SWAN CREEK WATERSHED RIPARIAN AND HABITAT ASSESSMENT

WIWCD

A Report Prepared by
Mark Lowdon M.Sc.
AAE Tech Services Inc.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PHOTOGRAPHS OF BARRIERS

Page

LIST OF APPENDICES

1.0 INTRODUCTION

The West Interlake Watershed Conservation District (WIWCD), with the assistance from the Manitoba Fisheries Enhancement Fund (FEF), initiated this assessment to gain a better understanding of issues potentially effecting water quality, in-stream habitat, and the riparian health of the tributaries and drains found within the Swan Creek Watershed. The WIWCD's goal is to design an integrated watershed management plan, in cooperation with all municipalities and area residents, to improve the function of each watershed within the conservation district (Figure 2). The WIWCD encourages sustainable development practices to assist in creating a healthy watershed, ultimately benefitting all user-groups.

The primary objective of this project was to provide a comprehensive overview of the riparian zone and aquatic habitat conditions found within the Swan Creek Watershed. The assessment was to identify areas within the watershed in need of habitat protection, rehabilitation or enhancement. Furthermore, the project will enhance measures in developing a watershed management plan to improve water quality and provide a foundation for understanding the state of the fishery and riparian conditions within the Swan Creek Watershed.

Specific objectives of the project include:

- Compile relevant historical data pertaining to water quality trends, in-stream flow requirements, hydrological data, and fish utilization of the Swan Creek Watershed;
- Describe riparian conditions and adjacent land use practices that may be negatively effecting water quality and valuable fish and wildlife habitat along the relevant drains within the Swan Creek Watershed;
- Describe the physical characteristics and hydrology of the watershed;
- Identify potential migration blockages or barriers to fish
- Gain a better understanding of fish species utilization of the watershed including, life stages, egg deposition sites, successful larval emergence, and upstream adult migration;
- Produce a list prioritizing sites potential rehabilitation efforts that can be undertaken to help improve water quality and in-stream habitat conditions within the watershed;
- Hold information meetings with the WIWCD Board; and
- Prepare a technical report to the WIWCD Board summarizing information gathered during field surveys.

This project will provide baseline data in which the WIWCD can utilize to move forward in improving upon the riparian and aquatic habitat conditions that currently exist within the Swan Creek Watershed. This report also provides supporting documentation for future funding applications to carry out the enhancement initiatives.

1.1 STUDY AREA

The Swan Creek Watershed (Figure 1) is located within the Interlake Region of Manitoba along the eastern shores of Lake Manitoba. The watershed is of significant importance to a number of user groups including; areas residents, recreational and commercial fishermen, and those involved in domestic and agricultural practices. Manitoba Water Stewardship also depends on the watershed as the province operates a spawn camp on Swan Creek, the largest of the tributaries found within the Swan Creek Watershed. Walleye (*Sander vitreus*), the targeted species, is captured at the mouth of the creek each year during their spring spawning migration, stripped of their eggs and milt (sperm), and then released unharmed. The eggs are fertilized, incubated, and hatched within the Swan Creek Hatchery (photo below). The fry are then dispersed around the province to enhance recreational fishing opportunities.

Sloughs, marshes, and wetlands are scattered throughout the flat landscape within the Swan Creek Watershed. In the 1960's the natural waterways were extensively channelized to help alleviate flooding conditions within the area to improve agricultural development. These changes, although important for the agricultural community, have likely had significant impacts on the fish and fish habitat within this watershed. A loss of riffle/run/pool habitat within the tributaries has likely resulted in a loss of valuable fish spawning habitat. Furthermore, as nature reshapes the waterways, man intervenes to return the tributaries back to their channelized state.

Seven main tributaries currently provide drainage to the Swan Creek Watershed (Figure 3). These tributaries include:

- Swan Creek Drain
- Burnt Lake Drain
- Hatchery Drain
- Mud Lake Drain
- North Wagon Creek Drain
- Island Lake Drain; and
- Hayward Drain.

Figure 1. Map of the Manitoba Conservation District boundaries. WIWCD is located on the east shore of Lake Manitoba.

Figure 2. Sub-district watershed boundaries of the West Interlake Watershed Conservation District.

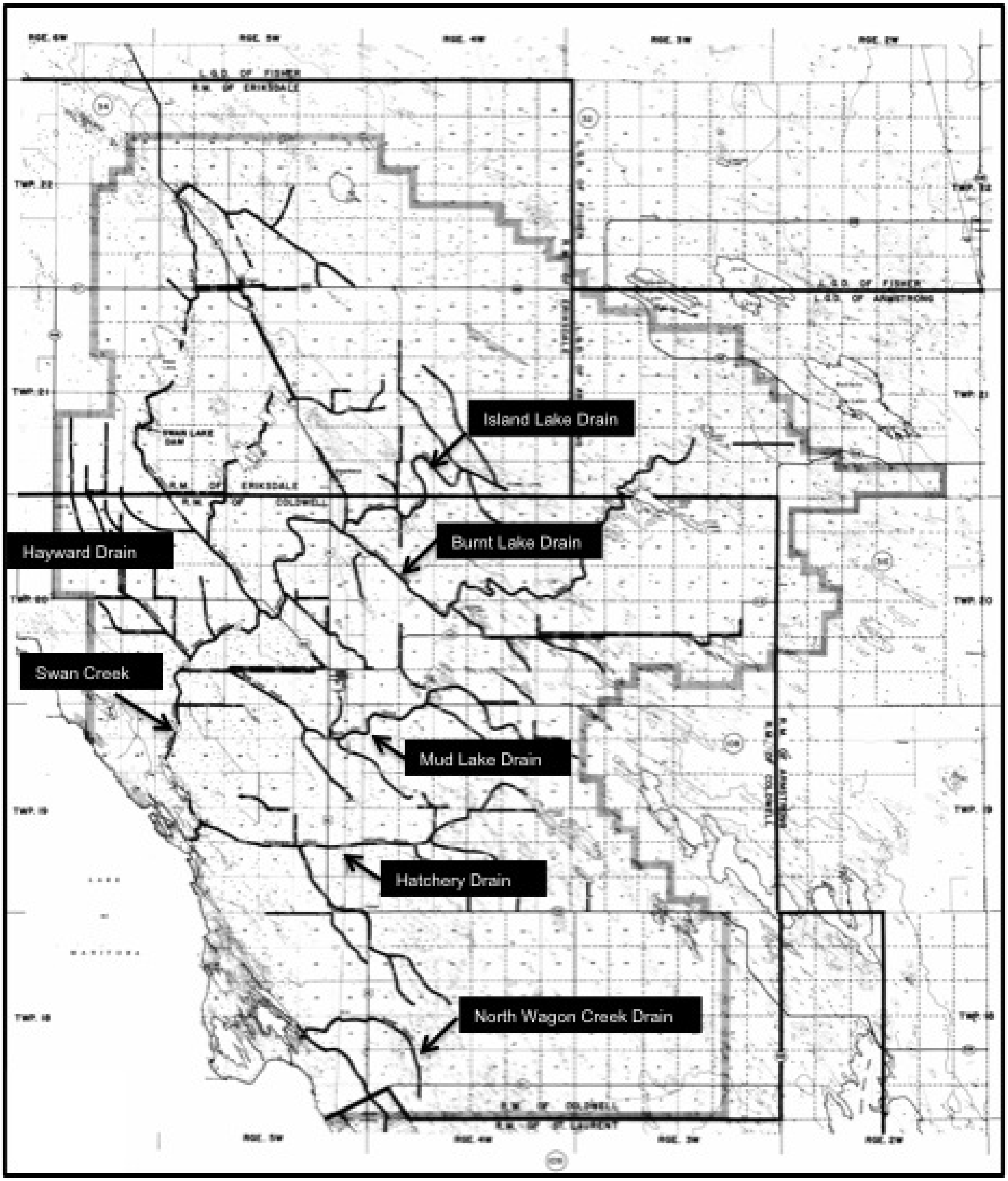


Figure 3. Overview map of the Swan Creek Watershed illustrating the network of drains found within.

Excluding North Wagon Creek, all tributaries flow into Swan Creek before eventually emptying into Lake Manitoba (Figure 4). Swan Creek, Burnt Lake Drain, and Hatchery Drain are the three largest tributaries within the watershed with drainage areas of approximately 1040, 496, and 410 km^2, respectively. Island Lake Drain, Mud Lake Drain, North Wagon Creek Drain, and Hayward Drain have drainage areas of 124, 106, 46, and 30 km^2 respectively. All drains flow through agricultural land, hay, and/or livestock operations. Soil conditions are displayed in Figure 5.

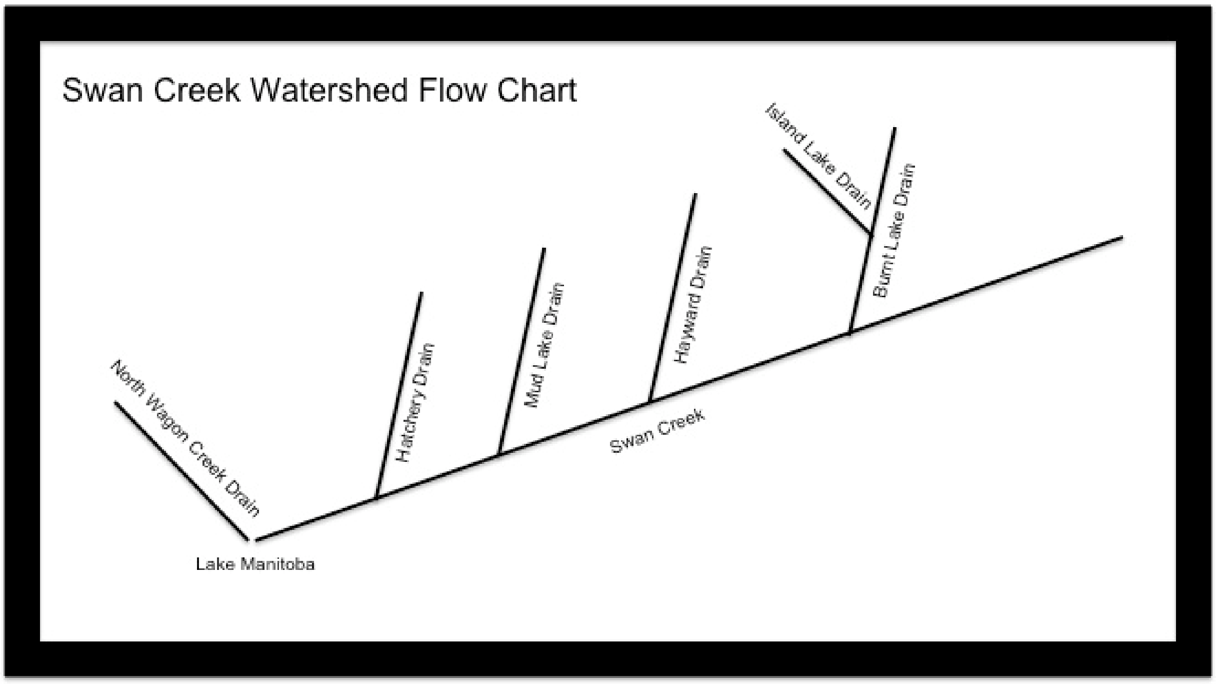


Figure 4. Schematic illustrating the network of tributaries found within the Swan Creek Watershed.

The climate within the area is typical of the northern temperate zone, characterized by short, warm summers and cold winters. The mean annual temperature is 1.2°C, the average growing season is 175 days, and growing degree-days number about 1500. The mean annual precipitation is approximately 510 mm, of which nearly one-quarter falls as snow. Precipitation varies greatly from year to year and is highest from spring through early summer. In 2008, the Swan Creek Watershed experienced abnormally high precipitation causing extensive flooding. High water levels and flows were therefore documented during the spring runoff and the 2009 Swan Creek Watershed riparian and aquatic habitat assessment.

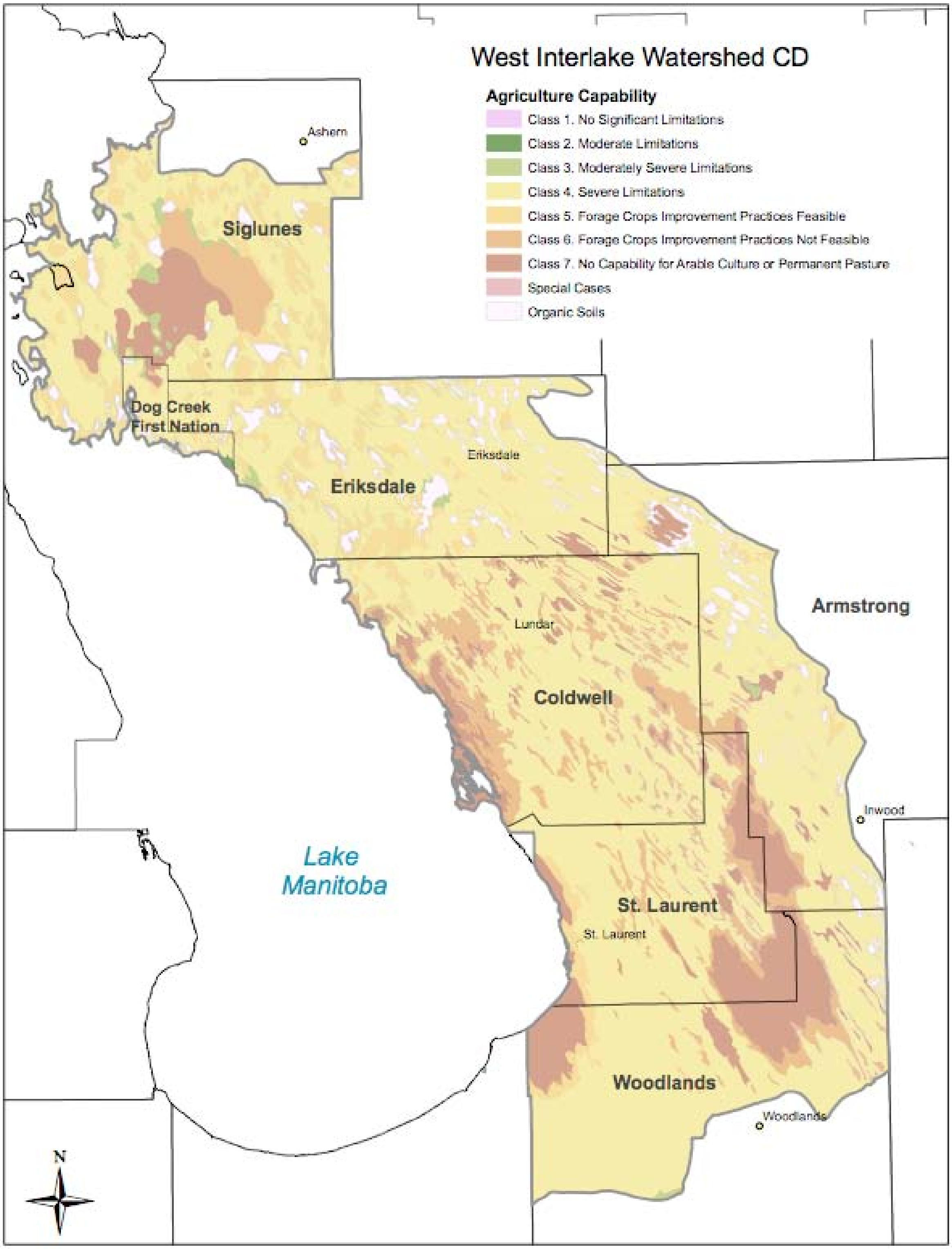


Figure 5. Soil conditions within the West Interlake Watershed Conservation District.

2.0 APPROACH AND METHODOLOGY

In order to document the riparian and aquatic habitat conditions within the Swan Creek Watershed, various sampling methodologies were utilized, including aerial surveys, ground truthing surveys, physical characteristics and hydrology assessments, water quality sampling, and fish utilization surveys. Refer to section 2.1 to 2.7 for detailed descriptions of the methodologies used to assess the individual sections of the riparian and aquatic survey.

2.1 RIPARIAN SURVEY

The riparian zone is defined as the transition zone between the terrestrial and aquatic environment. Found along lakes, rivers, streams, drains, and wetlands, a well-established riparian zone plays an important role for establishing a healthy ecosystem. Diverse vegetation within a riparian zone including plants, shrubs, trees, and/or grasses is essential for protecting the integrity of the aquatic environment. Healthy riparian zones provide:

- A natural filtration system preventing pollutants from entering the waterway (i.e., chemicals, pesticides, animal waste, high nutrient inputs, etc.),
- A natural means for protecting water quality within the aquatic environment,
- A means to control or alleviate erosion by stabilizing banks, and
- A means to reduce downstream flooding by slowing water movement along the boundaries of a waterway

Aerial and ground surveys were the primary methods used to document the state of the riparian zones along the tributaries of the Swan Creek Watershed. Specific characteristics examined during this assessment included documenting the width of the riparian zone, the type of vegetation within the riparian zone or lack there of, and land use practices along the riparian corridors.

2.1.1 AERIAL SURVEYS

Aerial surveys were conducted along each of the seven main tributaries and the shoreline of Lake Manitoba within the Swan Creek Watershed to achieve three goals;

1) Provide digital video and still images of the riparian zone along each corridor to aid in riparian zone classification;
2) Identify and document potential rehabilitation project sites; and
3) Identify land use practices that may be negatively affecting water quality along the tributaries of the Swan Creek Watershed.

Two aerial surveys were conducted. The first flight was completed on May 4th during the spring runoff. A helicopter was chartered from St. Andrews Airport to conduct this survey. The second flight was completed on September 11th of 2009. AAE Tech Services recommended chartering a slow flying fixed-wing aircraft (Cessna 180) as an alternative to the helicopter to be more cost effective. During both flights, a digital SLR Canon 30-D camera was used to take still images. Digital video was also recorded during both flights using a high definition 10.2-mega pixels Sony camcorder with image stabilization capabilities. To provide a track of the flight path a Garmin 60CSx GPS unit was used, recording waypoints (latitude and longitude coordinates) at one-second intervals. The photographs were then post-processed using a software program (GPS Photolink - standard edition) designed to link still images to their appropriate GPS coordinates by matching the time stamp produced by each device. In addition, the software program created files compatible with MapSource and ArcView software mapping programs, to allow one to display the flight path and linked photographs. Upon completion of the aerial surveys, identified potential rehabilitation sites were then subject to additional ground truthing surveys.

2.1.2 GROUND TRUTHING SURVEYS

Ground surveys were conducted over the course of the study starting on April 15th and commencing October 28th of 2009. The primary objective of these surveys was to provide additional data and evaluate potential rehabilitation sites. Coordinates of specific sites of interest were recorded using a Garmin GPS unit. Digital photographs were taken using a Canon 30-D SLR camera.

2.1.3 RIPARIAN CLASSIFICATION

Once the aerial and ground truthing surveys were completed, all data was analyzed and the riparian zone corridors along each tributary were classified or grouped into one of three categories.

Class A Habitat - Little to no impact to riparian corridors. The riparian corridor within this category is considered adequate to protect the integrity of the aquatic environment. Typically buffer zones are greater than 10 m on each side of the waterway. Erosion control problems and sediment loading is not a concern.

Class B Habitat - Moderate impacts to riparian corridors. Riparian zones are typically less than 10 m and nutrient loading is likely. Vegetation within the corridors has either extensive or limited damaged as a result of livestock grazing.

Class C Habitat - Severe impacts to riparian corridors. Riparian zones are less than 5 m on each side of the waterway and nutrient loading is likely. Vegetation within the corridors has extensive damaged as a result of either the presence of feedlots or livestock trampling near watering areas. Buffer zones are inadequate to protect the aquatic environment.

2.1.4 PROJECT SITE EVALUATION

Upon completion of the aerial and ground surveys a list of potential rehabilitation sites was generated. The primary focus was to provide the WIWCD with a list prioritizing sites that have the greatest negative impact on the watershed and are most important to put effort towards enhancing in order to improve the water quality and fish habitat within the Swan Creek Watershed. Types of sites included within the list included barriers to fish movement, confined cattle access areas negatively impacting the aquatic environment, and those sites with limited riparian zones inadequate to protect the waterways. General guidelines or recommendations on how to improve upon the habitat and water quality currently found within the Swan Creek Watershed are also provided.

2.2 FISH HABITAT ASSESSMENT

Fish habitat is defined as those parts of the environment “on which fish depend, directly or indirectly, in order to carry out their life processes” (Fisheries and Oceans Canada 1986). This includes habitat used for migration, spawning, feeding and refuge. Diverse habitat makes for good fish habitat. Natural run, riffle, pool habitats found with natural waterways provide the essential characteristics for those fish utilizing the habitats to carry out their life processes. Cover in the form of water depth, woody debris, aquatic vegetation, boulders or undercut banks increase habitat diversity and thus created better fish habitat. Substrates dominated by sand, gravel, cobble and boulders typically are those selected by fish during spawning. All of these characteristics are typically found in pristine waterways undisturbed by man.

Extensive channelization of waterways likely reduced the amount of “good” fish habitat available to the fish community within these specific water bodies. Spring runoff is allowed to leave the land more quickly increasing the chance of stranding eggs, larval or adult fish. In addition, agricultural practices along waterways may also have negative impacts to the aquatic environment as pesticide, chemicals, and nutrients have the potential to enter the water column. Livestock grazing within the waterways likely degrade spawning habitat within waterways as course material is pushed beneath the silt and fine particles residing in the waterway. Barriers within waterways impede fish movement and ultimately reduce the available habitat for the fish communities. All of these factors can limit or degrade the fish habitat within waterways and affect the state of the fishery and fish communities.

For the purpose of this study, a fish habitat assessment was conducted in conjunction with the riparian survey. Fish habitat was documented along the corridors of the seven main tributaries and the lake shore of Lake Manitoba within the Swan Creek Watershed. Quantitative sampling was however, not conducted. Instead a general description of the habitat observed along each corridor of the seven main tributaries was documented. Notes were also taken when valuable spawning habitat was observed.

2.3 BARRIERS TO FISH MIGRATION

Barriers to fish migration within this study included any structure potentially obstructing fish movement. Barriers that were identified and assessed included those anthropogenic in nature such as: perched culverts, undersized culverts (resulting in high water velocity) bridges, concrete structures, earthen dams, dikes, ford crossings, rock weirs, or commercial fishing nets. Natural barriers such as beaver dams, debris, log jams, or rapids were also assessed and documented. All barriers identified within this survey were photographed and location information recorded using with a Garmin GPS unit. Head differential and flow rates were also documented at each barrier.

The severity of a barrier was prioritized based on a number of key factors including, the location of the barrier, the type of barrier, and the length of time a specific barrier was situated within the watershed impeding fish movement. For example, if a barrier were located at the downstream end of a system, the barrier would likely be ranked as high priority as upstream habitat within the system would be unavailable to those fish migrating upstream to spawn from Lake Manitoba. Alternatively, if a barrier were either at the upper end of the tributary or transitional in nature (i.e. beaver dams), priority would likely be considered low. Each and every barrier has the potential to either segment habitat or reduce the amount of valuable habitat available to those fish communities utilizing the tributaries within the Swan Creek Watershed. Furthermore, the longer a barrier is situated within a tributary and blocking fish movement, the greater impact that barrier will have on the fish community. Valuable fish habitat is essential for maintaining and/or improving the fish stocks for those fish utilizing the Swan Creek Watershed.

It is however, important to mention that a barrier identified during this study might not necessarily be considered a barrier in subsequent years. For instance, high velocities flowing through a culvert one year may impede fish movement. The same culvert assessed during low flow conditions may in fact be passable and not obstruct fish movement.

2.3.1 CULVERT ASSESSMENT

To get a better understanding of flows, discharge, and potential barriers to fish movement, a detailed culvert assessment was conducted over the entire watershed. A total of 105 culverts at 53 crossings were assessed. Water velocity, water depth, discharge and diameter of each culvert were documented. A note was also made for those culverts that were perched or had water velocities of 1.0 m/sec or greater.

To determine the amount of water passing each culvert (m^3/s), at both the upstream and down stream ends, it was necessary to calculate the surface area of the water passing each culvert and the velocity of that water. To determine the surface area of the water, where the fluid level was less than half the radius of the culvert, the following definite integral was used:

$$2 \cdot \left(\frac{y}{2}\sqrt{r^2 - y^2} + \frac{r^2}{2}\sin^{-1}\frac{y}{r} \right) \Bigg|_0^{depth}$$

where *r* is the radius of the culvert and *y* is the measured water depth (to the nearest cm). The water velocity (m/s), at both the upstream and downstream ends of the culverts, was measured using a Swoffer™ (Model 2100) current velocity meter at the top (0.8 · depth), middle (0.5 · depth), and bottom (0.2 · depth) of the water column. To calculate discharge (m^3/s), the surface area and the average water velocity were multiplied. This again was calculated for both the upstream and downstream ends of each culvert.

2.4 PHYSICAL CHARACTERISTICS AND TOPOGRAPHY

Prior to conducting fieldwork, each tributary was delineated into three sampling reaches, identified as the upper, middle, and lower reach. To gain a better understanding of the physical characteristics of the waterways within the watershed; longitudinal profiles, cross-sectional profiles and sinuosity were assessed to measure slope, channel width, and curvature of the channel within the three sampling reaches of each tributary. Topographical 1:50,000 maps were also used to plot the longitudinal profile of the entire length of each tributary and delineate the watershed boundaries of the tributaries.

2.4.1 LONGITUDINAL PROFILES

Longitudinal profiles were conducted within the upper, middle and downstream reaches of each tributary, delineated prior to the start of the fieldwork, within the Swan Creek Watershed. A Top Con laser level and survey rod was used to measure slope of the water surface, channel bed, and floodplain. Four hundred meter segments were assessed within each sampling reach. Longitudinal profile methodologies were carried out using the methodologies outlined in Stream Channel Reference Sites: An Illustrated Guide to Field Technique (Harrelson et al. 1994). Longitudinal profiles are an important component for better understanding of the topography, hydrology, channel morphology and fish habitat within the sampled reaches.

2.4.2 CROSS-SECTIONAL PROFILES

Cross-sectional profiles were conducted within the three sampling reaches delineated prior to the start of the project for each tributary examined within the Swan Creek Watershed. A tape measure was extended across the channel at each cross-section. At 1.0 m intervals, the water depth (m) and velocity (m/s) were recorded. A Swoffer™ (Model 2100) current velocity meter was used to measure the water velocity at 40% (0.4 · depth) of the water column. A Top Con laser level was used to assess elevation of the cross-sectional profiles. Flood plain, water level, and the thalweg (the deepest part of channel bed) were documented. A Garmin GPS unit was used to mark sampling locations.

2.4.3 HYDROLOGY

Water velocity was documented at random locations within each of the tributaries. More detailed hydrology surveys were conducted while assessing the flows and discharges during the culvert assessment.

2.5 WATER QUALITY

In order to understand the conditions fish face while utilizing the tributaries of the Swan Creek Watershed some basic water quality parameters were measured in situ (in the field) using a YSI multi meter (model 556) and a LaMotte 2020e/I turbidity meter. Parameters examined including, dissolved oxygen, pH, conductivity, turbidity, and water temperature. Samples were taken daily at random locations in conjunction with ground truthing and fish surveys. A Garmin GPS 276 unit was used to record locations of each sampling site. Samples were collected from April 15th to September 24th 2009. Refer to Appendix A for maps illustrating the sample locations.

Water samples were also collected from each of the seven tributaries within the Swan Creek Watershed. Samples collected were delivered to ALS Laboratory Group located in Winnipeg within 24 hours of their collection. Water quality parameters analyzed included; ammonia (NH3), chlorophyll a, nitrate + nitrite-N, total phosphorous, total dissolved phosphorous, total dissolved solids, total kjeldahl nitrogen, and total suspended solids. Fecal coliform levels were also measured during these analyzes.

2.5.1 WATER TEMPERATURE

Water temperature loggers (Hobo® -Water Temp Pro) were placed within the main tributaries of the watershed to record and monitor water temperature throughout the study. The locations the temperature loggers were positioned within each tributary are displayed in Appendix A. The loggers were set to record and monitor water temperature every hour for the duration of the project. Minimum and maximum temperatures were therefore recorded daily at approximately 8:00 am and 8:00 pm respectively. Water temperatures were recorded from April 15th to September 11th 2009 at which time all the temperature loggers were successfully retrieved. Water temperature (ºC) was also recorded daily during the fish surveys using a YSI multi-meter (model 580).

2.6 FISH UTILIZATION

2.6.1 SPRING

Fish inventories were conducted in the spring and summer of 2009 within the seven main tributaries of the Swan Creek Watershed. Hoop-nets were used as the primary method to access fish utilization during the spring of 2009. In addition, AAE Tech Services collaborated with commercial fishermen and the workers at the Swan Creek Hatchery to identify the anticipated peak of the upstream spawning migration of fish within the Swan Creek Watershed. Collection data was also shared between all parties.

Sampling began on April 15th and commenced on May 11th. The nets were set at random locations within each tributary, not only to identify the extent of upstream spawning migrations, but also to better understand which habitats were being utilized. The hoop-nets were 1.2 m in diameter and constructed of 1.85 cm^2 nylon mesh. Attached to the first hoop of each net were two, 4.5 m wings, used to guide fish into the traps. The hoop-nets were set and monitored daily for the duration of the study. A minimum of three sampling days was conducted for each creek. Captured fish were placed in a holding tank, identified, sex and maturity assessed, and fork length (FL) measured. Digital photographs of representative specimens were also taken. All fish were released unharmed.

Dip netting, seining and conducting visual observations were additional methods used to assess fish utilization during the spring spawning migration during 2009.


Hoop-nets used during the spring survey

2.6.2 SUMMER

Summer fish utilization of the Swan Creek Watershed was assessed using a Smith-Root Model LR24 backpack electroshocker (Figure X). Electrofishing was conducted within each of the sample reach delineated at the start of the project. Refer to the maps in Appendix A for specific sampling locations. Sampling was conducted between June 7th and June 21st 2009. Fish captured were identified, had their fork length measured, and were released live. Digital photographs were taken of representative specimens. A voucher specimen of each species was also taken and preserved in 10% formalin to verify identification.

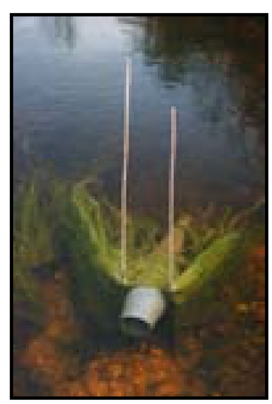
2.6.3 EGG SAMPLING

Egg sampling was conducted from April 27th to May 23rd within the various tributaries of the Swan Creek Watershed. Sampling was conducted over all substrate types (gravel, cobble, boulder, silt, sand, and vegetation), but with more emphasis on areas where available sand, gravel and cobble substrates were present. No attempt was made to try and quantify or standardize egg counts per surface area.

Kick sampling was conducted by wading and disturbing the substrate in an upstream direction while dragging a dip net, with a mesh size of 0.250 mm and a surface area of 0.1 m^2, behind to capture the downstream drift. Eggs collected were counted, preserved in 10% formalin, and identified to family [Percidae (walleye), Catostomidae (suckers), Esocidae (northern pike), or unidentified] using a dissecting scope with 40 X magnification.

2.6.4 LARVAL DRIFT NET SAMPLING

Larval drift nets were used to capture larval fish that successfully hatched within the Swan Creek Watershed during the spring of 2009. Each drift net was positioned on two rebar rods that were embedded into the stream bottom. The traps were positioned into the flow as shown by the illustrations below. The surface area of each trap opening was 0.02 m^2 and the water velocity (m/sec) and the lengths the traps were set was recorded. The traps were set approximately 0.30 m below the water surface in the faster moving water. Larval fish drifting downstream enter the funnel opening on the upstream end of the trap. Once inside, the larval fish are unable to escape. The mesh size of the nitex mesh lining is 0.250 mm. Larval fish collected were preserved in 10% formalin and then identified using a microscope with 40X magnification. The larval key entitled Identification of Larval Fishes of the Great Lakes Basin with Emphasis on the Lake Michigan Drainage (1983) by Nancy A. Auer was used to confirm identification. Figure 6 is a diagram of a Walleye, White Sucker, and Northern Pike larval fish.



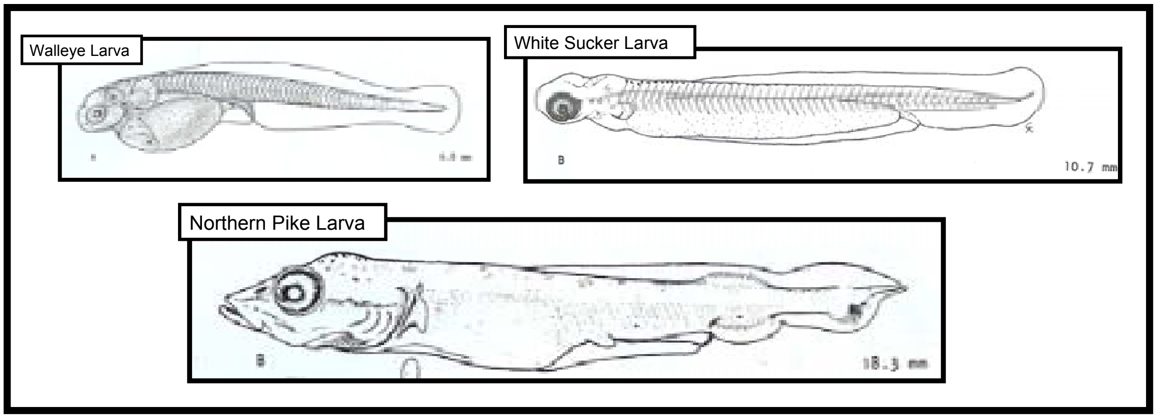


Figure 6. Diagram of Walleye, White Sucker, and Northern Pike larval fish (Auer, 1983).

Larval fish sampling was conducted within each study reach delineated at the start of the project and at random sampling locations within each creek. A minimum of three sampling days was conducted for each tributary within the Swan Creek Watershed. Sample dates were chosen based on the stages of the eggs collected during the study.

2.7 BENTHIC INVERTEBRATE COLLECTION

Examining the benthic invertebrate communities within these water bodies is an important tool and good indicator for determining poor water quality within the waterways found within the Swan Creek Watershed. The absence of specific invertebrates, such as those in the orders Ephemeroptera, Odonata, and Trichoptera, can signify poor water quality. The invertebrates within these orders are typically very sensitive to poor water quality conditions and will not tolerate or inhabit these types of environments. In contrast, invertebrates such as Oligochaeta, (also known as tuberficid worms) or Chironomidae larva (order Diptera) can tolerate poor water quality and flourish with increased nutrient loading. By identifying the invertebrate community within a system one is able to determine the status of the water quality without having to pursue the analysis of costly water quality samples. Examining the invertebrate community provides an additional means for assessing the health of the ecosystem within the waterways. Furthermore, a diverse invertebrate community most often signifies diverse fish habitat and a well balance ecosystem.

