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Report 2.3

Overview Assessment of Fish Passage at Stream Crossings within Selected Watersheds

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Weldwood

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The methodology for this assessment was developed in consultation with Chris Spytz, Biologist, with Weldwood of Canada Ltd. (Hinton Division). Rick Bonar, also with Weldwood, provided review of our study design and draft reports. The 2002 field crew included Jason Blackburn, Scott Wilson and Chad Sherburne, under the direction of Richard McCleary. Prior to 2002, Craig Johnson oversaw the stream crossing project. The 2001 field crew was comprised of Mike Blackburn, Chantelle Bambrick, Jason Blackburn and Cameron Nelin. The 2000 field crew included Cam Davis, Jill Collyer and Mike Blackburn. The 1999 field crew included Cam Davis, Mike Blackburn, Jason Cooper, Chantelle Fourny and Twila Arsenault.

Abstract

For our purposes, a stream crossing was defined as the intersection of a stream with a road or railway. Within the study area, many historic crossings were designed based on water conveyance and fish passage. Hanging outfalls have evolved at some of these crossings and therefore, some structures were known to prevent upstream fish migration.

The Foothills Model Forest had several goals for this overview assessment. We recognized that considerable investment will be required to modify the existing road and railway infrastructure, and therefore we selected a watershed perspective to establish priorities for future engineering and biological assessments. These more detailed assessments will be required to identify options and establish budgets for remediation. Our study area included 14 watersheds and we included the intersection points of all mapped streams with mapped roads and railways within these watersheds.

We assessed a total of 302 crossings and identified four structures that currently present a full barrier to upstream fish migration within known fish bearing streams. If these crossings were repaired, access to a total of 6.2 km of known upstream habitat would be created. We also identified 18 crossings that present potential partial barriers to upstream fish migration in known fish bearing streams. Detailed assessments are required to determine the degree to which each of these crossings poses a barrier to upstream fish migration. If these crossings are all found to present some type of barrier and repairs are subsequently made, access to a total of 94.1 km of known fish habitat would be created. A total of 49 other crossings that would present either a full barrier or a potential partial barrier are located in streams with unknown fish bearing status and additional fish inventory is recommended prior to assessing these crossings for fish passage.

There are two main recommendations from this report. First, the findings from this report should be communicated to the crossing owners. Identification of the specific owners will require some effort, particularly for the oil & gas sector crossings. Second, a protocol should be developed for completing a detailed fish passage assessment. The Foothills Model Forest is willing to assist, where possible, with additional assessments. Ultimately, the crossing owner remains responsible for completing any detailed assessments and completing repairs to improve passage. Our goal is to increase awareness of fish passage issues and to provide practical tools for moving forward with remediation.

Table of Contents

List of Figures

List of Tables

1. Introduction

Fish migrate to different locations in a watershed in order to meet a variety of life history requirements. This includes both adult fish returning upstream to spawn, juvenile fish dispersing throughout watersheds to access suitable rearing habitat and all life stages as they move towards suitable over-wintering areas (Whyte et. al 1997). Stream crossings occur wherever roads or railways intersect streams. Structures designed to convey water under roads and railways have the potential to block upstream fish migration. Over the long-term, stream crossings that block upstream fish migration have the potential to reduce the productivity and distribution of the various fish species that inhabit an impacted area.

Within the Foothills Model Forest (FMF), native fish including Bull Trout (*Salvelinus confluentus*), Rainbow Trout (*Oncorhynchus mykiss*), Mountain Whitefish (*Prosopium williamsoni*), Arctic Grayling (*Thymallus arcticus*) and Long Nosed Sucker (*Catastomus catastomus*) have been observed making the seasonal upstream migration for spawning (FMF 1999 - 2001). Juveniles of these species have significantly reduced swimming capabilities (Katopodis 1994) and have also been observed widely distributed throughout the region. Other species including Spoonhead Sculpin (*Cottus ricei*), Northern Pike (*Esox lucius*) and Burbot (*Lota lota*), which have reduced swimming capabilities in moving water due to their mode of swimming (Katopodis 1994), also inhabit small streams in the region (FMF 1999 - 2002).

Barriers typically occur when upstream fish migration was not identified as an objective during the stream crossing design and engineering phase. Current standards for stream crossings include maintaining fish passage at man-made structures (Fisheries Act 1985). Fish passage on older roads and crossings may not have been identified as an objective at the time of construction. Or, due to scour at a culvert outlet, structures that initially met fish passage requirements may now present a migration barrier. Both the federal and provincial governments have more recently established approval processes to ensure that long-term fish passage requirements are addressed in the project design phase (Fisheries and Oceans Canada 1991 and Alberta Government 2001).

Following the recognition of the amount of productive fish habitat that was not accessible, many jurisdictions have initiated programs to restore fish passage. Such efforts include the British Columbia Watershed Restoration Program (Parker 2000), US Forest Service restoration programs (Love & Firor 2001) and the Weldwood Stream Crossing Remediation Program (R. Bonar, Weldwood Chief Biologist, pers. comm. 2002). The Weldwood program for stream crossing remediation involves all crossings that the company is responsible for within their FMA. Their program is based on a comprehensive assessment that includes safety, sedimentation, as well as fish passage concerns. Our study is intended to augment their ongoing program by providing a watershed perspective that may assist the company in determining priority sites for fish passage remediation.

Determining the fish-bearing status and fish migration barrier status at all 302 crossings within the monitoring watersheds was beyond the scope of this project. Therefore, the first objective of this preliminary assessment was to identify crossings that may require one of the three more detailed assessments. First, we identified crossings that presented a fish migration barrier within a known fish-bearing stream. These crossings would be suited to a remediation design assessment. Second, we identified potential fish migration barriers that are present in known fish-bearing streams. These crossings would be candidates for a more detailed crossing assessment to determine the severity of the barrier and the priority for remediation. Third, we identified barriers and potential barriers in streams with unknown fish-bearing status. These crossings would be candidates for future assessment in the ongoing FMF fish and fish habitat inventory program. The reader should be aware that our preliminary assessment was not intended to be definite in all cases but to serve as a tool to establish priorities for further work in an ongoing remediation program.

A second objective was to develop a methodology that could be useful to guide other remediation efforts outside of the project study area. Our project may also provide some of the background for the terms of reference for the development of a more detailed fish passage assessment as part of Weldwood's remediation program.

A third objective was to determine the extent of upstream habitat that may have been isolated due to migration barriers within each of the monitoring watersheds.

The final objective was to increase awareness and encourage the companies and government agencies responsible for stream crossings to develop and implement plans to upgrade existing structures in order to satisfy fish passage requirements.

The study area for this project includes several watersheds within the Foothills Model Forest (Figure 1). The stream crossings within the study area are managed by a number of agencies including:

- Weldwood of Canada Ltd. (Hinton Division)
- Government of Alberta, Ministry of Transportation
- Alberta Railnet Inc.
- CN Rail
- Other License of Occupation holders including oil and gas companies
- Parks Canada is responsible for crossings within Jasper National Park

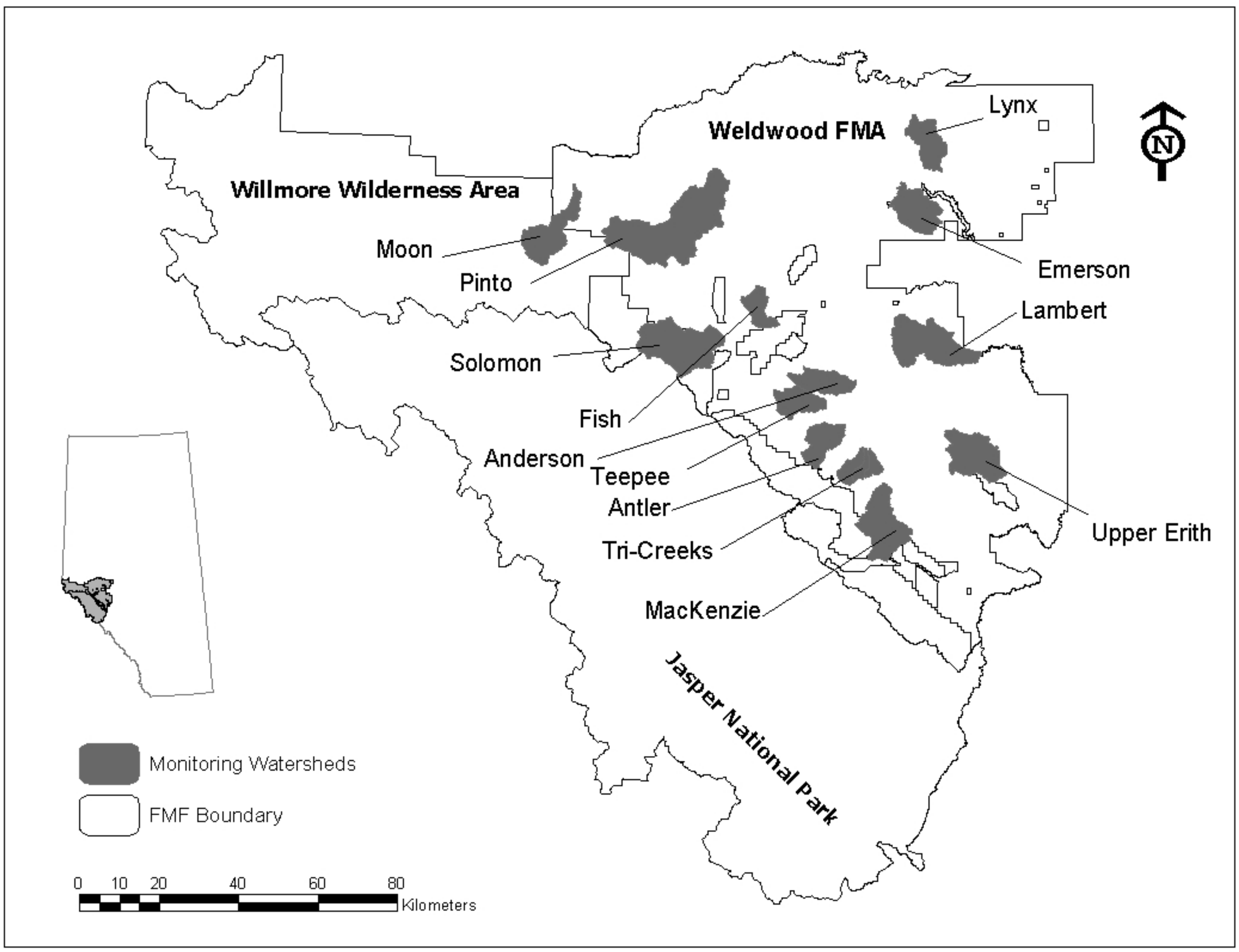


Figure 1. Monitoring Watersheds within the Foothills Model Forest

2. *Methods*

2.1. Site Selection

To identify field survey sites within the monitoring watersheds, maps were produced showing all streams along with highways, railways, and industrial roads. All road-stream intersections and railroad-stream intersections were numbered and field maps were created.

