

**EAST INTERLAKE CONSERVATION DISTRICT:
WATERSHED 050J RIPARIAN ASSESSMENT SURVEY – WITH
EMPHASIS ON THIRD ORDER DRAINS and HIGHER – 2007 and 2008**

A Report Prepared
for



by

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EXECUTIVE SUMMARY

The East Interlake Conservation District (EICD) invited North/South Consultants Inc. to conduct the *Watershed 05OJ – Riparian Assessment Survey*. The primary objective of this survey was to provide the EICD board with a comprehensive overview of riparian and land use conditions affecting Watershed 05OJ. Secondary objectives included the identification of barriers to fish passage and migration; to determine the utilization of recreationally important fish species in the watershed; and to provide a list of potential fisheries-based projects for future works within Watershed 05OJ.

The study area within Watershed 05OJ (third order drains and higher) includes the riparian areas along: Cochrane Creek; Fisher Drain; Gramiak Drain; Grassmere Creek Drain (including Grassmere Creek Drain west); Jackfish Creek; Jennifer Creek; Netley Creek; Parks Creek; Ross Creek; Steele Drain; Tugela Creek; Wavey Creek; Whiskey Ditch; and Norris Lake. Also included in the study area was the shoreline of Netley Marsh (from Chalet Beach approaching the mouth of the Red River).

The Water Quality Management Section, Manitoba Water Stewardship, was queried for water quality records relating to Watershed 05OJ. Library and internet searches were also conducted for existing documentation. With the exception of some existing data on Netley and Wavey creeks, water quality information for Watershed 05OJ was limited.

Existing fisheries records (Manitoba Water Stewardship – Fisheries Branch) and spring/summer investigations conducted by North/South Consultants Inc. identified 39 species of fish within Watershed 05OJ. With the exception of the bigmouth buffalo (special concern), none of the species identified are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered, threatened, or of special concern.

Spring fisheries investigations (2008), conducted by North/South Consultants Inc., identified a definite barrier to fish passage into the Grassmere Creek Drain. Spring investigations also suggest that adult spawning fish can migrate at least 25 km up the Netley Creek and 28 km up Wavey Creek for spawning purposes.

Approximately 229 km of riparian area within Watershed 05OJ was reviewed for land/use cover and/or classified according to aquatic habitat quality using aerial videography,

groundtruthing, and a review of existing orthophotos. Approximately 125 km was covered by ground while the remaining 103 km was covered by air. The majority of the riparian area throughout Watershed 05OJ, as classified according to land use/cover, was determined to be other agricultural land (47.8%). This was followed by: pasture/grazing (14.4%); cropland (14.3%); mixed forest land (9.1%); other urban or built-up land (5.1%); residential/commercial (3.4%); hayland (3.2%); and non-forested wetland (2.7%).

A review of combined aquatic habitat quality ratings suggests Watershed 05OJ is highly impacted by anthropogenic (i.e., human induced) forces (Class C). With the exception of some 'natural' areas in the lower reaches of Netley and Wavey creeks and along Norris Lake the majority of the watercourses in this watershed have either been channelized or modified by land use/cover. Primarily, the fish habitat reviewed in this watershed was marginal. The exceptions were areas along Netley Creek, Wavey Creek, and Norris Lake. Some of the smaller watercourses, near their confluences, also had limited areas of important fish habitat.

Based on a review of the aerial video, groundtruthing, and existing information, 47 potential rehabilitation sites, prioritized on a scale from 1 to 3, were identified within Watershed 05OJ by North/South Consultants. In addition, 7 other rehabilitation sites were identified by a study conducted in 1996. Rehabilitation efforts will need to be based on a watershed management plan developed by the EICD. Although there are some fish passage issues within this watershed (e.g., Grassmere Creek Drain), rehabilitation efforts may best be focused on improving water quality and maintaining the important fish habitat that currently exists (e.g., Netley and/or Wavey creeks).

ACKNOWLEDGMENTS

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Manitoba Water Stewardship Fisheries Branch (Gimli) and the East Interlake Conservation District are thanked for providing field assistance and support during the spring, 2007, fish utilization component of this study. EICD also assisted with the summer fish utilization component of this project.

Fieldwork described within this report was conducted under Scientific Collection Permit # 42-07 issued to North/South Consultants Inc. by Manitoba Water Stewardship, Fisheries Branch.

TABLE OF CONTENTS

| | <u>Page</u> |
|---|-------------|
| 1.0 INTRODUCTION | 1 |
| 2.0 METHODS..... | 2 |
| 2.1 Review of Existing Information | 2 |
| 2.1.1 Physical and Hydrological Information | 2 |
| 2.1.2 Water Quality | 2 |
| 2.1.3 Fish Species Utilization | 2 |
| 2.2 Field Surveys..... | 3 |
| 2.2.1 Physical and Hydrological Information | 3 |
| 2.2.2 Water Quality | 3 |
| 2.2.3 Fish Species Utilization | 3 |
| 2.2.3.1 Summer and Fall 2007 | 3 |
| 2.2.3.2 Spring 2008..... | 4 |
| 2.2.4 Groundtruthing..... | 4 |
| 2.2.5 Aerial Videography..... | 5 |
| 2.3 Classifications | 6 |
| 2.3.1 Land Use/Cover and General Classifications | 6 |
| 2.3.2 Aquatic Habitat Quality and Qualitative Ratings..... | 8 |
| 2.3.2.1 Channel Morphology | 8 |
| 2.3.2.2 Bank Stability | 9 |
| 2.3.2.3 Riparian Zone Function | 9 |
| 2.3.2.4 Barriers to Fish Migration | 10 |
| 2.3.2.5 Qualitative Ratings | 11 |
| 2.3.3 Fish Habitat Classification | 13 |
| 2.3.4 Potential Rehabilitation Sites | 14 |
| 3.0 RESULTS AND DISCUSSION..... | 15 |
| 3.1 Cochrane Creek | 16 |
| 3.1.1 Review of Existing Information..... | 16 |
| 3.1.2 Field Surveys – 2007 and 2008..... | 17 |
| 3.1.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 17 |
| 3.2 Fisher Drain..... | 18 |
| 3.2.1 Review of Existing Information..... | 18 |
| 3.2.2 Field Surveys – 2007 and 2008..... | 18 |
| 3.2.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 18 |
| 3.3 Gramiak Drain..... | 19 |
| 3.3.1 Review of Existing Information..... | 20 |
| 3.3.2 Field Surveys – 2007 and 2008..... | 20 |
| 3.3.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 20 |
| 3.4 Grassmere Creek Drain | 21 |

| | <u>Page</u> |
|--|-------------|
| 3.4.1 Review of Existing Information..... | 21 |
| 3.4.2 Field Surveys – 2007 and 2008..... | 22 |
| 3.4.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 24 |
| 3.5 Jackfish creek | 24 |
| 3.5.1 Review of Existing Information..... | 25 |
| 3.5.2 Field Surveys – 2007 and 2008..... | 25 |
| 3.5.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 25 |
| 3.6 Jennifer Creek | 26 |
| 3.6.1 Review of Existing Information..... | 26 |
| 3.6.2 Field Surveys – 2007 and 2008..... | 26 |
| 3.6.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 26 |
| 3.7 Netley Creek..... | 28 |
| 3.7.1 Review of Existing Information..... | 28 |
| 3.7.2 Field Surveys – 2007 and 2008..... | 29 |
| 3.7.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 31 |
| 3.8 Parks Creek | 32 |
| 3.8.1 Review of Existing Information..... | 32 |
| 3.8.2 Field Surveys – 2007 and 2008..... | 33 |
| 3.8.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 33 |
| 3.9 Ross Creek..... | 34 |
| 3.9.1 Review of Existing Information..... | 35 |
| 3.9.2 Field Surveys – 2007 and 2008..... | 35 |
| 3.9.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 36 |
| 3.10 Steele Drain | 36 |
| 3.10.1 Review of Existing Information..... | 36 |
| 3.10.2 Field Surveys – 2007 and 2008..... | 36 |
| 3.10.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 37 |
| 3.11 Tugela Creek | 38 |
| 3.11.1 Review of Existing Information..... | 38 |
| 3.11.2 Field Surveys – 2007 and 2008..... | 38 |
| 3.11.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 38 |
| 3.12 Wavey Creek | 39 |
| 3.12.1 Review of Existing Information..... | 39 |
| 3.12.2 Field Surveys – 2007 and 2008..... | 41 |
| 3.12.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 41 |
| 3.13 Whiskey Ditch..... | 43 |
| 3.13.1 Review of Existing Information..... | 44 |
| 3.13.2 Field Surveys – 2007 and 2008..... | 44 |
| 3.13.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 44 |
| 3.14 Norris Lake..... | 45 |
| 3.14.1 Review of Existing Information..... | 45 |

| | <u>Page</u> |
|--|-------------|
| 3.14.2 Field Surveys – 2007 and 2008..... | 46 |
| 3.14.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites..... | 46 |
| 3.15 Netley Marsh Shoreline..... | 46 |
| 3.16 Overview of Watershed 05OJ | 47 |
| 4.0 REFERENCES | 48 |

LIST OF TABLES

| | <u>Page</u> |
|---|-------------|
| Table 1. Length of watercourse (determined by the National Topographic Service Base), distances reviewed by ground and air, and percent of each watercourse classified for Watershed 05OJ, 2007. | 52 |
| Table 2. Fish species known to, or possibly, utilizing watercourses in Watershed 05OJ. Information based on a Fisheries Inventory Habitat Classification System (FIHCS) search conducted by Manitoba Water Stewardship – Fisheries Branch, 2007. | 53 |
| Table 3. Summer and fall fish utilization results, by watercourse and waypoint site (in <i>italics</i>) throughout Watershed 05OJ, 2007. Descriptions of waypoints are provided in Appendix 1.1 | 55 |
| Table 4. Results of spring fish utilization studies, conducted by North/South Consultants Inc. throughout Watershed 05OJ, 2008. | 56 |
| Table 5. Total number of reaches (by land use/cover), length of watercourse classified, and percentage of reach by land use/cover in Watershed 05OJ, 2007. | 58 |
| Table 6. Total number of reaches (by habitat quality rating), length of watercourse classified, and percentage of reach by rating in Watershed 05OJ, 2007. | 63 |
| Table 7. Index of potential rehabilitation sites identified by groundtruthing and aerial footage throughout Watershed 05OJ, 2007. | 66 |

LIST OF FIGURES

| | <u>Page</u> |
|---|--------------------|
| Figure 1. Watershed 05OJ study area, reaches of watercourse viewed by ground and air, and elevation points used to generate selected elevations profiles. | 68 |
| Figure 2. Longitudinal elevation profile (m) along the Grassmere Creek Drain..... | 69 |
| Figure 3. Longitudinal elevation profile (m) along Netley Creek..... | 69 |
| Figure 4. Longitudinal elevation profile (m) along Parks Creek..... | 70 |
| Figure 5. Longitudinal elevation profile (m) along Wavey Creek. | 70 |
| Figure 6. Sites groundtruthed throughout the northern portion of Watershed 05OJ, indicated by waypoint #, and specific land use/cover identified, 2007. | 71 |
| Figure 7. Sites groundtruthed throughout the central portion of Watershed 05OJ, indicated by waypoint #, and specific land use/cover identified, 2007. | 72 |
| Figure 8. Sites groundtruthed throughout the southern portion of Watershed 05OJ, indicated by waypoint #, and specific land use/cover identified, 2007. | 73 |
| Figure 9. Aquatic habitat quality ratings and potential rehabilitation sites (including previously identified sites) identified throughout the northern portion of Watershed 05OJ, 2007..... | 74 |
| Figure 10. Aquatic habitat quality ratings and potential rehabilitation sites (including previously identified sites) identified throughout the central portion of Watershed 05OJ, 2007. | 75 |
| Figure 11. Aquatic habitat quality ratings and potential rehabilitation sites (including previously identified sites) identified throughout the southern portion of Watershed 05OJ, 2007..... | 76 |

LIST OF APPENDICES

| | <u>Page</u> |
|---|--------------------|
| APPENDIX 1. Site descriptions and work conducted by North/South Consultants Inc..... | 78 |
| APPENDIX 2. Physical parameters and biological information obtained throughout watershed 05OJ | 82 |
| APPENDIX 3. Ground and air classifications for watercourses throughout watershed 05OJ | 91 |
| APPENDIX 4. A summary of detriments to riparian and/or aquatic ecosystem health, negative impacts, and potential mitigative measures. Reference section provided at end of appendix. | 110 |

1.0 INTRODUCTION

The use of water in Manitoba for such practices as agriculture, urban expansion and development, and recreation has severely taxed this precious resource. Policy developments (The Manitoba Water Strategy, 2003; *Water Protection Act*, proclaimed in 2006) focus on a number of water protection strategies, with a focus on watershed planning and a reduction in nutrient loading to Lake Winnipeg.

With funding obtained through the Manitoba Fisheries Enhancement Initiative and the federal Stewardship in Action fund, the East Interlake Conservation District (EICD) retained North/South Consultants Inc. to conduct the Watershed 05OJ -Riparian Assessment Survey. The primary objective of this survey was to provide the EICD board with a comprehensive overview of riparian and land use conditions affecting 3rd order drains (and higher) within Watershed 05OJ. Specific watercourses included: Cochrane Creek; Fisher Drain; Gramiak Drain; Grassmere Creek Drain (including Grassmere Creek Drain west); Jackfish Creek; Jennifer Creek; Netley Creek; Parks Creek; Ross Creek; Steele Drain; Tugela Creek; Wavey Creek; Whiskey Ditch; and Norris Lake (Figure 1). Also included in the study area was the shoreline of Netley Marsh (from Chalet Beach approaching the mouth of the Red River).

Specific objectives of the assessment included:

- To identify and assess the quality of riparian and aquatic ecosystem habitat;
- To identify barriers to fish passage and migration;
- To identify the extent in which recreationally important fish species utilize the watershed; and
- To provide a list of potential fisheries-based projects for future works within Watershed 05OJ.

This report provides baseline aquatic habitat and riparian conditions pertaining to the watershed. It can act as a resource tool for continued watershed management and water quality improvements.

2.0 METHODS

2.1 REVIEW OF EXISTING INFORMATION

2.1.1 Physical and Hydrological Information

The Environment Canada web page (www.msc.ec.gc.ca/wsc) was reviewed for historical hydrological data throughout Watershed 05OJ.

Using a USGS digital elevation model (DEM), elevation profiles were generated for the Grassmere, Netley, Parks, and Wavey creeks. The profiles were produced by intersecting points along polylines with 90 m Shuttle Radar Topography Mission (SRTM) USGS DEM, using Spatial Analyst extension in ESRI ArcGIS® v.9. Due to the coarse resolution of the DEM (i.e., each pixel is 90 m x 90 m) spikes in the elevation profiles may be exaggerated.

2.1.2 Water Quality

The Water Quality Management Section, Manitoba Water Stewardship (WQMS-MWS 2007), was queried for water quality records relating to Watershed 05OJ. Library and internet searches were also conducted for existing documentation.

2.1.3 Fish Species Utilization

Existing information on fish utilization in Watershed 05OJ was documented by querying the Manitoba Water Stewardship - Fisheries Branch (MWSFB) office in Winnipeg. The MWSFB Fisheries Inventory Habitat Classification System (FIHCS) was also searched by provincial staff. Where possible, interviews were conducted with local landowners and tenants who live within the watershed, and members of the Department of Fisheries and Oceans.

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) website was searched for fish species listed as: endangered; threatened; or special concern.

2.2 FIELD SURVEYS

2.2.1 Physical and Hydrological Information

To provide a general understanding of stream morphology and substrates in the various branches of the watershed, a number of sampling locations were selected during groundtruthing investigations. Site selection depended on road access, stream accessibility (i.e., depths and velocity), groundtruthing locations, and/or if fisheries investigations were to be conducted.

Substrate types (i.e., composition) were assessed based on a modified Wentworth classification, as outlined in Bain and Stevenson (1999). Substrate compaction was based on three general criteria (i.e., soft, medium, or hard) and determined by inserting a survey rod into the bottom of the stream bed (where possible). Stream velocities were measured with a Swoffer-Model 2100® velocity meter. Velocities measured in culverts were typically taken near the bottom. Discharges were calculated using the ‘mean section method’ outlined in Terzi (1981).

2.2.2 Water Quality

In conjunction with groundtruthing and fish utilization surveys, basic water quality parameters were measured *in situ* (i.e., in the field) with a Horiba U-10, YSI-550A, and/or a YSI-63 water quality meter. The parameters measured included: dissolved oxygen; conductivity (measured as specific conductance); temperature; pH; and turbidity. In some locations, water temperature was measured with a hand-held alcohol filled pocket thermometer. Water quality parameters were measured at or just below the water surface.

2.2.3 Fish Species Utilization

2.2.3.1 Summer and Fall 2007

Fish use within Watershed 050J was assessed during the summer (August 3 to 10) and fall (October 25 to 26) of 2007. Methods included back-pack electrofishing (Smith-Root Model LR-24), dip netting, and visual surveys. Effort was comparable at each site and was conducted to determine presence/absence and possible extent of spawning migration through capture of young-of-the-year fish species.

Sampling was conducted at sites throughout the watershed where access and/or water was available. All fish collected were identified to species and released. A number of the small-bodied fish were preserved in the field (10% formaldehyde solution) for subsequent identification. Any commercial or recreationally important species captured (i.e., northern pike, white sucker, yellow perch) were measured for fork length (± 1 mm).

2.2.3.2 Spring 2008

It was determined, by consultation with the EICD, that spring fishing efforts be focused on the following watercourses: Grassmere Creek Drain; and Netley, Parks, Ross, and Wavey creeks. The objective of spring fishing in Grassmere Creek Drain and Parks Creek was to determine species utilization. Efforts in Netley, Ross, and Wavey creeks were to determine species composition as well as extent of fish migration.

Fishing locations were based on suitable flow conditions (e.g., minimal spring velocity), depths (<1.5 m), and site accessibility. Efforts were based on water temperatures within the range of 4.0 °C to 10.0°C.

Oriented to capture fish moving upstream, hoop nets (1.2 m in diameter, constructed of 6.45 cm² nylon mesh, and 10.0 m long wings) were deployed between April 14 to 22. All fish captured were identified to species and released. A sub-sample of fish (approximately 25/species/day) were also measured for fork length (± 1 mm) and weight (± 25 g), classified by sex and state of maturity, and released. The duration of each set was approximately 20 to 24 hours.

Where possible, visual inspections for fish presence were conducted along stream reaches.

2.2.4 Groundtruthing

Areas of Watershed 050J were groundtruthed for the identification of potential rehabilitation sites and collection of ground-based photographs. This was accomplished by driving along lengths of drain and/or creek (where possible) and observing existing conditions (Figure 1). All sites visited were geolocated with the use of a hand held Global Positioning System (GPS).

For the purpose of groundtruthing, the riparian area was defined as the area of land starting at the channel bank, extending perpendicular by at least one full channel width. Also, bank sides (i.e., left or right) were delineated while looking upstream.

Limitations of ground based reconnaissance usually center on landowner approval, presence of roads, or the ability of the vehicle being used.

2.2.5 Aerial Videography

Between the hours of 10:00 and 12:30, aerial videography was collected from an Airvan® fixed wing plane on October 11, 2007. Videography equipment included: a laptop loaded with ESRI ArcGIS®, ArcView Geographic Information System (GIS) software, a handheld Garmin Etrex® GPS unit, and a Canon Mini-DV digital video recorder. The video was collected at an average airspeed of 80 knots and an altitude between 1,700 to 2,000 feet.



Photo1. Airvan® fixed wing airplane chartered for aerial videography on October 11, 2007.

The flight path was developed to gather information from areas that could not be readily accessed by vehicle or where natural stream sinuosity appeared to occur on map (Figure 1). The aerial video was compiled to assist in the identification of potential rehabilitation sites (Section 2.3.4) and to document existing conditions within Watershed 050J.

The collection of video via fixed wing aircraft can limit the effectiveness or resolution of classification. Limitations may include: the aircrafts inability to alter speed or altitude in quick response to a stream course; turbulence impacting the aircrafts stability and thus video clarity; and the inability to fly directly over a stream channel often resulting in the collection of video from only one bank.

2.3 CLASSIFICATIONS

Information collected on Watershed 050J (via groundtruthing and aerial video was reviewed for basic land use/cover (Section 2.3.1), areas of detriment to aquatic habitat (e.g., eroding shorelines), and potential barriers to fish migration. The end results were to classify riparian areas within the watershed according to aquatic habitat quality and to develop a prioritized list of potential fisheries-based projects for future works.

Where noted, reaches were bound by obvious changes in classification attributes and extended at least two active channel widths on each side. The active channel width is the stream width at 'bank full' discharge or the flow rate that controls the shape and size of the active channel (USDA 1998).

The following sections outline the rationale behind the land use/cover classifications, the rating system incorporated for aquatic habitat quality and the prioritization methodology employed for each potential rehabilitation site.

2.3.1 Land Use/Cover and General Classifications

Within the boundaries of classification systems, the definition of land use and/or land cover is often interchangeable. However, within this document the accepted definition of land use refers to the direct use of land by humans (e.g., agricultural practices, homesteads, industry) (Clawson and Stewart, 1965 in: Anderson et al. 1976). Although land cover can also refer to human practices (e.g., cropland), within the scope of this document land cover refers to more 'natural' cover types (e.g., mixed deciduous, non-forested wetland).

Land use/cover within Watershed 050J was reviewed for eight general categories as outlined below. The categories were developed by North/South Consultants Inc. based on the predominant land use practices found in the region and by implementing classifications described by Anderson et al. (1976). The categories focused on reaches of the watercourses and the predominant land use adjacent to them. Although the reaches classified could incorporate more than one land use/land cover type, classification of each reach was based on the most intensive use within the area.

Residential/Commercial: Anderson et al. (1976) define residential as an area with multiple units (e.g., houses) or houses on lots of more than one acre. Generally, residential strips have uniform size and spacing of structures, linear driveways, and lawn areas. Examples of residential areas are towns or the recently developed 'suburbs' of these small towns. The

commercial classification outlines areas used for the sale or production of goods and services, and may include: warehouses; waste disposal areas; strip developments; junkyards; etc.

Other Agricultural Land: This category is applied when separate land uses cannot be mapped individually and typically involves agricultural practices. This classification may include: farmsteads; holding areas for livestock (i.e., corrals); or structures associated with agricultural practices (e.g., barns, storage silos, etc.). Practices under this category are typically on a small scale.

Other Urban or Built-up Land: Land use within this category is defined as golf courses, parks, cemeteries, and undeveloped land within an urban setting (Anderson et al. 1976).

Crop Land: This category may be defined as land used for the production of food (e.g., wheat crop, legumes, etc.). These areas are generally characterized by coarser textures, linear crop/cultivation features, and yellow to gold colour tones. Land under cultivation or without vegetative cover (e.g., tilled) also falls under this category.

Hayland: This category is defined as land used for the production of forage crops for livestock (e.g., alfalfa, timothy, etc.). Hayland crops are often characterized by hay bales spotting the landscape adjacent to watercourses.

Pasture/Grazing: Areas of land used for livestock operations were classified as pasture/grazing. This land use is generally characterized by a smooth texture resulting from grazed herbaceous cover. Pasture/grazing is often associated with heavily defined linear tracks and, where applicable, fence lines. Pastures in forested areas were identified by a decreased density of trees within the forest stand.

Mixed Forest: This classification includes forested areas where evergreens and deciduous trees are growing, yet neither predominate (Anderson et al. 1976).

Non-forested wetland: This classification is defined as an area where wetland herbaceous vegetation dominants (e.g., *Juncus*, *Typha*, *Carex*, etc.) (Anderson et al. 1976). However, within this document, woody species (e.g., willow, alder, oak) may also be present.

Residential/commercial, other agricultural land, other urban or built-up land, cropland, hayland, and pasture/grazing, were considered to be anthropogenic in origin. Mixed forest land and non-forested wetland are assumed to be in natural states or areas not necessarily altered by anthropogenic means.

2.3.2 Aquatic Habitat Quality and Qualitative Ratings

Aerial video and information collected by groundtruthing were used to classify aquatic habitat conditions within Watershed 050J. Streams were classified based on a visual qualitative assessment of conditions in and adjacent to the watercourse. Stream condition assessments were based on the United States Department of Agriculture Stream Visual Assessment Protocol (USDA 1998).

The classification system was based on identifying potential impacts to aquatic habitat as either a 'Positive' or 'Negative' attribute to stream processes. The four criteria selected for the evaluation of impacts were: channel morphology (hydrologic alterations and channelization); bank stability; riparian zone function; and barriers to fish migration. These criteria were chosen based on their relative importance to stream health as described within the USDA Stream Visual Assessment Protocol (1998), and the ability to interpret these criteria using both the quality of the video and the accessibility of the watercourse.

The following sections describe the stream conditions assessed in determining aquatic habitat quality, as well as the classification methods used.

2.3.2.1 Channel Morphology

Bank full flows and flooding are important in maintaining both the shape of a channel and its function (USDA 1998). High flows can redistribute larger sediments and debris to form pool/riffle habitats and increase the habitat diversity of a watershed. Altered channel morphology can limit the scouring effect of high flows, allowing siltation of important spawning areas and habitat zones (USDA 1998; Bain and Stevenson 1999).

Channel morphology was rated based on the following criteria (USDA 1998):

Negative condition(s):

- Dykes or other man-made structures were present that prevented natural flooding of the adjacent floodplain;
- Channel was altered, braided, or contained man-made structures restricting floodplain width. Channel may be incised; or
- Evidence of past channel alteration, but with significant recovery of channel and banks.

Positive condition(s):

- Channel appears to be ‘natural’ with no structures or dykes. No dams, water withdrawal, dykes or other structures limit stream access to the floodplain.

2.3.2.2 Bank Stability

Stream banks are important transition zones between aquatic and terrestrial systems (Bain and Stevenson 1999). Eroding banks can reduce instream fish cover, reduce water transparency, smother fish eggs and benthic invertebrates with silt, and infill shallow water habitats (Bain and Stevenson 1999). Although some bank erosion is normal in a healthy watershed system, excessive erosion can occur when riparian areas are degraded, hydrology is altered, or when sediment load is increased (USDA 1998).

Assessments of bank stability were based on the potential for detachment of soil from the upper and lower stream banks and the subsequent deposition to the stream channel. Due to the scale and resolution of the aerial video, bank stability was at times difficult to assess visually using videography. Therefore, ratings were primarily based on the application of groundtruthing data and an overall visual assessment of the stream reach being classified.

Bank stability was rated on the following criteria (USDA 1998):

Negative condition(s):

- Bank(s) unstable and typically high. There may be overhanging vegetation at top of a bare bank, trees falling into stream, or a number of slope failures apparent;
- Bank(s) moderately unstable and typically high. Some trees may be falling into the stream and there may be some slope failures apparent; or
- Bank(s) moderately stable and low. A lower amount of eroding surface on outside bends is protected by roots that extend to the base-flow elevation.

Positive condition(s):

- Bank(s) are stable and low. A large amount of eroding surface area on outside bends is protected by roots that extend to the base-flow elevation.

2.3.2.3 Riparian Zone Function

Riparian zone is defined as an area adjacent to a body of water or as the transition zone between aquatic and upland areas; it can also be referred to as riparian buffer zone, buffer strip, or vegetation retention zone (Kipp and Callaway 2003; Williams et al. 1997; Bain and

Stevenson 1999). The health of the riparian zone is fundamental to the well-being of an entire stream ecosystem (USDA 1998). A healthy riparian zone can: buffer the introduction of pollutants and/or organic matter to a stream; regulate instream algal production via shading; decrease erosion by stabilizing stream banks and dissipating energy during flood events; provide a source of cover, food, and microclimate control for fish and invertebrates; and act as a travel corridor for terrestrial animals/birds (Williams et al. 1997; USDA 1998; Bain and Stevenson 1999; Koning 1999).

From an agricultural standpoint, riparian vegetative cover helps regulate soil climate, stimulate soil activity (via biomass production), and acts as a buffer between water courses and fertilizer and pesticide applications (Donat 1995). It has been found that dew formation and soil moisture increase in the vicinity of a well-established riparian zone (Donat 1995). The quality of the riparian zone increases as both the width and complexity of woody vegetation within it increases (USDA 1998).

Riparian zone function was rated based on the following criteria (USDA 1998):

Negative condition(s):

- Natural vegetation/regeneration of vegetation is lacking and the ‘filtering’ function of the riparian zone is severely or moderately compromised.