Due to a limited budget quantitative invertebrate sampling was not conducted. However, invertebrates were collected as bi-catch to both the egg and larval drift net sampling surveys and were therefore assessed within this survey. Invertebrates collected were identified to order or family level. Sampling was conducted at various locations within each of the seven tributaries within the Swan Creek Watershed.

3.0 RESULTS AND DISCUSSION

3.1 RIPARIAN SURVEY, CLASSIFICATION, AND AQUATIC ASSESSMENT

Although the tributaries of the Swan Creek Watershed have historically provided the fish communities of Lake Manitoba with valuable spawning habitat, results of this assessment identified several issues potential affecting, not only the health of the individual tributaries, but the health of entire aquatic ecosystem within the Swan Creek Watershed. Below is a list of types of impacts negatively affecting the water quality and fish habitat within the Swan Creek Watershed, identified within this study.

- Barriers to fish movement segmented habitat and restricted fish from reaching upstream spawning and nursery habitat;
- Extensive channelization of natural waterways reduced fish habitat diversity and altered natural flow regimes;
- Point source nutrient and sediment loading (i.e. confined cattle areas) reduced water quality within sections of individual drains;
- Unrestricted livestock access to the tributaries within the watershed degraded spawning habitat and reduced water quality;
- Removal and degradation of riparian zones adjacent waterways appeared to limit the ability of the riparian zone to protect the integrity of the aquatic environment; and,
- Wetland draining and filling was evident as a result of the extensive channelization.

As previously stated, all of the tributaries within the Swan Creek Watershed have been straightened and channelized to increase drainage within the watershed. This practice has resulted in a significant loss of valuable fish spawning habitat. Spawning habitat within most drains has now been limited to areas immediately downstream of culvert crossing where the substrate types are dominated by sand, gravel, cobble and boulders. Within the main stem of the channels, silt is the dominant substrate type, with the exception of Hatchery and Island Lake drains where large sections are composed of mostly sand and gravel substrate types. Furthermore, the habitat characteristics of each drain can be described as uniform with limited to marginal fish habitat.

The riparian zone along the corridors of each tributary is also uniform. Grasses are the dominant vegetation type within the riparian zones along each waterway. Pasture and native hay are the two most common land use practices documented within the watershed, accounting for 49 and 36% respectively. Unrestricted cattle access, commonly observed within all tributaries, likely has the greatest impact to water quality and fish habitat within the sampled tributaries. The most severe cases observed where located on Mud Lake Drain and North Wagon Creek Drain. Livestock within these drains were confined to small watering areas along each tributary (Figures 7 and 8). The riparian zones along Burnt Lake Drain, Hatchery Drain, and Swan Creek were unique as large dikes where constructed along both the left and right banks. Cattle access within these sections was limited and the riparian zone was only marginally affected.

Figure 7. Livestock watering site on North Wagon Creek Drain (Characteristic of Class C habitat type)

Figure 8. Riparian damage along Mud Lake Drain. Nutrient loading and fish habitat degradation is evident.

Five of the seven tributaries within the Swan Creek Watershed, including Island Lake Drain, Mud Lake Drain, North Wagon Creek Drain, Hayward Drain, and Hatchery Drain had substantial sections flowing along side municipal roads. This habitat typically was very uniform thus providing limited habitat for spawning, feeding, migration, and/or refuge. Managers or engineers designing or constructing drains do not always take into consideration the importance these drains provide to the fish community. Drains are most often designed to allow water to leave the land as quickly as possible in order to reduce flooding on agricultural land. Drains should be designed, to not only provide adequate drainage, but provide efficient means to increase habitat diversity within each drain to help sustain fish populations within the individual watersheds. For existing drains, enhancement efforts should be common practice in order to improve fish habitat to ultimately benefit all user groups.

Habitat feature maps illustrating the different classifications assigned to the riparian zones along the seven main tributaries within the Swan Creek Watershed are displayed in Appendix A. A total of 145.7 km were assessed during this survey within the seven main tributaries of the Swan Creek Watershed. The lake shore of Lake Manitoba within the watershed was also assessed. Ninety-one percent of the riparian zones and habitat within the tributaries within the Swan Creek Watershed were classified as Class B Habitat. Class B Habitat included moderately impacted riparian zones with marginal livestock grazing, typically less than 10 m in width, and appeared adequate to protect the integrity of the aquatic environment. Unrestricted livestock grazing was evident along most of the waterways within the watershed. Waterways along the roads within the conservation district were also found within the Class B Habitat classification, as surface water runoff was likely to enter the tributaries.

Class A Habitat accounted for a combined total of 3% of the riparian zones along the seven tributaries within the watershed. This classification was typically found within the sloughs and marshes along the drains near the confluence with Swan Creek or at upper ends of the drains where livestock grazing was unlikely. This type of habitat was identified on Hatchery Drain, Burnt Lake Drain, Mud Lake Drain, and Swan Creek Drain.

Class C Habitat, consisted of severely impacted habitat as a result of extensive erosion, inadequate riparian zones of less than 5 m in width, and/or extensive cattle trampling around watering areas. This type of habitat was found on Mud Lake Drain, North Wagon Creek Drain, Burnt Lake Drain, and Hayward Drain (Figure 7 and 8). Refer to the Appendix A and the list compiled of potential rehabilitation project sites (Appendix I) for more details regarding the Class C Habitat within the identified tributaries.

3.1.1 AERIAL SURVEYS

All aerial photographs taken during this project for both flights are included within the attached cd. The photographs are organized and separated into folders, identified by tributary name and flight data. Displayed on each photograph are the tributary name, time and date of the photograph, and the GPS coordinate locations of each photograph. In addition, files compatible with MapSource and ArcView are included within the attached cd. These files allow one to display the flight path and location of the individual photographs using either software program.

Representative aerial photographs of each tributary can also be found within Appendix B. These photographs were compiled to provide a general summary of the habitat found along each corridor of the seven main tributaries of the Swan Creek Watershed. All photographs were captured at an altitude of approximately 500 feet.

3.1.2 BARRIERS TO FISH MIGRATION

A total of 15 barriers were identified within the main stems of the seven tributaries of the Swan Creek Watershed. Most of the barriers were anthropogenic in nature (man-made). The identified barriers included culvert crossings with high water velocities, perched culverts, Ducks Unlimited control structures, and commercial fishing nets (mullet traps). Natural barriers found within the waterways included beaver dams and densely vegetated sections, chocking off entire waterways. The natural barriers were however likely only temporary obstructions to fish passage.

A series of photographs illustrating the barriers observed within the Swan Creek Watershed during the spring runoff in 2009 is compiled within this section of the report. Accompanying each photograph is a description of the barrier (i.e., beaver dam, high velocities at a culvert crossing, perched culverts, or man made control structures), site location information (tributary name, coordinates, upstream/downstream location, etc.) and potential impacts the individual barriers may have on the fish community (i.e. reduction of spawning habitat upstream). The locations of each barrier can also be viewed within the habitat-featured maps produced for each tributary (Appendix A).

Barrier 1. Ducks Unlimited control structure at the upper end of Hatchery Drain at Goulet Lakes.

Although located at the upper reach of Hatchery Drain, this control structure appears to be a complete barrier to all fish movement. Northern Pike, Yellow Perch and White Sucker would likely utilize the habitat upstream for spawning or as nursery habitat. Identified as barrier 4 on habitat featured map (Appendix A-3)

Barrier 2. Ducks Unlimited control structure on Burnt Lake Drain near Stone Lake.

This barrier likely would impede all fish movement between Stone Lake and Burnt Lake Drain. The barrier was located at the upper end of Burnt Lake Drain; identified as barrier 4 on habitat featured map (Appendix A-2)

Barrier 3. Ducks Unlimited control structure on Burnt Lake Drain upstream highway #6 crossing.

This barrier is located near the middle of the tributary and was identified as an important rehabilitation site. Fish habitat upstream is abundant. The barrier is identified as 4 on the habitat featured map (Appendix A-2).

Barrier 4. Ducks Unlimited control structure on Swan Creek downstream of Swan Lake.

Built in 1978 this barrier has impeded fish movement for 32 years. It is a complete barrier to all fish movement. A fish ladder could be constructed around the control structure to provide fish passage. There is valuable nursery and spawning habitat upstream. The barrier is identified as 3 on the habitat featured maps (Appendix A-1).

Barrier 5. Culvert crossing on Hatchery Drain with velocities greater than 1.0 m/sec.

Water velocity of 1.23 m/s was recorded at the first crossing upstream of highway #6. However, it was unclear whether fish were able to pass these culverts, as fish were not observed at this site, as a result of downstream barriers. Barrier was identified as 4 on habitat featured maps (Appendix A-3).

Barrier 6. Culvert crossing on Hatchery Drain at Highway #6 had water velocities greater than 2.0 m/sec.

Countless fish were observed downstream trying to pass culverts. Northern Pike, Carp, Walleye, and White Sucker were observed in large numbers downstream of culvert crossing. Barrier is identified as 3 on habitat featured maps (Appendix A-3).

Barrier 7. Culvert crossing on Hatchery Drain located 15.5 km upstream of Lake Manitoba.

Ice plugged the north culvert during the first week of the spawning migration. Water velocities within the south culvert approached 3.0 m/sec. Fish were not observed at this crossing as barriers downstream likely impeded all fish movement. Barrier is identified as 4 on habitat featured maps (Appendix A-3)

Barrier 8. Culvert crossing on Swan Creek Drain upstream of the confluence with Burnt Lake Drain.

Water velocities approached 3.0 m/sec at this site. Fish were congregating downstream of the barrier. Many people were also observed dip netting for suckers at this site. Walleye carcasses were also observed. The barrier was located near the middle of the tributary. The barrier is identified as 3 on the habitat featured maps (Appendix A-2).

Barrier 9. Perched culverts on Hatchery Drain upstream near Goulet Lakes.

Water velocities of 2.2 m/sec were documented at this site. The perched culverts appeared to impede upstream fish movement. Great spawning habitat was documented downstream of the culverts. Fish eggs were collected at this site. Barrier is identified as 4 on habitat featured maps (Appendix A-3).

Barrier 10. Beaver dam situated on Burnt Lake Drain.

Beaver dam appears to have been in place for quite some time. The dam is located at the upper end of Burnt Lake Drain, upstream of Stone Lake. Barrier is identified as 3 on habitat featured map (Appendix A-2).

Barrier 11. Beaver Dam on Burnt Lake Drain near the confluence with Island Lake Drain.

Beaver dam on Burnt Lake Drain. This dam was only temporary as it was not observed during the September flight (Appendix A-2).

Barrier 12. Trap net used to capture fish for spawn camp on Swan Creek

The pound net is used to capture adult Walleye during the spawning migration. Once captured and stripped of their milt or eggs, most fish are released on the upstream side of the net to allow the individual fish to carryout their natural spawning migration. It is not known what impact this has on those fish captured and released. Barrier identified as 1 on habitat featured maps (Appendix A-1).

Barrier 13. Commercial fishing mullet trap on Mud Lake Drain.

This trap was situated on Mud Lake Drain near the confluence with Swan Creek. Notice the trap appears to be blocking the entire tributary, impeding all fish movement. The barrier was situated in the creek for approximately 2 weeks. It was to be removed once Walleye started their upstream spawning migration. Barrier is identified as 3 on the habitat featured map (Appendix A-5).

Barrier 14. Commercial mullet trap on North Wagon Creek Drain near Lake Manitoba.

This trap was situated at the mouth of North Wagon Creek Drain near its confluence with Lake Manitoba. The net blocked approximately 95% of the waterway and was a major barrier to fish movement. The barrier was situated within the tributary for approximately 2 weeks during the spring spawning migration. The barrier is identified as 1 on habitat featured map (Appendix A-6).

Barrier 15. Commercial mullet trap on North Wagon Creek Drain along PR 511.

Hundreds of White Sucker were observed captured within the trap on May 2nd. The trap was situated near the middle reach of the drain. Valuable spawning habitat was located upstream. Barrier is identified as 2 on habitat featured map (Appendix A-6).

3.2.1 CULVERT ASSESSMENT

The results of the culvert assessment are displayed in Appendix H. In addition, a map of all culvert crossings is included on the attached cd. The map is entitled "Map Culvert Assessment". Refer to Appendix H for identification numbers of the individual culvert crossing displayed on the map.

3.3 PHYSICAL CHARACTERISTICS

This section of the report summarizes the physical characteristics of the tributaries within the watershed including information regarding the drainage area, slope, length, and average bankfull width and depth. All data is displayed in Appendix C, D, and E. In addition, representative photographs for each tributary are displayed within Appendix B. Descriptions and a summary of the fish habitat within each drain are also included within this section of the report.

Because there are no active gauging stations within the watershed, historical data from 1976-1996 for Swan Creek and 1967-1987 for Burnt Lake Drain were utilized to document potential monthly discharge with the watershed (Figures 9 and 10). The hydrographs presented within this report were produced by D. Milani (2000).

Swan Creek Drain

Originating from Swan Lake and terminating at Lake Manitoba, Swan Creek is the largest tributary within the Swan Creek Watershed. It is 32.0 km long and has a drainage area of approximately 1040 km^2. The average bankfull width of the creek is 22.3 m and average bankfull depth is 1.43 m. The slope of the creek is 0.05%, dropping an average of 0.5 m per 1.0 km of channel.

Three barriers obstructing fish movement were identified in Swan Creek (Appendix A-1). A trap net at the mouth of the creek, a culvert crossing with high water velocities, and a Ducks Unlimited control structure near Swan Lake. All barriers restricted fish from reaching upstream spawning and nursery habitat. The most significant of these barriers was the barrier located at the first culvert crossing upstream of the confluence with Burnt Lake Drain. At this crossing hundreds of fish were concentrated immediately downstream of the culvert crossing. Herds of people were also observed dip netting for mullets at this site. Unfortunately, pouching was also occurring as Walleye carcasses, with fillets removed, were found.

Fish habitat within the drain could be described as marginal. The drain consisted of uniform habitat within the straight channelized waterway. Emergent vegetation was commonly found along the entire length of the drain and would likely provide valuable spawning habitat for those species that utilize vegetation for spawning (Northern Pike, Yellow Perch, etc.). Silt and clay were the dominant sediment types observed; however, scattered sections of sand, gravel, cobble, and boulders were documented downstream of a few culvert crossings.

Burnt Lake Drain

Burnt Lake Drain is the second largest drain within the Swan Creek Watershed. It has a drainage area of 496 km^2 and is 37.8 km long. The headwaters originate at Burnt Lake and then flow predominately through wetland habitat for the first 7.5 km. The drain becomes more defined as it approaches Stone Lake at which point it flows into a Ducks Unlimited man-made wetland (Appendix B-2). The overall slope of the drain of 0.06 % is similar to that observed on all drains within the Swan Creek Watershed. The average bankfull width and bankfull depth was 15.92 and 1.14 m respectively.

Three barriers were identified on Burnt Lake Drain (Appendix A-2). The most severe barrier, with potentially the greatest impact on the fish community, was a Ducks Unlimited control structure located upstream of the highway #6 crossing. The control structure was built to regulate the water levels within the Ducks Unlimited wetland. The other barriers identified were located near the headwaters of Burnt Lake Drain and likely had little impact on the fish community.

Fish habitat within the drain is considered marginal. The only valuable spawning habitat within the drain would be the abundance of vegetation within the waterway. Nursery habitat within the drain was substantial as water depth was typically greater that 0.8 m. Enhancement efforts are encouraged to improve the spawning habitat within Burnt Lake Drain as it is one of the largest tributaries within the Swan Creek Watershed.

Hatchery Drain

Hatchery Drain is the third largest tributary within the Swan Creek Watershed. It originates at Goulet Lakes and terminates at Swan Creek near Lake Manitoba. The drain is 22.4 km long and has a drainage area of 410 km^2. The average bankfull width is 16.2 m. The average bankfull depth is 1.5 m. The slope of the drain is 0.07%, dropping an average of 0.7 m along 1.0 km of channel.

Numerous barriers were identified along Hatchery Drain. The culvert crossings within the drain typically had flows approaching or greater than 2.0 m/s (Appendix A-3). In addition, at the upper end of Hatchery Drain, a Ducks Unlimited control structure restricted fish from reaching potential spawning habitat sites within Goulet Lakes.

Fish habitat diversity, compared to the other drains found within the watershed, could be described as abundant. There are segments within the drain where fish-spawning habitat was evident as sand, gravel, and cobble substrate types dominated the waterway. There are wide sections providing good nursery habitat. There are also sections where run/riffle/pool habitats appeared to be forming (upstream old highway #6 road).

Island Lake Drain

The next four tributaries including Island Lake Drain, Mud Lake Drain, North Wagon Creek Drain, and Hayward Drain are small in comparison to Swan Creek, Burnt Lake Drain and Hatchery Drain. However, these tributaries are still very important to the fish communities within this watershed.

Island Lake Drain originates within the Island Lakes and terminates at Burnt Lake Drain. The drainage area of Island Lake Drain is 124 km^2. It is 12.6 km in length and has an average bankfull depth and width of 9.3 and 1.16 m respectively. Slope of the drain is 0.09%. This drain was the second steepest drain within the watershed.

No barriers were identified on Island Lake Drain (Appendix A-4).

Some of the best fish habitat was found within Island Lake Drain, in comparison to the other drains within the watershed. Sand and gravel substrates were common throughout. Nursery habitat was observed within the deeper sections of the drain. Thick vegetation along the waterway provided additional cover for forage or young of the year fish. A negative attribute or characteristic of the drain was that approximately 50% of the drain ran along side a number of the municipal roads within the area. Therefore the riparian zone was marginal and did not appear to provide adequate protection to the aquatic ecosystem within the drain.

Mud Lake Drain

Mud Lake drain begins at Mud Lake and ends at Swan Creek. The drain is 15.6 km long, with a drainage area of 106 km^2. The slope of the drain is 0.06%. Average bankfull width and depth are 9.41 and 1.00 m respectively.

No barriers were observed on Mud Lake Drain.

Fish habitat was segmented. There were numerous sections heavily impacted by livestock grazing. Significant sections of the drain had riparian zones of less than 5 m, and did not appear to provide adequate protection to the waterway (Appendix A-5, B). The substrate was dominated by silt and clay. Flooded grasses within the waterways likely provided the fish species utilizing the drain with some spawning habitat and cover.

North Wagon Creek Drain

North Wagon Creek Drain was the second smallest drain within the watershed. It had a drainage area of 46 km^2 and was 17.0 km in length. The average bankfull width and depth were 7.47 and 1.04 m respectively. The slope of the drain was 0.07%. North Wagon Creek Drain was designed to alleviate flooding on Wagon Creek Drain.

The only barriers identified on North Wagon Creek drain were two commercial fishing mullet traps. One was situated near the mouth of North Wagon Creek while the other was situated closer to the upper end of the creek. Refer to photographs of each trap (Barriers 14 and 15) in the previous section.

Fish habitat within North Wagon Creek Drain was severely impacted by livestock grazing at watering areas. The riparian zone was trampled along much of the middle sections of the creek. Upstream sections of the drain flowed along PR 511.

Hayward Drain

Hayward drain was the smallest drain within the watershed. The drainage area was only 30 km^2 and flows within only persisted for a short period during the initial spring runoff. The length of the main stem of Hayward drain was 8.3 km in length. Average bankfull width and depth were 6.62 m and 0.64 m respectively. A slope of 0.11% was the steepest amongst all of the other drains within the watershed.

No barriers were identified within Hayward drain to impede fish movement (Appendix A-7).

The fish habitat within the drain was not ideal. Because flows did not persist for long periods of time during the spawning period, egg and larval fish would likely become stranded within this tributary if spawning did occur. Furthermore, with only minimal flows persisting in 2009 after the flooding events of 2008, it is likely that Hayward Drain is typically dry for most of the year with pockets of water forming after rainfall events. In addition, fish habitat was marginal as well. Silt and clay were the dominated substrate types within the waterway. Sand, gravel, and cobble substrates were found within the waterway but at only one location, a ford crossing upstream of highway #419. The riparian zone along Hayward drain was however the most diverse among all the drains sampled. Shrubs, trees, and grasses were all documented with the riparian zones at numerous sites along the waterway. Overall, Hayward drain would be of little significance to the fish communities within this watershed as flows were minimal and the habitat was marginal.

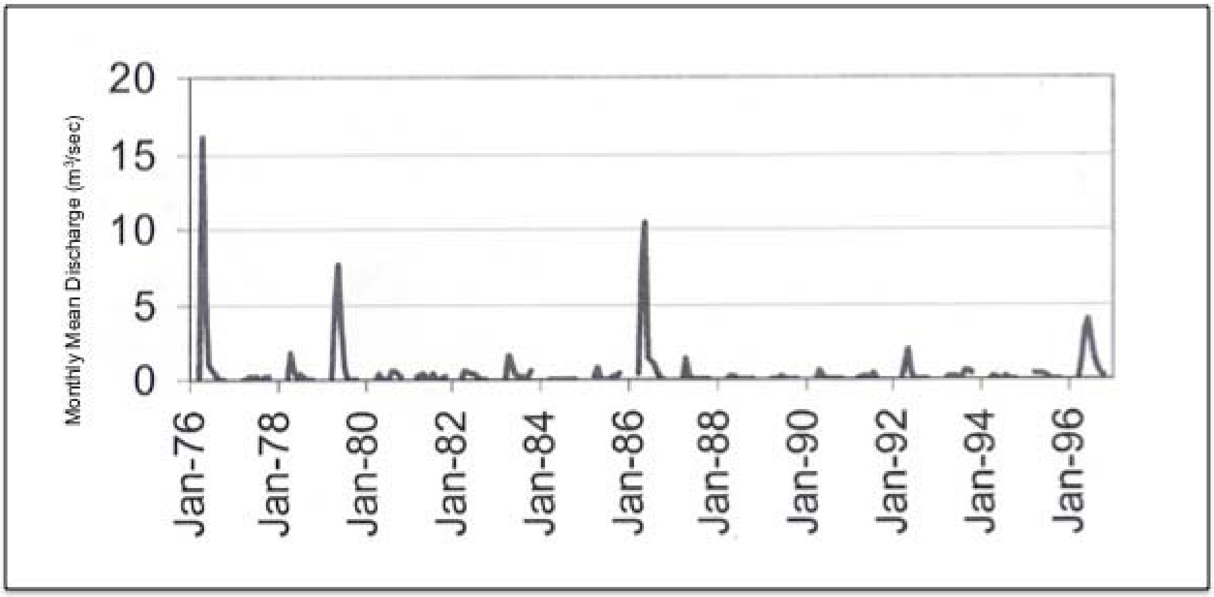


Figure 9. Historical discharges for a 20-year period on Swan Creek Drain. Data is displayed as a mean monthly discharge (m3/sec) hydrograph.

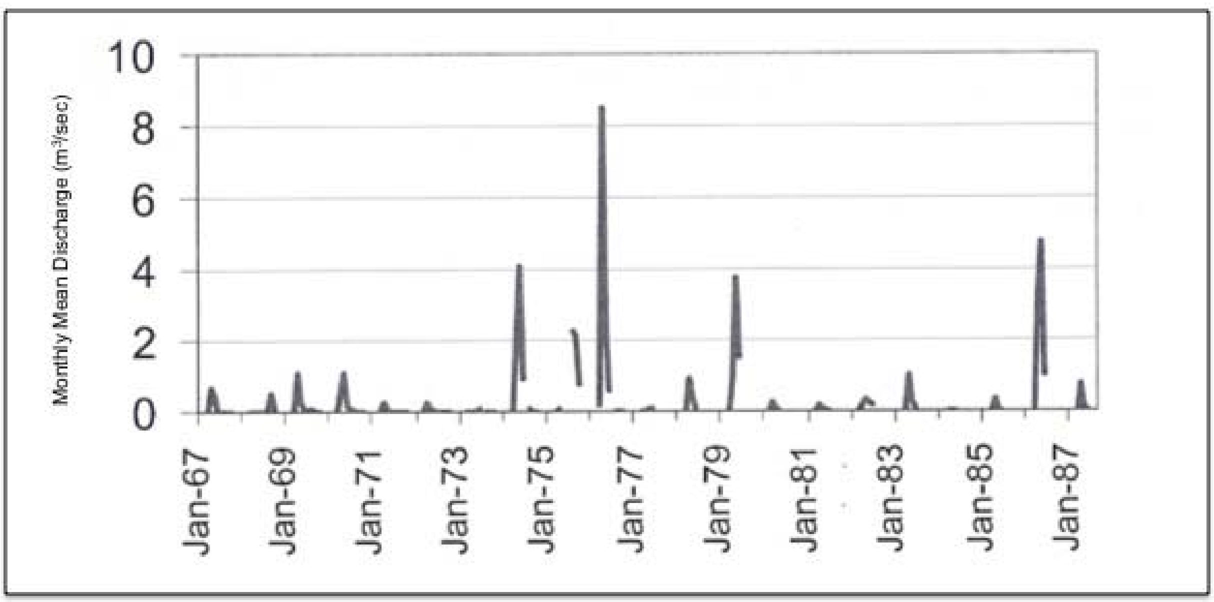


Figure 10. Historical discharges for a 20-year period on Burnt Lake Drain. Data is displayed as a mean monthly discharge (m3/sec) hydrograph.

3.4 WATER QUALITY

Limited historical data of water quality trends was available for the Swan Creek Watershed. Manitoba Water Stewardship does not have a water quality station within the Swan Creek Watershed.

Good water quality is the foundation for having a healthy aquatic environment and balanced ecosystem. Fish, wildlife, and all those area resident, agricultural producers, commercial and recreational fishermen and those using the waterways for recreational activities depend on good clean healthy water. Because most of the tributaries run along agricultural land, used for either hay or pastured lands, agricultural practices are the major focus within this report. Golf courses, sewage lagoons, storm water discharges, and large urban centers all contribute to polluting water quality, however none of these are a cause for concern within the Swan Creek Watershed. The WIWCD is fortunate to only have agricultural practices affecting the waterway within this area, as most problems can be an easy fix.

Results of this study indicated that water quality within the region was satisfactory. Dissolved oxygen and water temperatures were well within the standards and normal ranges for Manitoba surface waters. Dissolved oxygen levels within winter may become anoxic within some of the systems that have higher nutrient levels (Mud Lake Drain, Hayward Drain, and North Wagon Creek Drain). Microbial activity under ice conditions uses oxygen within the water to carry out their life processes. This depletes oxygen within the water column, ultimately creating anoxic conditions. The pH within all tributaries ranged from 7.36 to 8.78. The highest and the lowest pH were both documented on Mud Drain (Table 1).

Nutrient loading was most evident on Mud Lake Drain and Hatchery Drain. Within both of these systems large algal blooms were observed (Figure 11). Nutrient loading was also evident on Burnt Lake Drain where feeding operations took place within the drain (Figure 11). However, based on the classification system developed by Dodds et al. (1998), using Total Phosphorus (TP) as the indicator, all creeks within Swan Creek Drain would be classified as Oligotropich to Mesotrophic as TP was well below 0.075mg/L (boundary between Mesotrophic/Eutrophic).

Turbidity was one of the major concerns within the waterways. Livestock grazing, causing damage to riparian zones along banks, increased erosion and created higher sediment loads within the waterways. Figure 12 is a photograph illustrating the difference between a non-turbid waterway and a turbid one. Fish, most likely prefer non-turbid waters. The turbidity within the main stem of Hatchery Drain was 4.17 NTU, while the turbidity was 0.12 NTU flowing out the vegetated side tributary.

Figure 11. Livestock grazing, a common site within the tributaries of the Swan Creek Watershed may lead to nutrient and sediment loading within the aquatic environment.

Figure 12. A photograph displaying the turbidity within Hatchery Drain. The clear water is flowing from a vegetated ditch.

Table 1. Water quality data collected on each tributary while conducting the fieldwork component of this project.

Tributary	Reach	Date	Conductivity (µs/cm)	Temperature (^{o}C)	Dissolved Oxygen (mg/l)	pH	Turbidity (NTU)
Swan Creek Drain	1	15-Apr-09	207	4.56	11.1	7.41	--
	2	20-Apr-09	175	4.59	13.25	7.61	1.71
	2	24-May-09	407	15.19	13.02	8.22	0.89
	1	03-Jun-09	455	16.7	11.98	8.22	0.93
	2	06-Jun-09	403	12.29	12.82	8.24	2.54
	1	16-Jun-09	521	22.39	11.21	8.19	2.66
	3	16-Jun-09	510	23.28	8.97	8.06	1.55
	2	16-Jun-09	540	24.32	11.51	8.24	1.32
	1	11-Sep-09	542	20.44	10.29	8.19	2.55
Burnt Lake Drain	2	15-Apr-09	196	4.23	12.05	7.66	--
	2	18-Apr-09	194	2.7	13.43	7.87	0.55
	1	28-Apr-09	307	10.96	11.82	--	0.64
	3	24-May-09	480	14.32	10.94	7.95	1.22
	2	03-Jun-09	493	16.71	11.43	8.13	1.33
	1	06-Jun-09	462	12.93	12.18	7.95	1.24
	2	16-Jun-09	564	23.51	9.22	8.05	4.32
	1	16-Jun-09	582	24.48	10.43	8.19	4.61
	2	11-Sep-09	523	20.12	9.24	7.98	2.1
Hatchery Drain	2	15-Apr-09	213	5.49	13.32	7.88	--
	3	17-Apr-09	182	3.4	11.24	7.75	1.22
	2	18-May-09	435	10.83	11.94	7.97	1.38
	3	18-May-09	362	11.08	13.94	8.14	0.77
	2	03-Jun-09	527	18.05	12.2	8.13	2.76
	1	06-Jun-09	502	13.57	13.01	8.06	2.07
	2	11-Sep-09	598	20.48	10.22	8.36	2.22
Island Lake	2	15-Apr-09	185	3.46	11.42	7.63	--
	3	17-Apr-09	172	2.68	10.32	7.74	0.78
	2	20-Apr-09	158	7.28	11.62	7.5	0.68
	3	23-May-09	312	12.71	12.03	7.6	0.76
	1	03-Jun-09	381	16.47	9.19	7.84	0.89
	2	06-Jun-09	350	13.48	10.8	7.75	0.78
	3	15-Jun-09	459	23.02	8.15	7.69	0.66
	2	15-Jun-09	470	23.29	8.43	7.7	0.77
	1	15-Jun-09	473	23.5	8.35	7.77	0.77
	2	11-Sep-09	486	20.31	11.46	8.2	0.64

Table 1. Continued.

Tributary	Reach	Date	Conductivity (µs/cm)	Temperature (°C)	Dissolved Oxygen (mg/l)	pH	Turbidity (NTU)
Mud Lake Drain	2	15-Apr-09	203	7.37	9.55	7.36	--
	2	17-Apr-09	206	5.88	9.69	7.66	0.36
	3	20-Apr-09	239	9.37	13.22	7.79	1.64
	2	18-May-09	653	11.55	13.77	8.13	0.27
	2	18-May-09	542	11.98	13.35	8.12	1.27
	3	18-May-09	467	12.08	12.86	8.00	1.38
	1	23-May-09	632	14.14	13.67	8.09	1.84
	1	03-Jun-09	718	17.62	12	8.22	1.91
	2	06-Jun-09	585	13.27	12.98	8.06	3.08
	3	15-Jun-09	717	22.13	9.68	7.88	2.44
	2	15-Jun-09	792	24.01	9.26	7.97	3.34
	1	16-Jun-09	**1172**	19.92	4.58	7.91	4.55
	2	11-Sep-09	618	20.39	10.14	8.2	4.82
	1	11-Sep-09	**886**	20.17	11.78	8.78	4.55
North Wagon Creek	1	18-Apr-09	310	5.04	12.29	7.79	3.55
	2	18-May-09	646	9.87	11.42	7.96	--
	3	18-May-09	548	10.14	12.15	7.93	--
	1	03-Jun-09	**951**	19.56	11.3	8.24	**19.1**
	3	06-Jun-09	656	13.37	16.67	8.39	**0.73**
Hayward Drain	2	15-Apr-09	230	8.05	7.61	7.28	--
	3	17-Apr-09	213	2.27	9.4	7.71	1.33
	2	13-May-09	586	16.58	12.04	8.5	2.14
	1	03-Jun-09	679	18.04	9.07	8.16	2.68
	3	16-Jun-09	857	18.67	10.48	7.48	3.33
	1	16-Jun-09	**1047**	23.99	14.06	8.22	4.44
	2	11-Sep-09	**1852**	18.43	6.23	7.72	4.85

Table 2. Results of water samples collected within the tributaries of the Swan Creek Watershed. Samples were analyzed at ALS Laboratory Group in Winnipeg.

Water Quality Parameter	Units	Swan Creek Drain	Burnt Lake Drain	Hatchery Drain	Island Lake Drain	Mud Lake Drain	North Wagon Creek Drain	Hayward Drain
Ammonia (NH3) - Soluble	mg/L	0.0152	0.0232	0.0032	0.0172	0.0032	0.0552	0.389
Chlorophyll a	µg/L	6.9	5	4.6	5	1.5	5.7	1.5
Fecal Coliform	CFU/100	5	8	<1	3	3	6	Overgrown
Phosphorus, Total	mg/L	0.0276	0.044	0.0231	0.0274	0.0375	0.0525	0.679
Total Dissolved Phosphorus	mg/L	0.0158	0.0248	0.0166	0.0181	0.0302	0.0307	0.54
Total Dissolved Solids	mg/L	216	270	296	194	332	464	516
Total Suspended Solids	mg/L	<5.0	14	<5.0	6	<5.0	14	<5.0
Nitrate+Nitrite-N	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.008
Total Kjeldahl Nitrogen (TKN)	mg/L	0.99	1.17	0.9	0.93	1.02	1.28	4.05
Total Nitrogen	mg/L	0.99	1.17	0.9	0.93	1.02	1.28	4.06

3.4.1 WATER TEMPERATURE

Water temperature data for each tributary is shown in Appendix F. All of the tributaries within the watershed had similar water temperatures.

