	2.5	-0.2	0.8	-2.3
31-Jan							2.6	2.6	2.5	-0.2	3.5	-2.2	4.2	4.5	3.9	3.8	5.9	1.8	2.6	2.9	2.4	-1.7	1.2	-3.3
1-Feb							2.5	2.5	2.5	-0.1	0.0	-2.4	4.0	4.1	3.9	2.6	4.2	1.4	2.7	3.1	2.6	-2.1	1.8	-4.3
2-Feb							2.4	2.5	2.4	0.3	2.7	-0.9	3.9	4.1	3.8	3.2	4.9	2.3	2.7	2.9	2.6	-0.8	1.8	-3.1
3-Feb							2.5	2.5	2.4	0.4	4.5	-1.2	4.1	4.4	3.9	3.0	5.2	1.8	2.7	2.9	2.6	2.6	4.7	0.4
4-Feb							2.5	2.6	2.5	0.7	6.8	-1.3	4.1	4.2	4.1	3.7	4.8	3.0	2.6	3.2	1.5	4.2	6.9	1.3
5-Feb							2.5	2.6	2.5	0.2	2.6	-1.7	4.2	4.4	4.0	4.7	6.2	3.8	2.9	3.3	2.7	2.0	4.6	0.6
6-Feb							2.6	2.7	2.5	1.2	4.7	-2.6	4.3	4.6	4.0	4.6	7.3	2.1	2.9	3.1	2.8	2.4	4.0	1.2
7-Feb							2.7	2.7	2.6	1.3	3.3	-4.1	4.5	4.9	4.1	3.3	7.8	0.0	2.7	2.8	2.5	2.2	3.7	0.6
8-Feb							2.6	2.7	2.6	0.7	2.8	-0.5	4.5	4.7	4.3	2.3	5.5	-0.8	2.6	2.9	2.3	-0.1	1.3	-2.8
9-Feb							2.7	2.7	2.6	-0.8	3.4	-3.4	4.4	4.8	4.1	0.6	5.7	-1.7	2.6	2.8	2.2	-1.8	2.0	-4.2
10-Feb							2.7	2.7	2.6	-2.5	-1.5	-4.4	4.3	4.4	4.1	1.5	2.8	-0.5	2.8	3.1	2.6	-1.4	3.5	-3.9
11-Feb							2.6	2.6	2.5	-1.1	1.0	-3.1	4.2	4.4	4.1	3.7	5.7	2.0	2.8	2.8	2.7	0.1	1.2	-1.1
12-Feb							2.5	2.5	2.5	-0.5	2.6	-2.5	4.1	4.4	4.0	3.4	5.5	2.4	2.7	2.8	2.2	2.9	4.4	0.2
13-Feb							2.5	2.5	2.4	-0.5	3.1	-2.1	4.1	4.2	4.0	4.0	5.7	3.1	2.7	2.9	2.5	1.5	2.7	0.5
14-Feb							2.4	2.4	2.3	-1.9	2.5	-4.1	4.4	4.8	4.1	4.1	8.1	-0.3	2.6	2.8	2.5	1.7	3.2	1.0
15-Feb							2.3	2.4	2.3	-1.3	5.1	-5.5	4.3	4.4	4.2	2.0	4.7	-0.8	2.3	2.4	2.0	0.2	0.7	0.0
16-Feb							2.3	2.3	2.3	-3.8	2.3	-9.0	4.4	4.7	4.2	3.7	7.6	-0.7	1.9	2.0	1.7	-0.1	0.6	-0.6
17-Feb							2.2	2.3	2.2	-1.5	3.7	-5.6	4.3	4.7	4.1	0.6	6.7	-1.9	1.7	1.8	1.5	-1.6	-0.2	-3.4
18-Feb							2.2	2.2	2.2	-2.5	2.1	-6.7	4.2	4.5	4.0	0.0	5.2	-2.5	1.8	2.0	1.5	-1.8	0.4	-3.7
19-Feb							2.2	2.2	2.1	-0.9	6.8	-5.1	4.4	5.0	4.0	0.9	7.0	-2.3	2.1	2.4	1.9	-3.8	2.1	-6.9
20-Feb							2.2	2.2	2.1	-1.6	6.5	-5.8	4.8	5.1	4.5	1.6	8.9	-1.6	2.2	2.4	2.0	-3.5	1.2	-8.1
21-Feb							2.2	2.2	2.1	-0.9	6.8	-5.1	4.9	5.4	4.6	2.1	9.7	-1.6	2.3	2.4	2.2	-1.1	2.1	-2.5
22-Feb							2.2	2.2	2.1	1.1	2.8	0.3	4.6	5.2	4.2	1.9	9.4	-1.7	2.4	2.6	2.3	-2.6	1.1	-6.1
23-Feb							2.1	2.2	2.1	1.1	2.4	0.2	4.5	4.7	4.4	1.8	2.8	0.4	2.4	2.4	2.4	-5.9	-3.6	-8.5
24-Feb							2.4	2.9	2.2	1.6	4.4	-0.2	4.4	4.7	4.2	2.8	4.5	1.7	2.4	2.4	2.4	-7.3	-4.9	-12.2
25-Feb							2.7	2.9	2.6	-0.6	1.1	-3.6	4.4	4.6	4.1	3.2	5.0	1.4	2.4	2.4	2.4	-7.9	-1.5	-12.0
26-Feb							2.6	2.7	2.6	-3.0	-0.1	-6.2	4.5	4.7	4.4	4.1	5.3	3.0	2.4	2.4	2.4	-5.3	-1.2	-12.3
27-Feb							2.5	2.6	2.5	-1.6	0.4	-2.9	4.5	4.6	4.5	4.8	6.0	3.7	2.4	2.4	2.3	-1.4	-0.2	-3.5
28-Feb							2.5	2.5	2.5	-0.6	1.8	-3.4	4.6	4.9	4.4	5.1	7.1	2.7	2.3	2.3	2.2	-2.0	-0.1	-3.3
1-Mar							2.5	2.5	2.4	1.5	3.7	0.0	4.9	5.1	4.7	5.1	7.5	3.1	2.2	2.2	2.1	-1.4	0.4	-3.0
2-Mar							2.6	2.9	2.4	2.3	6.7	-0.6	5.0	5.2	4.8	5.2	7.2	2.8	2.0	2.2	1.6	0.1	1.2	-0.7
3-Mar							2.9	2.9	2.8	0.3	2.7	-1.0	4.9	5.6	4.5	3.2	9.3	-0.4	2.0	2.1	2.0	-0.6	1.4	-2.0
4-Mar							2.9	3.1	2.9	1.2	7.1	-2.3	4.9	5.6	4.4	2.9	8.7	-0.7	1.9	2.0	1.9	-1.4	-0.3	-3.0
5-Mar							2.9	3.0	2.8	0.9	5.7	-2.7	5.0	5.4	4.8	3.3	8.5	-0.2	1.8	1.9	1.8	0.0	2.0	-2.3
6-Mar							3.1	3.2	2.9	-0.7	5.9	-5.4	4.9	5.8	4.4	3.2	12.2	-1.4	1.8	1.8	1.7	0.1	3.2	-1.5
7-Mar							3.0	3.1	2.9	-1.0	2.1	-6.9	4.7	5.1	4.4	2.2	5.2	-0.7	1.7	1.7	1.7	-0.9	2.1	-4.4
8-Mar							3.0	3.0	2.9	-3.3	0.5	-6.9	4.5	5.1	4.1	-0.5	4.8	-3.6	1.7	1.7	1.6	0.6	2.8	-0.2
9-Mar							2.9	3.0	2.9	-3.6	1.3	-9.4	4.3	4.5	4.0	-0.9	1.6	-3.8	1.6	1.7	1.6	1.0	2.4	-0.3
10-Mar							2.9	2.9	2.8	-5.4	2.5	-10.1	4.3	5.1	3.9	0.9	3.8	-0.2	1.7	2.0	1.6	1.3	2.4	0.2
11-Mar							2.8	2.8	2.7	-4.5	5.3	-10.9	3.7	4.1	3.2	0.8	3.2	-0.3	2.0	2.1	2.0	0.7	2.6	-0.1
12-Mar							2.7	2.7	2.7	-2.4	8.5	-9.1	3.8	4.0	3.5	0.0	2.0	-1.0	2.0	2.1	1.9	1.4	4.1	0.1
13-Mar							2.7	2.8	2.6	2.0	9.5	-2.3	3.7	4.3	3.2	0.8	3.3	-0.2	2.0	2.1	1.8	1.7	4.0	0.0
14-Mar							2.7	2.8	2.7	0.5	2.6	-1.8	3.9	4.1	3.8	1.1	1.8	0.6	1.9	2.0	1.7	1.5	2.2	0.7
15-Mar							2.7	2.8	2.4	-0.8	0.1	-1.7	3.9	4.2	3.6	2.1	4.2	0.6	1.8	1.9	1.8	1.8	2.9	0.6
16-Mar							2.5	2.6	2.4	-0.4	1.1	-1.4	4.2	4.7	4.0	2.9	6.1	1.7	1.9	2.0	1.8	0.9	2.4	0.0
17-Mar							2.4	2.5	2.3	-0.8	2.0	-4.4	4.3	5.1	3.6	2.5	7.7	-1.4	2.1	2.2	1.9	0.6	3.2	-1.5
18-Mar							2.3	2.3	2.2	0.3	1.4	-1.0	4.4	5.1	4.1	0.9	6.7	-2.7	2.0	2.1	2.0	0.8	2.2	-0.1
19-Mar							2.2	2.3	2.2	2.5	5.1	1.2	4.4	5.4	4.0	2.1	11.0	-2.3	2.1	2.3	1.9	1.2	4.7	-0.9
20-Mar							2.2	2.3	2.1	0.7	2.4	-2.4	4.6	5.4	4.1	3.5	9.6	-1.9	2.2	2.3	2.0	1.5	5.7	-1.3
21-Mar							2.5	2.7	2.3	-0.1	6.3	-4.0	4.8	5.3	4.4	4.8	6.3	2.7	2.2	2.4	2.1	1.4	4.4	-0.2
22-Mar							2.6	2.6	2.5	0.6	3.4	-2.2	5.1	5.9	4.4	4.3	9.2	1.2	2.4	2.5	2.2	1.4	6.1	-1.0
23-Mar							2.4	2.5	2.4	0.3	1.2	-0.6	5.3	5.9	4.8	4.0	8.4	0.3	2.6	2.8	2.4	2.3	8.1	-1.0
24-Mar							2.4	2.4	2.3	1.6	3.9	0.1	5.6	6.4	5.0	5.6	13.6	0.5	2.7	2.9	2.6	2.3	8.2	-1.2
25-Mar							2.3	2.4	2.3	1.2	6.2	-2.5	5.9	6.2	5.6	5.2	6.9	3.4	2.8	2.9	2.7	1.4	3.6	-0.1
26-Mar							2.4	2.5	2.4	0.9	5.9	-3.2	5.8	6.5	5.2	4.5	8.8	1.8	2.8	3.0	2.7	2.4	6.9	-0.5
27-Mar							2.5	2.6	2.4	2.3	4.7	0.1	5.7	6.2	5.3	5.3	8.8	2.8	2.9	3.1	2.8	1.8	6.4	-0.5
28-Mar							2.5	2.6	2.4	0.7	3.0	-1.0	5.8	6.6	5.3	4.2	7.2	2.0	3.0	3.1	2.8	2.1	5.4	-0.4
29-Mar							2.5	2.6	2.4	2.2	8.5	-0.6	4.9	5.4	4.3	1.2	2.3	0.5	3.0	3.2	2.9	1.5	3.1	0.3
30-Mar							2.6	2.7	2.6	2.1	4.6	0.3	4.8	5.7	4.2	1.5	4.6	0.1	2.9	3.1	2.9	4.2	6.1	2.0
31-Mar							2.6	2.7	2.5	1.5	4.8	-1.7	5.2	5.7	4.8	1.0	4.2	-1.6	2.9	3.4	2.2	5.9	11.8	3.4

Appendix H – Water and air temperature records for Shelton Lake, Sep 2008 to Dec 2011.

