APPENDIX F
SUMMARY OF DATA COLLECTION AND ASSESSMENT METHODOLOGIES

This appendix summarizes the types of data collection and assessment tools used to develop the Grave Creek Water Quality and Habitat Restoration Plan. The plan is based on review of existing data and assessments as well as new data collection and analyses. Several sources of existing information were reviewed including existing watershed assessments, and fish habitat and population data. New information collected included channel morphology data, sediment source inventory, and remote and field-based vegetation surveys. New analyses of relevant spatial information using GIS modeling were conducted. The spatial analyses results were used to evaluate the role of land use activities on the existing stream conditions and impairment status.

Other appendices include detailed methods descriptions for specific analyses including sediment source assessments (road sediment sources (Appendix I) and in-stream sediment sources (Appendix J)), and land use assessments (timber harvest (Appendix A), road building (Appendix B), water yield/ECA/rain-on-snow zone (Appendix C)).

F.1. Existing Data and Watershed Assessments

In 1999 MDEQ reviewed existing data related to water quality and fish habitat in the Grave Creek Watershed. The existing information reviewed included fish habitat, channel morphology, and upland assessments completed, primarily by MFWP and USFS.

F.1.1 MDEQ-led Existing Data Review and Coarse Screen Analysis

Water quality chemistry data were determined to be limited for the focus stream. To verify this, the Environmental Protection Agency's STORET database was accessed to evaluate collected water chemistry data. The lack of water quality chemistry data has no bearing on the physical parameter analysis linked to sediment and habitat impairments.

Documents in MDEQ's reference library include USFS stream habitat assessments, MFWP fish population estimates and reports, and limited USGS gaging station discharge data. Of particular importance were MDEQ's SCD/BUD data sheets[1], which summarize the agency's rationale for placing streams on the 2000 303(d) list. The existing data were determined by MDEQ to be adequate for making beneficial use determinations for all uses but drinking water, due to the absence of water chemistry data. Appendix E provides a summary of the beneficial use impairment justifications.

1 Available: http://nris.state.mt.us/scripts/esrimap.dll?name=tmdl&Inst=10120&Null=9910205&Cmd=Main2.

As part of the data inventory process, resource specialists from state and federal agencies (MFWP, USFS, and USFWS) were consulted for their professional opinions on the condition of Grave Creek. Agencies were also asked to provide any additional data or reports not previously considered in MDEQ reviews.

F.1.2 USFS Watershed-scale Assessments

The USFS has completed numerous resource investigations in the Grave Creek Watershed. In 1995, the USFS commissioned sediment source investigations in primary tributaries to Grave Creek. The surveys identified major sources and recommended treatments to mitigate sediment delivery to primary tributaries. Bryce Bohn, former Fortine District Hydrologist with the USFS, conducted a study of Grave Creek with primary emphasis on the application of watershed scale analyses to identify and remedy causes and source of water quality degradation (Bohn and Kershner, 2002). The report provided generalized recommendations aimed at improving native fish habitat, reducing sediment sources, re-establishing proper channel form and function, and improving fish passage and habitat conditions in select locations in the watershed. The study also provided geomorphic unit descriptions for major stream segments and rated their sensitivity to varying levels of physical inputs including large woody debris, sediment, and increased peak flows.

The USFS completed a baseline evaluation of the Tobacco/Grave bull trout subpopulation in 2000. The baseline assessment covered the Lower Clark Fork Fifth Code HUC, including individual evaluations for each subordinate sixth code HUC. The sub-population of bull trout within the Tobacco/Grave sixth code HUC received one set of evaluations. Each set of evaluations included 19 habitat indicators to determine the level of habitat integrity.

In September 2002, the USFS completed the Grave Creek Watershed Ecosystem Analysis at the Watershed Scale (EAWS). This effort estimated direct, indirect, and cumulative effects of management activities that have occurred in the watershed. The document also identified the purpose and need for management recommendations for implementation of the Forest Land and Resource Management Plan (Forest Plan), current policy, and other applicable state and federal regulations (USFS, 2002).