Positive condition(s):

- Natural vegetation extends at least two active channel widths on each side and the ‘filtering’ function of the riparian zone does not appear to be compromised.

2.3.2.4 Barriers to Fish Migration

Barriers to fish movement can be defined as any structure or habitat conditions that create a potential obstacle to fish movements under certain hydrologic conditions (Bain and Stevenson 1999). These barriers can be anthropogenic in origin (e.g., concrete structure, earthen dam, dike, perched culvert) or natural (e.g., beaver dam, debris dam, rapids). Besides limiting/stopping the movement of fishes, barriers can affect the health of a stream via disruption of stream flow, sediment transport, and thermal regimes (Bain and Stevenson 1999).

Barriers, or areas with the potential to impede migration of fish movement, were primarily identified from groundtruthing and, where possible, review of aerial video. Barriers were classified as follows:

- 1) Beaver dams;
- 2) Debris – accumulations of natural or man-made debris; and
- 3) Anthropogenic – dams, fords, or culverts.

Under the classification of anthropogenic barriers, dams may also be referred to as ‘low-head dams’. A low-head dam is defined as a constructed barrier in a river, spanning the entire width, with a hydraulic height not exceeding eight meters (ICF Consulting 2005). Dam composition may include concrete, sheet metal, rubble, boulder (or a similar aggregate).

Fords are typically defined as low-water stream crossings with bank access allowing either temporary or permanent passage to vehicles and livestock (Fisheries and Oceans - Manitoba Natural Resources 1996; Armantrout 1998). Within this document, ford composition may include naturally occurring materials (e.g., stream bed), transported aggregate (e.g., gravel, boulder, cobble), or a low level composition of cement and culvert. Although allowing some fish passage via culvert placement, the cement culvert ford is considered a potential barrier. Upstream fish passage at these sites may be hindered in the spring during low water events. Downstream (larval, juvenile, or adult) migrations may also be hindered during similar hydrologic conditions. The culverts may also act as velocity barriers or become plugged with debris.

Culverts, within roads, are also listed as potential barriers if: they act as velocity barriers; become plugged with debris; or appear to be perched.

Each barrier was assessed as to the severity of blockage including the potential to limit fish access to important areas for feeding, reproduction, and/or rearing.

Given the limitations of aerial videography and the logistics involved with groundtruthing, it is expected that some barriers were not identified.

2.3.2.5 Qualitative Ratings

To assist in the identification of sites for rehabilitation, a qualitative rating of aquatic habitat quality was assigned to areas of streams based on an overall visual assessment of the four basic stream processes described above (Section 2.3.2). The rating system incorporated four classes as outlined below:

- Class A: Stream reaches within this category were minimally impacted and tended to have natural channel morphology. The riparian vegetation, which was typically present on both stream banks, provided a high level of buffering capacity, fish habitat, and bank stability.
- Class B: Stream reaches in this category were moderately impacted, and typically had a more natural channel morphology and hydrologic regime than Class C reaches. Bank stability in this class tended to be moderate. Commonly, a margin of natural vegetation may have remained, increasing bank stability and buffering capacity. Some stream reaches in this category had more 'natural' conditions on one bank and a greater amount of impact on the opposite bank.
- Class C: Stream reaches within this category were highly impacted and generally had altered hydraulic regimes (e.g., channelization, barriers). Bank stability in this class tended to be moderate. Reaches with marginal riparian vegetation may have had a moderate filtering capacity.
- Class D: Stream reaches within this category were severely impacted and generally characterized by altered channels and a heavily altered hydrologic regime. There was a lack of vegetative regeneration within the riparian zone, and because of this the filtering function of the riparian zone may have been severely compromised. The bank was generally unstable within this class.

Typically, drains are constructed to either remove excess water from fields or to supply irrigation water to areas which require water (Evanitski, no date; AAFC-PFRA 2004). Although drains can offer certain agricultural advantages (e.g., earlier planting times) there are environmental concerns associated with them. An accelerated removal of water from fields can place rivers into a flood or near flood stage, increasing the risk of water erosion and bank failure (AAFC-PFRA 2004). Man-made drains are often also associated with marginal riparian zones, which are unable to act as effective buffers resulting in increased introduction of substances deleterious to the aquatic habitat (DFO 1995; AAFC-PFRA 2004).

By definition, drains typically exhibit one or all of the negative conditions associated with degraded aquatic habitat discussed within this document. Therefore, when a watercourse was labelled as 'drain' during the initial land use/cover classification it automatically received a Class C rating. However, segments of the drain may also receive a Class D rating if multiple negative conditions are observed (e.g., linear design, barrier present, slumping bank(s), denuded/removed riparian, agricultural inputs, etc).

2.3.3 Fish Habitat Classification

Upon reviewing existing information, and completing: ground truthing investigations and surveys; land use/cover classifications; and defining stream reaches according to aquatic habitat quality; watercourses within the study area were assessed for their ability to support a fish community. Within this document and for the purpose of developing fisheries based rehabilitation plans, 'fish community' is defined as habitat utilization by commercial or recreational important species. These typically larger bodied fish could be species such as northern pike, walleye, sucker *sp.*, channel catfish, freshwater drum, lake whitefish, etc. Although smaller bodied/forage fish species (e.g., brook stickleback, central mudminnow, common shiner, etc.) are not included in this definition, they are still taken into consideration and recognised as an important part of the aquatic ecosystem. Based on a subjective assessment, outlined in Newbury and Gaboury (1993), four standardized classes were utilized:

- Class 1: Water bodies having a high capability for production of fish;
- Class 2: Water bodies having slight limitations to production of fish;
- Class 3: Water bodies having moderate limitations to production of fish; and
- Class 4: Water bodies having severe limitations to production of fish.

In addition to the classes defined above the following three definitions were also considered in assessment of fish habitat within the study area (DFO 1998):

- Critical Habitat: Habitat requiring a high level of protection due to their importance in sustaining subsistence, commercial or recreational fisheries, rareness, high productive capacity, or sensitivity of certain life stages of fish species being supported;
- Important Habitat: Habitat requiring a moderate level of protection, including areas utilized for fish feeding, growth, and migration. These areas are not considered critical, contain a large amount of comparable habitat, and may include areas previously disrupted by human activity; and
- Marginal Habitat: Habitat requiring minimal protection. These areas would have a low productive capacity and marginally contribute to fish production. However, these areas would also have a reasonable potential for enhancement or restoration.

2.3.4 Potential Rehabilitation Sites

A compilation of potential rehabilitation sites was developed following completion of groundtruthing, a review of the aerial footage, and an application of the qualitative rating systems discussed above. Once reviewed, sites were prioritized using a scale from 1 to 3. Sites given a priority of 1 were often ‘large’ in scale, exhibiting multiple environmental issues (e.g., water quality degradation, shoreline erosion, denuded riparian, etc.) that may warrant more immediate attention (i.e., rehabilitation efforts). These sites typically had many direct negative impacts on the health of the watershed. Conversely, sites labelled as priority 3 were often ‘smaller’ in scale, typically exhibiting only one environmental concern. Sites identified as priority 3 were also areas in which: long-term planning could be required; a return to the sites ‘full’ potential could not occur within a reasonable time frame; the site may not currently be a detriment to habitat quality, but may become one in the future (USDA 2004).

3.0 RESULTS AND DISCUSSION

For ease of reference, results for watercourses are provided in alphabetical order.

The majority of existing information on Watershed 05OJ was collected through discussions with Manitoba Water Stewardship and, to a lesser extent, conversations with local landowners. The Department of Fisheries and Oceans conducted a number of fisheries based surveys within Watershed 05OJ; however the data is currently in an unpublished stage (Milani 2007).

Agriculture and Agri-Food Canada – Prairie Farm Rehabilitation Administration (AAFC-PFRA 2004b) compiled a summary of resources and land use issues related to riparian areas in the lower Red River watershed. This document could be used for baseline data in the development and refinement of a management plan for Watershed 05OJ.

Distances provided in this document (i.e., length of watercourse, length of reaches defined by land use/cover, and length of reaches defined by aquatic habitat quality) may vary slightly from one identifier to another. This variation stems from the inability to view all portions of a watercourse either from the ground or air and from inferences developed while completing classifications for certain reaches of stream. Therefore, distances provided should be taken as best approximations.

Length of watercourse, distance covered by air and ground, and the percentage of the watercourse classified is provided in Table 1. Table 2 outlines results of the FIHCS search conducted by Manitoba Water Stewardship – Fisheries Branch. Summer/fall 2007 fishing, and spring 2008 fishing conducted by North/South Consultants Inc. are provided in Tables 3 and 4. Land use/cover and aquatic habitat classifications are provided in Tables 5 and 6. Potential rehabilitation sites are outlined in Table 7.

The study area is presented in Figure 1. Elevation profiles are presented in Figures 2 to 4. Land use/cover classifications and groundtruthing sites (i.e., waypoints) are provided in Figures 6 to 8. Aquatic habitat classifications and potential rehabilitation sites are provided in Figures 9 to 11.

Waypoint descriptions are provided in Appendix 1. All stream properties measured (i.e., discharges, depths, substrate composition), in situ parameters measured by North/South Consultants, and biological information recorded during fisheries investigations are provided in Appendices 2.1 to 2.4. Ground and aerial based classifications are provided in Appendix

3 (Appendices 3.1 to 3.15). A summary of detriments to riparian areas and/or aquatic ecosystem health, as well as potential mitigative measures are provided in Appendix 4.

3.1 COCHRANE CREEK

Cochrane Creek primarily flows in an easterly direction for approximately 5 km, before emptying into Lake Winnipeg, south of Chalet Beach (Table 1, Figure 1).

3.1.1 Review of Existing Information

No hydrometric data was found on the Water Survey of Canada website pertaining to Cochrane Creek (ECWSC 2008). The WQMS-MWS (2007) did not have existing information regarding Cochrane Creek.

Brook stickleback are known to inhabit Cochrane Creek (FIHCS search, Manitoba Water Stewardship – Fisheries Branch) (Table 2).

3.1.2 Field Surveys – 2007 and 2008

Cochrane Creek was visited on the ground, where possible, for the collection of ground based photographs. No fisheries investigations were conducted in Cochrane Creek during the summer/fall of 2007 due to limited to non-existent flow conditions (Photo 2). Cochrane Creek was not identified for spring 2008 fisheries investigations.



Photo 2. Looking downstream along Cochrane Creek, Wpt. 85, September 25, 2007.

3.1.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground based classifications for Cochrane Creek are provided in Appendix 3 (Table A3-1). Starting at its headwaters, at least one-half of Cochrane Creek has been channelized (Figure 6, between waypoints 9 and 85). Although not immediately accessible by road, it is assumed that the remainder of this watercourse (from waypoint 85 to its mouth) maintains a natural sinuosity and relatively un-impacted wooded area.

The 3.2 km of Cochrane Creek classified according to land use/cover was determined to be other agricultural land (Table 5). Based on field observations and existing land use practices, the portion of this creek reviewed was given a Class C aquatic habitat rating (Table 6). However, the unobserved/un-classified portions would likely fall into a Class B or A rating.

No potential rehabilitation sites were identified along the sections of Cochrane Creek that were reviewed (Figure 9).

The fish habitat between waypoints 9 and 85 is identified as Class 4, having severe limitations to the production of fish, and consisting of marginal habitat (i.e., uniform channels, minimal to non-existent flows). It is assumed that the fish habitat between waypoint 85 and the mouth of Cochrane Creek would be Class 2 fish habitat, but would remain marginal.

3.2 FISHER DRAIN

The Fisher Drain flows, primarily, in an easterly fashion for approximately 5 km before emptying into Lake Winnipeg (Table 1, Figure 1).

3.2.1 Review of Existing Information

No hydrometric data was found on the Water Survey of Canada website pertaining to Fisher Drain (ECWSC 2008). In addition, the WQMS-MWS (2007) did not have existing water quality information regarding this watercourse.

No information was found regarding fish utilization of the Fisher Drain during the FIHCS search conducted by Manitoba Water Stewardship – Fisheries Branch.

3.2.2 Field Surveys – 2007 and 2008

Fisher Drain was visited on the ground, where possible, for the collection of ground based photographs. No fisheries investigations were conducted in Fisher Drain during the summer/fall of 2007 due to limited to non-existent flow conditions. Low flow conditions also prevented the collection of hydrometric data (Photo 3). Fisher Drain was not identified for spring 2008 fisheries investigations.

3.2.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground based classifications for Fisher Drain are provided in Appendix 3 (Table A3-2).

Over half (58.4%) of the 5.4 km of the Fisher Drain classified according to land use/cover was determined to be other agricultural land. This was followed by mixed forest land (21.1%), cropland (14.4%), and hayland (6.2%) (Table 5, Figure 6).

This highly channelized watercourse was given an aquatic habitat quality rating of Class C (highly impacted) (Table 6, Figure 9). The fish habitat observed (between waypoints 13 and 19) exhibited Class 4 fish habitat (i.e., severe limitations to production of fish) and should be considered as marginal (Figure 6).



Photo 3. Looking downstream on Fisher Drain at Wpt. 17, August 3, 2007.

One potential rehabilitation site was identified on the Fisher Drain (Table 7, Figure 9). Involving bank erosion, this site (#30) was given a priority 3 due to the close proximity of the agricultural practice (i.e., crops).

3.3 GRAMIAK DRAIN

Located near the town of Argyle, the Gramiak Drain primarily flows eastward for approximately 9 km before discharging into the headwaters of the Grassmere Creek Drain (Table 1, Figures 1 and 8).

3.3.1 Review of Existing Information

No hydrometric data was found on the Water Survey of Canada website pertaining to the Gramiak Drain (ECWSC 2008). In addition, the WQMS-MWS (2007) did not have existing water quality information regarding the Gramiak Drain.

No information was found regarding fish utilization of the Fisher Drain during the FIHCS search conducted by Manitoba Water Stewardship – Fisheries Branch.

3.3.2 Field Surveys – 2007 and 2008

Gramiak Drain was visited on the ground, where possible, for the collection of ground based photographs. No fisheries investigations or hydrometric surveys were conducted in Gramiak Drain during the summer/fall of 2007 due to the absence of any water (Photo 4). Gramiak Drain was not identified for spring 2008 fisheries investigations.

3.3.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for the Gramiak Drain are provided in Appendix 3 (Table A3-3).

All (100%) of the 8.8 km of the Gramiak Drain reviewed for land use/cover was determined to be other agricultural land (Table 5). The Gramiak Drain is primarily a ‘grassed ditch’, channelized (likely) to accelerate the flow of water from agricultural land, and was therefore rated as Class C (highly impacted) (Table 6, Figure 11). In addition, the fish habitat along this drain is considered as Class 4 (severe limitations to fish production) and/or comprising marginal habitat.

No potential rehabilitation sites were observed along the Gramiak Drain.



Photo 4. Looking downstream along Gramiak Drain, Wpt. 35, August 8, 2007.

3.4 GRASSMERE CREEK DRAIN

The Grassmere Creek Drain (including west arm) primarily flows in a south easterly direction for approximately 46 km before emptying into the Red River (Table 1, Figure 1). This drain passes through or in the vicinity of the communities of Grosse Isle (in the west) and West St. Paul (near the Red River and the City of Winnipeg's north perimeter Hwy.). With an average elevation of 238 m, the Grassmere Creek Drain drops only 26 m between its headwaters and its confluence with the Red River (Figures 1 and 2).

3.4.1 Review of Existing Information

Located near Middle Church, archived hydrometric data is available for one station (# 050J017; 1963 to 2007) on the Grassmere Creek Drain (ECWSC 2008). A cursory inspection of the data shows peak mean monthly flows occurring in April ($4.32 \text{ m}^3/\text{s}$), which taper off from May through June (ECWSC 2008). There is a second peak during July ($0.654 \text{ m}^3/\text{s}$), but the discharge tapers off again through to October ($0.053 \text{ m}^3/\text{s}$). Typically, flows along the Grassmere Creek Drain are 'slow' and by mid-summer often stagnate. This is likely a result of the gradual drop in elevation from the headwaters of Grassmere Creek Drain to its confluence with the Red River (approximately 26 m over a distance of 46 km) (Table 1, Figures 1 and 2).

The WQMS-MWS (2007) did not have existing water quality information regarding the Grassmere Creek Drain.

A total of 4 species of fish were identified to be utilizing the Grassmere Creek Drain (FIHCS search, MWSFB 2007). These were fathead minnow, northern pike, white sucker, and yellow perch (Table 2).

3.4.2 Field Surveys – 2007 and 2008

Water quality parameters measured in the field (by North/South Consultants Inc.) are provided in Appendix 2 (Table A2-2). Dissolved oxygen measured at waypoint 26 on August 26, 2007 was below the MWQ objective instantaneous minimum of 5.00 mg/L for the protection of cool water aquatic life (i.e., 3.94 mg/L) (Photo 5). However, when measured at Wpt. 26 on October 25 the dissolved oxygen was within the MWQ guidelines (i.e., 11.29 mg/L).



Photo 5. Grassmere Creek Drain at Wpt. 26, August 9, 2007.

Summer/fall fish utilization surveys were conducted at a total of 4 sites throughout the Grassmere Creek Drain (Table 3, Figure 8, Appendix Table A1-1). Twenty fish, representing 4 species were captured, which included: black crappie; brook stickleback;

johnny darter; and pearl dace. A number of forage fish (likely pearl dace) were also observed at Wpt. 26 (Photo 5).

Hoop nets were established at two locations along the Grassmere Creek Drain in the spring of 2008 (Wpts. 87 and 90; Figure 8, Appendix Table A1-1). At Wpt. 87, only one northern pike was captured after five evenings of fishing effort in water temperatures ranging from 3.0 to 11.0°C (Table 4). The fishing effectiveness of this hoop net was impaired by large amounts of debris floating through the Grassmere Drain, specifically grass trimmings and cardboard.

The hoopnet set at Wpt. 90 (located on the downstream side of a sheet pile weir) captured 23 northern pike in less than 24 hours (Photo 6). The majority of these fish were ripe males and/or females ready to spawn in the current year. Under the flow conditions exhibited in the spring of 2008 (i.e., 0.296 m³/sec on April 23 determined by North/South Consultants) the sheet pile weir located at the mouth of this drain effectively prevented the upstream



Photo 6. Hoop net near the mouth of Grassmere Creek Drain (Wpt. 90), spring 2008.

migration of fish species. In previous years of higher water (i.e., discharges greater than 0.296 m³/sec) local residents have seen migrations of what appeared to be northern pike and sucker species migrating past their properties (located between Hwys. 8 and 9). This

information suggests that the sheet metal weir near the mouth is not a complete barrier to migration events, although it is likely a deterrent to both upstream and downstream migrations of all life stages.

3.4.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for the Grassmere Creek Drain are provided in Appendix 3 (Table A3-4).

Approximately 41 km of Grassmere Creek Drain were classified by land use/cover (Table 5, Figure 8). Other agricultural land (70.3%) comprised the majority of the classification, followed by: other urban or built-up land (18.2%); hayland (9.2%); and residential/commercial (2.4%).

The nearly 41 km of the Grassmere Creek Drain classified by aquatic habitat was rated as Class C (96.6%), followed by Class D (3.0%), and B (0.5%) reaches (Table 6, Figure 11). With the exception of the small reach of drain that extends from Wpt. 90 downstream to the Red River (rated as Class 2) and the length of drain from Wpt. 90 upstream to Wpt. 26 (Hwy. 9) (rated as Class 3) the entire length of the Grassmere Creek Drain should be considered as Class 4 fish habitat with low productive capacity (i.e., marginal).

A total of 5 potential rehabilitation sites have been identified along the Grassmere Creek Drain (Table 7, Figure 11). Three of these sites (#'s 31, 32, and 33) were identified as Priority 2, relating to the potential to block the passage of fish at low ford crossings and/or culverts. Rehabilitation site #34 related to the slumping of the drain, however reconstruction was already underway along this site. The final rehabilitation site (#46) related to a sheet metal weir which prevented the spring migration of fish in 2008. Given a Priority 1, this site could be reconstructed to allow both the upstream and downstream migration of fish species at any water level.

3.5 JACKFISH CREEK

From its headwaters, nearly one-half of this (approximately 21 km) watercourse flows in a southerly direction prior to heading east and emptying into the headwaters of Wavey Creek (Table 1, Figure 1).

3.5.1 Review of Existing Information

Neither hydrometric data nor water quality information was found pertaining to Jackfish Creek (ECWSC 2008; WQMS-MWS (2007)).

Manitoba Water Stewardship-Fisheries Branch (FIHCS search) identified a total of 4 fish species (blacksided darter, central mudminnow, white sucker, and yellow perch) to have utilized Jackfish Creek at some point in time (Table 2).

3.5.2 Field Surveys – 2007 and 2008

No discharge measurements or fisheries investigations were conducted on Jackfish Creek in 2007 due to minimal/non-existent water levels (Photo 7). Jackfish Creek was also not identified for spring fisheries investigations in 2008 .



Photo 7. Looking upstream on Jackfish Creek at Wpt. 38, August 9, 2007.

3.5.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for Jackfish Creek are provided in Appendix 3 (Table A3-5).

Approximately 59% of the 21 km of Jackfish Creek reviewed for land use/cover was determined to be cropland (Table 5, Figure 7). This was followed by pasture/grazing (21.8%), other agricultural land (16.1%), and hayland (2.9%).

The 21 km of Jackfish Creek rated for aquatic habitat quality was either Class C (78.4%) or Class D (21.6%) (Table 6, Figure 10). Although this watercourse maintains some natural sinuosity and channel diversity, its riparian area is typically ‘thinned’ to accommodate agricultural practices or channelization (east of Hwy. 7). This accounts for the high percentage of highly and severely impacted areas.

The location of this watercourse (i.e., tributary to the headwaters of Wavey Creek), ephemeral nature, impacted aquatic habitat, and existing land/use/cover were all considered when rating the fish habitat of Jackfish Creek as Class 4; having severe limitations to fish production and/or comprising marginal habitat.

Four sites have been identified along Jackfish Creek that may warrant rehabilitation (Table 7, Figure 10). Primarily dealing with agricultural practices (i.e., cattle pasture and hayfield) these sites were rated as Priority 2 (n = 2) and 3 (n = 2).

3.6 JENNIFER CREEK

Jennifer Creek primarily flows in a south easterly direction for approximately 16km before emptying into the headwaters of Wavey Creek (Table 1, Figure 1).

3.6.1 Review of Existing Information

No existing hydrometric or water quality data was located for Jennifer Creek (ECWSC 2008; WQMS-MWS 2007).

No fisheries records were located for Jennifer Creek following an FIHCS search (MWSFB 2007).

3.6.2 Field Surveys – 2007 and 2008

Neither hydrometric nor fisheries investigations were conducted on Jennifer Creek in 2007 due to minimal/non-existent flow (Photo 8).

3.6.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for Jennifer Creek are provided in Appendix 3 (Table A3-6).



Photo 8. Looking upstream on Jennifer Creek at Wpt. 36, August 9, 2007.

Along Jennifer creek, other agricultural land (59.6%) (i.e., cropland and hayland) was the primary land use/cover, followed by pasture/grazing (38.2%), and mixed forest (2.2%) (Table 5, Figure 7). The two reaches of pasture/grazing identified along this creek appear to be extensive and may warrant additional investigation.

With the exception of two reaches of Class D habitat and one reach of Class B, the majority of Jennifer Creek was given a Class C aquatic habitat quality rating (Table 6). While maintaining some natural stream sinuosity (between Wpts. 6 and 36), the upper and lower portions of Jennifer Creek have been channelized (Figure 10). In addition, hayland and cropland appears to extend very close to the creek channel, thus reducing effectiveness of any riparian areas and (likely) increasing erosion.

One potential rehabilitation site was identified (by groundtruthing) on Jennifer Creek (Table 7, Figure 10). This site (# 39) was identified as an area of potentially extensive grazing within the channel of this creek. Although not listed as a rehabilitation site, the second reach of pasture/grazing along this creek should be inspected for potential rehabilitation.

Given its location in Watershed 050J (i.e., headwaters of Wavey Creek), lack of natural stream flow (evidenced in 2007), and current land practices, it is unlikely that Jennifer Creek provides either important or marginal fish habitat. However, as a tributary to larger

watercourses rehabilitation efforts (e.g., improvements to water quality) on this creek still warrant consideration.

3.7 NETLEY CREEK

With its headwaters located near Norris Lake, Netley Creek primarily flows in a south easterly direction before emptying into the Red River, a distance of approximately 60 km (Table 1, Figure 1).

3.7.1 Review of Existing Information

Environment Canada - Water Survey of Canada has hydrometric data from two stations located on Netley Creek (ECWSC 2008). Station # 05OJ009, located near Matlock, is discontinued but has 37 years of flow data from 1960 to 1996. Located near Petersfield station # 05OJ008 is still active, providing flow and level data since 1960. Horne and MacDonell (1996) summarized this data providing monthly discharges and an annual flood frequency curve between 1960 and 1994. A review of the more current data indicates flows on Netley Creek still peak during the spring melt, receding into summer. The course of Netley Creek is gradual, dropping only 47 m over a distance of approximately 60 km (Table 1, Figures 1 and 3).

Existing water quality information from 4 separate stations was available for Netley Creek between the years 1994 and 2005 (WQMS-MWS 2007). This data was provided to the EICD manager (electronic copy) for inclusion into their existing water quality database on Netley Creek.

Provincial fisheries records indicated the presence of 27 species of fish within the Netley Creek watercourse (Table 2) (FIHCS search, MWSFB 2007). Some of the economically and recreationally important species of fish (larger bodied) itemized in this watercourse are: carp; channel catfish; goldeye; northern pike; sauger; walleye; white bass; white sucker; and yellow perch.

The FIHCS search also indicated the presence of 20 species of fish within the Netley Marsh (Table 2). Comparable to the list of species found in Netley Creek, additional large bodied species included: bigmouth buffalo; cisco; freshwater drum; and quillback.

The bigmouth buffalo was designated as a species of ‘special concern’ in April 1989 because it has a ‘limited and disjunct distribution in Canada and occurs in low numbers’ (COSEWIC 2008). The Species At Risk Act (SARA) defines special concern as ‘a wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats’. Often misidentified as carp, the bigmouth buffalo is primarily found in the Assiniboine (downstream of Portage La Prairie) and Red rivers, and within the lowermost reaches of tributaries entering the Red River (Stewart and Watkinson 2004). Its preferred habitat is the shallow depths of slow or still waters of larger rivers, oxbows, or reservoirs with a tolerance for turbid water (Scott and Crossman 1979). Despite its designation, Stewart and Watkinson (2004) suggest that there has either been a noticeable increase in the abundance of this species or that more efficient capture techniques (i.e., electrofishing) are being utilized.

Netley Creek is known to support an open water and ice covered recreational fishery. At the mouth of Netley Creek and near the confluence with Wavey Creek, winter catches can include northern pike, walleye, and yellow perch (North/South Consultants Inc., unpublished data).

Horne and MacDonell (1996) completed a fish habitat inventory of Netley Creek for the South Interlake Land Management Association. This report provided a basic stream characterization, potential rehabilitation sites (discussed in Section 3.7.3), and a stream habitat classification summary (discussed in Section 3.7.3).

3.7.2 Field Surveys – 2007 and 2008

Focused in the headwaters of Netley Creek, summer/fall fisheries investigations were conducted at three sites in 2007 (Appendix Table A1-1, Figure 6). A total of 10 fish, representing 2 species (i.e., central mudminnow and lake chub) were captured at Wpt. 46 (Table 3, Figure 6). Although not captured, an undetermined number of ‘forage fish’ were also observed at Wpts. 45 and 47.

One hoop net was set on Netley Creek in the spring, 2008, west of Hwy. 8 (Wpt. 89; Figure 6, Appendix Table A1-1) (Photo 9). Effectively fishing for three days, 3 species of fish were captured at this site, including: 27 white sucker; two northern pike; and one walleye (Table 4). One northern pike was a female ready to spawn in the current season and the other was a male, preparing to spawn. The walleye was also a male preparing to spawn in the current season. The majority of the white suckers captured were males, either ready to

spawn ($n = 12$) or preparing to spawn ($n = 7$) in the current season. Eight female white suckers were captured



Photo 9. Hoop net set on Netley Creek (at Wpt. 89) to capture fish moving upstream, spring 2008.

also preparing to spawn in the current season. The data suggests that, at least with the sucker species, sexually mature (adult) fish can migrate approximately 25 km upstream on the Netley Creek. With suitable flow conditions, these fish would likely continue their migration to the next impassable barrier. This may be as far as the control structure located at the end of Netley Creek and the Norris lake control structure. At this location there have been reports of white sucker and northern pike in the spring. However, on April 21 there was no flow into Netley Creek from the outlet and, subsequently, no fish present at Wpt. 41 (Figure 6).