	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Apr							2.6	2.7	2.6	-0.2	1.8	-2.2	4.9	5.3	4.7	0.9	3.6	-0.6	3.2	3.5	2.9	2.1	3.5	0.2
2-Apr							2.6	2.6	2.5	1.0	5.4	-1.2	4.2	4.7	3.9	0.9	1.6	0.1	3.5	4.3	2.8	2.6	9.0	-0.8
3-Apr							2.5	2.6	2.2	1.5	7.4	-2.0	4.2	4.6	3.9	1.1	2.6	0.0	3.6	3.8	3.3	1.0	4.0	-1.9
4-Apr							2.6	2.7	2.5	1.6	10.2	-3.6	4.5	4.9	4.2	1.9	5.1	0.0	3.3	3.6	3.0	1.5	3.3	0.4
5-Apr							2.8	2.9	2.6	2.7	10.7	-1.7	4.7	5.2	4.3	2.4	5.8	0.4	3.3	4.2	2.8	1.4	6.5	-0.1
6-Apr							3.1	3.4	2.8	3.7	13.8	-1.0	5.1	5.7	4.5	3.1	6.8	0.5	3.6	4.9	2.8	2.0	8.9	-1.5
7-Apr							3.9	4.5	3.4	4.0	13.9	-1.8	4.7	4.9	4.3	2.5	4.5	0.5	3.6	4.5	2.2	2.1	9.3	-1.7
8-Apr							4.4	4.7	4.3	3.5	9.0	-0.4	4.6	5.6	3.9	0.8	3.7	-1.3	4.3	5.3	3.7	3.1	10.8	-2.6
9-Apr							4.5	4.6	4.4	2.4	5.4	0.4	4.8	5.9	3.9	0.3	3.5	-2.9	4.3	4.7	3.9	3.4	6.0	1.2
10-Apr							4.5	4.8	4.4	3.3	11.0	-0.7	4.7	5.6	4.4	0.7	6.9	-2.5	4.2	4.6	4.0	3.3	5.4	1.7
11-Apr							4.5	4.7	4.4	3.5	7.6	1.3	4.8	5.6	4.2	2.6	10.1	-2.0	4.3	5.1	3.4	2.3	6.0	0.5
12-Apr							4.4	4.5	4.3	2.5	4.3	1.3	5.4	6.6	4.5	5.1	13.3	-1.0	4.4	4.9	4.0	2.1	5.3	0.1
13-Apr							4.4	4.7	4.3	2.1	7.2	-1.2	5.9	6.7	5.4	5.6	11.4	1.6	4.5	5.1	3.9	2.2	5.2	0.3
14-Apr							4.6	4.8	4.4	3.1	10.9	-1.7	5.8	6.7	4.8	6.0	12.3	1.9	3.7	4.2	3.1	0.4	1.4	-0.5
15-Apr							4.9	5.3	4.6	3.5	13.1	-2.4	6.6	7.4	4.8	5.6	11.6	1.2	4.3	4.8	3.6	0.4	3.9	-3.1
16-Apr							4.9	5.3	4.4	3.6	8.4	-0.2	6.7	7.1	6.0	7.3	14.8	1.0	4.7	5.3	4.2	1.2	4.8	-1.3
17-Apr							4.7	5.0	4.4	3.9	9.7	1.5	7.2	7.6	6.5	6.7	9.3	3.6	4.9	5.8	4.3	2.1	8.6	-2.2
18-Apr							4.8	5.5	4.3	4.5	11.5	0.2	7.8	8.5	7.3	8.2	12.4	4.7	4.8	5.6	4.3	2.5	8.2	-1.6
19-Apr							4.8	5.3	4.4	5.0	7.8	2.0	8.5	9.4	7.9	10.0	15.8	6.2	5.3	6.5	4.3	2.6	8.5	-1.3
20-Apr							5.3	5.9	4.8	7.4	11.4	3.7	8.1	8.9	6.8	7.3	9.7	5.7	5.1	5.8	4.3	0.8	4.1	-2.1
21-Apr							5.9	7.0	5.0	8.3	16.3	2.6	7.5	8.8	6.3	6.7	13.0	2.7	5.2	6.6	4.0	3.3	9.7	-0.7
22-Apr							5.5	6.4	4.9	3.9	9.3	-0.6	8.1	9.5	7.2	5.5	11.4	1.0	5.7	6.5	4.7	3.2	10.6	-1.0
23-Apr							5.3	6.2	4.7	4.4	10.9	-0.5	8.3	8.6	7.8	3.4	8.6	-0.3	5.7	7.8	4.4	4.5	14.0	-1.8
24-Apr							6.1	7.4	4.6	4.6	13.3	-2.2	8.2	8.8	7.8	3.3	6.3	0.9	6.8	7.4	5.3	4.7	8.0	1.0
25-Apr							6.2	6.7	5.6	4.8	11.3	0.5	8.4	9.1	7.8	5.4	8.8	2.3	7.3	7.8	6.8	4.2	7.0	1.3
26-Apr							6.4	7.2	5.2	4.6	11.1	-1.3	8.7	9.0	8.5	6.9	11.5	4.0	7.5	8.3	6.9	5.2	10.3	1.1
27-Apr							6.8	7.9	6.1	6.5	13.9	0.9	8.5	8.9	8.0	5.8	8.0	3.7	6.7	8.0	5.9	1.9	3.1	0.4
28-Apr							6.9	8.0	6.2	6.1	13.9	0.4	8.6	9.4	7.9	5.8	10.4	2.3	6.2	6.7	5.6	1.7	4.4	0.3
29-Apr							7.6	8.3	6.5	6.2	12.0	0.5	8.9	9.4	8.4	5.8	10.6	1.0	6.8	7.5	6.1	3.9	9.2	-0.3
30-Apr							7.9	9.1	7.1	7.7	16.9	1.1	9.0	9.8	8.6	5.9	11.4	1.6	7.0	7.8	6.3	4.5	8.9	0.3
1-May							9.0	10.4	7.5	8.6	17.9	0.3	8.7	9.3	8.3	6.6	9.5	3.1	7.3	8.4	6.3	6.0	14.2	-0.4
2-May							9.4	9.7	9.1	7.3	11.4	3.6	8.5	9.0	8.1	5.2	6.3	3.4	8.0	8.4	7.8	4.7	7.6	3.4
3-May							9.4	10.0	8.7	7.0	11.1	3.9	8.5	9.2	7.8	4.7	7.3	1.5	7.8	8.5	7.2	5.4	8.8	2.3
4-May							9.1	9.7	8.7	5.7	7.4	4.0	8.6	9.2	8.2	2.0	6.6	-1.1	8.2	9.1	7.3	6.6	13.9	0.0
5-May							8.6	9.1	8.2	5.4	8.0	3.5	8.4	8.9	8.0	3.7	10.8	-1.8	8.6	9.1	8.0	7.0	10.8	4.4
6-May							8.5	8.7	8.3	4.8	6.9	2.4	8.8	9.8	7.8	4.8	10.4	-0.3	8.3	8.7	7.8	5.6	8.1	4.0
7-May							8.2	8.5	7.9	5.2	7.5	2.6	9.0	9.8	8.3	6.4	14.4	0.4	8.5	8.9	8.1	5.2	7.5	2.4
8-May							8.3	8.8	7.8	5.6	9.6	2.2	9.4	10.1	8.4	6.0	12.7	-0.2	8.2	8.7	7.7	5.4	9.4	0.5
9-May							8.4	9.3	7.8	7.2	15.7	0.5	10.3	11.4	9.3	7.3	15.9	-0.1	8.7	9.9	7.8	8.4	13.3	5.2
10-May							9.2	10.2	8.0	7.7	14.0	2.0	10.1	10.8	9.3	8.8	15.5	4.8	9.0	9.6	8.6	7.4	11.2	5.1
11-May							9.7	10.3	9.4	6.2	9.8	3.4	10.6	11.4	9.9	9.9	18.3	2.5	8.9	9.2	8.5	5.4	6.7	2.9
12-May							9.7	10.3	9.2	5.2	11.2	0.0	11.1	11.9	10.6	8.6	13.3	3.4	8.8	8.9	8.5	3.9	6.8	1.7
13-May							9.2	9.5	8.8	3.2	6.2	0.4	11.0	11.6	10.5	9.6	17.9	2.3	8.8	9.9	8.1	7.2	13.6	1.4
14-May							9.4	14.4	8.5	6.3	14.9	0.3	11.5	12.8	10.9	11.0	18.5	4.7	8.9	9.7	8.1	8.6	13.0	5.0
15-May							9.5	10.1	9.0	8.2	15.0	2.5	13.1	14.6	11.7	11.8	18.7	4.8	9.3	9.5	9.0	7.9	10.2	5.5
16-May							10.7	11.9	9.3	11.1	16.2	6.6	13.4	14.7	12.8	11.9	17.5	6.7	9.1	9.3	8.9	6.0	8.2	3.0
17-May							11.8	12.8	11.1	13.8	21.1	9.5	13.7	14.5	12.8	11.5	18.6	6.5	8.8	9.6	8.1	5.8	11.9	0.1
18-May							12.4	12.8	11.8	9.2	13.5	4.1	13.8	14.2	13.4	9.8	12.6	7.7	8.7	9.8	8.0	6.9	13.3	0.8
19-May							11.9	12.4	11.3	7.0	12.2	3.4	13.2	13.5	12.2	7.7	11.0	5.1	9.3	10.4	8.6	8.9	18.1	1.4
20-May							12.0	13.3	11.4	8.0	15.9	2.8	11.9	12.3	11.5	4.0	6.0	1.9	10.4	12.1	9.3	10.8	19.2	2.9
21-May							11.6	12.3	11.2	8.4	17.2	1.5	11.7	11.8	11.4	3.8	6.1	1.5	11.1	11.4	10.8	9.2	10.9	6.5
22-May							12.1	13.7	11.5	10.0	18.6	1.7	11.2	11.6	10.9	4.7	8.6	0.5	10.9	11.4	10.5	7.7	10.8	4.7
23-May							12.3	13.1	11.7	10.6	18.9	2.7	11.4	12.1	10.7	7.2	11.2	4.1	11.0	11.5	10.7	7.9	11.9	5.4
24-May							13.0	13.6	12.5	11.6	19.8	3.9	11.6	12.0	11.2	7.2	10.5	3.5	11.5	11.9	11.0	8.3	13.1	3.1
25-May							14.1	14.9	13.3	11.8	18.3	5.5	11.7	12.1	11.4	8.0	10.5	5.8	11.2	11.5	10.7	8.0	10.2	6.1
26-May							14.3	15.1	13.8	10.6	16.8	5.0	11.5	11.8	11.3	8.2	9.4	6.7	10.9	11.6	10.2	7.2	10.6	4.7
27-May							14.2	14.6	13.9	8.5	14.1	2.8	11.6	12.3	11.3	10.2	14.4	6.5	11.2	11.6	10.7	6.8	10.8	3.6
28-May							14.7	16.4	13.7	12.1	22.8	4.4	12.1	12.5	11.8	9.7	11.2	8.7	11.0	11.5	10.6	6.9	12.1	3.0
29-May							16.0	17.4	14.4	15.3	25.5	7.4	11.9	12.2	11.6	8.7	10.1	7.3	11.6	13.0	10.6	9.4	15.4	3.2
30-May							15.8	16.5	15.2	13.7	21.2	7.3	11.9	12.3	11.5	7.3	10.1	3.4	11.7	12.0	11.0	8.5	10.6	6.3
31-May							15.9	16.4	15.4	14.5	22.6	6.4	12.2	12.8	11.8	9.7	12.9	7.1	11.6	12.5	10.8	9.3	14.5	3.7
1-Jun							16.7	18.0	16.0	16.2	25.7	7.7	12.2	12.6	11.6	9.6	12.8	6.2	12.5	13.0	12.1	10.1	13.3	7.8
2-Jun							17.2	18.5	16.5	18.0	28.4	10.5	12.2	12.7	11.7	9.5	11.9	6.3	12.1	12.3	11.6	8.5	10.4	7.4
3-Jun							17.9	18.5	16.7	19.1	30.6	10.3	12.3	12.9	11.6	8.0	12.2	4.6	11.7	12.2	11.4	9.4	13.0	6.6
4-Jun							18.5	19.3	17.9	19.7	31.3	10.6	12.6	13.3	12.2	9.2	15.5	5.7	12.0	12.5	11.4	11.8	19.7	4.8
5-Jun							19.0	19.4	18.5	18.3	25.7	11.6	12.4	13.0	12.1	9.5	13.3	4.9	12.7	13.5	12.1	13.5	19.9	6.5
6-Jun							19.2	19.7	18.9	14.3	18.9	10.3	12.6	13.1	12.2	9.4	13.6	4.9	13.5	14.2	13.0	14.4	22.4	7.6
7-Jun							19.1	19.6	18.8	13.9	18.1	9.7	13.2	14.1	12.4	11.8	18.5	7.6	13.9	14.5	13.6	10.8	15.6	7.4
8-Jun							18.9	19.2	18.6	14.5	20.5	9.8	13.2	13.6	13.0	11.3	15.9	5.6	14.4	15.1	13.8	12.9	20.8	6.1
9-Jun							18.8	19.2	18.5	14.8	21.2	9.1	13.6	14.1	13.1	10.6	13.5	8.3	14.9	15.4	14.7	11.3	14.2	7.2
10-Jun							19.0	19.6	18.4	15.6	20.6	10.4	13.6	13.9	13.3	9.2	12.1	5.0	14.8	15.0	14.5	10.4	12.7	7.1
11-Jun							19.3	19.7	18.9	16.3	22.7	10.3	13.9	14.7	13.4	11.1	15.2	8.6	14.8	15.3	14.4	10.5	13.7	8.7
12-Jun							19.4	19.9	18.9	16.4	24.0	9.9	14.2	15.5	13.5	13.5	21.2	6.9	15.1	15.6	14.6	10.9	15.4	6.2
13-Jun							19.8	20.3	19.3	16.0	24.8	10.0	14.8	15.0	14.3	13.1	18.8	8.4	15.1	15.6	14.8	10.5	13.5	8.3
14-Jun							20.1	20.6	19.6	15.2	22.5	9.0	15.0	15.6	14.5	9.9	15.0	3.6	14.6	15.1	14.2	9.7	12.4	7.4
15-Jun							20.0	20.5	19.8	13.9	19.7	9.7	15.2	15.7	14.9	9.6	15.2	5.5	14.5	15.1	14.2	9.7	13.9	5.9
16-Jun							20.0	20.4	19.6	13.6	18.4	9.7	15.3	15.7	14.8	11.0	19.4	4.0	15.0	16.0	14.0	10.8	16.7	4.0
17-Jun							20.0	20.8	19.4	14.9	21.9	10.7	15.9	16.5	15.2	11.2	15.2	8.3	15.1	15.5	14.8	12.0	17.2	6.3
18-Jun							20.1	21.0	19.5	14.6	21.4	10.1	15.9	16.4	15.5	10.6	15.7	6.7	15.0	15.5	14.6	11.8	14.2	9.5
19-Jun							19.4	20.0	19.1	13.2	18.7	9.5	15.9	16.4	15.4	14.0	20.9	6.8	15.1	15.6	14.6	11.9	15.2	8.8
20-Jun							18.7	19.1	18.4	10.3	14.1	6.3	16.5	16.9	16.1	13.6	18.1	10.1	15.1	15.4	14.9	12.3	14.8	9.7
21-Jun							18.3	19.1	17.9	11.4	15.6	6.4	16.6	17.0	16.4	12.5	16.4	9.7	15.6	16.7	14.9	14.3	19.9	9.3
22-Jun							18.1	18.8	17.6	11.3	16.3	7.2	16.6	17.0	16.4	13.1	17.4	7.6	16.5	17.8	15.5	13.9	21.6	8.8
23-Jun							18.3	19.0	17.7	12.7	18.5	6.1	17.4	18.2	16.6	16.1	21.1	11.1	16.1	16.4	15.6	10.2	13.0	6.2
24-Jun							17.8	18.2	17.4	10.8	13.8	9.3	17.6	18.3	17.0	14.8	20.4	11.1	15.6	15.8	15.2	9.4	13.0	6.9
25-Jun							17.7	18.5	16.9	11.9	17.1	9.3	17.6	17.9	17.2	14.1	20.6	9.8	15.4	15.8	14.9	9.7	13.3	6.5
26-Jun							17.6	18.3	17.2	11.8	18.3	5.9	17.6	18.1	17.3	12.6	16.4	8.2	15.3	15.5	15.0	10.9	15.6	5.9
27-Jun							17.5	18.0	17.1	11.3	16.4	6.6	17.8	18.6	17.1	13.3	18.9	8.5	15.6	16.5	15.0	12.6	15.2	10.5
28-Jun							17.5	18.1	16.9	10.8	18.2	4.3	17.8	18.3	17.4	10.8	16.4	5.6	15.8	16.2	15.4	13.6	16.1	11.6
29-Jun							17.4	18.0	16.9	11.1	18.2	4.1	17.2	17.9	16.6	10.0	14.3	6.5	15.5	16.3	15.1	11.7	15.0	8.8
30-Jun							17.6	18.4	16.9	12.1	20.6	4.5	17.1	17.8	16.4	10.4	16.8	5.9	14.8	15.3	14.5	9.1	11.4	7.1

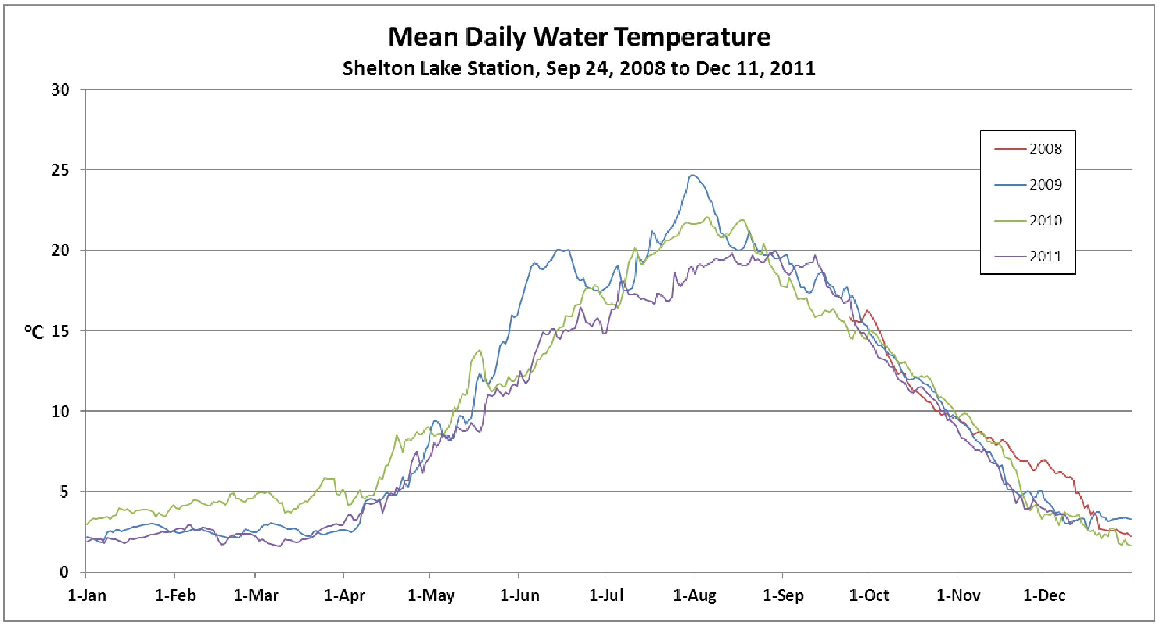
Appendix H – Water and air temperature records for Shelton Lake, Sep 2008 to Dec 2011.