Water temperature was well below the normal range for temperatures during the month of April. Temperatures did not warm up and maintain temperatures of 10°C until the second week of May. As a result fish spawning runs were reduced or prolonged. Spring surveys were extended to try and effectively determine fish utilization of the Swan Creek Watershed during the 2009 spring runoff. Sampling began on April 15th and commenced May 12th, 2009. In addition to the cool waters, egg development was likely reduced and the larval drift was spread out over a longer period. It was therefore difficult to anticipate and sample the peak larval drift. In 2007, during a fish passage assessment on Hatchery Drain, water temperatures reached and remained above 10°C on April 19th (Lowdon 2007).

Average water temperatures will only be discussed for Hatchery Drain, as water temperature within all drains was similar. Average water temperatures on Hatchery Drain were as follows: April average water temperature was 7.55°C, May average water temperature was 12.52°C, June average water temperature was 19.0°C July average water temperature was 20.84°C, August average water temperature was 19.86°C, and September average water temperature was 20.75°C. The maximum water temperature documented within the study was 28.25ºC, recorded in August of 2009. One exception observed within the study was a temperature spiked to 40°C recorded on Hayward Drain on July 27th. It is believed that the temperature logger within Hayward Drain went dry during a brief period during the summer months.

3.5 FISH SPECIES UTILIZATION

White Sucker was the most abundant species captured within all of the tributaries sampled within the Swan Creek Watershed (Appendix G). Walleye was the second most abundant fish species captured migrating upstream from Lake Manitoba to spawn within the tributaries (Figure 13). Northern Pike, Yellow Perch, Common Carp, Iowa Darter, Logperch and Spottail Shiner where also caught in relatively high numbers within the Swan Creek Watershed. All of these fish would likely overwinter in Lake Manitoba and utilize the Swan Creek Watershed tributaries for spawning, feeding or as nursery habitat. Brook Stickleback, Central Mudminnow, and Fathead Minnow, found within the tributaries, likely overwintered within the marshes and wetlands within the watershed. Stewart and Watkinson (2004) report a total of 42 species within the Lake Manitoba watershed that could potentially utilize these tributaries. Fourteen have been confirmed to utilize the Swan Creek Watershed (Table 3; Figure 14).

The Swan Creek Watershed is of significant importance to the Lake Manitoba fish communities as it is one of the largest watersheds draining into Lake Manitoba along the eastern shore of the lake. The mullet fishery within the watershed is also of significant importance as many people use this resource to make a living. It is therefore important to protect and restore the fish habitat within these waterways to help benefit all of the fish communities utilizing this watershed.

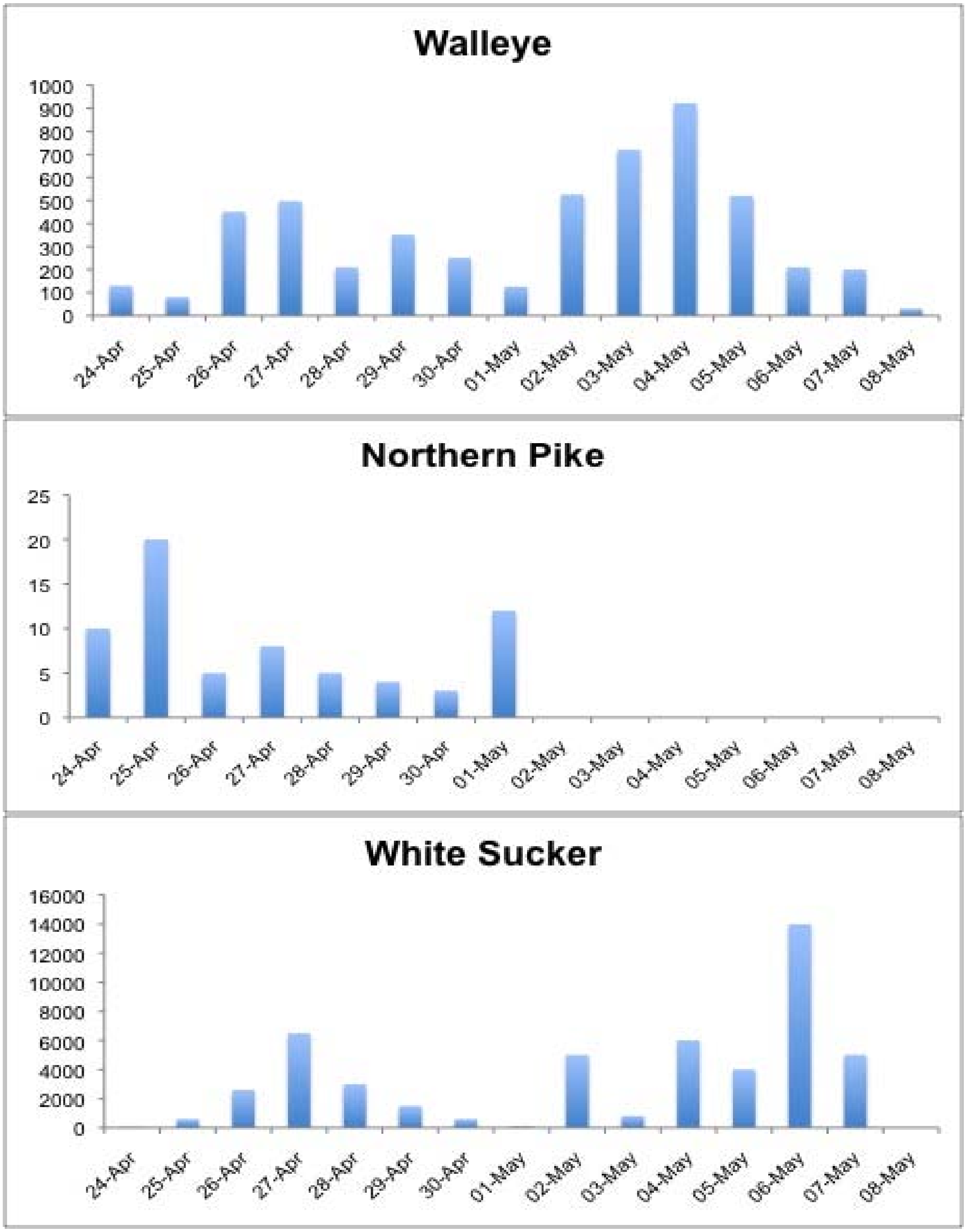


Figure 13. Collection records of fish captured at the mouth of Swan Creek by the Swan Creek Hatchery Team. (Data provided by Jim Brandson.)

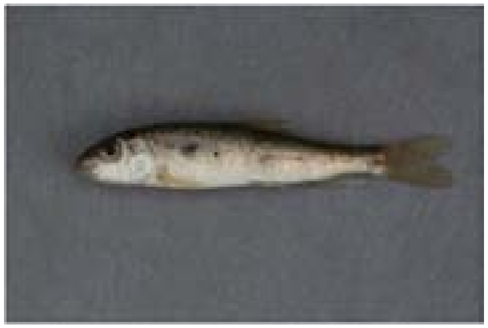
Table 3. Fish species potential utilizing the Swan Creek Watershed. Information collected from Stewart and Watkinson (2004).

Common Name	Family	Genus	Species	Occurrence	COSEWIC Status	Known Occurrences
Goldeye	Hiodontidae	*Hiodon*	*alosoides*	Native	not listed	Lake Manitoba
Mooneye	Hiodontidae	*Hiodon*	*tergisus*	Native	not listed	Delta Marsh - Lake Manitoba
Common Carp	Cyprinidae	*Cyprinus*	*carpio*	Introduced	not listed	**Swan Creek Watershed**
Pearl Dace	Cyprinidae	*Margariscus*	*margarita*	Native	not listed	Unknown
Golden Shiner	Cyprinidae	*Notemigonus*	*crysoleucas*	Native	not listed	Lake Manitoba (The Narrows)
Emerald Shiner	Cyprinidae	*Notropis*	*antherinoides*	Native	not listed	Lake Manitoba
Spottail Shiner	Cyprinidae	*Notropis*	*hudsonius*	Native	not listed	**Swan Creek Watershed**
Northern Redbelly Dace	Cyprinidae	*Phoxinus*	*eos*	Native Rare, Tributaries	not listed	Lake Manitoba
Finescale Dace	Cyprinidae	*Phoxinus*	*neogaeus*	Native Rare, Tributaries	not listed	Lake Manitoba
Fathead Minnow	Cyprinidae	*Pimephales*	*promelas*	Native	not listed	**Swan Creek Watershed**
Longnose Dace	Cyprinidae	*Rhinichthys*	*cataractae*	Native	not listed	Unknown
Creek Chub	Cyprinidae	*Semotilus*	*atromaculatus*	Native	not listed	**Swan Creek Watershed**
Quillback	Catostomidae	*Carpiodes*	*cyprinus*	Native	not listed	Lake Manitoba
White Sucker	Catostomidae	*Catostomus*	*commersonii*	Native	not listed	**Swan Creek Watershed**
Bigmouth Buffalo	Catostomidae	*Ictiobus*	*cyprinellus*	Native Rare	special concern	Delta Marsh - Lake Manitoba
Silver Redhorse	Catostomidae	*Moxostoma*	*anisurum*	Native	not listed	unknown
Shorthead Redhorse	Catostomidae	*Moxostoma*	*macrolepidotum*	Native	not listed	Lake Manitoba
Black Bullhead	Ictaluridae	*Ameiurus*	*melas*	Native Recent	not listed	Delta Marsh - Lake Manitoba
Brown Bullhead	Ictaluridae	*Ameiurus*	*nebulosus*	Native Recent	not listed	Delta Marsh - Lake Manitoba
Channel Catfish	Ictaluridae	*Ictalurus*	*punctatus*	Native Recent	not listed	Delta Marsh - Lake Manitoba
Tadpole Madtom	Ictaluridae	*Noturus*	*gyrinus*	Native Recent	not listed	Delta Marsh - Lake Manitoba
Northern Pike	Esocidae	*Esox*	*lucius*	Native	not listed	**Swan Creek Watershed**
Central Mudminnow	Umbridae	*Umbra*	*limi*	Native Recent	not listed	**Swan Creek Watershed**
Cisco	Salmonidae	*Coregonus*	*artedi*	Native	not listed	Lake Manitoba
Lake Whitefish	Salmonidae	*Coregonus*	*clupeaformis*	Native	not listed	Lake Manitoba
Rainbow Trout	Salmonidae	*Oncorhynchus*	*mykiss*	Introduced	not listed	Lake Manitoba
Brown Trout	Salmonidae	*Salmo*	*trutta*	Introduced	not listed	Lake Manitoba
Brook Trout	Salmonidae	*Salvelinus*	*fontinalis*	Transplanted (Native Manitoba)	not listed	Lake Manitoba
Trout Perch	Percopsidae	*Percopsis*	*omiscomaycus*	Native	not listed	Lake Manitoba
Burbot	Gadidae	*Lota*	*lota*	Native	not listed	Lake Manitoba
Brook Stickleback	Gasterosteidae	*Culaea*	*inconstans*	Native	not listed	**Swan Creek Watershed**
Ninespine Stickleback	Gasterosteidae	*Pungitius*	*pungitius*	Native	not listed	Lake Manitoba

Table 3. Continued….

Common Name	Family	Genus	Species	Occurrence	COSEWIC Status	Known Occurrences
Mottled Sculpin	Cottidae	*Cottus*	*bairdii*	Native	not listed	Lake Manitoba
Rock Bass	Centrarchidae	*Ambloplites*	*rupestris*	Native	not listed	Lake Manitoba
Iowa Darter	Percidae	*Etheostoma*	*exile*	Native	not listed	**Swan Creek Watershed**
Johnny Darter	Percidae	*Etheostoma*	*nigrum*	Native	not listed	**Swan Creek Watershed**
Yellow Perch	Percidae	*Perca*	*flavescens*	Native	not listed	**Swan Creek Watershed**
Logperch	Percidae	*Percina*	*caprodes*	Native	not listed	**Swan Creek Watershed**
River Darter	Percidae	*Percina*	*shumardi*	Native	not listed	Lake Manitoba
Sauger	Percidae	*Sander*	*canadensis*	Native	not listed	**Swan Creek Watershed**
Walleye	Percidae	*Sander*	*vitreus*	Native	not listed	**Swan Creek Watershed**
Freshwater Drum	Sciaenidae	*Aplodinotus*	*grunniens*	Native	not listed	Lake Manitoba

White Sucker (juvenile)



Logperch

Iowa Darter

Walleye

White Sucker

Central Mudminnow

Northern Pike

Fathead Minnow

Common Carp

Spottail Shiner

Figure 14. Photos of representative fish species capture during the fish inventory within the Swan Creek Watershed, 2009

3.5.1. EGG SAMPLING

Egg sampling was conducted within each reach of each tributary within the Swan Creek Watershed (Table 5). Thousands of White Sucker eggs were collected. They were typically found on gravel substrates within all tributaries. Walleye eggs were only found in Hatchery Drain downstream of the culverts at the # 6 highway crossing.

Table 5. Results of egg collection within the Swan Creek Watershed tributaries.

Drain	Date	Reach	Type of Egg	Number Collected	Number Dead
North Wagon	18-May-09	3	White Sucker	527	28
North Wagon	18-May-09	3	White Sucker	35	3
North Wagon	18-May-09	3	White Sucker	45	5
Hatchery	18-May-09	3	--	0	0
Hatchery	18-May-09	2 (downstream #6 crossing)	White Sucker	363	0
Mud Lake	18-May-09	2	--	0	0
Mud Lake	18-May-09	3	White Sucker	44	3
Mud Lake	18-May-09	1	--	0	0
Island Lake	23-May-09	3	White Sucker	183	1
Island Lake	23-May-09	2	White Sucker	23	0
Island Lake	23-May-09	1	White Sucker	32	0
Hayward	13-May-09	1,2,3	--	0	0
Hatchery Drain	23-May-09	2 (downstream #6 crossing)	White Sucker	1119	22
Hatchery Drain	24-May-09	3 (downstream #6 crossing)	Walleye	5	0
Burnt Lake	24-May-09	1,2,3	--	0	0
Swan Creek	24-May-09	2 (downstream #6 crossing)	White Sucker	220	11

3.5.2 LARVAL DRIFT

Larval drift was most abundant on Island Lake Drain where thousands of White Sucker larval fish were collected (Table 6). Brook Stickleback larva, which resemble Walleye larval fish, were also captured within the study on Mud Lake Drain, Hayward Drain, Burnt Lake Drain and North Wagon Creek Drain. Walleye larval fish were only captured on Hatchery Drain downstream of the #6 highway culvert crossing. Water velocities were quite high at that site making it easier to capture fish. To get a better understanding of return rates to Lake Manitoba, extensive sampling would be required. This assessment was essentially done to document upstream successful larval emergence.

Table 6. Results of larval drift net sampling within the Swan Creek Watershed tributaries.

Drain	Date	Reach	Larval Fish Captured
North Wagon	05-June-09	1	No fish
North Wagon	06-June-09	2	White Sucker (No fish)
North Wagon	07-June-09	3	White Sucker (N=13)
Hatchery	05-June-09	1	White Sucker (N=12)
Hatchery	06-June-09	2	White Sucker (N=298); Walleye (N=5)
Hatchery	07-June-09	3	No Fish
Mud Lake	05-June-09	1	Brook Stickleback (N=342)
Mud Lake	06-June-09	2	BRSB (N=35)
Mud Lake	07-June-09	3	White Sucker (N=76)
Island Lake	08-June-09	1	White Sucker (N=98)
Island Lake	09-June-09	2	White Sucker (N = 963)
Island Lake	10-June-09	3	White Sucker (N= 1097)
Hayward	08-June-09	1	Brook Stickleback (N=2)
Hayward	09-June-09	2	No Fish
Hayward	10-June-09	3	No Fish
Burnt Lake	08-June-09	1	White Sucker (N=5)
Burnt Lake	09-June-09	2	White Sucker (N=3)
Burnt Lake	10-June-09	3	Brook Stickleback (N=4)
Swan Creek	08-June-09	1	White Sucker (N=17)
Swan Creek	09-June-09	2	White Sucker (N=98)
Swan Creek	10-June-09	3	No Fish

3.6. BENTHIC INVERTEBRATE COMMUNITY

The invertebrate community within the Swan Creek Watershed, although not heavily sampled, appeared diverse. Odonata, Ephemeroptera, and Trichoptera, the most sensitive species to poor water quality, were collected in all of the tributaries sampled. More effort however should be taken to sample the invertebrate community within known livestock watering areas, areas with limited diversity, and areas where riparian zones appear inadequate. By having a good understanding which types of invertebrates are found within the different tributaries, the WIWCD will be able to determine how healthy each system is. Invertebrates are excellent indicators of poor water quality conditions.

Table 7. Invertebrates (Insects) identified within the sample reaches of each tributary within the Swan Creek Watershed. Sampling was qualitative.

Invertebrates Identified	Swan Creek Drain			Burnt Lake Drain			Hatchery Drain			Island Lake Drain			Mud Lake Drain			North Wagon Creek Drain			Hayward Drain		
Sampling Reach	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Amphipoda	y	y	y	y	y	y		y	y	y	y	y	y	y	y	y		y	y		
Odonata		y				y	y	y		y	y		y		y						
Trichoptera		y	y			y	y	y		y	y	y		y	y						y
Ephemeroptera		y						y		y	y							y			
Hemiptera/Corixidae		y							y				y								
Diptera/Ceratopogonidae		y													y			y			
Diptera/Simulidae		y	y	y	y			y	y	y	y	y		y	y	y	y	y		y	
Diptera/Chironomidae		y	y					y	y		y	y		y	y	y	y	y	y		y
Water mites			y				y	y					y	y				y			
Leeches														y	y	y		y			
Planorbidae	y	y	y		y		y	y				y		y		y		y			
Lymnaeidae			y																y	y	y
Snails unidentified									y						y						
Finger Nail Clams															y						y
Oligochaetes													y	y		y	y				
Cladocerans	y				y			y						y	y						

4.0 POTENTIAL REHABILITATION SITES

Within Appendix I is a table listing 12 rehabilitation projects that AAE Tech Services feel are important to improve the aquatic ecosystem within the Swan Creek Watershed. The projects range from riparian enhancement to removing or providing fish passage at a number of barriers along the waterways. General recommendations are also provided to enhance or create fish spawning habitat within the Swan Creek Watershed. As all the drains have been extensively straightened, there has been a downward trend in the amount of valuable spawning habitat for Lake Manitoba fish species. Livestock grazing within the watershed was common on each of the seven tributaries studied. The WIWCD must work and collaborate with local landowners, government agencies, municipalities and producers to jointly improve the conditions within the Swan Creek Watershed.

5.0 SUMMARY

To better understand the waterways within the conservation district, the WIWCD initiated this study. Results were intended to assist the WIWCD to effectively restore, enhance, and protect the aquatic environment within their conservation district to develop a healthy aquatic ecosystem for the benefit of all user groups.

Results of this assessment identified numerous barriers to fish movement, damaged riparian zones along waterways that appeared inadequate to protect the aquatic environment, and a lack of fish habitat diversity within the watershed. However, positive results were also found. Only 6% of the riparian condition was considered severally impacted by livestock grazing. Most of the tributaries, although very uniform, had riparian zones adequate to provide protection to the aquatic environment. Urban development within the watershed was minimal to non-existent. Most of the land use along the tributaries was either pastured land or hay fields. These types of environments do not typically have excessive nutrient loading to the aquatic environment; with the exception of heavily livestock grazed sections were bank trampling is common.

The results of this survey provided much needed data to understand the fish habitat and fish communities utilizing this Swan Creek Watershed. As previously stated, there is a severe lack of habitat diversity within the tributaries of this watershed. All of the drains have been straightened and channelized. As a result, a significant amount of habitat was lost. In addition, the habitat remaining within the drains was simple, with limited cover, limited spawning habitat, and a lack of nursery habitat. Barriers were common within the three major drains, Hatchery Drain, Burnt Lake Drain, and Swan Creek Drain. Culverts appeared to be undersized as flows were much greater than the recommended flow of 1.0 m/s by the Department of Fisheries and Oceans at various crossings.

Many enhancement efforts can be undertaken to improve the habitat. The WIWCD is going to have to partner with local landowners, commercial fishermen, agricultural producers, municipalities, and government agencies to accomplish the ultimate goal of providing a healthy ecosystem within the watershed to benefit all user groups. Throughout this report there has been much discussion about livestock grazing in the creeks of the Swan Creek Watershed.

With that said, the intent of this project was not to put blame on any one group. The project was intended to provide recommendations on how to improve the health and sustainability of the watershed for user groups and fish and wild life. This can be a win-win for everybody if all parties work together to improve the habitat within this watershed. Off site watering stations for livestock can be set up in places were watering areas are common. Riparian zone plantings can occur to provide additional cover for the benefit of the fish community. Barriers along the waterways can be removed or fish passage provided. Additional spawning habitats can be constructed within the drains to restore and enhance the fish spawning sites that once resided within these waterways. All of these recommendations, if followed, will help to improve the health of the Swan Creek Watershed.

6.0 RECOMMENDATIONS

The recommendations below are based on the results of this study and discussions had with the West Interlake Watershed Conservation District and Provincial and Federal Government Agencies.

- Conduct additional biological research at rehabilitation sites prior to conducting any work. It is important to be able to prove that the rehabilitation efforts were successful, in order to confidently determine whether the time a cost of conducting a project was worth it. If the project was successful then that project can be used as guidelines for future rehabilitation work.

- A better understanding of fish utilization within each tributary is required. By conducting intense field surveys of selected tributaries will allow the WIWCD to effectively plan where monies should be spent to enhance fish habitat.

- Assess fish population studies within each tributary. Quantify the fish that are utilizing the tributaries. This will allow the WIWCD to determine where enhancement efforts are needed.

- Walleye spawning surveys should be conducted to understand the importance these tributaries provide as valuable spawning habitat to the targeted species. Detailed drift net sampling should be conducted.

- Hold information meetings with local landowners to discuss future plans of the WIWCD. By getting everyone involved within the community will help with future enhancement initiatives.

- Conduct telemetry or tagging studies on the Lake Manitoba to better understand walleye movement within the lake. By identifying valuable spawning habitats will allow the WIWCD to replicate selected spawning habitat and recreated it within the tributaries of the Swan Creek Watershed.

- Use this report to tackle or enhance the potential rehabilitation sites listed within to improve fish habitat, water quality and the health of the aquatic ecosystem.

- Remove all barriers on the Swan Creek Watershed tributaries to allow fish the ability to reach upstream spawning and nursery habitat.

- Conduct similar riparian and aquatic assessment studies on other tributaries within the WIWCD to better understand the fish and fish habitat within those water bodies.

- Return the channel back to its natural state where possible to provide natural riffle/run/pool habitat within the tributaries of the Swan Creek Watershed. Diverse fish habitat will benefit the fishery and the Lake Manitoba fish communities.

- Monitor the mullet fishery to understand the cumulative impact it may have on the fish populations of Lake Manitoba. One mullet trap along an individual tributary may not appear to have any significant impacts on the fish community. However, if every tributary within the watershed has a mullet trap on it then the cumulative impacts may be more severe. Also, fishing nets were most often stretched from bank to bank blocking off the entire waterways within the watershed, completely blocking all fish movement. Traps should be set to only block one third of the waterway to allow some fish to reach the upstream spawning ground within these tributaries.

7.0 ACKNOWLEDGEMENTS

Thanks to everyone on the West Interlake Watershed Conservation District for giving AAE Tech Services the opportunity to conduct this riparian and aquatic survey on the Swan Creek Watershed and for being so interested and helpful throughout the course of the study. Special thanks to Elliot Macdonald, Logan Queen, and Kristin–Yaworski-Lowdon for assisting with the fieldwork component of the project. Thanks to Doug Oliver and the WIWCD board for their dedication and support to the Conservation District. Thanks to Jim Brandson of the Swan Creek Hatchery and the commercial fishermen who provided AAE Tech Services with fish collection data during the spring runoff of 2009. Thanks to Laureen Janusz of Manitoba Water Stewardship for the collection permit.

8.0 REFERENCES

Agricultural and Rural Development Act. 1968. Soil Capability for agriculture Canada Land Inventory. Ottawa, Canada.

Auer, N.A. (eds). 1982. Identification of larval fishes of the Great Lakes basin with emphasis on the Lake Michigan drainage. Great Lakes Fishery Commission, Ann Arbor, MI 48105. Special Pub. 82-3. 744p

Dodds, W.K., J.R. Jones, and E.B. Welch. 1998. Suggested classification of stream trophic state: Distributions of temperate stream types by chlorophyll, total nitrogen, and phosphorus. Wat. Res. 32:1455-1462.

Environment Canada – Climate Weather Office (ECCWO). 2009. www.climate.weatheroffice.ec.gc.ca.

Environment Canada. 1998. Historical stream flow summaries – Manitoba – to 1996. Inland Waters Directorate, Water Resources Branch, Water Survey of Canada. Ottawa, Canada.

Communications Directorate, Department of Fisheries and Oceans. 1991. The Department of Fisheries and Oceans Policy for the Management of Fish Habitat, Ottawa, Ontario.

Harrelson, C.C., C.L. Rawlins, J.P. Potyondy. 1994. Stream channel reference sites: an illustrated guide to field techniques. Gen. Tech. Rep. RM-245. Fort Collins, CO:US Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Lowdon, M.K. 2007. Hatchery Drain – Fish Passage Survey. A report prepared for Water Stewardship Infrastructure and Operations Division: Regional Operations Branch Interlake Region. Prepared by AAE Tech Services. 49 p.

Milani, D.W., and R.D. Milani. 2000. Fish habitat inventory of selected Lake Manitoba north basin tributaries. Phase I report. A report prepared to the Lake Manitoba Fish Enhancement Committee. D. Milani Environmental. 86-p.

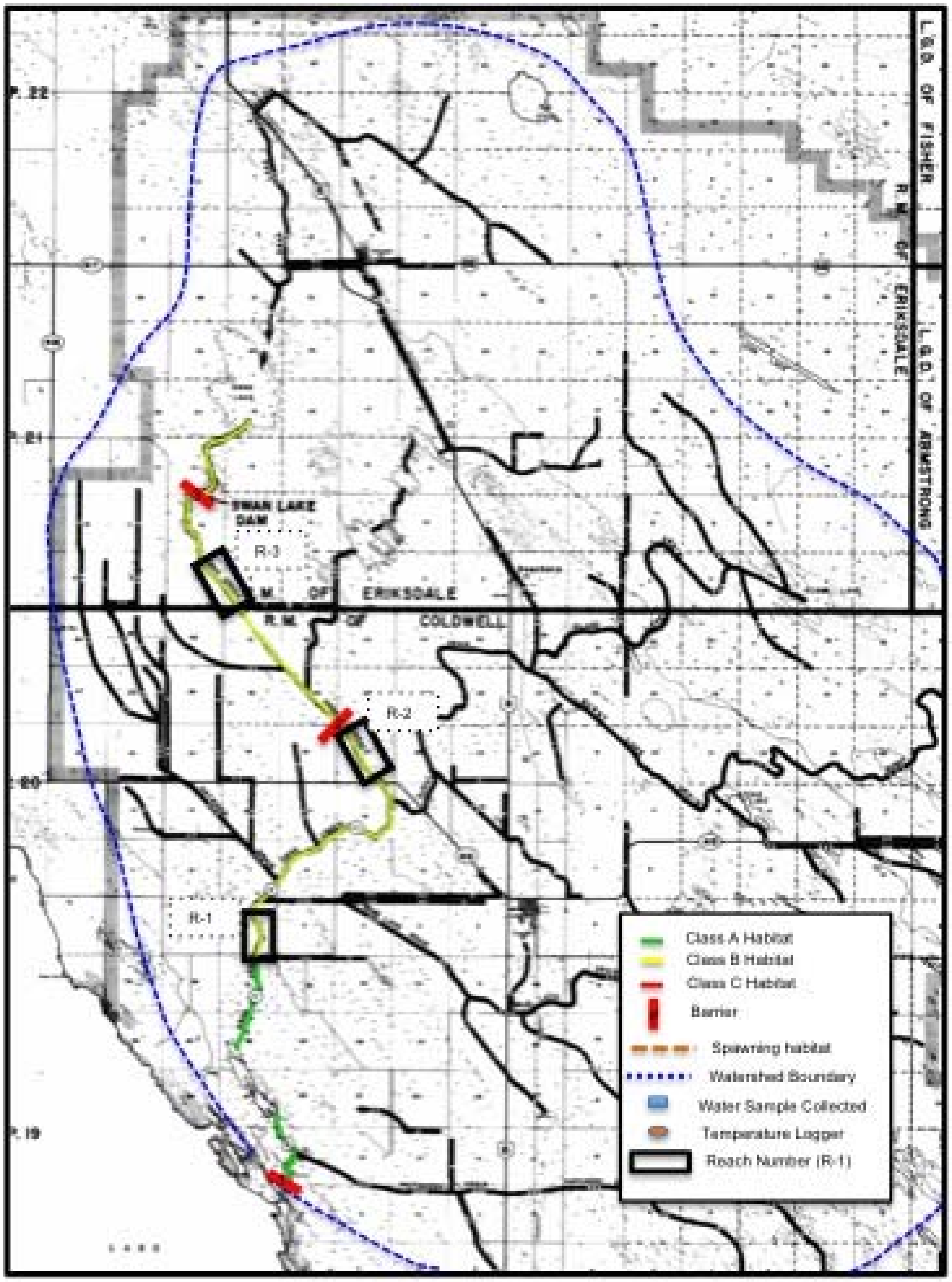
Newbury, R.W. 2008. Sream Restoration Design Manual: Canadian Rivers Institue "Stream Restoration Design". University of New Brunswick, Canada. Newbury Hydraulics Stream Design Manual. 187 p.

Newbury, R.W. and M.N. Gaboury. 1993. Stream analysis and fish habitat design – a field manual. Newbury Hydraulics Ltd. 256 p.

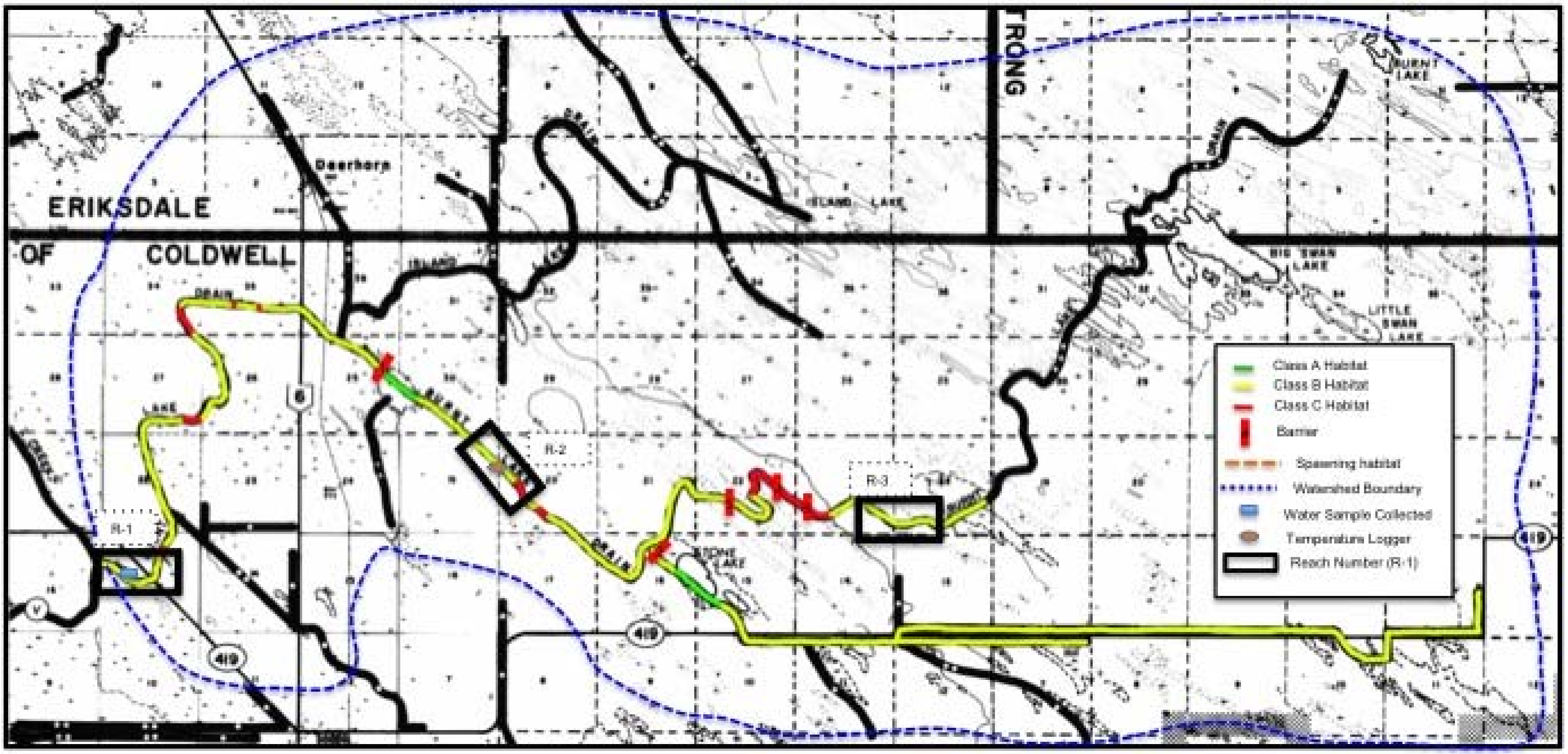
Smith, R. E., H. Veldhuis, G. F. Mills, R. G. Eilers, W. R. Fraser, and G. W. Lelyk. 1998. Terrestrial ecozones, ecoregions, and ecodistricts of Manitoba: An ecological stratification of Manitoba's natural landscapes. Research Branch Technical Bulletin. Land Resource Unit, Brandon Research Centre, Research Branch Agriculture and Agri-Foods Canada.

Stewart. K.W. and D.A. Watkinson. 2004. The freshwater fishes of Manitoba. University of Manitoba Press, Winnipeg, MB. 276p.