Also oriented to capture upstream migrating fish, a hoop net was set under the bridge on Hwy. 9 in late April, 2008 (D. Kroeker, MWSFB, pers. comm.). Established by Manitoba Water stewardship – Gimli Fisheries Branch, preliminary results of this hoopnet showed spring fish utilization by white sucker ($n = 108$), northern pike ($n = 8$), and walleye ($n = 2$). The white sucker and walleye captured were preparing to spawn in the current year while the northern pike were in spawning condition.

3.7.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground and aerial classifications for Netley Creek are provided in Appendix 3 (Tables A3-7 and A3-15).

The primary land use/cover along Netley Creek was identified as pasture/grazing (35.7%) (Table 5, Figure 6). This was followed by: other agricultural land (33.0%); nonforested wetland (10.5%); residential/commercial (9.4%); cropland (8.4%); and other urban or built-up land (3.0%).

The aquatic habitat quality along Netley Creek was nearly evenly comprised of Class B (36.0%) and Class C (33.2%) reaches (Table 6, Figure 9). This was closely followed by Class D (20.3%) and, to a lesser extent, Class A (10.5%) reaches.

The fish habitat along Netley Creek, from its mouth upstream to the confluence with Ross Creek (approximately Wpt. 82), is considered as Class 1 and/or important habitat (Figure 6). However, upstream of Wpt. 83 to and including the outlet at Norris Lake, this habitat (through channelization, potential barriers, land/use cover, etc) is reduced to Class 3; being composed of severe limitations to the production of fish and/or having marginal habitat (Figure 6). A Class 3 rating was designated (rather than Class 4) because some natural stream processes are still evident between Wpts. 48 and 45 (Figure 6). These findings were comparable to Horne and MacDonell (1996) wherein Class 1 habitat extended from the mouth of Netley Creek upstream to Hwy. 8, with the remainder of Netley Creek being designated as either Class 3 (i.e., Ross Creek upstream to Provincial Road 225 and from approximately 1 km east of Hwy. 7 upstream for 8km) and Class 2 (i.e., Hwy. 8 upstream to Ross Creek and Provincial Road 225 upstream to the first mile road east of Hwy. 7) habitat.

A total of 24 potential rehabilitation sites were identified along Netley Creek (Table 7, Figure 9). The majority (n = 13) of these sites were identified as Priority 3, followed by Priority 1 (n = 10) and Priority 2 (n = 1). All of the Priority 1 sites were related to livestock and the potential for grazing directly in the creek channel. The Priority 3 sites were related to some impacts within/to the riparian areas, potential barriers to fish migrations, and/or eroding banks. The Priority 2 site also related to agricultural practices and the possibility of grazing and/or the stockpile of manure.

Horne and MacDonell (1996) identified six potential rehabilitation sites along Netley Creek (Table 7, Figure 9). Five of these sites were related to direct access of cattle into the stream while the remaining site dealt with a stream crossing issue. It is unknown if any efforts have been undertaken towards the rehabilitation of these sites.

3.8 PARKS CREEK

Parks Creek Primarily flows in a south easterly direction (under Hwys. 8 and 9) for 13 km before emptying into the Red River, north of West St. Paul (Figure 1).

3.8.1 Review of Existing Information

No hydrometric data was found on the Water Survey of Canada website (ECWSC 2008) and WQMS-MWS (2007) did not have existing information pertaining to Parks Creek. The elevation change along Parks Creek is gradual, dropping only 7 meters over a course of approximately 13 km (Table 1, Figures 1 and 4). The majority of this change (i.e., 6 m) occurs between Hwy. 9 and the confluence with the Red River (Photo 10).

An FIHCS search identified 5 species of fish to have inhabited Parks Creek, including: brook stickleback, fathead minnow, johnny darter, northern redbelly dace, and yellow perch (Table 2).



Photo 10. Parks Creek, between the mouth and Hwy. 9, spring 2008.

3.8.2 Field Surveys – 2007 and 2008

A total of 11 fish, representing 3 species (i.e., brook stickleback, northern pike, and pearl dace) were captured at Wpt. 25 during summer/fall fish utilization surveys, 2007 (Table 3, Figure 8). Another site (Wpt. 29) was fished but there was no catch, only the visual observation of forage fish. The northern pike captured at Wpt. 25 was determined to a young-of-the-year, suggesting that this species can utilize Parks Creek for spawning.

One hoop net was deployed on Parks Creek between April 14 and 22, in water temperatures ranging from 3.0 to 10.0 °C (Wpt. 88; Table 4, Figure 8, Appendix Table A1-1). Effectively covering nearly 100% of the channel and fishing for a total of 5 nights, this hoop net captured 3 northern pike and 1 white sucker (Table 4). The northern pike captured on April 15 was a male preparing to spawn, the remaining 2 northern pike were ripe females. Although water temperatures were within the normal range for spawning of northern pike, walleye, and suckers (the targeted species) very few were captured. With a discharge of 0.282 m³/sec (taken April 23, 2008) there was apparently enough water in this watercourse to allow fish passage (Appendix Table A2-1) (Photo 10). Also, an inspection of the creek from Wpt. 88 to its confluence with the Red River did not reveal any major barriers to fish migration. With the exception of some restrictions at Hwy. 9 (Wpt. 29) and a few smaller beaver/debris dams passage for some spring migratory species should be possible (Photo 11).

A brief discussion with local landowners at Wpt. 88 revealed that in previous years, with higher water levels, fish species such as northern pike and sucker were observed in Parks Creek. The land owners also suggested that the fish may only travel approximately 100 m upstream from this waypoint due to an instream restriction/barrier.

3.8.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for Parks Creek are provided in Appendix 3 (Table A3-8).

Land use/cover along Parks Creek was determined to be primarily cropland (85.4%), followed by residential commercial (8.4%), and mixed forest land (6.2%) (Table 6, Figure 8).

Aquatic habitat quality along Parks Creek was determined to be primarily Class C habitat (89.0%), followed by: Class B (6.3%) and Class D (4.7%) habitat. From its confluence with the Red River, upstream (just past Wpt. 88), Parks Creek may fall within a Class 3 rating (moderate limitations to production of fish) but be important habitat (Figure 8). However,



Photo 11. Debris on Parks Creek, between Hwy. 9 and the Red River, spring 2008.

upstream of Wpt. 88 the fish habitat within Parks Creek has more severe limitations to the production of fish (i.e., Class 4) comprising ‘marginal habitat’.

One potential rehabilitation site (#42) was identified on Parks Creek (Table 7, Figure 11). Located at Hwy. 9 (Wpt. 29), this Priority 3 site exhibited eroding banks likely exacerbated by the presence of a drainage culvert located at the top of the right bank and a formerly cultivated field with denuded riparian. The infrastructure at this site (i.e., bridge) is also failing, depositing large chunks of concrete into the main channel of the creek. It is assumed that the structure and creek banks at this site will be rehabilitated in the near future based on the Manitoba Infrastructure and Transportation proposed fall advertising schedule for the 2008 construction season (www.gov.mb.ca/mit/contracts/capitalprogram/schedule.pdf, Accessed February 2008).

3.9 ROSS CREEK

Ross Creek primarily flows in an easterly direction for 20 km before emptying into Netley Creek (east of Hwy. 8) (Table 1, Figure 1).

3.9.1 Review of Existing Information

Neither hydrometric data nor existing water quality information was found relating to Ross Creek (ECWSC 2008; WQMS-MWS 2007).

Six species of fish have been identified inhabiting Ross Creek, including: brook stickleback; central mudminnow; fathead minnow; northern pike; northern redbelly dace; and white sucker (Table 2) (MWSFB 2007). With the exception of the northern pike and white sucker, these species are considered 'small bodied' and likely to inhabit smaller water bodies. The northern pike and white sucker likely move upstream, into Ross Creek, from Netley Creek during spring migration events.

3.9.2 Field Surveys – 2007 and 2008

No stream properties (i.e., discharges, depths, substrate composition) or summer/fall fish utilization surveys were conducted on Ross Creek in 2007 due to non-existent and/or marginal stream flows (Photo 12).

Although Ross Creek was identified for spring migration studies in 2008 low flow conditions prevented the placement of hoop nets.



Photo 12. Looking upstream along Ross Creek (Wpt. 79), September 19, 2007.

3.9.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for Ross Creek are provided in Appendix 3 (Table A3-9).

Land use/cover along this creek was primarily classified as other agriculture (e.g., a mix of cropland, hayland, and some residences) (87.2%), followed by: mixed forest land (96.6%); and hayland (6.2%) (Table 5, Figure 6).

With the exception of the area near Wpt. 40 (Hwy. 7) (Class A: 6.5%), the majority of this watercourse has been channelized and given a Class C (93.5%) aquatic habitat quality rating (Table 6, Figure 9). Although some fish species may migrate into Ross Creek from Netley Creek under suitable hydraulic conditions; the degree of channelization and ephemeral nature of Ross Creek (including existing land use/cover) suggest this watercourse has severe limitations to the production of fish (i.e., Class 4) and/or has marginal habitat for the production of fish.

No potential rehabilitation sites were identified along Ross Creek.

3.10 STEELE DRAIN

Forming the headwaters of Wavey Creek, the Steele Drain flows northward for approximately 4 km emptying into the headwaters of Wavey Creek (Table 1, Figure 1).

3.10.1 Review of Existing Information

Neither hydrometric data nor existing water quality information was found relating to Steele Drain (ECWSC 2008; WQMS-MWS 2007).

Three species of fish have been identified inhabiting the Steele Drain, including: brook stickleback; fathead minnow; and northern pike (Table 2) (MWSFB 2007). The northern pike likely moved into the Steele Drain, from Wavey Creek, during periods of high flow.

3.10.2 Field Surveys – 2007 and 2008

No stream properties (i.e., discharges, depths, substrate composition) or summer/fall fish utilization surveys were conducted on the Steele Drain in 2007. This drain was dry near

Wpt. 5, but wetted between Wpts. 3 and 4. The water between these waypoints appeared to maintain a constant depth (due to channelization) and did not exhibit any flow (Photo 13).

The Steele Drain was not identified for spring fisheries studies in 2008.



Photo 13. Looking upstream along Steele Drain (Wpt. 4), August 2, 2007.

3.10.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for Steele Drain are provided in Appendix 3 (Table A3-10).

All 4.3 km (100.0%) of the Steele Drain reviewed for land use/cover was determined to be cropland (Table 5, Figure 8).

The Steele Drain is a straight line ‘ditch’, likely constructed to expedite the removal of water from the surrounding agricultural fields. Riparian cover, natural sinuosity, instream cover, and habitat variability are all lacking along this drain (Photo 13). Therefore, it was given a Class C aquatic habitat quality rating for its entire length (Table 6, Figure 11). With its location in the headwaters of this watershed, degree of channelization, and ephemeral nature, the fish habitat of Steele Drain can be designated as Class 4 (having severe limitations to production of fish) and/or comprising marginal habitat.

No potential rehabilitation sites were identified along the Steele Drain.

3.11 TUGELA CREEK

Tugela Creek flows eastward for approximately 2 km before emptying directly into Lake Winnipeg (Table 1, Figure 1).

3.11.1 Review of Existing Information

No existing information regarding hydrometric data, water quality information, or fisheries records were found relating to Tugela Creek (ECWSC 2008; WQMS-MWS 2007; MWSFB 2007).

3.11.2 Field Surveys – 2007 and 2008

No hydrometric surveys or fisheries investigations were conducted on Tugela Creek in 2007. With the exception of the mouth of this creek, the majority of this watercourse was dry or had ponded sections of water (Photo 14).

Tugela Creek was not identified for spring fisheries investigations in 2008.

3.11.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground classifications for Tugela Creek are provided in Appendix 3 (Table A3-11).

The 2.3 km of Tugela Creek reviewed for land use/cover was primarily hayland (80.0%) and, to a lesser extent, residential/commercial (20.0%) (Table 5, Figure 6) (Photo 14).

The length of Tugela Creek reviewed for aquatic habitat quality received a Class C (i.e., highly impacted with altered hydraulic regimes) (Table 6, Figure 9). This watercourse is primarily channelized, flows through a residential area, is surrounded by hayfields, and maintains minimal flow; it should therefore be designated as having Class 4 fish habitat (severe limitations to production of fish) and/or comprising marginal fish habitat. However



Photo 14. Looking upstream along Tugela Creek (Wpt. 19), August 2, 2008.

it is a direct tributary to Lake Winnipeg and, under certain hydraulic conditions, its mouth could provide some degree of fisheries habitat (e.g., spawning, rearing, feeding).

Two potential rehabilitation sites were identified on Tugela Creek (Table 7, Figure 9). Related directly to residential land use, these Priority 3 sites exhibited manicured lawns with minimal riparian cover and/or buffer strips (Photo 14). As a tributary to Lake Winnipeg, Tugela Creek acts as a direct conduit for potentially deleterious substances (e.g., sediments, nutrients, residential and agricultural herbicides, etc). In the case of these two sites (or as one longer site), the best rehabilitation efforts could start with educational programs extolling the benefits of a healthy riparian zone.

3.12 WAVEY CREEK

With its headwaters located east of the town of Stonewall, Wavey Creek flows in a north east direction for approximately 41 km before discharging into Netley Creek (Table 1, Figure 1).

3.12.1 Review of Existing Information

The elevation of Wavey Creek drops approximately 18 m over a course of 41 km (Table 1, Figures 1 and 5). With the exception of the spring freshet or other high precipitation events, this gradual decline in elevation usually results in slow moving and, sometimes, idle sections

of watercourse. No hydrometric data was located pertaining to Wavey Creek (ECWSC 2008).

In 1995, a relatively intense water quality sampling program (n = 10 stations) was conducted along the Wavey Creek watercourse (WQMS-MWS 2007). A cursory inspection of the data suggest it was collected to determine the effects of field runoff throughout the course of the open water season. The WQMS-MWS data has been provided to the EICD Manager in digital form for inclusion into their Wavey Creek water quality data base.

Up to 17 species of fish have been reported utilizing Wavey Creek (Table 2) (MWSFB 2007). Some of the larger bodied species identified included: carp; channel catfish; freshwater drum; northern pike; walleye; white sucker; and yellow perch. These species likely utilize the lower portions of Wavey Creek migrating upstream from Lake Winnipeg, the Red River, or Netley Creek.

On July 23, 2007, North/South Consultants Inc. (unpublished data) captured 107 fish, representing 13 species {(i.e., black crappie (n = 12); blackside darter (n = 1); brook stickleback (n = 1); fathead minnow (n = 22); johnny darter (n = 7); rock bass (n = 21); sand shiner (n = 10); shorthead redhorse (n = 1); tadpole madtom (n = 1); walleye (n = 1); white sucker (n = 15); and yellow perch (n = 15)} underneath the bridge at Hwy. 9. Six of these species (i.e., black crappie, johnny darter, rock bass, walleye, white sucker, and yellow perch) were represented by young-of-the-year and/or juvenile life stages. This data suggests successful spawning of these species and/or suitable nursery habitat, at least up to this section of creek.

From Hwy. 9 downstream to its confluence with Netley Creek, Wavey Creek supports a relatively active recreational fishery during the open water and ice cover seasons (North/South Consultants Inc., unpublished data). Catches in winter can include walleye, northern pike, and yellow perch. Captured in early spring, the presence of sexually maturing northern pike suggests that, at least, this species is staging in the area with the likelihood of spawning in the current year.

Horne and MacDonell (1996) completed a fish habitat inventory of Wavey Creek for the South Interlake Land Management Association. This report provided a basic stream characterization, potential rehabilitation sites, and a stream habitat classification summary (discussed in Section 3.12.2).

3.12.2 Field Surveys – 2007 and 2008

A total of 24 fish, representing eight species were captured at Wpts. 22 and 84 during summer/fall fish utilization surveys, 2007 (Table 3, Figure 7, Appendix Table A1-1). Primarily small bodied fish, the species captured included: blacknose shiner; blackside darter; golden redhorse; johnny darter; longnose dace; pearl dace; rock bass; and white sucker.

Effectively fishing for three nights and covering 100% of the channel, the hoopnet set at Wpt. 22 captured a total of 7 northern pike, 5 white sucker, and 1 walleye (Table 4, Figure 7). Four of the northern pike captured were ripe females, while the remaining 3 were males preparing to spawn in the current season (Appendix 2 Table A2-4). The 3 female and 1 male white sucker captured were preparing to spawn in the current season. The fifth white sucker was a ripe male. The one walleye captured was a male preparing to spawn in the current season.

Fishing for two nights and covering 100% of the channel, the hoopnet set at Wpt. 78 captured a total of 19 white sucker and 1 northern pike (Table 4, Figure 7) (Photo 15). The majority ($n = 14$) of the white suckers captured were females preparing to spawn in the current season, while 5 were males preparing to spawn (Appendix 2 Table A2-4). The one northern pike captured was a ripe female. The presence and number of these adult spawning fish suggests that fish passage is possible at least 28 km upstream on Wavey Creek and at a discharge of $1.008 \text{ m}^3/\text{sec}$ (Appendix 2 Table A2-1).

3.12.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground and aerial classifications for Wavey Creek are provided in Appendix 3 Tables A3-12 and A3-15).

The land use/cover along Wavey Creek was comprised of other agricultural land (66.2%), mixed forest land (30.6%), and pasture/grazing (3.2%) (Table 5, Figure 7).

The aquatic habitat quality along Wavey Creek was determined to be primarily Class C (69.4%), followed by Class A (27.1%) and Class B (3.5%) habitat (Table 6, Figure 10). The relatively high percentage of Class A habitat may be attributable to the remaining natural riparian areas and lack of channelization of this watercourse from its confluence with Netley Creek upstream to Wpt. 22 (Figure 7). With it's natural sinuosity, varying depths and substrates, healthy riparian, etc. this section of Wavey Creek (i.e., confluence to Wpt. 22) can be defined as having Class 1 fish habitat (i.e., high capability for fish production) and/or



Photo 15. Hoop net set on Wavey Creek, just downstream of the control structure at Wpt. 78, spring 2008.

comprising important habitat. Upstream from Wpt. 22 to Wpt. 5, Wavey Creek is primarily channelized having comparable depths, substrate, and (often) minimal riparian. This section of watercourse was therefore identified as having Class 4 fish habitat (i.e., severe limitations to production of fish) and/or marginal fish habitat.

Horne and MacDonell (1996) also suggested that the fish habitat from the mouth of Wavey Creek, upstream to Hwy. 9 was also Class 1. This habitat then declined to Class 2 habitat for a short distance until becoming Class 4 up to the end of their study area (just south of Provincial Road 515).

Five potential rehabilitation sites were identified on Wavey Creek with an additional site identified on a wider tributary entering Wavey Creek (Table 7, Figure 10). Rehabilitation Site 1, located on the extension of Wavey Creek, was designated a Priority 1. Given the extent of grazing/livestock access and proximity to Lake Winnipeg, the possibility of nutrient loading to this waterbody should be addressed. Rehabilitation sites 2 and 3 (both Priority 2) revealed the likelihood of extensive grazing. Rehabilitation sites 4, 5, and 6 (all Priority 3) identified areas of: potential rock barrier; grazing areas; and a barrier at a cement ford; respectively. Although no information was available regarding Site 4, it is possible that this area is the site of previous rehabilitation efforts (e.g., placement of aggregate as

spawning habitat in a riffle sequence or to slow velocities) (Photo 16). Groundtruthing investigations could be warranted at this site during spring migrations. Identified as a low level, concrete and culvert ford, in 2007 Site 6 was unlikely a barrier to upstream fish migration. However, this site should be monitored periodically for accumulations of debris (which could hinder upstream and downstream movements) or washouts (which could cause bank erosion and subsequent sediment loading).



Photo 16. Looking upstream on Wavey Creek (Wpt. 22) towards riffle sequence, spring 2008.

Horne and MacDonell (1996) identified one site on Wavey Creek that warranted rehabilitation (Table 7, Figure 10). This site, identified as high priority, outlined problems associated with direct cattle access (e.g., siltation) and provided remedial options (i.e., fencing, stream crossing, and re-vegetation). It is unknown if rehabilitation efforts were attempted at this site.

3.13 WHISKEY DITCH

Whiskey Ditch flows south to north for approximately 4 km, emptying into an area south of the confluence of Netley Creek and the Red River (Table 1, Figure 1).

3.13.1 Review of Existing Information

Neither hydrometric data nor existing water quality information was found relating to Whiskey Ditch (ECWSC 2008; WQMS-MWS 2007).

An FIHCS search identified three species of fish to inhabiting the Whiskey Ditch ,these were: black bullhead; brook stickleback; and fathead minnow (Table 2) (MWSFB 2007).

3.13.2 Field Surveys – 2007 and 2008

With the exception of ground based photography and aerial reconnaissance, no field inspections (i.e., hydrometric surveys or fisheries investigations) were conducted on Whiskey Ditch in 2007. The area of this ditch that was accessible by road exhibited minimal to non-existent flow conditions (i.e., dry) (Photo 17).

Whiskey Ditch was not identified for spring fisheries investigations in 2008.



Photo 17. Looking downstream along Whiskey Ditch (Wpt. 86), September 25, 2007.

3.13.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground and aerial classifications for Whiskey Ditch are provided in Appendix 3 (Table A3-13).

Land use/cover along Whiskey Ditch was determined to be comprised entirely of other agricultural land (100.0%) (Table 5, Figure 6) (Photo 17).

The entire length of the Whiskey Ditch has been designated as Class C (aquatic habitat quality) (Table 6, Figure 9). With the degree of channelization, minimal riparian, and homogeneous instream habitat it is assumed this ditch would also offer little in the way of beneficial fish habitat (i.e., Class 4 and or marginal fish habitat). However, this may not be the case near the mouth of this ditch (which was not accessible or viewed from the air) which flows northward towards Lake Winnipeg (Figure 9).

No potential rehabilitation sites were identified along the Whiskey Ditch in 2007.

3.14 NORRIS LAKE

3.14.1 Review of Existing Information

Neither hydrometric data nor existing water quality information was found relating to Norris Lake (ECWSC 2008; WQMS-MWS 2007).

An FIHCS search identified 7 species of fish either inhabiting or previously inhabiting Norris Lake (Table 2) (MWSFB 2007). Species accounts included: black bullhead; brook stickleback; brook trout; central mudminnow; fathead minnow; northern pike; rainbow trout; and yellow perch. The Manitoba Water Stewardship – Fisheries Branch website (www.gov.mb.ca/waterstewardship/fisheries/habitat/index) has stocking records from 2002 to 2007. Records for the assumed stocking of Norris Lake with brook and rainbow trout were not available for this period. However, in April 2005, 200 adult northern pike were released into Norris Lake.

Norris Lake supports both a open water and ice-cover fishing season (North/South Consultants Inc., unpublished data). Winter catches on this lake may include both northern pike and yellow perch. Although relatively small in size, these species appeared to be generally healthy and, based on internal and external examination, exhibited varying degrees of sexually reproductive capabilities.

3.14.2 Field Surveys – 2007 and 2008

Field surveys of Norris Lake were limited to the collection of ground based photographs and the collection of some in situ water quality parameters.

3.14.3 Land Use/Cover, Aquatic Habitat and Rehabilitation Sites

Ground and aerial classifications for Norris Lake are provided in Appendix 3 (Table A3-14).

Based primarily on aerial footage the 13.8 km of Norris Lake reviewed for land use/cover consisted of: mixed forest land (58.0%); other urban or built-up land (20.1%); pasture/grazing (20.0%); and other agricultural land (1.9%) (Table 5, Figure 6).

An aerial review of Norris Lake revealed it still maintained a relatively strong percentage (58.0%) of Class A aquatic habitat quality (Table 6, Figure 9). This was followed by Class B (20.1%), Class D (13.2%), and Class C (8.7%) aquatic habitat quality. Although Norris Lake exhibits a relatively healthy aquatic habitat (i.e., Class A) it may still be limited in its capacity to support a ‘thriving’ fish community (based on recreational standards); nonetheless the fish habitat in Norris Lake would be Class 2 and or important habitat.

3.15 NETLEY MARSH SHORELINE

The Netley Marsh is an important area to maintain and protect for a number of reasons. This area (i.e., Netley-Libau Marsh) was officially dedicated as a Canadian Important Bird Area on October 1st, 2000 and is also a heritage marsh candidate under the Manitoba Heritage Marsh Program (www.ibacanada.com/cpm_netley, accessed June 30, 2008). Although it is beyond the scope of this document to develop mitigative strategies and/or rehabilitation plans for this vast area (24,381-ha of upland and wetland habitat); it is hoped that this document be used to further assist working groups involved in ongoing conservation efforts. For example, Lindgren and The Netley Libau Marsh Foundation Inc. (2001) have compiled information pertaining to this area, associated threats, and conservation goals/objectives.

Classified as non-forested wetland (100.0%), the 17 km of Netley Marsh shoreline was not rated according to aquatic habitat quality. However, it is assumed (based on the absence of development and/or major agricultural practice) this area would be Class A (i.e., minimally impacted with natural morphology). In addition, this area would be Class 1 fish habitat (i.e., high capability for fish production) and/or important.

No potential rehabilitation sites were identified along the Netley Marsh shoreline.

3.16 OVERVIEW OF WATERSHED 05OJ

The comparison of one watershed to another, or even one waterbody to another, is often problematic. A number of factors (e.g., land use practices, size of watershed, population dynamics, soil composition, etc.) all must be considered. With this in mind, the health/integrity of Watershed 05OJ is apparently no worse or better than other watersheds within agro-Manitoba (e.g., a number of watersheds throughout Manitoba are now channelized, which is a major factor in the 'health' rating of these systems). Each watershed is unique and requires the development of independent watershed management plans to deal with specific issues.

The majority of potential rehabilitation sites within watershed 05OJ were identified along the Netley and Wavey creeks (Table 7, Figures 9 and 10). These sites, especially the ones in areas of important fish habitat, could be the focus of mitigative efforts and/or watershed management plans. Maintaining existing 'quality' habitat and rehabilitating damaged areas (e.g., via exclusion fencing, riparian rehabilitation, bank stabilization, etc.) would be important steps towards effective watershed management and a reduction in potentially deleterious substances. Potential detriments to aquatic health, negative impacts, and potential mitigative measures are outlined in Appendix 4.