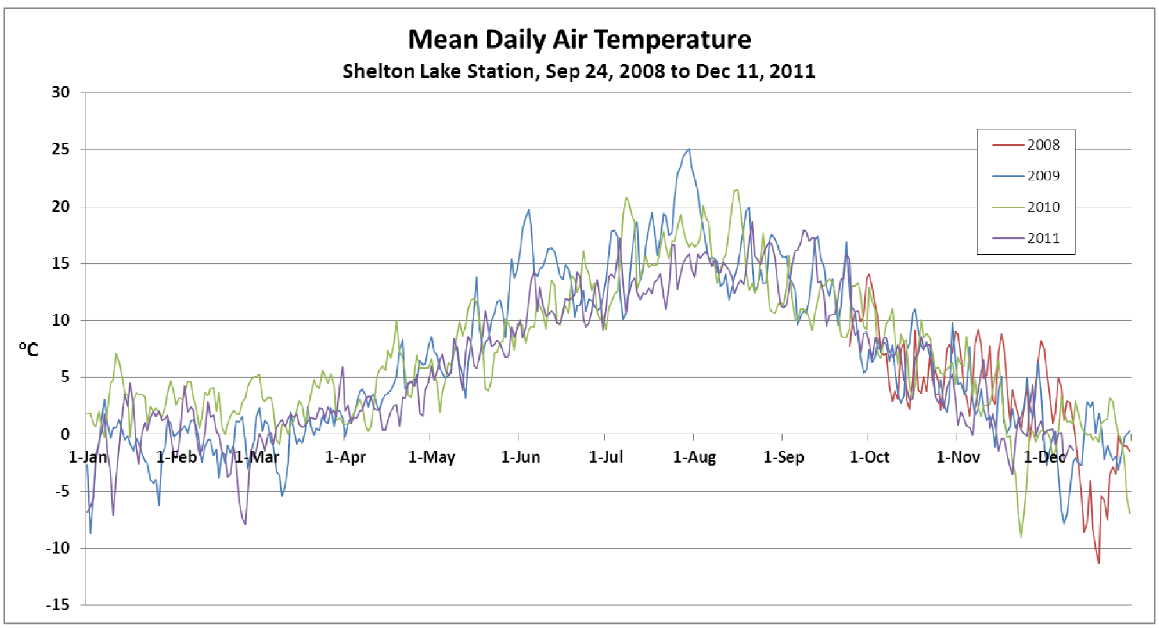
	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Jul							17.7	18.4	17.1	13.5	21.9	5.8	16.7	17.0	16.5	9.2	11.4	7.9	14.9	16.0	14.1	11.0	16.4	7.7
2-Jul							17.9	18.5	17.3	15.9	25.0	7.2	16.6	17.1	16.3	11.1	15.8	6.4	15.8	17.1	14.5	13.9	22.6	7.3
3-Jul							18.2	18.8	17.6	17.8	28.1	9.1	16.7	17.7	15.9	11.6	17.2	6.3	16.3	17.5	15.4	14.1	20.1	10.0
4-Jul							18.8	19.3	18.2	18.0	25.9	10.6	16.6	16.9	16.2	12.4	15.9	9.8	16.3	17.6	15.4	13.7	23.1	6.5
5-Jul							19.1	19.6	18.6	17.4	23.2	11.2	16.4	17.1	16.0	12.6	19.7	9.1	16.9	18.0	16.4	15.5	24.7	7.7
6-Jul							18.4	18.7	17.9	12.5	14.5	9.9	16.7	17.5	16.0	15.0	24.5	6.6	18.0	19.4	17.0	17.2	24.3	10.2
7-Jul							17.5	17.7	17.4	10.1	11.4	8.7	17.4	18.1	16.8	19.2	30.4	10.7	18.1	18.6	17.7	13.2	17.6	8.5
8-Jul							17.5	17.7	17.3	10.7	12.6	8.7	18.4	19.2	17.6	20.8	31.5	12.4	17.6	18.0	17.2	10.5	14.5	7.3
9-Jul							17.5	18.0	17.2	12.5	17.4	9.1	19.3	20.4	18.7	20.5	27.9	13.6	17.2	17.7	16.8	12.1	18.1	5.7
10-Jul							17.6	18.2	17.1	15.7	24.6	8.9	19.6	20.0	19.1	19.3	27.3	12.0	17.3	17.7	17.0	13.4	16.6	9.7
11-Jul							18.3	18.8	17.7	18.0	27.8	9.8	20.2	20.7	19.7	18.6	25.3	13.4	17.3	17.6	17.0	13.7	15.8	11.8
12-Jul							19.7	21.4	18.4	18.6	27.1	12.3	19.9	20.5	19.4	12.8	16.5	9.4	17.2	17.5	17.1	12.5	14.8	11.2
13-Jul							19.4	20.0	19.0	13.5	17.4	10.0	19.2	19.7	18.7	13.7	20.7	9.7	16.9	17.2	16.7	11.8	13.3	10.6
14-Jul							19.3	19.8	18.9	14.6	20.9	10.2	19.2	19.7	18.7	14.9	23.8	7.4	17.0	17.7	16.6	12.5	16.1	10.1
15-Jul							19.5	20.0	19.0	16.5	23.5	9.8	19.5	20.0	19.0	15.7	23.5	9.6	16.9	17.1	16.7	12.3	14.0	10.6
16-Jul							20.1	21.9	19.4	18.1	25.2	11.5	19.7	20.2	19.2	14.7	22.5	7.9	16.8	17.1	16.6	12.8	14.9	11.4
17-Jul							21.2	22.6	20.0	19.4	29.0	12.0	19.8	20.3	19.3	15.0	23.4	7.7	16.8	17.3	16.5	12.4	15.5	8.7
18-Jul							21.0	21.5	20.5	18.1	23.5	12.2	19.8	20.4	19.3	14.8	23.1	8.0	16.7	17.0	16.3	13.3	16.2	11.4
19-Jul							20.5	20.9	20.2	15.7	23.6	8.8	20.0	20.5	19.5	14.9	23.1	7.5	17.3	18.4	16.4	13.6	19.3	9.4
20-Jul							20.4	20.9	19.8	17.2	26.4	9.3	20.2	20.7	19.9	16.4	24.6	11.1	17.3	18.2	16.6	14.1	19.0	10.8
21-Jul							20.7	21.2	20.2	19.4	28.6	11.1	20.4	21.0	19.9	17.8	27.0	10.5	17.1	17.7	16.7	12.1	15.0	8.7
22-Jul							21.0	21.7	20.5	19.2	26.5	12.8	20.6	21.1	20.2	16.5	22.2	12.4	16.9	17.3	16.4	11.0	15.2	6.5
23-Jul							21.2	21.8	20.8	17.4	24.2	11.4	20.6	21.2	20.2	15.4	23.9	7.9	16.9	17.6	16.4	13.0	19.4	7.5
24-Jul							21.5	22.1	20.9	17.8	25.2	10.6	20.8	21.3	20.3	17.0	24.7	10.7	17.1	18.1	16.4	16.6	25.8	9.4
25-Jul							21.7	22.3	21.2	20.7	28.8	13.4	20.9	21.5	20.4	16.9	25.0	9.3	18.7	19.7	17.4	16.6	22.6	12.3
26-Jul							22.2	22.6	21.8	22.9	30.1	16.6	20.9	21.5	20.5	18.1	27.4	10.1	18.0	18.7	17.3	12.8	16.0	10.0
27-Jul							22.7	23.3	22.2	23.5	32.5	15.9	21.4	22.6	20.7	19.3	27.8	12.2	17.8	18.4	17.3	14.1	20.3	10.4
28-Jul							23.2	23.7	22.7	24.4	34.0	16.4	21.6	22.2	21.2	18.1	26.1	11.1	18.0	19.0	17.4	15.0	21.1	9.1
29-Jul							23.7	24.1	23.2	24.8	34.8	17.3	21.7	22.3	21.3	17.0	23.9	10.9	18.2	18.6	17.8	15.5	21.9	11.7
30-Jul							24.5	25.5	23.8	25.1	32.6	18.6	21.7	22.4	21.1	16.4	24.3	9.7	18.9	20.1	18.0	15.8	23.4	10.2
31-Jul							24.7	25.1	24.3	23.5	30.1	17.9	21.6	22.3	21.1	16.8	24.9	10.2	19.0	20.0	18.5	14.6	19.7	10.3
1-Aug							24.7	25.2	24.3	22.4	29.5	15.9	21.7	22.3	21.2	16.4	23.0	11.3	18.6	19.2	18.1	13.8	22.0	6.9
2-Aug							24.5	25.2	24.1	21.4	29.6	14.5	21.7	22.3	21.4	16.7	23.2	12.8	19.1	20.0	18.3	15.8	22.4	11.3
3-Aug							24.3	24.8	23.8	19.4	27.6	12.5	21.7	22.3	21.3	17.3	24.2	12.3	19.1	19.4	18.8	15.4	19.1	12.2
4-Aug							24.0	24.7	23.5	18.2	25.4	11.7	21.8	22.6	21.3	20.1	28.8	13.0	19.0	19.7	18.6	15.8	21.0	10.4
5-Aug							23.7	24.3	23.4	16.5	22.7	12.4	22.1	22.6	21.7	18.9	24.4	15.2	19.1	19.6	18.6	16.0	21.9	10.8
6-Aug							23.2	24.0	22.8	15.3	22.3	10.1	22.0	22.6	21.7	18.6	25.0	13.2	19.2	19.8	18.8	15.6	21.8	11.7
7-Aug							22.9	23.6	22.6	15.6	21.5	10.2	21.5	21.7	21.3	15.3	16.9	14.2	19.3	19.9	18.8	14.8	22.7	8.0
8-Aug							22.3	22.6	22.0	15.3	18.2	12.8	21.4	21.7	21.1	14.7	17.1	13.5	19.5	20.1	19.0	15.4	22.5	9.6
9-Aug							22.1	22.7	21.5	15.2	20.0	12.2	21.0	21.4	20.8	13.2	16.7	10.8	19.5	20.2	19.1	14.2	19.5	10.0
10-Aug							21.1	21.4	20.9	13.0	14.9	11.5	20.8	21.5	20.4	14.4	21.8	10.0	19.4	20.4	18.9	14.2	18.6	10.9
11-Aug							21.0	21.6	20.4	13.3	18.4	9.0	20.8	21.6	20.2	15.5	22.6	9.6	19.4	20.2	19.1	15.1	20.1	12.2
12-Aug							20.9	21.6	20.5	14.0	17.9	10.1	21.0	21.9	20.5	15.8	22.7	9.9	19.5	20.5	19.0	14.8	21.3	10.4
13-Aug							20.3	20.5	20.1	11.8	13.6	10.1	21.0	21.8	20.5	17.8	27.9	10.0	19.6	20.4	18.9	14.4	19.8	9.9
14-Aug							20.2	20.7	19.9	12.9	18.0	9.3	21.3	22.2	20.8	20.1	30.0	12.5	19.8	20.8	19.2	13.8	19.8	9.4
15-Aug							20.2	20.7	19.8	13.8	17.4	11.3	21.5	22.1	21.1	21.4	31.0	13.8	19.4	19.9	19.0	12.4	16.6	7.7
16-Aug							20.0	20.6	19.4	14.7	21.0	8.4	21.7	22.3	21.3	21.5	30.8	14.3	19.2	20.0	18.7	13.1	20.0	7.3
17-Aug							20.1	20.7	19.6	16.4	23.7	10.2	21.9	22.6	21.4	19.7	28.0	12.3	19.1	20.1	18.6	13.6	20.1	8.0
18-Aug							20.2	21.2	19.7	18.2	25.8	11.8	21.9	22.6	21.5	17.1	23.2	11.7	19.1	19.7	18.7	13.2	20.1	8.4
19-Aug							20.5	20.9	20.0	19.6	28.5	13.3	21.5	22.0	21.2	14.3	18.0	10.6	19.1	19.8	18.6	14.4	22.3	7.4
20-Aug							21.2	22.4	20.4	20.0	27.9	15.3	21.0	21.3	20.6	12.6	16.9	9.8	19.2	19.9	18.8	16.9	26.2	9.9
21-Aug							20.5	21.1	20.1	15.0	19.8	10.2	20.7	21.6	20.1	13.3	20.9	7.1	19.7	20.4	19.3	18.7	24.0	14.1
22-Aug							20.4	21.3	19.9	12.5	20.6	6.6	19.9	20.6	19.5	12.4	17.8	8.9	19.4	19.8	19.0	15.7	17.0	13.5
23-Aug							20.0	20.7	19.4	13.1	18.1	8.3	19.8	20.4	19.4	12.9	19.6	6.8	19.5	20.3	18.7	15.3	20.5	11.7
24-Aug							20.0	20.8	19.2	14.4	22.0	7.7	19.8	21.1	19.1	15.7	24.5	8.2	19.3	19.8	18.9	14.9	20.2	9.9
25-Aug							19.7	20.4	19.3	13.2	18.0	9.4	20.5	22.0	19.4	17.7	26.1	10.9	19.2	19.9	18.8	15.7	23.0	10.6
26-Aug							19.7	20.6	19.1	13.3	18.9	8.5	19.9	20.4	19.2	14.5	18.6	11.7	19.5	20.2	18.9	16.4	23.8	11.3
27-Aug							19.8	21.2	18.9	17.0	28.1	8.4	19.1	19.7	18.8	11.1	16.5	7.4	19.8	21.1	19.3	16.9	24.4	12.0
28-Aug							19.7	20.2	19.2	17.5	23.6	12.1	18.9	19.9	18.5	10.8	18.2	5.4	19.8	20.4	19.4	16.6	25.4	9.9
29-Aug							19.5	20.1	19.0	17.1	23.7	12.3	18.6	19.3	18.1	10.6	17.8	5.2	20.0	20.6	19.6	15.5	21.0	11.8
30-Aug							19.5	20.3	18.9	16.5	24.0	10.5	18.4	19.1	18.0	11.4	17.2	4.8	19.7	20.2	19.3	12.9	16.8	9.0
31-Aug							19.5	20.3	19.1	15.8	23.0	9.9	17.8	18.2	17.5	11.7	14.2	9.4	19.3	20.1	18.9	11.4	19.2	5.8
1-Sep							19.7	20.4	19.2	15.5	21.7	10.3	17.8	18.4	17.3	11.4	16.0	7.4	18.8	19.0	18.5	11.1	15.0	7.5
2-Sep							19.8	20.6	19.2	15.6	22.9	9.9	17.7	18.6	17.2	13.0	20.3	7.4	18.6	19.3	18.3	11.4	18.0	6.3
3-Sep							19.2	19.5	18.7	13.8	16.1	11.8	18.3	19.2	17.3	15.7	24.9	8.4	18.4	19.1	18.0	12.7	23.0	5.8
4-Sep							19.2	19.7	18.8	13.4	17.5	10.0	17.9	18.6	17.2	12.0	17.4	7.1	18.7	20.3	18.0	14.8	24.6	8.1
5-Sep							18.8	19.2	18.6	12.7	15.8	10.6	17.4	18.0	17.0	10.1	15.6	4.1	19.0	19.8	18.2	16.1	24.7	9.7
6-Sep							18.2	18.6	18.0	9.6	10.6	8.1	17.0	17.4	16.6	10.0	12.2	8.3	19.1	20.5	18.5	16.2	25.4	10.3
7-Sep							17.7	18.0	17.5	10.4	13.5	7.5	17.0	17.6	16.7	11.0	14.3	9.2	18.9	19.5	18.5	16.8	26.1	10.3
8-Sep							17.7	18.4	17.3	10.8	16.1	5.8	16.9	17.8	16.3	11.0	16.2	6.8	19.0	19.7	18.6	17.9	27.0	11.2
9-Sep							17.4	17.8	17.2	10.7	13.4	8.3	17.0	18.1	16.4	10.9	18.1	6.1	19.2	20.0	18.8	17.8	25.3	12.4
10-Sep							17.3	17.9	16.9	11.8	19.2	7.5	16.4	16.9	16.0	10.2	12.6	8.7	19.2	20.0	18.8	17.0	25.3	10.6
11-Sep							17.5	18.7	16.7	14.3	24.4	8.0	16.2	16.8	15.8	9.1	13.6	4.9	19.2	19.9	18.9	17.2	27.0	10.7
12-Sep							18.1	19.5	17.3	17.0	26.6	10.6	15.9	16.2	15.6	10.5	12.2	8.9	19.7	20.7	19.0	17.2	25.4	12.3
13-Sep							18.5	19.2	18.0	17.4	23.2	13.7	15.9	16.4	15.7	11.8	14.8	10.2	19.2	19.4	19.0	13.3	14.9	11.5
14-Sep							18.6	19.5	17.9	15.4	21.6	12.3	16.0	16.8	15.5	13.1	19.4	9.3	18.8	19.0	18.6	13.4	15.3	11.4
15-Sep							18.6	19.1	18.1	14.7	20.7	11.6	16.3	16.6	15.7	13.0	15.4	10.8	18.3	18.6	18.1	12.2	16.0	9.8
16-Sep							18.1	18.4	17.8	13.0	16.1	9.7	16.2	16.7	16.0	13.3	16.3	11.3	17.8	18.1	17.5	9.5	12.3	6.6
17-Sep							17.8	18.7	17.3	12.2	17.8	6.5	16.2	16.7	15.9	13.7	16.5	12.1	17.7	18.2	17.4	10.5	14.3	8.5
18-Sep							17.8	18.5	17.3	13.7	20.6	10.0	16.4	16.9	16.0	13.3	15.6	12.2	17.3	17.6	17.0	10.5	13.1	8.5
19-Sep							17.4	17.9	17.0	12.2	16.3	7.9	16.2	16.5	15.7	12.5	13.9	11.6	17.2	17.9	16.8	10.5	17.6	6.2
20-Sep							17.0	17.9	16.5	9.6	17.3	5.0	15.8	16.2	15.5	10.9	13.9	8.4	17.2	18.0	16.5	11.9	20.5	5.6
21-Sep							17.1	18.1	16.3	11.4	21.3	6.2	15.6	15.8	15.3	8.7	11.5	5.9	17.0	17.3	16.7	13.7	17.2	12.4
22-Sep							17.5	18.4	16.6	14.2	24.8	8.1	15.6	16.3	15.1	8.5	15.2	3.5	16.8	17.1	16.6	13.7	14.9	12.3
23-Sep							17.7	18.5	17.0	16.8	26.0	12.7	15.2	15.5	14.8	8.5	10.7	6.8	16.8	17.2	16.4	15.8	17.1	14.7
24-Sep	15.8	16.2	15.4	7.7	9.0	6.3	17.0	17.7	16.4	12.2	18.1	7.2	14.6	15.0	14.3	9.4	11.9	7.4	17.0	17.6	16.5	15.4	20.2	12.3
25-Sep	15.6	15.9	15.3	9.5	11.5	7.7	17.2	18.4	16.3	11.2	21.4	4.8	14.5	14.8	14.2	13.1	14.0	11.9	16.1	16.4	15.7	10.1	14.5	6.6
26-Sep	15.6	16.0	15.5	10.8	13.3	9.0	16.7	17.3	16.2	10.8	16.4	7.3	15.0	15.9	14.3	13.0	17.3	9.8	15.3	15.9	15.0	8.7	10.9	7.3
27-Sep	15.6	16.2	15.1	10.8	16.6	7.0	16.2	17.0	15.8	8.3	17.4	2.3	15.1	15.2	14.9	13.3	14.9	11.2	15.1	15.5	14.7	9.1	13.0	6.9
28-Sep	15.5	16.7	15.0	9.9	19.3	5.1	15.7	16.1	15.4	6.8	13.3	3.4	14.8	15.2	14.4	12.3	14.9	8.2	14.9	15.4	14.6	7.2	11.8	3.5
29-Sep	15.9	17.2	15.0	10.4	21.7	4.5	15.4	15.6	15.2	5.4	8.6	3.1	14.5	15.2	14.2	9.5	16.6	5.1	14.9	15.5	14.3	8.9	14.8	4.5
30-Sep	16.3	16.9	15.6	13.7	21.8	8.4	15.3	16.0	14.7	5.6	12.0	0.4	14.5	14.9	14.1	9.2	16.5	4.4	14.6	15.0	14.3	9.0	10.3	6.5

Appendix H – Water and air temperature records for Shelton Lake, Sep 2008 to Dec 2011.