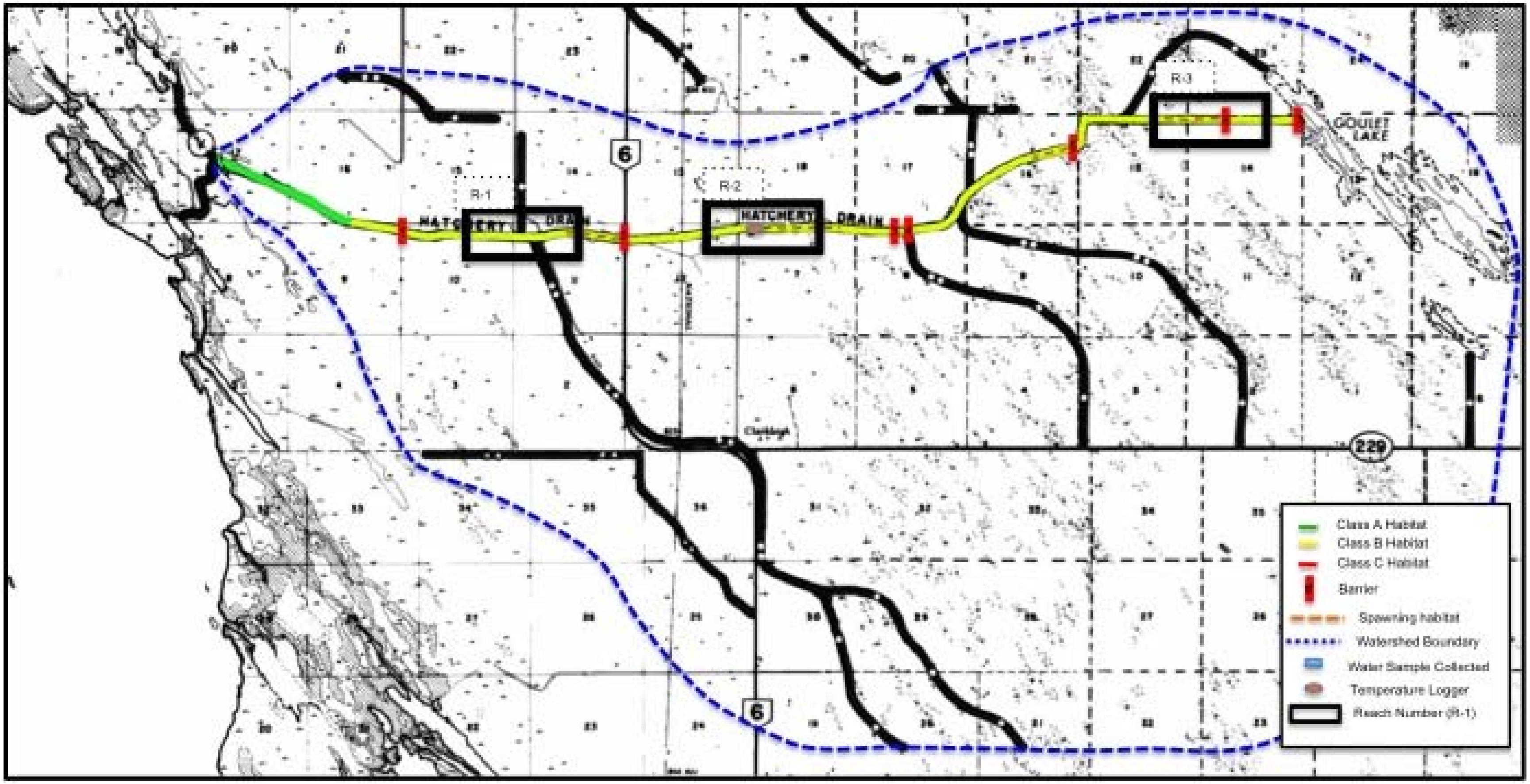
APPENDIX A: Habitat featured maps illustration the riparian zone classification of the drains within the Swan Creek Watershed. Locations of Barriers included on maps



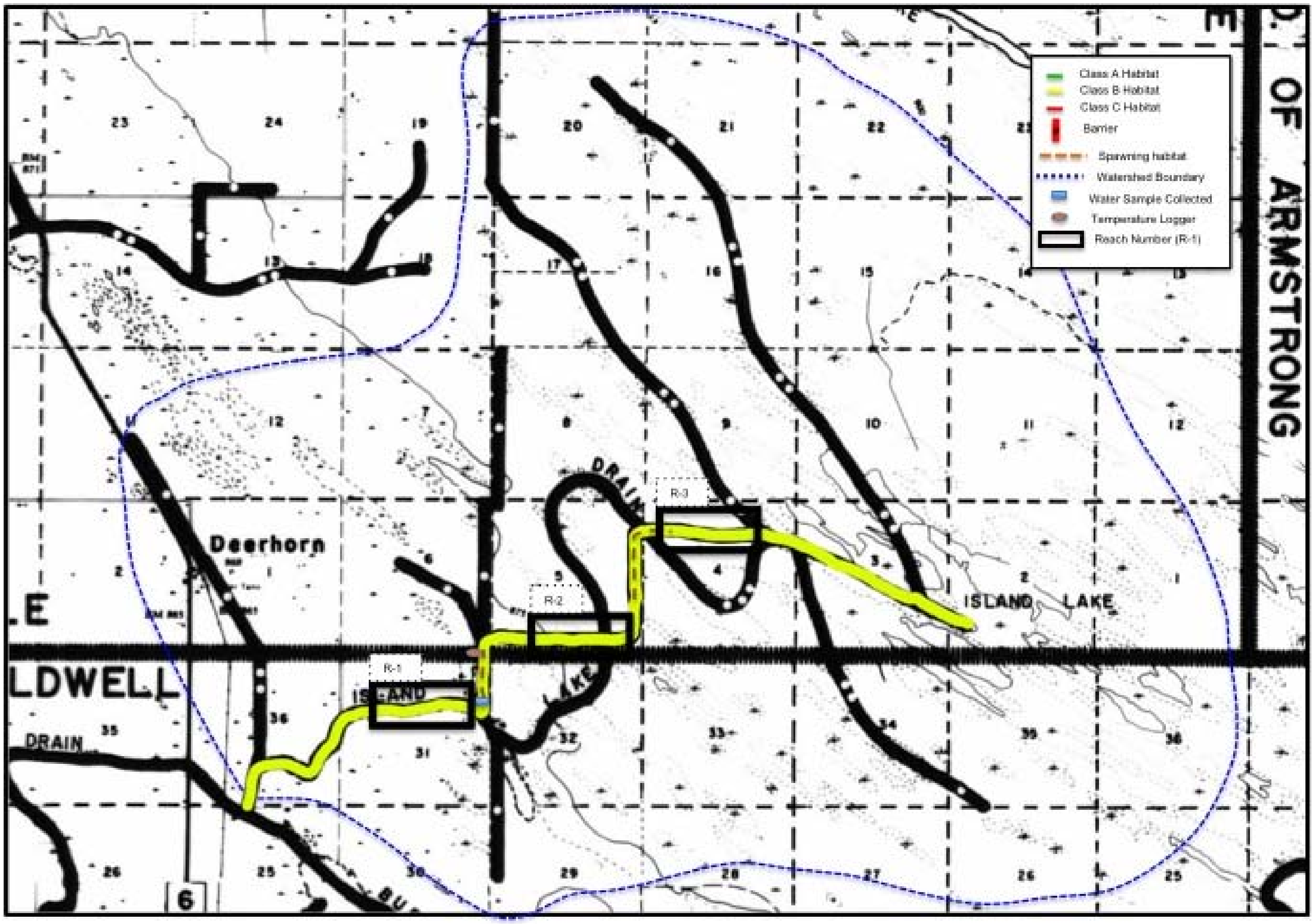
Appendix A-1. Swan Creek Drain habitat featured map



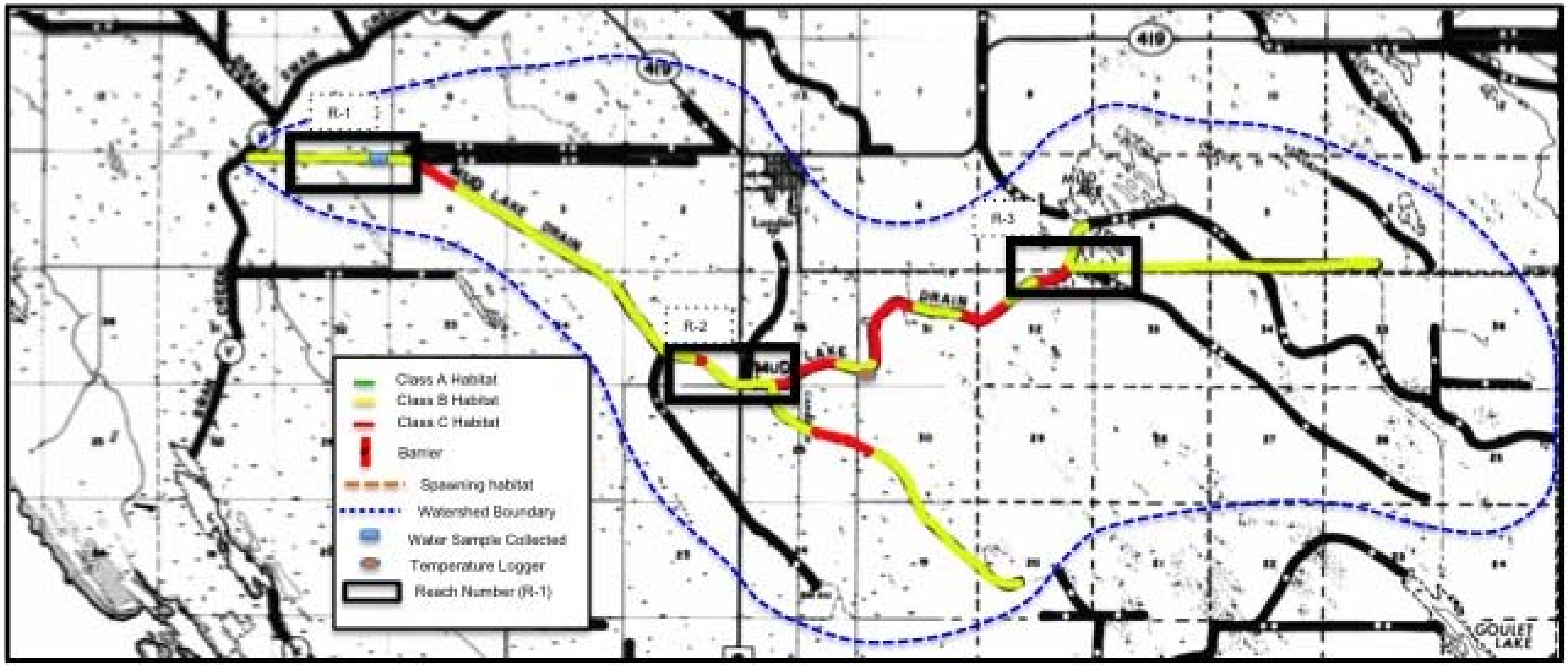
Appendix A-2. Burnt Lake Drain habitat featured map**.**



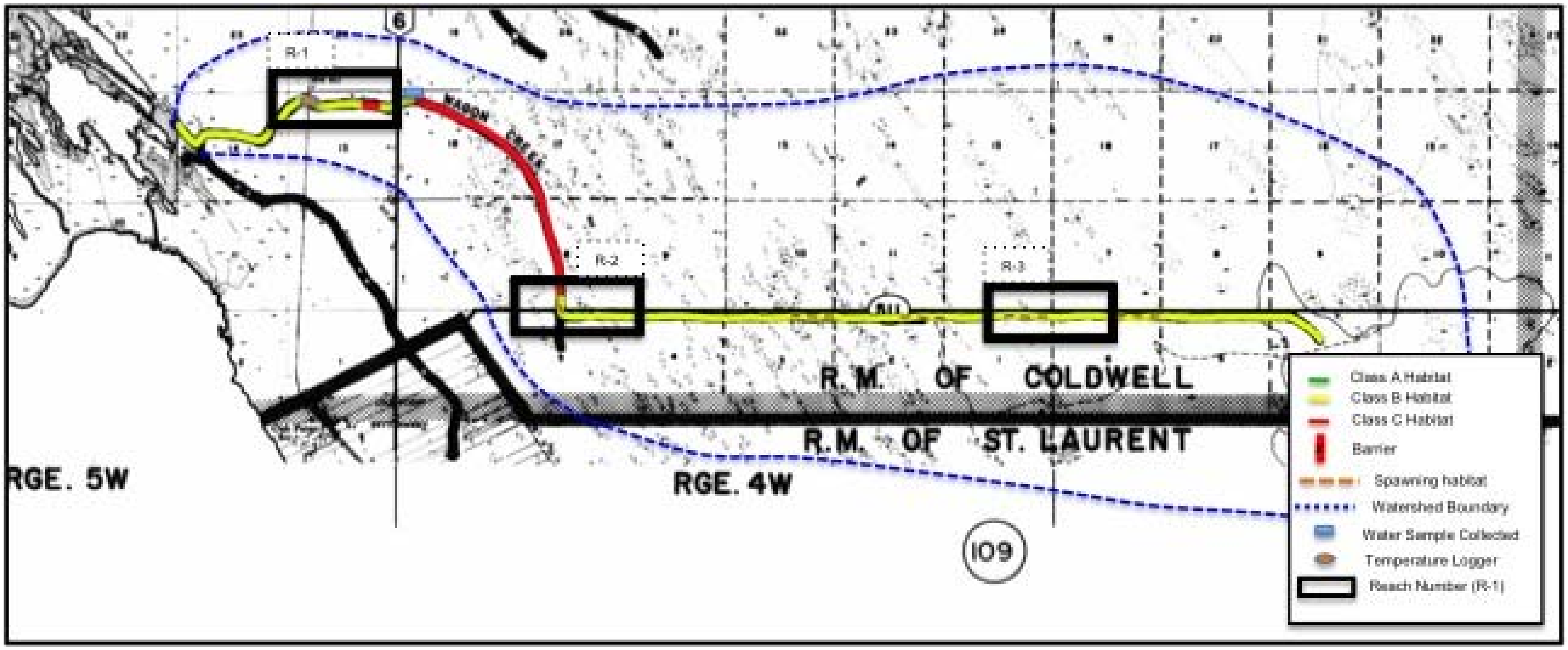
Appendix A-3. Hatchery Drain habitat featured map.



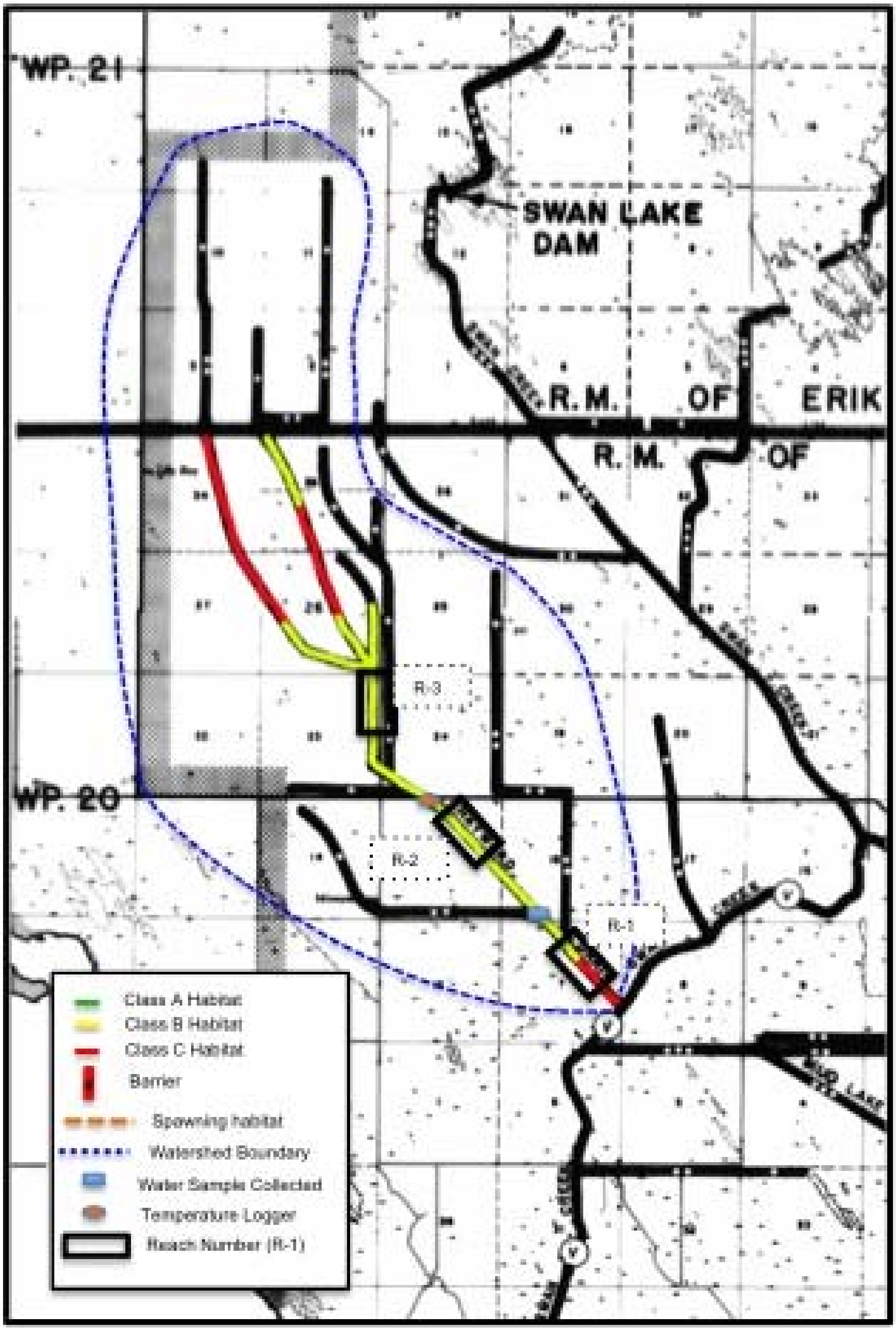
Appendix A-4. Island Lake Drain habitat featured map**.**



Appendix A-5. Mud Lake Drain habitat featured map.



Appendix A-6. North Wagon Creek Drain habitat featured map.



Appendix A-7. Hayward Drain habitat featured map.

APPENDIX B. Aerial and ground photographs representing the characteristics of the seven main Swan Creek Watershed tributaries.

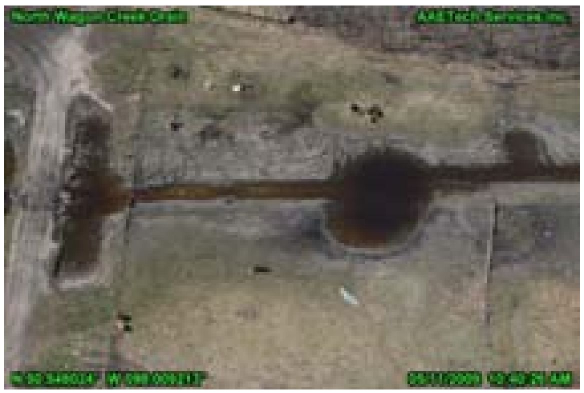
SWAN CREEK
(Appendix B-1)

BURNT LAKE DRAIN
(Appendix B-2)

HATCHERY DRAIN
(Appendix B-3)

ISLAND LAKE DRAIN
(Appendix B-4)

MUD LAKE DRAIN
(Appendix B-5)

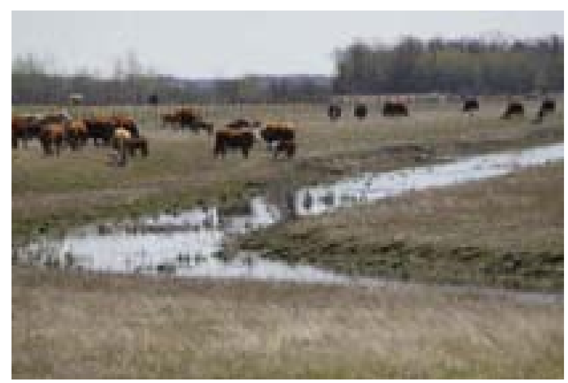


NORTH WAGON CREEK DRAIN
(Appendix B-6)

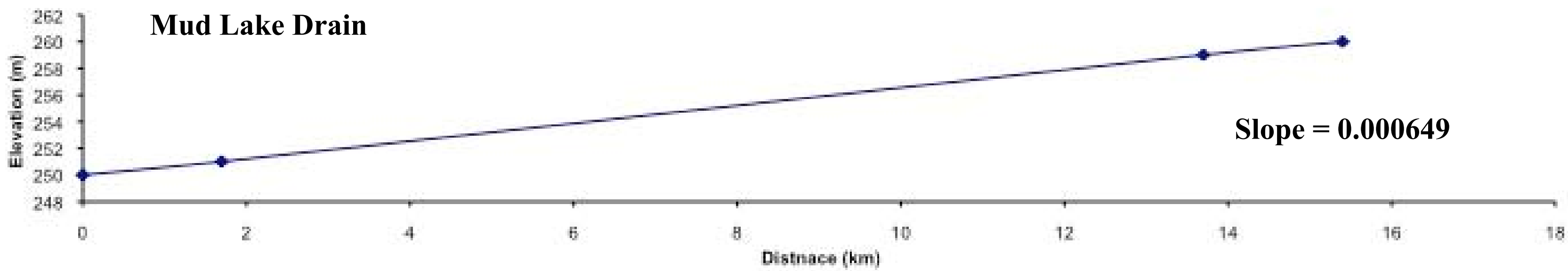


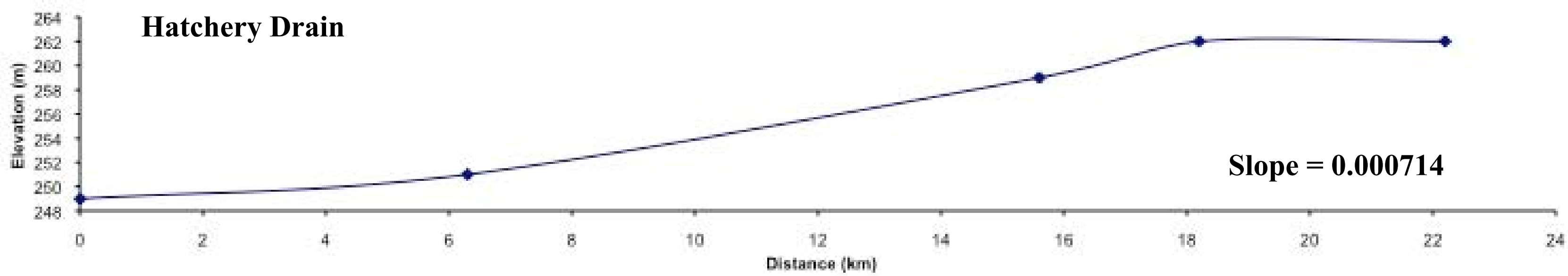

HAYWARD DRAIN
(Appendix B-7)

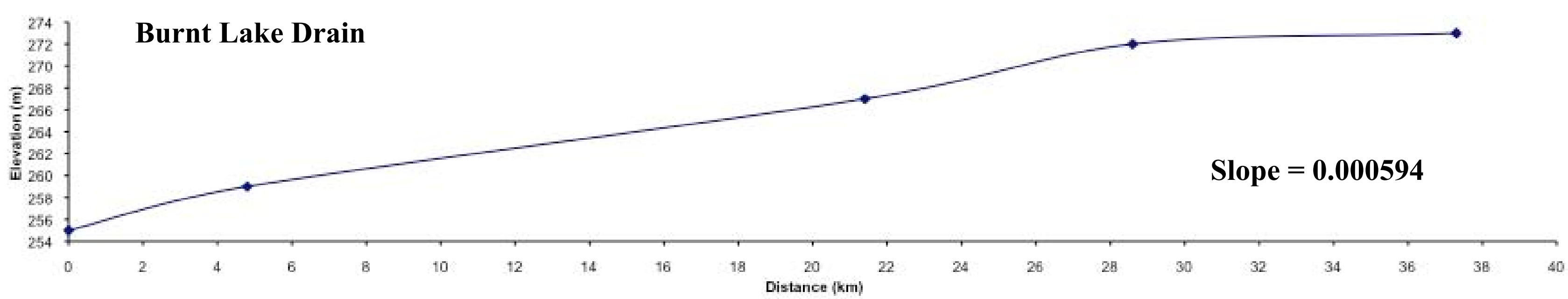


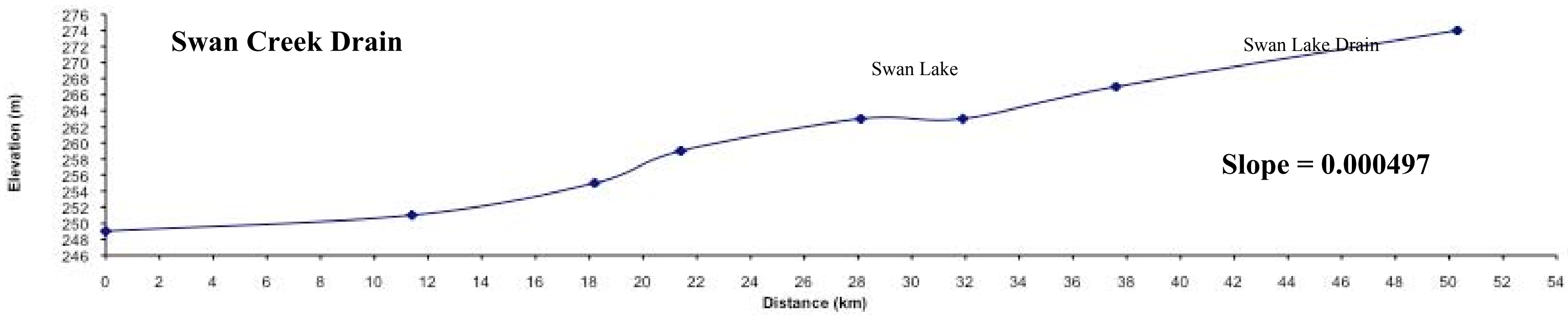



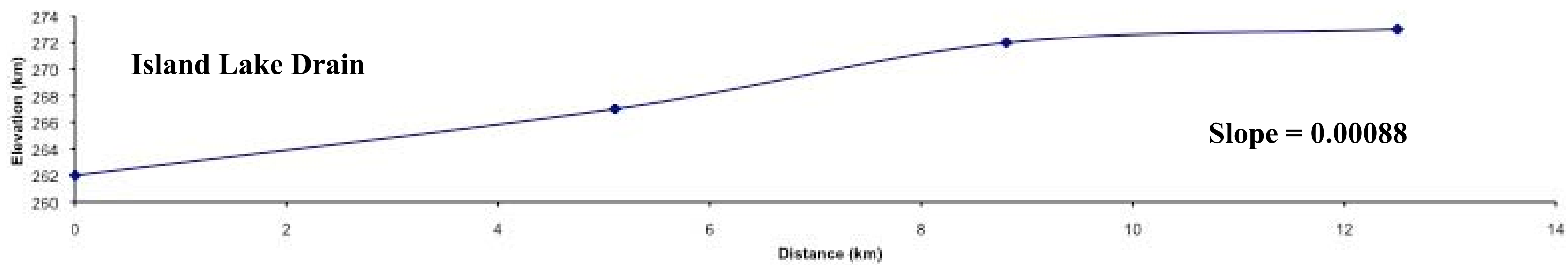
APPENDIX C. Longitudinal profiles incorporating the entire length of each tributary of the Swan Creek Watershed. Produced from 1:50,000 topographic maps

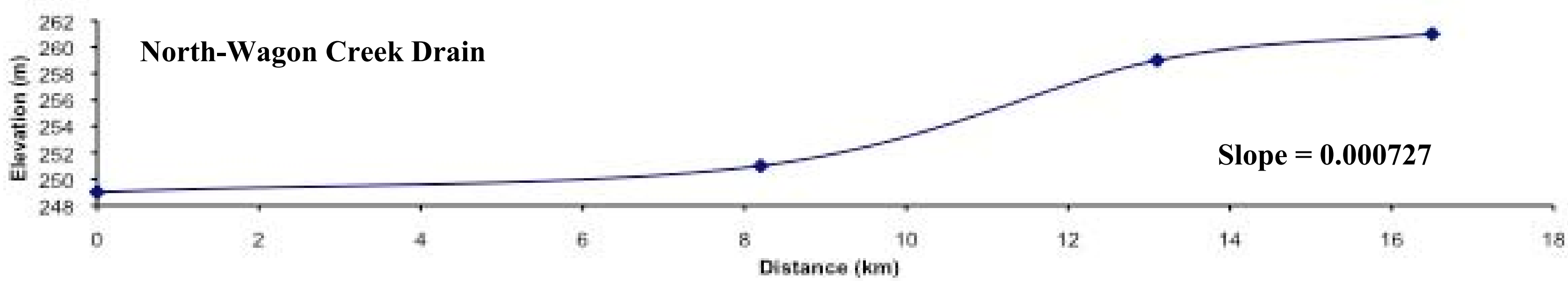

Mud Lake Drain
Slope = 0.000649
Elevation (m)
262
260
258
256
254
252
250
248
0
2
4
6
8
10
12
14
16
18
Distnace (km)

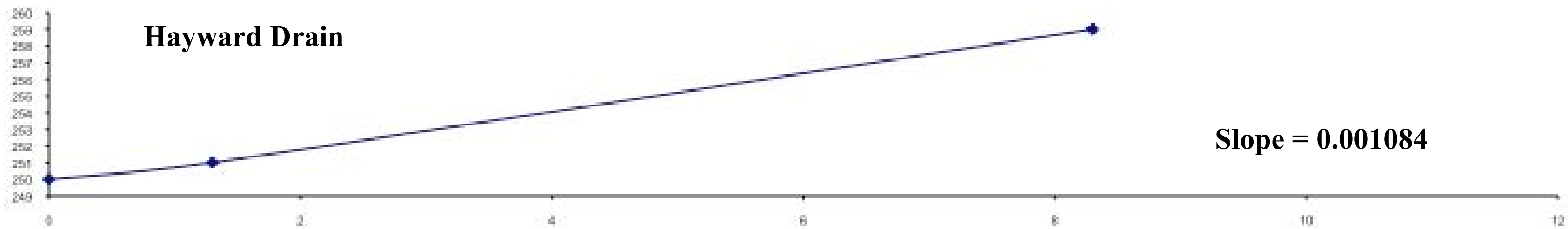

Hatchery Drain
Slope = 0.000714
Elevation (m)
264
262
260
258
256
254
252
250
248
0
2
4
6
8
10
12
14
16
18
20
22
24
Distance (km)


Burnt Lake Drain
Slope = 0.000594
Elevation (m)
274
272
270
268
266
264
262
260
258
256
254
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
Distance (km)


Swan Creek Drain
Swan Lake
Swan Lake Drain
Slope = 0.000497
Elevation (m)
Distance (km)

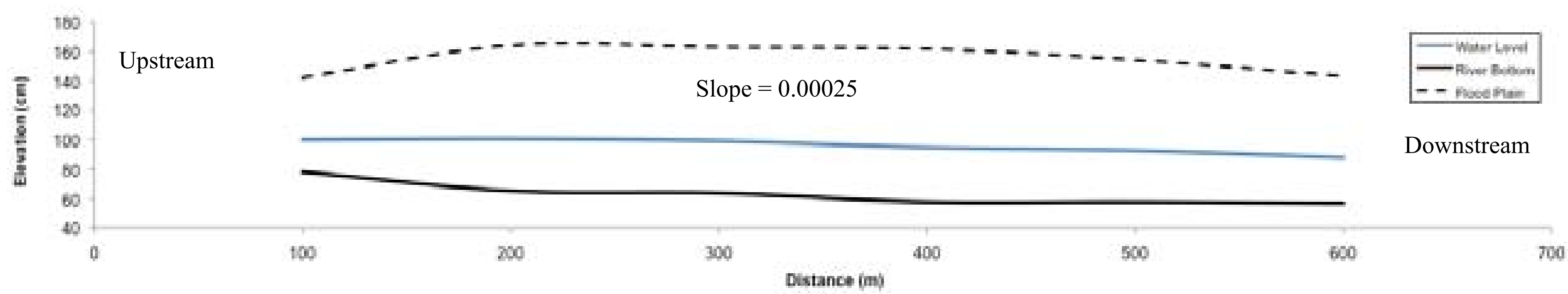

Island Lake Drain
Slope = 0.00088
Elevation (km)
Distance (km)


North-Wagon Creek Drain
Slope = 0.000727
Elevation (m)
Distance (km)

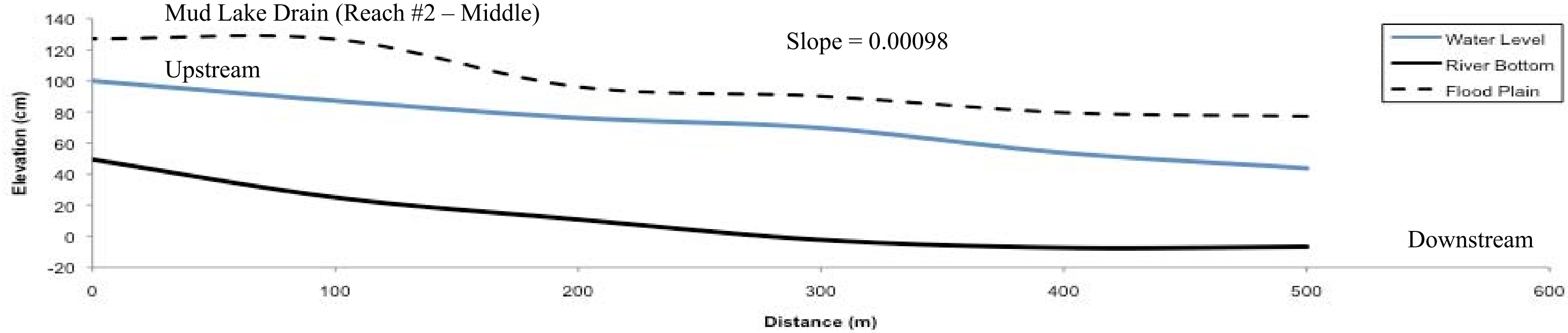

Hayward Drain
Slope = 0.001084

APPENDIX D. Longitudinal profiles within the sample reaches of each tributary within the Swan Creek Watershed.