2.2. Field Methods

All field data were recorded on a crossing data form (Appendix I). This data included location description, structure type, stream channel measurements, and crossing details. Along with a general description of the site location, GPS coordinates were taken at each site. Photographs of each inflow, outflow and any other important features were also taken.

Field assessments were completed during the summers of 1999 - 2002. Each crossing was identified as a bridge, a culvert, or a ford. At all sites, stream channel measurements were taken at a location upstream of the crossing's influence. Measurements included wetted stream width, rooted/bank-full width, and three representative depths across the channel (Figure 2).

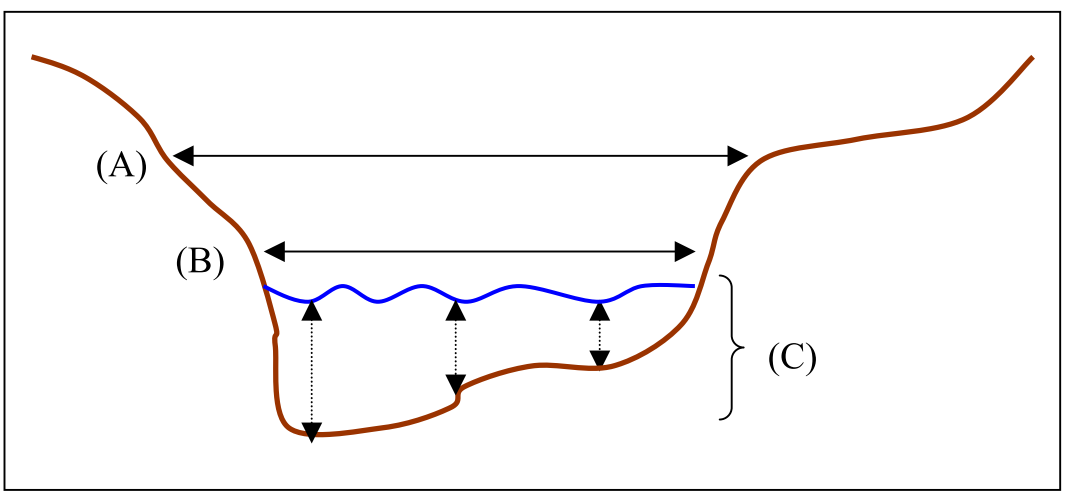


Figure 2. Stream channel measurements taken upstream of each crossing included; rooted width (A), wetted width (B), and three water depths across the channel (C).

For stream crossings with a culvert, field measurements included hang height, culvert diameter, plunge pool presence and depth, and the total length of the culvert (Figure 3). In addition, presence of substrate within the culvert was noted.

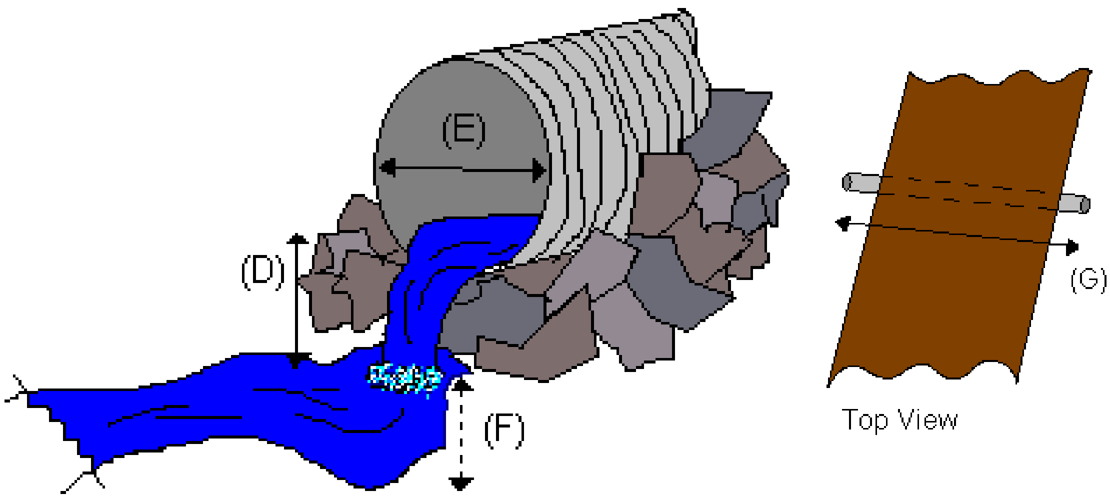


Figure 3. Typical measurements taken from a culvert-type stream crossing, where; (D) hang height, (E) culvert diameter, (F) pool depth, and (G) culvert length.

2.3. Assessment of Fish Passage Status

All field data were entered into a Microsoft Access database. For quality control, all database tables were compared to the original field data sheets. In the office, the status of each crossing as a barrier was determined based on criteria identified in other fish passage studies (Table 1).

Table 1. Stream crossing barrier classification

Barrier Type	Barrier Class	Criteria
No barrier	1	A culvert was considered to allow unobstructed passage if either of the following criteria were met: 1. Outlet not hanging and culvert backwatered by grade control downstream of outlet (Love & Firor 2001). 2. Water velocity in culvert comparable to upstream water velocity indicated by retention of substrate of similar composition as the natural streambed inside culvert (Parker 2000).
Full barrier	3	A culvert was considered a full barrier if any one of the following criteria were met: 1. Hang height greater than 0.6m (Love & Firor 2001). 2. Outfall pool depth less than 1.25 times hang height (Love & Firor 2001). 3. Debris at inlet or outlet.
Potential partial barrier	2	All other culverts not meeting the criteria above were identified as potential partial barriers including: 1. Outlet hang height less than 0.6m but greater than 0 (Love & Firor 2001). 2. Outfall pool depth greater than 1.25 times hang height (Love & Firor 2001). 3. Water velocity in culvert greater than upstream water velocity indicated by lack of retention of substrate of similar composition to the natural streambed within culvert (Parker 2000).

All bridges, fords, or engineered culverts with baffles were considered to allow full passage and were classified as non-barriers.

2.4. Determination of Fish-bearing Status

Another objective of the ongoing human-use study was to improve knowledge of basin-wide fish distributions throughout these watersheds. As a result, inventory efforts provided more information about fish distribution within study area watersheds than most other basins within the Weldwood FMA.

Understanding fish distribution can help to establish priorities for further work. Ideally, sites for remediation would be priorized by a number of factors such as the amount of habitat located in upstream areas and the degree to which the culvert presents a barrier. In order to assist with such a priorization exercise, a classification scheme based on probability of fish capture at any individual site was developed (Table 2). The authors recognize the limitations of this present model and will continue to refine a model of fish habitat status.

Table 2. Determination of probability of fish capture.

Probability of Fish Capture	Class	Mapped Stream Color	Criteria
High	1	Red	• Those stream reaches from the automated classification (Golder 2002) where fish were captured during FMF inventories. • All stream reaches located downstream of fish-bearing sites, as well as those stream reaches located upstream with the same gradient class and stream order.
Low	3	Green	• Within the Foothills Model Forest, no fish have been captured in any stream with a gradient exceeding 8.5 % slope (Figure 4). Therefore, to be conservative, all stream reaches with a gradient exceeding 10 % were considered non-fish bearing. • The smallest fish-bearing stream within the Foothills Model Forest had a drainage area of 0.23 km^2. Therefore, all stream reaches with a drainage area of less than 0.23 km^2 were considered non-fish bearing. • Any stream reaches where fish had not been captured in two different years and two different seasons using backpack electrofishing for a 300m long section. • Any stream reaches upstream of a confirmed non-fish bearing reach based on backpack electrofishing. • Any headwater tributary with no stream flow during a summer field visit. • Any headwater stream channel vegetated with emergent wetland type vegetation across the entire channel.
Medium	2	Yellow	• All other stream reaches.

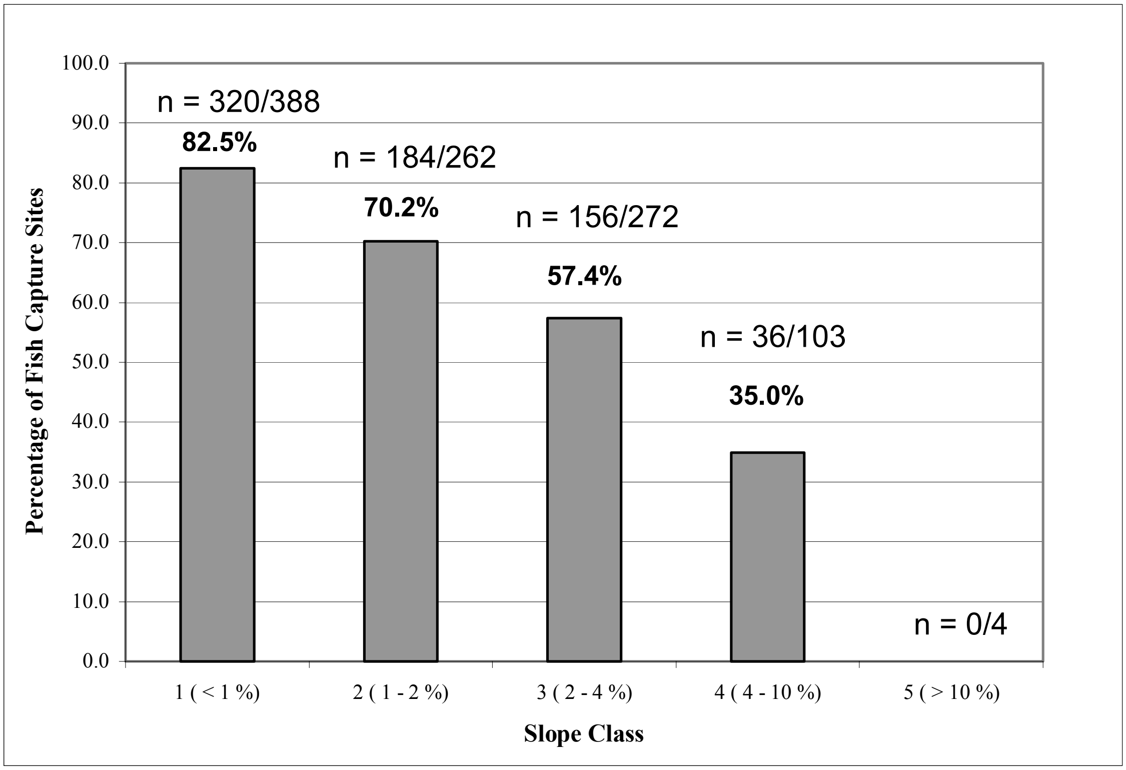


Figure 4. Percentage of sites where fish were captured within the Foothills Model Forest according to stream reach slope class.

2.5. Summary of Findings

Preliminary field assessments were grouped by monitoring watersheds. For each watershed, results were summarized into one figure and up to three tables. The figure was a map showing roads, streams and crossings. The status of each crossing was represented by a symbol and the fish capture probability was represented by one of three different colors.