	2008						2009						2010						2011					
	Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)			Water (°C)			Air (°C)		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
1-Oct	16.1	16.7	15.7	14.1	22.0	8.9	14.9	15.1	14.7	7.5	10.3	6.1	15.1	16.0	14.3	12.9	22.0	8.2	14.3	14.7	14.1	8.0	14.0	5.5
2-Oct	15.8	16.0	15.6	12.9	14.0	12.0	14.6	15.1	14.1	6.3	11.5	2.5	14.9	15.4	14.4	11.7	17.0	8.9	14.1	14.3	13.9	6.7	10.5	1.9
3-Oct	15.5	15.7	15.3	11.3	12.1	10.6	14.3	15.0	13.9	6.9	12.9	2.0	14.8	15.3	14.4	10.9	15.0	7.4	13.8	14.0	13.6	8.5	10.5	7.3
4-Oct	15.1	15.5	14.6	10.4	12.5	6.6	14.1	14.9	13.5	8.4	16.7	4.3	14.6	14.9	14.1	7.1	11.0	4.1	13.4	13.7	13.1	7.5	10.0	6.4
5-Oct	14.8	15.3	14.5	7.2	11.9	4.3	14.1	15.1	13.4	7.3	17.8	1.8	14.2	15.0	13.9	6.7	15.8	1.5	13.3	13.4	13.2	7.6	8.6	6.6
6-Oct	14.3	14.6	13.6	7.0	8.1	5.7	13.9	14.8	13.5	8.1	15.6	2.7	14.1	14.5	13.7	8.6	16.9	3.3	13.2	13.8	12.9	8.5	14.7	6.2
7-Oct	13.5	13.9	13.1	7.1	9.9	4.1	13.7	14.4	13.3	7.9	14.1	4.2	14.1	14.5	13.8	9.7	13.1	6.4	13.1	13.7	12.8	8.5	12.6	5.2
8-Oct	13.3	13.7	13.1	4.2	9.3	1.3	13.5	14.3	13.1	6.5	13.8	2.2	13.8	14.0	13.4	10.1	10.9	9.4	12.8	12.9	12.6	7.3	10.3	4.3
9-Oct	12.9	13.1	12.5	2.9	4.6	1.0	13.5	13.9	13.1	7.8	11.1	5.1	13.5	13.7	13.3	11.1	13.1	9.7	12.7	13.1	12.5	6.8	11.8	4.4
10-Oct	12.7	13.1	12.4	3.8	11.3	-0.7	13.3	13.6	12.9	5.7	10.5	0.3	13.4	13.7	13.2	8.6	13.4	4.0	12.4	12.5	12.1	7.0	8.4	5.4
11-Oct	12.3	12.7	12.0	3.1	8.8	-1.3	13.1	13.7	12.6	3.6	11.4	-0.8	13.0	13.2	12.8	6.2	8.5	3.7	12.0	12.2	11.7	7.8	8.6	6.9
12-Oct	12.5	12.9	12.1	7.5	14.1	3.1	12.6	12.8	12.2	2.7	7.2	-0.6	13.0	13.1	12.9	8.8	10.7	6.6	11.9	12.1	11.6	6.7	8.3	5.0
13-Oct	12.3	12.6	12.1	8.1	9.7	6.4	12.2	12.4	11.9	3.4	6.1	1.2	13.1	13.5	12.6	8.0	15.1	4.4	11.8	12.1	11.5	4.8	9.2	1.6
14-Oct	11.9	12.1	11.6	3.0	6.7	-0.3	12.0	12.4	11.7	7.3	10.0	5.4	12.9	13.1	12.5	8.3	12.1	4.8	11.5	11.9	11.2	4.2	10.0	1.4
15-Oct	11.6	12.0	11.3	2.2	7.7	-1.1	12.0	12.4	11.8	8.0	11.1	5.3	12.5	13.0	12.2	4.2	10.7	0.3	11.2	11.6	11.0	3.0	9.6	-0.4
16-Oct	11.3	11.5	10.9	4.9	8.1	1.8	12.0	12.5	11.5	10.6	13.0	8.5	12.1	12.7	11.9	3.1	10.3	-0.3	11.1	11.6	10.8	3.1	9.5	-0.5
17-Oct	11.3	11.7	11.0	9.1	11.5	4.3	12.1	12.3	12.0	11.0	12.7	9.6	12.2	12.6	11.7	4.4	12.1	0.1	11.3	11.7	10.9	6.8	12.3	3.7
18-Oct	11.1	11.5	10.8	3.9	8.4	0.8	12.1	12.5	11.8	9.2	11.2	7.1	12.1	12.4	12.0	7.4	10.1	5.1	11.5	12.3	10.7	7.1	13.5	3.7
19-Oct	10.9	11.3	10.6	3.6	9.0	-0.5	11.9	12.3	11.7	7.8	11.5	6.6	12.2	12.6	11.9	10.0	16.1	5.9	11.5	11.8	11.2	8.6	13.7	5.2
20-Oct	10.9	11.5	10.3	5.0	11.5	1.5	11.7	12.0	11.6	7.4	9.4	5.1	12.1	12.6	11.7	8.5	15.0	4.5	11.4	11.7	11.1	7.7	11.1	5.2
21-Oct	10.6	10.8	10.5	3.7	6.7	0.6	11.7	12.3	11.3	8.2	12.6	6.5	12.2	12.6	11.8	8.9	15.7	5.1	11.2	11.4	10.9	7.8	10.0	6.4
22-Oct	10.6	11.0	10.1	7.0	12.9	2.7	11.5	11.6	11.2	6.8	9.3	4.6	11.9	12.4	11.5	8.5	11.8	6.6	11.0	11.2	10.7	7.9	10.2	6.2
23-Oct	10.3	10.7	10.1	4.7	10.5	0.8	11.2	11.7	10.9	7.2	10.8	4.1	11.7	11.9	11.3	7.4	8.9	6.5	10.8	11.3	10.5	5.5	10.6	2.6
24-Oct	10.0	10.1	9.9	5.7	8.0	2.8	11.2	11.7	10.9	3.5	10.9	0.7	11.2	11.4	11.0	5.8	7.2	4.4	10.7	11.2	10.4	3.4	10.4	0.1
25-Oct	10.0	10.3	9.7	4.6	9.1	-0.8	10.7	10.9	10.4	3.5	4.8	1.4	10.9	11.1	10.7	5.9	7.4	4.6	10.4	10.7	10.1	2.7	9.3	0.0
26-Oct	9.8	10.2	9.5	2.1	8.6	-1.2	10.6	11.0	10.4	4.8	7.4	0.8	10.9	11.0	10.8	5.4	6.6	4.7	10.0	10.2	9.8	3.1	5.2	1.0
27-Oct	9.8	10.3	9.5	4.5	12.5	0.2	10.2	10.4	9.9	2.6	7.1	-0.9	10.7	10.9	10.6	5.3	6.6	4.4	10.0	10.3	9.7	2.3	7.5	-0.3
28-Oct	9.9	10.2	9.6	7.5	12.5	3.3	10.0	10.1	9.8	2.0	4.0	0.1	10.5	10.6	10.4	5.7	7.0	5.0	9.5	9.8	9.2	4.1	5.9	2.4
29-Oct	9.7	9.9	9.5	7.9	8.8	6.3	9.6	9.8	9.4	3.3	7.1	0.8	10.4	10.6	10.3	6.0	8.0	4.1	9.5	9.9	9.2	4.6	8.3	1.9
30-Oct	9.6	9.7	9.5	7.1	8.5	5.7	9.8	10.1	9.4	9.8	10.6	7.9	10.2	10.4	9.9	6.4	7.6	4.9	9.3	9.6	9.1	5.3	8.5	3.6
31-Oct	9.7	9.9	9.5	9.0	10.4	8.3	9.6	9.9	9.4	6.3	9.2	3.5	9.8	10.0	9.3	4.4	6.1	1.4	9.1	9.5	8.8	3.1	7.8	0.1
1-Nov	9.6	9.7	9.5	8.8	9.5	7.8	9.5	9.8	9.3	4.4	10.9	1.4	9.5	9.7	9.2	6.7	8.0	4.2	8.8	9.0	8.6	0.8	4.4	-1.6
2-Nov	9.3	9.6	9.0	6.8	9.0	3.9	9.3	9.5	9.2	4.5	6.5	3.2	9.8	10.0	9.5	6.1	11.9	3.6	8.3	8.6	8.1	2.0	4.7	0.3
3-Nov	9.3	9.6	9.1	3.9	6.6	2.1	9.2	9.4	9.0	3.6	5.6	1.4	9.9	10.3	9.7	6.0	11.1	4.0	8.3	8.6	8.1	1.4	3.9	-0.5
4-Nov	9.1	9.5	8.9	3.3	7.9	-0.1	9.1	9.3	8.9	3.9	8.0	0.7	9.8	10.0	9.6	8.6	12.4	5.1	8.1	8.3	7.9	0.8	4.6	-0.7
5-Nov	8.9	9.2	8.6	1.6	5.3	-1.3	8.9	9.1	8.5	7.7	9.3	4.5	9.6	9.8	9.3	5.9	8.9	1.1	7.9	8.2	7.7	0.6	3.7	-1.3
6-Nov	8.5	8.8	8.2	4.6	7.5	2.9	8.4	8.6	8.3	2.9	4.2	1.3	9.2	9.3	9.1	3.4	6.5	0.2	7.8	8.1	7.6	-0.1	2.4	-2.1
7-Nov	8.6	8.7	8.5	8.0	9.2	6.5	8.2	8.4	7.9	1.7	3.2	0.5	9.0	9.3	8.8	4.9	7.6	2.9	7.6	7.7	7.5	2.3	3.9	0.1
8-Nov	8.7	8.9	8.6	9.2	10.0	7.7	8.1	8.3	7.9	2.3	4.6	0.4	8.8	9.1	8.7	2.3	7.5	-0.2	7.6	7.8	7.4	3.8	4.9	2.7
9-Nov	8.7	8.9	8.6	7.8	8.8	7.1	7.9	8.1	7.7	4.0	5.1	1.1	8.5	8.7	8.5	1.5	2.1	-0.4	7.5	7.6	7.3	5.6	7.2	4.3
10-Nov	8.5	8.8	8.3	4.9	7.8	3.7	7.7	7.9	7.4	2.2	2.9	1.3	8.6	8.8	8.4	2.5	5.7	0.3	7.7	8.1	7.4	6.5	10.7	3.3
11-Nov	8.3	8.5	8.0	5.2	7.0	3.3	7.5	7.7	7.4	1.2	3.0	-0.1	8.2	8.4	7.9	2.5	3.6	0.3	7.3	7.5	6.9	3.9	6.2	0.1
12-Nov	8.4	8.5	8.2	7.8	9.4	6.4	7.4	7.6	7.3	1.6	3.4	0.2	8.1	8.4	7.8	2.7	6.0	-0.3	6.9	7.1	6.6	0.6	1.7	-0.7
13-Nov	8.2	8.3	8.0	3.0	5.9	-0.2	7.0	7.3	6.6	0.5	2.9	-1.3	8.0	8.1	7.8	3.9	4.7	3.4	6.8	7.0	6.5	1.8	3.8	-0.2
14-Nov	7.9	8.0	7.7	2.7	5.0	0.2	6.8	7.0	6.3	-1.1	0.4	-3.3	8.1	8.4	7.8	5.2	8.6	3.8	6.7	7.2	6.4	0.9	3.4	-1.6
15-Nov	8.0	8.2	7.7	7.2	10.1	4.2	6.5	6.8	6.1	3.8	7.5	0.2	8.0	8.2	7.9	6.5	8.3	4.5	6.5	6.8	6.3	-1.4	2.8	-3.1
16-Nov	8.2	8.5	8.1	8.8	10.9	6.3	6.7	6.9	6.4	5.1	8.0	0.5	7.8	8.0	7.4	4.1	6.5	2.2	5.8	6.3	5.0	-0.4	0.8	-2.2
17-Nov	8.2	8.4	8.0	7.7	10.8	5.3	6.1	6.5	5.7	1.1	2.8	0.2	7.2	7.5	6.9	1.5	3.4	0.1	5.5	5.8	5.1	-0.3	0.5	-1.7
18-Nov	8.0	8.2	7.7	4.3	7.9	-0.7	5.2	5.7	4.3	0.1	0.7	-0.3	7.1	7.2	6.9	-0.3	0.3	-1.2	5.5	5.8	5.3	-1.7	0.1	-3.6
19-Nov	7.6	7.7	7.4	1.1	5.7	-1.6	5.1	5.5	4.3	0.7	4.6	0.0	7.0	7.1	6.7	-0.2	0.4	-1.1	5.3	5.6	5.1	-2.9	-0.5	-4.8
20-Nov	7.5	7.6	7.2	3.9	6.4	1.3	5.2	5.3	5.0	2.3	4.0	0.5	6.5	6.7	6.4	-2.4	-1.2	-4.1	5.0	5.2	4.8	-3.5	-1.3	-5.5
21-Nov	7.1	7.4	6.8	2.6	3.9	1.1	5.0	5.2	4.7	0.6	1.3	-0.4	6.4	6.6	6.1	-3.5	-3.1	-5.0	4.3	4.7	3.8	-0.5	0.7	-2.4
22-Nov	7.0	7.2	6.8	1.6	4.3	-1.2	4.8	5.2	4.4	1.2	3.2	0.1	5.6	6.0	4.9	-7.2	-4.8	-10.3	4.7	4.9	4.0	1.6	3.5	0.2
23-Nov	6.9	7.1	6.6	0.3	4.1	-1.8	4.8	4.9	4.6	1.6	2.9	0.8	4.9	5.2	4.7	-9.0	-6.1	-10.3	4.7	4.8	4.5	0.4	2.9	-0.6
24-Nov	6.9	7.3	6.6	2.3	7.6	-0.8	4.9	5.0	4.8	2.4	3.9	1.0	4.6	4.9	4.3	-6.9	-5.1	-9.4	3.9	4.4	3.4	0.1	0.6	-0.7
25-Nov	6.9	7.2	6.7	4.3	7.5	0.1	5.0	5.3	4.9	5.0	7.0	2.7	4.0	4.6	3.6	-3.8	-0.6	-5.7	3.9	4.1	3.7	-0.1	1.2	-2.1
26-Nov	6.6	6.8	6.4	-0.6	1.1	-1.7	4.9	5.1	4.7	2.6	5.1	0.4	3.8	4.2	3.4	0.3	0.9	-0.3	4.0	4.5	3.7	2.5	6.8	0.4
27-Nov	6.3	6.5	6.2	1.6	3.4	-1.0	4.6	4.8	4.3	1.4	3.2	0.3	4.1	4.4	3.5	0.3	1.6	-0.2	4.5	4.7	4.4	4.3	6.8	0.5
28-Nov	6.4	6.6	6.3	4.6	6.1	3.1	4.7	4.8	4.6	3.9	5.0	2.2	4.2	4.5	4.0	-0.7	1.8	-2.5	4.3	4.4	4.2	-0.1	1.0	-0.8
29-Nov	6.7	7.0	6.5	6.6	8.1	5.4	5.0	5.3	4.8	6.4	7.8	4.6	3.8	4.1	3.3	-0.1	0.6	-1.2	4.1	4.2	3.9	0.6	1.9	0.0
30-Nov	6.9	7.1	6.8	8.2	9.6	7.1	5.0	5.2	4.7	3.6	6.9	-1.1	3.3	3.5	3.0	0.3	1.0	-0.1	4.0	4.1	3.8	1.1	4.6	-1.2
1-Dec	7.0	7.1	6.9	7.5	8.9	6.3	4.5	4.7	4.3	-1.2	1.4	-3.0	3.6	3.9	3.4	0.2	1.3	-0.3	3.9	4.1	3.8	0.0	2.0	-1.5
2-Dec	6.8	7.0	6.6	5.5	6.6	4.2	4.4	4.5	4.2	-2.8	-0.1	-4.3	3.6	3.8	3.4	0.3	1.7	-0.4	3.7	3.9	3.5	0.4	3.9	-1.4
3-Dec	6.5	6.6	6.4	3.3	4.5	0.6	4.2	4.3	4.1	-1.3	0.9	-3.5	3.5	3.7	3.3	-0.4	1.0	-1.2	3.8	4.0	3.7	0.4	2.2	-1.9
4-Dec	6.3	6.5	6.1	0.9	2.4	-1.0	3.9	4.1	3.7	-0.2	2.2	-2.8	3.8	3.9	3.5	-2.0	0.1	-4.3	3.7	3.9	3.6	0.5	2.5	-1.5
5-Dec	6.2	6.3	6.0	1.9	3.1	0.1	3.7	3.8	3.5	0.2	2.9	-2.6	3.4	3.9	2.8	-1.5	1.0	-4.5	3.6	3.8	3.4	-0.9	0.4	-2.3
6-Dec	6.2	6.4	6.0	5.0	6.1	2.7	3.7	3.8	3.5	-3.4	-0.5	-4.8	2.9	3.2	2.1	0.0	1.5	-1.5	3.6	3.7	3.4	0.0	1.2	-1.3
7-Dec	6.2	6.3	6.0	4.1	5.8	0.5	3.6	3.8	3.4	-6.7	-3.3	-9.3	3.4	3.9	3.0	3.3	4.2	1.2	3.6	3.7	3.5	0.1	1.3	-2.4
8-Dec	6.0	6.2	5.9	1.2	3.4	-0.5	3.0	3.7	2.6	-7.8	-3.3	-10.2	3.8	3.9	3.7	2.1	3.2	1.0	3.6	3.8	3.2	-2.4	0.0	-4.0
9-Dec	5.9	5.9	5.8	2.9	3.7	2.2	3.0	3.2	2.8	-7.1	-3.2	-9.5	3.6	3.6	3.6	1.1	2.2	-0.4	3.3	3.6	3.0	-1.6	1.1	-3.3
10-Dec	5.9	6.1	5.7	2.8	4.8	-0.3	3.2	3.2	3.1	-4.9	-2.6	-9.0	3.5	3.7	3.2	1.1	3.4	-0.1	3.0	3.2	2.8	-1.0	1.0	-2.4
11-Dec	5.7	5.8	5.6	1.0	2.9	-0.9	3.2	3.3	3.2	-2.4	-1.1	-3.3	3.4	3.6	3.2	0.9	1.6	0.3	3.2	3.4	2.9	-1.4	-0.1	-4.1
12-Dec	4.9	5.6	4.0	-0.3	-0.1	-1.1	3.2	3.2	3.1	-2.1	-1.1	-2.6	3.5	3.9	3.2	2.9	6.2	-0.4						
13-Dec	4.9	5.0	4.7	-2.8	-0.1	-5.1	3.3	3.4	3.2	-2.5	-0.6	-4.1	3.6	3.7	3.5	1.8	4.1	-0.6						
14-Dec	4.5	4.8	4.0	-5.5	-4.8	-7.2	3.4	3.4	3.3	-2.7	-2.1	-3.3	3.0	3.7	2.5	0.6	3.7	0.1						
15-Dec	4.0	4.3	3.5	-8.6	-5.1	-11.0	3.3	3.4	3.2	-0.1	1.8	-2.0	2.9	3.1	2.5	0.3	1.0	-0.2						
16-Dec	4.2	4.4	4.0	-7.8	-5.1	-10.7	2.6	3.3	2.1	2.9	3.8	1.2	2.6	3.0	2.3	-0.1	0.7	-1.0						
17-Dec	3.6	4.1	3.2	-4.0	-1.9	-6.0	3.2	3.5	2.8	2.4	3.9	1.0	2.5	2.7	2.3	0.0	1.1	-1.0						
18-Dec	3.8	3.9	3.6	-8.3	-6.2	-11.1	3.5	3.7	3.3	2.9	4.7	0.2	2.6	2.8	2.4	-0.5	0.0	-1.0						
19-Dec	3.5	3.9	3.2	-10.0	-8.1	-11.4	3.7	4.0	3.5	0.1	0.9	-1.0	2.3	2.4	2.1	-0.2	0.5	-1.1						
20-Dec	2.7	3.2	2.4	-11.3	-8.7	-13.4	3.7	3.9	3.5	1.8	2.8	0.1	2.4	2.7	2.1	-0.7	0.3	-1.4						
21-Dec	2.7	2.8	2.5	-5.4	-4.1	-8.2	3.5	3.6	3.3	0.8	3.0	-1.5	2.1	2.2	2.0	1.0	1.9	0.4						
22-Dec	2.6	2.7	2.5	-5.8	-4.1	-9.8	3.4	3.5	3.3	-2.2	0.0	-3.8	2.4	2.8	2.1	1.2	2.6	0.5						
23-Dec	2.6	2.7	2.5	-7.5	-5.1	-10.8	3.1	3.3	3.0	-1.0	0.2	-2.2	2.2	2.6	1.8	1.3	3.0	0.3						
24-Dec	2.6	2.6	2.5	-3.5	-2.1	-4.9	3.2	3.3	3.1	-1.6	0.9	-3.3	2.7	2.9	2.6	3.2	4.1	1.6						
25-Dec	2.6	2.7	2.5	-2.8	-0.9	-4.1	3.3	3.3	3.2	-2.2	0.5	-4.0	2.7	3.0	2.5	2.9	4.1	1.4						
26-Dec	2.7	2.7	2.6	-3.5	-0.4	-6.9	3.3	3.3	3.3	-1.9	1.3	-3.5	2.4	2.6	1.8	1.1	1.8	0.1						
27-Dec	2.5	2.6	2.4	0.0	1.0	-0.6	3.3	3.4	3.3	-3.1	0.2	-4.4	1.8	2.0	1.6	0.0	0.3	-0.2						
28-Dec	2.4	2.5	2.3	-0.9	-0.1	-2.7	3.3	3.4	3.3	-1.6	0.8	-4.5	1.7	2.0	1.5	-0.5	0.6	-2.8						
29-Dec	2.4	2.5	2.3	-1.0	-0.2	-2.6	3.4	3.4	3.3	-0.2	1.1	-1.0	2.1	2.3	1.8	-2.4	-0.6	-3.6						
30-Dec	2.4	2.5	2.3	-1.0	-0.1	-2.3	3.4	3.4	3.3	0.0	1.0	-1.0	1.8	2.1	1.4	-5.5	-3.6	-7.5						
31-Dec	2.2	2.3	2.0	-1.5	-0.2	-2.8	3.3	3.3	3.1	0.3	0.9	-0.1	1.7	1.9	1.5	-7.0	-3.3	-8.4						

Appendix H – Water and air temperature records for Shelton Lake, Sep 2008 to Dec 2011.





Appendix I – Stream habitat typing results, South Englishman River, Aug 20 and 21, 2009.