4.0

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TABLES AND FIGURES

Table 1. Length of watercourse (determined by the National Topographic Service Base), distances reviewed by ground and air, and percent of each watercourse classified for Watershed 05OJ, 2007.

| Watercourse | Length of Watercourse (km) ¹ | Distance Covered by Air (km) | Distance Covered by Ground (km) | % of Watercourse Classified |
|--|--|---------------------------------|---|-----------------------------------|
| Cochrane Creek | 4.9 | - | 2.4 | 49.5 |
| Fisher Drain | 5.4 | - | 4.7 | 87.7 |
| Gramiak Drain | 8.8 | - | 8.2 | 92.8 |
| Grassmere Creek Drain | 45.9 | - | 41.0 | 89.3 |
| Jackfish Creek | 21.4 | - | 8.7 | 40.7 |
| Jennifer Creek | 15.7 | - | 7.6 | 48.5 |
| Netley Creek | 60.4 | 60.4 | - | 100.0 |
| Parks Creek | 12.8 | - | 7.0 | 54.8 |
| Ross Creek | 19.9 | - | 14.5 | 73.0 |
| Steele Drain | 4.3 | - | 4.2 | 98.6 |
| Tugela Creek | 2.2 | - | 0.5 | 22.2 |
| Wavey Creek | 41.1 | 6.8 | 26.4 | 80.8 |
| Whiskey Ditch | 3.9 | 3.9 | - | 100.0 |
| Norris Lake | 14.9 | 15.0 | <1.0 | 100.0 |
| Netley Marsh Shoreline | 17.4 | 17.4 | - | 100.0 |
| Total (km) | 278.9 | 103.4 | 125.2 | |
| Total length of watercourses | | 278.9 | | |
| Total length of watercourses classified | | 228.6 | | |
| Total percentage of watercourses classified | | 82.0 | | |

¹ Source: Department of Natural Resources, Government of Canada; 1:50,000 National Topographic Service Base

Table 2. Fish species known to, or possibly, utilizing watercourses in Watershed 050J. Information based on a Fisheries Inventory Habitat Classification System (FIHCS) search conducted by Manitoba Water Stewardship – Fisheries Branch, 2007.

| SPECIES | WATERCOURSE | | | | | | | | | | |
|------------------------|-------------------|--------------------------|-------------------|-----------------|-----------------|----------------|---------------|-----------------|----------------|------------------|----------------|
| | Cochrane Creek | Grassmere Creek Drain | Jackfish Creek | Netley Creek | Netley Marsh | Parks Creek | Ross Creek | Steele Drain | Wavey Creek | Whiskey Ditch | Norris Lake |
| Bigmouth buffalo | | | | X | X | | | | | | |
| Black bullhead | | | | X | | | | | | X | X |
| Black crappie | | | | X | X | | | | | | |
| Blackside darter | | | X | X | | | | | X | | |
| Brook stickleback | X | | | X | | X | X | X | X | X | X |
| Brook trout | | | | X | | | | | | | X |
| Brown bullhead | | | | X | X | | | | X | | |
| Burbot | | | | X | X | | | | | | |
| Carp | | | | X | X | | | | X | | |
| Central mudminnow | | | X | X | | | X | | | | X |
| Channel catfish | | | | X | X | | | | X | | |
| Cisco | | | | | X | | | | | | |
| Common shiner | | | | X | | | | | | | |
| Creek chub | | | | X | | | | | | | |
| Emerald shiner | | | | X | X | | | | X | | |
| Fathead minnow | | X | | X | | X | X | X | X | X | X |
| Freshwater drum | | | | | X | | | | X | | |
| Goldeye | | | | X | X | | | | | | |
| Iowa darter | | | | X | | | | | | | |
| Johnny darter | | | | X | | X | | | X | | |
| Longnose dace | | | | | | | | | X | | |
| Northern pike | | X | | X | X | | X | X | X | | X |
| Northern redbelly dace | | | | | | X | X | | | | |
| Quillback | | | | | X | | | | | | |
| Rainbow trout | | | | | | | | | | | X |
| River shiner | | | | | | | | | X | | |
| Rock bass | | | | X | X | | | | X | | |
| Sauger | | | | X | X | | | | | | |

Table 2. Continued.

| SPECIES | WATERCOURSE | | | | | | | | | | |
|-----------------|-------------------|--------------------------|-------------------|-----------------|-----------------|----------------|---------------|-----------------|----------------|------------------|----------------|
| | Cochrane Creek | Grassmere Creek Drain | Jackfish Creek | Netley Creek | Netley Marsh | Parks Creek | Ross Creek | Steele Drain | Wavey Creek | Whiskey Ditch | Norris Lake |
| Spottail shiner | | | | X | | | | | | | |
| Tadpole madtom | | | | X | X | | | | X | | |
| Trout perch | | | | | X | | | | | | |
| Walleye | | | | X | X | | | | X | | |
| White bass | | | | X | X | | | | | | |
| White sucker | | X | X | X | X | | X | | X | | |
| Yellow perch | | X | X | X | X | X | | | X | | X |

Table 3. Summer and fall fish utilization results, by watercourse and waypoint site (in *italics*) throughout Watershed 050J, 2007. Descriptions of waypoints are provided in Appendix 1.1

| SPECIES | Netley Creek | | | Wavey Creek | | Parks Creek | | Jackfish Creek | Steele Drain | Grassmere Creek Drain | | | | Ross Creek | TOTALS |
|----------------------|--------------|-----------|-----------|-------------|-----------|-------------|-------------|----------------|--------------|-----------------------|-----------|-----------|-----------|------------|--------|
| | <i>46</i> | <i>45</i> | <i>47</i> | <i>22</i> | <i>84</i> | <i>25*</i> | <i>29**</i> | <i>78</i> | <i>3</i> | <i>1**</i> | <i>26</i> | <i>65</i> | <i>71</i> | <i>81</i> | |
| Black crappie | - | - | - | - | - | - | - | - | - | - | 1 | - | - | - | 1 |
| Blacknose shiner | - | - | - | 1 | - | - | - | 3 | - | - | - | - | - | - | 4 |
| Blackside darter | - | - | - | 3 | 2 | - | - | - | - | - | - | - | - | - | 5 |
| Brook stickleback | - | - | - | - | - | 1 | - | 1 | - | - | - | 7 | - | Yes | 9 |
| Central mudminnow | 1 | | | - | - | - | - | - | - | - | - | - | - | - | 1 |
| Golden redhorse | - | - | - | - | 1 | - | - | - | - | - | - | - | - | - | 1 |
| Johnny darter | - | - | - | 4 | 3 | - | - | 3 | - | - | - | - | 3 | - | 13 |
| Lake chub | 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | 9 |
| Longnose dace | - | - | - | 4 | - | - | - | - | - | - | - | - | - | - | 4 |
| Northern pike | - | - | - | - | - | 1 | - | - | - | - | - | - | - | - | 1 |
| Pearl dace | - | - | - | 2 | - | 9 | - | - | - | - | 4 | 2 | 3 | - | 20 |
| Rock bass | - | - | - | 2 | - | - | - | - | - | - | - | - | - | - | 2 |
| White sucker | - | - | - | - | 2 | - | - | - | - | - | - | - | - | - | 2 |
| Forage fish (visual) | - | Yes | Yes | - | - | - | Yes | - | Yes | - | Yes | - | - | Yes | - |
| TOTALS | 10 | - | - | 16 | 8 | 11 | - | 7 | - | - | 5 | 9 | 6 | - | 72 |

* young-of-the-year northern pike, August 3, 2007.

** fished in fall but no catch

Table 4. Results of spring fish utilization studies, conducted by North/South Consultants Inc. throughout Watershed 050J, 2008.

| DATE | Temperature (°C) | Grassmere Creek @ train bridge (Wpt. 87) | | | | Comments |
|---------------|---------------------|--|--------------|---------|--------|--------------------|
| | | Northern pike | White sucker | Walleye | TOTALS | |
| 14-Apr-07 | 3.0 | - | - | - | - | Hoop net installed |
| 15-Apr-07 | 3.0 | 0 | 0 | 0 | | Hoop net pulled |
| 16-Apr-07 | - | - | - | - | - | No fishing |
| 17-Apr-07 | - | - | - | - | - | No fishing |
| 18-Apr-07 | 9.0 | - | - | - | - | Hoop re-installed |
| 19-Apr-07 | 10.0 | 0 | 0 | 0 | 0 | 80% cover |
| 20-Apr-07 | 11.0 | 1 | 0 | 0 | 0 | |
| 21-Apr-08 | 10.0 | 0 | 0 | 0 | 0 | |
| 22-Apr-08 | 7.0 | 0 | 0 | 0 | 0 | Hoop pulled |
| TOTALS | | 1 | 0 | | 1 | |

| DATE | Temperature (°C) | Grassmere Creek @ mouth (Wpt. 90) | | | | Comments |
|---------------|---------------------|-----------------------------------|--------------|---------|--------|--------------------|
| | | Northern pike | White sucker | Walleye | TOTALS | |
| 21-Apr-08 | 10.0 | - | - | - | - | Hoop net installed |
| 22-Apr-08 | 7.0 | 23 | 0 | 0 | 23 | Hoop net pulled |
| TOTALS | | 23 | 0 | 0 | 23 | |

| | | | | | | |
|---------------|------|---|---|---|---|--------------------|
| 14-Apr-07 | - | - | - | - | - | Hoop net installed |
| 15-Apr-07 | 3.0 | 1 | 0 | 0 | 1 | Hoop net pulled |
| 16-Apr-07 | - | - | - | - | - | No fishing |
| 17-Apr-07 | - | - | - | - | - | No fishing |
| 18-Apr-07 | 7.0 | - | - | - | - | Hoop re-installed |
| 19-Apr-07 | 9.0 | 1 | 0 | 0 | 1 | 100% cover |
| 20-Apr-07 | 9.0 | 0 | 0 | 0 | 0 | |
| 21-Apr-08 | 10.0 | 0 | 0 | 0 | 0 | |
| 22-Apr-08 | 6.0 | 1 | 1 | 0 | 2 | Hoop net pulled |
| TOTALS | | 3 | 1 | | 4 | |

Table 4. Continued.

| DATE | Temperature (°C) | Netley Creek (Wpt. 89) | | | | Comments |
|---------------|---------------------|------------------------|--------------|---------|--------|--------------------|
| | | Northern pike | White sucker | Walleye | TOTALS | |
| 19-Apr-07 | 10.0 | - | - | - | - | Hoop net installed |
| 20-Apr-07 | 9.0 | 0 | 27 | 1 | 28 | |
| 21-Apr-08 | 8.0 | 2 | 0 | 0 | 2 | Hoop net pulled |
| 22-Apr-08 | 7.0 | 0 | 0 | 0 | 0 | |
| TOTALS | | 2 | 27 | 1 | 30 | |

| DATE | Temperature (°C) | Wavey Creek @ ford crossing (Wpt. 22) | | | | Comments |
|---------------|---------------------|---------------------------------------|--------------|---------|--------|--------------------------------------|
| | | Northern pike | White sucker | Walleye | TOTALS | |
| 19-Apr-07 | 12.0 | - | - | - | - | Hoop net installed |
| 20-Apr-07 | 9.0 | 1 | 2 | 1 | 4 | |
| 21-Apr-08 | 6.0 | 0 | 0 | 0 | 0 | Large hole in net Hoop net pulled |
| 22-Apr-08 | 4.5 | 6 | 3 | 0 | 9 | |
| TOTALS | | 7 | 5 | 1 | 13 | |

| DATE | Temperature (°C) | Wavey Creek @ control structure (Wpt. 78) | | | | Comments |
|---------------|---------------------|---|--------------|---------|--------|--------------------|
| | | Northern pike | White sucker | Walleye | TOTALS | |
| 20-Apr-07 | 9.0 | - | - | - | - | Hoop net installed |
| 21-Apr-08 | 8.0 | 1 | 17 | 0 | 18 | |
| 22-Apr-08 | 7.0 | 0 | 2 | 0 | 2 | Hoop net pulled |
| TOTALS | | 1 | 19 | 0 | 20 | |

Table 5. Total number of reaches (by land use/cover), length of watercourse classified, and percentage of reach by land use/cover in Watershed 050J, 2007.

| LAND USE/LAND COVER | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|--|--------------|------------------------------|-------------------|
| <i>Cochrane Creek</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 1 | 3.2 | 100.0 |
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Cochrane Creek</i> | | 3.2 | 100.0 |
| <i>Fisher Drain</i> | | | |
| Hayland | 1 | 0.3 | 6.2 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 1 | 0.8 | 14.4 |
| Other Agricultural Land | 1 | 3.1 | 58.4 |
| Mixed Forest Land | 3 | 1.1 | 21.1 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Fisher Drain</i> | 6 | 5.4 | 100.0 |
| <i>Gramiak Drain</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 1 | 8.8 | 100.0 |
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Gramiak Drain</i> | 1 | 8.8 | 100.0 |
| <i>Grassmere Creek Drain</i> | | | |
| Hayland | 1 | 3.8 | 9.2 |
| Residential/Commercial | 1 | 1.0 | 2.4 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 1 | 28.7 | 70.3 |

Table 5. Continued.

| LAND USE/LAND COVER | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|---|--------------|------------------------------|-------------------|
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 1 | 7.4 | 18.2 |
| <i>Total along Grassmere Creek Drain</i> | 4 | 40.9 | 100.0 |
| <i>Jackfish Creek</i> | | | |
| Hayland | 1 | 0.6 | 2.9 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 2 | 4.7 | 21.8 |
| Cropland | 1 | 12.6 | 59.2 |
| Other Agricultural Land | 1 | 3.4 | 16.1 |
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Jackfish Creek</i> | 5 | 21.3 | 100.0 |
| <i>Jennifer Creek</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 2 | 4.0 | 38.2 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 4 | 6.3 | 59.6 |
| Mixed Forest Land | 1 | 0.2 | 2.2 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Jennifer Creek</i> | 7 | 10.5 | 100.0 |
| <i>Netley Creek</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 1 | 5.6 | 9.4 |
| Pasture/Grazing | 7 | 21.1 | 35.7 |
| Cropland | 4 | 5.0 | 8.4 |
| Other Agricultural Land | 6 | 19.5 | 33.0 |
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 2 | 6.2 | 10.5 |
| Other Urban or Built-up Land | 1 | 1.8 | 3.0 |
| <i>Total along Netley Creek</i> | 21 | 59.2 | 100.0 |

Table 5. Continued.

| LAND USE/LAND COVER | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|--|--------------|------------------------------|-------------------|
| <i>Parks Creek</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 1 | 1.1 | 8.4 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 1 | 10.9 | 85.4 |
| Other Agricultural Land | 0 | 0.0 | 0.0 |
| Mixed Forest Land | 1 | 0.8 | 6.2 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Parks Creek</i> | 3 | 12.8 | 100.0 |
| <i>Ross Creek</i> | | | |
| Hayland | 1 | 0.9 | 6.2 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 1 | 12.7 | 87.2 |
| Mixed Forest Land | 1 | 1.0 | 6.6 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Ross Creek</i> | 3 | 14.5 | 100.0 |
| <i>Steele Drain</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 1 | 4.3 | 100.0 |
| Other Agricultural Land | 0 | 0.0 | 0.0 |
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Steele Drain</i> | 1 | 4.3 | 100.0 |
| <i>Tugela Creek</i> | | | |
| Hayland | 1 | 1.8 | 80.0 |
| Residential/Commercial | 1 | 0.5 | 20.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 0 | 0.0 | 0.0 |

Table 5. Continued.

| LAND USE/LAND COVER | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|---|-----------------|---------------------------------|-------------------------|
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Tugela Creek</i> | 2 | 2.3 | 100.0 |
| <i>Wavey Creek</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 1 | 1.1 | 3.2 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 1 | 22.0 | 66.2 |
| Mixed Forest Land | 3 | 10.2 | 30.6 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Wavey Creek</i> | 5 | 33.2 | 100.0 |
| <i>Whiskey Ditch</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 1 | 3.9 | 100.0 |
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Whiskey Ditch</i> | 1 | 3.9 | 100.0 |
| <i>Norris Lake</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 3 | 2.8 | 20.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 1 | 0.3 | 1.9 |
| Mixed Forest Land | 3 | 8.0 | 58.0 |
| Nonforested Wetland | 0 | 0.0 | 0.0 |
| Other Urban or Built-up Land | 2 | 2.8 | 20.1 |
| <i>Total along Norris Lake</i> | 9 | 13.8 | 100.0 |

Table 5. Continued.

| LAND USE/LAND COVER | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|--|--------------|------------------------------|-------------------|
| <i>Combined</i> | | | |
| Hayland | 5 | 7.4 | 3.2 |
| Residential/Commercial | 4 | 8.1 | 3.4 |
| Pasture/Grazing | 15 | 33.6 | 14.4 |
| Cropland | 8 | 33.5 | 14.3 |
| Other Agricultural Land | 19 | 111.9 | 47.8 |
| Mixed Forest Land | 12 | 21.2 | 9.1 |
| Nonforested Wetland | 2 | 6.2 | 2.7 |
| Other Urban or Built-up Land | 4 | 12.0 | 5.1 |
| <i>Total combined</i> | 69 | 234.0 | 100.0 |
| <i>Netley Marsh Shoreline</i> | | | |
| Hayland | 0 | 0.0 | 0.0 |
| Residential/Commercial | 0 | 0.0 | 0.0 |
| Pasture/Grazing | 0 | 0.0 | 0.0 |
| Cropland | 0 | 0.0 | 0.0 |
| Other Agricultural Land | 0 | 0.0 | 0.0 |
| Mixed Forest Land | 0 | 0.0 | 0.0 |
| Nonforested Wetland | 1 | 15.9 | 100.0 |
| Other Urban or Built-up Land | 0 | 0.0 | 0.0 |
| <i>Total along Netley Marsh Shoreline</i> | 1 | 15.9 | 100.0 |

Note: The value(s) for Netley Marsh Shoreline were not included in the total combined, as it is below the total combined cell.

Table 6. Total number of reaches (by habitat quality rating), length of watercourse classified, and percentage of reach by rating in Watershed 050J, 2007.

| AQUATIC HABITAT CLASSIFICATION | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|---|-------------------------|---|------------------------------|
| <i>Cochrane Creek</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 1 | 3.2 | 100.0 |
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Cochrane Creek</i> | 1 | 3.2 | 100.0 |
| <i>Fisher Drain</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 1 | 5.4 | 100.0 |
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Fisher Drain</i> | 1 | 5.4 | 100.0 |
| <i>Gramiak Drain</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 1 | 8.8 | 100.0 |
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Gramiak Drain</i> | 1 | 8.8 | 100.0 |
| <i>Grassmere Creek Drain</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 1 | 0.2 | 0.5 |
| Class 'C' | 1 | 39.1 | 96.5 |
| Class 'D' | 2 | 1.2 | 3.0 |
| <i>Total along Grassmere Creek Drain</i> | 4 | 40.5 | 100.0 |
| <i>Jackfish Creek</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 3 | 16.9 | 78.4 |
| Class 'D' | 2 | 4.7 | 21.6 |
| <i>Total along Jackfish Creek</i> | 5 | 21.5 | 100.0 |

Table 6. Continued.

| AQUATIC HABITAT CLASSIFICATION | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|---|-------------------------|---|------------------------------|
| <i>Jennifer Creek</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 1 | 0.2 | 2.3 |
| Class 'C' | 3 | 6.3 | 59.5 |
| Class 'D' | 2 | 4.0 | 38.2 |
| <i>Total along Jennifer Creek</i> | 6 | 10.5 | 100.0 |
| <i>Netley Creek</i> | | | |
| Class 'A' | 2 | 6.2 | 10.5 |
| Class 'B' | 4 | 21.3 | 36.0 |
| Class 'C' | 8 | 19.6 | 33.2 |
| Class 'D' | 7 | 12.0 | 20.3 |
| <i>Total along Netley Creek</i> | 21 | 59.2 | 100.0 |
| <i>Parks Creek</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 1 | 0.8 | 6.3 |
| Class 'C' | 1 | 10.9 | 89.0 |
| Class 'D' | 1 | 0.6 | 4.7 |
| <i>Total along Parks Creek</i> | 3 | 12.3 | 100.0 |
| <i>Ross Creek</i> | | | |
| Class 'A' | 1 | 1.0 | 6.5 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 1 | 13.6 | 93.5 |
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Ross Creek</i> | 2 | 14.5 | 100.0 |
| <i>Steele Drain</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 1 | 4.3 | 100.0 |
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Steele Drain</i> | 1 | 4.3 | 100.0 |
| <i>Tugela Creek</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 1 | 2.3 | 100.0 |

Table 6. Continued.

| AQUATIC HABITAT CLASSIFICATION | # OF REACHES | TOTAL LENGTH OF REACHES (km) | % OF REACHES (km) |
|--|-------------------------|---|------------------------------|
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Tugela Creek</i> | 1 | 2.3 | 100.0 |
| <i>Wavey Creek</i> | | | |
| Class 'A' | 2 | 9.0 | 27.1 |
| Class 'B' | 1 | 1.2 | 3.5 |
| Class 'C' | 3 | 23.0 | 69.4 |
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Wavey Creek</i> | 6 | 33.2 | 100.0 |
| <i>Whiskey Ditch</i> | | | |
| Class 'A' | 0 | 0.0 | 0.0 |
| Class 'B' | 0 | 0.0 | 0.0 |
| Class 'C' | 1 | 3.9 | 100.0 |
| Class 'D' | 0 | 0.0 | 0.0 |
| <i>Total along Whiskey Ditch</i> | 1 | 3.9 | 100.0 |
| <i>Norris Lake</i> | | | |
| Class 'A' | 3 | 8.0 | 58.0 |
| Class 'B' | 2 | 2.8 | 20.1 |
| Class 'C' | 2 | 1.2 | 8.7 |
| Class 'D' | 3 | 1.8 | 13.2 |
| <i>Total along Norris Lake</i> | 10 | 13.8 | 100.0 |
| <i>Combined</i> | | | |
| Class 'A' | 8 | 24.1 | 10.3 |
| Class 'B' | 10 | 26.5 | 11.3 |
| Class 'C' | 28 | 158.4 | 67.9 |
| Class 'D' | 17 | 24.3 | 10.4 |
| <i>Total combined</i> | 63 | 233.3 | 100.0 |
| <i>Netley Marsh Shoreline</i> | | | |
| Class 'A' | 0 | 0.0 | |
| Class 'B' | 0 | 0.0 | |
| Class 'C' | 0 | 0.0 | |
| Class 'D' | 0 | 0.0 | |
| <i>Total along Netley Marsh Shoreline</i> | 0 | 0.0 | |

Table 7. Index of potential rehabilitation sites identified by groundtruthing and aerial footage throughout Watershed 050J, 2007.

| WATER BODY | WPT. # | GROUND OR AIR SITE # | PRIORITY | REHAB. # | VIDEO TIME | DESCRIPTION |
|----------------|--------|----------------------|----------|----------|------------|--|
| Wavey Creek | - | A | 1 | 1 | 00:05:03 | Possible grazing and dugout area with access to a main channel; structures in area |
| Wavey Creek | - | A | 2 | 2 | 00:06:26 | Possible pasture (extensive?) in wooded area on both banks |
| Wavey Creek | - | A | 2 | 3 | 00:06:32 | Possible pasture in wooded area on left bank; continuation from 06:26 |
| Wavey Creek | - | A | 3 | 4 | 00:06:56 | Appears to be riffle (rock) in center channel; not an obvious barrier; spawning project? |
| Wavey Creek | - | A | 3 | 5 | 00:07:04 | Homestead with out buildings and grazing potential; wooded riparian |
| Wavey Creek | 22 | A | 3 | 6 | 00:07:13 | Cement ford with culverts; passage likely; drain with buffer |
| Netley Creek | - | A | 3 | 7 | 00:09:56 | Netley Golf Course; some beaver dams in area |
| Netley Creek | - | A | 3 | 8 | 00:10:22 | Apparent beaver dam in river; temporary barrier |
| Netley Creek | - | A | 1 | 9 | 00:10:28 | Outbuildings; possible grazing and shelter; access to creek? (confirm) (and at 13:00) |
| Netley Creek | - | A | 1 | 10 | 00:14:01 | Thinning riparian, possible grazing in creek; manure piles present? HWY 8? |
| Netley Creek | - | A | 3 | 11 | 00:14:16 | Possible grazing area on right bank (could be fenced?) |
| Netley Creek | - | A | 1 | 12 | 00:14:59 | No apparent blockage at this water level; possible spring barrier; Groundtruth |
| Netley Creek | - | A | 3 | 13 | 00:18:57 | Appears to be fenced pasture beyond road and drain; Colony in vicinity? |
| Netley Creek | - | A | 1 | 14 | 00:20:06 | Multiple issues; Grazing, manure piles, access to drain, denuded riparian: mostly LB |
| Netley Creek | - | A | 2 | 15 | 00:20:16 | On LB, thinned riparian, possible access; manure piles? |
| Netley Creek | - | A | 3 | 16 | 00:20:51 | Grazing on LB but appears to be beyond the riparian; access limited to nil |
| Netley Creek | - | A | 3 | 17 | 00:21:18 | Footage is grainy, but grazing with an impacted riparian could result |
| Netley Creek | - | A | 3 | 18 | 00:21:28 | Possible heavy grazed area with impacted riparian and eroding banks |
| Netley Creek | - | A | 3 | 19 | 00:21:42 | Possible heavy grazed on both banks; channelized here; fence line unapparent |
| Netley Creek | - | A | 3 | 20 | 00:21:52 | Homestead on LB with grazing; fenced at this point; See photos from Wpt. 44 |
| Netley Creek | - | A | 1 | 21 | 00:22:01 | Heavy grazing; barns; access to creek; dugout in channel |
| Netley Creek | - | A | 1 | 22 | 00:22:45 | Heavy grazing; trails into creek; no riparian; dugout; cattle present |
| Netley Creek | - | A | 1 | 23 | 00:23:00 | Heavy grazing, into and through creek, no riparian, erosion? |
| Netley Creek | - | A | 1 | 24 | 00:23:11 | Dugout directly in channel; grazing in area likely |
| Netley Creek | - | A | 1 | 25 | 00:23:26 | Grazing in creek; no riparian; outbuildings; cattle apparent |
| Netley Creek | - | A | 3 | 26 | 00:23:34 | No blockage apparent (likely no water); from operation at 00:23:26 |
| Netley Creek | - | A | 1 | 27 | 00:24:10 | Dugout in channel (watered); grazing/access in area likely |
| Netley Creek | 89 | G | 3 | 47 | - | Concrete ford with culverts; low profile |
| Norris Lake | - | A | 1 | 28 | 00:26:21 | Holding areas; grazing; bales; access to lake and/or grazing shoreline (fenced?). Decent buffer between grazing and shoreline? |
| Norris Lake | - | A | 3 | 29 | 00:27:47 | Pasture area, but it appears to be fenced and away from the lake; see cattle |
| Fisher Drain | 15 | G | 3 | 30 | - | Grassed drain extending to crop; erosion |
| Grassmere Ck. | 63 | G | 2 | 31 | - | Well grassed drain extending to cropland; cement ford with no culverts (flow over); impedes flow; barrier |
| Grassmere Ck. | 64 | G | 2 | 32 | - | Well grassed drain extending to cropland; cement ford with no culverts (flow over); impedes flow; barrier |
| Grassmere Ck. | 69 | G | 2 | 33 | - | Well dyked and grassed; hay LB; road RB; flow does not pass through culvert |
| Grassmere Ck. | 70 | G | 3 | 34 | - | Slumping in area but construction under way upstream |
| Grassmere Ck. | 90 | G | 1 | 46 | - | Low head, sheet metal weir; barrier to upstream migration |
| Jackfish Creek | 7 | G | 3 | 35 | - | Fenced area, no immediate creek channel or signs of cattle |
| Jackfish Creek | 7 | G | 3 | 36 | - | Grassed drain but closely bordered by hayfield |
| Jackfish Creek | 37 | G | 2 | 37 | - | Riparian but cattle access |
| Jackfish Creek | 38 | G | 2 | 38 | - | Same pasture as Wpt. 37 |

Table 7. Continued.

| WATER BODY | WPT. # | GROUND OR AIR SITE # | PRIORITY | REHAB. # | VIDEO TIME | DESCRIPTION |
|---------------------------------|-----------|-------------------------|---------------|------------|------------|--|
| Jennifer Creek | 6 | G | 1 | 39 | - | Fenced pasture area with cattle |
| Netley Creek | 45 | G | 3 | 40 | - | Slight erosion at bank; some rip rap; manicured |
| Netley Creek | 49 | G | 3 | 41 | - | Slight bank erosion due to cropping close (?) |
| Parks Creek | 29 | G | 3 | 42 | - | Eroding bank at top and culvert |
| Tugela Creek | 10 | G | 3 | 43 | - | Manicured drain with minimal buffer and cottages |
| Tugela Creek | 11 | G | 3 | 44 | - | Manicured drain with minimal buffer and cottages |
| Norris Lake | 42 | G | 1 | 45 | - | Pasture could extend to banks of lake |
| <i>Netley Creek¹</i> | <i>1</i> | <i>A</i> | <i>High</i> | <i>P1</i> | - | <i>14U 622175 5595013; Livestock</i> |
| <i>Netley Creek¹</i> | <i>2</i> | <i>A</i> | <i>High</i> | <i>P2</i> | - | <i>14U 619911 5595776; Livestock</i> |
| <i>Netley Creek¹</i> | <i>7</i> | <i>A</i> | <i>Medium</i> | <i>P7</i> | - | <i>14U 643143 5575207; Livestock</i> |
| <i>Netley Creek¹</i> | <i>9</i> | <i>A</i> | <i>Medium</i> | <i>P9</i> | - | <i>14U 630552 5589815; Stream crossing</i> |
| <i>Netley Creek¹</i> | <i>10</i> | <i>A</i> | <i>Low</i> | <i>P10</i> | - | <i>14U 625663 5592974; Livestock</i> |
| <i>Netley Creek¹</i> | <i>11</i> | <i>A</i> | <i>Low</i> | <i>P11</i> | - | <i>14U 639286 5576716; Livestock</i> |
| <i>Wavey Creek¹</i> | <i>5</i> | <i>A</i> | <i>High</i> | <i>P5</i> | - | <i>14U 644210 5570254; Livestock</i> |

¹ Source data: Horne and MacDonell (1996)

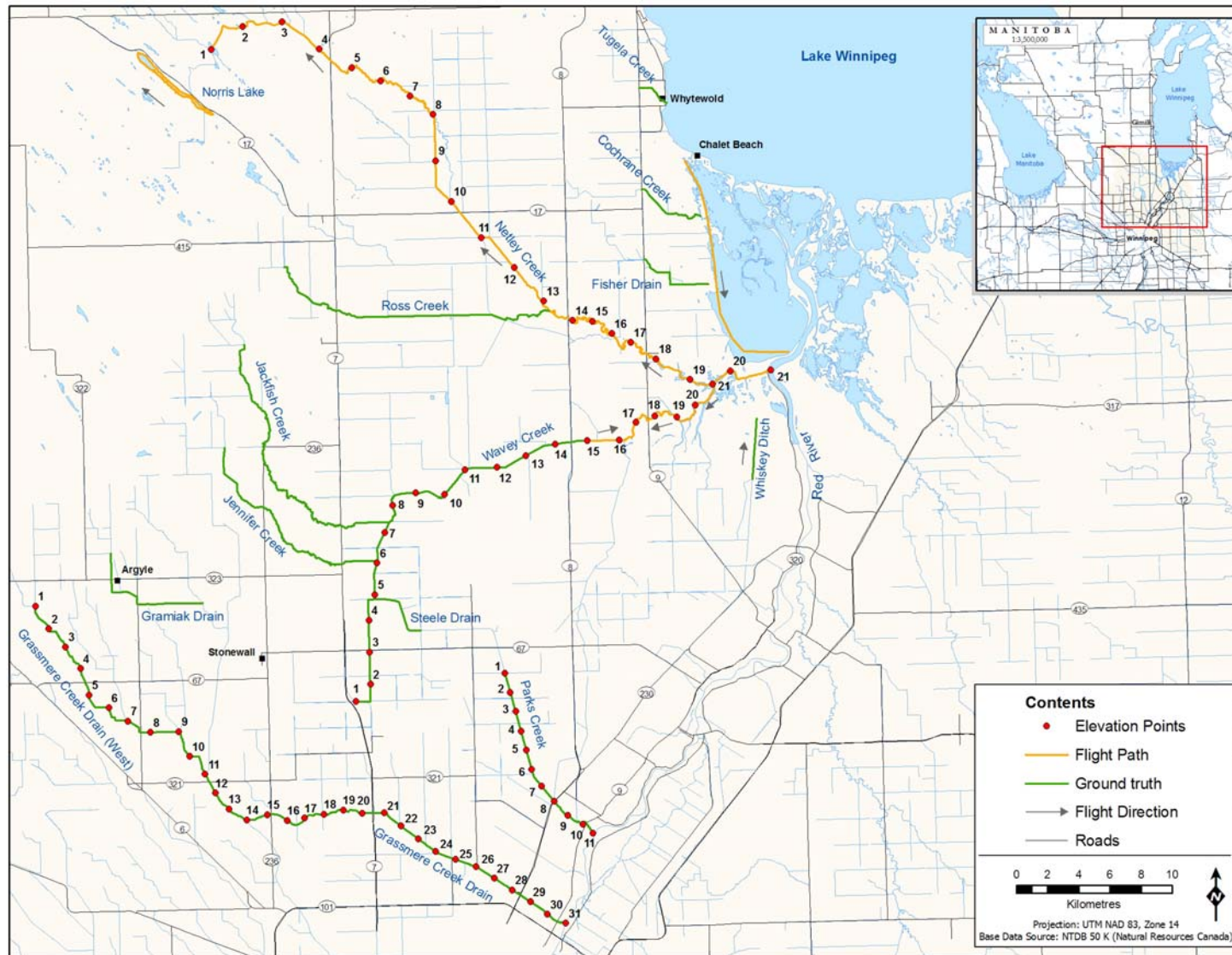


Figure 1. Watershed 050J study area, reaches of watercourse viewed by ground and air, and elevation points used to generate selected elevations profiles.