The first table described those crossings located in high probability of fish capture streams that present a full barrier to fish migration. The table included the crossing number, the length of high probability fish capture stream located upstream from the crossing and the responsible agency. These sites would be candidates for detailed restoration prescriptions.

The second table described those crossings located within high probability streams that present a potential partial barrier to fish migration. The table included the crossing number, the length of high probability fish capture stream located upstream from the crossing and the responsible agency. These sites would be candidates for more detailed crossing assessments.

The third table described those crossings located within medium probability of fish capture streams that presented either a full or potential partial barrier to fish migration. The table included the crossing number, the length of medium probability fish capture stream located upstream from the crossing and the responsible agency. These sites would be candidates for additional inventory of fish and fish habitat to confirm the fish habitat status.

Not all watersheds had crossings that require all three types of follow-up assessments and therefore the number of summary tables presented for each watershed will vary.

3. Results

The results from our overview field assessment are presented in two sections. The first section summarizes the findings for each monitoring watershed. The second section provides a summary of the findings for all watersheds.

Weldwood, or other disposition holders, may have conducted remediation work to improve fish passage on their crossings since the date of the initial FMF inspection. Therefore, the status assigned should be considered valid for the date of inspection shown on the preliminary assessments.

3.1. Summary by Watershed

3.1.1 Anderson Creek Watershed

In this watershed, there were no remediation candidate sites. Several sites that require a detailed fish passage assessment were identified (Table 3). Of these sites, crossings C99028 and C99022 have substantial amounts of upstream fish habitat (Figure 5). Possible locations for future fish inventory are listed in (Table 4). Of these sites, crossing C20203 has the most potential upstream habitat of all the future inventory sites (Figure 5).

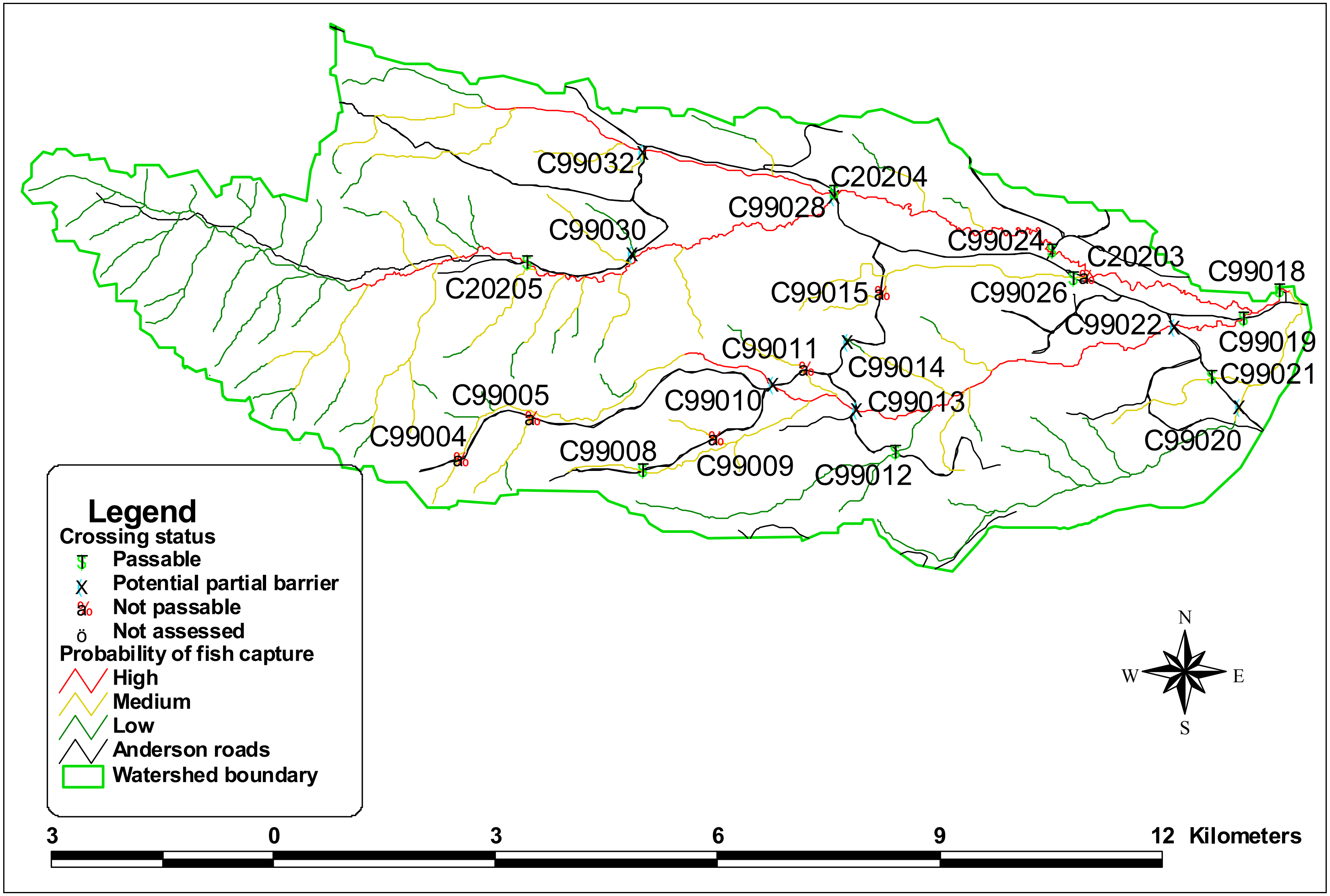
Table 3. Detailed fish passage assessment sites in Anderson Creek Watershed

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C99028	1999	8.1	Potential partial
C99022	1999	7.7	Potential partial
C99013	1999	2.6	Potential partial
C99032	1999	2.3	Potential partial
C99010	1999	1.4	Potential partial

Table 4. Future inventory sites in Anderson Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20203	2002	5.7	Full
C99005	1999	1.4	Full
C99011	1999	1.0	Full
C99015	1999	0.9	Full
C99004	1999	0.7	Full
C99009	1999	0.7	Full
C99020	1999	0.3	Potential partial

Figure 5. Location and status of stream crossings within Anderson Creek Watershed.



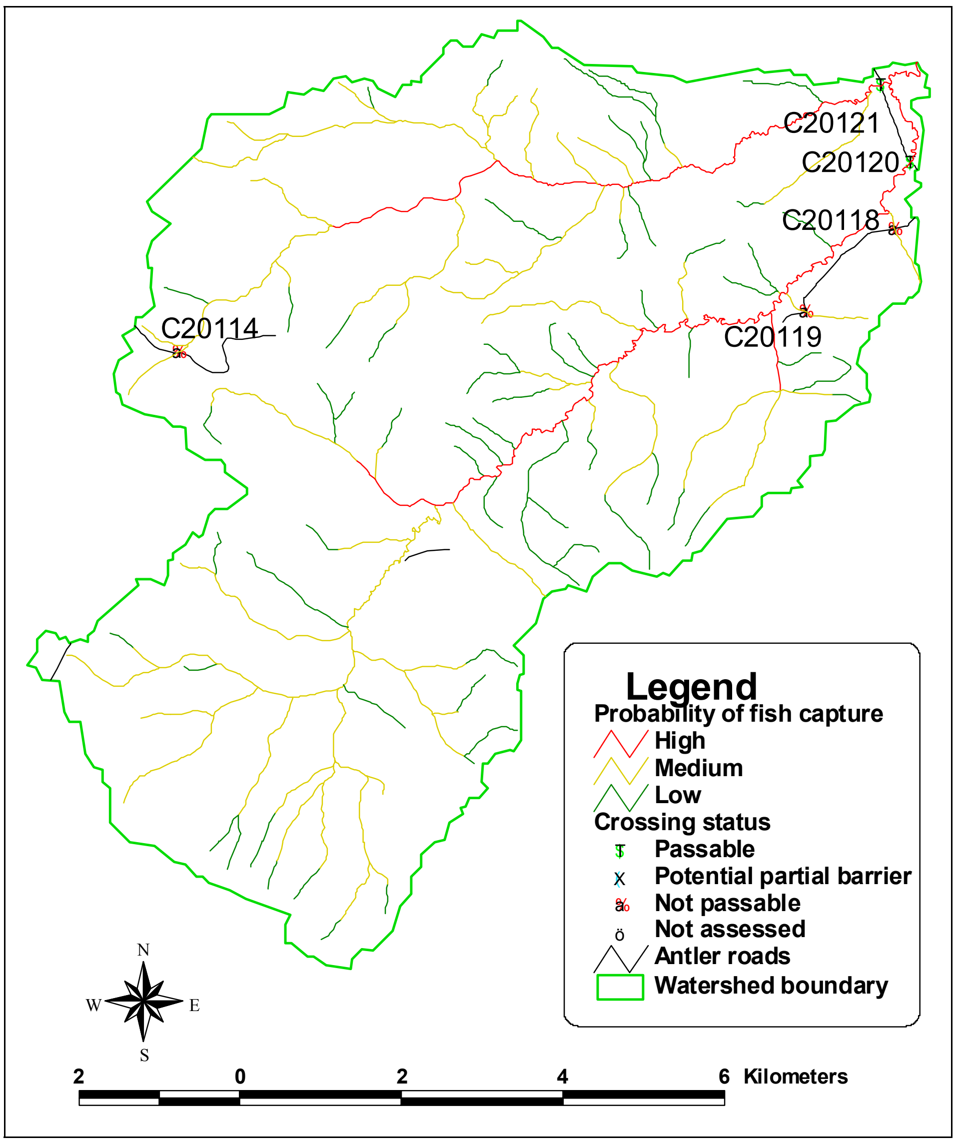
3.1.2 Antler Creek Watershed

There were no full or potential barriers to fish passage within high probability of fish capture streams in Antler watershed. Three future inventory sites were identified (Table 5). There were very few road-stream intersections in this watershed (Figure 6).

Table 5. Future inventory sites in Antler Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20114	2001	0.8	Full
C20118	2001	0.8	Full
C20119	2001	0.8	Full

Figure 6. Location and status of stream crossings within Antler Creek Watershed.



3.1.3 Emerson Creek Watershed

Of the 26 crossings visited, three were identified as potential partial barriers and none as full barriers to fish migration (Table 6). One crossing (C20122) was located at the mouth of the watershed and has 32.4 km of potential upstream habitat for fish (Figure 7). It has been modified by Weldwood to promote fish passage but may remain a barrier to various species and life stages. There are only two future inventory locations in Emerson watershed (Table 7).