F.2. Fish Habitat Assessment

During summer 2001, the USFS completed fish habitat condition surveys (USFS, 2001) using the R1/R4 fish habitat inventory method (Overton et al., 1997). Field surveys were completed for the entire main stem and primary tributaries including Williams Creek, Blue Sky Creek, Lewis Creek, Clarence Creek, and Stahl Creek.

R1/R4 data collection includes stratification of all inventoried stream reaches by Rosgen channel type (Level I A, B, C, D, E F or G) and by channel units' type (fast-riffle or step; or slow-pool). For each channel unit, measurements include width, depth (average and maximum), length, percent pool tailout surface fines, and number LWD pieces. From this information, measures of pool frequency and LWD concentration and other measures were calculated for each reach. An Access database was created to query and analyze the habitat data by stream, reach type and by channel unit type.

R1/R4 data characterize the wetted channel conditions during the time of the survey; therefore, some R1/R4 results are biased by water levels at the time of the survey (e.g. width or depth). Comparison of R1/R4 data among surveys or even the same channel reach under different surface water conditions can provide considerably different information. Some R1/R4 measures, such as LWD values, pool counts, and residual pool measures would not be expected to result in this type of variation since the information is not linked to current water levels and stream width measures.

F.2.1 Pool Frequency

Pool frequency methodology for Grave Creek assessment work and reference stream assessment work is presented in this section.

F.2.1.1 Grave Creek

Pool frequency for each stream, reach and channel type was calculated by tallying the total number of pools. For each stratification, the pool count was then divided by the total length in miles to get a value of pools per mile for that stream, reach, and/or channel type.

According to the modified R1/R4 protocol used by the Kootenai National Forest, pools are slow water habitat units associated with channel bed scour or where the stream course has been damned by wood or rock. To ensure correct delineation between channel units (e.g. riffle versus pools), surveys are conducted at base flows. Surveying at base flow also ensures more accurate measurements for calculating residual pool volume. R1/R4 also counts pocket pools, which are defined as any pool in fast water habitats (e.g. riffles) that are 10 to 30% of the wetted channel width, however, pocket pools were not included in the TMDL analysis.

F.2.1.2 Reference Streams

Several sources were used to develop pool reference values. These include: 1) data from the Swan Lake Watershed used for TMDL development (MDEQ, 2004d), 2) unpublished reference data provided by the Libby Ranger District of the KNF, 3) unpublished reference data provided by the Rexford Ranger District of the KNF, 4) reference data from the Lolo National Forest (USFS, 1998), and 5) an internal reference reach for lower Grave Creek. Methods varied between studies although the various methods can result in similar values, particularly for the 2nd and 3rd order streams and smaller 4th order streams. For the Swan River data, features with slack water and a deepened thalweg were counted as pools. Pools in the Libby Ranger District data were areas with slack water at least one-third the bankfull width with a scour feature and a hydraulic control. Pools in the Rexford Ranger District reference data (and also the

Grave Creek existing condition data) include slow water habitat features with a channel bed scour or a damming obstruction (such as wood or a large boulder). The Lolo reference data counted slow water areas as pools using the Lolo National Forest Basin Wide Method (Kramer et al., 1993).

Caution should be used when comparing pool frequency values from data sets, or when planning pool assessment activities. Pool frequency data from longitudinal profiles are likely to be lower than pool frequencies from R1/R4 surveys due to differing survey methods and pool identification criteria. This is because there may be significant pocket pools in areas outside the thalweg where the longitudinal profile is typically measured.

F.2.2 LWD Frequency

LWD frequency methodology for Grave Creek assessment work and reference stream assessment work is presented in this section.

F.2.2.1 Grave Creek

Table F-1 describes the large woody debris counting method used by the Rexford Ranger District of the Kootenai National Forest for determining LWD concentrations in Grave Creek.