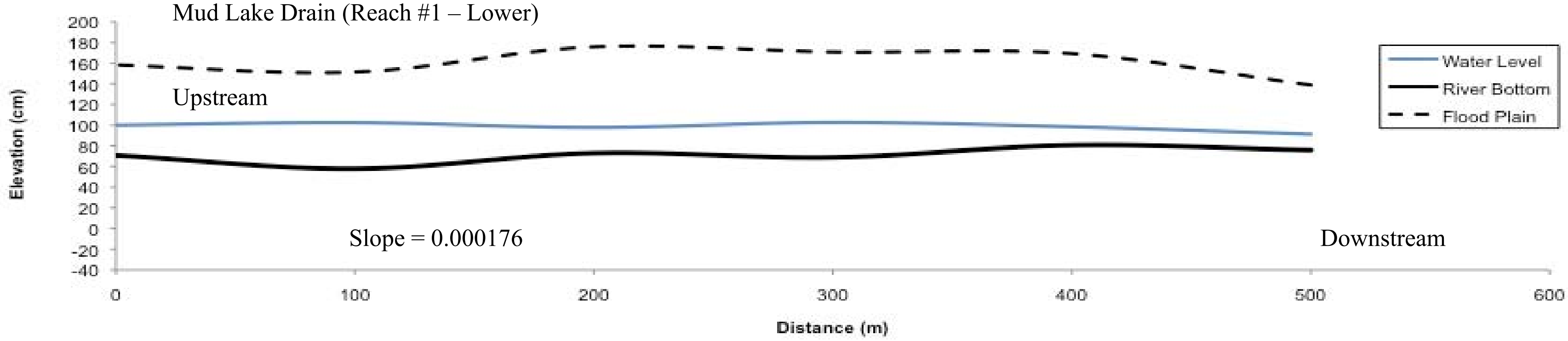
Mud Lake Drain (Reach #3 – Upper)

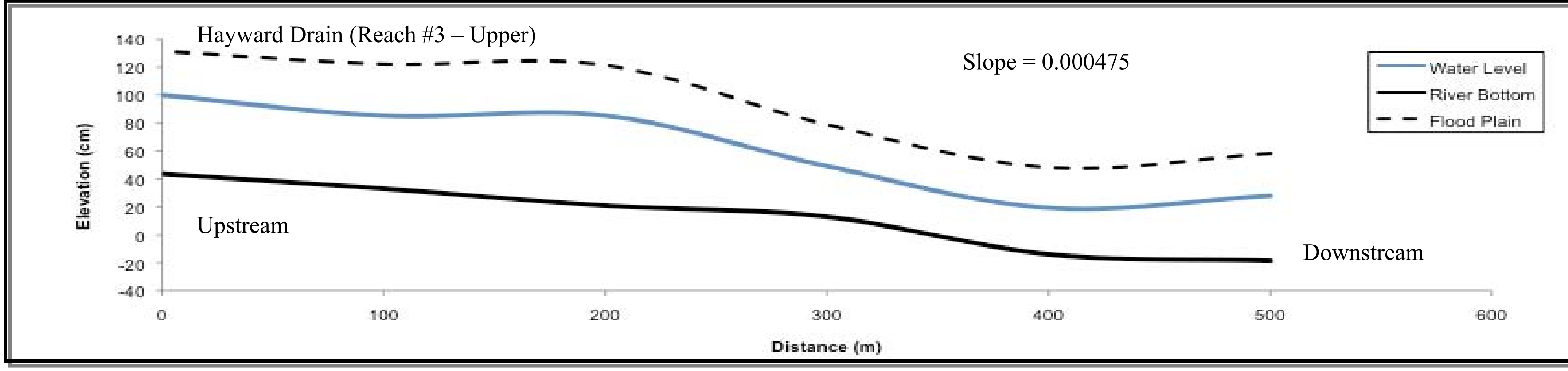


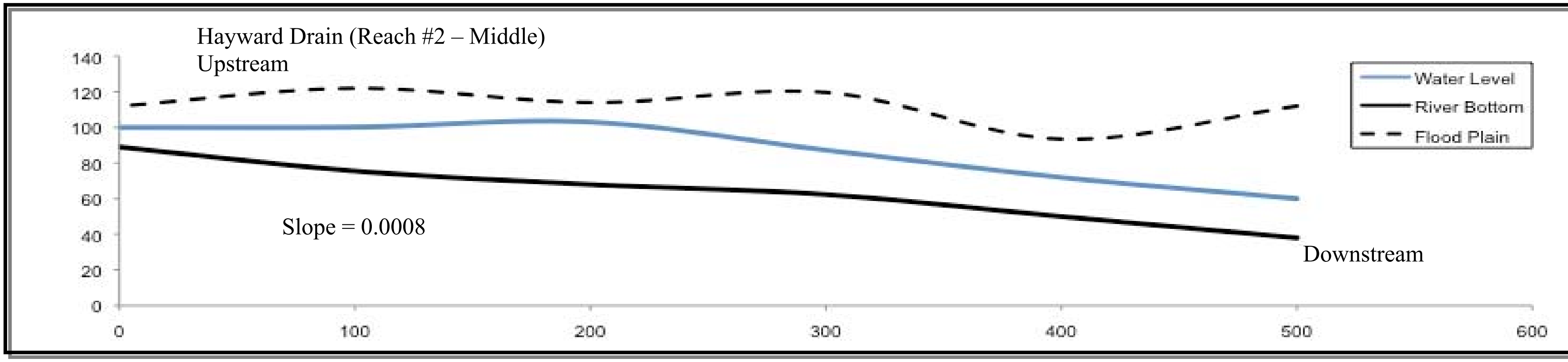
Mud Lake Drain (Reach #2 – Middle)

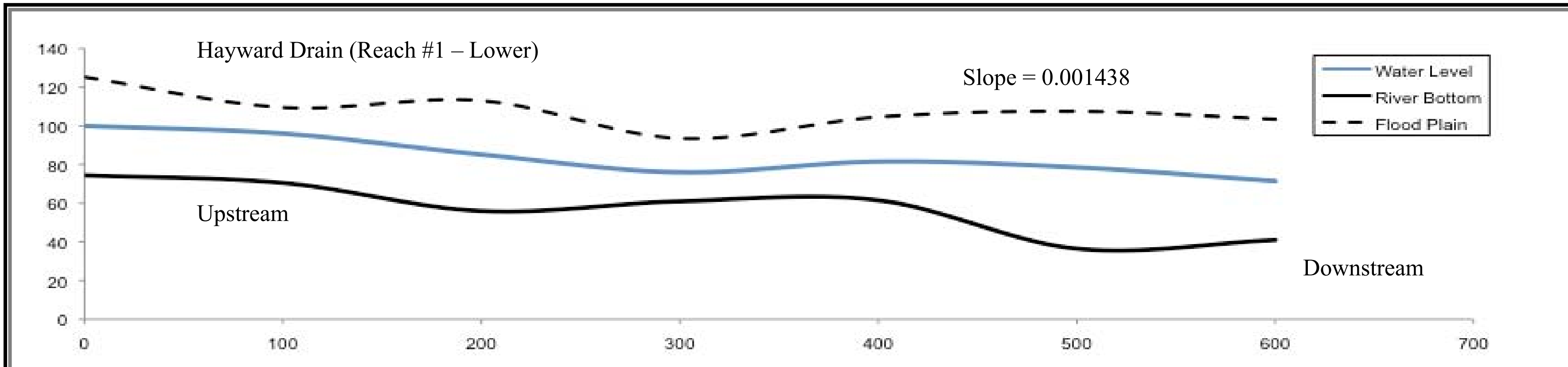


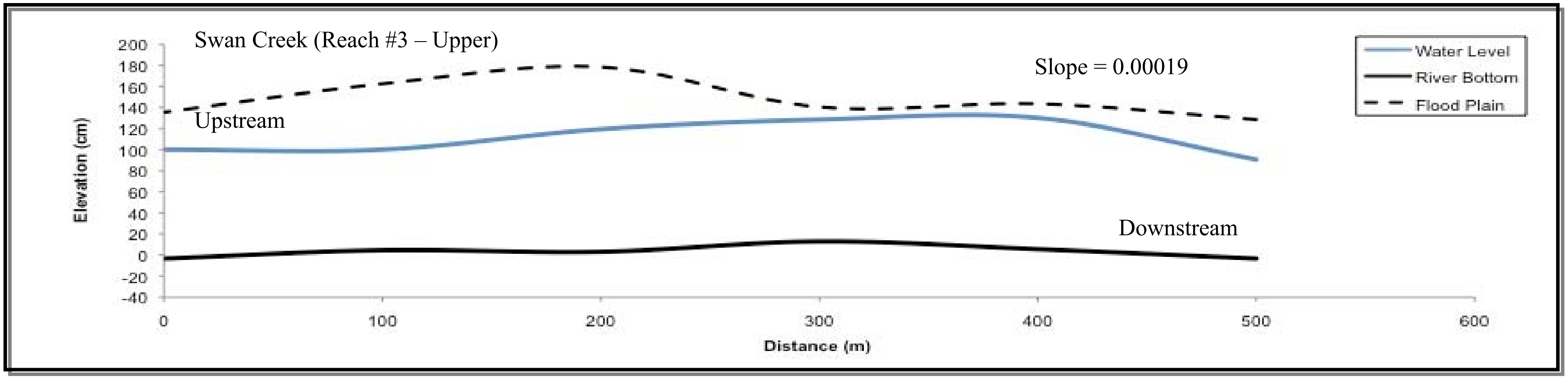
Mud Lake Drain (Reach #1 – Lower)

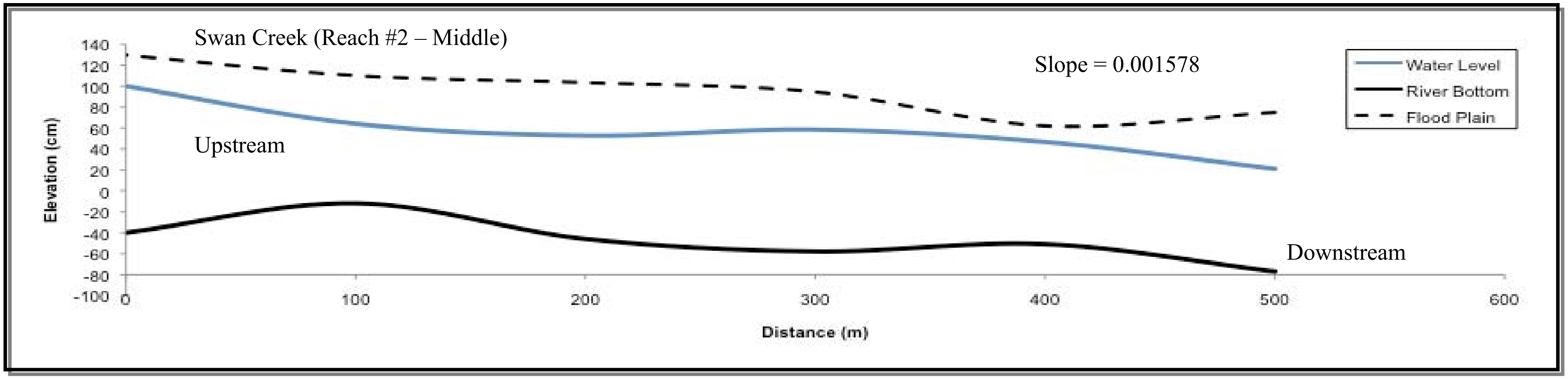


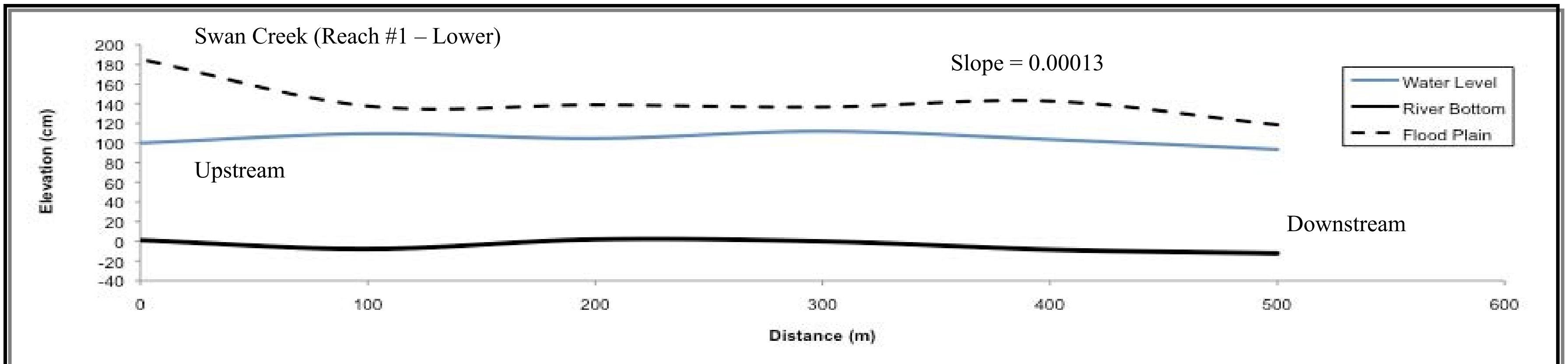

Hayward Drain (Reach #3 – Upper)
Slope = 0.000475
Water Level
River Bottom
Flood Plain
Elevation (cm)
140
120
100
80
60
40
20
0
-20
-40
Upstream
Downstream
0
100
200
300
400
500
600
Distance (m)

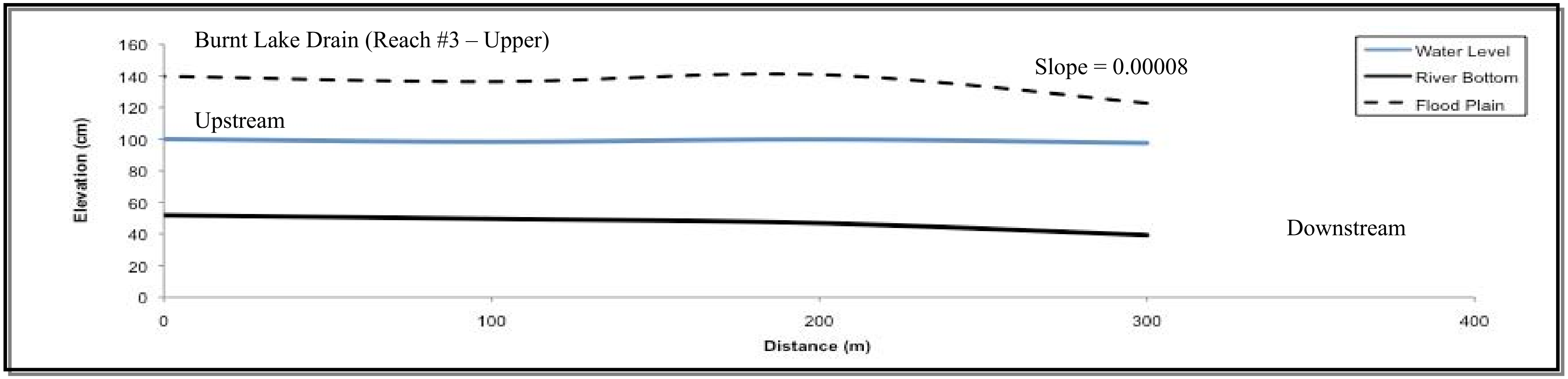

Hayward Drain (Reach #2 – Middle)
Upstream
Water Level
River Bottom
Flood Plain
140
120
100
80
60
40
20
0
Slope = 0.0008
Downstream
0
100
200
300
400
500
600

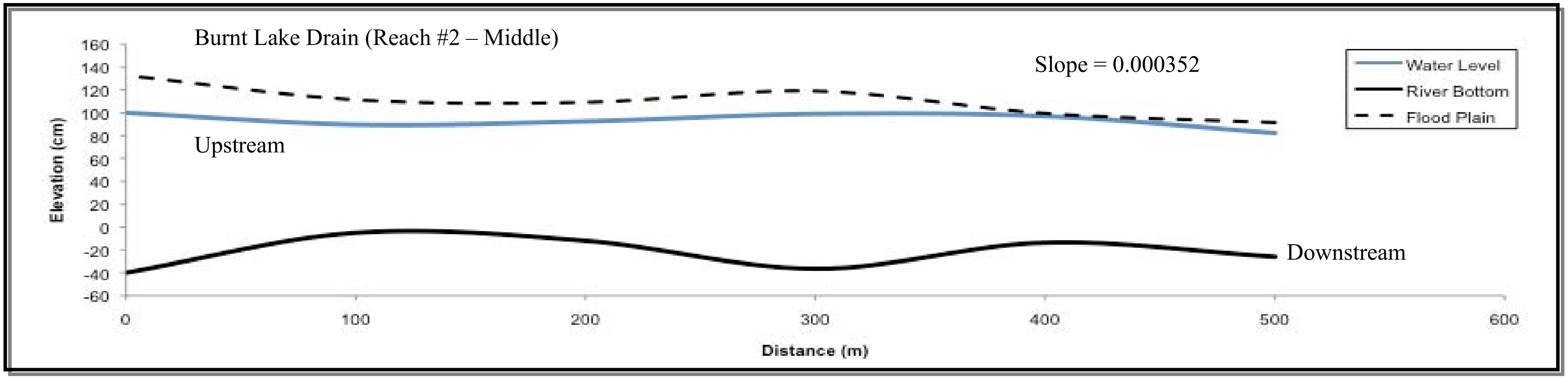

Hayward Drain (Reach #1 – Lower)
Slope = 0.001438
Water Level
River Bottom
Flood Plain
140
120
100
80
60
40
20
0
Upstream
Downstream
0
100
200
300
400
500
600
700

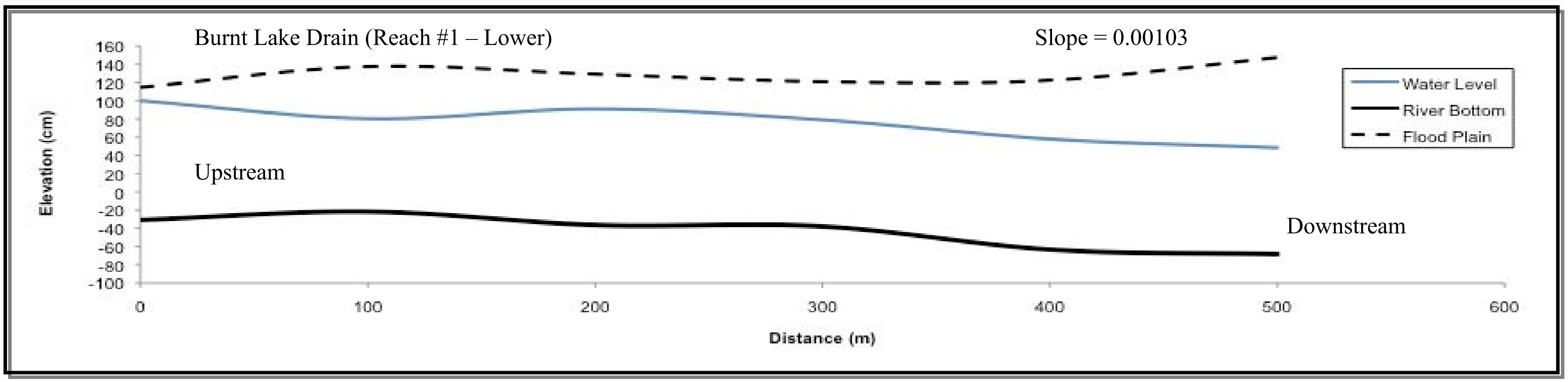

Swan Creek (Reach #3 – Upper)
Slope = 0.00019
Upstream
Downstream
Elevation (cm)
Distance (m)
Water Level
River Bottom
Flood Plain

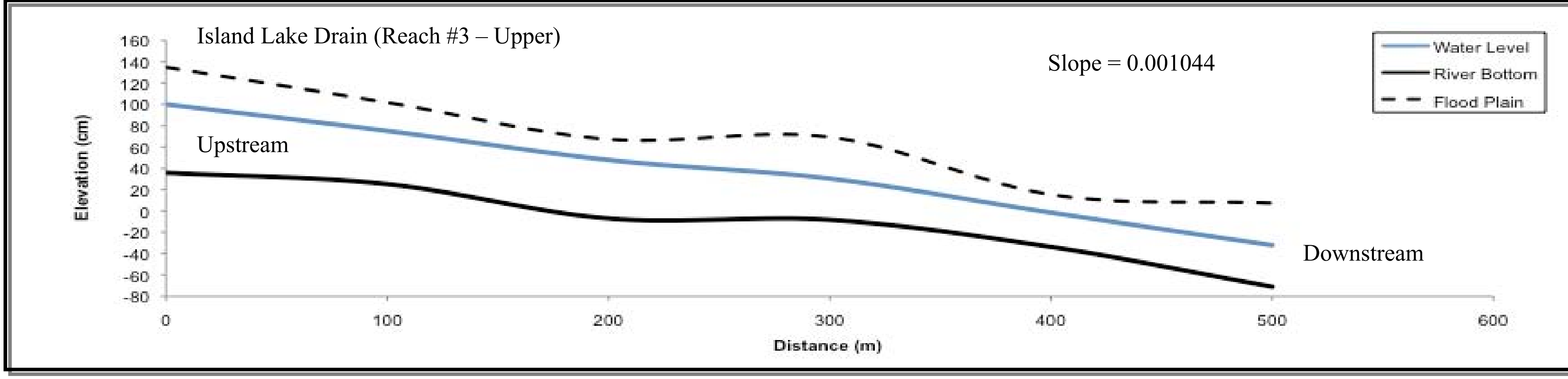

Swan Creek (Reach #2 – Middle)
Slope = 0.001578
Upstream
Downstream
Elevation (cm)
Distance (m)
Water Level
River Bottom
Flood Plain

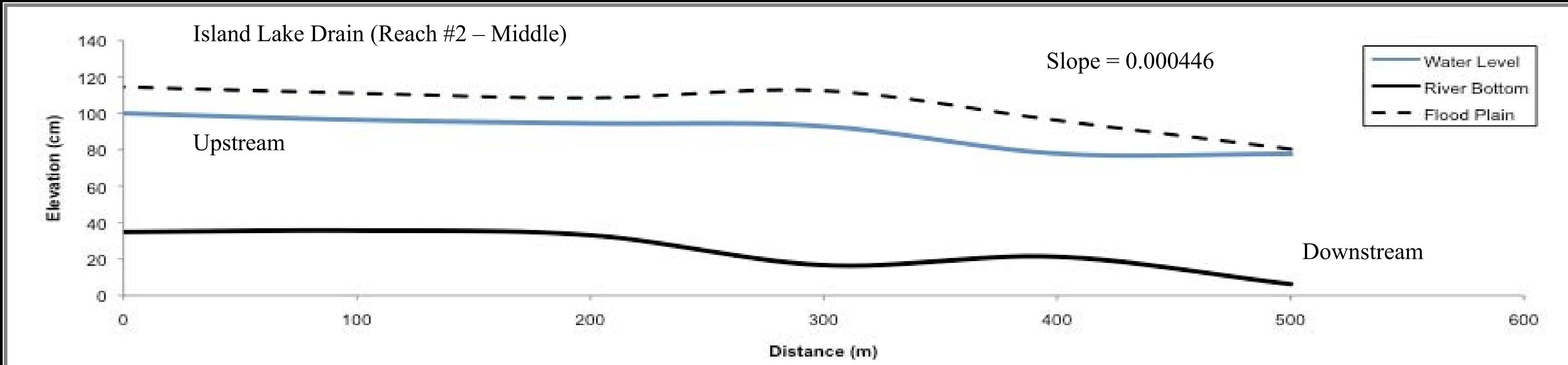

Swan Creek (Reach #1 – Lower)
Slope = 0.00013
Upstream
Downstream
Elevation (cm)
Distance (m)
Water Level
River Bottom
Flood Plain

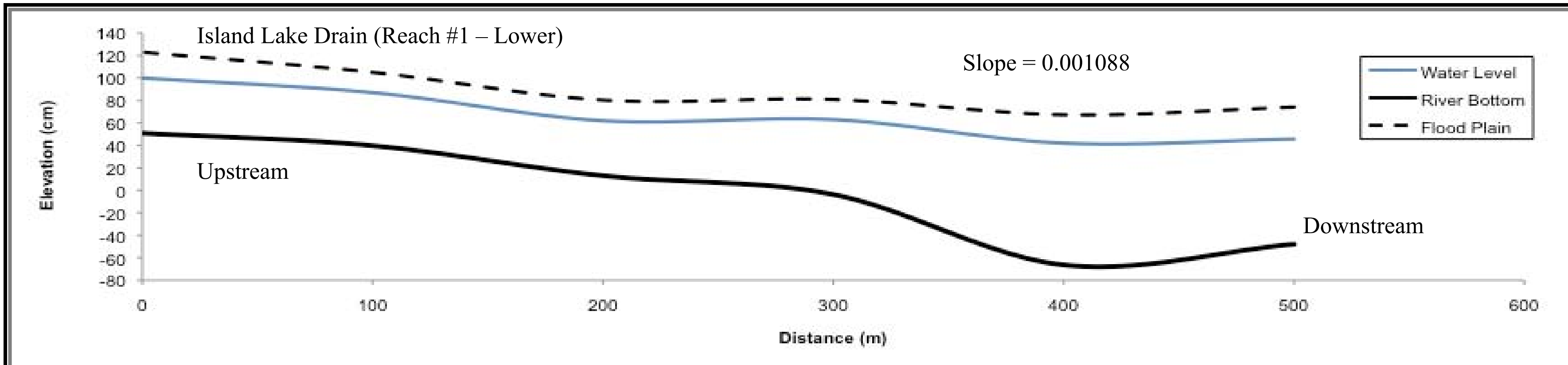

Burnt Lake Drain (Reach #3 – Upper)
Slope = 0.00008
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
160
140
120
100
80
60
40
20
0
0
100
200
300
400
Distance (m)

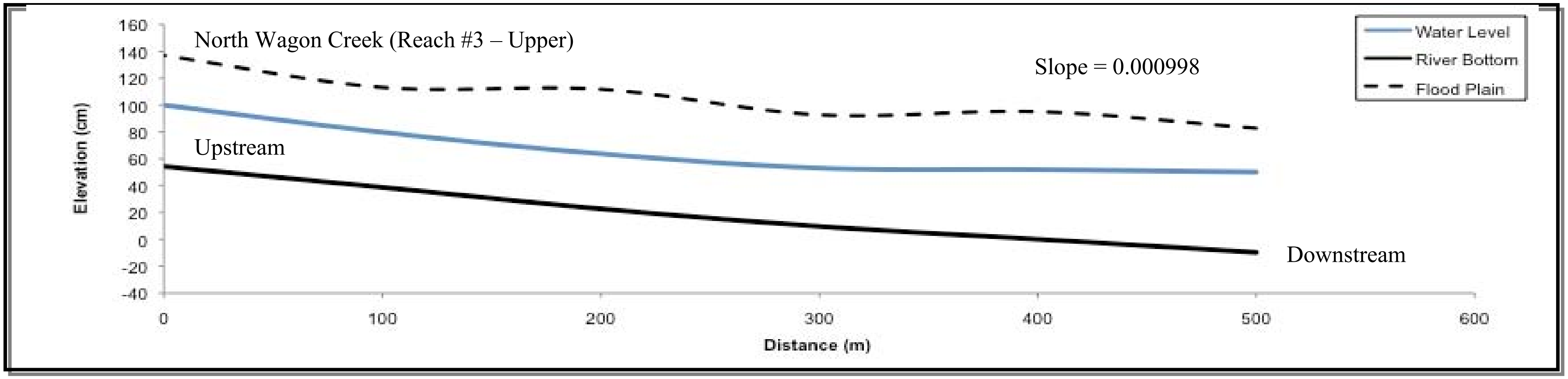

Burnt Lake Drain (Reach #2 – Middle)
Slope = 0.000352
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
160
140
120
100
80
60
40
20
0
-20
-40
-60
0
100
200
300
400
500
600
Distance (m)

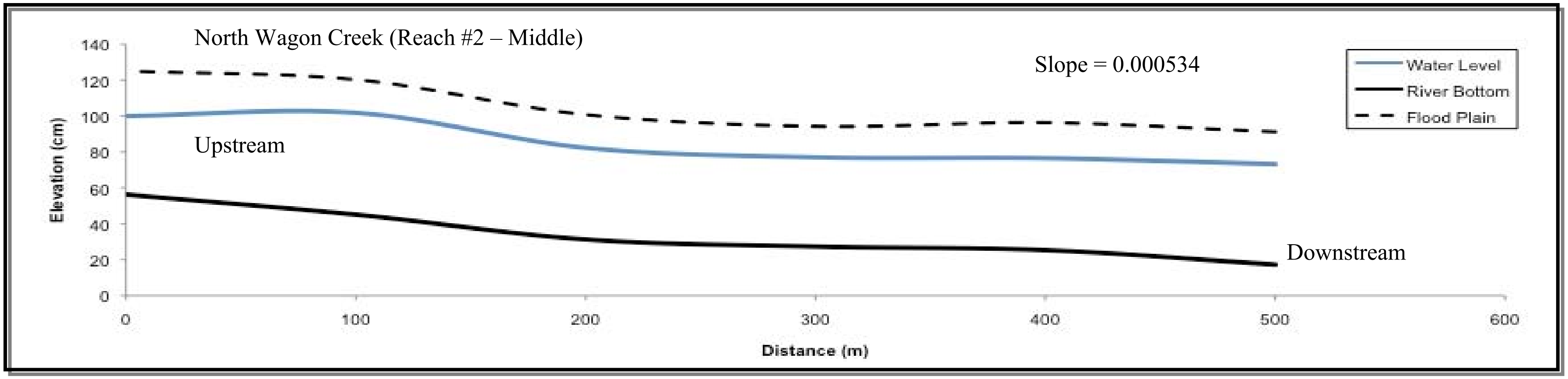

Burnt Lake Drain (Reach #1 – Lower)
Slope = 0.00103
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
0
100
200
300
400
500
600
Distance (m)

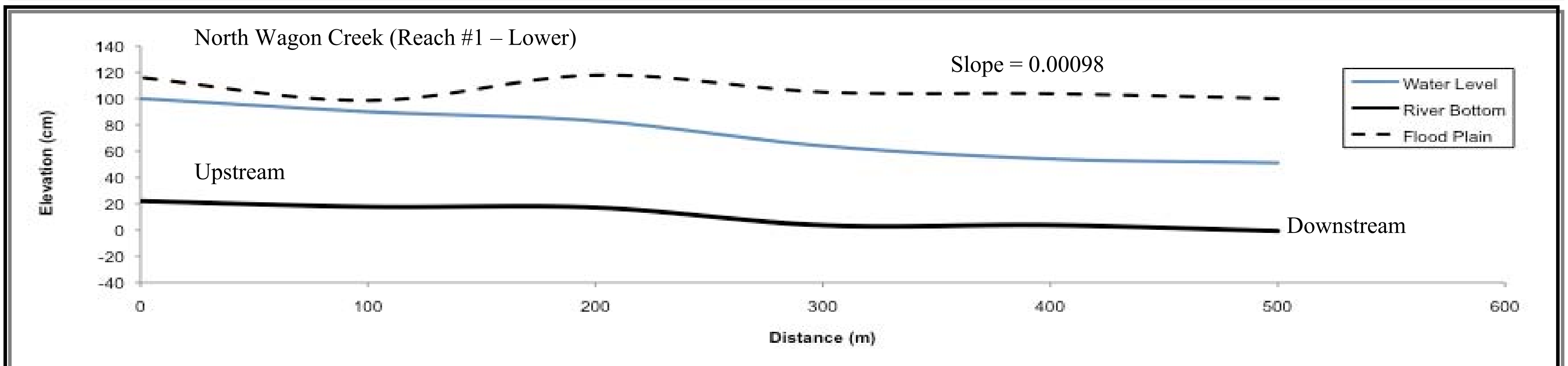

Island Lake Drain (Reach #3 – Upper)
Slope = 0.001044
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
Distance (m)
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
0
100
200
300
400
500
600

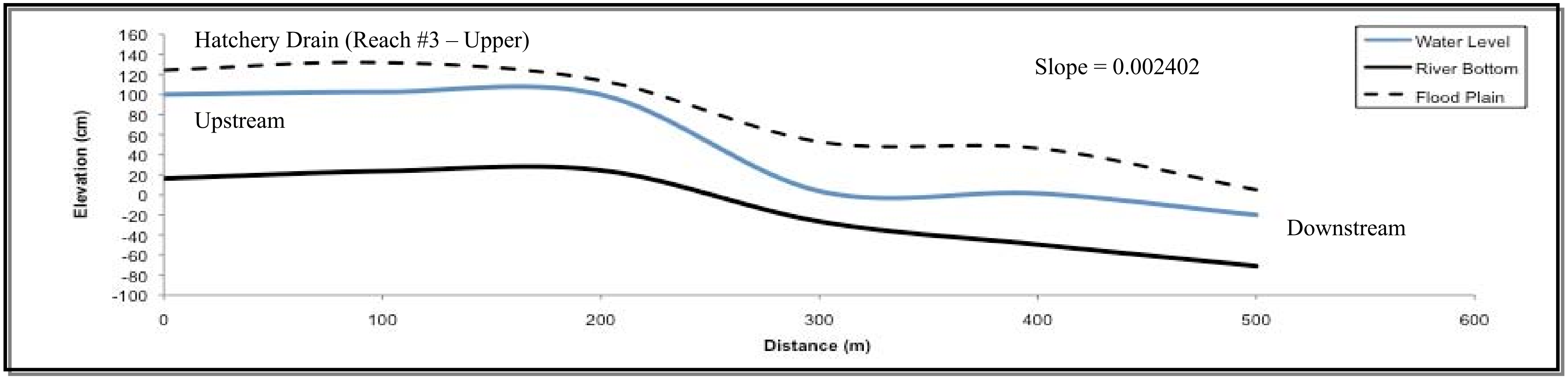

Island Lake Drain (Reach #2 – Middle)
Slope = 0.000446
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
Distance (m)
140
120
100
80
60
40
20
0
0
100
200
300
400
500
600

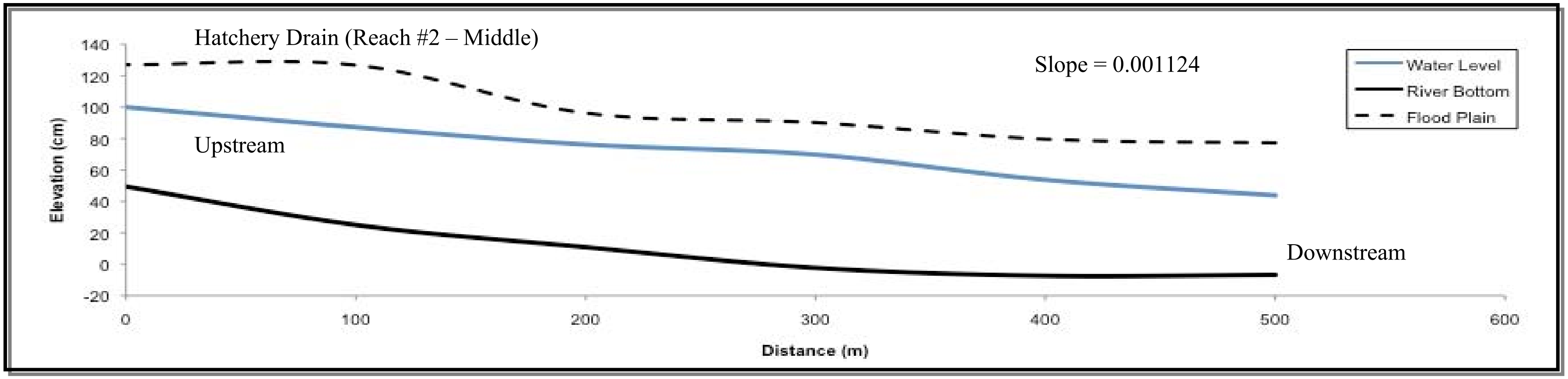

Island Lake Drain (Reach #1 – Lower)
Slope = 0.001088
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
Distance (m)
140
120
100
80
60
40
20
0
-20
-40
-60
-80
0
100
200
300
400
500
600