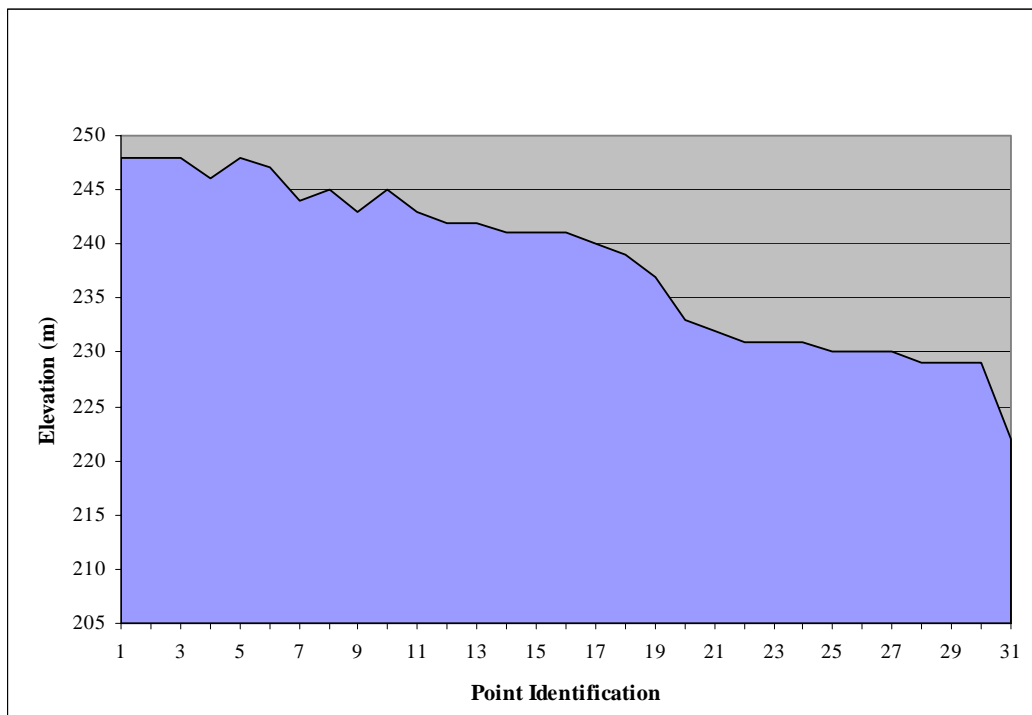


Figure 2. Longitudinal elevation profile (m) along the Grassmere Creek Drain.

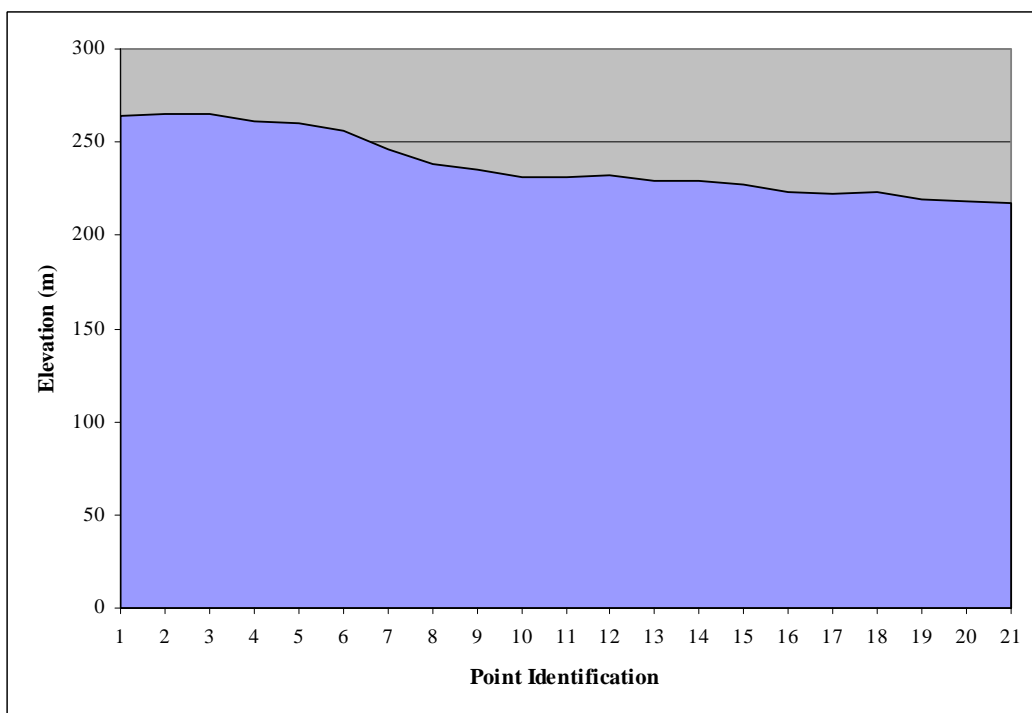


Figure 3. Longitudinal elevation profile (m) along Netley Creek.

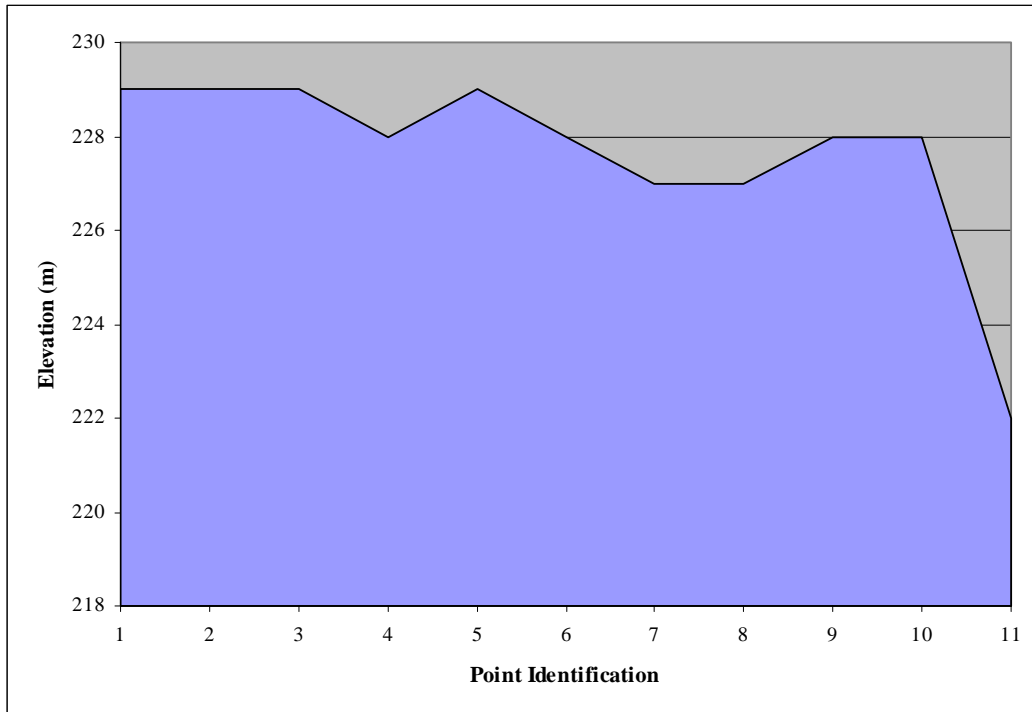


Figure 4. Longitudinal elevation profile (m) along Parks Creek.

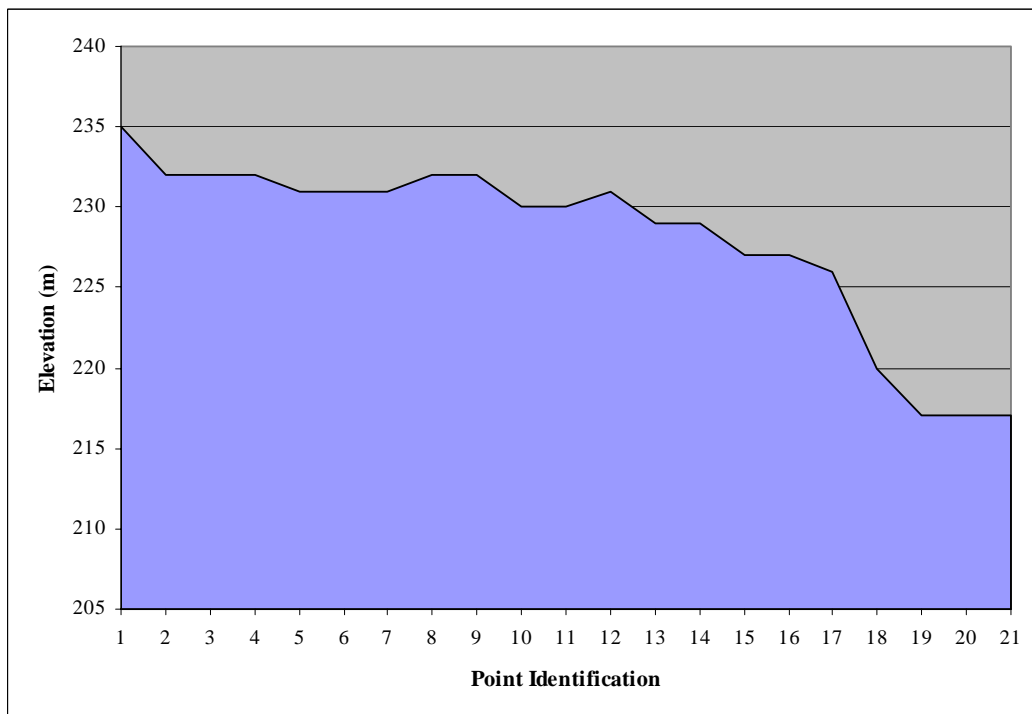


Figure 5. Longitudinal elevation profile (m) along Wavey Creek.

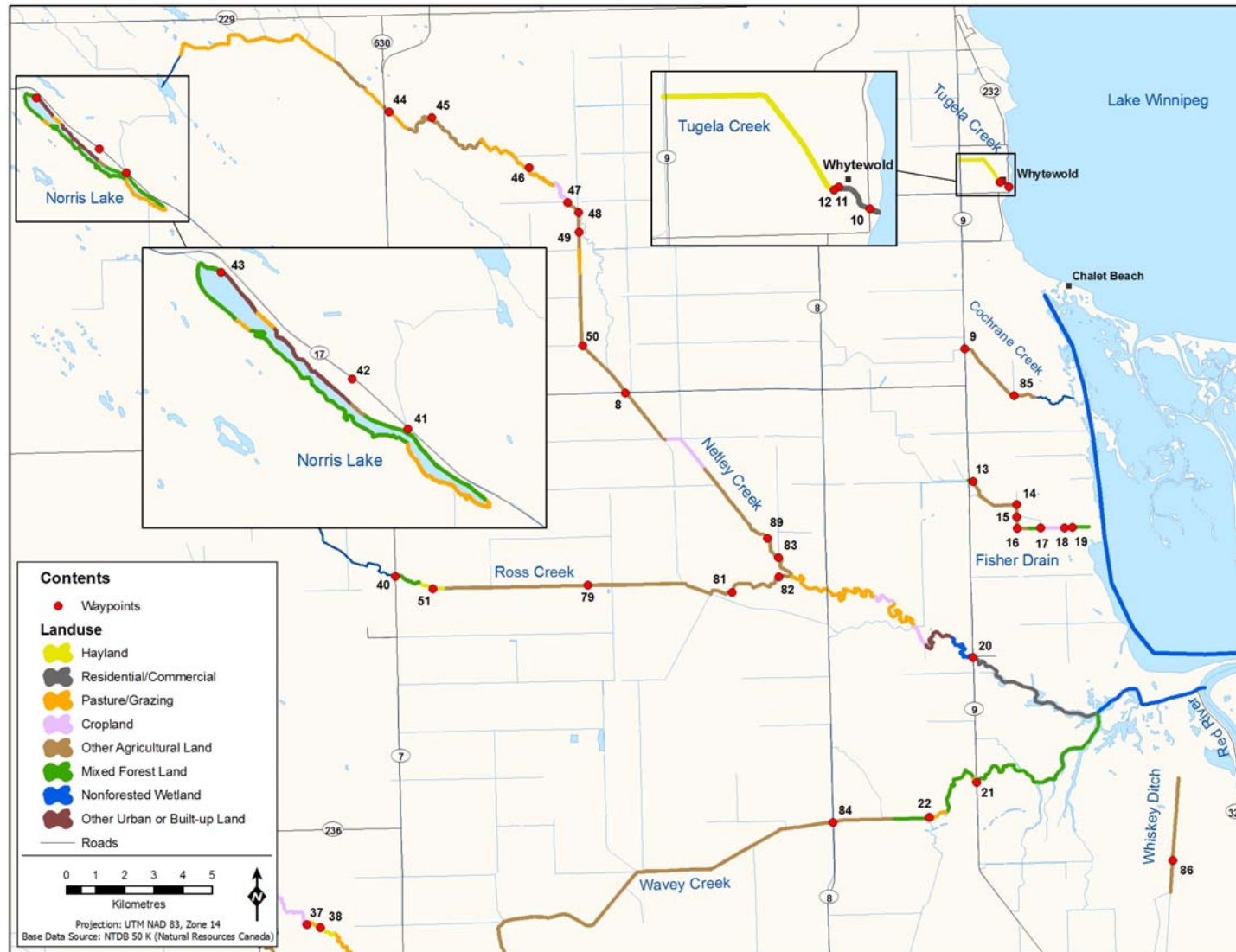


Figure 6. Sites groundtruthed throughout the northern portion of Watershed 050J, indicated by waypoint #, and specific land use/cover identified, 2007.

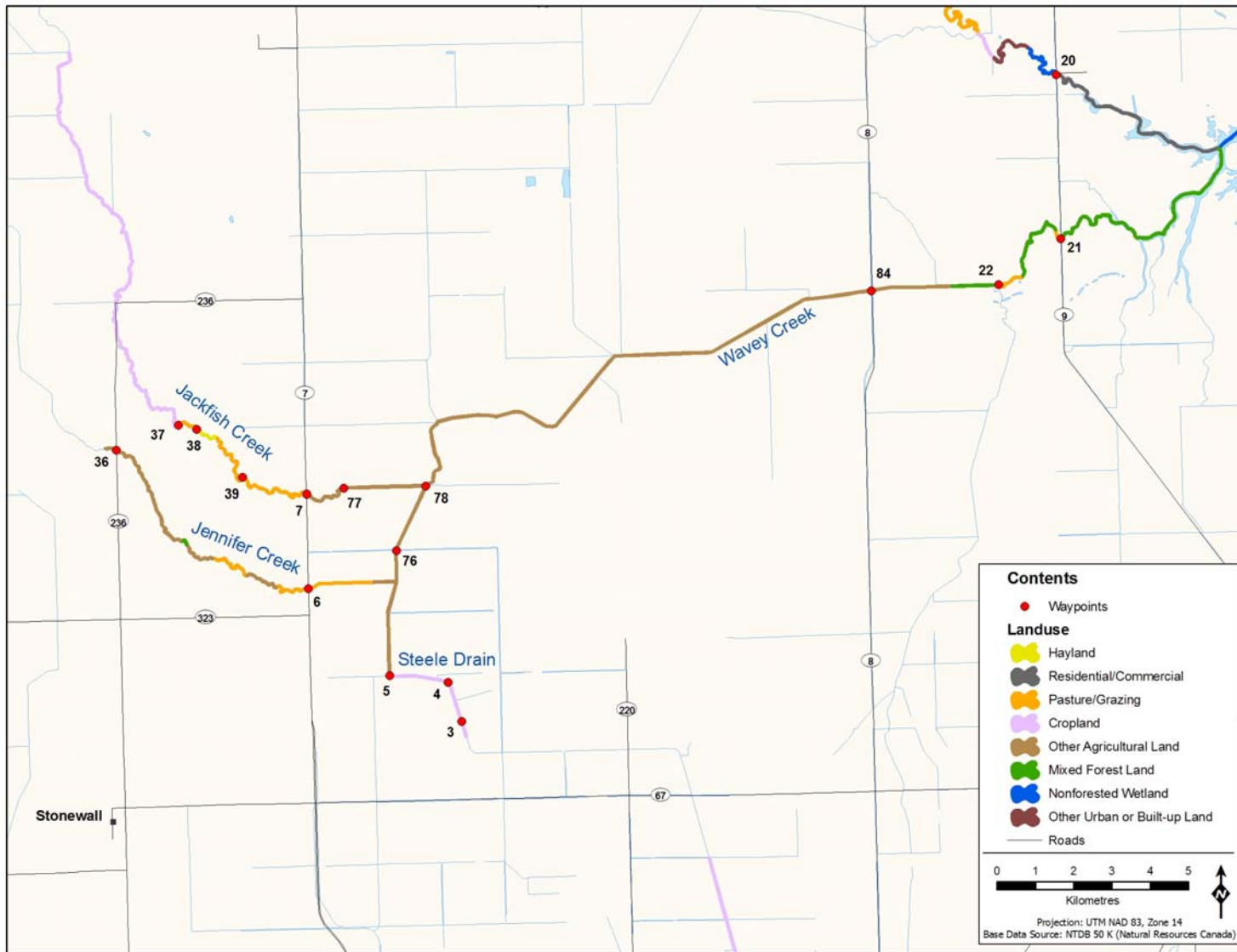


Figure 7. Sites groundtruthed throughout the central portion of Watershed 05OJ, indicated by waypoint #, and specific land use/cover identified, 2007.

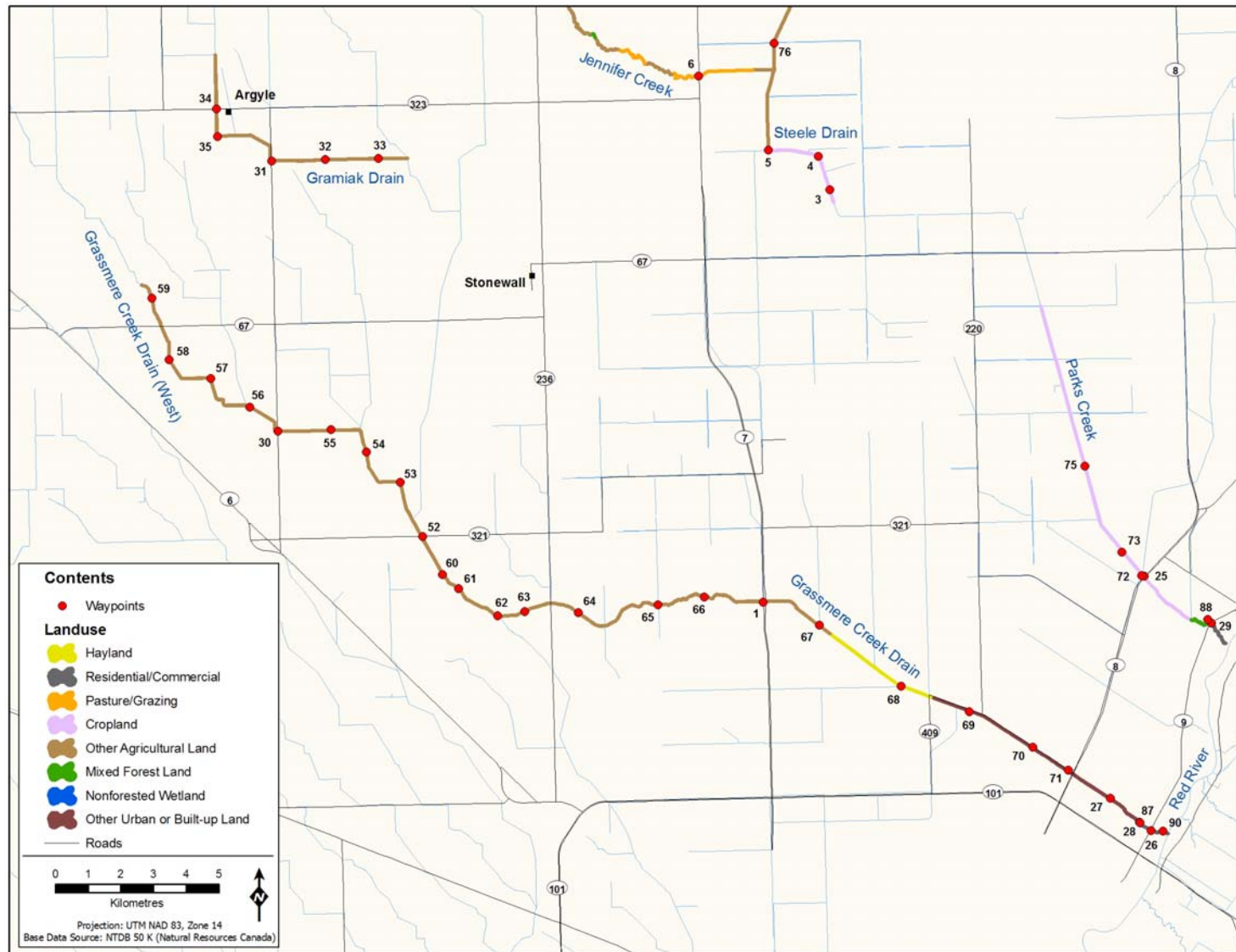


Figure 8. Sites groundtruthed throughout the southern portion of Watershed 05OJ, indicated by waypoint #, and specific land use/cover identified, 2007.

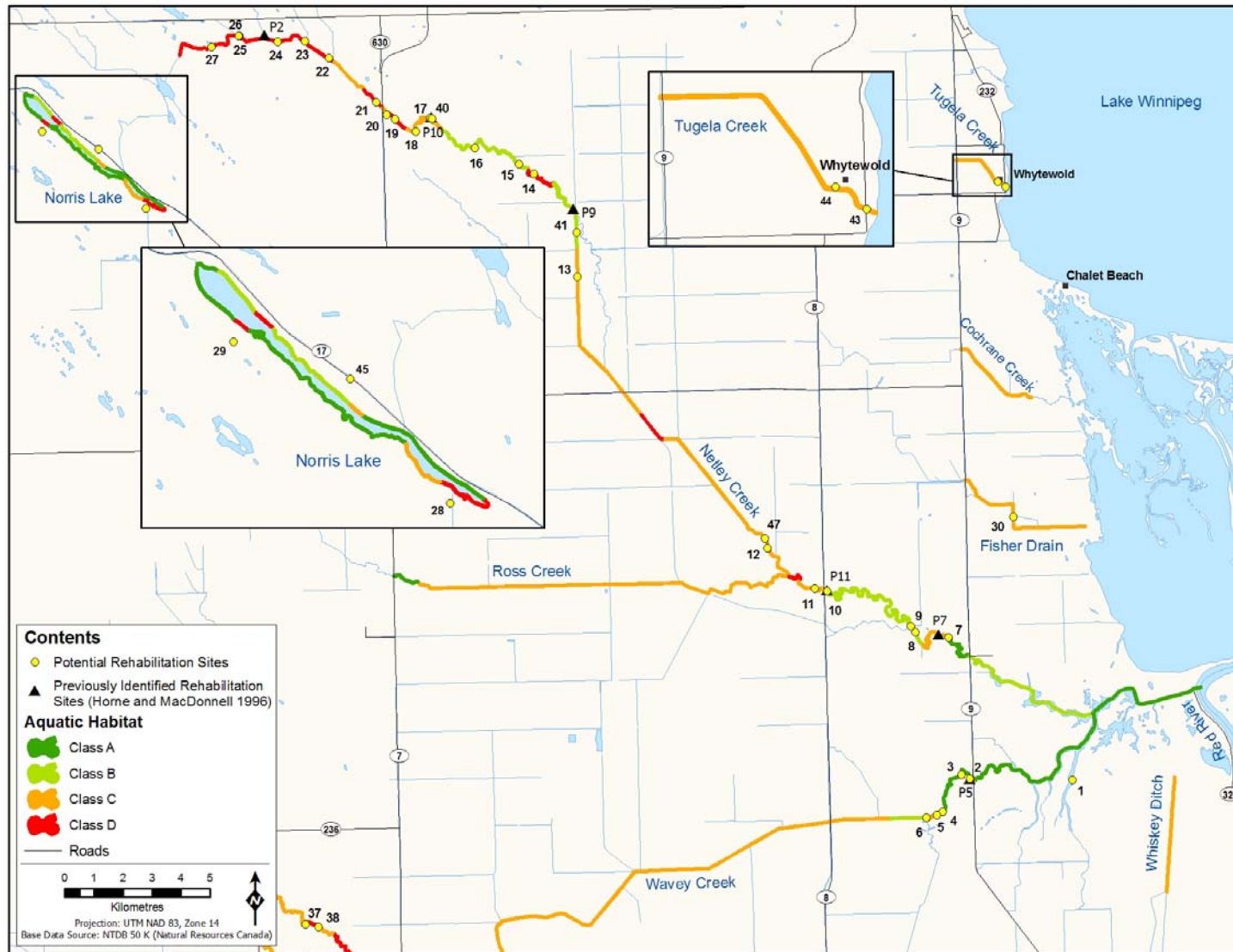


Figure 9. Aquatic habitat quality ratings and potential rehabilitation sites (including previously identified sites) identified throughout the northern portion of Watershed 050J, 2007.