Table F-1: R1/R4 Large Woody Debris Count Criteria.

LWD Category	Criteria	
LWD Singles	> 3 m long OR > 2/3 bankfull width AND 0.1 m diameter AND within active bankfull width	Number of qualifying pieces
LWD Aggregates	2 or more pieces entangled within active channel	Number of qualifying aggregates
LWD Rootwads	rootwads providing cover for fish OR affecting hydraulics of stream at bankfull flows in future	Number of qualifying rootwads

F.2.2.2 Reference Streams

The same streams used for pool frequency reference development were used for LWD frequency reference development. As with pools, methods for determining pieces of LWD generally varied from study to study. The LWD method in the Swan TMDL development effort is similar to the method used in the Grave Creek Watershed R1/R4 surveys to establish existing condition. The Swan data are primarily from streams with minor impacts that may not represent the ideal reference condition, although all data is from stream reaches representing satisfactory conditions from a beneficial use support perspective for LWD and pool values.

The Libby Ranger District and Lolo/Flathead data are from streams with no or minimal human impacts using methods which both tend to result in lower LWD counts than the method used for Grave Creek Watershed, with greater potential discrepancy as bankfull width increases. LWD in the Libby data set includes both live and dead material inside the bankfull channel that is larger than 6" in diameter, longer than the bankfull width, and in contact with the channel or suspended above it. LWD in the Lolo data set included the "acting" LWD defined as stable wood within the channel according to the LNF Basin Wide Methodology (Kramer et al., 1993).

The Rexford Ranger District collected LWD data from 81 reaches using the same method as used for Grave Creek. Of those 81 reaches, twenty met INFISH RMOs and received either a good or fair Pfankuch rating. These twenty reaches were therefore considered as reference reaches. Lower LWD reference values in the Rexford data are attributed to the 1910 fires in that area and, as a result, a lag in LWD recruitment compared to the other reference data sets. In recent years, a notable increase in LWD recruitment has occurred, possibly representing a recovery in this lag (Pat Price, personal communication, 2004)

F.2.3 Percent Fines in spawning areas

Evaluation of percent fines in spawning areas provides an indicator of spawning habitat conditions. A high percentage of inter-gravel fines in spawning areas are detrimental to fry development. Percent surface fines in pool tail outs were measured using the 49-point grid toss method for each pool surveyed in the USFS-led R1R4 fish habitat survey (2001). These surface fines results were then used as an indicator of the total substrate fines down to the depth where impacts can occur to fry. Most data from reference streams were based on this same methodology, although some reference data were based on a viewing bucket modification to the grid toss.

F.3 McNeil Core Substrate Percent Fines Sampling

Percent fines in surface and sub-surface channel bed material was measured using the McNeil core sampling methods (Weaver and Fraley, 1993). McNeil core data was collected by MFWP on upper Grave Creek upstream of Clarence Creek. Reference data is based on this same methodology.

F.4 Fish population and Other Biological Indicators

MFWP efforts in Grave Creek have focused primarily on pre and post restoration effectiveness monitoring of fish populations as well as bull trout redd estimates from the period 1983 through present. Macroinvertebrates were collected in September 2002 and September 2003 in the lower reach of Grave Creek for the Restoration Project work

(Appendix D). Taxa and metrics were computed and analyzed by EcoAnalysts, Inc. and MDEQ.

Recent reports including Mitigation for the Construction and Operation of Libby Dam Annual Report 2001-2002 (MFWP, 2003a) were provided to KRN during the Phase 1 coarse screen assessment. The reports summarized the status of bull trout in the Kootenai River Drainage and provided preliminary effectiveness monitoring results from two restoration projects completed in the lower Grave Creek Watershed on private land.

Additional data and methodology regarding fry and juvenile bull trout entrapment in the GLID conveyance canal is presented in Appendix D. Appendix D also includes other fish population data provided by MFWP and presented in Appendix D.