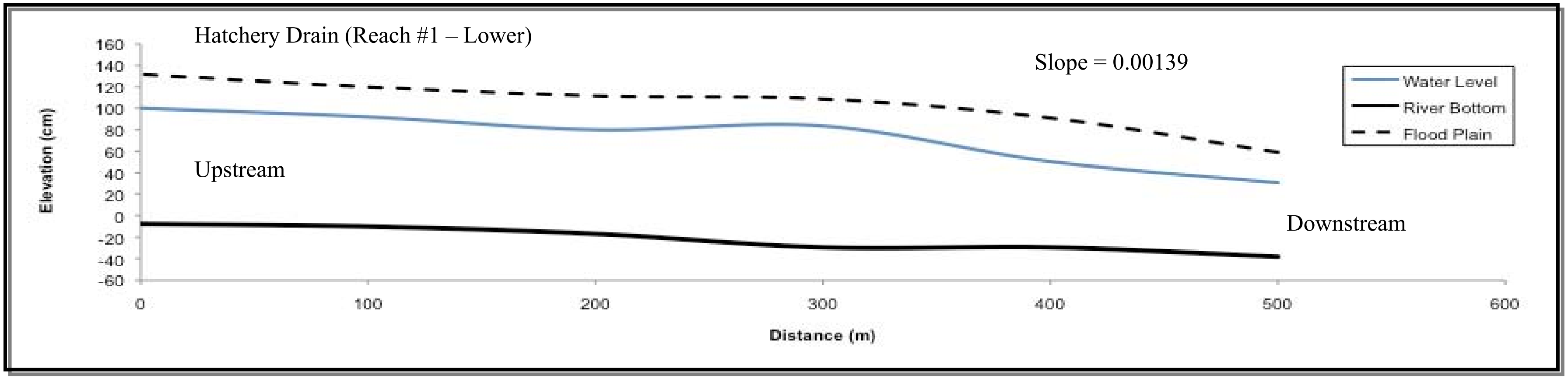

North Wagon Creek (Reach #3 – Upper)
Slope = 0.000998
Upstream
Downstream
Water Level
River Bottom
Flood Plain
Elevation (cm)
Distance (m)
160
140
120
100
80
60
40
20
0
-20
-40
0
100
200
300
400
500
600


North Wagon Creek (Reach #2 – Middle)
Slope = 0.000534
Upstream
Downstream
Water Level
River Bottom
Flood Plain
Elevation (cm)
Distance (m)
140
120
100
80
60
40
20
0
0
100
200
300
400
500
600

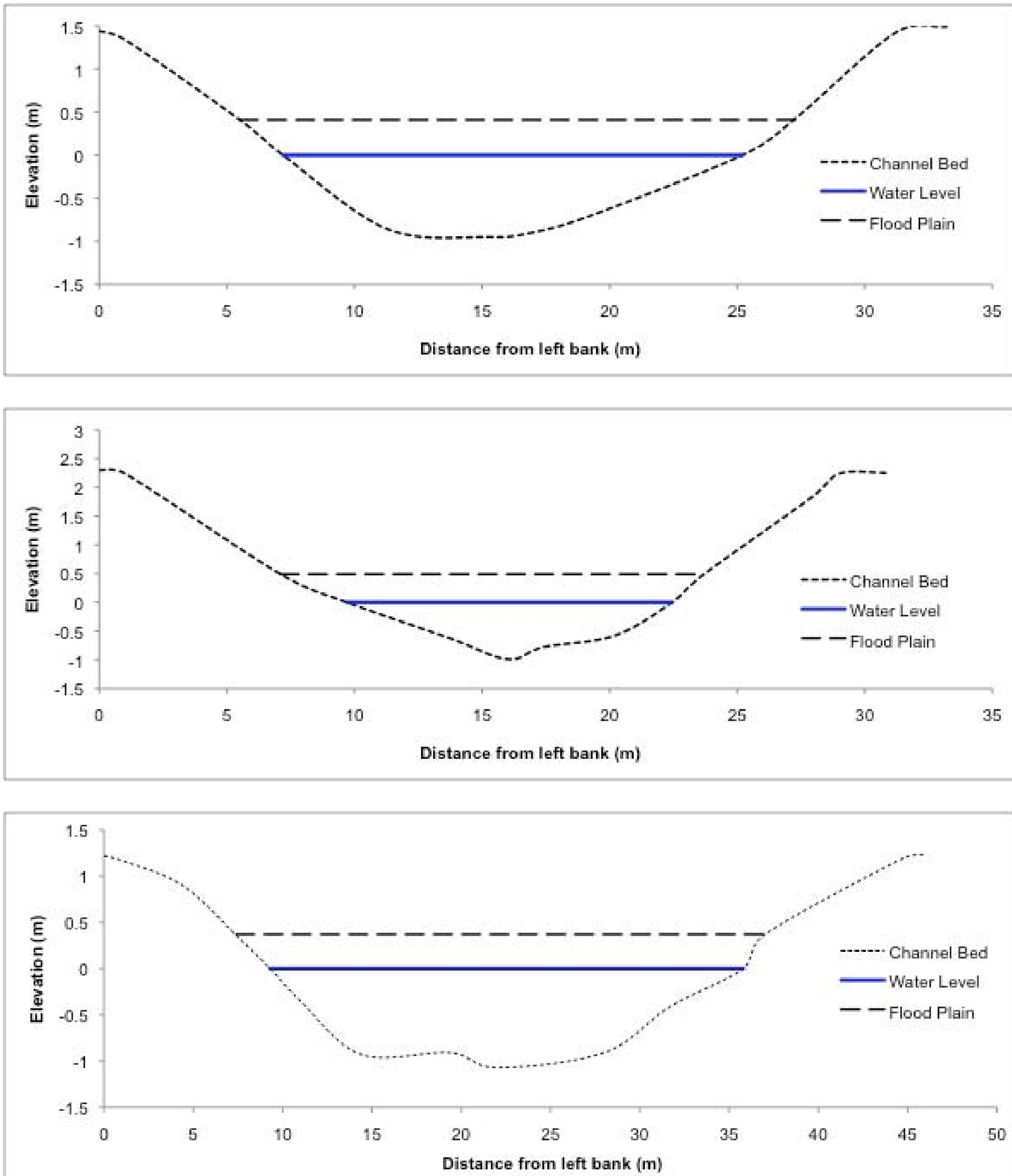

North Wagon Creek (Reach #1 – Lower)
Slope = 0.00098
Upstream
Downstream
Water Level
River Bottom
Flood Plain
Elevation (cm)
Distance (m)
140
120
100
80
60
40
20
0
-20
-40
0
100
200
300
400
500
600


Hatchery Drain (Reach #3 – Upper)
Slope = 0.002402
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
Distance (m)
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
0
100
200
300
400
500
600

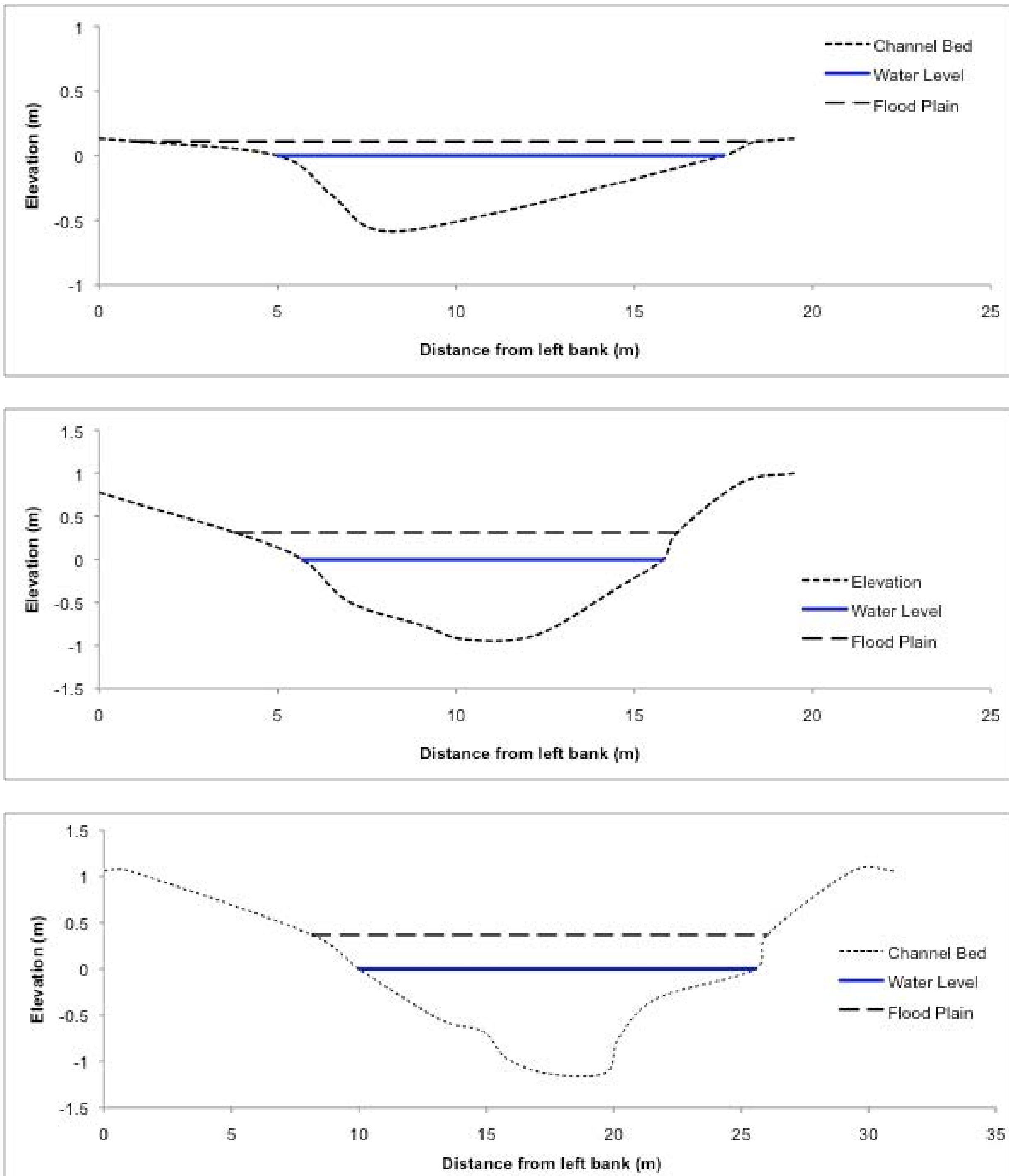

Hatchery Drain (Reach #2 – Middle)
Slope = 0.001124
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
Distance (m)
140
120
100
80
60
40
20
0
-20
0
100
200
300
400
500
600


Hatchery Drain (Reach #1 – Lower)
Slope = 0.00139
Water Level
River Bottom
Flood Plain
Upstream
Downstream
Elevation (cm)
Distance (m)
160
140
120
100
80
60
40
20
0
-20
-40
-60
0
100
200
300
400
500
600

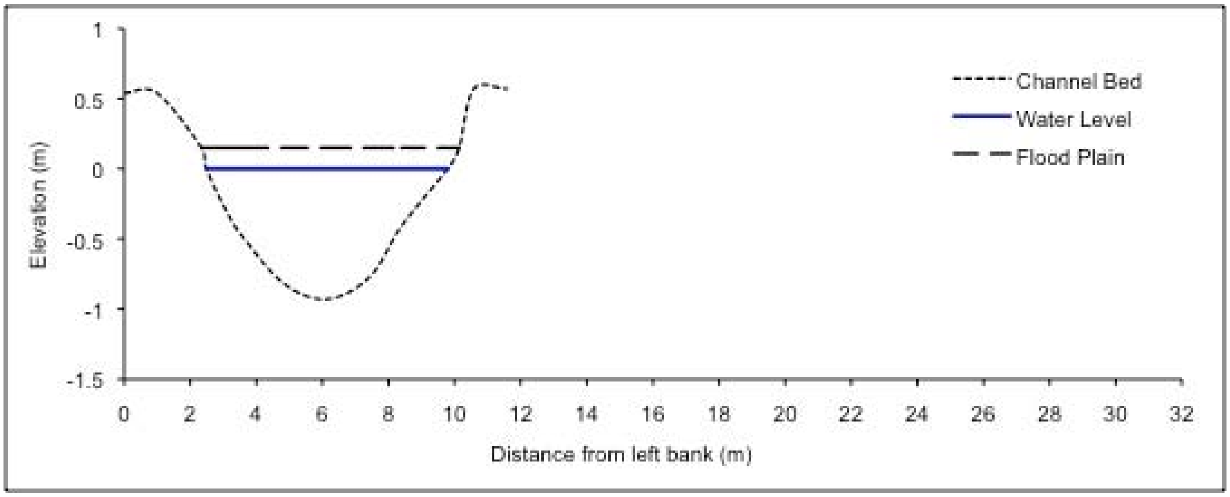
APPENDIX E: Cross-sectional profiles within the sampled reaches of each tributary within the Swan Creek Watershed.

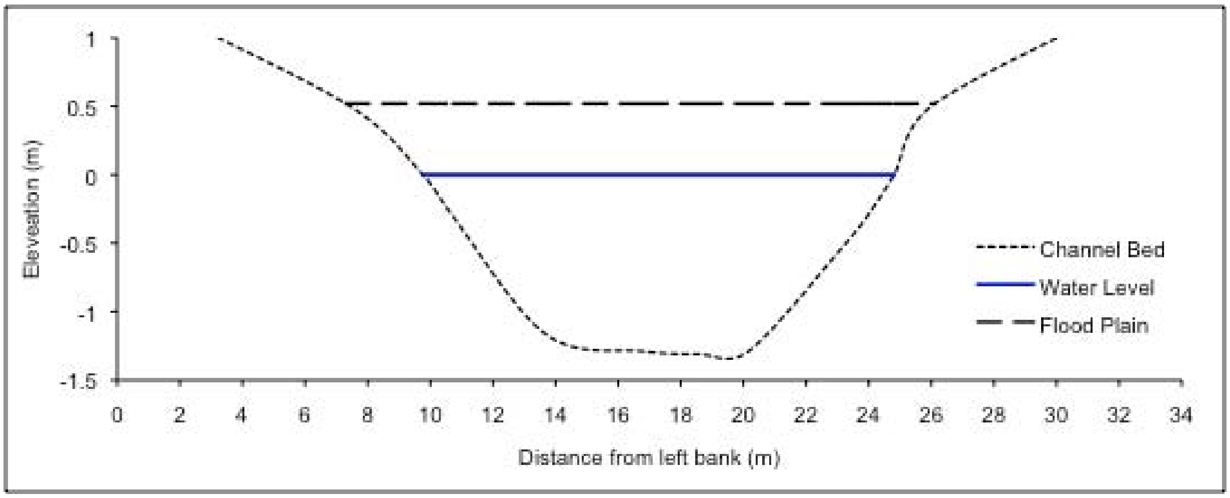


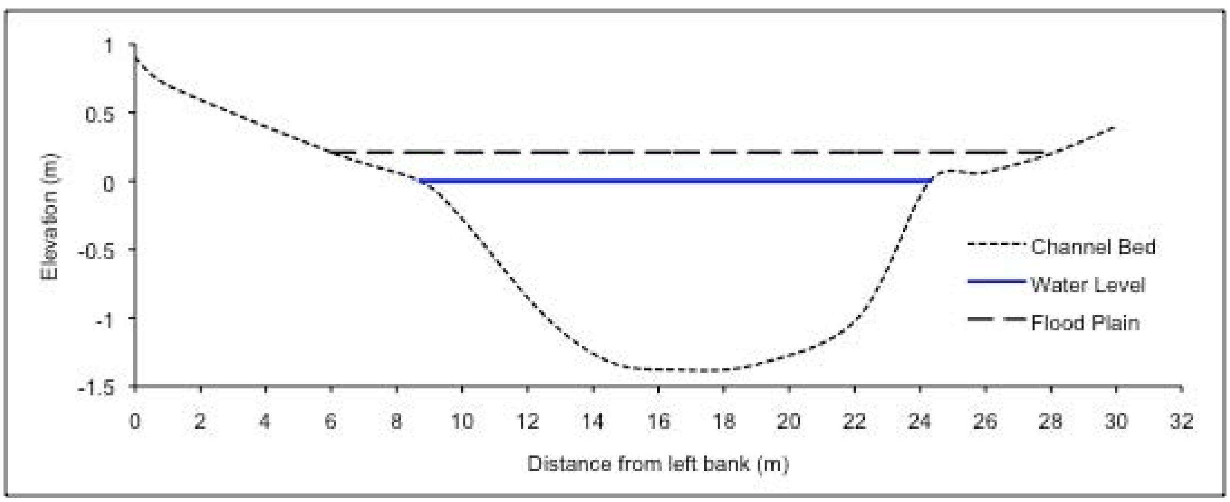
Appendix E-1. Swan Creek cross-sectional profiles for the upper, middle and lower reaches of the tributary.



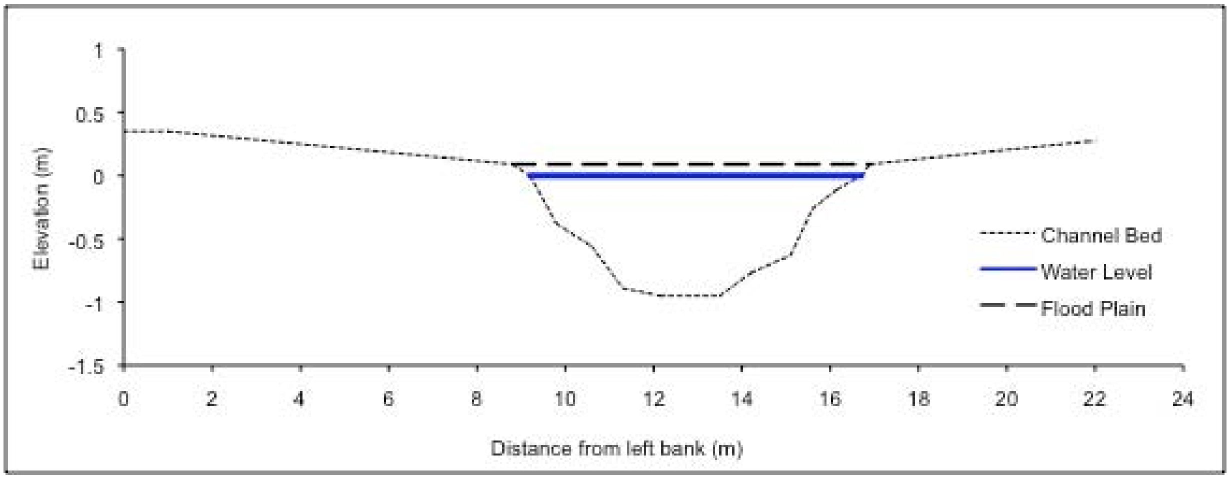
Appendix E-2. Burnt Lake Drain cross-sectional profiles for the upper, middle and lower reaches of the tributary.

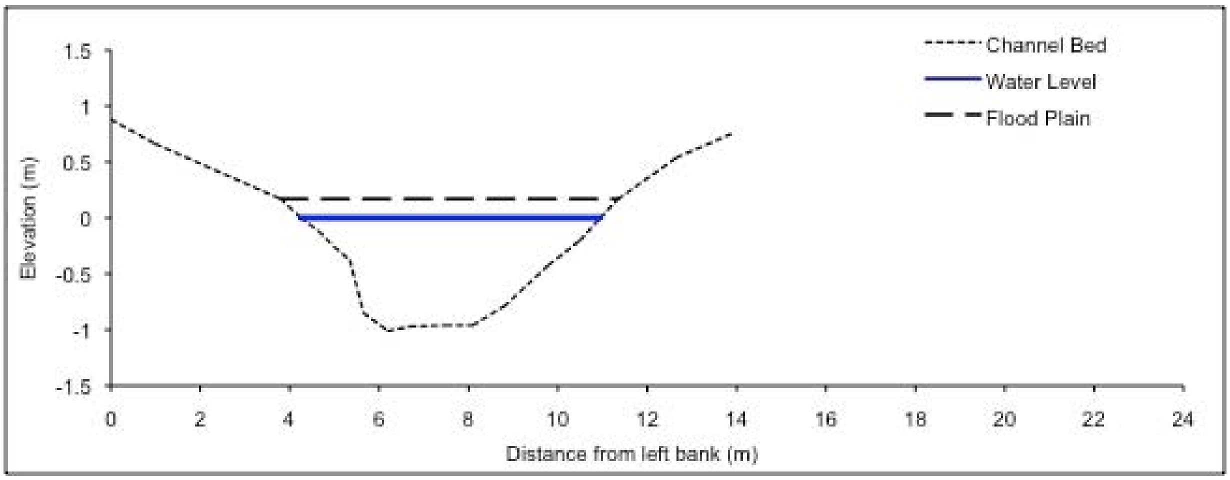


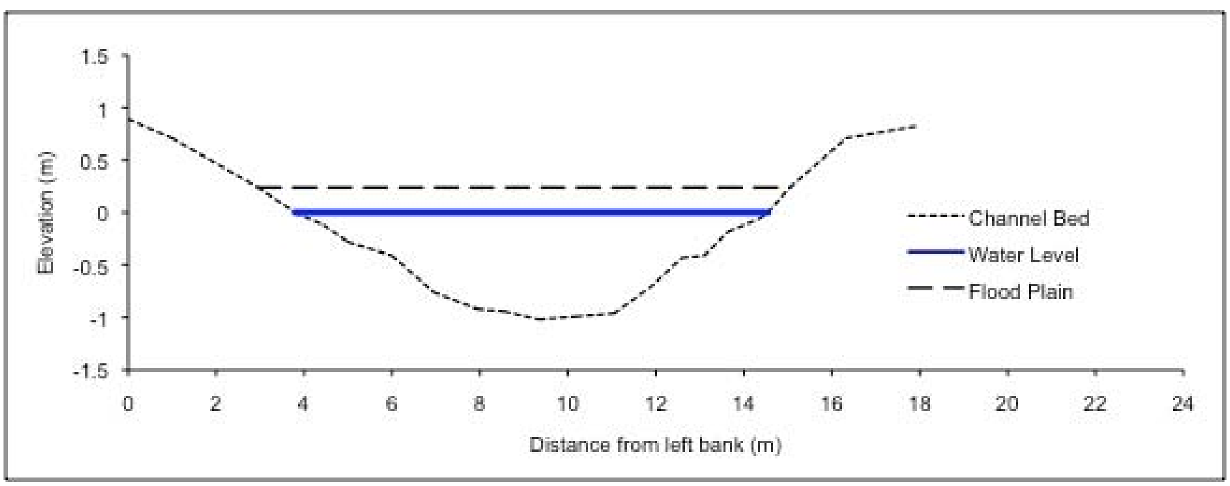




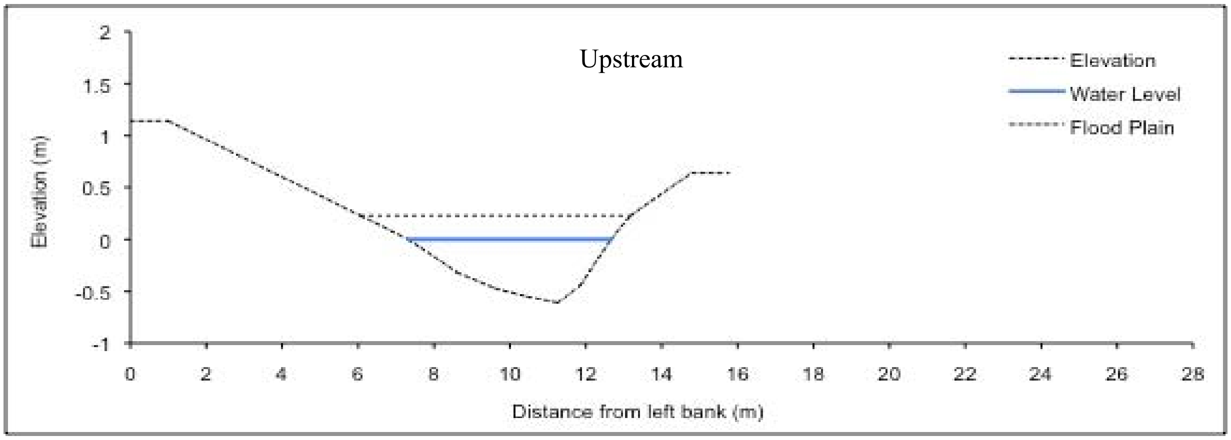
Appendix E-3. Hatchery Drain cross-sectional profiles for the upper, middle and lower reaches of the tributary.

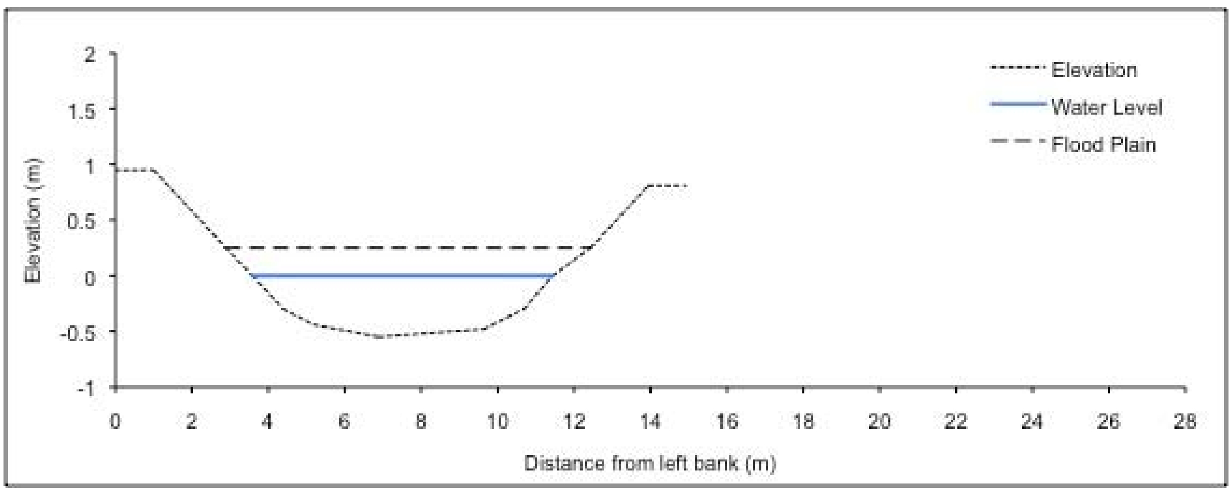


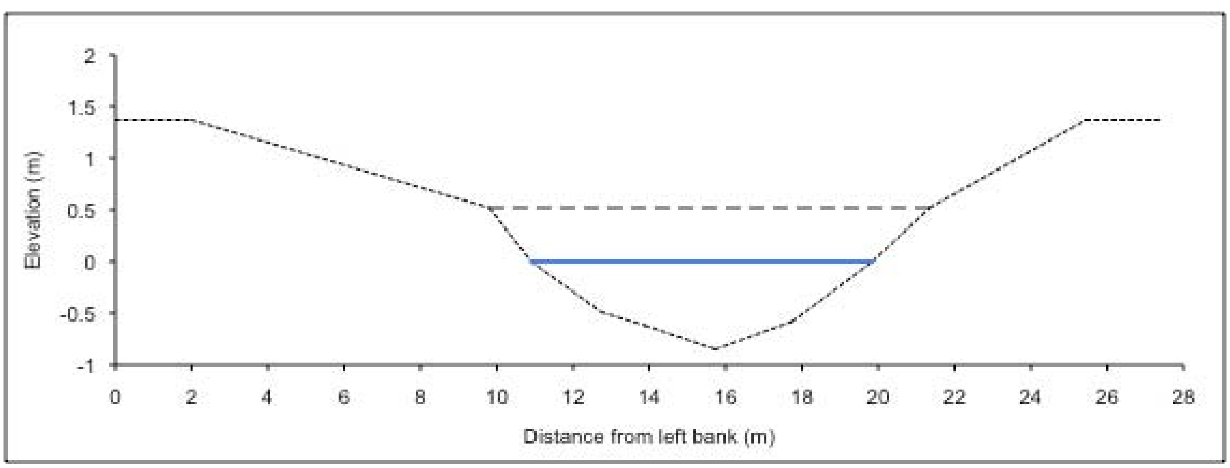




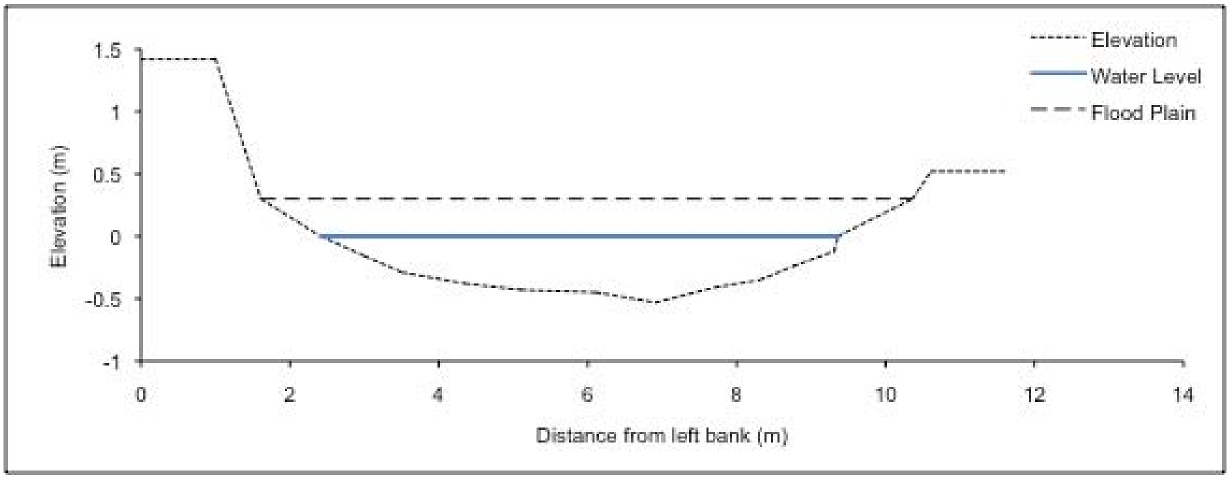
Appendix E-4. Island Lake Drain cross-sectional profiles for the upper, middle and lower reaches of the tributary**..**

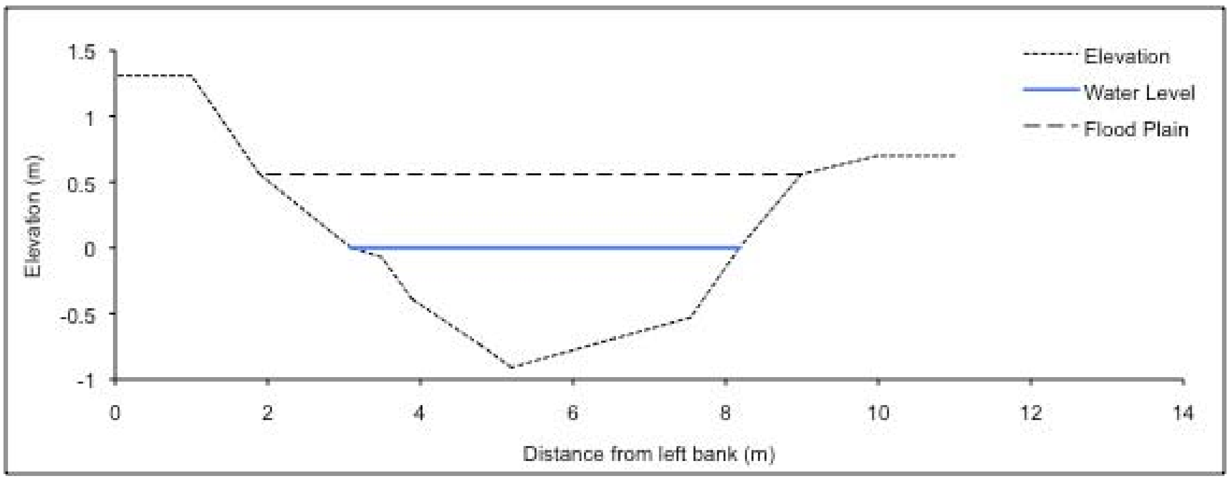


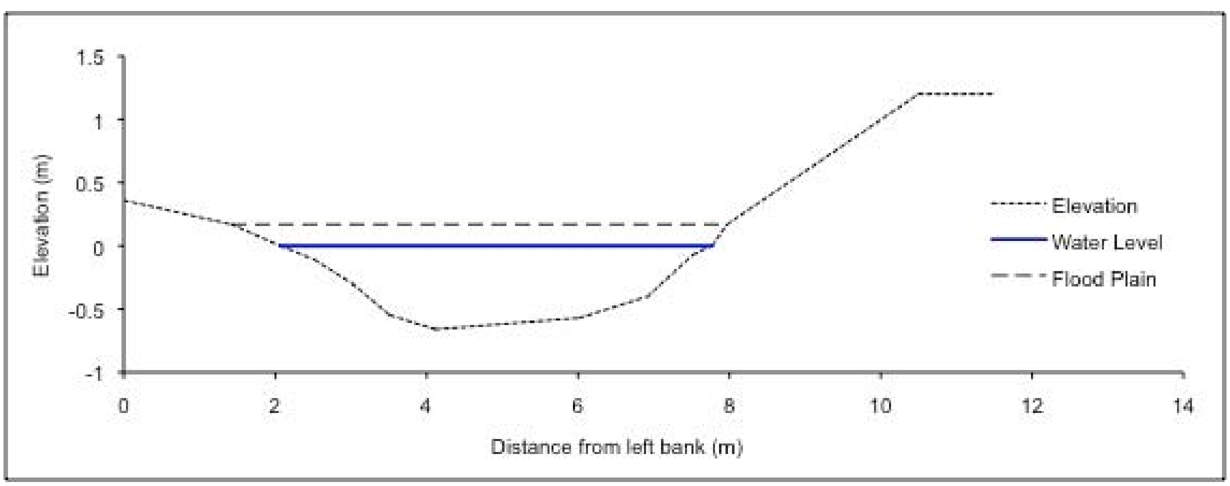




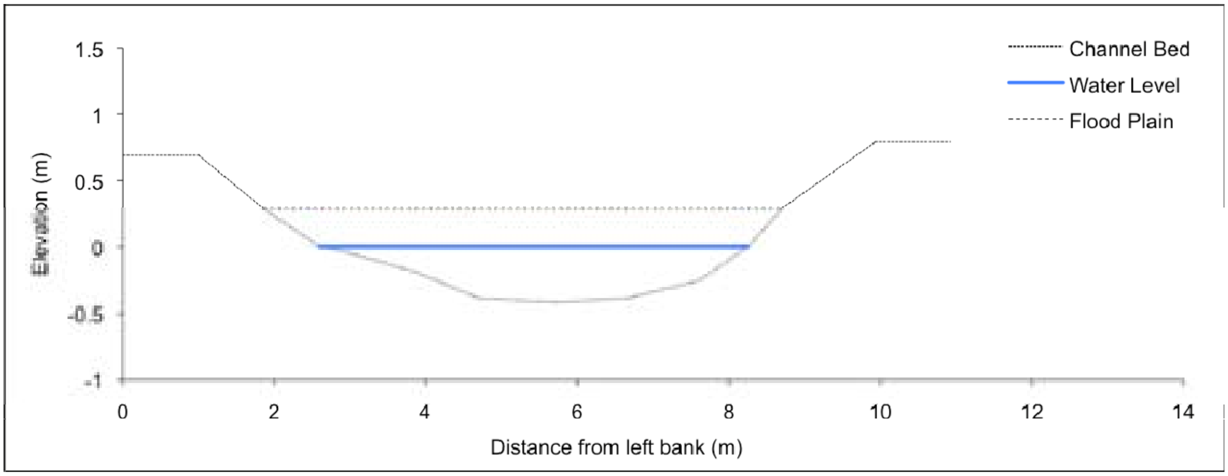
Appendix E-5. Mud Lake Drain cross-sectional profiles for the upper, middle and lower reaches of the tributary.