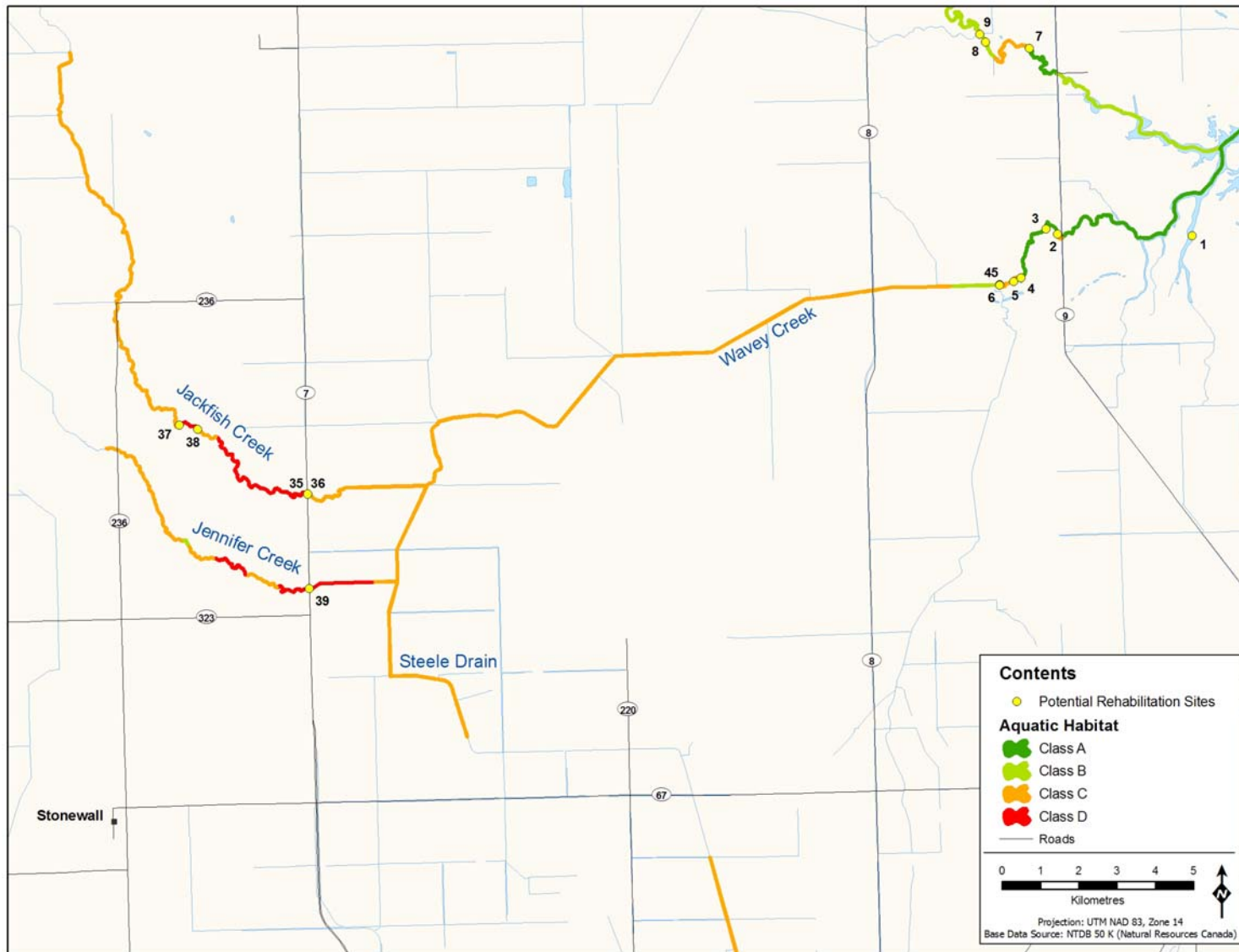


Figure 10. Aquatic habitat quality ratings and potential rehabilitation sites (including previously identified sites) identified throughout the central portion of Watershed 05OJ, 2007.

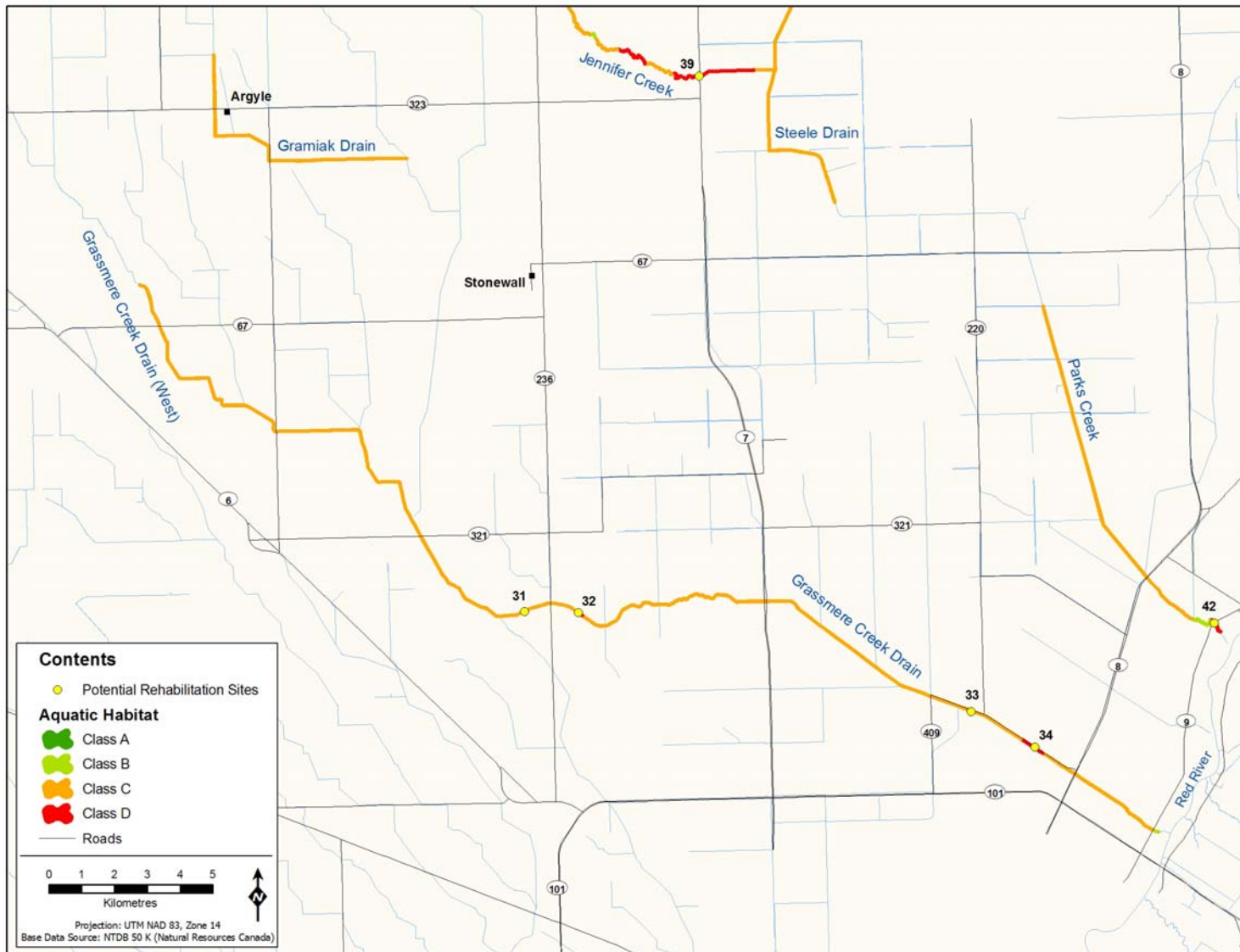


Figure 11. Aquatic habitat quality ratings and potential rehabilitation sites (including previously identified sites) identified throughout the southern portion of Watershed 05OJ, 2007.

APPENDICES

APPENDIX 1.
SITE DESCRIPTIONS AND WORK CONDUCTED BY NORTH/SOUTH
CONSULTANTS INC.

Table A1-1. Reference list of sites visited (by Wpt. #), site description, and work conducted by North/South Consultants Inc. throughout Watershed 05SB, 2007 and 2008.

| STUDY POINT | Watercourse | Site Description | UTM (14U) | | WORK CONDUCTED | | | | | | | |
|--------------------|---------------------|---|-----------|----------|----------------|-------|----------|-----------|------------|------------|---------|----------|
| | | | easting | northing | in situ | hoops | pictures | discharge | velocities | dip net | electro | physical |
| 1 | Grassmere Ck. Drain | at Hwy. 7 | 626667 | 5544970 | | | Y | | | | Y | Y |
| 3 | Steele Drain | Headwaters | 628696 | 5557538 | | | Y | | | | | |
| 4 | Steele Drain | Corner of drain | 628347 | 5558562 | | | Y | | | | | |
| 5 | Steele Drain | Road 79N | 626826 | 5558743 | | | Y | | | | | |
| 6 | Jennifer Creek | at Hwy. 7 | 624702 | 5561006 | | | Y | | | | | |
| 7 | Jackfish Creek | Hwy. 7 (south of Road 82N) | 624656 | 5563473 | | | Y | | | | | |
| 8 | Netley Creek | Hwy. 17 and Netley Creek | 632264 | 5583499 | | | Y | | | | | |
| 9 | Cochrane Creek | at Hwy. 9 | 643922 | 5585020 | | | Y | | | | | |
| 10 | Tugela Creek | at Lk. Wpg. (Gimli Road and Grove Ave.) | 645428 | 5590580 | | | Y | | | | | |
| 11 | Tugela Creek | at tracks | 645174 | 5590760 | | | Y | | | | | |
| 12 | Tugela Creek | u/s of tracks | 645134 | 5590732 | | | Y | | | | | |
| 13 | Fisher Drain | Hwy. 9 and Netley Road | 644195 | 5580466 | | | Y | | | | | |
| 14 | Fisher Drain | at Janisch Road | 645697 | 5579681 | | | Y | | | | | |
| 15 | Fisher Drain | between Wpts. 14 and 16 | 645706 | 5579253 | | | Y | | | | | |
| 16 | Fisher Drain | Taylor Road and Janisch Road | 645718 | 5578866 | | | Y | | | | | |
| 17 | Fisher Drain | between Wpts. 16 and 18 | 646528 | 5578876 | | | Y | | | | | |
| 18 | Fisher Drain | | 647342 | 5578892 | | | Y | | | | | |
| 19 | Fisher Drain | furthest pt. accessible by road at Lk. Wpg. | 647620 | 5578901 | | | Y | | | | | |
| 20 | Netley Creek | at Hwy. 9 | 644204 | 5574430 | | | Y | | | | | |
| 21 | Wavey Creek | at Hwy. 9 | 644317 | 5570138 | | | Y | | | | | |
| 22 | Wavey Creek | Road 85N (and ford) | 642703 | 5568946 | | Y | Y | | Y | | Y | Y |
| 25 | Parks Creek | at Hwy. 8 | 638310 | 5545760 | | | Y | | | | Y | Y |
| 26 | Grassmere Ck. Drain | at Hwy. 9 (Middle Church) | 638519 | 5538006 | Y | | Y | Y | | | Y | Y |
| 27 | Grassmere Ck. Drain | off Grassmere Rd. btw. Hwy. 8 and 9 | 637282 | 5538991 | | | Y | | | | | |
| 28 | Grassmere Ck. Drain | Grassmere Rd. and rail line west of Hwy. 9 | 638172 | 5538252 | | | Y | | | | | |
| 29 | Parks Creek | at Hwy. 9 | 640357 | 5544335 | Y | | Y | | | | Y | Y |
| 30 | Grassmere Ck. Drain | Hwy. 322 and Road 74N | 611837 | 5550175 | | | Y | | | | | |
| 31 | Gramiak Drain | Hwy. 322 and Road 79N | 611645 | 5558417 | | | Y | | | | | |
| 32 | Gramiak Drain | east on Road 79N | 613286 | 5558456 | | | Y | | | | | |
| 33 | Gramiak Drain | down Road 79N and 3E | 614919 | 5558485 | | | Y | | | | | |
| 34 | Gramiak Drain | Meridian Road west of Argyle | 609962 | 5560006 | | | Y | | | | | |
| 35 | Gramiak Drain | Meridian Road south of Argyle | 610002 | 5559166 | | | Y | | | | | |
| 36 | Jennifer Creek | Hwy. 236 (south of Road 83N) | 619694 | 5564618 | | | Y | | | | | |
| 37 | Jackfish Creek | Road 83N and 7E | 621320 | 5565264 | | | Y | | | | | |
| 38 | Jackfish Creek | Road 83N | 621785 | 5565167 | | | Y | | | | | |
| 39 | Jackfish Creek | south on Road 8E | 622993 | 5563907 | | | Y | | | | | |
| 40 | Ross Creek | Hwy. 7 | 624368 | 5577226 | | | Y | | | | | |
| 41 | Norris Lake | Hwy. 17 | 615119 | 5591055 | Y | | Y | | | | | |

Table A1-1. Continued.

| STUDY POINT | Watercourse | Site Description | UTM (14U) | | WORK CONDUCTED | | | | | | | |
|--------------------|---------------------|--------------------------------------|-----------|----------|----------------|-------|----------|-----------|------------|------------|---------|----------|
| | | | easting | northing | in situ | hoops | pictures | discharge | velocities | dip net | electro | physical |
| 42 | Norris Lake | Hwy. 17 and Norris Lake Road south | 614194 | 5591876 | | | Y | | | | | |
| 43 | Norris Lake | boat launch and campground | 612031 | 5593634 | | | Y | | | | | |
| 44 | Netley Creek | east of Hwy. 7 and Road 100N | 624147 | 5593144 | Y | | Y | | | | | |
| 45 | Netley Creek | | 625619 | 5592953 | | | Y | | | | | |
| 46 | Netley Creek | Road 12E | 628953 | 5591240 | | | Y | | | | | |
| 47 | Netley Creek | Road 98N | 630275 | 5590035 | | | Y | | | | | |
| 48 | Netley Creek | Road 13E | 630646 | 5589696 | | | Y | | | | | |
| 49 | Netley Creek | south of Wpt. 48 (Road 13E) | 630668 | 5589017 | | | Y | | | | | |
| 50 | Netley Creek | Road 95N | 630795 | 5585124 | | | Y | | | | | |
| 51 | Ross Creek | east of Hwy. 7 | 625643 | 5576791 | | | Y | | | | | |
| 52 | Grassmere Ck. Drain | off Hwy. 321 | 616264 | 5546970 | | | Y | | | | | |
| 53 | Grassmere Ck. Drain | | 615573 | 5548614 | | | Y | | | | | |
| 54 | Grassmere Ck. Drain | | 614548 | 5549539 | | | Y | | | | | |
| 55 | Grassmere Ck. Drain | | 613467 | 5550213 | | | Y | | | | | |
| 56 | Grassmere Ck. Drain | | 610991 | 5550904 | | | Y | | | | | |
| 57 | Grassmere Ck. Drain | | 609790 | 5551782 | | | Y | | | | | |
| 58 | Grassmere Ck. Drain | | 608514 | 5552351 | | | Y | | | | | |
| 59 | Grassmere Ck. Drain | | 607995 | 5554222 | | | Y | | | | | |
| 60 | Grassmere Ck. Drain | | 616868 | 5545809 | | | Y | | | | | |
| 61 | Grassmere Ck. Drain | | 617364 | 5545393 | | | Y | | | | | |
| 62 | Grassmere Ck. Drain | | 618557 | 5544553 | | | Y | | | | | |
| 63 | Grassmere Ck. Drain | | 619375 | 5544691 | | | Y | | | | | |
| 64 | Grassmere Ck. Drain | | 621015 | 5544646 | | | Y | | | | | |
| 65 | Grassmere Ck. Drain | | 623461 | 5544893 | | | Y | | | | Y | Y |
| 66 | Grassmere Ck. Drain | | 624875 | 5545131 | | | Y | | | | | |
| 67 | Grassmere Ck. Drain | | 628384 | 5544276 | | | Y | | | | | |
| 68 | Grassmere Ck. Drain | | 630883 | 5542417 | | | Y | | | | | |
| 69 | Grassmere Ck. Drain | Gr. Ck. Drain and Grassmere Ck. Rd. | 632965 | 5541633 | | | Y | | | | | |
| 70 | Grassmere Ck. Drain | at Hwy. 220 | 634914 | 5540545 | | | Y | | | | | |
| 71 | Grassmere Ck. Drain | at Hwy. 8 | 635987 | 5539857 | | | Y | | | | Y | Y |
| 72 | Parks Creek | west of Hwy. 8 | 638231 | 5545783 | | | Y | | | | | |
| 73 | Parks Creek | | 637628 | 5546491 | | | | | | | | |
| 75 | Parks Creek | Parks Creek at Mud Road | 636502 | 5549107 | | | Y | | | | | |
| 76 | Wavey Creek | Headwaters | 627002 | 5562012 | | | Y | | | | | |
| 77 | Jackfish Creek | Road 82N and Jackfish Creek | 625625 | 5563618 | | | Y | | | | | |
| 78 | Jackfish Creek | Jackfish Ck. and confluence at Wavey | 627759 | 5563679 | | Y | Y | | | | Y | Y |
| 79 | Ross Creek | Ross Creek along Road 90N | 630982 | 5576921 | | | Y | | | | | |
| 81 | Ross Creek | Ross Creek along road | 635923 | 5576671 | | | Y | | | | | |
| 82 | Ross Creek | | 637531 | 5577199 | | | Y | | | | | |
| 83 | Netley Creek | | 637518 | 5577868 | | | Y | | | | | |
| 84 | Wavey Creek | at Hwy. 8 | 639384 | 5568776 | | | Y | | | | Y | Y |
| 85 | Cochrane Creek | on Cochrane Road | 645607 | 5583409 | | | Y | | | | | |

Table A1-1. Continued.

| STUDY POINT | Watercourse | Site Description | UTM (14U) | | WORK CONDUCTED | | | | | | | |
|--------------------|---------------------|---------------------------------------|-----------|----------|----------------|-------|----------|-----------|------------|------------|---------|----------|
| | | | easting | northing | in situ | hoops | pictures | discharge | velocities | dip net | electro | physical |
| 86 | Whiskey Ditch | and Road 84N | 651065 | 5567466 | | | Y | | | | | |
| 87 | Grassmere Ck. Drain | Spring 2008 hoop at rail bridge | 638177 | 5538251 | | Y | | Y | | | | |
| 88 | Parks Creek | Spring 2008 hoop | 640258 | 5544449 | | Y | | Y | | | | |
| 89 | Netley Creek | Spring 2008 hoop | 637145 | 5578524 | | Y | Y | | Y | | | |
| 90 | Grassmere Ck. Drain | Spring 2008 hoop and sheet metal weir | 638886 | 5537991 | | Y | Y | | | | | |

Description of Work Conducted:

in situ = water quality parameters measured in the field
hoops = hoop nets set for adult migrating fish
pictures = digital 'still' photos
discharge = hydrologic measurement
velocities = taken near bottom of culverts
dip net = fine mesh dip net used for larval fish
electro = backpack electrofishing unit used to capture small bodied fish
physical = physical parameters recorded (e.g., substrate compaction, composition)

APPENDIX 2.

PHYSICAL PARAMETERS AND BIOLOGICAL INFORMATION OBTAINED THROUGHOUT WATERSHED 050J

Table A2-1. Physical information (substrate composition/compaction, water depths, velocities, discharges) collected by North/South Consultants Inc. throughout watershed 05OJ, 2007 and 2008. Definitions provided at end of Table.

| DATE | LOCATION | STUDY | SIDE | DISTANCE | WIDTH | DEPTH | SUBSTRATE | | AREA | VELOCITY | DISCHARGE | Comments | |
|-----------------|-----------------------|-------|------|----------|-------|-------|------------|--------------------------------------|------------|----------|-----------|--|------------------------|
| | | SITE | | (m) | | (m) | Compaction | Composition | | (m/sec) | (m³/sec) | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | LB | 0.00 | 0.13 | 0.00 | hard | boulder/cobble/gravel | 0.00 | - | - | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 0.25 | 0.25 | 0.20 | hard | boulder/cobble/gravel | 0.05 | 0.08 | 0.004 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 0.50 | 0.25 | 0.30 | hard | boulder/cobble/gravel | 0.08 | 0.05 | 0.004 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 0.75 | 0.25 | 0.35 | hard | boulder/cobble/gravel | 0.09 | 0.07 | 0.006 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 1.00 | 0.25 | 0.42 | hard | boulder/cobble/gravel | 0.11 | 0.06 | 0.006 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 1.25 | 0.25 | 0.32 | hard | boulder/cobble/gravel | 0.08 | 0.07 | 0.006 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 1.50 | 0.25 | 0.36 | hard | boulder/cobble/gravel | 0.09 | 0.03 | 0.003 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 1.75 | 0.25 | 0.33 | hard | boulder/cobble/gravel | 0.08 | 0.09 | 0.007 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 2.00 | 0.25 | 0.22 | hard | boulder/cobble/gravel | 0.06 | 0.12 | 0.007 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 2.25 | 0.25 | 0.30 | hard | boulder/cobble/gravel | 0.08 | 0.13 | 0.010 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 2.50 | 0.25 | 0.20 | hard | boulder/cobble/gravel | 0.05 | 0.11 | 0.006 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | | 2.75 | 0.13 | 0.05 | hard | boulder/cobble/gravel | 0.01 | 0.00 | 0.000 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | RB | 2.77 | - | 0.00 | hard | boulder/cobble/gravel | - | - | | | |
| 0.058 Discharge | | | | | | | | | | | | | |
| 25-Oct-07 | Grassmere Creek Drain | 26 | | | | 0.55 | hard | boulder/cobble/gravel | | | | filamentous algae, minimal flow | |
| 25-Oct-07 | Parks Creek | 29 | | | | 0.61 | medium | silt/sand/gravel | | | | filamentous algae; aquatic plants; minimal flow | |
| 25-Oct-07 | Parks Creek | 25 | | | | 0.60 | very soft | silt/mud | | | | some algae and aquatic plants present; no flow | |
| 25-Oct-07 | Grassmere Creek Drain | 71 | | | | 0.75 | medium | mud/cobble | | | | minimal aquatic plants and/or current | |
| 25-Oct-07 | Grassmere Creek Drain | 1 | | | | 0.80 | soft | silt/gravel | | | | minimal aquatic plants and/or current | |
| 25-Oct-07 | Grassmere Creek Drain | 65 | | | | 0.70 | medium | silt/gravel | | | | emergent vegetation; minimal flow | |
| 25-Oct-07 | Jackfish Creek | 78 | | | | 0.80 | very soft | silt | | | | lots of algae and aquatic plants; no flow | |
| 26-Oct-07 | Wavey Creek | 84 | | | | 0.50 | soft | cobble/gravel | | | | filamentous algae; emergent vegetation; low flow | |
| 26-Oct-07 | Wavey Creek | 22 | | | | 1.00 | medium | silt/sand/gravel | | | | some boulders and flow | |
| 22-Apr-08 | Wavey Creek | 22 | RB | 0.00 | 0.5 | 0.00 | hard | mud/cobble | 0.00 | 0.00 | 0.000 | | |
| 22-Apr-08 | Wavey Creek | 22 | | 1.00 | 1.0 | 0.20 | hard | mud/cobble | 0.20 | 0.40 | 0.080 | | |
| 22-Apr-08 | Wavey Creek | 22 | | 2.00 | 1.0 | 0.70 | hard | mud/cobble | 0.70 | 0.39 | 0.273 | | |
| 22-Apr-08 | Wavey Creek | 22 | | 3.00 | 1.0 | 0.70 | hard | mud/cobble | 0.70 | 0.28 | 0.196 | | |
| 22-Apr-08 | Wavey Creek | 22 | | 4.00 | 1.0 | 0.55 | hard | mud/cobble | 0.55 | 0.29 | 0.160 | | |
| 22-Apr-08 | Wavey Creek | 22 | | 5.00 | 1.0 | 0.40 | hard | mud/cobble | 0.40 | 0.29 | 0.116 | | |
| 22-Apr-08 | Wavey Creek | 22 | | 6.00 | 1.0 | 0.20 | hard | mud/cobble | 0.20 | 0.36 | 0.072 | | |
| 22-Apr-08 | Wavey Creek | 22 | | 7.00 | 1.0 | 0.25 | hard | mud/cobble | 0.25 | 0.33 | 0.083 | | |
| 22-Apr-08 | Wavey Creek | 22 | | LB | 8.00 | 0.5 | 0.20 | hard | mud/cobble | 0.10 | 0.29 | 0.029 | |
| 1.008 Discharge | | | | | | | | | | | | | |
| 22-Apr-08 | Wavey Creek | 22 | | | | | | culvert diameter 0.5 m; length 7.9 m | | | 1.39 | | LB culvert at ford |
| 22-Apr-08 | Wavey Creek | 22 | | | | | | culvert diameter 0.5 m; length 7.9 m | | | 1.52 | | Center culvert at ford |
| 22-Apr-08 | Wavey Creek | 22 | | | | | | culvert diameter 0.5 m; length 7.9 m | | | 1.51 | | RB culvert at ford |

Table A2-1. Continued.

| DATE | LOCATION | STUDY SITE | SIDE | DISTANCE (m) | WIDTH | DEPTH (m) | SUBSTRATE | | AREA | VELOCITY (m/sec) | DISCHARGE (m³/sec) | Comments |
|-----------|-----------------------|---------------|------|-----------------|-------|--------------|------------|--|------|---------------------|-----------------------|------------------------|
| | | | | | | | Compaction | Composition | | | | |
| 22-Apr-08 | Netley Creek | 89 | | | | | | culvert diameter 0.35 m; length 12.0 m | | 0.45 | | LB culvert at ford |
| 22-Apr-08 | Netley Creek | 89 | | | | | | culvert diameter 0.4 m; length 12.0 m | | 0.61 | | Center culvert at ford |
| 22-Apr-08 | Netley Creek | 89 | | | | | | culvert diameter 0.2 m; length 12.0 m | | 0.62 | | RB culvert at ford |
| 23-Apr-08 | Grassmere Creek Drain | 87 | LB | 0.00 | 0.25 | 0.00 | medium | grassed | 0.00 | 0.00 | 0.000 | |
| 23-Apr-08 | Grassmere Creek Drain | 87 | | 0.50 | 0.50 | 0.35 | medium | silt/gravel | 0.18 | 0.31 | 0.054 | |
| 23-Apr-08 | Grassmere Creek Drain | 87 | | 1.00 | 0.50 | 0.38 | medium | silt/gravel | 0.19 | 0.47 | 0.088 | |
| 23-Apr-08 | Grassmere Creek Drain | 87 | | 1.50 | 0.50 | 0.35 | medium | silt/gravel | 0.18 | 0.23 | 0.040 | |
| 23-Apr-08 | Grassmere Creek Drain | 87 | | 2.00 | 0.50 | 0.25 | medium | silt/gravel | 0.13 | 0.41 | 0.051 | |
| 23-Apr-08 | Grassmere Creek Drain | 87 | | 2.50 | 0.50 | 0.25 | medium | silt/gravel | 0.13 | 0.38 | 0.048 | |
| 23-Apr-08 | Grassmere Creek Drain | 87 | | 3.00 | 0.50 | 0.20 | medium | silt/gravel | 0.10 | 0.12 | 0.012 | |
| 23-Apr-08 | Grassmere Creek Drain | 87 | RB | 3.50 | 0.25 | 0.15 | medium | silt/gravel | 0.04 | 0.08 | 0.003 | |
| | | | | | | | | | | | 0.296 | Discharge |
| 23-Apr-08 | Parks Creek | 88 | LB | 0.00 | 0.25 | 0 | hard | grassed | 0.00 | 0 | 0.000 | |
| 23-Apr-08 | Parks Creek | 88 | | 0.50 | 0.50 | 0.55 | medium | silt/sand | 0.28 | 0.22 | 0.061 | |
| 23-Apr-08 | Parks Creek | 88 | | 1.00 | 0.50 | 0.58 | medium | silt/sand | 0.29 | 0.26 | 0.075 | |
| 23-Apr-08 | Parks Creek | 88 | | 1.50 | 0.50 | 0.60 | medium | silt/sand | 0.30 | 0.27 | 0.081 | |
| 23-Apr-08 | Parks Creek | 88 | | 2.00 | 0.50 | 0.50 | medium | silt/sand | 0.25 | 0.22 | 0.055 | |
| 23-Apr-08 | Parks Creek | 88 | RB | 2.50 | 0.25 | 0.28 | medium | silt/sand | 0.07 | 0.15 | 0.010 | |
| | | | | | | | | | | | 0.282 | Discharge |