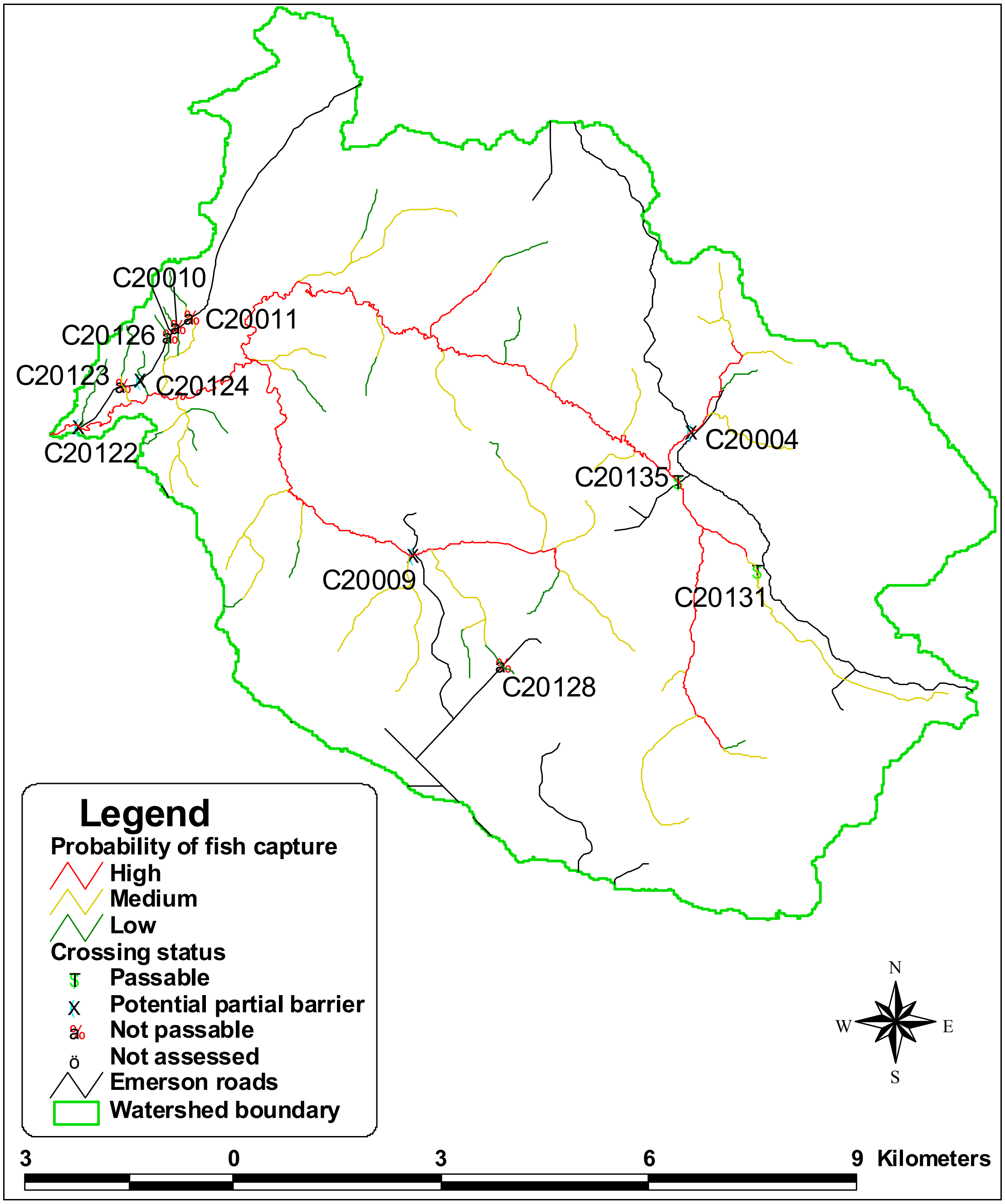
Table 6. Detailed fish passage assessment sites in Emerson Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20122	2001	32.4	Potential partial
C20009	2000	2.5	Potential partial
C20004	2000	1.8	Potential partial

Table 7. Future inventory sites in Emerson Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20010	2000	0.2	Full
C20123	2001	0.2	Full

Figure 7. Location and status of stream crossings within Emerson Creek Watershed.



3.1.4 Erith Creek Watershed

There was only one full barrier on a fish-bearing stream in Erith watershed (Table 8). Three sites have been recommended for a detailed fish passage assessment (Table 9). Several locations have been identified for further data collection (Table 10). Figure 8 shows the locations of crossings within the watershed.

Table 8. Remediation candidate sites in Erith Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C99127	1999	0.8	Full

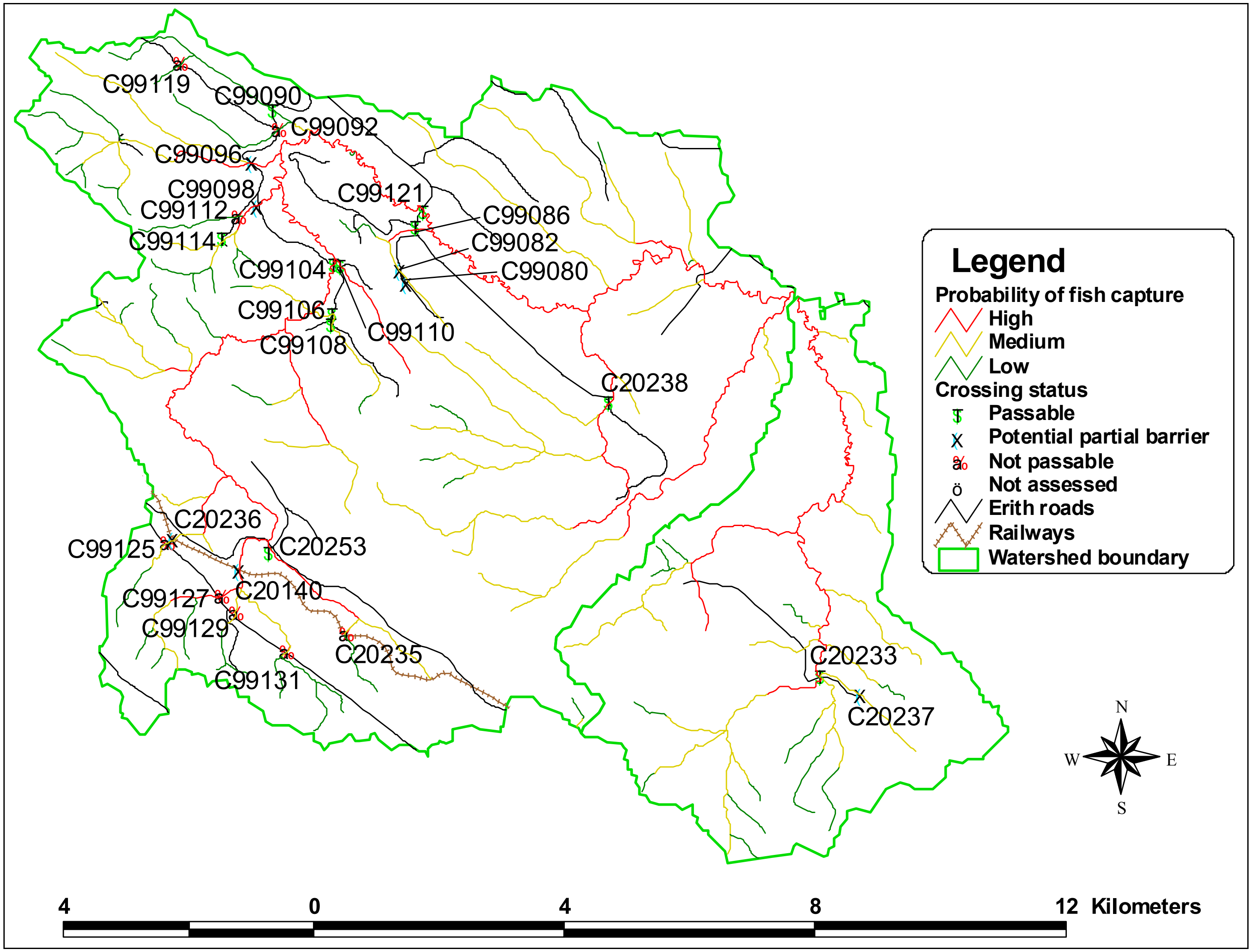
Table 9. Detailed fish passage assessment sites in Erith Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20140	2001	1.5	Potential partial
C99096	1999	1.4	Potential partial
C99098	1999	0.6	Potential partial

Table 10. Future inventory sites in Erith Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20237	2002	1.3	Potential partial
C99082	1999	1.2	Potential partial
C99080	1999	1.0	Potential partial
C20236	2002	0.7	Potential partial
C99129	1999	0.3	Full
C99131	1999	0.1	Full
C20235	2002	< 0.1	Full

Figure 8. Location and status of stream crossings within Erith Creek Watershed.



3.1.5 Fish Creek Watershed

A potential partial barrier was identified near the mouth of this watershed (Figure 9) and a substantial amount of potential habitat is located upstream of this crossing (Table 11). One site was identified for further inventory (Table 12).

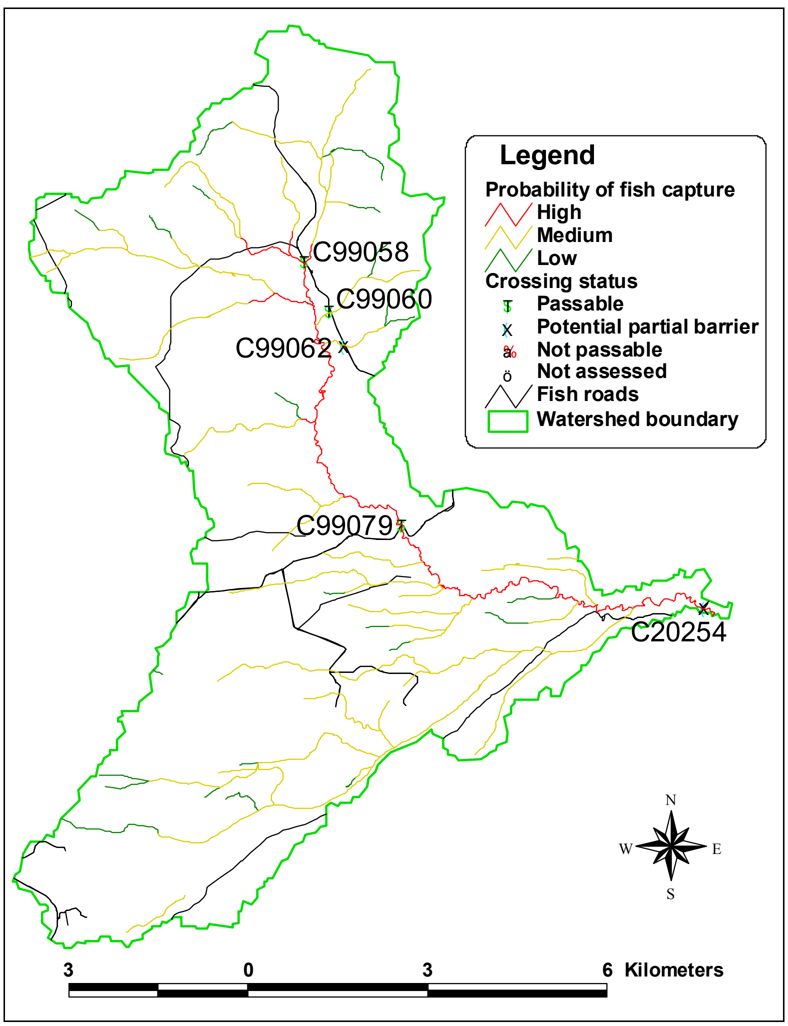
Table 11. Detailed fish passage assessment sites in Fish Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20254	2002	18.7	Potential partial

Table 12. Future inventory sites in Fish Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C99062	1999	0.8	Potential partial

Figure 9. Location and status of stream crossings within Fish Creek Watershed.