F.5. Channel Morphology and Stability

During summer 2003, the USFS (USFS, 2003) completed channel morphology surveys to characterize stream channel dimensions, channel stability, and composite riffle-pool substrate particle distribution. Similar morphology assessments were also conducted by WCI (2000) in both C (reference) and D (degraded) reaches of lower Grave Creek.

Pebble counts and cross sections are positioned at a location along the reach that is representative of conditions throughout the reach. They represent one sample along the length of a stream reach. Pfankuch channel stability assessments are conducted for the length of the reach or a representative length of the reach.

F.5.1 Channel Cross-Section Dimensions

During summer 2003, the USFS completed channel morphology surveys using the Rosgen methodology (Rosgen, 1996), which focuses on bankfull dimensions. Field surveys were completed at representative cross sections throughout the entire main stem above private land, and primary tributaries including Williams Creek, Blue Sky Creek, Lewis Creek, Clarence Creek, and Stahl Creek. WCI conducted similar surveys on representative reaches of lower Grave Creek on private land. Bankfull indicators were used to determine bankfull channel width. Mean depth was calculated from the plotted cross section (or cross section area divided by bankfull width). Entrenchment, sinuosity and slope were also measured in order to determine a Rosgen Level 3 stream type for each location. The results were used to calculate width to depth ratios based on bankfull width and mean bankfull depth.

F.5.2 Pfankuch Channel Stability Rating

The Pfankuch channel stability method is a semi-quantitative field analysis technique used to rate the relative stability of a channel based on a number of parameters including vegetation condition, channel morphology, and bank material composition among other variables. The USFS included Pfankuch ratings for each reach.

F.5.3 Substrate Distribution

Wolman pebble counts were used to determine channel substrate particle size distribution. Both USFS and consultant-led channel morphology surveys used the Wolman pebble count for all surveyed cross-sections. Pebble counts sampling represented particles from both riffles and pools. The number of individual particles sampled from each feature corresponded to the relative percent of riffle versus pool with in each reach. For example, in a reach consisting of 60 percent riffle and 40 percent pool, a count of 100 particles included 60 from riffles and 40 from pools. The resulting particle size distribution is thus a composite. A cumulative percent finer-than graph was generated for each cross-section pebble count.

F.5.4 Percent Surface Fines

From Wolman pebble counts discussed above, cumulative percent finer-than graphs were used to interpolate percent fines less than 6.35mm and less than 2mm

F.5.5 Plan Form Geometry

Multi-temporal air photo sets were used to evaluate changes in plan form geometry of lower Grave Creek. In particular changes in channel length, radius of curvature, sinuosity and meander wavelength were noted.

F.6 Sediment Source Assessment

Following compilation and review of all pertinent and available data and information, a coarse screen analysis was conducted to develop the framework for the source assessment phase of restoration planning. The coarse screen analysis included development of a color balanced, image mosaic of the entire watershed used to conduct preliminary stream reach delineations. A hazard rating map was developed based on degree of channel departure over time (with reference to the 1954 photo series), concentration of past timber harvest and road construction activities, and visible sediment sources. All potential upland and in-stream sediment sources visible and within 300 ft of perennial and intermittent drainages in the watershed were mapped and measured for field validation during this phase of source assessment.

Supplemental field data were collected by RDG during the fall and winter 2003. Data collection was streamlined to ensure inventories of conditions noted on the 303(d) list for the main stem Grave Creek. The objectives of the field assessment were to fill data gaps to the extent practical, identify sources of sediment loading and habitat alterations, and collect data used in the development of numeric and performance targets for TMDLs and other restoration goals.

F.6.1 Upland Sediment Sources

Sediment sources were identified during air photo interpretation. Initially, these sources were stratified by distance from riparian areas: proximal - within 150', midslope - 150'-500', and distal - greater than 500'. For each source, approximate area and primary cause (e.g. natural, harvest related, road related, etc.) were was assigned.