Reach	Chain	Meso	Photo	Length	Grad	Pool D_{max}	Width (m)		Substrate		Comments
	(m)	Type	#	(m)	(%)	(m)	Bankfull	Wetted	Dom	Sub-dom	
1	29.7	P	1	29.7	0.0	0.98	48.0	7.1	Cobble	Boulder	LWD Pool just before Eman
1	40.3	R	2	10.6	1.0	0.23	43.0	5.0	Cobble	Boulder	
1	53.8	G	3	13.5	0.0	0.43	35.0	4.7	Cobble	Boulder	
1	71.8	R	4	18.0	1.5	0.18	31.0	8.6	Cobble	Boulder	to next LWD pool
1	98.4	P	5	26.6	0.0	0.62	28.0	10.0	Cobble	Gravel	
1	119.1	R	6	20.7	1.0	0.23	28.0	6.2	Cobble	Gravel	flood channel on RB
1	127.7	G	7	8.6	0.0	0.23	19.4	5.9	Cobble	Gravel	
1	146.6	P	8	18.9	0.0	0.55	16.6	8.2	Gravel	Cobble	
1	165.7	R	9	19.1	2.0	0.18	24.9	6.8	Cobble	Boulder	habitat study R1 WW riffle
1	192.5	P	10	26.8	0.0	0.90	33.0	9.2	Cobble	Boulder	
1	206.5	R	11	14.0	1.0	0.23	30.0	4.7	Cobble	Gravel	
1	231.2	P	12	24.7	0.0	0.62	44.0	9.9	Cobble	Boulder	
1	237.4	R	13	6.2	0.5	0.21	41.0	7.7	Cobble	Boulder	
1	253.7	P	14	16.3	0.0	0.68	39.0	7.6	Cobble	Gravel	
1	275.8	G	15	22.1	0.5	0.23	28.0	3.3	Cobble	Gravel	
1	325.2	R	16	49.4	2.0	0.24	21.0	11.4	Cobble	Boulder	
1	378.1	P	17	52.9	0.0	1.06	30.0	11.5	Gravel	Cobble	adj Centre Creek conf
2	403.2	R	18	25.1	1.0	0.21	20.0	6.1	Cobble	Boulder	above Centre Creek conf
2	434.2	G	19a	31.0	0.0		20.0	7.5	Cobble	Gravel	
2	454.2	P	19	20.0	0.0	0.42	20.0	8.9	Cobble	Gravel	
2	488.2	R	20	34.0	1.0	0.22	15.0	13.1	Cobble	Gravel	
2	504.2	P	21	16.0	0.0	0.50	21.0	6.2	Cobble	Gravel	
2	518.8	G	22	14.6	0.5	0.22	16.4	4.6	Cobble	Bedrock	
2	541.8	R	23	23.0	1.5	0.27	19.0	5.7	Boulder	Cobble	
2	574.3	G	24	32.5	0.5	0.22	18.0	5.4	Cobble	Bedrock	
2	587.5	G	25	13.2	0.0	0.34	19.0	6.7	Bedrock	Boulder	
2	638.7	R	26	51.2	1.5	0.18	21.0	4.6	Boulder	Cobble	
2	728.4	G	27	89.7	0.5	0.78	14.4	11.6	Bedrock	Gravel	
2	751.1	R	28	22.7	3.5	0.21	22.0	9.5	Boulder	Cobble	
2	786.0	G	29	34.9	0.0	0.50	19.0	9.5	Cobble	Bedrock	
2	839.2	R	30	53.2	2.0	0.25	15.7	9.3	Boulder	Cobble	
2	875.8	G	31	36.6	0.5	0.47	15.0	8.5	Bedrock	Cobble	
2	904.1	R	32	28.3	2.0	0.20	15.0	6.8	Boulder	Cobble	
2	919.1	G	33a	15.0	0.0		14.5	8.3	Bedrock	Gravel	
2	954.2	P	33	35.1	0.0	0.76	14.0	9.9	Bedrock	Gravel	
2	1007.7	G	34	53.5	0.5	0.31	13.0	6.1	Bedrock	Cobble	
2	1027.5	R	35	19.8	3.0	0.23	14.0	9.3	Boulder	Cobble	
2	1042.5	G	36a	15.0	0.0		15.5	12.6	Bedrock	Gravel	
2	1090.2	P	36	47.7	0.0	3.50	17.0	15.8	Bedrock	Gravel	
2	1100.3	R	37	10.1	0.5	0.34	17.0	9.8	Cobble	Boulder	
2	1159.7	G	38	59.4	0.5	0.30	15.5	9.5	Cobble	Boulder	
2	1213.0	R	39	53.3	3.0	0.24	14.2	5.2	Cobble	Boulder	
2	1253.0	G	40a	40.0	0.0		15.6	8.0	Cobble	Gravel	
2	1295.4	P	40	42.4	0.0	1.50	17.0	10.9	Cobble	Gravel	
2	1319.5	R	41	24.1	1.5	0.29	18.0	2.3	Cobble	Boulder	
2	1339.5	G	42a	20.0	0.0		19.0	4.3	Gravel	Cobble	
2	1378.4	P	42	38.9	0.0	0.92	20.0	6.2	Gravel	Cobble	
2	1429.5	R	43	51.1	2.0	0.26	16.0	6.2	Cobble	Boulder	
3	1442.6	P	44	13.1	0.0	0.71	21.0	11.7	Clay	Gravel	
3	1480.9	R	45	38.3	2.0	0.27	15.0	4.5	Cobble	Boulder	
3	1500.9	G	46a	20.0	0.0		19.5	6.9	Cobble	Gravel	
3	1535.7	P	46	34.8	0.0	1.90	24.0	9.3	Cobble	Gravel	
3	1582.8	R	47	47.1	1.5	0.20	13.0	5.8	Cobble	Boulder	
3	1612.8	G	48a	30.0	0.0		22.5	8.1	Cobble	Clayrock	
3	1659.7	P	48	46.9	0.0	1.60	32.0	10.3	Cobble	Clayrock	
3	1702.3	G	49	42.6	1.0	0.53	21.0	7.6	Cobble	Clayrock	
3	1717.0	R	50	14.7	1.5	0.20	9.1	3.4	Boulder	Cobble	island splits mainstem; flow in LB
3	1722.7	P	51	5.7	0.0	0.60	9.1	5.9	Bedrock	Cobble	
3	1751.0	R	52	28.3	3.0	0.14	12.0	11.2	Cobble	Boulder	
3	1777.6	G	53	26.6	0.0	0.47	11.0	8.5	Cobble	Boulder	
3	1790.4	R	54	12.8	4.0	0.24	12.8	6.3	Boulder	Cobble	
3	1800.4	G	55a	10.0	0.0		10.9	6.5	Boulder	Cobble	
3	1816.2	P	55	15.8	0.0	0.65	9.0	6.6	Boulder	Cobble	
3	1831.1	R	56	14.9	3.5	0.22	23.0	3.2	Cobble	Boulder	
3	1867.4	G	57	36.3	0.5	0.37	21.0	7.8	Clayrock	Cobble	
3	1914.5	R	58	47.1	2.0	0.26	21.0	7.1	Cobble	Boulder	
3	1946.4	G	59	31.9	1.0	0.35	25.0	6.6	Cobble	Boulder	
3	1969.5	P	60	23.1	0.0	0.62	25.0	8.1	Cobble	Boulder	end of mainstem split
3	2072.2	R	61	102.7	3.0	0.32	20.0	12.1	Cobble	Boulder	
3	2090.8	G	62	18.6	0.5	0.41	25.0	7.3	Cobble	Boulder	

Chain 0.0 metres = mouth of South Englishman River (confluence with Englishman mainstem).
Mesohabitat types: R=riffle, P=pool, G=glide, C=cascade.

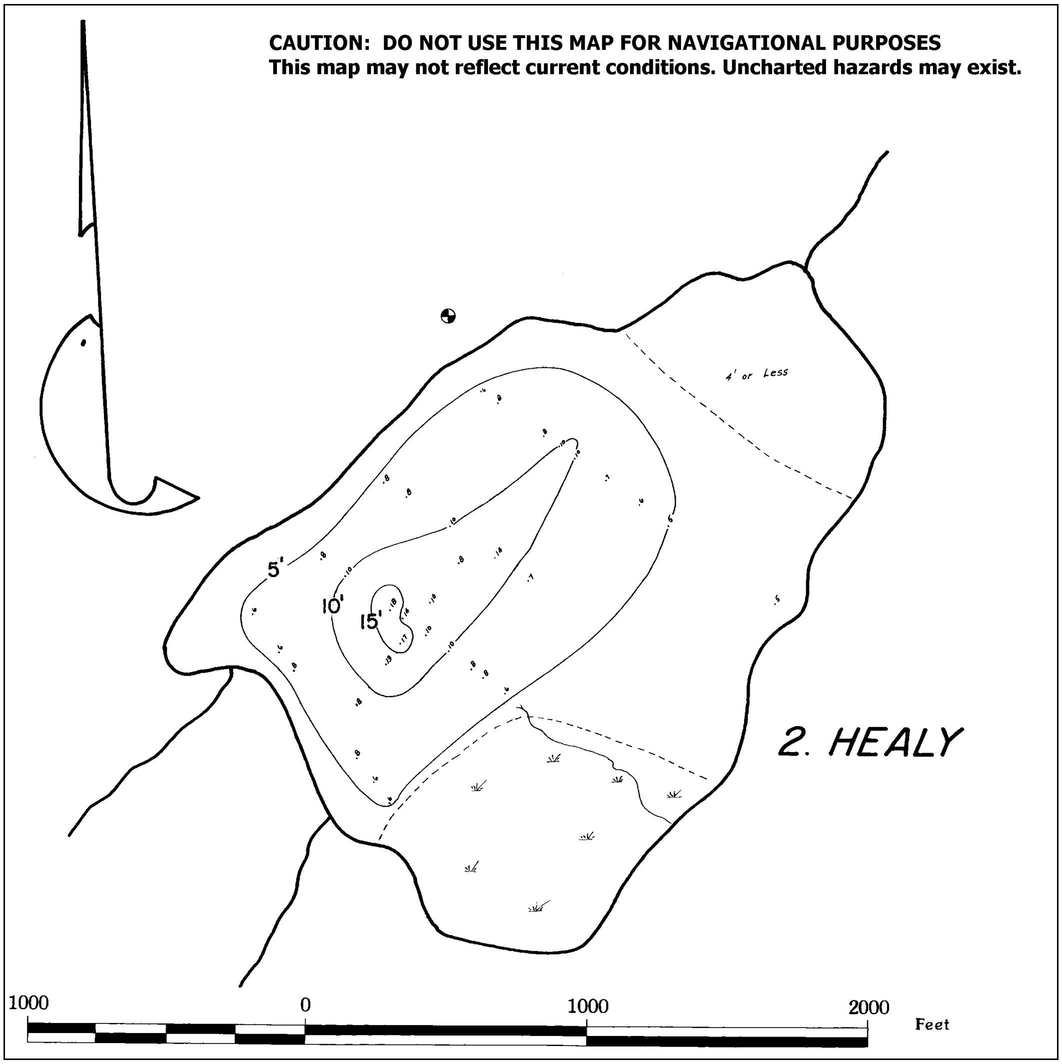
Appendix I – Stream habitat typing results, South Englishman River, Aug 20 and 21, 2009.

Reach	Chain	Meso	Photo	Length	Grad	D_{max}	Width (m)		Substrate		Comments
	(m)	Type	#	(m)	(%)	(m)	Bankfull	Wetted	Dom	Sub-dom	
3	2111.3	R	63	20.5	2.0	0.25	23.0	4.0	Cobble	Boulder	
3	2134.9	G	64	23.6	1.0	0.50	32.0	3.1	Cobble	Boulder	
3	2154.5	R	65	19.6	5.5	0.16	32.0	2.0	Gravel	Cobble	
3	2184.5	G	66a	30.0	0.0		27.5	5.2	Boulder	Cobble	
3	2211.8	P	66	27.3	0.0	0.91	23.0	8.4	Boulder	Cobble	
3	2236.3	R	67	24.5	2.0	0.28	25.0	11.2	Boulder	Cobble	
3	2251.3	G	68a	15.0	0.0		27.0	9.2	Gravel	Boulder	
3	2274.7	P	68	23.4	0.0	0.72	29.0	7.1	Gravel	Boulder	
3	2278.9	R	69	4.2	2.0	0.10	27.0	1.9	Cobble	Boulder	
3	2317.3	G	70	38.4	0.5	0.50	21.0	8.1	Cobble	Gravel	
3	2362.4	R	71	45.1	1.5	0.38	25.0	4.5	Boulder	Cobble	
3	2379.7	G	72	17.3	1.0	0.51	24.0	5.1	Cobble	Boulder	
3	2441.4	R	73	61.7	3.0	0.16	23.0	14.3	Boulder	Cobble	
3	2468.2	P	74	26.8	0.0	1.20	22.0	10.6	Gravel	Cobble	channel splits
3	2570.7	R	75	102.5	5.0	0.28	10.0	7.6	Cobble	Boulder	
3	2577.2	P	77	6.5	0.0	0.61	22.0	5.1	Gravel	Cobble	
3	2615.8	R	78	38.6	2.5	0.30	12.0	3.5	Cobble	Gravel	
3	2632.3	G	79a	16.5	0.0		13.0	3.1	Gravel	Cobble	
3	2642.3	P	79	10.0	0.0	0.41	14.0	2.7	Gravel	Cobble	flow largely subsurface
3	2659.2	R	80	16.9	1.0		15.5	3.0	Gravel	Sand	
3	2671.2	P	81	12.0	0.0	0.35	17.0	3.4	Cobble	Gravel	
3	2693.1	R	82	21.9	1.5	0.10	19.0	3.3	Cobble	Boulder	
3	2732.1	G	83	39.0	0.5	0.42	19.0	7.9	Cobble	Gravel	
3	2750.9	P	84	18.8	0.0	0.81	20.0	5.3	Cobble	Boulder	
3	2759.1	R	85	8.2	6.0	0.13	47.0	4.9	Cobble	Boulder	
3	2769.1	G	86a	10.0	0.0		39.0	7.3	Gravel	Boulder	
3	2791.9	P	86	22.8	0.0	1.05	31.0	9.8	Gravel	Boulder	
4	2807.6	G	87	15.7	0.5	0.28	23.0	8.3	Boulder	Cobble	
4	2972.4	R	88	164.8	8 to 10	0.25	22.0	4.3	Boulder	Cobble	
4	2990.0	G	89	17.6	2.5	0.48	21.0	16.1	Gravel	Cobble	
4	3157.3	R	90	167.3	6 to 8	0.22	17.0	13.9	Boulder	Cobble	minor RB trib/groundwater?
4	3169.3	G	91	12.0	0.5	0.42	16.0	12.0	Bedrock	Boulder	substrate now predominantly bedrock
4	3243.8	R	92	74.5	4.0	0.34	18.0	11.3	Boulder	Cobble	
4	3283.5	G	93	39.7	4 to 6	0.40	18.0	11.9	Bedrock	Cobble	
4	3348.9	G	94	65.4	0.0		17.0	9.0	Bedrock	Boulder	
4	3405.6	P	95	56.7	0.0	3.00	16.0	6.2	Bedrock	Boulder	
4	3405.6	C	96	0.0		0.24	18.0	31.0	Bedrock		
4	3436.8	P	97	31.2	0.0	2.00	16.0	7.7	Bedrock	Sand	
4	3436.8	C	98	0.0		0.90	11.0	1.1	Bedrock		
4	3474.7	G	99	37.9	1.0	0.40	16.0	5.6	Bedrock	Boulder	
4	3502.6	R	100	27.9	4.0	0.15	19.0	3.9	Bedrock	Boulder	
4	3582.4	G	101	79.8	2.0	0.58	18.0	13.9	Bedrock	Boulder	
4	3635.6	R	102	53.2	4.0	0.51	17.0	5.1	Bedrock	Boulder	
4	3668.3	P	103	32.7	0.0	1.30	19.0	6.2	Bedrock	Boulder	
4	3669.1	R/C	104	0.8	8.0	0.14	16.0	1.5	Bedrock	Boulder	riffles w cascades
4	3688.6	P	105	19.5	0.0	0.50	20.0	5.8	Cobble	Gravel	
4	3688.6	C	106	0.0		0.24	19.0	1.6	Bedrock		
4	3767.0	R/C	107	78.4	8.0	0.60	21.0	5.3	Bedrock		riffle/plunge/cascade sequence
4	3788.8	G	108	21.8	0.5	0.91	19.0	6.8	Boulder	Cobble	
4	3805.3	R	109	16.5	4.0	0.32	18.0	1.3	Bedrock	Boulder	
4	3836.3	G	110	31.0	0.5	0.61	17.0	9.3	Bedrock	Cobble	
4	3848.6	P	111	12.3	0.0	2.00	18.0	8.6	Bedrock	Gravel	
4	3860.4	C	112	11.8	7.0	0.20	18.0	0.8	Bedrock		
4	3864.8	P	113	4.4	0.0	2.80	19.0	13.0	Bedrock	Cobble	
4	3869.1	C	114	4.3	8.0	0.25	20.0	0.5	Bedrock	Boulder	
4	3885.2	G	115	16.1	0.5	0.43	20.0	0.5	Boulder	Gravel	
4	3893.9	P	116	8.7	0.0	3.00	21.0	20.0	Bedrock	Gravel	
4	3893.9	C	117	0.0			21.0	0.3	Bedrock		
4	3908.9	G	118	15.0	1.0	0.34	20.0	3.7	Bedrock	Gravel	
4	3931.6	R	119	22.7	5.0	0.22	21.0	1.4	Bedrock	Boulder	
4	3994.8	G	120	63.2	1.0	0.55	21.0	7.7	Bedrock	Gravel	
4	4046.1	R	121	51.3	5.0	0.41	22.0	1.7	Bedrock	Gravel	
4	4079.2	G	122	33.1	1.0	0.60	20.0	8.3	Bedrock	Gravel	
4	4118.2	R	123	39.0	2.0	0.41	19.0	2.8	Bedrock	Boulder	
4	4139.9	P	124	21.7	0.0	1.20	19.0	7.5	Bedrock	Boulder	
4	4207.0	R	125	67.1	1.5	0.30	19.0	2.0	Bedrock	Boulder	
4	4213.7	G	126	6.7	0.5	0.42	21.0	4.2	Bedrock	Boulder	
4	4331.6	R	127	117.9	7.0	0.30	20.0	7.3	Bedrock	Cobble	
4	4354.5	G	128	22.9	1.0	0.61	16.0	7.8	Boulder	Gravel	
4	4472.5	R	129	118.0	6.0	0.24	20.0	3.2	Boulder	Cobble	
4	4507.7	G	130	35.2	1.0	0.70	15.0	12.0	Boulder	Gravel	
4	4559.2	R	131	51.5		0.55	11.9	4.5	Boulder	Cobble	mostly subsurface flow
4	4569.2	P	132	10.0	0.0	3.80	8.7	8.7	Bedrock	Gravel	under 151 ML bridge

Chain 0.0 metres = mouth of South Englishman River (confluence with Englishman mainstem).
Mesohabitat types: R=riffle, P=pool, G=glide, C=cascade.

Appendix J. – (under separate cover) Report, October 2008 – ECVI Storage Feasibility – Environmental Assessment Component for Shelton and Healy Lakes. Prepared by E. Wind Consulting, Nanaimo, BC.

Appendix K. Healy Lake bathymetry (provincial F&W Branch; May 2, 1970); DO and temperature profiles (BCCF; August 26, 2009); and commentary related to potential flow through effects.



Depth (m)	Temp (°C)	% DO	mg/L DO	Comments
0	18.7	89.0	8.31	
1	18.7	86.3	8.06	
2	18.5	84.4	7.90	
3	18.3	83.8	7.88	
4	18.3	83.8	7.88	
4.5	18.5	3.3	0.31	DO reading fluctuated between 0.5% and 60%
4.75	18.5	0.3	0.03	Stable readings

Appendix K. Healy Lake bathymetry (provincial F&W Branch; May 2, 1970); DO and temperature profiles (BCCF; August 26, 2009); and commentary related to potential flow through effects.

Dr. Ken Ashley, Limnologist, NHC Ltd., North Vancouver, BC:

According to accepted limnological theory and practice, the increased flushing rate in Healy Lake resulting from additional summer storage releases from Shelton Lake will cause an incremental reduction in annual biological production based on decreased residence time alone.

However, this loss in production may be countered by increased dissolved and particulate nutrient loading from Shelton Lake, which may partially offset the reduced residence time. Also, if the hypolimnion of Healy Lake becomes anoxic during summer, the water released from Shelton Lake may be cold enough to sink into the hypolimnion in Healy Lake and increase the oxygen concentrations, which would actually increase productivity despite the reduced residence time cause by the higher flushing rate.

In order to quantify this, it would take a minimum of several years pre-flushing, and several years post-flushing, with fairly detailed water chemistry, emergent aquatic insect sampling, plankton sampling, water chemistry and monthly C14 measurements.

As interesting as this may be from an academic point of view, I suspect the various offsets would largely cancel each other out, and from a management perspective, I would not object to the decreased summer residence times in Healy Lake, but I would like to see an oxygen-temperature profile in Healy Lake in August to determine the degree, if any, of hypolimnetic anoxia.

Bottom line: unless there is something very unique about the RBT and any other organisms in Healy Lake, I believe the increase in late summer MAD in the Englishman River more than compensates for any potential decreased production in Healy Lake. At this point in the climate change continuum, we had better start examining these types of resource trade-offs, as the situation is only going to get worse in the future as the climate becomes warmer and dryer throughout the summer on the East Coast of Vancouver Island and the Lower Mainland.

Tom Johnson, Biologist, Stock Assessment Specialist, Ministry of Forests, Lands and Natural Resource Management, Vancouver, BC:

- *Effects are difficult to forecast, and relative effects are highly uncertain.*
- *Flows at Shelton Lake outlet stream and at Healy Lake inlet and outlet streams will presumably be reduced in the spring as water is stored at Shelton Lake. RB egg-fry survival may decline if flow reductions occur during the period of RB spawning and egg incubation.*
- *Changes in stream flow during the summer may alter the amount or quality of RB rearing habitat in the streams if fry or juveniles rear in-stream before entering the lakes.*
- *Effects on in-lake productivity are likely to be low.*
- *If the higher Secchi depth at Healy Lake indicates higher phytoplankton density (and not simply higher turbidity or higher DOM in the shallower lake) then we expect Shelton Lake to have lower zooplankton densities than Healy Lake. Withdrawal of epilimnial water from Shelton Lake might result in a slight dilution effect at Healy Lake and might slightly reduce zooplankton productivity at Shelton Lake.*
- *Provided water depths at Healy Lake do not increase significantly (more than, say, 0.2 m) as a result of releases from Shelton Lake, there should be little effect on the production of epibenthic algae, littoral macrophytes, and benthic or epiphytic insect production. Entrainment of benthic sediments or shoreline erosion which increase turbidity would reduce productivity, but the effects do not seem likely.*
- *If RB feed primarily on aquatic insects, as seems likely for a shallow lake like Healy, there should be little direct effect on in-lake RB production.*

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

South Englishman River

Biomass= 202.1 Alkalinity= 31

Juvenile Standing Stock Electrofishing Results, 1998-2006, 2008, 2009.