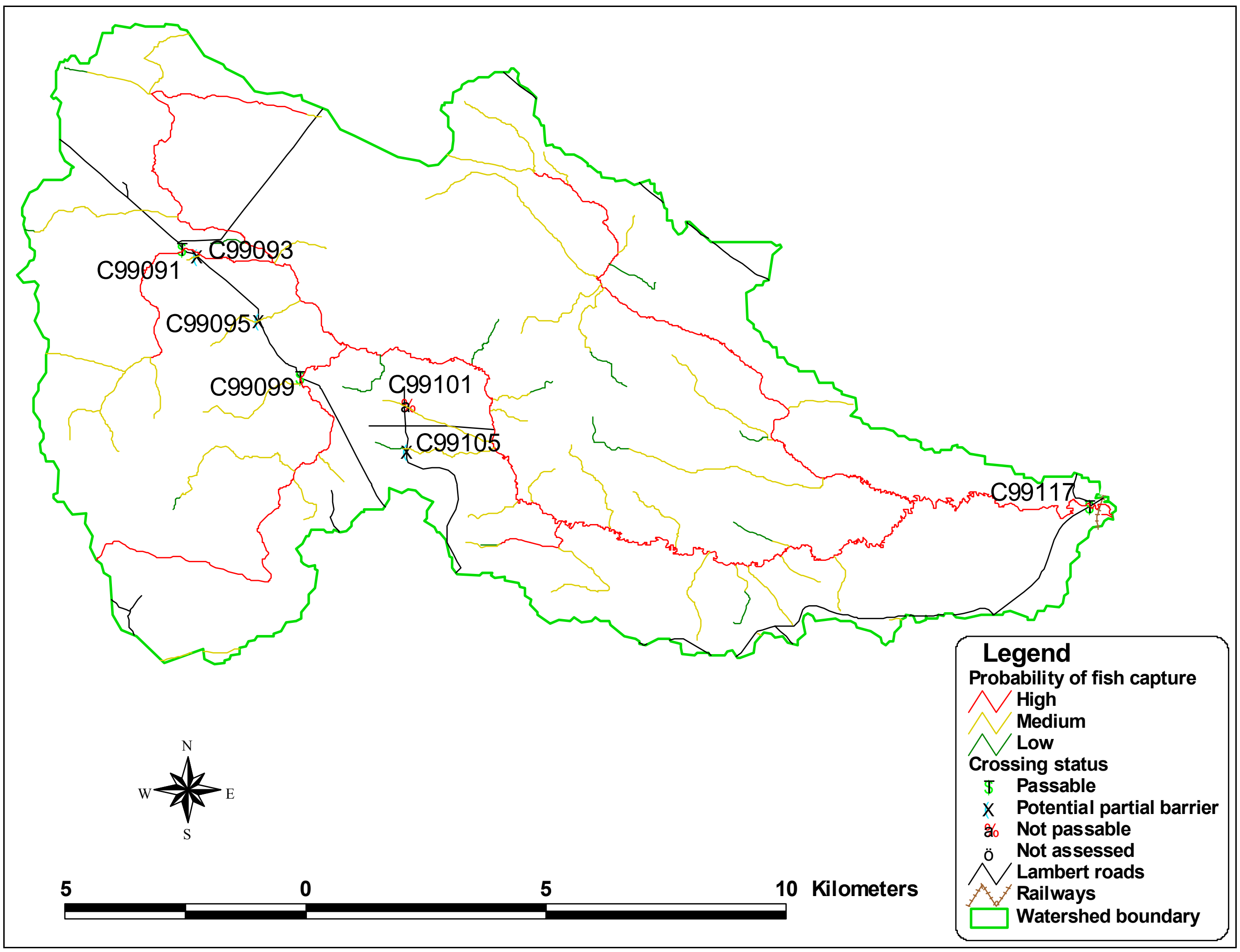
3.1.6 Lambert Creek Watershed

No crossings in Lambert posed a barrier to fish passage in known fish bearing streams, but several sites were identified for further inventory (Table 13). Figure 10 shows the location of crossings within the watershed.

Table 13. Future inventory sites in Lambert Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C99095	1999	1.4	Potential partial
C99101	1999	0.5	Full
C99093	1999	0.3	Potential partial
C99105	1999	0.1	Potential partial

Figure 10. Location and status of stream crossings within Lambert Creek Watershed.



3.1.7 Lynx Creek Watershed

Two sites in Lynx watershed were potential partial barriers in fish bearing streams (Table 14). Several sites have been identified for further inventory (Table 15). Locations of crossings in Lynx creek watershed are shown in Figure 11.

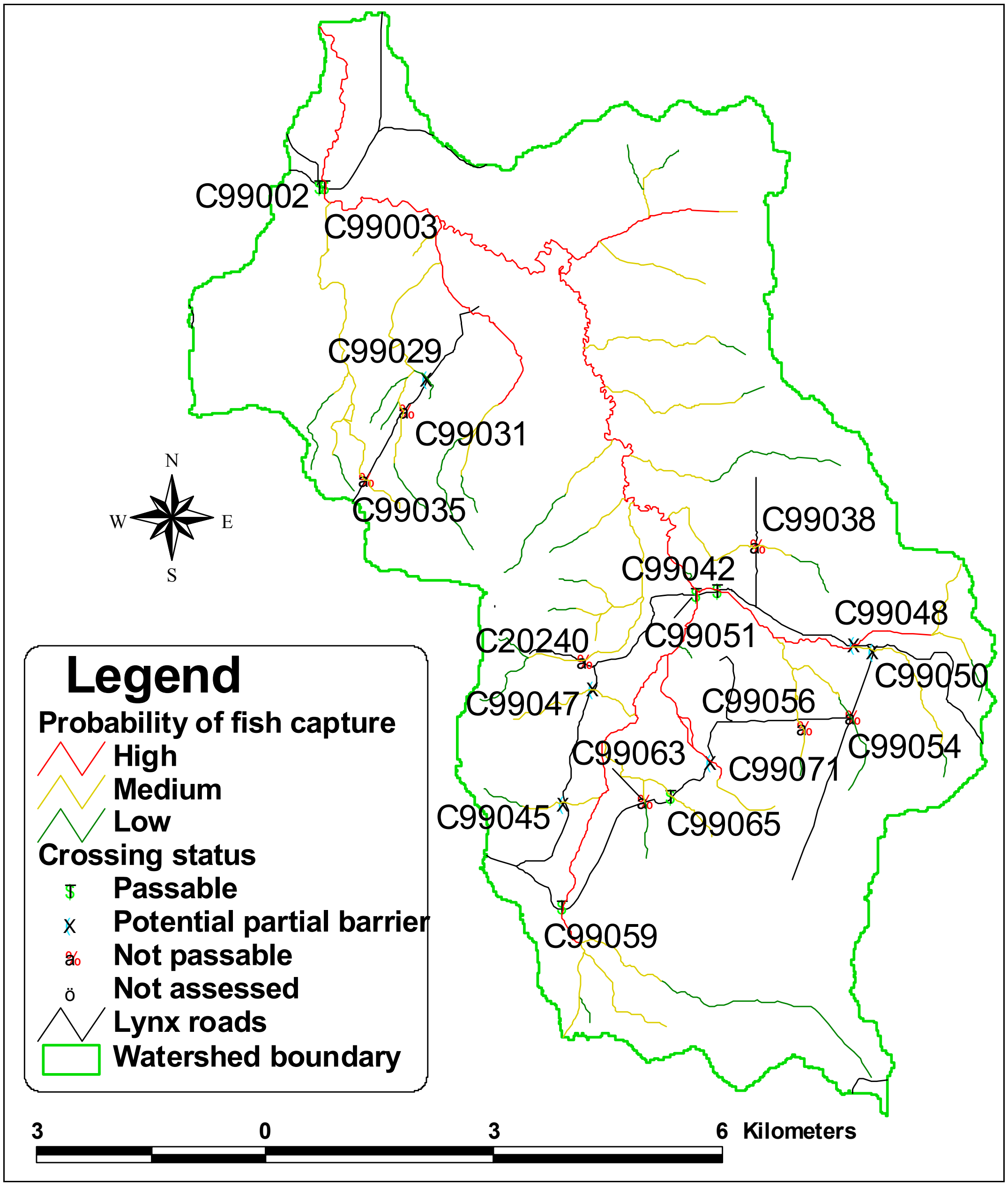
Table 14. Detailed fish passage assessment sites in Lynx Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C99048	1999	1.1	Potential partial
C99071	1999	0.2	Potential partial

Table 15. Future inventory sites in Lynx Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C99050	1999	1.9	Potential partial
C99047	1999	1.2	Potential partial
C99031	1999	0.8	Full
C99035	1999	0.7	Full
C99045	1999	0.6	Potential partial
C99038	1999	0.5	Full

Figure 11. Location and status of stream crossings within Lynx Creek Watershed.