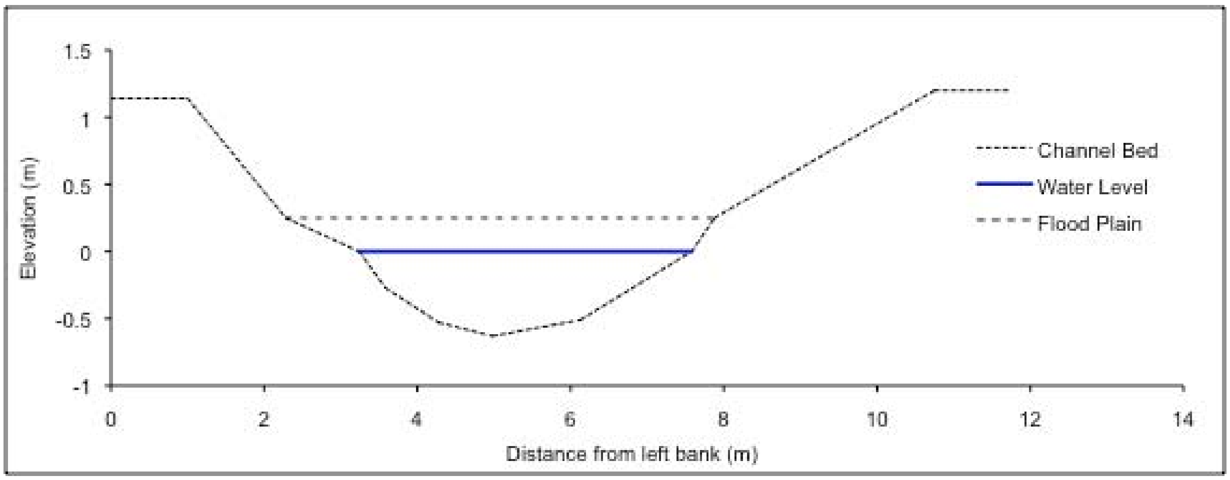


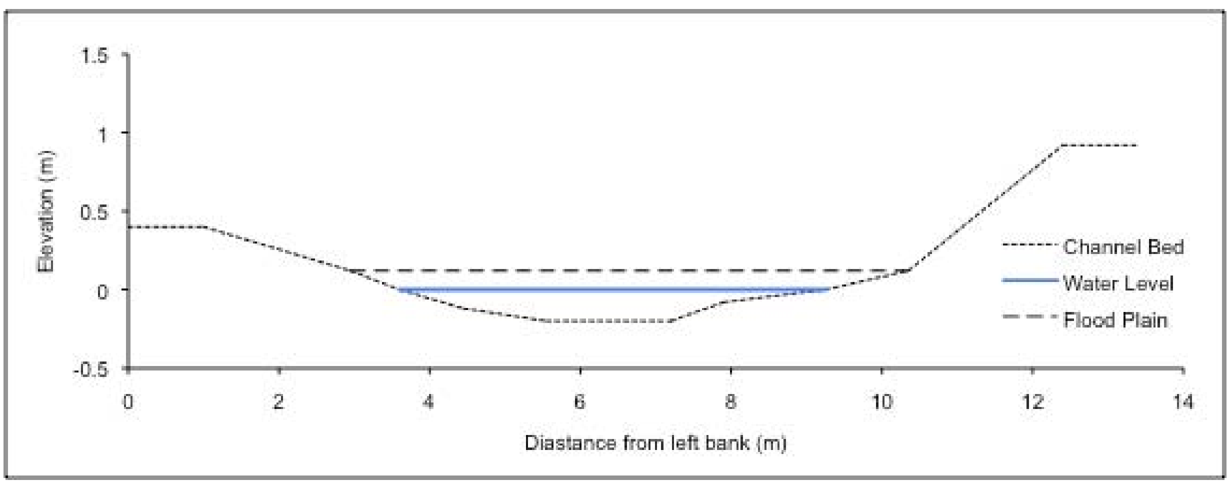




Appendix E-6. North Wagon Creek Drain cross-sectional profiles for the upper, middle and lower reaches of the tributary.



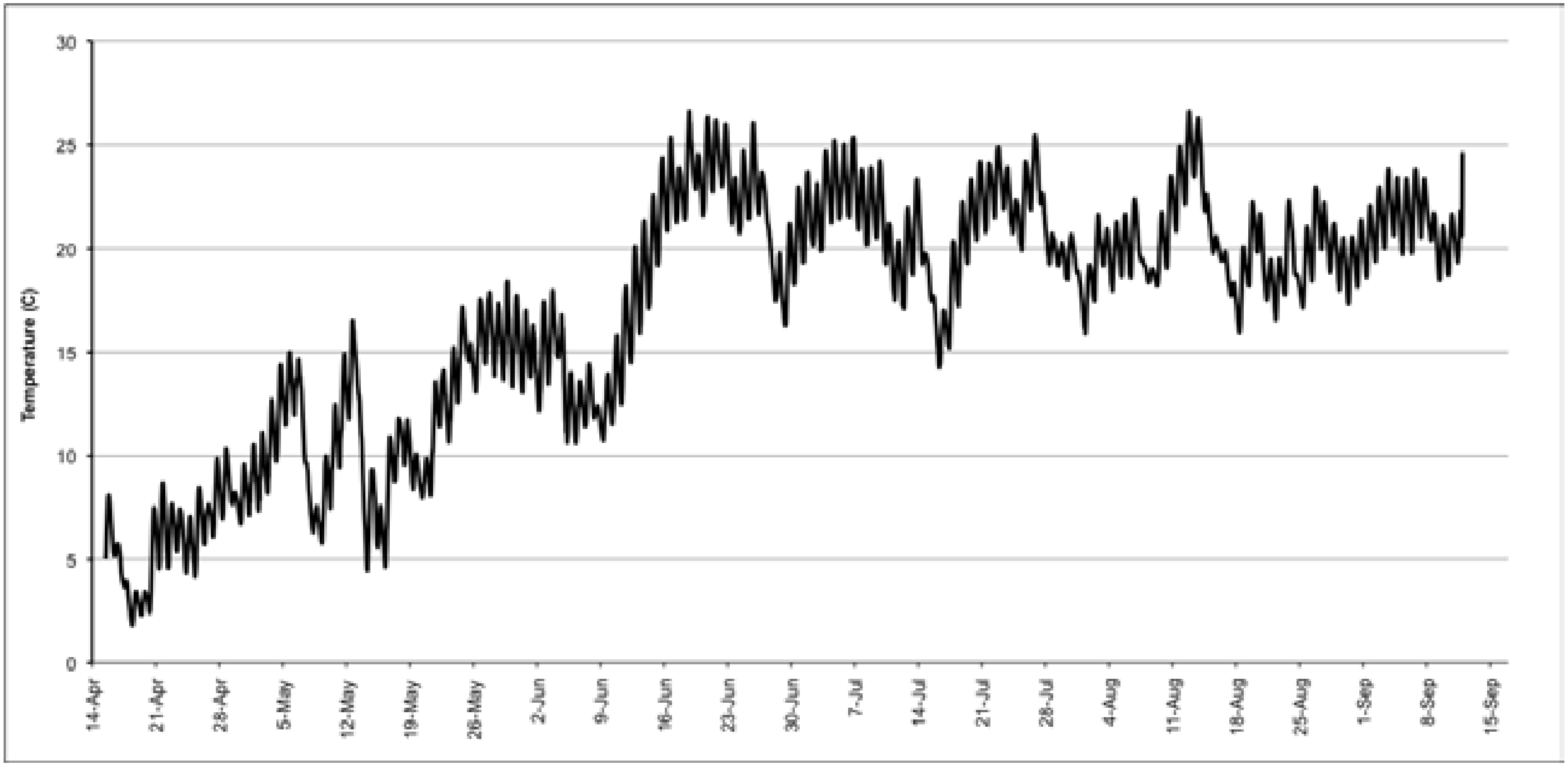




Appendix E-7. Hayward Drain cross-sectional profiles for the upper, middle and lower reaches of the tributary.

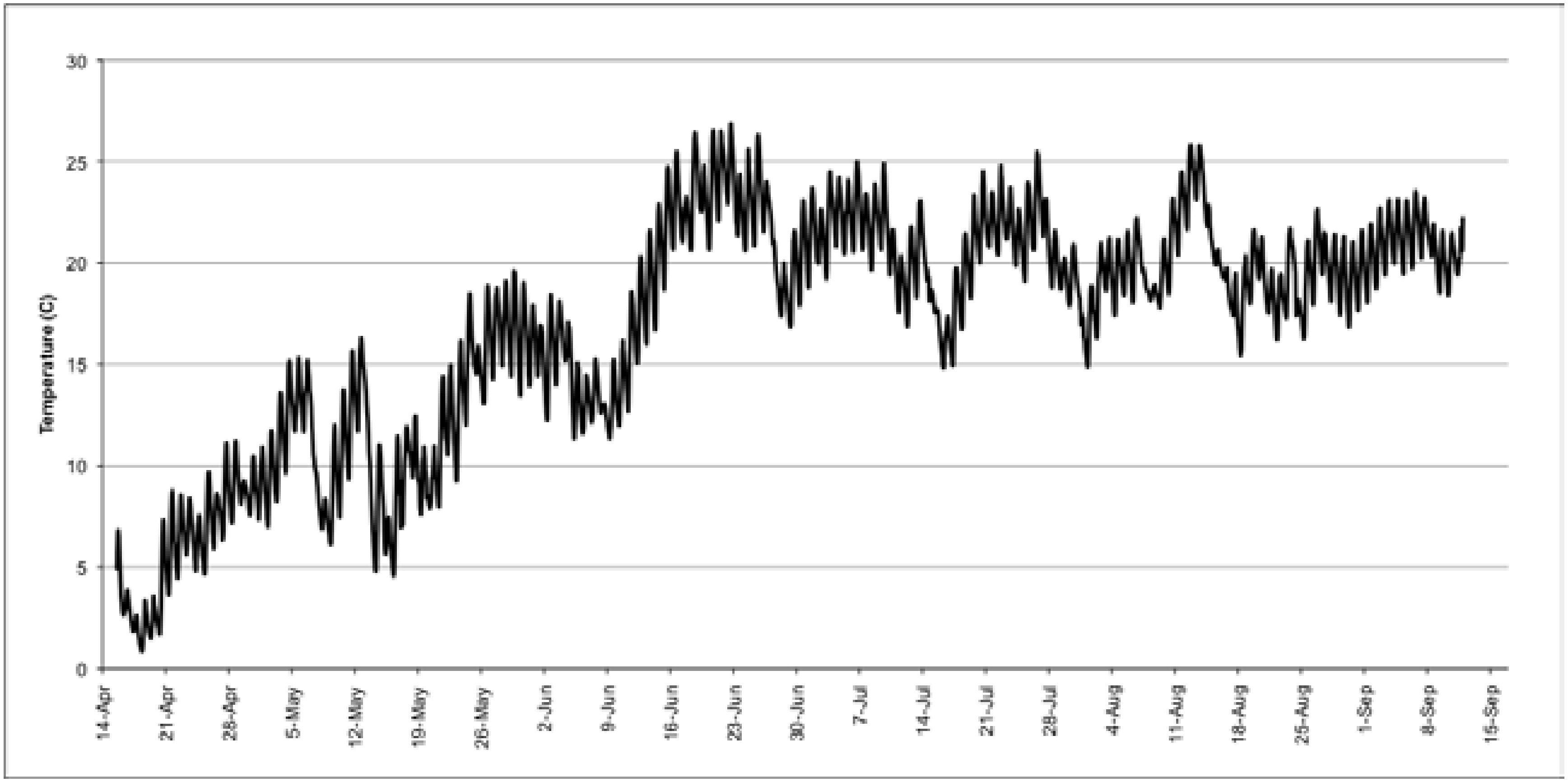
APPENDIX F: Water temperature data for the seven tributaries within the Swan Creek Watershed.

Swan Creek



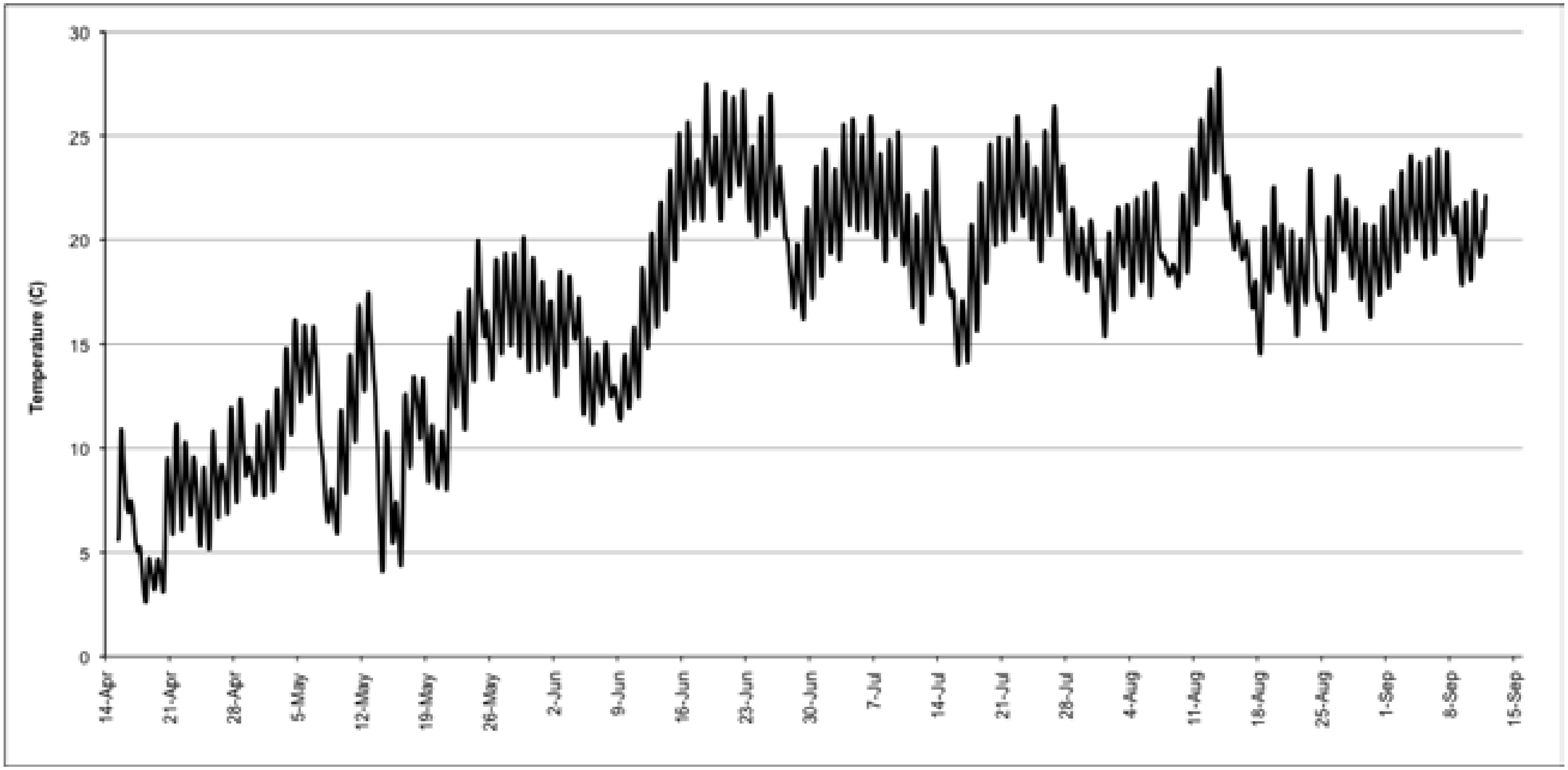
Appendix F-1. Swan Creek Water Temperature data. Temperature logger positioned near Lake Manitoba (N50.68349 W98.14336).

Burnt Lake Drain



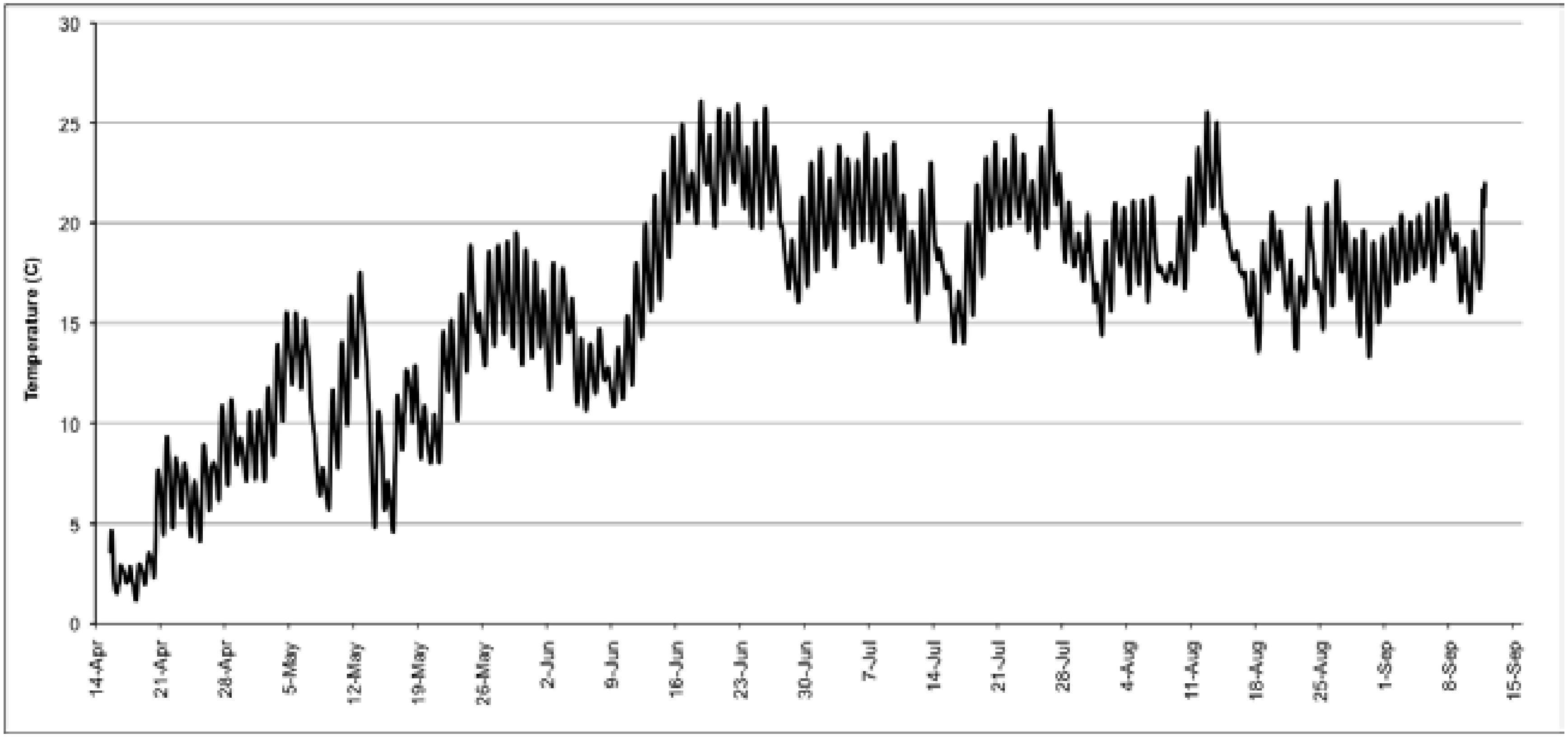
Appendix F-2. Burnt Lake Drain water temperature data. Temperature logger positioned upstream highway #6 (N 50.73820 W97.99483).

Hatchery Drain



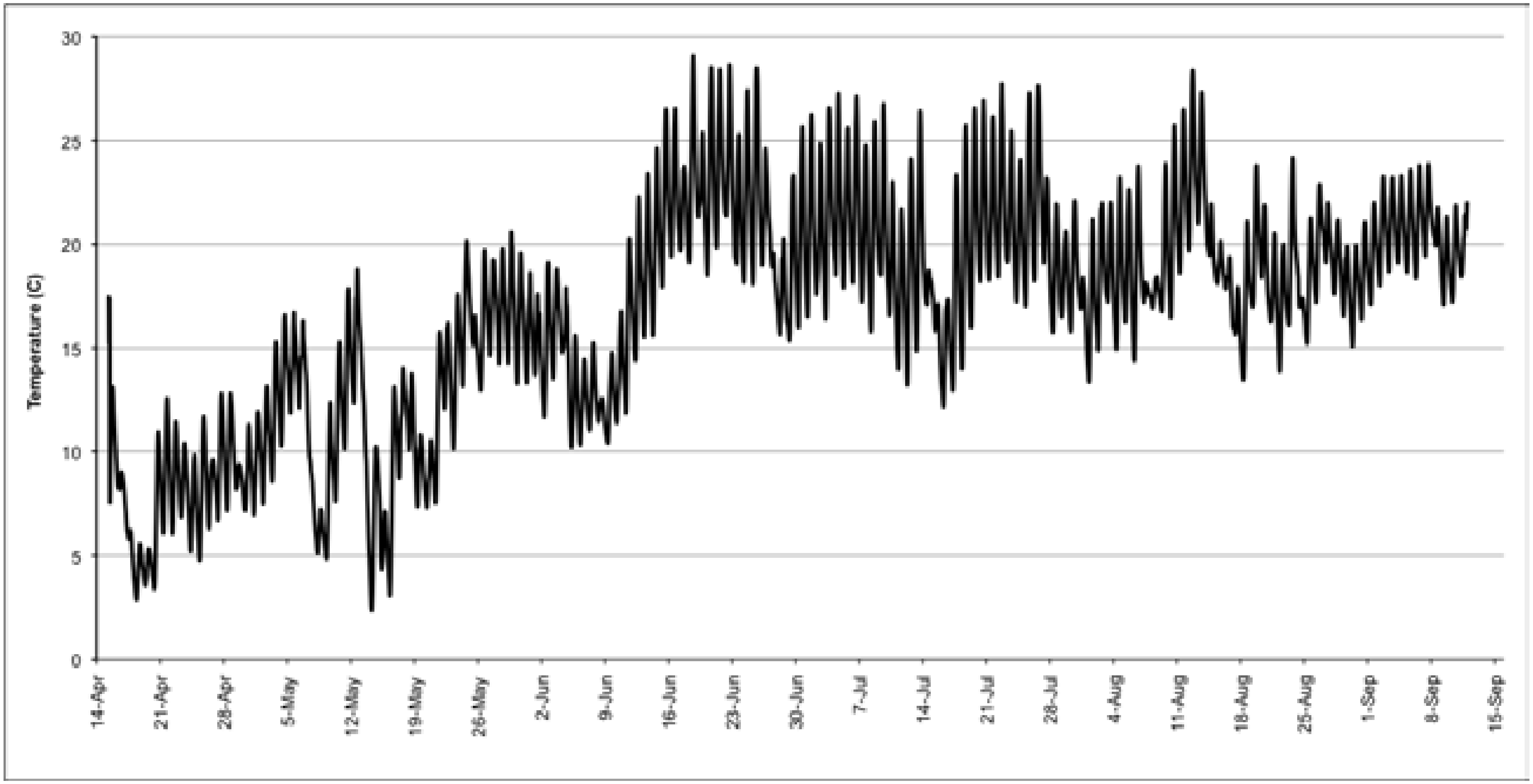
Appendix F-3. Hatchery Drain water temperature data. Temperature logger positioned upstream highway #6 (N50.62415 W98.01863).

Island Lake Drain



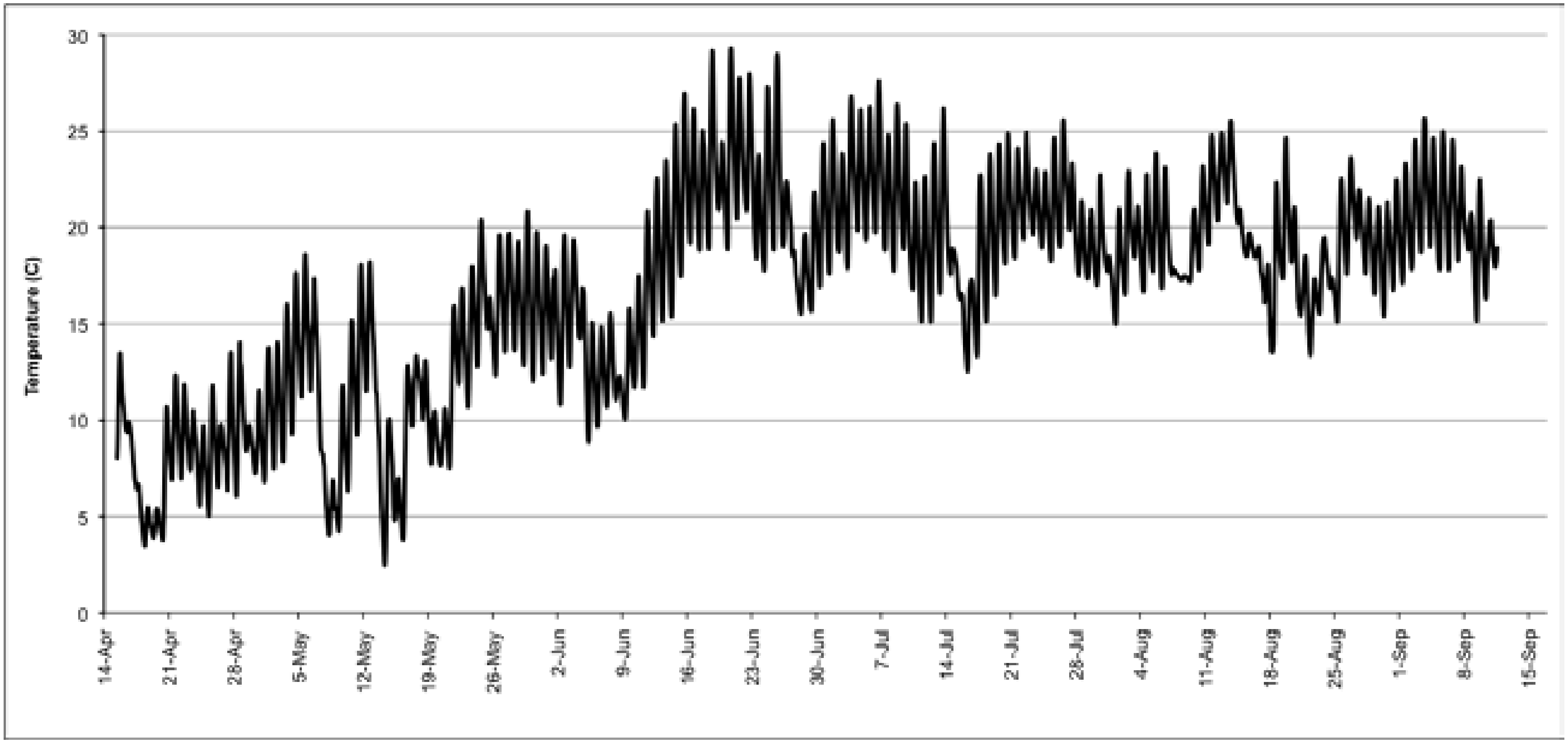
Appendix F-4. Island Lake Drain water temperature data. Temperature logger positioned within the middle sampling reach (N50.77192 W97.99520).

Mud Lake Drain



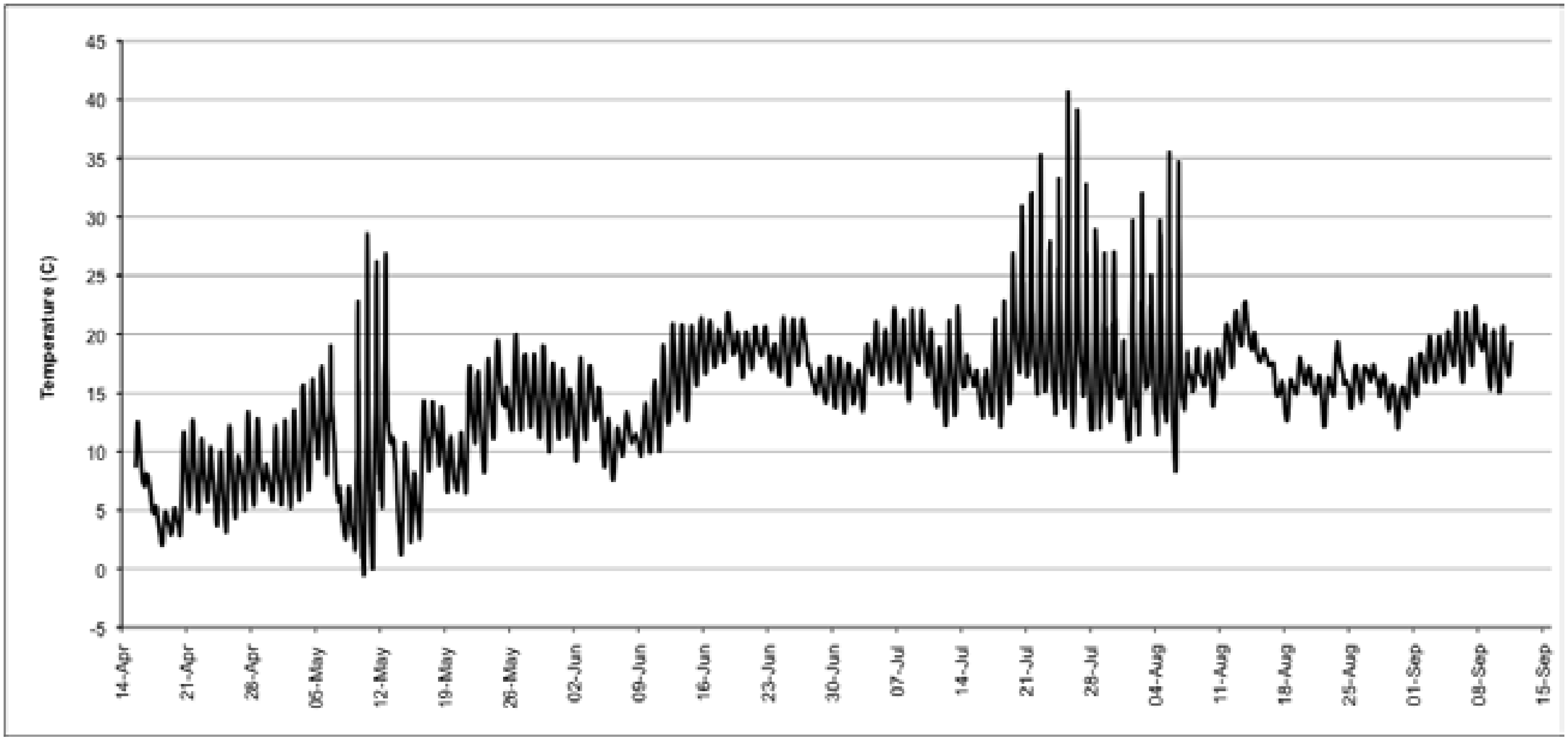
Appendix F-5. Mud Lake Drain water temperature data. Temperature logger positioned in middle sampling reach (N50.67129 W98.01841).

North Wagon Creek Drain



Appendix F-6. North Wagon Creek Drain water temperature data. Temperature logger positioned near Lake Manitoba (N50.55070 W98.03338).

Hayward Drain



Appendix F-7. Hayward Drain water temperature data. Temperature logger positioned near Swan Creek (N50.72774 W98.16753).

Appendix G. Fish collection data for the 2009 Swan Creek Watershed riparian and aquatic survey. Symbols VO – Visual Observation; HN – Hoop-nets; EF – Electrofishing; SH – Seine Haul; DN – Dip netting.