Side = Left (LB) or Right (RB) bank
Distance = Distance (m) from either the left or right bank
Width = Distance between two vertical points of measurement.
Area = Width x Depth

Table A2-2. Water quality data collected in situ (i.e., in the field) by North/South Consultants Inc. throughout Watershed 050J, open water season, 2007 and 2008.

| DATE | LOCATION | SITE | Dissolved Oxygen ¹ YSI-550A | Temperature (°C) | | | pH ² YSI-63 | Turbidity ³ (NTU) |
|-----------|-----------------------|------|---|------------------|----------|--------|---------------------------|---------------------------------|
| | | | | Horiba | YSI-550A | YSI-63 | | |
| 9-Aug-07 | Grassmere Creek Drain | 26 | 3.94 | 20.2 | 20.2 | 20.2 | 8.91 | 2 |
| 9-Aug-07 | Parks Creek | 29 | 8.62 | 20.7 | 21.4 | 20.9 | 8.84 | 39 |
| 9-Aug-07 | Norris Lake | 41 | 8.61 | 25.2 | 25.0 | 26.8 | 8.43 | 49 |
| 9-Aug-07 | Netley Creek | 44 | 7.64 | - | 23.8 | 27.9 | 8.46 | 58 |
| 25-Oct-07 | Grassmere Creek Drain | 26 | 11.29 | - | 6.1 | - | 8.24 | - |
| 25-Oct-07 | Parks Creek | 29 | 12.22 | - | 5.1 | - | 8.05 | - |
| 25-Oct-07 | Parks Creek | 25 | 11.90 | - | 6.8 | - | 8.02 | - |
| 25-Oct-07 | Grassmere Creek Drain | 71 | 13.51 | - | 7.0 | - | 8.37 | - |
| 25-Oct-07 | Grassmere Creek Drain | 1 | 15.45 | - | 7.0 | - | 8.65 | - |
| 25-Oct-07 | Grassmere Creek Drain | 65 | 12.58 | - | 7.7 | - | 8.47 | - |
| 25-Oct-07 | Jackfish Creek | 78 | - | - | 7.8 | - | 8.44 | - |
| 26-Oct-07 | Wavey Creek | 84 | - | - | 7.2 | - | 8.50 | - |
| 26-Oct-07 | Wavey Creek | 22 | - | - | 6.2 | - | 8.50 | - |
| 14-Apr-08 | Grassmere Creek Drain | 87 | - | - | - | 3.0 | - | - |
| 14-Apr-08 | Parks Creek | 88 | - | - | - | 3.0 | - | - |
| 15-Apr-08 | Grassmere Creek Drain | 87 | - | - | - | 3.0 | - | - |
| 15-Apr-08 | Parks Creek | 88 | - | - | - | 3.0 | - | - |
| 18-Apr-08 | Grassmere Creek Drain | 87 | - | - | - | 9.0 | - | - |
| 18-Apr-08 | Parks Creek | 88 | - | - | - | 7.0 | - | - |
| 19-Apr-08 | Grassmere Creek Drain | 87 | - | - | - | 10.0 | - | - |
| 19-Apr-08 | Parks Creek | 88 | - | - | - | 9.0 | - | - |
| 19-Apr-08 | Wavey Creek | 22 | - | - | - | 9.0 | - | - |
| 19-Apr-08 | Netley Creek | 89 | - | - | - | 10.0 | - | - |
| 20-Apr-08 | Grassmere Creek Drain | 87 | - | - | - | 11.0 | - | - |
| 20-Apr-08 | Parks Creek | 88 | - | - | - | 9.0 | - | - |
| 20-Apr-08 | Wavey Creek | 22 | - | - | - | 9.0 | - | - |
| 20-Apr-08 | Netley Creek | 89 | - | - | - | 10.0 | - | - |
| 21-Apr-08 | Grassmere Creek Drain | 87 | - | - | - | 10.0 | - | - |
| 21-Apr-08 | Parks Creek | 88 | - | - | - | 10.0 | - | - |
| 21-Apr-08 | Wavey Creek | 22 | - | - | - | 6.0 | - | - |
| 21-Apr-08 | Netley Creek | 89 | - | - | - | 8.0 | - | - |
| 21-Apr-08 | Norris Lake | 41 | - | - | - | 4.0 | - | - |
| 21-Apr-08 | Wavey Creek | 78 | - | - | - | 8.0 | - | - |
| 22-Apr-08 | Grassmere Creek Drain | 87 | - | - | - | - | - | - |
| 22-Apr-08 | Parks Creek | 88 | - | - | - | 6.0 | - | - |
| 22-Apr-08 | Wavey Creek | 22 | - | - | - | 4.5 | - | - |
| 22-Apr-08 | Netley Creek | 89 | - | - | - | 7.0 | - | - |
| 22-Apr-08 | Grassmere Creek Drain | 90 | - | - | - | 7.0 | - | - |

¹MWQ objective instantaneous minimum of 5 mg/L for the protection of cool water (>5°C) aquatic life.

²MWQ guidelines for: Recreation (5.0-9.0); Protection of Freshwater Aquatic Life (6.5-9.0); and Drinking Water Aesthetic Objectives (6.5-8.5).

³ Collected with Horiba meter

Table A2-3. Fish species (common name and code used) identified throughout Watershed 050J and definitions of sex and maturity codes outlined in Table A2-4.

| FAMILY | COMMON NAME | ABBREVIATION | GENUS | SPECIES |
|----------------|------------------------|--------------|---------------------|-----------------------|
| Ictaluridae | Black bullhead | BLBL | <i>Ameiurus</i> | <i>melas</i> |
| Gasterosteidae | Brook stickleback | BRST | <i>Culaea</i> | <i>inconstans</i> |
| Ictaluridae | Brown bullhead | BRBL | <i>Ameiurus</i> | <i>nebulosus</i> |
| Cyprinidae | Carp | CARP | <i>Cyprinus</i> | <i>carpio</i> |
| Umbridae | Central mudminnow | CNMD | <i>Umbra</i> | <i>limi</i> |
| Cyprinidae | Emerald shiner | EMSH | <i>Notropis</i> | <i>atherinoides</i> |
| Cyprinidae | Fathead minnow | FTMN | <i>Pimephales</i> | <i>promelas</i> |
| Sciaenidae | Freshwater drum | FRDR | <i>Aplodinotus</i> | <i>grunniens</i> |
| Percidae | Iowa darter | IWDR | <i>Etheostoma</i> | <i>exile</i> |
| Percidae | Johnny darter | JHDR | <i>Etheostoma</i> | <i>nigrum</i> |
| Cyprinidae | Longnose dace | LNDC | <i>Rhinichthys</i> | <i>cataractae</i> |
| Esocidae | Northern pike | NRPK | <i>Esox</i> | <i>lucius</i> |
| Cyprinidae | Northern redbelly dace | NRDC | <i>Phoxinus</i> | <i>eos</i> |
| Percidae | Sauger | SAUG | <i>Sander</i> | <i>canadensis</i> |
| Cyprinidae | Spottail shiner | SPSH | <i>Notropis</i> | <i>hudsonius</i> |
| Percidae | Walleye | WALL | <i>Sander</i> | <i>vitreus</i> |
| Moronidae | White bass | WHBS | <i>Morone</i> | <i>chrysops</i> |
| Catostomidae | White sucker | WHSC | <i>Catostomus</i> | <i>commersoni</i> |
| Percidae | Yellow perch | YLPR | <i>Perca</i> | <i>flavescens</i> |
| Catostomidae | Bigmouth buffalo | BGBF | <i>Ictiobus</i> | <i>cyprinellus</i> |
| Centrarchidae | Black crappie | BLCR | <i>Pomoxis</i> | <i>nigromaculatus</i> |
| Percidae | Blackside darter | BLDR | <i>Percina</i> | <i>maculata</i> |
| Salmonidae | Brook trout | BRTR | <i>Salvelinus</i> | <i>fontinalis</i> |
| Salmonidae | Rainbow trout | RNTR | <i>Oncorhynchus</i> | <i>mykiss</i> |
| Cyprinidae | River shiner | RVSH | <i>Notropis</i> | <i>blennioides</i> |
| Centrarchidae | Rock bass | RCBS | <i>Ambloplites</i> | <i>rupestris</i> |
| Ictaluridae | Tadpole madtom | TDMD | <i>Noturus</i> | <i>gyrinus</i> |
| Percopsidae | Trout perch | TRPR | <i>Percopsis</i> | <i>omiscomaycus</i> |
| Gadiformes | Burbot | BURB | <i>Lota</i> | <i>lota</i> |
| Ictaluridae | Channel catfish | CHCT | <i>Ictalurus</i> | <i>punctatus</i> |
| Cyprinidae | Pearl dace | PRDC | <i>Margariscus</i> | <i>margarita</i> |
| Salmonidae | Cisco | CISC | <i>Coregonus</i> | <i>artedi</i> |
| Cyprinidae | Lake chub | LKCH | <i>Couesius</i> | <i>plumbeus</i> |
| Cyprinidae | Common shiner | CMSH | <i>Luxilus</i> | <i>cornutus</i> |
| Cyprinidae | Creek chub | CRCH | <i>Semotilus</i> | <i>atromaculatus</i> |
| Catostomidae | Golden redbelt | GLRD | <i>Moxostoma</i> | <i>erythrurum</i> |
| Hiodontidae | Goldeye | GOLD | <i>Hiodon</i> | <i>alosoides</i> |
| Catostomidae | Quillback | QUIL | <i>Carpionodes</i> | <i>cyprinus</i> |
| Cyprinidae | Blacknose shiner | BLSH | <i>Notropis</i> | <i>heterolepis</i> |

Sex and Maturity Codes Used:

F = Female

F2 = Female preparing to spawn in the current year

F3 = A female, ripe and ready to spawn in the current year

F4 = A female that has spawned in the current year (spent)

M = Male

M7 = Male preparing to spawn in the current year

M8 = A male, ripe and ready to spawn in the current year

M9 = A male that has spawned in the current year (spent)

Table A2-4. Spring fishing results and biological information collected from fish captured by North/South Consultants Inc. throughout Watershed 05OJ, 2008. Fish species codes and sex/maturity ID are outlined in Table A2-3.

| Waterbody | Wpt. # | Total Count | Fish Species | Check Date (y/m/d) | Check Time (h:m) | Fork Length (mm) | Weight (g) | Sex ID | Maturity ID | Comments |
|-----------------------|--------|-------------|--------------|--------------------|------------------|------------------|------------|--------|-------------|-------------|
| Parks Creek | 88 | 1 | NRPK | 15-Apr-08 | 12:00 | 535 | 1450 | M | 7 | |
| Grassmere Creek Drain | 87 | 0 | - | 15-Apr-08 | 11:30 | | | | | |
| Grassmere Creek Drain | 87 | 0 | - | 19-Apr-08 | 10:45 | | | | | |
| Parks Creek | 88 | 1 | NRPK | 19-Apr-08 | 11:15 | 430 | 600 | F | 3 | |
| Grassmere Creek Drain | 87 | 1 | NRPK | 20-Apr-08 | 10:30 | - | - | - | - | Not sampled |
| Parks Creek | 88 | 0 | - | 20-Apr-08 | 10:50 | | | | | |
| Wavey Creek | 22 | 1 | WALL | 20-Apr-08 | 11:50 | 478 | 1300 | M | 7 | |
| Wavey Creek | 22 | 1 | NRPK | 20-Apr-08 | 11:50 | 526 | 1200 | F | 3 | |
| Wavey Creek | 22 | 1 | WHSC | 20-Apr-08 | 11:50 | 390 | 900 | F | 2 | |
| Wavey Creek | 22 | 1 | WHSC | 20-Apr-08 | 11:50 | 430 | 1100 | M | 7 | |
| Netley Creek | 89 | 1 | WALL | 20-Apr-08 | 12:50 | 485 | 1500 | M | 7 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 478 | 1600 | M | 7 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 480 | 1650 | F | 2 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 487 | 1500 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 425 | 1150 | M | 7 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 406 | 900 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 452 | 1400 | F | 2 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 432 | 1350 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 460 | 1700 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 545 | 2600 | F | 2 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 461 | 1200 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 517 | 2400 | F | 2 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 540 | 2700 | F | 2 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 451 | 1400 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 450 | 1600 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 415 | 1200 | M | 7 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 450 | 1500 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 510 | 2000 | F | 2 | |

Table A2-4. Continued.

| Waterbody | Wpt. # | Total Count | Fish Species | Check Date (y/m/d) | Check Time (h:m) | Fork Length (mm) | Weight (g) | Sex ID | Maturity ID | Comments |
|-----------------------|--------|-------------|--------------|--------------------|------------------|------------------|------------|--------|-------------|----------------------------------|
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 513 | 2200 | F | 2 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 450 | 1500 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 445 | 1400 | M | 7 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 447 | 1650 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 441 | 1300 | M | 7 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 451 | 1600 | F | 2 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 445 | 1400 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 443 | 1550 | M | 8 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 387 | 1050 | M | 7 | |
| Netley Creek | 89 | 1 | WHSC | 20-Apr-08 | 12:50 | 456 | 1650 | M | 7 | |
| Grassmere Creek Drain | 87 | 0 | - | 21-Apr-08 | 8:30 | | | | | |
| Parks Creek | 88 | 0 | - | 21-Apr-08 | 8:55 | | | | | Hole in net Net vandalized |
| Wavey Creek | 22 | 0 | - | 21-Apr-08 | 9:30 | | | | | |
| Netley Creek | 89 | 1 | NRPK | 21-Apr-08 | 10:25 | 384 | 350 | M | 7 | |
| Netley Creek | 89 | 1 | NRPK | 21-Apr-08 | 10:25 | 709 | 3600 | F | 3 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 499 | 2000 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 438 | 1400 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 438 | 1300 | F | 2 | |
| Wavey Creek | 78 | 1 | NRPK | 21-Apr-08 | 11:45 | 610 | 1750 | F | 3 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 450 | 1225 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 448 | 1450 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 468 | 1675 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 413 | 1050 | M | 7 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 405 | 1000 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 464 | 1500 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 365 | 800 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 463 | 1500 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 439 | 1200 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 500 | 2250 | F | 2 | |

Table A2-4. Continued.

| Waterbody | Wpt. # | Total Count | Fish Species | Check Date (y/m/d) | Check Time (h:m) | Fork Length (mm) | Weight (g) | Sex ID | Maturity ID | Comments |
|-----------------------|--------|-------------|--------------|--------------------|------------------|------------------|------------|--------|-------------|----------|
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 431 | 1100 | M | 7 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 430 | 1325 | M | 7 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 442 | 1300 | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 21-Apr-08 | 11:45 | 373 | 700 | M | 7 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 640 | 2500 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 624 | 2300 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 735 | 3450 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 560 | 1450 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 435 | 600 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 559 | 1500 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 264 | 100 | M | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 395 | 475 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 250 | 100 | M | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 292 | 200 | F | 3 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 422 | 450 | M | 8 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 290 | 100 | M | 8 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 300 | 200 | M | 7 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 314 | 200 | | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 270 | 125 | | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 275 | 150 | M | 8 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 284 | 150 | | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 320 | 300 | | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 271 | 100 | | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 260 | 150 | M | | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 273 | 100 | M | 8 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 272 | 100 | M | 7 | |
| Grassmere Creek Drain | 90 | 1 | NRPK | 22-Apr-08 | 9:25 | 268 | 150 | M | 7 | |
| Parks Creek | 88 | 1 | NRPK | 22-Apr-08 | 11:00 | 400 | - | F | 3 | |
| Parks Creek | 88 | 1 | WHSC | 22-Apr-08 | 11:00 | 200 | - | | | |
| Wavey Creek | 22 | 1 | NRPK | 22-Apr-08 | 11:30 | 545 | 1150 | F | 3 | |

Table A2-4. Continued.

| Waterbody | Wpt. # | Total Count | Fish Species | Check Date (y/m/d) | Check Time (h:m) | Fork Length (mm) | Weight (g) | Sex ID | Maturity ID | Comments |
|--------------|--------|-------------|--------------|--------------------|------------------|------------------|------------|--------|-------------|----------|
| Wavey Creek | 22 | 1 | NRPK | 22-Apr-08 | 11:30 | 492 | 700 | M | 7 | |
| Wavey Creek | 22 | 1 | NRPK | 22-Apr-08 | 11:30 | 528 | 1100 | F | 3 | |
| Wavey Creek | 22 | 1 | NRPK | 22-Apr-08 | 11:30 | 539 | 1000 | M | 7 | |
| Wavey Creek | 22 | 1 | NRPK | 22-Apr-08 | 11:30 | 494 | 850 | M | 7 | |
| Wavey Creek | 22 | 1 | NRPK | 22-Apr-08 | 11:30 | 910 | 5400 | F | 3 | |
| Wavey Creek | 22 | 1 | WHSC | 22-Apr-08 | 11:30 | 393 | 1000 | M | 8 | |
| Wavey Creek | 22 | 1 | WHSC | 22-Apr-08 | 11:30 | 483 | 2000 | F | 2 | |
| Wavey Creek | 22 | 1 | WHSC | 22-Apr-08 | 11:30 | 520 | 2500 | F | 2 | |
| Netley Creek | 89 | 0 | - | 22-Apr-08 | 13:30 | | | | | |
| Wavey Creek | 78 | 1 | WHSC | 22-Apr-08 | 14:15 | 435 | - | F | 2 | |
| Wavey Creek | 78 | 1 | WHSC | 22-Apr-08 | 14:15 | 360 | - | M | 7 | |

APPENDIX 3.

GROUND AND AIR CLASSIFICATIONS FOR WATERCOURSES THROUGHOUT WATERSHED 050J

Table A3-1. Results of ground based classification, by waypoint, along Cochrane Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|----------------|-------------------------|-----------|----------|------------|-------|---------|-------|--|
| | | | | easting | northing | | | | | |
| 9 | 2-Aug-07 | Cochrane Creek | Hwy. 9 and Cochrane Ck. | 643922 | 5585020 | Upstream | Left | Yes | Drain | Homestead with coniferous and grass buffer |
| | | | | | | | Right | Yes | Drain | Either hay or crop land |
| | | | | | | Downstream | Both | Minimal | Drain | Grassed drain and dykes extending to hay |
| 85 | 25-Sep-07 | Cochrane Creek | Cochrane Rd. | 645607 | 5583409 | Upstream | Both | No | Drain | Well grassed; some crop beyond |
| | | | | | | Downstream | Both | Pool | Drain | Well grassed; some crop beyond |

Table A3-2. Results of ground based classification, by waypoint, along Fisher Drain, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|----------|--------------|------------------------|-----------|----------|------------|-------|-------|-------|--|
| | | | | easting | northing | | | | | |
| 13 | 3-Aug-07 | Fisher Drain | Hwy. 9 and Netley Rd. | 644195 | 5580466 | Upstream | Both | No | Drain | Grassed drain with hay on right |
| | | | | | | Downstream | Both | No | Drain | Grassed drain; likely hay |
| 14 | 3-Aug-07 | Fisher Drain | Janisch Rd. | 645697 | 5579681 | Upstream | Left | No | Drain | Grassed drain extending to crop |
| | | | | | | | Right | No | Drain | Grassed drain extending to hay (?) |
| | | | | | | Downstream | Left | No | Drain | Grassed drain extending to crop |
| | | | | | | | Right | No | Drain | Grassed drain bordered by road |
| 15 | 3-Aug-07 | Fisher Drain | Janisch Rd. | 645706 | 5579253 | Upstream | Left | No | Drain | Grassed drain extending to crop; erosion |
| | | | | | | | Right | No | Drain | Grassed drain bordered by road |
| | | | | | | Downstream | Left | No | Drain | Grassed drain bordered by road |
| | | | | | | | Right | No | Drain | Grassed drain extending to hay |
| 16 | 3-Aug-07 | Fisher Drain | Taylor and Janisch Rd. | 645718 | 5578866 | Upstream | Both | No | Drain | See Wpt. 15 photo |
| | | | | | | Downstream | Left | No | Drain | Grassed drain bordered by road |
| | | | | | | | Right | No | Drain | Grassed drain extending to hay |
| 17 | 3-Aug-07 | Fisher Drain | on Taylor Rd. (?) | 646528 | 5578876 | Upstream | Left | No | Drain | Grassed drain bordered by road |
| | | | | | | | Right | No | Drain | Grassed drain extending to full riparian |
| | | | | | | Downstream | Left | No | Drain | Grassed drain bordered by road |
| | | | | | | | Right | No | Drain | Grassed drain extending to hay |
| 18 | 3-Aug-07 | Fisher Drain | on Taylor Rd. (?) | 647342 | 5578892 | Upstream | Both | No | Drain | Grassed drain |
| | | | | | | Downstream | Left | No | Drain | Grassed drain bordered by road |
| | | | | | | | Right | No | Drain | Grassed drain extending to hay |
| 19 | 3-Aug-07 | Fisher Drain | towards Lk. Wpg. | 647620 | 5578901 | Downstream | Both | No | Drain | Fully grassed and heavy riparian |

Table A3-3. Results of ground based classification, by waypoint, along Gramiak Drain, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|----------|---------------|-----------------------------|-----------|----------|------------|-------|-------|-------|--|
| | | | | easting | northing | | | | | |
| 31 | 9-Aug-07 | Gramiak Drain | Hwy. 322 and Rd. 79N | 611645 | 5558417 | Upstream | Left | No | Drain | Well grassed extending to fenced yard and crop |
| | | | | | | | Right | No | Drain | Well grassed extending to road |
| | | | | | | Downstream | Left | No | Drain | Well grassed extending to road |
| | | | | | | | Right | No | Drain | Well grassed extending to crop |
| 32 | 9-Aug-07 | Gramiak Drain | Rd. 79N (east on) | 613286 | 5558456 | Upstream | Left | No | Drain | Well grassed extending to road |
| | | | | | | | Right | No | Drain | Well grassed extending to hay |
| | | | | | | Downstream | Left | No | Drain | Well grassed extending to dyke top |
| | | | | | | | Right | No | Drain | Well grassed extending to crop |
| 33 | 9-Aug-07 | Gramiak Drain | Rd. 79N and 3E | 614919 | 5558485 | Upstream | Left | No | Drain | Well grassed extending to road |
| | | | | | | | Right | No | Drain | Well grassed extending to dyke top and full riparian |
| | | | | | | Downstream | Left | No | Drain | Well grassed extending to dyke top |
| | | | | | | | Right | No | Drain | Well grassed extending to fenced pasture |
| 34 | 9-Aug-07 | Gramiak Drain | Meridian Rd. (west Argyle) | 609962 | 5560006 | Upstream | Left | No | Drain | Well grassed extending to crop |
| | | | | | | | Right | No | Drain | Well grassed extending to road |
| | | | | | | Downstream | Left | No | Drain | Well grassed extending to hay |
| | | | | | | | Right | No | Drain | Well grassed extending to road |
| 35 | 9-Aug-07 | Gramiak Drain | Meridian Rd. (south Argyle) | 610002 | 5559166 | Upstream | Left | No | Drain | Well grassed extending to crop |
| | | | | | | | Right | No | Drain | Well grassed extending to road |
| | | | | | | Downstream | Left | No | Drain | Well grassed |
| | | | | | | | Right | No | Drain | Well grassed |

Table A3-4. Results of ground based classification, by waypoint, along Grassmere Creek Drain, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|---------------|------------------------|-----------|----------|------------|-------|-------|-------|---|
| | | | | easting | northing | | | | | |
| 1 | 2-Aug-07 | Grassmere Ck. | Hwy. 7 | 626667 | 5544970 | Upstream | Both | Yes | Drain | Well grassed drain with cropland beyond both banks |
| 26 | 9-Aug-07 | Grassmere Ck. | Hwy. 9 (Middle Church) | 638519 | 5538006 | Upstream | Both | Yes | Creek | Riffle sections and thick riparian |
| | | | | | | Downstream | Both | Yes | Creek | Riffle sections and thick riparian; cobble substrate |
| 27 | 9-Aug-07 | Grassmere Ck. | off Grassmere Rd. | 637282 | 5538991 | Upstream | Left | Yes | Drain | Well grassed drain extending to hayed dyke |
| | | | | | | | Right | Yes | Drain | Well grassed drain extending to Grassmere Rd. |
| | | | | | | Downstream | Left | Yes | Drain | Well grassed drain extending to hayed dyke |
| | | | | | | | Right | Yes | Drain | Well grassed drain extending to Grassmere Rd. |
| 28 | 9-Aug-07 | Grassmere Ck. | off Grassmere Rd. | 638172 | 5538252 | Upstream | Left | Yes | Drain | Well grassed drain extending to crop |
| | | | | | | | Right | Yes | Drain | Well grassed drain extending to homes |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain with homes on both sides |
| 30 | 9-Aug-07 | Grassmere Ck. | Hwy. 322 and Rd. 74N | 611837 | 5550175 | Upstream | Both | No | Drain | Well grassed and hayed |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed and hayed |
| 52 | 19-Sep-07 | Grassmere Ck. | off Hwy. 321 | 616264 | 5546970 | Upstream | Both | No | Drain | Well grassed and hayed immediately |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed and hayed |
| 53 | 19-Sep-07 | Grassmere Ck. | along drain | 615573 | 5548614 | Upstream | Left | No | Drain | Grassed drain extending to road |
| | | | | | | | Right | No | Drain | Grassed drain extending to hayfield |
| | | | | | | Downstream | Both | No | Drain | Grassed drain extending to cropland |
| 54 | 19-Sep-07 | Grassmere Ck. | along drain | 614548 | 5549539 | Upstream | Both | No | Drain | Well grassed and dyked drain with crop/stubble fields |
| | | | | | | Downstream | Both | No | Drain | Well grassed drain extending to cropland |
| 55 | 19-Sep-07 | Grassmere Ck. | along drain | 613467 | 5550213 | Upstream | Both | No | Drain | Grassed and dyked up to mixed deciduous riparian |
| | | | | | | Downstream | Both | No | Drain | Grassed and dyked up to mixed deciduous riparian |

Table A3-4. Continued.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|---------------|------------------|-----------|----------|------------|-------|-------|-------|---|
| | | | | easting | northing | | | | | |
| 56 | 19-Sep-07 | Grassmere Ck. | along drain | 610991 | 5550904 | Upstream | Both | No | Drain | Well grassed drain extending to cropland |
| | | | | | | Downstream | Both | No | Drain | Well grassed drain immediately hayed |
| 57 | 19-Sep-07 | Grassmere Ck. | along drain | 609790 | 5551782 | Upstream | Left | No | Drain | Grassed drain extending to road |
| | | | | | | | Right | No | Drain | Grassed drain extending to hay |
| | | | | | | Downstream | Both | No | Drain | Well grassed drain likely hayed |
| 58 | 19-Sep-07 | Grassmere Ck. | Rd. 1W | 608514 | 5552351 | Upstream | Left | No | Drain | Grassed drain extending to road |
| | | | | | | | Right | No | Drain | Grassed drain extending to hay |
| | | | | | | Downstream | Both | No | Drain | Well grassed drain likely hayed |
| 59 | 19-Sep-07 | Grassmere Ck. | along drain | 607995 | 5554222 | Upstream | Both | No | Drain | Grassed drain; dykes not high; cultivated fields |
| | | | | | | | Both | No | Drain | Grassed drain; dykes not high; cultivated fields |
| 60 | 19-Sep-07 | Grassmere Ck. | along drain | 616868 | 5545809 | Upstream | Both | Yes | Drain | Well dyked and grassed extending to hay |
| | | | | | | Downstream | Both | Yes | Drain | Well dyked and grassed extending to hay |
| 61 | 19-Sep-07 | Grassmere Ck. | along drain | 617364 | 5545393 | Upstream | Both | Yes | Drain | Well grassed drain extending to cropland |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain extending to cropland |
| 62 | 19-Sep-07 | Grassmere Ck. | along drain | 618557 | 5544553 | Upstream | Both | Yes | Drain | Well grassed drain extending to cropland |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain extending to cropland |
| 63 | 19-Sep-07 | Grassmere Ck. | along drain | 619375 | 5544691 | Upstream | Both | Yes | Ford | Well grassed drain extending to cropland; cement ford with no culverts (flow over); impedes flow; barrier |
| | | | | | | Downstream | Both | Yes | Drain | |