(Note: objective was ST fry density evalution - only shallow riffle habitats were sampled)

ST fry (0+)

Year	Date	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1998	13-Jul	1.0	12.4	12.4	213	6%
1999	27-Jul	1.0	28.7	31.6	208	15%
2000	24-Aug	1.1	9.6	11.1	190	6%
2001	28-Aug	1.2	6.9	11.5	175	7%
2002	29-Aug	1.4	28.0	50.3	148	34%
2003	26-Aug	2.3	18.0	30.6	87	35%
2004	18-Aug	1.3	7.2	16.5	155	11%
2005	25-Aug	2.3	16.5	28.2	89	32%
2006	22-Aug	1.4	45.9	136.7	145	94%
MEAN		**1.4**	**15.9**	**36.5**		**27%**

ST parr (1+, 2+)

Year	Date	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1998	13-Jul	10.4	3.0	6.2	19	32%
1999	27-Jul	None captured				
2000	24-Aug	None captured				
2001	28-Aug	None captured				
2002	29-Aug	4.4	0.8	9.4	46	20%
2003	26-Aug	8.3	2.9	36.0	24	148%
2004	18-Aug	7.5	2.2	69.8	27	259%
2005	25-Aug	7.2	1.2	10.9	28	39%
2006	22-Aug	6.7	3.3	147.3	30	485%
MEAN		**7.4**	**2.0**	**46.6**		**164%**

CO fry (0+)

Year	Date	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
1998	13-Jul	1.6	20.9	43.5	126	35%
1999	27-Jul	2.5	17.0	58.6	80	74%
2000	24-Aug	1.4	45.9	161.2	150	108%
2001	28-Aug	1.5	18.0	26.6	133	20%
2002	29-Aug	1.2	66.3	173.3	168	103%
2003	26-Aug	2.7	11.5	19.7	75	26%
2004	18-Aug	1.5	19.0	50.3	139	36%
2005	25-Aug	2.6	17.3	45.0	77	58%
2006	22-Aug	0.9	38.5	113.8	226	50%
MEAN		**1.8**	**24.2**	**76.9**		**57%**

September 30, 2008

Sp. Age	Site	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
ST fry (0+)	1	3.0	22.3	34.2	68	50%
	2	1.9	31.6	71.2	106	67%
	3	2.5	10.8	12.5	80	16%
	MEAN	**2.5**	**19.6**	**39.3**		**44%**
ST parr (1+ 2+)	1	10.1	0.7	5.6	20	28%
	2	5.4	0.9	8.2	37	22%
	3	8.5	6.0	21.4	24	89%
	MEAN	**8.0**	**1.6**	**11.7**		**46%**
CO fry (0+)	1	2.1	38.9	97.1	98	99%
	2	2.2	9.5	25.6	92	27%
	3	2.8	31.7	46.0	71	64%
	MEAN	**2.4**	**22.7**	**56.2**		**63%**

September 22, 2009

Sp. Age	Site	Mean Weight (grams)	Unadj'd FPU	D/V Adj'd FPU	Predicted FPU	% of Predicted
ST fry (0+)	1	2.8	24.7	51.0	72	71%
	2	2.2	10.7	22.1	94	24%
	3	1.0	4.9	10.2	195	5%
	MEAN	**2.0**	**10.9**	**27.8**		**33%**
ST parr (1+ 2+)	1	9.6	2.4	54.3	21	258%
	2	None captured				
	3	9.9	4.9	111.9	20	547%
	MEAN	**9.7**	**3.4**	**83.1**		**402%**
CO fry (0+)	1	1.7	122.6	259.6	118	219%
	2	1.4	41.2	87.1	147	59%
	3	1.7	136.5	288.9	121	238%
	MEAN	**1.6**	**88.3**	**211.9**		**172%**

Sampling Description/Location

Site#	Desc	UTM
1	~85m d/s of Centre Creek Confluence	10U 450606mE, 5459214mN
2	~60m u/s of Centre Creek Confluence	10U 405637mE, 5459084mN
3	~600m u/s of Centre Creek Confluence	10U 405832mE, 5458582mN

NOTES:

The single site completed annually from 1998-2006 was site #2

Predicted fish/unit (FPU) based on Ptolemy Alkalinity model (1993):

$FPU=(A)^{0.5} \times 36.3 / W$

where A = alkalinity, in mg/l $CaCO_3$

W = mean weight of sampled fish, in grams

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

			Species /age	Mean weight (g	Catch 1	Catch	Estimate populati(	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
STREAM	S Englishman R									
SITE:	2									
LENGTH	14.6	Sp. #1	Rb(0+)	0.95	7	3	12.25	12.43	1.00	12.4
WIDTH:	6.75	Sp. #2	Rb(1+)	10.38	3	0	3.00	3.04	0.49	6.2
AREA:	98.6	Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
DATE:	980713	Sp. #4	Co(0+)	1.61	12	5	20.57	20.87	0.48	43.5
		Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
		Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.
Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5			Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights(	Length	c1+c2	weight	Length	c1+c2	weights(
39	1	0.6	94	1	7.9				40	1							
41	1	0.8	99	1	9.8				46	1							
42	1		110	1	13.6				48	1							
43	1								50	1	1.3						
44	1	0.8							51	1							
47	1	1.2							52	1							
44	1	0.9							54	1							
48	1	1.1							56	2							
59	1	2							57	1							
39	1	0.5							67	1							
									72	1							
									40	1							
									44	1							
									49	1							
									54	1							
									55	1							

			Species /age	Mean weight (g	Catch 1	Catch	Estimate populati(	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
STREAM	S Englishman R									
SITE:	2									
LENGTH	17.5	Sp. #1	Rb(0+)	0.97	13	5	21.13	28.74	0.91	31.6
WIDTH:	4.2	Sp. #2	Rb(1+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
AREA:	73.5	Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
DATE:	990727	Sp. #4	Co(0+)	2.54	10	2	12.50	17.01	0.29	58.6
		Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
		Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

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Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5			Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(
38	1								52	1	1.9						
39	1	0.5							53	1	1.6						
40	2	0.5							55	2	2.1						
40	1	0.6							56	1	2.1						
42	1	0.8							58	1	2.6						
45	2	0.8							58	1	2.5						
45	1	0.9							60	1	2.8						
50	1	1.4							62	1	2.9						
54	2	1.6							63	1	2.9						
56	1	1.8							63	1	3.4						
38	1	0.6							66	1	3.6						
39	1	0.6															
46	1	1.1															
50	1	1.3															
51	1	1.5															

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

STREAM:	S Englishman R
SITE:	2
LENGTH:	14
WIDTH:	8.99
AREA:	125.9
DATE:	24-Aug-00

	Species /age	Mean weight (g	Catch 1	Catch	Estimate populati	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	1.06	11	1	12.10	9.61	0.87	11.1
Sp. #2	Rb(1+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.17	#DIV/0!
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.17	#DIV/0!
Sp. #4	Co(0+)	1.35	51	6	57.80	45.91	0.28	161.2
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.

Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5			Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(
46	1								37	1	0.4						
46	2	1							38	1	0.6						
47	1	0.8							38	2							
47	1	1							39	1							
48	1	1.2							40	2							
48	1	1.1							41	1	0.6						
48	1	1.4							41	1	0.8						
48	1	0.8							42	1							
49	1	1.2							43	1	1.1						
50	1	1.2							43	1							
46	1	1.1							43	2							
									44	1	0.9						
									44	1	1						
									44	1	0.7						
									45	1	0.8						
									46	1	0.8						
									46	2							
									46	1	0.7						
									48	1							
									49	1							
									52	2							
									52	1	1.6						
									53	1	1.8						
									53	1	1.7						
									53	1	1.9						
									53	1							
									54	1							
									54	1	1.8						
									54	1	1.5						
									55	1	1.7						
									55	1	2.1						
									55	1							
									55	1	2						
									56	1							
									56	1	1.5						
									57	1	1.9						
									57	1	2.4						
									58	1	2.3						
									59	1	1.6						
									60	1	2.5						
									60	1							
									60	1							
									61	1							
									62	1	2.7						
									65	1	3						
									58	1							
									39	1	0.5						
									41	1							
									41	1	0.7						
									42	1							
									51	1	1.4						
									55	1	1.7						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

STREAM:	S Englishman R
SITE:	2
LENGTH:	18.9
WIDTH:	3.83
AREA:	72.4
DATE:	28-Aug-01

	Species /age	Mean weight (g	Catch 1	Catch	Estimate populati	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	1.15	5		5.00	6.90	0.60	11.5
Sp. #2	Rb(1+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.23	#DIV/0!
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.23	#DIV/0!
Sp. #4	Co(0+)	1.51	13		13.00	17.95	0.67	26.6
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.

Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5			Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
36	1	0.5							42	1	0.8						
43	1	0.8							42	1	0.6						
48	1	1.1							44	1	1						
53	1	1.5							46	1	1.2						
57	1	1.8							46	1	1						
									50	1	1.5						
									50	1	1.6						
									53	1	1.8						
									54	1	2.1						
									55	1	1.9						
									56	1	2.1						
									62	1	3						
									51	1	1.5						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

			Species /age	Mean weight (g	Catch 1	Catch	Estimate populati	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
STREAM:	S Englishman R									
SITE:	2									
LENGTH:	21.85	Sp. #1	Rb(0+)	1.37	28	7	37.33	28.02	0.56	50.3
WIDTH:	6.78	Sp. #2	Rb(1+)	4.40	1		1.00	0.75	0.08	9.4
AREA:	133.2	Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.08	#DIV/0!
DATE:	29-Aug-02	Sp. #4	Co(0+)	1.20	74	12	88.32	66.29	0.38	173.3
		Sp. #5	Bt(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
		Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.

Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Bt(0+)		Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
43	1	0.90	77	1	4.4				36	1	0.4						
44	1	0.8							37	1							
45	1	1.3							38	1							
45	1	0.9							39	2							
46	1	1							39	1	0.5						
46	1	1.1							40	7							
46	1	0.7							40	1	0.6						
47	1	1.1							40	1	0.5						
48	1	1.2							41	1	0.7						
48	1	1.1							41	1							
50	1	1.6							42	1	0.9						
52	2	1.4							42	1	1						
52	2	1.5							42	2							
53	1								43	2	0.8						
54	1	1.7							43	1							
55	1	1.8							44	2							
55	1	1.7							44	1	1						
55	1	1.3							44	1	0.9						
57	1	2.1							44	1	0.8						
60	1	2.4							45	1							
61	1	2.3							45	1	1						
61	1								45	1	0.9						
49	2	1.1							46	2							
49	1	1.3							46	1	0.9						
49	1	1.2							47	1							
42	1	0.8							47	1	1.3						
42	1	1							47	1	1.2						
44	1								48	1	1.1						
47	1	1							49	1	1.4						
50	1	1.4							49	1							
51	1	1.3							50	2							
52	1								51	5							
									51	1	1.5						
									51	1	1.4						
									51	1	1.3						
									52	4							
									52	1	1.5						
									53	1	1.3						
									53	1	1.7						
									53	1	1.8						
									54	1							
									55	1	1.7						
									55	1							
									56	2							
									56	1	1.9						
									56	1	2.1						
									57	1	2						
									58	1	2.1						
									58	1							
									58	1							
									59	1	2.3						
									59	1							
									62	1							
									63	1							
									39	2							
									40	2							
									44	1							
									45	3							
									49	1							
									55	2							
									58	1							

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

		Species									
STREAM:	S Englishman R		Species	Mean			Estimate	Fish/unit	Prob.	Adjusted	
SITE:	2		/age	weight (g	Catch 1	Catch	populati	(100m2)	of use	Fish/unit	This spreadsheet is designed
LENGTH:	22.2	Sp. #1	Rb(0+)	2.34	24	1	25.04	18.00	0.59	30.6	to process electrofishing data.
WIDTH:	7.38	Sp. #2	Rb(1+)	8.32	4		4.00	2.87	0.08	36.0	Data can only be entered into non-
AREA:	139.2	Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.08	#DIV/0!	shaded cells - all shaded cells are
DATE:	26-Aug-03	Sp. #4	Co(0+)	2.68	8	4	16.00	11.50	0.58	19.7	protected.
		Sp. #5	Bt(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!	Poul Bech, Reg. 2 Fisheries,
		Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!	B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Bt(0+)		Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
48	1	1.60	80	1	5.6				54	1	1.7						
48	1	1.3	84	1	7.3				54	1	1.8						
50	1	1.6	96	1	8.8				57	1	2						
52	1	1.5	103	1	10.9				60	1	2.6						
53	1	1.9							61	1	3						
53	1	1.9							64	1	3.4						
53	1	1.7							64	1	3						
54	1	1.9							71	1	4.2						
54	1	2.1							57	1	2.5						
54	1	1.8							58	1	2.3						
55	1	2							62	1							
56	1	1.9							64	1	2.9						
57	1	1.8															
57	1	2.3															
57	1	2.1															
58	1	2.3															
58	1	2.5															
58	1	2.2															
60	1	2.4															
60	1	2.4															
61	1	2.5															
61	1	2.4															
65	1	3.3															
74	1	4.9															
80	1	5.3															

STREAM:	S Englishman R		Species	Mean			Estimate	Fish/unit	Prob.	Adjusted	
SITE:	2		/age	weight (g	Catch 1	Catch	populati	(100m2)	of use	Fish/unit	This spreadsheet is designed
LENGTH:	21.5	Sp. #1	Rb(0+)	1.31	12	1	13.09	7.25	0.44	16.5	to process electrofishing data.
WIDTH:	8.40	Sp. #2	Rb(1+)	7.49	4	0	4.00	2.21	0.03	69.8	Data can only be entered into non-
AREA:	180.6	Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.03	#DIV/0!	shaded cells - all shaded cells are
DATE:	18-Aug-04	Sp. #4	Co(0+)	1.46	31	3	34.32	19.00	0.38	50.3	protected.
		Sp. #5	Bt(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!	Poul Bech, Reg. 2 Fisheries,
		Sp. #6	Cn[0+]	0.00	1		1.00	0.55		#DIV/0!	B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Bt(0+)		Sp. #6	Cn[0+]	
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
44	1	0.90	84	1	6.4				41	1	0.8				65	1	2.8
45	1	0.7	89	1	6.8				43	1	0.8						
49	1	1.2	90	1	8.2				44	1	1						
52	1	1.3	94	1	8.5				46	1	1						
52	1	1.4							48	1	1.4						
52	1	1.5							48	1	1.2						
56	1	1.8							50	1	1.4						
41	1	0.7							51	1	1.5						
47	1	1.3							52	1	1.3						
52	1	1.5							52	1	1.5						
53	1	1.7							52	1							
55	1	1.5							53	2	1.6						
52	1	1.5							53	1	1.9						
									54	1	1.7						
									55	1	2.2						
									55	1	2						
									55	1							
									56	1	1.9						
									56	1	2.2						
									57	1	1.9						
									58	1	2.1						
									58	1	2.5						
									59	1	1.9						
									60	1	2.5						
									62	1	2.3						
									63	1	3						
									43	1	0.7						
									44	1	0.9						
									48	1	1.2						
									55	1	1.6						
									52	1	1.5						
									58	1	2						
									63	1	3.1						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

STREAM:	S Englishman R
SITE:	2
LENGTH:	16.8
WIDTH:	6.05
AREA:	81.3
DATE:	25-Aug-05

	Species /age	Mean weight (g)	Catch 1	Catch	Estimate populati	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	2.26	11	2	13.44	16.53	0.59	28.2
Sp. #2	Rb(1+)	7.20	1	0	1.00	1.23	0.11	10.9
Sp. #3	Rb(2+)	14.50	1	0	1.00	1.23	0.11	10.9
Sp. #4	Co(0+)	2.62	13	1	14.08	17.32	0.39	45.0
Sp. #5	Bt(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	Cn[0+]	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.

Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Bt(0+)		Sp. #6	Cn[0+]	
Length	c1+c2	weight	Length	c1+c2	weights(g)	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
46	1	1.10	81	1	7.2	116	1	14.5	49	1	1.5						
52	1	1.4							55	1							
53	1	1.5							56	1	1.9						
53	1	1.5							57	1	2.4						
54	1								58	1	2.5						
55	1								58	1	2.5						
57	1								60	1	2.3						
58	1	2.1							60	1	2.8						
62	1	2.9							62	1							
66	1	2.9							63	1							
72	1	4.1							65	1	3.1						
52	1	1.6							68	1	3.5						
78	1	4.7							68	1							
									61	1	2.4						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

STREAM:	S Englishman R		Species	Mean			Estimate	Fish/unit	Prob.	Adjusted	
SITE:	2		/age	weight (g	Catch 1	Catch	populati	(100m2)	of use	Fish/unit	This spreadsheet is designed
LENGTH:	17.5	Sp. #1	Rb(0+)	1.39	42	10	55.13	45.89	0.34	136.7	to process electrofishing data.
WIDTH:	8.08	Sp. #2	Rb(1+)	6.66	2	1	4.00	3.33	0.02	147.3	Data can only be entered into non-
AREA:	120.1	Sp. #3	Rb(2+)	#DIV/0!	0	0	#DIV/0!	#DIV/0!	0.02	#DIV/0!	shaded cells - all shaded cells are
DATE:	22-Aug-06	Sp. #4	Co(0+)	0.89	34	9	46.24	38.50	0.34	113.8	protected.
		Sp. #5	Bt(0+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!	Poul Bech, Reg. 2 Fisheries,
		Sp. #6	Cn[0+]	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!	B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Bt(0+)		Sp. #6	Cn[0+]	
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
36	1	0.40	87	1	6.5				39	1							
38	1	0.4	75	1	4				43	1	1.1						
42	1	0.8	101	1	9.3				43	1	0.7						
44	1	0.7							44	1	1.1						
44	1	0.8							54	1	1						
44	1								45	1	1.1						
46	1	1.2							45	1							
46	1								46	1							
47	1	1.1							48	1	1.1						
47	1								49	1	1.4						
48	1	1.3							49	1	1.3						
48	1	1.1							49	1							
48	1								50	1	1.7						
48	1								50	1							
48	1								51	1	1.7						
49	1								51	1	1.1						
50	1								51	1							
51	1	1.5							52	1	2						
51	1								52	1	1.4						
52	1	1.7							52	1	1.5						
52	1	1.5							53	1	1.4						
52	1	1.4							54	1	2						
52	1								55	1	1.9						
52	1								55	1	1.5						
52	1								55	1							
53	1	1.6							57	1	2.4						
53	1								57	1							
53	1								57	1							
54	1	2							58	1	2.3						
54	1	1.6							58	1	1.9						
54	1								62	1	2.6						
54	1								63	1							
55	1	1.4							64	1	2.6						
56	1	2.1							65	1	3.3						
56	1								45	1							
56	1								49	1							
57	1	1.9							50	1							
58	1	1.8							52	1							
59	1	2.2							52	1							
59	1	1.9							54	1	1.6						
62	1	2							56	1							
65	1								59	1	2.5						
45	1	1							64	1	2.8						
46	1																
48	1	1.1															
48	1																
51	1																
52	1																
52	1																
53	1																
54	1																
56	1	1.5															