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Swan Creek	27-Apr-09	2	VO	30 minutes	White Sucker	*Catostomus*	*commersonii*	400+	--	--
Swan Creek	27-Apr-09	2	VO	30 minutes	Brook Stickleback	*Culaea*	*inconstans*	100+	--	--
Swan Creek	03-May-09	2	VO	--	White Sucker	*Catostomus*	*commersonii*	~500	--	--
Swan Creek	03-May-09	2	VO	--	Walleye	*Sander*	*vitreus*	~20	--	--
Swan Creek	03-May-09	2	HN	14 hours	no fish	no fish	no fish	no fish	--	--
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	451	M
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	488	F
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	406	M
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	474	F
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	491	F
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	471	F
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	448	F
Swan Creek	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	454	M-RR
Swan Creek	18-May-09	2	VO	30	White Sucker	*Catostomus*	*commersonii*	~30	--	--
Swan Creek	18-May-09	2	VO	30	Carp	*Cyprinus*	*Carp*	7	--	--
Swan Creek	13-May-09	2	VO	30	Carp	*Cyprinus*	*Carp*	~30	--	--
Burnt Lake	28-Apr-09	1	HN	5 hours	no fish	no fish	no fish	0	--	--
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	270	--	--
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	441	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	425	F-RR
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	435	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	497	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	415	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	398	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	437	F-RR
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	435	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	435	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	442	F-RR
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	415	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	420	F

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	430	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F-RR
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	460	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	490	M
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	429	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	495	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	455	F-RR
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	375	F-RR
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F-RR
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	410	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	435	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	450	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F
Burnt Lake	01-May-09	2	HN	16 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F-RR
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	released 80	--	--
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	421	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	435	M
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	579	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	455	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	450	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	470	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	415	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	450	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F-RR
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	480	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	475	M

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	430	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	460	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	445	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	445	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	455	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	450	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	500	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	470	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	430	F
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	--	430	M
Burnt Lake	01-May-09	1	HN	17 hours	White Sucker	*Catostomus*	*commersonii*	released 30	--	--
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	561	?
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	566	M
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	592	M-RR
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	476	?
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	632	F
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	484	M
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	584	M
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	580	M
Burnt Lake	01-May-09	1	HN	17 hours	Walleye	*Sander*	*vitreus*	--	689	M-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	released 26	--	--
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	436	M-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	430	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	418	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	425	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	492	M
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	394	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	387	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	425	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	374	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	393	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	446	M-RR

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	375	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	434	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	398	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	412	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	400	M
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	450	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	422	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	400	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	472	M
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	466	M
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	426	M
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	382	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	412	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	444	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	416	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	428	M
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	418	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	392	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	394	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	419	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	412	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	450	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	432	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	424	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	408	F-RR
Burnt Lake	03-May-09	2	HN	14.5 hours	White Sucker	*Catostomus*	*commersonii*	--	414	F-RR
Burnt Lake	18-Apr-09	2	HN	4.25 hours	no fish	*no fish*	*no fish*	0	--	--
Hatchery	27-Apr-09	2	VO	20 min.	Fathead Minnow	*Pimephales*	*promelas*	~25	--	--
Hatchery	27-Apr-09	2	VO	20 min.	Brook Stickleback	*Culaea*	*inconstans*	~100	--	--
Hatchery	27-Apr-09	2	VO	20 min.	Central Mudminnow	*Umbra*	*limi*	~20	--	--
Hatchery	28-Apr-09	3	VO	--	Northern Pike	*Esox*	*lucius*	1	--	--
Hatchery	17-Apr-09	3	HN	6.25 hours	no fish	no fish	no fish	no fish	--	--
Hatchery	17-Apr-09	3	VO	--	Central Mudminnow	*Umbra*	*limi*	2	--	--

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Hatchery	17-Apr-09	3	VO	--	Northern Pike	*Esox*	*lucius*	4	--	--
Hatchery	29-Apr-09	2	HN	18 hours	White Sucker	*Catostomus*	*commersonii*	1	--	--
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	455	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	418	M
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	447	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	413	M-RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	410	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	456	F RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	465	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	448	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	455	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	455	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	462	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	453	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	451	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	455	F RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	441	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	415	M
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	434	M-RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	422	M
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	382	M-RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	451	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	434	M
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	399	M
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	392	M
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	454	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	449	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	425	M-RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	435	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	464	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	418	M-RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	459	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	408	M-RR

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	422	M-RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	471	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	392	M
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	422	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	399	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	382	M-RR
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	467	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	490	F
Hatchery	30-Apr-09	2	HN	19 hours	White Sucker	*Catostomus*	*commersonii*	--	377	M
Hatchery	30-Apr-09	2	HN	48 hours	White Sucker	*Catostomus*	*commersonii*	--	452	F
Hayward	18-Apr-09	1	HN	5.5 hours	White Sucker	*Catostomus*	*commersonii*	1	481	F
Hayward	18-Apr-09	1	HN	5.5 hours	White Sucker	*Catostomus*	*commersonii*	1	470	F
Hayward	18-Apr-09	1	HN	5.5 hours	Northern Pike	*Esox*	*lucius*	1	352	M-RR
Island Lake	17-Apr-09	2	HN	6.5 hours	Northern Pike	*Esox*	*lucius*	1	322	?
Island Lake	17-Apr-09	2	HN	6.5 hours	Brook Stickleback	*Culaea*	*inconstans*	~40	--	--
Island Lake	20-Apr-09	2	DN	--	Brook Stickleback	*Culaea*	*inconstans*	12	--	--
Island Lake	20-Apr-09	2	VO	--	Brook Stickleback	*Culaea*	*inconstans*	~200	--	--
Island Lake	20-Apr-09	3	VO	--	White Sucker	*Catostomus*	*commersonii*	~50	--	--
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	466	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	504	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	464	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	470	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	458	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	484	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	456	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	462	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	450	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	470	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	472	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	478	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	456	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	422	M
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	402	M

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	442	F
Island Lake	20-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	1	372	F-RR
Island Lake	21-Apr-09	2	VO	20 min	White Sucker	*Catostomus*	*commersonii*	~500	--	--
Island Lake	23-May-09	3	VO	30 min	White Sucker	*Catostomus*	*commersonii*	~300	--	--
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	450	F-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	428	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	480	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	450	M
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	446	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	462	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	487	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	499	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	437	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	460	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	454	F-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	400	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	424	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	442	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	450	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	410	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	416	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	414	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	438	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	496	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	562	F-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	407	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	420	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	440	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	440	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	461	F-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	451	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	420	M
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	472	F

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	434	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	456	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	451	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	452	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	420	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	392	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	470	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	430	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	462	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	461	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	462	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	499	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	420	M-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	467	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	435	M
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	373	F
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	440	F-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	470	F-RR
Mud Lake	28-Apr-09	2	HN	6 hours	White Sucker	*Catostomus*	*commersonii*	--	407	F
Mud Lake	28-Apr-09	2	VO	--	White Sucker	*Catostomus*	*commersonii*	~75	--	--
Mud Lake	28-Apr-09	2	VO	--	White Sucker	*Catostomus*	*commersonii*	~100	--	--
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	453	?
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	418	M
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	429	M
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	418	M
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	437	M
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	459	?
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	438	?
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	460	?
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	479	F
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	410	M
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	466	?
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	440	M

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	426	M-RR
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	450	?
Mud Lake	17-Apr-09	2	HN	3.5 hours	White Sucker	*Catostomus*	*commersonii*	--	420	M
Mud Lake	17-Apr-09	2	HN	3.5 hours	Northern Pike	*Esox*	*lucius*	--	422	?
Mud Lake	17-Apr-09	2	HN	3.5 hours	Northern Pike	*Esox*	*lucius*	--	434	M-RR
Mud Lake	17-Apr-09	2	HN	3.5 hours	Northern Pike	*Esox*	*lucius*	--	452	M-RR
Mud Lake	17-Apr-09	2	HN	3.5 hours	Northern Pike	*Esox*	*lucius*	--	438	M-RR
Mud Lake	20-Apr-09	1	HN	8.5 hours	no fish	*no fish*	*no fish*	0	--	--
Mud Lake	29-Apr-09	3	VO	--	White Sucker	*Catostomus*	*commersonii*	24	--	--
North Wagon	18-Apr-09	1	HN	8.5 hours	White Sucker	*Catostomus*	*commersonii*	1	412	M
North Wagon	03-May-09	3	CN	?	White Sucker	*Catostomus*	*commersonii*	~1000	--	--
North Wagon	18-May-09	3	VO	--	White Sucker	*Catostomus*	*commersonii*	~20	--	--
Hayward	27-Apr-09	2	HN	4 hours	no fish	*no fish*	*no fish*	0	--	--
Hayward	27-Apr-09	2	VO	10 min.	White Sucker	*Catostomus*	*commersonii*	1	~250	--
Hayward	18-Apr-09	2	SH	30 m	no fish	*no fish*	*no fish*	0	--	--

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Swan Creek	18-Jun-09	1	EF	247 sec	Fathead Minnow	*Pimephales*	*promelas*	15	--	--
Swan Creek	18-Jun-09	1	EF	247 sec	Spottail Shiner	*Notropis*	*hudsonius*	6	--	--
Swan Creek	18-Jun-09	1	EF	247 sec	Yellow Perch	*Perca*	*flavescens*	3	--	--
Swan Creek	18-Jun-09	1	EF	247 sec	Common Csrp	*Cyprinus*	*carpio*	2	--	--
Swan Creek	18-Jun-09	2	EF	211 sec	Common Csrp	*Cyprinus*	*carpio*	40	--	--
Swan Creek	18-Jun-09	2	EF	211 sec	Spottail Shiner	*Notropis*	*hudsonius*	12	--	--
Swan Creek	18-Jun-09	2	EF	211 sec	Brook Stickleback	*Culaea*	*inconstans*	32	--	--
Swan Creek	18-Jun-09	2	EF	211 sec	Yellow Perch	*Perca*	*flavescens*	90	--	--
Swan Creek	18-Jun-09	2	EF	211 sec	Fathead Minnow	*Pimephales*	*promelas*	246	--	--
Swan Creek	18-Jun-09	3	EF	512 sec	Common Csrp	*Cyprinus*	*carpio*	3	--	--
Burnt Lake	15-Jun-09	2	EF	150 sec	Brook Stickleback	*Culaea*	*inconstans*	3	--	--
Burnt Lake	18-Jun-09	1	EF	347 sec	Fathead Minnow	*Pimephales*	*promelas*	2	--	--
Burnt Lake	18-Jun-09	1	EF	347 sec	Yellow Perch	*Perca*	*flavescens*	1	--	--
Burnt Lake	18-Jun-09	1	EF	347 sec	Common Carp	*Cyprinus*	*carpio*	1	--	--
Burnt Lake	18-Jun-09	1	EF	347 sec	Northern Pike	*Esox*	*lucius*	2	--	--
Burnt Lake	18-Jun-09	3	EF	247 sec	Brook Stickleback	*Culaea*	*inconstans*	2	--	--
Burnt Lake	18-Jun-09	3	EF	247 sec	White Sucker	*Catostomus*	*commersonii*	2	--	--
Hatchery	07-Jun-09	2	EF	523 sec	Fathead Minnow	*Pimephales*	*promelas*	83	--	--
Hatchery	07-Jun-09	2	EF	523 sec	Brook Stickleback	*Culaea*	*inconstans*	27	--	--
Hatchery	07-Jun-09	2	EF	523 sec	White Sucker	*Catostomus*	*commersonii*	1	--	--
Hatchery	07-Jun-09	2	EF	523 sec	Yellow Perch	*Perca*	*flavescens*	1	--	--
Hatchery	07-Jun-09	2	EF	523 sec	Iowa Darter	*Etheostoma*	*exile*	32	--	--
Hatchery	07-Jun-09	2	EF	523 sec	Logperch	*Percina*	*caprodes*	2	--	--
Hatchery	07-Jun-09	1	EF	342 sec	Spottail Shiner	*Notropis*	*hudsonius*	3	--	--
Hatchery	07-Jun-09	1	EF	342 sec	Fathead Minnow	*Pimephales*	*promelas*	5	--	--
Hatchery	07-Jun-09	3	EF	602 sec	Fathead Minnow	*Pimephales*	*promelas*	21	--	--
Hatchery	07-Jun-09	3	EF	602 sec	Brook Stickleback	*Culaea*	*inconstans*	1178	--	--
Hatchery	07-Jun-09	3	EF	602 sec	Central Mudminnow	*Umbra*	*limi*	2	--	--
Island Lake	15-Jun-09	3	EF	317 sec	Yellow Perch	*Perca*	*flavescens*	107	--	--
Island Lake	15-Jun-09	3	EF	317 sec	Spottail Shiner	*Notropis*	*hudsonius*	84	--	--
Island Lake	15-Jun-09	3	EF	317 sec	Fathead Minnow	*Pimephales*	*promelas*	23	--	--
Island Lake	15-Jun-09	3	EF	317 sec	Central Mudminnow	*Umbra*	*limi*	4	--	--
Island Lake	15-Jun-09	3	EF	317 sec	Brook Stickleback	*Culaea*	*inconstans*	180	--	--

Appendix G. Continued...

Drain	Date	Reach	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Island Lake	15-Jun-09	2	EF	274 sec	Brook Stickleback	*Culaea*	*inconstans*	4	--	--
Island Lake	15-Jun-09	2	EF	274 sec	White Sucker	*Catostomus*	*commersonii*	1	--	--
Island Lake	15-Jun-09	2	EF	274 sec	Central Mudminnow	*Umbra*	*limi*	5	--	--
Island Lake	15-Jun-09	2	EF	274 sec	Spottail Shiner	*Notropis*	*hudsonius*	7	--	--
Island Lake	15-Jun-09	2	EF	274 sec	Fathead Minnow	*Pimephales*	*promelas*	10	--	--
Island Lake	15-Jun-09	1	EF	264 sec	Common Carp	*Cyprinus*	*carpio*	1	--	--
Island Lake	15-Jun-09	1	EF	264 sec	Northern Pike	*Esox*	*lucius*	1	--	--
Island Lake	15-Jun-09	1	EF	264 sec	Brook Stickleback	*Culaea*	*inconstans*	10	--	--
Island Lake	15-Jun-09	1	EF	264 sec	White Sucker	*Catostomus*	*commersonii*	1	106	--
Island Lake	15-Jun-09	1	EF	264 sec	Spottail Shiner	*Notropis*	*hudsonius*	68	--	--
Island Lake	15-Jun-09	1	EF	264 sec	Fathead Minnow	*Pimephales*	*promelas*	31	--	--
Island Lake	15-Jun-09	1	EF	264 sec	Central Mudminnow	*Umbra*	*limi*	2	--	--
Mud Lake	15-Jun-09	3	EF	340 sec	Central Mudminnow	*Umbra*	*limi*	89	--	--
Mud Lake	15-Jun-09	3	EF	340 sec	Fathead Minnow	*Pimephales*	*promelas*	73	--	--
Mud Lake	15-Jun-09	3	EF	340 sec	Common Carp	*Cyprinus*	*carpio*	6	--	--
Mud Lake	15-Jun-09	3	EF	340 sec	Common Carp	*Cyprinus*	*carpio*	3	--	--
Mud Lake	15-Jun-09	3	EF	340 sec	Northern Pike	*Esox*	*lucius*	1	431	--
Mud Lake	15-Jun-09	3	EF	340 sec	Brook Stickleback	*Culaea*	*inconstans*	2	--	--
Mud Lake	16-Jun-09	1	EF	379 sec	Common Carp	*Cyprinus*	*carpio*	2	--	--
Mud Lake	16-Jun-09	1	EF	379 sec	Northern Pike	*Esox*	*lucius*	1	--	--
Mud Lake	16-Jun-09	1	EF	379 sec	Brook Stickleback	*Culaea*	*inconstans*	2	--	--
Mud Lake	16-Jun-09	1	EF	379 sec	Fathead Minnow	*Pimephales*	*promelas*	2	--	--
North Wagon	07-Jun-09	2	EF	330 sec	Spottail Shiner	*Notropis*	*hudsonius*	94	--	--
North Wagon	07-Jun-09	2	EF	330 sec	White Sucker	*Catostomus*	*commersonii*	1	--	--
North Wagon	07-Jun-09	2	EF	330 sec	Fathead Minnow	*Pimephales*	*promelas*	41	--	--
North Wagon	07-Jun-09	3	EF	449 sec	Spotail Shiner	*Notropis*	*hudsonius*	11	--	--
North Wagon	07-Jun-09	3	EF	449 sec	Fathead Minnow	*Pimephales*	*promelas*	48	--	--
North Wagon	07-Jun-09	1	EF	815 sec	Spotail Shiner	*Notropis*	*hudsonius*	26	--	--
North Wagon	07-Jun-09	2	EF	815 sec	White Sucker	*Catostomus*	*commersonii*	1	--	--
North Wagon	07-Jun-09	1	EF	815 sec	Fathead Minnow	*Pimephales*	*promelas*	2	--	--
Hayward	16-Jun-09	2	EF	243 sec	Fathead Minnow	*Pimephales*	*promelas*	4	--	--
Hayward	16-Jun-09	2	EF	243 sec	Brook Stickleback	*Culaea*	*inconstans*	1	--	--
Hayward	16-Jun-09	2	EF	243 sec	Central Mudminnow	*Umbra*	*limi*	1	--	--

Appendix G. Continued...

Drain	Date	Reac h	Method	Effort	Common Name	Genus	Species	Number Collected	FL (mm)	Sex
Hayward	16-Jun-09	1	EF	207 sec	Fathead Minnow	*Pimephales*	*promelas*	30	--	--
Hayward	16-Jun-09	3	EF	252 sec	Fathead Minnow	*Pimephales*	*promelas*	2	--	--
Hayward	16-Jun-09	3	EF	252 sec	Brook Stickleback	*Culaea*	*inconstans*	1	--	--

APPENDIX H: Culvert Assessment within the Swan Creek Watershed.

Appendix H-1. Swan Creek Drain Culvert Assessment. Velocity = m/s; Depth = m. Symbols N- North; S- South; NM – North Middle; SM- South Middle, E – East; W - West.

	Date	Longitude	Latitude	Culvert Number(s)	Diameter (m)	Velocity inlet	Depth inlet	Velocity outlet	Depth outlet
4th Order (34 map)	25-Apr-09	50.7441	98.11108	E	1.2	1.61	1.1	2.63	0.86
				M	1.2	1.91	1.1	2.66	0.8
				W	1.2	1.57	1.08	1.84	1
4th Order (35 map)	25-Apr-09	50.77212	98.1113	N	0.76	0.74	0.48	1.73	0.33
				S	1.5	1.17	0.98	1.93	0.65
3rd Order (36 map)	25-Apr-09	50.78563	98.11128	E	1.5	1.17	0.92	1.35	0.86
3rd Order (37 map)	25-Apr-09	50.77198	98.15098	N	1.5	1.74	0.85	2.43	0.81
				M	1.5	1.25	1.06	2.11	0.68
				S	1.5	1.31	1.06	2.27	0.7
4th Order (34 map)	03-May-09	50.7441	98.11108	E	1.2	1.44	1.03	2.2	0.56
				M	1.2	1.12	1.07	2.42	0.75
				W	1.2	1.57	1.01	2.05	0.73

Appendix H-2. Burnt Lake Drain Culvert Assessment. Velocity = m/s; Depth = m. Symbols N- North; S- South; NM – North Middle; SM- South Middle, E – East; W - West.

	Date	Longitude	Latitude	Culvert Number(s)	Diameter (m)	Velocity inlet	Depth inlet	Velocity outlet	Depth outlet
4th order (#7 map)	22-Apr-09	50.7379	97.99489	N	1.4	0.94	1.4	1.06	1.4
				M	1.4	--	1.4	1.02	1.4
				S	1.4	--	1.4	0.87	1.4
4th order (#8 map)	22-Apr-09	50.72761	97.97616	E	1.4	?	1.4	1.01	1.4
				W	1.4	0.92	1.4	1.09	1.4
3rd order (#9 map)	22-Apr-09	50.71301	97.92497	N	0.72	0.6	0.56	0.88	0.45
				M	0.88	0.84	0.57	1.02	0.55
				S	0.88	0.8	0.6	1.09	0.55
3rd order (#10 map)	22-Apr-09	50.71296	97.91755	N	0.76	0.83	0.38	1.57	0.31
				M	0.88	0.96	0.5	1.57	0.4
				S	0.88	0.86	0.56	1.49	0.4
3rd order (#11 map)	22-Apr-09	50.71297	97.91117	N	0.58	0.8	0.56	1.12	0.45
				M	0.92	0.83	0.56	1.07	0.53
				S	0.92	0.8	0.55	1.15	0.47
3rd order (#12 map)	22-Apr-09	50.71298	97.90184	N	0.8	0.6	0.67	0.5	1.2
				M	0.8	0.74	0.67	0.51	1.31
				S	0.8	0.78	0.56	0.54	1.05
3rd order (#13 map)	22-Apr-09	50.72961	97.90196	N	0.85	0.65	0.85	0.83	0.85
				S	0.85	0.75	0.85	1.05	0.85
4th order (33 map)	25-Apr-09	50.74258	98.07809	W	1.9	0.97	1.36	0.97	1.35
				M	1.9	0.86	1.18	0.8	1.35
				E	1.9	0.92	1.32	0.63	1.36

Appendix H-3. Hatchery Drain Culvert Assessment. Velocity = m/s; Depth = m.

	Date	Longitude	Latitude	Culvert Number(s)	Diameter (m)	Velocity inlet	Depth inlet	Velocity outlet	Depth outlet
crossing # 8 (44 map)	20-Apr-09	N50.63882	97.90406	N	1.15 m	--	--	1.06	1.15
crossing # 7 (45 map)	20-Apr-09	N50.63915	97.91501	S	0.8 m	0.75	0.8	0.95	0.8
				N	0.8 m	0.82	0.8	0.97	0.8
crossing # 6 (46 map)	20-Apr-09	N50.63911	W97.92842	N	0.75	1.29	0.75	2.54	0.35
				S	0.75	1.18	0.75	2.82	0.37
crossing # 5 (47 map)	20-Apr-09	N50.63424	W97.94796	N	0.88	--	--	--	--
				S	1.15	1.57	1.15	3.19	0.66
crossing # 4 (48 map)	20-Apr-09	N50.62418	W98.01842	N	1.3	1.15	0.75	1.14	0.83
				NM	1.3	0.71	0.88	1.39	0.81
				SM	1.3	1.23	0.87	1.06	0.76
				S	1.3	1.06	0.77	0.93	0.66
crossing # 2 (49 map)	20-Apr-09	N50.62215	W98.05954	N	1.25	0.88	0.9	0.97	0.9
				NM	1.25	1.04	0.9	1.16	0.9
				SM	1.25	0.76	0.9	0.98	0.9
				S	1.25	0.94	0.9	1.08	0.9
crossing # 1 (50 map)	20-Apr-09	N50.62331	W98.08815	N	1.85	1.22	1.1	1.26	1.2
				M	1.85	1.45	1.26	1.55	1.23
				S	1.85	1.2	1.25	1.4	1.1
(Hwy #6) (51 map)	20-Apr-09	N50.62184	W98.04198	N	1.56	1.6	1.1	2.66	0.65
				M	1.56	1.55	1.06	2.85	0.65
				S	1.56	1.79	1.65	2.79	0.65
(Hwy #6) (51 map)	30-Apr-09	N50.62184	W98.04198	N	1.56	1.03	1	2.76	0.54
				M	1.56	0.89	0.97	2.84	0.53
				S	1.56	0.98	1	2.76	0.55

Appendix H-4. Island Lake Drain Culvert Assessment. Velocity = m/s; Depth = m. Symbols N- North; S- South; NM – North Middle; SM- South Middle, E – East; W - West.

	Date	Longitude	Latitude	Culvert Number(s)	Diameter (m)	Velocity inlet	Depth inlet	Velocity outlet	Depth outlet
2nd order (#1 map)	22-Apr-09	N50.77190	98.03101	N	0.75	0.23	0.25	0.24	0.24
3rd order (#2 map)	22-Apr-09	50.77191	97.99516	E	1	1.02	0.93	1.42	0.9
				W	0.75	0.2	0.75	0.23	0.67
3rd order (#3 map)	22-Apr-09	50.77194	97.98714	N	1	1.25	1	1.7	1
3rd order (#4 map)	22-Apr-09	50.77775	97.97169	N	0.85	1.15	0.57	1.76	0.45
2nd order (#5 map)	22-Apr-09	50.77203	97.951	E	0.38	0.35	0.29	0.61	0.38
2nd order (#6 map)	22-Apr-09	50.76512	97.99505	N	1.15	0.34	1.15	0.36	0.97

Appendix H-4. Mud Lake Drain Culvert Assessment. Velocity = m/s; Depth = m. Symbols N- North; S- South; NM – North Middle; SM- South Middle, E – East; W - West.

	Date	Longitude	Latitude	Culvert Number(s)	Diameter (m)	Velocity inlet	Depth inlet	Velocity outlet	Depth outlet
3rd order (20 map)	23-Apr-09	50.69824	98.11114	N	1.2	0.69	0.85	0.62	0.71
				M	1.36	0.96	0.92	0.57	0.81
				S	1.36	0.79	0.91	0.53	0.83
3rd order (21 map)	23-Apr-09	50.68951	98.08804	N	1.15	0.56	0.83	0.42	0.79
				NM	1.15	0.5	0.89	0.58	0.8
				SM	1.15	0.57	0.87	0.58	0.88
				S	1.15	0.35	0.9	0.37	0.84
2nd order (22 map)	23-Apr-09	50.66866	98.0597	E	1.4	--	0.88	0.16	0.72
3rd order (23 map)	23-Apr-09	50.67111	98.01844	N	1.5	0.92	0.8	0.92	0.75
2nd order (24 map)	23-Apr-09	50.66097	98.01853	N	0.9	0	0.2	0	0.25
				S	0.5	0.42	0.3	0.52	0.35
3rd order (25 map)	23-Apr-09	50.68339	97.97641	N	0.9	0.72	0.9	0.98	0.8
2nd order (26 map)	23-Apr-09	50.68339	97.93761	N	0.32	?	?	1.12	0.32
3rd order (27 map)	23-Apr-09	50.68247	97.98301	N	0.7	0.87	0.7	?	?

Appendix H-4. North Wagon Creek Drain Culvert Assessment. Velocity = m/s; Depth = m**.** Symbols N- North; S- South; NM – North Middle; SM- South Middle, E – East; W - West.

	Date	Longitude	Latitude	Culvert Number(s)	Diameter (m)	Velocity inlet	Depth inlet	Velocity outlet	Depth outlet
2nd order (28 map)	25-Apr-09	50.51727	98.0143	N	1.02	1.25	0.45	0.75	0.65
1st order (29 map)	25-Apr-09	50.51515	98.01208	E	0.9	0.58	0.9	1.13	0.78
2nd order (30 map)	25-Apr-09	50.52137	98.01692	E	0.7	0.76	0.7	0.76	0.7
				W	0.7	0.79	0.7	0.79	0.7
2nd order (31map)	25-Apr-09	50.54881	98.01434	N	1.15	0.86	0.9	1.14	0.81
				S	1.15	1.05	0.9	1.15	0.86
2nd order (32 map)	25-Apr-09	50.54832	98.03761	N	1.2	1.21	0.91	1.66	0.81
				S	1.2	1.21	1.18	1.5	1.05
2nd order (38 map)	30-Apr-09	50.52148	97.98111	E	0.76	0.67	0.76	1.05	0.76
				W	0.76	0.88	0.76	0.82	0.76
Road 511 (39 map)	30-Apr-09	50.52141	97.97888	N	0.58	--	--	0.86	0.36
				S	0.76	--	--	0.78	0.47
Road 511 (40 map)	30-Apr-09	50.52139	97.96826	N	0.58	0.43	0.53	0.54	0.48
				S	0.76	0.5	0.65	0.51	0.64
Road 511 (41 map)	30-Apr-09	50.52141	97.96266	N	0.76	0.85	0.61	1.11	0.53
Road 511 (42 map)	30-Apr-09	50.52142	97.9566	N	0.76	--	--	1.58	0.42
Road 511 (43 map)	30-Apr-09	50.52142	97.94525	N	0.76	0.86	0.48	1.91	0.28

Appendix H-4. Hayward Drain Culvert Assessment. Velocity = m/s; Depth = m. Symbols N- North; S- South; NM – North Middle; SM- South Middle, E – East; W - West.

	Date	Longitude	Latitude	Culvert Number(s)	Diameter (m)	Velocity inlet	Depth inlet	Velocity outlet	Depth outlet
3rd order (#14 map)	18-Apr-09	50.71305	98.15053	N	1.05	0.16	0.45	0.15	0.42
				M	1	0.17	0.5	0.26	0.35
				S	1.06	0.23	0.48	0.45	0.35
3rd order (#15 map)	23-Apr-09	50.72775	98.16755	N	1.2	0.69	0.27	0.56	0.31
				S	1.2	0.47	0.24	0.47	0.34
3rd order (16 map)	23-Apr-09	50.73439	98.18085	E	0.91	0.18	0.58	0.11	0.75
3rd order (17 map)	23-Apr-09	50.73556	98.18092						
				E	0.77	0.53	0.42	0.43	0.44
2nd order (18 map)	23-Apr-09	50.75714	98.20126	N	0.7	0.35	0.41	0.18	0.43
2nd order (19 map)	23-Apr-09	50.74222	98.22738	N	0.36	0.07	0.32	0.09	0.34

APPENDIX I: Potential Rehabilitation Sites.

Appendix I. A list of potential rehabilitation sites to improve water quality and fish habitat within the Swan Creek Watershed.

Location	Type	Comment	Rehabilitation Efforts	Benefit	Northing	Easting
Hatchery Drain #6 Highway Culvert Crossing	Barrier to Fish Movement	- Water velocity at this culvert crossing was over 2.0 m/s and significantly impeded fish movement in 2009 - Plenty of valuable fish habitat was documented upstream	-Provide an additional culvert at the crossing, - Replace or re-set culverts, or - Build riffles upstream and downstream of crossing to augment flow	- Allow fish to reach upstream spawning and nursery habitat	N50.62184	W98.04198
North Wagon Creek Drain	Class C Habitat	- The habitat upstream of #6 highway flows through confined livestock operations - The habitat and riparian zones are severely impact by livestock trampling impacting water quality, fish habitat, and the health of the aquatic environment.	- Provide off site watering stations - Fence off riparian zone to prevent livestock trampling - Re-seed channel preventing erosion and decreasing turbidity within the waterway	- Increase water quality within drain - Protect and enhance fish habitat	N50.54872 N50.52148	W98.01357 W97.98111
Burnt Lake Drain	Fish Habitat Enhancement	- There is limited habitat within Burnt Lake Drain - Enhancement efforts are required to restore the habitat and provide valuable spawning habitat for the fish communities of Lake Manitoba. - Burnt Lake Drain is the second largest drain within the watershed and has the least amount of spawning habitat	- Provide additional spawning habitat by constructing spawning shoal or riffles within the channel	- Creating spawning habitat to increase the spawning success of Lake Manitoba fish species	N50.76170 N50.76277	W98.05199 W98.06950

Appendix I. Continued…

Location	Type	Comment	Rehabilitation Efforts	Benefit	Northing	Easting
Burnt Lake Drain	Barrier to Fish Movement	- A Ducks Unlimited control structure upstream of highway #6 crossing obstructs fish movement - Plenty of valuable fish habitat was documented upstream	- Construct a rock fish ladder within the drain to provide passage	- Allow fish to reach upstream spawning and nursery habitat	N50.75289	W98.02311
Swan Creek Drain	Barrier to Fish Movement	- Water velocity at this culvert crossing was over 2.0 m/s and significantly impeded fish movement in 2009 - Plenty of valuable fish habitat was documented upstream	-Provide an additional culvert at the crossing, - Replace or re-set culverts, or - Build riffles upstream and downstream of crossing to augment flow	- Allow fish to reach upstream spawning and nursery habitat	N50.74441	W98.11108
Mud Lake Drain	Class C Habitat	- The habitat upstream of #6 highway flows through confined livestock operations - The habitat and riparian zones are severely impact by livestock trampling impacting water quality, fish habitat, and the health of the aquatic environment.	- Provide off site watering stations - Fence off riparian zone to prevent livestock trampling - Re-seed channel preventing erosion and decreasing turbidity within the waterway	- Increase water quality within drain - Protect and enhance fish habitat	N50.68247 N50.68339	W97.98301 W97.97641

Appendix I. Continued…

Location	Type	Comment	Rehabilitation Efforts	Benefit	Northing	Easting
Hatchery Drain	Fish Habitat Enhancement	- Enhancement efforts are require to restore the habitat and provide valuable spawning habitat for the fish communities of Lake Manitoba. - Hatchery Drain is the third largest drain within the watershed and has great potential to provide excellent spawning habitat	- Provide additional spawning habitat by constructing spawning shoal or riffles within the channel	- Creating spawning habitat to increase the spawning success of Lake Manitoba fish species	N50.62418 N50.62153	W98.01842 W98.02666
Burnt Lake Drain	Class C Habitat	- The habitat downstream of #6 highway flows through unrestricted livestock areas - The habitat and riparian zones are severely impact by livestock trampling impacting water quality, fish habitat, and the health of the aquatic environment along sections of the drain	- Provide off site watering stations - Fence off riparian zone to prevent livestock trampling - Re-seed channel preventing erosion and decreasing turbidity within the waterway	- Increase water quality within drain - Protect and enhance fish habitat	N50.76170 N50.76277	W98.05199 W98.06950
Swan Creek Drain	Barrier to Fish Movement	- A Ducks Unlimited control structure downstream of Swan Lake obstructs fish movement - The Ducks Unlimited barrier was built in 1978 and has been obstructing fish movement for 32 years. - Plenty of valuable fish habitat was documented upstream	- Construct a rock fish ladder around the barrier to provide fish passage	- Allow fish to reach upstream spawning and nursery habitat	N50.80048	W98.16943

Appendix I. Continued…

Location	Type	Comment	Rehabilitation Efforts	Benefit	Northing	Easting
Burnt Lake Drain	Fish Habitat Enhancement	- There is limited cover within all drains of the watershed -By increasing vegetation (shrubs and trees) along the riparian zone fish habitat diversity is gained.	- plant willows, shrubs, or trees along Burnt Lake Drain to provide additional habitat cover for fish	- provide fish with increased habitat and protection	N50.76170 N50.76277	W98.05199 W98.06950
Hatchery Drain #6 Highway Culvert Crossing	Barrier to Fish Movement	- Water velocity at this culvert crossing was over 2.0 m/s and significantly impeded fish movement in 2009 -Culverts Perched and impede fish movement - Plenty of valuable fish habitat was documented upstream	- replace or re-set culverts	- allow fish to reach upstream spawning and nursery habitat	N50.63911	W97.92842
Hatchery Drain	Barrier to Fish Movement	- A Ducks Unlimited control structure downstream of Goulet Lakes obstructs fish movement - the Ducks Unlimited barrier was built in 1978 and has been obstructing fish movement for 32 years. - Plenty of valuable fish habitat was documented upstream	-replace barrier with another control structure that is fish friendly	- allow fish to reach upstream spawning and nursery habitat	N50.63882	W97.90406