Most of the sources within 150' of the riparian area overlapped with in-stream sources (all mass wasting sites) identified during the in-stream inventory of sediment sources. Sediment loading from these specific riparian area sources is accounted for in the In-stream Sediment Source Analysis (Appendix J).

The remaining sites identified via aerial assessment were located at mid and upper slope and were determined to be beyond the sediment contributing distance to the stream network. Therefore, sediment loads from these sources were not calculated.

F.6.2 In-stream Sediment Sources and Associated Riparian Vegetation

Detailed field sediment source surveys were completed on the main stem and primary tributaries. Results from the Coarse Screen Analysis indicated that sediment sources associated with roads, old logging units, bank erosion and natural sources such as debris slides and avalanche paths were the primary sources of sediment to the watershed.

F.6.2.1 Bank Erosion in Lower Watershed

Bank erosion was linked to apparent land management activities on or adjacent to the eroding bank in the lower watershed. As such, the field source assessments included inventorying and measuring the area of eroding surfaces (e.g. streambanks, terraces, moraines) contributing to the drainage network, and linking sources to one of several land use categories. A bank hazard erosion index (BEHI) rating was applied to each site based on several factors including the ratio of low bank height to bankfull stage, rooting depth ratio, bank angle, and percent surface protection (Rosgen, 1996). Bank erosion sources and eroding areas with the potential to contribute sediment to the stream network were quantified to generate a contributed load for each of the tributaries and main stem Grave Creek. Appendix J provides details and analysis results of the in-stream sediment source and associated riparian vegetation assessment.

F.6.2.2 Mass Wasting in the Middle and Upper Watershed

Mass wasting sites along the middle and upper main stem Grave Creek and several tributaries were identified and measured in the field. Two methods were used to model loading from these sites. First, surface erosion from mass wasting sites was evaluated using the WEPP model and treating the slope failure sites similar to road fill slopes. Second, erosion of sediment from the toe slopes of mass failures is activated by in-stream and/or out of bank flows. This erosion mechanism was evaluated with a modified BEHI approach.

F.6.2.3 Riparian Vegetation Assessment

Modified Daubenmeyer vegetation plot surveys were conducted at each in-stream sediment source assessment sites. At each sediment source identified, a percent cover class was assigned to each vegetation class. Vegetation classes included overstory, understory and groundcover. Percent cover classes included absent, sparse, moderate, heavy and very heavy. Table F.2 presents percent cover and vegetation class criteria. Associated land use, ownership, and sediment source dimensions and stability rating were also collected.

Table F-2: Riparian Vegetation Class Survey Criteria.

Vegetation Cover Density			Vegetation Cover Class	
Percent Cover Class	Percent Cover		Vegetation Class	Vegetation Class Criteria
Absent	0		Overstory	> 5 m high, large and small trees
Sparse	< 10		Understory	0.5 – 5 m high, shrubs, herbs, forbs
Moderate	10-40		Ground Cover	< 0.5 m shrubs, seedlings, herbs, forbs, grasses
Heavy	40-75			
Very heavy	> 75			

F.6.3 Road Sediment Source Modeling

The USFS conducted an analysis of sediment derived from forest roads using WEPP. The modeled delivery rates were extrapolated to all system roads in the watershed to estimate total sediment contribution from roads at the sub-watershed level. Appendix I provide details and analysis results of the road sediment source assessment.

F.7 Land Use Indicator Assessments

USFS TSMRS database records noting the activity year, type, and extent of harvest and road construction in the basin were queried and analyzed using GIS. Appendix A and B provide details and analysis results of the timber harvest and road building land use assessment.

Equivalent clearcut acres (ECA) and water yield and peak flow increase modeling results and analysis of vegetation removal in the rain-on-snow zone were evaluated to determine possible effects of land use activities on water yield. Appendix C provides details and analysis results of the water yield assessments.