Table A3-4. Continued.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|---------------|----------------------|-----------|----------|------------|-------|-------|-------|---|
| | | | | easting | northing | | | | | |
| 64 | 19-Sep-07 | Grassmere Ck. | along drain | 621015 | 5544646 | Upstream | Both | Yes | Ford | Well grassed drain extending to cropland; cement ford with no culverts (flow over); impedes flow; barrier |
| | | | | | | Downstream | Both | Yes | Drain | |
| 65 | 19-Sep-07 | Grassmere Ck. | along drain | 623461 | 5544893 | Upstream | Both | Yes | Drain | Well grassed drain extending to hayfield |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain extending to cropland/hayfield |
| 66 | 19-Sep-07 | Grassmere Ck. | along drain | 624875 | 5545131 | Upstream | Both | Yes | Drain | Well grassed drain likely extending to hay/crop |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain |
| 67 | 19-Sep-07 | Grassmere Ck. | along drain | 628384 | 5544276 | Upstream | Both | Yes | Drain | Well grassed drain likely extending to hay/crop |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain likely extending to hay/crop |
| 68 | 19-Sep-07 | Grassmere Ck. | along drain | 630883 | 5542417 | Upstream | Both | Yes | Drain | Well dyked and grassed extending to hay |
| | | | | | | Downstream | Both | Yes | Drain | Well dyked and grassed extending to hay |
| 69 | 19-Sep-07 | Grassmere Ck. | Grassmere Creek Road | | | Upstream | Left | Yes | Drain | Well dyked and grassed extending to hay |
| | | | | | | | Right | Yes | Drain | Well grassed drain extending to Grassmere Rd. |
| | | | | | | Downstream | Left | Yes | Drain | Well dyked and grassed; hay LB; road RB; flow does not pass through culvert |
| | | | | | | | Right | Yes | Drain | |
| 70 | 19-Sep-07 | Grassmere Ck. | Hwy. 220 | 634914 | 5540545 | Upstream | Both | Yes | Drain | Slumping in area but construction under way upstream |
| | | | | | | Downstream | | | | |
| 71 | 19-Sep-07 | Grassmere Ck. | Hwy. 8 | 635987 | 5539857 | Upstream | Both | Yes | Drain | Well grassed and dyked drain; buffered |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed and dyked drain; buffered |
| 87 | 14-Apr-08 | Grassmere Ck. | hoop net and railway | 638177 | 5538251 | Upstream | Both | Yes | Drain | Well dyked and grassed |
| | | | | | | Upstream | Both | Yes | Drain | Well dyked and grassed |
| 90 | 21-Apr-08 | Grassmere Ck. | near Red River | 638886 | 5537991 | Upstream | Both | Yes | Creek | Rip rap and sheet metal weir; residential |
| | | | | | | Upstream | Both | Yes | Creek | Rip rap and sheet metal weir; residential |

Table A3-5. Results of ground based classification, by waypoint, along Jackfish Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) easting northing | Direction | Bank | Water | Use | Comments |
|--------|-----------|----------------|-------------------------------|-------------------------------|------------------------|-----------------------|------------------|-------------------------|---|
| 7 | 2-Aug-07 | Jackfish Creek | Hwy. 7., south of Rd 82N | 624656 5563473 | Upstream Downstream | Both Both | No No | Pasture Drain | Fenced area, no immediate creek channel or signs of cattle Grassed drain but closely bordered by hayfield |
| 37 | 9-Aug-07 | Jackfish Creek | Rd. 83N and 7E | 621320 5565264 | Upstream Downstream | Both Both | No Some | Crop Pasture | Grassed along drain but cropped close Riparian but cattle access |
| 38 | 9-Aug-07 | Jackfish Creek | Rd. 83N | 621785 5565167 | Upstream Downstream | Both Left Right | Some No No | Pasture Hay Hay | Same pasture as Wpt. 37 Hay in area but also some grazing (?) Grassed drain but hayed |
| 39 | 9-Aug-07 | Jackfish Creek | Rd. 83N and 8E | 622993 5563907 | Upstream Downstream | Both Both | No No | Creek Creek | Heavy riparian Heavy riparian |
| 77 | 19-Sep-07 | Jackfish Creek | Rd. 82N | 625625 5563618 | Upstream Downstream | Both Left Right | No No No | Creek Drain Drain | Grassed drain; some riparian and fields Grassed drain extending to road Grassed drain extending to fenced pasture |
| 78 | 19-Sep-07 | Jackfish Creek | near confluence with Wavey | 627759 5563679 | Upstream | Left Right | Yes Yes | Drain Drain | Grassed drain extending to road Grassed drain bordered by crop |

Table A3-6. Results of ground based classification, by waypoint, along Jennifer Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|----------|----------------|------------------|-----------|----------|------------|-------|-------|---------|---|
| | | | | easting | northing | | | | | |
| 6 | 2-Aug-07 | Jennifer Creek | Hwy. 7 | 624702 | 5561006 | Upstream | Both | No | Pasture | Fenced pasture area with cattle Grassed drain extending to hayfield |
| | | | | | | Downstream | Both | No | Drain | |
| 36 | 9-Aug-07 | Jennifer Creek | Hwy. 236 | 619694 | 5564618 | Upstream | Both | No | Drain | Grassed field and drain Hayfield Transportation |
| | | | | | | Downstream | Left | No | Hay | |
| | | | | | | | Right | No | Hwy. | |

Table A3-7. Results of ground based classification, by waypoint, along Netley Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) northing easting | | Direction | Bank | Water | Use | Comments |
|--------|----------|--------------|---------------------------|----------------------------------|---------|----------------------------|--------------------------------|----------------------------------|------------------------------------|--|
| 8 | 2-Aug-07 | Netley Creek | Hwy. 17 and Netley Creek | 632264 | 5583499 | Upstream Downstream | Both Both | Yes Yes | Drain Drain | Grassed drain and dykes with hay Grassed drain and dykes with hay |
| 20 | 3-Aug-07 | Netley Creek | Hwy. 9 | 644204 | 5574430 | Upstream Downstream | Left Right Both | Yes Yes Yes | Creek Creek Creek | Natural creek with reeds and deciduous Natural creek with grass and deciduous Natural creek with grass and deciduous; some manicuring |
| 44 | 9-Aug-07 | Netley Creek | Rd. 100N (east of Hwy. 7) | 624147 | 5593144 | Upstream Downstream | Left Right Left Right | Yes Yes Yes Yes | Creek Creek Pasture Hay | Grassed area extending into mixed deciduous Grassed creek extending to fenced pasture Grassed creek extending to fenced pasture Grassed creek extending to hayfield |
| 45 | 9-Aug-07 | Netley Creek | | 625619 | 5592953 | Upstream Downstream | Left Right Left Right | Yes Yes Yes Yes | Creek Hay Creek Homestead | Grassed creek Grassed creek extending to hayfield Apparent natural grass area Slight erosion at bank; some rip rap; manicured |
| 46 | 9-Aug-07 | Netley Creek | Rd. 12E | 628953 | 5591240 | Upstream Downstream | Left Right Left Right | Pools Pools Pools Pools | Creek Creek Creek Creek | Grassed/riparian with fenced pasture beyond Heavy riparian Grassed and mixed deciduous Grassed and mixed deciduous |
| 47 | 9-Aug-07 | Netley Creek | Rd. 98N | 630275 | 5590035 | Upstream Downstream | Both Both | Yes Yes | Creek Creek | Grassed and mixed deciduous Mixed riparian with apparent crop beyond |
| 48 | 9-Aug-07 | Netley Creek | Rd. 13E | 630646 | 5589696 | Downstream | Left Right | No No | Drain Drain | Grassed drain and heavy riparian into field? Grassed drain and Road 13E |

Table A3-7. Continued.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) easting | UTM (14U) northing | Direction | Bank | Water | Use | Comments |
|--------|-----------|--------------|------------------|----------------------|-----------------------|------------|-------|-------|-------|---|
| 49 | 9-Aug-07 | Netley Creek | south of Wpt. 48 | 630668 | 5589017 | West | Left | No | Crop | Slight bank erosion due to cropping close (?) |
| 50 | 9-Aug-07 | Netley Creek | Rd. 95N | 630795 | 5585124 | Upstream | Left | No | Crop | Grassed drain extending to crop |
| | | | | | | Downstream | Right | No | Drain | Grassed drain and road |
| | | | | | | | Both | Pools | Drain | Grassed drain extending to crop/hay |
| 83 | 19-Sep-07 | Netley Creek | | 637518 | 5577868 | Upstream | Both | Yes | Drain | Grassed drain and dykes |
| | | | | | | Downstream | Both | | | Grassed drain and dykes; crop beyond LB |
| 89 | 19-Apr-08 | Netley Creek | Hoop net at ford | 637145 | 5578524 | Upstream | Both | Yes | Drain | Grassed drain extending to hay; ford in area |
| | | | | | | Downstream | Both | Yes | Drain | Grassed drain extending to hay |

Table A3-8. Results of ground based classification, by waypoint, along Parks Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|-------------|------------------|-----------|----------|------------|-------|-------|-------|---|
| | | | | easting | northing | | | | | |
| 25 | 3-Aug-07 | Parks Creek | Hwy. 8 | 638310 | 5545760 | Upstream | Both | Some | Drain | Well grassed drain extending to hayfields |
| | | | | | | Downstream | Both | No | Drain | Well grassed drain extending to hayfields |
| 29 | 9-Aug-07 | Parks Creek | Hwy. 9 | 640357 | 5544335 | Upstream | Left | Some | Creek | Well grassed with thick deciduous |
| | | | | | | | Right | Some | Creek | Well grassed with some deciduous and homes |
| | | | | | | Downstream | Left | Yes | Creek | Grassed bank with some riparian |
| | | | | | | | Right | Yes | Creek | Eroding bank at top and culvert |
| 72 | 19-Sep-07 | Parks Creek | west of Hwy. 8 | 638231 | 5545783 | Upstream | Both | Yes | Drain | Well grassed drain extending to crop |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain |
| 75 | 19-Sep-07 | Parks Creek | Mud Rd. (?) | 636502 | 5549107 | Upstream | Both | No | Drain | Well grassed drain extending to crop |
| | | | | | | Downstream | Both | Pool | Drain | Well grassed drain extending to crop or hay |
| 88 | 18-Apr-08 | Parks Creek | Hoop net | 640258 | 5544449 | Upstream | Both | Yes | Creek | former bank stabilization in area |
| | | | | | | Downstream | Both | Yes | Creek | former bank stabilization in area |

Table A3-9. Results of ground based classification, by waypoint, along Ross Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|-------------|---------------------------|-----------|----------|------------------------|-----------------------|----------------|-------------------------|--|
| | | | | easting | northing | | | | | |
| 40 | 9-Aug-07 | Ross Creek | Hwy. 7 | 624368 | 5577226 | Upstream Downstream | Both Both | No No | Creek Creek | Heavy riparian of mixed deciduous Heavy riparian of mixed deciduous |
| 51 | 10-Aug-07 | Ross Creek | east of Hwy. 7 (drain) | 625643 | 5576791 | Upstream Downstream | Both Left Right | No No No | Drain Drain Drain | Grassed drain with hay in immediate vicinity Grassed drain extending to road way Grassed drain extending to hayfield |
| 79 | 19-Sep-07 | Ross Creek | along Rd. 90N | 630982 | 5576921 | Upstream Downstream | Both Both | Pool No | Drain Drain | Well grassed/reeds; cultivated field/hay Well grassed; stubble fields beyond |
| 81 | 19-Sep-07 | Ross Creek | | 635923 | 5576671 | Upstream | Left Right | Yes Yes | Drain Drain | Grassed drain and field beyond Grassed drain to deciduous riparian and homestead |
| 82 | 19-Sep-07 | Ross Creek | | 637531 | 5577199 | Upstream Downstream | Both Both | Yes Yes | Drain Drain | Grassed drain with some deciduous riparian; cultivated field RB Grassed drain and dykes |

Table A3-10. Results of ground based classification, by waypoint, along Steele Drain, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|----------|--------------|-----------------------------|-----------|----------|------------|-------|-------|-------|--|
| | | | | easting | northing | | | | | |
| 2 | 2-Aug-07 | Steele Drain | Steele Drain off Hwy. 67 | 628138 | 5555524 | Downstream | Both | No | Drain | Grassed/reed drain bounded by road and hayfield |
| 3 | 2-Aug-07 | Steele Drain | Headwaters of drain | 628696 | 5557538 | Upstream | Both | Yes | Drain | Grassed dyke bounded by cropland on both sides |
| | | | | | | Downstream | Both | Yes | Drain | Grassed dyke bounded by cropland on both sides |
| 4 | 2-Aug-07 | Steele Drain | | 628347 | 5558562 | Upstream | Left | Yes | Drain | Grassed dyke topped with dirt roadway |
| | | | | | | Upstream | Right | Yes | Drain | Grassed drain extending to crop |
| | | | | | | Downstream | Left | Yes | Drain | Grassed dyke topped with dirt roadway |
| | | | | | | Downstream | Right | Yes | Drain | Grassed drain extending slight mixed deciduous |

Table A3-11. Results of ground based classification, by waypoint, along Tugela Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) easting northing | Direction | Bank | Water | Use | Comments |
|--------|----------|--------------|-----------------------------|-------------------------------|----------------------------|-----------------------|----------------------------|------------------------------------|--|
| 10 | 2-Aug-07 | Tugela Creek | Lake Wpg. and Tugela Ck. | 645428 5590580 | Upstream Downstre am | Both Left Right | Yes Yes Yes | Cottages Access point Buffer | Manicured drain with minimal buffer and cottages Manicured bank with access to pier Full riparian |
| 11 | 2-Aug-07 | Tugela Creek | upstream at train tracks | 645174 5590760 | Upstream Downstre am | Both Both | Minima l Minima l | Cottages Cottages | Manicured drain with minimal buffer and cottages Manicured drain with minimal buffer and cottages |
| 12 | 2-Aug-07 | Tugela Creek | upstream of train tracks | 645134 5590732 | Upstream | Left Right | No No | Drain Drain | Grassed drain extends to hay Grassed drain into heavy riparian |

Table A3-12. Results of ground based classification, by waypoint, along Wavey Creek, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|-------------|------------------|-----------|----------|------------|------|-------|-------|--|
| | | | | easting | northing | | | | | |
| 21 | 3-Aug-07 | Wavey Creek | Hwy. 9 | 644317 | 5570138 | Upstream | Both | Yes | Creek | Natural creek with grassed banks and mixed deciduous |
| | | | | | | Downstream | Both | Yes | Creek | Natural creek with grassed banks and mixed deciduous |
| 22 | 3-Aug-07 | Wavey Creek | Rd. 85N | 642703 | 5568946 | Upstream | Both | Yes | Ford | Cement ford with culverts; passage likely; drain with buffer |
| | | | | | | Downstream | Both | Yes | Ford | Cement ford with culverts; passage likely; creek with buffer |
| 76 | 19-Sep-07 | Wavey Creek | | 627002 | 5562012 | Upstream | Both | Yes | Drain | Grassed drain extending to cultivated fields |
| | | | | | | Downstream | Both | Yes | Drain | Grassed drain extending to fields |
| 84 | 19-Sep-07 | Wavey Creek | Hwy. 8 | 639384 | 5568776 | Upstream | Both | Yes | Drain | Well grassed drain and dykes |
| | | | | | | Downstream | Both | Yes | Drain | Well grassed drain and dykes |

Table A3-13. Results of ground based classification, by waypoint, along Whiskey Ditch, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|-----------|---------------|---------------------|-----------|----------|------------|-------|---------|-------|--------------------------|
| | | | | easting | northing | | | | | |
| 86 | 25-Sep-07 | Whiskey Ditch | Rd. 84N | 651065 | 5567466 | Upstream | Left | Minimal | Drain | Grass and road beyond |
| | | | | | | | Right | Minimal | Drain | Grass and full deciduous |
| | | | | | | Downstream | Left | No | Drain | riparian |
| | | | | | | | Right | No | Drain | Grass and mud road |
| | | | | | | | | | | Grass extending to crop |

Table A3-14. Results of ground based classification, by waypoint, along Norris Lake, 2007.

| Wpt. # | Date | Watercourse | Site Description | UTM (14U) | | Direction | Bank | Water | Use | Comments |
|--------|----------|-------------|---------------------------------|-----------|----------|-----------|------|-------|-------------|---------------------------------------|
| | | | | easting | northing | | | | | |
| 41 | 9-Aug-07 | Norris Lake | Hwy. 17 | 615119 | 5591055 | at lake | Both | Yes | Lake | Appears to have well buffered banks |
| 42 | 9-Aug-07 | Norris Lake | Hwy. 17 and Norris Lk. Rd. S | 614194 | 5591876 | | n/a | n/a | Pasture | Pasture could extend to banks of lake |
| 43 | 9-Aug-07 | Norris Lake | Norris Lake boat launch | 612031 | 5593634 | north | Both | Yes | Boat launch | Appears to be well buffered |
| | | | | | | south | Both | Yes | Boat launch | Appears to be well buffered |

Table A3-15. Results of aerial based classification, by video time, along Wavey Creek, Netley Creek, and Norris Lake, 2007.

| AREA | TYPE | COMPOSITION | COMMENT | VIDEO TIME |
|--------------|-------------|-------------------|---|------------|
| Wavey Creek | Grazing | Left Bank | Possible grazing and dugout area with access to Wavey Creek; structures in area | 00:05:03 |
| Wavey Creek | Grazing | Pasture | Possible pasture (extensive?) in wooded area on both banks | 00:06:26 |
| Wavey Creek | Grazing | Pasture | Possible pasture in wooded area on left bank; continuation from 06:26 | 00:06:32 |
| Wavey Creek | Barrier | Riffle | Appears to be riffle (rock) in center channel; not an obvious barrier; spawning project? | 00:06:56 |
| Wavey Creek | Homestead | Mixed | Homestead with out buildings and grazing potential; wooded riparian | 00:07:04 |
| Wavey Creek | Ford | Cement/gravel | Confirm Wpt. 22 ground photos; not likely a barrier to passage (noted for observation) | 00:07:13 |
| Netley Creek | Golf course | Golf course | Netley Golf Course; some beaver dams in area | 00:09:56 |
| Netley Creek | Barrier | Beaver dam? | Apparent beaver dam in river; temporary barrier | 00:10:22 |
| Netley Creek | Homestead | Medium | Outbuildings; possible grazing and shelter; access to creek? (confirm) (and at 13:00) | 00:10:28 |
| Netley Creek | Homestead | Multiple | Thinning riparian, possible grazing in creek; manure piles present? HWY 8? | 00:14:01 |
| Netley Creek | Pasture | Grazing | Possible grazing area on right bank (could be fenced?) | 00:14:16 |
| Netley Creek | Ford | Gravel (culvert?) | No apparent blockage at this water level; possible spring barrier; Groundtruth | 00:14:59 |
| Netley Creek | Grazing | Pasture | Appears to be fenced pasture beyond road and drain; Colony in vicinity? | 00:18:57 |
| Netley Creek | Operation | Medium | Multiple issues; Grazing, manure piles, access to drain, denuded riparian: mostly LB | 00:20:06 |
| Netley Creek | Grazing | Pasture | On LB, thinned riparian, possible access; manure piles? | 00:20:16 |
| Netley Creek | Grazing | Pasture | Grazing on LB but appears to be beyond the riparian; access limited to nil | 00:20:51 |
| Netley Creek | Homestead | Small | Footage is grainy, but grazing and riparian impacts could be occurring | 00:21:18 |
| Netley Creek | Grazing | Pasture | Possible heavy grazed area with impacted riparian and eroding banks | 00:21:28 |
| Netley Creek | Grazing | Pasture | Possible heavy grazed on both banks; channelized here; fence line unapparent | 00:21:42 |
| Netley Creek | Homestead | Small | Homestead on LB with grazing; fenced at this point; See photos from Wpt. 44 | 00:21:52 |
| Netley Creek | Operation | Medium | Heavy grazing; barns; access to creek; dugout in channel | 00:22:01 |
| Netley Creek | Homestead | Medium | Heavy grazing; trails into creek; no riparian; dugout; cattle present | 00:22:45 |
| Netley Creek | Grazing | Pasture | Heavy grazing, into and through creek, no riparian, erosion? | 00:23:00 |
| Netley Creek | Dugout | Dugout | Dugout directly in channel; grazing in area likely | 00:23:11 |
| Netley Creek | Homestead | Grazing | Grazing in creek; no riparian; outbuildings; cattle apparent | 00:23:26 |
| Netley Creek | Crossing | Culvert | No blockage apparent (likely no water); from operation at 00:23:26 | 00:23:34 |
| Netley Creek | Dugout | Dugout | Dugout in channel (watered); grazing/access in area likely | 00:24:10 |
| Norris Lake | Operation | Larger | Holding areas; grazing; bales; access to lake and/or grazing shoreline (fenced?). There appears to be a decent buffer between grazing and shoreline | 00:26:21 |
| Norris Lake | Grazing | Pasture | Pasture area, but it appears to be fenced and away from the lake; see cattle | 00:27:47 |

APPENDIX 4.

**A SUMMARY OF DETRIMENTS TO RIPARIAN AND/OR AQUATIC
ECOSYSTEM HEALTH, NEGATIVE IMPACTS, AND POTENTIAL
MITIGATIVE MEASURES. REFERENCE SECTION PROVIDED AT END
OF APPENDIX.**

PRESENCE OF LIVESTOCK IN THE RIPARIAN ZONE:

Negatives^{1, 3, 8}:

- Not only is it a detriment to aquatic health the well being of livestock is also threatened via direct access to water bodies (e.g., foot rot and/or mastitis, water becomes contaminated with livestock waste providing a transfer medium for other diseases; cattle drink less water if dirty resulting on lower beef production);
- Livestock trample shorelines and destroy aquatic vegetation (erosion and sedimentation are increased);
- Stream flow is more variable which increases bank instability.

Potential Mitigative Measures¹:

- Completely restrict access by fencing;
- Provide off site watering systems;
- If access is required limit it with on-site fencing or install erosion ramps (e.g., cattle crossings);
- If possible, initiate a rotational grazing system;
- A 'best possible scenario' would involve complete livestock exclusion with a (fenced) 9 to 10 m buffer strip along the waters edge.

Potential Benefits (gains) of Mitigative Measures¹:

- Reduced risk of infection and disease (e.g., less bacteria);
- Cleaner water via reduced sedimentation;
- Less nutrient loading and potential algal growth;
- Protected and potentially improved habitat for fish and other aquatic organisms.

Note⁶ – The real issues of livestock within a riparian area are not the animals themselves but rather the poor management issues associated with this practice (i.e., overgrazing, continuous grazing, poor water access and crossings, pasture overstocking, and proximity of feedlots to stream sides).

REMOVAL OF RIPARIAN VEGETATION (LACK OF BUFFER STRIPS):

The removal of riparian vegetation can be a result of overgrazing by livestock, deforestation to allow for agricultural practices, or as a result of urban expansion.

Negatives²:

- Fields cropped to close to watercourses may not be able to slow runoff, resulting in erosion and bank failure;
- Without buffer strips or riparian areas detriments to aquatic health (e.g., sediments, fertilizers, pesticides, pathogens) are not filtered/stopped before the enter the stream;
- Increased levels of nitrogen and phosphorus entering streams (if not trapped by riparian vegetation) can result in toxic conditions (e.g., algal blooms);
- Ground water may also be affected by the leaching of nitrates.

Potential Mitigative Measures^{2, 4, 5}:

- Re-establish buffer strips and riparian vegetation where it is needed;
- If buffer strips have been reduced as a result of livestock, include exclusion fencing;
- Buffer strips can be allowed to regenerate naturally or can be assisted with bio-engineering practices (e.g., plantings of willow, grasses or other naturally occurring hardy species);
- The recommended width of a buffer strip is at least 10 m, however 30 m is more ideal.

Potential Benefits (gains) of Mitigative Measures^{2, 5}:

- Dense buffer strips slow the rates of spring runoff and flood water. The result is a reduction in soil erosion and potential groundwater recharge (e.g., vegetated banks can withstand up to three times the flow of an un-vegetated bank);
- Vegetation traps sediments and organic matter, thus enriching soils;
- Less leaching of nitrates and phosphates into the water system occurs;
- There is a direct improvement to water quality and (often) clarity;
- Diverse plant communities in riparian and or buffer strip areas can reduce weed invasion;
- Water temperatures can be kept cooler as a result of overhanging vegetation. The result is an increase in oxygen for aquatic organisms and a reduction in the effects of pollution (which are magnified by warmer water).

URABAN ENCROACHMENT AND RECREATIONAL OVERUSE/ABUSE:

Human-induced (i.e., anthropogenic) disturbances related to land use can have the greatest impact on water bodies and can include crop and livestock production (discussed above), urban practices (e.g., waste matter, construction activities, concrete drains and roads, channelization), industry (e.g., mining, forestry, assembly and production), and recreational use/abuse (e.g., parks, golf courses, marinas)⁶.

Negatives^{6, 7, 8}:

- Recreational development can reduce species diversity, result in compaction of soils, and disrupt wildlife.
- Manicured lawns in areas such as parks, golf courses, and/or private properties are often directly to the edge of water bodies. This can result in: a reduction in species diversity; the direct input of deleterious substances (e.g., fertilizers, lawn trimmings, brush); or bank failure.
- Marinas can result in oil/gas spills or leaks, direct nutrient loading via improperly functioning privies or improperly disposed waste material, bank failure due to excessive/un-checked vessel activity; or the introduction of invader species (e.g., zebra mussels).
- Urbanization can: increase runoff that is potentially polluted (e.g., drains and ditches or paved roadways); result in the clearing of riparian areas; and increase the number of stream crossings in an area.

Potential Mitigative Measures^{6, 7, 8}:

- Avoid riparian areas and increase buffer widths along water bodies;
- Plan for a reduction in impervious cover (e.g., roofs, roads, parking lots, etc);
- Limit the disturbance and, subsequent, erosion of soils;
- Treat storm water runoff;
- Initiate buffer widths in urban areas, especially along water courses;
- Reduce or ban the use of lawn fertilizers and chemicals used in the home;
- Enforce regulations to prevent the illegal dumping of material into watercourses;
- Educate the public on how they can make a difference.

Potential Benefits (gains) of Mitigative Measures:

- Increased riparian areas which serve a filtering function and act towards erosion control;
- Improved riparian areas are aesthetically pleasing;
- Treating storm water runoff can improve water quality;
- A reduction of lawn fertilizers and chemicals should reduce the amount of phosphates and nitrates entering a water body, thus improving water quality.

IMPROPERLY DESIGNED STREAM PASSAGE:

Improperly designed stream passage can take a number of forms, including: improperly sized culverts; the use of fords; bridges, or lack of complete structure.

Negatives⁹:

- Improperly designed stream crossings can cause washouts and increase erosion within a stream channel.
- Stream crossings can act as barriers to fish migration. For example, culverts may be perched, act as velocity barriers, or become clogged with debris;
- If not properly maintained, crossings can become blocked by debris (e.g., logs, silt, gravel, etc). These blockages can result in washouts or act as barriers to fish migration;
- Through construction activities sediments entering the stream may increase. These sediment loads could destroy or alter fish habitat and reduce water quality;
- Construction activities can also result in altered or destroyed riparian areas.

Potential Mitigative Measures⁹:

- All road crossing should be designed properly and maintained;
- New road crossings should follow all applicable construction guidelines and guidelines for the protection of fish and aquatic habitat;
- Crossings determined to be detrimental to aquatic health should be replaced.

Potential Benefits (gains) of Mitigative Measures:

- Properly designed and maintained crossing should allow for the passage of fish;
- Properly designed and maintained crossings should not increase sedimentation or result in erosion;
- Properly designed crossings are cost effective if they do not result in washouts and subsequent repairs.

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