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

STREAM	South Eman
SITE:	1
LENGTH	24.55
WIDTH:	5.78
AREA:	142.4
DATE:	30-Sep-08

	Species /age	Mean weight (g	Catch 1	Catch 2	Estimated population	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	2.98	27	4	31.70	22.27	0.65	34.2
Sp. #2	Rb(1+)	0.00	0	1	0.00	0.00	0.13	0.0
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #4	Co(0+)	2.06	44	9	55.31	38.86	0.40	97.1
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	Ch(0+)	2.54	3	0	3.00	2.11	0.14	15.6

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Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Ct(2+)		Sp. #6	Ch(0+)	
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(g)	Length	c1+c2	weights(g)	Length	c1+c2	weight	Length	c1+c2	weights(g)
54	1	1.7	90	1	10.1				41	1	0.6				55	1	1.6
57	1	2.2							43	1	0.9				59	1	2.4
57	1	2							45	1	0.9				71	1	3.6
59	1	2.3							46	1	1						
60	1	2.3							47	1	0.8						
60	1	2							47	1	1.2						
60	1	2.4							47	1	1.2						
63	1	2.7							47	1	1						
63	1	3.2							47	1	1.2						
63	1	2.4							47	1							
63	1								48	1	1.3						
65	1	3.8							48	1	1.2						
65	1	2.8							49	1	1.2						
65	1	2.7							51	1	1.6						
65	1								51	1	1.6						
66	1	2.9							51	1	1.3						
67	1	3.6							52	1	1.4						
67	1	3.1							52	1	1.7						
68	1	3.3							54	1	2						
68	1	3.2							55	1	2						
68	1	3.4							56	1	1.9						
69	1	3.2							57	1	2.2						
69	1	3.4							58	1	2.5						
69	1	3.3							60	1	2.5						
71	1	3.6							60	1	2.4						
72	1	3.8							61	1	2.5						
74	1	4.4							61	1	2.6						
63	1	2.5							61	1	2.5						
64	1	2.9							62	1	2.7						
69	1	3.2							62	1	2.8						
72	1	4.1							62	1	2.8						
									63	1	2.8						
									64	1	2.8						
									64	1	3.5						
									64	1	3						
									66	1	3.2						
									66	1	3.1						
									66	1	3.8						
									68	1	3.2						
									68	1	3.1						
									69	1	3.8						
									69	1	3.4						
									71	1	3.7						
									73	1	4.2						
									49	1							
									49	1							
									55	1	1.8						
									56	1	1.8						
									57	1	2.1						
									57	1							
									60	1	2.4						
									60	1							
									61	1	2.4						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

			Species /age	Mean weight (g	Catch 1	Catch	Estimate populati(	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
STREAM	South Eman									
SITE:	2									
LENGTH	15.2	Sp. #1	Rb(0+)	1.91	31	4	35.59	31.58	0.44	71.2
WIDTH:	5.60	Sp. #2	Rb(1+)	2.90	1	0	1.00	0.89	0.11	8.2
AREA:	112.7	Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.11	#DIV/0!
DATE:	30-Sep-08	Sp. #4	Co(0+)	2.19	8	2	10.67	9.46	0.37	25.3
		Sp. #5	CT(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.24	#DIV/0!
		Sp. #6	Ch(0+)	3.30	0	1	0.00	0.00		#DIV/0!

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.
Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	CT(2+)		Sp. #6	Ch(0+)	
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
38	1	0.9	82	1	2.9				41	1	1.1				70	1	3.3
44	1	0.9							54	1	2						
44	1	0.8							57	1	2.5						
45	1	0.9							58	1	2.2						
45	1	1.1							58	1	2.1						
47	1	1.4							60	1	2.4						
48	1	1.4							64	1	2.9						
48	1	1.3							66	1	3.6						
49	1	1.2							42	1	0.8						
50	1	1.5							56	1	1.9						
51	1	1.4															
53	1	1.8															
54	1	2															
54	1	1.8															
54	1	2															
55	1	1.6															
56	1	2.7															
56	1	1.8															
58	1	2.4															
58	1	2.6															
58	1	2.5															
58	1																
59	1	2.5															
59	1	2.4															
60	1	2															
61	1	2.4															
62	1	3.1															
62	1	2.4															
62	1	3.1															
63	1	2.6															
68	1	3.4															
50	1	1.3															
50	1	1.3															
51	1	1.8															
57	1	1.8															

			Species /age	Mean weight (g)	Catch 1	Catch 2	Estimate populati(	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
STREAM:	South Eman									
SITE:	3									
LENGTH:	14.7	Sp. #1	Rb(0+)	2.52	6	1	7.20	10.76	0.86	12.5
WIDTH:	4.17	Sp. #2	Rb(1+)	8.45	4	0	4.00	5.98	0.28	21.3
AREA:	66.9	Sp. #3	Rb(2+)	0.00	1	0	1.00	1.49	0.28	5.3
DATE:	30-Sep-08	Sp. #4	Co(0+)	2.84	19	2	21.24	31.72	0.69	46.0
		Sp. #5	0	#DIV/0!	0	0	#DIV/0!	#DIV/0!	#REF!	#DIV/0!
		Sp. #6	Ch(0+)	2.09	4	0	4.00	5.98	0.36	16.8

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.
Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5			Sp. #6	Ch(0+)	
Length	c1+c2	weight	Length	c1+c2	weights(g)	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
52	1	1.8	86	1	6.6	121	1	17.9	52	1	1.7				52	1	1.4
53	1	1.7	91	1	7.6				57	1	2.1				56	1	1.8
56	1	1.6	92	1	7.7				57	1	2.2				56	1	2
59	1	2.5	107	1	11.6				59	1	2.1				67	1	3.2
59	1	2							59	1	2.2						
78	1	5.3							59	1	2.4						
63	1	2.7							61	2	2.4						
									62	1	2.8						
									64	2	2.8						
									66	1	4.1						
									66	1	3.5						
									68	1	3.1						
									69	1	3.7						
									69	1	3.4						
									70	1	3.5						
									70	1	4.5						
									71	1	4.5						
									53	1	1.5						
									55	1	1.8						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

STREAM	South Englishman
SITE:	1
LENGTH	18
WIDTH:	4.75
AREA:	83.4
DATE:	22-Sep-09

	Species /age	Mean weight (g	Catch 1	Catch 2	Estimate populati	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	2.82	17	3	20.64	24.74	0.48	51.0
Sp. #2	Rb(1+)	9.59	2	0	2.00	2.40	0.04	54.3
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.04	#DIV/0!
Sp. #4	Co(0+)	1.71	79	18	102.31	122.62	0.47	259.6
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

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Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1 Length	Rb(0+) c1+c2	weight
51	1	1.4
54	1	1.6
57	1	2.2
60	1	2.4
60	1	2.3
60	1	2.1
61	1	2.8
62	1	2.5
64	1	2.8
66	1	2.9
66	1	3.9
67	1	3
67	1	3.3
68	2	3.4
70	1	3.5
75	1	4.2
37	1	1.2
60	1	2.3
62	1	2.4

Sp. #2 Length	Rb(1+) c1+c2	weights(g
97	1	8.9
101	1	10.3

Sp. #3 Length	Rb(2+) c1+c2	weights(

Sp. #4 Length	Co(0+) c1+c2	weights
38	1	0.6
39	2	0.6
40	2	0.6
40	1	0.9
41	1	0.9
41	1	0.6
42	1	1
42	1	1.3
42	1	0.7
43	2	0.7
44	2	1
44	1	0.8
45	1	0.9
45	1	1
45	2	1.1
45	1	1.3
46	2	1.1
47	1	0.8
47	1	0.9
47	2	1
48	1	1.1
49	2	1.3
49	2	1.4
49	2	1.6
49	1	
50	1	1.6
51	1	1.3
51	1	1.4
51	2	1.5
52	1	1.4
52	1	1.5
52	1	1.6
53	1	1.4
53	2	1.7
53	1	1.9
54	1	1.6
54	1	1.8
55	1	1.6
55	1	1.7
55	1	1.8
55	2	1.9
56	1	1.8
56	2	1.9
56	1	2
56	1	3.1
57	1	2
57	1	2.1
57	1	2.3
58	1	2.3
59	1	2
59	1	2.1
59	1	2.3
59	1	2.6
60	1	2.1
60	1	2.6
61	1	2.4
61	1	2.7
63	1	2.9
64	1	2.9
65	1	2.6
66	1	2.7
66	1	2.9
67	1	2.2
70	1	3.8
70	1	
42	1	0.7
43	1	1.2
44	1	1
45	1	0.8
49	1	1.2
49	1	1.6
50	1	1.6
51	1	1.3
51	1	1.4
55	1	1.7
58	1	2.1
59	1	2.4
59	1	2.6
59	1	
60	1	2.7
68	1	3.6
70	1	3.6
77	1	5

Sp. #5 Length	Ct(2+) c1+c2	weight

Sp. #6 Length	c1+c2	weights(g)

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

STREAM	South Englishman
SITE:	2
LENGTH	13.5
WIDTH:	5.87
AREA:	76.2
DATE:	22-Sep-09

	Species /age	Mean weight (g	Catch 1	Catch 2	Estimate populati(	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
Sp. #1	Rb(0+)	2.16	7	1	8.17	10.72	0.48	22.1
Sp. #2	Rb(1+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.04	#DIV/0!
Sp. #3	Rb(2+)	#DIV/0!	0		#DIV/0!	#DIV/0!	0.04	#DIV/0!
Sp. #4	Co(0+)	1.38	28	3	31.36	41.15	0.47	87.1
Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

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Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Ct(2+)		Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weigh	Length	c1+c2	weights(g)
53	1	1.6							42	1	0.8						
55	1	2							43	1	0.9						
57	1	1.7							43	1	0.7						
57	1	1.8							44	1	0.9						
59	1	2							45	1	1.3						
61	1	2.3							45	1	1						
66	1	3							45	1	1						
66	1	2.8							46	1	1.1						
									46	1	1.3						
									47	1	1.1						
									47	1	1.2						
									48	1	1.2						
									48	1	1.1						
									49	1	1.1						
									50	2	1.4						
									51	1	1.3						
									52	1	1.4						
									52	2	1.6						
									53	1	1.5						
									56	1	1.9						
									58	1	2.2						
									58	1	2.1						
									58	1	2.1						
									59	1	2.2						
									61	1	2.4						
									45	1							
									46	1	1.1						
									48	1	1.1						
									52	1	1.6						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

				Species /age	Mean weight (g	Catch 1	Catch 2	Estimate populati	Fish/unit (100m2)	Prob. of use	Adjusted Fish/unit
STREAM	South Englishman										
SITE:	3										
LENGTH	15.5		Sp. #1	Rb(0+)	1.03	2	0	2.00	4.94	0.48	10.2
WIDTH:	2.73		Sp. #2	Rb(1+)	9.88	2	0	2.00	4.94	0.04	111.9
AREA:	40.5		Sp. #3	Rb(2+)	15.00	1	0	1.00	2.47	0.04	55.9
DATE:	22-Sep-09		Sp. #4	Co(0+)	1.67	47	7	55.23	136.46	0.47	288.9
			Sp. #5	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!
			Sp. #6	0	#DIV/0!	0		#DIV/0!	#DIV/0!		#DIV/0!

This spreadsheet is designed to process electrofishing data. Data can only be entered into non-shaded cells - all shaded cells are protected.

Poul Bech, Reg. 2 Fisheries, B.C. Environment, August 1993

Sp. #1	Rb(0+)		Sp. #2	Rb(1+)		Sp. #3	Rb(2+)		Sp. #4	Co(0+)		Sp. #5	Ct(2+)		Sp. #6		
Length	c1+c2	weight	Length	c1+c2	weights(g	Length	c1+c2	weights(	Length	c1+c2	weights	Length	c1+c2	weight	Length	c1+c2	weights(g)
39	1	0.6	93	1	7.8	116	1	15	41	1	1						
58	1	1.2	108	1	11.9				42	1	0.5						
									43	1	0.6						
									43	1	0.7						
									43	1	0.8						
									43	1							
									44	1	0.9						
									44	1	0.8						
									45	1	0.8						
									45	1	1.2						
									46	1	1						
									46	2	1.1						
									48	1	1						
									48	1	1.1						
									49	1	1.4						
									49	2	1						
									49	2	1.3						
									50	1	1.2						
									52	1	1.7						
									52	1	1.3						
									52	1	1.4						
									43	1	1.6						
									53	1	1.5						
									54	1	1.8						
									54	1	1.5						
									54	1	1.6						
									55	1	1.6						
									56	1	1.6						
									56	1	1.5						
									57	1	2.1						
									59	1	1.8						
									59	1	2.2						
									60	1	2.3						
									62	1	2.5						
									63	1	2.4						
									63	1	2.7						
									65	1	2.6						
									65	1	3.1						
									65	1	2.9						
									66	1	2.9						
									70	1	4.5						
									70	1	4						
									75	1	4.8						
									51	1	1.4						
									39	1	0.7						
									41	1	0.6						
									45	1	0.9						
									51	1	1						
									52	1	1.5						
									59	1	2.2						
									69	1	3.9						

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

South Englishman River
ELECTROFISHING SITE DESCRIPTION FORM

Site 1

Stream:	South Englishman River		**COVER (%)**			
Watershed Code:	920-462800-21300		**log:**		0	%
			boulder:		5	%
Site Number:	1 - 50m d/s CC confluence pool		**instream vegetation:**		0	%
Date:	9/30/2008		**overstream vegetation:**		<3	%
Surveyed by:	JC/SS/MK		**cutbank:**		0	%
Hydraulic type:	R/G		**SUBSTRATE (%)**			
Main/side-channel (m/sc):	M		**fines:**		0	%
			small gravel:		5	%
Field gradient:	N/A	%	**large gravel:**		15	%
Stream width:	N/A	m	**cobble:**		60	%
Channel width:	~20m	m	**boulder:**		20	%
Mean depth:	0.10-0.15	m	**bedrock:**		0	%
Maximum depth:	0.23	m				
Mean velocity:	N/A	m/s	**Compaction:**		low	
Maximum velocity:	N/A	m/s	**Sand:**		<3	
			d90:		0.25	m
Turbidity:	clear		**dMax:**		0.48	m
Temperature (deg.C):	10.4					
			Site length (m):	(mean)	24.55	m
Stream stage:	low		**Site width (m):**	(mean)	5.78	m
Conductivity (mS*cm-1):	N/A		**Site area (m2)*:**		142.35	m2

* At non-symmetrical sites, area is calculated from field measurements, not as site length* site width

Site 2

Stream:	Englishman River		**COVER (%)**			
Watershed Code:	920-462800-21300		**log:**		0	%
			boulder:		10	%
Site Number:	2 - equal to traditional S Eman site (1998-2006)		**instream vegetation:**		0	%
Date:	9/30/2008		**overstream vegetation:**		4	%
Surveyed by:	JC/SS/MK		**cutbank:**		0	%
Hydraulic type:	R/G		**SUBSTRATE (%)**			
Main/side-channel (m/sc):	M		**fines:**		2	%
			small gravel:		13	%
Field gradient:	1.5	%	**large gravel:**		15	%
Stream width:	~7.5	m	**cobble:**		50	%
Channel width:	18	m	**boulder:**		20	%
Mean depth:	0.15	m	**bedrock:**		0	%
Maximum depth:	0.23	m				
Mean velocity:	N/A	m/s	**Compaction:**		low	
Maximum velocity:	N/A	m/s	**Sand:**		low	
			d90:		0.6	m
Turbidity:	clear		**dMax:**		0.8	m
Temperature (deg.C):	11.2					
			Site length (m):		15.2	m
Stream stage:	low		**Site width (m):**		5.6	m
Conductivity (mS*cm-1):	N/A		**Site area (m2)*:**		112.72	m2

* At non-symmetrical sites, area is calculated from field measurements, not as site length* site width

Appendix L. South Englishman River juvenile fish sampling results, 1998-2006, 2009.

South Englishman River
ELECTROFISHING SITE DESCRIPTION FORM

Site 3

Stream:	South Englishman River			**COVER (%)**		
Watershed Code:	920-462800-21300			**log:**	0	%
				boulder:	10	%
Site Number:	3 - u/s side of R2 Riffle 1			**instream vegetation:**	0	%
Date:	30-Sep-08			**overstream vegetation:**	5	%
Surveyed by:	JC/SS/MK			**cutbank:**	0	%
Hydraulic type:	R/G			**SUBSTRATE (%)**		
Main/side-channel (m/sc):	M			**fines:**	0	%
				small gravel:	10	%
Field gradient:	N/A	%		**large gravel:**	15	%
Stream width:	N/A	m		**cobble:**	30	%
Channel width:	~28	m		**boulder:**	45	%
Mean depth:	0.25	m		**bedrock:**	0	%
Maximum depth:	0.38	m				
Mean velocity:	N/A	m/s		**Compaction:**	low	
Maximum velocity:	N/A	m/s		**Sand:**		
				d90:	0.35	m
Turbidity:	clear			**dMax:**	1.3	m
Temperature (deg.C):	12.4					
				Site length (m):	14.7	m
Stream stage:	low			**Site width (m):**	4.17	m
Conductivity (mS*cm-1):	N/A			**Site area (m2)*:**	66.94	m2

* At non-symmetrical sites, area is calculated from field measurements, not as site length* site width

Appendix M. BC Ministry of Environment Shelton Lake assessment, 2006.

VANCOUVER ISLAND - REGION 1
LAKE STOCK ASSESSMENT 2006

LAKE NAME: Shelton Lake: ***ALIAS:*** Echo Lake ***BC WBID:*** 00752PARK

LAKE LOCATION: 36 km northwest of Nanaimo ***DRAINAGE:*** Nanaimo River
UTM: 10.403480.5442629

LAKE ATTRIBUTES:

Surface Area: 37.7 ha
Perimeter 3200 m
Max Depth: 19.5 m
Mean depth: 10.8 m
Elevation: 548 m
T.D.S.: 14.8 ppm

MANAGEMENT OBJECTIVE:

		RB	CT
Objective 1	Family Fishery (High CPUE <30 cm)	☐	☐
Objective 2	Average Quality (30-40 cm)	☐	☐
Objective 3	Above Average (40-50 cm)	☐	☐
Objective 4	Trophy (20% > 50 cm for RB, 20% > 40 cm for CT)	☒	☐

MANAGEMENT/SURVEY HISTORY:
Previous gill net assessment(s): no ☐ yes ☒
Year(s) Surveyed: 2000, 1979, 1970

STOCKING DATA:
Augmented: Stocked
Current Stocking Rate: 53.1 fish/ha annually
Stock Type: Tzenzaicut TW Yearling
Species: RB
Sterile Introduction: No
Marked Fish: No
Natural Reproduction: Yes
Previous Stocking Rate: See stocking list

SURVEY OBJECTIVE:

SURVEY METHODS:

	Method	Date (yy.mm.dd)	Survey Agency	Crew
Fish	gillnet, angle	2006-10-05	MOE	TA,GF
TDS	surface	2006-10-05	MOE	TA,GF
Temp./D.O.	depth profile	2006-10-05	MOE	TA,GF

NETTING SPECS: Standard Experimental 90 m (6x15 m)
Sinking and floating

SURVEY RESULTS:
Catch

	RB	TOTAL
2006	57	**57**

Survey Year	2006	
Effort Hours	10:04	
RB CPUE:	4.41	RB/Net Hour
# of Sets:	3	

Appendix M. BC Ministry of Environment's Shelton Lake assessment, 2006.

SURVEY CONCLUSIONS:

Objective Achieved	Yes	No
1. Family	☐	☐
2. Average	☐	☐
3. Above Average	☐	☐
4. Trophy	☐	☒

RECOMMENDATIONS:

Creel Results: No effort was reported in the 2002 lakes angler survey. The alias for this lake is Echo and the alia may have confused some anglers as there is also a gazetted Echo.