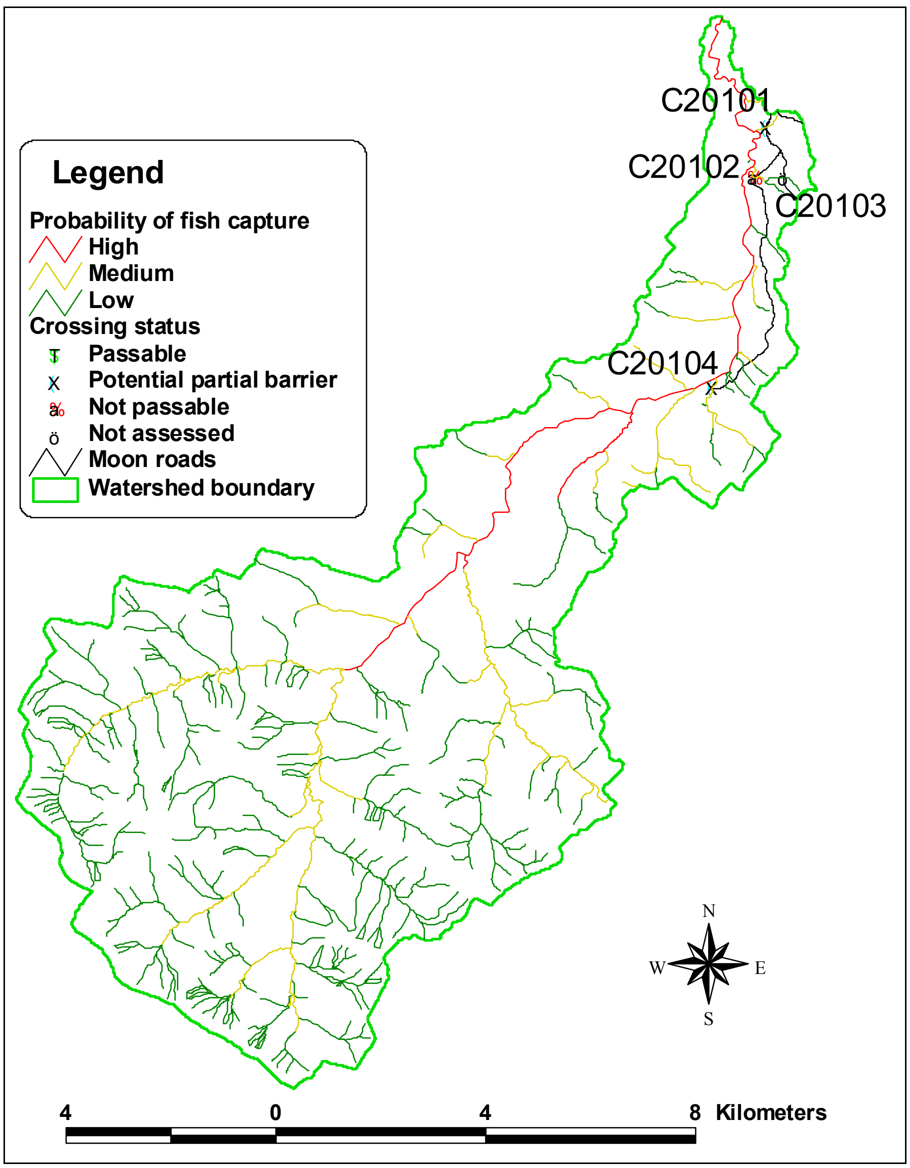
3.1.8 Moon Creek Watershed

Crossing C20103 requires an overview field assessment (Figure 12). There were no barriers on high probability fish bearing stream in Moon, but three sites were identified as future inventory locations (Table 16).

Table 16. Future inventory sites in Moon Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20104	2001	2.0	Potential partial
C20101	2001	0.4	Potential partial
C20102	2001	0.3	Full

Figure 12. Location and status of stream crossings within Moon Creek Watershed.



3.1.9 Pinto Creek Watershed

Pinto has the greatest number of crossings in any watershed, but it is also has a significantly larger area (Figure 13). It is the only watershed with more than one remediation candidate site (Table 17). There are two sites that are recommended for a detailed fish passage assessment (Table 18). Of these, crossing C20228 has the largest amount of potential upstream habitat in this watershed. Five crossings have been identified for further inventory (Table 19). One crossing (C20088) will require a follow-up overview assessment.

Table 17. Remediation candidate sites in Pinto Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20234	2002	3.9	Full
C20218	2002	1.1	Full
C20083	2000	0.4	Full

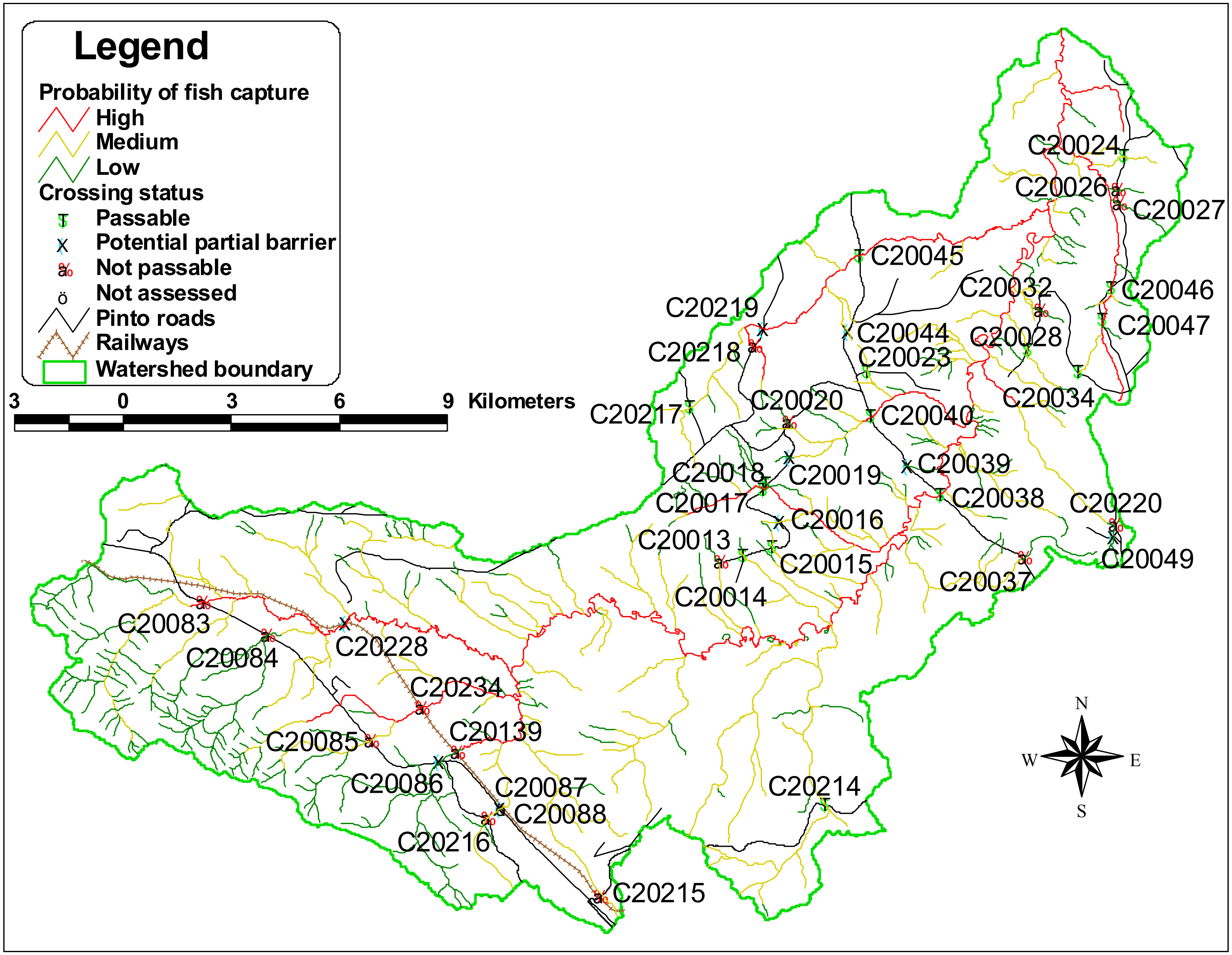
Table 18. Detailed fish passage assessment sites in Pinto Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20228	2002	6.1	Potential partial
C20219	2002	2.3	Potential partial

Table 19. Future inventory sites in Pinto Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20215	2002	0.8	Full
C20087	2000	0.7	Potential partial
C20016	2000	0.6	Potential partial
C20044	2000	0.3	Potential partial
C20216	2002	0.2	Full

Figure 13. Location and status of stream crossings within Pinto Creek Watershed.



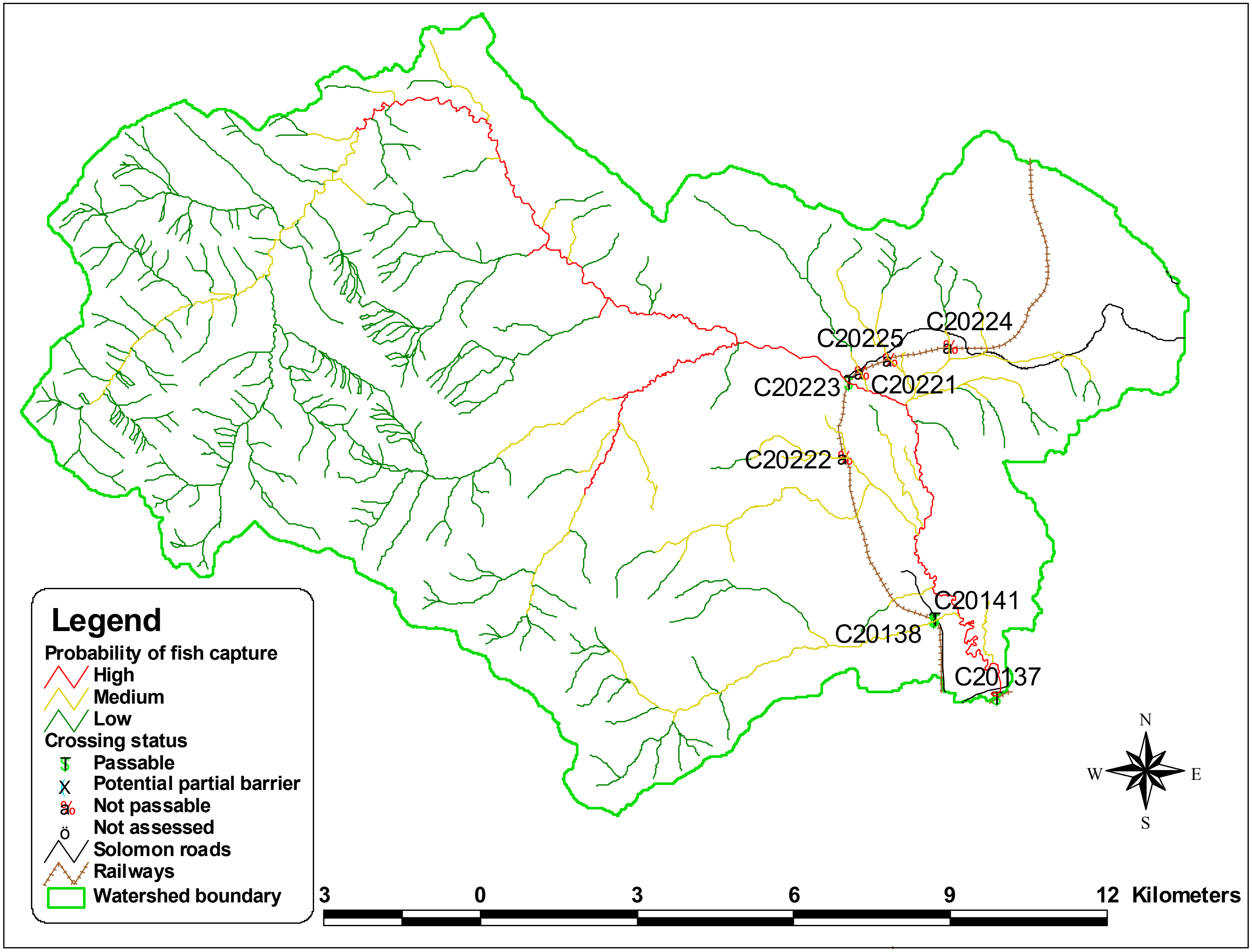
3.1.10 Solomon Creek Watershed

Most crossings in Solomon were bridges, and did not affect fish passage (Figure 14). Four sites were identified as barriers on potentially fish bearing streams and require additional inventory to confirm fish bearing status (Table 20).