Assessment: High density stunted RB population. Some of the RB with encysted round worms. Depth, temperature and pelagic habitat is suitable for kokanee.

Management: Shelton is located on TimberWest private land and public access has been blocked. If access is restored, effort could be increased through stocking low density Pennask AF3N (25 ye/ha) with the objective of developing a trophy fishery. Alternatively, 3N kokanee could be stocked at 50 fry/ha (2000 3N kokanee @ 4 g)

Comments: This lake is suitable for developing a kokanee fishery.

Recent Brood Request Comments:
Cancel stocking until access is restored.

History of Angling Regulations:

Lake Access: Access via Nanaimo Lakes Road. Two gates sometimes locked. Gate key required. Contact Timberwest - Sheri Jablonski 729-3716

Appendix M. BC Ministry of Environment's Shelton Lake assessment, 2006.

Table 1. Catch summary.

		Length (mm)				Weight (g)				Condition (k)				
Sample Year	Sample Size	Mean	Min	Max	StdDev	Mean	Min	Max	StdDev	Mean	Min	Max	StdDev	Var
Rainbow Trout														
2006	57	239	180	320	28.8	141	64	307	47.1	1.00	0.80	1.34	0.09	0.01

Table 2. Proportion of Catch.

Rainbow Trout	Percent	#	Mean K
Less than 200 mm	8.8 %	5	1.1
Between 200-250 mm	64.9 %	37	1.0
Between 250-300 mm	24.6 %	14	1.0
Between 250-350 mm	26.3 %	15	1.0
Greater than 350 mm	0.0 %	0	0.0

Table 3. Stocking History for Shelton Lake (last five years).

Release Date	Species Name	Fish Count	Stock	Mark	Average Size (g)	Life Cycle Stage
5-May-06	Rainbow Trout	2000	Tzenzaicut TW		26.5	Yearling
9-May-05	Rainbow Trout	2000	Tzenzaicut TW		33.8	Yearling
7-May-04	Rainbow Trout	2000	Blackwater DR		35.35	Yearling
23-May-03	Rainbow Trout	2000	Blackwater DR		29.7	Yearling
27-May-02	Rainbow Trout	2000	Tzenzaicut DR		29.65	Yearling

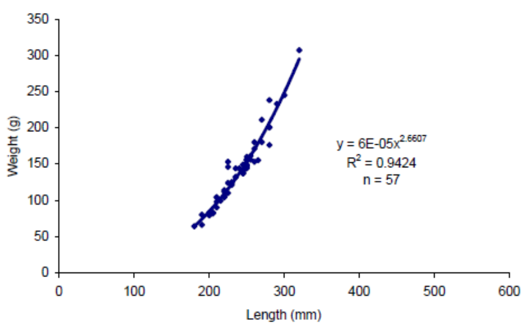


Figure 1. Length weight power relationship for rainbow trout.

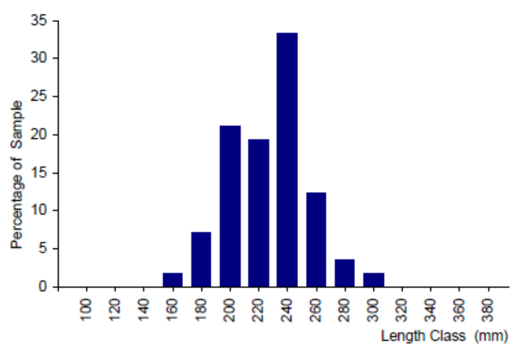


Figure 2. Length frequency distribution for rainbow trout.

Appendix M. BC Ministry of Environment's Shelton Lake assessment, 2006.

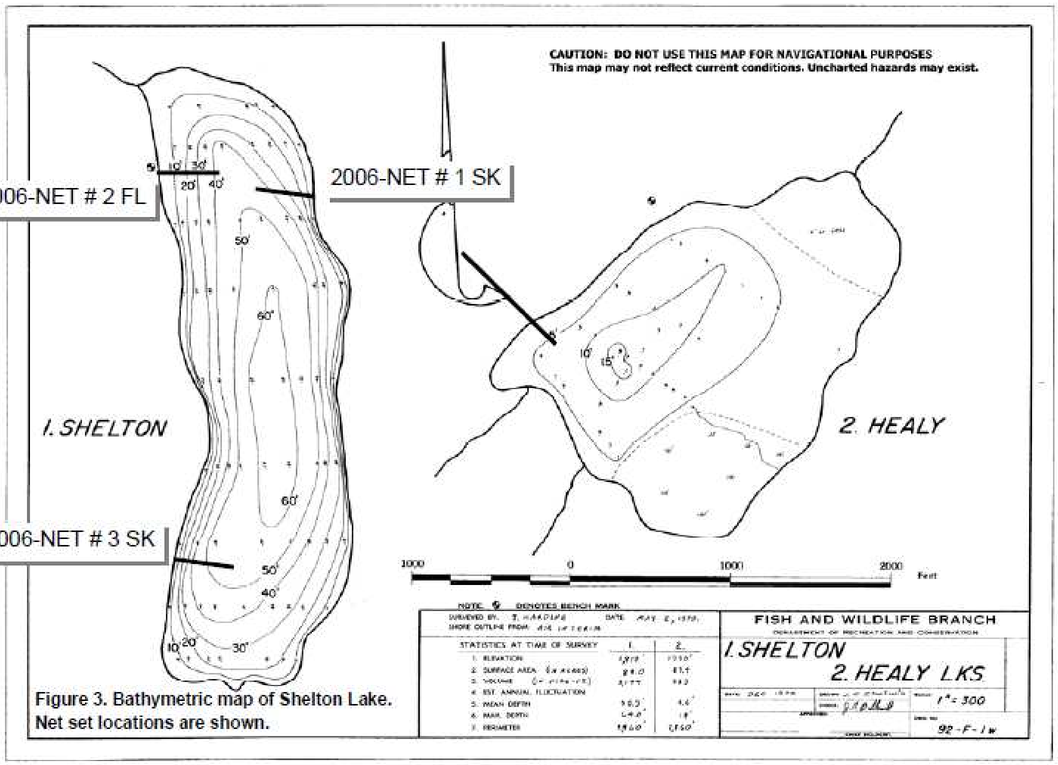


Figure 3. Bathymetric map of Shelton Lake. Net set locations are shown.

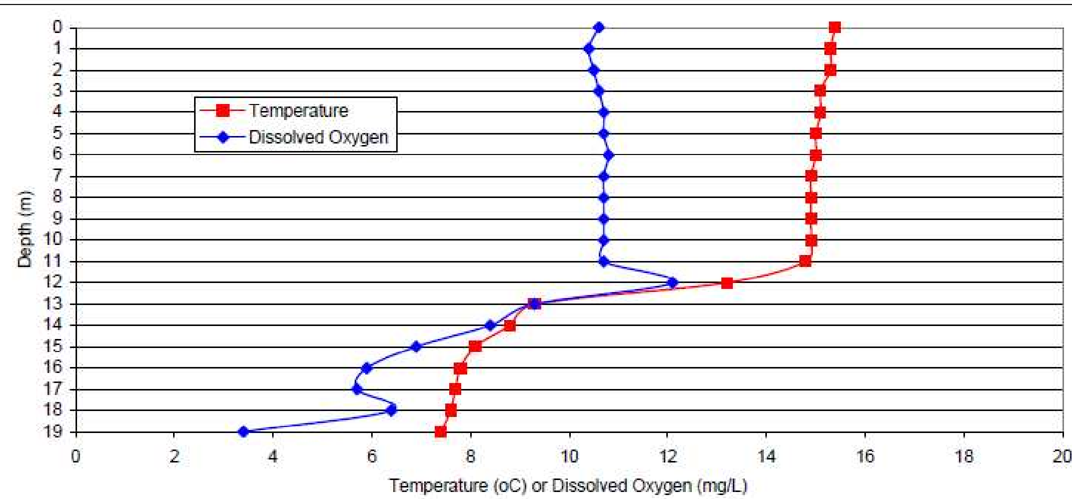
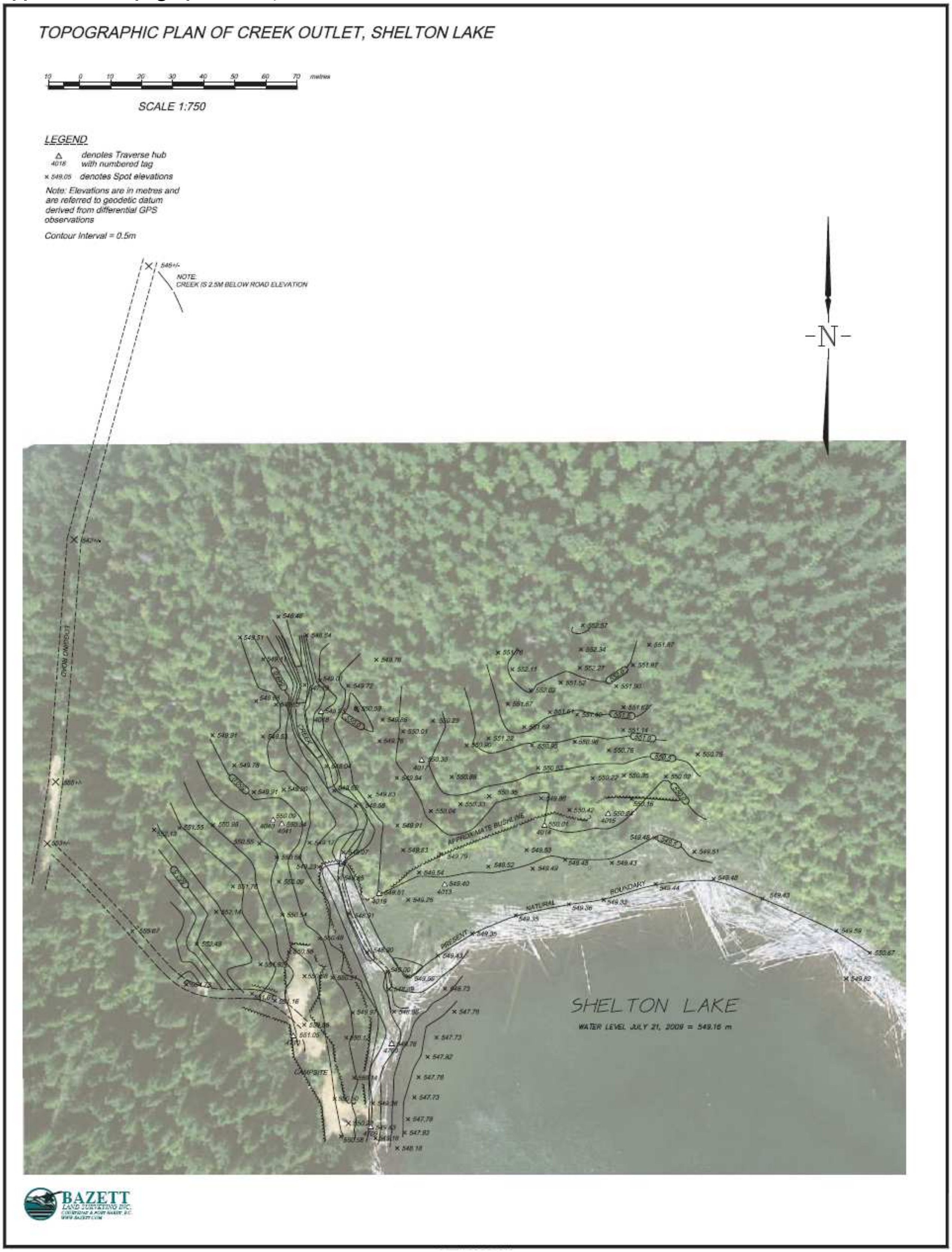


Figure 4. Temperature-oxygen profile of Shelton Lake.

Appendix N. Topographic survey results of Shelton Lake outlet, Jul 21, 2009.



Appendix N. Topographic survey results of Shelton Lake outlet, Jul 21, 2009.

Point	North	East	Elev (m)	Desc
1	5442580.696	403469.871	550.86	CL_RD,,
2	5442588.459	403460.428	551.16	CL_RD,,
4	5442593.649	403431.948	554.73	CL_RD,,
5	5442610.83	403414.664	555.67	CL_RD,,
14	5442544.85	403481.659	550.58	CL_RD,,
15	5442556.932	403479.659	550.5	CL_RD,,
18	5442549.1	403484.063	550.28	PHOTO,,
21	5442544.305	403492.8	549.16	W_LVL,,
23	5442555.503	403491.881	549.36	PNB,,
29	5442631.437	403474.551	549.23	PNB,,
34	5442596.309	403503.236	549.56	PNB,,
35	5442602.939	403512.799	549.43	PNB,,
36	5442609.995	403523.788	549.35	PNB,,
37	5442615.928	403537.779	549.35	PNB,,
38	5442619.449	403554.863	549.36	PNB,,
39	5442620.881	403566.124	549.33	PNB,,
40	5442626.014	403582.713	549.44	PNB,,
41	5442627.614	403601.431	549.48	PNB,,
42	5442621.284	403617.056	549.44	PNB,,
43	5442610.968	403640.851	549.59	PNB,,
44	5442595.533	403643.921	549.82	PHOTO,,
45	5442603.825	403651.593	550.67	PNB,,
46	5442636.362	403595.168	549.51	GND,,
47	5442640.733	403582.369	549.48	GND,,
48	5442632.752	403568.684	549.43	GND,,
49	5442633.723	403553.693	549.48	GND,,
50	5442630.893	403543.258	549.49	GND,,
51	5442636.879	403541.281	549.53	GND,,
52	5442631.535	403529.034	549.52	GND,,
53	5442629.617	403506.74	549.54	GND,,
54	5442620.892	403503.273	549.25	GND,,
55	5442636.169	403482.426	548.07	CL_CRK,,
56	5442627.903	403481.036	548.85	CL_CRK,,
57	5442616.535	403484.236	548.91	CL_CRK,,
58	5442604.075	403490.093	548.9	CL_CRK,,
60	5442597.866	403496.647	549	CL_CRK,,
61	5442592.201	403497.118	548.89	CL_CRK,,
62	5442584.913	403498.652	548.86	CL_CRK,,
69	5442592.323	403515.098	548.73	GND,,
70	5442541.079	403499.701	548.18	GND,,
71	5442546.092	403502.098	547.93	GND,,
72	5442550.411	403503.183	547.78	GND,,
73	5442557.444	403505.229	547.73	GND,,
74	5442563.895	403506.633	547.78	GND,,
75	5442570.422	403509.492	547.82	GND,,
76	5442576.662	403512.34	547.73	GND,,
78	5442584.948	403518.097	547.78	GND,,
94	5442655.946	403479.508	548.6	CALC
101	5442595.859	403478.9	550.51	TOP,,,,
103	5442608.463	403474.859	550.48	TOP,,,,
104	5442604.07	403464.942	550.58	GND,,,,
105	5442600.101	403455.86	551.92	GND,,,,
106	5442636.861	403501.632	549.83	TOP,,,,
108	5442635.586	403513.86	549.79	BUSHLN,,,,
109	5442649.402	403510.5	550.04	GND,,,,
110	5442651.129	403486.404	548.58	CL,3WIDE,,,
111	5442654.07	403490.866	549.83	TOP,,,,
112	5442660.018	403499.622	549.84	GND,,,,
113	5442660.378	403517.196	550.86	GND,,,,
114	5442654.165	403529.278	550.35	GND,,,,
116	5442651.614	403520.014	550.33	GND,,,,
117	5442670.442	403522.061	550.9	GND,,,,
118	5442676.41	403540.541	551.69	GND,,,,
119	5442672.778	403529.097	551.22	GND,,,,
120	5442683.813	403535.255	551.67	GND,,,,
121	5442678.382	403511.2	550.29	GND,,,,
122	5442674.989	403501.581	550.01	GND,,,,
123	5442671.881	403494.068	549.76	GND,,,,
128	5442663.814	403476.978	548.04	CL,2WIDE,,,
132	5442684.785	403454.462	549.68	GND,,,,
133	5442683.619	403460.763	549.63	BRK,,,,
135	5442673.367	403456.527	549.53	GND,,,,
145	5442689.925	403470.041	547.19	CL,2.5WIDE,,,
148	5442705.191	403449.234	549.51	GND,,,,
149	5442698.166	403456.745	549.11	GND,,,,
154	5442705.88	403470.606	548.64	TOP,,,,
155	5442711.804	403461.583	546.46	CL,5.0WIDE,,,
156	5442691.32	403474.911	549.01	TOP,,,,
163	5442698.006	403493.013	549.76	GND,,,,
164	5442689.643	403483.987	549.72	BRK,,,,
166	5442682.339	403486.586	550.59	GND,,,,
168	5442678.756	403495.005	549.86	GND,,,,
169	5442670.568	403543.071	550.95	GND,,,,
170	5442663.265	403544.969	550.63	GND,,,,
171	5442653.471	403545.959	549.86	GND,,,,
172	5442649.752	403555.06	550.42	GND,,,,
174	5442653.276	403575.042	550.16	GND,,,,
175	5442660.497	403585.997	550.02	GND,,,,
176	5442667.63	403596.305	550.75	GND,,,,
177	5442659.971	403562.557	550.22	GND,,,,
180	5442660.834	403572.556	550.35	GND,,,,
181	5442681.128	403548.764	551.61	GND,,,,
182	5442688.232	403542.633	552.02	GND,,,,
183	5442694.966	403536.698	552.11	GND,,,,
184	5442700.249	403532.157	551.76	GND,,,,
185	5442690.645	403552.301	551.52	GND,,,,
186	5442709.007	403559.303	552.57	GND,,,,
187	5442701.313	403558.754	552.34	GND,,,,
188	5442695.363	403558.338	552.27	GND,,,,
190	5442680.354	403557.567	551.4	GND,,,,
192	5442689.504	403570.067	551.9	GND,,,,
193	5442696.315	403575.466	551.97	GND,,,,
194	5442702.831	403580.662	551.87	GND,,,,
196	5442682.729	403572.442	551.67	GND,,,,
197	5442675.403	403572.363	551.14	GND,,,,
198	5442668.951	403567.705	550.76	GND,,,,
199	5442563.719	403485.915	550.14	TOP,,,,
200	5442576.575	403483.356	550.12	TOP,,,,
201	5442584.664	403485.512	549.97	TOP,,,,
203	5442596.334	403469.98	550.68	GND,,,,
205	5442590.745	403453.071	551.61	CL_RD,,,,
206	5442616.063	403462.733	550.54	GND,,,,
207	5442626.679	403461.706	550.09	GND,,,,
208	5442634.531	403461.011	550.56	GND,,,,
210	5442606.693	403435.329	552.48	GND,,,,
211	5442616.985	403441.617	552.14	GND,,,,
212	5442625.151	403446.901	551.76	GND,,,,
213	5442638.937	403455.447	550.55	GND,,,,
215	5442644.925	403440.574	550.98	GND,,,,
216	5442643.977	403429.797	551.55	GND,,,,
217	5442643.357	403421.616	552.13	GND,,,,
218	5442655.472	403453.637	549.91	GND,,,,
219	5442664.118	403447.397	549.78	GND,,,,
220	5442673.737	403440.372	549.91	GND,,,,
221	5442656.276	403463.293	549.9	GND,,,,
235	5442644.786	403499.807	549.91	TOP,,,,
237	5442639.266	403471.571	549.17	GND-FLOOD,,,,
4016	5442671.618	403556.802	550.96	SPK,,,,
4700	5442574.544	403497.963	549.76	NAIL