Table 20. Future inventory sites in Solomon Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20222	2002	2.9	Full
C20225	2002	2.4	Full
C20224	2002	0.5	Full
C20221	2002	0.4	Full

Figure 14. Location and status of stream crossings within Solomon Creek Watershed.



3.1.11 Teepee Creek Watershed

There were a high number of crossings in Teepee watershed (Figure 15), but only one site was a partial barrier in a fish-bearing stream (Table 21). Five sites were barriers in medium probability of fish capture streams (Table 22).

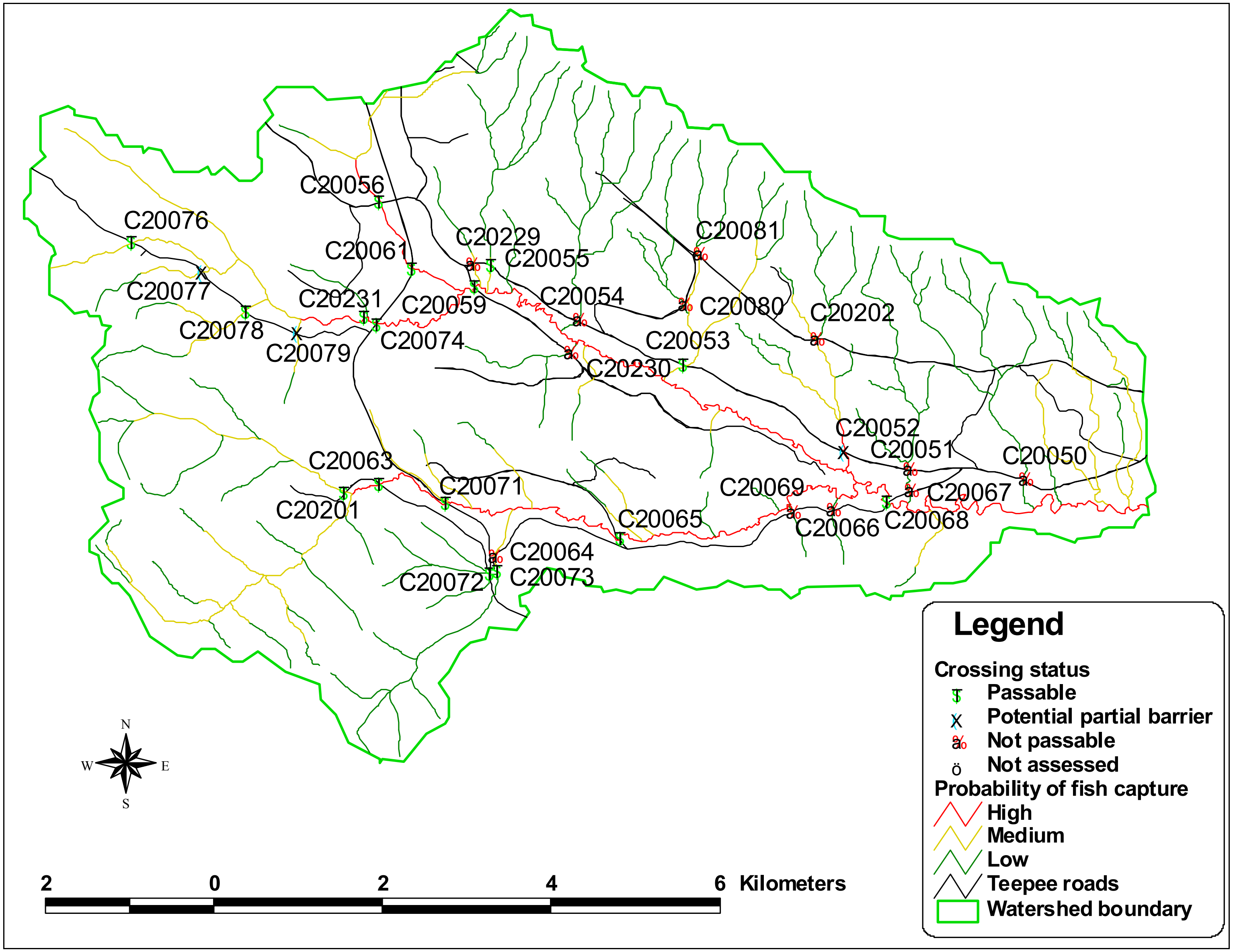
Table 21. Detailed fish passage assessment sites in Teepee Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20052	2000	0.4	Potential partial

Table 22. Future inventory sites in Teepee Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20077	2000	0.8	Potential partial
C20079	2000	0.5	Potential partial
C20064	2000	0.2	Full
C20081	2000	0.1	Full
C20229	2002	0.1	Full

Figure 15. Location and status of stream crossings within Teepee Creek Watershed.



3.1.12 Tri-Creeks Watersheds

Tri-creeks is an amalgamation of three adjacent watersheds; Wampus to the West, Deerlick in the center, and Eunice to the East (Figure 16). The only sites of interest were a potential partial barrier on Deerlick creek (Table 23), and two locations in Eunice watershed that need further fish inventory (Table 24).

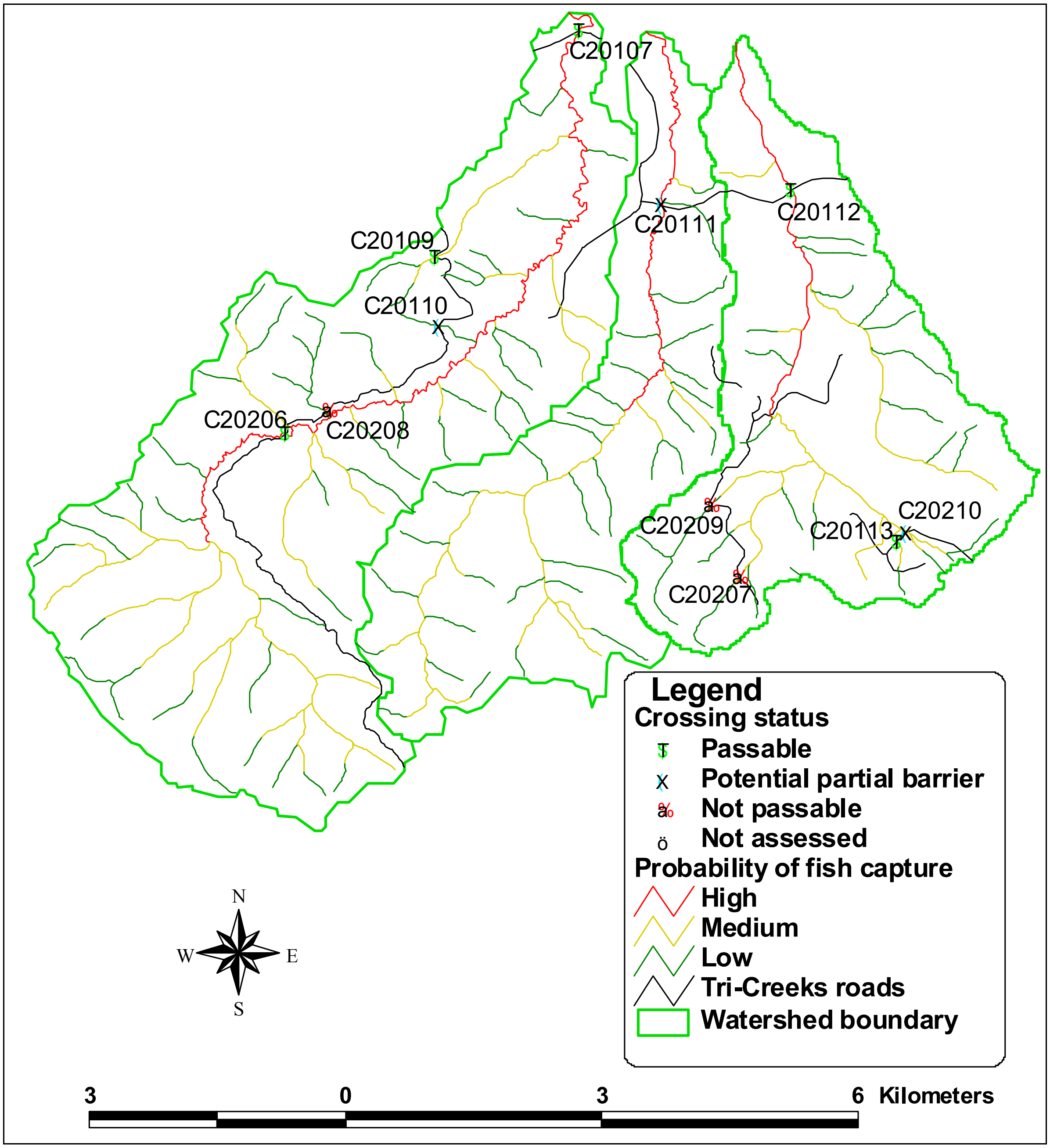
Table 23. Detailed fish passage assessment sites in Deerlick Creek Watershed.

Crossing #	Inspection Year	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20111	2001	3.0	Potential partial

Table 24. Future inventory sites in Eunice Creek Watershed.

Crossing #	Inspection Year	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20210	2002	0.8	Potential partial
C20207	2002	0.1	Full

Figure 16. Location and status of stream crossings within Tri-Creeks Watersheds.



4. Summary of Crossings in all Watersheds by Follow-up Assessment Type

Our findings indicate the need for one of three more detailed assessments at a number of crossings. These detailed assessments include: remediation design assessments; detailed fish passage assessments; and upstream fish habitat assessments. In addition, the overview assessment remains outstanding at several crossings within the study area watersheds.

A total of four crossings that presented a full migration barrier in high probability of fish capture streams were identified for a remediation design assessment (Table 25). Restoring fish passage at these four crossings would provide access to a total of 6.2 km of high probability fish capture stream.

Table 25. All remediation candidate sites in the Monitoring Watersheds.

Crossing #	Inspection Year	Watershed	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20234	2002	Pinto	3.9	Full
C20218	2002	Pinto	1.1	Full
C99127	1999	Erith	0.8	Full
C20083	2000	Pinto	0.4	Full

A total of 18 crossings that presented a potential partial barrier in high probability of fish capture streams were identified for a detailed fish passage assessment (Table 26). Priority for these assessments should be based on the length of high probability fish capture stream located upstream from each crossing.

Table 26. All detailed fish passage assessment sites in the Monitoring Watersheds.

Crossing #	Inspection Year	Watershed	Km of High Probability of Fish Capture Stream Upstream	Barrier Status
C20122	2001	Emerson	32.4	Potential partial
C20254	2002	Fish	18.7	Potential partial
C99028	1999	Anderson	8.1	Potential partial
C99022	1999	Anderson	7.7	Potential partial
C20228	2002	Pinto	6.1	Potential partial
C20111	2001	Deerlick	3.0	Potential partial
C99013	1999	Anderson	2.6	Potential partial
C20009	2000	Emerson	2.5	Potential partial
C99032	1999	Anderson	2.3	Potential partial
C20219	2002	Pinto	2.3	Potential partial
C20004	2000	Emerson	1.8	Potential partial
C20140	2001	Erith	1.5	Potential partial
C99010	1999	Anderson	1.4	Potential partial
C99096	1999	Erith	1.4	Potential partial
C99048	1999	Lynx	1.1	Potential partial
C99098	1999	Erith	0.6	Potential partial
C20052	2000	Teepee	0.4	Potential partial
C99071	1999	Lynx	0.2	Potential partial

A total of 49 crossings that may present a full or partial barrier in streams with unknown fish habitat value were identified (Table 27). Inventory priority should be based on the amount of potential upstream fish habitat.

Table 27. All future inventory sites in the Monitoring Watersheds.

Crossing #	Inspection Year	Watershed	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C20203	2002	Anderson	5.7	Full
C20222	2002	Solomon	2.9	Full
C20225	2002	Solomon	2.4	Full
C20104	2001	Moon	2.0	Potential partial
C99050	1999	Lynx	1.9	Potential partial
C99005	1999	Anderson	1.4	Full
C99095	1999	Lambert	1.4	Potential partial
C20237	2002	Erith	1.3	Potential partial
C99082	1999	Erith	1.2	Potential partial
C99047	1999	Lynx	1.2	Potential partial
C99011	1999	Anderson	1.0	Full

Table 27 (continued). All future inventory sites in the Monitoring Watersheds.

Crossing #	Inspection Year	Watershed	Km of Medium Probability of Fish Capture Stream Upstream	Barrier Status
C99080	1999	Erith	1.0	Potential partial
C99015	1999	Anderson	0.9	Full
C20114	2001	Antler	0.8	Full
C20118	2001	Antler	0.8	Full
C20119	2001	Antler	0.8	Full
C20210	2002	Eunice	0.8	Potential partial
C99062	1999	Fish	0.8	Potential partial
C99031	1999	Lynx	0.8	Full
C20215	2002	Pinto	0.8	Full
C20077	2000	Teepee	0.8	Potential partial
C99004	1999	Anderson	0.7	Full
C99009	1999	Anderson	0.7	Full
C20236	2002	Erith	0.7	Potential partial
C99035	1999	Lynx	0.7	Full
C20087	2000	Pinto	0.7	Potential partial
C99045	1999	Lynx	0.6	Potential partial
C20016	2000	Pinto	0.6	Potential partial
C99101	1999	Lambert	0.5	Full
C99038	1999	Lynx	0.5	Full
C20224	2002	Solomon	0.5	Full
C20079	2000	Teepee	0.5	Potential partial
C20101	2001	Moon	0.4	Potential partial
C20221	2002	Solomon	0.4	Full
C99020	1999	Anderson	0.3	Potential partial
C99129	1999	Erith	0.3	Full
C99093	1999	Lambert	0.3	Potential partial
C20102	2001	Moon	0.3	Full
C20044	2000	Pinto	0.3	Potential partial
C20010	2000	Emerson	0.2	Full
C20123	2001	Emerson	0.2	Full
C20216	2002	Pinto	0.2	Full
C20064	2000	Teepee	0.2	Full
C99131	1999	Erith	0.1	Full
C20207	2002	Eunice	0.1	Full
C99105	1999	Lambert	0.1	Potential partial
C20081	2000	Teepee	0.1	Full
C20229	2002	Teepee	0.1	Full
C20235	2002	Erith	< 0.1	Full

Four sites within the study area were not assessed or had insufficient data collected (Table 28). These sites cannot be assessed without a complete overview crossing assessment.

Table 28. Sites that require completion of overview assessment.

Crossing #	Inventory Year	Watershed	Barrier Status
C20062	2000	Teepee	Not Assessed
C20103	2001	Moon	Not Assessed
C20140	2001	Erith	Not Assessed
C20088	2000	Pinto	Not Assessed

5. *Recommendations*

5.1 Communication of Findings to LOC Holders

The actual undertaking of detailed assessments is ultimately the responsibility of the crossing owner, therefore additional work is required to identify the License of Occupation (LOC) holder or responsible agency for each crossing that requires additional study. Once the LOC holders are identified, they can be provided with the information contained within this report, at which time they could consider how to incorporate our recommendations into their infrastructure maintenance process. As of March, 2003, Weldwood noted that findings from this assessment for individual culverts would be utilized in their culvert remediation and road maintenance activities.

5.2 Development of a Protocol for Completing Detailed Fish Passage Assessment for Restoration Purposes

Like almost all management activities, the task of restoring fish habitat at stream crossings involves establishing priorities based on measurable benefits. With limited resources, a focused approach that provides the greatest short and long term benefits to our fish and fish habitat resources is required. At all new crossings, current policy requires that in all fish bearing streams, all life stages of all species are permitted upstream migration. However, this approach is not well suited for establishing remediation priorities. Therefore, a system for rating the degree that an existing crossing may impede migration may be worth considering. Such a system may require consideration of culvert hydraulics, seasonal stream discharge and peak flows, as well as fish life history and swimming capability information. Ultimately, the costs of developing such a protocol compared to crossing replacement of removal value should be considered by the crossing owner.

5.3 Identification of Future Roles of the Foothills Model Forest

1. Over the long-term, the Foothills Model Forest hopes to facilitate the restoration of fish passage at all crossings on fish bearing streams.

2. As a follow-up to this assessment, the Foothills Model Forest could work with those agencies responsible for stream crossings in the study area to explore options for proceeding with the remediation process.

6. Glossary

Baffles – structures installed within a culvert, designed to reduce water velocity and aid fish passage upstream; typically concrete blocks or metal plates.

Bankfull width – width of a stream channel at the slope break, or a typical 1.5 year flood occurrence (Rosgen 1996).

Culvert – corrugated metal pipe, or concrete slab structure used to convey water across/underneath a road.

Electrofishing – method of fish capture which uses electricity to stun fish so they can be sampled and returned to the stream.

Ford – no structure present at a crossing; vehicles pass directly through the stream itself.

Geographic Information System – GIS is a system of hardware and software used for storage, retrieval, mapping, and analysis of spatial geographic data (Mayhew 1997).

Global Positioning System – GPS is a radio navigation system that allows users to determine their exact location 24 hours a day anywhere in the world (Isaacs 2000).

Hang height – distance from the bottom of the culvert to the top of the water surface; sometimes called outfall drop (Parker 2000).

Inlet – point where water enters a culvert or other water conveyance structure.

Left upstream bank (LUB) – used to denote the left side of the stream, looking upstream.

Outlet – point at which water returns to the natural stream channel after passing through a structure.

Right upstream bank (RUB) – used to denote the right side of the stream, looking upstream.

Rooted width – See bankfull width.

Stream order – Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked/unbranched stream. Two first-order streams flow together to form a second-order, two second-orders combine to make a third-order stream, etc. (Armantrout 1998).

Substrate – bed material in a stream channel.

Wetted width – representative width of water in a stream channel.

7. Literature Cited

Alberta Government. 2001. Administrative Guide for Approvals to Protect Surface Water Bodies under the Water Act. Environmental Assurance, Regulatory Assurance Division.

Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society, Bethesda, Maryland.

Fisheries Act. 1985. Fisheries Act, Federal Statutes Chapter F-14.

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

FMF (Foothills Model Forest). 1999. 1999 Fish and stream inventory-site summaries. Prepared for the ACA, Weldwood of Canada (Hinton Division), and the NRS. FMF, Hinton, Alberta.

FMF (Foothills Model Forest). 2000. 2000 Fish and stream inventory-site summaries. Prepared for the ACA, Weldwood of Canada (Hinton Division), and the NRS. FMF, Hinton, Alberta.

FMF (Foothills Model Forest). 2001. 2001 Fish and stream inventory-site summaries. Prepared for the ACA, Weldwood of Canada (Hinton Division), and the NRS. FMF, Hinton, Alberta.

FMF (Foothills Model Forest). 2002. 2002 Fish and stream inventory-site summaries. Prepared for the ACA, Weldwood of Canada (Hinton Division), and the NRS. FMF, Hinton, Alberta.

Isaacs, A., ed. 2000. The Macmillan encyclopedia 2001. Market House Books Ltd. 1400pp.

Katopodis, C. 1994. Analysis of icthyomechanical data for fish passage or exclusion system design, *in* American Fisheries Society and Fish Physiology Association symposium proceedings, pp 318-323. Department of Fisheries and Oceans, Winnipeg, Manitoba.

Love, M. and S. Firor. 2001. FishXing v2.2 (software). Available Online @ http:// www.stream.fs.fed.us/fishxing/ Last visited 10/18/02.

Mayhew, S., ed. 1997. A dictionary of geography. Oxford University Press, England. 451pp.

Parker, M.A. 2000. Fish passage – culvert inspection procedures; *in* Watershed Restoration Technical Circular no. 11. Ministry of Environment, Lands and Parks, Vancouver, British Columbia.

Rosgen, D. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Whyte, I.W., S. Babakaiff, M.A. Adams, and P.A. Giroux. 1997. Restoring fish access and rehabilitation of spawning sites. Chapter 5 *in* Watershed Restoration Technical Circular no. 9. Ministry of Environment, Lands and Parks, Vancouver, British Columbia.

Appendix I. Culvert Data Form

FOOTHILLS MODEL FOREST
ROAD CROSSING DATA FORM -Monitoring/CEA projects
R:\FMF Fish\Field Forms\culvert dataform.xls

foothills model forest
a growing understanding

Culvert ID:____________________

Site ID: ____________________

Road Name: ____________________ Km (approx.): __________
Stream Name: ____________________ Tributary to: __________
Monitoring Watershed: ____________________ Date: __________2002
Crew: Day/Month

	Easting	Northing
Crossing locaton UTM:		
Mouth location UTM (if unnamed):		

Legal Land of Crossing: ____ ____ ____ W____
sec twp rge mer

Working Circle: ____________________ Compartment: __________

Crossing type (bridge, culvert, etc.): __________ Culvert type: __________

Measurements (m)	Height	Width	Length	Type	Hang Ht	Water in pipe	Water depth at: Outfall	Max.
Culvert 1								
Culvert 2								
Culvert 3								
Culvert 4								

Interior water velocity: High ☐ Medium ☐ Low ☐

Sketch of Culvert (from D/S corresponding to measurement table)

Erosion Potential: High ☐ Medium ☐ Low ☐

Baffles? Yes ☐ No ☐ Substrate in Pipe? Yes ☐ No ☐

Is this crossing a barrier to fish? Yes ☐ No ☐
Reasoning:

STREAM MEASUREMENTS (upstream of crossing's influence)

Widths (m) rooted: _____ Wetted: _____ Depths (m) left:_____center:_____ right:_____

Description of photographs taken:

Comments: